Astronomy and Astrology in al-Andalus and the Maghrib by Julio Samsó

Variorum Collected Studies Series CS887. Aldershot, UK/Burlington, VT: Ashgate, 2007. Pp. xiv+366. ISBN 0–7546–5934–1. Cloth $124.95

Reviewed by
J. L. Mancha
University of Seville
mancha@us.es

Over the last 30 years, Julio Samsó and his colleagues from the University of Barcelona, most of them his former students, have continued the work of Millás Vallicrosa in the first half of the 20th century and have substantially modified our knowledge of the history of astronomy and its related sciences in the Iberian Peninsula during the Middle Ages. We are much indebted to them for their efforts in making new textual evidence available, since this is the first task of historians.

This interesting collection of articles is the second, and very welcome, volume of Samsó's papers in the Variorum series. The first, *Islamic Astronomy and Medieval Spain*—20 papers published between 1977 and 1994 (four of them co-authored with M. Comes, F. Castelló, H. Mielgo, and E. Millás)—covered a wide range of topics: the survival of Latin astronomy and astrology in al-Andalus, Eastern influences in Andalusian astronomy and trigonometry, astronomical theory (mainly the work of Ibn al-Zarqālluh and his school on access and recess[1] and solar theory) and the presence of Islamic materials in the works sponsored by Alfonso X. In this collection, two papers on 'eccentric' subjects are, in my opinion, especially worth mentioning: the one devoted to a homocentric solar model described by Abū Ja^{c}far al-Khāzin (d. *ca* 965), and 'On al-Biṭrūjī and the *hay'a* Tradition in al-Andalus', which emphasizes the Neoplatonic components in al-Biṭrūjī's physics and challenges the view of al-Biṭrūjī's *Kitāb fī-l-hay'a* as the Aristotelian culmination of the (not well understood but often mentioned) 'Andalusian revolt' against Ptolemy.

[1] The theory of access and recess, or trepidation, accounted for supposed long-term oscillatory changes in stellar longitudes.

ISSN 1549–4497 (online) ISSN 1549–4470 (print) ISSN 1549–4489 (CD-ROM)
Aestimatio 6 (2009) 95–104

The volume under review assembles 16 papers (of which chapters 2, 4, 5, and 8 are co-authored with M. Castells, H. Mielgo, H. Berrani, and E. Millás, respectively) published between 1994 and 2004. Seven of them are still devoted to Andalusian astronomy; but the rest deal with the Maghribī tradition of astronomical tables from the 13th to the 17th centuries, a tradition that depends strongly, at least until the beginning of the 15th century, on the work of Ibn al-Zarqālluh (d. 1100). Contrary to what the volume's title suggests, only two articles relate directly to astrology.

Chapter 2 concerns the lists found in old texts such as *De mensura astrolabii* (ms. Ripoll 225, classified by Kunitzsch as Type III), which is attributed to the school of Maslama al-Majrīṭī (d. 1007), of the names and coordinates (*latitudo* and *altitudo*) of 27 stars. Previous research by Kunitzsch and North established that the values for *latitudo* are equivalent to those of the column labelled *mediatio* in the star list of Type I (Maslama, *ca* 978); they concluded, after taking into account the low level of accuracy attained in deriving the values for *altitudo* from the declinations in Maslama's list, that these values were obtained neither from observations nor from derived calculation, but probably from measurement on the *rete* of an astrolabe. Samsó presents a new derivation from Maslama's declinations (although it does not provide exact agreement) and consequently argues that the list was composed after 978.

Chapter 3 provides an edition (with translation and commentary) of seven chapters of a lost *zīj* (astronomical tables with instructions for use) by Ibn al-Ṣaffār (d. 1035), a disciple of Maslama, which have been preserved in Arabic written in Hebrew characters in a manuscript of the Bibliothèque Nationale in Paris (Heb. 1102, 1r–5r). The text deals with eclipses, the equation of time, and the determination of astrological houses. Similarities between this text and the canons on the use of the *Almanac* of Ibn al-Zarqālluh and some passages of Adelard of Bath's translation of al-Khwārizmī suggest a common source for all these texts.

'Ibn al-Haytham and Jābir b. Aflaḥ's Criticism of Ptolemy's Determination of the Parameters of Mercury' deals with two Andalusian texts from the 12th century. The first is by Ibn Bājja, the founder of Spanish Aristotelianism, who is mentioned by Maimonides in his *Guide* [2.24] as the author of astronomical models without epicycles; and the second, by Jābir b. Aflaḥ.

Jābir's *Iṣlāḥ al-Majisṭī* (*Improvement of the Almagest*) is the most original astronomical text in the 12th century al-Andalus: it exhibits a knowledge of Ptolemy's mathematics that is exceptional in the Middle Ages.[2] Samsó analyzes in detail passages in book 7 in which Jābir points out a flaw in Ptolemy's determination of the apogee of Venus and of Mercury [*Alm.* 9.7, 10.1]—Ptolemy assumes without proof that equality of maximum morning and evening elongations indicates symmetry of the positions of the epicycle with respect to the apsidal line[3]—and proposes his own solution.

Studies of Jābir show that, except when it is based on an error in the manuscript of the *Almagest* that he used, his criticism is sound. Thus, in my opinion, to speak of Jābir's 'mathematical scruples' [7.218] is a bit unfair. Ptolemy's derivation of the eccentricity and the apogees of the outer planets [*Alm.* 10.7] requires, in modern terms, the solution of an eighth degree equation; and the problem of finding $\sin a$ from $\sin 3a$ in the construction of the table of chords [*Alm.* 1.10], a cubic equation. In both cases, Ptolemy resorted to iterative procedures which, according to him, did not constitute rigorous demonstrations. Ptolemy's criteria are Euclidean, and the Middle Ages shared without objection his view that approximation methods do not provide proofs reducible to apodeictic syllogisms.

The text by Ibn Bājja (d. 1138) is a letter to Abū Ja^{c}far Yūsuf ibn Ḥasdāy, calling attention to a mistake made by Ibn al-Haytham [*Doubts* 1.9] in his criticism of Ptolemy's determination of the eccentricity of the equant of Mercury and Venus [*Alm.* 9.9, 10.3]. For, in attacking Ptolemy's account, Ibn al-Haytham stated that the line joining the center of the Earth and the mean Sun always passes through the center of Venus' epicycle. This was indeed an elementary error, and Ibn Bājja concluded that Ibn al-Haytham 'only studied astronomy in a superficial way'.[4] Samsó wonders if Ibn al-Haytham's

[2] Unfortunately, neither modern translation nor edition of the complete Arabic text are still available. Gerard of Cremona's Latin translation was published in 1534. As noted by Samsó in the addenda, Josep Bellver's Ph. D. dissertation (Barcelona, 2005) was devoted to Jābir's analysis of Ptolemy's solar and lunar theory. Bellver 2006, 2007, 2008a, and 2008b provide much new light on Jābir.

[3] This was also pointed out by Sawyer [1977], who was unaware of Jābir.

[4] Samsó [7.204] considers Ibn al-Haytham's error 'understandable' since in the *Zīj al-Shāh* (as well as in Ḥabash and al-Battānī) the apogees and the

unsound criticism might have had any influence on Andalusian scholars, and his answer is negative: neither Averroes in his *Epitome of the Almagest* nor Jābir allude to it. In my opinion, since Ibn Rushd used Ibn al-Haytham's *Doubts* profusely in his *Epitome*, his silence rather suggests that he knew Ibn Bājja's argument and agreed with it. Ibn Bājja's letter was surely very influential: even al-Biṭrūjī, who had an extremely poor knowledge of the *Almagest*, states twice in his *Kitāb fi'l-hay'a* that the centers of the epicycles of Venus and Mercury have only two conjunctions with the mean Sun every year [Goldstein 1971, 1.129,1.141].

Samsó also underlines that Ibn Bājja ascribes to Ibn al-Zarqālluh a non-extant treatise on the invalidity of Ptolemy's method to determine the position of Mercury's apogee, and concludes that these texts confirm that in 11th- to 12th-century al-Andalus 'there was a certain awareness of the existence of an error' in Ptolemy's value for the longitude of Mercury's apogee. In fact, Ptolemy's longitude of 190° is in error by about 30°. Samsó alludes here to his hypothesis formulated in 1994 [ch. 4] according to which the longitude of Mercury's apogee preserved in Ibn al-Zarqālluh's *Almanac* (210°) is derived from a new determination by the Toledan astronomer. But this hypothesis was apparently abandoned in 1998 [ch. 8.267], once it was established that Ibn al-Zarqālluh's disciples had transmitted a longitude close to 198°.

In the second section of the book, Samsó focuses entirely on Maghribī astronomy, adding much important information to what was known before. Chapters 11–12 provide an outline of the history of the Maghribī *zīj*es from the 13th century onwards. The earliest extant *zīj* was composed by Ibn Isḥāq (beginning of the 13th century); it was also the most interesting and editions of it were prepared by Ibn al-Bannā (1256–1321) and Ibn al-Raqqām (d. 1315). The Andalusian school—namely, Ibn al-Zarqālluh, Ibn al-Kammād (fl. 1115) and Ibn al-Hāim (fl. 1205)—is the predominant influence in all them; it is also evident in two other *zīj*es by two 14th century astronomers of Constantine, Abū l-Ḥasan ᶜAlī ibn Abī and Abū l-Qāsim ibn ᶜAzzūz. Both chapters shed light on the role played by observation in the abandonment of the main feature of the Andalusian school (the theory of

equations of center of Venus and of the Sun coincide. But even if the corrected solar longitude and the corrected argument of Venus are equal, Ibn al-Haytham's claim is wrong.

trepidation) and its replacement by uniform precession as found in Eastern *zīj*es.

Chapter 8 is an analysis of the parameters and methods of computation in Ibn al-Bannā's *Minhāj zīj*. With Zarqallian roots and independent of those in al-Kwārizmī's *zīj*, Ibn al-Bannā's mean motions and mean longitudes depend on Ibn Isḥāq's. The same can be said for the apogees derived for the superior planets from al-Battānī, although the correction for precession used is not evident. Samsó is inclined to think that when the parameters of Ibn Isḥāq, Ibn al-Bannā, and Ibn al-Raqqām seem unrelated to known sources (mean motions in longitude of Saturn and Mars, motion in anomaly of Venus, lunar nodes, apogees of Venus and Mercury), they reflect research undertaken by Ibn al-Zarqālluh himself after the completion of the Toledan Tables. Ibn al-Bannā's *zīj* is more original in the presentation and methods of composition of the tables: he was, apparently, the first Western Islamic astronomer to use tables of 'displaced' equations of center (always positive by addition of a constant to facilitate the computation), well known in the East since the 9th century. Other characteristics of his *zīj* are the use of the method found in the *Handy Tables* to compute the lunar anomaly in calculating the equation of anomaly of Saturn and Jupiter, and the extension of the motion of the solar apogee discovered by Ibn al-Zarqālluh to the apogees of the inferior planets. (This is in agreement with Ibn Isḥāq; whereas in the *zīj*es of Ibn al-Kammād and Ibn al-Hāim, the motion of the solar apogee affects all the planets).

Chapters 9–10 are devoted to the work of Abū l-Qāsim ibn ᶜAzzūz al-Qusanṭinī (d. 1354). The first is a detailed description of his *Muwāfiq zīj*. In the introduction, Ibn ᶜAzzūz explains the reasons which motivated his revision of Ibn Isḥāq's tables: the disagreement between the calculated times of past events using *tasyīr* techniques[5] and the historical data. To correct this divergence, Ibn ᶜAzzūz claims to have made observations with an armillary sphere in 1344 which led him to modify Ibn Isḥāq's parameters (although this revision, in

[5] *Tasyīr* and the projection of rays are the subject of chapter 5, 'World Astrology in Eleventh-Century al-Andalus: The Epistle on *tasyīr* and the Projection of Rays by al-Istijī'. The text of al-Istijī's letter (with translation and commentary) has been published in Samsó and Berrani 2005 and reprinted in Samsó 2008.

my opinion, is only a return to the Toledan and Ibn al-Kammād's tables). It would be interesting to obtain additional evidence confirming Ibn ^{c}Azzūz's use of the 31 years lunar cycle known to us from David Bonjorn's tables (epoch: 1361).

In chapter 10, 'Horoscopes and History: Ibn ^{c}Azzūz and His Retrospective Horoscopes Related to the Battle of El Salado (1340)', Samsó provides a detailed analysis of the data of four horoscopes contained in the second part of Ibn ^{c}Azzūz's *Kitāb al-Fuṣūl fī jam^{c} al-uṣūl* (*The Book of the Chapters on the Totality of the Principles*), corresponding to the vernal equinox of 1305, the Sun-Moon opposition preceding the Saturn-Jupiter conjunction of 1305, and the vernal equinoxes of 1340 and 1344. Recomputation of the textual values has been made using computer programs provided by the late J. D. North [1986] for the longitudes of the points (cusps) at which the astrological houses begin and by E. S. Kennedy (revised by H. Mielgo and J. Casulleras) for planetary positions, using Ibn ^{c}Azzūz's parameters.[6]

I agree with Samsó that this *zīj* deserves a detailed study, but I am not sure about Ibn ^{c}Azzūz's claim that his modifications of Ibn Isḥāq's parameters were based on observation. The text does not say at which date these horoscopes were cast. Samsó achieves good recomputations of Ibn ^{c}Azzūz's numbers using parameters of the *Muwāfiq zīj*, but some doubts remain on the role played by observation in those changes. For example, the position and date given in the text for the Saturn-Jupiter conjunction of 1345 are computed, not observed, values: thus, for February 25, the sidereal longitude is 303°(actual: March 24, 319°, tropical), which is very close to those we can obtain with the Toledan tables. In fact, there are no significant differences for these planets in their mean motions, mean longitudes, and apogees between the Toledan (or Ibn al-Kammād's) values and Ibn ^{c}Azzūz's [ch. 9.98–101, Tables 1 and 2]. The same can be said regarding Ibn ^{c}Azzūz's position for Saturn on March 24, 1344 (Capricorn 25°, sidereal; actual: Aquarius 308°, tropical) [Tuckerman 1964]. Now, at the end of the 13th century the Toledan

[6] Although it is said [10.13] that the column of true longitudes in the appendix is computed from the formula 'manuscript second *markaz* + [recomp. corrected apogee] + [recomp. equation of anomaly]', the column is indeed computed from 'mean longitude + equation of center + equation of anomaly').

longitudes for Saturn were already systematically low by more than 2°, as observers of the time record and modern computation shows.[7] Moreover, there is no trace in Ibn ^{c}Azzūz's tables of anything like the correction in Saturn's radix introduced by the tables of Toulouse (before 1240) to correct this deficiency. Better contemporary computations of that conjunction required changes in mean motions and radices (John of Murs, March 21, with the Alfonsine Tables) or mean motions and apogees (Levi ben Gerson, March 28, with al-Battānī's) [Goldstein and Pingree 1990]. But without details of the computer program used by Samsó, it is is difficult to see how Ibn ^{c}Azzūz avoids the Toledan errors for Mars (e.g., for March 1305), taking into account that he seems to have made the worst choice for its parameters (apogee 119; 41°, as in Ibn al-Kammād's tables, instead of Ibn Isḥāq's 122;13°; mean longitude 211;7,57°, closer to the Toledan one than to Ibn Isḥāq's 210;37,25°). Note also that Ibn ^{c}Azzūz adopted Ibn al-Kammād's table for trepidation, whose maximum is 9;59°.

I should like also to add some comments on the appendix of chapter 9 ('On the Epoch of the Star Table of Ibn al-Kammād and Ibn ^{c}Azzūz'), in which Samsó echoes discussions among scholars who in the last years have resorted to the first two trepidation models described in chapter 5 of Ibn al-Zarqālluh's *Treatise on the Motions of the Fixed Stars* [Millás 1950, 315–319][8] in order to explain the different numerical values found in texts or tables composed by Ibn al-Zarqālluh's and his followers. These models have thus supported 'reconstructions' for Ibn al-Kammād's trepidation table (model 2, with parameters not mentioned by Ibn al-Zarqālluh), Ibn al-Kammād's star list (model 1A), as well as Ibn al-Kammād's trepidation table (model 2B), and even the planetary apogees in Ibn al-Zarqālluh's treatise on the construction of the *equatorium* (model 1B). That Ibn al-Zarqālluh himself or his followers could have used these models so indiscriminately is a *guess* and a historically implausible one at that; yet, that Ibn al-Zarqālluh ultimately accepted only one, the third, and explicitly rejected the others, is a *fact*. Ibn al-Zarqālluh's

[7] See Duhem 1958–1959, 4.16 (according to William of Saint Cloud's report of his observation, the Toledan error for the date of the Saturn-Jupiter conjunction of 1285 exceeded 20 days) and Gingerich and Welther 1977.

[8] To account for observational data, Ibn al-Zarqālluh considers three models and gives two sets of parameters for the two first and only one for the third (hereafter, 1A, 1B, 2A, 2B, and 3).

reports a set of data that he considered soundly derived from observations according to which the amount of precession since Hipparchus was 16;56°(=Δλ), with differences resulting from the sum of the differences 2;46° (interval from Hipparchus to Ptolemy), 11;36° (Ptolemy to al-Battānī), and 2;34° (al-Battānī to al-Zarqālluh).[9] The models yield the following results when parameters are provided to account for these data:

	1A	1B	2A	2B	3
	2;22	2;47	2;52,30	2;48	2;45,45
	10;56	11;57	11;35	11;34	11;35,41
	2;27	2;42	2;34,20	2;34	2;34,19
Δλ	15;45	17;25	16;41,30	16;56	16;55,45

After concluding that model 3 provides the best results, in chapter 6 of the same treatise, Ibn al-Zarqālluh mentions additional reasons to reject the first two: in model 1, the amplitude of the motions of access and recess cannot be equal; and in model 2, as he writes, 'the positions should be increased since the beginning of the motion of the small circle until our time, but we have investigated this matter and we do not found them increased' [Millás 1950, 320–321]. Thus, the 'explanation' provided by appealing to models 1 and 2—indeed to the underlying formulae, or to numbers from columns 1A–2B deprived of their context—is in fact an explanation *per obscurius*: why would astronomers who recognized Ibn al-Zarqālluh as the greatest authority refuse to accept his conclusions?

'On the Lunar Tables in Sanjaq Dār's *Zīj al-Sharif*' closes the Maghrib section of the volume and analyzes the solar and lunar tables in this late *zīj* (end of the 16th century), the main characteristic of which is the use of double argument tables of equations for the Moon. This is the first instance in the Maghrib of this kind of table, though it is well documented in the East since the time of Ibn Yūnus (d. 1009). Mean motions and equations derive from Ulugh Begh's *Zīj i-Sulṭanī* (15th century).

The last three papers of the collection are a thorough complement to a recent monograph on Abraham Zacut (1452–1515) [see

[9] Millás 1950, 316. Millás gives also 2;47°, 11;32°, and 2;37°[1950, 297–299].

Chabás and Goldstein 2000]. Samsó offers a minutely detailed account of the assimilation and adaptation of the *Almanach perpetuum* (1496) in the Muslim world from the 16th century onward, and of the role played in the process by the two Arabic versions by Moses Galiano (Istanbul, *ca* 1506) and Aḥmed b. Qāsim al-Ḥajarī (Marrākush, *ca* 1624). Samsó's exhaustive survey of the copies of these versions preserved in Eastern and Western libraries also contains useful information on the transmission of other Jewish, Andalusī, and Maghribī astronomical and astrological materials to the Mashriq. These manuscripts not only certify the long survival of Ḥajarī's version, which was still in use at the end of the 18th century, but also (*pace* Samsó's sceptical look to social history) to the deep decline of science and society in these Islamic countries during a time in which European astronomy had long ago forgotten Zacut's work.

BIBLIOGRAPHY

Bellver, J. 2006. 'Jābir b. Aflaḥ on the Four Eclipse Method for Finding the Lunar Period in Anomaly'. *Suhayl* 6:159–248.

________ 2007. 'Yābir b. Aflaḥ en torno a la inclinación de los eclipses en el horizonte'. *Archives Internationales d'Histoire des Sciences* 57:3–23.

________ 2008a. 'Jābir b. Aflah on lunar eclipses'. *Suhayl* 8:47–91.

________ 2008b. 'On Jābir b. Aflaḥ's Criticisms of Ptolemy's *Almagest*'. Pp. 181–189 in E. Calvo, M. Comes, R. Puig, and M. Rius edd. *A Shared Legacy: Islamic Science East and West.* Barcelona.

Casulleras J. 2007. 'El cálculo de aspectos o la proyección de rayos en la astrología medieval árabe'. *Archives Internationales d'Histoire des Sciences* 57:25–46.

Chabás, J. and Goldstein, B. R. 2000. *Astronomy in the Iberian Peninsula: Abraham Zacut and the Transition from Manuscript to Print.* Philadelphia.

Díaz Fajardo, M. 2008. *Tasyīr y proyección de rayos en textos astrológicos magrebíes.* Ph. D. dissertation, University of Barcelona.

Duhem, P. 1958–1959. *Le système du monde.* 10 vols. Paris.

Gingerich, O. and Welther, B. 1977. 'The Accuracy of the Toledan Tables'. Pp. 151–162 in Y. Maeyama, W. and G. Saltzer edd. *Prismata. Festschrift für Willy Hartner.* Wiesbaden.

Goldstein, B. R. 1971. *Al-Biṭrūjī: On the Principles of Astronomy.* 2 vols. New Haven/London.

Goldstein, B. R. and Pingree, D. 1990. 'Levi ben Gerson's Prognostication for the Conjunction of 1345'. *Transactions of the American Philosophical Society* 80.6.

Millás Vallicrosa, J. M. 1950. *Estudios sobre Azarquiel.* Madrid.

North, J. D. 1986. *Horoscopes and History.* London.

Samsó, J. 2008. *Astrometeorología y astrología medievales.* Barcelona.

Samsó, J. and Berrani, H. 2005. 'The Epistle on Tasyīr and the Projection of Rays by Abū Marwān al-Istijī', *Suhayl* 5:163–242.

Sawyer, F. W. 1977. 'On Ptolemy's Determination of the Apsidal Line for Venus'. Pp. 169–181 in Y. Maeyama, W. and G. Saltzer edd. *Prismata. Festschrift für Willy Hartner.* Wiesbaden.

Swerdlow, N. M. 1987. 'Jābir ibn Aflaḥ's Interesting Method for Finding the Eccentricities and Direction of the Apsidal Line of a Superior Planet'. Pp. 501–512 in D. A. King and G. Saliba edd. *From Deferent to Equant. A Volume of Studies in the History of Science in the Ancient and Medieval Near East in Honor of E. S. Kennedy.* New York.

Tuckerman, B. 1964. *Planetary, Lunar and Solar Positions A.D. 2 to A.D. 1649 at Five-Day and Ten-Day Intervals.* Philadelphia.