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Theodosius, *De diebus et noctibus*

Paul Kunitzsch and Richard Lorch

Key Words: day (*yawm*; *nahār*), ecliptic, equator, hemisphere (visible and invisible), horizon, meridian line, night, Qusṭā b. Lūqā, spherical astronomy (before Ptolemy), Sun (position of), tropics (summer and winter), Theodosius of Bithynia.

Abstract

Theodosius' *De diebus et noctibus* was one of several texts of pre-Ptolemaic spherical astronomy. Like many other scientific texts it was translated from Greek into Arabic in the ninth century. Qusṭā b. Lūqā was possibly the translator. In two "books" comprising altogether 33 propositions, it describes the lengths of days and nights according to the various positions of the Sun on the ecliptic with respect to the tropics. In this paper the full text of three propositions (I 1, II 20 and 21) alone is given; of the other propositions only the "enunciations" are here edited. The Arabic text is followed by an English translation with comments.

Introduction

The three extant works of Theodosius of Bithynia (fl. 100 BC)¹ are the *Sphaerica*, the *De habitationibus* and the *De diebus et noctibus*. Together with Euclid's *Phaenomena* and Autolycus' *De sphaera quae movetur* and *De ortibus et occasibus*, they belong to a group of texts that present Greek spherical astronomy. These and other texts are

¹On Theodosius, see Fecht 1-11; Ziegler coll. 1930-1932.

usually considered to form a loose collection of works called the “little astronomy” (μικρὸς ἀστρονομούμενος), in contrast to Ptolemy’s “Great Collection” (in Arabic later called *Almagest*)². The *De diebus et noctibus* is about the lengths of days and nights when the Sun is at various parts of the ecliptic³.

These three works by Theodosius have all been edited in Greek: the *Sphaerica* by Heiberg (1927) and recently by Claire Czinzenheim (2000) and the *De habitationibus* and *De diebus* by R. Fecht (1927)⁴. Further, all three works were translated into Arabic, perhaps in the ninth century. And of these the first two, *Sphaerica* and *De habitationibus*, were translated from Arabic into Latin by Gerard of Cremona in the twelfth century. The Arabic and Latin versions of *Sphaerica* have been edited by Kunitzsch – Lorch 2010, and the *De habitationibus* by Kunitzsch – Lorch 2011. As for *De diebus*, which was not translated into Latin in the Middle Ages⁵, it was planned to edit its Arabic version. Due to circumstances and lack of time, we had to shorten the project. So we here edit only three of the thirty-three propositions of the text completely, i.e. with the mathematical proofs, whereas of the other propositions only the enunciations are here presented, so that the reader can see which problem is treated in each proposition. In this way he can gain an impression of the contents of the whole book.

Fecht edited the Greek text from only four manuscripts, the oldest of which MS Vat. gr. 204 of the 10th century. In her edition of *Sphaerica* Czinzenheim collated and fully described 23 Greek manuscripts, of which 15 also contain *De habitationibus* and *De diebus*, among them the four manuscripts used by Fecht. Several more manuscripts of these two texts are listed in the data-base *Pinakes: Textes et*

²Cf. Ziegler col. 1932; Bulmer-Thomas 320a; Kunitzsch – Lorch 2011, 7.

³For the contents of the work, see Heath 1921, II 246.

⁴For some information on Fecht, see Kunitzsch – Lorch 2011, 8f.

⁵An outline of *De diebus* was included by Dasypodius (Konrad Rauchfuß, 1530/32 – 1600/01) in his Latin work *Sphaericae doctrinae propositiones*, Strasbourg 1572 (cf. Sarton I 211; for Dasypodius, see Verdonk). In 1591 G. Auria (d. 1615) published in Rome an annotated Latin translation “(libri duo) nunc primum de Graeca in Latinam conversi” (this quotation is copied from the titlepage of the book, reproduced on the internet). On the defects of Auria’s translation, see Fecht 12.

manuscripts grecs, issued by the Institut de recherche et d'histoire des textes, Paris⁶.

The Arabic version of *De diebus* differs from the version of *De habitationibus* in so far as, while the Arabic text of *De habitationibus* follows the wording of the Greek text very closely, also in the use of the diagrams and the diagram letters, in *De diebus* only the text of the enunciations follows the Greek closely, but the text of the mathematical proofs, the forms of the diagrams and the use of the diagram letters are mostly quite different from the Greek text (with very few exceptions, which will be mentioned in the footnotes to the English translation). In order to be quite sure of the authenticity of Fecht's Greek edition, we ordered and inspected a copy of MS Vat. gr. 204 on CD from the Vatican Library and compared it with Fecht's edition of 1927. We found that Fecht rendered everything – text, diagrams and diagram letters⁷ – exactly as it appears in MS 204⁸. Therefore it seems that the difference between the text of the mathematical proofs in the Arabic version and Fecht's text either is derived from some variant of the Greek text or is due to some Arabic revision of a translation closer to Fecht's Greek text. We may note that some diagrams – e.g. that of the very first proposition – show a difference in Greek and Arabic that cannot have come about by simply copying without reference to the text. Another difference between the Greek and Arabic versions of *De diebus* is manifest in the numbering of the propositions in the two texts:

	Arabic	Greek
Book I		
Def.	(3)	(5 – two are absent in Arabic)
Prop.	1	1
	2	2 (+ Porisma, Fecht 68,8–18)

⁶Cf. Kunitzsch – Lorch 2011, 9 n. 11. We are grateful to Menso Folkerts for searching this data-base.

⁷Also Fecht's doubtful letters ,A and ,B (cf. Kunitzsch – Lorch 2011, 12f.) truly render what is in MS 204.

⁸Our doubts about the authenticity of Fecht's edition expressed in Kunitzsch – Lorch 2011, 9 and 12f. are now disposed of. Neugebauer's strictures (p. 752) on Fecht's treatment of the diagram of II 13 were based on the comparison of Fecht's edition with MS Vat. gr. 191 (13c.), which we do not have at hand.

	3	3 (+ Lemma 4, 72,25–74,5)
	4	4 (+ Porisma 80,19–82,8)
	5	5
	6	7
	7	6
	8	8
	9	10
	10	9
	11	11
	12	12
Book II Prop.	1	1
	2	2
	3	3
	4	4 (<i>Assumptæ</i> 1–4, 108,32–114,4, not in Arabic)
	5	5
	6	6
	7	7
	8	8

Arabic Prop. 9 begins with “quasi lemma” (120,3–15) and enunciation of 9 (120,17–18). The text of Prop. 9 itself is a mixture of 120,19ff. and the lemma 122,19 – 124,7.

There is no clear correspondence between Arabic Props. 10, 12 and 13 and the Greek.

11	11 (cf. notes 25 and 26 to the English translation)
14	13
15	14
16	(cf. note 29 to the English translation)
17	15
18	16
19	17
20	18
21	19

The text of the Arabic translation edited below appears in two manuscripts⁹:

A: Istanbul, Seray, Ahmet III 3464, ff. 124v–151v. The text is here written in three different hands: 124v–133v in the hand that has written most of the texts in the codex (ca. 1228 AD); a second hand on 134r–149v; the third hand on 150r–151v. The third hand gives a date in the colophon: *salkh shahr al-ḥarām Rajab sanat thalāthīn wa-sittimī'a hijrīya* (about 12 May 1233)¹⁰.

K: Private library (formerly in the possession of H. P. Kraus), ff. 135v–157r¹¹. According to a notice on the fly-leaf, the manuscript is in the hand of the famous North-African astronomer Abū 'Alī al-Marrākushī, who was active in Egypt in the late 13th century. Characteristics of the writing suggest that the annotator is right¹².

As it appears, the translator of *De diebus* into Arabic was Qusṭā ibn Lūqā (d. ca. 300H/912-13 AD). His name is mentioned as translator in **A** at the beginning of the text (124v) and in **K** at the beginning and end of Book I (135v and 145r) and at the beginning of Book II (145v). Neither the bio-bibliographers¹³ nor al-Ṭūsī in his *taḥrīr* of *De diebus* mention the name of a translator¹⁴.

The Arabic text below is followed by an English translation with comments in the footnotes. For the diagram letters we there use the letters introduced by Gerard of Cremona in his Latin translations of *Sphaerica* and *De habitationibus*¹⁵. As said above, we only edit

⁹A third manuscript of interest here (Lahore, private library of M. Nabī Khān) contains on pp. 185–294 the Arabic versions of *Sphaerica* and *De habitationibus* (cf. Kunitzsch – Lorch 2010, 3f.; Kunitzsch – Lorch 2011, 10). The late Dr. Anton Heinen very kindly gave us paper copies of these pages for our edition of the two texts. It might be that the codex, on analogy with other *majmū'as* of the kind, also contains the text of *De diebus*. Unfortunately, we no longer have access to this library and therefore cannot ascertain that.

¹⁰For a detailed list of the 17 items contained in the manuscript, cf. Lorch 2001, 22–23

¹¹For a detailed list of contents of the manuscript, see Lorch 2001, 28.

¹²Cf. Kunitzsch – Lorch 2011, 10f.

¹³Ibn al-Nadīm 269,5–7; Ibn al-Qiftī 108,1–5 and 11–14.

¹⁴Al-Ṭūsī 1358, last text in the volume, p. 2; al-Ṭūsī 1383, p. 147.

¹⁵Cf. Kunitzsch – Lorch 2010, 8; Kunitzsch – Lorch 2011, 13.

the full text of I 1 and II 20–21. Therefore in the following table we show only the letters occurring in these three propositions. In some propositions, e.g. Fecht's II 10, 11, 13 and 14, there occur letters or symbols beyond Ω (cf. the tables of identities cited in footnote 15), which, however, do not appear in the three propositions edited here in full. Because, as said above, in the Arabic version of *De diebus* the forms of the diagrams and the use of their letters are mostly different from those in the Greek, we do not give in the following table Greek-Arabic equivalents of the diagram letters. Here follows the table:

Arabic	English
--------	---------

ا	A
ب	B
ج	G
د	D
ه	E
ز	Z
ح	H
ط	T
ك	K
ل	L
م	M
ن	N
س	S
ع	Q
ف	F