Islamic Astronomy in the Service of Yuan and Ming Monarchs

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Abstract: A substantial dissemination and influence of Islamic astronomy was first seen in China during the Mongolian Yuan dynasty which ruled the country between 1260 and 1368. An observatory equipped with Arabic instruments and books in astronomy was set up exclusively for Muslim astronomers, who were charged with the responsibilities similar to their Chinese counterparts. With the establishment of the Ming dynasty in 1368, Muslim astronomers were recruited not only from the former capital of the Yuan, but also from the Arabic areas to serve the new dynasty. Islamic section continued to exist and function in the official establishment of astronomy all the way to the mid-17th century, when Jesuit missionaries began to introduce European astronomy to the country. For the first time, Chinese astronomers were sent to study with Muslim astronomers, and books on Islamic astronomy and astrology were translated into Chinese and became an ever-lasting source of inspiration for Chinese astronomers. In the official establishment, Arabic astronomy was adopted as a reference system in parallel with the orthodox Chinese system of calendrical astronomy, and applied not only in the calculation of civil almanacs and astronomical ephemerides, but also in the prediction luni-solar eclipses and occultations of the moon and the five planets, two important categories of portents in Chinese astrology.

Keywords: Islamic astronomy, influence in China, Yuan dynasty, Ming dynasty.

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In traditional Chinese ideology, astrology and astronomy are important and interconnected matters in the legitimization and maintenance of a regime. Establishments were always installed by governments to take care of these matters. This formed a tradition very scrupulously observed and documented by every Chinese dynasty without substantial interruption at least since the Zhou Dynasty (c. 1046–256 BC). As a result, a special system consisting of astrology and astronomy was developed and kept on developing on its own track. Despite this long and independent tradition, however, most Chinese monarchs would not refuse, though sometimes with reluctance and selection, any art and knowledge from outside that might supplement and enhance the indigenous ones. Their interest provided a pivotal force under which the major introduction, adoption and documentation of foreign systems of either astronomy or astrology could happen, as can be seen in the dissemination of European astronomy and astrology in China in the 17th and 18th centuries[1].Here I would like to bring up an earlier example, viz. the introduction of Islamic astronomy into Yuan / Mongol China. In fact, this is not a new topic at all. Since the 1940s, a number of leading scholars in the field have done important works on both the general history and some specific issues such as the Arabic and Persian sources of the Chinese works on Islamic astronomy and astrology, the identification of the Islamic instruments constructed in China in the 13th century, the decoding of the titles of the Arabic-Persian books on astronomy and mathematics preserved in the Bureau of Imperial Secretariat of the Yuan dynasty, the first Chinese translation of an Islamic astrological work, and compilation and the theoretical basis of the Chinese-Islamic system of calendrical astronomy[2]. On the basis of

[1]For the absorption of European astronomy by the Ming and Qing dynasties, see, e.g. Hashimoto Keizo (1988). *Hsü Kuang-ch'i and Astronomical Reform: The Process of the Chinese Acceptance of Western Astronomy 1629-1635*. Osaka: Kansai University Press; and Shi Yunli (2008). "Reforming Astronomy and Compiling Imperial Science in the Post-Kangxi Era: Social Dimension and the *Yuzhi Lixiang kaocheng houbian*." *East Asian Science, Technology and Medicine*, vol.28, pp.47-73. For the introduction of European astology to China, see Nicolas Standaert (2001). "European Astrology in Early Qing China: Xue Fengzuo's and Smogulecki's Translation of Cardano's Commentaries on Ptolemy's *Tetrabiblos*." *Sino—Western Culture Relations Journal*, XXIII, pp.50-79; and Han Qi (2011). "From Adam Schall von Bell to J. N. Smogulecki: The Introduction of European Astrology in late Ming and Early Qing China." *Monumenta Serica*, 59, pp.485-490.

[2]See, for example, Chen Jiujin (1996). *Huihui tianwenxueshi yanjiu* (*A Study of Islamic Astronomy in China*). Nanning, Guanxi jiaoyu chubanshe (contains all papers on Islamic astronomy and astrology in China written in Chinese by Chen Jiujin from 1984 to 1991); Chen Jiujin (1997). "Comparative Research between the *Huihui Calendar*, *Chilchonsan oepyon* and *Qizheng tuibu*", in *Oriental Astronomy from Guo Shou-jing to King Sejong* (Il-Seong Nha & F. Richard Stephenson eds.), p. 105–111. Seoul,Yonsei University Press; Chen Meidong (1987). "A

these works and the new materials I have discovered in recent years, I would like to discuss the role played by Islamic astronomy in the statecraft of the Yuan and Ming dynasties in China. Meanwhile, I will also show the efforts of Chinese astronomers in studying the Islamic system and assimilating it into their own tradition.

Study of Some Astronomical Data in Muslim Calendar," in G. Swarup, A.K. Bag & K.S. Shukla eds., *History of Oriental Astronomy*, p. 169–174. Cambridge University Press. Benno van Dalen (1999), "Tables of Planetary Latitude in the 'Huihui li' - Part II", in *Current Perspectives in the History of Science in East Asia* (eds. Yung Sik Kim and Francesca Bray), Seoul (Seoul National University Press), pp. 315-329; Benno van Dalen (2000), "A Non-Ptolemaic Islamic Star Table in Chinese", in *Sic itur ad astra. Studien zur Geschichte der Mathematik und Naturwissenschaften. Festschrift für Paul Kunitzsch zum 70. Geburtstag* (eds. Menso Folkerts and Richard P. Lorch), Wiesbaden (Harrassowitz), pp. 147-176. Benno van Dalen (2002). "Islamic and Chinese Astronomy under the Mongols: a Little-Known Case of Transmission", in *From China to Paris: 2000 Years Transmission of Mathematical Ideas* (Yvonne Dold-Samplonius, Joseph W. Dauben, Menso Folkerts and Benno van Dalen, editors), *Boethius,* 46, Stuttgart (Steiner), pp. 327-356; Benno van Dalen (2002), "Islamic Astronomical Tables in China: The Sources for the Huihui li", in *History of Oriental Astronomy. Proceedings of the Joint Discussion-17 at the 23rd General Assembly of the International Astronomical Union*, organised by the Commission 41 (History of Astronomy), held in Kyoto, August 25-26, 1997(S.M. Razaullah Ansari, editor), Dordrecht (Kluwer), pp. 19-31; Willy Hartner 1950: "The astronomical Instruments of Cha-ma-lu-ting, Their Identification, and Their Relations to the Instruments of the Observatory of Maragha". *Isis*, vol.41, pp.184-194; Ma Jian馬堅(July 7, 1955). "Yuan mishujian huihui shuji shiyi" 元秘書監回回書籍釋義 (An Explanation of the Islamic Books in the Directorate of the Yuan Imperial Library). *Guangming ribao* 光明日報 (Guangming Daily); Ma Mingda 馬明達 and Chen Jing 陳靜 (1996) *Zhongguo huihui lifa jicong* 中國回回曆法輯叢 (A Comprehensive Collection of Chinese Materials related to the *HHLF*). Lan Zhou, Gansu minzu chubanshe; Martzloff, Jean-Claude (1988). "Les Contacts entre les Astronomies et Mathématiques arabes et Chinoises", in *Actes du Deuxième Colloque Maghrébin*. Tunis, 1–3 Dec. 1988, University of Tunis, 1991, p. 164–182; Miyajima Kazuhiko (1982). "A New Identification of the Islamic Astronomical Instruments Recorded in the Astronomical Annals of the *Yuan Shi*", in *Science and Technology in Asia: Festschrift for the 77th Anniversary of Prof. Yabuuchi Kiyoshi,* pp. 407-427. Kyoto: Dohosha; Shi Yunli (2001). "The Korean Adaptation of the Chinese-Islamic Astronomical Tables". *Archive for the History of Exact Sciences*. 57 (2003), pp. 25–60; Yabuuchi Kiyoshi (1954). "Indian and Arabian Astronomy in China," *Silver Jubilee Volume of the Zinbun Kagaku Kenkyusyo*, Kyoto, Kyoto University, pp. 585–603; Yabuuchi Kiyoshi (1964). "Kaikai riki kai" (Explanation of the *Huihui li*), *Tōhō gakuhō*, vol. 36, p. 11–632; Yabuuchi Kiyoshi (1969) *Chūgoku no tenmon rekihō* (Chinese Astronomy and Calendars), Tokyo: Heibonsha, Showa 44; Yabuuchi Kiyoshi (1987). "The influence of Islamic astronomy in China", in *From Deferent to Equant: A Volume of Studies in the History of Science in the Ancient and Medieval Near East in Honor of E. S. Kennedy* (David A. King and George A. Saliba eds.), NewYork, The NewYork Academy of Sciences, pp. 547–559; Yabuuchi Kiyoshi (1997), "Islamic Astronomy in China during the Yuan and Ming Dynasties," translated and partially revised by Benno van Dalen. *Historia Scientiarum*, vol. 7–1, pp. 11–43; Michio Yano (1997). *Kūšyār Ibn Labbān's Introduction to Astrology*. *Studia Culturae Islamicae*, (62). Tokyo: Institute for the Study of Languages and Cultures of Asia and Africa.

1. Early contacts

According to materials from family genealogies, the earliest influence of Islamic astronomy in China may be traced back to 961 when a Muslim astronomer from Lumu 魯穆 named Ma Yize 馬依澤 in Chinese came to the court of the Song dynasty and took part in a compilation project on astronomy[3]. However, it was not until the rise of the Mongolian power in the north of Asia that much more substantial and better documented contacts between Chinese and Muslim astronomers took place[4]. In 1220 and 1221, when Genghis Khan 成吉思汗 (1162-1227, r. 1206–1227) was campaigning in Tashkent and Samarkand, his famous Khitan consultant Yelü Chucai 耶律楚材 (1189-1243), an expert in astronomy and astrology, got in touch with some local Muslim astronomers in the prediction of two lunar eclipses. Yelü Chucai's predictions turned out to be more precise in both cases, but this did not lead him to have a low opinion on Islamic astronomy. From the Muslim astronomers, he learnt the concept of time difference at different geographical longitudes and incorporated it into his own work Gengwu Epoch System of Calendrical Astronomy for Western Expedition (Xizhen gengwuyuan li 西征庚午元曆). He also saw the superiority of Islamic astronomy in the calculation of the positions of the five major planets and adapted the related techniques into his Madaba Calendar (Madaba li) , a work believed to be based on Islamic astronomy but not extant.

In 1260, Khubilai 忽必烈 (1215-1294, r.1260-1294) was enthroned in Kaipin as the Great Khan of the Mongolian Empire and emperor of the Yuan dynasty. Like most monarchs that had ruled China, he established a Bureau for the Administration of the Heaven (Sitian jian 司天監) for calendar-making, sky-watching (chiefly for astrological purposes), astronomical and meteorological observations, timekeeping and divination[5]. In fact, he had already begun to recruit experts in these arts while still being a prince, and a Muslim from the

[3]Chen Jiujin 陈久金 (1996). *Huihui tianwenxueshi yanjiu* 回回天文学史研究 (*A Study of Islamic Astronomy in China*). Nanning: Guanxi jiaoyu chubanshe, pp.52-66.

[4]Benno van Dalen (2002). *Islamic and Chinese Astronomy under the Mongols: a Little-Known Case of Transmission*, in *From China to Paris: 2000 Years Transmission of Mathematical Ideas* (Yvonne Dold-Samplonius, Joseph W. Dauben, Menso Folkerts and Benno van Dalen, editors), *Boethius,* 46, Stuttgart (Steiner) , pp. 327-356.

[5]For a recent study in English of the development of astronomy, especially the official system of calendrical astronomy, in the Yuan dynasty see Nathan Sivin (2008). *Granting the Seasons. The Chinese Astronomical Reform of 1280, with an Annotated Translation and Study of its Many Dimensions*. Sources and Studies in the History of Mathematics and Physical Sciences. Secaucus, NJ: Springer.

west, named Zhamalading 札馬剌丁, or also Zhamaluding 札馬魯丁, supposedly Jamāl al-Dīn in original form, had come to his service in 1244. In 1267, he constructed seven astronomical instruments of Islamic style for Khubilai[6]. In turn Khubilai created a Muslim Bureau for the Administration of the Heaven (Huihui Sitian jian 回回司天監) and appointed Zhamaluding as the first director. A quick comparison (Table 1[7]) will show that the Muslim Bureau was largely modeled on the Chinese Bureau although it was of a smaller size. From the structure, it is clear that the Muslim Bureau was also responsible for calendar-making, sky-watching or astrology, astronomical observation, timekeeping and divination. Presumably, the most important difference between the two parallel institutes is the tradition they followed: while the Chinese Bureau adhered to the well established Chinese tradition, the Islamic system was adopted in the Muslim Bureau. In calendar-making, for instance, the Muslim Bureau was responsible for compiling an Islamic almanac for the Muslim population in the country, while the Chinese Bureau was charged with the making of various Chinese almanacs according to Chinese tradition. The dual system of Chinese and Islamic astronomy was kept unchanged within the bureaucratic structure of the Yuan dynasty after Khubilai moved his capital to Beijing in 1267.

[6] Willy Hartner (1950). "The Astronomical Instruments of Cha-ma-lu-ding, their identification, and their relations to the instruments of the observatory of Marāgha." *Isis* (41), pp.184-194.

[7] The data of the two bureaus are taken from the *Annals of Officials* (*Baiguan zhi*百官志) of the History of the Yuan Dyansty (*Yuanshi* 元史) .

Table 1: A Structural Comparison between the Two Bureaus for the Administration of the Heaven of the Yuan Dyansty

Bureau for the Administration of the Heaven 司天監			Muslim Bureau for the Administration of the Heaven 回回司天監		
Position	Rank	Number of Persons	Position	Rank	Number of Persons
Superintendent 提點	4+	1	Superintendent 提點	4+	1
Director 司天監	4+	3	Director 司天監	4+	3
Vice-director 司天監少監	5+	5	Vice-director 司天監少監	5+	2
Assistant 監丞	6+	4	Assistant 監丞	6+	2
Magistrate 知事	9-	1	Magistrate 知事	9-	1

Managing Clerk 令史	9-	2	--		
Translation Clerk 譯史	9-	1	--		
Translator and Seal Keeper 通事兼知印	9-	1	Translator and Seal Keeper 通事兼知印	NS	1
--			Memorial Maker 奏差	NS	1
Supervisor of Staff Training 屬官提學	9-	2	--		
Professor 教授	9-	2	Professor 屬官教授	NS	1
Instructor 學正	9-	2	--		
Manager of Astrological Division 天文科管勾	9-	2	Manager of Astrological Division 天文科管勾	NS	1
Manager of Calendar-making Division 算曆科管勾	9-	2	Manager of Calendar-making Division 算曆科管勾	NS	1
Manager of the	9-	2	Manager of the	NS	1

Three-cosmic-disk Divination Division 三式科管勾			Three-cosmic-disk Divination Division 三式科管勾		
Manager of Observation Division 測驗科管勾	9-	2	Manager of Observation Division 測驗科管勾	NS	1
Manager of Clepsydra Division 漏刻科管勾	9-	2	Manager of Clepsydra Division 漏刻科管勾	NS	1
Head of Yin-yang Divination 陰陽管勾	NS	1	--		
Officer for Night Time-keeping 押宿官	NS	2	--		
Officer for Time-keeping 司辰官	NS	8	--		

Student for Astrology 天文生	NS	75	--		
--			Person for Yin-yang Divination 陰陽人	NS	18

Although the Yuan dynasty maintained a very impressive establishment of Islamic astronomy, equipped with a group of large instruments and a good library of Arabic-Persian books on astronomy, astrology, divination, instrumentation and mathematics,[8] Chinese and Muslim astronomers in Beijing did not have any apparent communication, although they were both put under the jurisdiction of the Mishu jian 秘書監 (Imperial Secretariat) after 1273. In the hundred years of the Yuan history, no cooperation was encouraged. No single work in astronomy and astrology was ever translated from Arabic or Persian into Chinese. This situation was not changed until the Ming taking-over of the Yuan dynasty.

2. Chinese Studies and Assimilations

The founding emperor of the Ming dynasty Zhu Yuanzhang 朱元璋(1328-1398, r. 1368-1398) was also a deep believer in the importance of astrology and calendar-making for the security and authority of his ruling. As soon as his troops captured Beijing and Kaiping in 1368 and 1369, he summoned both Chinese and Muslim astronomers in the cities to the capital of the new dynasty Nanjing, where a Chinese and a Muslim Bureau for the Administration of the Heaven were set up. The number of Muslim astronomers recruited from the former Yuan Bureau ran up to twenty five, including the former Directors Heidi'er黑的兒 and Adula阿都剌, the former Assistant Dieliyueshi 迭里月實 and the former Officer for Calendar-making Zheng Ali 鄭阿里. Meanwhile, books from the royal library of the Yuan dynasty, including a number of Arabic

[8]Tasaka Kōdō (1957). *An Aspect of Islamic Culture Introduced into China*. Tokyo: Tōyō Bunko; and Ma Jian馬堅(July 7, 1955). "Yuan mishujian huihui shuji shiyi" 元秘書監回回書籍釋義 (An Explanation of the Islamic Books in the Directorate of the Yuan Imperial Library). *Guangming ribao* 光明日報 (Guangming Daily).

and Persian books in astrology and astronomy, were transported in mass from Beijing to Nanjing. In 1370, Zhu Yuanzhang decided to change the names of the two Bureaus into the Bureau for the Reverence of the Heaven (qintian jian, 欽天監) in the view that the Heaven could only be revered, rather than administrated, by human beings[9].

In addition, Zhu Yuanzhang even sent an envoy to Muslim countries to recruit Arabic astronomers. By his call, a Muslim astronomer Madeluding 馬德魯丁 came to Nanjing in 1369 with his three sons Mashayihei 馬沙亦黑, Mahama 馬哈麻 and Mahasha馬哈沙. Madeluding was assigned to the directorship of the Muslim Bureau, while his sons became officials in the Bureau. They worked so hard in astronomy and astrology that Zhu Yuanzhang eventually granted the family an honorary title, "Dace tang"大測堂 (the Hall of Great Measurement), and married Mashayihei with a princess[10].

These efforts had very important consequences for the history of Islamic astronomy in China. Zhu Yuanzhang was very interested in the books taken from the royal library of the Yuan dynasty. When being released from his duty as an emperor, he often asked official-scholars to give him tutorials on the basis of these books so that he could learn the way of ruling. He noticed the books in Arabic and Persian and knew that some of them were related to astronomy and astrology. Yet nobody among his official-scholars could understand a word of them. In view of the fact that Muslim astronomers were very precise in their calculation of celestial phenomena and that they commanded the technique for calculating the latitudes of the moon and five planets which was unknown in Chinese astronomy, he decided to initiate a project of translation. On 24 October 1382, he ordered two official-scholars from the Royal Academy named Wu Bozong 吳伯宗 (1334-1384) and Li Chong 李翀 to collaborate with four Muslim masters Haida'er 海達爾, Adawudin阿答吾丁, Mashayihei 馬沙亦黑 and Mahama 馬哈麻 in order to translate some of the books into Chinese. By his order, an office for translation was set up in the capital, and a translated work on astrology was completed no later than April 1383. The result is the Book on Celestial Patterns (Tianwen shu 天文書) . It is a translation of Kushyār ibn

[9]Anonymous Author. A Summary of the Administrative Activities Adapted from the Archives of the Imperial Secretariate (Mige yuangui zhengyao秘閣元龜政要) , j.6.

[10] Chen Jiujin陈久金 (1989). "Madeluding fuzi he huihui tianwenxue" 马德鲁丁父子和回回天文学 (Madeluding and His Sons' Contribution to Islamic Astronomy in China), *Ziran kexueshi yanjiu*自然科学史研究 (*Studies in the History of Natural Sciences*), 8(1). pp.28-36.

Labbān's (971-1029) Introduction to Astrology (al-Madkhal fī Ṣināʿat Aḥkām al-Nujūm), an important Arabic work on horoscopical astrology[11] It seems that the famous Chinese-Islamic System of Calendrical Astronomy, (HHLF) (Huihui lifa 回回曆法), a set of astronomical tables with instructions for their use was also a work produced by the same office on the basis of selective translations[12].

Recently, I found another book on Islamic astronomy from the same period, which shows that Zhu Yuanzhang's plan for introducing Islamic astronomy and astrology was not limited to simple translations. The book is entitled A Gateway to the Islamic Method for the Calculation of the Sun (Weidu taiyiang tongjing 緯度太陽通徑) and turns out to be very rare. Up to now, only one copy is found in the Kyujanggak 奎章閣 Archives in the Seoul National University of Korea. The author Yuan Tong 元統 (fl. 1384-1396) was originally a Doctor of Clepsydra (louke boshi, 漏刻博士) at the Chinese Bureau for the Reverence of the Heaven. He was promoted to Director of the Bureau in 1385 after his codification of the official system of calendrical astronomy, the Datong li 大統曆 (Great Union System of Calendrical Astronomy).

From Yuan Tong's own preface to the book, it is very clear that Zhu Yuanzhang hoped a gain from the translation of Islamic books. So in December 1385, he ordered his astronomers to integrate both Chinese and Islamic techniques for calendar-making and thus to produce a united system of calendrical astronomy for the new dynasty. Three official-astronomers from the Chinese Bureau for the Reverence of the Heaven, Zhang Fu 張輔, Cheng Zhu 成著and Hou Zheng 侯,政were dispatched to learn from Muslim masters. They completed the study in three years and came back with a notebook on what they learnt. Apparently, this notebook is also an early version of the famous HHLF.

As soon as the notebook was brought back, Yuan Tong began a careful research. He found that the astronomical year in the Islamic system started on the day of the spring equinox. This was different from the Chinese convention using the day of the winter solstice. So he tried to convert the tables and the algorithms in the HHLF to conform them to the Chinese standards, which led to the completion of the Weidu taiyiang tongjing in February 1396. The book falls in twelve sections. While the first seven sections discuss the calculation of the

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[11]Michio Yano (1997). *Kūšyār Ibn Labbān's Introduction to Astrology*. *Studia Culturae Islamicae*, (62). Tokyo: Institute for the Study of Languages and Cultures of Asia and Africa.

[12] Yabuuchi Kiyoshi (1997), "Islamic Astronomy in China during the Yuan and Ming Dynasties", translated and partially revised by Benno van Dalen. *Historia Scientiarum*, vol. 7–1, pp.11–43. For recent studies on the *Huihui lifa*, see footnote 2.

Islamic calendar and the conversion between Islamic and Chinese calendars, other sections are about the concrete steps of computing the longitude of the sun[13].

After these works, more Chinese astronomers were able to learn Islamic astronomy. In 1398, the Muslim Bureau for the Reverence of the Heaven was formally shut down, and its staff was merged into the Chinese Bureau to make up four divisions: Division for Celestial Patterns (tianwen ke天文科) , Division for Clepsydra (louke ke 漏刻科) , Division for Chinese Calendar [viz. Datong li] (datong ke 大統科) , and Division for Muslim Calendar (huihui ke 回回科) . Theoretically, this provided a better opportunity for Chinese and Muslim astronomers to communicate with each other. Two other important Chinese experts in Islamic astronomy from this period should be mentioned: Liu Bowan 劉伯完 and his son Liu Xin 劉信.

Liu Bowan was originally recommended by local officials to the central government on account of his expertise in astrology and divination. He became a disciple of Liu Ji 劉基 (1311-1375), the founding Director the Chinese Bureau for the Reverence of the Heaven. He was good enough to be eventually promoted to the position of Vice-Director of the Chinese Bureau for the Reverence of the Heaven. In the meantime, he also got an opportunity to learn the HHLF and became so versed in it[14] that he was named Vice-Director of the Muslim Bureau as well. During the civil war between the second Ming Emperor Zhu Yunwen 朱允炆 (1377-?, r. 1398-1402) and his uprising uncle Zhu Di 朱棣 (1360-1424, r.1403-1424), Liu Bowan was captured by Zhu Di's troops. After being released, he chose to seclude himself from officialdom, apparently as a way to avoid serving an usurper like Zhu Di, but he trained his son Liu Xin. Liu Xin then worked in the Bureau for the Reverence of the Heaven and became the Summer Officer (xiaguan zheng, 夏官正) between 1429 and 1449.[15]

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[13]Yuan Tong 元統. *A Gateway to the Islamic Method for the Calculation of the Sun (Weidu taiyang tongjing* 緯度太陽通徑).

[14]Jiao Hong 焦竑. *Veritable Records of the Famous Officials of the Present Dynasty* (*Xichao mingchen shilu*熙朝名臣實錄) , j.6; Tu Shufang 屠叔方. *A Compilation of the Anecdotes from the Court to Country during Jianwen's Reign* (*Jianwen chaoye huibian*建文朝野彙編) , j.13; Zheng Xiao 鄭曉. *A Compilation of My Studies* (*Wu xue bian* 吾學編) , j.5.

[15] For a detailed study of Liu Bowan and Liu Xin, see Chen Zhanshan 陳占山 (2009). "Ming qintianjian xiaguanzheng Liu Xin shiji kao 明欽天監夏官正劉信考 (A Study of the Biography of Liu Xin, the Summer Officer of the Bureau for the Reverence of the Heaven of the Ming Dynasty)",. *Ziran kexueshi yanjiu* 自然科學史研究. 2009, vol., 8 (2): pp.205-213.

Before his premature death in 1449 during a war against the invading Mongolian troops, Liu Xin completed a very voluminous work on Islamic astronomy entitled A Gateway to the Islamic System of Calendrical Astronomy (Xiyu lifa tongjing 西域曆法通徑), which arguably bears an abridged title Treatise on the Islamic System of Calendrical Astronomy (Xiyu lishu). The book was not printed, and now only eight hand-written volumes of it still exist in the National Library of China in Beijing, viz. volumes 11-14 and 21-24, meaning that the whole book was at least in 24 volumes. The remaining volumes are all pre-calculated tables that are arguably derived from the same planetary models as those in the HHLF, but are much more detailed and convenient for practical use. In his preface to the book, Liu Xin's close friend Xu Youzhen makes this clear:

"My friend Liu Zhongfu 劉仲孚 [viz. Liu Xin] … is also proficient in Western [viz. Islamic] methods. He noticed that the Muslim computus is somewhat inconsistent and devoid of uniform rules, and would therefore become more and more confusing with the lapse of time. Consequently, he translated the Muslim texts precisely, prescribed rules for its usage, and pre-calculated the essential ready tables. The resulting procedures are brief, simple and clear. They form an orderly book devoted to the [Muslim] school of astronomy which is feasible to be used indefinitely and to remain essential to students of mathematical astronomy."[16]

Presumably, part of Liu Xin's knowledge in Islamic astronomy came from his father, but he must also have had access to the original sources of the HHLF so that he was able to redo the translation and recalculate the tables.

The study of the HHLF was still maintained among Chinese astronomers after the death of Liu Xin. In November 1477, the Vice-Director of the Bureau for the Reverence of the Heaven in Nanjing Bei Lin 貝琳 (?-1490) reedited the HHLF in six volumes and printed the whole book. Eighteen years later, it was reprinted again by Zhou Xiang 周相, another officer of the Bureau for the Reverence of the Heaven in Nanjing[17]. From that time on, the HHLF became available to a

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[16]Xu Youyzhen徐友貞. *A Preface to the Book on Calendar from Western Areas* ("Xiyu lishu xu" 西域曆書序).//Xu Youzhen. Collected Writings of Xu Youzhen (*Wugong ji* 武功集) , j.2.

[17] Shi Yunli 石云里 (2009). "Yuan Tong *Taiyang weidu tongjing* de faxian--jianlun Beilin *Huihui lifa* de yuan keben 元統《太陽緯度通徑》的發現——兼論貝琳《回回曆法》的原刻本 (On the Discovery of Yuan Tong's *A Gateway to the Islamic Method for the Calculation of the Sun*, with a Discussion on the Original Version of Bei Lin's *Chinese-Islamic System of Calendrical Astronomy*)." *Zhongguo kejishi zazhi* 中國科技史雜誌 (The Chinese Journal for the History of Science and Technology), Vol. 30 (1): pp. 31-45.

much wider Chinese readership across the country and became a source of inspiration for the calendar reform in the 16th century.

3. The Actual use of Islamic astronomy

The Islamic system was used by the Ming government as "a reference" (canyong, 參用) in parallel with the mainstream Chinese system. According to official documents, the HHLF was frequently used in the prediction of luni-solar eclipses, two of the most severe portents that the Bureau for the Reverence of the Heaven had to take great care of. Our recent analysis shows that within the time span of the Ming dynasty this system was spectacularly worse than the Datong li in the prediction of eclipse times, but much better than the latter in predicting the magnitude of the eclipses, meaning that HHLF could really provide important references in some aspects of the eclipse prediction, especially in the prediction of eclipses with very small magnitudes [18].

In calendar-making, evidence shows that the HHLF was also adopted in parallel with the Datong lifa. In Book 7 of the A Catalogue of Books Preserved in the Cabinet (Neige cangshu mulu 內閣藏書目錄)[19] we can find the following entries:

The Grand Union Almanac, 25 volumes, from the 3rd to 31st years of the Hongwu reign (Datong li ershiwu ce, qi Hongwu sannian zhi sanshiyi nian zhi 大統曆二十五冊, 起洪武三年至三十一年止);

The Grand Union Almanac of the Yongle Reign (Daming yongle datong li shice大明永樂大統曆十冊) , 10 volumes;

Chinese-Islamic Almanacs of the Hongwu Reign of the Grand Ming Dynasty Daming Hongwu huihui li shisi ce 大明洪武回回曆十四冊 , 14 volumes;

Calendar-making Methods for Cross Reference, 1 volume, without the name of the cross-reference maker, from winter [solstice] of the year jiazi in the Hongwu Reign [viz. 1384] to the 12th year of the Wanli Reign [viz. 1584], and the contents being all about calculating methods (Canjiao lifa yice, weixiang canjiao xingshi, zi Hongwu jiazi zhi wanly shier nian dong, nei jie tuibufa ye 參校曆法一冊, 未詳叅校姓氏,自洪武甲子至萬曆十二年冬,內皆推步法也) .

The last book is very interesting because at least two different systems are needed for a cross-reference. From the fact that the HHLF was said to be adopted together with the Datong li as a reference (canyong, 參用), it seems highly possible that the book is devoted to a step-by-step comparison of the

[18] The detailed results will be published in another paper.
[19] Edited by Sun Nengchuan 孫能傳 et al. in 1603.

Datong and Huihui systems in the practical calculation of almanacs from 1384 to 1584.

Besides civil almanacs, the Bureau for the Reverence of the Heaven was also required to calculate astronomical ephemerides for each year. Apparently, the HHLF was also applied for this purpose. For instance in Book 88 of the Comprehensive Examination of Literature Continued (Xu wenxian tongkao 續文獻通攷) by Wang Qi王圻(1529-1612) it is clearly recorded that astronomical officials were required to calculate 3 Ephemeris:

The Ephemeris Detailing the Longitudes and Latitudes of the Seven Governing-Luminaries Calculated with the Chinese-Islamic System ("Huihui qizheng jiangweidu li回回七政經緯度曆) ,

A List of Celestial Events for the Imperial Reference, Calculated with the Great Union System of Calendrical Astronomy ("the Datongli yulan tianxiang lu 大統曆御覽天象錄) ,

Ephemeris Detailing the Positions of the Seven Governing-Luminaries [Calculated with the Grand Union System ([Datong] Qizheng chandu li [大統] 七政躔度曆)]."

Recently, I found another interesting document from the Kyujanggak Archives, which reveals another important application of the HHLF in the Ming Bureau for the Reverence of the Heaven. It is a small pamphlet entitled The Occultation Events of the Moon and Five Planets in the 10th Year of the Xuande Reign (XSYWLF) (Xuande shinian yue wuxing lingfan 宣德十年月五星淩犯) , , which was imported from China to Korea in the early 15th century and reprinted in 1447 at the court of the Joseon dynasty with a number of other Chinese books on astronomy. The book contains very detailed information about the lingfan 淩犯 (occultation) for the whole of the 10th Year of the Xuande Reign (Jan. 29, 1435- Jan.17, 1436). The mutual occultation of the moon and the five major planets, as well as their occultation of the fixed stars, are very important in Chinese astrology. The XSYWLF is a pre-calculation of this type of phenomena for a whole year. It begins with a general description of the situation for the given year, and then runs into a day by day prediction:

> "The general list of the occultation of the moon and five planets in 1436:
>
> Total number is 325:
>
> Occultation 136 times, entry into lunar-lodges 41 times, non-occultation 148 times.
>
> Moon 196 times: …

The five planets 129 times: …
Saturn 5 times: …
Jupiter 7 times: …
Mars 16 times: …
Venus 53 times: …
Mecurry 38 times: …
The occultation of the moon and five planets in 1436:
1st Month:
Night of the 2nd day, Venus occults the 1st star of the west of Outer-screen, and is 3 min. below it.
Night of the 4th day, Mars occults the 14th star of Ophiuchus, and is 18 min. below it.
Night of the 5th day, Mars approaches the 13th star of Ophiuchus, and is 1 deg. 5 min. below it, which is not an occultation.
Night of the same day, Venus occults the 12th star of Pisces, and is 38 min above it. […]"

The prediction of such phenomena involves the calculation of the latitudes of the moon and planets, a difficult problem that all traditional Chinese systems up to the Ming dynasty did not solve. However, every existent version of the HHLF contains sections especially devoted to the topic, including sections on [Computation of] the Latitudes of the Moon ("Taiyin weidu" 太陰緯度) , [Computation of] the Latitudes of the Five Planets ("Wuxing weidu"五星緯度) and [Computation of] the Occultation Events of the Moon and the Five Major Planets ("Taiyin wuxing lingfan" 太陰五星淩犯)[20]. According to our recomputations we conclude that the predictions in the XSYWLF were all done with the HHLF. Table 2 shows some results of these recomputations related to the moon[21].

[20]Bei Lin 贝琳 (ed.). *Chinese-Islamic System on Calendrical Astronomy* (*Huihui lifa*回回曆法) , bk. 1. Original printed version of 1447 now preserved in the National Archives of Japan.
[21]My thanks to Dr. Li Liang for his work on the computer program and the calculation.

Table 2: The Occultation of the Moon on Fixed Stars

Date and Time	Position of the moon according to HHLF	Position of the fixed stars according to HHLF	Distance according to HHLF	Description in the XSYWLF
14 35-6-8-17:30	Long. 235°9′ Lat. 0°45′ South	The 6th star in Scorpio Long. 235°18′ Lat. 0°13′ North	Dist.in Long. 9′ Dist. in Lat. 58′	Moon reaches the 6th star in Scorpio, 58′ below.
1435-6-8-19:00	Long.235°57′ Lat. 0°41′ South	The 5th star in Scorpio Long. 236°1′ Lat. 1°17′ North	Dist.in Long. 4′ Dist.in Lat. 1°58′	Moon reaches the 5th star in Scorpio, 1°58′ below, not encroaching.
14 35-6-8-23:30	Long.238°24′ Lat. 0°28′ South	The 22nd star in Ophiuchus and Serpens Long. 238°31′	Dist.in Long. 7′ Dist.in Lat. 1°58′	Moon reaches the 22nd star in Ophiuchus and Serpens, 1° 58′ below, not

		Lat.1°30′ North		encroaching.
14 35-6-9-01:00	Long.239°29′ Lat. 0°23′ South	The 24th star in Ophiuchus and Serpens Long. 239°16′ Lat.1°0′ N	Dist.in Long. 13′ Dist.in Lat. 1°23′	Moon reaches the 24th star in Ophiuchus and Serpens, 1° 24′ below, not encroaching.

Before the translation of the HHLF in China, occultation astrology was always done after such portents were discovered through actual observations[22]. To an ancient Chinese believer in astrology, however, it must have been a very attractive idea to know the portents beforehand so that prophylactic measures could be taken in easing the foreshadowed bad-luck even before the portents turned up. Apparently, this was the key reason which attracted Zhu Yuanzhang toward Islamic astronomy. This is why he pointed to the computation of the lunar and planetary latitudes while ordering his officials to carry out the translation. The existence of the XSYWLF shows that the Bureau for the Reverence of the Heaven did apply the HHLF to such calculations. In the Neige cangshu mulu, we can find another testimony of this practice:

Hongwu ershisi nian yue ji wuxing lingfan yice洪武二十四年月及五星凌犯一册 (The Occultations of the Moon and Five Planets in the 24th Year of the Hongwu Reign, one volume).

Doubtlessly, this is a book similar to the XSYWLF. We have not been able to see how the Chinese version of Kushyār ibn Labbān's Introduction to Astrology was used by the astrologers from the Bureau for the Reverence of the Heaven, but here we interestingly find how an Islamic system of calendrical astronomy was used for the purpose of Chinese astrology!

[22]See, e.g. Qutan Xida (瞿昙悉达). *The Kaiyuan Reign Canon of Astrology* (*Kaiyuan zhanjing* 開元占經) , bk. 12-14，19-22，24-29，31-37，39-44，47-52 and 54-59. The book was compiled by the Astronomical Bureau of the Tang dynasty during the Kaiyuan Reign (713-741).

From the newly discovered work from the Ming dynasty entitled The Imperial Records of the Grand Ancestral Emperor (Taizu huangdi qinlu太祖皇帝欽錄) , we obtain information about how occultation astrology was used by Zhu Yuanzhang, the Grand Ancestral Emperor of the Ming dynasty, in his administrative, or political, activities:

> "On 16th day 2nd month in the 20th year of the Hongwu Reign [6 March 1387], [the Emperor] issued a command paper:
>
> Hereby let me announce the disastrous anomaly foreshadowed by the celestial phenomena with clearly noted dates. Four times the moon and Venus will occult the asterism of Kings, and there must be someone who will be responsible for these disasters. Last year, as the moon and Mars occulted the asterism of Kings four times, I was so worried about the princes, being afraid that someone would be responsible for the disaster. I did not anticipate that the Kings of Zhou, Qi, Tan and Lu had all carried misdeeds that offended the god. Although they have been punished already, how could this ease the anger of the Divine Heaven? They will not be able to continue their life if they do not correct their mistakes immediately. Again this year, the moon and Venus will occult four times. I do not know which king is still carrying on misdeeds every day and thus enrages the Heaven on high. Therefore the two luminaries will abruptly occult [the asterism of the Kings]. It seems that the crime has been exclusively committed by the Kings of Zhou, Qi, Tan and Lu. Why do I think that the Kings of Zhou, Qi, Tan and Lu should be responsible for this? Take the King of Zhou as an example. He did many evil things that cannot be described completely. The biggest crime is his kidnapping and raping of the fiancée of Yan Dun, a successor of the county examination, and the fact that he kept her with him. The King of Qi illegally captured the girls of ordinary families, and kept them in his palace. He killed those uninteresting to him, burned their corpses into ash and threw them out of the palace. The King of Tan whipped a Scribe one thousand times to death and killed a Ceremonial Guarder with an iron hammer. The King of Lu is extremely savage and cruel, and his Queen deserves to be put to death by dismembering her body. […] The couple [of the King and Queen of Lu] cannot evade the penalty of death, while the Queen, the daughter of Lord Xinguo, should be dismembered. Now I brief every king on these deeds. The celestial

> phenomena have been appearing like this. Those who value their life have to guard themselves and retrieve the mandate of the heaven with good deeds. Otherwise the disaster cannot be evaded.
>
> In the 20th year of the Hongwu Reign [1387], the moon and Venus will occult the asterisms four times: on the 7th day 2nd month [25 February], the moon will occult the 2nd star in the eastern part of the asterism Kings; on the 27th day 6th month [12 June], Venus will occult the 2nd star in the east part of the asterism King; on the 28th day of the same month [13 June], Venus will occult the 1st star in the east part of the asterism King; and on the 22th day 7th month [6 August], the moon will occult the 2nd star in the east part of the asterism King."[23]

The event is well noted in the history of the Ming dynasty. To us, however, it is important to see how astrology was involved in a political operation of such high level. At least three of the occultations had not actually taken place yet when Zhu Yuanzhang's edict was issued. There is no doubt that they are the result of before-hand computation rather than after-hand records of observations. The result was calculated with the Huihui lifa which was the only system that provided the needed algorithms. In other words, the yearly compiled book about the occultations of the moon and five major planets was really used by the Ming emperor in his political and administrative activities as an important source of reference.

[23]Zhang Dexin张德信 (2005). The Discovery, Study and Transcription of the *Imperial Records of the Grand Ancestral Emperor*: with a discussion of the *Imperially Composed Documentation of the Misdeeds* ("*Taizu huangxi qinlu* jiqi faxain yu jilu yanjiu: jianji *yuzhi jifeilu*"**太祖皇帝**钦录及其发现与研究辑录——**兼及《御制**纪非录》). In Zhu Chengru **朱**诚如 (ed.). *Mingqing luncong* **明清**论丛 (Ming and Qing Study Series) (6). Beijing: Palace Museum Press, pp. 83-110. This text was discovered and made available to me by Dr. Li Liang.

4. Concluding remarks

In this paper, we have shown how Islamic astronomy was used in parallel with Chinese astronomy in the service of the Mongolian Yuan and Chinese Ming monarchs. Through the newly discovered materials, it is clear that Muslim astronomers of the Ming dynasty were charged with responsibilities similar to those of the Chinese astronomers. Their task was far more important than we have previously thought. Apart from the prediction of luni-solar eclipses, they also had to calculate both civil almanacs and astronomical ephemerides just as their Chinese colleagues did every year. In addition, they even did something that their Chinese colleagues were not capable of, viz. the prediction of the occultations of the moon and the five planets, a category of portent very important in traditional Chinese astrology. Both Yuan and Ming monarchs relied mostly on the Chinese tradition to show their legitimacy to rule China. Yet this did not prevent them to adopt any non-Chinese technique as long as it proved useful to meet their interests. This largely promoted the reception and assimilation of scientific knowledge from outside. In such a pragmatically orientated milieu, however, little attention was paid to theoretical aspects. That must have been the reason why no book on geometrical astronomy was translated and studied in the early Ming dynasty.