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PETRUS DE S. AUDOMARO:
TRACTATUS DE SEMISSIS

Fritz S. Pedersen

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i kommission hos (distributeur):
ERIK PALUDAN - INTERNATIONAL BOGHANDEL
FIOLSTRÆDE 10, DK-1171 København K

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Contents:

Notation, etc.

For symbols concerning planetary models see F11, and for abbreviations of book-titles, the List of modern authors.

References to the Latin text have the form

Ch.3	: Chapter 3
3,2	: Ch.3, paragraph 2
2,3-4.8;3,5	: 2,3 + 2,4 + 2,8 + 3,5

References to the comments have the form

Sec.B	: Section B
B7a	: Sec.B, paragraph 7a
B3.7-8;D5a	: B3 + B7 + B8 + D5a

In the apparatus and commentary, Latin phrases such as

Quoniam non conceditur nobis philosophiæ studium
may be abbreviated as *q.n.c-tur nobis ph-æ s-m*
or *q.n.c-tur--s-m*

Critical signs:

[ ]	: text in ms., deleted by editor
< >	: text not in ms. or illegible, inserted by editor
[[ ]]	: text deleted by scribe
≪ ≫	: text inserted by scribe
( )	: any comment by editor

The signs of the ecliptic *Ari,Tau,Gem,...* each cover 30 degrees, numbered 1-30. - As a location, *Tau 6* means '35 to 36 degrees from the vernal point', generally taken as 36 degrees. - As a measure, 1^s = 1 sign = 30^o = 30 degrees = 1800' = 1800 minutes of arc.

1^h = 1 hour = 60^m = 60 minutes of time.

Sexagesimals are indicated by semicolons and commas, decimals by periods.

Thus 2^h;30,18 = 2 hours 30 minutes 18 seconds = 2^h.505

A. INTRODUCTION.

A1. The *Tractatus de semissis* "Quoniam non conceditur"(T&K 1288+), ascribed to Petrus de S. Audomaro and written in 1293/4, probably in Paris, describes an instrument designed to simulate the Ptolemaic planetary models mechanically, thus enabling a user, aided by a set of tables of mean motions, to determine the true longitudes of the sun, moon, and planets at a given moment. The Western tradition for such instruments (*æquatoria*) had started with Campanus' *Theorica planetarum* from the early 1260's (B&T 5); the present instrument is the next well-attested one (B&T 32; North II 259) and the first Western instrument designed to accommodate all the planetary models within the practicable minimum of three movable parts. Besides the directions for construction and use of the instrument, the treatise contains several lengthy instructions for other astronomical calculations such as listed in A7 below and in Sec.F. Most of these are obviously derivative; but some attention may at least be given to their connection with contemporary sources, as e.g. in the discussion of the Toulouse Tables (cf. Zinner 1936,326-7; O.Pedersen 1968,10; and P2-3, on the use of William of St Cloud).

A2. The treatise was apparently first brought to notice by Zinner (1925,2055ff.and p.407;1932;1936), in connection with his registration project, and by Glorieux (1928,225). Since then the instrument was reconstructed and authoritatively treated of by Olaf Pedersen (1963;1968); a manuscript list and a summary documentation of the treatise, comprising most of the material presented in this introduction, is due to the same scholar (1976). - The present edition aims to supplement these findings by giving for the first time a full version of the text, accompanied by some aids to reading and such other documentation as may help resolve some of the remaining problems concerning authorship, sources, and subsequent use of the treatise. I learn that Prof.E.Poulle's work on equatoria will appear at the end of this year: it will no doubt extend or correct much of the previous work.

A3. The treatise is by now known, in whole or in part, from upwards of 20 manuscripts as specified in Sec.B, to which the reader is referred for the symbols used below. The manuscripts mention the name (*magister/do-*

minus) *Petrus* (N) *de Sancto Audomaro* (ECFXR;...*Amato* V), i.e. Peter of St Omer; the present knowledge of the tradition, imperfect as it is, yields no reason to consider that attribution secondary. For a plainly secondary ascription to Profatius Iudæus in some British sources, see Sec.G on testimonia. This may originate from the fact that our author is also the editor of, apparently, two revised versions of Profatius' *Tractatus novi quadrantis* (T&K 143+18;1267), to the latter of which he himself refers in 3,16 of the present treatise. The manuscripts of both Quadrant treatises name the author as above, in two cases also surnaming him, in the ablative, *Dane*, once *Dano* (cf. O.Pedersen 1976,41-5; add Kristeller II 402a).

The *inscriptio* of the Quadrant treatise T&K 143 places it in Paris (O.Pedersen 1976,*l.c.*); this could be positively affirmed for the present treatise as well, could we only be certain of the reading *Parisius* at 2,21 instead of *præcisius*. Our treatise was composed in the year starting with March 1293 (cf.3,16), as was also the Quadrant version T&K 1267 (cf. Thorndike 1960).

A4. Our author could be identified with several persons known from elsewhere, as follows: *(a)* Petrus de S.Audomaro, canon in Paris before 1296 and known to have been active as a master at the University of Paris at several times during the years 1289-1300; chancellor of the University in 1296, then archdeacon of Brie *in ecclesia Parisiensi* before 1302, and still active in 1308 (for these results see Glorieux 1928,223-5; 1933,I 404-5;1971,294-5, also dating the Quadrant T&K 143 to 1309). Under his name are left several Quodlibet-fragments on topics of Canon law (Glorieux 1925,230-42; 1935,222-3), and at his death, at an unknown date, he left the Sorbonne a collection of writings of St Thomas (Delisle II,169 *ap.* Glorieux 1928,224 n.1). Our author was identified with that master by Renan 1877,613, and by Glorieux himself; this is comparatively unproblematic except for the lack of confirmation from his remaining known scholarly activity, which caused Meyer (1898,575) to doubt the identification and Zinner (1932=1936) to reject it, cf. *c* below. - *(b)* magister Petrus de S.Audomaro, author of a treatise on the preparation of colours, most recently edited by van Acker 1972; the treatise is tentatively placed in the 13th-14th century but yields few clues for identification; cf. van Acker 165 (from De Smet 1947,240f.) on the unlikelihood of identifying this author with *a*. - *(c)* magister Petrus Philomena de Dacia, probably in Bologna before 1290 and in 1292, at Paris in some period during the 1290's, in Roskilde 1303, and canon in Roskilde at that date and probably before (Zinner 1932=1936; O.Pedersen 1974;1976, with refs.). He is the author of several surviving works in astronomy and other branches of science. Zinner, having rejected the identification with *a*, proposed *c* instead; this identification was rejected by Thorndike (1959;1960) and hesitatingly adopted by O.Pedersen in the works cited. At present I consider it rather unlikely, for reasons including those given below in S10, but the matter cannot yet be regarded as settled. I propose to treat of it at greater length when the relevant material is available.

A5. The text here printed mainly rests upon the five longest manuscripts NHBEV, which contain all ten chapters of the text (except that E lacks Ch.9) and cover nearly all the text found elsewhere. For details of the text-constitution see Sec.C, especially C3-7 for the redactional variants, and Sec.D for the design of the apparatus. As for the over-all state of the tradition, the rest of the manuscripts mostly exhibit longer coherent segments of the full text just described: thus CMP contain the preamble and Ch.1-3; L, closely connected with E, the preamble and Ch.1-8; A, the preamble and Ch.1; X and six more, Ch.9 only, which may have been wanted for its popularization of the Ptolemaic theory of latitudes. - A problem is posed by G(and some British cognates: Sec.B,Appendix),Y,and F, some passages of which appear to consist of paraphrases and/or selections of shorter bits from the full text, adding nothing but brief connective platitudes. I have examined these texts so far as to observe that the selections differ considerably; and in the passages corresponding to 3,16, absent in Y, FG are alone to update the precession value for 1293 to 1299 (cf. O.Pedersen 1976,40). This does not encourage assumptions about the priority of any of these selections.

A6. Turning, then, to the full version, the text which is here made Ch.10 occurs as such in the manuscripts NBEG, whereas HVF exhibit it as a separate treatise (T&K 295), and one manuscript (Sec.B,App.) even appends it to a different treatise. The problem of the unity of our treatise, thus posed, will be remarked on below. As concerns the chapter division, this edition follows O.Pedersen 1976,39-40 in using the division of NH; this is also the one used by BEVG, except that BE has a further cut before 7,6 and VG one at 8,16. G alone divides at 1,13; V ineptly at 10,10; and E at 10,16. For the treatment of 2,22 in VMP, see C5(a). Thus, except for the possibility of a further cut at 7,6, the present chapter-division can be safely taken to be as old as the tradition itself. On the other hand, chapter rubrics only occur in a few manuscripts, in quite unstable wordings, so I have not registered nor reproduced them.

A7. The contents of the full text can be summarized as follows:

Pr Preamble.
Ch.1: Preparation of instrument.
Ch.2: Finding mean motions from tables.
Ch.3: Use of instrument: finding longitudes of planets.
- The preceding chapters are on all accounts the core of the treatise, and occur by themselves in CMP. This is probably not a sign that CMP are early apographs, cf. below and C7.
Ch.4: The equation of time: theory, and author's table.
Ch.5: Mean and true syzygies, etc., with use of instrument.
Ch.6: True angular velocities of planets, use of instrument.
Ch.7,1-5: Stations and retrogradations, visualized on instrument.
- These sections contain extensions to the longitude calculations above, presumably for the astrological purposes hinted at in Ch.5. To be self-contained on that account, the treatise might have ended anywhere after Ch.5 (cf.S5), but it does not do so in any manuscript.
Ch.7,6: True apogees, arguments, etc., found on instrument.
Ch.8: Latitudes of planets, calculation from tables.
Ch.9: Latitudes of planets, qualitative summary.
- May all be conceived as a supplement, using the instrument only incidentally. Partly a rather slavish transcription of other sources, cf.A8.
Ch.10: Eclipses, graphical method.
- No use of instrument. For the manuscript evidence see A6.

As appears from the list, most chapters concern the use of the instrument; in those which do not, the instrument or its use are referred to at 2,6.8. 22;4,12(used in Ch.5 and 10); and the application in 7,6 is for use in Ch.8. - In other matters 2,6 refers forward to 3,4, and 2,5 to Ch.4 in all witnesses having both chapters except L, and also in CMP. The rest of the cross-chapter references are backwards, such as 2,10 from 3,15; 3 from 4,1; 3,7 from 7,4 and 9,14; 4 from 5,6; 8,1 from 9,1; less plainly, 8,2 from 10,3 and 10,11. Thus, at least, the treatise is no fortuitous agglomerate of smaller pieces, and so I shall consider it to be a unity for the purpose of this treatment, at most with a slight hesitation concerning Ch.10.

I have found no obviously unfulfilled cross-references, and the text may well be taken as complete. For the tables said to accompany the treatise, see Sec.P: only one seems to be missing from our manuscripts, namely, the author's own table P10 of the equation of time (cf.4,15). The manuscripts make varying selections, and two tables are preserved by V only. A figure of the instrument is referred to at 1,2, and in fact several manuscripts contain more or less finished drawings, discussed in Sec.E.

A8. Some observations on the question of sources can be found in Sec.P on parameters and Sec.S on textual sources and parallels. It would be premature to attempt a synthesis on the subject, but I take it to be fairly certain that the author knew Ptolemy's Almagest at second hand only (e.g. through Albattani: Ch.8). He knew the Toledan Tables, in their Toulouse version, plus the Canones Azarchelis, possibly in some slightly adapted form (Ch.2); traces of the Alfonsine Tables (P8) are faint or nonexistent. Our author may have quoted the Theorica Planetarum, possibly from memory (Ch.2.3.9). He certainly knew some translation of Albattani, very close to Plato of Tivoli, though perhaps with modernized terminology (Ch. 8). The correspondences in content with the Almagestum Parvum (Ch.4) and Alfargani (Ch.9) seem less conclusive, being at most rather loose paraphrases. There are two extensive coincidences with Jo. de Lineriis, one of which may be due to a common use of Albattani (Ch.8); the other one cannot be so explained (10,7-10), so John may have known our treatise.

All this, together with the obvious signs of influence from contemporary Parisian work (1,4 with P1; 2,20-1) serves to confirm Zinner's and O.Pedersen's (*opp.citt.*) impressions of our author as a man well versed in the source-material current in his day and probably in close contact with the work of his local colleagues. On the other hand, except for the invention of the instrument, this edition did not set out to disclose instances of the author's originality, so pretty few have been found; this question, and indeed the very problem of the unity of the treatise, reduces to a detailed charting and analysis of the contemporary literature, which, although much improving in recent years, is still far from completion.

My thanks are due to Odense University for travel grants and for defraying the cost of printing; to the Institute for Medieval Studies, Copenhagen, and the Institute for Classical Studies, Odense, for factual and other assistance; to the Danish Academy in Rome, for hospitality during studies at the Vatican Library; and to Prof. Olaf Pedersen, Dr. C.M.Taisbak, and Mrs. Aya Pedersen, for several improvements, the errors being, as usual, mine.

B. LIST OF MANUSCRIPTS.

The manuscripts under B1-2 all contain the preamble "Quoniam" and the tables printed in the text, unless otherwise noted below or *ad loc.* To the more important manuscripts I append some notes from the collation, to determine reliability of reading and in some cases to justify use or non-use. "OP"=O.Pedersen 1976.

B1. Manuscripts containing the full text (Ch.1-10), or nearly so.

N Paris B.N. nouv.acq.lat.1893. 14.c., prob. before 1323.
OP 10,9. T&K 1288. Contains the entire text.

79va: Incipit tractatus de semissis ad omnes planetas æquandos.
Quoniam non conceditur-
91rb: -moderamine recta. Explicit.
Explicit instrumentum æquationum Petri quod vocatur semissæ.

81r-82r: schematic drawings of the parts of the instrument.
89r-90r: drawings of eclipse triangle for Ch.10.

Some erasions and one cursive correction were tacitly accepted. No good distinction between hæc/hoc, tamen/tantum, immediate/in medietate; the convenient alternative was chosen without comment. - Two or three individual homoeoteleuta against HBEV(FG).

H London B.L. Harl.3647. 14.c., early. OP 10,7.
Contains the entire text; Ch.10 occurs separately.

195ra: Cum eclipsim lunæ- (Ch.10)
197rb: -moderamine recta. Explicit.

215ra: Quoniam non conceditur-
224vb: -planetarum sufficiant.

225r: drawing of two half-circles.

A few corrections, by the text-hand, tacitly adopted. Some confusion among ita/infra, linea/littera, not consistently noted. Our scribe, or his Vorlage, manages to write 'divinarum' for 'diurnarum', 'excelsum' for 'excessum', and 'theologe' for 'Tholos(an)æ'. - One larger omission (1,4) and a couple of lesser private homoeoteleuta against NBEVC (FG)MP.

NH have 7-8 homoeoteleuta in common against BEV(CGMP) and alone contain the verses 'Pravos eventus' at the end of Ch.10.

B Basel U.B. F.iii.25. 13.-14.c. OP 10,1. T&K 1269.1288.1443. Zi 2055.
Contains the entire text.

1ra: Quoniam non conceditur-
16rb: -sicut eclipsis lunæ.

1r,lower margin: Conventus Basiliensis ordinis prædicatorum est iste liber, et fuit quondam fratris Iohannis Tagstern professionis eiusdem. (prob.15.c.)

8r: some astronomical notes, not in any of the text-hands. The text continues with Ch.5 at 9ra.

At least two text-hands. Extensive additions and corrections by at least two hands, one of which (B2) may be the same as the first text-hand. The contents of B2 roughly correspond to the variants in VEL(CMP) and will be discussed in C5-6. The rest (B3) are short and sparse and have mostly been tacitly accepted, as well as some erasures. - Some trivial miswritings, e.g. s/f and omissions of nasal strokes, were ignored when leaving a vox nihili. Hæc/hoc and tamen/tantum not well distinguished. 'Diameter' is made masculine in Ch.8, with some secondary corrections to the adjectives. - Some 10 homoeoteleuta against NHV(ECGMP), one short explication.

V Vatican B.A.V. Barb.lat.303. 13.-14.c. Silverstein p.82ff. Contains the entire text. Ch.10 occurs separately.

5ra: De eclipsi lunæ et solis.
Cum eclipsim lunæ- (Ch.10)
6ra: -et sic de aliis. Explicit.

12rb: Incipit tractatus de semisse magistri Petri de sancto amato.
Quoniam non conceditur-
14rb: -5 minutis cum dimidio.(3,16)
Explicit de veris locis planetarum secundum instrumentum magistri P.D.S.A.
(Continuing:) Ex iam dictis-
16v: -planetarum sufficiant.

16v: Tabula latitudinis lunæ (P11)
17r: Tabula trium superiorum planetarum latitudinem, pars superior (inferior part follows, without inscription) (P12)
Tabula ad sciendum latitudinem Veneris et Mercurii, pars superior (inferior part follows, without inscription) (P13)
17v: Tabula quantitatis semidiametrorum luminarium et umbræ (P14)
Drawings of eclipse-triangle for Ch.10.

A few annotations in the text-hand and in cursive, possibly contemporary, contents not recurring elsewhere; ignored. Ms. is damaged in a corner, losing some passages of 1-2 words and some longer pieces in 9,7-9; these are ignored where the extent seems to fit and there are no variants elsewhere. Ch.4 has 'tabulis' for 'tabula' and 'certam meridiem' for 'veram meridiem' a number of times. For some of the longer individual variants, see C3 and C6. Some good readings against the rest; one was adopted in the preamble. At least one homoeoteleuton against NHBECMP.

E Erfurt W.A.B. CA 4°366. Mid-14.c. OP 10,4. T&K 1288. Zi 2056. Contains the entire text except Ch.9, which is represented only by its first 4 words.

58r: Tractatus semisse.
Quoniam non conceditur-
68r: -sicut eclipsis lunæ.
Explicit tractatus semissarum M. Petri de sancto Odomaro.

61v: (note) Motus octavæ sphæræ anno 1357...

Some lesser corrections in the text-hand, tacitly adopted. Some Roman numbers. Vacillation between volvella/novella, hæc/hoc, proportionibus/ /-alibus, not generally noted. In Ch.4 'dies' is made masculine fairly consistently. There are some good readings against NHBV, and 3-4 omissions against NHBV(CGFMP), mostly homoeoteleuta.

L Melbourne State Libr. of Victoria 224(Sinclair,1969,p.382).
14th c.,first half, from writing ('mid-15c.',Sinclair). Contains Ch.1-8.

187rb: Incipit tractatus instrumenti quod dicitur semissa de æquationibus planetarum. Capitulum primum prohemiale. / Quoniam non-
189vb: - difficultate et inquisitione (8,16). Deo gratias.
Explicit tractatus instrumenti semissarum.

The text follows E closely against NHBV(CMP). L has many private errors against the mss. mentioned; on the other hand, the errors of E against L and the rest are few but enough to show that L is no apograph of E. But the advantage of using L is slight (exception,5,3), so with few exceptions I have disregarded it in this preface and in the apparatus.

B2. Manuscripts containing varying selections.

C Cues Hosp.Bibl. 214. Early 14.c. OP 10,3. T&K 1269,1288(misprint '215'). Zi 2057. Contains Ch.1-3. End of text, cf.Thorndike 1960,204 n.6.

1ra: (upper margin) Liber hospitalis sancti Nicolai prope Cusam. (15-16c).
(text) Compositio instrumenti domini Petri de sancto Audomaro.
Quoniam non conceditur-
9rb: -5 minutis cum dimidio.
Explicit de veris locis planetarum. (cf.ms.V, above)
1v: Drawing of semissa sphærarum, Side 1
4v: Drawing of semissa epicyclorum

Several cursive corrections, possibly contemporary. The shorter of these were tacitly accepted; two longer ones, supplementing homoeoteleuta in 2,7, look like improvisations and were disregarded. A lacuna in 1,3 was not registered, space being about adequate. - C is not given to individual revisions: indeed, the 10 longer individual variants are all homoeoteleuta, except the omitted reference to the New Quadrant in 3,16.
C has the correct readings alone at 1,7-8: these may be original, as well as the reading 'præcisius' at 2,21, which it shares with MPFG against the 'Parisius' of the rest.

M Melk Stiftsbibl. 51. 14.c., later half? OP 10,8. Zi 2058.
Contains Ch.1-3.

107ra: Quoniam non conceditur-
111rb: -5 minuta cum dimidio &c.
Explicit usus et utilitas semissarum.

108v: Drawings of semissa sphærarum (Side 1-2 in one) and of semissa epicyclorum, both rather detailed; see Sec.E.

P Vatican B.A.V. Pal.lat.1340. 14.c.,later half.
Seen by me in 1978; used also by Prof.Poulle.
Contains Ch.1-3.

47va: Incipit tractatus de semissis.
Quoniam non conceditur-
52rb: quinque minuta cum dimidio.
Explicit usus et utilitas semissarum.

49r: Drawings of semissa sphærarum (Side 1-2 in one) and of semissa epicyclorum, both rather detailed and like those of M, cf.Sec.E.

- MP are almost twins, sharing numerous lesser errors and a great deal of short explanatory notes against the rest. Not counting these, they may go back to a text fairly independent of the others, and some likely readings are cited at 1,7.12.15;2,4.7.19. But C seems to possess most of the virtues of MP, and indeed the state of the text appears to be such as not to re-pay the trouble of a consistent collation. Thus MP were collated only for the redactional variants of Sec. C3-7, and for Sec.E as concerns their figures.

F Firenze B.N. ii.iii.24. 13.-14.c. OP 10,5; T&K 1288.
Contains Ch.1 and 10(occurring separately), and a collection of passages found in Ch.2-3;7-8, and 9 of the full text.

206rb: Incipit tractatus eclipsium solis scilicet et lunæ secundum Petrum de sancto Odemaro.
Cum eclipsim lunæ- (Ch.10)
208rb: -sicut eclipsis lunæ. Explicit.

225ra: Incipit tractatus de semissibus.
Quoniam non conceditur-
228ra: -reperiatur, erit directus. (7,1)
Expliciunt utilitates supra semissas.

228ra-232v: Toulouse tables of mean motions of sun, moon, node, and the five planets (P7).

A couple of running corrections in the text-hand and one in a cursive. One longer repetition of text (10,23-26). F generally reads with the majority, and in collating Ch.1 and 10 I have found no individual variants of any account.

G Cambridge U.L. Gg.6.3. 14.c.,later half. OP 10,2; T&K 302,1288.
Contains Ch.1 and 7-10 and a collection of passages found in Ch.2-3; 8-9 of the full text. The collection is not strikingly similar to that of F.

322r: (upper margin, apparently corrector's hand:)
Tractatus semissarum Profatii Iudæi ad æquandum planetas.
(Text-hand:) Tractatus semissis.
Incipit prooemium cuiusdam instrumenti quod vocatur semissis.
Quoniam non conceditur-
330rb: -vel sic de aliis. Explicit.

323rb-va: Drawings of Side 1 and 2 of semissa sphærarum, semissa epicyclorum, and the novella.

"Oxonia" is sometimes mentioned, mostly replacing "Tolosa". Some corrections, mainly rectifying obvious errors. G has a lot of errors and revisions against the rest. It shares the addition in 10,33, and some lesser variants, with V; it is more consistent than V at including redactional variants, cf. Sec.C. Two good readings are noted to 10,8.31, but elsewhere G was only collated for figures and redactional variants, and only for Ch.1 and 7-10.

Y New York Pierpoint Morgan L., Bühler 12. Ca.1425. Census,Suppl.p.389. Contains Ch.1 and a drastically abbreviated version of Ch.3.

132r: Incipit tractatus compositionis instrumenti ad inveniendum vera loca omnium planetarum, ut sequitur in præsenti.
Quoniam non conceditur-
137v -in cuius directe est aux (3,9).
Expliciunt distantiæ et quantitates supradictæ.

136r: Figure of novella, "Volvella"
137v-139r: List of absolute distances in the planetary system.
139r-v: Repetition of table (1,16).

Text, when comparable, most like version of VC. Not used.

A London B.L. Arundel 88. Ca.1500. OP 10,6. T&K 1288.
Contains Ch.1 only.

87r: De æquatione et motu planetarum per instrumentum quoddam.
Quoniam non conceditur-
88v: -centri deferentis solis (Table 1,16 follows.)

Text most like NH. Not used.

B3. Manuscripts containing Chapter 9 only.

I have only used X and only examined RX in any detail.

X Bologna B.U. 132. 14.c. T&K 1571. Frati,SIFC 16(1908)166. B&T 109.

27r: Incipit theoricha motuum latitudinis planetarum.
Theoricam motuum latitudinis planetarum-
28r: -statuæ prius intellectæ--planetarum sufficiant.
Explicit capitulum de latitudinibus planetarum editum a magistro Petro de sancto Hodomaro secundum regulas Albatengni.

Preceded by the Theorica Planetarum.

R Vatican B.A.V. Ross.732. 15.c. B&T p.91.

121r: Incipit theorica motuum latitudinis planetarum.
Theoricam motuum latitudinis planetarum-
121v: -statuæ prius intellectæ--planetarum sufficiant.
Explicit capitulum de latitudinibus planetarum editum a magistro Petro de sancto Hodomaro secundum regulas Albategni &c.
E<x>plicit feliciter.

Preceded by the Theorica Planetarum. This ms. is probably an apograph of X above.

- Erfurt W.A.B. CA 4°349. 14.c., wr. by Jo.de Wasia. T&K 1571. Zi 7839.

  7v: Theorica motuum latitudinis planetarum-
  8r: -statuæ prius intellectæ--planetarum sufficiant.
  Explicit tractatus de latitudinibus planetarum.

  Preceded by (Jo.de Lineriis) "Circa canonem".

- Erfurt W.A.B. CA 4°386. Mid-14.c. T&K 1571. Zi 7840.

  49r: Theoricam motus planetarum cognitio-
  50v: -statuæ prius intellectæ--planetarum sufficiant.
  Explicit &c&c&c&c&c.
  (Table from 1,16)

  Preceded by the Theorica Planetarum. Table most resembling version of NHB.

- St.Gallen Stadtb.(Vadiana) 412. Ca.1340? T&K 1571.

  41v: Theoricam motus planetarum quo ad latitudines-
  42v: -per imaginationem statuæ. Et hæc omnia clarius patent in tabulis.

  Preceded by the Theorica Planetarum. Text somewhat abbreviated, otherwise most resembling NHB.

- Wien Oe.N.B. 5203. 15.c. T&K 1571. Zi 7842.

  119r: Theorica latitudinum planetarum.
  Theorica motus planetarum in latitudine-
  120r: -statuæ prius intellectæ. Et hæc sufficiant de latitudinibus.

  Text much altered and abbreviated. Among some treatises by Peurbach and Henry of Hesse. Erroneously ascribed to Regiomontanus by Zinner, Regiomontanus (1938),220, followed by T&K.

- Münster U.B. 741(Ständer,*olim* 530), 76r-v. 13.-14.c. OP 5,48. Zi 7841.

  "durch Bomben vernichtet" (librarian).

Appendix. Manuscripts not used.

The following manuscripts came to my notice too late to be utilized. They are all British and textually close to G.

- Cambridge U.L. Hh.6.8. Ca.a.1300(T&K,below). Contains Ch.10, appended to the treatise "Quia in huius operis initio"(92r:T&K 1220) or "Quicumque vult planetas æquare"(80r:T&K 1239).

  93v: Investigatio eclipsis lunæ per protractiones geometricas.
  Cum eclipsim lunæ- (Ch.10)
  95r: - vel 2a vel 3a, et sic de aliis.

  Scribal variants mainly as G, but somewhat closer to V and the rest. Choice of longer passages, e.g. (C5b) and 10,33, as in G.

- Cambridge (U.L.) Gonville and Caius 141/191. 14th c., early (cat.) Start and (apparently) end of treatise missing in ms.

  p.535: et constitue prædicto modo - (1,6; preceding page blank)
  p.539: - protende filum a centro sui æquantis transiens (text as 3,2; my photo ends here)

p.536-7 drawings of Side 1 and 2 of semissa sphærarum, semissa epicyclorum, and the novella, entirely like those of G.

Lay-out of manuscript, and choice and arrangement of text, like G in all essentials. Variants, including "Oxonia", mainly as in G, somewhat approaching the rest of the tradition. (Not written in the same hand as the preceding ms.) The date "1299" (see A5) corrected from "1293". Could be an ancestor of G, or next to one.

\- Oxford Bodl.L. Laud.misc.594. 14th c. 153r(old fol.)=154r(new fol.) -T&K 1267.

153ra: Quoniam con centris mediis - (2,1)
153rb: - reperiatur, erit directus. (7,1)
(Bottom of page:) Explicit tractatus semissarum pro (planet-symbols).

153rc-154r: Tables of mean motions(P7)
154v: Tabula diversorum motuum planetarum in una die
Latitude table (P12+13 in one)

Text chosen and organized as in G, some readings in common with G and with VC against the rest. Has 'Tolosa' against G and others.

C. THE MANUSCRIPT TRADITION.

C1.

This edition rests on a collation of the manuscripts NHBEV, which contain the full text (Ch.1-10), except that E lacks Ch.9. Further, for Ch.1-3 I have had recourse to C, for Ch.9 to X, and for Ch.10 to F, these being impressionistically the best remaining witnesses. See the comments in Sec.B for some justification of the choice. I have collated the manuscripts from microfilms, and inspected V for its difficult passages.

I do not think it safe to postulate scribal errors common to all these manuscripts. At 7,4 NHBV have a corrupt passage not in E and marked for deletion in B; the section 3,16 on the precession rate is suspect, cf. P3; some emendation seems to be needed at 2,4 (MP right?), 4,3 and 4,12; 4,7-8 mis-report Azarchel's table, probably mixing it up with the author's own, see P9-10; and I do not understand 10,17, cf.Sec.S. All this may not be worse than expected from some not quite legible or finished autograph, and on the whole, the parts of the text common to all manuscripts can be established with fair confidence.

The larger individual errors referred to in the comments in Sec. B, plus numerous minor ones, preclude the assumption that any of these manuscripts descends from any one of the others. In particular, B+B2 has no descendant among the manuscripts mentioned. As for the rest, R almost certainly descends from X, and there may be further affiliations among the manuscripts containing Ch.9 only; and I have not examined the relation of MP, which is quite close. - Some good readings have been preserved, or conjectured, by any one of the manuscripts E,V,C,MP,G, hardly any by NHB; some of these were adopted, mostly from E and C.

A different problem is presented by the numerous and extensive passages which occur in some of the manuscripts only, notably those in E(B2VFC) and not in NHB. Many of these are redactional variants, intended to correct or develop the sense of the text, and generally appear as additions meaningful in themselves. The phenomenon strongly suggests that one ancestor was an annotated text, the notes accruing while apographs were taken. Some attempts at identification of these variants can be found in C3-7 below.

C2. Scribal variants (Manuscripts NHBEV(CFX) only).

A study of the apparatus will reveal that, even when discounting easily fluctuating variants such as those mentioned in Sec.B under the individual manuscripts, no manuscript filiation can be established assuming only a slight amount of contamination. Thus, as a substitute for a stemma, I give some common variant groupings with an estimate of what action to prefer in each case.

NHBE:VC Common throughout Ch.1-3. Mostly both versions give sense. NHBE is probably in error in one case (2,15, propter--medium *om*); VC is, at least, ungrammatical several times in (1,16); and in the lesser variants 2,2(annos) and 2,4(signa quoque) NHBE rather than VC agree with the Canones Azarchelis. Cf. also 1,12(subiciatur) and 2,7(necesse). - NHBE were preferred in case of doubt.

From the start of the treatise until about 2,10 there is no obvious structure within NHBE. From then on, the two following groupings occur often:

BEV(C,F):NH NH generally show rather obvious errors and need never be seriously considered. Instances are 2,13(invenies), 3,1(extremitatem), 3,11(et--circuli), 5,1(nam--), 8,4(si vero). The concluding verses 10,33 are peculiar to NH.

EV(C,F):NHB NHB generally show errors concerning lesser variants such as 2,21(motu), 4,4(in c.obl.), ?4,8(collectum--), 5,9(modo), 10,19(datum). - NHB were generally rejected; in Ch.9 where they stand against VX, a freer choice was made.

EV:NHB(C,F) Mainly in Ch.2 and 10. EV accord with my ms. of the Canones Azarchelis in some very minor variants (2,2 minuta secunda; 2,3 minutis et secundis; 10,30 provenerit), and are wrong in 10,15(inter initium); there seems to be no obvious choice elsewhere. Some preference was given to EV.

NHE(F):BV Some instances in Ch.7-8 and 10. BV is in error at 10,2(pedem) and 10,16(lunæ), NHE probably at 7,5(quia similiter); at 8,10 the near co-occurrence of homoeoteleuta in BV may be fortuitous. - A slight preference was given to NHE.

EF:NHBV Some instances in Ch.10. NHBV are in error at 10,2(C-B) and probably at 10,3(lunæ). - EF were preferred in case of doubt.

Leaving out details, it appears that NH,B constitute one group, at least from the middle of Ch.2 on, and VC another group throughout Ch.1-3. E may be more or less independent of the rest, and in fact the rules above amount to using it as reference manuscript.

C3. Redactional variants.

This section mainly treats of variants comprising several words and making sense in all cases; included are also all the notes in B which can be referred to B2 on the strength of the writing. There is an obvious fluidity between all these and the purely scribal variants, and in the event some of them will be treated as scribal.

There is one omission in H (1,4) and two larger revisions in E (2,9 and 7,5), which are probably individual. The remaining variants can be conveniently classified as *(C4)* those where V(C) differ from NHBE, B2 being mainly absent, and *(C5-7)* those where E differs from NHB, B2 being present under certain conditions. - One cannot fail to note that (C4) is most frequent up to Ch.3, and (C5-7) from then on; this may indicate that the original had undergone a revision to that extent before any apographs were taken; but details are quite obscure.

C4. V against NHBE.

The numerous variants in the table 1,16 mainly set off VFC(MP) against NHBE. The former set bears the mark of an unsuccessful revision, and I have felt free to adopt the latter.

(a) Additions in V(CFGMP) against NHBE.

1,10	('oppositum centri',def.)	VCFGMP:	*om* NHBE
2,15	propter hoc--medium	VC MP:	*om* NHBE (?erroneously)
2,19	(Toulouse Tables, properties)	VC MP:	*om* NHBE
3,14	(see C5a below)		
10,33	(jottings on eclipses, end of treatise)	VG:	*om* NHBEF

10,33 must be a secondary addition, and 3,14 could be, having probably no connection with the version of B2EC. At 2,15 I have failed to find a conjecture to make up the loss of the main sentence. I would not venture on the rest; they may also be omissions in NHBE.

(b) Omissions in V(C) against NHBE(CFGMP).

2,17	(mean velocities)	NHBECMP:	*om* V
2,18	(mean velocity, re-statement)	NHBECMP:	*om* V
3,1	æquante--iacente (practical)	NHBE MP:	*om* VC
3,4	qui--novellæ (specification)	NHBE MP:	*om* VC
5,9	si--attamen (proviso) - B2 and V not quite co-extensive.	B2NHBE :	*om* V
7,6	secundum--epic. (specif.)	NHBE G :	*om* V

8,12	(sign of *reflexio*, condition 2)	NHBE G :	*om* V
10,8	(equation of time)	NHBEFG :	*om* V

Some of these are erroneous omissions in V, such as 2,17, presupposed by the part of 2,18 which does occur in V; 8,12, which is necessary and present in the probable sources, cf.S8; and possibly 10,8, which may be a homoeoteleuton. Some others were redundant and may have been glosses, such as 2,18; 3,1; 3,4(homoeoteleuton?); 7,6. - Possibly some of these were notes in the original of V; one such may be 5,9, which could have been somehow transmitted into B2; it is in fact the only place where B2 duplicates NHB. But this trace lacks confirmation.

C5. EB2(VCFMP) against NHB(V).

The rest of the larger variants are those where E differs from NHB. They start at the end of Ch.2 and continue throughout the treatise. These passages mostly coincide with the notes constituting B2. In fact, except for some one-word corrections to B (1,6.7.16;5,6.10;6,1) and two secondary adaptations (3,9;8,2), B2 takes no notice of the individual aberrations of B, neglecting some 10 longer private omissions throughout the text of B (e.g. 4,4; supplement by another hand 8,14) and once duplicating B's text where its errors are hardly significant (5,9, above). See C6 below for conjectures on the genesis of B2.

The following passage (3,9-10) may serve as an example:

NH:	motus,	videlicet quantum	distat -- deferentis.	
B:	motus,	videlicet quantum	distat -- deferentis.	
CMP:	motus.	Tantum enim corpus pl'æ	distat -- deferentis,	quantum -- zo'co
V:	motus.	Tantum enim corpus pl'æ	distat -- deferentis,	quantum -- zo'co
E:	motus.	Tantum enim corpus pl'æ	distat -- deferentis,	quantum -- zo'co
B2:				quantum -- zo'co

NH:		Et hoc, si	centrum eius verum	fuerit	6		signis
B:		Et [[hoc, si	centrum eius verum	fuerit]]	6		signis
CMP:	instrumenti.	Et hoc, si	centrum eius verum	fuerit	6	*in*	signis (in,C)
V:	(-- *om.* --	) si	centrum eius verum	fuerit	6		signis
E:	instrumenti.	Et hoc, si	hæc d.a.a.deferentis	fuerit	6		signis
B2:	instrumenti.	Et hoc, si	hæc d.a.a.deferentis	fuerit			

The longer version gives at least the better sense, and I have chosen to print that, partly in italics. B2 is seen to neglect the first variant in NHB; then, at an 11-word omission, B2 sets in and continues until it finds the texts agreeing again. Then the short overlapping passage in B was deleted. The result remains ungrammatical. - Note also that B2 is closest to E in a detail, and cf. C1, to 7,4.

(a) Tables of mean centra, and table of moon's mean elongation.

2,22	(mean centra tables)	B2EVCMP:	*om* NHB
	+(table $\frac{1}{2}c_m$(moon))	B2E C :	*om* NHBVMP
3,14	($\frac{1}{2}c_m$(moon)) B2EC: (re-statement of 3,13)	VMP:	*om* NHB
5,2-3	($\frac{1}{2}c_m$(moon),table)	B2E :	*om* NHBV
5,7	($\frac{1}{2}c_m$(moon),table)	B2E :	*om* NHBV

As for the part of 2,22 occurring in VMP, at the end of the chapter, MP mark a chapter division before it, and VM omit the division after it, so it was probably a note ambiguously placed in the original of VMP. On account of the order of 2,22, it would be earlier than, or contemporaneous with, the four extensive passages on (the table of) the moon's mean elongation, which are all in B2E, and C when present, and all omitted by V, and by MP when present. Stylistically I should judge them to be secondary; for the possible inspiration for them cf.P8. In any case they probably arose in the form of notes, like the first part of 2,22.

(b) Parallax: Sign; correction tables; special cases.

10,18 (*recessus* defined) EFG: (*recessus*,sign) NHB: *om* V

10,22 (table P16a, ident.) B2EVFG: lunæ NHB

10,24 (sign of parallax,90°) B2EVFG: *om* NHB
+10,25 +(parallax in longitude, outside eclipses; table P16b, ident.) B2EVFG: *om* NHB

10,27 (time of parallax, sign,90°; corrects only the second of two statements in 10,26) B2EVFG: *om* NHB

10,29 (parallax in latitude, outside eclipses) B2E FG: *om* NHBV

10,30 (sign of parallax,90°) EVFG: (sign of parallax,meridian) NHB

The passages on the nonagesimus are almost certainly secondary corrections or qualifications to the meridian criterion of NHB, cf. what looks like an imperfect revision in 10,27. Probably 10,18 should be considered together with these: here the omission of V leaves a sentence unfinished; perhaps V met a deletion and ignored a note replacing it. - It appears from 10,25 that the table identifications (10,22.25) and the somewhat irrelevant passages on parallax outside eclipses (10,25.29) could all be contemporaneous; the order of 10,24-5 might indicate that they are at least not earlier than the nonagesimus-notes. - V is seen to omit 10,29, retaining 10,25.

(c) Other notable explications.

4,2 (*vera meridies*) B2EV : et NHB

4,7 (start of year,reminder) B2EV : *om* NHB

8,2 (*verus motus Geuzaar*) B2EV G: cum quo argumento NHB(+Can.Az.) - B2 misplaced and secondarily adapted to B.

8,5 (latitude table entry) B2EV G(+Jo.Lin.) : *om* NHB

10,11 (advice for scaling on figure) B2EVFG: *om* NHB

In 8,2 NHB should be the earliest version when compared to the probable source. On the other hand, if Jo. de Lineriis and the relevant portions of Ch.8 are independent (see S8), then NHB were altered in 8,5.

(d) Re-statements in NHB.

4,8	collectum--pr-itis	EV	: collectionum--pr-itarum NHB
4,8	collecto--æqualibus	EV	: collectionis--æqualium NHB

5,6	temporis	EV	: quae--continget	NHB
7,6	addatur--interceptus debet addi--interceptus	E V(G)	: : addatis--interceptum	NHB
9,12	de Mercurio--retro	B2 VGX	: et per--Mercurio	NHB

It appears that B2 generally does not occur in these passages. Together with 3,9;10,18;and 10,30, these are the only ones where NHB exhibit a text of some extent compared to the alternative.

(e) Various lesser notes.

4,4	in circ. directo B2EV : *om* (and farther on *add* "in circ.obliquo")NHB		
4,5	nonæ sphæræ (misplaced by B2) B2EV: *om* NHB		
7,2	(*directus*, threefold)	B2EV G :	vel NHB (one more small addition)
7,2-3	(piecemeal explic.)	B2E G :	*om* NHBV (5 instances)
7,4	(*stationes* defined)	B2E G :	*om* NHBV
8,10	cum--additamento	EV G(+Jo.Lin.) :	*om* NHB
10,19	et præcisæ	B2EVFG :	*om* NHB
10,28	accipe	B2EVFG :	*om* NHB, erroneously
10,32	in eodem climate	B2EVFG :	*om* NHB
3,15	tunc--proice--signa tunc--aufer--signa aufer 12 signa	CMP : V : E :	 *om* NHB

Most of these, and certainly 4,4 and 10,28, would be due to secondary omissions in NHB. In 3,15 the omission could be more wide-spread and variously supplemented.

C6. Properties of B2 and V.

Some, perhaps all, of the notable variants (a-c) are likely to have occurred as notes somewhere in the tradition. One might ask whether B2 descends from such notes and is thus, by its presence, an indication of whether some one variant is a redactional alteration. In fact B2 itself was probably copied from notes, being misplaced in 4,5;8,2. As was mentioned, B2 does not fit B (except for 1-2 adaptations and a few other cases, noted above), but generally occurs only where there is some deviation between NHB and some text like E, and then mainly where NHB seem to omit some length of text ((de) above). B2 sometimes corrects obvious errors in NHB (cf.(e)), and supplements what seem to be secondary omissions (8,5), even quite inconspicuous ones (4,5;10,19). On the other hand, B2 fails to emend some shorter passages which appear to be either omissions in NHB (e.g. 3,15;8,10), or alternative versions: cf.(d) and, conspicuously, 10,30, where B2 contains the rest of the analogous passages. Thus B2 does not simply descend from redactional notes nor simply from corrections to NHB's nearest ancestor. It might be composite, or the result of a collation of some ancestor of NHB with a text close to E. In the latter case the nonappearance in 10,18.30 and in (d) could be due to the fact that such a collation mainly intended to supplement omissions, which is anyhow not implausible.

V omits some passages which could in any case be supposed to be later than the rest, cf. (a) and 10,29. In the case of the (a)-pieces it is tempting to assume that V, with MP, never saw them. On the other hand V seems generally to omit trivial-looking text such as mentioned under C4; and it is hard to believe that V did not possess 10,29 as well as 10,25, and the bits in 7,2-4 as well as 7,2, whatever the form of these pieces in the original of V. Thus it might be safer to say that the present material does not offer reasons enough for separating layers in the additions.

C7. To summarize: On the strength of the scribal variants (C2), NHB clearly form an isolated group, whereas the rest show no such over-all dependence. It might thus be held that all or most of the longer variants between NHB and E etc.(C5a-c) were due to secondary alterations or omissions in NHB, as are no doubt most of the smaller ones (C5d-e). If so, it would have to be explained e.g. why NHB altered a correct doctrine to a false one (C5b; Ch.10), and it should be noted that at least once NHB is nearer to the probable original (C5c; 8,2). - The more plausible assumption is that some of the extra passages arose as additional glosses, probably at the start of the tradition, but unseen by the ancestor of NHB. This would explain e.g. an erratic chapter division (C5a; 2,22), a senseless omission in V (10,18) and a seemingly incomplete revision (C5b;10,27), and generally why V shares many significant omissions with NHB. B2 might descend from such glosses, but since on that assumption it is both incomplete and mixed up with foreign material, it had probably better be explained otherwise (C6). - If in fact NHB descend from an early version without ascertainable glosses, then the full text of Ch.1-10 contained in NHB is original, and the abbreviation used in C(MP) is secondary (see also A7), so that traces of successive composition of the text must be looked for elsewhere. The passages from Ch.2; 3;5 (C5a) which are in B2E(C) and not in V(MP), could be thought to have been added later than other glosses; but VC are still quite close on other accounts (cf.Sec.B and C2), so the evidence for this is slight. - I print the (C5a-c)-passages in italics in the text, with a note in the first section of the apparatus. On the assumptions above, the lesser variants C5de could mainly be due to alterations in NHB, so I have treated them as scribal and generally followed EB2(V). Nevertheless I italicize at most of these places as well, to notify readers with different judgment.

D. EDITION.

For the manuscripts NHBEV(CXF) consistently collated, and those used for single readings, see C1.

Text: For readability I have consistently used a near-Classical orthography and a modernizing punctuation. The chapter division is from the manuscripts, cf.A6; paragraphing is by me. Some readings which are uncertain in individual manuscripts were mentioned in the comments in Sec.B; generally, in collating I neglected orthographical variants such as Arabic figures/ Roman numbers/ words; the spelling of Arabic names or loan-words; or whether *signa, gradus* etc. were abbreviated or not.

The italicized passages are mainly those not in NHB or not in V, some of which at least may be redactional additions, cf.C3-7. Alternative texts are printed in two columns.

The *heading of the apparatus,* on each page, shows which of the manuscripts NHBEVCXF are generally present there.

The *first part of the apparatus* indicates the more notable passages occurring in fewer manuscripts than mentioned in the heading, and is generally positive. It covers all the pieces italicized in the text, plus such other longer variants as are not obviously senseless errors.

The *second part of the apparatus* contains a selection of variants which are considered to be scribal. The entries are generally negative as concerns the manuscripts mentioned in the heading or first part of the apparatus. If some further out of these manuscripts omit the passage in question, they are marked with *def* in the pertinent entries. The rest should be taken to read as the text, except in such cases as mentioned above.

The apparatus endeavours to include all readings of the manuscripts mentioned, except those which occur in single manuscripts or NH only. Such individual readings have only been noted (1) for some more extensive alterations which are not obvious errors, (2) for some numerical variants, (3) if the reading of the text rests on one manuscript or on NH, (4) if several individual readings are similar enough to suggest some one alternative, (5) in a few more suggestive cases. - For the italicized passages all readings are included. - Other manuscripts, mainly MPG, are adduced independently: an entry including only these says nothing about the readings of those normally used.

E. SCALE DRAWINGS. NOTE ON THE MANUSCRIPT FIGURES.

The drawings are meant to illustrate the construction in Ch.1; for the terms and symbols used the reader is referred to there and to Sec.F.

The manuscripts NCGMPHY show drawings of the instrument, as listed in Sec.B. Those of HY are mere rudiments. The figures of N and M are drawn approximately to scale; the rest are not, and the distortions show no striking similarities. In some cases, measurements could have been taken from larger-scale figures.

Some ambiguities in Ch.1, which must be taken into account in the criticism of the manuscript drawings, are:

(A) The rotational direction (succession of the signs) is leftwards, as appears by implication from 3,7. Thus, if the semissa sphærarum is viewed from the straight edge, the apogees will be to the right, and the 'AEB' of 1,1 should be read in reverse. - This holds true only for the figures in N and C; G reverses the semissa sphærarum, and so do probably MP, since the scale numbers on their zodiac are ordered clockwise, and the labels *aux* etc. are placed to the left.

(B) The equant scales are conceived as circles to be divided; their width is left for the user to decide. In fact, GMP draw them schematically as single circles, NC as proper scales; I have followed the latter.

(C) The radius of the semissæ is set at 45^p, cf.1,3-4. Except for the special question of the sun's deferent (1,8) it is immaterial whether the inner or outer radius of the zodiacal scale is used. However, the radius of Venus' epicycle will be about .96 of the radius chosen, so that in the latter case it may collide with the outer scale of the semissa epicyclorum. - The problem arises only in the figures of N and M, and in fact both of them use the outer radius, thereby experiencing the difficulty. N contracts the epicycle slightly whereas M mingles it with the outer scale, remarking upon the fact, cf. below. For convenience I have used the inner radius.

(D) The equant scales should almost touch at the apogee A or K, cf.1,6; and the solar deferent should exactly touch the inside of the zodiacal scale (implied in 1,8). - In N,C and G all scales touch at the apogee; this is not quite so in MP, which causes a remark in M, cf.below. I have somewhat separated the scales where clarity demanded.

- MP's figures are very similar in arrangement (even if only M is drawn to scale), both showing Sides 1-2 of the semissa sphærarum in one figure, and taking literally the "quendam circulum subtilem" of 1,5; these superfluous circles are in both, more consistently in M than in P. In fact the scribes allow themselves some responsibility for the figures:

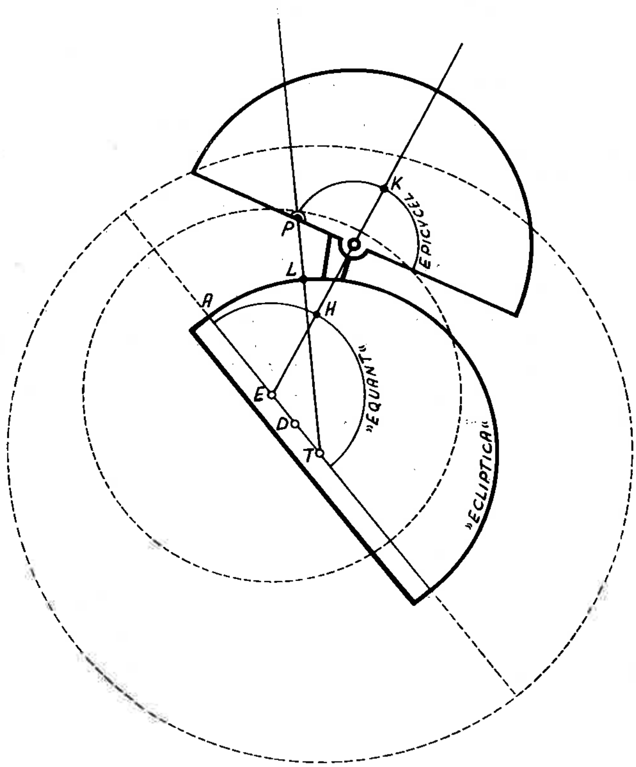
(M, to sem.sph.:) Nota, erratum est, quoniam æquantes debent esse contigui < > versus augem.

(P, to sem.sph.:) Erratum est maxime, quare inspiciendi sunt canones plus quam præsens figura: aliquo (!) enim modo tactum est. Non mirum quod erravi, quia difficilis est divisio.

(M, to sem.epi.:) Nota, erratum est in hac semissa, quia epicyclus Veneris deberet esse intra circulum ubi scribuntur signa. Sed ille error cavetur, quando linea superius divisa capitur secundum diametrum EC et non secundum exteriorem circumferentiam ubi scribuntur gradus.

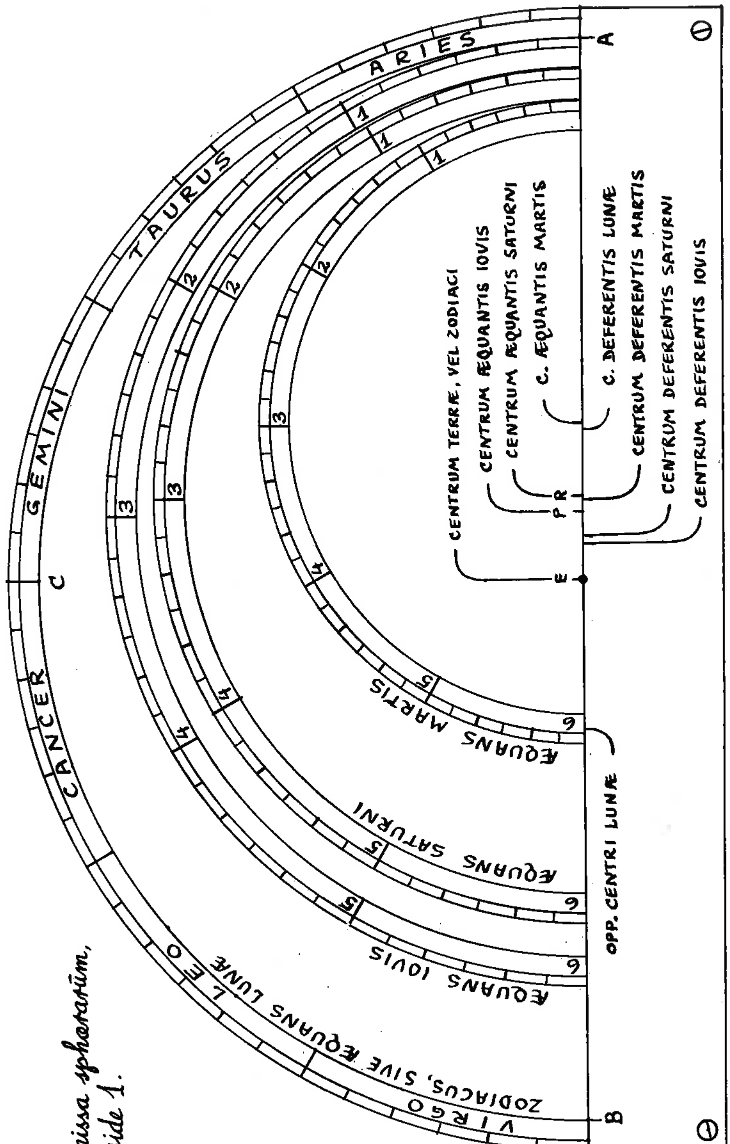
(P, to sem.epi.:) Sphæræ semissæ præsentis sunt positæ loco exempli; sciendum ergo est quod hæc est modus et forma earum, sed non sunt hic bene divisæ, ut patet in canonibus earundem supra bene intuenti.

Thus at least there is no reason to assume that the figures of MP are in any sense authentic. The figure of G should also be rejected on account of the reversal. - We are then left with the figures of NC, which are unobjectionable on the accounts mentioned. They are unfinished, lacking e.g. the numbers on the scales. The present drawings mainly recapitulate these figures, with the exceptions mentioned, and adding numbers and most of the legends.

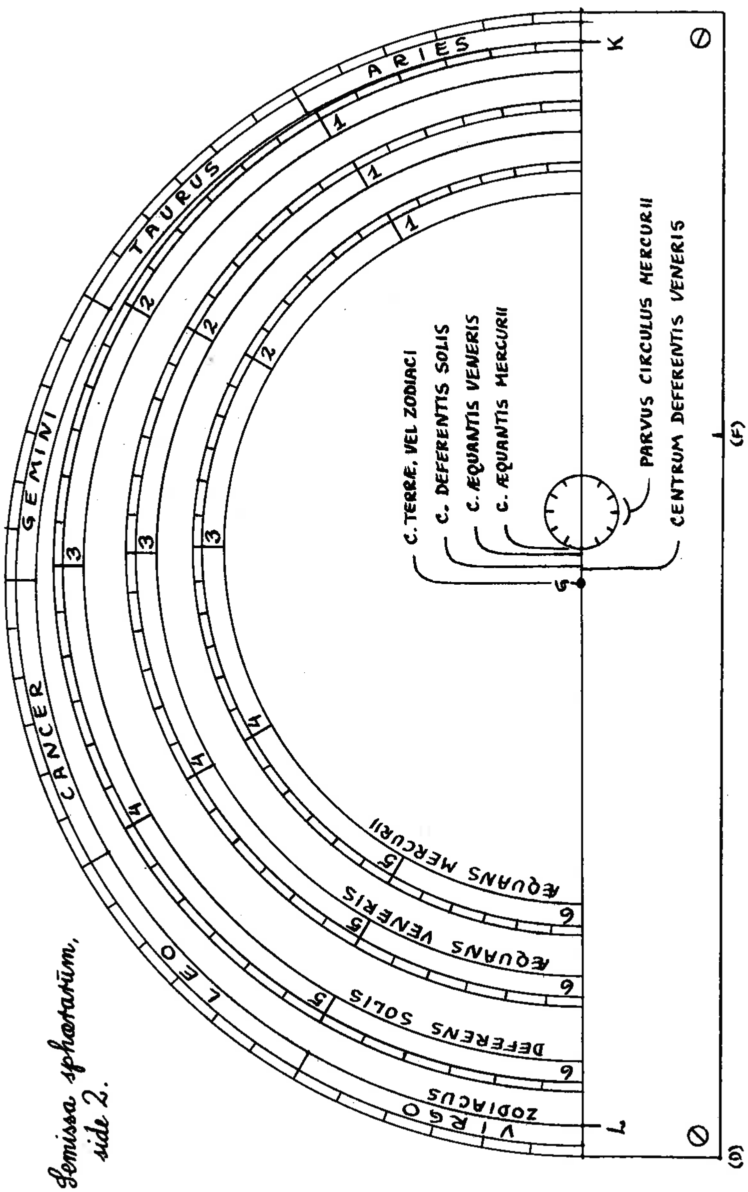


The principle of the equatorium. T is the centre of the Earth, P the planet, and A its *aux*, or apogeum. D and E are the deferent and equant centres, respectively. The great dotted circle is the ecliptic, concentric with the "Ecliptica" of the instrument. The other dotted circle is the equant, concentric with the "Equant" scale on the *semissa sperarum*.

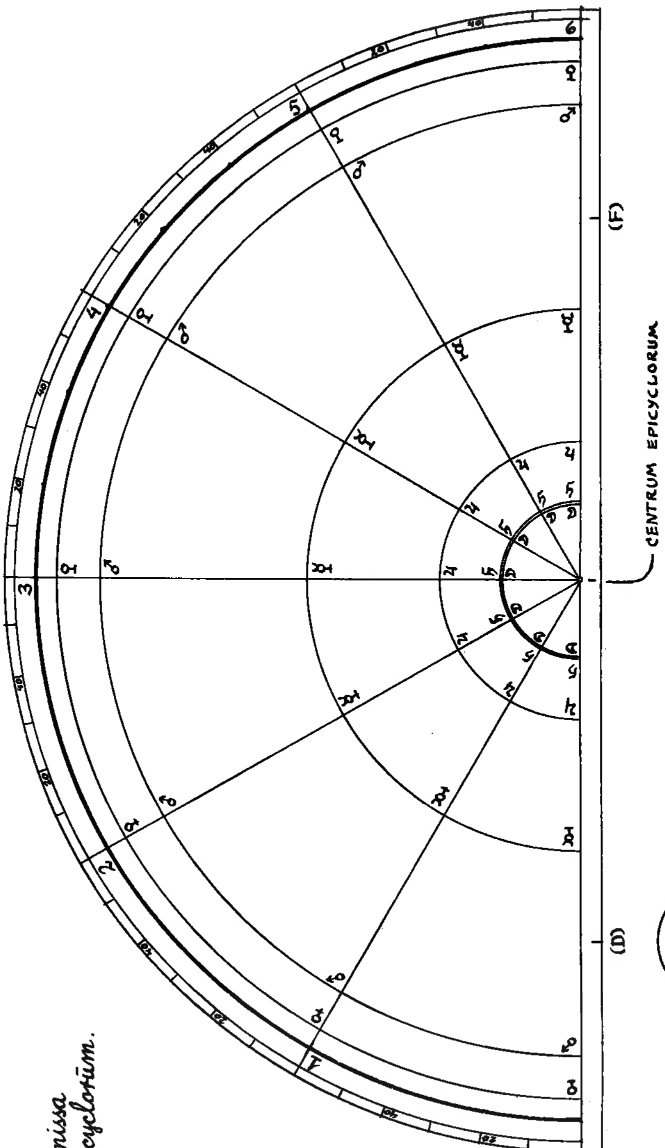
From O.Pedersen 1968,8.



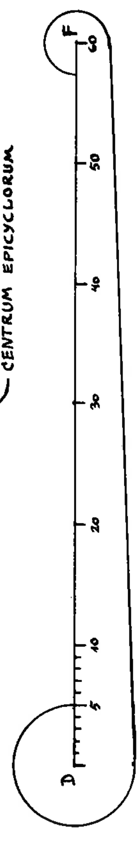
Semissa sphaerarum, side 1.



Semissa sphærarum, side 2.



Semissa epicyclorum.



Novella.

F. SYNOPSIS.

For further explanations see generally Sec. P and S. - () indicate editor's notes, <> longer putative additions to the text.

F1. Chapter 1: Preparation of instrument. (See figures in Sec.E.)

1,1-2 Take two equal half-circles, *semissae*, one to be denoted *semissa sphaerarum*, the other one *semissa epicyclorum*.

Semissa sphaerarum, side 1: marked as a half-circle ACB, zodiac, over the centre E, earth. Divide zodiac ACB into 180 degrees. (Draw a corresponding zodiac on side 2 and divide it.)

1,3-4 Make a ruler, *novella*, DF, so that DF = 4AE/3. - In all planetary models, DF will constitute the radius of the deferent, so that D will be the epicycle centre and F the deferent centre. - Fasten pins at D and F, to fit into perforations to be made in the semissae. Divide DF into 60 equal parts (to be denoted 'p'). p will be the unity for the relative distances, listed in 1,16 from PTOLEMY's Almagest (cf.P1). Make a safety copy of DF on each semissa.

1,5-6 Equants of Jupiter, Saturn and Mars (semissa sph., side 1): These are half-circles with centres (P) lying on EA, so that EP(Jupiter) = 5^p;30, EP(Saturn) = 6^p;50, EP(Mars) = 13^p. The radii are arbitrary, but the equant of Jupiter should be just inside the zodiac, that of Mars innermost, and the equants should almost touch each other. - The intersections of the equants with the diametre AB, nearest to A, are called the apogees, *auges*, of the equants; the opposite points are called the perigees, *opposita augium*. A is called "apogee in the zodiac" (or *directum augis*), B "perigee in the zodiac" (or *directum oppositi augis*). - Divide the equants into 180 degrees.

1,7-8 Equants of Venus and Mercury (semissa sph., side 2). Side 2 has the diametre LGK, these points being opposite A,E,B, resp. - The equants are half-circles with centres (P) lying on GK, so that GP(Venus) = 2^p;30 and GP(Mercury) = 3^p.

Deferent of the sun (ibidem): Half-circle, centre (P) on GK so that GP = AE/31 (=GK/31, and radius = 30 GP, so that it touches the zodiac in K). - (These circles are to be drawn and divided into 180 degrees. The deferent of the sun should be outermost and the equant of Mercury innermost.)

The equant of the moon is the zodiac itself.

1,9-12 Deferent centres (F') (all planets except sun).

Jupiter:	on AE; EF' = 2^p;45.	Saturn:	on AE; EF' = 3^p;25.
Mars:	on AE; EF' = 6^p;30.	Venus:	on GK; EF' = 1^p;15.
Moon:	on AE; EF' =12^p;28.		

For the moon, the opposite point of F', *oppositum centri* (F"), should be placed on EB so that EF" = EF'. - Perforate the semissa at all centres of equants and deferents.

Mercury: The deferent centre moves on a small circle so that $3^p \leq GF' \leq 9^p$; in the limits, F' is on the apsidal line GK. - Draw the circle with its centre F" on GK (with GF"=6^p and radius 3^p). Divide the circle into 360°, or in suitable divisions, e.g. of 5°, and perforate it at the divisions. If the semissa has no room for the small circle, attach a piece to accommodate it.

1,13-14 Semissa epicyclorum. To be inscribed with a main diameter and a half-circle, near the edge, with its centre C in the middle of the main diameter. Divide the half-circle into 180 degrees. For each division of 1^s (=30°) draw a radius to the half-circle. Draw the epicycles as half-circles with the common centre C and the following radii: Moon: 6^p;20, Saturn: 6^p;30, Jupiter: 11^p;30, Mercury: 22^p;30, Mars: 39^p;30, Venus: 43^p;10. - Perforate the semissa at C and at the intersections of the epicycles with the main diameter and the radii drawn above.

For each planet, mark the equant, the centre of the deferent, and the intersections mentioned, with the sign of the planet.

1,15-16 (Table with canon, containing the distances given; cf. P1.) - PTOLEMY sets the eccentricity of the solar deferent at 1/24 of its radius, AZARCHEL and MESSEHALLAH at 1/30; the latter value was adopted above.

F2. Chapter 2: Finding mean motions from tables. (See figures F11, below.)

2,1-5 Finding mean motus λ_m of any planet (from the vernal point T_8 in the eighth sphere), ot the mean argument a_m of moon, Venus or Mercury (from the mean apogee A_m of the epicycle) by the Toulouse Tables (P7): Add the relevant entries from the tables for collected years, single years, months, days, hours, and minutes of an hour, *modulo* 12^s, always entering with the residual number of integer units elapsed. - A day ends at noon, starting at the noon preceding. For places at terrestrial longitudes other than that of Toulouse, find the mean motion during the time-difference, and add it if the place is to the West of Toulouse, otherwise subtract it.

2,6-7 Mean arguments a_m (superior planets): Since $CA_m \| TP^*$ and $CP \| TM_s^*$, then $a_m = \angle A_mCP = \angle P^*TM_s^* = \angle TTM_s^* - \angle TTP^* = \lambda_{ms} - \lambda_m$. Also, during some interval of time, e.g. one day, $\Delta a_m = \Delta\lambda_{ms} - \Delta\lambda_m$.

2,8-12 Mean centra c_m (all planets except moon; for the sun, called "mean argument").

Usually, when computing by means of tables, c_m is defined with reference to the ecliptic, where (see F11, first figure) the longitude of the apogee, *aux in secunda significatione* (2,10), $\lambda_a = \angle TTA^*$. Thus $c_m = \angle A^*TP^* = \angle TTP^* - \angle TTA^* = \lambda_m - \lambda_a$.

However, when using this instrument, c_m is referred to the equant, where

P' : *terminus medii motus in æquante* (intersection of equant circle and EC, such that $EP' \| TP^*$)

T' : point such that $\angle AET' = \angle A^*TT$

λ_a = T'EA : longitude of apogee, as above

Then $c_m = \angle AEP' = \angle T'EP' - \angle T'EA = \lambda_m - \lambda_a$, as above.

λ_a is tabulated, except for the moon; values taken from the Toulouse Tables (P7), and referring to the eighth sphere, where they are constant.

2,13 Mean centrum of moon c_m, given λ_m. – The mean elongation between sun and moon is $<M_s^*TC = <TTC - <TTM_s^* = \lambda_m - \lambda_{ms}$. Since $<ATM_s^* = <M_s^*TC$, then $c_m = <ATC = 2 <M_s^*TC = 2(\lambda_m - \lambda_{ms})$.

2,14 Mean centrum of Venus. – Equal to the mean argument of the sun, since $TM_s^* = TP^* \parallel EC$ and $EA = EA_s$, so that $c_m = <AEC = <A_sTM_s^* = c_m$(Sun).

2,15-16 Mean centrum of Mercury. – (Let A_+ be the apogee of Venus/Sun.) As above, $TM_s^* = TP^* \parallel EC$, but $<A_sEA = <A_+EA = 119^\circ;39,50$, so that $c_m = <AEC = <A_+EC - <A_+EA = c_m(\text{Venus}) - 119^\circ;39,50$.

2,17-18 Daily increments (Δx) of some mean motions. (Cf.2,6-7)

- Mean centra of all planets except moon, and mean argument of sun: $\Delta c_m = \Delta\lambda_m$ (cf.2,8-12)
- Mean motus of Venus and Mercury: $\Delta\lambda_m = \Delta\lambda_{ms}$ (cf.2,14-16.8-12)
- Mean centrum of moon: $\Delta c_m = 2\ \Delta\lambda_m - 2\ \Delta\lambda_{ms}$ (cf.2,13).

2,19-21 The Toulouse Tables of mean motions (P7), advantages in finding mean centra and arguments: (a) time is reckoned according to the Christian era; <(b) the year starts with March, so that the trouble with leap-years is minimized;> (c) their *radices* are more correct than those of other tables. – However, in accordance with modern observations, the following corrections are suggested: Saturn: $+1^\circ;15$, Moon: $+0^\circ;22$, Jupiter: -1°, Mars: -3°. These corrections, or any others which may prove to be more exact, should be added to the values in the tables of mean motus for collected years.

2,22 <(not in NHB:) It is recommended to prepare tables of mean centra and arguments (P8), to replace the tables of mean motus.> <(not in NHBV:) For the moon, however, the table should show $\frac{1}{2}c_m$, i.e. the mean elongation $\lambda_m - \lambda_{ms}$: this can replace the tables of λ_m and λ_{ms}. When using the instrument, the tabular values should be doubled.>

F3. Chapter 3: Using the instrument to find longitudes of planets.

Note: From now on, the parts of the instrument are designated by the same symbols as their counterparts in the figures F11.

3,1-4 Superior planets and Venus: setting $c_m = <AEC$, and finding the mean apogee A_m of the epicycle. – Fix one pin (cf.1,3) of the novella in the appropriate deferent centre D, from below the semissa sphærarum. Fix the semissa sphærarum on a board, with the novella underneath and the equant visible. – If $c_m \leq 6^s$: Locate c_m on the equant, reckoning from A, and mark it. Fix a thread in E, extend it over the mark in the equant, and fix the other end on the board. If $c_m > 6^s$: Locate $(c_m - 6^s)$ on the equant, reckoning from A, and mark it. Extend a thread from the mark over and beyond E, and fix the other end on the board. – The thread is called the centrum line EC, *linea centri*. – Fix the centre of the semissa epicyclorum on the free pin of the novella. The join is the epicycle centre C. Shift C to fall on the centrum line.

A_m is now found as the intersection of the centrum line and the part of the appropriate epicycle farthest from E (or the graduated rim of the semissa epicyclorum, for the purpose of measuring angles; thus the text).

3,5 Moon: As above, except that T is used for E, and c_m is measured on the zodiac. - A_m is the intersection of the epicycle and the extension of D'C (*linea oppositi centri*).

3,6-7 The perigee of any epicycle is the intersection diametrically opposite A_m. The *longitudines mediae* are the points of the epicycle 90° from A_m. The moon moves clockwise on the epicycle (seen from the North), the other planets counterclockwise (visualized from a figure of a man lying on the epicycle).

3,8 Setting mean argument $a_m = <A_mCP$: Take one of the perforations on the appropriate epicycle to be the planet P. Rotate the semissa epicyclorum to make $<A_mCP = a_m$, along the motion on the epicycle.

3,9-10 Finding true apogee-distance $\ell_v = <A^*TP = <ATP$ (*verus locus ab auge*, or (3,10) *centrum verum*; not to be taken for the *centrum verum* (= $<ATC$) in 7,6). - Extend a thread through T and P. This is called *linea veri loci*. Read ℓ_v on zodiac at the thread. If $\ell_v > 6^s$, extend the thread beyond T and read (ℓ_v-6^s) on zodiac at the extension.

3,11 Mercury: As above, except that D should be located on the small circle such that $<AFD = -c_m$, and the pin of the novella placed accordingly.

3,12 Sun, special procedure, given the mean argument c_m.
If $c_m \leq 6^s$: Locate c_m on the deferent, reckoning from A, and mark it. Extend a thread through T and the mark. Read ℓ_v on zodiac at the thread, reckoning from A*. If $c_m > 6^s$: Locate (c_m-6^s) on the deferent, reckoning from the perigee A', and mark it. Extend a thread through T and the mark. Read (ℓ_v-6^s) on zodiac at the thread, reckoning from A'*.

3,13-15 Finding true longitude in the ninth sphere $\lambda_v = <T_9TP$ (*verus locus /motus ab initio arietis nonæ sphæræ*). - Motion of 8th sphere $p=<T_9TT_8$.

Planets, except the moon: $\lambda_v = p+\lambda_a+\ell_v$ $(= <T_9TT_8+<T_8TA+<ATP)$

Moon: $\lambda_v = p+\lambda_m-c_m+\ell_v$ $(= <T_9TT_8+<T_8TC+<CTA+<ATP)$

<(in V:) same, re-phrasing.> <(not in NHBV:)
$\lambda_v = p+\lambda_{ms}-\frac{1}{2}c_m+\ell_v$ $(= <T_9TT_8+<T_8TM_s^*+<M_s^*TA+<ATP)$. Or
$\lambda_v = p+\lambda_{as}+c_{ms}-\frac{1}{2}c_m+\ell_v$ $(= <T_9TT_8+<T_8TA_s+<A_sTM_s^*+<M_s^*TA+<ATP)$.>

3,16 The motion of the eighth sphere (P3) was 10°;10 in 1294 (*anni ab incarnatione D.N.J.C. 1293 perfecti*) and increases 55" per year according to PTOLEMY (false, see P3), the eighth sphere moving eastwards. - The position of any apogee in the ninth sphere is λ_a+p: for instance, the apogee of the sun is at 88° in the ninth sphere, *et hoc declaravi in tractatu cuiusdam novi quadrantis*.

F4. Chapter 4: The equation of time; mean solar time.

Note: For this purpose, the (right) ascension of an arc *s* of the ecliptic, *asc*(*s*), is the projection of *s* on the equator from the poles of the equator, or e.g. the arc of the equator passing the meridian together with *s*. In the figure below, PT = *asc*(OS), both oriented in the direction of the signs.

4,1-2 "Day", definitions: (1) mean solar day, *dies æqualis/medius/mediocris*; in PTOLEMY (cf.S4), *iomin diei cum sua nocte* (=(ὁμαλὸν) νυχθήμερον): the time of 1 entire revolution of the equator + 0°;59,8 ($=\Delta\lambda_m$, the daily motion of the equatoreal mean sun). -

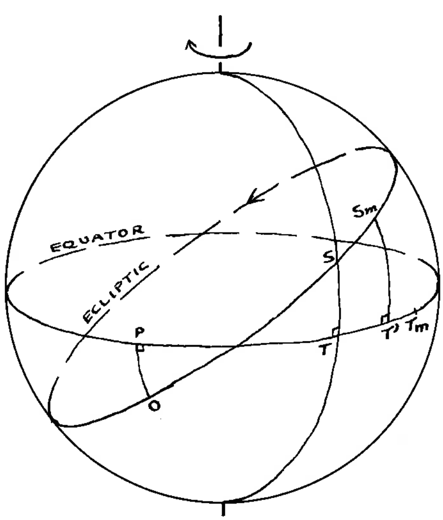
(2) true solar day, *dies inæqualis/diversus*: the time between two successive meridian passages, i.e. culminations, of the true sun, each called true noon, *vera meridies*. <(not in NHB:) This is in fact mid-day within observational accuracy.>

(The length of (1) is constant, whereas) the length of (2) varies above and below that mean length, on account of *(a)* the inequality of ascensions of (equal arcs of)the ecliptic, due to the obliquity, and *(b)* (the unequal motion of the sun on the ecliptic, due to) the eccentricity of the sun's deferent.

4,3-4 A true solar day, then, is the time of 1 entire revolution of the equator + $asc(\Delta\lambda)$, where $\Delta\lambda = \lambda_{n+1}-\lambda_n$, i.e. the increment in the true sun's longitude between two successive culminations, *portio solis diurna*. - $asc(\Delta\lambda)$ varies with time, because *(b)* $\Delta\lambda$ varies, being maximal when the sun is in its perigee, minimal when in apogee; and *(a)* even if $\Delta\lambda$ were constant (e.g. at its mean value $\Delta\lambda_m$), $asc(\Delta\lambda)$ would vary, being minimal at the equinoxes, maximal at the solstices.

(For the present purpose, mean and true solar days are defined to start together at a noon when the sun is in Aqu 18. Counting from then, the arcs of the equator passing the meridian during the n'th mean solar day, resp. the n'th true solar day, differ by the amount of $\Delta e = \Delta\lambda_m - asc(\Delta\lambda)$. The total difference of arc over the n days is the equation of time (*æquatio dierum*) e, i.e. the arc which is the sum $\Sigma(\Delta e)$ of all Δe's.

In the following figure, let O be the starting point Aqu 18, and P its projection on the equator. After n days the true sun has travelled the arc $OS = \Sigma(\Delta\lambda)$ on the ecliptic; and the ecliptic mean sun has travelled $OS_m = \Sigma(\Delta\lambda_m) = n\cdot\Delta\lambda_m$. Let $PT_m = OS_m$: thus T_m will be the equatoreal mean sun, defining mean solar time. Let T be S's projection on the equator: then $PT = asc(OS) = \Sigma(asc(\Delta\lambda))$, and consequently $TT_m = PT_m - PT = OS_m - asc(OS) = \Sigma(\Delta\lambda_m) - \Sigma(asc(\Delta\lambda)) = e$, thus re-stating Ptolemy's calculation of e in III,9.



As appears from Ptolemy, Δe can be broken into two approximately additive components, as follows:

$\Delta e = \Delta\lambda_m - asc(\Delta\lambda) =$
$(\Delta\lambda_m - asc(\Delta\lambda_m)) + (asc(\Delta\lambda_m) - asc(\Delta\lambda)) \approx$
$(\Delta\lambda_m - asc(\Delta\lambda_m)) + (\Delta\lambda_m - \Delta\lambda) = (a)+(b)$.

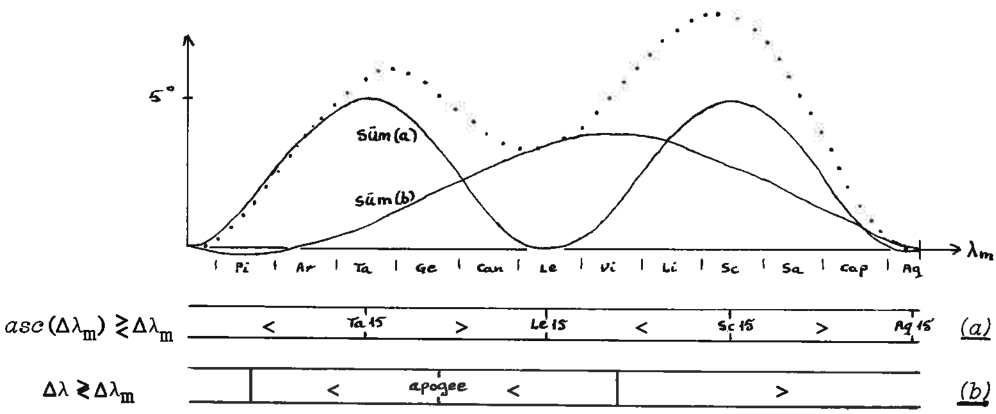
These are understood as *(a)* the decrement of $asc(\Delta\lambda_m)$ below $\Delta\lambda_m$, *deminutiones ascensionum*, and *(b)* the decrement of $\Delta\lambda$ below $\Delta\lambda_m$, *deminutiones portionum diurnarum*, due to the unequal motion of the true sun. - On the figure, let T' be the projection of S_m on the equator. Then

$e = TT_m = T'T_m + TT' \approx$
$(PT_m - PT') + SS_m =$
$(OS_m - asc(OS_m)) + (OS_m - OS) = \Sigma(a) + \Sigma(b)$.

Ptolemy used this expression only as an estimate of e; our author seems to have believed that Azarchel's table was so made (4,5), and probably made his own table by that method, without too inaccurate results (see P10).)

4,5 The equation of time, characterized as the *collectio* of the sums *(a)* and *(b)* above, was tabulated by AZARCHEL (P9; as a function of the (?mean) longitude of the sun) and arranged in columns parallel to those containing right ascensions.

4,6 The function is not monotonous, since the components vary, as follows (starting from Aqu 18, and setting the sun's apogee at Gem 18):



(The scale chosen from now on is λ_m (9th sphere), linear with respect to n. For the approximations involved see, e.g., O.Pedersen 1974²;157. The dotted curve used to illustrate the variation of e is simply the superimposition of the two others, as is the sense of the text.)

4,7-8 The starting-point Aqu 18 is so chosen that e, interpreted as the two-component sum above, is never negative, and does not become zero until the sun is in Aqu 18 again. Thus n true solar days are always shorter than n mean solar days, except when n is such that the sun returns to Aqu 18 (9th sphere) and the 7 degrees following. (For the values cited, see P9-10. - Accordingly, the hour in <u>civil time</u>, i.e. true solar time, is E ≈ 4e minutes later than mean solar time.) - e is maximal when the sun is in Sco 7-8 (9th sphere), with a value of 7°;57 ($E=31^m;48$).

4,9-13 <u>Time-scale of mean motion tables.</u>

(4,9) The time-difference E ≈ 4e, *tempus æquationis dierum*, has a perceptible effect for the moon only. The time-scale in the table of the moon's mean motion should be thought to start at a noon where the sun is in Aqu 18 (,and to progress according to mean solar time, like the rest of the mean motion tables).

(4,10-12) (Thus all other times used as entries to the tables are E later when expressed in civil time.) Especially, the table values given for New Year (= last day of preceding year, noon, mean solar time) are valid for the civil time which is E later than true noon; and a value of the moon's longitude, found by entering the tables with the mean solar time T and using the instrument, is valid for the civil time T+E, after true noon. E is found from the table by entering with λ (or λ_m) on that day. - This method is used particularly when calculating syzygies, eclipses, and other aspects involving the moon.

(4,13) Conversely, a longitude of the moon observed at the civil time T', e.g. at true noon (solar eclipse?) is valid for the mean solar time T'-E. When that time-value is used for entering the tables, the calculated place should correspond to the observed one, or the tables are incorrect to the amount of the difference.

4,14-15 The values in the tables of e depend on the longitude of the sun's apogee in the ninth sphere (cf.4,6). The table of AZARCHEL (P9) assumed it to be in Gem 17;50 (both in the eighth and the ninth sphere: false, cf.P3), so this is where we still place it in the eighth sphere. However, between AZARCHEL's time and our own it has moved to Gem 28 in the ninth sphere, so that the components *(a)* and *(b)* have been relatively shifted, and their superposition has altered. So I have constructed the following table, showing e.g. (as a maximum) 0^{o};20 more than AZARCHEL's table for Gem 6^{o}. (Table not extant, see P10.)

F5. Chapter 5: True syzygies of sun and moon; other aspects of sun, moon, and planets.

5,1 Time of mean conjunction of sun and moon: For an arbitrary time t, find the numerical value of $\lambda_{ms}-\lambda_m$(moon) (= $\frac{1}{2}c_m$(moon), or the mean elongation between sun and moon) by means of the tables of mean motions (P7). Divide this by $\frac{1}{2}\Delta c_m$(moon) (as found from 2,18). The quotient will show the difference between t and the time t_n of the mean conjunction. Add the quotient to t if the sun is ahead of the moon, otherwise subtract it. The result is t_n.

5,2-3 <(not in NHBV:) t_n is the time for which $\frac{1}{2}c_m$(moon) = 0. If a table (P8) of $\frac{1}{2}c_m$(moon) is available, it can be utilized to determine $|t-t_n|$, given the value of $\frac{1}{2}c_m$ at the time t, by a reverse use.>

5,4-7 Time of true conjunction of sun and moon: Find the longitudes λ'_s and λ' of sun and moon at the time t_n by means of the instrument. If $\lambda'_s = \lambda'$, then t_n is the time T_n of the true conjunction. If not, let $e' = |\lambda'-\lambda'_s|$, and divide e'(1+1/12) by the true angular velocity of the moon near the time t_n. Add the quotient to t_n if the sun is ahead of the moon, otherwise subtract it. The result is T'_n, i.e. the approximate time of the true conjunction.

(5,5) - Another method: Find the difference between the true angular velocities of the sun and moon at the time t_n; divide e' by that difference; and add or subtract the quotient as above.

(5,6) Find the longitudes λ_s and λ of sun and moon at the time T'_n by means of the instrument. If $\lambda_s = \lambda$, T'_n is the exact time T_n of the true conjunction. If not, let $e = |\lambda-\lambda_s|$, and continue as in 5,4 or 5,5.

(5,7) <(not in NHBV:) If a table of $\frac{1}{2}c_m$(moon) is available, it can be used for determining $|T'_n-t_n|$, etc., given e', etc., by proceeding as in 5,2-3. (This is inexact, since the variation of the true angular velocities is not allowed for; but the iterated calculation of longitudes tends to remedy this.)>

5,8-10 Time of oppositions and other aspects of sun, moon and the planets. For oppositions of the sun and moon, the procedure is as above, replacing the moon with its diametrical opposite (*nadir*) on the ecliptic. For other aspects of the sun and moon, e.g. the quadrature and the sextile, the moon is replaced with a point appropriately elongated from it (viz. 90^{o}, resp. 60^{o}).

– For any aspects of the planets, the procedure is as above, using the appropriate angular velocities as in 5,5. (For aspects other than the conjunction, a planet is replaced with its *terminus aspectus* τ, a point of the ecliptic suitably elongated from the planet.) Thus the slower planet, or its τ, takes the place of the sun, the faster one, or its τ, the place of the moon. – This is valid only if neither planet is stationary or retrograde.

Each planet has its *semidiameter orbis luminis* (P4), as follows: orb(Saturn) = 9^o on the ecliptic; Jupiter: 9^o; Mars: 8^o; Sun: 15^o; Venus: 7^o; Mercury: 7^o; Moon: 12^o. – If, for a given aspect of two planets p and q, the longitude difference $|\lambda(\tau_p)-\lambda(\tau_q)| \leq \frac{1}{2}|orb(p)-orb(q)|$, the aspect may be considered valid, although it is most powerful when $\tau_p = \tau_q$.

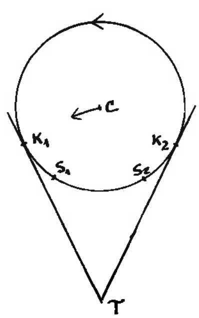
F6. Chapter 6: True angular velocities (*buth*) of planets.

Use the instrument to find ℓ_v (cf.3,9) at the start of two successive days. The difference is the *buth* during one day, and analogously for the motion during other periods of time. – The mean motus during the same intervals of time is easily found from the tables (P7).

F7. Chapter 7: Planetary motions: stations and retrogradations.

7,1 For a given planet, use the instrument to find the longitude at the start of a certain day, $\lambda(d)$, and of the next day, $\lambda(d+1)$. Consider $\Delta\lambda = \lambda(d+1)-\lambda(d)$. – If $\Delta\lambda=0$, the planet is stationary; if <0, retrograde; if >0, direct. In the last case, if $\Delta\lambda = \Delta\lambda_m$ (cf.2,17-18), the planet is direct and even, *directus et æqualis cursu*; if $<\Delta\lambda_m$, direct and slow, *directus et tardus cursu*; if $>\Delta\lambda_m$, direct and fast, *directus et velox*.

7,2-5 The corresponding positions of the planet on the epicycle (except sun and moon) are as follows:



TK_1, TK_2: tangents from the earth to the epicycle. – May be represented by threads on the instrument when in position.

S_1, S_2: stations, only described as being somewhat below K_1 and K_2, at equal distances.

Positions:	Motion:
Near K_1 or K_2	Direct and even
Above K_1 or K_2	Direct and fast
On K_1S_1 or S_2K_2	Direct and slow
At S_1 or S_2	Stationary
On S_1S_2	Retrograde

Moon: At K_1 or K_2, even; above K_1 and K_2, slow; below K_1 and K_2, fast. The moon cannot be retrograde, because the epicycle is small, and because always $\Delta a_m < \Delta\lambda_m$. Also, the direction of the motion on the epicycle is contrary to that of the remaining planets, with the results stated.

For all planets, the variations mentioned are those caused solely by the motion on the epicycle (assuming an even motion on the deferent).

To obtain the true properties they should be considered together with the variations caused by the eccentricity of the deferent.

7,6 Definitions of some variables as represented on the instrument:

- True apogee of epicycle A_v : farthest intersection of epicycle and TC.
- True argument a_v = $<A_vCP$, along the motion on the epicycle.
- True centrum c_v = $<ATC$, measured on the zodiac.
  – If $c_m > 6^s$, 6^s should be added to the reading.

F8. Chapter 8: Latitudes of planets.

8,1 Sun: declination from equator. Consider $\lambda = \lambda_{s9}$ (longitude of sun in ninth sphere). The sign of the declination varies with λ as follows:

$0 < \lambda < 3^s$: northern, increasing; $3^s < \lambda < 6^s$: northern, decreasing;
$6^s < \lambda < 9^s$: southern, decreasing; $9^s < \lambda < 12^s$: southern, increasing.

The declinations of the other planets can be found similarly.

8,2-3 Moon: argument of latitude λ_β and latitude β. - Given, the true longitude of the moon λ_v, and either the true longitude of the ascending node Ω, λ_Ω, or the mean longitude of Ω, $\lambda_{m\Omega}$, <where $\lambda_\Omega = 12^s - \lambda_{m\Omega}$.>
Then $\lambda_\beta = \lambda_v - \lambda_\Omega = \lambda_v + \lambda_{m\Omega}$.

Take $\beta = \beta(\lambda_\beta)$ from the appropriate table (P11), usually the last column of the tables called *æquatio lunæ*, or occurring alone. - β depends on λ_β as the declination does on λ (8,1).

8,4-5 Superior planets: latitude β.

Let c = $c_v + 50^o$ for Saturn; $c_v - 20^o$ for Jupiter; c_v for Mars. (Cf.P5.) (c will be the distance of the epicycle centre from the top of the deferent, cf.9,3-5.) - Take m = m(c) from the table of *minuta proportionalia*, included in the table of latitude for the planets (P12). Take $\beta_1 = \beta_1(a_v)$ from the table of latitude. If $9^s < c < 3^s$, β_1 is northern, otherwise southern. - Let $\beta = \beta_1 \cdot m/60$. This will be the latitude.

8,6 On sources: The canon and table (P12) for the superior planets was that of PTOLEMY; the canon is approved by ALBATTANI. The author of the canons to the (Toledan) Tables (=AZARCHEL) has other canons and tables, which disagree with reality and with PTOLEMY/ALBATTANI (P13), also as concerns Venus and Mercury. As for the latter, ALBATTANI disagrees with PTOLEMY's Almagest in the numbers to be added to c_v (see P5); but the tables are the same. ALBATTANI, Chap.31, thought that the copy or translation of Ptolemy was faulty.

8,7-14 Venus and Mercury. (Table: P13, sub-tables as below; constants: P5.)

Take j' = j'(a_v) from the table of deviation, *inclinatio*, of epicycle.
Take k' = k'(a_v) from the table of slant, *reflexio*, of epicycle.
For Mercury, if $9^s < c_v < 3^s$, let k = k'-k'/10;
if $3^s < c_v < 9^s$, let k = k'+k'/10.
For Venus, k is not adjusted, because the eccentricity is small.

(8,9) Let c = $c_v + 60^o$ for Venus; $c_v + 270^o$ for Mercury.
(c will be the distance of the epicycle centre from the longitude for which the deviation is maximal and southern.) - Take m = m(c) from the appropriate table of *minuta proportionalia*. -

Let $\beta_1 = j'\cdot m/60$. This is the component of latitude resulting from the deviation of the epicycle. β_1 will be southern if $9^s < (c \text{ and } a_v) < 3^s$ or if $3^s < (c \text{ and } a_v) < 9^s$, otherwise northern.

(8,11) Let $c' = c_v$ for Venus; c_v+180^o for Mercury. (c' will be the distance of the epicycle centre from the longitude for which the slant is maximal and northern.) - Take $m' = m'(c')$ from the appropriate table of *minuta proportionalia*.

Let $\beta_2 = k\cdot m'/60$. This is the component of latitude resulting from the slant of the epicycle. - Sign of β_2:

	$0\leq a_v<180^o$	$180^o\leq a_v<360^o$
$9^s<c'<3^s$	northern	southern
$3^s<c'<9^s$	southern	northern

(8,13) For Venus, let $\beta_3 = m'/6$. This is always northern.

For Mercury, let $\beta_3 = 3m'/8$ (see P5). This is always southern. β_3 is the component of latitude resulting from the inclination of the deferent.

(8,14) Let $\beta = \pm\beta_1\pm\beta_2\pm\beta_3$, using + for northern and - for southern. β will be the latitude.

8,15 Maximal latitudes according to PTOLEMY (P12-13): Saturn: $3^o;2$ northern, $3^o;5$ southern. Jupiter: $2^o;8$ NS. Mars: 4^oN, 6^oS. Venus: $8^o;56$ NS. Mercury: $4^o;18$ NS.

8,16 To know if any planet is ascending or descending in latitude, compare two calculations made at an interval of 10 days. - For the superior planets,

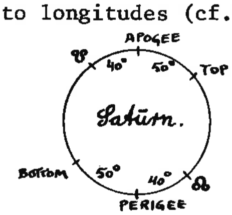
β	$0\leq a_v<180^o$	$180^o\leq a_v<360^o$
northern	ascending	descending
southern	descending	ascending

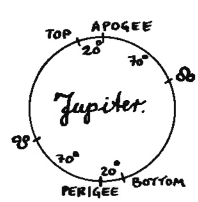
There is no similar rule for the inferior planets.

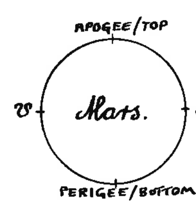
F9. Chapter 9: Latitudes of planets, explanation.

9,1-2 Moon. - The centre of the epicycle moves on the deferent towards the East. The deferent is inclined to the ecliptic at a fixed angle, and the intersections are diametrically opposite both on ecliptic and deferent. These points are called the ascending node ☊ (*caput draconis, Geuzaar*) and the descending node ☋ (*cauda draconis*). They move on a circle with its centre in the earth, radius equal to that of the deferent, and in the plane of the ecliptic. The motion is $0^o;3,11$ per day towards the West (P7). - The epicycle is in the plane of the deferent.

9,3-7 Superior planets. - The deferents are at fixed angles to the ecliptic; the intersections ☊ and ☋ are stationary, except for the motion of the eighth sphere. (The top of the deferent is the point with the greatest northern latitude; its longitude is 90^o greater than that of ☊.) - The points of the deferents are placed as follows according to longitudes (cf.P5):

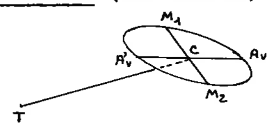






The table of latitudes (P12)(gives a function of a_V and) supposes the epicycle centre to be at the top of the deferent.

(9,6) Deviation (*inclinatio*) j of epicycle.



In the figure, T: earth; C: centre of epicycle; A_V: true apogee of epicycle; A'_V: true perigee; M_1M_2: *longitudines mediæ*.

The epicycle oscillates about the diameter M_1M_2, which is always parallel to or coincident with the plane of the ecliptic. - j is here understood to be the angle from TC to CA'_V. - When C is in one of the nodes, j=0. When C is at the top or bottom of the deferent, j is maximal. CA'_V is inclined to the north of the deferent when C is in the northern part of the deferent, and vice versa. So if the planet is in the farthest half of the epicycle, it will generally be between the planes of the deferent and the ecliptic.

9,8-14 Venus and Mercury. - For both planets, the nodes are at the *longi-*
(9,9) *tudines mediæ* of the deferent, i.e. the points with longitudes 90° from the apogee. The top and bottom of the deferent, if existent, will be at the apogee and perigee.

(9,8) Inclination (*declinatio*) i of deferent: The plane of the deferent oscillates about the nodal line. The actual angle to the plane of the ecliptic is the inclination. (The period is one year, dependent on the yearly revolution of the epicycle centre C.) - When C is in one of the nodes, i=0. When C is in the apogee or perigee, i is maximal. The result is that, for Venus, C is always North of the ecliptic when not in the nodes; and for Mercury, always South of the ecliptic.

(9,11-2) Deviation (*inclinatio*) j of epicycle. - j is here taken to be the angle from (?)TC to CA_V (see figure to 9,6). Some values (cf.P5):

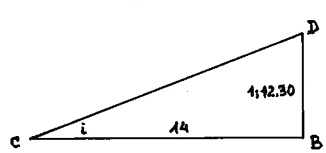
Venus, longitude of C	Mercury, longitude of C	j
60° before apogee	90° after apogee	maximal, southern
opposite of above	opposite of above	maximal, northern
middle points	middle points (=apogee or perigee)	zero: CA_V in plane of deferent

(9,13-4) Slant (*reflexio*) k of epicycle. - k is the angle of the radius CM_1 with the plane of the (?)deferent. Some values (cf.P5):

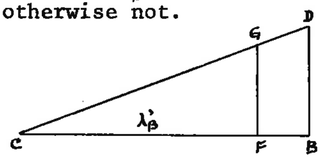
Venus, longitude of C	Mercury, longitude of C	k
apogee of deferent	perigee of deferent	maximal, northern
perigee of deferent	apogee of deferent	maximal, southern
middle points,=nodes	middle points,=nodes	zero: CM_1 in plane of deferent

F10. Chapter 10: Lunar and solar eclipses: use of diagrams and tables.

10,1-5. Lunar eclipses, preliminaries. - Construct a right-angled triangle CBD, with the cathetes CB = 7 or 14 feet or palms; BD = CB(1;12,30)/14. (Cf.P11). - CB represents an arc of 14° on the ecliptic, and is sub-divided accordingly. CD represents an arc on the moon's deferent, C the ascending or descending node.



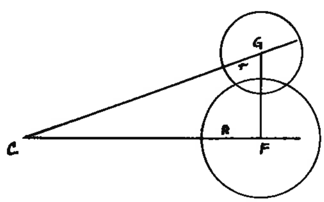
(10,3) Find the time T_n of the true opposition (see 5,8) and the moon's argument of latitude λ_β at the time T_n (see 8,2). - If $0 \leqq \lambda_\beta \leqq 12^o$ or $168^o \leqq \lambda_\beta \leqq 192^o$ or $348^o \leqq \lambda_\beta \leqq 360^o$, then a lunar eclipse is possible, otherwise not.



Let λ'_β be the distance of the moon from the nearest node (i.e. $\lambda'_\beta = |\lambda_\beta|$ or $|\lambda_\beta - 180^o|$, whichever is less). - In the triangle, let F be on CB; G on CD; $CF=\lambda'_\beta$; $<CFG=90^o$.

(10,5) Take the moon's radius $r = r(a_v)$ from the table of radii (P14, with the sub-tables mentioned below). Take the radius of the shadow $R' = R'(a_v)$ from the table of radii, assuming the sun to be in its apogee. (If not,) take the value $\rho = \rho(\ell_v(\text{sun}))$ from the table of variation of the shadow. The value $R'-\rho = R(a_v, \ell_v(\text{sun}))$ is the radius of the shadow.

10,6-10 Lunar eclipse, maximal obscuration. - Describe the circle of the shadow with F as centre and R as radius. Describe the circle of the moon with G as centre and r as radius. - The part of the moon-circle covered by the shadow-circle represents the part actually covered at the height of the eclipse.



The time T_n used was not in fact the exact hour of the middle of the eclipse. To obtain the latter, take, for the time T_n, the argument of latitude λ_β; the latitude β of the moon; and the angular velocity $\underline{v}$ of the moon per minute of hour; and find

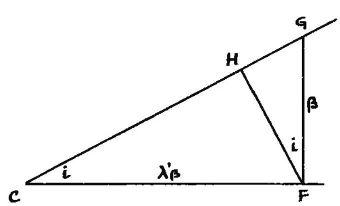
$$\Delta T = \frac{1}{v}\frac{13}{12} \, arc \, sin \, \frac{sin^2\beta}{(sin^2\lambda_\beta + sin^2\beta)^{\frac{1}{2}}} \approx \frac{1}{v}\frac{13}{12}\frac{\beta^2}{\lambda'_\beta} \, .$$

The corrected time of the mid-eclipse is then

$T_n - \Delta T$ if the moon is retiring from the nearest node;

$T_n + \Delta T$ if the moon is approaching the nearest node.

To get the civil time T_c, add the time correction E from 4,9.



(The sense is that the time of the maximum obscuration can be better approximated as the time when the moon's centre is at H, where FH is perpendicular to CG. The expression of ΔT above, whose derivation seems to be mixed spherical and rectilinear, approximates the interval of time taken by the moon to travel the distance GH, with the addition of a twelfth for the intermediary movement of the shadow. See also S10. - The sign of ΔT is easily verified from a figure.)

The time of the middle of a solar eclipse can be found analogously, using the time of true conjunction.

10,11 <(not in NHB:) Precision can be enhanced by making the triangle large, or by changing scale on CF and FG.>

10,12-14 Time of start and end of eclipse. - Given: T_c, β, v, r, R (from 10,5; for solar eclipses, R is the sun's radius). - Find $\Delta T = (1/v)(13/12)((r+R)^2-\beta^2)^{\frac{1}{2}}$. The eclipse will start at $T_c - \Delta T$ and end at $T_c + \Delta T$.

(10,13) Another method: Draw the moon as usual, with its centre (P) on CG, to touch the shadow or sun externally. Measure PG (or PH) by the scale of the ecliptic. Find $\Delta T = (1/v)(13/12)PG$, and proceed as in 10,12. - A further method: Let P and T be on CD so that PF=TF=R+r. Find ΔT as above, from PG or TG, and proceed as in 10,12.

10,15 Total lunar eclipses: duration of total obscuration. - Draw the moon as usual, to touch the shadow internally in two places. (Let the centres be P and T.) Measure PT by the scale of the ecliptic, and find $\Delta T = (1/v)(13/12)PT$. This is the duration of the totality. The interval of time between the beginnings of obscuration and totality, or between the ends of totality and obscuration (*minuta casus*) can now be found.

10,16-25 Solar eclipses: Parallax in longitude at time of true conjunction.

(10,17) Finding the hour angle of the true conjunction. - Determine the arc corresponding to the interval of time between T_c and the nearest true noon (cf.4,1-2). Divide that arc by 15 degrees/hour. The result is the hour angle T_c' of the true conjunction, reckoning from true noon (,or the meridian: *horæ longitudinis coniunctionis a meridie*. See S10).

(10,18) Enter the table of parallax (P17) with T_c' and λ_{s9} (longitude of sun at the time of true conjunction), to find the parallax in longitude $\pi_\lambda' = \pi_\lambda'(T_c',\lambda_{s9})$. If T_c' indicates an hour angle to the East of the meridian, use the upper ("eastern") part of the table; if to the West, the lower ("western") part; if in the meridian, use the middle row of the table ("*recessus*"). <(NHB:) The *recessus*-values are eastern in the first half of the table, western in the second half.>

(10,19) The parallax table contains π_λ'-values corresponding to integer hour-values of T_c', to integer sign-values of λ_{s9}, and supposes the moon to be at the (true) apogee of its epicycle. - If T_c' and/or λ_{s9} contain fractional parts, use linear interpolation in the parallax table. If the moon is not in its true apogee, enter the table of correction (P16a) with the (true) argument a_v, taking $f(a_v)$, and find $\pi_\lambda = \pi_\lambda'+\pi_\lambda'\cdot f(a_v)$. - <(not in NHB:) The table is the one which contains values not greater than 12/60, and it is usually found together with the table (P15) of the moon's velocity.> - This will be the parallax in longitude at the time of the true conjunction.

(10,24-5) <(not in NHB:) The parallax found is eastern if there are less than 90° between the ascendent and the moon; western, if more than 90°. - To obtain the parallax in longitude when the moon is not in a syzygy, enter the table of corrections for the deferent (P16b) with ℓ_v(moon), taking $g(\ell_v)$, and find $\pi_\lambda+\pi_\lambda\cdot g(\ell_v)$. The table is that which contains values not greater than 32/60.>

10,26-30 Time of apparent conjunction T.

(10,26) Let $T' = T_c' + \frac{1}{v}\frac{13}{12}\pi_\lambda$. (This is an estimate of the time of apparent conjunction, reckoned from the nearest true noon.) Take $\pi_\lambda'' = \pi_\lambda''(T',\lambda_{s9})$ from the table of parallax. Let $T = T' + \frac{1}{v}\frac{13}{12}\pi_\lambda''$.

(10,27) <(not in NHB:) In the expression of T, the last item should be added only if the point of the ecliptic 90° from the ascendent is between the meridian and the moon; otherwise that item should be subtracted.>

(10,28) Take $\pi_\lambda''' = \pi_\lambda'''(T,\lambda_{s9})$ from the table of parallax, and analogously the parallax in latitude $\pi_\beta''' = \pi_\beta'''(T,\lambda_{s9})$.

(10,29) <(not in NHBV:) To obtain the parallax in latitude when the moon is not in a syzygy, proceed as indicated in 10,25 for the parallax in longitude.>

(10,30) Let $T_v = T_c \pm \frac{1}{v}\frac{13}{12}\pi_\lambda'''$.

<(NHB:) Subtraction of last item, if the lower (eastern) part of the parallax table was used, otherwise addition.>

<(EVGF:) Subtraction of last item, if the moon is less than 90° from the ascendent, otherwise addition.>

(For these alternative versions see S10, to 10,24+.)
- T_v will be the time of the apparent conjunction. Find λ_{s9} and the longitude of ☊ at the time T_v.

10,31 Solar eclipse: start, end, magnitude, etc.
Proceed as indicated in 10,4ff. The shadow-circle is replaced with a circle of the sun, whose radius is found in the table of radii (P14) as a function of the argument ℓ_v of the sun. The circle of the moon should be shifted the amount π_β''' orthogonally towards the ecliptic.

10,32 Limits and frequency of eclipses. - Because π_β''' is always southern, solar eclipses can take place in Clima 4-6 only when the moon is to the North of the ecliptic. Thus, for a solar eclipse, λ_β should be within the limits $0 \leqq \lambda_\beta \leqq 12^o$ or $168^o \leqq \lambda_\beta \leqq 180^o$, whereas, for a lunar eclipse, there are four limits as stated in 10,3. - Lunar eclipses must take place twice a year, though possibly at day-time. Two lunar eclipses must be at least 6 lunar months apart, so that a higher frequency is impossible. Solar eclipses are possible twice a year but may not all be observable in the same clima.

10,33 <(Addition in VG, mostly repetitions of 10,32, then:) A solar eclipse can occur in the conjunction succeeding a lunar eclipse, or in the following conjunctions.>

F11. Figures to Synopsis (F2-10).

Points:

T : earth
D : centre of deferent circle
E : equant point (centre of equant circle)
C : centre of epicycle
P : planet
F : for Mercury, centre of small circle
D': for moon, opposite of deferent centre (*oppositum centri*)

A : apogee (*aux*) of equant, or of deferent
A_s: apogee of sun's deferent
A_+: apogee of equant of Venus
A_m: mean apogee (*aux media*) of epicycle (3,1-5)
A': perigee (*oppositum augis*)

T : vernal equinox (*initium arietis*)
T_8: vernal equinox in 8th sphere
T_9: vernal equinox in 9th sphere

P*: mean position of planet on ecliptic (*terminus medii motus*)
A*: projection of A on ecliptic (*directum augis*)
M_s^*: ecliptic mean sun (*terminus medii motus solis*)

Distances, constant for each planet:

TD: eccentricity of deferent
DC: radius of deferent, set at 60^p
CP: radius of epicycle
EF,FD: for Mercury, radius of small circle

Angles, increasing evenly for each planet:

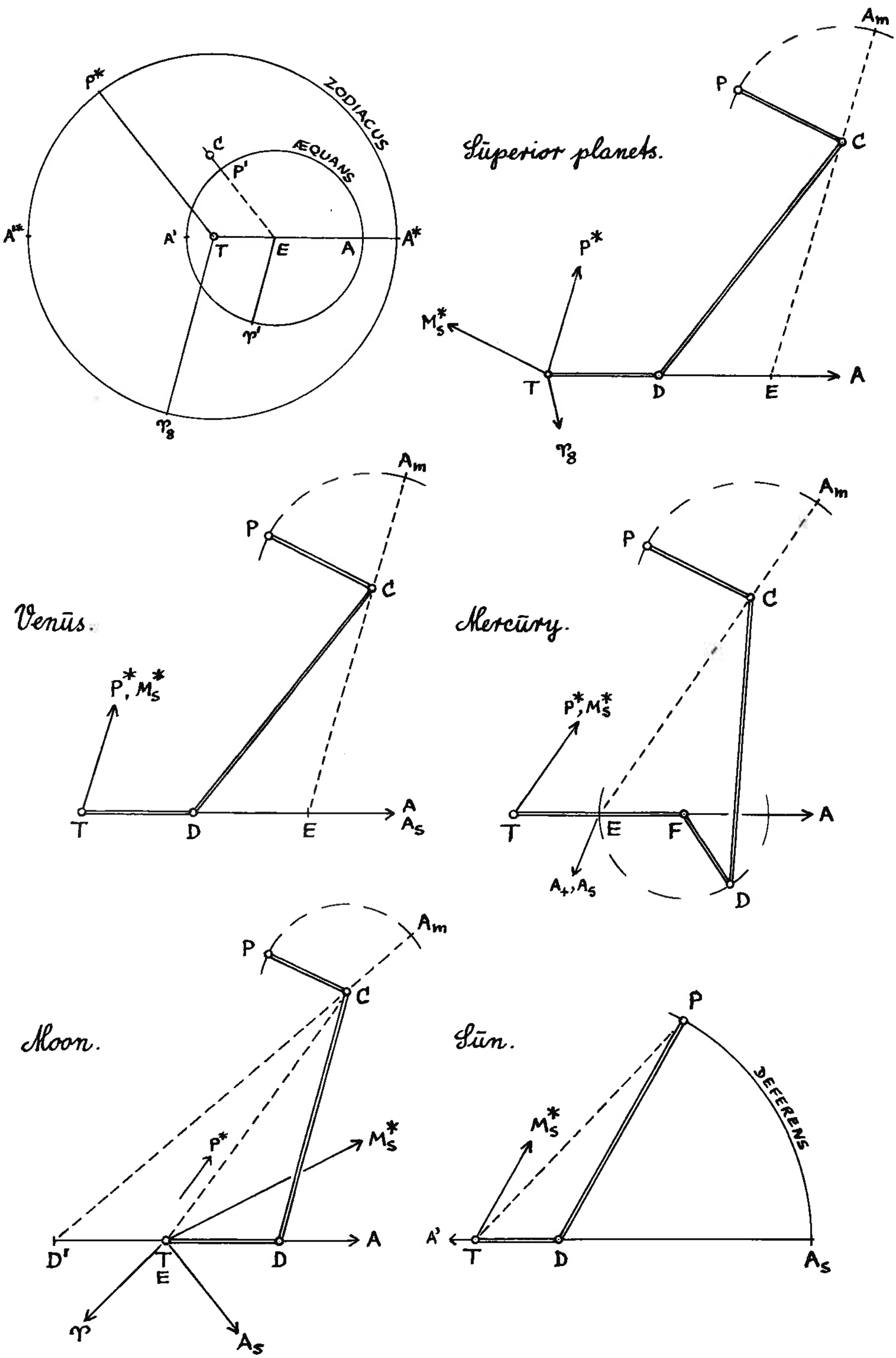
$c_m = \angle AEC = \angle ATP^*$: mean centrum (for moon, $= \angle ATC$)
$a_m = \angle A_mCP$: mean argument (for sun, $\angle A_sDP$)

Mercury: $\angle AFD = -c_m$
Moon: $\angle M_s^*TC = -\angle M_s^*TA$

$\lambda_a = \angle T_8TA^*$: longitude of apogee (in 8th sphere, *aux in secunda significatione*)
λ_{as} : longitude of sun's apogee
$\lambda_m = \angle T_8TP^*$: mean motus in eighth sphere
$\lambda_{ms} = \angle T_8TM_s^*$: mean motus of sun

For the 'true' points and angles $\ell_v, \lambda_v, c_v, A_v, a_v$, see 3,9-12 and 7,6.

Double lines in the figures correspond to fixed-length parts of the instrument, stroked lines to threads used during operation.


ZODIACUS
ÆQUANS
P*
C
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Superior planets.
Am
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Venus.
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P*, Ms*
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G. TESTIMONIA.

From other sources I know of 2-3 references to the instrument and one apparent quotation from the treatise:

(G1) Erfurt W.A.B. 2° 394,119r. Text discussed by O.Pedersen 1965,71-2, from Wien Oe.N.B. 5203,88r-92r, possibly written by Regiomontanus. Incipit "Quoniam experimentum sermonum verorum est ut consonent cum rebus sensatis". Schum dates the Erfurt ms. to the start of the 14th cent; the writing of this piece is definitely not later than the first half of the 14th cent., and a table in the treatise bears the date 1347, so this piece at least cannot be attributed to Peurbach as was done by Zinner but doubted by O. Pedersen, l.c.

--- Multi circa hoc laboraverunt; et quidam * instrumentum sumptuosissimum continens 6 matres, id est, tabulas habentes limbos ut in astrolabio; et quælibet mater habet duas tabulas in se locatas vel tres. Quidam vero fecerunt cum una tabula per regulam deferentem orbem revolutionis; sed (si *ms*) regulam oportet esse latam, ideo cooperit loca zodiaci vel æquantis quandoque planetæ, qui debet æquari, et est difficultas magna in inveniendo vera loca, et modica certitudo. Et fecerunt unam parvam tabulam pro centro excentrici lunæ revolvendo, et unam pro centro excentrici Mercurii. Quidam fecerunt cum duabus semissis et una regula, sed in hoc est difficultas in æquando planetas, et incertitudo ut in prædicto. Item (idem *ms*) oportet ibi sexies inscribere zodiacum, sex scribere æquantes. Ideo omnibus istis applicavi studium ad instrumenti compositionem pauci operis et sumptuum paucorum, per quod facillime supradictas commoditates quilibet parum in astrologia instructus poterit consequi ---

The other instruments referred to are those of Campanus and Jo.de Lineriis, as in the following item.

(G2) Oxford Bodl.L.Digby 57, 130r-132v. Short text on an equatorium, following a canon to the Albion, date c.1360?(North). Cited from North II, 271-2 (first part) and from B&T 37 n.31(2nd part). Incipit "Quia nobilissima scientia astronomie", as Jo.de Lineriis' æquatorium, but not the same text (North).

--- Profatius Iudeus in Monte Pessulano aliud equatorium consimilis operacionis prudenter composuit quod vocatum est semissa --- Et uoco instrumentum datum omnia instrumenta Campani simul iuncta vel equatorium magistri Iohannis de Lyneriis vel semissas prefacii iudei vel aliud equatorium de nouo compositum et pro parte abbreuiatum omnia predicta excellens in locorum certitudine et operis facilitate sed sciendum est quod iste canon precedens non tangit modum operandi cum albion sed cum instrumentis prius dictis &c.

(G3) Cambridge Peterhouse 75.I (a.1392), 70r. Cited from Price 1955,91. Note to a table of ascensions. Cf. 4,8 in our treatise.

Profacius / maiorum (!) equacionem temporis collecti ex diebus inequalibus a tempore in quo est sol in 18 g^a aquarii 9^e spere . est cum sol fuerit in 8 & in 9 scorpionis 9^e spere / & in 7 g^a & 57 m^a qui valent 31 mi^a hore & 48 secunda.

I have not found this passage in the canones to Profatius' Almanach.
– Both G2 and G3 are of English provenance, so the ascription could be compared to the third one known, from the Cambridge manuscript G. I do not know if there is any closer connexion, and G itself does not contain the reference to the New Quadrant (3,16) which might have misled a reader.

Sigla.

Memorantur hic tantummodo partes codicum constanter adhibitæ: de reliquis vide Sec.B.

N	Paris B.N. n.a.l.1893, sæc.XIV^1, 79v-91r	Cap.1-10.
N2	varia additamenta	
H	London B.L. Harl.3647, sæc.XIV^1, 195r-197r;215r-225r	Cap.1-10.
B	Basel U.B. F.III.25, sæc.XIII-XIV, 1r-16r	Cap.1-10.
B2	additamenta marginalia coæva, de quibus vide Sec.B1;C5-7	
E	Erfurt W.A.B. CA 4^{o}366, sæc.XIV, 58r-68r	Cap.1-8 & 10.
E,E2	duplex textus (10,32)	
V	Vat.Barb.lat.303, sæc.XIII-XIV, 5r-6r;12r-17v	Cap.1-10
C	Cues Stiftsbibl.214, sæc.XIV^1, 1r-9r	Cap.1-3.
X	Bologna B.U.132, sæc.XIV^1, 27r-28r	Cap.9.
F	Firenze B.N. II.III.24, sæc.XIII-XIV, 206r-208r	Cap.10.
F1,F2	duplex textus (10,23-6).	

Interdum adhibentur:

G	Cambridge U.L. Gg.6.3, sæc.XIV^2, 322r-330r
M	Melk Stiftsbibl.51, sæc.XIV^2, 107r-111r
P	Vat.Pal.lat.1340, sæc.XIV^2, 47v-52r
L	Melbourne State Libr.of Victoria 224(Sinclair), sæc.XIV^1, 187rb-189vb
Az	Canones Azarchelis (Par.lat.7406: ad 2,2-5)

2,3: sectio 3 capituli 2

§3: sectio 3 capituli præsentis

om,add,ins,exp: omittit, addit (in contextu), inserit, expungit

def: deficit (non affertur ubi liquet e prima parte apparatus)

[[ ]],«»: deletio,additio scribæ cuiuscumque

(): commentum editoris

In capite apparatus cuiusque paginæ afferuntur sigla codicum præsentium et constanter adhibitorum. Prima pars apparatus dat addita vel omissa notabiliora, secunda pars lectiones varias, quarum de selectione videsis Sec.D.

Litteris in contextu inclinatis indicantur sectiones fortasse additiciæ, quæ in Sec.C prolixius tractantur.

(Pr.) Quoniam non conceditur nobis philosophiae studium nec tempus philosophandi, neglegimus hanc astrorum scientiam, abhorrentes taedio suae difficultatis ac prolixitatis temporis apponendae. Sed quod in hac arte est horribilius, difficilius et magis prolixum est opus numerandi et aequatio numerorum: igitur expediens est in operibus huius artis uti aliquo instrumento absque magno labore numerorum. Composui ideoque auxiliante deo quoddam instrumentum, per quod faciliter invenientur vera loca omnium planetarum sine tabulis aequationum, quarum operationes in numeris sunt maxime taediosae.

(1,1) Cum igitur hoc instrumentum componere intendas, accipe duos semicirculos tenues, aequales si velis in magnitudine, quae semissae vocentur. Et una erit semissa sphaerarum omnium planetarum, et alia erit semissa omnium epicyclorum. Sit autem diameter semissae sphaerarum AEB, et huius semissae semicircumferentia sit ACB loco zodiaci supra punctum E constituta. Et sit punctus E in medio diametri AEB, qui erit centrum terrae vel zodiaci, quod idem est. *(2)* Et hunc circulum zodiaci ACB divide in 180 partes aequales, quae gradus zodiaci dicuntur; quod facies dividendo ipsum primo in 2 aequalia - et sit punctus mediae divisionis C -, deinde dividatur quaelibet pars, videlicet AC et BC, in 3 partes aequales, quae erunt partes signorum; et inde quamlibet istarum divide in 6 partes, et iterum quaelibet istarum dividatur in 5, quae erunt gradus signorum. Et pone distinctiones apparentes inter divisiones signorum et partium et graduum, ut patet in figura.

(3) Postea compone quandam regulam tenuem ad modum novellae, et sit eius linea fiduciae DF, quae erit semidiameter deferentium omnium planetarum. Et sit linea DF circa quartam partem sui longior semidiametro semissae sphaerarum, unde sit linea DF sicut 4 et semidiameter semissae sicut 3. Et sit punctus D in capite novellae, videlicet in termino latiori, et sit punctus F in cauda novellae, videlicet in termino strictiori. Unde punctus D erit centrum omnium epicyclorum et punctus F erit centrum omnium deferentium. Postea pone in puncto D et in puncto F duas breves cuspides,

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NHBEVC

2 taedio: -dium E 3 app-ae: -i V 5 instr. *om.* NHBEC 11 si: sicut C *(+corr.)* 11 quae: qui NC 14 semici-: ci- BEV 14 sit *om.* VC 17 quae: qui BMP 22 div.sig.: gradus s.d. BV (gradus *exp.*V) 24 comp.: pone NV

spissas secundum quantitatem foraminum tabularum, et sint ambae cuspides erectae super unam superficiem novellae. *(4)* Deinde dividatur linea DF vel alia tantae quantitatis loco sui in 60 partes aequales; secundum enim illas partes sumuntur distantiae centrorum aequantium et deferentium planetarum a centro terrae et etiam quantitates omnium epicyclorum. Et quantae sunt illae distantiae centrorum et magnitudines epicyclorum, habebis per tabulas sequentes de distantiis centrorum et magnitudinibus epicyclorum, quae ab Almagesti Ptolomaei sunt abstractae. Haec autem linea aequalis lineae DF, divisa in 60 partes, ponatur in utraque semissarum, ut exemplar lineae DF semper habeatur, quocumque casu amissionis partium contingente.

(5) Cum ergo aequantem Iovis velis componere, accipe in tabula Iovis distantiam inter centrum terrae et centrum eius aequantis; et reperies ibi 5 puncta et 30 minuta, quae valent dimidium punctum. Extende ergo pedes circini supra puncta novellae, donec 5 puncta novellae cum dimidio inter hos pedes fuerint comprehensa. Tunc secundum illam quantitatem describe quendam circulum subtilem supra centrum E; et ubi iste circulus intersecabit semidiametrum AE, pone notam P. Erit igitur punctus P centrum aequantis Iovis. Describe tunc circulum supra punctum P infra circulum zodiaci prope eum, et divide eum in 180 partes, quemadmodum divisisti circulum zodiaci. Et erit iste circulus aequans Iovis.

(6) Eodem autem modo pone in linea AE punctum R centrum aequantis Saturni, tantum distantem a centro E quantum invenies in tabulis, et constitue praedicto modo supra illum punctum R aequantem Saturni. Postea etiam per praedictum modum constitue interius circulum aequantis Martis. Et isti tres circuli aequantium versus auges satis prope sint coniuncti, ita quod versus auges interior suum superiorem quasi contingat. Et erunt auges horum trium circulorum, ubi ipsi intersecant semidiametrum AE versus A, et ubi ipsi intersecant semidiametrum EB, erunt opposita augium. Et punctus, in quo haec semidiameter AE zodiacum intersecat, qui est punctus A, est aux in zodiaco sive directum augis; et punctus, in quo semidiameter EB hunc

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NHBEVC 8 haec--cont. *om.* H

4 sumuntur: -entur NHB 8 A-ti: A-to NE 20 partes: gradus NHVC
22 autem modo: m.a. H; m. BC 24 per *om.* B, *ins.* B2

zodiacum in opposita parte intersecat, qui est punctus B, est oppositum augis in zodiaco sive directum oppositi augis. Et sit semper aequans, qui maiorem habet excentricitatem, interius descriptus et qui minorem exterius.

(7) Et eodem modo penitus describes in altera parte tabulae tres alios circulos, scilicet solis, Veneris et Mercurii; et illa diameter alterius partis tabulae, in qua ponentur haec tria centra, scilicet solis, Veneris et Mercurii, sit in directo diametri AEB, et sit illa diameter LGK; unde sit L directe sub A, et G sub E, et K in directo B. Et si centra aequantium trium superiorum ponantur in semidiametro AE, tunc centra aliorum, scilicet solis, Veneris et Mercurii, debent poni in semidiametro KG, quae est sub semidiametro EB.

(8) Quia tamen circulus solis non est aequans, sed deferens, ideo oportet aliter sumere eius excentricitatem quam per sexagesimas semidiametri deferentium: nam sumetur eius excentricitas secundum divisiones semidiametri semissae sphaerarum. Dividatur igitur semidiameter AE in 31 partes aequales, et sit A ubi interior circulus zodiaci intersecat semidiametrum AE. Sume igitur unam 31am partem semidiametri AE, et secundum illam quantitatem pone centrum deferentis solis distare a centro terrae, sicut fecisti de aliis; et describe supra illud centrum solis deferentem pro aequante. Lunae autem non ponetur alius aequans quam zodiacus.

(9) Postea pone centra deferentium reliquorum planetarum in diametris, quemadmodum posuisti centra aequantium; sed non oportet supra ipsa circulos deferentium describere. Et scias quod in eadem parte tabulae et in eadem parte diametri debent poni centra deferentium planetarum, ubi ponuntur centra eorum aequantium: igitur centra deferentium trium superiorum debent poni in semidiametro AE, et centra deferentium aliorum, scilicet solis, Veneris et Mercurii, debent poni in semidiametro KG. *(10)* Centrum

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NHBEVC

2 sit: sic NHEV 4 des-es: -as MP 5 et i.--sit *om.*V; et i.--Merc. *om.*B 7 sit(1): et sint E; sic H; *def.*V 8 aequ. *om.* B, *ins.* B2 9 tunc *om.* NHBE 11 semid.: d. NHBEV 13 semid.: d. VC 15 igitur: ergo NE 15 p-s a-s: p-m a-m NB 16 A: K E 17 AE: LGK E 17 semid.: d. NHBEV 19 supra: super BE 20 autem *om.* NHBE 20 ponetur: ponitur VC 21 centra: centrum HB 25 sup.: planetarum *add.* VC

vero deferentis lunae potes ponere in quacumque parte diametri volueris; sed cum posueris ipsum centrum in una parte diametri, pone punctum sibi oppositum in altera parte eiusdem diametri, tantum distantem a centro terrae, videlicet a puncto E, quantum distat illud centrum deferentis lunae a centro terrae; *et dicetur ille punctus oppositum centri.* Unde si centrum deferentis lunae sit positum in semidiametro AE, oppositum centri ponetur in semidiametro EB. Et in omnibus istis centris aequantium et deferentium sit tabula perforata, et sint foramina omnia multum parva.

(11) Sed sciendum est, quod excentricitas deferentis Mercurii non semper est eadem, sed aliquando maior, aliquando minor est, secundum quod centrum sui deferentis movetur super suum parvum circulum: unde non semper erit centrum in eadem diametro cum centro sui aequantis, sed eius excentricitas, quae in tabulis sequentibus scripta est, est eius maxima excentricitas, quae est 9 punctorum praecise: et tunc est in una diametro cum centro sui aequantis. Et minor eius excentricitas est eadem cum excentricitate eius aequantis, quae est 3 punctorum praecise: et tunc est etiam in eadem diametro et in eodem puncto cum centro aequantis. *(12)* Igitur ut habeatur semper excentricitas sui deferentis, quaeratur unus punctus in medio aequaliter distans a centro deferentis maxime distante et a centro aequantis; et supra illum punctum describatur unus parvus circulus transiens per illa centra deferentis et aequantis, et dividatur ille circulus in 360 gradus, si potes, vel per 5 vel per 10 vel per 15 procedentes; et in unaquaque divisione sit unum gracile foramen, quemadmodum est in aliis centris. Et si huic circumferentiae dividendae non satis subiciatur de materia, oportet ut aliquod frustum de materia sibi apponatur et figatur subtiliter cum eo, ita quod superficies illius additi cum superficie tabulae una sit et aequaliter elevata.

(13) Postquam sic perfeceris semissam sphaerarum, praepara semissam epicyclorum, quod facies ponendo in ipsa diametrum, quemadmodum fecisti in semissa sphaerarum. Et pone punctum in medio diametri, qui erit centrum omnium epicyclorum, et supra illum punctum fac circulum prope limbum; et divide eum in 180 gradus, sicut divisisti circulum zodiaci in semissa

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NHBEVC 5 et--centri VC

10 est(2) *om.*E 13 quae: est *add.*VC 13 est est: est NBC 16 etiam *om.*VC 22 5--10--15: 12--18--24 C 22 pro-ntes: -ndo MP (*cf.*10,1) 24 subic.: subiciat NB: sufficiat VC 26 eo: ea MP

sphaerarum; et a terminis uniuscuiusque signi protrahe lineas usque ad centrum epicyclorum, quae omnes erunt semidiametri. *(14)* Postea fac circulos subtiles supra centrum epicyclorum secundum quantitatem semidiametri epicycli uniuscuiusque planetae. Et ubi isti circuli intersecabunt omnes illas semidiametros, fac foramen parvum, sicut fecisti in centris sphaerarum; et sit etiam unum tale foramen in centro epicyclorum. Quantitatem vero semidiametri uniuscuiusque epicycli invenies per tabulas sequentes de distantiis centrorum et de quantitatibus epicyclorum et per sexagesimas novellae DF, quemadmodum invenisti excentricitates sphaerarum.

Pone ultimo signum uniuscuiusque planetae supra suum aequantem et supra suum centrum et supra unumquodque foramen in suo epicyclo positum. Et iam perfectum erit instrumentum et ad opus paratum.

(15) Iam vero licet ponere quantitates distantiarum centrorum et orbium epicyclorum et omnium planetarum, et primo de sole. Distantia autem inter centrum orbis signorum et centrum excentrici solis, si sumatur 24 vicibus, est aequalis semidiametro deferentis solis secundum Ptolomaeum; secundum tamen Azarchelem, compositorem tabularum, et secundum Messehallah, si sumatur ipsa distantia 30es, est aequalis ipsi semidiametro. Et penes hanc opinionem Azarchelis tradita est superius ars situationis centri deferentis solis.

NHBEVC

3 epic.(2): ipsius *add.*VC   7 de--et *om.*NHBE   14 et(1) *om.*MP

(16) Tabula Solis	Partes	Minuta
Semidiameter deferentis solis continet	60	0
Distantia centri deferentis solis a centro terrae continebit de illis 60is partibus secundum Ptolomaeum	2	30
sed haec distantia secundum Azarchelem continebit de illis 60is illius diametri quod semper est intellegendum	2	0

Tabula Lunae		
Semidiameter deferentis lunae	60	0
Distantia centri deferentis eius a centro terrae	12	28
Semidiameter epicycli eius	6	20

Tabula Saturni		
Semidiameter deferentis Saturni	60	0
Distantia centri deferentis a centro terrae	3	25
Distantia centri aequantis eius a centro terrae	6	50
Semidiameter epicycli	6	30

Tabula Iovis		
Semidiameter deferentis Iovis	60	0
Distantia centri deferentis a centro terrae	2	45
Distantia centri aequantis a centro terrae	5	30
Semidiameter epicycli	11	30

Tabula Martis		
Semidiameter deferentis Martis	60	0
Distantia centri deferentis a centro terrae	6	30
Distantia centri aequantis a centro terrae	13	0
Semidiameter epicycli	39	30

Tabula Veneris		
Semidiameter deferentis Veneris	60	0
Distantia centri deferentis a centro terrae	1	15
Distantia centri aequantis a centro terrae	2	30
Semidiameter epicycli	43	10

Tabula Mercurii		
Semidiameter deferentis Mercurii	60	0
Distantia centri deferentis a centro terrae	9	0
Distantia centri aequantis a centro terrae	3	0
Semidiameter epicycli	22	30

1 *Titulos 'Tabula Solis' &c.*om.*E, qui communem titulum "Tabula omnium planetarum" exhibet. Pro titulis 'Partes Minuta' alii alia praebent.* 3 centri def.: d.c.E 4 partibus *om*.C 5 continebit: continet H; *om*.VC 6 ill. dia.: d.i.E 6 sem.est: e.s.N 9 eius *om*.VC 10 quod semper est intellegendum *add*.VC 12 Saturni: eius H 13 cen.def.a: inter centrum deferentis eius a VC 14 *duplicat hanc lineam* V 14 centri: inter centrum VC 14 50: 25 B 15 epicycli: Saturni *add*.VC 18 centri: inter centrum V 18 deferentis: eius *add*.VC 18 2: 6 V(*in* 2 *corr.*) 19 centri: inter centrum VC 19 aequantis: eius *add*.C; Iovis *add*.E 20 epicycli: Iovis *add*.VC 23 centri--a centro: inter centrum ⟦Terrae et centrum⟧ deferentis eius a centro V; inter centrum deferentis et c-m C 23 30: 32 *in ras.*B: 0 B2 24 centri--terrae: inter centrum terrae et centrum aequantis VC 25 epicycli: Martis *add*.VC 27 semidia.: dia.H 28 centri--terrae: inter c-m terrae et c-m def-is VC 28 cen.def.: d.c. B 29 cen.--terrae: inter c-m terrae et centrum aequantis VC 30 epicycli: Veneris *add*.VC 32 60: 30 V; 6 C 33 centri--terrae: inter centrum terrae et centrum eius deferentis VC 34 aequantis: eius *add*.VC 35 epicycli: Mercurii *add*.VC

(2,1) Quoniam cum centris mediis et mediis argumentis inveniuntur aequationes planetarum et eorum vera loca, ideoque iam est apponenda ars inventionis horum centrorum et argumentorum atque mediorum motuum, per quos inveniuntur haec centra et argumenta.

(2) Medium autem motum hoc modo invenies: Numerum annorum Christi perfectorum quaere in tabula Tolosana annorum collectorum eiusdem planetae, et si illum numerum annorum ibi non inveneris, sume numerum eo minorem, propiorem tamen; et quod in eius directo inveneris ex signis gradibus atque minutis et secundis suscipe et singillatim eo ordine, quo sunt in tabula, extra scribe. Deinde quot tibi remanserint annos a numero invento quaere in tabula annorum expansorum eiusdem planetae, et quae ibi inveneris signa gradus minuta secunda ordinatim sub primis pone, scilicet signa sub signis, gradus sub gradibus, minuta sub minutis, secunda sub secundis. Intrabis etiam cum mensibus anni praesentis, et quae <s>ibi debentur signa gradus minuta et secunda, ut superius dictum est, sub aliis pone. *(3)* Vide similiter quot dies mensis imperfecti transierint, et cum eis tabulam dierum intra, et quod ibi inveneris ex signis gradibus et minutis et secundis cum aliis seorsum ut prius dictum est scribe. Sciendum quoque quod quaelibet dies incipit a medio praecedentis diei et finitur in medio sui. Vide similiter quot horae transierint post mediam diem praesentem, et cum eisdem tabulam horarum ingredere, et quod eisdem debetur extra sub aliis pone. Intrabis etiam cum minutis horae imperfectae tabulam minutorum, et quod ibi inveneris ex minutis et secundis atque tertiis sub aliis pone, sicut supra dictum est; et si fuerint ibi 30 tertia vel plura, pro uno secundo integro possunt poni. *(4)* Quae omnia cum ita inveneris, in unum cito potes colligere: secunda enim in unum collecta per 60 partire, et quotiens ex divisione 60 provenerint, tot minuta minutis adde, et quae secunda inde remanserint posterius per se pone. Item minuta simul iuncta per 60 partire, et quotiens 60 inde provenerint, tot gradus gradibus adde; et quae ex divisione remanserint minuta ante secunda pone. Divides etiam gradus simul

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NHBEVC

2 est app.: a.e.VC 2 app.: apposita E 8 eius: eiusdem NBC 10 annos: anni VC 11 gradus: et *add.*NC 12 minuta: et *add.*NHBC 14 praes.: imperfecti pr.N; pr.imperf.E; perfectis *add.*Az 14 sibi Az; ibi *omnes* 17 et(3): atque NHBC 19 pr.di.: di.pr.VC 22 cum--et *om.*B 22 quod: quot BEC 25 poni: sumi NHBC 30 di-es: di-e HV

iunctos per 30, et quot ibi trigenarios habueris, tot signa signis adiunge, et qui remanserint post divisionem gradus minutis et secundis praepone; signa quoque in unum sumpta per 12 partire, et quod ex divisione provenerit praetermitte, et quod remanserit in anteriori loco, scilicet ante gradus minuta et secunda, scribe. Et hic erit medius cursus ad horam civitatis Tolosae quaesitam; ad hanc enim civitatem sunt medii cursus planetarum in hiis tabulis constituti. *(5)* Si autem ad civitatem alterius longitudidinis medium cursum planetae scire desideras, considera quot horarum sit longitudo inter eandem civitatem et Tolosam, et tunc medium cursum planetae in tot horis invenias. Quod si fuerit civitas illa a Tolosa in occidente, adde eum medio cursui planetae ad Tolosam invento; sed si fuerit in oriente, ab eodem subtrahendus est. Et quod tunc remanserit erit medius cursus planetae in civitate illius longitudinis, hora quaesita, et hoc ad horam diei aequalis et non ad horam diei inaequalis, quod ostendetur posterius evidenter.

Et per hunc modum penitus, per quem invenitur medius motus cuiuslibet planetae, invenies argumentum medium lunae, Veneris et Mercurii. *(6)* Est autem argumentum medium cuiuslibet planetae elongatio corporis ipsius planetae ab auge media sui epicycli secundum motum eius in epicyclo. Quid autem sit aux media epicycli, posterius patebit in arte usus huius instrumenti.

(7) Argumentum autem trium superiorum habebis auferendo medium motum eorum a medio motu solis: residuum enim erit argumentum eorum, et hoc est ideo, quia quando in eodem gradu est terminus medii motus alicuius istorum trium cum termino motus solis, tunc necesse est centrum corporis illius planetae esse in auge media sui epicycli, et quantum terminus medii motus solis recedit a termino medii motus ipsius planetae, tantum elongatur centrum corporis eiusdem planetae ab auge media sui epicycli. Et ideo, si velis scire quantus est motus argumenti medii alicuius horum in aliquo tempore, ut in die, subtrahe medium motum illius planetae in die a medio motu solis in die, et residuum erit motus argumenti medii eiusdem planetae in uno die.

NHBEVC

2 qui MP,Az; gradus qui E; similiter qui N; quae HBVC 2 gradus MP,Az; cum gradibus NHBEVC 3 quoque: vero VC 3 proven.: perven.NB 4 reman.: in parte *add.*VC 11 planetae: per se NHB; per se *add.*VC 20 epicycli: tibi *add.* VC 25 termino: medii *add.*EMP 25 nec.est: est nec.E; nec.NHB; necessario est VC 26 esse *om.*V, *exp.*C 31 medii *om.*HBV, *def.*C

(8) Centrum autem medium cuiuslibet planetae dicitur elongatio termini medii motus planetae a loco augis sui aequantis vel deferentis, et hoc secundum motum eius in suo aequante; sed haec distantia solis dicitur solis argumentum et non centrum. Ista autem distantia centri planetae consideratur in examinatione veri loci planetae per tabulas, secundum quod ipsa est inter terminum medii motus in zodiaco et inter directum augis aequantis vel deferentis; sed in inquisitione veri loci planetae per hoc instrumentum consideratur ipsa distantia, prout ipsa est inter terminum medii motus in aequante vel vim aequantis habente et inter augem aequantis. *(9)* Est tamen iste arcus distantiae centri medii, prout ipse est arcus zodiaci, aequalis et in aequalibus gradibus cum arcu eiusdem centri medii, prout est in aequante. Cum igitur subtraxeris augem in secunda significatione alicuius planetae a medio motu eiusdem planetae, residuum erit centrum medium illius planetae. Et si aux in secunda significatione alicuius planetae fuerit in pluribus gradibus quam eius medius motus, adde suo medio motui 12 signa et a toto aufer augem eius in secunda significatione, et inde operetur ut dictum est. *(10)* Est autem aux in secunda significatione distantia inter punctum directi augis in zodiaco ipsius octavae sphaerae et inter initium arietis eiusdem octavae sphaerae, et hoc secundum quod distat ille punctus directi augis ab illo capite arietis secundum successionem signorum. Vel aux etiam in secunda significatione est illa distantia in aequante vel in aequantis vim habente, quae est inter augem aequantis et inter illum punctum aequantis qui est versus arietem, qui tantum distat ab illa auge aequantis, quantum initium arietis distat a directo augis in zodiaco octavae sphaerae. *(11)* Et istae auges in secunda significatione solent scribi cum tabulis mediorum motuum planetarum, et ponuntur ibi istae auges, prout sunt in zodiaco ipsius octavae sphaerae, quia ut sic sunt istae auges invariabiles, et numquam punctus augis in octava sphaera alicuius planetae magis vel minus distabit in uno tempore quam in alio a capite arietis ipsius octavae sphaerae. Et hae auges omnium planetarum in hac tabula ponuntur, sicut positae sunt cum tabulis Tolosanis de mediis motibus:

NHBEVC

3 solis(2): solum E; *om.*V 4 arg.: medium *add.*HB 11 in aeq.: inaequalis NVC, *def.*B 16 et(2)--dictum est: et residuum erit centrum planetae medium E (*cf.*§13) 18 directi: directe VC 20 directi: directe VC 22 in aeq.vim: vim aeq.VC 26 ponu.: pona.VC 31 cum: in VC

(12)	Si.	Gr.	Mi.	2a.
Aux Solis	2	17	50	10
Aux Saturni	8	0	5	0
Aux Iovis	5	14	30	0
Aux Martis	4	1	50	0
Aux Veneris	2	17	50	10
Aux Mercurii	6	17	30	0

(13) Centrum vero medium lunae non potest inveniri sicut centra aliorum, quia eius aux in secunda significatione cotidie variatur. Nam quantum recedit terminus medii motus lunae in aliquo tempore a termino medii motus solis a parte ante, ut secundum successionem signorum, tantum recedit in eodem tempore aux sui deferentis ab eodem termino medii motus solis, et hoc a parte retro, ut contra successionem signorum. Et ideo centrum medium lunae invenies auferendo medium motum solis a medio motu lunae et residuum duplicando, quod erit centrum lunae medium. Et si medius motus solis a medio motu lunae auferri non posset, adde supra medium motum lunae 12 signa et inde operare, ut dictum est.

(14) Habito autem argumento medio solis habetur centrum medium Veneris et Mercurii, quia terminus medii motus solis semper est cum termino medii motus Veneris et Mercurii, et aux deferentis solis semper est cum auge aequantis Veneris: et ideo penitus idem est medium argumentum solis et medium centrum Veneris. *(15)* Quia tamen aux aequantis Mercurii non est cum auge deferentis solis, licet terminus sui medii motus semper est cum termino medii motus solis, quoniam aux eius in secunda significatione maior est auge Veneris vel solis, propter hoc argumentum solis non est eius centrum medium; et ideo invenies centrum Mercurii auferendo distantiam, quae est inter augem aequantis Veneris et augem aequantis Mercurii, a centro medio Veneris: residuum enim erit centrum Mercurii medium. Et si a centro medio Veneris illam distantiam augium auferre non posses, adde illi centro medio

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NHBEVC

1 *deest tabula* HEC *Ordo*: So Sa J Ma V Me,N; So Sa J Ma Me V,B; Sa J Ma So V Me,V 9 cotidie *omnes, cf.*3,13 14 invenies *om.*NH 15 duplicando: duplando NHBC 15 quod: et C 19-20 quia--Mercurii *om.*V 21 med.(1) *om.*VC 23 est: sit V 25 propter--med.*om.*NHBE 26 ce.Me.: Me.ce. NHB 28 enim *om.*VC

Veneris 12 signa, et inde a toto illam distantiam augium subtrahe; et residuum erit Mercurii centrum. - *(16)* Unde hoc habeatur semper pro canone universali, quod quando maior portio circuli est a minori auferenda, oportet supra minorem portionem addere totum circulum, scilicet 12 signa, et inde a toto auferre portionem auferendam. - Haec autem distantia inter auges horum planetarum, scilicet Veneris et Mercurii, continet 3 signa 29 gradus 39 minuta et 50 secunda; et ista signa et gradus huius distantiae computata sunt ab auge Veneris secundum successionem signorum procedendo usque ad augem Mercurii.

(17) Ex iam utique dictis apparet quod motus centri medii trium superiorum, et etiam Veneris et Mercurii, atque solis medii argumenti, tantus est in aliquo tempore, ut in uno die, quantus medius motus cuiuslibet eorum in uno die; et tantus est medius motus Veneris et Mercurii in uno die, quantus est medius motus solis in die, quia in eodem puncto est semper terminus medii motus Veneris et Mercurii cum termino medii motus solis, ut praedictum est.

(18) Sed motus centri medii lunae in uno die tantus est, quantus est eius medius motus in die duplicatus cum deminutione dupli medii motus solis in die. Unde si duplum medii motus solis in die subtraxeris a duplo medii motus lunae in uno die, residuum erit centrum medium lunae in die; vel si subtraxeris medium motum solis in die a medio motu lunae in die et residuum duplicaveris, habebis etiam centrum lunae in die.

(19) Haec autem centra media planetarum et media argumenta expedientius est invenire per medios motus planetarum in tabulis Tolosanis collocatos quam per alios, quoniam intratur illas tabulas cum tempore Christi, quod nobis est notum et paratum, et quia etiam *incipiunt annum a Martio, versus cuius medium est introitus solis in arietem, et si accidat error ex omissione diei bissextilis, non durabit nisi per 6 dies. Et similiter* veriores sunt radices mediorum motuum in illis tabulis positorum quam radices mediorum motuum aliarum tabularum. *(20)* Attamen adhuc hae radices Tolosa-

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NHBEVC 10 ex--praed.est *om.*V 20 vel--cen.lunæ in die *om.*V 26 inc.--similiter VC

6 signa: et *add.*HVC 7 gradus: et *add.*VC 10 sup.: planetarum *add.*C, *def.*V 17 motus: semper V 18 duplic.: duplatus NHB 20 medium: medii motus V; mediu⟦medii motus⟧ C 21 motum *om.*NHB, *def.*V 22 duplicav.: duplav. NHBC, *def.*V 22 in die *om.* NHBC, *def.*V 25 intr.: in *add.*MP 25 tempore: annis E; ⟦annis⟧ tempore V 30 att.adh.:adh.tamen E; et tamen adh.VC

nae in aliquibus a veritate deviant, quia, secundum quod in tempore nostro observata sunt et visa loca planetarum per sensibilem aspectum, Saturnus plus motus est secundum medium motum per 1 gradum et 15 minuta quam ponunt hae tabulae Tolosanae; et luna etiam plus mota per 22 minuta; et Iupiter non tantum motus est per 1 gradum; nec Mars per 3 gradus, quantum ponunt hae tabulae Tolosanae. *(21)* Ideo, ut modo praecisius habeantur medii motus planetarum, oportet addere 1 gradum et 15 minuta medio motui Saturni per tabulas Tolosanas invento, et medio motui lunae 22 minuta, et a medio motu Iovis oportet auferre 1 gradum, et a medio motu Martis 3 gradus. Et forte hae correctiones adhuc omnino non sunt praecisae; illud tamen, quod per certam observationem invenietur esse addendum mediis motibus planetarum aut ab eis auferendum, auferatur vel addatur supra quemlibet annorum collectorum; et sic habebis tuas tabulas correctas.

(22) Pro usu autem huius instrumenti erit valde expediens constituere tabulas mediorum centrorum et argumentorum planetarum. Nam omnia centra et argumenta media tunc invenies absque mediis motibus planetarum penitus per eandem artem prius datam ad inveniendum medios motus. Non autem constituas tabulam centri lunae, sed tabulam medietatis centri lunae, quae est tabula elongationis medii motus lunae a medio motu solis; et illa erit in opere valde utilis et sufficiens pro inquisitione veri loci lunae absque tabula medii motus solis et medii motus lunae. Intrabis enim instrumentum cum illa medietate centri lunae, computando in zodiaco instrumenti 2 signa pro 1 et 2 gradus pro 1 et 2 minuta pro 1 minuto, et sic de aliis.

(3,1) Cum volueris examinare per hoc instrumentum certum locum alicuius planetarum, pone in centro deferentis planetae quaerendi unum clavum novellae DF, videlicet F, qui est in cauda novellae, ipsa autem novella sub semissa iacente. Et inde figatur in quodam assere lato et plano ipsa semissa sphaerarum, aequante planetae quaerendi superius iacente; et sint duo foramina, per quae figetur haec semissa versus extrema diametri semissae, et non sint

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NHBEVC 14 pro--med.motus B2EVC 17 non--de aliis B2EC 28 aeq.--iac.*om*.VC

2 sunt et: est H; et B; est et N; sunt ac C 3 15: 75 NH; 25 V 4 mota: est *add*.E 4 22: 12 B 6 Tol.: Tholose C; theologe H 6 mod.praec. CMPFG; modo Parisius V; Parisius NHB; Parysius EL 7 15: 5 B; 25 V 8 et med.: med.VC 8 22: 12 B 9 motu (2) *om*.NHB 11 invenietur: -iatur E; -itur VC 14 huius: istius V 18 sed--lunae *om*.C 21 tabula *om*.B2 21 enim ins.: in argumentum C

in diametro, sed aliquantulum extra, versus extremitatem lateris semissae sphaerarum. *(2)* Postea considera gradus centri medii, vel signa vel utrumque simul cum minutis iuxta aestimationem, si quae fuerint in centro medio planetae adaequandi; et computa tot signa vel gradus in eius aequante, incipiendo ab auge aequantis, eundo versus oppositum augis; et ubi finietur numerus in signis, gradibus et minutis, pone notam. Deinde si fuerit centrum medium planetae 6 signis vel minus 6 signis, protende filum a centro sui aequantis, transiens per illam notam, et protendatur etiam hoc filum satis ultra, ne illud, quo figetur ipsum filum in assere, superiorem partem epicycli contingat. *(3)* Si vero fuerit centrum medium planetae plus 6 signis, ab eo aufer 6 signa et cum residuo operare ut prius, computando illud residuum ab auge aequantis et ponendo notam ubi finietur numerus, et inde protende filum ab illa nota, transiens per centrum eius aequantis et ulterius satis longe extra latus semissae sphaerarum. Et vocatur illud filum linea centri, sive istud filum fuerit terminans centrum quod est plus 6 signis sive quod est minus 6 signis.

(4) Et inde pone centrum epicycli super clavum D ipsius novellae, qui est in capite novellae. Postea duc centrum epicycli cum ipsa novella, donec centrum epicycli cadat sub linea centri, clavo autem D non evadente centrum epicycli; et ubi haec linea centri tangit superiorem partem circuli versus limbum semissae epicyclorum constituti, ibi est aux media epicycli.

(5) Quoniam autem zodiacus est lunae aequans, ideo eius linea centri erit protensa a centro terrae vel a centro zodiaci, quod idem est, transiens etiam per centrum epicycli eius; et haec linea terminabit in zodiaco centrum medium lunae, sicut lineae centri aliorum terminant eorum centra in aequantibus. Haec tamen linea centri lunae non ostendit augem mediam epicycli, sed alia quaedam, vocata linea oppositi centri, quae protensa est a quodam puncto opposito centri deferentis lunae, qui quidem punctus stat in eadem diametro cum centro deferentis lunae et cum centro terrae, tantum distans a centro terrae quantum centrum deferentis lunae distat ab eodem centro terrae. Ubi enim haec linea a tali puncto protensa transiens per

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NHBEVC

1 extr.lat. *om*.NH 2 utrumque: utraque VC 4 ad-di: ad-de NHB 6 minutis: et *add*.NHB 7 6(1) sig.: plus 6 signis V; 6 signa E 10 medium *om*.NHBEV 12 numerus *om*.NHBV 14 illud: istud NHB 17 qui--nov. *om*.VC 20 t-it:t-et H 28 centri: centro E 31 a: de VC

centrum epicycli lunae tangit circumferentiam superiorem ipsius epicycli, ibi est aux media epicycli.

(6) Et omnes istae lineae, quae ostendunt auges medias in epicyclis, ostendunt etiam in ipsis opposita augium, videlicet ubi ipsae lineae intersecant inferiorem partem circuli epicycli per intellectum vel per eius motum completi. Sed linea transiens per centrum epicycli, diametrans orthogonaliter hanc lineam centri, ostendit in circulo epicycli longitudines medias.

(7) Quoniam autem motus corporis planetae in circulo epicycli dicitur medium planetae argumentum, et est aux media epicycli terminus, a quo incipit iste motus, ideo, ut faciliter intellegatur qualiter unusquisque planeta movetur in circulo sui epicycli, imaginetur in epicyclo unus homo iacens in supinis, cuius caput sit in auge media epicycli et pedes sui sint in opposito augis, bracchia vero eiusdem sint in longitudinibus mediis: movebitur ergo planeta in circulo sui epicycli, cum fuerit in capite vel in auge, tendendo versus manum dextram hominis praedicto modo imaginati. Sed e converso est de luna: nam cum fuerit luna in capite hominis, movebitur versus manum sinistram.

(8) Considera igitur signa vel gradus argumenti medii planetae adaequandi, et tantum facias corpus planetae signatum in epicyclo elongari ab auge media epicycli, et hoc secundum motum eius in epicyclo; quod facies, cum illam semidiametrum, in qua corpus planetae situatur, elongaveris ab auge media epicycli per tot signa vel gradus circuli epicycli, et hoc secundum motum eius in epicyclo.

(9) Habito itaque centro medio ac medio argumento planetae adaequandi, invenies eius verum locum protendendo filum aliquod a centro terrae transiens per corpus planetae. Nam ubi hoc filum, quae linea veri loci vocatur, abscindet zodiacum, ibi est terminus eius veri motus. *Tantum enim corpus planetae* distat ab illa parte zodiaci octavae sphaerae, in cuius directo est aux sui aequantis et deferentis, *quantum ille terminus veri loci distat ab auge in zodiaco instrumenti.* *(10)* Et hoc, si centrum eius verum

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NHBEVC 28 tantum--6 *vid.praef.*, C 5

1 t-it: t-et C 5 cir.epi.: epi.cir. NHB 17 mov.: luna *add*.VC
19 ad-ndi: -nti NHB 21 et--epi. *om*.V 27 quae: quod NV; qui H

fuerit 6 in signis vel minus 6 signis; si autem eius centrum verum fuerit plus 6 signis, tunc linea veri loci cadet extra semissam, et ideo tunc oportebit protendere filum a corpore planetae transiens per centrum terrae usque ad zodiacum; nam gradus vel signa intercepta inter hoc filum et directum augis erunt gradus vel signa, in quibus verus locus ab auge erit plus 6 signis. Addantur enim illi gradus vel illa signa supra 6 signa, et habebis verum locum planetae ab auge vel a directo augis in zodiaco.

(11) Hac igitur arte invenies, quantum unusquisque planetarum a directo sui augis veraciter distabit, praeterquam de Mercurio et de sole, in quibus canon aliquantulum variatur, quoniam, cum centrum deferentis Mercurii non est stabile in diametro sicut centra deferentium aliorum, ideo oportet habere scientiam situationis huius centri, quam habebis per eius centrum medium. Nam quantum distat terminus centri medii Mercurii in aequante ab auge sui aequantis, tantum debet versus contrariam partem distare centrum deferentis Mercurii ab auge sui parvi circuli. Et est aux sui parvi circuli quidam punctus in illo circulo, qui maxime distat a centro terrae. Pone igitur clavum F novellae DF in centro deferentis Mercurii per hanc artem invento, et inde operare penitus sicut in aliis planetis est operandum.

(12) Verum autem locum solis invenies ponendo terminum argumenti solis in deferente suo, sicut ponitur terminus centri medii cuiuslibet alterius planetae in suo aequante, nisi dum solis argumentum fuerit plus 6 signis; nam tunc oportet illum excessum ultra 6 signa computare in suo deferente ab opposito augis deferentis, tendendo versus augem. Et tunc verum locum eius ab auge invenies protrahendo filum a centro terrae per terminum sui argumenti. Nam si fuerit eius argumentum 6 signa praecise vel minus 6 signis, erit eius verus motus ab auge distantia zodiaci, quae est inter augem et abscissionem fili in zodiaco. Sed si argumentum eius fuerit plus 6 signis, eius verus locus ab auge constabit ex 6 signis cum distantia zodiaci, quae est inter oppositum augis et abscissionem fili in zodiaco.

NHBEVC

1 in *om*.NHBEV   1 ei.ce.: ce.ei.V   3 planetae *om*.NHB, *ins*.B3   4 signa: zodiaci *add*.VC   5 quibus: centrum verum planetae vel eius *add*.B   7 a: e VC   15 et--circuli *om*.NH   15 sui(2): eius B; illius C; *def*.NH   21 def.suo: s.d.VC   24 t-dendo: -tendo B; -endo NH   26 signa: signis NHBV   27 motus: locus V

(13) Habito igitur vero loco ab auge cuiuscumque planetae, habebis faciliter quantus erit eius verus motus ab initio arietis nonae sphaerae, videlicet super hunc verum motum ab auge addendo augem in secunda significatione planetae cum motu octavae sphaerae. Sed quia aux lunae in secunda significatione continue variatur, ideo oportet addere supra medium motum lunae cum motu octavae sphaerae illud, in quo excedit verus locus lunae ab auge eius centrum medium, vel auferre ab eodem medio motu addito motui octavae sphaerae illud, in quo centrum medium lunae excedit eius verum locum ab auge. Et habebis verum locum eius ab initio arietis nonae sphaerae.

(14) Vel aliter, adde verum locum lunae ab auge medio motui lunae cum motu octavae sphaerae, et a toto collecto subtrahe medium centrum lunae; et habebis verum locum lunae ab initio arietis nonae sphaerae sicut prius.

(14') Et si non habueris medium motum lunae, sed solum medietatem eius centri, subtrahe illam medietatem centri lunae a medio motu solis, et residuum cum motu octavae sphaerae adde supra eius verum locum ab auge, et habebis similiter eius verum locum ab ariete nonae sphaerae. Vel si solum habueris argumentum solis, subtrahe medietatem centri lunae ab argumento solis, et residuum cum auge solis et cum motu octavae sphaerae adde supra verum locum lunae ab auge, et habebis idem.

(15) Quid autem sit aux in secunda significatione, prius fuit declaratum. Si vero ex additione augis in secunda significatione cum motu octavae sphaerae supra verum locum planetae ab auge proveniat plus quam 12 signa, tunc a toto proice 12 signa, et residuum erit verus locus planetae ab initio arietis.

(16) Est autem motus octavae sphaerae in tempore nostro, quo computantur anni ab incarnatione domini nostri Ihesu Christi 1293 perfecti, in 10 gradibus et 10 minutis. Et ideo, si volueris scire loca augium in nona sphaera, adde hunc motum octavae sphaerae supra loca augium in ipsa octava sphaera, et habebis loca augium in nona sphaera. Erit itaque locus augis deferentis solis in 28 gradu geminorum ipsius nonae sphaerae, et hoc de-

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NHBEVC 10 vel--prius V(MP) 10' et si--idem B2EC

1 igitur: itaque C 3 super: supra VC 5 continue *om.*B 7 vel: et NHB 7 add.mot.: lunae, addito scilicet ei motu VC 8 quo: e converso *add.*VC 8 eius ver.loc.: ver.loc.BE; ver.loc.eius NH 9 et: sic *add.*VC 12 medio--lunae: media MP 11' illam *om.*B2 11' medietatem: *spat.vacans add.*B2 13' ei.ve.lo.: ve.lo.ei.E 14' simil.*om.*E 19' ha-is: -it C 22 pro-iat: -iant E; -erint V 22 tunc--signa:*om.*NHB; aufer 12 signa E; tunc aufer a to<to 12> signa V 30 28: 18 V 30 et--qua.*om.*C

claravi in tractatu cuiusdam novi quadrantis. Motus vero octavae sphaerae semper est ab occidente in oriens, et praecise in uno anno movetur secundum Ptolomaeum 55 secundis, unde in 6 annis movetur 5 minutis cum dimidio.

(4,1) Ex iam dictis itaque invenies verum locum planetae ab ariete in zodiaco nonae sphaerae, et hoc ad horam diei aequalis temporis quaesiti et non ad horam diei inaequalis.

Et est dies aequalis sive medius sive mediocris, qui constat semper ex tempore revolutionis 360 graduum aequinoctialis et 59 minutorum et 8 secundorum. Et vocat etiam Ptolomaeus hoc tempus iomin diei cum sua nocte. Dies vero inaequalis sive diversus constat aliquando ex maiori tempore hoc tempore iomin, aliquando ex minori, quod contingit propter diversitatem ascensionum signorum, quae provenit ex obliquitate zodiaci, et propter diversitatem longitudinis longioris et longitudinis brevioris deferentis solis, quae provenit ex excentricitate ipsius deferentis. *(2)* Unde dies inaequalis est tempus, quod ponit sol, cum fuerit semel centrum sui corporis in linea medii caeli, donec iterum redeat ad eandem lineam. Et est linea medii caeli illa, in qua sol est cum fuerit in eius maxima elevatione diurna, vel cum fuerit in medio sui arcus diurni. Cum autem sol fuerit in hac linea medii caeli, dicitur vera meridies, *quamvis aliqualis est differentia temporis inter tempus, quod fit ab ortu solis usque ad hanc meridiem, et tempus, quod ab hac meridie usque ad occasum; nam differentia horum temporum minima est et insensibilis. Est autem ista vera meridies,* scilicet meridies diei inaequalis. *(3)* Quoniam autem, cum centrum corporis solis fuerit in hac linea medii caeli, antequam in revolutione diurna redeat ad eandem lineam, pertranseunt de gradibus aequinoctialis 360 et insuper minuta illa et secunda aequinoctialis, quae respondent tantae portioni zodiaci, quantam pertransit sol in zodiaco motu proprio contra firmamentum in illa revolutione diurna, -- et dicitur haec portio solis diurna; sed tot minuta et secunda aequinoctialis non respondent uni solis portioni diurnae factae in una revolutione diurna, quot et alteri factae in alia revolutione: nam portio solis diurna maior est, cum fuerit sol versus oppositum augis sui deferentis, quam cum fuerit versus augem. *(4)* Et licet etiam aliquae solis

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NHBEV,C(*usque ad l.3*) 19 quamvis--vera meridies B2EV 28 et--diurna V

3 in 6 ann.: infra 6 annos VC 4 dic.ita.: i.d.NHB 11 aliq.: autem *add.*HB 12 pro-it: -iunt NHBV 14 pro-it: -iunt NHBV 14 dies: die HB 19 al.est: est al.V 19 diff.: distantia V 21 diff.: distantia V 22 autem *om.*V 22 scilicet: et NHB; *om.*E 27 q-am: q-a NHBV

portiones diurnae adinvicem essent aequales, tot tamen minuta et secunda aequinoctialis, quae dicuntur minuta ascensionum, non oportet ascendere cum una portione solis diurna, quot ascendunt cum alia: nam pauciora aequinoctialis minuta ascendunt cum portionibus zodiaci nonae sphaerae existentibus versus gradus aequinoctiales, ut versus caput arietis et librae, quam cum portionibus zodiaci existentibus versus gradus solstitiales, ut versus caput cancri et capricorni, quia minimae sunt ascensiones partium aequinoctialis, quae cum ipsis gradibus aequinoctialibus ascendunt *in circulo directo*, maximae autem sunt, quae cum gradibus solstitialibus ascendunt, quia inaequalitatem diei consideramus secundum quod dies in meridie et in linea medii caeli terminantur, quae linea medii caeli est circulus rectus.

(5) Omnes autem deminutiones ascensionum, quae proveniunt a tempore in quo sol est in 18. gradu aquarii *nonae sphaerae*, donec sol in revolutione unius anni solaris redeat ad eundem 18. gradum aquarii, collegit Azarchel insimul cum deminutionibus portionum diurnarum solis provenientibus in eadem revolutione ex elevatione augis deferentis solis. Et dicuntur hae deminutiones collectae aequationes dierum, quibus aequantur dies, et quibus reducuntur dies inaequales ad dies aequales et e converso. Et posuit eas Azarchel in tabula aequationis dierum, quam cum tabulis ascensionum signorum in circulo recto permixtim situavit. *(6)* Et istae deminutiones, quae aequationes dierum dicuntur, non ponuntur in tabula aequationis dierum secundum continuam augmentationem, quia non continue deminuuntur ascensiones signorum, quia in quarta, quae est a medio tauri usque ad medium leonis, auctae sunt ascensiones; et similiter in quarta, quae est a medio scorpii usque ad medium aquarii; licet in reliquis quartis sint illae ascensiones deminutae. Et licet etiam in illa medietate zodiaci, in cuius medio est aux deferentis solis, sint portiones solis diurnae deminutae, in reliqua vero hae portiones augmentantur. *(7)* Collectio tamen augmentationum harum portionum simul cum augmentationibus ascensionum ablata a collectione deminutionum positarum in tabula aequationis dierum numquam eam deminuit usque ad nihil, donec sol redeat ad 18 gr. aquarii, videlicet nonae sphaerae, quod semper est intellegendum; et ideo necesse est tempus quod colligitur

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NHBEV 8 in--directo B2EV 13 non.sph.VE(B2,*v.i.*)

8 quae--ae-bus *om.*B 8 ipsis *om.*V,*def.*B 8 ae-bus: ae-is NH,*def.*B
9 asc.: in circulo obliquo *add.*NHB 11 ter-antur: -atur V 13 gra. *om.*NHBE
14 aqu.: nonae sphaerae *ins.*B2 14 co-git: co-xit NHB 15 po-:propo- NHBE
22 quia: quae NHBV 25 sint: sunt NHB 30 ae-nis: ae-num NHBV
32 nec.est: nec. NHBE, *cf.*(2,7)

ex diebus inaequalibus transactis a tempore, in quo sol est circa 18 gr. aquarii, existere in minori tempore et breviori quam collectio temporis tot dierum aequalium, nisi donec perveniat ad illum 18 gr. aquarii. Nam cum sol fuerit ibi et in 7 sequentibus gradibus, aequale erit tempus, quod colligitur ex omnibus diebus inaequalibus *anni incepti ab existentia solis in illo 18 gr. aquarii*, et ex tot diebus aequalibus; *(8)* et ideo est impossibile aliquod tempus collectum ex diebus inaequalibus praeteritis a tempore, in quo sol est in illo 18. aquarii, esse maius tempore collecto ex tot diebus aequalibus. Maior autem deminutio temporis collecti ex diebus inaequalibus transactis a praedicto tempore est cum sol fuerit in 8. et in 9. scorpii nonae sphaerae, et est 7 graduum et 57 minutorum, qui valent 31 minuta horae et 48 secunda.

(9) Quoniam tamen non est multum perceptibilis in tanto tempore motus uniuscuiusque planetarum praeterquam motus lunae, ideo hoc tempus aequationis dierum pro motu lunae solum est curandum. Oportet igitur supponere radicem medii motus lunae fuisse positam et verificatam ad aliquam meridiem praeteriti temporis, in qua sol fuit in 18 gr. aquarii nonae sphaerae. *(10)* Et quia annus non incipit in illo tempore nec in illa meridie, in qua sol est in illo 18 gr. aquarii, ideo locus medii motus lunae positus in initio anni, videlicet in meridie ultimi diei, non est positus ad veram meridiem illius diei, sed ad tantum tempus post veram meridiem, quantum invenitur de tempore aequationis dierum in tabula in directo illius gradus zodiaci, in quo sol est in initio anni; *(11)* et etiam locus lunae inventus per tabulas ad meridiem cuiuslibet alterius diei non erit ad veram meridiem illius diei inventus, sed ad tantum tempus post illam veram meridiem, quantum respondet gradui solis illius diei de tempore aequationis dierum. Et hoc ideo accidit, quia locus lunae, sicut loca aliorum planetarum, invenitur mediante tempore dierum aequalium transactarum ab illa die, in qua sol est in 18. aquarii; et hoc tempus semper maius est et longius tempore tot dierum inaequalium, nisi cum sol fuerit in 18 gr. aquarii et in 7 gradibus sequentibus illum, sicut prius ostensum est.

NHBEV 5 anni--aqu. B2EV

2 in: ex HV; *om*.N 3 donec: sol *add*.E 3 gr. *om*.NHB 5 omnibus: aliquibus NHB 5 an.inc.: inc.an.V 7 coll.--praet.: collectionum dierum inaequalium praeteritarum (-itorum NH, -itarum B) NHB 8 coll.--aequ.: collectionis tot dierum aequalium NHB 17 gr. *om*.NHB 20 est pos.: p. e.NHBE 21 tempus: p̅p̅c NHB 21 veram: certam V; verum E (& *saep*.) 22 tabula: tabulis V(*saep*.) 25 illam veram: illam certam V; illam B; illum verum E 27 ideo.acc.: a.i.NHB 29 18: gr.*add*.V 30 gr.(1) *om*.NHB

(12) Et ideo, si velis scire, per quot horas post veram meridiem inventus sit locus lunae, qui invenitur per tabulas et per hoc instrumentum, oportet te semper addere supra tempus, mediante quo medium motum lunae invenisti, tempus aequationis dierum, quod in tabula aequationis dierum ponitur in directo illius gradus zodiaci, in quo sol est in die inquisitionis veri loci lunae. Et hoc erit verum tempus et tempus aequatum, in quo verus locus lunae post veram meridiem est inventus. Et hoc modo invenies verum tempus uniuscuiusque coniunctionis et oppositionis solis et lunae et eclipsis et aliorum aspectuum lunae cum sole et cum ceteris planetis.

(13) Sed cum locum lunae observaveris per sensibilem aspectum ad certam horam, ut ad veram meridiem alicuius diei, et velis scire utrum haec observatio cum tabulis concordaverit, quod oportet ad hoc quod tabulae verae sint, subtrahe tempus aequationis dierum positum in directo illius gradus zodiaci, in quo sol est in illo die observationis lunae, ab illa meridie, in qua locum lunae observasti, et mediante residuo temporis examina locum lunae. Nam in quantum hic locus lunae hoc modo iam examinatus ab observatione facta per sensibilem aspectum discordaverit, in tantum tabulae falsae sunt et incorrectae.

(14) Quoniam autem ista tabula aequationum dierum supponit augem deferentis solis existere in gradu determinato zodiaci nonae sphaerae - sicut tabula Azarchelis de aequationibus dierum supponit augem deferentis solis esse in 17 gr. et 50. minuto geminorum nonae sphaerae, sed in nostro tempore pervenit ipsa aux ad 28. geminorum ipsius nonae sphaerae, et ideo dicimus hanc augem semper esse in 17. gradu et 50. minuto octavae sphaerae - sic utique ponimus auges reliquorum planetarum existere in zodiaco octavae sphaerae in illis gradibus, in quibus gradibus zodiaci nonae sphaerae posuit Azarchel ipsas esse in suo tempore - et quia ipsa aux deferentis solis non est in 17. vel in 18. gradu geminorum nonae sphaerae, sed in 28. geminorum, ideo collectio deminutionum ascensionum cum deminutionibus portionum diurnarum solis altera erit et aliter disposita in nostro praesenti tempore quam in tempore Azarchelis.

NHBEV

8 ecl-is: -es NHBEV   9 asp-uum: -um HBE   17 disc-it: -is NHB
18 incor.: corruptae V   19 is.ta--sup.: istae tabulae--supponunt V (*ut saep.*)   23 28: 18 gr.V   28 in(2) *om.*NE

(15) Et propter hoc auxiliante Deo constitui hanc tabulam aequationis dierum et direxi ad nostrum tempus, supponendo locum augis deferentis solis esse in 28. gradu geminorum nonae sphaerae. Et discordat ista praesens tabula in aliquibus a tabula Azarchelis propter diversitatem suppositionum locorum augium deferentis solis: unde in directo 6 graduum geminorum ponuntur plus 20 mi. in tabula Azarchelis quam in praesenti tabula.

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(5,1) Si autem tempus verae coniunctionis solis et lunae scire desideras, quaere tempus mediae coniunctionis solis et lunae per tabulas mediorum motuum. Quod sic invenies: Divide distantiam, quae est inter terminum medii motus solis et terminum medii motus lunae, per medietatem motus centri medii lunae in uno die vel in una hora vel in minuto horae. Et numerus quotiens ostendet numerum horarum vel minutorum, qui addendus est supra tempus in quo ipsam distantiam invenisti, et hoc si sit longitudo solis, id est si terminus medii motus solis praecedat terminum medii motus lunae; nam ab ipso tempore auferendus est, si sit longitudo lunae, ut si terminus medii motus lunae sit in pluribus gradibus quam terminus medii motus solis. Facta autem tali additione vel subtractione habebis tempus mediae coniunctionis solis et lunae.

(2) Facilius autem habebis hoc tempus coniunctionis mediae per tabulam medietatis centri lunae: nam quando nihil habebis in medietate centri lunae, tunc erit media coniunctio, et quantum ibi erit de medietate centri, in tantum praecessit coniunctio media, et tanta erit distantia inter medium motum lunae et medium motum solis. Tempus autem illius distantiae faciliter invenies absque aliqua divisione per illam tabulam medietatis centri lunae: nam cum gradibus et minutis illius distantiae intrabis illam tabulam, et quod ei debetur de tempore erit tempus quaesitum illius distantiae. (3) Si autem numerum graduum illius distantiae in tabula praecise non inveneris, accipe similiorem sibi, minorem tamen, et quod in directo eius debetur de tempore in linea numeri accipe. Deinde cum residuo graduum vel

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NHBEV 20 fac.--hui.dist.B2E

1 hanc--aeq.: tabulam hanc bipertitam de aequationibus V (*et sim.infra*) 4 supp.: positionum V 15 nam--motus lunae *om.*NH 17 sit--motus solis: sit--motus lunae sit--motus solis NH 21 habebis: habebit E 23 medium *om.*B2 24 med.mot.*om.*E 25 aliqua: omni E 28 numerum L: numerus B2E

minutorum sequentem tabulam minoris temporis ingredere, et quod ei debetur de tempore cum tempore prius accepto collige. Et ita semper operare, donec sic intraveris tabulas cum praeciso numero graduum minutorum et secundorum ipsius distantiae, et hoc modo colliges praecise tempus huius distantiae.

(4) Deinde cum hoc tempore mediae coniunctionis examina per instrumentum verum locum solis et lunae. Et si in eodem gradu et in eodem minuto inveniatur verus locus solis cum vero loco lunae, erit idem tempus mediae coniunctionis et tempus verae coniunctionis. Sed si haec vera loca solis et lunae non reperiantur in eodem loco, adde 12am partem distantiae ipsorum locorum supra ipsammet distantiam, et productum divide per verum motum lunae in una hora vel in minuto horae ad tempus vel circa tempus coniunctionis factum. Et inde numerus quotiens ex divisione proveniens ostendet numerum horarum vel minutorum, qui addendus est supra tempus mediae coniunctionis, si sit longitudo solis, vel qui ab eo subtrahendus est, si sit longitudo lunae. Et inde habebis tempus verae coniunctionis vel prope.

(5) Aliter autem hoc idem invenies, ut verum motum solis in una hora vel in uno minuto horae factum circa tempus coniunctionis subtrahe de vero motu lunae in una hora vel in uno minuto horae ad idem tempus coniunctionis, et per residuum divide praedictam distantiam; et numerus quotiens ostendet tempus addendum vel subtrahendum a tempore mediae coniunctionis solis et lunae, ut invenias tempus verae coniunctionis.

(6) Et quia adhuc contingit quod tempus verae coniunctionis solis et lunae praecise non invenietur - parva tamen erit differentia temporis - ideo cum hoc tempore ultimo invento, quod fere est tempus verae coniunctionis, quaere adhuc per instrumentum vera loca solis et lunae. Nam si in eodem loco eorum vera loca inveniantur, erit tempus habitum praecise tempus verae coniunctionis. Sin autem, cum eorum distantia, quae de necessitate parva erit, et cum tempore ultimo habito, quod fere fuit tempus verae coniunctionis, erit penitus operandum, sicut cum priori distantia et cum tempore mediae coniunctionis fuit operatum; et inde habebis praecise tempus verae con-

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NHBEV

3 pr-o: pr-e? B2 3 et *om.*E 11 prod.: praedictum E 19 in uno: in NHB; *om.*E 19 horae *om.*BE 20 ostendet: tibi *add.*E 24 inv-etur: -atur E 24 diff.: distantia V 24 temp.: quae ex distantia continget NHB 27 tempus *om.*B, *ins.*B2

iunctionis solis et lunae. Et hoc erit ad horam diei aequalis et non ad horam diei inaequalis: unde si velis scire, in qua hora post veram meridiem erit vera coniunctio, operare ut praemonstratum est in praecedenti capitulo de aequationibus dierum.

(7) Poteris etiam tempus verae coniunctionis solis et lunae invenire absque aliqua divisione, ut quaerendo per tabulam medietatis centri lunae tempus, quod debetur tot gradibus vel minutis, quot sunt in distantia quae est inter verum locum solis et verum locum lunae, quemadmodum ostensum est in inquisitione coniunctionis mediae.

(8) Hoc autem modo penitus invenies tempus verae oppositionis solis et lunae. Nam solis et lunae oppositio est coniunctio solis cum nadair lunae, et ideo penitus oportet operari cum distantia, quae est inter solem et nadair lunae, sicut est operandum in coniunctione cum distantia, quae est inter solem et lunam. Et sic etiam invenies tempus ceterorum aspectuum solis et lunae, quia eorum sextilis aspectus est coniunctio solis cum 60. gradu a luna, et aspectus quartus est etiam coniunctio solis cum 90. gr. a luna; et ideo similiter per praedictum modum oportet operari cum distantia, quae est inter istos gradus et solem, ad habendum tempus horum aspectuum.

(9) Hoc etiam modo penitus invenies universaliter certum tempus omnium aspectuum quorumlibet planetarum. Nam quemadmodum dividitur distantia inter solem et lunam per illud quod remanet post abstractionem motus solis in aliquo tempore a motu lunae in eodem tempore in inquisitione temporis coniunctionis solis et lunae, sic etiam in inquisitione temporis omnium aspectuum planetarum oportet distantiam inter terminos aspectuum planetarum dividere per illud quod remanet post subtractionem motus planetae tardioris in aliquo tempore a motu velocioris planetae in eodem tempore. Numerus enim quotiens ex divisione proveniens ostendet tibi sicut prius tempus addendum supra tempus, in quo ipsa distantia inter terminos aspectuum est inventa; et hoc si sit longitudo tardioris planetae; nam si sit longitudo

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NHBEV 5 poteris--mediae B2E

2 veram: certam NHB; verum E 3 erit: ipsa *add.*NHB 4 dierum: et si verum locum coniunctis *add.* V 5 pot.: quaerendo pot. E 5 invenire *om.*B2 7 quot sunt: quod sunt B2; quod est E 7 quae est *om.*E 12 opo.ope-i: ope-e NH; opo.ope-e B 17 ope-i: ope-e HB 20 modo *om.* NHB 22 abs-: sub- E 28 tibi: etiam NH; et B; *om.*V 30 tard.: ponderosioris V

velocioris, erit auferendum illud tempus a tempore inventionis ipsius distantiae; et habebis inde certum tempus aspectuum planetarum. Si sit tamen statio vel retrogradatio in planetis, aliter continget operari. *(10)* Attamen, licet termini aspectuum planetarum non sint in eodem gradu, adhuc dicuntur planetae se aspicere, dum tamen quantitates medietatis semidiametri orbis luminis utriusque simul iunctae tantum vel plus comprehendant de zodiaco quam distantia inter terminos suorum aspectuum, licet tamen verius et fortius se aspiciant, cum inter terminos suorum aspectuum nulla fuerit distantia. Et sunt orbes luminis planetarum quidam circuli, quorum centra sunt gradus zodiaci, qui sunt vera loca planetarum. Et semidiameter huius orbis Saturni continet 9 gr. zodiaci, et semidiameter orbis Iovis continet etiam 9 gr., sed semidiameter orbis Martis continet 8 gr., et semidiameter orbis solis 15 gr., et Veneris 7, et etiam Mercurii 7, et lunae 12.

(6,1) Si autem scire volueris verum motum planetae in uno die vel in una hora vel in uno minuto horae, qui dicitur buth planetae in tanto tempore, examina per instrumentum verum locum planetae ad initium illius diei et ad initium sequentis diei. Differentia enim inter haec loca planetae iam sic inventa erit buth illius planetae in uno die. Et eodem modo penitus invenies buth planetae in una hora vel in minuto horae. Et hoc modo etiam invenies verum motum planetae in multis diebus et in anno. Medium autem motum planetae in uno anno vel in uno die vel in aliquo alio tempore invenies faciliter in tabula medii motus illius planetae.

(7,1) Si autem velis scire utrum planeta sit retrogradus vel stationarius vel directus, quaere verum locum planetae per instrumentum ad initium diei, in quo hoc scire volueris; deinde quaere etiam verum locum eius ad initium sequentis diei. Nam si in utroque tempore in eodem loco reperiatur, erit stationarius; si vero in sequenti tempore in paucioribus gradibus reperiatur quam in tempore praecedenti, erit retrogradus; sed si in sequenti tempore in pluribus gradibus vel minutis reperiatur, erit directus. *(2) Et potest esse tripliciter: vel erit directus velox vel directus* tardus cursu

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NHBEV 29 et--dir.(tard.) B2EV : vel NHB

2 si--attamen *om.*V 3 planetis: planeta NHB, *def.*V 3 cont.: oportet E, *def.*V 3 oper.: si tamen sit--planetis--contingit operari *ins.*B2 5 sem.: centri E; seī t' B, *corr.*B2 8 as-ant: -unt HB, *def.*N 12 etiam *om.*NHE 15 uno *om.*NHBV 21 tempore *om.*B, *ins.*B2 25 deinde: et inde NHB; et deinde E 25 qu.et.: et.qu.NE 30 trip.: triplatus V

vel *directus* aequalis. Nam si ille excessus, in quo plus motus est in sequenti tempore quam in praecedenti, sit in tot gradibus vel in tot minutis, in quot gradibus vel minutis est eius medius motus in die, tunc est *directus et* aequalis cursu; sed si sit in paucioribus quam est eius medius motus, erit *directus et* tardus cursu; si vero sit in pluribus gradibus, erit directus *velox*.

(3) Et loca epicycli, in quibus reperiuntur hae proprietates quae solum contingunt occasione epicycli, faciliter hoc modo invenies. Posito centro medio ac medio argumento, protende duo fila a centro terrae usque ad circulum epicycli ipsius planetae, contingentia circumferentiam ipsius epicycli in parte dextra et sinistra. Nam cum planeta fuerit in istis punctis contactuum et prope ipsa, erit *directus et* aequalis cursu; cum autem fuerit in superiori portione epicycli comprehensa inter ista puncta contactuum, erit semper ipse directus *et velox*; sed cum fuerit parum sub istis punctis, erit tardus cursu. *(4)* Et etiam parum sub istis punctis suae tarditatis erunt termini suae retrogradationis, *quae sunt loca stationum;* unde in illa portione inferiori circuli sui epicycli, quae est comprehensa inter istos terminos retrogradationis, erit semper planeta retrogradus. Est autem punctus sub puncto contactus existens in dextra parte epicycli punctus stationis primae, et qui sub puncto contactus existit in parte sinistra epicycli est punctus stationis secundae. †Et quamvis incipiat eius directio in puncto contactus sinistro, tamen in puncto contactus dextro non incipit eius retrogradatio†: nam per aliquod spatium sub eo est terminus initii retrogradationis, per quod etiam spatium est finis retrogradationis sub puncto contactus sinistro. Quae autem sit pars dextra vel sinistra, per statuam imaginatam in circulo epicycli superius fuit declaratum.

(5) Luna vero non omnes istas proprietates habet, sed habet velocitatem et tarditatem et aequalitatem motus. Unde in punctis contactuum est ipsa ae-

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NHBEV 1 dir. B2EV 3 dir.et B2E 5 dir.et B2E 6 velox B2E
12 dir.et (et *om.*E)B2E 14 et velox B2E 16 quae--stat. B2E

2 in tot (mi.) *om.*BE 3 quot: quos B; quibus V; *def.*NH 4 sit *om.*NHBE
12 (cont.) et: vel (*ex* et B) BE 12 ipsa: ipse NE 15 erit: directus vel *add.*E 16 quae: qui B2 16 stat.: sectionum E 20 qui--existit: punctus contactus existens V; qui existit E 21-25 et--sinistro *om.*E; *lineá dist.*B 21-23 (et quamvis--retrog.: *fortasse* et quantum--directio sub--sinistro, tantum sub--dextro incipit--) 21 incipiat: incipit NHB, *def.*E 21 directio: tam *add.*NH,*def.*E 22 tamen: tam NH,*def.*E
24 puncto: ipso NHB,*def.*E

qualis cursu, et in medietate superiori epicycli comprehensa inter puncta contactuum est ipsa tarda, et in reliqua medietate inferiori est velox. Et ipsa numquam potest esse retrograda, quia parvum habet epicyclum, et quia etiam tardior est motus sui argumenti quam eius medius motus. Et quod similiter sit in superiori medietate tarda et in alia velox, hoc accidit eo quod motus sui argumenti contrarius est motui argumenti cuiuslibet alterius planetae.

Si autem comparaveris has proprietates provenientes occasione epicycli ad ipsas quae proveniunt causa excentricitatis deferentis planetae, habebis has proprietates, sicut veraciter contingent.

(6) Si vero centrum verum et argumentum verum et augem veram in epicyclo scire desideras, protrahe filum per centrum terrae transiens per centrum epicycli usque ad zodiacum; ubi enim hoc filum superiorem partem epicycli contingat, ibi erit aux vera in epicyclo; et quantum elongatus fuerit planeta ab illa auge secundum motum eius in epicyclo, tantum erit eius verum argumentum; et arcus zodiaci interceptus inter augem et abscissionem fili ostendet eius centrum verum. Et hoc si fuerit centrum medium minus 6 signis; sed si fuisset plus 6 signis, tunc addatur ille arcus interceptus inter augem et filum supra 6 signa, et quod inde proveniet erit eius centrum verum.

(8,1) Quoniam sol non deviat ab ecliptica zodiaci, ideo non dicitur habere latitudinem; sed declinationem habet ab aequinoctiali. Unde si velis scire partem suae declinationis, considera, quantus est eius verus motus a capite arietis nonae sphaerae. Nam si sit ab 1 gradu in tribus signis, est septentrionalis ascendens, et si sit a 3 in 6, erit septentrionalis descendens, et si sit a 6 in 9, erit meridionalis descendens, et si sit a 9 in 12, erit meridionalis ascendens. Et sic habebis partem declinationis solis ab aequinoctiali, et sic declinationes ceterorum planetarum posses invenire.

NHBEV

1 sup-i: sup-is NHBV 2 tarda: cursu *add.*E 2 in *om.*NHB 3 ip.nu.: nu.ip.NHB 5 quod: quia NHE 5 hoc--planetae *om.*E 8 has--deferentis: motum in zodiaco provenientem ex parte argumenti ad ipsum qui provenit ex parte centri E 14 con-at: -et N; -it V 15 sec.--epi. *om.*V 17 fuerit: fuerat NHB 18 addatur i.a.i.: debet addi i.a.i. V; addatis illum arcum interceptum NHB 25 sit *om.*NHE

(2) Sed latitudines planetarum ab ecliptica alio modo invenientur. Cum enim latitudinem lunae scire desideras, verum motum Geuzaar, id est capitis draconis, de vero motu lunae minue, vel medium motum Geuzaar vero motui lunae adiunge, et habebis argumentum latitudinis lunae. *Verum autem motum Geuzaar habebis auferendo eius medium motum a 12 signis: residuum enim erit eius verus motus. Deinde cum argumento latitudinis lunae* lineas numeri tabularum aequationis lunae ingredere - nam in extremis ultimis tabularum illarum solent poni latitudines lunae - et sume quod in directo illius ponitur de latitudine lunae. *(3)* Unde haec latitudo sic inventa erit septentrionalis ascendens, si fuerit argumentum latitudinis ab 1 gradu in 3 signa, et erit septentrionalis descendens, si fuerit a 3 signis in 6, sed si sit a 6 in 9, erit meridionalis descendens, et si a 9 in 12, erit meridionalis ascendens; et hoc est sicut prius de solis declinatione. Et potest tabula latitudinis lunae per se poni absque tabulis aequationis lunae.

(4) Si vero latitudines trium superiorum planetarum scire volueris, considera, cuius latitudinem hic scire desideras: nam si Saturni, centro eius vero 50 gradus adde; sed si Iovis, a centro vero Iovis 20 gradus minue; si vero Martis, ab eius centro vero nihil subtrahe nec adde. Cum hoc quod inde provenit lineas numeri tabulae latitudinis trium superiorum ingredere, et quod in directo eius inveneris de minutis proportionalibus sume. *(5)* Deinde cum argumento vero planetae intra easdem lineas numeri, et quod in directo eius inveneris de latitudine planetae septentrionali vel meridionali sume. Si enim centrum verum planetae cum suo additamento, si quod habuerit, cum quo centro minuta proportionalia sumpsisti, fuerit ab 1 gradu in 3 signa vel a 9 in 12, *id est in superiori parte tabulae*, accipe latitudinem septentrionalem; sin autem, meridianam. Postea accipe de latitudine hanc partem proportionalem secundum proportionem minutorum proportionalium ad 60, et sic habebis latitudinem trium superiorum.

(6) Et hunc canonem latitudinum trium superiorum cum sua tabula, quae in sequenti posita est, constituit Ptolomaeus, et huic canoni est omnino ad-

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NHBEV 4 verum--motus B2EV 6 deinde--lunae EV; *ras.*B2; cum quo arg-to NHB 25 id est--tab.B2EV

3 drac.: *hic ins.*B2 verum--motus (*v.s.*) 5 enim: autem E 6 motus: locus E 9 erit *post* unde(*supra*) NHB 11 si fuerit: si sit B; et si sit V 16 hic: *ras.*B; hoc(?) NH 16 eius *om.*NH; *ras.*B 18 si-- adde *om.*NH, *ins.*N2 18 subtrahe nec adde: adde vel minue N2V; adde nec minue B; *def.*NH 23 enim: fuerit *add.*BV 24 fuerit *omnes* 27 hanc: hac NB 30 omnino *om.*NHE

haerens ipse Albategni, et iste canon veritati consonat. Ab eo tamen diversus est canon latitudinum trium superiorum, quem posuit auctor canonum tabularum, et cum alia tabula ibi operatur; sed ille canon a veritate multum discordat. Et maxime etiam canon illiusmet auctoris super latitudinibus Veneris et Mercurii a veritate deviat, et est similiter a canone Ptolomaei et Albategni diversus et aliam supponit tabulam. Et est etiam canon Albategni de hiis latitudinibus Veneris et Mercurii in aliquibus diversus a canone Ptolomaei in Almagesti posito, et est eorum discordia in numeris addendis vero centro Veneris et Mercurii; ambo tamen operantur cum eadem tabula, quae posterius ponetur. Unde Albategni in fine 31. capituli imponit errorem translatori in transferendo illud capitulum, aut quod liber, a quo transtulit, erat ibi falsus.

(7) Cum igitur latitudinem Veneris et Mercurii scire desideras, intra lineas numeri tabulae latitudinis eorum cum argumento vero illius, cuius latitudinem scire desideras, et accipe quod in directo eius fuerit in tabula declinationis et in tabula reflexionis, et unumquodque seorsum scribe. *(8)* Et si fuerit inquisitio tua de Mercurio et esset centrum eius verum in superiori medietate, ex sola reflexione decimam partem eius minue, sed si fuerit in medietate inferiori, illam decimam partem reflexionis super ipsam reflexionem adde. Dicitur autem universaliter medietas superior tam in centro quam in argumento illa, in qua numerus centri vel argumenti est, cum fuerit ab 1 gradu in 3 signis vel a 9 in 12, et dicitur inferior, si fuerit a 3 signis in 6 vel a 6 in 9. Reflexioni autem Veneris nihil oportet addere vel deminuere, quia eius excentricitas parva est. *(9)* Postea centro vero Veneris 60 gradus adde, et centro vero Mercurii 270 gradus adde; et si post additionem proveniunt ultra 360 gradus, cum illo quod fuerit ultra 360, sicut cum illo quod fuerit minus 360 gradibus ingredere easdem lineas numeri, et quod in directo eius inveneris de minutis proportionalibus sume. Deinde a declinatione prius habita accipe partem proportionalem secundum proportionem minutorum proportionalium ad 60. Et haec erit eius prima latitudo examinata, quae provenit ex declinatione epicycli; et serva eam. *(10)* Si autem hoc centrum verum cum suo additamento et ar-

NHBEV

4 lat-ibus:-em H 6 et est: est NHB; et E 7 div.: est *add.*NHE 9 vero *om.*BV 10 31: tricesimi suimet V; 31.sui B 19 decimam: 12am NH: *om.*V 23 vel: et BV 24 vel: nec H; vel nec N; *del.*B 24 deminuere: minuere V 26 prov-iunt: -erint NHB 27 sicut: si erit V 32 hoc *om.*NHB 32 cum --add.*om.*NHB

gumentum verum, cum quo operatum fuerit, sint in eadem parte circuli, id est, si ambo sint in medietate superiori aut ambo in medietate inferiori, erit ipsa latitudo aequata meridiana; sed si unum illorum fuerit in una medietate et aliud in altera, erit ipsa septentrionalis. Et sic eius partem cognosces, quam memoriae commenda, scribens super eam nomen suae partis.

(11) Post hoc accipe centrum verum utriusque, et si fuerit inquisitio de Venere, eius centro vero nihil adde nec subtrahe, sed si fuerit de Mercurio, centro eius vero 180 gradus adde et cum eo, quod inde provenit, sicut cum simplici centro Veneris, lineas numeri eiusdem tabulae ingredere; et quod in eius directo fuerit de minutis proportionalibus in duobus locis seorsum scribe. Deinde considera, in qua proportione ad 60 sunt ipsa minuta proportionalia in aliquo duorum locorum posita: nam ex reflexione prius reservata sume partem proportionalem secundum proportionem illorum minutorum ad 60, et haec erit reflexio examinata: scribe eam. *(12)* Unde si fuerit in medietate superiori centrum verum simplex ipsius Veneris vel centrum verum Mercurii cum suo additamento, per quod haec minuta proportionalia invenisti, et cum hoc fuerit argumentum verum planetae minus 180 gradibus, erit reflexio examinata septentrionalis; si autem ipsum verum argumentum fuerit plus 180 gradibus, erit illa reflexio meridionalis. Tamen, si fuerit praedictum centrum in medietate inferiori et argumentum verum planetae fuerit minus 180 gradibus, erit ipsa reflexio meridionalis; sed si fuerit argumentum verum plus 180 gradibus, erit reflexio septentrionalis. Et haec erit latitudo secunda examinata, quae provenit ex reflexione epicycli.

(13) Postea, si sit tua inquisitio de Venere, accipe de minutis proportionalibus in altero locorum positis sextam partem, quae erit latitudo Veneris tertia examinata, proveniens ex deviatione deferentis ab ecliptica; et est semper haec tertia latitudo Veneris septentrionalis. Si autem examinatio fuerit de Mercurio, de ipsis minutis proportionalibus accipe quartam partem et illius quartae dimidium, quae quarta pars cum suo dimidio erit latitudo Mercurii tertia examinata, quae semper erit meridiana.

NHBEV 19 tamen--sept.*om*.V

1 quo: est *add*.B3 1 fuerit: erit E; *om*.B; fuerat NH 2 med.sup.--erit: med.inf.erit B; med.sup.erit V 6 hoc: haec EH, *alii?* 8 et *om*.NHEV, *ins*.B 15 in med.: immediate (?) NHE 17 minus: unius NH; *om*.V 22 arg.: centrum E, *def*.V 22 plus: planetae B, *def*.V 23 haec: hoc E,V? 30 ill.qu.: eius NHB 30 suo dim.: d.illo N; illo d.HB; d.V

(14) Postea istas tres latitudines adinvicem collige, si omnes sint in eadem parte; si tamen sint in diversis partibus, ut si una sit in parte septentrionali et aliae duae in meridionali vel e converso, tunc subtrahe omne illud, quod meridionale est, ab illo quod est septentrionale, si illud, quod est septentrionale, fuerit maius eo quod est meridionale; et residuum erit planetae latitudo septentrionalis ultimo verificata. Si tamen illud, quod est meridionale in latitudine, fuerit maius quam illud quod est septentrionale, tunc subtrahe illud quod est septentrionale ab eo quod est meridionale, et residuum erit latitudo verificata meridionalis.

(15) Est autem Saturni latitudo septentrionalis maxima secundum Ptolomaeum 3 graduum et 2 minutorum, meridionalis vero 3 graduum et 5 minutorum. Iovis autem maxima latitudo septentrionalis et etiam meridionalis est 2 graduum et 8 minutorum. Martis quidem maxima latitudo septentrionalis est 4 graduum, meridionalis vero 6. Veneris autem tam septentrionalis quam meridionalis est 8 graduum et 56 minutorum. Et etiam Mercurii tam septentrionalis quam meridionalis est 4 graduum et 18 minutorum.

(16) Si vero volueris scire utrum planeta sit ascendens vel descendens in parte, in qua fuerit, eius latitudinem post 10 dies examina. Quod si sit latitudo eius septentrionalis et eius latitudinem augmentari videris, indubitanter erit ascendens; et si eam deminui videris, erit descendens. Sed si eius latitudo meridiana fuerit et augmentetur, erit descendens, et si minuatur, erit ascendens. De Saturno autem et de Iove et Marte hoc idem aliter cognosci potest. Nam si latitudo alicuius istorum fuerit septentrionalis et eius argumentum verum minus 180 gradibus extiterit, ipse erit ascendens; si vero plus 180 gradibus fuerit, erit descendens. Sed e converso erit, si fuerit eius latitudo meridionalis; nam si fuerit tunc eius argumentum verum minus 180 gradibus, erit descendens, si vero plus, erit ascendens. De Venere vero et Mercurio hoc ita non poteris invenire nisi secundum primam viam propter velocitatem et pluralitatem motuum suarum latitudinum, + nisi cum magna difficultate et inquisitione.

NHBEV

3 et al.: reliquae E; *om.*NH 3 in: parte *add.*E 4 si--sept.*om.*B
4 illud *vel* id NH(EV?), *def.*B 9 et *om.*NHB 9 residuum *om.*BV
15 56: ≪12≫56 B 16 18: ≪5≫18 B 16 min.: ascendens vel descendens *add.*E 17 vol.sci.: s.v. NHB 22 min.: demin. V

(9,1) Theoricam autem motuum latitudinis planetarum iam conveniens est perscrutari. Unde, ut praedictum est, sol nullam habet latitudinem ab ecliptica, luna vero hanc latitudinem habet sicut alii quinque planetae. Quoniam enim movetur luna motu centri epicycli ab occidente in oriens supra proprios polos sui excentrici et non supra polos zodiaci et secat superficiem zodiaci in duobus punctis oppositis, sic itaque eius deferens in suis punctis oppositis a zodiaco secatur, et declinat suus deferens a superficie zodiaci in duabus partibus, scilicet septentrionis et meridiei, et est quantitas suae maximae declinationis semper eadem et invariabilis. *(2)* Et illa intersectio, in qua incipit declinare luna ad septentrionem, dicitur caput draconis sive Geuzaar; sed alia intersectio, in qua incipit declinare ad meridiem, dicitur cauda draconis. Moventur autem cotidie istae intersectiones ab oriente in occidens 3 minutis et 11 secundis; et ducit istas intersectiones quidam circulus concentricus mundo, existens in caelo lunae, aequalis deferenti lunae in magnitudine, et est in eadem superficie cum ecliptica zodiaci. Et est etiam superficies sui epicycli semper in eadem superficie cum superficie sui deferentis. Quapropter luna non habet nisi unam latitudinem, quae est propter declinationem deferentis ab ecliptica.

(3) Hanc igitur latitudinem, quae provenit ex declinatione deferentis, habent tres superiores planetae quemadmodum luna invariabilem secundum eius maximam quantitatem; intersectiones tamen suorum deferentium cum ecliptica non moventur sicut intersectiones lunae; non enim moventur nisi motu octavae sphaerae. Et dicetur semper, sicut de intersectionibus lunae, illa intersectio Geuzaar, in qua centrum epicycli incipit declinare ad septentrionem. *(4)* Et est locus Geuzaar Saturni distans a loco oppositi augis deferentis a parte ante, id est secundum successionem signorum, per 40 gradus, et eius alia intersectio a loco augis etiam per 40 gradus distat a parte ante. Erit igitur locus partis deferentis maxime declinantis ad septentrionem distans a loco augis deferentis a parte retro per 50 gradus, et locus partis deferentis maximae declinationis ad meridiem distat etiam a loco oppositi augis per 50 gradus a parte retro. Et est semper locus maximae declinationis deferentis, qui aequaliter distat ab utraque intersectione.

NHBXV

1 autem *om.*NHX 4 mov.luna: l.m.V 7 suus: suum V 11 inc.dec.: declinat V 13 et 11 sec.: 11 sec.H; et secundis 11 X; et 8 sec.BV 16 sui *om.*V 24 ad sep. *om.*NHB 27 eius *om.*V 28 de-ntis: -tionis BX; -ns N 30 de-tionis: -ns B;*def.*NH

(5) Locus autem Geuzaar Iovis a loco augis sui deferentis distat per 70 gradus a parte retro, quare locus partis sui deferentis, quae maxime declinat ad septentrionem, erit distans a loco augis a parte ante per 20 gradus. Locus vero Geuzaar Martis per 90 gradus distat a loco augis sui deferentis a parte retro; erit igitur locus illius partis sui deferentis, quae maxime declinat ad septentrionem, in loco augis deferentis. Et latitudines horum trium planetarum scriptae in eorum tabula positae sunt, ac si semper centrum epicycli esset in illo loco deferentis, qui maxime declinat ad septentrionem.

(6) Est autem quidam alius motus latitudinis horum trium planetarum, scilicet Saturni Iovis et Martis, et est iste motus secundum quod movetur superior medietas epicycli et inferior, declinando se a superficie deferentis ex utraque parte, scilicet septentrionis et meridiei; et dicitur iste motus motus declinationis vel inclinationis epicycli. Est autem iste motus super diametrum, quae transit super ambo puncta longitudinum mediarum epicycli, quae quidem puncta per 90 gradus distant ab auge vera epicycli. *(7)* Et ista diameter semper est aequidistans superficiei eclipticae, nisi dum fuerit centrum epicycli in nodis intersectionum; nam tunc ipsa est in superficie eclipticae, et tunc etiam tota superficies epicycli est in eadem superficie cum superficie deferentis; tunc enim nulla erit inclinatio epicycli. Sed maxima erit haec inclinatio, cum centrum epicycli fuerit in locis intermediis duorum nodorum; et est semper inclinatio medietatis inferioris epicycli a superficie deferentis ad partem illam, ad quam declinat a superficie eclipticae ipsa medietas deferentis, in qua est centrum epicycli. Et ideo, quamdiu centrum epicycli fuerit extra nodos, planeta existens in superiori medietate epicycli erit inter duas superficies, scilicet eclipticae et eius deferentis.

(8) Venus vero et Mercurius tres habent latitudines, quarum una latitudo est declinatio superficiei deferentis a superficie eclipticae, sicut est de aliis, nisi quod eius maxima declinatio ab ecliptica est variabilis. Illa enim pars deferentis, quae nunc maxime declinat ab ecliptica ad sep-

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NHBXV

1 autem: augis V; *om.*B   2 quae: qui NB   5 er.ig.l.i.: erit l.i.B; et ideo erit l.i.V; erit illius igitur X   6 augis: sui *add.*V   8 qui: quae NHB   10 scilicet *om.*NHBX   15 ambo: duo V   20 def.: eclipticae X   20 epic. *om.*NHX   23 d-at: d-atur NHBX   31 nunc: tunc B;*om.*V

tentrionem, infra medietatem anni tantum ipsa eadem pars declinabit ad meridiem, et infra 3 menses et infra 9 menses a tempore suae maximae declinationis ad septentrionem ipsa veniet directe sub ecliptica; et tunc orbis deferentis nullam habebit latitudinem, nam tunc eius superficies eadem erit cum superficie eclipticae. *(9)* Loca autem intersectionum deferentis cum ecliptica, quae actu sunt, cum deferens habeat latitudinem ab ecliptica, sunt in longitudinibus mediis deferentis, sicut de Marte; quae longitudines mediae distant per 90 gradus ab auge deferentis et ab opposito augis deferentis. Et quando centrum epicycli Veneris et Mercurii est in istis longitudinibus mediis, tunc deferens nullam habet latitudinem. Et ideo loca deferentis, quae contingunt maxime declinare ab ecliptica, erunt in auge et in opposito augis deferentis; et dum in ipsis locis fuerit centrum epicycli Veneris et Mercurii, tunc ipsorum locorum maxima erit declinatio ab ecliptica. *(10)* Et cum centrum epicycli Veneris fuerit in aliquo duorum nodorum, tunc erit inceptio declinationis ad septentrionem illius medietatis deferentis, quae sequitur ipsum nodum secundum successionem signorum, id est, illius medietatis, ad quam tendit immediate centrum epicycli. Sed e contrario haec medietas deferentis Mercurii semper declinat ad meridiem, et ideo sequitur quod non est possibile centrum epicycli Veneris esse in medietate deferentis declinata ad meridiem, nec centrum epicycli Mercurii esse in medietate declinata ad septentrionem.

(11) Adhuc autem Venus et Mercurius duos habent motus latitudinis provenientes quidem ex parte epicycli, quorum unus est secundum quod movetur superior medietas epicycli et inferior declinando se a superficie deferentis ex utraque parte, scilicet septentrionis et meridiei, sicut est in tribus superioribus planetis; nisi quod diameter epicycli utriusque, quae transit per ambas longitudines medias epicycli, supra quam fit iste motus, non semper aequidistat eclipticae. *(12)* Est autem maxima declinatio superioris medietatis epicycli ad meridiem, cum centrum epicycli fuerit in quodam loco deferentis, qui distat a loco augis deferentis per 60 gradus a parte retro, et hoc de Venere; *de Mercurio vero distat per 90 gradus a*

NHBXV 31 de Mer.--retro B2VX; et per 90 a parte ante de Mercurio (per *om.*NH) NHB

2 suae *om.*V 4 ea.er.: er.ea.V; erit X 7 sicut--Marte *om.*V 9 et(2): aut V 11 de-re: de-te NH 13 et: aut V 13 tunc--nodorum *om.*B 13 ab ecl.*om.*V; *def.*B 16 signorum: deferentis Mercurii *add.*V 18 e cont.: e converso V 18 def.Mer.*om.*V(*v.s.*) 18 d-at: d-atur NHBX 31 vero: qui *add.*X

parte ante vel per 270 a parte retro. Maxima vero declinatio superioris medietatis epicycli ad septentrionem est in quodam puncto deferentis opposito huic in quo est maxima declinatio ad meridiem. Cum igitur centrum epicycli utriusque fuerit in locis intermediis ipsorum in quibus fiunt hae maximae declinationes epicycli, nulla erit haec declinatio; unde tunc diameter epicycli transiens per augem veram epicycli et per eius oppositum erit in superficie deferentis.

(13) Est autem alius motus eorum secundum quod longitudines mediae epicycli moventur declinando se a superficie deferentis ex utraque parte, scilicet septentrionis et meridiei; et dicitur hic motus reflexio epicycli. Et est iste motus super diametrum epicycli, quae transit per augem veram epicycli et per eius oppositum. *(14)* Est autem maxima reflexio medietatis anterioris epicycli ad septentrionem, cum centrum epicycli fuerit in auge deferentis, et hoc de Venere; sed de Mercurio, cum fuerit in opposito augis deferentis. Et in eorum oppositis est maxima reflexio eiusdem partis anterioris utriusque ad meridiem. In eorum vero locis intermediis nulla erit haec reflexio: tunc enim diameter epicycli, quae transit per ambo puncta longitudinum mediarum epicycli, erit in superficie deferentis. Est autem medietas epicycli anterior, quae dicitur dextra secundum imaginationem statuae prius intellectae.

Et haec de latitudinibus planetarum sufficiant.

(10,1) Cum eclipsim lunae et eius quantitatem prompte et evidenter invenire volueris, protrahe lineam rectam super planum ad longitudinem 7 vel 14 pedum vel palmarum, et sit haec linea CB, quae dividetur in 14 partes aequales; et erunt hae divisiones 14 gradus eclipticae. Deinde supra punctum B erigatur una linea recta orthogonaliter per 11am primi Euclidis, et sit haec linea orthogona BD. Postea divide aliquem gradum lineae CB in 60 partes aequales, quae erunt minuta gradus. Et etiam, si posses, quodlibet horum minutorum divide in 60 secunda; sin autem, protrahe divisiones per 5 vel per 10 secunda procedentes. *(2)* Post hoc extende pedes alicuius circini supra lineam CB, donec 1 gradus cum 12 minutis atque 30 secundis inter hos pedes fuerit comprehensus. Deinde pone pedem circini immobilem in puncto

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NHBXV(*l*.1-21); NHBEVF(*l*.22-32)

1 ante *om*.X 3 est: eorum *add*.V 16 eor.ver.loc.: l.v.e. N; eor.veris loc.V 26 sit: sic HB 27 gr-um: -uum NHB,V?;gra E 30 post hoc: post hec HF; postea E 31 supra: super NHV 31 inter--pedes *om*.NHEF 32 pedem *om*.BV

B, et secundum ipsam quantitatem describe circulum subtilem; ubi enim iste circulus abscindet orthogonam BD, sit punctus D. Tunc a puncto D ad punctum C protende lineam rectam; erit igitur linea DC pars deferentis lunae et linea CB pars eclipticae, et punctus C erit intersectio capitis vel caudae. Serva igitur hunc triangulum CBD, quia pro omnibus eclipsibus tam solis quam lunae invariabilis erit et paratus.

(3) Hoc facto quaere certam horam verae oppositionis, hoc est quaerere coniunctionem lunae et nadair solis. Deinde videbis, quantum distat locus huius coniunctionis a capite vel a cauda per modum praedictum in canone inventionis argumenti latitudinis lunae; unde, si ille locus coniunctionis a loco capitis vel caudae plus distat quam per 12 gradus ante vel retro, non est possibilis eclipsis lunae, sed si minus, est possibilis. Et ideo eclipsis semper erit possibilis, si sit argumentum latitudinis ab uno gradu, hoc est ab initio primi gradus, in 12 vel minus, vel cum fuerit in 168 gr., donec perveniat ad 192, et cum fuerit etiam in 348 et ulterius usque ad 360. *(4)* Habito autem argumento latitudinis apto pro eclipsi, pone punctum F in ecliptica CB tantum distantem a puncto C, quantum ipsum argumentum latitudinis lunae ponit locum lunae a capite vel a cauda distare a parte ante vel retro. Et supra illum punctum F erige lineam orthogonam sicut prius per 11am primi Euclidis; et sit haec linea orthogona FG, unde sit punctus G, ubi ipsa deferentem CD intersecat.

(5) Postea cum vero argumento lunae ingredere lineas numeri tabulae quantitatum diametrorum et suscipe minuta et secunda, quae in eius directo inveneris in tabula semidiametri umbrae et in tabula semidiametri lunae. Quia tamen quantitas semidiametri umbrae in loco transitus lunae, quae in tabula ponitur, posita est tali condicione, ac si sol esset in auge sui deferentis - sed cum sol recesserit ab auge, minoratur quantitas umbrae - ideo ingredere cum solis argumento tabulam variationis umbrae, et quod ibi inveneris subtrahe de quantitate semidiametri umbrae per suam tabulam inventa; et sic habebis eam aequatam.

(6) Deinde extende pedes circini super aliquem gradum eclipticae divisum in sua minuta, donec omnia minuta et secunda semidiametri umbrae inter hos pedes fuerint comprehensa, et inde describe circulum secundum quantitatem

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NHBEVF

2 D(2)--C: C--B NHBV 12 lunæ *om.*NHBV 22 lineas--susc.: tabulas lineae numeri cum semid-o et recipe V 23 diam.: semidiam. G 27 auge sui: sua auge NHBF 33 pedes: circini *add.*B; termini *add.*V. 33 desc.: scribe NHBF

horum minutorum supra punctum F in ecliptica, et erit hic circulus umbrae. Deinde per hunc modum penitus describe circulum corporis lunae supra punctum G secundum quantitatem suorum minutorum ex sua tabula acceptorum. Quantum igitur circulus umbrae de circulo lunae comprehendet, tantum umbra de corpore lunae hora verae oppositionis vel hora mediae eclipsis obscurabit.

(7) Attamen siquis loqui vellet secundum praecisam veritatem, hanc horam verae oppositionis non dicet esse horam mediae eclipsis nec horam maximae obscurationis illius eclipsis: nam per aliquod tempus ante erit ipsa hora mediae eclipsis, si locus eclipsis transiverit nodos capitis vel caudae; sin autem, erit per aliquod tempus post horam verae oppositionis. *(8)* Si igitur hoc curare volueris , adde quadratum sinus recti argumenti latitudinis hora verae oppositionis supra quadratum sinus recti latitudinis lunae in eadem hora; deinde provenientis quaere radicem quadratam et serva eam. Postea multiplica sinum rectum latitudinis lunae in semetipsum et productum divide per radicem prius servatam; et inde sinus recti ex divisione provenientis quaere arcum, supra quem addas sui 12am; et quod inde resultat divide per buth lunae in uno minuto horae; et quod ex divisione proveniet ostendet tibi minuta horae, quae auferenda sunt a tempore verae oppositionis, si locus eclipsis transiverit nodos intersectionum; sin autem, ei est addendum. Et sic praecise habebis tempus mediae eclipsis et eius maximae obscurationis, supra quod adde tempus aequationis dierum, ut habeas tempus aequatum mediae eclipsis. *(9)* Quia tamen parva est differentia inter ipsos sinus et suorum portiones, et etiam arcus radicis prius reservatae non excedit arcum argumenti latitudinis in sui 12a parte, ideo satis praecisum erit opus cum arcubus pro chordis et cum arcu argumenti latitudinis pro radice prius habita, et non accidet ex hoc opere sensibilis error.

(10) Et super hoc ponamus exemplum in casu illo, dum argumentum latitudinis sit 12 graduum: nam tunc accidit maior diversitas, quae est inter horam verae oppositionis et horam mediae eclipsis. Tunc enim latitudo lunae est 62 minutorum, quae multiplicabis in se ipsa, et provenient 3844 secunda, quae debent dividi per 12 gradus argumenti latitudinis, et ex divisione

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NHBEVF

17 sui: suam E 21 est add.: sunt addenda G; est addendus V 21 et eius--eclipsis *om.*V 25 in--parte: et suam 12am partem E 27 pri.hab. *om.*NHB 31 pro-ent: -et E; -unt HBF

provenient 320 secunda, quae valent 5 minuta et 20 secunda. Et super hanc summam adde suam 12am, quae est 27 secundorum; et habebis 5 minuta et 47 secunda, quae debent dividi per buth lunae in uno minuto horae. Et habebis minuta horarum addenda vel subtrahenda a tempore verae oppositionis, ut praedictum est, si sit de eclipsi lunae. Si tamen sit operatio de eclipsi solis, erunt habita minuta horae addenda aut auferenda a tempore verae coniunctionis.

(11) Per ea autem, quae circa praedictam figuram eclipsium ostensa sunt, et per artem inventionis latitudinis lunae prius datam poteris praecisius describere eclipses absque compositione intersectionis capitis vel caudae. Nam potes lineas orthogonaliter erectas, videlicet lineas latitudinis et lineas orbium, quantascumque volueris constituere, ita quod earum partes poteris dividere in minuta, secunda et tertia magna et sensibilia. Nam cum linea orthogonaliter erecta fuerit in multas partes divisa, possunt multae illarum partium sumi pro uno minuto vel secundo, unde illa eadem linea deserviet pro magna latitudine et pro parva.

(12) Cum autem praecise sciveris tempus mediae eclipsis et volueris scire tempus initii vel finis eclipsis, quantitatem semidiametri lunae cum quantitate semidiametri umbrae simul collige, vel cum quantitate semidiametri solis, si sit pro eclipsi solis, et quod collectum fuerit in se ipsum multiplica. Et a producto subtrahe quadratum latitudinis lunae, et inde residui quaere radicem, supra quam addas suam 12am; et quod inde resultat divide per buth lunae in minuto vel secundo horae; et quod ex divisione provenerit ostendet minuta et secunda horae, quae auferenda sunt a tempore mediae eclipsis, ut habeatur tempus initii eclipsis, et quae tempori mediae eclipsis addenda sunt, ut habeatur tempus finis eclipsis.

(13) Aliter autem et facilius hoc idem invenies, ut describe circulum supra lineam deferentis lunae secundum quantitatem corporis lunae, tangentem circulum umbrae vel solis, ita quod eius convexum tangat convexum alterius solum secundum punctum. Deinde considera distantiam, quae est inter centrum circuli lunae iam positum et inter centrum eiusdem circuli positum

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NHBEVF 8 per ea--pro parva B2EVF

1 pro-ent: -unt V 8 ea aut.: eam E; ea V 8 ecl-ium: -is E 10 vel: et E 11 nam: tunc *add.*V 11 potes: poteris B2 13 in: per V 13 et(1): in V 14 in *om.*E 15 sumi: situari E 16 pro(2) *om.*E

in ea linea deferentis ad horam mediae eclipsis; et hanc distantiam mensura per minuta eclipticae, et super eam adde suam 12am, et quod inde excreverit divide per buth lunae in minuto vel secundo horae; et quod ex divisione provenerit ostendet minuta et secunda horae, quae auferenda sunt a tempore mediae eclipsis, ut habeatur tempus principii eclipsis, et quae eidem tempori sunt addenda, ut habeatur tempus finis eclipsis, ut praedictum est.

(14) Aliter etiam hoc idem invenies, ut collige minuta et secunda semidiametri lunae cum minutis et secundis semidiametri umbrae vel solis; deinde extende pedes circini supra gradus eclipticae tantum donec minuta et secunda ipsius collecti inter hos pedes fuerint comprehensa. Hoc facto describe circulum secundum hanc quantitatem super locum eclipsis in ecliptica linea, qui est punctus F, videlicet centrum circuli umbrae vel solis; et ubi iste circulus abscindet lineam deferentis lunae, pone notam P in una parte et T in alia. Tunc illam distantiam, quae est inter P et G vel inter T et G, mensura per minuta gradus eclipticae, et ei etiam adde suam 12am; et inde operare penitus, ut praedictum est, et habebis idem quod prius. Sic igitur faciliter invenies tempus quod est inter initium eclipsis et finem, sive eclipsis fuerit totalis sive partialis.

(15) Cum vero eclipsis fuerit totalis et volueris scire moram totalis obscurationis, describe in duobus locis circulum corporis lunae secundum suam quantitatem supra deferentem lunae infra circulum umbrae, ita quod convexum utriusque circuli tangat in puncto concavum circuli umbrae. Deinde considera hanc distantiam, quae est inter duo centra horum duorum circulorum contingentium, et mensura eam per minuta eclipticae, et supra eam adde suam 12am. Postea divide eam per buth lunae in una hora vel minuto horae: quod enim ex divisione provenerit ostendet moram totalis obscurationis. Et sic invenies tempus, quod est inter initium eclipsis et initium totalis obscurationis, et etiam quod est inter finem totalis obscurationis et finem eclipsis.

(16) Quemadmodum autem invenitur eclipsis lunae cum quantitate semidiametri lunae et semidiametri umbrae et hora verae oppositionis, sic penitus inve-

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NHBEVF

2 super: supra V 4 et: vel NHF 11 col-i: col-a NHVF 12 super: supra V 13 qui: quae NHEVF 14 abs-det: -dit BV 19 p-alis: p-cularis E 26 vel: in *add.*E; unico *add.*H 28 inter *om.*EV 31 lunae *om.*BV 32 inv-itur: -ietur NHBF

nitur eclipsis solis cum quantitate etiam semidiametri corporis lunae et semidiametri corporis solis et cum hora coniunctionis visibilis. Horam vero coniunctionis visibilis invenies per horam verae coniunctionis et per diversitatem aspectus lunae in longitudine et latitudine. *(17)* Habito enim tempore verae coniunctionis aequato cum aequatione dierum, considera quantum ipsum distat a tempore certae meridiei ante vel post. Deinde divide illam distantiam per quantitatem unius horae aequalis, scilicet per 15 gradus, et quae ex hac divisione proveniunt dicuntur horae longitudinis coniunctionis a meridie. *(18)* Cum hiis igitur horis longitudinis a meridie et cum signo, in quo fuerit locus coniunctionis, ingredere tabulam diversitatis aspectus lunae pro tuo climate constitutam et etiam illam partem tabulae, in qua fuerit locus coniunctionis. Nam si fuerit ante meridiem, ingredere partem tabulae superiorem, quia illa pars tabulae orientalis est; si autem fuerit post meridiem, ingredere partem inferiorem, nam ipsa occidentalis est. Quod autem scribitur in loco recessionis

, scilicet in loco meridiei, est orientale in prima tabula, quae est a principio cancri usque ad principium capricorni secundum successionem signorum; sed occidentale est quod ponitur in loco recessionis in secunda tabula, quae est a principio capricorni usque ad principium cancri.

est diversitas aspectus quae debetur lunae, cum fuerit centrum corporis eius in linea medii caeli.

(19) Cum igitur hac scientia tabulam intrasti, quod in eius directo fuerit de diversitate aspectus in longitudine tantum accipe, quod erit diversitas aspectus lunae in longitudine sufficienter aequata pro hora verae coniunctionis, si locus coniunctionis sit in initio sui signi, et si horae longitudinis a meridie sint perfectae *et praecisae* absque minutis horae, et etiam si luna sit in auge vera sui epicycli.

(20) Pro quocumque vero istorum trium ita in casu contingente oportet aequationem facere: Si enim in pluribus gradibus signi fuerit luna vel locus coniunctionis, considera, in qua proportione illi gradus se habeant ad

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NHBEVF 16 scil.--cancri NHB 16' est--caeli EF 27 et praec. B2EVF

5 aeq.: quantitate V 6 cer.mer.: verae mer.E; mer.veræ F 8 pro-iunt:-erint VF 11 tuo: uno HE 17' quae: qui F 20' eius *om.*E 23 intrasti: intra et G 24 tantum: datum NHB 24 quod: quia E 29 trium: non *add.* HBVF,N?

totum signum. Deinde cum eisdem horis, cum quibus prius tabulam intrasti, sequens signum ingredere, et quod ibi inveneris de diversitate aspectus in longitudine accipe. Considera inde differentiam inter diversitatem aspectus modo acceptam et prius; cuius enim differentiae accipies partem proportionalem ad totam differentiam secundum praehabitam proportionem graduum lunae ad totum signum, et hanc partem proportionalem addas diversitati aspectus prius acceptae, si ipsa minor fuerit eâ quae posterius accepta fuerit in sequenti signo, sed si maior fuerit, eam ab ea minue; et sic habebis hanc diversitatem aspectus aequatam pro gradibus signi. *(21)* Si vero cum horis longitudinis a meridie fuerint minuta horae, operare penitus cum illis minutis horae, quemadmodum iam operatum fuit cum gradibus signi. Oportet enim talem partem proportionalem sicut prius invenire, quae addenda vel auferenda est de diversitate aspectus in longitudine aequata pro gradibus signi; et sic etiam habebis eam aequatam pro minutis horae. *(22)* Si autem luna non fuerit in auge vera sui epicycli, cum suo argumento vero ingredere tabulam aequationis diversitatis aspectus *pro epicyclo, quae non crescit ultra 12 minuta - et haec tabula cum tabula buth solis et lunae in una hora solet situari -* , et per minuta, quae in directo eius inveneris, multiplica minuta vel secunda diversitatis aspectus ultimo aequatae. Deinde minuta vel secunda huius producti adde super diversitatem aspectus in longitudine ultimo aequatam; et sic habebis similiter eam aequatam pro argumento lunae; et sic erit ipsa iam perfecte aequata ad horam verae coniunctionis.

(23) Intellege quidem provenire secunda, si multiplicaveris minuta per minuta, et provenire tertia, si multiplicaveris secunda per minuta vel e converso, et provenient 4a, si 2a per 2a, et sic deinceps.

(24) Intellege etiam, quod ista diversitas aspectus in longitudine iam accepta ponet semper locum visibilem lunae in pluribus gradibus zodiaci quam est eius verus locus, si inter gradum zodiaci ascendentem et verum locum lunae fuerit minus 90 gradibus zodiaci; si vero plus, ponet in paucioribus.

NHBEVF 16 pro--situari B2EVF; lunae NHB 23 (quidem, *incip.*F2)
26 intell.--operatum B2EVF

7 post.: prius NV 7 fuerit(2): fuit BE 11 fuit: fuerit NHBF 17 12 *om.*V 17 cum tabula *om.*V 17 lunae: et *add.*E 20 adde: semper *add.*HBV 20 super: supra V 21 ae-am(1): -a EF 22 ad horam: pro hora NHBV 23 mult.V; multiplicatis *alii* 24 et pr.ter.--deinceps *vacat* E 24 tertia: secunda BV, *def.*E 27 semper: super E 27 lunae: ut *add.*E 28 et: inter *add.*E 29 90: 30 E

(25) Si etiam ad aliquod aliud tempus quam circa tempus eclipsis diversitatem aspectus lunae in longitudine scire desideras, fac omnes tres praedictas operationes sicut prius; et cum hoc, quia luna non erit in auge sui deferentis, igitur etiam intrabis tabulam aequationis diversitatis aspectus pro deferente cum distantia corporis lunae ab auge sui deferentis – quae tabula crescit usque ad 32 minuta et situatur cum tabula aequationis diversitatis aspectus pro epicyclo – et cum illis minutis, quae in eius directo inveneris, operare penitus quemadmodum in aequatione diversitatis aspectus pro epicyclo fuerat operatum.

(26) Ut tamen diversitatem aspectus lunae in longitudine hora coniunctionis visibilis invenias, adde diversitati aspectus ultimo perfecte aequatae suam 12am partem, et collectum divide per buth lunae in una hora vel minuto horae; et quod ex divisione proveniet adde semper supra horas longitudinis a meridie, cum quibus tabulam prius intrasti. Post hoc cum horis, quae inde resultant, adhuc eandem tabulam ingredere et accipe quod in eius directo inveneris de diversitate aspectus in longitudine per artem praedictam, cui addas suam 12am, et quod inde resultat divide similiter per buth lunae in una hora; quod enim ex divisione proveniet adde horis longitudinis a meridie, cum quibus ultimo tabulam intrasti, *(27) et hoc si gradus zodiaci, qui per 90 gradus distat ab ascendente et per 90 a gradu zodiaci occidente, sit inter lineam medii caeli et locum lunae; sed si locus lunae sit inter illum gradum et lineam, oportet illud, quod ex tali divisione provenerit, auferre ab illis horis longitudinis a meridie.*

(28) Adhuc autem cum hiis horis inde collectis tabulam ingredere, et quod in eius directo fuerit de diversitate aspectus in longitudine et etiam in latitudine *accipe*, et hanc diversitatem aspectus in latitudine accipies et aequabis penitus quemadmodum eam, quam in longitudine accepisti, eamque in scriptis reserva.

NHBXV 15 (directo, *desin.*F1) 19 et hoc--meridie B2EVF 26 accipe B2EVF

2 lunae: ipsae F1 2 in long.*om.*B2 2 tr.pr.: pr.tr. EF1F2 4 tabulam *om.*V 6 aequ. *om.*F1F2 7 minutis *om.*F1 7 eius dir.: d.e.V 13 quod: quot V 13 pro-iet:-erit E; -iunt V 13 supra: super VF 14 hoc: haec HEF1F2 19 si gra.: signa(!) F 20 distat: distant B2 20 90(2):gradus *add.* E 21 sit: sed B2 21 inter: intra F 22 lineam: lunam V 22 prov-erit: -it F; crescit V; *om.*B2 25 in(3) *om.*HEF 27 eam *post* long.NH 27 quam: qui(?) E; que HB; quando N

(29) Si vero diversitatem aspectus lunae in latitudine ad aliud tempus quam circa tempus eclipsis scire volueris, operare penitus quemadmodum ostensum fuit in aequatione diversitatis aspectus in longitudine ad aliud tempus quam circa tempus eclipsis.

(30) Diversitati autem aspectus in longitudine adde suam 12am, et quod inde provenerit divide per buth lunae in una hora vel minuto horae. Deinde tempus, quod ex divisione proveniet, subtrahe a tempore verae coniunctionis,

si diversitates aspectuum accepisti in orientali parte tabulae, sed si in occidentali, ei adde;	*si inter gradum ascendentem et locum lunae fuerint minus 90 gra. zodiaci, sed si plus, ei adde;*

et sic habebis tempus coniunctionis visibilis certissimae, ad quod tempus aequabis locum solis et capitis draconis, considerando distantiam solis a capite.

(31) Et inde penitus operare in descriptione sui eclipsis, sicut operatus fuisti in descriptione eclipsis lunae. Nam sicut prius descripsisti circulum umbrae secundum suam quantitatem, sic iam describes circulum corporis solis, cuius etiam quantitatem invenias intrando tabulam quantitatum diametrorum cum solis argumento, sicut prius intrasti tabulam cum vero argumento lunae pro quantitate umbrae et corporis lunae. Centrum tamen corporis lunae non oportet ponere in linea deferentis lunae, sicut oportet pro eclipsi lunae, sed ponatur in tot minutis vel secundis distare a linea sui deferentis, accedendo ad eclipticam, in quot minutis vel secundis fuerat diversitas aspectus in latitudine reservata; et hanc distantiam mensurabis per minuta gradus eclipticae, sicut in eclipsi lunae sensibiliter est ostensum.

(32) Quoniam autem diversitas aspectus lunae in latitudine semper meridiana est, ideo eclipsis solis non est possibilis in climate quinto nec sexto nec septimo, quando luna est in meridionali parte deferentis; et propter hoc eclipsis solis non habet nisi duos terminos, lunae vero quattuor, ut prius ostensum fuit. Sunt autem duo termini possibilitatis eclipsis solis 12 gradus sequentes caput draconis et 12 gradus praecedentes caudam. Est autem

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NHBEVF 1-4 si--eclipsis B2EF 8 si div.--adde NHB 8' si int.--adde EVF

2 temp.ecl.: eclipsim E 2 quem.--fuit: sicut dictum est E 3 in long. *om.*E 6 pro-erit: -iet NHBF 9' 90: 30 E 10 ei adde *gem.*B 17 inv-as: -es NHBF 19 pro q-te VG; per q-tem NHBEF 30 sunt aut.--sicut ecl. lun. *rep.*E *fol.ant.* (=E2) 31 gradus(2) *om.*VE2

eclipsis lunae necessaria bis in anno, aut supra terram aut sub terra, et pluries est impossibilis. Nam cum semel fuerit, nondum erit, donec 6 menses lunares transiverint complete. Est etiam eclipsis solis possibilis bis in anno, non tamen necessaria *in eodem climate*, et pluries similiter est impossibilis sicut eclipsis lunae. *(33) Et licet eclipsis solis, luna existente in meridionali parte sui deferentis, non sit possibilis in quinto, sexto et septimo climate, tamen in aliis climatibus est possibilis. Item nota quod lunam in anno contingit bis eclipsari, sive eclipsis sit sub terra sive supra terram. Et simile esset de sole, nisi essent diversitates aspectus. Item cum luna fuerit eclipsata, non potest amplius eclipsari, nisi prius transeant 6 menses. Sed tamen, si luna fuerit eclipsata in oppositione, hoc non impedit eclipsari solem in sequenti coniunctione vel 2a vel 3a, et sic de aliis.*

[Pravos eventus habet ordo rei male tentus
Resque fit electa recto moderamine recta]

NHBEVF   4 in--climate B2EE2VF   5 et lic.--de aliis V(G)   14 pravos --recta NH

1 t-am: t-a HE2   7 et *om*.G   7 ta.in al.: in al.ta. G   8 lunam--ecl-i: luna c.b.i.a.e. G   9 sive supra: vel super G   11 menses: lunares *ins*. G   11 sed--ecl.: si t.l.e.f. G   12 ecl.sol.: s.e. G   12 vel(1) G; secundum V   13 et: vel G

P. PARAMETERS AND TABLES.

Some contemporary innovations occur (P2-3, William of St Cloud), including one mis-attribution of obscure origin (P1,?Campanus). Elsewhere, except for P4.10.14, the sources are the TOLEDAN TABLES (or, for mean motions, the TOULOUSE Tables,P7) and/or the text and tables of ALBATTANI (typically P3.5.12.13, where the references to Ptolemy may have been taken over from Albattani; P5 seems to indicate that Plato's translation was used). To judge from the text, Toledan/Toulouse tables were held to be available (P11.15 "solent poni") and were not to be published with the text; again, those expressly to be appended are either the latitude tables peculiar to Albattani (P12.13) or the author's own table P10 of the equation of time. - Some tables are in fact appended in the manuscripts F (P7) and V (P11-14), possibly secondarily, though almost certainly those meant; I print P14, which seems to be rarely found.

The constants cited separately are noted under P1-6; P7-17 contain tables plus such constants as may be taken as readings from tables.

P1. Relative distances in the planetary models.

Values collected in the tables 1,16, named *tabulas de distantiis centrorum et magnitudinibus epicyclorum, quæ ab Almagesti PTOLOMÆI sunt abstractæ* (1,4,cf.1,14). A couple of values repeated in 1,5.11. The value of 2/60 for the sun's (eccentricity)/(deferent radius) is ascribed to AZARCHEL and MESSEHALLAH (1,15-6) and used in 1,8.

The values ascribed to PTOLEMY are as in the Almagest, except the eccentricity of Mars, which all manuscripts set at 6P;30 (6;0 Ptol.), but for the attempted correction in B. This value was in CAMPANUS (B&T 438 n.95) and in John of Sicily (50ra), and was later on repeated by Jo. de Lineriis and 'Chaucer' (B&T, ibid., referring to Price 1955,69.126-7). With the present information, the dependence relations are obscure, but as yet Campanus has the priority.

For AZARCHEL's value of the sun's eccentricity, cf. the value of 1 to 30 in the Azafea (Rico III,141, cf. Toomer 1969,321+n.61); John of Sicily assigns to him either Albattani's value of 2;4,45 (thus also Alm.Parv.14v) or 1;58,30. Messehallah uses the value 1/30 in the Astrolabe (e.g. Paris Ste.Genevieve 1043,68vb). - On this point Campanus had Ptolemy's value of 1/24 (B&T p.150).

P2. Corrections for the Toulouse Tables (2,20-1).

Values compared to WILLIAM of St Cloud, canons to Almanach (Par.lat.7281, 141r+; Par.nal 1242,41v+), concerning the Toulouse Tables; and to Profatius, canons to Almanach (version of Vat.lat.3125,2v), for the Toledan Tables, "quae moderni pro isto tempore correxerunt". In each case the following values are to be added to the entries in the table of *anni collecti*:

	Here	William	?Profatius
Saturn, motus	+1°;15 (;25 V)	+1°;15	+1°;24 (!)
Moon, –	+0°;22 (;12 B)	+0°;22	+0°;27
Jupiter, –	-1°	-1°	-1°;40
Mars, –	-3°	-3°	-1°;58
Venus, –	--	0	0
Mercury, –	--	0	0
Moon, argument	--	--	+0°;20
Node, mean motus	--	--	-0°;8

As noted by Zinner 1936,326-7, our author's values are obviously those of WILLIAM, published in 1292 from his own observations. On the other hand there is no obvious correlation with Profatius.

P3. Motus of eighth sphere, and longitude of sun's apogee.

Values: Motus, 10°;10, 1293 complete years from incarnation (3,16; no variants except in FG, which also confirm that reading, cf. below). Apogee of sun, in Gem 28, 9th sphere (4,14; 3,16 with reference to the Quadrant treatise) against AZARCHEL's value of Gem 17;50(,10) (2,12;4,14). Azarchel seems to be credited with this value both for the 8th and 9th sphere; in fact he used a larger value for the 9th sphere (cf.Toomer 1969,320ff), but the mis-reporting is fairly general.

To be conferred with WILLIAM of St Cloud's precession value of 10°;13, determined *Lætare* Sunday, March 12, 1290 (canons to Almanach; and the tables of the Almanach, Vat.lat.4572, give e.g. 10°;15 for 1292 and 10°;16 for 1293, the year starting in March).

The manuscripts of the Quadrant treatise (T&K 1267) seem to read 10°;14 for 1293, and correspondingly Gem 28;4 for the sun's apogee (cf. O. Pedersen 1976,44). Did the author take William's edition year 1292 for the year of observation, as did e.g. Duhem, and I myself (1978,5, following Duhem and kindly corrected by Prof.Poulle)? In that case he was not in close contact with William. - The precession value in our treatise, if it must be explained, could be taken as an approximation convenient for constructing the table P10, q.v.

The precession rate of 55"/year (3,16) is that of ALBATTANI (1°/66 years, Cap.33.45.51-2;Nal II,107). Our treatise falsely assigns it to PTOLEMY, whose value of 1°/100 years was, however, commonly known, and cited e.g. by Albattani cap.52. - The manuscripts F and G use the former rate to update the precession value, giving 10°;15,30 for 1299 (for F, cf. O.Pedersen 1976,40).

P4. Orbs of planets (*orbes luminis*,5.10).

When compared to the values given by Nallino I 305-6, identical to those of HALY ABENRUDIAN on Ptol.Tetrab.I,24; numbers perhaps from Porphyry, and also e.g. in Haly Abenragel and Zael), against: Ptol.Tetrab.III,10; Albattani c.54; Haly (*l.c.*, citing Ptolemy). The latter also differ among themselves.

P5. Constants in the theory of latitudes.

Values: Top of deferent: Saturn,50° before apogee; Jupiter,20° after apogee; Mars, in apogee (9,4-5,used in 8,4). - Maximal southern deviation of epicycle: Venus,60° before apogee (as ALBATTANI, tr.Plato, Nbg. and Vat.lat.3098, against the 90° of Ptolemy and the Arabic Albattani, Nal I, 115); Mercury, 270° before apogee (9,12, used in 8,9). - Maximal northern slant of epicycle: Venus,in apogee; Mercury, 180° before apogee (9,14, used in 8,11).

The present values are those of Ptolemy XIII,6 and Albattani cap.47, except in the one case which appears to depend on the Latin ALBATTANI against Ptolemy. This is noted in 8,6 "discordia in numeris addendis vero centro Veneris et Mercurii", valid for Venus. The author may have known parts of Ptolemy after all, or the comparison may be a commonplace, as is certainly the comparison with the Toledan Tables, ibid., cf. P12 and S8.

The increment of ±1/10 (8,8) and the factor 1/6 (8,13) are as in Ptolemy or Albattani. For the factor 3/8 ("quartam partem et illius quartæ dimidium"/".. et eius dim.",8,13), compare ALBATTANI, tr.PLATO ("quartam partem et eius dimidium",Nbg 74r), against Can.Tol.("quartam partem eius et dimidiam",25vb), Ptolemy ("medietatem et quartam",Ven 149v), and Albattani (Nal I,116).

P6. Eclipse limits.

For lunar eclipses, 12° before and after the nodes (10,3); for solar eclipses, 12° after ascending and 12° before descending node (10,32). The eclipse triangle is extended to 14° of the ecliptic (10,1), presumably to accommodate the circles drawn on it. - The rule-of-thumb limit of 12° is probably from the CANONES AZARCHELIS; as an approximate limit the number is also found in Ptol.VI,7(Man.p.378) and Albattani cap.43.

P7. Tables of mean motions.

Not meant to accompany the treatise (2,11; excerpts in 2,12). A set of tables are nevertheless found appended in F,228r-232v, with table headings mentioning Toulouse. - Named *Tabulæ Tolosanæ* (2,2.4.11.19-21), *tabulæ mediorum motuum* (2,11,general statement; 5,1, sun and moon; 6,1). - Said to contain *(a)* mean motions of planets and moon's ascending node, in various units of the Christian time-reckoning (2,19,years starting in March), as used in 2,2-4; *(b)* longitudes of apogees in the 8th sphere (2,11). - Values quoted: (A) Apogees (2,12), including second-values as in F's table, against the shorter values common in the Toledan Tables (Too p.45). Values as in the tables of F (variant, Jupiter 5,14,10,0 in F, both text and table) and as in the Toledan Tables except for the rounding. The distance between the apogees of Venus and Mercury (2,16) agrees with 2,12. (B) Mean motion of sun, 0°;59,8/day (4,1), origin indeterminate; Ptol.III,9 and Alb.cap.29 say 59'. (C) Motion of moon's ascending node, 0°;3,11/day (9,2,NHX;0°;3,8 BV) as in F's tables and common elsewhere. - For the attempted corrections see P2 above.

The tables cited are no doubt the same as the Toulouse tables occurring in F (and e.g. in Princeton U.L.Garrett 99,83v+), corresponding to the Toledan Tables Too 28-36(p.44-55). F comprises only mean motion tables, which are the only ones needed (Pr.).

P8. Tables of mean centra and arguments.

Not in the manuscripts. The reader is recommended to construct such tables for himself (2,22). Especially, (a table of) the moon's mean elongation is referred to in 2,22; 3,14; 5,2-3; 5,7; with tables for various time-units (5,3). All these passages are absent from NHBV and may be later additions, cf.C5a.

Not among the Toledan Tables. A table of the moon's mean centrum (days, hours,minutes) is at f.93v in the Princeton ms. above, among the Toulouse tables; later on, the edition of the Alfonsine Tables has one *Tabula medii motus in elongatione sui* (=lunæ) *a sole* in the sexagesimal time-units. The only other references I have seen are to the Alfonsine Tables: a *tabula elongationis lunæ a sole* is mentioned in Jo. de Lineriis' Canones primi mobilis (T&K 276; 44vb) and used as in 5,2-3. A *Tabula mediæ elongationis lunæ a sole, posita in tabulis Alfonsii* is referred to in the 14-c. comment on Jo. de Lineriis (T&K 204; 4v); one further reference in T&K 1213, 49v. I suppose the whole idea could have been suggested by the Alfonsine Tables.

P9. Table of equation of time, ascribed to Azarchel.

Probably not meant to be included: not in the manuscripts. Attributed to AZARCHEL, 4,5-6.14.15. - Said to contain the values of the equation, intermingled with the tables of ascensions *in circulo directo* (4,5). To be entered with the sun's longitude (in the 9th sphere)(4,12). - Values quoted, either from this table or from P10: (A) Equation = 0 when sun is in Aqu 18, 9th sphere (4,5.7.11) and in the 7 degrees following (4,7.11). (B) Maximal equation = $7^o;57 \sim 31^m;48$ when sun is in Sco 8-9,9th sphere (4,8, no variants; cf.G3). -

Presumably identical with the Toledan table Too 17, but some of the quoted values do not fit that table, which has the maximal equation of $7^o;54$ (for Sco 8-9, as above) and zero for Aqu 18-19 (not for 8 successive degrees). Same table in Albattani, Nal II,61-4. Albattani cap.29 mentions the starting-point λ_{ms}=Aqu 18;19, with λ_v=Aqu 20, the latter value having been forgotten e.g. by John of Sicily 53rb.

P10. Table of equation of time, by author (4,15).

Not in the manuscripts, though meant to be appended. - Value quoted: for Gem 6, $0^o;20$ less than Azarchel's table, or $5^o;12$. Described as assuming the sun's apogee to be at Gem 28^o, 9th sphere, against Azarchel's alleged value of Gem 17;50 (4,14-5; cf.P3).

No copies known. Not identical with the table in Tractatus eclipsorii (p.49), nor with Cambr.Peterhouse 75.I,65r (Price 1955, Plate IX facing p.87; cf.G3), which are both based on the Toledan values.

I have tried to re-construct the table using the Toledan table for solar equations (Too 37, rounded to minute-values) and the one for right ascensions (Too 17), from Paris Ste.Genevieve 1043, with some obvious corrections, and assuming the solar apogee and the starting-point to have the exact values Gem 28 and Aqu 18. - See F4 for the terms following.

With Ptolemy's formula e = OS_m-*asc*(OS), e will have (A) a minimum of zero at Aqu 19-21; (B) a maximum of $7^o;55$ at Sco 9-12; (C) the value of $5^o;9$ for Gem 6. This does not too well fit any of the values quoted.

The additive expression e ≈ $(OS_m - asc(OS_m)) + (OS_m - OS)$ is implicit in the text of Ch.4, and permits a fairly uncomplicated and interpolation-free use of the tables, given the integer parameters above. It yields values within 10' of the ones found above. - e gets (A) a minimum of $-0^o;2$ for Aqu 19-23 and non-positive values for Aqu 16-26; (B) a maximum of $7^o;57$ at Sco 7-10; (C) the value of $5^o;12$ for Gem 6; in effect Gem 5-6 is where the maximum difference from the Toledan table is found, to an amount of 20' as stated. - There is a striking similarity between the function-values found and those quoted; the interval-limits are not so well reproduced, but then they are sensitive to small variations in the function-values. In any case the long minimum-interval (P9(A)) can be taken as explained, assuming that our author neglected small negative values.

For the sake of recognition in manuscripts which may emerge, I quote some of the values found. Angular values, e.g.: Ari 30 = Tau 0 = 30^o. I believe the values are precise to within 1'.

Gr.	Cap	Aqu	Pis	Ari	Tau	Gem	Can	Leo	Vir	Lib	Sco	Sag
1	3;48	0;38	0;8	2;6	4;32	5;17	4;0	2;48	3;40	6;4	7;52	7;6
8	2;56	0;14	0;26	2;43	4;55	5;8	3;37	2;48	4;10	6;38	7;57	6;29
18	1;47	-0;1	1;3	3;34	5;15	4;43	3;8	3;1	4;58	7;18	7;49	5;24
28	0;52	0;3	1;51	4;20	5;19	4;11	2;51	3;29	5;49	7;46	7;18	4;11
30	0;42	0;6	2;1	4;29	5;19	4;4	2;48	3;36	5;59	7;50	7;11	3;56

P11. Table of moon's latitude.

Probably not meant to be appended, cf. 8,2-3 "solent poni","et potest...". In fact a *Tabula latitudinis lunæ* with Toledan values (see below) is in V,16v. - Values quoted: (A) $1^o;12,30$ for 14^o of the argument of latitude (10,2); (B) 62' for 12^o of the same (10,10, round value in example; table has $1^o;2,16$). - Described as usually occurring in the table of *æquatio* of the moon, or alone (8,2-3).

This would be the Toledan table Too 39(6), occurring and with values as described. Also in Albattani, Nal II 78+; the table in Ptol.V,8 has different values.

P12. Table of latitudes of Mars, Jupiter, Saturn.

Meant to accompany the treatise (8,6). In fact a *Tabula <ad sciendum> trium superiorum planetarum latitudinem* is found appended in V,17r, with form and values as below, but much mis-copied and corrected. - Named *Tabula latitudinis trium superiorum* (8,4); ascribed to PTOLEMY, implicitly to ALBATTANI (8,6), and said to differ from the table of "auctor canonum tabularum", or Azarchel, cf. below. Said to contain an upper part, for arguments 0^s-3^s and 9^s-12^s, and a lower part for arguments 3^s-9^s (8,5); columns of latitude for each planet, and one column for *minuta proportionalia* (8,4-5). The table-values suppose the epicycle centre to be at the top of the deferent (9,5).

V's table fits the descriptions and should be identified with the table of ALBATTANI, Nal II,140, or perhaps the table in Gerard's translation of PTOLEMY, Ven f.149; Ptolemy's original table (XIII,5) contains extra entries in the interval 3^s-9^s. - Although V's table occurs in some collections of Toledan Tables (Too 47,p.71-2), it differs from the usual Toledan latitude tables and is probably additional (Too p.72); for this cf. also Theor.Plan.§107, and S8(to 8,6).

The maximal latitudes quoted "secundum Ptolomæum" in 8,15 generally fit the tables mentioned and the text of ALBATTANI Cap.47. The values 4°/6° for Mars disagree with the 4°;21/7°;7 of the tables, but correspond to Plato's translation of Albattani (ed.Nürnberg; Vat.lat.3098,137r has 7° for 6°), from whom the whole of 8,15 must then be taken, including the reference to Ptolemy. Ptolemy's own observed values (Man II,336-8;340), repeated in Alfargani cap.18, are: Saturn,3°; Jupiter,2°; Mars,4 1/3°/7°; Venus,6 1/3° (Alf., also 9° "extra Almag."); Mercury,4°.

P13. Table of latitudes of Venus and Mercury.

Meant to accompany the treatise (8,6). In fact a *Tabula ad sciendum latitudinem Veneris et Mercurii* is found appended in V,17r, with form and values as below, but much damaged, corrupt, and corrected. - Ascribed to the Almagest of PTOLEMY and to ALBATTANI and said to differ from the table of "auctor canonum tabularum" (8,6), cf. to P12. - Said to contain one column of *declinatio* and one of *reflexio* for either planet (8,7) and one column for *minuta proportionalia* (8,9.11).

V's table is the one of ALBATTANI, Nal II,141, or perhaps the table in Gerard's translation of PTOLEMY, Ven f.149; Ptolemy's original table (XIII,5) has the same values but with extra entries in the interval 3^s-9^s. V's table is also the same as Too 48 but differs from the usual Toledan table (Too p.72, cf.to P12).

The maximal latitudes quoted in 8,15, probably also as from PTOLEMY, correspond to those quoted in ALBATTANI cap.47 (for Venus, the Nürnberg ed. has 8°;26, lost in a homoeoteleuton in Vat.lat.3098; Nal I, 116 reports THEON for 8°;56). - See P12 for Ptolemy's values.

P14. Table of radii of sun, moon and shadow of earth.

Not mentioned as accompanying the treatise. In fact, a copy is found in V,17v, *Tabula quantitatis semidiametrorum luminarium et umbræ*, as follows:

Lineæ numeri, Gradus argu'ti		Semidiameter solis		Semidiameter lunæ		Semidiameter umbræ		Variatio umbræ
Gr	Gr	Mi	2a	Mi	2a	Mi	2a	2a
0	360	15	43	14	50	38	34	0
6	354	15	44	14	51	38	36	1
12	348	15	45	14	52	38	39	2
18	342	15	46	14	53	38	43	3
24*a*	336	15	47	14	55	38	48	4
30	330	15	48	14	57	38	54	5
36	324	15	50	15	0	39	0	6
42	318	15	52	15	4	39	10	8
48	312	15	54	15	9	39	23	10
54	306	15	56	15	15	39	39*e*	12
60	300	15	58	15	21	39	55	13
66	294	16	1	15	27	40	10	15
72	288	16	4	15	34	40	28	17*f*
78	282	16	7	15	41	40	47	19
84	278	16	10	15	48	41	3	21*g*

90	270	16 14	15 55	41 23	24
96	264	16 18	16 3	41 44	27
102	258	16 22	16 11	42 5	30
108	252*b*	16 26	16 19	42 25	33
114	246	16 30	16 28	42 49	36
120	240	16 33	16 37	43 12	38
126	234	16 36	16 47	43 38	40
132	228	16 39	16 57	44 4	42
138	222	16 41	17 6	44 27	44
144	216	16 43	17 15	44 51	46
150	210	16 45	17 22	45 9	47
156	204	16 46	17 28	45 25	48
162	198*c*	16 48	17 33	45 38	49
168	192	16 48	17 37	45 48	50
174	186	16 49	17 39	45 53	50
180	180*d*	16 49	17 40	45 56	50

Some obvious emendations: (a)24:14V (b)252:254V (c-d)198-180:298-280V (e)39:29V (f)17:35V (g)21:31V

Named *Tabula quantitatum diametrorum* (10,5.31). - Said to contain columns for radii of sun, moon and shadow (ibid.) and one for *variatio umbræ* (10,5).

V's table is Too D4, p.157-8, only cited from Bodl.Digby 68,75v (14th c., containing Toledan tables including this one, plus a collection of Alfonsine Tables, Too p.12). I have found no such table in the edition of the Alfonsine Tables from 1483. In Vat.Ottob.lat.1826,148r, a somewhat similar table is found *secundum tabulas Alfonsi*, with values differing systematically from those above. It is ascribed to *M.J.C.*, not John of Sicily, who did not know the table in 1290 (cf. V57vb+, with the usual computation rules). John of Genoa had one in 1332 (Sarton, Intr.III,641).

P15. Table of velocities of sun and moon.

Probably not to accompany the treatise, cf. "solet situari"(10,22, possibly additional). Named *Tabula buth solis et lunæ in una hora* (ibid.). - Not otherwise mentioned, although its use may be presupposed in e.g. 5,4-5 ("verus motus lunæ"); 10,8.10.12-3.15.26("buth lunæ"); the use of the instrument, as suggested in Ch.6, would be impracticable.

Could be identified with the Toledan table Too 56 = Albattani, Nal II,88.

P16(a-b). Correction tables for lunar parallax.

Probably not to accompany the treatise, cf. "solet situari"(10,22, as above). Named (a) *Tabula æquationis diversitatis aspectus (pro epicyclo)* (10,22.25), and (b) ...*pro deferente* (10,25); these passages may be additional, cf.C5b. Said generally to occur together and alongside with P15 (10,22.25). Maximum values: 12', resp. 32' (ibid.).

To be identified with the Toledan tables in Too 79 (*Tabula attatium*), columns (a) *circulus brevis* and (b) *circulus egressus*. In the Toledan tables of Paris Ste. Genevieve 1063,164r, they do occur on the same page as P15. - These tables are also in Albattani and the Handy Tables (Too,*l.c.*).

P17. Parallax table.

Not mentioned as accompanying the treatise. Named *tabulam diversitatis aspectus pro tuo climate constitutam* (10,18). - Said to consist of two half-tables (Can-Sag and Cap-Gem, for longitude of true conjunction, each with an upper and lower part, for hour-angles before and after the meridian, also called 'eastern' and 'western', plus a 'locus recessionis' for zero hour-angle.

To be identified with one of the Toledan tables Too 63-72, also in Albattani (Nal II,95-101). Part of them derive from Ptolemy's Handy Tables as revised by Theon, under whose name they were known (cf.e.g. Albattani c.39, Nbg 52r; for the reservations, Too p.97). See S10 for remarks on the canons in general, and a comparison with the *Tractatus eclipsorii* of Petrus Philomena.

S. TEXTUAL SOURCES AND PARALLELS.

Except for 2,2-5 there are generally no striking verbal parallels with the predecessors I have seen, so the following does not pretend to identify any immediate sources. Nevertheless I have cited near-parallels fairly freely, if only to illustrate some point of doctrine or the state of our text, and thus I must ask the reader's indulgence for the comparisons as to 'content', 'composition','phrasing','wording',etc. For some general conclusions see A8.

The quotations by name are: PTOLEMY: 1,4(+Almagest);1,15-6;3,16; 4,1;8,6(+Almagest);8,15. AZARCHEL: 1,15(+'compositor tabularum');4,5.14.15; 8,6(='auctor canonum tabularum'). ALBATTANI: 8,6. MESSEHALLAH: 1,15. - Reference to the author's own Quadrant treatise, 3,16. Details below.

S1. Chapter 1. As concerns the constructional directions, I have found no striking similarity either to Campanus or Messehallah. It may be noted that both take care not to let the solar deferent scale touch the zodiac (Cam. III,127) whereas 1,8 makes the circles touch, as they seem to do in Azarchel's Azafea (Rico III,141). - In 1,4 the relative distances in the table 1,16 are attributed to Ptolemy's Almagest; as is seen from P1, the source would in fact be some extract current at least in Paris. - 1,15-6 quotes the two values for the sun's eccentricity "secundum Ptolomæum", and "secundum..Azarchelem, compositorem tabularum, et secundum Messehallah", both apparently correctly, cf.P1; Azarchel's value occurs in the Azafea, not in the Toledan Tables or the Canones (see Toomer, P1).

S2. Chapter 2. The directions for using the mean motion tables 2,2-5("hora quæsita") are worded like the CANONES AZARCHELIS, 10rb-va: "Toletum" has been replaced by "Tolosa", other changes are comparatively insignificant. - Most of the rest of the chapter contains platitudes which may be reminiscences of the Theorica Planetarum or some other description. I have noted the following near-parallels: 2,7(et hoc est ideo-), John of Sicily 51va; (et ideo--uno die), Can.Az. 11vb; 2,8(definition of "centrum medium"), Th.Pl.§45; 2,10(the term "aux in secunda significatione"), probably from THEORICA PLANETARUM §§7.44. - For the Toulouse Tables cited at 2,11-12. 19.20, see P7. - The content of 2,20-1 depends on WILLIAM OF ST CLOUD, Almanach 42r-v, cf.P2, including the provision for the possibility of finding better corrections. - For the mean centrum tables referred to in 2,22 (non autem-), cf.P8.

S3. Chapter 3. The directions for use of the instrument, especially 3,2. 4.8, can be compared to Campanus, e.g. VI 846ff.: the phrasing is quite similar but may merely follow the subject; the equivalent method for the sun, III 192-202, is described rather differently, and so is the procedure for Mercury (V,597-628, cf.3,11). - The directions are interspersed with commonplace definitions of elements in the planetary models: cf.e.g. 3,5 (mean apogee of moon), wording close to THEOR.PL.§19; some other passages could be more or less close paraphrases, but as above, it is probably not worth the trouble to look for a single source. One might hope that 3,7 (the statue) was original. - For 3,16(precession) see P3: the value must be from WILLIAM of St Cloud, and Ptolemy is mis-quoted for the precession rate.

S4. Chapter 4. The section 4,1-4.6-9, on the equation of time, insists on the two-component description and calculation, as against Ptol.III,9; Alb. c.29; and Jabir bk.3,p.44-5, all of whom provide a different method for the actual calculation (cf.F4, to 4,3-4). The Almagestum Parvum (III,18-25) also describes both methods, adding on the latter "et nota quod hoc quoque modo facilius differentias ex duabus pariter causis provenientes ad dies singulos poteris colligere", thus apparently equating the two methods. There are also some near-coincidences in wording (the definitions 4,1.3) against the former authors; on the other hand, Albattani is the one to mention the starting-point of the table, cf.P9. - At 4,1 PTOLEMY is quoted for the term *iomin*, common in Gerard of Cremona's translation with the meaning "dies et nox eius"(*l.c.*); it seems to be Arabic (North II 168-71, and III 284) and fairly common elsewhere. - 4,5.14: the table is probably ascribed to Azarchel merely because it was among the Toledan Tables. At 4,14 AZARCHEL is credited with the assumption that the solar apogee was in Gem 17;50 (8th and 9th spheres) in his own time; see P3 for the reservations to this.

S5. Chapter 5. This chapter apparently intends to treat syzygies of the sun and moon as special examples of planetary aspects (cf.5,8ff) instead of heading straight for the calculation of eclipses, as e.g. in Ptol.VI,4 and Alb.c.42. This may be why 5,1 calculates the mean syzygies by means of the mean motion tables only, ignoring the usual 4-column tables specially designed for eclipses; the pertinent values have to be calculated separately (argument of latitude, 8,2). The method of 5,1 is found in the Almagestum Parvum VI,1(38r; cf. the calculations in Ptol.VI,2), apparently to be used for constructing the special tables. - 5,2-3: cf. P8 for the parallel use of a similar table by Jo.de Lineriis. - Except for the use of the instrument, the phrasing and methods of 5,4(true conjunctions, sun and moon) and 5,5(same, general) could be paralleled from almost anywhere from Ptolemy on (Ptol.VI,4; Alb.c.42; Can.Az.13rb-va, the last only using the method of 5,4). - 5,10 belongs to astrology, and I know of no parallels except a mention in Albattani c.54. For the content of 5,10 see P4, the numbers being common in the current astrological tracts.

S6. Chapter 6 corresponds to the CANONES AZARCHELIS 17va for the term *buth* (common, however, elsewhere) and the procedure of measurement on two successive days. Special tables existed for the velocities of the sun and moon (see P15); and at least for the outer planets, an instrument of manageable size would hardly yield the daily movements with any accuracy, so the self-sufficiency hereby claimed for the instrument is fictitious.

S7. Chapter 7 does not closely correspond to any earlier material I have seen: especially, the question of whether planets are "slow" or "fast" seems to belong mainly to astrology. The procedure parallels Campanus (moon, IV 646-50; Mercury and the other planets, V 629-50) but lacks Campanus' difference method for determining whether a planet is stationary. It avoids the mis-definition in the text of Albattani c.31, where the tangents' points of contact are taken for the stationary points, an assumption which is also e.g. in John of Sicily 51ra. - 7,5, on the moon, is phrased somewhat similarly to Theor.Plan.§82, but the correspondence goes no further. - The definitions in 7,6(true apogee,etc.), which are for use in Ch.8-9, are trite.

S8. Chapter 8. 8,1, declination of sun: wording most like Can.Az.12ra, but the content is commonplace, corresponding e.g. also to Alb.c.4 and Can.Tol.

22va-b. The same is true for 8,2-3: the wording is mainly as in the CANONES AZARCHELIS 12ra (the definition of *verus motus Geuzaar* may have been fetched from 11r: 12ra only has "cum quo", corresponding to NHB's "cum quo argumento", which seems to point out NHB's version as the earlier one). Jo.de Lineriis 44ra has a somewhat abbreviated version, probably from the Canones Azarchelis. The content corresponds to Albattani c.38 and Can.Tol. 26ra-b.

The sections on the planets' latitudes 8,4-5.7-16 is a translation or paraphrase of ALBATTANI c.47. The composition, and sometimes the phrasing, closely corresponds to Plato's translation (and in a slightly lesser degree to the Can.Tol., which at this point at least must be an independent version of Albattani, ignoring the Toledan latitude tables treated in the Can.Az.). Most of the content is of course ultimately from Ptol.XIII,6, but the structure as well as several details (cf.P5.12.13; the phrasing of 8,10) indicate dependence on the Latin Albattani rather than on Ptolemy. Note that the omission of V in 8,12 is not shared by Ptol. nor Alb., so it is probably individual.

These sections are also in JO. DE LINERIIS 44rb-vb, in mainly the same wording and with numbers as in P5.12.13. John, against our text and Albattani(including Can.Tol.), splits up the sections for Venus and Mercury, repeating the common passages. John and our author, against Albattani, have the definition in 8,8 "dicitur--(6 in) 9". John and Albattani, against our author, have a sentence in 8,8 which in John runs "illam 10am partem super reflexionem adde, et quod post additionem vel deminutionem provenerit, loco primæ reflexionis serva, primâ deleta". Thus apparently John and our author both had access to some version of Albattani which used a terminology more modern than did Plato's version but had the same numerical details.

The source section 8,6 also serves to point out "ipse Albategni" as the source; the mention of Ptolemy would be from the close of Alb.c.31 as cited. See, however, P5 for the remark on a specific difference originating from someone knowing PTOLEMY and the Latin Albattani. For a comparison with the tables of "compositor tabularum", cf. THEOR.PLAN.§105.107, plus the explication by John of Sicily 52^{a}ra, contrasting these (Toledan) tables with those of Ptolemy/Albattani and attributing the "veri numeri" to the latter. - The mention of Ptolemy in 8,15 is also in Albattani.

S9. Chapter 9. 9,2 is worded much like THEOR.PLAN.§29-30.99, which is probably the source except for the quantity 0°;3,11, cf.P7. - 9,1 could be an expansion of Alfargani c.18, uncertain which translation; but cf. Campanus IV 8-9 for the phrase "secat--et secatur ab eodem". - The rest of Ch.9 is comparable in content to Ptol.XIII,1, but there is no significant verbal similarity. There is a closer resemblance in phrasing to Alfargani c.18, as above, and some near-verbal coincidences such as 9,9(et dum-)-10(-declinat ad meridiem); but terminology is modernized, Albattani's numbers are used, and the content is differently organized. - The statement "secundum regulas Albategni" in the manuscripts RX is not, at least, valid as concerns the wording.

S10. Chapter 10 seems to be an after-thought, cf. S5. The graphic method employed, which supplants the use of the usual eclipse tables for magnitude, duration etc., could be the author's own development of a device which is common enough elsewhere. Ptolemy (e.g.V,19;VI,7), Albattani (c. 43-4) and the Can.Az. all use rectilinear figures, for pure illustration or because some part of the computations could be adequately carried out by replacing great circles by straight lines; but such figures are not explicitly used to take measurements from. In other words, Ch.10 is not comparable for its structure to any other texts I have seen, so the following remarks mostly concern isolated instances of computation.

10,4: for the eclipse limits see P6 and below; the phrasing most resembles the Canones Azarchelis, but the content is trite.

10,7-10 (see F10 with figure). The problem was posed by Ptolemy (VI,7: Man.377-9; cf. Alm.P., bk.V, f.37r-v). He demonstrates that the difference is less than 2' of arc and thus negligible, by way of an example using the near-maximal argument of latitude, as is done in 10,10. But one of the triangles in Ptolemy is isosceles, whereas our text assumes both to be right-angled, so the value arrived at is about double Ptolemy's. That value is older than our text: in fact, William of St Cloud (41vb) allows for a time-difference of maximally $10\text{-}12^{m}$, corresponding to the present difference of arc. - Our author's argument is not in Albattani, but can be found in JABIR p.76-7, who also assumes both angles CHF and CFG to be right, but takes CG to be known (i.e. the argument of latitude), and arrives at an expression equivalent to $\sin FH = \sin \beta \cos i / \cos \beta$, where $\sin \beta = \sin i \sin CG$.

The passage of our text is also in JO. DE LINERIIS 49va-b; there are some slight changes connected with John's preference for dividing by the velocity difference (cf. the method in 5,5) and with an elaboration on solar eclipses; elsewhere John's wording is very similar indeed, if somewhat shorter, lacking e.g. the passage "supra--eclipsis" at the end of 10,8. In 10,9 "prius habita" is read, against the omission in NHB. Generally, I have found no variants indicative of any specific affiliation with our text or any part of the manuscripts.

10,12: The calculation of start and finish of an eclipse is trite and frequent in the sources (e.g. Ptol.VI,7, used for computing tabular values of *minuta casus*; Alb.c.44,Nal 107). I have found no verbal resemblances which I should venture to call significant.

10,17. The problem is to determine the hour-angle of the syzygy, but I cannot see the sense here. One possibility consists in a reduction for different meridians (Handy Tables, Hei 181; Almagest VI,10; Alb.c.44, Nal 110); this may be the simpler assumption. The other meaningful parallel seems to be that of Albattani c.39 (Nal 82-3; Nbg 52r) where the hour-angle of the moon is determined, given the longitudes of the moon and of the intersection of the meridian and ecliptic, at the same hour (whatever the time-reckoning): this is done by subtracting the respective rectascensions and dividing by 15 degrees/hour. A degree of rectascension could be called a *tempus* (cf. Ptol.I(last chap.),Ven.f.11; Alb.,*l.c.*), whence conceivably the terminology here; but this conflicts with the use of *tempus* elsewhere and with the application of the time-correction in 4,12 and 10,8.

10,16-30. The parallax in longitude and latitude is as usual calculated by means of Ptolemy's Handy Tables as revised by Theon, under whose name they were known (cf.e.g. Alb.c.39,Nbg 52r), and contained in Albattani and the Toledan Tables (for the reservations see Toomer 1968,97). The canons to the parallax tables no doubt ultimately derive from Ptolemy's own (Hei 174-6;181-3). - For content and phrasing the present text is very similar to the CANONES AZARCHELIS 15rb-16ra, although the organization is different. Albattani, c.39 and 44, has a comparable procedure, but his calculations include some corrections not in the texts mentioned. A detailed comparison should be left for a general study of these canons; at this juncture it must suffice to furnish some material for certain points, supplementary to my earlier discussion of Petrus Philomena's Eclipsorium (1978,p.82-3).

10,22. For correcting the tabular value according to the moon's place on the epicycle, use was generally made of the table P16a (*circulus brevis*), from the Handy Tables, also in Albattani and the Toledan Tables (Rome I(1931)LI-LVI; Nallino II,89; Too 79). None of the canons identified it very explicitly, and confusion ensued through the ages (for Heiberg on Ptolemy, see Rome LI), the table being mostly mixed up with the proportional tables of Ptol.VI,8 (=Alb.,Nal.II,89) or of the Toledan Tables (Too 80, from Alkhwarizmi), which are analogous, both with a maximum of 60' (=unity) but stepping 6^{o}, resp. 2^{o}, in the argument values. - The confusion was realized in the 13th century, as witness John of Sicily 59va (later part irrelevant but interesting):

> Scire autem debes quod diversi auctores diversimode in hoc passu asserunt operandum. Quidam enim voluerunt quod, ad æquandam diversitatem aspectus pro loco lunæ in epicyclo, cum argumento in gra. resoluto intrandum sit in tabulam proportionis; sed simpliciter non est verum, quoniam illa tabula solummodo facta est ad puncta eclipsis et minuta casus secundum differentiam longitudinum adæquanda. Alii vero dicunt quod intrandum est in tabulam circuli brevis, in quam superius intrabamus, quod procul dubio verum est; sed tamen isti dissimiliter operantur. Alii namque, per minuta ibi reperta multiplicantes diversitatem aspectus æquatam duobus primis modis, per 12 dividunt quod fuit ex multiplicatione productum; et quicquid ex tali additione consurgit addunt æquationi priori. Sed isti, quamvis recte in aliis operentur, in divisione tamen faciunt minus bene, quia dividendo per 12 continget eis, quando luna fuerit in longitudine propiori, diversitatem ipsam duplicare; constat autem ipsorum corporum considerantibus quantitatem non fieri tantam differentiam per diametrum epicycli, ut quantum ad omnes condiciones duplo maior ibi sit aspectus diversitas quam in auge. --(One more argument)-- Ex quo patet hunc modum operandi non esse verum, et propter hoc est aliter operandum, scilicet quod fiat divisio per 60: in quanta enim parte minuta illius tabulæ se habent ad 60, in tanta parte diversitas in longitudine propiori excedit eam quæ est ad longitudinem longiorem.

Others, such as William of England (16v, text below) and Petrus Philomena 2,39, seem to use the wrong table without recognizing a problem. In our text the ambiguity was realized only at second thought, if the passage in 10,22 identifying the proper table is additional. (In this case it would be contemporaneous with the parallel specification in 10,25.)

10,19.22. In using a parallax table as above one has to know whether it supposes the moon to be at the apogee or at mean distance. The Handy Table, and Albattani, supposed the former (Hei 175; Alb.c.39,Nbg 52v), the Canones Azarchelis the latter (15va; text, Pedersen 1978,86-7); both, however, seem to enter the correction table with the argument of the moon, reckoned from the apogee of the epicycle. Both Ptolemy/Theon and Azarchel are cited by William of England 16v-17r:

> Quoniam quilibet gradus cuiuslibet signi propriam habet diversitatem aspectus, tam secundum sui declinationem quam secundum sui ascensionem ad circulum meridianum, ad confusionem evitandam compositæ sunt tabulæ de diversitate aspectus tam in longitudine quam in latitudine, ad initiales gradus signorum et ad initia horarum æqualium, tam ante meridiem quam post, qui meridies "recessus" dicitur. Et sumitur semper cum horis elongationis a meridie, id est, cum arcu verso in horas æqua-

les interiacente gradum solis et gradum medii cæli. Fiunt etiam eædem tabulæ secundum quod luna est in longitudine media sui epicycli, secundum AZARCHELEM; secundum THEON et PTOLOMÆUM, secundum quod luna est in longitudine longiori. Et verificatur diversitas aspectus, ut docet canon, tam secundum signa quam secundum partes horarum. Similiter verificatur diversitas contracta ex longitudine secundum minuta proportionalia, quæ "minuta superfluitatis" (cf. Too 79 n.1) dicuntur, quia secundum AZARCHELEM semidiameter epicycli pro 60 minutis reputatus est; et quando luna est in superiori medietate epicycli, minuitur de diversitate aspectus secundum minutorum proportionem ad 60, in alia additur; et sumitur cum argumento lunæ, quia ipsum docet, in directo cuius partis (partes *ms*) diametri epicycli sit luna. Sed in tabulis climatum, quas fecit THEON, semper additur pars proportionalis, quia factæ sunt tabulæ ad longitudinem longiorem.

John of Sicily 55va implies that there is only one sort of parallax table in question, and rejects the precept of Azarchel. - Our text, as is seen, takes the position of Ptolemy/Albattani without comment; conversely, the Eclipsorium of Petrus Philomena (2,39) just as definitely follows Azarchel.

10,24.26-7.30. The question of the sign of the parallax, and of the time difference due to the parallax, was variously treated. The doctrine that the sign changes at a longitude of 90° from the ascendent (the *nonagesimus* of later authors) is from the Almagest and commonly found. The other opinion, that the sign changed according to whether the syzygy was East or West of the meridian, apparently originated in the canon to the Handy Tables (Hei 182). These criteria were mixed up in Arabic sources (Kennedy 1956, 47-9), and the Latin versions seem to reflect the ambiguity as concerns the term *medium cælum* etc. - Albattani, c.39 near beginning, remarks that the parallax in longitude is zero at the *nonagesimus*, not in the meridian except when the solstice points are in the meridian; and Jabir (bk.5,p.82) criticizes Ptolemy by name for the doctrine of the meridian. The Canones Azarchelis only know the *nonagesimus*-concept, concerning both the parallax and the time-difference (15va).

The doctrines were confused by Latin authors as well, such as William of England (17r: "--quandoque in parte orientali, quod est quando inter locum lunæ et gradum ascendentem sunt minus 90 gra.-- si 90 tantum, tunc circulus altitudinis et meridianus sunt in una superficie, nec fit diversitas aspectus in longitudine"); John of Sicily (texts in Pedersen 1978, App.3); Can.Monsp. (290rb: "pauciores 90, id est ante meridiem"); and the Eclipsorium only mentions the meridian. - Our treatise seems to have undergone a revision in this respect. Indeed, NHB's version shows no trace of the *nonagesimus*-criterion and once (10,30) explicitly uses the alternative; and in 10,27, where NHB twice uses the meridian-doctrine by implication, the other version only corrects it once.

Thus no doubt the meridian-criterion was fairly wide-spread at the time, and both our treatise and the Eclipsorium originally partook of it.

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Index of text-references in Sections A,C,E,G,P,S.

Selective. Explanations to single passages should generally be sought at the proper places of Sections F and S.

INDEX OF SELECTED TERMS.

Only definitions and important uses are referred to. For personal names see Sec.S.