From Tunis to Venice

Traces of Maghribī Astronomy and Geography in Manuscripts from Late Medieval Italy

C. Philipp E. Nothaft
All Souls College, Oxford

Abstract

This article discusses the shared content of three interrelated astronomical manuscripts from late medieval Italy, arguing that certain elements of this shared content trace their origins to Maghribī sources. This includes two tables of geographic coordinates with a pronounced focus on locations in North Africa as well as a gnomonic table for the latitude of Tunis. One of the coordinate tables is known to resemble an Arabic table in a *zīj* by Ibn al-Raqqām, who was active in Tunis, Béjaïa, and Granada in the period 1280–1315. It will be argued that a likely explanation of this knowledge transfer lies in the documented mercantile and diplomatic contacts between the Republic of Venice and Ḥafṣid Tunisia in the decades around 1300.

Key Words

Maghribī astronomy; Arabic-to-Latin translations;
Geographic coordinates; Sundials; Venice

I. *Introduction*

From approximately the second half of the tenth century AD to the collapse of the *taifa* kingdoms at the end of the eleventh century, the area known as al-Andalus gave rise to a sophisticated tradition of mathematical astronomy, which managed to develop its own unique models and approaches compared to the ways in which the discipline was cultivated in the Arabic East. While this Andalusian astronomy entered the path of a slow decline in the twelfth century as far as its centres of origin are concerned, substantial traces of it continued to flourish for centuries in two adjacent regions, Latin Europe and the Maghreb, resulting in what Julio Samsó

has described as « a common astronomical tradition on both sides of the straits of Gibraltar ».[1]

In the Latin European case, much of this state of affairs was due to Arabic-to-Latin translations produced on the Iberian Peninsula during the twelfth century, which resulted in the first genuine flowering of mathematical astronomy in the Christian West.[2] In the Maghreb, a full adoption of Andalusian mathematical astronomy is first in evidence in the early thirteenth century, starting with the lost astronomical tables of Ibn Isḥāq al-Tūnisī (*c.*1222). The resulting Maghribī

[1] 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 1, 144), p. 1. See also Id., « La ciencia en al-Ándalus y su papel como puente entre la ciencia árabe y la europea », *Awraq*, 17–18 (2018), p. 9–22; Id., « Al-Andalus, a Bridge Between Arabic and European Science », *Alhadra*, 1 (2015), p. 101–125.

[2] Samsó, *On Both Sides*, p. 18–33. For a selection of relevant literature, see Charles Homer Haskins, *Studies in the History of Mediaeval Science*, Harvard University Press, Cambridge (Mass.) 1924; Francis J. Carmody, *Arabic Astronomical and Astrological Sciences in Latin Translation: A Critical Bibliography*, University of California Press, Berkeley 1956; Olaf Pedersen, « The *Corpus Astronomicum* and the Traditions of Mediaeval Latin Astronomy: A Tentative Interpretation », in Owen Gingerich, Jerzy Dobrzycki (eds.), *Colloquia Copernicana III: Proceedings of the Joint Symposium of the IAU and the IUHPS, Cosponsored by the IAHS Astronomy of Copernicus and Its Background, Toruń 1973*, Wydawnictwo Polskiej Akademij Nauk, Wrocław 1975 (Studia Copernicana, 13), p. 57–96; David C. Lindberg, « The Transmission of Greek and Arabic Learning to the West », in Id. (ed.), *Science in the Middle Ages* University of Chicago Press, Chicago 1978, p. 52–90; Marie-Thérèse d'Alverny, « Translations and Translators », in Robert L. Benson, Giles Constable (eds.), *Renaissance and Renewal in the Twelfth* Century, Harvard University Press, Cambridge (Mass.) 1982, p. 421–462; Charles Burnett, « The Translating Activity in Medieval Spain », in Salma Khadra Jayyusi (ed.), *The Legacy of Muslim Spain*, Brill, Leiden 1992 (Handbook of Oriental Studies, Section 1, 12), p. 1036–1058; Id., « The Coherence of the Arabic-Latin Translation Program in Toledo in the Twelfth Century », *Science in Context*, 14 (2001), p. 249–288; Id., « Translation and Transmission of Greek and Islamic Science to Latin Christendom », in David C. Lindberg, Michael H. Shank (eds.), *The Cambridge History of Science*, vol. II: *Medieval Science*, Cambridge University Press, Chicago 2013, p. 341–364; Paul Kunitzsch, « Gerard's Translations of Astronomical Texts, Especially the *Almagest* », in Pierluigi Pizzamiglio (ed.), *Gerardo da Cremona*, Libreria del Convegno, Cremona 1992 (Annali della Biblioteca statale e Libreria civica di Cremona, 41), p. 71–84; Stephen C. McCluskey, *Astronomies and Cultures in Early Medieval Europe*, Cambridge University Press, Cambridge 1998; Julio Samsó, « El procés de la transmissió científica al nord-est de la península Ibèrica al segle XII: els textos llatins », in Juan Vernet, Ramon Parés (eds.), *La ciència en la història dels Països Catalans*, vol. I: *Dels àrabs al Renaixement*, Institut d'Estudis Catalans, Valencia 2004, p. 269–296; John North, *Cosmos: An Illustrated History of Astronomy and Cosmology*, University of Chicago Press, Chicago 2008, p. 215–269; Max Lejbowicz, « L'acculturation latine selon Platon de Tivoli », in Id. (ed.), *Une conquête des savoirs: les traductions dans l'Europe latine (fin du XI^e^ siècle–milieu du XIII^e^ siècle)*, Brepols, Turnhout 2009 (Rencontres médiévales européennes, 9), p. 121–141; 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.

branch of the Andalusian astronomical tradition continued to be cultivated well into the second half of the fourteenth century.[3]

What has so far received very little consideration from historians of science is the question of what, if any, interactions there may have been between Latin and Maghribī astronomy during the period of their parallel development. An opportunity to pose this question and bring fresh evidence to bear is offered by three astronomical codices of North Italian origin, two of which date from the first half of the fourteenth century. The following article is dedicated to an analysis of the shared content of these manuscripts. As will be shown below, they preserve evidence of a transmission of astronomy-related material from Northwest Africa to Italy, which included two tables of geographic coordinates, some diagrammatic drawings of astronomical instruments, and a gnomonic table for the latitude of Tunis. In the case of one coordinate table, there is a demonstrable link with a set of astronomical tables by Ibn al-Raqqām (*al-Zīj al-Shāmil*), who was active in Tunis, Béjaïa, and Granada in the decades around 1300.

Most of the first half of this article will be taken up by a comparative discussion of the overall contents of the three manuscripts in question, focusing in particular on material related to the astrolabe. This will be followed by studies and editions of the two coordinate tables and the gnomonic table for Tunis, which will highlight the evidence of their Maghribī origin. A brief section towards end will consider the path of transmission that facilitated the arrival of this material in Italy, which could potentially have been a consequence of the mercantile and diplomatic links that existed between Ḥafṣid Tunisia and the Republic of Venice in the thirteenth and fourteenth centuries.

[3] Samsó, *On Both Sides*, p. 4–18. See also David A. King, « On the History of Astronomy in the Medieval Maghrib », in *Études philosophiques et sociologiques dédiées à Jamal ed-Dine Alaoui*, Département de Philosophie, Sociologie et Psychologie, Fès 1998 (Université Sidi Mohamed Ben Abdallah, Publications de la Faculté des Lettres et des Sciences Humaines Dhar El Mahraz–Fès, N° Spécial, 14), p. 27–61; Julio Samsó, « Andalusian Astronomy in 14th Century Fez: *Al-Zīj al-Muwāfiq* of Ibn ʿAzzūz al-Qusanṭīnī », *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften*, 11 (1997), p. 73–110; Id., « Astronomical Observations in the Maghrib in the Fourteenth and Fifteenth Centuries », *Science in Context*, 14 (2001), p. 165–178. On the *zīj* of Ibn Isḥāq, see Angel Mestres i Valero, « Materials andalusins en el zīj d'Ibn Isḥāq al-Tūnisī », Ph.D. Diss., University of Barcelona 1999.

II. *Three Latin manuscripts and their shared content*

The following discussion will make frequent use of three manuscript sigla, which are:

E	Edinburgh, Royal Observatory, Crawford Collection, Cr. 3.28
F	Florence, Biblioteca Riccardiana, 866
V	Vienna, Österreichische Nationalbibliothek, 2452

Taking these manuscripts in reverse order, *V* is a slim codex of only 15 folios that is concerned with astronomy and some related geographical knowledge.[4] Fol. 1r–14r were written by one hand, roughly datable to the first half of the fourteenth century, whereas an astrological text on fol. 14v–15r (inc. *Septem planete dicuntur sydera que sunt omnium artium…*) was added later by a second scribe.[5] Fol. 15v used to be the back cover of the booklet in question. It carries an owner's note showing that the booklet was at one point the property of Andrea Dandolo, who was the Doge of Venice from 1343 to 1354.[6]

The content of *V*, fol. 1r–14r is replicated with certain additions on fol. 1r–16r of *F*. This codex of 69 folios is mostly devoted to texts on the quadrivium, which were probably copied in the first half of the fourteenth century. Although the original core of this manuscript was almost certainly written in Italy, its precise origin as well as provenance remain unknown. The main scribal hand detectable on fol. 1r–16r also wrote most of the remaining items, namely: a glossed and diagrammatically illustrated copy of John of Sacrobosco's *Tractatus de spera* (fol. 18ra–23va),[7] to which is attached an anonymous *Tractatus de planetis* (fol. 23vb–24vb);[8] a dialogue between a student and a teacher (inc. *Principium omnium rerum est sapientia perfecta…*), which is derived from bk. 1 of Petrus Alfonsi's *Dialogus contra*

[4] For a description, see Tarif Al Samman, Otto Mazal, *Die arabische Welt und Europa: Ausstellung der Handschriften- und Inkunabelsammlung der Österreichischen Nationalbibliothek, Handbuch und Katalog; Prunksaal, 20. Mai–16. Oktober 1988*, Akademische Druck- und Verlagsanstalt, Graz 1988, p. 294. The authors date *V* to the thirteenth century, which is probably too early given the content discussed later in this article. Digital images of the manuscript are available at: <https://digital.onb.ac.at/RepViewer/viewer.faces?doc=DTL_6874206&order=1&view=SINGLE> (Accessed Oct. 2024).

[5] This text also appears in MS Paris, Bibliothèque nationale de France, lat. 6972A, fol. 130va–136rb (s. XV^{in}). See David Juste, *Catalogus codicum astrologorum Latinorum*, vol. II: *Les manuscrits astrologiques latins conservés à la Bibliothèque nationale de France à Paris*, CNRS éditions, Paris 2015 (Documents, études et repertoires, 84), p. 70.

[6] For biographical information, see Giorgio Ravegnani, « Dandolo, Andrea », in Alberto Maria Ghisalberti (ed.), *Dizionario Biografico degli italiani*, vol. XXXII: *Dall'Anconata–Da Ronco*, Istituto della Enciclopedia Italiana, Roma 1986, p. 432–440.

[7] Edition: Lynn Thorndike, *The* Sphere *of Sacrobosco and Its Commentators*, University of Chicago Press, Chicago 1949, p. 76–117.

[8] This text is unedited and seems to be unique to this manuscript.

Iudaeos (fol. 25ra–28ra);[9] a text on the zodiacal signs, which was mainly excerpted from John of Sacrobosco's *Computus* (fol. 29ra–30rb);[10] Alexander de Villa Dei's *Massa compoti* accompanied by a commentary (fol. 32ra–41r);[11] commentaries on passages in John of Sacrobosco's *Computus* concerning the motions of the Sun and Moon (fol. 41ra–43ra);[12] a parallel edition of Alexander de Villa Dei's metrical *Carmen de algorismo* and John of Sacrobosco's prose *Algorismus* (fol. 46va–51vb);[13] an illustrated treatise on practical geometry, entitled *Ratio terre mensurandi secundum regulas et figuras* (fol. 53ra–57rb);[14] a collection of mathematical problems, entitled *De quibusdam rationibus sive compotis secundum abacum* (fol. 58ra–62va).[15] Other than the text texts just mentioned, *F* received numerous augmentations by later fourteenth-century hands (e.g., astronomical tables on fol. 16v–17r, 30v–31, 44v–45) as well as copious annotations from different scribes, some of which are in Castilian rather than Latin (e.g., fol. 10v–12r).

The third manuscript in this group, *E*, only dates from the latter half of the fifteenth century and is a slim codex comprising 52 folios.[16] It begins with treatises on the construction and use of the astrolabe originally written by Christannus of Prachatice in Prague in 1407 and here wrongly attributed to Prosdocimo de' Beldomandi (fol. 1r–22v).[17] They are followed by a fourteenth-century text on

---

[9] Petrus Alfonsi, *Dialogus*, bk. 1.109–144, ed. and trans. Carmen Cardelle de Hartmann, Darko Senekovic, Thomas Ziegler, Peter Stotz, SISMEL–Edizioni del Galluzzo, Firenze 2018 (Millennio Medievale, 116), p. 60–88: « Cum Deum esse per scripturas ... | ... undique fulcit probatio. »

[10] John of Sacrobosco, *Nova computi compilatio*, c. 5, in *Opera de computo a tempore post Gerlandum usque ad Iohannem de Sacrobosco*, ed. Alfred Lohr, Brepols, Turnhout 2025 (Corpus Christianorum Continuatio Mediaevalis, 272A), p. 651–655 (ll. 85–161).

[11] For printed editions of the *Massa compoti*, see Robert Steele, *Opera hactenus inedita Rogeri Baconi*, vol. VI: *Compotus Fratris Rogeri*, Clarendon Press, Oxford 1926, p. 268–283; Walter Émile van Wijk, *Le Nombre d'Or: étude de chronologie technique suivie du texte de la Massa compoti d'Alexandre de Villedieu*, Nijhoff, La Haye 1936, p. 52–64.

[12] The lemmata commented upon are: John of Sacrobosco, *Nova computi compilatio*, c. 7, 14–17, 22, ed. Lohr, p. 661 (ll. 17–18), 684 (ll. 20–21), 685 (l. 50), 691 (l. 22), 692 (l. 2), 693 (l. 2), 705 (l. 2)..

[13] John of Sacrobosco's *Algorismus* was last printed in Fritz S. Pedersen (ed.), *Petri Philomenae de Dacia et Petri de S. Audomaro Opera quadrivialia*, vol. I: *Opera Petri Philomenae*, Gad, Copenhagen 1983 (Corpus philosophorum Danicorum Medii Aevi, 10.1), p. 174–201. On the *Carmen de algorismo*, see Nadia Ambrosetti, « Algorithmic in the 12th Century: The Carmen de Algorismo by Alexander de Villa Dei », in Fabia Gadducci, Mirko Tavosanis (eds.), *History and Philosophy of Computing: Third International Conference, HaPoC 2015, Pisa, Italy, October 8–11, 2015, Revised Selected Papers*, Springer, Cham 2016, p. 71–86.

[14] This text is unedited and seems to be unique to this manuscript.

[15] This text is unedited and seems to be unique to this manuscript.

[16] For a description, see Neil Ripley Ker, *Medieval Manuscripts in British Libraries*, vol. II: *Abbotsford–Keele*, Clarendon Press, Oxford 1977, p. 569–570.

[17] Critical editions of both texts appear in: Alena Hadravová, Petr Hadrava (eds.), *Křišťan z Prachatic: Stavba a užití astrolábu*, Filosofia, Praha 2001. See also Petr Hadrava, Alena Hadravová, « Christannus de Prachaticz's Treatises on the Astrolabe », in Filippomaria Pontani (ed.), *Certissima*

fractional calculation, the *Algorismus de minutiis* of Jean de Lignères (fol. 22v–30v).[18] Almost the entire remainder of the codex, from fol. 31r to fol. 52r, is taken up by texts, tables, and diagrams that are also found in *F*, fol. 1r–16r. This holds true with the single exception of an unfinished diagram in the top half of fol. 50v and a table for the solar declination on fol. 51r.[19] A paper slip placed before fol. 1r and a note on the verso of the final page (fol. 52v) inform us that *E* was at one point the property of Federico Delfino (1477–1547), who taught mathematics (including astronomy/astrology) at the University of Padua from 1520 to 1547.[20] It is known that Delfino spent an earlier part of his career practicing medicine in Venice, which raises the unresolved question of his relations to the famous Delfin or Dolfin family, which belonged to Venice's ancient nobility. A Venetian connection is evident in the case of *V*, whose provenance from the collection of Andrea Dandolo has already been noted. This leads us to the interesting possibility that at least two of the three manuscripts considered here originated in the Republic of Venice, which may be relevant to explaining the transmission of some of their shared content to (Northern) Italy, a point to be considered at the end of this study.

Codices *FV* open with the same pairing of texts on the astrolabe, which are here both claimed to be Arabic-to-Latin translations by « John of Spain » (*Iohannes Yspanus*). The first text is a manual on how to construct an astrolabe, whose opening words seem to imply that its content was taught or dictated by John, the supposed translator (inc. *Dixit Iohannes: Cum volueris facere astrolabium accipe auricalcum optimum...*).[21] Other than in *F* (fol. 1ra–6va), *E* (fol. 31r–40r), and *V* (fol. 1r–5v), it has been preserved in at least five other manuscripts:

signa: A Venice Conference on Greek and Latin Astronomical Texts, Edizioni Ca' Foscari, Venezia 2017 (Antichistica, 13; Filologia e letteratura, 2), p. 295–312.

[18] Edition: Hubertus L. L. Busard, *Het rekenen met breuken in de middleleeuwen, in het bijzonder bij Johannes de Lineriis*, Paleis der Academiën, Brussel 1968 (Mededelingen van de Koninklijke Vlaamse Academie voor Wetenschappen, Letteren en Schone Kunsten van België, Klasse der Wetenschappen, Jaargang 30, nr. 7), p. 21–36.

[19] Heading: *Tabula declinationis solis verificata que est distancia eius ab equinoctiali secundum Albategni*. The table was computed to a precision of minutes for an obliquity of the ecliptic of 23;33°. Contrary to what is stated in the heading, it does not go back to al-Battānī (who used 23;35°, see n. 144 below), but instead resembles BA21 in *The Toledan Tables*, ed. Fritz S. Pedersen, 4 vols., Reitzel, Copenhagen 2002 (Det Kongelige Danske Videnskabernes Selskab, Historisk-filosofiske Skrifter, 24), vol. III, p. 964 (for 23;33,30°).

[20] Concetta Bianca, « Delfino (Dolfin), Federico », in Alberto Maria Ghisalberti (ed.), *Dizionario Biografico degli italiani*, vol. XXXVI: *De Fornari–Della Fonte*, Istituto della Enciclopedia Italiana, Roma 1988, p. 552–554.

[21] Partially edited in José María Millás Vallicrosa, *Las traducciones orientales en los manuscritos de la Biblioteca Catedral de Toledo*, CSIC, Madrid 1942, p. 322–327, from MS Toledo, Archivo y Biblioteca Capítulares, 98–27, fol. 35r–48v (s. XV). See Paul Kunitzsch, « Glossar der arabischen Fachausdrücke in der mittelalterlichen europäischen Astrolabliteratur », *Nachrichten der*

1. Fermo, Biblioteca Civica 'Romolo Spezioli', 85, fol. 99rb–106rb (s. XIII$^{2/2}$)
2. Oxford, Bodleian Library, Canon. Misc. 340, fol. 49r–54r (attr. to John of Seville; s. XIV)
3. Paris, Bibliothèque nationale de France, lat. 7293A, fol. 1r–14v (s. XIII/XIV)
4. Toledo, Archivo y Biblioteca Capítulares, 98–27, fol. 35r–48v (s. XV)
5. Vatican City, Biblioteca Apostolic Vaticana, Vat. lat. 4087, fol. 74v–80v (s. XV$^{1/4}$)

The second text is a Latin translation of a well-known treatise on astrolabe use by the Andalusian astronomer Ibn al-Ṣaffār (d. 1035), which has been transmitted much more frequently than the preceding text on construction (inc. *Primum capitulum in invention astrolabii…*).[22] In addition to *F* (fol. 6va–12ra), *E* (fol. 40r–48v), and *V* (fol. 5v–10r), the entire text of this translation or substantial excerpts from it can be found in the following manuscripts:

1. Barcelona, Biblioteca de Catalunya, 634, fol. 32r–40v (s. XV$^{1/2}$)
2. Berlin, Staatsbibliothek, lat. fol. 62, fol. 218r–226v (s. XIV)
3. Cambridge, Clare College, 15, fol. 24ra–29ra (s. XIII$^{2/2}$)
4. Cambridge, Fitzwilliam Museum, McClean 165, fol. 48v (c. 23, 37; s. XII$^{4/4}$)
5. Cambridge, St John's College, F.25, fol. 61v–69v (s. XIII/XIV)
6. Cambridge, University Library, Kk 1.1, fol. 112ra–117vb (s. XIII$^{1/2}$)
7. Erfurt, Universitätsbibliothek, Dep. Erf. CA 4° 363, fol. 95vb–97ra (c. 14–17, 19, 21–23, 25–26, 28, 34–35, 37–40; s. XIII/XIV)
8. Erfurt, Universitätsbibliothek, Dep. Erf. CA 4° 369, fol. 183vb–184ra (excerpts; s. XIV$^{1/2}$), fol. 241ra–va (c. 21; s. XIV$^{1/2}$)
9. Fermo, Biblioteca Civica 'Romolo Spezioli', 85, fol. 87vb–94vb (c. 1–beginning of c. 36; XIII$^{2/2}$)
10. London, Wellcome Library, 19, fol. 95ra–102v (a. 1332)
11. Madrid, Biblioteca nacional de España, 10053, fol. 112ra–117vb (s. XIII^{med})
12. Manchester, John Rylands Library, 67, fol. 255r–261r (s. XV$^{1/2}$)

Akademie der Wissenschaften in Göttingen, phil.-hist. Kl., 1982/11, p. 455–571 (488); Richard Lorch, « The Treatise on the Astrolabe by Rudolf of Bruges », in Lodi Nauta, Arjo Vanderjagt (eds.), *Between Demonstration and Imagination: Essays in the History of Science and Philosophy Presented to John D. North*, Brill, Leiden 1999 (Brill's Studies in Intellectual History, 96), p. 55–100 (93–95); C. Philipp E. Nothaft, « The *Liber Theoreumacie* (1214) and the Early History of the *Quadrans Vetus* », *Journal for the History of Astronomy*, 51 (2020), p. 51–74 (61); Samsó, *On Both Sides*, p. 413–414.

22 Edited in Millás Vallicrosa, *Las traducciones*, p. 261–284, from MS Madrid, Biblioteca nacional de España, 10053, fol. 112ra–117vb (s. XIII^{med}) and (for c. 1) MS Toledo, Archivo y Biblioteca Capítulares, 98–27, fol. 48v–49r (s. XV). See José María Millás Vallicrosa, « Los primeros tratados de astrolabio en la España árabe », *Revista del Instituto Egipcio de Estudios Islámicos en Madrid*, 3 (1955), p. 35–49 (40–49); Kunitzsch, « Glossar », p. 486–487; Samsó, *On Both Sides*, p. 376–377.

13. New York, Columbia University, Rare Book and Manuscript Library, Smith Western Add. MS 06, fol. 29r–44r (s. XIII/XIV)
14. Oxford, Bodleian Library, Canon. Misc. 340, fol. 54va–56rb (excerpts, c. 13, 15–17, 24–27, 30–32, 38, 40; s. XIV)
15. Oxford, Bodleian Library, Selden supra 76, fol. 37v (c. 39; s. XIII$^{2/2}$)
16. Oxford, Merton College, 259, fol. 48r–53r (s. XIII$^{1/2}$)
17. Oxford, St John's College, 188, fol. 97ra–98rb, 99ra–102ra (c. 2–17, 19, 21–23, 25–26, 28, 34–35, 37–40, 33; s. XIII/XIV)
18. Paris, Bibliothèque nationale de France, lat. 7293A, fol. 16v–25v (s. XIV)
19. Pommersfelden, Gräflich Schönbornsche Bibliothek, 66 (2640), fol. 34ra–47ra (s. XIII$^{1/2}$)
20. Stuttgart, Württembergische Landesbibliothek, Math. 4° 33, fol. 49r (c. 19; s. XII$^{2/2}$)[23]
21. Toledo, Archivo y Biblioteca Capítulares, 98–27, fol. 48v–49r (c. 1; s. XV)
22. Vatican City, Biblioteca Apostolica Vaticana, Reg. lat. 1285, fol. 1ra–8rb (s. XIII$^{1/2}$)
23. Vatican City, Biblioteca Apostolica Vaticana, Vat. lat. 3133, fol. 55r–v (end of c. 37–c. 40; s. XIV)
24. Vatican City, Biblioteca Apostolica Vaticana, Vat. lat. 4087, fol. 62r–71r (s. XV$^{1/4}$)

The translation of the use treatise is widely and plausibly ascribed to John of Seville (*Iohannes Hispalensis*), who was active in the 1120s and 1130s.[24] It is less clear that this John was also the author or translator of the treatise on construction, especially given the separate existence of a translator of the mid-twelfth century named John of Spain (*Iohannes Hispanus*).[25] Our three manuscripts differ from other witnesses on the above two lists in the way they treat the texts on astrolabe

[23] See Irene Caiazzo, Charles Burnett, « New Manuscripts of *On the Astrolabe* by Raymond of Marseilles », *Scriptorium*, 65 (2011), p. 338–349 (342–343).

[24] On this translator, see Manuel Alonso Alonso, « Juan Sevillano: sus obras proprias y sus traducciones », *Al-Andalus*, 18 (1953), p. 17–49; Maureen Robinson, « The Heritage of Medieval Errors in the Latin Manuscripts of Johannes Hispalensis (John of Seville) », *Al-Qanṭara*, 28 (2007), p. 41–71; Charles Burnett, « John of Seville and John of Spain: A *mise au point* », *Bulletin de philosophie médiévale*, 44 (2002), p. 59–78; Id., « Introduction: John of Seville and Limia », in Charles Burnett, Pedro Mantas-España (eds.), *« Ex Oriente Lux »: Translating Words, Scripts and Styles in Medieval Mediterranean Society; Selected Papers*, UCOPress, Córdoba 2016 (Arabica Veritas, 2), p. 11–17; Dag Nikolaus Hasse, « Stylistic Evidence for Identifying John of Seville with the Translator of Some Twelfth-Century Astrological and Astronomical Texts from Arabic into Latin on the Iberian Peninsula », in Charles Burnett, Pedro Mantas-España (eds.), *« Ex Oriente Lux »: Translating Words, Scripts and Styles in Medieval Mediterranean Society; Selected Papers*, UCOPress, Córdoba 2016 (Arabica Veritas, 2), p. 19–43.

[25] See Burnett, « John of Seville », p. 75–76, who notes stylistic similarities between the construction treatise and the *Epitome totius astrologiae*, whose attribution to John of Seville is very likely to be spurious.

construction and use as one unified composition, which they introduce with the following title: *Liber astrolabii editus a magistro Iohanne Yspano interprete quem translatavit de Arabico in Latino* (*F*, fol. 1ra; *V*, fol. 1r; *E*, fol. 31r, where *Latino* is corrected to *Latinum*). The copy in *E* qualifies this to some extent, as it also inserts a colophon differentiating between the construction part (*canones compositivi*) and the use part (*canones operativi*) contained in the overall work (*E*, fol. 40v):

> *Expliciunt canones compositivi astrolabii quos Ioannes Yspanus transtulit de Arabico in Latinum. Et sequuntur hos canones operativi, ut vides.*

The scribe responsible for this *explicit* was evidently confused about where to place it and ended up writing it only after the opening chapter of the use treatise. This error stems from the fact that his exemplar identified the said opening chapter as a *Recapitulatio*, as is evident from the chapter headings preserved in *F* (fol. 6va: *Recapitulatio primum capitulum*) and *V* (fol. 5v: *Recapitulatio I capitulum in mentione astrolabii et omnium super illud cadentium*). In *E*, the same heading reads *Recapitulatio totius operis* (fol. 40v), thus suggesting that the chapter in question still belongs to the preceding treatise on construction.

F's copy of the construction treatise incorporates a table showing the declinations and mediations (in whole degrees) of 29 astrolabe stars. It is written across the two columns of fol. 6r, where it separates the text's instructions on how to make the instrument's suspension rings from the chapter describing the hour-lines on its alidade. The column for the degrees of the mediation is misleadingly labelled *hic est locus stellarum 12 signorum*, making it seem as if the numbers within it referred to each star's ecliptic longitude. *E* places its version of the same table on the page that follows the aforementioned colophon (fol. 41r), allowing it to serve as a divider between the construction and use parts distinguished in this manuscript. It is different in *V*, where the star table only appears several pages after the two astrolabe texts (fol. 13v), being separated from them by the two tabular lists of geographic coordinates that are discussed below.

According to Paul Kunitzsch's 1966 classification, the table in question represents a unique type within the wider tradition of Latin star tables, which probably depends on a separate Arabic source.[26] Other than in *EFV*, it has so far only been found, in a somewhat altered form, in MS Oxford, Bodleian Library, Canon. Misc. 340, fol. 54r (s. XIV), which codex is a witness to both astrolabe treatises contained in our three manuscripts. The position of the star table here resembles that in *E*, as the page containing it intervenes between the end of the

[26] See Paul Kunitzsch, *Typen von Sternverzeichnissen in astronomischen Handschriften des zehnten bis vierzehnten Jahrhunderts*, Harrassowitz, Wiesbaden 1966, p. 31–33, who knew *V* and the Oxford manuscript and considered the table to belong to the construction treatise.

construction treatise (fol. 49r–53v) and some chapters that were excerpted from the use treatise (fol. 54v–56r).

The recension of the use treatise in *EFV* divides the text into 42 chapters as opposed to the 40 chapters counted in certain earlier copies, such as MS Vatican City, Biblioteca Apostolica Vaticana, Reg. lat. 1285, fol. 1ra–8rb (s. XIII$^{1/2}$), and MS Madrid, Biblioteca nacional de España, 10053, fol. 112ra–117vb (s. XIII^{med}). A further peculiarity concerns the final chapter, which normally offers instructions on how to compute the day of the week in the Julian calendar (based on a calendrical diagram), followed by some remarks on the equivalent date in the Arabic calendar for 1 January in certain years between 1023 and 1036.[27] The recension in *EFV* omits the second half of the chapter involving the Arabic calendar. In *EF*, the chapter accordingly ends with this sentence, which refers to a Mozarabic custom of inserting the Julian bissextile day in December: *Tunc scies quia December, qui est novissimus mensium, erit eodem anno ex 32 diebus* (*F*, fol. 12va; *E*, fol. 48v, which has *quod* for *quia*). *V* concludes one sentence earlier, with *Et scies annum bisextilem cum fuerit sub anno scripto in circulo tertio bissextus* (*V*, fol. 10r), which is one of multiple indicators that neither *F* nor *E* depend on it.

Another astrolabe-related item that occurs in all three manuscripts is a brief text beginning *Astrologie speculationis exercicium habere volentibus* (*F*, fol. 14v; *V*, fol. 14r; *E*, fol. 50r), which has the character of a prologue. Most of it comments on the significance of the name « astrolabium » as well as the instrument's various purposes, after which was supposed to follow an explanation of its method of operation. Rather than moving on to this topic, the text before us attaches a paraphrase of a passage in Cicero's *Cato Maior de senectute* and a quote from Macrobius's commentary on the *Somnium Scipionis* in Cicero's *De re publica*, which appear together in this form in a thirteenth-century commentary on Peter of Spain's *Summule logicales*.[28] The resulting text runs as follows:[29]

> Astrologie speculationis exercicium habere volentibus huius instrumenti ratio naturali quodam[30] ordine primitus occurrit investiganda. Nullius enim artis

[27] Ibn al-Ṣaffār, *On the Uses of the Astrolabe*, trans. John of Seville, c. 40, in Millás Vallicrosa, *Las traducciones*, p. 284. See Samsó, *On Both Sides*, p. 377.

[28] Lambertus M. de Rijk, « On the Genuine Text of Peter of Spain's *Summule logicales* », *Vivarium*, 7 (1969), p. 8–61 (11); Sten Ebbesen, « A New Version of 'Robertus Anglicus' on Peter of Spain », *Cahiers de l'Institut du Moyen-Âge Grec et Latin*, 90 (2021), p. 384–500 (425–426). The sources quoted are M. Tullius Cicero, *Cato maior de senectute* 21.77, ed. J. G. F. Powell, *De re publica* [etc.], Oxford University Press, Oxford 2006, p. 310; Ambrosius Theodosius Macrobius, *Commentarii in Somnium Scipionis* 1.8.3, ed. James Willis, 2nd ed. (repr.), Teubner, Stuttgart 1994, p. 37, ll. 7–9.

[29] The following edition follows *F* while using the notes to record variants in *EV* as well as some errors in *F*.

[30] quodam] quodam modo *V*

noticiam sive exercicium sine proprio et convenienti[31] instrumento quemquam habere posse[32] manifestum est. Sed quia astrologie dum[33] instrumentum est astrolabium, primo videndum est quid sit[34] astrolabium et unde dicatur et quid[35] sit eius utilitas et de modo operacionis[36] per ipsum.

Est igitur[37] astrolabium tabula[38] plana in modum celestis spere circulis, colluris,[39] axe et ceteris que in spera maiori continentur insignita. Dicitur autem astrolabium quia sicut labia intra se continent naturalia instrumenta vocis, ita astrolabium motus in se continet[40] celestium corporum; vel, sicut quibusdam placet, astrolabium dicitur ab[41] « astrorum lapsus ». Unde dicitur astrolapsus a quibusdam quia astrorum representat ortus et occasus.

Utilitas vero eius iocunda est[42] et delectabilis, quia non solum hore diei et noctis equales vel inequales secundum augmentum vel decrementum dierum vel noccium[43] per illud inveniuntur,[44] verum etiam[45] ortus et occasus siderum,[46] altitudo stellarum fixarum, loca planetarum, longitudo et latitudo terreni[47] ambitus orbis et geometralium[48] disciplinarum seu aliorum, que pene numerum et ingenium nostrum ad presens excedunt, perutilis habetur certitudo, que omnia quantum alliciunt animum scrutantis nemo quis ingenii in hiis[49] haberet[50] exercitacionem facile advertere potest. Hiis habitis, videndum est de nominibus super illud accidentibus, ut hiis primo memorie commendatis[51] que in sequentibus[52] dicenda sicut de facili comprehendantur.[53]

31 convenienti] conveniente *F*
32 posse] *om. E*
33 dum] *lege* certum
34 sit] est *E*
35 quid] que *EV*
36 operacionis] operandi *V*
37 igitur] enim *E*
38 tabula] tabulla *E*
39 colluris] coluris *EV*
40 in ... continet] continet in se *E*
41 ab] quasi *V*
42 iocunda est] est iocunda *V*
43 dierum ... noccium] diei vel noctis *V*
44 inveniuntur] invenitur *E* inveniunt *V*
45 etiam] eciam *E*
46 siderum] syderum *E*
47 terreni] terre in *E*
48 geometralium] geumetralium *EV*
49 in hiis] *om. E*
50 haberet] haberent *F*
51 commendatis] commendaris *E*
52 sequentibus] sequenti *E*
53 comprehendantur] comprehendentur *E*

> Tullius in libro de senectute[54] ait[55] ob hoc nobis animus ex altissimo Dei domicilio datus est, ut celestium motus et ordines contemplaremur et contemplando sequeremur. Idem libro de sompno: illos liquet esse sapientes qui superna tota mentis [56] acie requirunt et quesita sagaci diligencia comprehendunt.

The two Ciceronian quotes are clearly extraneous to the preceding prologue on the astrolabe, which is otherwise attested as the opening portion of a treatise on astrolabe use. Differing recensions of this treatise are attested in the following manuscripts, which all date from the fourteenth or fifteenth centuries:

1. Bergamo, Biblitoteca Civica Angelo Mai, MA 388 (Sigma II 2), fol. 76r–85r (attr. to Robert Grosseteste; s. XV$^{2/2}$)
2. Cracow, Biblioteka Jagiellońska, 813, fol. 174rb–178vb (s. XIV$^{2/2}$)
3. Erfurt, Universitätsbibliothek, Dep. Erf. CA 4° 386, fol. 110v–115v (attr. to John of Seville; s. XIV^{med})
4. Paris, Bibliothèque nationale de France, lat. 7292, fol. 292va–296vb (attr. to John of Seville; s. XV^{med})
5. Prague, Národní knihovna České republiky, XIII.F.24, fol. 82ra–87vb (s. XIV)
6. Salamanca, Biblioteca Universitaria, 2353, fol. 13rb–15vb (s. XIV)
7. Vatican City, Biblioteca Apostolica Vaticana, Pal. lat. 1381, fol. 221r–226r (s. XIV/XIV).

Barring some negligible variations, the opening sentences of this text are practically identical with the prologue attested in *EFV* up to *de facili comprehendantur*. However, *EFV* share an error with regards to the penultimate sentence, where the clause *que omnia quantum alliciunt animum scrutantis nemo quis ingenii in hiis haberet exercitacionem facile advertere potest* should have read *que omnia quantum alliciunt animum scrutantis nemo nisi qui ingenii in hiis haberet exercitacionem facile advertere potest* (« how much all these things attract the mind of the investigator, no one can easily notice unless they have exercised their intellect in these matters »).[57] This seems to rule out that the text in *EFV* represents some original nucleus of the prologue in question. Rather, we are dealing with a slightly corrupted excerpt from the use treatise found in the seven manuscripts just listed. The latter closely resembles the use treatise by Ibn al-Ṣaffār in John of Seville's translation, not least by featuring nearly the same opening chapter after the prologue. Some of the other chapters, however, show greater similarities with the

[54] senectute] senetute *E*
[55] ait] *om. V*
[56] mentis] metis *F*; mente *E*
[57] As seen, e.g., from MS Erfurt, Universitätsbibliothek, Dep. Erf. CA 4° 386, fol. 110v.

popular *Practica astrolabii* of pseudo- Māshā'allāh (inc. *Nomina instrumentorum sunt hec...*), which was itself based on this translation.[58]

It seems worth noting, moreover, that a similar prologue to the one quoted above precedes a concise treatise on astrolabe construction,[59] which the thirteenth-century *Speculum astronomiae* identifies as another translation by John of Seville.[60] This text is much shorter than the construction treatise in *EFV* beginning *Dixit Iohannes* and may in part depend on it. Its extant witnesses include the following, some of which come without the prologue in question:

1. Edinburgh, Royal Observatory, Crawford Collection, Cr. 5.14, fol. 7ra–vb (s. XIII$^{2/2}$)
2. Göttingen, Niedersächsische Staats- und Universitätsbibliothek, Theol. 124, fol. 143va–145ra (no prologue; s. XIV$^{1/2}$)
3. London, Wellcome Library, 19, fol. 102va–104va (a. 1332)
4. Madrid, Biblioteca nacional de España, 10009, fol. 18rb–20rb (s. XIII$^{2/2}$)
5. Madrid, Biblioteca nacional de España, 10063, fol. 12ra–13ra (s. XIII$^{4/4}$)
6. Munich, Bayerische Staatsbibliothek, Clm 28229, fol. 67r–69v (s. XIV$^{1/2}$)
7. New York, Columbia University, Rare Book and Manuscript Library, Smith Western Add. MS 06, fol. 44v–47r (s. XIII$^{2/2}$)
8. Oxford, Merton College, 259, fol. 89v–90v (s. XIII$^{1/2}$)
9. Paris, Bibliothèque de l'Arsenal, 879, fol. 48v–51v (s. XIII/XIV)
10. Pommersfelden, Gräflich Schönbornsche Bibliothek, 66 (2640), fol. 106ra–109rb (attr. to John of Seville; s. XIII$^{1/2}$)
11. Prague, Národní knihovna České republiky, XIII.F.24, fol. 87vb–90arb (without prologue; s. XIV)
12. Salamanca, Biblioteca Universitaria, 2353, fol. 3va–4va (attr. to Hermann of Reichenau; s. XIV)

---

[58] Edition: Ron B. Thomson (ed.), *Pseudo-Māshā'allāh: On the Astrolabe*, vol. IV: *Practica*, version 1.7 (Toronto, 2022) <https://shareok.org/handle/11244/14221.3> (Accessed Oct. 2024). See Paul Kunitzsch, « On the Authenticity of the Treatise on the Composition and Use of the Astrolabe Ascribed to Messahalla », *Archives Internationales d'Historie des Sciences*, 31 (1981), p. 42–62 (48–56); Id., « Glossar », p. 501–502; Wilbur R. Knorr, « Sacrobosco's *Quadrans*: Date and Sources », *Journal for the History of Astronomy*, 28 (1997), p. 187–222 (200–212).

[59] Edited in Millás Vallicrosa, *Las traducciones*, p. 316–321, from MS Madrid, Biblioteca nacional de España, 10009, fol. 18rb–20rb (s. XIII$^{2/2}$). See Kunitzsch, « Glossar », p. 496–497.

[60] *Speculum astronomiae*, c. 2, ed. Stefano Caroti, Michela Pereira, Stefano Zamponi, Paola Zambelli, in Paola Zambelli, *The* Speculum Astronomiae *and Its Enigma: Astrology, Theology and Science in Albertus Magnus and his Contemporaries*, Kluwer, Dordrecht 1992 (Boston Studies in the Philosophy of Science, 135), p. 218: « Sunt praeterea libri necessarii de hac parte scientiae, qui per viam narrationis demonstrationem planisphaerii imitantur, ut est ille quem transtulit Ioannes Hispalensis, qui sic incipit: Astrologicae speculationis etc. » The same passage mentions John of Seville's translation of Ibn al-Ṣaffār use treatise, which suggests that the author had seen a manuscript in which the two texts followed each other.

13. Salamanca, Biblioteca Universitaria, 2353, fol. 12ra–13rb (without prologue; s. XIV)
14. Vatican City, Biblioteca Apostolica Vaticana, Barb. lat. 276, fol. 51r–56v (a. 1473)
15. Vatican City, Biblioteca Apostolica Vaticana, Reg. lat. 1285, fol. 36ra–38rb (s. XIII$^{1/2}$)
16. Vatican City, Biblioteca Apostolica Vaticana, Vat. lat. 3114, fol. 75r–77v (s. XIII/XIV)

The opening portion of this text once again bears a close resemblance to the prologue in *EFV* up to the words *representat ortus et occasus*, the difference being that here the words in question serve to introduce a discussion of astrolabe construction rather than use. To make this relationship clearer, I shall quote the beginning of the construction treatise as found in one of the earliest known witnesses, MS Vatican City, Biblioteca Apostolica Vaticana, Reg. lat. 1285, fol. 36ra (s. XIII$^{1/2}$). Wording shared with the prologue as it appears in *EFV* is italicized:

> *Astrologice speculationis exercitium habere volentibus ratio*ne *naturali quodam ordine primitus occurrit investiganda. Nullius enim artis exercitium* absque *proprio et convenienti* sibi *instrumento quemquam habere posse manifestum est. Sed quia astrologie instrumentum* fore certum *est astrolabium*, ipsius constitutionis apertissima ex libris Ptolomei aliorumque quorundam astrologorum collecta in hoc brevi opusculo dabimus documenta. Cuius talis est nominis interpretatio. *Astrolabium dicitur* quasi astrorum labium, per similitudinem dictum. *Sicut* enim *labia infra se* claudunt *naturalia instrumenta vocis, ita astrolabium in se motus celesitum continet corporum*; *vel, ut quibusdam placet, astrolapsus,* id est, *astrorum lapsus, quia* eorum *representat ortus et occasus.*

It seems reasonable to suppose that the prologue beginning *Astrologi(c)e speculationis exercitium habere volentibus* originated in the form just quoted and was subsequently detached from the construction treatise to be remodelled into the opening of a use treatise.

In addition to the astrolabe-related material discussed so far, *F* and *V* also share the following content, which I shall discuss in more detail below:

- A table of the geographic longitudes and latitudes of 95 locations as allegedly found (*sicut continetur*) in the *liber algerafien*, i.e., in the *Book of Geography* (*F*, fol. 12va–13ra; *V*, fol. 10v–12r).
- A second set of tables of geographic coordinates showing the longitudes and latitudes of 63 locations (*F*, fol. 12ra–b; *V*, fol. 12r–13r).

- A gnomonic table showing the solar azimuth and the length of a shadow for each completed seasonal hour at the summer and winter solstice, as valid for a northern latitude of 36°, here identified with Tunis (*F*, fol. 15r; *V*, fol. 14r).

While *F*, fol. 1r–16r replicate the entire content of *V*, fol. 1r–14r, the former manuscript as well as *E* preserve some additional material not found in *V*. This includes a brief text on the seven geographic climates and their determination through altitude measurements (*F*, fol. 13v: *Climatum autem divisio et distinctio per quadrantem poterit habere per hunc modum...*). It assumes the same boundaries between the climates as does John of Sacrobosco's popular *Tractatus de spera*, which appears later in the same manuscript (fol. 18ra–23va).[61] The text is accompanied by numerical tables showing for each degree of latitude within the seven climates the maximum daytime length (in hours and minutes) and the cumulative extent in terrestrial miles. It extends from 12° to 50° and implicitly equates one degree of terrestrial latitude with a length of 87.5 miles, which is rooted in the classical Eratosthenian estimate for the circumference of the Earth (252,000 stades = 31,500 miles).

The text and table on the climates appear in *E* on fol. 49r–v, where they are accompanied by a drawing of an astrolabe's rete (fol. 49r). A note that was left on fol. 38r shows that this drawing had originally been intended to appear on the latter page, in the context of the construction treatise on fol. 31r–40v (*figura que deberet esse in hoc spatio est descripta in 49ª carta supra tabulas climatum*). It was presumably moved to a later page because of a lack of adequate drawing space on fol. 38r. *F* shows this drawing in its original context (fol. 5ra), but in an unfinished version that lacks most of the star pointers and inscriptions. The more fully executed state of this drawing in *E* would seem to indicate that, despite all similarities, that relevant parts of *E* are not an apograph of *F*.

Also included in *F* is an unusual astronomical table that shows the altitude of the Sun as a function of (i) the twelve unequal hours of daylight and (ii) the noon altitude (*F*, fol. 14r). There are accordingly ninety rows of entries for the ninety full degrees of solar noon altitude.[62] Its entries do not seem related with those in the gnomonic table for Tunis, which will be discussed below. The latter table as well as the previously discussed prologue on the astrolabe (*F*, fol. 14v: *Astrologie speculationis exertitium habere volentibus...*) both appear in *F* in the context of a four-page sequence of detailed and well-executed technical drawings (*F*, fol. 14v–16r). Leaving aside a few geometrical sketches on fol. 15v, these drawings include the

[61] JOHN OF SACROBOSCO, *Tractatus de spera*, c. 3, ed. THORNDIKE, p. 111–112.

[62] This table bears no close resemblance to a table for the same purpose edited in *The Toledan Tables*, ed. PEDERSEN, vol. III, p. 1136–1138 (BM13), which begins at a noon altitude of 10°, showing altitudes in steps of 0;30° and times in steps of 0;15h.

following: (i) a drawing of the rete of an ordinary astrolabe (*F*, fol. 14v); (ii) two construction drawings with added degree scales for inscribing azimuths and almucantars on an astrolabe's horizon plates (*F*, fol., 14v–15r; *E*, fol. 52r); (iii); a construction drawing with degree scales for a horizontal sundial (*F*, fol. 15r; *E*, fol. 52r); (iv) two drawings showing the inscriptions on the face of an universal astrolabe in the style of Ibn al-Zarqālluh's *ṣafīḥa shakkāziyya* (*F*, fol. 15v–16r; *E*, fol. 50r–v).[63]

E (fol. 50r–v, 52r) contains four of these six drawings, as it omits the astrolabe's rete and the diagram for the almucantars (found in *F* on facing pages, fol. 14v–15r). Its renditions of the remaining ones are on the whole very similar to those in *F*, suggesting that both sets of drawings faithfully represent the content of a lost archetype.

III. *Two coordinate tables*

The two tables of geographic coordinates that are included in *F* on fol. 12r–13r and in *V* on fol. 10v–12r are both very unusual in a Latin context and have so far not been found in any other manuscript.[64] Their primary focus is on locations in Iberia and North Africa (including Egypt), although they both also include a selection of cities or regions in Italy, the Levant, and the Arabian Peninsula. Their relatively broad coverage of North Africa explains why both tables as they appear in *V* were included in the *Monumenta cartographica Africae et Aegypti*, published between 1926 and 1951 and financed by the Egyptian prince Yusuf Kamal (1882–1965). Their

[63] On this type, see Roser Puig, « Concerning the *Ṣafīḥa Shakkāziyya* », *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften*, 2 (1985), p. 123–139; Id., *Al-Šakkāziyya: Ibn al-Naqqāš al-Zarqālluh*, Instituto « Millás Vallicrosa » de Historia de la Ciencia Árabe, Barcelona 1986; Samsó, *On Both Sides*, p. 450–453.

[64] On the wider subject of medieval Latin tables of geographic coordinates, see Dana Bennett Durand, *The Vienna-Klosterneuburg Map Corpus of the Fifteenth Century: A Study in the Transition from Medieval to Modern Science*, Brill, Leiden 1952, p. 93–113; C. Philipp E. Nothaft, « A Thirteenth-Century Latin List of Ptolemaic Coordinates », *Mediterranea*, 7 (2022), p. 1–15; Id., « Geographic Longitude in Latin Europe during the Twelfth and Thirteenth Centuries », *Archive for History of Exact Sciences*, 78 (2024), p. 29–65. For the Islamic world, see 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, Frankfurt am Main 1987 (Veröffentlichungen des Institutes für Geschichte der Arabisch-Islamischen Wissenschaften, Reihe A: Texte und Studien, 2); Eric Mercier, « Mathematical Geography in the Western Islamic World: Geographical Coordinates of Localities in the al-Maghreb and al-Andalus Localities (9th–18th Centuries) », *Suhayl*, 18 (2020–2021), p. 25–49.

printed edition is there juxtaposed with photographs of the relevant manuscript pages in *V*.[65]

F features the same two tables in reverse order. The second table in this manuscript (*F*, fol. 12v–13r), which is the same as the first in *V* (fol. 10v–12r), contains 95 entries. With the notable exception of the first eight entries, which may have a separate origin, the entries in this table are placed in a mostly consistent order of increasing longitude, starting in the far west and ending in the east. A column to the very left assigns each location to one of the first five climates, which are bands of northern latitude.[66] These placements suggest overall that the third climate was assumed to begin between 27° and 28° and to end at *c.*33°, but there is no consistency as to whether latitudes between 37° and 38° still belong to the fourth or already to the fifth climate.

The heading of this table in *F* is *Latitudo et longitudo regionum sicut continetur in libro algerafien*. In *V* the same heading appears four times, at the top of each page, but the word *algerafien* is twice (fol. 10v, 11v) misspelled as *algeralien*.[67] The same word, which is clearly a transliteration from Arabic (*al-jughrāfiyā*), makes an earlier appearance in both manuscripts in the treatise on the uses of the astrolabe by Ibn al-Ṣaffār. Its chapter on the determination of geographic longitudes contains the following reference to Ptolemy's *Geography*:

> *Et iam collegit Ptolomeus in libro quem nominavit algerafien collegitque in eo longitudines civitatum cognitarum posuitque latitudinem earum…* (*F*, fol. 9ra–va; *V*, fol. 8r).[68]

Another mention of this *liber algerafien* appears in the immediately following chapter, which deals with determining the direction (azimuth) of a location of known geographic longitude and latitude (*F*, fol. 9va; *V*, fol. 8r).[69] It would appear, then, that the heading is not germane to the table in question but was added to

---

[65] Yusuf Kamal, *Monumenta Cartographica Africae et Aegypti*, vol. IV: *Époque des portulans, suivie par l'époque des découvertes*, fasc. 1, sin. loc., 1936, p. 1115. Reprinted in Fuat Sezgin, *European Geographical Tables Based on the Arabic Tradition*, Institut für Geschichte der Arabisch-Islamischen Wissenschaften an der Johann Wolfgang Goethe-Universität, Frankfurt am Main 1992 (Islamic Geography, 23), p. 57–60.

[66] On the climates and their role in ancient and medieval geography, see Ernst Honigmann, *Die sieben Klimata und die ΠΟΛΕΙΣ ΕΠΙΣΗΜΟΙ: Eine Untersuchung zur Geschichte der Geographie und Astrologie im Altertum und Mittelalter*, Winter, Heidelberg 1929.

[67] In Kamal, *Monumenta*, p. 1115, it is reproduced as *Alg'alien*.

[68] See Ibn al-Ṣaffār, *On the Uses of the Astrolabe*, trans. John of Seville, c. 26, ed. Millás Vallicrosa, p. 275.

[69] See Ibn al-Ṣaffār, *On the Uses of the Astrolabe*, trans. John of Seville, c. 27, ed. Millás Vallicrosa, p. 276. For a discussion of the references to the *Geography* in these two passages as well as in some other twelfth-century Latin texts, see Patrick Gautier Dalché, *La Géographie de Ptolémée en Occident (IV^e^–XVI^e^ siècle)*, Brepols, Turnhout 2009 (Terrarum orbis, 9), p. 98–111.

create a link with the book of geographic longitudes and latitudes mentioned in the preceding treatise. This circumstance may also speak in favour of considering the arrangement of the tables in *V* to be closer to the shared archetype, as here the table of coordinates *sicut continetur in libro algerafien* comes immediately after the use treatise, while the second table is introduced with the simpler title *Item alia tabula de eodem*. The scribe of *F* may have found the same arrangement of tables in his exemplar but decided to reverse their order to make the best possible use of manuscript space. Owing to its smaller size, the second table could fit onto the page that contained the end of the use treatise (fol. 12ra), leaving the following page spread (fol. 12v–13r) free to receive the first table with its comparatively larger number of entries (95 vs. 63).

When it comes to the 95 entries contained in the table linked with the *liber algerafien*, it can be observed that of the 72 entries whose locations can be identified with some confidence, almost half (35) are found in North Africa. The Maghreb—as defined by modern-day Morocco, Algeria, Tunisia, and Libya, plus the city of Ceuta—accounts for most of these (30). Another sizeable cluster of entries belongs to Iberian cities, of which there are at least 14, while most of the remaining places can be found in Italy, the Levant, and the Arabian Peninsula.

An important discovery with regards to the origin of this source was made by Fuat Sezgin (1924–2018), who noticed some decades ago that the first table in *V* resembles a geographic coordinate table included in a *zīj* by Ibn al-Raqqām, a noted Andaluso-Maghribī astronomer.[70] The *zīj* in question, *al-Zīj al-Shāmil*, was computed for Béjaïa in modern-day Algeria, perhaps as early as 1279–80, but more plausibly around 1290.[71] Besides the *Shāmil zīj*, Ibn al-Raqqām is known to have

[70] Fuat Sezgin, *Geschichte des arabischen Schrifttums*, vol. X: *Mathematische Geographe und Kartographie im Islam und ihr Fortleben im Abendland: Historische Darstellung, Teil 1*, Institut für Geschichte der Arabisch-Islamischen Wissenschaften an der Johann Wolfgang Goethe-Universität, Frankfurt am Main 2000, p. 231; Id., *Geschichte des arabischen Schrifttums*, vol. XIII: *Mathematische Geographie und Kartographie im Islam und ihr Fortleben im Abendland: Autoren*, Institut für Geschichte der Arabisch-Islamischen Wissenschaften an der Johann Wolfgang Goethe-Universität, Frankfurt am Main 2007, p. 394–398. See previously already E. S. Kennedy, « The Astronomical Tables of Ibn al-Raqqām, a Scientist of Granada », *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften*, 11 (1997), p. 35–72 (35–36, 66–67), who credits Sezgin.

[71] A partial edition of this *zīj* appears in Muhammad ʿAbd al-Raḥmān, « Ḥisāb aṭwāl al-kawākib fī al-Zīj al-shāmil fī tahdhīb al-kāmil li-Ibn al-Raqqām », Ph.D. Diss., University of Barcelona 1996, which I have not been able to access. Regarding the date, see Samsó, *On Both Sides*, p. 769. On the author, see Julio Samsó, « Ibn al-Raqqām, Abū ʿAbd Allāh », in Jorge Lirola Delgado (ed.), *Biblioteca de al-Andalus*, vol. IV: *De Ibn al-Labbaña a Ibn al-Ruyūlī*, Fundación Ibn Tufayl de Estudios Árabes, Almería 2006, p. 440–444; Josep Casulleras, « Ibn al-Raqqām: Abū ʿAbd Allāh Muḥammad ibn Ibrāhīm ibn ʿAlī ibn Aḥmad ibn Yūsuf al-Mursī al-Andalusī al-Tūnisī al-Awsī ibn al-Raqqām », in Thomas Hockey et al. (eds.), *The Biographical Encyclopedia of Astronomers*, 2nd ed., Springer, New York 2014, p. 1057–1058; José Bellver, Julio Samsó, « Ibn al-Raqqām on Lunar Parallax », *Suhayl*, 11 (2012), p. 189–229 (189–193).

authored two other sets of astronomical tables. *Al-Zīj al-Mustawfī*, his most frequently preserved *zīj*, was made for Tunis shortly after 1280–81.[72] *Al-Zīj al-Qawīm* was likewise originally made for Tunis after 1280–81 but later received revisions for Granada, where Ibn al-Raqqām settled at some point between 1288–89 and 1302 and died in 1315.[73]

Of the two *zīj*es just mentioned, the first contains a coordinate table for 67 locations, the second for 94 locations.[74] The table in the *Shāmil zīj*, which has 97 entries, has been translated into German by Sezgin on the basis of the only known manuscript (MS Istanbul, Kandilli Observatory, 249, copied *c.*1800).[75] Using Sezgin's translation as a reference, I have found at least 75 entries in Ibn al-Raqqām's table with a counterpart in the relevant table in *FV*, which almost always places these locations in the same relative order.[76] This overlap is less consistent when it comes to the numerical values for longitudes and latitudes shown in both tables, though much of this can be explained with transcription errors in both versions as well as with a downward displacement of the coordinates relative to their place name that affects some entries in the table published by Sezgin.[77]

The following edition of the table *sicut continetur in libro algerafien* takes into account both available witnesses, *F* and *V*. It usually follows the readings in *F*, whose scribe made slightly fewer mistakes when transcribing numbers. Variants in *V* and occasional emendations are indicated in the footnotes. The six middle columns replicate the columns found in the manuscripts, which are for: (i) the number of the climate in which the location is found; (ii) the name of the location; (iii) the degrees of longitude; (iv) the minutes of longitude; (v) the degrees of latitude; (vi) the minutes of latitude. Added to the left of the core table is a column providing an index number for each entry. A second number placed in square brackets indicates the position of the same entry in the coordinate table of Ibn al-Raqqām *Shāmil zīj*, as reproduced by Sezgin.[78] A column to the right has been added to provide, wherever possible, modern identifications of the locations shown in the table. It uses the following country codes: DZ = Algeria, EG = Egyptian, ES =

---

[72] Julio Samsó, « Ibn al-Raqqām's *al-Zīj al-Mustawfī* in MS Rabat National Library 2461 », in Nathan Sidoli, Glen Van Brummelen (eds.), *From Alexandria, Through Baghdad: Surveys and Studies in the Ancient Greek and Medieval Islamic Mathematical Sciences in Honor of J.L. Berggren*, Springer, Berlin 2014, p. 297–328; Id., *On Both Sides*, p. 770–771.

[73] Samsó, *On Both Sides*, p. 769–770.

[74] On the other two tables, see Samsó, « Ibn al-Raqqām's *al-Zīj al-Mustawfī* », p. 324–325.

[75] Sezgin, *Geschichte*, vol. XIII, p. 395–397.

[76] Kennedy, « The Astronomical Tables », p. 67, found that only 40 entries in *V* also appear in the *Shāmil zīj*, which is too low an estimate.

[77] This displacement was already suspected by Kennedy, « The Astronomical Tables », p. 66. It is made a practical certainty if the data are collated with those in the Latin table, which are often more accurate. I do not see on what basis Sezgin, *Geschichte*, vol. XIII, p. 395, 397, twice characterizes the table in *V* as « dilettantisch ».

[78] Sezgin, *Geschichte*, vol. XIII, p. 395–397.

Spain, IL = Israel, IQ = Iraq, IT = Italy, LB = Lebanon, LY = Libya, MA = Morocco, SA = Saudi Arabia, SD = Sudan, SY = Syria, TN = Tunisia, TR = Turkey, YE = Yemen.

No.							Identification
			Longitudo		Latitudo		
	Climata	Nomina civitatum	Gradus	Minuta	Gradus	Minuta	
1	4	Frequia	36	30	33	0	Ifrīqiya (region)
2	4	Esfaquiç	41	0	35	30	Sfax (TN)
3	4	Affrica	42	0	35	30	
4	4	Suça	41	50	35	50	Sousse (TN)
5	4	Capiç	43	0	34[79]	0	Gabès (TN)
6	4	Ierba[80]	43	30	34	40	Djerba (island, TN)
7	4	Querquena	43	20	35	40	Kerkennah (islands, TN)
8	2	Cuç	48	20	27	0	
9	3	Villa ethiopum	20	15	31	0	
10 [3]	3	Marrochium	21	20	31	30	Marrakesh (MA)
11 [4]	3	Tedeliç	24	0	32	0	Tadla (region, MA)
12 [5]	4	Cadiç	24	0	36	0	Cádiz (ES)
13 [6]	3	Daraa	24	20	28	30	
14 [7]	4	Sale	24	40	33	20	Salé (MA)
15 [8]	4	Calata elmedina[81]	24	40	33	32	
16 [9]	4	Mequineç çeytu	24	50	33	32	Meknes (MA)
17 [10]	4	Feç	25	0	33	40	Fez (MA)
18 [11]	4	Açile	25	34	34	0	Asilah (MA)
19 [12]	4	Tanger	25	0	35	0	Tangier (MA)
20 [13]	4	Cacer abdelcarim[82]	25	32	35	25	
21	4	Algeçira dalhadra	25	40	36	36	Algeciras (ES)
22 [15]	4	Sibilia	25	40	37	30	Seville (ES)
23 [18]	4	Septa	26	0	35	20	Ceuta (ES)
24 [16]	4	Saguielmesa[83]	26	20	35	20	Sijilmasa (MA)
25	4	Malecha	26	22	36	30	Malaga (ES)
26	4	Corduba[84]	27	0	38	30	Córdoba (ES)
27 [20]	4	Granada	27	30	37	30	Granada (ES)
28 [21]	4	Almeria	28	36	37	30	Almería (ES)
29 [22]	4	Toledo	28	0	40	0	Toledo (ES)

79 34] 43 *V*
80 Ierba] Ierma *V*
81 Calata elmedina] Calamelmedina *V*
82 abdelcarim] abdelçirim *V*
83 Saguielmesa] Daguielmesa *F* Saguielmessa *V*
84 Corduba] Cordova *V*

30 [23]	4	Maqueda	28	0	30	0	Oujda (MA)(?)
31 [24]	5	Jaen	29	0	38	0	Jaén (ES)
32 [25]	4	Trimse	29[85]	30	34	30	Tlemcen (DZ)
33 [26]	4	Mursia[86]	30	0	37	30	Murcia (ES)
34 [27]	5	Valencia	30	0	39	30	Valencia (ES)
35 [28]	5	Denia	30	0	37	59	Dénia (ES)
36 [29]	3	Ahruna[87]	30	0	32	0	Oran (DZ)(?)
37 [30]	3	Thaharath[88]	30	0	32	0	Tiaret (DZ)
38 [31]	5	Xativa	30	20	37	25	Xàtiva (ES)
39 [33]	4	Teneç	32	0	34	0	Ténès (DZ)
40 [34]	3	Castel dehamech[89]	32	0	33	0	
41 [35]	3	Tabna	32	0	31	0	Tobna (DZ)(?)
42 [36]	5	Tortosa	32	0	37	15	Tortosa (ES)
43 [37]	4	Algeçer	33	0	35	0	Algiers (DZ)
44 [38]	4	Bugia	34	0	36	0	Béjaïa (DZ)
45 [39]	3	Capsa[90]	35	0	29	0	Gafsa (TN)
46 [40]	3	Touçer	36	0	29	0	Tozeur (TN)
47 [41]	4	Constantina	36	0	35	0	Constantine (DZ)
48 [42]	4	Herca[91]	37	15	34	40	
49 [43]	5	Manorca[92]	38	15	39	10	Menorca (island, ES)
50 [44]	4	Elcaroen[93]	38	45	36	0	Kairouan (TN)
51 [45]	3	Tacayuç	39	0	28	0	
52 [46]	5	Sicilia palerm	39	8	38[94]	0	Palermo (IT)
53 [47]	4	Çubela	41	0	34	0	Zawīla (TN)
54 [48]	3	Capiç	41	0	32	0	Gabès (TN)
55 [49]	4	Sardinia[95]	41	30	37	30	Sardinia (island, IT)
56 [50]	4	Tuniç[96]	41	35	36	40	Tunis (TN)
57 [51]	4	Tripol	41	0	34	0	Tripoli (LY)
58 [52]	5	Ienoa[97]	43	0	39	0	Genoa (IT)
59 [53]	5	Pisa	44	0	39	0	Pisa (IT)
60 [54]	5	Roma	45	0	41	0	Rome (IT)

85 29] 39 *V*
86 Mursia] Murcia *V*
87 Ahruna] Ahuca *V*
88 Thaharath] Taharath *V*
89 hamech] hamet *V*
90 Capsa] Capça *V*
91 Herca] id est pedam, terra nigrorum *add. F* Terra de negres *V*
92 Manorca] Manorcha *V*
93 Elcaroen] Elcarcen *V*
94 38] 28 *V*
95 Sardinia] Serdeyma *V*
96 Tuniç] Tunis *V*
97 Ienoa] Genoa *V*

61 [55]	5	Sicilia	45	20	37	30	Sicily (island, IT)
62 [56]	3	Vden	46	0	28	0	Waddan (LY)
63 [57]	3	Barcha	45[98]	0	33	0	Cyrenaica (region, LY)
64 [58]	4	Antiochia	60	0	37	0	
65 [59]	3	Alexandria[99]	61	59	31	0	Alexandria (EG)
66 [60]	3	Macçer	64	50	30	0	Miṣr/Cairo (EG)
67 [62]	3	Ascalona	65	0	33	0	Ashkelon (IL)
68 [63]	3	Armenia	65	50	32	0	Ramla (IL)(?)
69 [64]	3	Acon	66	0	35	0	Acre (IL)
70 [66]	3	Sur	66	0	33	0	Ṣūr/Tyre (LB)
71 [67]	4	Damascus	66	0	34	0	Damascus (SY)
72 [68]	3	Falastin	66	15	32	30	Palestine
73 [69]	4	Tripol de suria	66	20	34	0	Tripoli (LB)
74 [70]	3	Iherusalem	66	30	32	0	Jerusalem
75	1[100]	Sanacha[101]	67	0	14	0	Sanaa (YE)
76 [72]	2[102]	Sussan	69	0	27	0	Aswan (EG)
77 [74]	5	Emç	69	35	38	50	Homs (SY)
78 [75]	4	Antalia	69	35	34	10	Antalya (TR)(?)
79 [76]	2	Coç	69	32	26[103]	0	Qus (EG)
80 [77]	4	Halap	71	35	34	30	Aleppo (SY)
81	1[104]	Aaçen	71	40	15	0	
82	4	Arcelfe[105]	72	30	35	40	
83	4	Antiochia	69	5	34	10	Antakya (TR)(?)
84 [80]	1[106]	Aadeb	73	0	19	30	ʿAydhab (EG/SD)
85 [81]	4	Arracha	73	15	36	0	Raqqa (SY)
86	5	Satalia	74	0	39	0	
87	1[107]	Terra etiopum	74	40	13	0	
88	1[108]	Çeeria	76	0	17	0	
89 [85]	2	Jeddehe	76	12	21	10	Jeddah (SA)
90 [86]	2[109]	Mecha	77	0	21	40	Mecca (SA)

98 45] ?5 *F* 35 *V*
99 Alexandria] in ...ne ...li *add. F*
100 1] 2 *V*
101 Sanacha] Sanaha *V*
102 2] 3 *V*
103 26] 21 *V*
104 1] 2 *V*
105 Arcelfe] Arcelphe *V*
106 1] 2 *V*
107 1] 2 *V*
108 1] 2 *V*
109 2] 3 *V*

91	2	Etip[110] elmedina	77	0	25	0	Medina (SA)
92 [89]	3	Achalbi	79	20	20	0	
93 [90]	3	Babilonia	80	0	33	0	Baghdad (IQ)
94 [91]	1[111]	Çaba	80	30	16	4	Saba'
95 [92]	3	Hacça	81	0	31	0	

Tab. 1: table of geographic coordinates in *F*, fol. 12va–13ra and *V*, fol. 10v–12r

The second coordinate table in *V* is considerably shorter, containing 63 entries, as well as more compact, showing only degrees of longitude and latitude while omitting any columns for minutes. Like the preceding table related to Ibn al-Raqqām's *Shāmil zīj*, it is especially concerned with locations in the Maghreb, which account for at least 24 of its 57 securely identifiable entries. The Iberian Peninsula comes in a close second, with 19 entries. Compared to the longer list, there is a slightly higher percentage of places outside the Islamic world, including Paris (#59) and 8 islands or cities in Italy. There are some glaring inconsistencies in the displayed longitudes, which would seem to indicate that the information in this table was gathered from disparate sources using different meridians of reference. This is nowhere more obvious than in the case of the four Italian cities listed, where Pisa (#39, long. 51°) and Genoa (#40, long. 50°) have assigned longitudes that exceed those of Venice (#47, long. 29°) and Rome (#48, long. 25°) by over 20°.

Instead of being ordered according to geographic longitude, most of the 63 locations in this table are grouped according to climates, starting with those in the second climate and ending with those in the fifth. Overall, these groupings seem to place the lower boundary of the third climate at or before 28°, that of the fourth climate between 34° and 35°, and that of the fifth climate between 38° and 39°. An entry that clearly violates this rule is that for the Tunisian city of Tozeur (*Touçer*, #28), which despite its assigned latitude of 29° (correct: 33;55°) is here assigned to the fourth climate. The final six entries, which include one city in the seventh climate (Paris, #59), eschew the ordering according to climates altogether, presumably because they were later additions to the original list.[112]

The location of the first entry is identified as *Elmedina ubi pseudo iacet*, which can perhaps be interpreted as « Medina, where the false prophet lies » and was obviously meant as a derogatory reference to Mohammed and his tomb in the Prophet's Mosque in Medina. If this statement was not simply inserted by the translator, it could be a sign that the source itself was created by a Christian rather than a Muslim. The same possibility is raised by the third entry on the list, for

[110] Etip] Etrp(?) *F*

[111] 1] 2 *V*

[112] In *V*, a later hand repeated the names of the last seven location below the end of the table, but added no coordinates except for a longitude of 28° that is here wrongly assigned to *Saguialmesa*.

Sepulcrum domini (« The Lord's Sepulchre »), an obvious reference to the Holy Sepulchre and hence to the city of Jerusalem. Of some interest, moreover, is the use of *Mont de Barques* (#6), a medieval Catalan name for the Cyrenaica region, which raises the possibility that the table was in some way connected with the activities of Catalonian traders in North Africa in the thirteenth and fourteenth centuries.[113]

As was already mentioned above, *F* reverses the order between the two coordinate tables, by placing the shorter table immediately after the end of the treatise on astrolabe use. It here carries the descriptive heading *Tabula in qua inveniuntur longitudines et latitudines locorum*, followed by a redundant opening statement: *Hec est tabula per quam inveniuntur longitudines et latitudines civitatum et locorum et in quo climate sint* (fol. 12ra). Evidence of the use of this particular table in the second half of the fourteenth century appears in a long gloss written in Castilian that fills the upper and outer margins of the facing page (fol. 11v). It comments on the penultimate chapter of the treatise on astrolabe use by Ibn al-Ṣaffār, which deals with computing the so-called revolution of the years of the world (*revolutio annorum mundi*). In explaining how to adjust this calculation for geographic longitude, the author uses as his example the year 1360 and the longitudes of Tunis (*Tunes*) and Marrakesh (*Maroques*), placing them 20° apart, at 21° (Marrakesh) and 41° (Tunis). These longitudes correspond exactly to those shown in the table on fol. 12ra (see entries #12 and #25 in the edition below) and were presumably plucked from there.[114]

The below edition of the second table observes the same principles as Tab. 1 above. To the four columns that make up the table in the two manuscripts, it adds a column of index numbers to the left and a column of place identifications to the right. *F* is once again used as the guide manuscript, while variants in *V* or emendations are documented in the footnotes.

No.					Identification
	Climata[115]	Nomina civitatum	Longitudo	Latitudo	
1	2	Elmedina ubi pseudo iacet	87	25	Medina (SA)
2		Meca	77	21	Mecca (SA)
3	3	Sepulcrum domini	68	33	Jerusalem
4		Alexandria	66	31	Alexandria (EG)

[113] Maria Teresa Ferrer, « Catalan Commerce in the Late Middle Ages », *Catalan Historical Review*, 5 (2012), p. 29–65 (39).

[114] *F*, fol. 11v: « Debes saber que el montante del anno sse varia segunt las lunguezas de las tieras. Exemplo: [...] en Tunes fue el montante del dicho anno Capricornius en 5 gradus, que es la longueza suya 41 grado. Et la longueza de Maroques es 21, asy 20 grados es mayor la longueza de Tunes de la de Maroques, que fa 1 hora et terzia. »

[115] climata] *om. V*

5		Acre	69	34	Acre (IL)
6		Mont de Barques[116]	60	33	Cyrenaica (LY)
7		Capsa	33	30	Gafsa (TN)
8		Tenes[117]	31	34	Ténès (DZ)
9		Algeçer[118]	30	33	Algiers (DZ)
10		Hauran[119]	28	32	Oran (DZ)
11		Tenimsen[120]	28	34	Tlemcen (DZ)
12		Marrochs	21	31	Marrakesh (MA)
13		Besquera	28	28	Biskra (DZ)
14		Busch[121]	35	34	
15	4	Ierba	48	34	Djerba (island, TN)
16		Querquena[122]	47	35	Kerkennah (islands, TN)
17		Cicilia[123]	46	37	Sicily (island, IT)
18		Cerdinia	43	37[124]	Sardinia (island, IT)
19		Affrega	46	39	
20		Capiç	48	34	Gabès (TN)
21		Sfaquis	46	35	Sfax (TN)
22		Sussa[125]	45	36	Sousse (TN)
23		Hamamet	44	36	Hammamet (TN)
24		Besert	39	36	Bizerte (TN)
25		Tuniç	41	37	Tunis (TN)
26		Alcaroen	36	36	Kairouan (TN)
27		Tripol de Barbaria	47	34[126]	Tripoli (LY)
28		Touçer[127]	34	29	Tozeur (TN)
29		Bugia	33	36	Béjaïa (DZ)
30		Almeria	28	36	Almería (ES)
31		Granada	27	37	Granada (ES)
32		Iaen	28	37	Jaén (ES)
33		Cartagenia	41	36	Cartagena (ES)
34		Maleca	26	37	Malaga (ES)
35		Bona	37	36	Annaba (DZ)

116 barques] barches *V*
117 tenes] teneç *V*
118 algeçer] algeer *F*
119 hauran] hurara *V*
120 tenimsen] tenimse *V*
121 busch] brasch *V*
122 querquena] querqna *V*
123 cicilia] sicilia *V*
124 37] 38 *add. F*
125 sussa] suça *V*
126 34] 38 *V*
127 touçer] toucçer *V*

36		Septa	25	35	Ceuta (ES)
37		Feç	24	34	Fez (MA)
38	5	Assur	150	40	
39		Pisa	51	39	Pisa (IT)
40		Ienoa	50	39	Genoa (IT)
41		Barchinona[128]	31	39	Barcelona (ES)
42		Mayorcha	37	39	Mallorca (island, ES)
43		Minoricha[129]	35	39	Menorca (island, ES)
44		Tortosa	31	40	Tortosa (ES)
45		Saragossa	30	41	Zaragoza (ES)
46		Marsela	33	38	Marseilles (FR)(?)
47		Venecia	29	41	Venice (IT)
48		Roma	25	43	Rome (IT)
49		Cordova	27	38	Córdoba (ES)
50		Xibilia[130]	28	29	Seville (ES)
51		Tarif	27	38	Tarifa (ES)
52		Traya	22	48	
53		Tarragona	28	40	Tarragona (ES)
54		Valencia	27	39	Valencia (ES)
55		Gerona	30	39	Girona (ES)
56		Leyda	29	39	Lleida (ES)
57		Murcia	28	38	Murcia (ES)
58	3	Antaquia	70	32	Antakya (TR)
59	7	Paris	20	48	Paris (FR)
60	4	Cremona	31	45	Cremona (IT)
61		Corduba[131]	39	37	Córdoba (ES)
62	5	Napols		40	Naples (IT)
63	3	Saguialmesa	15	22	Sijilmasa (MA)

Tab. 2: the second table of geographic coordinates in *F*, fol. 12ra–b and *V*, fol. 12r–13r

IV. *A Tunisian table for the construction of sundials*

Ibn al-Raqqām's period of activity, from the composition of his first astronomical tables in the early 1280s to his death in 1315, provides us with an approximate *terminus post quem* for the Arabic source that must underlie some of the material we find in *V* and *F*. A possible hint that this source was written in Tunisia can be gleaned from a small table for the solar azimuths and shadow lengths at the two

[128] barchinona] barcelona *V*
[129] minoricha] menorcha *V*
[130] xibilia] sibilia *V*
[131] corduba] cordova *V*

solstices that has, to my knowledge, never been mentioned in any earlier literature. The table appears in *F* on fol. 15r, where it is accompanied by construction drawings for an astrolabe's horizon plate and a horizontal sundial. This juxtaposition of the sundial diagram and the table is probably not coincidental and may point towards a shared origin for this material. *V* has the same table on fol. 14r, placing it underneath the prologue on the astrolabe edited above. According to the headings in both manuscripts, the table was computed for a geographic latitude of 36°, which is here identified with that of Tunis. Tab. 3 below provides an edition of the table that takes into account variants between the two witnesses.

[*F*] Hec est tabula de horis cognoscendis in diei in lapide de 36 latitudo Tunicii [*F*]
[*V*] Ista tabula est de horis cognoscendis in lapide de 36 latitudo Tunicii [*V*]

	[*F*] Çempt [*F*] [*V*] arçemut [*V*]		umbra			[*F*] Çempt [*F*] [*V*] arçemut [*V*]		umbra	
hore	gradus	minuta	gradus	minuta	hore	gradus	minuta	gradus	minuta
1	19[132]	41	51	0	1	36	0	84	46
2	10	3	23	16	2	45	22	43	50
3	0 meridies	14	13	27	3	54	52	30	27
4	12	28	8	2	4	65	34	24	17
5	34[133]	53[134]	4	27	5	75	30	21	38
6	90	0	2	47	6	90[135]	0	20	24

Tab. 3: table of solar azimuths and shadow lengths for Tunis (36°) in *V*, fol. 14r and *F*, fol. 15r

Tables of this general type could be used in conjunction with a gnomon of known length to mark the solstitial shadow traces of a horizontal sundial, which take on a hyperbolic shape.[136] The reference to a « stone » (*lapis*) in the headings in both witnesses points towards a horizontal dial with vertical gnomon whose diagram was inscribed on a marble or some other type of stone surface, as was commonly

[132] 19] 10 *F*
[133] 34] 0 *add. sub linea FV*
[134] 53] 0 *add. sub linea FV*
[135] 90] 9 *V*
[136] David A. King, « On the Astronomical Tables of the Islamic Middle Ages », in Owen Gingerich, Jerzy Dobrzycki (eds.), *Colloquia Copernicana III: Proceedings of the Joint Symposium of the IAU and the IUHPS, Cosponsored by the IAHS Astronomy of Copernicus and Its Background, Toruń 1973*, Wydawnictwo Polskiej Akademij Nauk, Wrocław 1975 (Studia Copernicana, 13), p. 37–56 (51–53); Id., *In Synchrony with the Heavens: Studies in Astronomical Timekeeping and Instrumentation in Medieval Islamic Civilization*, vol. I: *The Call of the Muezzin*, Brill, Leiden 2004 (Islamic Philosophy, Theology and Science: Texts and Studies, 55), p. 84–89.

done in al-Andalus, the Maghreb, and elsewhere in the Islamic world.[137] As can be seen from the above transcription, the copies of the present table in *F* and *V* are not perfectly identical. Each contains one clear numerical error, which presumably demonstrates their mutual independence. *F* mistakenly gives the degrees of the first azimuth in the left half of the table as 10;14° instead of 19;14°, making it too close to the 10;3° in the next line below. *V* gives the final azimuth in the right half as 9° when the logic of the table dictates that it must be 90°, which here stands for due south.

A more striking difference between the two manuscripts concerns the headings of the two azimuth columns, which have the word *Çempt* in *F* but the alternative form *Arçemut* in *V*. This difference is presumably rooted in the distinction between the singular and plural forms of the same Arabic word, *as-samt* (« the direction », « the way »). *F*'s transliteration corresponds to the singular, whereas *V*'s *Arçemut* mirrors the plural *as-sumūt*.[138] There is no apparent reason why this should be the case, unless *F* and *V* preserve two independent translations of the same Arabic source.

Given the fact that one of the two geographic coordinate tables in *F* and *V* overlaps to a significant extent with a table in the *Shāmil zīj* of Ibn al-Raqqām, it may be relevant to observe that Ibn al-Raqqām's other known works include the *Risāla fī ʿilm al-ẓilāl* (*Treatise on the Science of Shadows*), which consists of 44 chapters on the theory and construction of sundials.[139] While this work leaves no doubt that he would have been capable of constructing a table of the type shown above in Tab. 3, there is no further evidence that would allow us to trace this particular table to him. What would seem to make his authorship unlikely is the evidence of Ibn al-Raqqām's two *zījes* for the coordinates of Tunis (*al-Mustawfi* and *al-Qawīm*), in which the city's latitude is given not as 36°, but as 36;37°, or occasionally as 36;40° (same as #56 in Tab. 1), values that are fairly close to the modern one

[137] See Karl Schoy, *Die Gnomonik der Araber*, Vereinigung wissenschaftlicher Verleger, München 1923 (Die Geschichte der Zeitmessung und der Uhren, 1.F); David A. King, « Three Sundials from Islamic Andalusia », *Journal for the History of Arabic Science*, 2 (1978), p. 358–392; Id., « Los cuadrantes solares andalusíes », in Juan Vernet, Julio Samsó (eds.), *El legado científico Andalusí: Museo Arqueológico Nacional, Madrid, abril-junio 1992*, Ministerio de Cultura, Centro Nacional de Exposiciones: Comisión Quinto Centenario Al-Andalus 92, Madrid 1992, p. 89–102; Carmen Barceló, Ana Labarta, « Ocho relojes de sol hispano-musulmanes », *Al-Qanṭara*, 9 (1988), p. 231–247; Joan Carandell, « Dos cuadrantes solares andalusíes de Medina Azara », *Al-Qanṭara*, 10 (1989), p. 329–342; Samsó, *On Both Sides*, p. 110–115.

[138] For an overview of different transliterations of *samt* and *asumūt* in Latin astrolabe sources, see Kunitzsch, « Glossar », p. 546–553.

[139] See Joan Carandell (ed.), *Risāla fī ʿilm al-ẓilāl de Muḥammad Ibn al-Raqqām al-Andalusī*, Instituto « Millás Vallicrosa » de Historia de la Ciencia Árabe, Barcelona 1988. See also Samsó, *On Both Sides*, p. 109–110.

(36;48°).[140] Moreover, while his *Shāmil zīj* does employ a round latitude of 36°, it is there applied to Béjaïa, not to Tunis.[141]

The picture painted thus far is complicated, however, by inconsistencies detectable in the numerical data provided by our table. These will be the subject of the following analysis, which is there to test the assumption that the table was indeed computed for a round latitude of 36°. Owing to the role that translation or transcription errors seem to have played in deforming the data at hand, the results of this analysis must necessarily remain tentative.

As a first step, it will be expedient to convert the shadow lengths on display into the solar altitudes from which they were, theoretically, derived. This is done using the modern relation $h = \arctan(\frac{12}{s})$, where h is the instantaneous solar altitude and s the length of the shadow, measured in digits that represent $1/12^{\text{th}}$ of the height of a gnomon. The results of this transformation (rounded to minutes) are shown in Tab. 4 below.

0° ♋			0° ♑		
T	*s*	*h*	T	*s*	*h*
1	51;0°	13;14°	1	84;46°	8;3°
2	23;16°	27;17°	2	43;50°	15;19°
3	13;27°	41;44°	3	30;27°	21;31°
4	8;2°	56;12°	4	24;17°	26;18°
5	4;27°	69;39°	5	21;38°	29;1°
6	2;47°	76;56°	6	20;24°	30;28°

Tab. 4: shadow lengths (*s*) in Tab. 1 converted into solar altitudes (*h*)

Let us next turn to the implied values for the obliquity of the ecliptic (ε) and the geographic latitude (φ), which can normally be derived from the solar noon altitudes at the two solstices. However, in the case at hand the result for the obliquity would be ε = (76;56° − 30;28°) ÷ 2 = 23;14°, which is too low to be realistic. Another problem with these two values for the solstitial noon altitudes is that they fail to converge on φ = 36°. In fact, 90° − (30;28° + 23;14°) = 90° − (76;56° − 23;14°) = 36;18°. To obtain φ = 36° from a minimum solar noon altitude of 30;28° would require ε to be 90° − 36° − 30;28° = 23;32°. However, in that case one would expect the maximum solar noon altitude to be 90° − 36° + 23;32° = 77;32°, which would require a shadow length of 2;39 as opposed to the 2;47 offered by Tab. 3.

The latitude mentioned in the table headings is thus irreconcilable with a maximum solar noon altitude of 76;56°, as this would require the underlying value of ε to be 76;56° − (90° − 36°) = 22;56°. Things look different if we accept the more

[140] Samsó, « Ibn al-Raqqām's *al-Zīj al-Mustawfī* », p. 298–299, 301, 321.
[141] Kennedy, « The Astronomical Tables », 62.

accurate latitude value known from Ibn al-Raqqām, who placed Tunis at 36;37°. It would enable us to retain the maximum solar noon altitude of 76;56° shown in the left half of Tab. 4, provided that ε = 23;33°, which is indeed a widely attested value.[142] The same is not true, however, of the minimum noon altitude in the right half of the same table, where a reduction from 30;28° to 29;50° would be in order, since 90° – 36;37° – 23;33° = 29;50°.

A potential explanation for this strange state of affairs lies in the hypothesis that the two halves of Tab. 3 were computed for different latitudes, and perhaps also with different underlying values for ε. To test this hypothesis, I have converted each solar altitude (h) shown in Tab. 4 into a value for the solar azimuth (a) using the formula

$$(1) \qquad a = \arcsin \frac{\sin h \sin \varphi - \sin \delta}{\cos h \cos \varphi},$$

which is equivalent to solutions already used in medieval Islamic astronomy.[143] In addition to h and φ, this conversion involves δ, the solar declination, which at the solstices will be equivalent to positive or negative ε. The result, a, will be positive for southern azimuths, negative for northern ones. Using ε = 23;33°, the results for φ = 36° and φ = 36;37° will be as shown in Tab. 5. It can be seen that the re-computed azimuths for the summer solstice attain a closer overall fit with the tabulated azimuths if the value of φ is taken as 36;37° rather than 36°. The opposite is true in the case of the winter solstice, where 36° leads to results that are significantly closer to what is shown in the table.

0° ♋				0° ♑			
T	*a*Tab.3	*a*36°	*a*36;37°	T	*a*Tab. 3	*a*36°	*a*36;37°
1	−19;41°	−19;40°	−19;40°	1	+36;0°	+36;59°	+37;26°
2	−10;3°	−10;26°	−10;11°	2	+45;22°	+45;19°	+46;2°
3	−0;14°	−0;47°	−0;14°	3	+54;52°	+54;49°	+55;54°
4	+12;28°	+11;23°	+12;26°	4	+65;34°	+65;30°	+67;18°
5	+34;53°	+32;36°	+34;54°	5	+75;30°	+75;25°	+78;57°
6	+90°	+90°	+90°	6	+90°	+90°	+90°

Tab. 5: comparison of the values for the solar azimuth (a) in Tab. 3 with recomputed values for φ = 36° and φ = 36;37°, assuming ε = 23;33°

Given these results as well as the remaining discrepancies, it appears likely that the two halves Tab. 3 were computed using not just different latitudes but also different values of ε. A re-computation that closely approaches most of the

[142] For attestations of 23;33° and its variants in Andalusī and Maghribī astronomy, see the index of Samsó, *On Both Sides*, p. 980–981.

[143] See Schoy, *Die Gnomonik*, p. 17–21; King, *In Synchrony*, p. 36–37.

tabulated values for the winter solstice can in fact be achieved on the assumption that ε = 23;35°, which is a value introduced into Islamic astronomy by al-Battānī,[144] provided the solar noon altitude (*H*) is adjusted from 30;28° to 30;25°.[145] To find *h* from *H* and the completed seasonal hour before noon, one can use the formula

$$(2) \qquad h = \arcsin \frac{\left(vers\frac{d}{2} - vers\, t\right) \sin H}{vers\frac{d}{2}},$$

where *t* is the hour angle counted from noon, and *d* is the arc of daylight.[146] The maximum and minimum value for *d* at a given latitude can be obtained via the relation,

$$(3) \qquad d = 180° \pm 2e,$$

where *e* is the ascensional difference obtained via

$$(4) \qquad e = \arcsin (\tan \delta \tan \varphi).$$[147]

Applying ε = 23;35°, φ = 36°, and *H* = 30;25° in formulae (1) to (4) will lead to the results shown in Tab. 6 below.

T	*a*Tab. 3	*h*Tab. 4	*a*	*h*
1	+36;0°	8;3°	+37;2°	8;3°
2	+45;22°	15;19°	+45;22°	15;19°
3	+54;52°	21;31°	+54;52°	21;30°
4	+65;34°	26;18°	+65;36°	26;18°
5	+75;30°	29;1°	+77;27°	29;22°
6	+90°	30;28°	+90°	30;25°

Tab. 6: Comparison of the values for the solar azimuth (*a*) and solar altitude (*h*) at the winter solstice according to Tab. 3 and Tab. 4 with re-computed values assuming ε = 23;35°, φ = 36°, and *H* = 30;25°

[144] AL-BATTĀNĪ, *De motu stellarum*, c. 4, trans. PLATO OF TIVOLI, in *Continentur in hoc libro: Rudimenta astronomica Alfragani; item Albategnius astronomus peritissimus de motu stellarum*, Petreius, Nuremberg 1537, fol. 8r–v.

[145] The suggested set of parameters (ε = 23;35°, φ = 36°, *H* = 30;25°) has a precedent in the *zīj* of al-Battānī, which contains tables for *h* and *a* at the summer and winter solstice. See AL-BATTĀNĪ, *Opus astronomicum*, ed. CARLO ALFONSO NALLINO, 3 vols., Hoepli, Milano 1899–1907 (Pubblicazioni del Reale osservatorio di Brera in Milano, 40), vol. II, p. 188. See also the tables (*a*, *s*) for 36° and 38° included in AL-BATTĀNĪ, *De motu stellarum*, c. 56, trans. PLATO OF TIVOLI, fol. 88r.

[146] KING, *In Synchrony*, p. 33–36; SAMSÓ, *On Both Sides*, p. 95.

[147] SAMSÓ, *On Both Sides*, p. 93.

The overall agreement seems strong enough to sustain the hypothesis that the right hand of the table was computed using the parameters in question. This presupposes that the noon shadow was assumed to be 20;26, such that h = 30;25°, though in *F* and *V* it is mistakenly given as 20;24. The most problematic set of entries are those for the end of the fifth hour from sunset, where h = 29;1° (as implied by s = 21;38) and a = 75;30° are not compatible with the surrounding values and presumably resulted from a computational error.

V. *A Venetian route of transmission?*

The pathways by which astronomical material of Maghribī origin became part of the Italian manuscripts discussed in this article must ultimately remain a matter of speculation. Nevertheless, a plausible hypothesis can be derived from the recorded ownership of *V* and *E*. It has already been mentioned that *V* was at one point the property of Andrea Dandolo, who was Doge of Venice in the mid-fourteenth century (1343–1354). *E* is a significantly later manuscript and its potential Maghribī contents, if they are present at all, would be limited to some of the astrolabe and sundial-related drawings that are also encountered in *F*. Its former owner, Federico Delfino, worked for some time in Venice and later taught for many years at the University of Padua, which from 1405 was part of the Republic of Venice. All this raises the possibility that the content of *E* was derived from a Venetian exemplar.

It is a matter of record that the trading networks of the Republic of Venice during the thirteenth to fifteenth centuries covered multiple ports in the Maghreb. In the case of Tunis, such mercantile contacts were first formalized in 1231, when Venice signed a treaty with the recently established Ḥafṣid ruler Abu Zakariya Yahya and opened a consulate in the city.[148] Tunis's role as a frequent destination for Venetian traders is manifest from late medieval merchant's notebooks such as the *Zibaldone da Canal*, whose content goes back to the early fourteenth century.[149] In the absence of more specific evidence, the existence of a

[148] Alberto Sacerdoti, « Venezia e il regno hafsida di Tunisi: trattati e relazioni diplomatiche (1231–1534) », *Studi Veneziani*, 8 (1966), p. 303–346; Bernard Doumerc, *Venise et l'émirat hafside de Tunis (1231–1535)*, L'Harmattan, Paris, 1999. On the wider subject of contacts between Italy and the Maghreb during the Middle Ages, see Georges Jehel, *L'Italie et le Maghreb au Moyen Âge: conflits et échanges du VII^e^ au XV^e^ siècle*, PUF, Paris 2001; Joel Pattison, « Italy and the Ḥafṣids in the Medieval Period », *Oxford Research Encyclopedia of African History* <https://doi.org/10.1093/acrefore/9780190277734.013.1289> (Accessed Oct. 2024).

[149] See John E. Dotson (trans.), *Merchant Culture in Fourteenth Century Venice: The Zibaldone da Canal*, Medieval & Renaissance Texts & Studies, Binghamton (NY) 1994 (Medieval & Renaissance Texts & Studies, 98), p. 83–89, 94–98, 117, for notes on the conversions of Tunisian coins, weights, and measures.

well-established trade route between Tunis and Venice offers what is perhaps the best explanation for the textual transfer witnessed by *EFV*, though other European maritime powers such as Pisa, Genoa, or the Crown of Aragon could have played a role as well. We gain a very approximate *terminus post quem* for this transfer from the completion of Ibn al-Raqqām's *Shāmil zīj* around 1290, seeing as its table of geographic coordinates provides a close match with a coordinate table preserved in *FV*. The fact that this *zīj* was cast for Béjaïa, which at the time was controlled by a different branch of the Ḥafṣid dynasty than Tunis,[150] complicates our picture, as does the absence of any demonstrable link between the gnomonic table in *FV* and Ibn al-Raqqām's known output. It must be borne in mind, however, that the handful of Maghribī astronomical texts and tables that are currently known from the thirteenth and fourteenth centuries are likely to be no more than a tiny fraction of what once existed.

VI. *Conclusion*

The main purpose of this article has been to document a particular instance of the movement of astronomical and geographic information from North Africa (Tunis) to Italy (Venice), which appears to have taken place in the early decades of the fourteenth century. Scholars have so far shown little interest in this direction of travel when it comes to sources of mathematical astronomy, despite Latin Europe and the Maghreb sharing a common legacy inherited from al-Andalus. Here it must be mentioned that traces of a seemingly unrelated transfer of astronomical material from the Maghreb to Latin Europe have recently been discovered in a document associated with Magister Alard of Diest (*fl.*1301/1308), which mentions astronomical tables for the coordinates of Tunis. As has been argued elsewhere, this could be a reference to a lost Latin translation of the tables of Ibn Isḥāq al-Tūnisī (*c.*1222), which are the earliest known Maghribī astronomical tables cast in the Andalusian tradition of Ibn al-Zarqālluh. Unlikely as it may seem, these tables were apparently known to the Parisian astronomer John of Sicily in *c.*1293 and used by Alard of Diest in *c.*1307.[151]

Together with the results presented in this article, these recent findings go to highlight the importance of maintaining a broad geographic and chronological framework for the transfer of astronomical knowledge from the Islamic world and to Latin Europe, which in some instances continued beyond the thirteenth century and involved points of origin other than Iberia.

[150] Dominique Valérian, *Bougie, port maghrébin, 1067–1510*, École française de Rome, Rome 2006 (Bibliothèque des Écoles françaises d'Athènes et de Rome, 328).

[151] C. Philipp E. Nothaft, « Were the Tables Ibn Isḥāq al-Tūnisī Known in Paris *c.*1300? », *Journal for the History of Astronomy*, 55 (2024), p. 490–503.

Bibliography

Manuscripts

Barcelona, Biblioteca de Catalunya, 634
Bergamo, Biblitoteca Civica Angelo Mai, MA 388
Berlin, Staatsbibliothek, lat. fol. 62
Cambridge, Clare College, 15
Cambridge, Fitzwilliam Museum, McClean 165
Cambridge, St John's College, F.25
Cambridge, University Library, Kk 1.1
Cracow, Biblioteka Jagiellońska, 813
Edinburgh, Royal Observatory, Crawford Collection, Cr. 3.28
Edinburgh, Royal Observatory, Crawford Collection, Cr. 5.14
Erfurt, Universitätsbibliothek, Dep. Erf. CA 4° 363
Erfurt, Universitätsbibliothek, Dep. Erf. CA 4° 369
Erfurt, Universitätsbibliothek, Dep. Erf. CA 4° 386
Fermo, Biblioteca Civica "Romolo Spezioli", 85
Florence, Biblioteca Riccardiana, 866
Göttingen, Niedersächsische Staats- und Universitätsbibliothek, Theol. 124
Istanbul, Kandilli Observatory, 249
London, Wellcome Library, 19
Madrid, Biblioteca nacional de España, 10009
Madrid, Biblioteca nacional de España, 10053
Madrid, Biblioteca nacional de España, 10063
Manchester, John Rylands Library, 67
Munich, Bayerische Staatsbibliothek, Clm 28229
New York, Columbia University, Rare Book and Manuscript Library, Smith Western Add. MS 06
Oxford, Bodleian Library, Canon. Misc. 340
Oxford, Bodleian Library, Selden supra 76
Oxford, Merton College, 259
Oxford, St John's College, 188
Paris, Bibliothèque de l'Arsenal, 879

Paris, Bibliothèque nationale de France, lat. 6972A
Paris, Bibliothèque nationale de France, lat. 7292
Paris, Bibliothèque nationale de France, lat. 7293A
Pommersfelden, Gräflich Schönbornsche Bibliothek, 66 (2640)
Prague, Národní knihovna České republiky, XIII.F.24
Salamanca, Biblioteca Universitaria, 2353
Stuttgart, Württembergische Landesbibliothek, Math. 4° 33
Toledo, Archivo y Biblioteca Capítulares, 98–27
Vatican City, Biblioteca Apostolica Vaticana, Barb. lat. 276
Vatican City, Biblioteca Apostolica Vaticana, Pal. lat. 1381
Vatican City, Biblioteca Apostolica Vaticana, Reg. lat. 1285
Vatican City, Biblioteca Apostolica Vaticana, Vat. lat. 3114
Vatican City, Biblioteca Apostolica Vaticana, Vat. lat. 3133
Vatican City, Biblioteca Apostolica Vaticana, Vat. lat. 4087
Vienna, Österreichische Nationalbibliothek, 2452

Printed Sources

al-Battānī, *De motu stellarum*, trans. Plato of Tivoli, in *Continentur in hoc libro: Rudimenta astronomica Alfragani; item Albategnius astronomus peritissimus de motu stellarum*, Petreius, Nuremberg 1537.

— *Opus astronomicum*, ed. Carlo Alfonso Nallino, 3 vols., Hoepli, Milano 1899–1907 (Pubblicazioni del Reale osservatorio di Brera in Milano, 40).

Cicero, M. Tullius, *Cato maior de senectute*, ed. J. G. F. Powell, *De re publica* [etc.], Oxford University Press, Oxford 2006, p. 267–315.

Ibn al-Ṣaffār, *On the Uses of the Astrolabe*, trans. John of Seville, in José María Millás Vallicrosa, *Las traducciones orientales en los manuscripts de la Biblioteca Catedral de Toledo*, CSIC, Madrid 1942, p. 261–284.

John of Sacrobosco, *Nova computi compilatio*, in *Opera de computo a tempore post Gerlandum usque ad Iohannem de Sacrobosco*, ed. Alfred Lohr, Brepols, Turnhout 2025 (Corpus Christianorum Continuatio Mediaevalis, 272A), p. 637–717.

Macrobius, Ambrosius Theodosius, *Commentarii in Somnium Scipionis*, ed. James Willis, 2nd ed. (repr.), Teubner, Stuttgart 1994.

Petrus Alfonsi, *Dialogus*, ed. Carmen Cardelle de Hartmann, Darko Senekovic, Thomas Ziegler, Peter Stotz, SISMEL–Edizioni del Galluzzo, Firenze 2018 (Millennio Medievale, 116).

Speculum astronomiae, ed. Stefano Caroti, Michela Pereira, Stefano Zamponi, Paola Zambelli, in Paola Zambelli, *The* Speculum Astronomiae *and Its Enigma: Astrology, Theology and Science in Albertus Magnus and his Contemporaries*, Kluwer, Dordrecht 1992 (Boston Studies in the Philosophy of Science, 135), p. 203–273.

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

Modern authors (after 1789)

ʿAbd al-Raḥmān, « Muhammad, Ḥisāb aṭwāl al-kawākib fī al-Zīj al-shāmil fī tahdhīb al-kāmil li-Ibn al-Raqqām », Ph.D. Diss., University of Barcelona 1996.

Al Samman, Tarif, Otto Mazal, *Die arabische Welt und Europa: Ausstellung der Handschriften- und Inkunabelsammlung der Österreichischen Nationalbibliothek, Handbuch und Katalog; Prunksaal, 20. Mai–16. Oktober 1988*, Akademische Druck- und Verlagsanstalt, Graz 1988.

Alonso Alonso, Manuel, « Juan Sevillano: sus obras proprias y sus traducciones », *Al-Andalus*, 18 (1953), p. 17–49.

Ambrosetti, Nadia, « Algorithmic in the 12th Century: The Carmen de Algorismo by Alexander de Villa Dei », in Fabia Gadducci, Mirko Tavosanis (eds.), *History and Philosophy of Computing: Third International Conference, HaPoC 2015, Pisa, Italy, October 8–11, 2015, Revised Selected Papers*, Springer, Cham 2016, p. 71–86.

Barceló, Carmen, Ana Labarta, « Ocho relojes de sol hispano-musulmanes », *Al-Qanṭara*, 9 (1988), p. 231–247.

Bellver, José, Julio Samsó, « Ibn al-Raqqām on Lunar Parallax », *Suhayl*, 11 (2012), p. 189–229. <https://raco.cat/index.php/Suhayl/article/view/267264> (Accessed Oct. 2024).

Bianca, Concetta, « Delfino (Dolfin), Federico », in Alberto Maria Ghisalberti (ed.), *Dizionario Biografico degli italiani*, vol. XXXVI: *De Fornari–Della Fonte*, Istituto della Enciclopedia Italiana, Roma 1988, p. 552–554.

Burnett, Charles, « Introduction: John of Seville and Limia », in Charles Burnett, Pedro Mantas-España (eds.), *« Ex Oriente Lux »: Translating Words, Scripts and Styles in Medieval Mediterranean Society; Selected Papers*, UCOPress, Córdoba 2016 (Arabica Veritas, 2), p. 11–17.

— « John of Seville and John of Spain: A *mise au point* », *Bulletin de philosophie médiévale*, 44 (2002), p. 59–78. Reprinted as Chapter 6 in Id., *Arabic into Latin in the Middle Ages: The Translators and Their Intellectual and Social Context*, Ashgate, Farnham 2009. <https://www.brepolsonline.net/doi/abs/10.1484/J.BPM.2.303854?journalCode=bpm> (Accessed Oct. 2024).

— « The Coherence of the Arabic-Latin Translation Program in Toledo in the Twelfth Century », *Science in Context*, 14 (2001), p. 249–288. Reprinted as Chapter 7 in Id., *Arabic into Latin in the Middle Ages: The Translators and Their Intellectual and Social Context*, Ashgate, Farnham 2009. <https://www.cambridge.org/core/journals/science-in-context/article/abs/coherence-of-the-arabiclatin-translation-program-in-toledo-in-the-twelfth-century/E898FAE696E4D7EA152616BEB6D92345> (Accessed Oct. 2024).

— « The Translating Activity in Medieval Spain », in Salma Khadra Jayyusi (ed.), *The Legacy of Muslim Spain*, Brill, Leiden 1992 (Handbook of Oriental Studies, Section 1, 12), p. 1036–1058. Reprinted as Chapter 4 in Id., *Magic and Divination in the Middle Ages: Texts and Techniques in the Islamic and Christian Worlds*, Variorum, Aldershot 1996.

— « Translation and Transmission of Greek and Islamic Science to Latin Christendom », in David C. Lindberg, Michael H. Shank (eds.), *The Cambridge History of Science*, vol. II: *Medieval Science*, Cambridge University Press, Chicago 2013, p. 341–364.

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.

Busard, Hubertus L. L., *Het rekenen met breuken in de middleleeuwen, in het bijzonder bij Johannes de Lineriis*, Paleis der Academiën, Brussel 1968 (Mededelingen van de Koninklijke Vlaamse Academie voor Wetenschappen, Letteren en Schone Kunsten van België, Klasse der Wetenschappen, Jaargang 30, nr. 7).

Caiazzo, Irene, Charles Burnett, « New Manuscripts of *On the Astrolabe* by Raymond of Marseilles », *Scriptorium*, 65 (2011), p. 338–349. <https://www.persee.fr/doc/scrip_0036-9772_2011_num_65_2_4137> (Accessed Oct. 2024).

Carandell, Joan, « Dos cuadrantes solares andalusíes de Medina Azara », *Al-Qanṭara*, 10 (1989), p. 329–342.

— (ed.), *Risāla fī ʿilm al-ẓilāl de Muḥammad Ibn al-Raqqām al-Andalusī*, Instituto « Millás Vallicrosa » de Historia de la Ciencia Árabe, Barcelona 1988.

Carmody, Francis J., *Arabic Astronomical and Astrological Sciences in Latin Translation: A Critical Bibliography*, University of California Press, Berkeley 1956.

Casulleras, Josep, « Ibn al-Raqqām: Abū ʿAbd Allāh Muḥammad ibn Ibrāhīm ibn ʿAlī ibn Aḥmad ibn Yūsuf al-Mursī al-Andalusī al-Tūnisī al-Awsī ibn al-Raqqām », in Thomas Hockey et al. (eds.), *The Biographical Encyclopedia of Astronomers*, 2nd ed., Springer, New York 2014, p. 1057–1058.

d'Alverny, Marie-Thérèse, « Translations and Translators », in Robert L. Benson, Giles Constable (eds.), *Renaissance and Renewal in the Twelfth* Century, Harvard University Press, Cambridge (Mass.) 1982, p. 421–462. Reprinted as Chapter 2 in Id., *La transmission des textes philosophiques et scientifiques au Moyen Âge*, ed. Charles Burnett, Variorum, Aldershot 1994.

de Rijk, Lambertus M., « On the Genuine Text of Peter of Spain's *Summule logicales* », *Vivarium*, 7 (1969), p. 8–61.

Dotson, John E., *Merchant Culture in Fourteenth Century Venice: The Zibaldone da Canal*, Medieval & Renaissance Texts & Studies, Binghamton (NY) 1994 (Medieval & Renaissance Texts & Studies, 98).

Doumerc, Bernard, *Venise et l'émirat hafside de Tunis (1231–1535)*, L'Harmattan, Paris, 1999.

Durand, Dana Bennett, *The Vienna-Klosterneuburg Map Corpus of the Fifteenth Century: A Study in the Transition from Medieval to Modern Science*, Brill, Leiden 1952.

Ebbesen, Sten, « A New Version of 'Robertus Anglicus' on Peter of Spain », *Cahiers de l'Institut du Moyen-Âge Grec et Latin*, 90 (2021), p. 384–500.

Ferrer, Maria Teresa, « Catalan Commerce in the Late Middle Ages », *Catalan Historical Review*, 5 (2012), p. 29–65.

Gautier Dalché, Patrick, *La Géographie de Ptolémée en Occident (IVe–XVIe siècle)*, Brepols, Turnhout 2009 (Terrarum orbis, 9).

Hadrava, Petr, Alena Hadravová, « Christannus de Prachaticz's Treatises on the Astrolabe », in Filippomaria Pontani (ed.), *Certissima signa: A Venice Conference on Greek and Latin Astronomical Texts*, Edizioni Ca' Foscari, Venezia 2017 (Antichistica, 13; Filologia e letteratura, 2), p. 295–312.

Hadravová, Alena, Petr Hadrava (eds.), *Křišťan z Prachatic: Stavba a užití astrolábu*, Filosofia, Praha 2001.

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

Hasse, Dag Nikolaus, « Stylistic Evidence for Identifying John of Seville with the Translator of Some Twelfth-Century Astrological and Astronomical Texts from Arabic into Latin on the Iberian Peninsula », in Charles Burnett, Pedro Mantas-España (eds.), *« Ex Oriente Lux »: Translating Words, Scripts and Styles in Medieval Mediterranean Society; Selected Papers*, UCOPress, Córdoba 2016 (Arabica Veritas, 2), p. 19–43.

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

Jehel, Georges, *L'Italie et le Maghreb au Moyen Âge: conflits et échanges du VII^e^ au XV^e^ siècle*, PUF, Paris 2001.

Juste, David, *Catalogus codicum astrologorum Latinorum*, vol. II: *Les manuscrits astrologiques latins conservés à la Bibliothèque nationale de France à Paris*, CNRS éditions, Paris 2015 (Documents, études et repertoires, 84).

Kamal, Yusuf, *Monumenta Cartographica Africae et Aegypti*, vol. IV: *Époque des portulans, suivie par l'époque des découvertes*, fasc. 1, sin. loc., 1936.

Kennedy, E. S., « The Astronomical Tables of Ibn al-Raqqām, a Scientist of Granada », *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften*, 11 (1997), p. 35–72.

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 am Main 1987 (Veröffentlichungen des Institutes für Geschichte der Arabisch-Islamischen Wissenschaften, Reihe A: Texte und Studien, 2).

Ker, Neil Ripley, *Medieval Manuscripts in British Libraries*, vol. II: *Abbotsford–Keele*, Clarendon Press, Oxford 1977.

King, David A., *In Synchrony with the Heavens: Studies in Astronomical Timekeeping and Instrumentation in Medieval Islamic Civilization*, vol. I: *The Call of the Muezzin*, Brill, Leiden 2004 (Islamic Philosophy, Theology and Science: Texts and Studies, 55).

— « Los cuadrantes solares andalusíes », in Juan Vernet, Julio Samsó (eds.), *El legado científico Andalusí: Museo Arqueológico Nacional, Madrid, abril–junio 1992*, Ministerio de Cultura, Centro Nacional de Exposiciones: Comisión Quinto Centenario Al-Andalus 92, Madrid 1992, p. 89–102.

— « On the Astronomical Tables of the Islamic Middle Ages », in Owen Gingerich, Jerzy Dobrzycki (eds.), *Colloquia Copernicana III: Proceedings of the Joint Symposium of the IAU and the IUHPS, Cosponsored by the IAHS Astronomy of Copernicus and Its*

Background, Toruń 1973, Wydawnictwo Polskiej Akademij Nauk, Wrocław 1975 (Studia Copernicana, 13), p. 37–56.

— « On the History of Astronomy in the Medieval Maghrib », in *Études philosophiques et sociologiques dédiées à Jamal ed-Dine Alaoui*, Département de Philosophie, Sociologie et Psychologie, Fès 1998 (Université Sidi Mohamed Ben Abdallah, Publications de la Faculté des Lettres et des Sciences Humaines Dhar El Mahraz–Fès, N° Spécial, 14), p. 27–61. Reprinted as Chapter 6 in Id., *Islamic Astronomy and Geography*, Ashgate Variorum, Farnham 2012.

— « Three Sundials from Islamic Andalusia », *Journal for the History of Arabic Science*, 2 (1978), p. 358–392.

Knorr, Wilbur R., « Sacrobosco's *Quadrans*: Date and Sources », *Journal for the History of Astronomy*, 28 (1997), p. 187–222. <https://journals.sagepub.com/doi/abs/10.1177/002182869702800301> (Accessed Oct. 2024).

Kunitzsch, Paul, « Gerard's Translations of Astronomical Texts, Especially the *Almagest* », in Pierluigi Pizzamiglio (ed.), *Gerardo da Cremona*, Libreria del Convegno, Cremona 1992 (Annali della Biblioteca statale e Libreria civica di Cremona, 41), p. 71–84.

— « Glossar der arabischen Fachausdrücke in der mittelalterlichen europäischen Astrolabliteratur », *Nachrichten der Akademie der Wissenschaften in Göttingen*, phil.-hist. Kl., 1982/11, p. 455–571.

— « On the Authenticity of the Treatise on the Composition and Use of the Astrolabe Ascribed to Messahalla », *Archives Internationales d'Histoire des Sciences*, 31 (1981), p. 42–62. Reprinted as Chapter 10 in Id., *The Arabs and the Stars: Texts and Traditions on the Fixed Stars and Their Influence in Medieval Europe*, Variorum, Northampton 1989.

— *Typen von Sternverzeichnissen in astronomischen Handschriften des zehnten bis vierzehnten Jahrhunderts*, Harrassowitz, Wiesbaden 1966.

Lejbowicz, Max, « L'acculturation latine selon Platon de Tivoli », in Id. (ed.), *Une conquête des savoirs: les traductions dans l'Europe latine (fin du XI^e^ siècle–milieu du XIII^e^ siècle)*, Brepols, Turnhout 2009 (Rencontres médiévales européennes, 9), p. 121–141.

Lindberg, David C., « The Transmission of Greek and Arabic Learning to the West », in Id. (ed.), *Science in the Middle Ages* University of Chicago Press, Chicago 1978, p. 52–90.

Lorch, Richard, « The Treatise on the Astrolabe by Rudolf of Bruges », in Lodi Nauta, Arjo Vanderjagt (eds.), *Between Demonstration and Imagination: Essays in the*

History of Science and Philosophy Presented to John D. North, Brill, Leiden 1999 (Brill's Studies in Intellectual History, 96), p. 55–100.

McCluskey, Stephen C., *Astronomies and Cultures in Early Medieval Europe*, Cambridge University Press, Cambridge 1998.

Mercier, Eric, « Mathematical Geography in the Western Islamic World: Geographical Coordinates of Localities in the al-Maghreb and al-Andalus Localities (9th–18th Centuries) », *Suhayl*, 18 (2020–2021), p. 25–49. <https://raco.cat/index.php/Suhayl/article/view/377825> (Accessed Oct. 2024).

Mestres i Valero, Angel, « Materials andalusins en el zīj d'Ibn Isḥāq al-Tūnisī », Ph.D. Diss., University of Barcelona 1999.

Millás Vallicrosa, José María, *Las traducciones orientales en los manuscritos de la Biblioteca Catedral de Toledo*, CSIC, Madrid 1942.

— « Los primeros tratados de astrolabio en la España árabe », *Revista del Instituto Egipcio de Estudios Islámicos en Madrid*, 3 (1955), p. 35–49. Reprinted as Chapter 4 in Id., *Nuevos estudios sobre historia de la ciencia Española*, CSIC, Barcelona 1960 (Asociación para la historia de la ciencia española: estudios, 7).

North, John, *Cosmos: An Illustrated History of Astronomy and Cosmology*, University of Chicago Press, Chicago 2008.

Nothaft, C. Philipp E., « A Thirteenth-Century Latin List of Ptolemaic Coordinates », *Mediterranea*, 7 (2022), p. 1–15. <https://journals.uco.es/mediterranea/article/view/13608> (Accessed Oct. 2024).

— « Geographic Longitude in Latin Europe during the Twelfth and Thirteenth Centuries », *Archive for History of Exact Sciences*, 78 (2024), p. 29–65. <https://link.springer.com/article/10.1007/s00407-023-00316-y> (Accessed Oct. 2024).

— « The *Liber Theoreumacie* (1214) and the Early History of the *Quadrans Vetus* », *Journal for the History of Astronomy*, 51 (2020), p. 51–74. <https://journals.sagepub.com/doi/abs/10.1177/0021828619885504?journalCode=jhaa> (Accessed Oct. 2024).

— « Were the Tables Ibn Isḥāq al-Tūnisī Known in Paris *c.*1300? », *Journal for the History of Astronomy*, 55 (2024), p. 490–503.

Pattison, Joel, « Italy and the Ḥafṣids in the Medieval Period », *Oxford Research Encyclopedia of African History* <https://doi.org/10.1093/acrefore/9780190277734.013.1289> (Accessed Oct. 2024).

Pedersen, Fritz S. (ed.), *Petri Philomenae de Dacia et Petri de S. Audomaro Opera quadrivialia*, vol. I: *Opera Petri Philomenae*, Gad, Copenhagen 1983 (Corpus philosophorum Danicorum Medii Aevi, 10.1).

Pedersen, Olaf, « The *Corpus Astronomicum* and the Traditions of Mediaeval Latin Astronomy: A Tentative Interpretation », in Owen Gingerich, Jerzy Dobrzycki (eds.), *Colloquia Copernicana III: Proceedings of the Joint Symposium of the IAU and the IUHPS, Cosponsored by the IAHS Astronomy of Copernicus and Its Background, Toruń 1973*, Wydawnictwo Polskiej Akademij Nauk, Wrocław 1975 (Studia Copernicana, 13), p. 57–96.

Puig, Roser, *Al-Šakkāziyya: Ibn al-Naqqāš al-Zarqālluh*, Instituto « Millás Vallicrosa » de Historia de la Ciencia Árabe, Barcelona 1986.

— « Concerning the *Ṣafīḥa Shakkāziyya* », *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften*, 2 (1985), p. 123–139.

Ravegnani, Giorgio, « Dandolo, Andrea », in Alberto Maria Ghisalberti (ed.), *Dizionario Biografico degli italiani*, vol. XXXII: *Dall'Anconata–Da Ronco*, Istituto della Enciclopedia Italiana, Roma 1986, p. 432–440.

Robinson, Maureen, « The Heritage of Medieval Errors in the Latin Manuscripts of Johannes Hispalensis (John of Seville) », *Al-Qanṭara*, 28 (2007), p. 41–71. <https://al-qantara.revistas.csic.es/index.php/al-qantara/article/view/31> (Accessed Oct. 2024).

Sacerdoti, Alberto, « Venezia e il regno hafsida di Tunisi: trattati e relazioni diplomatiche (1231–1534) », *Studi Veneziani*, 8 (1966), p. 303–346.

Samsó, Julio, « Al-Andalus, a Bridge Between Arabic and European Science », *Alhadra*, 1 (2015), p. 101–125.

— « Andalusian Astronomy in 14th Century Fez: *Al-Zīj al-Muwāfiq* of Ibn ʿAzzūz al-Qusanṭīnī », *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften*, 11 (1997), p. 73–110. Reprinted as Chapter 9 in Id., *Astronomy and Astrology in al-Andalus and the Maghrib*, Ashgate, Aldershot 2007.

— « Astronomical Observations in the Maghrib in the Fourteenth and Fifteenth Centuries », *Science in Context*, 14 (2001), p. 165–178. Reprinted as Chapter 12 in Id., *Astronomy and Astrology in al-Andalus and the Maghrib*, Ashgate, Aldershot 2007. <https://www.cambridge.org/core/journals/science-in-context/article/abs/astronomical-observations-in-the-maghrib-in-the-fourteenth-and-fifteenth-centuries/A828A01242968D545002659804727895> (Accessed Oct. 2024).

— « El procés de la transmissió científica al nord-est de la península Ibèrica al segle XII: els textos llatins », in Juan Vernet, Ramon Parés (eds.), *La ciència en la història*

dels Països Catalans, vol. I: *Dels àrabs al Renaixement*, Institut d'Estudis Catalans, Valencia 2004, p. 269–296.

— « Ibn al-Raqqām, Abū ʿAbd Allāh », in Jorge Lirola Delgado (ed.), *Biblioteca de al-Andalus*, vol. IV: *De Ibn al-Labbāna a Ibn al-Ruyūlī*, Fundación Ibn Tufayl de Estudios Árabes, Almería 2006, p. 440–444.

— « Ibn al-Raqqām's *al-Zīj al-Mustawfī* in MS Rabat National Library 2461 », in Nathan Sidoli, Glen Van Brummelen (eds.), *From Alexandria, Through Baghdad: Surveys and Studies in the Ancient Greek and Medieval Islamic Mathematical Sciences in Honor of J.L. Berggren*, Springer, Berlin 2014, p. 297–328.

— « La ciencia en al-Ándalus y su papel como puente entre la ciencia árabe y la europea », *Awraq*, 17–18 (2018), p. 9–22.

— *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 1, 144).

Schoy, Karl, *Die Gnomonik der Araber*, Vereinigung wissenschaftlicher Verleger, München 1923 (Die Geschichte der Zeitmessung und der Uhren, 1.F).

Sezgin, Fuat (ed.), *European Geographical Tables Based on the Arabic Tradition*, Institut für Geschichte der Arabisch-Islamischen Wissenschaften an der Johann Wolfgang Goethe-Universität, Frankfurt am Main 1992 (Islamic Geography, 23).

— *Geschichte des arabischen Schrifttums*, vol. X: *Mathematische Geographe und Kartographie im Islam und ihr Fortleben im Abendland: Historische Darstellung, Teil 1*, Institut für Geschichte der Arabisch-Islamischen Wissenschaften an der Johann Wolfgang Goethe-Universität, Frankfurt am Main 2000.

— *Geschichte des arabischen Schrifttums*, vol. XIII: *Mathematische Geographie und Kartographie im Islam und ihr Fortleben im Abendland: Autoren*, Institut für Geschichte der Arabisch-Islamischen Wissenschaften an der Johann Wolfgang Goethe-Universität, Frankfurt am Main 2007.

Steele, Robert, *Opera hactenus inedita Rogeri Baconi*, vol. VI: *Compotus Fratris Rogeri*, Clarendon Press, Oxford 1926.

Thomson, Ron B. (ed.), *Pseudo-Māshā'allāh: On the Astrolabe*, vol. IV: *Practica*, version 1.7 (Toronto, 2022) <https://shareok.org/handle/11244/14221.3> (Accessed Oct. 2024).

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

Valérian, Dominique, *Bougie, port maghrébin, 1067–1510*, École française de Rome, Rome 2006 (Bibliothèque des Écoles françaises d'Athènes et de Rome, 328).

van Wijk, Walter Émile, *Le Nombre d'Or: étude de chronologie technique suivie du texte de la Massa compoti d'Alexandre de Villedieu*, Nijhoff, La Haye 1936.