A previously unnoticed appendix in the Iṣlāḥ al-Majisṭī *by Jābir ibn Aflaḥ*

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Abstract: An examination of the preserved Arabic copies of the *Islāḥ al-Majisṭī* (12th century AD) has revealed an unnoticed before appendix preserved in MS Escorial ár. 930. The appendix contains in Arabic a portion of a larger passage which was known from (presumably) Gerard of Cremona's Latin translation of the *Iṣlāḥ al-Majisṭī* but which had not been found in Arabic copies of the work. The passage pertains to Book VI of the *Iṣlāḥ al-Majisṭī*, on the fixed stars, and relates particularly to the Milky Way, the Solid Globe and the configurations of the fixed stars. In this article the chapters preserved in the appendix will be located in the context of Book VI of the *Iṣlāḥ*. It is further examined how far the newly found appendix helps to determine whether the passage known from the Latin formed an original part of Jābir ibn Aflaḥ's work or was supplemented later, in particular based on the Arabic translations of the *Almagest* that were available in twelfth-century al-Andalus.[1]

Keywords: Jābir ibn Aflaḥ, *Iṣlāḥ al-Majisṭī* (*Corrections of the Almagest*), Fixed Stars, Gerard of Cremona, Arabic and Latin translations.

1. I refer here to the Arabic translation made by al-Ḥajjāj ibn Yūsuf ibn Maṭar (completed ca. 827/828 AD in Baghdad) and the other, by Isḥāq b. Ḥunayn emended by Thābit b. Qurra (ca. 892 AD). A third Arabic version, by Thābit b. Qurra alone, which was recently identified by Dirk Grupe, seems to have had only little influence in the West; see: D. Grupe, *The Latin Reception of Arabic Astronomy and Cosmology in Mid-Twelfth-Century Antioch: The Liber Mamonis and the Dresden Almagest,* PhD dissertation, University of London, The Warburg Institute, 2013, and, by the same author, "The `Thābit Version' of Ptolemy's *Almagest* in MS Dresden Db. 87", in *Suhayl*, vol. 11, 2012, pp. 147-153.

Richard Lorch established that Jābir himself used the versions of Ḥajjāj and Isḥāq/Thābit alternatively to fill extensive parts in the *Iṣlāḥ*. See R.P. Lorch, "The Astronomy of Jābir ibn Aflaḥ", in *Centaurus* 19 (1975), pp. 85-107, esp. p. 91, reprinted in R.P. Lorch, *Arabic Mathematical Sciences: Instruments, Text, Transmission*, VI, Aldershot: Variorum, 1995.

* I want to express my gratitude to Dirk Grupe for his suggestions concerning this article and for proofreading the Latin passages.

1. Introduction

The so-called *Iṣlāḥ al-Majisṭī* [2] (*Corrections of / Emendations to the Almagest*), written by the twelfth-century Andalusian mathematician and astronomer Jābir ibn Aflaḥ al-Ishbīlī, is important, among other reasons, because it provides a rare example of critiques of Ptolemy's *Almagest* written in the Islamic West. It is also the only work by Jābir b. Aflaḥ that is preserved in Arabic and in its Latin and Hebrew translations. The introduction of the *Iṣlāḥ al-Majisṭī* contains a list of fifteen critiques to the *Almagest*, but more such critiques are found in the work itself.[3] The text is divided into nine books which encompass the topics of the thirteen books of the *Almagest;* a general introduction to trigonometry, philosophy and spherical astronomy, a discussion of the Sun, the Moon, the observational instrument, the fixed stars (the subject of Book VI, to which the newly found appendix relates), the planetary spheres, stations and retrogradations, the planetary latitudes and heliacal risings and settings.

In modern studies of the work it has often been assumed that Jābir's interest in re-writing and simplifying the *Almagest* was purely mathematical.[4] It has fur-

2. This title, which appears in a manuscript in Berlin, was established as standard title by Lorch (1975), p. 88. However, the work is entitled differently in other manuscripts (see below, section 2), and also in the old sources it is not referred to in a consistent way; Ibn al-Qifṭī cites the work as *Iṣlāḥ Hay'at* (*sic*) and *Istikmāl fī al-Hay'at*, in the latter case also mentioning a correction of the text by Maimonides; Ibn al-Qifṭī, *Ta'rīkh al-ḥukamā'*, ed. A. Müller and J. Lippert, Leipzig, 1903, pp. 319 and 393. The work is referred to as *Sharḥ al-Majisṭī* in Ḥājjī Khalīfa, *Kashf al-ẓunnūn 'an asāmī al-kutub wa-l-funūn*, 3 vols., Tehran, 1967 (3rd ed.), esp. vol. 2, col. 1595.

3. J. Bellver, "El lugar del *Iṣlāḥ al-Maŷisṭī* de Ŷābir b. Aflaḥ en la llamada *Rebelión andalusí* contra la astronomía ptolemaica" in *al-Qanṭara* 30 (2009), pp. 83-136, esp. pp. 103-105.

4. Important studies on the *Iṣlāḥ* were made by Richard Lorch, who in 1971 completed his PhD dissertation entitled *Jābir ibn Aflaḥ and his Influence in the West* and since then published various articles on the subject: "Jābir ibn Aflaḥ" in *D.S.B.*, vol. 7, New York, 1973, pp. 37-39; "The Astronomical Instruments of Jābir ibn Aflaḥ and the *Torquetum*" in *Centaurus* 2 (1976), pp. 11-34, reprinted in R.P. Lorch, *Arabic Mathematical Sciences: Instruments, Text, Transmission*, XVI, Aldershot: Variorum, 1995. Further publications were made by N.M. Swerdlow, "Jābir ibn Aflaḥ's Interesting Method for Finding the Eccentricities and Direction of the Apsidal Line of a Superior Planet" in G. Saliba and D.A. King (eds.), *From Deferent to Equant: A Volume of Studies on the History of Science of the Ancient and Medieval Near East in Honor of E. S. Kennedy*, Annals of the New York Academy of Sciences, vol. 500, 1987, pp. 501-512. H. Hugonnard-Roche, "La théorie astronomique selon Jabir ibn Aflah" in *History of Oriental Astronomy* (*IAU Colloquium*

ther been known that one of the most important differences between the Arabic text and the Latin translation of Book VI is to be found in the descriptions of the Milky Way and of the Solid Globe, which are included in the Latin, but which are not found in the Arabic sources, including the Hebrew-Arabic MSS. The absence of such non-mathematical topics in the Arabic text would correspond to Jābir's focus on mathematical questions. This, in turn, would suggest that the additional parts in the Latin tradition are not original to Jābir's work, but were added later. However, as will be seen, the difference between the versions is larger than that. Moreover, the newly found appendix in the Arabic MS Escorial, ár. 930 proves that large parts of the passage were also transmitted in Arabic. At the same time the inclusion of these parts in the form of an appendix makes the situation more complex. That complexity is reflected also by the Hebrew translations of the *Iṣlāḥ al-Majisṭī*.

2. Preserved Arabic manuscripts[5]

Today, seven copies of the *Iṣlāḥ al-Majisṭī* are known, three of which are written in Hebrew-Arabic.

(a) Manuscripts written in Arabic:

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91), Cambridge, 1987, pp. 207-208; J. Samsó, "Ibn al-Haytham and Jābir b. Aflaḥ's criticism of Ptolemy's determination of the parameters of Mercury" in *Suhayl* 2 (2001), pp. 199-225, reprinted in J. Samsó, *Astronomy and Astrology in al-Andalus and the Maghrib,* VII, Aldershot: Variorum, 2007. Recent studies on the subject were made by J. Bellver, "Jābir b. Aflah on the four-eclipse method for finding the lunar period in anomaly" in *Suhayl* 6 (2006), pp. 159-248; *Críticas a Ptolomeo en el s. XII: El caso del Iṣlāḥ al-Majisṭī de Jābir b. Aflaḥ,* unpublished PhD dissertation, Universitat de Barcelona, 2007; "Ŷābir b. Aflaḥ en torno a la inclinación de los eclipses en el horizonte" in *Archives Internationales d´ Histoire des Sciences,* vol. 57, nº 158 (2007), pp. 3-23; "Jābir b. Aflaḥ on lunar eclipses" in *Suhayl* 8 (2008), pp. 47-91; "On Jābir b. Aflaḥ's Criticisms of Ptolemy's Almagest" in E. Calvo, M. Comes, R. Puig and M. Rius (eds.), *A Shared Legacy - Islamic Science East and West,* Barcelona, 2008, pp. 181-189; "Ŷābir b. Aflaḥ on the Lunar Eccentricity and Prosneusis at Syzygies" in *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften* 18 (2008/09), pp. 213-239.

5. See the list in R.P. Lorch, "Appendix 1 to item VI: The Manuscripts of Jābir's Treatise" in Lorch (1995), VII, pp. 1-2. The present list includes further references to the relevant printed catalogues and some additional observations.

(1) Berlin, SPBK, Lbg. 132 [116 fols.].[6] The colophon, on f. 116v, is dated 10 Rabī‘ I 626 AH (5 February 1229 AD) in Damascus. A seal belonging to Ḥājj Muṣṭafā Ṣidqī (d. 1183/1769-70) might indicate an Ottoman provenance.[7] The title is clearly added by a later hand: اصلاح المجسطي لجابر بن افلح

(2) Escorial árabe 930 [150 fols.].[8] The undated manuscript has been estimated to stem from around the 14th century AD. The title, as written by the copyist on the title page, reads:[9]

النسخة الكبرى من كتاب الشيخ ابي محمد جابر بن افلح الإشبيلي

(3) Escorial 910 [120 fols.].[10] The script of the undated manuscript has been estimated to be a fourteenth-century Maghrebian handwriting.[11] The title is:

كتاب الهية [كذا] لابي محمد جابر بن افلح الاشبيلي وهو تلخيص كتاب المجسطي وهي
النسخة المجزقة [i.e. the well-versed copy]

6. W. Ahlwardt, *Verzeichnis der arabischen Handschriften der Königlichen Bibliothek zu Berlin,* vols. 1-10, Berlin, 1887-99, esp. vol. 5 (1898), p. 141.

7. The inscription of the seal is من متملكات الفقير الحاج مصطفى صدقي غفر له ; see F. Déroche, *Islamic Codicology: An Introduction to the Study of Manuscripts in Arabic Script,* translated into English by Deke Dusinberre and David Radzinowicz, edited by Muhammad Isa Waley, London: Al-Furqān Islamic Heritage Foundation, 2006, p. 341, Fig. 133.

8. H. Derenbourg, H. P. J. Renaud and E. Lévi-Provençal, *Les manuscrits arabes de l´Escurial,* 3 vols, Part II/Fasc 3: Sciences exactes et sciences occultes, Paris, 1941, p. 39; M. Casiri, *Biblioteca Arabico-Hispana Escurialensis sive Librorum omnium Mss. Arabicè ab auctoribus magnam partem Arabo-Hispanis compositos Biblioteca Coenobii Escurialensis complectitur, recensio & explanatio,* 2 vols, Madrid, 1760-1770, reprinted Osnabrück, 1969.

9. A large part of the title page is occupied by a star table of 30 stars. The table gives the mediation (درجة التوسط), *m,* and the declination (البعد عن معدل النهار), δ. According to the heading, the table was written by a certain ‘Alī b. Aḥmad b. Mafrūj. Some sample values are: *Akhīr al-nahr*: *m* = 21;2°; δ = 6;22° south; *Al-Dabarān*: *m* =30;0°; δ = 44;54° north; *Suhayl*: *m* = 0;56°; δ = 51;30° south.

10. See Derenbourg, vol. 2, fasc. 3, pp. 10-11.

11. See Derenbourg, vol. 2, fasc. 3, pp. 10-11.

(4) Tehran, Library of the Parliament, 1440 S [167 fols.].[12] The manuscript has been estimated to be a very late copy, from the 18th century AD. Only Books I to VI are preserved. On the title page the work is described as:

كتاب في علم الهيئة شرح المجسطي

This manuscript was identified in October 2015 by S. Muḥammad Muẓaffarī.

(b) Manuscripts written in Hebrew-Arabic:

(5) London, British Library, or. 10725 [fols. 92v-175v].[13]

(6) Cambridge, University Library, Add. 1191, [fols. 19r-131r].[14] The colophon, on folio 131v, is dated 2 Adar I 1665 Sel. (26 January 1354 AD). The *Iṣlāḥ al-Majisṭī* is the second work in this collection of two, following an incomplete copy of the *al-Tabṣira fī 'ilm al-hay'a* by al-Kharaqī [fols. 1r-18v].

(7) Paris, BnF, heb. 1102, [fols. 12r-16r]. The manuscript contains a fragment from Book V.

3. Book VI of the *Iṣlāḥ al-Majisṭī*[15]

In the Latin translation,[16] Book VI of the *Iṣlāḥ al-Majisṭī* consists of nine complete, yet unnumbered, chapters (in what follows, the chapters will be referred to

12. The manuscript is catalogued in Dānišpažu, Muḥammad Taqī and Anwārī, Bahā' al-Dīn 'Alamī, *Fehrest-e kotob-e khaṭṭī-e ketāb-khāna-ye Majles-e Šūrā-ye Eslāmī* (*Senā-ye sābeq*) II, Tehran, 1359 Š./1980 (mss. 651-1513), p. 255.

13. N. Allony and D. S. Löwinger, *The Gaster Collection of Hebrew manuscripts in the British Museum (now British Library),* Jerusalem, 1960.

14. The manuscript is catalogued in S. C. Reif, *Hebrew manuscripts at Cambridge University Library: a description and introduction,* University of Cambridge Oriental Publications 52, Cambridge, 1997, pp. 337-338.

15. A list of the editions and manuscripts and their respective abbreviations as used in the following study is given at the end of this article.

16. From an inspection of all manuscripts of Gerard's Latin translation of the *Iṣlāḥ* as listed in Lorch, (1995), VII, pp. 1-2, the arrangement of the contents in Book VI agrees in all cases with Apianus's edition, which I used as main source for the Latin (see the reference at the end of this article).

by numbers in square brackets, in accordance with their order of appearance in the Latin text):

[1] The Latin and the Arabic versions of this chapter correspond to *Alm*. VII, 1 in al-Ḥajjāj's translation.

[2-3] The Latin and the Arabic correspond to *Alm*. VII, 2-3 according to Isḥāq/Thābit, whereas the title of [2] derives from al-Ḥajjāj.

[4] In the Latin, the chapter combines *Alm*. VII, 4-5 according to Isḥāq/Thābit. Of these parts, the Arabic text includes only *Alm*. VII, 4, which is directly followed, without a section break, by the content of [9]. Relative to the Latin, the Arabic version of the *Iṣlāḥ* is thus lacking parts of chapter [4], the entire chapters [5] to [8] and the separation, including a title, of chapter [9]. The corresponding chapters in the Latin version have the following titles:

[5] *De affirmatione stellarum quae sunt in medietate septentrionali sphaerae et positione earum in tabulis*.

[6] *In descriptione almaiarati siue uiae lacteae*.

[7] *De fabricatione sphaerae solidae*.

[8] *De uarietatibus figurarum quas habent stellae fixae*.

[9] *De declinatione et mediatione coeli*.

Chapter [5] replaces Ptolemy's extensive star catalogue and is based on the inventory which appears at the end of the star catalogue.[17] In accordance with Ptolemy's data, it is recited in this chapter that there exist 316 southern stars, 7 of which correspond to the first magnitude, 18 to the second, etc. Then the total number of stars, 1022, is given, 15 of which being stars of the first magnitude, 45, of the second, etc. The text of [6-8] corresponds to Isḥāq/Thābit's version of the *Almagest*.[18] Chapter [9] is the only chapter of Book VI of the *Iṣlāḥ* which has no correspondence in any Arabic version of the *Almagest*.

Regarding the parts which are absent in the Arabic version, an appendix in MS Escorial ár. 930 provides further information. A marginal note on f. 94v of MS Escorial ár. 930 relates exactly to the seam in the Arabic text between the content

17. That is, the end of the star catalogue in the Isḥāq/Thābit version in MS Tunis, 07116, f. 134v, and in the Ḥajjāj's version in MS Leiden, UB, Or. 680, f. 134v.

18. See MS Tunis ff. 135r-137r for [6], ff. 137r-138r for [7], and ff. 138r-139v for [8].

of chapter [4] and chapter [9]. The note, which was written by the main copyist, says that "other copies of the work contain what is written at the end of the present copy":

ثبت في بعض النسخ من هذا الكتاب في المكان المخرج ما كتب في اخر هذا السفر في كراسة المخالف .. .. الكتاب فانظره

In accordance with the note, after the end of the main text on f. 140v, folios 142v-150v contain an appendix including three further chapters (the last chapter is incomplete, as some lines are missing):

في صفة مواضع الفلك اللبني المسمى بالمجرة
في صنعة كرة مضمتة
في اصناف الاشكال التي تليق بالكواكب الثابتة

The chapters essentially correspond to *Alm*. VIII, 2-4 in Isḥāq/Thābit's translation. As such, however, they also correspond to chapters [6-8] in the Latin translation of the *Iṣlāḥ,* in which the Milky Way, the Solid Globe and the configurations of the fixed stars are discussed.

The appendix of the Escorial manuscript ár. 930 thus contains a large portion of the passage by which the Latin translation differs from the Arabic copies of the *Iṣlāḥ*. Moreover, according to the marginal note in the manuscript the chapters could be found in some Arabic copies at the same place as in the Latin text. At the same time, there is no indication of an Arabic correspondence also of the extended chapter [4] and chapter [5] as found in the Latin translation.

The evidence in the Escorial manuscript has a parallel in the Hebrew tradition of the *Iṣlāḥ al-Majisṭī*. It is known that Samuel ben Jehuda of Marseille (fl. 1335 AD), who revised Jacob ben Maḥir ibn Tibbon's Hebrew translation of Jābir's text,[19] had access to a more complete version of the *Iṣlāḥ*. From the Arabic copy which he used he noticed that the passages of the Milky Way, the Solid Globe and the configuration of the stars, among other things, were missing from Tibbon's

19. Two Hebrew translations are known, one by Moses ibn Tibbon in 1274 and another by his nephew Jacob ben Maḥir (1236-1304). Lorch (1975), pp. 92-94, contains a lucid account of the transmission.

translation.[20] While this resembles the situation in the Arabic, the Hebrew manuscripts of Samuel's revision, MSS Paris, BnF, hebr. 1024 and 1025, further show the following arrangement of chapters, in close correspondence with the marginal note and the appendix in the Escorial manuscript.[21]

Paris, BnF, hebr. 1024. The chapters are unnumbered. Chapter 1, starting on f. 62r, chapter 2, on f. 64v, and chapter 3, on f. 65r, correspond to the text in the Arabic and Latin versions. Chapter 4, starting on f. 69v, like in the Arabic version, does not include the content of *Alm*. VII, 5 of Isḥāq/Thābit, like in the Arabic and different from what is found in Gerard of Cremona's Latin *Iṣlāḥ*. Also similar to the Arabic, the short chapter [5] of the Latin translation is missing in Samuel's revision.

Furthermore, chapter 5 (f. 69v) dealing with the Milky Way, corresponds to Latin [6]; chapter 6 (f. 72r), dealing with the Solid Globe, correspond to Latin [7]; chapter 7 (f. 73r), like Latin [8], deals with the configuration of the fixed stars; chapter 8 (f. 75r) corresponds to the final chapter [9] in the Latin translation.

Paris, BnF, hebr. 1025 contains the same text as BnF 1024. The distribution of chapters is: 1, starting on f. 106v; 2, f. 110v; 3, f. 112r; 4, f. 119r; 5, f. 119v; 6, f. 124r; 7, f. 126r; and 8, f. 129v.

4. Conclusions

Jābir may have decided not to include in his work a discussion of the Milky Way, the Solid Globe and the configuration of the fixed stars due to the little relevance of these topics to Jābir's mathematical interests. Alternatively, a later copyist of the Arabic text may have left these parts out and the work was henceforth transmitted incomplete in certain parts of the transmission.

A later omission of the affected chapters is possible, because the most important chapter of Book VI, and the only one conceived by Jābir himself, is the last

20. Lorch (1975), pp. 92-94. The story about this Arabic copy is found in an epilogue in the existing MSS of Samuel's revision; see Lorch (1975), pp. 92-93, and note 52 on p. 106. The passage has been transcribed by Neubauer and Renan in "Les Écrivains Juifs Français", *Histoire Litéraire* XXXI (1893), pp. 562-3.

21. Four MSS are mentioned in Lorch (1975), p. 106, note 52. I have been assisted in the reading of the chapter titles and the beginnings of some chapters by Hayim Malkhasy M.A., to whom I want to express my gratitude.

chapter, which deals with the trigonometry required for determining a star's distance from the equator and the co-culminating point of the ecliptic.[22] However, whereas in the Latin the chapter is entitled "De declinatione et mediatione coeli", it is striking that no title is found in the Hebrew revision by Samuel and not even a chapter break in the Arabic. It seems more probable, therefore, that the three chapters included in the appendix of MS Escorial ár. 930 were part of a common correction, based on the *Almagest* which had also found its way into the main text of the Hebrew revision by Samuel of Marseille.[23]

Regarding the combination of *Alm*. VII, 4-5 of Isḥāq/Thābit's translation in Gerard's chapter [4], and Gerard's short chapter [5] based on Ptolemy's star catalogue, it is plausible to suggest that Gerard himself added these contents. For they appear neither in the Arabic sources nor in the Hebrew revision by Samuel of Marseille. Gerard could have easily included these parts, based on his knowledge of the corresponding chapters of the *Almagest*. In that case it may also not be a coincidence that those chapters of Gerard's translation of Book VI of the *Iṣlāḥ* which are based on Isḥāq/Thābit's version of the *Almagest* appear in accordance with al-Ḥajjāj in Gerard's translation of the *Almagest*, and *vice versa*.[24]

22. R.P. Lorch, "Appendix 2 to item VI" in Lorch (1995), VIII, p. 9, note 12.

23. A similar case concerns the description of the observational instrument in the *Iṣlāḥ*, which differs from the description in the Latin translation. The Hebrew translation of the *Iṣlāḥ* by Moses ibn Tibbon's in 1274 was found to describe the same instrument as Gerard, whereas Samuel of Marsella later included both instruments in his revision; Lorch (1976), pp. 11-34.

24. This supports Lorch's idea that the *Almagest* was translated into Latin after the translation of the *Iṣlāḥ;* Lorch (1975), p. 91.

Appendix: Chapter Beginnings in Book VI of the *Iṣlāḥ al-Majisṭī*

Chapter [1], that the fixed stars maintain equal positions relative to each other.

Iṣlāḥ — VI, [1][1] *Alm.* — VII, 1 — Ḥajjāj[2]	*Iṣlāḥ,* Latin[3]
في إنّ الكواكب الثابتة لازمة لخواص مواضعها بقدر بعد واحد ابدا في ما بين بعضها إلى بعض	Quod stellae fixae sunt communicantes proprietates suorum locorum cum quantitate spacii unius semper inter se ad inuicem,
قال بطلميوس[4] ومن بعد أخبارنا في ما تقدّم هذا القول[5] من الأقاويل بما يعرض	inquit Ptolomeus, et postquam narrauimus in eis quae praecedunt hunc sermonem illud quod accidit
في الكرة المستقيمة وفي الكرة المائلة وأيضا ما يعرض في جهة حركة الشمس[6] والقمر	in sphaera recta, et in sphaera decliui, et iterum quod accidit in partibus motuum solis et lune,
وما يرى فيها من الأشكال على ...	et quod uidetur in eis de figuris secundum...

1. [E1, ff. 82v-86r], [E2, ff. 68v-71r], [B, ff. 70r-72v], [TP, ff. 146v-152r].
2. Leiden 680, ff. 105r-106v.
3. Apianus, pp. 84-87.
4. Only in B.
5. فيها تقدّم لهذا القول in B.
6. في جهات حركات الشمس in B.

Chapter [2], on the rearward motion of the sphere of the fixed stars along the ecliptic.

Iṣlāḥ — VI, [2][7] *Alm.* — VII, 2 — Isḥāq/Thābit[8]	*Iṣlāḥ* - Latin[9]
في إنّ كرة الكواكب[10] الثابتة لها حركة إلى جهة[11] توالي البروج	Quod sphaera stellarum fixarum ad successionem signorum moueatur. Quod autem comparatio stellarum que dicuntur fixae
كلّها على الاطلاق بعضها عند بعض واحد بعينه وحركتها واحدة بعينها	omnium absolute adinuicem sit una et eadem, et motus earum unus et idem

فمن هذه الأشياء وما أشبهها يمكننا الوقوف	ex istis rebus, et his similibus possibile est scire.
على ذلك وإمّا أن كرتها أيضا يكون لها حركة خاصّيّة	Sed quod sphaera earum iterum habet motum proprium
تلقى حركة الكلّ أعني تلقى الحركة التي تكون بالدائرة العظمى	occurrentem motui totius, scilicet ocurrentem motui qui sit per circulum magnum
التي ترسم مارة بالقطبين جميعا	que[12] signatur transiens per duos polos simul,
أعني قطبي معدّل النهار وقطبي فلك البروج...	scilicet duos polos aequatoris diei, et duos polos orbis signorum....

7. [E1, ff. 86r-87v], [E2, ff. 68v-71r], [B, ff. 72v-74r], [TP, ff. 152r-154v].
8. Tunis, ff. 112r-113r.
9. Apianus, pp. 84-87.
10. Om. in TP.
11. Om. in E2.
12. *Sic!*

Chapter [3], on the rearward motion of the sphere of the fixed stars being about the poles of the ecliptic.

Iṣlāḥ — VI, 3[13] *Alm.* — VII, 3 — Isḥāq/Thābit[14]	Latin[15]
في إنّ حركة كرة[16] الكواكب الثابتة إلى توالي البروج	Quod huiusmodi motus fiat super polis eclipticae, et non aequatoris diei.
إنّما يكون على قطبي فلك اوساط البروج	
فقد بإنّ لنا بيانا واصحا بهذه الأشياء أن كرة الكواكب الثابتة	Iam ergo ostensum est nobis declaratione manifesta per res istas, quod sphaera stellarum fixarum
أيضا[17] ينتقل على توالي البروج هذه النقلة التي ذكرنا على التقريب مبلغها على التقريب.	iterum permutatur secundum continuitatem signorum hac permutatione, cuius summam diximus secundum propinquitatem...

14. [E1, ff. 87v-93v], [E2, ff. 72r-76v], [B, ff. 74r-78v], [TP, ff. 154v-164v].
15. Apianus, pp. 88-93.
16. Om. in TP.
17. Om. in E1.

Chapter [4] integrates *Alm*. VII, 4-5 of the Isḥāq/Thābit version while the Arabic contains only chapter 4.

Iṣlāḥ — VI, 4[18] *Alm*. — Isḥaq/Thābit — VII, 4[19]	Latin[20]
في صفة تخطيط فصول جداول الكواكب الثابتة[21]	In descriptione differentiarum tabularum fixarum stellarum
قال[22] فلمّا تقرّر عندنا بالرصد والمقايسة	Inquit, et postquam affirmatum est apud nos per considerationem et comparationem,
اللذين وقعا على مثال	que euenerunt secundam similitudinem
واحد في أمر هذه الكواكب وغيرها من الكواكب المضيئة	unam inesse harum stellarum luminosarum,
وبموافقة أبعاد سائر الكواكب لمّا أعتبر منها فوقف على أمره	et per casum longitudinum reliquarum stellarum ad illud quod expertum est de eis, et scitur secundum esse eius,
أن كرة الكواكب الثابتة	quod sphaera stellarum fixarum
أيضا تزول نحو توالي البروج	iterum separatur uersus continuitatem signorum...

Last fragment of this chapter in the Arabic and the continuation in the Latin

وذلك أنّ تباعده في الطول كان يتفرز عن الفصل المشرك بين	Et illud est, quoniam elongatio eius in longitudine separatum a differentia communi, quae est
هذه الخلقة وبين فلك	inter hanc armillam et inter orbem
البروج وتباعده في العرض كان يتفرز عن القوس منها	signorum, et elongatio eius in latitudine
التي تحصل بين هذا	separatur ab arcu eius, qui continuat
التقاطع الذي تقدّم ذكره وبين النقب الذي فوق	inter hanc sectionem,
الأرض	cuius rememoratio praecessit, et inter foramen, quod est supra terram.
[…][23]	Ut ergo sit nobis iste modus ex modis stellarum in sphaera corporea positus situs,…

18. [E1, ff. 94r-94v], [E2, ff. 76v-77r], [B, ff. 78v-79r], [TP, ff. 164v-165v].
19. Tunis, ff. 116v-117r.
20. Apianus, pp. 93-95.

21. The title in Arabic corresponds to al-Ḥajjāj, Leiden, f. 110v.
22. Only in E1.
23. This section is only extant in the Latin text which corresponds to *Alm*. VII, 5 according to Isḥāq/Thābit, see Tunis, f. 117r.

Chapter [5], which is absent in the Arabic version, is entitled in the Latin text: De affirmatione stellarum quae sunt in medietate septentrionali sphaerae, et positione earum in tabulis.[25]

As is said in the text itself, an inventory of stars, classified by magnitude, is given and is found under the star catalogue, in a sub-table. The text begins:

> Inquit, ubi inuenimus apud magnitudinem quae est in tabulis stellarum fixarum notam,...

Aside from the introduction, the following text is very close to the text in Gerard of Cremona's Latin translation of the *Almagest* according to Ḥajjāj's version, while Isḥāq/Thābit differs:[26]

> Omnes ergo stellae meridianae sunt 316, de quibus in magnitudine prima sunt 7, et in secunda 18, et in tertia 63, et in quarta 164, et in quinta 54, et in sexta 9, et nebulosa una.
>
> Omnes ergo stellae fixae in septentrione et meridie et orbe signorum ex eis, quae magnitudinem habent, sunt 1022 stellae, de quibus in magnitudine prima sunt 15, et in magnitudine secunda 45, et in magnitudine tertia 208, et in magnitudine quarta 474,...

Appendix in MS Escorial ár. 930 and the corresponding parts in the Latin translation

Chapter [6] in the Latin translation corresponds to the first chapter in the appendix, dealing with the Milky Way.

Appendix, *Iṣlāḥ*[24] *Alm*. VIII, 2[25]	Latin[26]
في صفة مواضع الفلك اللبني المسمّى بالمجرة[27]	In descriptione almaiarati siue uiae lacteae.
فهذا ما نضعه من مراتب الكواكب الثابتة	Hoc ergo est quod narrauimus de ordinibus stellarum fixarum,

25. Apianus, p. 95.
26. See Kunitzsch, P, *Der Sternkatalog des Almagest*, vol. 2, Wiesbaden, 1990, p. 168.

ونحن مضيفون الى ذلك	et nos sumus adiungentes ad
على ما يجب	illud, secundum quod oportet,
احوال الدائرة اللبنية ايضا	dispositiones circuli lactei iterum.
فنروم بغاية ما نقدر عليه وعلى حسب ما	Conabimur ergo quanto plus
ادركناه...	poterimus, et secundum quod
	comprehendimus...

24. E1, ff. 142v-147r.
25. Tunis, ff. 135r-137r.
26. Apianus, pp. 95-98.
27. The title is like in Ḥajjāj, see Leiden, f. 110v.

Chapter [7] in the Latin translation corresponds to the second chapter in the appendix, dealing with the Solid Globe.

Appendix, *Iṣlāḥ*[28] *Alm*. — VIII, 3[29]	Latin[30]
في صنعة كرة مصمتة	De fabricatione sphaerae solidae.
فهذه صفة وضع ما يرى في المجرة.	Iste ergo est modus situs eius quod uidetur in almaiarati,
وكيما بعد أيضا	et ut praeparemus iterum
مثالا بكرة مصمتة	exemplum per sphaeram solidam convenientem
شكلا للأصول التي بيّنت	radicibus quae firmatae sunt
في كرة الكواكب الثابتة التي ظهر بها ...	in sphaera stellarum fixarum, apparet quod hanc sphaeram etiam reuoluit…

28. E1, ff. 147r-149r.
29. Tunis, ff. 137r-139v.
30. Apianus, pp. 98-99.

Chapter [8] in the Latin is corresponding to the third chapter in the appendix.

Appendix, *Iṣlāḥ*[31] *Alm*. VIII, 4[32]	Latin[33]
في أصناف الأشكال التي تليق بالكواكب الثابتة	De uarietatibus figurarum quas habent stellae fixae.

في أصناف الأشكال التي تليق بالكواكب الثابتة	De uarietatibus figurarum quas habent stellae fixae.
فإذ قد دللنا على هذه الجهة	Et quia iam significauimus hunc modum
أيضا التي عليها خاصة ينبغي ان يجري	etiam super quem proprie oportet, ut currat
الأمر في إثبات الكواكب الثابتة فقد ينبغي[34] الآن أن نصرّف القول إلى شكلها.	res in firmatione stellarum fixarum, tunc oportet nunc, ut conuertamus sermonem ad species figurae earum.[35]

31. E1, ff. 149r-150v.
32. Tunis, ff. 138r-139v.
33. Apianus, pp. 99-102.
34. In Tunis the word ينبغي is a marginal correction.
35. Here, the passage is closer to Tunis which differs from the appendix:
الآن أن نصرّف القول التي أصناف التشكّل
The variant is not unique to the appendix, but is also in MS Tehran, Sipahsalar, 594, f. 107r, which contains a copy of the Isḥāq/Thābit version of the *Almagest*.

Chapter [9] lacks a title in the Arabic version, whereas in the Latin it is entitled: De declinatione et mediatione coeli.

Iṣlāḥ[36]	Latin[37]
ولمّا تبيّنت له هذه الأشياء وعلم بالرصد	Et postquam ostensae fuerunt ei res istae, et sciuit per considerationem
موضع هذه الكواكب من فلك البروج وأبعادها عنه في العرض إمكنه أن يعرف الاجزاء من فلك البروج ومن معدل النهار الذي	loca harum stellarum in orbe signorum, et longitudines earum ab ipso in altitudine, possibile fuit ei, ut sciret
يتوسط السماء والذي يطلع ويغرب معها لكوكب في	partes orbis signorum et aequatoris diei quae mediant coelum, et quae oriuntur, et quae occidunt cum stella in
إقليم مفروص ...	climate posito,...

36. E1 [94v-95v], E2 [77r-78r], B [79r-80r], TP [165v-167v].
37. Apianus, pp. 102-103.

List of editions, manuscripts and abbreviations

Editions

(1) Petrus Apianus, *Instrumentum primi mobilis* [12-84]; Geber, *Liber super Almagesti* [86-231]. Nürnberg, Johannes Petreius, 1534 — abbreviated here as Apianus

(2) Liechtenstein, *Almagestu[m] Cl. Ptolemei Pheludiensis Alexandrini Astronomo[rum] principis : Opus ingens ac nobile omnes Celoru[m] motus continens. Felicibus Astris eat in luce[m]*. Venice, 1515.

Manuscripts

Arabic

(1) Escorial, RBMSL, ár. 930 — abbreviated here as E1
(2) Escorial, RBMSL, ár. 910 — E2
(3) Berlin, SPBK, Lbg. 132 — B
(4) Tehran, Library of the Parliament (*Majlis*) 1440 S — TP

Hebrew Arabic

(1) London, BL, or. 10725
(2) Cambridge, University Library, Add. 1191
(3) Paris, BnF, heb. 1102

Arabic for the Isḥāq/Thābit version

(1) Tunis, BN 07116 — Tunis
(2) Tehran, Sipahsalar 594

Arabic for the Ḥajjāj version

(1) Leiden, UB, Or. 680 — Leiden

Hebrew

(1) Paris, BnF, hebr. 1024
(2) Paris, BnF, hebr. 1025