Early Alfonsine Astronomy in Paris:
The Tables of John Vimond (1320)

José Chabás and Bernard R. Goldstein

It has been clear for many years that medieval European astronomy in Latin was heavily dependent on sources from the Iberian peninsula, primarily in Arabic, but also in Hebrew, Castilian, and Catalan. The Castilian Alfonsine Tables, compiled by Judah ben Moses ha-Cohen and Isaac ben Sid under the patronage of Alfonso X (d. 1284), were an important vehicle for the transmission of this body of knowledge to astronomers north of the Pyrenees, but the details of this transmission remain elusive, in part because only the canons to these tables survive (see Chabás and Goldstein 2003a). In this paper we build on our preliminary studies of a figure who previously had barely been mentioned in the recent literature on medieval astronomy (Chabás and Goldstein 2003a, pp. 267–277, and 2003b). John Vimond was active in Paris ca. 1320 and, as we shall see, his tables have much in common with the Parisian Alfonsine Tables (produced by a group in Paris, notably John of Murs and John of Lignères), but differ from them in many significant ways. As far as we can tell, there is no evidence for any interaction between Vimond and his better known Parisian contemporaries and in our view the best hypothesis is that they all depended on Castilian sources. As a result of our analysis, we are persuaded that Vimond's tables are an intelligent reworking of previous astronomical material in the Iberian peninsula to a greater extent than is the case for the Toledan Tables (compiled in Toledo about 2 centuries before the Castilian Alfonsine Tables). It is most likely that Vimond's principal source was the Castilian version of the Alfonsine Tables.

Paris, Bibliothèque nationale de France, MS lat. 7286C is a 14th-century manuscript containing an unusual set of tables (ff. 1r–8v) as well as the canons and tables of 1322 by John of Lignères (ff. 9r–58r). In a brief text at the end of the first set of tables they are attributed to John Vimond (Iohannes Vimundus), an astronomer who compiled them "for the use of students at the University of Paris" (f. 8v):

> *Et in hoc terminatur opus Iohannis Vimundi baiocensis dyocesis de disposicionibus planetarum et stellarum fixarum; et cum istis sequitur de hiis que per ipsum ordinantur ad conversionem temporum verorum et equalium sociatorum, et de disposicionibus eclipsalibus solis et lune sibi pertinentibus, et de aliis disposicionibus ipsorum et aliorum corporum celestium, ad utilitatem scolarium universitatis parisiensis et omnium aliorum.*
>
> Here ends the work by John Vimond of the diocese of Bayeux on the dispositions of the planets and the fixed stars; (...) and on the dispositions of solar and lunar eclipses and [other syzygies] corresponding to them, and on the other dispositions of these and other celestial bodies, for the use of students at the University of Paris and all others.

The complete set of Vimond's tables are uniquely extant in this manuscript, and no canons for them have been identified. They are a coherent set of tables with all the elements needed to compute the positions of the celestial bodies, much in the tradition of the Arabic zijes and their derivatives. The exact date of composition of Vimond's tables is not given in the text, but they were probably produced shortly before 1320. In the paragraph preceding his tables, Vimond tells us that they were compiled for Paris with 1320 as epoch (f. 1r: see below) and this date is confirmed by recomputation. These tables also include a calendar with the dates of syzygies: this strongly suggests that they were constructed prior to the year of the calendar because the astronomical information would no longer be of any use after the year had passed. However, the calendar poses special problems which will be discussed below.

Vimond's only other known work is a short treatise on the construction of an astronomical instrument, extant in Erfurt, MS CA 2° 377 (ff. 21r–22r), beginning *Planicelium vero componitur ex eis que sunt diversorum operum*..., and ending *Explicit tractatus johannis vimundi*... in a manuscript containing various works by other Parisian astronomers such as John of Murs and John of Lignères (Thorndike and Kibre 1963, col. 1050; Saby 1987, pp. 471, 474).

John Vimond and his works were seldom mentioned by his contemporaries. However, in Vatican, Biblioteca Apostolica, MS Ottob. lat. 1826, we are told that John of Spira (14th century), the author of a commentary on John of Lignères canons (Thorndike and Kibre 1963, col. 204), composed his own canons to several of Vimond's tables (for a description of this manuscript, especially ff. 148–153, see F. S. Pedersen 2002, p. 177). This manuscript includes a text that begins on f. 148ra ascribed to a certain M. J. C., *Canon tabulae sequentis quae intitulatur tabula motus diversi solis et lunae in una hora et semidiametrorum secundum tabulas Alfonsi*, at the end of which John Vimond is mentioned. On the other hand, Vimond is not mentioned in Madrid, Biblioteca Nacional, MS 4238, a manuscript containing a few tables that can be attributed to him, as well as a copy of the Parisian Alfonsine Tables computed for Morella (in the province of Valencia) for the years 1396 and 1400 (Chabás 2000).

As far as we can tell, John of Murs and John of Lignères do not refer to Vimond at all in any of their numerous works, but it seems implausible that they did not know him or his work which was addressed to the students at the University of Paris. Indeed, there were not so many competent astronomers working in Paris around 1320 and both Vimond and Murs came from the same region, Normandy, from places about 70 km apart, Bayeux and Lisieux, respectively.

We would expect Vimond to be well known and frequently cited by practitioners of astronomy, for he is named as one of the outstanding astronomers of his time by Simon de Phares in his *Recueil des plus celebres astrologues* (1494–1498), a chronologically ordered list with comments, edited by Boudet (1997–1999, 1:467). In fact, Vimond is mentioned before John of Lignères, John of Saxony, John of Janua, and John of Murs:

> *Maistre Jehan Vymond fut a Paris, homme moult singulier et grant astrologien, lequel eut en ce temps grant cours pour la science des estoilles. Entre ses euvres, fist une verifficacion de la conjunction des lu[mi]naires, aussi des eclipses et estoilles fixes pour plusieurs ans. Cestui predist les grans vens qui furent en son temps et fist plusieurs beaulx jugemens, dont il acquist grant loz et renommee en France et fut moult devost en Nostre Seigneur.*

> Master John Vimond lived in Paris, a most singular man and a great astrologer, who had at that time much prestige because of (his knowledge of) the science of the stars. Among his works is a verification of the conjunction of the luminaries, as well as eclipses and the fixed stars, for many years. He predicted the great winds which took place in his time and made many fine judgments for which he acquired great praise and renown in France and he was most devoted to our Lord.

The "veriffication de la conjunction des lu[mi]naires" refers to Vimond's tables. These tables are arranged very differently from those of his Parisian contemporaries and are based, in part, on parameters that probably came from the Castilian Alfonsine Tables or a tradition closely associated with them. Of special interest is the proper motion of the solar and planetary apogees, a feature previously unknown in medieval tables produced outside Spain and North Africa. We are convinced that Vimond's tables provide an indication of the arrival in Paris of new astronomical material coming from Castile, in the sense that they propose new approaches to replace those based on the Toledan Tables and developed at the end of the 13th century by astronomers working in Paris such as Peter Nightingale, Geoffreoy of Meaux, and William of St.-Cloud. Further, we believe that Vimond's tables are prior to, and independent of, the tabular work developed in the early 14th century, which we call the Parisian Alfonsine Tables, by the group of Parisian astronomers that included John of Murs and John of Lignères, which were also based on Castilian sources. Vimond's tables and the Parisian Alfonsine Tables have many parameters in common both for mean motions and equations. In principle, it is possible that one set of tables depended on the other, but the differences between them suggest to us that it is far more likely that they depended on a common source. Moreover, if Vimond composed his tables prior to 1320, he did so before any datable text of the Parisian Alfonsine Tables.

A description and analysis of Vimond's tables follow.

f. 1r The first numerical information given in this set of tables is the "radix for mean conjunctions of the Sun and the Moon": 13;54,54d. In modern terminology, the initial time for a set of tables is called its "epoch" whereas its "radices" are the positions of the Sun, Moon, planets, etc., at that time. The medieval convention, however, is to use "radix" for both the time and the position.

We are convinced that the author refers to the time, in Paris, of the mean conjunction on March 10, 1320. The year and the place are mentioned by Vimond himself in a short paragraph following the numerical value of the radix (f. 1r):

> *Et est intelligendum quod ista radix mediarum coniunccionum sit immediate post 19 secunda diei que consistunt immediate post (...) lucis beati Mathie composite procedendo ab ortu solis usque ad occasum scilicet anno domini nostri Ihesu Christi 1320 secundum numeracionem annorum romanorum qui incipiunt ex inicio diei circoncisionis domini nostri Ihesu Christi et existentis ad longitudinem civitatis Parisius que distat a medio mundi per 49 g et 30 min ita quod illa civitas est in parte occidentali et etiam distat ab illo medio per 8 min et 15s diei equalis.*
>
> Note that this radix for the mean conjunctions comes immediately after 19 seconds of a day that fall immediately after the (...) [space for one word; illegible] (day)light of Saint Matthew, proceeding from sunrise to sunset, namely, in the year of our Lord Jesus Christ 1320 according to the count of Roman years which start from the beginning of the Day of the Circumcision of our Lord Jesus, for the longitude of the city of Paris which is distant from the middle of the world by 49 degrees and 30 minutes because that city is in the western direction and distant from that middle by 8 minutes and 15 seconds of an equinoctial day.

Madrid, Biblioteca Nacional, MS 4238, f. 66v, has a short text which is very similar to the paragraph on f. 1r in Paris, Bibliothèque nationale de France, MS lat. 7286C:

> *Radix coniunccionum: dies 13 m 54* 2^a *54*
> *Radix opposicionum: dies 14 m 45* 2^a *55*
> *Hec radix est post 19* 2^a *diei que sunt post meridiem diei Mathie anno* 1320^o *secundum romanos. Nota quod annus in meridie diei mathie 25 dies bisexti erit semper ultimus dies*

> *anni. Iste tabule radicum sunt facte Parisius ad meridiem cuius cenith distat ab equinocciali 49 g 30 m vel 8 m 15 2ª diei.*

The numerical datum, 0;0,19d (= 0;7,36h), represents the equation of time for that day. In the Madrid version, the "radix of the opposition", 14;45,55d, is half the length of a mean synodic month which is about 29;31,50d, and this is the entry for the first opposition in Vimond's calendar (see below). It is clear that, according to the version of this text in the Paris manuscript, the civil day in the calendar includes the period of daylight, that is, the time from sunrise to sunset, in contrast to the astronomical day that goes from noon to the following noon. Both values given for the longitude of Paris from Arin, called "the middle of the world", are equivalent. Arin, a corruption of Ujjain (a city in India), was thought to be halfway between the eastern and western limits of the world (Neugebauer 1962, p. 11, n. 2). The distance from Arin to Toledo was taken to be 61;30° and, since Paris was generally said to be 0;48h or 12° to the east of Toledo, its longitude from Arin is 49;30°, as in the passage above (Millás 1943–1950, p. 49; Kremer and Dobrzycki 1998, p. 194; and F. S. Pedersen 2002, p. 431). Moreover, when a day is taken to be 360°, it follows that 49;30° corresponds to 0;8,15d, for 49;30°/360° = 0;8,15. The expression in the Madrid manuscript, "Parisius ad meridiem cuius cenith distat ab equinocciali" is a corrupt version of the better reading in the Paris manuscript, for it would imply that 49;30° is the latitude of Paris, but then its equivalence to 0;8,15d would become meaningless. We also note that, according to this text, Vimond's tables were computed for Paris whereas in the early 1320s other Parisian astronomers who recast the Alfonsine Tables computed them for Toledo, as is the case for the tables with epoch 1321 by John of Murs (see, e.g., Lisbon, Biblioteca de Ajuda, MS 52-XII-35).

According to our computations based on the Parisian Alfonsine Tables, the mean conjunction on March 10, 1320 took place in Toledo at 9;10h, civil time (i.e., counting from midnight) which, with a correction of 0;48h, is 9;58h in Paris (civil time), that is, 2;2h before noon. Thus, the radix for the tables on f. 1r (as well as the radices for the planetary tables, as will be seen later) is the time of the first mean conjunction in March 1320 (March 10, 1320, at 9;58 a.m., Paris, or March 9, 1320, 21;58h, Paris, counting from noon). Indeed, the sexagesimal part of the "radix" (0;54,54d) is exactly the sum of 12h and 9;58h. The integer part of the "radix", as will be explained later in reference to the annual calendar presented on this same folio, is counted from the epoch of the calendar, almost 14 days before the mean conjunction of March 10, 1320, that is, February 25, 1320 or February 24b, 1320, where 24b represents the second day called February 24 in a leap year (such that the last day of February is always day 28 both in ordinary and leap years).

f. 1r Table 1: mean conjunctions

The entries in this table give the instant of the first mean conjunction after a certain number of years. We are given entries for 1, 2, 3, and 4 years; for multiples of 4 years up to 76 (= 19 · 4) years; and for 152, 304, 608, 1216, and 2432 years. The entries represent the excess of days after an integer number, n, of synodic months have elapsed (where n = 13 for year 1, …, and 30,081 for year 2432). Madrid, Biblioteca Nacional, MS 4238, f. 66v, reproduces this table except for the last row for 2432 years, which is missing.

Table 1: mean conjunctions (f. 1r)

[years]	[excess] d	[years]	[excess] d	[years]	[excess] d
1	18;53,52	28	20; 6,54	64	12;13,41
2	8;15,53	32	6; 6,50	68	27;45,27
3	27; 9,45	36	21;38,37	72	13;45,23
4	15;31,46	40	7;38,33	76	29;17,10
8	1;31,43	44	23;10,19	152	29; 2,29
12	17; 3,29	48	9;10,15	304	28;33, 8
16	3; 3,25	52	24;42, 2	608	27;34,26
20	18;35,12	56	10;41,58	1216	25;47, 1
24	4;35, 8	60	26;13,44	2432	21;43,12

The value for the mean synodic month derived from year 2432 is 29;31,50,7,44,35d ± 0;0,0,0,0,4d. Thus, for year 1: 13 · 29;31,50,7,44,35d – 365d = 18;53,52d, in agreement with the tabulated value. In the Parisian Alfonsine Tables, the mean synodic month is 29;31,50,7,37,27,8,25d: this value is found, for example, in Lisbon, Biblioteca de Ajuda, MS 52-XII-35, f. 16v, containing the tables for epoch 1321 by John of Murs. So Vimond's parameter is very similar to, but not identical with, the parameter in the Parisian Alfonsine Tables.

	Vimond	Parisian Alf. T.
Mean synodic month	29;31,50,7,44,35d	29;31,50,7,37,27,8,25d

f. 1r Table 2: annual calendar with syzygies

This annual calendar begins on the day of Saint Matthew (February 24) and lists the dates associated with several saints, as well as the dates and times of 25 consecutive mean syzygies. The practice of adding the extra day in a leap year after Feb. 24 goes back to the Roman calendar as revised by Julius Caesar, when the additional day followed Feb. 24 and was called *bis-sextus ante calendas martias* (the sixth day before the calends of March). In a leap year February lasted 29 days, but the last day was numbered "28", for the 24th was assigned to two consecutive days. This is what is intended in Vimond's calendar where the year begins on that very day. We know of no other calendar in the late 13th century or early 14th century beginning on Feb. 24; in particular, the calendars composed by Geoffreoy of Meaux and William of St.-Cloud do not begin on that day (Chabás and Goldstein 2003a, pp. 245–247). It is worth noting that Vimond's calendar which lists mean syzygies together with saints' days is in the tradition of these two astronomers who were active in Paris shortly before him: they displayed planetary data in calendars and depended on the Toledan Tables for their computations. We also note that the feast of St. Matthew is mentioned in the canons to the Parisian Alfonsine Tables by John of Saxony as the last day in a leap year (see Poulle 1984, p. 36, line 41). Vimond offers no explanation for basing his calendar and his tables on syzygies; we can only conjecture that he was being faithful to some unknown source.

In Table 2, columns 1 and 2 have no heading, but column 3 has the heading "days, minutes, and seconds". In the manuscript the name of the month is usually given in col. 2, and occasionally in col. 1 which has about 90 entries such as: *Annunciatio Domini, Dyonisius, Lucas Evangelista, Innocentes*, etc. The syzygies are numbered from 1 to 25, and they are transcribed below. The numbers in column 3 are integers when a saint's day is meant and indicate the number of days that elapsed since the epoch (day 0) of the calendar, that is, February 25, 1320 (Julian) or what we have called February 24b, 1320. Vimond seems to use here civil days (from midnight to midnight) rather than astronomical days (from noon to noon), which makes sense in a calendar. When a conjunction or an opposition is indicated, we would expect the number in column 3 to refer to the accumulated time from the radix (the conjunction on March 10, 1320) in multiples of half a mean synodic month, i.e. 14;45,55d but, in fact, we are given the accumulated time from the mean syzygy—an opposition—immediately preceding the radix, which occurred on February 24, 1320. If this was the author's intention, it is not clear how the user of these tables was to take account of the radix given at the beginning of them. Moreover, despite the coherence of the arithmetic in this calendar, something is seriously wrong with it, for we find the word *oppositio* next to March 10, when a conjunction took place, and the word *coniunccio* next to March 25, when an opposition occurred. The same pattern is followed throughout the calendar. There is an "explanatory" note on f. 1r concerning the calendar, but we were unable to make sense of it.

Table 2: annual calendar with syzygies (f. 1r)

(1)	(2)	(3)
[Saint's day / No. syzygy]	[date]	[time since epoch] d
Romanus	February 28	4
Perpetua virgo	March 7	11
1 Opposition	March 10	14;45,55
Gregorius papa	12	16
…		
2 Conjunction	March 25	29;31,50
…		
3 Opposition	April 9	44;17,45
…		
4 Conjunction	April 24	59; 3,40
…		
5 Opposition	May 8	73;49,35
…		
6 Conjunction	May 23	88;35,30
…		

7 Opposition	June 7	103;21,25
…		
8 Conjunction	June 22	118; 7,21
…		
9 Opposition	July 6	132;53,16
…		
10 Conjunction	July 21	147;39,11
…		
11 Opposition	August 5	162;25, 6
…		
12 Conjunction	August 20	177;11, 1
…		
13 Opposition	September 3	191;56,56
…		
14 Conjunction	September 18	206;42,51
…		
15 Opposition	October 3	221;28,46
…		
16 Conjunction	October 18	236;14,41
…		
17 Opposition	November 2	251; 0,36
…		
18 Conjunction	November 14	265;46,31
…		
19 Opposition	November 31	280;32,26
…		
20 Conjunction	December 16	295;18,21
…		
21 Opposition	December 31	310; 4,16
Circoncisio domini Ihesu Christi initium anni	[January 1]	311
…		
22 Conjunction	January 14	324;50,11
…		
23 Opposition	January 29	339;36, 6
…		
24 Conjunction	February 13	354;22, 2
Iuliana virgo	16	357
Petrus ad cathedram	22	363
25 Opposition	February 28	369; 7,57

Year 1324 might be considered as an alternative date for the calendar for, according to computations with the Parisian Alfonsine Tables, a mean opposition occurred on March 10 (counting from noon) or on March 11 (counting from midnight). This would conform with the character of the syzygy mentioned in the calendar, and the computations associated with this date yield results that are quite close to (but not exactly the same as) the information given in the text. Indeed, in our preliminary discussion of these tables, this near agreement mislead us to think that 1324 was the radix of Vimond's tables (Chabás and Goldstein 2003a, p. 270). However, as indicated previously, year 1320 is specifically mentioned, and it fits much better with the radix of mean conjunctions and with the radices for planetary positions displayed on ff. 1v and 4r.

f. 1v Radices for the argument of solar anomaly, the argument of lunar anomaly (henceforth, solar and lunar anomaly, respectively), the solar apogee, and the lunar ascending node:

Solar anomaly	8s 26;14,33°
Lunar anomaly	1s 3; 6,14°
Solar apogee	2s 29;56,15°
Ascending node	10s 13;14,43°

Note the use of signs of 30°, a characteristic of all tables in this set.

A short text below these parameters explains that the radices for the motion of the solar apogee and the ascending node are counted from the beginning of Aries on the 9th sphere, indicating that tropical coordinates are used here. These radices were calculated for March 10, 1320, at the time of the mean conjunction of the Sun and the Moon. According to the Parisian Alfonsine Tables the solar apogee for March 10, 1320 is 89;23,50°, a value which differs by about half a degree from the entry in the text. Both values in turn differ from the solar apogee for 1320 in the tables for 1322 by John of Lignères (89;24,22°) that is found by adding two values given on f. 9v of this same manuscript: the solar apogee (81;7,15,39°) and the motion of the 8th sphere at that time (8;17,6,48°). The same result, 89;24,22°, can also be found in another copy of John of Lignères's tables, Erfurt, MS CA Q 362, f. 21ra. For the rest of the radices, recomputation with the Parisian Alfonsine Tables for the epoch, March 9, 1320, at 21;10h in Toledo (counting from noon), yields results which are very close to the values in the text, especially for the Moon:

	Vimond	Parisian Alf. T.
Solar anomaly	266;14,33°	266;47, 0°
Lunar anomaly	33; 6,14°	33; 6,28°
Solar apogee	89;56,15°	89;23,50°
Ascending node	313;14,43°	312;54,39°

The solar longitude is the sum of the solar anomaly and the solar apogee:

	Vimond	Parisian Alf. T.
Solar longitude	356;10,48°	356;10,50°

and again the agreement is very good. Since this is the time of a mean conjunction, the mean lunar longitude will be equal to the mean solar longitude. According to the Parisian Alfonsine Tables, the mean lunar longitude at this epoch was 356;11,3°, i.e., it differed from the mean solar longitude by only 0;0,13° (note that the Moon travels this distance in about 20 seconds of time which is below the accuracy of 1 minute for the time of mean conjunction). Hence the absence of a radix for lunar mean motion simply reflects the fact for the epoch of Vimond's tables the mean longitude of the Moon is the same as the mean longitude of the Sun.

The agreement for the radix of lunar anomaly to the minute is particularly impressive since the motion in lunar anomaly is about 0;30°/h. Lunar anomaly is not subject to precession and it is independent of solar motion. (We use the term *precession* for a constant motion of the eighth sphere, and *trepidation* for a variable motion of the eighth sphere.) So, even though Vimond and the authors of the Parisian version of the Alfonsine Tables differ on matters of definition and made slight changes in mean motions, it is unlikely that either of them would change the motion in anomaly significantly from what it had been in their common source.

f. 1v Table 3: yearly radices

This table displays the radices for the solar anomaly, the lunar anomaly, the solar apogee, and the lunar ascending node for 1, 2, 3, and 4 years; for multiples of 4 years up to 76 years; and then for 152, 304, 608, 1216, and 2432 years, as in Table 1. A selection of the entries is displayed in Table 3.

Table 3: yearly radices (f. 1v)

	Year 1		Year 2		Year 3	
	…					
	s	(°)	s	(°)	s	(°)
Solar anomaly	0	18;22, 3	0	7;37,47	0	25;59,49
Lunar anomaly	11	5;37, 8	9	15;25,15	8	21; 2,22
Solar apogee	0	0; 1,12	0	0; 2,18	0	0; 3,30
Ascending node	11	9;43,23	10	20;58,27	10	0;40,50

	…	Year 8		…	Year 608		…
		s	(°)		s	(°)	
Solar anomaly		0	1;24,48		0	20; 6, 6	
Lunar anomaly		1	5;51,58		4	8;22, 2	
Solar apogee		0	0; 9, 7		0	11;32,36	
Ascending node		6	25;27,27		4	29;26,44	

The entries for year 1 represent the progress made by the Sun, the Moon, the solar apogee, and the lunar node in a year of 13 mean syzygies of the same kind (henceforth "lunations") of 29;31,50,7,44,35d. To be sure, the difference between the solar anomalies for year 2 and year 1 is 349;15,44°, meaning that year 2 contains 12 lunations, for 349;15,44°/ (29;31,50…· 0;59, 8, …) = 12, whereas the difference between year 3 and year 2 is 378;22,2° (the same value than for year 1), indicating that year 3 contains 13 lunations (378;22,2°/ (29;31,50…· 0;59, 8, …) = 13), as is the case with year 1. With this procedure, we see that 50 is the total number of lunations in the first 4 years, 99 in the first 8 years, …, 7,521 in the first 608 years, and so on. That is, for Vimond 1 year is equivalent to 13 mean lunations, 2 years is equivalent to 25 mean lunations, etc. Where possible, we have derived the associated mean motions from the entries for year 608, because those for years 1216 and 2432 are not completely legible in the manuscript.

The mean motion in solar anomaly resulting from the entry for year 608 (0s 20;6,6°), that is, after 7,521 lunations, and the length of the synodic month obtained before (29;31,50,7,44,35d), is 0;59,8,8,23,30°/d, for

(608 · 360° + 20;6,6°)/(7521 · 29;31,50,7,44,35d)
= 0;59,8,8,23,30°/d.

This daily mean motion implies a year length of 365;15,42,32d which is sidereal. In the Parisian Alfonsine Tables, however, the length of a sidereal year is variable, and the fixed length of the tropical year is 365;14,33,9,57,...d (= 360°/0;59,8,19,37,19,13,56°/d).

Similarly, the mean motion in lunar anomaly can be computed from the entry corresponding to 7,521 lunations (year 608 :4s 8;22,2°), for 7521 lunations corresponds to 8060 complete revolutions in anomaly with an excess of about 120° (computed with approximate values for the appropriate parameters). Hence, with the data in the text, the mean motion in lunar anomaly is

(8060 · 360° + 128;22,2°)/(7521 · 29;31,50,7,44,35d)
= 13;3,53,57,27,11°/d,

in very good agreement with the corresponding value in the Parisian Alfonsine Tables (13;3,53,57,30,21°/d); the difference only accumulates to 1° in well over 10,000 years.

As for the motion of the solar apogee derived from the entry corresponding to 7,521 lunations (year 608: 0s 11;32,36°), we find 0;0,0,11,13,35°/d. By the same reasoning, the mean motion of the lunar ascending node resulting from the entry of year 8 in the table (6s 25;27,27°) is –0;3,10,18,6,48°/d, in contrast to the value found in the Parisian Alfonsine Tables (–0;3,10,38,7,14,49,10°/d). In this case, the entry in the manuscript for 608 years is corrupt.

	Vimond	Parisian Alf. T.
Year	365;15,42,32d	365;14,33,9,57d
Solar anomaly	0;59, 8, 8,23,30°/d	0;59, 8,19,37, 19°/d
Lunar anomaly	13; 3,53,57,27,11	13; 3,53,57,30,21
Solar apogee	0; 0, 0,11,13,35	—
Ascending node	–0; 3,10,18, 6,48	–0; 3,10,38, 7,14

We note that Vimond's value for the motion of the solar apogee includes precession as well as its proper motion for, if we add the value for the mean motion in solar anomaly (which is sidereal) to the motion of the solar apogee, we find 0;59,8,19,37,4°/d , in close agreement with the corresponding value of the mean motion in solar longitude (tropical) in the Parisian Alfonsine Tables. In the *Almagest*, the planetary apogees are sidereally fixed whereas the solar apogee is tropically fixed. In the 9th century, astronomers in Baghdad fixed the solar apogee sidereally so that it too was subject to precession (or trepidation). But in the 11th century Azarquiel realized that the solar apogee had a proper motion in addition to precession, and fixed its amount as 1° in 279 Julian years or about 0;0,0,2°/d (Chabás and Goldstein 1994, p. 28). In one Andalusian tradition, this proper motion of the solar apogee was applied to the planetary apogees as well (see Samsó and Millás 1998, p. 269; cf. Mestres 1996, pp. 394–395). If we take al-Battānī's value for precession of 1° in 66 years or about 0;0,0,9°/d and add it to the proper motion of the solar apogee, the result is about 0;0,0,11°/d. There is no hint of this proper motion for either the solar apogee or the planetary apogees in the Parisian Alfonsine Tables where these apogees are all sidereally fixed and, instead of precession, the Parisian Alfonsine Tables have tables for trepidation; hence, there is nothing in those tables with which to compare directly the motion of the solar apogee in Vimond's tables. We see, then, that the parameters in Vimond's tables are not identical with those in the Parisian Alfonsine Tables, and some of these parameters (e.g., the length of the solar year) are defined differently.

ff. 1v–2r Table 4: monthly radices

This table displays the radices for the solar anomaly, the lunar anomaly, the solar apogee, and the lunar ascending node for 25 consecutive syzygies after the corresponding integer numbers of semi-lunations have elapsed. An excerpt is shown in Table 4.

Table 4: monthly radices (ff. 1v–2r)

	Syzygy 1 s (°)	Syzygy 2 s (°)	…	Syzygy 25 s (°)
Solar anomaly	0 14;33, 9	0 29; 6,19		0 3;48,53
Lunar anomaly	6 12;54,30	0 25;49, 1		4 22;42,27
Solar apogee	0 0; 0, 3	0 0; 0, 6		0 0; 1, 9
Ascending node	11 29;13,10	11 28;26,20		11 10;29,13

The entries represent the progress made by the Sun, the Moon, the solar apogee, and the lunar node in 1, 2, …, 25 mean semi-lunations of 29;31,50,7,44,35d/ 2 = 14;45,55,3,52,17d. The entries in this table agree with those in Table 3, for in each case the value for 26 consecutive semi-lunations (the sum of the entries for Syzygy 1 and Sygygy 25 in Table 4) equals the value for 13 lunations (year 1 in Table 3).

f. 2r Table 5: Sun

This table in 5 columns is original in presentation. Column 1 gives the argument (*argumentum*) at 3°-intervals in signs and degrees from 0s 3° to 12s 0°; this is the mean solar anomaly. Column 2 displays the true solar anomaly (*motus completus*) in signs, degrees, and minutes. Column 3 (*motus gradus*) displays the increment in true anomaly per degree of the argument. Column 4 gives the solar velocity, in units of minutes and seconds of arc in a minute of a day (*minutum diei*), i.e., in a sixtieth of a day. Column 5 displays the time (also called *argumentum*), in days, with sexagesimal fractions of a day, that the Sun takes to complete the arc indicated in column 1.

Table 5: Sun (f. 2r)

(1)		(2)		(3)	(4)	(5)
argum.		*motus c.*		*motus g.*	*min. diei*	*argum.*
s	(°)	s	(°)	min.	min.	d
0	3	0	2;54	57;51	0;57	3; 2,38
0	6	0	5;47	57;51	0;57	6; 5,16
...						
2	27	2	24;51	59;47	0;59	88;16,18
3	0	2	27;50	59;59	0;59	91;18,55
3	3	3	0;50	60; 3	0;59	94;21,33
3	6	3	3;50	60;16	0;59	97;24,11
3	9	3	6;51	60;19	0;59	100;26,49
...						
5	27	5	26;53	62;24	1; 1	179;35,13
6	0	6	0; 0	62;24	1; 1	182;37,51
6	3	6	3; 7	62;22	1; 1	185;40,29
...						
8	21	8	23; 9	60;16	0;59	264;48,53
8	24	8	26;10	60; 3	0;59	267;51,31
8	27	8	29;10	59;59	0;59	270;54, 9
9	0	9	2;10	59;47	0;59	273;56,46
9	3	9	5; 9	59;43	0;59	276;59,24
...						
11	27	11	27; 6	57;51	0;57	362;13, 4
12	0	12	0; 0	57;51	0;57	365;15,42

To obtain an entry in column 5 multiply the corresponding entry in column 1 by the daily mean motion in solar anomaly; the entry for 360° (365;15,42d) represents the length of the sidereal year, in good agreement with the value deduced from 99 mean synodic months in Table 3.

As shown in Table 5A, the difference between the argument (col. 1) and the true anomaly (col. 2) represents the solar equation, with a maximum of 2;10° as in the Parisian Alfonsine Tables. To emphasize the solar equation, we have added a third column for the differences between entries in columns II and I, labeled II – I.

Table 5A: the solar equation embedded in Table 5

I		II		II – I
argumentum		*motus completus*		
s	(°)	s	(°)	(°)
0	3	0	2;54	–0; 6
0	6	0	5;47	–0;13
...				
2	27	2	24;51	–2; 9
3	0	2	27;50	–2;10
3	3	3	0;50	–2;10
3	6	3	3;50	–2;10
3	9	3	6;51	–2; 9
...				
5	27	5	26;53	–0; 7
6	0	6	0; 0	0; 0
6	3	6	3; 7	0; 7
...				
8	21	8	23; 9	2; 9
8	24	8	26;10	2;10
8	27	8	29;10	2;10
9	0	9	2;10	2;10
9	3	9	5; 9	2; 9
...				
11	27	11	27; 6	0; 6
12	0	12	0; 0	0; 0

The entries for the solar equation are not explicit in Vimond's table; they can be graphed as a smooth curve but they do not allow us to decide which specific table for the solar equation he used. The reason is that Vimond's entries are only given to minutes in contrast to most other tables in which the maximum equation is 2;10,0° where entries are given to seconds, and rounding those values produces Vimond's entries.

ff. 2v–3r Table 6: Moon

This table has the same format as Table 5. An excerpt is displayed in Table 6.

Table 6: Moon (ff. 2v–3r)

(1)				(2)	(3)	(4)	(5)
argumentum				*motus c.*	*motus min.*	*min. diei*	*latitud.*
s	(°)	s	(°)	(°)	sec.	min.	(°)
0	1	11	29	0; 5	5	12; 9	0; 5,13
0	2	11	28	0;10	5	12; 9	0;10,27
...							
2	29	9	1	4;54	0	13; 4	4;59,58
3	0	9	0	4;55	0	13; 5	4; 0, 0 *
3	1	8	29	4;55	0	13; 6	4;59,58
3	2	8	28	4;56	0	13; 8	4;59,50
3	3	8	27	4;56	0	13; 9	4;59,35
3	4	8	26	4;56	0	13; 9	4;59,15
3	5	8	25	4;56	0	13;11	4;58,51
3	6	8	24	4;56	0	13;13	4;58,21
3	7	8	23	4;56	0	13;14	4;57,45
3	8	8	22	4;55	0	13;15	4;57, 4
...							
5	29	6	1	0; 6	6	14;25	0; 5,13
6	0	6	0	0; 0	6	14;25	0; 0, 0

* *Sic*, instead of 5;0,0.

Column 1 gives the argument (*argumentum*) at 1°-intervals in signs and degrees from 0s 1° to 6s 0° and its complement in 360° from 6s 0° to 11s 29°. For columns 2, 3, and 4, one enters with the mean argument of lunar anomaly, whereas for column 5 one enters with the argument of lunar latitude. Column 2 displays the lunar equation of center (*motus completus*) in degrees and minutes with a maximum of 4;56° as in the

Parisian Alfonsine Tables. Column 3 (*motus minuti*) displays the line-by-line differences in column 2 divided by 60 (for purposes of interpolation). Column 4 gives the lunar velocity, in minutes and seconds, in a minute of a day (*minutum diei*). The minimum corresponds to 0;30,23°/h and the maximum to 0;36,3°/h: for a comparison with other tables for lunar velocity, see Goldstein 1996. Column 5 displays the lunar latitude, with a maximum of 5;0,0° as in the Parisian Alfonsine Tables and the *Almagest*. It is surprising that the expression *motus completus* is used here for the lunar equation of center, whereas in Table 5 it was used for the true solar anomaly; clearly, it has a range of meanings and cannot be translated by a single expression.

f. 3r Table 7: true syzygies

There are two subtables for computing the time from mean to true syzygy: see Tables 7(1) and 7(2). The first subtable is a double-argument table where, on analogy with the other subtable, the vertical argument seems to be the elongation between the Sun and the Moon (at 1°-intervals from 1° to 7°) and the horizontal argument, the velocity in elongation (i.e., the difference between the lunar and the solar velocities) in degrees per minute of a day (only four values for the velocity in elongation are given: 11, 12, 13, and 14).

Table 7(1): true syzygies (f. 3r)

* (°)	11 (°)	[diff.]	12 (°)	[diff.]	13 (°)	[diff.]	14 (°)
1	1;31	7	1;24	7	1;17	5	1;12
2	3; 2	15	2;47	13	2;34	11	2;23
3	4;33	23	4;10	19	3;51	16	3;35
4	6; 4	31	5;33	25	5; 8	22	4;46
5	7;35	38	6;57	32	6;25	28	5;57
6	9; 6	45	8;20	38	7;42	33	7; 9
7	10;36	53	9;43	45	8;58	38	8;20

*In the MS, *gradus velocitatis* appears above this column but it refers to the headings of the other columns, labeled: 11, 12, 13,14.

An entry, e, in this subtable was derived by means of the formula (expressed in modern notation)

$$e = 16;40 \cdot \eta / [(v_m(t) - v_s(t)]$$

where η is the true elongation at mean conjunction (or the result after subtracting 180° at mean opposition), and the velocity in elongation, $v_m(t) - v_s(t)$, is the difference between the daily velocities of the Moon and the Sun at the time of mean syzygy. We cannot give a satisfactory explanation for the factor 16;40 (= 100/6) or for the headings of the columns indicating that the entries are in degrees and minutes (rather than in units of time). Between these four columns, one finds the differences, in minutes (but labeled "seconds"), between two consecutive entries in the same row, to facilitate interpolation.

The second subtable is also a double-argument table giving the time in days as a function of the elongation (at intervals of 0;1° from 0;1° to 1°, or 60 minutes) and the velocity in elongation in degrees per minute of a day (again, only 4 values for the velocity in elongation are given: 11, 12, 13, and 14). Between these four columns, one finds the differences, in minutes of a day, between successive entries in the same row, to facilitate interpolation. Some selected rows of this subtable are displayed in Table 7(2).

The entries in this subtable were computed by means of the formula (expressed in modern notation)

$$\Delta t = -\eta / [(v_m(t) - v_s(t)]$$

where Δt is the time interval between mean and true syzygy, η is the true elongation, and the velocity in elongation, $v_m(t) - v_s(t)$, is the difference between the daily velocities of the Moon and the Sun at the time of mean syzygy. This approach to the problem of finding true syzygy was followed by a number of medieval astronomers and differs from that presented by Ptolemy in *Almagest* VI.4 (Chabás and Goldstein 1997, pp. 93–96; cf. Kremer 2003, pp. 305–329).

Madrid, Biblioteca Nacional, MS 4238, f. 67r, reproduces both subtables except that the last row of Table 7(2) corresponds to the argument of 9 min.

Table 7(2): true syzygies (f. 3r)

min.*	11	[diff.]	12	[diff.]	13	[diff.]	14
	min.	sec.	min.	sec.	min.	sec.	min.
1	5;27	27	5; 0	23	4;37	20	4;17
2	10;55	55	10; 0	46	9;14	40	8;34
...							
9	49; 5	245	45; 0	208	41;32	178	38;34
	days	min.	days	min.	days	min.	days
10	0;55	5	0;50	4	0;46	3	0;43
...							
59	5;22	27	4;55	23	4;32	19	4;13
60	5;27	27	5; 0	24	4;37	20	4;17

*In the MS, *gradus velocitatis* appears above this column but it refers to the headings of the other columns, labeled: 11, 12, 13,14.

ff. 3v–4r Table 8: correction of the lunar position for each day between syzygies

This double-argument table displays two columns for each day, from day 1 to day 14. The days in the horizontal argument refer to the time from conjunction to opposition. The vertical argument is given at intervals of 12°, from 0s 12° to 12s 0°. The heading calls it *elongatio lune ab auge epicicli* and it represents the mean lunar anomaly at mean syzygy. For each day, the first column gives the increment in lunar longitude, here called *motus completus*, in signs and degrees, to be added to the mean lunar longitude at the preceding mean syzygy, whereas the second column displays one sixtieth of the differences between successive entries in the same row, here called *motus ad minutum diei*, and given in arc-minutes.

The entries in the second column thus represent the true lunar velocity in a minute of a day for that particular day.

Table 8: correction of the lunar position for each day between syzygies (ff. 3v–4r)

	Day 1		Day 2		…	Day 14	
	motus c.	min	*motus c.*	min		*motus c.*	min
s (°)	s (°)		s (°)			s (°)	
0 12	0 10;57	11;53	0 22;50	11;55		6 5;37	14;37
0 24	0 10; 7	12; 1	0 22; 8	12; 6		6 6;41	14;26
1 6	0 9;24	12;11	0 21;35	12;19		6 7;38	14;10
…							
2 0			0 21; 4	12;53			
…							
2 24	0 8;10	13;18				6 9;27	13;56
…							
5 18	0 13;37	14;50	0 28;27	14;52		6 5;25	11;49
6 0	0 14;45	14;45	0 29;30	14;41		6 4;27	11;51
6 12	0 15;47	14;35	1 0;22	14;26		6 3;30	11;55
…							
7 18			1 1;38	12;52			
…							
8 12	0 18;11	13; 7					
…							
9 6						5 29;30	13;28
…							
11 6	0 13;46	11;49	0 25;35	11;41		6 2;17	14;44
11 18	0 12;48	11;48	0 24;36	11;42		6 3;27	14;46
12 0	0 11;51	11;49	0 23;40	11;47		6 4;29	14;45

As mentioned above, John of Spira composed canons to some of Vimond's tables. In particular, the canon in Vatican, Biblioteca Apostolica, MS Ottob. lat. 1826, ff. 152v–153r, describes the use of Table 8, here entitled *Tabula veri loci lune ad dies datos post mediam* *coniunccionem vel opposicionem solis et lune*. The canon ends with an explicit reference to John Vimond working in Paris:

> *Explicit canon tabule sequentis que est una tabularum quas composuit Magister Johannes Vimondi. Iste autem canon est undecimus canonum quos composuit magister Johannes de Spira supra tabulas predicti magistri Johannis Parisius.*

On ff. 153v–155v we find a copy of Table 8, but in this case the entries in the second column (the true lunar velocity in a minute of a day) are given to one sexagesimal place.

We know of only a few similar tables for the same purpose, but the entries in them differ from those given by Vimond. Erfurt, MS CA 2° 388, is a 15th-century manuscript which, according to Poulle (1973), contains one of the rare copies of John of Lignères *Tabule magne*. On ff. 30r–32v, there is an expanded version of Table 8, with the same structure and the same columns. In this case, the horizontal argument runs from day 1 to day 15 and the column for velocity gives entries in minutes and seconds per hour which result from the entries in Vimond's Table 8 by multiplying them by 2;30 (= 60/24) for conversion from arc to time. Another example is furnished by Levi ben Gerson (d. 1344) who compiled a double-argument table, based on his own model, for finding the lunar position between syzygies as a function of the number of days since syzygy from 1 to 14 and the mean lunar anomaly at 10°-intervals from 0° to 350° (Goldstein 1974, pp. 148–149, 246–254). Yet another such table is found in an anonymous zij in Hebrew for year 1400: this double-argument table shares the same structure, but the anomaly is given at intervals of the daily increment in mean lunar anomaly from day 0 to day 27 (cf. Goldstein 2003, p. 166). The zij of Judah ben Verga (ca. 1470) also includes a table with the same structure (Goldstein 2001, pp. 247, 269–270).

f. 4r Radices for the planets

In a small table, the text gives the following values for the radices of the planets:

Mercury	11s 10; 6,10°
Venus	3s 3;46,55°
Mars	3s 15; 9,42°
Jupiter	6s 4; 8, 5°
Saturn	9s 14; 0,46°

When recomputed for the instant of the mean conjunction on March 10, 1320, these radices that depend on the mean longitudes or mean arguments of anomaly (henceforth, simply "anomaly") confirm the use of this date as epoch. In the case of the superior planets the radix can be represented by the following formula:

$$\mathrm{Rx(planet)} = \bar{\lambda}_0 - \mathrm{A(Sun)}$$

where $\bar{\lambda}_0$ is the mean longitude of the planet at epoch, and A(Sun) is the apogee of the Sun at that time. According to the Parisian version of the Alfonsine Tables, the mean motions for the superior planets on that day, in Toledo at 9;10 a.m. (= 9;58 a.m. in Paris), counting from midnight, are:

Saturn	13;57, 1°
Jupiter	274; 4,20°
Mars	195; 5,57°

If we subtract the value of the solar apogee for this epoch (89;56,15°) given by Vimond (f. 2r), we obtain:

Saturn	284; 0,46°
Jupiter	184; 8, 5°
Mars	105; 9,42°

in perfect agreement with the radices given in the text. Note that using the standard Alfonsine value for the solar apogee at that time (89;23,50°) yields no agreement, confirming the author's preference for his value, 89;56,15°. The reason for subtracting the solar apogee is that for Vimond the planetary apogees partake in the motion of the solar apogee.

For Venus and Mercury, Vimond's radices can be obtained by adding the planet's anomaly and the solar longitude and subtracting from the sum the value for the solar apogee at epoch. For Venus we compute according to the Parisian Alfonsine Tables at Vimond's epoch:

$\mathrm{Rx(Venus)} = t \cdot v + \bar{\alpha}_0\mathrm{(Venus)} + \bar{\lambda}_0\mathrm{(Sun)} - \mathrm{A(Sun)}$
$= 24754;52,55\mathrm{d} \cdot 0;36,59,27,23,59,31°/\mathrm{d} + 45;45,55,19° + 356;10,50° -$
$89;56,15° = 93;46,58°$

where t, the time from epoch Alfonso to epoch Vimond, is 24754;52,55d; v, the mean motion in anomaly for Venus, is 0;36,59,27,23,59,31°/d; $\bar{\alpha}_0$(Venus), the radix for Venus's mean anomaly at Alfonso's time, is 45;45,55,19°; $\bar{\lambda}_0$(Sun), the mean longitude of the Sun at Vimond's epoch, is 356;10,50°; and A(Sun), the solar apogee at Vimond's epoch, is 89;56,15°. This result, 93;46,58°, differs from the radix in Vimond's text by only 0;0,3°.

For Mercury, we compute according to the Parisian Alfonsine Tables at Vimond's epoch, as for Venus, where $\bar{\lambda}_0\mathrm{(Sun)} - \mathrm{A(Sun)} = 266;14,35°$:

$\mathrm{Rx(Mercury)} = 24754;52,55\mathrm{d} \cdot 3;6,24,7,42,40,52°/\mathrm{d} + 213;48,38,56° +$
$266;14,35° = 346;6,15°$

whereas Vimond's text has 11s 16;6,10° (= 346;6,10°), in excellent agreement with our recomputation.

A short text below these radices tells us that we should add two quantities, the radix for the planet and the solar apogee. For Vimond the solar apogee and each of the planetary apogees share the same motion; hence the difference between them is always the same. In particular, since Venus's apogee is always the same as that of the Sun, nothing is given for Venus. The text then displays values for each planet of the distance of its apogee from the solar apogee:

Saturn	5s 12° = 162°
Jupiter	2s 22° = 82°
Mars	1s 14° = 44°
Venus	–
Mercury	3s 29° = 119°

These values agree closely with those of Ibn Isḥāq (early 13th century) [Mestres 1996, p. 395]. They are used as shifts in subsequent tables for the planets, and can be derived from the radices used in the Parisian Alfonsine Tables by subtracting the solar apogee for the time of Alfonso from the radix of the apogee for each planet (see, e.g., the *editio princeps* of the Alfonsine Tables printed by Ratdolt (1483), c8–d1; note that the signs used there are signs of 60º):

Saturn	4, 2;35,20,41° – 1,20;37,0° = 161;58,20°
Jupiter	2,42;48,38,41° – 1,20;37,0° = 82;11,38°
Mars	2, 4;23,51,41° – 1,20;37,0° = 43;46,51°
Venus	1,20;37, 0° – 1,20;37,0° = 0°
Mercury	3,19;51,11,41° – 1,20;37,0° = 119;14,11°

These results, when rounded to the nearest degree, are in perfect agreement with Vimond's data. Therefore, the conclusion is that Vimond started with the same planetary apogees as those in the Parisian Alfonsine Tables.

f. 4r–v Table 9: yearly radices

Table 9 displays selected entries.

Table 9: yearly radices (f. 4r–v)

	Year 1		Year 2		…	Year 8		…
	s	(°)	s	(°)		s	(°)	
Mercury	4	11; 1,24	4	21;11,55		2	23;56,47	
Venus	8	15; 2,47	3	12;46,53		0	3;48,53	
Mars	6	1;10, 7	0	26;51,41		3	1;58,32	
Jupiter	1	1;53,32	2	1;19,53		8	2;52,21	
Saturn	0	12;50,22	0	24;41,28		3	7;46,36	

This table displays the radices for the five planets for 1, 2, 3, and 4 years; for multiples of 4 years up to 76 years; and then for 152, 304, 608, 1216, and 2432 years, as in Table 3. As was the case for the radices for the Sun and the Moon, 1 year is equivalent to 13 mean lunations, 2 years is equivalent to 25 mean lunations, …, 8 years is equivalent to 99 mean lunations, etc.

The mean daily motion in longitude resulting from the entries for year 8 (computed in the same way that was used for finding the mean motions in Table 3) are shown below under the heading "Vimond". If we add the daily motion of the apogees (0;0,0,11,13,35°/d), as we did in the case of the Sun, we obtain the entries displayed in the second column, in good agreement with the values for the mean motions in longitude in the Parisian Alfonsine Tables (see Ratdolt 1483).

	Vimond	Including the motion of the apogee	Parisian Alf. T.
Saturn	0; 2, 0,24, 3,56°/d	0; 2, 0,35,17,31°/d	0; 2, 0,35,17,40°/d
Jupiter	0; 4,59, 4, 1,19	0; 4,59,15,14,54	0; 4,59,15,27, 7
Mars	0;31,26,27,26,34	0;31,26,38,40, 9	0;31,26,38,40, 5
Venus	1;36, 7,35,47,21	1;36, 7,47, 0,56	1;36, 7,47, 1,19
Merc.	4; 5,32,16, 5,55	4; 5,32,27,19,30	4; 5,32,27,20, 0

It is most unusual for the mean motions of Venus and Mercury to be the sum of their mean motions in anomaly and the solar mean motion, but there can be no doubt that this is what Vimond did, as is confirmed by the note on f. 4vb. In fact, we know of no other medieval astronomer writing in Latin who presented the mean motions of the inferior planets in this way. For purposes of comparison, the entries for Venus and Mercury under "Parisian Alfonsine Tables" are the sum of the mean motions in anomaly and the solar mean motion: for Venus 0;36,59,27,24,0°/d and 0;59,8,19,37,19°/d, and for Mercury 3;6,24,7,42,41°/d and 0;59,8,19,37,19°/d. Note that in Ptolemy's models the solar mean motion is also the mean argument of center for Venus and Mercury.

ff. 4v–5r Table 10: monthly radices

Table 10 displays selected entries.

Table 10: monthly radices (ff. 4v–5r)

	Syzygy 1		Syzygy 2		…	Syzygy 25		
	s	(°)	s	(°)		s	(°)	
Mercury	2	0;25,26	4	0;50,53		2	10;35,57	
Venus	0	23;39,20	1	17;18,41		7	21;23,27	
Mars	0	7;44,14	0	15;28,28		6	13;25,52	
Jupiter	0	1;13,36	0	2;27,12		1	0;29,57	*
Saturn	0	0;29,38	0	0;59,16		0	12;20,44	

* *Sic*, instead of 1s 0;39,57°.

This table displays the radices for the five planets for 25 consecutive syzygies. The entries in this table are based on the same motions as those embedded in the previous table. As was the case for the monthly radices in Table 4, for each planet the entries for Syzygy 1 and Syzygy 25 add up to the entry corresponding to Year 1 in the previous table (except for 1″ for Mercury, Mars, and Jupiter). For Venus and Mercury the mean motions extracted from Table 9 give exact agreement, confirming the interpretation given above. Thus, in the cases of Venus and Mercury one has obtained the sum of the solar anomaly and their mean anomalies, respectively, at any syzygy (see Fig. 1). This quantity is not the argument in the table of equations (see Tables 12 and 15, below), and it is not clear that there is any advantage to this method as against computing the mean anomaly directly.

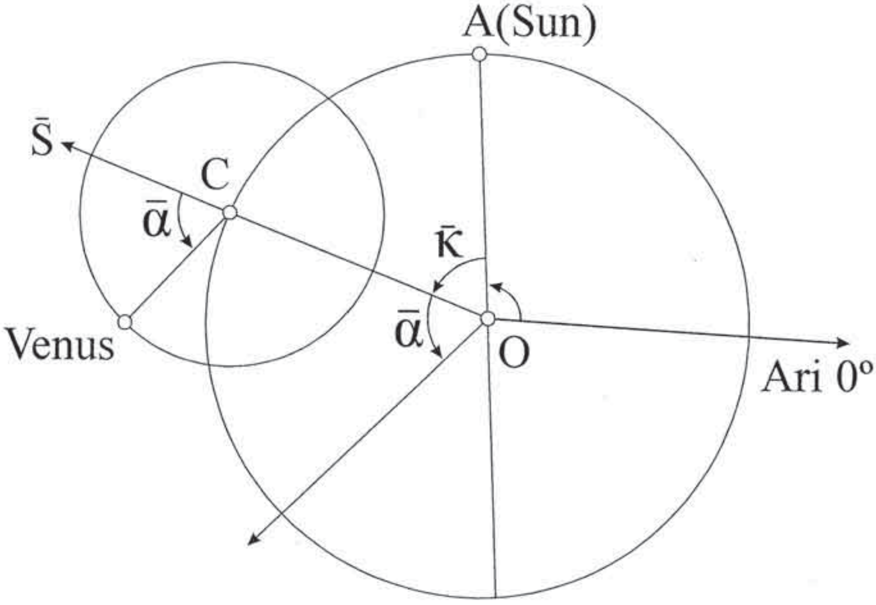

Fig. 1. A geometric interpretation of Vimond's tables for the mean motion for Venus

Tables 11 (Mercury, f. 5r), 14 (Venus, f. 5v), 17 (Mars, f. 6r), 20 (Jupiter, f. 6v), and 23 (Saturn, f. 7r): equation of center and first station

Tables 11 and 12 are to be used together to compute the true longitude of a planet from its mean longitude. In most zijes in the Ptolemaic tradition, there is only one such table for each planet, but Vimond has separated those functions that depend on the mean argument of center from those that depend on the mean anomaly and put them in different tables. A similar idea is already found in the zij of Ibn Isḥāq, described in Mestres 1996. Ibn Isḥāq's parameters for the maximum equations of center for Mars and Mercury are those of al-Battānī, but for Saturn, Jupiter, and Venus they are not; rather, they are 5;48° for Saturn, 5;41° for Jupiter, and 1;51° for Venus. "The tables for planetary equations (...) are divided into two groups: the first group contains the tables for the equation of centre and the interpolation function. (...) The second group (two tables for each planet) contains the tables for the equations of anomaly at apogee and perigee and for the middle position" (Mestres 1999, p. 234). So, the arrangement of Vimond's tables bears a similarity to an Andalusian/Maghribi tradition that is not otherwise attested in Latin.

However, it is not uncommon to find later sets of tables associated with the Parisian Alfonsine Tables where the planetary equations are split into two tables for each planet: see, e.g., Erfurt, MS CA Q 362, ff. 28r–36r, where the entries are displayed at intervals of 1° and the radices are given for Paris (1320) as well as for London and Brugge (1366).

Besides offering two tables for the equations of each planet, Vimond's tables give additional information arranged in a presentation which is certainly peculiar, as explained below.

Table 11: equation of center and first station of Mercury (f. 5r)

(1)		(2)		(3)	(4)	(5)	(6)	
s	(°)	s	(°)	min	min	min	s	(°)
0	6	0	8;51	61; 0	60	60	4	24;30
0	12	0	14;57	60;30	60	59	4	24;30
0	18	0	21; 0	60;20	59	58	4	24;32
0	24	0	27; 2	59;40	59	57	4	24;35
1	0	1	3; 0	59;30	59	54	4	24;38
1	6	1	8;57	59; 0	58	51	4	24;44
1	12	1	14;51	58;50	58	48	4	24;50
1	18	1	20;44	58;20	57	44	4	24;56
1	24	1	26;34	58;10	57	40	4	25; 7
2	0	2	2;23	58;10	57	35	4	25;20
2	6	2	8;12	57;50	57	29	4	25;37
2	12	2	13;59	57;40	57	24	4	25;53
2	18	2	19;45	57;30	57	19	4	26; 9
2	24	2	25;30	57;30	57	14	4	26;24
3	0	3	1;15	57;30	57	10	4	26;38
3	6	3	7; 0	57;30	57	6	4	26;50
3	12	3	12;45	57;30	57	4	4	27; 2
3	18	3	18;30	57;30	57	2	4	27; 9
3	24	3	24;15	57; 0	56	1	4	27;13
4	0	3	29;59	57;10	56	0	4	27;14
4	6	4	5;40	57;30	57	1	4	27;12

4	12	4	11;25	57;30	57	3	4	27; 7
4	18	4	17;10	57;30	57	5	4	26;59
4	24	4	22;55	57;30	57	7	4	26;46
5	0	4	28;40	57;30	57	11	4	26;34
5	6	5	4;25	57;30	57	16	4	26;19
5	12	5	10:10	57;40	57	21	4	26; 4
5	18	5	15:56	58; 0	57	26	4	25;48
5	24	5	21;44	58;10	57	31	4	25;30
6	0	5	27;33	58;10	57	37	4	25;16
6	6	6	3;22	58;30	58	41	4	25; 3
6	12	6	9;13	59; 0	58	45	4	24;54
6	18	6	15; 7	59;10	58	49	4	24;48
6	24	6	21; 2	59;30	59	52	4	24;42
7	0	6	26;59	59;50	59	55	4	24;37
7	6	7	2;58	60;30	60	57	4	24;34
7	12	7	9; 1	60;40	60	59	4	24;31
7	18	7	15; 5	61; 0	60	60	4	24;30
7	24	7	21;11	61;40	61	60	4	24;29
8	0	7	27;21	61;50	61	60	4	24;29
8	6	8	3;32	62; 0	61	59	4	24;29
8	12	8	9;44	62;10	61	59	4	24;30
8	18	8	15;57	62;20	61	58	4	24;32
8	24	8	21;11	62;30	62	57	4	24;34
9	0	8	28;26	62;40	62	56	4	24;36
9	6	9	4;44	63; 0	62	55	4	24;38
9	12	9	11; 2	63;10	62	54	4	24;39
9	18	9	17;21	63;10	62	54	4	24;40
9	24	9	23;44	63;20	62	53	4	24;41
10	0	10	0; 3	63;10	62	53	4	24;42
10	6	10	6;22	63;10	62	53	4	24;41
10	12	10	12;41	63;10	62	54	4	24;40
10	18	10	19; 0	63; 0	62	54	4	24;39
10	24	10	25;18	62;50	62	55	4	24;37
11	0	11	1;35	62;40	62	56	4	24;35
11	6	11	7;51	62;40	62	57	4	24;33
11	12	11	14; 7	62;10	61	58	4	24;31
11	18	11	20;20	62; 0	61	59	4	24;30
11	24	11	26;32	61;50	61	60	4	24;29
12	0	12	2;43	61;20	60	60	4	24;29

The table for the equation of center of each of the five planets has six columns. Column 1 gives the argument (*argumentum*) at 6°-intervals in signs and degrees from 0s 6° to 12s 0°. Column 2 displays the entry in col. 1 corrected for the equation of center (*motus completus*), in signs, degrees, and minutes. The author follows here the same pattern as that for the true solar anomaly (see Table 5). Column 3 (*motus gradus)* gives the increment of the true argument per degree of the argument, in minutes and seconds. Most entries in this column are generated by dividing by 6 the differences between two successive entries in col. 2 and thus were probably intended for interpolation in col. 2. Column 4 (*motus diei*) displays the velocity in minutes of arc per day, and the range of values for each planet is the same as in the column labeled *motus centri* or *motus puncti* (that only depends on the argument of center) in the table for planetary velocities associated with the Toledan Tables and the Castilian Alfonsine Tables (Chabás and Goldstein 2003a, pp. 170–182); for the other component of the planetary velocity, see Tables 12, 15, 18, 21, and 23, col. 4, below. So, the entries in this column are only one component of the planet's velocity. Column 5 is intended to provide minutes of interpolation and is headed *diametri* (perhaps to distinguish these "linear" minutes from minutes of an hour, minutes of a day, and minutes of a degree). Finally, column 6 lists the first station in signs, degrees, and minutes.

Table 14: equation of center and first station of Venus (f. 5v)

(1)		(2)		(3)	(4)	(5)	(6)	
s	(°)	s	(°)	min	min	min	s	(°)
0	6	0	5;47	57;50	57	0	5	15;52
0	12	0	11;34	57;50	57	0	5	15;54
...								
2	24	2	21;51	59;50	59	27	5	17; 2
3	0	2	27;50	60; 0	59	31	5	17;11
3	6	3	4;50	60;20	59	33	5	17;17
3	12	3	9;52	60;30	60	36	5	17;23
...								

8	18	8	20; 8	60;20	59	36	5	17;23
8	24	8	26;10	60; 0	59	33	5	17;17
9	0	9	2;10	59;50	59	31	5	17;11
9	6	9	8; 9	59;30	59	27	5	17; 2
...								
11	24	11	24;13	57;50	57	0	5	15;52
12	0	12	0; 0	57;50	57	0	5	15;50

Table 17: equation of center and first station of Mars (f. 6r)

(1)		(2)		(3)	(4)	(5)	(6)	
s	(°)	s	(°)	min	min	min	s	(°)
0	6	0	12;31	50;50	26	6	5	8;41
0	12	0	17;36	50; 0	26	4	5	8;21
...								
1	12	1	12;22	49; 0	26	0	5	7;29
1	18	1	17;16	49;10	25	0	5	7;31
...								
4	18	4	6;36	60;30	31	32	5	13;46
...								
7	12	7	11;33	73;30	38	60	5	19;14
7	18	7	18;54	73;10	38	59	5	19;13
...								
10	12	10	23;24	58;50	30	31	5	13;36
...								
11	24	12	2;13	51;50	27	10	5	9;31
12	0	12	7;24	51;10	26	8	5	9; 6

Table 20: equation of center and first station of Jupiter (f. 6v)

(1)		(2)		(3)	(4)	(5)	(6)	
s	(°)	s	(°)	min	min	min	s	(°)
0	6	0	11;43	58; 0	5	23	4	5;19
0	12	0	17;31	57;20	5	20	4	5; 9
…								
2	12	2	12;59	44;10	4	0	4	4; 6
2	18	2	18;23	44; 0	4	0	4	4; 5
2	24	2	23;48	44; 0	4	0	4	4; 5
3	0	2	29;12	44;10	4	0	4	4; 6
…								
5	24	5	18; 3	60;10	4	32	4	5;44
…								
8	12	8	10;55	66;20	6	59	4	7;10
8	18	8	17;33	66;30	6	60	4	7;11
8	24	8	14;14	66;20	6	60	4	7;11
9	0	9	0;52	66;20	6	60	4	7;10
…								
11	18	11	23;57	59;50	5	32	4	5;47
11	24	11	29;56	59;10	5	29	4	5;39
12	0	12	0;51*	58;40	5	26	4	5;29

* *Sic*, instead of 5;51.

But for a shift of the entries, the equations of center for Mercury, Mars, and Saturn that can be derived from cols. 1 and 2 are basically the same (with minor variants) as in the zij of al-Battānī (Nallino 1903–1907, 2:110–137) and the Toledan Tables (Toomer 1968, pp. 60–68; F. S. Pedersen 2002, pp. 1259–1308).

Table 23: equation of center and first station of Saturn (f. 7r)

(1)		(2)		(3)	(4)	(5)	(6)	
s	(°)	s	(°)	min	min	min	s	(°)
0	6	0	8;46	66;20	2	57	3	25;22
0	12	0	15;24	66; 0	2	55	3	25;19
...								
2	12	2	18;31	59;20	2	31	3	24;11
...								
5	6	5	6;39	53;30	2	0	3	22;45
5	12	5	12; 0	53;30	2	0	3	22;44
5	18	5	17;21	53;40	2	0	3	22;45
...								
8	12	8	5;29	60;10	2	31	3	24;11
...								
11	6	11	12; 0	67;10	2	60	3	25;30
11	12	11	18;43	67;10	2	60	3	25;28
11	24	11	25;25	67; 0	2	59	3	25;27
12	0	12	2; 7	66;30	2	58	3	25;25

The maximum value for Mercury (3;2°) occurs at about 0s 24° and 7s 6°, that of Mars (11;24°) at 4s 18° and 10s 12°, and that of Saturn (6;31°) at 2s 12° and 8s 12°. However, for the other two planets the entries differ systematically from those in the above-mentioned zijes: for Venus the maximum value is 2;10° at 3s 0° and 3s 6°, and 8s 24° and 9s 0°; and for Jupiter the maximum value is 5;57° at 5s 24° and 11s 18°. The entries for Mercury, Mars, Jupiter, and Saturn are shifted by about 119°, 44°, 82°, and 162°, respectively, in relation to those in the zij of al-Battānī and the Toledan Tables. No such shift appears in the table for Venus. As mentioned above, these shifts result from the difference between the apogee of each of the planets and that of the Sun. Because of these shifts, for the superior planets one enters these tables in col. 1 directly with their mean motions for a given syzygy (the radix plus the motion in years and semi-lunations); for Venus and Mercury one enters with the solar anomaly for a given syzygy. Clearly, Vimond intended to make this table more "user-friendly" than the standard version of the table for the equation of center.

Vimond has a double motion of the solar apogee: precession and proper motion. The planetary apogees are fixed with respect to the solar apogee (i.e., they are subject to both precession and the proper motion of the solar apogee). If we add the solar apogee (about 90°) to the values for the shifts listed above, we find that the planetary apogees are 209° for Mercury, 90° for Venus, 135° for Mars, 172° for Jupiter, and 252° for Saturn. In the Toledan Tables, the apogees of the Sun and of Venus are both 77;50° (Toomer 1968, p. 45), that is, about 12° less than 90°. Adding this difference to the planetary apogees in the Toledan Tables rounded to degrees, we find the following:

Apogees

	V (from the shifts)	V (from the radices)	TT + 12°
Mercury	209°	209°	210°
Venus	90°	90°	90°
Mars	135°	134°	134°
Jupiter	172°	172°	176°
Saturn	252°	252°	252°

The agreement of Vimond's data with the apogees in the Toledan Tables shows that Vimond has included the motion of the solar apogee in the motions of the planetary apogees, thus following a theory for which there was no previous evidence outside al-Andalus and the Maghrib (Samsó and Millás 1998, pp. 268–270). We know of no other set of planetary equation tables arranged in this way. See also Table 27 (equation of access and recess), below, for yet another shift in Vimond's tables.

The maximum values for the equation of center in Vimond's planetary tables are the same as in the *editio princeps* of the Alfonsine Tables (see Table 11A).

Despite their agreement for the values of the maximum equations, the structure of Vimond's tables is very different from that of the Parisian Alfonsine Tables and would seem to be independent of it. Moreover, it is significant that the maximum equation of center for Jupiter in both cases is 5;57°, for this value is not known in any text prior to the Parisian Alfonsine Tables, indicating a strong connection between the tables of

Vimond and the work of his Parisian contemporaries. The origin or derivation of this parameter for Jupiter is not described in any extant text, and it is likely that this value was simply taken from an earlier work: the most reasonable candidate is the Alfonsine Tables as they existed in Castile.

Table 11A: maximum values for the equation of center

	al-Battānī	Toledan T.	Vimond	Parisian Alf. T.
Mercury	3; 2°	3; 2°	3; 2°	3; 2°
Venus	1;59°	1;59°	2;10°	2;10°
Mars	11;24°	11;24°	11;24°	11;24°
Jupiter	5;15°	5;15°	5;57°	5;57°
Saturn	6;31°	6;31°	6;31°	6;31°

For all planets, except Mercury, an entry, c, in column 5 can be computed, but for shifts, from the modern formula

$$c = 60\,(1 - \cos\bar{\kappa})/2,$$

where $\bar{\kappa}$ is the mean argument of center. The same approach is found in Levi's lunar theory (Goldstein 1974, table 35, col. II: see p. 54).

The entries for Mercury in col. 5 do not follow the same pattern as that for the rest of the planets. The entries can be recomputed, approximately, according to the following formula:

$$c_5(\bar{\kappa}) = [D - r(\bar{\kappa})] / [D - d] \qquad [1]$$

where D is the maximum distance of the center of the epicycle from the observer, d is the minimum distance, and $r(\bar{\kappa})$ is the distance as a function of the mean argument of center, $\bar{\kappa}$.

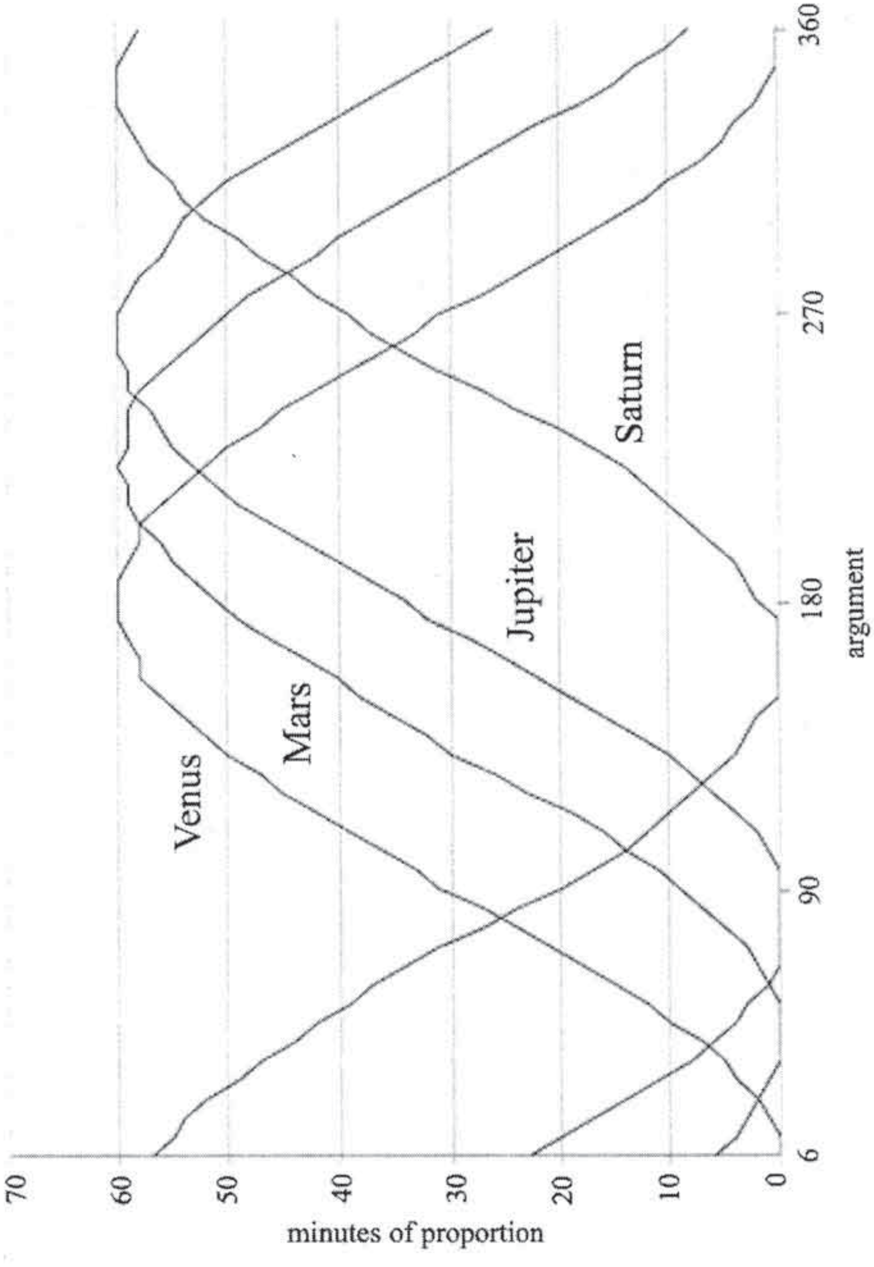

Fig. 2. Vimond's equation of center, col. 5, for Venus, Mars, Jupiter, and Saturn

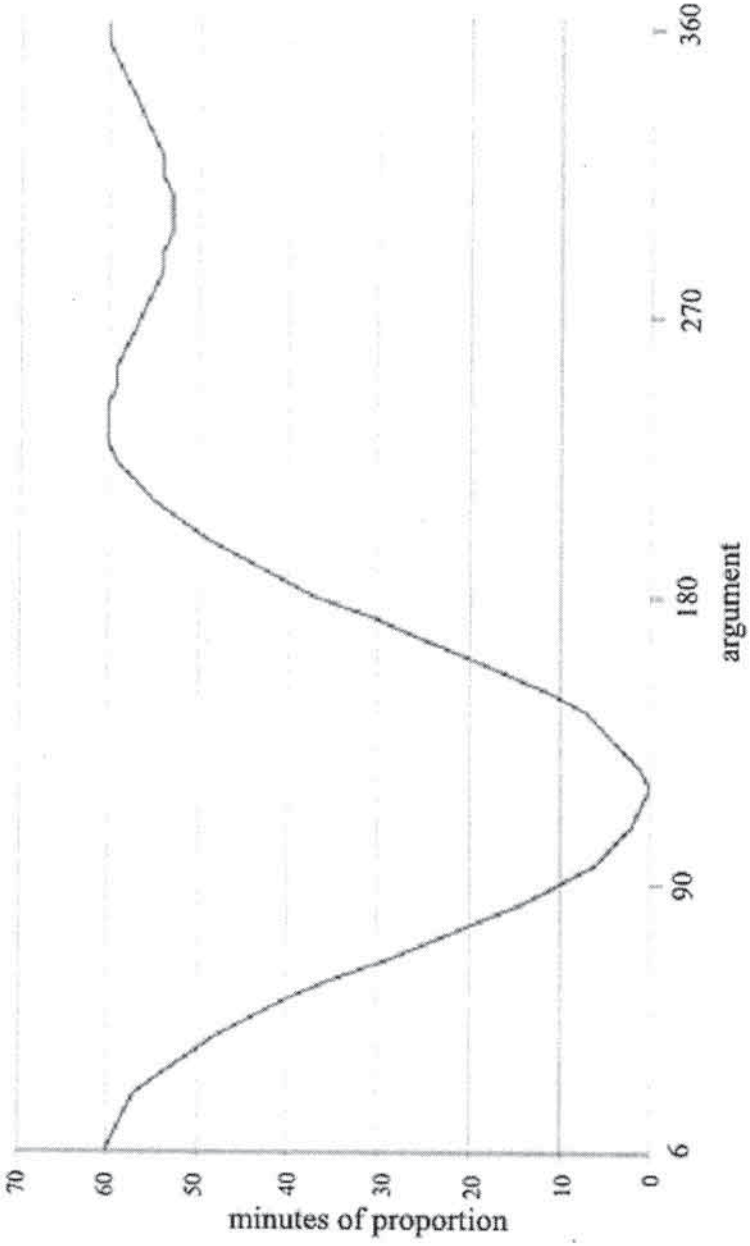

Fig. 3. Vimond's equation of center, col. 5, for Mercury

A similar formula for interpolation was already used by Ḥabash in the 9th century (as-Saleh 1970, pp. 137–138). In Ptolemy's model for Mercury D is 69 for argument 0°, d is 55;34 for an argument close to 120°, and r(180°) is 57 (O. Pedersen 1974, pp. 313–324). Hence, formula [1] can be replaced by

$$c_5(\bar{\kappa}) = [69 - r(\bar{\kappa})] \,/\, 13;26. \qquad [2]$$

In general, the computation of $r(\bar{\kappa})$ is a difficult and lengthy procedure, and it is likely that Vimond (or his source) used approximations (if this, indeed, was the formula he had in mind). We computed the distances from the observer to the center of Mercury's epicycle according to formulas in modern terms given by O. Pedersen (1974, p. 320, equations 10.34 and 10.35), and then used them in equation [2], above. A comparison of our results for $c_5(\bar{\kappa})$ with the entries in Vimond's table is displayed in Table 11B. Col. II has the values for $c_5(\bar{\kappa})$ that depend on the distances computed according to the formulas given by O. Pedersen and equ. [2], above; col. III has the arguments in Vimond's table (with the shift); and col. IV has the entries in Vimond's Table 11, col. 5. Although the agreement is not exact between col. II and col. IV, the trend is clear. Vimond's value for 180°, 37, has the poorest agreement, but this entry should probably be corrected to 36, judging from the surrounding values.

Table 11B: a comparison of column 5 for Mercury with recomputation

I	II	III	IV
$\bar{\kappa}$	$c_5(\bar{\kappa})$	$\bar{\kappa}$ (Vimond)	$c_5(\bar{\kappa})$: Vimond
0	0; 0	120	0
30	10;50	150	11
54	29;24	174	31
60	34;15	180	37
66	38;53	186	41
90	53;33	210	55
120	60; 0	240	60
150	56;38	270	56
180	53;34	300	53

It may be of interest that in Copernicus's table for the equations of Mercury (Copernicus 1543, ff. 177v–178r), his col. 4 (for interpolation) shows the same trend as Vimond's col. 5. We are convinced that column 5 in Vimond's tables for the equation of center is intended to be used for interpolation with column 5 in the tables for the equation of anomaly, and this is analogous to Copernicus's use of his col. 4 (see below). Indeed, Vimond's col. 5 serves much the same purpose as col. 8 in Ptolemy's tables for the planetary equations (*Almagest*, XI.11) but, since the definitions for the columns that yield the equation of anomaly are different, so is the function for interpolation. Moreover, in contrast to the geometric methods in the *Almagest* used for computing the coefficients of interpolation for each of the four planets (Venus, Mars, Jupiter and Saturn), Vimond has approximated the results that would be derived from the geometry of the models by introducing a single trigonometric function in those cases.

In *Almagest*, XI.11 (Toomer 1984, pp. 549–553), col. 8 in the planetary equation tables is intended for interpolation as a function of $\bar{\kappa}$, the mean argument of center, and the entries are given to minutes and seconds (for Ptolemy's method of computation and a graph of the entries in his col. 8, see Neugebauer 1975, pp. 184–186, 1267). A similar set of values, given only to minutes, is found in al-Battānī's zij in the tables for the planetary equations, col. IV (Nallino 1903–1907, 2:110–137), and in corresponding tables in the Parisian Alfonsine Tables, col. 3 (Ratdolt 1483, e7r–g5v).

As for the entries for the first station of each planet, they are essentially the same as in previous tables of the same kind (*Almagest*, Handy Tables, al-Khwārizmī, al-Battānī, and the Toledan Tables) with the same shifts that we noted above.

Tables 12 (Mercury, f. 5r), 15 (Venus, f. 5v), 18 (Mars, f. 6r–v), 21 (Jupiter, f. 7r), and 24 (Saturn, f. 7v): equation of anomaly

The tables for the equation of anomaly for each of the five planets have seven columns. Table 12 displays a selection of values for the equation of anomaly for Mercury.

Table 12: equation of anomaly for Mercury (f. 5r)

(1)		(2)	(3)	(4)	(5)	(6)	(7)
s (°)	s (°)	(°)	min	min	min	sec	sec
0 6	11 24	1;28	15	45	0;18	2	8
0 12	11 18	2;56	15	45	0;33	2	8
0 18	11 12	4;24	14	44	0;48	2	8
0 24	11 6	5;50	14	44	1; 3	2	8
1 0	11 0	7;15	14	42	1;18	2	8
1 6	10 24	8;37	13	42	1;33	2	8
1 12	10 18	9;58	13	40	1;48	2	8
1 18	10 12	11;15	12	39	2; 0	2	8
1 24	10 6	12;30	11	36	2;18	3	9
2 0	10 0	13;39	10	34	2;35	3	9
2 6	9 24	14;44	10	31	2;53	3	9
2 12	9 18	15;44	9	28	3;10	4	8
2 18	9 12	16;38	8	25	4;14	4	8
2 24	9 6	17;25	7	19	4;30	4	8
3 0	9 0	18; 4	5	15	4;45	4	8
3 6	9 24	18;34	3	9	4;57	4	8
3 12	8 18	18;53	1	3	5; 5	4	8
3 18	8 12	19; 1	1	3	5;10	3	6
3 24	8 6	18;56	3	9	5;13	2	4
4 0	8 0	18;39	6	18	5; 6	1	3
4 6	7 24	18; 4	9	27	4;55	1	1
4 12	7 18	17;12	11	35	4;29	0	1
4 18	7 12	16; 4	15	45	4;55	2	6
4 24	7 6	14;36	18	55	4;12	4	13
5 0	7 0	12;49	21	66	4;29	6	18
5 6	6 24	10;42	24	74	3;55	7	22
5 12	6 18	8;18	26	81	3;12	9	29
5 18	6 12	5;42	28	87	2;15	11	34
5 24	6 6	2;53	29	89	1;10	12	36
6 0	6 0	0; 0	29	89	0; 0	12	36

Column 1 gives the mean argument of anomaly (*argumentum*) at 6°-intervals (at 3°-intervals for Mars and Venus) from 0s 6° to 6s 0° and its complement in 360° from 6s 0° to 11s 24°. Column 2 displays the correction due to the argument of anomaly at maximum distance (*motus completus*) in degrees and minutes and represents the difference between the equation of anomaly and the correction for maximum distance (cf. *Almagest*, XI.11, columns 6 and 5; and Neugebauer 1975, pp. 183–184). The only other text of which we are aware that treats the equation of anomaly in this way is the zij of Ibn al-Bannā' (d. 1321) where this presentation is applied in his tables for Saturn and Jupiter but not in those for the other planets (see Samsó and Millás 1998, pp. 278–285). The extremal values in col. 2 that appear in the text are shown below; they are followed by the corresponding entries for col. VI and col. V in the zij of al-Battānī (Nallino 1903–1907, 2:109–137):

	Vimond	al-Battānī
Mercury	19; 1°	(= 21;59° – 2;58°) at 3s 18°
Venus	44;49°	(= 45;59° – 1;10°) at 4s 15°
Mars	36;44°	(= 40;58° – 4;14°) at 4s 6°
Jupiter	10;34°	(= 11; 3° – 0;29°) at 3s12°
Saturn	5;53°	(= 6;12° – 0;19°) at 3s 0° and
		(= 6;13° – 0;20°) at 3s 6°

These corrections agree with those that follow from the *Almagest* as well as the zij of al-Battānī, the Toledan Tables, and the *editio princeps* of the Alfonsine Tables (with minor variants: 40;59° rather than 40;58° for Mars; 6;12° and 0;19° correspond to 3s 0° rather than 3s 1° for Saturn), and this means that Ptolemy's eccentricities underlie them even though, in the case of Venus and Jupiter, the eccentricities were modified for computing the equation of center (cf. North 1976, 3:196). Similarly, in the tables of Ibn al-Bannā' the eccentricities underlying the equations of anomaly are taken from the *Almagest*, but his maximum equations of center for Venus and Jupiter are not those of either Ptolemy or of Vimond (Samsó and Millás 1998, p. 276).

Column 3 (*motus gradus)* gives the increment of the *motus completus* in col. 2 per degree of the argument in minutes: in most cases the entry results from taking the difference between successive entries in col. 2 and dividing that difference by 6 (or by 3 for Mars and Venus); the purpose of this column is facilitate interpolation. Column 4 (*motus diei*) displays the velocity in minutes of arc per day, and the range of values for each planet is the same as in the column labeled *motus argumenti* (that only depends on the argument of anomaly) in the table for planetary velocities; see the comments to the Castilian Alfonsine Tables, chapter 27 (Chabás and Goldstein 2003a, p. 170–182). So, an entry in this column is the second component of the planet's velocity and it complements the first component already displayed in Tables 11, 14, 17, 20, and 23, above. The entries in column 5 (*minutum diametri*), in minutes and seconds, actually represent degrees and minutes, and result from adding the correction for maximum distance to the correction for minimum distance (columns c_5 and c_7 in *Almagest*, XI.11). For the extremal values in col. 5 in the text see below; they are followed by the corresponding entries for col. V and col. VII in the zij of al-Battānī (Nallino 1903–1907, 2:109–137):

	Vimond	al-Battānī
Mercury	5;13°	4;56° *
Venus	3;34°	(= 1;42° + 1;52°) at 5s 12°
Mars	13;37°	(= 5;34° + 8;3°) at 5s 9°
Jupiter	1; 3°	(= 0;30° + 0;33°) at 3s 24°
Saturn	0;46°	(= 0;21° + 0;26°) at 3s 12°

* In al-Battānī's zij for 3s 24° we find 3;4° + 1;52° = 4;56°, whereas for 3s 24° in Vimond's table we find 3;12° + 2;1° = 5;13°, al-Battānī's maximum which occurs at 4s 10°–4s 12°.

In the absence of instructions by Vimond it is not easy to decide how the correction to the planet's mean longitude is to be computed, but it seems likely that one component of this correction is to be computed by adding an entry in col. 2 to an interpolation factor times an entry in column 5, as is the case with the tables of Ibn al-Bannā' for Saturn and Jupiter. The most likely candidate for this interpolation factor is col. 5 in Table 11, for it depends on the argument of center as it should (see Samsó and Millás 1998). Column 6 (*motus gradus)* seems to be the increment per degree of argument of the entries in col. 5: in many cases the entry in col. 6 results from taking the difference between successive entries in col. 5 and dividing it by 6 (or by 3 for Mars and Venus), and it is for purposes of interpolation. The entries in col. 6 are given in seconds. The entries in column 7 (*motus diei*) are also given in seconds; they are probably associated with those in the preceding column, for in all cases columns 6 and 7 have their extremal values for the same arguments, but we have failed to identify their specific purpose.

Table 15: equation of anomaly for Venus (f. 5v)

(The entries from 5s 18° to 6s 12° are given at 2°-intervals, rather than at 3°-intervals as in the rest of the table.)

(1)		(2)	(3)	(4)	(5)	(6)	(7)
s (°)	s (°)	(°)	min	min	min	sec	sec
0 3	11 27	1;15	25	15	0; 2	0	0
0 6	11 24	2;30	25	15	0; 3	1	0
...							
4 12	7 18	44;44	2	1	2;18	2	1
4 15	7 15	44;49	2	1	2;25	2	1
4 18	7 12	44;44	6	4	2;32	3	2
...							
5 12	6 18	33;25	74	46	3;34	2	1
5 15	6 15	29;43	89	55	3;27	4	2
5 18	6 12	25;25	104	64	3;14	7	4
...							
5 28	6 2	4;48	144	89	0;45	22	14
6 0	6 0	0; 0	144	89	0; 0	22	14

Table 18: equation of anomaly for Mars (f. 6r–v)

(The entries from 5s 18° to 6s 12° are given at 2°-intervals, rather than at 3°-intervals as in the rest of the table.)

(1)		(2)	(3)	(4)	(5)	(6)	(7)
s (°)	s (°)	(°)	min	min	min	sec	sec
0 3	11 27	1; 8	23	11	0; 8	3	1
0 6	11 24	2;16	23	11	0;17	3	1
…							
4 3	7 27	36;40	1	1	8;53	9	4
4 6	7 24	36;44	0	0	9;19	9	4
4 9	7 21	36;43	3	1	9;46	9	4
…							
5 6	6 24	28;15	46	21	13;30	0	0
5 9	6 21	25;56	53	25	13;37	6	2
5 12	6 18	23;17	62	29	13;19	13	6
…							
5 28	6 2	3; 1	90	42	2;29	74	35
6 0	6 0	0; 0	90	42	0; 0	74	35

Table 21: equation of anomaly for Jupiter (f. 7r)

(1)		(2)	(3)	(4)	(5)	(6)	(7)
s (°)	s (°)	(°)	min	min	min	sec	sec
0 6	11 24	0;57	9	8	0; 4	1	1
0 12	11 18	1;52	9	8	0; 8	1	1
…							
3 6	8 24	10;33	0	0	0;59	0	0
3 12	8 18	10;34	1	1	1; 1	0	0
3 18	8 12	10;29	2	2	1; 2	0	0
3 24	8 6	10;15	3	3	1; 3	0	0
4 0	8 0	9;54	5	4	1; 2	0	0

...							
5 24	6 6	1;21	13	12	0; 9	1	1
6 0	6 0	0; 0	13	12	0; 0	1	1

Table 24: equation of anomaly for Saturn (f. 7v)

(1)		(2)	(3)	(4)	(5)	(6)	(7)
s (°)	s (°)	(°)	min	min	min	sec	sec
0 6	11 24	0;34	5	5	0; 3	1	1
0 12	11 18	1; 7	5	5	0; 7	1	1
...							
2 24	9 6	5;46	1	1	0;41	0	0
3 0	9 0	5;53	0	0	0;42	0	0
3 6	8 24	5;53	0	0	0;44	0	0
3 12	8 18	5;51	1	1	0;46	0	0
...							
5 24	6 6	0;42	7	7	0; 7	1	1
6 0	6 0	0; 0	7	7	0; 0	1	1

Figure 4 displays Ptolemy's model for the three superior planets and Venus. O is the observer, D is the center of the deferent circle RAC, and E is the equant point, such that the eccentricity, $e = OD = DE$. A is the planet's apogee, and $\bar{\kappa}$ = angle AEC, the mean argument of center, is measured from it to the center of the epicycle about point E. Angle GCP is the mean argument of anomaly, $\bar{\alpha}$, and the planet is at point P. Angle HCG is the equation of center and it is also applied to correct the mean argument of anomaly to yield the true argument of anomaly, α = angle HCP. In the case of the superior planets, CP, the direction from the center of the epicycle to the planet, is always parallel to O $\bar{S}$, the direction from the observer to the mean Sun. In the case of Venus, EC is parallel to the direction from the observer to the mean Sun. The goal is to find the direction from the observer to the planet, i.e., angle ROP is the longitude of the planet, and R is in the direction to Aries 0°.

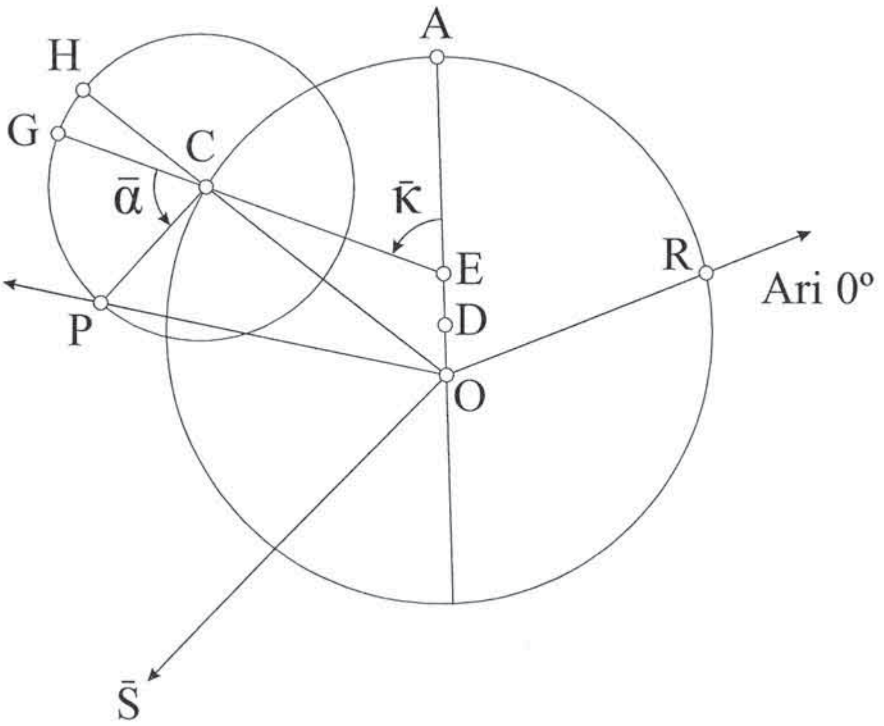

Fig. 4. Ptolemy's model for the three superior planets and Venus (not to scale)

The mean argument of center, $\bar{\kappa}$, is angle AEC, and the true argument of anomaly, α, is angle HCP. With these arguments, $\bar{\kappa}$ and α, we can determine the equation of anomaly, $c(\alpha)$, with Vimond's tables and compare the result with computations based on the Parisian Alfonsine Tables. According to our understanding of Vimond's procedure,

$$c(\alpha) = c_2(\alpha) + c_5(\bar{\kappa}) \cdot c_5(\alpha),$$

where c_i refers to the i-th column in the table. Note that $c_5(\bar{\kappa})$ is taken from the table for the equation of center (with the shifts), and $c_5(\alpha)$ is taken from the table for the equation of anomaly. For instance, for Venus, when $\bar{\kappa} = 120°$ and $\alpha = 135°$

$$c(\alpha) = c_2(135°) + c_5(120°) \cdot c_5(135°)$$
$$c(\alpha) = 44;49° + 0;45 \cdot 2;25°$$
$$c(\alpha) = 46;38°.$$

With the same arguments for Venus in the Parisian Alfonsine Tables, we find

$$c(\alpha) = c_5(\alpha) + c_3(\bar{\kappa}) \cdot c_6(\alpha)$$
$$c(\alpha) = c_5(135°) + c_3(120°) \cdot c_6(135°)$$
$$c(\alpha) = 45;59° + 0;31 \cdot 1;15°$$
$$c(\alpha) = 46;38°$$

and this is exactly what resulted from Vimond's tables. In the tables for the planetary equations in *Almagest* XI.11 and its derivatives in al-Battānī and in the Parisian Alfonsine Tables (among others), the rules for computing the equation of anomaly require careful attention to algebraic signs. Vimond simplified the rules for this computation, making his tables more "user-friendly". A similar procedure is described by Copernicus for using his planetary tables in *De revolutionibus*, V.23, to compute the equation of anomaly (Copernicus 1543, ff. 173v–179r; cf. Swerdlow and Neugebauer 1984, p. 453).

Tables 13 (Mercury, f. 5r), 16 (Venus, f. 6r), 19 (Mars, f. 6v), 22 (Jupiter, f. 7r), and 25 (Saturn, f. 7v): planetary latitudes

The tables for the planetary latitudes, both for the superior and the inferior planets, are in the style of *Almagest* XIII.5, the zij of al-Battānī (Nallino 1903–1907, 2:140–141), and some tables associated with the Toledan Tables (Toomer 1968, pp. 71–72; F. S. Pedersen 2002, pp. 1322–1326), as opposed to those in the *Handy Tables* and those in the zij of al-Khwārizmī.

The table for the planetary latitudes of Mercury has seven columns; the table for Venus lacks the seventh; and the tables for the superior planets have only five columns (i.e., cols. 1, 3, 4, 5, and 6).

Table 13: latitude of Mercury (f. 5r)

(1)		(2)	(3)	(4)	(5)	(6)	(7)
s	(°)	min	min	min*	min	min*	sec
0	12	13	57	1;44	17	0;12	1
0	24	4	60	1;40	5	0;44	4
1	6	5	60	1;39	7	1; 6	7
1	18	14	57	1;16	19	1;26	9
2	0	23	51	0;59	31	1;44	10
2	12	31	44	0;38	41	2; 0	12
2	24	37	34	0;16	49	2;14	13
3	6	41	23	0;15	55	2;25	14
3	18	44	11	0;48	59	2;29	15
4	0	45	0	1;25	60	2;29	15
4	12	43	13	2; 6	58	2;20	14
4	24	40	25	2;47	54	2; 0	13
5	6	36	36	3;26	48	1;29	9
5	18	29	45	3;54	39	0;48	5
6	0	22	52	4; 5	29	0; 0	0
6	12	13	57	3;54	17	0;48	5
6	24	4	60	3;26	5	1;29	9
7	6	5	60	2;47	7	2; 0	12
7	18	14	52	2; 6	19	2;20	14
8	0	23	51	1;25	31	2;29	15
8	12	31	44	0;48	41	2;29	15
8	24	37	34	0;15	49	2;25	14
9	6	41	23	0;16	55	2;10	13
9	18	44	11	0;38	59	2; 0	12
10	0	45	1	0;59	60	1;44	10
10	12	43	13	1;16	58	1;26	9
10	24	40	25	1;30	54	1; 6	7
11	6	36	36	1;40	48	0;44	4
11	18	29	45	1;44	39	0;12	1
12	0	22	52	1;46	29	0; 0	0

* Despite the headings, these columns display degrees and minutes.

Table 16: latitude of Venus (f. 6r)

(1) s (°)	(2) min	(3) min	(4) min*	(5) min	(6) min*
0 12	10	12	1; 1	59	0;16
0 24	9	24	0;59	55	0;33
1 6	8	35	0;55	48	0;49
1 18	7	44	0;46	40	1; 5
2 0	5	52	0;35	30	1;20
2 12	3	57	0;29	18	1;35
2 24	1	60	0;18	6	1;50
3 6	1	60	0;10	6	2; 3
3 18	3	52	0;32	18	2;15
4 0	5	44	0;59	30	2;25
4 12	7	35	1;38	40	2;30
4 24	8	24	2;23	48	2;28
5 6	9	12	3;44	55	2;12
5 18	10	0	5;13	59	1;27
6 0	10	12	7;12	60	0; 0
6 12	10	24	5;13	59	1;12
6 24	9	35	3;44	55	2;28
7 6	8	44	2;23	48	2;30
7 18	7	52	1;38	40	2;25
8 0	5	57	0;59	30	2;15
8 12	3	60	0;32	18	2; 3
8 24	1	60	0;10	6	1;50
9 6	1	57	0;19	6	1;35
9 18	3	52	0;29	18	1;20
10 0	5	44	0;35	30	1; 5
10 12	7	44	0;46	40	0; 5 **
10 24	8	35	0;55	48	0;49
11 6	9	24	0;59	55	0;33
11 18	10	12	1; 1	59	0;16
12 0	10	0	1; 3	60	0; 0

---

* Despite the headings, these columns display degrees and minutes.

** *Sic.*

In all cases column 1 displays the argument (*argumentum*) at 12°-intervals from 0s 12° to 12s 0°. Column 2 is only found in the tables for the inferior planets and the entries are given in minutes. The heading is *radix meridionalis* in the case of Mercury and *radix septentrionalis* in that for Venus. This column is for determining the deviation, otherwise called the third component of latitude, that is, the inclination of the plane of the deferent with respect to the ecliptic. The entries for deviation can be derived from:

$\beta_3 = -0;45 \cdot c_5$ for Mercury
$\beta_3 = +0;10 \cdot c_5$ for Venus

where c_5 is the column for the minutes of proportion in the table for planetary latitude in *Almagest* XIII.5 (given there in minutes and seconds). As will be seen, column 5 for Venus in Table 16, given only to minutes, corresponds to c_5 in *Almagest* XIII.5. It is noteworthy that column 2 for Mercury is shifted downwards about 119° whereas there is no shift in the case of Venus. This is exactly the same feature we noticed in the tables for the equation of center and the amount of the shift is the same. The column for deviation is certainly not a common feature in medieval tables (for a survey of the few that have them, see Goldstein and Chabás 2004), and Vimond's is the earliest set of tables in the West we know to display such columns.

For the inferior planets, columns 3 and 5 (*diametri*) give the minutes of proportion for the inclination and the slant, respectively. We note that columns 3 and 5 for Mercury also exhibit a shift of less than 120°, and that no shifts appear in the case of Venus. We also note that column 5 for Venus lists the rounded values in the column for the sixtieths found in the corresponding table in the *Almagest* XIII.5, the zij of al-Battānī, etc.

For the superior planets, columns 3 and 5 give the minutes of proportion for the northern and southern latitudes, respectively, of the planets. Only half of the columns are filled with numbers, the others have capital letters indicating "North" [S] and "South" [M]. Column 3 is shifted about 45° (Mars), about 100° (Jupiter), and about 110° (Saturn) in relation to the corresponding columns in the *Almagest*, whereas the shifts for column 5 are increased by 180° in each case. These shifts are totally consistent with those found for the equation of center (about 44°, 82°, and 162° for Mars, Jupiter, and Saturn, respectively). Indeed, subtracting these numbers for each planet, we find 0° (Mars), about –20° (Jupiter), and +50° (Saturn), in perfect agreement with the differences given by Ptolemy in *Almagest* XIII.6 between the northern limits on the deferent and the apogees of each superior planet, respectively. Thus, it is quite clear that the compiler of Vimond's tables, whether Vimond or not, had a good understanding of this difficult issue as it is presented in the *Almagest*.

Table 19: latitude of Mars (f. 6v)

(1) s (°)	(3) min	(4) min *	(5) min	(6) min *
0 12	50	0; 9	M	0; 4
0 24	55	0;13	M	0; 6
1 6	59	0;16	M	0; 9
1 18	59	0;21	M	0;15
...				
4 12	8	2; 1	M	2;10
4 24	S	2;34	10	2;56
...				
6 0	S	4;21	43	7;30
...				
10 12	S	0;21	2	0;15
10 24	10	0;16	[blank]	0; 9
11 6	22	0;13	M	0; 6
11 18	33	0; 9	M	0; 4
12 0	43	0; 6	M	0; 2

* Despite the headings, these columns display degrees and minutes.

Columns 4 and 6 display the inclination (*declinatio minuti diametri*) and the slant (*reflexio minuti diametri*) for the inferior planets, and the entries are given in degrees and minutes, despite the headings, which read "minutes and seconds". For the superior planets, these two columns display the northern and southern limits (both labeled *latitudo minuti diametri*) and are given in degrees and minutes.

Table 22: latitude of Jupiter (f. 7r)

(1) s (°)	(3) min	(4) min *	(5) min	(6) min *
0 12	10	1; 8	0	1; 6
0 24	12	1; 9	M	1; 7
...				
3 6	60	1;33	M	1;33
3 18	60	1;39	M	1;39
...				
6 0	12	2; 5	M	2; 8
6 12	0	2; 3	0	2; 6
6 24	S	2; 0	12	2; 3
...				
9 6	S	1;27	60	1;26
9 18	S	1;21	60	1;21
...				
11 18	S	1; 8	34	1; 6
12 0	S	1; 6	12	1; 5

* Despite the headings, these columns display degrees and minutes.

The extremal values of columns 4 and 6 in the text are shown below:

Mercury	4; 5° (for 6s 0°)	2;29° (for 3s 18°–4s 0° and 8s 0°–8s 12°)
Venus	7;12° (for 6s 0°)	2;30° (for 4s 12° and 7s 6°)
Mars	4;21° (for 6s 0°)	7;30° (for 6s 0°)
Jupiter	2; 5° (for 6s 0°)	2; 8° (for 6s 0°)
Saturn	3; 2° (for 6s 0°)	3; 5° (for 6s 0°)

Table 25: latitude of Saturn (f. 7v)

(1) s (°)	(3) min	(4) min *	(5) min	(6) min *
0 12	[blank]	2; 5	9	2; 3
0 24	2	2; 7	[blank]	2; 4
1 6	14	2;10	S	2; 7
…				
3 18	60	2;39	S	2;39
…				
5 18	33	3; 1	S	3; 3
6 0	22	3; 2	S	3; 5
6 12	10	3; 1	S	3; 3
6 24	N	2;59	2	3; 0
…				
9 18	N	2;21	60	2;21
…				
11 18	N	2; 5	33	2; 3
12 0	N	2; 3	22	2; 2

* Despite the headings, these columns display degrees and minutes.

These extremal values in Vimond's tables agree with those in the Toledan Tables with two exceptions, one of which is a trivial variant for Mercury. But, as far as we know, the maximum value for the inclination of Venus in Vimond's table is not attested in any other previous text. It is probably significant that this value later appeared in the *editio princeps* of the Alfonsine Tables (1483), as indicated in Table 13A.

Table 13A: extremal planetary latitudes

	Almagest	al-Battānī	Toledan T.	Vimond	Paris. Alf. T.
Mercury	4; 5°	4; 5°	4; 5°	4; 5°	4; 5°
	–2;30°	–2;30°	–2;30°	–2;29°	–2;30°
Venus	6;22°	6;22°	7;24°	7;12°	7;12°
	–2;30°	–2;30°	–2;30°	–2;30°	–2;30°
Mars	4;21°	4;21°	4;21°	4;21°	4;21°
	–7; 7°	–7; 7°	–7;30°	–7;30°	–7;30°
Jupiter	2; 4°	2; 4°	2; 5°	2; 5°	2; 8°
	–2; 8°	–2; 8°	–2; 8°	–2; 8°	–2; 8°
Saturn	3; 2°	3; 2°	3; 2°	3; 2°	3; 3°
	–3; 5°	–3; 5°	–3; 5°	–3; 5°	–3; 5°

For the inferior planets, between columns 2 and 3 and between columns 5 and 6 we are also given some indications ("North" and "South") to help the user.

Column 7 appears only in Table 13 (Mercury), and it seems to be outside the general framework of the table. Its entries are given in seconds and result from dividing the corresponding entries in column 6 by 10. This probably corresponds to the instructions given by Ptolemy in *Almagest* XIII.6: to compute the true minutes of proportion for the slant, add 1/10 when the argument lies between 90° and 270°, or subtract 1/10 when the argument lies between 0° and 90° or 270° and 360°. Whether tabulated or not, these instructions are rarely found in the medieval Latin literature on the planets (Goldstein and Chabás 2004).

f. 7v Table 26: yearly radices

This table displays the radices for the mean motion (*motus*) and argument (*argumentum*) of the fixed stars for intervals of 76, 152, 304, 608, 1216, and 2432 years. Vimond does not give a radix for a specific year but perhaps this information was in the canons that we have not found. As we shall argue (see Table 27, below), it is likely that the epoch of this table was also 1320 or a date close to it, that is, the epoch is consistent with our dating of the other radices.

Table 26: yearly radices (f. 7v)

	s	(°)		s	(°)
years		76	years		608
mean motion	0	0;33,32	mean motion	0	4;28, 3
argument	0	3;54,46	argument	1	1;16,21
years		152	years		1216
mean motion	0	1; 7, 2	mean motion	0	8;56, 4
argument	0	7;49,16	argument	2	2;32,27
years		304	years		2432
mean motion	0	2;14, 3	mean motion	0	17;52, 5
argument	0	15;38,18	argument	4	5; 4,38

In 76 years the value in the text for the mean motion of the fixed stars is 0;33,32° and in 2432 years it is 17;52,5°, corresponding to 0;0,0,4,20,56°/d and 0;0,0,4,20,42°/d, respectively. These values are equivalent to 48,954 years and 48,999 years, respectively, to complete one revolution, or 1° in about 136 years, as in the linear term in the standard Alfonsine model for trepidation which is based on one revolution in exactly 49,000 years. These differences in the periods depend on the seconds in the entries in Vimond's table and have no astronomical significance. However, they indicate that Vimond is not using the standard table for mean motion of the apogees and the fixed stars in the Parisian Alfonsine Tables (Ratdolt 1483, f. d4v).

In 76 years the value in the text for the mean motion of the argument for the fixed stars is 3;54,46° and in 2432 years it is 4s 5;4,38°, corresponding to 0;0,0,30,26,47°/d and 0;0,0,30,24,52°/d, respectively. These values are equivalent to 6,992 years and 7,000 years, respectively, to complete one revolution. The periodic term in the standard Alfonsine model for trepidation is based on one revolution in exactly 7,000 years, and it corresponds to 0;0,0,30,24,49°/d. These differences have no astronomical significance, but indicate that, once again, Vimond is not using the standard table for mean motion of access and recess in the Parisian Alfonsine Tables (Ratdolt 1483, f. d4r).

In fact, an entry for the mean motion of the argument is 7 times the corresponding entry for the mean motion of the linear term.

As in the Parisian Alfonsine Tables, Vimond separates two terms for trepidation: a linear term which corresponds to the difference between the calendar year of 365;15 days and a fixed tropical year, and a periodic term which corresponds to the difference between a variable sidereal year and the calendar year of 365;15 days. But in his other tables Vimond has used a fixed sidereal year: we are unable to account for this inconsistency. To be sure, Vimond's canons may have explained what he intended.

f. 7v Table 27: motion of the fixed stars

The argument is given at 6°-intervals from 0s 6° to 12s 0° and the equation of access and recess (here called *motus*) is given in degrees and rounded to minutes. In Table 27, below, the editors have supplied a minus sign in a few entries, where appropriate. The table has a maximum of 17;17° for argument 204° and a minimum of –0;43° for argument 24°. These extremal values are 18° apart (= 17;17° + 0;43°); hence the amplitude of the sinusoidal curve corresponding to Vimond's table is 9°. This is indeed the characteristic parameter of the table for the equation of access and recess in the Parisian Alfonsine Tables, whose maximum is 9° for argument 90°.

Comparison of the entries in both tables shows that the curve representing Vimond's table is the same as that used by other Parisian astronomers of his time but shifted in two ways: 247° on the x-axis and –8;17° on the y-axis. In fact, the entries in Vimond's table can be derived from those in the Parisian Alfonsine Tables by taking an argument and its corresponding equation in the latter (where they are given to seconds) and then adding 113° to the argument and 8;17° to the equation.

Table 27: motion of the fixed stars (f. 7v)

argumentum (°)		*motus* (°)
0	6	–0;19
0	12	–0;33
0	18	–0;41
0	24	–0;43
1	0	–0;39
1	6	–0;29
1	12	–0;13
1	18	0; 8
1	24	0;35
2	0	1; 6
2	6	1;43
2	12	2;24
2	18	3; 8
2	24	3;56
3	0	4;47
3	6	5;40
3	12	6;35
3	18	7;30
3	24	8;26
4	0	9;22
4	6	10;18
4	12	11;12
4	18	12; 4
4	24	12;54
5	0	13;41
5	6	14;24
5	12	15; 4
5	18	15;39
5	24	16;15
6	0	16;34

argumentum (°)		*motus* (°)
6	6	16;53
6	12	17; 7
6	18	17;15
6	24	17;17
7	0	17;13
7	6	17; 3
7	12	16;47
7	18	16;26
7	14	15;59
8	0	15;28
8	6	14;51
8	12	14;10
8	18	13;26
8	24	12;38
9	0	11;47
9	6	10;54
9	12	9;58
9	18	9; 4
9	24	8; 8
10	0	7;11
10	6	6;16
10	12	5;22
10	18	4;30
11	24	3;40
12	0	2;53
11	6	2;10
11	12	1;30
11	18	0;55
11	24	0;19
12	0	0; 0

Vimond's table begins at a point that in the Parisian Alfonsine Tables corresponds to a value of the equation of –8;17° and an argument of about 247°. The value for the equation of access and recess that Vimond thought correct for his time was 8;17°, and he shifted the curve (i.e., the entries in the table) accordingly; indeed, calculation of the periodic term in trepidation with the parameters for 1320 in the Parisian Alfonsine Tables yields 8;17° exactly:

1320 · 0;3,5,8,34,17°/y ≈	67;53°
radix Incarnation	359;13
Total	67; 6

and

9° sin 67;6° = 8;17°.

Note that 67;6° + 180° = 247;6° or about 247°, and 360° – 247° = 113° which is the phase angle of the shift introduced by Vimond.

This table establishes a strong connection between Vimond and the Parisian Alfonsine Tables, for this theory of trepidation is not found in any previous text. But again, since the mean motions are different (see Table 26), we see no reason to assume that Vimond based his theory on the Parisian Alfonsine Tables. Rather, Vimond may have depended on an Andalusian or Castilian tradition that was closely related to (but distinct from) the Castilian Alfonsine Tables, for there is no hint of phase shifts in the Castilian canons.

f. 8r–v Table 28: fixed stars

This table displays the longitude, the latitude, and the magnitude of 225 stars and nebulae but, in general, their names are omitted. The list is too long to be related to an astronomical instrument, and the absence of star names makes us wonder what purpose it was intended to serve. Both coordinates are given to minutes. The stars are divided into three groups, in turn divided into several subgroups according to the associated planets, a feature which is certainly not common. Group I has 137 stars that belong to the zodiacal constellations arranged in 52 subgroups, group II has 44 stars in northern constellations (19 subgroups), and group III has 44 stars in southern constellations (19 subgroups); the total number of subgroups is thus 90. We note the balanced representation of the stars on both sides of the zodiac.

We have found the same table in an early 14th-century copy: Cambridge, Gonville and Caius College, MS 141/191, pp. 377–382 (for an excerpt, see F. S. Pedersen 2002, pp. 1507–1508). There are some cases where an entry in one copy does not agree with the value in, or derived from, Ptolemy's treatises in contrast to the other copy, but there are also examples where entries in both copies do not agree with those in Ptolemy. On the other hand, in all cases where there is a blank entry in one copy, it is filled in the other copy.

In the Paris copy only 18 star names are given whereas in the Cambridge copy this number is reduced to 15. The star names in these copies are generally not identical, and they are not always ascribed to the same stars. For instance, the names "almalak" and "almalac" are attributed, respectively, to the star in the 20th subgroup (MS Paris) and to the first star of the 8th subgroup (MS Cambridge). The star list does not bear a general title in the Paris copy but the Cambridge copy reads *tabula de dispositionibus stellarum fixarum existentibus ad terminum complementi radicis mediarum coniunctionum solis et lunae quae alibi signantur. Et primo de dispositionibus illarum stellarum quae sunt prope viam solis.* (Here begins the table on the groups of the fixed stars as they were at the point of completion [the epoch?] of the radix of the mean conjunctions of the Sun and the Moon specified elsewhere. First come the groups of those stars close to the zodiac [lit.: the path of the Sun].)

The first sentence serves as a general title for the table, and the second sentence is a heading for the groups in the zodiacal constellations, corresponding to the headings in both manuscripts for the groups in the northern and southern constellations. The expression "the radix of the mean conjunctions" seems to refer to the radix given on f. 1r, "13;54,54d", which we identified with March 10, 1320. But we do not understand the expression "at the end of the complement".

Madrid, Biblioteca Nacional, MS 4238, ff. 65v–66v, reproduces the same star list except that the signs used here are of 60°, contrary to the other manuscripts containing this list.

We are grateful to Paul Kunitzsch for information on two additional copies of the same star list: Erfurt, Universitätsbibliothek, MS Amplon. 2°395, ff. 104v–105v; and Munich, Bayerische Staatsbibliothek, MS Clm 26667, ff. 46v–47v (cf. Kunitzsch 1986a, p. 96, n. 10, and p. 98, n. 44). In both manuscripts the list is anonymous, but in the Erfurt copy a marginal note (in the same hand as the list) reads: *Notandum istas stellarum tabulas fuisse equatas ad annum domini 1338* (f. 105v). As Kunitzsch suggested to us (in a private communication), this marginal note may have been added by the copyist and not belong to the original list; no date appears in the other three manuscripts.

In fact, the list in the Erfurt MS has two extra stars: one is added to the northern constellations, in subgroup 7 (Bootes), and the other to the southern constellations, in subgroup 6 (Eridanus). We also note that in the list for the southern constellations the stars in subgroup 19 (Ara) are located in the Erfurt MS between subgroups 4 and 5 in the manuscripts in Paris and Cambridge (we have not seen the manuscript in Munich). Another special feature of the Erfurt MS is that the subgroups are not numbered; rather, most are given the name of a star belonging to them or even a generic name. But its main distinguishing characteristic is that the subgroups have no associated planets, in contrast to the copies in Paris and Cambridge.

It may be of interest that the 5 manuscripts of which we are aware that contain this star list are spread all over Europe: 2 in Germany, 1 each in England, France, and Spain.

The order and the grouping of the stars in this list is peculiar, for they do not follow the pattern of the catalogue in Ptolemy's *Almagest* that was generally adopted in medieval star lists and catalogues. Rather, this list is organized according to Ptolemy's *Tetrabiblos*, a handbook on astrology written by Ptolemy after the *Almagest.* It was translated several times from Arabic into Latin: in 1138 by Plato of Tivoli, in 1206 anonymously, and in 1256 via Castilian at the court of Alfonso X by Egidius de Tebaldis (Chabás and Goldstein 2003a, p. 232), and was known as the *Quadripartitum*. In *Tetrabiblos* I.9, Ptolemy grouped the stars into three main categories (zodiacal, northern, and southern constellations), following an order differing from that in the *Almagest* where the northern constellations precede the zodiacal constellations, and grouped the stars within each category according to their associated planets. As an example, we reproduce a passage of *Tetrabiblos* I.9 corresponding to the stars in the constellation of Aries (Robbins 1940, p. 47):

> The stars in the head of Aries, then, have an effect like the power of Mars and Saturn, mingled; those in the mouth like Mercury's power and moderately like Saturn's; those in the hind foot like that of Mars, and those in the tail like that of Venus.

As is readily seen, the order, the subgroups, and the planets associated with the stars in Aries in Vimond's list perfectly match those in Ptolemy's *Tetrabiblos*. And this is indeed the case for almost all stars in the 90 subgroups displayed in Vimond's list.

The star positions generally agree with those in Gerard of Cremona's version of Ptolemy's star catalogue in the *Almagest* with an increment in longitude of 17;52° for precession, a value otherwise unattested. If the rate of precession was taken to be 1° in 66 years, 17;52° would correspond to about 1179 years and, if we add it to 137 A.D. (the date of the star catalogue in the *Almagest*), we get 1316 A.D. But it is not clear that this date had any significance for the author. We have compared this list to that in the *Libro de las estrellas de la ochaua espera* (Madrid, Universidad Complutense, MS 156; see also Rico Sinobas 1863–1867, vol. 1, pp. 5–145), also known as *Libro de las XLVIII figuras de la VIII spera* or even as *Libro de las estrellas fixas*. This is an adaptation of the star catalogue for 964 AD by the Persian astronomer al-Ṣūfī (903–986) which in turn depended on the star catalogue in Ptolemy's *Almagest* (see Comes 1990). This work, where the total precession is 17;8°, was compiled in 1256 by Judah ben Moses ha-Cohen, one of most distinguished collaborators of Alfonso X. The presentation of the star data in this Alfonsine text differs substantially from that of a typical star list although the data themselves are what one would expect, namely, for each star we are given its name, longitude, latitude, and magnitude. The associated planets are also given for each star, often adding an indication of their relative strength, showing that the Alfonsine *Libro* ultimately relied on Ptolemy's *Quadripartitum*. However, after comparing the data in the *Libro* with those of Vimond, we see no evidence to suggest that the star list found among Vimond's tables is systematically related to this Alfonsine book. As Kunitzsch informed us, there is a star list by John of Lignères containing data for 276 stars, but the longitudes are Alfonsine, i.e., Ptolemy's values plus 17;8°: Bibliothèque nationale de France, MS lat. 10264, ff. 36v–38v, and Florence, Biblioteca Nazionale Centrale, MS Conv. soppr. J.4.20, fols. 214v–216r. This list was extracted from the star table that later appeared in the *editio princeps* of the Alfonsine Tables (1483), and sheds no additional light on the list included in Vimond's tables.

Moreover, in the course of examining the star names in the four manuscripts containing this list, Kunitzsch noticed that the author drew upon a variety of Latin sources, mainly the translations of the *Tetrabiblos* but also sources not in the *Tetrabiblos* tradition (some of which cannot be identified). Thus, Vimond's list is dependent on Ptolemy in two ways: the choice of the stars, their order and grouping, as well as the associated planets, are borrowed from the *Quadripartitum*; and the numerical data are taken from the Latin version of the *Almagest*.

In sum, we believe that the star list attributed to Vimond in the Paris MS, and that is anonymous in the Cambridge, Erfurt, Madrid, and Munich MSS, derives from an unknown archetype; we know of no similar star list in Latin in the 14th century or in the previous Arabic literature with which to compare it.

In Table 28 we present in the first 3 columns a complete transcription of the Paris copy with translations of the headings and the names of the associated planets in each case. For the latitudes "north" is indicated by an abbreviation of the term *septentrionalis*, and "south" by an abbreviation of *meridionalis*; we have replaced them with the modern designations + and –. Column IV gives the few star names found in the Paris copy, which were added in interstitial spaces within the table (some of the star names are partly hidden in the gutter of the manuscript and cannot be read completely); column V lists the modern star designation; column VI gives the standard number assigned to each of the 1028 stars in Ptolemy's catalogue; column VII offers comparisons and comments, together with variants in the Cambridge copy; and column VIII provides the identification of the star names.

Table 28: star list (f. 8r–v)

[Constellation]			Associated planets						
	I		II	III	IV	V	VI	VII	VIII
	Longitude		Latitude	Magn.	Name	Modern designation	Number (P.-K.)	Comparisons and comments	Identification of Star names
	(sign)	(degrees)	(degrees)						

[Zodiacal constellations]

1 [Aries]			Mars, Saturn						
	0	24;32	+ 7;20	3		γ Ari	362		
	0	25;32	+ 8;20	3		β Ari	363		
2 [Aries]			Mercury, Saturn						
	0	28;52	+ 7;40	5		η Ari	364	C(III): blank C(IV): flamai?	Unidentified
	0	29;22	+ 6; 0	5		θ Ari	365	C(III: blank C(IV): hercules	Unidentified: see β Gem, below
3 [Aries]			Mars						
	1	2;52	– 5; 5	4		μ Cet	374	C: +5;15, G: –5;15	
	1	5;52	– 1;30	5		σ Ari	373	C: +1;30	
	1	7;32	– 1;20	5		ɔ Ari	372	C: +1;20 G: –1;10, +1;10	

4 [Aries]			Venus						
	1	9;12	+ 4;50	5		ε Ari	368		
	1	11;42	+ 1;40	4		δ Ari	369		
	1	13;12	+ 2;30	4		ζ Ari	370		
	1	14;52	+ 1;50	4		τ Ari	371		
5 [Taurus]			Venus, Jupiter					C: Moon	
	1	17;32	– 9;30	5		30(e) Tau	384		
	1	21;32	– 8; 0	3		λ Tau	385	C: +8; 0	
6 [Taurus, The Pleiades]			Moon, Mars						
	1	20; 2	+ 4;30	5		19 Tau	409		
	1	20;22	+ 4;40	5		23 Tau	410		
	1	20;32	+ 5; 5	5		27 Tau*	412		
	1	21;32	+ 5;20	5		BSC 1188*	411		
7 [Taurus]			Mars						
	2	0;32	– 5;10	1	aldebaran?	α Tau	393	C(IV): aldebaran	G, p. 89 n. 10, etc.
8 [Taurus]			Saturn, Mercury						
	1	26;52	– 5;45	3		γ Tau	390	C(IV): almalac	If this is a corruption of Arabic *al-malik* (the king), it should designate α Leo (Regulus). See G, p. 101 n. 12.

	1	28;42	– 5;50	3		θ^{1} Tau	392	C: +5;50 G: –5;50, –0;50	
	1	29;42	– 3; 0	3		ε Tau	394	C: +3; 0	
	2	3;32	– 4; 0	4		τ Tau	399	C: +4; 0 G: –4; 0, +4; 0	
9 [Taurus]			Mars						
	2	7;52	– 3;30	5		106(l) Tau	397		
	2	8;12	– 5; 0	5		104(m) Tau	396	C: +5; 0	
	2	13;32	+ 5; 0	5		β Tau	230/400	G: 3	
	2	15; 2	– 2;30	3		ζ Tau	398	G + 17;52: 15; 2, 15;32	
10 [Gemini]			Mercury, Venus						
	2	24;22	– 1;30	4		η Gem	437	C: +1;30	
	2	26; 2	– 1;15	4		μ Gem	438	C: +1;15	
	2	28; 2	– 3;30	4		ν Gem	439	C: +3;30	
	2	29;52	– 7;30	3		γ Gem	440	C: +7;30	
	3	2;32	–10;30	4		ξ Gem	441	C: +10;30	
11 [Gemini]			Saturn						
	3	9;32	– 5;30	3		δ Gem	435		
12 [Gemini]			Mars						
	3	11;12	+ 9;40	2	( )annai?	α Gem	424		

13 [Gemini]			Mars						
	3	14;32	[..]6;15	[..]	hercules?	β Gem	425	C(II): +6;15. C(III): 2 C(IV): almueredan	R, p. 48: Herakles K1959, p. 127: ε Vir is called almuredin
14 [Cancer]			Mercury, Mars						
	3	20;32	+ 1; 0	5		μ Cnc	456		
	3	25; 2	– 7;30	4		β Cnc	457		
15 [Cancer]			Saturn, Mercury						
	3	26;12	+11;50	4		ι Cnc	455		
	4	4;22	+ 5;30	4		α Cnc	454	G: –5;30	
16 [Cancer]			Moon, Mars						
	3	28;12	+ 0;40	n	meollef?	GC 2632 Galaxy M 44	449	C: 2. C(IV): mellef?	P, f. 15va: meelef
17 [Cancer]			Mars, Sun						
	3	28;12	+ 2;40	4	assinis?	γ Cnc	452	C(IV): asini	G
	3	29;12	+ 0;10	4		δ Cnc	453	G: –0;10	
18 [Leo]			Saturn, Mars						
	4	12; 2	+ 9;30	3		ε Leo	465		
	4	12; 2	+12; 0	3		μ Leo	464	G + 17;52: 12;12	
19 [Leo]			Saturn, Mars					C: Mercury	
	4	18; 2	+11; 0	3		ζ Leo	466		

	4	18;32	+ 4;30	3		η Leo	468		
	4	20; 2	+ 7;30	2		γ Leo	467	G: +8;30	
20 [Leo]			Mars, Jupiter						
	4	20;22	+ 0;10	1	almalak?	α Leo	469		G, p. 101 n. 12.
21 [Leo]			Venus, Saturn						
	4	29;12	+13;15	5		60(b) Leo	480	C, G: +12;15	
	5	2; 2	+13;40	2		δ Leo	481		
	5	2;12	+11;30	5		81 Leo*	482		
	5	4;12	+9;40	3		θ Leo	483		
	5	12;22	+12;50	1	??	β Leo	488	G: +11;50	
22 [Leo]			Venus, Mercury						
	5	8;12	+ 5;50	3		ι Leo	484		
	5	8;22	– 3; 0	5		υ Leo	487		
	5	9;32	+ 0;50	4		τ Leo	486		
	5	9;32	+ 1;15	4		σ Leo	485		
23 [Virgo]			Mercury, Mars						
	5	14;12	+ 4;35	5		ν Vir	497		
	5	14;52	+ 5;40	5		ξ Vir	498		
	5	17; 2	+ 6; 0	3		β Vir	501	G.+ 17;52: 16;52	

	5	18; 2	+ 5;30	5		π Vir	500		
24 [Virgo]			Mercury, Venus						
	5	26; 7	+ 1;10	3		η Vir	502		
	6	1; 2	+ 2;50	3		γ Vir	503		
25 [Virgo]			Saturn, Mercury						
	6	0; 2	+15;10	3		ε Vir	509		
26 [Virgo]			Venus, Mercury						
	6	14;32	– 2; 0	1	almure?	α Vir	510	C(IV): alcimech	G: ascimech
27 [Virgo]			Mercury, Mars						
	6	24;32	+ 7;30	4		ι Vir	518		
	6	25;12	+ 2;40	4		κ Vir	519		
	6	7;52	+ 0;30	4		λ Vir	521	C, G + 17;52: 27;52	
	7	0;32	+ 9;50	4		μ Vir	522		
28 [Libra]			Jupiter, Mercury						
	7	5;52	+ 0;40	2		α Lib	529		
	7	10; 2	+ 8;30	2		β Lib	531		
29 [Libra]			Saturn, Mercury						
	7	9;12	[..]1;15	[..]		ν Lib	534	C(II): +1;15. C(III): 4	
	7	11;52	[..]1;40	[..]		ι Lib	533	C(II): +2;40. C(III): 4	

	7	15;22	[..]3;45	[..]		γ Lib	535	C(II): +3;45. C(III): 4	
	7	20;52	[..]4;30	[..]		θ Lib	536	C(II): +4;30. C(III): 4	
30 [Scorpius]			Mars, Saturn						
	7	23;32	– 1;40	3		δ Sco	547		
	7	23;32	– 5; 0	3		π Sco	548	C: +5; 0	
	7	24;12	+ 1;20	3		β Sco	546		
31 [Scorpius]			Mars, Jupiter						
	8	0;29	– 4; 0	2		α Sco	553	G + 17;52: 0;32	
32 [Scorpius]			Saturn, Venus						
	8	5;52	–15; 0	4		$\mu^1 + \mu^2$ Sco	558	G + 17;52: 6;42	
	8	11; 2	–19;30	3		η Sco	561	C: +19;30	
	8	16; 2	–18;50	3		θ Sco	562	C: +18;50	
	8	15;52	–15;10	3		κ Sco	564	G + 17;52: 16;52 C(II): +16;10	
	8	18;22	–16;40	3		ι^1 Sco	563	C: +16;40	
33 [Scorpius]			Mercury, Mars, Moon					C: [blank]	
	8	15;52	–23;30	4		υ Sco	566	C, G + 17;52: 14;52 C, G: –13;30	
	8	14;22	–13;20	3		λ Sco	565	C, G + 17;52: 15;22 C(II): +13;20	
34 [Scorpius]			Mars, Moon						

	8	19; 2	−13;15	n		G Sco* + CGlo 6441	567	C: 2	
35 [Sagittarius]			Saturn, Moon						
	8	22;22	− 6;30	3		γ Sgr	570		
	9	0;52	− 3;50	4		φ Sgr	576	C: +3;50	
36 [Sagittarius]			Jupiter, Mars						
	8	24;32	+ 2; 7	4		μ Sgr	574		
	8	26;52	− 1;30	3		λ Sgr	573		
37 [Sagittarius]			Mercury, Jupiter, Sun, Mars					C: Moon	
	9	3; 2	− 7;45	n		$\nu^1 + \nu^2$ Sgr	577	G: −0;45. C(IV): 2	
38 [Sagittarius]			Jupiter, Mercury						
	9	4;12	− 6;45	3		ζ Sgr	591		
	9	5;32	− 2;30	4		τ Sgr	590	C: +2;30, G: −4;30	
	9	7;52	− 2;30	5		ψ Sgr	589	C: +2;30	
39 [Sagittarius]			Jupiter, Saturn						
	9	4;52	−18; 0	2		α Sgr	593		

	9	5;32	–23; 0	2		$\beta^1 + \beta^2$ Sgr	592	C: +23; 0	
	9	14;32	–13; 0	3		η Sgr	594	G + 17;52: 24;32 C(II): +13; 0	
40 [Sagittarius]			Venus, Saturn						
	9	16;32	– 5;50	5		59(b) Sgr	599	C, G + 17;52: 16;22	
	9	16;32	– 4;50	5		60(A) Sgr	598	G + 17;52: 15;32 C(II): +4;50	
	9	16;42	– 4;50	5		ω Sgr	597	C: +4;50	
	9	17;32	– 6;30	5		62(c) Sgr	600	C: +6;30	
41 [Capricornus]			Mars, Venus						
	9	25;12	+ 2;20	3		$\alpha^1 + \alpha^2$ Cap	601		
	9	25;12	+ 5; 0	3		β Cap	603		
	9	26;42	+ 1;30	6		ρ Cap	607		
	9	26;52	+ 0;45	6		ο Cap	605		
42 [Capricornus]			Mars, Mercury						
	9	29;32	– 8;40	4		ω Cap	612		
	10	4;32	– 7;40	4		24(A) Cap	613	C: +7;40	
	10	8; 2	– 6;50	4		ζ Cap	614	C: +6;50	

	10	8;12	−6; 0	5		36(b) Cap	615	C: +6; 0	
43 [Capricornus]			Saturn, Mercury						
	10	12;42	+ 2;10	3		γ Cap	623	G: +2;10, −2;10	
	10	14;12	+ 2; 0	3		δ Cap	624	G: +2; 0, −2; 0	
	10	14;42	− 0;20	4		42(d) Cap	625	G: +0;20	
	10	15;32	− 2;50	5		λ Cap	627	C, G: +2;50	
44 [Aquarius]			Saturn, Mercury						
	10	2;32	+ 8;40	3		ε Aqr	636		
	10	4; 2	+ 8; 0	4		μ Aqr	635		
	10	14;22	+ 8;50	2		β Aqr	632		
	10	24;12	+11;15	4		α Aqr	630	G: +11;0. G: 3	
45 [Aquarius]			Mercury, Saturn						
	10	19;12	− 5; 0	4		τ Aqr	647	G + 17;52: 29;12	
	10	19;32	− 7;30	3		δ Aqr	646	G + 17;52: 29;32 C, G: +7;30	
	10	22;32	− 5;40	5		53(f) Aqr	648	C: +5;40	
46 [Aquarius]			Saturn, Jupiter						
	11	5;32	− 1; 0	4		83(h) Aqr	653		
	11	6;52	− 7;30	4		ψ^1 Aqr	656	C: +7;30, G: −8;30	
	11	7;52	− 0;30	4		φ Aqr	654	C: +7;30	

	11	8;12	− 1;40	4	a[n]phora	χ Aqr	655	C: +1;40	See note 1.
47 [Pisces]			Mercury, Saturn						
	11	9;32	+ 9;15	4		β Psc	674		
	11	12; 2	+ 7;30	4		γ Psc	675		
	11	13;52	+ 9;20	4		7(b) Psc	676		
48 [Pisces]			Jupiter, Mercury						
	11	13;52	+ 4;30	4		κ Psc	679		
	11	17;32	+ 2;30	4		λ Psc	680		
49 [Pisces]			Saturn, Mercury						
	11	23;52	+ 6;20	4		ω Psc	681		
	11	28;52	+ 5;45	6		41(d) Psc	682		
50 [Pisces]			Jupiter, Venus						
	0	17;12	+15;20	4		φ Psc	706	G + 17;52: 17;22	
	0	20; 2	+17; 0	4		υ Psc	705		
51 [Pisces]			Saturn, Jupiter						
	0	13;32	+14;20	4		ψ^1 Psc	702		
	0	14;12	+13; 0	4		ψ^2 Psc	703		
	0	15;32	+12; 0	4		χ Psc*	704		

52 [Pisces]			Mars, Mercury						
	0	20;22	– 8;30	3		α Psc	692		

[Title:] Then follow the constellations (*dispositio*) of the other fixed stars in the northern part.

[Northern constellations: all latitudes are positive]

1 [Ursa Minor]			Saturn, Venus						
	4	5; 2	72;50	2	aliedin	β UMi	6	C(IV): aliedim	See note 2.
	4	14; 2	74;50	2	alforcami	γ Umi	7	C(IV): alfoza	K1961, p. 58: al-farqadān (β+γ UMi)
2 [Ursa Maior]			Moon, Venus						
	5	0; 2	53;30	2		ε UMa	33	G: 13;30	
	5	5;52	55;40	2	benezna	ζ Uma	34	G: 15;40	K1966, p. 42, no. 23: benenaz (η UMa)
	5	17;42	54; 0	2		η UMa	35	G: 14; 0	
3 [Draco]			Saturn, Mars						
	5	26;22	84;50	3		ζ Dra	67		
	5	27;52	88; 0	3		η Dra	68	G: 78; 0	
4 [Cepheus]			Saturn, Jupiter						
	0	4;32	69; 0	3		α Cep	78		
	0	25;22	71;10	4		β Cep	77		

	11	27;12	72; 0	4		η Cep	79		
5 [Hercules]			Saturn, Mars						
	7	28; 2	53;30	4		ε Her	130	G: 13;30	
	7	29;42	54;10	3		ζ Her	129	G + 17;52: 21;42 G: 16;10	
	8	1;52	59;50	3		π Her	133	G: 19;50, 59;50	
	8	3;12	60;20	4		69(e) Her	134		
6 [Corona Borealis]			Venus, Mercury						
	6	29;32	46;10	4		β CrB	112		
	7	2;32	44;30	2	alfeca	α CrB	111	C(IV): alfeca	G
	7	5; 2	44;45	4		γ CrB	115		
	7	7; 2	44;50	4		δ CrB	116		
7 [Bootes]			Mercury						
	6	9;12	28; 0	3		η Boo	107		
8 [Lyra]			Venus, Mercury						
9 [Perseus]			Saturn, Jupiter						
	1	17;29	23; 0	2	eiumezuz?	β Per	202	G + 17;52: 17;32	Unidentified
10 [Perseus]			Mars, Mercury						
	1	22;42	30; 0	2		α Per	197		

11 [Auriga]			Mars, Mercury						
	2	12;52	22;30	1	alhaioch	α Aur	222	C(IV): alhaioch	G
12 [Ophiuchus]			Saturn, Venus						
	8	12;42	36; 0	3	alhanue	α Oph	234	C(IV): alhanue	K1966, p. 55, no. 33: alhaue, alhane
13 [Serpens]			Saturn, Mars						
	7	12;12	25;30	3		α Ser	271	G: 25;20	
	7	12;42	36;30	4		λ Ser	270	C, G: 26;30	
	7	14;12	24; 0	3		ε Ser	272		
	7	16;32	16;30	4		μ Ser	273		
14 [Sagitta]			Mars, Venus						
	9	24;32	39;10	6		ζ Sge	282		
	9	28; 2	39;20	4		γ Sge	281		
15 [Aquila]			Jupiter, Mars						
	9	21;42	29;10	2	vultur	α Aql	288	C: 19;10 C(IV): vultur	G
16 [Delphinus]			Saturn, Mars						
	10	6;22	32; 0	3		β Del	304		
	10	8; 2	33;50	3		α Del	305		
	10	9;12	32; 0	3		δ Del	306		

	10	11;22	32;10	3		γ Del	307	G: 33;10	
17 [Pegasus]			Mars, Mercury						
	0	15; 2	12;31	3		γ Peg	316	G + 17;52: 10; 2 G: 12;30. C, G: 2	
	11	20; 2	31; 0	2		β Peg	317		
18 [Andromeda]			Mars, Venus						
	0	13;32	15; 7	3		η And	345		
	0	19;42	30; 0	3		μ And	347		
	0	19;52	32;30	3		ν And	348		
	0	25;42	26;20	3		β And	346	G + 17;52: 21;42 C(II): +16;20	
	1	4;42	23; 0	3		γ And	349		
19 [Triangulum]			Mercury						
	0	28;52	16;30	3		α Tri	358		
	1	3;52	20;40	3		β Tri	359		

[Title:] Then follow the constellations (*dispositio*) of the other stars in the southern part.

[Southern constellations: all latitudes are negative]

1 [Piscis Austrinus]			Mars, Venus, Mercury						
	10	9;42	16;30	4		θ PsA	1020		

	10	16; 2	15; 0	4		η PsA	1019	C, G + 17;52: 13; 2	
	10	16;42	14; 0	4		λ PsA	1018	G: 14;40	
	10	18;32	20;20	4		β PsA	1012		
2 [Cetus]			Saturn						
	0	12;52	20; 0	2		ζ Cet	725		
3 [Orion]			Mars, Mercury						
	2	19;52	17; 0	1		α Ori	735		
4 [Orion]			Jupiter, Saturn						
	2	7;42	31;30	1		β Ori	768		
	2	13;12	24;10	2		δ Ori	759		
	2	15;12	24;50	2		ε Ori	760		
	2	16; 2	25;40	2		ζ Ori	761		
5 [Eridanus]			Jupiter						
	0	18; 2	53;30	1		θ Eri	805	C(I): 16; 2, G: 13;30	
6 [Eridanus]			[..]					C: Saturn	
	2	5;12	31;50	4		λ Eri	772	G + 17;52: 6;12	
7 [Lepus]			Saturn, Mars						
	2	12;42	44;20	3		β Lep	813		
	2	13;22	41;30	3		α Lep	812		

8 [Canis Maior]			Venus						
	2	13;52	57;40	2		α Col	845		
	2	16;52	59;40	2		β Col	844	C: 57;40	
9 [Canis Maior]			Jupiter, Mars						
	3	5;32	39;10	1		α CMa	818		
	3	7;32	35; 0	4		θ CMa	819		
10 [Canis Minor]			Mercury, Mars						
	3	13;22	14; 0	4		β CMi	847	G + 17;52: 12;52	
	3	17; 2	16;10	1		α CMi	848		
11 [Hydra]			Saturn, Jupiter						
	4	17;52	20;30	2		α Hya	905		
	4	23;52	26;30	4		κ Hya	906		
	4	26;32	26; 0	4		υ^1 Hya	907		
12 [Crater]			Venus, Mercury						
	5	17;52	18; 0	4		δ Crt	923		
	5	17;52	18;30	4		ζ Crt	924	G + 17;52: 24;52	
	5	20;22	19;30	4		γ Crt	922		
13 [Corvus]			Saturn, Mercury						
	6	2;12	19;40	3		ε Crv	929		

	6	6;22	14;50	3		γ Crv	931	C: 6;12	
14 [Argo]			Saturn, Jupiter						
	3	5; 2	69; 0	1		α Car	892	G: 29; 0	
15 [Centaurus]			Mars, Venus						
	6	24; 2	25;40	3		ι Cen	939		
	7	3;32	22;30	3		θ Cen	940	C: 2	
16 [Centaurus]			Venus, Jupiter						
	6	26;13	41;10	1		α Cen	969	G + 17;52: 26;12 C: 26;12	
	6	27;52	51;10	2		γ Cru	965		
	6	29; 2	55;20	2		α Cru	968		
	7	3;12	51;40	2		β Cru	966		
	7	12; 2	45;20	2		β Cen	970	C: 45;[..]	
17 [Lupus]			Venus, Mars						
	7	13;42	29;10	3		α Lup*	973		
	7	15;52	24;10	3		β Lup	972	G: 24;50	
18 [Corona Australis]			Saturn, Mercury						
	9	4;22	15;20	4		γ Cr A	1005	G: 15;10	
	9	4;42	16; 0	4		α Cr A	1004		
	9	5;12	17;10	4		β Cr A	1003	G + 17;52: 4;52	

19 [Ara]			Jupiter, Mercury						
	8	8;32	30;20	4		ε^1 Ara	994	G: 5	
	8	12;52	33;20	4		β Ara	996		
	8	13; 2	34;10	4		γ Ara	995		

Col. I. The number of the zodiacal sign is not repeated in col. VII where variants are listed; in all cases reported in that column only the degrees and minutes differed from the entry in the Paris manuscript.

Col. III: n means nebulous.

Col. IV: In the manuscript the names of the stars are not presented in a column.

Col. V: The entries in this column have been taken from Toomer 1984.
* indicates that Kunitzsch 1986 and Kunitzsch 1991, pp. 187–200, give a different modern designation.

Col. VI: These numbers are taken from Peters and Knobel 1915 (ultimately from Baily 1843), and they are also used in Kunitzsch 1986 and 1990.

Col. VII: C refers to Cambridge, Gonville and Caius College, MS 141/191; in certain cases, it is followed by a column number in Roman numerals. G refers to Gerard of Cremona's version of Ptolemy's star catalogue (Kunitzsch 1990). We underline entries in Vimond's table for which there is a variant reading. The entries for longitudes in both copies generally agree with those in G with an increment of 17;52° for precession; those cases where they differ have been noted.

Col. VIII: G refers to Gerard of Cremona's version of Ptolemy's star catalogue (Kunitzsch 1990); K1959 refers to Kunitzsch 1959; K1966 refers to Kunitzsch 1966; P refers to Plato of Tivoli's Latin version of the *Tetrabiblos* (ed. 1493); and R refers to Robbins 1940.

Note 1. We are informed by Kunitzsch that *anphora* is not a proper name but rather a noun used in the description of the star's position: "where the water flows out *from the vessel*"; Erfurt, Universitätsbibliothek, Amplon. 2°395, f. 105r, *in decursu aque ... ab anphora*); P, f. 16va: *In aque vero decursu collocate* (without *anphora*).

Note 2. As Kunitzsch informed us, *aliedim*, apparently renders the Arabic *al-jady* (the kid), an old Arabic name for α UMi (Kunitzsch 1961, p. 62). It is uncertain where the compiler of this list might have found it. In the *Tetrabiblos* tradition this name never occurs.

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