UNIVERSITÉ DE COPENHAGUE

CAHIERS DE L'INSTITUT DU MOYEN ÂGE GREC ET LATIN
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PETRUS DE DACIA:
TRACTATUS INSTRUMENTI ECLIPSIUM

Fritz S. Pedersen

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Stougaard Jensen/København
Un 55-3

Contents:

Notation, etc.

References to paragraphs of the text have the form (2,3), meaning Chapter 2, paragraph 3.

The scales of F's and N's instruments are referred to by means of the numbers on pp. 6 and 71.

The tables of F and N have reference numbers as in Appendix 1.

In Appendix 2 and 3, and once or twice in the text of the treatise, the following critical signs are used:

[ ] : 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

1^s = 1 sign = 30^o = 30 degrees = 1800' = 1800 minutes of arc, etc.

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

Sexagesimals are indicated by semicolons and commas, decimals by periods. Thus 100;30,18 = 100.505.

Additions and comparisons are modulo the appropriate number, mostly entire revolutions of $360^o = 12^s$. Thus the interval $359^o \leq x \leq 1^o$ has a length of 2^o, and $4^s + 9^s = 1^s$.

In Appendix 1, the calculations suppose numbers containing half-units to be rounded downwards, contrary to our custom. Thus the value 1;30 would be rounded to 1 if rounding were needed.

Works cited:

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The 'tractatus eclipsorii' or 'tractatus instrumenti eclipsium' here edited is the only astronomical text of some extent which may as yet confidently be attributed to Petrus (Philomena) de Dacia. Canon in Roskilde (cf. text, (2,24)) by 1303, he is known to have been at Bologna and Paris in the 1290's. Petrus is the author of a Kalendarium, a commentary to Sacrobosco's Algorismus and some minor works (cf., most recently, O.Pedersen 1976 with refs. to the earlier literature). The treatise has the merit of containing original designs for an instrument to be of aid in computing solar and lunar eclipses by means of a set of tables derived from the Toledan ones or some adaptation of them (cf.Appendix 1), the instrument being meant to facilitate some of the more laborious calculations involved. It is one of the earliest of its kind, soon to be followed by several more developed ones (cf. North 1976, II p.268ff.).

When not treating of the instrument, the text is probably entirely derivative in content, as indeed sometimes in wording; accordingly, a main purpose of the remarks contained in this edition is to bring out such features as may be suitable for locating the text and numerical material within some doctrinal context. Some suggestive parallels are given in Appendix 3, but the general question of sources, none of which is named in the treatise, must be left until more contemporary material is available, notably the Canones Azarchelis and their commentaries and derivatives. - An interesting special question, discussed by several scholars, concerns the identity of Petrus (Philomena) de Dacia and Petrus (Danus?) de S.Audomaro, author of the Tractatus de semissis and of the revision of Profatius' Treatise on the New Quadrant (cf. O.Pedersen 1976, 9-11,48-50). On this point, some indications may be gleaned from Appendix 2 §27, further judgment being reserved for a later discussion of the sources of the treatises in question. The reader who knows of textual or numerical parallels to the present treatise, respectively to Appendix 1, or containing characteristics as in Appendix 2 §27, or any others, is hereby invited to communicate them to me at the Institute of Mediaeval Studies, University of Copenhagen.

The treatise is at present known from two manuscripts, namely:

Firenze Bib.Naz.ii.3.24,208rb-217r, 14th cent. (F), written in the same hand throughout and showing no corrections which cannot be reasonably attributed to the scribe or some immediate collaborator. The

tables appended to the treatise are rather faulty (cf. the notes in App. 1). Thus F may not have been in use. - The manuscript was described, and the treatise mentioned, by Thorndike 1959 p.37-38 with notes 32-37. F contains three drawings of parts of the instrument, shown on p.100-102.

Napoli Bib.Naz.vii.A.26,243ra- 258r, 14th cent. (N), written in the same hand throughout but showing two sets of additions, namely (Na) one set of marginal corrections, probably by the same hand as that of the main text (cf.App.2 §17), and (Nb) several glosses and corrections, and transcriptions of all chapter headings and several table headings, possibly by the same hand as that of the main text, but writing with a thinner pen (cf. App.2 §§17 and 19). Some markings in the tables of mean conjunctions and oppositions seem to indicate that N was used for calculating eclipses between 1289 and 1312; and Table 7 starts in 1300. The manuscript and the treatise is mentioned in Kristeller 1965 p.402a, referring to Chiappini 1919 p.149 no.152; here the treatise had apparently been hiding under the title 'Tractatus ecclesiarum per magistrum Petrum de Dacia'.

I have collated both manuscripts form microfilms procured and kindly lent to me by Prof. Olaf Pedersen, Aarhus.

As will be seen from the passages with full apparatus, mentioned below, and from Appendix 2, the texts of F and N often differ widely in content and in details. The decision to edit from one manuscript thus imposes itself. F was preferred in this case because of the editor's impression that on most points F provides a more lucid explanation of the instrument and of the procedures involved than does N. This is not meant to prejudice the question of which version, if either, has the priority; some indications of this may be found in Appendix 2 §§ 23-26.

This edition, then, is based on the text of F and aims to include all readings of F except trivial errors corrected in the course of writing. In the text italics are used to indicate an actual or possible departure from the text of F. The apparatus exhibits all variant readings for the paragraphs (1,1),(2,23-24),(2,36-43) and (3,19-24), and any parallels in N of the non-trivial numbers in F. Otherwise N is only cited as a source of conjecture or confirmation and at points where F and N differ considerably in content. In the latter case, references may be given to Appendix 2, which contains a summary of the more notable deviations between F and N. The sign (N) denotes passages of N which differ markedly

in wording from the corresponding ones of F but are still considered comparable in the relevant respects.

In the text, the editor is responsible for orthography, including the choice of denoting numbers by figures or letters, and for punctuation and division into paragraphs. The paragraph headings of F have been kept in the text, sparse and inconsistent as they are. The word 'novella', 'vovella', or 'volvella', the latter form occurring only in F, has been spelt 'volvella' throughout. F's choice among some near-synonyms, such as superaddere/semper addere; uterque/uterlibet/alteruter, etc., has been retained.

The non-trivial tables of F and N are given in Appendix 1 with variant readings and, where appropriate, brief indications of their affinities to the Toledan Tables. For details, see the introductory remarks to App.1.

As aids to reading, some drawings of the instrument described by F, and a detailed paraphrase of Chapter 2 of F, are included. The paraphrase is intended to function as a translation, thus also including any errors of doctrine inherent in the text of F and/or N.

The only means of internally dating the treatise more accurately than might be inferred from the above, seems to be the values given for the motion of the eighth sphere (text,(2,24)), namely, $10^{\circ};22$ in F and 10° 1/3 in N. These values do not derive from the theory of Thebit, which would give c.1446 and c.1440, respectively, as the nearest dates. A reasonable guess at the source of the values would be Guillaume de St Cloud's estimate of $10^{\circ};13$ for the year 1292, which recurs, at least approximately, in the two treatises by Peter of St Omer mentioned. Together with the precession rate of 55 seconds per year accepted by the Tractatus de semissis, this would date the versions of F and N to 1300 or a little later, and most other similar assumptions would date them as much as 15 years later still. But all the premisses, including the origin and intended precision of N's reading, are uncertain.

This work was conditioned by St.Kannikestræde, Copenhagen, and the Danish Academy in Rome. The staff of the Institute of Mediaeval Studies, directed by Prof. Jan Pinborg, have all helped me generously and patiently. The Institute of Classical Studies and the Collegium Mediceum have supported me much in several ways. My obligation to Prof. Olaf Pedersen, Aarhus, is implicit as well as explicit in these pages.

F'S INSTRUMENT: LIST OF SCALES; DIAGRAMS

Scales of F's instrument.

References are to the descriptions of the scales in Chap.1 of the treatise.

Front (facies)

Main disc (limbus) with a fixed radius (nodus, 'node'). 2 zones (1,7).

(1) Magnitude of lunar eclipse (puncta et minuta eclipsis lunaris: 1,11).
- Leftwards from the node; 20 equal divisions, denoting digits, numbered 20-1, covering the space between 0°;25 and 10°;49 on Scale 3. The space between the node and 0°;25 on Scale 3 is in part subdivided into 0;46 digits.
- For the values, cf. App.1, to Table 13.

(2) Half-duration of lunar eclipse (dimidium durationis eclipsis lunaris: 1,12).
- Rightwards from the node; divided according to App.1 Table 15, the points of division (first column of table) being read off Scale 3 numerically, starting at the node.

(3) Argument of latitude (argumentum latitudinis: 1,8-10).
- 24 equal divisions, denoting degrees, covering the circumference, starting at the node; numbered 1-12 from the node leftwards, (30)-13 from the node rightwards.

Cursor, with a middle line (diameter: 1,15). 5 zones (1,14).

(4) Reference scale (arcus aequationum, arcus zodiaci: 1,16).
- Two halves, starting from the middle line leftwards resp. rightwards, each half covering 5°;1 on Scale 3 and divided accordingly.

(5) Equation of the sun (deferens solis, zodiacus: 1,17-18).
- Occupying two zones. Divided cyclically according to App.1 Table 3, the points of division (first column of table) being read off Scale 4.

(6) Equation of the moon (epicyclus lunae: 1,19-20).
- Occupying two zones. Two halves, each divided cyclically according to App.1 Table 4, starting rightwards resp. leftwards of the middle line in the upper zone, the points of division (first column of table) being read off Scale 4.

Volvella solis, with two extended radii (fiduciae) suitably apart and serving as pointers to the above-mentioned scales (1,4). Disc with 2 zones (1,21&23).

(7) Elongation (longitudo inter solem et lunam: 1,21-22).
- Two halves, starting at each fiducia leftwards resp. rightwards, either half covering 7° on Scale 3 and divided accordingly; divisions numbered 1-7 from the fiducia outwards.

(8) Twelfth of elongation (duodecima longitudinis: 1,23-24).
- Like Scale 7, divisions each denoting 0°;5 and numbered and subdivided accordingly.

Back (dorsum).

Outer part of main disc (limbus dorsi), with a fixed radius (nodus) opposite its counterpart on the front (1,25). 2 zones.

(9) Magnitude of solar eclipse (puncta et minuta eclipsis solaris: 1,26).
- Leftwards from the node; 10 equal divisions, denoting digits, numbered 10-1, covering the space between $0^{o};48$ and $6^{o};37$ on Scale 11. The space between the node and $0^{o};48$ on Scale 11 is in part subdivided into 0;45 digits.
- For the values, cf. App.1, to Table 9.

(10) Half-duration of solar eclipse (dimidium durationis eclipsis solaris: 1,27).
- Rightwards from the node: divided according to App.1 Table 10, the points of division (first column of table) being read off Scale 11 numerically, starting at the node.

(11) Argument of latitude (argumentum latitudinis: 1,25).
- Like Scale 3.

Part of main disc between Scales 9-11 and the disc of volvella maior. 3 zones (1,31).

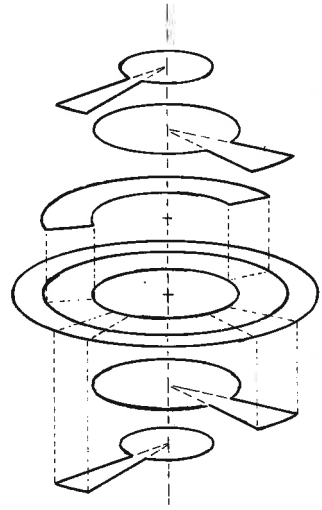
(12) Elongation (longitudo inter solem et lunam: 1,32-33).
- 7 equal divisions, denoting degrees, covering the circumference, starting at the node, numbered 1-7 from the node rightwards.

(13) Time of elongation (tempus longitudinis: 1,33).
- 15;4 equal divisions, denoting hours, covering the circumference, starting rightwards at the node, the integral divisions numbered 1-15 from the node rightwards.

(14) Difference in time of elongation (differentia temporis ... longitudinis..: 1,34).
- 2;29 equal divisions, denoting hours, covering the circumference, starting rightwards at the node, the integral divisions numbered 1-2 from the node rightwards.

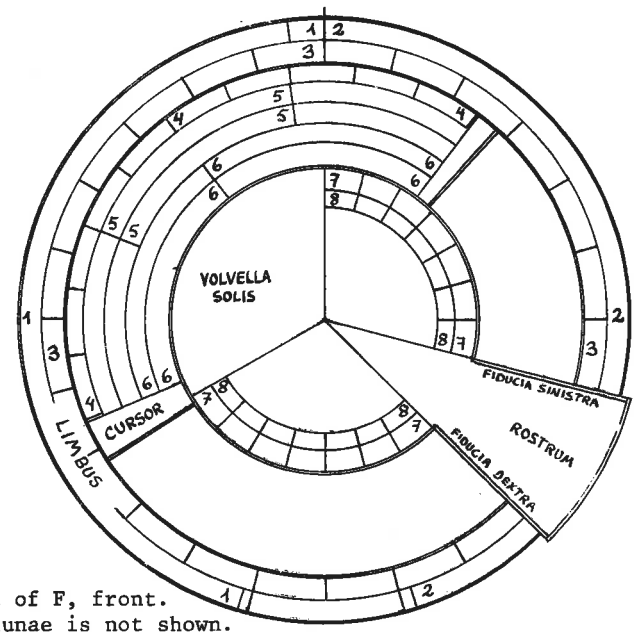
Volvella maior (*or* volvella solis), with two extended radii (fiduciae), 1 degree apart measured on Scale 11 (1,25). Disc with 1 zone (1,29).

(15) Parallax in latitude (diversitas aspectus in latitudine: 1,30).
- Two halves, starting at either fiducia leftwards resp.rightwards, either half covering $11^{o};30$ on Scale 11 and divided equally into 12 divisions, each denoting 5 minutes of arc and sub-divided accordingly.

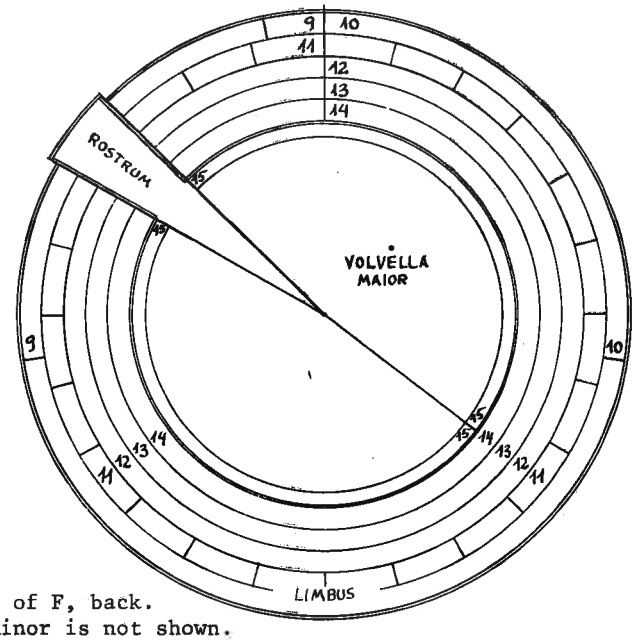


Parts of F's instrument.

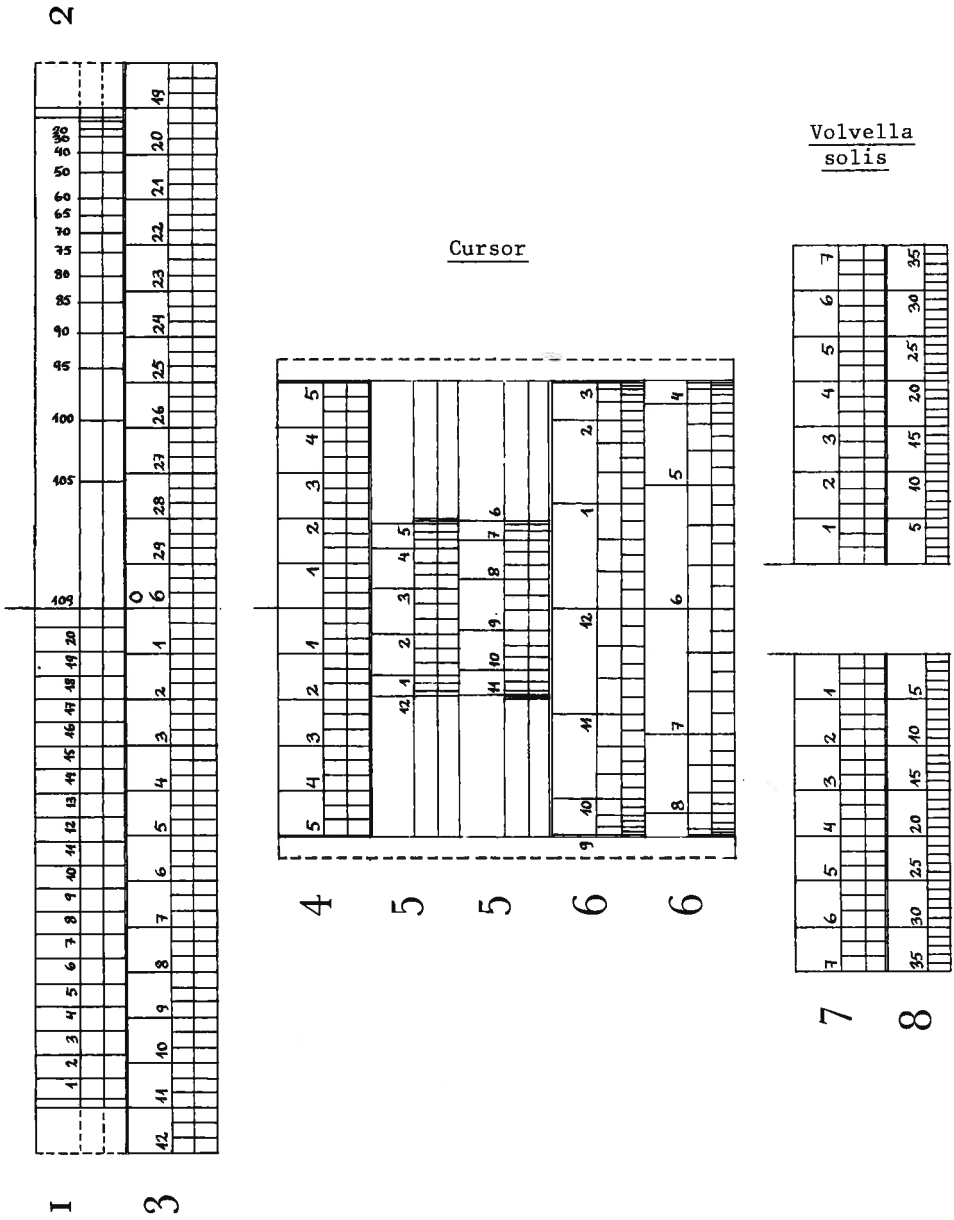
Cursor to fit into groove in main disc; remaining parts to be joined with bolt through middle axis.



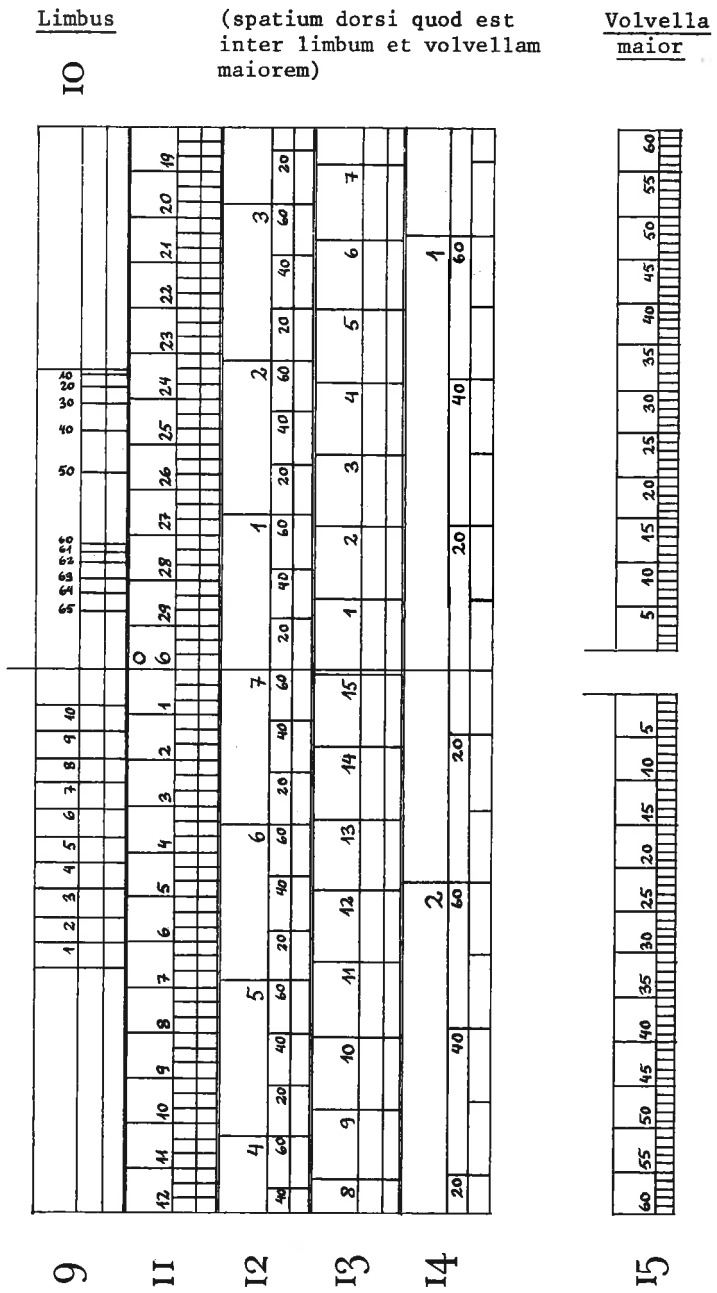
Instrument of F, front.
Volvella lunae is not shown.



Instrument of F, back.
Volvella minor is not shown.



Scales on front of F's instrument, graduation.



Scales on back of F's instrument, graduation.

SYNOPSIS OF THE TEXT

2,1-8. Finding the mean syzygies in a given year and testing for possibility of eclipses. For the time of a possible eclipse, finding mean motus of sun, argument of moon, and argument of latitude.

Variables used: A (current Christian year)
Tables used: 5,6,7,8. - "Table 0" means "Table 5" if conjunctions are sought for, "Table 6" if oppositions.

Condition used:
p(x) = for a conjunction, $0^{o} \leqq x < 12^{o}$ *or* $5^{s}18^{o} < x \leqq 6^{s}$;
= for an opposition, $11^{s}18^{o} < x < 12^{o}$ *or* $5^{s}18^{o} < x < 6^{s}12^{o}$

Variables found:
t_o = number of a year, to be used as entry to Table 0.
t_7 = number of a year, to be used as entry to Table 7.
t_8 = number of a month, to be used as entry to Table 8.
λ_α : argument of latitude at first syzygy near the beginning of a year; "radix anni"
t_n *or* $t_n(t)$: item concerning time of a mean syzygy
$\lambda_{m\odot}$ *or* $\lambda_{m\odot}(t)$: item concerning mean motus of sun or moon (=longitude of mean sun) at time of mean syzygy
a_v *or* $a_v(t)$: item concerning true argument (= mean argument, approx.) of moon at time of mean syzygy (cf.(2,8))
λ_β *or* $\lambda_\beta(t)$: item concerning mean argument of latitude at time of mean syzygy (cf.2,8))
$t_j, \lambda_j, a_j, \lambda_{\beta j}$ = values of $t_n, \lambda_{m\odot}, a_v, \lambda_\beta$ for January in Table 8.
$d(x)$ = number of days in month no. x

Procedure:
-Testing the syzygies near the beginning of a year.
(2,1) (2,1-2 is used if A is among the entries to Table 0.)
Take $\lambda_\beta(A)$ from Table 0.
(2,2) If $p(\lambda_\beta)$, an eclipse is possible near the beginning of the year A.
(Let t_o=A,) note t_o and λ_β.
(Let $\lambda_\alpha=\lambda_\beta$ and go to (2,4).)
(2,3) (This section is used if A is not among the entries to Table 0.)
Let t_o= the greatest entry to Table 0 lower than A.
Let t_7=A-t_o.
Let $\lambda_\beta=\lambda_\beta(t_o)+\lambda_\beta(t_7)$.
If $p(\lambda_\beta)$, an eclipse is possible near the beginning of the year A.
Note t_o, t_7 and λ_β.
(Let $\lambda_\alpha=\lambda_\beta$.)
(2,4) -Testing the syzygies in single months.
For every value of t_8:
Let $\lambda_\beta=\lambda_\alpha+\lambda_\beta(t_8)$.
If $p(\lambda_\beta)$, an eclipse is possible in or near the month t_8.
Note λ_β and whichever of t_o, t_7, t_8 are applicable.
(2,5) (The following three sections are used for every set of values noted above. If either of the indices t_7, t_8 is not applicable, the corresponding function values are set to zero.)
Let $\lambda_{m\odot}=\lambda_{m\odot}(t_o)+\lambda_{m\odot}(t_7)+\lambda_{m\odot}(t_8)$.
Let $a_v = a_v(t_o)+ a_v(t_7)+ a_v(t_8)$.

(2,6) Let $t_n = t_n(t_o) - t_n(t_7) + t_n(t_8)$.
If the subtraction was possible (i.e. if $t_n \geq 0$ (or, in a leap year, $t_n \geq 1$)), then $[t_n]+1$ (or, in a leap year, $[t_n]$) is the desired calendar day in the month numbered t_8 (or January if t_8 is not applicable). Go to (2,9).

(2,7) If necessary, rearrange the items above to make the subtraction possible.
(The following is used if $t_n < 0$ (or, in a leap year, $t_n < 1$).)
Let $t'_n = t_j + t_n(t_o) + t_n(t_8) - t_n(t_7)$.
Let $t_n = d(t_8-1) - t_n$ (or $31 - t_n$ if t_8 is not applicable).
$-[t_n]+1$ (or, in a leap year, $[t_n]$) is the desired calendar day in the monteh t_8-1 (or December of the preceding year if t_8 is not applicable).)
Subtract λ_j from $\lambda_{m\odot}$.
Subtract a_j from a_v.
Subtract $\lambda_{\beta j}$ from λ_β.

Comments:

For the construction of the tables of mean conjunctions and oppositions, see App.1 to Tables 5-8.

The tables are entered with the year (A) of the Christian calendar. Tables 5 and 6 contain years at 24-year intervals. If A is not in those tables, the values for the next lower entry are extracted; then Table 7 is entered with the years remaining in A, and the values found are added to those already extracted (except for the value for the time, which resembles an epact and is subtracted (2,6-7)). Then the values for months within the year A can be developed by adding the values from Table 8.

The values thus found are, for each column of the tables, the time (t_n) of a mean syzygy: this is generally the one to be found within the calendar month in question, if Table 8 is used, or near the beginning of the year, if not; the mean motus of the sun ($\lambda_{m\odot}$), i.e. the longitude of the mean sun; the mean (or true) argument of the moon (a_v), i.e. the distance of the moon from the apogee of its epicycle; and the mean argument of latitude (λ_β), i.e. the distance, measured on the moon's deferent, of the moon's epicycle centre form the ascending node. The three last magnitudes are those found at the time t_n.

In fact, the values of the mean argument of latitude are calculated first for all times in question, and only where these indicate a small enough distance ($<12^o$) of the moon from one of the nodes are the rest of the values calculated. For solar eclipses, the moon should also have a northern latitude.

Due to the subtraction of the time-value from Table 7(2,6-7) the user is sometimes directed to seek the mean syzygy in the month before the one intended. But this means changing the value for λ_β, which had been tested as above. The situation is easy to remedy.

The passage has both general and specific resemblances to the canones Azarchelis (see App.3(A)).

2,9-15. Finding elongation at mean syzygy, longitude of sun at true syzygy, argument of latitude of true moon at mean syzygy, and argument of latitude of true moon at true syzygy.

Variables used: $\lambda_\beta, \lambda_{m\odot}$, a_v (from 2,1-8)
Scales used: 3,4,5,6,7,8

Constants used: 12^{o} (limit of solar eclipse);
$12^{o};48$ (limit of lunar eclipse).

Variables found:

$p_{\odot} = p_{\odot}(\lambda_{m\odot})$: equation of sun
$p_{\leftmoon} = p_{\leftmoon}(a_{v})$: equation of moon
$e = p_{\odot} - p_{\leftmoon}$: elongation at mean syzygy
$|e/12|$: twelfth of elongation, *or* motion of sun between mean and true syzygies
$\lambda_{\odot} = \lambda_{m\odot} + p_{\odot} + e/12$: longitude of (sun at) true syzygy
$\lambda_{\beta 1} = \lambda_{\beta} + p_{\leftmoon}$: argument of latitude of true moon at mean syzygy, 'primo aequatum'
$\lambda_{\beta 2} = \lambda_{\beta} + p_{\odot} + e/12$ (= $\lambda_{\beta 1} + e + e/12$) : argument of latitude of true moon at true syzygy, 'secundo aequatum'

Procedure:

(2,9) Set diametre of cursor at λ_{β} on Scale 3.
Set volvella solis at $\lambda_{m\odot}$ on Scale 5.
- It will then stand at $p_{\odot}$ on Scale 4.
Set volvella lunae at a_{v} on Scale 6.
- It will then stand at $p_{\leftmoon}$ on scale 4.

(2,10) Read e from Scale 7 at volvella lunae.
- e is called 'elongation of the sun' if e>0, otherwise 'elongation of the moon'.

(2,11) Read $|e/12|$ from Scale 8 at volvella lunae.

(2,12) Move volvella solis away from volvella lunae, to the amount of $|e/12|$ on Scale 4.
Read $p_{\odot}+e/12$ from Scale 4 at volvella solis.
Find $\lambda_{\odot}$.

(2,13) Read $\lambda_{\beta 1}$ from Scale 3 at volvella lunae.

(2,14) Read $\lambda_{\beta 2}$ from Scale 3 at volvella solis.

(2,15) If $\lambda_{\beta 2}$ has a value outside 12^{o} of the nodes, a solar eclipse is impossible; and if outside $12^{o};48$, a lunar eclipse is impossible, whichever is investigated.

Comments:

The method is the one commonly found from Ptolemy on. At the time of the mean syzygy, the longitude of the true moon, or its opposite, is $\lambda_{m\odot}+p_{\leftmoon}$; the argument of latitude (neglecting the obliquity of the lunar orbit) is $\lambda_{\beta 1} = \lambda_{\beta} + p_{\leftmoon}$; the longitude of the true sun is $\lambda_{m\odot} + p_{\odot}$; and the elongation from the true moon to the true sun is $e = p_{\odot} - p_{\leftmoon}$. From the mean to the true syzygy, the moon is supposed to travel $e + e/12$, and the sun $e/12$. Now these values are used as increments to the argument of latitude and to the sun's longitude, respectively, to obtain the corresponding values ($\lambda_{\beta 2}$ and $\lambda_{\odot}$) at the time of the true syzygy. The intermediary movement of the nodes is neglected.

The instrument may be said to simulate the table look-ups for $p_{\odot}$ and $p_{\leftmoon}$ (2,9); the subtraction $e = p_{\odot} - p_{\leftmoon}$ (2,10); the finding of e/12 and the use of it to increment the sun's position (2,11-12); and the finding of $\lambda_{\beta 2}$, by adding $p_{\odot} + e/12$ to λ_{β} directly (2,14).

Peter neglects the special case $e = 0$ (i.e. $p_{\odot} = p_{\leftmoon}$), which is mentioned by the canones Azarchelis; in this case $\lambda_{\beta 2} = \lambda_{\beta 1}$, which explains Peter's mention of $\lambda_{\beta 1}$ (2,13).

2,16-24. Finding time-interval from mean to true syzygy.
Finding time of true syzygy.

Variables used: e, e/12, $\lambda_\odot$ (from 2,9-15); a_v, t_n (from 2,1-8)
Constants used: $10^o;22$ (motion of the eighth sphere);
Scales used: 12,13,14
Tables used: 1,20,24
Variables found:

$t_1 = t_1(e)$: time-interval from mean to true syzygy when moon is in apogee (= (e + e/12) / $0^o;30,12$)
$t_2 = t_2(e)$: difference between $t_1(e)$ *and* time-interval from mean to true syzygy when moon is in perigee (= $t_1(e)$ - (e + e/12) / $0^o;36,10$).
$m = m(a_v + (e+e/12)/2)$: minuta proportionalia
$t_3 = t_1 - t_2 \cdot m/60 = t_3(e,a_v)$: time-interval from mean to true syzygy
$T_n = t_n + t_3$: time of true syzygy
$\lambda_{\odot 9} = \lambda_\odot + 10^o;22$: longitude of sun in ninth sphere
$E = E(\lambda_{\odot 9})$: equation of time
$T_c = T_n + E$: civil time of true syzygy in Paris

Procedure:
(2,16) Set volvella maior at e on Scale 12.
Read $|t_1|$ from Scale 13 at volvella maior.
(2,17) If the moon is in its apogee, set $t_3=t_1$ and go to (2,23).
Read $|t_2|$ from Scale 14 at volvella maior.
(2,18-20) (Canon to Table 24)
(2,21) Find $a_v+(e+e/12)/2$.
Take m from Table 20.
(2,22) Find t_3, using Table 24 for finding $t_2 \cdot m/60$.
(2,23) Find T_n.
(2,24) Find $\lambda_{\odot 9}$.
Take E from Table 1.
(2,25) Find T_c.

Comments:

Between the mean syzygy and the true one the moon is supposed to travel e + e/12. The corresponding interval of time is commonly found by dividing this distance by a value representing the angular velocity of the moon. The true velocity is generally uneven, depending on the varying position of the moon on the epicycle. As an approximation, the canones Azarchelis advise to use the velocity found for a position of the moon when mid-way between the mean and the true syzygies. The corresponding value of the argument of the moon a_v is found by incrementing the value at the mean syzygy by (e + e/12)/2, thus supposing a_v to increase about as rapidly as the position of the true moon (or the mean moon, cf. 3,15b in App.2 §17, and the parallel passage from John of Sicily's comment on the canones Azarchelis, App.3(D)).

Peter, wanting to avoid the process of division, provides a scale showing the quotient t_1, supposing the moon to be in its apogee, and another scale showing the decrement t_2 to be applied when the moon is in its perigee (Scales 13 and 14; cf. the account 3,12-12a in App.2 §14 and, for the approximation involved, App.2 §27). For other positions of the moon on the epicycle, interpolation is carried out using the interpolation function m (minuta proportionalia), dependent on a_v; the value of a_v used is the one recommended by the canones Azarchelis.

In 2,23-5 the equation of time is applied to find the civil time of the true syzygy.

The instrument is used simply to simulate table look-ups for t_1 and t_2 (2,16-17).

For the uncommon expression "ascensiones buth solis" (2,24) cf. the explanation in App.3(C) and, e.g., the expression "ascensiones veri motus" found in 'Marsiliensis' (cf. App.3) to explain the differing theory of al-Battani. - It may be noted that in this instance, Peter takes the term "buth" to mean "the motus during one day". This usage can be paralleled from John of Sicily, by elsewhere, e.g. in the canones Azarchelis, Jo.de Lineriis, etc., the term can mean the velocity over any period of time. - The canon 2,18-20 for the table of proportions seems to have been repeated later, e.g. in the text of Jo.de Lineriis, App.3(M).

2,25-32. Lunar eclipses: magnitude, half-duration of eclipse and of total obscuration.

Variables used: $\lambda_{\beta 2}$ (from 2,9-15); m, T_c (from 2,16-24)
Scales used: 1,2,3
Tables used: 14,16,17,18,24
Variables found:

$d_1 = d_1(\lambda_{\beta 2})$: points (=twelfths) of lunar diametre eclipsed when moon is in apogee

$d_2 = d_2(\lambda_{\beta 2})$: difference between d_1 *and* points of lunar diametre eclipsed when moon is in perigee

$d_3 = d_1+d_2 \cdot m/60 = d_3(\lambda_{\beta 2}, a_v)$: points of lunar diametre eclipsed

$c_1 = c_1(\lambda_{\beta 2})$: half-duration of eclipse when moon is in apogee

$c_2 = c_2(\lambda_{\beta 2})$: difference between c_1 *and* half-duration of eclipse when moon is in perigee

$c_3 = c_1+c_2 \cdot m/60 = c_3(\lambda_{\beta 2}, a_v)$: half-duration of eclipse

$2c_3$: duration of eclipse

$i = T_c-c_3$: time of beginning of eclipse

$f = T_c+c_3$: time of end of eclipse

$n_1 = n_1(\lambda_{\beta 2})$: half-duration of total obscuration when moon is in apogee

$n_2 = n_2(\lambda_{\beta 2})$: difference between n_1 *and* half-duration of total obscuration when moon is in perigee

$n_3 = n_1+n_2 \cdot m/60 = n_3(\lambda_{\beta 2}, a_v)$: half-duration of total obscuration

$2n_3$: duration of total obscuration

$j = T_c-n_3$: time of beginning of total obscuration

$q = T_c+n_3$: time of end of total obscuration

Procedure:

(2,25) Set volvella solis at $\lambda_{\beta 2}$ on Scale 3.
Set volvella lunae symmetrically to volvella solis with respect to the node.
Read d_1 from Scale 1 at volvella.
Read c_1 from Scale 2 at volvella.
If moon is in apogee, let $d_3=d_1$, $c_3=c_1$, and go to (2,28).

(2,26) Take d_2 from Table 16.
If necessary, interpolate in Table 16 using Table 24.
Find d_3, using Table 24 for calculation of $d_2 \cdot m/60$.
- Obscuration should be taken as southern when moon is north of ecliptic, and vice versa.

(2,27) Take c_2 from Table 18, and find c_3, analogously to d_2 resp. d_3.
(2,28) Find i, f and $2c_3$.
(2,29) If $d_3>12$ there will be a period of total obscuration.
Otherwise go to (2,33).
(2,30) Take n_1 from Table 14.
If necessary, interpolate in Table 14 using Table 24.
If moon is in apogee, let $n_3=n_1$ and go to (2,32).
(2,31) Take n_2 from Table 17, and find n_3, analogously to c_2 resp. c_3.
(2,32) Find j,q and $2n_3$.

Comments:

The operations are trivial, deriving in a simple way from the usage in the canones Azarchelis and elsewhere. Cf. the comments on Tables 9-18 in App.1, p.47f. For the use of the interpolation function m, cf. to 2,16-24, and App.2 §§17 and 26. For the values of the angular velocities of the moon inherent in the tables, cf. App.2 §§19 and 24.

The instrument is used for simulating table look-ups for d_1 and c_1 (2,25).

2,33-34. Lunar eclipses: Testing whether eclipse takes place at night.

Variables used: T_c, $\lambda_{\odot 9}$ (from 2,16-24); i,j,q,f (from 2,25-32)
Table used: 2
Variables found:

$t = t(\lambda_{\odot 9})$	: length of day
$t' = t(\lambda_{\odot 9}+180^{\circ})$	: length of following night
t/2	: time-interval from noon (=beginning of day) till sunset
t" = t/2+t'	: time-interval from noon till following sunrise

Procedure:
(2,33) Take t from Table 2.
Find t/2.
Find t".
(2,34) If f<12 hours, the whole eclipse will take place before midnight.
Otherwise go to (2,34§)
Subtract t/2 from each of i,j,T_c,q,f, whichever exists.
The remainder will show the time of each after sunset.
Any negative remainder will indicate a time before sunset.
(2,34§) If i>12 hours, the whole eclipse will take place after midnight.
(Appropriate action if eclipse takes place around midnight.)
Find t".
Subtract each of i,j,T_c,q,f (whichever exists) from t".
The remainder will show the time of each before sunrise.
Any negative remainder will indicate a time after sunrise.

2,35. Solar eclipses: Testing whether eclipse takes place at day.

Variables used: T_c, $\lambda_{\odot 9}$ (from 2,16-24)
Table used: 2
Variables found:
$t = t(\lambda_{\odot 9})$: length of day
$t' = t(\lambda_{\odot 9}+180^o)$: length of following night
$t/2$: time-interval from noon (=beginning of day) till sunset
$t'' = t/2+t'$: time-interval from noon till following sunrise

Procedure:
(2,35) Take t from Table 2.
Find t/2.
If $T_c < t/2$, the eclipse will take place before sunset, and the time before sunset will be $t/2-T_c$.
Otherwise, find t".
If $t'' < T_c$, the eclipse will take place after sunrise, and the time after sunrise will be T_c-t''.
Otherwise, the eclipse will take place at night, and calculation should be discontinued.

Comment:
A textual parallel may be found in John of Sicily: see App.3(E).

2,36-45. Solar eclipses: Finding parallax in longitude and latitude, and time and place of visible conjunction.

Variables used: T_c, $\lambda_{\odot 9}$, m (from 2,16-24); $\lambda_{\beta 2}$ (from 2,9-15)
Scales used: 7,8,12,13,14
Tables used: 19,24
Variables found:
T_c' = T_c if conjunction takes place in the afternoon, otherwise = 24^h-T_c (: T_c, reckoning from nearest noon)
π_λ' = $\pi_\lambda'(x,y)$: parallax in longitude when moon is in apogee
T : time of visible conjunction, reckoning from nearest noon
π_λ = $\pi_\lambda'+\pi_\lambda' \cdot m/60$ if $m < 29$, otherwise = $\pi_\lambda'-\pi_\lambda' \cdot m/60$: parallax in longitude
t_1 = $(\pi_\lambda+\pi_\lambda/12)/0^o;30,12 = t_1(\pi_\lambda)$: time-interval from true to visible conjunction when moon is in apogee
t_2 = $t_1(\pi_\lambda)-(\pi_\lambda+\pi_\lambda/12)/0^o;36,10 = t_2(\pi_\lambda)$: difference between $t_1(\pi_\lambda)$ *and* time-interval from true to visible conjunction when moon is in perigee
t_3 = $t_1-t_2 \cdot m/60 = t_3(\pi_\lambda, a_v)$: time-interval from true to visible conjunction
π_β = $\pi_\beta(x,y)$: parallax in latitude
π_λ'' = $\pi_\lambda+\pi_\lambda/12$: parallax in longitude with its twelfth; distance in longitude between true and visible conjunction

$\lambda_v = \lambda_{\odot 9} + \pi''_\lambda$ if conjunction takes place before noon,
otherwise $= \lambda_{\odot 9} - \pi''_\lambda$
: longitude of visible conjunction

$\lambda_{\beta 3} = \lambda_{\beta 2} \pm \pi''_\lambda$ analogously to λ_v
: "argumentum latitudinis tertio aequatum"

Procedure:

(2,36) Find T'_c.
(Let $T = T'_c$.)

(2,37) Take $\pi'_\lambda(T,[\lambda_{\odot 9}])$ from Table 19.
If necessary, interpolate between $\pi'_\lambda([T],[\lambda_{\odot 9}])$ and $\pi'_\lambda([T]+1,[\lambda_{\odot 9}])$, using Table 24.

(2,38) Take $\pi'_\lambda(T,\lambda_{\odot 9})$ from table 19.
If necessary, find $\pi'_\lambda(T,[\lambda_{\odot 9}]+1)$ analogously to (2,37), and interpolate between $\pi'_\lambda(T,[\lambda_{\odot 9}])$ and $\pi'_\lambda(T,[\lambda_{\odot 9}]+1)$ using Table 24.

(2,39) Find π_λ, using Table 24 for calculation of $\pi'_\lambda \cdot m/60$.

(2,40) Set a volvella at π_λ on Scale 12.
Read t_1 from Scale 13 at volvella.
Read t_2 from Scale 14 at volvella.

(2,41) Find t_3, using Table 24 for calculation of $t_2 \cdot m/60$.
Let $T = T'_c + t_3$.

(2,42) Perform (2,37-41) once more.

(2,43) Perform (2,37-39) once more, also finding π_β analogously to π_λ.

(2,44) Perform (2,40-41) once more.
- This results in the final value of T.

(2,45) Set volvella lunae at π_λ on Scale 7.
Read $\pi_\lambda/12$ from Scale 8 at volvella lunae.
Find π''_λ, λ_v and $\lambda_{\beta 3}$.

Comments:

In its main features, the procedure is identical with that of the Canones Azarchelis. The parallax (in longitude and latitude) depends on the time considered, reckoning from the nearest noon (T_c) and on the longitude ($\lambda_{\odot 9}$). The table of parallax is entered with these two arguments, interpolating for both if necessary. Then a correction factor is applied, dependent on the position of the moon on the epicycle. (Peter takes this to be the minuta proportionalia (m) used before: in fact another function was used, cf. App. 2 §27). - When thus once applied to the arguments given, the method yields the parallax in longitude π_λ, i.e. the apparent elongation between sun and moon at the time of the true conjunction. With addition of its twelfth, this (π''_λ) is an estimate of the distance in longitude travelled by the moon between the true and apparent conjunctions. An estimate of the time elapsing between them (t_3) is obtained by dividing that distance by the velocity of the moon. The quotient is subtracted from the (civil) time of the true conjunction if the parallax is eastern, i.e. if at the time of the true conjunction the moon has already apparently overtaken the sun; otherwise it is added. The result is an estimate of the (civil) time of the apparent conjunction. The apparent longitude can be had correspondingly.

The parallax in the true conjunction generally differs from the parallax in the apparent conjunction thus estimated (cf.3,21-2); so, in the latter, the sun and moon may be visibly out of line to the amount of the difference. To get closer estimates of the apparent conjunction,

a procedure of iteration is prescribed. The table of parallax is entered twice more, each time using the recent estimate of the time of the apparent conjunction, and obtaining new estimates of parallax and time. (Neither the canones Az.nor Peter are explicit on whether to use corrected estimates of the longitude as well, though Peter seems to have this idea in 3,22.) In the last iteration, the parallax in latitude is also sought for. The result is taken to be the time of the apparent conjunction and the parallaxes at that time. - Finally, the apparent longitude of the moon (λ_v) and the apparent argument of latitude ($\lambda_{\beta 3}$) are found by addition or subtraction of the arc π'_λ travelled by the moon between the true and apparent conjunctions.

Unlike the canones Azarchelis (cf. App.3(B)) Peter considers the parallax in longitude to be eastern (and so the visible conjunction to be earlier than the true one) whenever the moon is East of the meridian, i.e. when the true conjunction takes place before noon, and vice versa (cf. 3,19.21.24). This implies that Peter can restrict himself to using the time T_c reckoning from the nearest noon, always adding the increment due to the parallax (2,41, cf.3,21).

The instrument is used in 2,40 analogously to 2,16-22, namely, to simulate table look-ups for t_1 and t_2 and thus to help avoid division by the velocity of the moon (cf. App.2 §19). In 2,45 it is used to take a twelfth of π_λ.

For the parallels in content between Peter and John of Sicily as against the canones Azarchelis, see App. 2 §27 and App. 3 (F-K).

2,46-49. Solar eclipses: Correcting for parallax in latitude; testing for possibility of eclipse; finding magnitude and half-duration.

Variables used: $\lambda_{\beta 3}$, π_β (from 2,36-45): m (from 2,16-24)
Constants used: $7^\delta;10$ (limit of eclipse);
44 minutes of time (2,49)
Scales used: 9,10,11,15
Tables used: 24(implied); 11,12(not in F)
Variables found:

$\lambda_{\beta 4} = \lambda_{\beta 3}+11.5\pi_\beta$ if $5^s<\lambda_{\beta 3}<7^s$, otherwise $= \lambda_{\beta 3}-11.5\pi_\beta$
: "argumentum latitudinis quarto aequatum"

$d_1 = d_1(\lambda_{\beta 4})$: points (=twelfths) of solar diametre eclipsed when moon is in apogee

$d_2 = d_2(\lambda_{\beta 4})$: difference between d_1 *and* points of solar diametre eclipsed when moon is in perigee

$d_3 = d_1+d_2\cdot m/60 = d_3(\lambda_{\beta 4}, a_v)$
: points of solar diametre eclipsed

$c_1 = c_1(\lambda_{\beta 4})$: half-duration of eclipse when moon is in apogee

$c_2 = c_2(\lambda_{\beta 4})$: difference between c_1 *and* half-duration of eclipse when moon is in perigee; numerical

$c_3 = c_1+c_2\cdot m/60$ if $c_1<44$ minutes (i.e. if $\lambda_{\beta 4}>$ca.5^o), otherwise
$= c_1-c_2\cdot m/60$: half-duration of eclipse

($2c_3$: duration of eclipse)

$i = T-c_3$: time of beginning of eclipse

($f = T+c_3$: time of end of eclipse)

Procedure:

(2,46) Set volvella solis at $\lambda_{\beta 3}$ on Scale 11.
Set volvella lunae at π_{β} on Scale 15, to the left of volvella solis if $5^{s} < \lambda_{\beta 3} < 7^{s}$, otherwise to the right.
Read $\lambda_{\beta 4}$ from Scale 11 at volvella lunae.

(2,47) If $\lambda_{\beta 4}$ has a value outside $7^{o};10$ of the nodes, eclipse is impossible.

(2,48) Set volvella solis symmetrically to volvella lunae with respect to the node.
Read d_1 from Scale 9.
Read c_1 from Scale 10.

(2,49) Take d_2 from Table 11, take c_2 from Table 12, and find d_3, analogously to (2,26-27).
Find c_3.
Find i (,f and $2c_3$).

Comments:

Like the tables of lunar eclipses (cf.2,25-32) the tables of solar eclipses are designed to be entered with values representing arguments of latitude, supposing the moon to be on the deferent. Due to the parallax in latitude, the moon appears to be south of the deferent. An appropriate argument of latitude would be that of a point on the deferent having the latitude of the moon (cf.3,27). This is obtained by multiplication of the parallax in latitude by 11.5 (i.e. division by sin 5^{o}), subsequently adding or subtracting the product from $\lambda_{\beta 3}$ according to whether the conjunction is next to the descending or the ascending node. - The remaining operations are trivial and analogous to those for lunar eclipses.

The instrument serves to simulate the multiplication of π_{β} by 11.5 and the addition or subtraction of the product from $\lambda_{\beta 3}$ (2,46). Further it is used to simulate table look-ups for d_1 and c_1 (2,48).

For a textual parallel to (3,27) see App.3 (L).

Sigla.

F	Firenze B.N. ii.iii.24, saec.xiv, 208rb-217r
N	Napoli B.N. vii.A.26, saec.xiv, 243ra-258r
Na	N in margine, correctiones eiusdem ut videtur scribae
Nb	N in margine, correctiones vel annotationes calamo tenuiore exaratae, eiusdem fortasse scribae
(N)	N contextu aliquatenus immutato, satis tamen comparabili

(3,2)	sectio 2 capituli 3
(2)	sectio 2 capituli praesentis
§2	sectio 2 Appendicis 2
vide vel *v.*	in Appendice 2 N verbatim exprimitur

Litteris inclinatis lector ad apparatum refertur.

Ad sectiones (1,1),(2,23-24),(2,36-43),(3,19-24) variae lectiones omnes exhibentur, alibi selectae tantum.

/208rb/ *(1)* Prooemium in tractatum eclipsorii Petri Daci.

Prolixitatem quae *quamplurimos* in proiectione eclipsium laborantes citra finem affectos taedio ab amore artis retrahit intendens praescindere, formidinem quoque quae nonnullos labore prorsus indefessos in pronuntiatione earundem praeoccupat /208va/ excludere, quomodolibet modum novum in utraque eclipsi investigandi necessaria, multiplicatione et divisione exclusis, penitus succincte faciliter et sensu palpandum plurimum propono tradere, qui *aspiravit* altissimo inspirante. Et *quia* instrumento plerumque utendum est, eius compositio praemittatur.

(2) De inscriptione faciei instrumenti cum suis partibus.

Extrahatur igitur tabula circularis de ligno sive metallo et ex utraque parte complanetur. Fiatque in ea circulus ab eius ambitu ad *aliam* partem semidiametri distans, et spatium quod hinc est ad ambitum vocetur limbus. *(3)* Fiatque alius circulus distans a limbo ad tertiam partem semidiametri totalis, inter quem et limbum interceptum spatium evacuetur, sic ut in eo tabula quaedam arcualis moveri possit, quae vocetur cursor. *(4)* Secundum quantitatem autem residui ad centrum sumatur alia tabula bene rasa quae, posito centro supra centrum primae tabulae, attingat circulum ultimo factum secundum totum suum ambitum, nisi quod ab una sui parte rostrum exeat ad ambitum primae tabulae, quod inter duas rectas lineas a centro ductas quantum volueris distantes comprehendatur, et haec tabula sic rostrata vocetur volvella solis. Duae vero lineae rostrum concludentes vocentur duae fiduciae, dextra et sinistra. *(5)* Deinde fiat circulus ab ambitu huius volvellae secundum tertiam partem semidiametri eius distans, et secundum quantitatem residui ad centrum fiat tertia tabula rostrum similiter habens, quod etiam ad ambitum primae extendatur, inter duas lineas a centro quantum volueris distanter ductas comprehensum, et vocetur haec tabula volvella lunae. *(6)* Deinde fiat foramen commune per centrum omnium tabularum,

1 Prooemium-Daci F: Incipit tractatus instrumenti eclipsium magistri Petri de Dacia N 2 quamplurimos N: etiam plurimos F 3 praescindere F: praecindere N 5 excludere F: praecludere N 8 aspiravit: inspiravit FN 8 inspirante F: aspirante N 9 quia N:*om.* F 9 utendum est F: uti oporteat N 13 aliam *ipsis litteris* F, *an ex* 7am?: tertiam *fortasse voluit* (N) 15 tertiam: §4 3o *(6)*: *v.* §3

sic ut clavus notabilis quantitatis transire possit, qui omnes tabulas per cuneum contineat sicut in astrolabio esse solet.

(7) De inscriptione totius limbi.

Taliter autem hiis dispositis dividatur limbus secundum latitudinem in duo aequalia et quodlibet eorum in tria inaequalia, sic ut inscriptioni graduum et minutorum cum suis numeris spatia adaptentur, proviso quod singulorum trium quod infimum sit minimum et maximum quod supremum, et in clavo centro invento fiant circuli in punctis divisionum. *(8)* Hoc facto linea limbi infima in 24 aequaliter dividatur, et in uno /208vb/ quo volueris divisionum puncto posita alterutra fiduciarum *volvellae* utriuslibet ducatur linea per totum limbum, quae vocetur nodus; a quo utrimque 11 puncta numeres et duas lineas similiter per totum limbum ducas ab eisdem. Ab aliis autem punctis ducantur lineae per tria spatia inferiora solum. *(9)* Et erunt 24 spatia, in quorum 12 sinistrorsum a nodo scribantur superius 12 gradus argumenti latitudinis lunae, ab 1 iuxta nodum inchoando. *(10)* Dextrorsum autem in primo spatio *scribantur* 0 et 6, in secundo 29, in tertio 28 et deinceps ad 19 descendendo; quibus in spatio proximo subscribantur *5 et 11*, quae sunt signa. Et erunt scripta signa et gradus argumenti latitudinis lunae, quibus subscribantur minuta singula et minutorum numeri, qui in utroque latere crescant sinistrorsum.

(11) Reliqua autem pars limbi sic *inscribatur*. Numerentur enim sinistrorsum a nodo 25 minuta argumenti, et ibi posita sinistra fiducia volvellae utriusque ducatur linea per tria spatia superiora, sicque fiat ad 10 gradus et 49 minuta, et quae est inter has duas lineas longitudo in 20 aequaliter dividatur. Et erunt in toto 21 spatia, in quorum ultimo scribatur superius 1, in paenultimo 2 et deinceps ad 20, ut primum iuxta nodum vacet, cui 46 minuta subscribantur, aliis autem singulis 60, quae crescant versus nodum. Et erunt inscripta puncta et minuta eclipsis lunaris ad augem epicycli. *(12)* Numerentur

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2 per cuneum F: per cuneum qui per clavum transeat (N); *vide* §3
9 24 F: 28(N), *vide* §9 11 volvellae: volvella F 14 *(9-10)*: *v.* §9
17 scribantur: scribatur F 18 subscribantur 5 et quae sunt signa F: scribantur 11 et 5 signa (N) 19 scripta F: inscripta N 22 *(11)*: §7 22 inscribatur: inscribitur F 26-28 21,1,2,20,46 F(N)

iterum dextrorsum a nodo 2 gradus et 50 minuta, et ibi posita *dextra* fiducia volvellae utriuslibet ducatur linea per duo spatia proxima inferiora, sicque fiat ad 4 gradus et 9 minuta et consequenter secundum tabulam dimidii durationis. Inscribendo autem singula minuta sumatur eadem proportio inter duo singula quae est inter 5 singula sive 10. Et erit inscriptum dimidium durationis eclipsis lunaris, ea etiam condicione ut sit luna in auge. In spatiis igitur inter 11 gradus et 19 scribantur tituli inscriptorum. Et erit inscriptus totus limbus.

(13) Ut autem inscribatur cursor, extendatur eius longitudo ad 11 gradus limbi, fiatque prope eius extremum dextrum ratione custodiae a centro ducta linea, qua posita in principio alicuius gradus limbi numerentur sinistrorsum 10 gradus et 2 minuta, et ibi posita fiducia dextra volvellae utriusque ducatur alia linea per *totum limbum*, inter quam et primam longitudo sit de substantia cursoris. Quod autem ad dextram ultra /209ra/ fuerit pro custodia cursoris fiat. Quod autem ad sinistram ultra fuerit titulis inscribendorum reservetur. *(14)* Quo facto dividatur latitudo cursoris in 5 aequalia per lineas arcuales et illorum quodlibet in tria spatia inaequaliter sicut iam dictum est de limbo. *(15)* Longitudo vero eius secundum substantiam in duo aequalia dividatur per rectam lineam, quae transeat per tria spatia suprema et per sex infima solum. Et haec linea media erit diameter deferentis solis et epicycli lunae ad augem utriusque ducta.

(16) De inscriptione zodiaci.

Situetur igitur haec linea media sub principio alicuius gradus limbi, et dividantur hinc inde tria spatia suprema secundum divisionem graduum limbi, et erunt utrimque 5 gradus et 1 minutum. Et erit hic inscriptus arcus zodiaci, a quo epicyclus lunae comprehenditur, et in quo omnes aequationes solis et lunae cadunt, unde vocetur arcus aequationum.

(17) Inscriptio deferentis solis.

1-3 2,50,4,9 F, *om.* (N) 1 dextra: extra F 4 sumatur-10 F: servetur eadem proportio inter duo singula quae est inter 5 et 5 vel decem et decem N 9 11 F: *om.* N, *vide* §6 12 10,2 FN 13 totum limbum F: totam latitudinem? 18 inaequaliter-limbo: *v.* §8 26 5,1 FN 26 et erit hic F: et sic erit N

Post haec numerentur in hoc arcu aequationum 4 minuta dextrorsum a linea media, et ibi fiat signum, et ad 24 minuta similiter, et consequenter ut in tabula zodiaci inscribendi continetur. Et in signis ducantur lineae per spatia arcui aequationum proxima. Cum autem ad 1 gradum et 59 minuta, quae sunt maxima aequatio solis, factum fuerit, cum aliis divisionibus per inferiora spatia proxima sinistrorsum recurratur, usque dum iterum pro 1 gradu et 59 minutis signetur; tunc enim per prima spatia superiora *sinistrorsum* est ad lineam mediam redeundum. Provideatur autem quod lineae divisionum ducantur per tria spatia in complemento signi, aliae autem per duo tantum. *(18)* Et erunt 12 maiora spatia, in quorum primo ad sinistram superius ponatur 1, in secundo 2 et consequenter usque ad 12. Et erunt inscripta 12 signa zodiaci, quibus singulis in tribus spatiis proximis numeri superiorum graduum secundum signorum ordinem subscribantur, primo scilicet 10, secundo 20 et tertio 30, et secundum hoc spatia minima in 10 vel alias pro quantitate instrumenti distinguantur. Et erit inscriptus deferens solis.

(19) Inscriptio epicycli lunae.

Hoc facto *** numerentur in dicto arcu aequationum ab eadem linea media dextrorsum 24 minuta, et ibi fiat signum, et ad *48* minuta similiter, et consequenter secundum tabulam epicycli lunae. /209rb/ Ducantur etiam sicut prius in complementis signorum lineae divisionum per tria spatia, initium primi signi statuendo lineam in medietate superiori. *(20)* Fiant autem omnia alia hic, ut in inscriptione zodiaci dicebatur, nisi quod hic ad 5 gradus et 1 minutum, quae accipiuntur superius, fiat reditio per tria inferiora spatia ad lineam mediam inferius in complemento tabulae quae est ibidem; quam a capite reincipiens sinistram partem inscribas, superius ut prius inchoando. Et erit inscriptus epicyclus lunae et consequenter totus cursor, sic dictus a currendo: curret enim, sed cum quadam difficultate, in spatio sibi adaptato.

1-5 4,24,1,59 FN 7 1,59 FN 8 sinistrorsum F: *an* ad sinistrum?: *om.* N 10 Et erunt-Zodiaci: *v.* §8 19 hoc facto numerentur F: hoc autem modo epicyclus lunae in sex inferioribus spatiis inscribatur. Numerentur N 20 24 FN 20 48 N *et* F *in tabula*: 28 F 24 hic ut FN 25 5,1 FN 25 quae accipiuntur superius F: *om.*N 27 quae est ibidem F: *om.* N

(21) De inscriptione volvellae solis.

Inscribatur autem volvella solis hoc modo. Posita alterutra fiduciarum eius in nodo numerentur in partem fiduciae 7 gradus, positaque ibidem volvella lunae ducatur linea ab ambitu volvellae *rotundae* solis in centrum. Deinde ab hac linea ad dictam fiduciam, scilicet volvellae solis, ducatur linea circularis ab ambitu volvellae tantum distans quantum inscriptioni graduum et minutorum cum suis numeris solet assignari. Unde spatium iuxta hoc in tria inaequalia secundum latitudinem dividatur, secundum longitudinem vero sic. *(22)* Posita enim quae prius fiducia in nodo ponatur volvella lunae supra singulos gradus, ubi et ducantur lineae per omnia tria spatia latitudinis. Et erunt in longitudine 7 spatia, in quorum primo iuxta fiduciam scribatur superius 1, in secundo 2 et consequenter usque ad 7, quae 7 /209va/ erunt 7 gradus maximae longitudinis inter solem et lunam vel eius nadair per medios motus coniunctos; quibus singulis sua minuta cum suis numeris subscribantur. *(23)* Amplius huic longitudini subtendatur linea ab ipsa longitudine tantum distans quantum solet inscriptioni minutorum cum suis numeris assignari. Et iuxta hoc spatium in duo inaequaliter dividatur secundum latitudinem, secundum longitudinem autem sic. *(24)* Posita enim volvella lunae supra singulos gradus longitudinis occupentur ambo spatia latitudinis. Et erunt in longitudine similiter 7 spatia, in quorum primo iuxta nodum scribantur superius 5, in secundo 10 et consequenter, et secundum haec spatia inferiora singula in 5 aequaliter dividantur. Et erunt 35 minuta, quae sunt duodecima longitudinis iam inscriptae. Et sicut inscribitur longitudo et sua duodecima in uno latere volvellae, sic et in alio, proviso quod divisiones dextri lateris fiant cum sinistra fiducia volvellae lunae, et e converso. Et erit inscripta volvella solis et ex consequenti completa prima pars instrumenti quae facies appellatur.

(25) De inscriptione dorsi.

Lineetur consequenter limbus in dorso eodem modo sicut in facie, in clavo centro circulorum invento. Adaptetur etiam clavo una volvella

1-16 *(21-22) om.* N: §11 4 rotundae F, *secludendum?* 5 dictam fiduciam: fiduciam dictam *cum signis transpositionis* F 13 7 FN 24 5,35 FN 31 lineetur: linietur F, dividatur (N) 32 adaptetur--maior *om.* N: §1

aequalis in magnitudine volvellae solis vel maior, proviso quod rostrum eius praecise occupet 1 gradum limbi; positoque nodo contra nodum inscribatur argumentum latitudinis penitus *sicut* supra, et fiant lineae divisionum per volvellam.

(26) [Inscriptio argumenti latitudinis in dorso instrumenti.]

Omnino igitur hic ut in facie *inscripto argumento latitudinis*, numerentur sinistrorsum a nodo 48 minuta argumenti, et ibi posita sinistra fiducia volvellae ducatur linea per tria spatia superiora, sicque fiat ad /209vb/ 6 gradus et 37 minuta, et quae est inter has lineas longitudo in 10 aequaliter dividatur. Et erunt in toto 11 spatia, in quorum ultimo scribatur superius 1, in secundo 2, usque ad 10, ut primum iuxta nodum vacet, cui 45 per aequales divisiones subscribantur, aliis autem singulis 60, quae crescant versus nodum. Et erunt inscripta puncta et minuta eclipsis solaris, ea etiam condicione ut sit luna in auge epicycli sui.

(27) Inscriptio dimidii durationis eclipsis solaris.

Deinde numerentur iterum a nodo dextrorsum 1 gradus et 18 minuta, ibique fiducia dextra volvellae posita ducatur linea per duo spatia proxima, sicque fiat ad 1 gradum et 43 minuta et consequenter secundum tabulam dimidii ** durationis eclipsis solaris, luna etiam ut prius in auge epicycli existente.

(28) Mox quoque adaptetur centro alia volvella aequalis in magnitudine volvellae lunae, et disponantur haec et alia consimiliter aliis quae sunt in facie instrumenti. *(29)* Post haec fiat *a* capite maioris circularis quaedam linea ab ambitu eius tantum distans quantum solet

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2 1 gradum F: 70 minuta (N); §10 3 sicut: sic F?
5 *(26)*: §7 5 inscriptio-numerentur F: deinde numerentur N
6 inscripto-latitudinis: inscriptio argumento l. F, *secludendum?*
7 48 F: 13 *et postea* 48 (N) 8 fiducia: fiduci F 10 10 F: 11 (N *secundum tabulam no. 9*) 10 11 F: 12 N 11 10 F: 11 N
12 45-subscribantur F: 45 minuta subscribantur N 17 1 gradus et 18 minuta F: 39 minuta N 18 duo: dua F? 19 1,43 F: 1,18 N
20 dimidii durationis eclipsis solaris F, *homoeoteleuton? Cf.(12)*
22 *(28) om.* N; §1 24 fiat-eius F: fiat circulus a limbo capitis (N) 24 a F: in? *vel plura conturbata?*

inscriptioni minutorum cum suis numeris assignari. Linea autem ista ab una fiducia vadat ad aliam, spatio quod sub rostro est intacto. Dividatur igitur spatium secundum dicta in duo inaequalia secundum latitudinem, secundum longitudinem vero sic. *(30)* Posita enim alterutra fiduciarum eiusdem volvellae in nodo numerentur in partem fiduciae 11 gradus cum 30 minutis, et ibi posita volvella minori ducatur linea per ambo spatia, et haec erit aequidistans utrique fiduciarum. Consequenter distantiarum hinc inde utraque in 12 aequaliter dividatur, et in punctis divisionum posita volvella minori per utrumque spatium lineae protrahantur. Et erunt hinc inde 12 spatia, quorum cuilibet 5 per aequales divisiones *subscribantur*. Et erunt in utroque latere 60, quibus utemur pro diversitate aspectus in latitudine in eclipsi solis.

/210ra/ *(31)* Expeditis hiis inscribatur spatium dorsi quod est inter limbum et volvellam maiorem isto modo. Latitudo enim eius dividatur in tria aequalia et horum quodlibet in tria inaequalia more solito, spatiaque per circulos distinguantur. *(32)* Deinde sub modo facto in initio longitudo ipsa in 7 aequaliter dividatur, et in punctis divisionum fiducia sinistra volvellae utriusque posita ducantur lineae per tria suprema spatia. Sic in ambitu spatia 7 fiant, in quorum primo dextrorsum a nodo ponatur superius 1, in secundo 2 et consequenter usque ad 7. Et erunt hic ut in facie inscripti 7 gradus maximae longitudinis inter solem et lunam vel eius nadair per medios motus coniunctos, quibus etiam singulis sua minuta cum suis numeris subscribantur, ut dicit figura signi.

(33) Amplius, in fine 2 minutorum huius longitudinis sinistrorsum a nodo sinistra fiducia volvellae maioris posita, ducatur linea per tria spatia proxima. Longitudo quoque maior ab hinc ad nodum in 15 aequalia dividatur, et fiant lineae divisionum per sinistram fiduciam. Eruntque 16 spatia longitudinis, in quorum primo dextrorsum a *dextra fiducia* scribatur superius /210rb/ 1, in secundo 2 et consequenter usque ad 15, ut ultimum vacet, cui 4 per aequales divisiones subscribantur, aliis autem singulis 60, quae crescant dextrorsum. Et erunt

4 *(30) de numeris* §10 11 subscribantur: substernantur F
12 *post* solis *add.* F Capitulum 16 *(32) om.* N: §14
27 15 FN 29 dextra fiducia F: *scribendum* nodo, *vide* §25
29-30 1,2,15 F: *idem aliter* (N)

inscriptae 15 horae et 4 minuta quae fluunt *in motu* lunae per inscriptam longitudinem in auge existentis. *(34)* Quo facto numerentur in circulo nunc inscripto 12 horae et 8 minuta, positaque ibidem sinistra fiducia ducatur linea per duo spatia inferiora tantum, inter quam et nodum longitudo maior in 2 aequaliter dividatur. Eruntque 3 spatia, in quorum primo dextrorsum a nodo scribatur superius 1, in secundo 2, ut ultimum vacet, cui 29 per aequales divisiones subscribantur, aliis vero singulis 60, quae crescant dextrorsum. Et erunt hic inscriptae 2 horae et 29 minuta, quae sunt differentia temporis inscriptae longitudinis, luna in auge existente, ad tempus eiusdem longitudinis, ipsa in opposito augis existente. Et erit ex consequenti dorsum inscriptum instrumenti et completum totum instrumentum.

/210va/ *(2,1)* Secunda pars huius tractatus, quae est de utilitatibus seu operationibus huius instrumenti.

Narrata compositione instrumenti, suppositiones et principia in omni eclipsi sic sumantur. Si in quocumque anno an eclipsis sit possibilis volueris investigare, cum annis domini, adnumerato eo de quo intendis, tabulam coniunctionis pro eclipsi solis vel oppositionis pro eclipsi lunae intres, et quod de ultimo titulo in directo eorum fuerit extra scribas. *(2)* Quod si in tabula coniunctionis inventum fuerit minus 12 gradibus, vel plus 5 signis *et* 18 gradibus usque ad 6 signa, erit eclipsis solis possibilis circa principium illius anni. Si autem tabulam oppositionis intrans inveneris aut 0 vel 6 in signis et minus 12 in gradibus, sive 5 vel 11 in signis et plus 18 in gradibus, erit eclipsis lunae possibilis circa principium eiusdem anni. *(3)* Quod si annos intentos non inveneris, pauciores propinquiores tamen quaeras, et quod de eodem titulo in directo eorum fuerit signes. Deinde cum residuis tabulam communem /210vb/ coniunctioni et oppositioni intres, et quod de eodem titulo in eorum directo fuerit priori subscribas et eidem aggreges eo modo qui in collectione mediorum motuum planetarum observatur. Et si aggregatum in aliquo dictorum casuum fuerit, erit

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1 15,4 *om.* N 1 in motu: a raptu F, *cf. (2,16)* 3 12,8 FN 5-6 1,2,29 FN 9 2,29 FN 17 intendis F: intenderis N 20 quod si-erit: quod si nihil fuerit in signis et minus 12 in gradibus vel 5 in signis et plus 18 in gradibus usque ad 6 signa, erit N 21 et: vel plus F 23 0 vel 6-sive- 18 in gradibus F: 0 vel 6-aut -18 in gradibus N

circa principium anni propositi eclipsis illius luminaris possibilis de quo intendisti. Et hoc ex quo circa principium anni indicatur eclipsis possibilis dicatur radix anni. *(4)* Si etiam utrum in quocumque mense eiusdem anni sit eiusdem luminaris eclipsis possibilis scire volueris, tabulam mensium intres, et quod in directo singulorum, etiam de ultimo *titulo*, fuerit divisim aggreges radici anni. *Et si ex* cuiuscumque ad radicem hanc aggregatione aliquis dictorum casuum provenerit, erit iterum eiusdem luminaris eclipsis possibilis circa illum mensem *ex edirecto* cuius sumpto, et radice anni, casus provenit. *(5)* Cum igitur aliquem dictorum casuum inveneris, intres secundo eandem vel easdem tabulas et eodem vel eisdem locis, et quod e directo fuerit ex tribus primis titulis secundum ordinem tabulae extra scribas, quodlibet sub alio sui generis collocando, duoque ultima eodem modo aggreges sicut iam fecisti. *(6)* De primo autem alia ratio est: primum *enim* per secundum minuas, et residuo tertium addas, et quod provenerit a principio mensis introitus *numeres*. Et ubi dies fractionum ceciderit, erit coniunctio vel oppositio si annus sit communis, si autem bisextilis erit, procul dubio in die praecedente. *(7)* Si vero secundum a primo non possit subtrahi, tertium primo superaddas et ab aggregato secundum minuas, et residuum a principio mensis introitus *numeres*, et cetera sicut prius. Si etiam a primo et tertio simul iunctis aut a primo, non existente tertio, *secundum* non possit subtrahi, ei quod minus est tempus Ianuario *ascriptum* superaddas, factaque subtractione residuum de diebus mensis praecedentis mensem introitus minuas, et residuum a principio eiusdem praecedentis *numeres*, et cetera sicut prius. Et invenies diem et horam, minutum et secundum quo luna soli con-/211ra / iungetur sive opponetur per medios motus Parisius, incepta die qualibet in meridie praecedentis. Sed diligenter caveas, cum tempus Ianuario ascriptum in casu qui dictus est addideris, ut ea quae e directo eiusdem fuerint ex aliis titulis prius collectis minuas, *ab alio* scilicet sui generis unumquodque. *(8)* Et habebis per hos 4 *titulos* 4 suppositiones et principia eclipsis cuiuslibet /211rb/ investigandae. Per primum enim, qui est tempus mediae coniunctionis vel oppositionis,

6 titulo N: circulo F? 6 et si ex: et ex FN 9 ex edirecto N: ex directo F 14 enim N: autem F 16,20 numeres N: minues F 22 secundum N: *om.* F 23 ascriptum N: *om.* F 25 numeres N: minues F 30 ab alio: et ab alio F 31 titulos: circulos F

habebis quando luna soli coniungetur vel opponetur per medios motus. Per secundum, qui est medius motus utriusque, habebis locum solis cum luna sibi coniungetur vel opponetur. Per tertium, qui est argumentum lunae, habebis distantiam lunae ab auge vera epicycli in ipsa hora coniunctionis sive oppositionis. Per quartum vero, qui est argumentum latitudinis, habebis distantiam centri epicycli lunae a capite draconis ad eandem horam.

(211va) *(9)* Ad examinandam igitur possibilitatem inventam in utraque eclipsi via hac communi incedas. Signatis enim 4 capitulis quae extraxisti de tabulis, quaeras simile argumento latitudinis in alterutro latere faciei instrumenti, et sub ultimo minuto eius statuas mediam lineam cursoris. Quo sic locato quaeras in eo simile medio motui solis et lunae, et super ultimum gradum eius ponas alteram fiduciarum volvellae solis. Quaeras etiam simile argumento lunae, et super ultimum minutum eius ponas similiter alteram fiduciarum volvellae lunae, sic ut quantum ad utrumque utaris, si possis, fiducia dextra in sinistra parte cursoris et *e converso*. *(10)* Et notentur loca volvellarum in arcu aequationum; quod enim de ipso fuerit inter mediam lineam cursoris et volvellam solis erit aequatio solis, et quod de eodem arcu fuerit inter eandem lineam mediam et volvellam lunae erit aequatio lunae. Quod etiam inter utrasque volvellas fuerit de eodem arcu aequationum vel de longitudine quae scripta est in volvella solis, quod idem est, erit longitudo inter solem et lunam vel eius nadair, et dicatur haec longitudo illius cuius volvella fuerit magis ad sinistram. *(11)* Quod similiter inter eas fuerit de arcu duodecimae longitudinis, erit duodecima longitudinis praesentis, quam cum ipsa longitudine seorsum extra scribas. *(12)* Et quia duodecima ipsa correspondet motui solis, ad eius quantitatem moveas volvellam solis in arcu aequationum, recedendo semper a volvella lunae stante; et quod iam fuerit de arcu aequationum inter mediam lineam cursoris et volvellam solis, si in parte dextra fuerit, de medio motu solis minuatur, vel eidem addatur si fuerit in sinistra. Et habebis locum solis verum ad horam verae coniunc-

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1 motus: utriusque *add.et exp.* F 5 vero-horam F *in marg. sup.* 10 simile: argumentum *add.et exp.* F 13 alteram F, N *ex* ultimam *correctum* 17 e converso: eius F: econtra N 21 fuerit: fuerit et F 21 fuerit- nadair F: fuerit, est corporalis distantia solis et lunae vel eius nadair secundum medios motus coniunctorum, quod (!) vocatur longitudo N: §11

tionis vel oppositionis in octavo orbe. *(13)* Quibus extra signatis notetur locus volvellae lunae in gradibus limbi. Et habebis argumentum latitudinis quod est distantia lunae a capite draconis in hora mediae coniunctionis vel oppositionis, quod dicatur primo aequatum. *(14)* Notetur similiter locus volvellae solis in gradibus limbi. Et habebis argumentum latitudinis quod est distantia lunae a capite draconis in hora verae coniunctionis vel oppositionis, quod dicatur secundo aequatum. *(15)* Quibus cum aliis signatis videas si haec volvella solis plus 12 gradibus a nodo distiterit. Impossibile enim erit eclipsim solis fieri illa vice, vel si plus 12 gradibus et 48 minutis distiterit, impossibilis erit eclipsis lunae. /211vb/ *(16)* Dato igitur infra has metas volvellam solis existere, longitudinem iam inventam resumas et simile ei in circulo longitudinis in dorso instrumenti quaeras, positaque ibi volvellae maioris sinistra fiducia quod sub *ipsa* fuerit de tempore longitudinis sumas. Et hoc erit tempus quod fluet in motu lunae a media coniunctione vel oppositione ad veram in auge existentis. *(17)* Si autem ibi non fuerit, sumas id quod in infimo circulo fuerit de differentia temporis, et hoc a primo subtrahens habebis tempus eiusdem longitudinis, luna in augis oppositione existente.

(18) Et quia luna est aliquando extra haec duo loca, de hac differentia partem proportionalem invenire est necesse iuxta descensum lunae in epicyclo; unde ad aequandum in posterum haec et similia tabulam portionis composui, cuius usus est iste: *(19)* Cum duorum numerorum portionem volueris, unius secundum proportionem alterius ad 60, ut in aequationibus planetarum plerumque accidit, alterum horum quaeras in capite alicuius columnae huius tabulae et reliquum in latere columnae eiusdem; et quod in cellula communi fuerit, erit portio quam volebas, ita quod numerus superior cellulae eiusdem erit generis cum numero cuius portionem quaerebas, et inferior posterioris. Verbi gratia, si de 49 secundis portionem volueris secundum proportionem 39 minutorum ad 60 minuta, tunc in capite tabulae invenies 49, scilicet in tertia columna, et 39 in latere eiusdem, vel e converso. Et stabunt in cellula communi superius 31 secunda et inferius 51 tertia, eadem proportione in aliis servata. *(20)* Si etiam in alterutro numerorum sint diversa genera fractionum, cum quolibet sui et reliquo divisim intres. Si etiam in

1 orbe-quibus: *v.* §15 9 12 F(N) 10 12,48 F: 13,15 N 11 *(16-17)* *om.* N; §15 14 ipsa: ipso F

utroque sint diversa genera, cum quolibet unius et quolibet alterius seorsum intres. Si autem alicuius numeri portionem volueris secundum alterius proportionem ad 30, modo iam dicto opereris, et quod inveneris duples *praeter ultimum, si minus sit 30.* Et haec hactenus.

(21) Digressione hac facta resumatur argumentum lunae et longitudo cum sua duodecima. Deinde medietas duodecimae addatur medietati longitudinis, et aggregatum addatur argumento lunae si longitudo erat solis, vel *ab* eo minuatur si erat lunae, et cum argumento sic aequato tabulam minutorum proportionalium intrans quae ibi minuta proportionalia inveneris extra scribas. *(22)* Receptis igitur minutis proportionalibus resumatur differentia temporis longitudinis, et cum utrisque, modo qui iam dictus est, portionis tabulam intrans quod inveneris de tempore longitudinis semper demas. Et residuum erit tempus longitudinis praesentis et suae duodecimae, quod cadit inter mediam coniunctionem vel oppositionem et veram. *(23)* Videas igitur cuius erat /212ra/ longitudo; et si solis, quia tunc media praecedit veram, addatur tempus longitudinis aequatum tempori coniunctionis vel oppositionis mediae, vel ab *eodem* minuatur si longitudo erat lunae, quia tunc vera mediam praecedit. Et quod nunc inventum fuerit erit tempus coniunctionis vel oppositionis verae, sed ea condicione ut dies naturales omnes sint aequales. *(24)* Quia igitur propter inaequalitatem ascensionum buth solis superadditarum revolutionibus caeli diurnis efficiuntur dies naturales inaequales, excrementum inaequalitatis, quod vocatur aequatio dierum, cum gradu solis accipitur. Vero igitur loco solis in octavo orbe addas motum octavae sphaerae, qui nunc est 10 gradus et 22 minuta, et exibit locus solis in nono orbe, cum quo tabulam aequationis dierum intrans tempus quod e directo eius vel minoris proximi fuerit tempori verae coniunctionis vel oppositionis semper addas. Et habebis tempus

4 duples-30 FN 5 *(21) vide* §17 8 ab (N): *om.* F 13 Et residuum-veram: *u.* §18 16 solis: fuerit *add.* N 16 media: coniunctio vel oppositio *add.* N 17 aequatum tempori F: nunc aequatum super tempus N 18 vel: idem *add.* N 18 eodem N: eadem F 18 erat lunae F: lunae fuerit N 18 quia-fuerit F: quia tunc vera coniunctio vel oppositio praecedit mediam. Et quod post additionem vel minutionem fuerit N 22 efficiuntur-naturales F: d.n.e. N 25 octavae sphaerae F: orbis eiusdem N 25 10 gradus et 22 minuta F: 10 graduum et tertiae unius N 26 exibit locus F: habebis locum N 26 dierum-fuerit F: "intres "dierum, et aequationem e directo eius vel minoris proximi ascriptam dicto N

verae coniunctionis vel oppositionis aequatum ad Parisius, cui *25 minutis* superadditis erit tempus eiusdem coniunctionis vel oppositionis ad Roskildis Daciae. Et haec est illa de qua dixi in utraque eclipsi communis via.

(25) Complere autem volens eclipsim lunae specialiter sic procedas. Dextram enim fiduciam volvellae solis ponas super argumentum latitudinis secundo aequatum in dextro latere faciei instrumenti et sinistram alterius super consimile in sinistro vel e converso, et habebis puncta et minuta eclipsis lunaris ad sinistram et dimidium durationis ad dextram, sed ea condicione ut luna sit in auge. *(26)* Si igitur alibi fuerit, cum eodem argumento latitudinis tabulam differentiae duarum longitudinum in punctis eclipsis lunaris intrans quod de punctis et minutis inveneris sumas, et si bis intrare oporteat, cum differentia amborum introituum et cum minutis argumenti tabulam portionis intrans quod inveneris duples et duplatum primo addas. Et erit differentia aequata, cum qua et minutis proportionalibus eandem tabulam portionis intrans quod inveneris punctis et minutis ex instrumento acceptis superaddas. Et habebis puncta et minuta ex diametro lunae eclipsanda, quae in particulari eclipsi versus meridiem numeranda sunt si argumentum latitudinis secundo aequatum *5 vel 0* sit in signis, versus septentrionem vero si 6 vel 11 sit in signis. *(27)* Consimiliter quoque operaberis pro differentia duarum longitudinum in dimidio durationis, intrando tabulam ad hoc constitutam, et differentiam aequatam superaddas dimidio durationis quod ex instrumento accepisti. Et habebis dimidium durationis eclipsis aequatum; *(28)* quod si de tempore oppositionis verae, quod est tempus mediae eclipsis, minueris, remanebit initium eclipsis, et si idem eidem /212rb/ addideris, exibit eius finis; si etiam id ipsum duplaveris, habebis totalis eclipsis durationem.

(29) Investigato igitur quando quamdiu et quanta futura sit eclipsis lunaris, considerandum est si plus vel minus ex punctis vel praecise

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1 aequatum–Daciae F: diebus aequatis ad meridianum civitatis cuius longitudo ad orientem de Parisius est 32 minutorum temporis N: diebus aequatis ad Parisius N *cum* Na 3 utraque F: omni N 10 si–superaddas: *v.* §17 20 5 vel 0: 7 vel 0 F: 0 vel 5 N 21 6 vel 11 FN 25 aequatum; quod: *v.* §18 28 totalis F: totalem N

12 eclipsantur. Quantumcumque enim minus, particularis erit, si praecise 12, universalis sed sine mora, si autem plus, universalis et cum mora. *(30)* Ut igitur quantitatem morae invenias, cum argumento latitudinis secundo aequato tabulam dimidiae morae intrans minuta quae inveneris extra scribas ibi. Si etiam bis intrare oporteat, cum differentia duorum introituum et minutis argumenti opereris sicut in capitulo proximo dicebatur. Et habebis dimidium morae, ea etiam condicione ut luna sit in auge. *(31)* Ea igitur alibi existente, cum eodem argumento latitudinis tabulam differentiae duarum longitudinum in dimidio morae intrans opereris consimiliter sicut pro differentia earundem longitudinum in dimidio durationis fecisti, quodque aequando inveneris dimidio morae iam invento superaddas. Et habebis dimidium morae aequatum; *(32)* quod si de tempore mediae eclipsis minueris, remanebit initium morae, quod est instans extinctionis lunae totalis, et si eidem idem addideris, exibit finis morae, qui est instans primae reaccensionis lunae; si etiam idem duplaveris, exibit totalis mora lunae, quod est tempus deambulationis lunae in umbra terrae absque aspectu solis.

(33) Ad sciendum autem an eclipsis inventa futura sit de die vel de nocte tota vel in parte, cum gradu solis in nono orbe tabulam temporis diurni intres, et medietatem temporis quod e directo eius steterit extra scribas, et hoc erit tempus a meridie ad occasum solis in die gradus. Tempus quoque totale quod e directo nadair gradus eiusdem fuerit cum eodem scribas, et istud erit tempus noctis illius diei. Addas igitur secundum ad primum, et exibit tempus a meridie diei *praesentis* ad ortum solis inde sequentem. Quibus sic scriptis videas si tempus finis eclipsis fuerit minus 12 horis: erit enim tunc ante mediam noctem eclipsis tota; et si tempus initii eclipsis fuerit maius 12 horis, erit post mediam noctem eclipsis tota. *(34)* Si igitur ante futura sit, medietatem temporis diurni subtrahas de quolibet temporum eclipsis seorsum, et residuum cuiuslibet ostendet horam suam post occasum solis. A quocumque *vero* non poterit subtractio fieri, hoc in die erit /212va/ et ante occasum solis secundum differentiam utriusque. Si vero post futura sit, medietatem temporis diurni iungas

4 dimidiae F: dimidii N 12 dimidium morae: §18 25 praesentis F: praecedentis N, *cf. (7)* 27 finis eclipsis N: eclipsis finis F *cum signis transpositionis* 32 vero N: modo F 32 poterit F: potuerit N

tempori suae noctis, et ab aggregato tollas unumquodque temporum eclipsis seorsum, et scies per residuum quantum unumquodque futurum sit ante ortum solis. Si etiam aliquod horum tolli non potuerit, hoc iterum in die erit et post ortum solis secundum differentiam utriusque. Et haec de eclipsi lunari.

(35) Specialiter etiam in eclipsi solis sic procedas. Invento enim argumento latitudinis quod secundo aequatum dicitur et tempore coniunctionis verae, ut sciatur utrum haec coniunctio futura sit in die vel in nocte, et si in die, utrum ante meridiem vel post, tabulam temporis diurni cum gradu solis sicut in capitulo proximo dictum est intrans medietatem temporis gradus et totale tempus nadair extra divisim scribas. Sique tempus coniunctionis minus fuerit medietate temporis gradus, erit illa coniunctio in die post meridiem et ante occasum solis secundum differentiam utriusque. Si vero tempus coniunctionis eadem medietate maius fuerit, ipsi medietati tempus nadair superaddas, et aggregatum si minus fuerit tempore coniunctionis, erit iterum illa coniunctio in die ante meridiem et post ortum solis secundum differentiam utriusque. Si autem tempus coniunctionis fuerit plus medietate ipsa et minus aggregato, erit coniunctio ipsa de nocte, nec pro illa est ulterius laborandum.

(36) Invento autem quod coniunctio de die futura sit post meridiem, cum tempore coniunctionis verae operaberis, si vero ante, tunc tempus coniunctionis verae de 24 horis *minuens* cum residuo operaberis. *(37)* Cum utrolibet igitur tabulam diversitatis aspectus intres sub signo coniunctionis et ante *titulum* "recessus" si futura sit ante meridiem, vel post si post sit futura, et diversitatem aspectus in longitudine tantum e directo accipias. Et si secundo intrare oporteat, cum minutis horae et differentia amborum introituum tabulam portionis modo solito intrans quod inveneris aspectui primi introitus superaddas. Et erit diversitas aspectus aequata pro parte horae ad signum coniunctionis.

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6 invento F: inventis N 21 de-meridiem F: futura sit de die N 22 operaberis: si sit post meridiem *add.* N 23 24-minuens: 24-minues F: 24 minuens N 24 igitur F: ergo N 24 aspectus: ad clima tuum vel civitatem *add.* N 25 titulum N: circulum F 26 in longitudine tantum F: t.i.l. N 27 directo: stantem *add.* N 27 et si: pro minutis horae *add.* N 27 minutis horae F: eis N 28 amborum F: duorum N 28 solito intrans F: consueto intres, et N 29 superaddas F: semper addas N 30 aequata F: *om.* N

(38) Sicque facias intrando sub sequente signo, si coniunctio non fuerit in principio signi. Deinde videas quot gradibus distet coniunctio a principio signi, et quae sit differentia amborum aspectuum aequatorum, et cum utrisque tabulam portionis intrans quod inveneris duples, et duplatum aspectui primo addas si minor sit secundo, vel idem ab eodem minuas si sit maior. Et erit aspectus aequatus pro parte horae et pro parte signi; *(39)* cum quo /212vb/ et minutis proportionalibus tabulam portionis intrans quod inveneris eidem aspectui addas si ipsa minuta proportionalia plura fuerint 29, vel idem ab eodem minuas si fuerint pauciora. Et erit diversitas in longitudine aequata etiam ad partem epicycli. *(40)* Cuius simile in circulo longitudinis ad dorsum instrumenti quaeras, positaque ibi sinistra fiducia volvellae utriusque tempus subscriptum et suam differentiam sumas. *(41)* Deinde cum differentia et minutis proportionalibus tabulam portionis intrans quod inveneris de tempore ipso semper minuas. Et erit tempus diversitatis aspectus aequatum primo, quod superaddendum est tempori cum quo tabulam diversitatis aspectus intrasti. *(42)* Quo facto cum tempore excrescente eandem tabulam diversitatis aspectus et sub eisdem signis intrans per omnem modum facias sicut prius, et tempus diversitatis aspectus aequatum addas eidem tempori cui et prius addidisti. *(43)* Amplius cum tempore nunc excrescente eandem tabulam diversitatis et sub eisdem signis tertio intrans accipias de utraque diversitate aspectus, *scilicet* in longitudine et latitudine, et utramque aeques seorsum ad partem horae, ad partem signi et ad partem epicycli sicut *alteram* solam prius bis aequasti. Et diversitas aspectus in longitudine sic *aequata* erit arcus orbis cadens inter locum in quo luna est corporaliter et locum ad quem

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2 signi: et erit aspectus aequatus pro parte horae ad signum sequens *add.* N 2 distet: haec *add.* N 3 aequatorum F: *om.* N 7 proportionalibus: secundis *add.* N: §17 8 intrans F: intres, et N 8 quod: ibi *add.* N 8 ipsa F: *om.* N 10 in longitudine F: aspectus N 10 etiam-sumas F: pro parte horae, pro parte signi et pro parte epicycli. Cum qua tabulam temporis aspectus et differentiae intres, et quod ibi de tempore aspectus et de differentia duarum longitudinum fuerit seorsum extra scribas N: §15 13 cum: ipsa *add.* N 13 differentia et: secundis *add.* N: §17 14 quod: ibi *add.* N. 15 ipso F: diversitatis aspectus N 15 *post* minuas *habet* N Si etiam diversitas ipsa maior 60 minutis fuerit, primo pro 60 et secundo pro residuo intres: §10 16 superaddendum F: semper addendum N 17 quo F: hoc N 18 aspectus F, *om.* N 19 aequatum F: quod in fine inveneris N 20 Amplius F: adhuc N 22 scilicet N: *om.* F 24 alteram N: ad partem F 25 et: erit *add.* N 25 aequata N: aequati F 25 erit F: *om.* N 26 in quo luna est F: lunae in quo est N

proicitur visibiliter versus orientem vel occidentem. Diversitas vero in latitudine est arcus orbis cadens inter eadem loca versus austrum sumptus.

(44) Tempus autem aspectus in longitudine quaeras in dorso instrumenti, et ipsum aeques penitus sicut prius, et quod aequando inveneris addas iterum illi tempori cui iam bis addidisti, et quod exit erit tempus coniunctionis visibilis, quod est tempus mediae eclipsis a meridie ante vel post numerandum. *(45)* Item simile huius diversitatis aspectus in longitudine quaeras in arcu longitudinis in volvella solis faciei, positaque ibi volvella lunae subscriptam duodecimam sumens ipsi longitudini eam addas. Et habebis diversitatem aspectus in longitudine cum sua duodecima, quae est arcus orbis a loco lunae in hora coniunctionis verae ad locum lunae in hora coniunctionis visibilis protensus versus orientem vel occidentem. Unde hunc arcum supra locum *solis* in nono orbe et supra argumentum latitudinis secundo aequatum oportebit addere si coniunctio visibilis ante meridiem sit inventa, vel eundem ab eisdem minuere si post sit futura. Et habebis locum lunae in hora coniunctionis visibilis et similiter argumentum latitudinis tertio aequatum, quod est arcus orbis cadens inter /213ra/ caput draconis et locum ad quem luna visibiliter est proiecta.

(46) Iterum in limbo dorsi quaeratur simile argumento latitudinis tertio aequato, quod si in signo 5 vel 6 fuerit, super ipsum statuas sinistram fiduciam volvellae solis, vel dextram si in signis fuerit 11 vel 0. *Qua* sic stante quaeras in volvella eadem et in partem fiduciae assumptae minuta diversitatis aspectus in latitudine iam aequatae, positaque ibi volvella lunae notetur locus eius in limbo. Et habebis argumentum latitudinis quarto aequatum, quod est arcus *orbis* cadens inter caput draconis et terminum lineae exeuntis a loco lunae visibili aequidistanter eclipticae, quae est via solis.

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1 vero: aspectus *add.* N 4 tempus-prius: §15 6 addidisti-exit: addidisti, et de tempore quod nunc excreverit tollas id quod per tabulam erroris tollendi per ea quae superadicta sunt est tollendum; et tempus quod remanserit N: §18 8 Item-addas: §11 14 solis F: lunae N 21 Iterum-dorsi F: Hoc expedito transferantur novellae ad dorsum instrumenti, et N: §3 21 quaeratur-volvella lunae F, *vide* §22. 23 solis: solis si in signis fuerit F 24 qua: quia F 28 orbis N: *om.* F

(47) Nunc quoque diligenter videas distantiam volvellae lunae a nodo in partem alterutram, quae si fuerit 7 in gradibus et plus 10 minutis, impossibile erit hac vice eclipsim solis fieri. *(48)* Si vero minor fuerit, ponas volvellam solis in consimili distantia a nodo in alio latere, proviso quod in sinistro latere utaris sinistra fiducia et in dextro dextra. Et habebis per volvellam sinistram puncta eclipsis solaris et per dextram dimidium durationis eclipsis eiusdem, sed ut supra ea condicione ut luna sit in auge. *(49)* Ea igitur alibi existente, pro differentia longitudinum duarum in punctis eclipsis solaris et dimidii durationis aeques sicut supra in eclipsi lunari, et quod de differentia punctorum aequando inveneris punctis ex instrumento sumptis superaddas. Quod etiam de differentia dimidii durationis aequando inveneris ipsi dimidio durationis addas si ipsum dimidium durationis minus fuerit 44 minutis, et si plus fuerit, idem minuas ab eodem. Et erit dimidium durationis aequatum, quod si de tempore mediae eclipsis minueris, remanebit tempus initii eclipsis, et cetera sicut supra dictum est de eclipsi lunae. Quae pars etiam solis eclipsanda fuerit scies sicut ibi dicebatur.

(3,1) Peracto eo quod intendebatur ab initio, ut "propter quid" viso auditor factus scientior fidem dictis accommodet, visum est perutile singulorum quae in compositione et usu instrumenti, nec non et eorum quae in investigatione utriusque eclipsis dicta sunt, reddere rationes. *(2)* Constitui igitur in facie instrumenti utrimque a nodo 12 gradus argumenti latitudinis lunae, non quia extra hanc metam luna existens eclipsari non possit, sed quia centro epicycli lunae in oppositione vel coniunctione media extra hanc metam existente impossibile est eclipsim fieri sive solis sive lunae. *(3)* Puncta igitur et minuta eclipsis lunaris aequavi pro argumentis singulis, et singula singulis superposui a nodo sinistrorsum. Dimidium autem durationis argumentis similibus ascripsi dextrorsum ab eodem nodo. Sed poteram latera permu-/213rb/tasse, sicque feci in dorso suo modo. *(4)* Amplius quia in hora coniunctionis mediae est linea medii motus solis eadem cum linea medii motus lunae, cuius pars est diameter epicycli lunae ad

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1 *(47) om.* N 2 7,10 F, *cf. ad (3,27)* 5 proviso-dextra F: *om.* N 8 *(49)*: §12 14 44 FN 23 *(2) vide* §9 31 sicque-modo: *vide* §23

augem ducta, *(5)* sequitur quod haec epicycli diameter ad orbem ducta terminet medium motum utriusque, et ob hoc circa eandem lineam, quae est media cursoris, ordinavi deferentem solis et epicyclum lunae. *(6)* Et quia aequationes solis sicut et lunae incipiunt ab auge deferentis sui, ideo eandem lineam mediam posui communem etiam diametro deferentis solis ab auge ad oppositum descendenti. *(7)* Adhuc quia maxima remotio solis corporaliter a linea sui motus medii est ad 1 gradum et 59 minuta orbis, quae dicuntur maxima solis aequatio, ideo pro deferente solis tantundem accepi hinc inde a nodo in argumento latitudinis quod partium est zodiaci, et signavi in cursore ac si totus deferens solis 3 gradibus et 58 minutis orbis subiectus esset. *(8)* Consimiliter quia maxima remotio lunae corporaliter a linea medii motus sui est ad 5 gradus et 1 minutum, quae dicuntur maxima lunae aequatio, ideo etiam pro epicyclo lunae tantundem accepi sub argumento latitudinis in cursore hinc inde. *(9)* Hiis consequens videbatur ponere arcum communem orbis, infra quem omnes aequationes solis et lunae cadunt, et hunc supra deferentem solis posui vocans eum propter dicta arcum aequationum. *(10)* Epicyclum vero *lunae* sub deferente solis secundum ordinem universi statui. Deinde epicyclum lunae et deferentem solis divisi in suas partes secundum aequationes singulorum, ut accepto medio motu solis et argumento lunae statim habeatur utriusque aequatio et ex consequenti verus locus utriusque. *(11)* Ceterum quia sol et luna per medios motus coniuncti possunt secundum dicta distare ab invicem per 7 gradus orbis, qui sunt maxima longitudo inter solem et lunam per medios motus coniunctos, ideo tantundem accepi sub argumento latitudinis hinc inde a nodo et posui in volvella solis ab utraque fiduciarum et eius duodecimam sub ea. *(12)* Et quia *motus solis* movetur tantum per duodecimam longitudinis, luna per totam longitudinem et duodecimam, consequens est quod locus lunae in hora mediae coniunctionis distare poterit a loco verae coniunctionis 7 gradibus et 35 minutis. Et sicut in coniunctione loquor de loco lunae, sic in oppositione de eius nadair est intellegendum. Tempus enim huius longitudinis commodius in dorso ordinavi.

6-7 1,59 FN 9 argumento-zodiaci FN 10 ac si-esset F: *om.* N
13 5,1 FN 18 lunae N: *om.* F 23 7 FN 25 ideo-nodo: §11
27 *(12) vide* §14 30 7,35 FN 32 enim F: autem?

(13) Apparet igitur quare media linea cursoris ordinetur sub ultimo minuto argumenti /213va/ latitudinis in principio eclipsis examinandae, cum argumentum illud *est* distantia centri epicycli lunae a capite draconis. *(14)* Ex hoc igitur sequitur quod, posita volvella solis supra medium motum solis in cursore, quod de arcu aequationum fuerit inter eam et lineam mediam cursoris erit aequatio solis, et quod, similiter posita volvella lunae supra argumentum lunae, quod de eodem arcu fuerit inter eandem volvellam et eandem lineam mediam erit aequatio lunae; et quod de eodem arcu fuerit inter ambas volvellas erit corporalis distantia solis a luna, quae longitudo dicitur, et quod de arcu duodecimae inferius fuerit inter easdem volvellas erit duodecima acceptae longitudinis. *(15)* Et quia sol tantummodo hanc duodecimam perambulat, ideo ad quantitatem huius duodecimae movere oportet volvellam solis in arcu aequationis, sed semper recedendo a volvella lunae, ut *haec* portio ipsi longitudini superaddi videatur per motum solis, ut locus verae coniunctionis vel oppositionis habeatur. *(16)* Item quia non est aliud argumentum latitudinis primo aequatum nisi distantia lunae corporaliter a capite draconis in hora mediae coniunctionis vel oppositionis, ideo hoc argumentum accipitur cum volvella lunae sic stante. Similiter quia non est aliud argumentum latitudinis secundo aequatum nisi distantia lunae corporaliter ab eodem capite in hora verae coniunctionis vel oppositionis, scilicet cum luna vel eius nadair est cum sole, ideo argumentum illud accipitur cum volvella solis sic stante. *(17)* Consequenter quia ubi est luna in oppositione vera, ibi est diameter umbrae terrae, ideo cum per locum lunae in hora oppositionis verae habeatur argumentum latitudinis secundo aequatum, habentur et puncta et minuta eclipsis lunaris ex consequenti. *(18)* Item quia tanta fit eclipsis in tanto tempore cuius dimidium positum est in alio latere, ideo cum argumentis latitudinis consimilibus accipitur quantitas eclipsis et dimidium durationis eiusdem.

(19) Aequata coniunctione vera, quia non videtur luna sub illa parte orbis sub qua est, sed ante meridiem orientalior et post occidentalior fit visibiliter plurimum et cum hoc semper australior quam est realiter,

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3 est: in *add.* F 14 aequationis F: aequationum N 15 haec: hoc F (h^c) 16 oppositionis habeatur: *vide* §§15&17 26 habeatur F: habetur N 30 eiusdem: *vide* §13 31 Aequata F: in N 31 coniunctione F: autem *add.* N 31 non videtur luna F: l.n.v. N 33 cum hoc semper F:s.c.h., N 33 realiter F: in veritate N

erit arcus orbis inter locum sub quo vere est et sub quo apparet partim versus orientem vel occidentem numerandus plurimum et semper partim ad austrum. *(20)* Sumptus autem versus orientem vel occidentem dicitur diversitas aspectus in longitudine, sumptus vero versus austrum dicitur diversitas aspectus in latitudine. Dicitur autem *uterque* diversitas aspectus, quia ad diversitatem aspicientium diversificatur. Prima etiam vocatur diversitas aspectus in longitudine /213vb/ quia secundum orbis longitudinem mensuratur. Secunda vero vocatur diversitas in latitudine quia secundum orbis latitudinem mensuratur. *(21)* Cum igitur motus lunae sit in orientem, prius erit luna soli coniuncta visibiliter *quam* vere ante meridiem, et post e converso. Et ideo tempus diversitatis aspectus additur ad tempus a meridie praesenti utrimque, ut habeatur tempus coniunctionis visibilis. Et iam statim in aequatione prima habe<re>tur tempus coniunctionis visibilis, si eadem esset diversitas aspectus lunae in loco ad quem proiecta est cum ista quam invenisti ad locum coniunctionis verae. *(22)* Sed erit utrarumque diversitatum diversitas aliqualis; et ideo, supposito lunam esse in hoc secundo loco, cum tempore arcus inter locum hunc lunae secundum et meridianum accipitur diversitas aspectus in longitudine secunda; et erit semper maior prima. Et tempus huius additur eidem tempori cui et prius addebatur. Sed non erit necessario luna adhuc inter nos et solem, sed erit aliquando et huius loci tertii diversitas diversa a secunda, et ideo tertio cum tempore arcus inter hunc locum et meridianum accipitur diversitas sicut prius, et eius tempus additur

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1 et sub F: et locum sub N 1 apparet F: est visibiliter N 2 numerandus plurimum F; *om.* N 2 semper F: *om.* N 3 austrum: numerandus *add.* N 3 versus F: ad N 4 longitudine: [[latitudine]] longitudine N 5 uterque FN 6 aspicientium: fit et *add.* N 6 prima-latitudinem mensuratur F: primus etiam dicitur in longitudine, quia mensuratur secundum partes orbis sive zodiaci in longitudine; secundus vero dicitur in latitudine, quia ad partem orbis vel zodiaci secundum latitudinem mensuratur N 10 in orientem F: ad orientem N 10 luna F: *om.* N 11 quam N: quam quam F 12 aspectus F: aspectus et suae duodecimae propter motum solis N 12 utrimque F: in utramque partem N 13 et-visibilis F: et iam statim haberetur N 15 proiecta F: tracta N 17 aliqualis : [[aequalis]] aliqualis N 18 locum hunc F: hunc locum N 19 secunda F: secundo N 20 prima F: primo N 20 Et-huius F: Et huius et suae duodecimae tempus N 21 et prius F: primo N 21 non-adhuc F: nec erit luna adhuc necessario N 22 tertii F: *om.* N 22 diversa: secundum aliquid *add.* N 24 eius tempus: et suae duodecimae *add.* N 24 additur: tempori *add.* N

cui et primo addebatur. Sed si cum tempore quod nunc excreverit intres tabulam ut prius, nullam invenies diversitatem sensibilem ab ea quae tertio est inventa. Et ob hoc tertio intrando tabulam *accipitur* diversitas in latitudine sicut in longitudine. *(23)* Aequatur autem ter qualibet vice, quia compositor tabulae supposuit coniunctionem esse in principio signi illius in quo est et in complemento horae et lunam esse in longitudine media sui epicycli, et quia ad haec puncta sumpta diversitas diversa erit ad quaecumque alia puncta, tum propter esse lunae superius et inferius in epicyclo, tum propter accessum epicycli lunae ad cenith vel recessum ab eodem, tum etiam propter distantiam solis maiorem vel minorem ab orbe lunae. *(24)* Ex dictis patet quare ad habendum locum lunae et argumentum latitudinis in hora coniunctionis visibilis diversitatem aspectus in longitudine cum sua duodecima loco lunae et argumento latitudinis in hora coniunctionis verae addi oporteat post meridiem et ante minuere ab eodem, quia coniunctio visibilis veram praecedit ante meridiem et post meridiem e converso. *(25)* Amplius quia diversitas aspectus in latitudine est arcus proiectionis lunae ad austrum visibiliter, qui sic se habet ad arcum deferentis lunae sicut 1 ad 11 /214ra/ cum dimidio, ad arcum dico deferentis lunae qui est inter locum lunae in hora coniunctionis visibilis et punctum sui quod tantum distat ab ecliptica quantum locus lunae visibilis: ideo, posita volvella solis supra argumentum latitudinis tertio aequatum et lunae volvella super diversitatem aspectus latitudinis, *habetur argumentum* latitudinis quarto aequatum, quia cuilibet minuto aspectus correspondent 11 minuta cum dimidio limbi; unde, cum diversitas aspectus in latitudine sit arcus protensus orthogonaliter a loco lunae visibili in deferente per partes latitudinis zodiaci, erunt partes sibi de limbo correspondentes arcus a loco proiectionis lunae aequidistanter ductus eclipticae ad contactum deferentis. *(26)* Supra

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1 et primo: et *om.* N 2 ea F: eo N 2 quae-inventa FN 3 tertio intrando F: i.t. N 3 accipitur N: accipiatur F 3 diversitas: et *add.* N 4 ter: quia *add. et exp.* F 6 est F: fit N 7 esse F: *om.* N 7 sui F: *om.* N 8 puncta F: *om.* N 9 et F: vel N 9 accessum-eodem F: accessum vel recessum lunae ad cenith vel ab eodem, et N 14 addi-minuere FN 16 post meridiem F: post N 19 11 F: xi N 21 lunae visibilis: visibilis lunae *cum signis transpositionis* F: visibilis lunae N 24 habetur argumentum N: convenienter argumento F 24 aequatum FN 25 11 F: xi N 29 *(26) om.* N: §22

argumentum autem latitudinis tertio aequatum dextra fiducia volvellae solis posita circa caput draconis vel sinistra circa caudam, invenitur ex hoc arcu argumentum latitudinis quarto aequatum, in partem fiduciae posita volvella lunae; sic enim faciendo intellegitur arcus iste ab argumento latitudinis tertio aequato circa caput minui et circa caudam addi. Itur enim primo modo contra et secundo secundum signorum seu graduum successionem a volvella solis in *volvellam* lunae. *(27)* Ex dictis patet quod locus contactus huius arcus paralleli cum deferente lunae et locus proiectionis eiusdem aequaliter distant ab ecliptica, ex quo sequitur quod quantum eclipsaret luna de sole in ipso puncto contactus, tantum eclipsabit de eo in loco suae proiectionis; unde nulli mirum si luna extra *metam* eclipsis solaris, quae est 7 graduum et 10 minutorum, inventa corporaliter solem quandoque eclipset vel infra existens eum non contingat.

7 volvellam: novella F 12 metam: metas N, *om.* F 12-13 7,10 F: 7,11 (N)

APPENDIX 1. THE TABLES.

1 Tabula aequationis dierum (equation of time)

2 Tabula temporis diurni ad medium septimi climatis (day-length)

3 Tabula deferentis solis inscribendi (equation of sun)

4 Tabula epicycli lunae inscribendi (equation of moon)

5 Tabula mediae coniunctionis solis et lunae in annis Christi collectis ad Parisius (constants for mean syzygies)

6 Tabula mediae oppositionis solis et lunae in annis Christi collectis ad Parisius

7 Tabula coniunctionis et oppositionis solis et lunae in annis Christi expansis

8 Tabula mediae coniunctionis et oppositionis solis et lunae in mensibus Latinorum

9 Tabula punctorum eclipsis solaris inscribendorum (magnitude of solar eclipse)

10 Tabula dimidii durationis eclipsis solaris (half-duration of solar eclipse)

11 Tabula differentiae duarum longitudinum in punctis eclipsis solaris

12 Tabula differentiae duarum longitudinum in dimidio durationis eclipsis solaris inscribendae

13 Tabula punctorum eclipsis lunaris inscribendorum (magnitude of lunar eclipse)

14 Tabula dimidii morae eclipsis lunae (half-duration of totality in lunar eclipse)

15 Tabula dimidii durationis eclipsis lunae (half-duration of lunar eclipse)

16 Tabula differentiae duarum longitudinum in punctis eclipsis <lunae>

17 Tabula differentiae duarum longitudinum in dimidio morae

18 Tabula differentiae duarum longitudinum in dimidio durationis eclipsis <lunae>

19 Tabula diversitatis aspectus lunae ad solem in septimo climate, quae supponit lunam esse in longitudine media epicycli (parallax)

20 Tabula minutorum proportionalium (table of interpolation)

21 Tabula erroris tollendi

22 Tabula temporis aspectus et duodecimae (division by constant)

23 Tabula temporis inter duas oppositiones vel coniunctiones (-"-)

24 Tabula magistri Petri Philomenae de Dacia ad inveniendum portionem cuiuslibet numeri secundum (pro)portionem cuiuslibet alterius ad 30 vel 60 (multiplication)

25 Tabula duodecimae cuiuslibet numeri (division by constant)

This appendix presents full numerical information about the non-trivial tables in F and N, including all numerical variants (but not variants in sub-headings, lay-out, etc.) between the copies of any table in either or both manuscripts.

To decide between the variants, I have mostly tried to re-calculate the tables on the basis of the Toledan tables, thus also ascertaining whether the basic parametres of the two sets of tables are compatible. Adaptations of the Toledan Tables, such as those for Toulouse, which may constitute nearer approximations to those of Peter, have not been available to me.

For reference and general descriptions of the Toledan tables I have relied on Toomer 1968 (=Too); for details I have used the collection in Erfurt WAB 4^{o} 369, 193v-203v (=E), which is appended to the treatise on eclipses 'Ut annos, menses et dies Arabum', in itself probably a paraphrase of the canones Azarchelis 'Quoniam cuiusque'. I have left aside the textual problems of the Toledan tables, thus choosing the convenient alternative in E where it shows corrections, and occasionally using figures from Vat.Ottob.lat.309, Vat.Ottob.lat.1826 and Vat.Pal.lat.1414. - It may be noted that the information on the textual history of the Toledan tables is as yet too incomplete to warrant conclusions involving peculiarities of F and N against the Toledan tables, or peculiarities of F,N and the Toledan tables as against some alternative means of producing FN's tables; if some such conclusion is nevertheless probable, it has been noted.

Generally N's text has been followed; in some cases the source is indicated in the upper left corner of the apparatus.

Tables 9-18.

For the purpose of description, these may all be compared to the Toledan eclipse tales Too 58 (solar eclipses) and Too 59 (lunar eclipses). The procedures to be used in transforming the tables can be summarized as follows:

(a) In all cases, the Toledan tables provide entries for each half-degree of the argument of latitude, and sometimes an extra entry for the argument value considered as the outer limit of the phenomenon. Some

of Peter's tables are constructed in the same way; others, being intended as models for inscribing scales on the instrument, provide entries for round values of the function, together with the corresponding values of the argument of latitude. The two types may be named 'look-up tables' and 'scale-inscribing tables', resp. - The latter might have been made by interpolation in the corresponding Toledan tables, or some table constructed from them.

(b) For each function considered, two Toledan tables are provided, one of them supposing the moon to be in its apogee, the other one for the moon in its perigee. If the moon is elsewhere, the canons prescribe a process of interpolation using the difference between correspondent entries in the tables (any non-existent values being set to zero) and the interpolation function indicated in Table 20. - Peter retains the apogee-tables and discards the perigee-tables, instead providing tables of the differences to be used, intitulated 'Tabula differentiae duarum longitudinum ---'.

(c) Toledan tables are provided giving the distance between start of obscuration and either start of total obscuration, if existent, or middle of obscuration (minuta casus), and, for lunar eclipses, between start and middle of total obscuration (dimidium morae/dimidia mora). The values are given in minutes and seconds of arc. - Peter retains the latter set. Additionally he provides tables of half-durations for both kinds of eclipse. For solar eclipses, the tables correspond to the Toledan minuta casus; for lunar eclipses, the basic values are found by adding correspondent entries in the table of minuta casus and that of dimidium morae, any non-existent values being set to zero.

(d) In Peter's tables just mentioned, the angular values of the function have been converted to hours (or minutes, etc.) of time by multiplication by 13/12 and division by fixed values of the angular velocity of the moon. For the apogee, the value appears to be $0^{\circ};30,18$/hour, and for the perigee, $0^{\circ};36,4$, as given by the table Too 56. - They certainly differ from the values used by Peter in constructing Table 22 and the scales for time of elongation (cf. explicitly App.2 §14); these were obtained by applying the correction of Too 57, assuming the elongation to be always 7°. - However, N, and still more F, confuse the two sets of values, as will be seen from the comments on Table 15 and from App.2 §19.

1. Tabula aequationis dierum.

F,216r; N,255v: Tabula aequationis dierum

Partes zodiaci		Aequatio	P.z.	Ae.	P.z.	Ae.	P.z.	Ae.	P.z.	Ae.	P.z.	Ae.
			1 16	22	5 7	17	6 23	31	8 22	19	9 22	5
Si.	Gr.		2 10	21	5 10	18	7 6	32	8 24	18	9 25	4
0	0	9	2 16	20	5 13	19	7 11	31	8 26	17	9 28	3
0	3	10	2 21	19	5 16	20	7 20	30	8 28	16	10 1	2
0	6	11	2 25	18	5 19	21	7 25	29	9 0	15	**10** 6	1
0	9	12	3 0	17	5 22	22	7 29	28	9 2	14	10 12	0
0	11	13	3 4	16	5 25	23	8 3	27	9 4	13	10 29	1
0	13	14	3 9	15	5 28	24	8 6	26	9 6	12	11 6	2
0	16	15	3 14	14	6 1	25	8 8	25	9 8	11	11 10	3
0	19	16	3 20	13	6 5	26	8 10	24	9 10	10	11 14	4
0	23	17	3 28	12	6 8	27	8 13	23	9 13	9	11 18	5
0	26	18	4 13	13	6 11a	28	8 16	22	9 15	8	11 21	6
1	1	19	4 23	14	6 15	29	8 18	21	9 17	7	11 24	7
1	5	20	4 28	15	6 18	30	8 20	20	9 19	6	11 27	8
1	9	21	5 3	16								

(a) 11 N: 12 F

Cf.Too7, 'Elevationes signorum in circulo directo', heading 'Aequatio dierum'. The table of E, starting with Aries corresponding to Peter's sign 0, gives the equation, in degrees and minutes of arc, for each integer degree of the zodiac.

As is seen from (2,24), Peter's table is not meant to be used for interpolation; instead, given a degree of the zodiac, the equation should be sought under this or the next lower one. Correspondingly, to convert the Toledan table to Peter's, the following might be done: multiply the Toledan values by 4, thus converting to minutes of time; then, starting from the top of the table, note (1) the first degree whose function value can be rounded to an integer higher than the current one (or lower, if the values happen to be descending); then note (2) the new integer as function of the degree already noted. - If this is done, only three values remain unexplained, as shown in the following specimen:

Degree	Toledan (x 4)	Peter	Degree	Toledan (x 4)	Peter	Degree	Toledan (x 4)	Peter
8	11;28		14	13;36		19	15;16	16(!)
9	11;48	12	15	13;56		20	15;34	
10	12;12		16	14;16	15(!)	21	16;0	
11	12;32	13	17	14;36		22	16;20	
12	12;56		18	14;56		23	16;44	17
13	13;16	14(!)						

Peter's values 14,15,16 all seem to have slid up one place. This may be due to a similar fault in the copy of the Toledan table presumably used by Peter.

The Toledan table is the same as al-Battani's, but different from the Handy Tables (Too p.35). The discrepancy between the Toledan table and

al-Battani (Too, ibid.) would not affect Peter's table on the above assumptions.

I have not seen the table indicated to Too, ibid., giving the equation in minutes and seconds of time. - The Alfonsine table (Vat.Pal.lat.1374, 33; Ottob.lat.1826,151v) differs markedly from the Toledan one and would not yield Peter's values.

2. Tabula temporis diurni ad medium septimi climatis.

F,216v: Tabula temporis diurni ad medium septimi climatis
N,256v: (same heading)

Aries / Virgo		Temp. diur.		Taurus / Leo		Temp. diur.		Gemini / Cancer		Temp. diur.		Libra / Pisces		Temp. diur.		Scorp. / Aquar.		Temp. diur.		Sagit. / Caprc.		Temp. diur.	
Gr	Gr	Ho	Mi	Gr	Gr	Ho	Mi	Gr	Gr	Ho	Mi	Gr	Gr	Ho	Mi	Gr	Gr	Ho	Mi	Gr	Gr	Ho	Mi
0	30	12	0	0	30	13	46	0	30	15	16	0	30	12	0	0	30	10	14	0	30	8	44
1	29	12	4	1	29	13	50	1	29	15	18	1	29	11	56	1	29	10	10	1	29	8	42
2	28	12	7	2	28	13	53	2	28	15	21	2	28	11	53b	2	28	10	7	2	28	8	39
3	27	12	11	3	27	13	56	3	27	15	23	3	27	11	49	3	27	10	4	3	27	8	37
4	26	12	14	4	26	14	0	4	26	15	25	4	26	11	46	4	26	10	0	4	26	8	35
5	25	12	18	5	25	14	3	5	25	15	27	5	25	11	42	5	25	9c	57	5	25	8	33
6	24	12	21	6	24	14	6	6	24	15	29	6	24	11	39	6	24	9	54	6	24	8	31
7	23	12	25	7	23	14	9	7	23	15	31	7	23	11	35	7	23	9	51	7	23	8	29
8	22	12	29	8	22	14	12	8	22	15	33	8	22	11	31	8	22	9	48	8	22	8	27
9	21	12	32	9	21	14	15	9	21	15	35	9	21	11	28	9	21	9	45	9	21	8	25
10	20	12	36	10	20	14	19	10	20	15	37	10	20	11	24	10	20	9	41	10	20	8	23
11	19	12	40	11	19	14	22	11	19	15	39	11	19	11	20	11	19	9	38	11	19	8	21
12	18	12	43	12	18	14	25	12	18	15	40	12	18	11	17	12	18	9	35	12	18	8	20
13	17	12	47	13	17	14	28	13	17	15	42	13	17	11	13	13	17	9	32	13	17	8	18
14	16	12	50	14	16	14	31	14	16	15	43	14	16	11	10	14	16	9	29	14	16	8	17
15	15	12	54	15	15	14	35	15	15	15	44	15	15	11	6	15	15	9	25	15	15	8	16
16	14	12	57	16	14	14	38	16	14	15	46e	16	14	11	3	16	14	9	22	16	14	8	14
17	13	13	1	17	13	14	40	17	13	15	47	17	13	10	59	17	13	9	20	17	13	8	13
18	12	13	4	18	12	14	44	18	12	15	48	18	12	10	56	18	12	9	16	18	12	8	12
19	11	13	8	19	11	14	47	19	11	15	49	19	11	10	52	19	11	9	13	19	11	8	11
20	10	13	12	20	10	14	49	20	10	15	50	20	10	10	48	20	10	9	11	20	10	8	10
21	9	13	15	21	9	14	52	21	9	15	51	21	9	10	45	21	9	9	8	21	9	8	9
22	8	13	18	22	8	14	55	22	8	15	52	22	8	10	42	22	8	9	5d	22	8	8	8
23	7	13	22	23	7	14	58	23	7	15	53	23	7	10	38	23	7	9	2	23	7	8	7
24	6	13	25	24	6	15	1	24	6	15	53	24	6	10	35	24	6	8	59	24	6	8	7
25	5	13	29a	25	5	15	3	25	5	15	54	25	5	10	31	25	5	8	57	25	5	8	6
26	4	13	32	26	4	15	6	26	4	15	54f	26	4	10	28	26	4	8	54	26	4	8	6
27	3	13	36	27	3	15	9	27	3	15	55	27	3	10	24	27	3	8	51	27	3	8	5
28	2	13	39	28	2	15	11	28	2	15	55	28	2	10	21	28	2	8	49	28	2	8	5
29	1	13	43	29	1	15	13	29	1	15	55	29	1	10	17	29	1	8	47	29	1	8	5
30	0	13	46	30	0	15	16	30	0	15	56	30	0	10	14	30	0	8	44	30	0	8	4

(a) 29 N: 28 F (b) 53 N: 52 F (c) 9 N: 10 F (d) 5 N: 7? F
(e-f) F shifts the section '46-54' two places down, superseding '55 55' in line 27-28 and adding '48 44' in line 16-17.

Not among the Toledan tables. Cf. Too26, whose heading in E is 'elevationes signorum in 7° climate, cuius latitudo 48 gradus 0 in minutis, horae aequales 15 et 56 minuta'. This gives the ascendants, in degrees and minutes of arc, for each integer degree of the zodiac.

The table of FN fulfils two symmetry relations, setting Aries $0^{o}=0^{o}$:
$f(x)=f((180^{o}-x) \textit{mod}\ 360^{o})$, which is used for giving a double argument to each column of the table;
$f(x)=24-f(360^{o}-x)$, which is fulfilled without exception by N's table. Wherever F deviates from N, F breaks the condition.

Consequently, to compare parametres, it suffices to check the interval 0^{o}-89^{o}. If FN's value is called f(x) and the Toledan one g(x), one should have $f(x)=(((g(x+180^{o})-g(x)) \textit{mod}\ 360^{o})/15$. At the points $0^{o},10^{o},\ldots,90^{o}$, and at the points where F and N differ, N's values can be exactly reproduced in this way.

A table in Vat.Pal.lat.1367, 81r-82r (XVth cent.), among some so-called additions to the Alfonsine tables, contains numbers comparable to those of Peter, but with many minor deviations.

3. Tabula deferentis solis inscribendi.

F,210v: Tabula deferentis solis inscribendi
N,246r: Tabula zodiaci inscribendi

Arcus aequationum Gr.	M.	Partes deferentis Si.	Gr.	A.A.	P.D.	A.A.	P.D.	A.A.	P.D.
				1 43	4 20	0 38	8 0	1 58	11 10
				1 52	5 0	0 17	8 10	1 59	11 20
				1 57	5 10	0 4	8 20	1 56	0 0
0	4	2	20	1 59	5 20	0 26	9 0	1 49	0 10
0	24	3	0	1 57	6 0	0 46	9 10	1 36	0 20
0	43	3	10	1 52	6 10	1 5	9 20	1 26	1 0
1	1	3	20	1 43	6 20	1 22	10 0	1 11	1 10
1	18	4	0	1 31	7 0	1 36	10 10	0 54	1 20
1	32	4	10	1 15	7 10	1 47	10 20	0 36	2 0
				0 58	7 20	1 54	11 0	0 16	2 10

F and N identical

Cf. Too37, 'Aequatio solis'. The table of E gives the equation, in degrees, minutes and seconds of arc, for each integer degree of the zodiac.

To convert the Toledan table to Peter's, the argument values should be shifted such as to make an argument of $2^{s}18^{o}$ in Peter correspond to 0^{o} in the Toledan table. - If this is done, Peter's values correspond to the rounded Toledan ones except for:

Peter		Toledan	
Degree	Equation	Degree	Equation
$4^{s}20^{o}$	1;43	$2^{s}\ 2^{o}$	1;43,31 (*or* 1;43,21)
0 20	1;36	10 2	1;39,5

The shift of $2^{s}18^{o}=78^{o}$ noted above corresponds to the position of the apogee of the sun in the eighth sphere, which is commonly given as $2^{s}17^{o};50$, cf. Too p.45 and O.Pedersen 1976 p.44.

The Toledan table is taken from al-Battani, whose source is the Handy Tables (Too p.56). The discrepancies noted by Toomer, ibid., would not affect Peter's table.

4. Tabula epicycli lunae inscribendi.

F,210v; N,246r: Tabula epicycli lunae inscribendi

Arcus aequationum Gr.	M.	Partes epicycli Si.	Gr.	A.A.		P.E.		A.A.		P.E.		A.A.		P.E.	
				2	41	1	5	4	57	2	25	3	46	4	15
				3	1	1	10	5	0	3	0	3	27	4	20
				3	20	1	15	5	1	3	5	3	6	4	25
0	24	0	5	3	38	1	20	5	0	3	10	2	43	5	0
0	48	0	10	3	54	1	25	4	57	3	15	2	18	5	5
1	12	0	15	4	9	2	0	4	51	3	20	1	52	5	10
1	35	0	20	4	22	2	5	4	42	3	25	1	25	5	15
1	58	0a	25	4	34	2	10	4	32	4	0	0	57	5	20
2	20	1	0	4	43	2	15	4	19	4	5	0	29	5	25
				4	51	2	20	4	4	4	10	0	0	6	0

(a) O N: 1 F

Cf. Too39, 'Tabula -- aequationis lunae', heading 'aequatio argumenti'. The table of E gives the equation, in degrees, minutes and seconds of arc, for each integer degree on the epicycle. The table has a double argument, giving equation(x)=equation(360°-x).

Peter's table agrees with the rounded Toledan values, except for one deviation, which is probably a round-off error, namely:

Argument	Toledan	Peter
3s25°	4;42,34	4;42

(E's values for arguments greater than or equal to 151° are in fact the values of the latitude of the moon, mis-copied when the table was compiled. The same error occurs in Vat.Pal.lat.1414,146, whereas Vat.Ottob. lat. 1826, 122r has the correct values.)

The Toledan values are in general agreement with al-Battani and the Handy Tables (Too p.59). The deviations there noted between the Toledan tables and al-Battani would not affect Peter's table. I have not seen the Handy Tables, which give two-place equation values like Peter's.

5. Tabula mediae coniunctionis solis et lunae in annis Christi collectis ad Parisius.

F,211r: Tabula mediae coniunctionis solis et lunae
in annis Christi collectis ad Parisius
N,247v: Tabula mediae coniunctionis solis et lunae
in annis Christi solaribus ad Parisius

Anni Christi collecti	Tempus mediae coniunctionis solis & lunae				Medius motus solis & lunae				Argumentum lunae verum				Argumentum latitudinis lunae			
	D.	Ho	Mi	2a	Si	Gr	Mi	2a	Si	Gr	Mi	2a	Si	Gr	Mi	2a
1217	8	20	51	5	9	16	37	33	7	0	10	18	4	27	22	10d
1241	13	10	55	35	9	20	59	31	10	17	44	1	8	16	31	26
1264	18	1	0	5a	9	25	21	29	2	5	17	43	0	5	40	42
1289	22	15	4	36	9	29	43	27	5	22	51	26	3	24	49	59
1313	27	5	9	6	10	4	5	25	9	10	25	9	7	13	59	15
1337	2	6	29	33	9	9	21	3	0	2	9	51	10	2e28		17f
1361	6	20	34	3	9	13	43	1	3	19	43	34	1	21	37	34
1385	11	10	38	34	9	18	4	58	7	7	17	17	5	10	46	50
1409	16	0	43	4	9	22	26	56	10	24	51b59		8	29g56		6
1433	20	14	47	34	9	26	48	54	2	12	24c42		0	19	5	22h

N. - F lacks first column.
(a) 5 N: 6 F, perhaps rightly (b) 51 FN: rightly 50 (c) 24 F: 25 N
(d) 10 F: 9 N (e) 2 N: (blank) F (f) 17 N: 27 F (g) 29 N: 9 F
(h) 22 F: 23 N

The tables of F and N give data concerning the first mean conjunctions in single years at 24-year intervals. N's table covers the years 1217-1433, that of F the wider interval 1073-1601. The part common to F and N is reproduced above.

A re-calculation of six entries from the Toledan tables in E,193v ff. (cf. Too 52-55), and from Campanus' tables in E,213 ff., lead to the following preliminary observations: For the same conjunctions, Peter's conjunction times are about 12^m greater than the Toledan ones and about $65^m;20$ less than Campanus'. For the three last columns, Campanus' values and the Toledan ones are equal within some 10 seconds, larger differences being probably due to errors; Peter's values are all less, differing from the others by about $0^o;1,12$ / $0^o;24$ / 0;27, respectively. Slight trends in some of the differences suggest that the parametres were not quite equal. Thus Peter probably calculated the table from his own set of parametres.

The difference in longitude between Paris and Toledo seems to be most commonly set at about 12^o or 48^m instead of the 12^m implicit in this table. (Duhem III, 518 should probably read $11^o30'$, not II^o30'.) The value of 12^m does approximately explain N's variant in (2,24) 'civitatis cuius longitudo ad orientem de Parisius est 32 minutorum temporis' if one might only read 'occidentem'. But this should probably not be taken too seriously.

An estimate of the parametres used can be most easily had from F's values for 1073 and 1601, a period containing 6531 synodic months:

1073	10	21	8	7	9	19	32	5	10	10	37	2	8	3	6	46
1601	23	4	35	3	9	28	16	20	2	19	31	41	3	2	30	2

Together with a control calculation in Table 7 this gives the results

T_s=29^d.530594146(5-7) for the length of a synodic month,
$w_\odot$= 0^s.970186993(2-4) for the mean monthly motion in longitude of the sun,
w_a=12^s.860556886(6) for the mean monthly motion in argument of moon,
w_d=13^s.022351798(7-8) for the mean monthly motion in argument of latitude.

The numbers in parentheses indicate the possible values for the last decimal given. This precision should be sufficient for textual purposes. - When appropriately transformed, the values reproduce the Toledan ones calculated by Too p.44, as against the values of Ptolemy.

The period covered by N's table contains 2672 synodic months, namely, 296 for the interval 1313-1337 and 297 for all others. Then each column can be re-calculated as the appropriate multiples of the parametres above, plus the relevant value for 1217, allowing for a round-off error of up to half-a-second in that value.

With the choice of readings indicated above, and except for the error common to F and N, the table can be reproduced using the parametres mentioned.

6. Tabula mediae oppositionis solis et lunae in annis Christi collectis ad Parisius.

F,211r: Tabula mediae oppositionis solis et lunae
in annis Christi collectis ad Parisius
N,247v: Tabula mediae oppositionis solis et lunae
in annis Christi solaribus ad Parisius

Anni Christi collecti	Tempus mediae oppositionis solis & lunae	Medius motus solis & lunae	Argumentum lunae verum	Argumentum latitudinis lunae
	D. Ho Mi 2a	D. Ho Mi 2a	D. Ho Mi 2a	D. Ho Mi 2a
1217	23 15 13 7 d	10 1 10 43	1 13 4 48 h	11 12 42 17
1241	28 5 17 37 e	10 5 32 41	5 0 38 31 j	3 1 51 33
1265	3 6 38 4	9 10 48 19	7 22 23 14g	5 20 20 35
1289	7 20 42 34	9 15 10 17	11 9 56 56	9 9 29 42
1313	12 10 47 5	9 19 32 15	2 27 30 39	0 28 39 8
1337	17a 0 51 35	9 23 54 13	6 15 4 21	4 17 48 24
1361	21 14 56 5	9 28 16 11	10 2 38 4	8 6 57 41
1385	26 5 0 35	10 2 38f 9	1 20 11 47	11 26 6 57
1409	1 6 21 2	9 7 53 46	4 11 56 29	2 14 35 59
1433	5 20 25b33c	9 12 15 44	7 29 30 12	6 3 45 15k

N. - F lacks the first column.
(a) 17 N: 18 F (b) 25 N: 35 F (c) 33 F: 32 N (d) 10,1,10,43 F: 9,2,4,24 N(should be 9,2,4,23) (e) 10,5,32,41 F: 9,6,26,21 N
(f) 38 N: 28 F (g) 14 N: 15 F: 13 rightly (h) 11,12,42,17 F: 10,12,2,2 N(should be 10,12,2,3) (j) 3,1,51,33 F: 2,1,11,19 N
(k) 15 F: 16 N

For the ranges of the tables in F and N, cf. to Table 5.

The period covered by this section of F's table contains 2671 synodic months, namely, 296 for the periods 1241-1265 and 1385-1409, and 297 for all others.

Then, for control, each column could be calculated like those of Table 5, coupling the respective round-off adjustments to the values for 1217. The apparatus above reflects such a calculation.

N's table, at least, was probably not calculated in this manner. Indeed, the variant values (d,e,h,j) in N lie one month before those of F, thus improperly assigning 297 months to the period 1241-1265. This probably means that the variant values were constructed by subtracting the half-monthly mean motus, resp. the half-monthly mean motion of the argument of latitude, from the corresponding values in Table 5, as would be proper for some other values. But it should be admitted that some minor variants cannot be explained in this way.

7. Tabula coniunctionis et oppositionis solis et lunae in annis Christi expansis.

F,211r: Tabula coniunctionis et oppositionis solis et lunae in annis Christi expansis ad Parisius
N,248r: Tabula communis mediae coniunctioni et oppositioni solis et lunae in annis Christi solaribus expansis

(Selected rows:)

(n)	Anni Christi expansi	Tempus coniunctionis vel oppositionis solis et lunae				Medius motus solis et lunae				Argumentum lunae verum				Argumentum latitudinis lunae			
		D.	Ho	Mi	2a	Si	Gr	Mi	2a	Si	Gr	Mi	2a	Si	Gr	Mi	2a
(11)	1324/1300	0	20	8	27a	11	28	21	47	9	1	4	20	7	1	11	43
(13)	1326/1302	23	2	31	7	11	6	53	51	5	20b	40	23	7	17	17	19
(17)	1330/1306	7	13	48	20	11	22	10	41	0	21	30	30	10	20	49c	59
(20)	1333/1309	10	22	38	16	11	19	5	8	8	16	43	35	0	15	37	37
(21)	1334/1310	21	13	49	36	11	8	21	11	6	26	31	37	0	23	40	24
(23)	1336/1312	13	7	28	13	11	15	59	35	4	11	56	41	2	10	26	14

N: variants from F concerning these rows only. - F has the (n)-column and lacks the column of years.
(a) 27N: 37 F (b) 20 N: 5 F (c) 49 FN: correctly 48

To compute the table one needs the number of days within n years
$d(n) = [365.25n]$

and the number of synodic months completed within n years
$p(n) = [d(n)/T_s]$.

Then the column 'Tempus...' gives the time between the end of the last synodic month in the n'th year and the end of that year, i.e.
$d(n) - p(n)T_s$

and the three last columns show, respectively, the longitude of the sun, the mean argument of the moon, and the mean argument of latitude at the end of the last synodic month of the n'th year, i.e.
$p(n)w_\odot$, $p(n)w_a$, and $p(n)w_d$.

N's table is exactly reproduced using the values above, but for one error shared with F. F has some 5 further erroneous readings.

The values are very close to the ones used in the Tabulae Novarienses (e.g.Vat.lat.3118, 54v, and closer still, Erfurt WAB 4° 369, 214v) whereas they deviate considerably from the Alfonsine values (e.g. Erfurt WAB 4° 362, 38).

8. Tabula mediae coniunctionis et oppositionis solis et lunae in mensibus Latinorum.

F,211ra: (as above)
N,248r: Tabula communis mediae coniunctioni et oppositioni solis et lunae in mensibus kalendaribus

Mensis	Tempus mediae coniunctionis vel oppositionis				Medius motus solis et lunae				Verum argumentum lunae				Argumentum latitudinis lunae			
	D.	Ho	Mi	2a	Si	Gr	Mi	2a	Si	Gr	Mi	2a	Si	Gr	Mi	2a
Ianuarius	29	12	44	3	0	29	6	20	0	25	49	0	1	0	40	14
Februarius	28	1	28	7	1	28	12	40	1	21	38	0	2	1	20	28
Martius	29	14	12	10	2	27	18e	1	2	17	27	0	3	2	0	42
Aprilis	28	2	56	13	3	26	25	21	3	13	16	1	4	2	40	56
Maius	27	15	40	17	4	25	31	41	4	9	5	1	5	3	21	10
Iunius	26	4	24	20	5	24	37f	1	5	4	54	1	6	4	1	24
Iulius	25	17	8	23	6	23	44	21	6	0	43	1	7	4	41	38
Augustus	24	5	52	27	7	22	50	42	6	26c	32	1	8	5	21	52
September	22	18	36	30	8	21	57	2	7	22	21	1	9	6	2	6
October	22	7	20	33	9	21	3	22	8	18	10	1	10	6	42	20
November	20	20	4	37	10	20	9	42	9	13	59	2	11	7	22	34
December	20	8	48a	40	11	19	16	2	10	9	48b	2	0d	8	2	48

(a) 48 N: 8 F (b) 48 F: 49 N (c) 26 N: 36 ?F (d) 0 N: 12 F
(e) 18 FN: 19 correctly (f) 37 FN: 38 correctly

The table gives the first twelve multiples of the parametres mentioned in the notes on Table 7. In the column 'Tempus' the n'th multiple has been decremented by the number of days in the (n-1) first months of a normal year.

The values exhibited are those calculated from the parametres mentioned, except for the two errors (ef) common to F and N.

9. Tabula punctorum eclipsis solaris inscribendorum.

F (no table, cf. App.2 §7)
N,246r: Tabula punctorum eclipsis solaris inscribendorum (N1:in text)
N,258r: Tabula punctorum eclipsis solaris (N2: in addenda)

Argumentum latitudinis Gr.	Mi.	Pc.	Mi.
6	37	0	0
6	3	1	0
5	27	2	0
4	51	3	0
4	17	4	0

Gr.	Mi.	Pc.	Mi.
3	42	5	0
3	7	6	0
2	33	7	0
1	58	8	0
1	23	9	0
0	48	10	0
a 0	13	11	0
0	0	11b	45

N1
N2 is similar to N1, but the entries are in reverse order. (a) Entry omitted by the text of F (1,26), rightly. (b) 11 N: 10F(1,26), rightly.

E has the outer limit of 6^{o};37 and the correct maximum value of 10;45, both shared by the text of F. N's two last entries are probably due to a misreading of this value; the argument 0^{o};13 may have been extrapolated from the entries for 9 and 10 digits.

The rest of N's table can be exactly reproduced by interpolation in E's table. Alternatively, when following the instructions of F(1,26), the argument values are reproduced within 1 minute of arc.

10. Tabula dimidii durationis eclipsis solaris.

F,210v: Tabula dimidii durationis eclipsis solaris
N,246r: (same heading) (N1,in text)
N,258r: (same heading) (N2,in addenda)

Argumentum latitudinis Gr.	Mi.	§ Ho.	Mi.
a 6	37	0	0
6	34	0	5
a 6	31	0	10
6	24	0	15
a 6	15	0	20
6	5	0	25
a 5	53	0	30
5	36	0	35
a 5	15	0	40

A.L.					
	4	50		0	45
a	4	21		0	50
	3	42		0	55
a	2	46	b	1	0
a	2	35		1	1
a	2	21		1	2
a	2	4		1	3
a	1	43		1	4
a	1	18		1	5
	0	39		1	6
a	0	0	c d	1	6

N1
(§) Horae F: Pc.N1: 0 N2 (a) These entries occur in F and N2, in reverse order. (b) FN2 gives this and the following function values as 0;60 etc. (c) 0 FN1: 1 N2 (d) 1;6 N1: 0;66 N2: 0;60 F

Two versions of the table are seen to occur, one in the text of N and the other in N's addenda and F. Both can be exactly reproduced by procedures (d) and (a) above p.47(f.),reading f(4;30)=22;41 in the Toledan table of minuta casus.

11. Tabula differentiae duarum longitudinum in punctis eclipsis solaris.

N,246r: Tabula differentiae duarum longitudinum in punctis eclipsis solaris (N1, in text)
N,258r: (same heading) (N2, in addenda)
F omits the table.

Argumentum latitudinis					A.L.			
	Gr.	Mi.		Mi.				
					5	0		59
					4	30		59
a	7	11	0	0	4	0		59
	7	5	0	10	3	30	0	59
a	6	58	0	20	3	0	0	59
	6	50		30	2	30	0	59
a	6	43		40	2	0		59
a	6	36		50	1	30		59
	6	30	0	58	1	0		59
	6	0	0	58	0	30	0	59
a	5	30	0	58	a 0	0	0	59

N1
(a) These entries occur in N2, in reverse order and lacking the column of zeros.

The outer limit of 7°;11 is that of E's table concerning the perigee.

Between the values 0°;0 and 6°;30 of the argument of latitude, the values obtained by procedure (a) above p. 47 vary between 0;55 and 1;0, accepting the correction from al-Khwarizmi, Too p.87. The deviations appear to occur irregularly. (In fact, they are partly reproduced in a table similar to N1 in the Alfonsine collection Vat.Lat.3116, 28r: cf. Table 25). - By contrast, N's values appear to be smoothed or re-calculated. N2 may be taken to indicate the choice of values for N1 in this range.

Above the value 6°;30 of the argument of latitude, N's values appear to be found by interpolation, setting f(6°;30)=0;58 (result of procedure (a)) and f(7°;11)=0;0. This reproduces the intermediary values of the argument of latitude within 1 minute of arc. Incidentally, the value 6°;36 of the argument is still within the common range of the Toledan apogee- and perigee-tables, and so f(6°;36) should have been about 0;58. On the other hand, the argument 6°;30 is the last one common to the two tables, so that the deviation can be explained by the choice of convenient limits for interpolation. - The admissibility of this method will not be discussed here. Note that a different method is used in Table 16.

12. Tabula differentiae duarum longitudinum in dimidio durationis eclipsis solaris inscribendae.

N,246r: Tabula differentiae duarum longitudinum in dimidio durationis eclipsis solis inscribendae (N1, in text)
N,258r: Tabula differentiae duarum longitudinum in dimidio durationis eclipsis solaris (N2, in addenda)
F omits the table.

Argumentum latitudinis				A.L.			
Gr.	Mi.		Mi.		5	30	0 2
				a	5	0	0 0
a 7	11	0	0	a	4	40	0 1
7	5	0	10	a	4	17	0 2
a 7	0	0	17	a	3	50	0 3
a 6	41	0	15	a	3	2	0 4
a 6	14	0	10	a	2	7	0 5
a 5	55	0	5	a	1 b	0	0 6

N1
(a) These entries occur in N2, in reverse order and lacking the column of zeros. (b) 1 N1:0 N2

For arguments below 6^{o}; 30, the table is reproduced to within two sexagesimals in the values of the argument by application of the procedures (d), (b) and (a) to the Toledan tables of minuta casus. This seems to imply some slight error. - It turns out that the values for arguments below ca. 5^{o} are to be taken as negative, which explains the remark in (2,49).

I cannot explain the value $f(7^{o})=17$ (unless it were mistakenly picked up from the tables of magnitude of solar eclipses): if the Toledan table has $g(7^{o})=7;56$, the value should be about 14. But if the value 17 is used for interpolation to both sides, the two remaining argument-values above $6^{o};30$ are reproduced.

In the perigee-table, N's readings were probably those given by Too for the Toledan tables rather than for al-Khwarizmi.

13. Tabula punctorum eclipsis lunaris inscribendorum.

F (no table, see App.2 §7)
N,245v: Tabula punctorum eclipsis lunaris inscribendorum

Argumentum latitudinis				A.L.			
Gr.	Mi.	Pc.	Mi.	5	7	11	
				5	39	10	
0	0	20	46	6	10	9	
0	25	20		6	41	8	0
0	56	19		7	12	7	
1	28	18		7	44	6	
2	0	17		8	16	5	
2	31	16	0	8	47	4	0
3	2	15		9	19	3	
3	34	14		9	50	2	
4	5	13		10	20	1	
4	36	12	0	10	50	0	0

The maximum obscuration of 20;46 (shared by F(1,11)) is identical to that of Too 60, and different from that of the Tabula Azarchelis, Too 61.

N's values of the argument can be exactly reproduced by procedure (a). The table not being linear, interpolation over longer stretches yields only

tolerable results: for example, when following F's instructions in (1,11), N's arguments are reproduced to within 4 minutes of arc.

N's eclipse limit of $10^{o};50$ does not occur in the Toledan tables (Too p.92). It may have been found by extrapolation from the Toledan entries for $10^{o};0$ and $10^{o};30$ rather than reproduced form al-Khwarizmi (Too ibid.). On both accounts, F's eclipse limit of $10^{o};49$ (in 1,11) remains unexplained.

14. Tabula dimidii morae eclipsis lunaris.

F,216r: Tabula dimid(ii) morae eclipsis lunae
N,256r: Tabula dimidii morae eclipsis lun(ae) (N1, in text)
N,258r: Tabula dimidiae morae (N2, in addenda)

Argumentum latitudinis			Dimi-dium morae	Diff. intro-ituum
c Gr.	Mi.		d	Mi.
4	36		0	0
4	0		22	22
3	30		27	5
3	0		34	7
2	30		38	4
2	0		41	3
1	30		43	2
1	0		45	2
0	30	a	46	1
b 0	0		46	0

Argumentum latitudinis			
Gr.	Mi.		Mi.
0	0		46
0	57		45
2	12		40
2	52		35
3	28	a	30
4	2		20
4	9		10
4	16		0

FN1
(a) 30 N:0 F (b) Entry missing in F (c) Gr.Mi. F:Si.Gr. N
(d) Heading missing in F

N2
(a) 28 corrected from 18, or vice versa

FN1's values for arguments less than or equal to 4^{o} can be exactly reproduced by procedure (d), assuming $f(3^{o};30)=12;47$ (e.g.: no evidence) rather than 13;47 in the Toledan table.

The outer limits given do not appear to be in the Toledan tables.

N2's table can be exactly reproduced by procedures (d) and (a) if the angular velocity of the moon is taken to be $0^{o};30,12$/hour (cf. to Table 23) instead of $0^{o};30,18$/hour, and if interpolation is assumed between the entries $f(4^{o};0)=22.28$, deriving from the Toledan table, and $f(4^{o};16)=0$.

The reading 28 in N2's table presupposes the reading $f(3^{o};30)=13;47$ as according to E (cf. above and to Table 17). The reading 12;47 would imply the reading 19 (rounded from 18.51).

15. Tabula dimidii durationis eclipsis lunaris inscribendi.

F,210v: Tabula dimidii durationis eclipsis lunae
N,245v: Tabula dimidii durationis eclipsis lun(aris) inscribendi (N1)
N,245v: (same table as above, including corrections) (N2)

Argumentum latitudinis Gr.	Mi.	Ho.		Mi.
0	0	0		109
2	43	0		105
4	12	0		100
5	14	0		95
6	4	0	a	90
6	44	0		85
7	19	0		80
7	50	0		75
8	16	0		70
8	39	0		65
9	1	0	b	60
9	37	0		50
10	3	0		40
10	23	0		30
10	35	0		20
10	42	0		10
10	50	0		0

N1
(a-b) 90-60: 95-65 N1

Argumentum latitudinis Gr.	Mi.	a Ho.	Mi.
0	0	1	49
2	50	1	45
4	9	1	40
5	18	1	35
6	6	1	30
6	47	1	25
7	20	1	20
7	51	1	15
8	17	1	10
8	40	1	5
9	2	1	0
9	38	0	50
10	4	0	40
10	23	0	30
10	34	0	20
10	42	0	10
10	49	0	0

FN2
(a) In N2, the columns of hours and minutes are the same as those of the preceding table.

N's table exists in two versions, the original values of the argument of latitude having been corrected. The corrections are identical with the readings of F's table.

For the upper limits $10^{o};50$ and $10^{o};49$, see the comments on Table 13.

The first table can be exactly reproduced by application of procedures (c), (d) and (a) above, except once, where my copies of the Toledan tables read:

(Longitudo longior:)

Arg.lat.	Mora	Casus	Dim.dur.	
$4^{o};30$	0	41;4	41;4	($88^{m}.09$)
$4^{o};0$	10;21	36;42	47;3	($100^{m}.93$)

The variant 41;4 is well-attested, but for this purpose a value between 45;55 and 46;1 would be needed.

The second table can be reproduced analogously to the first one, if the value $0^{o};30,12$/hour is assigned to the angular velocity of the moon. The reproduction is exact except twice, namely, for 95^{m} where the calculated argument is $5^{o};17$ (against $5^{o};18$), and for 100^{m} where it is 4;3 (against 4;9), keeping the Toledan readings shown above. I cannot explain these deviations.

16. Tabula differentiae duarum longitudinum in punctis eclipsis lunaris.

F,216r: Tabula differentiae duarum longitudinum in punctis eclipsis
N,256r: Tabula differentiae duarum longitudinum in punctis (N1,in text)
N,258r: Tabula differentiae duarum longitudinum in punctis eclipsis lunae (N2,in add.)

Argumentum latitudinis				Diff. intro-ituum	Argumentum latitudinis			
Gr.	Mi.	Pc.	Mi.	Mi.	Gr.	Mi.	Pc.	Mi.
13	0	0	26	0	0	0	0	45
12	30	1	13	47	0	19	0	50
12	0	2	2	49	0	56	1	0
11	30	2	50	48	1	39	1	10
11	0	3	36	46	2	19	1	20
10	30	3	54 a	18 b	2	49	1	30
10	0	3	49 c	5	3	20	1	40
9	30	3	30 d	19	3	56	1	50
9	0	3	19	11	4	12	2	0
8	30	3	9	10	4	25	2	10
8	0	3	1	8	5	42	2	20
7	30	3	1	0	6	21	2	30
7	0	2e	48	13	6	44	2	40
6	30	2	33	15	7	5	2	50
6	0	2	23	10	7	0	3	0
5	30	2	18	5	8	33	3	10
5	0	2	13	5	9	3	3	20
4	30	2	14	1	9	30	3	30
4	0	1f	51 g	23	9	46	3	40
3	30	1	43	8	10	3	3	50
3	0	1	34	9	10	30	3	54
2	30	1	23	11 h	11	4	3	30
2	0	1	15	8	11	23	3	0
1	30	1	8	7	11	43	2	30
1	0	1	1	7 i	12	1	2	0
0	30	0j	53 k	8	12	20	1	30
0	0	0	45	8	12	38	1	0
					12	57	0	30
					13	12	0	20
					13	31	0	10
					13	50	0	0

FN1

(a) 54 N1: 57 ?F (b) 18 N1:48 F
(c) 49 N1: 59 F (d) 30 N1: 10 F
(e) 2 N1: 3 F (f) 1 N1: 2 F
(g) 51: 15 FN1 (h) 11 N1: 5 ?F
(i) 7 N1: 8 F (jk) 0,53 N1: 1,43 F

N2

The maximum argument, 13°, of FN1's table is equal to that of the Toledan table for the perigee.

Using procedure (b), FN1's values can be exactly reproduced in all cases but two, namely,

Arg.lat.	Pc(apog)	Pc(perig)	Diff.	N1	F
4^{o};0	13;9	15;0	1;51	1;15	2;15
1^{o};30	17;57	19;0	1;3	1;8	1;8

Both deviations are probably copyist's errors from some common ancestor of F and N.

N2's table was presumably made by interpolation in the table of FN1: in fact it can be reproduced exactly in this way except for three values of the argument, assuming that the values 13^{o};12 and 13^{o};31 were determined by interpolation between f(13^{o})=26 and f(13^{o};50)=0. - It may be noted that N2 has read the correct value 1;51 in the first case mentioned above, and the value 1;8 in the second. - I cannot explain the upper limit of 13^{o};50.

A table similar to that of FN1 is found in Vat.lat.3116,27r; it has the values printed above, except for the correct f(1^{o};30)=1;3.

17. Tabula differentiae duarum longitudinum in dimidio morae.

F,216r: Tabula differentiae <> longitudinum in dimidio morae
N,255v: Tabula differentiae duarum longitudinum in dimidio morae (N1, in text)
N,258r: (as above) (N2, in app.)

	Argumentum latitudinis		Minuta differentiae	Diff. intro-ituum	
a	Gr.	Mi.	b	Mi.	
	6	0	0	0	c
	5	30	16	16	
	5	0	25	9	
	4	30	31	6	
	4	0	14	17	d
	3	30	12	2	
	3	0	9	3	
	2	30	7	2	
	2	0	5	2	
	1	30	4	1	
	1	0	4	0	
	0	30	4	0	
e	0	0	4	0	

FN1
(a) Gr.Mi. F: Si.Gr. N1
(b) F omits heading and has 'Gr.'.
(c) 0 N1: Mi. F (d) 17 N1: 10? F
(e) F omits entry.

Argumentum latitudinis		Mi.
Gr.	Mi.	
0	0	3
1	19	4
2	1	5
3	32	10
4	2	15
4	11	20
4	19	25
4	30	31
5	1	25
5	18	20
5	34	10
5	42	0

N2

The maximum argument, 6^{o}, of FN1's table is that of the Toledan perigee-table.

FN1's table can be exactly reproduced by application of procedures (d) and (b), possibly except for a slight round-off error at argument 5^{o}, and assuming f(3^{o};30, apogee)=12;47 (cf. to Table 14).

N2's table can be exactly reproduced (to within one sexagesimal of the argument in two cases) by procedures (d), (b) and (a) if the angular velocity of the moon is taken to be 0°;30,12/hour in the apogee and 0°;36,4/hour in the perigee (cf. to Table 14), if E's reading f(3°;30,apogee)= 13;47 is retained, and if interpolation is assumed between the entries f(5°;30)=16.38, deriving from the Toledan table, and f(5°;42)=0.

I cannot explain N2's upper limit of 5°;42.

18. Tabula differentiae duarum longitudinum in dimidio durationis eclipsis lunaris.

F,210r: Tabula differentiae duarum longitudinum (F1)
F,216r: Differentia duarum longitudinum in dimidio durationis eclipsis (F2)
N,256r: Tabula differentiae duarum longitudinum in dimidio durationis (N1, in text)
N,258r: Tabula differentiae duarum longitudinum in dimidio durationis eclipsis lunae (N2, in add.)

Argumentum latitudinis Gr.	Mi.	a Ho.	Mi.		Diff. intro-ituum Mi.		Argumentum latitudinis Gr.	Mi.	Mi.
13	0	0	22			b	0	0	3
12	30	0	38	c	16		2	0	4
12	0	0	47	f	9	d	3	0	5
11	30	0	55	g	8		6	15	10
11	0	1	h 2		7		7	45	15
10	30	0	41		21		8	50	20
10	0	0	33		8		9	24	25
9	30	0	26		7		9	47	30
9	0	0	21	i	5		10	26	40
8	30	0	18		3	e	10	43	50
8	0	0	16		2		11	0	62
7	30	0	14		2		11	49	50
7	0	0	12		2		12	23	40
6	30	0	11		1		12	45	30
6	0	0	9		2		13	5	20
5	30	0	8		1		13	27	10
5	0	0	8		0		13	50	0
4	30	0	8		0				
4	0	0	6		2				
3	30	0	7		1				
3	0	0	5		1	(!)			
2	30	0	4		1				
2	0	0	4		0				
1	30	0	3		1				
1	0	0	3		0				
0	30	0	3		0				
0	0	0	3		0				

F1F2N1 | N2

(a) Ho.:Pc. N1. - F1F2 lack the column of hours. (b) 0 F1F2

(c) 38 F1: 36 F2 (de) F1N omits '9' and shifts the following until '3' one place up. The rest of this column is filled out with '2'. (f) 47 F2N1:49 F1 (g) 55 F1N1: 50 F2 (h) 1 N1: column not present F1F2 (i) 21 N1F1: 31? F2

For the upper limits see to Table 16.

For the purpose of comparing F1F2N1's table to the Toledan table, the latter should be read as follows:

mora(3°;30,apogee)=12;47 (as proposed for Tables 14 and 17; not attested)
casus(4°;30,apogee)=41;4 (cf. to Table 15)
casus(5°;30,perigee)=47;14 (well-attested)
casus(9°;0,apogee)=28;7 (as given by E and partially by Too p.92 for al-Khwarizmi as against the Toledan tables)

With these readings, and by application of procedures (c), (d) and (b), F1F2N's table is exactly reproduced with the exception f(4°;30)=17 (against 8). (The error cannot be remedied by changing the value for casus (4°;30, apogee); indeed, the values possible in N1's Table 15 (q.v.) would produce the value 6 in the present table.)

N2's table can be exactly reproduced by interpolation in F1F2N1's table, adding an entry for the limit 13°;50 (cf. to Table 16). It cannot be as well reproduced by analogy with N2's versions of the Tables 14 or 17, nor by using a greater number of significant figures in F1F2N1's table.

19. Tabula diversitatis aspectus.

F,217r: Tabula diversitatis aspectus lunae ad solem in 7. climate, quae supponit lunam esse in longitudine media epicycli.
N,257r: Tabula diversitatis aspectus lunae in 7° climate, quae supponit lunam esse in longitudine media epicycli.

Hore Can. H.M.	Lo M.	La M.	Hore Leo. H.M.	Lo M.	La M.	Hore Vir. H.M.	Lo M.	La M.	Hore Lib. H.M.	Lo M.	La M.	Hore Sco. H.M.	Lo M.	La M.	Hore Sag. H.M.	Lo M.	La M.
8 0	30	42	7 40	39	33	6 54	45	24	6 0	46	21	5 6	45	24	4 20	39	33
7	38	38	7 r	40	32	6	45	23	5	45	22	5	45	25	4	37	34
6	34	35	6	40	28	5	43	22	4	42	23	4	42	27	3	33	38
5	32	31	5	39	25	4	40	21	3	37	25	3	37	31	2	26	41 h
4	29	28	4	35	23	3	35	20	2	31	26	2	31	34	1	19	44
3	24	25	3	30	23	2	27	24	1	23	28	1	24	38	0	0	0
2	17f	24	2	22	22	1	19	26	0	0	0	0	0	0	0	0	0
1	9	22	1	14	22	0	0	0	0	0	0	0	0	0	0	0	0
Reces. 0	21		Reces. 5		23	Reces. 11		29	Reces. 15		31	Reces. 17		41	Reces. 10		47
1	9	22	1	3	26	0	0	0	0	0	0	0	0	0	0	0	0
2	17	24	2	11	29	1	3	32	0	0	0	0	0	0	0	0	0
3	24	25	3	18	32	2	5	36c	1	7	35	1	8	44	0	0	0
4	29	28	4	22	36	3	11	40	2	0	38	2	0	46	1	2	48
5	32	31	5	25	39	4	15	43	3	6	42	3	7	47	2	6	49
6	34	35	6	25	42g	5	18	45	4	11	45	4	13	48	3	14i	48
7	38	38	7	23	45	6	18	46d	5	14	48	5	17	48	4	20	47
8 0	30	42	7 40	21	46	6 54	17	48	6 0	16	48	5 6	17	48	4 20	21	46

Hore Cap. H.M.	Lo M.	La M.	Hore Aqu. H.M.	Lo M.	La M.	Hore Pis. H.M.	Lo M.	La M.	Hore Ari. H.M.	Lo M.	La M.	Hore Tau. H.M.	Lo M.	La M.	Hore Gem. H.M.	Lo M.	La M.
4 0	30	42a	4 20b	21	46	5 6	17	48	6 0	16	48	6 54	17	48	7 40	21	46
3	24	45	4	20	47	5	17	48	5	14	48	6	18	47e	7	23p	45
2	17	47	3	14	48	4	13	48	4	11	45	5	18	45	6	25	42
1	9	48	2	6	49	3	7	47	3	6	42	4	15	43	5	25	39
0	0	0	1	2j	48	2	0	46	2	0	38	3	11	40	4	22	36q
0	0	0	0	0	0	1	8	44	1	7n	35	2	5	36	3	18	32
0	0	0	0	0	0	0	0	0	0	0	0	1	3	32	2	11	29
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	26
Reces. 0	49		Reces. 10		47	Reces. 17		41	Reces. 15		31	Reces. 11		29	Reces. 5		23
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	14	22
0	0	0	0	0	0	0	0	0	0	0	0	1	19	26	2	22	22
0	0	0	0	0	0	1	24	38m	1	23	28	2	27	24	3	30	23
0	0	0	1	19	44	2	31	34	2	31	26	3	35	20	4	35	23
1	9	48	2	26	41	3	37	31	3	37	25	4	40	21	5	39	25
2	17	47	3	33	38k	4	42	27	4	42	23	5	43	22	6	40	28
3	24	45	4	37L	34	5	45	25	5	45	22	6	45	23	7	40	32
4 0	30	42	4 20b	39	33	5 6	45	24	6 0	46	21	6 54	45	24	7 40	39	33

FN. Readings from E are added.
(a) 42 FE: 24 N (b) 20 FE: 40 N (c) 36 FE: 32 N (d/e) 46 NE: 47 F/ 47 FNE (f) 17 NE: 19 F (g) 42 NE: 32 F (h) 41 NE: ? F (i) 14 NE: 44 F (j) 2 NE: 21 F (k) 38 NE: 48 F (L) 37 NE: 27 F (m) 38 N: 28 F: 37 E (n) 7 NE: 6 F (p) 23 NE: 13 F (q) 36 NE: 26 F (r) F propagates all numbers of minutes throughout their respective columns.

Cf. Too 72. The heading in E is 'Tabula diversitatis aspectus lunae in 7° climate, quae supponit lunam esse in longitudine longiore'. - The outer appearance of FN's tables, which has been only approximately reproduced above, is almost exactly similar to that of E.

In principle, the tables should be symmetrical so that, if Aries=0, each value f(sign, hours before noon) should have the identical counterpart f(6-sign, hours after noon), cf. Too p.99. This condition is fulfilled by N's table except in the cases (a-e) above.

E has a score of corrections, destroying symmetry about as often as restoring it. In the cases where FN agree against the first hand of E, they always agree with some correction and/or counterpart in E. Consequently, no common errors in FN can be determined on this basis. - A comparison with some other copies of varying ages (notably Vat.lat.3118,63;Vat.Pal. lat.1374,30;1414,150v), which also deviate fairly often, suggests that at least Peter is peculiar in the readings (m) above, and in Pisces, +4 hours, longitude, the consensus being 41 against Peter's 42.

F and N differ only where E has uncorrected readings. In all of these cases except two, either F or N agrees with E, thereby restoring symmetry. In these cases I have adopted the majority readings. Once ((m) above) all three differ, only N retaining symmetry; and once ((d/e) above) N appears to reproduce an asymmetry in E. N's readings were retained in these two cases. - Probably, then, F and N were intended to be symmetrical, whether the symmetry was in a Toledan original, or produced by Peter or someone else.

In general, the Toledan table has the same values as al-Battani and the Handy Tables (Too p.109). FNE follow three of the four readings given by Too ibid., as peculiar to the Toledan tables as against their originals; in the fourth case, Leo, 4th hour before noon, longitude, the reverse is the case.

E, as against FN (and the canones Azarchelis), explicitly supposes the moon to be in its apogee, as do other copies of the Toledan tables (Too p. 100). Since all the tables seem to be basically identical, this difference presents a problem. Peter's text (2,29), faulty as it is, seems to treat the table according to its title. Cf.App. 2 §27.

20. Tabula minutorum proportionalium.

F,216r; N,255v: Tabula minutorum proportionalium

Argumentum lunae aequatum				Minuta proportionalia	A.L.A.				M.P.	A.L.A.				M.P.
Si.	Gr.	Si.	Gr.											
0	11	11	19 a	1	2	10	9	20	19	3	22	8	8	40
0	18	11	12	2	2	12	9	18	20	3	24	8	6	41
0	24 b	11	6	3	2	14	9	16	21	3	26	8	4	42
0	29	11	1	4	2	16	9	14	22	3	28	8	2	43
1	3	10	27	5	2	18	9	12	23	4	0	8	0	44
1	7	10	23	6	2	20	9	10	24	4	2	7	28	45
1	10	10	20	7	2	22	9	8	25	4	4	7	26	46
1	13	10	17	8	2	24	9	6	26	4	6	7	24	47
1	16	10	14	9	2	26	9	4	27	4	8	7	22	48
1	19	10	11	10	2	28	9	2	28	4	10	7	20	49
1	22	10	8	11	3	0	9	0	29	4	13	7	17	50
1	24	10	6	12	3	2	8	28	30	4	15	7	15	51
1	27	10	3	13	3	4	8	26	31	4	18	7	12	52
1	29	10	1	14	3	6 c	8 d	24	32	4	20	7	10	53
2	2	9	28	15	3	8	8	22	33	4	24	7	6	54
2	4	9	26	16	3	10	8	20	34	4	27	7	3	55
2	6	9	24	17	3	12	8	18	35	5	0	7	0	56
2	8	9	22	18	3	14	8	16	36	5	4	6	26	57
					3	16	8	14	37	5	8	6	22	58
					3	18	8	12	38	5	12	6	18	59
					3	20	8	10	39	5	20	6	10	60

(a) 19 N: 10 F (b) 24 N: 44 F (c-d) 6-8 N: 8-6 F

Cf. Too 80, 'Tabula proportionis (augmentata per duos gradus)'. This gives the value of the function, in minutes and seconds, for each double degree of the argument.

As is seen from (2,24), cf. App.2 §17, Peter's table is not meant to be interpolated in; instead, given a value of the argument, the function value should be sought under this or the next lower one. Correspondingly, to convert the Toledan table to Peter's, use linear interpolation to get the values for each integer degree; then, starting from the top of the table, proceed as indicated in the notes to Table 1. - If this is done, only one value remains unexplained, as shown in the following specimen:

Argument		E	Peter	Argument	E	Peter
4^s	2^o	45;0	45		48;21½	
		45;30		4^s10^o	48;57	49
4	4	46;00	46		49;13½	
		46;33½		4 12	49;30	
4	6	47;7	47(!)		49;54½	50
		47;26½		4 14	50;19	
4	8	47;46	48		50;42½	51
				4 16	51;6	

The value 47 is assigned to a degree more than expected. The Toledan values are taken from al-Khwarizmi (Too p.117). If al-Khwarizmi's values 45;55 for 4^s4^o, and 46;50 for 4^s6^o, are used instead of E's, the above error disappears, and no other errors are introduced with al-Khwarizmi's values (cf. Bjørnbo & all.,1914 p.187). Conclusions from this should be cautious.

21. Tabula erroris tollendi.

N,256r: Tabula erroris tollendi

Minuta proportionalia	Minuta erroris	M.P.	M.E.	M.P.	M.E.	M.P.	M.E.	M.P.	M.E.	M.P.	M.E.
		6	20	17	14	28	12	39	12	50	18
		7	20	18	12	29	12	40	12	51	18
		8	18	19	12	30	12	41	14	52	18
		9	18	20	12	31	12	42	14	53	20
		10	16	21	12	32	12	43	14	54	20
1	0	11	16	22	12	33	12	44	16	55	20
2	0	12	16	23	12	34	12	45	16	56	20
3	0	13	16	24	12	35	12	46	16	57	22
4	0	14	16	25	12	36	12	47	16	58	22
5	0	15	14	26	12	37	12	48	16	59	23
		16	14	27	12	38	12	49	16	60	0

Not among the Toledan tables. The table gives a function of the minuta proportionalia and thus indirectly a function of the argument of the moon. In this respect, when discounting the zeros in the table, the function seems to be symmetrical about 90^o. - I cannot guess at the purpose of the table; for its use cf. App.2 §18.

22. Tabula temporis aspectus et duodecimae.

N,257v: Tabula temporis aspectus et duodecimae

Aspectus Mi.	Tempus aspectus Ho.	Mi.	Differentia Mi.	A.	T.A.		D.	A.	T.A.		D.
				27	0	58	9	53	1	54	18
				28	1	0	10	54	1	56	19
1	0	2	0	29	1	2	10	55	1	58	19
2	0	4	1	30	1	4	10	56	2	0	19
3	0	6	1	31	1	7	11	57	2	2	20
4	0	9	1	32	1	9	11	58	2	4	20
5	0	11	2	33	1	11	11	59	2	7	20
.....				34	1	13	12	60	2	9	21
				.....							

Not among the Toledan tables. For the use, cf.App.2 §15. The effect is to multiply by 13/12, then divide by the velocity of the moon in its apogee, which gives the figures for 'Tempus aspectus'; and then to subtract the values correspondingly calculated for the moon in its perigee, which gives the figures for 'Differentia'. The values used for the velocity of the moon are probably 0^o;30,18/hour (apogee) and 0^o;36,4/hour (perigee), cf. p.79

Referred to in N(2,40) as 'Tabula temporis aspectus et differentiae'.

23. Tabula temporis inter duas oppositiones vel coniunctiones.

N,257v.

Longitudo Gr.	Tempus longitudinis Ho.	Mi.	Differentia Ho.	Mi.
1	1	59	0	0
2	3	58	1	59
3	5	58	2	0
4	7	57	1	59
5	9	56	1	59
6	11	55	1	59
7	13	54	1	59
8	15	54	2	0

Used in N(2,49a) (cf. App.2 §16) to supplement N's scale for time of elongation. The effect simply is to divide by the angular velocity of the moon in its apogee, which is set at $0^{o};30,12$/hour (cf.App.2 §19).

24. Tabula portionis.

N,254r-255r (no heading)
F,214v-215v: Tabula magistri Petri Philomenae de Dacia ad inveniendum portionem cuiuslibet numeri secundum <pro>portionem cuiuslibet alterius ad 30 vel 60. Et deservit prima columna utrisque minoribus 31, secunda alteri minori et alteri maiori, tertia vero utrisque maioribus.
- For one further manuscript see O.Pedersen 1976 p.14. In Thorndike 1959 p.37 n.34 the reference is in fact to a copy of the 'tabula lunae'.

Gives the products of all numbers between 1 and 59. The three sections ("columnae") contain the products ab, where, respectively, $1 \leq a,b \leq 30$ (first section); $1 \leq a \leq 30$ (columns) and $31 \leq b \leq 59$ (rows) (second section); and $31 \leq a,b \leq 59$ (third section.) - Not in the Toledan tables. Some fifteenth-century versions of the Alfonsine tables contain multiplication tables very like it in shape, notably Vat.Pal.lat.446,87r ff. For a possible successor to Peter's canon (2,18-20), see App.3 (M).

25. Tabula duodecimae cuiuslibet numeri.

N,257v.

Gives the twelfths of the integers between 1 and 60. Not in the Toledan tables. An exact copy is found in Vat.Lat.3116,26r.

APPENDIX 2. MAIN DIFFERENCES BETWEEN F AND N.

Scales of N's instrument.

The scales are assigned the same numbers as their counterparts on F's instrument. Compare the descriptions of the latter, p.6f., for details not given below. The paragraph references are to this appendix.

Front

Main disc

(1) Magnitude of lunar eclipse. Cf. §7.

(2) Half-duration of lunar eclipse.

(3) Argument of latitude. 28 divisions. Cf. § 9.

Cursor: Cf. §§ 4,6,8.

(4) Reference scale.

(5) Equation of the sun.

(6) Equation of the moon.

Volvella solis, fiduciae 70 minutes apart, cf. §§2 and 10. Disc with 4 zones.

(15) Parallax in latitude. Cf. § 10.

(13) Time of elongation. Cf. § 14. (Either half constructed such as to cover 39';34 on Scale 15, or appr. 7°;35 on Scale 3.)

(14) Difference in time of elongation. Cf. § 14. (Co-extensive with Scale 13; 2-hour mark coinciding with 12^h;8 on Scale 13.)

(8) Twelfth of elongation. Cf. § 11. Either half divided into 35 equal divisions denoting minutes of arc. (Constructed to cover 2^h;17,30 on Scale 14, or appr. 7° on Scale 3.)

Back

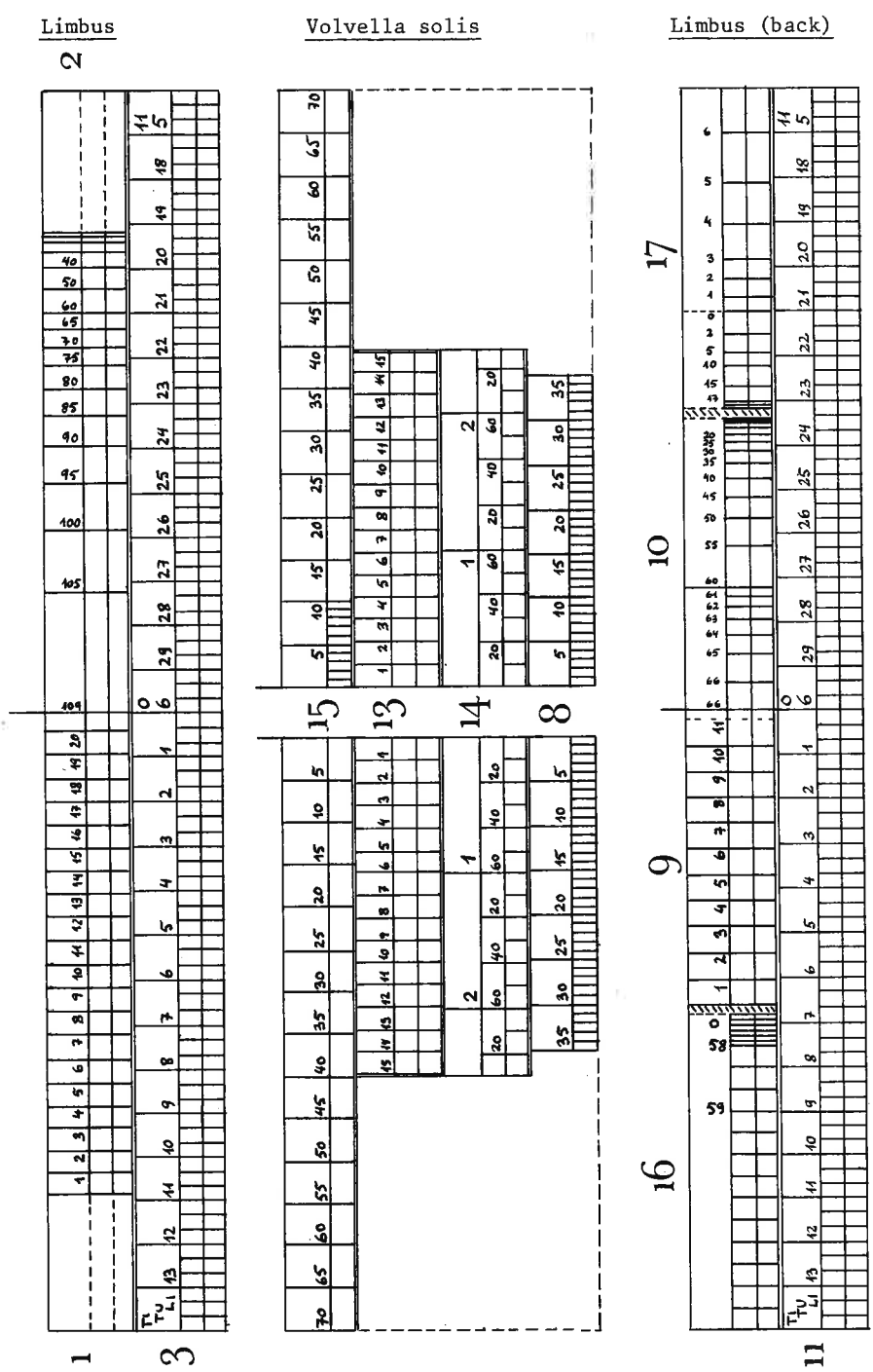
(9) Magnitude of solar eclipse. Cf. § 7.

(16) Difference in magnitude of solar eclipse (differentia duarum longitudinum in punctis eclipsis solaris). Cf. § 12. Starting from the point diametrically opposite the node; divided according to Table 11, the points of division (first column of table) being read off Scale 11 numerically.

(10) Half-duration of solar eclipse.

(17) Difference in half-duration of solar eclipse (differentia duarum longitudinum in punctis eclipsis solaris). Cf. § 12. Starting from the point diametrically opposite the node; divided according to Table 12, the points of division (first column of table) being read off Scale 11 numerically.

(11) Argument of latitude. - Like Scale 3.



Scales of N's instrument, graduation. - For the cursor, see p.10.

- From here on, 'F' denotes 'the text of F', 'the instrument described in F', etc., indiscriminately, and 'N' likewise. Reference-numbers of tables are as in Appendix 1, and of FN's scales as on pp. 6-7 and 71.

The parts of the instrument.

1. - F has 4 volvellae, N only 2, lacking F's volvella maior and volvella minor on the back. Accordingly, N lacks the passage on volvella maior in 1,25, and the whole of 1,28 on volvella minor.

2. - In return, N's volvella solis accommodates Scale 15, and the width of its rostrum is accordingly fixed at 70' on the scale (3) of argument of latitude (cf. 1,4 in N and §10 below).

3. - F's volvellae are fixed; N's can be transferred to the back of the instrument when necessary. Cf.:

> (1,6) Modus connectendi partes instrumenti. - Nunc vero perforetur instrumentum ad centrum, sic ut clavus notabilis quantitatis intrare possit, qui ambas novellas contineat ad instrumentum per cuneum qui per clavum transeat, (1,6a) sic ut novellae nunc in facie, nunc in dorso, ut opus fuerit, poni possint. Demum fiat foramen per utrumque nodorum, ut in eo axis armillae moveatur, per quam aptius portetur instrumentum.

The transference takes place at 2,46 in N.

4. - F's cursor occupies 1/3 of the radius of the main disc, N's only 1/4, presumably because N's volvella solis carries more scales and so demands more space. Cf. 1,3.

The preparation of the instrument.

5. - Generally, F makes the volvellae at early stages, mounts them and uses them for inscribing the scales. N makes them as late as possible, using a ruler for the scales. Cf., e.g., 1,8: F 'posita alterutra fiduciarum volvellae utriuslibet', N 'posita in centro regula'. - This is a main reason why chap. 1 of F and N are differently organised. For example, 1,6, describing the mounting of the volvellae, comes early in F whereas its counterpart, quoted above §3, is the last section in N's chap. 1.

6. - F's cursor is expressly designed with margins 'ratione custodiae' and extended to 11 degrees on scale 3 to make rooms for the margins (1,13); N does not mention these.

7. - For graduation of Scales 1 and 9, for magnitude of solar and lunar eclipses, N uses Tables 9 and 13 (see App.1); F uses a simple construction with approximately the same effect, thus (presumably) dispensing with the tables. Cf. 1,11 and 1,26.

8. - For the divison of the cursor into scales, N has

> (1,14) Latitudo vero eius (sc. cursoris) in 5 aequalia dividatur, et quodlibet eorum in tria inaequalia, ut sit semper quod supremum minimum et maximum versus centrum.
>
> (1,18, on the 'deferens solis') quo facto scribantur signa inferius et singuli gradus et eorum numeri superius, proviso quod signum tertium ponatur ad medium superioris medietatis.

Thus N places the widest zone of each scale, with the most significant part of the numbers, nearest to the centre of the instrument. F has no mention of this, and the reverse is true of the other scales described explicitly by F and N.

Scales and corresponding tables.

9. - Scales 3 and 11, for argument of latitude, have different lengths, namely, 24^{o} in F and 28^{o} in N.

> (1,8) Deinde circulus centro vicinior per 28 aequalia dividatur... (1,9) Sinistrorsum enim a nodo in 13 spatiis superioribus ponantur 13 gradus argumenti, ab 1 iuxta nodum inchoando. (1,10) Dextrorsum autem ponantur in primo spatio superiori 0 et 6, in secundo 29, in tertio 28, et deinceps ad 18 minuendo. In spatiis autem duobus quae inter huius 18 et 13 alterius lateris relicta sunt scribantur 11 et 5 signa in sinistro, in dextro vero tituli inscriptorum.
>
> (3,2) Constitui igitur in facie instrumenti utrimque a nodo 14 gradus argumenti latitudinis lunae, non quia meta eclipsis ultra 13 gradus et 16 minuta sit possibilis, sed propter circulum minutorum aspectus addidi quod est ultra.

10. - As the last quotation implies, N wants Scale 15, for parallax in latitude, to be longer than does F. Cf. 3,2 quoted above §9, and a passage of 2,41 in N providing for the possibility that the parallax in latitude could be greater than 60 minutes (cf. ad loc.). This passage is missing in F.

Indeed, F's Scale 15 contains 60 minutes, extending over $11^{o};30$ of Scale 3, whereas N's scale contains 70 minutes, extending over $13^{o};25$ of the same (cf. 1,30), both being employed to multiply by 11.5. The scales are placed on F's volvella maior and on N's volvella solis. In both cases, the scales are doubled, extending from each fiducia of the rostrum. Since

twice the length of a scale plus the width of the rostrum should co-extend with Scale 3, it follows that F's rostrum must extend over 60 minutes, and N's over 70 minutes, of Scale 3 (cf. 1,4 in N, 1,25 in F and §2 above).

11. - F has a scale for elongation (Scale 7) on its volvella solis. This is missing in N, which, accordingly, lacks 1,21-22 and the relevant passages in 2,10 and 3,11. (In 3,14, which is parallel to 2,10, F does not mention the scale either.)

Both have Scale 8, for 1/12 of the elongation, on the volvella solis. F constructs this from Scale 7 (1,24), N rather cumbersomely from Scale 14 (1,23a), inscribing the numbers somewhat differently.

F, having both Scales 7 and 8, can use them also for taking a twelfth of the parallax in longitude (2,45); N uses Table 25 for this, missing in F.

12. - N has two scales (16-17) on the dorsum for 'differentia duarum longitudinum in punctis eclipsis solaris / in dimidio durationis eclipsis solaris', which are inscribed from Tables 11-12 in 1,26a and 1,27a, and used in 2,49. F lacks the scales and the relevant passages; however, F contains no tables to take the place of the scales.

13. - Both F and N lack a scale of dimidium morae eclipsis lunaris, using Table 14 instead. N comments on this specifically:

> (3,18a) Sed quia multitudo inscriptionum deformitatem instrumento et errorem forsitan operanti induceret, placuit per distantiam novellarum a nodo accipiendum esse dimidium morae in tabulis ad hoc factis.

F lacks this passage.

14. - Both F and N have two scales (13-14) to calculate the time elapsing between a true syzygy and a mean syzygy at a given elongation.

F's scales are located on the dorsum and co-extensive with a scale (12) showing the elongation and divided into 7 degrees, this being the maximum elongation at a mean syzygy. F constructs this scale in 1,32; the scale, and 1,32, is missing in N.

N's Scales 13-14 are located on the volvella solis and doubled, extending from each fiducia. The scales each extend over $7^{o};35$ of the argument of latitude, this being the maximum elongation + 1/12 (cf. the construction in 1,30a, missing in F, and 3,12 quoted below).

The scales are equally divided into $15^{h};4$ and $2^{h};29$, respectively. N's account of the division is as follows:

(3,12) Et quia tempore motus solis per haec 35 minuta movetur luna per 7 gradus et eadem 35 minuta, consequens est quod locus lunae in hora mediae coniunctionis vel oppositionis distare pot[u]erit a loco suae verae coniunctionis vel oppositionis 7 gradibus et 35 minutis, quae dicuntur maxima longitudo cum sua duodecima. (3,12a) Quam per 30 minuta et 12 secunda, quae sunt motus lunae aequalis et aequatus in una hora ad augem epicycli, divisi, et 15 horas cum 15a unius, quae provenerunt, ordinavi in eadem novella solis hinc inde a rostro sub 7 gradibus et 35 minutis limbi. (3,12b) Deinde eandem longitudinem divisi per motum lunae aequalem et aequatum in una hora ad oppositum augis, scilicet per 36 minuta et 10 secunda, et 12 horas cum 35 minutis, quae provenerunt, subtraxi de horis et minutis primis; et 2 horas cum 29 minutis, quae remanserunt, ordinavi sub prioribus et sub dictis 7 gradibus et 35 minutis limbi.

Instead of this, F merely has (3,12): 'tempus enim huius longitudinis commodius in dorso ordinavi'.

15. - The differences in location and extension of Scales 13-14 result in extensive deviations between the passages of F and N concerning the use of the scales. N lacks 2,16-17 and has instead 2,12a, as follows:

(2,12) Et habebis verum locum solis ad horam coniunctionis vel oppositionis in octavo orbe. Unde fit, ut iste sit locus coniunctionis vel oppositionis corporalis in octavo orbe. (2,12a) Notetur etiam in eodem arcu aequationum, quod fuerit inter utrasque novellas, et haec erit longitudo cum duodecima. Videatur etiam, quantum de tempore longitudinis fuerit inter easdem, et hoc erit praesentis longitudinis et suae duodecimae tempus, sed ea condicione, ut sit luna in sua longitudine longiori. Quod si ibi non fuerit, videatur, quantum inter dictas novellas fuerit de differentia duarum longitudinum. (2,13) Quibus extra scriptis...

This corresponds to the account given in 3,15a, missing in F:

(3,15)...locus verae coniunctionis vel oppositionis. (3,15a) Et quod de tempore longitudinis fuerit nunc inter ambas novellas, erit tempus quod fluit inter ambas coniunctiones vel oppositiones, [[sub]] supposito quod luna sit in auge, et quod sub illo fuerit, erit differentia duarum longitudinum, quam cum minutis proportionalibus aequare oportebit.

In fact, N's scales are designed to be entered with the elongation + its twelfth as argument, F's with the elongation only.

For this reason, F's scales can be conveniently used also for determining the time elapsing for a given parallax in longitude (2,40.44). N, on the other hand, uses a 'tabula temporis aspectus et differentiae' (Table 22) for this purpose. In so doing, N distinguishes between two values of the apparent velocity of the moon which F, less correctly, does not (cf. § 19).

16. - Finally, N, because of the compression of Scale 13, provides a table

(23) to be used alternatively:

> (2,49a) Investigatio temporis longitudinis et duodecimae. - Ne autem, parvo [[instrumento]] quandoque existente instrumento, in acceptione temporis longitudinis et duodecimae in utraque eclipsi aliquod contingat dubium, longitudinem ipsam cum duodecima diligenter ab instrumento extrahas, sicut supra dictum est, et cum ea tabulam temporis longitudinis et duodecimae intrans invenies e directo eius suum tempus, ea condicione, ut sit luna in sua ≪longitudine≫ longiori. Quod si bis intrare oporteat, cum differentia duorum introituum et minutis, pro quibus secundo intraveris, tabulam portionis intrans quod inveneris duples, et duplatum tempori primi introitus addas. Et habebis tempus longitudinis et duodecimae, de quo dubitabas. Tempus autem differentiae duarum longitudinum praecise satis ex instrumento habebitur cum aliis quae sunt necessaria ad eclipsim.

Given equally large instruments, F's scale 13 would be physically several times as long as N's, and thus the difficulty would probably not occur; in any case, F lacks both 2,49a and Table 23.

Minuta proportionalia.

17. - This is the interpolation function defined in Ptol.Almag. 6,8 as a function of the true argument of the moon, and taken from Table 20. The values of the argument used for entering Table 20 can be: (a) the value found when the moon is half-way between the mean and the true syzygy; the corresponding value of the function is appropriate for calculating the time between the two syzygies, given the elongation (cf. 3,15b cited below), and is used for this purpose by N under the name 'minuta proportionalia prima' (2,21-22a). F calls it simply 'minuta proportionalia', recognizing no other possibility; (b) the value found when the moon is in true syzygy: the corresponding value of the function is appropriate for calculations of phenomena occurring near the true syzygy and is used as such by N (2,26.39. 41 and once or twice by implication) under the name 'minuta proportionalia secunda'. - The following gives N's account, first the one of the main text, next as the text with the replacements indicated by Na.

> (2,21,N) Modus aequandi tempus longitudinis et per ipsum tempus ≪coniunctionis vel oppositionis verae.≫ - Consequenter resumatur argumentum lunae, et addatur ei medietas longitudinis et duodecimae, si solis fuerit longitudo, vel eadem ab eodem minuatur, si lunae fuerit longitudo, et cum argumento lunae sic aequato intres; et quod e directo eius vel minoris proximi fuerit, de minutis proportionalibus sumas. (2,22) Quibus habitis, cum eis et differentia..

> (2,21,N&Na) Modus aequandi tempus longitudinis et per ipsum tempus ≪coniunctionis vel oppositionis verae.≫ - Consequenter resumatur argumentum lunae, et addatur ei medietas longitudinis et duodecimae primo, et tota longitudo cum duodecima secundo, si solis fuerit

> longitudo, vel easdem ab eodem seorsum minuas, si lunae fuerit longitudo. Deinde cum hiis argumentis lunae aequatis tabulam minutorum proportionalium seorsum intres, et minuta e directo utriusque vel minoris proximi sumas. Et minuta primo sumpta vocentur minuta proportionalia prima, et secundo secunda. Hoc igitur facto, cum minutis primis et differentia...

Concerning the use in 2,22 of the minuta proportionalia prima, N gives the following account, missing in F:

> (3,15b) Aequatur autem argumentum lunae per medietatem longitudinis et duodecimae propter motum lunae in epicyclo, qui fere tantus est sicut motus epicycli, ut habeatur argumentum lunae ad instans medium inter ambas coniunctiones vel ambas oppositiones. Sed non additur vel subtrahitur hic tota longitudo cum duodecima, quia sic haberetur argumentum lunae ad veram coniunctionem vel oppositionem, ubi notabiliter fingeretur vel plus vel minus debito moveri in toto tempore longitudinis et duodecimae. Aequando autem ad instans medium cum (et N) in prima medietate erretur in aliquo, in secunda ad aequalitatem reducitur.

In 2,26, N gives a corrupt description of the procedure. This is deleted by Nb and replaced by a description using the minuta proportionalia secunda, but otherwise in about the same wording as F's description. The versions are:

> (2,26,N) Aequatio praemissorum. - Si igitur alibi fuerit, [[<sump->]] to argumento latitudinis secundo aequato tabulam differentiae duarum longitudinum in punctis eclipsis intres, et quod e directo eius fuerit semper addas punctis et minutis in instrumento inventis. Si etiam tabulam bis intrare oporteat, cum differentia duorum introituum, quae stat ad dextram, et cum minutis pro quibus secundo intraveris tabulam portionis intres modo qui supra dictus est, et quod inveneris duplans cum cautela ibidem tradita addas supra id quod ad primum introitum invenisti, si ipsum secundo minus fuerit, si vero maius, idem minuas ab eodem. Et erit differentia aequata in punctis, quam semper addas punctis et minutis ex instrumento acceptis.
>
> (2,26N&Nb) Aequatio praemissorum. - Si igitur alibi fuerit, cum distantia novellarum a nodo tabulam differentiae duarum longitudinum in punctis eclipsis intres, et quod e directo eius fuerit de punctis et minutis sumas. Si etiam bis intrare oporteat, cum differentia [[duarum longitudinum]] amborum introituum, quae stat in tabula semper e directo posterioris, et cum minutis pro quibus secundo intraveris tabulam portionis intres, et quod in angulo communi fuerit duples, et duplatum primo addas. Et erit differentia duarum longitudinum in punctis aequata, cum qua et minutis proportionalibus secundis intres tabulam portionis, et quod inveneris punctis et minutis quae in instrumento invenisti semper addas.

The most likely explanation of N's error seems to be a confusion of 'minuta pro quibus secundo intraveris' with 'minuta proportionalia secunda', the latter being eventually left out.

Tabula erroris tollendi.

18. - In 2,22-22a.27a.31.44, having used the minuta proportionalia for computing time intervals, N adjusts the result by means of a 'tabula erroris tollendi' (Table 21). F has nothing similar. The use of the table is explained by N as follows:

> (2,22) ... Et residuum erit tempus longitudinis et duodecimae ad longitudinem lunae praesentem, sed aliquando non praecisum. (2,22a) Nec videbatur possibile errorem non incidere aliquem. Eum autem corriges isto modo: Intrans cum minutis proportionalibus tabulam erroris tollendi, minuta quae e directo eorum fuerint considera. Pro tot enim minutis de tempore longitudinis et duodecimae deminutis residuo semper unum addas, et praecise aequatum erit. (2,22) Erit igitur tempus nunc aequatum quod cadit de tempore inter ambas coniunctiones, mediam scilicet et veram. (2,23) Videas igitur...
>
> (2,27) Et habebis dimidium durationis eclipsis, sed non praecisum. (2,27a) Cum minutis igitur proportionalibus tabulam erroris tollendi intres, et pro tot minutis quot ibi inveneris unum de dicto dimidio durationis tollas. Et erit dimidium durationis aequatum; (2,28) quod si...

The values of the angular velocity of the moon.

19. - In Tables 10,12,14,15,17,18,22,23 and Scales 13-14 in F and their counterparts in N, two different sets of values of the angular velocity of the moon per hour seem to occur, as follows:

(A) $0^{\circ};30,18$ for the apogee and $0^{\circ};36,4$ for the perigee. These are found in the Toledan table Too 56 and are appropriate for calculating phenomena occurring near the true syzygy. They are used for this purpose by N in Tables 10,12,14,15 (first version), 17,18,22;

(B) $0^{\circ};30,12$ for the apogee and $0^{\circ};36,10$ for the perigee. These are the values of Too 56 adjusted according to Too 57. The latter table presents adjustments to be applied for the elongations 1°-7°; the adjustment here used presupposes a fixed elongation of 7°. The values were considered appropriate for calculating time of elongation when finding the true syzygy (cf. 3,12a-b,§14). N uses the values for this purpose in Table 23 and Scales 13-14.

F's tables 14,17 and 18 are identical to those of N. Table 10 looks like an abbreviation of N's table, identical to the one in N's addenda. All these have their appropriate A-values. Tables 12 and 23 are missing from F (cf.§§ 12 and 16). F's Scales 13-14 are identical to those of N except for their extension (cf.§14), and F, like N, appropriately uses them for the purpose B.

But F also uses Scales 13-14 instead of Table 22 where an A-value had been intended (§15). Further, F's Table 15 is identical to N's second version of that table, both inappropriately using the B-values.

Thus, in the two cases where F differs notably from N, a table resp. a couple of scales resting on B-values have been inappropriately made to serve purposes as under A. Thus probably F, or some ancestor, had forgotten or ignored a distinction which is preserved in N.

20. - Out of the tables relevant here, the addenda in N contain Tables 10,12,14,17,18 (N,f.258r); the second version of Table 15 (N,f.245v) probably belongs here as well. All of these are scale-inscribing tables (cf. p. 48).

Tables 10 and 12 for solar eclipses are shorter than those of N, common values being identical, so that the A-values are preserved. Table 10 re-occurs in F.

Tables 14,17, and 18, for lunar eclipses, correspond to look-up tables in FN and were probably planned to serve in an extension of the instrument. Table 18 is obviously derived from that of N, except for its upper limit. On the other hand, Tables 14 and 17 were re-calculated using the B-values.

Table 15 is a scale-inscribing table in both versions. The second one was re-calculated using the B-values. This table re-occurs in F and is proved to be secondary by the fact that Table 18, which presupposes a look-up version of Table 15, only occurs in the A-form.

Thus, as a whole, the addenda in N share F's defect in blurring the distinction between the A- and B-values. But although the two collections have Tables 10 and 15 in common, there is probably no simple dependence between them.

Various minor deviations.

21. - Glosses by Nb. - One correction by Nb was quoted in §17. Other additions are:

> (Before 1,1): Tractatus iste dividitur in 3 partes, in prohemialem, executivam, < >tionis rationis redditivam. Secunda in capitulo proximo ibi Exquisite (1,2); tertia in capitulo ultimo ibi Expedito (3,1). In prooemio primo ponitur intentio in generali; secundo ibi <Et quia> instrumento ponitur ordo.
>
> (2,6, on 'de primo autem'): id est de tempore mediae coniunctionis vel oppositionis.

(2,6, on 'primum enim'): id est, subtrahas illud quod invenitur in tabula communi de tempore mediae coniunctionis vel oppositionis de illo quod invenitur de tempore in tabula mediae coniunctionis, [[vel d]] si sit de sole, vel de tempore in tabula mediae oppositionis, si sit de luna. Et residuum per tertium extendas, id est, addas residuo post subtractionem illud quod invenitur de tempore in tabula tertia, id est, in tabula mensium, [[in]] in directo illius ad quem intrasti.

(2,7, on 'quod minus est tempus'): < id> quod est in directo Ianuarii de tempore.

22. - In 2,46, N gives the following instructions to place the fiduciae:

(2,46) et quaeratur simile argumento latitudinis tertio aequato, quod si in dextro latere inveneris, super ipsum statuas sinistram fiduciam novellae solis, vel (:ad N) dextram, si fuerit in sinistro. Locata igitur fiducia, quaeras in circulo diversitatis aspectus in latitudine simile diversitati aspectus in latitudine iam aequatae, et ibi posita novella lunae notetur locus eius in limbo. Et habebis argumentum latitudinis quarto aequatum...

In F's language, this means that the left fiducia is to be used if the argument of latitude (corrected for the parallax in longitude) belongs to the signs 5 or 11, and otherwise the right one. Contrast F's instructions and F's correct explanation (3,26), which is missing in N.

Observations on the relationship between F and N.

23. - F dispenses with a number of tables needed by N. Cf. §7 (Tables 9 and 13, a construction being used); §11 (Table 25, F using Scales 7-8); §15 (Table 22, F using Scales 12-14); and §16 (Table 23). - The passage of F(3,12) 'tempus enim huius longitudinis commodius in dorso ordinavi' reads like a comment on §16. At least, it surely means "more conveniently than in some earlier version".

Conversely (cf. §12) N has two scales (16-17) without counterparts in F, together with the tables for inscribing them. N refers to the scales in 3,3: 'sicque feci in dorso, addendo ibi quaedam, ne vacarent loca'. In fact, because of the greater extension of Scale 11, N has room for the scales whereas F has not. F also seems to have left out the tables to be used instead.

24. - At some stages F provides simplified or improved procedures. Cf. notably §§5-7 on the construction of the instrument. - In 2,46 F, as against N, apparently gives the correct instructions for placing the fiduciae (cf. §22). - In 2,47, F provides a facility, omitted by N, for discontinuing calculations when an eclipse turns out to be impossible.

25. - Some lesser inconcinnities in F may be understood on the basis of N's version, for example: §9, N providing room for the inscriptions '0 et 6', '5 et 11' whereas F has no natural place for the latter. - §11: F's version of 2,10 mentions Scale 7, but the corresponding section 3,14 omits it, as do N's versions of 2,10 and 3,14. - 1,25-34: F describes the scales on the dorsum in the following order: Scale 9-11 on the main disc, common to F and N (1,25-7); Scale 15, on F's volvella maior and N's volvella solis (1,29-30); then, returning to the main disc, Scale 12, not in N (1,32-3); Scale 13-14, on N's volvella solis (1,33-4, concluding F's first chapter). The order of describing scales from the edge inwards is observed elsewhere, and so the disturbance may be due to random additions at the end of an earlier version. - 1,33: F's 'a dextra fiducia', if not a slip, may correspond to a version which had Scale 13 on a volvella. - 2,13 (text, §15): The plural 'quibus extra scriptis' gains in meaning when referring to 2,12a, missing in F. - 3,3 (on Scale 1, cf.§7): the passage 'puncta igitur et minuta eclipsis lunaris aequavi pro argumentis singulis', common to F and N, may be thought to fit N's table better than F's construction.

So far the obvious assumption is that, in the passages common to F and N, F's version is a revision of a version similar to N.

26. - N's use of the two kinds of minuta proportionalia (§17) and of the tabula erroris tollendi (§18) are not as easy to explain. As for the former, N probably starts like F by having only one kind of minuta proportionalia, later on correcting itself and using the other kind. This might make out the distinction to be an independent development in N; on the other hand, N's version is in better agreement with such possible models as the canones Azarchelis.

27. - Some peculiarities common to F and N may be briefly indicated here, the general question being left for a future discussion of the sources. For some possible parallels see Appendix 3, and the references given there. Consideration has also been given to the eclipse treatise 'Cum eclipsim lunae et eius quantitatem' (here called 'A') ascribed to Peter of St Omer and generally forming part of the Tractatus de semissis (cf. O. Pedersen (1976) 40).

2,39 attempts to correct the parallax in longitude assuming that the table of parallax supposes the moon to be at a mean distance (which is

interpreted as 29 in the minuta proportionalia from Table 20, i.e. 90° in the argument of the moon). This is in agreement with the canones Azarchelis (cf. App.3(B)) and with certain copies of the parallax table (see Too p.100), but differs from the interpretation of A, which assumes the moon to be in its apogee (F,207va 'et etiam si luna sit in auge vera sui epicycli'). In fact, the question was in dispute early: 'Marsiliensis' devotes a chapter, citing al-Battani, to prove Azarchel wrong; the chapter is also in John of Sicily, who had, however, paraphrased the doctrine of the mean distance without any comment earlier on. The Astrologia Marsiliensis assigns the mean-distance procedure to the tables of Azarchel and the apogee-procedure to those of Theon, whereas some other authors, such as the presumably early 'Ut annos Arabum', only know the latter possibility.

- A, and the canones Azarchelis and all their followers, perform the correction by applying the function from the Toledan table Too 79, heading 'circulus brevis', and referred to by A as 'tabulam aequationis diversitatis aspectus, quae non crescit ultra 12 minuta' (F,207vb). FN, on the other hand, use the minuta proportionalia from 2,21 for a similar procedure of correction. This error, if original, may possibly have been caused by a mis-interpretation of Azarchel's rather brief statement on the procedure (App.3,(B) at the beginning). - In either case, the correction turns out to be discontinuous, which also seems to have been noticed by 'Marsiliensis' in the polemic referred to above and repeated by John of Sicily.

2,45 and 3,24: FN prescribe that the calculated parallax in longitude, etc., should be added if the conjunction takes place after noon, and subtracted if before noon (for details, see the comments ad loc., p. 20). The canones Azarchelis rightly let addition or subtraction depend on whether the distance on the ecliptic between the ascendent and the moon is less, resp. greater, than 90° (cf. App.3(B)). John of Sicily is the one who conflates the two criteria most explicitly and consistently, mostly expanding upon 'Marsiliensis' (see App.3(F-K), notably (G)); but other authors, notably 'Ut annos Arabum' and the Astrologia Marsiliensis, keep to the rule found in Azarchel. As for A, the difference is found within the manuscript tradition, one branch (e.g. F,207vb=208va) keeping to the rule of Azarchel, another one (e.g. Basel U.B.F III 25,16r) maintaining

that the upper half of the parallax table (i.e. for times before noon) denotes eastern parallaxes, the lower half western ones. The latter version is probably the earlier one within the tradition of A.

28. - 1,26, cf. §7: Assuming Table 9 and its probably Toledan ancestor to be approximately linear, the maximum obscuration in a solar eclipse will be reached for an argument of latitude greater than 0, viz. about $0^{o};20,40$. In graduating Scale 9, neither F nor N appears to realize this. Indeed, N wrongly assumes an extra division in the space next to the node (cf. to Table 9).

1,32 and 3,12, cf.§14: The fixed value of the angular velocity of the moon, used in constructing Scales 13-14 of F and their counterparts in N, can be found from the Toledan table Too 56 by applying a correction taken from Too 57 (cf. 'aequalis et aequatus', N(3,12) in §14). This correction supposes the elongation to be always 7^{o}, so that, on an average, the result is about as good an approximation as the uncorrected value.

2,20: I do not understand 'duples praeter ultimum', probably confirmed by 'cum cautela ibidem tradita', N(2,26) in §17.

3,5-6 seem to imply that the middle line of the cursor, besides representing the 'linea medii motus lunae' (for mean syzygies, equal to that diametre of the epicycle containing the earth) also represents the apsidal line of the sun as concerns Scale 5. This disagrees with the construction of Scale 5 from Table 3 (1,17-8) the argument values having been shifted by the amount of the longitude of the apogee of the sun (see Appendix 1, to Table 3).

APPENDIX 3. SOME PARALLELS.

The following manuscripts and texts are quoted or referred to:

B Vat.Barb.lat.303 (s.xiii-xiv)

F Firenze B.N. ii.3.24 (s.xiv)

P Vat.Pal.lat.1403 (s.xiv)

Q Vat.Pal.lat.1412 (a.1453)

R Erfurt WAB 2°394 (s.xiv)

V Vat.Pal.lat.1414 (s.xiv)

Canones Azarchelis ad tabulas Toletanas "Quoniam cuiusque actionis"
- Duhem III,208; T&K col.1268; Millás-Vallicrosa 1943,37sqq. Text from F,241v; R,120r; V,67r. F's and R's versions differ only insignificantly. F's text is followed with occasional corrections from R and V.

'Marsiliensis' = Scripta Marsiliensis super canones Azarchelis "Cum cuiuslibet actionis: Liber iste, scilicet canones"
- Duhem III,288; T&K col.822. Text from R,111v-119r.

Astrologia W. Marsiliensis "Quoniam astrologiae speculatio"
- Duhem III,289; T&K col.1261. Text from R,136r-140v.

Jo. de Sicilia, Expositio super canones Azarchelis "Inter cetera veritatis physicae documenta"
- Duhem IV,6; T&K col.766. Text from B,18r-67r. There are extensive verbal correspondences with 'Marsiliensis', and some with the Astrologia. Some readings from these have been introduced.

Jo. de Lineriis, Canones primi mobilis et eclipsium "Cuiuslibet arcus propositi"/"Priores astrologi"
- Duhem IV,64; T&K col. 276,1127. Text from Q,46vsqq; passage missing in P,39r-51r.

(A) Canones Azarchelis, F,248vb; R,124vb; V,76ra. (V and some other mss. leave out or transpose the chapter "Cum in quo --- si deus voluerit". The chapter is known by Marsiliensis.)
- Cf. (2,1ff.)

Cum in quo mense cuiuslibet anni an possit fieri eclipsis solis vel lunae volueris investigare, intra tabulam annorum collectorum in tabula<m> coniunctionis et expansorum cum anno in quo quaeris, si volueris eclipsim solis, vel in tabulam praeventionis annorum collectorum et expansorum, si volueris eclipsim lunae, et accipe quod in directo eorum inveneris de motu latitudinis tantum, et quod invenisti in annis collectis et expansis aggrega; et aggregatum vocatur motus latitudinis, quem scribes in 12 locis, et subscribe 12 motus latitudinis /F,249ra/ 12 mensium, qui inveni<un>tur in tabulis mensium coniunctionis et praeventionis; et aggrega unumquodque per se superiori radici. Et quod ex unoquoque provenerit, erit motus latitudinis sui mensis ad unumquemque mensium ipsius anni. Deinde aspice, si coniunctionem quaesivisti, in quo mense anni latitudinis motus sit nihil in signis et minus 12 in gradibus, vel plus 5 signis et 18 gradibus usque in 6 signis integris. Tunc possibile est fieri eclipsim solis circa finem illius mensis. Si vero praeventionem quaesivisti, vide in quo mense sit motus latitudinis 0 in signis et minus 12 gradibus vel plus 5 signis et 18 gradibus usque ad 6 signa integra, vel a 6 signis usque ad 12 gradus, vel plus 11 signis et 18 gradibus usque ad 12 signa completa. Tunc possibile est fieri eclipsim lunae circa medietatem illius mensis; et in aliis mensibus, in quibus praedictos terminos non inveneris, impossibile est fieri eclipsim. Cum itaque sciveris mensem, in quo potest fieri eclipsis solis vel lunae, aequa illam coniunctionem vel praeventionem illius mensis secundum regulas eclipsium; scies si erit eclipsis vel non; scies quoque diem et horam et quantitatem eclipsium, si deus voluerit.

Cum solis et lunae coniunctionis horam et impletionis lunae et eorum locum volueris invenire, tabulam solis et lunae ad hoc constitutam quaere, et tabulam coniunctionis ad annos collectos, si volueris coniunctionem, vel tabulam impletionis, si eam quaesieris, ut dictum est in collectione medii cursus planetarum intra; et quod ibi inveneris in 4 capitulis, scilicet dierum, et medii cursus solis et lunae, et argumenti lunae, atque argumenti latitudinis lunae, extra eo ordine quo inveneris nota. Deinde annorum expansorum tabulam cum numero annorum collectorum residuo ingredere, anno in quo fuerit coniunctio vel impletio addito; et quod ibi inveneris in 4 tabulis sub aliis scribe. Intrabis etiam in tabula<m> mensium cum mense in quo fuerit ipsa coniunctio vel impletio, et omnia ordinatim, ut dictum est, sub primis pone. Verumtamen si diem aliquem in annis expansis inveneris vel mensibus, de diebus in annis collectis inventis illos minue; et quod remanserit in 4 tabulis, ut fit in collectione medii cursus planetarum, unumquodque per se collige, reducendo scilicet minuta in horas et horas in dies. Et habebis diem et horam et minutum horae coniunctionis vel impletionis secundum medium cursum.

(B) Canones Azarchelis, F,249vb; R,125rb; V,77ra
- Use of table of lunar parallax. Cf. (2,39ff.)

Haec autem diversitas aspectus fit ea condicione ut sit luna in longitudine media. Si autem fuerit ultra vel infra, cum argumento lunae tabulam aequationis eius intra, et accipies quae in directo eius inveneris minuta

proportionalia, et multiplica ea in minutis longitudinis et latitudinis divisim; et quod inde provenerit minue unumquodque de suo genere, id est, minuta longitudinis de longitudine et minuta latitudinis de latitudine, si fuerit argumentum in medietate superiori, vel adde illud, si fuerit in inferiori. Et sic habebis minuta longitudinis et latitudinis certissima ad diversitatem aspectus lunae in eadem hora. Tunc si inter locum lunae et gradum ascendentem fuerint gradus pauciores 90, diversitatem aspectus lunae in longitudine adde loco lunae aequato, et si fuerint plures 90, minue eam de eo. Et quod inde remanserit erit locus lunae visibilis ad horam cui numerasti.

Si autem coniunctionis visibilis horam volueris invenire, diversitati aspectus in longitudine 12am eius partem adde, et quod collectum tibi fuerit per motum lunae aequatum in una hora divide; et quae inde provenerint horas et partes horarum minue de horis coniunctionis aequatae, si fuerit inter ascendens et locum lunae minus 90 gradibus, vel adde eas eisdem, si fuerit plus 90 gradibus. Et horae, quae tibi post augmentum vel deminutionem remanserint, erunt horae coniunctionis visibilis ad civitatem Toleti. Similiter facies, cum volueris diversitatem aspectus lunae ad quamlibet aliam horam. Differt tamen in hoc, quia si fuerit inter ascendens et locum lunae minus 90 gradibus, addes diversitatem aspectus lunae in longitudine loco lunae, si vero fuerint plures, minues.

Et si qua die vel hora eclipsis solis sit futura volueris invenire, eius coniunctionem et lunae diurnam, cum fuerit prope caput Geuzaar vel eius caudam, ut monstratum est, diligenter inquiras --- Scire etiam te oportet locum coniunctionis aequatum et argumentum latitudinis aequatum per longitudinem et eius 12am partem, nec non et horam coniunctionis aequatam per diversitatem dierum cum noctibus /F,250ra/ suis, quot etiam horae aequales sint inter horam coniunctionis et medium diem ante vel post, per quas horas aequales scias diversitatem aspectus lunae in longitudine et latitudine. Intrabis etiam cum eisdem horis signum in quo fuerit luna, et accipies de minutis longitudinis, quae ibi inveneris, aequando ea sicut supra docuimus; quibus addes etiam 12am partem eorum, et quod collectum fuerit divides per motum lunae aequalem in una hora; et horas, quae inde provenerint, et partes horarum minue de horis coniunctionis, si fuerint inter gradum ascendentem et locum lunae minus 90 gradibus; si vero plures fuerint, adde illas eisdem. Et quod inde provenerit scito longitudinem eius a media die, et intra cum horis longitudinis secundo, sicut prius fecisti, ut iterum diversitatem aspectus lunae in longitudinem invenias, et adde ei 12am partem eius et divide, ut prius fecisti. Et quod exierit adde vel minue, sicut praemonstratum est, [cum] illis eisdem horis quibus prius addidisti vel minuisti, et quod collectum fuerit, eius latitudinem a medio die considera; et cum ea tabulas diversitatis aspectus lunae tertio intra, et quod in directo eius inveneris de minutis longitudinis et latitudinis unumquodque per se sume. Deinde diversitati [eius] aspectus tantum in longitudine (V,latitudine FR) 12am partem eius adde, et quod inde provenerit per motum lunae aequalem unius horae divide; et quae inde exierint horae sunt addendae primis horis, per primum et secundum introitum augmentatis vel deminutis, vel minuendae, sicut praedictum est. Et sic habebis horas mediae eclipsis aequatas per diversitatem aspectus lunae, quae sunt horae coniunctionis visibilis; adde[n]s autem minuta longitudinis cum sua 12a argumento latitudinis aequato, si addidisti horas, vel minue, si praeminuisti.

Postea vero multiplica minuta (V, huius FR) diversitatis aspectus in latitudine tantum, quae semper est meridiana in omnibus regionibus quarum latitudo fuerit maior 34 (FR,24V) gradibus, in 11 et dimidio, et quod provenerit minue de argumento latitudinis, aequato per aequationem lunae et longitudinem inter solem et lunam et eius 12am <partem et (V)> per diversitatem aspectus in longitudine, si fuerit locus coniunctionis apud caput Geuzaar; vel adde illud <e>idem argumento, si fuerit coniunctio apud caudam. Et sic perficies argumentum latitudinis ad mediam eclipsim.

(C) Jo. de Sicilia, B53rb = Marsiliensis, R115va
- Equation of time. Cf. (2,24).

Tales autem dies vocantur dies diversi, quia sunt ab invicem inaequales, tam[en] ex eo quod sol in temporibus aequalibus pertransit partes inaequales de zodiaco, quam ex eo quod illae partes a sole pertransitae, quae supra revolutionem integram adiunguntur, inaequales habent ascensiones.

(D) Jo. de Sicilia, B53vb. From "Huius autem rei", correspondence with Marsiliensis, R115vb.
- Use of table for finding angular velocity of moon. Cf. (2,21) and (3,15b), App.2 §17.

... dicens quod si velis aliter et certius operari, longitudinem inter solem et lunam cum sua 12a per duo media partire, scilicet ipsam longitudinem per se sumptam per 2 aequalia divide et uni medietati 12am sumptae (?) ipsius medietatis adde, et quod habitum fuerit ab altero istorum adde argumento lunae, si fuerit longitudo solis, vel ab eodem argumento minue, si fuerit longitudo lunae; et habebis post augmentum vel deminutionem argumentum aequatum, cum quo intrando in tabulam supradictam invenies motum lunae, prout superius dicebatur.

Huius autem rei causa videtur esse, quod luna in temporibus aequalibus fere tantum arcum epicycli pertransit, quantus est arcus deferentis pertransitus a centro epicycli. Si vero nihil minueretur vel nihil penitus adderetur <de> motu longitudinis cum sua 12a iam completo, luna non videretur ulterius esse mota. Quod si totam longitudinem et eius 12am iam poneremus, poneretur in orbe signorum plus aut minus moveri quam veraciter moveatur, quia minus movetur, cum est in auge vel circa. Et propter hoc addendo medietatem longitudinis et eius 12ae reducitur ad quoddam medium, ubi vel parva vel nulla diversitas potest esse.

(E) Jo. de Sicilia, B54ra. Not in Marsiliensis.
- Solar eclipses: finding whether eclipse takes place at day or night. Cf. (2,35).

Secundo necesse est scire per quot horas aequales et minuta distat hora coniunctionis a meridie. Et hoc invenies isto modo. Cum gradu solis aequato ad certam horam <> verae coniunctionis, addito sibi motu octavae sphaerae, arcum diurnum quaere; cuius arcus medietatem per 15 divide, et exibunt in numero quotiens horae aequales, quae sunt a meridie illius diei usque ad solis occasum. Siquid autem fuerit ex hac divisione residuum, per 60 multiplica et productum divide per 15 sicut prius, et provenient ex hac divisione minuta horarum, horis prius habitis adiungenda. Has igitur

horas cum suis minutis comparans ad horas et minuta verae coniunctionis, si horas verae coniunctionis inveneris pauciores esse, pro certo scias coniunctionem illam esse post meridiem per tot horas, quot fuerunt horae coniunctionis, et ante occasum solis. Si vero fuerint horae coniunctionis plures horis medietatis arcus diurni, tunc <quaere> <<arcum>> noctis et divide /B54rb/ per 15 sicut prius; et horas et minuta illius arcus adde horis et minutis medietatis arcus diurni. Et totum aggregatum comparans ad horas coniunctionis, vide si istud aggregatum fuerit maius horis verae coniunctionis, quia tunc procul dubio erit coniunctio de nocte, nec oportebit in ea pro eclipsi amplius laborare. Si vero totum illud aggregatum fuerit minus horis verae coniunctionis, tunc scies coniunctionem esse de die ante meridiem. Subtrahe igitur totum illud aggregatum - ex horis noctis et ex horis medietatis arcus diurni - de horis coniunctionis, et remanebunt horae et minuta ab ortu solis usque ad horam coniunctionis verae; quas minue ab horis et minutis medietatis arcus diurni, et superant horae, quibus vera coniunctio distabit a meridie.

(F) Jo. de Sicilia, B54va. Not in Marsiliensis.
- Use of table of lunar parallax. Cf. (B).

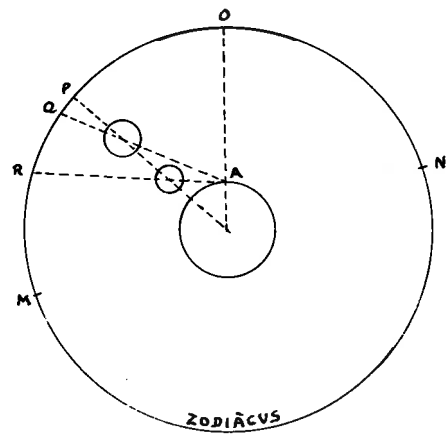
Consequenter cum dicit *Tunc si inter gradum*, docet invenire locum et tempus coniunctionis visibilis; et primo loco dicens, quod si inter gradum lunae, qui est gradus coniunctionis, et gradum ascendentem horã coniunctionis verae fuerint pauciores gr. 90, <id est,> si fuerit coniunctio ante meridiem, tunc diversitatem aspectus in longitudine, sicut habitum est superius adaequatam, adde loco lunae aequato, sive loco verae coniunctionis, quod est idem. Si vero fuerint plures gradus quam 90 inter verum gradum lunae et gradum ascendentem, id est, si fuerit coniunctio post meridiem, subtrahe diversitatem aspectus in longitudine de loco lunae ad horam verae coniunctionis aequato; et post additionem vel subtractionem habebis locum lunae visibilem, in quo luna videbitur seu videri poterit ad horam coniunctionis in civitate seu regione illa, ad quam fueris operatus. Sciendum autem quod, numerando gradus qui sunt ab ascendente ad locum lunae, incipienda est computatio a gradu ascendentis ad locum lunae contra successionem signorum, vel a loco lunae in gradum ascendentem secundum ordinem et successionem signorum, ut si principium arietis sit in ascendente et luna sit in medio caeli, erit in capricorn< > /B,54vb/ ariete usque ad capricornum contra ordinem signorum vel a capricorno ad arietem cum ordine signorum; et hoc praecipue super terram; sed sub terra contingeret e converso. Si autem inter locum lunae et gradum ascendentem fuerint praecise 90 gradus, tunc aspectus diversitas in longitudine nulla erit.

Secundo docet invenire tempus visibilis coniunctionis ibi *Si autem coniunctionis visibilis*, dicens quod si diversitati aspectus in longitudine sua 12a coniungatur et collectum per motum lunae aequalem in una hora <dividas>, habebis in numero quotiens horas; et si quid residuum fuerit, multiplica per 60 et divide sicut prius, et habebis minuta. Has igitur horas et haec minuta ex tali divisione provenientia minue de horis verae coniunctionis, si fuerit inter ascendens et locum lunae minus 90 gradibus, id est, si coniunctio fuerit ante meridiem, vel adde, si fuerit coniunctio vera post meridiem; et habebis post augmentum vel deminutionem horam coniunctionis visibilis ad Toletum vel ad alium locum, ad quem fueris operatus.

(G) Jo. de Sicilia, B54vb (Marsiliensis, R116ra has the passages "Circa istud - dictorum" and "Scire autem debes - post meridiem") - On the parallax in longitude. B has no figure: I attempt a reconstruction below.

Circa istud capitulum tria sunt declaranda. Primum est quid sit diversitas aspectus in longitudine et latitudine, et de aliis nominibus ignotis, quae in canone continentur. Secundum est de compositione tabularum. Tertium est de causis dictorum.

De primo, sciendum quod diversitas aspectus lunae est differentia sive distantia [eius] inter verum locum eius in orbe signorum et locum eius visibilem. Locus verus est punctus terminans lineam exeuntem a centro terrae per centrum corporis lunae usque ad orbem signorum. Locus visibilis est punctus in orbe signorum terminans lineam exeuntem ab oculo nostro per centrum corporis lunae usque ad zodiacum. Et arcus zodiaci interceptus inter haec 2 puncta dicitur diversitas aspectus, ita quod arcus inter haec 2 puncta secundum zodiaci longitudinem computatus dicitur diversitas aspectus in longitudine, arcus vero inter puncta secundum zodiaci latitudinem [[computatus]] interceptus dicitur diversitas aspectus in latitudine. Quando vero sol et luna sunt in eorum coniunctione vera, tunc arcus zodiaci interceptus inter locum visibilem unius et locum visibilem alterius dicitur diversitas aspectus lunae ad solem. Sit itaque moles terrae circulus ABCD super centrum E; circulus autem lunae sit FGH; circulus vero solis sit IKL; circulus quoque zodiaci MNO; sintque sol et luna coniuncti in puncto P orbis signorum inter 2 puncta M et O. Tunc linea a puncto A, quod est circulus in superficie terrae, per centrum corporis solis educta terminabitur inter 2 puncta P et M; sitque eius terminus in puncto Q. Dico quod arcus PQ est diversitas aspectus solis. Linea vero ab eodem puncto A per centrum corporis lunae educta usque ad zodiacum terminabitur inter 2 puncta <Q> et M; sitque terminus eius in puncto R. Dico quod arcus PQ est diversitas /B55ra/ aspectus lunae sive differentia inter locum eius



verum et apparentem. Arcus autem QR est diversitas aspectus lunae ad solem, sive differentia inter visibilem locum unius et visibilem locum alterius tempore coniunctionis eorum. Quando autem sol et luna fuerint in meridiano, tunc nulla erit diversitas aspectus in longitudine, quia linea egrediens a centro terrae et linea egrediens ab oculo per centrum utriusque erit linea una. Tempus coniunctionis visibilis dicitur illud quod fit ex aggregatione temporis, in quo luna pertransit arcum diversitatis aspectus cum sua 12a, cum tempore coniunctionis verae, vel quod relinquitur ex deminutione eiusdem temporis diversitatis a tempore verae coniunctionis. Scire autem debes, quod secundum diversitatem aspectus in longitudine videtur luna quandoque orientalior quam sit in rei veritate, scilicet ante meridiem, quandoque vero occidentalior, scilicet post meridiem; sicut, posito quod N sit principium arietis et occidentis, punctus vero M sit principium librae et orientis, O sit medium caeli, tunc si luna sit in zodiaco sub puncto P (B *scr.* B), manifestum est quod videbitur orientalior quam sit, id est, locus eius visibilis erit magis versus orientem quam locus eius verus. Erit igitur secundum locum eius visibilem in puncto R (I *scr.* B). E converso continget, si fuerit luna in puncto < >, scilicet post meridiem. Secundum diversitatem vero in latitudine semper apparet nobis luna meridionalior quam sit vere, eo quod totus zodiacus est nobis ad partem meridiei. Hoc autem in superficialibus figuris sensibiliter ostendi non potest, sed per ea, quae dicta sunt de longitudine, consimilis imaginatio capi potest.

(H) Jo. de Sicilia, B56ra = Marsiliensis, R116va

Causa quoque, propter quam ad habendum locum lunae visibilem oportet diversitatem aspectus in longitudine addere vero loco lunae, si coniunctio fuerit ante meridiem, et minuere, si fuerit post, est quia ante meridiem arcus veri loci computatus ab ariete secundum successionem signorum minor est quam arcus <loci> visibilis eodem ordine computatus; et ideo ad habendum locum apparentem ex vero necesse est aliquid addere vero, scilicet differentiam unius ad alterum, quae est diversitas aspectus in longitudine; post meridiem autem e converso, sicut patet consideranti figuram superius positam.

(J) Jo. de Sicilia, B56ra. Not in Marsiliensis.
- Finding time of visible conjunction. Cf. (B).

Deinde cum dicit *Intrabis etiam*, exequitur de proposito, dicens quod cum eisdem horis longitudinis seu distantiae coniunctionis a meridie intrabis tabulam diversitas aspectus ad tuum (3^{m} *scr.* B) clima, et diversitate aspectus secundum doctrinam habitam adaequatã addes eidem diversitati 12am sui partem; et numerum ex hac additione collectum divide per motum lunae aequalem in una hora, et quod provenerit in numero quotiens erunt horae. Siquid autem fuerit residuum ex divisione, multiplica in 60, et iterum dividatur, et erunt minuta, quae simul cum horis praedictis addas horis verae coniunctionis, si fuerit coniunctio post meridiem, hoc est, si fuerint inter locum lunae et gradum ascendentem plus quam 90 gradus; vel minue, si fuerit <coniunctio ante> meridiem, quod est /B56rb/ dum inter ascendentem et locum lunae fuerint pauciores gr. 90.

(K) Jo. de Sicilia, B56rb. Not in Marsiliensis. From "2m declarandum", some correspondence with Astrologia, R139vb.
- As the preceding.

Et nota quod si coniunctio non fuerit multum prope caput vel caudam, sufficit per primum introitum operari, et alii duo possunt absque magni erroris periculo praetermitti. Si vero coniunctio multum caudae vel capiti sit propinqua, non est aliquis de tribus introitibus dimittendus, sed omnes 3 aequationes sunt per ordinem faciendae. § Circa istam partem duo sunt causis propriis declaranda. Primum est quare ante meridiem oportet[, quod] tempus, <<quod>> ex diversitatis aspectus divisione provenerit, minuere de horis verae coniunctionis, post meridiem addere. Cuius rei causa est quia nos incipimus diem a meridie /B56va/ procedendo per occidentem et orientem, iterum redeundo ad meridiem, sicut patet in figura praemissa. Incipimus enim diem a puncto E, quod est punctum meridiei, discurrendo per puncta N M et iterum redeundo ad punctum E. Cum ergo fluxerit a meridie tempus illud, in quo movetur arcus ENMP, habemus horas coniunctionis. Cum vero fluxerit illud tempus, in quo movetur arcus ENMR, habemus horas coniunctionis visibilis. Et quia arcus primus excedit secundum in tanto quantus est arcus RP, qui est diversitas aspectus in longitudine, propter hoc, tempore verae coniunctionis invento, si ex eo volumus habere tempus visibilis coniunctionis, oportet removere tempus illud, in quo pertransitur arcus RP. Tempus enim visibilis coniunctionis antecedet tempus verae coniunctionis. Et quia iterum dum luna pertransit arcum illius longitudinis, sol etiam pertransivit <l>2am partem eiusdem longitudinis, ideo non solum est tempus transitus huius longitudinis minuendus, sed etiam cum 12a sui parte. Post meridiem autem accidit e converso, sicut patet figuram praehibitam intuenti. Et ideo tempus illud, quod ante meridiem demebatur, post meridiem est addendum. § 2m declarandum est quare (quia B) aspectus diversitas in longitudine tribus vicibus adaequatur. Cuius rei causa est, quia <cum> diversitas primo reper[a]ta a loco verae coniunctionis subtrahatur vel addatur eidem, nondum in veritate locus lunae visibilis notus erit. Quoniam si luna sit in parte orientali, quando fuerit in loco per subtractionem diversitatis aspectus invento, tunc erit propinquior horizonti. Et sic aspectus diversitas maior[[em]] est in rei veritate quam tunc est per tabulas adinventa. Si autem foret in parte occidentali, tunc luna remotior esset ab horizonte, et per consequens vera diversitas aspectus minor est ea quae per tabulas est reperta. Verbi gratia, dato quod sit coniunctio vera hora 3 diei ante meridiem in primo gradu tauri, ergo coniunctio vere visibilis fuit in ultimo gradu arietis. Sed prius oritur ultimus gradus arietis quam primus tauri; ergo luna ibi existens propinquior horizonti magis habet de diversitate aspectus in longitudine. E converso contingit in parte occidentali.

(L) Jo. de Sicilia, B56vb. The passage "De quo sciendum - designatur" has a counterpart in Marsiliensis, R116va.
- Cf. (3,27).

Primum est de operatione quam facimus circa diversitatem aspectus in latitudine. De quo sciendum est /B57ra/ quod in hora visibilis coniunctionis inventa luna videtur meridionalior quam sit vere, cuius excessus quantitas per arcum diversitatis aspectus in latitudine designatur. Licet autem distantia veri loci lunae ab ecliptica ex hoc non sit nobis simpliciter mandata, si tamen sciamus distantiam cuiuslibet puncti deferentis ab eclip<ti>ca, pro loco apparitionis lunae accipimus punctum deferentis, qui

loco lunae verius correspondet. Si enim a loco, in quo apparet visibiliter centrum lunae, versus propinquiorem nodum ducatur linea ipsi eclipticae parallela [[est punctus qui tantum distat ab ecliptica,]] quousque concurrat circulo deferenti, punctus contactus deferentis cum hac linea parallela est punctus qui tantum distat ab ecliptica, quantum locus in quo apparet visibiliter centrum lunae. Et propter hoc, loco illius arcus, qui est inter locum lunae visibilem et eclipticam, accipimus latitudinem quae est inter praedictum punctum et eclipticam. Hic autem punctus est arcus cuiusdam deferentis terminus, incepti a puncto deferentis in quo est luna, qui [[tantum distat]] arcus ita se habet ad diversitatem aspectus in latitudine sicut 11 cum dimidio ad unum. Et ideo pro argumento latitudinis lunae tripliciter adaequato, quod est arcus deferentis a capite draconis usque ad punctum praedictum, in quo tunc existens visibiliter corpus lunae interponitur inter nos et solem, accipimus praedictum arcum, qui a capite draconis extensus protenditur usque ad punctum contactus deferentis cum praedicta linea parallela, ita quod quantum de sole contingeret eclipsari, si vere esset in puncto, in quo deferens tangit dictam lineam parallelam, tantum etiam eclipsabitur de eo, cum vere sit in loco alio deferentis. Et hoc est quia arcus apparitionis lunae et locus contactus deferentis cum linea supradicta aequaliter accedunt ad eclipticam.

(M) Jo. de Lineriis, Q49v. The passage is not in P and is probably an interpolation. An extended version is found in Vat.Pal.lat.1376,86r (Germany, 15th c.), from which the supplements are taken.
- Use of multiplication table. Cf. (2,18-20).

Partem proportionalem alicuius numeri vel numerorum secundum proportionem alicuius alterius seu aliquorum ad 60 accipere. Ad <evitandum> multiplicem laborem multiplicationis et divisionis, qui multotiens tam in aequationibus planetarum quam eclipsium evenire solet, composita est tabula <partis> proportionalis, cuius usus talis est: Quaere numerum, cuius proportionem, id est partem proportionalem, vis habere secundum proportionem alterius ad 60, in capitibus tabularum et residuum in sinistro tabulae eiusdem; et quod inveneris in angulo communi erit proportio <quaesita, sub illa condicione, quod numerus> versus dextram aut infra secundum operam [semi]tabulae contentus <erit> istius denominationis (proportionis Q), quem denominationes simul coniuncti constituunt vel producunt, et numerus versus sinistram aut supra (super Q) erit proxime maioris (minutis Q). Si autem in alterutro sunt diversae fractiones, cum qualibet (que- Q) divisim et cum reliquo intres, et quod inveneris aggreges, quodlibet scilicet ad suum genus. Si autem in utroque sunt diversae fractiones, cum qualibet (que- Q) unius et cum qualibet alterius seorsum intres et fac ut prius. Si vero alicuius proportionem, id est partem proportionalem, volueris secundum proportionem alterius ad 30, modo qui dictus est operare, et quod inveneris duples. Si vero velles invenire partem proportionalem secundum semitabulam, quaere maiorem numerum in latere dextro aut sinistro descendentem et minorem in latere inferiori et fac ut prius.

INDEX OF TEXT-REFERENCES IN THE APPENDICES.

The index is meant as a supplement to the synopsis and the textual apparatus, giving only such references as may serve to elucidate particular points by quotation, explanation, parallel, etc. - For reference, the relevant folio numbers of F and N are also given.

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INDEX OF SELECTED TERMS.

Only definitions or main points of use are referred to. Scales and tables are mentioned only where treated outside their proper headings on pp.6 and 71 and in App.1.

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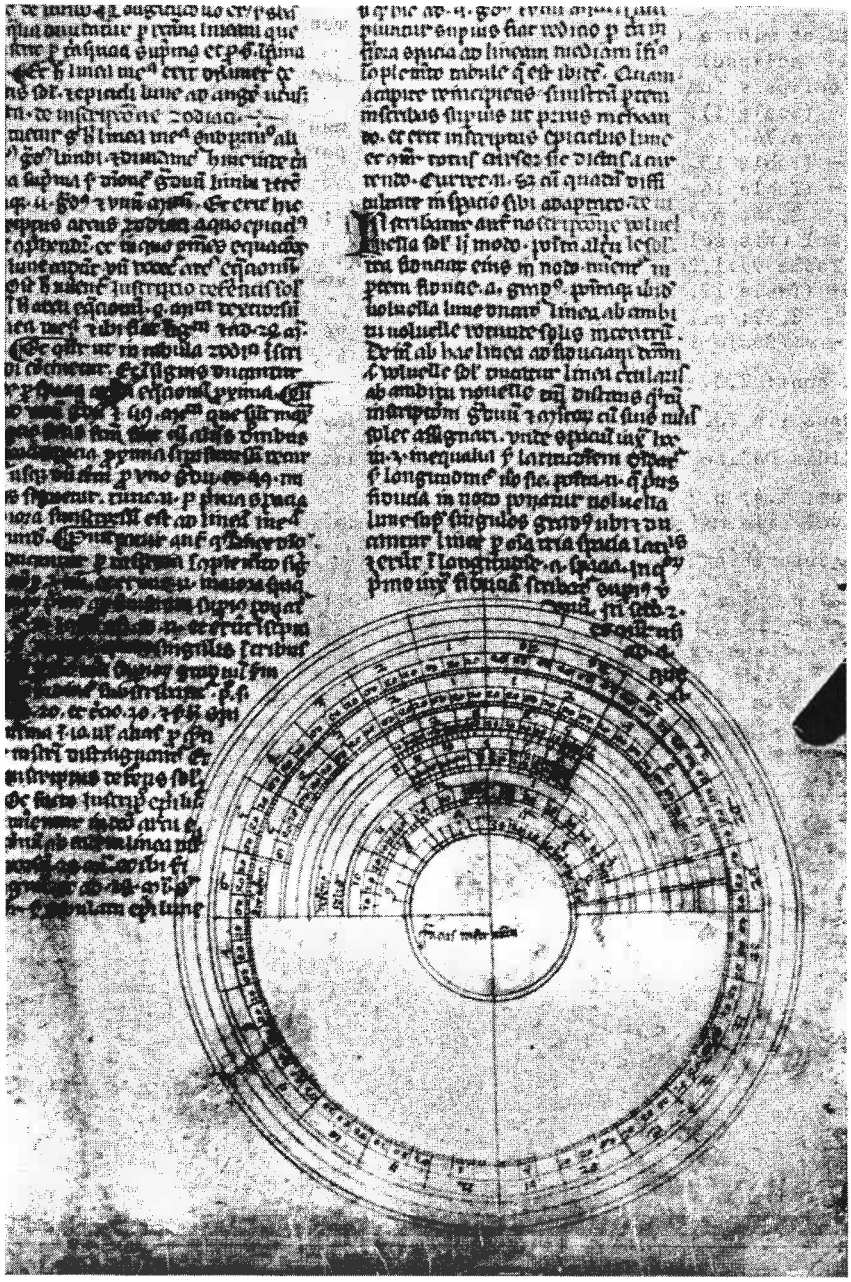
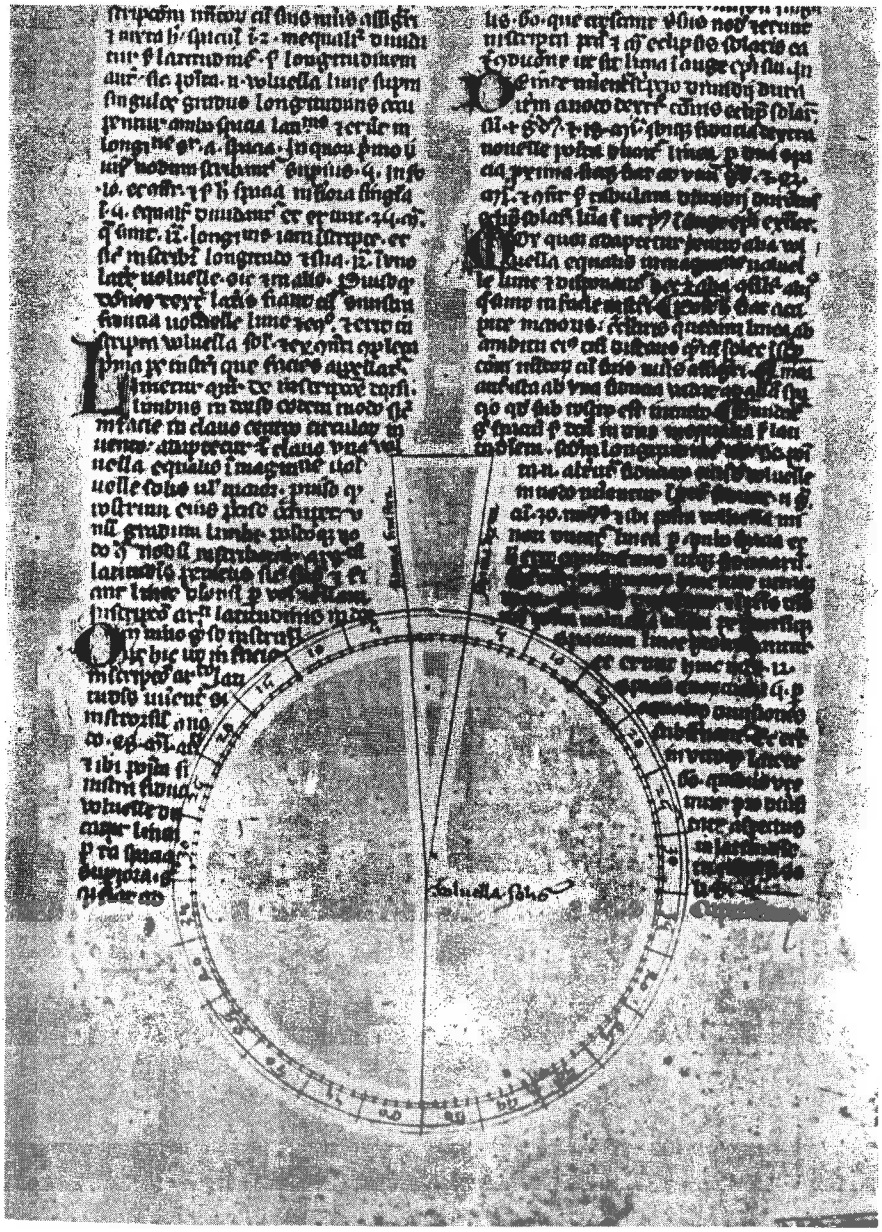
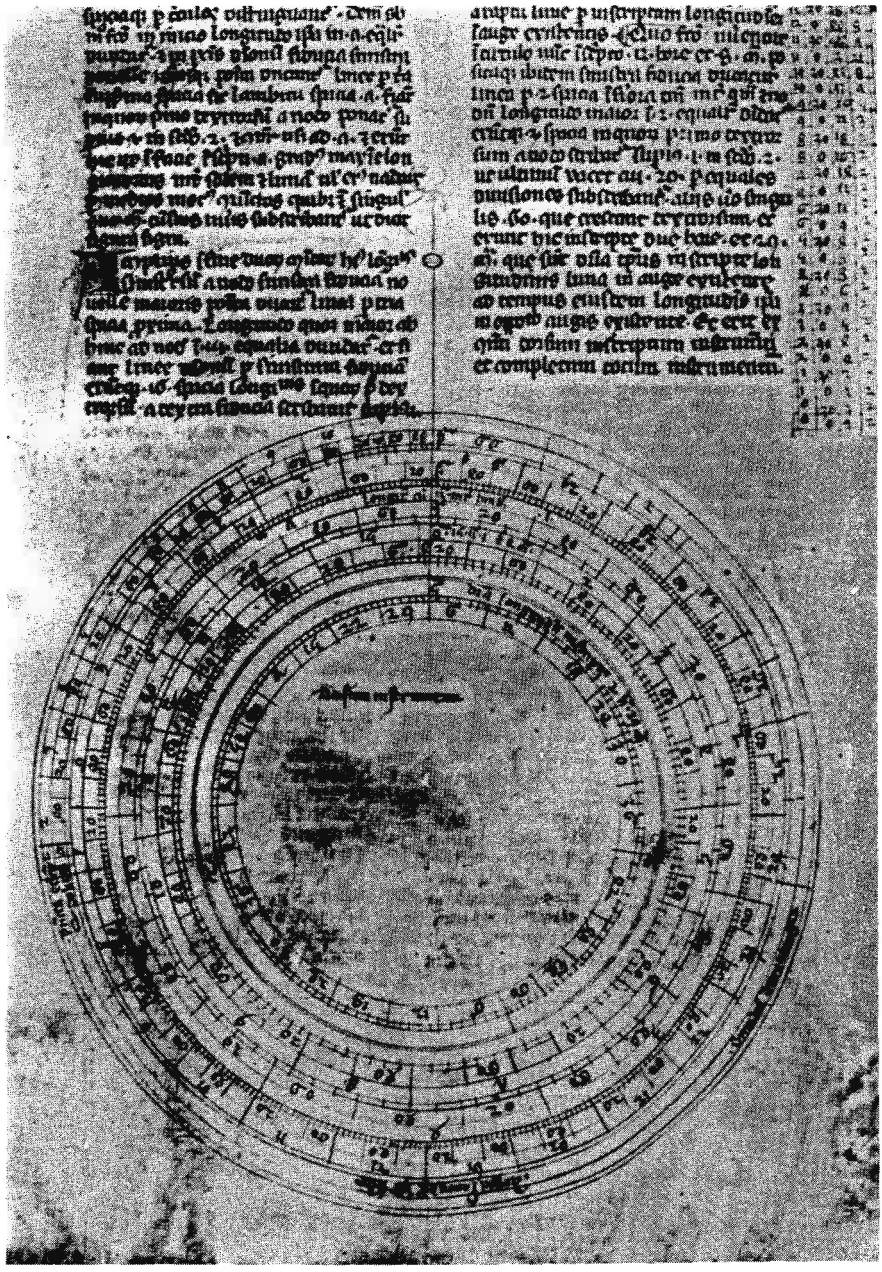


F,209r: Front of instrument, including cursor. Cf.p.9-10.



F,209v: Volvella maior (back of instrument). Cf.p.9-11.
- Inscribed 'volvella solis' and so possibly an adaptation from a version like the one of N (cf.p.72-3).



F,210r: Back of instrument (cf.p.9.11).