Reviews

Bruce S. Eastwood, *The Revival of Planetary Astronomy in Carolingian and Post-Carolingian Europe*. Variorum Collected Studies Series: CS720. Ashgate, Aldershot, 2002. XII+318 pp.

The present volume reprints ten papers by Bruce Eastwood which had previously appeared in various publications between 1983 and 2000, to which the author has added, following the standard usage of the Variorum series, a short introduction (pp. IX-XI), *Addenda* and *Corrigenda* and a brief index of authors. The set of ten papers shows a remarkable unity: they all deal with the survival of Classical Latin Astronomy in the Early Middle Ages a topic which, according to Eastwood (see paper no. X, footnote 1), has not received due attention in the recent general survey by Stephen C. McCluskey (*Astronomies and Cultures in Early Medieval Europe,* Cambridge U.K., 1998, where this topic is dealt with briefly in pp. 117 ff.). Eastwood tries to fill this gap by collecting a series of studies dealing with the survival of authors such as Pliny the Elder (23-79), Macrobius (ca. 360 - post 422), Calcidius (4th c.) and Martianus Capella (fl. ca. 410-439): paper I ("Astronomy in Christian Latin Europe c. 500 - c. 1150)") is an excellent summary of the topic as a whole.

All these papers are based on a very detailed analysis of an impressive number of early medieval manuscripts (the volume lacks an index of manuscripts which would be extremely useful here) paying special attention to glosses and, very particularly, to illustrations. Thus, papers I-III analyse carefully a series of diagrams drawn to illustrate some astronomical ideas of Pliny the Elder. They are concerned with the planetary *apsides* (Plinian apogees which do not always coincide with those of Ptolemy), planetary musical intervals, planetary latitudes, the circumsolar motion of Venus and Mercury, etc. The last two kinds of diagram are particularly interesting: the latitude diagram adopts two basic shapes of which the older one follows a circular pattern based on a stereographic projection on the plane of the ecliptic from its southern pole; the second version is a rectangular grid which looks like a graph with latitudes represented in the vertical scale; unfortunately the horizontal scale does not correspond to the planetary longitudes and the whole scheme is a mere attempt to give a graphical idea of the Plinian maximum latitudes for each planet.

The problem of the circumsolar motions of Venus and Mercury is particularly interesting. Item IX ("Heraclides and Heliocentrism: Texts, Diagrams and Interpretations") reviews the problem of the attribution to Heraclides of a model in which the centre of the epicycle of Venus coincides with the Sun. This is based on a misinterpreted passage of Calcidius' commentary on Plato's *Timaeus,* who seems to suggest that Mercury's motion can be explained in a similar way, and the correct interpretation has been known at least since the nineteen seventies. Eastwood's paper (first published in 1992) is, however, a very interesting and useful review of the whole topic (as well as of the attribution to Heraclides of a motion of rotation of the Earth, based on another misinterpreted passage of Simplicius' commentary on Aristotle's *Physics*), using all the available evidence and containing, in agreement with the interests of the author, a very thorough analysis of the Medieval tradition of illustrations which appear together with Calcidius' text. A planetary model in which the motion of Mercury and Venus is circumsolar appears clearly, as it is well known, in Martianus Capella (see items I, II, IV, VII; the problem of the order of planets is also studied in paper no. V) and interpolations or glosses in medieval manuscripts seem to ascribe the same kind of ideas to other authors such as Bede, Pliny or even Plato (see item VIII). On the other hand Martianus' words were interpreted in three different ways which appear described in diagrams extant in several manuscripts: Mercury and Venus may describe circles whose centre coincides with that of the Sun, or describe intersecting circular paths around the Sun or even move somehow along *incomplete* intersecting circles or undefined curves of another kind.

One may wonder why a historian of Islamic astronomy should become interested in a set of papers like the present one as they all deal with sources unrelated to any Arabic influence. The answer is obvious, in my opinion: Eastwood's research describes the work done by centres of European scholarly learning which were interested in Astronomy, precisely the centres in which the earliest samples of this influence were to appear. Paper X ("Calcidius's Commentary on Plato's *Timaeus* in Latin Astronomy of the Ninth to Eleventh Centuries") stresses the interest Abbo of Fleury had in Calcidius and recent research by Charles Burnett ("King Ptolemy and Alchandreus the Philosopher: the Earliest Texts on the Astrolabe and Arabic Astrology at Fleury, Micy and Chartres", *Annals of Science* 55 (1998), 329-368) has shown the important role played by the monastery of St. Benoît de Fleury, precisely in the time in which Abbo was its abbot (988-1004), in the transmission and European diffusion of the old corpus of texts on the astrolabe and other matters which were based on Arabic sources of some kind but which also contain a mixture of Latin materials (see, for example, David Juste's "Les doctrines astrologiques du *Liber Alchandrei*" in I. Draelants, A. Tihon and B. van den Abeele (eds.), *Occident et Proche Orient: Contacts scientifiques au temps des Croisades,* [Louvain], 2000, pp. 277-311). One should also remember that Calcidius' texts contained clear descriptions of planetary models based on deferents and epicycles and, thus, paved the way for the future introduction of Ptolemy. Finally Eastwood's paper IV ("Origins and Contents of the Leiden Planetary Configuration (Ms. Voss, Q.79, fol. 93v), an Artistic Astronomical Scheme of the Early Middle Ages") analyses a well known Carolingian illustration which includes approximate planetary positions that can be dated on the 18th March 816: he poses the problem of how the planetary positions were calculated and suggests the use of the *Preceptum Canonis Ptolomei* (ed. D. Pingree, Louvain, 1997). Whatever the solution, the situation is similar to that of the Andalusī astrologers of the early 9th century who computed horoscopes before the introduction in al-Andalus of the first Eastern *zījes*. Besides, the *Preceptum* appears in manuscripts containing materials of the old Arabic corpus and is quoted by the authors of the *De utilitatibus astrolabii* and of the prologue *Ad intimas...* On the whole, then, the interest of this volume for students of early European astronomy, both Latin and Arabic-Latin, is obvious.

Julio Samsó

Fritz S. Pedersen, *The Toledan Tables. A review of the manuscripts and the textual versions with an edition.* Historisk-filosofiske Skrifter 24:1-4. Det Kongelige Danske Videnskabernes Selskab. Copenhagen, 2002. 1662 pp.

The publication of this spectacular edition of the *Toledan Tables* deserves a very special welcome because editing *zījes* is the kind of task that has seldom been done in the scholarly world interested in the history of Arabic astronomy. Before 1956, the year of the publication of E.S. Kennedy's well known *Survey*, the only editions available were those of al-Battānī (Nallino, 1899-1907), al-Khwārizmī in Adelard of Bath's translation (Suter, 1914), Ibn al-Zarqālluh's *Almanac* (Millàs, 1943-50), the canons of Ibn al-Bannā's *Minhāj* (Vernet, 1952) and al-Bīrūnī's Mas^{c}udic Canon (Krause, 1954-56). A recent updating of Kennedy's book (D.A. King *et al.* in *Suhayl* 2 (2001), pp. 9-105) has only been able to add to this short list the English translation and commentary of al-Khwārizmī/Adelard of Bath by O. Neugebauer (1962, including an edition of the Latin adaptation of the same work by Petrus Alfonsi), the Byzantine version of al-Fahhād's *al-Zīj al-^{c}Alā'ī* (Pingree, 1985-86) and two unpublished doctoral dissertations presented in Barcelona in 1996 (Muhammad Abdurahman) and 2000 (Angel Mestres) on Ibn al-Raqqām's *Qawīm Zīj* and Ibn Isḥāq's *Zīj* (Hyderabad manuscript) respectively.

From the point of view of editions, one must acknowledge that Andalusī and Maghribī sources - including Mashriqī *zījes* (al-Khwārizmī, al-Battānī) mainly used in Western Islam - have received more attention than the Eastern ones. This tendency continues with Fritz Pedersen's masterly edition of the *Toledan Tables*, which has only one important predecessor: Toomer's analysis of the same tables published in 1968. We have now, however, something which is far more complete than the previous work: a critical edition of three sets of canons and of the numerical tables, based on more than a hundred manuscripts. In spite of the fact that the *Toledan Tables* cannot be considered original and are mainly the result of a hasty adaptation of Eastern materials that had reached al-Andalus, they definitely deserved an edition because they were the starting point of an important tradition of Maghribī *zījes* and because they were very well known in Latin Europe. It is obviously true that the manuscript tradition of these tables is a pure Latin one (see I, 11), the Arabic originals being apparently lost, but one should also remember that a revised version seems to have circulated in the Maghrib: the mean motion tables of the *zīj* of Ibn Isḥāq (Hyderabad MS) use parameters very near to those of the *Toledan Tables* and give radices both for Toledo and for Tunis. Pedersen has found traces of a revision of the tables which can be dated ca. 1110 (some ten years after the death of Azarchel in 1100) in an early Latin copy (I, 15 and III, 759): two horoscopes probably for the latitude of Toledo dated 1110 and 1106 (North, 1995) and a star table (on tables of this kind see IV, 1489-1508) with an increment on the Ptolemaic longitudes of 14;55° and in which the date is 1422 Alexander/1110-11 (Table 13A). I will discuss this latter topic below but, given the fact that Toledo was conquered by Alfonso VI in 1085, the existence of horoscopes cast for that latitude when the city was no longer under Muslim authority poses the very interesting problem of the possible survival of Islamic astronomy in Toledo until later than we thought.

Vols. I (pp. 1-323) and II (pp. 324-736) contain a General Preface and editions of the three sets of canons: 1) *Ca* ("Scito quod annus"), based on al-Battānī, carrying a plausible ascription to Ibn al-Zarqālluh/ Azarchel; 2) *Cb* ("Quoniam cuiusque"), the "vulgate", a revision of *Cc* with some Christian adaptations: a previous edition of this text had been published by Pedersen himself in 1987; 3) *Cc* ("the archaic version"), modelled on al-Khwārizmī's *Sindhind*, but also strongly influenced by al-Battānī. Pedersen, 1992, published an edition of a passage of the canons (Cc 123-212) and showed that *Cc* depends on a version of al-Khwārizmī's rules which corresponds to fragments of Ibn al-Muthannā, i.e. a version of the *zīj* independent of Maslama's revision (II, 571). *Cb* and *Cc* derive ultimately from the same Arabic exemplar, *Cb* being a thorough stylistic revision of the Latin text of *Cc* (II, 337). The attribution of the authorship of *Cb* to Azarchel and of the Latin translation to Gerard of Cremona does not seem well founded (see II, 331 and 338). The earliest dated reference to the Latin Toledan Tables corresponds to 1141 (see III, 754), but the oldest MSS of the three versions date from the late 12th or early 13th c., canons *Cb* dominating the scene in the late 13th c. They were still copied in the 15th c. although, from c. 1320 onwards, they faced competition from the *Alfonsine Tables*.

Vols. 3 (pp. 737-1237) and 4 (pp. 1241-1662) contain a general preface to the tables, a critical edition of them, without an explicit recomputation but with an extremely careful control of errors (which implies a thorough understanding of the underlying astronomical theory) and a very complete set of indices. Tables are classified (I, 18-20) into 7 different kinds corresponding to: A, chronology; B, trigonometry and spherical astronomy; C, mean motions of Sun, Moon, node and planets; D, apogees, nodes, daily mean arguments; E, equations of sun, moon and planets; F, planetary latitudes; G, mean syzygies; H, parallax; J, eclipses; K, visibility of the lunar crescent; L, fixed stars; M, geographical; N, projections of rays; O, planetary visibility and retrogradation; P, eighth sphere; Q, revolution of years; R, astrology; S, almanacs and ephemerides; T, calendars and computus; U, varius auxiliary tables. In relation to category S, it came as a surprise for me to discover that the term *almanac* is not always applied to a perpetual almanach such as Azarchel's, but also to a set of ephemerides calculated for a lunar or a solar year (II, 542-6).

Toomer's analysis of 1968 had made an accurate study of the sources used for the compilation of the *Toledan Tables* and established that only the mean planetary motions could be considered original, while the rest of the materials were the result of hasty adaptations of the corresponding tables in the *zījes* of al-Khwārizmī and al-Battānī. This general idea is fully confirmed by Pedersen (III, 1139 ff.) who states that the *Toledan Tables*, in a strict sense, comprise the planetary mean motions and the syzygy tables (I, 16-17). Although Theon's *Handy Tables* ("Zaiun Alexandrinum", II, 521) are mentioned, their influence (quite obvious in the planetary equation tables) was indirect and took place through al-Battānī's *zīj* (I,47). Pedersen also confirms Mercier's discovery (see for example his paper in *From Baghdad to Barcelona*, 1996) that only the solar mean motion can be considered original in the *Toledan Tables*, for "the differences between the tropical longitudes of the Sun and planets in the *zīj* of al-Battānī are respectively equal to the difference between the sidereal longitudes of the Sun and planets in the *Toledan Tables*" (Mercier, 1996, p. 300). According to Pedersen's computations (III, 1140-1) the value of precession subtracted from al-Battānī's tropical parameters to obtain the corresponding Toledan sidereal one is between, approximately, 0;0,0,9,18,27° and 0;0,0,9,18,35°/day. On the origin of this parameter I can give a hypothetical explanation: it could have been obtained by comparing Ptolemy's longitude of *Qalb al-Asad*/ Regulus for year 139 AD (122;30°) and Maslama's observation of the same star in 367 H/968 AD, mentioned by Azarchel in his treatise on the motion of the fixed stars (135;40°). Since the difference is 13;10° in a period of time which amounts to, approximately, 839 Julian years, it is easy to check that

$$13;10° / (839 \times 365.25) = 0;0,0,9,16,50,16°$$

The radices for Hijra are more difficult to justify. They are comprised between -0;24,13° and -0;24,18° in relation to those of al-Battānī. This value is in agreement with what one would expect in an Andalusī-Maghribī tradition in which precession reaches 0° some time before the Hijra. This is confirmed by a set of *tropical* mean motion tables for Toulouse (II, 1205), in which the collected-year values for A.D. 600 are about the same as those of the normal Toulouse sidereal ones, "so no doubt a year about 600, perhaps the Hijra, has been dated as the origin for precession". In spite of this, I have not been able to obtain 0;24° for the beginning of Hijra with the trepidation tables extant in the Toledan collection (IV, 1545) - considered by Pedersen to be probably the result of the work of the Toledan team - with which the calculated value amounts to 0;17,31°. Other attempts, made with al-Istijjī's parameters (see Comes in *Suhayl*, 2001, pp. 318-322) and with the different models described by Ibn al-Zarqālluh in his treatise on the motion of the fixed stars, have also been unsuccessful.

Trepidation, solar mean motion and tables adapted to the coordinates of Toledo are the topics one has to check when searching for original materials in Pedersen's edition of the *Toledan Tables*. As regards trepidation, it is interesting to note that canons *Ca* contain no allusion to precession/trepidation except in I, 232-233, where we find a canon on solar declination: "intra cum loco solis aequato, cuius initium est a capite arietis". If one takes this expression seriously, it implies the declination which corresponds to a sidereal longitude of the Sun, measured from the [movable] Head of Aries. Pedersen is obviously not happy with this interpretation for he translates (p. 233 n.2): "from the vernal point (= head of Aries)". Trepidation is dealt with in canons *Cb* and *Cc* (II, 478-79 and 686-87). In the former we find a peculiar expression which seems to show the influence of Andalusī astronomical terminology: in II, 436-437, at the end of the computation of the solar longitude, we read "et tunc habebis locum solis certissime cuius initium erit a initio arietis [in 8'a sphaera]". In this context *certissime* makes me think of an Arabic *dhātiyya* [= sidereal]. It is also interesting to remark that canons *Cb* (II, 533) refer to a tropical ascendent ("ascendens cum motu 8'vi circuli"), a practice that does not conform to the standard tradition of Andalusī -Maghribī astrology which tends to use sidereal ascendents.

Trepidation may also be connected with the precessional increments of star longitudes. Pedersen (IV, 1489-1508) edits several sets of star tables which seem to correspond to Toledan (or derived) early material. In them two different increments on Ptolemaic longitudes are used:

1) 14;7° in table LA11, of which a close Arabic cognate was published by Kunitzsch (1980), the latter being dated in 459/1066-67. This date makes sense, for it is confirmed by the "corrected" longitudes of Qalb al-Asad used by Azarchel, in his treatise on the motion of the fixed stars, to establish the accurate values of precession (Samsó, Variorum, 1994, VIII, pp. 7-10), which are 122;26° for the time of Ptolemy (139) and 136;35° for his own time (1075), the difference being 14;9°.

2) 14;55° in tables LA12, LA13 and LA13a, although LA12 also has 15;7° in 12 cases out of 35. One of the manuscripts containing LA12 gives 577H/1181-1182 as a date, while table 13a is dated in 1422 Alexander/1110-11 (Table 13A). Pedersen, following a suggestion by Kunitzsch, proposes that 1110-11 is the date to which an increase on Ptolemaic longitudes of 14;55° corresponds, while 577H could be corrected to 527/1132-33, a date to which an increase of 15;7° could be assigned. It is strange that table LA13 includes columns showing the maximum altitude of the star and its half daily arc, implying a latitude of 39;54° (Toledo). This latitude is peculiar when related to a date ca. 1110 (later than 1085, the year in which Toledo was conquered by Alfonso VI). The suggested dates (1110-11 and 1132-33) would however fit Ibn al-Kammād, who was probably Azarchel's disciple and who, as shown by A. Mestres (in *From Baghdad to Barcelona*, 1996), was active in Cordova in 1116-17. He might have corrected the star longitudes in a Toledan table without bothering to do the same with the maximum altitude of stars or their half daily arcs.

My impression is, however, that the increment of 14;55° may correspond to 527H/1132-33. The longitude of Qalb al-Asad in table 13A is Leo 17;25° (Ptolemy, Leo 2;30°: dif. 14;55°). The longitude of this star in Western Islamic tables for precession

0° is Leo 9;8° or 9;18° (see M. Díaz, *La teoría de la trepidación en un astrónomo marroquí del siglo XV*, Barcelona, 2001, p. 56). The absolute value of precession implied is, therefore, 8;17° or 8;7°. For the beginning of year 527 H I obtain, using Azarchel's tables based on his third model of trepidation a value of 8;4,4°, not far from 8;7°.

3) There is, finally, a star table (LA14) in which the star longitudes do not seem to be related to the Ptolemaic ones by adding a constant of precession. Some of them (Qalb al-Asad, for example, the longitude of which is Leo 9;10°) seem to derive from a table which computed star longitudes for precession 0°. A column includes values of the half daily arc for each star for a latitude between 33;30° and 34° (Fez?).

Solar mean motion is obviously related to the values of the *revolutio anni*: canons *Cb* (II, 484-7) mention an amount of 2481/9600, corresponding to $6;12,9^h$ and to 93;2,15° in *Cc* (II, 662-3). Other values are given in IV, 1567, although only one seems to be related to the tradition of the *Toledan Tables*: CG11 which gives 92;20,55...°, equivalent to $6;9,23,43...^h$ or $0;15,23,29,17...^d$. This value corresponds to the solar mean motion implicit in canons *Ca*01 (0;59,8,11,28,27,29,49°). Ibn al-Kammād ascribes to Azarchel a *revolutio anni* of 92;24°. It is interesting to remark that similar values can be found in a set of tables ascribed to Ibn al-Hā'im in the Hyderabad MS of the *zīj* of Ibn Isḥāq (Abdurahman, in *From Baghdad to Barcelona*, 1996, pp. 372-375): here the *revolutio anni* is 92;20,56,40,12°, $6;9,23,46,40,48^h$, or $0;15,23,29,26,42^d$. This is not the only value quoted by Ibn al-Hā'im who, in the text of his canons, says that the length of the solar year for the beginning of the $7^{th}/13^{th}$ c. (Abdurahman, 1996, pp. 370-371) was $365;15,23,37,30^d$ (which fits the values of the *revolutio anni* extant in the same text, 92;21,45° and $6;9,27^h$), very near to the value ascribed to Azarchel ($365;15,24^d$, see Samsó, *Ciencias de los Antiguos*, Madrid 1992, p. 213). Finally, in Pedersen IV, 1586-89, we find a set of tables of the *revolutio mensium*, which are the result of the division of a tropical year of 365^d 5;47,30° into 12 equal "months". Similar tables (though related to a sidereal year) appear in the Hyderabad MS of the *zīj* of Ibn Isḥāq ascribed to Ibn al-Hā'im (see Abdurahman, 1996, pp. 376-377).

Another solar parameter is the obliquity of the ecliptic and, in this respect, the values found in the *Toledan Tables* are remarkably homogeneous: 23;33° (I, 69) and 23;33,30° (I, 67 and 69; II, 508; III, 961-64) are ascribed to Yaḥyā b. Abī Manṣūr and/or to Azarchel and canons *Cb* (II, 410-11) and *Cc* (II, 612-13) add the remark "quae [i.e. Yaḥyā's value] apud nos ducitur verior, quia primam novimus rumore, et hanc didicimus per considerationem" ("and among us this is considered truer, since we know the former from hearsay but have learnt the latter from observation"). In this relation we find (in III, 765, 967) a declination table with a maximum 23;33,8° a parameter which, until recently, was only known through another declination table ascribed to Abraham ben ᶜEzra: the situation changed radically with the publication of a paper by George Saliba (*Al-Qanṭara*, 1999, p. 11) on the critiques of Ptolemy made by an anonymous Toledan astronomer who was a contemporary of Azarchel to whom he ascribes an obliquity of the ecliptic of 23;33,8°, obtained, probably, through observation.

The coordinates of Toledo are another set of values which can safely be considered original. It is interesting to see that MA11 (the principal version of the list of geographical coordinates of cities) gives a longitude for Toledo of 11° and a latitude of 40° (IV, 1516). A later set has a longitude of 28;30°, and a latitude of 39;51° (occasionally 39;54°). The longitude of 28;30° implies the use of the water meridian, commonly related to the Toledan tradition (see Comes, 1994) and it fits a longitude for Cordova of 27°, documented in al-Andalus since ca. 940 (Samsó 1992, p. 90). 28;30° for Toledo also fits the time difference with Arin of 4 1/10 hours (= 61;30°) found in canons *Ca* (I, 250-

1) and *Cb* (II, 430-1), as well as in a set of mean motion tables (III, 1211). In the fourteenth century Isaac Israeli (III, 754) ascribes to Abraham Zarkil a longitude for Toledo of 62° (= 28°) from Arin, a value which corresponds to the 4;8^h used by tables CB* (see III, 1191 ff). In another passage the same source states that Toledo is 4^h + 162/1080 (4;9^h, equivalent to 27;45° from the water meridian). As for the latitude of Toledo, the most common value seems to be 39;54° which appears both in tables (see III, 997-1003, 1125-1127, and in canons Cb (II, 431) and in a variant of Cc (II, 730).

This is about all I have to say on the masterly work of Fritz Pedersen. Other scholars will be interested in various other aspects of this edition which opens many doors to the study of an important medieval European tradition. For my part I was mainly interested in exploring the information it contains about the astronomical work of what Ibn al-Hā'im (fl. ca. 1200) calls *al-jamāʿa al-ṭulayṭuliyya* ("the Toledan community").

Julio Samsó

Ahmad Jabbār and Mūḥammad Aballāgh, *Ḥayāt wa-mu'allafāt Ibn al-Bannā al-Murrākushī* [sic] *maʿa nuṣūṣ ghayr manshūra*. Manshūrāt Kulliyyat al-Adāb wa l-ʿUlūm al-Insāniyya bi l-Ribāṭ. Silsilat Buḥūth wa-Dirāsāt, raqm 29. Rabat, 2001. 238 pp.

This is an important attempt to write a biobibliographical survey of the Moroccan mathematician and astronomer Abū 'l-ʿAbbās Aḥmad b. Muḥammad b. ʿUthmān al-Azdī, known as Ibn al-Bannā' al-Marrākushī. The authors have used all available published and unpublished primary sources, among which they emphasize the importance of the biobibliographical notes by two fourteenth century Maghribī mathematicians who wrote commentaries on the *Talkhīṣ aʿmāl al-ḥisāb* of Ibn al-Bannā': Ibn Haydūr al-Tādilī (d. 816/1413) - in his *al-Tamḥīṣ fī sharḥ al-Talkhīṣ* - and Ibn Qunfudh al-Qusanṭīnī (d. 810/1407) - in the *Ḥaṭṭ al-niqāb ʿan wujūh aʿmāl al-ḥisāb*. Working editions of these two notes are published here as two appendices (pp. 193-205): Ibn Qunfudh's text had been previously edited by Yūsuf Gargūr in his Ph.D. thesis (Algiers, 1990) but Ibn Haydūr's note was unpublished and it appears here for the first time: the MSS used to prepare this edition are mentioned on p. 91.

As a result of their efforts Djebbar (= Jabbār) and Aballāgh confirm the precise dates of birth (9th or 10th Dhū 'l-Ḥijja 654/29th or 30th December 1256) and death (5th Rajab 721/31st July 1321) (pp. 20-23) and reject (pp. 24-26) the legend that he was born in Granada as a myth created by Casiri. Ibn al-Bannā' was born in Marrākush where he studied with several masters (the authors name 17 on pp. 29-45) the *Qur'ān*, Qur'ānic readings, Arabic language, Arithmetic (*ḥisāb*) and other branches of Mathematics, Partition of Inheritances (*Farā'iḍ*), Logic, *Uṣūl al-Fiqh*, Astronomy and Astrology. All of these disciplines appear represented in the list of Ibn al-Bannā's own works. Djebbar and Aballāgh consider doubtful that Ibn al-Bannā' ever studied in Fez, a city which he seems to have visited only at a later stage of his life (pp. 27-29).

The authors discuss carefully (pp. 40-45) the very interesting problem of the relations between the Moroccan mathematician and the *Zāwiya Hazmīriyya* of Aghmāt and with its two founders the brothers Abū ʿAbd Allāh (d. 678/1279) and Abū Zayd al-Hazmīrī (d. 706/1306). This topic is connected with Ibn al-Bannā's reputation as a *ṣūfī*, which the authors consider another myth created by popular imagination to justify the success of certain predictions he made. In fact Ibn Haydūr himself gives a serious base for this belief because he states that Ibn al-Bannā' served (*khadama*) Abū ʿAbd Allāh al-Hazmīrī and entered his *ṭarīqa* together with the other poor (*fuqarā'*) who were his disciples. There, Ibn al-Bannā' remained in isolation (*khalwa*) for a whole year and one night he had the vision of a whole circle of the celestial sphere (*dā'irat al-falak bi-ajma*^{c}*i-hā*) and could contemplate the motion of the Sun from beginning to end. From that moment he began to study Astronomy and Astrology (^{c}*ilm al-hay'a wa 'l-nujūm*) until he acquired proficiency in both disciplines. However he did not accept any astrological principle established by the ancients (*al-aqdamūn*) until he had tested it and submitted it to experience (*illā jarraba-hu wa-khtabara-hu*). The result of this was that he could not find coherent laws to explore the knowledge of occult things (*al-mughayyabāt*) until, after several years, he returned to the practice of fasting and isolation and had a new vision in which he saw his master Abū Zayd al-Hazmīrī inside a copper *qubba*. After the vision he was ill but his master healed him and finally agreed to give him the esoteric knowledge he required to know the occult. This is followed by a couple of anecdotes in which Ibn al-Bannā' made an accurate prediction about the circumstances of the death of sultan Abū Sa^{c}īd (d. 731/1331) and about the place where a treasure was buried. No details about the techniques of devination used are given. In any case Djebbar and Aballāgh give a rationalistic interpretation of the whole story based on two well known facts: 1) Abū Zayd al-Hazmīrī was a good mathematician and astronomer and there is evidence that Ibn al-Bannā' used to go from Marrākush to Aghmāt to ask his advice on questions related to Geometry; 2) according to Ibn Ḥajar al-^{c}Asqalānī, Ibn al-Bannā' suffered some kind of nervous disease (*yubs fī dimāghi-hi*, "dryness in his brains") in 699/1299 and Abū Zayd al-Hazmīrī told his family to keep him in seclusion and he did in fact withdraw from normal life for one year until he recovered; this would account for the year of solitude (*khalwa*) mentioned by Ibn Haydūr. Djebbar and Aballāgh conclude that the relations between Ibn al-Bannā' and Abū Zayd al-Hazmīrī were unrelated to the mystical activities of the latter who was probably his master in Astrology, as well as in other branches of Mathematics. It is a fact that Ibn al-Bannā' had a clear interest in Astrology in an early stage of his scholarly life and had a reputation as a professional in that discipline.

Ibn al-Bannā' used to teach in the *Jāmi*^{c} mosque of Marrākush where his lessons were attended by students coming from other cities of the Maghrib and al-Andalus of which Djebbar and Aballāgh mention eight (pp. 45-52). He was also a prolific writer and the authors classify his works into three chronological stages, not well defined because Ibn al-Bannā' did not record a date for them (pp. 52-63). In the first stage (until ca. 1290) he seems to have written a series of short astrological texts, extant in an Escorial manuscript and edited here for the first time in an appendix (pp. 160-190): some of them are probably mere copies from other unknown sources. During the same period he seems to have written his first mathematical works, among which we find his *al-Uṣūl wa 'l-muqaddimāt fī 'l-Jabr wa 'l-Muqābala* (written before 686/1287) which, according to Abū Bakr Muḥammad al-Qalalūsī (d. 707/1307) - one of Ibn al-Bannā's masters - was a mere copy of the commentary of al-Qurashī on Abū Kāmil's *al-Kāmil fī 'l-Jabr*, an accusation which is discussed here in detail (pp. 55-58). The second stage (ca. 1290-1301) appears to be the most important in the scholarly production of Ibn al-Bannā', because during this period he wrote his two most important mathematical works (the *Talkhīṣ a*^{c}*māl al-ḥisāb* and the *Raf*^{c} *al-ḥijāb* ^{c}*an wujūh a*^{c}*māl al-ḥisāb*, written in 701/1301 according to Ibn Haydūr). Also in this stage he abandoned his previous belief in astrology and wrote his *zīj* (the *Minhāj al-ṭālib fī ta*^{c}*dīl al-kawākib*) as well as two summaries of it which seem to be lost. During his third stage (ca. 1301-1321) he seems to have dedicated himself to teaching his mathematical works and to writing on religious, philosophical and linguistic topics. It is during this period that Ibn al-Bannā' made frequent visits to Fez where he seems to have had good relations with the Merinid sultan Abū Sa^{c}īd (709/1309 - 731/1331) who probably consulted him as an astrologer (pp. 83-84), even though he seems to have lost his faith in the scientific character of astrology: see Ibn Marzūq, *Musnad*, ed. M.J. Viguera, Algiers, 1981, p. 438, and the anecdote mentioned by Ibn Haydūr about his prediction on the exact circumstances of the death of the sultan.

Djebbar and Aballāgh dedicate most of the rest of the book (pp. 73-149) to a very thorough bibliography of the works of Ibn al-Bannā' which is composed of 109 items divided into three sections: the first (items 1-88) corresponds to Ibn Haydūr's list as reproduced in the prologue to *al-Tamḥīṣ fī sharḥ al-Talkhīṣ*; the second is an appendix to Ibn Haydūr and comprises the supplementary titles found in other biobibliographical sources, mainly in Ibn Qunfudh's *Ḥaṭṭ al-niqāb*, as well as works ascribed to Ibn al-Bannā' found in manuscripts which do not appear in biobibliographies (items 89-105). Finally a third short group, composed only of four items, corresponds to texts which have been falsely attributed to Ibn al-Bannā' or whose attribution raises serious doubts. One should bear in mind, as the authors themselves acknowledge (pp. 153-158) that some of the astrological works extant in the Escorial manuscript and included in the second section should probably appear in the third one. For each item of the list, when the work is extant, Djebbar and Aballāgh give the title of the work, the list of the manuscripts, a short commentary, editions (if any), secondary bibliography, *incipit* and *explicit*. When the work is not extant, the authors assemble all the available information on it. In the case of well known works of Ibn al-Bannā', the bibliography includes the same kind of information about the commentaries on them: thus, in the case of the *Talkhīṣ aᶜmāl al-ḥisāb* (pp. 89-99), the authors list 17 commentaries written in prose plus four *urjūza*s and a summary (*ikhtiṣār*), each one of them including information on the author, the extant manuscripts, editions and secondary bibliography, *incipit* and *explicit*.

This long list tells a great deal about the range of interests to which Ibn al-Bannā' dedicated his scholarly life for it includes Qur'ānic studies, theology (*Uṣūl al-dīn*), Logic, Law (*fiqh*), Rhetorics, Prosody, Sufism, Partition of inheritances (*farā'iḍ*), Arithmetic (*ḥisāb*), Geometry, Algebra, weights and measures, measurement of surfaces (*misāḥa*), astronomy, astrology, talismanic magic, astronomical timekeeping, medicine (see no. 101, p. 142, where he seems interested in the problem of calculating the degree of heat/cold, humidity/dryness of a compound drug if one knows the corresponding degree of each one of its components). Ibn al-Bannā's writings on the qibla and on the visibility of the new moon of Ramaḍān of year 700/1301 (no. 100, pp. 138-140) show that he was interested in the applications of astronomy to Islamic worship and that he adopted a didactical attitude and tried to explain these problems to people in a non-technical way.

The bibliographical information given by the authors is important for it includes research published in Maghribī journals and books which are usually not widely circulated in Europe and America. I feel most grateful to them for the effort made to include an almost complete list of Spanish publications related to Ibn al-Bannā's astronomical works, mainly due to the fact that the Moroccan mathematician was interested in the Andalusī tradition of universal instruments and astronomical tables. In this respect I will only make a few remarks related to the astronomical materials:

- Concerning items 53-54 (pp. 122-124), which correspond to the two variants of Ibn al-Zarqāllūh's *ṣafīḥa* (the *shakkāziyya* and the *zarqāliyya*), the two kinds of instrument are considered to be the same. Ibn al-Bannā's summary on the use of the *shakkāziyya* has been edited at least twice and Djebbar and Aballāgh mention the editions by E. Calvo (in *al-Qanṭara*, 1989) and M. ᶜA. al-Khaṭṭābī (in *Daᶜwat al-Ḥaqq* vols. 241-242). I have not seen Khaṭṭābī's edition but I imagine that it is the same text later reprinted in M. ᶜA. al-Khaṭṭābī, *ᶜIlm al-mawāqīt. Uṣūlu-hu wa manāhiju-hu* (Mūammadiyya, 1986, pp. 136-174).

- On Ibn al-Bannā's *Minhāj* (no. 39, pp. 112-116), one should add to the secondary literature quoted by the authors a paper by Juan Vernet ("La supervivencia de la astronomía de Ibn al-Bannā'", *Al-Qanṭara* 1 (1980), 445-451, describing another manuscript extant in the Museo Naval, Madrid) and another by Eduardo Millás and the author of this review: "The computation of planetary longitudes in the *zīj* of Ibn al-Bannā'". *Arabic Sciences and Philosophy* 8 (1998), 259-286. The *Minhāj* is one of the five extant "editions" of the unfinished *zīj* by Ibn Isḥāq (not Abū Isḥāq as in p. 113) al-Tūnisī (fl. ca. 1200) on whom see Angel Mestres, "Maghribī Astronomy in the 13th Century: a Description of Manuscript Hyderabad Andra Pradesh State Library 298", in J. Casulleras & J. Samsó (eds.), *From Baghdad to Barcelona. Studies in the Islamic Exact Sciences in Honour of Prof. Juan Vernet* (Barcelona, 1996), I, 383-443.

- As for Ibn al-Bannā's *Kitāb al-anwā'* (no. 58, p. 126), the secondary literature should include the paper by Miquel Forcada, "Les sources andalouses du Calendrier d'Ibn al-Bannā' de Marrakesh" in *Actas del Segundo Congreso Hispano-Marroquí de Ciencias Históricas*, Madrid, 1992, pp. 183-198; an updated summary of this paper in Forcada, "Books of *Anwā'* in al-Andalus", in M. Fierro and J. Samsó (eds.), *The Formation of al-Andalus. Part 2: Language, Religion, Culture and the Sciences*, Ashgate-Variorum, Aldershot etc., 1998, pp. 305-328.

- There is also a working edition of the *Qānūn fī maᶜrifat al-awqāt bi 'l-ḥisāb* (no. 61, p. 127) in M. ᶜA. al-Khaṭṭābī, *ᶜIlm al-mawāqīt*, pp. 86-99.

An appendix presents editions of several texts, most of them astrological, written by Ibn al-Bannā' or copied by him extant in MS Escorial 918, which seems to correspond to the Marinid period. Some of them are interesting because they bear witness to the existence of a Maghribī astrological tradition with certain characteristics of its own. This tradition is practically unexplored although two texts dating from the eleventh and fourteenth century have been the object of preliminary surveys: see J. Samsó & H. Berrani, "World Astrology in Eleventh Century al-Andalus: the Epistle on *Tasyīr* and the Projection of Rays by al-Istijjī, *Journal of Islamic Studies* (Oxford) 10.3 (1999), 293-312; J. Samsó, "Horoscopes and History: Ibn ᶜAzzūz and his retrospective horoscopes related to the battle of El Salado (1340)", in Lodi Nauta and Arjo Vanderjagt (eds.), *Between Demonstration and Imagination. Essays in the History of Science and Philosophy Presented to John D. North*, Brill, Leiden - Boston - K.ln, 1999, 101-124.

The apparently authentic astrological texts are:

1. *al-Kalām ᶜalā 'l-tasyīrāt wa-maṭāriḥ al-shuᶜāᶜāt* ("On progressions and projections of rays", pp. 160-165). Like Ibn ᶜAzzūz al-Qusanṭīnī (d. 755/1354), Ibn al-Bannā' uses fixed stars (as well as planets) as promissors (*al-thānī* or *al-qāṭiᶜ*) in the computation of the *tasyīr*, while his significators (*al-dalīl*, *al-mutaqaddim* or *al-haylaj*) are the degree of the ascendent, the lunar position, the *pars Fortunae*, the degree of midheaven or the solar position... He insists on the importance of [astrological] experience (*al-tajriba wa 'l-imtiḥān*), an idea which I am finding often in Andalusī and Maghribī astrological texts (al-Istijjī, Ibn ᶜAzzūz and several others). He mentions an unidentified *madhhab jamāᶜat al-munajjimīn* which reminds me that Ibn ᶜAzzūz wrote an apparently lost work entitled *Madkhal al-ṣināᶜa ᶜalā madhhab al-jamāᶜa* ("Introduction to the Art [of Astrology] according to the opinion of the majority"). Following the *Kitāb al-madkhal* (undoubtedly one of Abū Maᶜshar's two *Madkhals*), this school considers four different kinds of *tasyīr*: the *al-dawr al-ṣaghīr* or *burj al-muntahā* (30° per year), the *al-dawr al-awsaṭ* or *al-tasyīr al-ᶜadadī* (5° per year), the *al-dawr al-akbar* or *al-sayr* (probably *al-tasyīr*) *al-ṭabīᶜī* (3° per year and 0;15° per month [not 0;25° as in the text]) and a fourth unnamed kind of *tasyīr* of 1° per year. Ibn ᶜAzzūz mentions the same *tasyīrs* to which he adds a fifth one, the *tasyīr al-qirānāt*. Of these, al-

Istijjī only uses the *tasyīrs* of 3° and 30° per year.

Ibn al-Bannā' does not explain the mathematical procedure used for the calculation of the *tasyīr* although he is slightly more explicit in that respect when he deals with the projection of rays, for which he defends the adequacy of the simple ecliptical method which contains no error if [the planet] has no latitude (see p. 163, line 14 where *ᶜ.w.ḍ* appears twice and it should be replaced by *ᶜarḍ* in both cases). If [the planet] has latitude he considers that the error (*ikhtilāf*) is unimportant in the case of the sextile and trine [there is no error, of course, for the quadrature]. I read, however (p. 163): "The basis [*aṣl*] for that is that we imagine that the celestial body is placed on the surface of the sphere and that we establish that a great circle passes through the centre of the celestial body and divides the sphere into two halves. Then you divide the sphere into the number of parts you wish and you take the sixth part of that number or the sixth part of that circle. The result will be the sextile of that celestial body towards any direction of the sphere". The text is not explicit enough but the reference to a great circle passing through the celestial body makes me think of the possibility that Ibn al-Bannā' might be referring to a method which uses the so-called "position circles" (*al-ufq al-ḥādith*, according to Muḥyī al-Dīn al-Maghribī): such methods were known in al-Andalus from the 11th c. at least.

2. *Masā'il fī 'l-jabr wa 'l-iqbāl* (pp. 166-167): the title is a proposed addition of the editors. This is a short text on astrological terminology in which a few technical terms are explained. The source used by Ibn al-Bannā' could easily be Abū Maᶜshar's *al-Madkhal al-ṣaghīr* (ed. Ch. Burnett, K. Yamamoto and M. Yano, Brill, Leiden..., 1994).

3. *Fī ᶜamal al-ṭalāsim* (pp. 168-169): the title is also a proposal of the editors. This is a very short tract on the making of a talisman in which only one example is given (a talisman made in order to obtain a fortune). The text insists on the importance of the horoscope of the nativity or the year or month transfer of the subject to which the talisman is to be applied. Modern authors (*al-muta'akhkhirūn*) have discovered that the failure of certain talismans was due to the fact that such horoscopes had been incorrectly cast. For that reason they reexamined the positions of celestial bodies (*al-kawākib*) and corrected their motions using observational instruments (*ālāt al-raṣad*).

The texts numbered 4 to 10, all of which have titles added by the editors, are of little interest and do not seem to be original works of Ibn al-Bannā' but mere copies from unknown sources in which the incipits usually say something like *Wa mimmā nuqila min khaṭṭ Abī 'l-ᶜAbbās Aḥmad b. al-Bannā'*, implying that the Escorial MS is a copy of another one written in Ibn al-Bannā's own hand. In fact the explicit of text number 4 (p. 173) offers a further detail for in it we read that "the *faqīh* Abū ᶜAbd Allāh al-ᶜAdadī told me (*dhakara lī*, i.e. to the copyist of the Escorial MS [?])... that the *shaykh* Abū 'l-ᶜAbbās copied it with his own hand in his house" (*naqala-hu ᶜinda-hu bi-khaṭṭ yadi-hi*). Djebbar and Aballāgh state (p. 53) that six of Ibn al-Bannā's masters bore the *kunya* Abū ᶜAbd Allāh which reinforces the idea of a set of student's notes copied by the scientist of Marrākush in his youth when he began to be interested in Astrology, which is the subject of texts 4-8.

4. *Naqūlu fī uṣūl aḥkām al-nujūm* (pp. 170-173).

5. *Fī 'l-munāsaba* (p. 174).

6. *Al-Kalām al-kullī al-ḍābiṭ li-aḥkām al-nujūm* (pp. 175-176).

7. *Naqūlu fī 'l-mawthūq wa 'l-masjūn* (p. 177).

8. *Naqūlu fī mawḍiᶜ al-nayyirayn* (pp. 177-178).

9. *Fī 'l-tanāsub bayna ḥisāb al-jumal wa-makhārij al-ḥurūf* (pp. 179-182): this text is an attempt to establish a relation between the numerical values of the letters in the *abjad* system and their phonetic description.

10. *Tanbīh ᶜalā ikhtilāf al-ᶜanāṣir* (pp.

183-184).

Texts 11 and 12 (*Maqāla fī 'l-qibla* and *Maqāla thāniya fī 'l-qibla*, pp. 185-190, titles added by the editors) deal with the *qibla* and Djebbar and Aballagh consider them to be authentic works by Ibn al-Bannā'. Both are extant in a second manuscript of the Ṣabīḥiyya Library in Salé. They both express the concern of the contemporaries of the Moroccan mathematician with the problem posed by the different orientations of mosques (see M. Rius, *La alquibla en al-Andalus y al-Magrib al-Aqṣà*. Barcelona, 2000). Ibn al-Bannā's attitude is to appease the consciences of good Muslims stating that all of them have a correct orientation and that it is not licit to change it, for all of them have been established with due intellectual effort (*ijtihād*). To establish the precise value of the *samt al-qibla* one needs to use Menelaos' theorem (*al-shakl al-qaṭṭā'*) or an instrument serving the same purpose (*aw mā yaqūmu maqāma-hu min al-ālāt*) and a procedure based on the knowledge of the latitudes of two places as well as the difference in their geographical longitudes: Ibn al-Bannā' does not think that the longitudes mentioned in astronomical tables (*azyāj*) are reliable, due to the different values quoted in the sources. Therefore he does not seem to consider it necessary to use a mathematical method or the standard methods of folk- astronomy to establish the *qibla* and this for two reasons: 1) the results obtained are not necessarily precise, and 2) the knowledge required cannot be demanded from a lay Muslim. The conclusion is that one should follow the direction of the *miḥrāb* of the mosque without further complications.

To end with these remarks: this is an excellent book (with good indexes of authors, works and manuscript copyists in pp. 209-223) which gives an enormous amount of information about what has been done and what remains to be done on the mathematical and astronomical works of Ibn al-Bannā'. It definitely deserves a translation into any Western language, because historians of science who are not necessarily Arabists should be aware of the importance of this Moroccan mathematician.

Julio Samsó

Ihsanoğlu, Ekmeleddin (Ed.): *Osmanli Astronomi Literatürü Tarihi, OALT (History of Astronomy Literature during the Ottoman Period)*. 2 volumes. Istanbul: Islam Tarih, Sanat ve Kültür Arastirma Merkezi (Research Centre for Islamic History, Art, and Culture, IRCICA), 1997. CCIII + 1146 pp.

Ihsanoğlu, Ekmeleddin (Ed.): *Osmanli Matematik Literatürü Tarihi, OMLT (History of Mathematical Literature during the Ottoman Period)*. 2 volumes. Istanbul: Islam Tarih, Sanat ve Kültür Arastirma Merkezi (Research Centre for Islamic History, Art, and Culture, IRCICA), 1999. CXII + 720 pp.

Ihsanoğlu, Ekmeleddin (Ed.): *Osmanli Coğrafya Literatürü Tarihi, OCLT (History of Geographical Literature during the Ottoman Period)*. 2 volumes. Istanbul: Islam Tarih, Sanat ve Kültür Arastirma Merkezi (Research Centre for Islamic History, Art, and Culture, IRCICA), 2000. LXXXIX + 912 pp.

These three studies, each comprising two volumes, are the result of the project launched by IRCICA in 1986 to prepare an inventory of Ottoman scientific literature, both handwritten and printed, which would provide a comprehensive idea of the knowledge of science during this period. Syria, Egypt, and the Maghrib —which belonged to the Ottoman state from the fifteenth century onwards— are included in the studies.

The goal of this project is not to present a full account of the history of the different sciences in the Ottoman period, but to provide access for scholars to the multitude of sources preserved in libraries not only in

Turkey but throughout the world.

The studies follow the tradition of previous reference books such as Suter (1900), Sarton (1927-48), Storey (1927), Brockelmann (1937-49), King (1981-1987), Sezgin (1978-2000) and others.

The entire text is in Turkish, except for a brief foreword in English. However, the main subject headings are in English or in both English and Arabic, which, together with the good organization of the items, makes that the books can be consulted by readers not proficient in Turkish.

The items are arranged in chronological order, according to the death of the author. The authors whose life periods are unknown are placed at the end, followed by anonymous works. The headings start with the order number, followed by the name of the author and the date of death. Where available, biographies and scholarly careers of each author are provided. The works of the author appear in alphabetical order. The title of each work is written in Latin and Arabic characters, and the language of the work (Arabic, Turkish or Persian) is indicated. Each entry includes information about the work: its incipit; the number of copies with codicological details such as the name of the collection, the call number of the manuscript, number of folios, lines, size, and date of copying, in case of manuscripts, as well as whether the book was printed or not. The colophon is also included if it is available. A related bibliography is given by the authors of the survey at the end of each item.

The first volume of each study starts with a general survey of the topic, followed by a number of tables (presenting summaries and statistics, for example) and a list of the collections where the works are kept.

The second volume ends with an exhaustive bibliography of reference works, a list of manuscript catalogs ordered by countries and very useful indexes on a range of subjects such as catalogs, persons' names, place names, book titles in Latin and Arabic characters, institutions, places and institutions mentioned in the colophons, copyists and copy owners.

The OALT is the first study in the series, and its purpose was to give a compact presentation of Ottoman astronomical literature. It includes authors who were permanent residents of the Ottoman state or who spent part of their lives in the Ottoman lands between approximately 1417 and 1962.

The study comprises CCIII + 1146 pages, in two volumes. The first volume has a wide-ranging introduction divided into two sections. The first section (pp. XL-XCVIII) gives information on scientific life in Anatolia during the pre-Ottoman Seljuk period. The second section (pp. IC-CCIII) is devoted to the astronomical activities during the Ottoman period, and institutions such as the Istanbul observatory, directed by Taqī al-Dīn (1525-1585) under the patronage of sultan Murād III (1574-1595), and destroyed in 1580.

The first part of the study (pp. 1-735) gives information about the authors (582 in total) arranged in chronological order, and their works. A supplement offers information about the authors who lived in periods unknown to the editors. A separate section (pp. 736-940) contains a long list of anonymous works classified alphabetically according to subject, dealing with general astronomy, instruments, astronomical tables and calendars.

The book gives an idea about the subjects of interest of the Ottoman astronomers: treatises on astronomical instruments (astrolabe, quadrants, and Andalusī universal instruments and related quadrants); planetary models and cosmology (*hay'a*); *zīj*es or astronomical tables; almanacs of ephemerides and texts applied to mathematical astrology (casting of houses, projecting of rays, observation of comets and eclipses); and material on timekeeping (*qibla*, time of prayers, visibility of the Moon).

The OMLT is the second study in the series and it was published to coincide with the 700th anniversary of the foundation of the Ottoman Empire.

The study comprises CXII+720 pages +13

reproductions of pages of manuscripts and printed pages of mathematical texts, in two volumes.

The first volume contains an introduction in Turkish dealing with the characteristics of mathematical literature in the Ottoman period. The work does not claim to cover the history of Ottoman mathematics exhaustively, but it is a good starting point. The main objective is to give a compact presentation of Ottoman mathematical literature, bringing to light the available material preserved in libraries in Turkey and elsewhere. The work includes authors who were permanent residents of the Ottoman state or who spent part of their lives in the Ottoman lands between approximately 1417 and 1965. The study focuses on 491 mathematicians who lived between the 15th and the 20th centuries. The earliest author included is Qāḍī Zāde Rūmī. Authors such as Ibn al-Hā'im, Ibn al-Bannā', Ibn al-Yasāmīn are mentioned in some mathematical works produced in this period. As in the OALT, the first part of the study (pp. 1-559) is devoted to authors, arranged in chronological order. Pages 560-567 give information on authors whose life periods are unknown, and pages 588-611 include works whose authors are unknown, classified in alphabetical order.

The areas of interest of the Ottoman mathematicians range widely. Together with works on *ḥisāb* (arithmetics), *handasa* (geometry), *jabr* (algebra), *muthallathāt* (trigonometry) we find works on weights and measures, or on *feraiz* (*fara'iḍ*, inheritance dividends). There are comments on the contents of each work. In all, 1116 mathematical works are mentioned.

As for the languages used, we find works in Turkish (561), Arabic (524), Persian (8), French (14), French-Turkish (2), French-Arabic (2), Arabic-Turkish (2), English (1), and two more in an unidentified language. Arabic is by far the most frequent until the end of the 17th century, when the works of al-Bīrūnī, for instance were still the object of explanations, as is the case with Muṣṭafā Ṣidkī (d. 1769) who writes on the construction of the regular heptagon, on algebra (and *muqābala*), etc., following al-Bīrūnī.

In the 18th century, the use of Turkish as the language of mathematics became more and more frequent. Gelenbevi (d. 1790), for instance, wrote in Turkish on trigonometry, algebra and logarithms, and other subjects.

Indeed, one can identify two periods: a first period until the 16th Century which sees the culmination of the Islamic scientific tradition and a second period which sees the first steps towards the learning and introduction of European mathematical sciences.

The OCLT, is the third study in this series and deals with several subjects: geography, cosmography, cartography, travel reports and topography.

The whole study comprises LXXXIX + 912 pp. + figures in two volumes. The first volume comprises the corresponding foreword, the list of contents, introduction, tables and collections as well as the beginning of the entries from number 1 (800H/1398AD) to number 289 (1326H/1908AD), and ends with several pages of illustrations. The second volume comprises entries from number 290 (1327H/1909AD) to 407 (1967AD), plus numbers 408 to 441 (undated). After this there are three more sections: one on anonymous works, another on atlases and the last one on charts and sketches. This second volume ends with the bibliography, indexes and illustrations, which, as in the first volume, are mainly cartographical.

The two volumes include the authors who produced geographical works as well as the anonymous works on this subject written in the Ottoman Empire during the Ottoman period: in total, 1628 works including writings and cartography. It is however a pity that such a comprehensive study cannot include information about most of the maps kept at the Topkapi Palace. When the information for the OCLT was being collected, the Museum was preparing a catalog of their maps, and therefore, the editors had to rely on other sources and, consequently, the information is not complete.

Apart from this, the account is impressive. The exhaustive treatment of the items together with the accompanying bibliography and indexes make this survey extremely useful for anyone interested not only in Ottoman geography but in related areas as well.

This enormous work is an excellent series of reference books which identify the sources to be explored in an assessment of the Ottoman contribution to almost five centuries of history of science.

We eagerly await the next survey, which will deal with natural sciences and promises to be as interesting as the ones reviewed here.

Emilia Calvo
Mercè Comes
Roser Puig