Theodosius, Sphaerica*: Arabic and Medieval Latin Translations* edited by Paul Kunitzsch and Richard Lorch

Boethius 62. Stuttgart: Franz Steiner Verlag, 2010. Pp. x + 431. ISBN 978–3–515–09288–3. Cloth € 64.00

Reviewed by
Sonja Brentjes
University of Seville
brentjes@us.es

Theodosius lived probably during the first, maybe also the second, century BC in Bithynia, a region which belongs today to Turkey at the northwestern coast of the Aegean. According to Vitruvius, he was known for having built a universal sundial. Strabo lists him among the famous men of Bithynia. Three works on geometry and astronomy by Theodosius are extant today in various languages: *Sphaerica*, *De habitationibus*, and *De diebus et noctibus*. *De habitationibus*, soon to be published too by Kunitzsch and Lorch, discusses the phenomena caused by the heavenly revolutions as seen in a geocentric model of the universe. It explains which parts of the world the inhabitants of different zones can see. *De diebus et noctibus* deals with the different lengths of days and nights in the course of a year and explains their variations and other related phenomena. *Sphaerica*, the most important of Theodosius' three treatises, is about the geometry of the sphere. It consists of three books with 60 propositions (23 in books 1 and 2 each, 14 in book 3) preceded by a small number of definitions. Earlier texts on this subject were written by Autolycus of Pitane (*ca* 310 BC) and Euclid; a later and the most sophisticated ancient text (lost in Greek but extant in Arabic, Latin, and Hebrew translations) is Menelaus of Alexandria's *Spherics* (first/second centuries AD).

Theodosius' work is of historical significance for its depiction of the knowledge of spherical geometry in his period and for the manner in which it is presented. It shares its structural set up and type of proofs with Autolycus' two works. All three treatises reflect an approach closely related to Euclid's *Elements*. The similarities between the *Spherics* and the *Elements* go beyond this methodological aspect. Book 1 and book 2.1–10 of the *Spherics* appear to be a translation

ISSN 1549–4497 (ONLINE) ISSN 1549–4470 (PRINT) ISSN 1549–4489 (CD-ROM)
Aestimatio 9 (2012) 119–123

of book 3 of the *Elements* from the circle to the sphere. Given the dearth of either direct or indirect early testimonies for the Euclidean *Elements*, this aspect of Theodosius' *Spherics* is very valuable. Moreover, since books other than the Euclidean *Elements* seem to have existed in the times of Autolycus and Theodosius, these similarities may inspire some future researcher to investigate in greater detail the traces of earlier works that these extant texts possibly contain.

Books 2.11–23 and 3 of the *Sphaerica* deal in purely geometrical form with matters of relevance to astronomy. This aspect explains why the *Sphaerica* became a sought after work when astronomy, astrology, and their mathematical foundations were taught in Late Antiquity, Islamic societies, medieval Jewish communities, and universities in various Catholic states of Europe. It found its stable position in a canonical set of textbooks which taught plane, solid and spherical geometry, planetary models, and the calculation of stellar positions. These textbooks were called in Antiquity the *Little Astronomy*, in Islamic societies the *Middle Books*. They were meant to be studied after Euclid's *Elements* and before Ptolemy's *Almagest*.

Other aspects of historical importance concern theorems that the *Sphaerica* shares with Autolycus' and Euclid's earlier texts and methods that are found only in later works. Although the positions of historians of ancient astronomy differ in regard to the interpretation of the relationship between Theodosius and his two predecessors, the possibility of using this textual overlapping as a point of departure for reflection on the preceding stages of spherical geometry should not be denied outright. The methods that Theodosius teaches only allow one to prove that some arc is greater than another one. In a few cases, he also determines ratios between arcs and compares them to ratios between line segments. These methods do not suffice however to solve practical astronomical problems such as finding the nightly hours from stellar positions. For the calculation of such quantities trigonometric methods are needed, and they seem to have been introduced shortly after Theodosius by Hipparchus (*ca* 190–120 BC). Hipparchus, apparently, was the first ancient astronomer to calculate a table of chords. On this basis, ratios between spherical arcs could be calculated. Thus, distances on the heavenly sphere could be determined quantitatively.

Theodosius' works are not only related to Euclid, Autolycus, Hipparchus, and Menelaus. They were also used in neighboring genres of astronomical literature such as the writings that included depictions of star constellations or provided surveys of astronomy, for instance in Geminus' *Introduction to the Phaenomena*.

The integration of Theodosius' three treatises into the corpus of textbooks for students of geometry and astronomy secured their survival for more than one and a half millennia. The number of Arabic, Latin, and Hebrew copies produced until the modern period testifies to their importance for classes taught at *madrasa* or universities and by private tutors. Kunitzsch's and Lorch's decision to edit one of the two Arabic translations and the shorter of the two versions that circulated since the 12th century in Latin is very welcome. Their work complements Claire Czinczenheim's edition of the Greek text [2000]. They provide an important basis for the study of these intermediary textbooks and their respective philological, codicological, textual, and class room properties.

The Arabic transmission of Theodosius' *Sphaerica* comprises two translations and three redactions. Kunitzsch and Lorch edit the anonymous translation represented by three manuscripts (Istanbul, Topkap, Ahmet III 3464, ff. 20v–53v; Lahore, private library M. Nabi Khan, pp. 185–281; Paris, BnF, hebr. 1101, ff. 1–53r, 86r–87r) [3-4]. The last one, as can be surmised from the *siglum*, is Arabic in Hebrew characters. The second copy describes its text at the end as having been revised by Thabit b. Qurra (died 901) but at the beginning of book 2 as his translation [2]. Its colophon claims also a relationship to a direct descendant of Thabit b. Qurra; it states that this earlier copy was transcribed in the Nizamiya Madrasa of Mosul in 554 h/1158 and that a century earlier (421 h/1030) some al-Hasan b. Sa'id had corrected the diagrams by collating his unreliable copy with a second manuscript [4].

The other translation into Arabic is ascribed once to Qusta b. Luqa and once, in all likelihood falsely so, to Hunayn b. Ishaq [2]. As usual with such ascriptions, things get more difficult over time. In the redaction of Theodosius' text that Nasir al-Din Tusi (1202–1274) completed in 1253, he claimed that Qusta b. Luqa translated the Greek text until proposition 3.5. Then, somebody else finished the work and Thabit b. Qurra revised it [2]. The two other redactions were made by Ibn Abi [al-]Shukr al-Maghribi (died between 1281 and 1291) and Taqi al-Din b. Ma'ruf (died 1585) [1].

Kunitzsch and Lorch did not pursue the issue of who translated and revised which parts of the extant Arabic texts. Their primary goal was to establish a critical edition of the anonymous Arabic version and its Latin parallel, and to explain the mathematical content of the Arabic text as well as particular features of the copies [7]. They established the Arabic text by collating the first two of three available manuscripts and comparing doubtful readings with the edited Greek text [6]. The diagrams of the Arabic text also underwent editorial procedures described and discussed by the two authors in detail in their notes on the diagrams [328–341]. The Latin text that they publish is a transcription of the oldest extant copy of the text (*ca* 1200) found in MS Paris, BnF, lat. 9335, ff. 12–19v corrected in the process of collation with 10 further manuscripts from the 13th and 14th centuries [5–6]. They identify it as a clear translation of the version of the three Arabic manuscripts mentioned above [5]. Due to its terminology and further linguistic characteristics as well as the inclusion of the *Sphaerica* among Gerard of Cremona's translations by his disciples, they identify this text as Gerard's work [5]. In their brief general remarks [7], Kunitzsch and Lorch direct the reader's attention to the fact that the Arabic and Latin texts contain extra material in book 1, definitions and early theorems not found in Czinczenheim's Greek edition [2000]. The established texts in the two languages are placed side by side in the book, which is of great advantage to the reader interested in comparing the translation practices.

The edition is followed by notes on the Arabic text in the second manuscript mentioned above by al-Hasan b. Sa'id, together with an English translation [313–315], several lemmas to 3.11 in the first and the third of the three extant Arabic copies, together with the Latin translation of the second lemma and two Latin notes on 2.dem.11. The mathematical summary [343–427] offers the reader who does not understand Arabic a translation of the definitions and enunciations of all propositions plus, for any reader who does not wish to do the labor herself, a summary of the main points of the proofs.

The editions, translations, and summary are carefully executed. They provide the interested researcher with a valuable text for further investigations. The two editors are to be congratulated for another fine result of their long years of cooperation.

BIBLIOGRAPHY

Czinczenheim, C. 2000. *Édition, traduction et commentaire des* Sphériques *de Théodose.* PhD dissertation, University of Paris 4 (Sorbonne). Paris.