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A Merton College Equatorium: Text, Translation, Commentary

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I Introduction

This article presents an edition and translation of a short anonymous treatise, extant in two manuscript versions, on the uses of an astronomical instrument. In some ways it is typical of fourteenth-century Latin instrument writing. Yet it has a number of striking features that make it worthy of scholarly attention.[1]

First, the instrument it describes perfectly matches the characteristics of the oldest surviving equatorium, combined with an astrolabe, at Merton College, Oxford (c. 1350). If, as seems likely, the treatise was written as a description of the uses of that instrument, this is a unique pairing of object and description in fourteenth-century Christendom. Secondly, that pairing reveals a striking approach to the blend of theory and practice. The treatise is explicit about the reciprocal didactic relationship of the instrument and the astronomical models which underpin it, and which it demonstrates. Not only does the practical section of the manuscript contain theoretical insights; the theory section employs practical, haptic explanation. Thirdly, in his introduction and conclusion the treatise's author discusses a range of contemporary instruments in a manner showing something of the attitudes of late-medieval astronomers to their sources and tools. Fourthly, the differences in drafting between the two near-contemporary copies of the treatise reveal how the priorities of astronomical copyists manifested themselves through their textual practices.

The following commentary can do no more than highlight these features of the text, and make some tentative suggestions of their significance. It is hoped that readers will find the edition and translation of this treatise useful in enabling them to draw their own conclusions.

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[1] It has previously been discussed by John North [1976, II.272] and Emmanuel Poulle [1980, 200–205].

I.1 *A striking instrument treatise*

This treatise is anonymous and untitled, so will be referred to by its opening phrase 'Quia nobilissima scientia astronomie non potest bene sciri sine instrumentis debitis', or, more succinctly, *Quia nobilissima*. It ostensibly comprises three sections: a 250-word introduction, a 1000-word theoretical section, and a 1900-word practical section; but, as we shall see, theory and practice are far from separate in the mind of its author.

The introduction is particularly striking for its references to a range of astronomical instruments, and citation of their inventors. It is partly copied from an equatorium treatise by John of Lignières (fl. c. 1320), and the two treatises share an incipit; this may explain why the scribe of one of the two extant copies (Ms. Gg.6.3) attributed it to John, even though a passage added to the introduction names him in the third person.[2] Alongside John of Lignières, this additional passage names three other astronomers. John of Lignières himself had discussed the equatorium of Campanus of Novara (c. 1220–1296), presenting his own instrument as an improvement on Campanus's large, hard-to-construct design. The new *Quia nobilissima* introduction praises John of Lignières, mentions Campanus again, and adds references to Profatius Judaeus (Jacob ben Machir ibn Tibbon, c. 1236–c. 1304) and Richard of Wallingford (1292–1336) as creators of similar instruments.

The author acknowledges that his canon does not cover the functions of Richard of Wallingford's Albion.[3] Yet the other three instruments he cites are also very different from the one whose use he describes, despite his claim at the end of the treatise that 'there is little difference between them' [l. 263]. The Campanus equatorium [ed. Benjamin and Toomer 1971] was nothing like the others, consisting of a separate instrument for each planet; this was the cause of its great bulk, severely criticised by John of Lignières in the introductory passage that our present author copied. John of Lignières's own equatorium also does not match the canon particularly closely, since it does not use equant circles and instead incorporates a separate deferent circle for each planet on its one main plate [Price 1955, 125–127, 188–196]. Concerning the third instrument, our author's remark that 'Profatius Judaeus, in Montpellier, cleverly composed another equatorium, similar in operation, which is called *semissas*' represents an incorrect attribution: the true author of the *Semissa* was not Profatius, but rather Peter of Saint-Omer (fl. 1289–1308) [Pedersen 1983, 43]. The attribution to Profatius occurs in several British copies of the *Semissa*, including one in the same codex as the earlier copy of the *Quia nobilissima* (Ms. Gg.6.3; see section I.5 below). The semissa is the closest of the three instruments to the description in the *Quia*

[2] The treatise was edited (with some misreadings) from Brussels, Royal Library Ms. 10124, ff. 142v–146r by Derek Price [1955, 188–196]. See also Thorndike and Kibre [1963, 1224].

[3] The *Tractatus albionis* (1326) was edited by John North [1976].

nobilissima.[4] However, it differs in having the equant circles on two sides of its main disc ('semissa sphaerarum'). If our author is describing any particular instrument, perhaps it is a fourth, 'the other, newly composed, equatorium,' which he mentions in his conclusion [ll. 259–260]. If so, one wonders why he did not mention it before the final folio, but it may have been because it could not be attributed to a famous inventor, something that was clearly a concern for this and other writers [Falk 2016, 18–19]. In any case, the closeness of his description to the 1350 equatorium at Merton College, Oxford, makes it tempting to identify this extant instrument as the new design.

I.2 *Relationship with the Merton College equatorium*

Merton College, Oxford, is home to the oldest surviving equatorium, a planetary face combined with an astrolabe, but lacking its epicycle [Figure 1]. A number of links between the extant instrument and the *Quia nobilissima* treatise are apparent.[5] They both refer to Oxford in 1350: the astrolabe plate of the Merton equatorium is engraved "Lat' 52. 6m. Oxonia", and a small table engraved on the equatorium face gives rough changes in the motion of the eighth sphere starting in 1350 [Figure 2], at a rate of 1° over the succeeding 100 years. The treatise gives an identical estimate for the motion of the eighth sphere.

The workings of the Merton equatorium are identical to the description in *Quia nobilissima*, and will be described in the following section. Unfortunately the common epicycle does not survive on the Merton instrument, but labelled holes on the instrument show where it was to be attached, and numerous scratches on the equatorium face (visible in Figure 2) testify to its use.[6] Another set of holes is that of Mercury's deferent centre, which moves around a small circle; the 36 holes on the Merton instrument match the description in the *Quia nobilissima* treatise that that circle 'is divided into signs, and each sign into three parts, and in each division is a small hole.' [ll. 201–202] The treatise also describes a 'small plate of the deferent of the Moon' [l. 221], which does not survive with the Merton instrument, but just as in the case of the common epicycle, a hole on the instrument labelled 'luna' marks where this plate was to be attached. The specificity of the instruction to 'let the plate be fixed to the face by its pin' [l. 223] again suggests that the author was describing a particular instrument, and undermines his claim to be writing canons that are applicable to various different instruments; it seems likely that that claim was added to widen the validity of the treatise, without its main content being modified.

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[4] Pedersen [1983] has edited the *Semissa* treatise from 22 surviving manuscripts; Poulle [1980, 205–210] has explained the workings of the instrument.

[5] The similarity was first noted by Emmanuel Poulle [1980, 200–201].

[6] Poulle [1980, 201–205] suggests some possible dimensions for the missing parts. North [2005, 359] provides a plausible diagram.

If the *Quia nobilissima* treatise was indeed written as a description of the Merton equatorium, could they share a creator? Price [1955, 129] suggested that the Merton equatorium was the 'larger astrolabe' bequeathed to the college by Simon Bredon at his death in 1372 [Powicke 1931, 84], but there is no further evidence for this, and one might suggest that Bredon's will would have been more likely to describe it as an equatorium; the Merton *electiones* of 1410 and 1452 list a 'brass equatorium' among the books and instruments loaned to scholars, quite possibly the same object that survives today [Powicke 1931, 68, 80]. Bredon's hand has been identified in a number of contemporary manuscripts [Gunther 1923, 52], but since neither of the copies of the Quia nobilissima treatise is authorial, this does not help us. A more likely owner-author is William Rede (c. 1315-1385), a fellow of Merton by 1344, who certainly had an interest in instruments, receiving an astrolabe as a bequest from his colleague Bredon [Powicke 1931, 84]. Rede donated a number of scientific instruments to the College in around 1374, including an albion, a quadrant, a cylinder dial, and indeed an equatorium. Although the dimensions and material of that equatorium are not recorded, it seems highly likely to be the very same Merton equatorium currently under discussion [Emden 1957, 1558; North 1976, III.133; North 2004]. In addition to the instruments given during his lifetime, Rede bequeathed the College 100 books 'of diverse faculties', together with money for the upkeep of the library [Powicke 1931, 87–88; Gunther 1923, 56–59; Poulle 1980, 201]. Both of the manuscripts containing the *Quia nobilissima* also include works attributed to Rede: Ms. Digby 57 has a copy of his tables of mean motions [ff. 32r-43v], adapted from the Parisian Alfonsine tradition to the meridian of Oxford [North 1977, 274–277], while in Ms. Gg.6.3 the explicit of a short treatise on planetary spheres, which immediately follows *Quia nobilissima*, names Rede as its abbreviator [ff. 221r-222v]. Furthermore, the simplified nature of *Quia nobilissima* is in keeping with the competent but fairly unoriginal nature of Rede's known work (though the treatise does also contain some small confusions, such as in the discussion of the model for Mercury). It should be noted that the latitudes given for Oxford in the treatise (51;56°) and on the equatorium (52;6°) do not match that computed by Rede (51;50°); these discrepancies also, of course, cast doubt on any simple identification of the treatise with the instrument. But such a variety of parameters is commonly found within astronomical manuscipts of this period. So it remains likely that the Merton equatorium was Rede's, and quite possible that he composed the *Quia nobilissima* treatise.

I.3 *Workings of the equatorium*

The reader may appreciate a summary sketch of the use of the instrument to obtain the true longitudes of the planets. The two essential preparatory steps are: first, to obtain the mean centres and mean arguments for each planet (with the exceptions of the Sun, which the treatise tells us only has a mean argument, and the Moon, for which we need the mean motus); and second, to place the instrument on a large, flat, table. Using the example of the Sun, the treatise explains in some detail how to use the radices and the various tables of years, months, days, hours and minutes to add up the motus for the desired time. A brief digression explains how to adjust this for different locations.

Once this preparation is complete, the instrument is used as illustrated in Figure 3. It comprises two pieces: a brass face (the surviving part of the Merton equatorium); and a 'common epicycle' that almost certainly took the form of an arbitrarily sized brass ring. The face has a graduated scale on its rim, representing the ecliptic, and is marked with a smaller equant circle for each planet, graduated and numbered from the planet's apogee. Since the size of the equant circle in Ptolemy's planetary theory is irrelevant, the equant circles can be nested on the face of the instrument, to make the best use of the space there. The epicycle ring has a rule pivoting at its centre, marked with the radii of the planets' epicycles, so that the epicycles are traced out as the rule rotates. Finally, the epicycle centre is held at an appropriate distance from the deferent centre by a common deferent radius; holes marking the deferent centres on the Merton equatorium allow this to be pinned in place. One such radius of arbitrary length can be used for the all the planets, provided that their epicycle radii are sized in the correct proportion to it.

The treatise explains the computation process in clear steps. We first find the mean centre ($\bar{\kappa}$) on the equant circle of the relevant planet, and the mean argument ($\bar{\alpha}$) on the rim of the common epicycle. We then fix the free end of the common deferent radius in the deferent centre (D) of the desired planet. We extend a thread from the equant centre (E) over the place on the equant circle corresponding to the mean centre we just found, then move the combined epicycle-deferent-radius until the epicycle centre (C) lies over or under that thread. The apogee of the epicycle (the zero point on the epicycle's graduation) must also lie under the thread, so the epicycle must have been attached to the deferent radius in a way that left it free to rotate independently. Next, holding the common epicycle still, we rotate the 'true epicycle' rule to the mean argument on the epicycle we found earlier. Finally, we draw a thread out from the centre of the Earth (O) through the mark of the planet (P) on the rule, and where it crosses the rim of the equatorium we can read the ecliptic longitude (λ) of the planet. This basic method holds for all planets, but the treatise further explains the variations in technique for Mercury and the Moon. Mercury's moving deferent centre is represented by one of the 36 holes mentioned above, while the Moon's moving deferent centre and opposite point (functioning as an equant centre) are carried on a small plate that rotates about the centre of the Earth. Curiously, the treatise tells us that this plate can also be used instead of the circle of holes of Mercury's deferent centre, to help find that planet's position, but with that part now missing from the Merton equatorium, the treatise does not contain sufficient details of its construction and markings to be sure how this could be done. As well as the two possible methods for Mercury, the treatise also provides two slightly different methods for using the instrument to find the Moon, depending on whether we start with the Moon's mean motus or mean centre.

In general the instrument provides some relief from what the *Quia nobilissima* treatise (in an addition to John of Lignières's introduction) calls 'the difficulty, length and tedium of calculation with tables' [ll. 12–13]. Yet it should be noted that tables are still far from redundant; indeed, the section dealing with the use of tables to prepare the mean motion data necessary as a precursor to the use of the instrument is almost as long as the section dealing with the instrument itself. Readers are instructed how to find the radices of mean motions and adapt them for different longitudes, and then how to use tables of motions in collected (groups of twenty) and expanded (single) years, months, days and hours, taking due account of whether it is a leap year, and interpolating for numbers of minutes that are not explicitly tabulated. We are also instructed how to add these values to each other and to the radix, or to subtract if we are interested in some time in the past. And we are instructed to perform these calculations for the mean centre and mean argument of each planet, taking due account of the motion of the eighth sphere. The treatise is thus far from the historical account of different instruments and their inventors that the introduction leads us to expect; it is as much a practical manual.

I.4 *Theory, theoric, and practice*

However, attention to the practical utility of this treatise should not obscure its nuanced balance and interplay of theory and practice. The introduction ends by noting that 'in order to operate the instrument of Campanus, Lignières or Judaeus, a theoric may be put forward so that its effect might be made sufficiently plain' [ll. 20–21]. 'Theoric' (*theorica* in Latin) refers to a geometrical model: something more than a theory. The boundaries between objects and ideas were blurred: instruments such as equatoria could have a pedagogical purpose beyond the purely practical, as three-dimensional diagrams with moving parts [North 1976, II.251]. On the other hand, Campanus of Novara's *Theorica planetarum* [ed. Benjamin and Toomer 1971] is a description of an instrument. The author of this treatise was clearly well aware of these blurred boundaries between theories and instruments; the use of the instrument was not only vital in expounding the theory; it *was* a physical manifestation of the theory. That ambiguity is also apparent in the use of the word '*effectus*', which could — perhaps intentionally — refer both to the instrument's functions and the theory's effects.[7]

For this reason, it is misleading to separate the ostensibly theoretical and prac-

[7] The implications of *theoricae* for our understanding of the purposes of instruments have been intensively discussed by historians. On the distinction between theoretical and practical purposes, see Price [1980, 76] and Bennett [2003, 136]; on the artificiality of such a distinction, see Mosley [2006, 194]; on the potential range of 'practical' purposes, see Maddison [1969, 7–8, 20].

tical sections of the treatise [cf North 1976, II.272]. The theoretical section was undoubtedly written by someone who had an equatorium in front of him, since its description of planetary motions is intensely physical. The mean centre of any planet is defined as 'the distance between the apogee of the equant and a *thread* coming out from the equant centre' [ll. 48–49]; a thread also designates the mean apogee on the epicycle. Likewise, the explanation of planetary stations and retrogradations is strikingly visual and even tactile; it is easy to imagine the author describing the parts of an existing instrument.

Conversely, when the practical use of the instrument is described, the aim — as promised in the introduction — is not solely to obtain numerical results, but to acquire theoretical comprehension. This is clear from the way the instrument is described. The description of tables and threads, holes and nails, is intensely physical, and highly unusual among instrument treatises which so often lack any sense of materiality; yet when the author explains the use of the common epicycle, he names the part on which the planets' radii are marked, which must have taken the form of a rule, as 'true epicycle' [l. 191]. This is a description of the object's function, rather than its form. Conversely, the argument is explained as moving on 'the common epicycle' [l. 198], a part of the instrument rather than the theoric. Boundaries are thus blurred between explanation of the use of the instrument and its role as a symbol in a model communicating planetary theory, just as the 'mental notes' suggested in process of finding a planet clearly become visible notes seen on the instrument [e.g. ll. 176, 184, 189–191, 205–207]. Yet the author makes his overriding aim of facilitating understanding clear when, in his final sentence before concluding, he states that a list of astronomical data 'are made sufficiently clear through the given instrument for the theoric to be understood' [l. 253–257].

I.5 *The manuscripts and their versions*

The treatise survives in two copies, neither authorial but both near-contemporary. A number of striking differences between their versions of the text will be discussed in the following section.

C = Cambridge University Library, Ms. Gg.6.3, ff. 217v–220v (c. 1348)

Described as 'a labyrinthine book' by the cataloguer M. R. James [1925–30], Ms. Gg.6.3 is a compilation of astronomical and related texts, written in a number of different fourteenth-century hands. It contains 399 leaves, many of which have suffered water-damage, and many have also been bound out of their original order. Among its contents are a number of works significant for this study, including items attributed to all four of the astronomers named in *Quia nobilissima*. It includes three texts by Richard of Wallingford: the *Albion* [ff. 288v–303v and 376, missing Part II]; the trigonometrical treatise *De sectore*, an adaptation of the author's own

Quadripartitum [ff. 54v–80v and 285r–287r]; and his canon on the Queen's calendar [f. 284v] [North 1976, II.129; II.39–41; II.373]. Richard of Wallingford is also credited with the adaptation of tables of syzygies, originally composed by Campanus for the meridian of Novara, for use in Oxford [ff. 132v–133v]. Campanus's *Theorica planetarum* [ed. Benjamin and Toomer 1971], in which he describes the equatorium described in *Quia nobilissima*, is not present in the manuscript, but another text by Campanus is: a work on squaring the circle [ed. Clagett 1964], beginning on f. 231v (this part of the codex is badly deteriorated). A more common *Theorica planetarum* is on ff. 206r–212r: the treatise beginning 'Circulus eccentricus vel egresse cuspidis' [TK 223j],[8] commonly (but erroneously) attributed to Gerard of Cremona, which was perhaps the most popular Latin introduction to planetary theory.

Alongside Richard and Campanus, another astronomer whose name appears in the manuscript is Profatius, wrongly credited as the author of the *Semissa* [ff. 322r–330r]. This copy of the *Semissa*, which is incomplete but well illustrated, has been updated for Oxford [f. 324r]; the attribution to Profatius [f. 322r] is in a different but contemporary hand to the main text [Pedersen 1983, 43, 690]. Profatius was, though, the author of the *New Quadrant* treatise, and an adaptation of that treatise by the Merton astronomer John Maudith (d. c. 1343) is found on ff. 273r–284r [North 1967, 74–76; Pedersen 1983, 732, 735]. This includes a table of latitudes and longitudes [f. 274v] featuring a number of English cities, though not all the longitudes have been filled in. Maudith also produced star catalogues [ff. 127r–128r] derived from Ptolemy's, as well as tables of ascensions, sines, and others [ff. 35v–44v; North 1976, I.3–19; II.242–243; III.155–158]. The table of fixed stars on f. 48v is headed 'Table of John Maudith: put these on a quadrant', and it is noted that the table 'was verified for the year of Christ 1316 for the new quadrant at the latitude of Oxford, which is 51;50°'.[9] The name of John of Lignières also appears above a table of chords [f. 373r], seemingly correcting its original attribution to Arzachel (al-Zarqālī). The tables in the manuscript start from various years; the last of these (also given in *Quia nobilissima*) is 1348 [f. 214v].

Although clearly originating in a university context, this was also a monastic book: it was taken to Norwich Cathedral priory as a donation or bequest from Adam Easton.[10] Like Richard of Wallingford, Easton was a Benedictine monk who studied at Gloucester College before experiencing rapid promotion — not, as in Richard's

[8] 'TK' is used to refer to entries in Thorndike and Kibre [1963].

[9] 'Tabula Johannis mauduth : has pone in quadrante'. 'verificata fuit pro anno Christi 1316 pro novo quadrante ad latitudinem Oxonie qui est 51 gra. 50 mi'.

[10] Julia Bolton Holloway [2008, 137] argues that the spire and tower illustrated in the treatise on practical geometry on ff. 317v–321v [inc. 'Iste tractatus vocatur tractatus arsmetrice', TK 794i] are 'clearly recognizable' as the cathedral and castle of Norwich, but the drawings seem too generic to justify such a conclusion.

case, within the cloister, but in the papal curia [Dobson 2004]. He donated some of his books to his mother house in Norwich during his lifetime, while others arrived there after his death. [Zutshi 2017]. These books were assigned library pressmarks beginning with a letter X; the books in this class that were numbered from 34 to 193 belonged to Easton (some higher numbers, perhaps as far as 243, may have done so too). Ms. Gg.6.3 bears the pressmark "X clxx" on f. 1r [Zutshi 2017; see also Ker 1949, 21]. Easton's anti-mendicant interests are represented by a couplet on f. 164v that slanders the 'fallacious friars' by association with the biblical sorcerer Simon Magus. A number of astrological texts also reflect Easton's interests in that subject.

From the Priory, Ms. Gg.6.3 passed into the hands of Sir Thomas Knyvett (c. 1539-1618) [McKitterick 1978, 32, 163] and later John Moore, bishop of Ely, before his library was given to the University of Cambridge in 1715.

D = Oxford, Bodleian Library, Ms. Digby 57, ff. 130r–132v (c. 1376)

This book also originates in the context of the University of Oxford. Like Ms. Gg.6.3, it is the result of a specific interest in instruments within a broader range of astronomical material. Its 179 leaves are relatively well preserved; the first two-thirds are almost entirely tables, with the final third given over to various astronomical and astrological treatises. It contains the *Tabule Anglicane* (or "Oxford Tables"): double-entry tables of planetary longitudes and latitudes, with mean motions starting in 1348, and a note at the head of some tables that they were 'in Oxonia constituta'. These tables [ff. 44r–99v], and the accompanying canon that begins 'Vera loca omnium planetarum' [ff. 100r–102r, TK 1686f], have been ascribed to William Batecombe [North 1977, 279–280]. Preceding them, as already mentioned, are William Rede's tables of mean motions [ff. 32r–43v]. Before those, an incomplete canon beginning 'Medium motum solis per kalendarium' accompanies calendars and unfinished tables starting in 1374 [ff. 9v–23v]. The manuscript also contains a descriptive table of terrestrial latitudes and daylight hours [f. 109r], and tables of syzygies for 1376–90, partially unfinished from 1381 onwards [ff. 111r–118v]. An almanac of eclipses for 1376–90 [ff. 119v–120r] has been calculated for the meridian of Oxford. These tables provide grounds for dating the manuscript to 1376 or soon afterwards.

The tables of equations beginning on f. 121r bear a close relationship with instruments: they reference the parts of an instrument which may be constructed using the information they contain. For example, one table is headed 'Maximum equations of planetary epicycles, and this is the first table of the first wheel of the first face' [f.122r],[11] while f. 123v contains a note that the motions given will fit in a spiral ('circuli girativi') of 28 turns. The contents list on f. 2*v calls these 'various tables for the construction of the Albion', a further note on f. 125r declares that 'with

[11] 'Maxime equaciones epiciclorum planetarum et hec est prima tabula prime rote prime faciei'.

the foregoing tables the Albion can be made', and on the verso are given the true places of the planets for 5 May 1361, calculated 'both by means of tables and by the instrument called Albion'.[12] However, the references to the parts and parameters of the instrument do not fit the Albion particularly precisely.[13] After these tables, Richard of Wallingford is immediately referenced again in a treatise on the diameter of the Moon and the equation of days [ff. 127r–129v].

Next in the manuscript comes the *Quia nobilissima* treatise, described in the contents list on f. 2*v as a 'treatise on the method of using an equatorium'.[14] It is then followed by a series of extracts from largely astrological texts, such as Robert Grosseteste's *De impressionibus aeris* [ff. 144r–145r; TK 57i] and Roger of Hereford's *De iudiciis astrorum* [ff. 145v–151r; TK 1425i]; both these texts are also represented in C [ff. 134r, 139r–153r]. Another astrological treatise, beginning 'Ad honorem Dei et ad habendum cognitionem iudiciorum astronomie' [ff. 171r–176v; TK 43j], has been attributed to the Carmelite friar Nicholas of Lynn, whose calendar Geoffrey Chaucer cites as a source for his *Treatise on the Astrolabe* [Chaucer 1988, 663]. Nicholas's calendar does not appear in this manuscript, but the other one Chaucer cites in the same sentence of the *Astrolabe*, that of the Franciscan John Somer, does [ff. 24r–31r]. Catto and Mooney [1997, 205–207] have compared this to other versions of Somer's calendar and concluded that it supports a dating around 1376, though later additions were made to the calendar both by its original scribe and in other hands.

The manuscript changed hands within Oxford during the medieval period: the flyleaf records three fifteenth-century owners including John Philipp, Rector of Exeter College, who sold it in 1468 [Emden 1957, 1476]. It was owned by the astrologer-mathematician Thomas Allen (1542–1632), who gave it to Kenelm Digby (1603–65), from whose collection it passed into the Bodleian Library in 1634 [Foster 2004].

I.6 *Editorial practices and comparisons*

D was chosen as the copy-text for this edition. This is because it was a higher quality text, and more legible throughout. However, neither version of the treatise is complete. C is certainly an earlier copy, but it contains several significant omis-

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[12] 'tabule diverse ad componendum Albion'; "cum tabulis precedentibus potest fieri albyon'; 'tam per tabulas quam per instrumentum vocatum albion'.

[13] This may be the reason why North [1976, II.271–272], in discussing these pages of Ms. Digby 57, ignored the references to the construction of the Albion, only mentioning the reference to its use. North [1976, III.100] transcribed the table on f. 122r from its appearance in another manuscript (Bodleian Library Ms. Ashmole 1796, f. 108r), pointing out that the apogees given in the table matched those marked on the Merton equatorium, but he did not note that the table also appears in Ms. Digby 57.

[14] 'tractatus de modo operandi cum equatore'.

sions, errors and inconsistencies. D contains a smaller number of such errors and omissions. In some cases, where particularly important material is omitted from D, I have supplied it in the main text, marked with [ ].[15] However, in general I have sought to maintain a single existing text rather than producing a composite text. Thus the variants given beneath the main text are worthy of consideration, and I have translated some notable variant passages. Among the variants, I have ignored most minor transpositions and differences in orthography. Longer transpositions – sometimes consisting of entire paragraphs – have been noted.

I have maintained the spelling used in D, which contains some unusual forms such as *essiam* for *etiam*, but have expanded abbreviations using conventional spelling.[16] For ease of reading I have distinguished consonant *v* from vowel *u*. Neither C nor D ever uses the diphthong *æ*, so when expanding abbreviations I have consistently used *e* (e.g. *sphere* rather than *sphaerae*). I have capitalised the names of people; other capitals (e.g. Albion) are those used by the scribe. I have inserted punctuation and paragraph breaks, with the aim of aiding the reader's comprehension.

Careful examination of the variants shown in this edition reveals a number of significant differences between the two versions. Most obvious are the changes in information they contain: the date and the longitude of Oxford. D also gives its latitude; C does not, but does provide definitions for latitude and longitude (the latter being the distance from the Pillars of Hercules) [ll. 132–134, 166var]. More generally, C seems to express a broader interest in instruments. This is shown by the longer list of examples of instruments [l. 4var], the extra (misleading) examples of information that can be obtained from the equatorium [l. 254var], and attention to the size of the instrument [l. 257var], as well as more minor details such as the information that the treatise on the astrolabe is 'newly composed' [ll. 166-167var]. In addition, C, is more concerned to clarify some distinctions such as that between the mean centre ('centrum medium') and the centre of the planet ('centrum corporis planete') (see, for example, lines 183, 199, 209, 230, 236, 239, 240–241).

However, there are many places where the explanations given in D are clearer than those in C. These range from a single word difference, such as 'ab auge sua media' (D) vs. 'ab auge sui equantis' (C), ll. 52–53, through longer phrases:

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[15] Alongside C, I have been able to correct the first part of D with reference to other copies of John of Lignières's equatorium treatise, i.e. Bodleian Library Ms. Digby 168, f. 64v, and the (unreliable) transcription in Price [1955, 188–196].

[16] This may lead to discrepancies; for example, where D writes 'defferens' in full it is always with two *F*s, but when I expand D's habitual abbreviation 'drns' I use the more normal 'deferens'.

D: a thread coming out from the equant centre to the epicycle centre through the mean place of the same planet on its equant.	C: a thread stretched from the equant centre through the end of motus of the centre of the planet on its equant. [ll. 48–50]

to complete sentences. In the example below, most of the words are the same, but some changes in vocabulary and especially the order of phrases make D rather more comprehensible than C:

D: the apogee of the eccentric moves through 11 degrees to the west and the Sun moves through 1 degree towards the east, hence there will be 12 degrees between the apogee and the place of the Sun at that time. Furthermore, the centre of the epicycle moves through 13 degrees towards the east and the Sun through 1 degree, so therefore there will be 12 degrees between the Sun and the centre of the Moon's epicycle, whence it is clear that the Sun is then in the middle between the apogee of the Moon's eccentric and the centre of its epicycle, so it follows, since those motions are uniform, that the Sun is always midway between the apogee of the Moon's eccentric and the centre of its epicycle, or the Sun is at their opposite, or all three are the same.	C: The centre of the Moon's epicycle and the apogee of its eccentric will be at the degree opposite the Sun, whereas the Sun is always midway between the apogee of the deferent and the centre of the epicycle, or the Sun is at their opposite, or all three are the same. For let it also be a model for all three motions. Then in one day the apogee of the deferent transits 11 degrees to the west and the Sun 1 degree towards the east, hence there will be 12 degrees between the Sun and the centre of the epicycle and the same number between the Sun and the apogee, on the other hand. Whence it is clear that the Sun is in the middle. [ll. 74-81]

The transposition of sections, some quite significant in length, seems to have been done quite deliberately [e.g. ll. 165-173]. A final significant difference is the consistent contrast in verbal voice and mood between the two versions, especially in section II: D uses the singular imperative and second person present tense, while C prefers the third person passive and gerundive (see, for example, lines 126, 128, 135, 136, 137, 139, 142, etc.). This does not change the basic meaning of the text, but addresses its audience differently, and provides us with an indication of the deliberate, thoughtful nature of the copying process.

II Edited and Translated Text

Quia nobilissima scientia astronomie non potest bene sciri sine instrumentis debitis, propter quod necessarium fuit componere instrumenta in ea. Composuerunt ea propter antiqui multa diversa instrumenta ut sunt astrolabium et saphea, cum quibus sciuntur plura tam de tempore quam de motu. Sed iam tarde quidam bonus vir et subtilis Campanus nomine composuit, et primitus adinvenit, quoddam instrumentum valde neccessarium per quod sciuntur [l]oca vera omnium planetarum et eorum stationes directiones et retrogradationes.

Sed eius compositio est [nimis] tediosa, propter multitudinem tabularum in eodem instrumento contentarum, cum earum concavitatibus diversis, et essiam propter magnitudinem eiusdem instrumenti, eo quod de levi non potest deferri de loco ad locum, seu de regione ad regionem. Quia propter multum expediens fuit tum propter causas predictas tum propter difficultatem prolixitatem et tedium calculationis per tabulas istud opus sic abbreviare, ut in una superficie unius tabule possent omnes planete leviter et satis veraciter equari. Unde magister Johannis de Lyners instrumentum Campani predictum multum subtiliter abbreviavit. Et Prefatius Judeus in Monte Pessulano aliud equatorium consimilis operationis prudenter composuit quod vocatum est semissem. Preterea quidam abbas de Sancto Albano quoddam instrumentum adinvenit, omnia instrumenta maiora et minora prius dicta prevalens et excellens, quod vocavit tribus nominibus anglicis: al.bi.on, simul iunctis albion. Set notandum est quod pro operatione in instrumento Campani Lyners vel Judei preponenda est theorica ut effectus pateat satis planus.

II

Scito in nomine dei quod quilibet planeta preter solem habet tres circulos, scilicet

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1 sciri] *adds* nec compleri **C** **3** ea propter] propterea **C** **3** et] *om.* **C** **4** motu] *adds* Et ut armille, sphere solida, triketum et regule cum quibus verificantur loca stellarum tam erraticarum quam fixarum, et chelindrum et quadrans quibus utebantur antiqui in accipiendo horas, et umbras et solis altitudinem et hiis similia parva. Potest etiam sphera materialis communis cum pauctis additis taliter componeri quod cum ea sola potest operari qui quidem potest cum omnibus atque singularis instrumentis predictis, in tempore atque in motu, et semisam autem valuerit superaddi **C** **4** Sed] Insuper **C** **5** composuit... adinvenit] *after* retrogradationes 7 **C** **6** loca] *adds* planetarum **D** **8** nimis] minus **D** **9** essiam] etiam **C** **11** multum] *om.* **C** **11** fuit] est **C** **13** tabule] *adds* tantum **C** **15** predictum multum subtiliter] *om.* **C** **15** abbreviavit] *adds* modo prius dicto **C** **17** vocatum est semissem] vocavit semissas **C** **17–18** quoddam instrumentum] quedam instrumenta composuit et primitus **C** **18–19** omnia instrumenta ... excellens] *om.* **C** **19** quod] quorum unum **C** **19** al.bi.on] al.by.on **C** **19** albion] *adds* et aliud rectangulum, qui omnia instrumenta prius inventa prevalet et excellit **C** **20** notandum est quod] *om.* **C** **20** in] cum **C** **23** Scito in nomine dei] In nomine domini nostri Ihesu Christi sciendum est **C**

equantem defferentem et epiciclum. Et omnes equantes et deferentes sunt eccentrici id est [centra eorum sunt] extra centrum mundi preter equantem lune qui est concentricus et est idem cum ecliptica. Quia ecliptica equipollet cuicumque circulo descripto super centrum mundi. Equans vero et defferens uniuscuiusque planete regula eiusdem puncti celi eleva[n]tur, ita quod tam centrum equantis quam centrum defferentis [erunt] in eadem linea recta a centro terre transeunte ad punctum predictum in firmamento; qui quidam punctus dicitur aux vel longitudo longior. Punctus vero oppositus dicitur oppositum augis vel longitudo propior. Puncta quidem media inter augem et oppositum augis dicuntur longitudines medie. Et nota quod in saturno jove marte et venere habito centro equantis punctus medius inter centrum equantis et centrum terre est centrum deferentis. Omnes vero auges tam equantium quam deferentium singlorum planetarum sunt inmobiles preter augem deferentis lune et augem deferentis mercurii et preter motum octave sphere qui in omnibus motibus veris est semper addendus.

Preterea notandum est quod filum egrediens a centro equantis per centrum epicicli ad superiorem eius partem augem epicicli mediam designabit. Sed in luna filum egrediens a puncto opposito centro deferentis lune, qui tantum distat a centro mundi quantum centrum ecentrici, transiens per centrum epicicli ad partem eius superiorem, eiusdem [epicicli] augem mediam designabit. [f. 130v D]

Equans vero cuiuscunque planete est circulus regula cuius centri motus planete medius est equalis, hinc est quod dicitur equans. Deferens autem dicitur [f. 218r C] quia defert centrum epicicli quoniam in circumferencia deferentis centrum epicicli situatur. Et nota quod deferens et equans uniuscuiusque planete sunt equales. Epiciclus vero dicitur circulus parvus in cuius circumferencia situatur centrum corporis planete. Centrum planete medium est distantia inter augem equantis et filum

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24 Et omnes] Omnes autem **C** **25** centra eorum sunt] *om.* **D** **26–27** Quia ecliptica … mundi] *om.* **C** **27** uniuscuiusque planete] saturni jovis martis vel veneris **C** **28** puncti] partis **C** **28** elevantur] elevatur **D** **29** erunt] est **D** **30** firmamento] *adds* quod centrum deferentis est punctus medius in eadem linea inter centrum equantis et centrum terre **C** **30** qui quidam punctus] punctus aut uniuscuiusque equantis aut deferentis maxime erectus a centro terre **C** **31** vero] *adds* ei **C** **32** oppositum augis] eius oppositionem **C** **32–34** Et nota … deferentis] *om.* **C** **35** augem deferentis] auges deferentium **C** **36** augem deferentis] *om.* **C** **36** et_2] *adds* etiam **C** **36–37** qui in … addendus] *om.* **C** **38–42** Preterea notandum est … designabit] *This paragraph appears below the next one, after* versus oriens computando 50var **C** **38** Preterea notandum est quod] *om.* **C** **38–39** filum egrediens … augem epicicli] Filum dicto transiens ad firmamentum per centrum epicicli, cuius epicicli superior pars cadens sub filo augem ipsius **C** **40** centro_1] *adds* ecentrici **C** **40** lune] *adds* in eadem diametro sito **C** **40** mundi] terre **C** **42** epicicli] lune **D** **42** designabit] declarabit **C** **44** medius] illius **C** **46** situatur] *adds* et figitur **C** **47** situatur] continue situatur *after* corporis planete 48 **C**

exiens a centro equantis ad centrum epicicli per locum medium eiusdem planete in suo equante.

Sol vero unicum habet circulum qui est ecentricus in cuius circumferencia equaliter movetur centrum solis. Argumentum solis est distantia centri corporis solis ab auge sua media, que distancia in omnibus aliis planetis dicitur centrum planete. Argumentum vero omnium aliorum planetarum est distantia centri corporis planete ab auge media sui epicicli procedendo sinistrorsum videlicet ab occidente in orientem. Preter in luna que movetur ab oriente in occidentem cum fuerit in superiori parte sui epicicli. Sed centrum epicicli cuiuscumque planete alterius et centrum corporis solis semper deferuntur ab oriente in occi[dentem] contra motum firmamenti et primi mobilis quod idem est.

[Medius motus lune est arcus zodiaci cadens inter primum arietis et filum protensum a centro terre ad centrum epicicli secundum successionem signorum computatus. Notandum insuper est quod filum a centro terre proveniens per centrum corporis planete ad firmamentum progrediens, verum locum vel motum eiusdem planete in cuiuslibet signorum manifestat.]

Istis vero non obstantibus sciendum est quod aux ecentrici deferentis lune semper movetur ab oriente in occidentem undecim gradibus fere omni die naturali. Et centrum ecentrici describit quemdam parvum circulum circa centrum mundi in quo motus centri deferentis equalis est motui augis eiusdem et ad eandem partem celi. Centrum quidem epicicli lune movetur omni die naturali per 13 gradus et sol circiter unum gradum ab occidente in orientem. Quare sequitur quod si centrum solis, aux ecentrici lune, et centrum epicicli lune fuerint in aliqua hora in aliquo gradu celi sicut sunt in omni coniunctione solis et lune et in omni oppositione solis et lune in crastina die eadem hora erit aux ecentrici lune versus occidentem distans a sole per 12 gradus. Quia aux ecentrici movetur versus occidentem per 11 gradibus et sol transit

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49 exiens] protensum **C** **49** ad centrum epicicli] *om.* **C** **49** locum medium eiusdem] terminum motus centri **C** **50** equante] *adds* versus oriens computando **C** **51–52** Sol vero ... solis] *This sentence appears earlier, after* epiciclum 24 **C** **52** Argumentum] *adds* vero **C** **53** sua media] sui equantis **C** **53** que distancia ... centrum planete] *om.* **C** **54** vero] *om.* **C** **54** planete] *adds* in epiciclo **C** **55** sui epicicli] ipsius **C** **55** sinistrorsum ... orientem] versus orientem **C** **56** Preter] Sed **C** **56** que movetur ab oriente in occidentem] ab auge versus occidentem proceditur **C** **56–59** cum fuerit ... idem est] *om.* **C** **60–64** Medius motus ... manifestat] *om.* **D** **65** Istis vero non obstantibus] Preterea pro luna **C** **65** ecentrici] *om.* **C** **65** lune] eius **C** **66** naturali] *om.* **C** **68** equalis est] est equalis *after* eiusdem 68 **C** **69** naturali per] circiter **C** **70** gradum] *adds* semper **C** **70** occidente in orientem] oriente in occidens **C** **71** ecentrici] deferentis **C** **71** gradu] loco **C** **71** celi] *adds* simul **C** **72–16.74** solis_2 ... gradus] *om.* **C** **74–75** Quia aux ... solis tunc] *This sentence appears below the next one, after* omnes 3 motus 81var **C** **74** Quia] Tunc in die uno **C** **74** ecentrici movetur] deferentis transit **C** **74** per] *om.* **C** **74** transit] *om.* **C**

versus orientem per 1 gradu, quare erunt 12 gradus inter augem et locum solis tunc. Centrum vero epicicli movetur versus orientem per 13 gradibus et sol per 1 gradu sic igitur erunt 12 gradus inter solem et centrum epicicli lune, quare manifestum est quod sol tunc est in medio inter augem ecentrici lune et centrum epicicli eiusdem, unde sequitur cum isti motus sunt uniformes, quod semper sol est in medio inter augem ecentrici lune et centrum epicicli eiusdem aut sol est in oppositio illorum aut omnes 3 erunt simul.

Sequitur etiam quod centrum epicicli lune bis percurrit ecentricum lune in omni mense lunari quia semel ab auge usque ad eius oppositionem quia tunc iterum centrum epicicli est in auge. Et semel ab oppositione usque ad coniunctionem quia tunc omnes erunt simul scilicet sol, aux ecentrici et centrum epicicli. Defferens vero mercurii sic describitur : protrahatur linea recta a centro terre ad augem equantis, in qua linea invento centro equantis capiatur in eadem tantum a centro equantis quantum est inter centrum terre et centrum equantis et ibi est centrum circuli quod describit centrum deferentis mercurii [f. 218v C] quod in duplo plus distabit a centro equantis quam centrum equantis a centro terre. Movetur autem centrum deferentis ab oriente in occidentem in suo parvo circulo tantum quantum movetur sol versus orientem. Quare sequitur quod centrum epicicli mercurii bis in anno pertransit ecentricum. Sed non est ubi semel in auge ecentrici. Patet etiam quod cum centrum epicicli mercurii fuerit in [f. 131r D] oppositio augis deferentis quod pro causa equans et deferens erunt idem circulus.

Notandum insuper est quod linea recta a centro terre ad firmamentum per cen-

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75 per] *om.* **C** **75** erunt 12 gradus inter augem et locum solis tunc] et totidem sunt inter solem et augem ex parte altera **C** **76** vero] *om.* **C** **76–77** movetur versus orientem per 13 gradibus et sol per 1 gradu sic igitur] lune et aux ecentrici eiusdem erunt in gradu oposito soli **C** **77** erunt . . . epicicli] *after* quare 75 **C** **77** lune] *om.* **C** **77–78** quare manifestum . . . in medio] *after* ex parte altera 75var **C** **78** tunc] *om.* **C** **78–79** inter augem . . . uniformes] *om.* **C** **80** ecentrici lune] deferentis **C** **80** eiusdem] *om.* **C** **81** simul] *adds* quia sint gratia exempli simul omnes 3 motus **C** **82** ecentricum lune] deferentem **C** **82** omni] *om.* **C** **83** eius] *om.* **C** **85** omnes] *adds* 2 **C** **85** scilicet sol, aux ecentrici et centrum epicicli] Sequitur gradum propositum **C** **89** quod] *adds* centrum deferentis ad maius **C** **91** circulo] *adds* representative **C** **91** orientem] *adds* in suo circulo **C** **92** ecentricum] suum differentem **C** **93** semel] *adds the repeated* ubi semel **C** **93** auge] *adds* deferentis **C** **93** ecentrici] *adds* Quod quidem aux continue vagatur inter 2 lineas exeuntes a centro terre ad deferentem contingentes parvum circulum prius descriptum. Quia linea transiens a centro terre ad deferentem per centrum eiusdem, motum augis illius demonstrabit, que linea semper est inter 2 lineas predictas vel eadem est cum altera predictarum patet gradum inventum. **C** **94** deferentis] equantis **C** **95** circulus] *adds* Et etiam quod omnes 3 superiores planete quando coniungentur cum sole sunt in augibus mediis suorum epiciclorum. Ex hiis autem dictis plura possit concludi. **C** **96–114** Notandum insuper est . . . minuitur] *om.* **C**

trum cuiusvis planete producta verum motum et locum quod idem est eiusdem planete declarat. Pro statione retrogradatione et directione est sciendum quod planeta dicitur directus quando motus eius iuvatur motu epicicli contra firmamentum. Retrogradus aut dicitur quando fit econverso. Prima statio est punctus epicicli in quo incipit planeta retrograri. Secunda statio dicitur punctus epicicli in quo incipit planeta dirigi. Luna vero non dicitur habere ista accidentia quamvis habeat epiciclum quia motus centri epicicli lune est maior quam motus lune in suo epiciclo. Dicitur tum in superiori parte epicicli tarda in cursu, in inferiori velox in cursu. Statio prima in secunda significatione dicitur arcus epicicli cadens inter augem veram epicicli et punctum stationis prime in prima significatione, que aux vera designatur per lineam exeuntem a centro terre per centrum epicicli ad superiore eius parte. Statio secunda in secunda significatione dicitur arcus epicicli existens inter augem veram epicicli et punctum stationis secunde in prima significatione arcus dico transiens per prima stationem ad secundam. Arcus vero retrogradationis est arcus epicicli cadens inter primam stationem et secundam, et arcus epicicli inter stationem secundam et primam transeundo per augem epicicli dicitur arcus directionis, et isti duo arcus variantur secundum quod centrum epicicli accedit ad centrum terre vel recedit ab eo et qua proportione unus eorum augetur alius minuitur. Pro instrumentis predictis hec dicta sufficiant.

III

Vera loca omnium planetarum; stacionem, directionem, et retrogradationem 5 planetarum retrogradarum ad quodcumque tempus propositum sive preteritum sive futurum et in qualibet regione per instrumenta prius dicta cognoscere. Cum hoc autem scire volueris a sole quidem incipiendum est, cum inter omnes planetas dignior ab omnibus reputatur, et motus aliorum a motu ipsius quodammodo regulantur. Sed in sole argumentum eius et in aliis planetis omnibus tam centrum medium quam argumentum medium cum medio motu lune ad tempus propositum primitus oportet per tabulas calculare; unde argumentum solis gratia exempli motuum singulorum pre aliis sic per tabulas calculetur.

Cum igitur locum solis certum investigare volueris, sumas radicem argumenti solis scriptam in capite tabule motus eius, ipsam scribendo in tabula tua calculatora. Et scias quod radix est motus certi planete ad certum tempus videlicet ad principium anni quod est in meridie ultime diei decembris, quia dies incipit in meridie diei

114 Pro] Sed pro **C** **114** predictis] *adds* de theorica **C** **115** sufficiant] *adds* Unde pro modo operandi cum instrumentis predictis doctrina sequentis communis est. **C** **119** instrumenta prius dicta] datum instrumentum **C** **120** volueris] habuerit **C** **120–121** ab omnibus] a quibusdam **C** **126** Cum igitur ... volueris] *om.* **C** **126** sumas radicem] Sumatur igitur primo radix **C** **127** eius] *adds* extra **C** **127** tua] *om.* **C** **128** scias] sciendum est **C** **128** certi] *om.* **C** **129** est] *adds* apud nos **C**

preteritis, et finitur in meridie eiusdem diei. Et ad locum certum cognite regionis, vero gradus radicis argumentorum et centrorum planetarum in istis tabulis posite sunt pro fine anni incarnationis domini nostri Ihesu Christi 1350 perfectis ad longitudinem 15 graduum ab occidente habitabili et ad latitudinem 51 graduum et 56 minutorum videlicet ad Oxoniam in Anglia. [f. 219r C]

Postea capias totum tempus preteritum vel futurum in annis, mensibus, diebus, horis et minutis horarum usque ad tempus in quo volueris verum locum solis cognoscere et illud tempus serva. Deinde primo intra cum annis Christi perfectis vel cum minoribus propinquioribus in tabulam annorum collectorum et expansorum sub argumento solis. Et motum ibi inventum extra scribe sub radice quodlibet genus sub suo genere. Iterum cum [f. 131v D] residuo annorum quamdiu fuerit intra eandem tabulam consimili modo operando ut predictum est. Deinde cum mensibus Christi perfectis intra tabulam mensium et cum numero dierum perfectorum intra tabulam dierum. [Sed si sit annus bisextilis et transiverit locus bisexti intretur cum uno diei ampliori.] Similiter cum horis intra tabulam horarum, et iterum cum minutis horarum intra eandem tabulam horarum. Et si minuta non precise inveniantur intra primo cum maiore et propiore numero, deinde cum minore, et quamlibet fractionem pone in una denominacione ulteriori, qua prius fecisti quando intrasti cum horis.

Deinde agrega omnes motus istorum introituum simul, incipiens ab extremis pro quibuslibet 60 secundis ponendo unum minutum, et pro quibuslibet 60 minutis 1 gradum. Pro 30 vero gradibus unum signum abiciendo 12 signa quotiens excreverint. Nam quod ex tali addicione provenerit est medius motus illius planete pro quo fit opus in tempore dato, qui addatur radici pro tempore futuro vel minatur ab ea pro

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132 domini nostri Ihesu] *om.* **C** **132** 1350] 1348 **C** **132** perfectis] *om.* **C** **133** 15] 18 **C** **133** graduum] *adds* fere **C** **133–134** et ad latitudinem 51 graduum et 56 minutorum] *om.* **C** **134** ad] *adds* civitatem **C** **135** capias] sumatur **C** **136** volueris] placuerit **C** **137** illud tempus serva] istud servetur **C** **137** intra] intretur **C** **139** Et] *om.* **C** **139** scribe] scribendo **C** **139–140** sub radice ... genere] *om.* **C** **140–141** intra eandem ... predictum est] intretur tabulam eandem semper extrahendo quodlibet sub suo genere **C** **142** perfectis] *om.* **C** **142** intra$_1$] intretur in **C** **142** intra$_2$] *om.* **C** **143–144** Sed ... ampliori] *om.* **D** **144** intra] *om.* **C** **144** iterum] *om.* **C** **145** intra$_1$] intretur **C** **145** non precise] *trs.* **C** **145** intra$_2$] intretur **C** **146** et propiore numero] *om.* **C** **146–147** quamlibet fractionem pone] qualibet fractio ponatur **C** **147** fecisti] fuerat **C** **147** intrasti] intrabatur **C** **147** cum horis] ad horas **C** **148** Deinde agrega] Habens peractis collingentur **C** **148** incipiens] incipiendo **C** **149** minutum] *adds* minutis **C** **149** quibuslibet] quolibet **C** **149** 1] unum **C** **150** gradum] *adds the repeated* et pro quibuslibet 60 minutis unum gradum; *adds* gradibus **C** **150** signum] *adds* signis **C** **151–152** medius motus ... opus] motus argumenti solis **C**

tempore preterito, et exibit motus argumenti solis in 9a spera ad tempus datum et hoc ad meridiem Oxonie. [f. 219v C] Et isto modo invenitur tam centrum medium quam argumentum medium omnium planetarum et medius motus lune ad quodcunque tempus. Preter verum locum capitis draconis lune qui debet addi radici pro tempore preterito et minui ab eadem pro tempore futuro et preter motum octave sphere qui addendus est omnibus veris motibus pro tempore futuro et minuendus pro tempore preterito in inicium operis. [Motus autem 8 sphere vix est 1 gradus in 100 annis futuris.]

Scias preterea quod argumentum solis est centrum veneris pro eodem tempore quia eadem est aux utriusque, et quod motus argumenti solis deservit centro veneris et centro mercurii, habita eius radice quia omnium illorum trium unus et idem est motus.

Sed pro locis aliarum regionum quarumcunque sic fiet equatio: capiatur longitudo civitatis regionis date inventa per tabulas secundum quod docetur in tractatu astrolabii, et longitudo prescripta in tabulis tuis. Et minuatur minor de maiori et exibit distancia in longitudine inter illas duas civitates, que reducatur in tempus, capiendo pro quolibet gradu 4 minuta hore, et pro qu[a]libet minut[a] gradus 4 secunda hore. Quo tempore distancie invento queratur motus omnium planetarum in eodem et argumentorum eorum; qui minuendus est pro locis orientalioribus, et addendus pro

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153 tempore preterito] transacto **C** **153–154** in 9a spera . . . Oxonie] Postea queratur motus 8 sphere cum eodem tempore qui addendus est super verum locum cuiuslibet planete pro tempore futuro, vel minuendus est a vero loco cuiuslibet pro tempore preterito, et exibit motus equatus ad [f. 219v C] 9 spheram per 8va pro tempore dato et situ Oxonum. **C** **154** isto] predicto **C** **154** invenitur] inveniuntur **C** **154** centrum medium] centra media **C** **155** argumentum medium] argumenta media **C** **155** et medius motus] cum medio motu **C** **155–156** ad quodcunque tempus] *om.* **C** **156** Preter verum locum] Sed verus locus **C** **156–159** qui debet . . . operis] sic invenietur: invento eius motu in tempore dato minatur ipse a radice sua pro tempore futuro et addatur pro transacto et exibit verus locus eius in 9 sphera ad tempus propositum cum addicione vel diminutione 8 sphere. **C** **159–160** Motus autem . . . futuris] *om.* **D** **161** Scias preterea] Preterea notandum est **C** **165–20.173** Sed pro . . . date.] *This paragraph appears earlier, after* Oxoniam in Anglia 134 **C** **165** quarumcunque] *adds* radicis **C** **166** civitatis] *adds* vel loci **C** **166** tabulas] *adds* in quibus scribitur longitudo, que est [f. 219r C] distantia civitatum a Gadibus Herculis, et latitudo que est elevatio poli mundi super orizontem ipsam, dividido per 15, et exibunt hore. Residuum vero si sit vel si est parvo non posset dividi per 15, multiplicetur per 60 et iterum dividatur per 15 et exibunt minuta hore vel **C** **166** secundum] per **C** **166–167** astrolabii] *adds* de novo prolato **C** **167** in tabulis tuis. Et] *om.* **C** **167** minuatur] *adds* iam **C** **168** illas duas civitates] illa **C** **168** que] ratio perfecta que **C** **169** minuta] *adds* unius **C** **169** qualibet minuta] quolibet minuto **D** **169** gradus] *om.* **C** **170** Quo] Et quo **C** **170** distancie] sic **C** **170–171** motus . . . eorum] medius motus cuiuslibet planete pro ut sunt [*unreadable*] ordine **C** **171** est] a sua radice comperi **C**

occidentalioribus locis; et exurget motus equatus pro longitudine ad locum regionis date.

(Nota modum operandi) Omnibus scitis, invento argumento solis ad tempus propositum in regione data, quere consimilem numerum in ecentrico equante solis, et fac ibi notam mentalem super quam extende filum centri terre usque ad orbem signorum et ubi hoc filum ceciderit in orbe signorum ibi est verus locus solis in 9a sphera.

Pro veris locis saturni, jovis, martis et veneris est sciendum quod solum requiritur centrum medium et argumentum medium cuiusvis eorum in instrumentis predictis, quibus ad tempus propositum ut predictum est per tabulas cognitis, [instrumento super tabulam planam et largam prius posito et clavato]; quere numerum similem centro planete cuiusvis eorum in suo equante et essiam numerum argumento eiusdem planete similem in epiciclo [f. 132r D] communi. Et fac notas in terminis utriusque mentales.

Tunc capias regulam semidiametri deferentis communis, in cuius uno fine figitur centrum epicicli et in altero clavus parvus quem pone in centro deferentis planete equandi, circumvoluendo semidiametrum deferentis communis et epiciclum communem quousque centrum epicicli et aux eiusdem sint sub filo vel supra filum extensum a centro equantis super tabulam multum extra instrumentum per notam factam in equante primitus transiens, et circumvoluatur epiciclus verus ad notam argumenti medii prius factam in epiciclo communi, epiciclo communi inmobili existente secundum dispositionem. Egrediatur consequentem filum a centro terre ultra zodiacum per centrum corporis planete in suo epiciclo, cuius fili contactus in orbe signorum

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172 motus equatus pro] radix equata in **C** **174** Nota modum operandi] *Marginal note in same hand as main text* **D**, *om.* **C** **174** Omnibus scitis] Pro vero loco solis habendo **C** **174** argumento solis] eius argumento **C** **175** in regione data] *om.* **C** **175–176** quere ... solis] queratur numerus similis argumento eius in suo equante ab auge eius computando, secundum quod signa iacent, ipso equante in omnibus planetis prius disposito et clavato, vel substantialiter descripto **C** **176** fac] fiat **C** **176** notam mentalem super] nota mentalis per **C** **176** extende] extendatur **C** **176–177** orbem signorum] firmamentum **C** **179** est sciendum quod] cognoscendis **C** **179–180** requiritur centrum medium] requirintur centra media **C** **180** argumentum medium cuiusvis] argumenta media **C** **180** in instrumentis predictis] *om.* **C** **181** per tabulas] *om.* **C** **181–182** instrumento ... clavato] *om.* **D** **182** quere numerum similem] queratur numerus similis **C** **183** centro] *adds* medio **C** **183** equante] *adds* ab auge versus oriens computando **C** **183** et essiam numerum argumento] Postea capiatur alius numerus argumento medio **C** **184** similem] similis **C** **184** communi] *adds* modo priori **C** **184** fac notas] fiant note **C** **186** Tunc capias regulam] Postea capiatur regula **C** **186** cuius] quo **C** **187** quem pone] qui ponatur **C** **190** notam] *adds* prius **C** **191** primitus transiens] procedens **C** **191** et] *om.* **C** **192** prius factam] peractam **C** **192–193** epiciclo communi ... dispositionem] *after* procedens 191var **C** **193** consequentem] 3 **C** **193** ultra zodiacum] ad firmamentum **C**

(nota bene) est verus locus illius planete pro quo fuerit opus in 9a sphera.

Pro mercurio equando. Queratur tam centrum medium quam argumentum medium ad tempus propositum, et signetur terminus centri in suo equante et terminus argumenti in epiciclo communi ut predictum est. Postea queratur similis numerus centro [medio] mercurii ab auge descendendo versus occidentem vel saltem propinquior ad augem vel ad retro in circulo parvo quem describit centrum deferentis mercurii qui dividitur in signa et quodlibet signum in 3 partes et in qualibet divisione est modicum foramen. Ponatur igitur clavus semidiametri deferentis communis in foramine correspondente centro mercurii, vel saltem propinquiori si precise non inveniatur. Circumvoluendo semidiametrum [f. 220r C] predict[u]m et epiciclum communem quousque centrum epicicli et aux eiusdem sint sub filo vel supra filum extensum [a centro equantis] per notam centri in equante multum extra instrumentum super tabulam. Epiciclo communi secundum hanc dispositionem inmobili existente, circumvoluatur epiciclus verus ad notam argumenti medii in epiciclo communi, et exeat filum a centro terre per centrum mercurii in suo epiciclo ad firmamentum, cuius abscisio in zodiaco est verus locus eius in 9a sphera. Vel sic ponatur tabula centri deferentis lune et mercurii super centrum circuli parvi et per clavum suum figatur, et circumvoluatur eadem tabula ab oriente in occidentem quousque consimilis gradus circuli extimi in predicta tabula descripti sit super lineam exeuntem a centro terre ad augem equantis, [quotus fuerit centrum mercurii]. Qua [tabula] sic disposita et fixa existente, ponatur clavus semidiametri deferentis communis in centro deferentis et cetera omnia fiant ut predictum est.

(Nota de luna) Pro vero loco lune cognoscendo. Primo medius motus lune, centrum medium, et argumentum medium eiusdem per tabulas inveniantur. Postea notetur medius motus lune a principio arietis versus orientem computando, ad cuius terminum exeat filum a centro terre, et multum extra [super tabulam]. Et circumvoluatur tabula parva deferentis lune, primitus posita et fixa per clavum, circa

195 nota bene] *Marginal note in same hand as main text* **D**, *om.* **C** **196** Pro mercurio equando] Pro vero loco mercurii cognoscendo **C** **197** medium] *adds* eiusdem **C** **197** propositum] *adds* ut dictum est **C** **197** centri] *adds* planete **C** **198** ut predictum est] *om.* **C** **199** medio] *om.* **D** **201** mercurii] *om.* **C** **201** qui] *adds* circulus **C** **201** in_1] *adds* 12 **C** **201** partes] *adds* equales **C** **204** predictum] predictam **D** **206** a centro equantis] *om.* **D** **207** secundum hanc dispositionem inmobili existente] sic disposito fixo remanente **C** **209** centrum] *adds* corporis **C** **210** abscisio] fili abcisio **C** **210** eius] mercurii **C** **211** suum] *adds* idem **C** **214** quotus fuerit centrum mercurii] *om.* **D** **214** tabula] *om.* **D** **215** deferentis] *adds* mercurii **C** **217** Nota de luna] *Marginal note in same hand as main text* **D**, *om.* **C** **217** cognoscendo] sciendo **C** **217** lune] *om.* **C** **218** eiusdem] *adds* modo predicto **C** **219** orientem] oriens **C** **219** ad] per **C** **220** et] *om.* **C** **220** super tabulam] *om.* **D** **221** tabula parva] parva tabula centri **C** **221–222** primitus posita ... terre] versus occidentem circa centrum terre prius per clavum firmata **C**

centrum terre, quousque terminus centri medii lune in extimo circulo cadat sub filo extenso. Quo facto figatur tabula per lingulam suam super asserem. Deinde ponatur clavus semidiametri [deferentis communis] in centro deferentis lune, ipsam circumvoluendo quousque centrum epicicli communis cadat sub filo vel supra filum. Postea circumvoluatur epiciclus communis, centro eiusdem existente fixo, quousque filum egrediens a puncto opposito centro eccentrici lune trans[e]at simul per centrum epicicli et augem eiusdem; de hinc vertatur epiciclus [f. 132v D] verus, epiciclo communi non amoto, ad medium argumentum lune in epiciclo communi. Quo facto extendatur filum a centro terre per centrum lune ultra zodiacum, et locus eius que filum absc[i]derit est verus locus lune in 9a sphera.

Vel sic habitis mediis motibus ut predictum est signetur centrum medium in equante et argumentum medium in epiciclo communi. Deinde ponatur clavus semidiametri communis in centro deferentis lune, ips[u]m semidiametrum circumvoluendo quousque centrum epicicli cadat sub filo vel supra filum extensum a centro terre per centrum [medium] lune in equante suo notatum, transiens multum extra zodiacum. Circumvoluatur quia epiciclus communis [q]uousque filum proveniens a puncto opposito centro ecentrici lune transeat per centrum epicicli lune et augem eiusdem. Deinde circumvoluatur epiciclus verus ad notam argumenti [medii lune], epiciclo communi inmobili existente, protendatur quia filum a centro terre per centrum [corporis planete] lune in suo epiciclo ultra zodiacum et locus zodiaci qui absc[i]ditur notetur, qui vel est equalis cum centro medio lune, vel maior, vel minor. Si equalis certum est quod medius motus lune et verus sunt idem. Si vero minor fuerit, capiatur excessus centri super locum inventum sub filo qui minuendus est a medio motu lune, et exibit verus locus eiusdem. Sed si maior [f. 220v C] fuerit addatur excessus medio motui lune, et exurget verus locus eiusdem in 9a sphera.

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224 deferentis communis] *om.* **D** **225** filo] *om.* **C** **225** filum] *adds* predictum **C** **227** transeat] transiat **D** **229** in epiciclo communi] contra cursum communem computatum **C** **230** centrum] *adds* corporis planete **C** **230** eius] *om.* **C** **231** absciderit] abscinderit **D** **231** lune] *adds* ad tempus propositum **C** **232** medium] lune **C** **233–234** semidiametri] *adds* deferentis **C** **234** ipsum] ipsam **D** **235** filo] *om.* **C** **236** medium] *om.* **D** **236** equante suo notatum] suo equante **C** **236** zodiacum] *om.* **C** **237** quousque] *adds the repeated* quousque **D** **238** transeat] transiat simul **C** **238** lune$_2$] *om.* **C** **239** medii lune] *om.* **D**, *adds* in **C** **240** inmobili existente] ipso non amoto **C** **240** protendatur quia] progrediatur **C** **240–241** corporis planete] *om.* **D** **241** absciditur] abscinditur **D** **242–243** certum est quod] autem **C** **243** sunt] est **C** **244** centri . . . est a] quo subtractus de **C** **244–23.245** et exibit . . .eiusdem] verus locus ipsius exurget **C** **246** exurget] exibit **C** **246** sphera] *adds* Et hec operatio semissarum in luna sed in aliis planetis omnibus addatur aux in secunda significatione, id est distantia inter arietem et augem equantis ad motum per predictam inventum. Et exurget verus locus ipsius pro quo fuerit opus in 9 sphera. Istius varietatis et aliarum diversitatum in operando cum instrumentis prius dictis immo et tabula est intelligenti cuilibet manifesta. **C**

Pro directione, stacione et retrogradacione 5 planetarum retrogradorum est notandum quod si aliquis planeta per duos dies vel tres vel per ebdomadam inveniatur in eodem loco vel per mensem est stacionarius. Si vero per certum tempus post plures gradus habuerit in motu est directus, si pauciores retrogradus. Arcus vero inferior epicicli est locus retrogradacionis, superior directionis. Puncta quidem contactuum linearum contingencium epicicli dextram et sinistram denotant staciones, ille vero a dextris primam, et alter secundam. Centrum verum, argumentum verum, et aux vera, et numquid planeta sit ascendens vel descendens sive in ecentro sive in epiciclo, et diversitas diametri circuli brevis, ex qua causantur longitudines longiores et longitudines propiores et his similia per datum instrumentum intelligenti theoricam satis patent.

Et voco instrumentum datum omnia instrumenta Campani simul iuncta, vel Equatorium magistri Johannis de Lyners, vel semissas Prefatii Judei, vel aliud equatorium de novo compositum, et pro parte abbreviatum, omnia predicta excellens in locorum certitudine et operis facilitate. Sed sciendum est quod iste canon precedens non tangit modum operandi cum Albion. Sed [solum] cum instrumentis prius dictis [quamvis in modo operandi cum eis parva sit diversitas; tamen pro eisdem hec dicta sufficiant].

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248 planeta] eorum **C** **248** per] *om.* **C** **248** inveniatur] reperiatur *after* loco 249 **C** **249** vel per mensem] vel mensem *after* ebdomadam 248 **C** **252** dextram] destram **C** **252** ille] illam **C** **253** alter secundam] altera altera **C** **254** vera] *adds* medius motus planete, et medius motus centri epicicli **C** **256** longitudines] *om.* **C** **256** propiores] *adds* et minuta proportionalia **C** **256** his] hiis **C** **256** theoricam] cuilibet **C** **257** patent] *adds* Modo predicto vera loca omnium planetarum in 9 sphera cum addicione motus 8 sphere pro futuro vel diminutione pro preterito ut predictum est per communem prescripto veraciter possunt sciri. Et hoc ad meridiem diei equalis quesiti vel ad certum tempus post, pro quo fuerit opus verum, quia motus lune qui maximus est, vix est sensibilis ubi instrumentum fuerit maius, inter meridiem diei equalis et differentis, immo de equacione dierum vel ad presens. Sed quia tam motus quam instrumentum equantur ad tempus presens immo illa vera fit equatio **C** **258** Et] Notandum est quod **C** **258** voco] vocatur **C** **260** omnia predicta] prenominata instrumenta prevalens et **C** **260–261** in locorum ... facilitate] tam in operis facilitate, quam in locorum certitudine **C** **261** iste canon precedens] non prescriptus **C** **262** Albion] vel rectangulo **C** **262** solum] *om.* **D** **262** prius dictis] predictis **C** **262–263** quamvis ... sufficiant] et cetera **D** **263** sufficiant] *adds* Explicit equatorium magistri Johannis de Lyners. **C**

II.1 *Translation*

Since the very noble science of astronomy cannot be well understood without the appropriate instruments, it was therefore necessary to construct instruments in this field. And so the ancients constructed many diverse instruments, such as the astrolabe and the saphea, with which much can be known about both time and motion.[17]. But recently a certain good and clever man named Campanus constructed — and originally invented — a certain very necessary instrument through which are known the true places of all planets, and their stations, forward motions and retrogradations.

But its construction is extremely laborious, owing to the multitude of plates contained in this instrument, with their various cavities, and also owing to the size of this instrument, so it cannot easily be moved from place to place, or from region to region. So it was highly expedient, both for the above reasons and on account of the difficulty, length and tedium of calculation with tables, to thus simplify this matter, so that on one face of one plate all the planets can be computed, easily and reasonably accurately. And so master John of Lignières very cleverly simplified the aforementioned instrument of Campanus. And Profatius Judaeus in Montpellier skilfully composed another equatorium of similar operation which is called the Semissa. In addition, a certain abbot of St Albans invented a certain instrument, which excels and is superior to all the larger and smaller instruments mentioned above, which he called by three English names: All-by-one, also joined "Albion". But it should be noted that, in order to operate the instrument of Campanus, Lignières or Judaeus, a theoric may be put forward so that its effect might be made sufficiently plain.

II

Know in the name of God that each planet apart from the Sun has three circles, namely

[17] **C** *adds* And such as the armillary, solid sphere, torquetum and rule with which the places of the fixed and wandering stars can be ascertained; and the cylinder and quadrant which the ancients used to take the hours, and shadows and the altitude of the Sun, and a few similar to these. The very common sphere can also be added in a few words: it is made in such a way that the functions of each and every one of the aforementioned instruments concerning time and motion can be carried out with it alone. And the Semissa is also worth adding.

the equant, deferent and epicycle. And all the equants and deferents are eccentric, that is, their centres are outside the centre of the World, except the equant of the Moon, which is concentric, the same as the ecliptic. For the ecliptic is like any other circle drawn around the centre of the world. Furthermore, the equant and deferent of any planet are raised on a straight line of the same part of the heaven, so that both the equant centre and the deferent centre will be in the same straight line running from the centre of the Earth to the aforesaid point in the firmament; and this point is called the apogee or greater longitude. And its opposite point is called the perigee or nearer longitude. Also, the midpoints between the apogee and perigee are called the middle longitudes. And note that, having the equant centre for Saturn, Jupiter, Mars and Venus, the mid-point between the centre of the equant and the centre of the Earth is the deferent centre. And all the apogees, both of the equants and the deferents of individual planets, are fixed, except the apogee of the deferent of the Moon and the apogee of the deferent of Mercury and except the motus of the eighth sphere, which for all the true motions should always be added.

Moreover, it should be noted that the thread coming out from the equant centre through the epicycle centre, to its upper part, designates the mean apogee of the epicycle. But as for the Moon, the mean apogee of its epicycle is designated by a thread coming forth from the point opposite the deferent centre of the Moon (which is as far distant from the centre of the Earth as the centre of the eccentric), passing through the epicycle centre to its upper part.

And the equant of whichever planet is a guiding circle, around whose centre the mean motion of the planet is uniform, and hence it is called equant. Furthermore, the deferent is named thus because it carries the centre of the epicycle, since the centre of the epicycle is situated on the circumference of the deferent. And note that the deferent and equant of each planet are equal. And the epicycle is the name for the small circle on whose circumference is situated the centre of the planetary body. The mean centre of the planet is the distance between the apogee of the equant and a thread coming out from the equant centre to the epicycle centre through the mean place of the same planet on its equant.[18]

However, the Sun has a single circle, which is the eccentric, in whose circumference the Sun's centre moves uniformly. The argument of the Sun is the distance of the centre of the body of the Sun from its mean apogee, which distance on all other planets is called the [mean] centre of the planet. The [mean] argument of all the other planets is the distance of the centre of the planetary body from the mean apogee of its epicycle proceeding to the left, that is from west to east. Except for the Moon which moves from east to west when it is on the upper part of its epicycle. But the epicycle centre of any other planet and the centre of the body of the Sun are always carried from east to west [sic] against the motion of the firmament and the Prime Mover, which is the same thing.

The mean motus of the Moon is the arc of the zodiac falling between the first [point] of Aries and a thread stretched out from the centre of the Earth to the centre of the epicycle, computed according to succession of signs. It is also to be noted that a thread from the centre of the Earth passing, through the centre of the body of the planet and proceeding to the firmament, shows the true place or motus of the same planet in whichever of the signs.

Apart from all that, it should be known that the apogee of the eccentric deferent of the Moon always moves from east to west by about 11 degrees every natural day. And the centre of the eccentric traces a certain small circle around the centre of the world, on which the motion of the deferent centre is equal to the motion of its apogee, and toward the same part of the heaven. Also, the centre of the Moon's epicycle is moved through 13 degrees every natural day, and the Sun around one degree from west to east. Whence it follows that if the centre of the Sun, the apogee of the eccentric of the Moon, and the epicycle centre of the Moon were, at a given hour, in a given degree of the heaven, just as they are at any conjunction of the Sun and Moon, and at any opposition of the Sun and Moon; on the next day at the same hour the apogee of the eccentric of the Moon will be 12 degrees distant from the Sun towards the west, because the apogee of the eccentric moves through 11 degrees to the west and the Sun moves

[18] *Instead of* a thread coming out ... its equant, **C** *has* a thread stretched from the equant centre through the end of motus of the centre of the planet on its equant, counting towards the east.

through 1 degree towards the east, hence there will be 12 degrees between the apogee and the place of the Sun at that time. Furthermore, the centre of the epicycle moves through 13 degrees towards the east and the Sun through 1 degree, so therefore there will be 12 degrees between the Sun and the centre of the Moon's epicycle, whence it is clear that the Sun is then in the middle between the apogee of the Moon's eccentric and the centre of its epicycle, so it follows, since those motions are uniform, that the Sun is always midway between the apogee of the Moon's eccentric and the centre of its epicycle, or the Sun is at their opposite, or all three are the same.

It also follows that the centre of the epicycle of the Moon runs around the Moon's eccentric twice in each lunar month, that is once from the apogee to its opposite, and then again the epicycle centre is at the apogee. And once from opposition to conjunction because then all of them will be the same, that is the Sun, the apogee of the eccentric and the centre of the epicycle. Furthermore, the deferent of Mercury is described thus: a straight line is drawn out from the centre of the Earth to the apogee of the equant; the equant centre having been found on this line, the same [measure] is taken from the equant centre as exists between the centre of the Earth and the equant centre, and there is the centre of the circle which the deferent centre of Mercury traces out, so it is twice as distant from the equant centre as the equant centre is from the centre of the Earth. Now the centre of the deferent moves from east to west on its little circle as much as the Sun moves towards the east. Whence it follows that the centre of Mercury's epicycle runs around its eccentric twice in a year. But it is not only once at the apogee of the eccentric.[19] It is also clear that when the centre of the epicycle of Mercury is at the perigee of the deferent, then for that reason the equant and deferent will be the same circle.[20]

Furthermore, it should be noted that a straight line drawn out from the centre of the Earth to the firmament, through

[19] **C** *adds* For the apogee continually wanders between the two lines coming out from the centre of the Earth to the deferent, touching the small circle described above. The line passing from the centre of the Earth to the deferent through its centre shows its apogee, and this line is always between the two above-mentioned lines or is the same as one or other of them.

[20] **C** *adds* And also that all three superior planets, when they are in conjunction with the Sun, are at the mean apogees of their epicycles. And much more can be concluded from these statements.

the centre of any planet, indicates the true motus and place — which is the same thing — of the same planet. For the station, retrogradation and forward motion, it should be known that the planet is called “direct” when its motion is supported by motion of the epicycle against the firmament. But it is called “retrograde” when it is the contrary. The first station is the point of the epicycle in which the planet begins to move retrograde. The second station is said to be the point of the epicycle in which the planet begins to move forward. However, the Moon is not said to have this characteristic, even though it has an epicycle, because the motion of the centre of the epicycle of the Moon is greater than the motion of the Moon on its epicycle. Moreover it is said to run slowly on the upper part of the epicycle, and to run quickly on the lower part. The second meaning of the “first station” is said to be the arc of the epicycle falling between the true apogee of the epicycle and the point of first station (in its first meaning); this true apogee is denoted by a line coming out from the centre of the Earth through the centre of the epicycle to its upper part. The second meaning of the “second station” is said to be the arc of the epicycle which is between the true apogee of the epicycle and the point of second station (in its first meaning); the arc, I say, passing through the first station to the second. And the arc of retrogradation is the arc of the epicycle falling between the first station and the second; and the arc of the epicycle between the second station and the first, passing through the apogee of the epicycle, is called the forward arc, and these two arcs vary according to [how far] the epicycle centre approaches the centre of the Earth or recedes from it, and as much as one of them is increased, the other is decreased. For the aforementioned instruments let these words suffice.

III

To know the true places of all the planets, the station, forward motion and retrogradation of the five retrograde planets at any time desired whether past or future and in any region through the aforementioned instruments. Now when you want to know this you should begin from the Sun, since it is thought by everyone to be the most important of the planets, and the motions of the others are, so to speak, regulated from its motion. But it is first necessary to calculate through tables: for the Sun its argument and for the other planets both the mean centre and the mean argument, and the mean motus of the Moon, for the desired time. Then let the argument of the Sun be calculated thus through tables before the others [planets], as an example of the individual motions.

Therefore, when you wish to investigate a certain location of the Sun, you obtain the radix of the argument of the Sun, written at the head of the table of its motus, writing this in your calculation table. And you should know that the radix is the motus of a certain planet at a certain time, that is at the beginning of the year, which is at noon on the last day of December, since a day begins at noon on the previous day, and is ended at noon of that day. And at a certain place of a known region, the degree of the radix of arguments and centres of planets in those tables are placed for the end of the year of the incarnation of our Lord Jesus Christ 1350 (complete), at a longitude of 15 degrees from the habitable west and at a latitude of 51 degrees and 56 minutes, that is at Oxford in England.

Afterwards you should take all the past or future time in years, months, days, hours and minutes of hours up to the time in which you want to know the true place of the Sun, and save that time. Then first enter with the completed years of Christ, or with the next smaller [number] into the table of collected and individual years under the argument of the Sun. And write the motus found there under the radix, each unit in its own column. Again with the remaining years, however many there may be, enter the corresponding table with the same method as stated. Then enter the table of months with the completed months of Christ, and with the number of completed days enter the table of days. But if it be a leap year and the leap day has passed, let it be entered with one day greater. Similarly with the hours enter the table of hours, and again with the minutes of the hour enter the same table of hours. And if the precise minutes are not found, enter first with the greater and closer number, then with the lesser, and put any fraction in a greater denomination, which you did before when you entered the hours.

Then add together all the motions now assembled, starting from the end, for every 60 seconds putting one minute, and for every 60 minutes one degree. And for 30 degrees one sign, casting away 12 signs whenever they arise. And from this addition the mean motus of the desired planet at the given time will come forth, and this is added to the radix for a future time, or subtracted from it for a past time, and it will show the motus of argument of the Sun in the 9th sphere at the given time, and this will be at the meridian of Oxford.[21] And in this way are found both the mean centre and the mean argument of all the planets, and the mean motus of the Moon at whatever time. Except the true place of Caput Draconis of the Moon, which must be added to the radix for past time and subtracted from it for future time, and except the motus of the eighth sphere which is to be added to all the true motuses for future time and subtracted for past time at the start of the task. And the motus of the 8th sphere is barely 1 degree in 100 future years.

Furthermore, you should know that the argument of the Sun is the centre of Venus for the same time because the apogee of both is the same, and insofar as the motus of the Sun's argument serves for the [mean] centre of Venus and the [mean] centre of Mercury, once you have its radix, because the motus of all three is one and the same.

But for places in other regions, the equation will be done thus: the longitude of a city or place of a given region is found through tables,[22] according to what is taught in the treatise[23] on the astrolabe, and the longitude inscribed in your tables [is also noted]. And the smaller is subtracted from the larger and it shows the distance in longitude between those two cities; let this be converted to time, taking for each degree 4 minutes of an hour, and for each minute of a degree 4 seconds of an hour. Having found this time difference, let the motus of all the planets, and their arguments, be sought in the same [table]; which is to be subtracted for more easterly places, and added for

[21] *Instead of* in the 9th sphere ... Oxford, **C** *has* Afterwards let the motus of the 8th sphere be sought with the same time, which is to be added to the true place of whichever planet for a future time, or to be subtracted from the true place of whichever for a past time, and it will show the motus equated to the 9th sphere through the 8th for the given time and place of Oxford.

[22] **C** *adds* in which longitude is written, which is the distance of cities from the Pillars of Hercules, and the latitude which is the altitude of the pole of the world above the horizon; [the longitude is] divided by 15, and they will show the hour. And the remainder, if there be one — or if [the longitude] is small and cannot be divided by 15 — let it be multiplied by 60 and again divided by 15, and this will give the minutes of the hour,

[23] **C** *adds* newly composed

more westerly places, and this gives the motus equated for longitude at the place in the given region.

(Note: the method of use) When all this is known, having found the argument of the Sun at the proposed time in a given region, seek a similar number on the eccentric equant of the Sun, and make a mental note there; above this, extend the thread of the centre of the Earth, as far as the circle of signs, and where this thread touches the circle of signs, there is the true place of the Sun in the 9th sphere.

For the true places of Saturn, Jupiter, Mars and Venus, it should be known that only the mean centre and mean argument of any of them is required by the aforementioned instruments, which are known through tables for the desired time as already stated; and the instrument having been placed and fixed on a large flat table, seek a number similar to the [mean] centre of any of the planets on its equant, and also similarly the argument of the same planet on the common epicycle. And make mental notes at the ends of both.

Then you take the rule of the common deferent radius, in one end of which the centre of the epicycle is fixed and in the other a small nail; place that in the deferent centre of the planet to be found, rotating the radius of the common deferent and the common epicycle until the epicycle centre and the its apogee are under a thread or over a thread extended from the equant centre over the table far beyond the instrument, through the note made on the equant it crosses first; and let the true epicycle be rotated to the note of the mean argument made earlier on the common epicycle; the common epicycle being immobile in this position. Next let a thread come out from the centre of the Earth beyond the zodiac, through the centre of the body of the planet on its epicycle; the intersection of this thread at the circle of signs is (note well) the true place in the 9th sphere of that planet which was being worked out.

To equate Mercury: let both the mean centre and mean argument be sought at the desired time, and let the end of the [mean] centre of the planet on its equant and the end of the argument on the common epicycle be marked, as previously stated. Afterwards let a number similar to the [mean] centre of Mercury be sought, descending from the apogee towards the west, either nearer the apogee or away from it on the small circle which the deferent centre of Mercury traces out, which is divided into signs, and each sign into 3 parts, and in each division is a small hole. So let the nail of the common deferent semidiameter be put in the hole corresponding to the [mean] centre of Mercury, or at least a nearby one if it cannot be precisely placed. The aforementioned semidiameter and common epicycle are rotated until the epicycle centre and its apogee are under the thread — or above the thread — extended from the equant centre, through the note of the [mean] centre on the equant, and far beyond the instrument on the table. The common epicycle being immobile in this position, let the true epicycle be revolved to the note of the mean argument on the common epicycle, and let a thread come out from the centre of the Earth through the centre of Mercury on its epicycle to the firmament; and the intersection of this [thread] with the zodiac is [Mercury's] true place in the 9th sphere. Or let the plate of the deferent centre of the Moon and of Mercury be placed thus on the centre of the small circle and fixed by its nail, and let the same plate be revolved from east to west until a similar degree of the outer circle drawn on the aforementioned plate be on a line coming out from the centre of the Earth to the apogee of the equant, at the number where the centre of Mercury was. And this [plate] being thus arranged and fixed, let the nail of the semidiameter of the common deferent be put in the deferent centre [of Mercury] and let all the rest be as already stated.

(Note: on the Moon) To know the true place of the Moon. First let the mean motus of the Moon, mean centre, and its mean argument be found through tables. Afterwards let the mean motus of the Moon from the start of Aries be noted, counting towards the east, to whose end let a thread go from the centre of the Earth, and far beyond on the table. And let the small plate of the deferent of the Moon, first fixed by a nail, be rotated around the centre of the Earth, until the end of the mean centre of the Moon on the outer circle falls under the stretched thread. This having been done, let the plate be fixed to the face by its pin. Then let the nail of the semidiameter of the common deferent be placed in the deferent centre of the Moon, and rotated until the centre of the common epicycle falls under the thread or over the thread. Afterwards let the common epicycle be revolved, its centre staying fixed, until a thread coming out from the point opposite the eccentric centre of the Moon crosses at the same time through the centre of the epicycle and the apogee of the same [epicycle]. From here let the true epicycle be turned, the common epicycle not being moved, to the mean argument of the Moon on the common epicycle. This having been done, let the thread be extended from the centre of the Earth through the centre of the Moon beyond the zodiac, and the place which the thread intersects [the zodiac] is the true place of the Moon in the 9th sphere.

Or, having the mean motuses as already mentioned, let the mean centre [of the Moon] be marked on the equant, and the mean argument on the common epicycle. Then let the nail of the common semidiameter be placed in the deferent centre of the Moon, the same semidiameter being revolved until the epicycle centre falls below the thread or above a thread stretched from the centre of the Earth through the mean centre of the Moon noted on its equant, passing far beyond the zodiac. Let the common epicycle be revolved until the thread coming out from the point opposite the eccentric centre of the Moon passes through the centre of the epicycle of the Moon and the apogee of the same [epicycle]. Then let the true epicycle be revolved to the note of the mean argument of the Moon and, the common epicycle being immobile, let a thread be extended from the centre of the Earth through the centre of the lunar planetary body on its epicycle beyond the zodiac, and let the place of the zodiac which is cut be noted; this is either equal to the mean centre of the Moon, or more, or less. If it is equal, it is clear that the mean and true motus of the Moon are equal. But if it is less, let the remainder of the centre beyond the place found under the thread be taken, which is to be subtracted from the mean motus of the Moon, and the true place of the same in the 9th sphere will result. But if it is greater, let the excess be added to the mean motus of the Moon, and its true place in the 9th sphere will come forth.[24]

[24] **C** *adds* And this is the operation of the Semissa for the Moon, but in for all the other planets let the apogee in its second meaning be added, that is, the distance between Aries and the apogee of the equant, to the motus found as stated. And the true place in the 9th sphere of the desired planet will come forth. This and other differences in working with the instruments named above, should be understood and clear to whomever through the instrument and table.

For the forward motion, station and retrogradation of the five retrograde planets, it should be noted that if any planet is found for two or three days, or for a week or a month, in the same place, it is stationary. But if after a certain time it has more degrees of motus it is direct; if fewer, it is retrograde. Furthermore, the inferior arc of the epicycle is the place of retrogradation; the superior [is the place] of forward motion. And the points of contact of lines touching the right and left of the epicycle denote stations; the one on the right is the first, and the other the second. The true centre, true argument, and true apogee,[25] and whether any planet be ascending or descending whether on the eccentric or on the epicycle, and the variation of the diameter of the small circle, by which greater longitudes and lesser longitudes and similar things are caused, are made sufficiently clear through the given instrument for the theoric to be understood.[26]

And I call "the given instrument" all the combined instruments of Campanus, or the equatorium of Master John of Lignières, or the Semissa of Profatius Judaeus, or the other equatorium, which is newly constructed, and by its abbreviation outshines all those mentioned, in the accuracy of its longitudes and the ease of its use. But it should be known that this above canon does not touch on the method of using the Albion. But only with the aforementioned instruments, inasmuch as in their method of use there is little difference between them. However, for all those let these words suffice.

References

Benjamin, F.S., Toomer, G.J., eds., 1971. *Campanus of Novara and Medieval Planetary Theory:* Theorica Planetarum, Madison, WI.

Bennett, J., 2003. "Knowing and Doing in the Sixteenth Century: What Were Instruments For?", *The British Journal for the History of Science* 36, 129–150.

Bolton Holloway, J., 2008. *Anchoress and Cardinal: Julian of Norwich and Adam Easton, O.S.B.* (*Analecta Cartusiana* 35:20), Salzburg.

Catto, J., Mooney, L., "The Chronicle of John Somer, OFM", in *Chronology, Conquest and Conflict in Medieval England* (*Camden Miscellany* 34), Cambridge, 197–285.

[25] **C** *adds* the mean longitude of the planet, and the mean motus of the epicycle centre,

[26] **C** *adds* In the aforesaid way, the true places of all the planets in the 9th sphere can be known truly through the common method, that is addition of the motus of the 8th sphere for the future or subtraction for the past as described. And this is for noon of the equal day desired, or for a certain time afterwards, which was the true task, since the motus of the Moon, which is greatest, is hardly perceptible when the instrument is larger, between the noon of the equalised and different day, but rather from the equation of days or for the present. But because both the motus and the instrument are to be equated for the present time, let the true equation be done.

Chaucer, G., 1988. *The Riverside Chaucer*, ed. L.D. Benson, Oxford.

Clagett, M., ed., 1964. "The *Quadratura circuli* Attributed to Campanus", in *Archimedes in the Middle Ages, Vol. I: The Arabo-Latin Tradition* Madison, WI, 581–609.

Dobson, R.B., 2004. "Easton, Adam (c.1330–1397)", in *Oxford Dictionary of National Biography* (online edn, May 2014), http://www.oxforddnb.com/view/article/8417.

Emden, A.B., 1957. *A biographical register of the University of Oxford, to A.D. 1500*, Oxford

Falk, S., 2016. "Learning Medieval Astronomy Through Tables: The Case of the *Equatorie of the Planetis*", *Centaurus* 58, 6–25.

Foster, M., 2004. "Digby, Sir Kenelm (1603–1665)", in *Oxford Dictionary of National Biography* (online edn, Jan 2009), http://oxforddnb.com/view/article/7629.

Gunther, R.T., 1923. *Early Science in Oxford, Vol. II: Astronomy*, Oxford

James, M.R, 1925–30. Unpublished medieval manuscript catalogue description for Ms. Gg.6.3. Available from Manuscripts Department, Cambridge University Library.

Ker, N.R., 1949. "Medieval Manuscripts from Norwich Cathedral Priory", *Transactions of the Cambridge Bibliographical Society* 1, 1–28.

Maddison, F., 1969. *Medieval Scientific Instruments and the Development of Navigational Instruments in the XVth and XVIth Centuries*, Coimbra.

McKitterick, D.J., 1978. *The Library of Sir Thomas Knyvett of Ashwellthorpe,* c. *1539–1618*, Cambridge.

Mosley, A., 2006. "Objects of Knowledge: Mathematics and Models in Sixteenth-Century Cosmology and Astronomy", in Kusukawa, S., Maclean, I., eds., *Transmitting Knowledge: Words, Images, and Instruments in Early Modern Europe*, Oxford, 193–216.

North, J.D., 1967. "Medieval Star Catalogues and the Movement of the Eighth Sphere", *Archives internationales d'histoire des sciences* 20, 71–83.

North, J.D., 1976. *Richard of Wallingford: An Edition of His Writings*, Oxford.

North, J.D., 1977. "The Alfonsine Tables in England", in Maeyama, Y., Saltzer, W.G., eds., *Prismata: Naturwissenschaftsgeschichtliche Studien: Festschrift für Willy Hartner*, Wiesbaden, 269–301. (Also reprinted in *Stars, Minds and Fate* (London, 1989), 327–60.)

North, J.D., 2004. "Rede, William (c.1315–1385)", in *Oxford Dictionary of National Biography* (online edn, May 2006), http://www.oxforddnb.com/view/article/23248.

North, J., 2005. *God's Clockmaker: Richard of Wallingford and the Invention of Time*, London.

Pedersen, F.S., 1983. *Petri Philomenae de Dacia et Petri de S. Audomaro opera quadrivialia*, Copenhagen.

Poulle, E., 1980. *Les instruments de la théorie des planètes selon Ptolémée : équa-*

toires et horlogerie planétaire du XIIIe au XVIe siècle, Geneva.

Powicke, F.M., 1931. *The Medieval Books of Merton College*, Oxford.

Price, D.J., 1955. "Philosophical Mechanism and Mechanical Philosophy: Some Notes towards a Philosophy of Scientific Instruments", *Annali dell'Istituto e Museo di Storia della Scienza di Firenze* 5, 75–85.

Price, D.J., 1955. *The Equatorie of the Planetis*, Cambridge, UK.

Thorndike, L., Kibre, P., 1963. *A catalogue of incipits of mediaeval scientific writings in Latin*, Cambridge, MA.

Zutshi, P., (forthcoming). "An Urbanist cardinal and his books: the library and writings of Adam Easton", forthcoming in Berndt, R., ed., *Der Papst und das Buch im Spätmittelalter (1350-1500)* (*Erudiri Sapientia*), Hugo von Sankt Viktor-Institut, Frankfurt am Main, 24–46.

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Figure 1: Back of Merton astrolabe-equatorium, c. 1350 (Merton SC/OB/AST/2). By permission of the Warden and Fellows of Merton College, Oxford

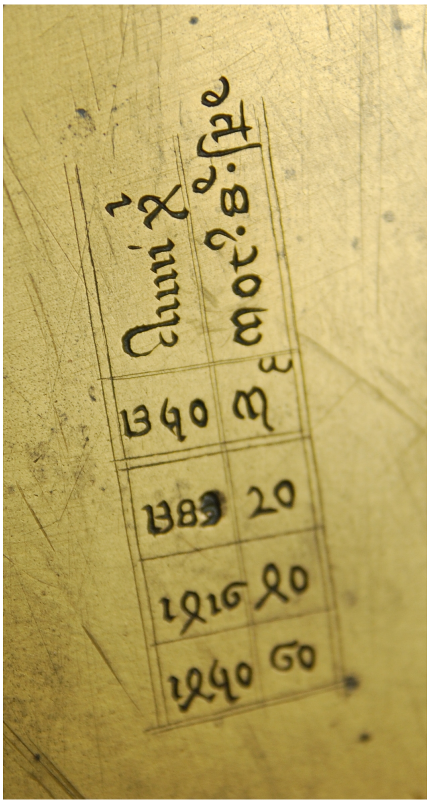

Figure 2: Ready reckoner for motus of the eighth sphere. Detail from back of Merton astrolabe-equatorium (see also figure 1), c. 1350 (Merton SC/OB/AST/2). By permission of the Warden and Fellows of Merton College, Oxford

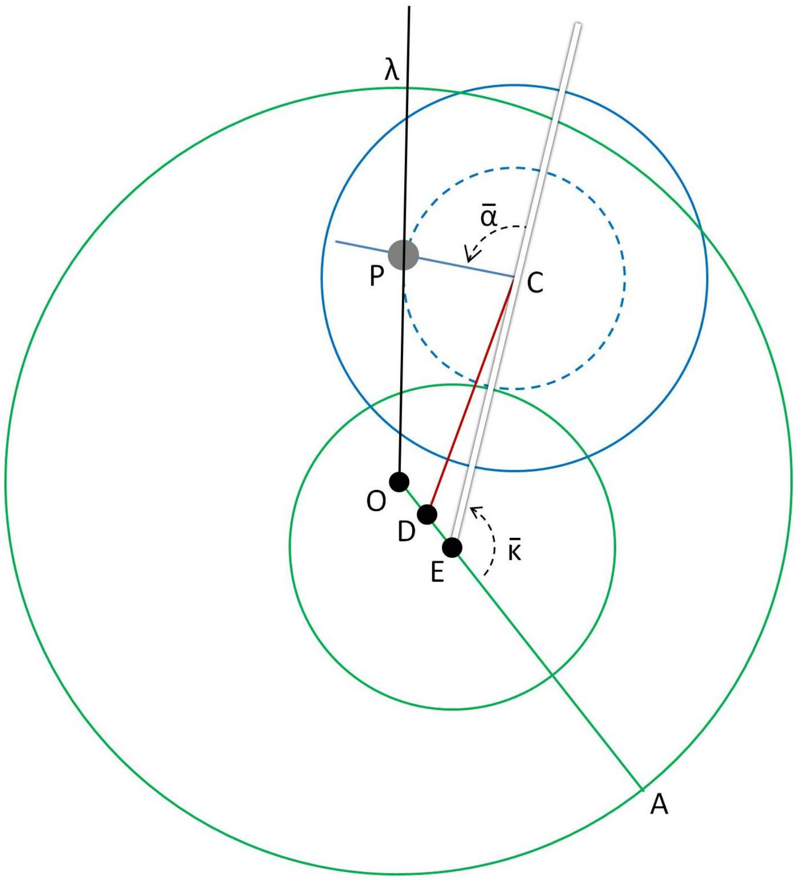

Figure 3: Diagram of Merton equatorium