« COMBUSTION TABLES » IN TWELFTH-CENTURY LATIN EUROPE: A PRELIMINARY STUDY[*]

C. PHILIPP E. NOTHAFT
ALL SOULS COLLEGE, OXFORD

Abstract

The Latin manuscript sources studied in this article jointly document the existence and erstwhile circulation of a highly atypical set of computational tables for planetary longitudes, coupled with extensive tables for ascensions, which served astrologers in Latin Europe as early as the 1130s. An associated text of *c.*1220 refers to the tables for the five planets as « combustion tables » (*tabule combustionis*), which reflects the way the tables in question use the time and position of the last conjunction between a planet and the Sun – known in medieval terminology as *combustio* – as an anchor for calculating the planet's true ecliptic longitude at a later date within its synodic period. Multiple lines of evidence suggest that the combustion tables as well as the associated solar and ascension tables originally circulated alongside the pseudo-Ptolemaic *Iudicia*, an astrological work of probable Arabic origin (pre-1138). Overall, the surviving manuscript material raises the possibility that the tables and the *Iudicia* were at one point a single work that supported astrological computations and judgments at an early stage of their respective development in Latin Europe.

Key Words

Astronomical tables; Almanacs; Ptolemy; *Iudicia*; Astrology; Arabic-to-Latin translations

[*] The research presented in this article was made possible by a visiting fellowship at the *Ptolemaeus Arabus et Latinus* project in Munich (Bavarian Academy of Sciences and Humanities) during September 2023. I hereby thank the project's director, Prof. Dr. Dag Nikolaus Hasse, and its two research leaders, Dr. David Juste and Dr. Benno van Dalen, for offering me this opportunity. My warmest thanks are also due to David Juste and Charles Burnett for their helpful comments on early versions of this article.

I. *Introduction*

Thanks to the ground-breaking research of David Juste, it is no longer possible to speak of a complete disappearance of astrology from early medieval Latin Europe, as relevant sources and even the ability to cast rudimentary horoscopes are clearly attested during this period and part of the world.[1] It is nevertheless true that the twelfth century experienced a dramatic resurgence in astrological literature and practice, a development that was closely connected with the activities of Arabic-to-Latin translators in contemporary Iberia.[2] As with the early medieval context,

---

1 David Juste, « Neither Observation nor Astronomical Tables: An Alternative Way of Computing the Planetary Longitudes in the Early Western Middle Ages », in Charles Burnett, Jan P. Hogendijk, Kim Plofker, Michio Yano (eds.), *Studies in the History of the Exact Sciences in Honour of David Pingree*, Brill, Leiden, 2004 (Islamic Philosophy, Theology, and Science: Texts and Studies, 54), p. 181–222; Id., « Horoscopic Astrology in Early Medieval Europe (500–1100) », in *La conoscenza scientifica nell'Alto Medioevo: Spoleto, 25 aprile – 1 maggio 2019*, vol. I, Fondazione Centro Italiano di Studi sull'Alto Medioevo, Spoleto 2020 (Settimane di studio della Fondazione Centro Italiano di Studi sull'Alto Medioevo, 67), p. 311–333.

2 The twelfth-century revival of astrology and the associated Arabic-to-Latin translations have been scrutinized in an increasingly vast secondary literature. A comprehensive bibliography, compiled by David Juste, can be accessed at <https://ptolemaeus.badw.de/astrobibl/start> (Accessed 29 Nov. 2023). For some particularly valuable perspectives on the topic, see Richard Lemay, *Abu Ma'shar and Latin Aristotelianism in the Twelfth Century: The Recovery of Aritotle's Natural Philosophy through Arabic Astrology*, American University of Beirut, Beirut 1962 (American University of Beirut, Publication of the Faculty of Arts and Sciences: Oriental Series, 38); Marie-Thérèse d'Alverny, « Astrologues et théologiens au XII^e siècle », in André Duval (ed.), *Mélanges offerts à M.-D. Chenu, maître en théologie*, Vrin, Paris 1967 (Bibliothèque Thomiste, 37), p. 31–50; eadem, « Abélard et l'astrologie », in René Louis, Jean Jolivet, Jean Châtillon (eds.), *Pierre Abelard – Pierre le Venerable: les courants philosophiques littéraires et artistiques en Occident au milieu du XII^e siecle; abbaye de Cluny, 2 au 9 juillet 1972*, Éditions du CNRS, Paris 1975 (Actes et mémoires des colloques internationaux du Centre National de la Recherche Scientifique, 546), p. 611–630; Małgorzata Hanna Malewicz, « Libellus de efficatia artis astrologice: traité astrologique d'Eudes de Champagne, XII^e siècle », *Mediaevalia Philosophica Polonorum*, 20 (1974), p. 3–95; Joshua David Lipton, « The Rational Evaluation of Astrology in the Period of Arabo-Latin Translation ca. 1126–1187 AD », Ph.D. diss., University of California, Los Angeles 1978; Charles Burnett, « Advertising the New Science of the Stars *circa* 1120–50 », in Françoise Gasparri (ed.), *Le XII^e siècle: mutations et renouveau en France dans la première moitié du XII^e siècle*, Le Léopard d'Or, Paris 1994 (Cahiers du Léopard d'Or, 3), p. 147–157; Id., « Astrology, Astronomy and Magic as the Motivation for the Scientific Renaissance of the Twelfth Century », in Angela Voss, Jean Hinson Lall (eds.), *The Imaginal Cosmos: Astrology, Divination and the Sacred*, University of Kent, Canterbury 2007, p. 55–61; Charles W. Clark, « A Christian Defense of Astrology in the Twelfth Century: The *Liber cursuum planetarum* of Raymond of Marseilles », *International Social Science Review*, 70 (1995), p. 93–102; John Tolan, « Reading God's Will in the Stars: Petrus Alfonsi and Raymond de Marseille Defend the New Arabic Astrology », *Revista Española de Filosofía Medieval*, 7 (2000), p. 13–30; Jean-Patrice Boudet, *Entre science et* nigromance*: astrologie, divination et magie dans l'Occident médiéval (XII^e–XV^e siècle)*, Publications de la Sorbonne, Paris 2006, p. 35–87; David Juste, « The Impact of Arabic Sources on European Astrology: Some Facts and Numbers », *Micrologus*, 24 (2016), p. 173–194;

such a reinvigoration of astrological practice could not have occurred to its documented extent without the availability of computational tools for predicting the configuration of the heavens as a function of time. It is no accident, therefore, that astronomical tables as well as associated texts on mathematical astronomy were being rendered from Arabic into Latin at the same time as astrological works, and often by the same translators.[3] At their most sophisticated, such tables stemmed from the Islamic tradition of astronomical handbooks known as *zīj*es, the first examples of which made their way to the Latin West as early as the 1110s.[4]

The present article is dedicated to another type of computational tables that supported the efforts of Latin astrologers at a relatively early stage, but which does not conform to the standard *zīj* model. Following the terminology in a previously unknown text of the early thirteenth century (discussed in Part V below), I shall refer to this unusual computational tool as « combustion tables » (*tabule combustionis*), as the tables in question use the time and position of the last conjunction between a planet and the Sun – known in medieval terminology as *combustio* – as an anchor for calculating the planet's ecliptic position at a later date. The surviving evidence shows that combustion tables for the five planets must have been available in Latin Europe at least since the mid-1130s, at which point they were already accompanied by additional tables for the ecliptic longitude of the Sun and for calculating the rising of signs according to both right and oblique ascensions. The resulting set contained most of the tools a practicing astrologer needed to establish a basic horoscope insofar as it allowed him not only to find the ecliptic longitudes of six of the seven planets (the Moon was not included), but also to determine the ascendant (via oblique ascensions) and establish the cusps of the remaining houses (via right ascensions).

Charles Burnett, David Juste, « A New Catalogue of Medieval Translations into Latin of Texts on Astronomy and Astrology », in Faith Wallis, Robert Wisnovsky (eds.), *Medieval Textual Cultures: Agents of Transmission, Translation and Transformation*, de Gruyter, Berlin 2016 (Judaism, Christianity, and Islam—Tension, Transmission, Transformation, 6), p. 63–76; David Runciman, « Bishop Bartholomew of Exeter (d. 1184) and the Heresy of Astrology », *Journal of Ecclesiastical History*, 70 (2019), p. 265–282; Julio Samsó, *On Both Sides of the Strait of Gibraltar: Studies in the History of Medieval Astronomy in the Iberian Peninsula and the Maghrib*, Brill, Leiden 2020 (Handbook of Oriental Studies, Section One, 144), p. 180–197.

[3] On astronomical tables in Latin, see Raymond Mercier, « Astronomical Tables in the Twelfth Century », in Charles Burnett (ed.), *Adelard of Bath: An English Scientist and Arabist of the Early Twelfth Century*, Warburg Institute, London (Warburg Institute Surveys and Texts, 14), p. 87–118; José Chabás, *Computational Astronomy in the Middle Ages: Sets of Astronomical Tables in Latin*, CSIC, Madrid 2019 (Estudios sobre la ciencia, 72).

[4] See Josep Casulleras, « Las *Tablas astronómicas* de Pedro Alfonso », in María Jesús Lacarra (ed.), *Estudios sobre Pedro Alfonso de Huesca*, Instituto de Estudios Altoaragonenses, Huesca 1996 (Estudios Altoaragonenses, 41), p. 349–366; Raymond Mercier, « Astronomical Tables of Abraham Bar Ḥiyya », in Sacha Stern, Charles Burnett (eds.), *Time, Astronomy, and Calendars in the Jewish Tradition*, Brill, Leiden 2014 (Time, Astronomy, and Calendars: Texts and Studies, 3), p. 155–207.

The following is an attempt to gather the available evidence concerning the nature and diffusion of this tabular work. Aside from dealing with the extant complete or partial copies that survive of the tables themselves (see Part III), this will involve examining sources that attest to their one-time circulation and use. One of these sources is Raymond of Marseilles's well-known *Liber cursuum planetarum* (*c.*1141), which contains a rather trenchant and uncharitable critique of our combustion tables and their users (see Part II). Another is a brief passage in Abraham Ibn Ezra's Latin *Liber de rationibus tabularum*, which is likewise critical of this approach to casting tables (see Part IV). Three other sources relevant to the subject have hitherto remained unpublished and entirely neglected. One is a brief canon composed in 1219 on one aspect of the operating with the planetary combustion tables (see Part V). Another is a list of combustions for the years 1139–1141, which appear to have been intended as computational starting points for users of these same tables (see Part VI). The third source is an explanation of the associated solar and ascension tables, which was incorporated into a twelfth-century commentary on the pseudo-Ptolemaic *Iudicia* (see Part VII). As will be shown in what follows, this astrological text of probable Arabic origin played a significant role in the transmission of our combustion and ascension tables. Indeed, the extant evidence hints at a stage at which the tables and the text were one and the same work, which appears to have informed some of the earliest Latin forays into horoscopic astrology.

II. *Raymond of Marseilles and MS Paris, Bibliothèque nationale de France, lat. 7291*

The first and hitherto only modern scholar to have noted the existence of any surviving copy of the combustion tables was Joshua David Lipton, whose 1978 dissertation on « The Rational Evaluation of Astrology in the Period of Arabo-Latin Translation ca. 1126–1187 AD » remains unpublished and, accordingly, little read. Lipton must also be credited with the brilliant intuition of connecting these tables with a passage in Raymond of Marseilles's *Liber cursuum planetarum*, which introduces Raymond's Tables of Marseilles, an adaptation of the Toledan Tables to the meridian of his hometown.[5] Writing in 1141 or perhaps slightly later,[6] Raymond tells us of his recent altercation with two other astrologers, who followed a *liber cursuum* based on very different principles than his own. He

[5] See LIPTON, « The Rational Evaluation », p. 169–176. His findings are passed over in silence in the introduction to the critical edition of RAYMOND OF MARSEILLES, *Liber cursuum planetarum*, in *Opera omnia*, vol. I, ed. and trans. MARIE-THERESE D'ALVERNY, CHARLES BURNETT, EMMANUEL POULLE, CNRS Éditions, Paris 2009 (Sources d'histoire médiévale, 40), p. 27–30.

[6] Raymond informs us that he « commenced » (*cepimus*) writing the book in 1141. See RAYMOND OF MARSEILLES, *Liber cursuum planetarum* 1.10, ed. D'ALVERNY, BURNETT, POULLE, p. 140.

characterizes this alternative work as an *almanach* and warns his readers against its use, claiming it to be completely unreliable and against the verdict of the observable heavens. According to his own – no doubt biased – report, he was eventually able to disabuse his opponents of their misplaced confidence in this so-called almanac, by demonstrating its failure to predict the position of Mars.[7]

As emerges from this account, the tables Raymond criticizes so severely relied on prior knowledge of the time and longitude of the last « combustion » (*combustio*) of the planet in question, which in this context refers to the moment of its true conjunction with the Sun. The days elapsed since this last combustion served as the argument for a dedicated table showing an increment in longitude. By adding this increment to the known longitude at the last combustion, users found the supposed true longitude on the day in question.[8] Raymond further claims that the two astrologers agreed with him that the most recent combustion of Mars had occurred around 5 p.m. on 27 October 1139, when its longitude was at or near 212;21°, as predicted by his own Tables of Marseilles.[9] At the end of the thirteenth month since this combustion, the astrologers' combustion tables allegedly showed Mars as resuming its direct motion after the last retrograde arc, being in the 20th minute of the 6th degree of Aries. Raymond rejected this prediction as grossly false, noting that Mars's actual position at that moment was in the 47th minute of the 11th degree of Cancer, more than three signs further east, and in the middle of its first station.[10]

---

7 For the entire passage, see RAYMOND OF MARSEILLES, *Liber cursuum planetarum* 1.25–36, ed. D'ALVERNY, BURNETT, POULLE, p. 148–154. See ibid. 1.31, ed. D'ALVERNY, BURNETT, POULLE, p. 152, for Raymond's decision to label the book an *almanach*, which appears to be the earliest attested usage of this term in a Latin text.

8 RAYMOND OF MARSEILLES, *Liber cursuum planetarum* 1.26a, ed. D'ALVERNY, BURNETT, POULLE, p. 148–150: « Consueverunt predicti vero astrologi planetarum combustionum loca tenere. Deinde a die qua quilibet eorum combustus esset, si locum ipsius scire vellent, computabant quot dies pertransissent, sicque lineam ejusdem diei super combustionis lineam addentes, locum planete inveniebant. »

9 RAYMOND OF MARSEILLES, *Liber cursuum planetarum* 1.26b, ed. D'ALVERNY, BURNETT, POULLE, p. 150: « Fuerat autem precedenti anno Mars combustus circa XVII horam si a media nocte, vel XI, si ab exordio lucis numeres, XXVII diei octubris mensis ipsius anni ab Incarnatione Domini M C XXXVIIII ita quod combustionis ejusdem locus certus esse potuit VII sign. II grad. XXI min. Et in hoc fere in nullo predicti a nobis discordabant viri. » According to the software *Deviations* <https://www.raymondm.co.uk/> (Accessed 29 Nov. 2023), this combustion was accurately calculated for *c.*5 p.m. on 27 October 1139. If the Toledan Tables are adjusted to a meridian 16;30° further east (which is the reference meridian of Raymond's Tables of Marseilles), they show true sidereal longitudes for the Sun and Mars of *c.*212;21° and *c.*212;22°, respectively. Compare Emmanuel Poulle's discussion in RAYMOND OF MARSEILLES, *Liber cursuum planetarum* 1.27b, ed. D'ALVERNY, BURNETT, POULLE, p. 27–39.

10 RAYMOND OF MARSEILLES, *Liber cursuum planetarum* 1.27b–c, ed. D'ALVERNY, BURNETT, POULLE, p. 150: « Secundum vero eundem librum, finito XIIIe mense cepit Mars in XX° minuto VIi gradus arietis

According to Raymond, the principal flaw of his opponents' tables was their reliance on the false assumption that a planet's daily velocities or patterns of motion were going to be identical for each synodic period, which ignored the variations caused by the eccentricity of the deferent.[11] The only way an « almanac » based on combustions could successfully apply to any and all synodic periods was if one made the effort to draw up, for each planet, 360 different tables representing each of the 360 possible degrees in which a combustion might take place.[12] Raymond, in fact, concedes the utility of such an undertaking by expressing his wish to construct an « almanac » of this very type in order to circumvent the laborious process of computing true longitudes via mean motions and equations.[13] The tables as they existed, however, could not possibly be useful. Those who kept relying on them even ran the risk of being deceived in a twofold manner, if they worked with an incorrectly computed combustion to derive an even worse result. Raymond claims to have witnessed such cases himself, citing the complaints of certain students in this art who had been furnished with « false combustions » by their masters.[14]

Lipton's key contribution in analysing this section of the *Liber cursuum planetarum* consists in his discovery that a tabular work closely matching Raymond's description survives in MS Paris, Bibliothèque nationale de France, lat. 7291 (hereafter referred to as *P*).[15] The manuscript in question is a slim codex of

dirigi, quod falsissimus erat. Nam eadem die Mars fuerat in XLVII° minute XI[i] gradus non arietis, ut ipsi aiebant, sed cancri, in medio firme stationis sue prime. Fueratque hujusmodi falsitas non unius aut duorum graduum tantum, sed trium signorum et V graduum et XXVII minutorum. »

11 Raymond of Marseilles, *Liber cursuum planetarum* 1.28, ed. d'Alverny, Burnett, Poulle, p. 150: « Unde novimus quod ille qui eas fecit tabulas propter nimiam insipientiam aut dolositatem taliter eas composuit. Proter nimiam insipientiam ideo dicimus quoniam forsitan suspicatus est ab omni combustione in combustionem equaliter debere procedere unumquemque planetam, quod mirabiliter falsum est. Nam, quamvis planeta velociorem cursum circa incoativam combustionem habere videatur, tamen, secundum quod modo augi propior, modo ab ea est longinquior, modo tardior, modo velocior habetur. »

12 Raymond of Marseilles, *Liber cursuum planetarum* 1.31–32, ed. d'Alverny, Burnett, Poulle, p. 152.

13 Raymond of Marseilles, *Liber cursuum planetarum* 1.34, ed. d'Alverny, Burnett, Poulle, p. 152: « Et hujusmodi almanach, si tantum divina clementis nobis vite spacium concesserit, nos in futuro facturos speramus, ideo presertim quoniam ultra modum grave videtur ad cursum certificationem semper in planetarum locis inveniendis recurrere; opinor autem quoniam ille qui premissas fecit tabulas invenit Martem in ultima arietis parte combustum, ut hec tabule minime videntur. »

14 Raymond of Marseilles, *Liber cursuum planetarum* 1.35, ed. d'Alverny, Burnett, Poulle, p. 154: « Vidimus autem preterea quosdam scolares, illius dogmatis sectatores, qui conquererentur et dicerent a magistris suis falsas sibi combusiones planetarum attributas, ut quos simplex error tabularum satis impedire poterat, duplex a veritate prorsus alienos redderet. »

15 Lipton, « The Rational Evaluation », p. 171–176. The manuscript is available at: <https://gallica.bnf.fr/ark:/12148/btv1b10033758x.r=latin%207291?rk=21459;2> (Accessed 29 Nov. 2023).

the twelfth or early thirteenth century. It comprises 25 folios that are taken up almost entirely by numerical tables, barring only some associated canons as well as two drawings with an equestrian theme: a falconer riding a horse (fol. 6r) and the front half of a horse (fol. 8v). The first seven folios contain tables for computing the ecliptic longitudes of the five planets, here placed in the order Saturn, Jupiter, Mars, Mercury, and Venus. Each planet is represented by two complementary tables, which I shall designate as Tables A and B in what follows. What comes immediately after these five pairs of tables is a single table for the daily increment in solar longitude (fol. 8r–v), whose layout is similar to that of Tables B for the five planets. It counts the days of the solar year up to day 365, to which is assigned a longitude of 359;46°.

The remainder of the manuscript consists in a long sequence of ascension tables (fol. 9r–25r), which appear as one continuous sequence of 528 columns with next to no written information explaining their purpose. Their labelling is restricted mostly to the headers *G* and *P* for *gradus* (i.e., degrees) and *puncta* (i.e., sexagesimal minutes) as well as the names of the zodiacal signs (placed above the degree columns). A closer look at the numerical content reveals that the first 24 columns belong to a table of right ascensions (fol. 9r–v) and the next 24 columns to a table of *normed* right ascensions, which begin at Capricorn and are increased by 90° relative to the right ascensions of the preceding sequence (fol. 9v–10r). As for the remaining 480 columns, they amount to a continuous series of twenty tables for oblique ascensions, one for each full degree of geographic latitude between 31° and 50° (fol. 10v–25r). With this ensemble of tables in place, manuscript *P* could have provided a practicing astrologer with most of the computational tools required to cast a horoscope in a wide range of European as well as North African locations. Its greatest oddity in this respect is the absence of any tables geared towards the position of the Moon. A twelfth-century user of this collection may have attempted to plug this gap by taking recourse to the *computus* tradition of Latin lunar reckoning, whose sources were far more widely available at the time than astronomical tables.[16] One of the more sophisticated tools in this regard were the conjunction tables composed between 1092 and 1112 by Walcher of Malvern, which came with instructions on how to derive from them zodiacal longitudes for the Sun and Moon.[17]

More so than the absence of the Moon, what makes the material in *P* stand out from among any of the other almanacs and sets of astronomical tables available in twelfth-century Latin Europe is the computational procedure for the five planets, as represented by Tables A and B mentioned above – or what Lipton respectively

16 See on this point Juste, « Neither Observation nor Astronomical Tables », p. 183–185.

17 See Walcher of Malvern, *De lunationibus* 4–5, in C. Philipp E. Nothaft, *Walcher of Malvern: 'De lunationibus' and 'De Dracone'; Study, Edition, Translation, and Commentary*, Brepols, Turnhout 2017 (De Diversis Artibus, 101 [N.S. 64]), p. 114–118.

dubbed the « Mensual » and « Daily Tables ».[18] The first step in this procedure is to enter Table B with the number of days since the last combustion to yield a longitudinal increment in degrees and minutes (*puncta*). The value in question will be added to the longitude of the combustion to arrive at a first approximation or intermediary result for the true longitude of the planet. As seen from Tab. 1, the length of each Table B depends on the approximate synodic period of the planet to which it is assigned. The shortest among them is the table for Mercury, which has 349 entries representing the rough equivalent of three consecutive synodic periods (3 x 116d = 348d). The longest is the table for Mars, which has 780 entries in almost exact accordance with the number of days in Mars's synodic period (modern value: 799.94d).

	Saturn	Jupiter	Mars	Venus	Mercury
approx. synodic period of planet	378d	399d	780d	584d	116d
number of entries in table	381	401	780	585	349
last entry in table	14;24°	34;31°	407;24°	576;40°	344;37°

Tab. 1: synopsis for Tables B in *P*, fol. 1r–7v

Tab. 2 below presents the layout and numerical content of Table A for Mars. As with Table A for the other four planets, it is a double-argument table that users were expected to enter with (i) a number of months since the last combustion and (ii) the zodiacal sign or degree in which the said combustion occurred. The entry thus found is the value of a correction in degrees and/or minutes together with an indication as to whether the correction must be subtracted (*minue*) from or added to (*iunge*) the intermediary result obtained via Table B. The precise method of extracting the correction from Table A differs from one planet to the next. Canons that in *P* appear near each Table A (fol. 1r, 2r, 3r, 5r, 6r) spell out most of the relevant procedure, though certain aspects appear to have been glossed over or merely left implicit. For elapsed time intervals that include days beyond a completed number of months, the rule for Jupiter prescribes a simple interpolation procedure: the difference between Table A's corrections for the current and completed month is divided by 30 and the quotient multiplied by the number of remaining days.[19] Curiously, the canon for Mars makes no reference to such a procedure for the current month, despite the fact that this planet's

18 Lipton, « The Rational Evaluation », p. 171.

19 *P*, fol. 2r: « Hoc modo prospice numerum primi mensis. In prima die illius mensis de ipso numero addas vel minuas XXX partem, in secunda die duas XXX[as], in die tertia tres trigesimas, et sic in XXX[ma] die iunge vel minue totum. In prima die secundi mensis accipe numerum primi et secundi mensis et considera quantum numerus primi vincgeat [*sic* in *P*] numerum secundi et ab eo quod superat subtrahe XXX[am] partem et adde vel minue numero presenti. » The calculation for Venus was supposed to work along the same lines. *P*, fol. 6r: « Verumtamen semper addet vel minuat de numero mensium eius, qui sunt XX, sicut diximus in Iove. »

relatively swift motion would have made it particularly sensitive to day-to-day changes. Instead of discussing the time since the last combustion, the rules focus entirely on the longitude of this combustion, as Mars is the only one among the five planets where users are required to consider the precise degree rather than just the sign. To this end, the canon preceding Mars's Table A spells out a different course of action for each one of 71 degree-ranges, which encompass between 4° and 10° consecutive degrees (see Appendix).

	ARI	TAU	GEM	CAN	LEO	VIR	LIB	SCO	SAG	CAP	AQU	PIS
1	+0;20°	0°	−1;33°	−1;58°	−2;8°	−1;27°	−1°	+0;41°	+1;58°	+1;34°	+2;1°	+1;10°
2	+0;20°	0°	−2;29°	−3;15°	−3;15°	−1;24°	−0;27°	+3;2°	+4;57°	+4;47°	+4;22°	+2;20°
3	+0;40°	0°	−3;33°	−4;15°	−3;37°	−0;31°	+1;13°	+6;3°	+8;39°	+8;15°	+6;32°	+3;16°
4	+1°	0°	−4;9°	−4;46°	−4;43°	+1;41°	+4;15°	+9;39°	+12;43°	+11;46°	+8;35°	+4;46°
5	+1;20°	0°	−4;26°	−4;46°	−1;43°	+5;7°	+8;15°	+13;9°	+16;55°	+15;13°	+10;26°	+5;53°
6	+1;40°	0°	−4;30°	−4;9°	+0;54°	+9;51°	+10;18°	+16;7°	+21;5°	+13;36°	+12;3°	+6;7°
7	+2°	0°	−4;6°	−3°	+4;5°	+15;52°	+16;46°	+22;40°	+25;25°	+21;54°	+13;44°	+7;52°
8	+2;40°	0°	−3;59°	−1;6°	+10;25°	+23;19°	+24;40°	+30;34°	+30;10°	+25;29°	+15;36°	+8;33°
9	+3°	0°	−2;14°	+2;25°	+18;15°	+32;30°	+34;18°	+40;12°	+35;22°	+30;3°	+18°	+10;30°
10	+4°	0°	−0;24°	+7;23°	+28;51°	+45;21°	+47;36°	+53;30°	+43;47°	+37;35°	+22;15°	+13;7°
11	+7°	0°	+2;45°	+14;36°	+47;3°	+64;14°	+56;56°	+62;50°	+57;46°	+49;55°	+29;31°	18;15°
12	+12;3°	0°	+3°	+19;36°	+66;49°	+77;37°	+90;46°	+96;40°	+75°	+64;2°	+36;8°	+24;5°
13	+6;56°	0°	+3;18°	+17;37°	+70;57°	+99;48°	+101;50°	+107;44°	+77;24°	+63;34°	+30;7°	+18;30°
14	+5;43°	0°	+5;23°	+16;5°	+60;20°	+85;19°	+84;22°	+88;22°	+60;22°	+46;46°	+19;41°	+12;13°

15	+4;9°	0°	+6;52°	+25;40°	+41;32°	+62;48°	+62;18°	+70;18°	+39;22°	+30;34°	+12;9°	+8;45°
16	+1;13°	0°	+8;16°	+15;37°	+34;1°	+45;54°	+45;21°	+48;18°	+24;22°	+20;11°	+7;13°	+4°
17	−0;9°	0°	+9;13°	+15;42°	+28;17°	+34;44°	+34;8°	+41;30°	+19;22°	+13;47°	+4;13°	+2;10°
18	−1;39°	0°	+8;56°	+13;57°	+22;44°	+26;28°	+25;42°	+37;25°	+16;22°	+7;21°	+1;14°	0°
19	−2;15°	0°	+8;3°	+11;51°	+17;35°	+19;6°	+18;19°	+31;38°	+13;22°	+3;6°	−0;9°	−1;5°
20	−2;23°	0°	+6;37°	+9;9°	+12;37°	+12;15°	+12;8°	+26;13°	+7;10°	0°	−2°	−2°
21	−2;13°	0°	+4;29°	+6;6°	+7;55°	+7;40°	+5;57°	+23;25°	+4;38°	−1;52°	−2;2°	−2;15°
22	−1;34°	0°	+2;46°	+3;10°	+3;18°	+3;23°	+3;1	+21;45°	+4;24°	−2;29°	−1;30°	−1;20°
23	−0;22°	0°	+0;29°	+0;35°	+0;44°	+0;32°	+0;24°	+21;22°	+3;48°	−1;32°	−0;5°	−0;20°
24	+0;58°	0°	−2;9°	−1;32°	−1;18°	−1;14°	−0;54°	+22;35°	+6;23°	+0;33°	+1;55°	+1;7°
25	+2;3°	0°	−2;27°	−3;3°	−3;5°	−1;14°	−0;30°	+24;54°	+7;4°	+3;23°	+4;4°	+3;3°
26	+4;19°	0°	−2;54°	−3;53°	−3;21°	−1;11°	−0;16°	25;43°	+11;47°	+6;47°	+7;27°	+5;23°
27	+3;14°								+12;35°	+8;54°	+6;34°	+4;57°

Tab. 2: Table A for Mars according to *P*, fol. 3v.[20]

While the precise methods by which Tables A and B were constructed raise difficult questions that cannot be pursued further here, the basic principles that guided their creation seem clear enough. Simply put, Table B was intended to chart a planet's daily progress in ecliptic longitude across one synodic period (or three, in the specific case of Mercury), while Table A takes into account the sensitivity of these daily increments to the ecliptic longitude at the initial combustion. This

[20] Where it seemed obvious from the surrounding entries that an entry in *P*'s copy of this table is corrupt, I attempted a silent emendation on the basis of witness *M* to be discussed in Part III below. A more thorough emendation of the numerical content of this table will have to await a complete analysis of its method of construction, which is beyond the scope of the present article.

initial longitude will make a difference to the sizes of the subsequent increments owing to the eccentricity of the planet's deferent, which modifies the equation of anomaly through the equation of centre and the changing apparent diameter of the epicycle.[21] The correction provided by Table A accordingly depends on two arguments or variables, of which one is the time elapsed since the last combustion (tabulated according to complete months) and the other is the initial longitude (tabulated according to zodiacal signs). Whoever created this arrangement was presumably motivated by a desire to avoid working with separate tables for mean motions and equations, as was also expressed by Raymond of Marseilles in the passage mentioned above. Indeed, computing with ordinary equation tables for the five planets required at least four separate entries (for the equation of centre, the equation of anomaly, the epicyclic diameter, and the minutes of proportion) as well as a much greater number of intermediary steps.[22]

As one would expect from combustion tables of the general type just described, each Table B in *P* shows one range of days within a given synodic period during which the longitude increment of the planet does not increase, but is static or negative in accordance with the planet's stations and retrogradations. For example, Saturn's increment is shown as remaining static at 10;59° between days 117 and 124, followed by a decrease to 3;28° between days 125 and 258. The planet remains stationary at 3;28° between days 259 and 263, after which the increment resumes its positive growth (*P*, fol. 1v). Likewise, Jupiter is shown stationary between days 138 and 141 (21;22°), retrograde between days 142 (21;21°) and 255 (11;41°), and stationary again between days 256 and 261 (11;41°) (*P*, fol. 2v). The table for Mars shows a more abrupt change from direct to retrograde motion, as there are no sequences of days during which the increment stays the same. The retrograde period is here from day 312 (170;10°) to day 389 (152;57°) (*P*, fol. 4v). This state of affairs seems to explain one of Raymond of Marseilles's specific objections against the Mars table used by his opponents, namely, its supposed

---

21 For some background, see Otto Neugebauer, *A History of Ancient Mathematical Astronomy*, 3 vols., Springer, Berlin 1975 (Studies in the History of Mathematics and Physical Sciences, 1), vol. I, p. 145–206.

22 José Chabás, Bernard R. Goldstein, *A Survey of European Astronomical Tables in the Late Middle Ages*, Brill, Leiden 2012 (Time, Astronomy, and Calendars: Texts and Studies, 2), p. 73–76. The idea of arranging astronomical tables on the basis of conjunctions between the planets and the Sun reappears in the fourteenth century in the context of Alfonsine astronomy. See ibid., p. 155–156; José Chabás, Bernard R. Goldstein, « John of Murs's Tables of 1321 », *Journal for the History of Astronomy*, 40 (2009), p. 297–320 (299–307). Note, however, that in this example the goal was to convert the mean conjunction into the true longitude at any other time via a single step, involving only one double-argument table. The process resembles that in the combustion tables only on a rather superficial level, especially given the absence of any counterpart to Table B.

failure to reflect the fact that the planet becomes stationary twice during each synodic period.[23]

Even besides this point concerning planetary stations, the case for identifying Mars's Table B in *P* with the relevant part of the combustion tables criticized by Raymond turns out to be extremely strong. According to the *Liber cursuum planetarum*, the incriminated « almanac » showed an increment of 170;10° in the line corresponding to « 12 days of 11 months made up of 30 days » (« XII dierum XI mensium ex diebus XXX constitutorum »).[24] Since Raymond mentioned in an earlier passage that his dispute with the astrologers was resolved ten months after Mars's combustion, it is clear that the line referred to here must be that for day 312 (= 12 + 10 x 30).[25] He tells us that the increment assigned to this day showed Mars as beginning to be retrograde at 212;12° + 170;10° − 360° = 22;31°.[26] The agreement of this information with *P*'s Table A happens to be flawless. Its entry for day 312 not only shows the expected increment of 170;10° but, crucially, it is also the first entry of a retrograde sequence (*P*, fol. 4v).

Raymond does not explain how exactly this result amounted to a refutation of the table championed by his opponents. Instead, he goes on to refer to the situation after thirteen months, for which the same table allegedly predicted that

---

23 Raymond of Marseilles, *Liber cursuum planetarum* 1.36a, ed. d'Alverny, Burnett, Poulle, p. 154: « Est preterea aliud in quo satis falsas esse percipi potest. Cum enim unusquisque planetarum duas habeat stationes, primam cum retrogradari incipit, secundum cum desinit, ecce in tabulis ad Martis cursum pertinentibus, nusquam eum stationarium invenire poteris, cum verum sit ipsum multis diebus, id est XXIIII et horis XV aut circa in utraque statione perdurare. » It is unclear how Raymond established his exaggerated value of 24d 15h for the duration of each of Mars's stations. Perhaps he extracted it from his own tables' values for the true anomaly at station and retrogradation. See Table 23 (ibid., p. 340), where the values for the first station and beginning of retrogradation are 157;28° and 169;15°, respectively. Dividing the difference of 169;15° − 157;28° = 11;47° by a mean motion in anomaly of *c.*0;27,42°/d would yield *c.*25d 12h.

24 See below, n. 26.

25 Raymond of Marseilles, *Liber cursuum planetarum* 1.25b, ed. d'Alverny, Burnett, Poulle, p. 148: « Cum autem in cursu Martis, qui gravissimus inter planetarum cursus habetur, eorum tabulas cognovissemus falsissimas, atque ab ipsius Martis combustionis die, decem menses pertransissent, ita plane eos convicimus ut jurarent se nunquam decetero tabulas presignatas sequuturos. » See Lipton, « The Rational Evaluation », p. 175, whose suggested emendation of the passage mentioning eleven incomplete instead of ten complete months (see below, n. 26) is probably unnecessary.

26 Raymond of Marseilles, *Liber cursuum planetarum* 1.27a, ed. d'Alverny, Burnett, Poulle, p. 150: « Addidimus super locum combustionis prenominatum XII dierum XI mensium ex diebus XXX constitutorum illarum tabularum lineam, que fuerat CLXX gradus et X minuta qui faciunt V signa et XX gradus et X minuta; habuimusque sic Martem in XXXII° minuto XXIII^{i} gradus primi signi idest arietis retrogradum incipientem. » Raymond writes that the planet was in the 32nd minute of the 23rd degree of Aries (« in XXXII° minuto XXIII^{i} gradus primi signi »). If this is taken literally as referring to incomplete degrees and minutes, such that the longitude is 22;31°, it explains the systematic discrepancy of 1;1° that unnecessarily puzzled Lipton, « The Rational Evaluation », p. 175–176.

Mars would be resuming its direct motion at a longitude of 5;19°.[27] Entering the table in *P* with 390 days (i.e., 13 x 30 days, making the date in question 20 November 1140), we find 152;58°, which marks the first increase in longitude since the beginning of the aforementioned retrograde arc. Adding 152;58° to 212;21° (i.e., to Raymond's assumed longitude at the last combustion), we obtain 5;19°, precisely as expected.

According to Raymond's polemic, this last result was a drastic 95;27° too low compared to the planet's actual longitude (i.e., that yielded by his own tables), which he gives as 100;46°.[28] While this is correct in arithmetical terms, his criticism ignores the entire second part of the computational procedure laid out in *P*, as represented by Table A. For an initial longitude of 212°–217°, which includes Raymond's longitude of the Mars combustion of 27 October 1139 (212;22°), the canon in *P*, if appropriately emended, requires us to take Table A's entry for Libra and either add or subtract 7/9 of the difference between the entries for Libra and Scorpio.[29] The corrective values shown in Table A in the row for thirteen months are +101;50° for Libra and +107;44° for Scorpio (see Tab. 2).[30] It is not immediately clear from the canon whether the difference between these values must be added or subtracted from Libra's entry in the case at hand. Addition seems more likely considering the consistently higher additive values shown in the column for Scorpio with respect to that for Libra. If this is so, the proper correction for a combustion longitude of *c.*212° will be: 101;50° + 7/9(107;44° – 101;50°) = 106;25[,20]°. This is almost 11° in excess of the discrepancy of 95;27° that Raymond of Marseilles encountered when comparing the combustion tables and his own calculations. It seems worth noting, however, that a much closer fit can be achieved by selecting the corrections from the row for twelve months: 90;46° + 7/9(96;40° – 90;46°) = 95;21[,20°].

Raymond's silence with regard to Mars's Table A may simply mean that the astrologers he criticized had discarded this table and blunderingly chose to operate only with Table B. But it is equally possible that Raymond deliberately misrepresented their combustion tables in order to bolster the authority of his own Tables of Marseilles.[31] In any case, he was not wrong to note that the combustions tables provided no specific means of finding the longitude for a particular hour of the day, since all computations were based on the completed

27 See above, n. 10.
28 See above, n. 10.
29 See *P*, fol. 3r, and the edition of the text in the Appendix below. Note that the two witnesses to the canon for Mars both systematically replace references to the difference between Libra and Scorpio with « Scorpio and Sagittarius ».
30 Lipton, « The Rational Evaluation », p. 176, erroneously used the value for Libra without further adjustment.
31 See on this point Lipton, « The Rational Evaluation », p. 176.

numbers of months and days since the last combustion.[32] Another valid criticism of his was that the tables lacked any utility in the absence of reliable information about the dates and longitudes of recent combustions.[33] In the case of *P*, however, the relevant data are readily provided as part of the canons that accompany each planet's Table A. They specify the dates and positions of eight different combustions ranging from 1 July 1135 to 4 September 1138, as listed chronologically in Tab. 3 below.

A peculiar feature of some of these combustion dates is that they are expressed according to two different eras: the conventional Christian era and the « Years of Adam » (*Anni Adam*).[34] The latter correspond to the Byzantine world era, as seen from the fact that they add 5509 years to the years of Christ. One should note, however, that years of the Byzantine world era ordinarily began on 1 September, being synchronous with the Byzantine indictional cycle. In contrast to this standard practice, *P*'s canon for Saturn informs us that the Years of Adam begin on 1 October,[35] which matches the beginning of the calendrical year that was commonly observed among Syrian Christians.[36] This makes for a rather peculiar as well as irritating feature of our source, as nothing else about *P*'s tables or canons seems to connect them firmly with either Byzantine or Syriac astronomy.

The canon for Saturn locates the present time in year 6644 of the Years of Adam as well as in AD 1135, noting that this number remains valid « usque ad nativitatem tunc venientem » (« until the coming Nativity »).[37] This must presumably be understood as a reference to 25 December 1135, which according to the author's

---

[32] Raymond of Marseilles, *Liber cursuum planetarum* 1.36b, ed. d'Alverny, Burnett, Poulle, p. 154: « Sunt vero sic iste tabule facte ut super nullam determinatam horam exeant cursus earum. »

[33] Raymond of Marseilles, *Liber cursuum planetarum* 1.36b, ed. d'Alverny, Burnett, Poulle, p. 154: « Et si contigerit quod astrologus combustiones perdat, necesse ad magistram Egyptum iterum docendus recurrere habeat. »

[34] This is the case in the canons for Saturn, Jupiter, Mercury. See *P*, fol. 1r: « Cuius incensionem, ne quis ignoret, annos Ade atque Christi mente(?) firmiter teneat. Ade anni in presenti sunt VI milia DC.XLIIII et mutantur in kl. Octubris. Anni nativitatis domini sunt mille C.XXXVI usque ad nativitatem tunc venientem. » *P*, fol. 2r: « Quando vis scire ubi sit Iupiter, scias ubi perussit eum Sol. Combustus autem erit Iupiter in hoc anno, id est anno Ade VI milia DC.XLIIII, anno autem incarnationis Christi millesimo centesimo XXXVI, in XII gradu Cancri et XXVIII punctis ad XXVIII dies Iunii. » *P*, fol. 5r: « Cum autem vis scire ubi ipse sit, considera eius primam incensionem, que fuit in XVI die Octubris, ad XXVIII gradus Libre et LI puncta, annis VI^{mi}.DC.XLIIII, in anno incarnationis Christi M^{o}.C^{o}.XXXV^{o}. » See also *P*, fol. 3r, where an addition to the canon for Mars refers to *annus Adam* 6647.

[35] See above, n. 34.

[36] Venance Grumel, *La chronologie*, Presses universitaires de France, Paris 1958 (Traité d'Études Byzantines, 1), p. 174, 209–210; Ludger Bernhard, *Die Chronologie der Syrer*, Böhlau, Vienna 1969 (Sitzungsberichte der Österreichischen Akademie der Wissenschaften, phil.-hist. Kl., 264.3), p. 64–74, 110–119; Andrew Palmer, trans., *The Seventh Century in the West-Syrian Chronicles*, Liverpool University Press, Liverpool 1993, p. xxxiv.

[37] *P*, fol. 1r.

style of reckoning (i.e., the Nativity style) was the beginning of AD 1136. Year 6644 of the Byzantine world era would have ordinarily run from 1 September 1135 to 31 August 1136, though in the specific version presupposed in *P*'s canons the time window shifts by one month to 1 October 1135 to 30 September 1136. Taken together, the indications provided at the start of the canon for Saturn seem to narrow the time of writing down to the days between 1 October and 25 December 1135. At the same time, the canons use the past tense whenever they refer to combustions that occurred in 1135 (Venus on 1 July, Mars on 8 August, Mercury on 16 October, and Saturn on 21 December). Since the latest of these combustions fell on 21 December, it could be that the precise time of writing was just before Christmas 1135, though one should probably be wary of drawing too precise a conclusion from this material. In the case of Jupiter, a combustion on 28 June 1136 is noted in what appears to be the future tense (« Combustus autem erit Iupiter in hoc anno »),[38] which lends further support to dating the canons to late 1135. If this is so, the canons in their original form only provided one combustion for each of the five planets. The fact that *P* records a second combustion for Mars on 12 September 1137 as well as two additional Venus combustions on 8 February 1137 and 4 September 1138 is probably due to later additions to the work. Indeed, these additional combusts are presented as events in the past, which would be inconsistent with the wording in the canons for Saturn and Jupiter.

By the time Raymond of Marseilles had his encounter with the astrologers, the most recent Mars combustion had occurred on 27 October 1139. Raymond gave the joint longitude of Mars and the Sun as 212;22°, claiming that the astronomers agreed with this starting point. It must be noted, however, that Raymond's Tables of Marseilles were an adaptation of the Toledan Tables, whose longitudes were based on a sidereal frame of reference. Raymond did not adjust these longitudes for precession, meaning that 212;22° is a sidereal rather than a tropical value.[39] The combustion longitudes provided in *P* are, in contrast, all tropical. Tab. 3 arranges them in chronological order and compares their date and longitude (λ) according to *P* with the tropical longitudes predicted by the Toledan Tables. Specifically, the fourth and fifth columns of Tab. 3 show (i) the approximate time at which the tropical true solar longitude according to the Toledan Tables reaches the longitude given in *P* (time TT) and (ii) the concomitant longitude (to the nearest minute of arc) of the planet whose combustion is at stake (λ TT). The comparison shows that the dates and longitudes in *P* are in good overall agreement with the Toledan true Sun, which in seven out of eight cases attains an identical longitude on the same

38 *P*, fol. 2r.
39 See above, n. 9.

date as the recorded combustion.[40] The planetary combustions are likewise confirmed in at least an approximate sense, as the Toledan placement of the planet is mostly within 1° of the solar longitude. The one outlier is the latest combustion on the list, that for Venus on 4 September 1138, where the Toledan Tables indicate 5 September for the date of the solar longitude and a longitude of Venus that is lower by approximately 1;33°.

date	planet	λ *P*	time TT	λ TT
1 Jul. 1135	Venus	104;45°	1 Jul., *c.*17;20h	104;6°
8 Aug. 1135	Mars	141;4°	8 Aug., *c.*13:38h	141;25°
16 Oct. 1135	Mercury	208;51°	16 Oct., *c.*8;49h	209;43°
21 Dec. 1135	Saturn	275;39°	21 Dec., *c.*2;32h	274;50°
28 Jun. 1136	Jupiter	102;28°	28 Jun., *c.*12;6h	102;39°
8 Feb. 1137	Venus	326;32°	8 Feb., *c.*13;33h	325;53°
12 Sep. 1137	Mars	175;37°	12 Sep., *c.*11;14h	176;24°
4 Sep. 1138	Venus	168;27°	5 Sep., *c.*10;14h	166;46°

Tab. 3: combustion dates and ecliptic longitudes (λ)
in *P* (fol. 1r, 2r, 3r, 5r, 6r) compared with the Toledan Tables (TT)

III. *Further witnesses*

Other than in *P*, the same unusual assembly of combustion, solar, and ascension tables is also attested in MS Munich, Bayerische Staatsbibliothek, Clm 18927 (= *M*), which is a collection of astronomical tables and astrological texts formerly at Tegernsee Abbey.[41] The relevant unit of the manuscript (fol. 70r–129r) was written by a single hand in the second half of the twelfth century. It begins with the canon explaining the use of Table A for Mars (fol. 70r–71r), which is the only part of the rules in *P* included here. Next in line are Tables A for all five planets (fol. 71v–76r), which here appear in their standard order (Saturn, Jupiter, Mars, Venus, Mercury). Rather than following this up immediately with Tables B, the scribe in question used the next verso-page to begin a copy of the *Iudicia*, an astrological text that

[40] This is true, at any rate, if all dates are reckoned from midnight, as was the case with Raymond's adaptation of the Toledan Tables. See Raymond of Marseilles, *Liber cursuum planetarum* 2.1d, ed. d'Alverny, Burnett, Poulle, p. 200. The original Toledan Tables instead began the day from the previous noon.

[41] Descriptions: *The Toledan Tables*, ed. Fritz S. Pedersen, 4 vols., Reitzel, København 2002 (Det Kongelige Danske Videnskabernes Selskab, Historisk-filosofiske Skrifter, 24.1–4), vol. I, p. 136; David Juste, « MS Munich, Bayerische Staatsbibliothek, Clm 18927 (update: 24.02.2022) », *Ptolemaeus Arabus et Latinus. Manuscripts*, <http://ptolemaeus.badw.de/ms/87> (Accessed 29 Nov. 2023). The manuscript is available at <https://www.digitale-sammlungen.de/en/view/bsb00047479?page=,1> (Accessed 29 Nov. 2023).

combines an introductory treatise with an extensive set of rules for interrogations.[42] Tables B (fol. 78r–92r), the table for the solar longitude (fol. 94r–97r), and the full set of ascension tables known from *P* (fol. 98v–120r) are all embedded at different points in this copy.

Since the tables and the text occasionally share leaves (fol. 92 and 120) or even a single page (fol. 97r), it is clear that this arrangement did not result from a binding accident, but was deliberate. The scribe responsible for this part of *M* effectively presents the combustion tables and the *Iudicia* as one cohesive work. Compared to *P*, the tables for right and oblique ascensions are here presented in a much tidier and more user-friendly format. Rather than being blended into a continuous sequence, each set of ascensions for a given degree of latitude occupies its own two-page spread (i.e., one verso and one recto page). *M*'s scribe copied the right ascensions (fol. 98v–99r) ahead of the oblique ascensions, as is also the case in *P*, but placed the normed right ascensions at the very end (fol. 119v–120r).

The *Iudicia* are extant in two significantly different versions, of which one is usually attributed to Ptolemy, the other to Aristotle. *M* transmits the pseudo-Ptolemaic version of the text, which was also the main source for Raymond of Marseilles's *Liber iudiciorum* (*c.*1141), an astrological companion work to the *Liber cursuum planetarum*. It seems interesting to note in this context that Raymond's *Liber cursuum* contains a passage ridiculing users of « certain apocryphal books falsely issued under Ptolemy's name », who adhere to these unreliable sources with such fervour that « they not only do not care to accept the truth of the heavens, but also reject in every way the possibility that the positions of the planets might be different from what is contained in [those books]. »[43] Raymond's condemnation of these astronomical pseudo-Ptolemaica is followed immediately by the much longer passage warning readers about the combustion tables and boasting about his successful refutation of the two astrologers. The way he segues into this discussion creates a strong implication that the combustion tables were

---

42 On the *Iudicia*, see the description and bibliography in David Juste, « Pseudo-Ptolemy, *Iudicia* (update: 10.03.2022) », *Ptolemaeus Arabus et Latinus. Works*, <http://ptolemaeus.badw.de/ms/483> (Accessed 29 Nov. 2023). The version in *M* substitutes the *Iudicia*'s final chapters with the pseudo-Aristotelian text *De luna* (fol. 129r–v), on which see David Juste, « Les textes astrologiques latins attribués à Aristote », *Micrologus*, 21 (2013), p. 145–164 (156–157), and the critical edition with translation in Charles Burnett, « *Nīranj*: A Category of Magic (Almost) Forgotten in the Latin West », in Claudio Leonardi, Francesco Santi (eds.), *Natura, scienze e società medievali: Studi in onore di Agostino Paravicini Bagliani*, SISMEL–Edizioni del Galluzzo, Florence 2008 (Micrologus Library, 28), p. 37–66 (56–65).

43 Raymond of Marseilles, *Liber cursuum planetarum* 1.24a, ed. d'Alverny, Burnett, Poulle, p. 148: « Sunt enim nonnulli qui quorumdam apocriphorum libros Ptolomei nomine falso pretitulatos habentes, adeo diligenter eos amplectuntur, tantaque religione venerantur et autenticant ut non solum ipsius firmamenti veritati adquiescere non curant sed etiam planetarum cursus aliter esse posse quam in eis contineatur, modis abnuant omnibus. »

themselves an example of the pseudo-Ptolemaic sources he laments in the preceding paragraph.[44]

That our tables were closely linked with the *Iudicia* in a way that went beyond their singular presentation in *M* is further suggested by a twelfth-century commentary on the pseudo-Ptolemaic text, which is transmitted alongside rules for the specific solar and ascension tables found in *M* and *P* (see Part VII). An additional sign of this association may be detected in the rule for Saturn in *P*, which starts off with using *turris* in place of *signum* to mean zodiacal sign.[45] This use of the term, which is explicable as a calque on the Arabic *al-burj* (« tower »), is a hallmark the *Iudicia* and other texts derived from it, but otherwise rather unusual.[46]

It might have been possible to explore this association even further were it not for the loss of MS Chartres, Bibliothèque municipale, 213 (s. XII), which was destroyed during the Second World War.[47] While the manuscript itself is no longer available for examination, the nineteenth-century catalogue description records a text with the same incipit as the *Iudicia* (« Signorum alia sunt masculini generis, alia sunt feminini… ») on fol. 41r. What follows on fol. 63r is an unidentified work starting « Incipit de planetarum coniunctione. Si Saturnus et Iuppiter… » The catalogue characterizes this work as « Tableaux astrologiques » allegedly composed in 1136 and followed by some observations for the years 1139 and 1140. To this, the cataloguers add the surmise that this was « peut-être le traité d'Aben-Eyzor, rabbin du XII^e^ siècle. »[48] The reasoning behind this suggestion is unfortunately opaque, especially as there is no indication of where in the

---

44 RAYMOND OF MARSEILLES, *Liber cursuum planetarum* 1.25a, ed. D'ALVERNY, BURNETT, POULLE, p. 148: « His dictis, nullatenus silentio preterire dignum credimus, in quo libri quorumdam astrologorum quos nostris temporibus vidimus sint vitiosi, ideo precipue ne in reliquum aliquem simplicem, si in manu ejus devenerint, errare faciant. »

45 *P*, fol. 1r: « Quicumque veraciter nosse desiderat turrem et gradum et puncta ubi sit Saturnus, diligenter attendet ubi perussit eum Sol. Et sciat omnes dies Saturni, que sunt CCCLXXXI. Ac noscat menses illius ab incensione, qui XIII scribuntur et unicuique de XII turribus aponuntur, sicut ratio subscripta monstrabit. » These are the only two occurrences of *turris* in the text.

46 An independent attestation of this calque is ADELARD OF BATH, *De opere astrolapsus*, ed. BRUCE GEORGE DICKEY, « Adelard of Bath: An Examination Based on heretofore Unexamined Manuscripts », Ph.D. diss., University of Toronto, 1982, p. 153, which refers to the zodiac as *circulus turrium*. See also DAVID JUSTE, *Les* Alchandreana *primitifs: études sur les plus anciens traités astrologiques latins d'origine arabe (X^e^ siècle)*, Brill, Leiden 2007 (Brill's Studies in Intellectual History, 152), p. 94, 652.

47 See JEAN-PATRICE BOUDET, « Chartres, BM, ms. 213 (ancien 169) – détruit (1944) », <https://www.manuscrits-de-chartres.fr/sites/default/files/fileviewer/documents/notices-detaillees/chartres-bm-ms-213_notice_jp-boudet.pdf> (Accessed 29 Nov. 2023).

48 H. OMONT, A. MOLINIER, C. COUDERC, E. COYECQUE, *Catalogue général des manuscrits des bibliothèques publiques de France: Départements*, vol. XI, *Chartres*, Plon, Paris 1890, p. 109. See also Charles Burnett, « The Contents and Affiliation of the Scientific Manuscripts Written at, or Brought to, Chartres in the Time of John of Salisbury », in MICHAEL WILKS (ed.), *The World of John of Salisbury*, Blackwell, Oxford 1984 (Studies in Church History: Subsidia, 3), p. 127–160 (140).

manuscript the name Aben-Eyzor appeared. It is, at any rate, similar to a garbled Latin form of the name of the ninth-century astrologer Sahl ibn Bishr that Raymond of Marseilles used in his writings (*Abeneisar*).[49] A further important hint as to the content of the « Tableaux astrologiques » was left by Charles Homer Haskins, who had been able to consult the manuscripts some decades prior to its destruction. According to his brief published remarks, fol. 63r–141v were taken up with « a treatise on astrology containing Arabic words which dates from 1135, with notes added from 1137 to 1141 ».[50] As evidence of the date, Haskins cites a sentence on fol. 116r mentioning a combustion of Venus on 1 July 1135: « In hoc anno quando erant anni a nativitate Christi M.C.XXXV. in kal. iulii fuit Venus incensa in Cancro. »[51] This happens to be identical with a sentence included in the combustion tables' canon for Venus, as found in *P* on fol. 6r.

In addition to the full set of tables preserved in *M* and *P*, one finds less complete representations of the same work in the following three manuscripts:

- D = Darmstadt, Universitäts- und Landesbibliothek, 765, fol. 181r–188v (s. $XIII^{1/2}$).[52] Fol. 181r–188r are a fragment of the second half of the tables for oblique ascensions, starting from Gemini at 40° latitude (fol. 17r–25r in *P*). The bifolium 185r–186v was bound out of sequence and has its proper place ahead of fol. 181r–184v. Fol. 188v has the first half of the table of normed right ascensions, which here appears after the oblique ascensions, as is also the case in *M*. A later hand (s. XIV/XV) noted at the head of fol. 181r that the subsequent tables are of no great value (« Istae tabulae sequentes non sunt magni valoris »).

- O = Oxford, Corpus Christi College, 233, fol. 97r–v, 101r–114v (s. $XIII^{2/2}$).[53] This manuscript preserves the full set of Tables A and B for the planets as

---

49 This was pointed out by Lemay, *Abu Maʿshar*, p. 144 (see footnotes); Burnett, « The Contents », p. 135–136. For Raymond's references to *Abenbeisar*, see Raymond of Marseilles, *Liber cursuum planetarum* 1.97, ed. d'Alverny, Burnett, Poulle, p. 194; Id., *Liber iudiciorum* (MS Paris, Bibliothèque nationale de France, lat. 16208, fol. 24va). Boudet, « Chartres », p. 2–3, instead suggests identifying Aben-Eyzor with Ibn al-Bāzyār, to whom Abū Maʿshar's treatise *On the Great Conjunctions* was frequently ascribed. He also raises the possibility that Raymond of Marseilles annotated the manuscript in question.

50 Charles Homer Haskins, *Studies in the History of Mediaeval Science*, Harvard University Press, Cambridge (Mass.) 1924, p. 90.

51 Haskins, *Studies*, p. 90 (n. 45).

52 Description: *The Toledan Tables*, ed. Pedersen, vol. I, p. 104–105. The manuscript is available at <http://tudigit.ulb.tu-darmstadt.de/show/Hs-765> (Accessed 29 Nov. 2023).

53 Descriptions: *The Toledan Tables*, ed. Pedersen, vol. I, p. 150–151; David Juste, « MS Oxford, Corpus Christi College, 233 (update: 01.03.2022) », *Ptolemaeus Arabus et Latinus. Manuscripts*, <http://ptolemaeus.badw.de/ms/483> (Accessed 29 Nov. 2023).

well as the solar table, but lacks the ascension tables. The scribe used Hindu-Arabic instead of Roman numerals throughout.

- W = Wolfenbüttel, Herzog-August-Bibliothek, Cod. Guelf. 51.9 Aug. 4° (3549), fol. 102r–108v (s. XIII).[54] This is a 14-page fragment limited to Tables A/B for Saturn and Jupiter. Table A for Jupiter is incomplete, finishing at day 180. A section on the astrolabe (fol. 91v–101v: Hermann of Reichenau, *De constructione astrolabii*; *De utilitate astrolabii*) separates the tables from a copy of the *Iudicia* (fol. 69r–91r), albeit in the alternative version that in other manuscripts comes with an ascription to Aristotle.

The contents of all the witnesses mentioned thus far – *DMOPW* – are summarized in Tab. 4, which gives the precise folio-numbers for each individual table.

	D	*M*	*O*	*P*	*W*
Saturn A	--	71v–72r	97r	1r	102r–v
Saturn B	--	78r–80r	103r–104r	1v–2r	103r–106r
Jupiter A	--	72v–73r	97v	2r	106v–107r
Jupiter B	--	80r–82r	104r–105v	2v–3r	107r–108v
Mars A	--	73v–74r	98r–v	3v	--
Mars B	--	82v–86v	106r–109r	4r–5r	--
Venus A	--	74v–75r	101r–v	6v	--
Venus B	--	87r–90r	110v–113r	7r–v	--
Mercury A	--	75v–76r	102r–v	5v	--
Mercury B	--	90v–92r	109r–110v	5v–6r	--
Sun	--	94r–97r	113r–114v	8r–v	--
RA	--	98v–99r	--	9r–v	--
NRA	188v	119v–120r	--	9v–10r	--
OA	181r–188r	99v–119r	--	10v–25r	--

Tab. 4: synopsis of the tables present in manuscripts *DMOPW*; RA = right ascensions; NRA = normed right ascensions; OA= oblique ascensions

IV. *Abraham Ibn Ezra on combustion tables*

Raymond of Marseilles's polemic in the *Liber cursuum planetarum* is not the only external testimony on the subject of combustion tables to have survived from the

[54] Description: Otto von Heinemann, *Die Augusteischen Handschriften*, vol. V: *Codex Guelferbytanus 34.1 Aug. 4° bis 117 Augusteus 4°*, Klostermann, Frankfurt am Main 1966 [1903] (Kataloge der Herzog-August-Bibliothek Wolfenbüttel: Die alte Reihe, 8), p. 58–59.

twelfth century. A second relevant source is Abraham Ibn Ezra's Latin *Liber de rationibus tabularum* (1154), which contains the following brief passage:

> Et cum Mars est in alto loco brevis circuli semper ibi soli adunatus, tunc iter eius velocissimum est secundum firmamentum, et ideo quidam inchoant tabulas Martis a combustione eius, et iste tabule vere sunt cum Mars combustum fuerit in 11 gradibus scorpionis vel tauri. Quia hec duo loca per quadratum a loco alto distant. Qui<a> cum combustus est in alto loco, iter eius tardum est ut omnium aliorum planetarum ut sit minus 40 minutis. Cum vero in humili loco combustus citum est iter eius, ut etiam sit plus 45 minutis, et ideo semper false sunt tabule eorum.[55]
>
> And when Mars is at the apogee of the epicycle, at which point it is always in conjunction with the Sun, then its path with respect to the firmament is at its fastest, and for this reason some begin tables for Mars from its combustion. And these tables are accurate provided Mars was combust at 11° of Scorpio or Taurus, because these two positions are one quadrant away from the apogee. For when [Mars] is combust at the apogee, its path is slow, as with the other planets, such that it is less by 0;40°. But when it is combust at the perigee, its path is fast, such that it is greater even by 0;45°. And so it follows that their tables are always false.

Much like Raymond of Marseilles before him, Ibn Ezra seems familiar only with the type of combustion table represented by Tables B. In fact, he claims that the values shown in such tables are « always false » unless the previous combustion occurred with Mars positioned at one of the « quadrants » or mid-points between

[55] Abraham Ibn Ezra, *Liber de rationibus tabularum*, ed. José María Millás Vallicrosa, *El libro de los fundamentos de las Tablas astronómicas de R. Abraham Ibn ʿEzra*, CSIC, Madrid 1947 (Instituto Arias Montano, Ser. D, 2), p. 119, ll. 12–20. I made one emendation to this passage on the basis of MS Oxford, Bodleian Library, Digby 40, fol. 70v. On the *Liber de rationibus tabularum* and the question of its authorship, see José María Millás Vallicrosa, « Sobre la autenticidad de una obra astronómica de R. Abraham ibn 'Ezra », *Isis*, 40 (1949), p. 32–33; Aleksander Birkenmajer, « À propos de l''Abrahismus' », *Archives internationales d'histoire des sciences*, 3 (1950), p. 378–390; Shlomo Sela, « Contactos científicos entre judíos y cristianos en el siglo XII: el caso del *Libro de las tablas astronómicas* de Abraham Ibn Ezra en su versión latina y hebrea », *Miscelánea de Estudios Árabes y Hebraicos*, Sección de Hebreo, 45 (1996), p. 185–222; Id., « Algunos puntos de contacto entre el *Libro de las tablas astronómicas* en su versión latina y las obras literarias hebreas de Abraham Ibn Ezra », *Miscelánea de Estudios Árabes y Hebraicos*, Sección de Hebreo, 46 (1997), p. 37–56; Id., *Abraham Ibn Ezra and the Rise of Medieval Hebrew Science*, Brill, Leiden 2003 (Brill's Series in Jewish Studies, 32), p. 23–27; Renate Smithuis, « Science in Normandy and England under the Angevins: The Creation of Abraham Ibn Ezra's Latin Works on Astronomy and Astrology », in Giulio Busi (ed.), *Hebrew to Latin, Latin to Hebrew: The Mirroring of Two Cultures in the Age of Humanism; Colloquium Held at the Warburg Institute, London, October 18–19, 2004*, Aragno, Turin 2006 (Berlin Studies in Judaism, 1), p. 23–59; Julio Samsó, « 'Dixit Abraham Iudeus': algunas observaciones sobre los textos astronómicos latinos de Abraham Ibn 'Ezra », *Iberia Judaica*, 4 (2012), p. 171–200; C. Philipp E. Nothaft, *Graeco-Arabic Astronomy for Twelfth-Century Latin Readers:* Ptolomeus et multi sapientum *(Abraham Ibn Ezra Latinus) — Robert of Chester,* Liber canonum*, pt. ii.*, Brill, Leiden 2023 (Time, Astronomy, and Calendars: Texts and Studies, 12), p. 13–23.

the apogee and perigee of its deferent, which entirely ignores the option of deriving a correction via Table A. He associates these quadrants with ecliptic longitudes of 221° (11° Scorpio) and 41° (11° Taurus), while a later passage in the same treatise puts Mars's apogee at 131° (11° Leo).[56] While the mutual derivation of these values is clear enough (131° + 90° = 221° and 131° – 90° = 41°), Ibn Ezra's specific comment on the quadrants elides the fact that the equation of centre is positive at one of the quadrants (90°), but negative at the other (360° – 90° = 270°). This difference implies divergent patterns of longitude increase for the synodic periods beginning at these two points. Ibn Ezra accordingly seems mistaken in suggesting that Table B for Mars can give accurate sets of values for combustions at either quadrant rather than just one of them.

A – *prima facie* – convenient way of narrowing down the initial position for which a given Table B was constructed would be to consider the signs or degrees for which the corresponding Table A shows no correction. In the case of *P*'s table for Mars, the column for Taurus displays a zero value across all rows. If this is read together with the computational rules in the corresponding canon (see Appendix), the implication seems to be that Mars's Table B was cast for a combustion at or near 0° Taurus = 30°, whereas Ibn Ezra's remarks suggest 11° Taurus.[57] Saturn's correction in Table A is zero for all combustions in Gemini and Cancer. Jupiter has a zero value in the same two signs, but only in the first month after the combustion. Venus's zero-value column is that for Sagittarius, while Mercury lacks a correction in Aries as well as in Gemini. With the possible exception of Mars, there seems to be no meaningful connection between these various signs in Table A and the apogees/quadrants of the corresponding planetary deferents.[58]

Rather than considering these positions, the originator of the combustion tables may have simply computed each Table B for a specific synodic period in the recent past, after which he added Table A to account for alternative initial longiudes. This, however, can be no more than a hypothesis at this stage. Further analysis will be required to unravel more fully the construction principles and parameters that underlie these unusual planetary tables.

56 Abraham Ibn Ezra, *Liber de rationibus tabularum*, ed. Millás Vallicrosa, p. 120, l. 23.
57 Raymond of Marseilles confirms this in an approximate sense when he notes that Table B for Mars was computed for a combustion in the « last part » of Aries. See above, n. 13.
58 According to the Toledan Tables, the planetary apogees would have had the following tropical longitudes at the end of AD 1135: 247;56° (Saturn), 172;21° (Jupiter), 129;41° (Mars), 85;41° (Venus), 205;21° (Mercury).

V. *Martin of Pamplona's supplementary canon*

MS Vienna, Österreichische Nationalbibliothek, 2385 (s. XIII$^{1/2}$) preserves on fol. 43r a brief canon explaining how to compute the date and longitude of a planet's combustion given knowledge of the date and longitude of the preceding combustion. It runs as follows:

> Cum igitur scire atque extrahere combustionem volueris, accipe combustionem transactam et vide in quo signo sit quilibet planetarum combustus et ab eo signo incipe, id est accipe gradum illius signi in combustione transacta et puncta similiter. Deinde accipe gradum et puncta ultime linee ultimi mensis cuiusvis planete et hos gradus mensis et signi, id est transacte combustionis, iunge.
>
> Postea cum signo in quo transacta fuit combustio intra in tabulam equationis planete eiusdem et curre ad ultimam in directo eiusdem signi et cape gradus et puncta que ibidem invenies. Sed ore sagaci perspice: si ibi invenies « M », minues hos gradus de primis gradibus adiunctis, et si inveneris eodem « I », hos gradus et primos adiunctos coniunges et[59] puncta similiter.
>
> Deinde vide in qua mense fuerit transacta combustio et cape a die transacte combustionis omnes eos dies qui sunt a die combustionis usque ad finem mensis illius. Similiter dies proficui capies et omnes hos et eos dies perfecte iunges, hoc tamen excepto quod de diebus proficui dabis duos Februario ut 30 permaneat diebus. Et hoc omni anno facies, id est dabis duos dies Februrario de proficuo, excepto anno tituli bisextili. Tunc autem dabis Februario de proficuo nisi unum diem, quia eo anno constat ex 29 diebus. Et ei da unum diem de proficuo et erit 30 factus. Sicque diebus proficui, exceptis duobus vel uno datis Februario, et diebus remanentibus a die combustionis transacte usque in finem mensis, scilicet hiis et illis diebus adiunctis, <numera> omnes menses. Unusquisque scilicet eorum ex 30 diebus permanebit. Et incipies numerare menses planete de quo facis combustionem. Sed non numerabis menses ab eo mense in quo fuerit transacta combustio, sed ab alio incipies.
>
> Verbi gratia: anno 1219 imperfecto Saturnus fuit combustus in Scorpione 15 gradu, 5 puncto prima[60] die Novembris. Dimitte ergo Novembrem et cape Decembrem et numera ab eo, id est, cum eo, et numera menses planete perfectos quotquot fuerint, quia quidam planetarum habet 13 perfectos et de 14 partem, ut Iupiter, Mars autem XXVII, et sic de reliquis ut in eisdem tabulis que « combustionis » intitulantur reperies. Et in ultimo mense planete resiste, id est resta, et da ei mensi dies mensis alterius, id est transacte combustionis, et dies proficui adiunctos. Et in eodem mense et eodem die quo numerus defecerit erit altera, id est presens, combustio quam conficere tractas.

[59] et] prima *addidit sed delevit*
[60] prima] a

Et si veritatem super hoc certissime nosse laboras, id est qua die illarum sit combustio, intra[61] in tabulam uniuscuiusque mensis et diei que constituta est in utero almanac vel etiam in almanac sapientissimi Ptolomei, vel etiam in eisdem tabulis combustionis, et vide qua die illarum invenies Solem in eo gradu eiusdem signi in quo est presens, id est a te facta, combustio. Verbi gratia: si combustio fuerit in mense Iunii, ut anno 1219[62] imperfeco fuit Iupiter in Cancro combustus 14 gradu et puncto 30 die Iunii, vide in predicta tabula vel Ptolomei almanac vel earum tabularum combustionis qua die Iunii fuerit Sol <in eodem gradu> et p<uncto> eiusdem signi, id est Cancri. Eodem die erit presens, id est per te facta, combustio certissime.

Et quod dictum est partim specialiter, generale dictum est de planetis quinque a Martino Pampilon<ensi> qui hunc canonem ad honorem cuiusdam domine Dies nomine composuit.

If you wish to know and extract a combustion, take a past combustion and see in which sign any of the planets is combust, and start from that sign, i.e. take the degree of that sign at which the past combustion [occurred] and similarly, the points. Take next the degree and points of the last line of the last month of whatever planet, and add together the degrees of the month and of the sign, i.e. [of the sign] of the past combustion.

Afterwards use the sign in which the past combustion occurred to enter the table of the planet's equation and proceed to the last [entry] belonging to the same sign, and take the degrees and points that you find there. But note the following with keen discernment: if you find « M » there, subtract these degrees from the degrees that you previously added together, and if you find « I » in the same place, join these degrees together with the previous ones, and likewise the points.

Next, see in which month the past combustion occurred and take all the days from the day of the past combustion up to the end of that month. Similarly, you will take the days of the profit [*dies proficui*] and you will perfectly join together these and those ones, with the exception that of the days of the profit you will give two to February so that it lasts 30 days. And you will do this every year, i.e. you will give two days of the profit to February, except in a leap year. In that case, you will give February only one day of the profit, because in that year it consists of 29 days. So, give it one day of the profit and it will become 30 days. In this way, after adding together the days of the profit, except for two or one given to February, and the days that remain from the day of the past combustion until the end of the month, [count] all the months. Each of them will last 30 days. And you will start counting the months of the planet for which you are calculating the combustion. However, you will not count the months from the month in which the last combustion took place, but instead you will begin from the next one.

For example, in the incomplete year 1219, Saturn was combust in Scorpio at 15 degrees and 5 minutes on the first day of November. Therefore, skip November and take December and count from it, i.e. with it, and count the complete months of the

[61] intra] *geminit*
[62] 1219] fuit *addidit sed delevit*

> planet, as many as there may be, because some planets have thirteen complete months and a part of the fourteenth, like Jupiter, while Mars has 27, and so on for the others, as you will find in the same tables titled « of the combustion ». And in the last month of the planet, pause, i.e. rest, and give it the sum of the days of the other month, i.e. the one of the past combustion, and the [remaining] days of the profit. And in the same month and on the same day at which the count runs out, there will be another combustion, i.e. the present one that you are seeking to calculate.
>
> And if you strive to know the truth about this with the utmost certainty, i.e. on which of day of those the combustion occurs, enter a table for each month and day that was placed in the womb of an almanac or also in the almanac of Ptolemy, the most wise, or also [a table] in the very same tables of combustion, and see on which day of those you will find the Sun at the same degree of the same sign in which the present combustion, i.e. the one calculated by you, occurs. For example, if the combustion was in the month of June, as in the incomplete year 1219, when Jupiter was combust at 14 degrees and 30 minutes in Cancer on the 30th day of June, look in the aforementioned table or in Ptolemy's almanac or in [a table contained in] these tables of combustion for the day in June when the Sun was in the same degree and minute of the same sign, i.e. of Cancer. On that same day, the present combustion, i.e. the one calculated by you, will undoubtedly occur.
>
> And what has for the most part been said specifically is said generally about the five planets by Martin of Pamplona, who composed this rule in honour of a lady named Díez.

The computational procedure described in this canon relies on a set of « combustion tables » (*tabulae combustionis*), which are clearly very similar to those in *P*. After a general rule of how to operate with these tables, the author gives an example based on a combustion of Saturn in November 1219. He also briefly explains how to verify the result by computing the concomitant position of the Sun, for which he uses the example of a combustion of Jupiter in June 1219. In both cases the date is expressed in the past tense (*fuit*), which suggests that the canon itself was written in 1220, or perhaps even slightly later. At the very end the author identifies himself as a certain Martin of Pamplona, who composed the foregoing canon in honour *cuiusdam domine dies nomine*, which I am inclined to interpret as « of a certain lady named Díez ». Both names strongly suggest an Iberian origin for this canon.

Martin's canon can be interpreted as a supplement to the canons in *P* insofar as it demonstrates how the Tables A and B might be harnessed to extract future combustions from those already known or recorded in the text. The first step in the procedure is to add the final entry of Table B to the longitude of the known combustion. Martin uses the same division of the sign into *gradus* and *puncta* that is familiar from the sources discussed so far. However, his specific wording, « take the degree and points of the last line of the last month » (« accipe gradum et puncta ultime linee ultimi mensis ») seems to suggest a table that divides the time since the last conjunction into months as well as days. This is not the case in Tables B as found in the known manuscripts, which only use a continuous count of days.

The second step is to enter Table A, which is here referred to as the « table of the equation » (*tabula equationis*), with the last month on display and the sign of the known combustion. Whatever correction appears in this position will be added or subtracted from the previous sum. The text mentions no interpolation rules for the specific day of the month or degree of the sign (as in the rules or Mars). What follows instead is a rule for converting the total number of days between the last combustion and the present one whose date is being sought into a number of Julian months. While the rule operates on the assumption that each month in the Julian calendar numbers 30 days, it does acknowledge that the number of days used in the calculation needs to be reduced by two days (in a Julian common year) or one day (in a bissextile year) to account for the fact that February is always shorter than 30 days. There is no similar caveat for Julian months that last 31 days, which raises questions about the soundness of the procedure that is being prescribed here. Another striking feature of this part of the text is the repeated use of the word *proficuum* (« profit »), whose meaning in this specific context is left undefined. In all likelihood, it was here intended to refer to the number of days that remain between the end of the month in which the last combustion took place and the date of the present one. This strange terminological choice is somewhat reminiscent of the rules for Mars preserved in *P* and *M*, where the adjective *proficuus* refers to the subtractive difference between the corrections for two adjacent signs in Table A.

Martin illustrates the rule by citing a past combustion of Saturn on 1 November 1219 at 225;5° (assuming that « 15 gradu, 5 puncto » is here to be understood as completed degrees and points). The Toledan Tables would show a tropical true solar longitude of 225;5° at *c.*3;15h of 1 November 1219, with a concomitant Saturn longitude of *c.*226;14°. In summarizing the procedure, Martin indicates that the combustion tables for Jupiter and Mars respectively display 13 and 27 complete months, which indeed matches the known layouts of Tables A for these planets.

The final segment of this canon describes a verification process for the date of the present combustion that is based on the independently computed position of the Sun. Martin here mentions three different types of astronomical tables that might be used for this verification:

(1) « a table for each month and day that was placed in the womb of an almanac » (« tabulam uniuscuiusque mensis et diei que constituta est in utero almana »)
(2) « the almanac of Ptolemy, the most wise » (« almanac sapientissimi Ptolomei »)

(3) « in the very same tables of combustion » (« in eisdem tabulis combustionis »).

The third reference is undoubtedly to something resembling our set of combustion tables, and more specifically to solar tables like those placed after the planetary tables in *MOP*. It is much more difficult to interpret the first reference, especially since the phrase « constituta ... in utero almanac » leaves it open whether the table described was simply part of an « almanac » or somehow « made » (« constituta ») with the help of one. In Latin texts of the twelfth and thirteenth centuries, the term « almanac » was most typically used to refer to ephemerides that showed, at a glance, the true positions of the planets for every day of the year (« for each month and day »).[63] Assuming that this is what Martin intended by « almanac » in the first instance, the « table ... placed in the womb of an almanac » is most plausibly interpreted as the column(s) for the Sun within a larger set of ephemerides.

If this is indeed so, the « almanac of Ptolemy » mentioned in second place is likely to be a wholly different type of tabular work. The most obvious candidate for such a work is a perpetual almanac based on « goal-year » periods, as was redacted in the late eleventh century by the Andalusian astronomer Ibn al-Zarqālluh.[64] A rudimentary twelfth-century Latin translation of this almanac survives in MS London, British Library, Royal 7.F.VIII, fol. 180r–191r (s. XIII$^{2/2}$), where the work in question is headed « The tables of the [planetary] positions by the Saracen [named] Amenuz, teacher of the daughter of King Ptolemy, which al-Zarqālluh [*Azarchellus*] converted from Egyptian years to the years of Alexander the Great. » A second heading inserted below it contradicts this attribution, however, as here the tables are labelled « The tables of Ptolemy that he himself taught to Cleopatra, his own daughter. »[65] The reference to *Amenuz* in the first heading derives from Ibn al-Zarqālluh's Arabic version of the same almanac, which

63 C. Philipp E. Nothaft, « Ephemerides in High Medieval Europe: The Textual Evidence », *Journal for the History of Astronomy*, 52 (2021), p. 33–52.

64 An edition and Spanish translation of this almanac and its canons was included in José Maríá Millás Vallicrosa, *Estudios sobre Azarquiel*, CSIC, Madrid 1943–1950, p. 72–237. See also the discussions in John D. North, *Richard of Wallingford: An Edition of His Writings, with Introductions, English Translation and Commentary*, 3 vols., Clarendon Press, Oxford 1976, vols. 3, p. 248–250; Julio Samsó, *Las ciencias de los antiguos en Al-Andalus*, Editorial MAPFRE, Madrid 1992, p. 168–171; Id., *On Both Sides*, p. 880–883.

65 MS London, British Library, Royal 7.F.VIII, fol. 184r: « Tabule locorum Saraceni Amenuz magistrum [*sic*] filie regis Ptholomei quas Azarchellus mutavit de annis Egipciorum ad annos Alexandri magni. Tabule Ptholomei quas ipse docuit Cleopatram filiam propriam. » For a second copy of this translation, see MS Erfurt, Universitätsbibliothek, Dep. Erf. CA 8° 81, fol. 1r–23v (s. XIII$^{2/2}$).

identifies the original author as Awmātiyūs.[66] A new Latin recension of the almanac's Latin version was eventually produced in Paris in 1239 by a certain John of Pavia, whose canons render Awmātiyūs's name as *Humenus* or some other variant such as *Humeniz*. They also repeat the claim that this *Humenus* was the teacher of Ptolemy's daughter, while adding the new one according to which he created the almanac at her request after her father had died.[67]

The contradicting claim in the London manuscript, according to which it was Ptolemy himself who composed this or a similar work, emerges also from a brief text contained in MS Vatican City, Biblioteca Apostolica Vaticana, Vat. lat. 5714, fol. 103v (Northern Italy; s. XIII), which purports to give the « doctrine of the tables that Ptolemy composed based on years of the Greeks and that another individual arranged for Latin [years] ».[68] Some of the features mentioned in the text, such as the intervals at which the tables show planetary longitudes, comport with Ibn al-Zarqālluh's almanac. At the same time, however, the tables for the five planets are claimed to share an epoch on 1 January 1226, which is not the case with any of the known almanacs.[69] Of the tables for the Moon it is said that they start in 1152 and that the current year is the 78th « year of the Moon ». This would date the text to

---

[66] It is unclear if this a reference to the Alexandrian Neoplatonic philosopher Ammonius (d. 517/526). See OTTO NEUGEBAUER, *An Astronomical Almanac for the Year 348/9 (P. Heid. inv. no. 34)*, Munksgaard, Copenhagen 1956 (Historisk-filologiske Meddelelser udgivet af Det Kongelige Danske Videnskabernes Selskab, Bind 36, no. 4), p. 15; ID., *A History*, p. 1037; SAMSÓ, *On Both Sides*, p. 880.

[67] JOHN OF PAVIA, *Canones super tabulas Humeniz philosophi summi egipciorum*, in JOSÉ MARÍA MILLÁS VALLICROSA, *Estudios sobre Azarquiel*, CSIC, Madrid 1943–1950, p. 379–380: « Sciendum quod Humeniz philosophus summus egipciorum, magister filie Ptholomei, composuit istas tabulas equacionum planetarum […]. Composuit autem Humeniz hos canones super annos grecorum post obitum Ptholomei rogatu filie ipsius Ptholomei. » See also MS Vatican City, Biblioteca Apostolica Vaticana, Pal. lat. 1410 (s. XIII$^{2/2}$), fol. 1ar: « Traditione antiquorum fuit quidam philosophus Eumenus nomine Ptolomei regis discipulus, qui per impetrationem Cleopatre predicti regis filie composuit hunc libellum de equatione 7 planetarum vocavitque eum cavulum(?). » This text appears on a parchment scrap that was inserted into a thirteenth-century copy of John of Pavia's version.

[68] MS Vatican City, Biblioteca Apostolica Vaticana, Vat. lat. 5714, fol. 103v: « Hec est doctrina tabularum quam Ptolomeus composuit super annos Grecorum et quidam alius super Latinos ordinavit. » For a description of the manuscript, see DAVID JUSTE, « MS Vatican, Biblioteca Apostolica Vaticana, Vat. lat. 5714 (update: 15.11.2022) », *Ptolemaeus Arabus et Latinus. Manuscripts*, <http://ptolemaeus.badw.de/ms/294> (Accessed 29 Nov. 2023). The manuscript is available at < https://digi.vatlib.it/view/MSS_Vat.lat.5714> (Accessed 29 Nov. 2023).

[69] MS Vatican City, Biblioteca Apostolica Vaticana, Vat. lat. 5714, fol. 103v: « Tabule itaque Iovis, Saturni, Martis, Veneris et Mercurii incipiunt anno incarnationis dominice M°CC°26° prima die Ianuarii et est ille annus incarnationis primus tabularum istarum. »

1229, which harmonizes with the previous statement that the current year is the second year after a bissextile intercalation.[70]

VI. *A list of combustions*

The availability of combustion tables in twelfth-century Latin Europe explains a curious addition to an eleventh-century planetary diagram in MS Dijon, Bibliothèque municipale, 448, fol. 63v (*D*).[71] Below this diagram, a later hand recorded the dates and zodiacal locations of ten combustions for 1139–1141, which are all marked as events in the past (*ustus est* or *combustus est*):

> [1] Anno Mª.C.XLI a natiuitate ustus est Saturnus in Piscibus, IIII^{or} gra<dibus>, XXXVI punctis, XXIII s<ueni>is, XVII die Februarii.[72]
> [2] Anno Mª.C.XL a natiuitate ustus est Iupiter in Scorpione, XV gra<dibus>, LII punctis, XXVI s<ueni>is, prima die Nouembris.[73]
> [3] Anno Mª.XXXº.IXº a natiuitate ustus est Mars in Scorpione, VI gra<dibus>, LVI punctis, XXXVI s<ueni>is, XXIIII die Octobris.[74]
> [4] Anno Mª.C.XL usta est Venus in Tauro, XXXVII punctis, XVII s<ueniis>, L secundis sueniis, XIIII die Aprilis.[75]

---

70 MS Vatican City, Biblioteca Apostolica Vaticana, Vat. lat. 5714, fol. 103v: « Sol habet tabulas 4. Prima illarum currit in anno post bissextum et postea alia et sic usque ad 4 annos. Modo itaque currit secunda tabula Solis eo quod sumus in 2º post bisextum. Tabula lune incepit in anno domini MºCºLII. Modo currit annus lune 78. »

71 On this manuscript, see Colette Jeudy, Yves-François Riou, *Les manuscrits classiques latins des bibliothèques publiques de France*, vol. I: *Agen–Évreux*, Éditions du Centre National de la Recherche Scientifique, Paris 1989, p. 483–500; Arno Borst, *Schriften zur Komputistik im Frankenreich von 721 bis 818*, vol. I, Hahnsche Buchhandlung, Hannover 2006 (Quellen zur Geistesgeschichte des Mittelalters, 21), p. 224–225; Dieter Blume, Mechthild Haffner, Wolfgang Metzger, *Sternbilder des Mittelalters: Der gemalte Himmel zwischen Wissenschaft und Phantasie*, vol. I: *800–1200*, Akademie Verlag, Berlin 2012, p. 227–233. I would like to thank David Juste for bringing it to my attention.

72 The Toledan Tables would show a tropical true solar longitude of 334;36,23° for 16 February 1141 at *c.*14;46h. Since these tables reckon dates from previous noon, this would qualify as 17 February. The concomitant Saturn longitude is 334;18,18°.

73 The Toledan Tables would show a tropical true solar longitude of 225;52,26° for 1 November 1140 at *c.*11;16h. The concomitant Jupiter longitude is 225;30,19°.

74 The combustion date here deviates from that assumed by Raymond of Marseilles in the *Liber cursuum planetarum*, which was 27 October. The Toledan Tables would show a tropical true solar longitude of 216;56,36° for 24 October 1139 at *c.*09;19h, with a concomitant Mars longitude of 217;55,40°.

75 The Toledan Tables would show a tropical true solar longitude of 30;37,17,50° for 14 April 1140 at *c.*10;16h. The concomitant Venus longitude is 28;15,4°.

> [5] Eodem anno ustus est Mercurius in Cancro, XXVI gra<dibus>, XXI punctis, XVII s<ueni>is, XII die Iulii.[76]
> [6] Anno Mª.C.XLI a nativitate ustus est Mercurius in Cancro, VII gra<dibus>, XXXIIII punctis, LV s<ueni>is, XXXVIII secundis, XXIII die Iunii, quinta hora diei et in XXVII fract<ionibus> hore.[77]
> [7] Anno Mª.C.XLI a nativitate Christi combustus est Mars in Sagittario, XXIIII gradibus, XXVIIII punctis, LI sueniis, XVII die Decembris.[78]
> [8] Anno Mª.C.XLI a nativitate combustus est Iupiter in Sagittario, XVI gra<dibus>, LVI punctis, LXI [*sic*] sueniis, II die Decembris.[79]
> [9] Anno Mª.C.XLI a nativitate combustus est Venus in Scorpione, XXIX gra<dibus>, XII punctis, XXXV sueniis, XVII secundis, XXV [*sic*] die Novembris.[80]
> [10] Anno Mª.C.XLI a nativitate ustus est Mercurius in Cancro, VII gradibus, XXX punctis, XL sueniis, LVI secundis, XXIII die Iunii.[81]

The order in which the combustions are listed seems haphazard. If placed in chronological sequence, they extend from 27 October 1139 to 17 December 1141, which places this batch of combustions after any of those mentioned in *P* (1 July 1135 to 4 September 1138; see Tab. 3). The latter source records two successive Mars combustions on 8 August 1135 and 12 September 1137, which are 766 days apart. In the Dijon manuscript, we find the next two following Mars combustions of 24 October 1139 (772 days later) and 17 December 1141 (785 Days later). The entries in the Dijon list exhibit a certain lack of uniformity suggesting that the combustion dates and longitudes were not all arrived at by the same method. This is especially noticeable in the case of items [6] and [10], which concern the same Mercury combustion of 23 June 1141, but give longitudes that differ by more than 4 minutes of arc (97;30,40,56° vs. 97;34,55,38°). In fact, the first of these entries is

76 The Toledan Tables would show a tropical true solar longitude of 116;21,17° for 13 [!] July 1140 at *c.*2;8h. The concomitant Mercury longitude is 113;20,44°.

77 The Toledan Tables would show a tropical true solar longitude of 97;34,55,38° for 23 June 1141 at *c.*16;12h. This is 24 June according to these tables' way of counting days from the previous noon. The concomitant Mercury longitude is 92;1,15°.

78 A solar longitude of 264;29,51° on 17 December 1141 can only be reconciled with a sidereal reference frame. The Toledan Tables show a true sidereal solar longitude for 17 December at *c.*9;58h with a concomitant Mars longitude of 265;28,14°.

79 The Toledan Tables would show a tropical true solar longitude of 256;56,41° [my emendation] for 2 December 1141 at *c.*6;7h. The concomitant Jupiter longitude is 257;10,1°.

80 A solar longitude of 239;12,35,17° on 25 November indicates a sidereal reference frame. The Toledan Tables would show a true sidereal solar longitude of 239;12,35,17° for 22 November 1141 at *c.*15;16h. This is 23 November according to these tables' way of counting days from the previous noon. Perhaps « XXII die Novembris » was mistranscribed as « XXV die Novembris ». The concomitant Venus longitude is 238;36,49°

81 The Toledan Tables would show a tropical true solar longitude of 97;30,40,56° for 23 June 1141 at *c.*14;25h. This is 24 June according to these tables' way of counting days from the previous noon. The concomitant Mercury longitude is 91;53°.

the only one in this list that specifies a time of day, placing the combustion at 27 « fractions » of the hour (presumably sexagesimal minutes) of the fifth hour of the day. The terminology suggests seasonal as opposed to equinoctial hours.

A further inconsistency concerns the underlying reference frame for plotting ecliptic longitudes. In eight of the ten instances, the combination of solar longitude and calendrical date implies that the combustion was computed according to a tropical reference from (where 0° Aries is the vernal point), whereas one of the Mars combustions [7] and one of the Venus combustions [9] each seem to reflect a sidereal mode of reckoning. [82] Moreover, both of the Venus combustions [4, 9] as well as the two separate records for the Mercury combustion of 1141 [6, 10] are recorded with an elevated degree of precision, as the arc of longitude is here given to the third sexagesimal-fractional place. Little can otherwise be said about the computational methods that led to these various longitudes. A comparison with the Toledan Tables reveals approximate agreement for the combustions of the three superior planets, which these tables generally place within a degree from the Sun on the dates in question. The most serious discrepancy is encountered in the two records for the Mercury combustion of 23 June 1141, where the Toledan values for the Sun and the relevant planet differ by more than 5°.[83]

One area where the ten entries are strikingly consistent is that they all divide the zodiacal sign into *gradus* (degrees), *puncta* – or perhaps *puncti* – (minutes), and *sueniae* (seconds). The four entries whose precision reaches up to sexagesimal thirds additionally have *secunda* [4, 6, 9,10], which in the first instance [4] are given the fuller name *secunda sueniae*. Our combustion and ascension tables mirror this terminology insofar as they, too, divide the degrees into sexagesimal *puncta*. The earliest datable appearance of this use of *puncta* is in Petrus Alfonsi's Latin version of the *Sindhind Zīj* of al-Khwārizmī, which uses an epoch date of 1 October 1116.[84] A more unusual terminological choice on the part of the Dijon annotator is that of *suenia*, *-ae*. We are here probably dealing with a corrupt Latin transliteration of the Arabic *thāniya*, the plural of which is rendered as *elthenie* in Adelard of Bath's

82 See above, notes 78 and 80.

83 See above, notes 77 and 81.

84 See MS Oxford, Corpus Christi College, 283, fol. 114r–141v (s. XII), and OTTO NEUGEBAUER, *The Astronomical Tables of Al-Khwārizmī: Translation with Commentaries of the Latin Version ed. by H. Suter, Supplemented by Corpus Christi College MS 283*, Munksgaard, København 1962 (Det Kongelige Danske Videnskabernes Selskab, Historisk-filosofiske Skrifter, 4.2), p. 133–205. See also PETRUS ALFONSI, *Epistola ad peripateticos*, c. 4, in JOHN TOLAN, *Petrus Alfonsi and His Medieval Readers*, University Press of Florida, Gainesville 1993, p. 166. The abbreviations *G*, *P*, and *S*, which stand for *gradus*, *puncta/puncti*, and either *secunda* or *suenie*, are used in a unique copy of canons for a different version of al-Khwārizmī's tables, preserved in MS Cambridge, Fitzwilliam Museum, McClean 165, fol. 76v–77v. These canons contain a reference to AD 1162/63. See NOTHAFT, *Graeco-Arabic Astronomy*, p. 178–180.

translation of the *Sindhind Zīj*.[85] One of the manuscripts of this translation, now lost (Chartres, Bibliothèque municipale, 214), in one instance attests to the variant *zenie*, which bears a stronger resemblance with the word in the Dijon manuscript.[86]

To my knowledge, the only other source to attest to this specific use of *sueniae* and their further division into 60 *secunda sueniae* is MS London, British Library, Cotton Appendix VI, fol. 22vb (s. XIII/XIV), a manuscript to which I shall refer as *L* in what follows.[87] The text on this manuscript page belongs to a condensed excerpt from the first chapter of Walcher of Malvern's treatise *De Dracone*, which Walcher wrote in *c.*1120 to report the teachings of the aforementioned Petrus Alfonsi (*L*, fol. 22rb–23rb).[88] The excerpt is part of a larger chain of passages that open a commentary on the pseudo-Ptolemaic *Iudicia*, a text whose evident connections with the combustion tables have already been noted.[89] Although the commentary proper only begins on fol. 23vb, its beginning is already signalled in a heading on fol. 20va, which is then followed by a sequence of what could be considered « preliminary material »: a prologue on the science of the stars (fol. 20va–21ra),[90] a brief account of the division of the celestial sphere (fol. 21ra), some definitions of astronomical concepts such as stations and retrogradations (fol. 21r–b), a section headed *Capitulum de instructione anni secundum Ptolomeum* and concerned with the use of ascension tables (fol. 21rb–22rb), and, finally, the section headed *De Drachone* and drawn from Walcher's treatise (fol. 22rb–23ra). What follows is a comparison between the original text and the relevant part of the excerpt in *L*:

85 Mercier, « Astronomical Tables », p. 118; cf. *Ezich Elkaurezmi*, trans. Adelard of Bath, ed. Heinrich Suter, *Die astronomischen Tafeln des Muḥammed ibn Mūsā al-Khwārizmī in der Bearbeitung des Maslama ibn Aḥmed al-Madjrīṭī und der latein. Übersetzung des Athelhard von Bath*, A. F. Høst & Søn, København 1914 (Det Kongelige Danske Videnskabernes Selskab, Skrifter, 7th Ser., Historisk og filosofisk Afd., 3.1).

86 *Ezich Elkaurezmi*, trans. Adelard of Bath, c. 2, ed. Suter, p. 3.

87 David Juste, « MS London, British Library, Cotton Appendix VI (update:20.02.2022) », *Ptolemaeus Arabus et Latinus. Manuscripts*, <http://ptolemaeus.badw.de/ms/49> (Accessed 29 Nov. 2023).

88 The origin and background of this text is discussed in C. Philipp E. Nothaft, *Walcher of Malvern:* De lunationibus *and* De Dracone; *Study, Edition, Translation, and Commentary*, Brepols, Turnhout 2017 (De Diversis Artibus, 101 [N.S. 64]), p. 46–55.

89 David Juste, « Anonymous, *Commentary on Pseudo-Ptolemy's Iudicia* (update: 05.12.2022) », *Ptolemaeus Arabus et Latinus. Works*, <http://ptolemaeus.badw.de/work/119> (Accessed 29 Nov. 2023).

90 For a discussion and edition of this prologue, see Charles Burnett, « A New Source for Dominicus Gundissalinus's Account of the Science of the Stars? », *Annals of Science*, 47 (1990), p. 361–374.

Walcher of Malvern, *De Dracone* 1.2:[91]	*L*, fol. 22va–b:
Sed magister noster, minutiarum quibus utuntur Latini usum non habens, tali utebatur divisione: zodiacum totum sicut et nos in XII signa, unumquodque signum in XXX gradus, unumquemque gradum in LX punctos, unumquemque punctum in LX minutias, unamquamque minutiam in LX minutias minutiarum dividebat [...].	Sed doctor noster, non habet usum minutiarum qua Latini utuntur, tamen quibus usus est zodiacum in XII divisit signa, unumquodque autem signum in XXX gradus, unumquemque gradum in LX punctos, unumquemque punctum in LX suenias, unamquamque suaver [*sic*] in LX secunda, unamquamque secundinam [*sic*] in LX minucleras [*sic*] et inde in LX momenta.

Writing in or shortly after 1120, Walcher of Malvern reported that his teacher, Petrus Alfonsi, divided a degree into 60 *puncti* (using a masculine as opposed to the more common neuter form), one *punctus* into 60 *minutiae*, and one *minutia* into 60 *minutiae minutiarum*. The excerptor who placed Walcher's text at the beginning of the *Iudicia* commentary retained the *punctus* as the equivalent of the sexagesimal minute, but replaced *minutiae* and *minutiae minutiarum* with the *sueniae* and *secunda* familiar from the Dijon manuscript. In addition, he continued the subdivisions down to sexagesimal fourth and fifths, labelling the corresponding parts *minuclerae*(?) and *momenta*.

VII. *Solar and ascension tables*

The convergence between the Dijon list of combustions and *L*'s commentary on the *Iudicia* in their terminology of sexagesimal divisions is not the only thread that connects this commentary with our tables. Even clearer evidence of such a connection is furnished by a portion of text that immediately precedes the excerpt from *De Dracone* in *L* (fol. 21rb–22rb). It appears below a rubricated heading, *Capitulum de instructione anni secundum Ptolomeum*, and opens as follows:

> Ptolomeus summus philosophus intendit in hoc opere docere climatum 4^{or} capitula valde necessaria ac perutilia, quorum primum est de instructione anni, in quo et principium anni docemur. Et que borgis cum amico suo, id est cui planeta, habet dominari in toto anno in gradu illius climatis. Secundum est scire certam horam moramque elevationis et declinationis borgium per universos gradus climatum, a Babilone usque in polum boreum. Tercium est scire augmentum et diminutionem

[91] WALCHER OF MALVERN, *De Dracone* 1.2, in C. PHILIPP E. NOTHAFT, *Walcher of Malvern: 'De lunationibus' and 'De Dracone'; Study, Edition, Translation, and Commentary*, Brepols, Turnhout 2017 (De Diversis Artibus, 101 [N.S. 64]), p. 196.

> dierum ac noctium tocius anni per universos gradus <et> p<unctos> climatum. Quartum est scire partitionem borgium per gradus ad questionem. Ad hoc igitur expeditius intelligenda, istarum compositionem tabularum monstramus, scilicet Toletanarum.[92]

> In this work concerning the climates, the great philosopher Ptolemy aims to teach four very necessary and highly useful chapters, the first of which is about the « instruction » [*instructio*] of the year, in which we are also taught the beginning of the year – as well as which sign along with its friend, i.e. which planet, has lordship throughout the entire year in the degree of that climate. The second is to know the specific time and duration of the rising and setting of the signs throughout all degrees of the climates, from Babylon up to the North Pole. The third is to know the increase and decrease of the days and nights throughout the whole year across all degrees and points of the climates. The fourth is to know, for the purpose of a question, the division of the signs into degrees. In order for this to be understood more readily, we shall show the composition of these tables, namely, the Toledan ones.

A close connection between this text and the *Iudicia* is evinced right away by its choice of vocabulary, specifically the phrase « borgis cum suo amico » (« the sign along with its friend ») as a way of referring to a zodiacal sign and its ruling planet. This mirrors a sentence near the beginning of the pseudo-Ptolemaic text, where *borgis* is introduced as another name for *signum* and readers are told that the planets are called « the friends of the signs » (*amici borgium*).[93] This is the only such occurrence, however, of *borgis* in the *Iudicia*, which otherwise uses the calqued equivalent *turris* (from *al-burj*, « tower »), as does the canon for Saturn in *P* (see Part III).

As becomes clear from the final sentence of the above passage, the supposedly Ptolemaic « work concerning the climates » (*opus climatum*) that is mentioned at the beginning must have involved certain astronomical tables, which are here characterized as « Toledan ». It may be tempting to see in this a reference to the Toledan Tables that were adapted by Raymond of Marseilles *c.*1141, yet a closer look at the remainder of the *Capitulum de instructione anni secundum Ptolomeum* instead reveals that we are dealing with a commentary on the ascension tables that accompany the combustion tables in *M* and *P*, and are also fragmentarily preserved in *D*. It has already been mentioned, in Part II, that these ascension tables are an unusually extensive set, one which includes two separate tables for right ascensions (one regular, one for normed right ascensions) as well as oblique

92 *L*, fol. 21rb–va.

93 Pseudo-Ptolemy, *Iudicia*, §13, ed. David Juste, « Transcription of Pseudo-Ptolemy, *Iudicia* (update 25.05.2021) », *Ptolemaeus Arabus et Latinus. Texts*, <https://ptolemaeus.badw.de/text/M106> (Accessed 29 Nov. 2023): « Signa autem XII borges appellantur, planetas amicos borgium dicunt, quorum unusquisque proprias suas horas habet. »

ascensions for twenty consecutive degrees of latitude. All ascension tables appear to rely on an obliquity value of 23;35°, as was famously employed by al-Battānī for casting the table of normed right ascension that also commonly appears in the context of the Toledan Tables.[94]

The identity between the ascension tables and « these tables » mentioned in the text in *L* is established beyond reasonable doubt by the following passage, which comes immediately after the introduction quoted above:

> In primis itaque paginis uniuscuiusque signi est positum ostachim per gra<dus> et p<unctos>. Appellamus autem « ostachim » moram elevationis signorum. In primo gradu primi climatis et in primo laterum et ceterarum paginarum semper est per numeros[95] gradus signorum ascriptus, quem per tabulas in quibusdam signis minui, in quibusdam augeri secundum diversitates climatum necesse est. Incipit autem a primo gradu climatis 4ti, qui[96] est ominum climatum XXXI gradus, docere moram elevationis signorum usque in quinquagesimum gradum. Et scias 4m clima VII gradus habere, quintum vero V, sextum 4, septimum tot quot remanent gradus. Inchoatur vero gradus cuiuslibet climatis ab Ariete et in Piscibus terminatur suntque ibi ascripta signa cum tot gradibus et punctis quot gradus ponunt in elevatione vel declinatione.[97]

> On the first pages are recorded the ostachim of each sign according to degrees and points. What we call « ostachim », however, is the duration of the rising of the signs. In the first degree of the first climate and in the first of the flanks [*laterum*] and of the other pages is always stated numerically the degree of the signs, which across the tables necessarily decreases in some signs, increases in others, in accordance with the differences between the climates. It begins teaching the rising of the signs from the first degree of the fourth climate, which is the 31st degree of all climates, [and continues] until the 50th degree. And you should know that the fourth climate has 7 degrees, the fifth has 6, the sixth has 4, [and] the seventh has as many degrees as are left. [Each] degree of each climate begins at Aries and ends with Pisces. And the signs are written there with as many degrees and minutes as they take to rise or set.

The strange word *ostachim* appears at the very beginning of the table of right ascensions in both *M* and *P*. Our text merely defines it as the « duration of the rising of the signs » (« mora elevationis signorum »), but fails to specify that its values only apply to *sphaera recta*, i.e., the situation at the equator. It is best explained as a corrupt transliteration of the Arabic *mustaqīm*, as in *al-falak al-mustaqīm* (« the

[94] See al-Battānī, *Opus astronomicum*, ed. Carlo Alfonso Nallino, 3 vols., Hoepli, Milan 1899–1907 (Pubblicazioni del Reale Osservatorio di Brera in Milano, 40), vol. II, p. 61–64; BB11 in *The Toledan Tables*, ed. Pedersen, vol. III, p. 968–976.

[95] numeros] numerus

[96] qui] quia

[97] *L*, fol. 21va.

right sphere »). Together with the author's decision to identify the ascension tables before him as « Toledan », this terminological quirk would seem to lend strong support to the hypothesis that the whole work originated in al-Andalus.

The description of the tables for oblique ascensions, which are here referred to as tables for the « climates », also conforms closely to what is preserved in manuscripts of the combustion tables. What these manuscripts do not specifically mention is the climate to which each individual degree of geographic latitude is supposed to belong. The first of the twenty tables of oblique ascensions is valid for a latitude of 31°, which according to the commentary in *L* coincides with the beginning of the fourth climate. To judge by the numbers of degrees the text assigns to this and the following three climates, the beginnings of the fifth, sixth, and seventh climate should be at 38°, 44°, and 48°. This progression does not line up particularly well with the boundaries between climates recorded in Greek or Islamic sources, where the fourth climate tends to begin only between 33° and 34°.[98] Be that as it may, the text also reveals that the ascension tables under discussion have a geographic range of 31°–50°, exactly as is the case in *MP*. There is, of course, a degree of tension between this information and a boast made in the preceding introduction, according to which the *opus climatum* enables its user to compute ascensions « throughout all degrees of the climates, from Babylon up to the North Pole ». The tables stop 40° before reaching the pole, although it may be worth observing that 31° is only slightly below the latitudes of Babylon that are commonly recorded in medieval Islamic sources (32°–35°).[99]

What comes next in the commentary is an explanation of how to use solar and ascension tables to compute the sign that is ascending at the vernal equinox. Knowing this sign is one component of what the introduction referred to as *instructio anni* and declared to be the subject of the first of the four « chapters ». The other is identifying the ruling planet of the rising sign, which is assumed to have lordship over the entire year that begins at the vernal equinox in question. However, rather than repeating the term *instructio anni*, the explanation refers to the sought result as *institutio anni* (« commencement of the year »):

98 GERALD R. TIBBETS, « The Beginnings of a Cartographic Tradition », in J. B. HARLEY, DAVID WOODWARD (eds.), *The History of Cartography*, vol. I/1: *Cartography in the Traditional Islamic and South Asian Societies*, Chicago University Press, Chicago 1992, p. 90–107 (102). See, in general, ERNST HONIGMANN, *Die sieben Klimata und die ΠΟΛΕΙΣ ΕΠΙΣΗΜΟΙ: Eine Untersuchung zur Geschichte der Geographie und Astrologie im Altertum und Mittelalter*, Winter, Heidelberg 1929.

99 E. S. KENNEDY, M. H. KENNEDY, *Geographical Coordinates of Localities from Islamic Sources*, Institut für Geschichte der Arabisch-Islamischen Wissenschaften an der Johann Wolfgang Goethe-Universität, Frakfurt/Main 1987 (Veröffentlichungen des Institutes für Geschichte der Arabisch-Islamischen Wissenschaften, Reihe A: Texte und Studien, 2), p. 53.

Si igitur per has tabulas anni institutionem scire desideras, considera in tabula Solis CCCLXV dies, cui ascripta sunt CCCLVIIII[100] gradus et XLVI puncta, quibus XLVI punctis additis[101] puncta presentis anni, id est puncta que cucurrerunt per illum annum, et quot puncta remanserunt a LX punctis, tot puncta distat Sol ab Ariete in illa die. Verbi gratia: anno M.C.XXXVIII Christi V cucurrerunt puncta, que si <addantur> superioribus[102] XLVI[a] puncta fient scilicet LI puncta. Et ecce, in illa die fuit Sol in Piscibus, XXVIIII[103] gradus et LI puncta, et sic ab Ariete per IX distat puncta. Et quando illa puncta ad XV vel[104] ultra non crescunt, recurrimus ad precedentem diem, que CCCLXIIII est, cui ascripta sunt CCCLVIII gradus et XLVII[105] puncta, quibus omnibus addimus 5 puncta et fiunt LII. Et ecce, Sol in illa die distat ab Ariete uno gradu et 8 puncta, de quibus dabimus sequenti medietati diei XV[106] puncta et remanent LIII, de quibus sequenti nocti dabimus XXX et remanebunt XXIII, quibus trancursis Sol necessario ingredietur Arietem.

Sed quoniam in singulis horis equinoctialibus Sol transit duo puncta et dimidium, illa enim sunt XXIIII pars LX punctorum que Sol currit in illa die, cum in unaquoque equinoctiali hora XV gradus eriguntur, restat quod XV gradus sunt XXIIII pars CCCLX graduum. Necessario enim unumquodque punctum VI occupat gradus, id est, puncto a Sole transcurso VI gradus zodaici sunt erecti, cum per senarium supradictum XXIII puncta multiplicare debes et faciunt <C>XXXVIII. Per hoc enim cognosces quot gradus zodiaci sunt erecti in die illa Sole ingrediente Arietem.

Hoc facto caveas in tabulis VII climatum et sub quo signo inveneris XXIII per senarium multiplicata et CXXXVIII, scias id esse in ortu Sole ingrediente Arietem et dominum illius signi dominum esse illius climatis tocius in illo anno.

Ideo autem diximus superius « si puncta illa ad XV vel ultra non excreverunt », quod(?) si[107] Sol distaret ab Ariete[108] illa die XV punctis, daremus illa XV medietati diei et si[109] in principio noctis Sol intraret Arietem, esset Libra in ortu, que toto anno cum suo planeta, Venere scilicet, dominaretur.

Si autem Sol distat ab Ariete plus quam XV puncta, ita tamen quod supra XXX non distet, scias quod illa nocte Sol intravit Arietem. Tribuas ergo XV medietati diei et reliqua per senarium multiplica fientque gradus quos CLXXX gradibus addas et videas que summa[110] inde excreverit. Et considera tabulas VII climatum et sub quo signo[111] illum inveneris numerum, scias id fuisse in ortu Sole ingrediente Arietem.

[100] ccclviiii] ccclxviii
[101] additis] ablatis
[102] superioribus] XL *addidit*
[103] XXVIIII] XXIII
[104] XV vel] XVIII
[105] XLVII] XLVIII
[106] XV] XII
[107] si] *sub linea*
[108] Ariete] oriente *ante correctionem*
[109] si] sic
[110] summa] scrima(?)
[111] signo] scilicet

Si autem ultra puncta noctis aliqua puncta remanserint, nihil addere debes. Cum enim in principio diei Aries oriatur et cum ab Ariete numerum graduum incipimus, non erectis gradibus quibus addamus aliquid, ita tamen ab Ariete incipimus tamquam nulli gradus sint erecti. In nocte autem, quoniam iam[112] sunt erecti <C>LXXX gradus ab Ariete, debemus gradus qui erigendi sunt in nocte usque dum Sol intret in Arietem[113] addere CLXXX gradibus.[114]

If you wish to know the commencement of the year by means of these tables, look up in the table for the Sun [the entry for] 365 days, to which are assigned 359 degrees and 46 points. By adding these 46 points to the points of the current year, i.e. the points that have passed in that year, and subtracting them from 60 points, [you will find] how many points the Sun is distant from Aries on that day. For example: in AD 1138 5 points have passed. If these are added to the above-mentioned 46 points, they become 51 points. And behold, on that day the Sun was in Pisces at 29 degrees and 51 points, and thus its distance from Aries is 9 points. And when these points do not exceed 15 or more, we go back to the previous day, which is 364, to which are assigned 358 degrees and 47 points. To all of these we add 5 points and they become 52. And behold, on that day the Sun is 1 degree and 8 points from Aries. Of this [sum] we will give 15 points to the next half of the day, leaving 53, of which we will give 30 to the next night, leaving 23. After passing these, the Sun will necessarily enter Aries.

Yet, since the Sun passes through two points and a half per equinoctial hour, which is the 24th part of the 60 points that the Sun traverses on that day, [and] since 15 degrees rise with every equinoctial hour, it follows that 15 degrees are the 24th part of 360 degrees. Indeed, each point necessarily occupies 6 degrees, meaning that for every point the Sun passes 6 degrees of the zodiac are erected, [which is why] you must multiply 23 points by the aforementioned 6, resulting in 138. By this, you will know how many degrees of the zodiac are erected on that day at the moment when the Sun enters Aries.

Having done this, refer to the tables of the seven climates, and the sign under which you find 23 multiplied by 6 and 138, know that it is the one that is rising at the moment when the Sun enters Aries and that the lord of this sign is the lord of that whole climate during the whole year in question.

The reason why we said earlier « when these points do not exceed 15 or more » is that if the Sun were 15 points away from Aries on this day, we would give these 15 to [the second] half of the day, and if the Sun entered Aries at the beginning of the night, Libra would be rising, which would then have lordship over the whole year together with its planet, which is Venus.

But if the Sun is more than 15 points away from Aries, but not more than 30, you should know that the Sun entered Aries that night. Give, then, 15 to the [second] half of the day and multiply the rest by 6, and the degrees thus obtained add to 180 degrees, and see what sum results from it. And look at the tables of the seven

[112] iam] non

[113] Arietem] debemus *addidit*

[114] *L*, fol. 21va–22ra.

> climates and under which sign you find that number, know that it was rising during the moment when the Sun entered Aries.
>
> But if some points of the night remain beyond this, you should not add anything. For since Aries rises at the beginning of the day and since we begin counting the degrees from Aries, such that no degrees have been erected to which we must add anything, we begin from Aries as if no degrees had been erected. During the night, however, since 180 degrees from Aries have already been erected, we must add the degrees that must be erected during the night until the Sun enters Aries to these 180 degrees.

The operation to find the rising sign at the Sun's entry into Aries depends on a solar table, which is recognizably the same table as that found in *M* (fol. 94r–97r), *O* (fol. 113r–114v), and *P* (fol. 8r–v). All three manuscripts confirm the values mentioned in the text, which tells us that the solar longitudes for days 364 and 365 are, respectively, 358;47° and 359;46°. Assuming that the previous entry into Aries coincided exactly with equinoctial sunrise, which is here taken as the beginning of the day, the difference between 359;46° and 360° can be used to predict both the time and the ascendant at the next entry. In practice, it will be necessary to add some correction to account for the time of the day of the previous equinox, as this will rarely coincide exactly with sunrise. According to the worked example provided in the text, the year AD 1138, which is mentioned as a year in the past, contributes a surplus of 0;5°, which the author claims « have passed » (*cucurrerunt*) during this year.

Once these 0;5° are added to the values obtained from the solar table, it follows that the Sun was 1;8° removed from the beginning of Aries at the end of day 364 (360° – 358;47° – 0;5° = 1;8°) and 0;9° at the end of day 365. The rest of the calculation proceeds on the simplifying assumption of a daily solar motion of one degree and an hourly motion of (60° ÷ 24 =) 0;2,30°, which does not fully align with the fact that the solar table shows an increase of 0;59° between day 364 and day 365. For the amount of oblique ascension corresponding to one minute of arc on the ecliptic, the author accordingly finds 360° ÷ 24 ÷ 2;30 = 6°.

One important point that he does not spell out in his instructions is that the longitudes shown in the solar table all apply, or are assumed to apply, to local noon. It follows from this that the Sun's distance from Aries at the end of day 365 can be used only if it exceeds 0;15°, which here is equivalent to the 6 hours between noon and equinoctial sunset. If this were the case, the rising sign could be calculated on the assumption that Libra began to rise at the beginning of the night. In the example it hand, it is necessary to go back to the end of day 364, for which the tables show the Sun at 1;8° from Aries. The author's approach is to subtract 0;45° for the span of time between noon and the following sunrise, leaving him with 0;23°. The amount of oblique ascension corresponding to this distance is 0;23°

x 6 = 138°, which can be used to enter the ascension tables for the appropriate degree of latitude to determine the rising sign.

The second « chapter » is a good deal shorter and more straightforward. It amounts to a brief explanation of how to derive the oblique ascension of each individual sign from the table for the relevant latitude:

> Si autem scire desideras quot gradus unumquodque signum ponat in ortu iuxta singulos gradus climatum, scias unumquemque [*sic*] gradus climatis incipere ab Ariete et durare usque in Arietem. Videas itaque quot gradus et puncta sint subscripta Arieti et scias quia tot gradus et puncta ponit Aries in illo gradu illius climatis. Similiter scias quot gradus et puncta sint subscripta Tauro et subtrahe inde numerum qui subscriptus fuit Arieti. Similiter a numero Geminorum subtrahe numerum Arietis et Tauri et reliquum scias esse moram erectionis Geminorum. Et sic de reliquis facias.[115]

> But if you wish to know how many degrees each sign takes to rise for each degree of the climates, you should know that each degree of a given climate starts from Aries and continues to Aries. Look up, then, how many degrees and points are written below Aries and know that Aries takes that many degrees and points at this degree of this climate. Similarly, find out how many degrees and points are written below Taurus and then subtract the number that was written below Aries. Similarly, subtract the number of Gemini from the number of Aries and Taurus and know that what is left is the rising time of Gemini. Continue this process for the remaining [signs].

In order to compute the ascendant for any time of the day at a given geographic latitude, it is useful to know the length of daylight or, what amounts to the same, the length of the seasonal hour.[116] Medieval tables of oblique ascensions accordingly often provide the time-degrees of the seasonal daytime hour (as a function of the solar longitude) in a separate column.[117] This is not so in the ascension tables in *M* and *P*, which is why the third « chapter » in the commentary teaches how to find the length of daylight through computation.

> Si autem scire cupis decrementum et augmentum <dierum>, hoc est incrementum et diminutionem in unoquoque gradu climatum, scias a primo[118] gradu Libre usque in ultimo gradu Piscium dies esse minores noctibus, a primo vero gradu Arietis usque in ultimum gradum Virginis dies esse maiores noctibus. Videas igitur in quo gradu alicuius signi sit Sol notaque ostachim, id est moram elevationis, illius signi in eodem gradu et numerum climatis eiusdem signi in eodem gradu climatis atque

115 *L*, fol. 22va.
116 Neugebauer, *A History*, vol. I, p. 40–42.
117 Chabás, Goldstein, *A Survey*, p. 29.
118 primo] I

> subtrahe, vel ostachim a climate, vel clima ab ostachim, minorem scilicet numerum a maiori, ac id quod remanserit dupla. Si sis a Libra in Arietem, debes minuere illud duplicatum CLXXX gradibus. Si autem sis ab Ariete in Libram, debes addere illud duplatum CLXXX gradibus. Hoc facto dividas illos per XV et de singulis XV facias horas. Et dies illa tot habebit horas naturales quociens XV in illo numero reperiuntur.[119]

> But if you wish to know the decrease and increase of the days, that is, the increment and diminution [of their length] for each degree of the climates, you should know that from the first degree of Libra to the last degree of Pisces the days are shorter than the nights. Conversely, from the first degree of Aries to the last degree of Virgo the days are longer than the nights. You must look up, therefore, in which degree of a particular sign the Sun is and note the ostachim, i.e. the duration of the rising, of this sign at the same degree, as well as the number of the « climate » of the same sign at the same degree of the climate, and then subtract either the ostachim from the « climate » or the « climate » from the ostachim (i.e., the smaller number from the larger) and double the result. If you are between Libra and Aries, you must subtract what you have doubled from 180 degrees. But if you are between Aries and Libra, you must add that doubled value to 180 degrees. Having done this, divide [the obtained value] by 15 and make hours out of each 15. And the day in question will have as many natural hours as 15 are found in this number.

The « natural hours » mentioned in this chapter are equinoctial hours, each of which corresponds to 15° of oblique ascension. Their number for a given daylight period is accordingly found by dividing the whole arc of daylight by 15. The most intuitive way of finding this arc $d(\lambda)$ for a given solar longitude (λ) would be to use the values for the oblique ascension (ρ) at the beginning and end of this arc, as in the formula: $d(\lambda) = \rho(\lambda+180) - \rho(\lambda)$.[120]

Our text goes down a different route, as it instead relies on the ascensional difference, or what was known in Islamic astronomy as the « equation of daylight ».[121] The relevant formula for deriving the length of daylight from the ascensional difference for the given solar longitude (γ) is: $D = 180° \pm 2\gamma$. This is recognizably the same approach as that taken in the above text, which instructs us to calculate the ascensional difference by finding the values for the right and oblique ascension of the ecliptic degree in question and subtracting the smaller from the greater value. A confusing aspect of the instructions in this passage is that the word « clima » is here used not only to refer to the climate to which the relevant degree of latitude belongs, but to the ascensional value shown in the table of oblique ascensions for this latitude.

---

119 *L*, fol. 22va–b.

120 NEUGEBAUER, *A History*, vol. I, p. 40.

121 SAMSÓ, *On Both Sides*, p. 93–94.

The commentary on the ascension tables in *L* ends at this point without revealing anything more about the declared subject of the fourth « chapter », which in the introduction (p. 409) was announced as dealing with the « the division of the signs into degrees, for the purpose of a question » (« partitio borgium per gradus ad questionem »). It is possible to recognize in this expression a reference to the subject of astrological questions or interrogations, to which the entire second half of the *Iudicia* is principally devoted. Whatever the precise nature of the « the division of the signs » mentioned here, the fact that its explanation is absent from the *Capitulum de instructione anni secundum Ptolomeum*, despite being mentioned at the beginning, may be taken as a sign that *L* does not preserve the whole text.

The same impression arises from a comparison between this manuscript and MS St Petersburg, Biblioteka Akademii Nauk, F. 8 (XXAb/IIII), fol. 171va–172rb, which is a thirteenth-century fragment of the beginning of the « preliminary material » that *L* inserts before the commentary proper. Despite its brevity, the text in the St Petersburg manuscript differs significantly from what can be found in *L*. Most notably, perhaps, it contains a passage mentioning Ptolemy's love for his son (fol. 171vb: « Sciendum est tamen Ptholomeum habuisse quendam filium quem non modice diligebat ») that seems quite germane to a *Iudicia* commentary, but is absent from *L*. In the St Petersburg manuscript, this remark concerning Ptolemy appears ahead of an account of the division of the celestial sphere (fol. 171vb–172rb), of which *L* preserves no more than a handful of highly condensed excerpts (fol. 21ra). The redactor responsible for the text in *L* acknowledges this by noting that he intends to pass over the section on the division of the sphere, since the same topic is alread covered « in the *sphere* and in other places », which was probably intended as a reference to John of Sacrobosco's *Tractatus de sphera* and other similar introductions to astronomy.[122]

He highlights another such omission in a remark that immediately precedes the already discussed *Capitulum de instructione anni secundum Ptolomeum*: « Then follows [a passage] on the reading of tables and on computing the true positions of the planets, as taught by the canon on the motion and equation of the planets ».[123] There is no further trace of this passage in the text as we have it, although the end of the fragment in the St Petersburg manuscript confirms that the section on

[122] For the pertinent background, see LYNN THORNDIKE, *The* Sphere *of Sacrobosco and Its Commentators*, University of Chicago Press, Chicago 1949.

[123] *L*, fol. 21rb: « Tunc sequitur de tabulis legendis et planetis equandis sicut docet canon de motu et equatione planetarum ».

the division of the sphere was supposed to be followed by an account of what is here called the « doctrina tabularum ».[124]

Given the clear presence in *L* of an explanation of the solar and ascension tables familiar from *P* and *M*, it may be tempting to assume that the lost section on computing planetary positions that once preceded it dealt with none other than the combustion tables that appear in the same two manuscripts. A reason to resist this temptation is provided by the explicit references in *L* to « computing the true positions » (« planetis equandis ») and « equation of the planets » (« equatione planetarum »), which would rather seem to indicate ordinary sets of planetary tables based on mean motions and equations, as are found in a *zīj*. What is clear, at any rate, is that more material connected with *L*'s *Iudicia* commentary once existed than is currently available, and that even the surviving rendition of the text explaining our solar and ascension tables (*Capitulum de instructione anni secundum Ptolomeum*) is incomplete.

VIII. *Conclusion*

The tables for planetary positions and ascensions that have been the primary object of this study add some new wrinkles to our existing picture of the tools that supported horoscopic astrology in twelfth-century Latin Europe. While their ultimate origins remain shrouded in much obscurity, we are at least able to date one of their known manifestations to 1135 (as per the canons in MS *P*), while the testimony of Raymond of Marseilles's *Liber cursuum planetarum* leaves no doubt that the tables had entered the services of Latin astrologers by 1140. A list of combustions for the years 1139–1141 provides further evidence of their currency around this time, as does the reference to the year 1138 in a commentary on pseudo-Ptolemy's *Iudicia*, which devoted a whole section to the associated tables for solar longitudes and ascensions.

The appearance of this section in the commentary makes it one of several pieces of evidence that hint at a close connection between the *Iudicia* and the tables discussed in this article. Indeed, the possibility arises that the tables and the pseudo-Ptolemaic astrological text not only circulated together, but were at one point regarded as a single work, notwithstanding the fact that the preserved text of the *Iudicia* makes no reference to tables. If this hypothesis is correct, a potential reason for the later separation between the text and the tables may be sought in practicing astrologers' changing preferences in the area of computation, as

[124] MS St Petersburg, Biblioteka Akademii Nauk, F. 8 (XXAb/IIII), fol. 172rb: «Hiis ita prelibatis doctrina tabularum primo docenda est. Et hoc est quod intendebamus. » The text breaks off at this point.

propelled by the increased availability of tables for mean motions and equations. Raymond of Marseilles's polemic in the *Liber cursuum planetarum* can be considered a harbinger of this change, perhaps even an overall turning point in our combustion tables' reception. Once pushed to the margins by the Toledan Tables as well as other *zīj*es, not to mention perpetual almanacs and ephemerides, the combustion tables were threatened by quick obsolescence. Thanks to the singular testimony of Martin of Pamplona's canon (see Part V), it appears that the tables had not yet entirely fallen out of use by 1220. It is doubtful, however, that they remained an active part of Latin astrological practice for very long afterwards.

The hypothesis of the combustion tables' swift marginalization is consistent with the relatively poor state of their preservation. Of the tables themselves, only two full and three partial copies are known to be extant. The rate of survival appears to be poorer still for the associated canons, which seem to be incomplete even in their principal witness, MS *P*. Collecting and sorting the surviving manuscript evidence, as this article has done, can only be the first step towards a more in-depth analysis of the tables themselves. It is at this stage an unresolved problem how exactly the author of this so-called « almanac » went about constructing Tables A and B. Further studies will hopefully be able to shed light on this question as well as probe more deeply into the ultimate origins of the combustion tables, which must probably be found in al-Andalus.

Appendix

COMPUTATIONAL RULES FOR MARS, TABLE A[125]

Regula Martis ubi sit.[126] Cum[127] scire desideras ubi sit Mars, qui ceteris immanior[128] esse[129] perhibetur, noscas ubi Sol eum combussit[130] et iunge numerum graduum et mensium sicut videbis inferius, donec Sol comburat eum alia vice. Et sicut in uno facis, ita in[131] omni tempore peragas. Est autem mensis cui additur et mensis est[132] cui diminuitur.

Regula Arietis.[133] Si igitur accendatur Mars a primo gradu Arietis usque ad quintum,[134] iunge aut minue sextam tantum partem mensis illius de quo queris,[135] qui inscriptus est Arieti. Nota autem Arietem et cetera signa cum additionibus et minutionibus[136] XXVII menses[137] habere donec iterum accendatur.[138] Si a sexto[139] gradu Arietis incendatur usque ad decimum, terciam partem predicti[140] sui mensis iunge aut diminue. Ab undecimo illo incenso usque ad quintum decimum sume medietatem mensis illius addendo seu minuendo. A sexto decimo si comburatur Mars rutilus usque ad vigesimum gradum, adde aut minue duas <tertias> partes mensium numeri qui asscriptus est[141] ibi. A vigesimo primo si incendatur usque vigesimum quintum, adde seu[142] diminue[143] mediam et tertiam partem illius

[125] The following edition of the canon for Mars relies on MS Munich, Bayerische Staatsbibliothek, Clm 18927 (= *M*), fol. 70r–71r, and MS Paris, Bibliothèque nationale de France, lat. 7291, fol. 3r (= *P*). Cardinal and ordinal numbers are written out even where they are represented by Roman numerals in the manuscripts. Conjectural additions of text presumably missing from the manuscripts are placed in angled brackets. The apparatus below does not record mere spelling differences between the two witnesses. It uses the following abbreviations: *a.c. = ante correctionem*; *del. = delevit*; *hom. = homoioteleuton*; *mg. = in margine*; *om. = omisit*; *p.c. = post correctionem*; *s.l. = sub linea*.

[126] regula ... sit] de marte *P*

[127] cum] *add.* autem *P*

[128] immanior] *s.l. P*

[129] esse] *om. P*

[130] sol eum combussit] combussit eum sol *P*

[131] ita in] sic *P*

[132] et mensis est] et est mensis *P*

[133] arietis] in marte *add. P*

[134] quintum] *add.* et *P*

[135] partem ... queris] post quam feceris secundum communem regulam *add. s.l. M*

[136] cum ... minutionibus] *om. P*

[137] menses] *s.l. P*

[138] accendatur] Mars *add. s.l. M*

[139] sexto] septimo *M*

[140] partem predicti] predictam partem *a.c. M*

[141] asscriptus est] est appositus *P*

[142] seu] sive *P*

[143] diminue] minue *P*

numeri.[144] Quod a vigesimo sexto gradu si incensus usque ad[145] tricesimum fuerit, numerum totum adde vel minue.

Regula Thauri.[146] Mars si incendatur a primo gradu Thauri[147] usque ad decimum, tolle numerum mensium Geminorum. Nam Tauro nullus inscriptus est numerus. Et adde vel[148] minue nonam partem illius numeri a numero graduum.[149] Si accendatur ab undecimo gradu usque ad[150] quintum decimum, iunge vel minue de novem partibus numeri Geminorum duas partes. Si comburatur a sexto decimo gradu usque ad vigesimum, iunge vel[151] minue tertiam partem numeri Geminorum.[152] Si peruratur a vigesimo primo usque ad[153] vigesimum quintum, de novem partibus iunge quatuor partes numeri Geminorum. A vigesimo sexto usque ad[154] tricesimum si comburatur, iunge vel[155] minue de novem partibus quinque partes numeri Geminorum.

Regula Geminorum.[156] Quod si Mars accendatur a primo gradu[157] Geminorum usque in quintum, iunge vel[158] minue de numero sibi asscripto[159] duas tertias[160] partes. Si accendatur a sexto usque ad decimum, iunge vel[161] minue de novem partibus septem[162] partes. Si accendatur ab undecimo usque ad[163] quintum decimum, iunge vel minue de novem partibus octo partes. Si accendatur a sexto decimo usque vigesimum, iunge vel minue totum numerum quem invenis ibi. Quod si comburatur a vigesimo primo usque ad[164] vigesimum quintum, cave[165] numerum Cancri et Geminorum et vide quantum numerus Cancri vincat numerum Geminorum, et econverso, et de proficuo tolle tertiam partem et iunge vel[166] minue

144 numeri] *om. P*
145 ad] in *P*
146 thauri] in marte *add. P*
147 thauri] tauri *s.l. P*
148 vel] aut *P*
149 graduum] id est, a communi cursu *add. s.l. M*
150 ad] *om. P*
151 vel] aut *P*
152 numeri geminorum] geminorum numeri *M*
153 ad] in *P*
154 usque ad] *om. M*; in *P*
155 vel] aut *P*
156 geminorum] in marte *add. P*
157 gradu] id est, a communi cursu *add. s.l. M*
158 vel] aut *P*
159 asscripto] iniuncto *P*
160 tertias] *om. M*; nonas *mg. P*
161 vel] aut *P*
162 septem] vi *M*
163 ad] *om. P*
164 ad] *om. P*
165 cave] *om. M*
166 vel] aut *P*

tertiam partem a numero Geminorum.[167] Quem numerum Geminorum[168] addere debes vel minuere a numero graduum. Si accendatur[169] a vigesimo sexto usque in tricesimum, iunge vel minue duas partes proficui Geminorum et Cancri numero Geminorum.

Regula Cancri.[170] Mars autem, si incendatur[171] a primo gradu Cancri usque ad[172] septimum, totum proficuum[173] Geminorum et Cancri adde vel minue numero Geminorum. Si comburatur ab octavo gradu in duodecimum, respice[174] numerum Leonis et Cancri et iunge aut minue septimam[175] partem proficui numero Cancri. Si vero comburatur a tertio decimo usque in decimum septimum,[176] proficui Cancri et Leonis de septem partibus duas iunge aut minue[177] numero Cancri. Si autem peruratur ab octavo decimo usque[178] in vigesimum secundum Cancri, de proficuo Cancri et Leonis[179] iunge aut minue numero Cancri tres partes de septem partibus. Si autem peruratur a vigesimo tertio usque[180] in vigesimum septimum, de proficuo Cancri et Leonis[181] quatuor partes de septem partibus adde vel minue numero Cancri. Si accendatur a vigesimo octavo in duos gradus Leonis, de proficuo Cancri et Leonis de septem partibus iunge aut minue quinque partes numero Cancri.

Regula Leonis, de cuius duobus gradibus iam diximus.[182] Cum autem Mars a tertio usque in septimum gradum Leonis incenditur, de proficuo Cancri et Leonis de septem partibus iunge sex partes numero Cancri. Quod si ab octavo incenditur[183] usque[184] ad duodecimum, totum proficuum Cancri iunge aut minue numero Cancri. Dum accenditur a decimo quarto usque ad[185] octavum decimum, numerum Leonis et Virginis[186] cave et de proficuo eorum adde vel minue septimam partem numero Leonis. Si accendatur a decimo nono usque in vigesimum tertium, iunge

---

[167] geminorum] a communi cursu *add. M*
[168] numerum geminorum] id est quam tertiam partem *add. M* | geminorum numerum *P*
[169] accendatur] autem *add. P*
[170] cancri] martis in cancro *P*
[171] incendatur] accendatur *P*
[172] ad] in *P*
[173] proficuum] id est differentiam *add. s.l. M*
[174] respice] aspice *P*
[175] septimam] id est dat intelligere numerum in VII dividere *add. s.l. M*
[176] septimum] *om. M*
[177] minue] de *add. P*
[178] usque] *om. M*
[179] leonis] iunge vel minue *add. sed del. M*
[180] usque] in *P*
[181] iunge ... leonis] *om. per hom. M*
[182] de ... gradibus] in marte. sed duos gradus ex eis *P*
[183] incenditur] incendatur *P*
[184] usque] *om. P*
[185] ad] *om. P*
[186] virginis] cancri *MP*

vel minue[187] de proficuo Virginis et Leonis duas partes septimas Leonis numero. Si accendatur a vicesimo quarto in vigesimum octavum, iunge vel minue de proficuo Leonis et Virginis tres septimas numero Leonis. Cum accenditur a[188] vigesimo nono in tribus gradibus Virginis, intende vel remitte de proficuo eorum quatuor septimas Leoni.

Regula Virginis.[189] Cum[190] autem Mars incenditur a quarto gradu Virginis usque in octavum, de proficuo Leonis et Virginis iunge vel minue quinque septimas[191] Leoni. Si a nono accendatur[192] usque tertium decimum, de proficuo eorum iunge vel minue sex septimas Leoni. Cum accendatur[193] a quarto decimo in octavum decimum, totum proficuum iunge vel minue Leoni. Si a nono decimo in vigesimum secundum accendatur, cave numerum Virginis et Libre et de proficuo eorum iunge aut minue tertiam partem Virgini. Cum incenditur a vigesimo tertio in vigesimo septimo, de proficuo eorum iunge vel minue duas tertias Virgini. Si autem a vigesimo octavo in duos gradus Libre, proficuum iunge vel minue totum Virgini.

Regula[194] ***Libre.*** Cum[195] Mars incenditur a tertio[196] gradu Libre in septimum gradum, cave numerum Libre et Scorpionis[197] et de proficuo eorum iunge vel minue nonam partem numero Libre. Si accenditur[198] ab octavo in duodecimum, de proficuo Libre et Scorpionis[199] iunge vel minue duas nonas numero Libre. A tertio decimo si accendatur[200] in septimum decimum,[201] de proficuo eorum tres nonas iunge vel[202] minue numero Libre. Ab octavo decimo in vigesimum secundum quatuor nonas iunge[203] vel minue Libre de proficuo eorum. Si a vigesimo tertio in vigesimum septimum, quinque nonas. A[204] vigesimo octavo in duos gradus Scorpionis si incenditur, sex nonas adde vel minue.

187 iunge vel minue] auge vel remitte *P*
188 a] *om. P*
189 virginis] in marte *add. P*
190 cum] dum *P*
191 septimas] partes *M*
192 accendatur] incendatur *P*
193 accendatur] incendatur *P*
194 regula] regule *M* | de marte in incensione *P*
195 cum] dum *M*
196 tertio] iiii *M*
197 libre et scorpionis] scorpionis et sagittarii *MP*
198 accenditur] accendatur *P*
199 libre et scorpionis] scorpionis et sagittarii *MP*
200 accendatur] incendatur *P*
201 septimum decimum] xvi *M*
202 vel] aut *M*
203 iunge] adde *M*
204 a] in *M*

Regula Scorpionis.[205] Si Mars inceditur a tertio gradu Scorpionis in septimum, de proficuo Libre et Scorpionis[206] adde vel minue septem nonas Libre. Ab octavo in duodecimum octo nonas numero Libre adde[207] vel minue de proficuo eorum. A tertio decimo usque in septimum decimum, totum proficuum Libre et Scorpionis[208] adde numero Libre. De nono decimo in vigesimum primum si accendatur, de proficuo Scorpionis et Sagittarii iunge vel minue septimam partem numero Scorpionis. De vigesimo secundo[209] in vigesimum sextum si accendatur, adde vel minue de proficuo eorum duas septimas Scorpioni. A vigesimo septimo in primum gradum Sagittarii tres septimas de proficuo Sagittarii et Scorpionis adde vel minue Scorpioni.

Regula Sagittarii.[210] A secundo gradu Sagittarii in sextum si Mars incenditur,[211] quatuor septimas de proficuo Sagittarii et Scorpionis adde numero Scorpionis vel minue. A septimo[212] in undecimum adde vel minue quinque septimas[213] de proficuo[214] Scorpionis et Sagittarii. A duodecimo in sextum decimum adde vel minue de proficuo eorum sex[215] septimas Scorpioni. A septimo decimo in vigesimum primum adde vel minue totum proficuum Scorpionum et Sagittarii numero Scorpionis. Si Mars accendatur a vigesimo secundo in vigesimum quintum, cave[216] numerum Sagittarii et Capricorni[217] et de[218] proficuo eorum[219] adde vel minue quintam partem numero Sagittarii. A vigesimo sexto[220] in tricesimum adde vel minue de proficuo eorum duas quintas numero Sagittarii.[221]

Regula Capricorni.[222] Dum Mars comburitur a primo gradu Capricorni in quintum, minue de proficuo Sagittarii et Capricorni tres quintas[223] vel[224] adde numero Sagittarii. A sexto in decimum quatuor quintas numero Sagittarii.[225] Ab

[205] scorpionis] martis *add. P*
[206] libre et scorpionis] scorpionis et sagittarii *MP*
[207] adde] addas *M*
[208] libre et scorpionis] scorpionis et sagittarii *MP*
[209] vigesimo secundo] xxi *M*
[210] sagittarii] incensionis martis *add. P*
[211] incenditur] incendatur *P*
[212] septimo] sexto *P*
[213] septimas] scorpionis *add. P*
[214] de proficuo] *om. M*
[215] vi] vii *M*
[216] cave] minue *p.c. P*
[217] sagittarii et capricorni] scorpionis et sagittarii *M*
[218] et de] inde *P*
[219] eorum] *om. P*
[220] vigesimo sexto] xvi *M*
[221] numero sagittarii] sagittarii numero *P*
[222] capricorni] de marte *add. P*
[223] tres quintas] quintas tres *P*
[224] vel] et *P*
[225] numero sagittarii] sagittarii numero *P*

undecimo in quintum decimum[226] totum proficuum Capricorni et Sagittarii adde vel minue numero[227] Sagittarii. A sexto decimo in vigesimum Capricorni Mars si accendatur, cave numerum Capricorni et Aquarii et nonam partem proficui eorum adde vel minui Capricorno. A vigesimo primo in vigesimum quintum duas nonas proficui eorum da vel aufer Capricorno. De vigesimo sexto in tricesimum tres nonas adde vel minue[228] de proficuo Capricorni et Aquarii Capricorno.

Regula Aquarii.[229] Cum Mars uritur in quinque gradibus Aquarii, tribue[230] vel aufer de proficuo Capricorni et Aquarii quatuor nonas Capricorni. Usque ad decimum quinque nonas. Ad quintum decimum sex nonas. Ad vigesimum septem[231] nonas. Usque ad vigesimum quintum octo nonas. Ad tricesimum totum[232] proficuum Capricorni et Aquarii da vel aufer Capricorno.

Regula Piscium.[233] Si Mars accenditur[234] in quinque gradibus Piscium, cave numerum Aquarii et Piscium et[235] de proficuo eorum adde vel minue tertiam partem numero Aquarii. Ad decimum duas tertias de proficuo eorum. Ad quinum decimum totum proficuum Aquarii et Piscium da vel aufer numero Aquarii. A sexto decimo[236] si accendatur in vigesimum, cave numerum Piscium et Arietis et de proficuo eorum da vel minue tertiam partem numero Piscium. Inde ad vigesimum quintum adde vel minue de proficuo eorum duas tertiam numero Piscium. Usque ad tricesimum adde vel minue[237] totum proficuum Piscium et Arietis numero Piscium.[238]

226 decimum] *om. M*
227 numero] *om. P*
228 minue] aufer *P*
229 aquarii] de marte *add. P*
230 tribue] tribuo *M*
231 septem] vi *M*
232 totum] *om. P*
233 piscium] in Marte *add. P*
234 accenditur] incenditur *P*
235 et] *om. P*
236 sexto decimo] xvii *P*
237 adde ... minue] *om. M*
238 piscium ... piscium] *om. M*

Bibliography

Manuscripts

Cambridge, Fitzwilliam Museum, McClean 165
Chartres, Bibliothèque municipale, 213†
Chartres, Bibliothèque municipale, 214†
Darmstadt, Universitäts- und Landesbibliothek, 765
Dijon, Bibliothèque municipale, 448
Erfurt, Universitätsbibliothek, Dep. Erf. CA 8° 81
London, British Library, Cotton Appendix VI
London, British Library, Royal 7.F.VIII
Munich, Bayerische Staatsbibliothek, Clm 18927
Oxford, Bodleian Library, Digby 40
Oxford, Corpus Christi College, 233
Oxford, Corpus Christi College, 283
Paris, Bibliothèque nationale de France, lat. 7291
Paris, Bibliothèque nationale de France, lat. 16208
St Petersburg, Biblioteka Akademii Nauk, F. 8 (XXAb/IIII)
Vatican City, Biblioteca Apostolica Vactiana, Pal. lat. 1410
Vatican City, Biblioteca Apostolica Vaticana, Vat. lat. 5714
Vienna, Österreichische Nationalbibliothek, 2385
Wolfenbüttel, Herzog-August-Bibliothek, Cod. Guelf. 51.9 Aug. 4°

Printed Sources

Abraham Ibn Ezra, *Liber de rationibus tabularum*, ed. José María Millás Vallicrosa, *El libro de los fundamentos de las Tablas astronómicas de R. Abraham Ibn ʿEzra*, CSIC, Madrid 1947 (Instituto Arias Montano, Ser. D, 2).

Adelard of Bath, *De opere astrolapsus*, in Bruce George Dickey, « Adelard of Bath: An Examination Based on heretofore Unexamined Manuscripts », Ph.D. Diss., University of Toronto 1982, p. 147–229.

al-Battānī, *Opus astronomicum*, ed. Carlo Alfonso Nallino, 3 vols., Hoepli, Milan 1899–1907 (Pubblicazioni del Reale Osservatorio di Brera in Milano, 40).

Ezich Elkaurezmi, trans. Adelard of Bath, ed. Heinrich Suter, *Die astronomischen Tafeln des Muḥammed ibn Mūsā al-Khwārizmī in der Bearbeitung des Maslama ibn Aḥmed al-Madjrīṭī und der latein. Übersetzung des Athelhard von Bath*, A. F. Høst & Søn, København 1914 (Det Kongelige Danske Videnskabernes Selskab, Skrifter, 7th Ser., Historisk og filosofisk Afd., 3.1).

John of Pavia, *Canones super tabulas Humeniz philosophi summi egipciorum*, in José María Millás Vallicrosa, *Estudios sobre Azarquiel*, CSIC, Madrid 1943–1950, p. 379–392.

Petrus Alfonsi, *Epistola ad peripateticos*, in John Tolan, *Petrus Alfonsi and His Medieval Readers*, University Press of Florida, Gainesville 1993, p. 164–180.

Pseudo-Ptolemy, *Iudicia*, ed. David Juste, « Transcription of Pseudo-Ptolemy, *Iudicia* (update 25.05.2021) », *Ptolemaeus Arabus et Latinus. Texts*, <https://ptolemaeus.badw.de/text/M106> (Accessed 29 Nov. 2023).

Raymond of Marseilles, *Liber cursuum planetarum*, in *Opera omnia*, vol. I, ed. and trans. Marie-Thérèse d'Alverny, Charles Burnett, Emmanuel Poulle, CNRS Éditions, Paris 2009 (Sources d'histoire médiévale, 40).

The Toledan Tables, ed. Fritz S. Pedersen, 4 vols., C. A. Reitzel, København 2002 (Det Kongelige Danske Videnskabernes Selskab, Historisk-filosofiske Skrifter, 24/1–4).

Walcher of Malvern, *De Dracone*, in C. Philipp E. Nothaft, *Walcher of Malvern:* De lunationibus *and* De Dracone; *Study, Edition, Translation, and Commentary*, Brepols, Turnhout 2017 (De Diversis Artibus, 101 [N.S. 64]), p. 194–217.

— *De lunationibus*, in C. Philipp E. Nothaft, *Walcher of Malvern: 'De lunationibus' and 'De Dracone'; Study, Edition, Translation, and Commentary*, Turnhout 2017 (De Diversis Artibus, 101 [N.S. 64]), p. 90–191.

Modern authors (after 1789)

Bernhard, Ludger, *Die Chronologie der Syrer*, Böhlau, Vienna 1969 (Sitzungsberichte der Österreichischen Akademie der Wissenschaften, phil.-hist. Kl., 264.3).

Birkenmajer, Aleksander, « À propos de l''Abrahismus' », *Archives internationales d'histoire des sciences*, 3 (1950), p. 378–390. Reprinted in Id., *Études d'histoire des sciences et de la philosophie du Moyen Âge*, Wydawnictwo Polskiej Akademij Nauk, Wrocław 1970, p. 237–249.

Blume, Dieter, Mechthild Haffner, Wolfgang Metzger, *Sternbilder des Mittelalters: Der gemalte Himmel zwischen Wissenschaft und Phantasie*, vol. I: *800–1200*, Akademie Verlag, Berlin 2012.

Borst, Arno, *Schriften zur Komputistik im Frankenreich von 721 bis 818*, vol. I, Hahnsche Buchhandlung, Hannover 2006 (Quellen zur Geistesgeschichte des Mittelalters, 21).

Boudet, Jean-Patrice, « Chartres, BM, ms. 213 (ancien 169) – détruit (1944) », <https://www.manuscrits-de-chartres.fr/sites/default/files/fileviewer/documents/notices-detaillees/chartres-bm-ms-213_notice_jp-boudet.pdf> (Accessed 29 Nov. 2023).

— *Entre science et* nigromance*: astrologie, divination et magie dans l'Occident médiéval (XII*e*–XV*e *siècle)*, Publications de la Sorbonne, Paris 2006.

Burnett, Charles, « Advertising the New Science of the Stars *circa* 1120–50 », in Françoise Gasparri (ed.), *Le XII*e *siècle: mutations et renouveau en France dans la première moitié du XII*e *siècle*, Le Léopard d'Or, Paris 1994 (Cahiers du Léopard d'Or, 3), p. 147–157.

— « A New Source for Dominicus Gundissalinus's Account of the Science of the Stars? », *Annals of Science*, 47 (1990), p. 361–374.

— « Astrology, Astronomy and Magic as the Motivation for the Scientific Renaissance of the Twelfth Century », in Angela Voss, Jean Hinson Lall (eds.), *The Imaginal Cosmos: Astrology, Divination and the Sacred*, University of Kent, Canterbury 2007, p. 55–61.

— « *Nīranj*: A Category of Magic (Almost) Forgotten in the Latin West », in Claudio Leonardi, Francesco Santi (eds.), *Natura, scienze e società medievali: Studi in onore di Agostino Paravicini Bagliani*, SISMEL–Edizioni del Galluzzo, Florence 2008 (Micrologus Library, 28), p. 37–66.

— « The Contents and Affiliation of the Scientific Manuscripts Written at, or Brought to, Chartres in the Time of John of Salisbury », in Michael Wilks (ed.), *The World of John of Salisbury*, Blackwell, Oxford 1984 (Studies in Church History: Subsidia, 3), p. 127–160.

Burnett, Charles, David Juste, « A New Catalogue of Medieval Translations into Latin of Texts on Astronomy and Astrology », in Faith Wallis, Robert Wisnovsky (eds.), *Medieval Textual Cultures: Agents of Transmission, Translation and Transformation*, de Gruyter, Berlin 2016 (Judaism, Christianity, and Islam – Tension, Transmission, Transformation, 6), p. 63–76.

Casulleras, Josep, « Las *Tablas astronómicas* de Pedro Alfonso », in María Jesús Lacarra (ed.), *Estudios sobre Pedro Alfonso de Huesca*, Instituto de Estudios Altoaragonenses, Huesca 1996 (Estudios Altoaragonenses, 41), p. 349–366.

Chabás, José, *Computational Astronomy in the Middle Ages: Sets of Astronomical Tables in Latin*, CSIC, Madrid 2019 (Estudios sobre la ciencia, 72).

Chabás, José, Bernard R. Goldstein, *A Survey of European Astronomical Tables in the Late Middle Ages*, Brill, Leiden 2012 (Time, Astronomy, and Calendars: Texts and Studies, 2).

— « John of Murs's Tables of 1321 », *Journal for the History of Astronomy*, 40 (2009), p. 297–320.

Clark, Charles W., « A Christian Defense of Astrology in the Twelfth Century: The *Liber cursuum planetarum* of Raymond of Marseilles », *International Social Science Review*, 70 (1995), p. 93–102.

d'Alverny, Marie-Thérèse, « Abélard et l'astrologie », in René Louis, Jean Jolivet, Jean Châtillon (eds.), *Pierre Abelard – Pierre le Venerable: les courants philosophiques littéraires et artistiques en Occident au milieu du XII^e^ siecle; abbaye de Cluny, 2 au 9 juillet 1972*, Éditions du CNRS, Paris 1975, p. 611–630 (Actes et mémoires des colloques internationaux du Centre National de la Recherche Scientifique, 546). Reprinted as Chapter XV in Ead., *La transmission des textes philosophiques et scientifiques au Moyen Âge*, ed. Charles Burnett, Variorum, Aldershot 1994.

— « Astrologues et théologiens au XII^e^ siècle », in André Duval (ed.), *Mélanges offerts à M.-D. Chenu, maître en théologie*, Vrin, Paris 1967, p. 31–50 (Bibliothèque Thomiste, 37). Reprinted as Chapter XVI in Ead., *La transmission des textes philosophiques et scientifiques au Moyen Âge*, ed. Charles Burnett, Variorum, Aldershot 1994.

Grumel, Venance, *La chronologie*, Presses universitaires de France, Paris 1958 (Traité d'Études Byzantines, 1).

Haskins, Charles Homer, *Studies in the History of Mediaeval Science*, Harvard University Press, Cambridge (Mass.) 1924.

Honigmann, Ernst, *Die sieben Klimata und die ΠΟΛΕΙΣ ΕΠΙΣΗΜΟΙ: Eine Untersuchung zur Geschichte der Geographie und Astrologie im Altertum und Mittelalter*, Winter, Heidelberg 1929.

Jeudy, Colette, Yves-François Riou, *Les manuscrits classiques latins des bibliothèques publiques de France*, vol. I: *Agen–Évreux*, Éditions du Centre National de la Recherche Scientifique, Paris 1989.

Juste, David, « Anonymous, *Commentary on Pseudo-Ptolemy's Iudicia* (update: 05.12.2022) », *Ptolemaeus Arabus et Latinus. Works*, <http://ptolemaeus.badw.de/work/119> (Accessed 29 Nov. 2023).

— « Horoscopic Astrology in Early Medieval Europe (500–1100) », in *La conoscenza scientifica nell'Alto Medioevo: Spoleto, 25 aprile – 1 maggio 2019*, vol. I, Fondazione Centro

Italiano di Studi sull'Alto Medioevo, Spoleto 2020 (Settimane di studio della Fondazione Centro Italiano di Studi sull'Alto Medioevo, 67), p. 311–333.

— *Les* Alchandreana *primitifs: études sur les plus anciens traités astrologiques latins d'origine arabe (X*[e] *siècle)*, Brill, Leiden 2007 (Brill's Studies in Intellectual History, 152).

— « Les textes astrologiques latins attribués à Aristote », *Micrologus*, 21 (2013), p. 145–164.

— « MS London, British Library, Cotton Appendix VI (update: 20.02.2022) », *Ptolemaeus Arabus et Latinus. Manuscripts*, <http://ptolemaeus.badw.de/ms/49> (Accessed 29 Nov. 2023).

— « MS Munich, Bayerische Staatsbibliothek, Clm 18927 (update: 24.02.2022) », *Ptolemaeus Arabus et Latinus. Manuscripts*, <http://ptolemaeus.badw.de/ms/87> (Accessed 29 Nov. 2023).

— « MS Oxford, Corpus Christi College, 233 (update: 01.03.2022) », *Ptolemaeus Arabus et Latinus. Manuscripts*, <http://ptolemaeus.badw.de/ms/483> (Accessed 29 Nov. 2023).

— « MS Vatican, Biblioteca Apostolica Vaticana, Vat. lat. 5714 (update: 15.11.2022) », *Ptolemaeus Arabus et Latinus. Manuscripts*, <http://ptolemaeus.badw.de/ms/294> (Accessed 29 Nov. 2023).

— « Pseudo-Ptolemy, *Iudicia* (update: 10.03.2022) », *Ptolemaeus Arabus et Latinus. Works*, <http://ptolemaeus.badw.de/ms/483> (Accessed 29 Nov. 2023).

— « Neither Observation nor Astronomical Tables: An Alternative Way of Computing the Planetary Longitudes in the Early Western Middle Ages », in Charles Burnett, Jan P. Hogendijk, Kim Plofker, Michio Yano (eds.), *Studies in the History of the Exact Sciences in Honour of David Pingree*, Brill, Leiden, 2004 (Islamic Philosophy, Theology, and Science: Texts and Studies, 54), p. 181–222.

— « The Impact of Arabic Sources on European Astrology: Some Facts and Numbers », *Micrologus*, 24 (2016), p. 173–194.

Kennedy, E. S., M. H. Kennedy, *Geographical Coordinates of Localities from Islamic Sources*, Institut für Geschichte der Arabisch-Islamischen Wissenschaften an der Johann Wolfgang Goethe-Universität, Frankfurt/Main 1987 (Veröffentlichungen des Institutes für Geschichte der Arabisch-Islamischen Wissenschaften, Reihe A: Texte und Studien, 2).

Lemay, Richard, *Abu Ma'shar and Latin Aristotelianism in the Twelfth Century: The Recovery of Aritotle's Natural Philosophy through Arabic Astrology*, American University of Beirut, Beirut 1962 (American University of Beirut, Publication of the Faculty of Arts and Sciences: Oriental Series, 38).

Lipton, Joshua David, « The Rational Evaluation of Astrology in the Period of Arabo-Latin Translation ca. 1126–1187 AD », Ph.D. diss., University of California, Los Angeles, 1978.

Malewicz, Małgorzata Hanna, « Libellus de efficatia artis astrologice: traité astrologique d'Eudes de Champagne, XII[e] siècle », *Mediaevalia Philosophica Polonorum*, 20 (1974), p. 3–95.

Mercier, Raymond, « Astronomical Tables in the Twelfth Century », in Charles Burnett (ed.), *Adelard of Bath: An English Scientist and Arabist of the Early Twelfth Century*, Warburg Institute, London 1987 (Warburg Institute Surveys and Texts 14), p. 87–118. Reprinted as Chapter VII in Id., *Studies on the Transmission of Medieval Mathematical Astronomy*, Ashgate, Aldershot 2004 (Variorum Collected Studies Series, 787).

— « Astronomical Tables of Abraham Bar Ḥiyya », in Sacha Stern, Charles Burnett (eds.), *Time, Astronomy, and Calendars in the Jewish Tradition*, Brill, Leiden 2014 (Time, Astronomy, and Calendars: Texts and Studies, 3), p. 155–207.

Millás Vallicrosa, José María, *Estudios sobre Azarquiel*, CSIC, Madrid 1943–1950.

— « Sobre la autenticidad de una obra astronómica de R. Abraham ibn 'Ezra », *Isis*, 40 (1949), p. 32–33.

Neugebauer, Otto, *A History of Ancient Mathematical Astronomy*, 3 vols., Springer, Berlin 1975 (Studies in the History of Mathematics and Physical Sciences, 1).

— *An Astronomical Almanac for the Year 348/9 (P. Heid. inv. no. 34)*, Munksgaard, Copenhagen 1956 (Historisk-filologiske Meddelelser udgivet af Det Kongelige Danske Videnskabernes Selskab, Bind 36, no. 4).

— *The Astronomical Tables of Al-Khwārizmī: Translation with Commentaries of the Latin Version ed. by H. Suter, Supplemented by Corpus Christi College MS 283*, Munksgaard, København 1962 (Det Kongelige Danske Videnskabernes Selskab, Historisk-filosofiske Skrifter, 4.2).

North, John D., *Richard of Wallingford: An Edition of His Writings with Introductions, English Translation and Commentary*, 3 vols., Clarendon Press, Oxford 1976.

Nothaft, C. Philipp E., « Ephemerides in High Medieval Europe: The Textual Evidence », *Journal for the History of Astronomy*, 52 (2021), p. 33–52.

— *Graeco-Arabic Astronomy for Twelfth-Century Latin Readers:* Ptolomeus et multi sapientum *(Abraham Ibn Ezra Latinus) — Robert of Chester,* Liber canonum*, pt. ii*, Brill, Leiden 2023 (Time, Astronomy, and Calendars: Texts and Studies, 12).

— *Walcher of Malvern:* De lunationibus *and* De Dracone; *Study, Edition, Translation, and Commentary*, Brepols, Turnhout 2017 (De Diversis Artibus, 101 [N.S. 64]).

Omont, H., A. Molinier, C. Couderc, E. Coyecque, *Catalogue général des manuscrits des bibliothèques publiques de France: Départements*, vol. XI: *Chartres*, Plon, Paris 1890.

Palmer, Andrew (trans.), *The Seventh Century in the West-Syrian Chronicles*, Liverpool University Press, Liverpool 1993.

Runciman, David, « Bishop Bartholomew of Exeter (d. 1184) and the Heresy of Astrology », *Journal of Ecclesiastical History*, 70 (2019), p. 265–282.

Samsó, Julio, « 'Dixit Abraham Iudeus': algunas observaciones sobre los textos astronómicos latinos de Abraham Ibn 'Ezra », *Iberia Judaica*, 4 (2012), p. 171–200.

— *Las ciencias de los antiguos en Al-Andalus*, Editorial MAPFRE, Madrid 1992.

— *On Both Sides of the Strait of Gibraltar: Studies in the History of Medieval Astronomy in the Iberian Peninsula and the Maghrib*, Brill, Leiden 2020 (Handbook of Oriental Studies, Section One, 144).

Sela, Shlomo, *Abraham Ibn Ezra and the Rise of Medieval Hebrew Science*, Brill, Leiden 2003 (Brill's Series in Jewish Studies, 32).

— « Algunos puntos de contacto entre el *Libro de las tablas astronómicas* en su versión latina y las obras literarias hebreas de Abraham Ibn Ezra », *Miscelánea de Estudios Árabes y Hebraicos*, Sección de Hebreo, 46 (1997), p. 37–56.

— « Contactos científicos entre judíos y cristianos en el siglo XII: el caso del *Libro de las tablas astronómicas* de Abraham Ibn Ezra en su versión latina y hebrea », *Miscelánea de Estudios Árabes y Hebraicos*, Sección de Hebreo, 45 (1996), p. 185–222.

Smithuis, Renate, « Science in Normandy and England under the Angevins: The Creation of Abraham Ibn Ezra's Latin Works on Astronomy and Astrology », in Giulio Busi (ed.), *Hebrew to Latin, Latin to Hebrew: The Mirroring of Two Cultures in the Age of Humanism; Colloquium Held at the Warburg Institute, London, October 18–19, 2004*, Aragno, Turin 2006 (Berlin Studies in Judaism, 1), p. 23–59.

Tibbets, Gerald R., « The Beginnings of a Cartographic Tradition », in J. B. Harley, David Woodward (eds.), *The History of Cartography*, vol. I.1: *Cartography in the Traditional Islamic and South Asian Societies*, Chicago University Press, Chicago 1992, p. 90–107.

Thorndike, Lynn, *The* Sphere *of Sacrobosco and Its Commentators*, University of Chicago Press, Chicago 1949.

Tolan, John, « Reading God's Will in the Stars: Petrus Alfonsi and Raymond de Marseille Defend the New Arabic Astrology », *Revista Española de Filosofía Medieval*, 7 (2000), p. 13–30.

von Heinemann, Otto, *Die Augusteischen Handschriften*, vol. V: *Codex Guelferbytanus 34.1 Aug. 4° bis 117 Augusteus 4°*, Klostermann, Frankfurt/Main 1966 [1903] (Kataloge der Herzog-August-Bibliothek Wolfenbüttel: Die alte Reihe, 8).