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research article

Kharaqī's Star Catalogue: A Star table from Medieval Arabic Astronomy[1]

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Abstract

In the Classical Islamic age, the star catalogues are highly influenced by Ptolemy's work. Nevertheless, Arab scholars were active in making amendments to *Almagest*'s values. Studying these catalogues in their context related to Arabic astronomical traditions will shed some light on the historical evolution of the subject. This paper focuses on the star catalogues in *hayʾa* tradition, specifically *Muntaha al-ʾidrāk fī taqāsīm al-ʾaflāk* (*The Utmost Attainment on the Divisions of the Orbs*), by ʿAbd al-Jabbār al-Kharaqī (1084-1158 A.D.), which presents a relatively detailed star catalogue. We introduce this catalogue, identify its sources, and discuss its distinctive features.

Keywords: ʿAbd al-Jabbār al-Kharaqī, *hayʾa* works, *Muntaha al-ʾidrāk fī taqāsīm al-ʾaflāk*, Star catalogue, Ptolemy

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1. Introduction

The fixed stars and the planets are distinct topics in ancient astronomy, the first are characterized by their uniform motion and they are fixed relative to each other while the latter have complicated motions and they move related to each other. The main body of the most astronomical texts is devoted to the planets, providing theories and models for their motions, whereas the fixed stars principally serve as a system of reference for locating the planets. There was not a unique standard system for coordinates in premodern astronomy but the constellations along the ecliptic suggested the possibility of the ecliptic coordinate. In the Ptolemaic catalogue, given in the *Almagest*, the number of the fixed stars is 1022,[1] which are classified into 48 constellations (21 on the north of the zodiac, 15 on the south of the zodiac, and 12 on the zodiac). We should have in mind that in the ancient and medieval period, only a few comprehensive catalogues, which comprise all the names and information, were prepared; the other sources just represent a summary based on these comprehensive catalogues. The fact that most of the astronomical tables in Islamic periods are merely a reproduction of *Almagest* or some other accepted source is undeniable besides some evidence of new observations. Regardless of this distinction, we can classify the genres, including stars' information as below:[2]

a) The tradition of *Ṣuwar al-Kawākib*: works belonging to this tradition take up ʿAbd al-Raḥmān al-Ṣūfī's (903-986 A.D.) famous work;

b) The *Almagest* tradition: redactions and commentaries of the *Almagest* constitute a vast tradition in medieval Arabic astronomy, which includes a reworking of the 7th and 8th books of *Almagest* concerning the fixed stars;

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[1] It is possible also to add three hidden stars called *Coma*; these three stars in Arabic text are categorized as "*hulbat*" which means the tail of Leo; the word chosen as the translation of Ptolemy Greek word "Plokamos" in Arabic texts is "*ḍafirat*" which means braided hair: ʿAbd al-Jabbār al-Kharaqī (2020, p. 90, paragraph [174]); Kunitzsch and Smart (2006, p. 41); Ptolemy (1984, p. 368, note 223); see also Kunitzsch (2002).

[2] Kunitzsch (2008, pp. 2019-2020) provides a dichotomy (*Almagest* and instrumental tradition) that is not enough precise.

c) The books on the astrolabe: the Arabic works on the theory and use of the astrolabe include a part on those fixed stars which should be shown on the astrolabe plate;

d) The astronomical tables or *Zīj*es: a table of the fixed stars is an indispensable part of every *Zīj*. In the table, the star's coordinates and even its temperament were indicated.[1]

e) The *hayʾa* tradition: a chapter on the fixed stars is an essential part of almost all *hayʾa* treatises, which in most cases is a summary on the subject.

The status of stars in these traditions could be a matter of distinct research. However, regarding the recent publications of *hayʾa* books, in this paper, we will study the fixed stars in *hayʾa* tradition, principally in *Muntaha al-ʾidrāk fī taqāsīm al-ʾaflāk*, which was written by ʿAbd al-Jabbār al-Kharaqī in 526-527 A.H./1132-1133 A.D. and containing a comprehensive fixed stars' catalogue.

This research addresses a subject at the intersection of two research literature: the historical survey on the fixed stars and the study of *hayʾa* books. The most contribution to the survey on fixed stars in Arabic texts was by Paul Kunitzsch. His studies were initially about *Almagest*'s fixed stars catalogue, then he extended his studies to the Arabic translation of *Almagest*. He also concentrated on the curious subject of Arabic star names in the catalogues.[2]

A survey on fixed star catalogues is an essential part of the history of astronomy in the Islamic classical age. The star catalogues provide us with information about the relationship between astronomical texts and observation in a specific period of time: which stars were a part of a standard catalogue in astronomy? Which stars' information was needed for an astronomer? Were the star catalogues updated due to

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[1] E.S. Kennedy (1956, p. 144).

[2] For instance, see: Kunitzsch. P. (1959). *Arabische Sternamen in Europa*. Wiesbaden: Harrassowitz; Kunitzsch. P. (1961). *Untersuchungen zur Sternomenklatur der Araber*. Wiesbaden: Harrassowitz; Kunitzsch. P. (1986-1991). *Claudius Ptolemäus: Der Sternkatalog des Almagest*, 3 vols. Wiesbaden: Harrassowitz; *The Arabs and the Stars*. (1989). Northampton: Variorum. [Variorum Reprints, Collected Studies Series, CS 307].

new observations? To answer all these questions concerning the Islamic classical age, more historical research should be accomplished, regarding that there are several textual and conceptual traditions dealing with fixed stars information.

The study of *hayʾa* books was initially in the spotlight because of including some non-Ptolemaic planetary models, then the vast tradition of these books invited more researchers to work on them. As a result of these independent researches, now, the major works in this tradition are edited and some of them are published, for instance, *al-Tadhkira fī ʿilm al-hayʾa* (*Memoir on Astronomy*), *al-Risālat al-Muʿīniyya*, and *al-Mulakhkhaṣ fī al-hayʾa*.[1] These publications prepare the ground for a comparative study of the *hayʾa* works: the gradual evolution of astronomical concepts is traceable in this tradition. Sections 2, 3, and 4 try to fill the gap in this intersection. Section 4 proposes a historical-astronomical method to date the works including fixed star catalogues. As an application, the writing date of al-Kharqī's *Muntaha* is estimated by this method.

2. Fixed stars section in *hayʾa* tradition

The *hayʾa* tradition was devised as a bridge between the *Almagest* planetary models and the Aristotelian image of the physical world, particularly of the heavens. The topics included in a typical *hayʾa* book are as below:

1. Mathematical and natural principles
2. Configuration of the heavens
3. Mathematical geography
4. Distances and sizes of celestial bodies.[2]

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[1] Ragep, F.J. (1993). *Naṣīr al-Dīn al-Ṭūsī's Memoir on Astronomy* (*al-Tadhkira fī ʿilm al-hayʾa*). New York: Springer-Verlag; Ragep, S.P. (2016). *Jaghmīnī's Mulakhkhaṣ An Islamic Introduction to Ptolemaic Astronomy*. Switzerland: Springer; Naṣīr al-Dīn Muḥammad al-Ṭūsī. (2020). *al-Risāla al-Muʿīniyya* and its Supplement. Edited by Sajjad Nikfahm-Khubravan and Fateme Savadi with prefaces by F. Jamil Ragep and Hossein Masoumi Hamedani. Teharn: Miras-e Maktoob.

[2] F.J. Rajep (1993, p. 36 introduction).

Some of the fixed stars are generally introduced in the second part, but the extents and details of the list were not the same in all *hayʾa* books.

In early *hayʾa* works, that have been written in the 9th and 10th century A.D. -- Farghānī's *Jawāmiʿ ʿilm al-nujūm* (Chapter 19), Kūshyār's *al-zīj al-jāmiʿ* (the third book, 15th chapter), and *Fī hayʾat al-ʿālam* attributed to Ibn al-Haytham -- the fixed stars are considered as an autonomous topic that should be discussed independently:

Farghānī only mentions the classification of stars according to their magnitudes; he also gives a list of the fifteen brightest stars in the sky, which are considered to be of the first magnitude in this classification.[1] Kūshyār introduces the fixed stars before talking about the planetary motions in longitude.[2] However, in *Fī hayʾat al-ʿālam*, the main source of later *hayʾa* works, the chapter on the fixed stars follows the chapters on the longitudinal motions of the planets. Here, the magnitude of the stars is mentioned as a criterion for their classification but the names of the constellations are not given.[3]

Only in some *hayʾa* books, there is an explicit reference to the al-Ṣūfī's work, but it seems that in all cases, al-Ṣūfī is their original source: they repeat not only the same value for the rate of the precession (see section 4), but also the Arabic folkloric names of stars given by al-Ṣūfī.

Bīrūnī's *al-Qānūn* is not a *hayʾa* work but it includes a comprehensive star catalogue in book 9,[4] which could be a source for the successors. He compares Ptolemy's table to Ṣūfī's table and pays attention to the difference in magnitudes between the two tables. It is also known that Bīrūnī's Persian work on astronomy, *al-Tafhīm*, had a certain influence on the *hayʾa* tradition. In this book, he calls the fixed stars "desert stars" (*sitārigān-i bīabānī*) and arranges them by name of constellations,[5] the method which could be found in most *hayʾa*

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[1] Alfarganvs (1669, pp. 74-76).

[2] Kūshyār Jīlī (fols. 105r-106v).

[3] Langermann (1990, pp. 61-63 Arabic text).

[4] Bīrūnī (1954, pp. 1010-1126).

[5] Bīrūnī (1988, pp. 89-98).

works. The naming shows that Bīrūnī in *al-Tafhīm* was thinking about the practical use of the stars, which is to find the way in the desert relying upon some well-known stars,[1] hence he is satisfied with naming the ecliptic south and north stars and he does not mention any specific details whereas, the text of *al-Qānūn* addresses professional astronomers who need a comprehensive catalogue to perform more detailed astronomical tasks.

From the 12th century A.D. onward, the *hayʾa* tradition was established in its standard four parts structure. Among the *hayʾa* works, Kharaqī's three independent treatises stand out for their breadth, clarity of exposition, and later influence:

- *Muntaha al-ʾidrāk fī taqāsīm al-ʾaflāk*, 526-527 A.H./1132-1133 A.D., 1444 Alexandrian (in Arabic)
- *al-Tabṣira fī ʿilm al-hayʾa*, 526-527 A.H./1132-1133 A.D., 1444 Alexandrian (in Arabic)
- ʿUmda-yi Khwārazmshāhī dar bayān-i badāyiʿ-i ilāhī, 536 A.H./1141 A.D., 1453 Alexandrian (in Persian)[2]

As we mentioned before in Bīrūnī's case, the sections devoted to the fixed star in these three works are not the same; it seems that their content and comprehension are adjusted according to their intended readers. The most comprehensive one is in the 12th chapter of *Muntahā*'s first book, which comes after the chapters on the description of the movement of planets in longitude,[3] (see section 3). In *al-Tabṣira* and *ʿUmda*, this section is in the final chapters of the first book, on the heavenly bodies: the 21st chapter of *al-Tabṣira* (the first book has 22 chapters) and the 24th chapter of *ʿUmda* (the first book has 25 Chapters). In both books, this section comes before the chapter on lunar mansions.[4]

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[1] Bīrūnī (1988, p. 60).

[2] For a short description of al-Kharaqī's works see. ʿAbd al-Jabbār al-Kharaqī (2020, pp. 40-42 introduction).

[3] ʿAbd al-Jabbār al-Kharaqī (2020, pp. 75-110).

[4] ʿAbd al-Jabbār al-Kharaqī (*al-Tabṣira*, fols. 63v-66v); ʿAbd al-Jabbār al-Kharaqī (*ʿUmda-yi Khwārazmshāhī*, fols. 39v-44r); ʿAbd al-Jabbār al-Kharaqī (2020, pp. 319-350), that the lunar mansion comes in the 3rd book.

al-Kharaqī's contemporary author, Sharaf al-dīn al-Masʿūdī, wrote two books on *hayʾa*: *al-Kifāya fī ʿilm al-hayʾa* in Arabic and *Jahān-i Dānish* in Persian. In his introduction to *al-Kifāya*, he explicitly refers to *al-Tabṣira* as his source and model.[1] Not surprisingly, in both of his works, the fixed star section has the same position and format as in *al-Tabṣira*.[2]

In the 7th A.H./13th A.D. century *hayʾa* books, the fixed star section gradually becomes more concise, and in some cases, for example, Jaghmīnī's *al-Mulkhkhaṣ*, the section is completely eliminated.[3] In the *hayʾa* books belonging to the famous Maragha School, only the constellations and the number of their stars are mentioned.[4] In these books, the information about the fixed stars is briefly stated because the knowledge of the fixed stars was then a separate discipline.[5] In table (1), we give a list of *hayʾa* works from 6th A.H./12th A.D. to 9th A.H./15th A.D. century and indicate the situation of the fixed stars chapter in these works.

Table (1): a list of *hayʾa* works in 6-9 A.H./12-15 A.D. Centuries and the statue of the chapter on the fixed stars

Title	**Author**	**Period**	**The number of chapters on Heavenly bodies**	**fixed stars Chapter's number**
Muntaha al-Idrāk fī Taqāsīm al-Aflāk	ʿAbd al-Jabbār al-Kharaqī	526-527A.H./1132-1133 A.D.	20	12

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[1] Sharaf al-Dīn al-Masʿūdī (*al-Kifāya*, fol. 107v).

[2] Sharaf al-Dīn al-Masʿūdī (*al-Kifāya*, fol. 131r-133r); Sharaf al-Dīn al-Masʿūdī (2003, pp. 97-105).

[3] S.P. Rajep (2016, p. 84 English translation and p. 85 Arabic text).

[4] Naṣīr al-Dīn Muḥammad al-Ṭūsī (2020, pp. 51-59); F.J. Ragep (1993, pp. 128-129); Saliba (1990, pp. 375-393); Quṭb al-Dīn al-Shīrāzī (*al-Tuḥfa al-Shāhiyya*, fols. 26r-27v).

[5] See. F.J. Ragep (1993, pp. 128-129) "Knowledge of the fixed stars and that which concerns them being a separate discipline." (و معرفة الثوابت و أحوالها فن مفرد)

Title	**Author**	**Period**	**The number of chapters on Heavenly bodies**	**fixed stars Chapter's number**
al-Tabṣira fī ʿIlm al-Hayʾa			22	21
ʿUmda-yi Khwārazmshāhī		536 A.H./1141 A.D.	25	24
al-Kifāya fī ʿIlm al-Hayʾa	Sharaf al-Dīn Masʿūdī	549 A.H./1154 A.D.	22	21
Jahān-I Dānish				
Al-Mulakhhaṣ fī al-Hayʾa	Jaghmīnī	602-603 A.H./1205-1206 A.D.	5	--
Zubda al-Hayʾa	Nasīr al-Dīn al-Ṭūsī	Probably before 632 A.H./1235 A.D.	This book entirely has 30 chapters	5[1]
al-Risāla al-Muʿīniyya		632 A.H./1235 A.D.	14	3
al-Tadhkira fī ʿIlm al-Hayʾa		672 A.H./1274 A.D.	14	4
Kitāb al-Hayʾa	Muʾayyid al-Dīn ʿUrḍī	Before 657 A.H./1259 A.D.	The book has numerous chapters and the section on the fixed stars is the last one	
Nihāya al-Idrāk fī Dirāya al-Aflāk	Quṭb al-Dīn Shīrāzī	680 A.H./1281 A.D.	13	4
Ikhtīyārāt Muẓaffarī				
al-Tuḥfa al-Shāhiyya		684 A.H./1285 A.D.	16	7

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[1] Ghalandari (2007, pp. 52-57): al-Ṭūsī talks only on the two principal movements and do not mention to the constellations:

Title	**Author**	**Period**	**The number of chapters on Heavenly bodies**	**fixed stars Chapter's number**
Lubāb-i ʾIskandarī	Ghīyāth al- Dīn Jamshīd Kashanī	Ca. 814 A.H./1411-1412 A.D.[1]	15	--
Fārsī-yi Hayʾa	ʿAla al-Dīn Qūshjī	9th A.H. century/15th A.D. century	6	3

The history of the fixed stars section in *hayʾa* books, especially in the 6th and 7th centuries, shows how the authors' motivations and considerations affected the composition of their books. These motivations are of two kinds: first, as we see in Bīrūnī's work, a fixed stars section could be devised for practical use; thus, the constellation stars description is the main topic. Second, a fixed stars catalogue could be prepared for calculational astronomy, specifically *Zīj*s. As for the considerations, they were also of two kinds: the Hayʾa tradition is notably characterized as being influenced by Ptolemy's less known book, *Planetary Hypotheses*, which bestows them their principal characteristic: presenting a physical model of heavens without entering into the calculations. The second consideration is related to *hayʾa* books intended public. Most of these books are written for educational purposes, so in most cases, the readers are students of science (to say nothing of the students of philosophy, theology, and even Islamic jurisprudence). The fact that some elaborated and innovative planetary models, such as al-Ṭūsī's couple, are introduced in the *hayʾa* books for the first time shows that these books were also suitable for amateur astronomers. These motivations and considerations can explain why the fixed stars section was out of the

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[1] There are two versions of this treatise, one of them have entirely 20 chapters and another divided into three parts: an introduction, on the heavenly bodies (15 chapters) and on the configuration of the earth (12 chapters). See. Bohloul (2017, pp. 25-26); Nikfahm Khubravan and Savadi (2011, pp. 54-55).

scope of the Hayʾa tradition and why it was eliminated gradually from these books.

3. al-Kharaqī's fixed star catalogue

3.1. al-Kharaqī's introductory points

The specific feature of al-Kharaqī's books is that, unlike the other *hayʾa* books, they contain a comprehensive chapter on the fixed stars as well as a catalogue of the names, ecliptic coordinates, and magnitude of 84 stars. In *Muntaha* al-Kharaqī starts the section on the fixed stars with a discussion on the proper place for this section in a *hayʾa* book:

> We should discuss this sphere [i.e., the sphere of the fixed stars] either before the sun and other planets, because this sphere is above all of them, or after the sun and moon's spheres because it is possible to know the positions of the stars only after knowing those of the sun and the moon.[1]

In this passage, he compares the two different places where a discussion of the fixed stars could be introduced. The first place respects the physical arrangement of celestial spheres, while the other place helps to provide a celestial coordinate system. al-Kharaqī's proposal could be understood as a critic of Ptolemy. He did not mention Ptolemy's name, but we know that the latter, in his *Almagest*, opts for the second place. Ptolemy wrote on the fixed stars in books 7 and 8, after having discussed the sun and moon's movement in the 3rd to 6th books, and before discussing other planets' movement in the 9th to the 12th books. Surprisingly, al-Kharaqī himself chose neither the first place nor the second one. He placed the fixed stars section after all these topics, arguing that the integrity of the subject of the celestial movements should be preserved.[2]

It seems that he is not content that Ptolemy disrupts the integrity of the subject by discussing motionless objects in the middle of moving objects, and also, he is not willing to respect the natural physical

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[1] ʿabd al-Jabbār al-Khraqī (2020, p. 75. Paragraph [142]).
من حق هذه الكرة أن تذكر إمّا قبل ذكر فلک الشمس وساير الكواكب لاستعلائها على ساير افلاک الكواكب أو أن تذكر بعد الفراغ
من ذكر فلکی النيرين إذ لا سبيل إلى معرفة شئ من أحوال الكواكب بالحقيقة إلّا بمعرفة موضعي النيرين

[2] ʿabd al-Jabbār al-Khraqī (2020, pp. 75-76. Paragraph [143]).

arrangement of the world. However, in practice, regarding the significance of the movements of the planets, he completes the subject with a section on fixed stars sphere. However, in his two other works, *al-Tabṣīra* and *ʿUmda*, he even goes further by setting the fixed stars section as the last part of the book "on the heavenly bodies".[1]

al-Kharaqī continues to implicitly add another consideration to *Almagest*. He gives two reasons for these stars are called fixed: the first is because they are fixed reciprocally, which means the distance between them never changes; Ptolemy already mentions the reason in the 7th book of *Almagest*.[2] The other reason is that in the old times (*qadīm al-dahr*), people thought the stars do not move at all. As we know, Hipparchus, in the second century BC, was aware of the precession movement. Ptolemy says that "it would not be appropriate to call this [sphere] too fixed"[3]; probably because of this movement. It seems that the old times refer to the Babylonian period because the astronomers of the Greek period were usually called "the predecessors: (*al-mutaqaddimīn*). Bīrūnī only admits the first reason and states his objection by saying that it is the most suppositious reason (*awh<u>a</u> al-ʿilal*), and we don't know who has invented it.[4]

al-Kharaqī arranges the 1022 fixed stars in 6 levels of magnitude and 48 constellations, as did Ptolemy and Ṣūfī, while he introduces Ṣūfī as his source. As al-Kharaqī acknowledges, his fixed stars catalogue is based on Ṣūfī's work so, we should expect only a reproduction of the same information. A comparison between his data and Ṣūfī's treatise shows that there are some points that could be investigated. In order to evaluate al-Kharaqī's dependence on Ṣūfī, we present a table comparing three principal books on his time available which could be available to him: *Ṣuwar al-Kawākib* as the direct, *Almagest* as the indirect, and Bīrūnī's *al-Qānūn* as a supplementary source. (See. Table 2)

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[1] Moreover, in these two works i.e., *al-Tabṣira* and *ʿUmda*…, he brought the section of lunar mansion after the fixed stars at the end of the book "on the heavenly bodies" while in *Muntaha* this section comes in 3rd book "History".

[2] Ptolemy (1984, pp. 321-322).

[3] Ptolemy (1984, pp. 321).

[4] Bīrūnī (1954, vol. 3, p. 988).

Table (2): Number of constellation stars in main Islamic sources

		Number of constellation stars				
	Constellations	***Almagest***	**Arabic translation of *Almagest***	**Ṣūfī's *Ṣuwar al-kawākib***	**Bīrūnī's *al-Qānūn***	**Kharaqī's *Muntahā***
North of the Zodiac	Ursa Minor	7; 1 out[1]	7; 1 out	7; 1 out	7; 1 out	7; 1 out
	Ursa Major	27; 8 out	27; 8 out	27; 8 out	27; 8 out	27; 8 out
	Draco	31	31	31	31	31
	Cepheus	11; 2 out	11; 2 out	11; 2 out	11; 2 out	11; 2 out
	Bootes	22; 1 out	22; 1 out	22; 1 out	22; 1 out	22; 1 out
	Corona Borealis	8	8	8	8	8
	Hercules	28;[2] 1 out	28;[3] 1 out	28;[4] 1 out	28; 1 out	29; 1 out
	Lyra	10	10	10	10	10
	Cygnus	17; 2 out	17; 2 out	17; 2 out	17; 2 out	17; 2 out
	Cassiopeia	13	13	13	13	13
	Perseus	26; 3 out	26; 3 out	26; 3 out	26; 3 out	26; 3 out
	Auriga	14	14	13 [5]	14	14
	Ophiuchus	24; 5 out	24; 5 out	24; 5 out	24; 5 out	24; 5 out
	Serpens	18	18	18	18	18
	Sagitta	5	5	5	5	5
	Aquila	9; 6 out	9; 6 out	9; 6 out	9; 6 out	9; 6 out
	Delphinus	10	10	10	10	10
	Equuleus	4	4	4	4	4
	Pegasus	20	20	20	20	20
	Andromeda	23	23	23	23	22
	Triangulum	4	4	4	4	4
Total for the northern region		360	360	359[6]	360	360

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[1] "out" =outside of the constellation

[2] Ptolemy, (1984, p. 349): at the end of the list, Ptolemy adds a description of a star which is on the end of the right leg of the constellation, but he did not count it because it is common to Bootes.

[3] Kunitzch (1986, pp. 48, 49).

[4] al-Ṣūfī (1986, p. 77) like Ptolemy have counted 29 stars in the description of the constellation and says that one of them is common to Bootes.

[5] In the description of the constellation, al-Ṣūfī (1986, p. 117) refers to Ptolemy and says it has 14 stars but in the table, he mentions 13 stars (al-Ṣūfī, 1986, p. 124).

[6] al-Ṣūfī (1986, p. 28): he said before that the total number of stars in the northern region is 360.

		Number of constellation stars				
	Constellations	***Almagest***	**Arabic translation of *Almagest***	**Ṣūfī's *Ṣuwar al-kawākib***	**Bīrūnī's *al-Qānūn***	**Kharaqī's *Muntahā***
In the Zodiac	Aries	13; 5 out	13; 5 out	13; 5 out	13; 5 out	13; 5 out
	Taurus	33;[1] 11 out	33;[2] 11 out	32;[3] 11 out	34; 11 out	33; 11 out
	Gemini	18; 7 out	18; 7 out	18; 7 out	18; 7 out	18; 7 out
	Cancer	9; 4 out	9; 4 out	9; 4 out	9; 4 out	9; 4 out
	Leo	27; 8 out[4]	27; 8 out	27; 8 out	27; 8 out	27; 8 out
	Virgo	26; 6 out	26; 6 out	26; 6 out	26; 6 out	26; 6 out
	Libra	8; 9 out	8; 9 out	8; 9 out	8; 9 out	8; 9 out
	Scorpius	21; 3 out	21; 3 out	21; 3 out	21; 3 out	21; 3 out
	Sagittarius	31	31	31	31	31
	Capricornus	28	28	28	28	28
	Aquarius	42; 3 out	42; 3 out	42; 3 out	42; 3 out	42; 3 out
	Pisces	34; 4 out	34; 4 out	34; 4 out	34; 4 out	34; 4 out
Total for the Zodiac		346 [350][5]	346 [350]	346 [349]	351	346 [350]
South of the Zodiac	Cetus	22	22	22	22	22
	Orion	38	38	38	40	38
	Eridanus	34	34	34	34	34
	Lepus	12	12	12	12	12
	Canis Major	18; 11 out	18; 11 out	18; 11 out	18; 11 out	18; 11 out
	Canis Minor	2	2	2	2	2
	Argo Navis	45	45	45	45	45
	Hydra	25; 2 out	25; 2 out	25; 2 out	25; 2 out	25; 2 out
	Crater	7	7	7	7	7
	Corvus	7	7	7	7	7

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1. Ptolemy (1984, p. 363, note 192): Toomer mentions that 32 stars are true because one of the stars is recorded before as part of Auriga.
2. Kunitzch (1986, pp. 82-83; p. 86, note 11).
3. al-Ṣūfī (1986, p. 186): it seems to have counted 33 stars in the description of the constellation and says that one of them is common to Auriga.
4. Here we have 5 stars plus Coma (counted 3), which is not counted in the number of the Stars.
5. The sum of the stars of the list is 350 but since Coma and one of Taurus are not counted, then we have 346 stars.

		Number of constellation stars				
	Constellations	***Almagest***	**Arabic translation of *Almagest***	**Ṣūfī's *Ṣuwar al-kawākib***	**Bīrūnī's *al-Qānūn***	**Kharaqī's *Muntahā***
	Centaurus	37	37	37	37	37
	Lupus	19	19	19	19	19
	Ara	7	7	7	7	7
	Corona Australis	13	13	13	13	13
	Piscis Austrinus	12;[1] 6 out	12;[2] 6 out	11; 6 out	11; 6 out	11; 6 out
Total for the southern region		316 [317][3]	316 [317]	316	318	316
Total for all stars		1022 [1027]	1022 [1027]	1021	1029	1022 [1026]

As expected, the tables are almost the same; however, there are some dissimilarities:

1- About the two constellations, Hercules and Andromeda, situated on the north of the zodiac, al-Kharaqī is not in accord with Ptolemy and al-Ṣūfī.

2- About the constellation Taurus, situated on the zodiac, surprisingly, al-Kharaqī is in accord with Ptolemy and not with al-Ṣūfī.

These differences could be either al-Kharaqī's mistakes or innovation; for example, α And is common between constellations Andromeda and Pegasus and, it may be al-Kharaqī mistakenly counts this again in Andromeda. It likes the case of Taurus in Bīrūnī's *al-Qānūn*, which has two common stars with Auriga; However, Bīrūnī is much more different than al-Kharaqī from Ptolemy and al-Ṣūfī, so it could not be al-Kharaqī's reference. Hence, we can assume that al-Kharaqī also has another complementary source.

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[1] Ptolemy (1984, p. 399, note 155): Toomer mentions that 11 stars is true because one of the stars is recorded before as part of Aquarius.

[2] Kunitzch (1986, p. 164,165).

[3] The sum of the stars of the list is 317 but since one of Piscis Austrinus is not counted, then we have 316 stars

al-Kharaqī's description of the constellations is so similar to al-Ṣūfī's that we can be sure that his main source was al-Ṣūfī. Subsequently, He presents his table consisting of 84 stars, which is, upon his own saying, a reproduction of al-Ṣūfī's table, with a correction related to the precession rate, a degree for 66 years (see section 4)

We registered the ecliptic longitudes and latitudes of some stars in the table for the beginning of the year 1444 Alexandrian, whose night altitudes are needed for Nativities (*mawālīd*) and other beginnings, endings, and prorogations (*tasyīrāt*) for detecting conditions such as the fortunate and unfortunate (*saʿd wa naḥs*). [1]

al-Kharaqī introduces his criteria for the selection of these 84 stars, which are exclusively dictated by astrological purposes. Hence it can be compared to the star catalogue of astrolabe tradition, regarding that the astrolabes also were used for astrological practice. However, it seems that al-Kharaqī's list includes more stars than these treatises, as an example, Biruni's *ʾIstīʿāb*, lists only 38 stars to be engraved on the astrolabe ecliptical ring. These 38 stars are already included in al-Khraqī's catalogue.[2]

3.2. al-Kharaqī's table

The star table's format is principally similar in Ptolemy, al-Ṣūfī, and Bīrūnī. There are four columns: local description of the stars, ecliptic longitude, ecliptic latitude, and magnitude; the order is from the most northern constellation, Ursa Minor (*al-Dubb al-ʾAsghar*), to the most southern one, Piscis Austriuns (*al-Ḥūt al-Junūbī*). al-Kharaqī's table, for its 84 stars, has their names instead of local description, and the order is arbitrary. (See table 3)

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[1] ʿabd al-Jabbār al-Kharaqī (2020, p. 99. Paragraph [197])
وقد أثبَتُّ مواضع طايفة من جملة هذه الكواكب في الطول والعرض في جداول لأوّل سنة ألف وأربعمائة وأربعة وأربعين من تأريخ ذى‌القرنين ممّا يكثر الحاجة إليها في الارتفاعات الليلية للمواليد وساير الابتداآت ومواضع الانتهاآت والتسييرات في معرفة الأحوال من السعادات والنحوسات وغيرها

[2] Bīrūnī (2001, pp. 35-50).

Table (3): al-Kharaqī's Star catalogue (for a critical edition: see appendix)

Number	Star name	Longitude	Latitude	Magnitude	Modern Identification
1	juday wa huwa dhanab al-dubb al-ʾaṣghar	Gem 15;7	N 67;0	3	α UMi
2	ʾanwar al-farqadayn	Leo 2;7	N 72;50	2	β UMi
3	ʾakhfā al-farqadayn	Leo 11;7	N 74;50	3	γ UMi
4	al-jawn	Leo 27;7	N 53;30	2	ε UMa
5	al-ʿināq	Vir 2;57	N 55;40	2	ζ UMa
6	al-qāʾid	Vir 17;46	N 57;0	2	η UMa
7	al-ʿayyūq	Gem 9;57	N 22;30	1	α Aur
8	al-kaff al-khaḍīb	Ari 22;47	N 51;40	3	β Cas
9	al-nasr al-wāqiʿ	Cap 2;17	N 62;0	1	α Lyr
10	al-nasr al-Ṭāʾir	Cap 18;47	N 29;10	2	α Aql
11	al-ridf	Aqr 22;7	N 67;0	2	α Cyg
12	minqār al-dajājat	Cap 17;7	N 49;20	3	β Cyg
13	al-nayyir min al-fakkat	Lib 29;37	N 45;30	2	α CrB
14	al-simāk al-rāmiḥ	Lib 11;57	N 31;30	1	α Boo
15	mirfaq al-thurayyā	Tau 19;47	N 30;0	2	α Per
16	raʾs al-ghūl	Tau 15;37	N 23;0	2	β Per
17	al-yad al-yumnā min barshāwūsh wa huwa al-suwayʿad	Tau 11;37	N 40;30	Nebular	--
18	raʾs al-hawwā wa yuqāl lah al-rāʿī	Sgr 9;57	N 36;0	3	α Oph
19	surrat al-faras	Ari 2;27	N 26;0	2	α And
20	janāḥ al-faras	Psc 27;7	N 12;30	2	γ Peg
21	mankib al-faras	Psc 17;7	N 31;0	2	β Peg
22	matn al-faras	Psc 11;37	N 19;40	2	α Peg
23	baṭn al-ḥūt	Ari 18;47	S 26;20	2	β And

Number	Star name	Longitude	Latitude	Magnitude	Modern Identification
24	al-dabarān	Tau 27;37	S 5;10	1	α Tau
25	raʾs al-tawʾam al-muqaddam	Cnc 8;17	N 9;40	2	α Gem
26	raʾs al-tawʾam al-muʾakhkhar	Cnc 11;37	N 7;15	2	β Gem
27	al-miʿlaf	Cnc 25;17	N 0;40	Nebular	--
28	qalb al-ʾasad al-falakī	Leo 17;27	N 0;10	1	α Leo
29	al-ṣarfat	Vir 9;27	N 11;50	1	β Leo
30	al-simāk al-ʾaʿzal	Lib 11;37	S 2;0	1	α Vir
31	al-ʾanwar min al-zubānā al-junūbī	Sco 2;57	N 0;40	3	α Lib
32	al-ʾanwar min al-zubānā al-shumālī	Sco 23;50	N 8;50	2	β Lib
33	qalb al-ʿaqrab	Sco 27;37	S 4;0	2	α Sco
34	al-shumālī min al-thalathat ʾallatī fī jabhat al-ʿaqrab	Sco 21;17	N 1;20	3	β Sco
35	al-wasaṭ minhā	Sco 20;37	S 1;40	3	δ Sco
36	al-junūbī minhā	Sco 20;37	S 5;0	3	π Sco
37	al-tālī li-jabhat al-ʿaqrab	Sgr 16;7	S 13;15	Nebular	--
38	ʿayn al-rāmī	Cap 0;7	N 0;45	Nebular	--
39	fam al-ḥūt al-junūbī wa huwa al-ḍafdaʿ al-ʾawwal	Aqr 21;57	S 23;0	1	α PsA
40	al-kaff al-jadhmā	Tau 2;37	S 17;20	3	α Cet
41	yad al-jawzāʾ al-yumnā	Gem 16;57	S 17;0	1	α Ori
42	mankib al-jawzāʾ al-yusrā wa yuqāl lah al-marzam	Gem 8;57	S 17;30	2	γ Ori
43	rijl al-jawzāʾ al-yusrā	Gem 4;47	S 31;30	1	β Ori

Number	Star name	Longitude	Latitude	Magnitude	Modern Identification
44	al-wasaṭ min al-minṭaqat	Gem 12;16	S 24;50	2	ε Ori
45	al-rijl al-yumnā min al-jawzāʾ	Gem 15;7	S 33;30	3	κ Ori
46	ākhir al-nahr	Ari 15;7	S 53;30	1	θ Eri
47	al-shiʿrā al-yamāniyyat wa hiya al-ʿabūr	Cnc 2;37	S 39;10	1	α CMa
48	al-shiʿrā al-shāmiyyat wa hiya al-ghumayṣāʾ	Cnc 14;7	S 16;10	1	α CMi
49	suhayl	Cnc 2;7	S 75;0	1	α Car
50	al-fard	Leo 14;57	S 20;30	2	α Hya
51	janāḥ al-ghurāb al-ʾayman	Lib 1;37	S 12;30	3	γ Crv
52	rijl qanṭūris al-yumnā	Lib 23;17	S 41;10	1	α Cen
53	rijlih al-yusrā	Sco 11;47	S 42;20	2	β Cen
54	ʿamūd al-ṣalīb	Aqr 2;37	N 29;10	3	ε Del
55	qābiḍ al-thurayyā	Tau 20;17	N 27;50	4	σ Per
56	ḥajfalat al-faras	Aqr 20;27	N 22;30	3	ε Peg
57	al-ʾanwar min saʿd al-bahāʾim	Psc 3;47	N 18;0	3	ζ Peg
58	dhanab qayṭis	Psc 19;17	S 9;40	3	ι Cet
59	dābbat al-Simāk wa huwa aḥad kawkabay al-rumḥ	Lib 17;57	N 40;15	3	ε Boo
60	al-thānī min kawkabay al-rumḥ	Lib 6;17	N 28;0	3	η Boo
61	rijl al-ʿayyūq	Gem 17;47	N 22;0	2	β Aur
62	rukbat al-rāmī	Cap 1;57	S 18;0	3	α Sgr

Number	**Star name**	**Longitude**	**Latitude**	**Magnitude**	**Modern Identification**
63	al-dhīkh wa huwa dhakar al-ḍibāʿ	Vir 27;37	N 70;0	3	ι Dra
64	ʾaḥad al-dhiʾbayn…	Vir 23;17	N 87;7	3	ζ Dra
65	al-thānī minhumā	Vir 24;57	N 78;0	3	η Dra
66	al-jāthī	Sgr 2;37	N 37;30	3	α Her
67	al-ḍafdaʿ al-thānī	Psc 20;37	S 20;20	3	β Cet
68	ʿunuq al-ḥayyat	Sco 9;17	N 25;20	3	α Ser
69	aḥad kawkabay ʿaḍud al-thurayyā	Tau 22;37	N 20;20	3	δ Per
70	al-thānī minhumā	Tau 21;47	N 21;50	4	ν Per
71	ʿātiq al-thurayyā aḥad kawkabayh	Tau 19;7	N 12;0	3	o Per
72	al-thānī minhumā	Tau 21;17	N 11;0	3	ζ Per
73	dhanab al-jady	Aqr 11;17	S 2;0	3	δ Cap
74	raʾs al-muthallath	Ari 26;57	N 16;30	3	α Tri
75	qarn al-thur wa huwa kaʿb dhi al-ʿinān	Gem 10;37	N 5;0	2	β Tau
76	al-nāṭiḥ	Ari 26;37	N 10;0	3	α Ari
77	ẓahr al-ʾasad	Leo 29;29	N 13;40	2	δ Leo
78	ʿurqūb al-rāmī	Cap 2;37	S 23;0	4	β Sgr
79	mankib al-ʾasad	Leo 17;7	N 8;30	2	γ Leo
80	rijl al-musalsalat wa huwa al-ʿināq	Tau 1;47	N 28;0	3	γ And
81	kabid al-ʾasad bayn al-qāʾid. wa al-faqrat al-ʾawlā	Vir 12;47	N 39;45	3	α CVn
82	aḥad kawkaby	Ari 25;57	N 16;30	3	α Tri

Number	Star name	Longitude	Latitude	Magnitude	Modern Identification
	al-ʾanīsayn				
83	al-thānī minhumā	Tau 0;57	N 20;40	3	β Tri
84	al-ʾubayyiḍ	Ari 1;37	N 69;0	3	α Cep

3.3. The Table Comparison

In this section, we compare al-Kharaqī’s catalogue to Ptolemy’s and al-Ṣūfī’s. We deemed it necessary because it is essential for connecting al-Kharaqī’s list, based on star names to its source based on local descriptions. The result was to find some discrepancies.

3.3.1. On the star number 74

It is called the vertex of the triangle (*Raʾs al-Muthallath*, α Tri), but its ecliptic longitude is different from α Tri. In the other row of the table, al-Kharaqī mentions the star α Tri as star number 82, called “one of the two companion stars” (*aḥad kawkabay al-anīsayn*) because this star and star β Tri form companions (*anīsayn*). The ecliptic longitude of No. 74 is Ari 26;57 while it is Ari 25;57 in No. 82 although, their ecliptic latitude (N 16:30) and magnitude (3) are the same. There is no better explanation than it could be the result of al-Kharaqī’s mistake. In Arabic alphanumeric script, we would have كو for 26 and كه for 25. so those numbers could be confused

3.3.2. On the star number 62

The star magnitudes are not similar in *Ṣuwar al-kawākib* and *Almagest*; al-Ṣūfī wrote that he had edited magnitudes upon his observation, an observation made by the naked eye.The 76 of 84 [1] stars have the same magnitude in *Ṣuwar* and *Almagest*. al-Kharaqī, for five of the eight remaining stars, expectedly, mentions the magnitude presented by al-Ṣūfī. The three other stars, two of them are according to Ptolemy, and the third has a different magnitude of both, indeed the magnitude of this star, α Sgr, is al-Kharaqī's own report (see Table 4). Its magnitude is two in *Almagest*, four in *Ṣuwar*, and three in *Muntaha*…. The star brightness is altering gradually over time in a way that is detectable by the naked eye. On the other hand, magnitudes are subjective in a way that latitudes and longitudes are

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[1] al-Ṣūfī (1986, p. 32)

not. In this case, it seems that Ptolemy's report was not accurate, so al-Ṣūfī tried to replace a suitable magnitude in comparison with other stars. al-Kharaqī found al-Ṣūfī's magnitude excessive so he presents the magnitude between Ptolemy's and al-Ṣūfī's magnitude. Regarding that the star magnitudes are subjective values; the revision of these values is an interesting part of star tables.

Table (4): discrepancies between al-Kharaqī, Ptolemy, and Ṣūfī in star magnitudes

Number	Modern Identification	Kharaqī	Ptolemy	Ṣūfī
3	γ UMi	3	2	3
23	β And	2	3	2
31	α Lib	3	2	3
32	β Lib	2	2	3
54	ε Del	3	3	4
62	α Sgr	3	2	4
75	β Tau	2	3	2
78	β Sgr	4	2	4

3.3.3. On the star number 51

There is an erratum about star number 51. On the constellation Corvus, we have two stars on the left-wing (*janāḥ al-ghurāb al-ʾayman*) and right wing. Kharaqī mistakenly registers the left. star's ecliptic coordinates for the star on the right.

However, some discrepancies in latitudes are found in the comparison between *Muntaha* and *Ṣuwar*, and *Almagest* (see Table 5). The source of the discrepancies is not readily identifiable; it could be produced by a range of different probable causes, from scribes' inexactitude to an unknown source of Kharaqī's, i.e. it is possible that Kharaqī profited from another star table than Ṣūfī's.

Table (5): discrepancies between Kharaqī, Ptolemy, and Ṣūfī in star latitudes

Number	Modern Identification	Kharaqī	Ptolemy	Lat. Ṣūfī
1	α UMi	N 67;0	N 66	N 66
6	η Uma	N 57;0	N 54	N 54
11	α Cyg	N 67;0	N 60	N 60

Number	Modern Identification	Kharaqī	Ptolemy	Lat. Ṣūfī
13	α CrB	N 45;30	N 44;30	N 44;30
26	β Gem	N 7;15	N 6;15	N 6;15
40	α Cet	S 17;20	S 12;20	S 12;20
51	γ Crv (on the right wing) δ Crv (on the left wing)	-- S 12;30	S 14;50 S 12;30	S 14;50 S 12;30
53	β Cen	S 42;20	S 45;20	S 45;20
59	ε Boo	N 40;15	N 40;20	N 40;15
61	β Aur	N 22;0	N 20	N 20
64	ζ Dra	N 87;7	N 84;50	N 84;50
69	δ Per	N 20;20	N 27;20	N 27;20

4. On the Precession

The date of the redaction of astronomical work, including data on fixed stars, could be determined by subtracting its values from Ptolemy's or al-Ṣūfī's values and dividing the result by the rate of precession because many of these works explicitly give *Almagest* or *Ṣuwar* as their principal source. However, the rate of precession is not unique. Moreover, the concept of year in this definition is not clear, and in a few cases, a lunar year (Hijrī), instead of a standard solar year (Persian or Egyptian), was the base of the recalculation of the star coordinates.

The rate of precession is not unique because lack of a consensus on its value:

> - Ptolemy's value is one degree in 100 years which is as same as Hipparchus' value,-alin the Islamic period Farghānī and Ibn [1] Haytham have the same value;[2]
>
> - Al-Ṣūfī's value is one degree in 66 years,[3] Kūshyār stated that the rate of the precession is 54 seconds per year and a complete

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1. Ptolemy (1984, p. 328); Neugebauer (1975, p. 293).
2. Alfarganvs, (1669, p. 74); Langermann (1990, p. 61 Arabic text).
3. al-Ṣūfī, (1986, p. 31).

rotation takes 24,000 years,[1] the same value given by al-Ṣūfī. Most the Islamic astronomers accept this value for the rate of precession;

- Some other astronomers determine a more accurate value for precession such as one degree in 70 years.[2] The modern value for the rate of precession is one degree in 71.6 years,[3] so one degree in 70 years is the most precise value given in the Islamic period.

Kharaqī, as he says, reproduces the star catalogue according to the rule of one additional degree for every 66 years. Fortunately, in this case, Kharaqī explicitly says that the sum of additional values is two degrees and fifteen minutes which should be added to Ṣūfī's values.[4] The additional value 2;15 is equivalent to 148 years; hence, the table reproduction year should be 1424.

Supposing that Kharaqī's values are for the year 1444 of the Alexandrian era/526-527 A.H, as it is stated in most of *Munataha*'s manuscripts, we can check his values by Ṣūfī's and the interval period. Ṣūfī set his catalogue for the year 1276 of the Alexandrian era/353-354 A.H,[5] that is, 168 years before Kharaqī. Hence the added value, regarding one degree for 66 years, should be almost two degrees and thirty-three minutes. In this step, the star table's data indicates if the table production year is 1444 and the additional value should be 2;33; or the additional value is 2;15, and the production year should be 1424.

It could be verified by a star table written around the same time, ʿAbd al-Raḥmān al-Khāzinī compiled his *Zīj* titled *al-Zīj al-Muʿtabar al-Sanjarī,* in 509 A.H., which is the year 1427 of the Alexandrian

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[1] Kūshyār Jīlī, (fol. 105v).

[2] Caussin de Perceval (1803-1804, p.171); F.J. Ragep (1993, pp. 124-125 Arabic Text); Naṣīr al-Dīn al-Ṭūsī (*Īlkhānī Zīj,* p. 195); also see. Kennedy (1956, pp. 153,160, 163,165); Mozaffari (2008, p. 29).

[3] Mozaffari, (2008, p. 29).

[4] ʿabd al-Jabbār al-Kharaqī (2020, p. 99. Paragraph [197]).

[5] al-Ṣūfī, (1986, p. 31).

era.[1] The *Zīj* includes a fixed stars table containing 43 stars. Khāzinī noted that his table is a reproduction of the catalogue in *Almagest* by adding 15 degrees to star longitudes.[2] A study of this table shows that its values are three minutes more than Kharaqī's. (See Table 6) There are some discrepancies between the two catalogs which for the most part could be referred to as scribal errors; these rows are shown in Table 6 in different colors. Considering the additional value of al-Ṣūfi to *Almagest*, which is 12;42,[3] Kharaqī's additional value to *Almagest* is 14;57. The difference of three minutes illustrates that Khāzinī's table is produced three years after Kharaqī's table.

Table (6): a comparison between Kharaqī's star table and Khāzinī's in his *al-Muʿtabar*

Number in Kharaqī's catalogue	Modern Identification	Star names	Longitude in *al-Muʿtabar*	Longitude in *Montaha*
19	α And	raʾs al-marʾat al-musalsalat (Kharaqī: surrat al-faras)	Ari 2;50	Ari 2;27
46	θ Eri	ākhir al-nahr	Ari 15;10	Ari 15;7
23	β And	baṭn al-ḥūt	Ari 18;50	Ari 18;47
8	β Cas	Al-kaff al-khaḍīb	Ari 22;50	Ari 22;47
76	α Ari	al-nāṭiḥ	Ari 25;40	Ari 26;37
74 & 82	α Tri	raʾs al-muthallath	Ari 26;0	Ari 25;57
80	γ And	rijl al-musalsalat	Tau 1;50	Tau 1;47
16	β Per	raʾs al-ghūl	Tau 15;40	Tau 15;37
15	α Per	janb Barshāwūsh	Tau 19;50	Tau 19;47

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[1] Khāzinī's table is a reproduction of *Almagest*, as he explicitly indicated, but for the rate of the precession, he followed al-Ṣūfī, not Ptolemy. The period between Khāzinī, who flourished in the late 11th century, and Ptolemy (2nd century A.D.) is less than ten centuries; since he added 15 degrees to *Almagest* values, his rate of precession could not be the same as Ptolemy's because, in this case, the period between them would be fifteen centuries.

[2] Khāzinī, (fols. 191v-192r).

[3] al-Ṣūfī, (1986, p. 32).

Number in Kharaqī's catalogue	Modern Identification	Star names	Longitude in *al-Muʿtabar*	Longitude in *Montaha*
		(Kharaqī: mirfaq al-thurayyā)		
24	α Tau	al-dabarān	Tau 27;40	Tau 27;37
43	β Ori	rijl al-jawzā (Kharaqī: rijl al-jawzāʾ al-yusrā)	Gem 4;50	Gem 4;47
7	α Aur	ayyūq	Gem 10;0	Gem 9;57
41	α Ori	yad al-jawzā (Kharaqī: yad al-jawzāʾ al-yumnā)	Gem 17;0	Gem 16;57
49	α Car	suhayl	Cnc 2;10	Cnc 2;7
47	α CMa	al-shiʿrā al-Yamāniyyat	Cnc 2;40	Cnc 2;37
--	--	janb al-tawʾam al-tālī	Cnc 6;40	--
25	α Gem	raʾs al-tawʾam (al-muqaddam)	Cnc 8;20	Cnc 8;17
48	α CMi	al-shiʿrā al-shāmiyyat	Cnc 14;10	Cnc 14;7
50	α Hya	al-fard	Leo 15;0	Leo 14;57
28	α Leo	qalb al-asad	Leo 17;30	Leo 17;27
77	δ Leo	ẓahr al-asad	Leo 29;10	Leo 29;29
29	β Leo	al-ṣarfat	Vir 9;30	Vir 9;27
51	γ Crv	janāḥ al-ghurāb (Kharaqī: janāḥ al-ghurāb al-ʾayman)	Vir 28;30	Lib 1;37
30	α Vir	simāk al-aʿzal	Lib 11;40	Lib 11;37
14	α Boo	simāk al-rāmiḥ	Lib 12;0	Lib 11;57
52	α Cen	rijl qanṭūris (Kharaqī: rijl qanṭūris al-	Lib 23;20	Lib 23;17

Number in Kharaqī's catalogue	Modern Identification	Star names	Longitude in *al-Muʿtabar*	Longitude in *Montaha*
		yumnā)		
13	α CrB	al-munīr min al-fakkat	Lib 29;40	Lib 29;37
68	α Ser	ʿunuq al-ḥayyat	Sco 9;20	Sco 9;17
33	α Sco	qalb al-ʿaqrab	Sco 27;40	Sco 27;37
66	α Her	raʾs al-jāthī (Kharaqī: al-jāthī)	Sgr 2;40	Sgr 2;37
18	α Oph	raʾs al-ḥawwā	Sgr 9;50	Sgr 9;57
9	α Lyr	nasr al-wāqiʿ	Cap 2;20	Cap 2;17
10	α Aql	nasr al-ṭāʾir	Cap 18;50	Cap 18;47
12	β Cyg	minqār al-dajājat	Cap 19;30	Cap 17;7
54	ε Del	dhanab al-Dulfīn (Kharaqī: ʿamūd al-ṣalīb)	Aqr 2;40	Aqr 2;37
73	δ Cap	dhanab al-Jady	Aqr 11;20	Aqr 11;17
56	ε Peg	ḥajfalat al-faras	Aqr 20;20	Aqr 20;27
39	α PsA	fam al-ḥūt al-junūbī	Aqr 22;0	Aqr 21;57
11	α Cyg	dhanab al-dajājat (Kharaqī: al-ridf)	Aqr 24;10	Aqr 22;7
22	α Peg	matn al-faras	Psc 11;40	Psc 11;37
21	β Peg	mankib al-faras	Psc 17;10	Psc 17;7
58	ι Cet	dhanab qayṭis	Psc 19;20	Psc 19;17
20	γ Peg	janāḥ al-faras	Psc 27;10	Psc 27;7

In conclusion, the decisive date of Kharaqī's star catalogue is 1424. Close scrutiny of *Muntaha*'s five extant manuscripts shows that three manuscripts have 1444,[1] a manuscript has 1424 in the body of the text[2] and a manuscript has 1424 as a marginal note.[3] In *Muntaha*, there are at least two indications supporting that the book was written in 1444: 1- Kharaqī asserts that the degree of the apogee of the sun, the location of the north pole and the degrees of the apogees of the planets are for the year 526 A.H./1444 Alexandrian; 2- In the section on calendar conversions, most of the examples are for the year 526 A.H..[4] Hence, it is plausible to suggest the book was written in 1444, but that the star table is copied from a source relating to 1424 without further corrections for 1444.

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[1] ʿAbd al-Jabbār al-Kharaqī, *Muntaha al-ʾidrāk fī taqāsīm al-ʾaflāk*, MS. Bibliotheque nationale de France, Paris, no. arabe 2499, fol. 45v; MS. Majlis Shawra library, Tehran, no. 6413, fol. 60v; MS. Biblioteca Medicea Laurenziana, Florence, no. Orientali 110, fol. 35v.

[2] ʿabd al-Jabbār al-Kharaqī, *Muntaha al-Idrāk fī Taqāsīm al-Aflāk*, MS. Staatbibliothek zu Berlin, no. 33 Landberg, fol. 30r.

[3] ʿabd al-Jabbār al-Kharaqī, *Muntaha al-Idrāk fī Taqāsīm al-Aflāk*, MS. Taymūr, Dār al-Kutub, Cairo, no. Riyāḍiyyāt 111, fol. 49r.

[4] ʿabd al-Jabbār al-Kharaqī (2020, pp. 42-43 introduction).

References

Alfarganvs. (1669). *Elementa Astronomica*. Arabicé & Latiné, Opera Jacobi Golii. Amsterdam [reprinted in *Islamic Mathematics and Astronomy*. (1997). ed. by Fuat Sezgin. vols. 9-10. Frankfurt: Institute for the History of Arabic-Islamic Science].

ʿAbd al-Jabbār al-Kharaqī. (2020). *Muntaha al-Idrāk fī Taqāsīm al-Aflāk*. edited, introduction, and translation into Persian by Hanif Ghalandari. Tehran: Miras-e Maktoob.

ʿAbd al-Jabbār al-Kharaqī. *al-Tabṣira fī ʿIlm al-Hayʾa*. MS. Staatsbibliothek, Berlin, no. Landberg 669.

ʿAbd al-Jabbār al-Kharaqī. *ʿUmda-yi Khwārazmshāhī*. MS. Topkapi Library, no. R-1719.

Bīrūnī. (1432 AH/2001). *ʾIstīʿāb al-Wujūh al-Mumkina fī Ṣanʿat al-ʾUṣṭurlāb*, critical edition and research by Muhammad-Javad Akbari Hosseyni. Mashhad: Astan-i Qods. [Arabic].

Bīrūnī (1954). al-*Qānūn al-Masʿūdī*. 3 vols. Hyderabad, India: Osmania Oriental Publications Bureau.

Bīrūnī. (1988). *al-Tafhīm*. critical edition and annotated by Jalāl al-Dīn Humāʾī. Tehran: Homa Publishing.

Bohloul, H. (January 2017). *A Critical Edition, Translation, and Commentary of Ghiyāth al-Dīn Djamshīd Kāshānī's* Nuzhat al-Ḥadāʾiq *and its Appendices along with a Survey of Origin, Construction, and Use of the Equatorium* (Ṣafīḥa). a thesis submitted to the Graduate Studies Office for the degree of Ph.D. in History of Science in the Islamic Period, Faculty of Western studies and science research, Institute for Humanities and Cultural studies. [in Persian].

Caussin de Perceval, A.P. (1803-1804). Kitāb *az-Zīj al-Kabīr al-Ḥākimī… Notice et extradites des manuscrits de la Bibliothèque Nationale et autres bibliothèques* 7 (12), pp. 16-240 [reprinted in *Islamic Mathematics and Astronomy*. (1997). vol. 24. edited by Fuat Sezgin Frankfurt].

Ghalandari, H. (December 2007). *Critical Edition and Commentary of "Risāla al-Zubda al-Hayʾa" written by Khwāja Naṣir al-Dīn al-Ṭūsī*. a thesis submitted to the graduate studies for the degree of M.A. in History of Science, Department of theology and Islamic studies, University of Tehran [in Persian].

Kāshānī, Ghiyāth al-Dīn Jamshīd. *Lubāb-i ʾIskandarī*. MS. Majlis-i Shawra Library (Tehran), no. 6312.

Kennedy, E.S. (1956). A Survey of Islamic Astronomical Tables. *Transaction of the American Philosophical Society*, 46 (2), 123-175.

Khāzinī, ʿAbd al-Raḥmān. *al-Zīj al-Muʿtabar.* MS. Vatican Library, no. Arabo 761.

Kunitzsch, P. (2002). Albumasariana. *Annali Istituto Universitario Orientale di Napoli*, 62/1-4, 19-28 [Reprinted in *L'Orientale Open Archive*, 2016, pp. 1-10].

Kunitzsch, P. and Smart, T. (2006). *A Dictionary of Modern Star Names*. Cambridge: Sky publishing.

Kunitzsch, P. (2008). Stars in Arabic-Islamic Science. *Encyclopaedia of the History of Science, Technology, and Medicine in Non-Western Cultures*. New York: Springer-Verlag, 2008. pp. 2019-2020

Kunitzch, P. (1986). *der Sternkatalog des Almagest*. Band 1, Die arabischen Übersetzungen. Wiesbaden: Otto Harrassowitz.

Kūshyār Jīlī. *al-Zīj al-Jāmiʿ*. MS Fatih Library, no. 3418.

Langermann Y.T. (1990). *Ibn al-Haytham's on the Configuration of the World*. New York and London: Garland Publishing.

Mozaffari, S.M. (2008).Taqdīm-i Iʿtidālayn (the precession). *The Great Islamic Encyclopedia*, vol. 16. Tehran: The Center for the Great Islamic Encyclopedia. pp. 29-31. [in Persian]

Naṣīr al-Dīn Muḥammad al-Ṭūsī. (2020). *al-Risāla al-Muʿīniyya* and its Supplement. Edited by Sajjad Nikfahm-Khubravan and Fateme Savadi wit prefaces by F. Jamil Ragep and Hossein Masoumi Hamedani. Teharn: Miras-e Maktoob.

Naṣīr al-Dīn al-Ṭūsī. *Īlkhānī Zīj*, MS. UCLA, no. 1147-1462.

Nikfahm Khubravan, S. and Savadi, F. (Mordad 1390/ August 2011). A Review of treatise *Lubāb ʾIskandarī*. *ʿUlūm wa Funūn*, no. 52. pp. 54-63 [in Persian].

Neugebauer, O. (1975). *A History of Ancient Mathematical Astronomy*. 3 vols. New York: Springer-Verlag.

Ptolemy. (1984). *Almagest*. translated and annotated by G.J. Toomer. London: Duckworth.

Qūshjī. *Fārsī Hayʾat*. MS. Majlis-i Shawra Library (Tehran), no. 2141.

Quṭb al-Dīn al-Shīrāzī. *Ikhtīyārāt Muẓaffarī.* MS. Iranian National Library (Kitābkhānih Millī), no. 2609.

Quṭb al-Dīn al-Shīrāzī. *Nihayat al-Idrāk fī Dirāyat al-Aflāk*. MS. Koprulu library, no. 956.

Quṭb al-Dīn al-Shīrāzī. *al-Tuḥfa al-Shāhiyya*. MS. Majlis-i Shawra Library (Tehran), no. 6130.

Ragep, F.J. (1993). *Naṣīr al-Dīn al-Ṭūsī's Memoir on Astronomy* (*al-Tadhkira fī ʿIlm al-hayʾa*). New York: Springer-Verlag.

Ragep, S.P. (2016). *Jaghmīnī's Mulakhkhaṣ An Islamic Introduction to Ptolemaic Astronomy*. Switzerland: Springer.

Saliba, G. (1990). *The Astronomical Work of Muʾayyad al-Dīn al-ʿUrḍī Kitāb al-Hayʾa*. Beirut: Centre for Arab Unity Studies.

Sharaf al-Dīn al-Masʿūdī. (2003). *Jahān-i Dānish*. edited and introduced by Jalīl Akhavan Zandjani. Tehran: Miras-e Maktoob.

Sharaf al-Dīn al-Masʿūdī. *al-Kifāya fī ʿIlm al-Hayʾa*. MS. Hafezefendi Library, no. 154.

al-Ṣūfī, ʿAbd al-Raḥmān. (1986). *Ṣuwar al-Kawākib*. edited by Fuat Sezgin, Facsimile editions, vol. 29, reproduced from MS. Bodleian Library (Oxford), no. Marsh. 144. Frankfurt: Institute for the History of Arabic-Islamic Science.

Appendix

Kharaqī's catalogue
MS. Staatbibliothek zu Berlin, no. 33 Landberg, (B), fols. 30r-31r
MS. Bibliotheque nationale de France, Paris, no. arabe 2499, (P), fols. 46r-47v
MS. Majlis Shawra library, Tehran, no. 6413, (M), fols. 61r-62v
MS. Taymūr, Dār al-Kutub, Cairo, no. Riyāḍiyyāt 111, (Q), fols. 49v-51r
MS. Biblioteca Medicea Laurenziana, Florence, no. Orientali 110, (F), fols. 36r-37v

أسماء الكواكب الثابتة	أطوالها			عروضها		جهتها	عظمها	مواضعها في الصور
	بروج	درج	دقائق	درج	دقائق			
الجُدَي وهو ذَنَب الدب الأصغر	ب	يه[1]	ز[2]	سز[3]	ō	شمالي	جـ[4]	من كواكب الدب الأصغر[5]
أنور[6] الفرقدين	د	ب	ز[7]	عب[8]	ن[9]		ب	
أخفى الفرقدين	د[10]	يا	ز[11]	عد[12]	ن		جـ[13]	
الجَون	د[14]	كز[15]	ز[16]	نجـ[17]	ل[18]		ب	ذَنَب الدب الأكبر
العِناق	ه	ب[19]	نز[20]	نه	م		ب[21]	
القائد	ه	يز[22]	مو[23]	نز[24]	ō		ب	
العَيّوق[25]	ب	ط[26]	نز[27]	كب	ل		ا	منكب ذي العنان

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[1] F: د
[2] P: يز
[3] P: سو; F: يو
[4] F: د
[5] F: من كواكب الدب الأكبر
[6] F: نور
[7] P: يز
[8] M, Q, F: كب
[9] M, Q, F: ز
[10] F: ز
[11] P: يز
[12] M, Q, F: كد
[13] P: د
[14] P, F: ز
[15] F: كد
[16] P: يز
[17] D: يج
[18] F: ز
[19] P: جـ
[20] P: ز; F: نو
[21] P: ا
[22] B, P, F: يد
[23] P: نو; Q, F: يو
[24] P: ند
[25] F: add. كف الخضيب
[26] P: ى
[27] P: ز; M: يز; F: يو

أسماء الكواكب الثابتة	أطوالها			عروضها		جهتها	عظمها	مواضعها في الصور
	بروج	درج	دقائق	درج	دقائق			
الكَفُّ الخَضيب[1]	ō	كب	مز[2]	نا	م[3]	شمالي	جـ[4]	من كواكب ذات الكرسي
النَسر الواقع[5]	ط	ب	يز[6]	سب	ō		ا	من الصنج الرومي[7]
النَسر الطائر[8]	ط	يح	مز[9]	كط	ى		ب	من كواكب العقاب
الرِدف[10]	ى	كب[11]	ز[12]	سز[13]	ō		ب	وهو ذَنَب الدجاجة
منقار الدجاجة[14]	ط	يز	ز[15]	مط[16]	ك		جـ	
النيّر من الفكّة[17]	و	كط	لز[18]	مه	ل		ب	

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1. F: add. النسر الواقع
2. P, F: نز
3. P: و
4. P, Q, F: د
5. F: add. النسر الطائر
6. P: بس; F: ن
7. F: الرامي
8. F: add. الردف
9. P, Q, F: يز
10. F: add. منقار الدجاجة
11. M: كز; B: كد
12. P, Q, F: مز
13. P, Q, F: ک
14. F: add. النيّر من الفكّة
15. F: د
16. Q, F: يط
17. F: السماک الرامح
18. P, Q, F: ز

أسماء الكواكب الثابتة	أطوالها			عروضها		جهتها	عظمها	مواضعها في الصور
	برج	درج	دقائق	درج	دقائق			
السِماك الرامح[1]	و	يا	نز[2]	لا	ل	شمالي	ا	من كواكب العوّا،[3] خارج عن[4] الصورة
مرفق الثريا[5]	ا	يط	مز[6]	ل	ō		ب	وهو جنب برشاوش
رأس الغول[7]	ا	يه	لز[8]	كجـ	ō		ب	
اليد[9] اليمنى من برشاوش وهو السُوَيعَد[10]	ا	يا	لز	م[11]	ل		سحابي	مِعصَم الثريا
رأس الحوا و يقال له[12] الراعي	ح	ط	نز[13]	لو	ō[14]		جـ[15]	

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1. F: add. مرفق الثريا
2. P, F: يو
3. P: من كواكب الغول
4. F: om. عن
5. F: add. رأس الغول
6. P, F: يز
7. F: add. اليد اليمنى من برشاوش
8. P, Q, F: مز
9. M: اليه
10. F: add. رأس الحوا وهو الراعي; F: om. هو السُوَيعَد
11. F: مز
12. F: وهو
13. P, F: لز
14. F: كا
15. P, F: د

أسماء الكواكب الثابتة	أطوالها			عروضها		جهتها	عظمها	مواضعها في الصور
	بروج	درج	دقائق	درج	دقائق			
سُرَّة الفَرَس	ō	ب	كز[1]	كو	ō	شمالي	ب	
جَناح الفرس	يا	كز	ز	يب	ل		ب[2]	
مَنكب الفرس	يا	يز	ز	لا[3]	ō		ب	
متن[4] الفرس	يا	يا	لز	يط	م[5]		ب	
بطن الحوت	ō	يح	مز[6]	كو[7]	ك	جنوبي	ب	وهو جنب المسلسلة
الدَبَران[8]	ا	كز[9]	لز	ه	ى[10]		ا	وهو عين الثور[11]
رأس التوأم المقدم	جـ[12]	ح	يز	ط	م	شمالي	ب[13]	
رأس التوأم المؤخر	جـ[14]	يا	لز	ز	يه		ب	

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1. P, F: يز
2. M, Q: ا
3. M: ō
4. F: بطن
5. F: و
6. P, F: ک
7. Q: يو
8. F: البراق
9. Q: لز
10. P, F: ک
11. P: om. وهو عين الثور
12. F: د
13. P: ا
14. F: د

أسماء الكواكب الثابتة	أطوالها			عروضها		جهتها	عظمها	مواضعها في الصور
	بروج	درج	دقائق	درج	دقائق			
المِعلف	جـ	كه[1]	يز	ō	م	شمالي	سحابي	من كواكب السَرَطان
قلب الأسد الفلكي[2]	د	يز	كز	ō	ى[3]		ا	وهو الذي يقال له الملكي[4]
الصَّرفة	ه	ط	كز[5]	يا	ن	جنوبي	ا	وهو على ذَنَب الأسد
السِماك الأعزل	و	يا	لز	ب	ō		ا	وهو على راحة العذراء
الأنور من الزبانا الجنوبي	ز[6]	ب	نز[7]	ō	م		جـ	من كواكب الميزان
الأنور من الزبانا الشمالي	ز	كجـ	ن[8]	ح	ن[9]	شمالي	ب	من كواكب الميزان

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[1] P, F: كب; Q: يب

[2] B, M, Q, F: الملكي

[3] F: د

[4] F: om. وهو الذي يقال له الملكي

[5] F: كو

[6] F: ب

[7] P, Q, F: يز

[8] M, F: ز

[9] P, F: له

أسماء الكواكب الثابتة	أطوالها			عروضها		جهتها	عظمها	مواضعها في الصور
	بروج	درج	دقائق	درج	دقائق			
قلب العقرب	ز[1]	كز	لز[2]	د[3]	ō	جنوبي	ب	
الشمالي من الثلاثة التي في جبهة العقرب[4]	ز[5]	كا	يز	ا	ك	شمالي	جـ[6]	
الوسط منها	ز[7]	ك	لز	ا	م	جنوبي[8]	جـ	
الجنوبي منها	ز	ك	لز	ه	ō	جنوبي	جـ[9]	
التالي[10] لجبهة[11] العقرب	ح	يو[12]	ز	يجـ	يه		سحابي	
عين الرامي	ط	ō	ز	ō	مه	شمالي	سحابي	

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1. M, Q: و
2. P: نز; F: يز
3. P, F: جـ
4. B: ... من الستة التي في ناحية العقرب; P: الشمالي من السلة; Q: الشمالي إلى ناحية العقرب; F: من الثلاثة في ناحية العقرب الشمالي من السلسلة
5. P, M, Q: و
6. P: د
7. P, M, Q: و
8. F: شمالي
9. P: يجـ
10. F: اتالي
11. P: لجملة
12. M: يز

أسماء الكواكب الثابتة	أطوالها			عروضها		جهتها	عظمها	مواضعها في الصور
	بروج	درج	دقائق	درج	دقائق			
فَم[1] الحوت الجنوبي وهو الضَفَدَع الأوّل[2]	ى	كا	نز[3]	كجـ	ō	جنـــــوبي	ا	
الكَفّ الجَذما	ا	ب	لز[4]	يز	ك		جـ	وهو الثاني من صورة[5] قَيطِس
يد الجَوزاء اليمنى	ب	يو[6]	نز[7]	يز	ō		ا	
مِنكب الجَوزاء اليُسرى ويقال له المَرزَم[8]	ب	ح	نز[9]	يز	ل		ب	من كواكب الجبار
رجل الجَوزاء اليسرى	ب	د[10]	مز[11]	لا	ل[12]		ا	

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1. B, P: om. فم
2. F: om. وهو الضَفَدَع الأوّل
3. P: ز
4. B, Q: كز; P: نز
5. F: om. صورة
6. F: يز
7. P: كز; F: يز
8. F: مِنكَب الجَوزاء وهو المرزَم
9. P, F: يو; Q: يز
10. P, F: جـ
11. P: س; F: ن
12. P, F: د

أسماء الكواكب الثابتة	أطوالها			عروضها		جهتها	عظمها	مواضعها في الصور
	بروج	درج	دقائق	درج	دقائق			
الوسط من المنطقة[1]	ب	يب	يو	كد[2]	ن[3]	جنوبي	ب	
الرجل اليمنى من الجَوزاء	ب	يه	ز	لجـ[4]	ل		جـ	
آخر النَهر[5]	ō	يه	ز	نجـ[6]	ل		ا	
الشِعرى اليَمانية وهي[7] العَبور[8]	جـ	ب	لز	لط[9]	ى[10]		ا	من كواكب الكلب الأكبر[11]
الشِعرى الشامية[12] وهي الغُمَيصاء[13]	جـ	يد	ز	يو	ى[14]		ا	من كواكب الكلب الأصغر
سُهَيل	جـ[15]	ب	ز	عه[16]	ō		ا	من كواكب السفينة

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[1] F: وسط المنطة

[2] M: كز

[3] B: نز; P, Q, F: ند

[4] F: يجـ

[5] P: آخر الزهرة

[6] P, F: ط

[7] M, P: هو

[8] F: om. وهي العَبور

[9] M: يط

[10] P, F: د

[11] M, F: om. الأكبر

[12] P: اليمانية

[13] F: om. وهي الغُمَيصاء

[14] P, F: د

[15] P: د

[16] M, P, F: كه

أسماء الكواكب الثابتة	أطوالها			عروضها		جهتها	عظمها	مواضعها في الصور
	بروج	درج	دقائق	درج	دقائق			
الفَرد[1]	د[2]	يد[3]	نز[4]	ک[5]	ل	جنوبي	ب	من كواكب الشجاع
جناح الغراب الأيمن[6]	و	ا	لز[7]	يب	ل		جـ[8]	
رجل قَنطورس اليمنى	و	کجـ[9]	يز	ما	ی		ا	
رجله اليسرى	ز[10]	يا	مز	مب	ک		ب	
عمود الصليب	ی[11]	ب	لز[12]	کط	ی[13]		جـ	وهو ذَنَب الدلفين
قابض الثريا[14]	ا	ک	يز	کز[15]	ن[16]	شمالي	د	من كواكب برشاوش
حَجفلة الفرس	ی[17]	ک	کز[18]	کب[19]	ل		جـ[20]	من كواكب الفرس الأعظم

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1. P, Q, F: القرد
2. B: جـ
3. M: يه
4. F: يز
5. M, Q: كه
6. F: اليمين
7. F: لو
8. P, F: د
9. Q: لجـ
10. P, F: و
11. P, Q, F: د
12. P: لب; Q: يز
13. P, F: د
14. M, F: مابض الثريا
15. F: كو
16. M, P, Q, F: ز
17. P, F: د
18. Q: لز
19. P, Q: كز; F: كو
20. B: د

أسماء الكواكب الثابتة	أطوالها			عروضها		جهتها	عظمها	مواضعها في الصور
	بروج	درج	دقائق	درج	دقائق			
الأنور من سعد البهائم	يا	جـ	مز	يح	ō		جـ	من كواكب الفرس الأعظم
ذَنَب قَيطِس	يا	يط	يز	ط	م	جنوبي	جـ	
دابة السماک وهو أحد كوكبي الرمح[1]	و	يز[2]	نز[3]	م[4]	يه	شمالي	جـ	من كواكب العوا
الثاني من كوكبي الرمح	و	و	يز	كح[5]	ō		جـ	
رجل العيوق	ب	يز	مز[6]	كب	ō		ب	من كواكب ذى العنان[7]
ركبة الرامى	ط	ا	نز[8]	يح[9]	ō	جنوبي	جـ	

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1. Q: راية السماک وهو أحد كوكبي الرامح; F: السماک من كوكبي الرمح
2. P, Q: ند; B, F: يد
3. F: يز
4. P, F: هـ
5. P, F: يا
6. P, F: يز
7. F: om. من كواكب ذى العنان
8. Q, F: يز
9. M, Q, F: لح

أسماء الكواكب الثابتة	أطوالها			عروضها		جهتها	عظمها	مواضعها في الصور
	برج	درج	دقيقة	درج	دقيقة			
الذيخ[1] وهو ذكر الضباع	ه	كز	لز	ع[2]	ō	شمالي	جـ[3]	من كواكب التنين
أحد الذئبين وهما العَوهقان والجروان[4]	ه	كجـ	يز	فز[5]	ز[6]		جـ[7]	
الثاني منهما	ه[8]	كد	نز[9]	عح[10]	ō		جـ	من كواكب تنين
الجاثي	ح	ب	لز[11]	لز	ل		جـ[12]	وهو الذي[13] على رأسه
الضَفدَع الثاني	يا	ك	لز	ك	ك	جنوبي	جـ	من كواكب قَيطِس

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1. P: الذكر
2. Q: يح
3. Q: distorted; This line is not readable in B
4. P: والجوان; Q: om. والجروان; F: أحد التينين وهما
5. P, F: مه
6. B: ن
7. B, F: د
8. P, F: ح
9. F: يز
10. P, F: كح
11. P, Q, F: لو
12. F: د
13. F: التي

أسماء الكواكب الثابتة	أطوالها			عروضها		جهتها	عظمها	مواضعها في الصور
	بروج	درج	دقائق	درج	دقائق			
عُنق الحية	و[۱]	ط	يز[۲]	كه	ك	شمالي	جـ	
أحد كوكبي عضد الثريا[۳]	ا	كب	لز	ك	ك		جـ[۴]	من كواكب برشاوش
الثاني منهما	ا	كا	مز	كا	ن[۵]		د	من كواكب برشاوش
عاتق الثريا أحد كوكبيه[۶]	ا	يط	ز	يب	ō		جـ	
الثاني منهما	ا	كا	يز	يا	ō		جـ	
ذَنَب الجَدي	ى	يا[۷]	يز	ب	ō	جنوبي	جـ	
رأس المثلث[۸]	ō	كو[۹]	نز[۱۰]	يو[۱۱]	ل	شمالي	جـ[۱۲]	

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1. B, M, F: ز
2. M, P, Q, F: يو
3. F: عضد السها
4. F: د
5. P, F: ز
6. Q: أحد كوكبه; F: om. أحد كوكبيه
7. P, F: كو
8. B, P, Q, F: الملتهب
9. P, F: ى
10. P, F: يز
11. F: نو
12. B, Q, P, F: ب

أسماء الكواكب الثابتة	أطوالها			عروضها		جهتها	عظمها	مواضعها في الصور
	بروج	درج	دقائق	درج	دقائق			
قرن الثور وهو كعب[1] ذى العنان[2]	ب	ى[3]	لز	ه	ō	شمالي	ب[4]	مشترك بين صورة ذي العنان وبين قرن الثور
الناطح	ō	كو[5]	لز	ى[6]	ō		جـ[7]	من كواكب الحمل، خارج عن الصورة
ظهر الأسد	د[8]	كط[9]	كط	يجـ	م		ب[10]	
عُرقوب الرامي	ط	ب[11]	لز	كجـ	ō	جنوبي	د[12]	

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1. F: كف
2. B, P, Q: كف العنان
3. P, F: مو
4. P, F: جـ
5. P, F: كط
6. F: ک
7. P, F: ب
8. P, Q: ز
9. P, F: ب
10. P, F: جـ
11. P, F: يز
12. P, F: ب

أسماء الكواكب الثابتة	أطوالها			عروضها		جهتها	عظمها	مواضعها في الصور
	بروج	درج	دقائق	درج	دقائق			
مِنكَب الأسد	د[1]	يز[2]	ز[3]	ح	ل	شمالي	ب[4]	
رِجل المسلسلة وهو العناق[5]	ا	ا[6]	مز[7]	كح	ō		جـ[8]	
كبد الأسد بين القائد والفقرة الأولى[9]	ه	يب[10]	مز	لط[11]	مه		جـ[12]	خارج عن الصورة الدب الأكبر
أحد كوكبي الأنيسين[13]	ō	كه[14]	نز[15]	يو	ل		جـ	من كواكب المثلث يطلعان قبل الشرطين
الثاني منهما	ا	ō	نز[16]	ك[17]	م[18]		جـ[19]	
الأُبيّض	ō	ا	لز	سط[20]	ō		جـ[21]	على مِنكب المُلتهب

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[1] P: ز

[2] P, F: ا

[3] F: م

[4] P, F: جـ

[5] F: om. وهو العناق

[6] B, F: ب, P, Q: يب

[7] P, F: م

[8] P, F: ب

[9] M: القفرة; B: القفزة; F: om. كبد الأسد بين

[10] P, Q: كه; F: كط

[11] M: لو; P: يط

[12] P: ب

[13] F: الأسعدين

[14] P, Q, F: ō

[15] P, F: يز

[16] P, F: يز

[17] B: كب; P, F: سط

[18] P, F: ō

[19] F: د

[20] P, Q, F: د

[21] F: د