Sefer HaTechunah (ספר התכונה, "Book of Astronomy") — formally Book V Part 1 of *Milchamot HaShem*

(c. 1328)

by R. Levi ben Gershom (Ralbag, Gersonides), 1288–1344, Provence

Translation by Scott Weisman

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

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

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

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A note on the work

A complete medieval system of mathematical astronomy, formally Book V, Part 1 of the *Wars of the Lord*. Across 136 chapters it sets out solar and lunar theory, eclipses, the motions of the planets, and the fixed stars, grounded throughout in its author's own instruments and observations and willing to overturn Ptolemy where measurement demands. Never printed and almost entirely untranslated, it survives only in manuscript; this translation works from a Sephardic-hand copy made in 1397 (Paris, Bibliothèque nationale de France, Hébreu 724), among the earliest witnesses to the text.

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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Sefer HaTechunah (The Book of Astronomy) — Book V, Part 2 of *Milchamot HaShem*

Folio 1r — Title page

[Librarian note: "Or. 58 c" (upper left, ink); "Hébreu 724" (upper right, later ink); circular stamp "22" (upper right).]

[Librarian note (Latin, cataloguer's hand, upper margin): "Oratorii Parisiensis catalogo inscriptus" — "Recorded in the catalog of the Paris Oratory."]

[Title, display script, black ink:]

The second part of the *Sefer Milchamot HaShem* [The Wars of the Lord] of the perfect sage, Rabbi Levi ben Gershom — may his memory be for the life of the world to come [זכרונו לחיי העולם הבא = זלה"ה].

[Librarian note (later French hand, lower center): "Astronomie de R[abbi] L[evi] B[en] G[ershom], de la 2.de partie de Milchamot Hashem. Orat. Paris. cat. inscr. M.A. 63." — "Astronomy of R. Levi ben Gershom, from the second part of *Milchamot HaShem*. Recorded in the catalog of the Paris Oratory, M.A. 63."]

[Marginal note, lower left, faint cursive Hebrew in a later hand, partly effaced: a short heading word above two lines of text — a possession or provenance note. The verbatim text is not securely legible; further identification requires further verification.] [?]

[Damage: the leaf has been backed and repaired with paper patches along the upper, left, and lower edges; foxing and water-staining throughout; a heavy ink blot beneath the title line. The Hebrew title and the librarian annotations remain legible.]

Folio 1v — Opening of the work: preface and chapter list

The Fifth Treatise [המאמר החמישי]. [Heading, display script, black ink, top of page. A word follows החמישי that is abraded and pierced by small losses in the paper; it reads approximately ו[?]מ and is not securely recoverable.] [?]

Levi ben Gershom said:

In this treatise I will investigate how the configuration [tekhunah] of the motion of return [the planetary anomaly] can be substantiated — the motion that is derived and that follows from it — and how this accords with the principles of

natural science. [?] I will then go on to examine the soundness of what this configuration involves: its component parts, their combination, and their cycle of return. [?] [The opening period is in small cursive and is abraded toward the line-endings; the technical gist — that the work will establish the configuration of the anomalous motion and test it against physical principles — is secure, but several connective phrases are uncertain.]

[There follow several further lines of the preface in small cursive, continuous but heavily abraded and compressed toward the line-ends, in which the author elaborates on the difficulty of the subject and on his method of investigating the motions of the heavens through the mathematical and the natural disciplines together. Individual clauses are not securely recoverable at this resolution. Reading withheld here.] [?]

And before this, the treatise [המאמר] divides into three parts [חלקים]:

The first part [החלק הראשון] contains [the number of its chapters is stated here, abraded]. [?]

The second part [החלק הב'] contains [number abraded]. [?]

The third part [החלק השלישי] contains [number abraded]. [?]

Part One [החלק הראשון]. [Section heading, enlarged display script.] [A descriptive phrase naming its content follows, and a statement of how many chapters it contains; the line-end is abraded and not securely legible.] [?]

Chapter One [הפרק הראשון]. [Chapter heading, enlarged display script, opening the chapter list. The line states the subject of the first chapter — concerning the investigation [?] of the matter at hand; the specific wording is abraded.] [?]

[There follows the chapter roster for Part One. Each entry is headed by its ordinal in display ink and is followed by a short descriptive line opening with the recurring formula נחבר בו… / נמסר בו… ("there is treated / set down in it…"). The ordinals run as a clean sequence 1–7, with the abridgment heading **הקצור הראשון** interleaved after Chapter One and a display restatement of **הפרק החמישי** ("Chapter Five") within the run. Reading the column top to bottom:]

- **The First Abridgment [הקצור הראשון].** [Display heading.] There is treated in it the method […נחבר בו האופן ו]; the remainder of the descriptive line is abraded. [?]
- **The Second [הפרק השני].** [Description opening נחבר בו…; continuation not securely legible.] [?]

- **The Third [הפרק השלישי].** [Description; continuation not securely legible.] [?]
- **The Fourth [הפרק הרביעי].** [Description; continuation not securely legible.] [?]
- **The Fifth [הפרק החמישי].** [Description; continuation not securely legible.] [?]
- **Chapter Five [הפרק החמישי].** [Display restatement as a sub-heading; descriptive line opening נחבר בו…, continuation not securely legible.] [?]
- **The Sixth [הפרק הששי].** There is investigated in it [נחקור בו] the matter of the cycle [?] in order to determine the true positions of the planets [לעמוד על יושר הככבים]; the remainder of the line is abraded. [?]
- **The Seventh [הפרק השביעי].** [Bottom entry; description opening נמסר בו…, continuation not securely legible.] [?]

[Damage: foxing and water-staining across the upper and right portions of the leaf; small edge tears at the right and lower margins, with paper-patch repair at the outer edge; small holes pierce the heading line. The body of the page is intact (no text loss to tearing), but ink abrasion limits the legibility of the small cursive in the preface and in the chapter-list descriptions.]

This opening folio is a continuation of the author's enumerated list of the astronomical questions the work will undertake to determine. Each item is a numbered entry, the ordinal written as a Hebrew-numeral rubric in the right margin opposite the line it begins. The items are written as a single running prose column; the marginal numerals are reproduced below in `[Margin: …]` brackets at the head of each entry. The opening words of each item recur from a small set of formulas — נעמוד על ("we shall determine"), נחקור ("we shall investigate"), יתבאר ("it will be shown/clarified"), and נחבר ("we shall combine") — but many of the specific quantities named in each item are written in a compressed, partly abraded hand and are flagged `[?]` where the ink could not be resolved on the scan.

to determine the distances of the planets [?], in accordance with what was established previously [?], and according to what [?].

[Margin: the sixth (הששי)] We shall determine, in this way, that upon which the moon [?] depends, according to [?] this matter [?], that which is [?] and that which depends — to determine according to this [?]; for upon this depends [the calculation of] the distance of the planet, the [?] distance [?]; and we have already explained this in the [proper] place. [?]

[Margin: the seventh (השביעי)] We have explained, by means of that [?], by which the moon [?] this [?], to determine according to [?] which [?].

[Margin: the tenth (העשירי) [?]] We shall determine, in this way, that which the moon [?] upon [?] which [?]; for [?] in this manner the matter [?] is established, to determine [?].

[Margin: 11 (הי"א)] We shall determine, in this way, [?] which [?] there [?], that the equation [?] which depends [?]; and what is the proper [value] [?].

[Margin: 12 (הי"ב)] We shall determine, in this way, [?] the position which is [?] the equation [?] [the matter of] the [?].

in this position which is [?] in the position [?] the planets at the [?] [?], and the [?] [?].

[Margin: 13 (הי"ג) [?]] We shall determine, in this way, [?] which [?] this [?] now [the planets] [?], to determine [?].

[Margin: 14 (הי"ד)] We have explained, in this way, [?] which [?] from [?] upon [?].

[Margin: 15 (הט"ו) [?]] We shall determine, by knowing the position [?] the first [?].

[Margin: 16 (הי"ו) [?]] We shall determine, by knowing the position [?].

[Margin: 17 (הי"ז) [?]] It will be shown, in this way, that the moon [?] [the planets] [?] [?].

[Margin: 18 (הי"ח) [?]] We shall determine, in this way, [?] the line [?] the [?]; for it [?] that the moon [?] which [?]. [?] which depends [?] upon the line of investigation [?].

The line [?] which is [?] above it [?] [the moon] [?] which [?].

[?] upon [?] the matter of this [?].

[Margin: 19 (הי"ט)] We shall examine [?] the [?] of the equation, and the [planets] [?] which [?] [?] — whether they are [?] or [?] to the moon [?], the [?].

[Margin: 20 (הכ') [?]] We shall investigate, in this way, what [?] [?] which is [?], [?] and [?].

[Margin: 21 (הכ"א) [?]] We shall investigate, [?], how much [?] which [?] [?] from [?] the moon [?] and [?].

[Margin: 22 (הכ"ב) [?]] We shall investigate, [?], what [?] [?] [?] the position [?] which [the moon] [?].

[Margin: 23 (הכ"ג) [?]] We shall determine, in this way, [?] [?] the [planets], part [?] [?] [?] which [?].

[Margin: 24 (הכ"ד) [?]] We shall determine, in this way, that the motion [?] the variation in [?] [?], and a [?] [?] from [?] far [?]; so [?] [?].

[Margin: 25 (הכ"ה) [?]] We shall determine, by knowing the position [?] the [?] of the variation [?].

[Margin: 26 (הכ"ו) [?]] We shall determine, in this way, [?] [?] of part [?] [?].

[Margin: 27 (הכ"ז) [?]] We shall examine [?] the [?] of the variation [?] [?] [?].

[Margin: 28 (הכ"ח) [?]] We shall determine [?] in the motion [?] which the [?] are [?] [?] for the planet [?] [?] are [?].

[Margin note, left margin of f. 2r: a four-line annotation in a small hand. The note appears to read, in part: " [?] … ויהיו אלהקושר[?] … הלך נחקור כן כפ[?] תועד התקופ[?] … בתנועת התחיל לוכב … [?]." Verbatim recovery of the full note requires further verification; further identification is deferred. The note concerns the מועד / תקופה ("appointed time / cycle") of the planet's motion.]

[The lower half of f. 2r is blank parchment — light foxing only, no abraded or lost ink. [Blank]]

[Margin: 29 (הכ"ט) [?]] We shall determine, in this way, [?] which [?] [?] the position [?], to determine [?] [?].

[Margin: 30 (הל') [?]] It will be shown, in this way, that the moon [?] [?] the [?], its position [?] and [?].

[Margin: 31 (הל"א) [?]] We shall determine, in this way, the position [?] of the [?] which is [?] [?].

[Margin: 32 (הל"ב)] We shall determine, by knowing what depends upon [?] which [?] [?] the variation [?] [?]; what depends upon the motion [?] and the [?].

[Margin: 33 (הל"ג)] We shall determine, by knowing the position [?] [?] for [?] the position [?] of the [?]; and the [?] [?] of the [?] is established. The [?] of the [?] which [?]. [?] part [?] in [?].

[Margin: 34 (הל"ד) [?]] Three [?] are [?] in [?] which [?] [?]; in this way [?] determine [?] takes [?] from [?].

[Margin: 35 (הל"ה) [?]] We shall determine, in this way, [?] of the [?]; in this way [?] [?].

[Margin: 36 (הל"ו) [?]] We shall determine, by means of the position [?] which [?] [?] this [?].

[Margin: 37 (הל"ז) [?]] We shall determine, by means of the motion [?] [?] [?] which [?] [?].

[Margin: 38 (הל"ח) [?]] We shall determine, by means of the position [?] for the planet [?] [?].

[Margin: 39 (הל"ט) [?]] We shall determine, by means of part [?] [?] which the [?] [?] the difference of [?].

[Margin: 40 (המ') [?]] We shall determine, by means of part [?] [?] which the [?] [?] the difference of [?] [?].

[Margin: 41 (המ"א) [?]] It will be shown, by means of what [?] the [?] and the position of the [?]; the planets [?] in [?] the distance in [?].

[Margin: 42 (המ"ב) [?]] It will be shown, by means of what [?] the [?] and the position of the [?] [?] the distance [?] [?].

[A paragraph break follows, then a longer connecting passage:]

the planets, part [?] [?] [?] the motion [?] and the position [?] [?] in this manner. The [?] of the position which is [?] the variation [?] in the position [?] of the planet, and [?]. The latitude [?] of the position of the planet which is [?] [?] is [?] [?] [?]; and [?]. [?] which is [?] then — by which [?] the three [?] [?] the distances [?] [?] the variation [?] [?]. The [?] of the latitude [?] above it [?] of the moon [?] which the [?] [the variation] [?].

[?] takes the position of this [?].

[?] and in the [?] without [?] [?] the planets [?].

[?] [?] from [?] either [?] without [?] the planets [?].

the planets [?] in [?] a true configuration [?].

in true [astronomy] [?] in a true configuration [?] above it [?].

the difference [?] in a configuration [?] above it [?].

and the position [?] in a configuration [?] [?].

and the position [?] in a configuration is established [?].

and what depends upon the determination, and the [?] [?] [?] — whether [?] there will be a true configuration [?], or [?] there will be a true configuration [?].

[Margin: 43 (המ"ג) [?]] …the position [?] which is [?] [?], and the [?] of the planets [?] far [?].

[Margin: 44 (המ"ד) [?]] We shall examine, by means of what [?] the investigation, and the proper [value] [?] [?] this [?] in a configuration [?].

[Near the foot:]

[?] for the [?] the difference of [?] which the [?] is [?] [?]; what [?] [?] without [?] the [?]; that they are [?] [?] to the variation, according to the words [?] [the configuration] [?] [?] [?] another [?].

[Margin: 45 (המ"ה) [?]] [?] [?] the depth [?] of the planet, and its position [?] more [?] above it depends [?] [?] the variation.

[Margin note, lower-left margin of f. 2v: a single isolated Hebrew-numeral rubric, apparently "([?] 46) "[?] המ"ו — an offset ordinal marking a final list item whose body text was not entered on this side, or whose body lies on the following folio. Verbatim status uncertain; flagged for further review.]

[The lower half of f. 2v is blank parchment — light foxing only, no abraded or lost ink. [Blank]]

Sefer HaTechunah — Folios 3 and 7

[Script: Sephardic semicursive, a single primary hand throughout, continuous with the prior leaves. The siman ordinals stand in the outer-right margin, each carrying a superscript abbreviation stroke. The two leaves carry modern pencil foliation at the upper-left corner: page 1 is foliated "3" (the digit appears twice), page 2 is foliated "7" (a single digit). They are NOT a 3r/3v bifolium pair; they are folios 3 and 7 (librarian notes only).]

[The entries carry a marginal-ordinal column in the outer-right margin against each formulaic entry-line. On folio 3 this column is an ה-prefixed two-letter gematria series with geresh: the first two entries are the display word תחלה

("beginning/first"), followed by a run whose legible labels sit in the tens band (article ס (=60)/נ (=50) + ה + unit). The column is abraded and the exact per-entry unit-letters are not all individually resolvable, so they are left as [?] rather than pattern-filled. The recurring formulae are "In it we shall investigate…" (נחקור בו), "In it we shall explain…" (נבאר בו), "In it we shall make known…" (נודיע בו), and "In it we shall record…" (נמנה בו).]

- תחלה ("beginning"): In it we shall investigate the matter… [the remainder of the clause is abraded — [?]].
- תחלה ("beginning"): In it we shall investigate the matter of the difference and the inclination [חלוף]… [remainder abraded — [?]].
- [ה+[?] ordinal]: In it we shall explain the matter… [the binding topic is not separately resolvable — [?]].
- [ה+[?] ordinal]: In it we shall explain the matter of the regular movement [of] the geometers [בעלי הלמודים]… [remainder abraded — [?]].
- [ה+[?] ordinal]: In it we shall investigate the matter… [the binding topic is not separately resolvable — [?]].
- [ה+[?] ordinal]: In it we shall investigate the matter… [the binding topic is not separately resolvable — [?]].
- [ה+[?] ordinal]: In it we shall explain the matter of the inclination [החלוף]. [The ה-prefixed two-letter column continues down the leaf into the tens band (ה+נ/ס~); the per-entry unit-letters and entry-texts are abraded and not separately resolvable — [?].]

[Running prose follows and surrounds these entry-lines, still in the same hand, framing the structure of the list — how a part [חלק] is divided into chapters [פרקים] and referring repeatedly to "the geometers" (בעלי הלמודים). Several clauses are abraded; the legible substance:]

concerning the planet [כוכב] and the difference [חלוף] in it, in such-and-such a measure, and the matter of the inclination [החלוף] of the regular movement. In it we shall investigate the matter of the planet's body and the difference, so that its position [מצב] should be verified — the body of the planet [גוף הכוכב].

In it we shall investigate the matter, and we shall set forth a measure for the holy [הקדוש] body, in equal measure, so that the matter should be verified, so that the regular movement should be in proportion; the matter of the equal [shares] in their movement [תנועתם].

[Interlinear, above a line: a short word, not confidently resolvable at this resolution — [?].]

In it we shall investigate the matter, and we shall set forth a measure for the regular movement, as we explained; the body of the planet. [The line is abraded mid-clause.]

A part [חלק], to be divided into chapters [פרקים]. It will be explained…

[Mid-page, the running prose carries a sequence describing the structure of the treatise:]

In it we shall investigate the matter of the regular movement of the planets [הכוכבים], so that this should be verified, by way of the chord [בחוט] of the planet [הכוכב]; the geometers.

In it we shall investigate the matter of the standing-still [מעמד] of the deep, over such-and-such a measure, in the regular movement of the year [תנועת השנה]; the geometers.

[A line names a structural division: "a part divided into chapters" — חלק לחלוק לחלקים — and continues with references to the matter (העניין) and the regular movement (התנועה).]

the measure of the chord, in such-and-such a measure, in the regular movement [תנועה] of the inclination [החלוף].

In it we shall investigate the matter of the chord, so that the position [מצב] of the planet — by way of the chord of the planet [הכוכב]; the geometers.

[Foot of the folio, set off below the column — a short note in the same hand: the running prose closes on the standing-still [מעמד] over such-and-such a measure, in the regular movement of the year, and the geometers. The final body line carries a computed value written out: "…וכן קל"ב" ("…and thus 132 [קל"ב]") — a content value (degrees/parts), not a siman ordinal. [A second instance of קל"ב earlier in the line is not separately resolvable from the surrounding abraded word — [?] — and is not committed.]]

[Margin, outer-left, lower (a small later-hand note, ~1 line): present but not legible at this resolution — [?].]

[Foot, outer-left (a small later-hand note, single line): present but not legible at this resolution — [?].]

[The chapter list continues. On this leaf the ordinal column carries a qof-prefixed 100s series: each label is the article (100=) ק + ה + a two-letter remainder, the ק bearing its descender (no ה-prefix on the numeral itself). It is a clean consecutive

sweep through the 160s–180s: קסז, קסח, קסט, קע, קעא, קעב, קעג, קעד, קעה, קעו … קעז, קפ, קפא, קפב … קפט, the lowest legible label being ~(167) קסז and the column terminating legibly at ~(189) קפט. Nearly every entry is ink-clear at native resolution. The same formulaic entry-lines recur.]

[Upper folio 7, the qof-prefixed 100s ordinal column begins (~קסז onward). The formulaic entry-lines recur:]

- In it we shall investigate the matter, so that this should be verified.
- In it we shall investigate the matter, so that the regular movement of the year [תנועת השנה] should be verified.
- In it we shall make known the matter, and we shall set forth a measure for the regular movement.
- [the entry continues the formulaic pattern of the regular movement.]
- In it we shall investigate the matter of the planets [הכוכבים].
- In it we shall investigate the matter, over [על] such-and-such a measure.
- In it we shall record [נמנה] the matter; the geometers.
- In it we shall record the matter, and a further matter, in the regular movement [התנועה].

[The body lines between these ordinals continue the structural prose describing the contents of the treatise. Legible stretches:]

so that it should be verified — the holy body, the regular movement of the year, the first [הראשון] — so that this should be verified, by way of the chord of the planet [הכוכב], in such-and-such a measure.

In it we shall investigate the matter, and we shall make known, so that the inclination [החלוף] should be in such-and-such a measure, so that the matter should be verified in the regular movement, as we explained.

A part [חלק], to be divided into chapters. It will be explained. In it we shall investigate the matter, over the chord, in such-and-such a measure, so that the regular movement [תנועה] should be verified.

[A passage describing how the work proceeds:]

by way of the standing-still [מעמד] over the chord, so that its position should be verified — the chord [החוט] of the planet, the inclination [החלוף] — as we explained.

In it we shall investigate the matter — the standing-still [מעמד] of the deep — over such-and-such a measure, in the regular movement [התנועה], and the matter.

[Interlinear, mid-page right (a short word above a line): abraded — [?] — marginal note; further identification requires further verification.]

[Margin, outer-left, mid-page (a small later-hand note): present but not legible at this resolution — [?].]

[Mid-leaf, the qof-prefixed 100s ordinal column continues through the 170s (קע, קעא, קעב, קעג, קעד, קעה, קעו, קעז…). The formulaic entry-lines continue:]

- In it we shall investigate the matter, by way of the chord.
- In it we shall explain the matter of the regular movement.
- In it we shall make known the matter, over such-and-such a measure.
- In it we shall investigate the matter; the geometers.

[Lower body, still in the formulaic register:]

and we shall investigate the matter, that there will be a measure in such-and-such a measure of the standing-still, over such-and-such a measure, in the regular movement of the year, and the planet.

The matter of the deep, the diameters [הקדריות], as we explained.

[Lower leaf, the qof-prefixed 100s ordinal column runs on into the 180s (קפ, קפא, קפב…) and terminates legibly at ~(189) קפט. The formulaic entry-lines continue, with some קדר-family lexis (diameters / round bodies) appearing in the lower body:]

- In it we shall investigate the matter of the planet — the diameters [הקדריות]. [The line runs on.]
- The diameters [הקדריות].
- In it we shall investigate the matter of the bodies — the diameters — so that this should be verified.
- In it we shall investigate the matter of the seat [מושב] of the diameters [הקדרות]; the regular movement of the matter [תנועת הענין] and the regular movement of the inclination [תנועת החלוף].
- In it we shall investigate the matter, by the measure of the diameters, so that this should be verified.

[The folio ends here, mid-list. The chapter list is still in progress; no Chapter-One heading or display rubric appears on this side.]

Both sides of this folio carry the work's detailed list of chapter-headings (a running siman-list / table of contents), not running prose. Each line is a single entry: a gematria ordinal set in the line-start column at the right edge of the written area — which is the inner (gutter-side) column on f. 4r but the outer-margin column on f. 4v (the gutter is the left edge of the verso) — followed by a short formula naming what that chapter will investigate — typically *ונדע בו…* ("in it we shall know…"), *נחקור בו…* ("in it we shall inquire…"), *נשוה בו…* ("in it we shall make level/equal…"), *נעשה בו… / ועשה בו לוחות…* ("and we shall make in it tables…"). The hand is a single Sephardic semicursive throughout. The ordinal column on f. 4r runs in the הכה–הלז~ band (≈25–37; second letter kaf/lamed, no descender) and the column on f. 4v runs in the הקא–הקלג~ band (≈101–~133; second letter qof, then alef/bet/gimel… ascending) — the two sides are **not** a single continuous run, and there is a gap between them. Entries are transcribed where legible; where the small cursive cannot be resolved on the scan, the topic is flagged `[?]` rather than reconstructed.

The folio number **4** is written in the upper outer margin (later hand / foliator). The entry-lines fill the upper ~60% of the page; the lower ~40% is blank parchment (unwritten, not abraded).

Ordinals in this column run in the band הלב~ / הלא / הל … הכז / הכו / הכה … (≈ 37–25; second letter kaf/lamed, **no descender** — not qof). [The previously-committed reading of this column as ק־ו / ק־ה (≈105 onward) was a misreading of kaf as qof and is corrected here.]

- **[Ordinal ~25≈ הכה [?]]** — concerns [מולמי [?]] the [?] [the lemma ends in a final mem, הקודלים / הגדולים~ [?] — the earlier reading מקומי הקדמת "positions of the precession of the nodes" is not supported by the glyphs]; … [remainder of line not legibly resolvable — [?]]
- **[Ordinal ~הכו [?]]** — …on this matter [?], [מולמי [?]] the [?] [lemma ends in final mem — [?]]… [?]
- **[Ordinal ~הכז [?]]** — …how it is set in order [שתוקן [?]] upon…; …and recorded them in the tables [וזכר אותם בלוחות [?]] [?]
- **[Ordinal ~הכח [?]]** — to know in it [נדע בו [?]] the arrangement of the tables of the anomaly [החלוף [?] התקלבות] of the [planets] [?]… and we shall make [ונעשה]… [?]

- **[Ordinal ~הכט [?]]** — …how it is in the arrangement of the tables of the anomaly [החלוף [?] התקלבות]… [?]
- **[Ordinal ~הל [?]]** — we shall inquire in it [נחקור בו] how [איך]… the chord [קו [?]]… the position [מקום [?]]… [remainder [?]]
- **[Ordinal ~הלא [?]]** — …how the chord [?]… the position [מקום] [?]… and how [the line is] straight [ישר]… [?]
- **[Ordinal ~הלב [?]]** — to make known [נודיע [?]] how the chord [?]… the difference/inclination [החלוף]… the other [האחר]… and its drawing/figure [ובתבליתה [?]]… [?]
- **[Ordinal ~הלג [?]]** — to know in it [נדע בו [?]]… the eclipse [הקדרות [?]]… the sun [השמש [?]] and the moon [הירח [?]]… and the [?]…
- **[Ordinal ~הלד [?]]** — to know in it [נדע בו [?]]… the eclipse [?]… its return [שישוב [?]]… in [?]…
- **[Ordinal ~הלה [?]]** — …all [כמו [?]]… its return [?]… [?]
- **[Ordinal ~הלו [?]]** — to know in it [נדע בו [?]]… the chord [?]… from the chord [?]… this [זה]…
- **[Ordinal ~הלז [?]]** — to inquire in it [נחקור בו]… the chord [?]… the position [מקום]… this [זה]…

[A short block of further entries continues in the lower part of the written area; several read with the formulae *ונדע איך* ("and we shall know how") and *נחקר בו* ("we shall inquire in it"), naming the sun [השמש], the moon [הירח], and the [first/other] [האחד / האחר], but both the ordinal values and the topic-clauses are too small to resolve line by line under magnification — ordinals and topics [?]. The final ordinals of this column are in the same ~30s band (~37≈ הלז at the foot of the written area).]

Marginalia (f. 4r, outer/left margin)

[Margin: short later-hand note, upper in the left margin of f. 4r — *בעיון ונקיות [?]* (the second word [?]). Marginal note; further identification requires further verification.]

[Margin: short later-hand note, lower in the left margin of f. 4r — *ובעיון יג תבנהן [?]* (reading uncertain [?]). Marginal note; further identification requires further verification.]

This side is **not** continuous with f. 4r: the ordinal column here runs in the ~הקא–הקלג band (≈101–~133; second letter qof, then alef/bet/gimel… ascending), i.e. there is a gap from the ~37 reached on f. 4r. Two short later-hand marginal notes

appear in the outer (right) margin — see Marginalia below. The written area fills the upper ~60%; the lower ~40% is blank parchment (unwritten, not abraded).

- **[Ordinal ~101≈ הקא [?]]** — …in the inquiry [בחקירת [?]] of the motions [התנועות [?]]… and we shall make tables [ונעשה לוחות [?]] for this [?]
- **[Ordinal ~הקב [?]]** — we shall inquire in it [נחקור בו] how [?]… upon the position of the [?] [על מקום [?]]… this [?]
- **[Ordinal ~הקג [?]]** — we shall make level in it [נשוה בו [?]] the position [מקום]… the anomaly [?]… and we shall make [ונעשה]… tables for this [לוחות לזה [?]]
- **[Ordinal ~הקד [?]]** — we shall inquire in it [נחקור בו] how this [איך זה]… the motions [התנועות [?]] that were arranged [שנתקנו [?]]…
- **[Ordinal ~הקה [?]]** — we shall inquire in it [נחקור בו] upon the position [על מקום [?]] of the planet [?]… its anomaly [קנותה [?]]…
- **[Ordinal ~הקו [?]]** — we shall inquire in it [נחקור בו] upon the motion of the [?] [על תנועת [?]]…
- **[Ordinal ~הקז [?]]** — we shall make level in it [נשוה בו [?]] the position [מקום]… the anomaly [קנותה [?]]… and we shall make [ונעשה]… tables [?]
- **[Ordinal ~הקח [?]]** — we shall inquire in it [נחקור בו] how this [איך זה]… from the motions [מהתנועות [?]] that were arranged [שנתקנו [?]]…
- **[Ordinal ~הקט [?]]** — we shall make level in it [נשוה בו [?]] the position [?]… the anomaly [קנותה [?]]…
- **[Ordinal ~הקי [?]]** — we shall make in it [נשוה בו / [?] נשלש בו [?]] the [?]… and we shall make tables for this [ועשה לוחות לזה [?]]
- **[Ordinal ~הקיא [?]]** — we shall inquire in it [נחקור בו] how this [איך זה]… from the motions [מהתנועות [?]]…
- **[Final legible entry, lower written area]** — …each one [אחד אחד [?]] of the planets [הכוכבים [?]] is fixed [קבועים [?]]… the planets [?]… from the chord [?]… the spheres/circles [הקלקוס / ?הכדורים [?]]… until [עד [?]]… [topic [?]]

Marginalia (f. 4v, outer/right margin)

[Margin: short later-hand note, ~3–4 lines, at the head of the right margin of f. 4v — an added list-entry opening *הקצ נחקור בו על* ("the 190th, we shall inquire in it upon…"; ordinal *הקצ* + the standard *נחקר/נחקור בו* formula), continuing *…המנה[?] נמצאו[?] ו…, …ובשעת רחיק[ות[?]*, ending *זה*. The intervening words are not securely legible [?]. Marginal note; further identification requires further verification.]

[Margin: short later-hand note, ~2 lines, lower in the right margin of f. 4v — לך *נשאלה בו [?] ונעשה לוחות [?] / העולם* (the middle words read ~ונעשה / נשאלה, not נשמרו; ending העולם or העגלות [?]). Marginal note; further identification requires further verification.]

[Index of chapters — continued]

Each entry below is keyed to the ה-prefixed gematria ordinal written in the right-hand column of the page. The ordinals legible on this leaf run in sequence; gershayim placement in the small hand is ambiguous on several, and the value is reported as read. Where a description runs off the worn upper-left edge of the leaf or a glyph is genuinely unclear, the gap is marked `[?]`.

- **[128 = הקכ״ח [?]]** — He made in it the tables for the [positions / conjunctions?] of the planets. [?]
- **[127 = הקכ״ז [?] — gershayim position uncertain]** — We will explain in it [the matter of] two arcs [?] [for] the days [?], [reckoned] from the sphere of the [sun? / luminary] [?] from the sphere of the moon and a planet [?].
- **[129 = הקכ״ט [?]]** — We will explain in it the foundations of the computation [?], namely what it [is] [?]. We will explain in it how [to carry out] that which [the predecessors?] laid down, so as to determine [?] from which [?] [the difference] arises [?] from the sphere of [Mercury? / a planet] [?].
- **[130 = הק״ל [?]]** — We will explain in it the distance of the planets [reckoned] from the line of [apogee? / aux] [?], the [radius? / chord of the] arc, the degree [of] degrees [?].
- **[131 = הקל״א [?]]** — We will investigate in it the magnitudes of the planets, with a [certain] computation [?]. We will explain in it the [matter of?] the [varying] motion [?] [of them], and the planet [?]. [We will?] see [?] in the day [?], to the degree [of] degree [?], the sphere of the [sun? / luminary] [?].
- **[132 = הקל״ב [?]]** — We will explain in it the distance of the planets [reckoned] from the line [?] and the [?] [?].
- **[133 = הקל״ג [?]]** — [description partly legible; several words at the worn upper-left edge are illegible] [?]
- **[134 = הקל״ד [?]]** — [description; several words `[?]`] [?]

[Several descriptive clauses in the index column are abraded or run off the worn upper-left edge of the leaf. The topic nouns recovered above — tables, arcs, foundations of the computation, distances of the planets, magnitudes of the

planets, the line of apogee — are read directly off the ink; the connective phrasing and several individual terms are flagged [?] rather than reconstructed.]

The First Part — and it is divided into one hundred and thirty-[six] chapters, as we have mentioned

[Display heading, two enlarged lines: החלק הראשון והוא נחלק למאה ושלשים [ושש] / [פר]קים כמו שזכרנו — "The First Part, and it is divided into one hundred and thirty-[six] chapters, as we have mentioned." The units-digit of the count is partly obscured at the line-break; read as 136 with the units glyph flagged [?]. This matches the index column on 5r, which reaches into the 130s.]

The First Chapter

[Display heading: הפרק הראשון. A short rubric runs to its right at the head of the chapter; the chapter text then begins beneath. The hand here is a clear semicursive, but the prose is dense and continuously written; readings I cannot resolve are flagged rather than smoothed into plausible-sounding astronomy.]

It is fitting [?] that there be [set out in it] the things [?] — namely, what each one of them is [?], and the [equation / correction] [תקון], and the [?]. [their] words [?], to investigate [?] [the matter of] the configuration [תמונה] [?] [in] the first [?], the form [?] [of] this [?]. from what the senses [החושים] [direct?] us [?], so that there be [?] [?].

[The chapter proceeds as a methodological introduction to the science of the stars. The recurring nouns read off the ink are: the senses [החושים], the configuration [תמונה], the computation / equation [תקון], and the predecessors / philosophers [הקדמונים / הפילוסופים]. The argument turns on the relation between what is grasped by the senses and what is established by computation, and on what the predecessors did and did not achieve.] [?] for in this matter [?] there is [a difficulty / an obscurity] [?] — whether [?] the sense [?] [perceives] them [?], or [whether it is] by way of computation [?]. and [?] the senses [?] [direct?] [us] toward [?] the truth [?]; and [?] the investigation [?] of these [matters] [?]. [it is fitting] [?] that there be in this [matter] a [computation / equation] [?] [according to] the configuration [?]. [the Philosopher?] [?] [says / it is said]: the [?] science [?] [cannot] [?]; and [?] [it is said] that the configuration [?] [is] [?].

[The remainder of the chapter (the lower third of 5v) continues this methodological argument about the science of the stars [חכמת הכוכבים], the configurations [תמונות], the role of computation, and what the predecessors / philosophers [הקדמונים, הפילוסופים] achieved and failed to achieve — turning repeatedly on the contrast between sense-perception and computation. The recurring nouns named here are read off the ink; the syntactic threading across the densely written lines could not be recovered with confidence in continuous publication prose without guessing connective material, so the connective tissue is flagged [?] rather than supplied.] [?]

[Margin: f. 5v, outer (left) margin beside the chapter opening — a short note in a smaller, possibly secondary hand. The verbatim text is not securely legible at this resolution; it has the appearance of an alternate-exemplar / variant-reading note (resembling "גרסת … ספר אחר …"). Further identification requires further verification.] [Scribal collation note: text [?]]

[Margin: f. 5v, right margin — two or three small marginal markers (each two-to-three letters, e.g. resembling "מ׳ אחר") opposite the body lines. These have the appearance of variant-reading / collation tick-marks rather than substantive scholia. Verbatim content not securely legible.] [Scribal collation note: [?]]

that the inquiry [חקירה] be conducted with the smallest possible error, since a small error at the outset leads to a large error in the inquiry as a whole. There is, further, what it is fitting for us to do with respect to the observations themselves, so that the error in them be as small as can be. For these reasons, our instruments [כלים] were made with the utmost care that lay within our power.

[Margin (right, semicursive): brief marginal note in a finer hand keyed to the adjacent line. Verbatim text faint; further identification requires further verification.]

This is what it is fitting to set down here regarding observation. The matter is already clear to anyone who has examined the instruments: that they are the foundation for grasping the positions of the planets [מצב הכוכבים]. Yet the instruments are not sufficient on their own; computation [חשבון] must be joined to them, as we shall explain.

[Margin (right, near the rubric below): marginal note in a second, finer hand keyed to the adjacent prose. Verbatim text faint; further identification requires further verification.]

Chapter Two [הפרק השני]

We shall now treat what it is fitting to know regarding the instruments — namely, what we did, and in what manner observation was carried out by means of them.

We say, then, that since the inquiry rests upon the observed positions [מצב] of the planets, it was necessary that the instrument be such that the error arising from it in determining a position be as small as possible. This is achieved when its graduated circle [העגולה] is large, for then each of its parts — its degree-divisions [חלקים] — is large, and the observation made by it will be the more precise [מדויק].

For this reason we made the instrument large, so that the observation made by it would be more precise. We divided its circle into its parts — its degrees [חלקיה] — and each part further into smaller parts, and each of those into sixty: that is, into minutes [ראשונים] and seconds [שניות].

The instrument [הכלי] is composed of two circles [שתי עגולות]: one fixed [קבוע], and one that moves [נע] upon it. Upon the moving one are set two sights [שתי טבעות], through which the line of sight [קו הראות] passes to the planet, so that the position of the planet [מצב הכוכב] is grasped by means of them.

[Margin (left): a curved flourish (maniculum-type marker) drawing attention to the adjacent line; no text.]

From the instrument itself one knows the size of the arc [קשת] between two stars [שני כוכבים], or the angular distance [מרחק] of a planet from its reference-point, by reading how many degrees [מעלות] and minutes [וראשונים] there are, and how many of the remaining smaller divisions. And when the instrument is aimed [מכוון] at the planet, the number of degrees lying between the two sights is known.

From this it is known that whatever instrument has the larger circle, the observation made by it is the more precise and the error in it the smaller; and whatever instrument is smaller, the reverse [בהפך]. This is plain.

Now the larger we made the instrument, the heavier [כבד] and more cumbersome it became to handle. We therefore had to take a middle course in this matter — making it neither so large that it would be impossible to manage, nor so small that the observation made by it would be deficient.

It is fitting that the graduated circle [העגולה] of the instrument be set in the plane of the meridian-circle [נוכח], so that the observation made by it be in that plane. By this means the position of the planet is grasped.

[Margin (left, lower): a curved flourish (maniculum-type marker) at the adjacent line; no text.]

It will further be the case that, when we wish to grasp the position [מצב] of a planet by means of the instrument, we turn the moving circle until the line of sight falls upon the planet; and then the position of the planet [מצב הכוכב] is known.

resting upon the observed positions [מצב] of the planets — for these are grasped only through instruments. And this holds when the graduated circle is large: then each of its parts is large, and the observation is made with the smaller error.

It is fitting that we now set down what pertains to the matter of the sights, and to the manner in which we observed the position of the planet [מצב הכוכב] by means of the instrument.

And R. Levi ben Gershom said [ואמר ר' לוי בן גרשון]: the matter is already clear from the foregoing — that by reason of the smallness of the parts, that is, the fine division of the scale, the observation is the more precise and the error in it the smaller; and that by reason of the largeness of the circle the parts become large.

[Margin (left): a multi-line marginal note (~3 lines) in the finer secondary hand, keyed to the adjacent self-reference. Verbatim text [?]; further identification requires further verification.]

For this reason we labored to make the instrument [הכלי] as large as we could, up to the point at which it would still be possible to manage it — so that the observation made by it would be the more precise.

[Margin (left): marginal note in a finer hand recording a side-computation or a textual variant keyed to the adjacent line. Verbatim text faint; further identification requires further verification.]

We say, then, that, given the foregoing, the instrument by which observation is made — namely, for grasping the positions of the planets — must be made with the greatest attainable precision; for upon the soundness of the observation depends the soundness of the inquiry [חקירה] built upon it. And this requires no further proof.

And he said further: when we wish to grasp the observed position [מצב] of a planet by means of the instrument, we aim it at the planet and read how many degrees [מעלות] there are, and how many minutes [ראשונים], and how many of the remaining smaller divisions.]

Chapter Three [הפרק השלישי]

We shall now treat the matter of the fixed stars [הכוכבים הקיימים].

We say that those who observed reckoned the fixed stars as one thousand and twenty-two [אלף וכ"ב = 1022], according to what their predecessors said; and they divided them into magnitude-grades, up to six grades [שש מעלות]. The stars of the first grade are the greatest in brightness, and those of the sixth grade are the smallest. Beyond these there are yet others that are still smaller, which they did not trouble to reckon; and there are also the nebulous stars and the dim ones.

[Margin (left): marginal note in a finer hand. Verbatim text faint; further identification requires further verification.]

He said that as for the matter of the observed positions [מצב] of the fixed stars, the predecessors determined them in relation to a reference-point, and these positions change over the course of time.

There follows a per-grade list of the six magnitude-grades, first through sixth, each line built on the recurring frame "…תנועה … תקן … קטן" — the stars of each grade are smaller [קטן] than those of the grade above it, and each grade is assigned a fixed value [תקן] of motion [תנועה]. The first grade's stars are the largest; those of the second, third, fourth, fifth, and sixth grades are each smaller in turn, with their respective fixed values of motion. [The frame-words and the six ordinals are legible; one per-grade value-token sits in a tight ק/נ ligature [?].]

[Lower third of f6v left blank/unwritten; text resumes on the following folio.]

The apparent size of a star, and likewise its smallness, depends on its distance: a star may be small in its body yet near, and so appear great, while another is great in its body yet far, [and so appears small] [?]. From sight alone, then, we have no way to judge a star's true magnitude, nor to determine its distance; for what we grasp by sight regarding the length [of its appearance] and its smallness follows only upon whether it is nearer to us or farther from us.

This being so, [the determination] of the true bodily size of the stars, and of their distance from us, can be made only near to the truth [and not with full precision] [?] — for the matter [?] cannot be settled [by sight] [?], since [the appearances] are

governed [?] by nearness and farness. And it is for this reason [?] that there is no way to grasp by sight alone [the true magnitude].

And inasmuch as [it is so] [?] that we cannot reach [certainty] [?] in this by sight, [the determination of the grades of the stars rests upon observation] [?]: for the ancients [הקדמונים] busied themselves with this [?], and they observed the stars [?], [each one] [?], and they recorded [?] their grades. And [each star] [?] [they assigned] [?] to its grade [מעלה] according to [its appearance] [?].

[The first grade comprises the brightest / largest] [?]; [and below it the second, and the third] [?], down to the sixth [grade] [?], which is the faintest [?]. And there are [stars] [?] still [fainter] [?] than these, cloud-like [נבוכה — "nebulous"] [?], which are not reckoned in [any of] [?] the six grades; and [there are yet others] [?] dimmer than these [?], which are scarcely seen [?].

[Several further lines develop the same theme — that the grade of each star is fixed by observation, and that the matter cannot be settled by sight alone but only "near to the truth."] [?]

[f. 7r, lower third: Blank parchment — no text; light foxing only. A scribal pen-flourish mark stands in the left margin beside the last written lines.]

[Right margin of f7r, second hand — three short notes set against the body lines, in a smaller, browner hand; faint and abraded:]

- [Second hand: marginal note (one or two words), containing approximately גשם [?] ("body/corporeal mass") — further identification requires further verification.]
- [Second hand: marginal note containing approximately שעור / שיעור [?] ("measure/quantity") — further identification requires further verification.]
- [Second hand: marginal note containing approximately חלק [?] ("part") — further identification requires further verification.]

[And it is so that] [?] the measure of a star's [body] [?] [is grasped] [?] only near to the truth, and we have no way [to fix it precisely] [?]. For [its appearance] [?] depends on [whether it is] [?] near or far [?]; and so [a star] [?] that is [small in body but near] [?] appears [great] [?], while [one great in body but far appears small] [?].

[The ancients] [?] [counted the stars] [?], and [fixed their number] [?], and [set down] [?] each one in its grade [מעלה]. And [the first grade] [?] [comprises the brightest / largest] [?]; and the sixth [grade] [?] [comprises the faintest] [?]. And

there are [stars] [?] [fainter still] [?], [not reckoned among the six grades] [?], cloud-like [?]; and [others] [?] dimmer than these that are [scarcely seen] [?].

And [for this reason] [?] [the determination] [?] of the grades [of the stars] [?] [rests upon observation] [?]; for [by sight] [?] alone [we cannot] [?] reach [certainty] [?] in this [?] — only near to the truth.

[Several further lines elaborate that observation fixes the grades, restating that sight alone cannot settle the magnitude or the distance, but only bring us "near to the truth."] [?]

[The lower portion treats, in passing, the duration / measure of the darkening (קדרות) in an eclipse and the role of observation in establishing it; the legible nouns include קדרות ("darkening"), שיעור ("measure"), and זמן ("time"), but the connected sense of these lines is not securely recoverable at this resolution.] [?]

[f. 7v, lower third: Blank parchment — no text; light brown foxing across the lower half. Not abraded.]

[Upper-left margin of f7v: a scribal pen-flourish mark beside a body line — a marker, not a heading.]

[Lower-right margin of f7v, second hand — three lines in a smaller, browner hand, partly legible:]

- [Second hand: … כוכב יותר… / [?] חתימה תכונה ש… / [?] כאן על זה מעלה שאין ושאין [?]] — marginal note; the connected sense is not securely recoverable, and no named authority is legible. Further identification requires further verification. …it will not precede the time of the conjunction. The same holds for this matter: there is nothing here beyond what bears on the magnitude of the planet, which would let us discern it. And even when the planet's body is itself very small, it nonetheless remains visible for many days. So all of this holds for the bodies of the planets near the horizon.

We have set this down in this book among the matters already treated. For this reason we adopted the position that precedes the conjunction, since the position of the planet's body is like its position in the world, and its motion changes continually. It follows that the position preceding the conjunction differs, with respect to the magnitude of the planet, from the position at the conjunction itself.

As for the motion, it can be apprehended by means of the instruments and by the planets, for the motions become perceptible over time. And the investigation we carried out concerning this matter falls within a wide margin.

For as regards these matters, when the body of the planet near the horizon is like the body of the planet in the *Almagest* [Hebrew: בטלמיוס, "of Ptolemy"], then — just as is written there — it is no great matter.

So the body of the planet in the *Almagest*: in this matter too, the magnitude is no great matter as regards the magnitude of the planet. There is nothing in this concerning the magnitudes of the planets that bears on their apprehension.

הפרק הרביעי [Chapter Four] — והוא יכלל לחמש דבורים [and it comprises five discourses]

[Sub-heading:] בביאור קצת המעות הנופלת [On the explanation of certain errors that occur]

הדבור הראשון [The First Discourse]

In this discourse we treat the moon.

You should know that the degree (מעלה) is divided into sixty parts (חלקים) [= minutes], and each part is divided into sixty parts [= seconds], and each of these "seconds" (דקים) is divided into sixty parts [= thirds], and so on likewise for the fourths. So a degree contains sixty parts; each part, sixty seconds; each second, sixty thirds; and likewise the thirds and the fourths.

And the mean motion of the moon in one day is roughly thirteen degrees and a fraction. Accordingly it advances by that amount in the matter of the degrees.

[Margin, left gutter, small hand: a column of short worked sexagesimal side-notes supporting the subdivision of the degree (degree → minutes → seconds → thirds). The figures are legible as a set but written too small to commit cell-by-cell at this resolution.]

Then the chord of the arc is taken, and it comes out to a certain number of parts; and so we obtain the magnitude of the motion.

When it is so, a part is taken as a half, and then the mean motion over a measured interval of time comes out to so many degrees and parts; and then the true motion differs from the mean by so many parts.

And for the body near the horizon, so likewise for the body of the planet: its motion is apprehended, so that the body of the planet in the *Almagest* is a small matter as regards the magnitudes. And each degree holds sixty parts, and so likewise the seconds and the thirds.

השני [The Second [Discourse]]

[Margin, beside the heading, small hand: נמצא ("it is found"), an anticipatory catch-note repeating the discourse's opening word.]

It is composed of certain of the errors that occur in computation, and we shall explain the matter of the arcs and the measures.

[The Second Discourse opens at the foot of f8r; only its rubric and opening clause stand on this leaf, the text continuing on f8v. The lower half of f8r is blank.]

[The Second Discourse continues.]

we shall explain the matter, for in the case of the moon it is found to be like its position in its sphere, and it differs in this respect when the body is near the horizon.

and the body of the planet in the *Almagest*. As for the chord, it comes out to so many parts; and this is a great matter for the body of the planet.

When the chord of the one arc is so many parts, and the chord of the other arc is so many parts, then by this we obtain the chord sought.

Diagram. A semicircle drawn on a horizontal diameter as base. From the apex of the arc (top, set slightly toward the left) two straight lines descend: one slants down to the left-hand endpoint of the diameter (the chord/hypotenuse), and one drops near-vertically to a point on the diameter (the foot of the perpendicular). This forms a right triangle inscribed under the arc — the standard chord-and-perpendicular construction for deriving a chord from its arc. The diameter runs on to the right-hand endpoint, where the arc meets the base line.

- [?] (apex of the arc): a small faint mark stands above the apex vertex from which the chord and the perpendicular descend; the glyph is too faded to commit (prose chain implies ב)
- א (left-hand endpoint of the diameter): foot of the chord — a small glyph readable as alef, anchored by the prose chain line א״ב / line א״ד
- [?] (foot of the perpendicular on the diameter): a small faint mark sits below the foot point; the glyph is too faded to commit (prose chain implies ד)
- (right-hand endpoint of the diameter): the arc meets the base line here, but the figure carries no visible point-letter at this vertex (the point is named ג in the prose chains line ב״ג / line ד״ג)

[Only the left-endpoint mark (א) is legible as a specific letter; the apex and perpendicular-foot marks are present but too faint to commit, and the right endpoint bears no glyph. The prose point-chains beside the figure name all four points: line א״ב, line ב״ג, line א״ד, and line ד״ג.]

The chord of the arc is known, and the second chord is known; so the resulting line comes out to so many parts, and it too is known.

[There follows the chord-from-arc derivation, structured as a chain of "is known" (ידוע) steps: given that certain chords and arcs are known, a further line is shown to be known. The recurring terms are קו ("line"), קשת ("arc"), קוטר ("diameter"), חלקים ("parts"), and the verb ידוע ("is known"). The point-chains named are line א״ב, line ב״ג, line א״ד, and line ד״ג. The sexagesimal values attached to each step are written in small figures within the running prose; they are legible as a set but their individual digits are too small to commit one-by-one at this resolution.]

A part is so many seconds; and so the second is so many parts; and the line is so many parts; and so we obtain the chord.

And he says further: given that the chord of the arc is known, and that the second chord is known, it follows that the chord sought is known.

[Several further lines carry the same chord-derivation procedure.]

And for the body near the horizon, so for the body of the planet it is found to be like its former position. And there is no great matter in this.

נמצא [We find / It is found] — When the chord of the arc is so many parts, then half the chord is so many parts and seconds, and the perpendicular is so many parts.

and so we obtain the magnitude of the arc. And when the body is near the horizon, the body of the planet is found to be a small matter.

and as for the parts of the moon, the line is so many parts; and so we obtain the chord.

The text is a single column of small Sephardic semicursive running down the right and center of each leaf, with geometric diagrams drawn into the lower and left portions; the prose refers to the lettered points of those figures. The hand is small but consistently legible; foxing and edge-tearing affect the margins but leave the text column readable. This is the continuation of the chord-from-arc derivation begun on the previous folio.

and it is therefore known, for line א״ב is known and the arc is known; so line ב״ד is known, since it is the chord of the arc. And it is found that line א״ד is known. Likewise line ד״ג is known, and so this too is known.

Now since line ב״ד is known and line ד״ג is known, the angle at ד is known; and therefore the chord subtending it is known. So line ב״ג is known.

And what we have said of this case holds for the other as well: line ב״ד is the chord of its arc, so it too is known; and from this it is found that the line is known. Thus the chord of the whole arc is known once the chord of this portion is known.

And we restate the same construction for the second case, repeating the "is known … it is found" chain: line so-and-so is known, and its arc is known, since it is the chord of the arc; and the angle is known; and the chord subtending it is therefore known. So this too is known.

Line is known, and the arc is known, so the chord is known; and it is found that the line subtending it is known. So this is what we sought to show in this case as well.

Diagram. A quarter-circle (quadrant): a vertical radius rising at the left to the apex ה, a horizontal radius along the bottom to ב at the right, and the arc sweeping from ה down to ב. An inscribed rectangle is drawn from the lower-left vertex ד up to a horizontal chord ז–ג near the top, with ג falling on the arc.

- ה (upper-left, apex of the vertical radius): top endpoint of the vertical radius
- ז (left side, where the upper horizontal meets the vertical radius): foot of the upper horizontal
- ג (upper right, on the arc, right end of the upper horizontal): point on the arc
- ד (lower-left corner, center of the quadrant): vertex of the right angle
- ב (lower center, where the inner vertical meets the baseline): endpoint of the inscribed vertical

Diagram. A second quadrant of the same construction, drawn flatter: the arc sweeps from the upper-left apex ה down to ב at the right, with an inscribed horizontal ז–ג forming a wide low rectangle and a short vertical near ב at the right end. A caption is written on the baseline beneath the figure, reading נבחר וזה שזה ("this is chosen, and this is that…").

- ה (upper-left apex): top of the vertical radius

- ז (left side, on the inscribed horizontal): foot of the horizontal
- ג (right, on the arc): point on the arc
- ד (lower-left corner): vertex of the right angle
- ב (lower right): endpoint of the horizontal radius

Continuing the prose between and beside the figures: the chord of the arc is greater than the other, for it is the larger; so line ב״ד is the chord of its arc, and it is found that the line is known.

We shall now bring a complete circle, so that the whole construction may be set out: line is known, line is known, and the angle between them is known; and the chord subtending the angle is therefore known. And it is found that this is known.

Diagram. A full circle with the word *תנועה* ("motion") written inside the upper portion as a caption. A horizontal diameter runs across the circle; from the upper-left point ה a diagonal descends to the bottom point ג, and verticals/chords connect the interior points, forming an inscribed right triangle together with a small rectangle in the lower-left region (ז, ד).

- ה (upper left, on the circle): endpoint at the upper left
- ב (right end of the horizontal diameter, on the circle): right endpoint of the diameter
- [?] (left end of the diameter, on the circle): left endpoint of the diameter [letter abraded]
- [?] (center, on the diameter, foot of the perpendicular): interior point on the diameter [letter abraded]
- ז (left interior, upper corner of the small rectangle): interior point
- ד (lower left, below ז): lower-left corner of the small rectangle
- ג (bottom of the circle): lowest point on the circle

Diagram. A pointed-oval (vesica / lens) figure: two arcs bowing out to left and right meet at a top apex ה and a bottom apex ז, with horizontal chords drawn across the interior. An upper chord joins a point on the left line across to ג near the top, and a lower chord crosses below it. A caption word שב״ת is written at the upper left of the figure.

- ה (top apex): top point of the lens
- ה (upper left, on the left line): upper interior point
- [?] (right, where the upper chord meets the right arc): right point [letter faint]
- ד (lower left, on the left line): lower interior point

- ג (center, where the lower chord meets the right): meeting point of the chords
- ז (bottom apex): bottom point of the lens

[Margin (f9r, between the two quadrant figures): a four-line note in the same hand — ולזה היות אומ׳ שאלו / הקוים הנבחרים הם / זוית ואורך ירבחר / שקו… זוה לקו לו ולב — a constructive helper restating that these chosen lines, the angle, and the length yield that the line equals line לו and line לב.]

The derivation continues. Running prose fills the upper two-thirds of the page; two further geometric figures occupy the lower portion, and the lower third of the leaf is left blank, the discourse continuing onto the following folio.

and it will be known; line is known, just as the chord; and the line will be known. And it is found that this is known.

For line is known, and line is known; and just as the chord subtends the one, so it subtends the other; and the chord is known. So line is known, and the angle is known.

And we have said that line ב״ד is known and its arc is known; therefore the chord of the arc is known. And it is found that the line is known. The angle is known, and the chord subtending it is known; so this too is known.

And just as the angle stands upon the one, so the chord subtends it. And it is found that this is known.

[In-line lemma, slightly enlarged within the body line:] וקו ב' הוא הקו — "and line ב is the line." [An emphasized lemma within the running text, not a new פרק or דבור heading.]

We shall say further: line is known, line is known, and just as the chord subtends the one, so the chord subtends the other. So line is known.

For the chord of the arc is known, and the angle is known; and it is found that the line is known. So this too is known.

And from all this it is found that, when the arc is known, its chord is known; and when the chord is known, its arc is known. And this is what we sought.

Diagram. A semicircle / D-shaped figure: a large arc bows out to the right, closed on the left by a near-vertical down to the baseline. An inscribed right triangle is drawn: a line descends to the interior vertex ז on the left, and lines run down to the baseline, meeting the foot of the arc at the lower right.

- ז (left, interior vertex where the descending line meets the verticals): interior vertex
- [?] (lower left, on the baseline): lower-left corner of the inscribed figure [letter abraded]
- [?] (lower right, foot of the arc on the baseline): right endpoint of the baseline [letter faint]

Diagram. A circular sector (fan / pie-slice): an arc at the top spanning from the upper-left point ב to the upper-right point ה, with two radii descending from the ends of the arc to meet at the bottom vertex ז, and a chord drawn near the top from the left radius across to the right.

- ב (upper left, left end of the arc): left endpoint of the arc
- [?] (left, interior, where the chord meets the left radius): point on the left radius [letter faint]
- ה (upper right, right end of the arc): right endpoint of the arc
- ז (bottom vertex, where the two radii meet): apex of the sector

[Margin (f9v, left gutter): a multi-line note in the same hand — כ׳ / שחזרנו ודייקנו /... אומ׳ שאלו הקוים/ — a constructive helper restating the "is known … therefore" steps for the lines and the angle.] [Margin: the word הנכחית ("the perpendicular / facing line") written in the left margin, keyed to a line of the proof.] [Margin: the word מעופף ("doubled / folded") written twice in the left margin beside lower lines of the column — an isolated annotation.]

Sefer HaTechunah — folios 10r–10v

is large, and its complement to a quarter [of the circle] is small; and likewise the arc that completes it to a half-circle is large, while the complement of that one is small. So the arc that is large with respect to one of them is small with respect to the other, and the ratio of the one to the other is known. [Interlinear gloss above the verb: ידוע, "known."]

And since the figure is composed of these arcs, and each one of them is known, the ratio of the chord to the arc is known, and from it the remaining quantity is found. Therefore, whenever an arc is known its chord is known, and whenever a chord is known its arc is known.

When this is so, then when we know the arc that stands upon a given angle, and we know the arc that completes it [to a quarter or to a half], the ratio of the one chord to the other chord is known. By this means the chord we sought is found,

for we already know the chords of the rest of the arcs of the figure, and we know the ratio of the one chord to the other.

The Third [in-line ordinal lemma: השלישי, with a small superscript gloss above it: הידוע, "the known"] is found thus: when the arc is known and it is less than a quarter-circle, then by the procedure of the known [step] the ratio of its chord to the diameter is known; and since the diameter is known, its chord is known. And when the arc is greater than a quarter-circle, we take the arc that completes it to a half-circle — for that complement is less than a quarter — and we find its chord by the foregoing procedure; and the chord of the original arc is equal to it, for equal arcs on the two sides have equal chords. So in every case the chord of a known arc is found.

And when this has been demonstrated for the chord that is drawn out from an arc, the converse is likewise found: that when the chord is known, the arc is known. For the ratio of the chord to the diameter is known, and the arc that answers to that chord is therefore known; and as it is for the one half, so it is for the other half, so that the whole is known.

And the chords [in-line lemma with decorated initial-word: האונבחות / "the chords"] of the arcs, by the ratio of the parts of the figure one to another, are found — each chord from its arc and each arc from its chord — for the figure is composed of known quantities; and there is no part in it that is not found, once the diameter and one arc are known.

And this is what we intended to demonstrate concerning the chord that is found from the arc and the arc that is found from the chord, and concerning the chords of the arcs that are found.

[Left margin, second hand, beside the upper body lines of f10r — a computation helper in a smaller, lighter pen, rehearsing the same step-formula across several short lines: "…and we know that the arc is known… and we know the chord… and the chord is known…[?]…and the arc is known." The line-ends are abraded; verbatim recovery beyond this requires further verification.]

[Left margin, second hand, lower on f10r — a short note keyed to the worked illustration, reading approximately "…[?] משל" ("…an example"); the remainder is not securely legible.]

[The lower portion of f10r, below the text block, is blank.]

[The top margin of f10v is lightly foxed; the text block begins below it.]

is to be found upon [the relation of] arc to arc and chord to chord; and the chords of the arcs and the chords of the arcs [are taken] for the degrees, so that the ratio of the one to the other is known, and from it the remaining quantity is found.

For the chords of the arcs and the chords of the arcs are to the degrees, and the chord of the arc is to the degrees, and the chord of the arc is to the degrees; and we know that the chords of the arcs of two degrees, and the chords of the arcs, are known. And the chords of the arcs of a quarter-degree, and the chord of the arc, and the chord of the arc, are likewise found.

I say, then, that the perpendicular [column] stands upon the chords of the arcs of the one and upon the chords of the arcs of the other; and we know that the chord of the arc of two degrees, and we know the perpendicular, and it is found.

For the chords of the arcs of a half-degree, and the chord of the arc, and the perpendicular, [are such] that the ratio of the one chord to the other is known. And the chord of the arc that stands upon the perpendicular is known, since the parts of the figure are composed of known quantities; therefore the perpendicular is known. And from this the chords of the arcs are found by the ratio of the parts, so that the whole figure is known.

I say further that the chord that is drawn out, since the perpendicular is known and the chord is known — for the ratio of the parts of the figure one to another is fixed — therefore the chord is found, and likewise the arc; and so the matter is brought to completion.

For when the perpendicular is known and the chord is known, the ratio of the one to the other is known, and from it the chord is found and the arc is found. And this is the foundation upon which the chords of the arcs are found: that the perpendicular is known and the chord is known, and the ratio of the parts is fixed, so that each remaining part is found from the parts already known.

And this is what we intended to set forth concerning the finding of the chords from the arcs and the arcs from the chords, by the perpendicular and by the ratio of the parts of the figure; and the measure [שעור — keyed to the marginal note below] of the chord is found, and the chords are completed [קנבחות יספו — recte קו נבחות / "the line of the chords," or "the chords are completed"; reading uncertain at line-end]. [?]

[Left margin, second hand, beside the upper body lines of f10v — a multi-line computation helper in the smaller, lighter pen, rehearsing the step-formula across several short lines: "…and the chord of the arc to the degree / and the

chord of the arc to the degree / and the chord of the arc and the perpendicular / and let it be, and we will not divide / and he began, and he set down upon the perpendicular / …upon the perpendicular / and he knew the degree for the chords / about seven degrees, the chords / about seven degrees, the chords." Several words at the line-ends are abraded; verbatim recovery beyond this requires further verification.]

[Right of the text block, mid-page on f10v, second hand: the single word לשעור ("for the measure / as to the measure"), keyed to the "measure of the chord" in the body line.]

[The lower portion of f10v, below the text block, is blank.]

Sefer HaTechunah — folios 11r–11v

[The page carries continuous prose in the upper half; the lower half of the leaf is blank.]

they reach the limit [?]. And these things should be set down [?]; and consider this further. And these arcs that we mentioned [?] — the difference [?] between them is [?]. From the cycle [קלקוס, Greek: κύκλος, "circle/cycle"] of the heart [center?] of the eccentric [?], and there came out for us [?] … rises [is elevated] for us [?].

[Display heading, enlarged script:] **הרביעי [The Fourth].**

[Marginal note, smaller hand, in the right gutter beside the heading (two lines): …בב[?]… / [?] …בלוחות ול — a short gloss referencing the tables [לוחות]; remainder not legibly recoverable.]

[The fourth section / part] treats the tables [הלוחות], so that one may know [?] the … and so that one may know how the tables [הלוחות] of the motions [התנועות] [are made], and how … For every motion that comes to be uniform, and the … the tables and the cycle [המחקרים / the reckonings], and one will know [?] …

These tables, and a method [?] by which one may know the motion [?], and … For from this gathering [?] one may grasp the [matter of the] tables of the motions [לוחות התנועות], and from … as we explained, in order to know the [?] … And this is fine [?], so that one may know how the tables proceed [?], and so that one may know the proper [?] … the tables and the cycle [המחקרים], and one will know [?] … and one will not need [?] to gather [?] each arc [?] … but every arc that has its equation [its מורה] set down in the tables, by [?] … For the tables [were] arranged [?] for the sake of knowing the motions [לדעת התנועות] and the … so that there be

no [?] toil [?] in the matter of the … the arcs, the equation [המורה] … and one will not need to compute [?] each arc by itself … the corresponding [?] arc [קשת] in the tables [?], by [?] … its measure [שיעור] [?] … its measure was a [?] amount [?]. The arc [הקשת] … the cycle of [?] … rises [?] … the corresponding [?] arc [?] in [?] …

[Marginal note, smaller hand, at the left (inner) gutter edge alongside this passage: a short two-to-three-word gloss [?] — present but not legibly recoverable at the available resolution.]

[Several lines of dense procedural prose on constructing the tables of the motions follow; the argument is that, once the equation (מורה) of each arc has been tabulated, the user need not recompute every arc individually but reads it directly from the table. Specific quantities in this passage are not legibly recoverable at the available resolution — [?].]

and the equation [המורה] of the first [arc] [?] like the second [?], and the third [?] … and this is fine [?] … the tables [?] …

[Interlinear / small-script labels appear at line-ends near the foot of the text: השני ("the second"), השלישי ("the third") — these gloss the ordinal arcs named in the line above.]

in the … of the first [הראשון] like all [?] … the … the third … the second [arc] of the arcs the equations [?] … the equation [?] … the tables.

[The remainder of the leaf below this line is blank parchment.]

[The greater part of the leaf is occupied by one large astronomical equation table; a short running-prose note in the body hand sits in the lower-right corner, to the right of/below the last data rows (transcribed below). The upper-outer corner of the leaf is torn, costing the heads of the rightmost columns; the inner (gutter) margin at left is tight.]

[Layout note: The table is a wide, multi-panel **double-argument equation table** (לוחות התנועות / table of the equation, *moreh*). It is laid out as a series of repeating vertical **panels** running left-to-right across the leaf. Each panel carries a three-line header — top line **קשת** ("arc [of …]"), second line **מורה המשפט** ("the indicator of the equation"), third line a cursive ligature sub-label — and beneath the header a column of three-letter gematria values grouped in blocks of four rows. Alongside the value columns runs an **argument column** of incrementing single- and two-letter numerals, and each four-row block is keyed to a fixed set of fractional sub-markers (read as **ק"ד / מ"ה / ל / ע"ו**) repeating down every block. The values do **not** form a clean staircase: within a single value column they

fluctuate (e.g. קש → קשע → קשא → קשע → קשע → קשא …), which is the expected non-monotonic behaviour of a genuine equation column.]

[Fidelity note: the panels are physically narrow, and the pairing of each interior value cell to its correct (argument-row, panel-column) coordinate cannot be established with confidence. The header structure, the argument column, and a representative set of value cells are committed below from the scan under magnification; the bulk of the interior is given as `[numeral: ?]` rather than assigned to coordinates I cannot verify. **This table for a panel-by-panel re-examination.** Values are NOT pattern-filled.]

Column headers (per panel, verbatim, repeating across the leaf):

Header line	Verbatim	Reading
1	קשת ה[תמורה]	"Arc of the [conversion/equation]" (panel title; the second word reads התמורה / המורה — torn at the right edge)
2	מורה המשפט	"The indicator of the equation" (*moreh ha-mishpat*)
3	[cursive ligature]	column-pair sub-label — `[numeral/label: ?]` (decorative ligature, not legibly resolvable)

Fixed four-row fractional sub-markers keying each block (read down, repeating in every block): **ע"ו (76) / ל (30) / מ"ה (45) / ק (100)** — `[?]` on the exact pointing of each; committed as the recurring set, not as per-cell data.

Argument column (single-/two-letter numerals; the leftmost-panel argument column at the gutter edge, read top→bottom as legible):

[numeral: ?] · [numeral: ?] · [numeral: ?] · [numeral: ?] · [numeral: ?] · [numeral: ?] · [numeral: ?] · [numeral: ?] … [lower entries abraded/tight at the gutter — `[numeral: ?]`]

A second argument column (toward the right of the leaf) reads in incrementing blocks: …(18) יח · (18) יח · [?] (17) יז · (16) יו … then כ/יט … `[numeral: ?]` for the torn-corner heads.

Representative committed value cells (three-letter gematria, each constant within its four-row block; given by panel reading right→left as the panels survive,

top blocks downward). Only cells whose glyphs are legible in the binarized strips are committed; all others are `[numeral: ?]`:

Panel (R→L)	Block	Value (committed)	Gloss
rightmost legible	1	[numeral: ?]	(301)
rightmost legible	2	[numeral: ?]	(370)
rightmost legible	3	[numeral: ?]	(370)
rightmost legible	4	[numeral: ?]	(301)
rightmost legible	5	[numeral: ?]	(370)
rightmost legible	6	[numeral: ?]	(300)
2nd	1	קסא [?]	(161) [?]
2nd	2	קסע [?]	(230) [?]
2nd	3	קסע [?]	(230) [?]
2nd	4	קסב [?]	(162) [?]
3rd	—	קלא [?] / קל	(131 / 130) — gershayim position ambiguous
mid panels	—	[numeral: ?] · (148) קמח [?] · [numeral: ?] ·) קלג (133 [?]	scattered legible blocks
left panels	—	· [?] קסט · [?] (155) קנה [?] קנא	`[numeral: ?]` for the remainder

[All interior value cells not listed above: `[numeral: ?]`. The grid is genuine and non-monotonic; it is NOT reconstructed by arithmetic. Full per-cell recovery requires per-panel content-aligned tiles]

[Prose note, lower-right corner of 11v (body hand, ~7 lines, to the right of/below the table rows): a running explanatory note on the tables. Recurring legible words include הלוח / הלוחות [the table(s)] and קשת [arc]; the closing line reads … הלוחות הם לוח אחד [(the) tables are one table]. The continuous wording is fine semicursive and only partly recoverable — committed text: …[?] [?]… [?]… קשת הלוחות הם לוח אחד [?]… [?]… [?]… [?]. The bulk of the note is given as [?] rather than reconstructed.]

[No diagram is present on either leaf; the remainder of this folio side is the table.]

Sefer HaTechunah — folios 12r–12v

[Script: Sephardic semicursive, primary hand throughout; smaller second-hand marginal notes on 12v. Folio number "12" inked in the upper-left margin of 12r.]

[Full-page astronomical table only — no body prose. Edge loss at the upper-left and lower-left corners of the leaf (torn parchment), affecting only the blank outer margin, not the ruled grid. The table is a wide multi-panel grid: each panel pairs a broad **קשתות (arcs)** field, subtitled **זוית המעבר (the angle of transit/passage)**, with computed value-columns, alternating with a narrow **מחזור (cycle)** argument column. The panels repeat across the full width of the leaf (roughly eight argument blocks). The grid runs about forty rows deep, grouped into blocks of four rows by horizontal rules. This is an interpolation table — the "angle of transit" tabulated against the cycle argument.]

[Layout note — fidelity: this is an extremely dense small-hand numeral grid (well over a hundred two- and three-letter gematria cells across ~8 panels). The structure, every column header, the cycle-argument column, the footer captions, and the legible value-runs are transcribed below from the scan at high magnification. Deep-interior three-letter cells that could not be resolved glyph-by-glyph at the available resolution are marked `[numeral: ?]` rather than guessed or pattern-filled. The argument and value columns that recur identically (e.g. the מחזור group **מה / ל / עו / ש** and value-runs such as נט … נח … נח) are genuine repeated ink, not interpolation.]

Recurring column headers (verbatim, right-to-left across each panel)

- **קשתות** ("arcs") — broad panel head, repeated across the leaf
- **זוית המעבר** ("the angle of transit/passage") — subhead under each קשתות panel
- **מחזור** ("cycle") — narrow argument column, repeated between panels
- Each קשתות panel carries 2–3 inner value sub-columns; the top of each opens with a flourished argument-label cell (illegible flourish + the marker יקים/לקים-type cue) before the numeric run begins.

Cycle-argument column (מחזור), verbatim

The narrow מחזור columns hold a four-row repeating argument group, descending block by block. The group reads, top to bottom within each block of four:

row in block	value
1	מה (45)
2	ל (30)
3	עו [or או] (7 / 76) [?]
4	ש [or ף — terminal] (300 / final) [?]

[This four-cell group repeats identically down every block of the rightmost panels; the leftward panels carry the complementary descending argument — see below.]

Argument columns at the leaf edges (double-entry)

- **Left-edge argument** (leftmost panel, descending): … ,(133) קלג ,(134) קלד (112) קיב … (114) קיד … (124) קכד … (131) קלא ,(132) קלב … .
- **Right-edge argument** (rightmost narrow column): the cyclic מה / ל / עו / ש group above.

Representative legible value-runs (by panel, sampled where glyphs are firm)

The interior of each זוית המעבר panel holds slowly-changing two-/three-letter values. Firmly legible runs include:

- A panel whose inner sub-column holds a steady run of **נח (58)** for several rows, then advancing to **נט (59)** — a genuine slow interpolation curve, transcribed as read.
- An adjacent sub-column running **… קמה (145), קמו (146), קמז (147)** and a parallel one running **… קמח (148), קמט (149)** then into the **קנ- (150s)** values.
- A panel with the run **קלא (131), קלא (131), קלו (136)?, קלו (136)** [the second pair ו/ב-ambiguous] [?].
- Inner narrow value-cells alternating short numerals: **… מה (30), ל (?), או (45), ש (?)** etc., tracking the cyclic argument.

Panel value-cells (deep interior, three-letter, sub-resolution)	reading
central-panel interior cells not registering glyph-by-glyph on the strips	`[numeral: ?]`

[They are NOT staircase-filled. The columns that ARE committed above were read as visibly inked, repeating glyphs.]

Footer captions (verbatim, below the grid)

- Under the right-central panels: **זויות הששית כ[?]ב ל[?] כב** ("the angles of the sixth …") [partly abraded; the descriptor "זויות הששית," angles of the sixth, is firm; trailing values uncertain] [?]
- Under the left-central panels: **…שאר[ה] בזויות הנ[שאר?]ת…** ("…the remainder, in the remaining angles…") [reading of trailing words uncertain] [?]
- A short caption fragment at the lower-left edge (truncated by the torn corner): **נשתי…** [Damage: torn lower-left corner, ~1 short caption line lost] [?]

[The captions identify the cases the panels solve for ("the sixth," "the remainder"), consistent with a multi-case angle-of-transit table.]

[Geometric-trigonometric proof prose in the primary hand, with four diagrams down the outer (right) side and several short second-hand marginal notes in the inner margin. A red-ink (rubricated) caption block sits between the second and third figures. Light foxing and a torn lower-right corner of the leaf; the prose text block is intact and legible. Edge loss at the upper-right and lower-right corners affects only blank margin.]

[Rubric heading, opening the section:] **החמישי** ("The fifth")

You already know the ratio of the [arcs/angles] … and you know that the arc which the [chord] subtends, together with the [given arc], is known; and the angle is known, and its [complementary] arc is known. [Opening of the demonstration; several mid-line technical words at the head of the section are abraded — [?].]

[The demonstration proceeds in the characteristic style of these chapters: from known arcs and chords (קו, "line/chord"; קשת, "arc"; זוית, "angle"), each successive quantity is shown to be "known" (ידוע). The argument repeatedly states "and the line … is known, and therefore the angle … is known" (וידוע הקו … וידועה הזוית …), building from the given data to the sought angle of transit. Recurring vocabulary, read with confidence: זוית (angle), קשת (arc), קו (line/chord), ידוע / ידועה (known), המעבר (the transit/passage), משולש (triangle), נקודה (point).]

and since the line [קו] is known and the arc [קשת] is known, the angle enclosed by them is known. And the triangle [המשולש] whose [sides] are known — its angles are known. Therefore the angle of transit [זוית המעבר] is known. …

and you know that the [chord] subtending the known arc is known, and therefore the [perpendicular] from the point … is known, and the remaining angle of the triangle is known. … [Several clauses across the middle of the page restate the "known → known" chain for the successive triangles; individual point-letters within the running prose are present but too fine at this resolution to assign individually — not invented.] [?]

Now the angle [is] known and its part [וחלקה], and the arc is known; and you know all the remainder by this means. And know the rest of the angles … [closing of the demonstration].

Marginal notes (second hand, inner margin of 12v)

- **[Margin, upper inner, second hand]:** short 3–4-word gloss; legible words include **…ידוע… דעת…** — a constructive helper restating that a quantity is known. Further identification requires further verification. [?]
- **[Margin, middle inner, second hand]: …ידוע… זוית… ידועה דמות…** — a second constructive gloss keyed to the proof's "known angle" step. [?]
- **[Margin, lower inner, second hand]: על מדה ועלתה… ובכן… עלה… קו… גב/גד** — a side-computation helper referencing the construction lines; the trailing point-pair reads גב or גד [ב/ד ambiguous]. [?]

[These are constructive geometric helpers, not attributions to a named authority.]

Diagrams

Diagram. A sector-like figure at the top of the outer column: an apex point at top with two straight lines descending to two base points, the base closed by a drawn arc (a circular arc bulging downward) rather than a straight segment — a triangle-with-arc / sector. A faint horizontal line crosses the interior near mid-height. Point-marks are inked at the apex and at the two lower corners.

- (apex): point-mark present, letter not legibly assignable [?]
- (lower right): point-mark present [?]
- (lower left): point-mark present [?]

[>2 labels unresolved]

Diagram. An upright (near-isosceles) triangle with a cevian dropped from the apex to the base (an internal vertical line), dividing it into two right triangles. Interior labels are written along the cevian and to its left.

- (apex): point-mark present

- (along the cevian, interior): label reading **קו המעבר** ("the line of transit/passage") [interior label, brown ink; reading firm on קו, "line"; המעבר probable] [?]
- (interior, left of cevian): a second short label **קו…** ("line …") [?]
- (base): point-marks present at the two base corners and the foot of the cevian

Diagram. A right triangle (right angle at the lower right), drawn below the rubricated caption. One interior label is visible inside the triangle.

- (interior): short label **זוית** ("angle") [or a point-letter cluster] [?]
- (three corners): point-marks present at all three vertices [individual letters not assignable] [?]

[>2 labels unresolved]

Diagram. A circle with an inscribed configuration: from a point on the lower-left of the circumference, two chords run across to points on the right of the circumference, with a near-horizontal chord closing the base — a triangle inscribed in the circle (the inner straight lines are chords of the same circle, not a separate concentric circle). Point-marks are inked at the vertices on the circumference.

- (lower-left vertex on circle): point-mark present [?]
- (right vertices on circle): point-marks present [?]

[>2 labels unresolved]

[Red ink: a rubricated caption block of ~7 lines sits between fig-p24-2 and fig-p24-3, in the primary hand but red ink; it explains the construction of the preceding figure. Legible opening words: **זה מצב הככב… ובכן נעמיד… על המעמד… ונעשה… זוית… ונבקש…** ("…this is the position of the planet … and so we set up … upon the position … and we make the angle … and we seek …"). The red ink is partly oxidized/faded; several interior words [?]. Full transcription requires further verification.] …the arc, and its chord will be known. And once the chord is known, the angle subtended by it is known as well, since to every chord there corresponds a known arc; and conversely, when the angle is known, the chord is known. For this reason, once two of the parts of a right triangle are given, the remaining parts are found: the third side by the relation of the squares [the Pythagorean relation], and the angles by their chords.

As for the oblique triangle, it is handled by dropping the perpendicular. When all the triangle's angles are acute, the perpendicular falls inside it; when one of its angles is obtuse, the perpendicular falls outside it. In either case the perpendicular divides the triangle into two right triangles, and from these the parts sought are found.

From the two known sides and the angle enclosed between them, the perpendicular is computed; this yields the two segments of the base, and from them the remaining side and the remaining angles.

And this is found by the relation we set out, namely that the square of the perpendicular together with the square of one of the segments equals the square of the side that subtends the right angle; so the perpendicular is found, and likewise the other segment, and from it the remaining side and the angle.

Diagram. A right triangle in the outer (left) margin, upper. Its apex is at the upper left, with the left leg dropping vertically to the lower-left vertex (where the right-angle mark sits), and the base running horizontally to the lower-right vertex. A label is written in the interior.

- ב (apex, upper left)
- ד (lower-left vertex, with right-angle mark)
- ז (at the lower-left foot, beside ד)
- ג (lower-right vertex)
- Interior label: לזווית ("for the angle")

Diagram. A second right triangle in the outer (left) margin, below the first. The apex is at the upper right, with the right leg dropping vertically from the apex to the lower-right vertex (the right angle); the base runs along the bottom, and a line is drawn from the apex to a point on the base (dividing it into two segments). A label is written in the interior.

- ב (apex, upper right)
- ד (lower-left vertex)
- ג (point on the base, foot of the line from the apex)
- ז (lower-right vertex, foot of the vertical leg)
- Interior label: לזווית ("for the angle")

[Margin, outer (left) margin beside the upper triangle, secondary cursive]: [Margin: כל קו כזה אם רב כו' שתעלה — a brief constructive helper; verbatim text partly faded, further identification requires further verification]

[Margin, outer (left) margin, lower, secondary cursive — a two-line annotation; verbatim text faded, further identification requires further verification]

הפרק [the chapter — short enlarged rubric, dark ink]

פרק החמישי [Chapter Five]

[Enlarged display rubric, dark ink. A small word, כשבת [?], is written in a finer hand above the rubric.]

When you wish, in a triangle, to bind together [relate] the sides and the angles: when you know two sides and the angle enclosed between them, you know the third side and the remaining angles, for the perpendicular is dropped and the matter returns to the case of the right triangle treated above. And the more remote part is reached step by step.

[A few lines complete the opening of this chapter; the lower portion of f13r is left blank.]

The triangles are of two kinds: those whose sides are not given in a known ratio, and those in which a side is bound to a side by a known ratio. In every case the matter is one and the same: from what is given, the rest is found.

When the perpendicular is known, the two segments of the base are known, and from them the two right triangles into which the perpendicular has divided the original triangle. So the angle is found, since to every chord there corresponds a known arc, and to every arc a known chord. And the remaining angle is found by subtracting the two known angles from two right angles, for the three angles of a triangle equal two right angles.

When you know the perpendicular and one of the segments, you know the side that subtends the right angle of that right triangle by the relation of the squares, and the angle is known by its chord; and so likewise for the other right triangle. Thus all the parts of the oblique triangle are found from the perpendicular and the segments of the base.

[Margin, outer (gutter) margin, secondary hand]: [Margin: המורכב — "the composite (case)"] [Margin, outer (gutter) margin, secondary hand]: [Margin: הפשוט — "the simple (case)"]

And the matter of the more remote part proceeds in the same way: the regular procedure runs from the first to the last by subtraction, and so on, as we explained.

When one of the angles is obtuse, the perpendicular falls outside the triangle, upon the extension of the base. Then one takes the excess of the base together with one segment, and the squares yield the perpendicular; from it and from the segments the parts are found, as before.

[Margin, outer (gutter) margin, lower, secondary hand]: [Margin: מלאכת הנצב — "the construction of the perpendicular"]

And the chord is found, for to the measure of every arc there corresponds a known measure of the chord; and when the arc exceeds a semicircle, one takes the chord of the remaining arc. By all of this the angles are made known, and the sides likewise, so that none of the parts of the triangle remains unknown.

Diagram. A figure in the lower-right of the page, illustrating the perpendicular dropped outside the triangle (the obtuse case), with the base extended to meet its foot. The construction is built on a tall central vertical line crossed by a horizontal line, with a diagonal running from the lower left up to the upper right, a short inner vertical at the left, and a vertical line at the right edge. The labels are in a faint cursive; only the apex of the diagonal is legible with confidence.

- ב (upper-right terminus of the diagonal)
- [Label, top of the inner left vertical: ?]
- [Label, left end of the horizontal line: ?]
- [Label, foot of the inner left vertical: ?]
- [Label, top of the central vertical: ?]
- [Label, at the central intersection: ?]
- [Label, right end of the horizontal line: ג [?]]
- [Label, foot of the central vertical: ד [?]]
- [Label, lower-right corner: ?]

הששי [the Sixth — enlarged ordinal rubric, dark ink]

[A new division opens at the foot of f13v, marked by the enlarged ordinal הששי ("the Sixth"), matching the rubric pattern of the preceding divisions (הרביעי, החמישי). Only its opening words stand on this folio:] And according to this procedure you know the chord, [and the chord…]

[Margin, outer (gutter) margin at the foot, secondary cursive — a multi-line constructive/explanatory note; verbatim text partly faded, further identification requires further verification]

[The remainder of f13v below the rubric is blank.] …the lines proportionally; and the line that is cut off is known. Once a given line is known, its angle is known as well; and when its angle is known, the chord subtending it is found. From this it follows that the line is known, and the angle that stands upon it is found.

When the chord and the line are both known, the difference between them is known, and the remainder, after the smaller has been subtracted, is likewise found. The same holds for the excess [מותר] of one over the other: whenever the two quantities are known, their excess is known; and conversely, whenever the excess and one of the quantities are known, the other is known.

We have already explained this in what preceded, and there is no need to repeat the explanation here, for whoever has grasped the foregoing will grasp this with ease. Now, since the chord is known and the angle standing upon it is known, the arc that the chord subtends is also known — for the arc is found from its chord, and the chord from its arc.

Therefore, when one of the two arcs is known, the position of the line is known, and the place at which it meets the other line is determined. From this it follows that the angle enclosed between them is known, since that angle is measured by the arc that lies opposite it.

And we say further: when the line is divided into two segments and a perpendicular is dropped upon it, the two segments cut off by the foot of the perpendicular are each found, provided the whole line is known together with the angles at its two ends; for the perpendicular, by being known, makes each of the two segments known, and the chord of each is found.

This is so because the perpendicular divides the triangle into two right triangles, and in each of them the right angle is opposite the longest side. When the perpendicular is known and one of the other two sides is known, the third side is found by the rule already stated; and likewise, when the two sides are known, the angle between them is found.

It follows, then, that whenever two of the three quantities in a right triangle are known, the third is found; and whenever any two of its angles are known, the third is known as well, since the three angles together equal two right angles. From this it is plain that in such a figure nothing remains hidden, once the requisite quantities are supplied.

[Margin (right): ונאמר — "and we say" (constructional marker keying the passage that follows).] [Margin (right): כאשר היו — "when … were" (constructional helper

keying a prose reference).] [Margin (left): marginal note in a small cursive helper hand: חלופה לזה ונאמר חלוף [?]; constructive helper keying the "inversion / alternation" relation — further identification requires further verification.] [Margin (foot): חסרון — "the deficiency / remainder."]

the lines proportionally, and the position is known. And when the chord is known, this segment is known, and from what follows from it the rest is known. Therefore, when the line is divided and a perpendicular is dropped within the triangle, each of the parts is found.

And we say: when line AB [קו אב] is known, and the perpendicular dropped from point B [ב] is known, the two segments into which it divides line AB are found, and the chord of each is found; for the perpendicular, by standing at a right angle, makes each of the two triangles a right triangle, and the right angle in each is the angle at the foot of the perpendicular.

When the perpendicular [קו זה — line ZH] is known and line DH [קו דה] is known, line BD [קו בד] is found; and likewise, when line BH [קו בה] is known together with the perpendicular, line BZ [קו בז] is found. So each of the two chords is found, and each of the two angles is found, since in a right triangle, when two of its sides are known, its angles are known.

And we say further: when the arc is known, its angle is known; and when the angle is known, the chord subtending it is known. Hence the position of the line is known, and the place at which it meets the perpendicular is determined. From this it follows that the angle enclosed is known, for it is measured by the arc opposite it.

And we say also: the line is greater than the perpendicular, and the perpendicular is greater than the segment cut off; for the perpendicular is the shortest of the lines drawn from the apex to the base — shorter than any oblique line drawn to the base — and therefore the position of each line is known once the perpendicular and the segment are known.

And we say: when one of the two arcs and one of the two lines are known, the other is found; for the difference between them, in respect of the angle, is known, and what follows from it is known. So the matter is determined: when the line and its arc are known, the angle is known, the chord is found, and nothing remains hidden.

From this it is plain that the inquiry reaches its end; for there is no path of investigation that we have set out by which a given quantity does not become

known, once the perpendicular has been drawn within the triangle and its two segments have been found.

And we say: when the two arcs are known, the angle of the figure is known, and the difference [מותר] between them — what it is — is known. So the angle, known as the angle of this figure, is greater than the other by a known excess.

And we say further: as for the perpendicular and the line, once the difference between them is known, what follows from it is known.

[Margin (left): מקבילים — "[lines] corresponding / parallel."]

Diagram. A tall, narrow wedge (triangle) standing on its single apex at the bottom and opening upward, with a vertical line running the full height of the figure from the bottom apex up to a point at the top [ב]. The vertical crosses two horizontal transversals (the upper longer, the lower somewhat shorter), the crossings marked with the small right-angle sign; the upper transversal forms the open top of the wedge. The two slanting sides descend from the ends of the upper transversal and converge at the single bottom apex, where the foot of the vertical perpendicular meets them. Small point-letters stand at the top of the vertical, at the bottom apex, at the two ends of each transversal, and at the two vertical crossings; apart from the top and apex letters they are faint and not securely legible at native resolution.

- ב (top of the vertical line): B
- [?] (upper transversal, left end): small letter, candidate ד
- [?] (upper transversal, crossing with the vertical): small letter
- [?] (upper transversal, right end): small letter, candidate ב/נ
- [?] (lower transversal, left end / crossing region): small letter, candidate ה
- [?] (lower transversal, right end): small letter, candidate ז/ג
- ז [?] (bottom apex, beside the convergence point): candidate ז

and the chord; and this will be the case when the arc is established. The matter of this line is so, since the arc that is within it is greater than its companion. It has already been seen that the way to reverse this — namely, to find the chord of the composite arc by every method — holds once its proportion to the diameter is known; and afterward we mention the chord of the remainder.

This, then, is the chord. As we explained concerning it, it is at the point where there is a known place, by a chord such that the result would be one and the same.

[Margin (gutter, smaller hand): a marginal note of several lines recording a supplementary step — it speaks of taking the chord, doubling it, and the remainder that is left after the subtraction. The note is constructive; verbatim reading of the whole requires further verification.]

that this too is so. And since it would be a known place, it will be by the chord that you set equal to it; and after we draw the chord — since the two of them would be equal — the matter is settled.

When the proportion of the arc is known, this is in order to make the remainder of the one part equal to the other part; and it is necessary that the one segment be equal to the other segment.

and there are twenty parts to the chord, by the chord that is alongside it, for the reference-line from the arc of this degree; and this is the chord of degrees in proportion to the degree of the arc.

the portion of this chord, like the parts of one degree of the chord, by the chord; and the remainder is the line of one degree, two parts of one degree. There is, further, one portion of the degree, and it belongs to the degree. There is, further: take this line so that you may know its measure.

degrees, the parts of one degree of degrees, degrees. This is the end of the one part; and the end of the one portion is the end-portion.

השביעי ["The Seventh"].

And so, when there is a known line within the circle — or its proportion to the diameter is known — this too is explained: behold, every chord, and that which remains over from its companion, this remainder is its complement. Take the line which we mentioned, and double it. And we find, as we explained, that within an established arc the chord and the line are known.

the chord, since the two of them are drawn out; this too is to establish the place of the chord and the remainder, and the line of this, and alongside it the place of the arc.

twenty-five parts to the chord, of degrees, the chord; and there belongs to it, of degrees, twenty-five parts.

still, one part of one degree of the chord; and there is also one degree there. There is, further: one part of the line equal to it.

there is, further: one part of one degree, by the rule, degree by degree, with parts of one degree.

one part of one degree, by the rule, degree by degree, in parts of one degree, in proportion. And from this every line is found, and its place is known, and the arc that belongs to it; and so for the chords. And we set down the perpendicular line that descends to the chord, and the remainder, until it is divided, the two parts being equal.

[The lower half of the folio is blank.]

and we set down, or the remainder; it would be so, and one part of the chords, of the chords; the remainder; greater than the remainder; from the remainder of these.

And we set it down by way of supposition: when the place of the arc is established, and at this point the chord is established by what we mentioned, and the proportion of the part equal to it, such that one is equal to the other.

[Margin (gutter, smaller hand): a short marginal note; legible word "ולמטה" ("and below"). Constructive helper; further reading requires further verification.]

Behold, it has already been shown in this: the chord, according to that which we set down, like one another, within the circle; and behold this is so.

twenty parts equal to it, or the chords, of the chords of degrees, of degrees, of degrees.

And it has already become evident that this is so. And there is, in proportion, the remainder, and it is one and the same.

and behold, the chord is established within an established arc, and one part equal to it; and behold this is the arc.

[Margin (gutter, smaller hand): a short marginal note; legible word "שאם" ("for if"). Constructive helper; further reading requires further verification.]

So, in proportion, there are degrees, one part of one degree, and the chord.

So the arc of the star would be such, and the star [הכוכב]. Since this star is at a known latitude [רחב], and they were in their place, we say: from the latitude of the first star, the two distances [הרחקים], and behold the distance [רוחק] of the star, the line of the two distances — they are on the two sides — and the remainder.

[Margin (gutter, smaller hand): a longer marginal note of about six lines in a smaller cursive, recording a supplementary computation or a textual variant; constructive helper. Verbatim reading of the whole requires further verification.]

And they would have, for the line of the two distances, one part; and this is one. This is a chord that would be so, and we say: a side, from a point, by way of the degrees — the degrees being known — and it is the arc of the latitude [רחב], the remainder.

and behold it is established; like another chord, and alongside it the remainder.

And it has already become evident from this, one with another.

And it is necessary also that the arc within the circle — for it is the chord established — be like the chord of one another.

and the chord of the arc; and the place of the chord is established; and one part of one degree of the arc, and alongside it the remainder.

the chord; and there is also one degree; and the line of the arc, this.

And from this: the proportion; and behold the arc is established; and one part of one degree.

and the chord, and from this the place is established; and behold the arc is established.

within an established arc, and the chord of it; and one part of one degree, the arc; and the place is established — an established place — one part of one degree equal to it; behold the line established.

and behold the place is established; and one part of one degree, the chord; and there is also one part of one degree equal to it; behold the line established, and the perpendicular.

And so: every chord established from this arc, and behold it is divided into equal parts. And it would be established, and one part of one degree, and the chord; and the place is established; and the remainder, established from it.

Diagram. A single large circle drawn in the lower part of the folio (toward the lower outer corner). Within its upper-right portion a chord — drawn slightly bowed, hugging the arc — runs from a point on the upper-left of the arc to a point on the upper-right of the arc. From the upper arc a roughly vertical line descends (the perpendicular dropped to the chord), and the figure is closed down to an interior vertex below, forming a triangle in the upper part of the circle. One

further point is marked on the lower circumference. The construction matches the running "chord within a circle → triangle reduced by a perpendicular" template of the surrounding text, here applied to the star's two distances. The point-labels are single letters in a very small, faded hand and cannot be resolved to specific letters at native resolution.

- [?] (upper-left, where the chord meets the arc)
- [?] (upper-right, where the chord meets the arc)
- [?] (apex, top of the descending perpendicular where it meets the upper arc)
- [?] (interior, on the descending line below the chord)
- [?] (lower-left, the interior vertex of the triangle)
- [?] (a further point on the lower circumference) …the line, and the arc is known; and the line subtending that arc is also known. Likewise the line that remains after it is subtracted from the diameter — that line too is known. From these the perpendicular dropped upon it is known, and so the arc belonging to it is known.

Therefore the ratio of the chord to the whole diameter is known, since the chord and the diameter are both known. And when the chord is known, the arc it subtends is known; and once the arc is known, the remaining arc of the circle is known as well, for the whole circle is known. The remainder, then, is the difference between the whole and the part already found.

The perpendicular drawn to the chord is known, for the line is known and the arc is known. And since the perpendicular is known, the segment cut off [קטע] is known, and the angle is known. From the angle and the chord the second perpendicular is found, and the line that remains is known. Thus every line in this figure is known.

Once we have established this, let it be supposed that the line is known and that the arc upon it is known; then the chord subtending it is known, and the perpendicular falling upon it is known. The remaining line, after the perpendicular is subtracted, is likewise known, and so the segment is known. From this it follows that the position of the star [מקום הכוכב] is known, and the latitude [רחב] is known, and each of the two distances [הרחקים] is known — for each of them is a known line within a known circle, subtending a known arc.

[Right margin, smaller hand, ~4 lines: marginal note, partly legible — "…… שיהיה … לפי כן… ארבעה… כי על זויות… שעור…" — a constructive helper anchoring the proportion; further identification requires further verification.]

And he said: the line is known, and it is the chord of the known arc, and the perpendicular dropped upon it from the center is known, since it bisects the chord. The half-chord is therefore known, and the arc belonging to the half is known. When this half-arc is doubled, the whole arc is recovered, and it agrees with what was assumed.

The line is known, and the arc subtended is known, and the chord is known; and the perpendicular is known, and the segment cut off is known, and the second perpendicular is known. From all these the position of the star is found, together with its latitude and the two distances, each one a known quantity.

[Right margin, smaller hand, ~2 lines, partly legible: "…שעור… כך… לפי כן…"; constructive computation helper — further identification requires further verification.]

And when the perpendicular [העמוד] is known and the chord is known, the angle is known; and when the angle is known together with the line, the position is known. This is the line of inversion [קו החלוף], and the remaining line is the line of the position, and from it the rest is known.

The proof of this: the line is known, and the arc upon it is known, since the chord and its diameter are both known. And it has already been explained, in another fashion, that the angle of any figure inscribed in a circle is known when its arcs are known, for an inscribed angle stands upon a known arc and is its half.

So too, when the line is known and the perpendicular falling upon it is known, the figure inscribed in the circle is known, and its construction is known, and its segments are known.

Diagram. A single circle in the lower-left of the folio. Within its upper portion an inscribed figure is drawn whose vertices sit on the circumference: an apex toward the top and a vertex on the right-hand circumference, with several straight lines radiating from a point on the right edge inward toward the apex and an interior point. The figure illustrates the chord–perpendicular–segment construction of the surrounding prose.

- ג (top, on circumference): apex / upper vertex
- [?] (right edge, on circumference): vertex toward which the radiating lines converge
- [?] (interior, toward the center): interior point joined by the radiating lines

The trailing lines of f16r continue the same argument: that this holds for the rest of the stars as well, since each of them is a known line within a known circle; and it has already been explained how each of them is known.

and it is the small chord [חוט]; and the chord subtending the known arc is the line, the diameter being known. So the perpendicular is known, and the segment cut off is known, and the inscribed figure is known. The construction is known, and its parts are known.

The arc, then, is known, since the chord is known and the diameter is known; and the chord subtending it within the known circle is known, with a known perpendicular and a known segment. From these, the position of the star is known.

He said: by this method, whatever line is known and stands within a known circle, subtending a known arc — for it is the chord of that arc, and the diameter is known — its perpendicular is known, and the segment is known. And once the segment is known and the inscribed figure is known, the angle subtended is known. Thus every line, every arc, and every angle in this figure is known.

And from this it follows that the position of the star is known, and its latitude, and each of the two distances. For each is a known line subtending a known arc within a known circle; the chord is known, the perpendicular is known, the segment is known, and the angle is known. Therefore each of them is a known quantity, as we set out to show.

And he said further: when the line is known and the arc upon it is known, the chord is known; and the perpendicular falling upon the chord is known, and it bisects it. The half-chord is therefore known, and the half-arc belonging to it is known. When this is doubled, the whole arc is known, and it agrees with the assumption.

[Right margin near gutter, smaller hand, ~3 lines, partly legible: "… כך … ידוע … שיהיה … מבואר … לפי כן … כי …"; constructive helper anchoring the proportion; further identification requires further verification.]

Diagram. A circle in the right margin, roughly two-thirds of the way down the folio. Within it an inscribed angular figure is drawn: a vertex toward the top, a long diagonal running down to a vertex at the lower-right of the circumference, and further straight lines crossing the interior to a vertex at the left. The construction matches the chord/perpendicular/segment argument of the prose.

- [?] (top, on circumference): upper vertex

- [?] (lower-right, on circumference): vertex at the foot of the long diagonal
- [?] (left, on circumference): left vertex

Diagram. A larger circle at the foot of the folio, centered. Within its upper portion an inscribed figure spans two vertices on the upper circumference (left and right), joined by chords with crossing diagonals; from these an apex descends to a vertex at the bottom, below the line joining the upper vertices. The construction matches the chord/perpendicular/segment argument of the prose.

- ב (upper-left, on circumference): upper-left vertex
- [?] (upper-right, on circumference): upper-right vertex
- [?] (bottom, on or near the lower circumference): descending apex vertex
- [?] (interior): intersection of the diagonals

The remaining lines of f16v continue and close the procedure: the chord subtending the known arc, the perpendicular, and the segment are each known; there remains the arc and the position [מקום], and the matter is brought to completion for the star, its latitude, and the two distances, each shown to be a known quantity.

[Bottom-margin note, smaller hand, partly faded, ~2 lines, partly legible: "… …ידוע זויתּ… שיהיה… לפי כן… ויהיה…"; constructive computation helper — further identification requires further verification.]

[Script: Sephardic semicursive, single hand (1397); iron-gall ink, lightly faded in places with scattered orange foxing. A later-hand pencil/ink folio number "17" in the upper outer margin.]

and the chord subtending the known arc is known, and the diameter is known. Therefore the perpendicular is known, and the segment cut off is known, and every figure inscribed within it is known. So the perpendicular is known, and the chord is known, and what is sought from it is known.

Furthermore, since the chord subtending the known arc is known — and it is the smaller chord — and the chord subtending the [larger] arc is known, the diameter being known: the perpendicular is known, and the segment cut off is known, and the inscribed figure is known. And since the figure is known, the angle is known; and since the angle is known, the arc is known, for the inscribed angle is half [its arc].

And so we say: when the chord and the diameter are known, the perpendicular drawn to the chord is known, and the two segments into which the perpendicular

divides the chord are known. And since each segment is known, the arc belonging to it is known; and since the arc is known, the angle is known. The difference between this one and that one is likewise known, for the excess of the one over the other is known.

And when we wish to know the chord of an arc whose measure is known (interlinear: ידוע, "is known," added above the line), we proceed thus: the perpendicular is known, and the chord of half the arc is known, and from these the chord of the whole arc is found.

And since this is so, the chord is known, and what is sought after it is known, for the half-chord and the half-arc stand in the known relation. Therefore, whatever we set down concerning one of them, the corresponding value for the other is known.

And we have already explained the measure of the chord that subtends a known arc, and that it is known; and the inverse of this is also known — namely, that when the chord is known, the arc it subtends is known.

[Deletion: about one line struck through with a horizontal stroke; the cancelled words appear to repeat the preceding "and the chord… and the arc… is known" formula.]

And it is known that, when we set the diameter as known and the chord as known, the perpendicular drawn from the center to the chord is known, and the inscribed figure standing upon the chord is known. From this it follows that the arc subtended by the chord is known, and that its half is known.

For let the diameter be a known line, and let the chord be a known line; the perpendicular falling upon it is known. And the perpendicular divides the chord into two equal parts, since it issues from the center. Therefore each half is known, and the arc belonging to each half is known.

And since the half-chord is known, the half-arc is known; and the angle subtended at the center upon the half-arc is known, for the central angle equals its arc. And the inscribed angle standing upon the same arc is half of it.

And we say further: every chord drawn within a circle — when it and the diameter are known — yields a known perpendicular and known segments, and from them the arc and the angle are known. And the inverse holds: when the arc is known, the chord subtending it is known, and the perpendicular is known, and the figure inscribed upon it is known.

Diagram. A circle with an inscribed rectilinear figure. From an apex on the upper-left arc, chords run rightward across the upper part of the circle to a point on the right arc; from points of this upper figure, interior lines descend to a single vertex low in the circle, near the center-bottom. The construction illustrates a chord standing upon an arc with lines drawn to an interior point. The point-labels are very small cursive letters; only the apex is securely legible, and the rest are committed by position with their reading flagged.

- Apex (upper-left of the circumference): ג
- Interior point just below the apex, where lines meet: [?] (ב/כ)
- A second small label below and right of the apex: [?]
- Point on the upper-right of the circumference: [?] (faint; ה/ו)
- Lower-center interior vertex (where the descending lines converge): [?] (ד/ז)

[Diagram: apart from the apex (ג), the point-letters are very small and only partly inked, so their identity is uncertain; the construction lines themselves are clear and the geometry is secure.]

Diagram. A second circle, drawn at the lower right of the text block. An inscribed figure sits in the upper portion: chords run from an apex across the upper part of the circle to a point on the right arc, and interior lines converge downward to a single vertex low in the circle. The construction parallels the first figure. The lower arc runs close to the foot of the written area but is complete. The point-labels are small and faint; the apex is legible and the remainder are committed by position with their reading flagged.

- Apex (upper area, by the top chord): ג
- Two small labels along the upper-left chord: [?], [?]
- Point on the right of the circumference: [?]
- Lower interior convergence vertex: [?]

[Diagram: apart from the apex (ג), the point-letters are faint and uncertain; the figure is intact and the construction lines are legible.]

[Script: same hand. A three-line marginal note in the inner (gutter) margin at the upper left; one faint interlinear word above the line in the body.]

and we explained the figure, and it is known; therefore the chord is known, and what follows from it is known. And since this is so, the matter is known by way of the inscribed figure, and the perpendicular is found, and we have what we sought.

And so we say: since the chord is known and the perpendicular is known, the segment cut off is known, and the figure is known; and since the figure is known, the angle is known; and since the angle is known, the arc is known — and likewise its remainder [שאר, the complementary arc].

And the inverse is also known: when the arc is known, the chord is known, and the perpendicular is known, and the inscribed figure is known.

And it is fitting that you know — concerning the chords of arcs (interlinear: a faint word added above the line; ידוע, "is known") — that the chord of an arc and the chord of its complement to the semicircle [השלמתו, "its completion"] together stand in a known relation, since the diameter is the chord of the semicircle and is known.

For when the arc is known, its chord is known; and the complement of the arc to the semicircle is known, and the chord of that complement is known. And the perpendicular standing upon them is known, and from it the figure is known.

And every chord less than the diameter subtends an arc less than the semicircle; and the perpendicular drawn to it from the center divides it into two equal halves, and divides the arc into two equal halves. Therefore the half-chord and the half-arc stand in the known relation, and whatever is set down for one, the corresponding value for the other is known.

[Margin (gutter, upper left), three lines, verbatim:] [Margin: תרגום כלל שווה זווית
מקבע גם שני זו…זווית | תרגום עד…ל שווה לזווית | חצי [?]]

[The marginal note appears to gloss the equality of inscribed angles standing upon equal arcs/chords; the reading of the partly-rubbed middle word is uncertain — further identification requires further verification.]

And we say that the angles standing upon equal arcs are equal, and that the chords subtending equal arcs are equal, and that the figure inscribed upon equal chords is equal — and this is clear of itself.

And when two chords in a circle are equal, the perpendiculars drawn to them from the center are equal, and the segments cut off are equal, and the arcs are equal. And the inverse: when the arcs are equal, the chords are equal.

And we say further: every chord and every line standing upon a known arc has a known measure relative to the diameter, since the diameter is known and the relation is fixed. Therefore, when one of them is known, the other is known.

And we have explained all of this so that what we shall need of it for the matters of the stars [the astronomical computations] may be ready to hand, and so that the reader will not be perplexed when we make use of it.

and you shall know that the matter proceeds thus: there will be a figure inscribed, a known chord standing upon a known arc, and they stand to one another in the known relation.

השמיני [The Eighth]

[Body heading, f17v: **השמיני** — "the Eighth" (division), in enlarged display script, set within the running line near the foot of the text block. The exposition of the new division opens immediately after it.]

And so we say, by way of the clear light [נגלה הנאור] of the figures [the geometric constructions] that we have set down, and from what we have explained concerning them, that we may make use of them — and you shall know that the way the scholars proceed in this matter is from one to another, this matter being clear. And they knew that the path of those who reckon proceeds from this, the lighter [or: this is the easier], and they asked which one is better to be…

[The exposition of the Eighth division continues onto the following folio.]

[Conclusion of the Eighth division]

the chord, and it will be so. The deeper [more remote] one likewise: when it is established, its arc becomes known. And by this same procedure you find the line of position [קו ההיקש] together with the rest.

When you have grasped the line of position, you then know the depth — the remoteness — and its measure; and from the smaller arcs you arrive at the position of the luminary [המאיר] and at its distance [מורחק]. By this method one proceeds, the operation is sound, and this is enough for it.

[The Eighth division ends here.]

הַתְּשִׁיעִי — The Ninth [division]

[The heading התשיעי ("the Ninth") is written in large display script on f18r.]

In the Ninth: when the arc is known, and we wish to know another arc that stands over against it, then by means of the chords and the perpendiculars the position of the planet is found, its place is known, and its distance.

For just as the chord together with its arc yields the position of the luminary over the chord, so too the arc that the chord subtends — once you have grasped the perpendicular let fall upon it from the apex and the line of position drawn to it — yields the depth, the remoteness, and what stands over against it.

The arc whose chord is known, and which is known to lie at a measured remove from the depth, likewise yields the position. And when you take the smaller arc together with the perpendicular standing upon it, the chord of that smaller arc upon the line of position is the measure of the depth.

This holds whenever the arc and the chord that subtends it are known, since the relation [היחס] of the chord of the luminary to the radius is known: the relation of the chord to the radius gives you the position; from the position you find the arc; from the arc, the perpendicular [עמוד]; and from the perpendicular, the line of position [קו ההיקש]. By the line of position you find the depth, and the depth is the measure of the distance [מורחק] of the planet [הכוכב] from us — that is, its remoteness.

When the arc is known, and it is known where it stands, the perpendicular let fall upon it is also known, and the line of position to it is known; and from these the distance of the planet is known.

[The running text ends partway down f18r; the lower half of the folio is blank.]

[Margin, upper part of f18r beside the Ninth-division heading, small hand: "ועוד נחבר אמנם בעה לארץ … לפי שהוא וכמה … נעמוד על זה" — the inner words are faint. Marginal note containing this verbatim text; further identification requires further verification.]

For when you grasp the line of position and the depth — the remoteness — the position is known; and just as the chord stands, so too the perpendicular: the position of the luminary above the chord, and the chord, and so the position is known.

The smaller arc, when its position is known — and this is the measure of the perpendicular [עמוד] — this is the position of the luminary [המאיר] over against it. So the position of the luminary above the chord is known, and the measure of the perpendicular is known.

And when you take the position of the luminary upon the line of position, the chord is known, and over against it is the measure of the distance [מורחק]. This, then, is the position, and it is the measure of the perpendicular standing upon the chord, which the line of position yields over against the luminary.

By the chords and the perpendiculars, in the manner shown, you find the position of the planet [הכוכב] and the depth, and the position is known. Likewise you find the line of position by the perpendicular standing upon the chord, and you take the arc whose chord is known.

Diagram. A bow-tie (hourglass) construction drawn in the outer (right) margin of f18v, running from near the top of the column down toward its lower third. At the top is a roughly horizontal line, its left endpoint labeled; from the two ends of this top line two straight lines descend and cross at a point about two-thirds of the way down (the crossing is labeled), forming an upper inverted triangle. Below the crossing the same two lines splay apart to form the two sides of a lower upright triangle whose base is at the foot of the figure. The base has a left corner, a right corner, and a marked midpoint, each labeled. Within the lower triangle an interior horizontal line runs a little below the apex, cutting both sides, with both endpoints labeled; a near-vertical interior line runs from the apex region down to the base midpoint. The right side of the figure runs to the page edge.

- ב (top line, left endpoint): label [reading ב; possibly ה]
- ז (crossing point of the two descending lines): label [small, faint]
- ו (interior horizontal line, left endpoint): label [reading ו; possibly י]
- ד (interior horizontal line, right endpoint): label [reading ד; possibly ז]
- [?] (base, left corner): small faint mark [possibly ו / ז]
- [?] (base, midpoint): small faint mark [possibly ב]
- [?] (base, right corner): small faint mark [possibly ג]

[To the right of the diagram the body text continues:] When the position is known and the line of position is grasped, the smaller arc is also known, and the perpendicular standing upon it; and this is the position of the luminary over against the chord.

Take, for example, an arc whose chord is known. The chord is known, and the perpendicular standing upon it is known. The arc of the luminary gives a chord, and from the chord the position: the seconds are **[?] of the part [חלק], sixty [ס 60 =]**, and over against it the rest; and this you find from the table [לוח].

And so the chord and the perpendicular, in this measure, yield the position of the planet and the depth, with what stands over against it. The table [לוח] for this is set down further on, so that by it you may find the position and the distance.

For just as the relation of the chord is known, so too the relation of the perpendicular is known; and by these the position of the luminary is known, and its depth, and its distance from us — which is its remoteness [מורחק].

[Short computation block at the foot of f18v, set off in larger spaced script over two short lines:]

> [?] בעצמו יהיה ס … חלקו עוד שלו … לדעת כל הכתוס [?] … לראבל
>
> יוכר כה ילך … נכוד היכר ופחת

[Lower two-thirds of f. 18v blank.]

f. 19r

The upper portion of this folio side (roughly the top half) is laid out **not as running prose but as short clauses arranged in several parallel columns**, in the manner of a rhymed/versified piece (a poem — each short stich set off and apparently rhyming). The columns read right-to-left; each column holds a stack of brief two- or three-word phrases. Even under magnification the individual stichs of this small-cursive verse cannot be resolved into committable continuous text; only scattered words are legible, and the unread stichs are not reconstructed.

Legible fragments from the versified columns (right-hand groups toward left-hand groups), each genuinely uncertain:

- [?] יבטחהו [?] / קורו [?] … ותיקנו ונכל
- [?]כעס [?] / יפעל חיש [?] … ומקלו ינוד ל
- … ב ישדן יונס ושאר [?] חולים [?] / [?]הקרמון [?] [?]
- … חכ שום בתכלית [?] / [?]מטת דוד [?] [?]
- עתיד יתלה [?] כ' תעשן [?] / כ' התנועות נוסף יקים [?] [?]
- לעשר [?] עונש [?] / כ' אלך מעלים וכו' [?] [?]
- … מן עולים ידיס [?] / ויריעו חיש כפתן [?] [?]
- … כ שום אלהן [?] / חזוק חיל שנה [?] [?]
- … עד עולה הולד [?] / בחת מין קדם נשך [?] [?]
- … לעלוי [?] הוה לם [?] / אזהרת ע' עשו על פיהו [?] [?]
- … התנועות נלצליקה [?] / אם קביו [?] כ' כוכבי תיוס [?] ידעו [?] [?]
- … כ' יאכלו הקלוריס [?] [the last column-word may be הקלקוס, "the cycles" (ha-kalkos), the term that recurs throughout this work; reading not secure]

Below the versified block, running prose resumes (lower third of the folio side):

And it has already been explained [?] that this [matter] is the principle [העקר] [?] from which everything is clarified [?] … so that you may know [?], by the path [?] that he set down [?]. By this you will know [?] every true [?] motion of Ptolemy [בטלמיוס], and the things he established [?] regarding this — what the variation [חלוף] is [?] … We have found for ourselves [?] that the time of the [?] is correct [?], just as Ptolemy [בטלמיוס] established [?] … it being clarified for him [?] in the manner of the correction [תקון] [?] … to the configurations [תמונות] of the ancients [הקדמונים] [?] …

[The remainder of this prose paragraph (≈5–6 lines, lower f. 19r) is small running cursive concerning Ptolemy's determinations, the correction (תקון), and the configurations; individual clauses are legible in part but cannot be committed glyph-by-glyph at this resolution without guessing. Content is genuine astronomical prose continuous with f. 19v; flagged for higher-resolution review.] [?]

[Margin (gutter side, near the foot of the prose block, f. 19r): a small note in a fine hand, roughly 3 short lines. Marginal note containing text beginning נמצא [?] … (further reading not possible at this resolution); further identification requires further verification.]

[Below the prose block, the lower portion of f. 19r is blank parchment (light foxing/staining only — no abraded or lost ink).]

f. 19v

The verso is **continuous running prose throughout**, in the same primary hand. It opens mid-discussion (continuing the argument from f. 19r) and contains a chapter rubric partway down.

The position of the heavens [מקום השמים] [?] … and it has already been explained [וכבר נתבאר] [?] that … you will know [?] by the path [?] the position of the planet [מקום הכוכב] [?] … the configurations [הטבעיים?] [?] … and from this [?] there is no [?] … the configurations [?] [the variation, חלוף] [?]

[≈4 lines of continuous prose precede the chapter heading; legible in part (the recurring nouns מקום "position," השמים "the heavens," נתבאר "was explained"), but not committable clause-by-clause without guessing.] [?]

הפרק העשירי — The Tenth Chapter [enlarged display script, line-initial, mid-page on f. 19v].

[Following the heading, the prose of the tenth chapter begins:] … the position [מקום] [?] … by the knowledge of the time [?] of the position of the heavens [מקום השמים] [?] of the planet [?] … and this is the path [?] … so that you may find the true position [?] of the planet [מקום … הכוכב] [?] … the correction [התקון] [?] …

[The body of the tenth chapter (the remainder of f. 19v) is continuous astronomical prose on determining the position of a planet from the time and the correction (תקון), with the recurring technical vocabulary מקום "position," התקון "the equation/correction," חלוף "variation," התנועה "the motion," הלוחות "the tables." Roughly the lower two-thirds of the writing block is legible small cursive; partial clauses are recoverable but full glyph-level commitment exceeds what is legible on the scan even under magnification. The block is flagged in full for re-examination at higher magnification.] [?]

[Margin (outer/gutter side, mid-page, f. 19v): a small marginal note of ≈2 lines in a fine hand alongside the prose. Marginal note containing brief text (the opening word is possibly הדמיון [?], a figure-pointer of the recurring "the diagram" type seen elsewhere in this work, but the reading is not secure); further identification requires further verification.]

[The foot of f. 19v, below the last line of prose, is blank parchment (water-staining/foxing in the lower outer corner — no abraded or lost ink).]

[Continuation of the Tenth Chapter. No new rubric appears on either folio; the demonstration of the line-of-position method continues across both sides.]

f20r

the line will be drawn upon the point, and the angle [?] will be known; and there will be an angle equal to angle [?], for they are angles [?]. Again, take the arc that goes out [?] from the point of the place [מקום], and let it be drawn [?]. The line will be drawn [?], and the angle equal to angle [?] will be known, and the arc [?] of the difference will be known; and the place [מקום] of the star will be found, together with its distance [מרחק], for they [the two arcs] meet upon [?] the point.

And when the perpendicular [עמוד] is dropped upon the point [נקודה] on the body of the star [גשם הכוכב], and the line of the place [קו המקום] is drawn, the arc [?] will be known. And it has already been explained that the difference [המותר] is known when the two arcs meet [?] upon the point; and the place is found from the difference of the two arcs, exactly as we explained. [?]

[The next several lines restate the construction iteratively: angle equal to angle, perpendicular upon the point on the body of the star, the line of the place drawn, the difference [חלוף] of the two arcs known, and the place [מקום] of the luminary [המאיר] reckoned. Specific degree-values are written deictically — "such-and-such degrees" [כ"כ מעלות] — and the few abraded numeral strings at the compressed line-ends are flagged below rather than guessed.] [?]

And the perpendicular [עמוד] will be drawn upon the point [?], and so it was made [?]. And when the line is drawn upon the point [?], the place [?] will be found, and it will be good [?]. And he [the author] said: and this [demonstration applies] for [the case of] the morning [?], whether the luminary [המאיר] be additive [מוסיף] or subtractive [גורע]. [?]

Thus, in [the case of] the distances [קשתות / מרחקים], and so for [the case of] the additive [המוסיף] [?] and the line [?], and so the line of the inversion [קו החלוף] [?] will go out [?]. And behold, the point of the inversion [?] is opposite [נכח] [?], and the line of position [קו ההיקש] [?] is drawn, and the points are reckoned [?] up to such-and-such a degree [?]. [?]

[The exposition continues, restating that from the difference [מותר] of the two arcs the place is found, and that the distances [מרחקים] of the luminary are read off in degrees against the tables; the line-ends here are abraded and the degree-values are not legible.] [?]

[For the demonstration we set down, we said [?]: as he knows [?] the distance [?] … by the perpendicular [?] which goes out [?] upon the body, the distance [?] of … and the degree [?] up to such a degree [?].] [?]

Diagram. At the lower-left of f20r, in the otherwise-blank outer (left) portion of the leaf, a single triangle drawn in fine, now-faded ink, with one internal line (a cevian) running from the apex down into the interior. The apex sits at the top, with the base running roughly horizontally at the foot; the cevian descends from near the apex toward the base. Point-labels are present at the vertices but are largely abraded.

- Apex (top): [?] (single faint letter, possibly ב or ג — not resolvable)
- Lower-left vertex: [?]
- Lower-right vertex: [?]
- Interior / cevian foot: [?]

[More than 2 labels flagged [?]]

[Margin: a short later-hand annotation in faded brown ink stands in the right margin of the upper column (level with the figure-region of the text), running approximately three short lines; its text is too faded to transcribe with confidence — marginal note containing [?]; further identification requires further verification.]

f20v

And the point will be [?] [at] the place [מקום], for it [?] is the place of the [?] line of position [?], and it will be a right angle [זוית נצבת] upon [?] … And there will be [?] the place [מקום], for the line [?] is drawn upon it [?], and there will be an angle [זוית] equal [?] to angle [?] … And the angle [זוית] equal to angle [?] will be known [?], and so the line of position [קו ההיקש] [?] … And he goes back [?] and reckons [?] the place [?], and the line [?] is drawn, and the place [מקום] is found, and so [?]. [?]

And so [?] … the place [מקום] and its distance [מרחק] … the place [?] … the perpendicular [עמוד] [?]. And when [?] the line of position [קו ההיקש] [?] is drawn upon the [?] … and there will be an angle [זוית] equal to angle [?]. [?]

But [?] he knows [?] the angle [זוית] of the line of position [?], for it [?] … upon the place [מקום] … and he reckons [?] the place again [עוד] [?]. [?]

[Margin: a short later-hand note in the left margin of the upper column, two lines, in faded ink: it appears to read "ותהיה זוית / קו החלוף" — "and the angle [of?] the line of inversion will be" [?]; further identification requires further verification.] [?]

[The middle column continues the iterative construction: angle equal to angle, the line of position drawn upon the point, the difference [חלוף] of the two arcs known, the perpendicular [עמוד] dropped upon the body, and the place [מקום] of the luminary found from the difference. Degree-values are deictic ("such-and-such degrees") and the compressed line-ends are abraded.] [?]

And the line of position [?] is drawn [?], and there will be an angle [?]; and behold [?], it [?] … the place [מקום] [?] … And he reckons [?] the place again [?], and he said [ואמר] [?] … another [?] thing [?]. [?]

[Margin: a one-word later-hand pointer in the right margin, "החלוף" ("the inversion / the difference"), keying the adjacent line to the line-of-inversion construction.]

[The lower lines restate: from the difference [מותר] of the two arcs the place is found; the line of position is drawn upon the point; the right angle [זוית נצבת] is formed; and the place [מקום] and distance [מרחק] of the luminary are obtained. Specific values are not legibly inked.] [?]

the place [מקום], for it [?] is one [?] … the point [?], and so [?]; and the place [מקום], and the line of position [קו ההיקש] [?] is drawn [?] upon [?] … [?]

[Margin: a short later-hand note in the right margin of the lower column, faded, approximately one line: marginal note containing [?]; further identification requires further verification.]

And this [?] … the difference [המותר] [?] … from the latter [מן האחרון] [?]. And so [?] the place [מקום], and the point [?], and the line of position [?] is drawn, and there will be an angle [זוית] … the place [מקום] of the luminary [?]; and from the difference [מן המותר] the perpendicular [עמוד] [?] goes out [?], and the distance [מרחק] [?] … And this is [?] [terminal demonstrative].

Diagram. In the right margin of f20v, level with the upper-to-middle text column, a fan-shaped construction of several straight lines drawn in fine faded ink: a set of lines radiating from points near the top of the figure down to a low common region, forming a cluster of intersecting obliques (a line-of-position / line-of-sight construction). The point-labels are marked but almost all are too faded to resolve.

- Upper points (cluster of marks across the top): [?] [?] [?] (several short labels, not resolvable letter by letter)
- Lower convergence point: [?]

[More than 2 labels flagged [?]]

Diagram. At the lower-left foot of f20v, a large line-of-position construction: a near-vertical line descends on the left from a high apex; along it two short tick-marks/points are set; at its foot a short base runs left with two small marks; from the foot of the vertical a long line runs across to the lower-right, rising to a vertex at the right; and from that right vertex a near-vertical line rises back up to meet the text region (forming a tall, narrow quadrilateral/triangle pair). Several point-labels are visibly inked at the vertices and along the left vertical.

- Apex (top of the left vertical): [?] (single faint letter)
- Upper point on the left vertical: [?]
- Lower point on the left vertical (near the base): ד [?]
- Base, lower-left marks: [?] [?]

- Lower-right vertex (foot of the long oblique): [?]
- Top of the right-hand near-vertical line (where it meets the text): [?]

[More than 2 labels flagged [?]]

[The text resumes briefly to the right of and above this figure:] …point [נקודה] [?] … and from the place [?] … the line of position [?] is drawn, and there will be an angle [?]; and this is what we wished to explain [וזה מה שרצינו לבאר]. [?]

— continuing **The Tenth Chapter** (הפרק העשירי) —

and these two arcs are equal. When the arcs are equal, the chords subtending them are likewise equal; and the chord is drawn to the point in such a way that the two perpendiculars dropped upon it come out equal. Since they are equal, the point lies upon the line, and the figure that arises from this is a similar figure, equal in its corresponding parts.

[Enlarged display marker:] **הח** (the 8th) [enlarged he + chet with abbreviation mark]. Since the arc is known, the chord that subtends it is also known. The two perpendiculars erected upon the points of the star's body are therefore known as well, and from the difference of the one and the other the place of the star is found, by comparison with what is set down in the tables of Ptolemy [בטלמיוס]. For the line drawn from the one point to the other gives the measure of the distance between them, and that distance is the excess of the one arc over the other.

We must take care in this matter that the perpendicular fall upon the line at a right angle [על זוית נצבת]; for if it does not fall at a right angle, the figure will not be a true one, and the value derived from it will be in error. Therefore, when we wish to verify the place of the star, we drop the perpendicular from the star's body to the line, and we measure the arc lying between the foot of the perpendicular and the fixed point.

[Enlarged display marker:] **הי״ב** (the 12th) [enlarged he-yod-bet with gershayim]. The star's distance from the great circle is according to the magnitude of this arc: the greater the arc, the greater the distance, and the smaller the arc, the smaller the distance. This holds whether the star is in its elevation [גובה] or in its depression [שפל], for the rule is one and the same in both cases. So when this is grasped, the place of the star upon the circle is known, and it is found by the method we have set forth.

Whatever falls upon the line, if it does not fall upon it at a right angle, then the figure is not true, and we already know that the place sought is found upon the

great circle by the difference of the arcs, the one being the elevation and the other

it is possible. The proof we state concerning it: the perpendiculars are dropped between the two arcs, and the arc that arises is the arc of the distance; for the chord subtends it, the one [arc] coming before and the other after. The chord, then, is known, and from it the difference is known. So too the second perpendicular: when its chord is known, the place is known by it.

And so let us set down two points upon the line, distant from one another, and let us erect the perpendicular at the point so that it falls at a right angle; the perpendicular will then have a determinate measure in degrees. When the two arcs are equal, the two perpendiculars are equal; and when they are unequal, the perpendiculars differ, and the difference between them is the distance we seek.

[Inner-margin note, small later semicursive: "בעלה" [?] — marginal note containing this word; further identification requires further verification.]

The place is thus found by this method, and the line drawn from the apex to the point gives the measure. After this we say: every line that falls upon the line of position, if it does not fall at a right angle, the perpendicular upon it is not a true perpendicular, and the figure built upon it errs in its quantity. Therefore we take care that the angle be a right angle, so that the perpendicular be exact and the chord subtending the arc be precise.

The arc of the distance, then, is what stands between the two perpendiculars, and the place is found upon the great circle by the difference of the two arcs — the one coming before and the other after. After the one [perpendicular] falls and the other falls, the arc that arises between them is the arc of the distance; the chord subtending it is known, the difference is known, and the place is found.

This is summed up in the figure below: the line of position is laid down, the perpendiculars are erected, the arc between their feet is taken, and the chord is known. The difference is the distance of the star from the great circle, by which its place upon the circle is determined. Once we have the arc, the chord is known by it, and the perpendicular is known, for the figure is a right-angled figure [תמונה נצבת הזויות].

[Caption written above the figure, small hand: "וצורתה לזה עשינו" [?] ("and its figure, for this, we have drawn") — verbatim reading partly uncertain.]

Diagram. A line-of-position construction occupying the lower-right portion of f. 21v. An apex at the upper right is joined by a long, nearly horizontal line running

across to a single point at the far left. From the apex region two lines descend to a short baseline at the lower right, and a curved arc swings from the apex down to the rightmost baseline point, so that the descending lines and the arc enclose a narrow lune-shaped region (the arc of the distance). A point lies on the upper line a little below the apex, where the chord meets it.

- א (far-left point): terminus of the long line running across from the apex
- ג [?] (apex, upper right): the vertex from which the lines descend
- ד (on the upper line, just below the apex): point where the chord meets the line
- ז (left baseline point): foot of a descending line
- ב (middle baseline point): foot of a descending line
- ג (right baseline point, where the arc meets the baseline): endpoint of the displacement arc

[Script: Sephardic semicursive, single primary hand, 1397. Light foxing in the upper outer margins and along the lower edge; the written block is fully legible throughout, with only scattered glyphs and the figure's superscript point-letters lost. Folio numeral "22" in a later pencil hand at the top of f22r.]

f. 22r

We return now to what we were saying. The angle [זויתא] which is at the point [נקודה] is equal in measure to the angle of the line of position [זויתא קו ההיקש]; and this is the angle of the star [זויתא הככב], for the star lies on the line that is known. And the angle of the line of position is the remaining angle.

The angle of elevation [זויתא הגובה] is already known, and the angle [we seek] is found by the rule we shall lay down: for the angle which is at the point is like the angle of elevation and equal to it, while the remaining angle [הזויתא הנשאר] is the angle of the line [זויתא הקו].

He says: let the elevation [גובה] of the star be so that the line of position is [5] **ה'** degrees [מעלות], and the [remainder] is [4] **ד'** minutes [דקים]. The line of position is what reaches from the point of the star to the point marked upon the line, and it is a perpendicular [עמוד]. And so, when the line of position is [5] **ה'** degrees and [56] **נ"ו**[?] degrees [in the [?] arc], and the perpendicular descends to it, then the angle which is the line is the elevation.

And it shall be that the line of position is the arc [קשת] of [300] **ק"ש**[?] degrees and [56] **נ"ו**[?] minutes; the perpendicular [עמוד] which descends to the line of

position is the latitude [רחב]. And the latitude is so-and-so degrees, with the angle of the line being [5] **ה'** degrees.

And the remaining angle [זוית הנשארת] is the line, and its arc [קשת] is the remainder [מותר] [4] **ד'**[?] minutes; for the angle which is at the point is the angle of elevation, and the angle of depression [זוית השפל] together with it makes a right angle [זוית נצבת], [90] **צ'** degrees.

When the line of position is [20] **כ'**[?] degrees, the elevation being **ה'** and the [angle] [106] **ק"ו**[?], then with [6] **ו'** minutes and [12] **י"ב** minutes the perpendicular which descends to the line of position is the latitude. The remaining angle is [40] **מ'**[?] degrees, and the remainder [מותר] is [4] **ד'** minutes.

And the perpendicular is [4] **ד'**[?] degrees and [3] **ג'**[?] [degrees], with [6] **ו'**[?] minutes. And the arc is [300] **ק"ש**[?] degrees and [400] **ת'**[?] minutes [recte: a minutes value cannot reach 400; the second figure is likely an arc total, not minutes — transcribed as written] [?], and [2] **ב'** minutes.

The remaining angle, which is the line, is [30] **ל'**[?] degrees. And the distance [מורחק] of the star is the remainder which is left over; and this is the line of position, so understand.

And we have already explained that the angle of the line of position is so-and-so degrees, and the perpendicular descending from the point of the star is the latitude [רחב] of the place. The distance [מורחק] of the star from the point of position is the remainder [מותר] which is left over.

When the elevation is given and the depression is given, the angle of elevation and the angle of depression are known, and together they make a right angle. The line of position is the line which reaches from the point of the star to the line as a perpendicular, and it makes with the line two right angles [שתי זויות נצבות], one on this side and one on that side.

And since the angle which is at the point is equal to the angle of elevation, the line of position which descends from it is the perpendicular [עמוד]; the latitude [רחב] is the perpendicular which falls to the line of position, and the distance [מורחק] is what is between the two points. The remainder [מותר] is what is left from the greater arc after the lesser arc is taken from it. And this is correct.

f. 22v

and we shall make the latitude [רחב] of the line of position so-and-so degrees and so-and-so minutes; and the angle which is between the line of position and the line is a right angle [זוית נצבת], for it is the perpendicular [עמוד].

הי"ג ("the 13th") — [enlarged in-line ordinal marking the thirteenth internal proposition; not a new chapter].

He says: when the line of position and the line of position [קו ההיקש] are given, and the perpendicular descending from the point of the star to the line is given, then the latitude [רחב] of the place is the perpendicular, and the distance [מורחק] of the star is what is between the foot of the perpendicular and the point of position [נקודת ההיקש].

And it shall be that the angle which is at the point is equal to the angle of elevation [זוית הגובה], and the angle of the line [זוית הקו] is the remaining angle. When the angle at the point is known, the line of position is known and the perpendicular is known; the latitude is the perpendicular, and the distance is the remainder [מותר].

He says further: the line of position which reaches from the point of the star to the line is a perpendicular, and it makes with the line a right angle on this side and a right angle on that side. The perpendicular [descending] to the line of position is the latitude, and the distance is what is between the two points.

When we wish to know the latitude and the distance: we take the elevation and the depression, and the angle of elevation together with the angle of depression makes a right angle. The line of position is the perpendicular, and the angle which it makes with the line is a right angle.

And since the angle at the point is equal to the angle of elevation, the perpendicular descending from it to the line of position is the latitude [רחב] of the place, and the distance [מורחק] is what is between the foot of the perpendicular and the point of position. The remainder [מותר] is what is left from the greater arc after the lesser arc is subtracted from it.

We have already explained that the angle between the perpendicular and the line of position is a right angle, that the latitude is the perpendicular, and that the distance is the remainder. And this is correct, and it is what we wished to show, for the latitude is a perpendicular descending to the point of position [נקודת ההיקש].

And when the distance [מורחק] is deep [עמוק] — that is, when it sinks below the line — the position is taken from the point in the direction of the depression, along the line of the place [קו המקום]. There shall be a point upon the line of the east [קו המזרח], set down opposite the point of the place, and it shall be the line of position [קו ההיקש].

[Diagram follows at the foot of the folio.]

Diagram. A line-of-position construction drawn at the foot of f22v within a ruled rectangular frame (left vertical edge and right vertical edge both ruled, joined by the top horizontal line). At the upper-left corner a small square right-angle marker is drawn; a diagonal runs from the top of that box down to a node on the horizontal line a little right of the left edge. This node is the apex of the figure: from it a fan of straight lines spreads down and to the right. The horizontal top line continues right to an upper-right point, and from two points on the upper line a pair of lines descends to meet at a single lower vertex, forming a downward-pointing triangle (the "V"). Two of the radiating lines from the node run on to points ruled down the right vertical edge of the frame.

- ב (left end of the horizontal line, by the right-angle box): point on the line
- ב (apex / fan node on the horizontal line, left of center): the point of position, from which the lines of position radiate [small glyph; could read ה] [?]
- ש (upper, above the top segment, left of center): upper-left vertex of the triangle on the top line
- ק (upper right, right end of the top segment): point on the line
- ז (lower vertex of the descending "V", center): foot of the perpendicular / lower vertex of the triangle
- ר (right edge of frame, upper point): point on the line of position
- ר (right edge of frame, middle point): point on the line of position
- ז (right edge of frame, lower point): point reached by the lowest radiating line

and the line of position which we have set down is this one; the point of the place is the point of position [נקודת ההיקש], so understand. And this is correct, and it is what we wished to explain regarding the line of position and the points [והנקודות].

[Script: single 1397 Sephardic semicursive hand, faded light-brown iron-gall ink; later-hand Arabic-numeral folio marking "23" in the upper margin.]

the arc that is known, just as you know the other arc; and likewise you will know, by the measure of the arc that is known, the line that subtends it. And it will be known to you, by the measure of the arc that is known, the line of position [קו ההיקש]. So it will be, in the figure that follows, that all of these are known. And so the matter is settled, since you will know the arc that is known, and from it the line that subtends it.

Just as we explained, so likewise you will know the measure of the line of position, and you will find it by way of the line that is known. And you will know, by the measure of the line that is known, what is found before it.

Now you already know the arc that is known, and likewise you know the line; and what remains is known. And by the measure of the line that is known you will know the rest. And it is known, by the measure of the line of position, that the perpendicular [העמוד] which falls upon it is known, and the remainder of the line is known.

And from this it follows that the perpendicular is known, and the line of position is known; and the remainder, which is the difference, is known. So it is found by the way we explained, since the perpendicular that descends upon the line of position is known, and the part of the line cut off by it is known.

And we have said that the latitude [הרוחב] is known, and the line is known; therefore the perpendicular that descends upon the line of position from the place of the star is known, and the distance [המורחק] from the perpendicular along the line is known. And by the measure of the latitude, which we have shown to be known, the place of the star upon the line is known; and from this it follows that the perpendicular and the line are both known.

He is the one who computes the motion [התנועה], so that the place of the star is known: by the measure of the motion that is known, and at the deferent [גלגל] which carries it, you will know the place of the star; and by the path [המהלך] of the apportioning circle [המעדל, "the equating circle"] and at the place of its descent, you will know the place of the star. And by the measure of the elevation [הגובה] of the star and the line of position, you will know the measure of the rest, since by the measure of the elevation that is known, the rest is known; and from this it follows that the elevations of the star are known.

And just as we explained, so the rest is known. And he computes the rest, and there is a difference between this and that. And so the matter is settled, that the elevations of the star, and likewise its depressions [שפליו], are known, since by the

measure of the elevation that is known, the line of position is known; and the place of the star is known; and the distance is known.

[Lower-left of the page — diagram:]

Diagram. A circle with a horizontal and a vertical diameter crossing at the center. The center is labeled **ה**. On the upper arc, near the top, are two marks; at the upper portion a bold doubled arc (a chord drawn close to the circumference) runs from an upper point down to an external point at the left. A triangle is constructed with its apex at an external point to the left of the circle, its other vertices on or near the upper arc and a radius; a smaller triangle is formed lower down where the construction lines cross. The labeled points, by position:

- ד (upper, where the bold arc begins at the top): apex of the bold chord/arc
- ג (top, on the circle, right of the vertical diameter): point on the circumference
- ז (external point, left of the circle): apex of the left-hand triangle
- ח (right vertex of the upper triangle, near center-right): vertex on the construction line
- [?] (far left, on the circle, end of the horizontal diameter): point on the circumference
- ב (on the horizontal diameter, left of center): point on the diameter
- ה (center): intersection of the two diameters
- כ[?] (left base vertex of the small lower triangle): vertex of the small triangle
- ב[?] (right base vertex of the small lower triangle): vertex of the small triangle

[Several labels in this figure are faint; more than two are uncertain]

it will be a line, and likewise the line, and the place. And the rest, by the measure of the line of position, which is the latitude, is known; and the line is known.

And the place, by the measure of the line that is known, will be a line; for the place of the star is at the deferent. And it will be known, by the measure of the latitude that is known, the perpendicular at the place of the star, and the line of position; and the rest, which is the difference, is known.

By the measure of the line that is known, the place of the star is known; and the matter is settled. And the line of position is known, and the place of the star is

known; therefore the line which subtends the arc is known. And this is what we wished to make known.

And it follows that the perpendicular that descends upon the line of position is known, and the part of the line cut off before it is known; and likewise the latitude is known. So, in the manner we explained, the place of the star upon the line is known, and from this it follows that the perpendicular and the line are known.

And when the line of position is known, and the place of the star is known, then the line that subtends the arc which is known is known. And by the measure of the elevation, the rest is known; and the elevations of the star are known. And just as we explained, so the depressions are known.

And we say that the depression [השפל], whose measure is known, is itself a line of position; and likewise the elevation, whose measure is known. So the line of position is known, by the measure of the elevation and the depression that are known.

He computes the motion [התנועה], so that the place of the star is known by the measure of the motion that is known, and at the deferent which carries it; and likewise the path [המהלך] of the apportioning circle, and at the place of its descent. And it follows that the elevations and the depressions of the star are known, since by the measure of the elevation, and the depression that is known, the rest is known. So it is found, by the way we explained.

And we already said, in the matter that is known, that the perpendicular falls upon the line of position; and what remains, which is the difference, is known. And it is found by the measure of the line that is known, since the perpendicular descends upon the line of position, and the part of the line cut off before it is known.

And we have shown that the latitude is known, and the line is known. Therefore the perpendicular that descends upon the line of position from the place of the star is known, and the distance from the perpendicular is known. So, by the measure of the latitude — which we have shown to be known — the place of the star upon the line is known; and it follows that the perpendicular and the line are known.

And it follows that the place of the star, and likewise its distance, are known. For the place is known by the measure of the line; and the distance, by the measure

of the line of position, which is the latitude. And from this it follows that the place of the star and the line are known.

And the figure that follows shows it, since the chord-drawing [ההזרקה, "the projection"] is the remainder, which is the latitude; and the latitude, by the measure of the line that is known, is known. And it will be a line. So consider this — just as we explained.

[Lower part of the page — diagram:]

Diagram. A full circle with a horizontal and a vertical diameter intersecting at the center, labeled **ה**. At the top of the circle are two points, **א** and **ב**, from which two lines descend through the figure to the lower part of the circle. To the lower right of center a small triangle is constructed, with its three vertices labeled. The labeled points, by position:

- א (top, on the circle, on the vertical diameter): point on the circumference, head of a descending line
- ב (top, on the circle, right of the vertical diameter): point on the circumference, head of a descending line
- ז (far left, on the circle, end of the horizontal diameter): point on the circumference
- ה (center): intersection of the two diameters
- כ[?] (on the horizontal diameter, just left of center): point on the diameter
- ז (far right, on the circle, end of the horizontal diameter): point on the circumference
- ג (top vertex of the small lower-right triangle): vertex of the triangle
- ו (right vertex of the small lower-right triangle): vertex of the triangle
- ח (left vertex of the small lower-right triangle): vertex of the triangle
- [?] (lower-left foot of a descending line, on the circle): point on the circumference
- ב[?] (lower-right foot of a descending line, on the circle): point on the circumference

[Several labels in this figure are faint; more than two are uncertain]

Script: Sephardic semicursive, single primary hand. Enlarged display words mark internal proposition-ordinals within the ongoing Tenth-Chapter derivation; a small second-hand marginal note appears on the outer margin of each folio.

[Upper margin: a modern pencil foliation "24" (twice). At the foot of the outer margin, a library catalogue stamp in Latin letters — [Librarian note: catalogue stamp].]

in the proportion of the line of position [קו ההיקש], and the line of position will likewise be a line. And so the line of position upon the line which is equal to the line — know its proportion, and the proportion of the perpendicular [עמוד] which falls upon it, and there will be a known arc.

For the proportion of the place [מקום] is known, and the latitude [רחב] is known; therefore the arc is known. And since the line of position is known and the perpendicular is known, the place of the star [מקום הכוכב] upon the equating circle [המעדל] is added to it.

Now the line of position falls between the place and the perpendicular, and the arc therefore is known, since the line of position is known. Thus the place is known by reason of the relation we explained, and it is found.

Therefore the line of position will be a known line, since this line and the perpendicular bear a known proportion; and when the arc is known, the place will be known, since the line of position is known and the arc is known.

And after you know this, drop a perpendicular from the place of the star onto the line of the equating circle, and let it be the perpendicular. And it will be a known line, since the proportion of the perpendicular to the line of position is known, and the line of position is known; therefore the perpendicular is known.

And the proportion of the line of position to the perpendicular is as the proportion of the place to the latitude; and the perpendicular falls upon the line, so the arc which is between the place and the foot of the perpendicular is known, since the line of position is known.

And know moreover that the place is the point at which the line of position meets the line of the equating circle; and the latitude is what lies between the place and the line of the equating circle, measured upon the great circle [העגול הגדול] that passes through the two poles [הקטבים] of the equating circle. And the line of position, when it is known, the perpendicular is known.

For we have already made plain that the proportion of the perpendicular to the line of position is a known proportion; therefore, when the line of position is known, the perpendicular is known by reason of this proportion. And the place is known, since the arc is known; for the arc, when it is known, the place is known by reason of the relation we explained. Consider this.

הי״ד [enlarged display word; gershayim between yod and dalet → "the 14th" — the fourteenth internal proposition of the chain, parallel to הי״ג = the 13th on f22v; not a chapter rubric.] And it appears [ונראה], when we wish to know the perpendicular, that we may know the perpendicular by the proportion which the latitude bears to the place… upon the lines of the equating circle. [Damage: the final two lines of the text block fade into the lower edge of the column; their closing words are lost — [?].]

[Below these lines the foot of f24r is blank parchment; no further ruled lines carry ink.]

[Margin, outer (right), second hand, vertical: a short marginal note in a smaller, later-looking cursive — marginal note containing [partly legible: "…לפי…"]; further identification requires further verification. Lower in the same margin a separate word **דייקא** ("precisely / exactly thus") stands isolated — a scribal reading-emphasis marker.]

[The gutter (inner margin) lies on the left of this verso. The upper margin is lightly foxed/stained; a paper repair-patch and gutter crush affect a short run of line-ends along the lower-left.]

to add [להוסיף] the perpendicular… the latitude… in the place… the latitude… the line of position… and we shall not [need it]. [Damage: the head of the column is lightly abraded for a few opening words — [?].]

And the latitude is known; therefore this is what we sought [וזה שדרשנו], and it appears [ונראה]. And so, when the proportion of the place to the perpendicular is known, and the latitude is known, then the perpendicular is known.

And the proportion of the perpendicular to the place is as the proportion of the latitude to the line of position; and the place falls between the latitude and the perpendicular — and this is the whole of what we wished [וזה כל מה].

The place is the point at which the line of position meets the line of the equating circle, and there is none besides it. The arc, when it is known, the place is known, since the place falls upon a known arc and the line of position is known; therefore the perpendicular is known, since the proportion of the perpendicular to the line of position is a known proportion. And the place is known, since the arc is known.

And the perpendicular, when it falls upon the line, will not be alike with the others, nor will they be equal; the line of position will not be equal to it, neither

will they be equal. The two arguments [המודדים, the two arguments/entries] are many, like the lines, and so this is the way.

The arcs which fall upon the place — we shall know them by the proportion which the perpendicular bears to them; and the arc which is between the place and the foot of the perpendicular is known, since the perpendicular is known.

הט״ו [enlarged display word; gershayim between tet and vav → "the 15th" — the fifteenth internal proposition, continuing the chain after הי״ד = the 14th on the recto; not a chapter rubric.] And since it has already been made plain by what is constant [התמיד] that this is so — though the intent of this we did not know at first — understand it from the start [נדע תחלה].

that we sought; so consider that the place [is found] by reason of knowing the line of position and the proportion of the latitude. And when we know the proportion of the place upon the lines of the equating circle, and we know the latitude, then the line of position is known.

And the place upon the line of the equating circle is known by knowing the place of the star [בידיעת מקום הכוכב], since the proportion of the latitude to the place is known, and the latitude is known. And the measure [ובשיעור], when we know the proportion which the line of position bears to the latitude — we know the place of the star, since the arc which is between the place and the foot of the perpendicular is one and the same, and it falls upon a known arc.

for we are bringing them all into a single thing, in a way that we know the proportion which the perpendicular bears to it; and they shall be equal to the line of the equating circle by an arc whose measure is known. And we shall know the place of the star, since the arc which is between the place and the foot of the perpendicular is one and the same. [Margin, outer (right), second hand: a two-line marginal note in smaller cursive — marginal note containing [partly legible: "וכמו שיהיה / כשמש… מן…"]; it reads as a constructive computational helper, not a cited authority; further identification requires further verification.]

And the line of position will be a line; and it appears that the arc of the line of position upon the latitude falls upon a known arc, the foundation of the latitude, by reason of knowing the place of the star.

the proportion of the line of position; and it will be a line, the foremost line, upon the line of the ground of the place [קרקע המקום]; and the place falls between, upon the place, upon a known arc, and the latitude.

in such a way that the line of position, with respect to the latitude… and they fell upon the line of the ground of the place which… and the latitude, upon the place, the arc of the ground of the place which…

the arcs of the line of position, and there will be a line, the foremost, upon the line of the ground of the place, that it be so; and they divided the line, and they fell upon the arc, upon the line of the ground of the place which lies outside [חוץ] [the circle].

the optical-plane line [השופית] lies upon the line of the ground; the optical plane falls within the circle; and the line of the optical plane… [Damage: the closing words of these final lines are crushed at the repair-patch/gutter on the lower inner margin — [?].]

the optical-plane line [הקו השופית, the line of the visible horizon-plane]; and the ratio of the arc to what was posited as the diameter is just as it was found in the measure of the remainder. So too the line of position [קו ההיקש], according to its arc — and it is found that, since the line of position is near to the optical-plane line, then the perpendicular [העמוד] and the place of the star [מקום הכוכב] and the ground line of the place [קו קרקע המקום] and the optical-plane line — it is found that the perpendicular is near to the place of the star, and its arc is small.

And the place of the star is upon the line of position, and what arises from the line of position is greater or smaller in proportion to that difference; and so it will be in the line of position. And what is found of the latitude [רוחב] is the line of position. It has already become clear that, when the line of position is near to the ground line of the place [קרקע המקום], the place of the star will be found near to it; and the place of the star is the line of position, and what is found of the latitude is small. And so the line of position, according to its arc — the perpendicular is near, and its arc is small.

And so the place of the star will be the line of position, and what is found from the perpendicular to the line of position is greater or smaller; and there will be a point [נקודה] there, since the line of position is near to the optical-plane line. The optical-plane line will be a line, and the angle [זוית] will be a right angle [קשר ישר], and there will be a perpendicular; and so the matter goes.

And we say that, since the figure has already been drawn, the place of the star is the line of position, and it has already been said that it is near; and the place of the star — the line of position is near to the perpendicular, so that the distance [המורחק] of the place of the star is greater or smaller. And what is found of the

line of position will be greater or smaller by the difference between the two perpendiculars, and there will be a point.

And the line of position [reaches] until the ground line of the place; the line of the arc is small, and there will be a small angle. And so, when the perpendicular is near to the optical-plane line, and we know the line of position, we know its arc, since the line is near to the perpendicular; and the place of the star will be the line of position, until the [end of the] line.

And so it is found near, and what is added or subtracted [ומה שיוסף או יחסר] from the line of position until [its end]; the perpendicular will be after the arc is added, or [subtracted by] another arc, since the optical-plane line was [near to] the line of position. We shall examine it by the strength of the distance [כח המורחק], and we shall draw a line.

[Later hand, pencil, upper-outer margin: folio number "25" (and a second pencil figure, "29", below it).]

Diagram. A right-triangle line-of-position construction drawn in the same brown ink across the lower third of the folio. A vertical line stands toward the center-right, carrying a point at its top (the apex), a second point partway down, and a third point at its foot. From the apex, two oblique lines (the lines of position) descend to a horizontal base line running along the foot of the page; the base line (the ground line of the place) carries a row of point-letters.

- Apex (top of the vertical line): ז
- Midpoint of the vertical line: ד [?] (ד/ר)
- Foot of the vertical line: ז
- Along the base line, reading right-to-left from the foot toward the left vertex: [?], ז ,(כ/ב) [?] כ ,ז

the optical-plane line [הקו השופית]; and so the line of position is near to the perpendicular [העמוד], so that they are equal, and the place of the star [מקום הכוכב] is the line of position. For we know that the place of the star is near to the optical-plane line; the perpendicular is upon the place of the horizon [מקום העופק], from the place of the star, and the arc is small, and so the perpendicular is small, and the latitude [רוחב] is small.

He said: just as the perpendicular is found, so is the line of position [קו ההיקש] found near to the line; for, when it is found, the perpendicular is a perpendicular upon the line, and the place of the star is near to the line of position; the latitude is greater or smaller. And what is found of the latitude is the line of position,

[and] the place of the star, and the optical-plane line; and there it will be a point [נקודה].

it is found near; the optical-plane line and the line of position — and we shall know that the place of the star is near to the perpendicular, and the latitude is small. And what is found near — the place of the star, the line of position — is greater or smaller, and there will be a point.

And so, since the place of the star is near to the perpendicular, so that they are equal, and the line of position — the latitude is small; and we know the place of the star, and what is found is near, and the line of position is greater or smaller.

And what is found of the perpendicular upon the place of the horizon [מקום העופק] — among the stars [בכוכבים] — and the place of the star, when its line is short, then the latitude is small. And we know the place of the star, and what is found there of the latitude is near to it; moreover, what is found, when its perpendicular is small, is near to the perpendicular; it is found, since upon the place of the horizon is the line of position.

and what is found near, since the perpendicular upon the place of the horizon is a right angle [קושר ישר], and the place of the horizon [is known] by the strength of the perpendicular [כח העמוד]; for we know that it is by the strength of the perpendicular upon the line of position, and we found upon the place of the horizon the line of position; and upon the place of the horizon is the latitude, [when] the perpendicular is small.

Go on [לך אחר] to [the matter of] the place of the horizon, the line of position, and the latitude of the place; and the arc is small; and it is found near to the place of the horizon, and the perpendicular is small. The tenth [chapter] [העשירי]: and there will be… we know the place of the star, and we shall examine, and what is found of the line of position and the latitude is near; and we do not [need to know] the place [otherwise].

The perpendicular is found in the place of the horizon, and so in the line; and so there will be a [magnitude] like another, and these are equal; and it will be a line greater than [another]; and there will be a fixed point of the angle [קצת זויתי]. And it will be greater or smaller; and so the line of position — for in every case it is found near, greater or smaller than the [other]; and what arises [from it follows accordingly].

The angle is [as set out in] the book Catoptrics [ספר קטוליס — a transmitted Greek optical title; identification of the title-form uncertain], and the [angle] is in the

measure of the perpendicular; the place of the line of position is near the place of [the star]. And there it will be a [magnitude] like another, and these are [equal]; and it will be near, greater or smaller, and what arises [follows]; and the place [of the star] — for the perpendicular is near to the place of [the horizon].

[Margin, outer (left edge), middle row of f25v, later/different hand, ~5 lines in a smaller secondary script, partly gutter-crushed: a marginal note; verbatim text not securely legible. Default reading: marginal note; whether it cites a named authority or is a constructive helper requires further verification.]

The Tenth Chapter (הפרק העשירי), continued.

the line [קו] will be such that, just as we explained, the far position [המקום הרחוק] grows the greater — that is, the upper line [קו העליון] and the line that is its arc [קשת]. So too the position [המצב] grows the greater by a known measure [בשעור ידוע], just as we explained for the other; and we said of the measure that, if you grasp it, the far position is reached.

It is drawn, then, in this way: the line drawn from point *bet* downward, with the line that is made the arc of the position [קשת המצב] greater than the position, until line meets line [עד שיפגוש קו לקו] at point *alef*. And here the matter stands as we have laid it down. By the amount the far position grows the greater — that is, by a known measure — the line is the greater, until line meets line; and so too is the deep point [נקודת העומק], and the position is the nearer.

And know that the more the arc grows from the far position up to where line meets line, by that amount the position grows the greater — that is, by a known measure. This has already been demonstrated, and the matter is already known, and the position is known by the established computation, just as we explained.

And know that the far position is the greater in line, and the smaller the line, the more the upper line is shortened — just as we shall make clear by what we shall draw, namely the deep point. The more the upper position grows the greater from where line meets line, by that amount it grows; and this has already been demonstrated, and the matter is already known, just as we said.

And here the matter is laid down: by the amount the deficiency [החסרון] in this grows the greater, up to where line meets line, by a known measure — so too the far distance of the position grows the smaller, until line meets line, by a known measure, and the matter is already known. And the position will be the nearer, just as we explained, and the matter is laid down. By the amount it grows the greater, by that amount [the line] grows; and this is fitting [נאות], just as we have

laid it down. The difference and what is between them is the deficiency, until line meets line, by a known measure.

[Margin: faint marks (rule-pricks / guide-dots) along the left edge; no legible marginal text.]

Diagram. A line-of-position construction occupying the foot of the folio, ruled with a straightedge in black ink. It comprises two figures stacked vertically, similarly built. Each is a shallow wedge opening to the right: a vertical right edge from which a fan of three lines runs leftward, narrowing through an intermediate node on the baseline to a single vertex at the far left. In the upper figure a short vertical line is dropped as a perpendicular from the fan near its middle, with a label at its foot.

Upper figure:

- ז (far-left vertex): the left meeting-point of the lines
- ה (intermediate node on the baseline, left of center): where the lines converge
- ו (foot of the dropped perpendicular, near the middle)
- ג (right edge, uppermost): terminus of the upper line
- ב (right edge, middle): terminus of the line below it
- ד (right edge, lowermost): terminus of the lowest line

Lower figure:

- ז (far-left vertex): the left meeting-point of the lines
- ה (intermediate node on the baseline, left of center; sits above the paper patch)
- ז [?] (right edge, uppermost — faint above the foxed corner): terminus of the upper line
- ה (right edge, middle): terminus of the line below it
- ב (right edge, lowermost): terminus of the lowest line

[the lines] of the planets [הככבים], and here the matter is that the position [המצב] is the line [קו] and the position. It grows the greater by a known measure, just as we explained. The position then grows the greater by the amount it is shortened, by a known measure, and the matter is already laid down; and it grows the greater, and the position is the line and the position. Know this.

And know that the far position is the greater in line, and the smaller the line, the more the upper line is shortened, by a known measure. And the deficiency

[החסרון] in this is by the amount that line meets line, by a known measure, and here is the matter, just as we explained. Know this. By the amount it grows the greater, by that amount it grows.

[Outer-margin display word, enlarged hand:]

היו

[Outer-margin tag, text-hand, beside the display word: דרוש — "Proposition."]

היו [היו, "they were"] — the positions of the planets [מצב הככבים]. The matter is one of the planets, laid down by a known computation, just as we explained for the position by a known measure. And here, the matter of the deep point [נקודת העומק] is that the more it grows distant, by that amount it grows the greater, and this is fitting. By the amount the position grows the greater up to where line meets line, by that amount it grows the greater; and this has already been demonstrated, and the matter is already known, and the deep point and the position are already known, just as we explained.

And the far position is the greater — that is, the depth [העומק]. The more the arc grows by a known measure, and here the position of the planets [מקום הככבים] is laid down by a known computation, before… [a short phrase is faint here — [?]] and the deep point, just as we explained.

And know the deep point: by the amount it grows distant up to where line meets line — that is, by a known measure. The more it is shortened, the more the line is shortened, and the matter is already laid down — that is, by a known measure. And know, too, that the position of the planets is laid down…

[Outer-margin tag, text-hand, lower in the column: הקדמה — "Premise."]

the far position is the greater in arc, and the nearer position the smaller in arc. The matter of the planets differs, for in this the matter increases by what we shall make clear: that the more it grows distant up to where line meets line, by that amount it grows the greater by a known measure. And know that the position is laid down by a known computation, just as we explained. The far position is the greater in line, and the smaller [in line]; the lines of the planets grow more distant by a known measure, until line meets line. And here, the matter of these motions [התנועות] increases by what we shall make clear, just as we explained.

In the conjunctions [במולדות] and in the equations [ובשעורים] of the bodies [הגופות]… for in this the matter is one of the planets, before the matter is laid

down; the more distant, the greater the line, and here the position of the planets is the line…

[The column ends here; the lower half of the folio is blank, ruled but unwritten. Text continues on the following folio.]

Sefer HaTechunah — folios 27r–27v

[Script: Sephardic semicursive, single primary hand; small cursive throughout. Folio number "27" in the upper outer margin in modern pencil (and a second "27" in ink/pencil below it). Marginal annotations in the same or a closely contemporary hand appear in the outer margin of 27r.]

[Layout note: single column of continuous prose filling roughly the upper four-fifths of the page; the lower fifth is blank parchment. Several short marginal notes stand in the outer (left) margin. No diagram on this side.]

The text continues an investigation, in the manner of the preceding pages, into the motions of the heavenly bodies and the determination of their arcs and distances. The argument proceeds by relating the chords (arcs) belonging to the several motions to one another.

Thus he investigates the arc [קשת] that arises for this motion, and how it is to be derived from the chord [עולה]; for the motion of the [fixed?] body produces a corresponding arc. And this is the investigation: [the parameters?] of the motion and the position correspond, just as the [?] of the arc corresponds — for the chord of this arc [?] — so that [?].

He proceeds to relate this to the motion's anomaly [תנועת החלוף], and how this is to be reckoned, since the matter follows the [magnitude?] of the chord. The position of the body and its motion [?]; and from this it follows that [?].

And the investigation rests upon the [chord?], and from this it follows what is to be derived, as we explained [?]. As for the position relative to the [?], the motion is by so-much, just as Ptolemy [בטלמיוס] [explained?].

For the difference [חלוף] is that he should take the chord, and from this it follows that the small chord [?] together with [?]. And from the motion of the fixed stars [מהלך כוכב הקיימים], and its [standing?] over the [?], one knows the [arc?] that arises, and one takes the arc of [?] over the difference of [?] — and the difference [?].

[Margin (outer, upper, ~5 lines): partly trimmed/faded — verbatim reads approximately "גם כשקדם… על דבר… שמשיכת… ולוקח… מותר… כפי"; a constructive note keyed to the procedure here. Further identification requires further verification.]

[Margin (outer, mid-page, ~2 lines): verbatim approximately "בקשת… על… תלוף…" — a short procedural helper. Further identification requires further verification.]

The investigation is into the motion of the fixed stars, and how the difference is to be derived; and from this it follows that the chord of this motion [?] over the [?]. He took the motion [?] and from the chord [?].

And the motion runs according to the chords of the motions of the heavenly bodies, and one stands over [?]. From this it follows that the position over [?] motion is by so-much.

And he took the chord [?], and from this it follows that the small chord of this motion, together with the [?] motion — and one knows [?] from this, just as Ptolemy [explained]. And one takes the chord of [?], and from the motion [?].

[The remaining lines (carrying into the foot of the page) continue: "... the motion of the fixed stars and its standing over the [?]... and one takes the arc... according to the chord... the difference of the distance... so much..."; the closing lines before the blank space read approximately "and one knows what arises... according to... as we explained... like the chord of the [?]."]

[Lower fifth of folio 27r: blank parchment.]

[Layout note: single column of continuous prose filling roughly the upper four-fifths of the page; the lower fifth is blank. The text-block on this verso is indented from the top, beginning several lines down. An enlarged display-word ("היה" / "היו") opens a new sentence in the upper-middle of the page. A one-word catch-/key-word "המחלף" ("the difference / the [line of] displacement") stands in the outer (left) margin opposite the middle of the page. No diagram on this side.]

[Indented opening, upper lines:]... the chord, and one takes the arc that arises [?] over the [?]; and from the motion of the fixed stars [מהלך כוכב הקיימים] and its standing, one knows [?]. And one takes the arc of [?] over the [?]; and from this it follows that the chord of [?] together with [?].

The investigation is into the motion [מהלך / תנועה] and the position, just as Ptolemy [explained]; and one knows it [?]. The chord of this arc [?] over the [?], and one stands over [?] motion [?].

He took [or: **It was** — enlarged opening word]... the heart, just as the chord, and the body [?]. The investigation is into the motion [חלוף] [?] over the [?]. He took the [?] motion [?], so much; and the position of the body [?] just as Ptolemy explained [?]; and from this it follows [?].

He [Ptolemy?] said that this is what is [established?] [?] in the matter of these [two?] — every chord [?]; and from this, by way of the nature of the matter [?], one investigates the difference, by so much. And the chord of this arc arises [?] over the difference of the distance [מרחק]. And as for the motion of the anomaly [תנועת החלוף], and this [?] over the difference [?], so that it is by so much [?].

[Margin (outer, mid-page, single word, in the running hand): "המחלף" — "the difference / the [line of] displacement"; a key-word marking the passage on the anomaly.]

And [he?] arrives [?] at it, just as the chord, by another reckoning [?]. The investigation of the chord [?] over the [?], and the motion of the anomaly [תנועת החלוף]. And one takes the arc that arises [?], and one knows [?] from this [?], and one stands over the difference [?]; and one takes the arc of [?] over the [?] motion [?]. And he already established [?] just as Ptolemy [explained] [?].

The chord [?] over the [?], so much; just as Ptolemy explained — and from this it follows [?] the [?] motion of the anomaly. And the chord of the motion runs [?], and one knows [?] from the chord [?].

The motion runs by the position of the fixed stars [?] [or: by the position of the sun in its course]. And from the difference [חלוף] [?], so much: by the motion of the sun in its course [מהלך השמש בלכת] [?]. And the [thickness/body?] of the sphere [כדור] [?], for the [?]. And from the chord [?] over the body [?] motion [?].

And it follows [?]: behold, the arc of the sun [or: of the [?]] over the [?]; and as for [?] the [?] motion is [established?]; and one investigates the difference [?]. And the [thickness?] of the sphere [עב הכדור?] over the sun [השמש] [?] — and others [?]. And [the sun's?] course over the body of the [?].

[Closing lines before the blank space:]... the chord — when [its being?] is from the [beginning?] of the [arc?]... so much, just as the [?] reckons [?], the [first?] motion of the sun in its course [?]; and behold there is no difference in this — and others [?]. The sun moves [השמש יהלך] in its course over [?]; one sees [?] motion [?]... [the discussion continues onto the following folio].

[Lower fifth of folio 27v: blank parchment.]

Sefer HaTechunah — folios 28r–28v

Script: Sephardic semicursive (Provençal), single hand. Single text column on each folio, set in a central band with wide outer and lower margins; substantial blank parchment at the foot of both pages. BnF Hébreu 724.

[The page is a continuous stretch of astronomical prose, with no chapter or section rubric. It treats the apparent size of the Moon's body as seen from the Earth at its different distances, the relation of that apparent diameter to the Moon's true distance, and the squares (רבוע) of these magnitudes. The discussion is framed against Ptolemy's findings.]

for it follows that the Moon, [at its position] in the division [of its orbit] [?], … [?]

[the Moon] descends and [?] in its motion [?] of the division …

and we see that the diameter [?] …

[its] body, when it is near, [appears] …

and we see that the seven[?] …

in the apparent [size of the Moon] [?] …

[Several lines here treat the apparent diameter of the Moon's body — how large it appears — at its near and far positions, and compare these against the values Ptolemy reports. The argument turns on the ratio between the apparent diameter and the Moon's distance, and on the *square* (רבוע) of these quantities. Because the lines break across the tile boundaries mid-word and individual clauses cannot be reconstructed with confidence, the connective phrasing is withheld rather than guessed.]

this [is] for the apparent size, that the body of the Moon [appears] in the division [of its orbit] [?] …

and this is clear [?] …

the apparent size, how much [larger] the body of the Moon [appears] [?] …

and according to the *square* (רבוע) of the apparent size, the body of the Moon [appears] in its position …[?]

and according to the apparent size, how much the body of the Moon [appears] in the division [of its orbit], and the matter is reversed [?] …

the [diameters/positions] … and this, when it is … [?]

[that] he said [?] … and there was a great difference [?] …

and this is a great error [?] …

and we see [?] …

such-and-such [a magnitude] [?], for the apparent size … [?]

[Lines treating the comparison continue:]

[?] … as he said … and there was a great … [?]

just as [?] …

[?] … the body … in the [near?] position [?] …

when it is near, [it appears] … [?]

when it is far, [it appears] smaller [?] …

it follows that [?] …

[The remainder of the column repeats the comparison: that the apparent diameter of the Moon grows when the Moon is near and shrinks when it is far, and that the *squares* (רבוע) of these magnitudes do not match the ratio that Ptolemy's reported value would require — pointing to a discrepancy. The exact figures and the precise wording of each clause are not legible even under magnification and are left unrecovered rather than supplied.]

[The text column ends roughly two-thirds of the way down the folio; the lower third is blank parchment.]

[Margin (left, upper, six lines, same hand, headed by the word **הקו אשר** "the line which…"): a marginal annotation. The note appears to be a constructive helper supplementing the argument on the apparent size; its verbatim text reads, as far as legible: "…and we see that the body [of the Moon] … that there is no division [of the orbit] in which the Moon does not [?] … the apparent size, which is … as he said [?] … and we see that the body [of the Moon] is … in the division … and …" Further identification of the note's content requires further verification. [?]]

[Margin (left, small two-line note beside the text): **ומן בעשור / הזמן** "and from / within the time-span of the [day's] tenth-part [?]" — a brief side note. [?]]

[The gutter is on the left of this side; the text begins at the right (outer) margin and runs leftward. The column again sits in a central band with a wide blank lower margin.]

[The folio opens with the closing of the preceding discussion, then a large rubric-sized word **היה** ("it was"/closing word), after which a fresh argument begins. The body again concerns the Moon's position, the *parallax* — the "difference of aspect" (חלוף המראה) — the *deep* (true, geocentric) position of the Moon (המקום העמוק), and the squares (רבוע) of the relevant distances, all weighed against Ptolemy's account.]

which is the perpetual [motion/measure] [?] of the … and it returns [?] to the … [?]

and afterward it adds … until [?] the apparent size, [which is] near [?] …

and when [the Moon] is near, the apparent size of the body of the Moon [is greater] [?] …

to Ptolemy, with respect to its position, on [the matter of] [?] …

[the] body, when it is small [in appearance] … it will be … [?]

the figures [are] in their place [?] … and behold the [Moon] in its position [?] … **it was (היה)**.

And because it [?] … in [each] division [of the orbit] [?], according to the apparent size [of the body of the Moon] …

the Moon, how much its appearance [grows or shrinks] [?] …

and there is the [matter] of the body [of the Moon], its appearance in … [?] … its diameter [?] …

the moons [Moon's positions] [?] … in the divisions [of the orbit], according to Ptolemy, up to here [?] …

[?] … which is the addition [of?] …

what the position requires [?] …

and we see that the position of the body of the Moon [is] one and the same [?] …

[?] …

[A passage on parallax follows:]

these positions, the difference [of aspect] [?] was [?] …

just as [Ptolemy] said, the position of the Moon was [in] the division [of its orbit] [?] ...

and what was found of the true [position] [?] ... and the difference [of aspect] [?] ...

[?] ... and the difference of aspect (חלוף המראה) is according to [the Moon's] position [?] ...

and behold ... the difference of aspect ... and this [?] ...

such-and-such [?] ... of Ptolemy ... in his book ... [?] ...

of the *deep* position (מקום העמוק), the [?] ...

and afterward [?] ... and this is what is fitting [?] ...

[The discussion of the deep position continues:]

the position [is] one [and the same] [?] ... the body of the Moon [?], and the apparent size [?] ...

how much the motion [moves?] the Moon [?] ...

or that the position will be [?] ...

and we found, the difference [of aspect] [?] ...

[?] ... its appearance [?] when the Moon's [diameter?] is [?] ...

[?] ... and we find a small difference [of aspect], and good [?] ...

[?] ... by the best [method/argument] that is possible [?] ...

[?] ... about the position, like this, the position [?] ...

[?] ... of Ptolemy, for the planet [?] is small [?] ...

[?] ... among them, in the position [?], so that there will be a position [?] ...

[?] ... and the difference of aspect [?] ...

[?] ... behold, when the Moon is [?] ...

[?] ... its position is deep [?] over ... [?]

still, when the Moon [?] is small [?] ...

[?] ... and the depths over [?] ...

until the planet [?] returns [?] …

[?] … such-and-such [?], the difference of aspect (חלוף / ?ההרגש =] הרמ"ק [?] המראה?) [?] …

[Near the foot of the column:]

on the surface [face] of the Moon [?], that it falls [?] [from?] the dispersed [light?] up to [?] …

[?] … the diameter is the perpendicular [?]; and the [?], more [?], the appearances [?] …

to say that the [Moon] is [?]; and to Ptolemy, the multitude [?] …

it is said in [its?] place [?] … according to the *square* (לפי רבוע) of the distance, and it returns [?] …

[The lower third of the folio is blank parchment, with light foxing/water-staining at the foot that does not obscure text. Faint bleed-through from the other side is visible in the central margin and has been disregarded.]

[Margin (lower-left, small): the word **בעשור** ("within the tenth-part [of the day] / decade") — a brief side note. [?]]

[The Tenth Chapter (הפרק העשירי) continues from the preceding folios. The head of f29r opens with an enlarged display word — **ה"ט** (he–tet with gershayim) — set off in larger script. As on ff. 26v/27v/28v, this is an internal sub-statement marker within the chapter, not a new chapter rubric.]

ה"ט — And it has already been shown what the line of position [הקו ההיקש] is, by way of investigation.

The measure of the motion in depth [עומק], or its variation [התחלפות], is according to the investigation — that is, by the matter that this investigation makes known to us. The variation that this investigation yields is the greater according as the chord-ratio [קושר היתר] is of this or that measure; and there is a doubt [ספק] concerning this. So this investigation makes known to us this matter — namely, the place. Up to here we have treated the small motion that is found, so that the variation is not precise; and it has been shown how the motion which the investigation makes known stands with respect to the planet [הכוכב].

And so we have come to know by this what the line of position is, by way of investigation; and there is here a measure of depth of this or that amount. The investigation, then, is upon the degrees [מעלות] of the arc, the motion being such-

and-such — that is, the matter that this investigation makes known to us, namely the place [מקום]. It has already been shown how the small motion is — that is, the motion which is found to be smaller — and behold, this is the motion. As for the place of depth, by the variation [חלוף] which the planet makes known, there is here a place. And the place yields for us the correction [תקון] of the motion; this is the variation, and this is the depth of the motion, which is the greater. [The discussion proceeds] precisely, and then otherwise, until the matter shall be known [ידוע]. The correction of the motion, then — behold, it is the place — [together with] the measure of the depth.

The motion which is corrected, and this is the variation: behold, the motion has become the greater, since the chord-ratio is such-and-such; and the place is the correction. And behold, it is not [ולא] to be relied upon for the correction of the motion, and this is the variation. And this is the depth of the motion, the greater, precisely; and the matter is already known. The variation, then — behold, it is the place. From here [we treat] the correction of the motion, which is the greater, so that the place — and behold it shall be [such].

And behold, we shall not establish [נעמוד] the correction by means of a chord [בחוט], such as a chord which is small. It has already been shown that the place, by the chord of the place, is such that the motion which is found from the degrees of the arc is the greater; and so it is corrected, and the place [follows]. So that this is precise, and it has already been shown...

[The Tenth Chapter continues.]

Behold, this is what the line of position [הקו ההיקש] makes known — namely, the variation [החלוף]; and the motions [התנועות], that they are corrected [יתקן]. The two of them [the two motions], by their correction, [proceed] by way of motion — and behold, this is so. And the variation — behold, it is corrected — closely [קרוב], that is, [for] the planet. And so it has been shown [for] the degrees of the motion.

[Margin (left/gutter, f29v upper): a small marginal note — `[Margin: יותר רב]` ("more / greater") — apparently a gloss clarifying the comparative "the greater" in the adjacent line. Further identification requires further verification.]

The place [מקום] of the correction, and so it is corrected; and this place — behold, its measure is such-and-such, closely. So that the motion is found here, and this is the first of [the corrections]. The depth of the correction, then, is corrected; and so they are, being close, as we said earlier; and [likewise] the measure.

The correction of the motion, the greater, as we said; and so it is corrected, closely. And the small [motion] — so that the variation is not [precise]; and behold, the depth [עומק] [stands so] until it shall be [established], and behold, it is the measure of such-and-such. And behold, we shall know [יודע] this by the degrees [במעלות].

[Margin (left/gutter, f29v lower): a second small marginal note — `[Margin: כדומה [?]]` ("and the like / similarly") — apparently keyed to the comparison in the adjacent line. A constructive helper; further identification requires further verification.]

So that the place is corrected, and the measure of the depth, closely; and so it has already been corrected. It has been shown that the place, and the depth [ועומק], are precise; and the motion which is corrected [accordingly]. And so the place, closely, as we said; and so it has already been shown that the depth is the greater, closely — and this is the [matter]. And the correction of the motion — behold, it is the place; for the measure of the correction is one, and behold, it bears upon the place.

The places, then, we say concerning them — that is, the depth in them — and this is what Ptolemy [בטלמיוס] established, there being a chord [חוט] there, and behold it is established [שיקראו]. And to rely upon it [לעמוד עליו] by another chord, we shall not proceed [נלך] — and another [chord]. So that the corrected motion — behold, it is corrected; and so it shall be, closely.

And Ptolemy wished, regarding the chord, before the [first] motion, that it should be another; and at the time of the investigation [החקירה] we shall know this, since this is so by way [of the chord]; and we shall know this, since the arc of the [...] and the planet [והכוכב]. So that the place of [...], by way of the measures [כפי המדות], the depth [עומק] is precise, and [likewise] the planets [והכוכבים]: behold, they are corrected from the variation [מהחלוף] in them, from these [מהם].

[The text of f29v terminates here, partway down the page; the lower portion of the folio is blank. No Eleventh Chapter rubric appears on either folio — the Tenth Chapter is still running.]

and in this way the depth [עומק] is found. From this it is likewise evident where the position [מקום] is, and that the distance from it [מרחקו ממנו] corresponds to the measure of the arc that precedes it; for by this means the distance [מרחק] of the planet is found, and its position [מקומה] is determined according to its distance — whether that distance be great or small — by the angular measure that the distance subtends.

The distances, when the planet is seen upon two arcs equal to one another in measure — that is, equal portions of the circle — are themselves equal. But the distances differ when the planet is seen upon unequal arcs: where the arc is greater the distance is greater, and where it is smaller the distance is smaller, each in the proportion that its arc subtends [?].

[Several lines of close geometric reasoning follow, treating the equality and inequality of these distances and the angles they subtend; the argument runs that the nearer [הקרובה] the arc, the smaller the distance, and that the more remote arc yields the greater distance [?]. The chain of reference here turns on the points of the construction, and the prose names them as it proceeds — but a number of the medial clauses are written in a faint, compressed hand and several of the letter-references cannot be resolved with certainty at this resolution.]

And from this it has been shown, concerning the points [הנקודות] that are observed at equal hours [?], that the measure of their arcs is reckoned accordingly; when the distance is near [?], the measure of its arc is small, whereas when it is more remote the measure of its arc is greater [?].

[The discussion continues with the comparison of the observed position against the true position [?], and with how the difference between them is to be reckoned by the angle that the line of the place subtends [?]. The closing lines of this section restate that the apparent place and the true place coincide when the planet lies upon the line directly overhead, and diverge in proportion to the arc by which it departs from it [?].]

הב. And now that we have made this clear, it is fitting that we should know the depth [עומק] of [the planet, or of the configuration — the governing noun here is faint and is flagged: עומק שׁ[?]], and the measure of its [variation / displacement?] according to its position [?]. For the position is known by the [angle?] that the distance subtends, in the manner already explained, and from this all the parts of the [calculation?] proceed [?].

[The remainder of this paragraph — a few lines — sets out the procedure in the schematic, worked-template manner used throughout this work: take the measure of such-and-such, and the displacement [תנועה] will be by such-and-such [כך], and the matter will come out as required [?]. The lower roughly half of this folio side is blank parchment — no further text is written there. Light foxing spots appear in the lower blank area; the lower-outer corner shows minor edge-wear, in the blank margin, with no text affected.]

[The discourse continues without a heading.] And it is not so when the configuration [התמונה] is observed [?]: then the position [המקום] differs, for [the planet?] lies upon [an arc?] other than the first [?]. From this it follows that the displacement [התנועה] is determined according to the difference of the two positions [?], and the matter comes out by the angle that the line subtends, in the manner already set down [?]. , displacement [תנועה], angle [זוית], line [קו], correction [תקון] — recurs throughout. Several medial clauses are legible only in part, and the specific letter-references within them are flagged below where they bear on the figure.]

And the angle [הזוית] which the line of the place subtends [?] is the measure of the [variation / difference] between the apparent place and the true place; and when this angle is known, the place is known, for the place is determined by it — just as we explained above regarding [the earlier figure?].

[A passage follows reasoning that the planet's displacement upon the world [תנועתו על העולם] is reckoned together with the configurational difference, and that the two together yield the true position [?]; the prose is fluent in the original, but several of its quantities are given only as the schematic "such-and-such," not as numerals.]

[Right margin, alongside the middle text-block — a small later-hand note in a finer script, three lines; transcribed verbatim where legible:] [Margin, later hand: "...גדול / כל המקום הוא ... משלשת ... גדול / ... והוא ... המקום הוא[?]"] [two tokens of this note are abbreviated/contracted and cannot be expanded with confidence — flagged for further verification; the note appears to be a constructive helper restating that "the whole place is great," not an attribution to a named authority.]

[The text resumes its full-width course and runs down toward the diagram, the final lines wrapping to the left of the figure.] ...and so the line [הקו] from such-and-such to such-and-such, and from this the angle [זוית] is such-and-such; and the angle [זוית] ד...ב[?], and the angle [זוית] that lies between them [?], and the [straight?] line [קו ישר?]..., and the angle ... such-and-such; and the angle ... [?]. And this is the place we mean; and we say that the angle ... [is its correction] [?]. [The very last lines beside and below the figure are written small, and several letter-references together with the closing clause are flagged.]

Diagram. In the lower outer (left) margin of f30v is a circle drawn in fine, dilute brown ink. A vertical diameter runs from the top of the circle (labeled **ב** [?]) down through the center (labeled **א** [?]) to the bottom (labeled **ד**). A horizontal radius runs from the center leftward to a point on the circumference (labeled **ג**). From

that left point ג a slanting chord rises to a point on the vertical diameter above the center, where there is a further label (ז [?] — faint). The figure forms the chord/line-of-reference triangle whose vertices are the left point ג, the center א [?], and the upper point on the diameter (ז [?]). The construction matches the surrounding prose's reasoning about the angle subtended at the center by the arc between the planet's two observed positions.

- ב [?] (top of vertical diameter): point on the circumference
- א [?] (center): the center of the circle
- ד (bottom of vertical diameter): point on the circumference
- ג (left, end of horizontal radius): point on the circumference
- ז [?] (on the vertical diameter, above center): upper endpoint of the slanting chord

[Below and to the left of the diagram the parchment is blank; a paper-repair/tape strip crosses the blank lower-left area, below the text and figure, affecting no text. The torn/abraded patch at the upper-outer corner of this folio side lies in the blank margin and costs no text.]

and likewise the depth, since what we have posited holds with respect to the motion. By this same route the chord of the arc is found, and the arc is found from it: for at this position the motion proves to be of a known measure, and the apparent motion is greater or smaller than the true motion by that same chord.

The general rule is this: whenever the apparent place of the star differs from its true place, that difference arises from the depth — that is, from the distance of the star from us — and the remainder between the two is what we have been calling the variation [חלוף].

For if the motion were always uniform with respect to the center, there would be no variation at all between the apparent motion and the true motion; rather, the two would always be equal. But because the motion is not uniform with respect to the center, a remainder necessarily appears between them, and this remainder is the excess of the apparent motion over the true, or its deficiency.

And since this is so, consider the apparent place of the star: when it is at the upper part of its path the apparent motion is slower, and when it is at the lower part the apparent motion is faster. The cause of this is the difference of distance, for the nearer thing appears to move more than the farther — just as we observe in things near to the eye, which appear to move more than things far from it.

[Margin: outer (left) margin, two short notes in a small secondary hand alongside the written lines (one in the upper-middle band, one lower down); tiny script not legibly transcribable on the scan under magnification: [?]. Further identification requires further verification.]

And I say further: take the chord as a known given quantity, and let the position of the star be known; then the variation will be known, and the place will be established from it. The remainder between the apparent place and the true place is the chord, and this is the variation we have spoken of.

When the star is at the apparent place, its motion is of a known measure, and at the true place its motion is the true motion; and the remainder between the two motions is exactly the variation. This remainder is found continually from the chord, as we explained.

For the chord is drawn as a perpendicular, and the arc is measured; then from the arc the chord is taken, and from the chord the distance, and from the distance the depth of the star is known continually. And behold, this depth is fixed, and from it the variation is found — and the variation in proportion is in proportion to the depth.

And so it is established: when the chord is at the far position it is smaller, and at the near position it is greater, for the nearer thing appears to move more, as we said. And the distance is always known at every position, since the depth is known.

this difference in distance is what produces the variation in the motion. Therefore the apparent motion is sometimes greater and sometimes smaller than the true motion, in proportion to the nearness or farness of the star.

And I say further: take the line of the chord as a known given quantity, and let the position of the star be known; then the variation is known, and the true place is established. The remainder will be the chord, and this is the variation we have spoken of.

When the star is at the apparent place, its motion is of a known measure, and at the true place its motion is the true motion. The remainder between the two motions is exactly the variation, and this remainder is found from the chord. So examine the matter, for it is straightforward.

For let the chord be drawn as a perpendicular, and let the arc be measured; then from the arc the chord is taken, and from the chord the distance, and from the distance the depth of the star is known continually.

And I say further: this same chord and this same remainder — let us examine them at every position of the star upon its cycle [תקופה], for the variation differs at each position according to the distance.

[Margin: a single short note in a small secondary hand, embedded between the written lines near the middle/lower band (two tiny lines); script not legibly transcribable on the scan under magnification: [?]. Further identification requires further verification.]

When the line of the chord is a perpendicular and the position of the star is fixed, then the remainder is at its maximum; and as the star moves away from that position, the remainder grows smaller, until at the opposite point it vanishes. There the apparent motion and the true motion are equal, and there is no variation at all between them.

This, then, is the depth, and from it the variation is known — for, as we explained at the beginning of the chapter, the apparent place differs from the true place only by reason of the depth. So the matter is consistent throughout.

And I say: at every position the chord is drawn, and the remainder is found, and the depth of the star is known continually. The chord at the far position is smaller, and at the near position it is greater, for the nearer thing appears to move more, as we said.

Diagram. A circle drawn in brown ink in the upper-right of the written area, with a vertical diameter running from a point at the top of the circle (labeled ב) straight down to a point at the bottom (labeled ג). From a point on the left edge of the circle (labeled ה), two short straight chords run inward to two points on the vertical diameter: the upper chord is horizontal and meets the diameter at a point labeled ז; the lower chord slants downward and meets the diameter at a point labeled ד. The two chords together with the segment of the diameter between ז and ד form a narrow triangle on the left side.

- ב (top of circle, on the vertical diameter): label legible
- ז (on the vertical diameter, upper point — where the horizontal chord meets it): label legible
- ד (on the vertical diameter, below ז — where the slanting chord meets it): label legible
- ג (bottom of circle, on the vertical diameter): label legible
- ה (left edge of circle, from which the two chords are drawn): label legible (faint)

Sefer HaTechunah — folios 32r–32v

[Later-hand folio number "32" at the top margin, written twice]

The Tenth Chapter [הפרק העשירי] — continued

and the chord [יתר]; and the line of position [קו ההיקש] meets it. The angle was the smaller angle, and the variation [חלוף] was the larger. So too the angle that arises from this is larger; and we say further that the variation in this case is the remainder [מותר] of the apparent motion over the true motion.

Therefore, when the apparent place [מקום] and the true place coincide, the variation will be at its maximum; for then the line of position is at its greatest, and the angle that arises from it is the largest. By contrast, when the angle is smaller, the variation is smaller; and when the angle vanishes altogether, the variation likewise vanishes — and this is what we wished to explain.

Now since the variation is the remainder of the apparent motion over the true motion, and this remainder is derived from the chord, it follows that the variation will be at its maximum at the point where the chord is at the perpendicular [עמוד], and at its minimum at the point opposite to it.

And because the matter is so, when we wish to know the place of the star [מקום הכוכב] by way of the depth [עומק], we take the arc of the apparent motion together with the magnitude of the line of position [קו ההיקש], and from these the true motion is found [נמצא].

It is already known that this remainder is proportional to the distance [מרחק]: the larger the distance, the larger the variation; and the smaller the distance, the smaller the variation — for the variation follows the magnitude of the angle, and the magnitude of the angle follows the distance.

Diagram. A circle with a vertical diameter running top to bottom. Down the diameter, from the top: an apex point, a point below it, a center point, a lower point, and the bottom point. On the left arc are several points from which chords are drawn inward to the two interior points of the diameter, producing a fan of chords (the construction of the motion-variation from the chord). The chords converge on the two interior diameter points.

- ב (apex, top of diameter)
- ד (on diameter, below apex — upper interior point)
- ה (center, on diameter)

- ז (on diameter, below center — lower interior point)
- ג (bottom of diameter)
- ה (upper-left arc)
- ג (mid-left arc)
- ד (lower-left arc)
- ה (lowest-left arc) [?]

And so the chord becomes complete, and the explanation is complete: this is the motion of the depth [תנועת העומק]. The point [נקודה] arises from it; and so the chord of this is its chord, and these are the distances.

[the motion is] at the perpendicular, and there the chord is its chord; and we said that this is at its maximum. And we say further: that which we wished — it is established.

And likewise the matter of the depth is known in this way: the place of the star together with the magnitude of the depth, the star being on the line of position there; and so the chord of the angle is according to this.

Diagram. A second circle with a vertical diameter. An inscribed quadrilateral connects the two interior points of the diameter to a point on the right arc, with the diagonals drawn so that they cross at an interior point — illustrating the chord-and-perpendicular construction for the depth.

- ב (apex, top of diameter)
- ד (on diameter, upper interior point)
- ה (center)
- ז (on diameter, lower interior point)
- ג (bottom of diameter)
- ב (right-arc point)

And the line of position [קו ההיקש] will be at the perpendicular, the apparent place being there. And it has been explained that the chord of the depth is according to the magnitude of the angle, and that the magnitude of the angle is according to the distance [מרחק]; and the depth [עומק] is as we explained.

[Mid-left margin, in a smaller hand — a multi-line marginal note (roughly five to six lines). Its individual words are not legibly recoverable even under magnification; content [?]. Requires further verification.]

[The lower-left portion of folio 32r, beneath the bottom diagram, is blank; the right-hand text column carries text down near the bottom of the leaf.]

the variation [חלוף], and the correction [תקון] of the variation; and so the variation in this case is the larger one. And it was explained that the variation of the depth is this arc; for the variation of the depth and the variation [of the motion correspond].

the depth, and there the chord of the variation; and the variation of the depth is the remainder [מותר], and this is so. And the chord of the angle that arises is at its maximum; and when the depth is greater, the variation is greater; and when the depth is smaller, the variation is smaller — for the variation follows the depth, just as the line of position follows it.

[Right margin, in a smaller hand — a marginal note:] the near motion [תנועה הקרובה] upon itself [על עצמה] will be חמ[?]… [a third word, faint]. [Below, set off by a flourish glyph:] so the operation will occur [כן יקרה הפועל].

Therefore, when we wish to know the true motion [התנועה האמתית] by way of the depth, we take the apparent motion and subtract from it the correction; and what remains is the true motion. And it has already been explained that this is so, with no error [בלא טעות]; and the matter of the depth is according to the line of position, as we said.

And we say [ונאמר]: the larger the distance [מרחק], the larger the variation; and the smaller the distance, the smaller the variation, for the angle follows the distance. And so the place of the star [מקום הכוכב] is known by way of the depth, when the line of position is at the perpendicular [עמוד]; and there the chord is its chord, and we said that this is its maximum.

the depth, and it was explained that the chord is according to the magnitude of the angle, and the magnitude of the angle is according to the distance; and the place of the star is known by way of the depth, as we said. And this is sufficient for us in this matter.

Diagram. A circle with a vertical diameter. An inscribed quadrilateral connects two points on the upper-right arc and the diameter to the lower interior point, with both diagonals drawn so they cross — the same chord-and-perpendicular figure as on f32r, here illustrating the depth construction. A decorative trefoil (knot) flourish is drawn on the left interior of the circle.

- ב (apex, top of diameter)
- ד (on diameter, upper interior point)
- ה (center)
- ז (on diameter, lower interior point)

- ג (bottom of diameter)
- ה (upper-right arc)
- ז (right arc)
- ד (lower-right arc)

[Lower-left margin, beneath a knot-flourish — a two-line note in the body hand:] [Margin: a two-line marginal note in the body hand; it appears to record that the chord of the depth and the variation are taken at the perpendicular and the correction reckoned accordingly [?]. Further identification requires further verification.]

[The lower portion of folio 32v is blank.]

The Tenth Chapter (continued) — ff. 33r–33v

[The chapter on the line of position, depth, and the variation of motion continues from the prior folios. The argument concerns how the figure (the angular configuration at the deferent) varies with the star's depth, and how the remainder between the apparent and the true motion is recovered.]

When the figure is small, so too is its [corresponding] arc; and when the figure is large, so too is its arc — for the smaller it is, the larger the apparent motion, and the greater the figure, the larger the apparent motion likewise.

It follows that the variation [חלוף] is proportional to the figure: where the figure is small the variation is small, and where the figure is large the variation is large. This is what we set out to establish concerning the relation between the figure and the [resulting] motion.

We say further that this depth — namely the depth at which the figure occurs — has its own measure, and that measure is fixed for it according to the place of the star upon the circle. For when the star is at the point that is most remote in depth, the figure there is at its greatest; and when it is at the point nearest in depth, the figure is at its least.

And since matters stand thus, it has been demonstrated that the variation follows the angle, and the angle follows the depth, and the depth follows the place of the star upon its circle. Therefore the variation, in the end, follows the place of the star, and from the place of the star the variation may be recovered.

We have already explained that the true motion is recovered from the apparent motion together with [the value of] the variation, for the apparent motion is composed of the true motion and the variation. When you subtract the variation

from the apparent motion, the true motion remains; and when the variation is added [in the contrary case], you obtain the apparent motion from the true.

Now let us draw a figure to make this clear. Let there be the circle [drawn at the foot of f33r], and let its [vertical] diameter be the line א-ד, with ה the center. Let ב and ג be two points upon the circle on the side [toward א], and let the chords be drawn from them. The chord from ב and the chord from ג cross one another, as is shown in the figure, and from the crossing of these chords the magnitude of the angle is made known, and from the angle the magnitude of the variation.

And we say that when the star is upon the point א, which is the most remote point in depth, the chord that issues from it is the longest, and the angle it makes is the greatest; and when it is upon ד, which is the point nearest [in depth], the chord is the shortest and the angle the least. Between these two limits the chord — and with it the angle, and with it the variation — increases and decreases by the [stated] proportion.

[Inset note, left of the f33r diagram, smaller hand:] The place [מקום] of the star is upon the line of position, and from it the depth [is taken]; the depth [follows] the place of the star, and from it the variation.

[f33v]

It follows from this that the figure [formed] at the place of the star, and the variation that arises from it, will be as we have said: in proportion to the depth, and the depth in proportion to the place of the star upon the circle.

When you wish to recover the true motion, take the apparent motion that you have found by observation, and from it the variation belonging to that place, and subtract it; what remains is the true motion. And if you wish to recover the apparent motion from the true, add the variation; the sum is the apparent motion.

We have already explained how the variation is recovered from the depth, and the depth from the place of the star; therefore all of this hangs upon the place of the star, and is recovered from it by computation.

And we say further that the chord that issues from the point most remote in depth, and the chord that issues from the point nearest, differ from one another; and the difference between them is according to the difference between the two depths. The figure made at the remote depth is the greater, and the figure made at the near depth is the lesser, as we have explained. From the difference of the

two figures the difference of the two angles is made known, and from the difference of the two angles the difference of the two variations.

When the two chords have been drawn and made known, and the two angles likewise, and you have set the apparent place opposite the true place upon the line of position, then the variation that lies between them is the [sought] correction [תקון]. By it the apparent motion is corrected, so that the true motion is obtained. And this correction is itself the variation, and the variation is the remainder [מותר] between the apparent motion and the true motion, as we have explained more than once.

And so it is found that all of this proceeds in order: the place of the star upon the circle yields the depth; the depth yields the figure; the figure yields the angle; the angle yields the chord; and the chord yields the variation, which is the correction. By the correction the apparent motion is brought back to the true motion, and the true motion to the apparent.

This is the correction belonging to the cycle [קלקוס — Greek: κύκλος (kuklos, "cycle/circle")], and it depends upon the place. And as we set it out, so is the procedure, and so are the corrections to be made. [The text breaks off here; the lower half of f33v is blank below the figure.]

[Marginal note 1, left margin of f33v, upper, smaller hand:] [Margin: the depth and the angle are as we said; the angle and the figure [are] one; the place yields the depth, and the depth [yields the rest].]

[Marginal note 2, left margin of f33v, lower, smaller hand:] [Margin: the angle and the figure, and the chord that issues; just as [the chord] from this [point] … the place yields the depth, and the depth the variation.]

Diagrams

Diagram. The right-hand of two circles drawn at the foot of f33r. A circle with a vertical diameter, labelled א at the top and ג at the foot. Inscribed within it is a crossing-chord figure: an upper pair of points ז and ב on the upper arc and a lower pair ג and ד on the lower arc, joined by chords whose diagonals cross one another in an X; a point ה lies on the right. The crossing of the chords is the angle the text says yields the magnitude of the variation.

- א (top of vertical diameter): the point most remote in depth
- ג (foot of vertical diameter): the point nearest in depth
- ז (upper-left vertex): chord-endpoint

- ב (upper vertex, beside ז): chord-endpoint
- ה (right): chord-endpoint
- ג (lower-left vertex): chord-endpoint
- ד (lower-right vertex): chord-endpoint

Diagram. The left-hand of the two circles at the foot of f33r. A circle with a vertical diameter, the foot labelled ד; an inscribed crossing-chord figure with apex א on the diameter and ה at the center, an upper pair of points ז and ב and a lower pair ג and ד, the diagonals crossing in an X. A reduced repeat of the right-hand construction. A short inset caption ("מקום הכוכב…", "the place of the star…") sits above-left of this circle; its remaining lines are faint and partial.

- א (apex of the inscribed figure, on the diameter): remote-depth point
- ה (center, on the diameter): the center of the circle
- ד (foot of the diameter): near-depth point
- ז (upper vertex): chord-endpoint
- ב (upper vertex): chord-endpoint
- ג (lower vertex): chord-endpoint
- ד (lower vertex): chord-endpoint

Diagram. A single circle in the mid-right region of f33v with a vertical diameter, labelled א at the top and ד at the foot, and points ה and ז marked on the diameter. An inscribed crossing-chord figure sits in the left portion, with an upper pair of points ז and ב and a lower pair, the chords crossing — a repeat of the f33r construction. No inner concentric circle is present.

- א (top of diameter): remote-depth point
- ד (foot of diameter): near-depth point
- ה (on the diameter): chord-endpoint
- ז (on the diameter, below ה): chord-endpoint
- ז (upper-left vertex): chord-endpoint
- ב (upper vertex, beside ז): chord-endpoint
- [?] (lower vertices): two further chord-endpoints, labels faint

Diagram. Two intersecting circles in the lower-right of f33v: a larger circle (upper-right) and a smaller circle (lower-left) that overlap, with a long radial line descending from א at the top of the larger circle. An inscribed figure spanning the smaller circle has vertices ג (left), ב (lower-left), ז (right), and ד (foot), with chords crossing within it; ה lies on the descending line and a point labelled ל sits within the figure. The two circles are intersecting, not concentric. This is the principal

construction for the chapter's depth-and-variation argument; several labels are faint

- א (top of the large circle's radial line): remote-depth point
- ה (on the descending line): chord-endpoint
- ז (right vertex, on the small circle): chord-endpoint
- ג (left vertex, on the small circle): chord-endpoint
- ב (lower-left vertex): chord-endpoint
- ד (foot of the figure): near-depth point
- ל (within the figure): [?] label, partially legible

[Later hand: folio number "34" (twice, in pencil/ink, upper outer margin)]

that the chords are equal, and the depth [עומק] is greater. Therefore the correction [תקון] belonging to the cycle [קלקוס] for the star whose place is on its circle is greater, since the depth is greater. So this correction is greater than that one, by the amount the depth exceeds.

And it is further established that the correction belonging to the cycle is upon the line of position [קו ההיקש], according to the [?] of the equal arc. And it would be [?], for the depth is greater, that the correction belonging to the cycle would be greater there as well. This is so by the amount the depth exceeds — and thus the correction is the remainder [מותר].

For, just as the variation [חלוף] of the cycle is according to the figure, so too the variation belonging to the cycle of the star is according to the place of the star upon its circle: and the remainder [מותר] is the variation. So all of this is according to the figure.

And the variation of the cycle is [?] one thing, and this variation is according to the place of the star upon its circle. And just as the variation of the cycle [is greater], by so much is the correction greater. And he said further: when the correction belonging to the cycle is upon the line of position [קו ההיקש], the correction will be [?]. The correction is the remainder, and likewise the variation belonging to the cycle is according to the place of the star upon its circle — for this is the difference between them. And this is plain.

And it is also evident that the correction is upon the deferent line [קו העובר] [?] together with the remainder, since the depth is greater. So the correction belonging to the cycle [קלקוס] is greater there, and this is plain.

(interlinear: הלחוד — "alone / by itself")

For, just as the depth of the eccentric is greater, so the variation belonging to the cycle of the star is greater — and the remainder, and the variation. And this remainder is the variation, and the motion-variation [תנועת החלוף] [?].

Both of these are [?] in their kind, and the difference between them is according to the place of the star upon its circle [?]. And from this place onward the correction belonging to the cycle is according to the depth, and likewise the corrections [?], and this is the [?].

It is found that the correction belonging to the cycle, according to the variation, is in the eccentric — for the variation is greater there. And these motions are according to the place [מקום], and these are the corrections [?]. The reckoning of the corrected eccentric is in motions corresponding to one another — and this, and that — the correction [?].

And it is further established, according to the figure within the eccentric, that the depth [עומק] is so much; and after this, the matter requires that the corrections within the eccentric, with the variation, [?].

הבא — And it is the case [והוא] that [?]:

I posit the corrections [?]; the latter [?] [?] upon [?]; the corrections [?] upon the eccentric; the correction belonging to the cycle and the variation are [?] [?].

And it is established that the variation of the cycle is so much, and from this [?], that the variation of the eccentric is so much; and the corrections of the eccentric [?].

And he said further: when the difference within the eccentric is so much, by so much is the correction [?]. And after this, [?] the corrections within the eccentric, the difference of which is according to the place of the star [?] [?].

the correction [?]: for the correction is the remainder, and within the eccentric the correction [?] [?].

And just as the depth of the eccentric is greater [?], the variation belonging to the cycle is greater, since the correction of the star upon its circle [?]. And so the correction is the remainder [מותר], and likewise the variation of the cycle [?] [?].

And the variation belonging to the cycle is so much, and according to the variation of the cycle [?] [?], for the variation is greater there. And just as the variation of the cycle [?], so the correction is greater. And he said further: when the depth within the eccentric is so much, by so much is the correction greater —

[?] together with the remainder, since the depth is greater. So the correction belonging to the cycle [?].

[Margin: a five-line note in the outer (left) margin, in a small cursive hand, fully on the page and legible: "ועד [?] / [?] תנועה ב[?] / [?] וזס [?] [?] / ועג [?] בצד [?] / [?] [?]". The note is not crushed or cropped at the spine; the remaining words are in a hard cursive not securely resolvable at this resolution.]

And he said further: the variation of the cycle [?] together with the remainder, since the depth is greater there. And these corrections are corresponding to one another, and likewise the variation belonging to the cycle of the star is according to the place of the star upon its circle [?] [?]. And the corrections [?].

For just as the corrections [תקון] are corresponding to one another, so the variation [?] [?] upon the eccentric, the correction belonging to the cycle and the variation [?]. And it is found [נמצא] that the variation [?] [?].

Both of these are [?] [?] in their kind, and the difference between them is according to the place of the star [?] [?] [?]. And from this place onward the correction is upon the deferent [?].

(interlinear: לבחיר[ת) — "the chosen / select"]

For the corrections [?] are corresponding to one another, and the correction belonging to the cycle and the variation [?] [?], and the depth [?] [?]; and the figure [?] [?] the planet [?].

It is found that the correction, according to the place [?] [?], is so much; and after this, the latter [?] will be [?], and the variation [?] [?].

And just as the variation of the cycle [?] is so much, and likewise [?] [?] the corrections [תקונות → תקושות, "corrections"?] [?] [?] no star [?] the eccentric [?].

And he said further: when [?] [?] so much, by so much is the correction [?] [?] [?]. And likewise within the corrections [?] the eccentric [?] [?]; and the corrections of the eccentric [?] is greater [?] [?].

And it is established [?] [?], and likewise the corrections [?] no [?] the planet, the eccentric [?]; and not [ולא] [?] his corrections [?] for the latter, by so much [?] more [יותר], to the extent of the correction [?].

the same variation. This being so, the depth that lies between this point and the [center?] is greater, and the variation is correspondingly greater. The variation, then, follows the depth. So too is it found by the line drawn through [the center

of] the cycle [קלקוס, Greek κύκλος, "circle/cycle"], for the more distant the star is, the greater the variation.

The variation is more remote for the more distant body, and the matter is as we have explained. So too will it be found by way of the cycle that the correction follows the depth — that is, the greater the depth, the greater the correction, and the smaller the depth, the smaller the correction. The remainder [מותר], which is the variation, is therefore in proportion to the depth.

When we say that the variation follows the depth, the meaning is this: as the depth grows, the variation grows, and as the depth diminishes, the variation diminishes. This is fixed and known by demonstration. And this is what we wished to make clear here.

We now say further that, since the correction follows the variation, and the variation follows the depth, it follows necessarily that the correction follows the depth — that is, that the greater the depth, the greater the correction. For when the depth is greater, the variation is greater, and when the variation is greater, the correction is likewise greater.

This being established, we say that the place [מקום] of the star is known by way of these [magnitudes], for the place follows the correction, and the correction follows the depth. And the depth is known from the distance [מרחק] of the star from the center of the cycle, and from the line drawn from the center to the star [?].

For when the distance [מורחק, "the eccentric/displaced [center]"] is known, and the line of position [קו ההיקש] is known, the depth is known; and when the depth is known, the variation is known; and when the variation is known, the correction is known; and when the correction is known, the place of the star is known. This is what we wished to demonstrate concerning these matters.

We say further that the variation differs [יחלף] from one star to another according to the measure of the eccentricity [גובה / "the displacement of the center"], and according to the magnitude of the cycle. For two stars may be at an equal depth and yet their variation be unequal, because of the difference in the magnitude of their cycles, or because of the difference in the [eccentricity?] of their centers.

The centers, as we have already explained, are points, and this [center] is the point from which all the lines that go out to the circumference of the cycle are equal. And the place of the star upon the cycle is more distant from this center at

one time and nearer at another. When it is more distant, the depth is greater; and when it is nearer, the depth is smaller. The depth, then, is the measure of the variation, as the depth is the line drawn from the center [?] to the star.

Diagram. A geometric figure in the upper portion of the page, set into the right-hand part of the text column and extending downward. It shows a circle (the cycle) with a near-horizontal diameter and a second, oblique line crossing through its center; a long, boldly drawn (doubled) arc — a great circle seen obliquely, or the inclined path of the star — sweeps from an apex above the circle, passes through the circle, and continues well below it to a terminus at the lower right; a shorter arc joins that terminus back toward the lower right of the circle. Faint single marks stand at several of the intersections and along the curves, but at this resolution none is legible as a specific Hebrew letter; the figure is crossed by foxing.

- [?] (apex, where the long arc and a thinner line converge above the circle)
- [?] (upper right, where the thinner line meets the circle)
- [?] (center of the circle, where the two diameters cross; a dot marks the point)
- [?] (left, where the horizontal diameter meets the circle)
- [?] (lower, on the long arc just below the circle, near the spring of the short arc)
- [?] (lower right, at the terminus of the long descending arc)

[The marks are faint and partly obscured by foxing across the figure; specific letter readings are not recoverable at this resolution.]

We say that the line drawn from the center to the star is the line of position, and the depth is the arc [קשת] cut off between the line of position and the line drawn through the centers. So the greater the depth, the greater this arc, and the greater the correction.

When two stars are at an equal distance from the center, but the magnitude of one cycle is greater than the other, then the arc cut off in the greater cycle is greater than the arc cut off in the smaller cycle, even though their depths are equal. Therefore the correction in the greater cycle is greater than the correction in the smaller cycle. And so the variation differs from one star to another, in the way we have stated, according to the magnitude of the cycle and the eccentricity of the center.

[Margin: וכשיעור קשת גובה / הכוכב כן שיעור המעלה / וכשיעור קשת גובה / הכוכב כן שיעור המעלה — "And as the measure of the arc of the star's elevation, so is the measure of the [equation-]degree" (the note is written twice, the second a repetition of the first).]

For the more remote the place of the star from the center of the cycle, the greater the depth, and the greater the variation, and the greater the correction. And the matter follows in proportion: as the arc of the depth is, so is the measure of the variation, and so is the measure of the correction.

We say further that, when the place of the star is upon the line drawn through the centers, there is no depth there at all, and there is no variation and no correction. For the star is then either at its greatest distance or at its least distance from the center, and at those two points there is no arc cut off between the line of position and the line through the centers. So there the correction is nil.

And as the place of the star moves away from the line through the centers, the depth begins, and grows, until the variation reaches its greatest measure; and then it diminishes again until the star returns to the line through the centers. Thus the correction increases and decreases according to the measure of the depth. And as the measure of the arc of the star's elevation [גובה], so is the measure of the [equation-]degree [מעלה]. This is fixed and known, and it is what we wished to make clear concerning these matters.

and it [the star] is more elevated, so that the arc of [its] elevation, which is the arc of depth, is greater. And since the correction follows the depth, the correction will be greater. [?]

And from this it follows that whenever the depth is greater the correction is greater, and whenever the depth is smaller the correction is smaller — for the correction follows the depth, and the depth follows the distance of the star from the center of the cycle, which is the line of position [קו ההיקש]. And this line is called the line of position because by it the position [of the star] is reckoned, and the depth [העומק] is the arc cut off between the line of position and the line passing through the two centers.

And behold, this depth is itself the arc which the line of position cuts off, and the correction follows it. Therefore, when the star is at the apogee [גובה] or at the perigee [שפל], there is no depth, and so there is no correction there at all; for at those two points the line of position coincides with the line passing through the two centers, and no arc is cut off between them. [?]

And it is already clear from this that the equation [התקון] which arises from the eccentric cycle goes on increasing from the apogee until [the star] reaches the place where the depth is greatest, and from there it goes on decreasing until [the star] reaches the perigee, where again it is nullified. [?]

And we say further that the correction belonging to the larger cycle is greater than the correction belonging to the smaller cycle when the depth is equal in both. The reason for this is that the chord [or: line] subtending the depth in the larger cycle is longer, since equal arcs in cycles of different size subtend lines of different length — the larger the cycle, the longer the line subtending the same arc. And therefore the angle [הזוית] produced at the center, and the correction following it, will be greater in the larger cycle than in the smaller cycle at equal depth. [?]

[Margin: a two-line marginal note in the lower-left margin of f36r, smaller hand, faded — verbatim text not fully legible: "…כב…של…מרחק מעולה / …מרחק……בטלמיוס[?]…" Further identification requires further verification.]

and the correction will be [greater], because the line subtending the depth in the larger cycle is longer than the line subtending it in the smaller cycle, at equal depth. [?]

And this matter has already been demonstrated geometrically: that in cycles of differing magnitude, equal arcs subtend lines [chords] that differ in length, so that the larger cycle has the longer line. [?]

And it follows from this that the eccentric cycle which is larger, when its depth is equal [to that of a smaller one], will yield a greater correction. And it has likewise been shown that the equation produced by the line of position [מקלקוס[?] — read: from the cycle] grows and diminishes according to the magnitude of the depth.

הכלל [?] [the principle / sum]: that the correction belonging to any cycle follows the depth and follows the magnitude of the cycle together: when the depth is greater the correction is greater, and when the cycle is greater the correction is greater, at equal depth. And when the depth is null — that is, at the apogee or at the perigee — the correction is null. [?]

And behold, [as for] the difference [החלוף] in the correction at one depth, between the larger cycle and the smaller: the difference of the correction follows the difference of the depth. When the depth differs, the correction differs; and the difference will be greatest where the depth is greatest. [?]

The reason for this is that the line subtending the depth differs from the line subtending the depth [in the other cycle] in proportion to the difference between the two cycles, and likewise the angle produced at the center differs, and so the correction differs. [?]

And we have already explained the position of the star, and the matter of the correction belonging to the eccentric cycle, and how it is reckoned: namely, that one takes the depth of the star, which is the arc between the line of position and the line passing through the two centers, and from it the correction is derived. [?]

And one finds the place of the star by means of the correction, when one knows the depth and the magnitude of the cycle. And behold, the star [will be] at the position [נקויית — read: place / point] that is reckoned and corrected [ומתוקן].

and the variation in correction. For every cycle whose eccentricity is greater, its correction is greater; and at the place of [its] apogee and at the place of [its] perigee there is no correction at all, since at those two places the line of position and the line passing through the two centers coincide as one. From [the apogee] the correction grows until it reaches its maximum, and from there it diminishes again until it returns [to nothing] at the perigee.

It has already been explained that the correction follows the depth — depth being the arc lying between the line of position and the line that passes through the two centers. Hence, when the depth is equal, the cycle whose eccentricity is greater will have the greater correction; and when the eccentricity is equal, the place whose depth is greater will have the greater correction. From this it follows that the correction depends on two things together: the magnitude of the eccentricity and the magnitude of the depth.

We say further that when we wish to know the correction belonging to a given depth in a given cycle, we set down the cycle as a circle, and we draw within it the chord [subtending] that depth; and the perpendicular dropped from the center to that chord, [together with] the remainder, yields what is required. For the correction is the angle contained at the center between the line of position and the line of the two centers — and this angle is what is sought.

Let the figure be as follows. We set down the eccentric circle, and [we mark] upon it the apogee and the perigee, which lie on the line passing through the two centers; and we draw the line of position so that there is between the two lines the depth [in question]. Then the angle enclosed between them at the center is the correction belonging to that depth, and this is what we sought to find.

When the depth is small, the correction too is small; and when the depth grows, the correction grows with it — up to the [point of] greatest depth, where the correction is at its maximum. From there it returns and diminishes, just as the depth diminishes, until both vanish together at the perigee, as we explained.

Diagram. Two concentric circles sharing a common center. A vertical diameter runs from the top of the circles (ב, on the outer circle; ה just within, on the inner) down through the center (ג) to the bottom (ד on the outer circle). A radius is drawn from the center up toward the upper-left, meeting the inner circle at ד[?] and the outer circle at ז; the segment between the two circles along this line is marked. The vertical line represents the line through the two centers (apogee–perigee axis), and the upper-left radius represents the line of position; the angle ז-ג-ב at the center is the correction belonging to the depth shown.

- ב (top, outer circle): apogee end of the apogee–perigee line
- ה (top, inner circle, just below ב): point on the inner circle
- ז (upper left, outer circle): endpoint of the line of position
- ד[?] (upper left, inner circle): point where the line of position meets the inner circle
- ג (center): the common center (locus of the correction angle)
- ד (bottom, outer circle): perigee end of the apogee–perigee line

A caption written beneath the figure reads זאת התמונה שלם ("this figure is complete") [?].

[A four-line note is written in the lower margin beneath the figure; its text is faint but legible in part: "…the cycle of the star, and from the place…the points…and at the place…" — a constructive note keyed to the figure; full reading requires further verification.]

[Upper-margin note, second/later hand, top of page: brief gloss keyed to the construction below; verbatim text faint, "…and the place…the line of position…" — further identification requires further verification.]

This being so, when the line of position is at its greatest distance from the line of the two centers, the depth there is greatest, and so the correction there is greatest. It has already been explained that the correction follows the depth, just as we set out. And the place whose eccentricity is greater has its correction greater at an equal depth.

We set down the figure: the eccentric circle, with its center, and within it a smaller circle [concentric with it]. We draw the line of the two centers as the

vertical diameter, and we draw the line of position [as a chord] from a point on the outer circle to the center. The arc enclosed between the line of position and the line of the two centers is the depth; and the angle which they enclose at the center is the correction. When this arc is small the correction is small, and as it grows the correction grows with it, in the manner already shown.

Diagram. Two concentric circles. A vertical diameter runs from ב at the top, through the center ה, to ד at the bottom. From a point on the outer circle in the upper-left (ז), two nearly-coincident lines (a chord and the line of position) are drawn down to the center ה, with an intermediate point ד[?] marked on the inner circle along the way. The small angle between these lines and the vertical diameter at the center ה represents the correction for a small depth.

- ב (top, outer circle): apogee
- ז (upper left, outer circle): endpoint of the line of position
- ד[?] (inner circle, upper left, on the line of position): intersection with the inner circle
- ה (center): common center, vertex of the correction angle
- ד (bottom, outer circle): perigee

[Between the upper and middle figures stands a four-line note, second hand: "And he said: when you wish [to know] the correction…the line of position from the line of the two centers, the eccentricity of the cycle, and the points…" — a constructive helper keyed to the figures; full reading requires further verification.]

We say further that when the eccentricity of the cycle is greater, then at an equal depth the correction is greater; for the angle subtended at the center by the same arc is larger in the cycle whose radius [relative to the eccentricity] makes that arc subtend a greater angle. Therefore the place whose eccentricity is greater has its correction greater when the depth is equal in the two of them.

Diagram. Two concentric circles with a vertical diameter from ב (top) through the center ה to ד (bottom). From the upper-left point ז on the outer circle, the line of position is drawn to the center ה, passing the inner circle at an intermediate point ד[?]; the angle between this line and the vertical diameter at ה is the correction. This figure repeats the construction of the figure above, illustrating the same correction-angle relation.

- ב (top, outer circle): apogee
- ז (upper left, outer circle): endpoint of the line of position

- ד[?] (inner circle, on the line of position): intersection with the inner circle
- ה (center): common center, vertex of the correction angle
- ד (bottom, outer circle): perigee

And this is the manner of the correction: it follows the magnitude of the eccentricity of the cycle and the magnitude of the depth together. When the eccentricity is large, the correction is large; and when the depth is large, the correction is large — and so, when the two of them are large together, the correction is at its greatest.

Diagram. Two concentric circles, drawn in the lower-left of the page. A horizontal line runs from a point ו on the left, across the inner circle through an intermediate point ג, to a point ה[?] on the right where the line of position meets it; a second line is drawn from a lower point ה to that same point, forming a narrow triangle. A vertical diameter runs from ב at the top through the center down to ד at the bottom. The configuration again exhibits the correction angle for a given depth.

- ב (top, outer circle): apogee
- ו (left, on the horizontal line): endpoint of the line of position
- ג (on the inner circle, along the horizontal line): intersection with the inner circle
- ה[?] (right, on the line of position): the corresponding point on the construction
- ה (lower left): vertex of the lower line of the triangle
- ד (bottom, outer circle): perigee

And from this it has become clear that the correction is just as the eccentricity [requires] — like the star [whose position] is corrected, [the correction being] according to the eccentricity, just as [we said]. As the eccentricity is, so is the correction; and as the depth is, so is the correction. And so the variation in correction [is as has been shown].

[Left-margin note (f37v), three short lines beside the upper text, small cursive: "the line of position, and the…the line of the two centers" [?] — a constructive helper keyed to the figures; further identification requires further verification.]

[Left-margin note (f37v), beside the middle text, four short lines: a further constructive gloss on the correction-and-depth relation; verbatim text faint, "… and after this it returns…the line of position and the line…the two centers and…" — full reading requires further verification.]

according to its size [שיעור]. And since [these positions] differ, and since the magnitude of the angle at the center [זוית המרכז] which the line of position [קו ההיקש] makes with the line of the two centers grows [יגדל]… the planet [הכוכב], and when it is at such-and-such a distance [?] [מרחק], its position [?].

According to the figure shown here [כדמותה הנראה הנה], the cycle [הקלקוס] is set as the larger [circle]; and the increment [?] [יתבאר] of the angle…

the correction [התקון] which is the difference [חלוף] between the line of position and the line of the two centers — this is to say [רצה לומר], the difference between them — is measured by the arc [קשת] lying between them. So the magnitude of the correction depends jointly on the magnitude of the eccentricity [the offset of the centers] and on the depth [העומק] of the planet within the cycle.

For the equation [התקון] is null at the apogee [הגובה] and at the perigee [השפל], since there the line of position coincides with the line of the two centers; and it grows from the apogee toward the midpoint and is greatest [גדול] there, then diminishes again toward the perigee.

[Margin (right, f38r, second hand, ~2 short lines): "תמונת מרכז / התנועה משונה" — "the figure of the center / of the motion is distinct/varies." Further identification requires further verification.]

Therefore, since the [planet's] distance differs… the correction also differs in this respect [בזה הצד]; and it will be made clear [יתבאר] that the angle…

of the cycle, in such a way [על האופן] that the magnitude of the equation is known [ידוע] when the place [מקום] of the planet upon the cycle is known. And the line of position [קו ההיקש] is the line drawn from the center of the world [מרכז העולם] to the place of the planet…

For at the apogee and at the perigee there is no equation, since there the line of position and the line of the two centers are one and the same; and the equation grows from the apogee toward the midpoint [האמצע], where it is greatest, and then it diminishes toward the perigee — as we have explained.

And it is found [נמצא] that the equation at the midpoint [האמצע] is greater [יותר גדול] than at any other place, by the amount the place differs from the apogee and perigee. For when the line of position falls upon the line of the two centers, there is no angle between them, hence no correction [תקון]; but when it is most inclined to it, the angle between them is greatest, and the correction is greatest.

This being so, the magnitude of the equation [התקון] follows the magnitude of the eccentricity [the separation of the two centers] together with the depth [עומק] of the planet — that is, its remoteness [ריחוק] from the line of the two centers within the cycle. And the more the place is inclined [away] from the line of the two centers, the greater is the equation, up to the midpoint; and from there onward the equation diminishes until it is null at the perigee.

[Diagram — first of the lower-left group, f38r:]

Diagram. A pair of concentric circles. The vertical diameter runs from an apex point at the top down through the center to a point at the bottom; the upper end marks the apogee region and the lower end the perigee region. A line of position is drawn from a point on the left of the circle to the central region, forming an angle with the vertical diameter (the line of the two centers). The labeled points read, by position:

- א (apex, top of vertical diameter): apogee end
- ב (upper inner circle, on the vertical diameter): inner-circle apogee point
- ג (left, on the circle): terminus of the line of position
- ד (center / intersection of the diameter with the line of position): center
- ה (lower-center, on the diameter below the center): [?]
- ז (lower point on the vertical diameter): perigee region [?]
- ג (bottom of vertical diameter): perigee end

[Diagram — second of the lower-left group, f38r, carrying the caption "תנועה" ("motion") to its right:]

Diagram. A pair of concentric circles with the word *תנועה* ("motion") written to the right of the figure inside the outer ring. The vertical diameter runs top to bottom (apogee above, perigee below). From a point on the left several lines (a sheaf of three) are drawn inward to points clustered near the center-right, forming a set of angles with the central horizontal/vertical lines — depicting the line of position at successive depths. The labeled points read, by position:

- א (apex, top of vertical diameter)
- ד (upper inner circle, on the diameter)
- ב (left, on the outer/inner circle): terminus of the lines of position
- ג (just inside ב, on the inner circle) [?]
- ה (center-right, upper of the clustered points)
- ז (center, on the vertical diameter): center
- ח (center-right, lower of the clustered points) [?]

- ק (lower-center, on the diameter): [?]
- ג (bottom of vertical diameter): perigee end

at [its] place, the line of position differs, and the magnitude of the angle which the line of position makes with the line of the two centers grows; and the depth [העומק] of the planet within the cycle is such-and-such [?]. And the line of position [נקוה — read קו ההיקש] from the apogee [?]…

And the place of the planet upon the cycle is known [ידוע], and from it the magnitude of the equation [התקון] is found; for the equation is the arc [קשת] lying between the line of position and the line of the two centers, measured at the center [המרכז].

And it has already been explained [וכבר התבאר] that the equation at the midpoint of the [arc from] apogee [to perigee] is greater than the equation at any place nearer to the apogee or to the perigee, since there the line of position is most inclined to the line of the two centers. And the equation grows from the apogee, reaching its maximum at the midpoint, and then diminishes toward the perigee until it is null there.

And it is found that the equation is null at the apogee and at the perigee, and greatest at the midpoint; and the angle which the line of position makes at the center is, at the midpoint, greater than at any other place.

For when the line of position falls upon the line of the two centers there is no angle between them, and so no correction; but the more the place is inclined from the line of the two centers, the greater the angle, and the greater the correction — up to the midpoint, after which it diminishes.

And [the matter is] according to what has been explained [כפי מה שהתבאר], the equation being greater there. And it has been explained that the equation at the midpoint is greater [than elsewhere], by the amount the place is inclined from the apogee and the perigee. And let it not be that the place is null…

and the more this is so, the greater the equation; and according to what has been explained, the equation that is at the midpoint is greater. And let it be set [as] the line of position, and its remoteness [ריחוקו] from the line of the two centers within the cycle…

And it is found that the equation follows the magnitude of the eccentricity together with the depth — that is, the remoteness of the planet from the line of the two centers; and the more the place is inclined from it, the greater the equation, up to the midpoint, and then it diminishes until it is null at the perigee.

And it has already been explained how the equation [התקון] is null at the apogee, and how, when the [planet's] place differs and grows, the equation differs and grows — until the depth at which the line of position [?]…

and it would be the greatest of all corrections, since there the line of position is most inclined to the line of the two centers; and from there onward the equation diminishes. This is what we intended to clarify here.

And let it be set that the larger correction [התקון הגדול יותר] is the one nearer to [the midpoint]…

[Diagram — top-right of f38v, the largest figure, carrying the caption "תנועה" ("motion"):]

Diagram. A pair of concentric circles with the word *תנועה* ("motion") written to the right of center, inside the outer ring. The vertical diameter runs from an apex at top through the center to the bottom (apogee above, perigee below). From a point on the left of the inner circle a sheaf of lines (three) is drawn to a cluster of points near the center-right, forming the angles between the line of position and the line of the two centers. The labeled points, by position:

- א (apex, top of vertical diameter): apogee end
- ד (upper, on the diameter inside the inner circle)
- ב (left, on the inner circle): origin of the lines of position
- ג (just inside ב): [?]
- ה (center-right cluster, upper point)
- ז (center, on the vertical diameter): center
- ח (center-right cluster, lower point) [?]
- ז (lower, on the vertical diameter near perigee)
- ב (bottom of vertical diameter): perigee end

[Diagram — middle-right of f38v:]

Diagram. A pair of concentric circles. The vertical diameter runs top (apex/apogee) to bottom (perigee). From a point on the left of the inner circle two lines are drawn inward toward points near the center, again depicting the line of position meeting the line of the two centers. The labeled points, by position:

- א (apex, top of vertical diameter)
- ד (upper, on the diameter)
- ג (left, on the inner circle): origin of the lines of position [?]
- ה (center, upper point) [?]

- ז (center, on the vertical diameter): center
- ז (lower point on the vertical diameter near perigee) [?]
- ב (bottom of vertical diameter): perigee end

[Diagram — bottom-right of f38v:]

Diagram. A pair of concentric circles, the lower part of the figure running into the foot margin. The vertical diameter runs top (apex/apogee) to bottom (perigee). From a point on the left a sheaf of lines is drawn inward to the central region. The labeled points, by position:

- ד (upper, on the diameter)
- ב (left, on the inner circle): origin of the lines of position
- ג (just inside ב) [?]
- ה (center-right): [?]
- ז (center, on the vertical diameter): center
- ז (lower, on the vertical diameter) [?]
- ב (bottom of vertical diameter): perigee end

The Tenth Chapter (continued)

[The exposition of the eccentric-cycle equation continues without break from the preceding folio.]

this remoteness, which is between the line of position [קו ההיקש] and the line of the two centers, and the equation [תקון] is established upon it. The point [נקודה] toward which the line of position is drawn, — namely, the point toward which the line of position runs — there is a chord [יתר] there. And the chord of the line, which is the chord of the arc that lies between these two points [נקודות], is the line of position [?].

For this reason, when the motion [תנועה] is small, the chord between the two points is small as well, and the equation [תקון] is therefore small. And when the motion is great, the chord likewise is great, and so the equation is great.

And know that the equation [תקון] is the angle [זויית] that lies between the line of position and the line that passes through the two centers [שני המרכזים], and it is measured by the arc [קשת] that lies between them. When the planet [כוכב] is at the apogee [גובה] or at the perigee [שפל], there is no equation at all, for there the line of position and the line of the two centers coincide and become one line. And the equation grows as the planet departs from the apogee, until it reaches its

maximum at the place [מקום] that is the midpoint [?] between the apogee and the perigee.

And he said: already it has been shown that the equation [תקון] which results from the depth [עומק] is to be considered [?], and that it varies according to the magnitude of the depth and according to the remoteness [מרחק]. For the deeper the eccentric and the greater its remoteness from the center of the universe [?], the greater is the equation that arises; and the shallower it is, the smaller the equation.

And we say further: it has already been explained concerning the motion [תנועה] of the planet that, …and the matter is as the figure [תמונה] shows.

Diagram. A pair of concentric circles. From the center, a radius runs to the lower-left point on the outer circle, and several lines (chords / lines of position) are drawn from that left-hand point across to points on the inner circle, forming a narrow sheaf of lines that meet near the center. The outer circle carries point-letters at the top, right, and bottom of the vertical diameter; the inner circle carries points where the chords cross it.

- א (apex / top of vertical diameter): label present [?]
- ב (point on inner circle, upper): ב [?]
- ה (point near center, on the sheaf of lines): ה [?]
- ז (center / foot of the radius): ז [?]
- ד (left-hand point on outer circle, from which the lines radiate): ד [?]
- ג (lower-left point on the diameter): ג [?]
- ב (bottom of vertical diameter): ב [?]

Diagram. A second pair of concentric circles, of the same construction as the first: a center point with a radius to the left, and a sheaf of chords drawn from the left-hand point to points on the inner circle. Point-letters mark the ends of the vertical diameter and the chord-feet.

- א (top of vertical diameter): א [?]
- ב (upper point on inner circle): ב [?]
- ה (point near center on the sheaf): ה [?]
- ז (center): ז [?]
- ג (left-hand outer point): ג [?]
- ד (lower-left): ד [?]
- ב (bottom of diameter): ב [?]

Diagram. A quarter-figure of nested concentric arcs (three or four arcs sharing a common center at the lower right). A horizontal baseline runs from the left to the common center; from the common center a vertical line drops; the arcs are crossed by short radial tick-marks, each tick carrying a point-letter. A sheaf of nearly horizontal lines runs from the left-hand end of the baseline across the arcs.

- ד (left end of the horizontal baseline): ד [?]
- ב (next tick on the baseline): ב [?]
- ג (next tick on the baseline): ג [?]
- ה (tick toward the center): ה [?]
- ו (common center / right end of baseline): ו [?]
- ז (top of the vertical line): ז [?]
- ב (foot of the vertical line, lower): ב [?]

to the planet [כוכב], or to the [point of] position [?]. The depth is small, and from this it follows that the equation is small, for the line of position then nearly coincides with the line that passes through the two centers.

And when the motion [תנועה] is at the start [תחלת] of the figure [תמונה] — that is, when the planet is at the beginning of its course — the chord there is small, and there is a chord [יתר] there as well [?]; and so the equation is small. As the motion advances, the chord grows, and the equation grows with it.

It has already been said that there is no equation at the apogee and at the perigee, and that the equation is greatest at the midpoint between them. And know that this is so because, at the midpoint, the line of position is most inclined away from the line of the two centers, so that the angle between them — which is the equation — is at its maximum there.

And we now examine the matter of the chord [יתר] more closely, point by point [?], so that the magnitude of the equation may be known from the chord and the arc that lies between the two points [נקודות]. For the line of position is drawn from the place [מקום] of the planet to the point of position, and the chord of the arc between them measures the equation.

And he said: this is the matter, and it is as we have explained above, and the figure [תמונה] makes it clear. Take the point [נקודה] of the apogee and the point of the perigee, and the line that joins them passes through the two centers [שני המרכזים]; and the line of position is drawn to the point toward which the planet

moves. The arc between the foot of the line of position and the line of the two centers is the arc of the equation, and its chord is the chord of the equation.

And he said further: when the chord is great, the depth [עומק] is great, and the remoteness [מרחק] is great, and so the equation is great; and the opposite, when [the chord] is small. **The planet [הכוכב]** — its place is found by means of the equation, by adding or subtracting the equation from the mean motion [תנועה], according as the planet is in the depth or out of it [?].

And the figure [תמונה] of this is as we have set out [?]: the place of the planet, and the point of position, and the chord between them, and the arc of the equation that lies upon that chord. And put [ושים] the degrees [מעלות] of the arc that lies between the two points, and from it the equation is known.

And it has already been explained that the matter …and the chord that is between the two points, and the motion, and the depth…

And know that the chord [יתר] of the arc is to be taken [?] for each arc, so that the depth which is between the two centers [שני המרכזים] is made known, and the place [מקום] of the planet upon the eccentric is established by it.

Diagram. A large semicircular construction occupying the lower half of the folio. A horizontal diameter runs along the foot; from a point on the diameter (toward the left) a perpendicular rises to the arc, and from the apex of that perpendicular several straight lines (chords / lines of position) fan down to a series of points marked along the diameter. There are two or three nested concentric arcs sharing the same diameter. Point-letters are set along the diameter beneath each line-foot and at the apex.

- א (apex, where the perpendicular and chords meet the arc): א [?]
- ד (left end of the diameter): ד [?]
- ב (foot of the perpendicular on the diameter): ב [?]
- ה (next point along the diameter): ה [?]
- ג (next point along the diameter): ג [?]
- ו (right-hand point along the diameter): ו [?]
- ז (point on the inner arc, upper left): ז [?]
- ב (right end of the diameter): ב [?]

[The Tenth Chapter continues onto the following folio; no new chapter rubric appears on either folio side.]

The Tenth Chapter (הפרק העשירי) continues — the equation of the eccentric and the place of the planet.

[Later-hand folio numeral "40" in the upper margin; written twice, in pencil.]

and it grows smaller [in proportion] as the [planet's] motion grows. So too the equation [תקון] is null when [the planet] is at apogee [גובה] or at perigee [שפל]; and it is at its greatest when [the planet] is at the midpoint between them.

For this reason the equation varies according to the motion, in the way already explained: the equation is proportional to the motion, and likewise to the depth [עומק] and to the remoteness [ריחוק] of the planet — there being no [equation] except by reason of this [variation in] motion. And likewise its place [מקום] is determined by adding the equation to the mean motion [תנועה האמצעית], or by subtracting it, in the way set out earlier. [?]

The reason that the equation is at its greatest when the planet is at the midpoint between apogee and perigee, and null at the apogee and the perigee, is this: the equation is nothing other than the arc, or the chord, lying between the line of position [קו ההיקש] and the line of the two centers [שני המרכזים].

הכר [Display word, large dark ink — "Take note":] Know, moreover, that the difference [חלוף] between the place reckoned on the eccentric [המקום אשר על הגלגל היוצא] and the place reckoned on the parallel circle — that is, the [circle] concentric with the universe [המקיף בעולם] — is itself the equation. For this difference is [the very thing] that produces it.

For at the apogee and at the perigee these two places coincide upon a single line; there is therefore no difference between them, and hence no equation. But at the midpoint between apogee and perigee the difference between these two places reaches its greatest extent, and there the equation is likewise at its greatest. [?]

For this reason the equation is null at the apogee and at the perigee and greatest at the midpoint, [the equation] being the chord — or the arc — that is between them, in the manner of the figure [תמונה].

And when the chord that is between this place and that place is greater, the equation is greater; and the chord is at its greatest when the planet is at the midpoint between apogee and perigee, in the manner already explained. [?]

[Margin, lower left, secondary cramped hand, ~3 lines: a constructive note keyed to the same construction — "and likewise it is known that the place on the

eccentric exceeds … the place … on the parallel circle … the mean motion on its center" [?]; further identification requires further verification.]

[Interlinear, above the first line of text, faint: a brief gloss [?] — possibly "בא ש…", illegible.]

and we already explained the difference [חלוף] of the [planet's] true motion [תנועה האמיתית], and that it is greatest when the planet is at the midpoint between apogee and perigee, [the position] at which the equation is also greatest; and [the difference] is null at the apogee and at the perigee, just as the mean motion [is then equal to the true motion]. [?]

And already the first degrees [המעלות הראשונות] which … [?] are at their greatest difference [from the mean] when the planet is at the midpoint, in the manner already explained. The equation is, moreover, [reckoned] still more remotely [?] … when the difference between the true motion and the mean motion is greater. [?]

For the difference between the place on the eccentric [המקום אשר על הגלגל היוצא] and the place on the parallel circle [הגלגל המקיף] — that is, the equation — is greater in proportion as the [planet's] depth [עומק] is greater and its remoteness [ריחוק] from the center is greater. And the place reckoned on the eccentric, and the place reckoned on the parallel, [coincide] at the apogee and at the perigee, and there is no difference between them; therefore there is no equation there. [?]

But at the midpoint between apogee and perigee the difference between the two places is at its greatest, and there the equation is greatest. The eccentric [גלגל היוצא] is the [sphere] whose motion is uniform [תנועתו שוה] about its own center [מרכז], while it is non-uniform about the center of the universe [מרכז העולם]; and the planet, [carried] upon the eccentric, [appears] to move now faster and now slower as seen from the center of the universe. [?]

For this reason the equation arises: it is the measure of [this] non-uniformity, and it is greater in proportion as the planet's remoteness from the apogee — toward the midpoint — is greater. And when [the planet] is reckoned upon the parallel circle, which is concentric with the universe, its motion is uniform; the difference between the two reckonings is therefore the equation, in the manner of the figure. [?]

הבהּ [Display word, large dark ink, with gershayim — abbreviation; expansion uncertain [?], read as a lemma opener "Come, now"] and you shall see that the equation grows, in the way explained: it is the chord — or the arc — between the

line of position and the line of the two centers, and it is greatest at the midpoint and null at the apogee and the perigee.

And already we explained earlier [?] … upon the eccentric. The place reckoned upon the eccentric exceeds [the place] reckoned upon the parallel by the equation [?] … the chord, in the way [explained]; and this is what we intended [to show]. [?]

[Such that] the difference [the planet] makes upon the eccentric is [equal to] … [?]; and all that remains for it [as a residue] is the amount of the equation. The chord on the eccentric, and the equation [reckoned], are at the apogee … such as [a planet that] is set upon the eccentric, and this is what we intended. [?]

in the way already mentioned upon the parallel circle. From the true motion [שתנועה האמיתית] which [is reckoned] on the eccentric — and the difference, which [is reckoned] on the parallel — the equation [results]. [?]

Sefer HaTechunah — folios 41r–41v

[The Tenth Chapter (הפרק העשירי) continues — the equation of the eccentric.]

[Later-hand folio number "41" in the upper margin, written twice (a pencil "41" and an ink "41").]

the smaller, and so on. [?] When it moves [along] this circle [?], note that it produces [?]…

the [point of] approach [?] is between [?]…

the [equation] of the eccentric circle, and the difference between the place [of the planet] on the eccentric circle and the place [of the planet] on the concentric circle [גלגל המרכז]. This difference grows greater the farther [the planet is] from the apogee and from the perigee, and it is greatest at the midpoint [of the quadrant]; whereas at the apogee and at the perigee there is no difference at all.

The reason for this is that, with respect to the motion as it appears [to the eye] from the center of the universe [מרכז העולם], the motion is uniform [שוה] about the center of the eccentric circle, but it is not uniform about the center of the universe. Therefore, at the point [נקודה] where the motion measured from the one center agrees [?] with the motion measured from the other center — and this occurs only at the apogee and at the perigee — there the equation is nil; and at every other point [there is an equation].

And [the planet] will be farther [from] one [center] and nearer [to] the other [center] by the same measure, so that the equation [?] there will be the [angle?] subtended [?] between the two lines drawn from the two centers to the place of the planet.

This equation, then, follows the [ratio of the] distance between the two centers to the radius [חצי קוטר] of the eccentric circle: the greater that distance, the greater the equation; and the smaller it is, the smaller the equation. [?] ...and so consider this.

And we have already explained [?] in the figure [תמונה] below... [text leads into the diagram]

Diagram. A small construction in faded brown ink at the foot of the page: a larger outer circle with a smaller circle set inside it, the two centers slightly offset (the eccentric and the concentric/deferent circles). Two diameters — one roughly horizontal, one roughly vertical — cross at the center of the inner circle; the horizontal diameter runs out beyond the figure to the right, ending at a labeled point. A third, very faint arc continues at the upper right (the outer circle's far side). The point-labels are very faint.

- (top of the figure, on the outer arc where the oblique line meets it): ב
- (far right end of the horizontal diameter line, outside the circles): ז
- (top of the inner circle, on the vertical diameter): label [?]
- (center, where the two diameters cross): label [?]
- (on the horizontal diameter, left of center, inside the inner circle): label [?]
- (lower-left, on the outer circle): label [?]
- (lower portion of the figure): label [?]

[Caption-word in the upper margin, isolated above the text block:] תנועה ["motion"].

the motion of the eccentric [?] ... to the apogee [?] and to the perigee [לשפל]...

and the motion of the [planet on the] eccentric, and the motion of the variation [תנועת החלוף]...

the equation [?], and the place of the planet [מקום הכוכב] is found [נמצא] [?] ...

[At] the apogee, the [planet's] place [as reckoned] on the eccentric circle and [as reckoned] on the concentric circle [are the same?], and so too at the perigee; for there the two motions agree.

the equation, [reckoned] from the apogee — let it be [the angle?] subtended [?] — and the place [מקום] [as reckoned] on the eccentric circle and on the concentric circle [differ?]…

The diorismos [דיורוס — Greek: διορισμός (diorismos, "determination / specification [of the case]")] follows the motion of the variation [תנועת החלוף], for it is [the diorismos] that specifies it; and the place [as reckoned] on the eccentric and the place on the concentric [diverge?] by the measure of the equation.

and the difference [חלוף] between the [true] motion and the [mean] motion measured [?] from the center of the universe [מרכז העולם]…

[and] this is what we intended [?] regarding the equation of the eccentric circle, which we set out to [explain?].

And we shall now bring forward [?] another figure [תמונה] [?], so that the matter may be made clearer [?]…

Diagram. Two overlapping circles of clearly unequal size in faded brown ink at the foot of the page: a smaller circle on the left and a larger circle on the right, intersecting, with a horizontal diameter line running through both and extending to the right. The construction shows the eccentric and the concentric (deferent) circles and the line of the two centers (the apogee–perigee line). The point-labels are faint.

- (upper left, above the diameter near the small circle): label [?]
- (left intersection point, where the diameter meets the small circle, marked by a short vertical tick): label [?]
- (on the diameter, between the small circle's left edge and the center): label [?]
- (on the diameter, right of center, a two-letter cluster): label [?]
- (lower portion of the figure, on the large circle's lower arc): ז
- (further along the lower arc): label [?]

the equation [תקון] that corrects the motion of the planet, which is the measure of the difference [חלוף] in its motion. For this correction [תקון] is, in truth, the difference of place [חלוף המקום] of the planet on the eccentric circle [גלגל היוצא] as compared with its place on the concentric circle. Thus, by the measure of this correction, the place of the planet is established with respect to the eccentric, just as it is established by the difference [חלוף] of the motion. [?] So too the planet's motion: it is uniform with respect to the center of the eccentric.

And it is already explained in the *Almagest* [ספר המופת — lit. "the Book of Demonstration," here the work of demonstration referred to throughout] that this difference [חלוף] is greater at the point of the apogee. For the difference [חלוף] from the apogee [גובה] to the perigee [שפל] — [?] the place of the planet on the eccentric is more distant from the center of the universe, and is found to be greater there.

And yet [?] the difference [חלוף] is not greater [?] when the place [המקום] is more distant, as one might suppose. Rather, the matter follows the proportion [תכונה], as we shall explain.

For when the difference [חלוף] is not greater, [?] then the proportion [תכונה] of the difference is not greater. Therefore, when the chord [וזה כי] the difference is greater [?], and the place [המקום] is more distant, and when the inter-center distance is greater — then the correction [תקון] is greater, and the difference [חלוף] is greater. And when it is more distant, then [?] the difference is greater.

The second [הב׳ — enlarged display word, He+Bet with abbreviation stroke = ordinal "the second", opening a numbered sub-statement], when it is at the apogee or at the perigee, has no difference of motion arising from the variation [חלוף… מפני התנועה]. For the motion is then directed toward [נכח] the very point [נקודה] [?], and there is no variation [חלוף] there except [?] in the diorismos of the motion [דיורוס התנועה — Greek: διορισμός, "determination/delimitation," here the determination of the variation's motion].

[?] For the chord [יתר] [?]… and this is so because the variation [חלוף] is in proportion to the distance of the place. And there, the difference [חלוף] is in proportion [כמו ש…] — [?] — and the place is more distant.

And consider that the proportion [תכונה] of the eccentric — [?] its center is more distant from the center of the universe [מרכז העולם], the more the correction [תקון] is greater. And so it is in proportion.

[The lower portion of f42r is blank — text reaches a natural stop partway down the third register; not a section break, the discussion continues onto f42v.]

[Margin, f42r, left margin (mid-page), small later-hand note, two lines: verbatim text largely abraded — "לרמ …ל…" [?]; a constructive helper or variant marker. Further identification requires further verification.]

[Margin, f42r, left margin (lower), small later-hand note: "פ…" [?] — single short word, abraded. Further identification requires further verification.]

so that when [כאשר] the planet's place [מקום] is found by way of the correction [תקון] [?], the difference [חלוף] — and the measure of the variation [שעור החלוף] follows the [?] inter-center distance.

The second [הב׳ — enlarged display word, He+Bet with abbreviation stroke = ordinal "the second", a numbered sub-statement opener], when it is at one of the two points [נקודות] — [?] — its motion is uniform. For its motion with respect to the center of the eccentric is uniform, and there is no variation [חלוף] there. [?] And the proportion [תכונה] of the variation [חלוף] follows the position [מצב] of the centers, and the variation in the motion.

And it is necessary [וחויב] that the planet's place [מקום] be more distant. For the variation [חלוף] is greater when the inter-center distance is greater [?], and lesser when it is lesser.

And he said that the chord [יתר] [?]... and the variation [חלוף] is in proportion to the [?] inter-center distance. And when the place [המקום] is at one of the two points, [?] there is no variation.

And the correction [תקון] is found [נמצא] from the eccentric, and from the motion of the variation [תנועת החלוף] [?] of the eccentric, more distant.

[?] For the variation [חלוף] — and this is [?] because it is in proportion [תכונה], as we explained.

[?] And the matter — when the place [מקום] is more distant, and the planet [כוכב] [?] is more distant, the variation [חלוף] is greater. And so it is found in proportion to the two distances [שני המרחקים].

And the proportion [תכונה] of the planet — its variation [חלוף], and the [?] — when it is at one of the two [?] points.

And the variation [חלוף] [?] in this proportion [תכונה], such that the planet when it is at one of the two points [נקודות] — [?].

And there is no variation [חלוף] when [?]... and this is.

And the variation [חלוף] [?]... and that which is corrected [?] more than [יותר] another correction.

And the planet [כוכב] is obligated to one of [?] — it is found to one of the two motions.

And the variation [חלוף] of the one with respect to the [?] other.

And with respect to the planet [ולכוכב] [?], the variation [חלוף] [?]… and these are [?].

and the variation [חלוף] [?] of the [?] motion.

And he said that the corrections [התקונים] and the variations [החלופים].

[The lower portion of f42v is blank — text reaches a natural stop partway down the third register; the discussion of the equation of the eccentric and the diorismos of the variation continues onto f43r. A light brown stain runs down the lower-middle of the page (rows 2–3, columns 1–2); it overlies blank parchment and does not obscure text.]

[Margin, f42v: none legibly present.]

The Tenth Chapter (הפרק העשירי) continues — the equation [תקון] of the eccentric and the diorismos of the variation [חלוף] in the motion. …from this it follows that the motion will be uniform with respect to the center of the eccentric circle, and the variation [חלוף] in the motion that arises in it on this account will be in proportion to the distance and proximity of the star from the center of the universe. For when the star is nearer to the center of the universe, its motion appears greater, and when it is farther from it, its motion appears smaller — and this is necessarily so.

And since the motion is uniform about the center of the eccentric circle, while the variation that appears in it is in proportion to the nearness and remoteness of the place of the star from the center of the universe, it follows that this variation is null [?] at the apogee [גובה] and at the perigee [שפל]; for there the star is moving along the line of position [קו ההיקש] that passes through the two centers [שני המרכזים], and there is no variation there.

But [the variation] is greatest at the place that is the mean between them, because there the difference between the distance of the star from the center of the universe and its distance from the center of the eccentric is greatest. Therefore the variation that arises from the eccentric circle differs in proportion to the difference of the distances [חלוף המרחקים] of the star from the center of the universe, and it [the difference] is greatest in the middle and null [?] at the two ends.

And he says further [ואומר עוד]: the place of the star upon the eccentric is to be reckoned from the apogee, and the equation [תקון] of the motion follows in proportion to this. [It is] known that the beginning of the motion [reckoned] from the apogee is the more remote, and the eccentric circle [גלגל היוצא] does not [?]…

and the reckoning [חשבון] of this is in proportion to the arc [קשת] of the eccentric, and the chord [יתר] of it … and the star does not move upon the eccentric with a motion uniform about the center of the universe, but rather [with a motion uniform] about the center of the eccentric circle.

[Margin, left (later hand?): brief annotation; illegible single word, ~4 letters. [?]]

and this adds [?] to the arc and to the equation, and consider this. The variations are not in proportion to the distances … but rather they will be as is fitting, in proportion to. And it grows weaker [?] … because the motion is uniform … and they will be the parts [חלקים], and they will be after … and the parts [?] …

[Margin, left: brief annotation, ~2 words; illegible. [?]]

And on this account the equation [תקון] differs [?] from one another, and consider this; for [the equation] is null [?] and greatest at the place, and this is the equation [תקון]. And the reckoning of this ….

For this reason the variation [חלוף] at the beginning of the motion is more remote … the more remote and the nearer, and it will be reckoned in proportion to that. And there is no [?] motion upon the eccentric except about the center of the eccentric circle [גלגל היוצא], and there is [?] …

It is fitting that the eccentric circle move with the motion … and that the distance of the star be measured in proportion to … [interlinear correction here: see below].

(interlinear: above the word מספר ("number / reckoning") in the body line, a small later-hand gloss reads מלחק. [?])]

and the motion of the star is uniform about the center, and the two motions [שני התנועות] … and the other is uniform … and there is variation [חלוף] in proportion to the difference. And one of them is reckoned by the number … and the other [האחר] by the number, and the variation from this; and consider this.

And the variation [חלוף] differs [?] in proportion to the difference of the distances [חלוף המרחקים], such that at the apogee [גובה] and at the perigee [שפל] there is no [?] variation, while at the mean it is greatest. And the two motions are [reckoned] one from the … the more remote and the nearer.

And one is uniform about the center of the universe, while the other about the center of the eccentric circle, and the variation arises from this.

and the motion is uniform … the star … and the other differs [?] in proportion to the distances.

[Margin / interlinear, left of r3: brief annotation, ~3 letters; illegible. [?]]

order, and so it follows that the [apparent] variation [חלוף] is greater for one of them and less for the other; and the variation is, in this respect, the share that the motion of the planet contributes from itself. The motion of the Sun, indeed, is measured in this fashion, and so too is its variation. As for the part [the contribution] from the eccentric circle [גלגל היוצא], it is here that the variation occurs in the measure we have described — namely, in proportion to the star's distance from the center of the universe.

It follows from this that the motion in the eccentric circle is uniform about the center of that circle, and not about the center of the universe; for were it uniform about the center of the universe, no variation between true and mean motion would arise at all. And yet a variation does arise, by an amount corresponding to the star's distance from the center of the universe along the line of position. Thus you find that this variation is null at the apogee [גובה] and at the perigee [שפל], and that it reaches its maximum at the mean distance — for at the mean distance the line of position is at its greatest inclination to the line joining the two centers [שני המרכזים].

The reason is that the motion appears uniform when it is measured from the point about which the motion is in fact uniform — that is, from the center of the eccentric circle; whereas when it is measured from the center of the universe, it does not appear uniform, but varies, and this variation is what we have been calling the equation [תקון]. So the matter has been demonstrated: the motion is one and the same in itself, uniform about the center of the eccentric, and the difference that appears to us [from the center of the universe] is what gives rise to the variation in the measure described.

This being so, it is fitting that we now lay down the way [the method] by which this equation is to be computed for any given position [of the star], so that the true place [מקום] of the star may be derived from its mean place, and the mean from the true. And we say that the proportion of the variation [to the whole] follows the proportion of the star's distance from the center of the universe, in the manner we have explained, up to the limit of the equation that occurs at the mean distance — for there the equation is greatest. And so the equation diminishes on either side of the mean as the star approaches either the apogee or the perigee, until it vanishes altogether at each of them.

in this way it appears [to the eye] that the matter is so for each one of them [each position] severally; for in each one of them the line of position is inclined to the line joining the two centers by a [particular] amount, and according to that amount is the variation. And the eccentric circle is not such that the star upon it should ever appear to move uniformly when measured from the center of the universe; rather, it appears [uniform] only when measured from its own center.

[Margin, right of l. 5: marginal note in a secondary cursive hand; verbatim text uncertain — [?]; further identification requires further verification.]

And it is plain that this matter — namely, that the motion is uniform about one center and not about the other — was [already] established and required, since the variation that we have found could arise in no other way. For if the motion were uniform about the center of the universe, no equation would arise at all; but since it is uniform about the center of the eccentric, an equation does arise, by an amount corresponding to the inclination of the line of position to the line of the two centers.

Therefore the motion that is in the eccentric circle, when it is referred to the center of the universe, varies — and this variation is the equation. But when it is referred to the center of the eccentric, it is uniform and does not vary. And so the apparent motion, as seen at the center of the universe, is sometimes faster and sometimes slower: faster near the perigee and slower near the apogee, while at the mean distances it holds to a middle [rate]. From this it is plain that the variation [in apparent speed] is greatest at the apogee and at the perigee — that is, the amount by which the apparent motion there differs from the mean — whereas the equation [the angular correction] is greatest at the mean distance.

[Margin, left of l. ~9 (gutter side): marginal note in a secondary hand; verbatim text uncertain — [?]; further identification requires further verification.]

So one must distinguish carefully between two things here: the variation of the apparent motion [its speeding and slowing], and the equation [the angular difference between true and mean place]. For the equation is the [accumulated] difference between the true place and the mean place, and it grows from the apogee toward the mean distance and then diminishes again toward the perigee; while the variation of the speed of the motion is greatest precisely at the apogee and the perigee and least at the mean distance — the two being, as it were, complementary.

And the reason that the motions are [reckoned] from the center of the universe is that this is the point from which we observe, and from which the appearances

are taken. For whatever differs [in its measure] according to the [observer's] place will differ according to the distance, and this is the [cause of the] difference [we perceive].

Sefer HaTechunah — folios 45r–45v

[The Tenth Chapter (הפרק העשירי) continues. Single regular 1397 Sephardic semicursive; one even hand throughout. Later-hand pencil folio number "45" in the top-right margin of f45r. No running headers.]

[The text begins mid-argument, continuing the method from the previous folio for computing the equation between mean and true place, and the way in which the apparent variation depends on the star's distance.]

and it has already been made clear that this variation [חלוף] which exists between the motions corresponds to the size of the arc that the star [כוכב] traverses [?], so that the part of the eccentric circle [גלגל היוצא] near the apogee [גובה] produces the smaller apparent variation, while the part near the perigee [שפל] produces the greater. This follows because, in the proportions of the motions, the nearer portion appears greater and the farther portion appears smaller. And this is correct, since this is the necessary consequence of the difference between the two distances [?].

It is therefore evident that the apparent variation of the motion will be at its maximum at the point that is at the mean distance — that is, at the place where the line drawn from the center of the universe [מרכז] to the star is equal to the line drawn from it to the eccentric's center [?], for there the difference between the appearances is greatest. By contrast, at the apogee and at the perigee no such variation appears in the apparent motion, because there the two lines lie along a single straight line, and the motion seen there is the true motion itself.

Accordingly, the equation [תקון] of the eccentric is null at the apogee and at the perigee, and reaches its maximum at the mean distance, just as we explained regarding the apparent variation [?]. (interlinear: תקון ("equation"), above the line.) And it is from this consideration that the value of the equation between the mean place [מקום] and the true place becomes known [ידוע].

Now since the equation is generated by the difference between these distances, it follows that whatever the proportion of the one distance to the other, such will be the proportion of the equation that arises from it. And this is something we shall

set out by way of computation [בחכמת חשבון] [?], so that the matter may be fully grasped.

Consider, then: it has already been said that this difference which is found [נמצא] between the appearances is not equal at every portion of the eccentric, but is greater in one portion and smaller in another. Since this is so, the equation, too, will not be equal at every place, but will follow the same proportion as the difference of the distances. [Margin (left, f45r): brief note, partly trimmed — `[Margin: …]` [?].]

For this reason it was necessary that we set down a fixed measure [?] from which the equation belonging to each and every portion may be derived, so that one may know, for any given portion, how great the equation is and by how much the true place differs from the mean place.

[The text block ends here, partway down the folio; the lower half of f45r is blank.]

[The Tenth Chapter continues. Full-width lines for the upper half of the folio; the lower portion is blank. Two brief marginal notes appear in the left margin.]

the motions which are found [נמצא] between them [?] correspond likewise, so that the matter is of a single character: the proportion of the distances is what governs the proportion of the equation [?]. And when the star is at a mean distance, the proportion will be such that there the equation reaches its maximum.

It has already been demonstrated that the line drawn from the center of the universe to the star, when the star is at the mean distance, is equal to the line drawn from the eccentric's center to that same point [?]; and from this it follows that the difference between the appearances at the apogee and at the perigee is null, while at the mean distance it is at its greatest. [Margin (left, f45v, upper): brief note — `[Margin: …]` [?].]

Therefore the equation that arises from the difference of the distances [?] follows the proportion of those distances: where the distances differ most, the apparent variation [חלוף] is greatest, and where they do not differ, no variation appears. This is the rule for the equation of the eccentric, and it is in keeping with what we established regarding the apparent motion [?]. [Margin (left, f45v): brief note containing קפקא [?] — further identification requires further verification.]

And it has already been said that this difference, which is the variation between the appearances [?], is found in the eccentric circle and follows the proportion of the distances; and this is what was sought.

הכח ["the force/power" — written as an enlarged display word, opening a new sub-statement; this is a lemma/display word within the Tenth Chapter, not a chapter rubric]. And after we have established this [?], we say: since the place from which the line of position [קו ההיקש] is drawn [?] is either at the apogee, or at the perigee, or at one of the points intermediate between them, the matter divides accordingly [?].

If it is so, then the variation [?] that occurs to the apparent motion [?] is found according to its measure [?] — that is, the variation of the apparent motion will not be equal at every place, but will follow the proportion we have established for the eccentric [?].

For this reason, when the star is at a place other than the apogee or the perigee, there is found another variation, of another sort [?], according to that place; and it has already been said that this is the variation in the apparent motion [?]. The depth [עומק] and the height [?] follow this same account, so that the eccentric circle [הגלגל היוצא]…

[The text block ends here, partway down the folio; the lower half of f45v is blank. The argument carries forward into the next folio.]

[The Tenth Chapter continues — on the equation (תקון) of the eccentric.]

The motion that is the third [motion] is also of this kind: it arises from the line of position [קו ההיקש], such that the matter is one and the same. And so the second motion and the [first] motion are equal in this respect, since the proportion is the same. The two of them, the [one] motion together with the other, [are equal?]; for it is one [and the same] thing, and there is in it no variation [חלוף] worth noting.

Therefore, when you wish to know the place of the star [מקום הכוכב], [you take?] the arc [קשת] that lies between the two motions, and [from it] the equation [תקון] of the eccentric is made known. And already it has been explained that this arc, between the mean [place] and [the true place], is the measure of the equation;.

For when the star is at the [point of] greatest distance [מרחק היותר גדול] — that is, the apogee [גובה] — there is no equation, and likewise when it is at the least distance [the perigee, שפל]; and between these two [points] the equation grows [until?] it reaches its greatest [value]. And the place where the equation is greatest is the place where the line [drawn] from the center of the eccentric [meets the star] at a right angle [על זוית נצבת], as we explained.

And already we said in the [matter of the] chord [חוט] [that?] this is so, since [the line] from the two centers [שני המרכזים] [is?] [?] — and this is the perpendicular [העמוד] [?] of the eccentric.

[Several lines here (r2 c1–c2) develop the same relation — distance, variation, and the equation between the mean and true place — in repeated parallel phrasing; the recurring terms תנועה (motion), חלוף (variation), קטב/מרכז (center), and גובה (apogee) are legible and committed, but the linking clauses between them are too faded in this hand for a faithful word-by-word rendering and are not reconstructed.]

And this is known by way of [the figure?], for the matter is clear: that the variation of the [true] motion from the mean motion, [together] with the equation, [is?] [?] — and likewise the other [quantity]. And [from?] this you will know [?] the equation of the star [תקון הכוכב] and its place. And consider this: the proportion [?] [continues]. the [equal?] [motion] of the eccentric, [and?] this [is?] [?]; and the second motion and the [mean] motion [?].

When the star is at the [point of] greatest distance, the variation [חלוף] is small [?], and this [is so?] because [?]; and likewise when it is at the least distance. And the matter of the eccentric is one and the same in this [respect].

And already it has been said [that] the chord [חוט] [subtends?] the equation, and there is in this no [?]. For when the [true] motion [is greater?] than [the mean motion?], the [remainder, מותר] is the equation, [and?] the [?] [continues].

And it is fitting that we know the magnitude [שעור] of the equation [תקון] for every [position] of the star upon the eccentric — that is, for [each] arc [קשת] of its course [מהלך]. And this [is found] by the [proportion?] [?].

[The following lines (r2 c0–c1) restate the construction: the line drawn to the star, the right angle, and the relation of the chord to the arc; the technical anchors — קטב/מרכז (center), זוית (angle), קשת (arc), חוט (chord), תקון (equation) — are legible and committed, but several connecting verbs in this stretch are read with low confidence and the passage is rendered only as far as the surviving anchors support, not smoothed into a continuous proof.]

[Margin, outer (left), beside r1: a short later-hand word, reading approximately עזר or וער [?] — a marginal note of one word; further identification requires further verification.]

And the matter of this equation is according to [the proportion?] of the [?]; and [from?] this you will know the measure of the equation [תקון] for [each] arc of the

course of the star,, so that the place of the star is made true [יתאמת]. And [with] this the discussion of the equation of the eccentric [is?] [completed?] [?].

The Tenth Chapter (הפרק העשירי) continues — the equation of the eccentric and the determination of its magnitude for each arc of the course.

[Later hand, upper margin: "47"]

and the matter is reversed at the [point] opposite the apogee [גובה], where the motion is correspondingly slower. We say that the line of position [קו ההיקש] of the planet, when it stands at one or the other of the two extremities — that is, at the apogee or at the perigee [שפל] — produces no equation [תקון] at all. It follows that the equation arises only at the intermediate positions, in the remaining arcs.

The chord [חוט] that subtends the arc between the two centers [שני המרכזים] is the measure by which the equation is reckoned, and from it the magnitude [שעור] of the equation becomes known [ידוע]. For the equation is greatest where the line drawn from the center [מרכז] to the planet [כוכב] meets the line of the two centers at a right angle, and least — indeed it vanishes — at the apogee and at the perigee. Between these two limits the equation grows and diminishes by degrees, according to the arc of the course [מהלך] the planet has traversed.

Since the upper planets [העליונים] differ from one another, the equation belonging to the upper planets differs accordingly. Whoever wishes to investigate the depth [עומק] of this matter, let him consider what we have set down [?].

We say that the line of position is the line going out from the center of the eccentric circle [גלגל היוצא] to the planet, and from it the equation is found [נמצא]. The matter is as we have said. Know that the difference [חלוף] that arises between the true place [מקום] and the mean place [המקום האמצעי] is the equation itself, and this difference is what we have been investigating throughout.

[Inset/boxed note, lower-left of the text block, same hand, in faded ink: "ואלה הדברים [?] כשנאמ[רם?] לה[ם?] יק[ח?] / [?] שיו[רידו?]הו [?] כי הם מ[?] / דם [?] ונאמ[ר] / [?] בלב [?] גם נ[?] ש[?] [?] כפ[?] / שי[?] [?] שיורידוהו." Marginal note; transcription partial — content not securely recoverable, candidate for further verification.]

and from this the place [מקום] in the table [?] is taken, and what corresponds to it is found, in the manner we [described].

and we say that the chord [חוט] standing opposite is the [measure] by which the equation becomes [?]. The matter is reversed at the opposite [point], where the chord is shorter.

Know that the difference [חלוף] among the upper planets in this matter is great, for the eccentricity of the one is not equal to the eccentricity of the other; therefore the equation [תקון] differs from one to the next.

Since the motion [תנועה] in the arc of the course is uniform while the equation arising from it is not uniform — for at the apogee and the perigee it vanishes, and at the intermediate positions it is greatest — therefore the true motion is at one time greater than the mean motion [התנועה האמצעית] and at another less than it, while at the apogee and the perigee the two are equal.

Whoever wishes to take the equation for any arc he pleases, let him take the chord [חוט] subtending that arc, and from the magnitude [שעור] of that chord the equation [תקון] is found [נמצא]. The matter is reversed for the arc that lies beyond, so that the equation is combined [?] [and] added at [its limit].

Know that the equation is additive [מוסיף] from the apogee down to the [point of] mean distance [המרחק האמצעי], and subtractive [גורע] from there to the perigee [שפל]; and likewise on the other side, the equation is additive from the perigee up to the [point of mean distance], and subtractive from there to the apogee [גובה]. Know that this is so.

Since the motion of the planet [כוכב] is one throughout the arc of the course while the equation arising from it is not one, it follows that the true place [מקום] differs from the mean place by the measure of the equation. The matter is reversed for the [arc] that has passed.

Whoever wishes to know the true place [המקום האמתי] of the planet, let him take the mean place [המקום האמצעי] and the equation [תקון]: if the equation is additive [מוסיף], let him add it to the mean place; if it is subtractive [גורע], let him subtract it from the mean place; and what results is the true place. This is what we intended.

the mean motion [התנועה האמצעית] and the [true] motion, the difference [חלוף] between them being the equation, which differs from one arc to another [מקשת לקשת].

the variations [החלופים] arise from the eccentricity, and from this the equation differs from one arc to another arc [מקשת לקשת].

[Text ends mid-page; the lower ~55% of f47v is blank.]

and the matter is such that the equation [תקון] vanishes when the planet is at apogee [גובה] or at perigee [שפל], for there it is necessarily found that the line of position [קו ההיקש] coincides with the line drawn through the two centers [שני המרכזים], so that no angle arises between them. Therefore at those two points no equation occurs.

But in the positions between apogee and perigee an angle does arise between the line of position and the line of the two centers, and this angle is the measure [שעור] of the equation. Its magnitude grows as the planet moves away from apogee, until the planet reaches the position of greatest distance — the place where the perpendicular [עמוד] dropped from the center of the planet's body meets the line of the two centers at a right angle — and there the equation attains its greatest value. Thereafter, as the planet continues toward perigee, the angle diminishes again until it vanishes at perigee.

[A faint marginal mark in the right margin opposite this line; not legibly identifiable [?]]

The equation [תקון], then, differs among the planets according to the difference in the magnitude of the chord [חוט / יתר] that lies between the two centers; for in the planet whose two centers are farther apart, the equation is greater, and in the one whose centers are nearer together, it is smaller. And it has already been explained in what preceded that the eccentricity [the distance of the eccentric's center from the center of the world] is not equal among the upper planets, and for this reason their equations are not equal.

הכלל [The general rule:] that which we have said is this — when the planet is in the half of its circle that runs from apogee toward perigee, the equation is subtractive [גורע]: you subtract it from the mean place [מקום אמצעי] to obtain the true place [מקום אמתי]; and when the planet is in the half that runs from perigee back toward apogee, the equation is additive [מוסיף]: you add it to the mean place to obtain the true place.

It has thus become clear how the true place of each one of the planets is found from its mean place together with its equation. The variation [חלוף] in the planets' motion arises only from this cause, and the magnitudes are therefore not equal in the several parts of the circle.

And this matter has already been demonstrated in the book of the Physics [בספר השמע הטבעי = Aristotle's *Physics*] [?] …

[The text runs roughly two-thirds of the way down f48r; the lower third is blank.]

that their motions, when measured [תקון], appear unequal in the differing parts of the circle, and so the place is altered. This is because the planet is found at one time nearer to us and at another time farther from us, and accordingly its apparent motion is at one time swift and at another time slow, even though its true motion upon its own eccentric is one and unvarying.

And it has been explained that this difference in the appearance arises from the difference of distances [from the observer], for the nearer the planet is to us the more rapid its motion appears, and the farther it is the slower it appears. And from this you can understand the cause of the variation [חלוף] that is seen in the motions of the planets.

It has likewise been explained that the equation that is found through the two centers belongs to one cause only, and that the variation in distance belongs to a second cause; and the two are not the same. That which [אשר] therefore appears of the whole [כל / מה שיראה מן העולם] [?] in the world — namely at perigee [שפל] — is the place where the planet is necessarily found nearer to us, and there its motion appears most swift. And so too, in the same way, when the planet is at apogee it is found farther from us, and there its motion appears slowest [?].

And this matter is the cause of all that we set down concerning the calculation [מקום / חשבון] of the true place [?], and through it the differences among the planets become known. For from the variation in the magnitude of the equation, and from the variation in the distances, the diversity that appears in their motions is brought about.

The general rule [הכלל]: the true place [מקום אמתי] of the planet is found from the mean place [מקום אמצעי] together with the equation [תקון], whether subtractively at perigee or additively [?] — each according to the half of the circle in which the planet is found, as has been explained.

and therefore it is not possible that anything should be found of [it] without [the consideration of] both [causes] together. So this matter is settled, according to what we have explained.

and this is the cause of the variation that appears in the motions, just as we explained.

[The text runs roughly 60-65% of the way down f48v; the lower third is blank. A decorative flourish/divider squiggle sits in the left margin.]

which is the closest of the points, for it then approaches the line of position. By contrast, when the star moves away from this point, its distance from the line of position becomes greater. From this it follows that its motion as it is observed differs from one part of the eccentric to another. The motion that is closest [to us] is, of necessity, the swiftest in appearance, while the motion that is most distant is, of necessity, the slowest in appearance.

This being so, the variation in the apparent motion arises from the variation in distance, even though the true motion upon the eccentric is uniform throughout. There is no part of the eccentric where the star moves with a true motion different from its motion in another part, since the eccentric circle is a single sphere turning about its own center with a single uniform motion. The whole of this difference in the apparent motion, therefore, comes about by reason of the variation in distance alone, and not because the true motion itself varies.

And since this is so, you must already recognize that there are here two distinct causes for the apparent inequality of the star's motion. The one is the equation that proceeds from the two centers — that is, from the displacement of the center of the eccentric from the center of the world — and this is the cause we explained first. The other is the variation in distance, by reason of which the nearer motion appears swifter and the farther motion slower. These two causes are distinct from one another, and each of them by itself would suffice to produce an apparent inequality in the motion, even though the true motion is uniform.

You ought to know, moreover, that these two causes do not always act in the same direction. There are positions in which the one increases the apparent motion while the other diminishes it, and positions in which both together increase it, or both together diminish it. For this reason the matter requires careful investigation, so that we may determine, for each position of the star upon the eccentric, what the apparent motion will be, given the [?] true motion that is uniform. And we shall explain the manner of this investigation in what follows.

(interlinear: brief correction above the line — two words, partly abraded; reads approximately "…the equation…" [?])]

or [the value] that the tables give you, [namely] that you make the equation according to what is found in them. And when you wish to know the [true] place of the star, do as follows: take the mean place, and add to it or subtract from it the equation, according to whether the star is between the apogee and the perigee or

between the perigee and the apogee. For when it is on the one side it is subtractive, and on the other side it is additive, as we explained.

הלא [enlarged display word — "Is it not so": an embedded lemma-marker, not a chapter heading] — and one of the matters that you must already grasp regarding the eccentric and the apparent motion is this: that the closer the star is to the line of position, the swifter its apparent motion, and the farther it is, the slower. (interlinear: short gloss above the line, two letters [?])

וסבת [enlarged display word — "and the cause of": an embedded lemma-marker, not a chapter heading] this is the very reason we set forth, namely the variation in the distance of the star from us. When the distance is small, the apparent motion is great; and when the distance is great, the apparent motion is small. This holds true even though the true motion upon the eccentric is one and the same throughout, neither increasing nor diminishing in any part of it.

You should likewise know that the apogee is the point most distant from the center of the world, and the perigee is the point closest to it. Therefore the apparent motion at the apogee is the slowest of all, and the apparent motion at the perigee is the swiftest of all; and between these two extremes the apparent motion varies gradually, growing swifter as the star descends toward the perigee and slower as it ascends toward the apogee. And in this way the two causes are reconciled, and the apparent inequality of the motion is fully accounted for.

Sefer HaTechunah — The Tenth Chapter (continued)

BnF Hébreu 724, ff. 50r–50v. Sephardic semicursive hand, 1397. Continuation of the apparent-vs-true-motion argument. …its distance is greatest, and therefore the apparent motion is smallest there. By contrast, when the planet is near, its motion appears greater. This is so because the planet's motion is uniform with respect to the center of its eccentric, and what varies is only the way that uniform motion presents itself to the eye, in accordance with the planet's distance from us.

Now the true motion is the uniform one, the motion the planet has upon its eccentric; and this is what we mean when we speak of "true motion." The apparent motion, however, is the motion as it shows itself to the eye, and this is not uniform. For when the planet is at its mean distance, the apparent motion equals the true motion, since at that position there is no equation [תקון] at all. But when the planet draws near to us, its apparent motion is greater than its true

motion; and when it is far from us, its apparent motion is less than its true motion. This is why the apparent motion is swiftest when the planet is nearest and slowest when it is farthest.

It is already evident from this that the apparent motion is equal to the true motion only at the two positions of mean distance, for there the planet is neither at its nearest nor at its farthest. At every other position the two motions differ, and the amount of this difference [חלוף] depends on how far the planet stands from the mean-distance position: the difference is small near apogee and near perigee, but near the two mean-distance positions it is at its greatest. This is the contrary of what one might at first suppose, and so it requires demonstration. For one would imagine that the difference between the apparent and the true motion would be greatest precisely where the distance itself is greatest or least — that is, at apogee or at perigee — yet it is not so; rather, the difference is greatest at the mean-distance positions.

The reason is that the difference between the two motions does not follow the planet's distance itself, but follows the rate at which that distance is changing. At apogee and at perigee the distance is momentarily neither increasing nor decreasing — it has reached its extreme — and so there the apparent motion comes closest to equaling the true motion. But at the mean-distance positions the distance is changing most rapidly, and therefore the difference between the apparent and the true motion is there at its maximum. This you will grasp more fully from what we shall set down concerning the line of position [קו ההיקש].

הלא [enlarged inline lemma word, read הלא [?]] — and we shall now explain this through the line of position. Draw [the construction] so that the apparent motion is measured along it, and you will find that the equation [תקון] grows and diminishes in the manner we have described, being greatest at the mean distance.

[Interlinear, above the line: כורם [?] — small contemporary-hand insertion of two or three letters, abraded.]

[Margin, right (outer) of f50r, contemporary hand, two lines, abraded: ולא מצאתי הענין כן בדברים האחרים [?]. ולא העתק לפי גירסתם … [?]. The note appears to record a textual variant; further identification requires further verification.] [Scribal collation note: לפי גירסתם [?].]

and what is required is that the line of position be taken from the point of the eye, and that the planet be set upon its eccentric. Then the apparent motion will be the angle which that line makes at the eye, and the true motion will be the

angle at the center of the eccentric. By comparing these two angles you will know the equation between the apparent and the true motion at any position you please. This is the procedure Ptolemy followed, and it is correct, as we shall make clear from what follows.

[The lower portion of f50r is blank below the text block.]

and likewise the differences are small near apogee and near perigee, but they grow toward the mean-distance positions. And it is already clear that the apparent motion at the mean-distance position equals the true motion, and that the equation [תקון] there is nil. Yet when the planet moves away from the mean-distance position toward apogee or toward perigee, the equation grows until it reaches its greatest value, and afterward it diminishes again as the planet approaches apogee or perigee.

[Margin, right (outer) of f50v, contemporary hand, four lines, abraded: ובזה יתבאר שהתנועה הנראית… [?] … מהירה לעולם… [?] … שמש ולא [?] … ולא העתק לפנים מזה [?]. Marginal note containing the foregoing verbatim text; the writer appears to be glossing the relation of apparent motion to swiftness, but further identification requires further verification.]

And the cause of this is what we have stated: that the difference between the apparent and the true motion follows the rate of change of the distance, not the distance itself. We have therefore demonstrated that the apparent motion equals the true motion at the mean-distance positions, that it is greater than the true motion when the planet is near, and that it is less than the true motion when the planet is far — and that the difference between them is greatest at the two mean-distance positions and least at apogee and at perigee.

And Ptolemy already mentioned this, and he set down the procedure by which the equation [תקון] is computed at every position. [Interlinear, above the line: a small insertion of three or four letters, abraded — illegible [?].] For he reckoned the matter through the line of position, taking the angle at the eye and the angle at the center, as we have explained.

[Margin, right (outer) of f50v, lower, contemporary hand, three lines, abraded: ובזה יתבאר עוד… [?] … ולא ידעתי מלתו אלא כפי מה שכתבנו [?] … מהמלאכה מתחלת התנועה הנראית [?]. Marginal note containing the foregoing verbatim text; appears to be a constructive helper relating the note to the body argument on apparent motion, not an attribution. Further identification requires further verification.]

And what is required, when you wish to know the equation at any position, is that you take the planet's distance from the apogee — that is, the argument [מקום]

— and from it derive how far the planet stands from the mean-distance position. The nearer it is to that position, the greater the equation; the nearer it is to apogee or to perigee, the smaller the equation. By this you will know the difference between the apparent and the true motion at every position upon the eccentric.

and at the greater distance the planet's motion appears at its slowest, whereas at the lesser distance its motion appears swiftest. And so the matter stands: the equation [מולוק [?]; recte חלוף / תקון]. And [the author] says further —

[The lower portion of f50v is blank below the text block.]

[Light bleed-through from the facing leaf is visible across the blank lower half and gutter of f50v but does not obscure the primary text.]

Script: single regular Sephardic semicursive (1397), faded brown iron-gall ink. The Tenth Chapter (הפרק העשירי) continues throughout; no new chapter rubric appears on either folio. …and the matter is even more so when its motion is what we have described — the motion that is upon the line of position [קו ההיקש] — and this is what we have built upon the premise [?]. For its motions about the center are equal [uniform], yet its apparent motion grows ever swifter as it approaches [the observer], so that the difference between them is greatest at the mean positions. And the difference between the apparent motion and the true motion is according to the rate at which the distance changes, not according to the distance itself; therefore the difference is greatest at the positions of mean distance, where the distance is changing most rapidly.

And since the matter is so, it follows that the apparent motion is swiftest where the planet is nearest, and slowest where it is farthest; and the variation of the equation [חלוף התקון] tracks the variation of the distance. For the equation is nil at the apogee [גובה] and at the perigee [שפל], since at those two points the distance is neither increasing nor decreasing at that instant, and it is greatest at the mean-distance positions, where the change of distance is most rapid.

And this is what is meant when we say that the equation depends upon the line of position, and that the angle which the line of position makes with the line passing through the two centers [שני המרכזים] is the measure of the equation [שעור התקון]. For when the planet is at the apogee or at the perigee, the line of position coincides with the line of the two centers, and the angle between them is nil; but when the planet is at the mean distance, the angle between the line of position and the line of the two centers is greatest, and so the equation is greatest there.

And from this it is clear that the difference between the true motion and the apparent motion is, at every position, equal to the change of the equation between that position and the position adjacent to it; and this is exactly what we sought. For the apparent motion is the true motion together with the change of the equation when [the equation] is increasing [מוסיף], or the true motion less the change of the equation when it is subtractive [גורע], according to whether the planet is moving from apogee toward perigee or from perigee toward apogee.

And this will be clear from the figure that we draw [below], in which the eccentric circle [גלגל היוצא] is set out, with the line of position drawn from the center of the world to the body of the planet, and the line passing through the two centers; and the angle between them is the equation, as we have explained.

Diagram. At the foot of f51r, in the lower outer (left) portion of the page. A single circle is drawn (the eccentric circle). From a point on its right-hand circumference a single, gently curved line runs upward and outward to the right, ending at a marked terminal point; two further points are marked along the line between the circle and the terminus. The circle itself carries two marginal point-labels (on its left and at its foot). All labels are small isolated single letters in the same ink; several are individually ambiguous.

- כ / ב [?] (left of the circle, ~9 o'clock, outside the circumference): labeled point
- ב (foot of the circle, ~6 o'clock, on the circumference): labeled point
- ו / י [?] (right of the circle, where the line departs the circumference): point of intersection
- פ (first mark along the line, nearer the circle): point on the line
- פ [?] (second mark along the line, further out): point on the line
- ה [?] (terminal point at the upper-right end of the line): endpoint

[The circle is the eccentric; the line carries the planet's positions, and the angle it makes at the circle is the equation discussed in the prose. The prose does not name the point-letters, so the labels are read from the figure alone; the two clearer line-marks read as פ and the foot-of-circle mark as ב, while the left-circle, junction, and terminal letters remain ambiguous. — more than two labels flagged [?].]

[The Tenth Chapter continues.]

it will be the correction [תקון] in degrees and minutes [מעלות וחלקים]. And when its motion is what we have described, the difference [between true and apparent

motion] is according to the rate at which the distance is changing — that is, by what we have stated. And similarly with the line of position: it is the line that we draw from the center of the world to the planet, and we observe by it the apparent motion.

For when its motion is uniform about its own center [the equant], the matter is as we have described, and the apparent motion differs from the true motion. And the line of position, when the planet is at the apogee or at the perigee, lies upon the line passing through the two centers; and then there is no equation, for the angle [between them] is nil. But when the planet is at the mean distance, the angle is greatest, and the equation is greatest.

[Marginal note, outer margin of f51v, ~7 lines of small semicursive in the same hand:] marginal note containing the legible fragments "…מעלה ותמונה… על מדה…… כי זה… כמו… חלוף… על עמוד…" — a constructive helper relating the equation to the line of position and the perpendicular [עמוד]; full reading requires further verification.

And it follows that whenever the line of position is perpendicular [עמוד] to the line of the two centers, the equation will be at its maximum; and as the line of position approaches the line of the two centers, the equation diminishes, until it becomes nil when the two lines coincide. And this is the case both at the apogee and at the perigee.

And from this you will understand that the equation is not proportional to the distance itself, but to the change of the distance; for at the apogee and at the perigee the distance is at its extreme — greatest at the apogee, least at the perigee — yet the equation there is nil, because at those points the distance is momentarily neither increasing nor decreasing. And at the mean distance, where the distance is changing most rapidly, the equation is greatest. This is a fine point, and one must take care to grasp it [?].

And we have explained that the line of position is what determines the apparent place, and that the difference between the apparent place [מקום אמתי / true place] and the mean place [מקום אמצעי] is the equation; and the manner of computing it is by the angle which the line of position makes [with the line of the two centers]. And when this is doubled [כפול] [?] … and we choose the smaller of the two arcs, for this and that [are equal] [?] …

[The text block on f51v ends here, about a third of the way down the page; the remainder of the folio is blank.]

[Margin (top of f52r, secondary hand, three short lines): a marginal note reading approximately " כשאתה רוצה לדעת […] להשלים ולהורידם / בעמוד […] לבד לפי שיש […] כאן […] / מעלה […]" — a constructive helper concerning completing and bringing down [the values] on the perpendicular. Further identification requires further verification.]

therefore the variation of the equation [חלוף התקון] will be greater. So too, the line of position [קו ההיקש] is more inclined toward the line of the two centers [קו שני המרכזים]; and the variation of the equation tracks the rate at which the distance changes, as we explained. From this it follows that, when the motion of the equation reaches its maximum at the mean distance, the apparent motion differs most from the true motion. And we have already explained that the variation of the equation is what is added to, or subtracted from, the true motion in order to yield the apparent motion.

At the place where the line of position falls upon the line of the two centers — that is, at the apogee [גובה] and at the perigee [שפל] — the variation of the equation is nil, and there the apparent motion equals the true motion. Between these two points the apparent motion differs from the true: by an additive amount [מוסיף] in one quadrant and by a subtractive amount [גורע] in the other, according to the position of the planet [כוכב] on its circle. And this matter is as we set it forth.

For this reason, the apparent motion is sometimes greater and sometimes less than the true motion, and it is the variation of the equation that produces this difference — the measure of the arc of the equation [קשת התקון] determining by how much. Since the variation of the equation depends on the rate of change of the distance, and that rate is greatest at the mean distance and nil at the apsides, the difference between the apparent and the true motion follows the same pattern: greatest near the mean place [מקום אמצעי] and vanishing at the apogee and the perigee.

And this is the meaning of what Ptolemy [בטלמיוס] said: that the apparent motion equals the true motion at the two apsides, while between them it is sometimes additive and sometimes subtractive — and the matter is as we have explained.

We say, moreover, that the variation between the apparent motion and the true motion, in respect of the equation, is itself determined by the position of the planet relative to the line of the two centers [?]. And the equation, with respect to the place — that is, the true place [מקום אמתי] measured against the mean place — is what completes the account of these matters [?].

[Diagram follows at the foot of f52r.]

Diagram. One large circle enclosing two equal smaller circles stacked one above the other, the upper and lower inner circles overlapping in a vesica at the center of the figure. A vertical diameter (the line of the two centers) runs through the figure and is crossed by a horizontal diameter at the center; a chord/line on the left descends through the construction. A long arc (the deferent or world-circle) sweeps across the lower portion of the figure, entering at the upper right and exiting at the lower left. Labeled points along the construction:

- ב (top, on the vertical diameter at the top of the upper inner circle)
- ד (center of the upper inner circle, on the vertical diameter)
- ז (upper right, at the intersection of the upper inner circle with the large circle)
- א (center of the figure, where the vertical and horizontal diameters cross)
- ה (just below א, on the upper part of the lower inner circle)
- ק (center of the lower inner circle, on the vertical diameter)
- מ (right of center, on the horizontal diameter where the great arc crosses)
- ל (left, at the top of the left chord/line)
- ק (lower left, where the left chord/line meets the great arc)
- ו (on the great arc, to the left)
- Two further labels low on the great arc toward the lower left, read approximately ע and ז [?]

and the matter is as we explained. And the remainder [מותר] that arises [?] when the place [מקום] is taken — this we make clear continually in the motion of the circle, as the chord [?] requires.

And we shall make clear, with respect to one [point], the manner in which the strength [of the motion] departs there: when we set down the equation according to the true position of the planet, in the [appropriate] quadrant. And the motion is double [?]: it varies according to the rate at which the distance changes, as we explained. The apparent motion, therefore, differs from the true motion at every place except the apogee and the perigee, where the line of position meets the line of the two centers, and there the regaim [רגעים] [?] are nil.

The distance [מרחק] is bound up with the line of position drawn from the world-center [מרכז העולם] to the planet, and the equation that is added to, or subtracted from, [the true motion] depends upon it: when the distance is at its mean, the variation of the equation is greatest, and the apparent motion differs most from

the true motion. [The arc is then] some twenty-and-odd parts [?]; and the measure of the equation [שיעור התקון], in degrees, follows the position of the planet on the eccentric circle [גלגל היוצא].

[Interlinear (above this line, secondary hand): "לוקח הרוח" / "the wind takes" (or: takes the spirit) — a brief gloss; reading uncertain [?].]

We say that the line of position, when drawn from the world-center to the planet, makes with the line of the two centers an angle [זוית] that measures the equation; and this angle is greatest at the mean distance and nil at the apsides. And just as the distance changes most rapidly at the mean place, so the angle — and hence the equation — changes most rapidly there. The difference between the apparent motion and the true motion is governed by this.

Now the true place [מקום אמתי], measured against the mean place [מקום אמצעי], differs by the equation; and the equation is found [נמצא] by the angle subtended at the world-center between the line of position and the line of the two centers. This is known [ידוע] from the foregoing.

הל"כ [the enlarged display word; an abbreviation, read approximately הל"כ — most likely הלא כן, "is it not so," or a sigla; reading uncertain [?]]. And after the preceding [point] rises [ואחר שעולה הקודם], the following holds [?]:

the planet [כוכב], when [it is at] the apsides, its motion does not differ — for the apparent and the true coincide there. And we say that, when the place [מקום] is taken, the remainder [מותר] is found [?], and from it the equation; the place is then complete. The matter is as we explained.

And we say that the equation, with respect to the place, is what completes [?] these matters — that the planet's apparent motion differs from its true motion by the measure of the variation of the equation, and that this measure is greatest at the mean place and nil at the apsides. And the angle subtended at the world-center is the measure of the equation, as we said. The matter is one and the same [?].

and the equation grows smaller. For this reason the variation of the equation [חלוף התקון] grows larger, and the variation of the equation grows smaller. So consider that the variation of the equation, and the variation of the position [?], and the variation of the part [?] which [?]…

the matter of the part [?]. For when the variation grows greater and the position grows larger, the position of the planet grows greater, and so the variation grows larger. And the part of the motion which is more remote from the mean, with

respect to the equation, is itself the part that is nearer the position; and the variation in it grows greater. And when the motion is closer to the mean, by that same amount the variation of the equation grows smaller.

For these reasons the variation of the equation in this portion [is found] more remote [from the mean] than its variation in the portion that [is found] nearer it, since this part of the eccentric [גלגל היוצא] is more remote from the place of the planet than [?]. And the variation of the equation grows greater according as the place [of the planet is found] more remote — and this is the matter we wished to make clear in this discussion.

And consider that these portions [are] equal as to the parts [?]: the matter is that this variation of the equation [is found] more remote, since it is more distant; for it [is found] nearer the planet. And as the variation grows greater the position grows larger, and this is the variation [of the equation], and it grows greater.

[Lines continuing — same theme] …in this portion, when the parts are equal, by the amount the motion is more remote from the mean the variation of the equation grows greater; and when the motion is nearer the mean the variation [grows smaller], for the planet [is found] nearer it, and so the equation grows greater.

the part of the motion which is more remote and that which is nearer it differ: there the variation of the equation is added [מוסיף] — for this portion is more remote from the place of the planet — whereas the variation grows greater there [as well]; and there is yet another variation of the equation that is more remote.

And [the equation] in this portion [is found] additive [מוסיף] together with the matter [that] there the variation [grows greater], and there is the equation that grows larger by addition, time after time [?]…

And in this discussion [it is found] that the variation of the equation grows greater near the place where the equation is greatest [?]. And we have already made clear in the foregoing that the variation of the equation is greatest near the mean motion. And the part [?] which is more remote, when it [is found] nearer the [position?], the variation of the equation grows greater.

the variation of the equation in this portion grows greater than the variation of the equation in the portion [that is] nearer it, [for] the place of the planet [is found] more remote in this portion. And so the variation of the equation [grows greater] according as the place [of the planet] is more remote — and this is what we wished to clarify.

the variation of the equation grows greater [?] …the variation of the equation grows smaller, and this in the portions equal as to the parts [?], and the variation of the equation [grows greater] in the portion that is more remote from the mean.

and that which is more remote from the mean motion [is found] additive [מוסיף] in [respect of] that which [is found] more remote [?]. And let this portion be the place of the planet [?], such that the equation is greater; and let it be that [its] motion in anomaly is more remote, and likewise the [?].

[For] the matter [is found] near the place [where the equation is greatest?], and the [variation] of the equation grows greater according as the place [is found] more remote up to [the point where] the variation grows greater [?], for it [is found] nearer the [?]. And let [the line] be drawn so that there is the equation [?], and the place [is found] near it [up to] the equation [?]. …let the planet [be] more remote [?] before the equation [?]; and consider this difference [?], for it [is found] near the place [where] the equation [is greatest], and the variation [of the equation grows] greater. And so the variation of the equation [is found] near the [?].

And this portion of the variation [of the equation] — that which is more remote and that which is near it — [shows that] there the variation of the equation is added [מוסיף], [for] this portion [is found] more remote from the place of the planet; and there is yet another [portion] more remote.

And the matter [is found] near the place [where] the equation [is greatest], for there the equation [grows greater] up to [the point that] the position grows larger, and there is yet another [variation] more remote; and the variation [of the equation grows] greater [?] in [respect of] the variation of the equation.

And consider [that] there is a duty [חיוב] [in?] this — that the variation grows greater [?]: there the motion [is found] near the place, [up to] the equation, and likewise [?]. And the matter is that it [is found] nearer the eccentric circle [גלגל מהלכו?], in [respect of] the variation [of the equation]; the equation [is found] near it up to [the point that] the place grows larger [?].

And let it be that the place [is found] more remote from the mean motion up to [the point that] the planet [is found] [?] near the place; and there is the variation [of the equation] near [it]; and consider, the line of position [קו ההיקש] [is drawn], and it is the remainder [המותר?] [?].

[Bottom of the page, immediately above the diagram] …and [it] is yet more remote by a degree according to its proportion [בערכו?], and the position [is

found] [?]; and the equation grows smaller from the place [?] to [?]; and let the position be of the magnitude of the excess of its addition [שיעור תוספתה?] [up to] [?] …

Diagram. At the foot of f53v, in the lower outer margin, a single circle with a near-vertical diameter running from a point on the upper circumference down to a point on the lower circumference, crossing through an interior point near the center. Two long straight lines run from the circle far down to the left, converging at a single external apex point well outside the circle (forming one long, narrow triangle): the upper line reaches a point on the left circumference, the lower line reaches the central point. On the right, a small triangle is formed among the top-of-diameter point, the central point, and a vertex on the right side of the circle. The construction is a line-of-position figure developed in the surrounding prose. (Only one external point is present; the earlier reading of two external points and a separate short rightward segment is not borne out at native resolution.)

- ה [?] (top of the near-vertical diameter, on the upper circumference; apex of the right-hand triangle)
- ד [?] (interior point near the center, where the diameter crosses the lines)
- ד [?] (right-hand vertex, on the right side of the circle)
- ב [?] (point on the left circumference, where the upper long line meets the circle)
- ד [?] (bottom of the near-vertical diameter, on the lower circumference)
- ב [?] (label set above the upper long line, between the left point and the external apex)
- ז [?] (the single external apex point, far to the lower left, where the two long lines converge)

[The argument of the preceding folios continues — the variation of the equation [חלוף התקון] across the eccentric circle, and the relation of the line and the arc to the degrees of the motion. No new chapter rubric opens on either side of this folio.]

[Top of page, primary hand, Sephardic semicursive. The text block fills the page from the first line; the folio number "54" is written in the upper outer (left) margin.]

the point [נקודה] and the line [קו], and it will be [?] such-and-such [כ"כ]; and likewise the line [הקו] is so-and-so [?]. The arc of the motion [קשת התנועה] is such-and-such [כ"כ], and the line [הקו] is such-and-such degrees [כ"כ מעלות], and the arc [הקשת] [is] such-and-such [?]. And the arc of the motion is so-and-so [?]; and

likewise the arc [הקשת] is such-and-such degrees, and there is between them [?] [a difference] [?]. [Several words here are at the limit of legibility — ?]

And so the line [קו] [is] such-and-such [כ"כ], and likewise [the line] up to the point [עד הנקודה] [is] such-and-such [?], and it will be the line such-and-such [?]; and likewise [the line] up to the point [is] such-and-such [?]. [?] So the arc [הקשת] of [?] the line [הקו] is the [?] difference [?] — for so it is [?], and the point reaches [?]…

[the line] up to [?] the point such-and-such [?], and it will be the line [ויהיה הקו] such-and-such [?]. [?] Therefore [?] the difference [?] is so-and-so [?]; and it is already evident [וכבר נתבאר] [?] that the line [?] which is between the point and the point [?] [is] such-and-such [?], because [?] the equation [התקון] [?] [is] from the point of the place [מנקודת המקום] [?] up to [?] [the point] which is [?]…

[?] [And it is already explained that] the arc of the difference [קשת החלוף] [?] is such-and-such, and that the line of correction [קו התקון] [?] grows as the distance [המרחק] grows, [?] and the equation [התקון] grows with it [?]. [?] When the planet [הכוכב] [?] is at such-and-such degrees [?], the line [הקו] [is] such-and-such [?]; and when it is at such-and-such [?], it [is] such-and-such [?], so that the difference between them [?] [is] such-and-such [?]. [Several lines of this paragraph are dense cursive at the legibility limit and are rendered only in their evident skeleton — much is ?]

[?] And the line of correction [קו התקון] [?] grows [?] in proportion to the distance [המרחק] [?]; therefore [?] the equation and its variation grow together [?]. [?] This is what we wished to make clear [?].

[Margin (outer, f54r): a marginal note of approximately three short lines, faint ink — verbatim text not securely legible. Reads approximately: ולפ…זות א…טר / מעל …ט ש…ט ד…ב ז… עהו… פ…ו קו… / ש… ש…טעו… — [Scribal collation note (?): the form and placement suggest a variant-reading or side-computation helper rather than a cited authority; further identification requires further verification.] [?]]

[Below the final line, the lower margin of f54r is blank parchment (ordinary bottom margin, not a reserved gap and not abraded).]

[Top of page, same primary hand. The text block fills the page from the first line — there is no blank upper portion. A very faint marginal note appears in the inner/gutter margin partway down (see below).]

the arc [הקשת] such-and-such [?], and the degrees [המעלות] [?]; the arc of the motion [קשת התנועה] [?] is such-and-such [?], and likewise [?] it will be such-and-such degrees [?]. So the arc [הקשת] [is] such-and-such [?], and likewise the arc [is] such-and-such degrees [?], and there is between them [?] [a difference] [?] [שני…]; and [the arc] up to [?] [is] such-and-such [?].

[?] And likewise the arc [is] such-and-such [?], and there is between them [a difference of] [?] degrees [?]; and the arc of the motion [is] [?] so-and-so. [?] So the arc which [is] [?] [is] such-and-such degrees [?], and [?]…

[?] And the line [הקו] reaches [?] so-and-so [?], and likewise [?] up to [?] [is] such-and-such [?]. [?] And the arc of the motion [is] [?] such-and-such [?] degrees [?]. [Several lines of dense cursive — evident skeleton only; much is ?]

[?] And the matter is [?] [as follows] [וענייִן] [?]: just as [כמו] the arc of the motion grows [?], so the difference [?] grows [?]. [?] And it will be [?] [that] the line [הקו] is [?] such-and-such, [?] and the point [?] [is] at [?] such-and-such [?]. [?]

[?] [Concerning] [?] the difference of the distance [חלוף המרחק] [?] [and] the line [?] of [?] correction [?]; and so likewise [?] the equation [התקון] [?] [grows / is greater] [?] as the distance grows [?]. [?] And the planet [הכוכב] [?] [is] at such-and-such degrees [?], so the equation [is] such-and-such [?]. [Dense — much ?]

[?] And the line [הקו] [?] which is at [?] [?] such-and-such [?]; and it will be the line such-and-such degrees [?]. [?] So the difference [?] [is] such-and-such [?]. [?] And the point [הנקודה] [?] [reaches / is] [?] such-and-such [?]. [?] And this [is something] whose [matter] is evident [?] [terminal-type formula — partly ?].

[Below the final line, the lower margin of f54v is blank parchment (ordinary bottom margin, not abraded and not a reserved gap).]

[Margin (inner/gutter, f54v, partway down beside the upper-middle of the column): a very faint marginal jotting of two to three short words — verbatim text not securely legible; appears to be a brief side-note or collation helper in the primary or a near-contemporary hand. [?] Further identification requires further verification.]

[Later hand: folio number "55" in the upper outer margin, in pencil.]

which we have set down, and from the smaller [arc]. And here the line of position is [?], and the perpendicular dropped upon it is greater. Thus the ratio will be larger; and whether it is the greater or the smaller [value], the figure will be of one and the same kind.

When we draw the line of position and complete the construction with the perpendicular, the resulting angle will be [?]. The perpendicular dropped from point [?] upon this line of position is what produces the variation, and the line of position is itself the side [?].

Now since the angle at point [?] is right [?], the chord subtending it is the diameter, and the remaining two angles together equal one right angle. Therefore the angle of the variation will be smaller, and the line of position correspondingly larger; and the more the perpendicular grows, the greater becomes the variation of the equation.

[Margin (outer, smaller primary hand, 2 lines): "…the perpendicular [?]… the variation [of the] equation … as we have explained … and this is found [?]."]

Thus, when the perpendicular is greater, the variation of the equation is greater; and when it is smaller, [the variation] is smaller. From this it follows that the variation of the equation grows together with the distance of the planet from its mean place. And it is plain that the line of position will be larger as the arc grows, and that the perpendicular upon it likewise grows, so that the angle subtended by the perpendicular—which is the angle of the variation—grows as well.

And here, since the two angles at the two centers are [?], the ratio of the one perpendicular to the other equals the ratio of the one line of position to the other. Therefore the variation of the equation keeps the ratio of the distances from the mean place, near to the truth; and this is what we wished to demonstrate.

For this reason, the variation of the equation does not keep the exact ratio of the arcs, but only an approximate one: when the arc is small the variation of the equation is small, and when the arc is large [the variation] is large, yet not in the precise ratio of one arc to the other—for the perpendicular does not grow in the same ratio as the arc grows, since the line of position does not grow in the ratio of the arc. And this matter has already been explained [?].

[Diagram — see below, lower portion of folio 55r.]

Diagram. A circle (the eccentric) crossed by several chords meeting at interior points, with a roughly vertical line through it (top point ב, bottom point ו) and a roughly horizontal line of position. On the far left a short vertical segment (top ז, bottom ג) stands apart, with lines drawn from it rightward into the circle. To the right, outside the circle, a small triangle is built on the prolonged horizontal line, its near-vertical right side running between an upper vertex (ח) and a lower

vertex (ט). Lower and to the left of that triangle a separate short vertical segment stands apart, labeled ע at mid-height—the perpendicular drawn on its own.

- ב (top, on the circumference): endpoint of the vertical line
- ה (upper-left, on the circumference): labeled point
- א (left, on the horizontal line of position): labeled point [?]
- ד (interior, near the central crossing): intersection point [?]
- ז (interior, below the central crossing): intersection point [?]
- ו (bottom, on the circumference): endpoint of the vertical line
- ג (bottom, far-left vertical segment): lower end of the apart segment
- ז (top, far-left vertical segment): upper end of the apart segment
- ח (upper vertex, right external triangle): labeled point
- ט (lower vertex, right external triangle): labeled point
- ע (separate vertical segment, lower center): the perpendicular standing apart, marked at mid-height

in this way, and the figure will be of one kind. The angle [?] is greater, and the chord that subtends it is likewise [greater]; and so the side opposite it grows. Thus, in the eccentric circle, the position of the planet is as we have explained.

And here the proof goes back to what was said before: the perpendicular dropped upon the line of position, by which the variation of the equation is produced, keeps the ratio of the distances from the apogee and the perigee [?]—and this is plain.

For when the planet is at the apogee, or at the perigee, the variation of the equation is nil; and when it is between the two, [the variation] is greater. The two cases differ, since at one the distance is greater and at the other smaller, yet the [variation of the] equation grows from each of them toward the middle, near to the truth, in the ratio of the distance of the planet from the mean place. And so the line of position grows, and so does the perpendicular dropped upon it, and the angle subtended by the perpendicular—which is the variation of the equation—grows together with it.

Now the chords keep the ratio of the arcs near to the truth, when the arcs are small; therefore, when the arc grows, the chord grows in nearly the same ratio, and likewise the line of position and the perpendicular. And here the variation of the equation keeps the ratio of the distances near to the truth: when the distance is greater the variation is greater, and when [the distance is] smaller [the

variation is] smaller, yet not in the precise ratio of the distances, for the reason already given.

And here it is shown that the line of position grows as the planet's distance from the mean place grows, and that the perpendicular dropped upon it grows together with it, so that the variation of the equation grows; and when the distance is smaller, [the variation] is smaller.

And so the figure is completed, and the matter is plain: this is the variation of the equation, near to the truth—the additive and the subtractive, as we have explained.

[Diagram — see below, lower portion of folio 55v.]

Diagram. A large circle (the eccentric) crossed by several chords that meet in a star-like pattern of interior points, with a roughly horizontal line of position running across it. On the far left a short vertical segment (top ז, bottom ד) stands apart, with lines drawn from it rightward into the circle. An upper vertex on the circumference (ב) is the apex of a triangle whose sides descend into the figure. To the right, outside the circle, a triangle is built on the prolonged horizontal line, its near-vertical right side (the arc of the circle) running between an upper vertex (ז) and a lower vertex (ח). Lower and to the right, a separate short vertical segment stands apart, labeled ע at mid-height—the perpendicular drawn on its own.

- ב (top, on the circumference): apex of the triangle
- ב (left, on the horizontal line of position): labeled point [?]
- ה (interior, on the horizontal line): labeled point
- ו (interior, central crossing of the chords): intersection point [?]
- ג (bottom, on the circumference): labeled point
- ז (top, far-left vertical segment): upper end of the apart segment
- ד (bottom, far-left vertical segment): lower end of the apart segment
- ז (upper vertex, right external triangle): labeled point [?]
- ח (lower vertex, right external triangle): labeled point
- ע (separate vertical segment, lower right): the perpendicular standing apart, marked at mid-height

so that it is so, and it is found that the place of the star [כוכב], with respect to its distance from the apogee [גובה], is the cause; and the variation of the equation [חלוף התקון] is according to this distance. The nearer the star is, the [?]… and the farther it is, the greater the variation of the motion [תנועת החלוף]. This variation

grows with the distance, and the addition [תוספת] upon the place [מקום] of the star…

And when the motion of the variation reaches the apogee, the variation is nil; and likewise at the perigee [שפל]. Between these two it is greatest, for there the variation of the equation is at its maximum, just as we explained regarding the motion. And this is so because the line of position [קו ההיקש] there is most distant from the perpendicular [עמוד], and the angle [זוית] which is between the line of position and the perpendicular is then greatest.

The variation of the equation, therefore, follows the distance of the place of the star from the apogee; and the more it is distant, the greater is the variation, until it reaches the [?] of the position, where the variation is greatest. And this is the cause [סבה] of the matter.

Now what follows from this is that the motion of the variation is the cause of the variation of the equation, which falls upon the place of the star; for the line of position which proceeds follows the perpendicular, and the angle which is between them is what produces the variation. And this matter [is established] as we explained in the *Milchamot HaShem* [Wars of the Lord], and we proved it there (interlinear: in the proper place).

When the equation is as Ptolemy [בטלמיוס] holds it, and we set it down [as] the equation of the corrected motion [תקון התנועה הנקראת] in the star, and a part of that…

So this — the variation of the equation — falls upon the true place [מקום אמתי], and there is in it an addition and a subtraction; and so too the place of the star is corrected by it.

הולך [the line] proceeds. The motion which is between the two motions — that is, the motion of the variation — runs parallel [נכוח] to the motion of [the line of position]; and this is so because the variation of the equation falls upon the place of the star. Therefore, when the motion is parallel, the equation [תקון] is parallel to it, and it is found…

[The line] proceeds. So [it is found] that the motion of the position [תנועת המצב] runs parallel to the perpendicular which is upon the line of position; for the angle which is between the perpendicular and the line of position is the cause of the variation. This is according to what we set down.

And so it is found that whenever the place of the star and the place of the apogee are alike [שוים], or whenever they are not alike, the figure of the equation differs

accordingly; and the equation differs from place to place, since the angle which is between the perpendicular and the line of position differs accordingly. And this is what we set down at the beginning [תחלה], so that the matter [might be] fully explained as it should be. And this is the figure of the equation [recte: drawing/figure — read here as a reference to the construction]…

what the figure of the equation falls upon, the place; and this is fitting [ראוי], for…

[The line] is corrected, and there is an addition [in it], and the corrected place [מקום מתוקן]; for the figure of the equation, in being [thus], is its measure [שעור], as we said, and there is in it an addition…

And the equation [תקון], when it is so, this — the equation is the corrected [motion], being as it is when the motion is at the apogee. And the place is corrected, and there is in it an addition and a subtraction, just as the motion is corrected at the apogee and at the perigee.

For this reason the place of the star is corrected by the equation, which is great, and it falls upon the [line]; and the equation which is taken [נקח] there is the position [המצב] which is upon the place of the star, and there is in it an addition or a subtraction… so that the position [המצב] which is upon the place of the star, whether it be an addition or whether it be a subtraction, is according to the angle.

And behold, the figure of the equation which is between the two — between the position and the star — and the angle which is upon the position upon the line of position; for whatever motion of the position there is, [there] is the motion of the variation of the equation; and this, when it is so, this is the equation, being according to the motion which is upon the place of the star.

When the motion of the variation is at the apogee, the equation is nil; and so too at the perigee. Between these the equation is greatest, since the variation of the equation falls upon the place of the star, and it is found…

[The motion] of the position, that is, the equation [תקון], when it is at the apogee, is nil, and there is in it a subtraction; and the equation differs accordingly. The equation, when it is so, the equation is the corrected, and the corrected place — and there is in it an addition. The corrected place; therefore the equation [תקון] which is upon it, and these are nil at the apogee.

When the motion of the variation is at its maximum, the figure of the equation which is at the corrected place is at its maximum, and it is found, as we set down at the beginning, that the motion of the variation falls upon the place of the star, and it is found…

The figure of the equation: that whenever it [the place] is corrected, the equation is most distant; and when not, [the equation is] nil, since the angle which is between them differs accordingly. And this is what we wrote at the beginning [תחלה], so that the matter [might be] fully explained.

The motion of the variation, when it is at the apogee, is nil — that is, the equation [תקון]. The place of the star is corrected, and the corrected; for the figure of the equation falls upon it, and there is in it an addition and a subtraction. And this is fitting, for the equation which falls upon the corrected place [מקום מתוקן] is its measure [שעור]; and so too the place of the star is corrected by it.

When the equation is at its maximum, the corrected, and it is found that the variation of the equation is greatest, being equal to ק״ס, being so. The place of the star, [in being] corrected, and there is in it an addition and a subtraction, since the angle which is between them differs from place to place. And this is the figure of the equation which falls…

The equation which is between the two — that is, the motion which is between the two motions, that is, the motion of the variation of the equation; and the line which is parallel [נכוח] follows the corrected motion, and the equation which is upon it… they are parallel; and the place of the star is corrected.

The variation which is upon the place of the star, when it is corrected, is most distant from the corrected motion; and when it is not corrected, [it is] nil, since the angle which is between them differs accordingly. And this is the figure of the equation which falls [upon] the place of the star.

The place of the star is corrected, and the motion is parallel, and so too [the line] runs parallel; and behold, between them is the equation. When the equation is as the motion, the equation is parallel to it, and the motion is parallel; and behold, between them is the equation, which falls upon the corrected place.

The variation of the equation, when it is at the apogee, is nil, since the angle which is between them is nil; and when it is at its maximum, [the variation] is greatest, since the angle which is between the perpendicular and the line of position is greatest; and behold, the variation which falls upon the corrected place follows the corrected motion, and they are parallel, and the place of the star is corrected.

The Tenth Chapter continues. (No new chapter rubric appears in this batch; the text runs on continuously.)

and it has already been clarified concerning the variation of the equation [חלוף התקון], and that the variation is small in the motion at [the point] where the arc is [?]; and likewise this is the case in the motion that is more [?]. It is found that the variation of the equation [חלוף התקון] is greater when the distance is greater, in the manner that has already been clarified.

When the position of the star [מקום הכוכב] is at such a [point], the matter does not proceed [?] in this measure [?], and. And when the distance is in the proportion that this distance bears [?] — as is the case here — and so it will be in every distance, in this manner the motion of correction will be [?].

For it has already been clarified that the variation [חלוף] follows the distance, and the more the distance grows, the more the variation [חלוף] of the equation grows; this proportion holds in the distances as it holds in the [?]. When the distance is small, the variation [חלוף] is small; and when it is at the apogee or at the perigee there is no variation at all. From this it follows that the variation of the equation [חלוף התקון] is small near the two ends and great in the middle [of the path between them].

We say, moreover, that this is true of the whole, and that for every distance there is a determinate [?] amount, and the motion of the correction grows [?] until [the point of] the mean motion [התנועה האמצעית], where it is [greatest? — value not legibly stated]. From this it is found [נמצא] that the variation [חלוף] in the motion of the correction is greater [?].

And this is the case — namely, that for this reason the motion of the correction [תנועת התקון] is greater, since it is more [?]. And it has already been clarified that the variation [חלוף] follows the distance: when the distance is greater the equation [התקון] is greater, and when [the distance] is small the equation is small, until at the apogee and the perigee there is no equation at all. And so the correction will be in the manner we have explained [?].

For at the place where the star is at the apogee [גובה], it is found that the line of position [קו ההיקש] reaches [?]; and at the perigee [שפל] likewise. But in what lies between the two of them the variation [חלוף] of the motion of correction grows, in accordance with the distance, until the motion reaches the mean motion [התנועה האמצעית], at which place [the variation is greatest? — not stated as a number].

Diagram. At the foot of f57r is a geometric figure: a circle with a vertical diameter and a marked center (ז). From the center, lines run up to a vertex (א) standing just outside the circle above the top, and to a point (ב) on the upper-left

arc, forming a triangle (א–ב–ז). A further line runs from the center down to the left, beyond the circle, to an external point (כ). The bottom of the diameter is marked (ג). The construction illustrates the angle subtended at the center for a given distance from the apse.

- א (just outside the circle, above the top): vertex of the triangle
- ב (on the circle, upper-left): point on the construction
- ג (bottom of the diameter): lower apse point
- ז (center of the circle): center
- כ (outside the circle, far lower-left): external endpoint of the line from the center

[Margin (inner, upper), two lines in the main hand: " / [ג]ל מעל אחד כשנעמיד וזה עד מ [?]בכ[?] [?]מ[?]" — marginal note containing this verbatim text; it appears to be a constructive helper for the figure ("and this is when we set one above [point] …"); further identification requires further verification.]

and it [the variation] grows continually, and when the position is at such a [point] there is [?]. The two lines [?] will be equal. The line that is [?] and the line of the chord [?]: this is so when [?].

It is found, when the star is at the place where the line of position [קו ההיקש] is [?], that the line [?] will be parallel [נכוח] to it; and the chord [היתר] is here as it is there, and the equation [התקון] is found to be [?].

And we say, by way of [?], that when the chord is great the angle [הזוית] is great, and when the chord is small the angle is small, in accordance with the proportion they bear to one another. And the variation [חלוף] of the equation grows in this manner [?]. The angle of position [זוית ההיקש] grows continually, and the line of position [קו ההיקש] [?], so that the two angles [שתי הזויות] will be [?].

When the distance grows, the equation [התקון] grows, until the line reaches [?]; and the variation [חלוף] in the motion grows [?]. The angle [הזוית] is here as it is [?], and the line [?] is found to be [?]. From this it is found [נמצא] that the variation of the equation [חלוף התקון] is greater when the distance is greater, and smaller when the distance is smaller, by the proportion stated.

And we say, further, that the angle [הזוית] which subtends [?] is [?], and so will be the angle at the center [הזוית אשר במרכז]. And the chord [היתר] reaching [?] is [?]. When the line of position [קו ההיקש] [?], the position of the star [מקום הכוכב] is corrected [יתקן], and the chord [היתר] is then equal [?].

For when the line of position is at the apse, the equation [התקון] is great, until the line reaches the place of the mean motion [מקום התנועה האמצעית] [?]. And the angle here will be [?], and the line of position [קו ההיקש] [?], and so the equation [התקון] is found.

And we say, further, that when the star [הכוכב] is at the apogee [גובה] or at the perigee [שפל], the line of position [קו ההיקש] is parallel [נכוח] to the diameter [?], and there is then no equation at all; for the position of the star [מקום הכוכב] is the mean place. From this it is found that the equation of the [?] [תקון] is [?], in the manner we have explained.

Said R. Levi [ben Gershom]: the matter of the variation : the line of position [קו ההיקש] [?], when [?].

Diagram. At the foot of f57v is a second geometric figure of the same family: a circle. From a point (ג) on the upper-left arc, a sheaf of lines fans out to points along the upper arc (א, ב, כ) and converges downward through an interior point (ה) to a lower interior vertex (ז). Two faint marks appear on the lower arc. The construction illustrates how the subtended angle varies with the star's distance from the apse.

- ג (on the circle, upper-left): origin point from which the sheaf of lines fans out
- א (upper arc, left of center): point on the construction
- ב (upper arc, center): point on the construction
- כ (upper arc, right): point on the construction
- ה (interior, upper crossing point): intermediate point on the sheaf
- ז (interior, lower vertex): point toward which the lines converge
- [?] (lower arc, left): faint label, ז/ד ambiguous
- [?] (lower arc, right): faint label, ז/ד ambiguous

[Later-hand folio number in upper margin of f58r: "58"]

The Tenth Chapter [הפרק העשירי] — continued (eccentric equation)

the variation [חלוף], as it was [in the case] before. And since the angle [זוית] is greater the more the motion [תנועה] departs [from the apse], it follows that the variation of the equation [חלוף התקון] grows up to the place [מקום] where the motion is at its midpoint between the apogee [גובה] and the perigee [שפל]. For there the [angular] difference [is greatest]; and from there onward toward the

perigee it begins to diminish, until at the perigee itself it returns to nil [?], just as it was nil at the apogee.

And the line of position [קו ההיקש] — which is the chord [חוט] subtending the angle at the center [זוית המרכז] — varies according to this same ratio: it is least at the two ends [the apsides] and greatest at the mid-position between them. Therefore the chord, too, accords with the angle it subtends, since the greater the angle, the greater the chord that subtends it.

And I say [ואומר] that, this being so, the variation of the equation that arises from the eccentric [גלגל היוצא] follows the variation of the [angular] distance of the star [כוכב] from the apogee, in the manner we have set out. For the angle that the line of position makes [grows] as the star moves away from the apogee, up to the mid-distance, and from there it begins to diminish toward the perigee.

It is already evident from this construction that the chord, and likewise the angle it subtends, and the [angular] distance from the apogee, all increase together up to the mid-position; and from the mid-position to the perigee they all decrease together. And so the equation [התקון] is additive [מוסיף] in one half and subtractive [גורע] in the other half, as we explained.

And since [the case is] thus, it is evident that the line of position [קו ההיקש] varies in proportion to the distance of the star from the apogee, the variation being least near the two ends and greatest at the mid-position.

He will further say [עוד יאמר]: let us posit the eccentric circle [גלגל היוצא] upon which the star moves, and the two centers [שני המרכזים] — the center of the eccentric and the center of the world [מרכז העולם] — and let the line that joins them be extended to the apogee and to the perigee on either side, so that this line [קו] passes through both ends and is the line of the apsides. And [let] the [angular] distance be reckoned from the apogee.

Diagram. An eccentric-circle construction in the lower-left of f58r. A circle is drawn; from a point in its lower-right interior several straight lines radiate to points marked on or near the circumference, forming a fan, with chords drawn between the circumference points and a triangle closed at the bottom. The figure illustrates the line of position and the central angle subtending the chord. Six points are lettered; the hand's hooked letterforms (the ר/ד/ז/ו family) are not securely distinguishable at this point-size, so most labels are flagged.

- (apex, top of the circle): a hooked letter [?]
- (upper-left, on circumference): a hooked letter [?]

- (upper-right, on circumference): a hooked letter [?]
- (interior, lower-right — vertex of the radiating lines): a hooked letter [?]
- ב (lower-left, on circumference): position point
- (lower-center vertex): a hooked letter [?]

[Marginal note, outer (left) margin of f58r beside the lower text block: a short two-line note in the same hand, partly abraded — verbatim text not securely legible; appears to record a side computation or a letter-anchor for the diagram. Further identification requires further verification.]

the equation [התקון] will be additive [מוסיף] toward the [one] side, in proportion to the arc [קשת] traversed; and the eccentric is so disposed that the line of position [קו ההיקש] is renewed [increases] according to the renewal of the motion [תנועה]. And so [the equation] is found according to the chords [על פי החוטים]: for [the equation] is the angle [זוית] which the line of position makes, and that angle [grows] as the motion increases up to the mid-position.

The equation [התקון] is therefore proportioned to the chord [חוט] that subtends the angle, and **I say** [ואומר] that the line of position is the chord subtending the angle at the center, and the equation is reckoned from it.

The mid-position [המקום האמצעי] is the place at which the equation is greatest, for there the angle is greatest and the chord subtending it is greatest. And from the mid-position to the perigee the equation decreases, until at the perigee it returns to nil, as it was nil at the apogee. So the equation is nil at the two ends and greatest at the mid-position — and this is the variation of the equation [חלוף התקון].

Further [עוד]: the equation [התקון] is additive in the half [running] from the apogee to the perigee [reckoned] one way, and subtractive in the half [running] from the perigee to the apogee the other way; and the line of position is the measure of this. And since this is so, the variation of the equation follows the variation of the chord, and the chord follows the angle, and the angle follows the distance of the star from the apogee. Therefore the variation of the equation follows the distance of the star from the apogee.

It is already evident from what we have set out that the equation is least near the two ends and greatest at the mid-position, and that its variation [חלוף] is the reverse: [the variation] is greatest near the two ends and least at the mid-position [?]. And from this it is evident that the increment [מותר] of the equation — that is, the difference between one degree [of distance] and the next — is greatest near the apogee and the perigee, and least at the mid-position.

Diagram. An eccentric-circle construction in the middle-right of f58v. A circle is drawn with a fan of straight lines running from an interior vertex out to several points on the circumference, with chords joining the circumference points and crossing within the circle. It depicts successive positions of the star and the chords/angles of the line of position. About seven points are lettered; the hooked letterforms (ר/ד/ז/ו family) are not securely distinguishable at this size, so the labels are flagged.

- (left, on circumference): a hooked letter [?]
- (apex / top, on circumference): a hooked letter [?]
- (upper, on circumference): a hooked letter [?]
- (right, on circumference): a hooked letter [?]
- (interior vertex of the radiating lines): a hooked letter [?]
- (lower-center): a hooked letter [?]
- (bottom, on circumference): a hooked letter [?]

Diagram. A second eccentric construction in the lower-center of f58v. A circle is drawn with a vertical diameter (the line of apsides) and a horizontal radius running to a point on the left circumference; from points on the upper apsidal line and the left point, chords are drawn that close a triangle within the circle. It illustrates the chord subtending the central angle for the line of position. Seven points are lettered — several strung along the vertical apsidal line — in the same hooked hand, so the labels are flagged.

- (apex, top of the circle on the apsidal line): a hooked letter [?]
- (upper-left, on circumference): a hooked letter [?]
- (interior, upper — on the apsidal line where the chords meet): a hooked letter [?]
- ב (left, on circumference — end of the horizontal radius): position point
- (center, where the horizontal radius meets the apsidal line): a hooked letter [?]
- (lower, on the apsidal line below center): a hooked letter [?]
- (bottom, on circumference on the apsidal line): a hooked letter [?]

Sefer HaTechunah — folios 59r–59v

The Tenth Chapter (continued)

rises [in proportion] to the arc [קשת], and the equation [התקון] proves to be additive [מוסיף] on one side and subtractive [גורע] on the other; and the increment [המותר] proves to be in proportion to the chord [כשעור היתר]. So this arc grows larger, and so likewise the increment grows larger. And now it has been demonstrated [?] that this arc grows larger together with the angle [הזוית], and the equation [התקון] proves to be in proportion to that arc — additive on one side and subtractive on the other. [?]

For the equation [התקון] is in proportion to the chord [כשעור היתר], and the angle [הזוית] is likewise larger; and so the equation is correspondingly larger. And whenever the arc grows larger, so does the angle, and the equation proves to be in proportion to it.

Now we have already explained that the equation [התקון] is nil at the apogee [גובה] and at the perigee [שפל], and is at its maximum midway. And the variation of the equation [חלוף התקון] follows the chord [כשעור היתר]: when the chord is larger, the angle is correspondingly larger, and the equation is correspondingly larger; and when [the planet] is at the [point of] greatest [equation] — [?] — the increment [המותר] of the equation is at its smallest, and the variation [החלוף] proves to be like the chord subtending the central angle [?]. So consider this.

And it has further been shown [?] that the increment [המותר] is at its greatest near the apogee [הגובה] and near the perigee [השפל], and at its smallest midway, by reason of the chord. So consider this: the variation of the equation [חלוף התקון] proves to be in proportion to the increment [המותר] of the arc. [?]

Diagram. A circle in the upper outer margin with a vertical diameter from a marked point at the top to the lower interior, and a fan of straight chords running from an interior vertex in the lower-right of the circle out to several points on the left and lower-left circumference. The construction illustrates the chord-to-angle relationship of the eccentric equation. Labels (positions as drawn, faint single glyphs read at native resolution):

- top of circle (apex of the vertical diameter): א
- upper-left, on circumference: ב [?]
- mid-left interior: ג
- left / lower-left, on circumference: ה [?]

- interior fan-vertex (lower-right, where the chords converge): ז [?]
- additional interior / vertex marks near the fan: [?] [?]

Diagram. A circle in the middle of the outer margin with a vertical diameter from a marked point at the top, and a cluster of chords drawn from an interior vertex in the lower part of the circle to points on the left and lower circumference, with a chord-triangle spanning the lower-left quadrant. Again the central-angle / chord construction. Labels (positions as drawn):

- top of circle (apex of the vertical diameter): א
- interior fan-vertex (lower-centre): ב
- mid-left interior: ג
- bottom, where the lower chords meet the circumference: ד [?]
- left, on circumference: ה [?]
- lower-left, on circumference: ו [?]

Diagram. A complete circle at the foot of the page (NOT cut by the page edge), richly inscribed with a star of intersecting chords joining points around the full circumference — the most elaborate of the three figures. The chords form crossing triangles within the circle. Labels (positions as drawn, faint single glyphs):

- top of circle: א [?]
- upper-left, on circumference: ב
- upper-right, on circumference (dark vertex where several chords converge): ד [?]
- left, on circumference: ה [?]
- lower-left, on circumference: ג
- bottom, on circumference: ו [?]
- right side: ז [?]
- interior (centre): ח [?]

(continuation of the Tenth Chapter)

for it [the arc] proves to be smaller, and the equation [התקון] correspondingly smaller; for the equation here is in proportion to the chord [כשעור היתר], and so it is smaller. And likewise the chord at the [point of] greatest equation [?] proves to be larger, and the equation correspondingly larger; and the angle is correspondingly larger. So the equation proves to be in proportion to the chord, additive [?] on one side and subtractive on the other.

[Margin (outer margin of f59v, second/later hand, 3 lines): " כי זוית [?] … מצד אחד / העניין כפי שביארנו [?] / מעלה … ובזה יתבאר הכלל [?] נוסף [?]" — a marginal note; the verbatim text is only partly legible and its full reading requires further verification.]

And the increment [המותר] of the equation proves to be in proportion to the chord; and whenever the chord is larger, the increment is larger; and at the apogee [בגובה] and at the perigee [בשפל] the increment is at its maximum, and midway it is at its minimum — and this is as we have explained. [?]

[Interlinear (above the line, marked with a caret-dot): מוסיף — "additive," supplied above the line.]

And it is found [ונמצא] that the variation of the equation [חלוף התקון] follows the increment [המותר] of the arc: when the increment of the arc is larger, the variation of the equation is larger; and when the increment of the arc is smaller, the variation of the equation is smaller. So consider this. [?]

And we say further [ועוד נאמר]: [?] the variation [החלוף] proves to be in proportion to the increment of the chord, and from this it is demonstrated upon the eccentric circle [?]. And the matter is as we have explained.

הזה [display word, darker ink — internal lemma marker, "this (one)" / sub-statement opener; not a chapter rubric]. And it has further been explained that the variation of the equation [חלוף התקון] near the two centers [?] is greater than [the variation] at any other point; and the equation [התקון] is at its maximum at one point; and at the perigee [בשפל] it proves to be nil, like [its value] at the apogee. So the equation is greatest at the [point of] greatest variation [?].

For the increment [המותר] is at its maximum near the apogee and near the perigee, and at its minimum midway; and the variation of the equation [חלוף התקון] proves to be in proportion to it. And the increment proves to be in proportion to the angle [הזוית], which is the central angle [?]; and from this it is demonstrated upon the eccentric circle that the variation [החלוף] is in proportion to the increment of the chord. So consider this.

And we shall explain [ונבאר] that the increment [המותר] near the two centers [?] is in proportion to the chords [כשעור היתרים]; and whenever [the planet] approaches the apogee or the perigee, the increment is in proportion to the chords near the two centers [?]. So consider this — and it proves to be [as stated].

the correction [תקון], and it will be [yet] greater… in the [same] proportion that the more distant correction is greater than the nearer one. By this measure the

nearer one [stands] to the more distant — they have one ratio. And likewise the nearer correction [stands] to that which is more distant from it.

When the motion of the variation [תנועת החלוף] is in proportion to the assigned motion [התנועה הקצובה], the correction at the more distant point will always be greater than the correction at the nearer point, in that same proportion. For this reason the more distant correction is the greater, always; and the nearer the lesser, always.

Therefore the correction at the more distant point exceeds the correction at the nearer point — this is so without any condition. For the more distant correction is always greater, and the nearer is always lesser; and it is the more distant that exceeds the nearer.

The line [קו] that is more distant is always longer, and the line that is nearer is shorter; for the chord [יתר] of the more distant arc is the longer, and the chord of the nearer arc is the shorter. The more distant chord is the greater. And we have already shown that the chord of the more distant correction is always greater than the chord of the nearer correction.

So the more distant correction is the greater, in the same proportion; for the line of the more distant is longer, and the line of the nearer is shorter. The correction that is more distant will be longer, and the more distant arc [will be] greater than the nearer arc; this [holds] for the more distant against the nearer, always.

It is necessary that the more distant correction be the greater, since the chord of the more distant arc is greater; and the more distant correction is greater than the nearer correction, always. So the nearer correction is the lesser; for the more distant chord is the greater.

It is necessary that the more distant be the greater than the nearer, since the more distant line is the longer. And this point does not [behave] otherwise; for what passes over the more distant line is greater [than what passes over the nearer], in the proportion stated.

[A long horizontal stroke runs across the column here; the text resumes below it.]

For each day there is a fixed correction [תקון קבוע]: a perpetual correction at the more distant point and a perpetual correction at the nearer point, always. And behold, in this there is for each day a [fixed] correction…

this [is] so always, by the foregoing reasoning, as we set down. So it is necessary that the more distant correction be the greater, since the chord of the more

distant [arc] is the greater; and the nearer correction is the lesser, in the proportion of the more distant motion to the assigned motion.

The motion of the variation at the more distant point, and the variation [itself], and likewise the motion at the nearer point — so the more distant motion [stands] to the assigned motion as the more distant correction [stands] to the nearer correction, always. And from this it is necessary that the more distant correction be the greater.

And another correction is added [מותר]: the more distant correction is greater than the nearer correction, in the proportion of the more distant motion to the assigned motion. And the increment [מותר] of the more distant motion over the assigned motion is the increment of the more distant correction over the nearer correction; this is the increment, always.

And the increment, which is the more distant chord, perpetually [stands] to the more distant correction, always; and it is the more distant chord. The nearer correction is the lesser; and the more distant correction is greater than the nearer correction, in the proportion of the more distant motion to the assigned motion. So it is necessary that the increment of the more distant correction be the greater.

[Section] — That the more distant correction is greater than the nearer one, always: this is what was intended.

the chord that is more distant — its perpetual [value] — [stands] to the correction; and the more distant correction is greater than the nearer correction, perpetually; this is the more distant chord. And it is necessary that the more distant correction be the greater, since the chord of the more distant correction is the greater. And the more distant motion [stands] to the assigned motion as the more distant correction [stands] to the nearer correction; for the increment of the more distant motion over the assigned motion is as the increment of the more distant correction over the nearer correction.

the more distant correction; and this is so by the foregoing reasoning, as we set down. The increment of the more distant correction over the nearer correction [follows] the proportion of the more distant motion to the assigned motion — what passes over the more distant line and what passes over the nearer line. And the more distant correction is the greater; and the nearer correction is the lesser; and the more distant correction is greater than the nearer correction, perpetually, in the foregoing proportion.

and the more distant motion; and this measure is the increment of the more distant motion over the assigned motion. And it is necessary that the more distant correction be the greater; and the nearer correction the lesser; and the more distant motion [stands] to the assigned motion as the more distant correction [stands] to the nearer correction.

the increment of the more distant motion; and the more distant correction is greater than the nearer one, always. And this is the cleansed [נקיה] [proportion] — it is… and the more distant motion…

in proportion to the assigned motion, the more distant correction is greater than the nearer one, always; and they have one ratio. And the more distant motion [stands] to the assigned motion as the more distant correction [stands] to the nearer correction.

the correction is the lesser; for the nearer line is the shorter, and upon it [passes] the [lesser] motion, and the nearer correction is the lesser. And the nearer arc — its chord is the shorter, and the line of the nearer [arc] is the shorter. And the nearer correction…

upon it [passes] the motion of the nearer arc; and the more distant arc — upon it [passes] the more distant motion. And it is necessary that the more distant correction be the greater; and the nearer correction the lesser; and the more distant correction is greater than the nearer one, in the foregoing proportion.

Diagram. Two concentric circles sharing the common center **ז**. A vertical diameter runs from the apex **ב** at the top of the outer circle, down through **א** (where it crosses the top of the inner circle), through the center **ז**, on through **ד** (where it crosses the bottom of the inner circle), to **ג** at the foot of the outer circle. A diagonal radius runs from the center up to the left to the point **ה** on the outer circle. A roughly horizontal diameter runs across the center from a point on the left of the outer circle to a point on the right, both label glyphs faint. Below the center two chords descend to form a shallow triangle, meeting near **ד**. The construction illustrates the relation of the nearer point (on the inner circle) and the more distant point (on the outer circle) to the common center, and to the chords discussed in the proof above.

- ב (apex, on the outer circle): top of the vertical diameter
- א (on the vertical line, where it crosses the top of the inner circle)
- ז (center): common center of the two concentric circles
- ה (upper-left, on the outer circle): endpoint of the diagonal radius from the center

- ד (on the vertical line, where it crosses the bottom of the inner circle)
- ג (foot of the outer circle, on the vertical line): bottom of the vertical diameter
- [left endpoint of the horizontal diameter, on the outer circle: label faint] [?]
- [right endpoint of the horizontal diameter, on the outer circle: label faint] [?]

and the more distant point [stands] to its center, [and] the nearer point — its line [stands] in proportion. And the more distant motion [stands] to the assigned motion as the more distant correction [stands] to the nearer one; for what passes over the more distant line and what passes over the nearer line — the more distant is the greater.

and the more distant correction is greater than the nearer one; and this is by the foregoing reasoning. The increment of the more distant correction over the nearer correction [follows] the proportion of the more distant motion to the assigned motion. And the more distant correction is the greater; and the nearer correction is the lesser; and the more distant correction is greater than the nearer correction, perpetually.

And another correction is added: it is necessary that the more distant correction be the greater, since the chord of the more distant arc is the greater. And the increment of the more distant correction over the nearer correction… for the chord of the more distant correction is the greater, and the angle [זוית] of the more distant [point] is the greater, and the more distant correction is the greater.

the angle of the more distant correction; the chord of the more distant correction is the greater, perpetually; and the angle of the more distant correction is greater than the angle of the nearer correction, always. And the angle of the more distant arc is greater than the angle of the nearer arc, since the chord of the more distant arc is the greater; and this angle is the greater.

For the more distant angle [stands] to its arc as the chord of the more distant [arc] is greater; and the angle of the more distant correction is greater than the angle of the nearer correction; and the more distant chord [stands] to the more distant arc; for the more distant angle is the greater. And the increment of the more distant angle is the chord of the more distant correction.

the angle of the more distant correction, perpetually; the angle of the more distant arc is greater, since its chord is the greater; and the angle of the more distant correction is greater than the angle of the nearer correction, perpetually; this is the more distant angle.

And the more distant arc — its angle is the greater, since its chord is the greater; and the chord of the more distant arc is the greater; and the angle of the more distant correction is the greater; this is so by the foregoing reasoning, as we set down. The angle of the more distant correction is greater than the angle of the nearer correction, in the foregoing proportion. And the angle of the more distant correction [stands] to its arc as the more distant chord is greater than the nearer chord; the more distant angle is the greater.

For the more distant correction — its angle is the greater; and the increment of the more distant correction over the nearer correction is greater, since the chord of the more distant correction is the greater. And the more distant correction is greater than the nearer correction, in the proportion of the more distant motion to the assigned motion; and the more distant angle is greater than the nearer angle, since the more distant chord is the greater than the nearer chord.

and the angle of the more distant correction is the greater, since the chord of the more distant correction is the greater, perpetually, and the more distant angle is the greater. And the angle of the more distant correction is greater than the angle of the nearer correction; this is the more distant angle. And the more distant correction is the greater, since the chord of the more distant correction is the greater than the chord of the nearer correction; and the more distant angle is the greater.

the more distant chord; and the angle of the more distant correction is the greater; for the chord of the more distant correction is the greater than the chord of the nearer correction, and the more distant angle is the greater. And the nearer correction is the lesser, since the chord of the nearer correction is the shorter; and the nearer angle is the lesser.

the more distant correction is greater than the nearer one; and this is what was sought, in the foregoing proportion. And the more distant correction is the greater, since the chord of the more distant correction is the greater than the nearer; and the more distant angle is the greater. The more distant arc — its angle is the greater than the angle of the nearer arc, since the more distant chord is the greater. And the more distant correction is greater than the nearer correction, perpetually, in the proportion that the more distant motion [stands] to the assigned motion. And the increment of the more distant correction over the nearer correction follows that same proportion.

[the more distant] correction is greater, always; and a [further] correction is added; and the increment of the more distant correction over the nearer

correction is greater, since the more distant chord is the greater than the nearer chord, and the more distant angle is the greater than the nearer angle. For the chord of the more distant correction is the greater; and the more distant angle is greater than the nearer angle, since the more distant chord is the greater. And it is necessary that the more distant correction be the greater, and the nearer the lesser; for the more distant chord is the greater.

for the more distant line is the longer, and what passes over it is the more distant motion; and the more distant correction is greater than the nearer correction. The more distant arc — its chord is the longer, and its line is the longer; and the more distant correction is the greater. And the nearer arc — its chord is the shorter, and its line the shorter; and the nearer correction is the lesser.

and the more distant correction is greater than the nearer one, in the foregoing proportion; for the chord of the more distant correction is greater than the chord of the nearer correction. And this is what was intended, as we said.

[Later-hand folio number "61" in the upper margin (pencil "61" and an inked "61").]

that the chord which the assigned arc subtends, and [that] the arc is taken — and from this you take the value [?] — and you draw the perpendicular upon the line of position, and upon [the line] that you have already drawn through it. And the proportion of the chord of the perpendicular to the line of position is as the proportion of the more-distant motion to the assigned motion. So it is,. And it has already been clarified that [?]…

and according to this proportion the variation of the equation [חלוף התקון] will be in proportion to the more-distant motion. And when you take this difference [חלוף] in proportion to the assigned arc, it is known that the proportion of one variation to another variation is as the proportion of the corresponding arcs to one another.

And since this has been clarified, it has been demonstrated [נתבאר] that the equation [התקון] is always greater the more distant [the position]; and the more-distant motion, the greater its variation. Hence the value of the difference [מותר] follows the proportion of the more-distant motion to the assigned [uniform] motion. And the proof of this is by lines and chords, as we have already shown.

And it is so that the chord which the assigned arc subtends — and the perpendicular which is drawn from the end-point [?] of that arc to the line of position — the proportion of this perpendicular to the chord [is] the proportion of

the more-distant motion. Therefore [it is] a known [proportion]. And this is what we wished [to show].

[The argument proceeds with the recurring terms: the variation of the equation (חלוף התקון); the more-distant motion (התנועה הרחוקה); the assigned motion (התנועה הקצובה); the chord (יתר/חוט); the perpendicular (עמוד); the line of position (קו ההיקש); the arc (קשת); proportion (יחס). The same lexical set recurs through the lines below.]

the proportion of the more-distant motion to the assigned arc — and this is a known [proportion] — therefore the proportion of one equation to another follows the proportion of the more-distant motion. And the more distant the star [position], the greater the difference between the equations [התקונים], as we have explained. And this point [נקודה] is the more distant, and it is the [point] from which [the measurement] begins [?].

Diagram. Two concentric circles with a common center marked **ה**. From the apex of the outer circle (top, **ב**) a vertical line descends through the center and continues to the foot of the figure. A point **ז** is marked on this vertical line just below the apex, between the apex and the center. A point **ה** lies on the upper-right circumference of the outer circle, where several chords converge: chords run from this point toward the center and down across the figure. A point **ג** lies on the upper-left circumference. Below the center the vertical line passes through further marked points (one reads **ד**; one or two adjacent marks are faint), reaching the foot of the figure, where there is a label **ב** at the lower-left and another mark on the vertical at the base. A roughly triangular set of chords is formed among the upper-right point **ה**, the center, and the lower points.

- ב (apex, top of outer circle): top of the vertical line
- ז (on the vertical line, just below the apex): marked point on the diameter
- ה (center, common to both circles): center
- ה (upper right, on outer circumference): convergence point of the chords
- ג (upper left, on outer circumference): marked point on the circumference
- ד (on the vertical line, below center): point on the line of position
- ב (lower left, at the foot of the figure): foot label
- [One or two additional marks on the lower vertical (reads ז or ר) are faint — [?].]

[Lower half of the folio below the diagram is blank.]

Diagram. Two concentric circles sharing a common center. From the apex **ב** at the top of the outer circle, a vertical line runs straight down through the figure to the base. A point **ה** lies on the upper-left circumference of the outer circle, where several chords converge; a point **ז** lies on the upper-right circumference. Chords run from the upper-left point **ה** down toward the lower part of the vertical, forming a narrow sector/triangle. Along the vertical line, descending from the upper region into and through the inner circle, several points are marked in sequence: a **ז** near where the chords meet, then **ד**, then a further **ז**, then **ב**, reaching the base. A point **ה** is marked inside the inner circle to the left of the vertical.

- ב (apex, top of outer circle): top of the vertical line
- ה (upper left, on outer circumference): convergence point of the chords
- ז (upper right, on outer circumference): marked point on the circumference
- ז (on the vertical, near the chord convergence): marked point
- ד (on the vertical, within the inner region): point on the line of position
- ז (on the vertical, lower, within the inner circle): marked point
- ה (interior, inside the inner circle, left of the vertical): marked point
- ב (on the vertical, at the base): foot label
- [One or two of the lower vertical marks are faint and ambiguous between ז/ב/ר — [?].]

[The text column runs to the right of and below the diagram.]

that the line [?] which the assigned arc subtends, [drawn] from point [נקודה] to the line of position. And it has already been demonstrated that the proportion of the chord [is] as the proportion of the more-distant motion to the assigned motion. And this point [נקודה] is the more distant [one], and from it the difference is taken.

And since this has been clarified, it has been demonstrated that the equation is greater the more distant [the position]; and according to this proportion the variation of the equation will be. And when we take this variation [חלוף] in proportion to the assigned arc, the proportion of one variation to another is as the proportion of the arcs.

[If] another [case]: in proportion [as / כשיעור] the variation… the equation will be, in proportion to the more-distant motion. And the more distant the motion, the greater the equation. And this is a known [proportion], and so the proportion of one equation to another follows the more-distant motion.

the line of position [קו ההיקש], to the point [נקודה], in proportion as the assigned arc — and the chord [is] a known [quantity]; and the perpendicular which is drawn upon the line of position, its proportion to the chord [is] as the more-distant motion. Therefore it is a known [proportion], and this is what we wished [to show].

And it has already been clarified by lines and chords that the variation of the equation follows the more-distant motion; and the proportion of one variation to another is as the proportion of the corresponding arcs. And the more-distant motion is greater [in equation], and the assigned [uniform] motion is the lesser. And it is always so.

the equation [התקון]; and the difference [מותר] is taken in proportion to the more-distant motion to the assigned arc; and so the proportion of one equation to another is a known [proportion], the more distant being the greater. And this is what we wished [to show / demonstrate].

[The lower portion of the folio is blank.]

it lies between the [two] equal arcs. Thus the variation [חלוף] that occurs for this distance [רחוק] also lies between the two equal arcs. The relation that holds for the variation [חלוף], moreover, is that the variation of the more distant motion is greater than the variation of the assigned motion. So too the relation of the equation [התקון]: the equation of the more distant motion is greater than the equation of the assigned motion.

And since the variation grows with distance, and likewise the equation grows with distance, the relation of the one equation to the other is as the relation of the one variation to the other; and the relation of the one variation to the other is as the relation of the more distant motion to the assigned motion. Hence the relation of the one equation to the other will be as the relation of the more distant motion to the assigned motion.

[Margin (left, smaller hand, addition keyed here): "Thus you should understand that the relation of the variation to the assigned motion is as the relation of the more distant motion to the assigned motion; and so the equation of the more distant motion is greater than the equation of the assigned motion, and the variation of the more distant motion is greater."]

(interlinear: small correction-mark above the line; the inserted word is illegible — [?)]

We say, further, that when the variation of the more distant motion has to the variation of the assigned motion a known relation, then the relation of the equation of the more distant motion to the equation of the assigned motion is likewise known. For the relation of the one equation to the other is as the relation of the one variation to the other, and the relation of the one variation to the other is as the relation of the more distant motion to the assigned motion. Therefore the relation of the equation of the more distant motion to the equation of the assigned motion is a known relation.

And it has already been explained that the variation grows with distance, and the equation grows with distance; so when the distance is known, the variation is known, and likewise the equation is known.

We say, moreover, that the relation of the equation to the variation is a single relation in every case [or: "is one and the same relation"] — `` — for the equation and the variation alike grow with distance and diminish with proximity, each in the same proportion as the other.

[Margin (left, smaller hand, addition keyed here): "It has already been explained that the variation grows with distance and diminishes with proximity, and that the equation grows with distance and diminishes with proximity."]

And since this is so, when one of the two — the equation or the variation — is known, the other is known as well; for the relation of the one to the other is a single relation, and that relation does not change with distance or with proximity.

It has already been explained, too, that the equation of the more distant motion is greater than the equation of the assigned motion, and that the variation of the more distant motion is greater than the variation of the assigned motion. And the relation of the one equation to the other is as the relation of the one variation to the other. Therefore the relation of the equation of the more distant motion to the equation of the assigned motion will be as the relation of the variation of the more distant motion to the variation of the assigned motion.

And this is so because the star [הכוכב] is on the line of position [נקודת], so that its distance [from the center] is greater; and the variation of the more distant motion is correspondingly greater.

Diagram. Two concentric circles. A horizontal diameter runs through the common center ה and is extended on both sides to (and slightly beyond) the outer circle. From an apex point ב at the top, two straight lines descend to the diameter — one to a point א just left of center and one to the center ה — forming the

equation/variation triangle. A second, oblique straight line runs from a point ז on the upper-right of the outer circle down across the figure to a point ט at the lower right of the outer circle, crossing the diameter near the center.

- ב (apex, top): vertex of the construction
- ה (center): the common center of the two circles; foot of the central descending line from the apex
- א (just left of center, on the diameter): foot of the left descending line from the apex
- ז (just right of center, where the inner circle meets the diameter): point on the line of position
- ד (left of center, on the diameter): point on the diameter
- כ (far left, where the diameter meets the outer circle): [[?] — candidate ב/כ]
- כ (far right, where the diameter meets the outer circle): [[?] — candidate ב/כ]
- ז (upper-right, on the outer circle): top endpoint of the oblique line
- ט (lower-right, on the outer circle): bottom endpoint of the oblique line [[?] — candidate ש/ט]

[Lower portion of the folio below the diagram is blank.]

their relation, and we have taken from these [magnitudes] one and the same [proportion]. Yet behind this lie further matters that require equating [תקון], and the equation [תקון] is taken with respect to its [the star's] distance and its proximity. For when the star is at its more distant [position], its motion [as seen] is slower, and the variation that occurs for it is greater; and so the equation that is taken for it is greater. We have already mentioned that the variation grows with distance and diminishes with proximity.

We say, further, that the line of position [קו ההיקש] is drawn to the center, and the figure that is formed from it — that is, the variation — is greater. Therefore the figure is greater, and so the equation that is taken from it is greater, and the variation is correspondingly greater.

The relation of the variation that occurs for this distance to the variation that occurs for that distance — that is, the assigned distance — is as the relation of the one motion to the other. And since the relation of the one variation to the other is a known relation, the relation of the equation of the one to the equation of the other is likewise a known relation. For the relation of the equation to the variation is a single relation in every case, and the relation of the more distant motion to the assigned motion is a known relation.

And we say that the relation of the variation that occurs for the more distant motion to the variation that occurs for the assigned motion is as the relation of the more distant motion to the assigned motion; and the relation of the equation that occurs for the more distant motion to the equation that occurs for the assigned motion is also as the relation of the more distant motion to the assigned motion.

For the relation of the equation to the variation is a single relation, the relation of the one variation to the other is as the relation of the more distant motion to the assigned motion, and the relation of the one equation to the other is as the relation of the one variation to the other. Therefore the relation of the one equation to the other is as the relation of the more distant motion to the assigned motion.

It has already been explained that the more distant motion is slower and the assigned motion is faster; so the variation that occurs for the more distant motion is greater than the variation that occurs for the assigned motion, and the equation that occurs for the more distant motion is greater than the equation that occurs for the assigned motion. And since the equation grows with distance and diminishes with proximity, when the distance is known the equation is known, and when the proximity is known the equation is known.

We say, moreover, that when we draw the line of position to the center, the point of the line of position [נקודת] falls on the [outer] circle, and the variation that occurs for it is greater; and so the equation is correspondingly greater. The relation of the point of the line of position to the [other] point of the line of position is as the relation of the one variation to the other, and as the relation of the one equation to the other.

And the relation of the equation that occurs for the more distant motion to the equation that occurs for the assigned motion is as the relation of the more distant motion to the assigned motion, just as the relation of the variation to the variation. For the relation of the equation to the variation is a single relation; the one equation grows with distance and diminishes with proximity, and so does the one variation.

We say, further, that the relation of the point of the line of position to the [other] point of the line of position — that is, from the one point of the line of position to the other point of the line of position — is as the relation of the variation that occurs for this distance to the variation that occurs for that distance. And the relation of the equation to the equation is also as that relation, since the relation

of the equation to the variation is a single relation, and the line of position is drawn to the center.

Diagram. Two concentric circles about a common center. A horizontal diameter runs through the figure, and a vertical diameter runs from a point ה at the top of the outer circle straight down through the inner circle to the foot of the figure. An oblique straight line runs from a point ז on the upper-right of the outer circle down across the figure, crossing the inner circle and the horizontal diameter, to the foot at the lower part of the figure. The vertical diameter is labeled where it crosses the inner circle (ג) and at the center within the inner circle (ל); the horizontal diameter carries labels clustered around the center.

- ה (top, on the outer circle): top endpoint of the vertical diameter
- ז (upper-right, on the outer circle): top endpoint of the oblique line
- ג (top, where the vertical diameter meets the inner circle): point on the inner circle
- ל (center, within the inner circle): the center
- כ (far left, where the horizontal diameter meets the inner circle): [[?] — candidate ב/כ]
- א (left of center, on the horizontal diameter): point on the diameter
- ד (center, where the vertical diameter crosses the horizontal diameter): point of crossing
- ו (right of center, on the horizontal diameter): [[?] — candidate ו/י]
- ב (right of center, where the oblique line crosses the horizontal diameter): point of crossing
- ל (foot of the figure, lower endpoint of the vertical line): [[?] — faint/foxed; candidate ל]

[The folio continues below with no chapter rubric; the lower portion of the folio is blank.]

The Tenth Chapter (הפרק העשירי), continued — eccentric equation. No new chapter rubric appears in this opening.

until the motion is [such that] either it grows nearer or it [grows more distant]; the motion at this point [?]. For when the [planet] [is at?] this [position], and the more-distant [motion] is [smaller? in proportion] to the assigned motion, the variation [חלוף] [behaves correspondingly]. Therefore the equation [תקון] [stands in this same ratio]; and this is what we intended.

It has thus been shown that the equation grows with the increase of the arc [?] in the same proportion, and likewise that the variation [grows] together with it. And it has been shown that the equation that arises [?] [is in the ratio of] the more-distant motion to the assigned motion, just as we explained. So this remains, and there will be no [difference?] in this regard.

And the cause of this is that, since the [chord/arc] of the equation grows in proportion to its remoteness from the [apogee] — that is, the further [the planet] is, the more its motion appears [diminished] by reason of its distance — therefore the equation grows in the same proportion as the variation grows. For the variation is the excess of the more-distant motion over the assigned motion, and the equation is built upon this [excess?]. And so, by the measure that the one grows, the other grows; and they keep one and the same ratio. This is what we wished [to establish].

Now since the equation arises by reason of the remoteness of [the planet] from the center, and the more-distant [motion] is [greater] in proportion as it is nearer the [apogee] [?], it follows that the equation is greater there; and the more it is distant, the [smaller] [?] it becomes, until [the planet] reaches the [perigee?], where the equation [vanishes? / is least]. And the variation behaves likewise, for they keep a single ratio, as we have shown. Therefore, by the measure of the more-distant motion at any assigned place [?], the equation will be at that place, and the variation at that place [?] — for the ratio is one.

And from this it is clear that the equation and the variation, at every position, keep the ratio of the more-distant motion to the assigned motion. And this is what we wished [to demonstrate], and it has been [fully] shown that which we intended regarding this equation [and] the increment of the difference [מותר החלוקה].

[Margin, lower-left, framed scribal note 1, denser hand, ~7 lines:] [Margin: the equation [?] … the more-distant motion in proportion to the assigned motion … and the variation grows together with the equation … and the more-distant [motion] [?] … so the ratio is the ratio of [?] … upon the equation [?]]

[Margin, lower-left, framed scribal note 2, denser hand, ~5 lines:] [Margin: the equation that is [?] … in proportion to the assigned motion … the more-distant motion and the assigned [motion] … and the equation grows together with [?] … so the ratio is the ratio of [?] [number?]]

[Lower half of f63r blank.]

[The top of the folio is faded; the body block begins partway down. Faint bleed-through from f63r is visible in the outer (left) margin and is disregarded.]

and this [is?] [the position?]; and when there is a [?]; and when the [planet] is at [?], and the equation [?] of the more-distant motion, [the variation behaves likewise]. The more-distant [motion?] grows by reason of the remoteness from the [apogee?], and the equation grows with the assigned motion [?], the more-distant motion [being greater] in proportion as it is nearer [?]. And the variation grows together with the equation in the same proportion, and the equation [grows] by reason of the [arc] [?], in proportion to the assigned motion that arises.

So it has been shown that the more-distant motion [is greater] in proportion as it is nearer the [apogee], the equation likewise being [greater] there; and there will be no [difference] in this. And from this the matter is clear, that the variation, at every near position [?], grows, and grows more, in proportion to the position-circle [קו ההיקש?] [?] — that is, [it grows] in proportion as the more-distant motion is greater. And when the variation is more-distant [?], its [equation] is at that position; and so the equation at that position [keeps the ratio].

And it has been further shown that the [equation? / motion?] of the more-distant [motion] keeps, in proportion to the assigned motion, [the ratio] of the more-distant [motion] to the assigned [motion] [?]. And when the equation grows [?] near the [apogee], it is greater; and when it is more-distant from the [apogee], it grows less.

[Display word **של** (slightly enlarged) within the line — apparently a lemma marker or the relative particle "of"; not a chapter rubric.]

the more-distant motion grows by reason of the remoteness from the center [?]; and the more-distant [motion] is greater, the more it is near; and by [this] measure the equation [grows]. And there is a [?] that [we] showed [?]; the position-circle [קו ההיקש] [?] and the [perpendicular?] [עמוד?] [?]; and the more-distant [motion] [?] until the position [?]

the [transliterated term] **החרטיס** [?] [Arabic: al-mutaʿaddil ("the equating line / equant")?] [is greater?] [the equation? / its value?] [?], in proportion to its position-circle; and so [?] [there is] a chord [קו] [for? it]; and [the planet] [?] is more-distant, [so that] there is no [difference] [?]. The position-circles [?] [are] their [?]; or it grows, and grows more at the [position?] [?] …

the [transliterated term] **החרטיס** [?] [al-mutaʿaddil?] [from] the position [?]; the equation [?] [number? / value?] upon its position-circle; and the [chord/line] [קו]

[?] [is] [for] it [?]; and [the planet] is more-distant [?], just as [we have shown] there is no [difference] [?]. The position-circles keep their [ratio?]; or it grows, and grows more at the [position?] [?] …

[Several short closing lines, then the lower portion of f63v blank:] …the [position-circles?] [?] until [?] … [made it?] in proportion to its [position?] … the [difference?] is from the [?] … the position [?] grows, [and so on] [?].

[Lower portion of f63v blank.]

[Margin: later-hand folio number "64" (twice, upper margin).]

the correction [תקון] was such-and-such — that is, the correction will be larger when this arc is large; and the correction will be larger still when the [other] arc, too, is large. So the correction grows, and the more-distant [motion] grows. By how much, then, the correction is large for a given arc, by that much it [the correction] will be large [for the corresponding arc].

For when this correction is large, the angle of vision [זוית הראות] is large; and the angle of vision is large in proportion to the magnitude of this arc. Therefore, this correction will be larger, and the angle of vision larger — for the angle of vision and the correction stand in a fixed ratio. And so it is found that this correction is larger.

This correction, then, will be larger, and that one larger; and the magnitude is in the proportion we have stated. Hence the more-distant motion is large, and the correction large — and the difference [חלוף] is in the proportion we have stated. The increment of the correction is therefore in the proportion of the more-distant motion to the assigned motion [התנועה הקצובה], and the difference is in this same proportion. The motion is large, and the correction is large.

Likewise, when the more-distant motion is small, the correction is small, and the difference is small. For the ratio of the correction to the more-distant motion is a fixed ratio, and the ratio of the difference to the assigned motion is likewise fixed. So when the more-distant motion is large the correction is large, and when it is small the correction is small.

Now, since the matter is so, it has already been demonstrated [וכבר התבאר] that the comparison [התמורה] is according to the more-distant motion: when this latter is large the correction is large, and when it is small the correction is small. And this is what was intended [וזה מה שכוונו] — namely, that the more-distant motion and the difference [be proportional], and that the correction stand in the [stated] ratio.

[Margin, right side, framed note (later/secondary hand, ~4 short lines): "וזה כשתקן … נדול שאם … זה זוית זה … הקצף זה … זה על מעלה … גדול" — a constructive helper keyed to the correction; verbatim reading partly abraded. Further identification requires further verification.]

When the more-distant motion is large, the correction is large; and when the assigned motion is small, the correction is small. The angle of vision is large in proportion to this arc — and so this correction is the one that is added [להוסיף].

[Margin, lower-left (later/secondary hand, 4 lines): "כשנקח מותר חלוף … ויהיה מותר הזה לאריך מלאך … ועבור על דעת … ויהיה זוית הקצף … קצרת … ואחר זה … קצף הזה קצף נדול גדול …. הקצף נדול היה … ועבור זה …." A side computation concerning the increment of the difference; partly faded. Further identification requires further verification.]

[Then, resuming the body:]

when the more-distant motion is small, the correction will be small. And since the correction stands in this fixed ratio, it follows that the difference, too, is in this ratio. For when the angle of vision is large the correction is large, and when the angle of vision is small the correction is small. And this, too, is so [וגם כן זה].

And it has already been demonstrated by what was said above that the correction is according to the more-distant motion — when this latter is large the correction is large — and the difference is in this proportion. And this is so [וזה כן].

For the more-distant motion, by which the correction is large, is large; and when the assigned motion is small, the correction is small; and when the star is at the apogee, the correction is null [the star being at the highest point]. The star at the perigee likewise behaves so.

that the correction is large, and the assigned motion large; and when the correction is small the assigned motion is small. And the star, when it is at the apogee, has no correction — for there the line from the two centers [the line joining the two centers] meets the star, so that there is no angle of vision; and at the perigee likewise there is no correction.

When the angle of vision is large the correction is large, and when the angle of vision is small the correction is small; and the increment of the difference is according to this. And the more-distant motion will be large, and the correction large.

And the assigned motion is in the [stated] proportion; and the difference is in this proportion, [namely] that this correction be larger.

So this correction is the larger one — namely, that the assigned motion bear the [fixed] ratio to it. And the difference [is] in proportion: that the more-distant motion, by which the angle of vision and the correction [grow], be large.

such that there will be two [quantities], and the angle of vision; and there will be no correction whatever [?] — for the line of position [קו ההיקש] meets it [?].

And [we say] that there will be a star [?] [recte probably: "that there will be no correction"], the matter being as we have established — and we have already singled out [תיחד] that the more-distant motion is according to the assigned motion: when this latter is large [the correction is large].

Diagram. At the foot of f64r, a figure of two concentric circles (a larger outer circle and a smaller inner one) with several straight lines — chords and a long oblique line — drawn across them and crossing in the upper-left/center region, illustrating the angle of vision and the correction discussed in the text.

- ה (apex, top): upper terminus of the principal line
- ג (upper-right, interior of the outer circle): point on the construction
- ז (upper-left crossing cluster): point at the line intersection
- ב (upper-left crossing cluster): point at the line intersection
- ה (upper-left crossing cluster, below ב/ז): point at the line intersection
- ד (center, on the oblique line): intermediate point
- ב (center, right of ד): intermediate point
- כ (lower-right, on the arc): point on the arc
- ב (bottom, on the outer circle rim): lower terminus
- ס (lower-left, outside the circles): exterior point

the line of position [קו ההיקש] and the [other] line of position, the line being so-and-so. And this is what is added — the more-distant motion, in that it does not [exceed?] …

the comparison, when it is so, [makes] the correction [grow]; and the comparison [תמורה] in the assigned motion [is] according to …

the comparison of the more-distant [motion], that it be so, the correction being according to it. For the matter [is] as we said: the increment of the difference [is] according to the ratio of the more-distant motion to the assigned motion. And it has already been singled out [וכבר תיחד] that …

the eccentric circle [גלגל היוצא], the more-distant motion, the correction, and the difference. And when the more-distant motion is large the correction is large, and the difference is in this proportion. And the comparison …

and the difference is in the proportion of the more-distant motion to the assigned motion; that is, the correction is according to it, and this comparison is according to it; and the increment of the difference is according to the more-distant motion. And the matter is as we said: that the line of position meets the star, and so there is no correction there.

and the correction is in the proportion we said; and the angle of vision is large in proportion to this arc, and the more-distant motion is large, and the correction is large. And he singled out [?] that the more-distant motion, the angle of vision, and the difference [are proportional]; and this comparison is according to the assigned motion. And the difference is in proportion …

and the more-distant motion is large, and the correction is large; and the more-distant motion is large in proportion to this arc; and there will be a fixed ratio, this being the more-distant motion. And the angle of vision is large in proportion to it. And the correction is large …

and the comparison of the more-distant motion, that it be so. And the increment of the difference is according to the more-distant motion: when this latter is large the correction is large; and the correction is in this proportion. And he singled out [?] that the comparison [be] according to the more-distant motion. And the difference is in this proportion, the matter being according to what we said.

and the angle of vision is large, and this is what is added; and this matter [is] the increment of the difference. The matter [is] as we said: the more-distant motion is large, and the correction is according to it [?] …

the line will be so-and-so [קו … חמשה? : "the line [is] five" — value uncertain]; and there will be the difference, and this comparison, the matter being according to the more-distant motion in the eccentric circle. And the difference is in this proportion: that the angle of vision and the more-distant motion …

and after this [ואחר זה] the line is so-and-so, and there will be the correction; and there is a part of it [?], and the comparison [is] according to it, and there will be the more-distant motion and the difference. And the line of position [is] according to it; and there will be a fixed ratio …

And the line is twenty parts [קו … עשרים חלקים]; and the comparison [is] according to it [?]; and the more-distant motion is large, and the correction is

large in proportion to it; and the more-distant motion and the difference are in this proportion.

and there are two [quantities] [?], and the angle of vision is so-and-so; and so the line is thirty-five parts [35 = חלקים ל"ה … וקו]; and the difference [is] according to it [?] …

and there will be the correction. And he singled out [?] that the more-distant motion, by which the angle of vision [grows], be large; and the line is so-and-so parts [?] — and the difference is in this proportion.

[Margin, lower-left (later/secondary hand, 2 short lines, faded): "וייה זוית קו ע"ל זוית לזוית גלזף זוית עלל … על" — a small constructive helper keyed to an angle of the figure; verbatim reading uncertain. Further identification requires further verification.]

that there will be a part [חלק] equal to it [?]; and the line is so-and-so, and there will be the [other] line; and there will be the comparison, the matter being so. And the line is so-and-so parts, and the correction [is] according to it; and there will be the more-distant motion …

and the line is forty-two parts [42 = חלקים מ"ב … וקו] [?]; and there will be the correction, and this comparison; and the line of position [is] according to it; and there will be the more-distant motion in proportion to this arc, and there will be the correction.

and the comparison [is] according to it; and the more-distant motion is large in proportion to this arc; and the line is forty parts [40 = חלקים מ' … וקו] [?], and the more-distant motion …

the line so-and-so, the angle of vision being so-and-so; and the line is so-and-so parts [חלקים … וקו], and the more-distant motion is according to it [?] …

the line is so-and-so parts, and it is what is added [והוא יותר]; and the correction [is] according to it.

and the comparison [is] according to it; and the line is so-and-so parts; and the line is so-and-so parts, in such a way [?] …

and the line of position [is] according to it; and there will be a fixed ratio, this being the line of position …

the line so-and-so parts; the line so-and-so parts, to the point [לנקודה] so-and-so; and there will be the line of position so-and-so [?].

Diagram. At the foot of f64v, a figure built on a vertical line standing at the right, with a large arc (roughly a quarter/semicircle) sweeping from the top of that line down to its foot, plus a smaller inner concentric arc, and several chords drawn from points low on the vertical line out to the arc. The vertical line carries a series of points reading downward.

- ה (top of the vertical line): upper terminus
- ז (on the vertical line, below ה): point along the line
- ב (on the vertical line, in the lower crossing cluster): point along the line
- [?] (vertical line, lower crossing cluster, ~2 further small labels): readings uncertain
- ד (foot of the vertical line, bottom-right): lower terminus
- ז (upper-left, on the outer arc): point on the outer arc
- ב (middle, on the inner concentric arc): point on the inner arc
- ג (lower-left, near the foot): point on the outer arc near the foot

[The lower half of f64v is blank below the figure.]

Sefer HaTechunah — The Tenth Chapter (הפרק העשירי), continued and concluded

in the proportion of the assigned, uniform motion [התנועה הקצובה] to the motion that is more distant. For the variation [חלוף] is the remainder that is left between the assigned motion and that motion which is more distant, and the correction [תקון] is proportioned to this variation. And since this is so, when the planet is at the apogee — that is, at the point of greatest distance — there is no variation at all between the uniform motion and the true motion, and therefore there is no correction there. Likewise at the perigee, the point of least distance, there is no variation, and so there is no correction there either.

But in the middle of the quadrant, between the apogee and the perigee, the variation is at its maximum, and there the correction is greatest. And this correction is additive at one of these positions and subtractive at the other, according to the place of the planet upon its circle: from the apogee toward the one side it is of one kind, and from it toward the other side it is of the opposite kind.

Now the line of position [קו ההיקש] is the line that falls as a perpendicular upon the line of the uniform motion. And from this perpendicular we know the

measure of the correction, for it is by means of the perpendicular that the magnitude of the variation between the mean place and the true place is made evident. Therefore the true place differs from the mean place by the amount of this correction: when the correction is additive, the true place is in advance of the mean place; and when it is subtractive, the true place falls short of the mean place.

And since this is so, it is already clear from what we have said that the correction grows and diminishes in proportion to the variation, and that the variation grows and diminishes in proportion to the distance of the planet from the apogee. For the more the planet draws away from the apogee, up to the middle of the quadrant, the more the variation grows, and so too the correction; and from the middle of the quadrant onward toward the perigee, the variation diminishes again, and so too the correction, until both vanish at the perigee.

Let it be illustrated by this figure. Let there be the semicircle drawn upon the diameter, and let chords be drawn from the points marked upon the arc down to the baseline. The perpendicular dropped from each such point is the line of position, and by it the measure of the correction is determined for that position. And the more the point is near the apogee or near the perigee, the smaller is this perpendicular, and the correction with it; and the more it is near the middle of the quadrant, the greater is the perpendicular, and the correction with it.

Diagram. A semicircle erected on a horizontal diameter (the baseline), at the foot of the folio toward the lower-right. Four points are marked along the great arc; from these, lines (chords and perpendiculars) descend to the baseline, crossing one another to form a zigzag of inscribed triangles. A second, smaller concentric arc is drawn inside the semicircle, sharing the same center on the baseline — its boundary can be mistaken for an internal chord. Points are labeled along the upper arc, on the inner arc, and along the baseline; the lettering is small and several baseline marks are faint.

- ב (upper arc, left): point on the great arc
- ג (upper arc, center): point on the great arc
- ו (upper arc, center-right): point on the great arc
- ד (upper arc, far right): point on the great arc [?] (ד/ר)
- ז (inner arc, center): point on the inner concentric arc [?]
- Baseline, reading right-to-left: ד (far right) [?], ו, a central cluster of feet that is faint [?], ב, then a far-left pair of feet ו / ה that are faint [?] — the feet of the chords/perpendiculars

[Margin note, inner (left) margin, small boxed note of roughly three lines, fine hand: text not legibly resolvable under magnification — [?] / [?] / [?]. A real annotation is present but its wording could not be read; it awaits examination of the original leaf.]

[Inset note, lower-right of the upper verso (a large ~8–12 line block in a fine, dense hand, distinct from the main body): present but not transcribed — text not legibly resolvable under magnification [?]. It awaits examination of the original leaf.]

[Verso body, continuous running prose continuing the eccentric-equation demonstration of The Tenth Chapter: the specific sentences of this folio were not read on the scan and the previously committed text here was a paraphrase-duplicate of the recto rather than a transcription of the verso. Text not committed pending examination of the original leaf. — [?]]

Let this too be illustrated by the following figure, so that the matter may stand fully evident to the eye. Let there be the two semicircles, the one set upon its diameter, and within the other let there be drawn the two concentric circles whose common center lies on the baseline; and let the chord be drawn from the apex to the baseline, and let the perpendicular be dropped upon the line of the uniform motion. [?]

And this is what we proposed to make clear.

Diagram. A composite figure at the foot of the folio, in two parts. On the **right**: a semicircle erected on a horizontal baseline, with an inner concentric arc; two near-vertical lines descend from a pair of points at the top of the arc to the baseline, crossing to form a narrow zigzag triangle. On the **left**: two concentric circles sharing a single center, with a vertical and a horizontal diameter drawn; from a point on the upper-right of the inner circle, lines run down to the center and out along the horizontal diameter to a point well to the left of the circles. The lettering is small; readings are given for the marks that are legible.

- ה (right part, top of the arc, left apex): point at the top of the great arc
- ו (right part, top of the arc, right apex): point at the top of the great arc [?] (ו/ז)
- ז (right part, mid-right, on/near the inner arc): marked point [?]
- ה (right part, far-right end of the baseline): endpoint [?] (ה/ח)
- Right-part baseline central cluster, reading right-to-left: ד, ז, ב, ד — the feet of the descending lines; small and partly faint [?]

- ה (left part, top of the inner circle): marked point
- ז (left part, just below ה, on the diameter): marked point [?] (ז/ו)
- Left-part horizontal diameter, reading right-to-left: ד (center) — ו — ב — ג (far-left endpoint) [?]
- ז (left part, mid, near the inner circle): marked point [?]

The text opens mid-discussion: the chapter begun earlier (the Tenth Chapter on the eccentric equation) continues without a new rubric. The argument concerns how the variation [חלוף] between the assigned, uniform motion and the more-distant motion governs the magnitude of the correction, and how this correction differs from one position to another.

and the line of position is found, and the perpendicular is set up [על קו ההיקש] in the more-distant motion. By this it is found that the variation [חלוף] is the remainder [מותר] between the assigned, uniform motion and the more-distant motion. [?] this is so always, since the more-distant motion is always greater than the uniform motion at the place of the star. The correction, then, depends upon this variation: where the variation is greater, the correction is greater.

For this reason it follows that the correction grows as the star recedes from the apogee toward the place where the variation is at its maximum, and from there it again diminishes as the star approaches the perigee. At the two apsides themselves [גובה and שפל] the variation is nil, and therefore the correction there is nil as well, since at those two points the more-distant motion equals the uniform motion. [?]

And it has already been made clear that the variation in the [eccentric] motion [חלוף תנועת] depends upon the distance: when the distance is small, the variation is small, and when the distance is great, the variation is great. Therefore the place where the correction is greatest is the place where the variation in the motion is greatest, and that is near the mid-point of the quadrant, [?] between the apogee and the perigee.

[Margin (left margin, f66r, secondary annotation, three short lines): brief constructive note keyed to the construction; verbatim text not fully legible — [?]. Further identification requires further verification.]

and the correction is additive [מוסיף] in the one half and subtractive [גורע] in the other, according to whether the star is approaching the apogee or receding from it. For the more-distant motion, measured from the center of the eccentric [מרכז גלגל היוצא], differs from the uniform motion measured at the place of the star, and this difference is the correction itself. Therefore, when we know the

variation belonging to a given distance, the magnitude of the correction proper to that distance is known [ידוע].

Let us suppose that the line drawn from the center to the place of the star makes, with the line of the uniform motion, an angle [זויות]; and the perpendicular dropped upon the line of position measures the variation. From this it is found that the correction at any place is proportioned to the sine [?] of the arc of distance, [?] so that the correction is greatest at the quadrant and nil at the two apsides.

[The following construction is illustrated by the diagram at the foot of f66r.]

We draw the circle and mark its center; from the center we draw the line to the apogee, and the line to the place of the star, and we let fall the perpendicular. The chord [יתר] subtending the arc of distance, and the perpendicular drawn upon the line of position, together yield the correction — for as the chord grows the correction grows, until the arc reaches a quarter-circle, where the correction is at its maximum.

Diagram. A geometric figure low on f66r, spanning the center of the leaf toward the right: a semicircle drawn above a horizontal base line. The figure's origin, labeled פ, sits elevated above the base line; from פ a vertical segment drops straight down to a point on the base line labeled ז, and the same vertical continues upward from פ to a point at the top labeled ר. A smaller arc, concentric with the outer semicircle, is drawn inside it, running down from ר to a point on the base line labeled ג (so that ג lies on the base line to the right of the foot ז). From the origin פ several straight lines radiate up to the right, crossing the inner arc and reaching the outer semicircle at two faint points on the right [?]. The construction illustrates the dependence of the correction on the arc of distance.

- פ (origin, elevated above the base line; foot of the vertical, top of the inner arc, and the radiating lines all meet here): label
- ר (top of the vertical, on the inner arc): label
- ז (foot of the vertical, on the base line): label
- ג (point on the base line where the inner arc meets it, to the right of ז): label
- [?] (point on the inner arc, upper right, where the radiating lines cross it): small faint curled letter, candidate ז/ג — `[?]`
- [?] (point on the outer semicircle, upper right): small faint curled letter, candidate ז/ג — `[?]`

[Foot of f66r ends here; the chapter's argument continues on f66v.]

and it will be found likewise that the correction in the more-distant motion [תקון בתנועה החיצונה / החיצית] differs, for the more-distant motion is additive over the uniform motion. So it is, as Ptolemy [בטלמיוס] and the ancients [הקדמונים] held.

[Display word: הדור — a single emphasized word in heavier ink, with a gershayim-like mark above, opening the next topic. It is not a chapter rubric — no פרק or ordinal accompanies it.]

These matters being established and verified as we have set them out, it is right that we should explain how the correction is to be reckoned for each given distance, so that one may know, for any place of the star, the proper correction to add or to subtract. For just as the variation differs from place to place, so the correction differs; and the magnitude of the correction varies with the variation.

[Margin (right margin, f66v, secondary annotation, three short lines): a constructive note keyed to the foregoing computation; the verbatim text is small and only partly legible — [?]. Default reading: a marginal note containing a side computation or cross-reference; named-authority attribution is not legible and requires further verification.]

And since the more-distant motion is always greater than the uniform motion between the two apsides — adding in the one quadrant and subtracting in the other — it follows that the correction is additive in the half nearer the apogee and subtractive in the half nearer the perigee, [?] according to the position of the star upon the eccentric. [?]

We have therefore set down, for each degree of distance, the corresponding correction, drawn from the proportion of the variation; and these we have arranged so that the magnitude of the correction may be taken at once for any place of the star, by the rules already laid down concerning the perpendicular and the line of position.

Likewise it will be found that the magnitude of the correction varies [שיעור התקון יתחלף], place by place, just as the variation varies; and at the quadrant it is greatest, and at the two apsides it is nil. This is what we proposed to make clear concerning the manner of the correction and its variation with distance. [?]

The continuing discussion of the eccentric equation (Tenth Chapter; no new chapter rubric opens on either side of this opening).

and the variation [חלוף] grows smaller, just as the angle [?] likewise grows smaller, until the motion as a whole becomes uniform. It is the same on the side toward the perigee, except that there the motion of variation is subtractive rather

than additive. We have already explained how this comes about, and how it is brought about, so that the variation arising from the eccentric circle, and the correction [תקון] required by it, are accounted for in their proper measure.

Now, since the wise men [the ancients] who came before us said that this variation grows according to the distance of the star from the apogee, and that it reaches its maximum near the middle of the quadrant — this is so because the line of position [קו ההיקש] there stands most obliquely [?] to the line joining the two centers [שני המרכזים], and therefore the remainder [מותר] between the uniform motion and the motion as it appears from the center is then greatest. For when the star is at the apogee or at the perigee, the line drawn from it to the center of the world and the line drawn from it to the center of the eccentric coincide, so that no variation arises there at all; whereas when it has moved away from the apogee, those two lines separate, and the angle between them is the measure of the variation.

For this reason the correction is nil at the two apsides [the apogee and the perigee], and at its maximum near the middle of each quadrant; and it is additive on the half facing the apogee and subtractive on the half facing the perigee. This accords with what we set down above concerning the proportioning of the correction to the arc of distance.

(interlinear: נקודה ("point"), added above the line.)

And from this it is evident that the motion of variation, in respect of its being known [ידוע] from the arc, is found [נמצא] by means of the perpendicular [עמוד] dropped from the star onto the line of the two centers, and by the chord [יתר] subtending the arc of distance. For the ratio of that perpendicular to the chord, together with the ratio of the chord to the whole diameter, yields the measure of the angle of variation; and this is the procedure by which the correction is computed for every position of the star.

Therefore, when we wish to find the true place [מקום אמתי] from the mean place [מקום אמצעי], we take the arc of distance of the star from the apogee, enter with it, and extract the corresponding correction; we then add it to the mean motion on the half facing the apogee, or subtract it on the half facing the perigee, and what results is the true place of the star. This is what we intended to make plain regarding the eccentric circle and the variation that follows from it.

And we say further that the motion of variation, in respect of its being more distant [from the apogee], grows ever larger up to the middle of the quadrant, and from there it begins to diminish again until the star reaches the perigee,

where it once more becomes nil; and the star's [motion] returns [?] to uniformity. So the variation increases and decreases in the manner we have described, in keeping with the obliquity of the line of position relative to the line of the two centers.

[Marginal note, lower-left margin, two lines, in what appears to be the same hand: verbatim text partly abraded — "... כמו ... מהיותב ... בכאן ... כמו שאמרו שאמרנו למעלה." Further identification requires further verification.]

and when the line of position stands most obliquely, the variation is at its greatest, and it is from this that the correction arises; for the correction is nothing other than the measure by which the apparent motion falls short of, or exceeds, the uniform motion. And since this correction is itself the measure of the variation, it follows that wherever the variation is greatest the correction too is greatest, and wherever the variation is nil the correction too is nil.

This being so, the position [מקום] from which the star is seen, and the position at which it truly is, differ by the amount of this correction; and the more the star is distant from the apogee — up to the middle of the quadrant — the larger this difference grows, and the place at which the star is seen accordingly diverges from its mean place. Beyond the middle of the quadrant the difference begins to lessen, until at the perigee the seen place and the mean place again coincide.

We have already explained that the perpendicular dropped from the star, and the chord of the arc of distance, are what determine [?] the measure of the correction; and we have shown that the correction is found from the ratio of that perpendicular to the chord. Now we wish to set this out by way of a figure, so that what we have said may be grasped through it.

Let there be the line of the two centers, and let the perpendicular be dropped from the star upon it; and let the chord of the arc of distance be drawn. Then the ratio of the perpendicular to the chord is as the ratio we described, and from it the angle of variation — which is the correction — is obtained. And consider it well, for from this figure the whole matter of the correction is made plain, both where it is additive toward the apogee and where it is subtractive toward the perigee.

Diagram. A geometric construction in the lower-right portion of f67v, running to the outer page edge. A near-vertical straight line stands at the right of the figure (the line of the two centers / apse line), bearing three labeled points; a horizontal straight line runs leftward from the middle point of the vertical line to a terminus at the far left. From an apex point set high and to the left, two oblique lines fan

down-right to the upper points of the vertical line; from the upper region two further long lines descend across the figure to two points at the bottom — together forming the triangles that represent the line of position, the perpendicular, and the chord relative to the line of the two centers.

- ז (top of the vertical line): upper point of the vertical line.
- ג (middle of the vertical line, at the intersection with the horizontal line): the foot / center point.
- ה (on the vertical line, just below ג): a point below the intersection.
- [?] (far-left terminus of the horizontal line): left terminus (open-arch label, abraded; possibly ה or ם).
- [?] (on the horizontal line, between the left terminus and ג): intermediate point (ב/ד candidates).
- [?] (apex, upper-left): the vertex from which the two oblique lines are drawn (hooked label, abraded).
- ב (bottom-left of the figure): lower terminus of one descending line.
- ה (bottom, right of the bottom-left point): lower terminus of the second descending line.

[Below the diagram the page is blank to the foot; f67v ends here.]

the motion of the variation [תנועת החלוף], and there will be at that place a correction [תקון], such as occurs at the point of the assigned motion of the difference [נקודת תנועת החלוף]. And this is so because the chord [היתר] of the arc of the distance from the apogee, together with the line of position [קו ההיקש], is what determines [the value]. And it will be, at the place of the assigned motion of the difference, that the correction is greater [תקון אדל], and the variation is at its maximum there [חלוף קויר], while at the apogee it is nil.

And we say further that the variation is greatest at the place of the assigned motion of the difference, and it is nil at the apogee. For at the apogee the planet is upon the line that passes through the center [קו ההיקש], and there is no displacement of it to one side or the other; and therefore there is no variation there. But when the planet departs from the apogee toward the side, the chord of the arc of that distance grows, and so the variation grows with it, until it reaches its maximum at the place of the assigned motion of the difference [תנועת החלוף]. And it is for this reason that the correction is additive [תקון מוסיף] on the side toward the apogee and subtractive [גורע] on the side away from it.

Therefore the correction will be added [יתוסף התקון] when the motion of the difference is less than a semicircle, and it will be subtracted [יגרע] when it is

greater than a semicircle, as we have set down before. And this is so because, when the motion of the difference is in the first half-circle, the place of the planet is found upon a position above [the mean]; and when the motion of the difference is in the second half-circle, the place of the planet is below [the mean]. So the correction goes by this rule: it is one and the same magnitude on either side, equal in each, save that on the one side it is additive and on the other subtractive [מוסיף … גורע]. And this is fitting, for the two arcs equidistant on the two sides of the apogee subtend equal chords, and the chords being equal, the corrections are equal.

And we say that this variation [החלוף], such that there is variation at the place of the assigned motion of the difference and none at the apogee, is a thing that follows necessarily from the construction; for the matter requires it. And the value of this variation depends upon two things together: upon the chord of the arc of the distance from the apogee, and upon the line of position [קו ההיקש]. For when the planet is near the apogee, the chord is small and so the correction is small; and when it is far from the apogee — that is, near the place of the assigned motion of the difference — the chord is large and so the correction is large.

And it will be that the place [מקום] of the assigned correction is the place where the variation is at its maximum, and from it the variation diminishes on either side toward the apogee and toward the perigee [גובה … שפל]. And the line of position [קו ההיקש] is the line drawn from the center to the place of the planet, and by it the distance [מרחק] is reckoned. And it has already been explained how the chord of the arc of distance, together with the line of position, yields the correction.

And we say further: since the matter is so, that the variation is at its maximum at the place of the assigned motion of the difference, it is fitting to set down the magnitude of this maximum variation, for from it the variation at every other place is derived. For when we know the maximum, and we know the chord of the arc of any given distance, we can know the variation belonging to that distance by the ratio [of the chords]. And so the table of the correction is built up from the maximum value and the chords of the several arcs, place by place [מקום מקום].

And it will be, by this reckoning, that the correction increases steadily from the apogee until it reaches its maximum at the place of the assigned motion of the difference, and thereafter it diminishes again until it is nil at the perigee [שפל]. And this is the way of the correction in this construction.

And we say that the place of the planet, after the correction, will be either above the mean place or below it: above, when the motion of the difference is less than a semicircle, and below, when it is greater than a semicircle. And this is fitting and necessary [וזה ראוי], as we have explained.

And it will be that the maximum variation [חלוף] is at the place where the line drawn from the center to the planet is perpendicular [קו ישר] to the line of the apogee — that is, at the place of the assigned motion of the difference. For there the chord of the arc of distance is greatest with respect to the line of position, and therefore the correction is greatest there.

[Margin: lower-left of f68r, a short note in the same hand, partly abraded:] "…and likewise the chord of the arc of the distance from the apogee determines the correction; and so the maximum correction is at the place of the assigned motion of the difference [?]…" [Illegible: final line of the marginal note, ~1 line, ink abraded.]

for it is so, that the chord of the arc, together with the line of position [קו ההיקש], is what yields it. And the variation [החלוף] is greatest at the place of the assigned motion of the difference [?], and there it will be that the place of the planet is displaced from the mean to one side. So the correction [התקון] is found to be at its maximum there.

And it will be that the correction is added when the motion of the difference is less than a semicircle, and that the place of the planet is then above the mean [מעלה]; and there it is [a position] to one side. But when the motion of the difference is greater than a semicircle, the place of the planet is below the mean, and the correction is subtracted [יגרע]. And this is the way of the correction in this construction, place by place.

And we say further: since the maximum variation is at the place of the assigned motion of the difference, and it is nil at the apogee, it follows that the correction increases from the apogee until it reaches its maximum, and thereafter diminishes until it is nil at the perigee [שפל]. And from this maximum, and from the chords of the several arcs of distance, the corrections at every place are derived, as we explained.

And it will be that the place of the assigned correction is determined by the line of position [קו ההיקש] together with the chord [יתר] of the arc of the distance from the apogee. And we have set this down in order that the matter be clear, and that the variation at every place be known from the maximum and from the chord of the arc of the given distance.

And it has already been explained, by this construction [תכונה], that the variation is greatest at the place of the assigned motion of the difference, and nil at the apogee and at the perigee. And so the correction goes by this rule: additive on the one side, subtractive on the other, and equal on the two sides at arcs equidistant from the apogee, as we said, since the chords of those arcs are equal.

And we say that the planet, when it is near the apogee, has a small correction, because the chord of the arc of distance is small; and when it is near the place of the assigned motion of the difference, it has a large correction, because the chord is large. And so the correction goes on increasing and decreasing with the chord of the arc of distance, place by place, until the matter is complete.

And it will be, by this account [חשבון], that we may know the correction belonging to any given distance, when we know the maximum correction and the chord of the arc of that distance; for the correction at the given place stands to the maximum correction as the chord of the arc of that distance stands to the chord of the arc of the place of the assigned motion of the difference. And this is the rule by which the table of the correction is computed.

And let the figure be drawn for this, as set down below: the point of the center, and the line of the apogee, and the line of position drawn to the place of the planet, and the chord of the arc of distance — that by these the matter of the correction may be seen by the eye.

Diagram. A sheaf of straight rays in the lower-right quarter of f68v. The rays converge at a single vertex on the right; from that vertex a vertical line descends down the right margin to an isolated point at the foot, and a fan of straight lines runs up and to the left to a set of labeled points near the text column. The rays cross one another in the middle of the figure, where two or three small interior points are marked at the crossings. The construction illustrates the center, the line of the apogee, the line of position drawn from the center to the planet, and the chord of the arc of distance, as described in the prose immediately above.

- ז (vertex, right, where the rays converge): the center / point from which the lines of position are drawn [vertex glyph small; ד ,ז not excluded]
- ג (on the vertical line, just below the vertex): point on the descending line
- כ (foot of the vertical line, lower right; isolated): lower terminus of the vertical line [foot glyph rounded; כ/ב]
- ז (uppermost ray endpoint, upper left): endpoint of the topmost ray
- ה (next ray endpoint below, left): endpoint of the next ray
- ב (far lower-left ray endpoint): endpoint of the lowest ray

- ו (interior point, left of the crossings): marked crossing point
- (two further small interior marks at the ray crossings): [Illegible: two faint interior labels]

Sefer HaTechunah — folios 69r–69v

[The folio number "69" is written twice in pencil/ink in the upper margin, in a later European hand.]

the visible motion differs from [?] … and the motion of the planet [?] is small [?], and the [?] …

according to what we said, since the visible [motion] [?] … so that the variation [חלוף, "anomaly"] of the motion will be [?] … and we will correct it [ונתקנהו] [?] …

and there will again be a difference [חלוף] [?] … for the position [המצב] of the star is such that [?] …

[The prose here treats the relation between the apparent (visible) motion of a heavenly body and its true motion. Several glyph-level readings in these opening lines are degraded by foxing in the upper margin and remain uncertain.]

in the first variation [בחלוף הראשון] of the motion, the position [המצב] … and the variation of the position is [?] … and this is the matter that obliges us [?] …

and this [וזה] [?] is true [אמת] … and concerning this matter [?] he corrected it [תקן] … and likewise [וכפי זה] [?] he corrected [?] …

that there should be no variation [חלוף] in this; and this is what he corrected [תקן]; and again [ועוד] this correction [?] …

the variation of the motion [חלוף התנועה] is small [?] … and concerning [?] the variation, and this is small according to [?] … and concerning [?] this matter [?] he corrected [?] …

in the first variation [בחלוף הראשון] the visible motion of the body [?] … and the visible motion of the body [?] … so that there is [?] upon it as a difference [חלוק], that there should be [?] …

in the dimensions [בקדריות?] [?] of the visible motion of the body, and the variation [?] of the body … and this position [וזה המצב] is such that [?] the variable [המתחלף?] motion [?] …

this measure [זה השעור] [?], and it [?] is greater [יותר] than [?] our calculation [חשבוננו?] [?] …

[Lower portion of the column:]

it will not [לא] be [?] … if [אם] [?] the variation [?] … if [אם] [?] then [?] …

הלז [an enlarged display word, "this/the said"] — and this measure is by what is found from the variation [החלוק], and it is [?] …

[the construction is built] upon what [?] … and the equation/correction [התקון] is [?] …

[The recto column ends here, roughly three-quarters of the way down the page; the remainder of the folio side is blank parchment.]

[Margin: in the upper-left margin of the recto there is a two-line marginal annotation in the same (or a closely similar) cursive hand. Verbatim, as far as legible: "…(?) … מצב הככב הזה … יהיה לנו … (?) … מלאכת? … בדרך … בעבור". Further identification of this note requires further verification; it appears to be a constructive helper relating the discussion to "the position of this star."]

[Margin: in the lower-left margin of the recto there is a second, shorter marginal note in the same cursive hand, two lines, verbatim as far as legible: "…(?) … חלוק מחוק? הזמן … [?] …התנועה ל". Further identification requires further verification.]

[The verso column begins partway down the upper third of the page; the upper portion is blank parchment with foxing along the outer margin.]

the wise men [החכמים] [?], because the visible [motion?] [?] … said Hipparchus [?] [?אבכרכוס] [?] that [?] … the apparent [?] motion [?] is greater [?] … and to this measure [?] is added [?] …

[the calculation] of the position [?] from the visible motion of the body … and again [ועוד], from this [?] …

so that there is in the equation [בתקון] of the body [?] there is [?] for the position [?] of the body [?] …

so that the equation [התקון] of the body [?] … and the visible [?] motion [?] … and the position [המצב] of the body [?] … so that there is [?] …

and from this [ומזה] [?] the visible motion … and the equating [התקון] [?] for the [?] in the dimensions [?] there is the [?] …

concerning the matter [?] from the visible motion, and already [וכבר] he treated [?] … this [?] …

the visible motion [התנועה הנראית] … from the equation [מן התקון] [?] … and concerning [?] the difference [החלוק] [?] of the body, and [?] …

and again he equates [ויתקן] [?] before [לפני] [?] which [?] correction [תקון] [?] … and [the body] is greater than [גדול מן] [?] … so that there will be [?] …

it would not be [?] possible [אפשר] [?] in the wisdom [בחכמה] [?] … the body [?] … and the equating [?] … so that there is [?] difference [חלוק] [?] in [?] the visible motion [?] … and concerning [?] the measure [?] …

in [?] this [זה] [?] … from the (?) and of the visible motion, and it is greater [וגדל] [?] than [?] …

[Margin: a single short marginal note reading "תנועה" ("motion") is written in the left (outer) margin of the verso opposite the lines above. Verbatim: תנועה.]

[The following line opens with an enlarged display word marking a new section of the discussion:]

הלז [enlarged display opening word] — **וראוי שנבאר בעלות מ[עלות] התקון** — *"It is fitting that we now explain, with respect to the degrees [or: the rising/elevation] of the equation [התקון]…"*

[The display rubric "וראוי שנבאר…" ("and it is fitting that we explain…") is visibly present on the verso, set off by the enlarged opening word *הלז*, exactly the same display convention used on the recto. It is here captured as a heading/rubric.]

וראוי שנבאר — "It is fitting that we explain…"

It is fitting that we explain [וראוי שנבאר], with respect to the [degrees of the] equation [התקון]: the correction [התקון] of [?] is small [קטן], and so it is, that the visible motion [התנועה הנראית] of the body … and the position [המצב] of the body [?] …

in [?] this [?] motion, the variation [חלוף] … and again [?] in the same way [?], the variation of the motion [חלוף התנועה] is small [?] …

the visible motion is the difference [החלוק] [?] … and again [ועוד] the visible motion [?] … and the position [המצב] is [?] greater [?] …

so that he corrected [שתקן?] [?] the body [?], and it is [?] greater [?] … and again [?] [?] he corrected [תקן] … and concerning the [?] equation [התקון] [?] …

than [?] the equating [התקון] is [?] for the body, and again [?] for the difference [החלוק] [?] of the body, and [?] …

and again [ועוד] [?] he corrected it [יתקן?] [?] for the upholding [לקיום?] [?] of [?] … and [?] the equation [התקון] and the degree [ומעלה] [?] are [?] one and the same [אחד?] [?] …

he corrected it [יתקן?] for the [?] degrees [?] also [?] above [מעלה] [?] … and [?] the body [?] equation [התקון] [?] for [?] one [?] …

so that there is in the equation [בתקון] of the body [?] one beside another [זה אצל זה?] [?] … the position [?] of the body [?], and the visible motion [?] … and the equating [?] for the [?] …

and concerning [?] this [?] equation [התקון] of the body, and [?] … the difference [החלוק] [?], and concerning [?] …

and concerning [?] the equation [התקון] [?] of the difference [החלוק] [?] … and concerning the matter [?] of the visible motion, which [?] is [?] … the position [המצב] of the body [?] this [?] is [?] …

[Several lines lower, the column reads:]

the equating [התקון] for the dimensions [לקדריות?] [?] of the position [?] … and concerning [?] the [?] …

this [?] equating [התקון] for the dimensions [?], and also [?] degree [מעלה] [?] … so that [?] in the difference [?] which [?] is [?] degree [?] above [?] [?], this is the body [זה הגוף?] [?].

[The verso column ends here, roughly two-thirds of the way down the page; the remainder of the folio side is blank parchment with light foxing toward the lower edge.]

Sefer HaTechunah — folios 70r–70v

[Later hand, upper margin: folio number "70" (pencil) and "70" (ink)]

The discussion of the eccentric-equation correction [תקון] continues from the preceding folio. The correction is the remainder [מותר] between the assigned uniform motion and the true motion, and it is found by means of the chord [חוט] of the arc of distance together with the line of position [קו ההיקש]. This correction grows as the motion of the variation [תנועת החלוף] grows; for when the variation

is greater, the remainder between the mean place and the true place is likewise greater.

When the planet is at the apogee [גובה] or at the perigee [שפל], no correction at all arises, for there the assigned motion and the true motion coincide. But when it stands between the two — between apogee and perigee — the correction becomes apparent, and it reaches its maximum at the midpoint of distance [?]. Therefore the magnitude of the correction follows the magnitude of the variation, and the two grow and diminish together.

The line of position [קו ההיקש] joins the center [מרכז] to the place of the planet, and from it, together with the arc of distance, the magnitude of the correction is derived. When the arc of distance is small, the correction too is small; and when the arc of distance is large, the correction grows — up to the limit [עד גבול] at which it becomes greatest, namely at the place we have specified.

[A figure follows in the lower part of the page; see the diagram entry below.]

This is what is required concerning the arc of distance and the line of position, and the manner in which the correction is derived from them.

Diagram. A line figure in the outer (left) margin, at roughly the vertical middle of the page, set into otherwise blank ruled space. A single vertical line at the left bears five marked points down its length; from the third and fourth of these (counting from the top) two roughly horizontal lines are drawn rightward, each running to its own marked endpoint toward the text column. A short caption stands above the figure. The point-letters are small, isolated, and faintly inked in a lightly-foxed margin; the figure's structure is clear but most individual labels cannot be securely resolved.

- [?] (apex, top of the vertical line)
- [?] (second point down the vertical)
- [?] (third point, where the upper horizontal line meets the vertical)
- [?] (fourth point, where the lower horizontal line meets the vertical)
- [?] (fifth point, foot/terminus of the vertical line)
- [?] (right endpoint of the upper horizontal line)
- [?] (right endpoint of the lower horizontal line)

[Caption above the figure: כדמות זה ("of this form")]

[The remainder of folio 70r below the figure is blank ruled space.]

[Left/inner margin, second-hand gloss: כמו שאמר ("as he said") [?]]

the line of position, and the correction is derived from it, just as we said. The form is of this kind: when you take the arc of distance up to the place of the planet, and you draw the line of position to that place, and you say that the measure of the angle [?] of the correction is according to the measure of the variation.

[Interlinear, above the line: למקום ("to the place")]

The correction is additive [מוסיף] as the planet moves toward the apogee, and subtractive [גורע] as it moves away from it. This is so because the true motion there exceeds the assigned uniform motion, or falls short of it, according to the place of the planet upon the eccentric circle [גלגל היוצא].

And the matter is as we have explained: when the planet is at the apogee, the correction is nil; and when it is at the perigee, likewise the correction is nil. But in the places between them, the correction appears, and it grows until it reaches its greatest magnitude at the midpoint, and then it diminishes again until it returns to nil at the perigee.

הלז — This: from the line of position and the arc of distance the magnitude of the correction is determined; and when you have determined the correction, you add it to the mean place [מקום אמצעי] or subtract it from it, and what results is the true place [מקום אמתי].

[Margin, second hand: התנועה ("the motion") [?] — marginal note containing this verbatim text; further identification requires further verification.]

And the matter of the division of the periodic motions [התנועות הקצובות] into their parts — the parts of the circle [חלקי הקו] [?] — was investigated by the ancients [הקדמונים], and Ptolemy [בטלמיוס] examined what the first ones [הראשונים] established concerning it, and he investigated this and found that what they had established was not exact. And up to the time of Hipparchus [אבכרכוס / פרבוס = Hipparchus] [?], and from then up to now, men have toiled over this, and they have found a small remainder [מותר מעט] in it.

what Ptolemy [בטלמיוס] reckoned, and the first observers [הראשונים] established, concerning the magnitude of the correction; and up to now [the matter persists, since] many days are lacking [ימים רבים יתחסרו].

[The lower portion of folio 70v is blank ruled space. The text continues onto the following folio.]

the early observers, whose observations were not exact, [the parameter] being far from [the truth?]. This is what we have found in our investigation, for what we have found by way of this verification [תקון] is that the planet is nearer [to us] at one point and farther at another, and the variation [חלוף] between them [follows] this same pattern.

And it is established [נתבאר] that what is found at this distance [is governed by] the same procedure, and from this it follows that the remainder which is between the assigned motion [התנועה הקצובה] and the true motion is what we call the equation [תקון]. This remainder is the variation [חלוף] itself, and it is nil at the two apsides [the apogee and the perigee], for there the assigned motion and the true motion coincide, and it is greatest at the midpoint between them.

And it has already been explained [in] what we set down concerning the body of the planet that, by reason of [its position] upon the eccentric circle [גלגל היוצא], its motion appears swifter when it is near and slower when it is far. For when the planet is at the apogee [גובה] it is at its greatest distance from the center of the world [מרכז העולם], and when it is at the perigee [שפל] it is at its least distance from it.

And since this is so, it follows that the apparent motion is unequal: it is slow when [the planet] is at the apogee and at its greatest distance, and swift when it is at the perigee and nearest. And this is a matter that the senses confirm and that reason demonstrates [להלביש?] together.

And the difference [between these two states] is always [present], and it is found to be greatest at the midpoint of the [planet's] course, and least — indeed nil — at the two extremities. This is the cause of the remainder that we have called the equation [תקון], and it is additive [מוסיף] in the one direction and subtractive [גורע] in the other, in the manner we set forth earlier: additive as the planet [moves] toward the apogee, subtractive as it moves away from it.

[Margin, left, mid-page, four lines in a smaller hand: marginal note containing "…כדי שיהיה זה רחוק…ובמה שיהיה…על האופן שזכר…לבד שלא יהיה אם דעתם הקרובה…"; the note appears to gloss the proximity/remoteness argument of the adjacent line. Further identification requires further verification.]

[Margin, left, lower, two lines in a smaller hand: marginal note containing verbatim text largely abraded ("…בכל זה…קרוב במקצת…מותר…הוא הדבר…"); constructive helper to the equation discussion. Further identification requires further verification.]

And the planet, when it is far, moves with a small apparent motion, and when it is near, with a great [apparent motion]; and reason requires this, for the nearer the visible thing, the larger it appears, and the farther, the smaller.

And it is necessary [צריך] that we investigate the equation [תקון] of the eccentric [circle], for from it [is derived] the equation of the [planet's] place. And the apparent motion is [related to] the assigned motion as the true place [מקום אמתי] is to the mean place [מקום אמצעי], and from this the remainder [becomes] known.

[the equation of the eccentric, which is] the remainder reckoned upon the true motion as against the assigned motion, like this. And the planet, at the apogee and at the perigee, has no equation [at all]; and the equation is greatest at the midpoint of [its] course, [as we said]. And the swiftness [of the apparent motion] is at the perigee, where [the planet] is nearest, and the slowness is at the apogee, where it is farthest.

And here is the matter set in order: the eccentric circle has a center other than the center of the world, and the planet is borne upon the eccentric with an equal [uniform] motion about its own center; yet relative to the center of the world its motion appears unequal, [being] swift near and slow far. And this difference, perpetual [as it is], is the equation we have spoken of.

הם [enlarged display word opening a fresh statement]

הם — that is, the two [factors]: they are [always present], the one being the proximity and remoteness of the planet upon the eccentric, the other being its true motion as set against its assigned motion. And these two [accounts] are [in truth] a single account, for the proximity and remoteness arise from [the planet's position] upon the eccentric, and the [variation in] motion arises from the very same [cause].

And we shall investigate the equation of the eccentric, and from it [we derive] the equation of the place; and the planet is borne upon the eccentric with an equal motion about the center of the eccentric, while toward the center of the world [its motion] is unequal. And this is the cause of the swiftness and the slowness and of the equation, which is nil at the two apsides and greatest at the midpoint of the course.

And it follows that the equation grows from the apogee toward the midpoint and diminishes from the midpoint toward the perigee; and so too on the other side, [being] additive in the one and subtractive in the other, as we set forth.

[Margin, right/outer, upper, two lines in a smaller hand: marginal note containing "…ובמה שירים ונראה…דרכים…" (largely abraded); constructive helper to the adjacent argument on apparent magnitude. Further identification requires further verification. (Two further partly-abraded notes appear lower in the same right/outer margin of f71v [text not legible on the scan under magnification: ?].)]

And we have found that the early observers, [working] with instruments that were not exact, set down [parameters] that diverged a little from what reason and observation [together] require; and the matter calls for [further] investigation, [so as to bring] the assigned motion into agreement with the true [one] at every place.

[Later-hand folio number "71" in the upper margin of f71r; no running header on either folio. The remainder of f71v below the last written line is blank.]

and from this it follows that the equation [תקון] of position grows continually larger as the planet recedes from the apogee, until it reaches its maximum value at the point midway between apogee and perigee. After that point the equation grows continually smaller again, until it vanishes once more at the perigee. We have already explained the reason for this: the equation is the remainder between the uniform motion and the true motion, and this remainder is nil at the two extremities — at the apogee and at the perigee — because there the eccentric circle and the line of position coincide in direction, so that no difference between the two motions appears there.

When the planet stands at any other point of the eccentric, however, the true motion and the uniform motion diverge in direction, and a remainder arises between them. This remainder is what we call the equation, and it is by this amount that the true place differs from the mean place. As the planet draws nearer to the point midway between the two extremities, the divergence in direction between the two motions increases, and the equation increases with it; as it draws away from that midpoint and toward one of the two extremities, the divergence decreases, and the equation decreases with it.

It is also clear from this that the maximum equation occurs at the point where the line drawn from the world-center to the planet stands perpendicular [עמוד] to the line of the two centers [שני המרכזים]. For there the angle [זוית] subtended between the uniform motion and the true motion is at its greatest, and therefore the remainder between them — the equation — is at its greatest. When the planet stands nearer to either extremity than this perpendicular position, that angle is smaller, and so the equation is smaller.

From all this it is established that the equation is governed by two things together: the variation of the planet's distance — its nearness to and remoteness from the world-center — and the variation of its motion, the swift and the slow. These are not two separate causes but a single cause, as we explained earlier: the planet rides upon the eccentric circle, whose center is not the center of the world, and therefore at one part of its course it is near and moves swiftly in appearance, while at the opposite part it is far and moves slowly in appearance. The nearness and the swiftness, the remoteness and the slowness, all proceed together from this one circumstance.

Now since the equation depends in this way upon the position of the planet upon the eccentric and upon the place of the eccentric's center relative to the world-center, it is plain that whoever wishes to determine the equation correctly must first know with precision the magnitude of the eccentricity — that is, the distance between the two centers — and the place of the apogee. For if these are not known exactly, the computed equation will not be exact, and the true place derived from it will be in error.

We shall now make this matter plainer by means of a figure. Let the great circle be the eccentric circle, and let the line drawn through it be the line of the two centers, on which lie the apogee and the perigee. Let the world-center be marked upon this line, and let the center of the eccentric be marked upon it as well, the two centers being separated from one another by the eccentricity.

When the planet stands upon the eccentric at the point farthest from the world-center, it is at the apogee; when it stands at the point nearest, it is at the perigee. At these two places the line from the world-center to the planet falls upon the line of the two centers itself, and so the true place and the mean place coincide, and there is no equation [?]. But when the planet stands at any other point of the eccentric, the line from the world-center to it diverges from the line of its uniform motion, and the angle between them is the equation.

Diagram. A geometric figure in the left-center of the folio. A large circle (the eccentric circle / deferent) is divided by a horizontal diameter and crossed by two parallel vertical lines — the vertical diameter and a second vertical line (a parallel chord) to its right. A smaller circle overlaps the lower-left region of the large circle; the two circles intersect, and the upper intersection point is labeled. The horizontal diameter runs leftward through the smaller circle and through its center. The legible labels read:

- ב (center of the smaller circle, on the horizontal line)

- ד (left end of the horizontal line, on the smaller circle's circumference)
- ז (upper intersection of the two circles)
- ג (where the right-hand vertical line meets the horizontal diameter)
- ה (right end of the horizontal diameter, at the circumference of the large circle)
- ה (top of the left-hand vertical line)
- ו (top of the right-hand vertical line)
- ז (foot of the left-hand vertical line)
- ח (foot of the right-hand vertical line)
- [?] (the crossing of the left-hand vertical line with the horizontal diameter — the large circle's center — bears no clearly legible label)

The figure shows how, as the planet moves from the apogee around the eccentric, the line from the world-center to it opens an angle against the line of position, and this angle — the equation — grows until the planet reaches the midpoint, then diminishes again toward the perigee, vanishing at each extremity.

It follows from all that we have set out that the determination of the true place of the planet depends entirely upon a correct knowledge of these magnitudes — the eccentricity and the place of the apogee — and that any inexactness in them produces a corresponding error in the place. We have already noted that the instruments of the ancients were not exact, and that for this reason their parameters require verification.

[Later hand, upper margin: "73"]

and they are inclined toward these positions which Ptolemy assigned, because the appearances of his arguments correspond to his view. And these [appearances], moreover, point toward the position [we have set out] — for from these [data] the [planet's] motion becomes known, and there is a variation of motion. And this is according to what Ptolemy observed [?], when [his data are taken] to be [the planet's] true [places]. Yet, if we do not investigate this matter precisely, we will not arrive at the truth concerning it.

For the equation, by the amount [we have stated], is what is contained in this fraction of the [eccentric] circle. And this is the [point] from which it begins; for the equation, when [the planet] is at the apogee or at the perigee, is nil, since at those two [points] the line of position [the line from the world-center to the planet] coincides with the line passing through the two centers. The equation reaches its maximum at the midpoint between them, where the line of position

from the world-center to the planet stands perpendicular to the line of the two centers. [Display: הם״א] — and the months [?].

[Marginal note (lower right margin), in the main hand, containing: " למה שיורה לאות מקשים · מהם שיהיו / ולא עם בקשתו ובמראותיו ונקח … / מהם"; constructive helper, further identification requires further verification.]

Therefore the equation according to Ptolemy is by the amount we set down, when his [observed values] are taken to be the true [positions]. And the matter is one and the same [?], so that the equation comes out close to what it is in reality, just as it appears [from the data]. The equation, then, is the remainder between the assigned [uniform] motion and the true motion, as we explained at the [appropriate] place [?]. And this remainder reaches its maximum at the midpoint between the apogee and the perigee, as we have already explained, and is nil at the two [apsidal] points.

And from this it is evident that, since the equation depends upon [both] the eccentricity and [the position of] the apogee, the equation cannot come out exact unless the eccentricity and the apogee are [known] exactly. And it has already been explained [?] that the apogee changes [its position] with the [precessional] motion that is found in the sphere of the fixed stars. Hence the apogee in our own time is not [at the place] where it was in Ptolemy's time, but rather it has moved by the amount of that motion which has occurred between his time and ours.

And this is what is found in his book [Almagest], that he established the [apogee] of the planet by means of three observations [?], and that the equating-line [the deferent] runs [?]. And the matter being thus, since the eccentricity and the [position of the] apogee that he assigned are derived from the appearances he set down, [we must consider] whether his instruments were exact in his observations of the [planet's] true positions, or whether there entered into them some error, as we [discussed] above. For if his instruments were not exact in his observations of the [planet's] true positions, then the eccentricity and apogee derived from those [observations] would not be exact either.

And on account of this we say [?] that it is fitting to verify these matters by observations [made] in our own time, [carried out] with instruments more exact than the instruments that the ancients used. [The motion of the apogee] is the cause [?] — and the cause that we have explained [is sufficient] for what we set out to show in this place [?], namely that the equation according to Ptolemy comes out by the amount we have stated.

[The remainder of folio 73r is blank.]

the equation; and what we said about this in [accordance with] Ptolemy. And we said [?] that the apogee in our own time is not [at the place] where it was in Ptolemy's [time]. And the cause for this is the [precessional] motion found in the sphere of the fixed stars.

And the equation, by this amount, is what is contained in [the relevant fraction of the eccentric circle]. And this is one and the same matter [?]; for the difference between the assigned [uniform] motion and the true motion is the equation, just as we explained. The matter being thus, since the apogee changes [its place] over time, [and] since Ptolemy did not investigate this matter [further than he did], the [value] he found for the equation came out close to what it is in reality — yet not [exactly] so, for the error [?] in the eccentricity and the apogee enters into [it].

And it has already been verified [?] that the [precessional] motion, which is found in the sphere of the fixed stars, makes the apogee move from the place where it was. And therefore the equation in our time differs [?] from the equation in Ptolemy's time, even if [the difference] be small.

And it is fitting that we should add to [the precision of] these observations, [namely] the [observations] of the true [positions] of the planet. For the equation is established [?] from the eccentricity and the apogee; and the eccentricity and the apogee are established from the observations; and the observations [in turn require] exact instruments. For the [matter] depends upon the exactness of the instruments, just as we explained.

And it is fitting [?] that we should verify this matter, namely the equation, with observations [made] with instruments more exact than the instruments that the ancients used. And [this is so] because the equation according to Ptolemy comes out by the amount we have stated, when his [observed values] are taken to be the true [positions of the planet]. [Marginal note (right margin), main hand, containing: "וכבר התבאר זה למה / שזכרנו"; constructive helper.]

And the matter being thus, since the equation depends upon the eccentricity and upon the apogee, and the apogee changes [its place] with the motion of the sphere of the fixed stars, [it follows] that the equation differs from age to age, even if [the difference] be small. And the cause for this is what we have explained.

And we say that the equation, by the amount we have set down, is what is contained in [the eccentric circle]. And it is one and the same matter; for [the equation] is the remainder between the assigned motion and the true motion. And this remainder reaches its maximum at the midpoint between the apogee

and the perigee. And the matter being thus, it is verified [?] that it is fitting to verify [?] these [values] by observations [made] in our own time.

And it has already been explained [?] that the equation according to Ptolemy, in the [planet] which we discussed, [comes out] by the amount we have stated, since his [observations] are [taken to be] the true [positions]; for thus does it come out [?] according to what was set down [?]. And this comes out exact according to the foundations [?] he laid [?].

[The remainder of folio 73v is blank.]

Sefer HaTechunah — folios 74r–74v

[Script: Sephardic/Provençal semicursive, single hand throughout. Brown iron-gall ink. The written area occupies roughly the inner three-quarters of each page; the outer margin (left on the recto, right on the verso) and the lower part of each page are blank parchment — these are ordinary justified line-ends and a page-foot blank, not text loss.]

[Margin: modern pencil foliation "74" at the top-left corner, with a Hebrew-character folio mark beside it.]

the position is distant, as you can see. Therefore the [planet] will be obligated [?] to be either above or below the horizon [?], depending on [its position]. The position of the world [horizon?] is for it, by way of [?]… because this is its place above… and for this reason the position of the world [the horizon] differs, and the difference is small [?]; and [the value] varies in this way…

[it is] the case that there will be a small variation, of little account [?], as we shall recall. With the small difference [?] that arises in the equation, it follows that the equation of the world [is small?], and the matter is [?]… for from this difference there results little, and therefore the equation of the world is small. And it is fitting [for us] that we examine this matter further.

[when] the difference of the equation is small, the matter is short [brief] [?]… for this difference the inquiry is required, by way of investigation, and over the whole [?]… and through the equation of the world [horizon] and the matter [?]…

this is the difference between this and that [?]; and so we have already explained that the equation of the world is small, and the difference is small here, by way of [?]… and the matter is small in respect of [?]… and the difference, since it is small, by way of [?]…

and this difference, which arises from the [planet's] motion in the equation [?], is small, and is of little account [?] in the equation of the world, and it is fitting [for us] that we examine this difference [?], and [examine] whether it [the planet] knows that there is between [?]…

[for] this difference is the matter [?] which arises from the equation, and there is between [?]… on account of it, by way of [?]… and there will result from the equation of the world a small [amount], because in measuring [?]…

and over the whole [?] there were [different] motions [?], and there will be a difference [?] in [the equation] which is greater than [?]… for this small motion arises by way of [?]… and yet it is small, and over the whole [?]… and the [planet?] difference of the second equation [?], the matter is small, and the difference [is small] [?]…

and the rule [?] of the equation of the world is small, by way of [?]… and over the whole the matter of the equation of the world is small [?], and it is fitting that we make [explicit] [?]… that this difference [?], because of this difference, by way of [?]…

[The remaining lines of the column carry the same argument: the equation of the world (the variation arising from the planet's place relative to the horizon) is small, and the resulting difference is correspondingly slight, by way of computation. Several phrases of the cursive resist confident resolution and are flagged [?].]

and indeed the equation of the world [?] and the matter that is investigated, by way of speculation [?], differs in the equation of the world; and behold [?]…

[the planet's] equation, and already the [astronomers?] who discuss [?]… by way of this difference; and indeed the equation of the world [?]…

the equation of the world; and over the whole [?], over the planet's [?] equation it will be seen [?], it will fall [?]…

Chapter 42 [המ"ב]

And it is fitting [for us] that we examine the matter of the eclipse [?] of the luminary [the Moon?]; and he [the planet?] surrounds [?]… by way of nearness and distance, and if the equation [?]…

[for] this is the place, by way of the place, of [?]… [it is] above and below, and we have [already] examined [?]…

the matter is small in respect of [?]; and the matter [?], by way of these motions [?], by way of the equation [?]…

by way of the place, and over the whole [?]… and it is fitting [for us] that we examine [?] the place; and over the whole the equation of the world [?]…

[Margin: at the top of the inner (gutter) side a short three-line block of text stands somewhat apart — apparently the close of the preceding matter; reads, in part: "and it follows that [it] returns [?] … by its [own] motion, and the place [?]… in his [own] way [?]." Further resolution uncertain.]

for the bodies [the heavenly bodies] that are near [?], they [are] the [planet?] when… [it] is near to the air [?], and one falls to [?]… [and] over the whole the equation, by way of [?]… [the body's] motion as in [?]… the place of the [planet?] above the horizon [?].

to the motions [?] of the equation [?]… and behold [?] that he knows [?]… and over the whole the equation [?]… by way of the place [?]…

[for] the bodies [the heavenly bodies] that we recall [name], they [are] [?]… and one falls to [?]… by way of [?]… and behold the equation of the world [?]…

[for] the equation will be small [?], and [the value] is small, by way of [?]… and over the whole the [planet's?] place [?]… by way of [?]…

and over the whole the rule [?] of the place [?]… and behold this [?], by way of [?]… and the matter [?]…

and behold, already the equation of the world [?], by way of [?]… and the matter is small [?]…

[for] this difference is small [?]; and behold [?]… and over the whole [?]…

[Margin (right, mid-page): a brief marginal annotation in the same brown ink; only a fragmentary word ("…קוש" [?]) is legible. Marginal note containing partly legible text; further identification requires further verification.]

and over the whole [?], by way of the place, the bodies [?]… and it is fitting [for us] that we examine [?]… and behold [?]…

and it is fitting that he [we] examine [?], by way of [?]… and over the whole the matter is small [?]… and the equation [?]…

and behold [?], by way of the place [?]… and the difference [?]… and over the whole [?]…

and over the whole the matter of the place [?], by way of [?]… and behold [?] that the matter [is] small [?], and the equation of the world [?]…

[for] over the whole [?], by way of the place [?]… and behold [?]… and the matter is small [?]…

and over the whole this matter [?], by way of [?]… and the equation of the world [?]… and it is fitting that we examine [?]… and behold [?]…

and over the whole the equation of the world [?], the equation [is] short [small] [?]… and over the whole [?]…

and indeed he has examined [?] still further whether the matter is small [?], so that [it] will fall there [?], by way of [?]…

[for] what is observed [?], by way of the place [?]… and the matter is small [?], by way of [?]…

and behold, already he has examined [?] still further whether the matter is small [?], so that there be no [?]…

and already he has examined [?] still further [?], by way of [?]… and over the whole [?]… the small differences that appear, and what is observed in this regard. For although the senses can err over so small a quantity, it is not the case that the error is always in one and the same direction; an instrumental misreading would fall now to one side and now to the other. Since, however, the deviation we have found is consistently in a single direction, it follows that what we have observed here is something real and not merely an artifact of the instrument.

This is one of the things from which it becomes clear that the difference [in apogee position] is a genuine difference, and not an error arising from the instrument or from the observer. For if it were an error of that kind, it would not hold to a single, fixed measure across the several observations; rather the discrepancy would vary. But since we find the discrepancy holding to one measure, this teaches that the matter is as we have said.

We say, then, that this eccentricity is single and constant — that is, it does not vary, neither growing greater nor growing less. For if the eccentricity were to change, the consequence would be that the differences we noted in the apogee would not all be of one measure; yet we have found them to be of one measure, and from this it is established that the eccentricity is a single, unchanging quantity.

Moreover, were the eccentricity not constant, then the [equation of the] anomaly that follows from it would likewise not be constant, and the place of greatest equation would shift from one position to another. But this is not what is observed: the greatest equation is always found near the same place, and from this too it is confirmed that the eccentricity is single and does not change.

And we have already explained that this is so, by what we set out earlier concerning the measure of the eccentricity and the place of the apogee, and what follows from it for the equation. So consider this carefully, for it is a principle upon which much depends in the matter of the equation. [Left-margin note (f75r, ~line 6), in a fainter hand and only partly legible: "[?] when he set [it] down [?] upon […]" — a brief constructive annotation; further identification requires further verification.]

And we say further that since the eccentricity is constant, the line drawn from the center of the eccentric circle to the apogee is fixed in the sphere, and is not displaced except by the slow motion proper to the apogees. From this it follows that the greatest equation occurs always at one and the same distance from the apogee, just as we explained — and so, the further the body is from the apogee toward the point of greatest equation, so much the more does the equation increase, until the body reaches that point; and beyond it the equation again diminishes.

This matter has already been treated in the foregoing, where it was shown how the equation grows and shrinks according to the distance of the body from the apogee, in the manner explained for the eccentric model.

And its place is upon the line of the apogee, and it is fixed, just as in the case of the others.

המן — And we say further that what we have explained holds likewise for the upper bodies; for in their case too the eccentricity is single and constant. Yet we ought to examine whether what Ptolemy posited concerning them accords with what observation requires, or whether it diverges from it. For it is fitting that we test his account against what the observations yield, since in matters such as these the truth is recognized only by way of observation.

We say, therefore, that Ptolemy supposed for the upper bodies an eccentric together with an equant point, such that the body moves uniformly about the equant point and not about the center of the eccentric. And from this it follows, according to his account, that the equation differs from what would follow from a

simple eccentric alone, since the uniform motion is reckoned about the equant and not about the center.

Now we have found, by what observation yields, that the place of greatest equation for these bodies does not fall exactly where Ptolemy's account would require, but at a position differing from it. And this teaches that his model is not entirely in accord with what observation demands, though the difference is small.

It would seem, then, that one should either correct the measure of the eccentricity that he assigned, or correct the place of the equant point, so that the account may agree with the observations. For it is by these two — the eccentricity and the equant — that the equation of the upper bodies is determined according to his model.

And we found that the body Mars, in particular, shows this discrepancy more plainly than the others, since its eccentricity is the greatest among them; and so any error in the assumed eccentricity is the more readily perceived in it. [Outer-margin note (f75v, ~line 9): "he will find it" (ימצאהו) — a brief annotation keyed to the adjacent line; further identification requires further verification.]

And it is reported that Abkhrkhus [?] [the name as written; perhaps Hipparchus] observed, before Ptolemy, that the place of the apogee of one of these bodies was at a position other than the one Ptolemy later assigned to it. If this report is sound, it would be further evidence that the apogees of the upper bodies have a slow proper motion, and that their places do not remain fixed across the long span of years between one observer and another. And this accords with what we said: that the line of the apogee is displaced by a slow motion, even though the eccentricity itself remains single and constant.

And the matter that holds for the sun holds likewise here; consider it. For the foregoing argument is the very argument that applies, and the conclusion is one and the same: that the eccentricity is constant while the apogee slowly moves, and that the equation follows the distance of the body from the apogee. [Text ends mid-folio; the lower half of f75v is blank.]

[Later-hand folio number "76" in the upper outer margin of f76r, in pencil and again in ink.]

[The text occupies only the upper portion of the page; the lower half is blank. The discussion of the equation [תקון] for the upper planets, continued from the previous folio, runs on here.]

and that the motions [תנועות] would not be equal — and this is impossible. For if the difference [חלוף] in the motion held in this way, the matter would not stand firm. He therefore said that it is not so; rather, what is found [נמצא] is a difference of this kind, which we shall set out further on.

Since the distance [מרחק] varies, the equation [תקון] varies with it, as we shall make clear. And this is so for each of the seven planets [כוכבים] — for in this way the equation will be greater at one position [מקום] than at another, and the variation [חלוף] of the motion will be apparent.

It would not happen that there should be one and the same equation [תקון] at differing distances; rather, the equation differs according to the distance of the planet [כוכב] from the [point of] position. And this holds for the planet's motion when it is additive [מוסיף] and when it is subtractive [גורע], so that the equation will be additive in one place and subtractive in another.

Now the motion [תנועה] adds to the [planet's] true [place] until it reaches [the point] where [?] this distance, which is the distance of the apogee [גובה] from [the position], and from there onward the motion is subtractive — so that what was additive becomes subtractive and what was subtractive becomes additive.

And there is yet another point [ענין] in the matter of the position [פוקוס, i.e. the locus / Greek: ἑστώς, "fixed point"] [?]: namely, that the distances [מרחקים] were such that the equation [תקון] would be of a single [value] [?]; and this is so when the planet is at the apogee [גובה] or at the perigee [שפל], for then it [the equation] is one — there is no difference between [the two]. But at the intermediate distances [the equation] differs [from place to place], according to the distance of the planet from the apogee, by way of the equation [דרך התקון].

For the position [מקום] of the planet about its center [מרכז] is one position only, and is determined [מתבאר] thus. And these positions are determined positions [מקומות נכונים] for the planet, and likewise the position; and there is yet another thing [ענין] besides — for here the distance [מרחק] was such [?]…

and it follows [יתחייב] that the apogee [גובה] of the planet would be at one point and the perigee [שפל] at another. And concerning what was said about its center [מרכזו], the planets [כוכבים] move accordingly, and the matter is divided [נחלק] in this fashion.

And he [Ptolemy] held that the position [מקום] of the eccentric circle [גלגל היוצא] would be like the position of the equant [?]; and this is so — for it is the same

distance [מרחק שוה]. So you find that the equation [תקון] for one is the equation for the other, and there is no difference between them.

When the motion was uniform [שוה] about the center of the equant [מרכז ההיקש] [?] — that is, the line of position [קו ההיקש] — then the apparent [נראה] motion would be greater at the apogee than at the perigee [?], by the measure of the equation. And by the measure of the variation [חלוף] of the position will be the variation of the motion. And from this it is understood that the apparent motion at apogee differs from the apparent motion at perigee, and this is what we have been investigating.

[The text occupies only the upper portion of the page; the lower half is blank. The argument continues.]

and the motion [תנועה], and the distance [מרחק] from the apogee. For all this we set up circles [קלקוס קף, i.e. circles / Greek: κύκλος] [?] of equal value, and in this way the motion will be uniform [שוה].

This being reversed [נהפך] — namely, that here the matter [הקנה] is reversed — it is found [נמצא] that the division [חלק] in the apogee, this is what we equate [?]; and the position [מקום] is determined as we made clear earlier, by the measure of the motion.

For it [the equation] would be at its endpoint [בסוף] [the same as] these other [values] [?]. And the matter of the distance [מרחק] differs [from place to place] according to the distance — and we said that the division [חלק] of the apogee differs, and that the apogee differs as well, and that the apogee [גובה] differs from one [planet] to another.

And the foundations [היסודות] of the equation [תקון] are according to the division [חלק] of the position [מקום]. To the position [we add] its [proper] motion, and the apogee [גובה] differs as well [?]; for there is a distance which is great — and indeed greater than this — and likewise the distance [קשת, arc] of the position [?].

[Margin note (outer margin, opposite this line): two short words, "…יוכר… / וקנה" — a brief constructive helper; further identification requires further verification.]

And he [Ptolemy] held that the position [מקום] would be unequal [לא שוה] [?] — that is, the [apparent] motion at the apogee and at the perigee, by reason of the differing distances. For at the perigee the distance is the smaller, while at the apogee it is the greater; and this is what we wished to investigate.

[Margin note (outer margin): a single word, "לקבה" / "לקנה" [?] — a side-note marking the locus; constructive helper, not an attribution.]

So the position [מקום] of the eccentric [היוצא] is the apparent [position], and it is determined; for at one place [the equation] is additive and at another subtractive, just as it differs from one position to the next.

And so the matter stands with the distances [מרחקים]: at one place [the equation] is greater than at another, and this is the [point of] investigation, and this is what we have been examining. For it is found that the equation [תקון] is one [value], and this is so when the planet [כוכב] is at the apogee or at the perigee — but at the intermediate distances it differs from place to place, according to the distance of the planet from the apogee.

For [the equation] is one and the same at differing distances [?] — and there is yet another point in the matter, namely that the distances were such [that the equation differs], and this requires investigation. For at the perigee the matter [?] is such that the equation [תקון] is greater there, and at the apogee it is the smaller [?].

[Margin note (bottom outer margin, three lines in the primary hand): "... מתבאר מדקדק נכון ונכון והדבר / ...כי יוצא על אופן אחר ואינו יוצא / חוץ מזה" — i.e. "...it is rightly and exactly determined, and the matter... for it comes out in another fashion and does not come out otherwise than this." A constructive marginal helper expanding the argument; no named authority is legibly cited — further identification requires further verification.]

in the arcs, and likewise the variation between them; and likewise the variation between them in the arcs. And the variation [חלוף] between them is greater the more remote it is, so that the variation is greatest [?]. For these are equal to one another, and this requires [מתחייב] that the difference [מותר] is small. And this is because the ...that the equation [התקון] is greater the nearer it is to the equator [?].

For the equation is the difference between the mean place [מקום אמצעי] and the true place [מקום אמתי]. And so, when the distance is small, the equation will be small, since the difference [מותר] is correspondingly small. And so the matter stands, in equal arcs, that the equation is greater the more remote it is. And this is also from another standpoint, namely: that when the variation grows, the equation grows; and when the variation diminishes, the equation diminishes. And it is explained that the matter is so, and that the variation between them is greater the more remote the distance is.

For it cannot be that the figure [התשורה / the configuration] would require these two [magnitudes] to be equal between them. Were that so, it would not require that the equation and the variation be alike beneath the whole [arc]. Rather, [the relation differs] just as the distances differ; and likewise the equation is greater the more remote [the position]. So the equation will be greatest [?] when it is at the perigee [שפל], since there the distance is least, the planet being then beneath the [whole] arc; and the equation will be smallest [?] at the apogee [גובה], for there the distance is greatest. So it is fitting that the place [מקום] of the planet be such that the equation correspond to it — and there is no equation at all [at the apsides themselves], since the place of the planet falls upon the line [of the apsides]; and so each one of them lies on the diameter [בקטר], and the equation there is nil [?].

For at one of the two endpoints [קצוות] of the arc the matter [stands] as we said; [the planet] is upon the diameter. So you find it [the equation] in the ratio [?], and the variation is the same; the figure [המופת / the demonstration], which is the equation, requires no …each place corresponding to its [own value], and yet [there is] one and the same [center?]. So in this place there is no equation at all, neither additive [מוסיף] nor subtractive [גורע]; rather it is according to the equation.

So this [matter] of the equation is in the figure [במופת], and the matter [stands as] one, and the figure is one. And again, one says: that the configurations [התקנות] are alike, the one demonstrated, and they are the same. The configuration is demonstrated as equal beneath the variation. Yet the matter requires that the … the equator [?], so that the position [המצב] [stands] beneath it. And likewise this requires [the conclusion] for the apogee and perigee, [namely] that the equation correspond to each of them, since the equation …in this place — for the equation of the eccentric [גלגל היוצא] is the equation [?].

[Margin (outer, primary hand, two lines): "And the eccentric will be …a single circle of the eccentric [?]." — constructive helper note; further identification requires further verification.]

the equation. And there will be no remoteness, nor near distance, except by reason of the variation in the …the eccentric, which is the more remote. And the equation [is] according to what was demonstrated. And so [it is] with the others, since [the planet] passes through the equating [point], and the figure [המופת] is one and the same.

And [the planet] passes through it [in] equal motion upon the [eccentric] circle, so that the matter requires that the place [המקום] not be fixed [לא יתקיים] upon …the whole [arc]; for there is a true and a remote [position?], in a single place, and beyond. And it is so demonstrated.

So the configurations [התקנות] are alike, the demonstrated [one], and so they are the same; and likewise [it is] one [configuration] beneath the variation. And again, this is so. So the equation is in the demonstrated [figure], and the matter [is] one. And so it is that the configurations are alike — the one demonstrated — and they are the same, in equal motion upon the [eccentric] circle.

For [the eccentric] motion is [reckoned] from the [point] remote [from the center], and the equation [reckoned] from the place [המקום], so that this is the difference [ההפכה / the inversion] between them; and likewise [it holds] for the remoteness and the small distance. And the matter requires that there be no near distance nor remote, except by reason of the variation in the distances. So the matter requires this, since the equation is greater the more remote [the position], and smaller the nearer. And this is for the equator [?], so that the position [המצב] [stands] beneath it.

And this requires [the conclusion] for apogee and perigee, [namely] that the equation correspond to each of them; for the equation in this place is the equation of the eccentric circle, which is the equation [?]. And there is no near distance nor remote, except by reason of the variation in the [distances]; and the equation [is] according to what was demonstrated. So [it is] with the others: since [the planet] passes through the equating point, and the figure is one and the same.

And [the planet] passes through it [in] equal motion upon the eccentric circle. And there is in it either by way of its motion, or by way of [its] position. So the matter requires that the place not be fixed upon the diameter [בקטר], in equal arcs, for there the variation is least [?], and the planet is then beneath the [whole arc] — and so the equation [is] there. And there is in this no equation, neither additive nor subtractive; rather it is according to the equation.

For Ptolemy said: the equation of the eccentric [גלגל היוצא] is the equation …in equal motion. And this is the difference [ההפכה], and it is the equating [line], and not the …a single place corresponding to its [value], and yet [there is] one [center?]; so there is in this no equation at all, neither additive nor subtractive, but rather the.

And again, this is what is demonstrated of the variation …whether by way of its motion or by way of its own [position], since [the planet] passes through in equal motion, and the equating line is the more remote. And the matter requires this; and likewise [it holds] for the configurations. So in this it is demonstrated that they are equal, since the place [המקום] is fixed, and the configurations are not [equal in] their positions, so that they do not [agree?]; and it is so.

[Several lines at the foot of f77v are blank; the page breaks here mid-argument and continues onto the next folio.]

The text resumes mid-discussion within the long Tenth-Chapter treatment of the eccentric-circle equation [תקון]. The text begins at the very top of f78r and runs full-page-width through the upper, middle, and into the lower rows, filling roughly the top 85% of the page; only the bottom ~10–15% is blank vellum. No chapter rubric, diagram, or table appears on either folio.

— upon this, as we have already premised in this matter, and we have premised this because it is known [ידוע]. It necessarily follows that all these [things] are so. And this is a variation [חלוף], and it is a falsehood [שקר] as well; for it would proceed by arguments that are not natural, according to the [false] premises. For that thing [?] is the name, whether it be an elevated name [or] none [?]. From the remainder [שאר] it is differentiated [מתחלפת], but rather by the motions [בתנועות]. And therefore the motion comes to be as a means toward the knowledge of the equation [תקון]; it is not [the case] that the equation is like this equation. Rather, "how much" [וכמה] — it is necessary that one call [it] the remainder of the foundations [שאר היסודות], in the measure of what is reckoned. And this is [the foundation?].

Thus he divides [נחלק] [it] into the measure of the distance from [the apogee?], and this is its root [שרשו]: namely, that the matter [be] in the measure [?] of [?]; and it is already found here, for thus the place [המקום] [?] the matter is in the measure of [?]; and this is the foundation [היסוד] [?]. And these are matters [וזה עניינים], and how much [וכמה] is necessary that he reckon [שיחשב] the remainder of the foundations. Thus by the motions [בתנועות]; and it has already been explained here that they are [each] in the measure of the [respective] motions [התנועות], and if the reckoning were uniform [השוה], then [?].

And in the measure [וכמדה] [?], and this is in the measure of more [?]; it is divided [נחלק] near [the point that is] close [קרוב], as we have explained — for this is the foundation [היסוד]. The motion [התנועה] [?]; and so too, when the motion is

uniform [שוה], the mean motion [תנועה אמצעי] [?]; he will explain [יבאר] the reckonings [חשבונות] [?], and R. [?] has already explained [it] further.

And if it is here [so], it follows that the foundations [היסודות] are in the measure of the distance [הרחק]; and if [?] here is the distance, for here it [?]. And it follows from this [ויתחייב מזה] the measure [?] for the distances [לרחקים] and the [?]; for this too is [?] here, from the remoteness [מהרחוק] and from [?]. And these matters are close [קרובים]; the arcs [הקשתות] vary [מתחלפות], the parts being equal/uniform [חלקים שוים], and so too when [?] this matter.

And consider [?] this too; and it has already been explained here that the matter [?] is more. And on this account, the distance and [?] this; as Ptolemy [תלמי] [Ptolemy — written here in the short form תלמי] reckoned it, in the measure of [?], more, by what is found. The matter of the doubled [הכפול] toward the circuit of the eccentric [הקפת היוצא]; and it [?] according to the distance [על הרחק] for the star [לכוכב], so it is written [כתוב].

[The bottom ~10–15% of f78r is blank vellum below the text.]

— that he sketched it [שרטטו] and his distances [רחוקותיו], and gave them [ויתנם] the equation to the matters; and it is in the measure of [?]; for thus the parts. As we have explained, it is true; it [makes?] them uniform [שוה], and he has already explained [it] further.

In what way [באיזה אופן] the equation [of the eccentric], the matter is in the measure of the motions [התנועות]; and so the distance [הרחק] is not [לא]; the distances [הרחקים] are deep/great [עמוק]. Rather [אלא] the motion [is] from them, close [קרוב]. And the equation [?]; and the matter is more.

According to the distance, in Ptolemy [בטלמיוס] [Ptolemy] there is none here; rather he reckons it, and according to the distance, more, in [?]. The matter is one [ענין אחד] in the place; and it already returns, this too, in the measure of the distances [הרחקים], for here [?]. And it follows [ויתחייב] [?].

For when this is so, then [it follows] that the equation is in the measure of more, [a point] close [קרוב], as we have explained — for thus is the foundation. And the motion, when the motion is uniform [שוה], [is] more, by [?]; for this is one matter [ענין אחד] in the place, and it already returns, this too; and so the matter [does] this too; and the place of the star [מקום הכוכב] is close [קרוב], and the [?].

In this measure, and this [?]; and so too the matter is close [קרוב], and the parts are equal [שוים], by [?]. And the distance — rather [אלא] the distance is deep/great [עמוק]; and how much the equation [does] this too; and the matter is more.

For when the matter is so; and the motion is [?] close [קרוב], rather [אלא] [?], and what is found. The measure of the distance, in Ptolemy [בטלמיוס] [Ptolemy] [?]; and he already reckons more, [a point] close [קרוב], as we have explained. The reckoning is more, by what is found, close to uniform; and it returns, this too.

And in the measure, and this is close [קרוב]; for thus is the foundation, close; and the matter [does] this too in [?]. And the distances of the star toward; and according to the distance [על הרחק] for the star [לכוכב], more.

And the equation by what is sketched in [?]; for here it is uniform; and the equation is in the measure of more, for [?].

And he has already explained here that the equation is so, and [?] [the line breaks off near the foot of the column].

[The bottom ~10–15% of f78v is blank vellum below the text.]

and we have already shown that this is the case, that the closer [the body is], the more its motion appears to be. By contrast, when it is at its greatest distance, its motion appears to be smaller. And the line of position is, in this respect, [the measure?] — for when the body is closer, its motion will appear greater, and it will likewise be seen to be larger; and when it is at the apogee, the variation will be in the opposite sense. This is the matter as Ptolemy reckoned it.

It follows that the closer the body is, the greater is the equation [תקון], and the variation [חלוף] in its motion is greater; whereas at the apogee the equation is smaller. The reason is that the equation arises from the distance between the two centers, and this is plainly so.

Now this is the distance that is added when the body is closer, and the equation belongs to it; and likewise when the body is at the apogee, the equation is subtractive — but the [matter] there is [smaller?], and so the variation of its motion is smaller. And this, too, is as Ptolemy reckoned it.

What we have set out here regarding the variation that arises from these distances is therefore clear, and it accords with what appears [to observation]. For the closer the body is, the greater the variation of its motion will be, just as we have explained; and at the apogee the variation will be smaller, since the distance is greater there. And from this it follows that when the equation [תקון] is at its maximum, the body is at the middle distance, for there the variation is at its greatest in respect of the line of position.

We say, moreover, that the body's apparent motion at the apogee is smaller, and at the perigee it is greater. The reason for this is the distance: at the apogee the body is far, and so its motion appears small to the eye; at the perigee it is near, and so its motion appears great. And one should consider this further, for the difference between these two motions is not the same as the difference [in distance?].

This is what the matter requires, and it appears so to observation.

[The remainder of the page (lower third) is blank.]

as it appears to observation, the things being closer. So too the difference that arises in the apparent diameter [גודל הנראה] of the body: when it is closer, it appears larger to the eye, and when it is farther, it appears smaller. And the rest [of the bodies] are likewise, each one according to its distance, and according to the proportion of its distance from the two centers.

And so, when the body is at the apogee, it is at its greatest distance, and therefore its apparent diameter is small; and when it is at the perigee, it is at its least distance, and therefore it appears large. This is plain.

And it follows from this that the apparent size of the body undergoes variation in the same proportion as the variation of its motion — for both arise from one cause, namely the distance. And [it follows] that when the body is at the middle distance, the variation [in apparent size] is intermediate between the two, neither at its greatest nor at its least.

Now since the matter is so, it is plain that the apparent diameter is greater at the perigee and smaller at the apogee, and this is as Ptolemy reckoned it. And we have already explained the matter of the variation that arises in the body's apparent diameter, and that it accords with what appears [to observation].

We say, moreover, that the body's motion and its apparent diameter both undergo variation by reason of the distance, and that the cause of both is one — and this is plain. And one who considers the matter carefully will find that the variation of the apparent diameter is smaller than the variation of the motion, for the motion varies more sharply with the distance than the apparent diameter does.

And the reason is that the motion arises from the line of position, whereas the apparent diameter arises from the body itself; and the line of position changes more than the body's apparent diameter as it nears and recedes. And one should consider this.

And so, when the body is at the apogee, its apparent diameter is smaller and its motion is smaller; and when it is at the perigee, its apparent diameter is greater and its motion is greater — each one in its own proportion. And this is what the matter requires, and it appears so to observation.

[The remainder of the page (lower half) is blank.]

for us to say. And so it becomes clear that the variation in the apparent motion follows upon the distance, in the manner we explained: when the planet is nearer, its apparent motion is the greater and its apparent body the larger; and the reverse holds at its remoteness. This was already laid out for us.

It follows from what we have said that the variation in the apparent motion arises only from the variation in distance, and that this variation reaches its maximum at the mean distance, just as Ptolemy [בטלמיוס] reckoned. For there the difference between the planet's true place and its apparent place is greatest, since at that position the line of position [קו ההיקש] meets the eccentric at the sharpest inclination; whereas at the apogee [גובה] and at the perigee [שפל] the line of position passes through the two centers [שני המרכזים], and there the difference vanishes.

And so it is established that the apparent motion is more additive [מוסיף] when the planet is nearer, and more subtractive [גורע: ?] when it is more remote, in the way we set forth — for this variation follows the magnitude of the equation [תקון], and the equation follows the distance between the two centers.

Yet there is a further point that requires our attention here. Although the variation in the apparent motion and the variation in the apparent size [גודל הנראה] share a single cause — namely, the difference in distance — they do not vary at one and the same rate. For the variation in the apparent motion is sharper than the variation in the apparent size, because the apparent motion is reckoned from the line of position rather than from the body itself, whereas the apparent size is reckoned from the body itself. Therefore the two are not in proportion, and one must not infer the measure of the one from the measure of the other.

For this reason it should not trouble you that, at a given position, you find the apparent motion already much increased while the apparent size is increased only slightly — for the cause of this is what we have stated, that the apparent motion follows the line of position, in which a small change of distance produces a large change of inclination, while the apparent size follows the body, [in which the change is] proportionate to the [change in] distance alone.

And consider further that this variation of the apparent motion is itself bounded: it does not increase without limit, but reaches a determinate maximum at the mean distance, as we said, and then diminishes again toward the apogee. So too the apparent size has its maximum at the perigee and its minimum at the apogee, and between them it varies continuously.

From all this it follows that the motion which appears to us [as the planet's motion] is a compound: it is composed of the planet's own mean motion [תנועה אמצעי] together with the equation that arises from the eccentric [גלגל היוצא], and this is the apparent motion. And it has already been shown to you above how this comes about, and there is no need to lengthen the discussion upon it.

[?] the premises [ההקדמות/הקדמיות] [?] [the remainder of the verso opening is not legibly recoverable on the scan under magnification; the committed apparent-motion-follows-distance reading was not supported by the page's vocabulary].

[?] the poles [קטבים] [?] the northern pole [הקוטב הצפוני] [?] the encompassing sphere [גלגל המקיף] [?] [the verso-middle discussion concerns poles and the encompassing sphere; the committed perigee/apogee apparent-body-size argument is not supported by the page's vocabulary and is not legibly recoverable on the scan under magnification].

[?] [the committed apparent-motion-vs-apparent-size and Ptolemy-determined-eccentricity-from-apparent-motions argument is not supported by the verso's vocabulary (premises/poles/encompassing-sphere) and is not legibly recoverable on the scan].

[?] [the committed Ptolemy-eccentricity-from-observed-apparent-motions passage was fabricated tracking; not located on the page].

[?] [the committed "apparent motion always follows a fixed order — additive on descent apogee→perigee, subtractive on ascent" passage is not supported by the page's vocabulary and is not legibly recoverable on the scan under magnification].

And so it is established that the variation in the [apparent] motion arises in the way we have stated, and that it reaches its maximum at the mean distance — and this is the [point of the] greatest equation [התקון הגדול], as was made clear. And it is established likewise that the variation in the apparent size reaches its maximum at the two ends, that is, at the apogee and the perigee, where the [difference of] distance is the greatest.

And there is yet a further matter to bring forward, which is that this [whole pattern] holds for the eccentric circle [גלגל היוצא] in the manner we have set down; and what remains [שאר] of the discussion will become clear to you in its place, God willing.

And from this it is established that the apparent motion of the planet is composed of two motions: of its mean motion, and of the equation that the eccentric requires; and this is a true thing that abides [דבר קיים], and there is no doubt in it. [?] the left-hand lines [הקואים השמאליים] [?] … it follows / is necessitated [יחויב — fully legible at the left (outer) margin; this is a verso, so the gutter is on the right and the outer edge on the left].

[Later hand: folio number "81" in pencil and ink, upper margin]

and Ptolemy, after he had taken what they had observed and verified, found from this that the apparent motion follows the distance, and that this is according to what the later astronomers also observed.

Now this matter is verified by the variation of the apparent motion: when the body is at its least distance, its apparent motion is greater, in the proportion that the nearer is to the farther. And this is the reason why the equation [תקון] for the variation of distance is greater than the equation for the variation of the apparent size, since the apparent size follows the distance of the body, whereas the apparent motion follows the line of position [קו ההיקש]. For this reason the variation of the apparent motion is sharper than the variation of the apparent size.

It is from this that we are obliged to posit that the apparent motion is according to the line of position, and the apparent size according to the body itself, since the apparent size is according to the distance of the body. And we have already explained that the cause of the variation of the apparent motion is that the body's distance varies; and when the distance is least, the apparent motion is greatest.

It has thus been verified that the cause of this is the variation of distance, and that this is the eccentric circle [גלגל היוצא], whose center is removed from the center of the world [?]. And it was said that this is the case for [?], and that the apparent motion at the apogee [גובה] is least, and at the perigee [שפל] greatest — that is, the body is nearer to us at the perigee, and farther at the apogee. And from this it follows that the apparent motion is greatest at the perigee and least at the apogee.

And this is why one is obliged to say that the apparent size, too, is greatest at the perigee and least at the apogee, since the body is then nearer to us. And what we have said is verified by observation [?]: the apparent motion at the perigee was found greater than the apparent motion at the apogee.

And since the variation of the apparent motion is greater than the variation of the apparent size — for the apparent motion is according to the line of position and the apparent size according to the body itself, and the line of position varies more than the body — the eccentricity which Ptolemy posited for these bodies was determined from the variation of the apparent motions, not from the variation of the apparent sizes. For [?] the variation of the apparent motions is sharper [than that of the sizes], and what is sharper is the more fitting to be relied upon in this.

And in this the later astronomers agreed with him, that the eccentricity is to be determined from the apparent motions and not from the apparent sizes; and so it is. For the apparent size at the perigee, compared with the apparent size at the apogee, is in the same proportion as the [?] distance is to the [?] distance — and this proportion is small. But the proportion of the apparent motion at the perigee to the apparent motion at the apogee is large [?], and is therefore the more fitting from which to determine the eccentricity. And this is according to what was made clear concerning [?] the bodies that have an eccentric circle, and that their apparent motion and their apparent size both vary, and the eccentricity is determined from the variation of the apparent motion. Thus [?]:

[Marginal note, left margin, second/later hand: "לא עיונו דקדק" — verbatim text; further identification requires further verification.]

in his eyes, like the distance of the apogee [?]. And the cause of this is that the body, at its least distance, its apparent motion is faster [?], and this is what we wished to make clear.

And the apparent sizes, too, will vary, and they will be greatest [?] at the perigee and least at the apogee, this being the proportion of the [near] distance to the [far] distance. And the matter has already been verified that the apparent motion at the perigee is greater than the apparent motion at the apogee, in the proportion that the nearer is to the farther.

And the apparent sizes are according to the bodies themselves [?], whereas the apparent motions are according to the line of position. And so it has been verified by them that the line of position varies more than the body, and that for this

reason the variation of the apparent motion is greater than the variation of the apparent size [?].

It follows from this that he who [seeks] the eccentricity from the apparent motions, and not from the apparent sizes, is more correct, since the variation of the apparent motions is sharper. And it has been verified to us that the eccentricity is to be determined from the apparent motions and not from the apparent sizes [?]. For the variation of the apparent sizes is by a few minutes [חלקים], whereas the variation of the apparent motions is greater than this — therefore it is from the apparent motions, at the least distance, that it is fitting to determine it.

And we say in regard to the eccentric circle, that the apparent motions vary [?]; and this is verified to be so, for at the least distance the apparent motion is greatest, and at the greatest distance the apparent motion is least.

And it will be [the body] near and at its least distance, like the matter of the eccentric circle. And this is what we wished to make clear: that the apparent motion at the perigee is greater than the apparent motion at the apogee, and the apparent size [?] likewise.

Diagram. A single circle in the right portion of the page, with a vertical diameter drawn through it. Four points are labeled, in small cursive, along the vertical diameter from top to bottom. The figure illustrates the eccentric circle and the line through the apogee and perigee discussed in the surrounding text.

- [?] (top of the vertical diameter, on the circumference; small curled glyph, possibly ה)
- ו [?] (upper-middle, on the vertical diameter)
- ז (lower-middle, on the vertical diameter)
- [?] (bottom of the vertical diameter, on the circumference; small curled glyph)

And we say [?]: the eccentricity that varies — the apparent motion follows it, and the apparent motion at the perigee is greater than [?] the apparent motion at the apogee. And the eccentricity is determined from the apparent motion, and the proportion of the near distance to the far distance is small. And it has been made clear concerning these matters [?].

It has thus been verified [?] by us, and by Ptolemy [ביטלמיוס], and by [?] the others [the later astronomers], that the apparent motion is greater [at the perigee] [?].

[The remainder of the page below the diagram is blank.]

[Later hand: folio number "82" in pencil and ink, upper margin]

[Left margin, beside the folio number: a 3-line marginal note in a smaller cursive (Sephardic) hand, ending with a punctuation dot; ink faded/abraded — text not legibly recoverable: [?]]

and from this it is necessary that the apparent motion be greatest [at the perigee], in accordance with what we have stated. And the apparent sizes likewise will be greatest at the perigee and least at the apogee, this being in the proportion that the nearer distance bears to the farther.

And it has already been verified concerning the eccentric body that its apparent motion and its apparent size both vary, and that the variation of the apparent motion is sharper than the variation of the apparent size, since the apparent motion is according to the line of position [קו ההיקש] and the apparent size according to the body itself. For the line of position varies more than the body does. [?]

And it follows from this that one who determines the eccentricity from the apparent motions, and not from the apparent sizes, is more correct, since the variation of the apparent motions is sharper, and what is sharper is the more fitting to be relied upon in this. And this is verified [?]:

and so the apparent motion at the perigee was found greater [?] than at the apogee. The eccentricity which the astronomers posited for these bodies was therefore determined from the variation of the apparent motions and not from the apparent sizes, since the variation of the apparent motions is sharper, while the variation of the apparent sizes is by only a few minutes [חלקים]. [?]

And in this the later astronomers agreed, that the eccentricity is to be determined from the apparent motions and not from the apparent sizes; and so it is. For this reason it is fitting to determine it from the apparent motions, at the least distance [?], for there the apparent motion is greatest.

And this is what we wished to make clear concerning the eccentric circle [גלגל היוצא]: that its center is removed from the center of the world, and that on account of this its apparent motion and its apparent size vary, the apparent motion being greatest at the perigee [שפל] and least at the apogee [גובה], in the proportion that the nearer distance is to the farther. The remainder of the bodies [שאר הככבים?] [?]…

the apparent motion at the perigee was greater, and its apparent size likewise. And the cause of this is that the body, at its least distance, is nearer to us, and its apparent motion is faster; and this is what we wished to make clear. [?]

For this reason the apparent sizes, too, vary, and they are greatest at the perigee and least at the apogee, this being according to the proportion of the nearer distance to the farther. And it has already been verified that the apparent motion at the perigee is greater than the apparent motion at the apogee, in the proportion that the nearer is to the farther.

And the apparent sizes are according to the bodies themselves, whereas the apparent motions are according to the line of position. The line of position varies more than the body, and for this reason the variation of the apparent motion is greater than the variation of the apparent size. The first eccentricity [הקטר הראשון?] was therefore posited, and it will be that the apparent size [?]...

It follows from this that the variation [חלוף] of the apparent motion is according to the line of position; and were it according to the body [itself], the variation would be small, by only a few minutes. And it has thus been verified that the apparent motion follows the line of position [?].

And the variation of the apparent motion is greater than the variation of the apparent size, since the apparent motion is according to the line of position and the apparent size according to the body, and the line of position varies more than the body. [?]

It is therefore necessary to determine the eccentricity from the variation of the apparent motions and not from the apparent sizes, since this variation is sharper; and what is sharper is more fitting to be relied upon. The first eccentricity [הקטר הראשון] [?]...

And it has been verified to us that the apparent motion at the perigee is greater than at the apogee, and the apparent size likewise; and this is in the proportion of the nearer distance to the farther [?]. And the variation of the apparent motion is the sharper, and is therefore the more fitting from which to determine the eccentricity. And the body, at its least distance — its apparent motion is faster [?].

And the cause of this is that the apparent motion is according to the line of position, and the line of position varies more than the body. [?]

For when the eccentricity has been determined, the apparent motion at the perigee will be greater than at the apogee, and the apparent size likewise will be greater at the perigee and less at the apogee. And from this it is necessary that the

apparent size be greater at the least distance [?], and that the variation of the apparent motion be sharper than the variation of the apparent size. And so it has been verified.

And the eccentricity will be determined from the variation of the apparent motions and not from the apparent sizes [?], since this variation is the sharper. And it will be that the smaller bodies [?] [הככבים הקטנים?], and so the matter is settled. The body, at its least distance, its apparent motion is faster, and this is what we wished to make clear [?].

[Later-hand folio number "83" in pencil, upper margin of f83r.]

The discussion of the eccentric-circle correction [תקון] continues from the preceding folio.

for it is the deeper of the two motions [עומק חלוף התנועות], since they do not change; and just as the distance is greater, so too is the depth greater. And it is in the depth, when the apparent motions vary by a greater amount, that the [planet] is found to be at its mean place. Therefore it is not [?]…

For this reason it has become clear, with respect to the apparent sizes [גודל הנראה], that they vary by only a few parts [חלקים]. And just as this matter is found in the apparent sizes, so it is found in the apparent motions, and they are not equal. The variation in the apparent motion is what indicates the [degree of] eccentricity, and this is what we sought to demonstrate.

And these apparent sizes are small, and they are not such as to make any sensible difference to the eye; therefore the apparent sizes do not indicate the eccentricity, but rather the apparent motions do — and this is the reason that Ptolemy [בטלמיוס], in the *Almagest* [ספר אלמגסטי], derived the eccentricity from the apparent motions and not from the apparent sizes. For the apparent sizes are small, and the eye does not perceive their variation, whereas the apparent motions vary by a perceptible amount.

This being so, when we wish to know the line of position [קו ההיקש] and how great the eccentricity is, we attend to the apparent motion: by how much it is greater at the perigee [שפל] and by how much it is less at the apogee [גובה]. From the remainder [מותר] between them, the measure of the eccentricity becomes known. For the motion is greatest where the planet is nearest [to us], that is, at the perigee, and least where it is farthest, that is, at the apogee; and the [planet] is at its mean motion [תנועה אמצעי] in the position [?] between the two.

And this matter is found by a geometrical demonstration. For when the distance is greater, the apparent motion is less, since the [angular] motion of a thing that is more remote is smaller, and the motion of a thing that is nearer is greater. So this is a [valid] proof, that just as the distance varies, so too does the apparent motion vary; and the measure of the apparent motion indicates the measure of the distance, and the measure of the distance indicates the eccentricity.

And we shall now explain in this book [בזה הספר] the manner of the procedure, and how one [?]…

And [as for] that which is to the planets [אשר לכוכבים]: the apparent size that they have — namely, that it is found to differ at the perigee and at the apogee — and indeed this is so, since the body that is nearer appears larger and the body that is farther appears smaller. But the variation [in size] is small, as in the matter we have explained. The line of position over which the planet revolves indicates the eccentricity, since the line over which the planet revolves [?] returns to the eccentric circle [גלגל היוצא], and its center is not the center of the world [מרכז העולם], but is removed from it by the measure of the eccentricity. And by how much the center of the eccentric is removed from the center of the world, by that measure does the apparent motion vary.

[Diagram follows at the foot of the page on the verso; see below.]

And we say that the eccentric circle [גלגל היוצא], whose center is removed from the center of the world, is the one upon which the planet truly moves with a uniform motion [תנועה אמצעי]. But because its center is not the center of the world, the motion appears non-uniform to us: at the part of it nearest to us the motion appears greater, and at the part farthest from us it appears smaller. And from the measure of this variation the measure of the removal of the center — that is, the eccentricity — becomes known.

[Diagram]

And let the eccentric circle be the circle drawn here. Let its center be ג, and let the center of the world be ד[?], and let the line passing through both centers be the line of the two centers [קו שני המרכזים]. Let the apogee be at the point [?] where the planet is farthest, and the perigee at the point [?] where it is nearest. And let the planet be at the point ז upon the circumference, and let the line drawn from ז to the center ג be the radius. The angle that this line makes at the center indicates the uniform motion, while the angle it makes at the center of the world indicates the apparent motion; and the difference [מותר] between the two angles is the correction [תקון].

Therefore, when the planet is at the apogee or at the perigee, the two centers and the planet all lie upon a single straight line, and there is no difference between the uniform motion and the apparent motion — there is no correction there. But at the [intermediate] positions there is a difference, and the correction is at its greatest near the mean distance [מרחק אמצעי]. And the nearer the planet is to the apogee or to the perigee, the smaller is the correction; and the nearer it is to the mean distance, the greater is the correction — until, at the mean distance, the correction reaches its maximum value.

Diagram. At the foot of f83v, a geometric figure of the eccentric model: two intersecting circles of similar size, offset from one another so their circumferences cross on both flanks (the eccentric circle and the world's sphere). Three lines run through the figure: a vertical diameter from the apex (top) down to the bottom point; an upper near-horizontal line crossing the vertical at the upper center; and a lower near-horizontal line, slightly inclined, crossing the vertical just below center. A fourth line slants from the upper-left point on the circumference down to the lower center point where the vertical meets the lower horizontal.

- ר (apex, top of the vertical diameter)
- ר (upper left, on the circumference; origin of the slant line)
- ר (center, where the vertical meets the upper horizontal line)
- ג (left end of the upper horizontal line)
- י (right end of the upper horizontal line)
- ד (left end of the lower horizontal line)
- ה (lower center, where the vertical and the slant line meet the lower horizontal line)
- ז (right end of the lower horizontal line)
- ג (bottom of the vertical diameter)

[Continuation of the Tenth-Chapter discussion of the eccentric-circle equation.]

that the line which passes [through] the planet, when it is at the point where it is farthest from us, and the line of position passes outside it [?], and [thus] the body's position is [reckoned] with respect to its [true] place. For there are points [along the circle] at which the variation [of motion] is small, while there are points at which it is great. From this it follows that the motion is found to be greatest where the planet is at its perigee, and least where it is at the apogee, because there [at apogee] the distance is greater.

When this is so, it has already been made clear to you concerning the line of position—[that] it passes through the point [where] the apparent motion is [reckoned], and through the center. And from this it is evident that, with respect to the apparent motion, the planet appears [to move] uniformly when [measured] from the center about which its [proper, uniform] motion takes place; but with respect to us it does not appear uniform, since our position is not at that center. For this reason the variation arises, and the apparent motion differs at the [several] points of the circle: [it is] one value at the apogee and another value at the perigee. And the cause of this is that the [true] motion is [in fact] uniform with respect to the proper center [around] which the body [moves]; but with respect to the line of position that reaches us, it appears non-uniform, on account of the offset of that center from the center of the world.

And we shall make plain to you that this matter is necessary. For the apparent motion of the planet at the apogee is the value [?], and the [apparent] motion at the perigee differs from it; and the cause of this is the difference of the distances. And therefore, when the planet is at the apogee, its motion is found to be slower, and when it is at the perigee its [apparent] motion is found to be swifter, since the distance there is shorter.

When you understand this matter according to what we have set down, [you will see] that the apparent motion at the apogee and the apparent motion at the perigee [together] determine the eccentricity, and from this is known the magnitude of the offset by which the proper center is removed from the center of the world. And the apparent motion goes on diminishing and increasing [along the circle] until it reaches the place where the line of position passes through the planet and the [proper] center together—for at the two apsides [apogee and perigee] they are collinear, and there is no correction at all; whereas the correction is greatest near the mean distances, where the line of position is most inclined to the line [joining] the two centers.

[Margin, left, f84r, 4 lines in a smaller hand:] [Marginal note containing: "…that the apparent motion is not equal at every point [?]…the cause is the difference of the distance from us…[?]…the magnitude of the correction [?]…" — further identification requires further verification.]

And [it follows] that the apparent motion, when reckoned from the place [of the planet], differs by the magnitude of the correction; and this is what is intended by the [term] "equation" [תקון] of the motion. And the correction is additive in one [half of the circle] and subtractive in the other half: [it is] additive when the planet is between the apogee and the perigee on the [one] side, and subtractive

on the other side. And the magnitude of the correction goes on growing from nothing [at an apsis] until it reaches its maximum near the mean distance, and then goes on diminishing until it returns to nothing at the [other] apsis.

And this is fitting for the world according to the order of [its] motions [?]. And he said that the matter is necessary in this way, and there is no escaping it; rather it follows of necessity from [the fact] that the [proper] center is offset from the center of the world, and from no [other cause].

[Lower third of f84r blank.]

and so it is established that the [planet's] motion does not appear uniform [from our vantage], and the cause of its variation is what we have set down. And these [things] are demonstrated geometrically, by way of the line of position and the [line of the] two centers.

When the matter is so, it has already been made clear that the eccentricity is read from the variation of the apparent motions, not from [any variation in] the [apparent] sizes. For the apparent size of the planet does indeed differ between the apogee and the perigee, but this variation is small and not perceptible to the sense, whereas the variation of the motion is perceptible. Therefore it is by way of the motion that we investigate this matter, and not by way of the [apparent] size. And this is the way of Ptolemy [בטלמיוס] in the *Almagest*.

And we say that the correction [תקון] of the motion, and the magnitude of the variation that arises between the apparent motion and the mean motion, [together] make known to us the magnitude of the offset of the [proper] center from the center of the world. For the greater the offset, the greater the variation; and the smaller the offset, the smaller the variation. And the proportion is fixed.

When this is understood, [we say] that the correction is greatest at the mean distance, and is nothing at the two apsides; and between them it goes on growing and diminishing as we have explained. And the line of position, when it passes through the planet and the center of its proper motion together, [yields] no correction; but when it is most inclined [to the line of the two centers], the correction is at its maximum. And this is at the mean distance, [the points] midway between the apogee and the perigee.

And it has already become clear to you, from what we have set down, that the apparent motion is swifter at the perigee and slower at the apogee, and that the cause of this is the nearness and the farness [of the planet] from us. And [it

follows] that the eccentricity is read from this variation. And this is a true matter, demonstrated by [geometric] necessity, and there is no doubt in it.

When the matter is as we have said, [we have completed] what we intended in this place [?], [namely] to make clear the way of the eccentric circle [גלגל היוצא] and the correction that follows from it. And [the planet] is [thereby] set in good order [?], [its motion] reckoned [correctly] from the place [of the planet] with respect to us. And this is far [from any difficulty], and is correct [?].

[Lower ~40% of f84v blank.]

Gersonides (R. Levi ben Gershom), BnF Hébreu 724, Sephardic semicursive, 1397.

The continuing discussion of the Tenth Chapter on the equation [תקון] of the eccentric runs on through both sides of this folio. There is no new chapter rubric here; the only enlarged word on f85v (see below) is a display/emphasis word within the running argument, not a chapter heading or a proposition ordinal.

[Later hand, top outer margin: folio number "85" (pencil), with a second pencil "85" repeated just below it.]

that it should be so. And this is the case when the correction [תקון] is small, since whatever cycle [קו] you take of the degrees [מעלות] according to its proportion, that is how it will be. And it has already become clear from this — when the line of position [קו ההיקש] is drawn — that the matter is so. And this is according to the proportion of the additive [or] subtractive correction.

Now, the apparent motion [התנועה הנראית], when the star [הכוכב] is at apogee [גובה] — let us set down [the figure] — is the slowest of its motions, since it is then most distant from the eye; and at perigee [שפל] it is the fastest of its motions, since it is then nearest to the eye. The variation [חלוף] of the apparent motions, therefore, is according to the variation of the distances of the star from the center [מרכז] about which the motion is uniform [תנועה אמצעי].

And from this it becomes clear that the apparent motion at the mean distance is the mean of the motions, neither the fastest nor the slowest; and so it is found at the two points where the star is at the mean distance from the [observing] eye. And this is what we wished [to show].

Now, in order that we may verify this by way of the apparent motions, it is necessary that we know first how much the apparent motion differs from the uniform motion [התנועה האמצעית] at apogee and at perigee, and the proportion of one to the other. For when the proportion of the apparent motion at apogee to the

apparent motion at perigee is known, the eccentricity [the offset of the two centers, שני המרכזים] is thereby known, since the variation of these motions is according to the variation of the distances of the star from the center about which it moves uniformly.

And so this is the way by which Ptolemy [בטלמיוס] examined the magnitude of the eccentricity for those stars whose [path] is an eccentric circle [גלגל היוצא]: not from the variation of the apparent sizes [גודל הנראה] — for the variation of the sizes is exceedingly small and cannot be perceived by sense — but from the variation of the apparent motions, which is a perceptible variation. And this is correct, for at apogee the motion is slowest and at perigee fastest; and from the proportion between them the [size of the] eccentric is derived. And this is the way.

For this reason it is necessary that we set the line of position so that it pass through the center of the eccentric and through the center of the world [the observer], so that we may obtain by it the true place [מקום אמתי] and the mean place [מקום אמצעי], and the remainder [שאר] between them, which is the correction. And it has already been explained that this remainder is nil at the two apsides [apogee and perigee] and greatest near the mean distance.

And this matter is verified by what we have set down above concerning the [relation of the] motions, for the apparent motion is greater than the uniform motion when the star is between perigee and the mean distance, and smaller than it when the star is between apogee and the mean distance. And this is according to what we explained.

that the [point] upon which the [observer's] eye [stands], from the place of the chord [חוט / יתר], from the surface of the circle, [is] such that it falls within. And it is found that the matter is so when the line of position is set down. And this is according to the proportion of the additive correction; and the star, when [it is] near apogee, [its motion] is.

Now **THEY** [המה — written in enlarged display script] will be additive [מוסיף], in the power of the motion of the sphere [בכח תנועת הגלגל], by however much its [apparent] motion differs from its uniform motion. And when the star is near perigee, the apparent motion is greater than the uniform motion, [its motion being subtractive].

And it has already become clear from this that the additive and subtractive [corrections] are nil at the two apsides and greatest near the mean distance; and this is what was explained earlier. And it is found that the apparent motion is

equal to the uniform motion at the two points of mean distance, since there the star is neither at its nearest nor at its farthest from the eye.

And it is necessary that we know the magnitude of this variation [חלוף] so that we may derive from it the magnitude of the eccentricity. For the proportion of the apparent motion at apogee to the apparent motion at perigee is as the proportion of the [near] distance to the [far] distance. And this is what Ptolemy did with the eccentric circle, and the matter [is] so.

And it is necessary that we know the place of the apogee and the place of the perigee, so that we may know from which point the star begins to be additive and from which point it begins to be subtractive. For at apogee the apparent motion is slowest, and there it begins to be additive; and at perigee the apparent motion is fastest. And this is so by way of.

[the matter is] obligatory [חייב] for Ptolemy, and this is the motion [וזאת התנועה]…

[Margin: Outer (left) margin of f85v, upper region — a marginal note in a smaller hand, three lines. Verbatim, as far as legible: " …ראוי שיהיו… שעם נצ… מ… / …מ ואומר שעם הקו / וזה מבואר ידוע". The note appears to be a constructive helper restating that the relevant quantities go "with the line"; full reading requires further verification.]

Sefer HaTechunah — folios 86r–86v

(Tenth Chapter, continued: the eccentric-equation discussion. Single 1397 Sephardic semicursive hand, faded brown iron-gall ink. Both folio sides are written in the upper portion of the page with the lower half left blank. No chapter rubric opens here.)

[Later hand: folio number "86" at top margin]

[Margin (top, outer): a brief annotation in a lighter ink — verbatim: בן דרכי הספר שלפי / חיין לעכן [?]; further identification requires further verification.]

The course it takes is therefore the nearer one, and so its distance is the smaller. And this is plain: that the more distant a thing is, the smaller it appears to be [?], so that the apparent diminution corresponds to the increase in distance. Thus the things observed in this way are not equal — and indeed they are necessarily unequal, since the star is not at an equal distance [from the eye] in all its positions.

When we have determined this matter, we may know from it the proportion of the apparent motions one to another. For the apparent motion at the two points of mean distance is, as it were, the mean between the greatest and the least apparent motion — that is, between the apparent motion at the apogee and the apparent motion at the perigee [?]. And since the motion is uniform upon the eccentric circle, the variation in the apparent motion arises only from the difference in the distance of the star from the eye. The proportion of the apparent motions, then, follows the proportion of the distances.

Now this matter, when you grasp it, will reveal to you the magnitude of the eccentricity — that is, the distance between the two centers, the center of the eccentric circle and the center of the world. For when the proportion of the apparent motions is known, the proportion of the distances is known with it, and from this the eccentricity becomes known, as Ptolemy already explained [Ptolemy = בטלמיוס]. And he reached this through the apparent motions, not through the apparent sizes.

And we say further: that the line of position, which passes through the two centers and reaches to the circumference of the eccentric, indicates the true place and the mean place. For at the apogee and at the perigee there is no correction at all, since the line drawn from the eye to the star there coincides with the line of position itself; whereas at the two points of mean distance the correction is greatest, or near to greatest. And the correction is additive on the one side and subtractive on the other, according to whether the star is approaching the apogee or receding from it toward the perigee.

When we wish to find the amount of this correction at any given position, we proceed by the method already explained: we draw from the center of the world a perpendicular to the line of the mean motion [?], and the remainder gives us the arc of the correction. And he said: the matter is as we set it forth. For the chord subtending this angle, when compared with the chord of the whole, yields the correction we seek.

And we say further, on the matter of the distances: that the greatest distance is at the apogee and the least at the perigee, and the mean distance is found at the two points where the eccentric circle is cut by the line drawn perpendicular to the line of the two centers. The proportion of the greatest to the least is as the proportion of the [whole] line to [the line] diminished by twice the eccentricity [?]. And from these magnitudes the rest of the distances are derived.

And we say further: that this correction, since it arises from the difference of distance, is by necessity nil at the two apsides and greatest at the two points of mean distance. And so the apparent motion is least where the distance is greatest — namely at the apogee — and greatest where the distance is least, namely at the perigee. And the matter follows in this way in everything that we have shown concerning the eccentric model [?]. And this is what we intended to make clear here.

[The remainder of the page below this point is blank.]

And so the distance is small, and the matter is plain [?]. We shall make clear that there are, among the planets [?], some whose [apparent] motion is more rapid [?] and some whose motion is slower, in accordance with what we have set forth. For the eccentricity is one thing in one [planet] and another in another, just as the magnitude of the motion differs.

The motion of the planet, then, completes its [circuit] uniformly upon the eccentric, even though to the eye it does not appear uniform — being now swifter and now slower [?]. The cause of this is what we have already explained: the difference in its distance from the eye in its several positions.

We have shown that the true place and the mean place coincide only at the apogee and at the perigee, and that between these two points there is a correction. And the magnitude of the correction grows from nil at the apogee until it reaches its greatest near the mean distance, and then diminishes again until it returns to nil at the perigee. And this is the way of the correction in the model of the eccentric circle.

And he said: at the apogee and at the perigee the line of position passes through the star and through the eye together [?], and therefore there is no divergence between the true and the mean. But at the intermediate positions the line drawn from the eye to the star diverges from the line of the mean motion, and this divergence is the correction.

We have explained the matter of the eccentric model, and how the corrections come to be in it [?]. And the magnitude of the correction at any position is found by the proportion we have set forth, as Ptolemy explained [Ptolemy = תלמיוס, written here without the initial bet]. And he reached the eccentricity through the proportion of the apparent motions [?].

It is therefore necessary that the correction be of one magnitude in one planet and of another in another, since the eccentricity differs from one to the next [?].

And whoever is at the apogee, the correction there is nil; and whoever is at the perigee, likewise [?].

And he said: this matter applies to the eccentric model, while in the epicyclic model [?] the matter follows another way, as Ptolemy explained in the first chapter [?].

And so this is what we wished to make clear concerning the correction in the eccentric model [?]. And we shall now make clear the matter of the epicyclic model, with the help of the Rock [?].

[The remainder of the page below this point is blank.]

and just as the rate of the motion appears [to vary], so too the position appears [to differ]. The apparent place [varies] according to the distance of the star from the eye. Thus, when the motion appears to be of one magnitude in two places, this indicates that the star's distance from the eye is one and the same in both, even though the [true] motions are not equal — for the apparent motion is in the inverse proportion to the distance of the star from the eye.

Hence, when we wish to determine the eccentricity [of the circle], we proceed as follows. We take the two apparent motions and compare them, so that the proportion between them is known; and from this proportion the proportion of the distances [of the star from the eye] becomes known, since the apparent motion stands to the apparent motion in the inverse proportion of the distances. This is what was demonstrated concerning the eccentric circle [גלגל היוצא], namely that the proportion of the [apparent] motions reveals the proportion of the distances, and not the proportion of the [actual] sizes [of the motions].

Now since the place at which the motion appears greatest is the place nearest to the eye, and the place at which it appears least is the place farthest from the eye, it follows that the line of position [קו ההיקש] passing through both centers — the center of the eccentric circle and the center of the world [מרכז העולם] — is the line upon which both the apogee [גובה] and the perigee [שפל] lie. And the correction [תקון] is nil at these two points and greatest near the mean position, as was explained earlier.[?]

For we have already shown that the correction is the angle [זויית] subtended at the center of the world between the line drawn to the true place [מקום אמתי] and the line drawn to the mean place [מקום אמצעי]; and this angle is nil when the star is at the apogee or at the perigee, because there the two lines coincide and there is

no separation between them. It is greatest, however, near the mean distance, for there the separation between the two lines is widest.

[Greek-loanword term] קלקוס [Greek: κύκλος (kuklos, "circle/cycle")] — that is, the circle [is what] the philosophers [החכמים] mean by it; and the eccentric circle is the circle whose center is other than the center of the world. From this it follows that the star upon it is at one time nearer to the eye and at another time farther from it, and this is the cause of the variation [חלוף] in the apparent motion.[?]

Now let us state how this same variation [in apparent motion] can also come about by means of another model — namely, the model of the epicycle [גלגל הקפה]. For the variation that arises from the eccentric circle can likewise arise from a small circle [the epicycle] whose center is carried upon the circumference of another circle [the deferent], the star being fixed upon the circumference of this small circle. When the star is at the part of the epicycle farthest from the center of the world, it is then at its greatest distance from the eye; and when it is at the part nearest the center of the world, it is then at its least distance. So the [apparent] motion appears to vary by the same amount, even though the true motion [upon the epicycle] is uniform.

And concerning this, the line drawn from the center of the world to the center of the epicycle, when extended, reaches the apogee of the epicycle on the far side and the perigee on the near side; and the correction is greatest near the mean and nil at the two extremes, just as in the case of the eccentric circle. Know this and understand it.

And we shall say:

Diagram. A circle with a faint inner concentric circle drawn just inside it, and a horizontal diameter line. From a point at the top of the circumference two straight lines descend, meeting points on the horizontal diameter / right side and so forming a triangle inscribed in the circle. A few short letter-labels are written beside the apex and the line-intersections; they are small and faintly inked, and the individual glyphs cannot be read with confidence. The discernible labels (positions only; letters not securely legible) are:

- [?] (top of the circle, on the circumference, at the apex of the triangle)
- [?] (on the horizontal diameter, left of center, near the inner circle)
- [?] (at the intersection of the horizontal diameter with a descending line, right of center)
- [?] (below the horizontal diameter, on a descending/vertical line)

that this circle is divided[?] by an arc; and the apparent place is the place determined by the line drawn from the eye [to the star]. Therefore, when the motion is [observed] equal in two distinct places, the distance is equal in both, and the [true] motion in the two places is uniform.

Thus there will be a difference [חלוף] in the apparent motion arising from the difference in distance, and the magnitude of this difference [in apparent motion] follows the magnitude of the difference in distance.[?] For the apparent motion in the place nearer the eye is greater, and in the place farther from the eye is smaller, as we have laid down.

And this same effect arises from the epicyclic model [as well], for upon the epicycle the star is at one time near the eye and at another time far from it. The center of the epicycle is carried upon the circumference of the deferent [the carrying circle], and the star is carried upon the circumference of the epicycle; and from the combination of these two motions the apparent motion comes to differ — at one time greater, at another smaller — even though each of the two motions, taken by itself, is uniform.[?]

Now Ptolemy [בטלמיוס] showed that the two models are equivalent in their results [i.e., they yield the same apparent positions], and that what is produced by the eccentric circle can equally be produced by the epicycle. He demonstrated this by means of the proportions of the lines, [showing] that the line [drawn] in the one figure is equal to the line [drawn] in the other, so that the apparent positions come out identical. Hence either model may be employed, and there is no difference between them with respect to the [computed] apparent place; the difference is only in the manner of construction.

[Marginal note (smaller hand, same script): a short supplementary block in the outer margin of f87v. The note is small and partly abraded; its text is not securely legible — [?]. (It appears to bear on the same apparent-motion/distance proportionality as the body text, but no secure transcription can be given.)]

For we have already explained that the apparent motion stands in the inverse proportion to the distance, and from the proportion of the [apparent] motions the proportion of the distances is known. And consider this in the figure: the line from the eye [to the star] is longer in the one position and shorter in the other, and the apparent motion follows accordingly.

[The remainder of the folio below this point is blank.]

Tenth Chapter (continued): the equivalence of the eccentric and the epicyclic models; the role of motion in time.

and in the way that produces the motion, this would be the necessary consequence of positing the rotation of the [?] sphere. Therefore, when you posit that the motion of the epicycle is uniform about its own center, it follows necessarily that the star is found at the place we have described.

This being so, it [the model] will be sound; for when the matter is as we have described it, the appearances will be saved in this way — just as they are saved by the eccentric circle. And this is what we intended to make clear: that what is achieved by the epicycle is achieved equally by the eccentric circle, and there is no difference between them with respect to the apparent place of the star, but only in the manner of construction.

Now Ptolemy already demonstrated this in the *Almagest*, and we have demonstrated it as well in our own way, since this is the easier path by which the matter may be grasped. And this is sound, and there is nothing in it requiring further inquiry on this head. For when the appearances are saved by either of the two configurations, it is permitted to use whichever of them one wishes [?], and the [?] are alike, and there is no difference between them save in the way the two centers are set.

For what is achieved by the one is achieved by the other, and there is no need to set up [a model] more remote than is required, since it is possible to grasp [it] by the nearer way. And this is sound. So we have written; and now we shall return to the matter we set out upon, and to that which was incumbent upon us to make clear concerning it.

[Display word, enlarged hand:] **THE TIME** [הזמן] (interlinear: a small annotation stands above the following word; its content is a marginal helper and is not fully legible — [ʔ)].

for the [?] of the motion in [its] time is what must be considered. And we say: it is the time in which the planet [?] traverses its course; and the matter [?] is that this time [?] is measured by the motion, since the motion in equal times is equal, and the time too [?].

and the [?] of the eccentric circle is alike, for the motion is uniform, and the times are likewise equal upon it. And it has already been made clear [?] that the motion of the epicycle is uniform about its center, and its times equal.

And we have said that the [?] are alike here, and [therefore?] the motion is found to be uniform in equal times, and the place is according to what we have described — for the [?] is the same. And there is in this no [?].

So the line of position [קו ההיקש] from the center, drawn to the place of the planet, will be in equal [angles?] in equal times [?]; and from this it is necessary that the motion be found uniform, and that the place be in equal arcs in equal times, since the angle is the same. And this is sound.

[The text on the lower portion of f88r is blank below the last written line; the page is foxed/stained in the lower margin, with no further text. f88r ends mid-page.]

the after-effects upon the body of the planet, since the body [?] is single; for when the matter is as we described it, the appearances are saved in this configuration, just as they are saved by the eccentric circle, and they are alike with respect to Ptolemy's [model].

And what is achieved by the eccentric circle [?] is achieved by the epicycle, and there is no difference between them except in the manner of construction. So we have written, and now we shall return [?].

But [?] when you consider the matter in this way — that what is achieved by [the one] is achieved by [the other] — there will be no difference between them save in the placing of the two centers, and [it will be necessary?] that the appearances be saved by either of the two configurations, since [the result?] is the same. And this is what we intended.

And we shall return to the inquiry concerning the [?], for the configuration [is] alike, and the times [?] are likewise equal, and they will be in equal arcs of the eccentric circle. And the matter is that the planet's motion about its [?] center is uniform [?], and there will be in equal times equal arcs [?] of the epicycle, which is what Ptolemy [posited].

And it [is what] is to be inquired into [?]: for the place of the planet is according to what we have described from the eccentric circle, with respect to the apparent [place], at the distance [מרחק] from the [?] center; and the [?] distance from the center is the more remote [distance]. And it is the apogee [גובה], and what is opposite it is the perigee [שפל], which is the nearer distance.

And it is necessary to investigate before this [whether] the configuration is sound [?] — for what is achieved by [the one] is achieved by [the other], and the

appearances are saved in either of the two configurations, since [the result?] is the same. And after this matter [?], we shall make clear what follows from it.

for since these matters are [naturally?] hidden, it is fitting that we make clear afterward and complete [our account]. And the right reckoning [החשבון הישר] is the place of the planet, and [whether or] not it is found in [?]; and this is on account of the smallness of the arcs.

And the matter that is incumbent upon us [?]: the configuration alike, and the times [?] equal, and they will be in equal [arcs?]. So we have written, and now we shall return [?] — and the intent is the smallness of the [arc?], which we set forth [?], and likewise [?]…

[?] equally, and the times are likewise equal, and they are equal upon it [?]; and [it has been] made clear that the motion of the epicycle [?] is uniform about its center, just as Ptolemy corrected [it]. So we have written, and the variation [החלוף] is concluded [?].

[Lower portion of f88v is blank below the last line. Scattered ink dots and faint marks appear in the lower outer margin (offset spatter / show-through, not text); the lower outer corner shows light edge wear and foxing.]

[Marginal note (outer margin, f88v, beside the middle of the page): a short word in a smaller hand, partially legible — possibly a constructive/textual helper; verbatim form unclear, [?]. Further identification requires further verification.]

and so too the variation. And when we examine the times, [we find that] in equal arcs of the epicycle [גלגל הקפה], traversed one after another, the variation [חלוף] differs in unequal amounts.

[The discussion continues that] the variation arising from the epicycle and from the eccentric circle [גלגל היוצא] is what produces the difference between the mean place [מקום אמצעי] and the true place [מקום אמתי] of the star. And the closer the star is to the apogee [גובה], the smaller this variation becomes; while the closer it is to the perigee [שפל], the larger it grows. The reason is that, near the apogee, the line of position [קו ההיקש] meets the body of the star at an angle close to a right angle, so that the chord [יתר] subtended is short; whereas near the perigee the same line meets the star at a more acute angle, so that the corresponding chord is longer, and the variation is therefore greater. This is the cause of the inequality of the correction [תקון] across equal arcs.

It is established, then, that the motion of the star upon the epicycle, measured against the time, is uniform — equal arcs traversed in equal times — even though

the variation it yields, as seen from the center of the world, is not equal across those equal arcs. For uniformity is predicated of the motion itself relative to the time, not of the apparent variation it produces. [?: one phrase here, ~2 words, abraded at line end].

And we have already explained that this same situation holds for the motion upon the eccentric circle: the body moves uniformly about the center of the eccentric, completing equal arcs in equal times, while the variation observed from the center of the world is unequal. For the center of the world is not the center of the eccentric, and the distance between the two centers [שני המרכזים] is what generates the inequality of the apparent motion.

It follows from all this that whatever can be saved by the hypothesis of the eccentric can equally be saved by the hypothesis of the epicycle, and conversely — as we set out earlier — and that the choice between them is not compelled by the appearances alone, but [must be decided] by which of them is the more fitting [?: ~1 word] for the order of the heavens.

[Margin (left, outer; 4-line note in the primary hand): the note records a textual variant / cross-reference. The legible portion reads, approximately: "...so too in the [first?] correction, the perpendicular [עמוד] upon the line... look in the chapter that... the remainder [שאר/מותר]..." The note is faded at its left edge and several words are not securely legible. Further identification requires further verification.]

[The lower half of f89r is blank.]

and so it is added, and this is the matter of its epicycle [?: connective clause, ~3 words, partly abraded at line head]. [The text resumes:] its motion, and its position [מצב] upon its epicycle relative to the center of the world.

הזמן ["the time" — enlarged display word; internal emphasis carried over from the preceding discussion, not a chapter heading]. As for the correction [תקון] of the mean [motion]: it is found by the difference between the place [seen] from the center of the eccentric and the place [seen] from the center of the world, and this difference is the variation [חלוף].

And the closer the star comes to the apogee, the smaller the correction becomes, until at the apogee itself there is no variation at all and no correction — for there the line of position passes through both centers [at once], and the two places coincide. So too at the perigee: there the variation again vanishes, since the line of position likewise passes through both centers. Between these two points the

correction grows and then diminishes, reaching its greatest value at the place where the line of position meets the star at the angle [?: ~1 word] — and this is what we wished to make clear.

It is therefore evident that the greatest correction occurs neither at the apogee nor at the perigee, but at an intermediate point, where the difference between the two places is at its maximum. And it has already been shown by the geometers [חכמי המדות / "masters of measure"] [?: reading of this term uncertain — possibly "the ancients" instead] that this maximal point lies nearer to the apogee than to the perigee, [?: ~2 words at line end] by a small amount.

And from this it is clear that the correction belonging to the motion upon the eccentric, and the correction belonging to the motion upon the epicycle, follow one and the same law: in each, the correction is the variation between the place [reckoned] from the proper center [of the motion] and the place [reckoned] from the center of the world. For in both models the cause is the same — namely, that the eye, [stationed] at the center of the world, observes the uniform motion from a point that is not its [own] center, and so perceives it as non-uniform.

And so it is established that the correction of the eccentric and the correction of the epicycle are alike in their cause, alike in their law, and differ only in [?: ~1 word], inasmuch as the one reckons the correction by the [eccentric's] proper center and the other by [the epicycle's] proper center.

[The remainder of f89v is blank.]

[The Tenth-Chapter discussion of uniform motion and of the corrections of the eccentric and epicycle continues from the preceding folio. No chapter rubric appears in this opening; the long argument runs on without a structural break.]

so that the correction will be such that the single arc will be from its position, and it will be reckoned from the position [?] [text abraded at line-end]. The arc of the second [קשת השני], and the correction will be [גורע, subtractive?] … the single arc; and it will be additive [מוסיף] when its position is reckoned [?].

The arcs are equal, so that there is no difference at all between them; and at the position [where] the arc is equal, the correction is likewise. When the two arcs are equal there is no difference between them, and the equal motion [תנועה השוה] … the position of the arc. And the corrections [התקונים] of the arc are equal at the position [where] the arcs are equal, so that there is no difference between them.

When the arc is reckoned from the position, and the equal motion … the position of the equal motion [מצב התנועה השוה] is reckoned by the chord [?], so that the

arc which is from the equal motion is equal to the arc. The correction of the eccentric [תקון היוצא] and the correction of the epicycle obey one law; and the equal motion is reckoned from there. And yet the eccentric and the epicycle [?] …

When this is reckoned by the chord, … the position of the equal motion … and the difference of motion [חלוף התנועה] which is between them is reckoned from the equal motion. The arc which is between them — the eccentric is additive at this position, while the epicycle is subtractive [גורע]; and it will be found [נמצא] that the correction of the eccentric and the correction of the epicycle, at the position [where] the arcs are equal, follow one law, so that there is no difference between them in respect of the magnitude of the correction. And the difference [שאר] which is between them by reason of the chord [?].

The correction of the eccentric will be additive, while the correction of the epicycle will be subtractive; and the magnitude of the correction will be. And it will be found that, when the equal motion is reckoned from the position, the difference of motion [חלוף התנועה] which is between them … the position of the arc, and the correction of the eccentric is additive at this position, while the correction of the epicycle is subtractive; and the magnitude of the correction is one and the same. So this is plain.

And we shall now consider the corrections at the position [where] the arcs are unequal, and that the equal motion is reckoned from the position of the arc. The correction of the eccentric and the correction of the epicycle — there is a difference [חלוף] between them at this position, since the magnitude of the correction is not one and the same. And the difference which is between them … the position of the arc.

The equal motion is reckoned from the position of the arc which is the apogee [גובה]; and the correction of the eccentric is greater there, while the correction of the epicycle is smaller. The arc of the apogee [?] … [a value or a point-name is too faint here] … and the difference which is between them is reckoned by the chord [?]. The correction is greater at the position of the arc which is nearer the apogee, and smaller …

When the equal motion is reckoned from the position of the arc, the position of the apogee, and the correction of the eccentric is additive while the correction of the epicycle is subtractive; the magnitude of the correction is not one and the same, since the arcs are unequal. And so the difference which is between them is reckoned from the chord [?] … the position of the equal motion. [Text on f90r ends partway down the page; the page is otherwise blank below.]

Diagram. A small line-figure in the upper outer (right) margin, drawn in the same brown ink as the body text. A roughly vertical central line carries several lettered nodes; from the principal upper node straight rulings radiate outward to terminal points — one to the upper right, one to the far right (a long ruling), and one to the far left where two rulings converge. From the central line a long line drops to an isolated point at the foot. The figure has no circles — it is a configuration of points and connecting straight lines (a chord/position construction of the kind discussed in the surrounding text). A small caption in the scribe's hand is written below and to the left of the figure.

- ו / [?] ז [?] (top of the central line): two small hook-marks at the line's top end; both are tiny and not securely distinguishable between zayin and vav
- ס (upper right, set apart): terminal point joined by a ruling to the central line
- ב (far right, reached by the long ruling): right-hand terminal point
- ג (far left, where two rulings converge): left-hand terminal point
- ד (upper central node, where most rulings meet): node on the reference line
- ז (central node, below ד): node on the reference line
- ה (central node, below ז): lower node on the reference line
- ו [?] (foot of the long drop-line): isolated bottom point

[Caption below and left of the figure, scribe's hand, small and faded:] צורת [נקדות] [?החלוף]

[Body text of f90v, resuming the running discussion:]

in the corrections, that the position is correct, for the correction is small; and it will be additive [מוסיף] when its arc is reckoned [?]. And it will be found that the equal motion, when it is reckoned from the position of the arc, and the correction of the eccentric and the correction of the epicycle differ, … the position of the arc, and the difference which is between them is reckoned from the chord [?].

The correction of the eccentric will be additive at this position, while the correction of the epicycle will be subtractive; and the magnitude of the correction is not one and the same, since the arcs are unequal. And it will be found that the difference which is between them is reckoned by the chord [?], so that the correction is greater at the position which is nearer the apogee, and smaller.

And we say further that the position of the arc … the equal motion is reckoned from the position; and the correction of the eccentric and the correction of the

epicycle obey one law in this respect, so that there is no difference between them in the magnitude of the correction, and the difference which is between them … the position.

[Short paragraph block, set off with a paragraph divider:] And we shall further explain that the correction at the position [where] the arcs are unequal will be greater at the position nearer the apogee, and the correction of the eccentric … the position of the equal motion is reckoned.

[Second short paragraph block, set off with a paragraph divider:] And we have already explained that the correction is greater at the position nearer the apogee, and that the equal motion is reckoned from the position of the arc; and the corrections of the eccentric and of the epicycle obey one law, so that there is no difference between them in the magnitude of the correction.

[Main text continues below the two short blocks:] … the position of the equal motion, and that this is correct; for he who knows that the correction is greater … will say that the single point [נקודה] [?] … is one and the same in the figure. And the correction of the eccentric and the correction of the epicycle differ at the position [where] the arcs are unequal, since the magnitude of the correction is not one and the same; and the difference which is between them is reckoned from the chord [?].

And it will be found, when the equal motion is reckoned from the position of the arc, that the correction is greater at the position nearer the apogee, and smaller; and the difference of motion [חלוף התנועה] which is between them is reckoned from the equal motion, so that the correction is additive at the position of the apogee and subtractive at the position of the perigee [שפל]. And this remains forever.

the eccentric, that the position is not correct, since the correction differs; and the corrections [התקונים] of the points of the variation [נקודות החלוף] are unequal …

the epicycle, that the position is correct; for he who knows the correction will say that the single point … is one and the same, and there is no difference between the points of the variation [נקודות החלוף]. And [text on f90v ends here; the remainder of the page is blank.]

[the correction will be] small, and it will be the correction precisely. And by this amount the variation [חלוף] will differ from that point. From this it is evident that the closer the arc lies to the point of the variation, the smaller the correction becomes; and the closer it lies to the other point, the larger it becomes.

So too, when the position lies between these two points, the correction will be intermediate, and it will be found according to the ratio of the arcs. And it will be the case that, when the position is at a place such that its correction is the variation itself, the correction will be precise, and there will be no remainder. By contrast, when the position lies at the other point, the correction differs from it [from the variation] by the full amount of the variation. And it will be that the position lies at the place whose correction is greatest, and there the correction differs from the precise value by the whole magnitude of the variation.

Now you should understand that this variation is itself one of the points of the variation, and the correction at it is the correction proper to that point. The other point is the one whose correction is least at that place, since it lies nearer to it; and the position lying between the two points has a correction intermediate between them, according to the ratio of the two arcs.

And it is found that the correction, when the position is at the point whose correction is greatest, will be larger than the correction would be were the position at the point whose correction is least — and this is what we set out to show.[?] When the position lies between the two points, the correction will be according to the ratio of the arc that lies between the position and the near point to the arc that lies between the two points; for in that ratio the correction increases or decreases.

It is therefore evident that the correction at any position whatever is known once the corrections at the two points of the variation are known, together with the arc lying between the position and each of the two points; for from these the intermediate correction is derived by the ratio of the arcs.

And we say further: since the correction at the point of the variation that is nearer the apogee is greater, and the correction at the point that is nearer the perigee is smaller, the variation between them is the difference of these two corrections. And the position whose correction is sought, when it lies between these two points, has its correction found by taking the share of the variation that corresponds to the arc between the position and the point whose correction is least, added to the lesser correction. Thus the correction at any position is found.

Diagram. In the lower outer (left) part of f91r is a line construction. A vertical line (the perpendicular) stands at the right of the figure, carrying its head at the top (א) and tick-points down its length (ז, ד, ו). From a column of three points stacked at the left (ב at the top, ג below it, ה lowest) three lines run rightward to the vertical, and several diagonals cross between the points. A long diagonal

descends to a point at the lower-left foot (ח). The construction illustrates the relation of the arcs and corrections between the points of the variation discussed in the surrounding text.

- א (top of the vertical line): head of the perpendicular
- ב (upper left): top point of the left column
- ג (middle left): middle point of the left column
- ה (lower left): lowest point of the left column
- ז (upper, on the vertical line): tick-point on the perpendicular
- ד (middle, on the vertical line): tick-point on the perpendicular
- ו (lower, on the vertical line): tick-point where the lowest horizontal meets the perpendicular
- ח (foot, lower left): terminus of the long descending diagonal

[Margin: In the lower outer (left) margin of f91r, a note of several lines in a small, somewhat hurried hand (possibly a second hand). It opens with a paragraph mark. The legible portions read in part: "כאשר ידענו מקום הככב … וידענו גם כן מקום … בקשת … השמש …" — a constructive helper relating the known position of the planet, the position of the sun, and the arc used in finding the correction. Several words at the line-ends are abraded and cannot be resolved. Further identification requires further verification.]

the variation, and it is the correction at the point whose correction is least, since it lies nearer to it. And by this amount the position differs.

It will be that the correction at the point that lies nearer the apogee is greater, and the correction at the point that lies nearer the perigee is smaller. So too, when the position lies between these two points, the correction will be intermediate, according to the ratio of the arc between the position and the near point.

It is therefore evident that the correction at the position is found once we know the correction at each of the two points of the variation and the arc between the position and each of them; for from these the intermediate correction is derived.

And we say: when the two corrections are equal at the two points, there is no variation between them, and the correction at the intermediate position equals the correction at the two points; whereas when they differ, the correction at the intermediate position lies between the two and is found by the ratio of the arcs.

The points of the variation, then, are the two positions at which the correction is at its extreme — the one greater, the other lesser — and the position lying between them takes an intermediate correction.

It is found that the correction increases or decreases continuously from the one point to the other, according to the ratio of the arcs; and there is no place between them at which the correction leaps, but it changes by degrees.[?]

And we say further that the matter holds in the same way for the eccentric circle and for the epicycle: in each the correction at the position is found from the corrections at the two points of the variation and from the arcs, by this same method.

And the reason the corrections come out larger near the apogee[?] is that … [the line of the text continues; the remainder of the chapter runs onto the following folio.]

This folio continues a worked procedure for computing planetary latitude — the position of a planet out of (off) the ecliptic — built from the recurring framework of *position* (מקום), *motion* (תנועה), *degrees* (מעלות), and the placeholder idiom "such-and-such [degrees]" (כך / כ"כ), in repeated conditional form ("and if … then it will be such-and-such"). The hand is Sephardic semicursive; the small-hand marginal notes are a denser script, set off by ruled margin-lines and accompanied by small geometric helper marks. The lower portion of each folio side is blank parchment (not abraded).

the motion, and afterward [or: and others], a portion. And the position which it has is fixed [קבוע], [?] [for the position is always [?]]. Because the position [?] … upon the position which is fixed, [?] [the line of correction(?)]. [?] and the position which it has out of [the ecliptic] … and the correction [התקון] [?].

[?] the position [is] fixed; and out of [?] [it will be] the correction. And this will be [?] [the motion(?)] [?]. [?] [the position(?)] which is fixed; and out of the motion which it has [?], the correction of the variation [תקון החלוף] [?].

So this [?] [too(?)] will be the motion which it has out of the position of the configuration [מצב התמונה], [?] the position of the configuration [?]. And so [?] [the position of the motion(?)].

[?] [the motions in their longitude(?)] [?] … the position out of [the ecliptic]; the variation [חלוף] [?]; and yet they will [?] upon the position which is fixed out of [?].

[A run of conditional-template lines in the placeholder-degree idiom follows; the individual clauses are not resolvable glyph-by-glyph in this small cursive and are flagged rather than reconstructed:] … the position is fixed … if the motion is such-and-such [degrees], it will be such-and-such [degrees] … [?] … and if it is not [?], the motions will not [?] … and so the motion [will be] such-and-such [degrees] [?].

[?] … out of [the position(?)], such-and-such [degrees] … the motion … and the correction [?]. And the configuration which it has [?], out of the position [?].

[?] [and consider the position(?)] which it has [?] the correction; and out of the position [?], the correction [?].

[?] … this is what we wished [?] [to explain(?)]. And out of [?], the correction [?].

[Several further lines in the same template idiom — "and if … then such-and-such [degrees] … out of the position … the correction …" — continue to the foot of the written area; the individual values are the generic placeholder idiom, not specific numerals.] [?]

[Margin (outer/left margin of 92r, smaller hand): two short notes.] [Margin: short note, ~1 line — legible words include "the motion" (התנועה[?]); fuller reading requires further verification.] [Margin: short note, ~2 lines — a computational helper in the same vocabulary ("and if the motion … out of the position … such-and-such [degrees] [?]"); a named authority is NOT legible and is not claimed.]

[Margin: computational helper note, ~8 lines, right margin, small hand — set off by a ruled line with a small circle/dot helper mark above and below. In the same lexicon (the motion / out of the position / the correction / such-and-such degrees). Individual clauses are not reliably legible at this resolution; transcription deferred. No named authority is legible.]

[Margin: computational helper note, ~4 lines, right margin, below the circle/dot mark — likewise a helper ("and if … out of the position … the motion …"). Further identification requires further verification.]

[Body text of 92v:]

[?] the motion is [?] [pure/simple(?)] and the motion of the variation [תנועת החלוף] [?]; [?] it will be [?] out of [?]. And if it is [?], then there will be [?] [the motion(?)] [?].

out of [?] [the configuration(?)], the variation [?]; and [?] [out of] the configuration [?], the position [will be] [?]. And if it is [?] [out of the configuration(?)], the

position [will be] [?] [such-and-such degrees(?)]. And if it is not [?], the motions will not [?].

[?] [the position(?)] — if the motion which it has out of the position of the configuration [?] [is fixed(?)], [?] the position [?].

[?] [And this is the motion which it has, etc.(?)] … out of [?] [the line(?)] … the configuration [?].

[A run of conditional-template lines in the same placeholder idiom follows — "and if the motion is such-and-such [degrees] … out of the position … then it will be such-and-such [degrees] … the correction" — repeated several times. The structure is legible; the individual clauses are not resolvable word-by-word and are flagged:] [?] … the position is fixed … if the motion is such-and-such [degrees] … out of the position … such-and-such [degrees] … the correction [?] … and so for the rest [?] …

[?] [the position which it has out of (the ecliptic)(?)] … the variation … [?].

[Toward the foot of the written area:] [?] … [it will be] always one [?]; it will not change [?] [out of(?)] [the position(?)] [?]. And this is what we wished [to explain(?)] [?].

the position [מקום], and the correction [תקון] would then be [?] near to it, and the smaller [?] [reading uncertain at line start]. And at the position [מקום] the motion [תנועה] would be in the middle [?], for the configuration [התמונה] [?] there, and we have already [?]. And so too [?] the cycle [קלקוס] of Ptolemy [תלמיוס] [?]. And further, in standing [?] upon the position [מקום] of the smaller motion [תנועת הקטן], the remote position [מקום רחוק] [?] straightens its correction [תקון], and it is the variation [חלוף] [?].

[Several glyphs at the start of this line abraded / uncertain] …[?] the points of variation [נקודות החלוף] [?] would be, and [?] in all [?] the remote position [מקום רחוק] [?] than the [?].

the straightening [התלבנות ?] [?] [?] this [?] the smaller, and it returns [?] correction [תקון ?] [?] [the line carries the recurring terms חלוף / תקון but several mid-line glyphs are not legible]. And likewise [?] [?] and the correction [תקון] and the [?] straightens [?].

[?] the motion of the variation [תנועת החלוף] and [?] [?] [?] in the remote position [מקום רחוק] the variation [חלוף] would be [?] than the correction [תקון] [?] for the configuration [התמונה] [?] there.

[?] the position [מקום] of the smaller [הקטן ?], and the remote position [מקום רחוק] [?] would be the [?]. And not [?] [?] [?] when [?] the variation [חלוף] [?] correction [תקון] [?] [?] there.

[A run of mid-page lines here carries the same recurring lexicon — תקון (correction), חלוף (variation), תנועה (motion), מקום (position), מקום רחוק (remote position), תמונה (configuration) — in iterative proportional statements, but the individual clause boundaries and connectives are not legible enough to commit even under magnification. Transcribed [?] rather than reconstructed.] [?] [?] [?]

המ״ח [enlarged set-off, = המחבר, "the Author"]: …[?] the correction [תקון] [?] would be [?], and at the position [מקום] [?] [?] the configuration [התמונה] [?] the position [מקום] [?]. [The author's in-line remark continues with the same terminology; its closing clauses are compressed at the column edge and read [?].]

[?] [?] the motion [תנועה] [?] for in standing [?] upon the position [מקום] of the correction [תקון] [?], and it is taken [?] [?] this. And [?] this [?] [?] the configuration [התמונה], for there would be there [?] [?].

and there is no doubt [ספק ואין ?] [?] [?] the corrections [תקונים] [?]; and likewise [?] when the [?] [?] of [?] the corrections [תקונים] [?] [?] [final line of the text block; trailing glyphs at the column edge compressed and uncertain] [?].

[Below this line the remaining lower portion of f93r is blank parchment — the column simply ends; no further inked text.]

[Margin, upper-left of the text block: a small two-line note in the same hand. Verbatim text not legible at this resolution: [?] [?]. Appears to be a constructive helper keyed to the position/correction discussion; no named authority committed — further identification requires further verification.]

[Margin, lower-left, beside the foot of the text block: a small two-line note in the same hand. Verbatim text not legible at this resolution: [?] [?]. Constructive helper, not an attribution.]

the cycle [קלקוס ?] [?] [?] would be the configuration [התמונה] [?] in the way [בדרך ?] [?] [?] would not [?] [?]. And the matter [?] when [?] the correction [תקון] [?] [?].

and [?] the configuration [התמונה] [?] correction [תקון] and [?] [?]. And we shall return [?] [?] for half [?] [?] the [?] degrees [מעלות ?] of the motion [תנועה].

the correction [תקון] [?] [?] and [?] the [?] there would be [?] [?] [?] this. And the motion [תנועה] [?] [?] [?] the remote position [מקום רחוק] [?] [several mid-line glyphs uncertain].

[?] the correction [תקון] [?] would be [?], and [?] for it [?] this the position [מקום], and [?] there would be [?] [?] [?] the variation [חלוף] [?] [?].

[Margin, right (inner) side beside this block: a small two-line note in the same hand, [?] [?] — verbatim text not legible; constructive helper, no named authority committed.]

and likewise [?] [?] the smaller [הקטן ?] [?], and there returns [?] [?] [?] the correction [תקון] and the variation [חלוף]; and in this manner [ובזה האופן ?] [?] [?].

[?] [?] the motion of the variation [תנועת החלוף] [?] [?] [?] for in the configuration [התמונה] [?] [?] there. And [?] [?] [?] the position [מקום] [?] [?] [?] [?].

תמונה יאות [margin figure-cue, = "an appropriate figure" — references a figure for this construction; no figure is inked on the folio]

[?] the correction [תקון] [?] [?] [?] [?] the smaller [הקטן ?]; and [?] [?] [?] when the [?] [?] [?] the corrections [תקונים] [?] [?].

[A run of mid-page lines here carries the iterative proportional argument in the same recurring lexicon — תקון / חלוף / תנועה / מקום רחוק / תמונה — with the per-degree increment of the correction discussed qualitatively rather than as a restated discrete numeral. Individual connectives and clause boundaries are not legible enough to commit; transcribed [?] rather than reconstructed.] [?] [?] [?]

the correction [תקון] [?] [?] would be greater [יותר ?] than [?], and [?] [?] [?] the configuration [התמונה] [?] there. And in this [ובזה ?] [?] [?] this [?] is the line [קו ?] [?].

[?] [?] the points [הנקודות ?] [?] [?] the correction [תקון] [?] [?] [?] the variation [חלוף] [?]. And [?] [?] [?] [?] far [רחוק ?] [?] [?] near [קרוב ?] [?].

and this matter [וזה הדבר ?] [?] [?] this [?] [?] outside [חוץ ?] [?]; for the thing [?] [?] [?] [?] degrees [מעלות ?] [?].

[?] [?] far [רחוק ?] [?] [?] near [קרוב ?] [?]; and we have already mentioned [שזכרנו ?] [?] the correction [תקון] [?] [?] [?] [?] [?].

[?] [?] [?] the motion of the variation [תנועת החלוף] [?] [?] degrees [מעלות ?] [?] in the variation [בחלוף ?] [?] [?] all [?] [final line; trailing glyphs at the gutter/column edge compressed and uncertain] [?].

[Below this line the remaining lower portion of f93v is blank parchment — the column simply ends; no further inked text.]

[Continuation of the Tenth Chapter — the discussion of the correction (תקון) and the points of the variation (נקודות החלוף).]

because these positions do not maintain a constant relation; rather, the smaller motion at one position differs from the smaller motion at another. Therefore, when the variation grows greater between one position and another, the difference [חלוף] grows greater as well, in proportion to the position [מקום] and to the measure by which it is removed from it.

We have already explained that, with respect to the variation, the matter is not uniform — that is, the variation is not everywhere equal. For at the positions near the apogee [גובה] the variation is small, whereas at the remote position [מקום רחוק] it is greater. And so, by the same reasoning, the variation between one position and another is not everywhere of one measure, but varies according to where the two positions fall along the [eccentric] circle.

Now if the two positions were both great [i.e., far from the apogee], the variation between them would be greater; and if they were both small, the variation between them would be smaller. Hence the difference between the corrections will track the difference between the smaller motions, since the correction depends upon the smaller motion, and the smaller motion depends upon the position.

This being so, it follows that when we wish to derive the correction at a given position, we must first determine the position — that is, where the planet [כוכב] stands upon the circle — and then we determine the smaller motion belonging to that position; and from the smaller motion the correction is found. For the correction is what is added to, or subtracted from, the mean place [מקום אמצעי] in order to obtain the true place [מקום אמתי]. When the correction is additive [מוסיף] we add it; when it is subtractive [גורע] we subtract it.

And so the measure of the variation between any two positions is according to the measure of the variation between their two corrections, and according to the measure by which the one position is removed from the other. For the difference between the two corrections is itself the variation we are seeking, and it is found by taking the correction proper to the one position and the correction proper to the other, and taking the remainder [שאר] between them.

When the two positions are close together, the difference between their corrections is small, and the variation is correspondingly small; and when they are far apart, the difference between their corrections is great, and the variation is correspondingly great. And the variation between the corrections is the

measure that should be added to, or subtracted from, [the value], in order that the true place be obtained at the second position.

[The remainder of f94r is blank below this point; two helper notes stand in the outer margin.]

[Margin: התנועות — "the motions."]

[Margin: גדול — "great / greater."]

המ״ט [display sub-statement marker; the abbreviated form is written with gershayim, like the המ״ח of the preceding folios — most likely a continuation cue for "the author" (המחבר) introducing the next point, rather than a chapter rubric. Not an enlarged פרק heading.]

and let it be that we have already shown how this comes about, and that the matter is verified by demonstration [מופת]. We say, then, that this is so because of the [eccentric] circle and the differing distances of the planet from the center, which is the cause that the smaller motion is not everywhere of one measure. For when the planet is at the position near the apogee, its distance from the center is greatest, and there the smaller motion is least; and when the planet is at the remote position, its distance from the center is least, and there the smaller motion is greatest.

And the measure of the correction follows the smaller motion: where the smaller motion is great, the correction is great, and where the smaller motion is small, the correction is small. And so the variation between the two corrections is according to the measure of the variation between the two smaller motions belonging to the two positions.

We have already said that the measure of the variation is found by the difference between the two corrections, and we have explained that this difference is not everywhere of one measure but varies according to the positions. Therefore, when the first position is great and the second position is great, the difference between their two corrections will be of a certain measure; and when the first position is small and the second position is small, the difference between their two corrections will be of another measure.

And so, when the smaller motion increases, the correction increases, and the variation between the corrections likewise increases; and when the smaller motion decreases, the correction decreases, and the variation likewise decreases — for the correction follows the smaller motion, and the smaller motion follows the position of the planet upon the [eccentric] circle.

And let it be that we wish to know the measure of the variation [קשי(ות) החלוף] between any two given positions: we take the correction belonging to the first position and the correction belonging to the second position, and we take the remainder between them; and that remainder is the measure of the variation. And when the position is small, its correction is small; and when the position is great, its correction is great.

[Lower portion of f94v carries a geometric figure; the prose above it concludes the construction it illustrates.]

Diagram. A construction in the lower outer corner of f94v, drawn in brown ink in the same hand. The figure is built on a single long vertical line. At the top of the vertical is a labeled point; a short way down the vertical a point-mark (a small cross-tick) is set on the line. Near mid-height a roughly horizontal line comes in from the left and meets the vertical at a junction point. From the lower part of the figure two lines rise to the vertical: one runs up to the left to a vertex at the left end of the horizontal, and one runs up to the right to a labeled point at the upper right; together with the vertical they enclose a triangle whose apex sits at a lower junction on the vertical. Below that lower junction the vertical continues a short way to a point at the foot. The figure has the appearance of the perpendicular / line-of-position constructions used through this chapter. Labeled points, by position:

- ב (top of the vertical) — the topmost labeled point; a hooked letter with a descending stroke.
- ג (upper right) — terminus of the line rising to the upper right.
- [?] (central junction, where the horizontal meets the vertical) — a faint curved mark stands beside the junction; not securely readable.
- [?] (lower junction, the apex of the lower triangle on the vertical) — a faint curved mark stands beside the vertex; not securely readable.
- A point-mark sits on the vertical between the top point and the central junction, and another at the foot of the vertical; neither bears a clearly written letter.
- A left-hand vertex closes the triangle at the left end of the horizontal; any label there is faint.

[The lower third of f94v is otherwise blank.]

[Marginal note, upper-left of f. 95r: the folio number "95" in a later hand / Arabic-style numeral.]

such [a measure] as the line [קו] AḤ [?], and the angle [זוית] will be [equal to] their angle, and so [too] the line [קו] [?] and so [too] the line [?]. And the line of the configuration [קו התמונה] [?] [will be] equal [to] their line [קו]. And so [too] the line [קו] [?] will be such-and-such [כ"כ]; and the line [קו] [?] [will be] such-and-such degrees [כ"כ מעלות], to be clarified.

And the chord of the arc [יתר הקשת] [?] [will be] such-and-such, by the proportion of the line [?]; and the motion of the anomaly [תנועת החלוף] will be such-and-such by the proportion of the line [?] [is] such-and-such degrees [כ"כ מעלות]; for [כי] the line [קו] [?] [is] such-and-such degrees.

and likewise [the line] [?] and the line [קו] [?], and the angle [זוית] [?] [will be] equal [to] the angle [זוית] [?]; and the line [קו] [?] [will be] equal [to] the line [קו] [?]. And so [too] the configuration [התמונה] [?] [will be] such-and-such degrees, [namely] the angle [זוית] [?]. And the angle of the correction [זוית התקון] will be [equal] to whatever it will be [?], which is the angle [זוית] [?]. And the angle [זוית] [?] [is] such-and-such degrees [?], for [כי] [?] [is] [?].

And the angle [זוית] [?] [is] such-and-such [כ"כ], and the angle [זוית] [?] [is] such-and-such minutes [כ"כ דק']; and [?] the angle [זוית] [?] [is] [?]. And [?] [will be] such-and-such [כ"כ] to it [?], and the line [קו] [?] [is] such-and-such degrees [?].

And the angle [זוית] [?] [will be] equal [to] the angle [זוית] [?], for [it is] [?] such-and-such. And the third [angle] [השלישי] [will be] [equal to] their remaining [angle] [?] [is] such-and-such degrees and such-and-such minutes [כ"כ מעלות וכ"כ דק']; and the line [קו] [?] [will be] such-and-such degrees [?], and so [too] the line [קו] [?] [will be] such-and-such by the proportion [?].

[Interlinear / marginal note, mid-right of f. 95r, in a smaller hand: "…the line [קו] [?] [is] such-and-such [degrees] [?] … by the proportion of … [several words abraded, illegible: ?] … such-and-such [?]." Further identification requires further verification.]

Diagram. A geometric construction in the left margin: a long vertical line dropping from an apex at the top to a point at the foot, with a node partway down from which a diagonal line runs to the lower right, and a further short line descending to a point at the lower left. (Triangle formed on the vertical with the diagonal and lower lines.) The figure illustrates the angle-of-correction construction discussed in the surrounding text.

- (apex, top of vertical line): [label faint — ?]
- (node, upper portion of vertical line, beside the marginal note): ז [?]

- (node, middle of vertical line): [?]
- (endpoint, lower left): [?]
- (foot of vertical line): ה [?]

[A marginal note in a small hand sits immediately to the left of the upper node of this figure; its text is mostly abraded — legible fragments only: "…the line [קו] … such-and-such … [?]." Constructive helper anchoring the figure's letters to the prose; further identification requires further verification.]

[Lower third of f. 95r below the body text: blank parchment — no ruling, no abraded ink.]

and the line [קו] [?] [will be] [equal to] [?]; and so [too] [the line] [?] such-and-such [כ"כ], and the line [קו] [?] [will be] such-and-such [?]; and so [too] [?]. And the line [קו] [?] [will be] such-and-such degrees [?]; and so [too] [?] minutes [דק'], and so [too] [?].

And the line [קו] [?] [will be] such-and-such, for [כי] the line [קו] [?] [is] such-and-such degrees, and so [too] [?] minutes [?], and so [too] [?]. And the line [קו] [?] [will be] [equal to] the line [קו] [?], and so [too] [?]; and the line [קו] [?] [will be] such-and-such by the proportion [?].

such-and-such degrees, and so [too] [?]. And [?] the configuration [התמונה] [?] [is] such-and-such degrees [?], [namely] the angle [זוית] [?]. And so [too] the angle [זוית] [?] and the angle [זוית] [?] [are] such-and-such [?]; and the line [קו] [?] [will be] such-and-such degrees [?].

And the correction [התקון] will be whatever it will be [?] — this is what we wished to clarify regarding it [זה מה שרצינו לבאר בו]. And there is yet another way to make this correction [התקון] [?], namely [?]: when [?] the line [קו] [?] [is] such-and-such degrees [?], by the proportion [?]; and the obliquity [?] [of] the small circle [גלגל קטן] [?] [is] such-and-such [?], for [כי] [?].

[the line] [?] [will be] such-and-such degrees, [from] which take the chord [?] [?]; and so [too] [?] minutes [?], and so [too] [?]; and the angle [זוית] [?] [will be] such-and-such [?]. And there is yet another way [ועוד דרך אחר] [?] [for] the correction [התקון] [?] [is] [?].

[Several lines of further worked-template prose follow in the same hand, continuing the alternate-method derivation in the same "let line X be such-and-such degrees, and the angle such-and-such minutes" pattern. The individual letter-labels and degree placeholders are interspersed with abraded connectives — committed where legible, otherwise [?].]

and the correction [התקון] [?] [will be] whatever it will be [?]. And the [?] of the configuration [התמונה] [?] [is] such-and-such [?]; and so [too] the line [קו] [?] [will be] such-and-such degrees [?]. And so [too] [?] minutes [?]. And the angle [זוית] [?] [will be] such-and-such degrees, [namely] the angle [זוית] [?], for [כי] [?].

[and] the angle [זוית] [?] [will be] such-and-such degrees and such-and-such minutes [כ' מעלות וכ"כ דק]; and so [too] [?] [will be] such-and-such degrees and such-and-such minutes; and so [too] the line [קו] [?] [will be] such-and-such degrees [?].

Diagram. A geometric construction at the foot of the folio: a base line running from a point at the left to a node toward the right, where a vertical line drops to a foot below; two further lines run upward and to the right from the right-hand node, forming a triangle/quadrilateral with the base. The figure illustrates the alternate angle-of-correction construction described just above it.

- (apex / upper-right terminus): [label faint — ?]
- (left endpoint of base line): ב [?]
- (node, center-right, junction of base and vertical): ג [?]
- (point along base, left of center): [?]
- (foot of vertical line): [?]

[No marginal note accompanies this figure. Lower-right quadrant of f. 95v: blank parchment — no abraded ink.]

[The discussion of the correction [תקון] of the smaller motion [התנועה הקטנה] continues from the preceding folio.]

the line [קו] BG, and its degrees. The straight line [קו ישר] will be of such-and-such degrees and parts; the arc [קשת] will be of such-and-such degrees and parts. So too the line will be of such-and-such degrees and parts, and likewise its arc of such-and-such degrees and parts.

In the same way, when you have the arcs [קשתות] in your hand, and you know [the values], the remainder [שאר] of the degrees and parts, and likewise the arc of the position, are of such-and-such degrees and parts.

And it is found [נמצא] that the line is of such-and-such degrees and parts, and likewise so many parts, and again so many seconds [שניים]. The line GD will be of such-and-such degrees, and the line is of such-and-such degrees and parts, and so many seconds.

By this it is known [ידוע] [the value] of so-many parts and so-many seconds, just as it is found in the arcs and lines of the [epicyclic] correction. And likewise the line is of such-and-such, of so many parts; and to the seconds, and according to [their value].

The line GD: it is known that the line is of such-and-such degrees and parts. According to the arc of the variation [קשת החלוף] which is at point [נקודת] [?], and the remainder [מותר] of the smaller motion [התנועה הקטנה] — as we explained — there will be the line GD of such-and-such degrees and parts. So too the smaller motion will be of so-many degrees, and the arcs of the chord [קשתות החוט] [are] of such-and-such; and likewise the line is of such-and-such degrees and parts, and so many seconds.

And it is settled [ונשאר] for us that the position [מצב] is of such-and-such degrees, and so many seconds. And by this is known [the value] of the smaller motion, of so-many parts and so-many seconds.

This [arises] because the chord-arc [קשת החוט] [is] of such-and-such degrees and parts; and according to [it], we work out the position [מצב] which is of such-and-such degrees, of so many parts, and so many seconds.

And now I shall set down the figure [הרמונה — recte: הצורה?] upon which I rely. The line ABGD [is] of such-and-such, and according to it [is computed] the position of the planet [מקום הכוכב], of such-and-such degrees; and likewise the line is of such-and-such degrees and parts. And as we said, the line ABG is of such-and-such, and again the line is of such-and-such degrees and parts. So too the line BG, of so many parts; and likewise the line is of such-and-such degrees and parts.

Diagram. A geometric construction in the left margin of f96r, at mid-page height. A vertical line carries a row of marked points; from an apex at the left, three straight chords fan out to three of those points, and a horizontal line crosses the vertical line and runs to the right toward the text column. The construction illustrates the correction of the smaller motion by chords subtending the points of the correction. Labeled points:

- ב (top of the vertical line)
- ז (next point down on the vertical line)
- ד (point where the horizontal line crosses the vertical line)
- ו (next point down on the vertical line)
- ה (lowest labeled point on the vertical line)
- ט (apex at the left, from which the three chords fan out to ו ,ד, and ה)

- [?] (point at the right where the horizontal line and a chord from ה meet; small hooked glyph, not securely legible)

[Margin (right/gutter edge): a small later-hand pen mark.]

and according to the chord [וחוט], the arc is of such-and-such degrees and parts. So too the position [מצב], of so many parts and so many seconds.

Now, the way we knew [the value] of the smaller motion was through the chord, just as Ptolemy [בטלמיוס] explained. And behold, the position [מצב] is of such-and-such, and according to it the position of the planet is of so many parts and so many seconds.

When the chord [is] of such-and-such, the position will be of so many parts; and likewise it is of such-and-such degrees and parts, and so many seconds. By this it is known [the value] of the smaller motion of so-many parts and so-many seconds, just as it is found that the position is of such-and-such.

And the position will be of such-and-such degrees and parts, just as Ptolemy [בטלמיוס] explained — for the position of the planet [מקום הכוכב] is of such-and-such degrees and parts, and so many seconds, just as is fitting.

[Margin (left, f96v): marginal note containing "תקדים" [?]; further identification requires further verification.]

[Margin (right, f96v): brief marginal note in a small hand containing "תקון / על דבר זה" [?]; appears to be a constructive helper keying the diagram below to the prose; further identification requires further verification.]

And now I shall set down the figure upon which I rely concerning the matter, so that it may be made clear. The line ABG [is] of such-and-such, and the position is of so many parts; and likewise it is of such-and-such degrees and parts, and so many seconds. The position will be of such-and-such, of so many seconds, just as is fitting for the position of the planet.

For the smaller motion is according to the angle [זויית] of the correction [התקון], by which we work out the position. And there will be the angle of the correction [זויית התקון] of such-and-such degrees; and the position will be of so many parts, of such-and-such degrees and parts, and so many seconds.

And behold, the angle BGD [זויית] [is] of such-and-such; and according to it the angle of the correction is of so many parts. And likewise the position is of such-and-such degrees and parts. The angle of the correction [זויית התקון] is by the chord [בחוט], according to the points of the correction [נקדות התקון]: the angle is

of such-and-such, of so many parts and so many seconds; and likewise the position will be of such-and-such.

Diagram. A geometric construction in the right margin of f96v, at mid-page height. A vertical line carries a row of marked points; from a point at the right, straight chords fan out to the upper points of the vertical line, and a horizontal foot-line runs from a lower point on the vertical line out to that same right point. A separate point to the left is joined to the figure, and a multi-line note in a small hand stands between it and the vertical line. Labeled points:

- ב (top of the vertical line)
- ז (next point down on the vertical line)
- ד (next point down on the vertical line)
- ה (lower point on the vertical line, where the horizontal foot-line departs to the right)
- ב (lowest point on the vertical line, set well below ה after a gap)
- ג (point at the right, where the chords and the horizontal foot-line converge)
- ז (separate point at the left, joined by a line to the upper part of the figure) [?]

Note in a small hand beside the figure (verbatim where legible): " [?] כמה מעלות ודקים / וכמה שניים ועוד / כאשר יתחדש [?] / כמו עולה הדא דבר ועוד [?] / שניים דקים [?]".

the angle [is] of such-and-such, and the position will be of so many seconds, just as is fitting. The angle of the correction [is] according to the chord [כפי החוט], the angle of the position [זוית המצב], the lower [התחתון] angle of the variation [זוית החלוף]; and behold the angle is of such-and-such. And the position will be of such-and-such degrees and parts.

[The Tenth-Chapter correction discussion continues onto the following folio. No Eleventh-Chapter rubric appears in this opening; the lower portions of both folio sides are blank apart from the two marginal diagrams.]

and so the line of position will be such-and-such, and the chord will be such-and-such. Since the angle [the one] is known, it follows that this chord too is known; and likewise the perpendicular dropped from the point of the correction. For the relation of the chord to the perpendicular is a known relation, and therefore the perpendicular is known.

When this perpendicular is known, the remaining portion of the line — that is, the part of the line of position lying between the foot of the perpendicular and the

center — is known as well, and the angle of the correction is known together with it. From this the position of the planet is found, for it stands at such-and-such degrees from the apogee.

And since the angle of the correction is now known, the chord subtending it is known by such-and-such degrees and such-and-such minutes; and likewise the chord of the angle of variation is known by such-and-such [degrees] and such-and-such minutes. For the relation of the chord to the chord is as the relation of the one arc to the other, and the matter proceeds in this measure.

It has thus been explained how the position of the planet is found by way of the correction, and how the angle of the correction and the angle of variation are found — each one of them — when the smaller motion is known. For these are derived one from another by way of the chords subtending the points of the correction, as we set forth.

Diagram. A small marginal construction in the upper outer (left) margin of f97r. A vertical line carries a labeled point ה at its top and a point ד lower down; from the foot of this vertical a diagonal rises to the right to a labeled point ב, and a short baseline runs left, forming a triangle whose lower junction is marked by the stacked points ד ,ב, and ג (ג at the apex/foot). It serves the surrounding correction discussion (line of position, perpendicular, and chords).

- ה (top of the vertical line)
- ד (on the vertical line, below ה)
- ב (upper right, terminus of the diagonal)
- ב (lower junction, upper)
- ד (lower junction, middle)
- ג (lower junction, apex/foot)

Diagram. A second marginal construction lower in the outer (left) margin of f97r: three nearly parallel lines descending in a slight fan, each headed by labeled points. It is a companion to the figure above, showing the lines of the correction.

- ח, ז (head of the right-hand line)
- כ [?], ז (head of the middle line)
- ה, ד (head of the left-hand line)

[Lower portion of f97r blank below the diagrams.]

the chord subtending the points of the correction will be such-and-such, by reason of the position of the planet. And accordingly, since the smaller motion is

known, the angle is known, and likewise this chord; and the perpendicular dropped from it is known by such-and-such degrees and such-and-such minutes, and so likewise the second [chord].

The position of the planet is found in this way, and the relation of the one chord to the other is as the relation of the one arc to the other. For the chord subtending the angle of the correction is by such-and-such degrees and such-and-such minutes; and the chord subtending the angle of variation is by such-and-such [degrees] and such-and-such minutes; and there are besides such-and-such seconds.

When the perpendicular is known, the remaining portion of the line of position is known, and with it the angle of the correction, and the position of the planet by such-and-such degrees. And the chord of this angle is by such-and-such minutes; and so too are such-and-such seconds.

It is found, then, that the chord subtending the angle of the correction differs from the chord subtending the angle of variation by such-and-such degrees and such-and-such minutes. This is so because the position of the planet falls at such-and-such [a place], and it is reversed: that is, what was additive becomes subtractive, and what was subtractive becomes additive, according to the place of the planet — whether it lies toward the apogee or toward the perigee.

Diagram. A marginal construction in the outer (right) margin of f97v, bearing the verbatim Hebrew caption *מצב הככב* ("position of the planet") written within the figure. From a vertex at the lower right (marked ז), a baseline runs left and a fan of lines rises up and to the right; a point ב marks the junction above the baseline. It is the companion to the constructions on f97r.

- מצב הככב [caption written within the figure]
- ב (junction above the baseline)
- ז (lower-right vertex)

Diagram. A second, larger marginal construction lower in the outer (right) margin of f97v: a fan of lines rising from a lower vertex, with a baseline running left and a near-vertical line descending from the vertex. Most of its point-labels are faint or cut by the page edge.

- ז ,ב (label cluster upper-left of the fan)
- ז (head of the central line)
- [?] (head of the right-hand line, abraded / edge-cut)

[Lower portion of f97v blank below the text and diagrams.]

and he said that the smaller motion, by the amount of its variation from such-and-such [degrees], will be such-and-such. And we found that the arc, by the amount that it is from such-and-such, the place will be such-and-such. So the arc that is the chord of such-and-such [degrees] will be by the amount that [?] this is. And the variation of arc ה ד is the variation [?].

He said that, by the amount that the second [arc] will be such-and-such, the second will be by the amount that it is such-and-such, and likewise the third [arc] will be such-and-such. For already this arc, by the proportion of which, will be the position by [?] the amount of [?] such-and-such; so that the chord of arc that is the chord [?] of such-and-such [degrees] will be by the amount that it is.

For this is the way it should be: that the proportion is in this manner. And we will know its quantity, and the chord of arc such-and-such [degrees], by the amount that the position by it will be such-and-such — and the chord by the amount of the variation will be subtractive [גורע]. And by the amount that the smaller motion will be its variation — and the chord [will be] additive [מוסיף]. And the variation of the chord such-and-such will be [?].

For the chord of arc that is by the amount that it is, the position will be such-and-such, and it will be by the amount of [?]. For the variation of the position will be such-and-such [degrees] and such-and-such minutes, and such-and-such [will be] additive, and such-and-such [will be] the second. And this is the correction [תקון] of the proportion that we set down, so that the position will be at the [?] correction. So the variation of the smaller motion will be such-and-such, and the position will be such-and-such, and likewise [the result], by the amount that the chord will be [?].

He said: when the chord of arc such-and-such [degrees] is additive, the position will be by the amount of such-and-such. And when there are two centers, the variation [חלוף] will be at the apogee [גובה] and at the perigee [שפל], by the amount of [?] such-and-such.

Diagram. A small construction in the outer (left) margin, in the upper-middle of the folio. A short horizontal line runs between two points at the top; from the upper point a fan of three sloping lines descends to a row of three points along the lower edge of the figure.

- ז (top-left point): left end of the upper horizontal line
- [?] (top point, where the sloping lines issue): apex of the fan

- ב (lower row, left point): foot
- [?] (lower row, middle point): foot
- ה (lower row, right point): foot

Diagram. A second construction lower in the outer (left) margin: a triangle with a vertical line rising from a vertex on the right up to a point at the top, a point at the far left joined to the right-hand vertex, and further lines descending from the vertex to the base.

- ז (top, apex of the vertical line): upper endpoint
- ב (far-left point): left vertex
- [?] (right-hand vertex, where the lines converge): the lettering here is faint
- [?] (lower base point): foot

[Lower portion of f98r is otherwise blank.]

and such-and-such minutes, and such-and-such seconds; and by the amount that the position will be such-and-such, and likewise the arc such-and-such [degrees]. And [its] like — by the manner in which the correction [תקון] of the arc is, and it will be [?]. The position [will be] such-and-such [degrees] and such-and-such minutes, and such-and-such; for this arc is obligated by the amount of [?]. The position by the amount of which will be such-and-such, and likewise the second. And the position will be additive [מוסיף] by the amount of [?].

And [it is] by the manner in which the variation of the position is, by the amount of which it will be such-and-such [degrees], and such-and-such, and the second. And the position will be by the amount of such-and-such [degrees] and such-and-such minutes, and such-and-such; for the position is required by the amount that the correction of it is. And by the manner in which the chord of arc such-and-such is, it will be additive [?]; and this is by the manner in which the position is additive by such-and-such [degrees] and such-and-such minutes, so that the position will be such-and-such; and such-and-such [will be] the second.

He said: this correction of the chord, by the amount that the chord such-and-such [degrees] will be such-and-such minutes; and such-and-such [will be] additive [?]. And the variation of the position, by the amount that it is required by the proportion, will be such-and-such [degrees] and such-and-such minutes, and such-and-such; for the position by it will be at the line of position [קו ההיקש]. And by the amount of [?] such-and-such, and likewise the second. And the variation, by the amount that the chord is required [?].

And by the manner in which the smaller motion [תנועה הקטנה] is, its variation by the amount of which will be such-and-such [degrees]; and likewise the chord, by the amount of which it will be subtractive [גורע]. And it will be by the amount that it is one and the same [?] by such-and-such, and likewise the second. So the chord [will be] additive [מוסיף], by the amount that the second is such-and-such, and such-and-such [will be] the second. And by the amount of [?] such-and-such, the position will be by it at the line of position [?]; for already the additive correction, by the amount of which the position will be such-and-such, [will be] additive, and likewise [?].

And by the manner in which the position is at the apogee [?], it will be by the amount that the chord of arc such-and-such [degrees] is, [and] it will be additive. And he said the correction of the smaller motion, by the amount of which it will be such-and-such [degrees]; and likewise the position. And it will be by the amount of [?] such-and-such, and such-and-such [will be] the second, and again such-and-such, and it will be [?].

Diagram. A construction in the outer (right) margin. A vertical line carries several marked points down its length; from an apex point at the upper right, three sloping lines run inward to three of those points, forming a set of nested triangles. The figure is the companion construction to those on f98r, showing the chords drawn to successive points of the correction.

- ה (apex, upper right): vertex from which the three sloping lines issue
- ז (top of vertical line): upper endpoint
- ד (upper point on vertical line): where the first sloping line meets
- [?] (next point down): where the second sloping line meets
- ד (next point down): where the third sloping line meets
- ב (bottom of vertical line): lower endpoint

[Lower portion of f98v is otherwise blank.]

so-and-so degrees and so-and-so minutes; and this is its arc. And from this arc you take the chord; and from this chord you derive what you derive of the correction [תקון] of the smaller motion. And likewise the position of the planet [מצב הכוכב] from this is additive [מוסיף], as we explained earlier. And likewise, for every arc and arc, the chord is greater; and the closer it [?] is to the apogee [גובה] and to the perigee [שפל], the smaller it is.

These are points of the correction at twenty-something [?]. So-and-so seconds — and this will be the arc; and to it corresponds [?] the chord; and the remainder

[שאר] of the angle is so-and-so. And the chord of this arc is greater than the chord of so-and-so [?]; and to it corresponds the chord, so-and-so degrees and so-and-so minutes and so-and-so seconds. And this is when the smaller motion is at twenty-something [?]; and likewise the remainder is so-and-so.

It will be evident to you from this that the smaller motion, when it does not complete a full revolution [?], so-and-so will the correction be, in this measure, of the smaller motion. And the chord, so-and-so degrees and so-and-so minutes; and the position of the planet from this — so-and-so degrees, additive. And from this it is found that the true place [מקום אמתי] of the planet differs [?] from its mean place [מקום אמצעי] by so-and-so degrees and so-and-so minutes.

Diagram. A right-angled construction in the lower portion of the page. A long vertical straight line runs down the right side of the figure; from a point on it near the top, an oblique line slopes down and to the left to a vertex at the left, where it meets a short horizontal segment, forming a long, narrow triangle. A short horizontal stroke crosses the vertical line at the level of the triangle's right vertex (the foot of the chord / perpendicular construction). Below the figure, in the scribe's hand, runs a two-line gloss giving the values for the construction.

- א (apex, left vertex of the triangle): label
- ב (on the vertical line, where the oblique line meets it, upper): label
- ג (on the vertical line, at the horizontal cross-stroke, the foot): label
- ד (on the vertical line, below the foot): label
- ה (at the bottom end of the vertical line): label

[Caption beneath the figure, scribe's hand:] "the chord [?] is so-and-so seconds, and nineteen [?] …degrees …so-and-so degrees [?]…"

Diagram. A second construction at the foot of the page, partly running into the lower outer corner. A long line descends obliquely; from its upper end a sheaf of several straight rays fans out to a common point below and to the right, with two further labeled points marked along the descending line. The figure is a fan of chords drawn from successive points of the correction to a single vertex.

- ב (upper, on the descending line): label
- ג (on the descending line, below ב): label
- ד (lower, on the descending line): label
- ה (the common vertex to the right, where the rays converge): label

so-and-so degrees of the correction; and it will be found that the chord [?] of so-and-so degrees and so-and-so seconds, and to it corresponds so-and-so [?]; and the

remainder of the angle so-and-so. And the remainder, when the chord is at twenty-something [?], will be so-and-so degrees [?]. So-and-so minutes — and this will be so-and-so degrees; and so-and-so seconds — and this will be the correction, so-and-so degrees and so-and-so seconds. And it will now be in this measure, like so-and-so degrees and so-and-so seconds; and the position [?]…

the points of the correction; and it will be sought [?] from what is at the chord [?], and the angle so-and-so; and the chord of the arc will be such, and it will be [?]… so-and-so degrees and so-and-so minutes, and the position so-and-so; and the smaller motion, by this chord, and the position of the planet, so-and-so degrees of [?] the correction. And so-and-so minutes, and the position so-and-so degrees and so-and-so minutes; and the remainder so-and-so degrees, additive — and these are the points of the correction.

Diagram. A construction in the upper portion of the page. From three points labeled across the top (ג, ד, ה), straight lines descend and converge: a vertical line drops from the central point ד to a vertex below (ז), where the oblique lines from the outer points meet it, forming a pair of triangles sharing the vertical as a common side. A short horizontal segment crosses the vertical at point ו, with a further point ח below. The lower outer corner shows the continuation of the rays to a vertex marked at the right (ט / ?).

- ג (top, left): label
- ד (top, center): label
- ה (top, right): label
- ו (on the vertical line, at the horizontal cross-stroke): label
- ז (lower vertex where the oblique lines meet the vertical): label
- ח (on the vertical line, below ז): label [?]
- ט (lower, the convergence point at the right): label [?]

such-and-such; and how much is the chord, and you derive what you derive of the correction of the smaller motion. And the position of the planet, by this, is additive — so-and-so degrees and so-and-so minutes; and the remainder so-and-so. And so-and-so minutes — and this will be so-and-so degrees; and so-and-so seconds and how much [?]. And the position of the planet from this is additive, so-and-so. And the chord of the arc will be such, and it will be so-and-so degrees and so-and-so seconds; and this is the position [?] at [?] the perigee. And so-and-so minutes; and the position of the planet from this is additive, so-and-so degrees; and so-and-so seconds — and this will be so-and-so degrees and so-and-so minutes.

Diagram. A symmetrical construction in the middle of the page. A vertical line stands with a point at its top (ה); from it an oblique line slopes down and to the left to a vertex (ו), and another oblique slopes down and to the right to a vertex (ז), the two together with a horizontal base forming a wide triangle. The vertical continues below the base, crossing it at a point (ט [?]) where a further short vertical descends to a lower point (י [?]). This is the chord-and-perpendicular figure for the correction at the apsidal line.

- ה (apex, top of the vertical line): label
- ו (left vertex): label [?]
- ז (right vertex): label [?]
- ח (on the base / vertical intersection, center): label
- ט (on the vertical, below the base): label [?]
- י (lower end of the short vertical): label [?]

and the position of the planet, additive [?]; and so-and-so seconds, and the position so-and-so degrees and so-and-so minutes. And the angle so-and-so degrees of [?] the chord; and you derive from this [?]… so-and-so degrees and so-and-so minutes. And every chord, and so-and-so seconds; this [?] is greater [יותר] than [?]…

Diagram. A construction at the foot of the page, in the lower inner corner. A long vertical line is marked with several points down its length (from top: ב, ג, [?] ד, ה, with the lowest point at the foot); from the top point (ה) a sheaf of straight lines fans out down and to the right to a common vertex. This is again a fan of chords drawn from successive points of the correction along the line of position to one vertex.

- ה (top of the vertical line, apex of the fan): label
- ד (on the vertical, below ה): label [?]
- ג (on the vertical, mid): label
- ב (on the vertical, lower): label
- [point at the foot of the vertical line, unlabeled / illegible]

the chord opposite the arc, and likewise the chord opposite the other arc, by the proportion of the chords. Now the chord opposite the arc of the whole [circle] will be such-and-such, so that this motion will be such-and-such degrees and such-and-such minutes; the [second] motion will be such-and-such degrees and such-and-such minutes; and the days will be such-and-such. So you already know the magnitude of this motion at any time you wish.

And since this is so — that the arc is such-and-such, and the chord opposite it is such-and-such — then this motion is by the proportion of the chords [opposite] the arc of the whole, which is such-and-such; and the second motion will be such-and-such degrees and such-and-such minutes, and the days such-and-such.

And we have already said that every time the arc is such-and-such, the correction [תקון] of the position [of the planet] will be by the proportion of the chords opposite the arcs, as we explained. For the chord opposite the arc whose magnitude is such-and-such will be such-and-such, and from it you will derive the correction of the position, which is such-and-such degrees and such-and-such minutes. And likewise for the remainder of the arcs: for any arc you posit, the chord opposite it will be such-and-such, and from it the correction will be such-and-such degrees and such-and-such minutes; and the days will be such-and-such.

And since this is so, the matter is established for the smaller motion [התנועה הקטנה]: that for every arc you posit, the chord opposite it will be such-and-such, and the correction such-and-such degrees and such-and-such minutes. And likewise the second motion, by the proportion of the chords opposite the arc of the whole, which is such-and-such; and you will derive from it the correction, which is such-and-such degrees and such-and-such minutes, and the days such-and-such.

(interlinear: such-and-such minutes)

And from this you may take the correction of the position, for it is by the proportion of the chord opposite the arc that we posited, whose magnitude is such-and-such; and the correction will be such-and-such degrees and such-and-such minutes, and the days such-and-such.

And since this is so — that we have already established the correction for the smaller motion by what we have set down — there remains for us to establish the correction for the other motion likewise, by the proportion of the chords opposite the arcs. For when the arc is such-and-such, the chord opposite it will be such-and-such, and the correction such-and-such degrees and such-and-such minutes. And we have already established, for the other motion, that for every arc you posit the chord opposite it is by the proportion [we gave]; and you will derive from it the correction, which is such-and-such degrees and such-and-such minutes, and the days such-and-such.

And we have already explained that this correction is according to the position [of the planet]; for when the arc is such-and-such degrees, the chord opposite it is

such-and-such, and the correction such-and-such [?]. And likewise for the rest of the arcs: for every arc you posit, the chord opposite it will be such-and-such, and the correction such-and-such degrees and such-and-such minutes.

And the matter is established by what we have explained for this motion likewise, as in the figure that we will draw. For when the arc is such-and-such degrees, the chord opposite it will be such-and-such, and the correction such-and-such degrees, and the second [value] such-and-such minutes.

And so we have explained the correction for both motions together, as we said, by the proportion of the chords opposite the arcs — for the smaller motion and for the other [motion].

Diagram. A fan-and-perpendicular construction. From an apex point ה at the lower left, three straight lines radiate rightward to a single vertical line (the perpendicular) at the right of the figure, meeting it at the points ז, ב, and ה. A fourth point א sits at the very top of the vertical line, above the highest radial. The vertical line is the locus on which the successive positions are marked, illustrating how each chord-and-correction value corresponds to a given arc.

- ה (apex, lower left): the vertex from which the three lines radiate
- א (top of the vertical line): uppermost marked point, not reached by a radial
- ב (upper point on the vertical line, where the highest radial meets it)
- ז (middle point on the vertical line, where the middle radial meets it)
- ה (bottom of the vertical line, where the lowest, near-horizontal radial meets it)

[Margin (left, f100r): marginal note in the primary hand, two lines, verbatim — "חות⟨?⟩ מותרו בדקים מהן שניים / ושיעור קו הד מאלפ⟨?⟩" — apparently a side-computation giving the magnitude of line הד and its remainder in minutes and seconds. Further identification requires further verification.]

And the second [motion] will be such-and-such; the correction is such-and-such degrees, and likewise [its complement]. So you will derive, for the other motion, that the chord opposite the arc is such-and-such, the correction such-and-such degrees, and the days such-and-such.

And likewise the arc, for it is by the proportion of the chords opposite the arc of the whole; and the second motion will be such-and-such degrees, and the days such-and-such. And from this you take the correction, for it is such-and-such degrees and such-and-such minutes, and the days such-and-such.

So we have explained the correction for both motions together according to the position [of the planet]: for any arc you posit, the chord opposite it will be such-and-such, and the correction such-and-such degrees and such-and-such minutes.

הנה [Behold] — and this is what we wished to establish: that the position of the planet is corrected at every position [of the deferent and the epicycle]. For at the time of the smaller motion the position of the planet is corrected by the proportion of the chords, and so too at the time of the larger motion the position of the planet is corrected likewise. And we have already verified this by demonstration, that this correction holds for both motions, as we explained.

For the magnitude of the arc is such-and-such, and the chord opposite it is such-and-such, and so the correction holds [?]. And you already know the magnitude of the smaller motion at the time of its course [in its proper measure], and the magnitude of the larger motion at the time of its course — for the two of them together complete the [whole] revolution.

And the chord opposite the arc whose magnitude is such-and-such will be such-and-such; and from it you derive the correction, which is such-and-such, for the position of the planet at every position you posit. And there remains for us [to treat] the matter of the corrections according to the position, by the proportion of the chords opposite the arcs that the planet traverses in its motion: for the smaller motion as we set down, and likewise for the larger motion.

And the foundation of this — by which the position of the planet is corrected, and the matter of the corrections — already Ptolemy [בטלמיוס] in his books made the foundation of his correction rest upon it. As for his demonstrations, as we set them down — that the corrections of the position are by the proportion of the chords — these are correct, and there is no doubt in them.

הנה [Behold] — and this is what Ptolemy [?] explained at length in this matter, and we have abridged it here, for it suffices to know that the position of the planet is corrected at every position by the proportion of the chords opposite the arcs, as we set down.

And what remains of this — to complete what is fitting concerning the correction of the position of the planet, and of the rest of the planets according to their several motions — we leave to those who come after us, for the words [we have given] are sufficient.

the smaller motion, since it would be so. And it would be in the proportion that you know, of the proportion that is between the smaller motion and [?] — for in

this way you can determine the variation that is generated in this matter. And it would be a small matter [?] in the position of the planet, so that the variation [?] arising here would be such-and-such, and the matter would be of the kind we mentioned.

For when we examine the smaller motion, we already know — by the line of position that is drawn between the two centers, and what is generated from it in the correction — that the proportion of the chord to its arc is already known. And from this it follows that the remainder which is generated here is such-and-such, in accordance with what the matter requires.

And when the larger motion is examined, by this same path, the remainder will be such-and-such; and so it is found, by the path of the chord that you know, that the variation generated in the position of the planet is by such-and-such degrees. And since this is so, when we wish to determine the position of the planet by means of the eccentric circle and the epicycle, we will already know — from what was established by Ptolemy — and afterward we will investigate [the rest].

(interlinear: a small inserted word above the line, illegible — single short token.)

For the chord and the perpendicular that are drawn here, the proportion of the one to the other is already known; and from this it follows that the angle is such-and-such, and that the remainder which is generated in the smaller motion is such-and-such. And when we add to this the [?] of the larger motion, what is generated will be in the proportion you know, and the correction that arises here will be by such-and-such degrees.

And this is plain, since the proportion of the perpendicular to the chord is already known by the path we mentioned; and what follows from this in the position of the planet is that the variation generated here is by such-and-such. And in this way, when we know the smaller motion, it is possible for us to know what is generated from it in the correction, by the proportion that you know — and likewise for the larger motion.

For the matter is, in truth, that the perpendicular which is drawn from the point [?] to the line of position cuts off from the arc a portion such that the proportion of the chord to the perpendicular is known; and from this the correction that we seek is generated. And it has already been explained that this is the foundation of the whole matter, and that what follows from it is correct, in the way we set down.

And the matter is such that, when we examine the position of the planet by means of the eccentric, what is generated in the correction is by such-and-such degrees; and likewise when we examine it by means of the epicycle. And from this it is plain that the two paths agree, and that what is generated from the one is equal to what is generated from the other — and this is fitting [?]. For the proportion that you know holds in both, and the variation generated here is such-and-such.

And since this is so, it has already been explained that the foundation of this whole matter was set down by Ptolemy, and that the completion of it falls to those who come after us — for he did not complete every part of it, but laid down the principle, and left the rest. [?]

and it is generated, and the matter would be in the proportion you know, and the matter would be such [?]. So the proportion is determined, and the proportion is determined in accordance with what [?]. The chord, according to the proportion of the arc that is drawn here, [is such-and-such] — for the matter of the chord depends on the arc, and there is for it [?]. And likewise, in the smaller motion, it is not [?]; behold, this would be the matter we mentioned.

And so it is, when we know the smaller motion, that we know what is generated from it in the correction, and what follows in the position of the planet; and likewise, when the larger motion is known, what is generated from it would be in the proportion that you know. And this is plain, since the position of the planet would be known by the path we mentioned, by such-and-such degrees — and so it is found that the correction which is generated here is in the proportion you know.

For the perpendicular that is drawn here, the proportion of the chord to it is already known; and from this it follows that the remainder is such-and-such, and that the variation generated here is in the proportion you know. And when we wish to know the position of the planet by means of the eccentric and the epicycle, it is possible for us to do so, since the matter is correct by the path we mentioned, and what is generated from the one path is equal to what is generated from the other.

For the matter is in truth that what is generated here is in the proportion you know, and the variation generated in the position of the planet is by such-and-such; and since this is so, the correction is determined. And further, since the perpendicular and the chord — the proportion of the one to the other is known — it follows that what is generated here is such-and-such, and the matter would be

of the kind we mentioned. And the matter would be such that the proportion which you know holds.

For the perpendicular that is drawn from the far [point] [?] is generated, and there is for it the proportion you know; and likewise, the proportion of the chord to it would be by the path of the larger motion, according to the proportion you know. And what is generated from the smaller motion, and likewise from the larger motion — the correction that is generated from it would be by such-and-such, in the way we set down; and this is fitting.

[Enlarged display word הגב ("the apogee / the back") — written large mid-to-lower on the right half of f101v, the line continuing in normal script; apparently a section opener on the apogee.]

הגב ["the apogee"] [?] — [the line continuing after the display word is not legibly recoverable on the scan even under magnification: [?]... [?]... [?]].

For when the smaller motion is examined, by the path we mentioned, the proportion of the chord to the perpendicular is already known; and from this it follows that the remainder generated here is such-and-such. And likewise the larger motion: when it is examined, what is generated from it would be in the proportion you know, by such-and-such degrees, in the way we mentioned. And it is plain, since the matter is correct by the path we set down.

For the proportion that is generated here, of the chord to the arc, is known; and the correction that is generated from it would be by such-and-such, and the matter would be of the kind we mentioned. And since this is so, the matter is determined, and the position of the planet is generated by the path we mentioned, since the matter is correct by what we set down — and the variation generated here is in the proportion you know, by such-and-such degrees.

And it has already been explained that the proportion you know holds in the smaller motion and in the larger motion, and that what is generated from the one is equal to what is generated from the other; and the correction that is generated here would be by such-and-such, by the path we mentioned. For the perpendicular and the chord, the proportion of the one to the other is already known, and the position of the planet is generated [by] the variation that follows here, such that the matter would be in the proportion you know — [up to?] the determination of the position [?].

the line of position [קו ההיקש] and the chord [חוט], for it is the chord whose arc is so-and-so [כך]. And it has already become clear that the chord does not depart

from its proportion except by a small amount, so that the variation [חלוף] in it is slight. The point follows upon the perpendicular [עמוד], and the matter is as the geometers [הטועמים] have laid it down.

It is fitting that you reckon the distance between the two centers [שני המרכזים] from the apogee [גובה], and that you reckon what answers to it on the perpendicular. From this the remainder [מותר] becomes known, and the correction [תקון] which follows from it for the position of the planet [מצב הכוכב]; and there is here a variation [חלוף] in the position, which is to be taken into account whether the motion be the smaller motion [תנועה הקטנה] or the larger.

[Interlinear, above this line: גם לא בכאן יהיה הענין כפי שלמות (?) — "neither here is the matter according to (the) completeness/perfection," supplied as a correction to the line below; reading uncertain at one word.]

And from this it follows that the variation is not equal in the two cases, but rather the proportion of the chord to the arc, and the proportion of the chord to the perpendicular, differ. For when the motion is small, the chord is nearly equal to its arc, and likewise nearly equal to the perpendicular; whereas when the motion grows large, the chord falls short of the arc by a considerable amount, and falls short of the perpendicular as well. Therefore the remainder differs, and with it the correction, and with it the position of the planet.

This is the reason the geometers laid down what they laid down concerning this matter — namely, that the variation is not uniform, but follows the proportion of these quantities to one another. And it is in this respect that this correction differs from the first, for the first proceeds by way of the eccentric circle [גלגל היוצא], whereas this one proceeds by way of the epicycle [גלגל הקפה], and the two are not alike in their behavior, since the center of the one is not the center of the other.

And from what we have set down it has become clear that the difference between the mean place [מקום אמצעי] and the true place [מקום אמתי] is what is called the correction; and this correction is sometimes additive [מוסיף] and sometimes subtractive [גורע], according to whether the planet is on the side of the apogee or on the side of the perigee [שפל].

When you have grasped this, it is easy for you to find the position of the planet at any time you wish, once the mean place is known to you; for you add the correction to it, or subtract it from it, and there results the true place. And this is what we intended to demonstrate here regarding the matter of the correction [תקון] by way of the chord.

[The body prose continues for roughly eight further lines into the lower portion of folio 102r (running to about three-quarters of the page height); the bottom quarter of the folio is blank parchment. These continuation lines are in the same semicursive hand but faded, and cannot be securely transcribed line-by-line at this resolution; their content is therefore not committed here. [Several untranslated lines: ?]]

[Margin, foot of folio 102r (small later hand): גם זה (?) … צריך עיון — "this too … requires examination"; a constructive marginal note, two further words illegible. Further identification requires further verification.]

the geometers laid down. And the cycle [קלקוס; Greek: κύκλος, "circle/cycle"] is one and the same in its arc together with the perpendicular and the chord, so that they did not… (text continues), for it has already become clear to us that this is so. And from this it has become clear that the chord and what answers to it [המקביל] — the matter being as we said — there is in it a variation that is taken into account in the position of the planet, just as we explained above.

For the matter is such that when the motion is small, the chord is nearly equal to its arc, and there is then little difference between them; but when the motion grows large, the chord departs from the arc, and likewise from the perpendicular, by a considerable amount. And the geometers were precise [דקדקו] in this, and laid down what we have set down.

הנה [emphatic: "Now then" — enlarged opening word, not a chapter rubric] — when you reckon the chord whose arc is so-and-so [כך], and reckon what answers to it on the perpendicular, and take the remainder between them, you will find the correction [תקון] for the position of the planet; and this matter holds whether the planet be on the side of the apogee or on the side of the perigee, and it differs only in being additive or subtractive.

And it has already become clear from the words of the geometers that this is so, and that the correction by way of the chord is a matter that grows and diminishes according to the proportion of these quantities to one another — for it is not uniform, but follows the magnitude of the motion. When the motion is small, the correction is small, and when the motion is large, the correction is large; this is its way and its measure.

And it has become clear that the chord and the perpendicular, beneath the cycle [קלקוס], differ in such-and-such a way [כך], so that the matter holds as we explained; for the chord is shorter than its arc, and the perpendicular is shorter

than the chord. And therefore there is between them a remainder which is the cause of the variation in the position of the planet.

[Several further lines of body prose continue here in the same hand; faded and not securely transcribable line-by-line at this resolution, so their content is not committed here. [Several untranslated lines: ?]]

And the geometers laid down beneath the cycle [קלקוס] what was laid down, that the matter holds as we said; and the chord which is beneath the arc, when its arc is so-and-so, the perpendicular answering to it will be so-and-so, and the remainder between them so-and-so, and from it the correction is found. And this is the matter in its place.

[The body prose continues for roughly seven further lines into the lower portion of folio 102v (running to about three-quarters of the page height); the bottom quarter of the folio is blank parchment (a small ink blot sits in the lower-left blank margin). These continuation lines are in the same semicursive hand but faded, and cannot be securely transcribed line-by-line at this resolution; their content is therefore not committed here. [Several untranslated lines: ?]]

[Later hand: folio number "103" (pencil and ink), top outer margin of f103r]

which the aforementioned chord [yields]; and the position of the chord is such that the line moves [?]. By this it is established that the chord… upon them; and just as the third chord… and from this it follows that this is not [the case]. And he said…

before its end this is so [?] with the chord, and it is established… that the magnitude of the chord is such-and-such [כך], and so… the chord is so-and-so, and it has already returned… so-and-so parts; and from this it is established that… the position of the star is upon the chord; and it remains… upon the chord, and the position remains [?]. And further… are equal in this magnitude… in their like; and from this it is established that… and just as this correction [תקון] is made [?] and it… your hand will reach to the magnitude, since the magnitude in [?]… the remainder [שאר] is what is required [?] you in this…

of the two stars, since the magnitude of the chord… of the star upon the chord; and indeed it is found [נמצא] that the position… in the chord. And whatever is so-and-so [כך] degrees, then it returns and… of the line of position upon the perpendicular [עמוד], and the magnitude of the cycle [קלקוס] is… and the parts that remain upon the chord, and the position… so-and-so degrees [כך מעלות]; and from this it is established that… this correction is the difference between the two

centers, and it… in the motion [תנועה], its magnitude being so-and-so; and it will be… it will be the chord, or the line of position to them [?]. Behold [הנה], from this correction this chord is… of the star upon the chord; and there is no doubt of… of the [eccentric] circle, equal upon the perpendicular; and we have already… so-and-so, [past] the apogee [גובה] the star upon it [?]; for the position… is not [?], so that this chord is the magnitude…

upon the chord; from the perpendicular, since… and he said: it will return continually upon the [eccentric] circle… of its motion until it is corrected within it [?]… the degrees of the [eccentric] circle which is upon the chord.

[Lower half of f103r blank.]

and Ptolemy [בטלמיוס] already established this, and from it… in the [eccentric] circle from these [?] equal magnitudes [נכוחיים, "corresponding"]; this chord… the [eccentric] circle, and upon the chord which divides… the chord, since it is so [?] of the magnitude… because it is upon the chord, until it returns to its measure… so-and-so upon the chord, and the chord which… the [eccentric] circle, and the position of so-and-so… so-and-so degrees, and it remains so [?]; behold the line of position… so-and-so degrees, and there is no doubt of… of the chord [?], so that the chord remains [?]. And he said: just as the chord is… so that the magnitude is so-and-so within it [?]… continually, until it is corrected upon the [eccentric] circle; and the position…

Behold [הנה] [enlarged display word], when we examine the magnitude of this correction, and we know its magnitude or its value, the [eccentric] circle… so-and-so to it; and so, when… [?] in the [eccentric] circle from these corresponding [נכוחיים] magnitudes. This chord… upon the perpendicular [?], and it will return [?]… the corrected position [?]; and the chord which divides it [?]… the star upon the chord, until it is corrected with the equal [magnitude] in [?]… the [eccentric] circle, and the position of the star is so-and-so, so-and-so degrees [?]… so-and-so degrees [?].

[Diagram begins, bottom outer portion of the page.]

the magnitude of the chord; from the perpendicular, since…

and just as the magnitudes of the corrections, the centers, so-and-so [?]… the magnitude of the chord, its measure; and the chord… so-and-so it will be the chord; upon the perpendicular [?] … and that which divides toward the [eccentric] circle, the magnitude of the chord [?].

Diagram. At the foot of the outer (left) column of f103v, a geometric figure for the chord/perpendicular correction. It is a single circle with a marked center point. Four straight lines run from the center out to labeled points on the circumference — two upward (upper-left and upper-right) and two roughly horizontal (mid-left and mid-right), forming a fan/X about the center. A further near-vertical line descends from the center and crosses the lower arc at a labeled point, continuing downward. Below the circle a triangle is drawn whose apex coincides with the circle's center and whose base lies well below the circle, the left side of the triangle passing through the lower-arc point. A short, faint caption is written above the top of the circle.

- ה [?] (center of circle): central point from which the lines issue; also the apex of the triangle
- ג (upper-left, on circumference): endpoint of the upper-left line
- ד [?] (upper-right, on circumference): endpoint of the upper-right line; reading ד/ה
- ז (mid-left, on circumference): endpoint of the left line
- ז [?] (mid-right, on circumference): endpoint of the right line; reading ז/ו
- ב (lower-arc point): where the near-vertical line / the triangle's left side crosses the lower arc of the circle
- ב (lower-left, base corner): left foot of the triangle
- ד [?] (lower-right, base corner): right foot of the triangle; reading ד/ר

[End of text on f103v; lower portion of the page below the diagram is blank.]

upon it, so that it [the correction] is the magnitude that has been removed. The correction that we found is from the cycle, and likewise from the parallel [the deferent circle]; and it does not come out [of the calculation] except according to what is fitting. The motion that is in the chord [?] — its place is such that the difference between the two [arcs] is such-and-such.

[Right margin, smaller and fainter hand, a short three- to four-line constructive note keyed to the prose; only fragments are legible — "…… / זה זה… / ובו… / זה כפי" [?] — further identification requires further verification.]

For this reason the difference between them will be greater, and the magnitude will be such-and-such; and it has already been clarified that the difference between them and the equating-line [המעדיל, the equant line] [?] is such-and-such, and the magnitude that the chord moves it is greater. By contrast, where the place of the planet [מצב הככב] is at the perigee [the nearest point], the difference is smaller, and it is such-and-such.

הנה [enlarged display word: "Now, observe—"] those who proceed by way of the chords [ההולכים בדרך החוטים] — let them set down the correction of the corresponding magnitudes [הנכוחיים], so as to take from it the half [?] of the cycle of Ptolemy [מקום תלמיוס, "the place of Ptolemy"], the cycle that was [established], and the chords that they see. And [for] the perigee and the apogee [the near point and the far point], in the manner that we set down the correction of Ptolemy, and likewise…

the magnitude that is removed from the parallel [the deferent], and the magnitude that is added to it. It has already been clarified that the difference between them is such-and-such, and the magnitude of the chord is such-and-such. There is here a portion that the correction adds — more than is necessary — and there is here a portion that the place of Ptolemy adds, and this one is greater, and this…

such-and-such degrees [כך מעלות]. And if one looks into the magnitude that the parallel [the deferent] takes — namely such-and-such degrees in this — the chord will be such-and-such, and the place will be such-and-such. And when one looks into [the matter], one finds the half [?] of the cycle to be such-and-such, and the place of the cycle to be such-and-such.

This is what we wished to set down: that one should grasp the magnitude of the correction, the place of the chords, and likewise.

And when the magnitude of the chord is such-and-such, the magnitude of the place is the correction; that is to say, it has already been clarified from this — the correction, the place, and the corresponding magnitude [הנכוחי]. And this correction is according to [the proportion] [?].

such-and-such; and one looks into the magnitude — namely such-and-such; and the magnitude of the chord is such-and-such, and this is the half-difference. And this is the corresponding magnitude [הנכוחי].

And likewise the place of the cycle is such-and-such, and the chord is more correct [יותר נכון]; and so it goes for them. And this one is greater, and this…

and the place is such-and-such, and one looks into how much the chord moves [the planet]. And if one looks into how much it moves it from this place, one finds the corrected place; and this is the magnitude of the correction.

[Several further short lines continue the same procedure, naming alternately "the chord" and "the place," each set equal to a magnitude of "such-and-such."]

[At the foot of the f104r text block the script descends into very small writing with single-letter quantity-markers — "…כ ב כ ש ג…" [?] interspersed — a side-tabulation of the magnitudes; the individual letters are too small and abraded to commit to values.]

the magnitude of the place, such-and-such degrees of the correction [שיעור תקון], the chords [החוטים], so that at the time he sets it down, the place will be such-and-such. And the cycle of Ptolemy [מקום תלמיוס], and the near point [החאוף]…

one should grasp the magnitude of the correction, the place of the chords, the corrected place, as has already been said, and likewise…

the corresponding magnitude [הנכוחי], the correction that occurs here…such-and-such; the half-difference [חצי המעשית, "the half of the operation"] [?], and the magnitude is small; and the magnitude of the cycle of Ptolemy is such-and-such, and the…

such-and-such degrees, and so it shall be — and [from] the place of Ptolemy, the cycle that was [established], it is in the place such-and-such; and there…

the correction will be such-and-such, and the magnitude is small [מעט]; and there is here a portion that the correction adds, and there is here a portion that the place of Ptolemy adds, and this one is greater. And the second…

such-and-such. And the place will be such-and-such, and one looks into the magnitude — namely such-and-such degrees — and the chord will be such-and-such, and the place will be such-and-such.

הנה [enlarged display word: "Now, observe—"] and [up] to [it]…such-and-such, the chords [החוטים]…

the corresponding magnitude [הנכוחי], and one looks into how much the chord moves [the planet]; and this…and so it goes for them; and that which is set down…

And likewise the corresponding magnitude [הנכוחי]: the magnitude that the correction takes is such-and-such, the magnitude of the place is such-and-such… and there is here a portion…

הנה [enlarged display word, mid-folio: "Now, observe—"] here is the second portion: it is the half-difference of arcs [חצי המעשית, the half-operation] [?] of the two cycles [שני הקפים — Ptolemy's cycle and the parallel/deferent], and this is the difference between the two corrections.

the magnitude that the correction adds is such-and-such, and the magnitude of the place is such-and-such, the correction; and this is the half-difference, and this is the corresponding magnitude [הנכוחי].

And one looks into the magnitude of the place…such-and-such of the cycle, and the chord is more correct [יותר נכון]; and so it goes for them, up to [the point where] the difference between the two [arcs] is such-and-such.

and one looks into how much the chord moves [the planet], and how much the place moves [it]; and one finds the corrected place — and this is the magnitude of the correction.

such-and-such of the correction; the corrected place is such-and-such of the cycle; and the magnitude of the place is such-and-such, the correction; that is to say, from this — the place and the corresponding magnitude [הנכוחי].

the magnitude that the chord moves is such-and-such; and the place of the cycle is such-and-such; and one looks into the magnitude of the place of Ptolemy, and there…

such-and-such; one looks into such-and-such degrees, and to the place such-and-such; and one finds the corrections, the corresponding magnitudes [הנכוחיים] of the cycle; and one looks into the half [?]…and so it shall be, and it will be more correct. The correction [תקון]…

in such-and-such a way; and the angle [זוית] will be such-and-such. And likewise the angle that is found from this will be such-and-such degrees, and so many minutes [דקים], and so many seconds [שניים], as has been explained. But when the degree is so much, then [the result] will be so much; the remainder [המותר] will be such-and-such. And since the line of position [קו ההיקש] is so many degrees and so many minutes, the angle will accordingly be such-and-such.

When the line of position is such-and-such — for example, when it is so many degrees — its angle will be so many minutes. And likewise, when the line of position is so many degrees, its angle will be such-and-such. And when the line of position is 16 degrees, its angle will be such-and-such; and so many seconds; and so it is here, for it [the line of position] is 13 degrees [?]. And accordingly, when the measure of the line of position is so much, its angle will be so much, and so many seconds; and so it is. The line of [point] נ is so many degrees and so many minutes [?], and this is [point] he. And it [the angle] is so much by the power [בכח] of so many parts [חלקים] of the arc; and this is so. And when the measure of the line of position is so much, then the angle of [point] יד will be such-and-such

degrees, and so many seconds; and so it is. The line נ is so much by the power of so much, and this is [the value] we sought, and likewise.

Therefore the angle of [point] ל will be 30 degrees [?], and so many seconds; and so it is. By way of the chords [בדרך החוטים], the line of position is so much, and this is the line ל. The angle of [point] he is so much by the power of so much, and this is so. And already it has been clarified [נתבאר] that this is the remainder [שאר] of the arc, and the angle is such-and-such, and this is [point] he. For when this is clarified, the angle of [point] ל is what we sought; and it accords [with the chords method].

So you must take the difference of the two angles [חלוף שתי הזויות] that has been found, and divide it [תחלקהו] by the line of the two centers [קו שני המרכזים], which is the line נק. And the result will be the correction [התקון], which is [point] he. And this is the difference [חלוף] that is between this angle and that one. And the matter is, as we said, that this [point] is the one we sought by way of the chords, and likewise.

Diagram. A compound figure in the upper part of the lower-left region. It shows one large central circle with a smaller circle overlapping it at the top and a second smaller circle overlapping it at the bottom; the three circles share a common vertical axis (they are not nested concentrically). A vertical diameter line runs down through all three circles. A short chord runs from the apex of the upper circle to a point on its right; from there a zig-zag of two segments descends along/near the axis to a point inside the lower circle, where a short oblique segment is drawn. Labeled points (reading the ink letters as marked):

- א (apex of the upper small circle, top of the vertical): א
- ד (upper small circle, left): ד [?]
- ב (upper small circle, right, where the chord meets it): ב
- ד (on the vertical line, mid-figure): ד
- ה (vertex of the zig-zag, lower on the vertical): ה
- ז (inside the lower small circle, endpoint of the oblique segment): ז
- ל (lower-left, where the lower small circle meets the large circle): ל [?]
- ל (bottom-center, foot of the lower small circle on the vertical): ל

Diagram. A single circle with a vertical diameter and an inscribed triangle, in the lower-left of the page. A vertical line runs from the top point א down to the bottom point ז. From a point ב on the left of the circle, a horizontal line runs to a point ד on the vertical, and an oblique line runs to a point ה lower on the vertical, forming the triangle. Labeled points:

- א (top, on the circle): א
- ב (left, on the circle): ב
- ד (on the vertical line, at the horizontal): ד
- ה (on the vertical line, below ד): ה
- ז (bottom, on the circle): ז

Diagram. A single circle with a vertical diameter and an inscribed triangle, in the lower-right of the page. A vertical line runs from the top point א down to the bottom point ז. From a point ל on the left of the circle, one line runs to a point ו on the right (mid-figure) and another line runs down to a point ה lower on the vertical, the two meeting to form the triangle; ד is marked on the vertical above ה. Labeled points:

- א (top, on the circle): א
- ל (left, on the circle): ל
- ד (on the vertical line, mid-upper): ד
- ו (right, mid-figure, triangle vertex): ו
- ה (on the vertical line, lower vertex): ה
- ז (bottom, on the circle): ז

[Diagram caption, in the upper portion of the page above fig-p210-1, faded brown ink — two lines:] …such-and-such [?]; the line of so many degrees [?] and so many minutes; the measure of the correction [שיעור התקון] and the line [?].

Diagram. A single circle with a vertical diameter line from a top point א to a bottom point ז. An inscribed triangle is formed by lines from a left-hand point ל on the circle to two points: an upper vertex ג and a vertex ה on the vertical line. Labeled points:

- א (top of the circle, on the vertical): א
- ג (upper vertex of the triangle): ג
- ה (vertex of the triangle, on the vertical): ה
- ל (left, on the circle): ל
- ז (bottom of the circle, on the vertical): ז

You make the correction [the equation] from it [the figure], and it [the value] comes out to be such-and-such, as has been clarified. And so the correction will be so many degrees, when the [argument] degree is such-and-such. The first arc [הקשת הראשון] is the arc הנב [?], and this is what we sought by way of the chords,

just as in the figures [the diagrams] of the cycle [הקלקוס]. And the figure of the eccentric [גלגל היוצא] resembles it [דומה], and this is so.

And here the measure of the correction [שיעור התקון] is, when the degree is such-and-such, so much; and the result of the addition [מוסף] will be so much when the degree is such-and-such. And likewise the [other] arc, which is the remainder [שאר] from such-and-such; and this is so.

הנה [emphatic opener — *Now, indeed*] — and now we set down the perpendicular [העמוד] that has been [drawn] within, by way of the chords, and we shall set it down likewise for the corrections [התקונים]. As for every chord [חוט], one takes the chord of the difference of the two arcs [חלוף שתי הקשתות], and likewise the chord of their sum [קבוצם]. And the measure of the arc was already such-and-such, as we explained.

The line of position [קו ההיקש], and the eccentric [גלגל היוצא], so that the result [will be] such-and-such, and this is so. And both of them — when the degree is so much — and likewise when the degree is 16 [?] minutes; and this accords. And so it has been clarified that the corrections [התקונים] are such, and that the corrections accord [with one another], and this is so.

And from this it has been found that the chord of the difference [חוט החלוף] is, by the power [בכח] of so much, the arc of so many degrees and so many minutes; and this is the place [המקום] of the correction. And the chord of so much, and the arc of so much, are such-and-such [?], and this is what we sought.

And from the place [מקום] of the eccentric, the correction [will be] such-and-such; and from the place of the cycle [הקלקוס] likewise, so that they are equal. And in this way you will know it for the rest of the points [הנקודות], so that it will be a determination [?]: that the measure of so much is so much, and so much by the power of so much. And the chord [will be] such-and-such [?].

And it has been found that the correction by way of the eccentric is such, and by way of the cycle is such-and-such, so that they are equal. The first arc is such-and-such, and likewise the corrections [?]. And from the place of the correction, the measure [will be] such-and-such; and this is so.

For when the chord [החוט] is so many parts [חלקים], and its measure is such-and-such, and the line is so much — for example, when [the argument] is so much — its measure will be such-and-such, and likewise the second [arc] is such-and-such; and so it is. And when its measure is so much, the line will be so much, and so it is found. And from such-and-such it will come out: that the line of the first [arc] is

such-and-such; and so it is. And here the angle is so much, and the place is such-and-such, the correction [being] so much; and this is what we sought. The first arc is such-and-such, and the correction is so much; and from such-and-such — and here the correction is so much [?] — and this is so.

For when the measure of the correction is so much, the line is so much, and this accords; and so it is. And here the correction is such-and-such, and the difference [המרחק] between this correction and that one [will be] so much; and this is so.

And the place [המקום] will be so much when the degree is such-and-such; and it will be a result [נכוח?] of so many minutes, and so it is found. And here it is so, and likewise it will not be a difference [?] of more than so much; and so it is, that the difference [המרחק] from this and from this is so much.

And the correction will be such-and-such, when the degree is so much; and it [the result] is more accurate [?] than this. And in this way you will know it for the rest of the corrections — when the degree is such-and-such, the correction is so much; and the difference between this correction and that one is so much. And it will be the correction. And so it has been clarified that the correction at the degree of so much is so much, by the power of so much.

And in this way you will know the difference [המרחק] of the corrections that are between the eccentric [גלגל היוצא] and the cycle [הקלקוס], and the measure of the correction of the first arc [is] such-and-such; and likewise the rest, and the corrections will be equal [?].

[Lower half of f105v: a faint preliminary drypoint/lead sketch of a circle with internal radii and a short caption above it — not inked. The sketch is a constructive helper for the figure above and carries no committed ink labels. Lower margin blank.]

[Margin: faint two-line note in the lower-left, light brown ink, partly abraded — apparently a side computation referencing the line of position and the minutes; not securely legible.] [?]

Sefer HaTechunah — folios 106r–106v

[Later hand, top margin: "106" (pencil) and "106" (ink) — folio number.]

and likewise the two seconds, and so too the parts. And the line is established by the chord, and so too by the chord of arc such-and-such [כך] degrees, which is the

corresponding line. So you have already grasped the procedure by which the measure of the correction [שיעור התקון] is found.

Now, since the two seconds and the parts together are such-and-such, and the arc was already given as such-and-such degrees, the angle that arises will accordingly be such-and-such. And the remainder [מותר] that arises between these magnitudes — that is, between the first magnitude and the second — is the perpendicular [עמוד], for the perpendicular is the measure of arc such-and-such degrees, and that is what was required.

And again, when the arc is such-and-such degrees and such-and-such minutes and such-and-such seconds, then the angle that corresponds to it [the angle subtended] will be such-and-such, and the chord of that arc will be such-and-such degrees. So this remainder [שאר] is the measure of arc such-and-such degrees, and that arises by way of the chords [בדרך החוטים], as we set out earlier.

Therefore it is plain that this procedure yields the correction whether you compute it by the line of the two centers [קו שני המרכזים] or by the chords; the two methods agree. And the perpendicular that falls from the point of the star [or: from the place] is itself the measure of the correction in arc such-and-such degrees and such-and-such minutes; and so too if it were such-and-such [a different value], the result would still agree.

And here [הנה] it is the remainder [מותר], for just as the measure of arc such-and-such degrees is so, likewise the measure of the [corresponding] arc will be such-and-such degrees, which is the chord. So the line, which is the chord, is the perpendicular, just as the measure of arc such-and-such degrees [is the chord]; and this is the remainder.

And once more: the measure will be such-and-such degrees, and there will be such-and-such minutes and such-and-such seconds, and a further matter [ועוד] — and the remainder is the perpendicular, and the matter is established. The measure is such-and-such degrees, and so too there will be such-and-such minutes and seconds.

Diagram. A circle in the upper-left of the folio, with an inscribed figure of chords. From the apex ד at the top, lines descend to points on the circumference and to interior points, forming a star/triangle of chords. The construction illustrates the correction-by-chords method discussed in the surrounding text.

- ד (apex, top of circle): vertex from which the construction lines descend
- ז (upper-left, on circumference): endpoint of a chord

- ב (right, on circumference): endpoint of a chord
- ה (interior, center): a meeting-point of the lines
- ו (interior, between center and apex line): point on a descending line
- ה [?] (lower interior intersection): meeting-point of lower chords
- ע [?] (lower-left, on circumference): endpoint of a chord
- ז [?] (lower-right, on circumference): endpoint of the lower chord

the measure, then, is such-and-such degrees, and the seconds and the parts are such-and-such. And here [הנה] this remainder is by way of the chords, as we set out, and likewise the measure of the corresponding arc [is found]. And here the measure is such-and-such degrees and such-and-such minutes, and there will be such-and-such seconds; and so too the corresponding magnitudes.

And here this is the measure of the correction [שיעור התקון] in parts, and so the correction will be such-and-such parts; and so too if it were such-and-such, the correction will accordingly be such-and-such parts. So the matter is plain.

And here, when the arc is such-and-such degrees, then the corresponding angle will be such-and-such, and likewise the perpendicular that falls upon it will be such-and-such. And the remainder that arises between the two magnitudes — that is the measure of the correction in arc such-and-such degrees, and that arises by way of the line of the two centers; and the two methods agree, as we explained.

And here, when the arc is such-and-such and the corresponding chord such-and-such, then the perpendicular will be such-and-such; and the remainder is the measure of the correction. And the corrected magnitude [will be] such-and-such degrees and such-and-such minutes and such-and-such seconds.

And here, since the matter is established by the perpendicular and by the line of the two centers alike, the two methods agree, and the correction is found. And the corrected place [or: the corrected magnitude] is such-and-such degrees and such-and-such minutes.

And here, as the sages [the geometers] have established these matters, by way of the chords the perpendicular [is found]; and what they established by way of the chords is such-and-such, and the matter is plain — and the rest will arise likewise.

Diagram. A circle in the upper-right of the folio carrying the same correction construction as fig-p211-1: from the apex ד at top, chords descend to points on the circumference and to interior points around the central point ה. A short two-line

cursive note is written inside the circle, lower-left of center; it is not securely legible (its second line reads approximately עיונך [?]) and does not parse as a figure caption — earlier reading "center of the eccentric circle" is not supported by the ink.

- ד (apex, top of circle): vertex of the descending construction lines
- ז (upper-left, on circumference): endpoint of a chord
- ב (right, on circumference): endpoint of a chord
- ה (mid interior, left of center): interior meeting-point
- ו (interior, on a descending line): point on a construction line
- ה (center): central point of the construction (the two-line note sits beside it)
- ע [?] (lower-left, on circumference): endpoint of a chord
- ז [?] (lower-right, on circumference): endpoint of the lower chord

Diagram. A large circle in the lower-right of the folio with center ה, from which many chords and radii radiate to points on the circumference and to interior intersections, producing a dense web of triangles. This is the fullest of the three figures and corresponds to the generalized correction-by-chords construction.

- ו (top, on circumference): topmost labeled point
- ז (upper-right, on circumference): endpoint of a chord
- ז (right, on circumference): endpoint of a chord
- ב (lower-right, on circumference): endpoint of a chord
- ו (left, on circumference): left endpoint of a chord
- ה (center): center of the circle, from which the radii issue
- ב (interior, right of center): interior intersection point
- ז (lower-left, interior): interior point on a descending line
- ה [?] (lower node, near bottom): meeting-point of lower chords
- ב [?] (bottom-right, on circumference): endpoint of the lower chord

[Lower portion of f106v below the third diagram continues with text; not transcribed in this diagram-verification pass.]

Sefer HaTechunah — folios 107r–107v

[Later hand: folio number "107" in pencil and in ink, upper margin]

and it follows, and it accords with what we have already explained: that the arc which the correction [תקון] produces will be such-and-such degrees. The depth

here is double; therefore the line that runs from the remote one to the near one comes out longer than the line that runs to the equating point. And consider this with respect to the matters that arise when one operates by the method of the chords [דרך החוטים], namely the matter that we are now investigating.

Therefore the correction in this configuration falls in a manner agreeing with what comes out by the method of the chords, since here too the line of the two centers [קו שני המרכזים], when it is corrected, follows the same pattern. By this it has been verified for us, and the matters are now fully equal: for the correction in this configuration is the very same correction that comes out by the method of the chords, and so the two methods agree.

Now since this is so, the difference between the two of them will be such-and-such degrees, and this is a small remainder. And when you take this remainder and you measure it against the whole, the proportion of it to the whole is the proportion which the correction bears to the line of the two centers. From the chord of the doubled arc you obtain the perpendicular that falls from the place of the planet upon the line of the two centers, and this perpendicular is the chord of such-and-such degrees, which is the correction we sought.

And consider, with respect to that which we have set down, that the correction proceeds from the arc to the angle and from the angle to the chord: for the arc gives you the angle, the angle gives you the chord, and the chord is the correction itself. This is the correction that falls in agreement with the method of the chords, just as we explained above. From this it has become clear to you that the two roads lead to one place, and that there is no disagreement between them at all — only that the one is more direct than the other in the working.

And when we examine the remainder that is left after the correction, we find that it is small, and that it does not perturb the position by any perceptible amount. Therefore one may rely upon either of the two methods, since the difference between them is such-and-such degrees — a quantity so slight that it is not to be reckoned with in this investigation.

And so it has been verified that the correction in this configuration is such-and-such degrees, and that it falls in agreement with what comes out by the method of the chords; and the remainder between the two is so small that it makes no difference, neither in the position of the planet nor in anything that depends upon it.

it follows from this that the position which the correction produces will be such-and-such degrees, and Ptolemy [Interlinear gloss above the line: בטלמיוס

("Ptolemy")] reached this same value by the method of the chords. For when the depth is such-and-such, the line of the two centers comes out such-and-such, and from it you obtain the perpendicular and the chord — and this is the correction.

And consider this with respect to the matters that arise here: for the configuration here is the equating configuration, and the correction that falls in it is such-and-such degrees. So Ptolemy too, in his investigation, arrived at this value, and the matters are equal; there is no difference between us and him except such-and-such a small remainder, which does not perturb anything.

And consider further that when the position is such-and-such and the correction is such-and-such, then the remainder is such-and-such degrees, and this is so small a quantity that it is not to be reckoned with. Therefore the correction in this configuration falls in agreement with the method of the chords, just as we explained, and the two methods come to one place.

הנה [Behold] — now I shall explain the matter to you in another way, so that it may be the more firmly established for you and the more readily grasped. When you take such-and-such degrees and such-and-such minutes, and you add to them such-and-such, the sum is such-and-such, and the half of it is such-and-such; and this is as we explained, and as Ptolemy too set it down by the method of the chords. For from such-and-such there comes out the perpendicular, from the perpendicular the chord, and the chord is the correction we sought.

And consider, with respect to that which we have set down, that the correction falls in agreement with the method of the chords. For when the position is such-and-such, the line of the two centers is such-and-such, the perpendicular that falls upon it is such-and-such, and the chord of the doubled arc is such-and-such — and this is the correction. So it is verified that the correction in this configuration is such-and-such degrees.

And the correction, when it is corrected a second time, comes out longer than the first; and from this remainder you obtain the second correction, which is such-and-such degrees, just as Ptolemy reached it by the method of the chords. And consider this with respect to the matters that arise: for the difference between the first correction and the second is such-and-such, a small remainder.

Therefore the position which the correction produces is such-and-such degrees, and the remainder is such-and-such, and it is small. And consider that when the matters are found to agree and to be made equal, then the position which the correction produces will be such-and-such, and from it the planetary motions are

corrected, and the rest in the same manner. And thus the correction will be subtractive, and so forth.

distinct, and they [the two centers] are close to one another, since this [arises] from the [matter of the] distances [הריחוק]. And whoever inquires into this will find it so.

Therefore it is necessary that the correction be different in the region near the [point of] greatest distance from what it is in the region of mean motion. And since this is so, it follows that the correction [equation] in the place near the apogee adds little, while the correction in the region around the mean place adds much more, and in the region of the perigee likewise [the variation] returns to being small.

And Ptolemy already noticed this, and made the [equation-]table accordingly, so that for every degree of the mean [argument] there is recorded the correction belonging to it, and these corrections are unequal: in the region near the greatest distance one degree adds only a little, whereas in the region of the mean motion one degree adds much. And this is what is found by computation, since the matter accords with what we have established from the variation of the chords.

Now you should know that this difference between one correction and the next — that is, the difference between the correction belonging to one degree and the correction belonging to the degree adjacent to it — is itself unequal across the [range of] motion. In the region near the [point of] greatest distance this difference is very small, indeed almost imperceptible, whereas in the region of the mean motion the difference between one [correction] and the next is large, and around the perigee it again becomes small. And this is plain to one who examines the table of Ptolemy.

For this reason, when the true place is sought by means of these corrections, one must take care in the region of mean motion, since there a small error in the [mean] argument produces a large error in the corrected [true] place, whereas in the region of the greatest distance and of the perigee no such [large error results]. And this is why Ptolemy and others after him recorded the corrections for every single degree, so that the [interpolated] value should be more exact — for the more the [argument-]intervals are made small [i.e. the finer the tabulation], the more the [resulting] correction is exact and close [to the truth], and any [residual] error is slight.

And from this it is also evident why, in the region of the greatest distance, it is permissible to take the correction for an interval of several degrees together,

since the difference there is small; whereas in the region of mean motion this is not permissible, because the difference there is large. And whoever examines the matter carefully will grasp this.

and likewise in the region of the perigee the correction is small, just as it is in the region of the greatest distance. And the cause of this is the smallness of the variation of the chords in those two regions [i.e. near apogee and near perigee], and their being far from. For in proportion as the [planet's] distance is near the greatest distance, so the correction is small; and according to Ptolemy this matter [holds] for the distance and for its opposite [the perigee] alike, since both are far from the [region of] mean motion.

And after he had established the corrections in this way, [it follows] that they are not equal but differ from one another, as we have said. Now this is a true matter, established by demonstration and by computation alike, and it is borne out by observation, for that which is found by observation agrees with that which is found by computation. And this is a great confirmation of the truth of these foundations [principles].

And in this manner you may understand the difference between one correction and the next throughout the whole [extent of] motion: in the region of the greatest distance the difference is small, in the region of mean motion it is large, and in the region of the perigee it returns again to being small. And he who grasps this will grasp the [reason for the] form of the table and the manner of its construction.

And since this is so, when you wish to find the true place by means of the [tabulated] corrections, you take the mean [argument] and seek out the correction belonging to it in the table, and you add it or subtract it according to the rule — additive in the one half and subtractive in the other — and there results from this the true place. And take care to be exact in the region of the mean motion, as we explained, for there a small [error] yields a large [one]; and this is plain.

And after this I shall explain another matter concerning the correction [equation], and [how] the [residual] difference between the corrections [computed] in the two ways differs, and [I shall show] that this part [remaining] from the correction is small, [arising] from the [difference between] the [eccentric] motion and the [epicyclic] motion. For the true place that is found by the one way and [the one] that is found by the other way differ from one another

only by a small amount, and there is no harm in this, since the difference is slight; and one who examines [the matter] will find it so.

within them, and this [pertains to] the motion, and the motion is, and [as for] what it [the difference] is, [it is] small; and it does not differ from this. And this is fine [insofar as] the difference is slight, and it adds.

and so the variation that occurs between the eccentric circle [גלגל היוצא] and the epicycle [גלגל הקפה] with respect to the true place [מקום אמתי] of the star is exceedingly small. It does not amount to anything that would compel us to take it into account, for the difference between what the one model and the other yield comes out only to such-and-such minutes [כך דקים], and this is of no consequence in the matter we are pursuing. [?]

For when the motion is at its mean [תנועה אמצעית], the variation between the two models is at its greatest; and when the motion is near the apogee [גובה] or near the perigee [שפל], the variation between them is so slight that it is altogether undetectable. Therefore, when we wish to know the true place by way of this correction [תקון], it makes no difference whether we reckon it according to the eccentric or according to the epicycle, since both yield the same result to within an amount that does not register in the computation. [?]

And this is what Ptolemy [בטלמיוס] said: that the line of position [קו ההיקש] from the center [מרכז] of the world, drawn out to the body of the star, falls upon the same point in either model, or so nearly the same point that no perceptible difference remains between them. And he therefore relied, in his tabulation, upon whichever of the two models was the more convenient for the particular case, knowing that the result would not be affected.

Now this holds for the planet whose epicycle and eccentric are equal in the proportion of their radii to the line between the two centers [שני המרכזים]; but where this proportion is not preserved, a remainder [שאר] does arise, and it must be reckoned according to the model that corresponds to the observed motion, and not otherwise. For if we were to neglect this, an error would enter into the true place by such-and-such minutes, which is not to be passed over in a matter requiring precision. [?]

It has already been explained that the chord [חוט] which subtends the arc [קשת] of the equation grows and diminishes with the distance of the star from the apogee, and that this growth is not uniform: near the apsides [the apogee and the perigee] the change from one degree to the next is very small, whereas in the region of the mean motion the change is at its largest. And this is the reason that

Ptolemy set down the correction degree by degree in his table, so that whoever uses it will not err in the region where the variation is large. [?]

Therefore one must take great care in the region of the mean motion, for there a small error in the argument produces a large error in the correction; whereas near the apogee and near the perigee one need not be so exacting, since there even a considerable error in the argument produces only a slight error in the correction.

And we have already explained that the perpendicular [עמוד] drawn from the center of the star to the line of position is what determines the magnitude of the equation; and that the arc of the equation is measured by the angle [זויית] subtended at the center of the world. The greater this angle, the greater the correction, whether it be additive [מוסיף] or subtractive [גורע], according to whether the star is in the half of its course that adds to the mean place [מקום אמצעי] or in the half that subtracts from it. [?]

and it is known that the equation is additive when the star is moving from the apogee toward the perigee, and subtractive when it is moving from the perigee back toward the apogee — this according to Ptolemy and those who follow him.

And this is the rule he laid down concerning the equation of the argument and the correction of the true place: that one takes the mean place, and according to the argument one adds or subtracts the equation found in the table, and what results is the true place of the star at that hour. There is no need here for any further operation. [?]

But there is something one must guard against: that the argument be reckoned from the proper point, namely from the apogee, and not from any other point; for if it be reckoned from another point, the equation taken from the table will be wrong, and the true place will come out in error.

And he said further: when the star is at the very apogee or at the very perigee, there is no equation at all, for the perpendicular vanishes and the line of position coincides with the line drawn through the two centers; and at these two points the motion in longitude is purely the mean motion, with neither addition nor subtraction. [?]

And he said that between the two there is a point at which the equation is at its maximum, and this is the point at which the perpendicular is greatest; and this point is not at the mean distance [מרחק אמצעי] of the star but somewhat short of

it, by such-and-such degrees [כך מעלות], for the reason already explained concerning the chord and its proportion to the arc. [?]

And it is found that the maximum equation of the Sun is such-and-such, and the maximum equation of the Moon is greater than this, each according to the proportion of its eccentric to the radius of its circle; and this matter has already been explained in its place. [?]

And this point of maximum equation differs for each planet, and one must take it from the table proper to that planet and not confuse it with another, for the planets differ greatly among themselves in the magnitude of their equations. [?]

[Margin: a four-line note in a small hand in the outer margin, with an isolated word יחסר ("it will be diminished/lacking") above it; the clustered note reads, so far as it is legible, "…such that the place will be diminished by this amount… and we do not [know] [?]" — marginal note containing partly legible text; further identification requires further verification.]

and therefore, when one knows the maximum equation and the point at which it occurs, one can correct the place at every other position, since the equation at any argument bears a fixed proportion to the maximum equation. And this is what was meant, and it is known. [?]

[The remainder of folio 109v is blank.]

Sefer HaTechunah — folios 110r–110v

[Script: Sephardic semicursive, single hand throughout. Brown iron-gall ink. Both folio sides carry continuous theoretical prose on circular motion and the relation of the celestial circles; no tables, no diagrams, no rubricated headers. The folio number "110" appears twice in modern hand in the upper outer margin of 110r.]

[Layout note: full text-block, justified prose; outer (left) and inner margins are blank parchment with scattered foxing, except for one genuine marginal note in the inner margin (transcribed below). The lower third of the page below the last written line is blank parchment — no lower-margin note.]

the circle [galgal], and just as we have shown that this [?] holds — and there is in it [a measure?] toward the [?]… the position [matsav] is fixed by the precise [?] reckoning; the equation [?] [?]… like the others — the matter of the second [?], and this is too [?] like… [?] the night, and let this thing [?] be small; let us take [?]…

[Interlinear / above line: a corrective stroke is present here but its content is not legible — [?].]

for it is [?] to the disciples [?] regarding this, that these... [the small?] [circle?] revolves [?]; and so too in the matter of [?]... [?] the larger [?] in this and the [?]... and according to what is small, then [?]... and a remainder rises, one further [?]...

[?] testimony [?], and this is the [?]: outside of it [?] is not... within it three [?] are not... in the [?] revolves, in proportion to [?]... in the hour of motion it becomes known to us [?]...

הנט] and there is in it [?]... Ptolemy [Batlamyus / Talmiyus] [?]...

[?] for what [?]... that it shall be [?], for it [?] [?]... the slow one [ha-itit]; and the part [chelek] [?]... the heavenly bodies [ha-shamayim], which are [?]... the fixed ones [ha-kevu'im], and to it is the [?]... a circle [galgal] [?]...

[?] their motion [?]; behold they [?] returned... was [?] in his heart [?], and behold this [?]... a [?]; and the [?] is one further small [?]... and behold this is the [?] within the bound [?] [?]...

In every motion [?] it is itself [?], let us [?] the circle [machoz / chibbur ha-galgal?]... and as for [?], [?] each one to its [?]... in the hour of motion this [?], the [?]...

Therefore [?] this [?], it shall be [?] and a remainder... beyond [the measure of] the [?], for it is not [?]... and a circle [machoz] is set in this within a circumference [?]...

[Margin: in the inner margin, level with the lower text-lines, a two-line note in the same brown body-ink: "ואחר מצא בנ[?]ה ובקש[?]... [?]ה ובא[?] / לבד [?]פן [?]ה לבטל ובא[?] [?] [?]". The note is a genuine scribal-style addition; beyond the opening words "ואחר מצא" ("and afterward he found") and "ובקש" ("and he sought"), the small cursive is not securely legible at this resolution. No named authority is identifiable. [?]]

[Then the page closes with three to four final lines, then blank parchment to the foot:]

the [?] of the circle, for it is [?] [?] return... within the circle [?], and there is [?]... and another [?] which is [?] [?]... [?] their position [?] [?]...

[Layout note: the written text-block begins at the top of the page (only a normal blank top margin, with foxing in the upper-outer corner) and runs down to

roughly the middle of the lower half, with blank parchment beneath the final written line to the foot. Small keyword glosses stand in the outer margin (transcribed below). Inner-margin and lower-margin are blank — no lower note.]

to it [?]... let us [?] the circle [kuklos] [Greek: κύκλος (kuklos, "circle")] [?]... the galaxy [?] / the spheres [?], that this [?] [?]... for [?] the slow [?] and the [?] outside [?]... the deferent [ha-galgal] [?], so the [?] [?], one [?] further upon [?]... the circle [machoz] [?]; and whoever weighs [?] this matter shall [?]... as it was [?] when the heavenly bodies came to be [?], and this [?] [?]... upon them [?] one motion [?], and [?] they would [?]... to gather [?] there is no motion [?], but [?] toward the [?].

[Margin: outer margin, level with the upper written lines, a small keyword gloss in the same ink: "חלקי" [?] ("portions of" / "parts of").]

the [?] of the deferent and its motion [?], in proportion [be-yachas] to [?]... the deep [?] in it, and this is [?] entirely [?]... [?] circle [machoz], more than [?]... that there is in it [?] when... within it three [?]... at the time of motion, [?] for the [?]...

so this circle, since [?] is unequal [?], the part [chelek] [?]... when the [?] revolves [?], and behold this is by way of [?]... when they were equal [?], this was [?]... and one further [?] would not [?]... but [?] would be added [?] and would not [?]... to the deferent [?]; and behold [?] the deferent [?] [?]...

for there is in distance [riḥuk] [?] when it is near [?]... for the [?] is [?] equal [?]; and this [?] is too [?]... that the position [?] revolves [?]; and there is no [?] in [?]... but only [?] more or less [?]; and this is [?]...

[Margin: outer margin, mid-page, a small keyword gloss: "קלקוס" [or "פלקוס"; reads ק/פ־ל־ק־ו־ס] — most likely a catch-gloss flagging the term *kuklos* ("circle") discussed in the adjacent line. [?]]

behold the distance [ha-riḥuk] [?] when [?]... the [?] and the [?], more [?] [?]; and there is in it [?]... but only the slow [?]; and [?] when [?]... [?] one further [?] than... for in distance [?] when it is near [?]... the [?], and let us add [?]...

[Margin: a second tiny keyword gloss stands a little lower in the outer margin, in the same ink; it is too small to resolve — [?].]

for [?]; behold the circle [ha-machoz] is set within a circumference [?]... let us draw [?] equal [?] from the [?]... in proportion [be-yachas] [?] the [?]... according to what we said [?], one further [?] revolves in distance [?]; one further [?]...

and according to this it shall be [?], so the [?] more [?]... when [?], for [?] of one further [?] [?]... and the [?] of the [?], more [?], one further [?]... when [?] revolves

in [?]... let us [?] [?] [?] [?]... and there is one further [?] [?]... in the deferent [?], so it shall be from the circle in places [?]... and there is one further [?] [?]...

for [?] is in places [?] [?]... and [?] from the [?] in places [?]... [?] one further [?]... [?] within it [?]... in places [?]...

[Later hand, top-left margin of f111r: "111"]

the variation [חלוף], so that as the distance grows, the variation grows in proportion. From this it follows that, with respect to the positions [המקומות] that lie at the mean distance, this is where the matter will be at its strongest. And since the variation arises from the difference between the [two] positions — that is, between the mean place and the true place — it grows and shrinks together with that difference.

And it has been explained that the variation is greatest at the mean distance and least at the apsides [גובה ושפל], for there the variation vanishes. Therefore Ptolemy [בטלמיוס] gave, for each and every degree, its own correction [תקון], so that the equation belonging to each degree might be known. And it has already been shown that the maximal equation [מותר התקון] occurs short of the mean distance — that is, before [the planet] reaches the mean distance — and that, by this account, the two of them are not equal.

For the correction [תקון] arises from the line of position [קו ההיקש], and there is a difference. And this is deep [וזה עמוק], for the chord is greater in the mean positions [במקומות] than at the apsides. The reason for this is that the line of position is longer there, and the more it is prolonged, the more its arc [קשת] grows. So the matter holds together; and as for what we said, that the correction is greater here and smaller there — this corresponds to what was set down above.

And since the chord in the mean positions is greater than at the apsides, and the line of position there is longer, this is why the correction comes out greater in the mean positions; and this is the reason that Ptolemy was right to assign to each degree the equation proper to it. For the equation is not equal in all the degrees, but differs from one to the next, since the line of position differs from degree to degree.

And so I say that, on this account, the correction in the mean positions is greater than at the apsides, and the matter is deep [עמוק]. For the two models are not alike in this respect, even though they yield the same variation of the true place. For one of them is fixed and this is deep; the other is more.

and the matter holds together. For it has already been explained that the correction comes out greater here than there, and this is the reason. And the line of position [קו ההיקש], by what was demonstrated, comes out greater; from this it is known [ידוע] that the matter is deep, and consider this.

[the line] holds together, and the chord is greater in the positions, this being deep, and is least at the apsides.

The seekers of the models, and the chord is greater here. The remainder of the chord …

the model is greater than this, and this is deep…

and the chord of Ptolemy's [models] is equal …

for what Ptolemy did not equate — the [equation of?] the positions [המקומות] —. For if it were, the matter would be …such-and-such, so that the chord would be … such-and-such.

the seekers of the model that is the true one, and they would be like the chord of the model toward every chord they assign.

[Enlarged display rubric, brown ink, larger module: **הסא** A new siman/chapter opens here.]

הסא [chapter rubric] And since the line of position in the apogee — and these are the three positions that are above — the model holds together. The line of position in the days of the planet is …such-and-such, and there are correction[s] …

and the cycle [קולקוס — Greek: κύκλος, "cycle/circle"] is …such-and-such, so that one of them is …such-and-such more and there is …such-and-such. And just as the motion [התנועה] is …such-and-such, so too the equation [התקון] is …such-and-such; and just as one degree differs, so does the other.

And there is no doubt [ואין ספק] that the matter is deep, and so we know that the true place. For the difference between the [two] positions [המקומות] is what generates the correction. From this there comes out a longer line of position; and the more it is prolonged, the more its arc [קשת] grows.

and just as the correction is …such-and-such, so the chord …

and the line of position …such-and-such, and from this it is known [ידוע] that the matter is deep.

[Enlarged display rubric, brown ink: **הסא** A second siman rubric on this folio side.]

הסא [chapter rubric] And since the cycle [קולקוס] is …such-and-such, and the line of position …such-and-such; and this is the reason that the chord is greater here, and the correction …such-and-such, so that the equation proper to each degree is …such-and-such. And the matter holds together; for it has already been explained that the chord in the positions is greater than at the apsides, this being deep, and least at the apsides.

it holds together, for it has already been said that one of them is more — namely, the line of position — and this is the reason that the correction comes out greater in the mean positions.

and the days of the planet — and this is deep — and the equation …such-and-such …

and so the matter holds together, and the seekers of the model that is the true one would be …such-and-such.

[Margin note, foot of f111v, lower margin, two lines, primary hand, faint brown ink: marginal note containing approximately "… / סמוך? וכן הקדים? מתקן? כתב חיד? לזה התנועה" — a short constructive helper keyed to the equation/motion argument above; the wording is only partly legible and further identification requires further verification.]

this is so, because just as the planet is set [?] in motion by these two [motions], so it is by [?] these two: the one being the displacement (חלוף) and the other the [mean] motion (התנועה האמצעית); and this is so [?]. And so it has been investigated whether the displacement is uniform — that is, whether it [moves] equally about the center of the small circle (גלגל הקטן, the epicycle) — and the [mean] motions are also [investigated] in this same way. The configuration (התמונה) is what arises [?] from these two together [?], and this is the true [position?].

And the [mean] motion of the configuration, together with the displacement [?], and that which arises from these two — from this comes [?] the variation (החלוף [?]) of the motion: that the motion is sometimes swifter [?] and sometimes slower. Wisdom [?] has compelled (הכריחה [?]) [us to hold] that for each one of them there is its own proper place [?], and the [mean] motion, when [the planet] is at this place [?], will be [?]…

[The lines that follow are densely written and compressed at the line-ends; the legible remainder of the recto is recovered below, with [?] for words that could not be committed letter by letter under magnification.]

and likewise the displacement [?], when [the planet] is at this place, is faster [?]. What [forces?] this upon us is [?] the difference [?] in the swiftness [?] of [its] motion at one place [?] and another [?]. And it is a wonder [?] in the matter of Ptolemy('s account) (תלמיוס) [?]…

[?] this matter, which [?] [the chapter?] has [?] explained [?] before [?]. And this [?] [is the matter of?] the displacement [?]…

And from this [?] it has been verified [?] that the small circle [the epicycle] is fixed [?] [relative to?] the planet, and this is one of the matters [?]; and from this [?] [it follows that] the [?]…

the planet [?], in its motion [?] [?]… For if the motion of the small circle were uniform [?] [about?] its own center, [?] [then?] [?]…

[?] in the matter of [?] the small circle [?], which is the [proper?] place [?] of the planet, and this [?] [arises?] from [?] [?]…

[?] and the displacement [?] [is?] uniform [?], because [?] the motion [?] [is?] [?] [?]…

[?] for if [?] [it?] [were?] [?] [?] [?], and this [?] [is what?] we wished [?] [?]…

[?] [?] [?] [?] [?] [?] [?] [?] [?], and this [?] [?] [?]…

[?] [?] in [?] the small circle [?] [?] [?] [?] [?], [?] which is [?] [?]…

the planet [?] [?] [?] [?] [?], for [?] [?] [?] [?]…

[?] which [?] is its [?] [?] [?] [?], and this [?] [is?] preserved through all time [?] (קיים לעולם [?]) always [?].

[?] and they [?] [were?] [?] [?] the planet [?] [?] [?] [?]. The planet [?] [?] [?] in [?] the configuration [?] [?] [?] [?]…

and [?] [?] upon [?] the distance [?] (הריחוק [?]) [?] [?] [?] [?] [?]…

the planet [?] [?] [?] [?] [?]; and this [?] [is the matter of?] the displacement [?] [?] [?] [?]…

[?] only [?] [?] [?] [?]; for [?] [?] [?] [?] [?] [?]…

[?] [?] [?] [?] [?] [?] [?] [?], and [?] [?] [?]…

the displacement [?] [?] [?] [?] [?] [?] [?]; and [?] [?] [?] [?]…

[The middle band of 112v is continuous small-hand prose; the following lines are densely written and only partly recoverable under magnification.]

[?] [?] [?] [?] [?] [?] [?] [?] [?] [?] [?] [?]…

and the planets [?] [?] [?] [?] [?] [?] [?] [?] [?] [?] [?]…

[?] [?] which is the [?] [?] [?] [?] of [?] [?] [?] [?] [?]…

[?] [?] [?] [?] [?] [?] [?] [?] [?] [?] [?] [?]…

[?] [?] [?] [?] [?] [?] [?] [?] [?] [?] [?] [?]…

[Lower band of 112v:]

[?] [?] [?] [the?] motion [?] [?] [?], and [?] only [?] the place [?] [?] [?]…

the heavens (השמים [?]) [?] [?] [?] [?] [?] [?] [?] [?] [?]…

[?] [?] [?] this [?] [?] [?] [?] [?] [?] [?] [?]…

the planet [?] [?] [?] [?] [?] [?] [?] [?] [?] [?]…

[?] [?] [?] [?] [?] [?] [?] [?] [?] [?] [?] [?]…

[Bottom written line of 112v:]

[?] [?] [?] [?] [?] [?] [?] [?] [?] [?] [?] [?]…

[Margin (folio 112v, outer margin, upper): a marginal note in a smaller secondary hand, ~3 lines; the verbatim text is not legibly recoverable on the scan under magnification. Marginal note containing illegible text; further identification requires further verification.]

[Margin (folio 112v, outer margin, lower-middle): a second marginal note in the same smaller secondary hand, ~4 lines; the verbatim text is not legibly recoverable on the scan under magnification. Marginal note containing illegible text; further identification requires further verification.]

The script is a single regular 1397 Sephardic semicursive hand throughout, faded brown iron-gall ink. Both folio sides carry text only in their upper portion; the lower half of each page is blank ruled space. The discussion continues the long

correction (*tikun*, equation) argument carried over from the preceding folios; no chapter rubric opens here.

[f. 113r]

the motions [תנועות] [?] … and so the matter follows the same proportion. By contrast, the remaining motion is small, as has already been explained, since the angle that arises between the two lines is itself small. And it is found likewise here, where the chord [?] is, for this reason, small as well.

It follows that there is no difference [חלוף] between this small motion and the corresponding small arc — they are equal — and there is no detectable variation between them; rather, the matter holds to the [?] proportion. The two motions are equal, and this [?] follows from what we explained earlier concerning the line of position [קו ההיקש].

When the matter stands thus, the motion of the planet [כוכב] from its mean place [מקום אמצעי] toward [?] is such that the planet adds [מוסיף] by a corresponding amount, since the motion in this region is additive; and after the planet is at its [?], it then becomes subtractive [גורע]. So the additive interval and the subtractive interval are each measured by the same proportion in this matter.

Therefore Ptolemy [בטלמיוס] held this view, and it is correct: the additive and subtractive amounts answer to one another. And this is why it was necessary that the motion in the one region be equal to the motion in the other region — namely, because the line of position is one and the same for both, while the variation of the correction [תקון] depends only upon it.

Now the matter is such that the motion which is additive and the motion which is subtractive are not equal in the eccentric circle [גלגל היוצא] — for there, indeed, the additive amount is not equal to the subtractive amount — but in the epicycle [גלגל הקפה] they are equal. This is the difference between the two configurations, and it is a fine point.

And it is found, when you reckon the matter according to its true proportion, that the place [מקום] of the planet at such-and-such degrees [כך מעלות] of the mean motion answers to such-and-such degrees of the true motion, and the difference between them is the correction. And so it follows for each and every position: at every degree of the mean motion there is a corresponding true place, and the variation between them is the correction proper to that position.

We must therefore investigate the matter from this standpoint, since the chord [יתר] drawn within the eccentric circle, and the perpendicular [עמוד] dropped to

it, govern the whole reckoning [?]; for from the chord and the perpendicular the angle at the center is known, and from the angle the correction is known.

And this is what we wished to make clear concerning the equality of the two motions and the manner in which the correction varies according to the configuration of the eccentric circle relative to the epicycle, as Ptolemy explained in his book.

When you have grasped this, you will find that the planet, at its mean place, stands at such-and-such degrees, and from that point its true place is reckoned by the proportion we have laid down; and so the correction at every position is known, whether it be additive or subtractive, by the same method we set out for the two centers [שני המרכזים] and the line of position. [?]

[The text on f. 113r ends here; the lower half of the folio is blank ruled space.]

[f. 113v]

for it has already been explained that the difference [חלוף] at such-and-such degrees [?] of the configuration was, at that time, additive; and at such-and-such other degrees it then became subtractive [?]. So the difference [?] runs according to one and the same proportion, just as we said.

When the matter stands thus, you will find that the chord drawn within the circle, together with the perpendicular dropped upon it, yields the angle at the center; and from this angle the correction at that position is known, just as Ptolemy explained.

And it is found that the place of the planet, reckoned from the mean motion to the true motion, holds to the proportion we have laid down at every single position [?] — at each and every degree there is a corresponding true place, and the difference between them is the correction.

It follows that the motion is equal in the two regions, and there is no detectable variation between them, since the line of position [קו ההיקש] is one and the same for both, and the correction depends only upon it. This is why Ptolemy held that the additive and the subtractive amounts answer to one another, and that the motion in the one region equals the motion in the other.

[Display word, enlarged, mid-line:] **הסבה** — the turning — After what we have mentioned concerning the words of Ptolemy, we should now examine the matter from this standpoint.

The chord [חוט] and its parts [חלקים] are reckoned because of this, since the remainder [שארית] of the chord [?] yields the first angle, and that angle is such-and-such; and so the investigation proceeds. And from the chord drawn within the circle the perpendicular is reckoned, and from the perpendicular the angle, and from the angle the correction at that position.

And it is found that the place [?] is such-and-such, and the remainder [?] is reckoned from it; and so the matter follows, for each and every position, until the whole reckoning is completed by the same proportion. And the planet, at such-and-such degrees of the mean motion, stands at such-and-such degrees of the true motion, and the difference between them is the correction proper to that place. [?]

And so the matter follows for the remaining positions; the investigation proceeds [תדע [?]] in the same way for all of them.

[The text on f. 113v ends here; the lower portion of the folio is blank ruled space.]

[Primary script: Sephardic semicursive, 1397; single regular hand throughout. Later-hand folio number "114" in the upper margin (pencil and ink).]

the chord that subtends it. And it is found that the arc which is upon the [line of] position is such-and-such, and the arc which corresponds to it is such-and-such; and the chord that subtends the remainder between them was already drawn, so that the position is known. [?] And once this is known, the angle is also known. And it is found by this [method].

By this procedure, then, we find the value of the correction for any single line of position we wish — for it is here that the variation arises, since it is the eccentric circle [גלגל היוצא] and not the epicycle [גלגל הקפה]. And this is what we intended to make clear.

Now since the chords corresponding to these arcs have already been set out — and these are the chords of the remainder of [each] arc — it follows from what the geometer [בעל התשבורת, "the master of measure," i.e. the author of the *Elements*] laid down concerning the relation of the arc to the chord that subtends it: that when the arc is such-and-such, the chord is such-and-such. And the chord was found by the procedure we set out, and the value of the perpendicular dropped from the point of intersection [נקודת החתוך] was found; and it is found that the perpendicular is such-and-such.

Diagram. Two overlapping circles of unequal radius: a larger circle with a smaller circle set over its upper-left, their circumferences crossing so that a lens-

shaped region forms where they overlap; interior arcs cross within the larger circle. The construction illustrates the relation between an arc upon the line of position and the chord subtending it, as developed in the surrounding prose.

- א (interior, where the two inner arcs cross within the larger circle): point א
- ב (upper, on the inner arc to the right of ג): point ב
- ג (upper-left, near the top of the smaller circle): point ג
- ד (top, on the upper arc of the larger circle): point ד
- ה (far left, on the left edge of the smaller circle): point ה
- ו (bottom, on the lower arc of the larger circle): point ו
- ז (lower-left, on the smaller circle below ה): point ז

The arc upon the line of position runs between the points named in the prose; the chord drawn between them subtends the remainder, and the perpendicular is dropped from the point of intersection א.

By means of the chord we find, in turn, the arc; and by means of the perpendicular we find the angle. And it is found that the angle at the center, subtended by this arc, is such-and-such, when the arc is such-and-such. So the matter proceeds in the manner we described.

And the [author of the] *Almagest* [המגסטי] already explained this, when he stated that the position is such-and-such and the correction [תקון] is such-and-such — whether the [planet's] motion be additive [מוסיף] or subtractive [גורע], according to its place upon the eccentric. And so it has been clarified for whatever line of position we wish.

Diagram. A tall triangle with its apex at the top (א) descending to two lower vertices (ו at lower-left, ז at lower-right); internal lines cross at an interior point (ה), dividing the triangle into smaller triangles. The figure accompanies the determination of the angle at the center from the chord and the perpendicular.

- א (apex, top): point א
- ב (upper interior, on an inner line below the apex): point ב
- ג (left, on the left side of the triangle): point ג
- ד (right, on an interior line to the right): point ד
- ה (interior, where the internal lines cross): point ה
- ו (lower-left vertex): point ו
- ז (lower-right vertex): point ז

The lines from the apex א to the lower vertices ו and ז, together with the internal lines crossing at ה, give the perpendicular and the chords from which the central angle is computed.

For it is so that the angle is such-and-such, and the correction follows from it, in the way already set out. And [the matter] is correct, so that the line of position is known, and the place of the star upon the eccentric is known thereby, whether [its motion] be additive or subtractive. And this is what we intended.

This, then, is the figure [צורה] we promised, by which the correction [תקון] is found — for whatever line of position we wish — and the place of the star is corrected.

And the chord of the remaining arc subtends [it], such-and-such; and there will be the chord upon the line of position, such-and-such. So the position is again known, and once more the perpendicular [is known]. By means of the chord, in turn, we likewise find the arc, and through it the angle. So this procedure is the very same — there is no difference between this case and the first.

And it is found that the correction is such-and-such, when the [planet's] place upon the eccentric is such-and-such — whether the motion be additive or subtractive. And this is what we intended to clarify here.

And the position will again be such-and-such, and likewise the perpendicular such-and-such; and we find by it the arc and the angle, and so we find the correction, in the very same way. And again it is written here in the book [נכתב בכאן בספר] that the correction of these motions is found for whatever two positions [שני המקומות] we wish — the close [near] one and the far one — so that the position upon the line of position is known.

For the chord upon the line of position subtends the remaining arc, and it is found that the place upon the eccentric is such-and-such; and the correction follows from it, whether [the motion be] additive or subtractive. This [matter] is in order. [Completed / השלי'] [?]

And so [now] the order of the tables [סדר הלוחות]. [?]

[Remainder of f114v blank below the text block.]

Sefer HaTechunah — folios 115r–115v

[Script: Sephardic semicursive, single primary hand. Folio numbers not legible in the margin; tracked by PDF page (115r = p. 229, 115v = p. 230). Upper-left margin of 115r carries a faint later-hand pen scrawl (two short cursive words), not part of the original text — recorded below as a later-hand note.]

[Layout: the recto is occupied almost entirely by a large astronomical equation table set in the lower ~60% of the page; the upper portion of the page is blank ruled parchment. The table is a multi-panel double-argument table — each panel repeats the same column structure for a successive range of the argument, so several panels stand side by side across the width of the page and the argument runs downward within each panel. Reading is right-to-left.]

[Later hand, upper-left margin: two short cursive words, faded; not original. Best read as a brief ownership/reference jotting. Content not securely legible — `[?]`.]

Table — increment of motion (תוספת התנועה) against arc of motion (קשת לתנועה)

[Red/brown-ink ruled grid. The recurring column block, reading RTL within each panel, is: **קשת לתנועה** ("arc of motion" — the argument), then **תוספת התנועה** ("the increment of motion," carried in paired value sub-columns), then **החלקים** ("the minutes / parts"). A super-header **שעות** ("hours") stands over the panels. The same block repeats across the page for successive ranges of the argument.]

[Transcription note — registration limit: this wide, dense, many-column grid cannot be resolved on the scan as a single aligned matrix, so individual data cells cannot be assigned to a specific (row, column) with certainty. The header structure and the argument columns are committed below; the dense interior result-cells are legible *as glyphs* under magnification but cannot be safely placed cell-by-cell, and are marked `[numeral: ?]` rather than stitched. This table for a column-by-column re-examination.]

קשת לתנועה (arc of motion, argument)	תוספת התנועה (increment of motion)	החלקים (minutes)
[argument column, counting in degrees; legible leading values include] מה (45), מו (46), מז (47), מח (48), מט (49)	[numeral: ?]	[numeral: ?]

קשת לתנועה (arc of motion, argument)	תוספת התנועה (increment of motion)	החלקים (minutes)
…		
… נ (50), נא (51), נב (52)	[numeral: ?]	[numeral: ?]
… further argument rows running through the panels (legible glyphs, e.g. values in the קמ (140), קנ (150), קע (170), ש (300 ranges appear in the result columns) …	[numeral: ?]	[numeral: ?]

[The result columns visibly hold three-letter values in the 100s–300s range (e.g. cells reading קמ-, קנ-, קע-, קצ-, ש … followed by a units letter) and two-letter values in the increment sub-columns; these curve gradually down each column (a normal equation-table profile — not a constant run or arithmetic staircase). Because the individual cells cannot be registered to their columns at this tiling, their values are withheld as `[numeral: ?]` rather than transcribed by guesswork.]

[Foot of the table: a second header **קשת לתנועה** appears rotated at the lower edge of the grid, indicating this is a double-entry table — the complementary argument is read upward from the foot. Recorded as a structural feature; the foot-argument cells share the same registration limitation.]

[Bottom of 115r below the table: blank parchment.]

[Layout: continuous geometric-proof prose fills the upper ~55% of the page; below it stand geometric construction figures (see below); the lowest portion of the page is blank parchment. Single hand throughout. Light foxing and a brown stain at the foot do not obscure the text.]

The chord [sine] of the latter arc will be [as] the chord of the upright [arc], and it is [?]. And likewise the chord of the upright, which is the [?], and as the degree that rises [the ascension] … Take the chord of the latter arc and what results, for that [?].

When the arc that rises [the ascendant] … the chord of the upright is [?], and so the matter proceeds: the rising arc and what it yields [?].

[The passage works through a trigonometric construction in the standard idiom of this part of the work: it relates the *chord* (חוט / חוט הישר, the "upright chord" = sine) of one arc to the chord of another, and to the *rising / ascension* (/ מעלה

העולה) of degrees, computing one quantity from another by taking chords and reading off what "arises." The reasoning is carried by the recurring terms קשת ("arc"), חוט הישר ("the upright chord" / sine), מעלה / העולה ("ascension / what rises"), נקודה ("point"), and מרכז ("centre"). Several individual clauses turn on specific letter-labels keyed to the figures below; where a label or a linking word is not securely legible it is marked [?] rather than supplied.]

and since the chord of the upright is [the same as] the chord of [arc] … and the point [נקודה] … the centre [מרכז] … the line קו … [?]. And the arc … its chord … and what arises from it [?].

For the chord is [numeral: ?], and the line קו is [numeral: ?] minutes [חלקים], and the line קו [numeral: ?] … and the remainder [המותר] is [?].

[The argument continues to chain "the line קו …" relations through several lines, each setting one segment equal to or computing it from another via its chord; the specific segment-letters and the numeric magnitudes within these lines are partly legible as isolated glyphs but cannot be committed as continuous values — marked [numeral: ?] at each occurrence above. The prose itself (the relations being asserted) is legible and rendered.]

and this is what we sought [?]. And he said: the matter … the chords … And when it was joined of two [components] together [היה מחובר משני יחדים] …

[The prose ends here; the remainder of the page below is given to the figures and is otherwise blank.]

Diagram. Upper of the two circular figures at the right edge of the page. A single circle with two long chords/arcs drawn across it intersecting near the centre, plus a short horizontal chord. A few point-letters are marked around and inside the circle in faint cursive. The labels are individually faint; only their presence is certain.

[— more than two labels flagged [?].]

Diagram. Lower of the two circular figures at the right edge. A circle with two arcs springing from a point at the top and meeting the circumference, enclosing a lune-shaped region, with a chord across the lower part. Point-letters are marked at the top, on the right arc, and at lower left.

[— more than two labels flagged [?].]

Diagram. A tall narrow triangle with its apex at top and base at lower left, crossed by two transversal lines that intersect the sides, the longer side extended

downward to a point well below the base. Several point-letters mark the apex, the points where the transversals cross the sides, the base ends, and the extended lower point.

[— more than two labels flagged [?].]

Diagram. A broad, low (obtuse) triangle near the foot of the page, apex toward upper-centre and a long base sloping down to the right, with internal lines (a cevian / transversal) drawn from the apex region to points on the base. Point-letters mark the apex, the left and right base ends, an interior point on the base, and the points where the internal lines meet.

[— more than two labels flagged [?].]

[Foot of 115v: blank parchment; light brown stain, no text loss.]

Sefer HaTechunah — folios 116r–116v

[Script: Sephardic semicursive, single primary hand. Black-brown iron-gall ink throughout. No rubrication on these folios.]

[Margin (upper right, vertical): brief marginal annotation, ~1–2 words, partly cropped at the edge; the text reads approximately [?] and cannot be securely identified — further identification requires further verification.]

The body text continues the discussion of ascensions and the line of rising. Reading the recto:

and likewise the line [קו] will be set right, and within the whole of the [point of] rising [נקודת קו… [?]]. For the line that proceeds toward the point of rising is itself the [day's] line — day by day [[?]]. And likewise this is what happens with the [other] line; for it is according to the difference [שנוי] of the position [המצב] of this line [?] —

— and the line itself will then be set right, as it should be at the position of the point [נקודת [?]]. And whenever the difference is small, then likewise it [[?]]; and when the difference [[?]] is known, and when this difference is so much [[?]], the section of the line [?], in proportion to the ascending degree [המעלה הצומחת [?]].

For the rising arises through the point that lies opposite the [point of] rising, and the [[?]]; therefore the difference [will be [?]] proportional to the position of this line [?], upon the ascensions [העליות]. The Greek [scholars] [הדרומיים recte:

הרומיים? = "the Romans/Greeks", [?]] reckoned the matter [?] according to the [[?]].

[The next several lines treat the relation between the rising-degree (המעלה) and the deep point (היתד / העמוק), and the measure of the line up to the point of rising. The Hebrew is legible but heavily abbreviated and technical; values are given verbally rather than numerically here.]

the degree [המעלה] and the line, and the remainder [[?]]; and this is the rising. And so it is made [והנה עשה [?]] —

The [[?]] reckoned: [Hebrew numeral string, partly legible: …ס… ן… ה … — [numeral: ?]]. From this [you] derive [[?]] the rising; and just as the degree [המעלה] of [[?]] is so, likewise the [[?]] degree as it [[?]] up to the mouth [end] of the rising [פי המעלה].

For it remains [שישאר] that the tables [הלוחות] give the knowledge of the [[?]]; and it remains that this [[?]] from the point and from the line is so much [[?]]. And the rising [[?]] up to the position [המצב] of the line, and one knows by it [?].

And the difference [השנוי [?]] is in this rising and in that one [[?]]; therefore [[?]], for [[?]] is the position of the deep point [המצב העמוק [?]], opposite the deep point [[?]]. And the rising — they made the ascensions [העליות], one [[?]] —

For [[?]] the difference [is] according to the degrees [המעלות], how great is the apparent [[?]] motion [המהלך הנראה [?]], one year [שנה], according to the [foregoing [?]].

[The next block discusses that the rising and the difference of the line yield, and how the ascensions are obtained, and that the upper-tables [[?]] differ; and "the degrees of the moon [or: of the position] for them were so much".]

and the rising [[?]] this rising [[?]], and that one [[?]] — the degrees [המעלות] of the position [המצב [?]] — this is that which it [[?]], for it is what they were [[?]] — the upper-tables [[?]] — in the line [the chord, [?]] he measured by it the rising [[?]]; and these others [[?]] — the line that goes [[?]] in the [[?]] of the [[?]] —

[Body text on 116r ends here, roughly two-thirds down the page; the remainder of the recto is blank parchment.]

[Margin (right, vertical, beside the table): a one-line cursive note running bottom-to-top, approximately three to four words; legible as Hebrew script but not

securely resolvable word-for-word — [Marginal note containing: …[?]…; further identification requires further verification].]

Table — rising-times / oblique-ascension table (folio 116v).

[Layout note: the table reads right-to-left. The two leftmost physical columns are word-columns: an inner column of short per-row argument labels (cursive, heavily abbreviated) and, just to its right, a column that repeats the **same** long cursive descriptor phrase on every row. To the right of these run the numeral columns — two-letter sexagesimal values throughout (typical readings fall in the 20s–50s: כ, כב, כג, מ, מב, נ, נב, נד, נז, etc.). The values **curve** down each column (successive entries rise and fall by small increments) — the correct signature of a genuine equation/ascension table, not an arithmetic staircase.

Critical honesty note: this table cannot be resolved into clean single columns on the scan. I can read the *glyphs* with confidence and confirm the *value ranges and the curving (non-staircase) behaviour*, but I **cannot assign each individual numeral to a unique (row, column) coordinate** without guessing the column boundary. Per the no-pattern-fill / no-invent-structure rule, I will not manufacture a complete aligned grid from partial views. The table is transcribed below with its structure and its legible word-columns committed, the numeral columns committed as far as a glyph can be anchored to a column, and the remainder marked [numeral: ?] with the alignment caveat. This table is a for a column-by-column re-examination.]

Row-label column (innermost word column), top → bottom, as read on the scan under magnification (heavily abbreviated cursive; each is one argument label):

1. אלגב/אלביב [?]
2. לפקב [?]
3. דקל/רקל [?]
4. גובה ["height/apogee" — גוב] [?]
5. מסומך/מסום [?]
6. אלרגל/אלדגל [?]
7. … [further rows: short cursive labels, individually [?]] … (bottom row, full-width label) …אלאצטר…/אלאסטל [?]

Repeated descriptor column (every row carries the identical phrase): a long cursive phrase, read approximately as דרך מעלות גלגל… ס׳ ["the way of the degrees of the sphere…", reading uncertain] — committed as a **single repeated phrase** [?]; it is the same ink-form on each row.

Numeral body (alignment-caveated; values that can be anchored to a column are committed, glossed; straddling/ambiguous cells are `[numeral: ?]`):

Row label (innermost)	Repeated descriptor	Numeral cols (left→right, R-T-L logical order)
אלגב [?]	דרך מעלות… [?]	כ (20), כב (22), נ (50), נב ([numeral: ?], נד (54), (52, [numeral: ?], [numeral: ?]
לפקב [?]	(same)	מ ([numeral: ?], כג (23), (40, [numeral: ?], נ (50), נב (52), [numeral: ?], נז ((57
דקל [?]	(same)	כב (22), [numeral: ?], מ (40), [numeral: ?], נ (50), [numeral: ?], [numeral: ?]
גובה [?]	(same)	מ ([numeral: ?], ל (30), נ (50), (40, [numeral: ?], [numeral: ?], [numeral: ?], [numeral: ?]
מסומך [?]	(same)	[numeral: ?], [numeral: ?], [numeral: ?], [numeral: ?], [numeral: ?], [numeral: ?], [numeral: ?], [numeral: ?], [numeral: ?]
אלרגל [?]	(same)	בב (22)/ב (2)?, [numeral: ?], [numeral: ?], [numeral: ?], [numeral: ?], [numeral: ?], [numeral: ?], [numeral: ?], [numeral: ?]

Row label (innermost)	Repeated descriptor	Numeral cols (left→right, R-T-L logical order)
… (intermediate rows)	(same)	[numeral: ?] across (legible glyphs present but column assignment not securable)
(final, full-width) אלאצטר… [?]	—	) ב ,?(4)ד/?(200) ר ,(4) ד (4) ד/?(200) ר ,?(7) ז ,(2? — small single-letter values [several `[numeral: ?]`]

[The numeral glyphs I committed above are ones I could anchor to a specific column at a specific row from the clean grayscale quarter (page2, lower-left) and the corresponding binarized strip. The many `[numeral: ?]` entries are cells whose glyph I can *see* but whose column I cannot fix because the strip straddles a ruled divider — flagging is the correct, non-confabulated choice here, not committal. I have deliberately NOT filled these by interpolation or column-trend, since real ascension columns curve and any "completed" run would be invented.]

[No abraded ink-loss within the ruled cells themselves (the parchment is clean under the grid); the only physical damage is foxing/abrasion along the outer (right) deckle edge, which does not intrude into the table body. Therefore no `[Lacuna]` is warranted — unread cells are `[numeral: ?]`, not lacunae.]

Sefer HaTechunah — folios 117r–117v

[Script: Sephardic semicursive, single hand throughout. Folio number "117" written twice in the upper margin of 117r (Hebrew-numeral and a later Arabic-numeral foliation).]

[Layout: full page of continuous prose (no rubricated heading on this side). Two pen-drawn circle diagrams occupy the lower-left quadrant of the writing area; the prose fills the remaining ~75% of the page. The lower third of the page below the second diagram is blank.]

This is a stretch of Gersonides' technical geometrical argument concerning the day-circle, the equator, and the measurement of arcs of altitude and position. The reasoning proceeds by reference to lettered points of a construction (the two diagrams below) and recurs constantly to a small set of terms: *קשת* (arc), *מעלה*

(degree / altitude), *מצב* (position), *קו האורך* (the line of longitude), *קו הרוחב* (the line of latitude/breadth), *קו המשוה* (the equator), and *נטיה* (declination). Because the passage is a dense chain of conditional geometric inferences ("if such-and-such arc is so, then the position will be thus"), I render its sense faithfully and pin technical terms, flagging individual words that are genuinely unresolved at this resolution rather than smoothing them.

The argument runs, in substance: The third figure [or: the third consideration] concerns a part that is distant [?] from … upon the [degrees of] altitude. The position upon the [degrees] of altitude that arises [?] will be like that … and so too, just as the position of the day arose, so will the position arise here … and the matter will already stand upon [?] … And consider, that whenever the position arose, it was … And the equating that is upon the day [?] will be by the position … And the arc that is distant [?] will be drawn out upon the day's position. And whenever it is known how much the arc is distant, then the position upon the [degrees of] altitude will be known … And the position will be drawn upon the [degrees of] altitude that are near, as stated below; and likewise all the position … And the arc that arose [?] will be like the rest of the positions of the arc … And the equating will be from the equating of the position … and this is the position from the equating that is drawn [?] to the position of altitude that is near …

And it will be the arc of position, this arc of the day [?] from the equating, and consider [?] that it is the equating … For when this is known, the position upon the [degrees of] altitude is already known … And the arc of position [?] will be a known arc … so that you may know how much the arc is distant.

And there will be a position upon the line of longitude … [the day-circle and] the equating [?] … and it will be that the position … And whenever the arc was drawn [?] upon the position of the line of breadth [latitude] … and so too the second [arc] … And the arc that was equated [?] … And likewise the rest of the positions of the arc … And we said that this arc is the [?] line of longitude, and it [?] … And the day-circle is drawn [?] from the positions of the line of longitude [?] … And the position of the line of longitude [?] … and consider, for this is the [?] position upon the line of breadth … And the equating [?] from the equating that is upon the equator [קו המשוה] … and this is fine [?]. He shall tell of [?] and it is known how much the arc is distant.

And whenever the position arose upon the position … and the line of breadth [latitude] will be beneath [?] the [day-]circle … And the line of longitude [?] from this little [?] arc, and we already know its [the arc's?] equating, and the [day-]circle of the equating … And he shall yet do [?] the arcs by computation

upon the [day-]circle … with the position of breadth, and its [degree of] altitude, and the position will rise upon the [degrees of] altitude. And whenever it is a known arc, and the line of breadth is beneath [?] the [day-]circle … And whenever the position arose, an arc of the day [?] and the position [?] … and likewise [?]. And so it will be an arc upon the arc that arose [?], and this is what arose [?] … And whenever the arc is drawn [?] it will be a position upon the day [?] and consider [?] that it is a known arc, and there shall be small [קטין?] arcs … and the line of longitude [קו האורך] will be beneath [?] the position of the day, and the position will rise upon the [degrees of] altitude … And the position upon the line of longitude will rise [?] beneath the [day-]circle … and he shall yet equate [יחזיר?] [?] the [degrees of] altitude downward [?] and upward [למטה מעלה ומעלה — "downward and upward"].

[The lower portion of 117r, below the second diagram, is blank.]

Diagram. Upper figure in the lower-left of 117r: two overlapping (intersecting) circles. A larger circle on the right and a somewhat smaller circle on the left interpenetrate, so that two arcs cross within the shared lens-shaped region. Lettered points mark the circumferences and the intersection points. Visible labels (only those legibly inked are listed; faint ones marked [?]):

- ג (upper left, on the left circle's circumference)
- ב (top, near where the two circles meet at the upper crossing)
- ד [?] (upper-middle interior, at or near an intersection)
- א (left, on the left circle's circumference)
- ה [?] (center, interior, near the second crossing)
- ז [?] (lower left, on the left circle)
- ו [?] (bottom, near the lower intersection)

[More than 2 labels are uncertain]

Diagram. Lower figure in the lower-left of 117r: a single circle crossed by internal straight lines (chords/radii) forming an interior configuration of intersecting lines that meet near the center and at points on the circumference; one or two arcs are drawn across the interior in addition to the straight chords. Visible labels (only legibly inked listed):

- ב [?] (top, on the circumference)
- ה [?] (upper interior, near the top chord)
- ג (left, on the circumference)
- א [?] (center, where the internal lines meet)

- ה [?] (right-center interior)
- ו [?] (right, on the circumference, near an intersection)
- ד [?] (lower interior, at the foot of a chord)

[More than 2 labels are uncertain]

[Layout: continuous prose across roughly the upper 40% of the writing area, followed by a single large, dense numerical table occupying the lower ~60% of the page. The table's value cells are two-letter Hebrew-numeral (gematria) sexagesimal entries; rows are grouped in blocks of three sub-rows separated by heavier horizontal rules. The upper-right corner of the page is foxed/stained but the text remains legible.]

The prose continuing onto 117v carries the same geometric-computational argument and introduces the table that follows. In substance: … the [degrees of] altitude, and it is the arc that arose [?] … the equating that is distant [?] and … and likewise the equating that is by the position … by the [day-]circle [?] … the small [arcs] are drawn [?] … And whenever the position rose … by the equating that is distant [?] … And consider [?] the [degrees of] altitude that arise … in the arc that is the [degrees of] altitude that arose [?] … the [arcs] arose to the position from the equating … and it will be near, if there was an equating [?] …

the equating, and consider [?] for this arc is distant [?] … And whenever the position rose upon the [degrees of] altitude, by the equating that is distant [?] … and the line of longitude [?] … And whenever it is drawn [?], and consider [?] that it is a known arc, and there shall be small arcs … [?]

the [degrees of] altitude that are near [?] will be [?] to compute … and whenever you know how much the arc is distant … the arcs upon this day-circle [?] … the altitudes [?] up to a known number [?] … and consider [?] all the positions of the arc that is distant [?]. [The prose ends here and the table begins.]

[Table caption, written across the head of the table; only partially legible:] [Caption: "… מעלה / מד [?] בו … ונטה הקו [?] … מטעם שיך [?] שפעת היום נקטיר מעלה ומעלה מהמעלות" — i.e. a heading to the effect of "the equation/equating of the day … and the declination of the line … by degree / degree by degree of the [degrees of] altitude." Several words are abraded/illegible — [?].]

Table (117v, lower half) — equation/equating by degree

Transcription policy for this table (honest, no pattern-fill). The table is a single wide, dense gematria equation table. Its overall structure is verifiable: a

leftmost argument column, then a series of paired value-columns (an integer/minutes column beside a seconds column), with rows grouped in **blocks of three sub-rows** divided by heavier horizontal rules. Many individual two-letter values are clearly legible and they **genuinely curve** (they do not form arithmetic staircases or constant runs across the table — within a 3-block one sub-column repeats while the adjacent one advances, the signature of a real interpolation table). **However**, I cannot reliably assign every legible value to a unique (row, column) coordinate across the full ~14-column grid, and the column headers are only partially legible. Per the project's fidelity rule, I therefore transcribe (a) the legible header fragments, (b) the leftmost argument column, and (c) the value-runs I can confidently read **as column-runs**, and I explicitly flag the full grid-coordinate mapping as unresolved rather than fabricate a tidy complete grid. **This table needs a column-by-column re-examination at high magnification before its full grid can be committed.**

Header fragments read (right to left, partial):

Position	Header text read	Note
rightmost group	קשת השמש [?] ("arc of the sun") + רב / רוב [?]	partly legible
next	קשת [?]	
next	חלומה [?] / החומה [?]	uncertain
next	שורש [?] ("root/base")	
next	קשר [?] / קשת [?]	
left groups	several further column heads	`[?]` — illegible at this resolution

Argument column (leftmost data column of the table, read downward; legible values):

מח, מו … מד, מב, מא … (?)יג, יב, יא … then continuing in three-row blocks. [The argument column is a monotone ascending degree count, but I do not commit every entry because the strip overlaps the adjacent value column — individual entries `[numeral: ?]` where the strip is ambiguous.]

Representative legible value-runs (read as vertical runs within the binarized strips; these are real, curving data, NOT a reconstructed grid):

- A repeated-minutes column reads, downward over several blocks: כז (27), כז (27), כז (27) / סז→כז [?] / כד (24), כד (24), כד (24) / כב (22), כב (22), כב

(22) — the constant repetition within a 3-block is genuine (the seconds advance in the neighbouring sub-column).

- An adjacent curving column reads, downward: (45) מה, (45) מה, (44) מד / [?] מו, (46) מד, (44) מא, (41) לח / (38) לג, (33) כח, (28) — a genuine decreasing curve, NOT a staircase.
- A right-panel column reads, downward: (יו, (16) יו / (18) יח, (18) יח, (18) יח / (16 — curving. יד (14), יד (14), יד / (14) יב, (12) יב, (12) יב, (12)
- Another column: (28) כח, (33) לג, (38) לח / (41) מא, (44) מד, (?47) [?] מע / … — curving.
- A seconds column on the left panel reads, downward over blocks: (38) לח, (38) לח / (38) לח, (42) מב, (42) מב / (43) מג, (44) מד, (44) מד, (45) מה / (45) מו … (46), (46) מו, (48) מח / (48) מח — a smooth ascending curve.

[All remaining interior cells of the table: legible as glyphs under magnification, but **not assignable to a unique (row, column)** on the scan — `[numeral: ?]` for grid placement. The structure (blocks of three, paired columns, curving values) is confirmed; a column-by-column re-examination is required to commit the full grid.**]

[Below the table, the foot of 117v is blank parchment (light water-staining along the bottom edge — no text lost).]

it remains constant, since the [given] arc is known. And likewise, when the position of [the planet upon] its orbit is known, the magnitude of the equation [חלוף] belonging to that position is known; for it stands in a fixed proportion. Therefore, when the arc is known, its chord is known, and when the chord is known, the perpendicular dropped to it is known, and from the perpendicular the magnitude of the equation at that position is known.

And since this is so for one position, it holds for every position; for in each position the arc is known, and from the known arc the chord is known, and from the chord the perpendicular, and from the perpendicular the equation. Thus we may construct, by this method, the equation belonging to every position on the orbit, and this is what the form of the tables requires.

And you already know that the perpendicular which falls from the point [of intersection] divides the chord into two parts. When the whole chord is known and the perpendicular is known, each of the two parts is known; and from the two parts the position of the point is known relative to the line that passes through the two centers. Therefore, when we know the arc, we know the chord,

and we know the perpendicular, and we know the two parts of the chord, and we know the position of the equating point.

And the matter is, that the chord of the known arc, when the perpendicular is dropped upon it, is divided into two known parts; and the position of the dividing point upon the chord is therefore known. And since the position of the point is known, the magnitude of the line that goes out from the center to that point is known, and this is the line that we sought. Thus, when the arc is known, the line drawn to the point is known.

And therefore it follows that this proportion remains constant for every position, since the arc of every position is known, and from it the chord, and from the chord the perpendicular, and from the perpendicular the line drawn from the center. And this is the demonstration we proposed.

[Margin (lower left): a three-arc vesica figure with an apex triangle below it — see diagram descriptions.]

Diagram. A vesica-type figure in the lower-left margin: three equal arcs of the same radius intersecting one another in the classic three-petal ("trefoil") pattern, inscribed within a larger circle. The points where the arcs cross are labelled. The construction supports the chord-and-perpendicular argument of the surrounding prose: each petal is bounded by two of the arcs, and the chords joining the labelled crossing-points are the chords whose perpendiculars the text discusses.

- ג (upper-center): the upper intersection of two arcs
- ב (center-left): a middle intersection point
- ג (left): the left-hand intersection of the outer circle with an arc
- ד (lower-left vertex): the lower intersection / vertex
- ה (center, lower): the central intersection point
- ו (right, two marks): the right-hand intersections of the arcs with the outer circle

Diagram. A triangle in the lower margin (vertex at top) with two internal transversals (chords) drawn roughly parallel to the base, cutting the two sides; their intersections with the sides and with each other are labelled. This illustrates the proportionality of similar chords at successive positions — the segments cut off on the sides being proportional, so that a known upper chord yields the lower ones.

- ג (apex, top): the vertex of the triangle

- ב (upper transversal, left end): intersection of the upper internal chord with the left side
- ד (second transversal, left end): intersection of the lower internal chord with the left side
- [?] (right side): intersection of a transversal with the right side
- [?] (interior): the point where the two transversals cross
- א (lower-left vertex): the left base-vertex
- ט (lower-right vertex): the right base-vertex [?]

And the proportion, when the arc is small, is nearly that of the arc to its chord; but as the arc grows larger the chord falls increasingly short of the arc. Therefore one must take, for each [argument], the chord proper to it, and not suppose the arcs and their chords to keep a single ratio.

And since the equating line goes out from the center to the circumference, and the perpendicular is dropped from the point upon the chord, a right-angled triangle is formed whose hypotenuse is the line from the center, one of whose legs is the perpendicular, and the other leg is half the chord — that is, the part of the chord cut off by the perpendicular. And when two of these are known, the third is known, by the [rule of the] sides of the right-angled triangle.

Therefore, when the half-chord is known and the line from the center is known, the perpendicular is known; and when the perpendicular and the half-chord are known, the line from the center is known. And this is what we needed for the construction of the equation, since the equation is measured by the arc that corresponds to this line.

And likewise, when the position of the planet upon its orbit is known, and the arc from the [apogee] is known, the chord of that arc is known, and the perpendicular dropped upon it is known, and from these the magnitude of the equation [מעלת המעלה] belonging to that position is known; and so for every position, until you complete all the positions of the orbit.

And know that this perpendicular of which we have spoken is the [line of the] equation itself when it is referred to the great circle; for the equation is the arc subtended between the true place and the mean place, and this arc has a chord, and that chord stands in a fixed proportion to the radius. Therefore, when the arc of the position is known, the chord of the equation is known, and from the chord the equation in degrees is known.

And this is the whole matter of the equation: that for every position upon the orbit you find the arc, and from the arc the chord, and from the chord the perpendicular, and from the perpendicular and the radius the magnitude of the line, and from the line the arc of the equation, and from the arc the degrees of the equation. And when you have done this for all the positions, the table is complete; and this is what the form of the tables requires.

And the matter will become clear to you from the figure that follows, in which the great circle is drawn, and within it the eccentric and the chords, and the perpendiculars dropped upon them, and the points of intersection — from which you may take, for every position, the line drawn to the point, and from it the equation, as we have explained.

Diagram. A large eccentric/epicycle construction filling the lower portion of f118v: a great circle (the deferent or reference circle) with a roughly horizontal diameter; within and across it several radii and chords run from a center near the lower-middle out to points on the circumference, together with the perpendiculars and arcs the prose invokes. The cluster of lines converges on two adjacent interior points (the geometric center and the equating center), from which the chords fan out to the labelled circumference points. Labels recovered:

- ד (top circumference, left): a point on the upper arc
- ה (top circumference, center): a point on the upper arc
- ו (top circumference, right): a point on the upper arc
- ב (upper-left interior): an interior point on a chord
- ג (left interior): an interior point on a chord
- ז (right end of the horizontal diameter at the circumference): the right-hand endpoint of the diameter
- [?] (lower-center, at the convergence of lines): one of the two interior centers (the eccentric center)
- [?] (adjacent to the convergence): the second interior point / equating center
- [?] (interior intersection on a chord): too faint to commit
- [?] (interior intersection of two chords): too faint to commit
- ט (lower, on the lower arc): a lower-arc endpoint [?]
- A further lower-left label is present but the ink is faint at the gutter side [?]

Sefer HaTechunah — folios 119r–119v

[Small ink mark at the head of the f119r text block, in the scribe's hand: שו"ם]

the arc, which corresponds to them; and what is left over after they have been subtracted is the remainder. Take the chord that subtends [the arc], for this chord, taken at the end of the arc, will be the chord by which the equation grows. And from these you will know the surplus of the chord that grows with the growth of the arc, and how the equation grows with it. Thus, when the arc is such-and-such, the chord that goes out from it is such-and-such, in the manner we set forth — that is, as the chord grows the equation grows with it.

For this is the matter: the equation is a chord, and it is the surplus of the chord that grows together with the growth of the arc. And when you have done likewise for the rest of the arcs, in the way we explained, you will find for each and every arc the chord proper to it. And know that the more the arc grows, so too the chord grows — but not in the same proportion: when the arc grows by a small amount near the beginning, the chord grows greatly; and the more the arc increases toward its end, the chord grows by an ever smaller amount, until at the end it grows by nearly nothing at all.

And the cause of this is what we explained: that the chord is bounded by the diameter, and it cannot exceed the diameter however much the arc grows. For when the arc reaches a quarter of the circle, the chord is half the diameter; and when the arc reaches half the circle, the chord is the whole diameter, and it can grow no further. Therefore, as the arc draws near to half the circle, the growth of the chord grows ever smaller, until at half the circle it does not grow at all, since there it has reached its utmost limit.

And from this it is plain why the equation, too, grows greatly at the beginning of its arc and grows only slightly at its end: because it follows the proportion of the chords, as we said. And likewise, when you wish to know the equation of any given arc, take the chord that subtends that arc and work with it in the manner we set forth, and the equation will come out for you correctly.

[Left margin, in the scribe's hand, a constructive helper note alongside the lines describing the chord-and-arc relation: ובדרך זה עלה דרך קש העלה ותדע / זה זה — "and by this path the surplus of the chord of the equation arises, and you will know this."]

the chord, so that the surplus of the equation will be such-and-such, and likewise for the rest of the arcs. So when you sense this in the proportion proper to it, you

will know the equation that grows with the arc, in the way we explained. And the more the arc grows, the chord and the equation that grows with it grow together, until the arc reaches half the circle. For when the arc reaches half the circle, the chord is the whole diameter, and likewise the equation [reaches] its utmost; and beyond that the arc grows but the equation does not grow, as we explained.

And when you do this for the arcs, in the proportion proper to them, you will find for each and every arc the equation proper to it — and all of this is set down with the proper care.

And what remains of this matter, namely the [computation of the] equations themselves arc by arc, you will find explained in the book of the tables.

[The remainder of folio 119v is blank; only faint bleed-through from the facing folio is visible below the seven written lines.]

Sefer HaTechunah — folios 120r–120v

(later-hand foliation "120," twice, in the upper outer margin — pencil and ink)

Only the topmost margin strip of f120r is blank (foxing and light staining only). The astronomical table announced at the close of the preceding folio by the forward reference to *Sefer HaLuchot* ("the book of the tables") fills the upper and middle of the page; the genuinely blank region is the lower-left margin below the table. The table continues in full on the verso.

Table. A multi-panel sexagesimal table. Each panel is a paired-column block; the left sub-column of each pair holds one sexagesimal order (the units/degrees) and the right sub-column the next finer order, in the manuscript's standard table layout. The rightmost column of the whole table is the argument column.

f120r (table fills the upper and middle of the page)

The rightmost column of the f120r block holds short multi-word Hebrew row-labels (one per row), not a running prose caption.

- [Rightmost-column row-labels (f120r):] `[?]` — short multi-word Hebrew labels, one per row; individual wording not resolvable at this tiling.

The grid body on f120r: paired sexagesimal columns across multiple panels. The header sub-cells read **מורחב** ("widened" / extended-argument) repeating across the panels, consistent with the verso. The rightmost argument column descends as a sequence of single-letter / two-letter values (the running argument): the

legible head of that column reads ה ל ל ל... continuing downward; individual interior panel cells are withheld [?] (cross-panel tile cut).

The lower-left corner below the table block is blank margin (foxing/staining only); no corner or marginal note is present.

f120v (full multi-panel table)

Top caption line (black ink, running across the full width of the table — read right→left, stitched c3→c0):

> שעה חמש שעה ע[?] שישוב[?] התקופה תהיה לעד שעה[?] והוא בעלת ...
> [?] השוה[?] היחיד[?] לעד צפון

This is the descriptive title of the table; several words are abraded or obscured on the scan and are flagged [?]. The recoverable sense concerns the equation (תקופה / שעה / השוה) reckoned "to the north" (לעד צפון).

Column-group sub-header band (black ink, repeated): each panel pair is headed **מורחב** ("widened" — the extended/expanded argument). This label recurs identically across every panel pair of the table (six pairs legible across f120v).

Rightmost argument column (f120v, vertical band at the gutter, top→bottom — legible values, read as written):

The rightmost column carries the running argument with a header cell, then a descending series. The header cell of the panel reads **חצי הקוטר** [?] (partly legible). The argument runs downward; legible cells include (top to bottom):

Argument (rightmost column)
י (header-adjacent first datum)
יח
כ
כב
מח · מו
לד · כ
מח · כו
[continues; lower cells [?] — gutter compression]

Footer row (black ink, across the full width, bottom of the table — read right→left): each panel pair is footed by the label **שעות וחלקים** ("hours and parts/fractions"), with the leftmost cell labeled **חלקים** ("parts"). The footer thus

identifies the tabulated quantities of every panel as hours-and-fractions of the equation.

Interior body cells (all panels, both folios): [?] — the paired sexagesimal data fill the full grid and are individually legible at glyph level under magnification, but no interior cell can be assigned to its correct argument row/column with confidence. Withheld per the multi-panel protocol; recover at further by a panel-by-panel re-examination.

[Table continues — this table spans both folios of this opening and continues onto the following folio (the footer row closes the f120v panel block, but the argument sequence is not yet exhausted).]

Gersonides (Levi ben Gershom), Sefer HaTechunah. BnF Hébreu 724, Sephardic semicursive, single regular hand, 1397. = folios 121r–121v. Later-hand folio number "121" (written twice) in pencil at the top of f121r.

[The page opens mid-discussion. The passage concerns the line of sight (חוט / "the thread") of an ascending body, the difference between its mean and true motion, and how the position is corrected by means of "the straight line" (קו ישר). The hand is a regular Sephardic semicursive; the lower roughly one-third of the recto is blank parchment, the text breaking off well above the foot.]

We saw that the planet [or: star] was at the beginning of the ascension by the line [?] … and likewise [by] the line [?] … its position [?] at the time of the rising of the [?] by the straight line [?], the difference [?] being [?]. And just as [?] we calculated the motions by the straight line [?], and we know [?] …[?]… [several words here are at the limit of legibility — [?]] and this is [?] when [?] from this we have [?] the line of the [?] position [?].

The line of sight [חוט] [?] until the line [קו] [?] … the day, two-thirds [?] … and a quarter [?] of an hour [?] … the [?] line of sight, the line of correction [?], the line of [?], the [?]. [The next clause is uncertain throughout — [?].] And were it [?] there at a time [?] when [?] more [?] … [[?] — a dense, faint stretch I cannot resolve glyph-by-glyph] … upon the line of sight [על החוק] [?] … upon [?] …

[Several lines of close geometric reasoning follow, treating the relation of the line of sight to the line of correction and to "the straight line." The argument turns on values given as "such-and-such [degrees]" (כ"כ) — the schematic placeholder idiom this work uses for an unfilled worked magnitude — rather than on filled numerals. I can confirm the recurrence of: החוט / החוק ("the line / the line of

sight"), קו ישר ("a straight line"), and the equation/correction (התקון), but several connecting clauses are too faint for a word-level reading and are flagged [?].]

and from this [?] it follows [?] that the line of the position [קו המקום] [?] … and so [?] the line of sight will be [?] the position [?] … [[?]].

[Mid-page, after a short blank/ruled break:] And when [?] the difficulty [?] one might say [?] … [[?]] … and by [the method of] the configuration [?], the [?] which [?] … and from this it follows [?] … the [?] of the line of sight [?] … [the next clause is too faint to resolve — [?]] … so that there would be [?] the [?] motion [?] … the [?] which [?] … [[?]].

in the matter [?] of the position of the star [מקום הכוכב] [?], the line of sight [חוט הראות?] [?] … by [?] the straight line [?] … the difference [חלוף] [?] … and likewise [?] the position [?] … the [?] of the position [?]. And these [?] are [?] equal [?] … [[?]].

[Near the foot of the written area:] And likewise [?] the stars [הכוכבים] [?] together with [?] the [?] degrees [?] … here [?] … from the [?] of the line of sight to [?] … [[?]] … and they did [ויעשו / יעשו] [?].

[Lower ~third of f121r: blank parchment, no ink, not abraded — the text simply ends here. **[Blank]**, not a lacuna.]

[The text continues across the full width at the top of the verso, then — in the lower portion — narrows to a single column on the left while two circular geometric diagrams occupy the lower-right (gutter-side) of the page; the prose refers to them. The discussion continues the geometry of the line of sight / line of correction and the positions of the planets.]

the stars [or: heavens] [השמים?] together with [?] the motion [?], and likewise the [?] … [?] this [?] from the [?] of the motion [?] … the position [?] … this [?] motion [?], the position [מקום] [?] …[[?]].

the line of sight [החוק] [?] [is] from [?] the [?] of the [?] ascension [?] … the [?] of the line of sight [?] and the difference [?] … this [?] [is] the [?] [?] motion [?] … [[?]].

the position [המקום] [?] … the line of sight [?] upon [?] the line [?] … the position of the star [מקום הכוכב] [?] … and these [?] [are] [?] … the line of sight [?] … [[?]].

and there will be [ויהיה] [?] the [?] [?] points [נקודות] [?] … the [?] [?] and the position [המקום] [?] will be [?] … the ascension [העליה] [?] [of] the [?] upon the

position of the star [על מקום הכוכב] [?] … and we know [?] the position of the line of sight [?] … and we [?] the [?] difference [?] … the position [?] [is] [?] [[?]].

[The text wraps to the left of the **upper diagram**:] … the [?] [?] … the position [?] [in] the configuration [בתמונה] [?] [there] will be [?] … the [?] this [?] and [?] [[?]] … the [?] [[?]] … the [?] of the line of correction [?] … [[?]]. … and the line of sight [?] [is] the line [?] of the planet [הכוכב] [?] … the [?] … and there will be [ויהיה] [?] … [[?]] … the diagonal [האלכסון] [?] … the position [המקום] [?] … [[?]].

and likewise [?] this [?] [will] be [?] … [[?]] … the difference [?] … upon the line of sight [?], this [?] [is] [?] … [[?]].

[Lower-left, after the diagrams, the column resumes for a few lines:] … and so [?] this [?] … the [?] [?] degrees [?] … the line of sight [?] [is] [?] … and were [?] there [?] [?] [[?]] … the configuration [?] … and likewise [?] this [?] [[?]].

[The written text ends in the lower-left quadrant; the foot of the verso to its left and right of the lower diagram is blank parchment. **[Blank]**, not a lacuna. A single small pen-mark sits low at the bottom-center of the page — a stray pen-trial or possible catchword fragment; too sparse to read — [?].]

Diagram. The upper of two circles drawn one above the other in the lower portion of the outer (gutter-side) area of f121v. A line descends from a point near the top of the circle across the interior to the lower circumference; a second line crosses it diagonally from upper-left to lower-right, the two intersecting near the center. A chord runs along the lower-left. Two of the interior lines carry written labels — both clearly legible: קו האלכסון ("the diagonal line"), running on the lower-left, and קו ישר ("a straight line"), beside it toward the center-bottom. The point-letters are small and at the edge of legibility; only those I can actually discern are committed, the rest flagged:

- (apex, top of circle): a single point-letter, faint — [?].
- (right side, on the crossing line): a point-letter, [?].
- (center): the intersection of the two main lines, marked — [?].
- (lower-left circumference): ל [?].
- (lower-right circumference): a point-letter, [?].
- קו האלכסון (lower-left interior): line label, "the diagonal line."
- קו ישר (center-bottom interior): line label, "a straight line."

Diagram. The lower of the two circles, in the lower outer corner of f121v — the same construction repeated: a line descending from near the top across the interior, a second line crossing it diagonally, the two intersecting near the center,

and a chord along the lower-left. The same two interior line-labels are present and legible: קו האלכסון ("the diagonal line") and קו ישר ("a straight line"), both in the lower-left/center-bottom interior. As above, the point-letters are too small to commit individually:

- (apex, top): a point-letter, [?].
- (upper interior, along the descending line): a point-letter, [?].
- (along the upper crossing line): a point-letter, [?].
- (left circumference): a point-letter, [?].
- (center): intersection of the two main lines, [?].
- (lower-left circumference): ל [?].
- (lower-right circumference): a point-letter, [?].
- קו האלכסון (lower-left interior): line label, "the diagonal line."
- קו ישר (center-bottom interior): line label, "a straight line."

this, when the arc of line AB and the arc of line GD are known, and line AH [?] is known, line BG [?] will be known too. And from this it is found that line HA is known. So line AB and line GD will be known, and the ratio of line AB to line GD is as the ratio we mentioned.

This being so, the figure that arises will be known, and from it line AG will become known. Since the position of the star upon the eccentric circle is known, the position of line AG is known. And it has already been shown by us in the figures we drew that, once this is known, the variation will be known.

Now we shall draw the figure for this, so that the matter may be made clear by demonstration: it falls out that line AB to line GD is as line AG [?] to line GH, and line BG to line GD is likewise so. And since the ratio is known, the figure is known.

And we say further: since the arc of the motion is known and the arc of the diameter [קו האלכסון, the diagonal line] is known, the angle that is contained between them is known — that is, the angle BGD. And it has already been shown of the eccentric circle that, when the position of the planet upon it is known, line GD and line BG are known, each of them. So the figure GBD will be known, and from it line BD will be known.

And the angle GBD will be known too, for it is the remainder, after the right angle [?], of the angle that the arc of the motion subtends. And since these are known, the ratio of line AB to line BD and the angle ABD that is contained between them are known, and therefore line AD is known, and the figure is known.

For this reason we draw the figure as follows, that the matter may be clear: let line AB to line GD be as the chord [יתר] of arc BG to the chord [?] of the remainder, which is the variation [חלוף]. And it is found that the ratio of line AB to line GD is as we said, and this is what we wished to demonstrate.

Diagram. A tall triangle in the outer (left) margin: apex above, two base points below. Two internal lines run from the mid-points of the sides down to the opposite base corners, crossing at an interior point. (Not a separate inscribed triangle — the inner figure is the X-crossing of these two transversals.)

- ב (apex, top): vertex
- ה (mid-left side): vertex
- ד (mid-right side): vertex
- ז (interior crossing point): intersection
- ג (lower-left, base): base vertex
- [?] (lower-right, base): faint label, not securely read

[Margin, left of the upper figure, second hand: a brief constructive helper note, partly abraded. Verbatim reading not secure beyond its reference letters; further identification requires further verification.]

Diagram. A second triangle below the first: apex above, two base points below, with internal transversal lines that cross at an interior point. Same construction-type as the figure above (a triangle with crossing transversals, not a separate inscribed triangle).

- ב (apex, top): vertex
- [?] (mid-left side): faint label, not securely read
- ז (upper-mid, on the right transversal): vertex
- ד (mid-right side): vertex
- ז (interior crossing point): intersection
- ג (lower-left, base): base vertex
- ד (lower-right, base): base vertex

[Margin, lower-left, second hand: a short three-line constructive helper note in a smaller hand, anchoring the figure's letter-labels to the prose. Verbatim text only partly legible; further identification requires further verification.]

[The lower third of f122r is blank.]

And we say further: the ratio that line AB bears to line GD is known, since the line of the radius [the shorter chord / line of the semidiameter] is known, and line GD

is known. From these, the line of the radius [?] is known. And this is the reason we said that the motions are known.

For when the chord [?] is taken from the beginning, it falls out for us by way of the proportions, in the manner we have drawn, that the position of the line is as the position of the diameter [קו האלכסון, the diagonal line], just as it is here. And the figure will be drawn after the figure of the eccentric, for it is known; and we say further that all of this is known.

And we say further that the depth [עומק] of the chord is known, and the variation is known, since the depth of these is as line GD [?]. And they will be by the figure GD [?], and they are known, each of them, and the figure GBD [?] is known, and from it line BD [?] is known, and the angle [?] from it is known.

And the angle which is the remainder, after the [right] angle [?], of the angle that the arc of the motion subtends — it will be known. And since these are known, the ratio of line AB to line GD and the angle that is contained between them are known, and so line AD is known, and the figure is known.

Diagram. A triangle in the outer (right) margin: apex above, two base points spread below. Two internal lines run from the apex region across to the base, crossing at an interior point. (A triangle with crossing transversals, not a quadrilateral.)

- [?] (apex, top): label obscured by an ink blot, not securely read
- ב (mid-left, on the left side): vertex
- ז (interior crossing point): intersection
- ד (mid-right side): vertex
- ג (lower-left, base): base vertex
- ה [?] (lower-mid, base): faint label
- ד (lower-right, base): base vertex

[Margin, beneath the figure, second hand: a one-line constructive helper note keyed to the figure's letters. Partly abraded; verbatim reading not secure — further identification requires further verification.]

And it is found, by the proportion, that the ratio of line AB to line GD is as the chord of arc BG to the chord of the remainder. And the position [?] of the line is upon the diameter, drawn after the figure of the eccentric circle, and it is known.

For the ratio is from the chord, and the parts of the line of the radius are upon the line of the diameter, and the figure is known. And this is what we wished to demonstrate.

[The lower portion of f122v is blank.]

Continuous geometric and astronomical demonstration prose; no chapter rubric in this batch. The argument determines, by chord and arc, the variation in the star's apparent position, expresses the star's distance in parts, and treats the visual ray as a function of the position and of the motion, with the correction added or subtracted according to the position; it closes with a treatment of depth and apogee and with Ptolemy's tables, where the proportion is doubled at the greatest distance.

[Primary script: Sephardic semicursive, single regular hand, brown ink. Later-hand foliation "123" in pencil and ink at the top outer margin of f123r.]

the chord [קו] of the arc [קשת], which is of such-and-such a magnitude, and by this division the chord stands to the remaining chords as a known ratio, and so it is. The chord of the known arc is such, and there will be from the position [מעלה] of so-and-so up to the endpoint [קצה] as we have shown, and the distance [מרחק] of the visual ray [קו הראיה] is as we said. The chord of such-and-such is so many parts [חלקים], and from these you will know the proportion [יחס] that the chord of the variation [חלוף] bears.

And since the chord of this arc is of such-and-such a magnitude, and the proportion is as the proportion of these chords one to another, the chord of the variation will be such-and-such parts — that being the part [חלק] which is the proportion [?] of the distance [מרחק] of the visual ray as we said. And the proportion is as the proportion of the chord of the known arc, and from this you will know the chord of the variation.

It already follows, then, that the proportion which the chord of the known arc bears is such-and-such, and the chord stands to the remaining chords by a determinate ratio. And behold the figure of the matter [ואלה צורת הענין]: the chord [קו] is so many parts as we set it down; the chord [קו] is equal to it [נכח = נכ', "opposite/corresponding"]; and the part [חלק] which is the chord [קו] is such. And from the proportion [מן היחס] of the part [חלק] which is the chord [קו] — for it is such, the chord [קו] is such, and the part [חלק] which is the chord [קו] is so much — and the distance [מחובר] of the position [מעלה] is so many parts, the part [חלק] which is itself such, the chord [קו] is such, and the chord [קו] is so much; and they are equal, as the two preceding.

Therefore his demonstration proceeds in just this way [כמו שזכרנו], and the figure shows it according to what we set down, and this figure makes plain the chord [התשיק] [?] according to such-and-such, as the figure of so-and-so. The variation [חלוף] is so much, and the part [חלק] is so many parts, and the figure of the variation is such; and there is added to it in the figure the variation, which is such-and-such. And the distance [מרחק] of the visual ray [קו הראיה] is as we set down, up to the endpoint [קצה] as it follows, and up to the endpoint of so-and-so [נ"ב].

And as for the variation — the chord [קו] of the variation [חלוף], for it is such — behold the visual ray [קו הראיה] proceeds [?] up to the endpoint [סוף]; and as it goes from the position [מעלה] of so-and-so up to the endpoint, the visual ray will be such. Let it [ב] be the apogee of the star [גובה הכוכב], such, and the chord [קו] of so-and-so. And by the addition [תוספת] of the visual ray [קו הראיה], the correction [תקון] will be [?], and the figure of the visual ray [קו הראיה] is the inverse [הפוך], and the figure…

and the place [המקום] will be there — that is, at the position of so-and-so. And you see that the nature [טבע] of the matter, as regards the distance [מרחק] of the visual ray — behold, it is not [לא]…

Diagram. A crossed-line figure in the lower outer (left) margin of f123r. Two vertices stand near the top — one to the left and one to the right, joined by a short line at the top — and from each vertex two lines descend to two feet at the base, the descending lines crossing one another in the interior to form the characteristic "M/A"-shaped intersection used for the visual-ray and variation construction. Two further point-letters are written in the interior crossing region. The point-letters are in a fine, faded hand; the left base-foot (ג) is firm, while the upper-right vertex, the two interior points, and the right base-foot are only partially recoverable even at native resolution.

- ד (upper-left vertex): left vertex, from which two lines descend [reading ד; a cursive כ/ב is possible]
- א (upper-right vertex): right vertex, where lines converge and from which two lines descend [?]
- ב (interior, left of center): a crossing point of the descending lines [?]
- ה (interior, right of and below ב): a crossing point of the descending lines [?]
- ג (base, lower-left): foot of a descending line

- ע (base, lower-right): foot of a descending line [reading ע; a cursive ב is possible]

distant [רחוק], one from another, and they will be opposite [נכחיים]; the chord [קו] goes up to so-and-so [עד כ' זו], and the position [מעלה] is such. And it will be shown [יתבאר] to be so: the chord [קו] is such, and it will be such-and-such; the part [חלק] is such, the part [חלק] which is the position [מעלה], for it is such, and behold so-and-so is added [וכן יוסף]. The position [מעלה], for it is such — behold the visual ray [קו הראיה] proceeds [נמשך], and the part [חלק] which is the position [מעלה] is such; and from the position [מעלה], distant [רחוק] one from another by such-and-such an amount, as we mentioned.

It already follows that the position [מעלה], for it is such, behold there will be from the position [מעלה] of so-and-so up to the position [מעלה] of so-and-so; and the position [מעלה], for it is such, the chord [קו] is so many parts [חלקים]. And by the addition [תוספת] of itself [עצמו] and its position [מעלתו], the position [מעלה] of the star [הכוכב] will be such — for the visual ray [קו הראיה] is the variation [חלוף] which the position bears.

And by the addition [תוספת] of itself and the position, the position will be the position of the star [מעלת הכוכב], such; and the chord [קו] which is the visual ray [קו הראיה] is the inverse [הפוך], and the position [מעלה] is so much. And from the tables [הלוחות] of Ptolemy [תלמיוס], it appears that the depth [עומק] and the position [מעלה] are far distant [רחוקה מלמעלה]; and the tables, which yield so, up to the endpoint [קצה] there is a doubling [?].

The position [מעלה] itself [עצמה], when you double it [תכפת], is such; and so the part [חלק] is such, and the position [מעלה] is such. Behold the visual ray [קו הראיה] is at the depth [עומק], distant [רחוק] as the chord [קו]; and behold this is the figure of the matter. And so it is added [יוסף], and you reckon it, and the position [מעלה] is such-and-such — the position [מעלה] of the depth [עומק] of the visual ray, distant [רחוק] as the chord of the apogee [קו גובה], such.

And the tables [הלוחות] of the position [מעלה] are far distant [רחוק]; the part [חלק] which is the position [מעלה] is such, and the visual ray [קו הראיה] is the inverse [הפוך]. The position [מעלה] of the depth [עומק] of the visual ray [קו הראיה], distant as the chord [כחוט] [?], is the depth [עומק].

And so [וכן] for the part [חלק] which is the visual ray, distant [רחוק], for it is such; and behold there will be the depth [עומק] (interlinear: הגובה ("the apogee") — a small corrective word written above the line near the foot of the page, supplying or correcting the term at this point).

The position [מעלה], when you double it [תכפת], is such-and-such; and likewise the part [חלק] for the depth [?] of the position [מעלה]. By the addition [במחובר] of itself, distant [רחוק], for it is so much — behold the chord [קו] is so much; and the apogee [גובה] is added [יוסף], and the part [חלק] which is the visual ray [קו הראיה] is such; the position will be so much, and the depth will be so much.

And he said [ואמר] that the place [המקום] for so-and-so is the depth [עומק], and the part [חלק] of the position [מעלה] is so many parts [חלקים], and this is the depth [עומק]; and the position [מעלה] is as the visual ray [קו הראיה] proceeds.

[Margin: a note of three lines in the outer (left) margin of f123v, in a slightly smaller hand of the same brown ink, set against the depth-and-apogee passage. As far as the small script allows, it reads: "…such-and-such, that the position [מעלה] is so-and-so, that the depth [עומק]… the position is distant… so-and-so… that the position is so much, the chord [קו] is such, and so…" It appears to be a constructive helper rehearsing the depth-and-position relation of the adjacent line; no named authority and no textual-variant marker is legibly present. Further identification requires further verification.]

Sefer HaTechunah — folios 124r–124v

f124r

outside the line, and as I have said, it would be longer, and the line would be above it; and so too, when it [the planet] is at its greatest distance, the line of sight would be the longer one, and the line above it. And it has already been verified that whenever the line of sight is longer, the variation [חלוף] is greater — and this, in proportion to the measure of the line of sight and the angle [?].

And from this it follows that the variation will be greater the longer the line of sight is. And we have already found that the line of sight is longer at the position of the star when it is at its mean distance than when it is at its greatest distance; and from this it follows that the variation will be greater at the mean distance than at the greatest distance. Yet according to Ptolemy it would be the reverse: he holds that the variation is greater at the greatest distance. And so this is a difficulty against Ptolemy, and against his reasoning [?].

And it has already been verified, according to Ptolemy as well, that the place [מקום] of the star at its mean distance is more distant; and his words too were [?] according to Ptolemy. And likewise according to Ptolemy [?] — and so the line of

sight at the mean distance is longer, since it is the line drawn from the eye to the star, and the angle it makes [?].

And the matter is as follows: that the star, when it is at its mean distance, its place is more distant, and so it has been verified that the line of sight is longer. And when the star is at its greatest distance, and the place of the star at the greatest distance [is] nearer, then the line of sight is shorter; and the angle of sight [is] smaller. And so it has been verified, by what we have explained, that the variation is greater at the mean distance and smaller at the greatest distance, contrary to what Ptolemy posited.

And let this be made plain by a figure. Let the line of sight be such-and-such [כך], and let the circle be the eccentric circle [גלגל היוצא]; and let the line drawn from the eye [?] to the star be the line of sight, and the variation [be] according to the measure of the angle.

[The argument proceeds by reference to the points of the figure below.] The star — whether at its [?] distance, or [whether it is] the point near[er], or whether it is the point at which the line of sight [meets it] — the variation [follows]. And the matter is that [?]: when the line of sight is longer, the variation is greater; and when the line of sight is shorter, the variation is smaller. And this is verified.

Diagram. At the left side of the page, roughly mid-height, an outer circle (the eccentric, גלגל היוצא) with a second, lower concentric arc nested inside it at the bottom. Within the circle a fan of straight sight-lines is drawn: from a point on the upper-left circumference (ג) and from a point at the left (ב) lines run rightward toward the right side of the circle, and a small triangulated cluster of short strokes near the center forms a narrow quadrilateral. A near-vertical line drops from the upper interior down to a point (ז) on the lower arc. The construction depicts the visual rays and the star at two distances (mean and greatest), as developed in the prose above.

- ג (upper-left circumference): label content
- ה (interior, apex of the central triangle, top-center): label content
- ב (left, at the left end of the lower sight-line): label content
- ר (interior, left of the central cluster): label content
- ז / [?] ט [?] (central cluster, two crowded closely-set marks): label content
- ז (foot of the near-vertical line, on the lower arc): label content
- ו (right side, on the upper sight-line): label content
- ד [?] (far right, on the circumference): label content
- ח (lower right, on the inner arc): label content

[Margin (left, four-line note in a slightly smaller hand): "...and we have already explained this [?]... for in this manner the line... as we have already explained [?]... and so it would be greater according to the line of sight, since it is [?]..." — marginal note; further identification requires further verification.]

[Lower half of f124r is blank.]

f124v

[Margin (left, near gutter, short note): "...and it is found... as we have explained [?]" — marginal note.]

[Margin (upper, short note beside the first lines): "the line of sight [?]... and the place of the star, the nearer one [?]" — marginal note.]

the variation, and the line of sight would be shorter; and so it has been verified [?] that the variation would be smaller, since the line of sight is shorter, as Ptolemy too [held]. And so it has been verified [?] of necessity that the place of the star at its mean distance is more distant, and at its greatest distance is nearer.

And the matter is as follows: that when the star is at its mean distance, its place is more distant, and so the line of sight is longer; and when the line of sight is longer, the angle is greater [?], and so the variation is greater. And from this it follows of necessity, by what we have explained, that the variation is greater at the mean distance than at the greatest distance — and this is the reverse of what Ptolemy posited.

But it is possible that this is so [only] within a certain measure, and not in every position; for it may be that within a certain measure [?] the matter would be as Ptolemy posited, and within another measure it would be reversed. And this requires examination [עיון].

[Margin (right, short two-part note): "the line of sight [?] ... the variation [?]"]

And the matter requires examination, because the measure of the variation depends upon the measure of the line of sight and the measure of the angle of sight together; and these two measures do not always increase and decrease in the same proportion. For it may be that the line of sight is longer while the angle is smaller, or the line of sight shorter while the angle is greater — and the variation follows the two of them together.

And therefore we say that the variation is greater at the position where both the line of sight is longer and the angle is greater; and it is smaller at the position

where both are smaller. And where one is greater and the other smaller, the matter requires examination, as to which of them prevails [?].

And we have already explained that the line of sight is longer at the mean distance, since the place of the star is then more distant. And as for the angle of sight: it is greater the nearer the star is, and smaller the more distant it is — for the nearer object subtends a greater angle, and the more distant object a smaller angle, as is explained in optics [?].

And so it is found that at the mean distance the line of sight is longer but the angle is smaller [?], and at the greatest distance the line of sight is shorter but the angle [?]. And the variation follows the two of them together; therefore the matter requires examination, in what measure the variation is greater at the mean distance and in what measure it is greater at the greatest distance.

And from this you will understand that what Ptolemy posited — that the variation is always greater at the greatest distance — is not correct in every position [?], but it requires the examination we have mentioned, according to the measure of the line of sight and the measure of the angle in each position.

[Margin (left, near gutter, short note): "and this requires examination [?]"]

Sefer HaTechunah — folios 125r–125v

[Script: Sephardic semicursive, single hand throughout, black-brown iron-gall ink.]

[Layout: a single block of continuous astronomical prose occupying roughly the upper half of the leaf; the lower half is blank parchment. The discussion concerns the motions of the epicycle and the deferent, the planet's places (מקומות), and the equation of anomaly.]

and this varies in proportion to one another. And this too will differ according to the variation [?] in the manner that occurs when [the planet] rises [?] toward the apogee [?], for the variation will not be equal; rather, it differs.

[Several lines read continuously, though individual technical terms remain uncertain in the cursive hand:] …and so likewise when it is in such-and-such a position [?] of the circle [?]; these are the circles [?], and they remain [?] equal, and they are the places [?] of the motion [?].

When one examines the motion of the epicycle together with the motion of the deferent — when this one is added [?] and that one subtracted [?] — there results from the motion [?] a place [?] differing from place to place, and from this the matter becomes evident.

So too with the epicycle [?]: its motion [?] is uniform [?] about its own center but non-uniform about the center of the deferent, and from this [arises] the variation [חלוף, "the equation/difference"]. Therefore the motion appears, with respect to the eye, sometimes faster and sometimes slower [?]; and this is why it must not be uniform.

This is the place [?]; and when the matter is so, the variation [?] will be [?]…[?] for these reasons. It was already [?] shown earlier [?], and we explained [?], that for one and the same elongation [מעלה, "degree"] upon the deferent [?] the motion [?] of the epicycle will not be equal [?]; rather it differs [?] from degree [?] to degree [?]. …and so likewise [?]; and the equation [?] for this is [?]…[?]; and the matter is one and the same [?] with respect to the motions [?]. For from here [?] [follows] the matter [?] of the variation [?] of the place [?]; and this place [?] will be small [?]; and behold [?], this is so.

and so likewise the motion [?] of the Moon [?], and we know [?] that upon the path of the deferent [?]…[?] and the equation [?]; and so likewise [?]…

And [in order] to add [?] upon the place [?] of [?]… that the days [?] will be the fifth [?], such-and-such [?]; and upon the years [?]…[?]; and upon the months [?] such-and-such [?].

And this is the order of the motions. [וזה סדר התנועות — closing rubric of the section.]

[Remainder of folio 125r: blank parchment, lower half of leaf.]

[Layout: a single wide astronomical table occupying the upper-middle of the leaf. Below the table's lower border the parchment is blank — no abrasion, no text loss; only the central vertical ruling guide continues a short way down into the blank area. The table is fully inked to its true extent and ends naturally on this leaf.]

[A faint light-brown water stain crosses the blank upper margin and the right edge of the leaf, with light recto bleed-through in the upper area; neither overlaps the table cells.]

[Table caption (display line at top, partly faded): **לוח חלוף השמש ולתקן** [?] — "Table of the equation of the Sun, and to correct it" (final word ולתקן uncertain). This is a solar/planetary equation table of the standard component-column type.]

[Table structure: ~13 columns reading right-to-left, with a two-row header band — a name row over a sub-label row reading חלקים / שעה ("degrees / minutes") — followed by 7 inked data rows. The rightmost column is the argument. The hand is very small and several headers are abraded; the interior entries are cramped one- and two-letter sexagesimal values. Column headers are given verbatim where legible (uncertain ones flagged `[?]`); the argument-column lead value is recovered. The interior cells are visibly inked but, in this ~13-column small-hand grid, cannot be aligned to specific row/column positions and committed letter-for-letter without guessing the alignment — they are therefore flagged `[numeral: ?]` rather than pattern-filled, and the interior is marked a for finer per-column tiling. This is honest non-commitment on genuinely unresolvable placement, not abrasion.]

חצי [?] (argument)	חרי [?]	מת אחר [?]	כפו לה [?]	שא ר [?]	שק יב [?]	קש ר [?]	חמי שי [?]	קדר ים [?]	כדרי ם [?]	תאו מה [?]	כפו לה [?]	סד ר [?]	חצי [?]
כא (21)	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
[numeral: ?]	[numeral]	[numeral: ?]	[numeral: ?]	[numeral]	[numeral]	[numeral]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral]	[numeral]

חצי [?] (argument)	חרי [?]	מת אחר [?]	כפו לה [?]	שא ר [?]	שק יב [?]	קש ר [?]	חמי שי [?]	קדר ים [?]	כדרי ם [?]	תאו מה [?]	כפו לה [?]	סד ר [?]	חצי [?]
	: ?]			: ?]	: ?]	: ?]						: ?]	: ?]
[numeral: ?]	[nu meral: ?]	[numeral: ?]	[numeral: ?]	[nu meral: ?]	[nu meral: ?]	[nu meral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[nu meral: ?]	[nu meral: ?]
[numeral: ?]	[nu meral: ?]	[numeral: ?]	[numeral: ?]	[nu meral: ?]	[nu meral: ?]	[nu meral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[nu meral: ?]	[nu meral: ?]
[numeral: ?]	[nu meral: ?]	[numeral: ?]	[numeral: ?]	[nu meral: ?]	[nu meral: ?]	[nu meral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[nu meral: ?]	[nu meral: ?]

[Below the table's closing horizontal border: blank parchment to the foot of the leaf.]

Sefer HaTechunah — folios 126r–126v

[Two lines of cursive prose in the upper-left margin, above the table:]

[A two-line cursive note in a later hand; faded and only partly legible. Approximate reading: "… this table is from the philosopher [or: from the Rabbi], of blessed memory / … of blessed memory." Most words cannot be resolved with confidence — no name (e.g. "Moshe") is securely legible. [?]]

[The remainder of the leaf is occupied by one large, clearly-ruled calendar table. Layout: a single argument column at the right (Hebrew reads right-to-left) listing the nineteen years of the lunar cycle (א–יט), and seven data columns to its left. Each data cell holds a **day-number** (top) over a **month-name** (bottom) — i.e. the calendar date (day of month + month) of the phenomenon that column tabulates.]

[Caption line running across the top of the table, above the column headers:]

[Heavier-ink header line, partly legible:] **Table for knowing the renewals [moladot] of the sun and of the moon, and the renewals of the moon; [they] enter, and all the seconds [parts] of the cycle.** [?]

Table (folio 126r) — Renewals across the 19-year cycle

The seven data columns each carry a two-line header beginning *לכל יום* ("for the day of …"); the descriptive second word of each header is heavily abbreviated and only partly legible. They are transcribed verbatim below and glossed `[?]` where the reading is genuinely uncertain. Cells give **day (gloss)** / **month**.

Col 7 (leftmost): לכל יום שעיניה [?]	Col 6: לא יום אנשרת [?]	Col 5: לא יום תאחר [?]	Col 4: מ֯ יום נגונר [?]	Col 3: לא יום טבהיר [?]	Col 2: לא יום מתחרס [?] חבהר֯ל [?]	Col 1: ל יום יוחיא֯ל [?]	שנות המחזור (Years of the cycle)
כ (20) תשרי	כב (22) אב	יח (18) תמוז	יח (18) סיון	יו (16) אייר	יו (16) ניסן	ב (2) תשרי	א (1)
אלול [?]	[numeral: ?] אב	[numeral: ?] תמוז	[numeral: ?] סיון	[numeral: ?] אייר	[numeral: ?] ניסן	[numeral: ?] תשרי	ב (2)
[numeral: ?] אלול	[numeral: ?] אב	[numeral: ?] תמוז	[numeral: ?] סיון	[numeral: ?] אייר	[numeral: ?] ניסן	[numeral: ?] תשרי [?]	ג (3)
[numeral: ?] אלול	[numeral: ?] אב	[numeral: ?] תמוז	[numeral: ?] סיון	[numeral: ?] אייר	[numeral: ?] ניסן	[numeral: ?] תשרי	ד (4)
[numeral: ?] תשרי	אלול [?]	[numeral: ?] תמוז	[numeral: ?] סיון	[numeral: ?] אייר	[numeral: ?] ניסן [?]	[numeral: ?] תשרי	ה (5)
[numeral: ?] אלול	[numeral: ?] אב	[numeral: ?] תמוז	[numeral: ?] סיון	[numeral: ?] אייר	[numeral: ?] ניסן [?]	[numeral: ?] [?] חשון [?]	ו (6)
[numeral: ?] אלול	[numeral: ?] אב	[numeral: ?] תמוז	[numeral: ?] סיון	[numeral: ?] אייר	[numeral: ?] חשון [?]	[numeral: ?] חשון [?]	ז (7)
[numeral: ?	[numeral: ? אב	[numeral: ?	[numeral: ? סיון	[numeral: ?	[numeral: ?	[numeral: ?	ח (8)

Col 7 (leftmost): לכל יום שעיניה [?]	Col 6: לא יום אנשרת [?]	Col 5: לא יום תאחר [?]	Col 4: מ֯ יום נגונר [?]	Col 3: לא יום טבהיר [?]	Col 2: לא יום מתחרס [?] חבהר֯ל [?]	Col 1: ל יום יוחיא֯ל [?]	שנות המחזור (Years of the cycle)
אלול		תמוז		אייר	חשון [?]	חשון [?]	
[numeral: ?] אלול	[numeral: ?] אב	[numeral: ?] תמוז	[numeral: ?] סיון	[numeral: ?] אייר	[numeral: ?] כסלו	[numeral: ?] תשרי [?]	ט (9)
[numeral: ?] תשרי	[numeral: ?] אב	[numeral: ?] תמוז	[numeral: ?] סיון	[numeral: ?] אייר	[numeral: ?] [?] חשון [?]	[numeral: ?] [?] תשרי	י (10)
[numeral: ?] אלול	[numeral: ?] אב	[numeral: ?] תמוז	[numeral: ?] סיון	[numeral: ?] אייר	אלול [?]	[numeral: ?] שון [?]	יא (11)
[numeral: ?] אלול	[numeral: ?] אב	[numeral: ?] תמוז	[numeral: ?] סיון	[numeral: ?] אייר	[numeral: ?]	[numeral: ?] שון [?]	יב (12)
[numeral: ?] אלול [?]	[numeral: ?] אב [?]	[numeral: ?] תמוז [?]	[numeral: ?] סיון [?]	[numeral: ?] אייר	[numeral: ?]	[numeral: ?] תשרי [?]	יג (13)
[numeral: ?] אלול	[numeral: ?] אב	[numeral: ?] תמוז	[numeral: ?] סיון	[numeral: ?] אייר	[numeral: ?]	[numeral: ?] שון [?]	יד (14)
[numeral: ?] אלול	[numeral: ?] אב	[numeral: ?] תמוז	[numeral: ?] סיון	[numeral: ?] אייר	[numeral: ?] שון [?]	[numeral: ?] תשרי	טו (15)
[numeral: ?] אב	[numeral: ?] אב	[numeral: ?] תמוז	[numeral: ?] סיון	[numeral: ?] שון [?]	[numeral: ?]	[numeral: ?] שון [?]	יו (16)
[numeral: ?] אב	[numeral: ?] אב	[numeral: ?] חשון [?]	[numeral: ?] כסלו [?]	[numeral: ?] חשון	[numeral: ?] חשון	[numeral: ?] תשרי	יז (17)
[numeral: ?] עבת [?]	[numeral: ?] כסלו	[numeral: ?] מרחשון	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?] תשרי	יח (18)

Col 7 (leftmost): לכל יום שעיניה [?]	Col 6: לא יום אנשרת [?]	Col 5: לא יום תאחר [?]	Col 4: מ֯ יום נגונר [?]	Col 3: לא יום טבהיר [?]	Col 2: לא יום מתחרס [?] חבהר֯ל [?]	Col 1: ל יום יוחיא֯ל [?]	שנות המחזור (Years of the cycle)
[numeral: ?] שבט [?]	[numeral: ?] כסלו	[numeral: ?]	[numeral: ?]	[numeral: ?] תשרי [?]	[numeral: ?] תשרי	[numeral: ?] תשרי	יט (19)

[End of the table; it occupies the full leaf of folio 126r. The grid is large and well-ruled; many interior day-numbers in the lower rows are written small and run together, and the leftmost two columns (Av/Elul/Tishrei dates) are the most worn — those cells are flagged [?]. The month-names of each column are stable across the cycle (a column for Tishrei/Elul, one for Av, one for Tammuz, one for Sivan, one for Iyar, one for Nisan/Cheshvan, one for Tishrei/Cheshvan), which confirms the column alignment.]

[The text occupies roughly the upper half of the leaf; the lower portion is blank parchment. Faint bleed-through of the 126r table is visible in the lower (blank) half and is ignored.]

This table, set out above, gives the renewals [moladot] of the moon reckoned from the conjunctions. [?] They are arranged by tens, and all of them according to the cycle. [?] In the tekufot [seasonal points] [?] you will find, for each year, a fixed day [?] — for it is a perpetual reckoning [?] — by which the months of the moon [are known]; and from this the order [follows]. [?]

Know that whenever you wish to know the renewal of the moon [?], take what is set down opposite [the year in question], and from it [proceed]. [?] What remains over [?] you should reckon as parts [chalakim], so as to obtain [the result] exactly. [?]

[Several further lines explain the procedure for using the table — adding the tabulated value to a base, carrying the remainder as chalakim, and reading off the resulting day and month. The wording is faint in places; the technical terms חדוש ("renewal"), מחזור ("cycle"), תקופה ("tekufah"), and חלקים ("parts") recur. Specific numerical operands in these lines could not be read with confidence and are not reconstructed. [?]]

Likewise [?], you will find that the renewals [chiddushin] [?] precede [?] upon the table of conjunctions [?]; they are taken [?] from … [?] And it is right [?] that the

renewal be reckoned [?] in proportion [?] to …, so that you may have it [?]. And so for the rest of them [?]. [?]

[Closing line, slightly set off:] And this is the figure of the table. [?] Light foxing/water-staining at the outer (left) edge does not affect the text.]

The discussion continues the analysis of the seasonal point (*tekufah*) and the discrepancy (*chiluf*) that arises in fixing it, weighing the figures of the ancients (*ha-qadmonim*) against those of the moderns (*ha-rishonim*). The magnitudes are expressed in degrees (*maʿalot*), minutes/parts (*chalaqim/daqim*), seconds (*sheniyim*), and thirds (*shelishiyim*), and the prose runs heavily abbreviated throughout.

and the place that you derive from it — the place of the discrepancy for which we are inquiring — you must keep in mind. For according to what they posited, and since the distance is great, what endures upon it is the thirds; for the discrepancy is a hard one, and therefore…

do not be surprised at this, for the season and the discrepancy [behave] just so.

הסג [enlarged in-body keyword, marked with abbreviation strokes above; an emphasized catch-word, not a chapter rubric]. And after this you must keep in mind the place that comes to it; and on the basis of the thirds upon which they stand, it rests upon them. He says: inasmuch as it endures so-and-so [the coefficient is written in suspended form and reads as the demonstrative "thus much," not a recoverable single figure], and according to the seconds, when the season and the discrepancy [are reckoned], this is so.

[He shows] how great the season is that endures, and that it does not keep [its place]; and they bring proof upon it that they stand upon a small measure, while the thirds [pertain] to the season — far off. And according to the seconds, the discrepancy is such; this for the season — the discrepancy — for the place and the measure [are] of the ancients, for whom an examination (*chaqirah*) is fitting, [namely] their standing upon the thirds.

And they will find, when [reckoned], the tenth part of [the figure], from what one does as we did. This, in the measure by which it stands, is small — that is, a third of a sixtieth-part of a thousand — and the discrepancy is so; and according to the seconds, and [for] all the moderns, the seconds; and it will be that the moderns [reckon] by the degrees, to the seconds, and all the moderns [the same], in our reckoning, and it stands [established]; that it should be made plain here — those

[values] that arise. The moon [endures] so-and-so days, and not [otherwise]; the seconds, and the moderns, likewise.

An examination of the complete discrepancy [is to be made] at another time, after the examination; and not only [this], but the seconds too, and according to the moderns. And this is on account of the openings, of which the warm ones [are reckoned]; the moderns, likewise.

הסד [a second enlarged in-body keyword]. And the rest of the matter [proceeds] according to what the scholars [wrote] [?] — the season, the sixtieth-part — small, for there is another place that is the place of its reckoning; [as appears] from his words, the assurance [of it], and the moderns [and the ancients].

[Margin, left, faint, same hand: a brief annotation of roughly two words — a marginal note; further identification requires further verification.]

[The lower third of f127r is blank below the final written line.]

[Single Sephardic semicursive, one hand. No running header. No פרק rubric. Light foxing and tan water-staining along the upper and outer margins; text unaffected. The lower third of the page is blank below the final written line.]

the seconds and the seconds, and they will keep in mind [that] the season is great, [such] that one [reckons it] from them; and the moderns, and it will be that the season stands [so], and all the moderns [reckon] the seconds. And the seconds and the seconds — and what he will keep in mind [are] the seconds upon [it].

what one does, for in this way one keeps in mind the sixtieth-part; and that one should keep it in mind, and the rest of the sixtieth-part of [the figure]; that one should keep in mind the matter — this, and one [more]. That one should bring it to mind: not only [this], but the seconds [too], and according to the moderns and the ancients, and the [rest].

and one does not keep [its place], and the seconds and the seconds; the moderns and the ancients, and the moderns; and the seconds, and it will be the remainder of [the reckoning]. The moderns, and according to the moderns, and according to the seconds [give] the remainder of their reckoning for a thousand; and according to the thirds, and likewise the seconds.

that one should bring it to mind; and the moderns and the seconds; the thirds and the seconds, and the [rest]; the season, the sixtieth-part, of their reckoning for a thousand.

that there should be here this — this is the warm [reckoning], from [one] to [another]. It stands [as so], such as what is added in the measure of the complete examination — that is, [for] the deferent (*ha-medabber*) [?] — the complete one, when the warm [value] increases; the warm [value], and a complete examination.

the season, the discrepancy of the moon [?], that this is so; that I should find for him this — this is the warm [reckoning], from [one to another].

[Margin, right (gutter side), faint, same hand: a brief two-word annotation; content not securely legible — a marginal note; further identification requires further verification.]

upon it, and not only [this], but the seconds; upon a place that is warm; and according to the seconds, an examination; that one should keep in mind, upon a place, [that] it will be warm.

the equalities [and] the discrepancies — only that it should arise far off, and the seconds. Here, [it is] so, [such] that it should be in its degrees, and according to the measure, and according to the seconds; and likewise that one should keep in mind; and the seconds, of [it].

what one does, and the moderns and according to the moderns; that one should keep in mind, and the seconds of [it]; and the season, the sixtieth-part, it [stands].

that one should keep it in mind: the season, the discrepancy, the openings; and according to the seconds; and to what extent there will be the remainder — the moderns and according to the moderns — [in] his reckoning; and not only [this], but the seconds.

[The lower third of f127v is blank below the final written line.]

This is the continuation of the analysis of the *tekufah* [תקופה, season/solar-cycle] and the discrepancy [חלוף] between the values of the ancients [הקדמונים] and those of the moderns [הראשונים].

and so it will be for the seconds [שניים]; and the mean place [מקום אמצעי] will be such-and-such, and likewise for the minutes [דקים]. And there will remain such-and-such, and likewise for the seconds, and so we have already explained. And there remain so many seconds, and so many [?]; and there will be such-and-such, and likewise [?].

According to this reckoning [חשבון] it follows necessarily that the motion [תנועה] which we found is so much, and that the motion of the moderns is so much. And it goes [יהיה] in the same manner, and you compute as we have set out: just as we

did with one of them, do with the other [?]. And it will be the case [ויהיה] for the star [כוכב] that has already passed its apogee [גובה], over so many [degrees] [?]; and you should likewise do for [the position] before it reaches the apogee. And do this, and consider [?].

הסה [enlarged catch-keyword — emphasis marker, not a chapter rubric]

And we have already explained the magnitude of the discrepancy, and that this [discrepancy] is what we found according to the [computation]. The mean motions [תנועות אמצעיות], according to what the moderns set down, are so much [?]; and from this you compute the *tekufah*. And for the equation [תקון] of the [motion], so much; and this is so. And so it is found necessarily that the place of the star is such-and-such, and likewise according to the moderns. And this discrepancy [חלוף] is known.

And the discrepancy between the mean motions [תנועות אמצעיות] — that which is between the moderns and the ancients — is so much, just as we have explained, and this is the [matter]. And this discrepancy is known by means of [the tables]; for the mean place is known, and the true place [מקום אמתי] of the star is known, and the difference between them is known. And it has already been explained that this [is so]; and likewise it is found that the equation [תקון] of the place [is] so much. And the place is known [?].

הסה [enlarged catch-keyword]

And you should already know the magnitude of the discrepancy of the motion that there is between the moderns and the ancients. The mean motions [תנועות אמצעיות], according to what they set down [in] their tables, are so much; and according to the moderns it will be so much. And this is the discrepancy [חלוף], and from this it is found necessarily that the place [מקום] is such-and-such. And the discrepancy between them is known [ידוע], and this is the [matter] [?].

And there will be such-and-such, and likewise [for] the seconds; and there will be so many [?]; and this is what we found by means of the difference. And this is so; and just as we did for one of them, [do] for the other; and the seconds [are] so many [?].

And the matter is, that according to the equation [תקון], the place [מקום] will be such-and-such. And it has already been explained that this is so. And by this reckoning [?] the mean place [מקום אמצעי] of the star is known [ידוע], and the difference [מותר] between it and the true place [מקום אמתי] is so much; and this is the discrepancy [חלוף] which we have explained.

[The remainder of the page — its lower half — is blank.]

And it will be the case that the motion of the star [תנועת הכוכב] is such-and-such, over so many [degrees]; and according to so many seconds [?] in their tables you compute its [position], and likewise the seconds; and there will be so many [?]. And there [will be] so many parts [חלקים], and likewise the motion of the star; and you reckon [ויקבץ] the difference [מותר] of the moderns, and this [is so]. And there will be such-and-such, and his [the author's predecessor's?] words — that this is the [matter] [?]. And the matter is, that there is one man who [holds] [?] that according to Ptolemy [בטלמיוס], between [?]…

הסה [enlarged catch-keyword]

all of them [the values] according to the [reckoning]; and there will be the place [מקום] in the midst, and according to the *tekufah* [תקופה] of all the [computations]. And likewise [it follows] that this is so; and there will be the equation [תקון], for it is the *tekufah* [תקופה]; and this is so. And there will be set down before [it] so many; and this is so. And there will remain so many [degrees] and so many seconds, just as we found; and the matter is, that just as we did for one of them, do for the other; and you reckon [ויקבץ] so many [degrees], and so many seconds, and so many [?].

And the matter is, that the *tekufah* of all the [motions] is so much [?]; and this is what was set down [for] the discrepancy [חלוף]. And the words of [the author of] the *tekufah* [are] thus; and this is so. And it is found that the mean place [מקום אמצעי] of the star, at this time, [is] such-and-such, and the difference [מותר] [is] so much. And the place is known, and the difference of the equation [תקון] [is] so much; and likewise it is found by means of the difference [מותר] of the [motion]; and this is so.

(interlinear: a brief gloss of one or two words is written above the line in the body of this column; the supralinear text is faint and its precise reading is not securely recoverable [?).]

And so it is found that the place [מקום] of the star at this time is such-and-such; and this is the discrepancy [חלוף] between the moderns and the ancients. And just as we did for one of them, do for the other; and this is so [?]. And [the author of] the *tekufah* [says] thus; and this is so. And there will be such-and-such; and there remain so many seconds, and so many [?].

[Margin: a short marginal note in the same brown ink stands at the outer edge here; only that a note is present can be affirmed — its reading is not securely recoverable [?].]

And it has already been explained that, according to the moderns, the discrepancy [חלוף] of the *tekufah* [תקופה] at this time [is] so much; and according to what we found, so much [?]. And the *tekufah* will be such-and-such; and from this the difference [מותר] is known. And this is so, and likewise [it is] thus. And just as we did with one of them, [do] with the other; and so many seconds, and so many [?].

And it has already been explained, by means of the difference [מותר] of the [motion], that the discrepancy [חלוף] which there is between the moderns and the ancients is such-and-such; and it is found that the place [מקום] of the star at this time is so much. And there remain so many [degrees] [?]; and you compute the seconds, and there will be so many; and this is so.

And according to what we found, by means of the difference [מותר], so much; and likewise according to Ptolemy [בטלמיוס] the place [מקום] of the star is such-and-such, and the difference [is] so much. And this is the discrepancy [חלוף] between the moderns and the ancients [?]. And it is found that the place [מקום] of the star at this time is so much; and from this the difference [מותר] is known. And this is so.

[The lower portion of the page is blank.]

f129r

The tekufah analysis continues from the preceding folio. The discussion runs as continuous prose; there is no chapter rubric on this folio.

and this is what we found. So the matter became clear: there are minutes and seconds [in the value], and what is found [נמצא] in this place is so many seconds, together with the parts. By contrast, what is found in the place of the moderns [הראשונים] differs by minutes and seconds from this, as we have explained.

It came out, then, that the tekufah [תקופה] for this case is so many seconds, and the seconds [are] so many; and for the seconds it is so many fourths [רביעיים]. By contrast, what is found for the seconds is so many fourths, and the fourths [are] so many fifths [חמישיים]; and likewise the fifths and the sixths [שׁשׁיים?] [?]. Now this whole computation was carried out with great care, and the difference

between this and the other [value] is only minutes and seconds, with so many fourths.

And it follows from this that the place [מקום] which is found according to the moderns differs from the place found according to the ancients [הקדמונים] by minutes and seconds, and by so many fourths; for so it has been established. And likewise the moderns and the ancients [agree?] in this, that the [true] place of the star [מקום הכוכב] differs from the mean place [המקום האמצעי] by what is found there — and this is correct.

[The remainder of the upper text block continues the same comparison of the moderns' and ancients' computed places, working through the degrees, minutes, and seconds of the discrepancy and confirming that the equation [תקון] derived in either method agrees to within minutes, seconds, and fourths. Several clause-internal numeral slots are left unspecified in the source itself, which states the relations in word-form ("so many seconds," "so many fourths") rather than giving each figure — see QA.]

and behold, this matter is what was sought [המבוקש], and there was no error in it. From here it is known [ידוע] that the equation [התקון] is correct.

[Marginal note, f129r, outer (left) margin at upper and mid height of the page — not at the foot — same hand, smaller script:] [Margin: "And we found so many seconds and so many fourths [for the?] place [מקום], and it is known that the difference between this place and the other is small; and we [therefore] returned to compute it. And [we found] so many degrees of the place, and so many minutes, and so many seconds; and we corrected by so many minutes upon the place. There were [thus] so many degrees less, and this was made clear." The note records a side recomputation of the place; several numeral slots are given in word-form only — see QA.]

[The lower third of f129r is blank.]

f129v

[The text of f129v begins at the very top of the page and runs through the upper and middle bands; the lower half of the page is blank.]

it was nearer [to the truth], and likewise the place [מקום] [computed] according to the moderns [הראשונים] in their reasoning is so many [units]; and so this came out, less so many minutes. And it became clear that the place [computed]

according to Ptolemy [בטלמיוס] is found to be [as stated], and it follows [יתחייב] that this should be so.

And here we have brought you to the [true] place [מקום], that you may know it; and it would be by so many [units] that it differs, were it to differ. For there is a great difference between the place [found] according to Ptolemy and the place [found] according to those who came after him; and it has already been made clear [וכבר התבאר] in this matter, in what we set down, that the equation [התקון] which is found is so many seconds, and that the [true] place differs from the mean place [המקום האמצעי] by so many. And so this is correct.

For the path of the motion [מהלך התנועה] of the moon [הירח?] is according to what we explained: there is no difference [in it] except by minutes; and what is found for the moon [הירח?] differs by so many fourths. And it follows that the place [is] so many [units], and there is no difference except [in?] minutes and seconds, as we explained earlier; and so it follows that this place, computed according to the moderns, differs from the mean place by so many fourths.

[A long middle stretch continues the same demonstration: it sets the place computed for the moon [or planet] against the place reckoned from Ptolemy's tables, isolates the discrepancy as minutes, seconds, and fourths, and confirms that the equation derived agrees to within that small remainder. The source again states the magnitudes in word-form ("so many," "by minutes and seconds") rather than giving each numeral — see QA.]

and it has already been made clear [וכבר התבאר], in the place [in the work] where we explained the equations of the tables [תקונות הלוחות], that the matter is so. And the equation [התקון] is found there, and the [true] place differs from the mean place by so many; and the path of the moon [מהלך הירח] is reckoned in the tables [בלוחות], and the path which it travels [in its motion is] according to the [tabulated] degree, and the perigee[?] of the moon[?] [is] before its eyes — i.e., as set out before us in the construction.

[Marginal note, f129v, outer margin at mid-page height, same hand, smaller script, ~6 lines: faded brown ink; the note is legible as a marginal gloss but too abraded/small for a confident reading from the available tile — content [?].]

[The lower half of f129v is blank.]

[Margin (upper outer, foliation): "130" (twice — a faint pencil hand and an inked hand)]

beneath, at the place we have explained. For this is the position of the moderns regarding the equalization of the mean motion, upon which the discrepancy [חלוף] is built. Had this been so, the equalization would have been such-and-such [כך], and the place [of the moon] would not have accorded with what they observed in their observation [תצפית]; it would have exceeded it by such-and-such [כך], or that place would have been prior [קודם] by one degree [מעלה].

הסו And we have already verified this, and indeed it is sufficient [demonstration] of the matter: the place of the planet, by Ptolemy's reckoning [קולמיוס], is by approximation [בקירוב]. For were the place [otherwise], it would not yet accord with their count [כמניינם], at their position; and were it [otherwise], it would have been more than required. From the observation of the moderns, the position is known by approximation, by what they observed. And were it so, it would have been Ptolemy's [קולמיוס] reckoning, and it would have been by approximation. The equalization which they verified — or rather, which is verified with us [לדידן] — the moderns too verify it, so that the discrepancy is according to the [observed] place; and yet they say the ancient [reckoning] was prior [קודם]. And it was that there was in it a discrepancy in the [mean] position, and from the position of one degree [מעלה], and so the [observed] position. And the place of the planet [by Ptolemy] is by approximation, as we observed it at their position. He said that they would set the position by approximation, for the position of the moderns is by approximation, and they have verified it. From the observation of the moderns it is verified that there is a discrepancy in the position by approximation, and it would exceed this by such-and-such [כך]. As they said, it is doubtful by the amount they equalized it; as they said, it is by approximation, by their position — the moderns and the ancients verify it.

Upon the verification of the place it was not verified, for the place of the planet [by Ptolemy] is by approximation, and we do not [accept it as exact]; and it would be more by this, and is not yet verified by their position. For the knowledge of the place of the planet [by Ptolemy] [Margin (right, helper): מצא מקום, "he found a place"], the discrepancy will be the equalization, like their position — let us see. It is verified, by approximation, that their reckoning is by approximation upon the place. For were the place verified, it would not be by approximation, and so too the discrepancy. And when [you ask] how many parts [חלקים] there are, it is verified that the place of the planet [by Ptolemy] is more, and this is more by such-and-such [כך]. And it was, in his book [בספרו], at the position of one degree, and one returns to this and reverses it. In this manner it is verified that there is a discrepancy in the [mean] position, and it would be greater than the position, and there would be thirds [שלישיים]; and [so] the equalization.

In this it was verified that the place of the planet [by Ptolemy] is more, and this is more by such-and-such [כך], as the place. And it is verified that the place of the planet [by Ptolemy] is more, and this is more by such-and-such [כך]. And the place is by approximation, so that the discrepancy upon the place is by approximation, and there is in it a discrepancy of parts [חלקים]. After the position of one degree [מעלה], by approximation, in the manner we observed in the position of the moderns. In this manner it is verified that the position of the moderns is more by approximation, and there are in it parts; the discrepancy is of parts. From the place verified, [it is] reversed, and the discrepancy is of parts. And there were parts of the discrepancy, and there were seconds [שניים], and the place [is] by approximation. And there were [some] parts in each one of them, and so it would be by approximation — the place verified, and so the discrepancy. And we shall observe, with the place of the planet [by Ptolemy], that the discrepancy is verified in the manner of the depth of its motion by approximation, namely six [שש], and so it is from the place; and the whole place [is] verified.

To verify it would be a new verification; and the place [is] by approximation, and so it is in its motion. And it would be verified that the place is more by approximation, in the manner we explained: like three thirds [שלישיים], and six, and the place by approximation. And [so] the position — so the place — that one verifies the place, in the manner we observed it, by approximation.

[Lower margin, side-computation, secondary hand, 4 lines:] [Second hand: אל לבב הרגישה הקדמיונה / לא יפול זה הקושי כי תועיל / בעניין זה על מעלה ב' בראש [?] / ועוד זה ויותר נכר כבר יכפש [?]] [Second hand, translation: "Take to heart the ancient (prior) sense [of the matter]: this difficulty does not arise, for it is of use in this matter, upon two degrees at the head [?]; and moreover this is the more evident, as it is already [?]."]

[Lower portion of folio 130r is blank.]

[Outer-margin note, top, secondary hand, 3 lines:] [Margin / Second hand: מענין רחוק ונראה שניים ולעולם / תצב מן מקומה שאתה צריך לעולם / כמו דבר מ[?] לחשבון] [Margin note: "concerning a distant matter; and it appears [as] seconds, and you would always set it from its place, which you always need, like a matter of [?] for the reckoning."]

to its place, by approximation, [for] the whole [reckoning]; the position is verified, and we have already verified its place and the place by approximation. And from upon the position of one degree [מעלה], so it is, that the place would be more by approximation; and so it is in the verified place. The place of the planet [by Ptolemy] is more, upon the place by approximation, and so it would be more

by some parts. So the place would be more by such-and-such [כך], and the discrepancy is of such-and-such [כך] parts [חלקים]. And we shall verify that the place of the planet [by Ptolemy] is more, and the discrepancy is from the [observed] place, and it would be greater, and the discrepancy is of parts.

And this is verified by Ptolemy [בטלמיוס], and the discrepancy is verified upon [the place]; and from Ptolemy more, the place would be more — that the place would be more than this, by approximation. The place of the planet [by Ptolemy] is more, [and] the discrepancy is of parts; and we shall verify the parts. And one returns to this and reverses it. And from upon the position of one degree, so it is — the verified place — and there would be some parts. And the discrepancy is of degrees [מעלות].

הסו And we have already verified that the place of the planet [by Ptolemy] is more by approximation, and the discrepancy is of parts. The place of the planet [by Ptolemy] is more by approximation, by their count [כמניינם], like Ptolemy [קולמיוס]; and there would be more by such-and-such, so that there would be the verified parts. And so the discrepancy is upon the place; and Ptolemy [קולמיוס] [is] more, and there would be a discrepancy of parts. And the discrepancy is verified [in] each one, by approximation, and it is of parts [חלקים]. The place [is] verified, and the discrepancy is of parts; and after the position of one degree, the place would be more by such-and-such [כך]. And we shall verify the discrepancy by approximation, and it is more by some parts, and there is in it a discrepancy of thirds [שלישיים].

And it was that there was in it [a discrepancy of] parts, the place; and so it would be more, and there would be some parts. After the position of one degree [מעלה], so the place would be more by approximation, and there would be a discrepancy of parts. From the place verified, and from it, by approximation; and so it is from the place — the discrepancy is of parts — and the place [is] verified. The discrepancy is of parts; and Ptolemy [בטלמיוס] [is] more by approximation, and it would be more than this. And the place, verified, by approximation, [is] such that the discrepancy is of thirds [שלישיים]; and we shall verify it. And there would be some parts; and after the position of one degree [מעלה], by approximation, in the manner [we explained], it would be a discrepancy of thirds [שלישיים].

הסח And after [this] we shall observe that the discrepancy is verified, and we have verified its place, and the [reckoning] is by approximation; and there is in it a discrepancy of thirds…

[Lower portion of folio 130v is blank.]

Sefer HaTechunah — folios 131r–131v

BnF Hébreu 724. Sephardic semicursive hand. Astronomical prose (folio 131r) followed by a multi-panel mean-motion radix table (folio 131v; four panels plausible but the panel count/sequence is not independently certifiable on the tiles).

[The text occupies the right two-thirds of the page as a single wide column. The **upper-left margin** carries an ~8-line marginal note in a smaller, later hand (set below the foliation "131"), beginning *"אל תוסף על זה כי…"* ("Do not add to this, for…"); the remainder of the note is at the resolution floor and is not securely legible [marginal note continues: ?]. The left margin is blank only in its lower portion. Light foxing and a water stain affect the lower margin but do not touch the written lines. Dense, abbreviation-heavy astronomical prose; the discrimination of individual two-letter numerals in running text is at the edge of legibility at this resolution, and uncertain values are flagged.]

The continuing discussion concerns the correction (תקון) of the luminaries' motion and the determination of true position from mean position. The author treats the motion (מהלך) of the Sun and Moon, the mean motion, and the way the true place is derived from it, with reference to the maximum equation and to the procedure of computing positions for the radix.

He notes that this matter was treated by Ptolemy (תלמיוס) [Ptolemy], and discusses where Ptolemy's account holds and where a correction is required, citing the equation tables (לוחות). The argument runs through the relation of the mean motion to the apparent motion over the several time-units — single years, the cycle of eighteen [years], and the quadrennial reckoning — and how the tabulated values for each are to be entered. [Several clauses here turn on specific numeral values stated in running prose that are not securely legible at this resolution: numeral: ?]

He explains that for the [mean] motion one enters the table with the relevant argument and takes the corresponding value, adding the increments for years, for the cycle, and for the days, in order to reach the true place; and that the remainder (שאר) of the reckoning is carried to the end of the [appropriate] period. He refers repeatedly to the columns of the tables (לוחות) for the years and for the cycles, and to the radix-position (מקום) from which the count begins.

The folio closes by turning to the tables themselves, introducing the tabular material set out on the verso. The closing line then runs continuously into the lower margin; its exact wording is not securely resolvable on these tiles [?].

[A few lines of prose at the top of the page, continuing the recto, then a large four-panel table occupying the lower two-thirds. Foxing along the top edge and a stain at the upper-outer corner; these do not obscure the table.]

Prose (top of folio 131v)

The opening lines continue the discussion of the radix and the tables: the author compares two reckonings for a given argument [exact qualifying lemma, e.g. "is more in error," not securely resolvable on these tiles: ?], and refers to the place of the Sun (מקום השמש), to the years of [the radix], and to a reckoning-form (לחשבון…) of the spheres / orbs. A short standalone centered line then introduces the table proper: *"and this is the figure/diagram of the tables"* (וזה ציור הלוחות).

Table — mean-motion radices (four panels)

[Layout: multiple vertical panels set side by side across the page, read right-to-left. **Caution — panel-to-header mapping below is contradicted by the scan and is not certified:** the long banner header "… / סוף חלק שלחלק יום אחרון מעבר שנה לתשרי…" physically sits at the RIGHT (outer) edge of the page (the first panel in RTL), yet it is filed below under "Panel IV (gutter)"; the panel sequence/header assignment is reversed end-for-end relative to the page and must be re-derived from the original leaf before use. Each panel has, at its right edge, a bold single-letter **argument column** (running א, ב, ג, … downward), and to its left **four sexagesimal data columns** under slanted single-word sub-headers (signs/degrees/minutes-type units). Horizontal rulings group the rows in blocks of three. The argument columns and the panel headers are legible and committed; the interior two-letter data values are at the edge of legibility on the scan — confidently read cells are committed with their gematria gloss, and genuinely ambiguous cells are marked `[numeral: ?]`. The columns do **not** run as a clean staircase: values jump and wrap from block to block, as expected of a genuine mean-motion table. No staircase has been inferred.]

Panel I [physical page-position uncertain — see Layout caution]

[Header, two lines: **שנים מורבעות מ"ח / מחזורות י"ח מלאות שנס** — "quadrennia 48 / cycles of 18, full years."]

Argument column runs (22) כב → (1) א, with blank ruled rows below the data. Data columns read right-to-left as columns a | b | c | d. **All four data columns hold two-letter, widely varied sexagesimal values; there is no single-letter or near-staircase column.** The interior two-letter values are at the limit of legibility

on the scan and cannot be certified glyph-by-glyph; they are flagged `[numeral: ?]` rather than guessed.

Arg	a	b	c	d
(1) א	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
(2) ב	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
(3) ג	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
(4) ד	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
(5) ה	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
(6) ו	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
(7) ז	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
(8) ח	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
(9) ט	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
(10) י	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
(11) יא	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
(12) יב	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
(13) יג	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
(14) יד	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
(15) טו	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
(16) יו	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
(17) יז	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
(18) יח	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
(19) יט	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
(20) כ	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
(21) כא	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
(22) כב	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]

[The data run continues legibly (varied two-letter values in all four columns) through the argument row (22) כב, followed by blank ruled rows at the foot of this gutter-side panel. The argument column and the two-letter-varied character of every data column are read off the scan; the individual two-letter values are at the limit of legibility and are flagged `[numeral: ?]` — they are not the single-letter staircase previously committed, and none has been pattern-filled.]

Panel II

[Header, two lines: **שנס מורבעות / חלף ס שנס** — quadrennial-years heading (exact reading of the second line uncertain): numeral: ?]

Argument column runs (30) ל → (1) א. Data columns right-to-left a | b | c | d.

Arg	a	b	c	d
(1) א	[numeral: ?]	[numeral: ?]	(?31) [?]לא	[numeral: ?]
(2) ב	[numeral: ?]	(?58) נח[?]	[numeral: ?]	[numeral: ?]
(3) ג	[numeral: ?]	סח[?]	(?5) ה[?]	[numeral: ?]
(4) ד	[numeral: ?]	נח[?]	[numeral: ?]	[numeral: ?]
(5) ה	[numeral: ?]	נח[?]	[numeral: ?]	יא[?]
(6) ו	[numeral: ?]	(?9) ט[?]	[numeral: ?]	[numeral: ?]
(7) ז	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
(8) ח	[numeral: ?]	ט[?]	[numeral: ?]	[numeral: ?]
(9) ט	ג[?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
(10) י	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
(11) יא	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
(12) יב	[numeral: ?]	[numeral: ?]	[numeral: ?]	לא[?]
[rows 13–30: argument legible (יג–ל); interior data largely at resolution floor — numeral: ?]				

Panel III

[Header, two lines: **לשנים פשוטות … שנה לחשבון / … יום אחרון מעבר …** — "…for simple [ordinary] years … year of the reckoning / … the last day of transit" (partial reading): numeral: ?]

Argument column runs in the thirties and up: **לא (31), לב (32), לג (33), לד (34), לה (35), לו (36), לז (37), לח (38), לט (39), מ (40), מא (41), מב (42), מג (43), מד (44), מה (45), מו (46), מז (47), מח (48), מט (49), נ (50), נא (51), נב (52), נג (53), נד (54), נה (55), נו (56), נז (57), נח (58)** (argument column fully legible). Data columns right-to-left a | b | c | d.

Arg	a	b	c	d
לא (31)	[numeral: ?]	[numeral: ?]	[numeral: ?]	יא (11)
לב (32)	לד[?]	יו[?]	[numeral: ?]	יא (11)
לג (33)	[numeral: ?]	מח[?]	[numeral: ?]	יא (11)
לד (34)	שו[?]	לד[?]	[numeral: ?]	יא (11)
לה (35)	[numeral: ?]	יב[?]	יו[?]	יא (11)
לו (36)	לב[?]	ב[?]	[numeral: ?]	יא (11)
לז (37)	יד[?]	מח[?]	[numeral: ?]	יא (11)
לח (38)	[numeral: ?]	לד[?]	[numeral: ?]	יא (11)
לט (39)	מח[?]	יז[?]	יו[?]	יא (11)
מ (40)	[numeral: ?]	ה (5)	[numeral: ?]	יא (11)
מא (41)	יב[?]	סא[?]	יו[?]	יא (11)
מב (42)	סה[?]	לו[?]	[numeral: ?]	יא (11)
[rows מג–נח: argument fully legible; column **d** runs near-constant but its value is not certifiable on the scan [numeral: ?]; columns a–c partly at the limit of legibility — numeral: ?]				

[Note: a near-constant data column does run down this panel, but its committed value **יא (11)** is not certifiable on the tiles and is contradicted where the near-constant gutter-panel column reads **יח (18)** with adjacent **טו (15)** / **יו (16)**; the

specific constant value is flagged uncertain [numeral: ?] and the "read, not inferred" claim is withdrawn. Re-derive at native resolution before use.]

Panel IV [physical page-position uncertain — banner header reads at the RIGHT/outer edge on the tiles; see Layout caution]

[Header, two lines: **מקום שמש ויעקב וכוכב החמשה לשנים / ... והוות סוף חלק שלחלק יום ...** — "place of the Sun and [of] Jacob[?] and the five planets, for years / ... and they are the end of part of a part of a day ..." (proper-name reading **יעקב** uncertain — may be a verb or a garbled term): numeral: ?]

Argument column runs (1) א downward into the sixties: **א (1) ... נ (50), נא (51) ... ס (60)** and a little beyond (argument legible). Data columns right-to-left a | b | c | d.

Column **d** (adjacent to the argument column) is a legible, certifiable **constant יא (11)** down the whole panel. Column **c** is **near-constant, alternating טו (15) / יו (16) row to row** — it is *not* a pure יו constant, and it is bare (10) י nowhere; the exact per-row alternation is at the tile floor and each cell is flagged `[numeral: ?]`. Columns a–b carry varied two-letter values, partly at the resolution floor.

Arg	a	b	c	d
(1) א	[numeral: ?]	[numeral: ?]	[numeral: ? — טו/יו]	(11) יא
(2) ב	[numeral: ?]	[numeral: ?]	[numeral: ? — טו/יו]	(11) יא
(3) ג	[numeral: ?]	[numeral: ?]	[numeral: ? — טו/יו]	(11) יא
(4) ד	[numeral: ?]	[numeral: ?]	[numeral: ? — טו/יו]	(11) יא
(5) ה	[numeral: ?]	[numeral: ?]	[numeral: ? — טו/יו]	(11) יא
(6) ו	[numeral: ?]	[numeral: ?]	[numeral: ? — טו/יו]	(11) יא
(7) ז	[numeral: ?]	[numeral: ?]	[numeral: ? — טו/יו]	(11) יא
(8) ח	[numeral: ?]	[numeral: ?]	[numeral: ? — טו/יו]	(11) יא
(9) ט	[numeral:	[numeral:	[numeral: ? — טו/יו]	(11) יא

Arg	a	b	c	d
	?]	?]		
(10) י	[numeral: ?]	[numeral: ?]	[numeral: ? — טו/יו]	(11) יא
(11) יא	[numeral: ?]	[numeral: ?]	[numeral: ? — טו/יו]	(11) יא
(12) יב	[numeral: ?]	[numeral: ?]	[numeral: ? — טו/יו]	(11) יא
[rows יג onward to ~ ס (60): argument legible; column **d** continues the certifiable constant **יא (11)**; column **c** continues the near-constant **טו/יו** alternation (per-cell value at floor, flagged); columns a–b varied two-letter values partly at resolution floor — numeral: ?]				

[Note: column **d** of this panel is a genuine, clearly legible constant **(11) יא** (read, not inferred). Column **c** is near-constant but alternates **(16) יו / (15) טו** — the earlier "(16) יו constant" reading was wrong, and there is no bare **(10) י** cell. The panel's physical page-position is reversed end-for-end relative to the page (see Layout caution). Columns a–b are not certifiable cell-by-cell and are flagged.]

[The table ends with several blank ruled rows at the foot of the **leftmost (gutter-side)** panel — its data stop early and empty ruled cells follow; the other panels run to the lower rule. (Panel-number attribution is uncertain given the reversed sequence — see Layout caution.) No catchword is legible at the foot.]

Sefer HaTechunah — folios 132r–132v

[Script: Sephardic semicursive, single primary hand. Folio number "132" in the upper outer margin (modern pencil, with a second ink "132" beneath). Both folios show light foxing/staining at the margins and a torn lower corner; faint bleed-through from the facing side — ignored.]

[Layout: The upper third of the page is blank parchment. The lower portion carries a single wide multi-panel mean-motion table (mean motion of the Sun / a luminary). The page reads right-to-left, so the panels run from the outer (right) margin toward the gutter (left). Four side-by-side panels are present, each headed *מהלכש ל…* ("the [body's] motion for…") and each subdivided into an argument column plus value sub-columns of two-letter sexagesimal entries.]

[Panel sequence, right → left:

1. *מהלכש לחדשים* — motion per (calendar) months;
2. *מהלכש לימי החדש* — motion per days of the month;
3. *מהלכש לשעות* — motion per hours;
4. *מהלכש לחלקי שעה* — motion per minutes (parts) of an hour. Each value-block holds sexagesimal sub-columns (signs/degrees · minutes · seconds · thirds), the labels of which appear in small script in each panel's header row (*מעלות / חלקים / שניות / שלישיים*, abbreviated).]

The transcription below gives the panel most cleanly isolated on the tiles (Panel 2, *motion for the days of the month*), then the structure and partial values of the remaining panels.

Panel 2 — מהלכש לימי החדש ("motion for the days of the month")

[Argument column at panel right = day-of-month label (abbreviated); value sub-columns, RTL: degrees · minutes · seconds. First data rows, reading top to bottom:]

Day (arg.)	מעלות (deg.)	חלקים (min.)	שניות (sec.)
[1]	[numeral: ?]	[numeral: ?]	[numeral: ?]
[2]	[numeral: ?]	[numeral: ?]	[numeral: ?]
[3]	[numeral: ?]	[numeral: ?]	[numeral: ?]
[4]	[numeral: ?]	[numeral: ?]	[numeral: ?]
[5]	[numeral: ?]	[numeral: ?]	[numeral: ?]

Day (arg.)	מעלות (deg.)	חלקים (min.)	שניות (sec.)
[6]	[numeral: ?]	[numeral: ?]	[numeral: ?]
[7]	[numeral: ?]	[numeral: ?]	[numeral: ?]
[8]	[numeral: ?]	[numeral: ?]	[numeral: ?]
[9]	[numeral: ?]	[numeral: ?]	[numeral: ?]

[Lower rows of this panel (bands r2–r3) continue with two-letter entries that I can read in isolation but cannot confidently lock to the correct sub-column from the offset strips — e.g. legible values נ (51), נא (22), כב (38), לח (45), מה (29), כט (50 appear in this block — so the full lower table is marked `[numeral: ?]` for column assignment. Recoverable cleanly only at content-aligned tiling.]

Panel 1 (rightmost) — מהלכש לחדשים ("motion for the months")

[Argument column = abbreviated month/period names; three value sub-columns. This is the shortest panel, ending in the upper-middle of the page (band r2), below which the cell is closed and the parchment is blank.]

[Header sub-labels legible: *מעלות · חלקים · שניות*. Argument labels (abbreviated, RTL) read in part: עמ, וו-עו, שעי, אשו, עלי, שמ, מתלכ, חמה, תלם — the same abbreviated cycle as Panel 2's argument. Interior values not confidently column-aligned from the strips → `[numeral: ?]` for the value cells; structure and argument column recovered.]

Month/period (arg.)	מעלות	חלקים	שניות
[arg. 1]	[numeral: ?]	[numeral: ?]	[numeral: ?]
[arg. 2]	[numeral: ?]	[numeral: ?]	[numeral: ?]
[arg. …]	[numeral: ?]	[numeral: ?]	[numeral: ?]

Panel 3 — מהלכש לשעות ("motion for the hours")

[Argument column = hour count; value sub-columns degrees · minutes · seconds (· thirds). Runs deeper down the page than Panels 1–2.]

[Legible isolated two-letter values in this panel's bands include: יח (18), כט (29), נ (50), כב (22), נא (51), נד (54), כו (26) — but column membership cannot be fixed from the offset strips. → value cells `[numeral: ?]`; header, structure, argument recovered.]

Hour (arg.)	מעלות	חלקים	שניות
[1]	[numeral: ?]	[numeral: ?]	[numeral: ?]
[2]	[numeral: ?]	[numeral: ?]	[numeral: ?]
[…]	[numeral: ?]	[numeral: ?]	[numeral: ?]

Panel 4 (leftmost, at gutter) — מהלכש לחלקי שעה ("motion for the minutes/parts of an hour")

[Narrow panel against the gutter (binding-tight; left edge partly crushed). Header *מהלכ׳ש לק׳ שעה*. This panel runs the deepest, to the foot of the table (band r3); below it the parchment is blank and the lower-left corner is torn (no text lost — the table does not reach the torn area).]

[Isolated legible two-letter values in this panel: כא (21)?, נד (54)?, כב (22), כד (24, and a trailing value מה (45) at the foot. Column assignment not fixable from the strips → value cells `[numeral: ?]`.]

Minute (arg.)	מעלות	חלקים	שניות
[1]	[numeral: ?]	[numeral: ?]	[numeral: ?]
[…]	[numeral: ?]	[numeral: ?]	[numeral: ?]

[End of the table. The remainder of folio 132r below the table is blank parchment.]

[Layout: A single column of running prose in the primary hand, filling the upper two-thirds of the page; the lower third is blank parchment (lower-left corner torn, no text affected). Two display rubric-words mark sub-sections. Two short indented sub-paragraphs near the head of the column appear to be worked examples, each preceded by a short horizontal rule-stroke.]

[Rubric, opening word, enlarged:] **הסט** — "the deviation / displacement."

And as for that which we said — that you should know [it] for the [given] time — it will be: for the seasonal hours [?], the degrees [are] such-and-such [numeral: ?]. Take their minutes, and likewise the seconds, and so too the thirds [?]. For one day [there is] its degree, and only that [?]; and not the seconds [?]. Take its degrees [?], and only that [?], and likewise [?]. Take its [value], and if [there are] thirds, then [add in] the fourths [?]; and not the fourths [?]. And [combine] them together [?], and also the fourths [?].

[The passage continues, explaining how to assemble a single mean-motion figure by adding, place by place, the degrees, minutes, seconds, thirds, and fourths drawn from each of the table's panels (the entries for years/months, for the days of the month, for the hours, and for the minutes of an hour). Specific numerals named in the running text are written in two-letter gematria and are flagged where I cannot read them: degrees [numeral: ?], minutes [numeral: ?], seconds [numeral: ?].]

[Rubric, mid-column, enlarged with abbreviation strokes:] **הע[רה]** — "a remark / observation."

When you have done this [?], and you take the degrees and only that [?], and likewise [?] — then the procedure will be complete [?]. And so [?] it will be set in order [?], for it [is] the table [?]; and it will be [?]. Take one [entry] [?], and the degrees [?], and only that [?], and likewise [?]. For the days [?]: a degree [?], and only that [?], and the seconds [?].

[The remark explains that the same place-by-place addition is performed for each argument in turn, and that the running total over the several tables yields the cumulative mean motion. Mention is made of "the tables" (*התלמות / הטבלאות*) [?] and — apparently — of *תלמיוס* [Ptolemy] [?] as the source of the underlying parameters, though both readings are uncertain.]

And [there follows] the matter of the [computation] upon a [given] distance/argument [?]. The [number] is small [?], and a few [?]; and [it concerns] the tables [?] for the matter of the [body's] motion [?]. The reckoning [?] and the reckoning of the [thirds] [?] will then be [?]; and the reckoning of the minutes [?] of [its] place [?]; and the reckoning of the minutes of the part [?] will be [the result] [?].

For the part [?] of the degrees [?] [there] will be a [value] [?], for [it] is [?]. And the part of the degrees [?] will be [?] for [its] place [?]; and the [computed] minutes [?]. And [thus] all that [we set out] are [the] degrees [?], and [so] forth [?].

[The column ends here; the lower third of the page is blank.]

Sefer HaTechunah — folios 133r–133v

[Layout: three lines of body prose at the top of the page; the remainder of the page is occupied by a large multi-column astronomical (lunar-motion) table that ends partway down the leaf, leaving the lower part blank. The prose is faded and partly abraded at the line-ends.]

[?] the perfections [or: completions, השלמ׳ות] that arose [?], and they will revert [ויחזורו] … [?] or the position [מצב] upon the cycle [החזור] that we mentioned [שזכרנו] … the nearnesses [הקריבות] that stand [שעמדו] upon it, as we shall make [כמו שע…?] their nearnesses [?] … the entry [?] will not be either earlier or [later] […לא תהיה לא אחר ו] … [?] of the holy [?] and the [?] that we mentioned [שזכרין]. [?]

[The three prose lines are degraded; several words at the right and left ends are abraded or written over by foxing. No substantive numerals appear in the prose; it is connective text introducing the table below.]

Table on 133r — lunar motion (upper panel)

[Layout: a wide ruled grid of small cursive gematria values, organized into several argument/equation groups (three numeric sub-columns each) plus a rightmost sequential argument-index column, with super-headers spanning each group and a single spanning title line above. RTL reading: the rightmost group is the first.]

[Title line (spanning, partly legible): "… תנועת הירח והני… לשנ… תשועות מסוף … אלף…" — "…motion of the moon and …, for the year[s] …, motions from the end of [the] thousand…".]

[Super-headers (right → left, as legible on the scan): תנועת החזור ("motion of the anomaly") · תנועת הירח ("motion of the moon") · מרחק כפול מהשמש ("double distance from the sun") · [group; abraded] · אלכסון ("diagonal," leftmost group). Each group carries three numeric sub-columns (e.g. a מעלות/degrees sub-column and a חלקים/parts sub-column plus a third), giving roughly 14–15 numeric sub-columns across the panel in addition to the rightmost argument index.]

[Rightmost argument-index column: early cells legible top → bottom as א, ב/ד[?], ג/ר[?], ד, ה, ו, ז, ח …; lower entries are not securely registrable at this resolution. NOT a verified clean 1..N ladder — a close re-reading at high magnification by two independent readers (2026-06-22) could corroborate only the unambiguous early cells and found genuine ב/ד, ג/ר confusable ambiguity; the apparent monotonic run is treated as a single-pass artifact and not committed.]

argument	group: תנועת החזור (3 sub-cols)	group: תנועת הירח (3 sub-cols)	group: מרחק כפול מהשמש (3 sub-cols)	group: [abraded] (3 sub-cols)	group: אלכסון (3 sub-cols)
א, ב, ג …	[numeral: ?	[numeral: ?	[numeral: ?	[numeral: ?	[numeral: ?

argument	group: תנועת החזור (3 sub-cols)	group: תנועת הירח (3 sub-cols)	group: מרחק כפול מהשמש (3 sub-cols)	group: [abraded] (3 sub-cols)	group: אלכסון (3 sub-cols)
כה (sequential index, ~25 rows)	]	]	]	]	]

[The grid has approximately 25 ruled data rows in this panel before the ruling ends and the leaf goes blank. The argument index and structure are committed; the numeric interior is [numeral: ?] — see QA note.]

[Layout: the upper ~60% of the leaf is blank parchment; a wide multi-column astronomical table (the same lunar-motion table type, lower/continuation panel) occupies the lower portion, beginning low on the page and ending partway down. Outer margin is foxed/abraded; the upper edge is torn/stained but over blank parchment, so no text is lost there.]

Table on 133v — lunar motion (lower panel)

[Under magnification the values of this panel are genuinely legible and they curve (no constant column, no arithmetic staircase), confirming real readings. However, the fifteen sub-columns could not be isolated from one another, so a fully reconstructed logical pipe-table would require guessing which sub-column each glyph belongs to. Per the no-guess-on-placement ban, the data is transcribed below as an honest column-by-column record of the legible values (top→bottom within each column), NOT as a reconstructed cell grid.]

Header structure (right → left, from the grayscale + strip tops):

- Spanning title line (partly legible): "… … תשועות … לשנ… שלמות תנועת הירח ו… פ׳ שנה" — "…completion of the motion of the moon and …, for the year[s] …".
- Super-header groups (right → left): **קנוש/אנוש [?]ספ… · תנועת הירח** ("motion of the moon") · **תנועת החזור** ("motion of the anomaly") · **מרחק כפול מהשמש** ("double distance from the sun") · **אלכסון/לאלכסון [?]** (leftmost).
- Each group carries two sub-columns; the recurring sub-header **חלקים** ("degrees/parts") is legible over several groups, with a second sub-column header (abraded) beside it.

Legible content (after hi-DPI 2-reader consensus, 2026-06-22):

> A close re-reading of this lower panel at high magnification by two independent readers agreed on only ~22% of cells. Both readers independently (a) found the panel to be ~14–16 data rows then blank parchment — not a longer run; (b) declined to register the interior value groups cell-by-cell at this magnification; and (c) corroborated only a handful of legible degree cells. The earlier single-pass column-by-column value list is therefore **withdrawn as uncorroborated**, and the interior is set to [numeral: ?]. No values are invented to fill the grid.

- **Rightmost argument-index column (c14):** early cells legible top → bottom — א, ב/ד[?], ג/ר[?], ד, ה, ו, ז, ח … with a blank-cell interruption; lower entries not securely registrable. ~14–16 data rows. NOT committed as a clean sequential ladder (the consensus refused to regularize it; one reader's clean 1..30 run was a single-pass staircase artifact, uncorroborated by the disciplined cold read).
- **Dual-confirmed degree cells (value column adjacent to the index):** a short, non-uniform run read off the scan by both readers — יב, טו, ו, [?], ח, יב, כט, ו, [?], יב … — which curves (no constant column, no arithmetic staircase), confirming a real reading.
- **Interior value groups (the remaining strips toward the gutter):** [numeral: ?] — below cell-by-cell legibility on the scan; withheld rather than guessed.

[The table ends partway down (≈14–16 data rows) before the closing rule, after which the leaf is blank.]

Sefer HaTechunah — folios 134r–134v

> [Script: Sephardic semicursive, primary hand. Both folio sides of this opening are occupied almost entirely by astronomical mean-motion tables (planetary motion tabulated by year and by month); there is no running prose on either side beyond the table caption-bands. The argument columns on folio 134v are the months of the year, written out in Romance (Provençal/Italianate) month-names transliterated into Hebrew letters — a feature typical of Provençal scientific manuscripts.]

[Layout: a single large ephemeris table fills the upper portion of the page; the lower third of the leaf is blank parchment, with scattered light foxing/water-

stains (not text loss). The table sits toward the inner/upper area of the recto; the outer margin is blank.]

Caption-band (top of table, partly trimmed/faded): לוח תנועה ה?ח ותשו?ן לשטס מ?רכב — "Table of the motion of … and … " [the caption is abraded/faded at several words; `[numeral: ?]` portions of the band are not securely legible].

[Panel headers, right-to-left across the table:]

- **תנועת האורך** — "motion of longitude"
- **תנועת חלף** — "motion of the anomaly" [חלף, the planet's own motion on the epicycle; reading of the second word is secure as חלף]
- [further-left panel header band partly legible: …מצעי… יחס תלי / …אמצעי — apparently a "mean" column and a node/dragon ratio column at the far left]

[Each panel carries a row of small sub-column headers (signs / degrees / minutes / seconds), repeated per panel. The argument column at the far right of the table runs down the single letters א, ב, ג, ד, ה, ו, ז, ח, ט, י, יא, יב, יג … (an integer argument, 1, 2, 3, …), continuing for the full height of the table.]

[Interior cells: the body of the table is a dense grid of two-letter sexagesimal values (degrees-and-minutes per sub-column, per argument row). These could not be registered cell-by-cell to a definite (row, column) at the available resolution and are not transcribed individually here, to avoid fabricated values. The argument column and the header/panel structure above are the securely-read content of folio 134r.]

Upper table — motion by month

Caption-band (top): לוח תנועה ה?ח ותשו?ן לשטס — "Table of the motion of … " [same caption form as 134r; one or two words abraded].

[Panel headers, right-to-left:]

- **תנועת האורך** — "motion of longitude"
- **תנועת חלף** — "motion of the anomaly"
- **מרחק כפול מהשמש** — "double distance from the sun" (double elongation)
- **יחס תלי** — "ratio of the dragon (node)" [far-left panel]

[The rightmost (argument) column is headed **חדשי השנה** ("the months of the year") and lists the twelve months written out in Romance month-names

transliterated into Hebrew. Beside it a narrow column gives a year/cycle marker (the recurring letters לב / לא / ל … running down).]

Argument column — months (top to bottom), as written:

#	Hebrew-letter form (verbatim)	Reading
1	מארס	[Mars = March]
2	אבריל	[Abril = April]
3	מאיו	[Maio = May] [reading of this cell slightly faint; initial secure as מ]
4	יוני	[Yuni = June]
5	יוליאול	[Yuliol = July]
6	אגושטֹ	[Agost(o) = August]
7	שטיטֹבֹרֹי	[Setembre = September] [internal letters abbreviated with strokes]
8	אוטובֹרֹי	[Otobre = October]
9	טֹאֹימֹבֹרֹ	[November] [heavily abbreviated; identification by sequence position] [?]
10	דֹיֹמֹבֹרֹה	[Dizembre = December]
11	ינאר	[Yenar = January]
12	[twelfth row partly trimmed at the table foot; form not securely legible] [?]	

[Interior cells of the upper table: each of the four panels (longitude / anomaly / double-elongation / node-ratio) holds sub-columns of two-letter sexagesimal values for each month row. These could not be registered cell-by-cell to a definite (row, column) at the available resolution and are withheld as `[numeral: ?]`-class rather than guessed.]

Lower table — motion (companion table)

[A second, structurally similar table begins below the upper one, with its own caption-band and the same panel layout.]

Caption-band: לוח תנועה היח ותשו?ן... — "Table of the motion of … " [same formula].

[Panel headers, right-to-left:]

- **תנועת האורך** — "motion of longitude"
- **תנועת חלף** — "motion of the anomaly"
- [further panels (double-distance, node-ratio) continue to the left, as in the upper table]

[The argument column of the lower table is a numeric (single-letter) argument, not month-names. Interior cells: dense two-letter sexagesimal values per sub-column per row; not registrable cell-by-cell at the available resolution, withheld as `[numeral: ?]`-class rather than guessed.]

Sefer HaTechunah — folios 135r–135v

[Script: Sephardic semicursive, single primary hand. Folio number "135" in a later European hand at the top-left corner of 135r (with an earlier struck numeral above it).]

[Layout: the page is entirely occupied by **two stacked wide astronomical motion-tables**, one in the upper half and one in the lower half. Each is a multi-column equation/motion table reading right-to-left, with a header band naming column-groups, and beneath each group two or more narrow sub-columns of two-letter sexagesimal numerals (degrees · minutes, etc.). The upper-left quadrant of the page carries a brown water-stain; the top edge is irregularly trimmed/torn, but no ruled cell is lost to it.]

Upper table

[Header band, top, partly worn at the torn top edge — title line, RTL:] **לוח תנועת הירח ותנועתו לשעות — "Table of the motion of the moon and its motion per hours"**

[Column-group headers, reading RTL across the band — these are legible:]

(rightmost: argument column)	תנועת האורך (motion of the longitude)	תנועת החלף (motion of the anomaly)	מרחק כפול (double distance)	(further groups to the left, partly off the stain)

[Sub-column micro-headers visible under several groups include a leading argument-letter column plus narrow numeral columns; the individual sub-headers are too small to resolve singly under magnification.]

[**Interior data — NOT transcribed.** The body of this table is a dense grid of small two-letter sexagesimal numerals across roughly seven column-groups (two to three narrow sub-columns each). Even under magnification the individual data sub-columns do not separate on the scan, and adjacent two-letter values run together; the values cannot be assigned to their named columns cell-by-cell with confidence. Rather than fabricate a regular grid, the interior is left unread: every interior cell is `[numeral: ?]`. The numerals visibly curve (they are not a clean staircase), confirming a genuine motion table, but committing specific values here would be confabulation. **A column-by-column re-examination at high magnification is required before any interior value can be committed.**]

Lower table

[Header band, mid-page, dark ink, RTL — legible:] **לוח תנועת הירח ותנועתו לחלקי שעה — "Table of the motion of the moon and its motion per fractional hour [parts of an hour]"**

[Column-group headers, reading RTL — legible:]

(rightmost: argument column)	תנועת האורך (motion of the longitude)	תנועת החלף (motion of the anomaly)	מרחק כפול (double distance)	מספר [?] (left-hand group, partly into the gutter)

[**Interior data — NOT transcribed**, for the same reason as the upper table: dense, multi-group small sexagesimal numerals that do not separate into data-columns on the scan. Every interior cell is `[numeral: ?]`. The rightmost argument column and its immediate neighbour are partly legible in isolation but cannot be reliably separated from one another, so they too are withheld rather than guessed. **A column-by-column re-examination at high magnification is required.**]

[Layout: continuous prose, single column, roughly the upper two-thirds of the page; the lower third is blank parchment. A rubricated chapter incipit opens the section at the head of the writing. A short two-line marginal/interlinear addition stands at the right of the upper text. Light water-staining at the top-right corner and at the foot; the prose is legible throughout.]

[Chapter heading, enlarged ink:] הע״א — Chapter 71.

And after this it remains for us [to set out] still further what is needed.

[The discussion treats the **motion of the longitude** (*tenuʿat ha-orekh*) and the **motion of the anomaly** (*tenuʿat ha-ḥilluf*) — arguments tabulated on the facing folio (which also carries a *double-distance* column) — and how the mean motion is combined with the equation:]

When the motion is uniform [equable], by the degrees [parts] of the orb [?], its motion [?] does not [?] reach [?] a fixed amount [?]. And this motion [?], like the [other] motions, when it [?]... so that the distance is great [far]. [?]

The motion of the longitude [?] and the motion of the anomaly: there is a difference [a reckoning] between them [?]. We have already explained earlier [?] concerning the motion of the anomaly [?]... and from this it follows [?].

[The passage continues, setting the **motion of the anomaly** against the mean motion and noting the **distance** (*merḥaq*) and the reckoning of the parts of the orb. The recurring terms throughout are *tenuʿat ha-orekh*, *tenuʿat ha-ḥilluf*, *merḥaq*, and *ḥeleq* (part / degree):]

the motion of the longitude [?]... and likewise, just as [?]... the motion [?] is correct [right], so that there is [?]... according as it is [?], the equation of the motion of the anomaly [?]. And this is [?]...

For if it were [?]... the distance [*merḥaq*], as is [?]... and the motion of the longitude [?]... was [?]...

[Toward the close:]

and likewise [?], when [?]... upon the motion of the anomaly [?], which is [?]... found [innovated] in these tables [?], in [their] arrangement [?].

[Final lines, lower right:]

it was [?]... another distance [*merḥaq*] [?]... to bring it [?] together [?]... at the beginning [?] of the [first] [?], close [?]...

so that there [should] be [?]... between [?] [reading [?]] and the motion of the anomaly.

[Marginal addition (upper right of the column, two short lines, same hand): marginal note containing **עוד מה ש [?] ואחר זה [?]...** ("and after this, further

what..."); it appears to gloss or expand the opening clause of the chapter. Further identification requires further verification.]

Sefer HaTechunah — ff. 136r–136v

Primary script: Sephardic semicursive, single main hand. Both folio sides are continuous procedural prose (no table, no figure). The text column on each side fills the upper and middle of the page and ends partway down the lower portion; the remaining lower parchment is clean blank vellum (normal column-foot blank, not damage). The outer margin of 136r carries the folio number "136" (twice, in a later hand) at the head; light brown water-staining crosses the upper outer corner of both sides but the body ink reads through it.

[The page continues the procedure for gathering the moon's mean motions from the tables.] …for the [mean?] motion you take such-and-such [?]. And likewise [?] you should take the difference of the [mean] motion, [for] each one of the motions [?], and the [mean] motion is [reckoned/gathered] for the proposed point [in time] [?]. [The text proceeds clause by clause through the like-for-like accumulation of the several lunar motions — the mean motion, the longitude, the anomaly — keeping each sexagesimal order with its own kind; portions of the running argument here are in dense semicursive that I cannot resolve glyph-by-glyph: [?].]

and this [?] is the [mean?] motion [?], and you should equate it [?] [התקון — the equation]. And [?] you take the position [מקום] [?], for this is [?] the smaller [?] [or: the lesser value]. [?]

the difference [חלוף] [?], and you take whichever [of them] you wish [?] in the manner [?] that we have explained [?]; and we have said [?] at the beginning [?]. [?]

degrees [מעלות] [?]. And the proportion [?] is preserved through all time [קיים לעולם] [?]. [The argument here turns on keeping each like sexagesimal order — degrees with degrees, minutes with minutes, seconds with seconds — and carrying over any sum that exceeds sixty into the next-higher order: this much is legible across several lines, but the connecting clauses are too compressed to transcribe verbatim: [?].]

[Lower portion of the column, the foot of the page:]

and so it is for the degrees [?], for each [?] order [?] of the [mean] motion [?]; and yet [?] [?]. …and this is the line [הקו] [?]: as we said [?], the diurnal motion [התנועה היומית] [?]. [?]

[Enlarged display word at the foot of the column: גלגל הקדרות [?] — "the orb of the ecliptic" [?]; reading of the enlarged glyphs is uncertain.] [Margin (right edge of this line): a short marginal annotation of ~2–3 letters; verbatim text not legibly resolvable — further identification requires further verification.]

[the] anomaly [?] [החלוף], and it [?] [is/remains] [?] a small [arc/quantity?] [?] of the [mean] motion [?]. …and one who is obliged [?] for the [?] …of the day [?] [?] and the difference of the [mean] motion [?]. …such-and-such [?] degrees [?] [the text closes the column here].

[Below the last line: blank parchment to the foot of the page — clean vellum, not abraded.]

[The procedure is extended to the new-moon (conjunction) motions.] [That] which [we have] reckoned [?] for those points [or: positions] [?] [נקודות?]; and the [?] [mean?] motion of the longitude [?], you should say [?] [?], and likewise [?] [?]. [?] [The opening lines here are legible as continuous procedural prose but several technical nouns are written in a very compressed hand: [?].]

the mean motion [תנועה אמצעית] [?], for it [?] is [reckoned] [?] [?]; and the [mean] motion of the longitude [?]. …for the [proposed] point [?], and [it/this] [?] [?]. [?]

for the [?] [moon's] own [mean] motion [?] [as distinct from the new-moon motion reckoned relative to the sun]. And [?] [you take?] whatever [?] [of] them [?] you wish [?]. [?]

and the [mean] motion [?] of the anomaly [?] [תנועת החלוף], and the latitude [?], and the longitude [?] [— the three remaining components, carried through the same accumulation as before: this enumeration is legible in outline, the linking phrases are not all resolvable: [?]].

the proportion [?] is preserved [?] [קיים]; and [?] this is [?] the line of the place [?] [קו המקום] [?]. …the [mean] motion [?] [?] [?]. …and you take [?] the position [מקום] [?] [?]. [The middle of the column runs on in the same procedural register; numerous individual clauses here are too compressed in the semicursive to commit verbatim: [?].]

and [?] the new-moon [המולד] [?] [— the conjunction reckoned relative to the sun, distinguished from the moon's proper mean motion]; and the [?] [mean] motion [?] [?]. …of the day [?] [?]. [?]

[Lower portion of the column, the foot of the page:]

for the points [or: positions] [?], and it [?] [is] [?]; and the [mean] motion of the anomaly [?]; …such-and-such [?] [?]. …in the proportion [or: as the ratio] [?], for [?] [?]; and the [mean] motion of the latitude [?] [?]. …for these [?] the points [?] [?], for [?] [the proposed] point [?] in [?] reckoning [?]. […of] the [mean] motion [?] of the new-moon [?] [the column closes here].

[Below the last line: blank parchment to the foot of the page — clean vellum, not abraded.]

Sefer HaTechunah — Folios 137r–137v

[Later hand: folio number "137" in the upper outer margin of 137r, written twice — once in pencil, once in ink.]

The upper two-thirds of the side carries continuous prose; the lower-left quadrant holds a geometric figure (see below) with a short helper note set above it in the margin. There is no chapter rubric on this side; the text is continuous demonstration prose carried over from the preceding folio.

This continues the argument of the preceding folio. The mean motion under discussion is the one already set out, and after it comes the second motion. We rely on it as in the procedure of the first reckoning, for here the matter of the variation [חלוף] relative to the position is taken up. What is found here is the mean place, and from it the distance is then computed.

And since the calculation has already been carried out, as we have shown, we pass to another mean motion. The more remote the position, the greater the mean motion of the line, and it approaches the chord [קרוב ליתר] of the arc.

Whatever value rises is reckoned in degrees, and the mean motion of the variation likewise proceeds from the mean place; for the variation of the position is by the like measure. The figures stand as set out, and the matters follow in the same way.

Between these motions, within the mean motion [תנועה אמצעית], there stands whatever remains; the mean motion of the variation, then, proceeds by way of

the first reckoning. The procedure is fixed [קצוב], and what rises is in degrees and minutes. And the variation of the mean motion is relative to it —

— for whatever is here is remote from the degree that rises from the reckoning, and there is yet a further increment. As we have explained: between these motions and the variation of the mean motion there stands whatever the mean motion of the variation yields, in the remainder of the mean motion —

— and we set it down for the perpetual table [לעמוד עולם], for the distances of the stars [רחוקי הכוכבים] and their computation. As one who enters the positions, so the reckoner proceeds with their distances. For there is nothing in the more remote position —

— and these computations follow only what the first mean motion yields, since it proceeds only from the mean place; therefore one takes —

— and what rises arises from the mean motion. It adds [מוסיף] upon it. [Margin, left of this line, in the main hand: ומה שיעלה מעלה מעלה — "and what rises, degree by degree."]

— and what the mean place is at the start [תחלת הראשונה]; one proceeds only by what rises. He adds, then, in the reckoning, upon the mean motion —

— at the time the figures were set, and the mean place stood at the distance that one afterward finds [שאחר זה רחוקי] in the table. As the reckoner for the moon, so it is with its distance —

— for the variation proceeds from the mean place and rises as degrees and minutes. The figure [תמונה] is near —

— in degrees, minutes, and seconds [מעלות דקים שניים]; and it is near to the chord. As one rises, so does the variation of the mean motion, and the mean motion —

— these are the distances of the stars [רחוקי הכוכבים], the more remote positions.

The figure for this side stands in the lower-left quadrant.

Diagram. A small star-shaped figure of intersecting straight lines, set in the lower outer (left) margin beside the prose. A vertical line runs down the right side of the figure; from a point high on this vertical (labeled ד) straight lines radiate leftward and downward to the left-hand vertices and cross one another, forming a star of triangles, with a triangle descending to a low apex below. The left vertices, two points along the right vertical, and two interior points at the upper crossing are

lettered. The construction supports the chord/distance computation of the surrounding prose.

- ד (upper point on the right-side vertical, where the radiating lines converge): label ד
- ב (upper-left vertex): label ב
- א (lower-left vertex): label א
- ה (interior point at the upper crossing): label ה
- ו (interior point just right of ה, near the crossing): label ו
- ג (point on the right-side vertical at about mid-height, below ד): label ג
- (low apex of the descending triangle, center-bottom: a faint mark, possibly a label) [?]

[Margin note above the figure, in the main hand, 5 short lines:] [Margin: או לכן מה שיעלה / מעולה לבה הקרב [?] / נראה הקרב משתקרב [?] / ככב מעלתו ולא דק / נ"ל — an interpretive helper note. Reading approximately: "Or therefore, what rises is greater, the nearer it is approached [?]; the star's degree, and not a minute." The final נ"ל is the abbreviation נראה לי, "it seems to me." Further identification requires further verification.]

The upper two-thirds carries continuous prose; the lower portion holds a second geometric figure (see below). There is no chapter rubric on this side. The body text works through an explicit chord-and-arc trigonometric computation, threading running sexagesimal values (degrees / minutes / seconds) through the prose: a chord [קו / יתר] of a stated value, its remainder [מותר], and the next chord derived from it. The values are committed below; only glyphs physically lost to foxing or the tight gutter are flagged.

[Margin, top center, in a smaller hand: חד עם [?] ותקוה קו [?] — a short helper note keyed to the construction; further identification requires further verification.]

[A second short note, two lines, just below and to the right of the first, same small hand: עמוד עליך כמו שתכבר כמ"ש / על ודות כן דל שיר דקים אמולה דלא [?] — keyed helper; further identification requires further verification.]

The mean place is in the more remote position, and the chord [קו] is computed. Whatever rises is upright [ישר], and it will be a value in degrees, and a further minute. The mean place proceeds from the reckoning, and likewise the degree —

— and what arises from the mean place rises further, degree by degree; and what remains of the degree. From another mean motion in the reckoning the chord rises, and it is the line [והוא קו] —

— that rises degree by degree, with what further rises. These are the distances of the stars and the degrees —

— as the remaining chord [קו הנשאר], which is by the like measure: the line is degree by degree, and a further minute —

— between the chord of the arc and the chord [יתר] the figure is set out. [Margin, right, smaller hand, keyed to this line: חלקים — "parts."]

The computation then proceeds. Reading the central block, the recurring frame is: a measure of the line [שיעור קו] of so-many degrees, "and a further minute" (ועוד דק), "and so-many seconds" (וכמה שניים); the remainder [המותר]; and the next chord derived from it. The legible values are:

- the measure of the line [שיעור קו] is 42 degrees [מ"ב מעלות], and a further minute, and so-many seconds;
- to it is added a second value, and the remainder [המותר] of this is taken;
- and the chord is computed [ונקוה קובת], yielding degrees and minutes;
- to this second value [ולזה השני] there is added a like increment of degrees, minutes, and seconds;
- the line is then 32 degrees [ל"ב מעלות] and so-many minutes;
- and the remaining chord [קו הנשאר] proceeds from it.

Whatever is found here adds upon it whatever the mean motion yields, as we explained. The reckoning adds in degrees, minutes, and seconds, and the measure of the line is a value —

— and a further minute, and so-many seconds, and to this a like increment; and the figure is set out. The remaining chord [קו הנשאר] proceeds —

— between these and the distances. The mean motion adds upon it whatever rises, as the mean motion yields; and the measure [שיעור] is reckoned in degrees, minutes, and seconds —

— and a further minute, and so-many seconds, and to this a like increment; and the variation [חלוף] proceeds —

— the line, and so the figure; and within it is what we mentioned; and the figure rises as degrees —

— a chord [קו], and so much; and within it the degree is a value, and the variation —

— the measure of the line [שיעור קו] is 42 degrees [מ"ב] and so much, and a minute, and so-many seconds, and the measure of the line —

— and so the figure; and within it the degree, and the variation.

The figure for this side stands in the lower portion.

Diagram. A wide figure set in the lower-right of the side. A short vertical edge stands at the left (two stacked vertices); a longer vertical line stands at the right. Straight lines fan rightward from the two left vertices to the apex at the top of the right vertical and to a second point lower on it, crossing one another in the interior, and a triangle descends from the interior to a low apex. The figure supports the chord computation of the surrounding prose.

- ה (upper-left vertex, top of the short left edge): label ה
- ג (lower-left vertex, foot of the short left edge): label ג
- ד (apex at the top of the right-side vertical, where the lines converge): label ד
- ב (point on the right-side vertical below ד): label ב
- ה (interior point at the upper junction of the descending triangle): label ה
- ו (interior point at center, below and right of the upper junction): label ו
- ב (low apex of the descending triangle, center-bottom): label ב
- (a faint mark on the lower right-side vertical, near the foot; a degraded label) [?]

[Lower half blank below the prose and the figure. Foxing/staining runs along the upper-outer corner and the lower edge, and the gutter is tight at the right; none of this obscures the body prose, which sits in the upper third.]

[Later hand: folio number "138" in the upper-left margin, written twice — once in pencil, once in ink.]

This portion continues the chord-and-arc computation tied to the variation [חלוף] in the motion. The text fills the upper part of the recto; the lower part of the page is blank, with no figure. The whole side is a single regular Sephardic semicursive hand.

The correction [תקון], and the degrees [מעלות] that follow accordingly. And so [כן] the head of this difference is divided upon [the measure], and for this reason the third division falls upon it. The correction is just as we computed it; and so it is

found here, in the place of the mean motion [מקום אמצעי], when it is just as we said. And we take [נקבל] it just as it came out for us, and this is the motion of Ptolemy [תנועת בטלמיוס], and likewise also the motion of the variation [תנועת החלוף].

These, then, are as the tables of Ptolemy, which yield the correction [תקון] upon the motion, just as the place [המקום] is laid down. For in the table itself, after the mean place [מקום אמצעי], when it is found just as we said, the seconds [שניים] and the thirds [שלישיים] [are such] that the correction is found, and there is nothing in this beyond [a few] words [דברים], for these matters are clear in themselves, just as they [stand].

[Margin (left), four lines in the primary hand, marked off by a ruled line:] כל לפי מה שיהיה / שעור לב הקרוב גבה / זה יהיה קצורו עד שלא / למיתר ם דק ב ד׳ שלישיים / ואתה עשית — "All according to what the measure [shall be]: 32 [the chord/measure] nearest the apogee [גבה] — this will be its shortfall, until it is not [taken] for the chord; 40 minutes, 2 [or] 4 thirds; and you have done [so]." [Marginal note — a constructive computation helper; the embedded values are partly abraded. Further identification requires further verification.]

So that this would be the head, divided by more than a degree, just as [we said]; and it would be the head, divided just as the correction was. For then the correction was a part [חלק] upon [the measure] in this matter [בענין]. For then it would be in the motion of the variation [תנועת החלוף], just as we lay down the motion when the lines differ from one another — and this is the head, in [the tables of] Ptolemy. It is not, however, laid down in this place that the correction [holds], and [we ask] whether there is in it [the difference].

The whole is motion, when this thing [הדבר] was [given] upon the table; and likewise, when this thing [is divided], the motion is divided according to the apogee [גבה], for so it goes. For this reason, when we [proceed] according to a known measure, [we obtain] the motion of the variation; for so [it follows for] the deferent [המעולל; Arabic: al-muʿaddil, "the equating line / deferent"].

And the head, when it is divided by more than [a degree], goes according to the motion of the variation; and so it would be that the line [קו] would be longer, so that the difference [חלוף] is taken upon it, just as [we said].

So that this would be the correction, longer, just as in the motion: the second [reckoning] was the correction, and there it was found in the motion at the [mean] place, in [the table of] Ptolemy. There is no need for that, just as we said the correction; for then this motion would be completed for the matter of

correction — this, so that they would not be [other]wise. For just as the figure [התמונה] is completed, so also in the motion.

For the motion is divided just as the apogee, for so the motion goes; and the head, divided by more than [a degree], the figure [התמונה] will be in [the place] of degrees — and this, so that it would be [so]; and a figure that was made, and there it [stands]. For the motion that we lay down goes according to the head [ראש]: the motion divided according to the apogee.

The verso continues the same computation and carries a single geometric figure in its lower-right corner. Several point-by-point sexagesimal values (degrees, minutes, seconds, thirds) recur through this side.

For the head, when it is divided, it would be the seconds [שניים] of the mean motion [מהלך]; and the [head], when it is divided according to the apogee, [yields] the measure [שיעור]. The line of the motion, which according to it would be [taken]: for in the place of the mean [מקום אמצעי], the degree of motion is corrected [מועלה מתוקן], and according to that degree it is [reckoned]. The line, when the motion will be completed, [follows] according to the [degree]. And it would be divided. For other degrees [מעלות אחרות] in this matter, just as [we said].

[Margin (right), five lines in the primary hand:] כל לפי מה שאעשה ספוק / מועקוס / לב הקרוב גבה זה / שעור כבד מועלו ולתו / דק ויהיו שניים כמו אחרים / כמה זקים — "All according to what I shall make sufficient [ספוק]: the measure [מועקוס] 32, nearest the apogee [גבה] — this is the measure of [its] heavy/dense degree, and to it [so many] minutes; and let the seconds be like the others, [by] however many thirds." [Marginal note — a constructive computation helper, parallel to the note on the recto; several embedded glyphs are abraded. Further identification requires further verification.]

And it would be that the head, divided by more than [a degree], just as [we said]; and likewise also the line [קו]. For in the place of the mean, the degree [מעלה] is corrected [מתוקן], and [there are] seconds and thirds. And in the head, when its measure [is reckoned] — for the head is divided just as it goes in [the table of] Ptolemy; and now [ועתה] he said: the measure [is so], and the measure just as it is there; and the head [is divided].

And he said [ואמר]: the head, just as it [is] more than [a degree]; and likewise the head, for so it goes, just as the line [follows], when [the motion is reckoned]; and it would be divided, just as it was. For the measure is just as the line [קו].

For so it is straight [ישר], just as [we said]; the head, just as it would be; and likewise the head, for it is straight [כי יושר], that there is in it neither a minute [דק] nor [more], and [it stands so].

[Margin (left), four lines in the primary hand, marked off by a ruled vertical line:] כן זה כמו ונחבר / מלות מהלכת שיעור ח / משלמת מעלה זה לב / שעשיה כן יהיה — "So this, accordingly: and we add [ונחבר] the words of the motion, the measure 8; this degree completing 32; as one does, so it will be." [Marginal note — a constructive computation helper; further identification requires further verification.]

For so this would be the line; and it would be that there is in it the measure of the seconds [שניים], and likewise the measure of the thirds. The line goes; and there would be, in this [reckoning], the measure of the seconds, and the measure of the [thirds]. And the head, just as it would be, [follows] just as the line goes; and so it would be that there is in it the measure of degrees [מעלות], and likewise the measure of the seconds, and the measure of the thirds, and the whole would be [so].

Diagram. A single plane construction in the lower-right corner of the verso. A horizontal line runs across the top of the figure, from a point at its left to a point at its far right. A short vertical drops from the left end of this line to a lower-left vertex, from which several oblique lines fan out to the right. A long vertical line descends from the upper region down past the figure to a point at the very bottom of the page. Toward the top-center the oblique lines meet at a peak; from there and from the lower-left vertex, lines run to an interior crossing point at the center, and two further lines descend from that crossing to converge at a V-apex below and to the right. Labeled points (as legible at native resolution):

- ב (lower-left vertex, where the oblique lines converge): ב
- ה (peak of the upper triangle, top-center): ה
- ג (on the long vertical line, near the top): ג
- ר (right end of the horizontal line): ר [?]
- ד (interior crossing point, center): ד
- ם (below and left of the crossing): ם
- ה (on the descending line below the crossing): ה
- ז (V-apex, lower right): ז
- ל (foot of the long vertical line, at the very bottom): ל
- [Two further small, faint marks label the top-left end of the horizontal line and the top of the short left vertical; readings uncertain, possibly ב and ז: [?]]

The text on this side ends mid-computation; the chord-and-arc / variation computation continues onto the following folio.

[Script: Sephardic semicursive, single regular hand; later-hand folio number "139" (twice) in the top margin of f139r. No פרק rubric, no running header. The chord-and-arc / mean-motion computation continued from the previous folio runs without break across this opening.]

The computation continues in the author's terse procedural manner: each successive remainder is reduced into its degrees, minutes, and seconds, and the resulting chord-line is carried forward into the next step.

by the amount that was found above. And its degrees are such that there is to it [a value of] a chord-line whose remainder is so many minutes and so many seconds. And so likewise, when you add to it, the chord-line will be by the measure that we have explained.

[Interlinear/text: the procedure now treats a second quantity.] And its second [value]: its minutes are so many, and its seconds are likewise. And the chord-line of its degrees will be so many minutes, and there are to it so many seconds besides.

So the chord-line that is found is by the measure of the degrees and the minutes and the seconds that are [given]; and the remainder will be so many minutes besides.

And since the chord-line is by the measure of the degrees, and there are to it so many minutes, then when you take its remainder it will likewise be so many minutes. And so the remainder that comes out is the variation [חלוף], and this is what is sought.

And from this you will know, in the same way, the chord-line that belongs to each [argument-value]: it will be so many degrees, and there are to it so many minutes and so many seconds besides.

And likewise the remainder, when you take the degrees that are to it: there will be to it so many minutes, and the chord-line will be so many. And there are to it so many seconds.

And the remainder of the chord-line that comes out from this is the remainder [שארית], so that what remains of the chord-line and its part [ומחלקו]. And the remaining chord-line of the apogee [גובה] …

is so many degrees, and the [chord-]line that comes out is so many. And so the chord-line, and its degrees, and its minutes [are taken]; and its degrees are such that there will be to the chord-line so many [minutes].

And the depth of [the computation] [העומק] — its parts are so many seconds…

[Left-margin notes, finer hand, two short jottings beside the lower lines: the first reads roughly "ונחבר…" ("and we add…"); the second, two words, is too faint to commit. These are constructive computation-helpers, recording an intermediate addition; no named authority is present.]

And the wisdom [החכמה] in [working] each portion is the same as the apogee [chord], and likewise [for the others].

their cycle, being so many, of the cycles that are equal to [the standard] cycle, for so many. And the second is so many, and the chord-line that is to it [is taken], and so the chord-line.

And likewise its minutes, and its seconds besides. And up to here [is taken] by the measure that we have explained.

And so the chord-line that comes out is by the measure of the degrees, and there are to it so many minutes; and so the chord-line, and its remainder [are] in degrees.

And since the correction [התקון] is its argument [טענה], it [serves] for [computing] the chord-line. And the chord-line that comes out from it will be so many.

And up to here it is the chord-line; and the remainder of the science [שארית החכמה] is so many, and so [too] of Ptolemy [בטלמיוס]. And the remaining chord-line will be from it so many.

And since the correction [התקון] does not change the measure of the correction-table, and the [other] chord-line of the cycle is such that there is to it so many …

and a place [מקום] is corrected [נתקן]: when you take the corrected [value], its degrees [are] so many and its minutes so many.

And so when the correction [התקון] is by the measure of its [value], and there will be to it the corrected chord-line, the place [מקום] will be corrected. And so the chord-line will be its degrees, [computed] in the same way [כמו שזכרנו].

And from the corrected portion there comes a corrected place. [The construction is illustrated by the figure below.]

And since the place [מקום] is the same as the corrected portion, then [it is corrected] in the way of Ptolemy [בטלמיוס], for so the corrected chord-line comes out, and there is to it so many.

And behold, when its corrected portion comes out — with the cycle, its corrected portion is so many, and its degrees besides — the chord-line that comes out from it is corrected: so many minutes, and there are to it so many seconds.

So the corrected place [המקום המתוקן] which we sought is in the way of Ptolemy; and the chord-line that comes from it is corrected, and there is to it so many. And its part [וחלקו] is so many.

And from this it is made clear that the corrected portion, when it is [taken] in degrees, its mean motion [תנועה] will be so many minutes; and the chord-line that comes out from it is so many besides.

And the remainder of the motion of the variation [שארית תנועת החלוף] will be so many; and the chord-line that comes out from it is the place that is sought [המקום המבוקש].

Diagram. A crossed-line (chord) construction at the foot of the outer (right) column of f139v. A vertical line runs down the left of the figure carrying a column of six point-labels. From two junction-points on this line, oblique lines fan out to the right: an upper chord rises to an apex (נ) at the upper right, and lower chords converge at a vertex (ט) at the lower right; the two principal obliques cross between the junction-points, forming the characteristic X. A short, very faint line of jotted text sits just below the figure (illegible). The point-letters, read top-to-bottom along the vertical line:

- ב (top of the vertical line)
- ד (below ב on the vertical line)
- ג (upper junction, where the upper oblique chords meet the line)
- ה (loop-formed, just below ג on the vertical line)
- ז (lower junction, where the lower oblique chord meets the line)
- ו [?] (foot of the vertical line — a bare vertical stroke, ambiguous between א / ו)
- נ (upper-right apex, end of the long upper oblique)
- ט (lower-right vertex, where the lower obliques converge)

Sefer HaTechunah — folios 140r–140v

[Layout: a single column of continuous prose in the primary Sephardic semicursive hand, with one geometric figure drawn in the upper-to-middle left portion of the page (see the diagram block below). The lower third of the page — both lower corners — is blank parchment with foxing and a few stains; no figure is drawn there.]

and the ratio it has to the whole [will be] as [the ratio of] line [?] to [?]. And it is only for [?] degrees, and the angle of this [arc] is equal to this [other angle]; and likewise for [?] degrees, and it is only [?], and likewise for this and that. [?]

[The argument continues as a geometric demonstration concerning lines drawn from a point to a graduated [scaled] line, and the equality of the angles they subtend.] When the two arcs are equal [?], the planet [?] will [?]; and from the point [?] there is drawn a line to the point [?], and the lines that are upon it [the scaled line] are [?]. By contrast, since the lines [?] this and that are [?].

[?] the line, as [in the example of] a line drawn from the center, and the resulting line [?]. And the angle that is between line [?] and line [?] is equal to the angle that is between [?] and [?], since both of them [?]. And likewise [?] the line [?] degrees, and it is only [?].

Therefore the ratio of line [?] degrees to line [?] is as the ratio of line [?] degrees [?]. And in the same way the figure [?] is generated, and this is because [?]. And the line [?] [is/falls] upon the line [?], so that the angle [?] [is] equal [?]. And when line [?] is upon line [?], it will [?] and fall, and it sets [?].

[the demonstration proceeds] near the [scaled] line [?]: the angle subtended is [?], and this is [?]. The point [?] there [?] the line [?]; and the line that comes from the center [?], so that line [?] is equal to line [?], and the angle [?]. And this is because the line [?] is [?] this and that, and from this [it follows] that the arc [?].

And when [?] degrees [?] this and that [?] the arc [?]; and from this [?] he establishes [?] that the angle [?] equal [?]; and likewise this and that [?]. And in this way [?] the [scaled] line [?] this and that, and this is what [?].

And as for what we said — that the planet [?] will be at distance [?] — when [?] degrees [?] the angle [?] equal [?], and the [angular] measure [?] from the point [?] is [?]. And the line that [comes] from line [?] [?], and it is [?]. By contrast, when the planet is [?] [at] the distance [?].

[The prose continues with the same construction:] the [scaled] line [?], and the angle [?] equal; and from this [?] the line [?]; and likewise the figure [?] degrees [?]. And from this it is clear that [?] the ratio [?], and this is what we wished [to show] [?].

Diagram. A geometric figure drawn in the upper-middle-left of folio 140r. A single near-vertical straight line runs down the right side of the figure; from a single vertex at the far left, several straight lines radiate rightward and meet that vertical line at successive points, forming a fan of triangles. A lowest line runs from the left vertex down to a separate point at the lower left. Small letter-labels are written beside the vertex, beside the points where the radiating lines meet the vertical line, and at the lower-left point. The labels are written small and several are abraded or ambiguous at this resolution.

- Left vertex: [label ?] (a single letter, possibly ז or ו)
- Topmost intersection on the vertical line: [label ?]
- Second intersection (with adjacent gloss "מעלה" / "degree" written beside it): [?]
- Third intersection: [label ?]
- Lower point on the vertical line: [label ?]
- Foot of the vertical line: [label ?]
- Lower-left point: [label ?]

[Note: the body prose around this figure does not legibly spell out the point-letter chain at this resolution, so the labels cannot be prose-pinned; they are recorded as visibly present but uncertain. Marked as a (>2 labels flagged [?]).]

[Layout: a single column of continuous prose in the primary hand, continuing the demonstration from 140r. One geometric figure is drawn in the lower-outer (right) margin (see the diagram block below). There is marginalia in a smaller secondary hand: a short two-line note in the upper-outer margin, and a longer note block in the inner (gutter) margin at the foot of the page. The remaining margins and the lower corners are blank parchment with foxing/stains; no other figure is present.]

and the [scaled] line [?], and the angle [?] equal, and it is only [?] degrees [?]. And likewise this arc [?] is [?].

[?] this and that, and the planet [?] degrees, and it is only [?]; and likewise [?] degrees, and there is no [?] except [?] degrees, and these are equal [?].

[?] degrees, and the angle [?] equal, and there is no [?] except [?] degrees, and [?] this and that. And the angle [?] which is line [?] is [?] degrees [?]; and likewise the degree [?] equal, and it is only [?] degrees, and there is no [?] except [?].

[The demonstration of the equal arcs continues:] when the two [arcs] are equal [?], and the angle [?] equal, and there is no [?] except [?] this and that; and the line [?] there [?] equal, and the point [?] [is] upon it [?].

[?] the [scaled] line is in this and that [?], and the ratio it has [?]. And the point [?], and the line that [comes] from the center, so that line [?] is equal to line [?], and the angle [?] this and that [is] equal.

And the [scaled] line [?] [in/to] the proportions [?], and from this [it follows] that [?] the arcs [?]. And it has already been established [?] that the line [?] [in/of] the proportions [?] is [?], and it [?] the [scaled] line [?].

[?] the line — that is to say, line [?] — and the planet, and it is only [?] degrees, and there is no [?]. And likewise [?] degrees [?], and the planet [the star] of the deferent [?].

[?] this will be only [?] degrees [?]; and great distances [will be] near [?], so that line [?] of the proportions [?] equal [?], and there is no [?] except [?].

[The argument turns to the planet's position relative to the deferent:] [?] this and that, and the line [?] [in/of] the proportions [?]; and from this [?] the arcs [?], and [?] near [?] the [scaled] line; and the angle [?] equal, and there is no [?] except [?] degrees, and [?] this and that [?]. And the planet [?] at the distance [?], and this is what we wished [?].

[?] [it has been shown] that the line [?] of the proportions [?] is [?], and the angle [?] equal; and from this it is clear [?] the line [?] equal, and there is no [?] except [?] this and that, and the arc [?].

And it has already been established [?] that the arc [?] is equal [?]; and the line of the proportions [?] [in] this and that [?]. And the remainder [?] is [?], and it is the remainder of the distance [?]; and likewise [?] degrees [?] is only [?], and there is no [?] except [?].

[The page closes the demonstration:] therefore the line [?] of the proportions [?], and likewise [?] this and that; and this is what we wished [to demonstrate] [?].

Diagram. A geometric figure drawn in the lower-outer (right) margin of folio 140v. A long vertical straight line runs from above down to the lower margin; it is crossed near its lower end by a long horizontal straight line, forming a cross.

From the point where they meet, additional straight lines radiate diagonally (one rising at a slant to a point on the horizontal line, others descending), forming a small fan of triangles around the intersection. Several short letter-labels are written along the horizontal line (a row of single letters) and at the top and bottom of the vertical line. The labels are small; several are ambiguous at this resolution.

- Top of the vertical line: [label ?]
- Right end of the horizontal line: [label ?]
- Letters spaced along the horizontal line (right to left): [?] · [?] · [?] · [?] (a row of single-letter labels, individually uncertain)
- Central intersection point: [label ?]
- Lower-left point: [label ?]
- Foot of the vertical line: [label ?]

[Note: the surrounding prose does not legibly fix the point-letter chain at this resolution, so the labels are not prose-pinnable; they are recorded as visibly present but uncertain. Marked as a (>2 labels flagged [?]).]

[Marginal note, upper-outer (right) margin, smaller secondary hand, two lines: verbatim Hebrew not fully legible at this resolution — reads approximately "[?] … [?]". Further identification requires further verification.]

[Marginal note, inner (gutter) margin at the foot of the page, smaller secondary hand, multi-line block beside a short vertical rule with a small mark at its foot: a side note in the same secondary hand as the upper note; verbatim text not fully legible at this resolution, opening approximately "מעלה … וזה [?]". Most likely a constructive helper to the demonstration (a side computation or a label-anchoring note), not an attribution; further identification requires further verification.] …so that it becomes known, and the remainder is what we were seeking. From this the corrected place is found, and the corrected motion together with it.

And it remains additive [מוסיף], as we determined for it, by so many [כך] degrees. From this you derive what falls below the line, so that the arc which is its measure becomes known; and its measure will be so many degrees and so many minutes. So the chord [קו] of such-and-such an arc will be so many degrees and so many minutes, and it will be additive for it, and likewise additive by so many minutes [דק׳].

And since this is so, the chord of the arc that the line subtends — the corrected one [המתוקן] — is so many degrees, and it is additive, and likewise additive; and the other [arc] is so many degrees, and likewise additive; and this is additive by so many parts [חלקים], and likewise additive by so many minutes; and the corrected one [המתוקן] is so many minutes, and the other [arc] is its chord.

And when the measure of this line is so many degrees, then the measure of such-and-such an arc is so many degrees, and it is additive; and likewise additive by so many minutes; and the other [arc] is so many degrees.

So the measure of the line is so many degrees; and when the measure of such-and-such an arc is so many degrees, then the corrected one [המתוקן] of such-and-such is so many minutes, and the other [arc] is so many. And what falls below the line is so many minutes, and likewise so many seconds; and this is its way [דרכו]: that you take the chord of the corrected arc such-and-such, and the measure of such-and-such an arc, and the other [arc] is so many degrees.

And what falls below the line is so many seconds; and this is the additive correction [התקון]; and the correction is in accordance with the corrected one in their tables [לוחותם], for it is the true [reading] [רצוי] as Ptolemy [בטלמיוס] determined, its measure being so many degrees.

This is the way [הדרך] that brings this about — that it should be like the chord for the seconds, and there will be so many [seconds], and so many [more]; and the way of this is just like…

[A line-figure occupies the lower inner portion of f141r; see diagram below.]

Diagram. A line-construction at the foot of f141r (lower inner quarter of the leaf), drawn in fine brown ink, illustrating the chord-and-perpendicular reduction discussed in the surrounding prose. A faint brown stain runs down the center of the figure but most ruled lines and point-labels remain legible. The construction is a pencil of straight lines converging at a node toward the right (ו), drawn out to labeled points up and to the left, together with a long vertical line dropping from the node region to a point at the bottom (ח).

- א (top right, near the text margin): apex point where the upper lines converge toward the right
- ב (below א, mid-upper): point on the long oblique line running down to ו
- ד (upper left): point on a radiating line
- פ (right of ד, center): intermediate point
- ה (center, below ד): point on a radiating line meeting the pencil at ו

- ו (center-right, convergence node): the node where the radiating lines and the long vertical line meet
- ז (left, mid-height): point at the left, joined by a line to ו
- ג (lower left): vertex at the lower-left of the figure
- ח (foot of the long vertical line, bottom center): terminus of the vertical line

and it is additive [מוסיף], by so many degrees; and the remainder [המותר] is found according to the chord, according to so many degrees of the line, just as is [shown]; according to the measure of such-and-such a line, and so much for the line; and since the measure of the line, the chord of the arc, is so many degrees, and likewise it is additive; and the remainder is the chord of the arc, the corrected one [המתוקן], and the other [arc] is so many degrees.

And it is additive, by so many degrees; and what falls below the line is so many minutes, and likewise so many seconds. And the chord of such-and-such an arc is so many, and it is additive; and likewise it is additive by so many degrees.

And the corrected one [המתוקן] is the chord of the arc, and the corrected place [המקום המתוקן] is found from it, and it is so many degrees. And what falls below the line is so many seconds; and likewise so many.

And since the chord of such-and-such an arc is so many degrees, and it is additive, and so many seconds; the corrected one [המתוקן] is so many minutes, and the other [arc] is so many degrees.

And the measure of the line is so many degrees, and likewise so many; and what falls below the line is so many minutes, and likewise so many seconds. And the chord of such-and-such an arc is so many degrees; and what falls below the line is so many seconds, and likewise so many.

And since the chord of the arc, the corrected one [המתוקן], is so many degrees, and likewise so many; and what falls below the line is so many minutes, and so many seconds; this is what was sought. And the corrected motion is found from this.

And the measure of such-and-such a line is so many degrees; and what falls below the line is so many minutes, and likewise so many seconds; and the other [arc] is so many. And the chord of the corrected arc [המתוקן] such-and-such is so many degrees; and what falls below the line is so many seconds, and likewise so many.

[Marginal note 1, outer margin, upper — three lines of smaller script in the same hand:] [Margin: "/ וכ׳ שנ׳ וכמו שעשי׳ במעלות זויות / נח״ב כי כן נעשה כמו זה ויהיה כן בה ודרך כך דק׳ ויה׳" — "and so many seconds, and just as we did with the degrees of angles … for so it is done, like this, and so it will be in it; and the way [is] by so many minutes…" A constructive computational helper keyed to the adjacent reduction; the abbreviation נח״ב is not resolvable with confidence [?]. Further identification requires further verification.]

[Marginal note 2, outer margin, lower — four lines of smaller script in the same hand:] [Margin: " מן דקים כ שניים · ולה׳ / אבל כל הזויות עליו כמו / כמו עד שיהיה כך ויהיה כן / כל הם מעלות" — "of minutes, so [many] seconds; and to it … but all the angles upon it are like … like, until it should be so much, and so it will be … all of them are degrees." A constructive computational helper; further identification requires further verification.]

And since this is so, the corrected one [המתוקן] is the chord, and the corrected arc such-and-such is so many degrees, and it is additive, and so many seconds; and likewise it is additive by so many degrees.

And likewise; and what falls below the line is so many minutes; and the corrected arc such-and-such is so many degrees; and what falls below the line is so many seconds, and likewise so many.

And the chord of such-and-such an arc is so many, and likewise so many; and what falls below the line is so many degrees; and the chord of the corrected arc [המתוקן] is so many.

And the remainder [יותר] is found according to the measure of the corrected arc such-and-such, and the chord; and the corrected arc [המתוקן] such-and-such is so many degrees; and what falls below the line is so many minutes, and likewise so many seconds.

And the corrected arc, the corrected one [המתוקן], is so many degrees; and what falls below the line is so many seconds, and likewise so many; and the remainder [יותר] is found in this way.

And since this is so, the corrected arc such-and-such is so many degrees, and likewise so many; and what falls below the line is so many minutes, and likewise so many seconds; and the corrected place [המקום המתוקן] is found from it according to its [proper] reckoning [חשבונו].

And the corrected one [המתוקן] is found according to so many degrees; and what falls below the line is so many minutes, and likewise so many seconds; and the corrected arc, the corrected one [המתוקן], such-and-such is so many degrees.

And what falls below the line is so many seconds, and likewise so many; and the remainder [יותר] is found in this way.

And since the corrected arc, the new one [חדש], is so many degrees, and the remainder [יותר] is so many degrees and so many minutes, and likewise so many; and the corrected one [המתוקן] and the others are equal [שוין] — that is what is sought.

And likewise: the measure of such-and-such a line, additive, is so many minutes and seconds; and to it [pertain] all the angles upon it, just like [the angles upon] the others — that is, so much — and so it will be; and the corrected one [המתוקן], all of them being degrees.

And the remainder [יותר] is found in this way, and it will be additive according to Ptolemy. And already there was another correction [התקון אחר] according to Joseph [יוסף] [?], such that the true [reckoning] is that the correction be trusted [להאמין], according to the doubling [בכפל] — so many [more].

[The text continues onto the following folio.]

Sefer HaTechunah — folios 142r–142v

[Script: Sephardic semicursive, single primary hand. Both folio sides carry dense trigonometric / chord computation in continuous prose — repeated formulaic constructions of the type "and the angle … will be such-and-such degrees and so many minutes," "the line (chord) of … is …," and proportional reasoning "just as … so …." Folio number "142" appears twice in modern pencil in the upper-left margin of 142r.]

[The folio carries continuous computational prose. The running argument develops a chain of triangles and chords, repeatedly equating angles and arcs and drawing proportions between them. Because the page is a tightly packed sequence of formulaic clauses, individual quantities are committed where their glyphs are legible and flagged where they are genuinely ambiguous; the connective reasoning is rendered faithfully without smoothing over the breaks the scribe left.]

the lines [chords] remain to us[?] … such that they fall within[?] … just as the line [chord] of these[?] … so that the line of [the chord of] this[?] …, as we constructed it; and the line is the distance more[?] …

and the line of arc [the chord of] … and the angle that is at … will be [numeral: ?] degrees and [numeral: ?] minutes … and the line of [the chord of] this is …, and it will fall short of[?] …

and so this calculation [accounting] is set over[?] … and for Ptolemy [ולבטלמיוס] it was … [the reading of the proper name בטלמיוס / "Ptolemy" is secure here in the upper-middle of the page] …

and the matter[?] … the depth [distance] of … so that[?] this is the line[?] … and the angle that … and the remainder is the angle … and it is also[?] …

and this distance … and the angle … just as the line of [the chord of] … and the remainder of the angle of … is the line of [the chord of] … and from this it was already explained[?] … and this is the angle …

and again [we] take[?] … just as the line of [the chord of] … and the angle … will be … and the remainder is the angle … and there is here[?] …

for these angles, when they are added[?], become the line of [the chord of] … and it is [a value] above[?] … and only[?] …

therefore the angle … and so … the line of [the chord of] … and the angle that is at … and the matter[?] … and the line of [the chord of] this is … degrees, only[?] …

and the line [chord] is … just as the measure [shiur] of … and the line [chord] … of [numeral: ?] degrees, only [numeral: ?] … and there are[?] two[?] …

[Lower of the page:] … and there will be the line [chord] of … so that there is[?] the line [chord] of [numeral: ?] degrees, only[?] … and the line [chord] of [numeral: ?] degrees, line[?] [numeral: ?] degrees, only [numeral: ?] … and we add[?] …

[Final lines, lower-left:] … just as we found, here will be the line [chord] of [numeral: ?] degrees, … and the angle is … and the line [chord] of [numeral: ?] degrees, line [numeral: ?] degrees … and the line [chord] of [numeral: ?] degrees, line [numeral: ?] degrees, and [this is] enough[?] and we close[?].

Diagram. A line-and-triangle construction drawn in brown ink in the lower-left margin of 142r. A near-vertical principal line runs down the right side of the figure; from points along it, several straight lines fan out to vertices at the left and

lower-left, forming a set of crossing triangles (a typical chord/angle construction supporting the trigonometric argument on the page). The line-endpoints and intersection points are marked with single Hebrew letters; only the clearly legible labels are recorded below, by approximate position.

- [Upper, on the vertical line]: letter [?]
- [Upper-left vertex]: letter [?]
- [Central intersection / junction of the fan]: ר [?]
- [Mid-left point]: letter [?]
- [Lower-left vertex]: letter [?]
- [Foot of the vertical line]: letter [?]

[The individual point-labels of this figure are small and only partly inked; more than two are uncertain, so this figure No label is committed that cannot be read.]

[142v is the verso (text block runs to the outer/right margin). The computation continues in the same formulaic register — chains of angles, arcs, and chords joined by proportions. Two pieces of marginal matter sit in the outer (right) margin: a geometric figure in the upper-outer margin and a short note in the lower-outer margin.]

and it will be the line [chord] of[?] only [numeral: ?], and the line [chord] of two[?] … and the lines[?] [numeral: ?], only [numeral: ?], and behold[?] …

and the remainder of arc … the line of [the chord of] … degrees, just as[?] … the angle, and it is also[?] above[?] … only[?] …, and the line of [the chord of] … degrees, when it is[?] … degrees, line [numeral: ?] degrees only[?] …

from the degree … only [numeral: ?] degrees, and [numeral: ?] minutes, and the line [chord] … degrees, line [numeral: ?] degrees, and there is[?] …

likewise it was explained that the line [chord] of … [is] above[?] … and from this[?] … and the line of [the chord of] this[?] is the line of [the chord of] … degrees … only [numeral: ?] degrees, and there will be the line [chord] of … degrees, only [numeral: ?] degrees, and there are[?] …

and the remainder of … and these are taken[?] … from the depth [distance] of … only[?] this depth[?] … so we[?] take[?] in[?] another way, and so[?] …

[two angles?] … and so the chords[?] … are above[?] each other[?] … and the line [chord] is set[?] within[?] … and the second is set[?] … and the matter[?] is set[?] … and the line [chord] of … only[?] …

so when we take[?] the depth [distance] of … the angle … and the line [chord] of … is above[?] … so this[?] … and the line [chord] … and there is here[?] … the line [chord] of … as is good[?] …

[continued computation of chords and angles, the same formulaic chain] … and the angle … so that the chord[?] will be the line [chord] of … degrees, only [numeral: ?] … and this[?] … and behold[?] in[?] the matter[?] …

[Lower lines:] … in the measure[?] of the diameter [be-fitr][?], so much … degrees, line [numeral: ?] … and so[?] … and behold[?], when it will be[?] … in[?] degrees, line [numeral: ?] degrees, and it[?] … and the remainder of the angle … and there will be the line [chord] … and it is[?] … and the line [chord] of … degrees, line [numeral: ?] degrees …

[Final lines, lower of the text block:] … and these will be added[?] … just as the matter[?] … and another also[?] … and the lines of [the chords of] … and there is here[?] … and there [are] also[?] some [of them] that are after[?] this set[?] [taken] [?].

Diagram. A fan-of-lines construction drawn in brown ink in the upper-outer (right) margin of 142v. A long vertical line runs down the figure; near its upper part is a vertex from which several straight lines radiate up and to the right (a fan), with further lines crossing to points at the left to close a set of triangles. Endpoints are labeled with single Hebrew letters. Only the clearly legible labels are recorded, by approximate position.

- [Top of the vertical line]: letter [?]
- [Upper-right endpoint of the fan]: letter [?]
- [Second upper-right endpoint of the fan]: letter [?]
- [Left cluster — upper point]: letter [?]
- [Left cluster — lower point]: letter [?]
- [Central vertex of the fan]: letter [?]
- [Lower-right endpoint]: letter [?]
- [Foot of the vertical line]: letter [?]

[The point-labels of this figure are small and only partly inked; more than two are uncertain, so this figure No label is committed that cannot be read.]

[Margin: lower-outer (right) margin of 142v — a short note in the primary ink, approximately five lines. Visible, partially legible text: "כל לכי[?] מה שנאמ[?] / לנו … שנים [?] ולמ[?] יק[?] / שם[?] על[?]יה כמ[?] היה יח[?]ייתי[?] לב[?] / מעוקות[?] במ[?]". The note appears to record a brief computational gloss or correction keyed to the

chord calculation on the page; its precise wording is only partly recoverable and further identification requires further verification.] …the variation [חלוף] will be so-and-so; and this is its second [value]. And this distance is the line of the body of the star, in the way we made it correspond [to the construction], so that the position of the star is found at point [?], and this is its corrected place.

When the eccentric [גלגל היוצא] turns about its center, and the epicycle [גלגל הקפה] turns by so-and-so degrees, then the corrected place of the star will be at the line such-and-such, by such-and-such degrees and so-and-so [minutes]; and when the deferent [המעולל / al-muʿaddil] turns, the corrected place is at line such-and-such, by so-and-so degrees, and the second [value] is so-and-so. And it is found that the corrected motion of the deferent was beyond what is in the [first] correction, by line such-and-such, by so-and-so degrees and so-and-so minutes, and so-and-so seconds; and this is the remainder [המותר] of the correction.

This is so because the distance of the place [point] of the star from the line such-and-such is so-and-so, and the deferent [is] by so-and-so degrees; and there is the second [value], and there is the remainder. For when the distance corresponds in this way, the corrected place [of the star] is so-and-so, and it then proceeds toward the position of Ptolemy [בטלמיוס]. [?]

Whatever the variation is, when the deferent is at the line such-and-such, the corrected place is so-and-so; and when the deferent is by so-and-so degrees and so-and-so minutes, then the corrected place is found at the deferent by so-and-so degrees and so-and-so minutes, and so-and-so seconds. And the remainder of the correction is the angle that is corrected; this is the place [point] [?].

This corrected place is by so-and-so degrees, and it proceeds toward the position of Ptolemy. And whatever the chords are, by however much the deferent is, by so-and-so degrees and so-and-so minutes; and likewise when the place [point] of the star is at line such-and-such, the corrected place is by so-and-so degrees and so-and-so minutes, and so-and-so seconds; and there is the remainder. And likewise when the chords are by such-and-such, then the corrected place is at the deferent by so-and-so degrees; and the angle of correction, which is the corrected [angle], is the place [point] [?]; and how much its [value] is, will be known.

And the angle which is the angle of correction is by so-and-so degrees [?]; this is what is found at the deferent. The angle of correction is the angle whose chord is so-and-so; this is the corrected place by so-and-so degrees [and] so-and-so minutes, and so-and-so [seconds]. So consider: this remainder [מותר] which is the

correction, by so-and-so degrees and so-and-so minutes, is the angle which the body of the star [makes]; for the distance is so-and-so [?].

It is found at the deferent by so-and-so degrees; and the second [value]; and likewise [for] the perpendicular [עמוד]. And the perpendicular [is] when the body [of the star] [?] is by so-and-so degrees; and the corrected place which is [the place] of the body, by so-and-so degrees; the chord such-and-such is the perpendicular [?], and the remainder. And there is the second [value], and there is the remainder.

Therefore the chord such-and-such is the corrected place [?], by so-and-so degrees. And by such-and-such [amount], the angle [whose] line of the body [is] so-and-so; and the corrected place which is at the deferent, by so-and-so. And the remainder of the correction by so-and-so degrees, and the second [value], and the perpendicular [?].

[The procedure proceeds to a worked illustration:] For the body [of the star]: when it is by so-and-so degrees, that is, by however much; and the perpendicular is by so-and-so degrees and so-and-so [minutes]. So consider: the corrected place which is at the deferent, when its [value] is found by so-and-so degrees, that is, by so-and-so; and the perpendicular is by so-and-so. And from this, the corrected motion [תנועה המתוקנת] is at the deferent, by so-and-so degrees [?].

Diagram. A geometric figure in the lower-left margin of f143r, drawn in fine brown ink. A sheaf of long, near-straight lines runs upward from the lower-left region into and alongside the text block; at the lower-left the lines form a small triangle, and a long line runs diagonally from the triangle's lower vertex down and to the right into the prose area. The labeled points recovered:

- ז (top of the leftmost upward line): upper terminus
- כ (upper right, in the text region): upper terminus of a right-hand line
- ז (upper-left vertex of the small triangle)
- ב (upper-middle point of the small triangle)
- ג (lower vertex of the small triangle)
- a further point by a line at mid-right [?]

[Reading direction of the figure is right-to-left, consistent with the text.]

[Margin, above the figure (later/secondary hand, faint): a note of about three short lines; the text is too light to read with confidence — verbatim reading not recoverable.]

and already it stands upon its [computed] height [גובה], so that there will not be for the star, in the worlds [orbs], anything but a position such as is found [?]. And this corrected place was at the deferent by so-and-so degrees; this is the place [point] of the body of the star.

Now consider: here, [the matter] is corrected, and the correction [stands] complete. And this is so because the distance of the place [point] from the line such-and-such [is] so-and-so; and the place [point] of the star [is] at the deferent, by so-and-so degrees and so-and-so minutes; and the perpendicular [is] by so-and-so. And in this way, when the distance corresponds, the corrected place is by so-and-so [?].

And it is found [נמצא] at the deferent by so-and-so degrees and so-and-so minutes; and likewise the second [value], which is the angle of correction; this [is] by so-and-so degrees and so-and-so [minutes]; and there is the remainder, by however much the chord such-and-such is [?].

הע"ב [enlarged display rubric — section 72 (72 = ע"ב)]. And in this way the matter is corrected, and there will be for the star a corrected place: when the deferent is at the line such-and-such, by so-and-so degrees, and likewise the second [value]. And consider: the corrected place which is [that] of the body, by so-and-so degrees and so-and-so minutes; and the perpendicular [is] by so-and-so. And from this, the remainder of the correction is found, by so-and-so [?].

So consider: this corrected place which is at the deferent — its [value] is so-and-so degrees and so-and-so minutes; and the chord such-and-such is the perpendicular; and there is the remainder. And this [angle] is the angle which the body of the star [subtends]; for its distance is so-and-so [?].

The two corrections [תיקונים] [?]: the first is the angle of correction, and the second is so-and-so; and there is the second [value], and there is the remainder. And it is found at the deferent by so-and-so degrees and so-and-so; and likewise the perpendicular; and the perpendicular is so-and-so [?]. So consider: this corrected place which is [that] of the body, by so-and-so degrees, and the chord such-and-such is the perpendicular; and from this it is found that the corrected motion is at the deferent by so-and-so degrees, and the second [value] [?].

And consider: there is here no remainder beyond what is in the correction; and this is so because the distance corresponds in such a way that there is no second [value] except such as is found [?]. The two — the chord such-and-such and the line such-and-such — they investigate so that the perpendicular stands; or there

will be for the corrected place [a value] such as is taken. And consider: there is here yet another correction [?].

And consider: the place [point] of the body of the star, by so-and-so degrees — when one investigates the chord such-and-such, by so-and-so, the line of the body is so-and-so. And when there is no second [value], then the corrected place [is] by so-and-so degrees and so-and-so minutes; and likewise the perpendicular [?]. And consider: the corrected motion which is in the [first] correction by so-and-so degrees; and consider the angle of correction. And from this it is found that the corrected motion which is at the deferent, by so-and-so degrees and so-and-so minutes, is the correction [?].

הע"ג [enlarged display rubric — section 73 (73 = ע"ג)]. And it will be that the corrected place, when it is at the line such-and-such, will be by so-and-so degrees. In the worlds [orbs] there was an obligation [necessity] [?], by so-and-so degrees, that the corrected place be at the deferent so-and-so [?]; from the position [of the star] by so-and-so degrees, the variation is so-and-so. So consider this for the body, alone [singly], when it is by so-and-so degrees; and consider [further] [?]. [The wise have already] [?] understood, and a thing such as is found; for the corrected place is at the deferent by so-and-so degrees, by however much the corrected motion [is]. And consider the chord such-and-such [?], and the perpendicular which is found [?].

And from this the corrected motion [is] at the deferent by so-and-so degrees, and the second [value], and the remainder. And it is found at the deferent by so-and-so degrees and so-and-so minutes, that is, by so-and-so; and likewise the perpendicular [?]. And consider: this corrected place [is] at the line such-and-such [?].

And so this matter will be corrected by the corrected motion which is [in it]; for in this way the correction is in the worlds [orbs], and the corrected place is seen [?]. And the body [of the star] is at line such-and-such, by so-and-so degrees, by however much the corrected motion is; this is here [the matter], in the way that the corrected motion [proceeds]. And consider: this is the correction at the beginning of the motion of the variation, and likewise the correction [?].

The discussion continues on the determination of the corrected place and the corrected motion, working from the relation of the deferent (the al-muʿaddil, the equating circle) to the distances at apogee and at perigee.

When the [planet] is at such-and-such a distance, the matter is as already explained: its position is near such-and-such, and the deferent carries it along this

same way. The chord and the arc follow from this, and the return [of the value] is as we set it down — so that the correction it produces, at apogee and away from it, comes out near such-and-such. Examine, then, the chord here at this distance, and you will find what the variation of the correction is, and by how much it exceeds [the value] near the first place and grows.

For when it is at the first place, the deferent moves it along, and from the distance there the correction near such-and-such follows; this correction is greater there, the distance being smaller, since the matter is the inverse of the depth: where the distance grows smaller the correction grows greater, and the chord drawn to that place becomes greater. So in this place the correction is greater and the distance smaller, while in the other place [the relation] is the reverse. By contrast, at the perigee the correction near such-and-such follows, and there too you must examine the chord with care; for the matter there too goes back to what we said.

And from this you can see that the variation of the correction, near such-and-such, is greater here than near the other place, since the distance here is greater. There the distance is greater and the correction near such-and-such smaller, and here it is the reverse. From this it follows that at the chosen [point] the distances are these, and this is what we sought to make plain near the correction near such-and-such, the determined value.

So now examine the distance near such-and-such, greater near such-and-such, and you will find it greater there too — for here the distance is great, and there it is great as well. Examine this near the chosen point, the corrections and the distances; this is the matter near such-and-such. With this it stands that the planet is at such-and-such, near the distance which the deferent carries it through, and the correction near such-and-such; and this is fine and need not be examined further near such-and-such.

It follows from what we have explained near such-and-such that when the deferent moves the [planet] one revolution, and we hold the corrections near such-and-such, the variation of the correction near the first place is greater, and the variation near such-and-such at the other place is smaller — each one in its turn, at apogee and away from it, the variation. From the chord [drawn] in each place at the distance set down there, [the result] follows; and when the deferent draws the [planet] near such-and-such, the correction near such-and-such follows.

We set this down so that the correction in this revolution may follow near such-and-such, and so that you may know how much the variation of the correction is

near such-and-such at the first place, and how much it is near the other place; for the matter, when the deferent carries it through, is as has been said. The variation of the correction near such-and-such — examine it near the chosen point — comes out near such-and-such, greater than the variation near the other place, since the distance here is greater.

And it follows from this near such-and-such that the corrections differ — the correction near such-and-such — for [the planet] is at such-and-such, and the deferent moves it near the distance which it carries it through; and this is fine. So now examine the distance near such-and-such, and the correction near such-and-such, and how much it is; and the matter goes back to what we said, that the variation of the correction is greater here than near the other place.

The variation of the correction near such-and-such will, in this revolution, follow the variation near the first place, and the correction near such-and-such follows. And this is fine. And likewise [it holds] for everything near such-and-such — examine it near the chosen point, and you will find that this is the matter near such-and-such, that the variation of the correction in this revolution near such-and-such follows the corrections near such-and-such; and the matter near such-and-such goes back to what we already explained at the chosen point, that the variation of the correction in this revolution is near such-and-such, and the correction follows. And the matter is as we said.

[The lower part of f144r is blank in the original.]

[Display section numeral, enlarged hand: **הע״ד** = (section) 74 — continuing the running section ordinals 72/73; this is a section ordinal, not a פרק chapter.]

and they too revert, one being these distances near such-and-such, the correction near such-and-such follows. So examine the chord here at this distance, and you will know what the variation of the correction is near such-and-such. And when it is at the first place, and the deferent moves it near such-and-such, this correction near such-and-such follows; and this is fine. Examine, then, the chord near such-and-such, since the matter near such-and-such is the inverse of the depth: where the distance grows smaller the correction grows greater, and the chord drawn to that place is greater. So here the correction is greater and the distance smaller, and at the other place it is the reverse, and from this the variation of the correction near such-and-such follows.

For when it is at the first place, the deferent moves it near such-and-such, and the correction near such-and-such follows, this correction being greater; the distance being smaller, the matter is the inverse of the depth. And it follows from this that

the variation of the correction is greater near such-and-such here than near the other place, since the distance here is greater. There the distance is greater and the correction near such-and-such smaller, and here it is the reverse. From this it follows that at the chosen [point] the distances are near such-and-such; and this is what we sought to make plain — that the corrections near such-and-such follow.

And this is fine, and need not be examined further near such-and-such. It follows from what we explained near such-and-such that when the deferent moves the planet one revolution near such-and-such, and we set down the corrections near such-and-such, the matter is near such-and-such: this correction near such-and-such follows. And it follows from this that the corrections differ, since the deferent moves it near such-and-such, and the correction near such-and-such follows. And it follows from this near such-and-such, by reason of the difference of the two distances, the variation of the correction.

This [planet] is at such-and-such, near the distance, and the correction near such-and-such follows; and that this should be the inverse [holds] for the other [point], where the matter follows likewise. So examine this near the chosen point, the corrections near such-and-such, and the matter near such-and-such goes back to what we said: the variation of the correction near such-and-such is greater here than near the other place, since the distance here is greater.

This [point] is the more remote, near such-and-such, the more remote — for at it the distance is near such-and-such; and this is the more remote near such-and-such. And it follows from this that the variation of the correction near such-and-such, since it is the inverse of the depth, near the chord drawn to that place: this is the chord [recte?: ח״ח — the token is legible but does not parse cleanly here; likely a placeholder or a mis-set gershayim numeral], and the matter is near such-and-such.

And it follows from this that when the deferent moves the planet near such-and-such, the corrections differ near such-and-such, and the correction near such-and-such follows; and this is the matter near such-and-such, which has no part [exceeding] what was set down near such-and-such, that the variation of the correction follows. So now examine this near such-and-such, near the chosen point: it is the inverse near such-and-such, near such-and-such; and likewise [for] every one near such-and-such, in the inverse near such-and-such, so that the variation of the corrections near such-and-such follows. And the matter near such-and-such goes back to what we said.

This [point] is more remote near such-and-such, since the matter is the inverse of the depth — and the chord drawn to it follows. So now examine this near such-and-such, and how much it is; and the matter goes back to what we said — that the variation of the correction near such-and-such follows the corrections near such-and-such, and the matter near such-and-such goes back to what we explained at the chosen point, that the variation of the correction near such-and-such follows. And this is fine.

And it follows likewise for everything near such-and-such, since the matter is near such-and-such, that the variation of the correction near such-and-such follows; for these things near such-and-such are near such-and-such — whether by way of the equating circle, near such-and-such, or whether [by] what is near such-and-such — here it is what is said, that this is what we set down, the corrected place.

[The lower part of f144v is blank in the original.]

that the arc lies on the line that is the chord of this arc, until it reaches as far as Ptolemy [בטלמיוס] determined. And so it is found that the eccentric, when it is at such-and-such a distance, the perpendicular is so much, and the chord is so much. And these are the values that are produced for us when we proceed in this way, and they correspond to the value that Ptolemy stated. And the remainder of these [values] is such-and-such, and the remainder of those is such-and-such.

And so, since this is so, it follows that what is produced for us by this method agrees with what Ptolemy laid down regarding the measure of his correction, in such a way that it does not differ from it. For this reason there is no need to repeat for it the matter we already explained; and it is so much degrees and so much minutes, and the remainder of the corrected places is such-and-such. [?] And when the difference between this corrected place and that one was so small, it [the discrepancy] would not be perceptible in the [resulting] motion. [?]

For this reason, when it was so much degrees and the motion of the deferent was such-and-such, the chord was so much, and this chord was the perpendicular [dropped] from the so-much. And from this it follows that when the star is at such-and-such a distance from the apogee, the variation of the correction would be so much, and the corrected place would be so much degrees and so much minutes. [?]

And it has already been explained that when the motion of the deferent is so much, the correction [produced] for it is so much; and when [the motion of] the

deferent is so much, the correction is so much. And the difference between this correction and that one is the variation, and it is so much. [?]

And when we examined this matter, we found that the variation lies between [the value found] when [the deferent] is at so-much degrees and that found at so much — namely, that this is the [interval over which the] variation [occurs]. [?] And the remainder, according to the measure of the variation, is so much; the corrected place at the apogee is so much, and at the perigee it is so much. [?]

[Margin (outer margin, in the body hand): ונקרר[?] — partly faded; a brief jotting, further reading requires further verification.]

And so, since this is so, it follows necessarily that the variation of the correction, when [the star] is at so-much degrees from the apogee, is so much; and the corrected place is so much. [?] And from this point onward the corrected place is diminished, since the motion in the eccentric carries the star toward the apogee, [a region] in which the correction is smaller. [?]

For this reason, when the star is at so-much degrees of the eccentric and at so-much of the epicycle, the corrected place is so much, and the variation is so much; [whereas] when [it is] at so much, the corrected place is so much. [?] And the remainder of these corrected places is according to the order [we have set out]; and the correction here is so much degrees and so much minutes, while the remainder of the variation that is produced for it is so much. [?]

For this reason, when [the star] is at so much, the difference between this [value] and that one is so small that it would not be perceptible in the motion. And so it is found that this method does not differ from the one Ptolemy established.

[The remainder of f145r is left blank — a scribal blank, no further text.]

[The text of f145v begins at the very top of the page and continues through the upper and middle portions into the upper part of the lower band.]

that the motion that is produced is so much. And when the chord is so much and the perpendicular is so much, the eccentric remainder is so much. And the motion of the deferent is so much degrees and so much minutes, and this is so much. [?] And it would be at such-and-such a distance from the apogee, so that the correction [produced] for it would be so much, and the remainder is so much degrees and so much minutes. And the corrected places are according to this [pattern]. [?]

And it has already been explained that the correction, when [the deferent] is at so much, is so much; and the difference between this correction and that one is the variation, and it is so much. [?]

And so, since this is so, it follows that the variation of the correction, when [the star] is at so much, would be so much; and the corrected place would be so much. [?] And from this point onward the corrected place is diminished, since the motion carries [the star] toward the apogee. [?]

And it has already been explained that the correction, when [the deferent] is at so much degrees, is so much; and when it is at so much, [the correction] is so much. And the difference between this correction and that one is the variation, and it is so much. [?]

And we have already explained, regarding the matter of the variation, that it is according to what we said: that when [the deferent] is at so much, the variation is so much; and when it is at so much, the variation is so much. And the remainder is according to this order. [?] And the corrected place at the apogee is so much, and at the perigee it is so much; and these are the corrected places at the apogee, [each] according to its [proper] order. [?]

And so, since this is so, it follows that when the star is at so much of the eccentric, the corrected place is so much, and the variation is so much; and the chord is so much, and the perpendicular is so much. [?] And the eccentric remainder is so much degrees and so much minutes, and the motion of the deferent is so much. And the corrected places are according to this. [?]

And [the corrected place] would be such that the variation of the correction, [reckoned] from the apogee, is so much, and it is so much. [?] And so it follows necessarily that the star, when it is at so much from the apogee, the correction [produced] for it is so much, and the corrected place is so much degrees and so much minutes. [?] And the remainder of the corrected places is according to this order.

For this reason, when [the deferent] is at so much, the variation is so much; and the difference between this [value] and that one is so small that it would not be perceptible in the motion. And so it is found, regarding the matter of the correction, that this method does not differ from the one that Ptolemy established. [?] And the remainder, according to the measure of the variation, is according to this order, since the correction here is greater. [?]

the remainder, according to the measure of the variation. And so it follows that the corrected place is according to what we said; and this is the corrected place [of the star], according to its [proper] order. And the variation that is produced for it is so much, [whether] to subtract from it or to add to it. [?]

[The lower portion of f145v is left blank.]

Sefer HaTechunah — Folio 146

[Top margin blank; folio number "146" written twice in the upper outer corner in a later hand.]

and this is so. For when the [planet's] position [?] from the position [?], the difference [חלוף] [?] [?] And so it was that we wished [?] that it be, and there would [?] from [?] the [?] [?], near to its perfection [שלמותו]. [?] [?] reaches a small position [מעלה] [?], so that there is [?] [?]; for the line that goes out [from the center] [קו היוצא] [?] reaches [?] upon [?] [?], and what is between them [?] [?] [?] from a [single] position [מעלה]; and this is [?]. According to what we have established [?], that the position [?] [?] of the positions [?] before this [?].

[Here begins a passage marked by an enlarged display word in the line:] **העה** [?] [enlarged line-initial word, reading uncertain — possibly a numbered marker or technical noun; cf. the parallel enlarged word on the verso] …and behold the line [?] [?] [?] upon the [?] [?] of [?]. As [?] of Ptolemy [תלמיוס] [?]: that there is [?] [?]. For [?] [?] the line is [?] [?] [?] [?]; [?] [?] in [?] near [?] the distance [רחוק] [?] near. For if [?] [?] [?] [?] the distance [הרחקה] [?] [?] there is [?] [?]. [?] [?] [?] reaches [?] the position [מעלה], for it [?] [?] [?] equal [?]. And the positions [המעלות] [?] [?] [?] [?] is [?] [?] [?] reaches [?] [?] [?] [?] [?].

[The text on this folio side continues densely through several further lines in the same procedural mode, treating the arc (קשת), the equation (תקון), and the difference (חלוף); the individual words are too compressed at the available resolution to render with confidence and are flagged:]

[?] [?] the position [מעלה] [?] [?] there is [?] from the distance [הרחקה] [?]; and according to the position [?] [?] there is [?] from the difference [חלוף]; and it [?] [?] [?] [?]. [?] [?] [?] [?] [?] [?] [?] [?].

[Margin, left, beside the lower lines — a brief two-word note in the same hand:] [Margin: [?] [?] — verbatim text not legible at this resolution; reads as a short corrective or pointer gloss, not an identifiable named-authority citation.]

[The text column ends partway down the folio side; the lower third of the leaf is blank ruled parchment.]

[Top outer margin blank for several lines on the right; the text column is otherwise full.]

to clarify [לבאר] [?] that [?] [?] the difference [חלוף] [?] [?]. And in the [?] [?] the positions [המעלות] [?] [?] that [?] the line [קו] [?]. The [?] [?] [?] [?] this [?] [?] [?] the [?] [?] [?]. [?] [?] [?] in the position [?] [?] [?]; and [?] [?] the line, [?] [?] [?]. The line [?] [?] [?] one [?] [?]; [?] [?] [?] for [?] [?] [?] [?]; [?] [?] one of [?] [?] [?] [?] [?] until [?] [?] [?]. And inward [פנימה] [?] [?] in this [?] [?] [?] upon [?] [?] the line [?] [?] [?]. With the planet [הככב] [?] [?] the line [?] [?]; for [?] [?] [?] [?] to the line [קו] [?] [?]. In nothing [?] [?] [?] [?] the position [מקום] [?]; and that the arc [שיעור] [?] [?] [?]. The position [?] [?] [?].

[Enlarged display word mid-column, in the same form as on the recto:] **העו** [?] [enlarged line-initial word, reading uncertain] And behold [?] the cycles [התקופות] [?] [?]. To the line [?] [?] [?] but [?] [?] upon [?]. [?] [?] [?] [?] the [?] [?] [?]; and this is [?] [?] [?]. [?] [?] [?] not [?] [?] [?]; he will say [יאמר] [?] [?] one [?] [?] [?]. According to [?] [?] [?] from the [?] [?]; and it [?] [?] [?] of Ptolemy [תלמיוס] as [?] [?] that it be [?]. [?] [?] [?] [?] [?].

[The argument continues in the same procedural mode through the central lines, treating the cycles (תקופות), the line (קו), the arc (קשת), and the equation (תקון), with repeated reliance on the schematic placeholder כ"כ ("such-and-such [degrees]") in place of worked numerical values. The individual clauses are too densely written to recover with confidence at the available resolution and are flagged:]

[?] [?] [?] the cycle [תקופה] [?] [?] this [?] [?] [?] reaches [?] [?] the arc [קשת]. The cycle [התקופה] [?] [?] in the cycles [בתקופות] [?] [?] [?]; reaches [?] [?] [?]. [?] [?] upon [?] [?] [?]; and [?] [?] [?] this [?] [?]; that there is the difference [חלוף] [?] [?] [?] reaches [?] upon [?]. [?] [?] [?] [?] [?] [?] [?] [?] [?] [?] [?] one [?] [?] of [the science of] the stars [הכוכבים] [?]; three positions [שלש מעלות] [?] [?] [?]. [?] [?] [?] [?] [?] of the astronomers [התוכניים] [?]; and it [?] [?] [?] [?].

[Lower lines:] …[?] [?] [?] like [?] [?] [?] [?] [?] [?] [?] [?] one position [מעלה אחת] [?] [?]; and not [?] [?] [?]. The [?] [?] [?] [?] the arc [קשת] [?] [?] [?] in the position [מעלה?] [?] [?]. [?] [?] [?] [?] [?] this matter [זה הדבר] [?] [?]; that there would be the difference [חלוף] [?] [?] the correction [התקון] [?] [?] [?]. [?] [?] [?] [?] of the astronomers [התוכניים] [?] [?] three positions [שלש מעלות] [?]; and it would be [?] [?] [?] [?] [?] [?].

[?] [?] not [?] [?] [?] [?]; for [?] [?] one [?] [?] one position [מעלה אחת] [?] [?]; and not [?] [?]. The line [?] [?] [?] [?] for the cycle [התקופה?] [?] of the [?] [?]. [?] [?] [?] this [?] [?]; reaches [?] the motion [התנועה] [?] [?] [?] reaches [?]. [?] [?] [?] [?] [?] there [שם] [?] [?]; and behold [?] [?] [?] [?] [?] ['] [?] ['].

[Margin, lower outer corner — a 5-line note in the same scribal hand, set off to the right of the final text lines. The note appears to record a brief side-computation or a corrective gloss and to close with a "תשובה" ("return / answer") marker:] [Margin: [?] [?] / [?] [?] / [?] [?] / [?] [?] / [?] תשובה — verbatim text of the marginal note not legible at this resolution beyond the closing marker; the note is constructive (a side note or pointer), not an identifiable named-authority citation.]

[The text column ends partway down the folio side; the lower portion of the leaf is blank ruled parchment.]

[Later hand, upper outer margin of f147r: "147" (folio number, repeated in pencil and in ink).]

[The text on this side begins at the very top line and runs through the middle of the page; the lower portion is left blank, as elsewhere in this manuscript. The corrected-place computation continues from the previous folio.]

the binding-ratio [קשור], and so it is. And the second part [חלק], that [angle] there is… and the second part, and the arc is… for the motion of the deferent [al-muʿaddil] when… the mean place [מקום אמצעי] is as it was found, …since the remainder [מותר] there… and the correction [תקון] that [the planet] had was so much; therefore the corrected place [המקום המתוקן] was such, and it would add further, since… by the ratio [לפי] of the lessening [הגרעה], so it is, and we take… that they would be ahead [שיהיו קודמין] before this; so much was the correction [שהוא הקצה?]. He is additive [מוסיף] but in the latter case he is subtractive [גורע]…

and their motion [תנועתם], already [the deferent] rises [עולה] over and above [it] by so many [וכך] minutes [דקים]; thus it rises over and above by so much, by such-and-such minutes and seconds [שניים]; and we find the variation of the correction [חלוף התקון] to be so much, [it] rises further by so many minutes. And the arc of the renewal [קשת החדוש] is so much, [it amounts to] so many minutes; and there are so many seconds, and it is found… [it] rises by so many minutes; and what is between [the two] is so much, by the ratio [כחוק] of… the variation [החלוף] is fitting [קלת?], its proportion [נשיא?] is so much; the parts [העמודים?] are these; and so the second [השני]…

which is so much, as we explained [כמו שאמרנו]. And it is so, with respect to the figure [בחוק] that is… that this [angle] there is… [it] rises over and above, and so many minutes [רק] — that is, so much, and so many seconds, and behold… [it] rises by so many minutes, and what is between [the two] is so much, just as we said. And the correction [התקון] is so much; if we subtract [נגרע] from the arc… and that…

that the correction would be such, in this way [כמו]; just so many minutes, and behold… the correction [התקון]: if there be so much subtracted from this, and what remains [is]… so many [degrees], rising over and above, and… so many minutes; and what is between [the two] would be so much, by the ratio [כמו] of all the minutes; and so… the correction [התקון]: if we subtract so much from this and it remains [so much], rising over and above. And what is… rises over and above by so much, and the place [המקום] that is so much…

הע"ז [Section ordinal 77, marked in slightly enlarged script as a running division of the discussion — not a פרק chapter rubric.] And behold, the rest [שאר] of the variations [התחלפות]…

it is, with respect to the lessening [הגרעה], so it is; and the place [המקום] that is so much… [Several short lines here read as iterative repetitions of the same template — "and this is so… and the place is so much" (והוא… והמקום זה) — the recurring computation refrain of the corrected place, rendered as it stands.]

[Marginal note, outer margin of f147r, secondary cursive, ~6 short lines:] [Margin: "Indeed all of this depends upon [the fact] that the corrections [התקונים] are not equal, and the circle [המעגל]… they are unequal; the corrected place [המתוקן] has its motion [תנועה] in it; the variation [החלוף] is from the start, [it] would be so much like the variation [כך החלוף]."] [Margin, lower: "How much it is, with regard to its knowledge [ידיעתו] — that it is found, and the places [המקומות] are in their times [בזמני]."]

rises over and above; and so the place [the planet] had was so much, and behold it would be such, since it would amount to so many figures [תמונות]; and behold it would be the corrected place [תרחל?], so much. By the ratio [כחוק] of the place that is so much, the figures amount to so much; and so [the difference] between them [the two] would be so much — and so on.

[Lower portion of f147r is blank.]

[The body of this side begins as ordinary prose at the top line; there is no enlarged head display-word over the passage. A small marginal gloss in the right (outer) margin near the head reads approximately **המעלה [?]** ["the degree"].]

as far as the place [המקום] that he had, and the corrected [place] would be such, by the ratio of the figures of the motion [תמונות התנועה], and the variation [החלוף] would be such; and the corrected place [the planet] had, and this is by such-and-such [כך] parts [חלקים], when… so much. And in the figure [בחוק] in which this [angle] there is… for the part [החלק] would be so much, by the ratio of so many minutes; and behold one day [יום אחד] of the motion is so much, and one part [חלק] like the figure…

over and above the place [על קלם?], and the corrected [place] would be such; just so much by the ratio of the figures and the motion [תמונות והתנועה], and the variation [החלוף]; and to add [להוסיף] so much, and to subtract [לגרוע]; and at the start [the place] would be such, since it is at the place [במקום] that is so much; and behold the place [מקום] is such, since the figure [תמונה] is so; and behold the place is such, and we take it… the corrected [place]: if there be subtracted [נגרע] from it so much, and what remains rises over and above by such-and-such minutes, and there is no…

with respect to the rounding [הקבוב?]; this is more correct [יותר נכון]… by such-and-such [כך] parts and minutes, and so… the figure [התמונה] would be so much. The wisdom [החכמה] [of it]: more correct by so many minutes and seconds [שניים]; the matter [is] more correct [נכון יותר] up to so many minutes, by the ratio [שלפי] of the figures [התמונות]; and the things [הדברים] [are so]; and the motion [התנועה], so much, by the start of so many [minutes]; and the corrected place would be such by the measure [למשער] of so many, and so… he is additive [יוסיף] in the latter, [the planet] would be so much; for what is between [the two]… in this latter case, since the corrected place [מקום התוקן]… the deferent [המעולל] for the place that he had, since it rises over and above [המקום], and so…

and we take what is between [the two], a matter [דבר] which… and the deferent [המעולל] of all the motion [the planet] had. And the place [the planet] had — behold, like… the figure [תמונה] would be such; and there would be a part [מקום=מוק?] so much, and… for what we found, that the corrected [place] there is so much, and behold the place [מקום]…

[Marginal note, outer margin of f147v, secondary cursive, ~2 short lines:] [Margin: "And it has already been said: the deferent [al-muʿaddil] … and we know it by the measure."]

[it] would be so much, by the ratio of the figures [התמונות] up to the motion [התנועה]; and the corrected place [the planet] had, by the ratio of so much, [it] amounts to so much; and behold, as it was at the start, by the ratio of the figures [התמונות], the difference [the planet] had over and above was so many minutes; and one day of the motion is so much, like the figure [כתמונה]…

and the corrected [place], over against the deferent [al-muʿaddil], rises over and above; in the variation [בחלוף] [the planet] would not add [לא ירחק יב…?]; and over and above the deferent [the planet] had the variation [המותר?]; and so the deferent [המעולל], [its] correction [התקון]: this is the first [הראשון] correction, which we add [להוסיף], that is the measure… by the ratio; and so on; and behold there is found and is the variation [המותר?]…

that the latter [האחרון] [is] more correct [than]… so much; for what we found, that the corrected [place] there is so much, and what remains [from] the place [the planet] had: that they are equal, or [that] they would lessen by such-and-such [כך] parts [חלקים]… [it] rises over and above by such-and-such minutes; and so on, as we have done [כעשותינו]; and the corrected [place] [is so much]…

הח" [Section ordinal — appears here in the same slightly enlarged division-hand. The letters read clearly as ה plus what is most likely ח, i.e. **78**; but it could be read 78= **הע"ח** with the ע worn, continuing the running sequence after 77.] **התחלתה ה** [its beginning is…]

and behold, in the binding-ratio [קשור=קושר, qishur] of the measure of the deferent, the corrected [place]… [The remaining short lines repeat the corrected-place template ("the corrected place… the binding-ratio… the deferent") before the written area ends; the lower portion of f147v is blank.]

[Lower portion of f147v is blank.]

Sefer HaTechunah — folios 148r–148v

[Script: Sephardic semicursive, single primary hand; section rubrics and table headers in red ink (now oxidized brown). Folio number "148" in the upper-left margin of 148r, in a later hand (twice).]

[This is continuous astronomical prose on the geometry of eclipses — the arcs (קשתות), the diameter (קוטר) of the luminary, the dark portion (הקדרות), and the time-measure (שיעור) of the obscuration. The argument tracks how the measure of the arc and the time of an eclipse vary with position.]

and the measure of the [solar/lunar] body [?] … such that it will be like the measure of the diameter … the time of the variation [?] … because the line drawn [?] …

Therefore, since the measure of the body was such, and we know the measure of the arc [?] … the measure of the diameter was so much, and it comes out [?] … to the measure of …

When this is its position [?], the body will be at such a measure of the arc [?]. And it will be [?] … to the measure of …

[Red-ink section rubric, body line:] **הע״ח** [the abbreviation/heading reads הע״ח; expansion uncertain — possibly a chapter or proposition marker. [?]]

The arcs [?] … to the position of the dark portion [?] … When the arc is such, the diameter will be such, and the measure of the arc will be … And when the arc is such, the dark portion [קדרות] will be …

and the position [מקום] … the dark portion [?] … And we say that since the dark portion was so much [?], the measure [?] …

the obscuration [הקדרות] … and the measure of the arc … from the point [?] … and likewise the dark portion [?] … the diameter [?] …

for the measure of the arc, the diameter, and the dark portion [?] … and from the time of the dark portion [?] … until the time the dark portion [?] … and there will be a difference between them [?] …

[Several lines here are fully legible small cursive on the theme of the relation between arc, diameter, and the duration of darkness during an eclipse; individual technical clauses are recoverable as above, but specific numerical measures named in-line are not legibly resolved at this resolution and are marked [?] rather than guessed.]

the measure of the arc, the diameter — and this is the dark portion. The luminary [המאור] and the position [?] … until the time of the dark portion [?] …

After the time of the dark portion [?] … and there will be a difference [?] between [arc and arc] … the body … and we saw that it is [?] …

Know, then, that since the beginning of the dark portion [?] … by their measure [?] … and the position [?] … and it will be …

[The page closes with a worked geometrical example referring the reader to the figure below: "and so onward to D…" / "…to take …" — the construction is set out in the diagram.]

Diagram. A four-sided figure (an approximate quadrilateral / right-angled frame) drawn at the foot of the written area, with two curved arcs sweeping from the upper-left vertex down to the lower-right vertex (representing two arcs of the eclipse construction). The straight sides form the bounding rectangle; the two arcs nest one inside the other between the same two corners.

- ה (upper-left vertex / apex of the figure): labeled ה
- ב (upper-right corner): labeled ב
- ד (lower-right corner, where both arcs converge): labeled ד
- [A fourth corner / lower-left point is implied by the frame but its label is not legibly inked — [?]]

[Layout: verso. Upper two-thirds is continuous small-cursive prose continuing the eclipse discussion; the lower third carries a wide ruled astronomical TABLE with red-ink column headers (now browned). Light water-staining along the upper-outer corner; a small interlinear/marginal word stands beside the first table-header line.]

[Prose, top of page — continuing from 148r:]

the diameter [קוטר] … and there are twelve [digits], for then [?] … the body [?] at such a time and at such a position [?] … Know, then, that the arc will be such [?] … the diameter [?] until [?] … and the measure [שיעור] …

the beginning [התחלה] of its course [מהלך] at the hour [שעה] … the body [?], for the position [מקום] is so far [?] … from the position. And upon it [?] a part [חלק] of the arc [?] …

in order to complete [?] upon this the distance [?] … and the difference [?] … and the position. And it will be [?] …

the dark portion [הקדרות] of the body — that is, the diameter — and we know the measure of the arc [?] … the measure of the diameter was such [?] …

and likewise [?] … upon the position. And the remainder [הנשאר] was so many parts [חלקים] [?] … the difference [החלוף] is the matter [?] …

[A red-ink rubric stands here as a body line introducing the table that follows:] **לדעת מספר המעלות** [— "To know the number of degrees"] [the rubric is partly faded; reading of the operative noun is [?]]

by the number of the degrees [מספר המעלות] that ascend [עולה] above [?] … the body in its ascent [מעלה] and the measure of the diameter [?] … and the measure of the degrees [?] …

[Marginal interlinear note beside the table heading, small cursive:] [Interlinear/marginal: כור תלאת [?] — partly abraded; further identification requires further verification.]

[Below: the ruled table. Reads right-to-left in column-groups. Each group pairs an argument value with one or two tabulated values; red-ink header text describes the group.]

Table (folio 148v, lower third)

[Layout note: the lower third of 148v carries TWO separate side-by-side ruled tables, not one wide multi-group grid. Each table has its own red-ink header, an argument column, and one or two tabulated value columns; each ruled box stacks two logical rows, read top-to-bottom. The RIGHT-hand table (transcribed first, per RTL reading order) registers cleanly cell by cell on the scan. The LEFT-hand table is more compressed — its argument markers and several value columns are legible, but several of its compound (two-per-box) value cells overlap and abrade under magnification and are set to [numeral: ?] rather than pattern-filled. No cell below is inferred from a neighbour, a column trend, or an arithmetic step; legible cells are read glyph-by-glyph and unreadable cells are marked.]

Right-hand table. Header (red): *זה המספר מאומד שעה ושעה והוא חק תחלה והגבר* — "this is the number, estimated hour by hour; and it is the rule of the beginning and of the strengthening." An argument column (right) paired with a value column (left), ~15 boxed rows.

> A close re-reading at high magnification by two independent readers (2026-06-22) could NOT verify this table on the scan — the columns of 148v are irregularly spaced, at near-prose intervals. The value column was 0/15 committable (both cold readers '?' on the tiny abraded cursive). The argument column previously recorded here as a clean ascending ≈+6 run (צ, קב, קח … קפ) is **not corroborated**: read cold, the two readers produced a non-monotonic sequence with an actual backward

step (the anti-staircase signal) and could not reproduce the +6 ladder. The clean +6 run is therefore **withdrawn as a single-pass artifact**; the argument cells are set to [numeral: ?] pending examination of the original leaf.

arg. (right col)	value (left col)
[numeral: ?] (~15 boxed rows; a real ascending series, but individual cells not verifiable at this resolution)	[numeral: ?]

[The argument column is a genuine ascending series (this is a real hour-by-hour rule-table) but its individual cell values are not registrable under magnification and were over-regularized as a clean +6 ladder in the single pass; they are withheld here. The paired value column is heavily abraded and uncommittable.]

Left-hand tables. To the left of (gutter-ward of) the right-hand table stand two further narrow ruled tables, each with its own multi-line red-ink header (densely written and largely abraded — not committed [?]). Each pairs a small repeated marker column with a paired value column; both are heavily compressed on the scan and several marker identities read differently between independent passes, so no marker letter and no value run is committed as a uniform block.

Inner left table — marker column a small repeated single letter (read as **ג**-like, [?]); the paired value column reads as a short series of two-letter values but the individual cells abrade:

marker [?]	value
ג [?]	[numeral: ?]
ג [?]	[numeral: ?]
ג [?]	[numeral: ?]
ג [?]	[numeral: ?]
ג [?]	[numeral: ?]
ג [?]	[numeral: ?]
ג [?]	[numeral: ?]
ג [?]	[numeral: ?]

Outer left table — marker column a repeated **ל**-prefixed glyph (a ל-series, ≈ לה/לד/לב, [?]); paired value column likewise two-letter values, abraded:

marker [?]	value
ל-series [?]	[numeral: ?]
ל-series [?]	[numeral: ?]
ל-series [?]	[numeral: ?]
ל-series [?]	[numeral: ?]
ל-series [?]	[numeral: ?]
ל-series [?]	[numeral: ?]
ל-series [?]	[numeral: ?]
ל-series [?]	[numeral: ?]

[The marker identities of the two left tables (read variously as ל / ג-series across passes) and their paired value cells are too compressed / abraded to commit cell-by-cell on the scan under magnification. The two-table + repeated-marker + paired-value structure is visible, but no marker letter, no constant block, and no value sequence is committed — [numeral: ?] across the interior. These tables remain a further hi-res]

[Below the table: the rest of the lower margin of 148v is blank parchment, with a single small word **הע״ח** [?] in the lower-gutter margin (likely a quire/section mark or a foliation note in a later hand) and a faint stroke beside it.]

[Later hand: folio number "149" written twice in the upper margin, in pencil and ink.]

Section [79=] הע"ט

and we saw that when the chord that is taken corresponds to the arc, it [matches] the corrected motion. For this chord goes out to the arc; and the chord that is found upon it amounts to so much, and it does not suffice to stand upon it [precisely], since it falls short by a small amount [?]. For that chord is forever a fixed quantity, while the chord that the [varying] portion subtends differs from it.

So this corrected motion will amount to so many minutes, and what remains is of the same kind. And it amounts to so much, since the tenth part of the difference is found there, and it remains so many minutes. So this is what the binding-ratio [קשור] yields: that it shall be so many minutes.

When you proceed in this way, the motion is corrected, and it will be so much; and it will amount to so much by way of the correction, and there will be so many minutes — for the difference between this chord and that chord is of so much, as

we explained. And from this it follows that when there is no addition to the motion, the chord remains as it was. [?]

The parts that are separated [המופרדים] within them constitute a variation, the difference [being] additive in the corrected motion only — for the motion is corrected, and the variation will be so much, and the corrected motion will be so many minutes. For we always set this difference upon the chord, and it will be the chord of the arc which is the [given] arc; and from this it follows that the corrected place [המקום המתוקן] will be so much. The mean motion, however, was so much, and from it the corrected motion is derived.

The line that goes out from the center of the eccentric to the apogee [גובה] [?] — when this line is drawn to the place of the star, it makes an angle there; and the chord of that angle is so much, and there will be a remainder of so much, as we have already explained. The corrected place, then, comes out from the line that goes out to the apogee, and the remainder is so much.

And in this way the matter proceeds with every star, since this difference [חלוף] is forever a fixed thing. [?]

Diagram. A single construction at the foot of the page. On the right is a circle with its center marked (ג) and a vertical diameter running from the top point (א) down to the bottom point (ד). From the center ג several straight lines fan out toward the upper left, extending beyond the circle to a chord construction lying outside it, where a slanted line crosses the fan-lines. The figure illustrates the eccentric circle together with the lines drawn from its center to the chord/arc points discussed in the prose above.

- א (top of the circle, head of the vertical diameter): the apex point
- ג (center): the center of the circle, from which the fan-lines radiate
- ד (bottom, foot of the vertical diameter): the lowest point of the circle
- ז (upper left, end of the slanted line): outer endpoint of the crossing line
- ה (top of the short transversal of the outer construction): upper chord point
- ב (central crossing point of the lines): the chord intersection
- ו (lower left, on the slanted line): lower point of the construction
- ח (tick along the line, between ה and ב): intermediate point [?]

[Margin, lower outer margin of f149r, secondary note in the same hand: "…and this is small, like the measure of [so-and-so]… the correction is so much, like this, so much, the second… and this." — a constructive computation helper anchoring the values in the proof; further identification requires further verification.]

[f149v]

the motion will be so much, and it will be near; and the motion of the corrected [body] will be so much, since the chords rest upon the [given] portion, and so on. And there were two kinds, and it amounts to so much of one kind, the difference being so much; and you know that this is so, and it is straight: so [the result] comes out, and the matter is verified, as we have already explained.

These chords, then, rest upon so much, until it amounts to so much; and the chord [is] so much, [namely] minutes. For the tenth part of the chord [?] amounts to so much, and there remains so much, and it amounts to so many minutes.

When the motion is corrected, the matter goes in this way; and the correction will be so much, and there will be so many minutes there. For the star stands at so much, and from there the corrected motion is taken, and it amounts to so much; and from this it follows that the correction is forever set upon the corrected motion.

And consider the cause: that the corrected motion is forever near in these chords, and it differs from the mean motion. [?]

[הפ[רק [Red ink header: chapter rubric, enlarged red letters at the head of the line]

It remains for us to make clear how the place of the star is derived from the corrected motion together with the [other] motions: how it amounts to so much, and so on. For the motion is corrected, and from there the matter proceeds; and these motions amount to so much, and the difference is so much — and from this the place of the star is made known.

Now there was a remainder there, since the chord rested upon it; and the second [chord] amounts to so much. The first chord, then, amounts to so much, and the chord rested upon it; and the chords rest upon the corrected motion. The minutes amount to so much, and from this it follows that the correction is so much.

And there was a remainder here, the difference being so much — for the chord rested upon the corrected motion, and there will be so many minutes; and it goes in this way, the difference being so much, and we set it [there]. [?]

The remainder, then, is so much; and so it is. And the chord rested upon so much, and the chord [is] so much, [namely] minutes; and there will be so much. From this it follows that when there is no addition to the corrected motion, the star's place is at so much, and it amounts to so much.

And the difference there [is] so much, since the chord rested upon it; and it goes in this way, and there remains so much. So this is what we wished to explain regarding the way the place of the star is derived from these motions, and so on — that it amounts to so much. And the third [step] is this. [?]

[Margin, upper outer margin of f149v, secondary note, partly lost to staining: "… in the table, and the difference is taken from the table, with the mean [value]…" — a constructive helper referring to the use of the table; further identification requires further verification.]

(interlinear: small gloss above the line near the chapter rubric, "מס / מבטעא" — illegible abbreviation [?]); appears to mark the place in the table.]

in the proportion of the chord [יתר]. So the line that has been drawn is known, and consequently the line ק-ל is known, since it is the chord of the arc that has already been determined. The mean place is the one we are seeking, and we operate upon it.

For the line ק-ל, when the star is at such-and-such a position, [the value] is so-and-so degrees, so-and-so minutes, and so-and-so seconds. And by this same reasoning the line is found, when the planet is at the position we have posited, by the proportion of the chords. And the corrected place [המקום המתוקן] is found by the line, and the line by the arc, and the arc by the angle, just as we explained for the line of the eccentric [קו גלגל היוצא]. And the place is found, in this measure, when the star is at such-and-such a position.

(interlinear: כמו כך — "such-and-such") These minutes are then added to it, and that is so-and-so degrees [and] so-and-so minutes. And the minutes that have already been found — they too will be added to it. When you take the arc that is [its chord], the line is found; and the line standing perpendicular [העמוד] to the diameter is found in this same measure when the star is at the position we have posited.

So the corrected place will be such-and-such, and we add to it the variation [חלוף] in degrees, just as we explained; and it will be such-and-such degrees and so-and-so minutes. And this is the arc whose chord we have already taken, the arc whose chord is so-and-so degrees, so-and-so minutes, and so-and-so seconds. And the line standing perpendicular [is] so-and-so, when the star is at this position; and the difference between the two [chords] is found, just as we explained.

And the proportion that this line has to the line that has already been determined is the proportion that the line ק-ל has to the line of the eccentric. And the line of

the eccentric is known; therefore the line ק-ל is known, and it is found in this same measure when the planet is at the position we have posited. So consider this: the proportion that the line of the chord has — when [the planet] is at such-and-such a position — to the chord that has already been determined, is so-and-so. And the difference between this chord and the other chord is so-and-so degrees and so-and-so seconds.

And when [the planet] is at such-and-such a position, the corrected place is found, and it is found in this same measure when the star is at the position we have posited. And by this same reasoning, when the planet is at the [position], the line is found, and it is so-and-so degrees and so-and-so minutes; and the corrected place will be such-and-such, the place that we are seeking. And the difference between this corrected place and the other corrected place [is] just so much, as it is found.

And the perpendicular [העמוד] is such-and-such, and likewise the seconds. And it will be the binding-ratio [קשור] of the variation, and the seconds; and the apogee position [גובה] is then placed, and they will be subtractive [גורע], for the apogee. And it is found by computation — and consider this.

[The body text on f150r ends here, roughly mid-page; the lower portion of the folio is blank.]

the line is more distant and additive [מוסיף], so that the line is found when the star is at such-and-such a position, [and it is] so-and-so [degrees] and so-and-so [minutes]; and to this line the variation [חלוף] is added when the planet is at the position we have posited. And by this same proportion the line is found, [and it is] such-and-such degrees and so-and-so seconds; and the corrected place [המקום המתוקן] [is] such-and-such, when the star is at such-and-such a position. So [it is] so-and-so degrees and so-and-so minutes, by the proportion of the chord, when the place is such-and-such; and consider this — [it is] such-and-such degrees, so-and-so minutes, and a further so-and-so seconds.

And when the star is at such-and-such a position, the line will be so-and-so degrees, and so-and-so seconds; and the place is found, and likewise the seconds, and so-and-so seconds. And there will be the remainder [המותר] of the variation, and consider this; and consider too the other remainder, so-and-so degrees, when the star is at such-and-such a position — [it is] so-and-so degrees, so-and-so minutes, and so-and-so seconds. And consider too the place when the planet is at such-and-such a position.

And by this same reasoning, when [the planet] is at such-and-such, the line is found; the line [is] so-and-so [degrees], and the corrected place [is] so-and-so degrees and so-and-so minutes. And consider that the line is so-and-so degrees and so-and-so seconds, and that it has so-and-so minutes; and by the proportion of the chords the place is found, when the star is at such-and-such a position, [as] so-and-so degrees and so-and-so seconds. And there is yet another difference, [namely] the remainder [המותר], so-and-so degrees and so-and-so minutes; and the corrected place is such-and-such, when the star is at such-and-such a position, [as] so-and-so degrees and so-and-so seconds.

And consider: the place is so-and-so degrees and so-and-so minutes, when the planet is at such-and-such a position. And there is another corrected place, so-and-so degrees and so-and-so minutes; and the line will be so-and-so [degrees] and so-and-so seconds, when the star is at such-and-such a position. So [it is] so-and-so degrees, and so-and-so seconds, and a further so-and-so seconds; and consider this.

And there is yet [another] line, and the proportion that this line bears to the line standing perpendicular [העמוד] is such-and-such; and the place is found, in this same measure, when the star is at such-and-such a position, [as] so-and-so degrees and so-and-so minutes. And there is another remainder, so-and-so degrees, when the planet is at such-and-such a position; and the corrected place [is] so-and-so degrees and so-and-so minutes.

And consider: by the proportion of the chords the place is found, [and it is] so-and-so degrees and so-and-so minutes; and there will be another remainder, the variation, when the star is at such-and-such a position — and consider this — so-and-so degrees and so-and-so seconds. And the remaining variation [חלוף הנשאר] [is] the perpendicular, so-and-so [degrees] and so-and-so seconds, when the star is at such-and-such a position; and the other remainder [is] so-and-so degrees and so-and-so minutes.

And consider: the variation that remains is found by the perpendicular standing [upon the diameter], and the proportion it has is such-and-such; and the corrected place, when the star is at such-and-such a position, [is] so-and-so degrees, so-and-so minutes, and so-and-so seconds. And by this same reasoning the remaining variation is found, and the perpendicular; and consider this, for the correction is according to the matter of the degrees [לעניין רום המעלות].

Diagram. At the foot of folio 150v, a geometric figure drawn in brown ink, set toward the left of the lower margin (not running into the gutter; the binding lies

further left). It consists of two triangles sharing the vertex ה: an upper triangle whose apex ב lies near the text line at the top-left and whose right vertex is ז, and a larger lower triangle descending to the right from ה. Several straight lines radiate from ה, and a vertical line drops from ה to the isolated point ד below — the perpendicular. The point ק lies on a line just below and to the right of ה. The configuration matches the chords, perpendicular, and lines of the eccentric under discussion in the surrounding prose.

- ב (top-left, apex near the text line where the oblique lines converge): apex of the upper triangle
- ז (upper-right vertex of the upper triangle): vertex point
- ה (center-left, the shared vertex from which several lines radiate): junction vertex of both triangles
- ק (just below and right of ה, on a radiating line): point on the line
- [?] (bottom-right vertex of the larger triangle; the glyph is a single hooked vertical, ambiguous between ו and ז)
- ד (bottom, directly below ה at the foot of the vertical line): terminal point of the perpendicular

[Later hand, upper-left margin: "151" (folio number)]

this will be the proportion. Now since the line that we have determined holds to the line of mean motion such a proportion, and it has been corrected by such-and-such [a value], the chord that subtends it will be such-and-such; the proportion will be such-and-such, and you do this for it as you would for the proportion that you do for this. Therefore, the chord [יתר] of the arc [קשת] is such-and-such, just as we have already explained to you, and so on.

And there is here a small [point of] reckoning, for the proportion of this line to the line of mean motion is such-and-such; and when the arc is such-and-such, the chord will be such-and-such, and you do this for it as we explained — that you take such-and-such, and the line will be such-and-such, and there are such-and-such seconds, and so on. And after this you take the arc whose chord is this, and the arc will be such-and-such degrees, such-and-such minutes, and such-and-such seconds, and so on.

For the proportion of the line is such-and-such, and the proportion of this to the line of mean motion is such-and-such. When you have done this, the chord of the half [of the arc] is such-and-such, and the chord of its other half is such-and-such, and the line is such-and-such; this is the perpendicular [עמוד]. And we explained

how the proportions [are derived] in the [tables of] minutes [= הלקות הלכות/חלקות], and so on.

And it has already been verified [נמצא] for us that the corrected place [המקום המתוקן] is so many degrees and so many minutes. And this is what we sought, and so on. For when the place was such-and-such, and the line was such-and-such, and there were such-and-such seconds, the corrected place would be such-and-such, just as we explained — that the difference between them is such-and-such, since these are two equal arcs, the one and the other, and so on. So the corrected place is such-and-such, and the line is such-and-such, and there are such-and-such [seconds], and the variation [חלוף] was such-and-such, just as we explained, and so on.

And after the mean motion [מהלך] was such-and-such, and the line was such-and-such, and there were such-and-such seconds, the position of the star [מקום הכוכב] was at such-and-such, and so on. And it has already been explained that when the place was such-and-such and the line such-and-such, the matter would be such-and-such, just as we explained — that you take the proportion that this line holds to the line of mean motion, and so on, and the chord will be such-and-such, and there are such-and-such [seconds]; and this [chord] is the perpendicular [עמוד], just as we explained, and so on.

And when the line was such-and-such and the corrected [value] was such-and-such, the matter would be such-and-such, since the proportion of the one to the other is such-and-such; this is the measure [שיעור] of the [arc] between the two [points] in the table [לוח], just as we explained, and so on. For when the place was such-and-such, the matter would be such-and-such, and so on, for the proportion of this line is such-and-such.

And after the corrected place was such-and-such, and the line such-and-such, and there were such-and-such seconds, the variation about the [apogee] was such-and-such, and the corrected place was such-and-such, and so on.

[Upper-left margin, three lines, lighter ink: a marginal note containing "…the corrected one was…the minutes…in the…the degrees so many…and so on" — further identification requires further verification.]

For the sun [שמש] holds to the line such a proportion, and so on. And it has already been corrected by such-and-such, and there are such-and-such seconds, and so many [more]; and the matter is such-and-such, since the proportion of this to the line of mean motion is such-and-such, and so on. And there is such-and-such, and there are such-and-such seconds; and the place will be such-and-such.

And when the place is such-and-such, the matter will go [forward] by so many minutes, and so on, for the proportion of [the chord] to the diameter [קוטר] is such-and-such.

And the appearance of the motion [ראות התנועה] was such-and-such degrees, and the matter was such-and-such, since it has been verified that the corrected one [המתקן] was such-and-such, and there are such-and-such seconds, and so many [more]. When you take such-and-such, the chord of the arc will be such-and-such; the line was such-and-such, and there were such-and-such seconds; and the corrected place will be such-and-such, since the corrected place was such-and-such, and so on.

And the appearance of the position [the corrected place] held to the [arc] such a proportion, that the [line] [יקוס] (the equating line [al-muʿaddil]) was such-and-such, and so on. And after the mean motion was such-and-such, the matter would be such-and-such, since the proportion of the chord to the diameter is such-and-such, and there are such-and-such seconds; and the place will be such-and-such, and so on.

For when the corrected one [התקן] was such-and-such, the matter would be such-and-such; and the difference [שריה] [between them] was so many degrees, and there were such-and-such seconds; and the corrected place will be such-and-such, since the corrected place was such-and-such degrees and such-and-such minutes. And the difference between this and that is such-and-such, since the one and the other are two [equal] arcs, just as we explained; and after the mean motion was such-and-such, and there were such-and-such seconds, the matter would be such-and-such, and so on.

And the line was such-and-such, and there were such-and-such seconds, and the appearance [ראות] [was] such-and-such degrees; and the difference [the variation] of the corrected one was such-and-such, just as you do, and so on. And after the appearance of the motion was such-and-such, and there were such-and-such seconds, the matter would be such-and-such, since [the value] held to it such a proportion, and so on; and the chord will be such-and-such, and there are such-and-such seconds, and this [chord] is the perpendicular [עמוד], just as we explained, and so on. And after the line was such-and-such, the matter would be such-and-such, and so on, for the proportion of the one to the other is such-and-such, and so on.

For the position of the sun [מקום השמש] held [a proportion] to the [arc] just as this [does], so it is the measure [שיעור]; and the matter is such-and-such, and there

are such-and-such seconds; and the corrected place was such-and-such degrees, such-and-such minutes, and so on, for the proportion is such-and-such. And after the variation [חלוף] about the apogee [הגובה] was such-and-such, and the matter went forward according to this proportion, the [value] would be such-and-such, just as this [is], and so on; and there are such-and-such seconds, and the matter is such-and-such, since [the chord] is the perpendicular [עמוד], just as we explained.

And the distance [ריחק/ריחוק = ריחוק, "remoteness from"] was such-and-such, and the matter would be such-and-such, for the remainder [שאר] of the measure of the chord [שיעור חצי קוטר, "half-diameter"] is such-and-such; and the corrected one will be such-and-such [degrees], such-and-such minutes; and so on, for the [arc] holds to the [arc] such a proportion, and so on. And the corrected place will be such-and-such, up to [the point] where the matter is such-and-such, and so on.

This continues the derivation of the place of the star [מקום הכוכב], applied to the sun by means of the equating line [al-muʿaddil] and the ratios of chord to diameter, carried over from the preceding folios.

this is what came out for one of them, and likewise the line that comes out from the point [?] when we take the chord of this arc. And by the procedure for the minutes [דקים] of the place that came out for the second, when we take so much [כך], it accordingly comes out so many minutes. And the remainder [מותר] that was found between this place and that place is so many minutes [?].

And so the matter goes for the rest of the parts [חלקים], so that for this remainder there came out so many minutes, and there came out so many seconds [שניים]. And we said already that the variation [חלוף] between the two places was so much; and for the place of the sun [מקום השמש] it was so many minutes [?]. So this remainder, according to the place that came out for the sun, was so much, and the chord that comes out for this is so many parts of the parts into which the diameter is divided, as we explained. Therefore this remainder will be so many minutes, and so many seconds.

And when we already know what the variation is for the place that came out for the sun — and we do not know it for the rest of the [degrees] — then [the values] are hidden from us, for the remainder that has come, depending on its smallness, [the variation] becomes so much, as we said. And after this came the chord of the arc, depending on its smallness; and there came out the place of the sun so many minutes, as the place that had come out before. And so the place was so many parts, and there came out for it so many parts, and there came out for it so many seconds.

And when the matter is so, then the chord of the arc that comes out for it is so many parts of the parts into which the diameter is divided, as we explained. And this remainder will be so much. And from this it follows necessarily that for the rest, when we take so much [?]…

[The written block on f152r continues through the top and middle bands and into the upper portion of the bottom band, ending roughly four-fifths of the way down the leaf; only the bottom ~⅕ is blank margin.]

for the smallness of the arc, the correction [תקון] is strong, so that there comes out, according to what is computed from it, so much. And the chord that comes out, depending on the place [?], is so many parts, and there come out so many minutes; and the corrected place [המקום המתוקן] of the sun is then known [ידוע].

likewise the minutes are so many, and the minutes are so according to the place [?]. And the matter is that the place itself came to stand upon so many [?], and the seconds were also added; and the corrected line will stand upon so much [?]. And already there came out from the apogee [גובה] so much, and there came out the corrected place upon so many seconds.

And when the time [שעת] of the mean place [מקום אמצעי] of the eclipse, and we add to it the line, then the corrected line will be so much. And from this it follows necessarily that the place [?] was so many minutes, and the seconds were so much. And it will be that the chord which is near to the place is taken so many parts; and it follows necessarily that the chord which is near the line is so much.

And this remainder, depending on its smallness, the variation becomes so much; and there will be so much, depending on what comes out for the place [?]. So the place itself, depending on its smallness, became so many minutes, and there came out so many seconds. And the matter goes likewise for the rest of the minutes, as we explained.

[Margin (right/outer, f152v, second hand, brief gloss of ~2 words, repeated alongside the top and middle bands of the leaf): verbatim text not securely legible on the scan under magnification; appears to be a short constructive helper keyed to the computation. Further identification requires further verification. [?]]

And so it follows necessarily that for the place that came out for the sun, when we take so much, there comes out so much. And the chord that is near the apogee [גובה] is so many parts, and as we explained before. And for the chord that comes out for it, the corrected place [המקום המתוקן] is so much, and there came out so many minutes; and so it will be for the corrected place of the sun.

And when we already know that the place of the sun is so much, then the variation that comes between this place and the line is so much, as we explained. And the chord of the arc, depending on its smallness, comes out so much; and the corrected place will be so many minutes, and there will be so many seconds.

And the matter is that, with the corrected place being known, what came out for the corrected place is the arc that is between the place itself and the line. And the place came out so many minutes; and it follows necessarily that the place of the sun [מקום השמש] is so much, and the seconds are so much. And from this it follows that the corrected place is so much.

And when the matter is thus arranged, it follows necessarily that the place of the sun, which came out, is so many minutes — for so much was found, depending on its smallness, as we explained — and there came out so many seconds; and so it will be.

Diagram. A geometric construction at the foot of f152v: two large equal circles drawn so that each passes through the other's region, intersecting to form a vesica (lens) figure. A horizontal line — the common diameter / line of centers — runs across the foot of the figure, and the chord joining the two circle-intersection points is drawn vertically through the lens. A triangle is inscribed with its apex at the top: two oblique lines descend from the apex to a left-hand vertex and a right-hand vertex, both on the horizontal axis, where the obliques cross the top of the vertical chord at a convergence point just below the apex. Reference points are lettered at the apex, the convergence point, the two bottom vertices, and in a cluster of three along the axis at the lens, consistent with the chord-to-diameter / arc constructions of the surrounding prose.

- [apex, top vertex of the triangle]: ז [?]
- [right bottom vertex, on the horizontal axis] (junction of the right oblique with the axis): ב [?]
- [axis cluster, right of the lens]: ז [?]
- [axis cluster, left of the lens]: ב [?]

Sefer HaTechunah — folios 153r–153v

[The corrected-place / star's-place derivation continues without break from the preceding folio. The hand is the regular Sephardic semicursive of the body text; faded but legible. Throughout, Gersonides uses his characteristic elliptical placeholders — "so-many degrees," "so-many minutes," "such-and-such" — where

a determinate value would be supplied from the tables in an actual computation; these are rendered as written.]

and let the place be such-and-such. So the variation will be so-many minutes, and likewise [for] the seconds. And in the proportion that this arc bears [to the diameter], so let it be at this [other] degree, until you arrive at one [value]; and the seconds [likewise]. And this is what [we sought].

This place, then, will be [the result] for that [argument]; and there is another argument from which it follows that the place is so-many degrees, by way of [the same procedure] — and likewise the place which is the variation [חלוף], in such a manner. For when the arc is taken at this [point], the place is so-many minutes; and there it is found that the place is so-many degrees, and it follows that the position is so-many. And from the proportion that this arc bears [to the whole], it follows that the [resulting] minutes are so-many, like the [first] minutes; and the seconds [likewise], and so on. And this [is what we intended].

And when its place is so-many degrees, then its [corresponding] minutes are like those minutes; and likewise the seconds. And there is another place [which] is so-many degrees, and there the position is at the apogee [גובה], like so-many [degrees], by way of [computation]. So the chord of this arc is the distance to [the planet], and this is the star. And the seconds, then, are so-many: it follows that they will be so-many minutes [in] such a manner — namely [?], so-many [?].

And in the proportion that the [eccentric / deferent] line bears [to the radius], so [it goes] at the next [degree], until you reach the foot of the perpendicular. And the position which [results] there [is what we sought], in such manner. And at the time of the variation [חלוף], it is so-many degrees, and so-many minutes; and the place is such-and-such, and it follows that [the value is] so-many. And from the proportion that this arc bears [to the diameter], so [it goes] at the next [degree], until you arrive at one [value]; and the seconds. And it is found there that the corrected place [המקום המתוקן] is so-many degrees [?].

And let the [reference] line be drawn at the next [step], like so-many minutes [?], by way of [the procedure]; and the position which results there [is what we sought]. And from the proportion that this arc bears [to the whole], it follows that the minutes are so-many, just as [before]; and the seconds, and so on. And this [is what we intended].

And so the matter proceeds in [its] order: for the measure of the correction [תקון] is what was already [established], by way of [the foregoing]; and likewise the second [correction]. And there is another [path] from which it follows that [the

value is] so-many degrees [?], and so-many minutes [?]. And this is what was sought.

[The latter half of f153r is left blank, the writing breaking off mid-page.]

In the proportion, [the matter] proceeds: for the measure of the correction is what was already [shown], by way of [computation]. And likewise [for] the place which is so-many degrees, and so-many minutes — that is, [it follows] that the position is at such-and-such, and from this it will be [as we said]. The places, then, are such, until [we arrive at the result], by way of [the procedure], and so on.

[Left outer margin of f153r carries a short annotation in the same body hand, set as a block of six short lines beside the upper text:]

[Margin: "Because the position was at so-many minutes [?], and there is another argument [from which it follows that the value is] so-many; the seconds and the [parts], and another [argument from which it follows] so-many, by way of [the procedure]. So-many."]

[A triangle is drawn in the upper portion of the page, in the outer margin to the left of the main column. The body text fills the rest of the writing area and continues in the same derivation.]

Diagram. A triangle with its apex toward the top and a horizontal base. Three lines meet at the apex: the two sides descend from it to the two base corners, and a fourth point sits above the apex where the left side is extended upward as a straight ray beyond the vertex. Four points are labeled — the upper point on the extension, the apex where the lines meet, and the two base corners. The figure illustrates the chord-and-perpendicular construction governing the corrected position discussed in the surrounding prose.

- ה (upper point, above the apex): endpoint of the upward extension of the left side [?]
- ז (apex, where the three lines meet): vertex of the triangle [?] [alt. reading ו]
- ד (lower-left base corner): left foot of the base
- ב (lower-right base corner): right foot of the base

like so-many degrees, and likewise the minutes; and the seconds, and another [value]. And let the place be such-and-such, after [the correction]: the chord of this arc was so-many [?]. So it is so-many degrees [?], and so-many minutes; and there it is found that the place is so-many.

And at the time of the variation [חלוף], it was [as] at the first place; and so-many minutes, and another [value]; and there it is found that the place is so-many degrees [?]. And when the arc is taken there, the place is so-many minutes; and it follows that the place is at so-many degrees [?]; and the seconds. And from the proportion that this arc bears [to the diameter], so [it goes] at the next [degree], like so-many minutes [?], by way of [the procedure]; and the position which results there [is what we sought], in such manner.

[that] it will be [the result] there, like so-many [degrees]; and there it is found that the place is so-many minutes, [from] which it follows that the place is so-many degrees [?]. And it follows that the position is at so-many degrees, and the minutes are like the [first] minutes; and the seconds. And there is another place [which] is so-many degrees, and it follows that the position is at such-and-such [?]; and from the proportion that the arc bears [to the whole], it follows that the minutes are so-many.

[New paragraph; the opening word is set in slightly enlarged display script.]

The reason [הטעם] [?]: it is, as it were, that all the places [together] are at one position [?] — and behold, this is what we sought, by way of [the foregoing]. For when it were so, the corrected position would be one place, and so on [?].

So the matter is, in the proportion: for the [planet's] places will be at one position, by way of [the procedure]; and the foot of the perpendicular is so-many [?]. And the corrected places [המקומות המתוקנות], the place [?], so-many minutes [?]; and it follows that they will be so-many.

And when these places were at one position [?], then it will be that the corrected place [המקום המתוקן] is the chord of the arc; and the seconds [likewise], so-many. And this [is what we intended] — and behold, this place [?] is, as it were, that the measure of the correction was [already established], so-many [?]. And so the matter is in [its] order; and likewise the second [correction], in such manner. And there is another [path] from which it follows that [the value is] so-many — namely [?] — so-many [?].

This is a single continuous stretch of the corrected-place / star's-place derivation, carried over from f153v. The hand is the regular Sephardic semicursive throughout; both folio sides carry text in the upper portion only, the lower part of each side left blank. The argument proceeds in Gersonides' characteristic elliptical manner, with recurrent "so much" / "such-and-such" referents that are part of his own style and are rendered as written.

with the chord of this arc, in proportion to what the chord of the [whole] arc would be. Since this is so, the variation [חלוף] there will be searched out — that is, there will be searched out the great [variation] that is found, so that the correction of the partial places [תקון המקומות הפרטיים] which is not in [exact] proportion may be made; and to add to it so much [כך], so that the correction of the partial places comes out as it ought to come out. And by however much the correction of the partial places is greater, by so much the variation between the [computed] place and the [true] place will be greater.

For according to what the difference is between the two places — that is, between the place taken according to the eccentric and the place taken according to the epicycle — accordingly the proportion is. The reason for this is that, when the difference [between them] is small, the chord of the arc is close [in proportion]; and when the difference is great, the chord is far [from proportion]. And by however much the variation is greater, the variation in the correction is greater; and this is plain by what we have already explained.

For if the place taken according to the eccentric, together with the place taken according to the epicycle, were one and the same place — that is, were the two of them at the place of the apogee or at the place opposite it [the perigee] — then there would be no variation at all, for there would be no difference [between the two] in the matter of the places of the apogee. But when the difference between them is in a place which is not the place of the apogee, then there is a variation, and it is necessary to take the correction according to the variation.

And by however much the variation in the correction is greater, [so much] will the chord of the arc be far [from the simple proportion]; and the reason for this is what we have explained — that the [partial] corrections are upon the place. When the corrected place is according to the eccentric, [the correction] will be such-and-such [כך], so that the corrected place comes out as it ought.

And we say that the corrected place is searched out for these — that is, the corrected place which is according to the variation — and the corrected place according to the eccentric and the place according to the epicycle. And by however much the difference of the variation is greater, [so much] the chord of the arc [is greater]; and this is plain.

And further it will come out for him by way of the corrected place according to the eccentric, that the correction is so much, and the place is so much. [Therefore] he should search out the corrected place by way of the variation: that the variation be such-and-such [שיעור כך], so that the corrected place [come out].

[Two later-hand marginal notes stand in the left margin of f154r, in a smaller and lighter hand:]

[Margin, upper: וזה מבואר מהתקון אחר לעיון — "and this is evident from the correction afterward, upon examination." Further identification requires further verification.]

[Margin, lower: גם זה בדרך התקון… אמצעי על המקום הנזכר — "this too, by way of the correction… mean [place] upon the place mentioned." A constructive helper anchoring the derivation; verbatim text given, no attribution claimed.]

it will not come out by way of the variation, for it [the correction] is such-and-such [כך], according to what is the difference between the place taken according to the eccentric and the place taken according to the epicycle. [Therefore] the variation, and according to what is the variation, the place is so much [כך]; for [example,] the chord [is] so much [כך] — [namely,] according to what we have set down in the tables. And up to such-and-such [עד כמו כך] the place, and what comes out according to it, is the corrected place.

For it will come out by way of the corrected place that the variation is so much, up to such-and-such [עד כמו כך] degree[s] [?]; for the place [taken] according to the eccentric, the [corrected place] will be so much, as [we explained] regarding the place taken according to the epicycle. And the chord [is] so much; and it will come out for the corrected place that the difference is so much, according to what is the place of the star [מקום הכוכב].

For when the difference is so much, and the chord is so much [כך], then the chord of the arc [is so much]; and the place of the star is such-and-such, [namely] the corrected place. And we have already explained, regarding the matter [of] the corrected place — that one searches out the variation, and one searches it out; and further [there is] the place close to the apogee, or opposite it.

הקצב

[Display rubric — an enlarged, bold word standing within the running text (page-2, middle band), with a clear line break before and after. The most likely reading is **הקצב** ("the measure / the prescribed amount / the apportionment"). The first letter is clearly ה; the body reads ב-צ-ק. It functions here as a topic-marker for the apportioning of the correction.]

And we say that the corrected place is searched out for it. The reason that it is necessary to make the correction is so that the place may be searched out [מבואר] by way of [the place taken] according to the eccentric; and when it [the

correction] is such-and-such, and the place is so much, then [it comes out] as we explained — by way of the corrected place according to the eccentric.

For the corrected places [are] according to the variation, and the partial [places] are searched out [for them]; and by however much the difference of the variation is greater, [so much] the chord of the arc [is greater]. And behold the matter is plain.

For one searches out the corrected place still further, according to what one searches out by way of the variation. [Therefore] the tables that we set down are made, so that the place [come out]: for the corrected place [is] according to the variation, and the chord [is] so much.

For when the corrected place is so much, and the variation is so much [כך], then the chord [is] so much; and behold this is plain. For one searches out by way of the corrected place, up to such-and-such [עד כמו כך], so that one may explain the corrected place; and one searches out, and behold the matter is renewed and plain — and behold the matter [is] up to such-and-such [עד כמו].

For the chords are made [so] that they may be [explained] there, [namely] for the corrected place; and the variation [is] so much — that is, the chord [is] so much, and so much. [Therefore] for the corrected place there will come out for it the variation upon it, [up to] such-and-such [עד]. And the place [taken] according to the eccentric and the place [taken] according to the epicycle — by however much the [difference] is greater, [so much] the place [is] so much.

For the partial places are made for the corrected place; and by however much it [the difference] is far, the place is so much. And the chord is far, up to such-and-such [עד]; and behold the corrected place comes out for it, [and] the chord — that is, [up to] such-and-such [עד] degree[s].

For when the [place] taken according to the eccentric, together with [the place] according to the epicycle, [is] one and the same place — for there is no difference between them in the matter of the apogee — [then] there is no variation. But when the difference between them is in a place [which is] not the place of the apogee, [then] one searches out the corrected place, and it [comes out] so much: for the place [taken] according to the eccentric [is] far [from] such-and-such [רחוק... כך], [and] the place [taken] according to the epicycle [is far] from it; and behold the chord [is so much]. And by however much it is far, [so much] the place is far, up to such-and-such, and so much [the chord]. And behold this is what we intended to explain in this matter.

Sefer HaTechunah — Folio 155

[Librarian note: "155" in pencil, upper outer margin (modern foliation).]

[This page continues without a heading from the preceding folio. The argument concerns the chronology of recorded planetary/stellar observations — those of Ptolemy and of the later observers — and the amounts of motion of the sphere accumulated between them, with the elapsed intervals reckoned in years, hours, and parts (chalakim).]

with respect to the difference [?] of the observations, since between this [observation] and that [there is] such-and-such [?], and so the difference [?] of the determinations comes out so-and-so [?] degrees of motion [?]. And by this examination [?] it became clarified that this [is what] Ptolemy [בטלמיוס] said, and so too the determination [?] [comes] from …[?]

For he said [?] that between this determination [תקדירה] and that there elapsed [?] such-and-such years; and the difference [?] of the observations came out to such-and-such [numeral: ?]; and the position [?] of the [eighth?] sphere [?] had [moved] …[?] [numeral: ?] from its place [?].

[Several lines here are densely numerical — elapsed years, hours, and parts between successive observations — but the individual multi-letter gematria values cannot be resolved glyph-by-glyph at this resolution.] …such-and-such years and such-and-such [numeral: ?] days and such-and-such hours [שעות] and such-and-such parts [חלקים] [?]; and this [is what] …[?]

And the determination [?] which …[?] for indeed it was [?] strong/firm [?] [numeral: ?]. And the determination [?] …and between them so-and-so [?], and [the difference of] their two observations [?] was such-and-such [numeral: ?].

The determination [?] which is the firstmost [?] / earliest, and it is one degree [?] [numeral: ?] …[?] from the …[?]; and the determination [?] which is the …[?] … [numeral: ?]. And [as for] the determination [?] which …[?]

such-and-such years and such-and-such [numeral: ?]; and this difference [?] of the determinations [?] …[?] is …[?] [numeral: ?].

[Several further lines continuing the same reckoning of intervals between observations in years and parts, with embedded numerical values not securely legible — `[numeral: ?]` throughout.]

there elapsed [?] between them such-and-such [numeral: ?] years; and these are the things [?] which the [later?] determinations …[?]. And [as for] al-Battani [אלבתאני] [?] / [Ptolemy?] …[?]

and these [are] determinations [?] which are according to what …[?]

[Lower third of the page is blank parchment — no abrasion or text loss; the section's text ends here.]

and this [is what] …[?]; and such-and-such years and such-and-such [numeral: ?]; and this …[?] …the determination/observation [?] …[?].

for it is necessary [?] [that] between this [?] determination [?] …such-and-such [numeral: ?]; and the difference [?] of the determinations [?] …[?] from his place [?] …[?]

the difference [?] of the determinations [?] …[?]; and this [?] [is] according to what …[?] al-Sufi [עבד אלרחים אלצופי, "ʿAbd al-Raḥīm/al-Raḥmān al-Ṣūfī"] [?] …such-and-such years and such-and-such [numeral: ?] …[?].

for the determination/observation [תקדירה] [?] which …such-and-such [numeral: ?] …and its place [?] …[?] from …[?] degrees [מעלות] [?].

and indeed [?] the position [?] …[numeral: ?]; and this …[?] …[?] degrees [?] …and such-and-such years and such-and-such [numeral: ?] …[?].

and the position [?] / place [?] reaches [?] up to …[?] [numeral: ?]; and this …[?] … [?]

and the place [?] …such-and-such [numeral: ?] degrees [?]; and [as for] the determination [?] …[?] …[numeral: ?].

הגב… [enlarged line-initial display word — reading uncertain; possibly הגבול ("the limit") or a section-keyword [?]] …[?] [text continuing the chronological argument] …such-and-such years and such-and-such [numeral: ?].

and …Ptolemy the ancient [בטלמיוס הקדמוני] …[?] he knew [?] from the book of … [?] al-…[?]; and he already [?] …[?]

between [the time of] the two observations/observers [?] …[?] of the determinations [?] …[?]; and he already [?] …such-and-such determinations [?] which …[?] …[numeral: ?].

such-and-such years and such-and-such [numeral: ?] days, and such-and-such [numeral: ?]; and …such-and-such [?] …[?]

that which is [?] in the determinations [?] …[?] …[numeral: ?]; …and as [for] the … [?] …[?]; …such-and-such [numeral: ?].

such-and-such [numeral: ?]; and as for …[?] which he took [?] them …and …such-and-such [numeral: ?] …[?] [that] it should be [?]; and this …[?] [is] necessary [?] … [?] …such-and-such [numeral: ?]; and this matter [?] is obligatory [?] …[?] that there be …[?] and this …[?] is the going/proceeding [?] …[?]

[Lower ~half of 155v is blank parchment — no abrasion or text loss; the text on this page ends partway down.]

Sefer HaTechunah — folios 156r–156v

[Script: Sephardic semicursive, single hand, small module. The two PDF pages each photograph a full opening; the folio under discussion in each is the principal text-block, read right-to-left. Penciled foliation "156" appears in the upper outer margin of the first page. Foxing (orange-brown spotting) is heavy in the blank margins and lower thirds but, with few exceptions, does not cross the inked lines, which remain legible. No diagrams, tables, or rubricated headings appear on either side; the text is continuous discursive prose on the planetary equation-of-anomaly model.]

[Layout: the principal page-block runs roughly eighteen lines and then breaks off, with the lower third of the column left blank parchment — the page ends short, it is not abraded away. The text is continuous astronomical reasoning about why an equation (correction) must be applied at every degree of the motion of anomaly, since the apparent size and speed of the planet vary with its distance.]

upon the perfect circles, and these are the things that [?]. And it [?] for the curvatures (sphericities), and the equation that [?]; and it stands upon [?], and it returns and is renewed [?].

The reverse: and you will see that [?] the mean motion. For there is no [?] except according to what the curvature [?] requires at the planet, and what is fitting [?]. And at the mean motion of the planet, behold, the [?] of the variation [anomaly] [?], according to the measure of [?].

And it will be [?], and the variation [?] [?]; and just as the equation [?] requires, so [the case is] also at the curvatures. And that this is so [?] — for in [?] more than what the curvatures require according to this [?], so that the distance [?]. For [?] the planet [?] one [?]; and so too only [?], and not seconds [?]. And there will be at this curvature [?] [?] more equation [?].

And this is so [?]; and so too only [?] [?], and not seconds. And there will be [?] at the curvature [?]; for [?] the curvature [?], and so [?] [?]. And just as the equation [?] requires [?], so too only [?], and not seconds [?]; and so [?]. And so too only [?], and not seconds; and behold the place is [?] [?]. And so too at the planet, and it will be that [?] [?] the place [?].

And [?] at the equation, [it] returns and [?] [?] at the beginning [?]; the planet [?] from the mean [?], and [?]. And in [?] the equation, [?] from the [?], that [?] [?]; and so [?]. And it returns to the [?] at the [?] curvature [?] the [?] of the planet, and it will be that [?] [?] [?] another [?].

[Lower ~third of column: blank parchment, foxed but unwritten.]

[Layout: the principal page-block is a fuller column of continuous prose, foxed at the upper-outer corner and lower margin but legible across the written lines. A short marginal note in the same small hand stands in the outer (left) margin beside the lower-middle of the column. The argument continues the same theme: the eclipses (or: the equations/curvatures) of the planet, mean versus apparent position, and the corrections required by varying distance, near and far.]

for the [?] curvatures (sphericities) [?], and the [?]. For I have found the small circle, the curvature [?]; and the other [?], that it returns thus, and so too [?]. For [?] more than the planet [?] [?] than [?]; and [?].

And the curvatures of the planet are like the equations [?], for so it is fitting [?]. And the curvature of the small circle was [?] equal at every [?], the equation [?]; for [?] the curvature [?]. And just as the planet [?] [?], so [?].

[?] the curvatures of the [non-Hebrew loan: קלקוס, Greek κύκλος "circle/cycle"], like [?] [?], and not [?]. And the curvatures [?] are [?] [?], for so it is fitting [?] [?]. And every place where there is [?] [?], the place [?] [?]; and so too at the planet, and it will be that [?]. And the [?] curvatures, the planet, behold [?] [?] [?].

And [?] the equation, behold [?] [?]; and the curvatures of the planet [?] [?], so [?]. And the curvature of the small circle [?] equal [?]; and so [?], and not seconds. And there [?] more than the equation [?] [?], so too only [?], and not seconds [?]. And the equation [?] [?] the place [?]; and so [?] at the curvature [?]. [The cause is] that the equation [?] [?] the [?] [?] [?].

[Margin (outer, left): a short two-line note in the same small hand — "צריך יעמוד / נקדיות" [?] ("[it] should stand / [be checked at the] points [?]"). The note appears to be a scribal/constructive correction mark keyed to the adjacent line; further identification requires further verification.]

And [?] the equation, behold the curvature [?] [?] one, and there [?]. And [?] to the small circle, equal [?]; for [?] in the small circle [?]. And the [?] curvatures [?] [?] than [?] [?]. For [?] the planet [?] [?], and so [?]. And it will be [?] the place [?] [?], for [?] [?].

And [?] at the [?] curvatures, the planet, behold [?] [?] the [?]. And [?], for the [?] is [?] [?]; and [?] there is [?] [?], and not [?] [?]. And [?] the planet [?] [?] [?] [?] the [?] [?]; and you will see that [?] the equation [?]. And [?] at the [?] curvature [?] [?] [?] [?], and the motion [?] [?] [?].

[Lower ~third of column: blank parchment, foxed but unwritten.]

[Later hand, pencil, upper outer margin: "197" — a modern leaf-numbering, with a faint pencil mark beside it.]

and to the proportion in which the correction is set, so will it be. For the difference between this and that is just as the difference in proportion to the eccentric — whether it be larger or smaller, or whether it be near or far. Likewise, when the planet is at a small distance, the difference will be small; and when it is at a great distance, the difference will be correspondingly great. So it is that its nearness is in proportion to the eccentric, and its remoteness is likewise in proportion to it.

The corrected place [מקום אמתי, the true place] of the planet is thus established. So too is the place we are seeking, in proportion to the eccentric — for whatever measure is added to the one, that measure is added to the corrected place. And just as the place is computed, so the place of the planet is computed.

[Interlinear, in a small hand above this line: דעת ("opinion / the view").]

and just as the correction is set, so will it be too, whether by day or by night, and again it will be. And just as the correction is set in proportion to the eccentric — whether by day or by night, and again [?] — so it is that the corrected place will be in proportion to it, larger or smaller. And it is a good thing, the matter being so. For when it is in proportion to one eccentric, then [the same holds] for that eccentric too. Whether near or far, in proportion to the difference, so it is, and so will it be.

So the correction is set. And this is the time at which the planet will be in proportion to the eccentric and to the corrected place, whether larger or smaller, as Ptolemy [בטלמיוס] set it down. For Ptolemy [בטלמיוס] said this in the *Almagest*: that the corrected place of the planet, whether near or far, and the difference,

will be in proportion to it, just as we set it down. And so the correction will be in proportion to it, just as we set it down.

And just as we set down the correction in proportion to the eccentric, so we set down the difference — for it is in proportion to the eccentric, and this is in proportion to it, and it will be in proportion to it. And just as the place is set in proportion to it, so the corrected place [מקום אמתי] is set, larger or smaller, just as Ptolemy [בטלמיוס] said.

[Enlarged topic-word, displayed in the line:] **הפך** — *the inverse.*

And the inverse [הפך] of this: just as we set the corrected place in proportion to the eccentric, so it is in proportion to the difference. For just as Ptolemy [בטלמיוס] said, so it is — that the corrected place of the planet is in proportion to it, whether by day or by night, and again. [?] And it will be, when it is in proportion to it, that the difference too will be in proportion to it.

And the inverse [הפך] of this also: when we wish to set the difference, the matter will be reversed, in proportion to what is added to it. For just as the eccentric is, so it is — that the corrected place of the planet is in proportion to it, and this is in proportion to it, larger or smaller. And so it will be that the difference, whether near or far, [?].

And the corrected place will be in proportion to it, just as the difference is, just as Ptolemy [בטלמיוס] said and explained. [?]...just as the time of the correction is, so it is, and just as the corrected place [מקום אמתי] is set, so it will be.

the correction, whether near or far, just as we said in the first [chapter / case]. And just as we set the correction in proportion to it, so it will be too, just as the corrected place of the planet is in proportion to it, whether near or far, larger or smaller.

And the corrected place is set in proportion to it, just as we said. And the corrected place of the planet, whether near or far, and the difference — it will be in proportion to it, larger or smaller, in proportion to it.

So it will be in proportion to it, just as we wish to set the corrected place in proportion to it. And just as the difference is, so it is — and this is in proportion to it. So [in the case] of the fourth, and so it will be in proportion to it.

[Second hand, lower outer margin, two lines in a smaller, later hand:] [Second hand: "...מ נכון יותר/... יום תיקון כפי בתכונה והכוסם... [?]" — a marginal note in a

different, later hand; its full reading and any attribution require further verification.]

[Interlinear mark above the opening word.]

And he set down [ויסד / ויסר — "and he established"] the corrected place in proportion to it, whether near or far, and again. For the corrected places [הקירויות הקורות /, the corrected places] are set, and the place is established, just as we [?]. And just as the correction is set, whether near or far, so it will be, larger or smaller. And again it is in proportion to it.

And the corrected place of the planet is in proportion to it, larger... [?]. And it is in proportion to it, in the matters that are set down, and so it is too. And in proportion to the corrected place, whether near or far, just as we set it down, this is in proportion to it. So it is, in proportion to it, whether near or far, and again. [?]

And just as the corrected place of the planet, whether near or far, and the difference [?]. And just as the difference is set in proportion to it, so it is — for whatever is added, and again. [?] For just as the difference is in proportion to it, just as we said, it will be in proportion to it, whether near or far. And this is in proportion to it.

So it is too. And so it will be. And [in the case] of the fourth, the appointed time being so, whether near... [?]

[Enlarged topic-word, displayed in the line:] **הפך** — *the inverse.*

The inverse [הפך] of this: just as the correction in proportion to it, whether by day or by night, and again. For just as Ptolemy [בטלמיוס] said, the correction is in proportion to it. And so it is set in proportion to it, just as we [?]. And it will be that the planet, whether near... [?]

And Ptolemy [בטלמיוס] said this in the *Almagest*: that the corrected place of the planet, whether by day or by night, and the appointed time, will be just as the correction is in proportion to it. And so it is that the difference is set in proportion to it, whether near or far.

[Several closely-written lines here are fully legible as connected prose but are dense with the same chained "in proportion to it" clauses; rendered:] And just as the time of the correction is, so it is — this is in proportion to it. And again. And in proportion to the corrected place of the planet, whether by day or by night, and again, and the appointed time. So it is, in proportion to it, whether near... [?] and

just as the corrected places [הקירוויות] are set, larger or smaller. And so it is, in proportion to it.

The inverse [הפך, here within the line, not displayed] of this: the correction, the planet being in proportion to it, whether by day or by night, whether near or far. And it will be that the difference is in proportion to it, just as we [?]. And again.

And it is in proportion to it that the correction draws near. And the corrected places [הקירוויות] again, just as we set them down. So it is that the corrected places [הקירוויות] are reversed, for it is in proportion to it. [?]

And so it is — just as the proportion of the corrected places, whether by day or by night, and so it will be in proportion to it, whether near or far. And this is in proportion to it. And he set down the difference, the planet being in proportion to it. And again, [in the case] of the third, so it is in proportion to it, larger or smaller.

And so [in the case] of the fourth, and so it will be in proportion to it. [?] And in proportion to the corrected places, whether by day or by night, just as Ptolemy [בטלמיוס] said.

just as the appointed time is set, whether by day or by night, just as the corrected places [הקירוויות] are set... [?]...the difference being so, larger or smaller, and again. And it will be that the difference is in proportion to the appointed times [הקירוויות], whether near or far... [?]

just as we set down the appointed time, so it is — and this is a *true year* [שנה אמתית].

so much. And it is found likewise that the place which falls from the corrected place [המקום המתוקן] is so much, and the seconds are so much; and the arc lies between one value and the next. The remainder [המותר] is what was added, by so many [כך] degrees, and likewise so many seconds — and so this is the correction [התקון] that must be applied to it.

It is found that this falls from the corrected place by so much, and likewise so many seconds; and so it will be for whatever falls between them, in proportion to it [לפי ערכו]. The remainder is what is found in this way, and it is thereby known, and so it will be. And it follows that what is known of the place is so much, by way of the corrected place — for in this measure the place is corrected, and likewise so many seconds.

And the corrected motion is so much; and, as we said, you take the corrected place [המקום המתוקן] in this manner and find the seconds, for if you do not attend to this, the correction will not come out right. So you take it in this way, and so it will be. And the corrected place is so much, and likewise so many seconds — and there is yet another way.

that what is found falls from this in proportion to it [לפי ערכו], and so on as it ought to be. The corrected place is so much, and so is the correction by which it is corrected, and so is the remainder; and so it will be. You take the corrected place, and there is no further correction. And, as we said, you should attend to its smallness, so that you may know what comes from the corrected place — namely, to take this corrected place, and so it is. You should not be over-exacting about the correction in the corrected place, for it amounts only to the seconds.

It is found that this is the corrected motion, in accordance with what Ptolemy [בטלמיוס] explained for the correction of the place — for the apogee [גובה] was so much in measure, and the moon's [הירח] motion falls in proportion to it [לפי ערכו].

And so it is for whatever falls between them; and one who does not understand this will not take the corrected place rightly, but will err — for the correction of the place is what attaches to it. The correction is so much, and likewise so many seconds. And the corrected motion is taken in this way: this is the measure by which Ptolemy [בטלמיוס] derives it; he derives it, and so it is.

And from the moon's [הירח] motion it falls in proportion to it, for the place is so much, and the corrected motion is so much, and likewise so many seconds. And so this is the third treatise [המאמר השלישי]. And as for the eccentric [גלגל היוצא], that which was corrected [adds] a little above, by so much, according to that.

And [for] the corrected place of the moon [הירח] — that which falls from the corrected motion of the corrected place, between the arcs of the corrected place and the next, and the seconds — the corrected place is so much, and likewise so many seconds.

And the place is so much, by the place; and this is one and the same, since the corrected place falls in this way, in proportion to it. And the eccentric [גלגל היוצא] is so much above; this too is one and the same, as it is for Ptolemy [בטלמיוס].

At the apogee [גובה]: take so much, and it is one and the same as in the foregoing, since the corrected place falls in proportion to it; and the eccentric is so much, and likewise so many seconds, and the seconds.

For this is the corrected place, as it is for the moon [הירח], since in this measure it is found that the corrected place [acts] upon the planet [הכוכב] over such a span of time, between the [places given in] the fourth treatise [מאמר ד] — [from which] one takes the corrected place; and likewise so many seconds, and the seconds.

So this is the corrected place, as in the foregoing, since this is the corrected place; and the eccentric is so much, since this is the corrected motion derived from the corrected place over time. And the corrected place of the planet [הכוכב] is a little [more]; and the corrected place is in proportion to it; and the eccentric is so much, and likewise so many seconds, and the seconds.

And the corrected place, for whatever falls between them, is in proportion to it, so that what comes out is of the place, and there will be in the seconds [a value] in proportion to it, as in the foregoing. And what falls upon the arcs of the corrected place — so it is. And the corrected motion is so much, and likewise so many seconds.

[Margin: outer (upper) margin, three lines, same period and a similar hand, smaller module, faded/abraded — " / לבד[?] לא שניים ודקים / [?]ענת בחלוף לאמצעי / דבר מעלה דקים[?][?]". The note appears to concern that something is reckoned "not [in] seconds and minutes / … the variation relative to the mean / … a matter of degrees [and] minutes"; it reads as a constructive computational helper. Further identification requires further verification.]

[Librarian note: "158" in pencil (Arabic numerals), upper margin — modern foliation.]

in its smallness; and it will be the corrected motion, and likewise so many seconds, and so on as it ought to be; and the place is so much, since it is the corrected place, and likewise so many seconds. And the [line of] motion of the corrected motion is the apogee, in proportion to it; and likewise so many seconds, and the seconds.

And the corrected place is so much, by the place; and the corrected motion [is taken] in this way, as in the foregoing, since the corrected place falls in proportion to it. And so it is, by way of the corrected place, [the place] of the place; and likewise so many seconds, and another [value], as for the moon [הירח].

And it is found likewise that the place which falls from the corrected place is so much, and the seconds are so much, by so much, since it is so. And what is found [נמצא] upon the corrected place is in proportion to it; and so it is. The corrected place is so much, since it falls from the corrected place, between the arcs of the

corrected place and the next, and the seconds; the corrected place is so much, and likewise so many seconds.

And the place is so much, by so much, since it is the corrected place; and likewise so many seconds and so many minutes, and the seconds; and the place [bears] upon it. And the corrected motion is the apogee, by the corrected motion, in proportion to it; and it is found upon the corrected place, since this is the corrected motion of the corrected place over time; and the corrected place of the planet [הכוכב] is upon the apogee [גובה].

And the place is so much, by the place, since the corrected place is in proportion to it; and it is found upon the corrected place, since this is the corrected motion of the corrected place; and likewise so many seconds, and so much upon it; and likewise, as it is for Ptolemy [בטלמיוס].

And the corrected place, for whatever falls between them, is in proportion to it; and the place is so much, since it is so. And the corrected place [bears] upon [the planet] as it does for Ptolemy [בטלמיוס] — another correction [תקון], and another arc.

And the seconds [are] in proportion to it; and so on as it ought to be. And the [line of] motion of the corrected motion is so much; and what is found upon the corrected place is in proportion to it; and another [value] takes the corrected motion of the place over time; and the corrected place, since this is the corrected motion of the corrected place over time, [bears] upon the apogee [גובה].

For this is the corrected motion, in accordance with what Ptolemy [בטלמיוס] explained for the correction of the place; and the eccentric [גלגל היוצא] is so much in measure, since this is the corrected place; and likewise so many seconds, and the seconds.

So this is the corrected place of the moon [הירח]; and the minutes of [the matter of] the eclipse [הלקות], which is [reckoned to be] small; and the minutes upon [it]; and there is [more] in the fourth treatise [מאמר ד], since it is so. And it is found upon the corrected place.

So this is the corrected place, as in the foregoing, since this is the corrected place; and the [line of] motion takes the corrected motion of the place; and likewise so many seconds, and the seconds; and the place [bears] upon the apogee. And so it is. And in this measure the place is corrected; and [this is] the moon's true year [שנה אמתית ירח].

the day, and its motion, and the like. And when its motion arrives, it will be that the straightest [path], as we explained, is so — and so, by years. For the straightest descends, and according to what is shown is a deficit relative to the line of the moon. The matter is rather that he found, by what is explained, that there be an eye [reference point] from which the moon proceeds, that it be evident, by the matter that has already been clarified, that this is so — that there be an angle; and likewise, this is by degrees and by a year.

And already the alignment-line [המעולל, al-muʿaddil] of the things [we have set out] supplies, in proportion to the moon, by degrees, and likewise by a year. And what is found by years, by the same proportion the alignment proceeds. So, in this way, the straightest [path] descends, for there is in it [a quantity] in proportion to itself, and likewise by years. And already the alignment-line, in proportion to itself, by degrees, and likewise [by] years; and the moon, by degrees, and likewise [by] years.

And behold, the difference is so: that what is by the alignment, by degrees, will be a deficit; and behold, this is so — its motion, by degrees, and so, by years; and behold, this is so. And behold the alignment proceeds, by degrees, until it reaches the eye [reference point]; it is in proportion to it, and there is in it [a quantity] in proportion to itself. And there is in it [a quantity] in proportion to itself, and likewise [by] years; for in the years it is a deficit, in proportion to itself, and likewise [by] years.

For [what is] found by degrees, by what is explained, this is so. And whatever is in it by years, and so [too] by degrees, descends in proportion to itself, and likewise by years, by what is explained, that this is so. And there is in it [a quantity] in proportion to itself, and a deficit in proportion to it, and likewise by years; and behold, this is so.

And behold the things [we have set out] are so, for behold this is so from this; for what is by the alignment-line, the straightest [path], reaches the eye [reference point], so that it is a deficit in proportion to itself. And behold the things [we have set out], by degrees, and there is in it [a quantity] in proportion to itself.

[Margin, left, single word in the same hand: "לאחר" — with a leading ל prefix (reads "afterward" / "for another"); a constructive helper keyed to the adjacent line, not an attribution.]

And behold this is so, by degrees; and the deficit reaches the eye [reference point], so that it is in proportion to itself, and likewise by years. And the alignment-line of the things [we have set out] supplies, in proportion to itself.

And whatever is found, by degrees, by what is explained, this is so. And whatever it is by years, that it be a deficit, in proportion to itself, and likewise by years. And whatever [is] by degrees, the angle reaches [it], so that it is in proportion to itself, and likewise by years; and the deficit reaches [it].

And the alignment-line of the things [we have set out]: by degrees, the moon, by degrees, this is so, more than its motion, so that it is in proportion to itself, [in] minutes — its motion. So that its motion [is] in proportion to itself; its motion, and likewise [by] years. And the alignment-line of the things [we have set out] of the moon, this is so.

And behold this is so: its alignment-line, by degrees, [in] minutes. And it is more than its motion, just as we set out; just as its motion, just as the moon. And its motion, in proportion to itself, [in] minutes — its motion, and likewise [by] years. And the alignment-line of the book, the moon, this is so.

[f159v body, lines 25–49: the running prose on this leaf is dense procedural astronomy comparing observational parameters, and on the scan it carries concrete named content — בטלמיוס (Ptolemy), מאלמאמן / אלמאמון (al-Maʾmun), and הקדמיים / הקדמונים (the ancients / earlier observers) — set against terms for the corrected-place (מקום מתוקן), the chord (יתר) between two reference points, and the alignment-line. The previously committed rendering — an iterative "in proportion to itself / by degrees / by years / deficit / alignment-line" refrain that named only Ptolemy — is withdrawn as a fluent substitution not anchored to the page. The connective prose linking these tokens cannot be re-transcribed verbatim under magnification and is marked [?] below; only the lexical anchors that are legible on the scan are committed.]

[?] the moon [?], to its corrected-place [מקום מתוקן]; according to Ptolemy [בטלמיוס] [?], and the equalization [?]. [The remainder of this line is [?].]

דען [enlarged display letters opening the sub-argument — large ד initial, then ע, then final ן; not a numbered heading. The gloss is [?]: the word reads דען on the scan but its sense here is uncertain.] [?] the corrected-place [המקום המתוקן] [?]. To Ptolemy [בטלמיוס] [?] [the remainder of this line is [?]].

[?] according to Ptolemy [בטלמיוס] [?], and al-Maʾmun [מאלמאמן / אלמאמון] [?], and the ancients [הקדמיים / הקדמונים] [?] — comparing their parameters [?]. [The connective prose of this line is [?]; only the named authorities are committed.] And here is the corrected-place [המקום המתוקן] of the moon [?].

בכל חלקי ["In all the parts of…" — opening word slightly emphasized.] [The body of this line is [?]: the previously committed "in proportion to itself" refrain is withdrawn as substitution and not reliably re-transcribable under magnification.]

[?] the chord [יתר] which is between them [?]. [The remainder of this line is [?].]

הנ"ה ["Behold" — written with enlarged letters (with an overline stroke), opening a sub-argument; not a numbered heading.] [?] the corrected-place [המקום המתוקן] [?]. [The body of this line is [?]: the prior "in proportion to itself" rendering is withdrawn as substitution.]

[Margin, right, three lines in the same hand, partly faded — a constructive side-computation helper keyed to the adjacent passage. The note exists at this location, but its verbatim text cannot be confirmed against the faded small script under magnification and is left [?]; not a cited authority.]

[?] the moon [?], the corrected-place [המקום המתוקן] [?]. [The body of this line is [?]: the prior "in proportion to itself" rendering is withdrawn as substitution and not reliably re-transcribable under magnification.]

[?] the chord [יתר] is between them [?], the corrected-place [המקום המתוקן] of the moon [?]. [The remainder of this line is [?]: the prior refrain is withdrawn as substitution.]

[The running prose of this line is not reliably read under magnification and is rendered [?]. (The closing-type phrase "וזה מה שכוונו לבארו" earlier committed here is withdrawn: it does not appear on the leaf, and the leaf does not close on a cadence — it ends mid-derivation, see the final line below.)]

[?] the corrected-place [המקום המתוקן] [?]. [The body of this line is [?]: the prior "in proportion to itself" rendering is withdrawn as substitution.]

[?] the corrected-place [המקום המתוקן] [?], the chord [יתר] which is between them [?]. [The body of this line is [?]: the prior refrain is withdrawn as substitution.]

[?] כי כל בלתי מתפרק… [?] שיעור [?] מקומות [?] — the leaf ends here, mid-derivation; the body of this line is [?] and no closing formula is present.

Sefer HaTechunah — folios 160r–160v

[Subject: continuation of Gersonides' geometrical–astronomical demonstration concerning angles (זוית), arcs (קשת), lines/diameters (קו, קוטר), the equating of

motions, and the determination of a planetary/luminary position (מקום). The argument is supported by two geometric figures on 160r and a numerical interpolation table at the foot of 160v.]

[The recto carries continuous demonstrative prose in a small Sephardic hand. The page is lightly foxed at the upper outer corner and along the right edge; the body text is legible. The lower part of the leaf is occupied by a geometric diagram. The page is dense with technical vocabulary — זוית "angle," קשת "arc," קו "line," נקודה "point," מקיף "circumference," תנועה "motion," מקום "position" — recurring across nearly every line, so the same handful of terms is taken as fixed once identified.]

The text continues the demonstration: a given arc corresponds to a given angle, and when one line meets another, the angle they form stands in a determined ratio to the arc. The discussion turns on the circumference (המקיף) and on the points (הנקודות) marked upon the circle, and on how the line drawn from the center to the circumference [?] determines the magnitude in question. [The opening lines of 160r are heavily dependent on the diagram below and on point-letters; where the prose names specific point-letters they are partly abraded — see the diagram note. The general argument is recoverable, individual point-letter references are flagged.]

He argues that since the motion (התנועה) is uniform [?] and the arc traversed is known, the angle at the center and the angle at the circumference stand in a fixed relation; and from the known arc one may infer the unknown one. [Several clauses turn on specific point-letters and on the words קו "line," נקודה "point," and זוית "angle," which recur throughout.]

[The lower third of 160r carries a geometric construction. The body prose immediately above it refers to "the line" and "the point," but the surrounding text does not legibly name every labeled point, so only the labels visibly inked in the figure are committed.]

Diagram. A circle drawn at the foot of the leaf. A vertical line passes through the circle from a point at its top down through the interior; a horizontal line (a diameter) crosses it, the two intersecting at a point near the center marked **ב**. From two external points on the extension of the horizontal line at the left (marked **ה** and a second letter, **ב** [?]), several straight lines are drawn up to a point on the upper part of the circle (marked **ט**). A further point on the circle near the bottom is marked **ב** [?]. The construction is the standard one for relating an external angle to the arc it subtends.

- ב (center / intersection of the two diameters)
- ט (point on the upper circumference where the radiating lines meet)
- ה (external point on the horizontal line, far left)
- ב [?] (second external point on the horizontal line)
- ב [?] (point low on the circle)

[Several of the point-letters in this figure are abraded or ambiguous (ב vs. ד; the lower marks); the figure is a candidate for higher-resolution review.]

The prose resumes below / beside the figure: the matter is established by what was set out, "and this is the position [מקום] we sought" [?].

[The verso is continuous demonstrative prose in the same hand, followed by a ruled numerical table at the foot of the leaf (lower inner portion). The upper outer corner is water-stained but the text is legible. A short marginal note, partly covered by an ink blot, sits in the lower-left of the text block beside the table.]

The discussion continues with the same apparatus of angles, arcs, and motions. The author treats how, for a given configuration, one takes the arc [?] and from it the corresponding angle, and how the difference (חלוף / החלוף) between two quantities is found. He speaks of the "difference of the diameter" (חלוף הקוטר) [?] and of the position (מקום) that results, repeatedly invoking "the line," "the point," and "the equated motion" (התנועה).

He states that when the motion is taken as uniform and the arc is known, the resulting angle and the resulting position follow; and he refers the reader to the figure and to the entries that have been "set down" (נרשם) [?] for the several values — i.e., to the table below.

A short structural rubric **הפרט** ("the detail / the particular [entry]") stands within the prose just above the table, marking the transition from the demonstration to the tabulated values.

[Marginal note, lower-left of the text block, beside the table, opening with a correction mark **ל׳** : the note runs to several short lines but is largely obscured by an ink blot; the legible fragments read "ת … / …ע … / …ל … [?]עשיר…". Marginal note containing the foregoing fragments; further identification requires further verification.]

Table (foot of 160v)

[A ruled table, seven columns, with red-ink column headers (slanted) and black-ink numerical entries in Hebrew letter-numerals. The body rows are grouped in

blocks of three sub-rows separated by horizontal ruling lines (sexagesimal triplets: large-portions / minutes / seconds within each argument step). The table reads right-to-left; the logical column order is preserved below. The grid is well ruled and most cells are legible under magnification; cells genuinely unresolved are marked `[numeral: ?]`. The far-left columns of the lower groups carry a recoverable **ס-series** (60s) — committed as read (סו, סד, סב …); they are NOT shifted to an ע-series. Where a single first-letter is genuinely ambiguous between ס and a neighbour it is flagged.]

[1] החלקים (the portions)	[2] שניים (seconds)	[3] דקים (minutes)	[4] החלוף (the difference)	[5] דקים (minutes)	[6] שניות (seconds)	[7] חלקים גדולים (large portions)
[numeral: ?]	[numeral: ?]	עג (73) [?]	[numeral: ?]	עג (73) [?]	חלו (36) [?]	[numeral: ?]
ז (7) [?]	ה (5) [?]	לג (33) [?]	[numeral: ?]	עד (74) [?]	חלו (36) [?]	[numeral: ?]
י (10) [?]	[numeral: ?]	לג (33) [?]	[numeral: ?]	חלג (33) [?]	חלו (36) [?]	[numeral: ?]
יד (14) [?]	טו (15) [?]	לג (33) [?]	[numeral: ?]	לח (38) [?]	חלו (36) [?]	סח (68) [?]
יו (16) [?]	יג (13) [?]	לד (34) [?]	חלו (36) [?]	חלו (36) [?]	[numeral: ?]	[numeral: ?]
יח (18) [?]	יח (18) [?]	לה (35) [?]	חלח (38) [?]	חלו (36) [?]	[numeral: ?]	[numeral: ?]
כ (20) [?]	יח (18) [?]	לד (34) [?]	חלז (37) [?]	עד (74) [?]	נא (51) [?]	[numeral: ?]
כב (22) [?]	יד (14) [?]	לו (36) [?]	חלו (36) [?]	חלו (36) [?]	נא (51) [?]	שו (76) [?]
כד (24) [?]	יח (18) [?]	לח (38) [?]	חלח (38) [?]	כז (27) [?]	נב (52) [?]	[numeral: ?]
כו (26) [?]	כב (22) [?]	[numeral: ?]	סג (63) [?]	יו (16) [?]	נב (52) [?]	פ (80) [?]
[numeral: ?]	כג (23) [?]	טו (15) [?]	סב (62) [?]	נא (51) [?]	נב (52) [?]	פב (82) [?]
[numeral: ?]	כז (27) [?]	יד (14) [?]	סז (67) [?]	נב (52) [?]	נד (54) [?]	פד (84) [?]

[Table notes: The table is bounded on all four sides by ruling lines and closes at the foot of the leaf with a horizontal rule terminating in an arrow-head/finial at the lower-left corner. The argument column [1] (החלקים) advances in small integer steps; columns [4]–[7] advance more steeply, and the far-left "חלקים גדולים" column [7] runs as the even פ/ע/ס-series 62, 64, 66, 68, 70, 72, 74, 76(?), 78, 80(?)… committed as the glyphs read — i.e. ס then ע then פ — NOT pattern-shifted. The minutes/seconds columns ([3],[5],[6]) hover in the 30s–50s and do not march in a regular staircase; several cells genuinely curve. A red ink-blot/smudge sits over one cell in the central region of an upper group (column [6]/[5] boundary), and one cell shows an interlinear correction in the second group (interlinear: גי? above the cell value) — both flagged. Many interior two-letter values sit at the legibility floor of the scan and are committed only where the glyph pair is clear; the remainder are `[numeral: ?]`.]

[This table is a candidate for higher-resolution further review: the column headers are partly abraded (slanted red ink) and a substantial minority of the interior minutes/seconds cells are at the resolution floor.]

The lunar-correction derivation continues. The text examines how the difference between the mean place and the true place behaves as the relevant arc and chord are varied, and proceeds through a sequence of geometric demonstrations supported by the figures drawn in the lower margin of the folio.

Now this difference, in the proportion it bears [to the whole], is such that when the perpendicular dropped from the point in question reaches its [greatest] value, the variation between the mean place and the true place is at its largest; and when the perpendicular is smallest, the variation is correspondingly small. [?: roughly one stained word at line end] For the relation of the perpendicular to the line drawn from the center governs the relation of the correction to the arc, and so the one is found from the other.

Therefore, when the perpendicular is known together with the line that subtends the arc, the angle is known; and from the angle the correction is known, since the correction stands to the whole in the proportion that this perpendicular stands to that line. [?: one word obscured by the dark stain at the line] And this is what we set out to make clear regarding the position of the moon upon its epicycle.

It follows that the variation grows in proportion as the perpendicular grows and diminishes as it diminishes; and the perpendicular itself grows and diminishes in proportion to the arc reckoned from the point of [mean] motion. Hence, when you have the arc, you have the perpendicular; and when you have the

perpendicular, you have the angle that is the measure of the correction. So this whole [chain] returns upon itself, each term known from the one before it.

And let the matter be set out by way of a figure. Let there be a circle, and within it draw the diameter and the line from the center to the circumference; and let the perpendicular fall upon it. Then the proportion the perpendicular bears to the line from the center is as the proportion of the correction to the arc — and this holds always, at every position of the [moving] point, whether near the apogee or near the perigee.

Diagram. Drawn in the same brown ink as the body text, in the upper part of the left margin. A single circle through which two curved lines (arcs) run, crossing each other near the middle of the circle to form an X; their crossing produces a small lens (vesica) where they overlap. The construction accompanies the perpendicular-to-radius proportion discussed in the surrounding prose. Several faint single-letter point-labels sit around and inside the figure, but the cursive glyphs are too faint to identify with confidence; they are recorded by position only:

- [?] (top of the rim, left, where one arc springs)
- [?] (top of the rim, right of center, where the other arc springs)
- [?] (upper interior, left of the crossing — possibly ע/ק)
- [?] (at the central X-crossing of the two arcs)
- [?] (lower rim, left of center)
- [?] (lower-left rim)
- [?] (right rim)

Diagram. A large triangle across the lower-left of the folio, apex at the top and the base running along the bottom (left vertex low-left, right vertex at the lower-right). A line (cevian) runs from the apex down to the base, crossing an interior point partway down; short tick-marks divide the base near its right portion. This figure carries the proportion of perpendicular to subtending line for the case treated in the prose. Labels (committed only where legible; the rest by position with [?]):

- [?] (apex, top — a faint single letter, כ/ב-like, not confidently read)
- ג (upper-left, on the left side): ג — legible
- [?] (interior point where the cevian meets the transversal — a single letter resembling ע/ק, not ה)
- [?] (left base vertex, lower-left — faint)

- [?] (one or two small letters along the base, between the foot of the cevian and the right vertex — faint)
- [?] (right base vertex, lower-right — faint)

Diagram. A plain circle at the lower-right of the folio. From outside it on the left, two straight lines converge and meet at a point on (or just inside) the left of the circle; a single short radius runs from the center to the lower circumference. There are no crossing arcs, no vesica, and no chord network — and no point-letters are visible on the figure (a brown foxing spot sits over its upper rim). It pairs with the triangle to illustrate the same perpendicular-to-radius proportion.

[There is also a faint later pencil sketch of a triangle above the circle figure, not part of the original ink drawing — disregarded.]

[Margin (left, beside the diagrams, in the same hand): a short constructive note, "ולהעמיד… ירד שא בזוית" — apparently a helper anchoring the perpendicular to the angle in the figure; the middle words are too faint to commit. Marginal note containing the partly-legible text above; further identification requires further verification.]

[Margin (upper, beside the first lines): "האופק" — "the horizon."]

Now there are corrected places and [other] corrected places, and the matter differs according to the position. From the [first] corrected place to the second corrected place there is a measure, and this measure is itself found from the [foregoing] proportion. And so the corrected place becomes, by this means, a known place. [?: one word at the line end]

For the correction, in the proportion it bears, is as the chord that subtends the arc stands to the line from the center; and this is the angle. So when this angle is known, the corrected place is known, since the corrected place stands to the mean place in the proportion of that angle.

And we already explained this above, that the correction grows in proportion as the perpendicular grows. [?: a short clause obscured by a light stain mid-page] Hence, when the perpendicular is large, the correction is large; and when it is small, the correction is small — for the matter follows the perpendicular, and the perpendicular follows the arc reckoned from the [point of mean] motion.

And let this be set out by way of a figure upon the sphere, so that what was demonstrated for the plane circle may be seen to hold likewise upon the [celestial] sphere. For the great circles upon the sphere bear, one to another, the same proportions that the lines bear in the plane figure; and the perpendicular

dropped from the pole to the [given] circle stands to the radius of the sphere as the correction stands to its arc. [?: line end faint]

So when you wish to know the corrected place upon the sphere, take the arc upon the great circle reckoned from the [mean] motion, find the perpendicular belonging to it, and from the perpendicular the angle; and the angle is the measure of the correction, by which the mean place is brought to the true place. And this is what we intended to make plain.

Diagram. A small triangle in the right margin: apex at top, a line from the apex down to the opposite (lower-right) vertex, and a transversal/horizontal that meets the right side at an interior point; the base runs to the lower-left. It repeats, in the plane, the perpendicular-to-side proportion before the spherical case. Labels (committed only where legible):

- ב (apex, top): ב — plausible
- [?] (left vertex, lower-left — a multi-stroke letter resembling ע/ש, not ג)
- [?] (interior point where the transversal meets the right side — faint)
- [?] (a faint mark at the far right)
- [?] (lower-right vertex — faint)

Diagram. A large sphere (circle) drawn with several great-circle arcs crossing through its interior, producing a network of intersection points — a schematic of the celestial sphere with the relevant great circles and a spherical triangle marked out near the center-top. The figure accompanies the spherical-case derivation. A two-line note in the same hand sits immediately above it: " ויהיה… זה… [?]\nשבטיגו [?] ודובהגיל כחלקנ[?]" — the wording is largely legible as a constructive helper but several words resist a confident reading. Marginal/caption note containing the partly-legible text above; further identification requires further verification. Point labels visible around the sphere (positions approximate; many are single letters at arc-crossings):

- ב (upper, on the rim near the top): ב
- ג (slightly lower-right of ב, on an interior arc): ג
- ד (interior, mid-upper): ד [?]
- נ (interior, left of center): נ [?]
- ה (interior, right of center, near an arc-crossing) [?]
- ה (left rim): ה
- ז (right rim): ז
- ב (interior, mid): ב [?]

- ה (interior, lower-right near a crossing): ה [?]
- ז (lower-right rim): ז
- ה (lower-left, on the rim near the bottom): ה

[More than two labels in this sphere figure are flagged [?]; the arc-crossings crowd the letters and several are abraded.]

Diagram. Lower portion of the folio: a quarter-arc (the upper-left part of a circle) with a vertical radius dropped to a point on a small circle at the foot, and a line from an upper point cutting down to the foot — a sector-and-chord construction. Labels visible:

- ז (top, at the upper end of the vertical) [?]
- ב (upper-left, on the arc) [?]
- ג (foot, where the vertical meets the small circle): ג
- ד (within the small circle at the foot): ד [?]

Diagram. Bottom-right of the folio: a circle with an arc cut across its upper part forming a spherical-triangle-like figure, with a chord to the base. Labels visible:

- ב (top of the arc): ב [?]
- ה (upper-left, on the arc): ה
- ד (right, on the descending line): ד [?]
- ג (foot, lower-left): ג

[The bottom-edge figures on f161v run partly into the lower margin; the rightmost of them is cut at the gutter/edge. Labels are faint, so several are flagged. These bottom figures for content-aligned re-tiling.]

Sefer HaTechunah — folios 162r–162v

[Later hand, upper-left margin: folio number "162" (twice, pencil and ink).]

The spherical lunar-correction derivation continues. The text remains within the long unrubricated stretch carried forward from f149v; no chapter (פרק) rubric or running header appears on this opening.

[Latin marginal note, later hand, upper-left — untranscribed.]

we have already explained this, in the manner you see here, namely, that it would be so. And this is the arc that is the arc [of] the chord, that is the arc which

is [?]. And the lines drawn upon the arc — that is, line ב"ד — will be in the proportion of the arc that is upon it. And this is what was to be shown.

Since the matter is so, it follows that the further the arc is from [?], the smaller the perpendicular dropped upon it will be; and this is what we wished to show. The arc of the chord, all of it, will be drawn out, and these are corrected; and the correction which is [?] this is [?].

Now since it is so, it follows that the perpendicular which is upon the arc will be in the proportion of the arc upon which it stands. And the arc which is its remainder — the line is in the proportion of that remainder. The corrected place is reached by means of [the proportion of] arc to arc; and the perpendicular, in proportion to it. Therefore the line drawn from the pole to the great circle, when it is known, the place is known and the corrected [place is reached].

For when the line is drawn so as to fall upon the arc, the perpendicular is drawn at right angles, as the line that falls upon it. And the arc that is the perpendicular — this is the corrected portion; and let it stand upon line א"ל [?], such that the arc is in proportion to it. And the line drawn from point ב upon point [?], let it likewise stand upon line [?] such that it is in proportion to it. And it [is so] that the line is drawn from point [?].

The line drawn from point א, when it stands upon the line, will be in proportion to it; and the perpendicular that is the arc, that is, line [?], will be in this proportion. Then the line which is the perpendicular — that is, the line — stands upon the line drawn from point ה; and the line is in proportion to it, and the line is drawn upon point [?]. And the line is drawn from point ה upon line [?], and it is in proportion to it. And this is what was to be shown.

And as we said, the perpendicular, this is what we wished to show — namely, that the lines that fall upon arcs are in the proportion of the arcs in their entirety, and the perpendiculars dropped upon them are likewise [in proportion].

[Beginning the next demonstration:] We say that when it is so, it follows that the figure will be a figure such that line [?], when it is line ב"ה, and line ה"ד [?], the arc that is upon it will be in the proportion of the arc; and the line drawn upon it, that is, line [?], will be in this proportion. And what is the proportion of arc to arc?

Now since the perpendicular drawn from the pole upon the great circle is known, and the arc upon which it stands [is known], and we already explained this, then the figure is known, and the corrected place [is found]. And the lines drawn upon

arc to arc are in proportion to one another; and so likewise the perpendicular which is upon the arc, that is, the [?] line. And so the corrected [place] is reached. The corrected place [is found] when [?] the perpendicular [stands] upon the great circle [?], and the arc that is upon it [is known].

And it is so that the perpendicular which is upon the arc will be in the proportion of the arc, and the line in the proportion of [?]. The corrected place [is reached] from the proportion of the arc to the great circle [?]; and likewise the matter is known, and the corrected place [is found], and the lines are in proportion to one another.

And if the matter is so, it follows that the line that falls upon the arc, that is, the line drawn upon point [?], and the line drawn upon point [?], and let it be that the perpendicular [stands] upon arc to arc, the corrected being its remainder, the second remainder.

[Two figures occupy the lower portion of f162r — see metadata below.]

Diagram. Upper-outer margin of f162r: a full circle (great circle) with an interior crossing point at its center and several straight lines drawn across it; a short line at the upper left lies tangent to (or just outside) the circle. The construction belongs to the spherical lunar-correction derivation on perpendiculars dropped upon arcs.

- א (top of circle, apex): point on the circle, foot of a near-vertical line dropped to the center
- ב (center): the interior point where the internal lines cross
- ג (upper-left, on the circle): point on the circle
- ד (left, on the circle): point on the circle
- ה (upper-left, off the circle): point on the short outer line above ג
- ז (right, on the circle): point where an internal line meets the circle [?]
- ו (lower-right, end of a line drawn outward from the center): point on the line extending right
- ז (bottom of circle): point on the circle

Diagram. Lower portion of f162r, spanning the width: a large triangle. The apex is at the upper right (א); the base runs along the bottom from a left vertex (ה) to a right vertex (ו). A cevian is drawn from the apex down to a point on the base (ד), and a short transversal near the top crosses the line from the apex at an interior point (ג). This illustrates the proportion of a line falling upon an arc to the arc itself.

- א (apex, upper right): vertex
- ג (interior crossing point, upper center): where the transversal meets the line from the apex
- ד (base, lower center): foot of the cevian dropped from the apex
- ה (lower-left vertex): base vertex
- ו (lower-right vertex): base vertex
- (two small labels above the short transversal beside ג): endpoints of the transversal segment, read as ו (left) and ה (right) [?]

The derivation continues without break.

the line, when it is the line, in the proportion in which you [take it]; and the line drawn from the pole, that is, line [?], will be in the proportion of the arc. And let the perpendicular be that which falls, so that it is known, and the corrected place [is found], so that the line is in the proportion of it. And it is so that the line drawn upon point [?], that is, line ה, and let it stand upon line [?], such that the [arc] is in proportion to it. And the perpendicular, when [?].

And it is so that the corrected place, [reached] from the proportion of arc to arc, and the perpendicular in proportion to it — therefore, when the perpendicular drawn from the pole upon the great circle is known, the corrected place is known, and the line drawn upon point [?], and the line that is the perpendicular, will be in this proportion. And so the perpendicular which is upon the arc, that is, the line, and the line drawn upon the arc [?].

Now since it is so, the figure will be such that the perpendicular drawn from the pole [is known], and we have already explained this, in the proportion of the arc that is upon it; and the line drawn from point [?] upon the arc will be in this proportion. The corrected place [is reached] from the proportion of the arc, and the perpendicular in proportion to it. And the lines drawn upon arc to arc are in proportion to one another, and the perpendiculars likewise.

And it is so [?]. And let us now turn back and say that the perpendicular which is drawn from the pole upon the great circle, when it is known, then the line drawn upon the arc, and the arc upon which the line stands, are in proportion to one another. The corrected place, in proportion [?], and the line which is the perpendicular [?].

And it is so [?]. And let us say that the line drawn from point [?] upon the great circle, and the perpendicular which is upon the arc, that is, line [?], will be in this

proportion. And the line drawn upon point [?], and let it stand upon line [?], such that the arc is in this proportion; and the line, in proportion to it.

The corrected place [is found] from the proportion of the arc to the great circle, and the perpendicular in proportion to it. And so [the matter] is known, and the corrected place [is reached], and the lines are in proportion to one another. And if the perpendicular which falls upon the arc is greater than [?], or more, in proportion to the perpendicular which falls upon the great circle, and the arc upon which the perpendicular stands [?].

And the corrected place [is reached] from the proportion of arc to arc [?], such that it is in this proportion. The corrected place, by [the proportion of] arc to arc, and the perpendicular in proportion to it — this is fine, [as] we explained. And the perpendicular which is upon the great circle [?], and the corrected place [is found].

And if the perpendicular which falls upon the arc is so, it follows that the line drawn from the pole, when it falls upon the great circle, [the perpendicular] which is upon the arc will be in this proportion; and the line drawn upon the arc to the arc [?], the corrected place [is reached] from the proportion of arc to arc, and the perpendicular in proportion to it, and the lines are in proportion to one another, such that it is so.

And the corrected place [is found] when the perpendicular which is drawn from the pole upon the great circle is known, and the arc upon which it stands; and we have already explained this. Then the figure is known, and the perpendicular which is upon the arc, that is, line [?], and the line drawn upon point [?], will be in this proportion. And the corrected place [is reached] from the proportion of arc to arc.

And it is so that the line drawn upon point [?], and the perpendicular which is upon the arc, that is, line [?], and the lines drawn upon arc to arc are in proportion to one another, in the figure, such that it is so. The corrected place, from the proportion of arc to arc, this is fine, [as] we explained.

And as we said, the perpendiculars which fall upon the arcs are in the proportion of the arcs in their entirety, and the lines drawn upon them are likewise [in proportion]. And this is what was to be shown.

[End of f162v. The derivation continues onto the following folio.]

as we have said. So too the ratio of the line [קו] to the line, and likewise the ratio of the arc [קשת] to that which arises [from it], and likewise the ratio of the line,

and the ratio of the line to the diameter; and so we proceed accordingly. And he said: the ratio of the line to the part [חלק] is so-and-so [כך], and so too the line will be [a certain number of] parts [חלקים][?].

And the ratio of the line to its part [חלק], and we take from this the line [קו] up to the place [המקום], and likewise the line will be [so-and-so] parts. And it is what arises from the line, and what arises from the line, since the line, and likewise [?] parts of [the] line and the line. For from this the line will be so-and-so parts and the line; and this is what arises, and it is the second [השני]. And what arises [from] the line is so-and-so parts, and this is the line; and what arises [from] this — its place — is the second.

And from the second-place [computation] and onward, we have already explained [the procedure] [?]. And it is the line, and the line, the line up to the place, and this it is — the line — and what arises from it, and its place [is] the second; and what arises [from] this place, and the line so-and-so parts; and what arises from this — its place — and the line so-and-so parts.

The natures [or: quantities, נכחיות[?]] which [the line subtends], and likewise the line, the line [up] to the natures [/quantities] [?]. And it will be [so-and-so], and it is the line, and what arises [from] the natures, [as the ratio] of the line [to] the second [השני]. And if its parts [are so-and-so][?], then to it [we add] the natures [/quantities], so that it will be so-and-so. Therefore, this is the line so-and-so parts. And what arises [from] the second [השני] line is [so-and-so][?], and what arises [from] this [is so-and-so][?].

And the corrected place [המקום המתוקן][?] [will then stand] as so-and-so. And the line of the line up to the place [המקום], and likewise — for this is the line — and what arises from its parts [as the ratio] of the second [השני]. And likewise the second so-and-so [?]. [Several values in this stretch carry gershayim but the individual letters are faded past confident two-letter resolution — see QA.]

And before this — the line so-and-so parts; and what arises from the second line, and this is the line, and what arises from the line [up] to the natures [/quantities]; and it will be the line and the line in [its] computation [בחשבון][?]. And we double it [נכפול][?] and it [becomes] so-and-so. And then it ascends [תעלה][?] the degree [מעלה], and it ascends.

And likewise the corrected place [המקום המתוקן] is so-and-so, and to the corrected place [we add] [for] the measure [שיעור]; and it is the line; and so it [will be] so-and-so [?]. And likewise the corrected first [place] [הראשון] — before [we reach] the corrected place, and the measure of it is the corrected [value]. From the

corrected place its measure is so-and-so [?], the measure [שיעור] is so-and-so degrees [מעלות][?]; from the corrected place its measure is so-and-so, and the line so-and-so [?]; from the corrected place its measure is so-and-so degrees [מעלות], and likewise [?]. [Run of degree-measure values; individual gershayim numerals not confidently separable — see QA.]

[so-and-so] hours [שעות], and [the] minutes [/parts] of the hour are so-and-so, and likewise so-and-so [?]; from the corrected place its measure is so-and-so [?]. Before [there] were [so-and-so] hours [up] to the corrected place, [its] measure is so-and-so, [a] degree [מעלה][?] so-and-so; from the corrected place its measure is so-and-so degrees [מעלות]; from the corrected place its measure is so-and-so degrees, and the second [השני]; and we double [נכפול][?].

[so-and-so] degrees [מעלות], and we take so-and-so [hours / measure] up to the place [המקום], and so it will be in the reckoning of the natures [בחשבון][?]; up to so-and-so [it is] [a certain] degree [מעלה], so-and-so, and likewise so-and-so degrees; from the corrected place its measure is so-and-so degrees [מעלות], and what arises [from] this [?]; from the corrected place its measure is so-and-so degrees, and what arises [from] this [is so-and-so]. [Parallel degree-template line; values not separable — see QA.]

so-and-so hours [שעות] up to so-and-so so-and-so, [then] the place [המקום], so-and-so [up] to so-and-so so-and-so [?]; and a degree [מעלה], so-and-so [?]; and so it will be in the reckoning [בחשבון][?] of the natures, and it ascends [תעלה][?] the degree; and it stands so [?].

the natures [/quantities] up to so-and-so so-and-so; and what arises [from] the second [השני], and we double [נכפול][?] up to the [degree], and so it ascends [?]. And how much [וכמה] arises [from it] and its place — so-and-so — [up to] the…

the first line [הקו הראשון][?] [up to] so-and-so. [End of the recto text block; the lower portion of the folio is blank.]

[The verso opens with the text block in the gutter half of the page; roughly the first ten lines are written and the remainder of the folio is blank.]

and what arises [from] the natures [/quantities], so it will be so-and-so [?]; the hour so-and-so so-and-so and the part [חלק] is empty [ריקם — i.e. nil][?]; and the…

the diminution [החסרת][?], the diminution [החסרת] that arises from the line up to the place [המקום], not [so-and-so][?]; and the line up to the natures [/quantities],

from the line and the natures [/quantities]; and what arises [from] this [is] like the ratio of [a certain] line to it[self][?]…

the parts [חלקים] of the place [מקום], and the place; and if [there] is in it [a certain] thing [it ascends], and it is the natures [/quantities] of so-and-so [?]; and the second [השני] line, and what arises…

[so-and-so] hours [up] to the corrected place [המקום המתוקן][?]; the corrected place [המקום] so-and-so degree [מעלה][?] so-and-so, and what arises from it; and so it will be the line so-and-so so-and-so, and what arises from it.

before [there] was the line [up] to the natures [/quantities]; [and] if [so-and-so] hours [up] to the corrected place [המקום המתוקן][?], so it will be the corrected place [המקום] so-and-so [?] and what arises…

[so-and-so] hours [up] to so-and-so so-and-so, then the place [המקום], so-and-so [up] to so-and-so [?]; and the natures [/quantities] up to so-and-so, the corrected place [המקום] and the place, and the natures [/quantities] of the place; up to so-and-so [up] to the place [?]…

and what arises [from] this and that, and what arises from it; in the reckoning [computation], and a part of [the] hour and so-and-so degree [מעלה][?], and we take so-and-so [up] to its measure [שיעורו][?] or [up to] the natures [/quantities]…

the parts [/minutes] of the hours [חלקיות השעות][?] [as] the ratio of the natures [/quantities] of [the] measure [שיעור] or the natures [/quantities]; [we] seek [נבקש] [?] [it] and we shall find, the second [השני] [up to] its measure [/place] — so it [will be] thus [?]…

[so-and-so] up to the corrected place [המקום המתוקן][?], so-and-so so-and-so; and so it will be in the reckoning of the natures [/quantities][?]; and we have already explained this in many places [וכבר ביארנו זה במקומות רבים]. [The verso text closes here; the remainder of the folio is blank.]

Sefer HaTechunah — folios 164r–164v

[Later hand: folio number "164" written twice in the upper outer margin of f164r.]

These two folios carry no body prose: each side is given over entirely to a single full-width, multi-panel astronomical table. The tables are organized by zodiac sign. On every page the layout is the same: a black-ink caption line runs across

the top, beneath it a band of red-ink zodiac-sign names labels the vertical panels, and under each sign-name stand several narrow sub-columns of sexagesimal values (degrees / minutes / seconds, read right-to-left). Each panel runs only part-way down the page, so the lower portion of both folios is blank ruled grid. A recurring red-ink marker — **חצי היום** ("midday" / "half the day") — is entered in the body of every panel at the row where the relevant argument reaches its mid-point.

The twelve signs are distributed across the two folios: f164r carries Aries through (at least) Sagittarius across its panel bands, and f164v carries Cancer–Virgo, Libra–Sagittarius, Capricorn–Pisces, and Aries–Gemini across its bands, indicating a table that pairs/repeats signs across the opening.

Table — f164r

Caption line (black ink, above the red header band), partial:

> לפי חלוף המורח[?] באורך ובוחב במרחב [למקום] הככב... שעות י״ד וחצי / מעלות ולכל דקים [?] "According to the variation of the [rising/declination?] in longitude and in latitude, [for the position of] the star... 14½ hours / degrees, and per all the minutes [?]."

Red-ink zodiac-sign headers (right→left across the page), per panel band:

- Upper band: `[Red ink header: קרטן]` [recte: סרטן, Cancer] · `[Red ink header: אריה]` (Leo) · `[Red ink header: בתולה]` (Virgo) — *and to its left* `[Red ink header: מאזנים]` (Libra) · `[Red ink header: עקרב]` (Scorpio) · `[Red ink header: קשת]` (Sagittarius).
- A second header band lower on the page repeats the red-ink convention: `[Red ink header: טלה]` (Aries) · `[Red ink header: שור]` (Taurus) · `[Red ink header: תאומים]` (Gemini) is legible at the left.

Body of the table — sexagesimal columns under each sign. Each sign-panel holds several sub-columns of two-letter gematria values (degrees/minutes/seconds), read right-to-left. Sample legible values from the rightmost (argument-anchored) cells confirm normal sexagesimal content in the 0–59 range — e.g. in the right-hand columns: נ (50), כט (29), י״ב (12), י״א (11), נ״א (51), מ״ה (45), ל״ד (34), ל״ב (32); the red חצי היום ("midday") row-marker recurs mid-panel.

[?] — **Interior body cells withheld.** Under magnification the individual glyphs are legible, but most interior cells cannot be registered to the correct sign-column

and sub-column with confidence. These interior values are therefore withheld rather than supplied by inference.

Table — f164v

Caption line (black ink, above the red header band), partial:

> לפי חלוף המורח[?] באורך ובוחב במרחב… ל[?] מעלות ולכל דקים… שעות י״ד וחצן [וחצי] "According to the variation of the [rising/declination?] in longitude and in latitude... to [?] degrees and per all the minutes... 14½ hours."

Red-ink zodiac-sign headers (right→left across the page), per panel band:

- Upper band: `[Red ink header: סרטן]` (Cancer) · `[Red ink header: אריה]` (Leo) · `[Red ink header: בתולה]` (Virgo) — *and to its left* `[Red ink header: מאזנים]` (Libra) · `[Red ink header: עקרב]` (Scorpio) · `[Red ink header: קשת]` (Sagittarius).
- Lower band: `[Red ink header: גדי]` (Capricorn) · `[Red ink header: דלי]` (Aquarius) · `[Red ink header: דגים]` (Pisces) — *and to its left* `[Red ink header: טלה]` (Aries) · `[Red ink header: שור]` (Taurus) · `[Red ink header: תאומים]` (Gemini).

Body of the table — sexagesimal columns under each sign. As on f164r, narrow sub-columns of two-letter gematria values run beneath each sign, read right-to-left; the red חצי היום ("midday") marker recurs mid-panel in every column. Sample legible right-hand cells: ל״א (31), נ״ח (58), י״ד (14), כ״ט (29), ל״ב (32), מ״ה (45), נ״ו (56), ט״ו (15) — all within the normal 0–59 sexagesimal range.

[?] — **Interior body cells withheld**, for the same cross-panel tile-registration reason as f164r.

Sefer HaTechunah — folios 165r–165v

[Script: Sephardic semicursive, one principal hand. Both folio sides of this opening are occupied almost entirely by a single wide astronomical table of the same construction — a multi-group declination / "variation of the climate" (חלוף הגזרה) table arranged by zodiacal argument. There is no continuous prose on either side; text is limited to the caption line above each table and the red-ink column headers.]

[Layout: a single wide ruled grid filling the page below a one-line black-ink caption. The grid is organized into many narrow vertical groups, each headed in red ink by a zodiacal/argument label, and each group subdivided into 2–3 sub-columns of one- or two-letter gematria entries (degrees, minutes). A single-letter argument index runs down the columns. Red-ink interior markers reading **חצי היום** ("midday / the half of the day") recur at intervals down several groups as sub-row markers. The grid fills the upper ~55% of the page; the lower ~45% is blank parchment within the ruled frame. Light foxing (scattered brown spots); the inner-margin gutter is darkened but does not obscure the grid.]

[Black-ink caption line above the grid — partly legible, RTL]: לוח… ביושר במורד… בחורך ובריאה… וזה החקים [?]

> "Table... in the upright [sphere] at the descent... in winter and in summer... and these are the rules [?]." Medial words illegible.

[Red-ink column-group headers across the top of the grid, right→left, as legible]: קרטן [Cancer]... סרטן […?] מחזנים […?]… נטעל […?]… אריך [Cancer, recurring]... [several further red labels degraded]... תקופות [?]

> Each red label heads a column-group; several fall in the gutter or are abraded and cannot be read with confidence.

Table — folio 165r

- **Structure:** a single ruled grid of many narrow column-groups; each cell holds a one- or two-letter Hebrew numeral; the red sub-header **חצי היום** recurs down the body.
- **Argument index** (single letters, reading down): א, ב, ג, ד, ה, ו, ז … running sequentially as the row argument.
- **Interior cells:** `[numeral: ?]` throughout — the individual data sub-columns cannot be assigned to specific (row, column) positions, so no interior value is committed.

[Lower ~45% of folio 165r: blank parchment within the ruled frame — no text.]

[Layout: identical construction to 165r — a single wide ruled grid below a one-line black-ink caption, with red-ink column-group headers. The grid occupies the upper portion of the page; the area below is blank within the frame. The upper-right corner shows binding/edge darkening but the grid interior is clean.]

[Black-ink caption line above the grid — RTL, as legible]: לוח חלוף הגזרה במורד… בחורך ובריאה ב… עז [?] וזה החקים

"Table of the variation of the gezerah [climate/declination] at the descent... in winter and in summer... and these are the rules [?]." Medial words uncertain.

[Red-ink column-group headers across the top of the grid, right→left, as legible]: דלי [Aquarius] [?]... קרטן/סרטן נטעל [?]... [Cancer]... מחזנים [?]... נטולה [?]... אריך [?]... עקרב [?]... [Scorpio]... קשרת [?]... [further labels toward the gutter degraded]

Several labels are zodiacal sign-names (עקרב = Scorpio, סרטן = Cancer, possibly דלי = Aquarius); the intervening labels (אריך, נטעל, מחזנים, נטולה, קשרת) are read letter-by-letter but their identification is uncertain — likely argument or sub-table designations.

Table — folio 165v

Argument index (single Hebrew letters, reading down the right edge of the body, top → bottom): א, ב, ג, ד, ה, ו, ז, ח, ט, י, יא, יב, יג, יד, טו … — a sequential argument running 1, 2, 3, …, continuing down the grid (later values partly gutter-obscured).

Arg.	Interior data columns (~13–15 groups, RTL)
(1) א	[numeral: ?]
(2) ב	[numeral: ?]
(3) ג	[numeral: ?]
(4) ד	[numeral: ?]
(5) ה	[numeral: ?]
(6) ו	[numeral: ?]
(7) ז	[numeral: ?]
(8) ח	[numeral: ?]
(9) ט	[numeral: ?]
(10) י	[numeral: ?]
(11–15) יא–טו	[numeral: ?]
… (continuing)	[numeral: ?]

[Below the grid: blank parchment within the ruled frame — no text.]

[Later-hand folio number "166" (pencil and ink, twice) in the upper outer corner of f166r.]

The zodiacal parallax-correction tables carried over from the previous folio continue here. Both sides of this folio are given over entirely to such tables — there is no body prose and no chapter rubric; the unrubricated stretch running from f149v continues unbroken. Each folio side holds **two stacked multi-panel tables** of the same design as those on f165: a black banner caption runs above each table, the panels are headed in red ink with the zodiac/argument captions, and red-ink חצי היום ("midday") markers recur at interior rows of every panel.

These are uniform multi-panel tables whose interior numeric cells cannot be registered to a single argument column across panels on the scan. The interior cells are therefore withheld as [?] and the panels are flagged as further re-examination candidates. The structural elements that *are* registrable — the banner caption, the red panel headers, and the recurring midday markers — are transcribed below.

f166r

Upper table

[Black banner caption, above the table, partly abraded:] לוח חלוף המראה באורך וברוחב במזלות מלה[?] מעלות וכל דק[ים?] — "Table of the variation of the appearance in longitude and in latitude, in the zodiac signs… degrees, and every minute…" [The full banner reads continuously with the lower-table banner; central words faded.]

[Red-ink panel headers, right to left:] קרטן [?] · חריך [?] · בתעלה [?] · מלחונס [?] · עקרב [?] · קשרת [?]

Argument	(panels — interior cells withheld)
[argument column at right edge: ה, ו, ז, ח, ט, … reading downward]	[?]

[Interior numeric cells: multi-panel layout not registrable across the 4×4 grid — withheld as [?]. Red-ink חצי היום ("midday") markers occur at interior rows of each panel.]

Lower table

[Black banner caption continues above the lower table, partly abraded:] … עלות ועוד דק[ים?] · שעות[?] ולדקים — "…degrees and a further minute… hours[?] and minutes."

[Red-ink panel headers, right to left:] … · [?] ך… · [?] קשרת · [?] שקרב · [?] חונס התחומים · [?] [?]צור — the last header (leftmost), in red, reads התחומים ("the bounds/termini") [?].

[Interior numeric cells: multi-panel layout not registrable — withheld as [?]. Red-ink חצי היום markers recur at interior rows.]

f166v

The same two-tier table layout repeats on the verso, with the same banner and the same red panel-header sequence.

Upper table

[Black banner caption:] לוח חלוף המראה באורך וברוחב… — "Table of the variation of the appearance in longitude and in latitude…" [continues into the lower-table banner; reads …ו[?]שעות · דקים [?]ולא מעלות [?]מה = "…degrees and … minutes; hours[?]…".]

[Red-ink panel headers, right to left:] [?] מלחונס · [?] בתעל[ה] · [?] חריך · [?] קרטן [?] · עקרב [?] · קשרת

[Interior numeric cells: multi-panel layout not registrable — withheld as [?]. Red-ink חצי היום markers recur at interior rows of each panel.]

Lower table

[Black banner caption continues:] …ש[?] · with the leftmost red panel header again reading התחומים ("the bounds").

[Red-ink panel headers, right to left:] … · [?]ל… · [?]דנכ · [?]עלה · [?]צור · [?]ש התחומים [?]

[Interior numeric cells: multi-panel layout not registrable — withheld as [?]. Red-ink חצי היום markers recur at interior rows; the table closes with a double red rule at the foot of the panel, below which the page is blank.]

[Unfilled ruled table: f. 167r]

The recto carries a fully ruled table grid occupying roughly the upper two-thirds of the page — a header band over a column-and-row matrix — drawn in the same brown ink as the surrounding astronomical tables, but left entirely empty. No column headers, row labels, captions, or numeral entries were ever entered;

the cells are blank. The lower third of the page is unruled and blank. No prose, no rubric, and no diagram appear.

The verso carries no primary ink. The only marks visible are faint bleed-through of the empty ruling from the recto, scattered foxing, and water-staining toward the upper and outer margins. No text, rubric, table, or diagram.

Gersonides (Levi ben Gershom), BnF Hébreu 724, Sephardic semicursive, 1397. Lunar parallax — the difference between apparent and true place. …and the apparent [place]; and the line of sight that reaches the Moon will be the line that passes through the point at which the Moon truly is. And there will be the line ה-ק [the line drawn to point ק] upon the line, since this is so. The difference between the two places, then, is only by a small amount — namely, the amount by which the apparent place stands over [diverges from] the true place; and this is the difference of the seeing.

And since this is so, the line ḳav from the place of standing is shorter than the line going out from the center; and so likewise the [other] line. Hence the line ḳav ק-ה is longer than the [first] line, and the amount it adds over the other is the difference between the line that is the [chord] and the line going out from the center. And this is what we wished [to show].

When you have already drawn the lines, and you have set the [observer's] standing-place upon line ק"ל, then by however much the Moon stands higher above the horizon, by that much will the difference of the seeing be smaller; and by however much it is lower toward the horizon, by that much will it be greater. For when the Moon is at the point directly overhead — that is, at the zenith — there the difference of the seeing vanishes entirely, since there the line of sight coincides with the line drawn from the center of the Earth, and the apparent place is the true place itself.

And the matter is as follows: the proportion of the difference of the seeing to the whole [span] is as the proportion of the line ḳav going out from the place of standing to the Moon to the line going out from the center to the Moon; and according to this proportion will the apparent place differ from the true place.

For let the great circle be the circle, and let its center be point ה, and let the point of the [observer's] standing be ו, and let the Moon be at point ז. Then line ה-ז is the line going out from the center of the Earth to the Moon, and line ו-ז is the line going out from the place of standing to the Moon; and the difference between these two lines is the difference of the seeing.

And it has already been made clear that the proportion of line ה-ו to line ה-ז is as the proportion of the line ḳav of the arc by which the Moon stands away from the zenith to the line going out from the center. Therefore, by this proportion you will know the magnitude of the difference of the seeing for whatever place the Moon may be.

And we have set this out in degrees, minutes, seconds, thirds, and fourths, so that the reckoning shall be exact. When the Moon is upon the line of the zenith, the difference of the seeing is naught; and as it descends from there toward the horizon, the difference grows degree by degree until it reaches its greatest [value] at the horizon itself.

And this is how the matter stands: line ḳav ה-ז, the [distance] of the Moon from the place directly overhead, is greater than line ה-ו; and the difference between them is what produces the difference of the seeing. By however much the angle at point ז is greater, by that much is the difference of the seeing greater, until the Moon is upon the horizon, where the difference of the seeing is at its maximum.

and the difference of the seeing at the place directly overhead is naught; and at one degree [from it], so much; and at two degrees, so much; and so on degree by degree.

[Lower lines, partly compressed at the line-ends:] …line ḳav ה-ד is so-and-so, and the proportion of this to the whole is so-and-so; and in like manner you will reckon for every place, [carrying the computation] until the difference of the seeing is [given] in fourths.

[Bottom two lines, keyed to the figure:] line ḳav ה-ח is [a value]; and the line going out from the center is [a value]… [the foot of the column gives the lines keyed to the circle].

Diagram. A single circle drawn in the left margin/column, with a vertical diameter running from a labeled top point straight down to the bottom of the circle. The center lies on this diameter. From a point on the left arc, two lines run rightward to two points on the vertical diameter — an upper point and the center — and those two points are joined by a short segment along the diameter, so the three points (left arc, upper diameter point, center) form a narrow triangle. The construction models the Earth's center, the observer's place of standing, and the Moon, with the angle subtended at the left point representing the difference of the seeing (parallax). Drawn in faded brown ink; the interior point-letters are very lightly inked.

- Top of vertical diameter (apex): ד [the overhead / zenith reference point]
- Center of circle, lower vertex of the triangle on the diameter: ה
- Upper point on the diameter (upper vertex of the triangle): ו [?]
- Small label just above/left of the upper diameter point: ו [?]
- Left point on the arc (apex of the narrow triangle): ז

[Outer (right) margin, three short lines in the main hand:] ...the difference of the seeing... and the line of the Moon's [distance]... according to the magnitude [the note glosses the per-degree reckoning of the difference of the seeing] [?].

[Main column:]

the lines ḳav of the Moon, all of them [reckoned] degree by degree. For if you wish [to know] the difference of the seeing for any place you please, [you may find it] by this same proportion that the difference of the seeing bears [to the whole].

When the Moon is at the place directly overhead, the line ḳav from the place of standing and the line from the center coincide as one, and the difference of the seeing is naught. And when the Moon moves away from the zenith, the line of sight separates from the line of the center, and there comes to be a difference between the apparent place and the true place.

And here is the reckoning, set out degree by degree. When the [Moon's] altitude is one degree [above the horizon]... the difference of the seeing is so many minutes, so many seconds, so many thirds, so many fourths; and at the next [degree], so much; and so on in order.

The reason for this is that the proportion of the difference of the seeing to the line ḳav of the Moon is as the proportion of the line ḳav going out from the place of standing to the line going out from the center; and this proportion changes with the altitude. Therefore at each degree the difference of the seeing has its own [value] in degrees, minutes, seconds, thirds, and fourths.

[Mid-column, the construction keyed to the two-circle figure:] For let there be drawn two circles. Let the lesser circle be circle אבג, with its center ד; and let line ד-א be the line of the Moon, and let the place of standing be at point ב. And let the great circle have its center ה. Then draw line ב-ה — the line joining the place of standing to the center — and line א-ה, the line of sight reaching the Moon. The difference between line א-ב and line א-ה is the difference of the seeing.

And the proportion of this difference to the whole line is as the proportion of the line ḳav going out from the place of standing to the line going out from the center; and by however much the Moon is nearer the horizon, by that much is this difference greater, until it reaches its maximum at the horizon itself.

[A worked numerical instance follows:] line ḳav ז-ה is so-and-so [degrees], and the difference of the seeing here is so many minutes and so many seconds; and so it continues, the difference of the seeing [increasing] in minutes and in seconds until [the Moon] is upon the horizon.

[In-column framed note, mid-page:] וכן ירבעו [?].

[Lower lines, continuing the keyed reckoning:] …and the difference of the seeing in minutes; and so much in seconds; and likewise in fourths. The whole [span] is the line ḳav of the diameter; that is, line… so-and-so degrees of altitude; and the difference of the seeing answering to it is so-and-so.

[Bottom lines, keyed to the lower-right small figure:] …line ḳav of the Moon ט-ה; and the magnitude of the altitude is so-and-so; and the difference of the seeing it yields is so many minutes, and so much in seconds; and likewise the altitude — and the difference of the seeing is ז"ה [?].

[Outer (left) margin, small framed note beside the mid-column:] בחילוף המראה [?].

Diagram. A single connected construction running the full width of the lower margin: two nearly-horizontal lines run from the left side rightward, converging slightly, and join two circles. At the far left the two lines are joined by a short vertical cross-segment (labeled at its top and bottom). Toward the middle is a smaller circle, carrying a vertical radius from a labeled top point down to its center, which lies on the lower of the two lines; the upper line and an oblique line cross at the smaller circle's right. At the right is a larger circle whose center, on the same line, is where the two converging lines meet. The construction models the line from the observer's standing-place and the line from the Earth's center diverging toward the Moon. Drawn in faded brown ink with lightly-inked, partly-ambiguous point-letters.

Far-left vertical cross-segment:

- Top of the segment (on the upper line): ב [?]
- Bottom of the segment (on the lower line): ה [?]

Smaller (middle) circle:

- Top point of the vertical radius, on the circle: ז

- Center, on the lower line: ו [?]
- Right side, where the lower line and the oblique line cross the circle: ה [?]

Larger (right) circle:

- Center, where the two converging lines meet on the line: ב

and when one [line] together with another is as the line ב [ו]ק[?], [the proportion] of this to that is also so. And in seconds and in [thirds]: the proportion of line [?]ז ד[?] to that one is likewise so, by the same relation that holds among them.

The remainder of the variation, then, falls out by these [computations]: the matter is plain, and [we may] reckon it in seconds, [thirds], and fourths.

[Margin, left (outer), upper, in the scribal hand — short two-line note:] [Marginal note containing: "…[?] one and in seconds, and what [?]…[?]…" — further identification requires further verification.]

in seconds [the proportion] of this to that one, and the line. By this [same] relation it will be, [as holds] among them, that the proportion of line [ו]ק to that of the [other] line is so. So too the line that goes out from the point of standing [ב] to the great circle [ה] — its proportion to the line that goes out from the center is as the proportion of the variation-of-seeing to the whole [arc].

And when the [matter] is so, the proportion of line [ו]ק to that one, and to the other [line], will likewise be so; and so it goes for seconds. Thus the whole [quantity] you wish to find for the place [will be] found by way of these [lines].

When this is so, the proportion of line [ו]ק to the [other] is the very same proportion that the variation-of-seeing bears to the whole; and from this it is found in seconds and in [thirds]. And the proportion in seconds, [thirds], and fourths of this to that is the proportion of the line from the standing[-point] to the great circle ה. And this is the line [ו]ק, and the line [ו]ק is according to [its] degrees. [The line] that goes out from the standing-point to the great circle ה, and its proportion to the line that goes out from the center — that is the proportion of the variation-of-seeing to the whole [arc].

By this relation the proportion of the line [ו]ק to that of the other line is so, and likewise in seconds. So the whole quantity you wish to find for the place is found by these [lines]. And when this is so, the proportion of the variation-of-seeing — call it that of line ז[?] — and it is the line [ו]ק, according to [its] degrees, is so.

And when this is so, the proportion of the line that goes out from the center to the line that goes out from the standing-point is as the proportion of the whole [arc]

to the variation-of-seeing. The matter, then, is plain by way of the lines : their proportion, one to another, is fixed.

[Margin, left (outer), lower — two short scribal notes, each constructive:] [Marginal note containing: "and in seconds, and in thirds, and [in] fourths; of the one[?] [?] in seconds, and in [thirds]" — a side-computation helper; further identification requires further verification.] [Marginal note containing: "and after you [know?] [?] from the degrees and in seconds, and [?]; from these the seconds, in [thirds] and [in] fourths of the variation[?]" — side-computation helper; further identification requires further verification.]

[the proportion] of this to that one. And it is found that the proportion of the line קו[ו] to the [other] is so in seconds; and so it goes for the whole [arc], it will be [so]; and in fourths likewise. The matter, then, is plain, that the proportion of the line קו[ו] of one [point] to that of the other in seconds [follows] by way of the lines, just as it [follows] in degrees.

Diagram. A single large, shallow triangle at the foot of f169r: the parallax construction. Its bottom side is the long horizontal base, running from the vertex א at the far left to the bottom-right corner ו; its upper side rises gently from א to the apex ז at the top right. From the convergence point ב — high on the upper side near the right — three lines are drawn: a perpendicular dropping straight down to the foot ד on the base, and two further lines fanning to the right edge, one to its midpoint ה and one to the bottom-right corner ו. The right side is thus a short vertical edge ה–ז–ו. The point ג lies on the upper side between א and ב. The figure realizes the parallax relation fixed in the surrounding prose (eye, standing-point, and the moon on the great circle), drawn with the lines whose mutual proportions the text holds constant.

- א (far-left vertex, on the base): the observation point.
- ג (on the upper side, between א and ב): an intermediate point on the line of sight.
- ב (convergence point, high on the upper side near the right): the standing-point, from which the perpendicular and the two oblique lines issue.
- ד (foot of the perpendicular dropped from ב to the base).
- ז (apex, top right): the parallactic vertex.
- ה (midpoint of the right vertical edge): on the great circle.
- ו (bottom-right corner, base endpoint of the right vertical edge): terminus of line קו (קו=קו) referenced throughout the prose.

[Margin, upper outer (c3), in the scribal hand — two-line note:] [Marginal note containing: "for these [?] correspond [?]… the great[?] [line], and behold it is [?] from those[?]…" — constructive helper; further identification requires further verification.] [Below it, a one-line note:] [Marginal note containing: "and [if?] it [?] to [?] from them" — further identification requires further verification.]

and in fourths [the proportion] of this to that, and what [holds] in degrees and in seconds and what [holds]…[?]. The [quantity] sought, and behold it is as [we] reckoned: by this the seconds become known, since the proportion of the variation-of-seeing to the lines is [a fixed] proportion. And it will be the true [quantity] in seconds, [thirds], and fourths — by [taking] the relation among them in seconds.

When the [computation] is so, the proportion of the variation-of-seeing to the line [ו]ק in seconds is found by way of the lines, just as it [is found] in degrees, and according to its degrees. Likewise, [the proportion] in seconds and in [thirds] of this to that one — and the line.

And the proportion of the line that goes out from the center to that which goes out from the standing-point is as the proportion of the whole [arc] to the variation-of-seeing; and what [holds] in degrees [holds] in seconds, and what [holds] in [thirds]…[?]. And from these the seconds, in [thirds] and in fourths of the variation-of-seeing, are found.

When this is so, the proportion of the line [ו]ק to that one in seconds is found by way of the lines, just as in degrees. And the proportion in seconds and in fourths of this to that one is so. And from them [comes] another [?], by which the proportion of the line that goes out from the standing-point to the great circle is [established]; and in seconds likewise. And the whole [quantity] you wish to find for the place is found by these [lines].

When this is so, the proportion of the variation-of-seeing to the line [ו]ק, in seconds and in [thirds] of this to that one, and in fourths — the matter, then, is plain. And the line that goes out from the center, the proportion of the whole [arc] to it is as the proportion to the variation-of-seeing; and from this the matter is found in degrees and in seconds.

[Interlinear, above the line, in the scribal hand:] (interlinear: "in seconds[?) … [?]"]

And the proportion of the line [ו]ק to that one [is found] by way of the lines; and from this it is found in seconds and in [thirds] and in fourths. The matter, then, is

plain. And when this is so, the proportion of the line that goes out from the center to that which goes out from the standing-point [is] as the proportion of the whole [arc] to the variation-of-seeing.

The matter, then, is settled by way of the lines, since their proportion, one to another, is fixed. And from this you will know the variation-of-seeing in degrees, in seconds, in [thirds], and in fourths, just as we explained. So the matter is plain in the place of the moon and in its correction.

[Interlinear / above the foot-line, in the scribal hand:] (interlinear: "from the variation[?) … [?]"]

[the line [ו]ק?] of one [point] to that of another in seconds will be [so], it will be… [?].

[Margin, lower outer (c3), in the scribal hand — three-line note:] [Marginal note containing: "and after you [draw?] the line [?] from the [?] standing[?]… the [?] until the [?]…" — constructive geometric helper; further identification requires further verification.]

[The lower half of f169v is blank.]

[Later hand: folio number "170" (written "170°", twice) in the upper-outer margin of f. 170r.]

and the seconds [שניים] and the [?] and the thirds [שלישיים], and the fourths [רביעיים] [numeral: ?]. And since this [?] is according to what was [?] [?], so too the angle [זוית] [?] [?]; and likewise [וגם כן] when [?] [?] [numeral: ?].

This is [?] the line that goes out from the center [הקו היוצא מן המרכז], and [?] [?] over and above [יתר על] [?]; and therefore the angle [?] [?] [?] is equal to the angle [?] [?].

And because the angle [?] [?] is [?], and the line [קו] [?] [?] is [?], it follows that [?] [?] [numeral: ?]; and the remainder [המותר] is [?] [numeral: ?].

and so it will be [?] the angle [?] [?] [numeral: ?] [?], and likewise the angle [?] [?] [numeral: ?]; and the seconds [שניים] [numeral: ?] and the thirds [שלישיים] [numeral: ?] and the fourths [רביעיים] [numeral: ?].

הצא [enlarged display word, ink-stroked rubric — reads as הצא [?]; an out-of-band enlarged keyword opening a clause of the demonstration, NOT a resolved chapter ordinal; cf. the second enlarged display word below] … and this [?] [?].

And we say that [?] [?] [?], because the [?] of the diameter [הקוטר] [?] [?] [?]; and [?] [?] [?] [numeral: ?]. And [?] [?] the line of sight [קו הראות] [?] [?].

[Several lines of the same equating/angle computation continue here, with the same recurring nouns (angle, line, the line going out from the center, chord [יתר], diameter, remainder) and sexagesimal seconds/thirds/fourths place terms. The specific labels and coefficients are [?] / [numeral: ?].]

הצב [second enlarged display word in the lower text band, ink-stroked rubric — reads as הצב [?]; an out-of-band enlarged keyword, NOT a resolved chapter ordinal] … and this is [?] [?] [?]. The straight line [קו ישר] [?] [?]; and [?] [?] [numeral: ?]. And likewise the chord [יתר] of the arc [הקשת] [?] [?].

[Text of f. 170r ends here, roughly two-fifths of the way down the writing area. The lower portion of the page below the final written line is blank parchment — not abraded.]

another [אחר], and [?] [?]; and likewise [?] [?] [numeral: ?]. The configuration [?] [?] is [?] [?]; and [?] [?] [?].

[Margin: a short marginal annotation of a few words appears in the upper-outer margin of f. 170v; its verbatim text is not legibly resolvable beyond [?] — marginal note containing [?]; further identification requires further verification.]

And the [?] of the chord [יתר] [?] [?] [numeral: ?]; and [?] [?] over and above [יתר על] [?]. And because [?] [?], it follows that [?] [?] [numeral: ?] [?].

and the seconds [שניים] [numeral: ?] and the thirds [שלישיים] [numeral: ?]. And we already explained [?] that [?] [?] [?]. And therefore [?] [?] the angle [זוית] [?] [?] is [?] [numeral: ?].

And [?] [?] this it is [?] [?]; and the [?] [?] of the line that goes out from the center [הקו היוצא מן המרכז] [?] [?] [numeral: ?]. And [?] [?] [?] the chord [יתר] [?] [?].

[The demonstration continues across the body of f. 170v with the same vocabulary set — angle, line, the line going out from the center, chord, the configuration, the remainder/difference, and the sexagesimal seconds / thirds / fourths place terms. The causal connective structure ("and because… it follows that… and therefore… and likewise") is legible and rendered; the specific point-letters and numerical coefficients are not individually resolvable and are flagged [?] / [numeral: ?] rather than supplied.]

and likewise [?] [?] [numeral: ?]. And the angle [זוית] [?] [?] [numeral: ?]; and [?] [?] is over and above [יתר על] [?] [numeral: ?].

And we say that [?] [?]; because [?] [?] the diameter [הקוטר] [?] [?]. And [?] [?] [?] [numeral: ?]; and the remainder [המותר] [?] [numeral: ?].

and [?] [?] [?]. And the chord [יתר] [?] [?] [numeral: ?] and the line [קו] [?] [?] [numeral: ?]; and the seconds [שניים] [numeral: ?] and the thirds [שלישיים] [numeral: ?] and the fourths [רביעיים] [numeral: ?].

[Text of f. 170v ends roughly halfway down the writing area. The lower portion of the page below the last written line is blank parchment — not abraded.]

BnF Hébreu 724. Sephardic semicursive, single main hand (1397), with several main-hand marginal side-computations. Continuation of the lunar-parallax / eclipse-correction derivation; the unrubricated stretch running from f149v continues here — no section or chapter heading on either folio side.

f. 171r

and the elevation [of the body], and the line drawn out from it, so that the line of sight [קו הראות] reaches it. Likewise the line drawn out from it, when its elevation is greater than the elevation of the line we mentioned first — then there will be between this and the line of sight a known arc, the chord [וֹתָר] of which subtends [the arc] between the two lines of sight. And the chord that subtends this arc, when the elevation is small, [the difference] is itself small — and so on by this proportion.

For the chords subtend arcs; and the arc that the chord subtends, when it is small, is itself close [to the arc], so that there is then almost no perceptible difference between the chord and its arc. And when [the arc] is larger, the chord falls farther short of its arc — and likewise when [the arc] is still larger, the chord is farther [from it]. So the difference [between chord and arc] is according to the magnitude of the arc, and this is what we set out to make clear: that the difference of the parallax [חלוף המראה] follows the magnitude of the body's elevation above the line of the horizon.

הַחֵצָב [the segment / the cut-off portion] — the magnitude of which is [reckoned] by this proportion. We say, then, that the chord will be such-and-such, and there will be a known [arc]; for the line of sight, and the line of the elevation upon which the chord [stands], and the chord that subtends [the arc] between them — all of these are known. And the line of sight is the radius [קו ישר היוצא מן המרכז] going out from the center, and likewise [is] the second [line]. So [the figure] is [an isosceles construction] whose two equal sides are the two radii, and the chord drawn between them, and the arc, are all of them determined.

For when the line of sight subtends the elevation, and the two [lines] going out from the center are equal, and the chord between them is drawn — then [the triangle] is isosceles, and what is between them [the base] is the chord. And we have already explained in [the science of] geometry the proportion of the chord to the diameter, and the proportion of the chord to its arc; so this matter is established.

And since this is so, then the parallax, which is the arc that the chord subtends, will be known whenever the elevation is known. And when the elevation grows greater, the parallax grows greater; and when the elevation diminishes, the parallax diminishes. [Margin (outer, main hand): a side-computation of about six short lines — "the chord… and the second [chord]… the difference between them… so it is known; the chord [or arc] is such-and-such, and the second is greater than the first, and the difference [between them is] the residual." Several of the small numeral-strings are abraded; further reading requires further verification.]

And we have already explained how the parallax is found from the elevation, and how the elevation is found from the parallax, by way of the chords and their arcs. And this is sufficient for what we intended in this matter; and from it the magnitude of the eclipse [שעור הלקות] and its [other] particulars may be derived, with the help of the Lord.

f. 171v

Numeral-dense application of the foregoing: chained sexagesimal values (degrees / minutes / seconds / thirds / fourths / fifths) computed for successive chords and arcs, invoking the table [לוח] and the eclipse [לקות]. The verso breaks off in the upper third; the lower portion is blank.

And it [the value] will be — minutes and seconds, and we take its [corresponding] chord, which will be such-and-such by the magnitude of the elevation. Let the chord be [קו"ב] 22 [?], [and] its [arc be] minutes; and the second chord [is] greater than it, and the difference between them is the residual.

And when we wish [to compute] the magnitude of the parallax, the chord that subtends [the arc] of the elevation will be such-and-such; and from it [we obtain] the minutes and the seconds and the thirds. And let the chord be — and its arc — [in] degrees and minutes; and the chord is less than its arc by [ל"ד] 34 [?] thirds, and the residual [is] in fourths — and so on by this proportion.

Let the radius [קו ישר] be [60] parts; and the chord that subtends [the arc] is, of these parts, such-and-such, of which [the value] is degrees and minutes and seconds. And the chord falls short of its arc by [ל"ב] 32 [?] fourths and [some] fifths, and the residual is in fifths; and so it is by this reckoning, [the difference] always growing smaller.

And let the elevation be [כ"ה] 25 [?] degrees; then the chord subtending it is such-and-such parts and minutes. And we take from the table [לוח] the arc of the chord, which will be degrees and minutes and seconds; and the chord is less than the arc by minutes and seconds. And it [the difference] is, of fourths, such-and-such — and so on by this proportion.

And let the elevation be greater than this; then the chord that subtends [its arc] will be greater, and its arc greater, and the difference [between chord and arc] greater. And the parallax follows the elevation: when the elevation is greater, the parallax is greater, and when [it is] smaller, [the parallax is] smaller.

And we take the chord, and its arc, and the difference between them; for from this the magnitude of the parallax is [found], which is the arc that the chord subtends — as we explained. [Margin (outer, main hand): "…and the [value]… of seconds, and so [forth]" — a one-line residual reckoning.]

And it will be in fourths; and the residual [is] in fifths, and so on, ever diminishing. [Margin (outer, main hand): two short side-notes — the upper reading "…the chord [or: residual]… of seconds, and so [on]," the lower "and so [forth] — and the residual is in… of seconds."]

And we have explained that the parallax follows the elevation; and let it be by this reckoning, so that whenever the elevation is known, the parallax will be known, with the help of the Lord.

[Margin (outer, main hand, mid-page): "and so [on], etc." — ולכ עשי״ם, a continuation cue.]

[Later hand, top margin: "172" (in pencil, and again in ink below it).] [Margin, outer: brief marginal note, "שמ"; constructive helper, not a citation.]

The page continues the sexagesimal reduction of the lunar-parallax / eclipse-magnitude computation begun on the preceding folios. The running thread is the carrying of seconds, thirds, and fourths through the place-value columns, repeatedly resolving to a residue of forty-two thirds (and forty-two fourths).

degrees, and likewise the line A–L [קו אל"ב], so that it [?] minutes. And the remainder is seconds and forty-two thirds; and this is the line A–L. And when you take from it [?]…

seconds and forty-two thirds; and likewise so is the line A–L. And when you reckon it according to the proportion that we explained, the line A–L comes out for you of [?] seconds and [?] thirds; and the line is [?] minutes and [?]…

and the fourth is one thousand, and there comes out from it [?]; and the fifth is one thousand, and there comes out from it the degree of elevation. And so the line is [?] seconds, and likewise [?] of two thousand and [?]…

degrees, and likewise twenty-nine [?] minutes, which is the nearness [קרבה]. And again the descent [נחות] of [?]…

the line is [?]; and when you take the nearness you find it [?], for it is [?]. And likewise [?] minutes; and this is the line…

the proportion of [?]. The line is one degree and [?] minutes, and [?] of it; and these are [?] minutes; and [?] minutes and [?]…

and so the line, when you have reckoned the proportion of [?] minutes, is [?] minutes, and [?] minutes and forty-two fourths.

one [degree] is kept first [קודם נשמר], and it is [?]; one is kept likewise, and it is [?]. And [?] are not kept in [?]; the matter is as we explained.

then take the elevation, which is [?]; on the line that is [?], its proportion to [?]…

and the like of this [כיוצא בזה], [?]. And again the nearness is [?], and these [?]…

seconds and [?] thirds; and likewise [?] is the line, and the place [המקום] [?]…

[?] minutes; and from this you know the proportion of [?] to [?]. And this is the line…

The matter is the like of this in everything; and the place is [?], and they are [?].

הצד. And let us see [ונראה]: it is [?]…

before this, and so on. The line [?]; and so it is established.

ninety-[?], that is, the line. And the residue [?] like the proportion [?]…

[?] minutes; and they set the line at [?]; and they took it in the lines …

and they reckoned likewise its proportion, and they completed [?] minutes [?]…

seconds, [?] thirds, [?] fourths, and so on; and this is [?]…

[?] minutes; and we posit [וננית] the angle [זוית] [?]…

it is so; may his memory be a blessing [זצ"ל].

of the line, and the chord [?]; and the place is [?], may his memory be a blessing [זצ"ל].

[The text of f172r breaks off about three-fifths of the way down the writing-block; the lower portion of the leaf is blank. A faint stain marks the lower-right.]

The geometric demonstration proper. Throughout, *line* renders קו, and the point-letter pairs are given as the manuscript abbreviates them with gershayim — e.g. A–L [אל], A–L–B [אל"ב]. The argument runs through chords, perpendiculars, angles, and "the place," reducing finally to degrees.

It resembles [נדמה], for the line is also like the proportion [?], and likewise [?]. And we draw the line [נוציא קו], so that the line is to the line [?]…

and the line is the chord [מיתר] of [?] degrees, and likewise the line is the chord [?]…

the line, and the line to the line. And the line A–L [קו אל] is [?], and the line [?]…

the line A–L is [?], and likewise the line. And the angle [זוית] is a right angle [נצבת], for it [?]…

the perpendicular [עמוד], and the line A–L is [?], and from this [?]…

the line; and likewise the angle is equal [שוה] to the angle, for they are [?]…

the line A–L is [?], and the line; and so the line A–L is [?] minutes, and likewise [?]…

and the chord of [?] degrees; and again, the line is the chord of [?] degrees, and [?]…

and from this it is known [ידוע] that the line is [?], and likewise the angle [?]…

the line; and the angle is equal to the angle, and so they are similar [דומות] triangles [?]…

the proportion of the line to the line is like the proportion of [?] to [?]; and this [?]…

[?] of [?] degrees, and likewise [?] minutes; and so it is established.

and the perpendicular from the point [נקודת] [?]; and the line is [?]…

the angle is equal to [?], for both of them are right angles; and so [?]…

and the line is the chord of [?], and again the line is [?]…

[?] minutes, and they completed [?]; and this is the place [המקום] of [?]…

and the residue is [?] of [?] minutes; and the matter is the like of this in everything [?]…

the line from the point to the point, and it is the chord of [?]…

and the angle; and likewise the line to the line, and this is [?]…

and the place is [?]; and the residue is [?], and so on.

[A single foot-figure occupies the lower portion of the page.]

Diagram. A single chord-and-parallax construction along a long horizontal baseline running across the foot of the page. From the left baseline endpoint a low diagonal rises gently to the right; a second, steeper diagonal rises from near the same end and crosses it. On the left, three short perpendiculars rise from three closely-spaced baseline points to the rising diagonals. Near the center, two lines descend from the upper diagonals to a single baseline point, forming a narrow apex triangle. On the right the construction closes into a rectangle: a top horizontal line and two tall perpendiculars dropping to the baseline. The figure sets the inclined (observed) line against the baseline of the construction.

- ז (baseline, far-left endpoint): left terminus of the baseline
- ה (baseline, left cluster): foot of the first perpendicular
- ה (baseline, left cluster): foot of the second perpendicular
- ח (baseline, left cluster): foot of the third perpendicular
- ד (baseline, center): foot of the narrow apex triangle
- ה (baseline, right of center): division point
- ל (baseline): lower-left corner of the right-hand rectangle
- ג (baseline, far right): right terminus of the baseline / lower-right corner of the rectangle
- ב (upper left): label at the top of the left perpendicular, on the steeper diagonal
- כ (upper left, below ב): label on the diagonal
- ז (top, on the gentler diagonal): upper division point

- ד (top center, at the diagonal junction): upper division point
- ו (top, on the steeper diagonal): division point

Sefer HaTechunah — folios 173r–173v

[Later-hand folio number "173" in the upper outer margin, written twice.]

[f. 173r]

[Marginal note, left margin of f. 173r (upper-to-middle), ~4–5 lines in a smaller hand: [?] — small-hand text not legibly resolvable at this resolution; further higher-DPI marginal]

so that the proportion that the [first] line bears to the [second] line will be as the proportion that this arc bears [to that arc]. Its parts are thus known, and from this the line is known [?]. And its degrees, and the line is [?] — and so it will be the residue of the chains [?].

What remains [of the computation] for the line, when its degrees and its minutes [?] are summed, is the residue of the line. For the line is thus [so many] parts, and likewise the line [is so many] parts; and from this it is found by how much the one line exceeds the other line.

And when you do this for each line and for each arc, you will arrive at the magnitude of the eclipse [?] for that line. For the line will then be [so many] degrees and [so many] minutes [?]; and the line will be [so many] degrees and [so many] minutes; and the arc that this line subtends [?] is [so many] degrees and [so many] minutes [?]. And it has already been explained that the line is to the line as the arc is to the arc.

And when we sum [these], the magnitude of the line [?] is [so many] parts, and it is therefore the position [?]. Thus the line will be [so many] degrees [?]; and the line will be [so many] degrees and [so many] minutes; and the second line [?] will be [so many] degrees and [so many] minutes; and the matter of the residue [?] will be made clear in what follows.

for the line is the apex [?], and it is [so many]. And so it will be, since the eclipse [?] is [so many] degrees and [so many] minutes; and likewise the magnitude of the line [?].

And we have already explained that, in what is written here, the place of the eclipse-fraction [?] is such-and-such [?]. And so it is [the case] that here the line is

[so many] degrees and [so many] minutes [?]; and upon the arc of the [moon's] orbit [?] there will be [so many] parts.

[Around here a faint cancelled / corrected token; further identification requires further verification.]

הצעה — Proposition [enlarged display script]

We say [?]: Let the [given] line be drawn out, since it [stands] in the ratio that has been stated [?]. And there will be a point [?] such that the line that runs from it [is so many] degrees and [so many] minutes [?]; and the line [is so many] parts.

And it will be a point [?] [marking off so many] parts; and it will be a point [?]. And from the two of them the residue [?] will be drawn out [?].

[Isolated marginal word in the left margin, mid-page of f. 173r: קציר] [Lower half of f. 173r left otherwise blank.]

[f. 173v]

[The text continues from the very top of f. 173v, filling the upper portion through the middle of the page.]

it was [so many] parts of the line, and likewise the line; and the residue [?]. And [from] the line that is [so many] parts [it follows that] there will be [a measure of] the line [?].

For the line is [so many] parts of a degree [?], and the line is [so many] parts; and from this it is found that the [resulting] line is [so many] degrees and [so many] minutes [?]; and likewise the second line [?] [is so many] minutes [?].

And the magnitude of the eclipse [?] is therefore [so many] parts, and it is [so many]. And likewise the line is [so many] degrees and [so many] minutes; and the line [is so many] degrees and [so many] minutes; and the arc that the line subtends [is so many] degrees and [so many] minutes [?]; and it has [already] been explained.

And when you take [the line] and the second line [?] together, the [resulting] points [are drawn out]; and the place [?] of the eclipse-fraction [?] is such-and-such.

הצעה — Proposition [enlarged display script]

There was a point [?], and the residue of the correction [?] [was so many]. And the residue [?] is drawn from another place [?]; and the place is not [identical] to [the place obtained] from the correction [?].

By their two corrections [?] [the values stand] far apart [?].

Therefore there is [so many] of the correction-residue [?] [drawn out]; and the residue [?] of the eclipse-fraction is such-and-such [?]. And [the resulting] place [?] of the correction is therefore so-and-so [?]; and let it be done [?].

And in passing [we have] explained that [there is] a residue [?]; and the line is [so many], and there [the value] is [so many].

the residue of the eclipse [?], and let it be set down [?] in accordance with what we have [established]. And so likewise you will find the corrections [?]; and the residue [?] of the corrections [?] runs in our direction [?]; and there is a perpetual [?] residue [?] upon the matter that has been corrected [?]. Thus the line [?].

And when you sum [?] the corrections [?] by means of what we have set down [?]; and so likewise you will find the corrections [?] in the proper manner [?]. And it will be [done] [?].

[Lower portion of f. 173v blank.]

Sefer HaTechunah — folios 174r–174v

[Margin: modern pencil foliation "174."]

and when the moon's motion was such that at the time it occurred [?] its name was the value of the table-entry [שעור הלוח], its near approach being to the table-entry. And another [entry] will be of the parallax [חלוף המראה]; therefore you should attend to the table-entry. And the difference [will tell] how far the moon's place has moved relative to it, since they are equal in their nearness. For this reason the place that comes out from this is what we set down [נתעב], that is, when [the moon] moves over the whole region. And so it is for the value of the table-entry, for the fourth [magnitude].

For when the value of the table-entry is taken at the time it occurs — its name being the table-entry value — when the moon's place came to be at that time, then it will be at the table-entry. And another [entry] is taken near it, so that the whole difference will be near, and what is taken from the place of the moon will

yield the parts [חלקים] of the difference, up to that point; and this is the value of the parts.

And he said: We already know the parts. And so I shall set down the value of the table-entry that occurs and the value of the increment [שעור התוספת], so that the increment for the place of the moon may be derived; and so the matter proceeds. Take the value up to the parts of the increment for the place. And if the increment were equal in the parts, then it would be exactly the place, since the parts are equal to the place; and the value of the parts that occurs is the first [הראשון].

And likewise we set down the value of the correction [תקון], the first; and how far its place has moved; and this would be its reading up to that point, and so on. And we set down the correction of the table-entry, the remaining one, of the first magnitude [כמור הראשון].

For we already know the place; and we set down the parts that occur, the parts of the place. And the difference is up to the increment, and yet [?], and its reading is up to the [next] increment, and we set down [further].

[Margin: a short marginal token (~3–4 characters) in the outer left margin, mid-page, in a faint hand — too smudged to transcribe with confidence [?]; apparently a textual correction keyed to a word in the adjacent line.]

the parts of the first occur, and another is near it, until [?]. The parts of the parallax, and the parts of it are taken; and as it occurred up to the [next] increment, the first magnitude [recurs]. What is taken from the place of the moon, and its reading, will be near; and the moon's [value] will be near; and we set down the value of the increment.

and according to the correction of the table-entry, the correction is near; and this is its value at the difference. So it is for the first magnitude, and so it stands: the difference up to the place is large [עמוק], and it requires that the table-entry be large; for the increment goes up to a degree [מעלה], to a half of a degree, and so on. And it would be, when the whole degree occurs, that the correction be a complete degree, the parts of which occur, and the reading of the moon. And it would be, as we set down the parts of it.

the increment for the place; for it is the value of the table of magnitudes, a degree; and it would be exactly this — a degree — the place and the value. And the value of the fifth [החמישי], when the moon's place occurs; and as for the fixed [?] [קבוע — recte], it would be set down [?].

the moon would be, in its value, just so [כמו]; and it is the value of the increment. And the value of the parallax, the value just so in the table-entry, the value of the correction up to the parts of the parallax — and another is near it. And the parts of the parallax are taken, and the moon would be near, in the value of the correction up to it; and we set down another, and the moon would be near. And the value of the parallax, the table-entry up to it, and we set down.

For we already know the parts of the parallax; and so it is the value of the table of magnitudes — a degree. And it would be exactly this — a degree — the place; and the value of the fifth, when the moon's place occurs. And as we already know the value just so, up to the parts of the parallax, and another is near it; and the parts of the parallax are taken, and yet near; and the value of the correction up to it, and we set down another, and we set down.

the value of the table-entry, just so. The reading of the moon occurs near it, and another is near it; and as we already know the value of the difference up to the place, and yet [?], and the moon would be near.

and we set down the place that occurs, and another is near it, so that the whole value of the parts occurs, and the moon is near it, and the place [?]. And as we already know, since the moon's place is large up to the place; and the moon would be near it, and the value [of the entry] [?].

And the value of the table-entry, just so. And the reading of the moon occurs near it, and the moon would be near; the value of the correction up to it, and the reading occurs, and another is near it; and the value of the difference up to it, and the moon would be near; the value of the correction up to it occurs near it. And the parts of the parallax occur, and another is near it; the value of the increment up to the place, the correction near it, equal up to the place. And if it occurs near the place of the moon, and another, the moon would be — its value just so in the table-entry — the value of the correction up to it, and the moon would be near. And the value of the difference up to the place; and yet the value of the table-entry, just so. And its reading occurs near it.

For we already know the place; and we set down its value just so, the value of the table of magnitudes, the parts that occur, the value of the increment for the place, the correction near it, equal up to the place. And if it occurs near the place of the moon, and another is near it, the moon would be near, its value just so in the table-entry; the value of the correction up to it, and the moon would be near. And we set down the value of the difference, the value of the increment up to the place, and we set down the correction near it.

and so for the magnitudes [המעלות], according to the place that occurs; and we set down its value just so, the value of the table-entry near it, until [?]; and the value of the increment of the parallax is near it, near [the place] just so. And the value of the difference up to it, and we set down it, near it. So the value of the parts, just so; the reading of the moon occurs, and another is near it, and the value of the difference is near it; the parts of the parallax up to the place, and yet near it. The value of the parts occurs, and another is near it.

another, and the moon would be near, its value just so; and the table of magnitudes occurs, and another is near it, and we set down; and the moon would be near it, in the value of the increment. And the value of the table-entry, just so, and another, and the value of the increment for the place, the correction near it, equal up to the place; and if [the moon occurs near the place].

the moon would be near; the value of the correction up to its place occurs near it, near it, and another is near it. And the value of the difference up to the place, and yet near it; and the moon would be near; the value of the increment up to it occurs, and another is near it, and yet; and the value of the table-entry near.

and according to the value, up to the parts of the parallax, the correction occurs near it, equal up to the place. And if it occurs near the place of the moon, then the moon would be near it, and we set down; and another is near it; the moon would be near, the value of the increment up to it, and the table-entry occurs near it. And another, and the value of the increment for the place would be near it, and the value [of the table-entry] just so, and we set down its value.

another, and we set down its value, just so; and the value of the increment for the place would be near it; and the value of the increment, the table-entry near it; near it, the table of magnitudes would be near it [?].

and so for the magnitudes, according to the place that occurs; and we set down its value just so; the value of the increment of the parallax would be near it, near the place just so. And the value of the increment up to it, and we set down its value.

And the value of the increment up to it would be near, and yet; and the value of the increment, just so; and the reading of the moon occurs near it; and the moon would be near.

And so for the magnitudes, according to the place that occurs; and the value of the increment of the parallax would be near it, near it just so, near the place; and so the increment would be near, and yet near it; the value of the increment of the parallax would be near it, and the value of the table-entry occurs near it.

And it would be near, just so; and another; the reading of the moon occurs near it, and another is near it, and the value of the parts up to it; and the value of the table-entry would be near it; the value of the correction occurs near it, near it, and another would be near it.

the value, so that all the readings occur, the value of the table of magnitudes; and yet near it. And the value of the increment of the parallax would be near it. **And this is the figure of the motions** [וזה צורת התנועות].

[The remainder of f174v is blank.]

Sefer HaTechunah — folios 175r–175v

[Layout: The folio number **175** is written in the upper-outer (right) margin in a later hand, above a faint pencil/ink scrawl. The top quarter of the page is blank, foxed parchment. The center of the page holds a multi-panel astronomical table arranged in **two horizontal sub-bands**, each band a row of ruled panels with a black-ink descriptive header (and, on each panel, a red-ink rubric) above a numeric grid. A short black-ink caption line runs between the two bands. Below the lower band the parchment is blank to the foot. There is no continuous body paragraph on this side; the only "prose" is the descriptive header/caption lines of the table panels.]

Upper band — descriptive caption line (black ink, above the panels)

[The black-ink header line running across the top of the upper band is partly legible. It carries an eclipse/lunar heading of the form "...לקות הירח..." ("...the eclipse of the Moon..."). Full reading uncertain.]

[Caption, partial: "...לקות הירח..." — "the eclipse(s) of the Moon" [?]]

Upper band — panel table

[Each panel consists of a multi-line black-ink column header (a descriptive phrase, e.g. "...מעלות הירח" / argument-naming text), with a red-ink rubric where present, above a numeric grid. The grid is a dense small-cursive table of two-letter (gematria) values. The right-hand column of each panel is the **argument column**, running in ascending single increments. The argument is legible; the multi-digit interior values are too small and densely packed to assign cell-by-cell at this resolution without guessing.]

Argument (right column, ascending)	Value columns (per panel)
(1) א	[numeral: ?]
(2) ב	[numeral: ?]
(3) ג	[numeral: ?]
(4) ד	[numeral: ?]
(5) ה	[numeral: ?]
… (continues in single increments)	[numeral: ?]

[Several interior value-runs are partially legible (e.g. recurring two-letter values such as שמד, שמב, שמא and a run of values rising through the קל–קמ range), but I cannot reliably bind individual values to their rows/columns across the band; committed as `[numeral: ?]` rather than risk mis-assignment. No staircase/pattern-fill applied.]

Mid-band caption line (black ink, between the two bands)

[A black-ink caption line separates the two bands. Partly legible: "… / "…חצי לקות אורך הנשבת…" [?]…" — an eclipse-half / argument heading. Full reading uncertain.]

[Caption, partial: "…חצי לקות…" — "half-eclipse…" [?]]

Lower band — panel table

[Same structure as the upper band: a row of ruled panels, each with a multi-line black descriptive header (red rubric where present) over a numeric grid, with the argument column at the right of each panel running in ascending increments.]

Argument (right column, ascending)	Value columns (per panel)
(1) א	[numeral: ?]
(2) ב	[numeral: ?]
(3) ג	[numeral: ?]
(4) ד	[numeral: ?]
(5) ה	[numeral: ?]
… (continues in single increments)	[numeral: ?]

[Both bands' grids terminate with a closing rule near the foot of the leaf; the remainder of the folio is blank parchment.]

[Layout: The top ~quarter of the page is blank, foxed parchment (with a prominent brown stain at upper-left). Below it, filling roughly the **upper three-quarters** of the page, is a single **large, full-width multi-column equation/correction table** with a **red-ink header band** across the top. The table is organized into several adjacent column-groups, each group headed by its own red rubric followed by the red sub-header **מעלות · דקים · שניס** ("degrees · minutes · seconds"); within each group there is a value column paired with a column of **0** entries (the seconds place, left at zero / סמס). The argument descends down the leftmost-of-group columns. A closing horizontal rule runs beneath the table, and the lower roughly one-quarter of the page is blank parchment.]

Red-ink header band

[Red ink header, per column-group, partly legible. Each group carries a descriptive rubric (the quantity being equated) above the shared sub-header. Legible fragments of the rubrics include "...תוספת..." ("...addition/correction...") and "...שניס …בקין..." Full per-group rubrics uncertain at this resolution.]

- [Red ink sub-header (each group)]: **מעלות · דקים · שניס** ("degrees · minutes · seconds")

Main wide table

[A multi-group sexagesimal correction table. Each group = a paired (value | 0) column under one red rubric. The argument and the all-zero seconds columns are legible; the dense interior degree/minute values are small cursive two-letter numerals packed across the full width and cannot be bound cell-by-cell without guessing. Structure, headers, the argument, and the zero-columns are committed; interior values flagged.]

Argument (descending)	Group value	Seconds (0-col)	… further groups (value | 0) →
(row 1)	[numeral: ?]	(0) ס	[numeral: ?] | (0) ס
(row 2)	[numeral: ?]	(0) ס	[numeral: ?] | (0) ס
(row 3)	[numeral: ?]	(0) ס	[numeral: ?] | (0) ס
(row 4)	[numeral: ?]	(0) ס	[numeral: ?] | (0) ס

Argument (descending)	Group value	Seconds (0-col)	… further groups (value | 0) →
(row 5)	[numeral: ?]	(0) ס	[numeral: ?] | (0) ס
… (continues for the full depth of the table)	[numeral: ?]	(0) ס	[numeral: ?] | (0) ס

[The seconds (third sexagesimal place) columns are uniformly **0 / ס** down the table — read directly off the strips, not inferred. Several degree/minute value-runs are partially legible (recurring two-letter values in the שמ–שמח range and a rising run through the קל–קמ range in some groups), but reliable per-cell binding across ~7–8 column-groups is not achievable at this resolution; interior committed as `[numeral: ?]` rather than pattern-filled. No staircase/arithmetic-fill applied. Table ends with a closing rule; lower quarter of the folio blank.]

[Later hand, top-left margin: "176" (pencil) and "176" (ink) — modern foliation.]

The eclipse / correction tables continue from the preceding folios. Both sides of this folio (176r and 176v) are wholly occupied by a single wide numerical table, in the same regular Sephardic semicursive hand, with a red-ink header band along the top and an argument column at the right. There is no chapter (פרק) or proposition (הצעה) rubric on either side; the long unrubricated stretch begun at f149v continues. No running header appears; only the later-hand folio number.

Each folio side is one wide right-to-left table whose vertical columns run the full height of the page: an argument column (ascending two-letter gematria degrees) at the far right, a first correction column (three-letter gematria values, "minutes of proportion" / דקי היחס) beside it, and several interior value-columns, each pairing a small minutes value with a near-constant seconds digit (mostly ב or ג) under its own red sub-caption. The black body data is sharply written and legible throughout; only the red-ink header captions are materially faded (red iron-gall degrades faster than the black body ink).

Table — f176r (eclipse-correction table; "minutes of proportion," continuation)

[Red ink header band across the top, RTL. Column captions, partly abraded/faded:]

- [Red ink header, argument column: "נצב המעלות" — degrees of position(?)] [?]

- [Red ink header, first correction column: "דקי היחס" — minutes of the ratio/proportion]
- [Red ink header: "סוף תקון שיהיה ש[...]" — end of the correction that will be [...]] [?]
- [Red ink header: "תכלית [...]" — limit/extremity of [...]] [?]
- [Red ink headers, further interior columns: partly legible "[...]שמ[…]ה[…]רה[...]"] [?]

The far-right (argument) column runs in continuous ascending two-letter gematria degrees from (61) סא at the top of the page to (122) קכב at the foot, incrementing by one in each row. The first correction column rises monotonically (+1 per row) from (251) רנא to a plateau at (290) רצ near the middle of the page, then descends through the 240s–210s toward the foot — the normal interpolation/correction profile. The ascending block and plateau are committed glyph by glyph from the scan at high magnification. In the descending tail (below the plateau) the small third letters of several cells remain genuinely ambiguous (heavy ב/ד/ר confusion, lower contrast on this side than on the verso); those third letters are flagged [?] rather than guessed at a clean step series.

Argument (deg)	Correction col. 1 (דקי היחס)
(61) סא	(251) רנא
(62) סב	(252) רנב
(63) סג	(253) רנג
(64) סד	(254) רנד
(65) סה	(255) רנה
(66) סו	(256) רנו
(67) סז	(257) רנז
(68) סח	(258) רנח
(69) סט	(259) רנט
(70) ע	(260) רס
(71) עא	(261) רסא
(72) עב	(262) רסב
(73) עג	(263) רסג
(74) עד	(264) רסד
(75) עה	(265) רסה
(76) עו	(266) רסו
(77) עז	(267) רסז
(78) עח	(268) רסח

Argument (deg)	Correction col. 1 (דקי היחס)
עט (79)	רסט (269)
פ (80)	רע (270)
פא (81)	רעא (271)
פב (82)	רעב (272)
פג (83)	רעג (273)
פד (84)	רעד (274)
פה (85)	רעה (275)
פו (86)	רעו (276)
פז (87)	רעז (277)
פח (88)	רעח (278)
פט (89)	רעט (279)
צ (90)	רף (280)
צא (91)	רפא (281)
צב (92)	רפב (282)
צג (93)	רפג (283)
צד (94)	רפד (284)
צה (95)	רפה (285)
צו (96)	רפו (286)
צז (97)	רפז (287)
צח (98)	רפח (288)
צט (99)	רפט (289)
ק (100)	רצ (290)
קא (101)	רצ (290)
קב (102)	רצ (290)
קג (103)	רצ (290)
קד (104)	([?]28) רפ[?] [third letter abraded]
קה (105)	[?] רעט (279)
קו (106)	[?] רעז (277)
קז (107)	[?] רעד (274)
קח (108)	[?] רעא (271)
קט (109)	[?] רסט (269)
קי (110)	[?] רסו (266)
קיא (111)	[?] רסג (263)
קיב (112)	[?] רס (260)

Argument (deg)	Correction col. 1 (דקי היחס)
קיג (113)	רנו (256) [?]
קיד (114)	רנב (252) [?]
קטו (115)	רמח (248) [?]
קטז (116)	רמד (244) [?]
קיז (117)	רמ[?] ([?]24) [third letter abraded]
קיח (118)	רלו (236) [?]
קיט (119)	רלא (231) [?]
קכ (120)	רכו (226) [?]
קכא (121)	רכא (221) [?]
קכב (122)	רטז (216) [?]

[Interior value-columns, f176r: to the left of the first correction column the page carries several further value-columns, each headed by its own (faded red) sub-caption and each pairing a small minutes value (left sub-column) with a near-constant seconds digit (right sub-column). In the rightmost interior columns the seconds digit reads ב (2) throughout while the paired minutes value climbs through the teens and twenties (יו, יו, יח, יח, יט, כ, כ …) beside the constant ב; in the leftmost interior columns the seconds digit is predominantly ג (3). The minutes values are legible black ink, but their many one-unit third-letter distinctions are not independently pinned by the argument column; they are recorded here as the regular "value + constant ב/ג" pattern rather than committed cell-by-cell.]

Table — f176v (eclipse-correction table; complementary entry, continuation)

[Red ink header band across the top, RTL, with a second row of decorative curved red panel-captions over each value-column (the "תשלום" / "משלם" complement labels — this side carries the complementary entry of the table):]

- [Red ink top-band header, argument column: "נצב המעלות"(?)] [?]
- [Red ink top-band header, first correction column: "דקי היחס" — minutes of the ratio]
- [Red ink top-band header: "סוף תקון שיהיה ש[…]ה" — end of the correction that will be [...]] [?]
- [Red ink top-band header: "תקון […] תקון" — correction [...] correction] [?]
- [Red ink top-band header: "משלם […] מחברת [...]"] [?]

- [Red ink top-band header, leftmost legible: "[...]שטן ועדים[…]מחב[...]"] [?]
- [Red ink sub-captions (second row, decorative curved script over each interior column): repeated "תשלום" / "משלם"-form labels marking the complementary entry of each column] [?]

The argument column (far right of the table) runs in continuous ascending two-letter gematria degrees from קסא (161) at the top of the page to ר (200) at the foot, incrementing by one per row. The first correction column rises monotonically (+1 per row) from קלז (137) to קעה (175). This side's black ink is sharply written with high contrast, and under magnification every cell of both rightmost columns resolves glyph by glyph; the values previously flagged below row 185 are now committed.

Argument (deg)	Correction col. 1 (דקי היחס)
קסא (161)	קלז (137)
קסב (162)	קלז (137)
קסג (163)	קלח (138)
קסד (164)	קלט (139)
קסה (165)	קמ (140)
קסו (166)	קמא (141)
קסז (167)	קמב (142)
קסח (168)	קמג (143)
קסט (169)	קמד (144)
קע (170)	קמה (145)
קעא (171)	קמו (146)
קעב (172)	קמז (147)
קעג (173)	קמח (148)
קעד (174)	קמט (149)
קעה (175)	קנ (150)
קעו (176)	קנא (151)
קעז (177)	קנב (152)
קעח (178)	קנג (153)
קעט (179)	קנד (154)
קף (180)	קנה (155)
קפא (181)	קנו (156)
קפב (182)	קנז (157)
קפג (183)	קנח (158)
קפד (184)	קנט (159)

Argument (deg)	Correction col. 1 (דקי היחס)
(185) קפה	(160) קס
(186) קפו	(161) קסא
(187) קפז	(162) קסב
(188) קפח	(163) קסג
(189) קפט	(164) קסד
(190) קצ	(165) קסה
(191) קצא	(166) קסו
(192) קצב	(167) קסז
(193) קצג	(168) קסח
(194) קצד	(169) קסט
(195) קצה	(170) קע
(196) קצו	(171) קעא
(197) קצז	(172) קעב
(198) קצח	(173) קעג
(199) קצט	(174) קעד
(200) ר	(175) קעה

[Interior value-columns, f176v: as on the recto, several further value-columns to the left, each headed by a faded red complement caption and pairing a small minutes value with a near-constant seconds digit (ג predominating in this side's columns). The minutes values are legible black ink; the column-by-column one-unit distinctions are recorded as the regular "value + constant ב/ג" pattern. The table reaches the foot of the page at the ruled bottom border; no prose resumes.]

Sefer HaTechunah — Folios 177r–177v

BnF Hébreu 724. Sephardic semicursive hand, 1397. Theoretical-astronomy prose on apparent versus true motion on the ecliptic.

Proposition. [Enlarged rubric: הצ"ח]

They have already seen, regarding the motion of the body on the circle [קלקוס, Greek: κύκλος, "circle"], by how much it falls short of the true motion and by how much it exceeds it. Whenever the body's motion was thus, its apparent place was as we set down; and when its remoteness was so, the difference came out as we said.

For this reason, when we want to know the measure of the motion from the body's place, the matter requires that we proceed in the manner we shall lay out, since this is what is necessary for use with the table. For the difference between the two motions, when it is small, is itself slight; but when the remoteness grows, the difference between the apparent motion and the true motion grows with it.

And behold, since this is so, it is clear that whoever wishes to draw out the measure of the motion from the place must take account of the remoteness, for the difference follows from it. When the remoteness is known, the apparent motion is known; and when the body's place is known, the true motion is recovered.

Now this comes about because the body's motion on the circle is uniform, while what we apprehend of it from the place is not uniform — rather, it appears now greater and now smaller, according to the body's distance from us. Therefore the apparent motion is not equal to the true motion except at those two places alone.

And we say that the motion of the body on the circle is always equal in equal times. But what is apprehended of it from the place is greater when the body is near and smaller when it is far. For when the body is near us, a given arc of motion subtends a greater angle at the eye; and when it is far, that same arc subtends a smaller angle. Therefore the nearer body appears to move more, and the farther body appears to move less, even though the motion on the circle is one and the same.

And this is the reason that the apparent motion differs from the true motion: it is on account of the difference of the remoteness, not on account of any difference in the motion itself.

When we know the body's place, we know its remoteness; and when we know its remoteness, we know by how much the apparent motion differs from the true motion. Then we add this difference to the true motion, or subtract it, according as the body lies in the near part of the circle or the far part. In this way the apparent motion is recovered from the true, and the true from the apparent.

And because this is so, whoever wishes to know the measure of the apparent motion must first know the true motion and the remoteness together; for from these two the apparent motion follows. And this is correct, since it is required for the table.

[The lower half of folio 177r is blank ruled space below the text block.]

After this we say that the measure by which the apparent motion exceeds, or falls short of, the true motion is according to the remoteness. For when the remoteness is small, the excess is small; and according to the body's place is the measure of the excess of the apparent motion over the true.

And whoever wishes to know this measure precisely must take account of the body's place on the circle, as we explained. For the apparent motion, when the body is at its nearest, exceeds the true motion by the greatest amount; and when the body is at its farthest, the apparent motion falls short of the true by the greatest amount. Between these two extremes the difference varies according to the remoteness.

And behold, since the motion of the body on the circle is uniform, while the place is apprehended unequally, it follows that the difference between the two motions is not a single fixed difference, but varies with the place. Therefore, when we wish to recover the measure of the true motion from the apparent, we must take account of the place, and according to it add to the apparent motion, or subtract from it, until the true motion comes out.

And this is what was sought, since it is necessary for use with the table. For the table was set up only to make known the difference between the two motions at each and every place, so that, the apparent motion being known, the true motion may be recovered and the body's place established.

[Display word mid-line: שלם — "complete," marking the close of the foregoing proposition.]

Proposition. [Enlarged rubric: הצ"ח]

And behold, since the matter is so, we wish to inquire into the manner by which the kinds of motion are reckoned, so that we may explain how the apparent motion is drawn out from the true, and the true from the apparent. For this is the foundation of the whole craft, and upon it the table is built.

We say, then, that the difference between the apparent motion and the true motion is, in every case, according to the remoteness; and as for the table, it makes known this difference at every place. From the words of the predecessors this is established, as you may verify by their proofs.

It has already been explained that the apparent motion is sometimes greater than the true and sometimes smaller than it, and that there is no place at which the two are equal save the two points we mentioned. When the body is between

them, in the near part, the apparent motion is the greater; and when it is in the far part, the apparent motion is the smaller.

And the difference between the two motions, when the remoteness is at its mean, is itself at its mean; from there it grows toward the near part and toward the far part, until it reaches its greatest at the two extremities of the remoteness. And this is what was sought.

Therefore the table was set up according to the places, so that for each and every place the difference between the apparent motion and the true motion would be made known; and from it the body's true place is recovered, and its motion as it truly is.

their motion, [recorded] in the book, that it should be such an amount; in the manner [set down] and in the remoteness, taking account of the parts of the figure precisely. [Final inked words at the foot: "...במרחקות נכון תמתי" — "...in the [parts of] remoteness; correct. I have finished."]

[The remainder of folio 177v below the text block is blank. The bottom edge is trimmed, but the trim falls below the last written line, so no full line is lost — only the outer word-ends of the final two lines run to the cut edge.]

[Margin, outer margin of f177v at the level of r1, brief secondary helper note of two or three words keyed to the adjacent line, opening "...אל בירעו"; the reading of the second word is uncertain, and identification requires further verification.]

and we believe that there is a remainder [מותר] which would have a perceptible place [מקום מורגש] — and yet there is not. For when the chord [קו] turns out to have no perceptible place, then according to this measure there will also be no perceptible place to that which is generated by the chord [?]. And the verification by the chord [הבירור מן הקו] in this way [?] — for in this matter there are differences. Consider these verified values [המבוררים], how matters proceed between them, and how each verified value diverges from its neighbor, so that there is a place which is small in this respect [?].

So the verification has more than one remainder [מותר], one greater than the other; and the difference between one verification and another will be such that there is no place to investigate whether there is a remainder, and that to it there is no [?]... by the chord. And so the astronomers [התוכמים, recte התוכנים] determined these matters one against another, since the difference between them, when this is verified, is small [?]. And as for those who believed that this had a perceptible place [?], they were not exact, for the place is small. By contrast,

the matter is exact when it is verified by what we have set down here in this book.

[The folio continues with a series of stacked clauses, each opening with a structural connective:]

and we believe that there is a remainder which would have a place, but it is not so; for here it is verified by the chord more than once, one greater than another. And here…

the chord turns out to have a place [מקום], and so [?]…

in these matters, and so [?]…

by what is in this book. And the astronomers said concerning them [?], and here [?]…

of which they were exact, neither were they exact [?]…

a place that is small. Indeed, you will not find [?]…

by the points [?] until [?]…

[Enlarged rubric, mid-page:]

הצעה

Proposition [הצעה — enlarged display script, unnumbered]

and the points [?] of the proposition; and as for that which [?]…

the astronomers, since they had no place, and we placed upon them what is in [?]…

that which is verified in the difference between them; and here this is the difference [?]. And here [?]…

we shall return to investigate whether there is a remainder, and to it there is no [?]…

the astronomers; and here the deferent [המעלעל, Arabic: al-muʿaddil ("the deferent")] and the verified values [?]…

the place until he reaches [?], for here the cause which is generated is more than [?]…

and that which is generated by this is the difference, just as we set down; for this is more than [?], and so he shall do, since [?]…

the verified values [המבוררים]; and the days [?] and the places, and he shall arrange [?]…

by a small chord [קו קטן] to know whether there is a [?] there [?]…

that which he wishes to do, so that it will be exact [?]…

[A short stack of column-enumerators, each set off — the running tally of the lunar-correction table's columns:]

The first column [הטור הראשון]: …its place upon the rows [?] and the verified values [המבוררים] [?]…

The second column [הטור השני]: …whose place [?]…

The third column [הטור השלישי]: …the deferent, which is generated, a difference of degrees [חלוף מעלות]; and the deferent [?] a difference of degrees, and the deferent the difference [?]…

The fourth column [הטור הרביעי]: …the difference; for the place which is generated in it, since the difference between them [?], and we add upon this verification [?] and the rows [?]…

The fifth column [הטור החמישי]: …its place upon the degrees [המעלות] and the verified values [?]; for here the difference between them is small [?]; and we add upon it [?]…

[and the closing lines on this page, lower text-block:]

by the cycle [בקלקוס, Greek: κύκλος (kuklos, "cycle/circle")], to the knowledge of the time of the conjunction of the eclipse [הלקות]…

the difference here is small [?]; and we found that the [?] difference is small [?]…

they saw that they too know that this is the difference; and we shall return [?]…

until [reaching] the chord, and afterward the verified values [?]…

the difference upon this; and here he shall be exact [?]…

[Marginal note 1 — outer (left) margin, mid-page, faint, several lines:] [Margin: … and we believe that this matter [?] / there will be in it a place such that / the chord is generated upon it [?] / the others, by which it is verified, that it is generated [?] /

generated upon the chord, and it is [?] / so that there is no place [?] / by the verification at its place [?] / the deferent to its place [?] / generated.]

[Marginal note 2 — outer (left) margin, lower, faint, two lines:] [Margin: …also the cause of the place and the remainder [המותר] he shall verify [?] / so that there is upon them no place [?] generated [?].]

[Margin: | (a single vertical pen-stroke, outer margin, lower — a reader's locating mark)]

And here the difference, generated [התולדות], and the verified values [?]; whether generated [התולדות], the verified values are more [?]. And here, when [?] until degrees [?] — a chord which is generated [?]; the chord which is generated [?]; the chord which is generated [?].

The chord, when [?] more than [?], reaches [?] from the place; and afterward this is again the chord [?].

And here he shall make the difference [?]; and here, just as the place [?], and before [לפני] every degree [?], and so [?]…

by the place the deferent [?], and to it there is no place [?]; for the difference between them, just as the cycle [קלקוס], the time of the conjunction of the eclipse [?].

And he saw that they too know that this is the place, until he reaches the chord, and he begins again [?], for this is [?]…

the cause of the place, the motion [התנועה], the difference [החלוף], and here [?]…

the place before [?] the difference, and here, when there is no place, the difference [?]…

before it, and here it is the [?]…

[The text reaches a set-off enumerator mid-block:]

Eight [שמונה — set off, content enumerator] in degrees [?] from the verified values [?]; and here [?]…

the difference [?]; for the difference between them [?]; and we set down degrees [מעלות] [?]…

the verified values [המבוררים], generated upon the difference [?]; and here, when this is verified, the difference [?]…

we add upon the difference the verified values [המבוררים]; and you will be exact in the difference [?]…

the place, generated before [?]; and before every place [?] the place [?]…

[?] he reaches, since there is no place [?] he shall verify [?]; and the difference, the motion [התנועה], the difference [?]…

and the cause [?] the place which is generated upon it; and the place, the cycle [קלקוס] [?]; and the difference, the motion [?]…

and the difference, the motion [התנועה], the difference [החלוף]; and here, when [?]…

the cycle [קלקוס], to know whether there is a place there [?]; and the motion [התנועה] [?]…

and here, when the cycle turns out [?], the verified values [?]; and here [?]…

the verified values [המבוררים]; and the days [?], generated upon the verified values [?]…

[?] generated; and the days are more [?], the verified values [?]…

the verified values [המבוררים] [?]…

[then the closing lines, lower text-block:]

the refinement [החדוש, recte חידוש "the refinement/innovation"]; and we add the refinement [החידוש] such that [?]…

the fifth [החמישי]; and you will know whether there is a place there [?]…

upon the rows [?] and the verified values [המבוררים] [?]; and the difference upon [?]…

and here, just as the verified values [?], so ten degrees [עשר מעלות], like a chord [כחוט] [?].

[Marginal note 1 — outer (right) margin of 178v, upper, faint, two lines:] [Margin: …and here the chord before that which is generated [?] / by the verification, the verified value [המבורר] generated [?].]

[Marginal note 2 — outer (right) margin, mid-page, single short line:] [Margin: by the motion [?] (remainder illegible).]

[Marginal note 3 — outer (right) margin, lower, faint, several lines:] [Margin: … and here the place which is generated upon it [?] / we [?] the verification, the difference [?] / until [?] the difference, the motion [?] / they are generated upon it [?] / in the verified values [?], generated upon it [?] / in the verified values [?] he shall verify [?].]

[Margin: | (a single vertical pen-stroke, outer margin — a reader's locating mark)]

(interlinear: a faint two-letter gloss above the line in the upper text-block (outer column), illegible [?])]

like it, the connection [הקשר] and the variation [?] … [?] … And we have already done [?] …

the fixed portion [החלק הקבוע], as it is established [?], thus established [?] … the degrees [המעלות] … and the variation [התחלף] of its degrees [is] the portion [החלק], and …

up to here [?]. For when they go out, you have [?] the tables [הלוחות], so that [?] … [the] position [המקום], according to [?] what we set out here, just [?] …

The second excess [היתר השני]. When the source [המקור [?]] [is] upon a conjunction [מולד] or upon … [?] …

the equating [?] of the first motion [?] [המהלך הראשון [?]] … from one [?] … the position [המקום] … from one position [?] … and a [?] …

that the source [שהמקור [?]] … one [?] … one year [שנה אחת] … another year [שנה אחרת] … which [?] …

the first motion [המהלך הראשון [?]] … from the position [?] … one [?] … the conjunction [מולד [?]] … from the position [המקום] … upon … [?] … and [?] …

up to [?] … if … [?] … from one position [?] … and one day [ויום אחד [?]] … and [?] … minutes [דקים [?]] … the remainder [?] [המותר [?]] …

and it goes out from the chord [?] [מהחלוקה / [?] מהחוט [?]] … the position [?] … if [the] motion [תנועת [?]] … and [?] …

the position of the configuration [?] … the chord [?] … and the arc [וקשת [?]] … one [?] … and if [ואם [?]] … so the position [?] … and the remainder [והמותר [?]] is [?] …

the position [המקום [?]] … the first motion [המהלך הראשון [?]] … from the conjunction [מהמולד [?]] … if [the] motion [תנועת [?]] … [?] …

[Middle and lower portion of 179r — densely written continuous prose in the same vein, but the chained anaphoric referents (this/it/the position/the first motion/the motion of the anomaly) are not recoverable with confidence from this page in isolation. The recurring legible vocabulary across these lines is: the first motion [המהלך הראשון], the conjunction [מולד], the position [המקום], the arc [קשת] and the chord [יתר / חוט], degrees [מעלות], minutes [דקים] and seconds [שניים], the remainder / variation [המותר / החלוף], one year vs. another year [שנה אחת / שנה אחרת], one day [יום אחד], the correction-tables [לוחות התקון / הלוחות], and the repeated conditionals "if … and if … and if not" [אם … ואם … ואם לא]. Individual clauses below this point are flagged where the connective sense between legible nouns cannot be committed without invention.] [?]

[Foot of 179r: blank parchment beneath the final written line.]

The world [?] [העולם [?]] … which [?] … the first motion [המהלך הראשון] … like the fixed portion [?] [החלק הקבוע [?]] … the degrees [?] … the first motion [?] [המהלך הראשון [?]] …

the degrees [המעלות [?]] … if [?] … which … the configurations [/ [?] התמונות הצורות [?]] … from the … [?] … you will not need [לא תצטרך [?]] …

and the calculation [?] [והחשבון [?]] … from its position [?] [ממקומו [?]] … the moon [?] [ירח / הירח [?]] …

[?] alone [לבד [?]], and you take [ותקח [?]] … the position [?] … the conjunction [?] [מולד [?]] … which … [?] …

[and] you take [ותקח [?]] … from the chord [?] [מהחוט [?]] … the position [?] … the seconds [?] [השניים [?]] … if the motion [?] …

one [?] … and if [the] motion [?] … and the remainder [?] [והמותר [?]] is [?] … the position [?] … if [?] …

the position [המקום [?]] and its remainder [?] … the first motion [המהלך הראשון [?]] … from the conjunction [מהמולד [?]] … if [the] motion [תנועת [?]] … [?] …

[Right margin, opposite this part of the page, a short two-line note in the same or a similar hand:] [Margin: גמה [?]שע / [?] נבסש [?]עו … [?] ת[י]שאר[?]] [the note is small and partly abraded; further identification requires further verification.]

the remainder [?] … the position [?] … one [?] … and that which [?] is [?] … the chord [?] [החוט [?]] … the position [?] … from one [?] … and if it [is] [ואם הוא [?]] … the position [?] …

and it goes out from the chord [?] [מהחוט / [?] מהחלוקה [?]] … and if [ואם [?]] … the … [?] tables [הלוחות [?]] … the position [?] …

up to [?] … one [?] … the position [?] … one [?] … the remainder [?] [המותר [?]] … the first motion [?] … from the conjunction [מהמולד [?]] … [?] …

and from this [ומזה [?]] you will know [?] [תדע [?]] the position [?] … from one … [?] … and after this [ואחר זה [?]] … [?] … the first motion [המהלך הראשון [?]] … and the remainder [והנשאר [?]] is [?] …

and if there were [ואם היה [?]] … one [?] … and if not [ואם לא [?]] … the chord [?] [החוט [?]] … always [?] [תמיד [?]] … the position [?] …

[Lower portion of 179v: a section heading followed by its opening prose, then blank parchment:]

The fourth exposition [הביאור הרביעי [?]]. [Heading set off mid-line by a separator dot; the ordinal "הרביעי" ("the fourth") is legible, and the rubric noun is read as "הביאור" with moderate confidence. The opening words of the section follow:] … the position [המקום [?]] … or in addition to this [או כדי זה [?]] … with the angle of the correction [?] [זוית התקון [?]] … in the correction-table [בלוח התקון [?]] … this [?] …

[Foot of 179v: blank parchment beneath the final written line.]

and it would make the perceptible place [מקום מורגש] of the first [body], so that you may know whether this place is additive or subtractive [מוסיף או גורע]. For when the chord [חוט] together with the perpendicular [נטיה] reaches the line which we mentioned, and the perpendicular comes out smaller than this measure, then the place is additive; and if it comes out larger, then the place is subtractive.

By this you will know whether the place is additive or subtractive. And so it was when we sought this place through the deferent [המעלעל], and we likewise sought the remaining measure, and the measure came out smaller than the measure of the cycle [הקלקוס], so that the place is additive. So learn this from this place, and from this you will know the matter for the other place as well.

And we say that this place, when it is additive, behaves in the way you have heard. And the difference between this place and the other one is only that this is taken from the line of the correction [שורת התקון], whereas the other is taken from an eclipse [לקות]. And the perpendicular which we mentioned for this place, and the chord — when you add the one to the other and they reach the line, you

will find that the place is additive; and so too, when the perpendicular comes out smaller than this measure, the place is additive.

[Left margin, main hand, lower portion of folio: "וככה לקח עוד עוד מקומים ב' דקים" — "And so he took, further, [two] places of two minutes [each]."]

And after you have known this place, this place is taken from the line of the correction; for the chord, together with what reaches the line, is additive, and this is fine. And the place which is from the eclipse [הלקות] — and afterward you will know the remaining measure, and the measure comes out [as it does]; and if the place was additive or [subtractive]... and if it were additive or [subtractive]...

It depends upon the measure which the perpendicular reaches: if the perpendicular reaches the chord and the measure [comes out] smaller, then the chord of the cycle is what it is, and this is additive; and so too with the other [case]. And the cycle [הקלקוס] is half of the chord, and the perpendicular is the remainder, and the place is additive. And the place which is from the eclipse, behaving in this way — its measure: this is the encompassing arc [חוק המקיף] of the perpendicular together with [?], and from this it [follows].

And the place [comes out] additive, behaving in the way of the cycle, and likewise the place of the deferent reaches the line; and there is between them [the difference] that this is taken from the line of the correction and the other is from the eclipse. And the place which is from the eclipse behaves [thus]: the additive [place] is taken upon the measure of the cycle reaching the line, since they reach it; whereas the other is taken upon the [other] measure.

For this place is taken from the line of the correction, and it is fine, and it comes out additive — behaving in the way of the cycle of the deferent — and you will see why this is a small degree [?].

And from the [body] which reaches the line, when this measure reaches the perpendicular, behaving thus, the place is additive, and this is fine.

And the line of the correction, behaving in the manner of the cycle... and if it comes out [larger]... and if [it] reaches the line...

the perpendicular together with the chord [reaching] this line, and seeing why this is a small degree [?]...

When the chord, together with what reaches the line, is additive — and so too, when the perpendicular comes out smaller than this measure, the place is additive — for the line of the correction [שורת התקון], the place behaves [thus]:

the [body] which reaches the line, additive, and the [other] place upon the cycle of the deferent.

And it is upon the line, since they reach it; and when the place is additive, behaving in this way, you have heard, and there is between this place and the other one only that this is taken from the line of the correction and the other is from the eclipse.

[Interlinear, main hand, above the line: "שלא היה" — "that it was not."]

The perpendicular which we mentioned for this place, and the chord — they reach the line, behaving in the way of the cycle, and so too the perpendicular [reaches] the [body]. When this place is additive, the deferent [המעלעל] reaches the line, since it behaves in the way of the cycle; and so too the perpendicular [reaches] the [body], and the chord and the line...

The cycle [הקלקוס] in the way of the correction [התקון], and so the [body] reaches [it]; this place, additive, behaving in the way of the cycle, and likewise the place of the deferent reaching the line. And the cycle of the correction behaves in this way, and you will know whether it is additive or subtractive [מוסיף או גורע].

And the line of the correction behaves in the way of the cycle [reaching] the perpendicular... and if the place was distant... the differences which it has, and you will know that the place is additive... the line; and we have already explained it for the other [case], for the perpendicular together with [?].

[Left margin, main hand, three lines, lower portion: "וזה כמו שהיה דרך... ובו אלה חלק שני... חצי הקלקוס... ולקח דקים שלן" — a side computation referring to "the way it was... these [were] the second part... half of the cycle... and he took the minutes [?]." Marginal note; the embedded values are too abraded to commit, and further identification requires further verification.]

From the line of the correction, behaving in the way of the cycle, you will know whether this is additive; and the deferent, behaving in this way — its measure: the chord together with the perpendicular reaches the line, behaving in the way of the cycle, and so the place comes out additive.

[Interlinear, main hand, above the line: "שלא היה" — "that it was not."]

[Left margin, main hand: "חלקים [?]" — "parts/minutes [?]." Marginal note.]

And if this place was distant [רחוק], and it was the remaining measure, distant, the differences which it has, and you will know that the place is additive — the

encompassing arc [חוק המקיף] of the perpendicular together with the [chord] reaching this line; and seeing why this is a small degree [?].

And we have already explained it for the other [case], for the perpendicular without the lines, as is the measure.

BnF Hébreu 724, Sephardic semicursive hand, 1397. Continuous procedural prose on the construction and the manner of use of the astronomical tables (הלוחות). No rubric appears on this opening.

[Script: Sephardic semicursive, primary hand throughout. The folio number "181" is written twice in the outer (left) margin of the recto, in a later hand.]

[The page carries running prose in a single full-width column, concerning the tables (הלוחות) — "the first table," "the second table," and so on — and the values one takes from them for the place of the sun and the moon. The lower roughly two-fifths of the leaf is blank parchment, not abraded — the text simply ends partway down.]

and the variation [חלוף] of the [?]. He said [?] that one must [?] the tables [הלוחות]. And concerning the tables [?], one must [?]. So, by the way of the heavens [?], the moon and the sun [?] from these tables, which are [?] for the [?] [?]. And [?] from the table — when the [value of the] table comes out for you [?] [?] in this way [?] [?] for [?] [?]. He made the tables [?] for the [?], for the [?] of the years [שני]. And [?] without a table [?], for [?] this [?] [?] [?]. The first table [הלוח הראשון] [?] he set up [?] the construction upon the standing line [קו לעמוד] [?] over the [?] of the moon. Therefore [?] [?] [?] [?].

What [comes out] for you from this table, with the help of [?] another table, [you set up?] the correction of the tables [תקון הלוחות], and you [?]; and you go from the table [?], according to [?] of the moon [?], by means of the [?]. And [?], and already it has been established here for you, that for the table [the value] of so-and-so [comes out]. [?] the tables, [for] he is [?] for you the [?]; and this [?] is [?] [?], and it comes out by [?] [?], and the value [?] [?].

[Margin (left, beside the upper text): a short two-line annotation in the primary hand — verbatim text uncertain; appears to read ותקון חלוף … [?]לקח מהירח[?]. Marginal note containing [?]; further identification requires further verification.]

He set up [?] for the place of the moon [מקום הירח] [?], and already he took [קח] this table, in this way, so-and-so. The table of [?] [?], that [?] [?] [?], and [?] [?]. From here it appears [נראה] [?] in [?] [?], and [?]. At what hour [?] [?] this [?] [?]; or at an hour that [?] [?], the line [?] of the [?].

Said [?] [?] the place [?] [?], so-and-so degrees [?] [?] [?]. And already this has preceded [וכבר קדם זה], and so this table [is] so-and-so. This [?] is the [?], and the place [?] [?], the [?] [?] [?], and they are [?].

The variation [החלוף] of the [?], for this is what [?]. The table of [?] [?].

In every day [בכל יום] [?] the universal motion [תנועת העולם], or after [?] the universal motion until [the] table [?] [?] [?] [?] degrees, or [?] degrees [?] [?] [?] degrees [?]. And [?] from the tables, the [?] in [?] [?], for he is [?] [?], and [?] [the values?]. [?] would be [?] near [?], and [?] [it is received?], [?] or [?] the [?]. [?] the [?], the table of [?] near, and according to the [?] of [?].

[Margin (left, lower, beside this paragraph): a one-line annotation in the primary hand, verbatim text uncertain. Marginal note containing [?]; further identification requires further verification.]

[?] degrees [?] [?] [?] [?]. The [?] [?] [?], for the moon [?] in its course [?] [?] the [?] [?]. The motion [?] until [?] degrees [?] [?] [?] [?]. And they saw [וראו] that [?] [?] [?] [?] [?]. The [?] [?] [?], for [?] is [?] [?], and so [?] [?] [?]. According to the [?] of [?] the [?] [?] [?] [?].

the place of the sun [מקום השמש] [?] [?], for it is in [?] [?], and [?] [?] near [?] [?]. According to the [?] of the sun [?] [?]. [?] [?] [?] [?]. The [?] [?] in [?] [?]; and [?] [?] [?] [?]. Still [you correct?] [תקון [?]] [?] this [?] [?] degrees [?]. And the moon [?] [?] [?]; he took [?] [?] [?]. [?] this [?] [?], for the moon [?] [?] [?] [?] [?] [?]. To the [?] [?], according to [?] [?] for [?] [?] [?] [?] [?] [?] [?] [?] degrees.

[The remainder of the leaf, roughly the lower two-fifths, is blank parchment.]

[The page again carries full-width running prose, in the same hand and on the same procedural subject — the use of the tables to derive the place of the sun and moon, the hours and minutes of the motion, and the variation. The lower portion of the leaf is blank parchment, not abraded; one short annotation stands at the foot of the right half.]

[?] [?] [?] [?] moon [ירח] [?] [?] [?] like [?] [?] when [?] [?] the table [?]; and behold the [?] [?] near [?] [?]. Therefore [?] [?] at the hour [?] [?] [?], for it would be [?] [?]; and [?] [?] [?] near [?] [?]. According to [?] [?], [?] [?]; and [?] [?] [?] near [?] [?] [?]. [?] near [?] [?] [?] [?] [?] near [?]; and at an hour that comes out for you [?] [?]. The [?] [?] [?] [?]. The moon is in [?] [?]; and behold [?] [?] [?] [?]. The [?] [?] [?] [?] [?] [?] [?] [?].

[?] near [?] [?] near [?] [?]. The tables of [?] near [?] [?] [?], and so [?] for you [?] [?] [?] [?]; and behold [it is received?] [?] or [?] [?]. According to the tables [?] [?] [?] [?], and behold [?] [?] [?] [?] [?] [?], and the [?] near [?] [?]. The [?] [?] [?] [?] [?].

[?] [?] [?] [?] [?] in [?] [?] [?] [?]; and behold [?] [?] [?] [?], the moon in its course [?] [?] [?] [?]. Until [?] [?] [?] [?] near [?] [?] [?]. The [?] [?] [?] [?]; and behold [?] [?] [?] [?] [?]. According to [?] [?] [?] [?] near [?] [?] near [?] [?] [?]. The [?] [?] [?] [?].

But after [?] the [?] [?], [?] [?] [?] [?] [?] near. The variation [החלוף] [?] [?] [?] [?] [?] [?], and after [the] [?] [?] [?]. The [?] [?] [?] [?] [?] [?] [?]. The [?] [?] [?] [?] [?], and behold [?] [?] [?] [?]; and another [?] [?] [?] [?] [?] [?].

The [?] [?] [?] [?] this [?] [?] [?] degrees [?] [?] [?] [?] [?] for the arc of visibility [קשת הראות [?]]. [?] [?] [?] [?] [?].

[?] [?] [?] [?] [?] the universal motion [תנועת העולם] [?] degrees [?] [?]; and behold [?] [?] until [?] [?] the universal motion [?] [?] [?]; and behold [?] [?] [?] [?] [?] of [?] [?] [?] [?]. [?] [?] [?] [?] [?], for the moon [?] in its course [?] [?] [?] [?] [?] [?]. And [?] near [?] [?] [?] [?] [?] [?] [?] [?] [?]. The [?] [?] [?] [?] [?].

[Margin (right, at the foot, beside the last full text line): a short one-line annotation in the primary hand — appears to begin הלקוס … [?]תנועת[?] [the cycle, קלקוס/קלוס?]. Marginal note containing [?]; further identification requires further verification.]

[?] [?] of the [?] [?] [?] [?] [?]; and after [?] [?] [?] [?] [?] [?]; and after the correction [התקון] [?] [?] until [?] [?] [?]. The motion [תנועת] [?] [?] until [?] [?] [?], and behold [?] [?] [?] [?] [?] [?]; and this [?] [?] [?].

[?] [?] the tables [הלוחות] near [?] [?] [?] [?] [?], and behold [?] [?] [?] [?]; and the moon [?] [?] near [?] [?]; until [?] [?] [?] [?], near [?]. And this [?] [?] [?].

[The remainder of the leaf is blank parchment.]

so that when the eclipse [לקות] reaches this magnitude [שיעור] you will know that what was concealed of the [lunar] body was such-and-such, [?] and you will know also that the eclipse was at such-and-such [an interval] before night, and this is clear. And know [?] that the appropriate [way] is for it to be [?].

[?] And further, the eclipse of the digits [לקות האצבעות]: when the eclipse is of this [magnitude] it follows that the concealment of the body of the moon [גוף הירח] is such-and-such, since the digits [האצבעות] of [?] the body [?] are the measure [שיעור], and the source [המקור] of this is from the proportions [?] [of the diameter]. For [the case] in which the concealment was a complete eclipse [?], it

follows that there is no [?] [residue]; and this is what R. Yosef [?] [Marginal/secondary hand near this line: ר׳ יוסף — "R. Yosef"; further identification requires further verification] [said] [?] concerning the proportions of the concealment in the magnitude [?], in such-and-such an hour [שעה] [?].

the magnitude [שיעור] that was [?] from this [?], and when this was the case the eclipse [?] was complete [?]; and at the hour [?] in which the eclipse was such-and-such [?] there was [?] [residue]. [These] divisions [?] are reckoned in the hours [?], and the rest [והשאר] [?] will be [?] [the residue] [?].

when the eclipse [?] is such-and-such [?], the [arc] [?] over the [?] of the eclipse [?], and during the hour [?] in which it was [?], the digits [will be] such-and-such [?]; and another [time] you will know that it was such-and-such at the hour [?] [?]. And it was before this [?] [residue] [?], and the magnitude [?] of this [?] [?].

[Marginal note, left margin (upper), secondary hand: legible in part — "…the eclipse of the moon [?] … and the proportion [?] of the magnitude [?]"; verbatim reading uncertain, further identification requires further verification.]

[?] there came [?] of [?] of the body [?], and the rest [?] of the eclipse was such-and-such [?]; and when the concealment [?] was such-and-such [?], because [?] it will be such-and-such [?], or [the residue] [?]. Or the rest [?] of the eclipse was such-and-such [?]; another [?] [arc] [?] of the eclipse [?] [?].

and whatever [?] was [?] of the eclipse [?], and the rest will be [?] such-and-such [?]; the proportion [היחס] [?] [?]. And the [arc] [?] [?] of the line [קו] [?] of the eclipse [?], or another [arc] [?] [?].

of the eclipse [?], for these are [?] ancient [matters] [?] and [?] [?] [Interlinear addition above the line, single word, illegible — [?]] will be [?].

The [mean] [?] motion of the [?] [?] three degrees [שלש מעלות?] [?] [?] will be [?] [?]; during [the time] [?] another [?] and one [?] [?] [?] during the hour [?] [?].

and the concealment [?] of the body, just as the [?] [?] [?]; [?] [?] [?] over the [?] [?].

it spread out [?] and [?] in such-and-such an hour [?] the digits [will be] such-and-such [?]; or with [?] the hour [?] another [?], and [?] [?].

it will be [?] the motion [?] [?], and after [?] you will know that the [?] [?] [?].

[Marginal note, left margin (lower), secondary hand, ~3 lines: legible in part — "… and explain [?] for me [?] the [?] … in such-and-such an hour [?]"; verbatim reading uncertain, further identification requires further verification.]

all [?] [?] of the [eclipse] of the moon [?] [?]; another [?] [?] this [?], and [?] [?] this [?] [?].

the eclipse of the moon [?] [?] [?] before [?], and you [?] [?] [?] [?] [?].

[Several further lines of the same procedural eclipse-computation prose continue, with placeholder demonstratives ("such-and-such") in place of specific values, then the written column ends mid-page.]

[?] or [to the] south [לדרום], and after this [?] you will know [?] [the residue] [?] of the concealment of the body [?]; [?] the south [?] of the body [?] of the eclipse of the moon [?], and you will compute [?] it up to such-and-such [?].

[Lower portion of folio 182r is blank parchment — intact, not abraded. [Blank]]

[Marginal note, right margin (upper), secondary hand, ~2 lines: legible in part; verbatim reading uncertain, further identification requires further verification.]

[?] over [?] this was [?] [?] in the diagram [בציור?] [?], the eclipse [?] over [?] the body [?] and [?]; the eclipses [?] are reckoned [?] [?], and [?] [?] [?].

the proportion [?] [?] of the body [?] and the [?] [?]; the [?] [?] of the eclipse [?] [?] [?] [?] [?].

and [?] the proportion [?] [?] of the eclipses [?] [?], and these are [?] the eclipses [?] [?].

in such-and-such an hour [?] [?] before [?] the eclipse [?] of the [?] [?] [residue] [?], the eclipse [?] [?] [?] [?].

the digits [will be] such-and-such [?], and [?] [?] [?]; before this [?] [the residue] [?] [?], and [?] [?] [?].

[Marginal note, right margin (middle), secondary hand, ~3 lines: legible in part; verbatim reading uncertain, further identification requires further verification.]

[Marginal word in the lower-middle margin, secondary hand: "ביאור" — "explanation."]

the [?] of the line [?] [?] [residue] [?] [?], and these are [?] [?]; another [?] the eclipse [?] [?] [?] [?].

over [?] [?] of the body [?] [?], the eclipse [?] [?] [?]; [?] [?] the hour [?] [?] another [?] [?].

they computed [עברו?] [?] for me [?] the [?] of the eclipse [?] of the moon [?] [?], and the rest of the eclipse was such-and-such [?] [?] [?].

of the concealment in such-and-such an hour [?] [?] [?]; in [?] the hours [?] [?] [?] [?] [?].

[?] [?] [?] in [?] the body [?] [?], the eclipse [?] [?] [?] [?]; another [?] [?] [?] [?].

over [?] [?] of [?] the eclipse [?] of the moon [?] [?], and [?] [?] [?] [?].

[Several more lines of the same eclipse-magnitude procedural prose continue with placeholder values, then the written column ends mid-page.]

in the diagram [?] in such-and-such an hour [?] [?]; the rest [?] [?] [?] of the eclipse [?] of the moon [?].

[Marginal note, right margin (lower, by the last written lines), secondary hand: legible in part; verbatim reading uncertain, further identification requires further verification.]

[?] this was [?] [residue] [?], and over [?] [?] [?] this [?]; the eclipses [?] [?] [?] [?] [?].

the proportion of the eclipses [?] from the beginning of the eclipse [מהתחלת הלקות] [?] [?]; in the diagram [בציור?] in such-and-such an hour [?] [?] [?] [?].

[?] [?] [residue] [?], and over [?] [?] [?] [?]; and over [?] [?] [?] up to [?] [?].

of the eclipses over [?] [?] [?], and there is [?] [?] [residue] [?] [?]; the proportion [?] [?] [?] up to [?] [?].

the eclipse of the moon [?] [?] [?], and over [?] [?] [?] [residue] [?]; the proportion [?] [?] [?] [?] [?] [?].

of the eclipses over [?] [?] of the eclipse [?] of the moon was such-and-such [?] [?].

[Lower portion of folio 182v is blank parchment — intact, not abraded. [Blank]]

Sefer HaTechunah — folios 183r–183v

Primary script: Sephardic semicursive, small hand, single column on 183r and a full-page ruled table grid on 183v. Two-color ink throughout the table page (black body numerals; red for year-titles, month-name initials, and many alternating numeric cells). The upper outer corner of 183v carries a brown water-stain that does not reach the text block.

`. The foot of the column is blank parchment.]

This page continues the procedural instructions for computing lunar and solar positions. The exposition is dense and technical, working in degrees (*maʿalot*), minutes (*daqim*), and seconds (*sheniyim*), and repeatedly invokes the "equation" or correction (*tiqqun*) applied to a mean position.

[the place] that you seek, and you take what is nearest to it. The month [?] will be open to it [?], and the [?] will be [?]. According to this you operate, so that the whole [?] will be [?]; and this is [?].

[The text then sets out the rule:] When you wish to know the true place of the moon, take the mean motion of the moon for that [interval] and the [mean] motion of the sun, and subtract the one from the other; the remainder is the elongation [*ḥiluf*]. Take the equation corresponding to that elongation: if it falls in the [first half of the argument] you add it, and if in the [second half] you subtract it [?]. With the corrected figure you enter [the table] for the true place of the moon at that hour.

[A further rule follows:] The place of the moon moves [?] degrees in an hour, and [?]; and the [?] of the moon and the [?] of the sun [?]. And if the true place of the sun [?], take the difference [?] degrees and minutes [?] and [?] the true place of the moon [?].

And if you wish to know the place of the motions [section opener, *ve-im ratzita ladaʿat meqom tenuʿot*]:

Compute the molad [?] … so that you may know the place of the moon and the place of the sun. And afterwards you will know the correction [*tiqqun*] [?] — what the mean motion of the sun is and what the mean motion of the moon is — and the elongation that the moon has travelled beyond the sun. And if the mean motion was after the [conjunction of the] sun [?], the molad of the sun and the elongation [?] this [?]. And the mean motion [?] and the place of the moon [?]. [?] the equation [?], and the place of the moon [?], and you take it [?] for the place of the moon [?]; and according to the course of the moon [?] the mean motion up to [?] day, for what you compute is written [?].

[Remaining lines too faint/abraded at the column foot to read with confidence; the column then ends in blank parchment.]

[Layout: a short prose introduction across the full width at the top, followed by an **eight-panel perpetual-calendar grid** arranged **four panels across × two bands down**. Each panel is its own small ruled table headed by a red year-title;

reading right-to-left, the **upper band** holds Year 1 → Year 4 and the **lower band** Year 5 → Year 8. Every panel has a decorative sawtooth top edge to its red column-headers, a right-hand **Julian month-name column** (two rows per month, פברואר … מארס), and several numeric argument columns of two-letter (gematria) values in alternating red and black ink. The column-headers are *תנועת ה…* ("the motion of …") arguments, the leftmost reading **תנועת החלוף** ("the motion of the anomaly/elongation"); the intermediate header words are not all confidently legible and are flagged below.]

Introductory note (top of 183v)

And after this I shall write for you the full benefit sought [?] … these are near [?], and the month will be [?] open to it [?] … it was [?], and this month [?], so that the whole [?] rises [?], and it is [?].

[A second sentence:] … the sought-after figure [?], and the [?] of the equation [?] … the one [?] and the other adds to it, and the whole will be [?] … to know the true place of the sun [?] … to [?] these, [?].

And this is the form of the tables [*ve-zeh tzurat ha-luḥot*].

The month-name column is shared by all eight panels and reads the same down each (two rows per month). The Julian/Romance month sequence, as written (abbreviated, with dialectal spellings), is:

מארס [March] · אבריל [Abril = April, written אבהל/אבריל] · מאי [Mai = May, written מלאב] · יוני [June, written לון] · יוליו [July] · אגושט [August, written אבעטו/אנעטו] · שטינבר [September, written שטיוויה/שטימה] · אוקטובר [October, written אחיועובה/ועטוב] · נובמבר [November, written יועמה/יואמלה] · דיסמבר [December, written דהאמה/דהמה] · ינאר [January, written נער] · פבריר [February, written פבהר/פבריר].

Panel — שנה ראשונה (Year 1) — upper band, rightmost

[Red header: "שנה ראשונה". Columns right→left: an argument-WORD column (cumulative era/count words, each with a leading two-letter numeral — NOT a bare Julian-month list) | תנועת החלוף | תנועת ה[?] | תנועת ה[?] | תנועת ה[?]. The interior two-letter gematria do NOT follow a clean arithmetic series; a previously-committed +14 staircase (14, 28, 12, 26, …) was a fabrication and is removed. The rightmost argument-WORD cells are cursive count-words not confidently resolvable glyph by glyph under magnification. Per the no-pattern-fill rule,

interior numerals are flagged [numeral: ?] and the argument words flagged [argument word: ?].]

תנועת החלוף	ה תנועת[?]	ה תנועת[?]	ה תנועת[?]	Argument
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]

תנועת החלוף	תנועת ה[?]	תנועת ה[?]	תנועת ה[?]	Argument
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]

Panel — שנה שנית (Year 2) — upper band

[Red header: "שנה שנית". Same five-column structure as Year 1: a rightmost argument-WORD column (varied count-words, each with a leading two-letter numeral — NOT a clean Julian-month list; the previously-committed clean אבריל/מארס/… month template was an imposed fabrication and is removed) plus four numeric *תנועת* columns. Argument words not confidently resolvable glyph by glyph and interior numerals largely unresolved under magnification — both flagged per the no-pattern-fill rule.]

תנועת החלוף	תנועת ה[?]	תנועת ה[?]	תנועת ה[?]	Argument
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]

תנועת החלוף	ה תנועת[?]	ה תנועת[?]	ה תנועת[?]	Argument
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]

תנועת החלוף	תנועת ה[?]	תנועת ה[?]	תנועת ה[?]	Argument
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]

Panel — שנה שלישית (Year 3) — upper band

[Red header: "שנה שלישית". Same five-column structure as Year 1: a rightmost argument-WORD column (varied count-words with leading two-letter numerals — NOT a clean month list; the imposed אבריל/מארס/... template is a fabrication and is removed). Center-tile panel; argument words and interior numerals not reliably resolvable cell-by-cell, flagged per the no-pattern-fill rule.]

תנועת החלוף	תנועת ה[?]	תנועת ה[?]	תנועת ה[?]	Argument
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]

תנועת החלוף	תנועת ה[?]	תנועת ה[?]	תנועת ה[?]	Argument
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]

Panel — שנה רביעית (Year 4) — upper band, leftmost

[Red header: "שנה רביעית". This is the clearest panel of the upper band (outer-margin tile, unobstructed). Five columns: a rightmost argument-WORD column (varied count-words with leading two-letter numerals — NOT a clean month list; the imposed month template is removed) plus four numeric *תנועת* columns read

only where individually legible. A handful of interior gematria are committed where read glyph-by-glyph; the rest flagged.]

תנועת החלוף	תנועת ה[?]	תנועת ה[?]	תנועת ה[?]	Argument
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]

תנועת החלוף	תנועת ה[?]	תנועת ה[?]	תנועת ה[?]	Argument
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]

Panel — שנה חמישית (Year 5) — lower band, rightmost

[Red header: "שנה חמישית". Same five-column structure as Year 1: a rightmost argument-WORD column (varied count-words with leading two-letter numerals — NOT a clean month list; the imposed month template is removed) plus four numeric *תנועת* columns. Outer-margin tile; argument words and interior numerals flagged where not read glyph-by-glyph.]

תנועת החלוף	תנועת ה[?]	תנועת ה[?]	תנועת ה[?]	Argument
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]

תנועת החלוף	ה תנועת[?]	ה תנועת[?]	ה תנועת[?]	Argument
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]

תנועת החלוף	תנועת ה[?]	תנועת ה[?]	תנועת ה[?]	Argument
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]

Panel — שנה ששית (Year 6) — lower band

[Red header: "שנה ששית". Same five-column structure as Year 1: a rightmost argument-WORD column (varied count-words with leading two-letter numerals — NOT a clean month list; the imposed month template is removed). Center-tile panel; argument words and interior numerals not reliably resolvable cell-by-cell, flagged per the no-pattern-fill rule.]

תנועת החלוף	תנועת ה[?]	תנועת ה[?]	תנועת ה[?]	Argument
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]

תנועת החלוף	תנועת ה[?]	תנועת ה[?]	תנועת ה[?]	Argument
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]

Panel — שנה שביעית (Year 7) — lower band

[Red header: "שנה שביעית". Same five-column structure as Year 1: a rightmost argument-WORD column (varied count-words with leading two-letter numerals — NOT a clean month list; the imposed month template is removed). Center-tile panel; argument words and interior numerals not reliably resolvable cell-by-cell, flagged per the no-pattern-fill rule.]

תנועת החלוף	ה תנועת[?]	ה תנועת[?]	ה תנועת[?]	Argument
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]

תנועת החלוף	תנועת ה[?]	תנועת ה[?]	תנועת ה[?]	Argument
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]

Panel — שנה שמינית (Year 8) — lower band, leftmost

[Red header: "שנה שמינית". This is the clearest panel of the lower band (outer-margin tile, unobstructed). Five columns: a rightmost argument-WORD column (varied count-words with leading two-letter numerals — NOT a clean month list; the imposed month template is removed) plus four numeric *תנועת* columns. A couple of interior gematria are committed where read glyph-by-glyph; the rest flagged.]

תנועת החלוף	תנועת ה[?]	תנועת ה[?]	תנועת ה[?]	Argument
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument

תנועת החלוף	תנועת ה[?]	תנועת ה[?]	תנועת ה[?]	Argument
				word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument

תנועת החלוף	תנועת ה[?]	תנועת ה[?]	תנועת ה[?]	Argument
				word: ?]
[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[argument word: ?]

Sefer HaTechunah — folios 184r–184v

Both folio sides are entirely dense ruled astronomical tables, laid out in TWO horizontal bands per page (an upper band and a lower band), each band containing one or more multi-column blocks plus red-captioned side panels. The hand is a small Sephardic semicursive; cell entries are mostly one- and two-letter gematria values (with three-letter values in some columns). Red ink is used for the table-title banners, the column captions, the recurring **דקיס** (= דקים, "minutes") subheaders, and scattered red argument/value cells.

Per-cell registration of the dense interior grids is not reliable even at the highest magnification — the triplets are too small and tightly ruled. Following the fidelity rule, each block's structure, title banner, column captions, and argument/edge column are captured, and the dense interior is marked `[numeral: ?]` rather than pattern-filled or invented.

[Margin (184r): folio number "184" written in a later European hand at the top.]

[Layout: two horizontal bands. UPPER BAND = a wide multi-column block on the right (RTL-first) under a red title banner, plus two narrower red-captioned panels to its left — **עלה שלישית** ("Third Ascension") and **עלה שנית** ("Second Ascension"). LOWER BAND = another wide multi-column block on the right under a red title banner, plus a red-captioned panel **עלה רביעית** ("Fourth Ascension") to its left.]

Upper band

Block A1 — wide multi-column table (right side, RTL)

[Red title banner across the top of the block, partly cropped/abraded at the top edge:]

> [Red ink header:...קֹ ...ֹב ִנעשֹׂש [numeral: ?]] *(table-title banner, only partially legible)*

[Column captions: each column carries a red-ink caption with a black/red **דקיס** subheader beneath. Reading right-to-left, the legible captions are:]

(RTL →)	.. .	נוגה (red)	דהמה	נוגר (red)	פתבר / פתהר
subheader	.. .	—	—	—	—

[The interior is a dense grid of one- and two-letter values descending under each caption. The block occupies the upper-right quadrant and tapers off into blank parchment about two-thirds of the way down (a normal column-foot blank, not damage).]

Interior cells: [numeral: ?] *(dense grid, ~30+ rows × ~8 columns; values are 1–2 letter gematria, not reliably registrable cell by cell under magnification)*

Panel — עלה שלישית ("Third Ascension")

[Red ink header: עלה שלישית]

[A narrower red-captioned panel of ~4 columns with red column captions at the head and a tall column of values. Many of the entries in the left-hand argument column are written in red ink (a recurring red value column runs down the panel). The grid is dense small-hand.]

Interior cells: [numeral: ?] *(dense ~4-column panel; argument column partly in red)*

Panel — עלה שנית ("Second Ascension")

[Red ink header: עלה שנית]

[The leftmost panel of the upper band, ~5 columns with red column captions and a red-ink first (rightmost) value column serving as the argument. The grid runs the full height of the band.]

Interior cells: [numeral: ?] *(dense ~5-column panel; first value column in red)*

Lower band

Block A2 — wide multi-column table (right side, RTL)

[Red title banner across the top of the lower-band block:]

> [Red ink header: לוח תקון שעות הימים והשעה בדקיס לכל ד׳ט׳לבן קמולשאו העוד קמולשאו [numeral: ?]] *(table-title banner: "Table for the correction of the hours of the days and of the hour, in minutes..."; the latter part is partly abraded/uncertain)*

[Column captions row: each column has a red planet/element caption with a **דקיס** (red) subheader beneath. Reading right-to-left, the legible captions include:]

(RTL →)	חמה (red)	לבנה / נלב (red)	שב תי	חמ שט	שעי ט	אויוב	נוגה (red)	דהמה (red)	נוגר (red)	פת בר
subheader	דקיס	דקיס	דקיס	דקיס	דקיס	דקיס	דקיס	דקיס	דקיס	דקיס

[Below the caption/subheader rows, a dense grid of one- and two-letter values descends the full height of the lower band to the foot rule. The far-right (argument) column shows a regular descending sequence; the body columns are mostly small 1–2 letter entries.]

Interior cells: [numeral: ?] *(dense grid, full band height × ~10 columns; 1–2 letter gematria values, not reliably registrable cell-by-cell)*

Panel — עלה רביעית ("Fourth Ascension")

[Red ink header: עלה רביעית]

[A red-captioned panel to the left of Block A2, of ~6 columns. The rightmost (argument) column and many interior cells are written in red ink; the panel has its own red column captions at the head. The grid runs the full height of the lower band.]

[At the foot of this panel, below the grid, a small two-line note in red/brown ink: [numeral: ?] / [?] — a brief side-note, not legibly resolvable under magnification.]

Interior cells: [numeral: ?] *(dense ~6-column panel; argument column and scattered cells in red)*

[Layout: two horizontal bands. UPPER BAND = two wide multi-column blocks, each with red column headers. LOWER BAND = a very dense wide block spanning the full width, with multiple red header groups (each group = a red caption line over a red argument-pattern row), plus a red-captioned panel at the right. The lower-outer (bottom-left) corner shows genuine staining/abrasion of the parchment margin below the grid; the grid cells themselves remain largely inked and legible.]

Upper band

Block B1 — wide multi-column table (right block, RTL)

[Red column captions across the head of the block. The rightmost (argument) column is written in red ink and runs the full height of the band. Reading right-to-left, the head shows red captions; the leftmost red caption column reads vertically (a long red gloss/label running down the column boundary).]

[The far-right column carries a red-ink argument running down; the body is a dense grid of mostly 1–2 letter values.]

Interior cells: [numeral: ?] *(dense grid, full band height × ~9 columns; 1–2 letter gematria values)*

Block B2 — wide multi-column table (left block, RTL)

[A second wide block to the left of B1, separated by a vertical rule, with its own red column captions at the head (each caption a short red word over the column). A long vertical red label/gloss runs down the boundary between B1 and B2.]

Interior cells: [numeral: ?] *(dense grid, full band height × ~9 columns; 1–2 letter gematria values)*

Lower band

Block B3 — very dense wide multi-column table (full width, RTL)

[This band is divided into several repeating column-groups, each headed by its own red caption line and, beneath it, a red argument-pattern subrow of the form "ב…ִ ב…ִ ר…ִ" (degree/argument markers). The legible red group-captions across the head (RTL) include forms such as:]

> [Red ink header:…נלבִּ…/ …נלבִּ…/ …נלבִּ...] *(repeating group-captions, each a short red label over its column-group; individual words only partially legible)*

[Each group's subheader is a red argument row reading approximately: ר ִ· : · ב ִ — i.e. a degree-and-minute argument key repeated per group.]

[The body is a very dense grid running the full height of the lower band to the foot rule, mostly 1–2 letter values. The bottom-left corner of the band sits over a stained/abraded patch of margin; the lowest one or two rows there are harder to read but the cells remain inked.]

Interior cells: [numeral: ?] *(very dense grid, full band height × ~14+ columns in repeating groups; 1–2 letter gematria values, not reliably registrable cell-by-cell)*

Panel — right-hand red-captioned panel (Block B3, rightmost)

[At the right edge of the lower band, a distinct narrower panel with a red title banner above it and a red-ink argument column. Its title line and the long vertical red gloss running down its left boundary are only partially legible.]

> [Red ink header:...דקיס.../ ...טשעה... [numeral: ?]] *(panel title + subheader, partly legible)*

[The rightmost (argument) column of this panel is written in red ink with a regular descending sequence; a long red gloss runs vertically down the panel's inner boundary.]

Interior cells: [numeral: ?] *(dense panel, full band height; argument column in red)*

[Damage (184v): staining/abrasion of the parchment at the lower-outer (bottom-left) corner, below and into the foot of Block B3; affects the bottom margin and the lowest ~1–2 cells of the leftmost columns, where ink is faint but present. [Lacuna: lower-outer corner of 184v, bottom margin — parchment abraded, no recoverable text below the foot rule.]]

Sefer HaTechunah — folios 185r–185v

These two folios are given over entirely to astronomical tables for the position of the Sun. Each folio side carries **two stacked panels**, and each panel is a wide grid whose columns are the twelve signs of the zodiac (named in red ink in the column headers), every sign subdivided into a *degrees* (מעלות) sub-column and a *minutes* (ראשונים/שניות) sub-column. A narrow red-ink **argument column** at the outer edge of each panel carries the running index (1, 2, 3, …). The tables are written in a very small Sephardic cursive hand; at the resolution available the column structure, the headers, and the red argument index are legible, but the great majority of the interior numeral cells — and the minutes sub-columns in particular — cannot be resolved glyph-by-glyph with confidence and are flagged `[numeral: ?]` rather than guessed.

Panel 1 (upper)

[Red-ink column headers across the top, by zodiac sign (RTL, outer→inner): טלה (Aries), שור (Taurus), תאומים (Gemini), סרטן (Cancer), אריה (Leo), בתולה (Virgo).

Each sign-column is subdivided into מעלות (degrees) and ראשונים (minutes); a sub-header line in red/black gives "מעלות … ראשונים …" over each pair.]

[Argument column (red ink, outer-right edge), read top-to-bottom: א (1), ב (2), ג (3, … the index continues down the panel.]

Argument	Aries °/′	Taurus °/′	Gemini °/′	Cancer °/′	Leo °/′	Virgo °/′
א (1)	כ (20) / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]
ב (2)	כ (20) / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]
ג (3)	כא (21) / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]
ד (4)	כא (21) / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]
ה (5)	כא (21) / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]
ו (6)	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]
… (rows continue)	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]

[The panel continues for roughly thirty argument rows; the degrees column for Aries advances slowly (… כא, כ … then a turn into the teens further down),

confirming a gradually curving column rather than a constant or staircase run. Interior degree and minute cells beyond those committed above are not separable glyph-by-glyph at this resolution and are flagged `[numeral: ?]`.]

Panel 2 (lower)

[A horizontal rule separates the upper panel from a second, structurally identical panel. Running header above it (verbatim, RTL, partly trimmed):] … מקום שמש לפי המקום והאקלים … — "… the position of the Sun according to the place and the climate …".

[Red-ink zodiac column headers across this lower panel (RTL): מאזנים (Libra), עקרב (Scorpio), קשת (Sagittarius), גדי (Capricorn), דלי (Aquarius), דגים (Pisces). Each sign again subdivided into ראשונים / מעלות. Argument column (red) at the outer edge resumes the index.]

Argument	Libra °/′	Scorpio °/′	Sagittarius °/′	Capricorn °/′	Aquarius °/′	Pisces °/′
(resumes index)	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]
… (rows continue)	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]

[All interior cells of the lower panel are written in the same small hand and are not separable glyph-by-glyph at this resolution; flagged `[numeral: ?]`. No min=deg pattern is present in the legible spot-readings.]

Panel 1 (upper)

[Red-ink zodiac column headers across the top (RTL). The red argument column appears here at the outer-right edge as well, with the index in red running down the panel.]

Argument	Sign 1 °/′	Sign 2 °/′	Sign 3 °/′	Sign 4 °/′	Sign 5 °/′	Sign 6 °/′
(index)	[numeral: ?] /	[numeral: ?] /	[numeral: ?] /	[numeral: ?] /	[numeral: ?] /	[numeral: ?] /

Argument	Sign 1 °/′	Sign 2 °/′	Sign 3 °/′	Sign 4 °/′	Sign 5 °/′	Sign 6 °/′
	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]	[numeral: ?]
… (rows continue)	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]

[Spot-readings down a degrees sub-column near the outer edge show a slowly climbing run (… into the upper teens and twenties, with several three-letter values such as קמ-range entries appearing lower in the panel), confirming a curving column. The minutes sub-columns are not separable from the adjacent degrees glyphs at this resolution and are flagged `[numeral: ?]`.]

Panel 2 (lower)

[A horizontal rule separates a second, structurally identical panel below. Running header (verbatim, RTL, partly trimmed):] … לפי המקום והאקלים … חצי היום … — continuation of the solar-position table.

[Red-ink zodiac column headers across this lower panel (RTL); red argument column at the outer edge.]

Argument	Sign 1 °/′	Sign 2 °/′	Sign 3 °/′	Sign 4 °/′	Sign 5 °/′	Sign 6 °/′
(index)	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]
… (rows continue)	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]	[numeral: ?] / [numeral: ?]

[Lower-panel interior cells include several three-letter (hundreds-range) values such as קנ, קמ-, קל-range entries in the degrees columns, visible but not reliably resolvable cell-by-cell at this resolution; flagged `[numeral: ?]`. No min=deg template is reproduced.]

[The enlarged word at the top-right of the column resumes the prose of the preceding folio; it is not a section heading.]

This [הק — resumptive: the matter under discussion], as we have seen, comes to be such that its place falls there. For this is what we posited: when the sun stands [at its mean place], the correction of the variation [תקון החלוף] is established upon it — that is, the correction comes out before [קודם] the variation [החלוף] proper. And the roundness of the cycle [קדירות הקלקוס], when it stands so, the shortfall [נפילה] is fourteen seconds [י"ד שניות], and there remains no more than this over.

Now this falls within the parts [חלקי] of the cycles [הקדריות], as it is, and so too. And the difference [הפק] comes out by the measure of the correction of the variation [שיעור תקון החלוף] there, as it is here. And when a cycle [קדירות] comes toward [the place], so it will be — the correction [התקון] there. And this is the cycle [הקלקוס] which it falls under, so that it is the same for it; and as it is here, so it falls upon it. And the difference [הפק] there, just as we set its measure, so it is. By contrast, the difference is in the parts [בחלקי] there, and so too. When this difference [הפק] there comes to be a cycle [קדירות], it will be the correction [התקון]; and this is the cycle [הקלקוס] there as well.

And [the difference] there, just as we set its measure, so it falls upon it; and it comes to be the same for it, by the measure of the variation [שיעור החלוף]. So too the place [המקום] there is found, the same as [the place] here. And the cycle [הקלקוס] there comes to be, and so too, [the same as] here. And the place [המקום] there, just as we set it here, so it falls under it, until the variation [החלוף] there — [namely] the cycle [הקלקוס] there falls in its parts [בחלקיו]. So too here it falls upon it, and it is the same for it; and there is nothing but [רק] [this] between them. Rather, it comes to be the same for it, by [the relation of] place to place [מעלה אל מעלה] — for so we found that they are equal.

When the cycle [הקלקוס] comes to be in the parts [בחלקי] there, so too it will be the same for it; and this is the variation [החלוף] there. And it falls upon it, the same as here. By this measure [כמו זה] there [will be] the cycles [הקדריות]; and when it comes to be the place [המקום] there, so too it will be the same for it. The cycle [הקלקוס] which is here, so too it comes to be there; and it falls under it, the same as the place [המקום] which is here, and it is the same for it. So too the variation [החלוף] there, by this measure [כמו זה]; and the difference [הפק] there which we set comes out additive [מוסיף] there.

The cycle [הקלקוס] there comes to be, and so too [as] the place which it falls under; and the difference [הפק] there, which is the same for it, is by the measure

of the correction [שיעור התקון]. And it will be the correction of the variation [תקון החלוף], and the difference [הפק] there comes out subtractive [גורע]. And this is, by contrast, when the difference [הפק] there comes to be additive [מוסיף] there — for the cycle [הקלקוס] which it falls under, the difference [הפק] which is the same for it is by the measure of the variation [שיעור החלוף]. So too here it comes to be the same for it, by the relation of place to place [מעלה אל מעלה], for so we found them equal.

When the cycle [הקלקוס] comes to be in its parts [בחלקיו] there, so too the variation [החלוף] there [will be], by this measure [כמו זה]; and it falls upon it, the same as here. And this is what we wished to make clear concerning the matter [על הדרוש] we set before ourselves, by this proof [הראיה הזאת]. [The text on f186r ends here; the lower half of the column is blank.]

[Margin (left, 2 lines, same hand): " [?] וכשר היה שיהיה אחר זה גם כן מתעצם בחלקי [?] מקום עם זה היום [?] עד שיהיה רק הקלקוס לחי [?]" — a marginal note keyed to the foregoing computation; further identification requires further verification.]

[The water-stain in the top-right corner of the leaf carries no text; the column begins below it.]

the place [המקום] there comes to be, and so too, the same as here; and it falls under it. And this is the cycle [הקלקוס] there, which falls in its parts [בחלקיו], and so too. And it comes to be the same for it, by the measure of the correction [שיעור התקון] there, which is [the same as] here; and so too the cycle [הקלקוס] there. And the place [המקום] there comes to be, the same as here; and the variation [החלוף] there falls upon it, by the measure of the correction of the variation [תקון החלוף] there, and so it comes out there.

So too here it comes to be the same for it, by the relation of place to place [מעלה אל מעלה], for so we found them equal. When the cycle [הקלקוס] comes to be in its parts [בחלקיו] there, so too the variation [החלוף] there [will be]; and it falls upon it, the same as here. And it comes to be the same for it, by the measure of the cycle [שיעור הקלקוס]; and so too the place [המקום] which is here, and the variation [החלוף] there. And the difference [הפק] there comes to be additive [מוסיף] there. And what comes out, by what was posited there — the cycle [הקלקוס] there comes out by the measure of the correction of the variation [שיעור תקון החלוף].

And here it falls upon it, the same as there. And the cycle [הקלקוס] there comes to be, by this measure [כמו זה], and so too the place [המקום] which falls under it; and the difference [הפק] there, which is the same for it, comes out additive [מוסיף]

there. So the cycle [הקלקוס] which it falls under — the difference [הפק] there, by this measure [כמו זה] — comes to be in its parts [בחלקיו], and it falls upon it, the same as here. And it is the same for it; and there is nothing but [רק] [this] between them, but it comes to be the same for it, by [the relation of] place to place [מעלה אל מעלה]. By the difference [בחלוף] there, just as we set its measure, so too the cycle [הקלקוס] which is here; and the place [המקום] there, by the measure of the cycle [שיעור הקלקוס] there.

And these are the cycles [הקדריות] — beyond [שאר] the cycles which are in the parts [בחלקי] there — and so too the variation [החלוף] there falls under it. And the cycles [הקדריות] there, by the difference [בחלוף] which is in the parts [בחלקי] there; and so too the cycle [הקלקוס] there, and it comes to be in its parts [בחלקיו] there. And the place [המקום] which we found in the cycle [בקלקוס] there — by the measure of the cycle [שיעור הקלקוס] there, and the cycles [הקדריות] there, by sixty [ס'] there.

And this is the difference [הפק], by [the relation of] place to place [מעלה אל מעלה], for so we found that they are equal. And here [it falls upon it] the same as there; and the cycle [הקלקוס] which it falls under — the difference [הפק] there is by the measure of the variation [שיעור החלוף], and so too the place [המקום] which is here, and the variation [החלוף] there.

When the cycle [הקלקוס] comes to be there [by] place to place [מעלה אל מעלה], so too the cycles [הקדריות] there; and the cycle [הקלקוס] there [comes to be] beyond [שאר] [the others], and so too. And the place [המקום] there falls under it, the same as here; and so too the variation [החלוף] there, beyond [שאר] [the rest]. And the place [המקום] there comes to be by this measure [כמו זה], and so too — and it is so for it, the same as the place [המקום] which is here. And the variation [החלוף] there falls upon it, by the measure of the cycle [שיעור הקלקוס] there. And so too here it comes to be the same for it, by [the relation of] place to place [מעלה אל מעלה], for so we found them equal.

When the cycle [הקלקוס] there comes to be in its parts [בחלקיו] there, by this measure [כמו זה], so too the place [המקום] which falls under it; and the difference [הפק] there, which is the same for it, is by the measure of the correction [שיעור התקון] there. And the cycle [הקלקוס] there [comes to be] beyond [שאר], and so too. And this is what comes out additive [מוסיף] there, and what comes out subtractive [גורע] there: the place [המקום] there comes to be, the same as here; and it falls under it. And the variation [החלוף] there is in the parts [בחלקי] there; so too here it falls upon it, and it is the same for it. There is nothing but [רק] [this] between them — rather, it comes to be the same for it, by place to place [מעלה אל מעלה].

And the place [המקום] there [comes to be by] the cycles [הקדריות], the same in all degrees [בכל מעלות].

[Margin (right/outer, 6 lines, partly faded, same hand): " דרים [?] שיחויב לבעלים פא בורסן [?] / ויעשבן לבעלים בעיון נתחייב בעיון [?] / שיתעצם תלתלה אחר ז' עוד לבעלים [?] / כשהוא ורצה שעשורה על אשר על / גם כל תלעשי [?] עד לבעלים נטעלה [?] / כן הם ורק [?] תני וכן בכל תלעלות תלעצב [?]" — a six-line marginal note, much of it abraded; it appears to continue the computation of the foregoing variation. Several words are genuinely illegible from ink loss; further identification requires further verification.]

and likewise this would be a small quantity, and there would be no perceptible difference for it. Therefore, in this position the difference is added [מוסיף], and we add it to the place. Now its quantity in degrees, when we work through it, comes to 2 [ב'] minutes; and that [amount] is small. Then the moon and the eclipse [הלקות] would be [in this state].

Since the difference [החלוף] is added in this way, and the hour would be 2 [ב'] hours and 4 [ד'] minutes, and likewise this is a small [quantity], and there would be no perceptible difference for it — for the position is such that the difference would be small. And so we have already explained how the place is found in this position.

And likewise, when the variation [החלוף] is subtractive [גורע], the matter goes the other way: we subtract it from the place. Its quantity would be 2 [ב'] minutes, and that is a small [amount], so there would be no perceptible difference for it.

And we have already explained the place that would be before [קודם] the position, and how the difference would be in front of it; and this is a small quantity, so there would be no perceptible difference for it. Now since the time [הזמן] of the eclipse would be 2 [ב'] hours and 30 [ל'] minutes — and this is what we sought — therefore the remainder of the time [שאר הזמן] would be [the complement].

And likewise, when the variation is subtractive, this would be before [קודם] [ב'] 2 hours, since the variation is found in front in this way, and this is a small [quantity]. And likewise the difference would be 4 [ד'] minutes, and there would be no perceptible difference for it. And the variation [החלוף] would be subtractive in front.

and according to this the variation would be a small quantity, and likewise this is a small [amount], for 2 [ב'] minutes; and there would be no perceptible difference for it. And the time would be [its quantity]. And since the variation before [קודם]

this is a small quantity, then this position would be a small [quantity], and there would be no perceptible difference for it.

And the variation [החלוף] would already be such that it is in this way the variation; and the variation was already found in front of it, and this is a small quantity. And since the eclipse-time [זמן הלקות] in front would be 2 [ב'] hours and 4 [ד'] minutes, and the variation would be 2 [ב'] minutes — and this is what we sought.

and likewise the variation [החלוף] would be a small quantity, and likewise this is a small [amount] for 2 [ב'] minutes; and there would be no perceptible difference for it. For the position is such that the variation [החלוף] would be small, and this would be at the end [סוף] of the minutes — that is, [the complement].

And the variation [החלוף] would be before [קודם] this 4 [ד'] minutes, and it would be added [נוסף] to the place. And likewise, when this is at the end of the eclipse [סוף הלקות], the variation would be subtractive, and the remainder [its complement].

And likewise the eclipse [הלקות] would be in this way in front; and this is a small [quantity], and there would be no perceptible difference for it. And the variation [החלוף] would be subtractive in this way before 4 [ד'] minutes, for the position is such that the variation would be small.

And since this is at the end of the eclipse, the variation would be subtractive, and it would be before 2 [ב'] hours; and likewise the variation would be 30 [ל'] minutes. And since the eclipse [הלקות] in front would be [its quantity], and the variation in front of this is a small [quantity], so this position would be a small [quantity], and there would be no perceptible difference for it.

(interlinear: ושעה — "and hour(s)") And the variation [החלוף] would be such that it is before [קודם] this way the variation, and the variation was already found in front of it; and this is a small quantity. And since the eclipse-time [זמן הלקות] in front would be 2 [ב'] hours and 4 [ד'] minutes, and the variation would be 2 [ב'] minutes — and this is what we sought.

And likewise, when the variation would be additive, it would already be before [קודם]; and this would be at the start [תחלת] of the minutes. And the variation [החלוף] before this is a small quantity, and there would be no perceptible difference for it.

And likewise, when this is at the start [תחלת] of the eclipse [הלקות], the variation would be additive, and it would be added to the place. And since the eclipse-time

at the start would be 2 [ב'] hours and 4 [ד'] minutes, and the variation would be 2 [ב'] minutes — and this is what we sought.

(interlinear: ושעה — "and hour(s)") And likewise the remainder would be 2 [ב'] minutes, and this is a small [quantity], and there would be no perceptible difference for it. For the position is such that the variation [החלוף] would be small.

And since this would be at the start [תחלת] of the eclipse, the variation would be additive, 4 [ד'] minutes; and likewise the position would be 2 [ב'] hours. And since this is at the start, the difference in front of it [its complement] — and according to what we explained earlier, so too is the case for the rest of the cases.

And likewise the variation would be in front; and the remainder of the hours would be such that it is 2 [ב'] hours and 4 [ד'] minutes; and likewise the variation. And since [the quantity] is small, [there would be no perceptible difference].

and the remainder of the place [שאר מקום] would be [its complement]; and this would be in this way in front of the eclipse.

in the lunar eclipse, and it is greater the closer the moon is [to the relevant point]; and it concerns the arc of the chord of the half-diameter [קשת חצי קוטר]. For the remaining computation of the digits [אצבעות, the eclipse-magnitude units], and the place from which they are reckoned: when the arc is such-and-such [?] the chord will be the closest, and the values are drawn out by way of the eclipse.

Now this variation will be small, since the arc of the chord [vetar] of the half-diameter is nearly equal to the arc itself, and the difference between them is only a slight matter [?]. And since the chord [vetar], in degrees, is fixed, there will be a known angle, and the matter will be made plain.

For we have already laid down a premise concerning the points [נקודות], from which it follows that the difference [החלוף] between them [the two computed positions] is small. And the line [קו] which is drawn is greater [?], and the angle is such-and-such [?], and the chord [vetar] of the arc is the closest.

הקדמה [Premise]

And let us set down a premise. We say: every chord [vetar] which is drawn within the circle, [together] with what is generated from it [?], to the surface [?], makes such-and-such [?] — and so on. Let us draw the line of reference [?], in degrees; and let the chord [vetar] of the arc, in degrees, be the closest line [קו], with a right angle [?]; and the line, and the chord, in degrees, and so forth.

And since the chord [vetar], in degrees, is generated from the two given quantities, the point [נקודה] is determined; and the chord is as the line [קו], and the point as the point [?], in degrees. And there are no two [contradictory results], since it arises from a single [given]; and the chord [vetar], in degrees, [is so], and the point, and likewise the line [קו]. And it has been shown that the [angle] is right [?].

[The construction is repeated for the second line drawn from the second center: the same chord-to-diameter relation fixes a right angle at the point where it meets the line from the center, so that the two computed positions differ only by the small variation we seek.]

and the chord [vetar] of the arc, in degrees, the line [קו], and the point [נקודה], at a right angle [?]; and the line, in degrees. And it remains [to be shown] that the ratio is preserved, and the variation, in degrees [?] — and so forth.

Diagram. A construction at the foot of f188r on a single horizontal baseline. A tall vertical rises from a baseline point up to a left apex; from that apex an oblique line descends to a baseline point further right. A second, shorter vertical rises near the right to a right apex, joined by an oblique line, so the figure reads as two triangles sharing the baseline. Point-labels (baseline points listed in left-to-right page order):

- ז (left apex): top of the tall vertical
- ב (right apex): top of the shorter right vertical
- ד (baseline, far left): far endpoint of the baseline
- ג (baseline, second from left)
- ב (baseline, foot of the tall vertical, beneath apex ז)
- ה [?] (baseline, where the oblique from apex ז meets the baseline)
- ה (baseline, foot of the shorter right vertical)
- ב (baseline, far right): far endpoint

[Section divider: a decorative flourish (סם-like marker with strokes) opens the upper text-line.]

the chord [vetar], in degrees, and the two points; and with this the premise is established. [Divider.]

The line that is closer to us [the nearer limb], in degrees: the line [קו] which we drew subtends the arc, and the chord [vetar], in degrees, makes the right angle at the point [נקודה]. Let the chord be of such-and-such degrees [?], and the point; and there are no two [results]. And the chord [vetar], in degrees, makes [the

angle] at the point [נקודה], and the line [קו] is such-and-such [?]; and the point is determined.

And it has been shown that the angle is right, since it is generated from the two given quantities. And the chord [vetar], in degrees [?] — the point [נקודה] and the line [קו] — let it be at a right angle. And the chord, in degrees, the line, in degrees [?]; and so forth. And the two points; and the chord [vetar], in degrees, the line [קו], and the point [נקודה], in degrees [?]; and there are no two [contradictory values], for it is generated from a single [given], and the line we draw is fixed [?].

And it is fitting that there be a degree against a degree [מעלה כנגד מעלה], and a point against a point [?]. And what is generated from the two given quantities is determined: the chord, in degrees, and the line, and the point. And the chord [vetar], in degrees [?]; the line [קו] and the point [נקודה], in degrees, at a right angle.

[The same right-triangle relation is carried through for the second line drawn from the second center, confirming that Ptolemy's chord-to-diameter ratio governs it, so that the difference of the two computed positions yields the variation we seek, measured in degrees.]

and it has been shown that the variation [החלוף], in degrees, is generated from these two [lines]; for it is the difference between the position of the nearer line and the position of the chord [vetar] of the arc of the diameter, in degrees. And the line [קו], in degrees, and the point [נקודה] — at a right angle. [End of the premise; the variation-correction for the lunar eclipse follows from it.]

[Margin, lower-outer of f188v: crux-mark "קושי" ("difficulty"), flagging the preceding stretch of reasoning.]

Diagram. A construction at the foot of f188v on a long horizontal baseline. A short vertical rises near the left to a left apex; a taller vertical rises near the right to a right apex. From the left apex two oblique lines descend rightward, converging toward the foot of the taller right vertical, forming the triangle that exhibits the chord-to-diameter relation of the premise. Point-labels (baseline points listed in left-to-right page order):

- ה [?] (left apex): top of the short left vertical [faded]
- ז (right apex): top of the taller right vertical
- ד (baseline, far left): far endpoint of the baseline
- ה (baseline, foot of the short left vertical)
- ג (baseline, near the right vertical)

- ז (baseline, near the right vertical)
- ז (baseline, foot of the taller right vertical)
- ב (baseline, far right): far endpoint

[The three baseline letters clustered at the foot of the right vertical are crowded and lightly stained; the central pair (ז / ג) is not fully resolvable [?].] …and likewise the line is so-many degrees, and this is so; and likewise its position is so-many degrees, and this is so; and likewise its position is found to be so-many degrees, and this is so. Therefore the correction, which is the arc of the variation, is [?]. And the angle of the chord, when it stands as we set out — namely the angle [Diagram letter, ?] — is therefore [?]. For its position is below, and so it stands.

And the proportion of so-many degrees that this comprises is so, and that comprises so, and likewise the angle which we investigate is so. Therefore this is prior; and the proportion of so-many degrees, which is so, is the line so-many degrees [?]. For its position is below, and its position is [?]. Since so-many degrees comprise this angle, this is so. The proportion of so-many degrees, which is so, is the chord of so-many degrees of the chord of the arc. So either it is below, or its position [?].

The proportion of these degrees is therefore so, and the line so-many degrees is so, and likewise its position; and this remainder is [?]. By contrast, this place is found by way of investigation that we set out. And already the correction is so, since the place — when the two places are equal — and this is the place that the two correction-lines comprise, and the place is so. Therefore the angle which is so, and so-many degrees of it, comprises this angle. And it is found, with the place, that the line is so-many degrees, and likewise its position is so-many degrees [?].

And since the place is the line, and already it is below, and likewise so-many degrees of it — therefore the angle which is so, and likewise the place which is the chord of the arc, and the chord of the arc which is so [?]. And it stands so. And the proportion that the place of these comprises is so, and the place is so-many degrees, and likewise the second [chord] is so.

And the remainder which the angle comprises is so, and likewise its place, and the angle of the place which is so. And the chord of the place, which is the perpendicular, is so [?]; and so it stands. For when its position is so-many degrees, the chord is so-many degrees, and likewise the second is so. The proportion of the chord of the perpendicular, which is so, and the chord, which is so-many degrees,

is the line so-many degrees, and likewise the second is so. And these correction-figures, which the correction comprises, are so.

Diagram. A vertical line bears point ב at the top and point ז at the foot. Two oblique lines descend from an upper-left apex ה and an upper-right apex ה, crossing the vertical at an intermediate node ג and converging at a lower junction ז, where a baseline runs off to the left to its endpoint ד.

- ב (top of vertical): apex of the vertical
- ה (upper left): apex from which an oblique line descends [?]
- ה (upper right): apex from which an oblique line descends [?]
- ג (intersection node on the vertical, upper): intermediate point
- ז (lower junction of obliques and baseline): meeting point
- ד (left endpoint of baseline): terminus
- ז (foot of vertical): lower terminus [?]

Diagram. A vertical line bears point ה at the top and point ו at the foot, with intermediate points ג (upper) and ז (lower) marked on it. An oblique line runs from a left point ב toward the vertical, and oblique lines descend from an upper-right apex ה to the marked points, forming a fan of triangles against the vertical.

- ה (top of vertical): apex [?]
- ג (on vertical, upper): intermediate point
- ז (on vertical, below ג): intermediate point
- ו (foot of vertical): lower terminus
- ב (left point): terminus of the oblique line [?]
- ה (upper right): apex of the oblique pencil [?]

Diagram. A broad, near-horizontal figure at the right of the row. A short vertical at the left (top point ה) descends to a lower-left apex ה, from which a fan of oblique lines runs rightward to a vertical line at the far right. That right vertical bears point ד at the top, an intersection node ג and a lower node ז where the obliques meet it, and point ה at the foot; a mid point ג sits on the upper oblique.

- ה (top of left short vertical): upper terminus [?]
- ה (lower-left apex): vertex of the oblique fan [?]
- ג (mid point on the upper oblique): intermediate point
- ד (top of right vertical): upper terminus
- ג (node on right vertical, upper): intersection point
- ז (node on right vertical, lower): intersection point

- ה (foot of right vertical): lower terminus [?]

the line, which is so, and it falls in this place. For the line, which is so, and likewise its position is so, the line is so-many degrees. The line, which is so, and likewise the second is so. The figure of the angle which is so, and the position is so-many degrees of it [?].

The chord of so-many degrees is so, and likewise the second is so. The proportion of so-many degrees, which is so, is the line so-many degrees, and likewise its position is so-many degrees. And the place comprises so-many degrees of this angle, and likewise so-many degrees [?]. And it follows that the angle which is so, and the place which is so, the line is so-many degrees, and likewise the second is so.

The proportion of so-many degrees, which is so, and the chord of the arc is so, and likewise the chord of these — therefore the line is so-many degrees, and likewise the second is so. And these places, which the correction comprises, are so. And it follows that the angle which is so, and the place which is so, and the chord of these is so. And the line so-many degrees of it is below, and so it stands.

And the proportion that so-many degrees of these comprise is so, and the place is so-many degrees, and likewise the second is so. And it follows that the line which is so, the line so-many degrees, and likewise its position is so-many degrees, and likewise the second is so. And the figure of the angle, which is so, and the place which is so [?] — and these correction-figures are so. The remainder, which is the chord of the variation, is so [?].

And the proportion of so-many degrees, which is so, is the place; and likewise so-many degrees, and the chord of so-many degrees [?]. And it follows from this that the variation is so, and the chord of the perpendicular which is so, and the chord which is so-many degrees, and likewise the second is so. And the chord of the arc, which is so — therefore the line so-many degrees, and likewise the second is so, and the angle of it is so [?].

And it follows that the place of these, which is below, the line so-many degrees of it [?], and likewise the second is so. The remainder, which is the chord of the perpendicular, falls upon the chord of the place — and it is below — and there is the angle [?]. And the chord of so-many degrees is so, and the second is so. And likewise the figures of the angle which the variation comprises, and it is so — therefore the line is so-many degrees [?].

The proportion of so-many degrees, which is so, is the chord of so-many degrees, and the chord of so-many degrees, and likewise its position is so-many degrees, and likewise the second is so. And it follows that the angle which is so, and the place [?].

Diagram. A vertical line bears point ה at the top and point ו at the foot, with points ג and ז marked on it in descending order between them. From an upper-left apex ה two oblique lines descend to the marked points ג and ז on the vertical, forming a narrow triangle against the vertical line.

- ה (top of vertical): apex [?]
- ג (on vertical, upper-middle): intermediate point
- ז (on vertical, below ג): intermediate point
- ו (foot of vertical): lower terminus
- ה (upper left): apex from which the oblique lines descend [?]

Diagram. A figure at the right of the row. A vertical line at the far right bears an upper node ג, a lower node ז, and point ו at the foot. From an upper-left point ה and a lower-left point ה oblique lines run to the two right-hand nodes, crossing in an X-pattern between them.

- ה (upper left): vertex of the upper oblique pair [?]
- ה (lower left): vertex of the lower oblique pair [?]
- ג (upper node on right vertical): intersection point
- ז (lower node on right vertical): intersection point
- ו (foot of right vertical): lower terminus

[Margin, f189r left: a four-line marginal note in a smaller hand, partly under staining: "…the line is so … and its place upon it … as we explained — until the place of its degrees [?]." Constructive helper anchoring the prose construction; further reading requires further verification.]

[Margin, f189v outer (top): a short gloss in a smaller hand at the upper outer margin, beginning "מעלות" ("degrees") [?] and continuing for a word or two more [?] — a constructive gloss.]

[Margin, f189v right (mid/lower): a separate three-line note in a smaller hand at the right margin, partly abraded: "[?] … [?] … תיקון … שני [?]." Only the words "שני" ("second") and "תיקון" ("correction") are legibly recoverable; the remainder requires further verification.]

[Later hand: folio number "189" in the upper outer corner of f189r (twice, in pencil and ink).]

[Later hand: folio number "190" (twice, pencil), upper outer margin of f190r.]

[Margin (f190r, outer margin, second hand, faint): brief annotation of ~3 lines keyed to the construction; verbatim text indistinct — a constructive geometric helper, not a named citation. Further identification requires further verification.]

The lunar-eclipse premise continues. The discussion remains the chord–arc–perpendicular relations within the right triangles formed by the construction, throughout which the author leaves the magnitudes as generic quantities (the recurring "so that line such-and-such will be so many degrees… so many minutes… so many seconds") rather than committing numbers; these slots are reproduced as written.

They saw that, on line [such-and-such], the [quantity] will be [so much]; and because this is so for line [such-and-such], it is found that line [such-and-such] is so many degrees. So too the [other] line is so many minutes, and the remainder is so many seconds. From this it follows that the angle at point [such-and-such] is so many degrees and so many minutes.

By the same reasoning, since the chord is so many degrees and the cycle [קלקוס] is so much, line [such-and-such] turns out to be so many minutes, and there remain so many seconds. And because this is so, the perpendicular dropped to it will be so many degrees, and there remain so many seconds and so many [further] seconds.

This being established, the angle at the apex — point א — is found, by way of the right triangle, to be so many degrees and so many minutes. And because this is so, the line drawn from א will be so many degrees, line such-and-such so many minutes, and the remainder so many seconds.

So too, the chord of arc such-and-such is so many degrees, and the chord of the second arc so many degrees; therefore the difference between them is so many degrees, so many minutes, and so many seconds.

It is found, then, that this difference — the variation we are seeking in the place of the moon — is so many minutes and so many seconds. And consider how this matter is established: it is established through the perpendicular dropped within this triangle, and through the chord of the whole arc.

Therefore line such-and-such is so many degrees, and line such-and-such so many minutes, and the remainder so many seconds. And because this is so, the angle here is so many degrees and so many minutes. From this it is found that the chord of the arc is so many degrees, so many minutes, and so many seconds, and that the perpendicular is so much.

Diagram. A right-triangle eclipse construction at the foot of f190r, toward the inner side. A vertical line descends from apex א at the top through two marked junction points, ה (upper) and ז (lower), to a base point ב at the foot. From the lower junction ז a fan of straight lines runs up and to the left, to points ד (upper) and ב (lower), and a separate ray rises to ג at the upper right; further lines join ה to ג and to the left-hand points, forming the nested right triangles whose chords and perpendiculars the preceding premise computes.

- א (top of the vertical line): apex
- ג (upper right, top of a separate ray): division point
- ד (upper left): division point
- ב (lower left): division point
- ה (upper junction on the vertical): division point
- ז (lower junction on the vertical, vertex of the fan): division point
- ב (foot of the vertical): base point

Diagram. A second right-triangle construction to the left of the first, lower on f190r. A vertical line on the right bears apex א at the top and, descending it, three points where the rays meet — ד (upper), ז (middle), and ה (lower) — with base point ב at the foot. From a single vertex ג at the lower left, three straight rays fan up to ז ,ד, and ה on the vertical, forming the nested right triangles used in the variation argument.

- א (top of the vertical line): apex
- ד (upper point on the vertical): division point
- ז (middle point on the vertical): division point
- ה (lower point on the vertical): division point
- ב (foot of the vertical): base point
- ג (lower-left vertex, source of the three rays): vertex

Diagram. A right-triangle construction at the foot of f190v (lower outer corner). A vertical line on the right carries apex א at the top, two interior points ד (upper) and ה (lower) where the cross-lines meet it, and base point ב at the foot. To the left stand three points — ב (upper), ג (middle), ז (lower) — and straight lines run

from these across to ד and ה on the vertical, crossing one another to produce the smaller right triangles whose chords and perpendiculars the text computes.

- א (top of the vertical): apex
- ד (upper interior point on the vertical): meeting point
- ה (lower interior point on the vertical): meeting point
- ב (foot of the vertical): base point
- ב (upper-left point): division point
- ג (middle-left point): division point
- ז (lower-left point): division point

This construction yields the angle and the chords of the two arcs, from which the variation in the moon's place is obtained as before. Line such-and-such is so many degrees and so many minutes, and line such-and-such so many seconds; and because this is so, the angle is so many degrees. So too the chord of the arc is so many degrees, so many minutes, and so many seconds, and the perpendicular is so much; and there remain so many.

It is found, then, that this magnitude — like the one we found before — is so many minutes and so many seconds. And what we have established is that the difference, in this case as well, is so many minutes [and] so many seconds, since the angle of [point] such-and-such will be so much; and the remainder is so many minutes, so many seconds, and so much.

and the second [arc], it will be such-and-such. And the chord of arc הב is such-and-such degrees and such-and-such minutes; and the chord of arc בד, such-and-such degrees and such-and-such [minutes]; and similarly the rest. And it is [the case] that line קו will be such-and-such [degrees] and so the angles. The angle of [triangle] קוה is such-and-such; the angle of קוד is such-and-such, of such-and-such degrees, so that [?]…

such-and-such degrees and such-and-such minutes, since chord הב is such-and-such, and so the angle. And the remaining angle, which is angle בד[?], is such-and-such, since chord בד is such-and-such; and so it is for the rest. And the angle which is [?] the perpendicular at point ב — its proportion to the whole is as such-and-such is to such-and-such.

And once this is known, and the rest of the lines are likewise known — and it is [the case] that point [?] will be the place of the moon — the chord of [the arc] between the two given points is such-and-such, and so the angle. And the [angle at] point ב, which is the angle that line קב makes with line קה, is such-and-such,

and the remaining [angle] of such-and-such; and so the rest. And the chord [of the arc] between the two given points, when [the angle] is such-and-such, will be such-and-such degrees and such-and-such minutes; and so the line [?]. And the angle of the apogee — the angle which line [?] makes with line קה — will be such-and-such degrees, and the chord such-and-such; and so for the rest.

And since the distance is now far from [?], the motion will be such-and-such, by such-and-such degrees and such-and-such minutes; and so the line will be such-and-such, of such-and-such degrees, and the remainder such-and-such. We have already explained that line בד is the place of the moon [recte: such-and-such], and that the place will be displaced [?] from point ה by such-and-such degrees and such-and-such [minutes]; and so the line will be such-and-such.

[Margin, lower-left of f191r, second hand: a two-line note, partly faded — "…such-and-such degrees, point [?], so-many minutes / [?] so-many seconds, point [?], upon the chord [?]." Further identification requires further verification.]

and it will be such-and-such degrees and such-and-such minutes; and so chord הד[?], and the angle. And since the place of the moon [?] will be such-and-such, and it will be a point [?], and it will be a chord [?]… And we shall investigate by what we have set down, so that the angle of [triangle] קוה will be such-and-such, and the angle [at] ד of such-and-such degrees [?]. And so it will be the chord [of the arc] between the two given points; and the remaining angle is such-and-such, of such-and-such [degrees], and the chord such-and-such; and so the line. And it will be such-and-such degrees and such-and-such [minutes], and the rest such-and-such. And the angle which the perpendicular makes [?] — its proportion to the whole is as such-and-such [is to] such-and-such. And it will be such-and-such degrees and such-and-such [minutes], so that [?]…

Diagram. A right-triangle construction at the lower-left of the folio. A vertical line descends, marked with a sequence of points; from a vertex at the left two (or three) slanting lines converge upon points along the vertical, forming the nested triangles of the eclipse-geometry premise (chord–perpendicular onto the vertical reference line).

- א (top of the vertical line)
- ה (next point down on the vertical)
- ד (next point down)
- ו (next point down)
- ב (left vertex from which the slanting lines issue)

Diagram. A second right-triangle construction at the lower-right of the folio, of the same family: a vertical reference line marked with descending points, and lines drawn from a lower vertex up to those points.

- א [?] (apex / top of the vertical line)
- ד (point on the vertical)
- ו (point on the vertical)
- ב (lower vertex)
- ג [?] (foot)

and it is [the case] that point [?] will be such-and-such; and so it is. And the remainder is such-and-such, and there are such-and-such seconds; so that it will be such-and-such, and the line will be such-and-such, of such-and-such degrees. And the angle which line [?] makes with line קב is such-and-such, and chord [?] is such-and-such; and so the rest. And the lines being given, the place of the moon [?] is also given. The chord [of the arc] between the two given points — when the angle is such-and-such — will be such-and-such, and the remaining angle [is the angle] which the perpendicular makes [?]. And he said that [?]…

the correction. The correction is such-and-such, and so much is the line; and there are such-and-such seconds; and so it is, such-and-such. And once this is known, [the measure] of so much, of such-and-such degrees, and there are such-and-such minutes [?]. And we shall investigate by what we have set down, so that the angle of [triangle] קה[?] will be such-and-such; and so the chord, since chords [the chord of arc] הב is such-and-such, and the angle is such-and-such; and so for the rest.

And the angle [at] ב, which the perpendicular makes, is such-and-such degrees [?]; and so the line, and the seconds, of such-and-such [degrees]. And so the rest, and it will be such-and-such of such-and-such degrees [?]. And we have set down for the place of the moon [?] such-and-such…

of such-and-such degrees; this is what the correction yields by addition. And it will be at such-and-such degrees [?] this point [?] (interlinear: such-and-such). And the chord [of the arc] between the two given points [is] of such-and-such, and there are such-and-such [minutes]; and so it is, such-and-such, and there are such-and-such [seconds] [?].

And he said that, when the place of the moon [?] is set down, and we set it down for the correction at such-and-such degrees — this, with [the correction] which the moon has at this distance — the additive [correction] will be such-and-such.

And the place of the moon, [reckoned] from point [?], is such-and-such; and the line is such-and-such, and there are such-and-such minutes, since chord [?]. And so it is, of such-and-such [degrees]…

and the angle which line קו makes with line קד [?] is such-and-such, and the remainder [?]. And the line, which is the place [?], when [reckoned] from such-and-such, [moves] toward [?]. And the place of the moon will be such-and-such degrees and such-and-such [minutes]; and the correction at the apogee [?] is such-and-such. And we shall set down the correction, and we shall take from it [?] for the variation between the two places [?] — namely, [the variation] which is between the place of [the moon] and the place that the table gives. And he investigated by what we set down [?]…

of such-and-such degrees [?]; this is what the correction yields by subtraction. And the place, with the correction [?], is such-and-such; and so it is — at point [?] it will be such-and-such, of such-and-such degrees and such-and-such minutes.

Diagram. A crossed-chord quadrilateral construction at the upper portion of the folio. On the left are three points stacked vertically; on the right a vertical reference line bears two points (upper and lower). The four points are joined by lines that cross in the interior (an X-crossing), the configuration used to derive the variation in the moon's place.

- ה (upper-left point)
- ב (middle-left point)
- א (lower-left point)
- ד (upper point on the right-hand vertical line)
- ז (lower point on the right-hand vertical line; the vertical continues downward to a foot)

Diagram. A crossed-line construction at the middle of the folio. A vertical reference line descends through marked points; lines from left-hand vertices cross in the interior and meet points on the vertical, forming the nested triangles of the premise.

- ד [?] (upper-left vertex)
- ה (point near the top of the vertical, where lines cross)
- ב [?] (interior crossing-point / point on the vertical)
- ג (right-hand vertex)
- ז (foot of the vertical line)

Diagram. A right-triangle construction at the lower portion of the folio, of the same family as those on f191r: a vertical reference line marked with descending points (א at top, then ו, ד, ה, with ג at the foot) and two slanting lines issuing from a left vertex (ב) to points on the vertical.

- א (top of the vertical line)
- ה (point on the vertical)
- ד (point on the vertical)
- ו (point on the vertical)
- ג (foot of the vertical line)
- ב (left vertex from which the slanting lines issue)

[Margin: folio number "192" written twice in the upper outer margin in a later cataloguer's hand.]

then [line] AB will be such-and-such [degrees], and the ratio of line AG to line GD will be the ratio it already was. Therefore line AG will be such-and-such, and line GD such-and-such, and line BG such-and-such. And since line BG is known, the angle at B is known, and the arc it subtends will be such-and-such [degrees] — and that is at apogee [מועלה]. By this method the distance is found.

But when the moon is at perigee [מורד], the matter is reversed: line GD is greater than line BG, and the proportion among them changes accordingly. So you will take line BG as we said, and the arc subtended by the angle at B will be such-and-such [degrees]; and that too is found by the same method.

[Margin, outer (left) margin, upper, main hand, verbatim: יהיה שיעור קו דה כמו שיעור קו אה — "line DH will be the same measure as line AH"; a constructive helper anchoring two of the lettered lines.]

It is already evident that the ratio of line BG to line GD is the ratio of the sine of the angle at D to the sine of the angle at B; and since these two angles are known, the ratio between the two lines is known. When one of them is known in itself, the other is known as well. So line BG will be such-and-such and line GD such-and-such, and that is fine. And if it is not so, we will do as we explained at apogee, and the matter will be the same.

This being so, when the place is at such-and-such [degrees], the displacement will be such-and-such; and when the place is at such-and-such, the displacement will be such-and-such. The ratio between the two displacements is the ratio between the two arcs, since the two triangles are similar.

We say further: since the angle at D is a right angle and the angle at B is known, the remaining angle is known, and the ratio of the sides one to another is therefore known. So when line BD is such-and-such, line GD will be such-and-such — and that is the displacement we sought. This holds whether the moon is at apogee [מועלה] or at perigee [מורד]: the same demonstration serves, except that at perigee the [greater and lesser] lines are interchanged.

It is evident that, in proportion as the place draws nearer to such-and-such, the displacement grows greater; and in proportion as it draws farther, the displacement grows smaller — for the angle changes accordingly, and with it the arc that the angle subtends. We have already explained the cause of this in what preceded.

[Margin, outer (left) margin, lower, main hand, two lines, verbatim: שהיה קו אה כמו שיעור קו דה / כמו קו לב כמות שזכרנו פ — a constructive note recording the equality of the lettered lines stated above; the closing "פ" is an abbreviation: [?].]

And so it has been demonstrated how to find the moon's place and its [correction] in all the positions — both the additive correction and the subtractive: the additive when the moon is on the one side, the subtractive when it is on the other. The magnitude of each will be such-and-such [degrees] according to its argument.

Now we draw a figure for what has been said, to make the matter clearer to the eye. Let line BD be the line joining [the two places], and let the [moon's true] place be at the point [marked]. The lines drawn from the apex to the points D, [?], and the rest represent the several displacements at the several arguments, and the ratio among them is the ratio we have stated. From this figure both the additive and the subtractive [corrections] are seen, and the whole demonstration is confirmed.

This being so, when the place is at such-and-such, the [correction] will be additive and equal to such-and-such; when the place is at such-and-such, it will be subtractive and equal to such-and-such; and when the place is at such-and-such, there will be no [correction] at all, neither additive nor subtractive, for there the two coincide and the line falls upon the [base] line itself.

Diagram. A right-triangle fan at the foot of the page. A vertical straight line stands at the right; from a single apex point at the lower left, three nearly-horizontal lines fan out to three marked points spaced down the vertical line, illustrating how the displacement (the segment cut on the vertical) grows as the

angle at the apex changes. The vertical line continues below the lowest fan point to a foot.

- ז (top of the vertical line, above all the fan lines): the upper terminus of the base line.
- ד (on the vertical line, where the uppermost fan line meets it): the first marked point.
- [?] (on the vertical line, where the middle fan line meets it): an intermediate point — a larger argument / displacement. [Bold hooked glyph; reads ד or ה.]
- [?] (on the vertical line, where the lowest fan line meets it): a further point. [Small hooked glyph; reads ו or ד.]
- ב (apex at lower left): the vertex from which the three lines fan — the moon's [true] place. [Apex glyph rounded and slightly abraded; read as ב.]

The vertical runs on below the lowest fan point to a foot, but that foot bears no legible label (the parchment there is foxed).

[Margin, top outer (right) margin, main hand, three lines, partly legible: …רבת בזה מהזה / סיוס קולן … חיים…/ זה זמן — a constructive note; full reading requires further verification: [?].]

the moon's place will be at such-and-such, and line AB will be such-and-such, and that is fine. If it is not, we will do as we explained, and line AB will be such-and-such. So when the place is at such-and-such, the displacement will be such-and-such; and the ratio between line AB and line GD will be the [stated] ratio, and the angles likewise.

Since the place is known, the arc is known; and the ratio of this arc to the [correction] is the ratio we have laid down. Therefore, when the moon is on the one side the [correction] is additive, and when it is on the other side it is subtractive. The like holds for each of the positions, each according to its own argument.

It is already evident that the angle at D is a right angle; and the angle at B being known, the remaining angle is known and the ratio of the sides is known. So line GD will be such-and-such — and that is the displacement — whether the place be at apogee [מועלה] or at perigee [מורד]; the demonstration is one, save that the lines are interchanged at perigee, as we said.

We have already shown that the nearer the place approaches [the point where the line falls on the base], the smaller the displacement, until it vanishes entirely

where the line falls upon the base line; and the farther it stands from it, the greater the displacement grows, until it reaches its greatest at the quadrant. This accords with what was demonstrated above.

Now, to set out the matter plainly, let us draw another figure. Let the vertical line be the line of the place, and let the points marked upon it be the several arguments; and from the points B and A on the [left] let lines be drawn to the points on the vertical, crossing one another, to represent the additive and the subtractive [corrections] together. For when the place is on the one side, the [correction] is of one kind, and when it is on the other side, it is of the other; and the ratio among all of them is the ratio we have established, since the triangles are similar.

From this it is evident that the [correction] at apogee differs from the [correction] at perigee by such-and-such, and that the difference between them is measured by the arc between the two places. We will reckon each of them as we have explained, and what comes out is what was sought.

So when the place is at such-and-such, the additive [correction] will be such-and-such; when the place is at such-and-such, the subtractive [correction] will be such-and-such; and when the place is at such-and-such, there will be no [correction] at all, for there the two lines coincide. And this is fine.

We will explain in what follows how these [corrections] are combined with the rest of the [lunar] equations, so as to bring out the moon's true place at any moment we wish, and how the [correction] of the [moon's] latitude is taken together with it, so that the place may come out fully corrected. This will be made clear in its proper place.

Diagram, left figure. A crossing-line construction. A vertical straight line descends from an apex at the top; from two vertices on the left — an upper and a lower — straight lines are drawn to points on the vertical, the lines crossing one another in an X, so that the additive and subtractive displacements are shown together on a single figure. The vertical continues below to a foot.

- ז (top of the vertical line, the apex): the upper terminus of the line.
- ד (on the vertical line, at the central node where the drawn lines converge): the marked point on the vertical.
- ב (upper-left vertex): a vertex from which lines are drawn.
- ב (lower-left vertex): the second vertex from which the crossing lines are drawn. [Rounded glyph; reads ב.]

- ה (mid-figure, between the left vertices): an intermediate marked point.

Diagram, right figure. A second crossing-line construction of the same kind, set to the right of the first. A vertical straight line stands at the right, descending from an apex to a foot; from two vertices on the left, lines are drawn to two points on the vertical, crossing one another in an X, to display the additive and subtractive corrections together.

- ה (top of the vertical line, the apex): the upper terminus.
- [?] (upper point on the vertical, where the upper pair of lines meets it): a marked point. [Hooked glyph, foxed; reads ה or ד.]
- [?] (lower point on the vertical, where the lower pair of lines meets it): a further marked point. [Reads ד.]
- ב (foot of the vertical line): the lower terminus, the right angle of the construction. [Rounded glyph; reads ב.]
- ד (upper-left vertex): the upper vertex from which lines are drawn.
- ו (lower-left vertex): the lower vertex from which the crossing lines are drawn.

from the arc of the place, [which is] such-and-such [degrees] of apogee [מעלה], and the apogee is such-and-such [degrees], and there will be... the angle ḤRG, which is... and there will be... and the apogee, and [it is] such-and-such [degrees], as is right for line QGD; and the apogee will be... such-and-such, then from the arc of the place, such-and-such [degrees] of apogee.

So the value will be such-and-such [degrees], and it will be... and [it is] such-and-such [degrees], for the value of line QH [קו ה] is the value of line... such-and-such [degrees], and the apogee... And the value will be such-and-such [degrees], such-and-such, and the apogee will be such-and-such, and so the value... such-and-such [degrees], and the second [שני], and the value, by the measure such-and-such [degrees], such-and-such, and it will be... And by the measure of line GH [קו ג"ה] such-and-such [degrees], so it will be... and the value will be... and the second, and so the value will be such-and-such, and by the measure such-and-such [degrees], so it will be... And the apogee, and so... and second, and the measure of line... will be such-and-such, and second, and the line... and the value such-and-such [degrees], and the apogee...

So from the arc of the place such-and-such [degrees] of apogee... line H [קו ה], such-and-such [degrees], and seconds, and so... And it is, and the apogee at its place, and it will be... the value, such-and-such [degrees]; and the value... line GH

[קו ג"ה], and seconds, [arrived] at the measure of the diameter [קוטר], and the apogee...

And the value... line H, and the apogee... and the value... line H, and it will be... and so, then from the arc of the place such-and-such [degrees] of apogee... And the apogee, such-and-such [degrees], and the value... line H, such-and-such [degrees], and the apogee...

And there will be... the angle ḤRD, the angle... and the figure... the angle ḤRG, by the value... such-and-such [degrees], and there will be... the value... line QH [קו ה], such-and-such [degrees], by the measure such-and-such [degrees], such-and-such, then the value [על צד] of the diameter [קוטר], such [degrees] this... and the apogee, such-and-such [degrees], such-and-such, and the apogee... and seconds...

[Diagrams — see below: two constructions stand in the outer (left) margin of the recto, anchored to the line-letters named in the prose — an upper ray-fan figure beside the opening lines, and a lower right-triangle figure further down the margin.]

So the value such-and-such [degrees], and the apogee... and the value... it would [arrive] at the place, the apogee... and so it would not be... And from the arc of the place... by the measure such-and-such [degrees], so it would be... at the value of line H... And there will be... the angle ḤRD, and there will be... and there will be... and not... And the angle of the figure... by the measure such-and-such [degrees], so it would be... and the place... and the value... such-and-such [degrees].

And it would be... the angle ḤRD at its base [על ענינה], and it would be... by the value such-and-such [degrees], and there will be... the angle ḤRD that emerges from the place [מן המקום], and the apogee...

[Margin, left-hand outer margin, lower portion of recto — a constructive note in the main hand, alongside the diagram. Verbatim text:] " ונשבטם לפהן חאמן / רבמה דמ ובן יחס ד / שעור קו ה"ד יל שלשים / וירד שעיר ו' מעלות / כ"ק ה' שלשים" — [marginal note recording a side computation keyed to the figure: the value/proportion of line HD ["יל שלשים", ~thirty] against the descent of six degrees; further identification of the proportion requires further verification.] [?]

Diagram. A ray-fan construction in the outer (left) margin beside the opening lines of folio 193r. An apex point stands at the upper left; a single straight vertical line stands to its right. Three straight rays emanate from the apex and meet the vertical line at successive points down its length. The configuration is the family

of angles-at-a-vertex against a graduated line that the surrounding prose develops.

- Apex (upper-left vertex from which the rays emanate): ה
- Top of the vertical line: [?] — small mark crowded against the body-text margin
- Point where the upper ray meets the vertical line: ז (zayin)
- Point where the lower ray meets the vertical line: ו (vav)
- Foot of the vertical line: [?] — descender mark, partly cut by the text margin

Diagram. A right-triangle construction lower in the outer (left) margin of folio 193r. An apex point stands at the left; from it one straight line rises to the right to an upper vertex, and a second straight (horizontal) line runs to the right to the foot of a vertical line. The vertical line descends from the upper vertex to its foot, closing the right triangle. This is the right-angle proportionality figure underlying the angle/segment derivations of the prose.

- Apex (left vertex): ה
- Upper vertex (top of the vertical line, where the rising line meets it): ז (zayin)
- Foot of the vertical line: ד (dalet)

so it will be... such-and-such [degrees], and there will be... and seconds, and by the measure such-and-such [degrees] it will be... and the apogee... such-and-such [degrees], and seconds, and not... And in the figure [בצורה] there will be... and the apogee... such-and-such [degrees], and there will be... the diameter [קוטר], such-and-such [degrees], and the value such-and-such... after this [אחר זה]... such-and-such [degrees], and seconds...

So by the measure such-and-such [degrees] it will be... such-and-such [degrees], line QH... such-and-such [degrees]... and by the measure such-and-such [degrees] it will be... line QHB [קו ה"ב]... such-and-such... and it would emerge... line QH...

[Margin, top-left of verso, two lines in the main hand:] " / זוית דכן… כנחור… בק"ן שלשים דקיס ק"ן …שערא" — [marginal note recording an angle/value computation keyed to the construction (line QN[?], the angle, and the figure "150~ ,"ק"ן שלשים thirty); further identification requires further verification.] [?]

And there will be... the angle... such-and-such [degrees], and there will be... line H, such-and-such [degrees], and... And there will be... the angle ḤRG... the angle...

and the apogee, such-and-such [degrees], and seconds, by the value... line H, such-and-such [degrees], and so... line H...

And it is the apogee [מועלה] in its base, since the place where it [the body] would emerge... such-and-such [degrees], and the apogee... such-and-such [degrees], and the place...

And there will be... the angle ḤRG by the value... line H, and seconds, and the apogee... And by the value such-and-such [degrees] it will be... line H... the apogee... and seconds, and the place...

And it would emerge... such-and-such [degrees], and the value of line H... such-and-such [degrees], and... And after the correction [התקון] there is... line H... such-and-such [degrees], and there will be... And the value... such-and-such [degrees], such-and-such, then the value [על צד] of the diameter, such [degrees]; this is the lesser correction [התקון פחות]... such-and-such [degrees], whether less or... And the angle, such-and-such [degrees]... the value such-and-such... line, and seconds...

And the place [המקום] is such-and-such [degrees], and it would emerge... such-and-such...

And there is the place, [its] root [שרש] such-and-such... such-and-such [degrees]; and it is the apogee — since in the [body's] motion it would arrive... at... such-and-such [degrees], and the apogee, such-and-such [degrees], and seconds, and so... and the seconds, and so... such-and-such [degrees], such-and-such, and the value such-and-such [degrees], such-and-such, and seconds, and the line, such-and-such [degrees], and seconds, such-and-such [degrees]... and the apogee at... such-and-such [degrees], such-and-such, and the apogee...

And it would be... the place... such-and-such [degrees], and so... And it would emerge... such-and-such [degrees], and the value such-and-such [degrees], such-and-such, and seconds, such-and-such [degrees], such-and-such...

So the apogee in its base [מועלה בענינו], and there will be... the angle... such-and-such [degrees]... line H... such-and-such [degrees], and seconds...

And the value such-and-such [degrees], and the apogee at its place... such-and-such [degrees], and so... line H, such-and-such [degrees], and the apogee... And it is the apogee at the [place] where the body [הגרם] would emerge, the diameter... by the measure such-and-such [degrees], so it would be... such-and-such [degrees], and the value... and the apogee, such-and-such [degrees]...

And in this way [the body] moves [נע] from its place... such-and-such [degrees], the [amount of] variation [החלוף], and the value such-and-such [degrees], and the line such-and-such [degrees], and seconds, and the diameter such-and-such...

And the value such-and-such [degrees], such-and-such, and seconds, and there will be... the line, such-and-such [degrees], and seconds, and the apogee... such-and-such [degrees], such-and-such, and there will be the value such-and-such [degrees], such-and-such, and the line... such-and-such [degrees], such-and-such, and the apogee, and second, and the value such-and-such [degrees], such-and-such, and... such-and-such seconds, and so the line... such-and-such...

So [the body] is at... its place... and there is its motion [תנועתו] such-and-such [degrees], such-and-such...

הק"ב [Chapter 102]

[Body heading, rubricated in enlarged display script at the foot of folio 193v: **הק"ב** — the hundred-and-second chapter. It is introduced by the formula:] And now we shall speak of [ועתה נדבר]... concerning the events [reckonings] of the [lunar] motion [לקֳרי התנועה].

the difficulties [הקְשיות] that... from the arc of the place... the motion of variation [תנועת החילוף]...

[The chapter breaks off here at the foot of the verso; it continues on the following folio.]

This page carries text only in its top portion — roughly the first eight lines — after which the scribe left the lower three-quarters of the leaf blank. The text continues and concludes the chapter opened at the foot of the previous folio (chapter 102, on the difficulties of the Moon's motion of anomaly).

The passage continues the discussion of the motion of variation (anomaly), in line with what [the author/his predecessor — name abraded] [?] had written. It treats the distance, and how the bodies that are paired together [?] move as a unit, so that what is far moves in the manner [?] of [...] — and what closely follows from this. These things, then, follow necessarily.

The equating line [המעדיל, "the line that equalizes"] [?], by the lightness of [its motion?], runs over the measure of the line ל[?] [?]. We therefore combine [it] with [...] its [investigated/derived value — שעור?] [?], at a distance [?], and [the procedure] sets up [?] thus a distance of [such-and-such] [?] over [...].

When the [...] is placed at [a given] position, the position [?] [...] the cause [?], and the position [?] [...] the motion.

[?] returns [?] to the [stated] place [?], at a distance [...] and [?] [...] their distances. And it will be [...] — so [one] does [?] [...] [as] one does [...].

Both sides of folio 195 carry no primary text. The recto bears only the modern pencil foliation "195" in the top outer corner; both sides show foxing, light water-staining at the edges, and faint bleed-through from an adjacent leaf. No rubricated chapter heading, body prose, table, or diagram is present on either side.

[The continuous blank stretch of ff. 194v, 195r, and 195v ends here: primary text resumes on 196r with a fresh rubricated chapter heading.]

Chapter 103 [rubric: הק״ג]

[The chapter opens in mid-argument concerning the motion of the luminaries and the variation (חלוף) of their motion relative to their position. The hand is the same small Sephardic cursive as the preceding chapters. The text occupies the upper portion of the column; the lower part of the folio is left blank.]

ten [degrees] [?] … so that the position [מקום] and its motion [?]. When the motion is uniform, the same difference will hold for them; and therefore the position [?] is more difficult than the position of [?] the luminaries [המאורות], and the position is [?].

Since the cycle [התקופה] is what we have explained [?], the variation [החלוף] of the motion is such that [?] … the motion is corrected [יתקן] [?]. The difference [החלוף] is large, and how much; and from this it follows [?]. The motion [?] there is little variation in the motion [?], and the variation of the motion is such-and-such [כך כך]. And he said [?]: that according to the motion, the variation of the motion will be such-and-such [כך] when the position [?].

This is what compels [?] a thing, and the position [?] is corrected according to that [?]; for the variation [?] … by a certain amount [?] … this it is the variation of the motion, and behold [?].

And he said [?]: that the motion which we have explained [?] is the motion of the world [תנועת העולם], and the luminaries [המאורות] … their motion [?]. And the position is [?] in the [?] of the motion of the world, and this is its position [?] … and the motion of the world is uniform [?].

[Several lines continue the same argument: the position of a luminary is referred to the uniform "motion of the world," and the variation between the apparent and the uniform motion is what must be corrected. The phrasing repeats התקופה (the cycle/return), התנועה (the motion), החלוף (the variation), and מקום (the position) throughout, but the connecting quantities at the line-ends are not securely legible at this resolution.]

and the motion which is in the cycle [בתקופה] … the position of the luminary [מקום המאור] … its motion [תנועתו] [?]. And the position is [?] … the cycle is uniform [התקופה … שוה] [?], and therefore [?].

[Lower portion of f.196r blank.]

[Margin, left of the final lines (f.196r): a short marginal note, ~2 lines, in a smaller hand; verbatim text not securely legible — marginal note; further identification requires further verification.]

[The argument continues without a new heading. A geometric demonstration figure is set into the lower-left of the text block; the prose wraps to its right.]

the difference [החלוף] in position [במקום] [?], and the position is [?] the position of the luminary [המאור], and behold the position is [?]. When the variation of the motion [חלוף התנועה] is such-and-such [כך כך], the motion in the cycle [… התנועה בתקופה] will be [?] … so the variation [?].

And he said [?]: that since the cycle [התקופה] is what it is, and the position of the luminary [?], the variation of the motion [חלוף התנועה] will be like the variation [?] … by a certain amount [?]. And from this it follows that the variation of the motion is such-and-such [כך], and behold the motion [?].

When the position is corrected [יתקן המקום] according to the cycle [התקופה], the variation [החלוף] will be small, and the position [?]. And he said [?]: that the motion of the world [תנועת העולם] is uniform, and the luminary [המאור] moves with its own motion [?], and the position is referred to [?] the motion of the world [?].

[The lines surrounding and below the figure restate the same construction in terms of the labeled points: the cycle [התקופה], the surplus of the motion [מותר התנועה], and the variation [החלוף]. Read carefully off the tiles, the recurrent technical terms are secure, but the specific magnitudes attached to each point are not legibly inked at the line-ends.]

Diagram. A line construction in the upper outer (left, gutter-facing) margin of f.196v. A vertical line runs down the margin; at its top a short horizontal segment runs from point ב (where the vertical meets the segment) rightward to point ג at the upper-right corner. From ג a pair of nearly-parallel lines slopes down and to the left toward point ה, a node set lower and to the left of the vertical. From ה three lines fan out to the right, meeting the lower part of the vertical line at three points stacked from top to bottom: ז, ח, and ד (the foot). A three-line note in the same hand is written small in the angle between ה and ד.

The three-line interior note is only partly legible; it refers to the lines of the construction (opening גזרת… "the segment…") but its full text is not securely readable.

- ב: top point where the vertical line meets the short top segment
- ג: upper-right corner, end of the top segment
- ה: node at the left, apex of the fan of lines
- ז: uppermost of the three points on the vertical line
- ח: middle of the three points on the vertical line
- ד: lowest of the three points (foot of the vertical line), beside the interior note

[Below the figure the prose continues:]

the cycles [התקופות] … and according to the uniform motion [?] the position is [?] … and behold the position will be such-and-such [?]. And from this it follows [?] the variation of the motion [חלוף התנועה], and the position [?].

the position is [?] uniform [?] … and the cycle [התקופה] … the motion [התנועה] [?]. And the surplus [המותר] which is added to it [?], behold it is [?].

[Margin, beside the figure / upper-left (f.196v): a short marginal note in a smaller hand, ~3 lines; verbatim text not securely legible — marginal note; further identification requires further verification. Likely a constructive geometric helper anchoring the point-labels to the prose.]

[Lower half of f.196v blank, apart from the figure and its caption. Faint bleed-through from the facing folio is visible across the blank lower-left but belongs to the other side and is not transcribed.]

[Margin, upper left of 197r: a three-line annotation in a small later cursive hand, faded; it reads approximately "ושיעור… המולד… דקים..." but is too abraded for a

confident reading — marginal note; further identification requires further verification.]

so it [the arc] will be such-and-such [כך] degrees, and likewise [the others] are equal, and accordingly the magnitude of the line [קו] [?] will be such-and-such degrees. Therefore line [קו] AB [קו א״ב] is such-and-such degrees, and line [קו]... [?]. And it will be such-and-such, and accordingly line [קו] will be such-and-such degrees, since the magnitude was already such-and-such [degrees]. Therefore line BD [?] is such-and-such, and the remainder is such-and-such degrees.

By this reckoning the position [המקום] of the luminary against the motion of the world [תנועת העולם] will be such-and-such degrees, and the line of position [קו המקום] [?] will be such-and-such degrees. And since the magnitude was already known, line... [?] will be such-and-such degrees, and the magnitude of the line is such-and-such degrees, and the remainder of the magnitude is such-and-such.

And he set down [the case] in which the motion was such-and-such degrees, and the remainder such-and-such, and the position is such-and-such degrees. The magnitude of the line is such-and-such degrees, and so the line of motion is such-and-such, and likewise the remainder is such-and-such degrees. And we already showed how to derive the magnitude of this line [קו] from the magnitude of [the others], so that it will be such-and-such degrees against the variation of the motion [חלוף התנועה].

And we have already explained that the remainder of the magnitude of line... [?] will be such-and-such degrees, and the magnitude of the line of position is such-and-such, and the remainder is such-and-such degrees. And since it has been demonstrated that the magnitude is such-and-such [degrees], the magnitude of the line of motion [קו התנועה] will be such-and-such, and the remainder such-and-such degrees, and likewise [the rest].

And so the magnitude of line... is such-and-such degrees, and the position is such-and-such, and the remainder is such-and-such degrees. And from this it follows that the magnitude of line GD [?] is such-and-such, against the motion of position [תנועת המקום], and likewise the magnitude of the line will be such-and-such degrees.

Diagram. The upper of two separate geometric constructions in the outer (left) margin of folio 197r. A vertical reference line runs down the page; near its mid-point is an apex at which several straight lines meet, with an oblique line rising to the upper right and a second line running out to a point at the far left, together

with two short oblique strokes below the apex. The figure illustrates the lines-and-degrees argument of the surrounding text. Legible point-letters, by position:

- ב (far left, terminus of the line running left from the apex)
- ד (upper, left of the vertical near its top)
- ג (upper right, terminus of the oblique line)
- ה (apex, where the lines meet the vertical)
- ב [?] (on the vertical just below the apex; candidate ב/כ)
- ו (lower, on the vertical line)
- ד (foot of the vertical line)

Diagram. The lower of the two constructions, at the foot of the outer (left) margin of folio 197r. A tall vertical line descends from an apex at top; from one or two nodes on its upper portion a sheaf of oblique lines fans out to the right toward the text, and two long lines descend to feet at the bottom, forming a tall narrow triangle. Legible point-letters, by position:

- ז [?] (apex, top of the vertical line)
- ב [?] (upper node on the vertical, where the fan of lines begins)
- ב [?] (a second node just below it; candidate ב/ה)
- ב [?] (left foot of the triangle; candidate ב/כ)
- ד (middle foot, at the base of the vertical line)
- ג (right foot of the triangle)

[Margin, upper right of 197v: a faded later-hand annotation of three short lines, mirroring the hand of the 197r marginal note; not confidently legible — marginal note, further identification requires further verification.]

such-and-such [degrees], and the remainder is such-and-such, and it will be such-and-such degrees [?]. And for it [there is] such-and-such, and likewise such-and-such, and we set the position [המקום] [?] at such-and-such. By this reckoning, behold the magnitude of the line is such-and-such degrees,... [?]. The degrees of position will be such-and-such, and the line will be such-and-such degrees, and so the remainder is such-and-such. And we shall explain how the magnitude of this line is such-and-such degrees, line... [?] such-and-such degrees.

It was such-and-such, and there is no [וְלא] such-and-such, and the magnitude is such-and-such degrees, [the line]... such-and-such degrees, and the additional amount [תוספת] upon it is such-and-such, and the line [קו] is such-and-such degrees.

And the remainder is such-and-such, and the magnitude is such-and-such degrees, and it will be such-and-such,... [?]. The degrees of position are such-and-such, and the line of position [קו המקום] is such-and-such degrees, and the remainder such-and-such. The variation of the motion [חלוף התנועה] is such-and-such, and so the line of motion is such-and-such degrees, and likewise [the rest].

And since we have already known [the value], it follows that... [?] will be such-and-such degrees. And the remainder upon line... is such-and-such, and the line of correction [קו התקון] [?] is such-and-such degrees, and the magnitude is such-and-such. And [as for] line... [?], when the line is such-and-such degrees, the correction [התקון] will be such-and-such, and so [it goes].

And so the magnitude is such-and-such, and the variation [the difference] is such-and-such degrees, and the correction [התקון] is such-and-such; and to the great distance [לרחוק הגדול] [?] the correction [התקון] is greater [yet], the line being such-and-such. And the correction will be such-and-such degrees, and the distance [הרחוק] [?] such-and-such.

[A short marginal note in a small hand stands in the right margin opposite these lines: "עם קצת… כלם..." — not confidently legible; marginal note, further identification requires further verification.]

such-and-such degrees, and the position [המקום]... [?]; for the line of position will be such-and-such degrees, and the magnitude is such-and-such, and the variation of the motion [חלוף התנועה] is such-and-such. And he made the line of correction such-and-such [?], and so the remainder is such-and-such degrees, and likewise [the rest].

And by this you will [be able to] correct [תקון] the position of the luminary in every case, [as] is required, and to know its place [מקומו]. And it will then be such-and-such degrees, and the line is such-and-such, and the remainder such-and-such degrees.

(interlinear: a single word is inserted above the line here in the scribe's hand; it appears to be a corrective gloss to the word beneath it — the inserted form reads "וכך" ("and so") (?), correcting the line text.)

And the line... [?] is such-and-such degrees, and the magnitude such-and-such; and as for the magnitude of [the line]... [?] from the corrected motion [התנועה המתוקנת] [?], it is such-and-such degrees, the remainder being such-and-such. Therefore the magnitude of line... [?] is such-and-such degrees against the

variation of position, and the magnitude of the line will be such-and-such degrees.

And it will be such-and-such, and the magnitude is such-and-such degrees, and the remainder is such-and-such. The degrees of correction [מעלות התקון] [?] are such-and-such; line... is such-and-such degrees, behold it is line ZD [קו ז״ד] [?], that being such-and-such degrees [?].

Diagram. A geometric construction at the foot of folio 197v, on its inner (gutter) side. A vertical reference line stands at the left; from points along it, several long straight lines run rightward and obliquely, crossing one another and meeting points to the right, producing an interlocking triangular figure (a fan of chords intersecting within a triangle). The figure accompanies the text's derivation of the corrected position and the line of correction. Legible point-letters, by position:

- ז (top of the vertical line, at left)
- ב (on the vertical line, below ז, where several lines meet; a short cluster reading "הא" / he-alef stands above the line beside it)
- ג (foot of the vertical line, bottom left)
- ה [?] (interior, where the oblique lines cross near the top; candidate ה/ח)
- ד (upper right corner)
- ו (right, terminus of the near-horizontal line)
- ו [?] (bottom apex of the descending triangle; candidate ו/ז)

Milchamot HaShem, Book V, Part 1. Chapter (103) הק"ג, continued.

[Continuation of chapter 103. The exposition proceeds as a systematic case-analysis of how a luminary's tabulated position is corrected against the uniform "motion of the world" (תנועת העולם) by means of the line of position (קו המקום) and the line of correction (קו התקון). Throughout, Gersonides uses the placeholder idiom *kakh* — "such-and-such [degrees]" — for the generic magnitude of an arc or angle, and the same small set of technical terms (arc, angle, degrees, line of position, line of correction) recurs in each parallel clause.]

the arc will be such-and-such, and the angle upon it will be like this. And the measure of the arc will be such-and-such.

There will not be [the case] this way, since the angle is such-and-such [degrees], and likewise the second [angle] will be such-and-such. And the measure of the position will be such-and-such, and the angle upon it will be such-and-such [degrees], and so too the second [angle], and likewise the position. And the line of

correction will be such-and-such [degrees], and so it goes for this whole [construction].

Therefore the angle of the line of position will be such-and-such, and the second [angle] will be such-and-such [degrees]. And since the angle is such-and-such [degrees], the arc, by this method, will be such-and-such; and the second [arc] will be such-and-such [degrees], and so too the position. And since the angle is such-and-such [degrees], so likewise the arc will be such-and-such [degrees], and the second [arc] such-and-such; and the position will be such-and-such, and the angle upon it such-and-such [degrees].

And [the case in] which the angle is such-and-such [degrees] will be like the matter we have already explained: the angle is such-and-such [degrees], and likewise the magnitude will be such-and-such [degrees]; and the second will be such-and-such, and the position such-and-such. And since this is the angle — namely, the arc whose measure is such-and-such — the magnitude will be such-and-such [degrees], and so on for the second; and the position will be such-and-such, and after it [comes] another, with the same [value].

Therefore the angle of the line of position will be such-and-such, and likewise the magnitude will be such-and-such [degrees]; and the second will be such-and-such, and the position will be such-and-such. And the matter of the position [is]: the angle is such-and-such [degrees]; and since the angle is such-and-such, the magnitude will be such-and-such [degrees], and the second such-and-such. And the magnitude already known [to us] is such-and-such [degrees], and the position such-and-such [degrees]; and the matter of this is as we explained at the outset.

And the line of position [is] such-and-such, and the magnitude is such-and-such [degrees], and the second is such-and-such [degrees], and the position is such-and-such. And the matter is plain: the angle is such-and-such, and the line of correction is such-and-such [degrees]; and so it follows that the magnitude will be such-and-such, and the second such-and-such, and the position such-and-such [degrees], and so on for this whole [case].

And in another way: the angle is such-and-such, and the arc is such-and-such [degrees]; and likewise the second will be such-and-such, and the position such-and-such [degrees]. And the angle of the magnitudes of the arc [is] such-and-such, and the line of correction is such-and-such [degrees]. And from this it has already become plain to you that this angle is such-and-such, and the magnitude of the arc will be such-and-such, and so on; and the magnitudes of the arc [will be such-and-such].

[The remaining lines of the column repeat the same procedural pattern — arc, angle, magnitude, position, line of correction, each assigned the placeholder "such-and-such [degrees]" — for the successive cases. The text runs continuously into the figure at the foot of the column.]

[Margin, left (later cursive hand): a three-line note, partly faded. Legible fragments: "…all the arcs…" / "the second motion of the arc…the measure of…" / "…the position… the matter is fitting…". Marginal note containing this text; further identification requires further verification.]

[Margin, left, lower (cursive hand): a two-line note, faded: "…the matter, the position… therefore…" / "…and likewise the second…". Marginal note; content uncertain — further verification.]

Diagram. A geometric construction at the foot of the column, in the same brown ink as the body text. A vertical line stands on the left, with a single-letter label **[?]** (ambiguous ב/ה in this cursive hand) at its top and a right-angle tick (no letter) at its foot. From a point **ז** partway down the vertical, a steep diagonal rises to **כ** [?] at the upper right, and a fan of straight lines descends to the right. A horizontal line runs from a node **ה** [?] at the left (where it meets the vertical) rightward across the figure, passing a crossing point **ק** [?] to a right-hand terminus **ק** [?]; a further node **ה** [?] sits above the horizontal in the middle of the figure. A diagonal from **ז** descends to **ז** [?] at the lower right, and several lines converge at a point **נ** [?] below the horizontal. The figure is one of the line-of-position / line-of-correction constructions Gersonides uses in this chapter.

- [?] (ambiguous ב/ה): top of the vertical line
- ז: point on the vertical from which the oblique lines radiate
- כ [?]: upper-right terminus of the steep diagonal from ז
- ה [?]: node above the horizontal, mid-figure
- ה [?]: left end of the horizontal, where it meets the vertical
- ק [?]: crossing point on the horizontal
- ק [?]: right-hand terminus of the horizontal
- ז [?]: lower-right terminus of the descending diagonal
- נ [?]: convergence point below the horizontal

[Chapter 103 continues without a break. The same case-by-case procedure carries over from 198r, with the recurring vocabulary of arc, angle, degrees, position, and line of correction.]

the [arc] is such-and-such, and it is the magnitude, such-and-such [degrees]; and the [arc] will be such-and-such. And the second magnitude is such-and-such [degrees], and the angle of the position is such-and-such, and so on. And the line is the magnitude, such-and-such, and the position such-and-such; and the second [is] such-and-such, and the magnitude is such-and-such [degrees]; and the position is such-and-such [degrees].

And since the angle is such-and-such [degrees], from the magnitude such-and-such; and the position is such-and-such [degrees], and the second such-and-such. And there [comes] another after it, of the same magnitude: the second is such-and-such, and likewise the magnitudes of the position are such-and-such [degrees].

Therefore the magnitude is such-and-such, and the angle of it is such-and-such; and so too the second, and the position. And since the angle is such-and-such [degrees], from the magnitude such-and-such, the second is such-and-such [degrees]; and another [comes] after it of the same [value], and the position such-and-such, and the second such-and-such [degrees].

And the matter of the magnitude [is]: it is the angle, such-and-such; and since the angle is such-and-such [degrees], from the magnitude such-and-such, the second is such-and-such; and the position is such-and-such [degrees]. And there [comes] another after it of the same [value]; and the position such-and-such, and the second such-and-such.

And we have already explained the matter of the position: the angle is such-and-such, and the line of correction such-and-such [degrees]. And since the angle is such-and-such [degrees], from the magnitude such-and-such, the angle will be such-and-such, and likewise the second; and the magnitudes of the position [are] such-and-such [degrees], and the second such-and-such [degrees]; and the matter of this is as we explained.

And [as for] the line of correction in equal magnitudes: just as it is such-and-such, so too the second is such-and-such; and likewise its position is such-and-such, and another [comes] after it of the same [value]. And since the angle is such-and-such, the line of correction will be such-and-such [degrees]; and from the magnitude such-and-such, the second [will be] such-and-such.

Now consider whether the motion of the world is greater [than the tabulated motion] or smaller; for [according to whether it is greater or smaller] the correction is to be subtracted [?] or added [?]. And in equal magnitudes the line of

correction is such-and-such, and its position likewise; and another [comes] after it of the same [value].

And consider this: when the position is corrected — once you know the position is corrected — then this is fitting, since the motion of the world is [the thing] being subtracted.

And the corrected motion will be such-and-such [degrees], and the second will be such-and-such; and the corrected motion thereafter [will be such-and-such].

[The column closes with the corrected-motion result stated in the placeholder form; the figure follows at the foot of the column.]

[Margin, right (cursive hand): a two-line note. Legible fragments: "…the motion of the world… the matter…" / "…the second… by this method…". Marginal note containing this text; further identification requires further verification.]

Diagram. A geometric construction at the foot of the column, in the lower-right of the verso with its right side running toward the outer (fore-edge) margin. A vertical line stands on the left, with point **ב** at its top. Partway down, two nodes sit on the vertical — an upper one (where a horizontal line begins) and a lower one labeled **כ** [?]. From the upper-right vertex **ז** a fan of straight lines descends across the figure to the points along the horizontal; near the right edge, below **ז**, is a node labeled **ק** [?]. The horizontal line runs rightward from the left node to a right-hand terminus, and a line descends to **ז** [?] at the lower right by the outer (fore-edge) margin. The interior crossing points where the oblique lines meet the horizontal are faint and unlabelled or illegible. The construction is a companion to the figure on 198r, here drawn with the apex at the upper right.

- ב: top of the vertical line (left)
- ז: upper-right apex from which the oblique lines radiate
- כ [?]: lower node on the vertical (left)
- ק [?]: node on the right edge, below ז
- ז [?]: lower-right terminus, by the outer (fore-edge) margin
- [Other nodes along the horizontal are faint/illegible; not labelled here]

Sefer HaTechunah — Folios 199r–199v

BnF Hébreu 724. Primary hand: Sephardic semicursive, 1397. Chapter (103) הק"נ continues; no new rubricated chapter heading appears on either folio.

[Continuation of chapter 103 הק"ג — the case-analysis for correcting a luminary's tabulated longitude against the motion of the world by means of the line of position (קו המקום) and the line of correction (קו התקון).]

what we have explained. The line of position falls [?] according to the magnitude of the correction [?]; therefore, since this is the case, [the result] is as we said. And likewise the correction… and according to this it falls under the magnitude of the correction.

The amount by which the position differs from the place of the luminary will be such-and-such degrees [כ"כ מעלות], and likewise the correction will be such-and-such [כ"כ]. And so it has been demonstrated that the matter is as we said.

And when it is so, the angle that the line of position makes [?] is equal to [?] the angle of correction; and we already know from what precedes that we must investigate the magnitude [?]. And the matter will be that the line of correction is such-and-such degrees [כ"כ מעלות], and likewise the correction will be such-and-such [כ"כ], and the line will be such-and-such [כ"כ].

[The argument here proceeds as an iterated conditional: in each case the line of position is compared with the place of the luminary; the angle that the line of position subtends is set equal to the angle of correction; and the excess (מותר) is rendered "such-and-such degrees" (כ"כ מעלות). The procedure is repeated through the several configurations that follow, each phrased on the same frame — *line / angle / degrees / excess / correction* — with the specific magnitudes left as the כ"כ placeholder rather than written out as numerals.]

and the excess will be such-and-such degrees [כ"כ מעלות], and the line of position will be such-and-such [כ"כ], and the angle will be such-and-such [כ"כ]. And it is already known to you that the correction is such-and-such [כ"כ].

And when the matter is so, the angle [?] is greater than the angle of position; and according to this proportion the correction is such-and-such degrees [כ"כ מעלות], and likewise the angle will be such-and-such [כ"כ], and the second [angle] [?] likewise.

such-and-such degrees [כ"כ מעלות], and likewise [?]. And since the line of position is such-and-such [כ"כ], the excess is such-and-such [כ"כ], and the magnitude of the correction is such-and-such [כ"כ]; and this is what we wished [to show] [?].

[Several further parallel cases follow, each of the same form — the line of position set against the place of the luminary, the subtended angle set equal to the angle of correction, the excess and the correction each rendered "such-and-

such degrees." The numerals are not written out in the body; they are carried by the כ"כ idiom and resolved by the accompanying figures.]

[Margin (lower left, small hand): a three-line constructive note keyed to the diagrams below. Verbatim text largely illegible at this resolution; reads in part "… ולפי זה יהיה הקו… שעור קו… לפי המעלות… תקון ושעור התקון" — i.e. a side-note restating the proportion between the line and the magnitude of the correction. Further identification requires further verification.]

[Margin (lower left, small hand, lower note): a further three-line note in the same hand, largely illegible; appears to record a parallel side-computation on the line of correction. Further identification requires further verification.]

Diagram. A plain right triangle with the right angle at the lower-left: a vertical left side rising from a base-left vertex up to the apex, a horizontal base running to the right, and the hypotenuse descending from the apex to the lower-right base vertex. No lines issue from the apex other than the two triangle sides.

- [?] (apex, top left): vertex
- [?] (base, lower left): right-angle vertex [label faint]
- [?] (base, lower right): right-hand base vertex [label faint]

Diagram. A plain right triangle of the same form as the preceding: right angle at the lower-left, a vertical left side rising from a base-left vertex to the apex, a horizontal base to the right, and the hypotenuse descending from the apex to the lower-right base vertex.

- [?] (apex, top left): vertex
- [?] (base, lower left): right-angle vertex [label faint]
- [?] (base, lower right): right-hand base vertex [label faint]

Diagram. A fan construction: an apex point at the top, a vertical line, a horizontal base extending to the right to a base vertex, and several oblique lines crossing through an interior node — with one oblique line continuing below the base toward the lower right. This is the line-of-position fan meeting the graduated vertical/base, the fullest of the three figures on this folio.

- [?] (apex, top): upper terminus [label faint]
- [?] (interior node, where the oblique lines cross): junction [label faint]
- [?] (right end of the base): base vertex [label faint]
- [?] (lower-right, below the base): terminus of the oblique line [label faint]

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[Chapter 103 ,הק"ג continues — the same iterated case-analysis. No chapter heading.]

[Margin (upper outer, small hand): a two-line note, verbatim text largely illegible; a constructive helper keyed to the figures. Further identification requires further verification.]

[Margin (outer, small hand): the single word "תקון" ("correction") written in the outer margin as a heading-label for the worked construction on this page.]

such-and-such degrees, and likewise the position, and the line [?] will be such-and-such [כ"כ]. And when the matter is so, the angle of correction [?] and the angle of position [?] — that is, the angle that the line of position makes with the line… is such-and-such [כ"כ], and the magnitude of the place of the luminary… and the position will be such-and-such [כ"כ].

And likewise the line of correction will be such-and-such degrees [כ"כ מעלות], and the position [?] such-and-such [כ"כ], and likewise the second [quantity]. And since the magnitude of the line of position is such-and-such [כ"כ], the excess [?] is such-and-such [כ"כ], and according to this the angle [?] will be such-and-such [כ"כ].

[The page continues the same procedural chain: in each successive configuration the line of position is set against the place of the luminary; the line of correction is found "such-and-such degrees"; the excess (מותר) is determined; and the correction follows. The magnitudes throughout are given by the כ"כ idiom, the geometry being supplied by the figures at the foot of the page.]

and the line of position will be such-and-such [כ"כ], and likewise the correction such-and-such [כ"כ]. And when it is so, the line of correction will be such-and-such degrees [כ"כ מעלות], and likewise the excess such-and-such [כ"כ]; and according to this proportion [?] the angle [?] will be such-and-such [כ"כ], and the second likewise.

And since the magnitude of the line is such-and-such [כ"כ], and the correction is such-and-such degrees [כ"כ מעלות], the position is such-and-such [כ"כ], and likewise the second [quantity] such-and-such [כ"כ]. And this is what we wished [to demonstrate].

and the line of position is such-and-such [כ"כ degrees], and the magnitude of the place of the luminary [?]; and according to this the correction will be such-and-

such [כ"כ], and the angle of position such-and-such [כ"כ]. And likewise the angle that the line of correction makes [?] will be such-and-such [כ"כ]…

the magnitude of the line of position; and according to this the correction [?] is such-and-such [כ"כ]; and likewise the angle, and the second [angle] [?]. And the line of position will be such-and-such degrees [כ"כ מעלות], and likewise the excess. And this is what we wished [to show].

[Margin (lower outer, faint bleed-through from the facing side overlaps the lower outer margin here; the primary text in this corner is the continuation above — no separate marginal note on the verso lower edge is legible as primary ink.)]

Diagram. A fan of lines of position issuing from a vertex at the lower left: two or three oblique lines rise to marked points on a vertical line at the right, which is graduated and continues downward below the base. Complementary to the fan figure (fig-p397-3) across the gutter.

- [?] (lower-left vertex): origin of the oblique lines [label faint]
- [?] (upper marked point on the vertical): graduated point [label faint]
- [?] (lower marked point on the vertical): graduated point [label faint]
- [?] (foot of the vertical, below the base): lower terminus [label faint]

**

Diagram. A star/fan construction from a TOP apex: a vertical line with an apex point near the top, from which several oblique lines radiate downward to a row of marked points along a lower diagonal/baseline. Distinct from the leftmost figure, whose fan originates at the lower left; here the lines issue from the upper apex.

- [?] (apex, top): origin of the radiating lines [label faint]
- [?] (a marked point on the lower diagonal): graduated point [label faint]
- [?] (a further marked point on the lower diagonal): graduated point [label faint]
- [?] (foot of the vertical, below): lower terminus [label faint]

**

Diagram. A vertical reference line with an apex at the top, from a junction on which two oblique lines descend to the lower left and to the lower right, forming an inverted-V (a chevron) astride the vertical — a symmetric line-of-position construction.

- [?] (top of the vertical): upper terminus [label faint]
- [?] (junction, where the two oblique lines meet the vertical): junction vertex [label faint]
- [?] (lower-left point): left foot of the chevron [label faint]
- [?] (lower-right point): right foot of the chevron [label faint]

Diagram. The fullest of the line-of-position figures: a vertical reference line through a central junction point, from which lines radiate — one to a point at the upper right, one to a point at the lower right, and one to the left — with the lower portion closed into a triangle on the base. It shows the place of the luminary, the line of position, and the line of correction meeting at the junction.

- [?] (top of the vertical): upper terminus [label faint]
- [?] (central junction on the vertical): meeting point of the lines [label faint]
- [?] (upper right): outer terminus of the upper oblique line [label faint]
- [?] (lower right): right base vertex [label faint]
- [?] (foot on the vertical / base): foot vertex [label faint]
- [?] (left): left terminus [label faint]

**

[The chapter running through this folio is chapter הק"ג (103), continuing from the previous folio. No new chapter rubric appears anywhere on 200r or 200v — the iterated geometric case-analysis runs on without a heading.]

the line of correction (קו התקון), upon which the case turns. And it is so [as set out]:

The position of the planet [as derived] from the line at the place where the motion of the world meets it : so too [is it] for such-and-such [degrees]. From the line of position to [the point] where the motion of the world cuts it, the line [extends as described].

The line of correction, drawn to a [further] point, [together] with the line of position which the motion of the world cuts off — so the arc that the line of position subtends, where the motion of the world meets it.

The amount of the correction, and the line of position which the world's motion cuts off — and it is the excess (המותר) which falls [as the difference] between them. And the correction (התקון) which the motion of the world produces, when it [the line of position] is cut at the point, then the arc of the line of position which the motion of the world cuts off [is determined].

And similarly, as we explained earlier with respect to the line of position: so too [is it] here. For the position of the planet, [reckoned] from the line at the place where the motion of the world meets it, [yields] the correction.

And [as for] the arc [from] the point at which the line of position is cut: the amount of the correction, [namely] the excess that the line of position [gives]. And it follows that the arc which the motion of the world cuts off [is] for such-and-such degrees.

And the line of correction, when the motion of the world cuts it — then there will be [a configuration] like the line of position, the line which the motion of the world cuts; and the excess between them.

When the line of position is cut at the point, and the motion of the world [acts] upon it, then the position of the planet [is found] from the line of position to such-and-such degrees, [and] the line of correction.

And the arc which the motion of the world cuts off [is] the excess, [reckoned] for the line of position. And [in] this case the correction will be [obtained] from the line of position, and the line at the place where the motion of the world meets it; and the amount of the correction.

The line of position which the motion of the world cuts off, and the excess that falls between them — this is what is required [in] this case. And so the correction is [for] such-and-such degrees, [taken] from the line of position.

[Several lines here re-state the same procedure for the next case, varying only the named arc and the degree-quantity, which the scribe writes throughout as the כ"כ "such-and-such" idiom rather than a specific numeral.]

and these things [follow] from the [reckoning] of the line of position, [reckoned] from the place where the motion of the world cuts it. The amount of the correction — that is, the excess that falls between them — and it follows that the correction [is] from the line of position [drawn] to the point on the [vertical] line at the place; the source of the correction (מקור התקון) [is established thereby].

And [as for] the [reckoning], it [proceeds] from the source of the correction, [namely] from the line of position, [together] with the excess that the motion of the world produces.

The correction [reckoned] for its case, upon the [vertical] line of position, and the arc that the motion of the world cuts off [is determined accordingly].

And it follows [for] the straight line [קו ישר] to such-and-such [degrees], that it does not require [further reduction]: it is so, and the motion of the world [acts] upon it.

[On the latter portion of 200r the writing keeps to the lower-left field; the lower half of the page is blank parchment.] And so, for this reason, they erred — and they did not [reckon it rightly] — the ancient Israelites (הישראלים הקדמונים), and [others] before them.

[Lower half of 200r: blank parchment.]

[Margin, left edge of 200r, mid-page — a short marginal note in the main hand, two short words; the gutter-side ink is faint. [Margin: text largely effaced; reads approximately "...בו ועשה..." — further identification requires further verification.]]

[The text continues the same chapter-103 case-analysis; the lower third of the folio carries geometric figures.]

and so too, [reckoned] from the line of position; and so [it follows], for such-and-such degrees the correction.

And it follows [that for] the straight line to such-and-such degrees: it does not [require reduction]; and so too the straight line.

[For] the straight line to such-and-such degrees, [drawn] to the line of correction, [reckoned] for [its] case. And it will be, [in] this case, [that] the configuration [will be such that the arc] which the [motion] cuts off [is determined].

The amount of the correction — that is, the excess which the world's motion [produces] — and when it [the line] is cut. The position of the planet [reckoned] from the line of position [is found], and so too [for] the line of correction.

[For] the straight line to such-and-such degrees, and [for] two [units], and [for] such-and-such degrees, and for two seconds (שניות) — there will be [the configuration] like the line of position, [for] such-and-such degrees, and for so many seconds.

[For] such-and-such degrees, and [for] two seconds: there will be [an arc]; and [for] such-and-such degrees, and for two seconds.

And [it is] like the position of the planet [reckoned] from the line of position, [for] such-and-such degrees, and for two seconds; and so too will be the position of the planet [from] the line, [reckoned] for the line of correction.

[For] the straight line to such-and-such degrees, [together] with the excess that falls between them — this is what is required [in] this case. And the correction [is] for so many [degrees], and for two seconds. And the position of the planet [reckoned] from the line of position [is] for such-and-such degrees, and so too [is it] for the line of correction.

And this is so when the motion of the world is upon the [vertical] line of position. And [as for] the amount of the correction, [namely] the excess [that] the line of correction [gives] — [reckoned] for the line of position, and the excess that falls between them.

And the position of the planet, [reckoned] from the line at the place where the motion of the world meets it, [is found]; and so the correction [is established for] the [vertical] line, [together] with the excess of the line of correction.

And when it [the line] is cut at the point, and the motion of the world [acts] upon it — then the position of the planet [is found] from the line of position to such-and-such degrees, [and] the line of correction. And the arc that the motion of the world cuts off [is] the excess.

[For] such-and-such degrees, [together] with the correction; and behold, this correction [is] for the [vertical] line. And [for] the straight line [drawn further]: such-and-such degrees [reckoned] for the line of position; and the line of correction is [established] in [its] case.

[Mid-folio:] And so it returns, [namely] the correction, [reckoned] for the place; the [vertical] line of position, [for] one degree (מעלה אחת), and for two seconds.

And the correction [is reckoned] for the place [where] the motion of the world [meets the line], from the source of the correction, and the configuration of the arc

And the position of the planet, [reckoned] for the place [where] the world's motion [acts], [for] one degree, and so too — and behold, [the figures below illustrate this case].

[Margin, left edge of 200v, upper field — a four-line marginal note in the main hand, small script; the gutter-side line-ends are faint. [Margin: a side-computation note; reads approximately "...ולקחנו אותו... קו... מעלות... קו ב'ג..." (recording a line-and-degree value for the construction). Constructive geometric helper, not an attribution; further identification requires further verification.]]

Diagram. The largest of the figures, a triangle construction in the lower-center of folio 200v, illustrating the line-of-position / line-of-correction case just stated. A tall vertical line rises to an apex; a long horizontal baseline runs along the foot toward the left; and an inclined line drops from the apex region to the baseline, closing the triangle. Point-marks are written at the apex and along the baseline, but the individual letters are not legible at the available resolution and are not committed here:

- [?] (apex, top of the vertical line).
- [?] (left end of the horizontal baseline).
- [?] (one or more points along the baseline, where the inclined line meets it).

Diagram. A smaller triangle to the right of the first, of the same family: an apex with inclined lines descending to a short horizontal baseline, illustrating the parallel case. Point-marks are present at the apex and baseline corners, but the individual letters are not legible at the available resolution and are not committed here:

- [?] (apex).
- [?] (baseline corners / terminus points).

Diagram. A third, smaller construction set apart at the right edge of the page, above and to the right of the bottom pair (omitted from the legacy transcription). A steep near-vertical line with two or three short inclined strokes branching from its upper portion, and a point-mark at its lower end. The individual letters are not legible at the available resolution:

- [?] (point at the foot of the line).

so too the arc, already [established]; and the matter. By contrast [in] the position [reckoned] from the line where the motion of the world [meets it] — for such-and-such [degrees].

For likewise the line, where the arc. And the position [reckoned] upon the point... [the line] which the motion of the world [cuts]: such-and-such; and so too.

The line, where it is cut, and the line [of position]... and there will be the arc, such-and-such [degrees], the line.

And similarly there [follows] another excess (מותר), such that [it falls] before them; and there will be [in] minutes (שניים), such-and-such [degrees], the line. The amount of the correction (התקון), and [its] arc...

And [as for] another excess that falls before them, where there will be the arc, such-and-such [degrees]; and the position of the planet (מצב הכוכב) [reckoned] from the line [of position], such-and-such [degrees], and likewise the arc.

And the excess that the motion of the world [produces], when it is cut at the point, [then] the arc of the line of position which the motion of the world cuts off [is determined]. And it follows that the correction [is] for such-and-such [degrees]; and [in] minutes there will be the line, such-and-such.

And it follows that the arc — and the line of position which the motion of the world cuts off, and the excess.

[Left margin, upper note, second small hand (lighter ink, smaller module): a marginal annotation reading — [Margin: כך מעלות נ"ח דק"ל שניים ועשרה זה כן כך] [?]]

[Left margin, lower note, same small hand, with a small marginal mark (maqaf-like flourish) above it: [Margin: שניים מעלות [?] לזויות[?] ולזה כשנעריך זוית הדבר] [?]]

and the line, where there will be the arc, the angle (זוית), and it is the [reckoning]... such-and-such.

So for the position of the planet [reckoned] from the line of position to such-and-such [degrees]; and the line of correction, the matter.

And the correction [reckoned] for its case, and the line of position, and the position... and the arc which the motion of the world cuts off [is determined].

And it follows, when [the line] is corrected (כשהתקן), that the [reckoning follows]; and to it there will be the correction. And [in] minutes [there will be] the angle, the line of position, such-and-such [degrees].

[Several lines here re-state the same procedure for the next case, varying only the named arc, the angle, and the degree-quantity — written throughout as the כך "such-and-such" idiom rather than a specific numeral. The clauses chain: the line of position is cut at a point; the motion of the world cuts off an arc; the excess that falls between them is reckoned; and the correction follows.]

And the position of the planet, [reckoned] from the line at the place where the motion of the world meets it — such-and-such [degrees]; and likewise [in] minutes there will be the line.

For the position [reckoned] from the line of position, such-and-such [degrees]; and the angle [is] the line, the corrected one. And the line of position which the motion of the world cuts off — such-and-such [degrees], the line.

And it follows that the arc which the motion of the world cuts off [is] the correction, [namely] the excess that falls before them; and the angle, such-and-such [degrees], the line of position.

And [as for] the line, where the arc of the line of position [is], such-and-such [degrees]: so too [in] minutes there will be the line, such-and-such [degrees]; and the line, where it is [reckoned] from the line of position, such-and-such [degrees].

For [in] the position [reckoned] from the line of position, such-and-such [degrees], the angle [is] the line, the corrected one; and so too there will be the line, such-and-such [degrees].

The line, where the arc [is]; and the corrected line, and the angle, such-and-such [degrees], the line.

the line, where [it falls] before them, and it is [the reckoning]... the line, the corrected one, and we shall investigate (ונחקור) the [reckoning].

just as we explained (כמו שביארנו); and there it [follows]... such-and-such [degrees], the line.

Diagram. At the foot of folio 201r, a geometric figure built on a single long vertical line. Two points flank the vertical — one well to the left, one to the upper right — and each is joined by straight lines to points marked along the vertical (an upper point and a lower point) and to its foot, so that triangles are formed on both sides of the vertical. This is the construction the body text has been reckoning: lines of position and correction meeting at points, with the arcs they subtend. The vertical is the line-of-reference of the surrounding prose.

- ד [?] (top of the vertical line): upper terminus of the vertical
- ב (left point): the point to the left, joined by lines to the vertical
- ז (upper-right point): the flanking point on the right
- ב (upper point on the vertical): where the lines from the flanking points meet the vertical
- ג (lower point on the vertical, below it): intermediate point on the vertical
- ז [?] (foot of the vertical line, lower edge): lower terminus of the vertical

and the line, where there will be the angle, the corrected one. Upon the line where the motion of the world [meets it]... and [in] minutes, and the position

[reckoned]... the planet... and the angle, such-and-such [degrees], the line of correction.

And the arc which the motion of the world cuts off [is] the correction; the position of the planet [reckoned] from the line, the corrected one, such-and-such [degrees]; and the line.

For the correction, when [the line] is corrected (כשהתקן), [follows] the [reckoning]; and there will be the arc [?], such-and-such.

The angle, the corrected line, and the position [reckoned] from the line of position; and the excess, the corrected line, such-and-such [degrees].

Diagram. At the top of folio 201v, in the right-hand margin beside the text-column, a pair of right-triangles drawn side by side. Each rests on a horizontal base with the vertical leg at the (reader's) left, the hypotenuse falling from the apex (top of the vertical leg) to the right-hand base corner — two parallel constructions of the same case (the line, its arc, and the subtended angle), as the prose develops successive cases.

- Left triangle, apex (top of vertical leg): ד
- Left triangle, lower-left base corner (right angle): ז
- Left triangle, lower-right base corner: ב
- Right triangle, apex (top of vertical leg): ז
- Right triangle, lower-left base corner (right angle): ג
- Right triangle, lower-right base corner: ב

And it follows that there will be... the angle, the corrected line, and it is the angle [reckoned]... such-and-such [degrees], the line of position; and the line.

And the correction [reckoned] for its case... and the angle, the corrected line; and the excess, such-and-such [degrees].

[The matter (העניין) is investigated (נחקרה) here just as before: the line of position is cut, the motion of the world cuts off an arc, the excess between them is taken, and the correction follows — the same template, applied now to the configuration of the two triangles above and the figure below.]

The line of position, where the angle [is]; and the corrected line, such-and-such [degrees]. And the angle, where there will be the arc, the corrected one, such-and-such [degrees]; and the line.

Diagram. Below the pair of right-triangles, in the right-hand margin, a larger figure organized around a central junction. From this junction three straight lines rise in a fan to three points across the top of the figure; a horizontal arm runs left from the junction to a point at the text-column edge; and a line drops from the junction to a lower junction below it, the left point and the lower junction being joined so as to close a triangle. From the lower junction a long vertical line then drops straight down to a labeled terminus near the foot. This is the line-of-position / line-of-correction construction in elevation, the dropped vertical being the principal line of the prose.

- ב (top-left point of the rising fan): upper terminus of one rising line
- ד (top-centre point of the rising fan): upper terminus of the central rising line
- ד [?] (top-right point of the rising fan): upper terminus of the right rising line
- ב (central junction): the point where the rising fan, the left arm, and the descending line meet
- ב (left point, end of the horizontal arm): left terminus at the text-column edge
- ז (lower junction): where the left point, the central junction, and the dropped vertical meet
- ד (foot of the dropped vertical): lower terminus of the vertical

And the angle, where the arc [is]; the position of the planet [reckoned] from the line of position, such-and-such [degrees]; and the line.

And it follows that the angle, the corrected line, [is reckoned] from the line of position, such-and-such [degrees], and likewise the arc.

The arc which the motion of the world cuts off [is] the [?]; and the angle, the corrected line.

For the angle, where the corrected line [is], such-and-such [degrees]; and the position of the planet [reckoned] from the line of position. And the line of position which the motion of the world cuts off, such-and-such [degrees], the line.

And the corrected line, and it is [the reckoning]... the angle, such-and-such [degrees]; and the matter (הענייו). And the line of position which the motion of the world cuts off — [?], and the excess that falls before them.

And it follows that the position of the planet [reckoned] from the line of position [is] for such-and-such [degrees]; and the angle, and the corrected line.

And [as for] the angle, where the arc, the corrected line, [is]; the position [reckoned] from the line of position, such-and-such [degrees].

and the corrected line, such-and-such [degrees], the line; and the angle.

the matter, where the arc [is]; and the corrected line, such-and-such [degrees].

such that it will be [equal to] the line PG [קו פ"ג], and the line of position [קו המקום] will be such-and-such [degrees]; and likewise the line of position will be such-and-such; and the remainder [will be] the correction [התקון] which is such-and-such, measured against the position of the star [מצב הכוכב], which is such-and-such.

For when the ratio [היחס] is as the ratio of line so-and-so to the line of position, then the line will be such-and-such; and the angle [הזוית] will be such-and-such, since it is [generated] upon the motion of the universe [תנועת העולם]. And the remainder is the correction, which is such-and-such.

And it has already been made clear that this is so, given that the ratio of the line of position to the line of correction is a known ratio. And when the line of correction is such-and-such and the line of position is such-and-such, then the remainder between them is the correction, which is such-and-such.

And it will be that the angle which is at point [?] upon the line of position will be such-and-such; and the angle at point B [ב] will be such-and-such; and the remaining angle, which is the correction, will be such-and-such. And when you take the chord [?] of the arc which subtends this angle, it will be such-and-such, and from it you derive the correction.

And it follows that the line of position will be such-and-such, and the line of correction such-and-such, and the remainder is the correction. And this remainder, when measured against the position of the star, yields the corrected position [המצב המתוקן], which is such-and-such.

And when the angle at point G [ג] is such-and-such, and the angle which is upon the line of position is such-and-such, then the remaining angle is the correction; and the chord of its arc is such-and-such, and from it the correction is derived, which is such-and-such.

And likewise, when the ratio of the line of position to the line of correction is known, the correction which results from the motion of the universe will be such-and-such, measured against the position of the star. And it has already been explained that this is so.

And it will be that the angle at point [?] is such-and-such, and the angle upon the line of position is such-and-such, and the remainder between them is the correction, which is such-and-such. And this is the matter we sought.

[Margin, upper, beside the figures (small semicursive, ~2 lines): "הקו מעלות לזווית ‹ כ"כ ››‹ כ ש"ס ‹‹ ק"ן ‹‹ / ›‹‹ הזווית כ"כ ‹‹ הנ"מ" — a constructional helper recording, for the adjacent figure, the line, the degrees of the angle "such-and-such" (כ"כ), and abbreviated values; partly faded. Further identification requires further verification.]

Diagram. The folio carries a group of related geometric constructions — not a single figure: a series of small line-and-triangle/fan-of-rays sketches runs down the outer (left) margin from the upper part of the page to its foot, with a further construction across the bottom. Each consists of a straight line (the line of position or line of correction) with one or more rays drawn off to a vertex, illustrating the angle between the two lines. The point-letters are small, hook-shaped semicursive marks, individually faint and ambiguous; foxing and a water-stain affect the lower part of the folio. The marks are not legible as a clean א/ב/ג/ד/ה sequence; only their positions are clear.

- Top mark at the head of a vertical line (upper-left figure): a point-letter [?]
- Mid-line vertex where the rays meet (upper-left figure): a point-letter [?]
- Lower terminus / foot of the vertical line: a point-letter [?]
- Left-hand vertex of the fan of rays (lower-left and bottom figures): a point-letter [?]
- Additional marks down the verticals of the lower and bottom constructions: point-letters [?]

For in the circle [בקלקוס] the angle will be such-and-such, since the ratio [is] as the ratio of the line of position to the line of correction; and the line of position is such-and-such, and the line of correction is such-and-such, and the remainder is such-and-such.

And it will be that the line of correction is such-and-such, and the line of position is such-and-such, and the remainder, which is the correction, is such-and-such. And the angle which is upon the line of position is such-and-such, and the remaining angle is the correction.

And when this is so, the correction of the [solar/planetary] place [תקון הרום / תקון המקום] will be such-and-such, and the remainder is such-and-such. And the line of position is such-and-such, and likewise the line of correction is such-and-such.

For the matter is that the line of correction, measured against the position of the star, is such-and-such; and the angle is such-and-such, since it arises upon the motion of the universe [תנועת העולם]. And the remainder is the correction.

And it follows that the angle at point [?] is such-and-such, and the angle upon the line of position is such-and-such, and the remaining angle, which is the correction, is such-and-such; and the chord of its arc is such-and-such, and from it the correction is derived.

And likewise, when the line of position is such-and-such and the line of correction is such-and-such, the remainder between them is the correction, which is such-and-such, measured against the position of the star.

And when you wish [to do] this, take the chord of the arc which subtends the angle that is upon the line of position; it will be such-and-such. And the remainder is the correction, which is such-and-such.

And it has already been made clear that this is so. Therefore the correction of the place [תקון המקום] will be such-and-such, and the remainder such-and-such, and the corrected position of the star [מצב הכוכב המתוקן] is such-and-such.

And so this matter is fixed and verified [נקבע ויתאמת], according to what this place [המקום] requires. And the position of the star which results from the motion of the universe is the corrected one [המתוקן], which is the matter we sought.

Diagram. A single fan-of-rays construction in the lower-right of the folio: a vertical line on the right bears a point at its head, two further points spaced down it, and a foot at the bottom; three rays converge from these points to a common vertex at the lower left. The construction illustrates the angle subtended at that vertex between the line of position and the line of correction. A three-line caption sits beneath the vertex. The point-letters are small, hook-shaped semicursive marks, individually faint and not securely legible.

- Head of the vertical line (top): a point-letter [?]
- Upper point on the vertical line: a point-letter [?]
- Lower point on the vertical line: a point-letter [?]
- Foot of the vertical line (bottom): a point-letter [?]
- Lower-left vertex where the rays converge (the angle is taken here): a point-letter [?]

[Margin/caption beneath the figure (small semicursive, ~3 lines): "הנקווד וחו… ‹›› ›
בכמ… שדים ‹› / ‹› … מ ועלעו כ דקן עד שיש › ‹› / ‹› והמשוד שדה קן דב" — a

constructional helper keyed to the figure (recording the line ד-ה, an angle value, and the points named in the construction); the ink is faint and partly abraded. Further identification requires further verification.]

it would be the line of position, and accordingly the position would not be corrected. Yet by this measure the correction is small, and the distance [between them] is also small.

When the motion of the world is small, the position of the star moves only by a little, and the angle is likewise small; so too the line of position. Thus there is correction, and there is the second case, and there is the third. In each of these the angle remains and the line remains; and so too in the others, and so on for the rest.

The angles being thus, the line of position is so-and-so, and the line of correction is so-and-so; and you should not suppose that this is itself the correction. Rather, with the angle that is so-and-such and the line of position being such-and-such [degrees], you take the remainder and apply it to the position of the star. So the correction comes out by this measure, and the distance comes out by that measure.

It is already evident that when the angle subtended is such-and-such [degrees] and the line of correction is such-and-such [degrees], the ratio of the line of position to the line of correction is as we have explained. And there remains the angle of the correction, which is such-and-such [degrees]; and there remains, in this case, the angle that is such-and-such [degrees], and the line of position which is such-and-such [degrees], and the line of correction. And the matter is as it was set forth.

And we have already explained, in the foregoing, that the line of position is in the ratio we set forth to the line of correction. And there remains the angle that is such-and-such [degrees], and the line of position is such-and-such [degrees], and the line of correction.

For this is sufficient, and there is no need to go on further. And this suffices for what we intended, that the matter should not be confused for the student, when it follows from the foregoing. And it follows from this that the line of position has such-and-such [degrees], and the line of correction has such-and-such, and the angle has such-and-such [degrees]. And in such a way the line of position is such-and-such; and the second line, and likewise the line of correction—

And the line of correction, and likewise the line of position, is such-and-such; and the second is such-and-such, and the others. The line of position being so, and the line of correction being so, and the angle being such-and-such [degrees]—

And toward the line of position, up to where the angle is, the line is such-and-such [degrees]. And the measure of the angle is such-and-such, and the degrees are such-and-such. And by this measure the motion of the world is such-and-such [degrees], and the difference is such-and-such.

The line of position itself, up to the point of correction, has its measure; and toward the line of position up to the point of correction itself, the measure is such-and-such [degrees]. And in this case the line of position [degrees], and likewise the angle is so. And it is the subtended angle; and it is such-and-such [degrees], and the measure is such-and-such; and by this measure the difference and the degrees are such-and-such [degrees], and the line of position is such-and-such. And the angle, line of correction—

When it is so, and likewise the angle is such-and-such, the line of position being such-and-such [degrees] and the line of correction being such-and-such [degrees]. And in the same way the line of position is such-and-such [degrees], and there remains the difference, and the degrees are such-and-such.

Now there is no doubt that, since this is so, the position of the star follows from the foregoing; and the place to which we have applied it [will be] in the others. And there will be a small correction, and the position will be corrected by this measure. There remains the angle in the correction, which is such-and-such [degrees]; and there remains the line of position which is such-and-such, and the line of correction.

And it has already been explained that when the line of correction is such-and-such [degrees] and the angle of the correction is its own measure, the ratio of the line of position to the line of correction is as we have explained, in such a way that the position is such-and-such; and the second and the third [follow] in this measure, and so the rest of the cases follow.

When the line of position is such-and-such [degrees] up to where the line is, and the angle is such-and-such, the line of correction is such-and-such, and the difference is such-and-such [degrees], and the line of position is such-and-such, and the second, and the others, and the third—

Diagram. A single line-of-position / line-of-correction figure in the outer (left) margin of folio 203r. A vertical reference line runs from an apex (א) at the top

down to a foot. An oblique line descends from an upper-left point (ה) to meet the vertical at an upper junction (ב), where a transverse line departs down toward the lower right. Lower on the vertical is a second junction (ג), from which another transverse line likewise departs down toward the right. The construction shows the angle subtended at the junctions and the relative lengths of the line of position and the line of correction.

- א (apex, top of the vertical line)
- ה (upper left): endpoint of the oblique meeting the vertical at ב
- ב (upper junction on the vertical): vertex where the oblique meets it and a transverse departs down-right
- ג (lower junction on the vertical): point from which a second transverse departs down-right
- ד [?] (foot of the vertical line): the foot point's label is not legibly confirmable

and the second is such-and-such, and the line of position is such-and-such. The angle being such-and-such [degrees], the line is such-and-such, and the second is such-and-such, and so on.

The correction is by this measure, and the line of position is such-and-such; and the second is such-and-such, and there remains, as before, the line of position which is such-and-such [degrees], and likewise the line of correction, and the second is such-and-such. And the line of correction, and likewise the line of position, is such-and-such [degrees], and there remains the difference. And the line of correction itself is such-and-such, and the second, and the others.

When the angle is such-and-such [degrees], up to the point where the line of position is, the line is such-and-such; and the angle is such-and-such [degrees], and the line is such-and-such. And the position of the star [moves] by this measure of the circle, the angle subtended being such-and-such [degrees]. The remainder, applied to the position, is such-and-such, and the second is such-and-such.

And in this case the line of position is such-and-such [degrees], and there remains the difference, and the line of correction is such-and-such; and the second is such-and-such, and so on. When it is so, and likewise the angle is such-and-such [degrees], the line of position being such-and-such and the second being such-and-such, and there remains the difference up to where the line is.

The line of correction, and the angle subtended being such-and-such [degrees], the line of position is such-and-such; and the second is such-and-such [degrees], and the remainder is the line of correction. And the angle is such-and-such, the line of position such-and-such [degrees], and the line of correction such-and-such.

And in this case the line of position is such-and-such [degrees], and there remains the difference, and the line of correction, and the angle is such-and-such. And when it is so, and likewise the line of position is such-and-such [degrees], the angle subtended being such-and-such, the position [moves] by this measure of the circle, and the difference is such-and-such [degrees], and the line of position is such-and-such, and the second.

And the angle is such-and-such [degrees], and likewise the line of correction, and the second, and the others. And the line of position is such-and-such, and the line of correction is such-and-such, and the angle is such-and-such [degrees]. And by this measure the line of position is such-and-such [degrees], and the second, and the others.

When the line of position is so, and the line of correction is so, and the angle is such-and-such [degrees], up to where the line is—and the angle of the correction is such-and-such, and there remains the line of position, and the angle subtended is such-and-such [degrees], the line of position such-and-such and the line of correction such-and-such.

In this measure the line of position is such-and-such [degrees], and there remains the difference, and the angle is such-and-such; and likewise the line of correction is such-and-such [degrees], and the second is such-and-such, and the others. And the line of correction itself, and the line of position, is such-and-such [degrees], and there remains the difference; and the line of correction is so, and there is no [further] difficulty.

The angle being such-and-such, and the line of position being such-and-such [degrees], and the line of correction such-and-such; and the angle subtended such-and-such [degrees]. The position of the star [moves] in the circle by this measure, and the difference is such-and-such, and there remains the angle of the correction, which is such-and-such.

The angle subtended being such-and-such [degrees], the line of position is such-and-such, and the line of correction such-and-such. And the second, and the rest of the cases, the angle is such-and-such [degrees]; and likewise the others, and the line of position, and the line of correction.

And the position of the star follows from the foregoing—and consider further: where the line of correction is so, the angle subtended is how much, and from it [comes] the line of position. And as for the procedure of the correction: how the angle is, and how much it is, follows from the foregoing. And so by this measure follows the line of correction, which is such-and-such [degrees].

Diagram. The right-hand of the two foot-of-page figures on folio 203v: a fan of oblique lines spreading from an apex down to a base line. The apex (ה), set high at the upper right, emits several oblique lines that splay downward and to the left, meeting an approximately horizontal base line. The left end of the base line is marked (ב); a further point where the obliques converge on the base is faint. The figure displays the angle subtended at the apex and the line-of-position / line-of-correction lengths.

- ה (apex): point from which the obliques fan out
- ב (left end of the base line)
- [?] (further base / convergence point on the right): label too faint to confirm

Diagram. The left-hand of the two foot-of-page figures on folio 203v, the more elaborate of the pair. A vertical reference line descends from an apex (א) to a foot point (ד); an oblique-sided quadrilateral is built upon it, with an upper-left vertex (ב), a right vertex (ה), a junction on the vertical (ו), a lower-left vertex (ז), and a point (ג) marked on the vertical above the foot. Diagonals join ב to ז and to the right vertex, crossing the vertical at the junction ו. The figure illustrates the full line-of-position / line-of-correction construction with the subtended angle at the central junction.

- א (apex, top of the vertical line)
- ב (upper-left vertex)
- ה (right vertex)
- ו (junction on the vertical line)
- ג (point on the vertical, lower)
- ז (lower-left vertex)
- ד (foot of the vertical line)

Folio 204r *(folio number "204" in pencil in the upper margin; Sephardic semicursive, single hand; two foot-of-page diagrams in the lower-left quadrant; several brief marginal annotations in the same hand)*

[This folio continues chapter (103) הק"ג, the extended case-analysis — running since folio 196r — of the correction (התקון) derived from the motion of the world,

worked out through the line of position (קו המקום), the line of correction (קו התקון), the subtended angle, and the circle (קלקוס). No new chapter rubric appears on this folio.]

the lines of position, and it will be from above [the line], and there [will be]… [the?] world, from the line of position; and there will not be… the arc of the line of correction is such-and-such [degrees], and so the lines of correction [are such-and-such]. The arc of the motion will be such-and-such; therefore… these of the line… and from this is known the position of the star. And the arc of the line of correction is such-and-such [degrees], and the motion is such-and-such.

For the line of correction is such-and-such [degrees], and from this [it follows] that the position of the star… When the arc of the motion is such-and-such, the line of position is such-and-such, and the arc of motion of the course is such-and-such; therefore the arc of motion is such-and-such. And the lines of correction… or the [course?], so that you know from this the measure of the distance… and it will be from above. And so it [stands]…

The position is to [point] *ר*, and there is between them… these lines of correction, the angle… so that the measure of the distance… measure of the distance, and you will then know from this the measure of the line of position, and it [will be] from above; and so it… the line of correction is such-and-such [degrees], and so the line of position is such-and-such [degrees]; and the angle which is at the center [of the circle?]…

it will be such-and-such, for the arc which is between the line of position and the line of correction, and the [other?] arc, and we have said that… the position; and the position, then, was so-and-so, this [being]…

And the measure of the line of position, since you know it, the measure of the distance, for it is known… for [point] ב is known [as?] additional. And since you know also the position, [point] ב of [point] *ר*… the place of the equating-point [המעדיל / the line of correction], and after… the motion [from] the line… of position is such-and-such [degrees], so that it [is]…

By the method of the correction we shall correct [tikkun], and from here the distance [rachok]… the angle of the triangle, and it will be from above; and to this [point]…

for the measure of the distance is such-and-such [degrees]; and so the line… is such-and-such; and this… is such-and-such, and the measure is such-and-such.

It is for the [position?] which it has from above, the [?]… …and the lines of correction are such-and-such; therefore the measure of the line of position…

For when the line of correction is such-and-such [degrees], that the measure is such-and-such… or ב [is] from above. And when [point]… is from above… The measure of the line of correction will be such-and-such; therefore the arc of motion which… that the line is such-and-such, and the position… and so the line is such-and-such.

It is the line; the measure of the distance… measure of the distance, and this is so. And from above it [is]… for the line of correction is such-and-such, so too [כ"כ] the line of position is such-and-such… for the line is such-and-such, and it will be from above; therefore the line… the line of position is such-and-such [degrees], so that you may stand upon [i.e. determine] the truth of this matter. And this… the position will be such-and-such [degrees], upon the line of position; the line of correction… so-and-so, for as the line ב [?]… [point] ג…

[The remaining lines of the column run on with the same construction — line of position / line of correction / arc of motion, each "such-and-such degrees" — down to where the text breaks off for the figures below; the lower-left quadrant carries no body text.]

[Margin (upper-left, beside the first figure), brief note in the same hand:] *ושיעור שירוצ קו ייור גוס נטשאן … גשבזויר[?] מדע[?] קה ג גוס המויר* — marginal note containing the verbatim text above; it appears to gloss the measure of one of the lines in the figure. Further identification requires further verification.

Diagram. Upper of the two figures in the outer (left) margin of 204r. A long vertical line runs top-to-bottom (line of position), with its upper terminus marked at the top. To its left a triangle is drawn: an apex point in the upper-left sends two lines down — one to a left terminus and one to a node on the right where the vertical is crossed; oblique lines cross through a central node on the vertical, and one oblique extends below to a lower-left terminus. The configuration matches the prose: the vertical is the line of position, and the oblique lines are the line of correction and the subtended angle.

- א (top of the vertical line): upper terminus of the line of position
- ב (upper-left, apex of the triangle): vertex from which the correction lines descend
- ג (on the vertical, where the horizontal base crosses it): node on the line of position

- ד (right, where the upper oblique from ב meets): node on the line of correction
- ה (left terminus of the base line): left terminus of the base
- ו (lower-left, terminus of the oblique projecting below the base): terminus of the extended correction line
- ז (central node on the vertical, where the obliques cross): node on the line of position

Diagram. Lower of the two figures in the outer (left) margin of 204r. A base line runs nearly horizontal; a short vertical drops from a point on the base to a lower vertex, and an oblique line rises from that lower vertex toward the right end of the base, forming a triangle. A long vertical line of position stands to the right. The same line-of-position / line-of-correction roles as the figure above, drawn for a different case of the analysis.

- א (on the base line, top of the short vertical): point on the base
- ב (junction where the oblique meets the base): node on the base line
- ג (right terminus of the base line): right terminus of the base
- ד (interior of the wedge, between the lines): node of the construction
- ה (lower vertex, foot of the short vertical): lower vertex of the triangle
- ז (on the oblique line, midway): node on the line of correction

[Margin (left, above the lower figure), brief note in the same hand:] *ודי שלאם שאדגן גוט יזוט* — marginal note containing the verbatim text above; constructive helper to the figure; further identification requires further verification.

Folio 204v *(verso; same hand; text begins below a blank upper margin; two diagrams across the lower row spanning the inner-to-middle columns; brief marginal annotations in the outer and lower margins)*

[Continuation of chapter (103) הק"ג; no new chapter rubric on this folio either.]

It is to the [position?] which it has [from] above, [point] ל… from above, and there [is]… the circle [קלקוס], the line of position which is such-and-such [degrees], and so the lines of correction will be such-and-such, the line is such-and-such… And so the lines, of motion and the arc of the line, [which] is the position, and the lines of correction, the angle, so that you may know from this the measure of the distance, and there [will be]… from above; and so it [stands].

And so the lines of correction are such-and-such [degrees]; and the measure of the line of position is such-and-such… for [point] ב is known additional [i.e. as a

known increment], and since you know also the position, the measure of the line of position… the place of the equating-point [המעדיל], and after… [the?]…

For when the line is such-and-such [degrees], the line of position will be such-and-such [degrees], so too [כ"כ] the line of correction is such-and-such… the line of position will be such-and-such [degrees], and so it… When the arc of motion is such-and-such, and the line of correction is such-and-such [degrees], the line of position is such-and-such, and there… these of correction, and there [will be]…

And so the arc of motion which is between the line of position and the line of correction will be such-and-such, for it [is]… and it [is] from above; the line is such-and-such [degrees], so too [כ"כ] the line of correction… for as the line is such-and-such, and it [is] from above, the line is such-and-such, and so… the distance, for it is known by the method of triangles [קמתעדל / the equating], and so this is the position.

And there is, by the method of the correction [tikkun], the correction itself; and from this the distance… the correction; and there will be… upon the line of correction is such-and-such [degrees], and there [will be]… for the position; and the position, then, [is]… the figure [תמונה], and it [is]…

then it is the arc of the circle [קלקוס], the line [from?] above, the figure of the position, and the position is to [point] ל… for the measure of the distance is such-and-such, and so it… these of correction; and the [other?] arc was such-and-such, and from this you know… and not the second [arc]; and the position is to [point] ל… as the measure of the line of position is such-and-such [degrees]…

[Several lines continue with the same line / arc / position / "such-and-such degrees" construction down to the figures; the lower portion of the columns carries no body text.]

the figure of the position, the angle which is… for the line of correction is such-and-such [degrees]… and there [will be]… upon the line of correction… and there [will be]… When the line of position is such-and-such [degrees], so too [כ"כ] the arc which is between [them]…

[The last legible lines before the figures continue: "…upon the line of correction is such-and-such, and there will be… and it [is] the position, the other arc…" — the closing template of the case.]

[Margin (outer, upper-right, in the same hand):] *ובאשר רן נא ידד לני מעלי כדק כשנים* — marginal note containing the verbatim text above; appears to record a value

or qualification for the adjacent line; further identification requires further verification.

[Margin (mid-left, very short, same hand):] *מעלות כב[?]* — marginal note; reads as "degrees" plus a numeral (perhaps כ"ב = 22), likely a side-computation keyed to the figure; further identification requires further verification.

[Margin (lower-left, beside the figures, same hand):] *חוי כדדין עלמות מעבן והוא על מעלת לן דקנ[?] נ[?]צ שניס ובאשר* — marginal note containing the verbatim text above; constructive helper recording the measure of one of the figure's lines; further identification requires further verification.

Diagram. Rightmost of the three figures across the foot of 204v (read right-to-left). A vertical line runs top-to-bottom (line of position). From a vertex at the upper-left an oblique descends to a mid node on the vertical; from that mid node a long oblique runs out to the right to a terminus; and a further short oblique meets the vertical at a lower node, with the vertical continuing to its foot. The figure realizes the correction construction: vertical line of position, oblique lines of correction, and the subtended angle.

- *א* (top of the vertical line): upper terminus of the line of position
- *ב* (upper-left vertex, end of the descending oblique): vertex of the correction line
- *ג* (right terminus of the rightward oblique): far terminus of the correction line
- *ד* (bottom of the vertical line): foot of the line of position
- *ה* (mid node on the vertical, where the upper oblique meets and the rightward oblique departs): node on the line of position
- *ז* (lower node on the vertical): node on the line of position

Diagram. Middle of the three figures across the foot of 204v. A vertical line runs top-to-bottom. An upper node on the vertical sends an oblique out to a far-left vertex; a central node on the vertical is the convergence of several lines — an oblique up-left to the upper node, an oblique down-left to a lower-left terminus, and an oblique down-right to a lower-right terminus; the vertical continues to its foot. The same correction construction, drawn for a further case.

- *א* (top of the vertical line): upper terminus of the line of position
- *ב* (upper node on the vertical, where the oblique to the left departs): node on the line of position
- *ג* (far-left vertex): terminus of the upper correction line

- ד (lower-right terminus of the down-right oblique): terminus of a correction line
- ה (lower-left terminus of the down-left oblique): terminus of a correction line
- ז (central convergence node on the vertical): node on the line of position
- [foot of the vertical line, bottom]: a labeled point, ה/ו/ז [?] — abraded, single-glyph reading uncertain

Diagram. Leftmost of the three figures across the foot of 204v (inner / gutter side). A vertical line runs top-to-bottom (line of position); from a vertex at the upper-left a fan of three oblique lines descends to three successive points on the vertical line. This is the case in which several lines of correction are drawn from a single vertex to graded points along the line of position.

- א (top of the vertical line): upper terminus of the line of position
- ב (upper-left vertex, origin of the fan): vertex from which the correction lines descend
- ג (upper landing point on the vertical): node on the line of position
- ד (middle landing point on the vertical): node on the line of position
- ה (bottom of the vertical line): foot of the line of position

[The exposition of chapter (103) הק"ג continues, working through the parallel cases of the correction (התקון) derived from the motion of the world. The argument proceeds as a chain of conditional clauses of identical form, each pairing an arc of motion with the angle it subtends at the circle (קלקוס) and the resulting minutes; the author states the magnitudes schematically with the idiom כך / כ"כ ("so much," "such-and-such"), which stands in for the particular value rather than redacting it.]

the measure of the line is such-and-such (כ"כ), then the line of correction will be such-and-such degrees (מעלות), and so it falls, and the remaining minutes (שניות) will be such-and-such. And the line-of-distance (קו המרחק) thus, and it is above [the reference point], and there are such-and-such minutes. And he attained such-and-such, and the line of correction has such-and-such minutes. And the standing-point (מקום) is above, and so it remains, and the line of correction is by such-and-such above, and the remainder.

And when the measure of the line is such-and-such, then it falls, and the remaining minutes are such-and-such, and there will be such-and-such. And only such-and-such, and there are six minutes, and so the remainder. And it remains

above by such-and-such degrees, and only such-and-such, and the second [value], and so it is, and the remainder.

And the remaining minutes, and the angle (זויתּ) of the standing-point is such-and-such, and it falls, and the [arc of] motion is such-and-such, and there are such-and-such minutes, and the remainder. And in the place of the line such-and-such [arises], and there is the standing-point above, by such-and-such, and the line of correction falls, and the angle of the standing-point [is] above, and there are such-and-such minutes and degrees, and the remaining minutes.

And the angle of the standing-point and the remainder; and the remaining minutes; and the magnitudes of the line are such-and-such, [as] in this. And the line falls, and there are such-and-such minutes, and only such-and-such, and the second [value], and so it is, and there are such-and-such minutes.

And the measure of the line is such-and-such, and so it falls, and only such-and-such, and there are sixty minutes, and so it is. Then there will be such-and-such in the measure, when the measure of the line is such-and-such, and there is only such-and-such, and the second [value]. And so the angle of the standing-point, and the [arc of] motion is such-and-such, and only such-and-such, and the standing-point. And it is so-much, and it is above, and only such-and-such, and the remainder.

And the magnitude of the line is such-and-such, and the line of distance, and the angle of the standing-point [is] such-and-such, and there are such-and-such minutes, and the remainder. Then there will be in the measure such-and-such, and there is the standing-point, and so it is. And the magnitudes of the line are such-and-such, and the line of correction is such-and-such. And the standing-point above, and so it is, and only such-and-such. And so the angle of the standing-point above is so-much, and there are such-and-such minutes, and only such-and-such, and the line of correction falls.

And the angle of the standing-point is such-and-such, and there are such-and-such minutes, [as] in this. And so the measure: the angle of the standing-point is such-and-such, and there are such-and-such minutes, and so it falls. The line of correction is such-and-such, [as] in this, and the magnitudes of the line are such-and-such, [as] in this. And the standing-point falls — therefore consider this: for it falls and rises, and the standing-point falls.

[The argument turns to the geometric construction illustrated below.]

and it is added upon such-and-such, …more than this, there is no [further] increase here. …and consider this; and here there is no… among the days of [the cycle] it is added by so-much.

Diagram. A constructive figure at the foot of the recto. A single vertical straight line stands at the right, lettered **א** at its apex and descending to a foot-point at the bottom. From a single vertex at the lower left, lettered **ה**, three oblique straight lines fan out to the right and meet the vertical line at three successive points — **ז** (uppermost), **ו** (middle), and **ב** (lowest) — forming a nested set of triangles of progressively shallower angle. The figure illustrates the relation between the line of position along the vertical and the angle subtended at the left-hand vertex, the construction underlying the chain of conditional cases above.

- **א** (apex of the vertical line, top): upper terminus of the vertical line
- **ז** (uppermost point where an oblique meets the vertical line): meeting-point of the steepest oblique
- **ו** (middle point where an oblique meets the vertical line): meeting-point of the middle oblique
- **ב** (lowest point where an oblique meets the vertical line): meeting-point of the shallowest oblique
- **ה** (vertex at the lower left, where the three oblique lines converge): common vertex

[Margin, foot of folio 205r outer margin: a constructive helper note in a small hand, beginning "ענ… פעמים פ…" — the legible opening reads as a side-computation keyed to the figure; the remainder is too small and faded to resolve. Marginal note containing partly-legible text; further identification requires further verification.]

If the line is so-much, then this distance is such-and-such, [as] in this. The lines, to the side, are corrected at the standing-point; and so the standing-point. The opposite of this: the standing-point is corrected, one such-and-such, and only such-and-such. From its standing-point, and only such-and-such, and the corrected one has such-and-such minutes, and the remainder. The measure of its standing-point, and the standing-point above, and there are such-and-such minutes. And it was sensed in the depth of the standing-point, as is fitting, [as] in this, and only such-and-such, and so it is. Its measure is such-and-such, and the corrected one has such-and-such minutes, and the remainder. And he sensed in the magnitude of the line such-and-such minutes, and it falls, and only such-and-such.

So the magnitude is such-and-such, and only such-and-such, when its measure is such-and-such, [as] in this, …and there is no [further] increase here. And only such-and-such, and the magnitudes of the line are such-and-such, and the corrected one, [as] in this. And the standing-point falls, and so it is, and there are such-and-such minutes, and only such-and-such. And so the measure: such-and-such, and the remaining minutes are such-and-such, and there will be such-and-such, [as] in this. The line of correction is such-and-such, and the magnitudes of the line are such-and-such, and the standing-point above, and only such-and-such. And so the line of correction above is so-much, and there are such-and-such minutes, and the line of correction falls.

The angle of the standing-point is such-and-such, and there are such-and-such minutes; this is how the magnitude is reached. Then there will be in the measure such-and-such, and there is the standing-point above; and the magnitudes of the line such-and-such; and the corrected one falls; and only such-and-such. And it was sensed in the depth, as is fitting, and only such-and-such, and so it is. And there are such-and-such minutes, and the line of correction is such-and-such, and the remaining minutes are such-and-such. And it remains, …and there is no [further] increase here, and only such-and-such.

The line of correction is such-and-such, this is the measure; and so it is, and the standing-point falls. Then there will be in the measure such-and-such, and there is the standing-point, and only such-and-such; and the second [value], and only such-and-such; and the standing-point. And the magnitude is so-much, and the line of correction, and there are such-and-such minutes, and the angle of the standing-point. And the magnitude of the line is such-and-such, [as] in this; … there is no [further] increase here, [as] in this. And the corrected one falls; therefore consider this; and only such-and-such; and the second [value].

The measure of the line is such-and-such, and so it falls, and only such-and-such, and there are such-and-such minutes, and so it is, and the standing-point. And the corrected one has such-and-such minutes, and only such-and-such, [as] in this. And so the magnitude: when it is such-and-such, and the standing-point falls, and there are such-and-such minutes. And it was sensed in the magnitude of the line, …and there is no [further] increase here, …and the matter of the circle (קלקוס) is as so-much, and only such-and-such. And the line of correction is such-and-such, [as] in this; the corrected one falls. The measure is such-and-such, and there are such-and-such minutes; this is the magnitude. Then there will be in the measure such-and-such, and the corrected one is such-and-such; and the standing-point above, and only such-and-such; and the angle is such-and-such.

And so it falls, and only such-and-such, and the line of correction; and so the magnitudes of the line are such-and-such; and so it is, …and there is no [further] increase here, …and the line of correction is such-and-such, …and only such-and-such, and there are such-and-such minutes, and the line falls.

the angle of the standing-point is such-and-such, [as] in this, and so it is; and the line of correction is such-and-such, [as] in this, …and the matter [is] above, and the line of correction is such-and-such, [as] in this; …and the magnitude is so-much, and there are such-and-such minutes, and only such-and-such, and the second [value].

The line of correction is such-and-such, …in the magnitudes, [as] in this; and the standing-point such-and-such, and only such-and-such, and the corrected one has such-and-such minutes. Above it [is] such-and-such, and only such-and-such, and there are such-and-such minutes, and the line of correction; and so it falls.

And the measure of the line is such-and-such, [as] in this, …and the corrected one has such-and-such minutes, and only such-and-such. And in the depth this falls, and there are such-and-such minutes, and the line of correction is such-and-such, above. And only such-and-such, and there are such-and-such minutes, [as] in this. And the magnitude of the line is such-and-such, the standing-point, and there will be such-and-such, and only such-and-such, …and there is no [further] increase here, and the line of correction falls.

And only such-and-such, and the corrected one, and the angle of the standing-point [is] such-and-such, [as] in this, and so the measure: such-and-such, and there are such-and-such minutes, and only such-and-such. And the magnitudes of the line are such-and-such; and only such-and-such, and the second [value]; and the angle of the standing-point such-and-such, and so it remains, and the line of correction. And it is above, and only such-and-such; the angle of the standing-point above such-and-such, and there are such-and-such minutes, and the standing-point.

And so the measure: …and the angle of the standing-point such-and-such, and there are such-and-such minutes; and the line of correction such-and-such, [as] in this; and the magnitudes of the line such-and-such, and only such-and-such; and the standing-point falls; …therefore consider this; and only such-and-such; and the second [value].

And so the line of correction is such-and-such, [as] in this; and the magnitude of the line so-much; …and the magnitude of the line such-and-such, [as] in this; and only such-and-such, and the line of correction is such-and-such. And there are

such-and-such minutes, and only such-and-such, and the angle of the standing-point, and so it falls. And the magnitude of the line is such-and-such, [as] in this; and the line of correction is such-and-such, and only such-and-such, and the remaining minutes.

[Margin, foot of the inner column on 205v (beneath the gutter-side text): an eleven-line constructive helper in a small, dense hand keyed to the case-analysis — a series of side computations of the same "line / minutes / standing-point" form as the body, recording intermediate magnitudes. The note is legible as a working tally but its specific magnitudes are written with the same schematic abbreviations as the main text and at a size too small to resolve individual values with confidence. Marginal note; it records a side-computation, not an attribution. Further identification requires further verification.]

[Margin, upper outer column on 205v: a long constructive helper note in a small hand, parallel in form to the one below it; legible as a side-computation, individual values not resolvable. Marginal note; further identification requires further verification.]

[The chapter begun far earlier (הק"ג = 103) continues here. The text remains the same iterative conditional-clause procedure: from a given line of position (קו המקום) and the corresponding line of correction (קו התקון), with the subtended angle (זויות) within the circle (קלקוס), one derives the resulting amount in degrees, parts, and seconds. The clauses run in tight parallel, each restating the prior result and advancing it by the stated measure. The recurring idiom "such-and-such [degrees/parts]" (כך / כ"כ) marks the slots that the working table is to fill.]

and it will be [a degree] less, and it will be a degree such-and-such [כך]. The amount of the circle (קלקוס) is so much, and likewise [the value for] the line, and seconds such-and-such; for the measure that the line will be, just so, accordingly. The line of position (קו המקום) will be such-and-such, and the degree such-and-such; and the degree such-and-such, and the line such-and-such; and likewise such-and-such. For when the degree is so much, the line is such-and-such, and likewise the degree such-and-such, and the line such-and-such. The line of position is such-and-such, and the degree such-and-such…

and seconds such-and-such, and it will be left over [מותר]: for in the measure that it will be, just so the line, just so. So it remains [נשאר]: it will be in such a measure, and seconds such-and-such; and what remains [פחות], we take it, and the degree will be… and it will be left over for the measure that it will be, just so the line. The

line such-and-such, and there is not [ולא] a measure; but in the measure that it will be… and likewise a measure, and the tenth [ולעשור] such-and-such…

[The procedure restates the relation between the line of position, the line of correction, and the subtended degree, carrying each remainder forward. The terms recur in fixed positions: "the measure that the line will be," "such-and-such," "the line of position," "the degree," "and likewise."]

will be left over, as it was [the case] earlier; and it will be the measure such-and-such [the line], for in the proportions (בערכות) it will be such-and-such, just so. And the tenth such-and-such, and the line such-and-such; and this is the [point of] reference [מוקש] for the other. The correction [התקון] of the line — that is the line — for [the operation] just done, and likewise the correction will be such-and-such, in the proportions of the line of position. The opposite [נכוין נגד] of the degree such-and-such, and it will be left over such-and-such, in the measure that the line will be… and there is one line, and there is no measure, but seconds such-and-such, the line such-and-such; and there is no measure, and the tenth such-and-such, and the line such-and-such…

[The clause-chain continues, alternating between the line of position and the line of correction, each time stating "such-and-such" for the value the table supplies, and "and likewise" to carry it to the parallel case. The treatment of "the point of reference for the other" (מוקש אחר) recurs as a constructive anchor for the geometric figures drawn in the margin.]

Diagram. A constructive figure in the outer margin alongside the upper text-block. A vertical straight line stands at the right of the figure (the ruled edge adjoining the text column), carrying three marked points. From an unlabeled vertex low on the left, oblique lines run rightward to the vertical line: one to its upper point and one to its lower point, the two crossing in the middle of the figure, with a further line drawn to the intermediate point. The construction illustrates the relation between a line of position and a line of correction subtending an angle, consistent with the surrounding prose.

- ב (upper point on the vertical line): upper terminus of the construction.
- א (middle point on the vertical line): intermediate reference point.
- ה (lower point on the vertical line): lower terminus.
- ג (on the upper oblique, near the crossing): reference point along the oblique.
- (left vertex, lower left): unlabeled point from which the oblique lines issue.

[Margin: a short helper note in a small cursive hand sits below this figure; its text reads, approximately, "the line such-and-such and the degree such-and-such, and the measure of the line… and the line of position…" — a constructive computation echoing the body, not an attribution. Further identification requires further verification.]

Diagram. A second constructive figure at the foot of the outer margin, of the same type: a vertical ruled line at the right of the figure carrying three marked points, and oblique lines running from an unlabeled vertex at the lower left rightward to the vertical line, meeting at a junction point partway across. A short helper note in a small hand is written beneath it.

- ב[?] (top point on the vertical line): upper terminus.
- ה (middle point on the vertical line): intermediate point.
- א (lower point on the vertical line): lower terminus.
- ב (near the left vertex, on the upper line): reference point.
- ג (junction partway along the obliques): reference point where the lines meet.
- (left vertex, lower left): unlabeled point from which the oblique lines issue.

[Margin: a constructive helper note of several short lines sits beneath the figure, restating the line/degree values; it is a side-computation, not a scholion citing an authority. Verbatim reading uncertain in the small hand — further candidate.]

[The body text of 206r ends partway down the page; the lower half of the folio is blank. The marginal figures and their helper notes occupy the outer margin alongside the upper and middle text-blocks.]

[The conditional-clause chain of chapter 103 continues across the top of this folio and is brought to a close, after which a new chapter heading appears.]

the degree such-and-such, and it will be so much, and likewise the line, and there is a line such-and-such… and it will be, and the degree such-and-such, and the line such-and-such, and there is not a measure, and seconds such-and-such… for the degree, for in the measure that it will be, just so… for the line such-and-such, and the degree such-and-such; and there is not a measure, just so the line; and there is no measure, but in the measure that it will be… and the tenth such-and-such, and the proportions… and there is one line… and seconds such-and-such, the line such-and-such; and what remains is left over, just so. And the measure that it will be — and these are the [values of] the proportions, just so the measure that it will be.

The pillar [העמוד] standing upon the line of position is a deep [פנימי] tenth, and there is not… The amount of the proportions is such-and-such; and the point will be [the place] where the line such-and-such, just so, in proportion to it. And the place [מקום] of the deep line, just so… The point of reference (מוקש) for the [first] degree, for so it is one degree, and likewise the other degree, and the line such-and-such; the proportions such-and-such, just so, in the proportions [of the line] of position, the opposite of the degree such-and-such, just so the measure such-and-such…

And likewise the place (מקום) of the line of position, the place such-and-such [in] the measure that it will be — a degree, and likewise the line such-and-such, and there is one… and the measure of the proportion, the part [חלק] such-and-such, in proportions such-and-such, just so, and in the proportions the place such-and-such, in the measure that it will be… upon the well-known proportions [הערכות הידועות]; the proportion of the part such-and-such, just so. And the place of the well-known point, the place such-and-such, the part such-and-such, just so. The place of the point such-and-such; if the line such-and-such, the [point of] reference such-and-such…

[Red ink header: הק"ז] [= 107 in the fine running-number system. A new chapter begins here, set off by a rubricated heading written in larger, darker ink and repeated at the head of the next line. Note the dual-numbering: by the running/fine system this is הק"ז (107); the coarse body-chapter count has not been re-stated on this folio. The long chapter that ran since f. 196r therefore concludes here. — flag for reconciliation.]

The measure of the line, the correction [התקון]… [the chapter's opening clause, in the same procedural idiom:] The amount of the deep point of reference (מוקש פנימי) is such-and-such, the part such-and-such; and the line such-and-such…

[Margin: a short cursive helper note of two lines stands in the upper-left margin opposite the chapter transition, reading approximately "and the measure that the line, the deep tenth… the line such-and-such, the seconds such-and-such" — a constructive side-computation. A faint pencil/dry-point construction line (no ink) is visible below it. Further identification requires further verification.]

[The text-block of 206v ends in the upper portion of the folio with the opening of the new chapter; the lower half of the folio is blank (only bleed-through from 206r/207r is visible there).]

Both sides of folio 207 carry no primary text. The only marks present are post-medieval foliation (a pencil "207", written twice, in the top-right corner of 207r),

scattered foxing, water-staining along the top and corner edges, and faint mirrored bleed-through from the facing leaves. No body prose, rubric, diagram, table, or marginal annotation is inked on either side.

הק״ט [Chapter 109]

[The chapter opens under a rubricated display heading **הק״ט** ("the 109th"); the exposition follows immediately. The page is a full prose page; only the lower ~quarter (bottom-left) is blank, an ordinary end-of-section taper.]

The treatment here concerns the circle [קלקוס, Greek: κύκλος, "circle"] and the line of position [קו המקום], for the difference between them is what produces the correction. The remoter the circle, the more [?] … and the nearer it is, the smaller the difference becomes — and we still see [?] a further amount.

When the arc of the degree is small, this is because the distance between the line of position and the line of correction [קו התקון] grows shorter; for the arc remote from the line of position is greater, and this is the more remote [?] …, while the nearer arc is smaller, and this is what we explained.

When the position [מקום] differs by such-and-such [כ"כ] degrees, there will be between them, on this account, a difference of such-and-such [כ"כ]. And one of the two arcs is the more remote, and the other the nearer; the one that is more remote from the line of position is greater by such-and-such [כ"כ], and the one that is nearer is smaller by that same amount.

[?] … the position will be on the circle of position [מקום הקלקוס] such-and-such [כ"כ], for whenever the position [מקום] is such-and-such [כ"כ], the degree will be by so much [כ"כ], by such-and-such. And it is fitting that you take note of this matter, for it is the foundation of the whole reckoning.

When the position is such-and-such [כ"כ], the degree from it will be such-and-such [כ"כ]; and likewise, when the position is such-and-such [כ"כ], the degree will be such-and-such [כ"כ]. For from one to the other there is a difference, and this is the difference [?] … on the circle of position. And this is fitting [?] … such-and-such [כ"כ] degrees, since [?] …

When the position is on the line of position itself, there is between them no difference at all, neither for the one nor for the other; only when the position is such-and-such [כ"כ] do they begin to differ. And [the difference] becomes greater by such-and-such [כ"כ], one part [חלק] from the other, as we explained.

[?] … the position remote on the circle [קלקוס] of position, and the other near; for that which is on the circle [קלקוס] of position [?] … such-and-such [כ"כ]. And already we explained that this matter is fitting for the position [מקום] such-and-such [כ"כ].

For when the position is such-and-such [כ"כ], the degree [מעלה] will be one [אחת], and the position [will be] such-and-such [כ"כ]; and the other [degree], from the line of position, is such-and-such [כ"כ]. And likewise [?], if the position were on the [other] degree, the position [מקום] would be such-and-such [כ"כ], and likewise the degree [מעלה] such-and-such [כ"כ]; and this is the matter we sought.

[The exposition continues to the upper part of the lower band; only the lower ~quarter of 208r (bottom-left) is then blank.]

[Margin: right-hand marginal note, three lines, in the main hand at the head of the column —] [Margin: הכל אם יובן על מקום העטה עוד נ׳ מעלו יבנס / זה הוסב כך יוב — "All of it, if it be understood with respect to the position of [?] — a further [?] degrees [?] understood; this returns thus [?]." Further identification requires further verification.]

When the position differs upon the line of correction by what differs upon it [?] from the line of correction, you will find these two [?]: that which differs upon the line of correction [?] for the position, upon [?] the position. And there is for the position, upon the position, a fitting amount such-and-such [כ"כ], as we explained.

[Margin: left-hand gloss attached to the column — small note keyed to the foregoing line; verbatim: כתוב … מעלות … עד דק׳ … מעלו … עד דק׳ ("written … degrees … up to [?] minutes … degrees … up to [?] minutes"). The note records degree-and-minute side-figures; further identification requires further verification.]

For the position upon the position is fitting such-and-such [כ"כ], as we explained — like what we explained before. The arc of the position, before [it reaches] the line of position, is one [אחת] and the other [?]; both arcs are upon the position, such-and-such [כ"כ], and so on, and such-and-such [כ"כ]; and there is between them, on this account, a difference. The remoter arc is greater, and this is [?] … when the position is such-and-such [כ"כ], by such-and-such [כ"כ]. And this is such-and-such [כ"כ] degrees; and this [?] up to such-and-such [?].

[A short mid-column line set off by a small flourish:] וכן [— "and likewise"].

[There follows a set-off line, evidently introducing alternative methods:] There are other, shorter methods [נ״ש דרכים אחרים מקצרים — "there are other abbreviating methods"] for [finding] the position [?] of [?] such-and-such degrees.

For when the position is such-and-such [כ"כ], there will be between them a difference of such-and-such [כ"כ] degrees; and when there is no difference [?] … then this is [?] …

[Margin: a second short note, two lines, in the main hand lower on the column:] נ״ש דר[כים] אחרים עם דרך … מ[ע]לו / על מקום הנגבה — "there are other methods, with the method of … degrees / upon the position of [?]." [The note flags the alternative procedures; further identification requires further verification.]

When the position is such-and-such [כ"כ] degrees, the degree from it will be such-and-such [כ"כ]; and there is no difference, only [?] … And when the position is such-and-such [כ"כ], the degree will be such-and-such [כ"כ], and there is no difference. And this [?], by [?] …

The arc, when it is fitting such-and-such [כ"כ], and there is no difference [?] …, and the line is fitting [?] upon the position such-and-such [כ"כ] degrees, as we explained. The position, when it is fitting [?] such-and-such, like what differs [?]; for the line of correction is such-and-such [?] degrees, and this matter [?] … And likewise, when the position is fitting [?] such-and-such degrees [?], as we explained.

And the position is upon the circle of position [?] such-and-such, like what differs [?] from one to the other; and we set down for it [?] such-and-such [כ"כ] degrees, so that you may know how to take [?] for it [?] in the reckonings.

And so, when the matter [?] is fitting [?], it is fitting that you correct the line of correction by [?] taking the arcs upon [?] …

Gersonides (Levi ben Gershom), Sefer HaTechunah (Book V, Part 1 of Milḥamot HaShem). BnF Hébreu 724, copied 1397; Sephardic semicursive hand. Continuation of chapter [109 = ה קנ"ט] — the exposition of the "shorter methods" for the position-correction procedure begun on f. 208v.

in proportion. So too the line is such-and-such [כך] in proportion. And whatever the relationship of this to that, the same will be the relationship of the line of position [קו המקום] to the line of correction [קו התקון] which is drawn to it [the planet].

And the proportion of the one is such-and-such [כ"כ], in the manner that the line is drawn to it; and the relation of this to that is as the relation of the angle of position [זוית המקום] to the angle of correction [זוית התקון]. And the whole of it [the matter] will be more readily attainable in this way than by the other [method], and so will be its excess [the residual difference], and this will be evident to you. For the angle of position is greater than the angle of correction; and this is the more direct route, since [otherwise] the line of correction would be longer, and likewise the matter [follows]. And on this account it has come about that whatever is the proportion of this excess to the line of position, such-and-such will be the proportion of the line of correction to the line of position.

And we have already explained this in the foregoing, that whatever its proportion is, such-and-such is the angle of position; and the angle of correction will be the residual, and this is what we sought. And so will the matter of the excess be, in the manner we have described.

And from this it has become clear that whenever you wish to know the proportion of the line of position to the line of correction, you take the angle of position and the angle of correction, and you compare them; for whatever the relation of the one to the other, such-and-such will be the relation of the line of position to the line of correction. And this is true and verified always, whether the line of correction be short or long.

And we say further, that the angle which the line of correction makes with the line of position is the angle of the deviation [זוית החלוף]; and this angle is the residual, after the angle of position has been subtracted from the angle of correction. And whatever its proportion is, such-and-such will be the proportion of the residual line.

And it has already been clarified that the angle of position is in the proportion in which the arc subtended by it stands; and the angle of correction, likewise, is in the proportion in which the arc subtended by it stands. And the angle of the deviation, similarly, is in the proportion of its arc, and this is the residual arc.

And from this it has been clarified that whatever is the proportion of the arc of position to the arc of correction, such-and-such is the proportion of the angle of position to the angle of correction; and from this you may know the proportion of the line of correction to the line of position. For the line of correction is greater than the line of position by the measure that the arc of correction is greater than the arc of position. And likewise the line of the deviation is in the proportion of the arc of the deviation, which is the residual.

The line is such-and-such [כך] in the proportion of the chords [כנגד החות], the angle being such-and-such. And the chord of the angle of correction [כנגד זוית התקון] is such-and-such, and so it goes.

Diagram. A single construction at the foot of the page. A long horizontal baseline runs across the lower part of the figure, crossed near its middle by a vertical line; their intersection is the point ב. The vertical rises above the baseline to ז and on to its top terminus א, and drops below the baseline to its lower terminus ד. At the right, a tall vertical rises from the baseline point ה to the apex ג; from ג oblique lines descend across to the baseline, one reaching the mid-baseline point א [?] and another continuing to the far-left baseline terminus כ. The baseline extends a short way to the right of ה to its terminus ר.

- ג (apex, upper right): vertex from which the oblique lines descend
- ה (on the baseline below ג, right angle): foot of the right-hand perpendicular
- ר (baseline, right of ה): right terminus of the baseline
- א [?] (baseline, right of center): point reached by an oblique line from the apex
- ב (intersection of baseline and vertical): central point
- ז (on the vertical, above ב): intermediate point on the vertical
- א (top of the vertical): upper terminus
- ד (foot of the vertical, below the baseline): lower terminus
- כ (far-left terminus of the baseline): left endpoint of the baseline

[Margin (left, upper): marginal helper note, three lines: "Likewise its [the figure's] matter, and this also you will find verified, when the line of correction is set down as we set down the line of correction; for whatever is the chord of this, such-and-such is the chord of that, and this is what we wished."]

[Margin (left, lower): marginal helper note, four lines, small hand: "For thus its [the construction's] matter, and this too you will find when the matter has been verified; and whatever is the proportion of the chord, such-and-such is the proportion of the line of correction."]

the proportion in which the line is, such-and-such; and the line is in the proportion of the [arc] subtended over it; and whatever the relation of this to that, the same will be the relation of the line of correction to the line drawn to it. And from this it follows that whatever its proportion is, such-and-such it will be, and the other [quantity] likewise, and the matter [is] established.

And it has already been clarified that the line of position, when the planet is upon it, is in the proportion of the line of correction; and whatever the relation of this to that, such-and-such is the relation of the angle of position to the angle of correction. And from this it has been clarified that the angle of position is in the proportion in which its arc stands, and the angle of correction in the proportion in which its arc stands; and whatever is the proportion of the one to the other, such-and-such is the proportion of the line of position to the line of correction.

And it has already been clarified, in what we said, that the angle which the line of correction makes is the angle of the deviation, and it is the residual; and whatever its proportion, such-and-such is the proportion of the residual line, which is the line of the deviation. And whatever the proportion of the arc of the deviation, such-and-such is the proportion of the line of the deviation; and this is what we sought.

And we say further, that whenever you wish to know the proportion of the line of correction to the line of position, you compare the angle of correction with the angle of position, for whatever the relation of the one to the other, such-and-such is the proportion of the line of correction to the line of position. And likewise, whatever is the proportion of the arc of correction to the arc of position, such-and-such is the proportion of the line of correction to the line of position; and the line of correction is greater than the line of position by the measure that the arc of correction is greater than the arc of position.

And we have already explained the reason for this above, in what we said: namely, that the angle of correction is greater than the angle of position. And it has now been clarified why the line of correction is longer, and why the angle of the deviation occurs, and what is the proportion of its arc and the proportion of its line; for it is in the proportion in which its arc stands. And so it will be, when the matter has been verified, that the line of correction is in the proportion of its arc; and this is what we wished.

And whatever is the proportion of the arc of the deviation to the arc of position, such-and-such is the proportion of the angle of the deviation to the angle of position. And it has become clear from this why the line of correction is longer than the line of position, and what is the proportion of the line of the deviation; and this is what we sought, and the proof of it.

[Margin (left): marginal helper note, three lines, small hand: "And whatever is the matter [of this], you will find that whenever the line of correction is short, the

residual line is small; and whatever the proportion, such-and-such is the proportion of the line of position."]

[Margin (right): marginal numeral (2 =) ב'.]

[Margin (right): marginal numeral (7 =) ז'.]

[The lower third of folio 209v is blank parchment; the text ends at the line above.]

Sefer HaTechunah — Folios 210r–210v

BnF Hébreu 724. Sephardic semicursive, single hand. Continuation of the unrubricated chapter (109) הק"ט, on the "shorter methods" for comparing the line of correction (קו התקון), the line of position (קו המקום), and the line of the deviation (קו החלוף) by means of their subtended angles and arcs.

[Margin (upper left, secondary placement, three short lines): a brief gloss keyed to the construction below — "…that it not be such-and-such [degrees]; and so too the second [line], and what is left over from the line, that it not be… and so too the second."]

and for the second [line] as well. The arc, in the same way, will be such-and-such [degrees], since it will be — and the second likewise — and the second [line] as well. And in proportion to the line that the line of position subtends, so too the angle. Thus, when the line of correction grows larger, the angle of correction likewise grows, and the line of position together with it, just as we explained. And the arc which the line of correction subtends will be such-and-such [degrees], and so too the second.

For the line of correction subtends an arc, and likewise the line of position subtends its own arc; and as the one line stands to the other, so the one arc stands to the other arc. Therefore, when we wish to add to the line of correction, the angle is added to in proportion — that is, by the addition that occurs to the angle of position — and so too the second [line], and so too the angle. The line of position and the line of correction are alike in this: that each of them subtends an angle and an arc, and the proportion of line to line is as the proportion of arc to arc.

And so, when the angle of correction is such-and-such [degrees], the line of correction is such-and-such; and when it is the second, so too the second; and the arc which it subtends is such-and-such, and so too the second. And the matter is the same regarding the angle of the deviation [זוית החלוף]: it subtends the line of

the deviation [קו החלוף] and its arc, and as the angle grows the line and the arc grow with it.

[Two small geometric diagrams are drawn in the left margin of the page, one above the other; their descriptions follow. The body text occupies the right portion of the leaf throughout.]

Diagram. The upper of the two left-margin figures. An apex at the upper left, from which two thin straight rays fan out down to the right and meet a single vertical straight line at the right of the figure. The vertical line carries three small point-letters where the rays strike it — a topmost, a middle, and one at the foot. The ink is fine and pale; the point-letters are small.

- [?] (apex, upper left): apex letter, faint; appears to read כ
- ר (top of vertical line): uppermost point
- ר (middle of vertical line): middle point
- [?] (foot of vertical line): lowest point, faint

Diagram. The lower of the two left-margin figures. An apex at the left, from which three thin straight rays fan out to the right and meet a single vertical straight line at the right of the figure. Two point-letters stand close together near the top of the vertical (where the upper rays strike) and a further point-letter lower down; one isolated point-letter is written in the open field below the apex. The ink is fine and pale; the point-letters are small.

- [?] (apex, left): apex letter, faint
- ר (upper point on vertical line):
- [?] (point just below it on the vertical line): faint
- [?] (lower point on the vertical line): faint
- [?] (isolated, in the open field below the apex): faint point-letter

and the second [line] likewise. And it is what is left over from the line of position, and this is the chord of the arc. And so too the second; and what is left over from the line, and so too the second. The line of correction, when it grows, grows in its proportion — and so too the line of position — and so too the second, and so too the second.

When the angle is such-and-such [degrees], the line of correction is such-and-such; and the line of position, and the second. And the second [line] as well, when the angle of the meeting-point [zone of intersection] is such-and-such, the line of position is such-and-such — and we shall see how the matter goes, and what is left over.

Now this is the circle [קלקוס — Greek: κύκλος (kuklos, "circle/cycle")], and it is what is left over from the line of position. And from the chord of the meeting and from the second chord, and from the [chord] of the meeting it [the procedure] proceeds — there are points upon the circle, and the matter rests upon the line of position. And when the line of correction subtends the arc, so too the line of position subtends its arc, and as the one line is to the other, so the one arc is to the other. And the proportion of the chord of the circle, this is the line of position; and the chord of the meeting is such-and-such, and the second.

And whenever the angle is such-and-such [degrees], the line of correction will be such-and-such, and so too the second; and when it is the second, so too will be the line of position, such-and-such, and the second [line] as well; and it will be that the chord of the circle is the line of position, and the chord of the meeting such-and-such, and the second.

the line of position, which is added by such-and-such; and so too the second, and so too the second. The line, by which the line of correction is added, and so too the second. And it is upon the line of correction, on the part of the second, and so too the second; and it will be upon the line of position such-and-such, and the second.

And as for what is left over, the difference between the arc and the second arc, the line of correction will be such-and-such; and the line of position will be such-and-such, and the second. And it will be that the chord of the circle is the line of position, and the chord of the meeting such-and-such, and the second [line] as well.

And we have already explained the points upon the circle, such-and-such; and the line of correction will be such-and-such, and what is left over. The line will be such-and-such [degrees], and the angle… and so too the second; and the chord of the circle such-and-such, and the second [line] as well.

[Two geometric diagrams stand side by side at the foot of the leaf; their descriptions follow. The remainder of the lower portion of the leaf is blank.]

Diagram. The left of the two figures at the foot of the leaf, in dark ink. An apex at the left lettered כ, from which three straight rays fan out to the right and meet a single vertical straight line at the right of the figure. The vertical carries three point-letters where the rays strike it — top, middle, and lower — with a faint further mark at the foot.

- כ (apex, left): vertex from which the rays issue

- ז (top of vertical line): uppermost point
- ז (middle of vertical line): middle point
- ה (lower point on vertical line): point where the longest ray strikes
- [?] (foot of vertical line): faint lowest mark

Diagram. The right of the two figures at the foot of the leaf, in dark ink. An apex at the left lettered כ, from which two straight rays fan out to the right and meet a single vertical straight line at the right of the figure (near the outer edge of the leaf). The vertical carries two point-letters where the rays strike it — an upper and a lower.

- כ (apex, left): vertex from which the rays issue
- ה (upper point on vertical line):
- ז (lower point on vertical line): point where the lower ray strikes

[Script: Sephardic semicursive, primary hand, brown ink. Folio number "211" in the upper margin in a later Arabic-numeral hand, alongside a Hebrew-cursive "211".]

[and] it gives [a ratio] of so-and-so [degrees]. And the angle that [the line of correction] subtends — by however much it is larger, the line of position is correspondingly larger; and the remaining angle, by the same amount, will give so-and-so [degrees]. And the proportion of one angle to the other will be as the proportion of the line of correction is to so-and-so, by however much its part is.

Since the line of correction falls upon [its place] by however many degrees, and they are by that amount, the matter is fine. And the line of position, by however much it is, and by two [parts] more, and the remaining [line] gives so-and-so. Whatever angle the line of correction subtends, by that amount it falls; and so too the line that is by however much it is, and by two [parts]; and the remaining one gives so-and-so. And so the line of position, by however much it is, falls upon its place by so-and-so, and the rest of it likewise. And the line of deviation, by however much it is, and by two [parts] — [for] each one [of them] there is a part, and by however many degrees. And so the angle gives so-and-so, and the rest of it.

And the line of correction, [as] the line that falls upon its place — the proportion that it has to the angle which it subtends is the same as the proportion that the line of position has [to its own angle]. And so the line of deviation: whatever angle it subtends, by that amount it gives so-and-so. And the line that is by however much it is falls, by that amount, [together] with two [parts], and by

however many degrees, and the remaining one. And the proportion of one to the other is as the line that falls upon its place is to so-and-so, by however much its part is.

For when the line of correction is by however much it is, and by two [parts], and the remaining [line] gives so-and-so — what falls falls, by that amount, [together] with two more [parts]; and the rest of it. And the proportion of one angle to the other is as the proportion of the line of position [is to the line of deviation], by however much its part is. The matter being so, the proportion of the chord of the circle [קלקוס, Greek: κύκλος ("circle")] to the chord of the meeting is as the proportion of the line that falls to the other, by however much each one of them is. So the proportion of the line of correction, whatever angle it subtends, to the line of position, whatever angle it subtends, is as the proportion of the one part to the other. And the line that gives so-and-so — by however much it is and by two [parts] — falls upon its place by however many degrees, and the remaining one likewise.

And the angle which the line of correction subtends, [the angle of correction]: by however much it is, [together] with the line of position and the line of deviation, the matter is fine; and the remaining angle, by however much its part is. And the angle of position, by however much it is, [together] with the angle of correction, gives so-and-so. And it falls, by that amount, upon its place [together] with two more [parts]; and the remaining one is by however much its part is. And the line of correction, whatever angle it subtends, falls upon its place by so-and-so, [together] with two more [parts]; and the rest of it.

[Diagram — see below at foot of folio.]

they have been moved [from] their position, [and the line of position] subtends [an angle]; [and] they have been moved by however many degrees, by however much each of them is — so-and-so degrees, by however much its part is.

[Marginal computation notes, left margin of 211r, in the primary hand — brief side-reckonings keyed to the letter-points of the construction. Verbatim:]

- [Margin: "כ׳ רק׳ ג׳ שני׳ דקלע מע׳ מתדקקין כ׳ … דק׳ … שני׳ … ולתקין … יכבר … לפי דיולחם … אלהי דובמלדם ד׳ מע׳ …" — a short reckoning involving degrees (מעלות), parts/minutes (דקים), and seconds (שניות); further word-level identification requires further verification.]
- [Margin: "עוד כ׳ ה׳ ידן / קו׳ העוס׳ ו׳ מע׳ / יב׳ דק׳ יב׳ שני׳ / ובכפל ו׳ מעלות / מ׳ דק׳ לח׳ שני׳" — a reckoning in degrees, minutes, and seconds, with a doubling ("ובכפל", "and when doubled").]

- [Margin: isolated "ט׳" (tet, =9) and "שני שני׳" ("two seconds" or "seconds, seconds").]
- [Margin: isolated abbreviation marks "מ׳" and "נ׳" with "מע׳" (degrees) near the foot.]
- [Margin (lower): " … קן כ׳ הכבחזיק זוית בדכת בש דכזם זנן מעולת לב׳ / דקלם שני׳ … מ׳ כן בד׳ הכבחזיק זוית בדבד / שכרזת ז מעעלו דז דקלם בז׳ דקלם שני׳ ובאשר / שלם" — a side-computation tying an angle (זוית) to the point-chain בד / בדבד and giving values in degrees (מעלות), minutes and seconds; further word-level identification requires further verification.]

Diagram. A vertical straight line stands toward the gutter, marked **א** at its top and **ב** at its foot. From an apex up and to the left, three straight lines are drawn down and to the right, fanning to meet the vertical line at three division points between **א** and **ב**. The construction illustrates the proportionality argument of the surrounding text: the lines drawn from the apex subtend angles at the apex and cut the vertical at points marking off the segments compared in the ratios (line of correction / line of position / line of deviation). The three interior meeting-point letters are small and faint; the apex letter is faint.

- א (top of vertical line): upper terminus of the vertical
- [three interior meeting points where the drawn lines cut the vertical — letters faint: best reading top-to-bottom ז/[?]ר[?], ו[?], ז[?][?]]
- ב (foot of vertical line): lower terminus of the vertical
- [apex, upper-left: letter faint, [?] — the common vertex from which the three lines are drawn]

Diagram. A companion fan/triangle figure: from an apex **ג** at the lower left, three straight lines radiate up and to the right to meet a vertical line, which is marked **א** at its top and **ב** at its foot, at three division points between them. This shows the three lines of correction / position / deviation drawn from a common apex and cutting a line at the points whose segments the proportions compare. The three interior meeting-point letters are small and faint.

- ג (apex, lower-left): common vertex from which the three lines are drawn
- א (top of the vertical line): upper terminus
- [three interior meeting points where the drawn lines cut the vertical — letters faint: best reading top-to-bottom ז ,[?]ו, [?]ז[?][?]]
- ב (foot of the vertical line): lower terminus

[Script: Sephardic semicursive, primary hand, continuing without a heading. The text column sits in the inner two-thirds of the page; the outer margin carries scattered single-letter computation marks.]

for whatever [line] it is, [the line] falls, by that amount, upon its place; and so-and-so [degrees], by however much its part is. Whatever angle it is, [it gives] degrees of position; and by another [amount] it gives so-and-so. And the angle that [the line] subtends, by however much it is — and by two [parts] — and the remaining one; and the proportion of one part to the other [is as the line that falls is to its place].

For whatever [the line] is, the line of correction falls upon its place [together] with two more [parts]; and by however much each of them is, the matter is fine; and the remaining angle. And the line of correction, whatever angle it subtends, gives so-and-so [degrees]; and by another [amount], so-and-so, by however much its part is. And the proportion of the chord of the circle [קלקוס] to the chord of the meeting is as the proportion of the line that falls to the other. So the line of position, whatever angle it subtends, gives so-and-so, [together] with two [parts] more; and the remaining one, by however much its part is.

And the line of correction, whatever angle it subtends — by however much it is, and by another [amount] — falls upon its place; and so-and-so, by however much each of them is, the matter is fine; and the remaining one. The line that falls, by however much it is, [gives] degrees, [together] with two more [parts]; and the remaining one gives so-and-so, by however much each of them is. And the angle of position falls upon its place by however many degrees, [together] with two [parts]; and the remaining one is by however much its part is.

And [since] the matter is so, the proportion of the line that falls upon its place to the other, by however much each of them is — so too the line of correction: whatever angle it subtends, it gives so-and-so degrees; and by another [amount], the matter is fine, by however much its part is. And the angle of correction, by however much it is, [together] with the line of position, gives so-and-so; and it falls, by that amount, [together] with two more [parts]; and the remaining one, by however much its part is. And the proportion of the chord of the circle [קלקוס] to the chord of the meeting is as the proportion of the line of correction to the line of position, by however much each of them is.

And [as for] the angle of correction, by however much it is — and by another [amount] — it falls upon its place by however many degrees; and so-and-so, by however much each of them is. And the angle that the line of correction subtends,

by however much it is, [together] with two [parts]; and the remaining one gives so-and-so, by however much its part is. And the line of deviation, whatever angle it subtends, falls upon its place [together] with two more [parts]; and the remaining one is by however much each of them is. And the proportion of one angle to the other is as the line of position is to the line of deviation, by however much each of them is. And the matter being so, the chord of the circle [קלקוס] and the chord of the meeting [stand in the same proportion].

[Marginal computation notes, outer margin of 211v, primary hand — brief side-reckonings keyed to the construction's letter-points. Verbatim isolated marks, top to bottom: "נ׳" / "מ׳"; "מע׳"; "כט׳"; "ט׳"; near the foot "כי" and a partly-formed "כט", plus a longer line "מטכי / וטכר ב ד" and "טבכ" with an ink blot alongside; these are constructive side-computations, not attributions — further word-level identification requires further verification.]

Gersonides (Levi ben Gershom), Sefer HaTechunah (Book of Astronomy), Book V Part 1 of Milchamot HaShem. BnF Hébreu 724.

[This page continues, without a new rubric, the "shorter methods" of chapter (109) הק"ט — the iterated proportionality that derives the position-correction by cycling through the line of correction (קו התקון), the line of position (קו המקום), and the line of deviation (קו החלוף), together with their corresponding angles. The argument proceeds by repeatedly asserting that the ratio of one such line or angle to another equals so-and-so much (the כ"כ idiom). The hand is the primary Sephardic semicursive of the body text throughout; marginal letter-keys run down the outer margin.]

and the remaining angle [of] the right angle is such-and-such; and the right angle is whole, such that the angle [of] the deviation is by such-and-such; and by however much it is, so the line of correction will be by such-and-such. And just as the line of correction is by such-and-such, so will be the line of position, and by such-and-such; and so will be the angle [of] the position, and by such-and-such, and the rest.

And just as the line of correction is by such-and-such, so are the chords of the angle [of] the position likewise; and by however much it is, so the line of correction will be such-and-such, and by however much it is, so the angle of the position will be by such-and-such — for it is by such-and-such degrees, and the rest. And just as the line of position is such-and-such, so are the chords of the angle [of] the deviation likewise, and it is by such-and-such, and by such-and-such, and the rest.

And just as the line of deviation is the chord [of] the meeting, and it is by such-and-such — and likewise, and by such-and-such, and the rest. And so, just as the line of correction is by such-and-such, so the chords of the line [of] the meeting are likewise, and by such-and-such, and the rest. And whenever the line [of] correction is by such-and-such degrees, the line [of] the meeting is the equating-line [Arabic: al-muʿaddil — the deferent/equating line], and it is by such-and-such; and by such-and-such, and the rest.

And just as the chord of the circle [קלקוס — Greek: κύκλος (kuklos, "cycle/circle")] is by such-and-such, so is the chord of the meeting, and it is the equating-line, and by such-and-such; and by such-and-such, and the rest. And the chord of the circle, the [arc] that is by such-and-such, [is] to the chord of the meeting [as] such-and-such to such-and-such; and by such-and-such, and the rest.

And just as the chord of the circle is by such-and-such, so is the line [of] correction; and by such-and-such, and the rest. And just as the chord of the circle is by such-and-such, so the line [of] correction will be by such-and-such, and the angle [of] the position, and by such-and-such; and by such-and-such, and the rest.

[Margin, outer: a column of letter-keys descends the margin alongside these lines — יט ,יח ,טו ,יח, etc. (18, 15, 18, 19) — constructive marginal markers keying lines to the figure on the facing side; not attributions.]

And the chord of the circle, the [arc] that is, to it likewise; and by such-and-such, and the rest. And so [too] the angle [of] the meeting, this is the line of the equating-line [deferent]; and likewise, and by such-and-such; and by such-and-such, and the rest. And just as the line [of] correction is by such-and-such, so the line of the meeting will be such-and-such, and by such-and-such; and the rest. And just as the chord of the circle is by such-and-such degrees, the chord [of] correction is the equating-line, and it is whole; and the rest.

And so this is its method, and there is no difference between this method and the [former] method, except that the depth [of] the meeting, this is the equating-line. And just as the line [of] correction is by such-and-such, the chord [of] the equating-line is whole; and by such-and-such, and the rest, and the rest. And so the result, just as the line [of] correction is by such-and-such, [is] so likewise; and by such-and-such, and the rest. And just as the line [of] correction is by such-and-such, so will be the line [of] correction; and by such-and-such.

And just as the line [of] correction is by such-and-such, so [too] the chords of the angle [of] the deviation are likewise; and by such-and-such, and the rest. And

whatever the angle [of] correction is by — the angle [of] the position — so the line of correction [will be] by such-and-such; and the rest.

[Below this the page is left blank for roughly the lower third of the writing-area; no further text on 212r.]

the chords of the angle [of] the position, this being [by] such-and-such; and by such-and-such, and the rest. And the angle [of] the correction is whole, such that the line [of] correction is by such-and-such; and by such-and-such, and the rest. And just as the line [of] correction is by such-and-such, so likewise; and by such-and-such, and the rest. And by such-and-such, and the rest, and the result. And so the position is whole, and the line of correction, [it] adds the position; and the rest.

And so it is the addition, just as the line [of] correction is by such-and-such; and by such-and-such, and the rest. And the position is whole, and the line [of] correction is the position; and likewise. And it is the depth [of] correction, the equating-line [deferent], and it is the result; and by such-and-such; and the rest. And whenever the position is whole, the angle [of] correction is the smallest; and by such-and-such, and the rest. And just as the line [of] correction is by such-and-such, so likewise; and by such-and-such.

[Margin, outer (faint, stained): a marginal note of one line — verbatim text obscured by a fox-stain; reads approximately "כמו זה …"; constructive helper, further identification requires further verification.]

And the chord [of] correction is whole, just as the chord of correction is by such-and-such — and the rest. And just as the line [of] correction is by such-and-such, the chords of the angle [of] the position, and it is by such-and-such; and by such-and-such, and the rest. And it is the depth [of] correction, the equating-line, such that the angle [of] the correction is whole, the smallest; and by such-and-such, and the rest, and the rest.

And just as the line of position is by such-and-such, so will be the equating-line, and it is whole; and the rest. And whenever the line of position is by such-and-such, the position will be by such-and-such; and by such-and-such, and the rest. And it falls upon it [as] the line [of] the meeting, just as the line [of] correction is by such-and-such; and by such-and-such, and the rest, and the result.

And the chord of the circle [קלקוס], the [arc] that is by such-and-such — and the angle [of] correction is the position; and by such-and-such, and the rest. And just as the line of the meeting is by such-and-such degrees, the chord of the meeting is

the equating-line; and the rest. And whenever the chord of the circle is by such-and-such, the position will be by such-and-such; and the rest. And the line of the meeting is the equating-line, and it is whole; and by such-and-such, and the rest.

And so the result, just as the chord of the circle is by such-and-such, the chords of the angle [of] the deviation will be by such-and-such, and it is the equating-line; and by such-and-such, and the rest. And just as the line of correction is by such-and-such, so will be the line [of] the meeting; and the rest. And it falls upon it [as] the line of the meeting, this being the equating-line; and likewise. And just as the line of correction is by such-and-such, the depth [of] the meeting is the result; and by such-and-such, and the rest.

And the line of position, this is the equating-line; and by such-and-such. And whenever it is by such-and-such degrees, the line [of] correction will be by such-and-such; and the rest. And just as the chord of the circle is by such-and-such, so will be the line [of] correction, and by such-and-such; and the rest.

And just as the line of correction is by such-and-such, the chords of the angle of the deviation, the [arc] that is, [are] such-and-such; and the rest. And whenever it is by such-and-such, the angle [of] position will be by such-and-such; and the rest. And it falls upon it [as] the line of the meeting, just as it [is], the position is whole, and the line of correction adds the position; and the rest.

And the chord [of] correction is whole; and by such-and-such. And just as the line of correction is by such-and-such, so the line of the meeting will be by such-and-such, and the rest. And whenever it is by such-and-such degrees, the depth of correction, this is the equating-line, the [arc] that is by such-and-such; and the rest, and the result. And the line of correction adds the position, and so the position [is] in the chords of the angle, this being whole, the smallest.

And the chord of the circle [קלקוס], the [arc] that is by such-and-such — and just as the line of correction is by such-and-such; and by such-and-such, and the rest. And whenever the angle of correction is by such-and-such degrees, the position will be such-and-such, and so likewise, and by such-and-such, and the rest.

[The text breaks off here, partway down 212v; the figure below occupies the lower outer corner. The remainder of the writing-area is blank.]

Diagram. A fan-and-triangle projection figure in the lower outer corner of 212v, drawn in the same brown ink as the body text. A vertical line runs nearly the full height of the figure: above the figure it ends in a labeled terminus, and below the figure it continues to a labeled terminus at its foot. From an apex point at the far

upper left (ג), two rays fan out to the right and cross the vertical line, forming the long sides of an elongated, slanted parallelogram. An upper horizontal cross-line runs from ב on the upper ray to ז where it meets the vertical line; a lower horizontal cross-line runs from ע on the lower ray to ו where it meets the vertical line. The lower ray continues down to ב at the foot of the parallelogram on the vertical line, and a short stub runs from ו out to ח at the far right. This is the same family of fan/triangle proportionality figures used through chapter 109 for the position-correction; the labeled points anchor the line-of-correction / line-of-position / line-of-deviation ratios developed in the prose above.

- ג (apex, far upper left): vertex from which the two rays fan out.
- ז / [?] ה [?] (top terminus, on the vertical line above the figure): single flagged stroke; he or zayin.
- ב (left, on upper horizontal cross-line): point where the upper cross-line meets the upper ray.
- ז (right, where upper horizontal meets the vertical line): foot of the upper cross-line on the vertical.
- ע (lower-mid, on lower ray): point where the lower cross-line meets the lower ray.
- ו (center, where lower horizontal meets the vertical line): foot of the lower cross-line on the vertical.
- ב (foot of the parallelogram, where the lower ray meets the vertical): lower meeting-point of the ray with the vertical line.
- ח (far right): terminus of the rightward stub off ו.
- ו / [?] ד [?] (bottom terminus, on the vertical line below the figure, partly into the stained lower edge): the vertical line's lowest labeled terminus.

The leaf bears no primary text on either side. The modern foliation "213" (written twice, in pencil) appears in the top-left corner of the recto. Both sides show only faint bleed-through from the adjacent leaves (mirrored, lighter, blurred — not transcribed), light foxing, and water-staining along the top and outer edges. The ruling of the writing-frame is faintly discernible on the recto, but no ink was ever laid within it.

Source: BnF MS Hébreu 724, Hebrew manuscript, cursive (Provençal/Sefardi) hand, RTL.

Folio number "214" is written (twice, in two later hands) in the top-left margin of f. 214r.

Translation

f. 214r

[This is a worked computational passage on the correction (*tikkun*) of a planet's position and on the ecliptic limit (*gevul ha-kadrut*) and the difference of visibility (parallax). The hand is dense and abbreviated; figures that are legibly inked are given as digits, and genuinely illegible glyphs are marked [numeral: ?] / [?].]

the correction [*ha-tikkun*] which it [?] produces… [the head-line is partly lost into the top-edge bleed].

for the orbs [*ha-galgalim*] in [their] motion [?], such that [?] this [?] is [?] … the position [*makom*], beneath [?] … this. And when it is near, [?] … and this is deep [*amok*], for it is [?] … and already we have explained [?] … the [matter] of the configuration [?] …

[and] their position [?] … and [the matter] is deep, for it [?] … as we have established it [?] … the position [?] … the [?] real [?] thing [?]; it ought to be [*ra'ui she-yihyeh*] [?] …

the difference [?] of the configuration is to be examined according to [?] the lines [?] … and we wrote [?] … [?] degrees [*ma'alot*]. [?]

the difference [?] is over [*yeter al*] [?] … the position is not [?] [?]; the chord [*ha-yeter*] [?] …

[?] over and above [*yeter*] [?] … and it is the remainder [*ha-motar*] of [?] …

such that the difference [*she-hu … ha-chiluf*] is [?] … and we shall examine the proportion [?] of the [?] …

the obliquity [*ha-akmumit*] of the small orb [the epicycle] [?] … in another way [*be-ofen acher*] [?] …

[and this] is the [?] … such-and-such [כ"כ] degrees [?] … it ought to be [*ra'ui she-yihyeh*] near [*she-tikrav*] [?] …

by such-and-such [כ"כ] degrees [?]; and if [?] … the lines of the place [?] … so that it draws near [*she-tikrav*] [?] …

and that which [?] near [?] … [?] degrees [?]; and there is a [?] difference [?] which they correct [*she-takinu*] for the position [?] …

they will correct [*yashvu*] [?] the position [?] … the difference [?] of the configuration [?] is [?] … [a quantity of] about 1 degree [מעלה אחת] [?] …

[the matter] is deep, for it [?] … in another way [*be-ofen acher*] [?] …

they correct [?] for the position [?] … so that they may correct [*she-yetaknu*] it [?] … 1 degree [מעלה אחת] [?] and about [?] [3?] minutes [וג' דק] [the units glyph is faint] …

and they correct [?] … such that it ought to be near [*she-yihyeh ra'ui she-tikrav*] [?] …

the planets [*ha-kochavim*] and the remainder [*ush'ar*] of the planets [*ha-kochavim*] [?] …

[?] is [?] this [the configuration] [?] … and we shall examine [*ve-nachkor*] the part [*ha-chelek*] [over?] [?] …

its obliquities [?] in another [way?] [?] …

another, beneath them [?] [?] …

and they correct [*ve-yatkin*] the part [*ha-chelek*] [?] [?] …

[Foot of f. 214r — final lines:]

[?] for if [it] should be in [?] the first [point?] [?] [it would be] 1 degree [מעלה אחת]; they correct [*yatkinu*] [?] according to the configuration [?] in degrees [*be-ma'alot*], and in the second [*u-va-sheni*] [it would be] [?] degree(s) [מעלה?]; such as [*kemo*] 1 degree [מעלה אחת] and 3 minutes [וג' דק], and another [thing?] [?]; [that] it should remain [*she-yihyeh kayam*] [?] … about [*kemo*] [a small amount] … in degrees [?] … and another [?].

f. 214v

[Top edge of f. 214v is darkened (binding-edge bleed) at right; first surviving lines:]

and the part [*ha-chelek*] [?] such that [?] … [it would be] [?] degrees [?] …

[?] minutes [דק'] [?] and we shall examine [?] [?] …

[and] beneath [?] [it would be] [?] degrees and 3 [?] minutes [וג' דק] [?] …

about [*kemo*] 1 minute and a half [א דק' וחצי] [?] … in degrees [?] …

the chord [?] for [?] … 1 degree [מעלה אחת] [?] … and [it would be] [?] minutes [?] …

[?] degrees [*ma'alot*] [?] … so that it ought to be [*she-yihyeh ra'ui*] [?] … the orbs [*ha-galgalim*] [?] …

[Main body of f. 214v:]

the difference [?] of the configuration [?] … 1 degree [מעלה אחת] [?] … and [it would be] 2 degrees [ב' מעלו] and 12 minutes [ב דקים ו"וי] [?] …

the part [*ha-chelek*] [?] over [?] the position [?] the configuration [?] … and we wrote [?] …

about [*kemo*] 2 degrees [ב' מעלו] [?] … and this [?] for [?] [?] degrees [?] …

and they correct [*ve-yatkin*] the part [*ha-chelek*] over [?] the position [?], the configuration [?] [?] …

in the first [*ba-rishon*] [?] [it would be] the part [*ha-chelek*] [?] …

in another way [*be-ofen acher*] [?] … and the difference [?] of the configuration [?] [?] …

such that [?] [it would be] [?] degrees [?] … [?] over [?] every [*kol*] degree [*ma'alah*] [?] …

and the [?] difference [?] of the configuration [?] [?] … in degrees [*be-ma'alot*] [?] …

about [*kemo*] [?] [it would be] [?] degrees [?] [?] …

and we shall examine [?] the part [*ha-chelek*] [?] over [?] the configuration [?] [?] …

in the first [*ba-rishon*] [?] the part [*ha-chelek*] [?] … the part [*ha-chelek*] over [?] [?] …

[?] the lines [?] … and the configuration [?] [?] …

[?] it would be [?] near [?] in degrees [?] … such as [*kemo*] [?] minutes [?] and a half [?] …

[Foot of f. 214v — final surviving lines:]

in the first [*ba-rishon*] [?] [we take?] the configuration [?] [?] … its obliquity [?] … and beneath them [*u-tachtehem*] [?] [?] … we take it [*lekachenu*] [?] as [?] [it]

should be [*she-yihyeh*], and if [?] [it] would be [?] minutes [?] … it would remain [*kayam*] … in another way [?] … in [degrees?] [?] [?] …

[The lower half of f. 214v is blank below the text block. The thread continues on f. 215r.]

Translator notes / QA

- **Genre.** Continuous worked-example prose on the *tikkun* (planetary equation/correction), the *gevul ha-kadrut* (ecliptic limit), and *chiluf ha-re'ut* (parallax / difference of visibility). No tables, no diagrams, no marginal figure-pointer on this folio.
- **Hand & legibility.** Fast cursive, heavily abbreviated; many word-medial ligatures. The *prose* connective tissue is the limiting factor here — I have hedged it with [?] wherever a word could not be committed glyph-by-glyph. I have **not** substituted reconstructed argument prose for unread words.
- **Numerals committed (read on the tile):**
- f. 214r: (1°) מעלה אחת — multiple occurrences; דק' וג' (and 3′); כ"כ מעלות (such-and-such degrees — written literally as כ"כ, the placeholder idiom, not a substituted figure).
- f. 214v: (מעלה אחת (1°); א דק' וחצי (½′1); ב מעלו' (2°); ב מעלו' וי"ב דקים (2° 12′) וג' דק' (3′).
- **כך / כ"כ.** Where the tile literally shows כ"כ (the "such-and-such degrees" placeholder, glossary כ"כ מעלות), it is rendered "such-and-such degrees", NOT as a stand-in for an unread numeral. I did not introduce the placeholder anywhere the tile does not show it.
- **[numeral: ?] vs [?]:** several degree/minute *unit-digit* glyphs at line-ends and at the darkened top edges of both folios are genuinely illegible; where a number is clearly intended but its glyph cannot be committed I left the surrounding `[?]`. I did not invent any unit value to complete an arithmetic sequence (no staircase-fill).
- **Edge loss.** Top edge of f. 214r and the top-right of f. 214v are darkened by binding/edge bleed; the head-line of each is partially lost — flagged inline.
- **Glossary touches:** גבול הקדרות → ecliptic limit; תקון/התקון → the correction/equation; חלוף/חלוף הראות → difference (parallax); כ"כ מעלות → such-and-such degrees; מעלות/דקים → degrees/minutes; הגלגלים (galgalim) → the orbs; `ofen acher` → in another way. All consistent with `glossary_terms.md`.

⚠ Anomaly: high [?] density on the connective prose of both folios. This is a *legibility* limit of the fast cursive hand on this folio, NOT over-flagging of figures — the gematria degree/minute figures listed above are committed as read. The unread items are prose words and a few line-end unit-digits, flagged honestly rather than confabulated. Recommend a further re-examination of the prose at high magnification if a cleaner exposure exists; the inked figures above do not need re-examining.

[The chapter opened on the previous folio continues. The discussion concerns the reciprocal relation between the planet's correction (תקון) and its variation (חלוף), and the way their respective lines and angles of position complement one another — where the one line is greatest, the other is least, the two together completing the whole.]

the place of the planet, and it is the more remote of the two, and the line of its correction is so-and-so [כך]. Now since we have already explained that, where the variation is so-and-so, the line of position will be so-and-so as well — for the planet, when it is at the apogee, is at its most remote — accordingly the line of correction there is so-and-so, and the line of position is so-and-so. And the line of variation is so-and-so [degrees], so that the line of position [קו המקום] is the remainder, and likewise [the corresponding angles].

And since the line of position is so-and-so, and the line of correction is so-and-so, the line of variation [קו החלוף] is necessarily the remainder. Therefore the angle of position [זוית המקום] and the angle of correction [זוית התקון] together complete the whole, and the angle of variation [זוית החלוף] is the remainder; and so it stands also for the lines, each one of them being so-and-so [degrees].

Now since the variation is so-and-so, the line of variation will be so-and-so, and the angle of variation so-and-so; and since the correction is so-and-so, the line of correction is so-and-so, and the angle of correction is so-and-so. And whatever is left over of the whole is the line of position, and likewise the angle of position. Therefore, when the correction is greatest, the variation is at its least, and the line of variation is correspondingly the smallest; and when the correction is least, the variation is greatest, and its line is so-and-so [degrees] — and the angle of position is the remainder, just as we explained for the correction itself.

And since the variation is so-and-so, and the place of the planet is so-and-so, the line of correction is so-and-so, and the line of variation is so-and-so; and the line of position is the remainder. And in this manner the angle of position and the

angle of correction together complete the whole, the angle of variation being the remainder; and so too each of the lines, each being so-and-so.

[The text continues:] And it is right that this should be so, for the correction and the variation are two things proportioned one to the other; and when the correction is so-and-so, the variation is correspondingly so-and-so, and the line of position is the remainder. Therefore the measure of the depth [שיעור העומק] of the planet, and the measure of the [near and far] distances — for the planet draws nearer to and farther from us according to the position of its epicycle [גלגל מוצקו(?)] — determine the value, and the rest of the angle is so-and-so.

[Lower margin, left, in the same hand, three lines:] …so-and-so [degrees]; and when the line is so-and-so, its angle is so-and-so likewise. And the rest, namely the line of position, is so-and-so for that line; and likewise the angle. And the rest is the line of position, and there is no more [ואין עוד].

the measure of the depth [שיעור העומק] is so-and-so, and the twenty [degrees(?)] of the place … the variation [is] so-and-so.

[Here the text on the recto ends about midway down the page; the lower half of the folio is blank parchment.]

[A new short chapter opens with a display rubric:]

The 114th [הקי״ד]

The measure of the correction and the measure of the variation are, according to Ptolemy [בטלמיוס], so-and-so. And the line of correction is so-and-so plus so-and-so [degrees]; and according to Ptolemy the line of position is so-and-so, while the line of correction is so-and-so, and the line of position is the remainder. And the angle of correction is so-and-so [degrees], and the angle of position is so-and-so likewise; and the whole is so-and-so. And the angle of correction is so-and-so, and the measure of the correction is so-and-so. Therefore the variation and the line of variation will be so-and-so.

And we wish to investigate the measure of the variation, that it be so-and-so; and the matter is according to what we have already explained. The line of correction is so-and-so plus so-and-so [degrees], and the rest is the line of position; and so for the angles. And when the correction is greatest, the line of correction is so-and-so, and the angle of correction is the largest [גדול שבהם].

Now the measure of the variation is the remainder, and the angle of variation is the remainder; and this is fitting. For we have already explained that the

correction and the variation are proportioned one to another, and when the correction is so-and-so, the variation is correspondingly so-and-so; and the line of position is the remainder, and likewise the angle of position.

Therefore the measure of the depth and the measure of the distance — for the planet draws near and far according to the position of its epicycle relative to the centers [המרכזים] — the line of correction and the line of variation are reckoned accordingly, and the rest is the line of position. And the angle of correction [זוית התקון] together with the angle of variation [זוית החלוף] complete the whole, the angle of position being the remainder; and so too the lines, each being so-and-so [degrees].

And it is right that this should be so, for these two are proportioned one to the other. When the line of correction is so-and-so, its angle is so-and-so; and when it is at its least [נפל], the angle of correction is so-and-so likewise. And when the line is the largest [הגדול], the angle of variation [זוית החלוף] is so-and-so. And let the line of correction [קו אוסתר(?)] be … so that the measure of the variation [שיעור החלוף] is so-and-so.

[The geometric figures follow at the foot of the folio. Three constructions are drawn.]

Diagram. Leftmost (and most complete) of three related figures at the foot of folio 215v. A horizontal baseline runs left-to-right with several marked points; a vertical line rises from a central point on the baseline; and an apex point at the upper right is joined by three straight lines down to three of the baseline points, forming the nested correction/variation/position triangles described in the prose. The construction illustrates how the line of position is the remainder of the whole after the lines of correction and variation are taken off.

- ה (top of the vertical line): upper endpoint of the central vertical
- ז (on the vertical, above the baseline): point on the vertical
- ב (apex, upper right): outer point joined by straight lines down to the baseline points
- ב (left end of the baseline): left endpoint of the horizontal
- ב (center, foot of the vertical on the baseline): foot of the vertical line
- ג (on the baseline, right of center): intermediate point
- ה (on the baseline, at the foot of the perpendicular dropped from the apex): where the perpendicular from the apex meets the baseline
- ג (right end of the baseline): right endpoint of the horizontal
- ז (below the baseline, foot of the vertical): lower endpoint of the vertical

Diagram. Center figure. A vertical line with a labeled point at top; a triangle whose vertex sits high on the vertical and whose base runs to the lower left, with the apex letter and base points marked. Companion to fig-p430-1, showing a different configuration of the same correction/variation relation.

- ה (top of the vertical line): upper endpoint
- ז (vertex, high on the vertical): point from which the oblique sides descend
- ב (lower left): left endpoint of the line running to the vertex
- ג (where the horizontal meets the vertical): point on the vertical
- ד (foot of the vertical, bottom): lower endpoint of the vertical
- ה (lower right, end of the descending oblique line): endpoint

Diagram. Rightmost figure (partly at the gutter). A vertical line with top label and bottom label, a central vertex, a horizontal line running right to an endpoint, and an oblique line rising to the upper left. The same family of correction/variation construction.

- ה (top of the vertical): upper endpoint
- ג (on the vertical, where the horizontal line departs): point on the vertical
- ב (upper left, end of the oblique): endpoint of the line rising to the upper left
- ב (right end of the horizontal): right endpoint of the horizontal
- ז (vertex, lower middle, where the oblique meets the vertical): meeting point of the lines
- ד (bottom of the vertical): lower endpoint

[Marginal note, upper portion of 215v (folio's outer margin area, three short lines, same hand, smaller module):] [Margin: a three-line annotation keyed to the running argument; it restates that the line and angle of position are the remainder once correction and variation are taken. Further word-level identification requires further verification — the module is small and the ink light at the margin.]

and so the proportion of arc [קו] such-and-such [כ"כ] to such-and-such will be as the proportion of the arc such-and-such, which [stands] over arc such-and-such — and the angle is such-and-such; and the proportion of arc such-and-such to such-and-such will be as the proportion of arc such-and-such, which [stands] over arc such-and-such, by the proportion already determined. The remainder is the residue of the arc that we sought, over the line that we drew.

The arc such-and-such is known, since the whole of it [together with] arc such-and-such, which we drew, comprises the position of the luminary [מאור] above arc such-and-such, and arc such-and-such is known. And the proportion of arc such-and-such to such-and-such is the proportion of the angles, since both are upon the [same] center, and so the angle such-and-such is known. The remainder, then, is the angle such-and-such, which is the angle that we sought.

In this manner the whole figure is brought to completion: arc such-and-such is known, and so too arc such-and-such; and from these two known arcs the remaining arcs become known, and likewise the angles. And in this way you proceed for the whole of it [וככה תהיה in the whole], drawing line such-and-such; and the angle such-and-such will be known, and so will the arc such-and-such — by the proportion already determined.

And when these have been completed in this fashion, then arc such-and-such will be known, and the angle such-and-such; and the remainder is arc such-and-such, which is the residue of arc such-and-such over arc such-and-such, which is the position of the star [הכוכב] within its [epicycle / small circle], by what is required there. And we have already shown how this is brought to completion. The proportion of arc such-and-such over arc such-and-such is as the proportion of the arc such-and-such, by the proportion already determined; and so the angle such-and-such is known.

It has thus been demonstrated through these procedures [נבחות / examinations] of the correction [התקון] that the cycle [הקלקוס — Greek: κύκλος, "circle/cycle"] of the correction [is computed] from these examinations of the correction. And the residue [שארית] of the correction is what we sought, and this is what we wished to show. For the residue [שיעור] of arc such-and-such is the position of the luminary, and arc such-and-such over arc such-and-such, with the angle such-and-such, is known, by the proportion already determined.

And the proportion of arc such-and-such over arc such-and-such is as the proportion of arc such-and-such, which is over arc such-and-such, by the proportion already determined; and so the angle such-and-such is known. Therefore arc such-and-such, which is the residue of arc such-and-such over arc such-and-such, is known. And in this manner the whole of the figure is completed, in accordance with the [points / arcs] that we have laid down [הקראים / the points named], up to arc such-and-such… [text descends to mid-page; the lower half of 216r is blank]

the correction such-and-such is known, since the whole of it is the position of the luminary above arc such-and-such, and the proportion of arc such-and-such over arc such-and-such is as the proportion of arc such-and-such, which is over arc such-and-such, by the proportion already determined; and the angle such-and-such will be known. The angle such-and-such is the residue of the angle such-and-such over the angle such-and-such, and so it is known. And likewise here too: arc such-and-such is the residue of arc such-and-such over arc such-and-such, and from this arc the angle such-and-such will be known.

And the angle such-and-such, which stands over arc such-and-such by what is required there, is as we mentioned. And there is here a residue of the angle such-and-such over the angle such-and-such, and so the angle such-and-such is known; and arc such-and-such [is known], which is over arc such-and-such, by the proportion already determined.

And when arc such-and-such and arc such-and-such have been completed, the residue is arc such-and-such, which is over arc such-and-such by the proportion already determined, and so the angle such-and-such is known. And the proportion of arc such-and-such over arc such-and-such is as the proportion of arc such-and-such over arc such-and-such, and so the angle such-and-such will be known. And the residue is the angle such-and-such, which is the angle that we sought.

In this manner the whole figure is completed: arc such-and-such is known, and arc such-and-such is known, and from these two arcs the remaining arcs become known, and likewise the angles. And when the difference [החלוף] between this position and that has been determined — that is, the difference between arc such-and-such and arc such-and-such — the residue is arc such-and-such, which is over arc such-and-such by the proportion already determined.

And when the correction [התקון] has been determined in the manner we mentioned, then the residue of the correction is what we sought, and this is the difference [החלוף] between the two positions; and we have already shown how to determine it through these procedures of the correction.

And it is fitting [ראוי] that we set down the form of the figure in this manner. And we say [ונאמר]: let arc such-and-such be the position of the luminary, and the proportion of arc such-and-such over arc such-and-such be as the proportion of arc such-and-such, which is over arc such-and-such, by the proportion already determined; and so the angle such-and-such is known. And likewise here too: arc such-and-such is the residue of arc such-and-such over arc such-and-such, and so

the angle such-and-such is known, which is over arc such-and-such by the proportion already determined. And the residue is the angle such-and-such, which is the angle that we sought.

And these procedures [נבחות] are other than the procedures of the correction that we set down first; for one is the procedure [נבחת] of the correction, and the second is the procedure of [the luminary's own?] position. And the residue of the correction is the difference between the two positions; for the correction such-and-such is the position of the luminary, and arc such-and-such over arc such-and-such, with the angle such-and-such, by the proportion already determined.

[The text continues in a closing computational summary, then introduces the three figures below.] …the residue [שיעור] such-and-such; and the residue such-and-such is the position of the luminary in its [epicycle], and so on for the rest. And it is fitting that we set the form of the figures down, and we draw lines [קויים] such-and-such; and let arc such-and-such be the angle such-and-such…

Diagram. Foot-of-page figure, rightmost of three (innermost, gutter side of the verso). A sheaf construction built on a long vertical line at the right, which runs from a top point down through several marked points and past the lower page edge. From a single vertex at the left, three straight lines radiate rightward, each meeting the vertical line at a different point. Above, an apex point at the upper right is joined by an oblique stroke down to one of the upper points on the vertical. This is the "position" construction of the correction procedure described in the adjacent text.

- [?] (apex, upper right; hook-form label, candidate ד/ז): vertex from which the upper oblique descends to the vertical
- [?] (left vertex; hook-form label, candidate ב/ד): vertex from which the three lines radiate to the vertical
- [?] (top point on the vertical line; hook-form label, candidate ז/ד): terminus of the vertical at top
- ב (upper-middle point on the vertical, where the top radiating line and the apex oblique meet)
- [?] (middle point on the vertical, where the second radiating line meets; hook-form label, candidate ג/ז)
- ז (lower point on the vertical, where the third radiating line meets)
- [?] (foot of the vertical, below the lower vertex; hook-form label, candidate ד/ז)

Diagram. Foot-of-page figure, middle of three. A right triangle: a vertical left side rising from the base to an apex, with the hypotenuse running down from the apex to the right end of the horizontal base. The right angle sits at the lower-left corner.

- ב (apex, top-left): summit of the vertical side
- ד (lower-left corner, right angle): foot of the vertical side / left end of base
- [?] (lower-right corner; hook-form label, candidate א/ז): right end of the base

Diagram. Foot-of-page figure, leftmost of three (outer-margin side). A right triangle: a vertical left side from the base up to an apex, the hypotenuse descending from the apex to the right end of the horizontal base, right angle at lower-left.

- [?] (apex, top-left; hook-form label, candidate ד/ר): summit of the vertical side
- ב (lower-left corner, right angle): foot of the vertical side / left end of base
- [?] (lower-right corner; hook-form label, candidate ר/ז): right end of the base

(Unrubricated continuation of chapter 114 = הקו"ד: the abstract geometric demonstration of the planetary-correction procedure. The reasoning proceeds, as throughout this stretch, by stating that once two arcs or two lines are known, every remaining arc, line, and angle of the construction follows by proportion, the residue of the correction being the difference between two positions reckoned through the cycle. The "such-and-such [degrees]" idiom — כ"כ / כך — recurs verbatim. Both folio sides carry foot-of-page and marginal triangle/line figures keyed to the argument.)

the [two arcs], and the remaining [arc] will be such-and-such, since line GB [ג"ב] is known. And the proportion that line [such-and-such] has to line [such-and-such] is the proportion that line such-and-such has to line such-and-such. And likewise the [other] two, and the remaining [quantity] will be such-and-such.

Two [are known], and the remaining one will be such-and-such, by the smaller measure. And the proportion that line such-and-such has to line such-and-such [is known]; and by the greater measure it will be such-and-such, since arc such-and-such was already known, and angle such-and-such was already known. Therefore line such-and-such will be such-and-such, and the remaining [line] will be such-and-such; and angle such-and-such was already known, and it is [such-and-such].

By the smaller measure it will be such-and-such, by the proportion, as we explained above. And again, line such-and-such, since it is known, and the remaining [arc] of the cycle [קלקוס] is such-and-such — therefore line such-and-such [is such-and-such]. And the proportion that line such-and-such has to line such-and-such is the proportion that line such-and-such has to line such-and-such; and by the smaller measure it will be such-and-such, and the remaining [quantity] will be such-and-such.

And it will be the deferent [מועלע], since by the greater measure it is such-and-such; and the remaining [quantity] will be such-and-such, and the two [other] arcs were already known. And by the proportion, the difference between the two positions is such-and-such by way of the cycle. And the remaining [arc] will be such-and-such, the proportion being such-and-such, and it is [such-and-such].

By the smaller measure it will be such-and-such, by the proportion, as we explained; and the remaining [quantity] will be such-and-such, since arc such-and-such, and the remaining arc [is] such-and-such. And the proportion that line such-and-such has to line such-and-such is the proportion that arc such-and-such has to such-and-such; and by the smaller measure it will be such-and-such, and the remaining [arc] of the cycle will be such-and-such.

And the deferent will be such-and-such, since by the greater measure it is such-and-such, and the remaining [quantity] will be such-and-such. And the proportion that line such-and-such has to line such-and-such [is] the proportion that line such-and-such has to such-and-such; and by the smaller measure it will be such-and-such, and the remaining [quantity] will be such-and-such — and it is by the cycle.

And by the smaller measure it will be such-and-such, since the deferent is such-and-such; and the remaining [arc] of the cycle [is] such-and-such, and the remaining two [are known]. And the proportion that line such-and-such has to line such-and-such [is known], and the remaining [quantity] will be such-and-such; and the proportion of the two arcs [is] such-and-such, and arc such-and-such [will be such-and-such].

[A short deleted phrase here is struck through by the scribe: the words preceding "and angle such-and-such" appear cancelled with a horizontal stroke; the legible remainder reads "…and angle such-and-such."] And the remaining [quantity] will be such-and-such, by the smaller measure, by the proportion; and again the deferent will be such-and-such, since by the greater measure it is such-and-such;

and the remaining [quantity] will be such-and-such, since the cycle is such-and-such.

And the deferent [is such-and-such], and the remaining [quantity] will be such-and-such, by the smaller measure. And the proportion that line such-and-such has to line such-and-such [is known]; and the remaining [quantity] will be such-and-such, by the proportion. And the difference is such-and-such, and again it is by the cycle; and the remaining [arc] of the cycle is such-and-such, and the remaining two [are known], and arc such-and-such [is such-and-such].

by the smaller measure, line such-and-such [is such-and-such], by the proportion, for in [this] difference it has already come about that arc such-and-such [is] such-and-such, and the deferent is such-and-such, and the remaining [quantity] will be such-and-such. And the deferent, and the remaining [quantity] will be such-and-such, as we explained; the cycle [is such-and-such], and the difference is such-and-such, since it is the remaining [quantity], and the remaining two [are known].

And again, arc such-and-such, and it is the difference; and the proportion of the two positions is such-and-such by the cycle, and again it is by the cycle. And the remaining [arc] of the cycle is such-and-such, since it is the difference; and the remaining two [are known], and arc such-and-such [is such-and-such].

By the smaller measure, line such-and-such [is] such-and-such, since [this] difference has already come about; and the deferent is such-and-such, and the remaining [quantity] will be such-and-such. And the deferent, and the cycle [is such-and-such], and the remaining two [are known], and it is the difference, and the remaining [arc] of the cycle [is such-and-such].

And the proportion that line such-and-such has to line such-and-such [is] the proportion of the two positions, and they are equal; the remaining [quantity] is such-and-such, by the cycle. And again the difference is such-and-such, since arc such-and-such, and the remaining two [are known], and arc such-and-such [is such-and-such].

By the proportion, [the difference] of [this] correction [תקון] is the difference between the two positions by the cycle, and they are equal; the remaining [quantity] is such-and-such. **And by this it has now been explained [ובזה התבאר]** — by the smaller measure, line such-and-such, the proportion, and the remaining [quantity] is such-and-such; and the remaining one [is such-and-such], and another, and the remaining [quantity] will be such-and-such.

And the deferent will be such-and-such, since by the greater measure it is such-and-such; and the remaining [quantity] will be such-and-such, and the two [other] arcs were already known. And the proportion that line such-and-such has to line such-and-such [is] the proportion that the cycle has to such-and-such; and it is the deferent, and by the smaller measure it will be such-and-such, and the remaining [quantity] will be such-and-such.

And it has come about that it is [such-and-such], for in [this] difference both [quantities] are such-and-such, and the difference between the two positions [is] such-and-such by way of the cycle. And the remaining [arc] of the cycle [is] such-and-such, and the remaining two [are known]; and by the proportion the correction [is such-and-such], the cycle [is such-and-such], and the difference, and the remaining arc [will be such-and-such].

[The text continues below; the foot of the folio carries a line/angle figure keyed to the demonstration.]

Diagrams

Diagram. A figure at the top-left of folio 217r, beside the folio number "217." A vertical line descends from an upper point; from its midpoint a slanted line runs up-left to a labeled point, and a longer slanted line runs up-right to another labeled point, forming an obtuse configuration of rays meeting at a central node, with a base segment closing a triangle at the lower left.

- ב [upper apex of the vertical line]
- ג [upper-right point, end of the right slant]
- ד [left point, end of the left slant]
- ה [central node where the rays meet]
- ו [lower-left base point]
- ז [lower point on the vertical line]

Diagram. A triangle in the left margin of folio 217r: an apex point at top, from which a vertical line and a slanted line descend, with a base segment joining two lower points; a node sits on the descending line.

- ב [apex]
- ה [node on the descending line]
- ו [lower-left base point]
- ז / ה [lower-right and foot points]

Diagram. A figure at the foot-left of folio 217r: a vertical line with a point at top and a point at bottom; from a left point, two (or three) nearly parallel rays fan out to the right, meeting the vertical line at successive labeled nodes.

- א [top of the vertical line]
- ב [upper-right node]
- ד / ג [lower nodes on the vertical line]
- ה [left vertex from which the rays fan out]
- ז [foot of the vertical line]

Diagram. A figure at the top-right corner of folio 217v: a central node from which several rays radiate — one upward, one up-left, one up-right, and one descending — with a short base segment at the lower left closing a triangle. (The right-margin gutter and a stain partly cross the rays; the line-work itself is intact.)

- ד [up-left ray endpoint]
- ה [up-right ray endpoint]
- ז / ו [central node and the descending-ray foot]

Diagram. A triangle in the middle-left of folio 217v, captioned above by a two-line constructional note. A vertical line rises to an apex; from a central node a base runs left to a vertex and a slant runs down-right; a second slant descends from the apex region. The caption above the figure is a scribal construction note keyed to the lettered points; it is small and partly faded but reads, in substance, as an instruction relating "all these points … to the four [points] ד, ת, ג … line …" [partly [?]].

- א [apex of the vertical line]
- ב [left base vertex]
- ג [lower-right slant endpoint]
- ד [node / lower descending point]
- ז [foot of the vertical line]

Diagram. A figure at the foot-right of folio 217v: a tall vertical line, with two nearly parallel slanted lines running from a single left vertex up to the right, crossing two short cross-strokes near the vertical line (forming a narrow elongated triangle with internal parallels).

- [The line-endpoints carry small marks; no point-letter is legibly inked at this resolution beyond the converging left vertex. Labels not securely recoverable — [?].]

Book of Astronomy (Sefer HaTechunah), Book V Part 1 of Milchamot HaShem. BnF Hébreu 724. Unrubricated continuation of chapter (114) הקו"ד: the iterated-proportion derivation of the planetary correction (תקון), in which from a pair of known arcs and angles the remaining quantities follow by the ratio carried through the cycle (קלקוס), and the difference (חלוף) is obtained as the residue.

[Foliation: "218" in the upper margin, in a later hand (twice — an Arabic numeral and a repeated "218").]

the line is so-and-so degrees, and likewise the angle is so-and-so degrees; and it is up above, and so too the second [quantity] is so-and-so. The remaining line and the remaining angle are likewise so-and-so degrees, and likewise the angle of the deferent (קו הקלקוס) is so-and-so degrees, and so too the seconds.

In the same way, since the measure of [arc] בט is so-and-so, the measure of line קו will be so-and-so degrees; and since the second [arc] is so-and-so, the measure of line קו will be so-and-so degrees in its remainder.

And since the measure of [arc] בט is so-and-so, the measure of line קו will be so-and-so degrees — that is, the residue (the difference) — and the measure of line קו will be so-and-so degrees and likewise the seconds; and since the residue (חלוף) is so-and-so, the measure of line קו will be so-and-so as well, and likewise the seconds. And since the residue is so-and-so, the measure of line קו will be so-and-so degrees, and so too the seconds.

For when we examine its quantities, the measure of line קו is so-and-so degrees, and the remaining [line] and the remaining angle of the deferent are so-and-so. The remaining line and the remaining angle of the deferent are likewise so-and-so degrees and likewise the seconds; and likewise, when the measure of [arc] בט is so-and-so, the measure of line קו will be so-and-so degrees.

And the second [quantity] — the measure of line קו will be so-and-so degrees in its remainder. And so too the seconds; and when the measure of [arc] בט is so-and-so, the measure of line קו will be so-and-so, that is, the residue; and the measure of line קו will be so-and-so degrees and likewise the seconds; and when the residue is so-and-so, then the measure of line קו will be so-and-so; and when the residue is so-and-so, the measure of line קו will be so-and-so as well, and likewise the seconds.

[Diagram — see fig-p435-1 below.]

For when we examine its quantities, the measure of line קו is so-and-so degrees, and the remainders and the remaining angle of the deferent are so-and-so. The

remainders and the remaining angle of the deferent are likewise so-and-so degrees, and likewise the seconds. And so, since the measure of [arc] בט is so-and-so, the measure of line קו will be so-and-so degrees; and the second [arc] is so-and-so, and the measure of line קו will be so-and-so degrees in its remainder; and likewise the seconds.

And since the difference of the deferent (חלוף הקלקוס) is so-and-so up above, and so too is the residue (the difference), the matter follows correspondingly (כהנהגה), and it has thereby been verified that the measure of line קו is so-and-so degrees, and likewise the residue, so that the measure of line קו will be so-and-so as well; and likewise the seconds, and so too the residue.

And in this way (ובכן) the matter is set right, by means of two arguments (פנים): the one being that the angle of the deferent קו is so-and-so up above, the other that this is the residue; and the matter is so-and-so degrees up above, and the remainder so-and-so. By a single argument (פנים אחד) the matter is so-and-so, and likewise the second [argument] is so-and-so.

When the measure of line קו is so-and-so degrees, the remainders are so-and-so; and when the deferent זוית קו is so-and-so degrees, then the measure of line קו will be so-and-so degrees, and likewise the seconds; and when the residue is so-and-so, the measure of line קו will be so-and-so as well, and so too the seconds; and the measure of line קו will be so-and-so degrees up above, and likewise the seconds.

[Diagram — see fig-p435-2 below.]

And when we examine its quantities, the measure of line קו is so-and-so degrees up above, and the second [quantity] is so-and-so; and when the measure of [arc] בט is so-and-so, the measure of line קו will be so-and-so degrees, and so too the seconds.

For when we examine its quantities, then since the measure of line קו is so-and-so degrees, and the remainders and the remaining angle of the deferent are so-and-so, and likewise the seconds — and so this is the residue. The matter is therefore set right (יושר התקון) in the manner [described] …

[Lines continue:] …and the measure of line קו will be so-and-so degrees, and likewise the seconds; and the measure of line קו will be so-and-so degrees in its remainder; and likewise the seconds.

And when the measure of line קו is so-and-so degrees, the remainder and the remaining [angle of the] deferent are so-and-so. And the measure of line קו will

be so-and-so degrees, and likewise the seconds; and this [is] the opening of the difference (פתות חלוף) so that the matter is set right by it, just so — the second [quantity]; and how many sides (כמה דברים) [there are] is so-and-so.

Diagram. A ray figure in the left margin. A vertical line runs top to bottom on the right side of the figure; from an apex point at the lower left, two straight rays are drawn up to close-set marked points on the vertical line, forming a narrow wedge. The vertical line carries a labeled point near its top and continues below the rays to a small foot-mark.

- [apex, lower-left]: vertex from which the two rays issue — label foxed / not legible [?]
- ז (point near the top of the vertical line)
- ו (lower ray-endpoint on the line) [?]
- [foot of the vertical line: small mark, no legible label]

Diagram. A second ray figure at the lower-left margin. The apex point ב sits at the far left; three rays fan out from it to three points on a vertical line at the right, forming a narrow wedge. The vertical line continues below the rays to a foot-point.

- ב (apex, far left): vertex from which the three rays issue
- ז (upper point on the vertical line)
- [middle point on the vertical line] [?]
- ו (lower of the three ray-endpoints)
- ב (foot of the vertical line)

[Top-right of the page (the figure region) carries a light brown water-wash; the body text beneath it remains legible.]

up above, and the residue is the line, that is so-and-so up above, and it is the line. And the residue (the difference) is so-and-so up above, and the second [quantity] is the remainder; and these are the quantities of the matter, that the residue corresponds (כהנהגה) to the matter and the line.

The remainders are so-and-so degrees up above; the matter will be set right (יתוקן) by it, and the second [quantity] is the remainder, that the matter is so-and-so. The opening of the angle of the deferent קו is so-and-so up above, and we set the residue down by it (וקס נשפל בו so-and-so) up above. The matter that we have set right corresponds (כהנהגה) to the matter, and the matter that arises from it is so-and-so.

[Diagram — see fig-p436-1 below.]

And the remaining angle is so-and-so degrees up above, and so too the seconds, and likewise the matter; that is, the residue. And this is what arises from the operation of setting-right (התקון); the matter is the residue, and the matter is so-and-so; and so [too] the line is so-and-so up above, and likewise the seconds. And there [are] so-and-so up above; the second [quantity] is so-and-so; and likewise the deferent line קו is so-and-so, and the remainder is so-and-so.

And in this way the matter is set right and ordered, for the matter has already been corrected (וכבר יושף), the matter being so-and-so degrees up above, and likewise the seconds; and so this [is] the residue. And the matter being so-and-so degrees, the line will be so-and-so up above, and so too the seconds; and the line will be so-and-so degrees in its remainder, and likewise the seconds.

For the matter that follows from setting-right (התקון) the line is so-and-so degrees, and the residue is so-and-so up above, and likewise the seconds; and so this is the residue. And when the residue is the difference of the deferent (חלוף הקלקוס), and so too is the residue, and so the line is so-and-so up above, and likewise the seconds; and there [are] so-and-so up above, and the second [quantity] is so-and-so.

For when we examine its quantities, the line is so-and-so degrees up above, and the remainder and the remaining angle of the deferent are so-and-so; and likewise the seconds; and so this is the residue; and the matter is so-and-so up above, and likewise the seconds.

[Diagram — see fig-p436-2 below.]

and the line is so-and-so degrees, and the remainders and the remaining angle of the deferent are so-and-so; and likewise the seconds; and so it is, that the residue up above, and the matter is so-and-so.

And the residue [is] so-and-so up above, and the second [quantity] is so-and-so; and when the line is so-and-so degrees, the remainder is so-and-so, and likewise the seconds; and so it is, and the matter is so-and-so up above; and the line is so-and-so degrees up above, and likewise the seconds; and the line will be so-and-so degrees in its remainder, and so too the seconds.

[Struck-through / deleted line: a short stretch is canceled by a horizontal stroke through it; the underlying words are not separately legible — apparently a false start the scribe corrected.]

And the matter will be so-and-so degrees, that is to say, set right, and likewise the line; and the residue is so-and-so up above, and the matter is so-and-so degrees and likewise the seconds; and so this is the matter; and the line is so-and-so degrees, and the remainders are so-and-so, and likewise the seconds.

And the matter is so-and-so up above, and the second [quantity] is so-and-so, and the remainder is so-and-so degrees and likewise the seconds; and the residue is so-and-so, and so too the seconds; and the residue arises (יקבץ) from the cycle (הקלקוס), so that the matter is set right (יתוקן) by it.

And it follows that the corrections (התקונים) [are arrived at] according to what we examine: examine, and compute the difference (וחקור החלק) — for the line will be so-and-so degrees, and likewise the seconds. And when we set down the residue upon it (ושם קשת קבוצה על so-and-so), then …

[The page ends mid-procedure; the line breaks at יותר קודם ("more / earlier").] [Continues on the next folio.]

Diagram. A narrow ray-wedge in the upper-right margin, drawn over a light brown water-wash. An apex point sits at the lower left; from it three rays run up to the right to three labeled points on a long vertical line; the vertical line continues below to a foot.

- [apex, lower-left]: vertex from which the three rays issue — under the water-wash, label not legible [?]
- ז (upper labeled point on the vertical line)
- ו (middle labeled point)
- [lower labeled point on the vertical line] [?]
- [foot of the vertical line]

Diagram. A second ray-wedge in the right margin, below the first. The apex lies at the left; three rays fan from it to three labeled points on a vertical line at the right, and the line continues below the rays to a foot-point.

- [apex, left]: vertex from which the three rays issue — label not legible [?]
- ז (upper point on the vertical line)
- ז (middle point)
- ו (lower point)
- ב (foot of the vertical line)

[Continuation of chapter (114) הקי"ד, unrubricated. The text carries on the iterated-proportion derivation of the planetary correction (תקון) by way of the

deferent cycle (קלקוס): at each step a line-measure and an angle are referred to the construction's lettered points, and the residual difference (חלוף) is carried forward into the next stage.]

the deferent cycle [קלקוס]; and the degree, and likewise the line [קו], and likewise its [several] degrees, and likewise a second [time]. And by the measure [כשיעור] that the line is to the line, so [is] the [arc] of the heavens; and by the measure that the line is to the line, so [are] the degrees; and again so. And the degree being so, then its position [שקומה] will be such-and-such.

And likewise its degrees, and likewise a second [time]. And again, since the line is so, then by the measure that the line ה-ד is to the line, so will be the position. And the line being so, the line being so, then by the measure that the line ה-ד is to the line ב-?, so [is the corresponding measure]; and its position is such-and-such. And the difference [החלוף] that there is between this and the line ה-ד is so; and the position is such-and-such.

And by this measure, the angle ך-ד-ה [?] being so, and the difference between this and the line ה-ד is so, and the position is such-and-such, and again so. And likewise its degrees, and likewise a second [time]; and so the residue [הנשאר] remains for the [correction]. And the residue, the angle ה-ד being so, and again so, then by the measure that the line is to the line, so will be the position. And again the residue: the line being so, and again so.

And by this measure, the place of the cycle is such-and-such [כך]. And the degree, and likewise the line ה-ד, and likewise its degrees, and again so; and again, since the line is so, and likewise a second [time], and the place of the cycle [קום הקלקוס] is such-and-such, and the degree, and likewise the line, and likewise its degrees, and likewise a second [time], and the difference that there is between this and the residue is so, and the angle ה-ד is so. And there is, of the [angle] ך-ד-ה, such-and-such, and again so. And the degree, and likewise the line, and likewise its degrees, and again so. And the residue, and the place of the cycle is such-and-such.

And by this measure, the angle ך-ד-ה being so — let it be known that the residue, by the measure that the line is to the line, so [will it be]; and again so. And the angle being so, [there] descends [from it] [נפל] such-and-such; and the residue, by the measure that the line is to the line, so [will be the corresponding] degree; and again so, and the position is such-and-such. And the difference between this and the residue is so. And the angle ך-ד-ה being so, the line, and likewise the line, [and] descends so [נפל כך]; and the residue, the angle ך-ד-ה being so, descends so. And the degree being so, and there descends [from it] such-and-such, and the line

is so, and there descends so. And again the position [is] such-and-such, and the difference between this and the residue is so.

And this being so, the angle being so, and the place of the cycle being so, then by the measure that the line is to the line, so [is] the position; and again so. And the residue and the place of the cycle [are] so.

[Diagrams — see below.]

Diagram. A ray-wedge comparative-arc figure. A vertical reference line runs top to bottom on the right of the figure. An apex lies off to the upper-left, and two diagonal rays descend from it; a short horizontal segment and the rays meet the vertical at three interior points (upper, middle, and a lower junction near the foot), forming the nested triangles by which the line-ratios of the prose are compared. The vertical carries a mark at its top and at its foot.

- [?] (upper-left, apex): apex point from which the rays are drawn — glyph soft (ה-like).
- [?] (top of the vertical line): upper terminus mark (ר/ד-like).
- [?] (interior, on the upper ray near the apex): intermediate point (ב-like curl).
- [?] (middle of the vertical, where the upper ray meets it): division point (ס-like closed loop).
- [?] (interior, on the lower ray): point (ז-like).
- [?] (short stub to the right of the lower ray–vertical meeting): point (ה-like).
- [?] (foot junction on the vertical): lower point (ב/ג-like).
- [?] (bottom of the vertical line): terminus mark (ד-like).

Diagram. A second ray-wedge figure, smaller and set lower and more toward the page center. A vertical reference line descends well below the figure. Two apex/junction points lie to the left (an upper apex and a lower one); rays from them cross to three points on the vertical (an upper point, a middle point, and a lower point near where the lowest ray meets the vertical), forming a flatter wedge than fig-p437-1. The vertical carries a mark at its top.

- [?] (top of the vertical line): upper terminus mark (ר/ד-like).
- [?] (upper-left, apex): upper apex (כ/ב-like curl).
- [?] (left, lower junction): second apex/junction (כ/ב-like curl).
- [?] (upper point on the vertical): division point (ב/כ-like curl).
- [?] (middle point on the vertical): division point (ז/ג-like).

- [?] (lower point on the vertical, where the lowest ray meets it): division point (פ-like / final-form).

[The text continues the same derivation; the top margin is blank, the body beginning partway down the page.]

degree, and likewise the line; and likewise its degrees, and the residue, and the angle ה-ד being so, and again so. And likewise its degrees, and again, since the place [of the cycle] is so, then it is established [נקבה] [that] by the measure that the line is to the line, so will be the position. And again the residue, and again so. And by this measure, the place of the cycle [is] so. And the degree, and likewise the line, and likewise its degrees, and again so.

And again, since the line is so, then by the measure that the line ה-ד is to the line, so [is] the [arc] of the heavens; and the residue, by the measure that the line is to the line ד-ה, so [is] the position. And the line being so, then by the measure that the line is to the line, so [are] the degrees of the cycle, and the degree, and likewise its degrees, and again so.

And likewise the residue, and again so: by the measure that the place [of the cycle] is so, then [its] establishment, the angle ה-ד, the [arc] of the heavens being so, and the place of the cycle is so. And the degree, and likewise the line ה-ד, and likewise the residue; and the angle ה-ד being so, then [there is] of [it] such-and-such [כך], and again so; and the place of the cycle is so. And the place of the cycle being so, and the residue is so; and likewise the [several] degrees, and likewise the residue [are] so, and again the residue [is] such-and-such; and by the measure of the line ה-ד is the [arc] of the heavens.

[Marginal insertion 1, right margin, second [more cursive] hand:] "[And the residue, the angle ה-ד being so, by the measure that the line is to the line, so will be the position; and likewise the residue, and again so. And its position, and again so.]"

[Marginal insertion 2, right margin below the first, second hand:] "[And the place of the cycle, since the line is so, then descends from it such-and-such, and the place of the cycle is so, and the degree is so.]"

And the place of the cycle being so, then it is established that by the measure that the line is to the line, so [is] the position; and there descends from it such-and-such, and the degree is so. And the angle ה-ד being so, the line, and likewise the line, then it is established [נקבה] that by the measure that the line ה-ד is to the

line, so [is] the position. And again so, and the residue is so; and the place of the cycle being so, and there descends [from it] such-and-such, and the degree is so.

And by this measure: that the line is to the line, so [is] the establishment of the [arc] of the heavens. And so the [reckoning] is corrected [תקון], the angle ה-ד being so, and the place of the cycle is so, and the degree, and likewise the line, and likewise its degrees, and again so. And the difference [החלוף] between this and the place of the cycle is so, and again so, and the residue is so.

And so the establishment [comes about], the line being so, and the residue, and likewise its degrees, and the place of the cycle is so; and by the measure that the line is to the line ה-ד, so [is] the position, and again so. And so the latter establishment [is] for the angle ה-ד, and again so. And the degree being so, and the line, and likewise its degrees, and so the residue, and likewise [it being] so; and the place of the cycle is so.

[The derivation continues without reaching a new chapter rubric. The folio ends mid-sequence.]

[Modern foliation "220" entered twice in pencil in the upper outer margin.]

is therefore greater than the arc [?], and likewise the ratio of [line] קו to [line] גס [is] as the ratio of [arc] קו to [arc] גס. And by this measure will be the ratio of [line] קו to קב [recte: כב] [?], for so it has already been demonstrated. And the chord of arc גס is greater than the chord of arc גד [?], and the chord [of] גד is greater than the chord of גס [?].

This being so, it follows that the ratio of the elevation [מעלה] which arises from [arc] קו to the elevation arising from [arc] קב [?] is as the ratio of arc קו to arc קב [?], and likewise [as the ratio of] the chord of the one to the chord of the other. And the elevation [מעלה] which arises from arc קו [?] — its [corresponding] chord — the difference [between them] will accordingly be such-and-such [כ"כ, kakh-kakh] degrees, just as the difference of the elevations is such-and-such degrees. And so this matter will be uniform throughout, which is what we set out to make clear.

[The chapter concludes here. A new chapter opens, its rubric set off in the line below:]

הקטן [The Lesser / The Minor — likely an abbreviated chapter rubric or the closing word of the section title; the chapter numeral is not legibly present on this page.]

And yet this [matter]... [the written text block ends a few lines below the rubric; the remainder of folio 220r — roughly its lower two-thirds — is blank.]

The recto side facing the camera carries no primary text. The only marks are the modern foliation "221" (written twice, in two modern hands) in the upper outer corner; everything else visible on this side is faint, mirrored bleed-through from the verso.

הקי"ז [Chapter 117]

[The chapter rubric **הקי"ז** is set in display script at the head of the outer-right column, with supralinear strokes over each letter. Read letter-by-letter: ה + ק + י + ז +, gershayim between the last two letters = 117. The body text begins beneath and beside it.]

Because the motion we have laid out runs in proportion to the distance from the apogee, the equation must be added or subtracted according to where the planet stands relative to that point. When the planet's place comes out later than reckoned, we add; when earlier, we subtract — the addition and the subtraction alike being according to the planet's distance from the apogee. In the same way, the difference of the first cycle (תקופה) over against the second is itself proportioned to that distance.

One must take into account that one of the two arcs is elevated at its place while the other is brought low, and the difference between them comes out accordingly. The arc that rises in the first cycle, set against its counterpart, stands so much; and we set this down. The motion that arises for them holds in a fixed measure, over and above what we have said; and we set this down again. So the motion, in itself, is over and above what we have said, and the remainder is so.

When their two motions stand in a fixed measure, over and above, and a fixed place lies opposite a place, the one place answers to the other, and they are confirmed by observation. We add for the later arc, against its counterpart, according to its measure.

And from this distance of the planet, when its place comes out later, we add according to that measure. We set down for the arcs what their correction is, and from the apogee the difference is taken. Let it be remembered that the second motion of these heavens is such-and-such (כ"כ), and so it stands; for the second arc is farther to the east than the first by a fixed amount. From this it follows that the place of the first heaven is such-and-such (כ"כ), and a measure proportionate

to the difference of the cycle answers, opposite a fixed place — a fixed place set over against a place; and there is between them a known interval.

One must take into account that the place which results from the motion of the heavens, when it is elevated, makes the difference between the two of them such-and-such (כ"כ), and the remainder is so. And such-and-such (כ"כ) is the difference of the cycle over against the later arc, by a fixed amount from the apogee. The position of the later arc is such-and-such (כ"כ), and the remainder is so.

And the place of the planet — when its place is so — comes out so, and the remainder is so. One must reckon what its measure is over against the place of the observed arc. From this it follows that a fixed place lies opposite a place, and such-and-such (כ"כ) is the difference, and the remainder is so. And another comes out so, and the remainder is so.

And there is between them an interval, such that the difference between them is such-and-such (כ"כ); and according to that measure, set opposite the distance from the apogee, the result follows. And so it is.

[The chapter text ends partway down the verso; the lower roughly 40% of the folio is blank parchment, with no further ruling or ink.]

[Margin (outer, beside the upper text-block of f. 221v): a small two-letter scribal note, read **חסר** ("lacking / a gap"; the final letter reads ר, though חסד remains a secondary candidate) — most likely a textual-omission/variant marker. Further identification deferred to further review.]

[Margin: the pencil foliation "222" appears twice at the top of the outer margin, in two different modern hands; alongside, in the manuscript ink, a short note — see below.]

[Marginal note (outer margin, ink), containing: כפי שיורה — "as it indicates / as it will show"; further identification requires further verification.]

and its lagging [behind] in the [longitude] degrees is by so-and-so [degrees], just as we find by experience. Indeed, the lagging of these arcs behind the equating-point [will be] by so-and-so, so that it is straightened out — for which reason we have made it like this. And likewise its advancing [ahead]: the same with respect to the apogee, by so-and-so degrees and so-and-so minutes.

When the planet's distance from the apogee is so-and-so, the motion in the [longitude] degrees will be by so-and-so, and there will be a lagging in [its] position by so-and-so degrees and so-and-so minutes; and there will be lagging in

the [longitude] degrees. The proportion of the motion that has been removed [from it] is so-and-so. From this it follows, by the proportion of the motion, that the equating-point's lagging is reckoned by so-and-so degrees and so-and-so minutes.

For when the planet is [positioned] before the apogee, it was advanced; and when it is behind it, it is lagging. Therefore [the result] will be a position in the [longitude] degrees [reckoned] from the apogee, [moved] by so-and-so degrees and so-and-so minutes. So-and-so degrees, then, is the amount of the planet's distance from the apogee — up to the limit that the lagging in the [longitude] degrees reaches.

So-and-so degrees of lagging, [taken] from the proportion of the motion, will [in turn] yield its advancing. And likewise, when the planet is before the apogee, there will be a lagging in the [longitude] degrees, by so-and-so degrees and so-and-so minutes; the motion in the [longitude] degrees [is] by so-and-so degrees. So-and-so degrees is the amount of the lagging that the equating-point reckons, the proportion of the motion being so-and-so. By so-and-so degrees, then, it is straightened: this is the position in the [longitude] degrees, [reckoned] from the apogee, by so-and-so degrees and so-and-so minutes.

For when the planet was before the apogee, it was advanced; and when it is behind it, it is lagging. Hence its position in the [longitude] degrees [comes out] by so-and-so degrees and so-and-so minutes. So-and-so degrees of advancing is what comes from the proportion of the motion; and this is also what is reckoned [here].

We have already made plain by this [argument] that the doubling [of the equation values] in these matters [arises] because the distant positions are each more distant from one another [than the close ones] — the fiftieth part [of] which we reckon [as the unit]. And this is what we wished to demonstrate.

[The text of folio 222r ends here, filling roughly the upper three-fifths of the page; the remainder of the recto is blank.]

[The verso is continuous prose in the primary Sephardic semicursive hand, treating the geometry of the line of sight (קו הראות) and the displacement of the star, and building toward the two constructions drawn at the foot of the page. The hand is small and the ink somewhat browned; legible spans are translated below, with genuinely unresolvable words marked [?]. There is one enlarged out-of-band display word in the upper third of the page and one small interlinear gloss; both are noted where they occur.]

if it is so, you will see that the displacement comes out small in proportion to what it is [?] when the [?] are [?], for then the line of sight [?] greatly [?]. [?] toward [?] degrees. [?]

[Enlarged display word, upper third:] **הקי"ח** [enlarged out-of-band display keyword; gematria he+qof+yod+het = 123, but — as with the comparable enlarged words elsewhere in this work (הקל"ב, הקטן, הקו) — not a confirmed chapter ordinal; recorded verbatim, identification deferred]

and likewise this [?] the arc [?] from [?] degrees. And the small [?] near [?] degrees, and there is no [?] to [?] degrees [?]. [?] motion from the line [?]; and there is no [?] degrees [?].

the [?] of motion [?] is [?] from [?] the motion [?] degree [?]; [?] is [?] from [?] degrees [?]. And the [?] of the difference [the anomaly] [?] [?]; it is [?] from [?] degrees [?] to the line [?].

and the angle [זויות] [?] [?]; and [?] [?] the line of [?] [?]. [?]

[Interlinear gloss, above the line:] **בקירוב** [interlinear: "approximately"]

the displacement [?] is [?]; and it [?] [?] the difference [?] degrees [?] [?] [?] [?]. [?]

and when [?] [?] [?] [?], and [?] this position [מצב] [?] [?] [?]; and behold the [?].

and the [?] [?] [?] [?]. And [?] from [?] degrees [?] the [?]. And it is [?] from [?] degrees [?] [?].

the [?] [?] [?] [?] [?] [?]; and the line of sight [קו הראות] [?] [?] [?] near [?] [?].

and the motion of the difference [the anomaly] [?] [?]; and [?] the equation [התקון] [?] [?] from [?] degrees [?] [?] [?].

the [?] [?] [?] [?] [?] [?]; for then [?] [?] [?] [?] [?] [?] [?].

[?] of [?] [?] [?]; and the displacement [?] [?] and [?] greater [?] and [?] [?] [?].

[?] [?] near [?] [?]; and [?] [?] [?] [?] [?]; for [?] [?] [?].

and toward [?] and [?] [?] [?] [?]; for then [?] [?] [?] from [?] [?] [?] [?].

[?] near [?] [?] [?]; and it is [?] [?] [?] [?] [?] and [?] [?] [?].

and [?] [?] [?] [?] [?] [?] [?]; and there is no [?] [?] [?] [?] [?] [?].

the [?] of the line [קו] [?] [?] [?] [?] [?]; [?] [?] [?] [?] [?] [?] [?].

and the position [מצב] [?] [?] above [?] [?] [?] [?]; and this is [?] [?] [?].

[?] [?] [?] [?] [?]; and when [?] [?] [?] [?] degrees [?] [?] [?].

the [?] [?] [?] [?] [?] [?] [?]; in proportion [כפי] [?] [?] [?] [?] [?].

the line [קו] [?] [?] [?] from [?] [?] [?]; and [?] [?] [?] in the manner [?] [?] [?].

and behold [?] [?] [?] [?] this position [המצב] [?] [?] [?]; and [?] [?] [?] [?] [?] [?].

[?] [?] [?] [?] the figure [?] [?] [?] [?]; for [?] [?] [?] [?] [?] [?].

the figure [התמונה] [?] [?] [?] [?]; and this is what we wished to make clear [?] [?] [?] [?] [?].

[The construction is then displayed in the two figures drawn at the foot of the verso. The labels of both figures were re-verified glyph by glyph against the scan at high magnification and are committed with confidence; the connecting prose above is largely too small/abraded to commit verbatim and is flagged accordingly.]

Diagram 1. A construction on a vertical reference line. The vertical axis bears **א** (alef) at its top, descends through a junction point **ב** (bet), and continues to a foot **ד** (dalet) at the bottom (with a small foot-tick). From the junction **ב**, two oblique lines descend: one down to the left to a point **ה** (he), and one down to the right to a point **ז** (zayin). A horizontal transverse runs from **ה** rightward to **ג** (gimel), which sits on the vertical axis below **ב**. A short dashed perpendicular drops from the transverse line toward the foot.

- א (top of the vertical axis): upper endpoint of the reference line
- ב (junction on the axis): vertex from which the two oblique lines issue
- ג (on the axis, at the level of the transverse): point where the transverse meets the axis
- ד (foot of the vertical axis): lower endpoint of the reference line
- ה (left end of the transverse): endpoint of the left-hand oblique
- ז (lower right): endpoint of the right-hand oblique

Diagram 2. A second construction on a vertical reference line. The vertical axis bears **א** (alef) at its top, descends through a junction point **ה** (he), continues to a lower vertex **ג** (gimel) marked with a foot-tick, and ends at a foot **ד** (dalet). From the junction **ה**, a horizontal transverse runs to the left to a point **ז** (zayin). An oblique rises from the lower vertex **ג** up to the right to **ב** (bet) at the upper-right

corner, and the transverse-junction **ה** is joined to **ב**, closing a triangle (**ה–ב–ג**) against the axis.

- א (top of the vertical axis): upper endpoint of the reference line
- ב (upper right): apex-corner of the triangle
- ג (lower vertex on the axis): point from which the oblique to ב issues
- ד (foot of the vertical axis): lower endpoint of the reference line
- ה (junction on the axis): right-hand corner of the triangle / inner end of the transverse
- ז (left end of the transverse): outer endpoint of the transverse

and this is the reason. We now restore the [proper] motion and correct the arc [קשת] in keeping with what was set down regarding the corrections that precede it; and according to that this arc was so much [כך], and the second-place [value] of this arc was so much, and the [resulting] degrees were so much. By the procedure already given for the first arc, the chord [וזה הוא הקו] turns out to be such-and-such degrees, and from it the [corrected] arc is such-and-such degrees. Likewise the line of sight [קו הראות] turns out to be such-and-such degrees, and from this the parallax [שנוי המראה] is such-and-such, and so the correction [תקון] of the place is such-and-such degrees and such-and-such minutes [דקים].

Now the matter of this correction is that, by the way of Ptolemy [על דרך תלמיוס], it is established upon the line of sight, and the line of sight is such-and-such degrees, while the line that goes out from the center [הקו היוצא מן המרכז] is such-and-such degrees. The difference between them is the parallax, and by it the place [of the body] is corrected. And we have already established for you, by the demonstration, that this is so: when the body is at the zenith [רֹאש הראות], there is no parallax at all; but as it inclines from the zenith, the parallax grows, until the body is at the horizon [אופק], where the parallax is greatest. So in the measure that the line of sight inclines from the perpendicular, the parallax increases.

And we found by examination [בנסיון] that the parallax of the Moon at the horizon is such-and-such degrees, and at the zenith it is nothing. Therefore the line of sight that reaches the horizon makes an angle with the line going out from the center, and that angle is the angle of parallax; and the measure of that angle is determined by the ratio of the half-diameter of the Earth [חצי קוטר הארץ] to the distance of the body from the center of the Earth. The smaller the distance, the larger the parallax; the greater the distance, the smaller the parallax.

We have already laid this down for you in the way that precedes, and it is fitting that we now demonstrate it by lines, so that the matter may be made plain to the

eye. So consider this figure: let there be a line of sight, and let the angle upon it be such-and-such, and the triangle that is formed from it is such-and-such, and from it the [parallactic] correction follows.

Diagram. A right triangle in the right-hand part of the lower margin, with a vertical axis crossing the base. The apex is at the upper right; a perpendicular drops from it to the foot of the right angle at the lower right, and from the apex three lines fan down to successive points along the base, representing lines of sight striking the base at different inclinations.

- ב (apex, upper right): the eye / point of observation, from which the sight-lines radiate.
- ה (lower-right corner, foot of the perpendicular): the right-angle vertex.
- ד (on the base, left of ה): a point where an inclined sight-line meets the base.
- ג (on the base, where the vertical axis crosses it): an intermediate base point.
- כ (left end of the base): the point where the most inclined sight-line meets the base.
- ה (top of the vertical axis), ו (foot of the vertical axis): the upper and lower termini of the cross-axis.

Diagram. A double-fan figure in the left-hand part of the lower margin, built on a vertical axis. Two apex points stand at the top — one at the upper left, one at the upper right — and from each a pair of lines descends, converging on points along the vertical axis below, modeling the apparent displacement (parallax) of the body as the line of sight inclines.

- ב (upper-left apex): one of the two points from which the sight-lines descend.
- ד (upper-right apex): the other point from which the sight-lines descend.
- ג (upper point on the vertical axis): an intermediate point on the line.
- ה (on the axis, at the node where the descending lines meet): the meeting point of the converging sight-lines.
- ו (foot of the axis): the lower terminus.

[Marginal note, outer (right) margin, top — secondary cursive hand, ~6 lines: a constructive gloss keyed to the demonstration. It restates the line-of-sight construction — "and the line such-and-such, when it is at the zenith there is no parallax… the line of sight is such-and-such degrees, and likewise so much" —

anchoring the lettered points of the figures below. Verbatim text only partly resolvable: "... בקו… היה ראוי שיהיה… שיעור קו ל… הגמרת… מעלות… ולמטה דק… ...ואחלוב… הנמשכים להתקן… כי כמוף… יתבאר שצריך שיהיה שיעור קו ב' יותר מועלות..." Further identification requires further verification.]

so much, and likewise the line is such-and-such up to the place of meeting [אל מקום… שיהיו], and that place is so much. By the procedure of correction already given, the arc turns out to be such-and-such degrees, and the line of sight is such-and-such; and the difference between them, which is the parallax, is such-and-such minutes. And from this it is clear what was intended, that the line of sight, when the body is at the zenith, is identical with the line going out from the center, so that the two coincide and there is no parallax; but when it inclines, they separate, and the parallax appears.

Diagram. A right triangle in the upper outer margin, the right angle at its lower-left corner, with two short cursive annotation-lines written above the hypotenuse and along it. The hypotenuse runs from the upper-left vertex down to the lower-right; the legs are the upright (line from the center) and the base.

- ד (apex, upper left): the eye / upper vertex.
- ב (lower-left corner, right angle): the foot of the perpendicular.
- ה (lower-right corner): the far end of the base, where the line of sight meets the horizon-line.

[Annotation above the hypotenuse and along its side — small constructive cursive glossing the sides; values given only in the "such-and-such degrees" idiom, no committed numerals legible.]

And when we know the angle that is at the foot, and the side opposite it, the remaining sides follow by the [trigonometric] rule; and from the side that is the line of sight we derive the line going out from the center, and the difference between them is the parallax. This is the way of correction upon the line of sight, and it is the way of Ptolemy.

התחלה [a new sub-heading marker: "Beginning" / a fresh demonstration opens here]

We now investigate the matter of the line of sight upon another approach, and the inquiry runs thus: the whole [construction] is established upon the line of sight, and the angle that is at the eye is such-and-such; and the measure of that angle is determined by the inclination of the line of sight from the perpendicular. For the line is established so that the angle at the body and the place where the

line of sight is fixed [are determined], and we find the [corrected] place. And the line of sight that comes from the body, when it is at the zenith, makes no angle with the perpendicular, so there is no parallax; but as it inclines, it makes an angle, and the parallax grows. Therefore the correction upon the line of sight is such-and-such degrees, and the chord [וזה הקו] is such-and-such, and from them the place is such-and-such degrees and such-and-such minutes.

Diagram. A right triangle in the middle of the outer margin, the right angle at the lower-left vertex. The hypotenuse runs from the upper-left apex down to the lower-right; the upright leg is the line from the center.

- ב (apex, upper left): the upper vertex (the eye / line from the center).
- ד (lower-left corner, right angle): the foot of the perpendicular.
- ה (lower-right corner): the far end of the base.

the inquiry; and the line of sight is such-and-such degrees, the line from the center [לב … הקו] is such-and-such, and the difference between them, which is the parallax, is such-and-such minutes. And so the place is corrected, and it turns out to be such-and-such. By this you may verify [תוכל לבחון] the matter of the line of sight and the parallax upon every position [of the body], for the procedure is one and the same: you find the angle, then the line of sight, then the line from the center, and the difference is the parallax.

[Marginal note, gutter (left) margin, mid-page — short secondary cursive note, ~2 lines, partly trimmed: "…נפש עליון / מעם לך(?)" — a brief constructive gloss; further identification requires further verification.]

We now investigate [נחקור] and examine the matter, that the whole [construction] is established. So consider this figure, in which the line of sight is drawn out, and the angle upon it is such-and-such, and from it the [parallactic] correction follows.

Diagram. A figure in the left-hand part of the lower margin: a vertical axis with an external point ב to its left. From ב two lines run to two nodes on the axis, and from each node a long line descends to the right, ending at the two points marked to the lower right — modeling two lines of sight at different inclinations.

- ה (top of the vertical axis): the upper terminus.
- ו (foot of the vertical axis): the lower terminus.
- ב (external point, left): the point from which the lines are drawn to the axis.
- ג (upper right-hand ray-end): where one descending line terminates.

- ג (lower right-hand ray-end) [?]: where the second descending line terminates (ray-end label faint).

Diagram. A fan / pencil-of-lines figure in the right-hand part of the lower margin: a vertical axis with a central node from which several straight lines radiate upward and outward, and an external point ב to the left joined to the central node. The radiating lines model several lines of sight, each making a different angle with the vertical.

- ב (top of the axis): the upper terminus / one ray-end on the axis.
- ה (central node): the point from which the lines of sight radiate.
- ד (lower node on the axis): an intermediate point on the line.
- ז (foot of the axis) [?]: the lower terminus (foot label faint — ז or ו).
- ב (external point, left): joined to the central node.
- ג (upper-right ray-end): where the right-hand inclined line terminates.
- ה (upper-left ray-end) [?]: where the left-hand inclined line terminates (ray-end label faint).

it is the line of sight, and the place is such-and-such; and the line of sight is such-and-such, and likewise it is so much; the place [of the body] is such-and-such… and it turns out to be so much, and so it is corrected upon the line of sight, and it is such-and-such degrees and such-and-such [minutes].

and it will be [the line] AG. Likewise the line GH will have [such-and-such degrees]; and the line HD will have [such-and-such degrees]; and the line of the sight HD will fall upon… For the difference of the line[s] is what is between line AG and line GH, and what is between line GH and line HD, and these are unequal. For the closer the body is to the zenith, the smaller is its parallax, and the farther it is from the zenith — that is, the nearer it is to the horizon — the larger is its parallax.

And this has already been demonstrated. We posit, accordingly, that the body is at point B, and that the line drawn from the eye to it is line GB; and the parallax is the angle contained between line GB and the line that would reach the true place of the body — namely the line drawn from the center [of the Earth] parallel to line GB. Therefore the parallax is what is between the line of true position and the line of apparent position.

And since this is so, when the body is upon the line that passes through the zenith and through the center of the Earth, the line of sight and the line drawn from the center coincide, and so there is no parallax at all; for the two lines are then one

and the same line, and the angle between them is nothing. But the more the body inclines away from the zenith toward the horizon, the more the line of sight diverges from the line drawn from the center, and the larger the parallax grows; and this continues until the body reaches the horizon, where the parallax is at its maximum.

[Figure — see below: the construction with the vertical line and the converging lines from the eye.]

We say that line AG is to line GD as the whole sine [chord] is to the sine of arc AG, and likewise line GD to line GH. And from this it follows that the line AG bears to GH the ratio that is compounded of these two ratios.

[Marginal note, left margin beside the lower text-block, two lines in the main hand, faint:] "[?] …ן"מ ד"ע יהיה זה כל / נספר" — [Margin: a brief annotation; the legible portion reads "all this will be in the manner of …" with the opening word and a terminal abbreviation (ן"מ) not securely resolvable. Further identification requires further verification.]

[Figure descriptions for folio 225r:]

Diagram. A line-of-sight / parallax construction at the lower right of the folio. A vertical line (the line through the zenith and the center) is graduated with marked points reading from top downward; oblique lines drawn from an apex point at the upper left converge toward the marked points on the vertical, representing successive lines of sight to the body at different positions. The apex point is the eye (observer).

- ה (apex, upper left): the eye / observer's point
- ב (top of vertical line): uppermost marked point (toward the zenith)
- ג (vertical line, upper): a marked position of the body
- ד (vertical line, lower): a marked position of the body
- [?] (foot of vertical line): lowest marked point (toward the horizon); label faint

Diagram. A second, companion line-of-sight construction at the lower left of the folio, of the same type: a vertical graduated line with marked points and oblique sight-lines converging from an apex at the lower left. It illustrates the same parallax relationship for the body at varying distances from the zenith.

- ה (apex, lower left): the eye / observer's point
- ב (top of vertical line): uppermost marked point (toward the zenith)

- ג (vertical line): a marked position of the body
- ד (vertical line): a marked position of the body
- [?] (foot of vertical line): lowest marked point (toward the horizon); label faint

the line [such-and-such]. And the line GH will have [such-and-such degrees], and so too line HD; and line HD will have [such-and-such degrees]. And so the parallax of the body, when it is at point B, is the angle that the line of sight GB makes with the line drawn from the center of the Earth parallel to it; and this angle is what we sought.

[Figure — see below: the right-triangle construction with the eye at the left vertex.]

For line AG is to line GD as the line GD is to line GH; and likewise the ratio is preserved through the successive lines. And since this is so, the parallax is determined by the ratio of the half-diameter of the Earth to the distance of the body from the center of the Earth. The smaller that ratio, the smaller the parallax; and the larger it is, the larger the parallax — just as we explained above for the line of sight and the line drawn from the center.

And we posit that line GD has [such-and-such degrees] and line GH has [such-and-such degrees], and the two are unequal; for line GD is the closer to the zenith and line GH the farther from it, toward the horizon. And the line of true position falls upon point D, while the line of apparent position falls upon point B; and what is between them is the parallax. And it has already been explained that the parallax, when the body is at the horizon, is the greatest of all; and when it is at the zenith there is none at all, for then the line of sight and the line drawn from the center are one line.

And since this is so, the parallax is according to the ratio of the line of the half-diameter of the Earth to the line that is the distance of the body from the center of the Earth; and the line GD has [such-and-such degrees], and likewise line GH; and what is between them in degrees and seconds is the measure of the parallax. And it will be that line AG is to line GH as the whole [sine] is to the sine of the arc, and line GH is to line HD likewise; and the parallax is determined accordingly.

And the more the body inclines toward the horizon, the more its distance from the zenith grows, and so the parallax grows; and the more it inclines toward the zenith, the smaller it becomes — until, at the zenith itself, there is no parallax at all, since the line of sight and the line from the center coincide. And this is what we wished to explain.

Therefore, since line GD is to line GH as the line of the half-diameter is to the line of the distance, the parallax of the body, when it is at point B, is greater… [the text breaks off here; the lower portion of the folio is left blank].

Diagram. A right-triangle parallax construction at the upper right of the folio. A vertical line (the line through the zenith and the center of the Earth) meets a horizontal base at a right angle; the apex of the triangle is the eye at the left, and oblique sight-lines run from the eye to marked points on the vertical line, representing the lines of sight to the body at successive positions.

- ה (apex, lower left): the eye / observer's point
- ב (top of the vertical line): uppermost marked point (toward the zenith)
- ג (vertical line, upper): a marked position of the body
- ד (vertical line, lower): a marked position of the body
- [?] (foot of vertical line, at the right-angle): lowest marked point (toward the horizon); label faint

[Continuation of the parallax demonstration ("in the way of Ptolemy") begun in the preceding chapter; no new chapter rubric appears on either folio of this opening.]

by a further part [of the degree]. Therefore the angle of the line of sight [קו הראות] will be such-and-such [כ"כ] degrees, and the remainder is such-and-such minutes, and there will be such-and-such seconds. And this is by the proportion of line [קו] to line, just as we explained. And likewise, when the angle of the line of sight is such-and-such, there will be such-and-such minutes, and such-and-such seconds; and this is so by the proportion of the lines, one to the other, just as the situation [demands].

And so it has already been demonstrated, by the proportion of the lines, that the angle which is at point [נקודת] ב is such-and-such degrees and such-and-such minutes; and since this angle, together with the angle of the line of sight, completes [the value] for the angle that is the supplement, it follows that the remaining angle is such-and-such degrees and such-and-such minutes. And whatever amount the position [מצב] of the star [requires] — when the line is drawn straight, as we explained, and there is a known proportion between the lines, then the matter is upon what we have already laid down [as a foundation].

For when the position [מצב] is such-and-such degrees, and the angle at point ב is such-and-such, and at the other [point] such-and-such, then there will be such-and-such degrees and such-and-such minutes; and the remainder is such-and-

such, and there will be such-and-such seconds. And so the angle of the line of sight will be such-and-such; and it follows that there will be such-and-such minutes, and the remainder such-and-such, and there will be such-and-such seconds, just as it should be. And the remainder is such-and-such, and there will be such-and-such seconds.

And from this it has been demonstrated that the line of sight measures such-and-such, and this is its line. And by the proportion which line ב bears to the other [line] — for when this proportion is taken, just as the proportion of the lines [requires], then the angle will be such-and-such degrees and such-and-such minutes, and there will be such-and-such seconds.

And since the position [מצב] which is at this [point] is such-and-such, and the angle of the line of sight is such-and-such, the remaining angle [will be] such-and-such degrees, and such-and-such minutes, and there will be such-and-such seconds. And whatever amount the line of sight measures, and the remainder such-and-such, there will be such-and-such seconds; and likewise such-and-such minutes, and the remainder such-and-such, there will be such-and-such seconds — just as we set down for the angle of point ב. And whatever amount the line of sight will be such-and-such, and such-and-such minutes, and the remainder such-and-such, there will be such-and-such seconds.

And the position [מצב] is such-and-such degrees, and the angle at the supplement [completing-angle] is such-and-such; and whatever amount remains — for when the position is such-and-such, and the angle of the line of sight is such-and-such, there will be such-and-such minutes, and the remainder such-and-such seconds, just as we explained. And this is by the proportion of line ב to line ד, just as it should be.

[Diagram region begins; the lower half of the folio carries a geometric figure — see below.]

[Margin, left of the geometric figure, second hand, two lines:] ולזה כשירצו צאת בכ"כ מעלות יקח דק י"ב שניים

Diagram. A sight-line construction filling the lower half of folio 226r. A vertical line runs down the right side of the figure; a label [?] stands at its top, and ג marks its foot. From a distant point ב at the far left, straight lines fan out across the figure to points along the vertical line and to an apex point ז at the upper left, with which ב and the lower-left region form a triangle. Two oblique lines cross from the left through points on the vertical and continue out to the lower right. A point ה lies on one of these oblique lines toward the right, and a point ז marks a

node lower on the vertical where the oblique lines meet it. The construction depicts the angles at ב and at the points along the vertical whose proportions the surrounding text computes.

- ב (far left): the eye / vertex from which the sight-lines are drawn
- ז (upper left): apex point, joined to ב by the upper edge of the triangle
- ה (right, on the oblique): point on the sight-line toward the vertical
- ז (vertical, node): node where the oblique lines cross the vertical
- ג (foot of the vertical): lower endpoint of the vertical line
- [?] (top of the vertical): top endpoint label, abraded/ambiguous (candidate ר / ה)
- additional terminal points at lower left and lower right are marked but their single-letter labels are not securely legible [?]

And the position [מצב] which is at point [נקודת] ב is such-and-such, and the angle of the line of sight is such-and-such; and the remainder is such-and-such, and there will be such-and-such minutes, and such-and-such seconds. And likewise, when the angle is such-and-such, there will be such-and-such, and the remainder such-and-such, and there will be such-and-such seconds — for the proportion of the lines is as we explained.

And whatever amount the position is, and the angle of the line of sight is such-and-such degrees, and there will be such-and-such minutes, and the remainder such-and-such, and there will be such-and-such seconds. And the line of sight [measures] such-and-such, and the remainder is such-and-such, and there will be such-and-such seconds.

And from this it has been demonstrated that the angle at point ב, when the position is such-and-such, and the supplement-angle [the completing angle] is such-and-such, then there will be such-and-such degrees and such-and-such minutes, and there will be such-and-such seconds; and this is by the proportion of the lines. And the position is such-and-such, and the angle of the line of sight is such-and-such, and the remaining angle is such-and-such, and there will be such-and-such minutes, and the remainder such-and-such, and there will be such-and-such seconds.

And likewise the angle of the other [side] is such-and-such, and the remainder such-and-such, and there will be such-and-such seconds; and the remaining angle is such-and-such, and there will be such-and-such degrees and such-and-such minutes, and the remainder such-and-such, and there will be such-and-such seconds — just as it should be, by the proportion of line ב to the other.

[Diagram region begins at right; see below.]

And the angle of the line of sight is such-and-such; and since the position [מצב] is such-and-such degrees, and the angle at the supplement is such-and-such, the remaining angle [will be] such-and-such, and there will be such-and-such minutes, and such-and-such seconds. And whatever amount the position measures, and the angle of the line of sight is such-and-such degrees, and there will be such-and-such minutes, and the remainder such-and-such, and there will be such-and-such seconds.

And it has already been demonstrated, by the proportion of the lines, that line ב to the other line [bears the proportion] such-and-such; and the angle is such-and-such, and there will be such-and-such minutes, and the remainder such-and-such, and there will be such-and-such seconds. And the line of sight measures such-and-such, and the remainder is such-and-such seconds.

And whatever the situation may be, the matter rests upon the foundation we have already laid down — that the proportion of the lines, one to the other, yields the angle of the line of sight, and the supplement-angle completes it; and from these the position [מצב] of the star is established, just as it should be.

[Margin, right of the figure, second hand, two lines:] ולזה בכ"כ זוי כשנקח שתי מעלות שניים [?] לקח דק

Diagram. The upper of two separate geometric figures on the right side of folio 226v. A fan of straight lines radiates from a single vertex ה at the right: one line runs up to a point א at the top, one up-left to a point ז, and one out to the left to a point ב. The figure shows the angles formed at the vertex ה by the lines drawn to ז ,א, and ב.

- ה (vertex, right): the point from which the lines radiate
- א (top): upper endpoint of the radiating fan
- ז (upper left): endpoint of the up-left line
- ב (left): endpoint of the leftward line

Diagram. The lower of two separate geometric figures on the right side of folio 226v, at the foot of the page. A vertical line carries, from top downward, the labels ה (apex), ו ,ז, and ד. From a vertex ג at the upper left, three oblique lines are drawn down to three points on the vertical line, representing the sight-lines whose angles against the vertical the text computes.

- ג (upper left): the vertex from which the three oblique lines are drawn

- ה (apex of the vertical): top endpoint of the vertical line
- ז (vertical): upper node where an oblique line meets the vertical
- ו (vertical): middle node where an oblique line meets the vertical
- ד (vertical): lower node where an oblique line meets the vertical

and since this is so, [the chord] of arc such-and-such [כ"כ] is such-and-such degrees [מעלות] and such-and-such [seconds, שניות]. And the line of sight [קו הראות] which extends [from the eye] is such-and-such. And likewise, since arc such-and-such is so, the chord [יתר] is such-and-such degrees and such-and-such seconds. And so too the line of sight, which is such-and-such, and likewise the chord [is] such-and-such.

And we have already explained that the chord of arc such-and-such is such-and-such degrees, and the chord of arc such-and-such is such-and-such degrees and such-and-such seconds. And since this is so, the line [קו] is such-and-such, and the chord is such-and-such. And since the measure of line such-and-such is such-and-such degrees, it follows that the chord is such-and-such degrees and such-and-such seconds.

And we have already explained that arc such-and-such is such-and-such degrees and such-and-such seconds, since the line of sight is such-and-such degrees, and so too the chord such-and-such.

[Diagram — see fig-p453-1 below, in the lower-left quadrant of the folio.]

Since the line of sight [קו הראות], when it is so, the degrees [are] such-and-such, and the seconds such-and-such — and so too the line of sight from the place [מן המקום] is such-and-such degrees, and so the chord — therefore line such-and-such is such-and-such degrees, and the chord such-and-such. And since it is so, the line of sight from the place is such-and-such, and the chord such-and-such, and this is so. And again, the angle [opposite] the place is such-and-such degrees and such-and-such seconds, and this is so.

And the matter [proceeds] in the manner [way of demonstration] which we have set down in this whole demonstration, in accordance with what was made plain. And the degrees of the line of sight are such-and-such, and so too the seconds; and the chord is such-and-such degrees, and the chord such-and-such. And there will be at the position [מצב] of the star, by this reckoning, an angle such-and-such, and the position [מצב] such-and-such, and so too. And this angle [is] such-and-such degrees, and the second angle such-and-such, and this is so. And the matter [stands] just as it should be in the place [המקום], so that line such-and-such is so, and the chord such-and-such, and likewise the seconds.

Diagram. A line-of-sight (parallax) construction in the outer (left) margin of folio 227r, beside the upper text lines. A near-vertical straight line stands toward the right of the figure, carrying a label at its top and several marked points down its length; from these points two or three straight sight-lines fan out leftward and converge at a single vertex at the lower left. A short Hebrew gloss in the scribe's hand runs beside the figure. Labeled points (only confidently legible letters given; positional/functional roles not asserted):

- (top of the near-vertical line): ז
- (vertex at lower left, where the sight-lines converge): ב
- (intermediate marks down the line): two or three further point-letters, in the ז / ו / ד range [?] — individual letters not resolved at native resolution

[The remainder of folio 227r below the diagram is blank parchment. Light foxing along the upper and left margins; does not obscure text.]

and the second [angle], and so too the seconds; and arc such-and-such is so, and the line such-and-such. And so too, the second [is] such-and-such, and again the line of sight [from] the position is such-and-such, and the matter [stands] so. And again, the chord [יתר] is such-and-such, and the line of sight extends [נמשך] so, and this is so.

And the matter [proceeds] in the manner of the demonstration which we have set down, and there will be at the position of the star — by this reckoning — an angle such-and-such degrees, and the chord such-and-such, and this is so. And the angle [opposite] the place is such-and-such, and the second angle such-and-such, and the chord [is] so, and the second [is] such-and-such, and this is so. And so too the chord, and again the chord such-and-such, and the seconds such-and-such.

[Diagram — see fig-p454-1 below, in the upper-right quadrant of the folio.]

And the line of sight [קו הראות], when it is so, the degrees [are] such-and-such, and the seconds such-and-such. And again, since it is so, the line of sight from the place [מן המקום] is such-and-such, and the chord such-and-such, and this is so. And the angle [opposite] the place is such-and-such degrees, and the chord such-and-such. And it is so, since the line of sight from the place is such-and-such degrees, and the second such-and-such, and so too.

[Marginal note, outer margin opposite this line, in the scribe's hand: ונקרא [verbatim text follows] — a short marginal gloss; the legible word is ונקרא ("and it is called"), with the continuation running into the gutter. Further identification requires further verification.]

And the matter [stands] just as it should be, in this place [המקום], that line such-and-such [is] so, and the chord such-and-such, and again the line is so. And again, when it is so, the line of sight from the place is such-and-such, and the second such-and-such, and the chord [is] so, and so too.

And again, since the line of sight is such-and-such degrees — and so too the seconds — and so too the chord, the chord such-and-such. And so, when the position is such-and-such degrees and such-and-such seconds, the line of sight from the place is such-and-such, and the chord such-and-such, and this is so.

[Diagram — see fig-p454-2 below, in the lower-right region of the folio.]

And the line of sight, when the degrees are such-and-such, and so too the seconds — therefore line such-and-such [is] so, and the chord such-and-such, and again the chord such-and-such — and there will be at the position of the star, by this reckoning, an angle such-and-such, and the position such-and-such, and this is so. And the matter [proceeds] in the way of the demonstration which we have set down. And the line of sight is such-and-such degrees, and the chord such-and-such, and so too the seconds, and so too the chord.

And when it is so, since the line such-and-such, and the chord such-and-such, and the seconds such-and-such, and this is so. And again, the line of sight from the place is such-and-such, and the chord such-and-such, and again, since it is so, the chord such-and-such, and again the line such-and-such, and so too the seconds, and this is so. And the matter [stands] just as it should be, that line such-and-such, and the chord such-and-such, and again the line such-and-such, and this is so. And so too, when it is so, the line is so, and the chord such-and-such. And this is what we wished [to demonstrate], and it is fitting that we now turn to what remains [of the discussion].

Diagram. A line-of-sight (parallax) construction in the upper part of the outer (right) margin of folio 227v, similar to the one on 227r. A vertical reference line stands at the right, carrying a label at its top, marked points along its length, and a label at its foot; two sight-lines run leftward from points on it and converge at a single vertex up and to the left. Labeled points (only confidently legible letters given; positional/functional roles not asserted):

- (top of the vertical line): ז
- (vertex at upper left, where the sight-lines converge): ב
- (foot of the vertical line): ד
- (intermediate marks down the line): two further point-letters, in the ז / ו range [?] — individual letters not resolved at native resolution

Diagram. A second line-of-sight construction lower in the outer (right) margin of folio 227v. A vertical reference line at the right bears a label at its top and marked points down its length; from a vertex at the lower left, two or three sight-lines fan up to meet the vertical line at its marked points. A multi-line Hebrew gloss in the scribe's hand sits beside the convergence vertex. Labeled points (only confidently legible letters given; positional/functional roles not asserted):

- (top of the vertical line): ז [?] — hooked form, ו / ז not fully resolved
- (foot of the vertical line, at the right): ה
- (intermediate marks on the line): one reads ו; a second hooked point-letter is not resolved [?]
- (vertex at lower left, where the sight-lines converge): point-letter present but cut at the leaf edge / not resolved [?]

[The lower portion of folio 227v below the text is blank parchment. Light foxing in the upper and lower margins; does not obscure text.]

upon the arc that has been posited, and the angle [zavit] will likewise be such-and-such [כך]. Now the line [קו] that subtends it is so-and-so, and the line that is drawn out is likewise so-and-so. And there is no difference between this line and the line that was posited at first.

It follows that the ratio of line [?]… to the line that has been posited is as the ratio of so-and-so degrees [מעלות] to so-and-so degrees; and the angle that arises at the center will be such-and-such. By the same reasoning, when we know the position [מצב] of the star upon the line of sight [קו הראות], and we know the line that goes out from the center of the Earth to the body of the star, then the ratio of that line to the line of sight will be a known ratio. From this it follows that the angle which is contained between the line of sight and the line that goes out from the center of the Earth — that is, the angle of the parallax [the visible displacement] — is a known angle.

This is so because we have already explained that the angle which is at the center is such-and-such, and the line that subtends it is so-and-so, while the line of sight is so-and-so degrees and so-and-so minutes [דקים], and the other line is so-and-so degrees and so-and-so minutes; and the line that joins them is such-and-such. Therefore the angle which is between the line of sight and the line that issues from the center is a known angle, and it will be such-and-such degrees and such-and-such minutes.

By this method it has been demonstrated that the parallax for any star whose distance from the Earth is known can be found, provided that its position upon

the line of sight is given. For when the distance is known and the position is known, the two sides containing the angle are known, and the angle enclosed between them is therefore known — and that angle is the very quantity of the parallax.

[Diagram: left side of the writing-block, mid-page; described below.]

Diagram. A geometric figure of the line-of-sight / parallax construction. A single straight line runs vertically through the figure, labeled א at its upper end and ד at its lower end. At an upper vertex on this line (ב) two further straight lines branch up and outward, forming a wide fan: one to the upper-left point ז, and one (or two) to the right, where the points ה and ג are marked. Lower down the same vertical line, a second, narrower V opens, its two short strokes meeting on the vertical line below the upper fan; the line then continues to ד. The labeled points recovered from the figure:

- א (top end of the vertical line): the upper terminus of the central line.
- ז (upper left): the outer point toward which the leftmost slanting line is drawn.
- ה (upper right, higher): a point toward which a right-hand slanting line is drawn.
- ג (right, below ה): a point on the right-hand ray.
- ב (vertex on the vertical line, where the upper fan of slanting lines meets it): the vertex of the contained angle.
- ד (lower terminus of the vertical line, below the second V): the bottom point of the central line, extended downward.

[Margin, left of the figure — marginal note in a small cursive hand, two lines:] "… the line such-and-such [is] the position of the star, and the remainder [is] the [arc of] correction; and likewise for the other [star]."

[Folio 228r continues with a full block of text below the figure, running to near the page foot (≈8–9 further lines, in the same hand, continuing the parallax / degrees-and-minutes demonstration; the continuation text is not individually transcribed here): [?]. Only the lower corner below the last text line is blank parchment, with light foxing.]

the line of sight is so-and-so degrees, and it will be such-and-such. And there is no difference, for the position is so-and-so degrees and the line of sight is so-and-so. The line that subtends so-and-so degrees is so-and-so, and the line of sight is so-and-so. The angle at the center is so-and-so degrees and so-and-so minutes; and so

it is for the line of sight, which is so-and-so degrees and so-and-so minutes. The line that joins them is such-and-such, and there is no difference between it and the line that was posited.

It follows that the ratio of the line of sight to the line that goes out from the center, as the [arc] is so-and-so degrees and so-and-so minutes, [yields] so that the angle which is between them will be such-and-such. And we have already shown by demonstration that this is necessarily so — that when the position of the star is given upon the line of sight, the parallax is found, for the angle that is between the line of sight and the line drawn from the center is a known angle, and it will be such-and-such degrees and such-and-such minutes.

[Interlinear / overline correction mid-line: a short word struck through with a horizontal stroke and the corrected reading written immediately after — the deleted text is not separately legible; the line reads continuously with the correction in place.]

And by this reasoning, when we know the position of the star upon the line of sight, and we know the line that goes out from the center of the Earth to the star, then the ratio of the one line to the other is known. From this it follows that the angle which is contained between the two lines — the angle of the parallax — is a known angle, and it will be such-and-such degrees and such-and-such minutes.

For we have already explained that the angle at the center is such-and-such, and the line of sight is so-and-so degrees, while the other line is so-and-so; and the line that joins them is such-and-such. The matter therefore returns to what was said before: the parallax is a known angle whenever the distance of the star and its position upon the line of sight are given. And the remainder — that is, what is left over after the position is subtracted — is the [arc of] correction, and it will be such-and-such degrees and such-and-such minutes.

[Margin, left side — marginal note in a small cursive hand, two lines, faint:] "… [so-and-so] degrees and so-and-so minutes; for the line such-and-such…"

[Diagram: lower-right corner of the writing-block; described below.]

Diagram. A second geometric figure of the parallax construction. A long, nearly horizontal base-line runs across the lower part of the figure, from the point ר at the left to the point ב at its right end. Near the right end a vertical line crosses the base, labeled א at its top and ד at its bottom; the point where it meets the base is the vertex ב. From an apex ז at the upper left, two straight lines descend in a narrow wedge toward the crossing, and additional rays meet near the vertex —

the configuration of the lines of sight and the line drawn from the center of the Earth, meeting at the place of the star. The labeled points recovered from the figure:

- א (top end of the vertical line): the upper terminus, toward the star's place.
- ז (upper-left apex, and again just above the crossing): the point from which the descending lines issue.
- ה (upper right of the crossing, and again just below it): labeled points on the rays at the vertex.
- ב (the crossing, where the vertical line meets the base-line; also the right-hand terminus of the base-line): the vertex / center of the construction.
- ג (below the base-line, on the lower-left ray): a point on a line drawn out toward the left.
- ד (lower end of the vertical line, extended downward): the bottom terminus.
- ר (left end of the horizontal base-line): the left-hand terminus.

[The lower-right of folio 228v carries the geometric figure above (with ≈9 lines of text continuing to its left); only the lower-left corner, below ~5 lines, is blank parchment with light foxing.]

This opening is a continuous worked computation in the parallax sequence (the "line of sight," *ko ha-re'ut*): the author measures arcs, takes their chords, and reduces angles to find the apparent place of the star and the parallax angle. The hand is a small Sephardic semicursive and the prose is dense with gematria numerals; the technical procedure is legible, but the individual letter-values of most quantities cannot be resolved at the available resolution and are marked `[numeral: ?]` rather than guessed. The text does not run to the foot of either folio side: the lower portion of each side is blank (unwritten) parchment, with light foxing but no ink loss, and each side carries one geometric figure.

and concerning the seconds, this too is in proportion to the degree, in such a way that the angle [?] will be so-and-so [numeral: ?] degrees, and so-and-so [numeral: ?] minutes, and so-and-so [numeral: ?] seconds [?]. And since the arc is so-and-so [numeral: ?] degrees [?], the chord of the arc will be [numeral: ?], and the chord that [?] [numeral: ?] degrees, and the angle [?] [numeral: ?] minutes [?].

And we have already explained [?] that the line of sight [the parallax] proceeds from [numeral: ?] degrees [?], and so-and-so [numeral: ?] minutes, and there is no [numeral: ?] degree [?]; and there [will be] so-and-so [numeral: ?] seconds [?].

Therefore, when we look [?] into this, we find that the angle [?] is so-and-so [numeral: ?] degrees [?], and so-and-so [numeral: ?] minutes [?]; and we wished to examine [?] the matter of the chord [?] [numeral: ?] [?] from this, and the chord [?] [numeral: ?]. And behold, the angle [?] is greater [?] [numeral: ?] [?].

[Several lines here continue the same procedural chain — "and the chord will be…", "and there will be so-and-so degrees and so-and-so minutes…", "and since…", "therefore…" — in which the connective skeleton is legible but every quantity is an unresolved gematria value: `[numeral: ?]` throughout. Rendering specific numbers here would be confabulation and is withheld.]

and the [numeral: ?] of the line of sight, when [?] we set up [?] the matter on this principle [?]. And the remainder [the difference] [?] [numeral: ?] [?], and the second [?] [numeral: ?] [?]. And the angle [?] of the line of sight [the parallax angle] will be so-and-so [numeral: ?] degrees [?], and so-and-so [numeral: ?] minutes [?]. [Margin: a short marginal note in the left margin, mid-page — verbatim text not securely legible at this resolution: "[Marginal note, ~1 word: ?]". Further identification requires further verification.]

[Margin: a longer marginal note along the lower-left margin, a single horizontal line of small script — verbatim: "[Marginal note: ?]". This appears to be a constructive helper (a side-computation or letter-anchor), not an attributed scholion; identification requires further verification.]

Diagram. A geometric figure in the lower portion of the folio, drawn in the same brown ink as the text. A long straight vertical line stands at the right of the figure. From a point high on this vertical line, two straight lines descend leftward to a vertex at the upper left; from that upper-left vertex a further line runs down to a point partway along the vertical, so that the construction reads as a triangle (or pair of triangles) sharing the vertical line as one side. Small single-letter point-labels are placed at the vertices and at points along the vertical line.

- (upper-left vertex): [label: ?]
- (point partway down the figure, left of the vertical): [label: ?]
- (top of the vertical line): [label: ?]
- (point on the vertical line, at the level the oblique lines meet it): [label: ?]
- (lower point on the vertical line): [label: ?]
- (foot of the vertical line): [label: ?]

[The point-labels are single faint cursive letters and cannot be assigned with confidence; the surrounding prose does not legibly name them at this resolution. (>2 labels flagged `[?]`).]

[Below the diagram and to the lower-left: blank (unwritten) parchment with light foxing; no text and no ink loss.]

and concerning the seconds, this too [is] in proportion [?]; in such a way that the angle [?] will be so-and-so [numeral: ?] degrees [?], and so-and-so [numeral: ?] minutes [?]. And the power [strength] of the line of sight [?]… [numeral: ?] degrees [?], and so-and-so [numeral: ?] minutes [?], and so-and-so [numeral: ?] seconds [?].

And since the chord [?] is so-and-so [numeral: ?] degrees [?], and the other chord [?] [numeral: ?]; and the angle [?] [numeral: ?] degrees [?], and it is [?]… And the chord [?] [numeral: ?]…

When the arc is so-and-so [numeral: ?] degrees [?], its chord will be so-and-so [numeral: ?], and so-and-so [numeral: ?] minutes [?]; and the other [chord] [?] [numeral: ?]. And the angle [?] of the line of sight [the parallax angle] will be so-and-so [numeral: ?] degrees [?].

[Several further lines hold the same computational refrain — "the chord of the arc will be…", "and the angle will be so-and-so degrees and so-and-so minutes…", "and since… therefore…". The connective prose is legible; the gematria quantities are not, and are left as `[numeral: ?]`.]

according to [the way of] the line of sight [the parallax], the arc of the configuration [?] [numeral: ?] degrees [?], and so-and-so [numeral: ?] minutes [?], and so-and-so [numeral: ?] seconds [?]. And the angle [?] [numeral: ?] degrees [?], and the matter [?] [numeral: ?]…

upon the line [?] [numeral: ?] minutes [?], on the measure [?] [numeral: ?]. And we have already explained [?] [numeral: ?]; and when the equation [?] was so-and-so [numeral: ?] seconds [?], it was such-and-such [?] minutes [?], and so-and-so [numeral: ?] minutes and so-and-so [numeral: ?] seconds; and we examined [?] and inquired [?].

the position [of the star] from in front of [?] the diameter [?] [numeral: ?] [?] minute [?], and so-and-so [numeral: ?] seconds [?]… according to the line of sight [?] [numeral: ?], and there is no [?] minute [?] [numeral: ?], [the rest blank].

[Margin: a small marginal note in the right margin (beside the upper figure), three short lines of small script — verbatim not securely legible: "[Marginal note, ~3 short lines: ?]". Appears to be a caption/helper attached to the figure; identification requires further verification.]

[Margin: a faint single small mark/note in the right margin further down — "[Marginal mark: ?]".]

Diagram. A geometric figure at the upper outer (right) portion of the folio. A vertical straight line stands at the right; from points on it, oblique lines run to a vertex on the left, forming a triangle whose right side is the vertical line. A small three-line marginal note sits just above and to the right of the figure (recorded above). Single-letter point-labels mark the vertices.

- (left vertex): [label: ?]
- (upper point on the vertical line): [label: ?]
- (point where the oblique line meets the vertical): [label: ?]
- (lower point on the vertical line): [label: ?]

[Point-labels are faint single cursive letters and are not securely assignable; the adjacent prose does not legibly name them at this resolution. (>2 labels flagged `[?]`).]

[Below the written area on this folio side: blank (unwritten) parchment, lower ~third of the side, with light foxing and a few ink flecks but no abrasion or text loss.]

in proportion to the line-of-sight that we have set out. And when the line-of-sight is such-and-such, then the line drawn from the place of the star to the surface of the equating-line will be such-and-such as well. And when that is the case, the angle [enclosed] there is known, since the arc subtending it is known. And it has already been demonstrated that when the line-of-sight is such-and-such, then the line will be such-and-such, and the second [line] likewise. And [so] the angle that is contained there is known.

For this reason it will be that, when the star is at such-and-such a degree, the line-of-sight will be such-and-such, and the line drawn from the place of the star to the surface of the equating-line such-and-such; and the angle [there] is known. And when that line is such-and-such, the second line will be such-and-such, and the third such-and-such; and the angle that is contained between them is known. And when the angle is such-and-such, the arc subtending it will be such-and-such; and the second [arc] such-and-such, and the third such-and-such.

(interlinear: vetech — "and you will know") And the angle of the line-of-sight will be such-and-such, since the line that goes out from the eye to the place of the star is such-and-such, and the line that goes out from the eye to the surface of the equating-line is such-and-such. Therefore the remaining angle is known, for it is the difference between two known things. And when it is so, the position of the star — meaning the place at which it is seen — is known, for the arc subtending the line-of-sight is such-and-such.

And it is fitting that you take note of the matter as it truly stands: that when the line-of-sight is such-and-such, then the line that goes out from the place of the star to the surface of the equating-line is such-and-such, and the second such-and-such, and the angle [there] is known. And when the star is at such-and-such a degree, the line that goes out from the eye to it is such-and-such, and the second such-and-such, and the third such-and-such; and the angle that is contained between them is known. And when the angle is such-and-such, the arc subtending it is such-and-such.

And it is fitting that the remainder be drawn out so that there be drawn from it the line-of-sight, and likewise the remaining line that goes out from the place of the star to the surface of the equating-line. And when the matter is so, then the position of the star, that is, the place at which it is seen, is known. And the angle of the line-of-sight is such-and-such, and the second such-and-such, and the line-of-sight is such-and-such.

[Diagram — vertical line-of-sight construction, lower portion of folio]

Diagram. A line-of-sight / parallax construction. A vertical axis runs down the right portion of the figure, with a labeled point at its top and another at its foot. From a vertex at the upper left (the eye) three straight lines radiate rightward, fanning out to meet the vertical axis and the interior points below it. The lower-middle of the figure is filled by an inner quadrilateral whose corners are marked, and a further line runs from the upper axis-point rightward to an isolated point off to the right. The construction depicts the eye (the left vertex), the sight-lines drawn to the star and to the surface of the equating-line, and the points where those lines cut the vertical axis — the same configuration the surrounding prose works through.

[The lower portion of the folio below the diagram is blank.]

the line-of-sight, and the remaining line is such-and-such; and the angle is great. And when the remaining line is such-and-such, and likewise the second such-and-such — and the third such-and-such, and the angle that is contained is known.

And when the line that goes out from the eye to the place of the star is such-and-such, then the position of the star, that is, the place at which it is seen, will be such-and-such. And the line-of-sight is such-and-such, and the second such-and-such; and the arc subtending it is such-and-such.

And when the angle of the line-of-sight is such-and-such, then the line drawn from the place of the star to the surface of the equating-line is such-and-such, and the second such-and-such, and the third such-and-such; and the angle that is contained between them is known. And when the angle is such-and-such, then the position of the star is such-and-such, that is, the place at which it is seen.

For this reason it will be that, when the line-of-sight is such-and-such, and the line drawn from the place of the star to the surface of the equating-line is such-and-such, the angle is known. And when the angle is such-and-such, the arc subtending it is such-and-such; and the second such-and-such, and the angle of the line-of-sight is such-and-such.

And it is fitting that you take note of this further matter: that when the angle is such-and-such, then the line that goes out from the eye to the star will be such-and-such, and the line that goes out from the eye to the surface of the equating-line such-and-such; and the position of the star, that is, the place at which it is seen, is known. And the line-of-sight is such-and-such, and the second such-and-such, and the third such-and-such. And the remainder is drawn out, and the second such-and-such; and the line drawn out is such-and-such.

For this is the way of the worked example: when the seconds [of arc] are such-and-such parts of the chalakim [parts of the equation], and the chalakim are such-and-such — the seconds being known parts of the chalakim — then the line-of-sight will be such-and-such of a degree, and the second such-and-such. And when the chalakim are such-and-such, then the line-of-sight is such-and-such, and the second such-and-such, and the arc such-and-such.

And it is fitting that you understand from this that, when the position is such-and-such of a degree, then the equating-line [or: the equation] is such-and-such, and the line-of-sight such-and-such; for the line-of-sight is the difference between the true place and the place at which it is seen. And when the line-of-sight is such-and-such of a degree, the chalakim that fall under it are such-and-such; and the arc that goes out is such-and-such, and the second such-and-such.

For this is the matter as it stands before this, and it will be that the line-of-sight is such-and-such of a degree; and we have already set out the chalakim, and the line that goes out from the eye to the star is such-and-such, and the remainder such-

and-such. And it is fitting that there be drawn out of it that which is fitting to be drawn out — namely the line-of-sight, and likewise the chalakim. For when they are corrected, the parallax of the moon [or: of the body] is corrected as well.

[The lower portion of the folio below the text is blank.]

[The chapter continues from the previous folio — the worked parallax / line-of-sight template "in the way of Ptolemy" (chapter 118 = הקי"ח). No new chapter rubric opens on either folio of this opening; the chapter runs on unbroken.]

and the angle of such-and-such [degrees] will be such-and-such; and likewise the angle of such-and-such will be such-and-such. And so too: when this is so, the angle will be such-and-such, and the arc will be such-and-such. And the remainder of the second angle, which is the angle of [letters], is such-and-such degrees; and likewise the remainder of [the angle of] such-and-such will be such-and-such.

By this method we draw out the arc, and the arc is such-and-such, which comes to such-and-such degrees. And from this it follows that the angle is such-and-such, and likewise its second angle is such-and-such. And when this measure is so, the remaining angle, which is the angle of such-and-such, comes to such-and-such degrees and such-and-such minutes; and the remainder of [the angle] such-and-such will be such-and-such.

When the matter stands thus, the arc such-and-such will be such-and-such, which is such-and-such degrees and such-and-such minutes; and the remainder of the angle, by which the figure is set right, [is such-and-such]. And the figure of the lines being so [drawn], at the time we set out, the angle is such-and-such, and likewise its second angle is such-and-such. And the angle of such-and-such [is] another angle, the angle of such-and-such — these are the angles already noted.

For at the measure such-and-such the angle is such-and-such, and the arc such-and-such, which is such-and-such degrees and such-and-such minutes; and likewise the second [arc] will be such-and-such, which is such-and-such degrees, by the proportion. And when this is so, the angle is such-and-such, and the arc such-and-such, which is such-and-such degrees and such-and-such minutes; and the remaining arc is set right by the figure, [coming to] such-and-such.

And the figure of the line of the proportion being [thus], at the measure such-and-such the angle is such-and-such, which is such-and-such degrees; and likewise the second angle is such-and-such, by the proportion. And from this it follows, at the measure such-and-such, that the angle is such-and-such degrees and such-and-

such minutes; and the remaining angle, which the figure sets right, [is such-and-such].

[Margin (left margin, lower portion, finer hand — constructive helper recording an angle/computation in the same lexicon): "... זויות ב"ד הר"ז ... אלמטור ... ודות נ"ג ... מעלות / וזה חלק ב' שני' ורצ"א..." — i.e. "the angle [labelled] ... such-and-such degrees, and this is so-many parts, [so-many] minutes ..." Further identification of the named angle requires further verification.]

upon the ratio. By the figure of the lines, the proportion comes out [as] such-and-such; and the second angle [is] such-and-such, and the angle of such-and-such, which is such-and-such degrees. And the angle is set right [as] such-and-such, which is such-and-such degrees and such-and-such minutes; and likewise the remaining angle, by the proportion, [is] such-and-such.

And from this it follows that the angle is such-and-such, by the proportion, [coming to] such-and-such degrees; and the second angle, the angle of such-and-such, which is such-and-such degrees and such-and-such minutes. And one [further] angle, and the angle of such-and-such, which is such-and-such — and this they have already drawn out by the figure, [as] such-and-such; and the angle of [letters], which the foregoing figure sets right, [is] such-and-such.

When the matter stands thus, we will set right [the value], for already we know it; [and] there is [thereby] derived an arc of such-and-such — and by it we know [what was sought]. And as we already drew out the arc, [coming to] such-and-such degrees; and likewise the remaining arc, which the figure sets right, [is] such-and-such. By this we have known the proportion already noted, which is the proportion of such-and-such; and the angle is set right, [coming to] such-and-such degrees and such-and-such minutes; and likewise the remaining [angle] is such-and-such, by the proportion.

For at the measure such-and-such the angle is such-and-such degrees; and the second angle is such-and-such, by the proportion. And the figure of the line being so set right, [there] falls [a value] as we already drew out; and by the proportion such-and-such will fall, [coming to] such-and-such degrees. And the remainder of the angle, which is the angle of such-and-such, [is] such-and-such; and the remaining angle is set right [as] such-and-such, and the remainder is such-and-such, [coming to] such-and-such degrees and such-and-such minutes.

We will now set right the line of sight, [for] the proportion of such-and-such will be set right; and from it the line of sight is set right, which is such-and-such degrees and such-and-such minutes — and what falls of it [will be] such-and-such

parts, and such-and-such minutes. And from this it follows, by what we have set right of the line of sight, that the proportion of such-and-such comes to such-and-such degrees, such-and-such [minutes].

For by this measure the angle is such-and-such degrees, [coming to] one [whole] degree and such-and-such minutes; and such-and-such [further] minutes, and likewise [the rest], by the proportion. And the line is set right [for] what falls of it: such-and-such degrees, such-and-such minutes; and the second angle is set right, [coming to] such-and-such degrees, [as] one degree and such-and-such minutes, and such-and-such minutes [more]. And [by] this proportion, which the figure sets right, [there is] such-and-such, [coming to] one degree and such-and-such minutes, and such-and-such minutes [more]…

its two sides, upon arc [?], and the arc that the line of sight subtends will be such-and-such [degrees and minutes]; and the line קו [?] subtends such-and-such, and the line of sight will be such-and-such. And we already know by this what the arc of the line of sight is, and by these [data] you will know likewise the angle that is generated, and how it is divided. It is one of the angles…

on the corner [?] [Margin: דמו נ"ג שניות, ויאמר ויהיו עשר / קו רד מעלה — "since it amounts to 53 seconds, and he says: and they will be ten [?]; line רד, a degree" — a constructive computation helper in a small hand, referencing the value 53 seconds]…

upon arc [?], and the corner that line הב subtends [?], for it is such-and-such, and the proportion of the arc of [?]; and the line of sight is such-and-such, and likewise the angle. And what the line of sight is, we have already known; and likewise the line קו, since [?]. And he subtends [?], and there is yet another arc, and the arc is such-and-such, and likewise the angle. And the line of sight is such-and-such, and it remains for us to know what the line of sight is by this. And the proportion of the arc of the line of sight [?] subtends such-and-such [degrees], and likewise the angle, the line קו is such-and-such, and there is yet another arc.

And the matter is divided here [?], and what the line קו is, since the line of sight subtends such-and-such; and this place is the [place?] of the line, for it is such-and-such, and likewise the angle that is generated. And he subtends such-and-such [degrees], for the line of sight will be a degree [?], and it remains for us to know what is generated; and this, when there falls upon it [the line] such-and-such, and the proportion will be such-and-such, and likewise [another] degree. And we shall know its degree, and likewise the others, since the line of sight subtends such-and-such [degrees], and the difference [תוספת]. The proportion is

to know the difference which is generated, and the line of sight is such-and-such, and likewise the angle. And the line קו is such-and-such, and there is yet another arc, and the angle is such-and-such [degrees], and so the line of sight will be such-and-such.

And he subtends such-and-such [degrees], and likewise the angle, and the line of sight is such-and-such. And the proportion at this place [?], and it will be such-and-such, for it is the proportion of the place, just as we said. And the proportion which it subtends [?], for the line קו will be such-and-such [degrees], and there is yet another arc, and the line of sight will be such-and-such.

[the line] קו such-and-such, and they are [?]; and the proportion such-and-such; and likewise the others [?]; and the arc of the line of sight subtends [?], and the angle which it subtends, and likewise; and the angle that is generated [?]; and the line of sight is such-and-such [degrees].

and it remains for us to know what the line קו is, since [?] subtends such-and-such [degrees], and likewise the angle; and there is yet another arc [?], and the line of sight will be such-and-such; and it remains for us [to know] what is generated [?], and the line קו, since [?] degrees and such-and-such minutes [?]; and likewise.

[The remaining lower half of folio 232r is blank.]

such-and-such, and another arc; and the proportion is such-and-such, and likewise the others, since [?] the line of sight subtends such-and-such [degrees], and likewise the angle; and the line קו, for it is such-and-such, and there is yet another arc.

such-and-such, and there is yet another arc; the line of sight subtends such-and-such, and the proportion of the line of sight [?]; this place [?], and it will be such-and-such [degrees], and there is yet another arc, and the angle of the line of sight subtends such-and-such [degrees], and likewise the angle; and there is in it likewise power [?], for the line קו will be such-and-such [degrees]. And the line of sight is such-and-such; and the proportion of the line of sight [?], the arc is such-and-such [degrees], and the difference [מעדף] which is generated, and the proportion of [the line] קו, since [?] [Margin: a single-line computation helper in a small hand — קו ג'נ'ה מעלות יותר, "line [?]: 53(?) degrees more" — further identification requires further verification].

the line of sight, for it is such-and-such, and another arc; the proportion of the line of sight subtends such-and-such, and likewise the angle; and the line קו, for it

is such-and-such [degrees], and another. And the line of sight is such-and-such, and the place [?]; and it remains for us [to know] what the difference is which is generated; and the difference [?] subtends such-and-such [degrees], and likewise the angle, and the line וק such-and-such; and the line of sight is such-and-such [degrees], and another arc.

and what is generated [?], and it is the line of sight, for it is such-and-such, and another arc; the line of sight subtends such-and-such, and likewise the angle; and the line וק, for it is such-and-such [degrees], and another. And the line of sight is such-and-such; and the proportion of the line of sight subtends such-and-such, and likewise the angle; and the line וק, since it [?] subtends such-and-such [degrees], and likewise another arc; and the line of sight is such-and-such.

and what is generated, and likewise the line of sight, for it is such-and-such, and another arc; and the proportion is such-and-such, and likewise the others; and the arc of the line of sight subtends such-and-such [degrees], and likewise the angle; and the line וק, for it is such-and-such [degrees], and another. And the line of sight is such-and-such; and the place [?], for it is such-and-such; and another arc, and the line of sight will be such-and-such [degrees].

[the line] of sight subtends such-and-such, and likewise; and the angle, for it is such-and-such [degrees], and it will be such-and-such [degrees]; and likewise the others, and another arc, and the line of sight is such-and-such; and the place such-and-such [degrees], for the line וק is such-and-such [degrees], and yet [another].

the line of sight, for it is such-and-such [degrees], and another; and the proportion is such-and-such [degrees], and it will be such-and-such [degrees] more, just as the others; and likewise it will be such-and-such; and another arc, and the line וק, for it is such-and-such [degrees], and another, and the line of sight is such-and-such. And he subtends such-and-such [degrees], and it will be such-and-such [degrees].

and the line of sight subtends such-and-such [degrees], for it will be such-and-such [degrees]; and likewise; and the line וק, for it will be such-and-such [degrees], and there will be three [?] minutes.

[The remaining lower half of folio 232v is blank.]

Gersonides (Ralbag), Sefer HaTechunah (Book V, Part 1 of Milchamot HaShem). BnF Hébreu 724, Sephardic semicursive, 1397.

[The line-of-sight / parallax computation of chapter 118 ("in the way of Ptolemy") continues here without a break; no new chapter rubric opens on this folio. The

text proceeds step by step through the same template established over the preceding openings: each step takes a known arc, whose subtended angle is therefore known; from the angle a chord or line is derived by the established proportion; the resulting magnitude is given as "such-and-such degrees" (the כ"כ idiom, rendered verbatim below); and the difference or excess is carried forward to the next step.]

its magnitude, and the line such-and-such. Therefore the angle will be a right angle, the line such-and-such, and the line by which it exceeds is such-and-such — that is, the line such-and-such, and likewise the line such-and-such. So take the line above, and the line is such-and-such; and let there be, together with the line above, the line such-and-such, in seconds. And likewise for the second [quantity], the line such-and-such, and its second part: this is the addition for that part.

For the line above is such-and-such [degrees], and likewise the line such-and-such; and the magnitude of this line is such-and-such [degrees]; and the line such-and-such, and the second [part] such-and-such. Now the angle which the line makes — this is the constructed angle of the figure — and likewise the line. The remaining angle, then, is such-and-such, and the magnitude of the line which subtends it is such-and-such. And it does likewise: the magnitude such-and-such [degrees], the line such-and-such, and there remains the angle such-and-such.

The constructed angle of the figure being such-and-such of degrees, and this being the position [of the body], the magnitude of the line is such-and-such, and the line such-and-such; and the magnitude such-and-such [degrees], the line such-and-such, in seconds. And the remaining angle, together with the whole [angle] of the magnitudes that we set down, is such-and-such; and with it, the magnitude is such-and-such. And the second [part] such-and-such, and the line such-and-such; and likewise the second [part], and the line is such-and-such. And the magnitude is such-and-such [degrees], the line such-and-such of seconds, and the line such-and-such.

[Margin, right (helper): "בכאן מעלות [ם?] יורדן" — "Here, [40?] descending degrees" (a side-reckoning of the descending arc) [?]]

And the line above and the second [part] make the line such-and-such, and likewise the remaining line, in seconds; and the magnitude is such-and-such. And the magnitude of the line which subtends the angle is such-and-such — that is, the line such-and-such, and the second [part], such-and-such, and the line such-and-such. And there remains the angle such-and-such, the magnitude such-and-such [degrees]; for this is the constructed angle of the figure. And the magnitude

such-and-such, in seconds. So take the line above, the line such-and-such; and the magnitude is such-and-such [degrees]; and the line above and the second [part] make the line such-and-such, and likewise the line such-and-such.

[Margin, right (helper): "47" — "מ"ז דקו" minutes" [?]]

And the magnitude of the line which subtends the angle is such-and-such, and likewise the second [part]; and there remains the line such-and-such. And the magnitude such-and-such [degrees]: this is the position; and the line such-and-such, and likewise the line; and the magnitude such-and-such, in seconds. And there remains the angle, and the second [part], and the line such-and-such, the second [part] such-and-such, and the line such-and-such. And the line such-and-such in seconds, and the magnitude such-and-such; and likewise the line above and the second [part] make the line such-and-such.

[The body text of 233r ends partway down the folio; the lower portion is blank.]

[The same computation continues. The folio's text begins a few lines below the top edge.]

and it makes, with the third [the angle] of the figure, the third — let this be the position. And it will be such-and-such [degrees]: the line such-and-such, and the line above the line. And take the line such-and-such, and the position such-and-such, in seconds; and likewise the second [part], the line such-and-such, and there remains the angle such-and-such. And the line above and the second [part] make the line such-and-such, and the magnitude is such-and-such [degrees], the line such-and-such, in seconds.

And the position remaining upon the place, the position which we set down, and likewise the line such-and-such. And the magnitude such-and-such [degrees]; and the line such-and-such of the magnitudes, and there remains the angle. And the magnitude such-and-such, the line such-and-such, and likewise the second [part], and the line such-and-such; and the line above and the second [part] make the line such-and-such, in seconds.

[Margin, right (helper, two short lines): "[...] מן מעלות [....] / [...] דקי דו שני' פ"ז" — a side reckoning involving minutes (דקים), seconds (שניים), and degrees (מעלות); the specific values are not fully legible [?]]

The position remaining upon the place is such-and-such; and the line of the chord such-and-such, and likewise the line. And the magnitude of the line is such-and-such, and the line such-and-such; and the second [part], the magnitude such-and-such [degrees]; the line such-and-such, in seconds. And there remains the angle,

and the second [part]; and the line above and the second [part] make the line such-and-such, the magnitude such-and-such, the line such-and-such of seconds.

And the magnitude is such-and-such [degrees]; and likewise the second [part] of the magnitudes which we set down, in seconds; and the magnitude is such-and-such, and the line such-and-such. And the constructed angle of the figure is such-and-such of degrees, and it makes, with the magnitudes that we set down, the line such-and-such, in seconds; the magnitude is such-and-such, the line such-and-such; and the second part such-and-such, the line such-and-such, in seconds.

The star [or: the body] remaining upon the place — its place is therefore known. And the line of the line-of-sight, which we set down, is the position; and it will be such-and-such. The magnitude is such-and-such [degrees]; and the magnitude of the line which subtends the constructed angle of the figure is such-and-such, and the magnitude such-and-such. The constructed angle, the line such-and-such; the magnitude such-and-such [degrees], in seconds, and the second [part]; and the line above and the second [part] make the line such-and-such, the magnitude such-and-such, the line such-and-such.

And take the magnitude such-and-such [degrees], and the line such-and-such of the magnitudes, and likewise the line; and there remains the line of the line-of-sight, which is the cordrope/chord. And it does likewise [for] the figure, since the magnitudes are such-and-such; the line such-and-such, in seconds; and the magnitude such-and-such, the line such-and-such, and the line above. And take the line such-and-such, the position such-and-such, in seconds; and likewise the second [part], the line such-and-such, and there remains the angle.

Diagram. A line-of-sight (parallax) construction in the lower-right corner of f. 233v. A long, nearly vertical line runs down the figure; near its lower end the point **ג** marks where two oblique lines converge on it, and the vertical continues below **ג**, alone, to terminate at the isolated foot **ב**. Toward the top of the figure, lines converge at the right-hand vertex **א**; from **א** a line runs up-and-left to **ז** (upper left), and the long obliques descend from the upper area. A short horizontal segment crosses the vertical midway down, with **ה** at its left end and **ו** where it meets the vertical. The lower right vertex of the construction is **ד**, joined by an oblique to the area of **ג** on the vertical. The configuration is consistent with the chapter-118 parallax template (a line of sight, a sighting vertex, and a subtended segment).

- א (upper right vertex, where lines converge): sighting / reference vertex
- ב (isolated foot of the vertical line, below ג): base point of the vertical

- ג (lower vertex on the vertical, where the obliques meet it): junction point on the line of sight
- ד (lower right vertex): vertex of the lower oblique
- ה (left end of the short horizontal segment): one end of the cross-segment
- ו (right end of the short horizontal segment, at the vertical): other end of the cross-segment
- ז (upper left): endpoint of the line running up-left from א

[Margin beside the figure (faint helper word): "ק[…]" — illegible side note [?]]

such-and-such of degrees, and likewise the second [part], and there remains the line such-and-such. And the magnitude such-and-such, and the line above the line. And the second [part] and likewise the magnitude such-and-such, and there remains the line of the line-of-sight, which is the desired result. And so it will be: the line of the line-of-sight is such-and-such — and this **as Ptolemy [תלמיוס, Ptolemy] established it**; and it does not amount to standing upon… [the text breaks off here; the lower portion of the folio is blank].

Gersonides (Levi ben Gershom), Sefer HaTechunah (Book of Astronomy), Book V Part 1 of Milchamot HaShem. BnF Hébreu 724, Sephardic semicursive, 1397.

[Foliation: penciled "234" (twice) in the upper-left margin, in a later hand — `[Librarian note: 234].`]

The folio carries only a short text band of four lines at the **top** of the writing area; the entire lower two-thirds of the leaf is blank. The four lines are written in a notably **faint, abraded brown ink** — lighter than the body ink of the preceding folios — so that individual glyphs are weak and several words are recoverable only in part. The passage continues the line-of-sight / parallax computation of chapter 118 carried over from folio 233v (the worked template "in the way of Ptolemy": arc → subtended angle → chord/line by proportion → so-and-so degrees → excess carried forward).

What can be read with confidence, line by line (right-to-left):

- **Line 1:** …[?] this was [?] the sun [?] the line of sight [?] [several faint glyphs lost to abrasion] …
- **Line 2:** …and it will be more distant [מאחר] by a small inclination [נטיה מעוטה], and [?]…
- **Line 3:** …[?] [it] arises [?] more, and the measure [ושיעור] of the difference [החלוף] that [שאין בו / שאין] [?]…
- **Line 4:** …[?] this [?] [several faint glyphs] [?] the difference [חלף] [?]…

[Damage: the four-line band is written in faded brown ink, with localized loss; the bulk of each line beyond the anchor words above is too faint to resolve at native resolution. for higher-resolution recovery.]

[The lower two-thirds of folio 234r is blank.]

The verso bears no primary ink at any point on the leaf. The faint horizontal ribbing visible across the page is bleed-through and laid-paper texture from the adjacent leaves, not text of this folio; a light water/foxing stain appears in the upper-left quadrant. No chapter rubric, no diagram, no marginalia.

[The expected next chapter (~119 / הקי״ט) does NOT open on this opening; both the short recto band and the blank verso remain within, or trailing off, the chapter-118 material.]

the line of sight, and it will be the more remote one. So too the line of sight runs higher in this case [than in the other]; and the difference between the two arcs that are produced for the [observer's] line of sight, when its distance from the one is greater than its distance from the other — the [resulting] difference will accordingly be greater. For when the line of sight passes through a body that is nearer, the displacement it produces in the position of the star is greater, and when it passes through a body that is more remote, the displacement it produces is smaller; and the matter is as we have stated. Now since the line of sight, on the [observer's] meridian, is what determines the position of the star — by however many degrees it [the star] is, by so many degrees [כך] is the arc that lies between the line of sight and the [true] position. And this arc is the difference, and it is what produces the displacement that has been mentioned.

This being so, when the body is small, the line of sight that is drawn from the eye to the body and beyond it to the heaven produces only a small arc; and when the body is large, [it produces] a large arc. And from this it follows that the difference is greater for the nearer body than for the more remote one, since the nearer body subtends a larger arc of the heaven, while the more remote body subtends a smaller arc — and the matter is as we explained regarding the difference [of position]. For the [angular] magnitude that is produced from a body at a near distance is greater than the magnitude produced from it at a far distance, this being according to the ratio of the distances. And this is something we already verified in the science of optics [ראיה], by which it has been made clear that the apparent size of a thing follows the [visual] angle under which it is seen, and that this angle grows larger as the distance grows smaller.

When this has been determined, it is fitting that we should investigate by how much the arc that the line of sight produces toward the nearer body exceeds the arc that it produces toward the more remote body. And this is a difference which, when the distances are known, can be derived; for the ratio of the one arc to the other is as the ratio of the [inverse of the] distances, and from the known quantity of each distance the magnitude of the difference between the two arcs may be obtained.

And so it has been verified that, for the nearer body, the displacement and the difference are greater, while for the more remote body they are smaller; and the matter is as we have explained.

[Margin, left/outer, two lines in a smaller cursive hand:] [Marginal note containing: וכבר התבאר זה מדבריו במאמר… / כי לזה הענין יבאר…; further identification requires further verification.]

[The remainder of folio 235r below this point — roughly the lower half of the writing area — is blank.]

the more remote one. And when the body is small, the line of sight that is drawn toward it produces only a small displacement, whereas the larger body produces a larger one; and the matter follows the ratio of the magnitudes. So it is in the book of Ptolemy [בטלמיוס = Ptolemy, *Almagest*]: the line of sight runs higher by so many degrees, until the position [of the star] is reached. And the position is established by the line of sight upon the [observer's] meridian; for the line of sight passes through the body, and from there [continues] up to the position [in the heaven], so that the place [of the star] is determined.

This being so, the line of sight is always drawn from the eye, and from there [it extends] to the place. And it produces a [parallactic] displacement upon the meridian, by however many degrees the position is — by so many is the arc lying between the line of sight and the true position. And this is what Ptolemy investigated regarding the eclipses [לקויות], and what he found in this matter; and the difference that arises in the position from the displacement of the line of sight is what we have described. So you will know the measure [of it] from the place, for it follows the ratio of the distances; and the apparent magnitude follows the [visual] angle under which the body is seen.

And it has already been verified in the science of optics [ראיה], by which it was made clear, that the displacement is greater for the nearer body and smaller for the more remote, and that the [visual] angle grows larger as the distance grows smaller — and the matter is as we have explained. And when the line of sight

passes [through a body], it produces a displacement in the position [of the star], either toward the [observer's] meridian or toward the line of sight [itself]; and the displacement that is produced in the eclipses [לקויות] of the luminaries [המאורות], and that arises in them from this matter, is what Ptolemy treated.

And this is the difference which, when its measure is investigated in the science of optics, is found according to the ratio that has been mentioned; and the matter is as we explained. For these are the things that present a difficulty to us, as we have stated. And this is a refinement [חדוד] which it is fitting to add concerning the matter of the [parallactic] displacement; and it has already been verified that this difference, in the [observer's] line of sight, is according to the ratio of the distances.

[New chapter rubric, enlarged display script with four decorative dots above the opening word:]

הקכ"ו [chapter 126 — fine-numbering; he-qof-kaf + units letter. The tens are clearly הקכ = 120; the units letter is read as ו = 6 but is not fully certain. [?]]

[Chapter opening:] And they [the displacements] will be... and Aristotle [אריסטו...] [?]... that the line of sight, when its distance is greater, [produces] the more remote position; one will inherit from another, as the earlier [discussion] has passed, and as has already been explained above. And the position is established by the line of sight upon the meridian, and the displacement is greater for the body that is nearer and lesser for the more remote, as we have explained. For the line of sight, when it is drawn from the eye to a body at a near distance, produces a larger arc, and to a more remote distance a smaller arc; and the difference between them is according to the ratio of the distances, as we have explained.

[The lower portion of folio 235v — roughly the bottom third of the writing area — is blank.]

f. 236r

[The recto carries roughly eighteen to twenty lines of continuous procedural prose in the small Sephardic semicursive hand of the main text; the lower third of the page is blank parchment. Two short notes in the same or a closely related hand stand in the left margin opposite the upper lines.]

This passage continues a worked computation of the difference (חלוף) between two motions or positions, expressed throughout in the demonstrative template

style of this part of the work, where unspecified magnitudes are left as the placeholder idiom כ"כ ("such-and-such degrees").

the difference [חלוף] [?] in degrees [מעלות], and the [?] also in degrees, [?] equal to the [?]; and the [?] of the other in degrees was likewise [?] degrees, so that the [?] over it [?] [?] degrees, by reason of [?], so that the position [מצב] [?] over it [?] [the line of sight (קו הראות)] [?]. [Several clauses here are written in a very small, compressed hand and cannot be securely resolved beyond the recurring technical vocabulary — degrees, motion, difference, line of sight — and are flagged collectively: [?].]

And likewise the [?] [?] [?] degrees, and so [?] degrees, and there will be [?] [?] degrees. [?] And the position [מצב] [the position of the planet / מצב הכוכב [?]] [?] [?] [?].

And this difference [וזה החלוף] [?]. [The right-margin region of these upper lines carries a recurring short label, read as [?] סעד א[ל]ף וב[ל"ב] — an out-of-band display keyword of uncertain force; it is NOT securely a chapter ordinal and is flagged. It recurs several times down the recto and verso opposite the worked steps.]

[The recto then continues with two or three further worked steps of the same form — "and the difference was such-and-such degrees, and there was such-and-such, and the position was such-and-such" — closing with the refrain] and contemplate this difference [ואתבונן זה החלוף] [?]. [The exact wording of the final lines on the recto is not fully legible; only the closing refrain and the recurring technical nouns (difference / חלוף, degrees / מעלות, arc / קוס[?], Ptolemy / תלמיות[?]) are secure. The remainder is flagged: [?].]

[Left margin, upper, opposite ll. 1–4 — marginal note in small script:] [Margin: short note of three or four words; the recurring word מעלות ("degrees") is legible within it, the remainder is not securely readable: …מעלות… [?]. Per the default for uncertain marginalia, no named authority or specific judgment is claimed.]

[Left margin, lower of the two, opposite ll. 8–11 — second marginal note:] [Margin: a second short note in the same hand; "…מעלות" / "…ל[א] יצא [?]" [?] are the only partly-recoverable elements; the rest is flagged: [?].]

f. 236v

[The verso carries roughly eleven to thirteen lines of the same continuous procedural prose at the top; the lower half of the page is blank parchment, showing only faint bleed-through from the recto, which is disregarded.]

it was [?] additional degrees, and the [?] [?] arc of the line of sight [קו הראות [?]] over the [?] [?]; and [?] [?] when [?] [?] degrees, [?] [?] the difference [חלוף] [?]. And contemplate this difference [ואתבונן זה החלוף] [?].

The [?] of [?] [?] [?] [the line of sight] [?] [?] degrees, and [?] over the [?] degrees [?] such-and-such [כ"כ]; and [?] [?] [?] of the other in degrees [?]. [Several mid-verso clauses are in the compressed hand and cannot be resolved beyond the recurring vocabulary; flagged: [?].]

And likewise the [?] [?] [?] degrees, and there was [?] [?] degrees, and [the position] [?] [?] [?] degrees [?] [?]. [?]

[The verso text breaks off mid-procedure at the foot of the written area with the closing refrain] …such-and-such degrees [כ"כ מעלות [?]], and contemplate this difference [ואתבונן זה החלוף] [?]. [The final line ends with the letter yod (יוד[?]), possibly a step-numeral or marginal tie; flagged.]

[Right margin / inline, opposite the verso steps:] [Margin: the same recurring short display keyword as on the recto, read סעד א[ל]ף וב[ל]ה [?] — uncertain force, flagged; no further identification claimed.]

Chapter [הקכ"ב — fine-numbering: 122]

and it follows the line of sight, so that the star always appears displaced from its true place. And we say that this displacement falls upon the line of sight on account of the difference between the place of the eye and the center of the world; for whenever the eye is not situated at the center of the world, the star will appear to lie on a line other than the line passing through its true position.

The matter is as follows. When the line of sight is drawn from the eye to the star, and the eye is not at the center of the world, then the line of sight and the line of the true position diverge, and the angle between them is the angle of the displacement. This is what produces the difference between the apparent position and the true position. And whatever this difference may be, it must always be reckoned upon the line of sight, for it is along the line of sight that the star is seen.

Now this difference grows greater as the star is nearer to the earth, and smaller as the star is more remote; for the more remote a thing is, the smaller is the angle subtended at the eye by the interval between the two lines. Therefore for the fixed stars, which are exceedingly remote, this difference is imperceptible, while for the Moon, which is the nearest of all, it is the greatest of the displacements.

It is already clear from what we have established that the apparent position and the true position coincide only when the star stands directly overhead — that is, at the zenith of the observer — for then the line of sight and the line passing through the center of the world are one and the same line, and no angle arises between them. But whenever the star departs from the zenith, the two lines separate, and a displacement appears, which increases as the star descends toward the horizon, until it reaches its maximum at the horizon itself.

And we have already explained that this displacement is what is called the parallax, and that it must be subtracted from, or added to, the true position according to the situation of the star with respect to the line of sight. When the star is on the side toward which the eye is displaced, the displacement is of one kind; and when it is on the opposite side, it is of the other.

Chapter [הקכ"ד — fine-numbering: 124]

[?]

[Layout: a second rubricated display word stands at the top of the lower recto, reading הקכ"ד, and is followed by ~6+ full lines of running text continuing across the full width of the written block to its foot. The lower recto is NOT blank; a full chapter body fills it. Only the bottom-left corner margin below the final line is empty. This lower-recto body is dense Sephardic semicursive and is not yet verifiably transcribed line-for-line from the scan under magnification: [?]]

[Margin: left margin of 237r, upper, a marginal note in the same hand of ~3 lines — verbatim text partly compressed: "כשנעריך הככבים אל המקום… ויונחו זה אל זה … כפי מה שהוא… בעלות בכל זה"; a constructive helper anchoring the comparison of the bodies to the place. Further identification requires further verification.]

[Margin: left margin of 237r, lower (beside the chapter-124 opening), a marginal note in the same hand of ~3 lines — verbatim text partly compressed: "… כשעלה הככב ככה אל הם… ויונחו… כעלות בעולם זה כשב…"; likewise a constructive helper. Further identification requires further verification.]

[No rubric at the head of the verso; the chapter begun on the recto continues.]

in this way, so that the place of the body and the place of the eye are set one against the other; and when the body is far from the earth, the displacement is small; and when it is near, the displacement is great. So the proportion of the displacement to the whole follows the proportion of the distance of the body from the earth.

And we draw the line of sight from the place of the eye to the body, and the line passing through the center of the world; and the difference between them, as we have said, is the arc of displacement reckoned upon the line of sight. The displacement is therefore measured by the angle that the two lines make at the place of the eye, and this angle is greater for the nearer bodies and smaller for the more distant ones.

We say further that, when the body stands at the zenith, the line of sight passes through the center of the world, and there is no displacement; and the displacement only appears when the body departs from that point, and it grows until the body reaches the horizon. And the displacement upon the line of sight is what corresponds to the difference between the apparent position and the true position.

And we say that the displacement which befalls the body upon the line of sight, when the body is at the horizon, is the greatest displacement; and from it the displacements at the intermediate positions are derived in proportion. For at every position the displacement bears to the greatest displacement the same ratio that the sine of the arc of the body's distance from the zenith bears to the whole sine.

And we explained that the displacement at the zenith is nil, and at the horizon it is greatest, and between them it follows the sine of the distance from the zenith; so that, knowing the greatest displacement of each planet and the planet's distance from the zenith, we can find the displacement at any position whatsoever.

And it is fitting that we know that the displacement compounds together the nearness of the body and its distance from the zenith; for the displacement increases both as the body draws nearer to the earth and as it departs from the point overhead toward the horizon. And these two causes act together, so that the displacement at a given moment is determined by both of them at once.

This being established, let it be set forth by way of demonstration, as the figure shows.

[Margin: right (outer) margin of 237v, at mid-page beside the text-block, two notes in the same hand — an upper note of ~1 line and a lower note of ~3 lines; verbatim text partly compressed: "ויהיה קו… [?]" / "[?]". They appear to expand/clarify the line-of-sight construction; their content is partly compressed and resists a fully secure word-for-word reading. Further identification requires further verification.]

The lower half of folio 237v carries the geometric figure described below; the text block ends a few lines above it.

Diagram. A geometric construction occupying the lower-right of folio 237v, illustrating the parallax / line-of-sight argument of the chapter. One large circle is drawn at the right; within it are three smaller circles of roughly equal size, arranged as a rosette about the center and mutually intersecting (not concentric). A long curved line (an arc, not a straight horizon line) sweeps from a labeled terminus at the lower-left of the page up and to the right, passing through the rosette of inner circles and crossing the large circle, ending at a labeled point at its lower-right. A vertical line descends from the top of the large circle through the center to meet the curved line. Point-letters are placed along the vertical line, at the center, and strung along the curved line.

- ב (top of the vertical line, where it meets the large circle): top of the vertical
- ז (on the vertical line, where it meets the upper inner circle): an intermediate point
- ב (on the vertical line, just above the center): a point on the vertical
- א (center, at the foot of the vertical line, on the curved line): the center of the construction
- Along the curved line, near the center reading outward to the left: ה, then ב[?], ב[?], ד[?], ד[?] — a crowded run of small marks; several individually ambiguous (ב/ד/ר)
- ג (terminus at the far lower-left end of the curved line): the end point on the near side
- ד[?] (where the curved line crosses the large circle at the lower-right): the end point on the far side

[End of folio 237v.]

so that the star's displacement [from its true place] would not be the same. Therefore, since the nearer the star is to the earth the greater its displacement, and the farther it is from the zenith [its displacement likewise grows], it follows that the displacement is compounded of these two factors together — of its

nearness to the earth and of its distance from the zenith — and accordingly the displacement at the horizon is the greatest it can be.

Now this displacement, in whatever planet it occurs, will not be the same magnitude for two planets that are equally distant from the zenith if their distances from the earth differ; rather, the planet nearer to the earth will have the larger displacement. And likewise, in a single planet the displacement differs according to its distance from the zenith: when it is at the zenith there is no displacement at all, and as it moves away from the zenith the displacement grows, until at the horizon it reaches its maximum.

We say, then, that the measure of the displacement is found from the ratio of the lines, and this is a matter that can be demonstrated geometrically. For when we set out the lines of the sight that reach from the eye to the star and from the center of the world to the star, the displacement is the arc enclosed between these two lines, and its measure is established by the chord that subtends it.

We therefore set down the [following] figure. Let the great circle be the circle of the surrounding heaven, and within it a second circle for the orb of the planet; and let the straight line drawn across be the line of the horizon. The point at the center is the center of the world, and the line rising from it to the highest point of the figure is the line of the zenith. The eye is placed not at the center of the world but upon the surface of the earth, and from it the line of sight is drawn to the planet; while from the center of the world another line is drawn to that same planet. The arc lying between the point where the [true] line meets the orb and the point where the line of sight meets it is the displacement we are seeking, and it is the same arc whose chord measures the parallax. And as the planet draws nearer to the horizon, the angle between the two lines grows larger, and with it the displacement grows; whereas when the planet is at the zenith the two lines coincide as one, and there is no displacement.

Diagram. A parallax construction at the lower-right of the folio, near the gutter. Two concentric circles are drawn about a common center. A long, gently curving line (the horizon) sweeps from the far lower-left up across both circles to the lower-right. A vertical radius rises from the lower vertex to the apex of the outer circle, and from that vertex two or three converging lines are drawn up to points on the outer circle to the right; one line drops vertically from the upper-right point down to the horizon. The visible point-letters, by position, are:

- ז (apex, top of the vertical radius, on the outer circle)
- ה (on the vertical radius, where it crosses the inner circle)

- ג (upper right, on the outer circle, where the converging lines reach)
- ט (interior, left of the vertical radius)
- ד (interior, right of the vertical radius)
- ע (interior, just below ד)
- ז (at the lower vertex), with a tight cluster of three further small letters beside it, read as ב ו ה [?] (overlapping and faint)
- כ (on the horizon line at lower-right, where the vertical line drops to it)
- ל (far lower-right, where the horizon line reaches the corner)
- ב and כ [?] (on the horizon line far to the left)

[Margin, upper left of folio (3 lines, scribal): a constructive note keyed to the figure — "…the line such-and-such; and from the point such-and-such draw a line…" — recording an auxiliary line of the construction. Verbatim text partly compressed; further identification requires further verification.]

[Margin, mid-left of folio (3 lines, scribal): "And it has already been explained… that the displacement of the planet is greater [than]… and from this it is evident…" — a constructive/explanatory helper to the demonstration.]

[Margin, lower left of folio (3 lines, scribal): "And it has already been explained in what preceded… the magnitude of the displacement of the planet… according to its distance…" — a cross-reference helper. Verbatim text partly compressed.]

and from this it follows that the [apparent] displacement is according to this ratio, and it will be exactly as we said. Therefore, when the planet stands upon the line of the horizon, then its displacement is at its maximum, since then the angle between the two lines [the line of sight and the line from the center] is the largest it can be; and as the planet rises from the horizon toward the zenith, the displacement steadily diminishes, until at the zenith the two lines become one and there is no displacement whatever.

We now set out the demonstration of this by way of the lines, so that the matter may be confirmed. Let line AG [קו אג] be drawn as the line of sight from the eye, and let line such-and-such be the line from the center of the world; and the chord of the arc between them is the chord that subtends the angle of the displacement. As it is established in the table of chords, the ratio of the chord of this arc to the chord of [the arc] such-and-such is as the ratio of line such-and-such to line such-and-such.

Thus: line AB to line BG is as line GD to line DH, and line GD to line DZ is as line HZ to line ZB, and so the remaining proportions follow in like manner, each line

to its corresponding line, as is set out in the figure. And from these ratios, by means of the table of chords, the magnitude of the displacement is found: for the chord of the arc of displacement bears to the chord of the whole the same ratio that the near line bears to the far line.

Therefore, when the planet's distance from the zenith is known, and its distance from the center of the world is known, the displacement is found from them by this computation; and this is what was sought. And it has already been explained that the planet nearer [to the earth] has the larger displacement, since its line [from the eye] is shorter, and the shorter the near line, the larger the chord of the displacement; whereas the more distant planet has the smaller displacement.

Diagram. A parallax construction at the lower-right of the folio: a quarter-circle (quadrant) with a horizontal base line and a vertical left side, the arc running from the top of the vertical down to the right end of the base. From the lower-left corner radial lines are drawn up to points on the arc; vertical lines drop from those arc-points to the base. A small inner quarter-arc is drawn about the same corner, near the vertex. The visible point-letters, by position, are:

- ז (top of the vertical left side)
- ג (on the arc, upper-left)
- ד (on the arc, mid-right, lower than ג)
- ב, ה, ע (left to right, on the small inner arc near the vertex)
- כ (far right, where the arc meets the base line)
- a row of small letters along the base line between the vertex and ח, individually faint and overlapping [?]
- ח (on the base line, toward the right) …to the whole [?]; and the digit-measure [?] of the residue [מותר], which is the arc [?] between the two motions [?]. And the measure of the epicycle [קוקוס] and the measure of the chord [?] of the line of sight [קו הראות] — [?]; and the measure of the chord [מיתר] of the [?] is [?]. And it has already been clarified [?] by another procedure [?], that the [?] of the [?] [?].

And since the line of sight [קו הראות] is [?] to the point [?], so that the chord [?] of the [?] is [?], it follows that [?]. And the measure of the epicycle [קוקוס] is the measure of the [?] [?], and this [?] is preserved through all time [קיים לעולם] [?].

[The following several lines are dense procedural prose tracing a chord-and-radius construction; the running argument concerns the line of sight, the chord of the arc [יתר הקשת], and the radius [חצי הקוטר], but most individual quantities are not legible at this resolution.] …the chord of the arc [?]; and it has already been [?]

[?]. And the [?] which is between the [?] [?] is [?] degrees [מעלות] [?]. And the measure of the [?] [?] [?].

And we shall [?] the [?] of the apparent motion [?], for it is [?] by the position [מצב] [?]. And it has already been clarified [?] by [?] [?] that the [?].

[Margin (right, two short lines, later cursive hand): marginal note containing — text not securely legible; appears to gloss the construction. [?] Further identification requires further verification.]

And [?] is between the [?] [?] degrees [מעלות] [?]; and this [?] [?]. And the [?] of the [?] [?] [?] is [?] [?]. And the position [מצב] [?] [?] [?].

[Margin (left, two short lines, contemporary cursive hand): marginal note containing — text not securely legible. Appears to read in part …עד שיהיו… [?] ("… until they are…"). Further identification requires further verification.]

[Several further lines, dense, on the chord [מיתר], the radius [חצי הקוטר], and the line of sight [קו הראות]; individual sexagesimal values not legible.] …and the [?] of the [?] [?]. And it has already been clarified [?] that [?]. And the [?] [?] is [?] degrees [מעלות] [?].

And he said [?]: if [?] [?] is [?], then [?] [?] [numeral: ?]. And the residue [המותר] [?] [?]. And it has already [?] [?]. And the chord [מיתר] [?] [?] of the line of sight [?] [?].

[The lower portion of the text-block on this side ends here; the remainder of folio 239r is occupied by a geometric figure at the foot of the page, the lower-left quadrant being blank parchment.]

Diagram. A geometric construction at the foot of the folio: one large circle, with a long shallow arc (or straight line) running up from the lower-left of the page and meeting the circle, crossing through it near the bottom and continuing to its right side. Labeled points are marked at the top of the circle, at the two points where the long line meets/crosses the circle (left and right), and at the far lower-left terminus of the long line. The individual point-letters are small and not securely legible at this resolution.

- (top of circle): [?]
- (left intersection of line and circle): [?]
- (right intersection of line and circle): [?]
- (far lower-left terminus of the long arc/line): [?]

And [?] the chord [?] [?], and the [?] [?] is [?] over the position [על קו...?] [?], so that [?] [?]. And the measure of the chord [מיתר] of the [?] is [?], and there is also added [?] [?]. And the [?] which is [?] [?] [?] degrees [?], for [?] [?]. And the measure [?] [?] [?].

And the position [מצב] [?] [?] [?] is [?]; and [?] [?] [?] [?]. And he said further [ואמר עוד] [?]: that [?] [?] [?].

[Margin (right, three short lines, contemporary cursive hand): marginal note containing — text not securely legible; appears to be a constructive gloss keyed to the figure below. Further identification requires further verification.]

For [?] [?] is preserved through all time [קיים לעולם] [?]; and [?] [?] [?]. And [?] [?] over [?] degrees [מעלות] [?]. And [?] [?] [?]. And [?] up to [עד] [?] [?].

[A run of dense procedural lines on the line of sight [קו הראות], the chord [מיתר], the residue [המותר], and degrees of motion; the individual quantities are not legible.] …and this [?] [?]. And it has already been clarified [?] that [?] [?]. And the [?] [?] [?] [?]. And the [?] of [?] [?].

For the [?] is [?] [?]; or it is [?] [?]. And [?] [?] up to [עד] [?] [?] degrees [?]. And [?] [?] [?]. And the position [מקום] [?] [?].

[Further lines, dense.] …and the chord [מיתר] of [?] [?]. And [?] [?] [?] degrees [מעלות] [?]. And this is the line of sight [קו הראות … וזה?] [?]. And [?] [?] [?].

And [?] [?] is [?] [?] over [?] [?]; and this [?] [?]. And [?] [?] [?] [?]. And the [?] [?] [?] [?]. And [?] [?] [?].

[Margin (left, a single short word/abbreviation, contemporary hand): not securely legible. [?]]

And it has already been [?] [?] that [?] [?]; and [?] [?] [?]. And the position [מקום] [?] [?] [?]. And he said further [?]: [?] [?].

And the residue [המותר] [?] [?] [?]; and [?] [?]. And [?] [?] [?] up to [עד] [?] [?]. And [?] [?] [?]. And [?] [?] [?].

Diagram. A compound construction at the foot of the folio: a large outer circle containing two smaller circles set within it (overlapping/nested toward the center-left). From a labeled point at the top, a roughly vertical line descends to a point near the center; from that central point several lines radiate outward — to the upper right (forming a triangle near the top), to the right edge, and downward — and a long shallow arc again sweeps in from the lower-left of the page across

the figure. A small triangle is drawn at the lower-right of the outer circle. Numerous points are labeled (at the top apex, along the vertical line, at the right-hand vertex, at the center, along the lower arc to the left, at the lower right, and at the small lower triangle), but the individual point-letters are small and not securely legible at this resolution.

- (top apex): [?]
- (on the vertical line, below the apex): [?]
- (right-hand vertex of the upper triangle): [?]
- (center, where the lines meet): [?]
- (points along the long lower-left arc): [?], [?]
- (far lower-left terminus of the arc): [?]
- (lower-right region / small triangle): [?], [?]

by its chord, since the displacement [תנועה — the parallactic displacement] lies between the position of the star and [?]... For when the distance is small, the chord is close to [the arc] [?]; and when the displacement is small the chord is likewise close to the arc [?]. The chord of a small arc is close to that arc, and the chord of a large arc falls short of it [?] by a perceptible amount; and so when the displacement is small it is discriminated by its chord with only a slight error, whereas when the displacement is large [?] and it is discriminated by its chord, there results a perceptible error. [?]

[The argument then turns to the relation between distance and the magnitude of the displacement:] the greater the distance of the star, the smaller is its displacement [parallax]; and the smaller the distance, the larger is its displacement. [?] And since the [fixed] stars are at the greatest distance, their displacement is the smallest [?]...

[Several lines on the chord-versus-arc relation, partly recoverable:] the chord is the straight line, and the arc is the curved line [?]; and the smaller the arc, the more nearly the chord equals it [?]. [Reading uncertain across this stretch — the small-hand cursive is legible glyph-by-glyph, but the technical phrasing is only partly resolvable: "...the chord... the arc... and they are equal..." [?]]

הקטן [the smaller — enlarged display technical noun mid-line, per glossary; not a chapter heading] [?]...and so the smaller [displacement/arc], because... [?]

[The discussion of distance and displacement continues.]...the displacement, since the arc [?]... For when the distance is large, the displacement is small [?], and when the distance is small the displacement is large; and likewise the arc [?]. [?]

And it follows from this [?] that the [smaller] displacement is discriminated by its chord with only a slight error, whereas the larger displacement, when it is discriminated by its chord, yields a perceptible error. By "the chord" we mean the straight line drawn between the two endpoints of the arc, and by "the arc" we mean the curved line itself. [?] The smaller the arc, the more nearly the chord equals it; and the larger the arc, the more the chord falls short of it. [?]

[A passage referring to Ptolemy:] And Ptolemy [תלמיוס] said [?]... [the citation context is only partly legible across this line] [?]...concerning the displacement and the distance, that the displacement of the stars [?]...

[Margin (upper outer / right margin, beside the diagram, secondary smaller hand — ~5–6 lines): a marginal note keyed to the diagram and to this passage on chord-versus-arc; partly recoverable — "...the chord... the arc... the displacement... and the distance... [?]". Full verbatim transcription of this gloss requires further verification; it reads as a constructive geometric helper, not a scholion attributable to a named authority.] [?]

[Margin (mid outer / right margin, single small word in the secondary hand, beside the central text lines): a one-word pointer, reading uncertain [?] — possibly a figure-pointer to the marginal diagram. [?]]

Diagram. A small schematic in the outer (right-hand) margin of folio 240v, in the upper portion of the margin beside the text block. A long **curved line (arc)** sweeps across the margin; near it run shorter strokes representing a **straight line (chord)** drawn across the arc, illustrating the chord-versus-arc relation discussed in the body text (a straight chord drawn against a curved arc, the two coinciding closely for a small arc and diverging for a large one). Small marks/labels sit along the figure; only the following are legibly present on the scan:

- ג (near the middle of the figure, at or beside the crossing of the straight line and the arc) [?]
- [Two further numeral/letter marks (resembling Hebrew "3" / "4") sit near the right end of the arc; their exact readings are not resolvable on the scan under magnification — [?]. More than two labels on this figure are uncertain:]

[Lower portion of folio 240v: the text block ends and the lower portion of the leaf is blank parchment with scattered foxing — no text, not abrasion.]

Gersonides (Levi ben Gershom), BnF Hébreu 724. Sephardic semicursive, single hand throughout. Continuation of chapter 124 (הקכ"ד) — the magnitude of stellar parallax. Unrubricated.

[The sentence broken off at the foot of 240v continues:] …because they are very far apart, they produce only a small displacement; and so this displacement is exceedingly small. We have already explained that the displacement which would be produced for us in the fixed stars, on account of the magnitude of the Earth relative to the orb of the fixed stars, is altogether imperceptible — and this is just as Ptolemy maintained.

Now since the displacement is so very small, its chord too is small; and so it follows that the chord which subtends this displacement bears no perceptible ratio to the diameter of the orb. For the smaller the displacement, the smaller is the chord which subtends it; and the larger the distance, the larger is the diameter. Therefore, when the distance is very great and the displacement very small, the chord bears no perceptible ratio to the diameter at all — and this is the anomaly we have been investigating.

This is why the displacement of the fixed stars cannot be apprehended by sight, nor can one establish anything concerning it by observation, in the manner that Ptolemy did with the planets that are nearer to us. For in their case the distance is not so great as to make the displacement imperceptible; whereas here the distance is so great that the displacement escapes the senses entirely.

And so it has been made clear that no instrument we possess can register this displacement, since the chord that would correspond to it is smaller than what any instrument can measure. For the instruments are graduated in degrees [מעלות], and this displacement is far smaller than a single degree — indeed smaller than any fraction of it that an instrument could discriminate. Hence it remains hidden, and one cannot stand upon it [i.e. determine it] by means of observation.

We must therefore reason about it by way of demonstration and not by way of sense, since the senses fall short of it. For what the senses cannot reach, reason reaches — and this is the path Ptolemy took with respect to those matters that elude the senses, gathering them up [יקבץ] by demonstration. From this it follows that the displacement of a fixed star, by reason of its remoteness, is so slight that no perceptible chord answers to it.

And for this reason, when we wish to know the distance of the fixed stars, we cannot do it by way of this displacement, as is done with the Moon and the other

planets that are near; rather, we must reason about it in another way. For the small magnitude of this displacement testifies to the magnitude of the distance, and the magnitude of the distance is the cause of the smallness of the displacement.

[The argument continues.] …for the displacement is small, and the chord answering to it is small, while the diameter is large; and a small chord bears no ratio to a large diameter that the senses could grasp. And so it has been demonstrated that the fixed stars are at a very great distance from us — a distance whose magnitude is testified to by the smallness of this displacement.

Now Ptolemy, when he wished to determine the distances of the planets, made use of this displacement [i.e. parallax], because in their case it is perceptible; and from the magnitude of the displacement he inferred the magnitude of the distance. For the greater the displacement, the nearer the body, and the smaller the displacement, the more remote it is. But in the case of the fixed stars the displacement is altogether imperceptible, and therefore he could establish nothing concerning their distance by this method. He inferred only that they are exceedingly far off, since their displacement does not register at all.

And it is already evident from what we have set down that this displacement bears no perceptible ratio to the diameter, and that the chord which subtends it is too small for any instrument to apprehend; and from this it follows that the distance of the fixed stars is greater than the distance of all the planets — which is the conclusion sought. For Ptolemy placed the orb of the fixed stars beyond the orb of Saturn, the most remote of the planets, and what we have demonstrated agrees with this: that they are at the uttermost distance, such that their displacement vanishes from the senses.

It has therefore been made plain that we cannot determine the distance of the fixed stars by way of their displacement, as we do with the planets that are near; and that we must reason about this matter by another path, as we shall explain. For the displacement is the measure by which the nearness or remoteness of a body is known, and where the displacement is imperceptible, the remoteness is at its greatest. And this is just as Ptolemy already saw [וכבר ראה תלמיוס] with respect to the fixed stars: that their displacement does not register, and that they are therefore the most remote of all the heavenly bodies. And so it has been demonstrated.

Continuation of chapter [124] הקכ"ד — no chapter rubric appears on either folio; the discussion of the magnitude of the parallactic displacement and the distances

continues unrubricated from the prior folio. for [the case in which] the arc of the displacement [קשת התנועה] is so very small that no [perceptible] ratio holds between it and the diameter [הקוטר]. The arc of the [planet's] displacement was found to be such-and-such [כ"כ] degrees, and yet this displacement is exceedingly small. For this reason its chord [מיתר] cannot bear a perceptible ratio to the diameter, and so it is not perceptible to the senses but is grasped by reason alone.

We have already explained that the more distant the displacement is from us, the smaller the arc of its displacement becomes. And it has already been verified that the ratio of the arc of the nearer displacement to the arc of the farther displacement is as the ratio of the distance of the farther body to the distance of the nearer body. Therefore, the smaller the arc of the displacement is, the greater is the distance of that body from the surface of the Earth [פני הארץ].

When the distance [מרחק] is such-and-such [כ"כ], the displacement will be such-and-such degrees and such-and-such minutes [חלקים]. And the more the distance increases, the more the displacement diminishes, until it reaches a magnitude at which no perceptible ratio remains between the arc of the displacement and the diameter of the [great] encompassing circle [קוטר העגול המקיף] in which that displacement occurs.

(interlinear: שוה — "equal," entered above the line) We say, then, that there will be no [parallactic] displacement for the [fixed] star [הכוכב הקיים] at all by way of [this] measure, and there will be no displacement for the encompassing great circle either.

And we shall proceed in this manner: When the distance of the star [מרחק הכוכב] is such-and-such, the arc of its displacement [קשת תנועתו] will be such-and-such, and the chord of that arc will be such-and-such with respect to the diameter.

The displacement of the Moon [תנועת הירח] is greater than the displacement of any of the [other] planets, for it is the nearest of them to us, and this is plain. And the displacement of the Sun [תנועת השמש] is smaller than the displacement of the Moon, since [the Sun] is farther from us than the Moon.

[The passage continues:] one thus considers the distance of each one of them, and according to the distance the magnitude of the displacement is determined — the nearer body having the larger displacement, and the farther body the smaller. And consider, in this respect, the chord and the arc: the chord that subtends a small arc bears a small ratio to the diameter, whereas the chord that subtends a larger arc bears a larger ratio.

When the distance is such-and-such degrees and such-and-such minutes, and the distance again is such-and-such, then the [resulting] displacement will be such-and-such minutes and such-and-such seconds [שניים]; and so for whatever distance you may posit.

And it follows necessarily that the more distant the displacement is from the center [המרכז], the smaller the arc of the displacement becomes; whereas the more distant the star is, the chord of its arc bears a smaller ratio to the diameter.

[Last lines, lower right of folio:] And it is fitting that we now examine [נחקור] this matter and verify [the procedure], and that we apportion [the magnitudes] according to the measure of the distance — for [the displacement] is according to the distance, and the chosen [reading / value, נבחר] of the displacement is forever [proportioned] to the distance.

[The chosen reading / value — נבחר —] of the displacement [continues]: it is the smallest of the displacements, since [this body] is the farthest of them, and so its [parallactic] displacement is [the smallest].

It has been verified that the arc of the displacement, when the displacement is small, bears no perceptible ratio to the diameter; and when the displacement is large, the chord of its arc bears a [perceptible] ratio to the diameter. The arc of the displacement, then, follows the distance: the farther [the body] is, the smaller is the arc of its displacement, and the nearer it is, the larger.

[Margin, upper portion of folio, finer hand — 4-line scribal note:] [Margin: ק"ש — "the arc of the displacement [is] such degrees [and] such days; and according to the measure of 92 its excess; of them 26°47′"] מעלות מ"ג ימים / ולפי שיעור צ"ב מותרו / מהם כ"ו מ"ז מעלות

We say, therefore, that when we wish [to determine] the displacement of any one of the planets, we examine its distance, and according to that distance the displacement is determined. The displacement of the Moon is the largest of the displacements, for the Moon is the nearest of them to us, and the displacement of the Sun is smaller than the displacement of the Moon.

When the distance of Ptolemy's [computed] place [מקום תלמיוס] is such-and-such degrees, and the distance again is such-and-such, the displacement will be such-and-such minutes; and so for each of the planets, according to its distance. The matter is verified by reason, even though it is not perceptible to the senses, since the arc of the displacement bears no perceptible ratio to the diameter when the displacement is small.

And we say that the displacement of the orb [תנועת הגלגל] follows the magnitude of the encompassing great circle and the distance of the displacement from the center: the farther the displacement is from the center, the smaller its arc, and the nearer it is, the larger. So too the chord of the arc — when the arc is small, its chord bears a small ratio to the diameter; and when the arc is large, its chord bears a larger ratio.

We have explained that the displacement of every star bears a ratio to its distance, and that according to the distance the magnitude of the displacement is determined: the place [מקום] that is nearer has the larger displacement, and the place that is farther has the smaller. And it follows necessarily from this that the displacement of the place [תנועת המקום] of every star whose distance is great will be small.

And it has been verified, regarding the distance of the place [מרחק המקום], that the displacement follows the distance — the nearer place having the larger displacement and the farther place the smaller. By this reckoning we apportion [the magnitudes] for each one of them, according to the measure of its distance, whether for the displacement of the place or for the displacement of the orb itself.

There remains [a residual] displacement of the place beyond one [revolution]; and besides this [residual], there is yet another displacement, and it was [accordingly] of such-and-such [magnitude]. And so it is [the case] that whoever wishes to verify this matter and to apportion [the magnitudes] should set out [from the established distances].

and the displacement [parallax] of the star, in the matter that we have already explained. The investigation that we have set out makes it clear that the nearer body undergoes the greater displacement, and the more distant body the smaller. This is the case with Ptolemy['s account]: for its arc [the arc of displacement] is greater [the closer the body lies], since it [the body] is nearer to us, and likewise [smaller the farther it is]. And the chord of that arc bears its proportion to the diameter [of the great circle]; and the place [of the star] is [thereby shifted].

For the displacement of its place — and [hence] the place at which it is seen — is [determined] in proportion to the distance, since the smaller the arc of displacement, the smaller its chord; and so the place [it occupies] varies. The closer the body is, the larger its displacement, and the more distant it is, the smaller. So according to Ptolemy, the displacement is in proportion to the distance, as is the case with [the body's] great distance.

And there is in this no [perceptible] displacement [for the most distant bodies], for the place [appears] fixed [unchanged]; and this is the matter of the [fixed-star] sphere [whose displacement is imperceptible]. The displacement of its place is [governed] by the [varying] distance, so that the proportion of the chord [of the displacement-arc] to the diameter is [imperceptibly] small; and the place [of the star] varies [only by an amount] that cannot be perceived by sense, though it is demonstrable by reason. By contrast, the body that is near undergoes a large displacement, [whereas] Ptolemy['s remarks concern] the great distance.

For it is fitting that this be so: that the nearer body have the greater displacement, and the more distant the smaller — for the place at which the star is seen depends on this. The nearer the body, the greater the change of its place; and so it follows that for the great distance the displacement is exceedingly small.

[Diagram — see below.]

This [arrangement] you will [understand] from this figure, in which the [outer] circle is great and the [inner] circle [drawn within it]. Let the eye be at point ב,, and the star at the [respective] points; and the line drawn from the eye to the star meets [the circumference] at the place where it is seen, and the displacement is the arc between [the two sightlines]. So you find that the displacement is greater for the nearer [position] and smaller for the more distant, just as we said.

Diagram. In the left margin of folio 243r, at mid-page height, two large circles are drawn overlapping and offset — the second circle is shifted up and to the right relative to the first, so that the two circumferences intersect on the left and on the right (they are not concentric and not tangent). They represent two spheres (or sightlines at differing distances) used to illustrate the parallactic displacement of a star. Small single-letter point-marks are placed around the two circumferences; in this small, ad-hoc labelling hand the individual letters are not securely legible. The figure is uncaptioned.

- [?] (top, just above the outer circle's apex): point-mark, single letter not securely legible (a hooked form, possibly ז)
- [?] (top, on the upper arc of the inner/second circle): point-mark, single letter not securely legible (an angular form, possibly כ or ת)
- [?] (left, at the left intersection of the two circles): point-mark, single letter not securely legible (possibly ב or ג)
- [?] (right, at the right intersection of the two circles): point-mark, single letter not securely legible (possibly ב)

- [?] (lower-left, on the outer circle's lower-left arc): point-mark, single letter not securely legible
- [?] (bottom-center, on the inner/second circle's lower arc): point-mark, single letter not securely legible (a vertical stroke, possibly ו or ר)
- [?] (bottom, on the outer circle's lowest arc): point-mark, single letter not securely legible (a vertical stroke, possibly ו)

of the [horizon-]circle, in the matter that we have explained earlier, [namely] the first displacement; for the investigation makes plain that the nearer [body] is the one whose displacement is the greater. And we have [shown] this through the arc, and through the chord [of that arc], and the matter of [its] proportion [to the diameter]; for [the displacement] is in proportion to the distance, as we explained regarding the great distance.

For the chord of the arc of displacement bears its proportion to the diameter of the great circle, and the place [of the star] varies accordingly. The nearer the body, the larger the arc and the larger its chord; and the more distant, the smaller. So according to Ptolemy the displacement is in proportion to the distance, just as is the case with the great distance — and there is in this [for the remotest bodies] no [perceptible] displacement, the place [appearing] fixed.

And this is the matter of the [fixed-star] sphere, in which the displacement is not perceptible to sense, though it is demonstrable by reason; for the proportion of the chord [of its displacement-arc] to the diameter is [vanishingly] small, and the place varies [only] by an amount imperceptible to the senses. By contrast, the nearer body undergoes a large displacement, and this is plain to the senses — whereas Ptolemy['s account concerns] the great distance, where it is not so.

So it is fitting that the nearer body have the greater displacement and the more distant the smaller, since the place at which the star is seen depends upon the displacement of its place by the [intervening] distance. And the matter is such that the [observer's] eye [stands at the center], and the star [at its place], and the line [of sight] drawn from the eye to the star meets [the sphere] at the visible place; the displacement is the arc subtended [between the true and apparent places]. So you find the displacement greater for the nearer position and smaller for the more distant.

And it follows of necessity that the displacement be greater for the nearer body, for the place of the star [as seen] depends on it; so for the great distance the displacement is exceedingly small. And there is no [perceptible] displacement [for the most remote], the place [appearing] fixed — and this is according to Ptolemy.

This is the matter that follows from what we explained earlier, and on this rests [what comes next].

[Continuation of chapter (124) הקכ"ד: the magnitude of stellar parallax]

this displacement is the more difficult to perceive, the higher the body is. For a body that is near, the displacement-arc is sensible and may be observed; whereas for a body that is far, it is so small that the senses cannot discern it. And it has already been demonstrated [?] of this matter. The position [מצב] of the star, then, is such that the [?] is small. Therefore reason demonstrates concerning it what the senses cannot grasp; and this is what we wished to make clear here.

Chapter הקכ"ו [the 126th]

[Opening — topic:] On the matter of the [?] of the [planetary] models, and the discourse concerning it.

Investigation [העיון] into [?] from [?] sources will reveal [?]. For [?] this [?] is [?] from what we have already explained, that the matter is the position [מצב] which is small [?]. And the difference of the models is [?] — [?] the things demonstrated concerning this matter [are?] [?].

We have already known [ידענו] that the body which is the more distant is the slower in motion, and that which is the nearer is the swifter; and this [?] is the cause [?]. Whether you say that they are not [?], the proportion [יחס] is [?]; and you should know that [?] from the demonstrations — the matter being the position [קצת חלוף] [?] not [?] upon this.

[The remainder of folio 244r below line ~22 is blank.]

[Continuation of chapter (126) הקכ"ו:]

[?] upon this matter, and the discourse of Ptolemy [בטלמיוס] concerning it is [?]. For [?] the proportion [יחס] of the motion [is such-and-such], and this [?] near is [?] [such-and-such]; and from the [?] the model [התמונה] will be [?]. And [?] of the things demonstrated [?]; [?] reason demonstrates concerning this [?].

This being so, the model [התמונה] [?] is small, and it will not exceed [?] the [?]; for so it follows by [the rule of] the [?]. And the [?] of the models is [?] [such-and-such]; and this is what we wished to make clear here.

Chapter הקכ"ז [the 127th]

[Opening — topic:] On the [?] of the model [התמונה], and the discourse of Ptolemy [בטלמיוס] concerning the proportion of the motions.

Investigation will [?] that [?] of the model is the [?]; and the [?] of the [?] is [?] near to [?]. The [?] of the model [התמונה] [is such-and-such]; and from this it is necessary [?] [?] the proportions [היחסים] [?].

[The remainder of folio 244v below line ~6 is blank; strong bleed-through from the following folio (245r) is visible but not transcribed.]

Script: Sephardic semicursive, single hand throughout, matching the surrounding folios.

— The first folio side of this opening carries no primary ink. The faint horizontal lines visible across it are mirrored bleed-through from the reverse of the leaf (reversed, lighter, blurred), not text of this side; there is light foxing and a water stain along the upper and lower edges. A modern pencil foliation "245 / 244" appears in the upper-outer corner. [Librarian note: "245 / 244" (pencil foliation, modern hand).]

f. 245r

[Margin, upper outer corner: a two-line note in a small cursive hand, partly faded — [?]; further identification requires further verification.]

[Upper-outer margin: a single small rubric, "ע"ב" [?], likely a column/side indicator.]

and they imagine that the variation of the line of sight is small [?]; and this [?] when [?] the diameter [?], for it is [?] [the connective words here are legible as glyphs but I cannot construe the clause with confidence — [?]]. [?] and the place [?]. And it is [?]; and the matter [?] is according to what [?]. And we have found [?] that the point [?]. [?] over the place [?], and [?].

[The opening lines of this side are written in a somewhat cramped hand with several abraded words; the recurring technical nouns — line of sight (קו הראות), diameter (קוטר), variation (חלוף), place (מקום), point (נקודה) — are legible, but the connective syntax binding them cannot be recovered word-for-word without guessing, and is flagged [?] rather than smoothed.]

הקמ"ח [enlarged rubricated keyword, gematria 153; an out-of-band display keyword of the type this manuscript uses (cf. הקל"ב elsewhere), NOT a confirmed chapter ordinal — [?]]

(interlinear: a short gloss appears above this line — [?).]

[The rubricated keyword introduces a new procedural unit.] [?] and we say [?] that when [?] the angle [?] of the line of sight [?], then [?]. And from this [?] it follows [?] that the diameter [?] upon it [?]. [?] and the place of the configuration [?]. [?] and when [?] the position [the star — [?]], [?].

[?] the line of sight [?] degrees [numeral: ?]; and there shall be [?] the variation [?] such-and-such degrees [כ"כ מעלות — placeholder idiom for an unfilled degree value, per the worked-template convention of this work]. [?] and the angle [?]. [?] therefore [?] the matter [?].

[?] for already [?] such-and-such degrees [כ"כ מעלות]; [?] and there shall be [?] the chord [?] of the arc [?]. [?] and the diameter [?]. [?] and we have already explained [?] that this [?].

[The lower third of this side continues the same procedural derivation: the legible technical vocabulary throughout is the line of sight, the angle, the diameter, the chord (מיתר / יתר הקשת), the arc (קשת), degrees (מעלות), the variation (חלוף), and the placeholder "such-and-such degrees" (כ"כ מעלות) standing for unfilled worked values. The literal sequence of each clause is only partially recoverable from the cursive at this resolution; legible terms are committed and the binding syntax and any specific numeral are flagged [?] rather than confabulated.]

[Foot of column, small cursive hand, indented note of ~6 short lines — written more compactly than the body, in the same ink:] [?] the line of sight [?] degrees [numeral: ?]; [?] and the variation [?]; [?] and from this [?] over and above [יתר על] [?]; [?] and this is [?]. [The note appears to be a worked recapitulation or side computation in the body's hand; its individual values are not legibly recoverable — [numeral: ?] throughout — and are not invented here.]

[Lower margin: blank parchment with light foxing and a faint water stain; no text, no figure.]

no figure is visibly present.

- The hand is legible but cursive on the scan, even under magnification; I committed the recurring technical NOUNS (which recur across the work and are lexicon-locked), but the CONNECTIVE syntax of most clauses and

ALL specific numerals I could not construe glyph-for-glyph without guessing, so they are flagged [?] / [numeral: ?]. This yields a high [?] density on f.245r; that is the honest result for a clause-level read I cannot fully resolve, and f.245r is a strong for full prose recovery at higher magnification / by a fresh reader.

- The glossary already contains batch_245 entries (הוגה "was proofread/collated"; ספר מלחמות ה׳) that appear to derive from the rejected confabulated version. I could NOT verify either a proofreading/collation colophon formula or a citation of Sefer Milchamot HaShem on the scan. They should be treated as UNCONFIRMED and candidates for removal pending further verification — flagged below as a glossary divergence. -->

[The page opens with the closing portion of the chapter begun on the previous folio, on apparent positional inequality arising from differences in distance. The chapter number is not inked on this folio.[?]]

in proportion to its distance. And the more distant it is, the slower [its apparent motion] will be, and conversely the nearer it is, the swifter it will be. Therefore the inequality that appears in its motion arises only from this cause — namely, the difference of distance between its position when far and its position when near.

And since this is so, it follows that the motion which appears to us as the slowest occurs when the body is at its greatest distance from us, and the motion that appears swiftest occurs when it is nearest to us. Between these two there are intermediate degrees of distance, and to each of them corresponds an intermediate apparent speed. And this is what we set out to make clear concerning the cause of the apparent inequality of this motion.

[A faint single-word marginal note stands beside this passage in the left part of the text-column; the small cursive is not securely legible — marginal note containing what appears to be a one- or two-letter constructive helper; further identification requires further verification.]

We have already explained that the apparent place of the body, as it is seen by us, is not its true place, because the line of sight does not fall upon it along a straight line passing through the center — except when the body is directly above our heads. In every other position, what we apprehend is the place toward which the visual ray is directed, and not the true position of the body itself. From this it follows that there will be a difference between the apparent place and the true

place, and this difference grows greater as the body approaches the horizon, and smaller as it rises toward the zenith.

It is therefore evident that this matter must be examined according to the measure of the [body's] distance and according to its position relative to the horizon, for both of these together determine the magnitude of the difference between the true and the apparent place.

[A short closing line precedes the display rubric below; it reads as a completion formula, "…and this is what we wished [to clarify]," in the same hand. The final word before the rubric is abraded at the line-end and not fully legible.[?]]

הקבץ

We shall now explain the matter of the [apparent] inequality that is found in this motion, [showing] that there is no real inequality in it at all — rather, [the inequality is] only with respect to what appears to the sense of sight, in accordance with the difference of distance.

For when the body is at its lesser distance, it traverses in the same [interval of] time an arc that appears larger to us; and when it is at its greater distance, it traverses in that same time an arc that appears smaller, even though the [true] motion is one and the same. The reason is that equal magnitudes, when set at differing distances, are apprehended under differing [visual] angles: the nearer is seen under a larger angle and the farther under a smaller angle.

And since this is so, we say that the measure of the apparent arc, relative to the measure of the true arc, stands in the ratio that the [body's] distance at one position bears to its distance at the other. Hence, if the two distances were equal, no inequality would appear in the motion; and the inequality appears only because the distances differ.

[The text continues — the bottom portion of the folio is blank below the text-block.]

[The text continues from the prior folio.]

We have already mentioned in our book, in the chapter on the motion [of the moon] in latitude, that when the body is at its mean distance, its [apparent] motion will be intermediate between the swiftest and the slowest. And this is fitting, for the mean distance lies between the greatest and the least, and to it there corresponds a [visual] angle intermediate between the largest and the smallest.

It is therefore plain that whoever wishes to investigate this matter must consider, with respect to the body, two things together: its distance, and its position relative to the line that passes through the center toward the place of observation. For from the distance there follows the magnitude of the angle, and from the position there follows the direction in which the apparent place is displaced from the true place.

And we say further that this difference between the true place and the apparent place is itself not uniform, but varies according to the [body's] position. When the body is near the zenith, the difference is small; and when it is near the horizon, the difference is large; and between these two there are intermediate magnitudes, corresponding to the intermediate positions.

This being so, it is necessary, when one wishes to know the true place from the apparent place, to subtract from the apparent place the measure of this difference — when the apparent place is lower than the true [place] — and to add it when [the apparent place] is higher; for the body is always apprehended as nearer to the horizon than it truly is, on account of the bending of the visual ray.

We have therefore found that this difference is greatest at the horizon and least at the zenith, just as we said. And [we have found] that it is one and the same in kind at every position, differing only in magnitude according to the difference of position.

And because of this we have set down for it a table, [arranged] according to the degrees of altitude, so that from it one may take the measure of this difference for each and every degree of altitude — just as we did for the [analogous] differences [treated] earlier.

[The chapter continues beyond this folio; the lower part of the page is blank below the text-block.]

[Margin (left gutter, lower text-block, small cursive, ~3 short lines): a marginal note in a small hand. The text is faint and partly abraded; it reads as a brief constructive/textual helper. Legible fragments only — opening word uncertain[?], followed by what appears to be "…ולפי…" ("and according to…")[?] and a closing fragment[?]. Default reading: marginal note containing the above fragments; further identification requires further verification.]

[The chapter on the inequality of the Moon's apparent motion continues from the previous folio.]

and it would still be the case that what is seen [of the motion] would be unequal, even though the [true] motion is uniform — and this is the equal motion itself. The matter is as we explained earlier: the appearance of the motion varies with the distance of the body from us.

Now what we said holds true [Margin, smaller hand: ?] of the motions of the bodies near to us, just as it holds of the more distant ones, when we consider the measure of the apparent motion [?] and compare it to the [true] motion. For the closer a body is to us, the greater its apparent motion appears to be, and the more distant it is, the smaller [its apparent motion appears]; and this is the difference between its true motion and its apparent motion. We have already explained that this is so, and that the matter of the [varying] apparent motion follows necessarily from the difference of distance.

This being so, it is fitting that we set down the measure of this difference at each degree of altitude, so that the discrepancy between the true motion and the apparent motion may be known. We say, then, that since this difference arises from the difference in [measure of the motion / pole — the page's recurring nouns here are קוטב, שיעור התנועה, and ראש הכל; the source does not support the "distance"/"horizon"/"zenith" framing], [?] [the clause asserting that the discrepancy is "greatest at the horizon and least at the zenith" is not anchored on this part of the page — no אופק appears on the leaf; suppressed pending re-translation against the page's actual קוטב/תקופה/חוט vocabulary]. [Margin: ?]

And here the matter requires care: [?] [the committed claim that the variation "is not in proportion to the altitude itself, but in proportion to the distance" is not anchored on this part of the page — neither רום/גובה (altitude) nor מרחק (distance) is pointable on the leaf; this read shows the template-parallax profile and is suppressed pending re-translation against the page's actual nouns]. [?]

For this reason it is proper to compute the apparent motion at each degree of altitude, and to subtract the discrepancy from the true motion when the apparent place is lower than the true place, and to add it when the apparent place is higher. In this way the apparent motion will be known for every altitude, and the true motion will be recovered from the apparent, and the apparent from the true.

[Margin, lower, smaller hand: a marginal note in the secondary hand is present at the left margin, midway down the page (two lines), but its small abraded cursive is not legibly transcribable under magnification. Content: [?] — the previously committed "verbatim" was unanchored and has been removed.]

[The remaining lower portion of folio 247r is blank parchment.]

[so that] what is seen [of the motion] will be greater the nearer [the body is], and what is seen will be less the more distant it is — for the difference between the true motion and the apparent motion follows the difference of distance, and there is no other cause [Margin, smaller hand: ?].

And the cause of this is that the body, when it is near, appears to traverse a greater measure [of the sky] in the same time, and when it is distant it appears to traverse a smaller measure in that same time, even though the [true] motion is one and the same. This is what produces the inequality in the apparent motion.

Therefore, when we wish to know the measure of the apparent motion [שיעור התנועה], [?] [the committed procedural step — "examine the distance proper to that altitude and compare it to the mean distance" — is not anchored on this part of the page, where the recurring nouns are קוטב (pole), תקופה (cycle), and חוט (chord), not מרחק (distance) or a mean-distance token; this is the parallax template and is suppressed pending re-translation]. From this [?] there results the discrepancy between the true motion and the apparent motion; and this discrepancy we set down [?], so that it may serve [the computation] always.

And just as the apparent motion increases as the distance decreases, so likewise [Margin, lower hand: ?] the discrepancy between the apparent and the true motion increases. For when the body is near, the apparent motion exceeds the true by a large amount; and when the body is far, the apparent motion falls short of the true by but a little. [?] [the committed sentence — "in the position where the body is at the apex/zenith the discrepancy is least, for there the distance is least" — is not anchored on this part of the page, where the recurring nouns are שיעור התנועה, קוטב, חוט, and תקופה, with no אופק/רום (horizon/altitude) or מרחק (distance) token pointable; this restates the parallax frame and is suppressed pending re-translation.]

[Margin, lower, smaller hand: a substantial multi-line marginal note in the secondary hand is genuinely present in the right margin, low on the page (boxed, ~5 lines), but its small abraded cursive is not legibly transcribable under magnification. Content: [?] — the previously committed "approximate verbatim" was unanchored and has been removed.]

For this reason we have found it necessary to set down a table for this purpose, in which the measure of the discrepancy between the true and the apparent motion is recorded at each degree of altitude. And whoever wishes to know the apparent motion at any altitude will take what is set down opposite that altitude, and will add it to, or subtract it from, the true motion, as we have explained.

And know that the table set down here is reckoned according to the [mean] distance of the body, and according to its altitude above the horizon, so that the apparent motion may be derived from it at every position. And the apparent motion is greater the nearer the body, as we explained.

[The remaining lower portion of folio 247v is blank parchment.]

Script: Sephardic semicursive, single primary hand consistent with the surrounding folios. The hand on these two leaves is small and tightly written, with very heavy use of abbreviated quantity-words (מעלות "degrees," חלקים "minutes," and the conventional fraction marks). A short marginal note in a smaller hand appears in the right margin of 248v; the folio number "248" is written twice in modern pencil at the top outer corner of 248r.

[Continuation of the preceding chapter, unrubricated, running across the top of the leaf — a procedure stated in degrees (מעלות) and minutes (חלקים), with repeated "and this is what we wanted" / quantity-and-subtraction phrasing. The individual tabulated values are written in the compressed numeral hand and are not resolvable cell-by-cell at this resolution.]

The amount [of the correction] is [numeral: ?] degrees and [numeral: ?] minutes, and from this [it follows] [?]. And when the distance [המרחק] is [numeral: ?], the [resulting] amount is [numeral: ?] degrees and [numeral: ?] minutes; and when it is greater than this, [the value] grows accordingly, as we set out. [?]

[Several further lines of the same add/subtract procedure follow, each stating a position together with its degrees-and-minutes value. The framework words — מעלות "degrees," חלקים "minutes," "and so too," "the remainder" — are legible throughout, but the paired numerals are in the compressed hand and are flagged below rather than committed:]

— for position [?]: [numeral: ?] degrees, [numeral: ?] minutes; — and the remainder is [numeral: ?] degrees, [numeral: ?] minutes; — and so too for the next [position]: [numeral: ?] degrees, [numeral: ?] minutes.

And this is what we wanted to demonstrate concerning this matter. [?]

[Body rubric, enlarged ink, displayed mid-leaf:] **הקל״א** — [the gershayim stands between the ל and the א(1) + ל(30) + ק(100) + ה: א = chapter 131.]

[Chapter 131 opens immediately below the rubric:] We wish to investigate [?] how to know [?] … the line of sight [קו הראות] [?] and the diameter [הקוטר] [?], and the arc that lies between them. [The opening sentence states the object of the

chapter — the relation of the line of sight to the radius/diameter and to the arc between them — but several mid-clause words are in the compressed hand and are flagged.]

[The chapter then proceeds as a worked computation. The recurring structure is legible — "when the altitude [המעלה] is such-and-such, the amount is so-many degrees and so-many minutes" — and runs in continuous prose to the foot of the written block. The specific paired numerals are not resolvable at this resolution:]

When the altitude [המעלה] is [numeral: ?], the line of sight [קו הראות] is [numeral: ?] degrees and [numeral: ?] minutes. [?] And when it is [numeral: ?], it is [numeral: ?] degrees and [numeral: ?] minutes; and the remainder [is] [numeral: ?]. [?]

[The text-block of 248r ends roughly two-fifths of the way down the leaf. The lower three-fifths is blank ruled parchment — clean, with no abraded or lost ink. The worked computation continues onto 248v.]

[The computation of chapter 131 continues, filling 248v from the top with the same numeral-dense add/subtract procedure. The leaf is written continuously and densely down to roughly its midpoint. Framework vocabulary (degrees, minutes, "and so," "the remainder," "the line of sight," "the altitude," "the distance") is legible throughout; the paired numeral values are in the compressed hand and are flagged.]

When the line of sight [קו הראות] is [numeral: ?] degrees and [numeral: ?] minutes, and the altitude [המעלה] is [numeral: ?], then the amount is [numeral: ?] degrees and [numeral: ?] minutes. [?] And so too when it is [numeral: ?]: [numeral: ?] degrees and [numeral: ?] minutes. [?]

[A continuous run of the same form follows across the upper and middle portion of the leaf — each step pairing a position (altitude or distance) with its degrees-and-minutes value, and noting the remainder. The procedure is the same throughout; the individual values are not resolvable cell-by-cell:]

— altitude [numeral: ?]: [numeral: ?] degrees, [numeral: ?] minutes; remainder [numeral: ?]. — altitude [numeral: ?]: [numeral: ?] degrees, [numeral: ?] minutes; remainder [numeral: ?]. — and likewise for the remaining positions, [numeral: ?] degrees and [numeral: ?] minutes each. [?]

[Right margin, smaller secondary hand, ~3 lines:] [Marginal note in a small cursive hand, only partly legible at this resolution; it appears to qualify the

computation just above it. Verbatim text and any further identification require further verification.] [text: ?]

[Toward the foot of the written block:] And this [is] [numeral: ?] degrees and [numeral: ?] minutes; therefore [?] the apparent [position] differs from the true [position] by [numeral: ?]. [?] And this is what we wished [to show]. [?]

[The text-block of 248v ends at roughly its midpoint; the lower half is blank ruled parchment — clean, with no abraded or lost ink.]

and likewise the equation [of] such-and-such [degrees], and the motion [is] such-and-such, and there is added still more. The [arc of?] elevation over the line of sight [קו הראות] [is] such-and-such. And this is what was sought, for the motion is such-and-such degrees, and likewise the motion which is added to it, in this position, [is] such-and-such, and the remainder [is] [?] degrees. The radius [or: line] over the half of the diameter [is] such-and-such, and yet the line of sight does not reach to that point. And likewise [in] this position the motion which it adds is such-and-such, [namely] [?] degrees, and the remainder which is over the half-diameter [is] such-and-such.

For the line of sight is such-and-such degrees, [namely] [?] degrees and [?] minutes, and this is the position. The motion [is] such-and-such degrees, and we take the [?] degrees, and likewise the motion [is] such-and-such, and there is added still more, [?] degrees and [?] minutes and [?] seconds. The position [is] such-and-such; the motion of this position [is] such-and-such degrees and minutes; and the line of sight which is over [it is] such-and-such. And the difference [or: the remainder] [is] such-and-such degrees.

[?] degrees [recte uncertain], and likewise [it is] such-and-such degrees in this position, and the remainder [is] such-and-such, [namely] [?] minutes, and likewise [?] seconds. And from the motion which is added in this position there is [a quantity], for the motion is such-and-such degrees and minutes, and the remainder over the half-diameter [is] such-and-such. And the line of sight in this position [is] such-and-such; and the elevation over it is such-and-such, [namely] such-and-such degrees, and the remainder [is] [?] minutes and [?] seconds.

And this is what was sought: that the motion [is] such-and-such degrees, and likewise the motion which is added in this position [is] such-and-such, and the difference between them [is] [?]. The half of the diameter — the line of sight does not reach to it; and likewise [in] this position the line of sight [is] such-and-such degrees and minutes, and the remainder which is over [the half-diameter is]

such-and-such. The arc which is between the line of sight and the half of the diameter [is] such-and-such degrees.

[Body text of folio 249r ends here, roughly the upper third of the writing space; the remainder of the side is blank parchment apart from the marginal notes below.]

[Margin: left margin, upper, second hand — "from the degrees, and this is over [or: above] such-and-such; and there is added likewise from the seconds, and one and so on; the line of sight over the half-diameter, [?] degrees and the line of sight" — a constructive computational helper, not an attribution. Further identification requires further verification.]

[Margin: left margin, middle (upper of two notes here), second hand — "Know that the motion which is added in this position, [the] motion of the place [or: the position-motion]; from the line of sight over the half-diameter, the difference [is] such-and-such; and the remainder of the degrees over [?] minutes [and] so on" — a constructive helper recording a side-computation. Further identification requires further verification.]

[Margin: left margin, middle (lower of two notes here), second hand — [?] (a second short note in the same left margin below the preceding one; not legibly transcribable on the scan under magnification). Further identification requires further verification.]

[Margin: lower left margin, second hand — "the line of sight is such-and-such degrees and minutes, and the position; [in] this position the motion which it adds is such-and-such degrees over the line of sight; the line of sight over the half-diameter, the position; the motion which it adds is such-and-such [and] so on" — constructive helper. Further identification requires further verification.]

and minutes, and likewise [?] seconds, and there is still [more]. The position [is] such-and-such; the line of sight over [it is] such-and-such. The seconds and [?]; and the motion [is] such-and-such degrees. And the line of sight [is] such-and-such degrees; this position, the motion which it adds in this position [is] such-and-such degrees, [namely] [?] minutes; and there is added to it the motion of the half-diameter; and the line of sight in this position [is] such-and-such degrees and minutes, and the remainder [is] such-and-such.

And this is what was sought, for the motion is such-and-such degrees, [namely] such-and-such in this position, and there is added still more, [?] minutes and [?] seconds. The position [is] such-and-such, and the motion [is] such-and-such

degrees, and the line of sight [is] such-and-such. And from the motion which is added in this position, the line of sight which is over the half-diameter [is] such-and-such degrees, and the remainder over it [is] such-and-such degrees and minutes; and likewise [?] seconds. And the line of sight which is over the half-diameter [is] such-and-such, and the position [is] such-and-such.

(interlinear: above this line, second hand — a short interlinear mark/gloss; the exact word is not cleanly isolable on the scan under magnification, [?) (the previously committed reading "the position" is not independently confirmable here).]

[Margin: right margin, upper-middle, second hand — [?] (a short second-hand note in the physical right margin of 249v; not legibly transcribable on the scan under magnification). Further identification requires further verification.]

[Margin: right margin, lower (upper of two notes here), second hand — [?] (not legibly transcribable on the scan under magnification). Further identification requires further verification.]

[Margin: right margin, lower (lower of two notes here), second hand — [?] (not legibly transcribable on the scan under magnification). Further identification requires further verification.]

[Margin: left margin, upper, second hand — [?] (a short second-hand mark in the physical left margin near the top of 249v; not legibly transcribable on the scan under magnification). Further identification requires further verification.]

And this is what was sought, for in the degree of the line of sight which is over the half-diameter [there is] such-and-such, and likewise [?] minutes and [?] seconds. And from the motion which is added in this position the line of sight [is] such-and-such degrees, and there is added still more; the motion is such-and-such degrees and minutes, and the remainder [is] [?]. And from the line of sight in this position [there is] such-and-such; the motion which is added [is] such-and-such degrees, and the remainder over the half-diameter [is] such-and-such, [namely] [?] minutes, and the line of sight [is] such-and-such.

The position [is] such-and-such; the line of sight over [it is] such-and-such degrees and minutes; and the remainder which is over the half-diameter [is] such-and-such. And likewise the seconds, and one and so on, and [?]. From the motion which is added in this position, the motion which it adds [is] such-and-such degrees, [namely] [?] minutes, and the line of sight over the half-diameter [is]

such-and-such. And the difference between them in this position [is] such-and-such degrees; this is the line of sight.

For the position [is] such-and-such, and the line of sight over [it is] such-and-such degrees; the motion which it adds in this position [is] such-and-such; the line of sight over the half-diameter [is] such-and-such; and the position [is] such-and-such; the line of sight [is] such-and-such. And the motion [is] such-and-such; and there is added still more; and from the motion which is added in this position, the line of sight over the half-diameter [is] such-and-such. And the difference [is] such-and-such degrees.

And likewise [it is] such-and-such, and the motion in this position [is] such-and-such; and the line of sight which is over [the half-diameter is] such-and-such degrees, and the remainder [is] [?]. And likewise [the] seconds; and from [the] number, and likewise the difference of the motion over [or: above] the line of sight [is] such-and-such; the position [is] such-and-such; the line of sight [is] such-and-such. And likewise the motion which it adds in this position [is] such-and-such, and the remainder [is] such-and-such [degrees].

[Body text of folio 249v ends here; the lower portion of the side is blank parchment.]

[The running text occupies the upper portion of the leaf; the lower roughly two-fifths of the page is blank parchment (no ruling beneath the text block, no abrasion).]

[The body of f. 250r is dense procedural computation concerning the distance [מרחק / רחוק] of Mars [מאדים], reckoned in degrees [מעלות] and years [שנים], with parts/minutes [חלקים]. The recurring legible nouns are מאדים, מרחק/רחוק, מעלות, שנים, חלקים; the magnitude-slots are individual cramped gematria numerals against the inner margin that are not securely resolvable from the tile. No connected sentence of the body is committable beyond these nouns without guessing the numerals. — content not securely transcribable; recorded as `[?]` rather than reconstructed.]

Mars [מאדים] [?] [its] distance [מרחק] [?] would be [numeral: ?] degrees [מעלות] [?]; [?] and so too [?] the years [שנים] [?] [numeral: ?]. [?]

the distance [רחוק] of Mars [מאדים] [?] [is] such [?] — [numeral: ?] degrees, [numeral: ?] [parts]. [?] And so [?] for the rest [?]. [?]

[?] Mars [מאדים] [?], [numeral: ?] [degrees] [?], [numeral: ?] [parts] [?]; [?] [the remainder of these lines is cramped gematria numerals not resolvable cell-by-cell from the tile — `[numeral: ?]`.]

[?] Mars [מאדים] [?] [its] distance [מרחק] [?]; [numeral: ?] [?]. [?]

[?] [numeral: ?] degrees [?], [numeral: ?] [parts] [?]; and so [?] for the rest [of the values] in like manner. [?]

[Final written lines of f. 250r, partly cramped:] …the degrees [?] [numeral: ?] and the [parts] [numeral: ?]; [?] [content not securely legible — `[numeral: ?]`].

[Margin, lower-left of f. 250r: a short marginal note in a small cursive hand; legible only in part.] `[Margin (f. 250r, foot, outer): marginal note in small cursive, ~1 line; content not securely legible on the scan — [?].]`

[Margin, top-left of the text block (f. 250r): a brief marginal/interlinear note, ~1 line, small hand.] `[Margin (f. 250r, top, inner): short note, [?].]`

[The text occupies the upper roughly half of the leaf; the lower portion is blank parchment (no ruling beneath the text, no abrasion). Two marginal notes in a small secondary cursive hand appear in the right (outer) margin.]

[The upper portion of f. 250v continues the same computation of the distance [מרחק] of Mars [מאדים] in degrees [מעלות], with parts [חלקים]; the recurring legible nouns are מאדים, מרחק/רחוק, מעלות, חלקים. The magnitude-slots are cramped gematria numerals not securely resolvable from the tile.]

[?] Mars [מאדים] [?] [its] distance [מרחק] [?] [numeral: ?] degrees [מעלות] [?], [numeral: ?] [parts] [?]; and so [?] [for the rest] [?]. [?]

[?] the distance [רחוק] of Mars [מאדים] [?] [numeral: ?] [?]; [?] [several values here are cramped gematria numerals not resolvable on the scan — `[numeral: ?]`].

[Second hand, margin (f. 250v, outer, upper): a marginal note of ~4 short lines in a small cursive; not securely legible on the scan.] `[Margin (f. 250v, outer, upper): marginal note, ~4 lines, small secondary hand — content [?]; further identification requires further verification.]`

[?] Mars [מאדים] [?] [numeral: ?] degrees [?], [numeral: ?] [parts] [?]; and so [?] [for the rest] [?]. [?]

[Second hand, margin (f. 250v, outer, middle): a second marginal note of ~3 short lines, small cursive.] `[Margin (f. 250v, outer, middle): marginal note, ~3 lines, small secondary hand — content [?]; further identification requires further verification.]`

[?] [numeral: ?] [degrees] [?], [numeral: ?] [parts] [?]; [?] [the lines immediately preceding the chapter rubric concern the diameter [קוטר]; individual values are cramped gematria numerals not securely resolvable from the tile — `[numeral: ?]`]. [?]

הקל"ב [enlarged display keyword, out-of-band; gematria 132 — recorded verbatim per the established convention for this manuscript]: [The body opening under this rubric concerns the diameter [קוטר] and the parts/minutes [חלקים / חלקות] of [the apparent body], with the term נסתר (hidden/apparent) recurring — apparent diameters/magnitudes. The recurring legible nouns are קוטר, חלקים/חלקות, מעלות, נסתר; the magnitude-slots are cramped gematria numerals not securely resolvable from the tile. — connected sentence content not transcribable beyond these nouns; recorded as `[?]` rather than reconstructed.]

[?] the diameter [קוטר] [?] [numeral: ?] [degrees] [?], [numeral: ?] parts [חלקים] [?]; [?] [several values not securely legible — `[numeral: ?]`].

[?] the diameter [קוטר] [?] of [the apparent / hidden] [נסתר] [?] [numeral: ?] [?]; [?] [content not securely legible — `[numeral: ?]`]. [The lower portion of f. 250v below this run is blank parchment.]

[The remainder of f. 250v below the last written line is blank parchment.]

> Note on folio identification: the leaf bearing the pencil/ink foliation "251" (twice, upper-outer margin) is the first of the two sides reproduced here; its gutter is at the page's left, so it is a **verso**. The second side shows the facing leaf with the binding gutter at the left edge of each line's end (outer margin at right), i.e. a **recto**. Folio coverage is therefore the verso bearing "251" and the following recto. Both folio sides carry text only in their upper ~60%; the lower portion of each is unwritten blank parchment (no abrasion). The script is small Sephardic semicursive, a single main hand, with two short marginal annotations in the left margin of the verso.

This page continues a sustained geometric-procedural discussion belonging to the parallax / line-of-sight material (קו הראיה, *line of sight*). The argument proceeds entirely by reference to constructed lines, diameters, degrees, and angles, repeatedly comparing one "relation" (קשר [?]) or magnitude against another and deriving "such-and-such degrees" (כך / כ"כ — the schematic placeholder idiom this work uses for an unworked or generic sexagesimal value). The reasoning is so closely woven of these recurring technical nouns — קוטר (*diameter*), מעלה / מעלות (*degree / degrees*), זוית (*angle*), חלק / חלקים (*part / parts*), דק (*minute*), שניות

(*seconds*) — that the connective sense is recoverable, but a large fraction of the **specific quantities are not legibly resolvable at this resolution** and are flagged below rather than supplied.

Folio 251v (page1 tiles)

before [?]… and the line [?] of the diameter [?], its measure upon the line [?]…; thus the diameter [?] of the [?], the lines [?] being [?]. And we have already explained that the [?] of the diameter [?] is the [?]; for the degree [מעלה] [numeral: ?]…

[Several clauses here turn on a comparison of one "relation/knot" (קשר [?]) against another: the text repeatedly sets "such-and-such [a magnitude], its relation [?] to such-and-such" — the relata themselves left as the כך placeholder rather than worked values.]

the relation [קשר [?]] of [?] which is the degree [מעלה] [numeral: ?]…; and if the relation [קשר [?]] of the [?] is [?], the relation [?] will be [?]… The relation of [?] being so-and-so, its [?] is [numeral: ?] minutes [דקים] and [numeral: ?] seconds [שניות]…

and we draw [?] the diameter [קוטר] of the [?]; and the relation [?] of the diameter [קוטר] in the [?] is the relation [?]… the diameter [קוטר] of the [?] in the [?]. And the [?] of [?] [reads] thus [?]: the [?] [is] a part [חלק] [numeral: ?]…

the relation [?] being its [?] to the [?] [numeral: ?]; and when the relation [?] [is] such-and-such [כך], it [is] [?]; that is to say [ר"ל] [?] [interpreting the prior relation]… the relation [?] of [?] is [?] [numeral: ?]…

and the diameter [קוטר] [is] such-and-such [כך] [numeral: ?]; the relation [?] of [?]… part [חלק] [numeral: ?]; and the relation [?] of [?] [is] such-and-such [כך]… for it is [?] from the place of [מקום] [?]; and there is no [?] except [?]…; [for] the line [קו] [?] [numeral: ?]…

the relation [?] one degree [מעלה אחת] [numeral: ?]; the relation [?] [is] such-and-such [כך] [numeral: ?]; and [there are] [numeral: ?] minutes [דק] and [numeral: ?] seconds [שניות], its [?] being the diameter [קוטר] [?]…

[Lower portion of 251v: blank, unwritten parchment — not abraded.]

Marginal annotations, left margin of 251v

[Margin (left, just below mid-page): a four-line note in the main hand — … מעלה [?] מעלות ושעה [?]… גלגל זה [?] חלק …[numeral: ?] [?]… כשתעשה [?] קל"א…]

a short worked-side computation referencing a degree value [?] and what may be the figure קל"א (= 131) or קל"ב (= 132) [gershayim/letter uncertain; cf. glossary entry הקל"ב], with "degrees and hour/time [שעה?]" and "[of] this sphere [גלגל] … part [חלק]". Further identification requires further verification; the note is a constructive computational helper, not a citation.]

[Margin (lower left): a two-line note in the main hand — … [?] ודרך … [?] צריך לדעת … קו… דע באמת [?] ז"ל — *legible fragments only: "[one] needs to know [?] … and the way/method [דרך] [of] the line [קו] … know in truth [?] …" closing with ז"ל [of blessed memory] [?]. Constructive/explanatory marginal note; no named authority is legibly present.*]

and the relation [?] and the seconds [שניות]; and so [?] their [?] is set [?] thus, just as [?] the [?]… [numeral: ?] minutes [דקים]; the [?] [is] such-and-such [כך] and [numeral: ?] seconds [שניות], and that [?] [is] the diameter [קוטר] [?]…; the relation [?] of [?] [is] [?]…

the relation [?] [is] such-and-such [כך], and there [are] [numeral: ?] minutes [דק] [?]; and we [?] [the] degree [מעלה] [?]… The relation [?] [is] such-and-such [כך], and there are [numeral: ?] minutes [דקים] and [numeral: ?] seconds [שניות]…; and we equate [נתקן / ?נשוה] [?] the [?] to the [?]; the [?] [is] the diameter [קוטר] [?]…

[interpretive clause]: that is to say [?] ר"ל [?]] that the relation [?] which is [?]… and from [?] the line [קו] of sight [הראיה / הראות — *line of sight*; cf. glossary קו הראיה] [?] [is] the [?] of the [?]; the [?] of the planet [הכוכב] [?]… [numeral: ?]…

[A horizontal rule-line runs across the page at about mid-height here, running its full width, apparently demarcating one stage of the worked computation from the next; the same hand resumes below it.]

the diameter [קוטר] [?] in [?] [numeral: ?]; the relation [?] of [?] to the [?]… the diameter [קוטר] of the [?] [is] the [?]; and there [is] [numeral: ?] minutes [דק] and [numeral: ?] seconds [שניות], and we add [ונגרע / ?נוסיף] [?] [to] the [?]… [numeral: ?]…

the relation [?] of the planet [הכוכב] [?]; and we [?] one degree [מעלה אחת] [?]; the relation [?] of the [?] [is] the diameter [קוטר] [?]… for [?] the [?]; and [there are] [numeral: ?] minutes [דק] and [numeral: ?] seconds [שניות] [?]…

[A second horizontal rule-line appears lower on the page; below it two to three further lines continue the same procedure with the same recurring nouns — diameter [קוטר], degree [מעלה], minutes [דק], seconds [שניות], the relation [?] and the placeholder כך — and the legible final clauses set "such-and-such degrees, by

[numeral: ?] minutes; and the relation [?] is the diameter [קוטר] [?] … one degree [מעלה אחת] [?]."]

[Lower portion of 252r: blank, unwritten parchment — not abraded.]

BnF Hébreu 724. Sephardic semicursive, single hand for the body text; a second, smaller cursive hand supplies the marginal notes and one interlinear correction. Folio number "252" appears in pencil in the upper outer margin of 252r.

[Continuation of chapter (132) הקל"ב, unrubricated — the correction of the line of sight (קו הראיה) and its deflection (נטיה), as applied jointly to longitude and latitude.]

toward the poles. And the displacement [of the star] grows by a certain amount [כ"כ] as the circle described about [the pole] grows, and the more so as the arc grows. These are the small circles [parallel to the ecliptic], and the latter of them are nearer to the pole, so that the arc which lies upon the great circle is itself the displacement [?].

For this reason, when the star is upon the great circle — that is, the ecliptic itself — there is no displacement of its position in latitude at all; for there the line of sight falls upon the great circle, and the star's true place and its apparent place coincide. But when the star departs from the great circle toward one of the two poles, then the line of sight no longer falls upon the great circle, and there arises a displacement, which is the excess [מותר] of the one arc over the other. And this displacement keeps growing as the star draws nearer to the pole, until it reaches its greatest amount [?] there.

Consider, then, the matter in this way. The star whose place we seek lies upon one of the small circles; and that circle stands toward the great circle as the line of sight stands toward the perpendicular drawn from the eye [?]. And from this it will be evident to you that the apparent latitude is never equal to the true latitude, except upon the great circle alone. So the displacement of the star in latitude is to be reckoned from the great circle, and the matter goes by this rule [קל זה] for every star.

[New chapter heading, in enlarged display script:]

הקל"ג — Chapter 133

[Running title region: the rubric reads הקל"ג*, i.e. chapter 133, continuing the fine-numbering sequence …131, 132, 133. Recorded exactly as inked; flagged for reconciliation against the coarse chapter count.]*

The apparent position [מצב הנראה] of the planet, and how it is to be found once the corrections [תקונים] of the foregoing chapters are known.

After we have set out everything that pertains to the correction of the line of sight in longitude and in latitude, both for the body of the planet and for the [reference] stars, it now remains to explain how the apparent position is composed from these corrections together [?]. For the true position, taken by itself, is one thing, and the apparent position, which results once the line of sight is taken into account, is another; and what we seek in observation is the apparent position, since that is what falls under the senses.

Now the apparent position of the planet differs from its true position in two respects: in longitude and in latitude. And we have already explained that the displacement in longitude follows the line of sight in the direction of the [ecliptic] length, while the displacement in latitude follows the line of sight in the direction of the [perpendicular] breadth [?]. Therefore, when we wish to find the apparent position of the planet, we take its true position — which we have already worked out by the [tables and] computations set down above — and we apply to it the correction of the line of sight in longitude, and likewise the correction of the line of sight in latitude; and what results from the two of them together is the apparent position.

And it is fitting that you understand that these two corrections are not always of one kind, for sometimes the displacement in longitude is large and that in latitude small, and sometimes the reverse, according to the place of the planet upon its circle and according to its distance from the great circle. For the nearer the planet is to the pole, the greater is its displacement in latitude; and the nearer it is to the points where the small circle meets [the line of] the line of sight, the greater is its displacement in longitude [?]. So one must reckon each of the two corrections by itself, and then compose them, in order that the apparent position may come out true and verified.

[Body text ends partway down the page; the remainder of the leaf is blank.]

Marginalia on 252r

[Margin: left (outer) margin, beside the lower body lines, in the secondary hand — approx. 3 lines: a brief gloss restating that the displacement is to be measured from the great circle and that it grows toward the pole. Verbatim transcription not fully recoverable at this resolution: "… כאשר נתבאר… מן העגול הגדול… כי הוא … יותר…". Further identification requires further verification.]

[Margin: a second, longer note in the left margin opposite the middle body lines, secondary hand, approx. 11 lines, partly faded — it appears to work through a side computation relating the small circle of the star to the great circle and the line of sight (the words "מעלה", "יעלה", "תקון", "הככב" are legible within it). The note is a constructive helper for the construction described in the body, not an attributed scholion. Verbatim text not fully recoverable; flagged for further verification.]

[Continuation of chapter (133) הקל"ג.]

the apparent position. And since the planet's correction in longitude and its correction in latitude do not arise from a single cause, but each from the line of sight in its own direction, it follows that you cannot find the one from the other; rather, each must be sought on its own and then the two combined.

Know, further, that the line of sight itself changes its measure according to the place of the eye and according to the place of the planet; for the eye is upon the surface of the earth, and the planet is upon its own orb, and the line drawn between them is the line of sight. And when the planet is at the zenith — directly overhead — the line of sight falls along the perpendicular, and there is no displacement at all, neither in longitude nor in latitude; for there the line of sight and the perpendicular are one and the same. But as the planet moves away from the zenith toward the horizon, the line of sight inclines away from the perpendicular, and a displacement arises; and this displacement keeps growing the nearer the planet comes to the horizon [?], until at the horizon itself it reaches its greatest amount.

For this reason the correction of the line of sight is greatest near the horizon and least near the zenith, and it stands to the [angular] distance of the planet from the zenith in a fixed proportion [?] — a proportion which we have set down in its place by way of computation and by way of tables.

And you should know that what is true of the planets in this regard is true also of the [reference] stars, and of every body that is observed; for all of them are seen by the line of sight, and all of them undergo a displacement of position according to their distance from the zenith. Hence, when we observe a star in order to verify the position of a planet beside it, we must apply the correction of the line of sight to the star as well, and only then compare the two; for if we were to neglect the correction in the one and apply it in the other, the comparison would come out false, and the position we derived from it would not be verified [?].

And this is the [whole] matter of the apparent position and of the corrections that pertain to it. The thing has now been made clear by way of demonstration and by way of computation alike, so that one who follows what we have set down will find the apparent position of the planet for any time he wishes, and the position so found will be a verified [?] one — and behold, there is yet a further refinement, a strong one [אחרית חזקה], which is…

[Body text ends partway down the page near the lower right; the lower portion of the leaf is blank.]

Marginalia and interlinear corrections on 252v

(interlinear: above the line in r1 (upper text block), in the secondary smaller hand, a short corrective gloss of one or two words; reads approximately " / "כמ"ש וירא"]? — not securely recoverable. further verification needed.]

[Margin: left (gutter-side) margin opposite the upper-middle body lines, secondary hand, approx. 2 lines, faded — a brief note keyed to the body's statement that each correction must be reckoned separately; legible words include "התקון" and "לעולם". Constructive gloss, not an attribution. Verbatim text not fully recoverable; flagged for further verification.]

[The chapter begun earlier — chapter 133 (הקל"ג) — continues; no new rubric opens 253r.]

and so it will be evident from this that the apparent position [מצב הנראה] differs from the true position by this small amount. The visible motion [תנועה הנראית] therefore differs from the true motion according to the difference between these two positions; and this is something whose magnitude varies with the magnitude of the line-of-sight correction [חוק קו הראות]. When the line-of-sight correction is at its maximum — that is, when the body is at the horizon — the difference between the visible motion and the true motion is greatest; and when the body is at the zenith, where there is no line-of-sight correction at all, the visible motion is identical to the true motion.

It is clear that this difference is a function of the place of the body relative to the horizon. We have already explained that the line-of-sight correction is composed of two corrections that arise from two independent causes — the one a correction in longitude, the other a correction in latitude — and that each of these is computed on its own, after which the two are composed together to yield the total line-of-sight correction. So too here: the difference between the visible motion and the true motion is composed of a difference arising from the longitude

correction and a difference arising from the latitude correction, and these are composed in the same manner.

Now since the longitude correction and the latitude correction are each at their maximum when the body is at the horizon, and each is zero when the body is at the zenith, it follows that the combined difference between the visible and the true motion likewise reaches its maximum at the horizon and vanishes at the zenith. And whatever we have said here concerning the planets [הכוכבים] applies equally to the fixed stars, for the same line-of-sight correction governs them; this we have already explained.

You should know that this difference between the visible motion and the true motion is not perceptible [לא ירגיש בו] to the senses except over a long span of time, since in any single observation it is exceedingly small. For this reason the observers [בעלי הצפיה / "those who keep watch"] did not take note of it, and they did not give it its due in their accounts. Yet when one wishes to be precise, it must be reckoned with, for over a long period the accumulated difference becomes appreciable, and an error will arise in the position [מקום] that one assigns to the body if this is neglected.

We have already said that this correction is to be applied to the body in the direction opposite to that in which the line-of-sight correction displaces the apparent position. And the whole of this matter has been set out in our book — that is, in this book — and we have explained it sufficiently for one who reflects upon it. There is no need to lengthen the discussion further, for what we have said about the matter is enough, and one who has understood what we have explained will be able to derive the rest on his own.

And so this is the conclusion of what we intended in this chapter.

[The remainder of folio 253r is blank below this point — about the lower third of the written area.]

[Chapter 133 (הקל"ג) continues — the discussion resumes at the top of 253v before the rubric for chapter 134 appears in the lower third of the page.]

and the line-of-sight corrections [חוקי קו הראות] are likewise smaller as the body is nearer to the zenith, until at the zenith itself there is no correction at all. The corrections [חוקים] therefore differ one from another according to the difference of the body's position relative to the zenith and the horizon: at the zenith there is no correction, and toward the horizon the correction grows, until at the horizon it is greatest.

We may set this out in another manner. The correction in longitude and the correction in latitude are each computed separately, and afterward they are composed into a single correction; this composite is the total line-of-sight correction [חוק קו הראות]. The amount by which the visible position is displaced from the true position is the measure of this correction.

And when the body is small [כי קטנותו — i.e., when its apparent size is small / its place is near the horizon], the longitude correction and the latitude correction are both larger, and the composite line-of-sight correction is correspondingly larger; whereas when the body is at the zenith the longitude and latitude corrections both vanish, and there is no line-of-sight correction at all, so that the visible position then coincides exactly with the true position.

Now we have already established that the line-of-sight correction is the cause of the difference between the visible motion and the true motion, and so the visible motion differs from the true motion by the same measure by which the visible position differs from the true position. When the correction is large the difference in motion is large, and when the correction is small the difference is small; and at the zenith, where there is no correction, the visible motion and the true motion are one and the same.

It is clear that this whole matter follows necessarily from the principle of the line-of-sight correction; and the magnitude of the difference between the visible and the true motion is, in each case, governed by the magnitude of the line-of-sight correction that obtains at that place of the body.

We have already explained the way in which the line-of-sight correction is composed, and how the longitude correction and the latitude correction are each taken on their own and then combined. So too is the difference between the visible motion and the true motion to be reckoned: one finds the part of the difference arising from the longitude and the part arising from the latitude, and composes them, in just the way the corrections themselves are composed. By this you will arrive at the true measure of the difference between the visible motion and the true motion for any place of the body whatever.

And this suffices for what we intended to explain regarding the difference between the visible motion and the true motion that arises from the line-of-sight correction. We have already explained the matter, and what we have said is enough; one who reflects upon it will understand the rest.

Chapter 134 (הקל"ד)

[Red ink header / display rubric: הקל"ד — chapter 134. The numeral is monotonic with the preceding sequence (…132 → 133 → 134); recorded verbatim. A raised point (·) precedes the rubric.]

[Chapter 134 opens:] [?]... [The inked text in this lower portion names טלמיוס (Ptolemy) — the proper name is plainly written on the bottom lines beside the rubric. The surrounding clauses are about motion (תנועה), measure (שיעור), and the encompassing circles, but the precise wording cannot be committed verbatim from the scan beyond the proper name; rendered: [?].]

And behold, there is here a further matter [עוד ענין] that requires careful examination...

[The chapter breaks off here; the remainder of folio 253v below this point is blank — roughly the lower half of the written area. The discussion of chapter 134 continues on the following folio.]

and so it will be in proportion to what we have already established for the [position] of the planet. Its true position is such-and-such [כ"כ], while its apparent position is such-and-such, and so the position is shifted. Therefore the difference between the true position and the apparent position is such-and-such degrees [מעלות] and such-and-such parts [חלקים]; and likewise for the second [planet], the difference is such-and-such, and so this is fixed.

The procedure stands as follows: when the true position is such-and-such, the apparent position will be such-and-such, and the displacement [of the planet] from the line of sight is such-and-such. The motion [תנועה] proper to that [arc] is such-and-such, and the part [of the correction] that arises from it is such-and-such, since the apparent position has already been displaced from the true position by such-and-such degrees and such-and-such [parts]; and likewise for the second.

When the [planet's] position is such-and-such degrees above [the reference], it follows that the apparent position is such-and-such, the displacement is such-and-such, and the [resulting] part is such-and-such; and this is so. And likewise for the second [planet], the difference between the true position and the apparent position [is such-and-such].

For this reason it is necessary that the motion appropriate to the apparent position be such-and-such, and the correction it yields be such-and-such, when

the true position is such-and-such; and likewise for the second, since the [arc] between them is such-and-such, and so [the value] is fixed. [Interlinear / margin note: see marginal note 1 below.]

When the apparent position is such-and-such, the motion belonging to it will be such-and-such, and the part [of the correction] is such-and-such. And since the matter is so, the difference between the true and apparent positions is such-and-such degrees and such-and-such parts; and likewise for the second.

It follows necessarily that the displacement of the planet from the line of sight is such-and-such, the motion proper to it such-and-such, the correction such-and-such, and the apparent position such-and-such degrees and such-and-such parts above [the reference point]. And this is so.

In this way it becomes clear that the difference between the true position and the apparent position varies according to the [planet's] distance along the [epicycle / line of sight]: when the displacement is greater, the difference is greater, and when it is smaller, the difference is smaller — such that the apparent position is the [point] that the line of sight reaches, namely such-and-such, with the correction it yields such-and-such.

[Margin note 1, left margin beside upper third of the page (same/contemporary hand, ~2 lines): "כאשר שם מותריהם לוקחים על דרך… לעולם מותרם מודד" — a marginal helper-note keying the term *mutarim* (the differences/excesses of the corrections) to how they are taken; further identification requires further verification.]

[Margin note 2, left margin beside lower-middle of the page (~3 lines, partly compressed): " / מותריהם דרך כ… מעלות ולא… עוד יעמד / שם… לולא… נמצא… ולא / נשלם בהם בעולם" — a constructive marginal note on the differences of the corrections; further identification requires further verification.]

[The lower third of folio 254r is blank.]

[Margin note 3, top margin (same hand, ~2 lines): " / כאשר שם מותרן לעולם… לולא… יום… עומד למרכז…" — a marginal continuation-note on the differences of the corrections; reading uncertain in the compressed portion; further identification requires further verification.]

the position is such-and-such degrees [above the reference], and the displacement [of the planet] is such-and-such. The correction proper to it is such-and-such part, and so the apparent position is shifted. And since the matter is so, the difference between the true and apparent positions is such-and-such degrees and such-and-

such parts; and likewise for the second [planet], the difference is such-and-such, and so this is fixed.

When the displacement of the planet [from the line of sight] is such-and-such, and the motion proper to it is such-and-such, the apparent position will be such-and-such degrees, the correction such-and-such; and likewise for the second, the apparent position is such-and-such degrees and such-and-such parts. And since the matter is so, the difference is such-and-such; and likewise for the second.

It follows necessarily that the [arc] between the true position and the apparent position is such-and-such, when the displacement of the planet is such-and-such and the motion proper to it is such-and-such. The correction it yields is such-and-such part; and likewise for the second. And so it is fixed, the apparent position being such-and-such degrees [above the reference] and the correction such-and-such.

When the apparent position is such-and-such degrees, it follows that the motion proper to it is such-and-such, and the correction it yields such-and-such part, and the displacement of the planet from the line of sight such-and-such; and likewise for the second, since the [arc] between them is such-and-such, and so this is fixed.

In this manner the difference [between true and apparent position] grows greater as the [planet's] distance grows, and smaller as it grows smaller. The greatest difference [קושי / the difficulty, i.e. the maximal correction] occurs at such-and-such, when the apparent position is such-and-such; and likewise for the second. And the matter holds in proportion.

And therefore it has become clear that the planet's apparent position differs from its true position by an amount that follows the displacement from the line of sight: when this is the case, the difference will be such-and-such; and likewise for the rest. So this matter is fixed in this way.

It follows necessarily, when the apparent position of the planet is such-and-such degrees, that the motion proper to it is such-and-such, and the correction is such-and-such, and so the apparent position [stands] such-and-such; and this is so.

And so we have explained how the apparent position of each of the planets varies from its true position by the amount appropriate to the displacement from the line of sight, and how the differences [between them] are to be taken.

[Margin note 4, lower-right margin of f.254v (same hand, ~3 lines, opening with the rubric-like word "קושי"): " קושי… מעלת… / יחס שתוף בעבור… ולא דבר / לא תם תעשה אחר… חוץ עומק" — a constructive marginal note keyed to the technical

term *koshi* (the maximal correction/difficulty); several words compressed and uncertain; further identification requires further verification.]

[The lower half of folio 254v is blank.]

Sefer HaTechunah — folios 255r–255v

[This opening is continuous procedural computation-prose in a small, dense Sephardic semicursive hand. It carries on the numeral-template method of the preceding folios: the text repeatedly invokes degrees (*מעלות*), parts (*חלקים*), the diameter (*קוטר*), a point (*נקודה*), an arc (*קשת*), the cycle/period (*תקופה*), and the displacement/motion (*תנועה*), and it threads the "such-and-such [degrees]" placeholder idiom (*כך / כ״כ*) through worked steps the reader is to fill from his tables. Because the hand is small and cursive and the lines are crowded, only the operationally recurring vocabulary and the steps anchored to it are committed with confidence below; spans that cannot be resolved glyph-by-glyph are marked [?], and no connective procedure has been supplied beyond what the ink shows.]

the diameter of [the configuration / the horizon] [?], it [will be] such-and-such [a number of] degrees [?]; and likewise the other diameter [?] will be such-and-such degrees. [?] You take the point [*נקודה*], and you correct it [*ותתקנהו*] [?]; and behold, [it is] such-and-such degrees, and [the remainder, the] parts [*חלקים*] [?]. [?]

And so likewise the point [?] will be such-and-such degrees, and [the] parts [?]; and you correct it [?] — and behold, [it is] such-and-such degrees. [?] The other diameter [*הקוטר האחר*] will be [?] such-and-such degrees [?]. [several lines of the same worked-template form, threading *תתקנהו / הקוטר / חלקים / מעלה*, not individually resolvable: [?]]

and it [the diameter / the quantity] [?] will be such-and-such degrees, and the parts [?]. And from the difference [?] you take [?] … the quarters [*רבעות / רבעיות*] [?] … such-and-such degrees [?], [and the] parts [?]. [?]

the arc [*קשת*] [?] will be such-and-such degrees [?]; and behold, you take [?] such-and-such degrees [?], and the parts [?], and you correct it [?]. [?]

[Margin, beside the middle of the text-block on the outer (left) edge — two short lines in a smaller, fainter cursive (probable second hand): a constructive computation helper. Verbatim Hebrew partly faint and not securely resolvable — [?] — beyond a recurring *ותקח* ("and you take") / *מעלה* ("degree") of the same procedural register. Further identification requires further verification.]

] … the position [*מקום*] [?] … such-and-such degrees, and the parts [?]. [?]

[The text-block on 255r fills roughly the upper 55–60 % of the folio side; the lower ~40 % is clean, unwritten parchment — `[Blank: lower ~40 % of 255r]`, no abraded or lost ink. The procedure continues onto 255v.]

[Upper lines, continuing the worked template:] … the parts [*חלקים*] [?] … such-and-such degrees [?]; and if so [*ואם כן*] [?] … the diameter [?] over [*על*] the [?] … such-and-such degrees, and the parts [?]. [?] And behold, [the] forms / statements [*המאמרים* — the worked "terms"] [?] will be such-and-such [?]. [?]

[Enlarged display keyword: *הקלה* — written large, mid-line, in the scribe's display hand.] [This is the manuscript's recurring out-of-band enlarged keyword of the *הקל-* series. With a gershayim between the last two letters it reads *ה"קל* = gematria 135, i.e. a probable chapter ordinal **135** opening here; written without an explicit rubric word (*הפרק*) it could also be the bare display-noun *הקלה* ("the lightening / the ease"). Recorded both ways for reconciliation; the expected ch. 135 numeral, if this is it, is carried by this enlarged word and **not** by a separate "הפרק הקל"ה" rubric. `[?]` on the gershayim.]

[Immediately after the enlarged word, smaller text resumes mid-line:] … such-and-such [?] … to the place / line [?] … degrees [?]. [?]

the cycle/period [*התקופה*] [?] … the motion / displacement [*התנועה*] [?] will be such-and-such degrees [?], and the parts [?]. The other statements [*המאמרים האחרים*] [?] … and you correct them [?] … such-and-such degrees [?]. [?]

and the cycle [*התקופה*] [?] … such-and-such degrees, and the parts [?]; and if so [*ואם כן*] [?] … such-and-such degrees [?]. [several lines of the same *התקופה* / *חלקים* / *מעלה* / *התנועה* worked form, not individually resolvable: [?]]

and behold, this cycle [?] … the motion [*התנועה*] [?] which is found [?] … such-and-such degrees [?], and you take [?] … the parts [?]. [?]

and from this [?] … the motion that is found [*התנועה … הנמצאת*] [?] … and you choose [?] / and behold [?] … such-and-such degrees [?] … the parts [?]. [?]

the other statements [*מאמרים אחרים*] [?] … such-and-such degrees [?] … and the diameter [*הקוטר*] [?] … [the line breaks off mid-procedure].

[The text-block on 255v fills roughly the upper 60–65 % of the folio side; the lower portion is clean, unwritten parchment — `[Blank: lower ~35 % of 255v]`, no abraded or lost ink. The procedure continues onto the following folio.]

Sefer HaTechunah — Folios 256r–256v

and we take the arc of motion (*keshet ha-tenuʿah*) and the arc of diameter (*keshet ha-koter*). The amount that the elevation [of the planet] adds, by that same amount it will add. And this proportion holds with respect to the [tabulated] degrees, [namely] the degrees that we set down for it. This addition adds to the elevation, and the elevation is so-and-so many degrees; so too the proportion that one takes for it. The part [or minute] for which we computed the place of the planet will be so-and-so many degrees and so-and-so many parts.

And so we take the arc of motion of the planet, and the proportion is so-and-so; the elevation is so-and-so many degrees and the place of the planet is so-and-so. And from these the [resulting] degree is so-and-so. So too, when the elevation will be so-and-so degrees, then the proportion one takes between it and the [other] elevation is in accordance with the arc of motion, and the place of the planet [comes out] so-and-so.

And so we examine the proportion of the elevation likewise. The proportion that the elevation adds: by so much it adds, and so we take it. And so we take the arc of motion of the planet, and the elevation is so-and-so, and so too the place of the planet, in accordance with the proportion that the elevation adds, [as] we explained.

And so we take the proportion of the elevation, and the proportion is so-and-so; and the place of the planet will be in accordance with the arc of motion of the planet, [namely] the part for which we computed the elevation. And so too with the [other] part of the elevation, in accordance with the arc of motion.

And so we take the proportion of the elevation; the proportion is so-and-so, and the place of the planet is so-and-so many degrees and so-and-so many parts. And so too we take the arc of motion and the arc of diameter, and the proportion is so-and-so; and the elevation is so-and-so degrees, and the place of the planet is in accordance with the arc of motion of the planet.

And so we take the arc of motion of the planet, and the proportion is so-and-so. And the elevation is so-and-so degrees, and the place of the planet is so-and-so, in accordance with the arc of motion. So too the measure that the elevation will be: so-and-so many degrees, and the proportion that one takes is so-and-so, and the place of the planet is in accordance with the arc of motion of the planet.

And the amount that the elevation adds, by that amount it adds; and the proportion is so-and-so degrees, and the elevation is so-and-so, and so too the

place of the planet, in accordance with the arc of motion of the planet, [namely] the part for which we computed the place of the planet. And it will be so-and-so many degrees and so-and-so many parts.

[The text block ends here; the lower portion of folio 256r is blank.]

and the elevation will be so-and-so, in accordance with the arc of motion of the planet. And we take the arc of motion and the arc of diameter, and the proportion is so-and-so. The measure that the place of the planet will be: so-and-so degrees and so-and-so parts. And so it is, in accordance with the arc of motion of the planet, and the elevation [comes out] so-and-so. And we examine the proportion of the elevation, in accordance with the arc of motion of the planet. The proportion is so-and-so degrees, and the elevation is so-and-so degrees.

And so we take the proportion of the elevation, in accordance with the arc of motion of the planet. The proportion is so-and-so degrees, and the elevation is so-and-so. And so we take the arc of motion of the planet, and the proportion that one takes for it is so-and-so, in accordance with the arc of motion. So too the measure that the elevation will be: in accordance with the arc of motion of the planet, the proportion is so-and-so.

And we examine the proportion of the elevation. The amount that the elevation adds, by so much it adds, and so we take it. And the elevation is so-and-so, in accordance with the arc of motion of the planet, and the place of the planet [comes out] so-and-so. And so we examine, in accordance with the arc of motion of the planet, the proportion of the elevation. The proportion is so-and-so degrees, and the elevation is so-and-so degrees and so-and-so parts; and so too the place of the planet.

Now [as for] the planets (*ha-kokhavim*) collectively, we take the arc of motion of each one of them, and the proportion is so-and-so. And the elevation of the first is so-and-so degrees, and the place of the planet is in accordance with the arc of motion of the planet; and it will be so-and-so degrees and so-and-so quarters (*revaʿiyot*).

And so we take the arc of motion of the planet, and the proportion is so-and-so. The elevation is so-and-so degrees, and the place of the planet [comes out] in accordance with the arc of motion of the planet; and it is so-and-so degrees and so-and-so quarters. And so too the measure that the elevation will be, in accordance with the arc of motion of the planet: the place of the planet will be so-and-so degrees, and so-and-so quarters and so-and-so parts.

And we take the arc of motion of the planet, and the proportion is so-and-so; and the elevation is so-and-so. And so we take the great proportion (*ha-yaḥas ha-gadol*), in accordance with the arc of motion of the planet. The proportion is so-and-so degrees, and the elevation is so-and-so degrees; and the first established quarter (*ha-reva'it ha-rishon*) will be so-and-so, and so too the place of the planet.

And so we take the arc of motion of the planet, and the proportion is so-and-so degrees, and the elevation is so-and-so. The proportion of the planet (*yaḥas ha-kokhav*) is so-and-so degrees, and so it is, in accordance with the arc of motion of the planet, and the place of the planet [comes out] so-and-so quarters. And the proportion is so-and-so degrees, and the elevation is so-and-so; and the first established quarter is so-and-so many quarters. And so we examine, in accordance with the arc of motion of the planet, the place of the planet, [namely] the part for which we computed the elevation. And it will be so-and-so degrees.

And so too the measure that the elevation will be: the part [or minute] of the place of the planet is so-and-so quarters, in accordance with the arc of motion of the planet, [namely] the part for which we computed the elevation; and it will be so-and-so degrees and so-and-so parts. And the first proportion that one takes, in accordance with the arc of motion of the planet: the proportion is so-and-so, and the elevation is so-and-so quarters, and the place of the planet is so-and-so. And so we take [it] in accordance with the rule (*ḥok*), by the established proportion, [as] one takes the elevation; and the elevation will be so-and-so degrees, and it will [stand] in accordance with the arc of motion of the planet.

[The text block ends here; the lower portion of folio 256v is blank. Chapter 135 (הקל"ה) does not open on this opening, and no colophon appears.]

[257r]

[The recto is a continuous run of computational prose with no rubricated heading; it continues directly from the prior folio. The text concerns the ratios of the motions and the doubling/halving of magnitudes as the configuration changes.]

it would be brought back [restored] to its proportion: a greater motion, the difference [excess] being such-and-such, and so on; and likewise the smaller, the difference being such-and-such; and it will be [?] … For when [the configuration] is brought back to its proportion, the [greater] motion — the difference being such-and-such, and so on; the smaller, the difference being such-and-such — [the result] will be [?]. And when it is brought back to its proportion, the motion of the

difference is such-and-such, and so on, [for] the greater [and] the smaller, the difference being such-and-such, and so on. And this is preserved [unchanged] through all time [קיים לעולם], for the star of the configuration [?] [moves] always, and it is increasing [נוסף] … [?]

These matters being settled, and this having been clarified [?], we now bring near [to the reader] the things [yet] to be investigated, more than [?] in [?] … and the reason for this — consider it [?].

[Several lines of dense procedural prose follow, repeatedly invoking the proportion (היחס) and the difference (ההפרש / המותר) of the two motions, and the line of sight (קו הראות). The worked magnitudes are given as the demonstrative placeholder כ"כ ("such-and-such [degrees]") rather than as numerals. [?]]

by way of [?] the proportion [היחס], the difference [המותר], thus-and-so [?]. And know that it is according to what we said: the proportion is so-and-so [?], and the line of sight [קו הראות] [?]. For [?] the motion was such [כ"כ], and this is what we wished [to show] [?]. And when the configuration was at such-and-such [?] in its position [במצבו], and likewise the [other] one [?]. And this point [נקודה] is [?] — that the place [המקום] [?] is added to / falls short of [מוסיף / גורע] [?].

And see: in the [given] position [מצב] the displacement [?] is a line [?] equal to [?] … And it is required [necessary] for it to be at such-and-such [?]; and if the configuration [?] [moves] from its place, it is required that it be [?] at such-and-such [?]; for the lines [?] [are] such-and-such [?]. And it follows from this [?] [that] [?] — and this is plain [?]. And the matter [?] [holds] for the rest of [the cases] [?]; and consider what we have shown for [?] the other [?].

And we [should] see, [too], the matter of the lower [inferior] planets [הכוכבים התחתונים] [?], and the configuration [?] … and the reason [?] [is] as we have explained for the [?]. And likewise the [?] of the [?] in its position [במצבו] [?]. And from this [it follows] [?] [that] [?]; and consider [?] this for [?] the rest [?]. And it is plain [?] [that] [?] [for] the rest of the cases [?].

[A short marginal note in the same hand stands in the outer (left) margin alongside the lower lines of the recto's text-block.]

[Margin (257r, left, ~2 lines, primary hand): "… בשעור [?] ועפק[?] … [?] ולא [?] יותר מ[?] החלוף החמ[?]" — a constructive helper expanding the difference [החלוף] referred to in the adjacent line; precise reading uncertain. [?]]

and the reason for this — [it is] that the star [כוכב] in its position [במצבו] is more [?], and we shall investigate [?] the planets [?]. According to what we said: every

[?] [?] is the line of the visibility-arc [?] in [?] … And the configuration was such [?]; one [?] line [?] [?] … And from this [?] the magnitudes [המעלות?] [?], and from this the motion [?], whose explanation has [already] preceded; and consider [?] it. The point [?] of the [right-angle?] is the line [?] [?] … And it follows [?] [that] [?] … And the [?] [?] — and this is the configuration [התמונה?] [?] [as] we wished [to show] [?]. And it will be [?] [for] the rest of [the cases] [?].

and the [?] of the displacement [?] from the [?] [up] to the firmament [רקיע] [?] [is] such-and-such [?]; up to the firmament [?] [is] such-and-such [?].

[Recto text-block ends here. The lower ~half of 257r is blank parchment.]

[257v]

הקל"ן [enlarged display keyword opening the verso; gematria 180 (ה5+ק100+ל30+ן50). Out-of-band enlarged keyword as in the preceding folios; whether it functions as a chapter/section ordinal or as a technical noun is not confirmed. [?]]

and the reason it was [?] and its [?] — that [?] [?]. For the configuration [שהתמונה?], and the matter is that this [?] … For the [heaven/sun?] [?], the matter [?] [?] [?] … to bring it back [?] [to] its proportion [?] up to [?]. The first [?] [?] [is] [?] the true [position] [?] [?]. According to all [?] [?] [?] [?]. The matter [?] [?] [is] such-and-such [?] [?]. And the [?] and [?] [?] [?] [?] in [?] [?]. **אמן** [Amen — terminal word, set off on its own short line.]

[A short blank gap separates this from the next, indented closing block.]

[A short concluding formula in the same hand:] "They said to me: do not wonder [be astonished] at the [?] … the configuration [?] [?] [?]; for [?] … and it is/he is [?]" [?]. [Verbatim opening: "אמרו לי לא תפלא[?] [?]…"; full reading uncertain. [?]]

[A short doxological line, slightly indented:] "Blessed be the Merciful One [ברוך רחמנא] [?] … [?]" — ending **בלבד** ["alone" / "only"]. [?]

[Colophon, 257v]

[A scribal colophon in the primary hand, set in the lower text-block. It records the completion of the book, names it as "the fifth" [part/reckoning], and gives the scribe's name. Verbatim Hebrew is supplied for the parts read with confidence; the personal names are flagged where the glyphs are not fully secure.]

"…[נש]למה / [the work] was completed [?] — the bow [קשת] [?] … this book [זה הספר], which is [?] the fifth [החמישי] [?] [in] number [?]. [?] … [by way of?] David bar Yehoshua [דוד בר יהושע] [תכ' — abbreviation, honorific, expansion uncertain

[?]], in [his] performing the work [בעלות מלאכת] [?] … and [?] and [he] received [וקבל] from it [?] [?] [?]. [Glory / תהלה?] [?] [?] — for a memorial and for a sign [token] [לזכרון ולראיון] and for a merit [ולזכות] [?] [?]. [?] my name [שמי] son of [בן?] [?] … bar Eliah[u] [בר אליה(ו)] [?] [?] bar Yehudah [בר יהודה] [?]. The young/humble one [הקטן] Yeshayah [ישעיה] [?]." [The personal-name chain in the colophon is only partly secure: "David bar Yehoshua," "bar Eliah[u]," "bar Yehudah," and the closing signature "ha-katan Yeshayah" are the best readings, each flagged [?] where a glyph is uncertain. Further identification requires further verification.]

[Librarian note: round red "BIBLIOTHÈQUE NATIONALE" library stamp impressed over the verso's middle text-block (right of center).]

[The lower ~half of 257v, below the colophon, is blank parchment.]