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An Early witness of Alfonsine Astronomy: the London Tables for 1336*

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The first evidence of the Alfonsine Tables in England seems to be an anonymous set of tables computed for London, uniquely preserved in a late 14th century or early 15th century manuscript: Oxford, Bodleian Library, MS Bodley 790.¹ We may call this set the London Tables to distinguish them from another set, also for London and called the Tables of London, presumably computed by Robert of Chester (fl. 1141–1157) and based on the Toledan Tables.²

1. The London Tables are preceded by a short text (MS Bodley 790, 2v–4v) followed by several notes, mostly consisting of definitions of astronomical quantities. The text begins *Ad noticiam tabularum sequentium...* and finishes “... *et fac sicut dictum est in capitulo precedenti. Expliciunt canones tabularum sequentium*”. It explains the use of the tables and provides scant additional information. Nowhere in the text is the name of King Alfonso mentioned, nor that of any other astronomer. Likewise, there is no reference to London, or to any other place. Nonetheless, we are told that the radices are set for year 1336, complete, and this date is repeated in the heading of the first table (f. 5r). In his extensive paper on the Alfonsine Tables in England, John North (1977, p. 26) referred briefly to the London Tables and argued correctly, but without offering an explanation, that these tables “adopt a London-Toledo difference of 32 mnin”.

2. The tables (5r–33r) begin with two extensive lists of radices of 21 quantities for the Incarnation and 22 for year 1336, complete, both said to have been computed for London. Table 1 displays a selection of the radices for the Incarnation, which are here compared with those for Toledo in the *editio princeps* of the Parisian Alfonsine Tables (Venice, 1483). Note that the London Tables use signs of 30° (= 1s), whereas the edition of 1483 uses signs of 60° (= 1,0° in sexagesimal notation).

Table 1: Radices for the Incarnation

	Ms Bodley 790	1483 Edition	Differ.
Solar longitude	9s 8;19,41°	4,38;21, 0,30,28°	0; 1,20°
Lunar anomaly	6s 18;42,49°	3,19; 0,14,31,17°	0;17,26°
Argument of lunar latitude	7s 4;28,43°	3,34;28,42,38,29°	0; 0, 0°
Longitude of Saturn	2s 14; 5,17°	1,14; 5,20,12°	0; 0, 3°
...			

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In all cases the difference should account for the distance between Toledo and the place for which the tables were computed, but this is not so in many cases due to errors and miscopying. For example, a difference of 0;0,0° for the argument of lunar latitude, which is a fast-moving quantity indicates that the entry was just reproduced in a rounded form, but not recomputed for the new locality. In other cases, there is only a vague similitude between the values in the manuscript and those in the printed edition. It is possible, however, to extract a single meaningful value. For the Sun, a difference of 0;1,20° corresponds to a time difference of about 0;1,21d, and thus to a difference in longitude of about 0;32h between the two localities. Analogously, for the Moon, a difference of 0;17,26° corresponds to a time difference of 0;1,21d, that is, about 0;32h, using the corresponding mean motion in standard Alfonsine astronomy. This value of 0;32h fits well with the time difference between the meridians of Toledo and London, as indicated by North.

Moreover, a note below the table for the radices (f. 5r) mentions a solar altitude of 62;50°. If we take this value to be the maximum meridian altitude of the Sun at the place considered, presumably London, then it would correspond to a geographical latitude of $90^\circ - 62;50^\circ + \varepsilon$, where ε is the value of the obliquity of the ecliptic. Taking for this values in the range 23;30° – 23;34° yield values for the geographical latitude in the range 50;40° – 50;44°, which are consistent with London. In short, the derived values for longitude and latitude indicate that the tables were intended for London, as mentioned in the heading, even though the entries for the radices given in the manuscript were not always correctly computed.

With this caution in mind, we have compared some of the radices for 1336, complete, given in the text with analogous quantities recomputed for Toledo for January 1, 1337 (see Table 2).

Table 2: Radices for 1336, complete

	Ms Bodley 790	Recomputation	Differ.
Solar longitude	9s 18; 8,38°	248; 9,56°	0; 1,18°
Lunar anomaly	11s 3;23,21°	333;40,46°	0;17,25°
Longitude of Saturn	7s 9;37,24°	219;37,27°	0; 0, 3°
...			

Recomputation gives good results for that date, yielding the differences shown in Table 2, which agree with those in Table 1. Therefore, the entries correspond to values of the radices computed for January 1, 1337 and for the meridian of London, as indicated in the heading.

Besides these lists for the radices, the London Tables basically consists of tables for the mean motions and the equations of the Sun, the Moon, and the planets. As will be seen in what follows, all numerical values appearing in this set are typical of Alfonsine astronomy, as developed in Paris in the early 14th century.

3. The tables for the mean motions are presented in a peculiar order, which differs from that followed in similar sets of tables: Sun, elongation, lunar longitude, lunar node, longitude of Saturn, lunar center (taken as half the elongation), lunar anomaly, argument of Saturn, longitude of Jupiter, argument of Jupiter, longitude of Mars, argument of Mars, argument of Venus, argument of Mercury, access and recess, and apogees.

For each quantity, we are given four subtables: (i) collected years from 1 to 20, then from 20 to 100 at intervals of 20 years, then from 100 to 1000 at intervals of 100 years, and for 2000 and 3000; (ii) months in a year, beginning in January; (iii) days in a month, from 1 to 31; and (iv) hours, from 1 to 30. The tables for access and recess, and apogees have no subtables for days in a month and hours.

All mean motions refer to tropical coordinates and are given to thirds or seconds. In the case of the Sun, the values given for the first entry in each subtable are 11s 29;45,39,22^o (1 year), 0s 30;33,18^o (January), 0s 0;59,8^o (1 day), and 0;2,28,30^o (1 hour).

The relevant feature here is that the presentation of the mean motion tables does not follow the sexagesimal form in standard Alfonsine astronomy, with a single table and 60 consecutive multiples of a unique value for each quantity. Rather, it follows the traditional presentation of subtables for years, months, days, and hours, found in all previous sets of tables, such as the Toledan Tables, and also used by John of Lignères in his *Tabule magne*, dated 1325, and based on Alfonsine parameters.³ Moreover, John of Lignères's tables and the London Tables agree in the sequence of years and intervals of 20 years. It should nevertheless be noted that the mean motion tables in Oxford, MS Bodley 790, display more quantities than those in the manuscripts we have consulted containing John of Lignères's work. But for scribal errors, the common entries in both sets agree. As regards the transmission of the *Tabule magne* to England, it may be useful to recall that John of Lignères dedicated his work to Robert the Lombard of Florence, dean of Glasgow.⁴

4. Included among the tables for the mean motions of access and recess, and of the apogees, there are two tables: one for the revolution of the years, and the other for the equation of the 8th sphere.

The table for the revolution of the years is presented, as is most often the case, in two subtables. The entries in one are expressed as an arc (in degrees, minutes, and seconds) and in the other, as time (in hours, minutes, and seconds). The first entries are 87;18,59^o and 5;49,16h, respectively, and they both correspond to the difference between the tropical year and a year of 365 days. Thus, 365d + 5;49,16h = 365;14,33,10d is the length of the tropical year underlying this table. This is undoubtedly a rounding, to sexagesimal thirds, of the Alfonsine parameter, 365;14,33,9,50,20,7,30d, attributed by John of Murs in his *Expositio* of 1321 to the original Alfonsine Tables on which he was commenting (Paris, Bibliothèque nationale de France, MS 7281, 156v).⁵ As was the case with the tables for the mean motions, the argument is given for each year from 1 to 20, then at intervals of 20 years from 20 to 100, then at intervals of 100 years from 100 to 1000, as well as for 2000 and 3000 years.

The table for the equation of the 8th sphere is also characteristic of Alfonsine astronomy, and it is used together with the table for the mean motion of access and recess, the entries of

which serve as argument for the equation of the 8th sphere. Its maximum value, $9;0,0^{\circ}$ at 90° of the argument, makes the table easily distinguishable. To our knowledge, the first table of this type using the parameter $9;0,0^{\circ}$ is found among those compiled by John Vimond, working in Paris in 1320.⁶

5. The tables for the equations of the Sun, the Moon, and each of the five planets are presented separately in the usual order: Saturn, Jupiter, Mars, Venus, and Mercury. In all of them the argument ranges from 1° to 360° , at intervals of 1° , as is usual in this type of tables. The tables for the equations show several peculiarities worth mentioning.

The table for the solar equation, with its characteristic maximum of $2;10,0^{\circ}$ at 92° – 94° in Alfonsine astronomy, has an infrequent additional column, in seconds, for the differences of successive entries of the equation. The table for the lunar equations has the usual columns for the equation of center, the minutes of proportion, the increment, and the equation of anomaly, and presents a maximum value for the equation of anomaly, $4;56^{\circ}$ at 95° , which was integrated in Alfonsine astronomy by John Vimond. In this table, there is also a column for the lunar latitude, with the standard maximum value of $5;0,0^{\circ}$ at 90° , and still another column, in seconds, for the successive differences between its entries. Including lunar latitude into a table for the lunar equations is a common feature in all preceding major sets of tables (Tables of Toledo, the *zij* of al-Battānī, to name only a few), but rare in Alfonsine astronomy. The tables for the planetary equations, with their usual columns, have additional columns for the first station and the differences of successive entries of it. Again, the presence of a column for the first station in a table for planetary equations is characteristic of the Tables of Toledo. We also note that the maximum values for the equation of center of Jupiter and Venus, $5;57^{\circ}$ and $2;10^{\circ}$, respectively, are characteristic of Alfonsine astronomy and appear for the first time in John Vimond's tables.

In sum, the tables for the equations have all their entries in agreement with standard Alfonsine tables, but their format follows the Toledan Tables. As mentioned above, the tables for the mean motions, where zodiacal signs of 30° are used, as elsewhere in the London Tables, do not follow the purely sexagesimal presentation, described in the canons by John of Saxony (1327) to the Parisian Alfonsine Tables and very frequently found in later copies of this set. In this respect, the London Tables are an intermediary witness of the early evolution of the Parisian Alfonsine Tables. More specifically, the London Tables seem directly linked to the works of the first astronomers in Paris operating with the Alfonsine Tables: John Vimond, John of Murs, and John of Lignères.

In the current state of our knowledge, the London Tables, with January 1, 1337 as epoch and a presentation as that used John of Murs's *Tabule magne* (1325), are the earliest witness of Alfonsine astronomy in England, thus preceding the set of tables compiled for the meridian of Oxford by William Rede, with epoch 1340, and the Oxford Tables of 1348 by William Batecomb.⁷

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Notes

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- ¹ For a comprehensive survey of Alfonsine astronomy in England, see John D. North 1977. “The Alfonsine Tables in England”, in Maeyama Y. and W. G. Salzer (eds.) 1977, *Prismata, Naturwissenschaftsgeschichtliche Studien*, pp. 269–301. Reprinted in J. D. North 1989, *The universal frame: historical essays in astronomy, natural philosophy, and scientific method*. London, pp. 327–359. A broader picture of the diffusion of the Alfonsine Tables is given in José Chabás and Bernard R. Goldstein 2003. *The Alfonsine Tables of Toledo*. Archimedes: New Studies in the History and Philosophy of Science and Technology, 8. Dordrecht and Boston.
- ² Charles Burnett 2004, “Ketton, Robert of (fl. 1141–1157)”, *Oxford Dictionary of National Biography*. See also José Chabás, *Computational Astronomy in the Middle Ages: Sets of Astronomical Tables in Latin* (forthcoming).
- ³ Matthieu Husson 2007. *Les domaines d’application des mathématiques dans la première moitié du quatorzième siècle*. Unpublished thesis: École Pratique des Hautes Études, Paris.
- ⁴ Emmanuel Poulle 1973. “John of Lignères”, in *The Dictionary of Scientific Biography*, 7:122–128. New York.
- ⁵ Emmanuel Poulle 1980, “Jean de Murs et les tables alphonsines”, *Archives d’histoire doctrinale et littéraire du moyen âge*, 47: 241–271 ; see especially p. 251.
- ⁶ José Chabás and Bernard R. Goldstein 2004. “Early Alfonsine Astronomy in Paris: The Tables of John Vimond (1320)”, *Suhayl*, 4: 207–294.
- ⁷ José Chabás and Bernard R. Goldstein 2016. “The Moon in the Oxford Tables of 1348”, *Journal of the History of Astronomy*, 47:159–167.