

# From Alamut to Dadu: Jamāl al-Dīn's Armillary Sphere on the Mongol Silk Roads

ISAHAYA YOICHI\*

Hokkaido University, Kita 9, Nishi 7, Kita-ku, Sapporo

Received: September 13, 2019 • Accepted: March 19, 2020

© 2021 Akadémiai Kiadó, Budapest



## ABSTRACT

This article aims to shed light on a hitherto unknown transmission route of the astral sciences from Alamut to Dadu (Beijing). I argue that the *huntianyi* 渾天儀, an armillary sphere, which Jamāl al-Dīn dedicated to Qubilai in 1267, was designed in Alamut – the main stronghold of the Nizārī Ismāʿīlīs – on the grounds that the instrument was set to Alamut's latitude. After its fall in 1256, the armillary sphere traversed the Mongol Silk Roads. The *Dastūr al-munajjimīn*, an Arabic work of the Nizārī Ismāʿīlīs, functions as the missing link in this West-to-East transmission.

## KEYWORDS

Mongol empire, Ilkhanid dynasty, Yuan dynasty, *dhāt al-ḥalaq* (*zantu halaji* 咱秃哈刺吉), *huntianyi* 渾天儀 (armillary sphere), Jamāl al-Dīn (Zhamaluding 札馬魯丁), *Dastūr al-munajjimīn*.

\* Corresponding author. E-mail: yoichi.isahaya@slav.hokudai.ac.jp

## INTRODUCTION: THE MARAGHA AND DADU OBSERVATORIES

The political unification of Central Eurasia by the Mongols in the thirteenth century prompted the cross-cultural exchange of peoples, materials and ideas on a Eurasian scale. Adhering to the heavens/Tengri, the Mongols' actions were based on the principle of mirroring heavenly portents in their earthly activities. As a result, quite a few specialists in astral sciences from different intellectual backgrounds were gathered at the courts of the Mongol elites, either voluntarily or forcibly, which opened up the possibility of conflation among different astral traditions in Eurasia. As shown in Thomas Allsen's masterpiece on cross-cultural exchange in Mongol Eurasia, the cultures of this period were characterized by the Mongol conquest and their subsequent rule (Allsen 2001).

Due to the great importance of the cultural materials trafficked across Eurasia during this period, astral sciences have attracted scholarly attention since the earliest researchers, for example, by historians of civilizations such as George Sarton (1931) and Joseph Needham (1959). In addition to Allsen, Benno van Dalen (2002) provides us with a reliable historiography of this subject on the basis of the rigorous re-examination of studies which had accumulated until the turn of the twenty-first century. In the context of East Asia, the astral sciences of this period pivot upon the *Shoushi li* 授時曆 [Season-Granting Astronomical System], the official astronomical system of the Yuan Dynasty (1271–1368). On this subject, Yamada Keiji's monograph (1980) provided a broad perspective, comprehensive of the socio-intellectual traditions involved, while more recently Nathan Sivin (2009) accomplished an English translation of the astronomical system with a massive commentary that explores it from many different historical, social and scientific angles. Based on such solid foundations, the understanding of this subject has been deepened with more recent studies; for example, Miya Noriko (2016) refers to astral sciences to a certain extent in her discussion about the East-West exchange of knowledge during the Mongol period; Yang Qiao (2019) details the mobility of astronomers/astrologers in Mongol Eurasia, while Isahaya Yoichi (2020) pays attention to a cross-cultural 'astronomical dialogue' between Naṣīr al-Dīn al-Ṭūsī (1201–74) and Fu Mengzhi 傅孟質.

However, this accumulation of studies on cross-cultural exchanges relative to astral sciences in Mongol Eurasia has not necessarily been cross-referenced, which caused the situation that sometimes unfounded arguments are considered to be 'facts'. Under these circumstances, this article aims to mitigate the confusion by a combination of re-reading existing sources and providing new materials. The combination leads us to finding a missing link between Alamut and Dadu, in which Jamāl al-Dīn (Zhamaluding 札馬魯丁: d. ca. 1289) had a significant role.

At the beginning, I attempt to re-examine the argument of direct connection between the observatories in Maragha and Dadu, both of which were established under Mongol rule in the thirteenth century. As it turns out, the argument cannot be founded on any text-based evidence.

Rashīd al-Dīn's (ca. 1247–1318) *Jāmi' al-tawārikh* [Collection of Histories], one of the most important historical sources for the Mongol empire (1206–1368), recounts the details of the establishment of the Maragha observatory, beginning with the report that Möngke (r. 1251–59), the fourth Grand Khan, planned to found an observatory, perhaps in Qaraqorum, the capital of the United Mongol Empire. According to this, although Möngke first entrusted Jamāl al-Dīn with preparing for its construction, he was unable to accomplish this task. As a result, Möngke ordered his brother Hülügü (1218–65) to send Naṣīr al-Dīn al-Ṭūsī (1201–74) – a famed polymath in the Iranian Plateau – on this mission when the khan dispatched him to the land of Iran (JT, 2:



1024; Allsen 2001: 167). However, the succession struggle subsequent to Möngke's sudden death in 1259 detained Hülägü in Iran and Iraq, where he eventually inaugurated his own Ulus/state, that is, the Ilkhanid dynasty (ca. 1256–1353). As a close advisor of the khan, Tūsī initiated the construction of an observatory in Maragha, the early capital of the dynasty. The observatory was completed in 1259 (TW: 100; MA, 3: 54–56).

On the other hand, in the case of the Yuan dynasty, the Observatory of the Han Chinese (*Haner sitiantai* 漢兒司天臺) already functioned from 1260 in Dadu 大都, the capital of the dynasty, while the Observatory of the Westerners (*Huihui sitiantai* 回回司天臺)<sup>1</sup> was also established in 1271, at the same time that the aforementioned Jamāl al-Dīn was appointed as its director (YS, 1: 136; Yamada 1980: 58). In 1273, the two existing observatories were united when Jamāl al-Dīn was appointed director of the Imperial Library Directorate (*Mishujian* 秘書監), which was in charge of the united observatory (MZ: 115, 126; Yang 2017: 1235–36). The Yuan astronomical reform then commenced in 1276, lasting for four years and resulting in the compilation of the *Shoushi li*, known as the masterpiece of Chinese traditional astronomical systems (Yang 2017: 1236).

At the Maragha observatory, al-Ṭūsī compiled the *Zij-i ilkhānī* [Ilkhanid Astronomical Handbook] around 1272 on behalf of his master, Hülägü. When paying attention to the timing of the construction of the observatories and the compilation of the *Shoushi li* and *Zij-i ilkhānī*, such parallelism certainly tempts us to conjecture that the Dadu and Maragha observatories exchanged information, for example, about observational data, which would have reflected the contents of both works (Miya 2016: 30–31). However, no historical source – at least as far as existing ones are concerned – sustains such conjecture. In fact, shortly after the unification of the two observatories in Dadu, Liu Bingzhong 劉秉忠 (d. 1274) – one of Qubilai's trusted attendants – commanded that the two observatories should still report their official matters independently (MZ: 126; Yang 2017: 1236). This highly likely formed an obstacle to active collaboration between Chinese and 'western' astronomers. Regarding the aforementioned astronomical reform, too, as Yabuuti Kiyoshi (1997: 13) pointed out, the structure of the *Shoushi li* is entirely within the framework of the Chinese astronomical tradition, in which the influence of 'western' astronomy is only found in parts of instruments used in observations for the reform. In this context, Yang (2017: 1236–1237) also refers to the fact that there is no evidence for the participation of Jamāl al-Dīn and his 'western' colleagues in the reform.

A well-known attempt to unearth the West-to-East transmission of astral sciences was carried out by Willy Hartner, who aimed to identify seven 'western astronomical instruments' (*xiyu yixiang* 西域儀象) dedicated to Qubilai by Jamāl al-Dīn in 1267 (YS, 4: 998–999), by comparing them with instruments at the Maragha observatory which were explained in an Arabic treatise entitled *Risāla fī kayfiyat al-arṣād* [Treatise on the Method of Observations] (1261/62) by Mu'ayyad al-Dīn al-'Urḏī (d. ca. 1266), who was active at the Maragha observatory from the time of its construction. Following this comparison, Hartner confirmed the close relationship of both, which formed his well-known hypothesis that Jamāl al-Dīn may have come from the Maragha observatory with the seven instruments as a delegate to the Yuan court in 1267 (Hartner 1950: 192–193). Although Hartner's hypothesis has been sometimes treated as a living argument

<sup>1</sup> The term *huihui* is usually translated 'Muslims' in the case of the Yuan dynasty as well as later periods. However, in this period, especially in this context, the term includes non-Muslims who also came from the *xiyu* 西域, the western lands, such as Christians of the Church of the East. On this premise, the term is translated 'westerners' in this article.



(Needham 1959: 372–373; Prazniak 2018: 235–236), this has already been refuted by Yamada and Allsen. Jamāl al-Dīn first appears in the Chinese sources in a description of the time before Qubilai ascended the throne in 1260. The prince summoned ‘western’ astral scholars due to their high expertise in those sciences, and Jamāl al-Dīn was one of those who seized this opportunity (YS, 8: 2297; Yang 2017: 1233). The chronology also accords with the aforementioned description by Rashīd al-Dīn, who regards Jamāl al-Dīn as a person working for the construction of an observatory on behalf of Möngke (although the description shall be re-examined at the end of this article). Despite a certain similarity between the Maragha instruments and Jamāl al-Dīn’s ones, at least, there is no evidence to prove that Jamāl al-Dīn was at the Maragha observatory, whose construction began in 1258 at the earliest (Yamada 1980: 48–52; Allsen 2001: 166–167).

On the other hand, Jamāl al-Dīn was indeed engaging in a series of observations, perhaps together with his ‘western’ colleagues, at the Dadu observatory around 1275, which might have resulted in the compilation of a *zīj*/Islamicate astronomical handbook.<sup>2</sup> Although the original *zīj* has not come down to us, its contents are probably reflected in an extant one, that is, *al-Zīj al-sanjufīnī* [Sanjufīnī’s Astronomical Handbook], which was dedicated to a Mongol viceroy of Tibet in 1366. This *zīj* also shares a common archetype with the *Huihui li* 回回曆 [Islamic Astronomical System], the Chinese translation of a *zīj* in 1383, during the first decades of the Ming period (1368–1644) (van Dalen 2002: 336–339). However, this fact still does not sustain the aforementioned argument about the connection between the Maragha and Dadu observatories, because the contents of the *Zīj-i ilkhānī* were quite different from those of the two other *zījes*. That confirms for us that Jamāl al-Dīn carried out observations independent from those at the Maragha observatory (van Dalen 1999).

In addition, the *Zīj-i ilkhānī* itself was not necessarily produced on the basis of the fresh observations at the Maragha observatory. The introduction of the *Zīj-i ilkhānī* narrates that Hülägü urged al-Ṭūsī to complete the compilation of the *zīj* within a mere twelve years (ZI: 3v). To cope with the difficulty, al-Ṭūsī made use of his predecessors’ records of observations in their *zījes* to determine the parameters of the planetary motions and positions. Investigation into the contents of the *Zīj-i ilkhānī* confirms this: the parameters underlying the solar, lunar and planetary tables were in fact taken from those of *zījes* by Ibn al-A‘lam (d. ca. 985) and Ibn Yūnus (d. 1009), as well as ones by Ibn Yūnus and Abū Rayḥān al-Bīrūnī (973–ca. 1050) in the case of trigonometry (King & Samsó 2001: 46).<sup>3</sup> The core parts of the *Zīj-i ilkhānī*, therefore, do not depend upon the Maragha observations. This fact also works as a negative factor against the argument of the close relationship between the Dadu and Maragha observatories and their representative works, the *Shoushi li* and *Zīj-i ilkhānī*, because, let alone reflecting the exchange of observational data, the latter itself was not based on such data.

<sup>2</sup> On the *zīj* see, for example, Kennedy 1956 and King & Samsó 2001.

<sup>3</sup> This was based on the minute analysis of the tables of planetary mean motions in the *Zīj-i ilkhānī* by Faṭeme Sawādi and Sajjad Nik-Fahm (2012). On the other hand, a recent study also proves that some parameters are in fact not taken from previous *zījes* (Mozaffari and Zotti 2013: 56).



## LOOKING FOR LATITUDE 36°: JAMĀL AL-DĪN'S ARMILLARY SPHERE

As was discussed in the previous section, established evidence cannot be provided to sustain a direct connection between the Maragha and Dadu observatories. But, of course, this does not mean that the East-West exchange in the field of astral sciences is rejected totally. As already mentioned, 'western astronomical instruments', which were either brought to or constructed at the Yuan court, had some influence on Chinese astronomers.

Furthermore, in 1273, the Observatory of the Westerners sent to the Imperial Library Directorate a list of books at its disposal. This list included Euclid's *Elements* (Wuhuliede 兀忽列的), Ptolemy's *Almagest* (Maizheside 麥者思的), 'Abd al-Rahmān al-Šūfi's (903–986) *Šuwar al-ka-wākib al-thābita* [Book of the Constellations] (*Suwali kewaḡibi* 速瓦裏可瓦乞必), and Kūshyār ibn Labbān's (fl. second half 10th/early 11th century) *al-Madkhal fi šinā 'at aḡkām al-nujūm* [Introduction to Astrology] (*Mataheli* 麻塔合立) (MZ: 129–131).<sup>4</sup> The list also includes a work concerning chronology or history with the term of *tārīkh* (*Tielihei* 帖裏黑). Although the term had been previously considered to refer to some Persian or Arabic historical work, for example, by Abū Ja'far Muḥammad ibn Jarīr al-Ṭabarī (839–923) or 'Alā' al-Dīn 'Aṭā-Malik al-Juwainī (1226–1283) (Tasaka 1957: 112–113), Allsen (2001: 170) raised the possibility that it probably was Bīrūnī's *Āthār al-bāḡiya 'an al-qurūn al-khāliya* [The Chronology of Ancient Nations], in consideration of the Chinese annotation following the book title: 'Overview of the names of eras and nations' (*zong nianhao guoming* 總年號國名). This identification seems even more probable on the premise that the work was used at the Observatory of the Westerners. The observatory would have mainly benefited from technical works on astral sciences, so that the listed work may more likely to have been a work on calendars than on history. Although many other works on calendars were of course compiled in the Islamicate world, Bīrūnī's *Āthār al-bāḡiya* holds a unique position in the sense that the work covers both meanings of *tārīkh* – that is, both calendar and history.

Aside from the *Āthār al-bāḡiya* which shall be mentioned later, here I focus on another work of Bīrūnī's on astronomy, that is, *al-Qanūn al-mas'ūdī* [Mas'ūdī Canon] dedicated to Mas'ūd (r. 1030–1040) of the Ghaznavids (977–1186). *Al-Qanūn al-mas'ūdī* is a representative *zīj*, which consists of eleven *maqālas* (treatises) – each containing several chapters (*bābs*), some of which are further subdivided into sections (*faṣls*) – as follows: Maqāla I: Introduction dealing with the principles and basic concepts of astronomy as well as cosmology, time, and space; Maqāla II: Calendars such as the Hijri, Greek (i.e., Seleucid), and Persian; Maqāla III: Trigonometry; Maqāla IV: Spherical astronomy; Maqāla V: Geodesy and mathematical geography; Maqāla VI: Time differences, the solar motion, and the equation of time; Maqāla VII: Lunar motion; Maqāla VIII: Eclipses and crescent visibility; Maqāla IX: Fixed stars; Maqāla X: Planets; Maqāla XI: Astrological operations (Kennedy 1971; Yano 2013: 52).

High importance should be attached to Yano Michio's (2002) discovery that the first equation table of *al-Qanūn al-mas'ūdī* includes 'Bīrūnī's mistake', that was in fact inherited only by *al-Zīj al-sanjufīnī* and *Huihui li* – both productions based on 'Jamāl al-Dīn's observation' (ZS: 33v) –

<sup>4</sup> For the list and the identification of each work, see Tasaka 1957: 99–119 and van Dalen 2004: 25. Kūshyār's astrological work, like the *Huihui li*, was also translated into Chinese (as the *Tianwen shu* 天文書 [Book on Celestial Patterns]) in the early Ming period, no later than 1383 (Yano 1997).



among a number of extant *zījes*.<sup>5</sup> This fact strongly suggests that Jamāl al-Dīn, when compiling his *zīj* in China, had access to Bīrūnī's *al-Qanūn al-mas'ūdī* while also using his own observational data. The aforementioned booklist of the Observatory of the Westerners also includes a book entitled *jichi* 積尺, that is obviously a *zīj* in consideration of its phonetic transcription. The probability becomes more likely, when we also pay attention to the Chinese annotation of its title, 'various calendars' (*zhujiali* 諸家歷), since the first part of the *zīj* is generally assigned to the description of 'calendars', exactly like the case of *al-Qanūn al-mas'ūdī* (Maqāla II). But, if the *jichi* is to be identified with *al-Qanūn al-mas'ūdī*, we should consider the transmission route on Mongol Silk Roads. For this purpose, I re-examine an armillary sphere included in Jamāl al-Dīn's seven instruments.

As we have seen, Jamāl al-Dīn dedicated the seven 'western astronomical instruments' to Qubilai in 1267, but those were perhaps not brought from the Maragha observatory. However, there is no doubt that these instruments were certainly of 'western' origin. Here, among the seven, I deal with an armillary sphere (*dhāt al-halaq* in Arabic). In line with Hartner's hypothesis, Yang Qiao has recently suggested the assumption that Jamāl al-Dīn returned to the west – specifically to Maragha – during the late 1250s and early 1260s, and then he was sent back again to China. Her assumption derives from her interpretation of Jamāl al-Dīn's armillary sphere. On the premise that the armillary sphere was designed for latitude 36°, Yang (2017: 1235) interprets the latitude as an approximation to that of Maragha (37°20').<sup>6</sup> However, such an interpretation is somewhat problematic, in consideration of the exactness of observations at that time, both in eastern and western Eurasia. But, if so, why was the armillary sphere set at latitude 36°? In this article, I provide a new interpretation of this issue by focusing on Alamut, the main stronghold of the Nizārī Ismā'īlīs.

First, an English translation of the description of the armillary sphere should be provided for further discussion:<sup>7</sup>

*Dhāt al-halaq* (*zantu halaji*), or *huntianyi* (armillary sphere) in Chinese. That is designed with copper. There is a single circle parallel to the ground, in which the degrees of the celestial circumference are inscribed. The directions of the twelve earthly branches are [also] marked. There is a double circle which crosses [the first circle] at a right angle to the south and north. The half [of the double circle] is under the horizon. It is divided into the degrees of the celestial circumference. Inside [the first double circle], there is a second double circle, in which the degrees of the celestial circumference are also inscribed. [The double circles] are crossed and linked each other. The linked points which incline from

<sup>5</sup> The *zījes* to which Yano (2002: 41–42) referred are the following 15 astronomical handbooks: 1) Abū Maṣ'ūd, *al-Zīj al-mumtaḥan* (ca. 830), 2) al-Ḥabash al-Ḥāsib, *Kitāb al-Ḥabash al-Ḥāsib* (ca. 850), 3) al-Battānī, *al-Zīj al-ṣābi* (ca. 900), 4) Ibn Yūnus, *al-Zīj al-ḥākīmī* (ca. 990), 5) Kūshyār b. Labbān, *al-Zīj al-jāmī* (ca. 1000), 6) al-Bīrūnī, *al-Qanūn al-mas'ūdī* (1030), 7) al-Khāzinī, *al-Zīj al-sanjarī* (1120), 8) al-Ṭabarī, *Zīj-i mufrad* (ca. 1230), 9) al-Ṭūsī, *Zīj-i ilkhānī* (ca. 1272), 10) al-Maghribī, *Adwār al-anwār* (ca. 1280), 11) al-Baghdādī (ca. 1285), 12) Sanjar al-Kamālī, *Zīj-i ashrafi* (ca. 1310), 13) al-Sanjufīnī, *al-Zīj al-sanjufīnī* (1366), 14) Ibn Ishāq al-Tamīmī (ca. 14th), and 15) al-Kāshī, *Zīj-i Khāqānī* (ca. 1420).

<sup>6</sup> The armillary sphere was also used as evidence by Hartner (1950: 192) to support his hypothesis, on the grounds that an armillary sphere also operated at the Maragha observatory.

<sup>7</sup> For assistance in understanding the structure of the armillary sphere, I express my deep gratitude to Dr. Ōhashi Yukio. As he suggested, in Figure 1, I provide the image of Tycho Brahe's armillary sphere, which was based on the same principle as Jamāl al-Dīn's, to facilitate the understanding of the structure.





the horizon by 36 degrees are the south and north [celestial] poles. The [second double] circle turns around [the poles]. It represents the celestial motion and solar way. Inside [the second double circle], there are the third and fourth circles. They are linked to the second circle [at the ecliptic poles], which incline by 24 degrees to the south and north [celestial] poles. The circles turn around [the ecliptic poles]. All three circles are mobile. To each, a pair of bronze plates is attached. Each [of the latter] has a hole, through which observations are carried out.

咱禿哈刺吉，漢言混天儀也。其制以銅為之。平設單環，刻周天度，畫十二辰位，以準地面。側立雙環而結於平環之子午，半入地下，以分天度。內第二雙環，亦刻周天度，而參差相交，以結於側雙環，去地平三十六度以為南北極，可以旋轉，以象天運為日行之道。內第三，第四環，皆結於第二環，又去南北極二十四度，亦可以運轉。凡可運三環，各對綴銅方釘，皆有竅以代衡簫之仰窺焉。

(YS, 4: 998)

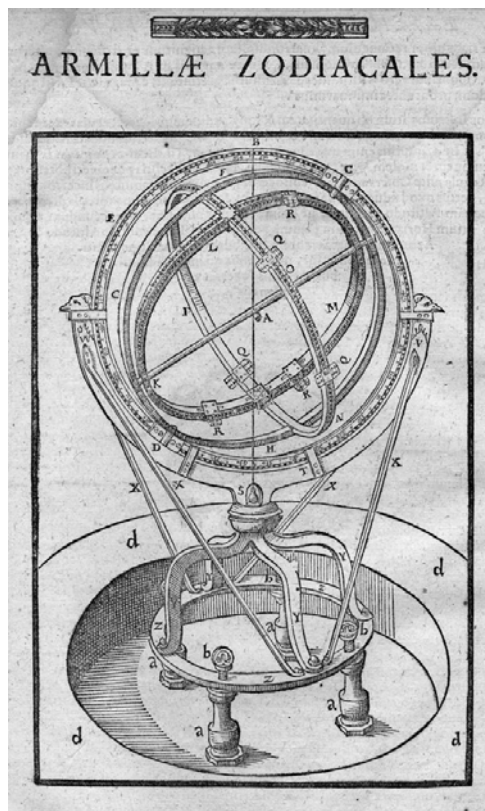


Figure 1: Armillary Sphere

From Tycho Brahe's *Astronomiae Instauratae Mechanica*.

The first circle: the horizon (not described); the first double circle: the prime meridian (EBG); the second double circle: the solstitial colure (CFIH); the third and fourth double circles: the ecliptic (POQN) and ecliptic meridian (KLRM); the north celestial pole (G) and north ecliptic pole (I).



The translation is based on Miyajima Kazuhiko's scrutiny of the 'western astronomical instruments'. Since the third instrument, a sundial for the equinoxes (*rukhāma-yi mu'awwaj*), is marked with 360 degrees of circumference, he supposes that the armillary sphere might also have been calibrated with the 'western' degrees (360°) rather than the Chinese ones (around 365°). On this understanding, he regards 'from the horizon by 36 degrees' as the 'western' latitude as we use it now, with the comments that latitude 36° is far south of Dadu (39°54') and Maragha (37°20') (Miyajima 1982: 411). On the other hand, Yang in focusing on 'by 24 degrees to the south and north [celestial] poles', considers the value to be 'inaccurate' in comparison with 23°30', which Muslim astronomers used even before that period (Yang 2017: 1235). It supports her aforementioned identification of a 'loose approximation to latitude 36°' with the latitude of Maragha. Her remarks are reasonable in that latitude 24° is inaccurate as the obliquity of the ecliptic, but I believe that there is still room to consider the meaning of latitude 36° in the historical context, especially of astronomers' traditions in the Islamicate world, as Yang did in the case of the obliquity.

## DASTŪR AL-MUNAJJIMĪN AS THE MISSING LINK

In examining the reason for latitude 36°, a (relatively) newly-discovered source should be taken into consideration; that is, the *Dastūr al-munajjimīn* [Manual of Astrologers]. Considerable importance is attached to this Arabic work as one of very few surviving sources ascribed to the Nizārī Ismā'īlī movement, especially those dating back to the period of Ḥasan-i Šabbāh (r. 1090–1124), its founder.<sup>8</sup> Although the work was mentioned in the early twentieth century, Moḥammad Karīmī Zanjānī Ašl, Eva Orthmann and Petra Schmidl (2017) recently conducted a close investigation into its entirety. On the basis of their analysis, the *Dastūr al-munajjimīn*, whose only known manuscript is the one preserved at the Bibliothèque nationale de France (Arabe 5968), consists of ten *maqālas* (treatises). Maqāla I–VIII are composed as a *zīj*, while Maqāla IX is specific to mundane astrology and Maqāla X is devoted to historiography.

Importantly in our context, Orthmann and Schmidl point out that especially in Maqāla I–VIII, the tables are based on latitude 36°, the midpoint of the fourth climate. It might also accord to the latitude of Alamut, the main stronghold of the Nizārī Ismā'īlīs, whose latitude is given in Persian *zījes* (including the *Zīj-i ilkhānī*) as 36°21' (cf. Kennedy & Kennedy 1987). The latitude 36° is also used in *al-Zīj al-šābi* by al-Battānī (d. 929) and *al-Zīj al-jāmi* by Kūshyār, two of the main sources of the *Dastūr al-munajjimīn* (Orthmann and Schmidl 2017: 29). Along with these two *zījes*, the astronomical part of this work to a large extent relies on Bīrūnī's *al-Qanūn al-mas'ūdī* (DM: e.g., 22r, 116r, 120r, 128r; Karīmī Zanjānī Ašl 2010: 228; Schmidl 2017: 40) as well as Šūfī's *Šuwar al-kawākib* (DM: e.g., 169r; Karīmī Zanjānī Ašl 2010: 228) and Kūshyār's *al-Madkhal* (DM: e.g., 238v–239r; Yano 1997: 138–142; Orthmann 2017: 80–81). In the historical part, Bīrūnī's *Āthār al-bāqīya* might have also been utilized along with *al-Qanūn al-mas'ūdī* (Karīmī Zanjānī Ašl 2013: 48–49). We cannot overlook the remarkable overlap of the sources of the *Dastūr al-munajjimīn* with the books on the booklist of the Observatory of the Westerners in Dadu.

Another feature worthy of attention concerning the *Dastūr al-munajjimīn* is related to Yano's discovery. As already mentioned, Yano revealed the close relationship between *al-Qanūn al-mas'ūdī* and two astronomical handbooks compiled in Yuan China – that is, the *Huihui li* and

<sup>8</sup> For the Nizārī Ismā'īlī movement, see Daftary 1990: 324–434.





the *al-Zij al-sanjufīnī* – in terms of the first equation table for Mercury. In light of the fact that *al-Qanūn al-mas'ūdī* is considered to be one of the main sources of the *Dastūr al-munajjimīn*, that work could function as a missing link between Alamut and Dadu. Here, I turn again to Jamāl al-Dīn's armillary sphere to trace the transmission route of the astral sciences.

Although Muḥammad Qazwīnī's assumption that the 'author(s)' of *Tārīkh-i jahān-gushā* made use of the *Dastūr al-munajjimīn* is reconsidered by Otsuka Osamu's (2017) recent investigation into its historical part, it is well known that, at the time of the fall of Alamut, 'Alā' al-Dīn 'Aṭā-Malik al-Juwainī (1226–1283) – the 'author' of *Tārīkh-i jahān-gushā* – rescued books and astronomical instruments from the famous library of the Alamut fortress:<sup>9</sup>

I suggested to the King that the valuable books in Alamūt ought not to be destroyed. He approved my words and gave the necessary orders; and I went to examine the library, from which I extracted whatever I found in the way of copies of the Qur'ān and [other] choice books after the manner of 'He brought forth living from the dead' (Q, XXX: 18). I likewise picked out the astronomical instruments such as *kursīs*, an armillary sphere (*dhāt al-halaq*), *astrolabium solipartium*, *astrolabium bipartium* and radial astrolabe.<sup>10</sup>

عرضه داشتم که نفایس کتب الموت را تضييع نتوان کرد. پادشاه آن سخن را پسندیده فرمود، و اشارت راند تا به مطالعه آن رفتم، و آنچه یافتم از مصاحف و نفایس کتب بر مثال «يُخْرِجُ الْحَيَّ مِنَ الْمَيِّتِ» بیرون آوردم، و آلات رصد از کراسی و ذات الحلق و اسطرلابهای تامة و نصفی و الشعاع دیگر که موجود بود، برگزفتم.

(TJG, 3: 270; Boyle 1997: 719; Jorati 2014: 134–135)

As noted in this quotation, there was an armillary sphere among the rescued instruments at the Alamut fortress of the Nizārī Ismā'īlīs. Marshalling the circumstantial evidence provided so far, I conclude that Jamāl al-Dīn's armillary sphere was designed in Alamut passing around latitude 36°. After the fall of Alamut in 1256 – and before 1267 when Jamāl al-Dīn dedicated the 'western astronomical instruments' to Qubilai – the armillary sphere was brought to the Yuan court with the rest of the 'Alamut collection', including Bīrūnī's *al-Qanūn al-mas'ūdī*, Kūshyār's *al-Madkhal* and al-Šūfī's *Šuwar al-kawākib*, perhaps with Bīrūnī's *Āthār al-bāqīya* and astronomical instruments.

The 'Alamut collection' was stocked at the Dadu observatory through the agency of Jamāl al-Dīn, who might have obtained access to the collection when he was already in Dadu. As an alternative hypothesis, however, I would also like to suggest the possibility that Jamāl al-Dīn was also active in Alamut. Of course, I shall address counter-evidence for this argument which appears, as already mentioned, in Rashīd al-Dīn's description of Jamāl al-Dīn, as follows:

[Möngke, owing to] his great wisdom and high mindedness, insisted that during his august reign an observatory (*raṣād*) be built. He commanded Jamāl al-Dīn Muḥammad ibn Ṭāhir ibn Muḥammad al-Zaydī al-Bukhārī to attend to this important matter [but] some works upon it were [too] complicated.

<sup>9</sup> Hadi Jorati, arguing the multiple authorship of *Tārīkh-i jahān-gushā* – one author would be Naṣīr al-Dīn al-Ṭūsī (see below) – refers to the possibility that it was not al-Juwainī but al-Ṭūsī who examined the Alamut library after the fall of the Nizārī Ismā'īlīs (Jorati 2014: 103, 135–136).

<sup>10</sup> The translation is a combination of those of Boyle and Jorati, with my minor modifications.



The fame of attainments of Khwāja Naṣīr al-Dīn [al-Ṭūsī], like the wind, spread over the face of the earth. Möngke Qa'ān, at the time he said goodbye to [his] brother [Hülegü], ordered that when the Assassins' fortresses were subdued, Khwāja Naṣīr al-Dīn be sent to court. But at the time, since Möngke Qa'ān was occupied with the subjugation of the countries of Manzi (South China) and the seat of government [was so] far, Hülegü ordered that he (Ṭūsī) also construct an observatory here (Marāgha).<sup>11</sup>

رای عالی و همت بلند او اقتضای آن کرد که رصدی در عهد همایون بنا کند. فرمود تا جمال الدین محمد طاهر بن محمد الزیدی البخاری به آن مهم قیام نماید، و بعضی اعمال آن بر ایشان مشتبّه بود.

و صیت فضایل خواجه نصیر الدین چون باد جهان پیمای. منگکه قان به هنگام وداع برادر فرموده بود که چون قلاع ملاحده مستخلص گردد، خواجه نصیر الدین [را] اینجا فرست؛ و در آن وقت چون منگکه قان به فتح ممالک منزی مشغول بود و از تختگاه دور، هولاگو خان فرمود تا هم اینجا رصد بندد.

(JT, 2: 1024; Allsen 2001: 167)

According to the chronology of Rashīd al-Dīn as quoted above, Jamāl al-Dīn was already at Möngke's court when the latter ordered his brother Hülegü to conduct an expedition to the western lands, which resulted in the annihilation of the Nizārī Ismā'īlīs. This does not accord with my argument that Jamāl al-Dīn brought his armillary sphere, designed in Alamut after the fall of the Nizārī highland state, to China.

However, revealing Rashīd al-Dīn's biased view of Hülegü's western expedition, Hadi Jorati (2014: 99–101) sheds doubt on the consensus among contemporary scholarship regarding al-Ṭūsī being raised to the position of the most senior executive officer immediately after the fall of Alamut due to his high reputation. He did not assume his position as a reward for the negotiation with or in the Nizārī Ismā'īlīs but as an expert in astral sciences. He even seems not to have been the most senior astrologer at Hülegü's court. This goes against Rashīd al-Dīn's narrative that Möngke sought al-Ṭūsī in Alamut, and ordered his brother to send him to Qaraqorum (Jorati 2014: 143–149). It might also make sense that at the time of the fall of Alamut, Jamāl al-Dīn might have been preferred to al-Ṭūsī as an astronomer to be brought to Möngke's court. Juwainī – Rashīd al-Dīn's source in this matter – does not mention such a request by Möngke at all.

## CONCLUSION: FROM ALAMUT TO DADU

The discussion of the present paper has uncovered a hitherto unknown transmission route of the astral sciences, from Alamut to Dadu, of which the key figure is Jamāl al-Dīn. It is possible that he might have been active in the Alamut fortress of the Nizārī Ismā'īlīs with Naṣīr al-Dīn al-Ṭūsī. The armillary sphere dedicated by Jamāl al-Dīn to Qubilai was perhaps designed at that time, given the fact that it was set at latitude 36°, that passes through Alamut. Then, after or immediately before the fall of Alamut in 1256, the 'Alamut collection' including the armillary sphere came to Dadu along the Mongol Silk Roads. Whether Jamāl al-Dīn was already in Dadu or whether he also came then from Alamut, the collection might have contributed to his entrance to Qubilai's entourage, before the latter ascended the throne in 1260.

The findings of this discussion also shed certain new light upon the nature of cross-cultural exchange in Eurasia under Mongol domination during the thirteenth and fourteenth centuries.

<sup>11</sup> The translation is based on Allsen's, adjusting the transliteration to the article format.



The period of the Mongol empire is – especially in the realm of the Ilkhanid dynasty – considered to be a ‘golden age’ of astronomy, in which Ptolemaic astronomy underwent fundamental innovations, the results of which lead directly to Copernicus’ (1473–1543) heliocentric celestial model (Saliba 1994). Under these circumstances, many new texts on mathematical and astronomical sciences were produced, especially by scholars active at the Maragha observatory, which functioned as one of the foremost intellectual centres of Mongol Eurasia. At the observatory, al-Ṭūsī compiled a series of texts such as the aforementioned *Zīj-i ilkhānī* and *al-Tadhkira fī ‘ilm al-hay’a* [Memoir on Astronomy] as well as the ‘rewriting’ (*tahrīr*) of classics in the fields of mathematical and astral sciences including Euclid’s *Elements* and Ptolemy’s *Almagest* (Ma ‘šūmī-Hamadānī 2000).<sup>12</sup>

Consideration of the coexistence of two large-scale observatories in Eurasia, located in Maragha and Dadu respectively, might lead one to infer the vital exchange of astral knowledge between these two observatories. However, Jamāl al-Dīn, who immigrated from the Islamicate world and at one time headed the Dadu observatory, was less connected to the Maragha observatory. Astral texts transmitted to the Yuan court – in certain cases, by him – did not include the ‘latest’ texts produced at the Maragha observatory. Jamāl al-Dīn did not belong to the so-called ‘Maragha school’. The cross-cultural exchange was greatly determined by personal connections, which were not based on the cohesive principles of the continental-wide imperial regime, either.

## ACKNOWLEDGEMENTS

The name of Dr. Yang Qiao (Max Planck Institute for the History of Science) appears first in these acknowledgements, as the friend who turned my attention to Jamāl al-Dīn’s armillary sphere, the main theme of this article. I would also like to express my deep appreciation to the faculty members of the Slavic-Eurasian Research Center, to which I currently belong, for their intensive discussion of an earlier draft of this article at my seminar. Dr. Yano Michio (Prof. Emeritus at Kyoto Sangyo University), the commentor of the seminar, took the essential role in forming miscellaneous materials into an article by providing me with many insightful comments. My special thanks are addressed to Dr. Leigh Chipman (Hebrew University of Jerusalem), whose editing made my sentences more readable. The research on which this article was based was supported by JSPS KAKENHI Grant Number JP19H00546. It would not have been possible to complete this article without the critical but thoughtful remarks made by Dr. Benno van Dalen (Bavarian Academy of Sciences and Humanities) in the very final phase of writing. These acknowledgments must be closed with my profound thanks to Dr. Ōhashi Yukio, whose sudden passing occurred shortly after I was advised by him about the structure of the armillary sphere.

<sup>12</sup> Almost of all the *tahrīr* texts were completed in the Alamut period by al-Ṭūsī, while he continued to revise them at the Maragha observatory; in case of the *Data* by Euclid, for example, see Sidoli and Isahaya 2019: 103–104. And, of course, Ṭūsī’s *tahrīr* was not included in the texts rescued from Alamut due to the fact that these had already left with al-Ṭūsī, who descended from the fortress and entered into Hülegü’s service.



## REFERENCES

### Primary Sources

- DM: Anonymous, *Dastūr al-munajjimīn* [Manual of Astrologers]. Ms. Paris, Bibliothèque nationale de France, Arabe 5968.
- JT: Rashid al-Dīn al-Hamadānī, Muḥammad RAWSHAN and Muṣṭafā MŪSAWĪ (eds.) *Jāmi' al-tawārīkh* [Collection of Histories]. 4 vols. Tehran: Nashr-i Arburz, 1994.
- MA: Ibn al-Fuwaṭī, Muṣṭafā Jawwād (ed.) *Majma' al-ādāb fī mu'jam al-alqāb* [The Confluence of *Adabs* in the Dictionary of *Laqabs*]. 4 vols. Damascus: Wizārat al-Thaqāfa wa al-Irshād al-Qawmī, 1962–67.
- MZ: Wang Shidian 王士點 and Shang Qiweng 商企翁 (eds.) *Mishujian zhi* 秘書監志 [Accounts of Imperial Library Directorate]. Hangzhou: Zhejiang guji chubanshe, 1992.
- TJG: 'Alā' al-Dīn 'Aṭā-Malik al-Juwaynī, Qazvinī, Muḥammad (ed.) *Tārīkh-i jahān-gushā* [The History of the World-Conqueror]. 3 vols. Leiden: Brill, 1912–1937.
- TW: Waṣṣāf al-Ḥaḍrat (Sharaf al-Dīn 'Abd-Allāh b. Faḍl-Allāh al-Shirāzī), *Tārīkh-i Waṣṣāf/Tajziyat al-amṣār wa tazjiyat al-a'sār* [The History of Waṣṣāf/The Apportioning of Lands and the Passing of Times]. Joseph VON HAMMER-PURGSTALL, *Geschichte Wassaf's*. Vol. 1. Wien: Kaiserlich-Königlichen Hof- und Staatsdruckerei, 1856.
- YS: Song Lian 宋濂 *et al.* (eds.) *Yuanshi* 元史 [The Standard History of the Yuan Dynasty]. 15 vols. Beijing: Zhonghua shuju, 1976.
- ZI: Naṣīr al-Dīn al-Ṭūsī, *Zīj-i ilkhānī* [Ilkhanid Astronomical Handbook]. MS. London, British Library, Or. 7464.
- ZS: 'Aṭā' al-Samarqandī, *al-Zīj al-sanjufīnī* [Sanjufinī's Astronomical Handbook]. Ms. Paris, Bibliothèque nationale, Arabe 6040.

### Secondary Literature

- ALLSEN, Thomas 2001. *Culture and Conquest in Mongol Eurasia*. New York: Cambridge University Press.
- BOYLE, John 1997. *Genghis Khan: The History of the World-Conqueror*. Manchester: Manchester University Press.
- DAFTARY, Farhad 1990. *The Ismā'īlīs: Their History and Doctrines*. Cambridge: Cambridge University Press.
- VAN DALEN, Benno 1999. 'Tables of Planetary Latitude in the *Huihui li* (II)'. In: Yung Sik KIM and Francesca BRAY (eds.) *Current Perspectives in the History of Science in East Asia*. Seoul: Seoul National University Press, 315–329.
- VAN DALEN, Benno 2002. 'Islamic and Chinese Astronomy under the Mongols: A Little-Known Case of Transmission'. In: Yvonne DOLD-SAMPLONIUS *et al.* (eds.) *From China to Paris: 2000 Years Transmission of Mathematical Ideas*. Stuttgart: Franz Steiner Verlag, 327–356.
- VAN DALEN, Benno 2004. 'The Activities of Iranian Astronomers in Mongol China'. In: Nasr Allah POURJAVADY and Živa VESEL (eds.) *Science, techniques et instruments dans le monde iranien (Xe-XIXe Siècle): Actes du colloque tenu à l'Université de Teheran (7–9 juin 1998)*. Téhéran: Presses universitaires d'Iran / Institut français de recherche en Iran, 17–28.
- HARTNER, Willy 1950. 'The Astronomical Instruments of Cha-ma-lu-ting, Their Identification, and Their Relations to the Instruments of the Observatory of Marāgha'. *Isis* 41/2: 184–194.
- ISAHAYA, Yoichi 2020. 'Fu Mengzhi: "The Sage of Cathay" in Mongol Iran and Astral Sciences along the Silk Roads'. In: Michal BIRAN *et al.* (eds.) *Along the Silk Roads in Mongol Eurasia: Generals, Merchants, and Intellectuals*. Berkeley: University of California Press, 238–254.



- JORATI, Hadi 2014. *Science and Society in Medieval Islam: Naṣīr al-Dīn Ṭūsī and the Politics of Patronage* (PhD thesis, Yale University).
- KARĪMĪ ZANJĀNĪ AŞL, Moḥammad 2010. 'From the *Dustūr al-Munajjimīn* to Ṭūsī's Works: Some Points on the Prevalent Sciences among the Nizārīs through the fall of Alamūt (1256 CE/654 AH).' In: Daniele CEVENINI and Svevo D'ONOFRIO (eds.) *Islām: Collected Essays*. ['Uyūn al-Akhbār: Studi sul mondo islamico 4.] Bologna: I libri di Emil, 223–238.
- KARĪMĪ ZANJĀNĪ AŞL, Moḥammad 2013. *Tārīkh wa ta'wīl ba-rawāyat-i Dustūr al-munajjimīn* [History and its Interpretation according to the *Dustūr al-Munajjimīn*]. Bonn: Goethe & Hafis.
- KARĪMĪ ZANJĀNĪ AŞL, Moḥammad, Eva ORTHMANN and Petra SCHMIDL 2017. 'The Sources and the Composition of the *Dustūr al-Munajjimīn*.' In: Eva ORTHMANN and Petra SCHMIDL (eds.) *Science in the City of Fortune: The Dustūr al-Munajjimīn and Its World*. Berlin: EB-Verlag, 35–113.
- KENNEDY, Edward 1956. 'A Survey of Islamic Astronomical Tables.' *Transactions of the American Philosophical Society* [N.S.] 46/2: 123–177.
- KENNEDY, Edward 1971. 'al-Bīrūnī's Masudic Canon.' *al-Abhath* 24: 59–81.
- KENNEDY, Edward and Mary KENNEDY 1987. *Geographical Coordinates of Localities from Islamic Sources*. Frankfurt: IGAIW.
- KING, David and Julio SAMSÓ 2001. 'Astronomical Handbooks and Tables from the Islamic World (750–1900): An Interim Report' *Suḥayl* 2: 9–105.
- MA ŞŪMĪ-HAMADĀNĪ, Ḥusayn 2000. 'Ustād-i Bashār' [Teacher of Humankind]. In: Nasr Allah POURJAVADY and Živa VESEL (eds.) *Nasir al-Din al-Tusi: Philosophe et Savant du XIIIe Siècle*. Téhéran: Institut français de recherche en Iran/Presses universitaires d'Iran, 113–130.
- MİYA, Noriko 2016. "'Knowledge" in East and West during the Mongol Period.' *Acta Asiatica* 110: 19–37.
- MİYAJIMA Kazuhiko 宮島一彦 1982. 'Genshi tenmon-shi kisai no Isuramu tenmonkiki ni tsuite 『元史』天文志記載のイスラム天文儀器について [New Identification of Islamic Astronomical Instruments Described in the Yuan Dynastic History]. In: *Tōyō no kagaku to gijutsu 東洋の科学と技術*. Kyoto: Dōhōsha, 407–427.
- MOZAFFARI, Mohammad and Georg ZOTTI 2013. 'The Observational Instruments at the Maragha Observatory after AD 1300.' *Suḥayl* 12: 45–179.
- NEEDHAM, Joseph (with the collaboration of WANG Ling) 1959. *Science and Civilization in China*, vol. 3. *Mathematics and the Sciences of the Heavens and the Earth*. Cambridge: Cambridge University Press.
- ORTHMANN, Eva 2017. 'Maqāla IX: Mundane Astrology.' In: Eva ORTHMANN and Petra SCHMIDL (eds.) *Science in the City of Fortune: The Dustūr al-Munajjimīn and Its World*. Berlin: EB-Verlag, 80–83.
- ORTHMANN, Eva and Petra SCHMIDL 2017. 'The Provenance and History of the *Dustūr al-Munajjimīn*.' In: Eva ORTHMANN and Petra SCHMIDL (eds.) *Science in the City of Fortune: The Dustūr al-Munajjimīn and Its World*. Berlin: EB-Verlag, 13–33.
- OTSUKA, Osamu 2017. 'The *Dustūr al-munajjimīn* as a Source of Early Ismaili History.' In: Eva ORTHMANN and Petra SCHMIDL (eds.) *Science in the City of Fortune: The Dustūr al-Munajjimīn and Its World*. Berlin: EB-Verlag, 173–187.
- PRAZNIAK, Poxann 2018. 'Marāgha Observatory: A Star in the Constellation of Eurasian Scientific Translation.' In: Patrick MANNING and Abigail OWEN (eds.) *Knowledge in Translation: Global Patterns of Scientific Exchange, 1000–1800 CE*. Pittsburgh: University of Pittsburgh Press, 227–243.
- SALIBA, George 1994. *A History of Arabic Astronomy: Planetary Theories during the Golden Age of Islam*. New York: New York University Press.
- SARTON, George 1931. *Introduction to the History of Science*, vol. 2. *From Rabbi Ben Ezra to Roger Bacon*. Baltimore: Carnegie Institution of Washington.



- SAWĀDĪ Fāṭeme and Sajjād NĪK-FAHM 2012. 'Ḥarakat-i wasaṭ-i kawākib dar Zīj-i ilkhānī wa naqd-hā-yi wārid bar ān [The Mean Motion of the Planets in Zīj-i ilkhānī and Critical Reading of It]'. In: Ḥusayn Ma'sūmī-Hamadānī (ed.) *Ustād-i bashar: pazhūhish-hā dar zindigī, rūzgār, falsafa wa 'ilm-i Khwāja Naṣīr al-Dīn Ṭūsī*. Tehran: Mirāth-i maktūb, 365–472.
- SCHMIDL, Petra 2017. 'Contents and Compilation of *Maqāla* I–VIII'. In: Eva ORTHMANN & Petra SCHMIDL (eds.) *Science in the City of Fortune: The Dustūr al-Munajjimīn and Its World*. Berlin: EB-Verlag, 37–79.
- SIDOLI, Nathan and ISAHAYA Yoichi 2019. 'Naṣīr al-Dīn al-Ṭūsī's Comments on Euclid's *Data*.' *Historia Mathematica* 47: 87–105.
- SIVIN, Nathan 2009. *Granting the Seasons: the Chinese Astronomical Reform of 1280, with a Study of Its Many Dimensions and an Annotated Translation of Its Record*. New York: Springer.
- TASAKA, Kōdō 1957. 'An Aspect of Islam Culture Introduced into China.' *Memoirs of the Research Department of Toyo Bunko* 16: 75–160.
- YABUUTI, Kiyoshi [YABUCHI Kiyoshi] (translated and partially revised by Benno VAN DALEN) 1997. 'Islamic Astronomy in China during the Yuan and Ming Dynasties.' *Historia Scientiarum* 7: 11–43.
- YAMADA Keiji 山田慶児 1980. *Jūjireki no michi: Chūgoku chūsei no kagaku to kokka* 授時曆の道: 中国中世の科学と国家 [The Road to the Season-Granting Astronomical System: Science and the State in Medieval China]. Tokyo: Misuzu Shobō.
- YANG, Qiao 2017. 'From the West to the East, from the Sky to the Earth: A Biography of Jamāl al-Dīn.' *Asiatische Studien / Études Asiatiques* 71/4: 1231–1245.
- YANG, Qiao 2019. 'Like Stars in the Sky: Networks of Astronomers in Mongol Eurasia.' *Journal of the Economic and Social History of the Orient* 62/2–3: 388–427.
- YANO, Michio 1997. *Kūshyār ibn Labbān's Kitāb al-Madkhal fī Ṣinā 'at Aḥkām al-Nujūm (Introduction to Astrology)*. Tokyo: Tokyo University of Foreign Studies.
- YANO, Michio 2002. 'The First Equation Table for Mercury in the *Huihui li*'. In: Razaullah ANSARI (ed.) *History of Oriental Astronomy*. Dordrecht: Kluwer Academic Publishers, 33–43.
- YANO, Michio 2013. 'al-Birūnī'. In: Kate FLEET et al. (eds.) *The Encyclopaedia of Islam, Three*. Leiden: Brill, 50–56.

