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Chinese Hereditary Mathematician Families of the Astronomical Bureau, 1620-1850

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CHINESE HEREDITARY MATHEMATICIAN FAMILIES
OF THE ASTRONOMICAL BUREAU, 1620–1850

by

PING-YING CHANG

A dissertation submitted to the Graduate Faculty in History in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York

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This manuscript has been read and accepted for the
Graduate Faculty in History in satisfaction of the
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Abstract

CHINESE HEREDITARY MATHEMATICIAN FAMILIES
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Adviser: Professor Joseph W. Dauben

This dissertation presents a research that relied on the online Archive of the Grand Secretariat at the Institute of History of Philology of the Academia Sinica in Taiwan and many digitized archival materials to reconstruct the hereditary mathematician families of the Astronomical Bureau in Qing China. The research found several patterns and strategies that these hereditary mathematician families exhibited during their long careers at the Astronomical Bureau. It found that family networks remained the most important channel that the Astronomical Bureau used to recruit new members until the last days of the Qing dynasty. Moreover, professional mathematicians at the Astronomical Bureau were willing to learn new knowledge—including switching from the Chinese traditional Great Concordance system of calendar making to the New Western Method introduced by European Jesuit mathematicians—and continue sending their descendants to work for the Astronomical Bureau as long as their families were properly rewarded.

This dissertation chooses the family of He Guozong, one of the most famous mathematicians of the early Qing period, as its representative case, because of the richness of the records related to the He family and the roles it played in several important junctures of the

history of the Astronomical Bureau. Familial connection became a cause of the stagnation of the Astronomical Bureau in the late eighteen century. However, the dissertation uses the case study of superintendent Jingzheng and the hereditary mathematician families in the first half of the nineteenth century to show that a capable administrator and a strictly implemented periodical examination system had effectively stimulated competition among mathematician families and ousted the old and incompetent ones, such as the He family.

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To all my friends: Jessie, Cj Chiang, SC Wang, Maylin, TzuChen, Vickie, Huailo and many others, thank you for keeping my spirits high and giving me so many helps to my life.

DEDICATED TO MY PARENTS,
TSANG-LANG CHANG and EMMY CHOU CHANG

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REIGN TITLES OF THE QING EMPERORS (1644–1911)

Shunzhi	順治	1644–1661
Kangxi	康熙	1662–1722
Yongzheng	雍正	1723–1735
Qianlong	乾隆	1736–1795
Jiaqing	嘉慶	1796–1820
Daoguang	道光	1821–1850
Xianfeng	咸豐	1851–1861
Tongzhi	同治	1862–1874
Guangxu	光緒	1875–1908
Xuantong	宣統	1909–1911

Chapter 1

Introduction

1.1 The Research Question

In the ninth month of the twelfth year of the Qing Yongzheng 雍正 reign (September 1734), Bao Qinhuai 鮑欽輝, the supervisor of the Winter Office (*Dongguanzheng* 冬官正) of the Astronomical Bureau (*Qintianjian* 欽天監), attended an imperial audience along with a group of officials from other institutions who were seeking to finalize their recent job promotions. An audience such as this represented the only occasion for lower-ranking civil servants like Bao to communicate directly with the emperor.¹ At the time, Bao was forty-six years old and had worked at the Astronomical Bureau all of his adult life.² Three years earlier he had been promoted to one of the highest positions in the Calendar Section 曆科 and had been in charge of calculating the official calendar for the dynasty. As a result of his long and excellent service record, Bao was granted a new position as a second-class secretary 主事 at the Ministry of Works 工部. However, while the other officials at this imperial audience hoped to be approved for new jobs, Bao's object was to convince the emperor to let him remain in his old post. Uncertain about how much time he would be allowed to talk to the emperor, Bao Qinhuai elaborated his concerns in the résumé that the emperor would be browsing through during the audience. Bao began by recounting his familial lineage:

¹ In the Qing dynasty, the civil service ranking hierarchy was divided into nine levels. Supervisor of the Winter Office ranked at the sixth level.

² This dissertation follows the Chinese traditional way of calculating birth year and age. Namely, newborns start at one year old. However, it should be noted that officials did not always report their ages honestly to the government. Therefore, these calculations would better be understood as approximations.

Although my intrinsic quality is mediocre and foolish, I have the fortune to meet such a prosperous era that the profession of computation and observation has been showered with favor and grace. My grandfather, Bao Yinghua, 鮑英華, was an erudite (*boshi* 博士) of the Astronomical Bureau. My grandfather's elder brother, Yingqi 英齊, was a senior vice director (*zuo jianfu* 左監副). My father, Kewei 可畏, was a student astronomer (*tianwensheng* 天文生), and his younger brother, Kecheng 可成, was the supervisor of the Spring Office (*chunguanzheng* 春官正). From grandfather to grandson, every generation [of my family] has learned the method of calendar making and received grace from the imperial state.³

After reminding the emperor that the members of his family had proudly served the dynasty for generations with their specialty in mathematical astronomy, Bao Qinhui recounted his own contributions. He listed three mathematical projects in which he had participated: the Office of Compiling Mathematical Treatises in the previous reign, the modification of the calendar-making system in the 1730s, and the new mathematics education program in the public schools that had commenced earlier in the current year. Bao concluded his résumé by informing the emperor, “I worry about my stupidity. Except for the knowledge of calendar making, there really is not anything that I can contribute.”⁴ Bao's petition successfully convinced the Yongzheng emperor, and he remained in his position as the supervisor of the Winter Office of the Astronomical Bureau until he died two decades later.⁵

The stories of Bao Qinhui, his family, and many other mathematician families, together with Bao's résumé and tens of thousands of Qing state documents that lie silently in archives, have attracted little attention from historians. Indeed, at first glance, Bao Qinhui's résumé is hardly exciting or inspiring. Mathematics as a hereditary profession has long been a historical phenomenon in China, but the Bao family was almost unheard of. Unlike other Qing mathematicians, such as He Guozong 何國宗, Mei Juecheng 梅穀成, and Ming'antu 明安圖,

³ QGLL 13:189. All translations are mine.

⁴ GYLL 13:189–90.

⁵ IHP 023895.

neither Bao Qinhuai nor any of his family members had previously been considered distinct enough to be included in the series of *Biographies of Mathematicians* (*Choren zhuan* 疇人傳) that Ruan Yuan 阮元 and other late-Qing mathematicians and historians compiled. The Qing official history includes very few descriptions of the two Yongzheng-period mathematical activities in which Qinhuai was involved—the modification of the calendar-making system and the new mathematics education program. Similarly, historians are typically more interested in the earlier and larger-scale project, namely, the compilation of the *Origins of Mathematical Harmonics and Astronomy* (*Luli yuanyuan* 律曆淵源), which Bao also participated in but was not included in the state-approved list of major contributors.⁶ Few historians perceive the Yongzheng mathematical activities to be relevant or important in the development of Chinese mathematics.⁷

Nonetheless, historical research is about revisiting the stories that have been told and investigating the parts of the stories that have not been told. In particular, the purpose of research is to find out what storytellers have purposely hidden from the readers, reassess the significance of the stories, and reconstruct the stories if necessary. For instance, knowing that the formidable Yongzheng emperor had banned the dissemination of Christian teachings, Bao Qinhuai did not mention in his résumé that he was from a Christian family.⁸ Qinhuai's granduncle, Bao Yingqi,

⁶ Yunlu 允祿 et al., *Yuzhi lixiang kaocheng* 御製曆象考成, SKQS 790:5–7.

⁷ On the development of mathematics in the Kangxi period, see, for instance, Catherine Jami's *The Emperor's New Mathematics: Western Learning and Imperial Authority during the Kangxi Reign (1662–1722)* (New York: Oxford University Press, 2012) and Han Qi's 韓琦 works listed in bibliography.

⁸ For the Bao family's involvement in the Rites Controversy, see Huang Yi-Long 黃一農, “Beihulue de shengyin—jieshao Zhongguo Tianzhujiatou dui ‘liyi wenti’ taidu de wenxian” 被忽略的聲音—介紹中國天主教徒對「禮儀問題」態度的文獻, *Qinghua xuebao* 清華學報 25, no. 2 (1993): 137–60; Han Qi 韓琦, “Fengjiao tianwenxuejia yu ‘Liyi zhi zheng’ (1700–1702)” 奉教天文學家與‘禮儀之爭’ (1700–1702), in *Xiangyu yu duihua: Mingmo Qingchu Zhongxi wenhuajiaoliu guoji wueshu yiantaohui wenji* 相遇與

had once been banished to the northeast borderland in the early Kangxi 康熙 reign (1662–1722) for being a member of the Jesuit faction.⁹ In August 1702, Bao Yingqi and Bao Kecheng led their family and more than forty Chinese Christians to send a petition to the Pope regarding the Rites Controversy 禮儀之爭, and they all signed the petition with their official titles at the Astronomical Bureau.¹⁰ Indeed, Bao Qinhui was from one of the oldest hereditary mathematician families to serve the Qing court since it was established in Beijing, and he appeared thankful for the rewards that Yongzheng and preceding emperors had bestowed on his family. However, the Bao family relied more on the Jesuits than on the Qing rulers' imperial grace. It is not a coincidence that the number of archival records related to the Bao family decreases as the Jesuits' status in the Qing court declined, and no record bearing the surname Bao dated after the mid-Jiaqing reign (1800s) has been found.¹¹

Historians of Chinese mathematics are familiar with the term *chouren shiye* 疇人世業, which describes the phenomenon that mathematics as a special kind of knowledge, or as a skill for the profession called *chouren*, often became a family tradition that spanned several generations. Zu Chongzhi 祖沖之 (429–500) and Zu Gengzhi 祖暅之, for example, were a famous father-son pair of Chinese mathematicians. Together they wrote *The Method of Interpolation* (*Zhui shu* 綴術), which arguably was the highest achievement of ancient Chinese mathematics.¹² In the Qing period, Ming'antu 明安圖 (c. 1692–c. 1763), who is known to

對話：明末清初中西文化交流國際學術研討會文集, ed. Zhuo Xinping 卓新平 (Beijing: Zongjiao wenhua chubanshe, 2003), 392–93.

⁹ Chen Fangzhong 陳方中, ed., *Zhongguo Tianzhujiào shiji huibian* 中國天主教史籍彙編 (Taipei: Furen daxie chubanshe, 2003), 520–25.

¹⁰ Huang, “Beihulue,” 149, 152–53.

¹¹ IHP 170472. Bao Duo 鮑鐸 was a student astronomer in 1807.

¹² Ruan Yuan 阮元 et al., *Chouren zhuan huibian* 疇人傳彙編 (Taipei: Shijie shuju, 1982), 91–109.

historians of Chinese mathematics for his calculations of infinite series, and his son Mingxin 明新 were a father-son pair of Mongolian mathematicians who worked at the Astronomical Bureau.¹³ Ming'antu's most important contribution was working on the theory of the power series expansions of sine and versed sine. Ming'antu's work was completed and published posthumously in the *Quick Methods for the Circle's Division and Precise Ratio* (*Geyuan milü jiefa* 割圓密率捷法), by Mingxin with assistance from his disciples Chen Jixin 陳際新 and Zhang Gong 張肱.¹⁴

It is noteworthy that although Bao Qinhui and Ming'antu both worked at the Astronomical Bureau until their deaths, there are more differences than similarities in their career experiences. The Bao family learned a method of calendar making from Jesuit missionaries, but Ming'antu learned mathematics from the Kangxi emperor and became a major compiler of the *Origins of Mathematical Harmonics and Astronomy*.¹⁵ When the treatise was completed, he was rewarded with the position of the supervisor of the Five Offices (*wuguanzhen* 五官正). Ming'antu devoted his later years to researching the analytic formulas that his Jesuit colleague Pierre Jartoux (Chinese name Du Demei 杜德美, 1669–1720) refused to explain.¹⁶ Although Mingxi inherited the profession of mathematician, Ming'antu's intellectual achievements seemed to be succeeded more by his disciples than by his own descendants.

¹³ Ruan, *Chouren zhuan*, 627.

¹⁴ See Jami, *Emperor*, 307, for a brief introduction to Ming'antu's achievements. For a more complete introduction, see Jianjin Luo, "Ming Antu and His Power Series Expansions," in *Seki, Founder of Modern Mathematics in Japan: A Commemoration on His Tercentenary*, ed. Eberhard Knobloch, Hikosaburo Komatsu, and Dun Liu (Tokyo: Springer Japan, 2013).

¹⁵ Yunlu et al., *Yuzhi lixiang kaocheng*, 790:6.

¹⁶ Ming'antu 明安圖 and Chen Jixin 陳際新, *Geyuan milü jiefa* 割圓密率捷法, XXSK 1045:1–2.

The comparison between Bao Qinhui and Ming'antu suggests that famous pairs of father-son mathematicians, such as Ming'antu and Mingxin, are not necessarily the most representative cases of the hereditary mathematician families. It calls for more complete and in-depth research into the mathematician families that had worked for the Astronomical Bureau generation after generation. Only after such research is completed can we understand the systematic design that discouraged Ming'antu and other non-Han professional mathematicians from passing knowledge and skills to their descendants and the family interests that Bao Qinhui had in mind when he considered whether or not he should accept the new position offered to him.

The initial goal of this research was to understand the life and career of a professional mathematician in the Qing period from the perspective of the hereditary mathematician family. It aimed to construct a cultural history of the Qing Astronomical Bureau from the prespect of hereditary mathematician families. Most Qing Astronomical Bureau officials learned the mathematical knowledge and skills needed for a career in the Bureau as part of their early family education. They often worked directly with relatives, and periodical examinations and job reviews were frequently administrated by a senior member of their family. The professional mathematicians of the Astronomical Bureau were not just individual officials but also members of their families. As such, the research naturally turns its attention to the relationship between an individual official's career progression and a mathematician family's collective interests. Re-examining historical events becomes important to understanding how mathematician families dealt with crisis and navigated external power struggles. It transpires that the historical significances of the two Yongzheng-reign mathematical activities that Bao Qinhui was involved in need to be revisited. Their significances lie in the fact that later Qing officials downplayed their importance and even avoided mentioning them. Such evasion, as this dissertation

demonstrates, is one of the byproducts of the continually changing and never-ending power struggle between the Qing monarch, European missionaries, and different hereditary mathematician families.

1.2 The Sources

Because of the nature of the research questions, many archival materials that are already familiar to researchers of Qing history are less helpful to this study than one might expect. The focus of this study, the mathematician families associated with the Qing Astronomical Bureau, has two distinct characteristics: their members were low-ranking officials of the central government and their profession depended on mathematical knowledge.¹⁷ Because their ranking in the civil service hierarchy was low, the Astronomical Bureau officials did not have the right to communicate with the supreme ruler directly. Therefore, popular archival materials such as the vermilion rescripted palace memorials (*Zhupi zouze* 硃批奏摺)—the secret written communications between the emperor and a small group of trusted officials—contain very few records related to the mathematician families. Although some superintendents and directors of the Astronomical Bureau were granted the privilege of submitting palace memorials, they mostly memorialized the monarch for affairs related to the jobs they held concurrently in other institutions that had nothing to do with the Astronomical Bureau. Similarly, the *Veritable Records* (*Shilu* 實錄) and the *Imperial Diary* (*Qijuzhu* 起居注) focused on the emperors, who—with the exception of the Yongzheng emperor—seldom paid attention to the routine operations and personnel administration of the Astronomical Bureau. These sets of archival sources are

¹⁷ The highest position in the Astronomical Bureau—director—was at the fifth level (out of nine) of the civil service hierarchy.

useful for gaining access to information on the monarch and his high ministers, whose policy decisions affected the Astronomical Bureau, but rarely do they provide insight into the lives of the mathematician families. The biographies contained in the *Draft History of the Qing* (*Qingshigao* 清史稿), *History of the Qing* (*Qingguoshi* 清國史), and the *Biographies of Mathematicians* (*Choren zhuan* 疇人傳) have not fared much better.¹⁸ They include about twenty mathematicians who were associated with the College of Mathematics (*Suanxue* 算學) or the Astronomical Bureau. However, how these individuals studied and worked at the two institutions is rarely mentioned.

Traces of the mathematician families have to be found in other types of sources. The *Collected Statutes of the Great Qing* (*Da Qing huidian* 大清會典), which was updated and amended several times throughout the lifespan of the dynasty, contains laws that governed the organization and administration of every government institution of the Qing dynasty. These laws proved essential and enabled this dissertation to reach an understanding of how the Astronomical Bureau operated and what the career path of a professional mathematician of the Astronomical Bureau typically looked like. However, as a set of laws, the *Collected Statutes* include almost no record of individual officials; only in the precedents that were added to the later versions of the *Collected Statutes* can some descriptions be found to include personal information about the

¹⁸ The Qing court maintained a State Historical Archive 國史館 to preserve and write its own history. The *Draft History of the Qing* (*Qingshi gao* 清史稿) was compiled in the 1910s and 1920s, mainly based on the documents left by the Qing State Historical Archive. The compilation is widely regarded as unsuccessful for the many errors it contains. The *History of the Qing* (*Qingguo shi*, *Jiayetang chaoben* 清國史, 嘉業堂鈔本) was directly copied from the documents preserved in the Qing State Historical Archive. This research uses both sets of documents but relies more heavily on the *History of the Qing*.

officials involved.¹⁹ Indeed, even locating the names of those who served at the Astronomical Bureau is not always easy.

Fortunately, previous researchers, such as Qu Chunhai 屈春海 and Shi Yumin 史玉民, have laid inspiring groundwork for this study. Qu's "A Chronological Table of Officials Serving in the Qing Dynasty's Imperial Board of Astronomy and Section of the Almanac" (*Qingdai Qintianjian ji Shixianke zhiguan nianbiao* 清代欽天監暨時憲科職官年表) collected the official rosters attached to the Qing official calendar.²⁰ A typical roster on the calendar consists of the titles and names of the Astronomical Bureau directorate and the higher-level Calendar Section officials. Qu's table suggests that the published official calendar could be used to trace the personnel change among the higher-level Calendar Section officials, although the names of lower-level officials and trainees—erudites and student astronomers—must be found elsewhere. Shi's "A Chronological Table for Officials Serving in the Division of Astronomy of the Qing Dynasty Qintianjian" (*Qing Qintianjian tianwenke zhiguan nianbiao* 清欽天監天文科職官年表) provides similar information for the officials of the Section of Heavenly Signs 天文科.²¹ Compared to Qu, who conventionally compiled his table from a single source, namely, the official calendar, Shi had to search the routine memorials 題本 preserved in the First Historical Archive in Beijing to abstract the names of the officials.²² Shi's table has the advantage that it

¹⁹ Since the third update performed in the Qianlong reign, compilers have kept the main body of the laws in the *Collected Statutes* but have moved the minor regulations and precedents to a separate work: the *Collected Statutes and Precedents of the Great Qing* (called *Da Qing huidian shili* 大清會典則例 in the Qianlong reign and *Da Qing huidian shili* 大清會典事例 in the Jiaqing and Guangxu reigns).

²⁰ Qu Chunhai 屈春海, "Qingdai Qintianjian ji Shixianke zhiguan nianbiao" 清代欽天監暨時憲科職官年表, *China Historical Materials of Science and Technology* 中國科技史料 18, no. 3 (1997): 45–71.

²¹ Shi Yumin 史玉民, "Qing Qintianjian Tianwenke zhiguan nianbiao" 清欽天監天文科職官年表, *China Historical Materials of Science and Technology* 中國科技史料 21, no. 1 (2000): 34–47.

²² *Ibid.*, 35–36.

sometimes includes officials of the erudite level. However, the number of officials that Shi located fluctuated during different periods, and he did not explicitly explain which types of routine memorials he used.²³ Nonetheless, Qu Chunhai's and Shi Yumin's tables are handy references for this research, and their works suggest that routine memorials and regular state documents could contain records related to the lower-level staff members of the Astronomical Bureau.

Among the 300,000 Qing state documents housed in the Archive of the Grand Secretariat 內閣大庫檔案 at the Institute of History and Philology (IHP) of the Academia Sinica in Taiwan, approximately 1,400 are related to the Astronomical Bureau and the College of Mathematics.²⁴ The majority of these documents are reports on routine duties and personnel affairs administrated according to the regulations prescribed by the *Collected Statutes*. Their contents include the nominations of officials when vacancies arose, requests for imperial approvals to hold periodical and entrance examinations for the Astronomical Bureau and the College of Mathematics, reports on the examination outcomes, the submission of sample calendars and predictions of solar and lunar eclipses to the emperor, and so on. When the Bureau submitted a progress or final report on the assigned task, it often attached the rosters of the officials responsible for that activity. If the report was related to personnel administration, then brief information about the officials in question—such as their ages, hometowns, academic degrees, and job performance reviews—often had to be included. Such reports provide personal information about the Astronomical Bureau staff, from the highest-level directors down to the lowest-level trainees. Moreover,

²³ One type of routine memorials that Shi Yumin used were those written to submit the *Weather Records* (*Qingyulu* 晴雨錄) on the first day of the second month every year.

²⁴ Grand Secretariat Archive 內閣大庫檔案, Institute of History and Philology of Academia Sinica, Taipei, accessed 2014, <http://archive.ihp.sinica.edu.tw/mctkm2/index.html>.

information found in the process can be used to correct some of the errors in Qu's table that resulted from incorrect typesetting, and it can also help to clarify some administrative regulations that the *Collected Statutes* did not explain.

The *Complete Collection of the Qing Officials' Résumés* (*Qingdai guanyuan lilü quanbian* 清代官員履歷大全) is another set of documents that are indispensable to this research.²⁵ This published archive consists of records related to the imperial audiences, including lists of the officials who attended the imperial audiences, individual officials' service records kept by the government, and the résumés prepared by individual officials. Among these records, the résumés were the most useful to this research. Before the Qianlong reign (1736–1795) commenced, the format of the résumés was less restricted, and officials were permitted to introduce themselves more freely or make suggestions related to their jobs. That is why some Astronomical Bureau officials like Bao Qinhui could describe their families' connection with the Bureau and state their preferences pertaining to their career transitions on their résumés. However, by the mid-Qianlong reign, lengthy résumés were no longer permitted, and the contents of these résumés became much less informative.²⁶ Nevertheless, audience résumés are one of the rare types of documents to include records about the ages, hometowns, and degrees of lower-ranking officials.

Other sets of archives were useful for some special topics in this research. Both the IHP and the Qing Dynasty Palace Memorials and Grand Council Archived Memorials 清代宮中檔奏摺及軍機處檔摺件, housed in the National Palace Museum (NPM) in Taipei, contain relatively few records related to the Astronomical Bureau in the Yongzheng period. As such, the *Sources*

²⁵ Qin Guojing 秦國經, ed., *Qingdai guanyuan lilü quanbian* 清代官員履歷檔案全編, 30 vols. (Shanghai: Huadong shifan daxue chubanshe, 1997).

²⁶ See Appendix A for sample résumés from different periods.

Related to the Personnel Administration in the Qing Dynasty (*Qingdai lizhi shiliao* 清代吏治史料) becomes a great complement to them.²⁷ Note that the title of the latter set of archives is misleading, for it includes only records from the Yongzheng reign, not from the entire dynasty. The *Sources Related to China in the Veritable Records of the Joseon Dynasty* (*Chaoxian Li chao zhilu zhong de Zhongguo shiliao* 朝鮮李朝實錄中的中國史料) complements Qing official records in a different way.²⁸ The *Veritable Records* of the Joseon Kingdom included numerous descriptions related to the Qing court that the Qing state historians would rather omit or alter than allow to embarrass their dynasty. This dissertation makes use of evidence in the Joseon *Veritable Records* that exposes the deterioration of the Qing official calendar in the Yongzheng period.

Finally, it is noteworthy that the digitization of archival records played a critical role in this research. Due to the low status of the members of the mathematician families within the giant bureaucratic system, finding records related to them was sometimes like searching for a needle in a haystack. Even when armed with the knowledge of which types of sources were more likely to contain useful material, locating useful details, which were often buried in tens or even hundreds of thousands of records, was challenging. To build a pool of members of the Qing Astronomical Bureau that was large enough to show the familial relations between them, a working environment that the researcher could effectively examine, abstract, and process the contents of archival records was important. Therefore, this research relied heavily on archives

²⁷ Qing Dynasty Palace Memorials and Grand Council Archived Memorials 清代宮中檔奏摺及軍機處檔摺件, National Palace Museum, Taipei, accessed 2014, <http://npmhost.npm.gov.tw/tts/npmmeta/GC/indexcg.html>; Ren Mengqiang 任夢強, ed., *Qingdai lizhi shiliao* 清代吏治史料, 103 vols. (Beijing: Xianzhuang shuju, 2004).

²⁸ Wu Han 吳晗, ed., *Chaoxian Li chao zhilu zhong de Zhongguo shiliao* 朝鮮李朝實錄中的中國史料, 12 vols. (Beijing: Zhonghua shuju, 1980).

that had been digitized. The IHP and NPM archives can be accessed online,²⁹ and the majority of the other sources used are published photocopies of archives. Instead of examining them in their familiar paper forms, it was more effective to digitize them into electronic books and then examine them on computer screens. After this extra step of digitization, the rest of the process of data abstraction, filing, and analysis could be accomplished much faster with computers than with traditional pen-and-paper methods. The time and effort spent on digitization undoubtedly repays itself for research involving large amounts of archival records.

1.3 The Plan of This Dissertation

The process of scrutinizing the archival papers related to the Astronomical Bureau from the late Ming dynasty to the end of the Qing dynasty has found over five hundred Bureau members who were from about thirty mathematician families. To convey the stories of the mathematician families that served the Qing Astronomical Bureau effectively, the He 何 family was used as a representative case. The He family began serving the Astronomical Bureau in Ming times. Before the last He departed the Bureau in the Daoguang 道光 reign (1821–1850), the family had worked at the Astronomical Bureau for two hundred years, and fifty members of the He family had left their traces in Qing state records. Among them was He Guozong 何國宗, one of the most famous mathematicians of the early Qing period. The richness of the records related to the He family and the roles it played in the important junctures of the history of the Astronomical Bureau made it a perfect case study in this research.

²⁹ The NPM archive is accessible at <http://npmhost.npm.gov.tw/tts/npmmeta/GC/indexcg.html> for a small annual fee. Accessing the IHP archive is free but requires a Taiwan IP address.

To facilitate an understanding of the contents of this dissertation, the next chapter will introduce the functions of the Qing Astronomical Bureau by describing its organization and functions on an institutional level, including the job requirements for each employee in the Bureau. The purpose of this chapter is to provide readers with a basic overview of the Astronomical Bureau rather than all of the details.

Chapter three begins by describing the historical contexts in the Ming period (1368–1644) that gradually transformed the profession of serving at the Astronomical Bureau from a mandatory career into an inheritable family interest. It then investigates the political concerns of China's new Manchu rulers that led Regent Prince Dorgon 多爾袞 to promptly adopt the new calendar that the Jesuit missionary Johann Adam Schall calculated according to Tychonic mathematical astronomy but to refuse Schall's request to dismiss the Astronomical Bureau officials who resisted giving up the Great Concordance (*Datong* 大統) system of calendar making. This chapter ends by showing that, although old mathematician families were suppressed and some withdrew from the Astronomical Bureau, family networks remained an important channel through which Schall could recruit new members for the Bureau and find suitable individuals to learn his New Western Method (*Xiyang xinfa* 西洋新法).

Chapter four examines the impacts that the Kangxi Calendar Dispute 康熙曆爭 had on the organization of the Astronomical Bureau and the roles hereditary mathematician families played in the dispute. After temporarily returning to the Great Concordance system of calendar making between 1665 and 1667, which was then referred to as the Ancient Method (*Gufa* 古法), the Qing court reinstalled the New Western Method and Jesuit mathematicians to the Astronomical Bureau. However, as chapter four reveals, the Jesuits never regained the same controlling power of the Astronomical Bureau that Schall once had. Moreover, the Kangxi

emperor did not give a decisive endorsement of the New Method until 1676. In the same way as Dorgon, he allowed the supporters of the Ancient Method to remain in the Astronomical Bureau. Among those supporters was one of the most influential hereditary mathematician families in the Qing period, the He family.

Chapter five focuses on the interactions between the Kangxi and Yongzheng emperors and the He family. In particular, it shows how these two emperors utilized the mathematical talents of He Guozong and two of his brothers, Guozhu 國柱 and Guodong 國棟, and manipulated their careers. The He brothers, whose talents and loyalty could be assured by their father's service records, became the Kangxi emperor's favorite candidates for testing his vision of mathematics. However, the Yongzheng emperor, who was famous for his tremendous attention to administrative affairs, grew concerned about the expansion of the He family's powers. Within years of the Yongzheng emperor coming to the throne, the fortunes of the He brothers declined precipitously.

Chapter six completes the discussion of the Yongzheng emperor and the He family presented in the previous chapter with a detailed study of the circumstances surrounding the solar eclipse of 1730. On the one hand, ministers and officials from all regions eulogized the emperor and denied that the Astronomical Bureau's prediction of the 1730 eclipse was a failure. On the other, the He family, Jesuit missionaries, the Astronomical Bureau officials, and even the Yongzheng emperors knew beforehand that the prediction was likely to fail. In the end, all Bureau officials, missionaries included, were forced into silence. Only the Yongzheng emperor, who staged a political performance, benefited from this incident.

Chapter seven investigates the roles of professional mathematicians and their family interests in the imperial state's management of reproducing mathematical knowledge. The first

case studied here is the new compilation project of mathematical treatises that took place in the early Qianlong reign. Rather than representing a voluntarily contribution from the Jesuits, this dissertation argues that the project arose from hereditary mathematician families' need to obtain the mathematical knowledge that their Jesuit colleagues in the Astronomical Bureau had shrouded in secrecy since 1730. The rest of the chapter is devoted to the comparison between the mathematics program of the late Yongzheng reign and the College of Mathematics founded in the early Qianlong reign. The attempt to add mathematics into the curriculum of general education failed, and the Yongzheng mathematics program was terminated after just four years. It was replaced with the College of Mathematics, which aimed to recruit newcomers for the Astronomical Bureau and did not conflict with the existing interests of the hereditary mathematician families.

Chapter eight explains some of the patterns and strategies that hereditary mathematician families exhibited during their long careers at the Astronomical Bureau. It describes how members of the same families often clustered in one section of the Astronomical Bureau until they overcrowded that section and new members had to be reallocated to a different section. It then investigates the personal concerns and family interests that motivated some officials to choose to remain in the Astronomical Bureau as opposed to accepting higher positions in different government institutions. This chapter ends by describing of some of the symptomatic events that declining mathematician families often exhibited.

Chapter nine focuses on the importance of the administrators and the administrative system. European missionaries' continual loss of status in the Qing court resulted in their complete withdrawal from the Astronomical Bureau in 1826. By then, the Astronomical Bureau and the College of Mathematics had become stagnant and the periodical examination system had

become formulaic. However, the stagnation gradually changed after May 1824, when the Daoguang emperor named Jingzheng 敬徵, who was famous for his administrative ability rather than his knowledge of astronomy or mathematics, superintendent of these two institutions. Aggressively utilizing the existing periodical examination system, Jingzheng ousted the old and incompetent He family from the Astronomical Bureau. New and proficient mathematician families arose. By the time Jingzheng retired from public service in 1845, the Bureau had repaired the astronomical instruments and had updated the constants used in the calendar-making process.

This dissertation focuses more on Han Chinese than non-Han mathematician families for two reasons. First, because the majority of the members and their families found were Han Chinese, their records can be comprised into a relatively complete storyline. Second, early in the research process it became apparent that administrative laws hampered the formation of non-Han mathematician families. The Qing dynasty maintained the social and legal division between Bannermen 旗人, the members of the social and military organization Eight Banners 八旗, and the conquered Han commoners 漢人. The members of the Eight Banners were further divided into three ethnic categories—Manchu, Mongol, and Han-Martial (*Hanjun* 漢軍)—and bestowed with different levels of legal privilege.³⁰ Section 4.2 is devoted to an assessment of the impacts of the ethnic categories had on Astronomical Bureau officials' career paths.

Based on the archival records, it is evident that the Astronomical Bureau mathematicians throughout the Qing period closely followed the traditional yet non-mandatory practice of using the same pattern of naming the newborns of the same generation. For instance, He Guozong and

³⁰ In most cases, the ethnic categories agreed with the members' ethnic origins. Han Martials were mainly composed of the descendants of Han Chinese who had lived in Manchuria and became allies of Manchu conquerors.

his brothers and cousins all had the character *guo* 國 in their names. Although there are not always enough surviving records to clarify the exact relations among the Bureau mathematicians, their urge to express the bond among themselves and their belonging to certain genealogical groups are undeniable. In fact, both the ambiguity and belonging reflected the ways that their contemporaries perceived these mathematicians. They might come to know or at least suspect that a Bureau mathematician was from a certain family but could not determine his exact relation to that family unless they became his acquaintance. Therefore, this dissertation uses the term *family* rather freely to denote a group of Bureau mathematicians with the same surname as long as some name patterns can be found among them. As such, this dissertation does not supplement or serve as a substitute for the genealogy of mathematician families. Rather, it examines the historical representation of the hereditary mathematician families.

While some hereditary mathematician families served the Qing dynasty until its last days, the narration of this dissertation stops around the time that the He family left the Astronomical Bureau. Rather than presenting a complete survey of the history of the Astronomical Bureau, it highlights the historical events that best reflect the characteristics of the hereditary mathematician families of the Qing Astronomical Bureau and their interactions with the imperial state. This dissertation ends with a conclusion that discusses the contributions that the research findings can make to the methodology and historiography of the history of mathematics in the Qing dynasty.

Chapter 2

The Organization of the Qing Astronomical Bureau

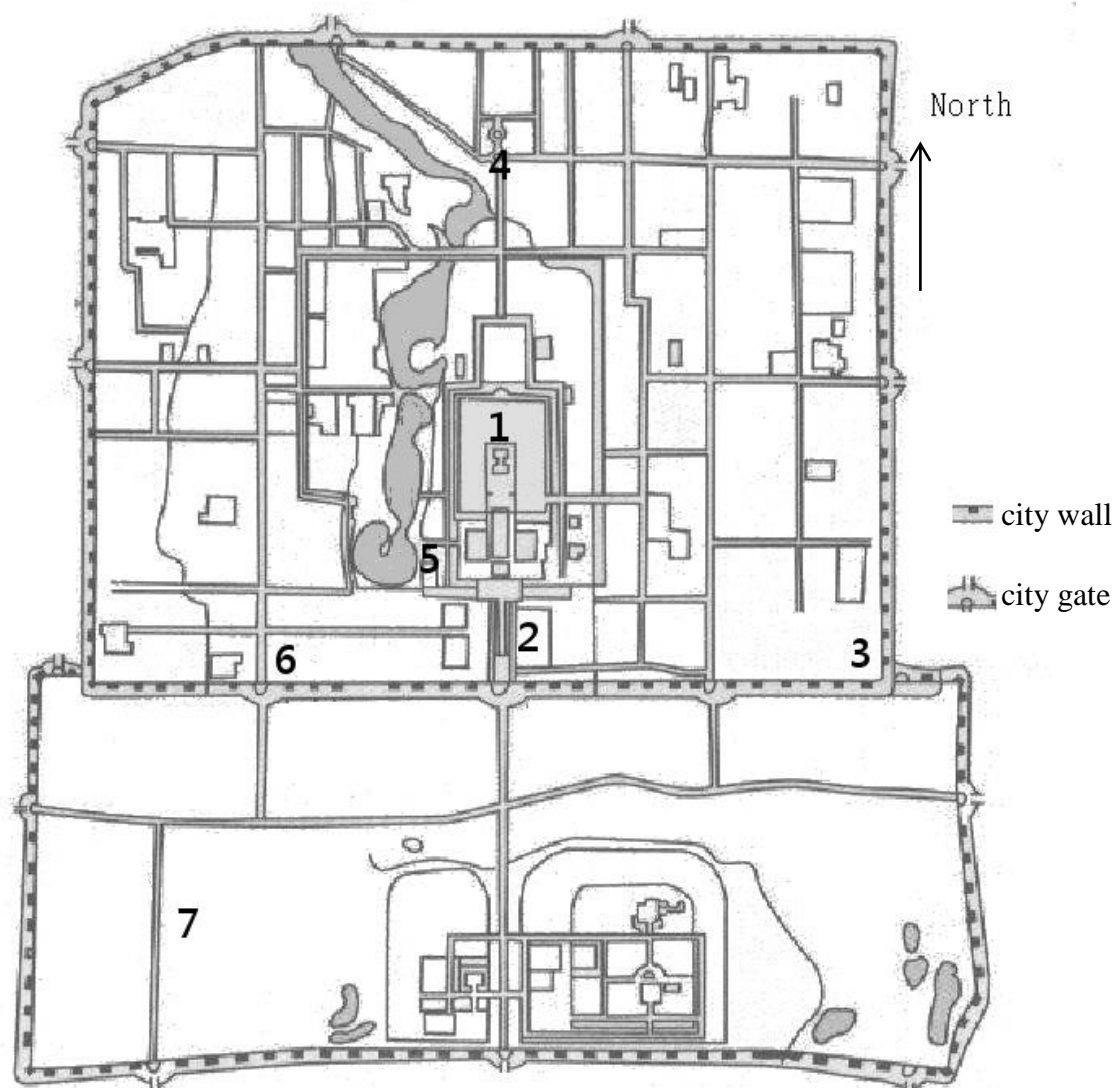
This chapter describes the organization and functions of the Qing Astronomical Bureau on an institutional level. Writing an institutional history for the Qing Astronomical Bureau needs a completely different essay, and it is not the purpose of this chapter to provide even a condensed version. Early in the research process, it became apparent that a clear understanding of the Bureau's organization and each official's position in the Bureau are fundamental to analyzing the Qing state papers related to the Astronomical Bureau. This chapter aims at removing such difficulties for the readers of this dissertation. It summarizes the organizational regulations relevant to the Astronomical Bureau from the level of the bureau to its subordinated sections and then to the individual officials.

2.1 The Bureau

The most essential duty of the Astronomical Bureau was to produce annual calendars for the dynasty. The Qing Empire regarded the calendar publication as a state-monopolized business. Every year on the first day of the tenth month, the court held a ceremony called calendar publication (*ban suo* 頒朔) to display the dynasty's authority.¹ All officials working in the capital of Beijing and representatives from the vassal states were required to attend the calendar publication ceremony to receive their copies of next year's calendars.² To fulfill this important task, the Astronomical Bureau had to have more than 67,000 copies of the new calendar in Chinese, Mongol, and Manchu languages ready for distribution before the calendar-publication

¹ QHDSL GX 803:75–81.

² QHD GX 794:718.



1. Forbidden city
2. Main office of the Astronomical Bureau
3. Observatory
4. Water tower
5. College of Mathematics
6. *Xuanwumen* chapel
7. Muslim community

Figure 1. Map of Beijing.

ceremony was held.³ As a result, the computation of the new calendar had to be finished even earlier. The statutory laws required the Astronomical Bureau to submit a sample civil calendar in Chinese to the emperor on the first day of the second month.⁴ After the emperor approved, the sample calendar was translated into the Manchu and Mongol languages and then reproduced. Sample copies were dispatched to each province on the first day of the fourth month so that the provincial government could start preparing the new calendars.⁵

Unlike the Ming dynasty, which maintained a branch of the Astronomical Bureau in Nanjing, the entire Qing Astronomical Bureau was in Beijing. The Bureau had three major workplaces. The first was the main office (*yamen* 衙門) of the Bureau, which was located in the block of central government institutions between and slight to the east of the Gate of Heavenly Peace (*Tiananmen* 天安門) and the Gate of the Great Qing (*Da Qing men* 大清門). Within the main office were various rooms of subordinated sections and storages that preserved records, documents, and printing blocks of astronomical treatises. It was in the main office that most official affairs were conducted, including calendar calculation and production.⁶

The second major workplace was the observatory (*guanxiangtai* 觀象臺) located at the southeast corner of the Beijing city wall. A small team of officials was on duty at the observatory at all times so that the Bureau could catch all irregular celestial events and immediately interpret them for the monarch.⁷ The third was the water tower (*qiaolou* 譙樓) located in the north side of

³ According to the number cited by Director Jinai 進愛 in IHP 019954.

⁴ QHD GX 794:718.

⁵ Ibid.

⁶ For a more detailed description, see Shi Yumin 史玉民, “Qing Qintianjian Yashu Ji Xieyu Guimo” 清欽天監衙署位置及廨宇規模, *China Historical Materials of Science and Technology* 中國科技史料 24, no. 1 (2003).

⁷ GHD GX 794:751.

the city. The Astronomical Bureau had to monitor a multilevel water clock in the water tower and announce the time to the public in Beijing from there.⁸

In addition to the routine works described above, the Astronomical Bureau was responsible for various kinds of temporary assignments. The most frequent assignment was to announce the time at court ceremonies and imperial palaces.⁹ The most important one, however, was the responsibility of finding auspicious burial grounds for the imperial family. Bureau officials with a *xiangdu* 相度 specialty—namely, *fengshui* 風水—were often sent on field trips, and they might have to stay there as long as the construction works needed their advice.¹⁰ Probably to make the various kinds of services that the Astronomical Bureau could provide—time keeping, astronomical interpretation, divination, and so on—readily available, the statutory laws required that any imperial trip had to include some Astronomical Bureau officials. The statutory laws even required envoys for bestowing honorary titles to vassal states to include Astronomical Bureau officials. However, this requirement had not been closely followed after the Kangxi emperor questioned the Bureau officials' usefulness in an envoy and permitted it to be dropped.¹¹ Finally, the court used the Astronomical Bureau officials for geographical surveys. This was not a task prescribed by the statutory laws. Nonetheless, in the rare case that the court needed experts for drawing up new maps or surveying river courses, it utilized the mathematical specialty of the Astronomical Bureau officials.

For most of the Qing era, the Astronomical Bureau was a middle-ranking but autonomous institution. Its directors were at the fifth level (of nine) of the civil service hierarchy, the same as

⁸ QHD GX 794:757.

⁹ Ibid.

¹⁰ Ibid.

¹¹ Zhongguo diyi lishi dang'an guan 中國第一歷史檔案館, ed., *Kangxi qijuzhu* 康熙起居注 (Beijing: Zhonghua shuju, 1984), 836.

the dean of the Imperial College of Physicians 太醫院.¹² However, unlike the Imperial College of Physicians, whose members were all Han Chinese, the Qing court added Banner officials to the Astronomical Bureau in 1665 on the ground that astronomical affairs were too important to be handled by Han Chinese alone.¹³ The Bureau did not need approval from any other department or ministry before submitting an annual calendar to the emperor. When a position become available in the Astronomical Bureau, the Bureau directorate nominated the candidates and then sent their background information to the Ministry of Personnel for scrutiny before asking the emperor to make a final decision. If the Ministry of Personnel found the nomination improper because it violated existing regulations, the Bureau directorate could petition the emperor directly.¹⁴

The administrative regulations of the Astronomical Bureau had been adjusted several times during the Qing dynasty to stimulate the staff's mathematical learning. Every three years, the Qing bureaucratic system held a grand-scale job review called the Metropolitan Inspection (*jingcha* 京察) for central government officials or the Grand Reckon (*daji* 大計) for provincial officials. In 1667, the Metropolitan Inspection was extended to the Astronomical Bureau officials.¹⁵ However, the way that Metropolitan Inspection graded an official's performance in four aspects—integrity 守, governing 政, ability 才, and age 年—did not seem suitable for evaluating a professional mathematician of the Astronomical Bureau. A routine memorial submitted in 1753 pointed out, “the only thing that should be considered is how well [an

¹² QHDSL GX 798:346.

¹³ SL 4:229.

¹⁴ See, for example, IHP 051696.

¹⁵ QHD KX 442.

Astronomical Bureau official] has learned mathematics.”¹⁶ Thereafter, the four-aspect grading system was abolished and the Bureau directors were required to write short comments on their subordinates in the Metropolitan Inspection report. On the other hand, examination performance gradually took a more important role in determining a person’s career progression in the Astronomical Bureau. In 1745, a triennial examination that aimed at rewarding the most learned officials and punishing the worst was added to the Bureau administrative system.¹⁷ The implementation of the periodical examination slackened in some periods, but after the first decade of the Daoguang reign (in the 1820s), a person’s promotion became largely dependent on his performance in periodical examinations.¹⁸

2.2 *The Sections*

The Qing Astronomical Bureau, as its predecessor in the Ming, was divided into three sections corresponding to different areas of duties.

2.2.1 *The Calendar Section*

The Calendar Section got its name, *li ke* 曆科, from its duty of making the state calendar. It was also a name inherited from the Astronomical Bureaus of previous dynasties. However, the character *li* 曆 became taboo when the Qianlong emperor came to the throne because it was identical to the second character of the emperor’s Chinese name, *Hongli* 弘曆. After that, the civil calendar was renamed from *shixian li* (時憲曆, Timely Modeling calendar) to *shixian shu* 時憲書 and the Calendar Section became *shixian ke* 時憲科.

¹⁶ QHDSL QL 620:255.

¹⁷ IHP 216304.

¹⁸ NPM 060148.

The statutory laws defined in detail what had to be included in the calendar. The civil calendar included a list of the number of days in every month, dates of the twenty-four solar terms 節氣 and eclipses, hours of the rising and setting of the sun and moon, and daily divination of whether it was favorable or unfavorable to conduct certain kinds of affairs. The complicated calculations needed for finishing the various entries on the calendar led the Calendar Section to become the most staffed section in the Bureau. When fully staffed, it had ninety-six officials and trainees—more than the other two sections combined. It is noteworthy that the Calendar Section had to calculate daily divinatory entries. The divination included thirty-seven kinds of affairs for the calendar used by the common people and sixty-seven for the monarch. For example, some affairs common to both the commoners and the monarch were ancestor worship, marriage, meeting friends, baths, and hair cutting, while the ones specific for the monarch were sending troops to the front and dispatching ambassadors.¹⁹ The broad range of affairs covered by divination indicates the calendar's great influence on daily life.

Calculating upcoming eclipses was another critical duty of the Calendar Section. By the Qing era, the cause of eclipses was no longer a mystery, but the traditional Rescue Ritual, *jiuhu* 救護, for saving the sun or moon was still performed at the state and provincial capitals.²⁰ The Calendar Section's ability to predict the solar eclipse accurately was particularly important for maintaining the symbolic connection between the sun and the emperor. The Calendar Section had to submit its prediction to the emperor five months before every solar or lunar eclipse. The

¹⁹ QHD GX 794:748.

²⁰ Ibid., 719.

prediction included time, duration, and magnitude of the eclipse not only for the capital region but also for all provinces.²¹

2.2.2 *Section of Heavenly Signs*

The Section of Heavenly Signs (*tianwen ke* 天文科) was in charge of observing celestial phenomena and timely delivery of the interpretations to the Son of Heaven 天子—namely, the emperor. The officials of the Section of Heavenly Signs were on rotation to conduct nonstop observation of the sky in every direction. If any unusual natural phenomenon occurred, such as a meteor, comet, or abnormally strong wind or rain, the Section of Heavenly Signs had to report it to the emperor immediately with a divinatory interpretation. Indeed, there were some occasions that the emperor scolded the Astronomical Bureau for failing to report in time.²² On the first day of the second month, the Section of Heavenly Signs had to submit to the emperor the *Weather Records* (*Qingyuru* 晴雨錄) composed of daily observation records from the previous year.²³

2.2.3 *The Water Clock Section*

This section was named after the instrument it used for time keeping. Time keeping was the simplest service that the Water Clock Section provided to the court. The Water Clock Section had a team of twelve members at the water tower on rotation for operating the water clock and announcing the time to Beijing residents. Another section staff was required to be on duty in the inner court to keep track of the time by burning incense. Most court ceremonies needed the

²¹ Ibid.

²² See SL 4:359 for one such incident that took place in June 1668.

²³ QHD GX 794:719.

Water Clock Section officials for telling the time. Because these tasks required little skill and knowledge, most of them were assigned to the lowest-level trainees of the section.²⁴

The other tasks of the Water Clock Section fell into two categories: selecting auspicious hours and selecting auspicious sites. Before holding a court ceremony or event, the court always consulted the Water Clock Section for selecting an auspicious day. For some routine ceremonies such as worshipping the imperial ancestors, the Water Clock Section had to select the proper days and hours two years ahead and inform related institutions.²⁵ Most state construction projects needed consultations from the Water Clock Section. The projects could be as grand as building a palace or as small as replanting a tree in front of an imperial grave.²⁶ Besides choosing an auspicious day for starting construction work, the Water Clock Section officials had to make sure the building was located at an auspicious spot and faced a favorable direction. Although the Water Clock Section officials' civil service ranks were low, they frequently received special rewards for their contribution to the state construction projects.

2.3 The Posts

During the Ming-Qing transition, the Astronomical Bureau changed its mathematical astronomy system and adjusted the organizational structure, but it hardly affected the officials' titles and job contents. This section introduces the posts of the Astronomical Bureau from the lowest level to the highest one. Although the posts of directors and vice directors are included here, the organization of Bureau directorate needs more elaboration and will be analyzed again in the next section.

²⁴ Ibid., 757.

²⁵ Ibid., 719.

²⁶ IHP 173768.

A brief introduction of the rank system in the Qing dynasty is necessary before proceeding. As in previous dynasties, the Qing bureaucratic system placed officials into a nine-level ranking hierarchy. Each level (*pin* 品) was subdivided into two categories: *zheng* 正 (denoted by A) and *cong* 從 (denoted by B). Officials of rank 1A—namely, the *zheng* category of the first level 正一品—were the most important and prestigious, while those who ranked at 9B 從九品 were at the bottom level of the hierarchy. There were also some government positions that were considered too insignificant to be awarded with any rank. The entry-level positions of the Astronomical Bureau—student astronomers and yin-yang students—were two such positions.

2.3.1 Student Astronomer and Yin-Yang Student

The entry-level position of the Calendar Sections and the Section of Heavenly Signs was student astronomer (*tianwensheng* 天文生). Within the Qing bureaucratic system, a student astronomer was considered as a student or a trainee 生 rather than an official 官. They were paid but generally were not assigned any civil service rank. Nonetheless, student astronomers were allowed to wear the same official robes and decorations as those at the lowest civil service rank (9B) when attending public ceremonies.²⁷ Student astronomers were divided into two categories, *shiliang* 食糧 and *shifeng* 食俸. *Shiliang* student astronomers were junior to *shifeng* student astronomers, and they only earned monthly stipends. *Shifeng* student astronomers earned stipends, and the government kept track of the number of years that they had worked at the Astronomical Bureau. The number of service years was an important factor in determining the

²⁷ QHDSL GX 813:304.

order of promotion. If an examination was not required or if more than one candidate passed the examination, typically the vacant position would be given to the one with more years of service.

The Water Clock Section had a position lower than student astronomer called yin-yang student (*yinyangsheng* 陰陽生), or yin-yang person (*yinyangren* 陰陽人) in the Shunzhi and early periods.²⁸ This was a position reserved for Han Chinese. Yin-yang students were in charge of the simplest works at the Astronomical Bureau: keeping track of and announcing the time by monitoring the water clock and incense burning. Probably because of the minimal amount of knowledge and skill needed for their jobs, yin-yang students were placed below student astronomers and paid less.

All three sections had unofficial—and probably unpaid—apprentices called *yiyesheng* 肄業生. *Yiyesheng* were newcomers to the Astronomical Bureau. By contrast, those who were from hereditary mathematician families were called hereditary students (*shiye zidi* 世業子弟, literally means descendants from the families that followed the same craft generation after generation). Apprentices and hereditary students had to pass entrance examinations to become student astronomers of the Calendar Section and the Section of Heavenly Signs or yin-yang students of the Water Clock Section. Because there is no surviving record to show the contents of the examination, it is impossible to assert how difficult it was to pass the examination. However, available evidence suggests that the examination might not have been implemented rigidly. Consequently, some student astronomers later failed miserably in periodical examinations (see chapter nine). In the early Qing era, there seemed to be no rigid regulation of how the Astronomical Bureau recruited its unofficial apprentices and how many apprentices it could have.

²⁸ QHD GX 744.

These were not standardized until July 1756.²⁹ Afterward, even becoming an apprentice required passing an examination.

2.3.2 *Erudite*

After serving some years and passing periodical examinations to prove his ability, a student astronomer could be elevated to the position of erudite (*boshi* 博士). An erudite was an official with rank 9B. Treating erudites as officials rather than as trainees implied that the imperial state considered erudites accomplished mathematicians. Although the *Collected Statutes of the Great Qing* prescribes no specific duty to each individual erudite, other sources show that proficient erudites were important assistants to senior colleagues. On occasion, state documents include names of the erudites who made significant contributions to the tasks.

2.3.3 *Calendar Collator, Official Observer, and Time Collator*

As the title suggests, a calendar collator's duty was to proofread the calendar's contents. Recall that the Calendar Section changed its name to avoid using the character of the Qianlong emperor's name. For the same reason, the title of calendar collator was changed from *sili* 司曆 to *sishu* 司書.

Originally, there were two seats of calendar collators in the Qing Astronomical Bureau. After 1675, only one seat remained, and it became the only middle-level position between erudites and the supervisors of the Calendar Section.³⁰ However, ranking merely at 9A, a calendar collator would be better considered a position for the most senior or proficient erudite

²⁹ NPM 403012106.

³⁰ QHD KX 132.

rather than a position with the responsibility to supervise other officials (see table 1). Like erudites and student astronomers, a calendar collator was required to take the periodical examination to prove the steady progress of his professional mathematical knowledge. Note that the position of calendar collator was reserved for Han officials.

The status and responsibilities of official observers (*jianhou* 監候) and time collators (*sichen* 司晨) were similar to those of calendar collators, except that they were positions in the Section of Heavenly Signs and the Water Clock Section. Official observer was a rank 9A position reserved for Han officials. Time collator of the Water Clock Section also had only one seat; it was rank 9B and was given to Han-Martial 漢軍 officials only. Official observers and time collators were required to attend the triennial examination.

2.3.4 Supervisor of the Five Offices

In the Calendar Section, Han and Banner officials both were given five seats of the highest-ranking positions of supervisors. However, their duties were not the same. Han supervisors were in charge of computing the new calendar, arguably the most critical and technically demanding work in the Astronomical Bureau, while Banner supervisors were responsible for translating and verifying the contents of the calendar.³¹ Probably because of these five Han supervisors' important role in the Bureau, each of them was given a distinct title—supervisor of the Spring Office (*chunguanzheng* 春官正), supervisor of the Summer Office (*xiaguanzheng* 夏官正), supervisor of the Autumn Office (*qiuguanzheng* 秋官正), supervisor of the Winter Office (*dongguanzheng* 冬官正), and supervisor of the Middle Office

³¹ QHDSL GX 813:307.

(*zhongguanzheng* 中官正). Manchu and Mongol supervisors were given a uniform title: supervisor of the Five Offices (*wuguanzheng* 五官正), while the Han-Martial supervisor was always called the supervisor of the Autumn Office 漢軍秋官正. Before the Muslim Calendar Section was closed down in 1675, the head of the Muslim Section 回回科 was also called the supervisor of the Autumn Office.³²

The civil service ranks of Han and Banner supervisors deserve more attention. Only the *Collected Statutes* compiled in the Qianlong reign reports that Han and Banner supervisors were of the same rank.³³ The other four editions of the *Collected Statutes* state that Han supervisors ranked slightly higher than Banner supervisors. Han supervisors ranked at 6A 正六品, the same as a vice director's rank, while Banner supervisors ranked at 6B 從六品. The Qing bureaucratic system in general gave Banner and Han officials the same ranks.³⁴ Thus, the difference between Han and Banner supervisors' ranks could be another acknowledgement of Han supervisors' critical role in the Astronomical Bureau.

2.3.5 Observatory Manager and Water Clock Manager

The heads of the Section of Heavenly Signs and the Water Clock Section were the observatory manager (*litaian* 靈台郎) and the water clock manager (*qiehuazheng* 挈壺正), respectively.³⁵ The observatory manager was of rank 7B, below the supervisor of the Five Offices but higher than the secretary-general. In contrast, the water clock manager ranked lower than the secretary-general at merely 8B (see table 1).

³² QHD KX 131–32, 7751.

³³ QHD QL 619:50.

³⁴ QHD KX 177.

³⁵ QHD GX 794:751, 756.

Nonetheless, the following example illustrates the important of the Han water clock managers in fulfilling the court's expectation of the Astronomical Bureau. In August 1744, the Astronomical Bureau had to nominate two candidates to succeed the vacant post of vice director. According to the administrative regulations, the two most senior officials among the supervisors of the Five Offices, observatory managers, secretary-generals, and water clock managers were the legitimate candidates. However, the Bureau directorate nominated a water clock manager and a Water Clock Section erudite. The Ministry of Rites opposed the nomination because the other candidates had more years of service, but the Bureau directorate asked the Qianlong emperor to grant an exception. The directorate argued that “because the selection of *xiangdu* 相度 was the most important work of my Bureau” and because the construction project of preparing the future imperial tomb had just begun, an official who was proficient in selecting auspicious sites and times was in need. The directorate suggested that experts from the Water Clock Section would fill the vacant post of vice director better than the ones from the Calendar Section or the Section of Heavenly Signs. The emperor immediately approved the Bureau directorate's suggestion and sent the new vice director from the Water Clock Section to continue the construction project right away. Even the routine audience for making the final decision between the two candidates was exempted.³⁶

³⁶ IHP 051696.

Table 1. Titles and civil service ranks of the Astronomical Bureau officials in the mid-Kangxi reign

Ranking	Administration office	Calendar Section	Heavenly Signs Section	Water Clock Section	
5A	Director 監正				
6A	Vice director 監副	Han supervisor of the Five Offices 漢五官正			
6B		Manchu supervisor of the Five Offices 滿洲五官正			
7B			Observatory manager 靈台郎		
8A	Secretary- general 主簿				
8B				Water clock manger 挈壺正	
9A		Calendar collator 司曆	Official observer 監候		
9B		Erudite 博士	Erudite 博士	Erudite 博士	Time collator 司晨
		Student Astronomer	Student Astronomer	Student Astronomer	Yin- Yang Person
None	Scribe 筆帖式	天文生	天文生	天文生	陰陽人

Source: QHD KX, 183–208.

Note: Mongol and Han-Martial officials were treated as Manchu officials. Except for the supervisors of the Five Offices, Han and Manchu officials of the same title were bestowed the same civil service ranks.

2.3.6 Director and Vice Director

From 1644 to 1826, the Qing dynasty employed a series of European missionaries as directors of the Astronomical Bureau. However, only the first one, Johann Adam Schall, had full administrative power over the Astronomical Bureau. In 1665, Manchu director and Banner officials were added to the Bureau. Between 1665 and 1669 European missionaries even lost the directorship at the Bureau.

Until European missionaries withdrew from the Qing Astronomical Bureau, the highest position that a Han official could obtain in the Bureau was vice director, not director. This was because the Kangxi emperor did not create a new position for European director in 1669 but ordered that the European director should fill the Han director's quota.³⁷ The number of vice directors of each ethnic group changed over time. For example, the Astronomical Bureau had two Manchu, one Western, and two Han vice directors until 1753. Afterward, the compositions of vice directors changed to one Manchu, one Han, and two Westerners.³⁸ When there were two vice directors from the same ethnic group, the senior one was called the *zuo jianfu* 左監副, and the junior one, *you jianfu* 右監副.

2.3.7 Secretary-General and Scribe

Secretary-general (*zhubu* 主簿) was a middle-level administrative position at the Astronomical Bureau. There was one seat for Han and one for Manchu. Secretary-generals were responsible for so many administrative affairs that they had a separate office within the Bureau main office. Their duties included manufacturing the official annual calendar, maintaining the

³⁷ QHD YZ 161.

³⁸ QHDSL QL 620:90.

day-to-day operations of the Bureau, corresponding with other institutions, and drafting the memorials to the emperor. Preserving the wood blocks used for printing the mathematical treatises published by the court was also part of secretary-general's duties.³⁹

Scribes (*bitieshi* 筆帖式) were Bannermen who had passed the translation examination. Their responsibilities were document translation and processing. Scribes were assigned to the Astronomical Bureau without having to pass the mathematics entrance examination, and they were not required to study mathematics during their service at the Bureau. After serving for a certain period, scribes would be transferred to other government institutions.

2.3.8 Seal Keeper

The position of seal keeper (*baozhangzheng* 保章正) was eliminated in 1675.⁴⁰ Because the elimination happened before the earliest *Collected Statutes of the Great Qing* was finished, it is not clear which duties had been assigned to seal keepers. However, because this title appeared in the list of officials appended to the annual calendar from 1672 to 1676, it is likely that seal keepers were posts in the Calendar Section and ranked higher than calendar collators.⁴¹

2.4 Superintendents and the Directorate

The position of superintendent was a later addition to the organization of the Qing Astronomical Bureau.⁴² In the first century of the Qing dynasty, the highest position at the

³⁹ QHD GX 794:744.

⁴⁰ QHDSL GX 813:304.

⁴¹ Qu, "Qingdai Qintianjian," 49.

⁴² For the invention and design of superintendency in the Qing central government, see Beatrice S. Bartlett, *Monarchs and Ministers: The Grand Council in Mid-Ch'ing China, 1723-1820* (Berkeley: University of California Press, 1991).

Astronomical Bureau was director. Frustrated by the Manchu directors' continuous malfeasance, the Qianlong emperor added two grand ministers to "in Charge of Affairs of Bureau Directors" 管監正事 in April 1745.⁴³ While this title was similar to what the Qing ruler gave to Schall, the first Western director of the Bureau, their natures were different and deserve more explanation.

From late 1644 to early 1665, Schall was the de facto head of the Bureau. He administrated the Bureau under the title of "in Charge of the Astronomical Bureau" 管欽天監, "in Charge of the Affairs of Bureau Director" 管監正事, or "Controlling the Seal and Affairs of the Astronomical Bureau" 掌欽天監印務.⁴⁴ During this period, Schall was the only one in the Bureau to have a title closer to the directorship. Although there were two Han vice directors, their names seemed to appear only on routine memorials related to divinations, in which Schall, as a Jesuit missionary, did not want to be involved.⁴⁵ For instance, when memorializing the monarch that the new annual calendar was ready for his approval, Schall listed only his name and no one else's.⁴⁶ This suggests that Schall alone was in charge of the Bureau affairs.

The composition of the Bureau directorate was rather different when the Qianlong emperor added the two grand ministers to the Bureau. At the time the Bureau had a Manchu director; a Western director, who was considered to be occupying the Han vacancy; two Manchu vice directors; two Han vice directors; and a Western vice director. When memorializing the monarch regarding the Bureau affairs, all directors and vice directors signed their names.⁴⁷ This indicates that Western missionaries' domination in Bureau's administration had been reduced. Moreover, the grand ministers—a Manchu and a Han—added to the Bureau did not replace the

⁴³ SL 12:41–42.

⁴⁴ For example, see IHP 006498, 038713, 036556, and 091676.

⁴⁵ IHP 087784, 091801.

⁴⁶ IHP 006498, 091676.

⁴⁷ IHP 090156, 127466.

existing directors; they were placed above the directors. As before, the vacant directorship left by the Manchu director, who had frustrated the Qianlong emperor, was filled by a Banner supervisor of the Five Offices.⁴⁸ In the mid-Qianlong era, the number of grand ministers in charge of director affairs was reduced to one. Nonetheless, in routine memorials, the grand minister always headed the directorate roster. Whenever the Bureau dissatisfied the emperor, the grand minister in charge of director affairs was always punished with the rest of the Bureau directorate. As such, the grand minister in charge of director affairs in the mid- and late Qing era was a superintendent whose status was not equivalent but higher than that of the directors.

The grand minister in charge of director affairs held the superintendence of the Astronomical Bureau as a concurrent job, and his social and political status depended more on his concurrent positions and title at the court than on the job at the Astronomical Bureau. Except for the first and only Han superintendent, He Guozong 何國宗, the Manchu superintendents were not known for their distinct mathematical knowledge. Unlike Bureau officials who earned their positions with a specialty in mathematics, the grand minister was given the extra duty of supervising the Astronomical Bureau only because the emperor trusted his administrative ability.

Manchu directorships and the superintendency are two important devices that the Qing rulers added to control the Astronomical Bureau. The superintendent, in particular, became an indispensable agent for the monarch, who most of the time had neither the knowledge nor the passion to care about the administrative details of the Bureau. Chapter nine analyzes the administrative reformation led by superintendent Jingzheng 敬徵 in the Daoguang reign (1821–1850), which resulted in the technical and knowledge renewals of the Astronomical Bureau.

⁴⁸ Qu, “Qingdai Qintianjian,” 55–56.

Chapter 3

From the Ancient Method to the New Method

3.1 Hereditary Mathematician Families in the Ming Dynasty

In China, calendar making had long been a state-monopolized business. The effect of this tradition was paradoxical. On the one hand, the imperial state need to produce accurate calendars and astronomical predictions stimulated the development of mathematics. In the founding period in particular, a new dynasty sought mathematicians who were capable of improving methods of calendar making and sometimes rewarded them handsomely. As a result, calendar making had been an advanced area of study, if not the most important one, in Chinese mathematics. On the other hand, the connection between the calendar and a dynasty made the study of astronomical mathematics a sensitive issue. Publishing unauthorized calendars was strictly prohibited, but even the theoretical study would have to be conducted carefully. Astronomical observation, for instance, could be a dangerous activity to a commoner, as the imperial state might interpret it as a malicious attempt to detect the messages from heaven that the Son of Heaven 天子, the monarch, did not always want to reveal to his subjects. In the same vein, when a dynasty had obtained a calendar-making system that was satisfactorily accurate, it did not necessarily want to share all the details of that system with its subjects in fear of losing its superior knowledge in calendar making.

Probably under such conservative views, the Hongwu 洪武 emperor, the founding emperor of the Ming dynasty (1368–1644) turned working at the Astronomical Bureau into a mandatory hereditary profession in 1373. Willing or not, the families that happened to work at the Astronomical Bureau at the time were forced to stay with the Bureau forever. “The staff

members of the Astronomical Bureau are forever forbidden to emigrate,” the Hongwu emperor decreed. “Their descendants shall learn only astronomy and the calculation method for calendar making. They are not allowed to learn other professions.”¹ The punishment for not obeying this imperial order was severe, “Those who do not learn will be banished to the South Sea.”² Because of the Hongwu emperor’s decree, the astronomical sciences became a profession confined to a small number of families working for the Astronomical Bureau. While some families were permanently commissioned to the task of making the official calendar, people not belonging to those families had no way of entering the profession of imperial astronomer.

As a side effect, the Ming court saw no need to maintain the College of Mathematics (*Suanxue* 算學) as previous dynasties had done. The recruitment and training of future professional astronomers were conducted within hereditary mathematician families. It was not until 1519 that the Ming court began to regulate the training of the Astronomical Bureau. It ordered the Bureau to select teachers from its own staff and at the end of a year, under the supervision of the Ministry of Rites, to hold an examination to check the staff members’ progress in their studies. If they made no progress, the teachers should be punished along with the students.³ However, these regulations did not clearly define what the punishments should be. Although confirmation of these findings requires more evidence from the archival materials, the effectiveness of this teaching and examination system is questionable.

In contrast to the abolishment of the College of Mathematics, the official status and organization of the Astronomical Bureau were preserved. There are at least two factors that contributed to this preservation. First, the imperial state needed a calendar that was not just

¹ MHD ZD, SKQS 618:723.

² Ibid.

³ MHD WL 4408–9.

accurate but also authoritative. It was desirable to the imperial state to have a calendar produced by a government institution rather than by civilian families. In fact, to strengthen its authority, at the end of every annual calendar published by the Ming Astronomical Bureau was a roster of the eleven officials in charge of making that calendar (see figure 2). Second, having an official status was more convenient for the Astronomical Bureau in terms of interacting with other government institutions. The Astronomical Bureau had duties other than calendar making. It was in charge of managing the state observatory, and its staff had to attend many court ceremonies. Even if the imperial state allowed some disorganization within the Astronomical Bureau, it had to give the Bureau a clear official status and bestow proper civil service ranks to its major staff members. Thus, the Astronomical Bureau was a subordinate bureau under the Ministry of Rites, and its director was placed at the fifth level of the civil service hierarchy.⁴

The *Collected Statutes of the Great Ming* (*Da Ming huidian* 大明會典, or *Ming Statutes*) provides more details on the organization of the Ming Astronomical Bureau. The Ming dynasty had updated the *Ming Statutes* several times. The update during the Zhengde 正德 reign (completed in 1509) was considered by the compilers of the *Four Treasures* 四庫全書 to be the best among all editions of the *Ming Statutes*.⁵ However, because this edition was published only slightly past the midpoint of the dynasty's lifespan, it did not include any information on the changes to the organizational or administrative regulations taken place in the later period of the dynasty. The last update of the *Ming Statutes* was the Wanli 萬曆 edition, published in 1587. As the following will show, the Wanli (1587) edition was less accurate than the Zhengde (1509)

⁴ Ibid., 4401.

⁵ MHD ZD, SKQS 617:2.

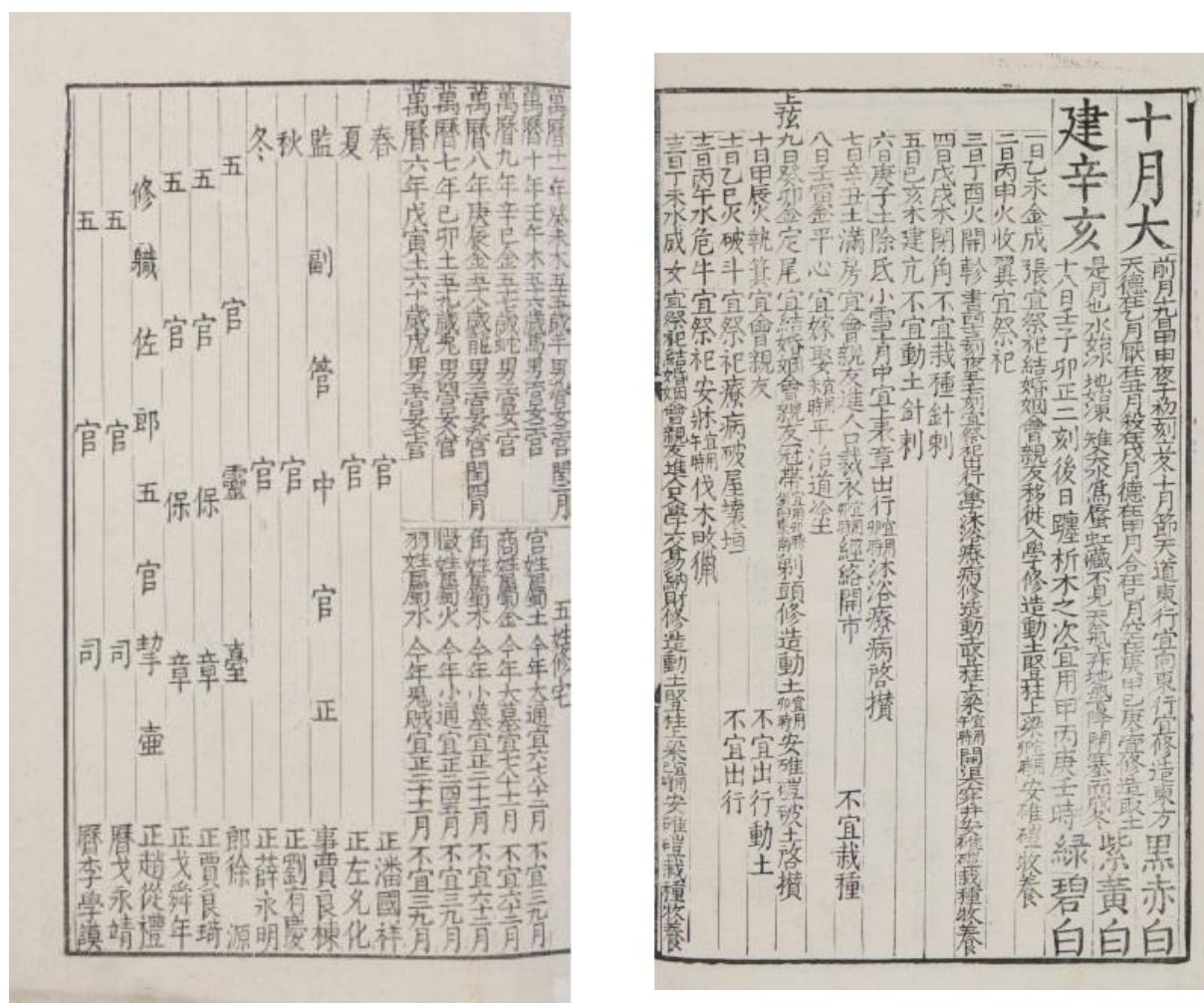


Figure 2. Ming Great Concordance calendar contents and official roster. *Right*: A sample page from the calendar of the tenth year of the Chongzhen reign (1637). A typical column includes daily advices on whether it was favorable or unfavorable to conduct certain kinds of affairs. *Left*: The official roster from the last page of the same calendar.

Reprinted from “大統曆,” Seoul National University Kyujanggak 奎章閣 Library, 奎中 5567, accessed October 11, 2014, http://kyujanggak.snu.ac.kr/GDS/GDS_VIEW_KG.jsp?ptype=list&subtype=kk&bookid=GC05567_00.

edition. Nonetheless, it provides valuable information about the late Ming period that is important to the understanding of the Astronomical Bureau during the Ming-Qing transition.

Table 2 shows the numbers of seats for each position of the Astronomical Bureau recorded in the 1509 and 1587 editions of the *Ming Statutes*. Some numbers from the 1587 edition, as the compilers of the *Four Treasures* criticized, indeed are problematic. For instance, the 1587 edition states that the number of seal keepers 保章正 had been reduced from two to one.⁶ However, figure 2 shows the 1637 official calendar listed two seal keepers. Furthermore, a quick examination of the official rosters of the annual calendars published from 1586 to 1643 proves that there were always two seal keepers in the late Ming Astronomical Bureau.⁷ The 1587 edition states that there was only one erudite in the Water Clock Section, but this was also unlikely to be true because a different paragraph describes that a certain court ceremony required two Water Clock Section erudites to be present.⁸ Similarly problematic is the description that the last three seats of Muslim erudites had been eliminated. Thus, the Astronomical Bureau should have no Muslim official at all.⁹ However, as the following sections show, plenty of archival records from the early Qing dynasty exist to testify that the Muslim officials not only existed in the Astronomical Bureau until the end of the Ming dynasty but well into the beginning of the Qing Kangxi reign (1662–1722).

⁶ MHD WL 48.

⁷ Ming Qintianjian 明欽天監, *Da Ming Datong li* 大明大統曆 (Taipei: National Central Library), Microfilms, 305.3 06315–06338.

⁸ MHD WL 4407.

⁹ MHD WL 48.

Table 2. Organization of the Astronomical Bureau in the late Ming period

	Zhengde 正德 edition (1509)	Wanli 萬曆 edition (1587)
Director 監正	1	1
Vice director 監副	1	2
Supervisor of the Five Offices 五官正	5	5
Observatory manager 靈台郎	8	4
Seal keeper 保章正	2	1
Secretary-general 主簿	1	1
Water clock manger 挈壺正	2	1
Calendar collator 司曆	2	2
Official observer 監候	2	2
Time collator 司辰	2	2
Erudite 博士	7	1 ^a
Muslim erudite 回回科博士	3	0
Student astronomer 天文生 ^b		
Yin-yang person 陰陽人 ^b		

Note: This table shows the number of available seats for each position at the Ming Astronomical Bureau according to the Zhengde and Wanli editions of the *Collected Statutes of the Great Ming*.

Sources: MHD ZD, SKQS 617:3940; MHD WL 47–48, 4408.

^a This number only includes the erudites of the Water Clock Section.

^b No information is provided in the sources.

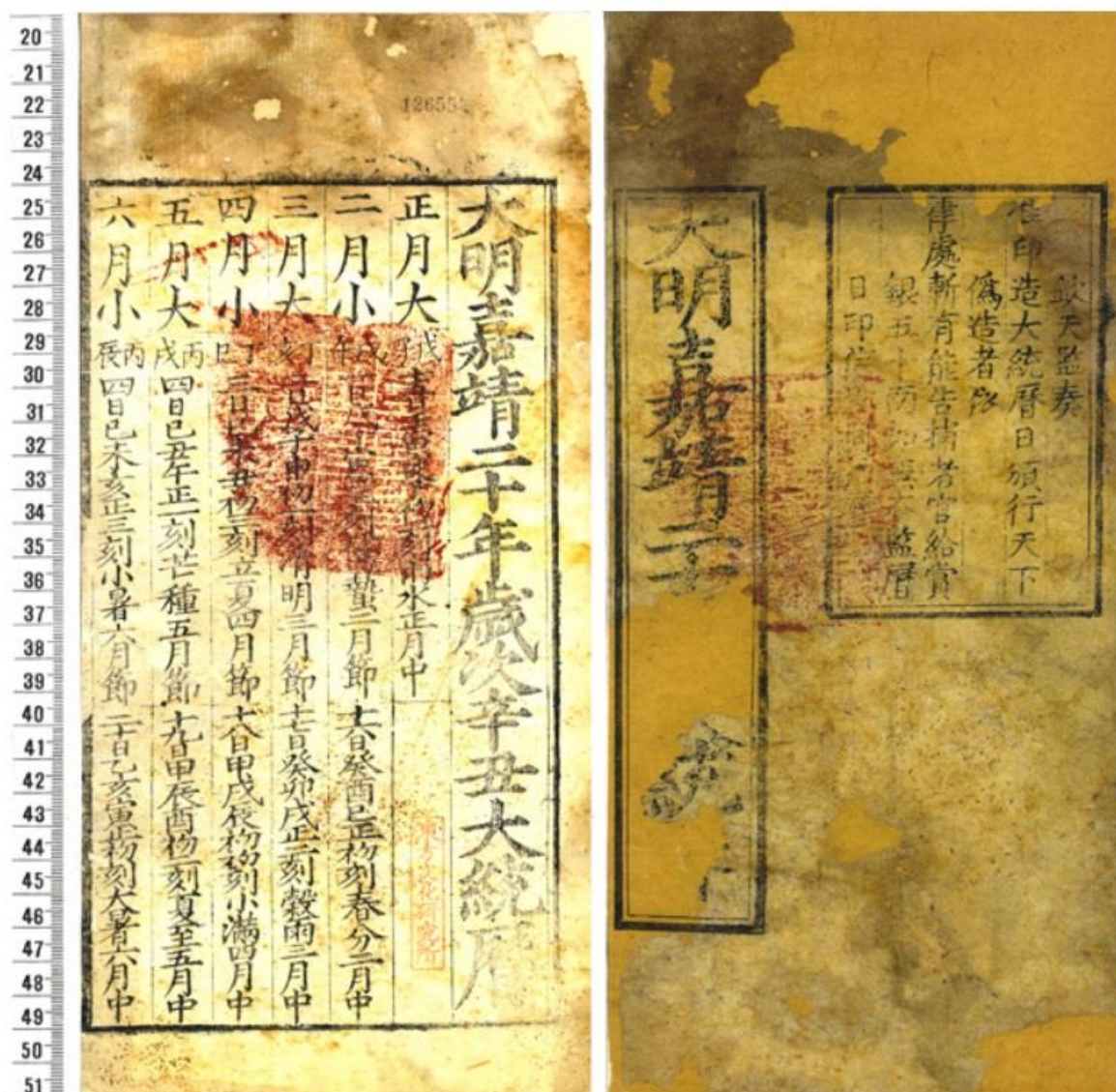


Figure 3. Ming Great Concordance calendar cover and first page. *Right*: The front cover of the calendar of the twentieth year of the Ming Jiajing 嘉靖 reign (1541). The statement in the right box declares that the Astronomical Bureau alone has imperial permission to make and distribute the calendar. Piracy will lead to death penalty, and the informers will be rewarded with fifty *taels* 兩 of silver. *Left*: The first page of the official calendar. Notice that both the front cover and the first page were stamped by the Astronomical Bureau.

Reprinted from “子部 天文算法類 推步之屬,” Institute for Research in Humanities, Kyoto University, accessed October 11, 2014, <http://kanji.zinbun.kyoto-u.ac.jp/kanseki?record=data/FA019705/tagged/0342025.dat&back=1>.

Despite its inaccuracy, the 1587 edition of the *Ming Statutes* supplies important information regarding student astronomers that is not found in the 1509 edition. Neither edition includes a count of student astronomers in the list of officials, perhaps because student astronomers were considered trainees rather than officials. The 1587 edition, however, contains a regulation added in 1570 that set the quota of food stipends given to student astronomers. The regulation allowed the Calendar Section to have 75 student astronomers; the Section of Heavenly Signs, 80; the Water Clock Section, 35; the Muslim Section, 50; and the yin-yang persons working at the water tower, 40.¹⁰ It seems reasonable to assume these were the number of student astronomers and yin-yang persons at the Bureau. In fact, the above number of student astronomers of the Section of Heavenly Signs was consistent with the number mentioned in a memorial written by Johann Adam Schall in 1655, in which he stated that the Section of Heavenly Signs was allowed to have 80 student astronomers in the Ming period.¹¹

A comparison with the Qing Astronomical Bureaus calls into question if the Ming Astronomical Bureau indeed needed so many student astronomers and yin-yang persons to maintain its operation. After the Qing dynasty was established, the Astronomical Bureau retained roughly the same numbers of officials but employed only 66 student astronomers and 10 yin-yang persons.¹² In contrast, the late-Ming Astronomical Bureau employed 190 student astronomers and 40 yin-yang persons for the three main sections, and there were 40 additional student astronomers in the Muslim section, whose calendar was only used for comparison and not for publishing. Thus, the number of student astronomers derived from the 1587 edition of the *Ming Statutes* suggests that the Ming court paid for a large number of lowest-level employees of

¹⁰ MHD WL 4408.

¹¹ IHP 036556-3.

¹² QHD KX 7749, 7763.

the Astronomical Bureau in order to maintain the Bureau's mandatory hereditary system. Recall the Hongwu emperor's decree in 1373 was essentially equivalent to force some families to accept the permanent commission of working for the Astronomical Bureau. To maintain such a commission system, the court was obligated to supply those families' basic living expenses. It seems this obligation was fulfilled by maintaining a pool of student astronomers that was larger than actually needed and paying them with monthly food stipends.

Nonetheless, it was unlikely that the Hongwu emperor's decree had been implemented literally. The increase in family members over each generation should have made it impractical to keep all descendants in the profession because there simply would not have been enough vacant positions in the Astronomical Bureau for them. Some regulations added in a later period indicate that the mandatory requirement of inheriting the profession of imperial astronomers had largely become a birthright for obtaining a job at the Astronomical Bureau. For example, when a student astronomer retired at sixty years old, one of his sons from his first wife 嫡男 was allowed to take his place.¹³ Only after the sons of all the officials' first wives had obtained positions could other relatives from the mathematician families be used to fill vacancies, regardless of their mathematical knowledge.

By the end of the fifteenth century, the Great Concordance system of calendar making (*Datong li* 大統曆) no longer could provide satisfactory astronomical predictions.¹⁴ However, most hereditary mathematician families did not seem to have the will or ability to carry out a calendar reform. In the second year of the Chongzhen reign (1629), the Bureau's prediction of a

¹³ MHD WL 4409.

¹⁴ Zhang Tingyu 張廷玉 et al., *Ming shi* (Beijing: Zhonghua shuju, 2000), 347.

solar eclipse failed again. Supervisor of the Summer Office 夏官正 Ge Fongnian 戈豐年 and other officials at the Bureau defended themselves:

The Great Concordance calendar used by our bureau was established by Director Yuantong 元統 when the dynasty was founded. Actually, it was the Season Granting calendar (*Shoushi li* 授時曆) created by Prefect Guo Shouji 郭守敬 and others in the Yuan dynasty. In the past 260 years, calendar officials computed according to the calendrical system and never made any change because we dared not and could not do so. *Any hasty change has the risk of causing the deviation to deteriorate more.* . . . Merely eighteen years after Shouji had created the calendrical system, there was an incident that the lunar eclipse did not take place as predicted. [Three years later,] the computation missed a lunar eclipse again. . . . Even Shouji could do nothing [to improve the system], because he had reached the limit of wisdom and skills and could not progress any further. *If the creator of the system could only offer so much, we, who only know how to follow the system step-by-step, of course could not do better.*¹⁵

Ge's words led later authors to portray him and other officials from hereditary mathematician families as caring more about keeping the Astronomical Bureau under their control than about making an accurate calendar.

Indeed, Ge Fongnian was from a prominent mathematician family of the Astronomical Bureau. Between the 1580s and mid-1620s, the Ge family had produced at least three supervisors of the Five Offices—Qianheng 乾亨, Qianheng 謙亨, and Jinheng 近亨—and one calendar collator, Kunheng 坤亨.¹⁶ After them were Fongnian 豐年 and Shunnian 舜年, a seal keeper in the mid-1630s. Serving the Calendar Section around the same period as Fongnian was the supervisor of the Spring Office Ge Chengke 戈承科, who was a relative from a different branch of the Ge family (see Appendix C.1).¹⁷ Later Chengke would become the last director of the Ming Astronomical Bureau. Chengke's father, Shougong 守躬, also held the directorship before. Chengke had three brothers—Chengguang 承光, Chengrong 承榮, and Chenghua 承華—and at

¹⁵ Xu Guangqi 徐光啟 et al., *Xinfa suanshu* 新法算書, SKQS 788:4–5.

¹⁶ Ming Qintianjian, *Da Ming Datong li*.

¹⁷ Ibid.

least three first cousins—Chengzhi 承祉, Chengyong 承允, and Chengxu 承緒—working for Astronomical Bureau, too.¹⁸ The large number of family members working at the Bureau and occupying high offices of the Calendar Section strongly suggests the possibility that the Ge family would have liked to preserve their positions in the Bureau by continuing to employ the Great Concordance system. However, it is wrong to assume that all mathematician families and individuals were against calendar reform.

For instance, the Zhou 周 family, no less prominent than the Ge family, seemed to hold a rather liberal view on calendar reform. Since the end of the fifteen century, several plans to amend the Great Concordance system have been suggested. One of the unapproved suggestions was from supervisor of the Middle Office Zhou Lian 周濂.¹⁹ In December 1610, the Astronomical Bureau made an inaccurate prediction of solar eclipse. The view that calendar reform was necessary gained more popularity among courtiers. The next year, Supervisor of the Five Offices Zhou Ziyu 周子愚 recommended the Jesuits to the emperor: “It was desirable to have Confucian courtiers who know the calendar system to lead the Astronomical Bureau officials so that all the books brought by them [the Jesuits] could be translated and used to amend the incompleteness of our treatises.”²⁰ Because of Zhou’s suggestion, the Ming emperor began to consider the Jesuit method of calendar making as a possible alternative, although it would take another eighteen years for the court to decide to set up a temporary Calendar Department 曆局 for translating and studying the Jesuit method. Zhou Ziyu personally helped to translate *On the*

¹⁸ “Wujin Piling Geshi jiasheng shiliu juan” 武進毗陵戈氏家乘十六卷, accessed October 2014, <http://geshi.10000xing.cn/2011/1011110040.html>; *Geshi jiapu* 戈氏宗譜, accessed November 5, 2014, <https://familysearch.org/pal:/MM9.3.1/TH-1961-28854-12957-99?cc=1787988&wc=SKRF-VZH:1023699001,1021934502,1021934702,1021956401,1023699002>.

¹⁹ Zhang et al., *Ming shi*, 349–56.

²⁰ *Ibid.*, 356, 5668.

Gnomon (*Biaodushuo* 表度說) for Sabatino de Ursis (Chinese name Xiong Sanba 熊三拔, 1575–1620) and *The Theory of Eclipse* (*Jiaoshilue* 交食略) for Johann Adam Schall.²¹ Ziyu later became the director of the Astronomical Bureau. His supportive view of integrating Western and Chinese methods of calendar making seemed to have been well known in the court. In a memorial written to persuade the Chongzhen emperor (r. 1628–1644) to set up the Calendar Department, Xu Guangqi 徐光啟 (1562–1633) reminded the emperor that in 1612 “Director Zhou Ziyu had suggested that integrating all [methods] into one was necessary in order to obtain consultations [of improving the official calendar].”²²

Zhou Yin 周胤,²³ a possible relative of Zhou Ziyu, appeared cooperative, too. After the Calendar Department was opened, Zhou Yin, then the supervisor of the Autumn Office 秋官正, dutifully took turns with other officials of the Astronomical Bureau going to the Calendar Department to learn the New Method and help out with the calculation. When Xu Guangqi sent his last memorial from his deathbed to the emperor in 1633 with regard to the business of the Calendar Department, he stated that Zhou Yin and eight other officials from the Astronomical Bureau “have been diligent learning [the New Method]. They should be rewarded after completing the study.”²⁴ Two years later, Li Tianjing 李天經 (1579–1659), the successor of Xu Guangqi, also wrote to the emperor: “For several months, together with the Astronomical Bureau

²¹ Sabatino de Ursis, *Biaodushuo* 表度說, SKQS 787:809.

²² Xu Guangqi 徐光啟, *Xu Guangqi ji* 徐光啟集, ed. Wang Zhongmin 王重民 (Beijing: Zhonghua shu ju, 1962), 327–28.

²³ Also known as Zhou Yun 周允 in documents published after 1722.

²⁴ Xu, *Xu Guangqi ji*, 428.

Director Zhang Shoudeng 張守登 and Vice Directors Ge Chengke 戈承科 and Zhou Yin 周胤, we have modestly examined [the New Method] without prejudice.”²⁵

By the late Ming period, serving at the Astronomical Bureau had been transformed from a mandatory profession to an inheritable family interest. On the one hand, the law that prohibited the descendants of the mathematician families of the Astronomical Bureau from transferring to other professions was no longer strictly implemented. For example, the genealogical records of the Ge family show many members passed the civil service examinations and became high courtiers or provincial officials.²⁶ On the other hand, there was no incentive for these families to completely give up the posts at the Astronomical Bureau reserved for them. The Ming court made little effort to reform the organization of the Astronomical Bureau, and it hesitated in replacing the traditional calendrical system with a new one, particularly a foreign one. As a result, the court repeatedly held competitions for predicting upcoming eclipses between different methods of calendar making. Yet, the Great Concordance system supported by the old mathematician families remained the official method of calendar making until the end of the dynasty. It was not until the Qing rulers settled in Beijing and inherited the people and government institutions from the Ming that a calendar reform was finally carried out.

3.2 Imperial Regent and Jesuit Missionary

Beginning at the turn of the seventeenth century, Jesuits followed the tactics of Matteo Ricci (Li Madou 利瑪竇, 1552–1610) in trying to extend their missionary work in Ming China.²⁷

²⁵ Xu, Xinfu suanshu, 65.

²⁶ “Wujin Piling Geshi.”

²⁷ For general introductions to Matteo Ricci’s life and influence on the Jesuits’ China mission, see Jonathan D. Spence, *The Memory Palace of Matteo Ricci* (New York: Penguin, 1985) and Nicolas

Ricci arrived in Macao in 1582. After some years of failure, he found that he could attract Chinese attention effectively through a rise in social status. Instead of shaving his head bald like a Buddhist monk, he wore the clothes of a Confucian scholar and tried to behave like the gentry.²⁸ He constantly showcased advanced scientific knowledge and gave away fancy mechanical presents from Europe, such as clocks and telescopes. As such, in 1601, he finally obtained permission to enter the capital of Beijing as an expert in calendar making.²⁹ He stayed in Beijing until his death in 1610 and became the first Jesuit buried there. The Xuanwumen Chapel 宣武門禮拜堂, a small church built by Ricci, became the foundation for the Jesuit China mission (see figure 1).³⁰

Establishing a permanent base in Beijing was only the first step. Subsequently, the Jesuit mission's progress slowed down. By the time Ricci came to Beijing, the Ming court was already badly in need of a calendar reform. Nonetheless, it was still almost three decades before Ricci and his fellow Jesuit mathematicians won the commission. Not until 1629 did the Chongzhen emperor approve courtier Xu Guangqi's proposal to set up a temporary Calendar Department 曆局 to research the New Western Method 西洋新法 of calendar making that the Jesuits introduced to China.³¹ Xu Guangqi 徐光啟 had learned mathematics from Ricci and eventually became a Christian. Under Xu's patronage, Jesuit missionaries and their Chinese converts at the Calendar Department prepared astronomical treatises and instruments based on the Tychonic

Standaert, "Jesuit Corporate Culture as Shaped by the Chinese," in *The Jesuits: Cultures, Sciences and the Arts, 1540–1773*, ed. John W. O'Malley et al. (Toronto: University of Toronto Press, 1999), 352–63.

²⁸ Spence, *Memory Palace*, 115.

²⁹ Standaert, "Jesuit Corporate Culture," 358–60.

³⁰ Xuanwumen Chapel 宣武門禮拜堂 is the oldest Catholic church in Beijing. Colloquially called the "South Church" (Nantang 南堂), it was built by Ricci in 1605. Then it was a small, Chinese-styled chapel. It has been augmented, destroyed, and rebuilt several times during the Qing era.

³¹ Xu, *Xu Guangqi ji*, 339.

system of mathematical astronomy. Unfortunately, Xu died in 1633 and his replacement at the Calendar Department, Li Tianjing 李天經, was less influential politically. The Calendar Department tried to establish the New Method's credibility by repeatedly challenging the Astronomical Bureau to predict solar and lunar eclipses. The results, according to later documents, seemed always to favor the New Method.³² But the Chongzhen emperor refused to give up the Great Concordance system that had been used to calculate the calendar since the founding of his dynasty.³³ Instead of a complete switch in the favor of the Calendar Department, the emperor ordered the Astronomical Bureau officials to conciliate the New Method with the Great Concordance system. The Jesuits' effort to convince the Chongzhen emperor to adopt the Western Tychonic system of mathematical astronomy was almost in vain.

Finally, in 1643 the Chongzhen emperor belatedly decreed, "If the New Method again closely predicts the next eclipses, make it [take the place of] the Great Concordance system that the whole world shall use."³⁴ By this time, Ricci's most important successor, Johann Adam Schall von Bell (Tang Ruowang 湯若望, 1592–1666), had already been living in Beijing for almost fifteen years. Perhaps the residents of Beijing knew the small Jesuit Christian chapel and heard some evangelical stories, but very few of them knew the meaning of the Christian dating system that numerated this year as anno Domini 1643. To the Chinese, the proper way to numerate the year used the reign title of the current emperor. Therefore, the Chinese under the Ming Emperor's regime, Beijing residents included, would call this year the sixteenth year of the Chongzhen 崇禎 reign. It is unknown whether the Chongzhen emperor would have kept his promise to adopt the New Method or command another conciliation of the New Method and the

³² Xu, *Xinfa suanshu*, 25–143.

³³ Zhang et al., *Ming shi*, 347–48.

³⁴ Xu, *Xinfa suanshu*, 143.

Great Concordance system, as he was dead within a year. Schall and other Beijing residents would soon have to change the way they numerated the year.

For those ruled by the rapidly growing Qing Empire in Manchuria, the year that the Chongzhen emperor died was not called the seventeenth of the Chongzhen reign but the first year of the Shunzhi 順治 reign. The Qing Empire was founded in 1616, and Shunzhi was the reign title for its third emperor. The Qing had not been able to expand their territory south beyond the Great Wall, but the uprising against the Chongzhen emperor brought it a great opportunity. In the third month of the year (April 1644), the Chongzhen emperor committed suicide outside the imperial palace when the rebel forces of Li Zicheng 李自成 (1606–1645) broke into the Imperial City Beijing.³⁵ Dorgon 多爾袞 (1612–1650), regent for the child Shunzhi emperor (r. 1644–1661), quickly marched Qing forces into China and defeated Li. On June 6, 1644, Dorgon's forces entered Beijing.³⁶ Dorgon's leadership of the Qing indeed was highly efficient. Soon the Qing emperor relocated from Manchuria to the Forbidden City. On the first day of the tenth month (October 30, 1644), the Shunzhi emperor declared himself the new sovereign of China.³⁷ On the same day, the Qing dynasty published the new official calendar printed with the Qing emperor's reign title, Shunzhi 順治.

During this chaotic period, Schall also made brave moves. He stayed in Beijing to protect the chapel properties. After Qing forces entered the capital, he petitioned Regent Dorgon for protection. Schall was granted a private audience, after which Dorgon ordered his army not to

³⁵ Zhang et al., *Ming shi*, 223.

³⁶ SL 3:57.

³⁷ SL 3:87.

disturb Schall's chapel.³⁸ Moreover, Dorgon soon decided to adopt Schall's new calendar. In July 1644, Dorgon announced that he would send some courtiers to observe the upcoming solar eclipse on the first day of eighth month (September 1, 1644) along with Schall and the Astronomical Bureau officials.³⁹ Ostensibly, this observation, as those of the Ming Chongzhen reign, was to compare the accuracy of Schall's New Method of calendar making with that of the old Great Concordance system. But, in fact, Dorgon already showed his preference for the New Method in the announcement of the comparison test:

The old calendar has accumulated errors while the New Western Method has repeatedly shown its accuracy. I knew about these. [Schall's] memorial includes [the predictions of] the beginning and ending times and shapes of the solar eclipse. It also gives different eclipse magnitudes and durations for observer in different provinces. It is already obvious that his calculation is detailed and carefully executed.⁴⁰

Days after the announcement, Dorgon again showed his preference for Schall's New Method by telling the Astronomical Bureau officials to discard their sample Great Concordance calendar.⁴¹ Dorgon dictated that the new calendar, called the Timely Modeling (*shixian* 時憲) calendar, had to be computed according to the New Method. Meanwhile, Dorgon told Schall, "The necessary calendar should all be computed according to the New Method completely. Speed up the preparation for the sample calendar and submit it to the Ministry of Rites."⁴² Dorgon even began to discuss some revisions of the calendar's format with Schall.⁴³ With a new ruler so enthusiastic about Schall's calendar, the Astronomical Bureau officials knew that the Great Concordance

³⁸ Johann Adam Schall et al., *Chongzhen lishu* 崇禎曆書, ed. Pan Naihui 潘鼐匯 (Shanghai: Shanghai guji chubanshe, 2009), 2045–46.

³⁹ SL 3:64.

⁴⁰ IHP 006903.

⁴¹ IHP 185043-010.

⁴² Schall et al., *Chongzhen lishu*, 2051.

⁴³ Ibid., 2052–53.

system's days were numbered. On August 26, 1644, six days before the observation of the solar eclipse, the Astronomical Bureau high officials sent the following to Dorgon:

The discrepancy of the Ancient Method has gradually worsened while the New Method repeatedly demonstrated in tests that it matches closely [with observed results]. . . . We have no other opinion about making all the calendar of the next year according to new format and calculating the orbits of five planets according to the New Method. We beg you to acknowledge and implement these.⁴⁴

After the eclipse, Dorgon's officials reported that the results closely matched the prediction of the New Western Method, while both the Great Concordance and the Muslim systems showed considerable errors.

When the Chinese received the new calendar, they noticed that it was printed with an additional phrase, "According to the New Western Method" 依西洋新法.⁴⁵ This phrase was more than an acknowledgement of Schall's contribution to the new calendar. It was so significant that two decades later, it would become critical evidence in accusing Jesuit mathematicians of treason. While the new reign title would tell the Chinese that they were now under a new Manchu emperor, the new phrase told them that the traditional Chinese method of calendar making had been replaced by a better one from the West. The new dynasty used the phrase to demonstrate its authority. Without further delay, the traditional yet outdated calendar should make way for a new, more accurate one, despite its foreign origin. Moreover, the new calendar declared the new dynasty's trust in the superiority of Western mathematical astronomy provided by Jesuit missionaries. As the declaration boosted the social status of Schall and his Jesuit colleagues, it would help the Jesuit China mission.

⁴⁴ Ibid., 2056.

⁴⁵ According to Ferdinand Verbiest, Schall did not include this phrase on the sample calendar he submitted. It was Dorgon who gave the order to add it to the cover of the calendar. See Ferdinand Verbiest, "Budeyi bian" 不得已辨, in *Tianzhujiao dongchuan wenxian* 天主教東傳文獻, ed. Wu Xiangxiang (Taipei: Taiwan xuesheng shuju, 1964), 348–49.

However, a more careful reading of Schall and Dorgon's discussions on the format of the new calendar reveals that Schall did not get everything he wanted. Schall requested that Dorgon let him remove the roster of the Astronomical Bureau officials customarily attached to the end of the calendar. He argued, "The submitted calendar is completely made according to the New Method. It is not calculated by the Astronomical Bureau officials."⁴⁶ Schall emphasized that while he and his Calendar Department labored day and night to verify each step of their calculations, but the Astronomical Bureau officials made no significant contribution. The only use of those officials was to copy the entries on auspiciousness. Schall said that the entries on auspiciousness "were not based on measurement. None of them needs to be calculated." Nevertheless, Dorgon did not approve Schall's request: "Since it is an old custom, the list shall still be appended after Schall's name."⁴⁷ Dorgon's concern went beyond undeserved credit for the Astronomical Bureau officials. As a conqueror, Dorgon wanted to take over the people and institutions the Ming left instead of completely brushing them aside. He was willing to adopt the New Method and acknowledge Schall's contribution but that was not equivalent to abolishing the old institution of the Astronomical Bureau. To ensure the new format of the calendar was what he wanted, Dorgon ordered a sample calendar from the Astronomical Bureau submitted to him as a reference.

Without Dorgon's full support, the power struggle between Schall and the Astronomical Bureau dragged on. After the test of solar eclipse, Dorgon let Schall and the Ministry of Rites hold an examination to determine which Astronomical Bureau officials had enough knowledge of the New Method to stay.⁴⁸ Before the examination, Schall wrote a palace memorial to Dorgon

⁴⁶ IHP 185043-49.

⁴⁷ Ibid.

⁴⁸ IHP 185045-13.

complaining that the Ministry of Rites took sides with the Astronomical Bureau. Schall bitterly described being threatened:

On the eighteenth day of the month, because of the instigation from the Astronomical Bureau officials, suddenly the Ministry of Rites summoned me. An interpreter then told me that at this critical moment, holding an examination on the Astronomical Bureau officials is not an urgent thing to do. If it causes any delay to the publication of the calendar, it will completely be my fault. Many of his words were so ridiculous that I dare to repeat them to you. Without giving me any chance to explain, they scolded me and sent me back. . . . I never imagine that at such an old age I would have to prostrate in a public office as a petty clergy. . . . How can I still have the honor to create the laws [of calendar making] for future generations and to make them part of this prosperous era?⁴⁹

Schall graphically described how disdainfully the Ministry of Rites had treated him. Yet, Dorgon did not respond to Schall's complaint. There was no record of any Ministry of Rites or Astronomical Bureau staff being punished for this incident. Moreover, when Schall passed only three of the eighty-six officials who took the examination, Dorgon decided to retain the ones who had failed. Dorgon followed the suggestions from the Ministry of Rites and gave most Bureau officials a three-month extension to learn the New Method.⁵⁰ He dismissed some senior officials, but promised that young members from their families would have the priority to fill their vacancies at the Bureau.⁵¹

Instead of converting the Bureau officials to the New Method, Schall saw replacement as the only solution. By the end of the three-month extension, Schall wrote another palace memorial to Dorgon:

Now that about half of the extension period has passed, the officials still fool around. Their indolence can be known from this. Moreover, the younger ones do not even know anything about the Ancient Method. How can they possibly concentrate on learning the New Method? If I teach them [the New Method], I am afraid not only that my efforts will be wasted but also that they will steal and alter the [New] Method. If so, the dispute will never end. I repeatedly think this over and feel that I cannot teach them the New Method

⁴⁹ IHP 185045-22.

⁵⁰ Schall et al., *Chongzhen lishu*, 2063–64.

⁵¹ Ibid.

rashly. . . . I beg Your Majesty to make a decisive verdict to cut off the residue so that the New Method can be transmitted to the eternity.⁵²

His resistance to teach the officials was clear, but Dorgon did not respond to Schall's memorial.

At the end of the tenth month of the year, Dorgon ordered the Ministry of Rites to have Schall submit an evaluation of the contributions of Astronomical Bureau and Calendar Department officials to him.⁵³ Schall sent a list of twenty-one people classified into three groups according to their contributions (see table 3). On the list, only three were from the Astronomical Bureau. These three officials had long been cooperative with the Calendar Department and eager to learn the New Method. The other eighteen people were all Schall's disciples at the Calendar Department. In light of the previous examination held for Astronomical Bureau staff, Schall intended his list to tell Dorgon that he did not want to retain them. Nevertheless, the Ministry of Rites once again took the Astronomical Bureau's side, holding Schall's list without delivering it to Dorgon. After more than twenty days' delay, the Ministry of Rites delivered Schall's list to Dorgon along with another list of contributors from the Astronomical Bureau.⁵⁴ Because some of his officials had diligently proofread the format of the calendar, the Astronomical Bureau director claimed, "We dare to obliterate their toil."⁵⁵ Again, Dorgon did not respond. On December 24, 1644, Dorgon gave Schall the administrative power of the Bureau but no significant reward for Schall's disciples or for the Astronomical Bureau officials.⁵⁶

⁵² IHP 117453.

⁵³ Schall et al., *Chongzhen lishu*, 2071.

⁵⁴ A comparison between the report written by Schall and the palace memorial submitted by the Ministry of Rites shows the difference of contents and the dates. See IHP 038804 and Schall et al., *Chongzhen lishu*, 2071–73.

⁵⁵ IHP 038804.

⁵⁶ Schall et al., *Chongzhen lishu*, 2079.

Table 3. Schall's disciples in the Ming Calendar Department and Astronomical Bureau, 1644

Name		Grade given by Schall	
Bao Yingqi	鮑英齊	2	Calendar Department
Huang Hongxian	黃宏憲	1	Calendar Department
Jiao Yingxu	焦應旭	3	Calendar Department
Jia Liangqi	賈良琦	2	Supervisor of the Middle Office
Li Hua	李華	3	Calendar Department
Li Zubai	李祖白	1	Calendar Department
Liu Youqing	劉有慶	2	Supervisor of the Autumn Office
Liu Yunde	劉蘊德	3	Calendar Department
Song Fa	宋發	1	Calendar Department
Song Kecheng	宋可成	2	Calendar Department
Song Keli	宋可立	3	Calendar Department
Sun Youben	孫有本	2	Calendar Department
Wu Zhiyan	武之彥	3	Calendar Department
Xu Huan	徐璦	2	Calendar Department
Yin Kai	殷鎧	2	Calendar Department
Zhang Sheng	掌乘	2	Calendar Department
Zhang Youzhuan	掌有篆	3	Calendar Department
Zhu Guangda	朱光大	1	Calendar Department
Zhu Guangxian	朱光顯	2	Erudite
Zhu Guangyin	朱光蔭	3	Student astronomer
Zhu Xingshu	朱廷樞	1	Calendar Department

Source: IHP 038804.

Table 4. Partial list of the Ming Astronomical Bureau officials, 1644

Name		Post at the Astronomical Bureau
Huang Daohua	黃道化	Official, Section of Heavenly Signs
Ge Chengke	戈承科	Director
Ge Yongjing	戈永靖	Supervisor of the Winter Office
Ge Yongcheng	戈永澄	Seal keeper
Jia Liangdong	賈良棟	Senior vice director
Jia Liangqi	賈良琦	Supervisor of the Middle Office
Li Xuemo	李學謨	Calendar collator
Li Zhigui	李之貴	Observatory manager
Li Zhiyou	李之猷	Official
Ma Yicai	馬以才	Student astronomer, Muslim Section
Pan Guoxiang	潘國祥	Supervisor of the Spring Office
Wang Ye	王燁	Student astronomer
Wu Mingxuan	吳明炫	Supervisor, Muslim Section
Wu Mingyao	吳明耀	Student astronomer, Muslim Section
Zhang Qichun	張其淳	Official, Section of Heavenly Signs
Zhao Congli	趙從禮	Water clock manager
Zuo Chengsi	左承嗣	Official
Zuo Chengye	左承業	Student astronomer
Zuo Yunhua	左允化	Supervisor of the Summer Office
Zhou Shichang	周士昌	Student astronomer
Zhou Shitai	周士泰	Student astronomer
Zhou Xiao	周曉	Seal keeper
Zhou Yin	周胤	Junior vice director

Sources: IHP 038804; Qu Chunhai 屈春海, “Qingdai Qintianjian ji Shixianke zhiguan nianbiao” 清代欽天監暨時憲科職官年表, *China Historical Materials of Science and Technology* 中國科技史料 18, no. 3 (1997): 45–71; Johann Adam Schall et al., *Chongzhen lishu* 崇禎曆書, ed. Pan Naihui 潘鼎匯 (Shanghai: Shanghai guji chubanshe, 2009), 2064; Xu Guangqi 徐光啟 et al., *Xinfa suanshu* 新法算書, SKQS 788; Johann Adam Schall, *Minli puzhu jiehuo* 民曆鋪註解惑, XXSK 1040:2–3.

大清順治十五年歲次戊戌時憲曆

都城順天府依新法推算節氣時刻

正月大	戊戌	二日巳亥酉初刻立春正月節	吉申寅寅初刻分雨水正月中
二月大	戊戌	二日巳巳午正二刻驚蟄三月節	吉甲申申未正三刻春分二月中
三月小	戊戌	二日巳亥戌初刻立春正月節	吉申寅寅初刻分雨水三月中
四月大	丁卯	四日庚午申正刻立夏四月節	吉丙戌戌初刻九分小滿四月中
五月大	丁酉	五日辛丑夜子初刻分芒種五月節	吉丁巳酉初刻立分夏至五月中
六月小	丁卯	七日癸卯正刻立分小暑六月節	吉己丑卯正刻九分大暑六月中

Figure 4. Qing Timely Modeling Calendar, the Shunzhi reign. The first page of the official calendar of the fifteenth year of the Shunzhi reign (1658). Unlike the Ming Great Concordance calendar, the new Timely Modeling calendar had a phrase declaring that the following table was “calculated according to the New Method” 依新法推算.

Reprinted from “大清順治十五年歲次戊戌時憲曆,” Taipei National Central Library, accessed December 11, 2014, <http://catalog.digitalarchives.tw/item/00/07/ec/dc.html>.

The Jesuits hoped that the New Method would replace the Chinese system of calendar making rather than supplement it. Their goal was to conduct missionary work, not merely to assist the Chinese in their scientific progress. The Jesuits would not rest easy when the Chongzhen emperor offered to assimilate the New Method to the Great Concordance system.⁵⁷ If the Chongzhen emperor felt bound to the traditional system, Dorgon probably had different thoughts. Dorgon discarded technology inadequate to serve the imperial privilege and obligation of producing the annual calendar. Nothing held Dorgon, a foreign conqueror, to the traditions of the conquered. If a non-Chinese method of calendar making could reinforce the Qing conquest of China, Dorgon would take it.

Still, Dorgon attempted to reconcile the conquered and the conquerors. Dorgon considered more than whether the Astronomical Bureau officials had indeed contributed to the new calendar. Dorgon wanted to show his new subjects that the Astronomical Bureau, the only state institution legally responsible for interpreting heavenly signs, endorsed the Qing. Consequently, he would not let Schall remove the roster of Astronomical Bureau officials from the calendar. Dorgon adopted Schall's New Method, but Schall would have to reconcile the Calendar Department and the Astronomical Bureau for Dorgon.

3.3 New and Old Mathematician Families in the Shunzhi Reign

The Shunzhi emperor displaced his regent in February 1651. Johann Adam Schall, however, was still trying to consolidate control over the Astronomical Bureau. Schall faced a bureau poisoned by factionalism and mutual distrust among its staff. Damage was caused by a power struggle that had worsened during the last decade of the Ming Chongzhen reign between

⁵⁷ In Ming times, the Astronomical Bureau had a Muslim Section. The official calendar was computed according to the Great Concordance system, but the Muslim calendar was kept as a comparison.

the Calendar Department and the Astronomical Bureau. The new dynasty merged these two institutions and appointed Schall head of the Astronomical Bureau. However, because Dorgon did not allow Schall to discharge the staff left over from the Ming dynasty, these rivals were stuck working together.

As late as 1655, it was still difficult for Schall to hire a full staff for the Astronomical Bureau. To boost morale, Schall memorialized the Shunzhi emperor to present special rewards to Observatory Manager Li Zhigui 李之貴 and two Manchu officials in charge of translating the calendar. Furthermore, he stated:

Even if the Section [of Heavenly Signs] cannot have the quota of hiring eighty student astronomers as in the Ming era, it should be allowed to add sixteen men to make the total twenty. Moreover, compared to eighty, twenty merely makes up a quarter of the trainees needed. The lesser the number of trainees, the heavier the work they have to do. . . . Previously, according to decision of the Ministry [of Rites], the quota of student astronomers was only allowed to increase by eight. . . . Now that more than seven months has passed . . . because the monthly food stipend of six *dou* 斗 is not enough for sustaining a living, nobody has come forward to take this job. Even though this winter is fiercely cold, there are only four student astronomers available to take turns for going up to the observatory.⁵⁸

While the Ming court allowed the Section of Heavenly Signs to hire eighty student astronomers, the Shunzhi reign saw Schall cut it down to merely four student astronomers. The severely reduced quota was not Schall's only problem. The student astronomer job was so miserably paid that few wanted it. Despite the Ministry of Rites agreeing to triple the quota from four to twelve, Schall complained that nobody was willing to take such a low-ranking position.

Outside the Astronomical Bureau, Schall built a close connection with the imperial house and high ministers during the Shunzhi reign. By Shunzhi's death, Schall was bestowed the first

⁵⁸ IHP 036556-3.

level of civil service rank.⁵⁹ However, Schall's high status was of little help for recruiting new workers for the Astronomical Bureau. Therefore, this section investigated the effectiveness of Schall's administration of the Astronomical Bureau. Based on historical records related to the Shunzhi reign, it explored the career prospects of different officials working at Schall's Astronomical Bureau.

Schall published the *Response to Concerns over the Notes on Civil Calendar* (*Minli puzhu jiehuo* 民曆鋪註解惑) in 1662, a year after the end of the Shunzhi reign.⁶⁰ As the highest administrator of the Astronomical Bureau, Schall had dutifully produced the annual Qing Empire calendar for almost two decades. As a missionary, however, he faced challengers in the Jesuit order accusing his calendar, which calculated daily fortune advice calculated according to Chinese divinatory theories, to be an act of promulgating superstition. Perhaps to make the *Response* more convincing, his preface includes a list of twenty-eight endorsers from the Astronomical Bureau (see table 5).

Recall that when Dorgon chose Schall to produce the official calendar in 1644, Schall did not want the Astronomical Bureau officials' names appearing on his new calendar. Eighteen years later, Schall could proudly display the endorsement from an impressive number of high Bureau officials. Moreover, while Schall's disciples clustered in the Bureau's Calendar Section, the endorsers came from three major sections of the Bureau. Both water clock managers, Yang Hongliang 楊弘量 and Du Ruyu 杜如預, endorsed Schall's treatise, as did the observatory managers, Huang Gong 黃輦 and Zhang Qichun 張其淳. The endorser list shows that Schall had firm control of the Bureau after he took over.

⁵⁹ Zhao Erxun 趙爾巽 et al., *Qingshigao* 清史稿 (Beijing: Zhonghua shuju, 1976), 10020.

⁶⁰ Johann Adam Schall, *Minli puzhu jiehuo* 民曆鋪註解惑, XXSK 1040:2.

Table 5. Endorsers of Schall's *Response to Concerns about the Notes on Civil Calendar*

Names		Title
Bao Yinghua	鮑英華	Erudite
Bao Yingqi	鮑英齊	Erudite, rank 8B
Du Ruyu	杜如預	Water clock manager
Ge Guoqi	戈國琦	Erudite
Ge Jiwen	戈繼文	Calendar collator
He Qiyi	何其義	Erudite, rank 8B
Huang Gong	黃鞏	Observatory manager
Jia Liangqi	賈良琦	Supervisor of the Middle Office
Jiao Yingxu	焦應旭	Erudite, rank 8B
Li Guangda	李光大	Erudite, rank 8B
Li Zubai	李祖白	Supervisor of the Summer Office
Liu Youqing	劉有慶	Senior vice director
Liu Youtai	劉有泰	Seal keeper
Si Ergui	司爾珪	Erudite, rank 8B
Song Fa	宋發	Supervisor of the Autumn Office
Song Kecheng	宋可成	Supervisor of the Spring Office
Sun Youben	孫有本	Erudite, rank 8B
Xue Wenbing	薛文炳	Erudite, rank 8B
Yang Hongliang	楊弘量	Water clock manager
Yin Kai	殷鎧	Calendar collator
Zang Wenxian	臧文顯	Erudite, rank 7B
Zhang Sheng	掌乘	Secretary-general
Zhang Guangxiang	張光祥	Erudite, rank 7A
Zhang Qichun	張其淳	Observatory manager
Zhang Wenming	張問明	Seal keeper
Zhou Shichang	周士昌	Erudite, rank 8B
Zhou Yin	周胤	Junior vice director
Zhu Guangxian	朱光顯	Supervisor of the Winter Office

Source: Johann Adam Schall, *Minli puzhu jiehuo* 民曆鋪註解惑, XXSK 1040:2–3.

A closer examination to the endorser list shows that the majority of the Astronomical Bureau high officials had affiliated with Schall since the Ming era, particularly the Calendar Department officials. Compare tables 3 and 5. The names of Vice Director Liu Youqing 劉有慶, Secretary-General Zhang Sheng 掌乘, and the Calendar Section supervisors—Song Kecheng 宋可成, Li Zubai 李祖白, Jia Liangqi 賈良琦, Song Fa 宋發, and Zhu Guangxian 朱光顯—appear in both. This means that they were among Schall's disciples who worked on Qing China's first official calendar.⁶¹ They were from the Ming Calendar Department, except that Jia Liangqi and Liu Youqing were from the Astronomical Bureau. Nonetheless, Jia and Liu had been cooperative with the Calendar Department and had diligently learned the New Method since the late Ming era. Ranked below them in the Shunzhi Astronomical Bureau were Calendar Collator Yin Kai 殷鎧 and Erudites Jiao Yingxu 焦應旭, Bao Yingqi 鮑英齊, and Sun Youben 孫有本. Their names also appeared in Schall's recommendation list to Dorgon (see table 3).

Although the Astronomical Bureau converted to the New Method, family networks remained an important channel through which the Bureau recruited apprentices. Several new officials listed on table 5 were from the families of Chinese Christians who learned the New Method from the Jesuits during the Ming era. Liu Youtai 劉有泰, perhaps Liu Youqing's brother, became a seal keeper by 1658.⁶² Liu Youtai's name was not in Schall's list to Dorgon; therefore he might be Schall's new disciple. Liu Youtai mastered the New Method so well that his career at the Astronomical Bureau advanced faster than Schall's old Ming-era Calendar Department disciples such as Bao Yingqi 鮑英齊. Nevertheless, Bao Yingqi should have valued his

⁶¹ IHP 038804.

⁶² In Qu's "Qingdai Qintianjian," Liu Youai is listed with the title of Supervisor of Five Offices 五官正. However, it is more likely that Liu was a seal keeper of the Five Offices 五官保章正, as referred to in the palace memorial written in 1663 (IHP 091306).

Astronomical Bureau career enough that his younger brother Bao Yinghua 鮑英華 joined the profession and became an erudite in October 1658.⁶³ By the end of Shunzhi times, the next generation—Jia Liangqi's son Jia Wenyu 賈文郁 and Liu Youqing's son Liu Biyuan 劉必遠—had started working at the Astronomical Bureau.⁶⁴

Comparing the *Response* to a different historical document, the *Register of Metropolitan Officials Recorded on the Shunzhi Imperial Screen* (*Shunzhi Yuping Jinggua Zhimingce* 順治御屏京官職名冊), reveals different aspects of the Shunzhi Astronomical Bureau. The *Register of Metropolitan Officials* originated with the Ming practices of keeping a special screen in the imperial palace. With a map of the whole country painted on the screen's background, each official's name was pinned to the screen on a piece of paper. When officials changed posts, their names were switched on the screen. Therefore, the screen served as a convenient register of officials. The *Register*, which was used for the following analysis, comes from the official roster printed by the Ministry of Personnel in late 1660 to update the imperial screen.⁶⁵ Printed less than two years before the *Response*, it includes records of all Astronomical Bureau officials at the time. Unlike the preface of the *Response*, which contains only the endorsers' names, the *Register* includes all officials' birthplaces, educational background, and most importantly the dates that they obtained their current positions (see Appendix B.2). The *Response* is critical in reconstructing how Schall ran the Astronomical Bureau. For instance, the *Register* contains records of four Muslim erudites but no mention of the Muslim supervisor of the Autumn Office,

⁶³ Wenxian congbian 文獻叢編 (Beijing: National Palace Museum, 1935), 28:14.

⁶⁴ Chen, *Zhongguo Tianzhujiao*, 523.

⁶⁵ Wenxian congbian, 27:1.

Wu Mingxian 吳明炫. It indicates that despite Wu Mingxian's discharge from the Astronomical Bureau, the Muslim Section remained.⁶⁶

Several observations can be obtained from the *Register*. First, the old mathematician families at the Bureau survived the loss of prestige after Schall's takeover. Zhou Yin 周胤 from the Zhou family, kept his position as the junior vice director (*You Jianfu* 右監副) probably because he had not been hostile to the Jesuits and the New Method in the Ming Chongzhen reign. The *Register* sees four other Calendar Section erudites with surname Zhou.⁶⁷ Among them, Zhou Yin and Zhou Shichang 周士昌 endorsed the *Response*.⁶⁸ For the Ge family, some members should have left the Astronomical Bureau; therefore only two officials, Ge Jiwen 戈繼文 and Ge Guoqi 戈國琦, appear on the *Register*. However, Ge Jiwen and Ge Guoqi seemed to have adjusted to Schall's administration so well that the former received a promotion to calendar collator in July 1646 while the latter became an erudite in December 1655.⁶⁹ Both endorsed the *Response* (see table 5).

By contrast, although the Zuo 左 family stayed in the Qing Astronomical Bureau, none of its members endorsed Schall's *Response*. The Zuo family might have been more resistant to Schall's reformation than the Zhou and Ge families. Recall that in 1644, two young Zuos—Zuo Chengsi 左承嗣 and Zuo Chengye 左承業—did not bother to take the qualifying examination to stay in the Astronomical Bureau.⁷⁰ Surely, not every member of a family thinks the same and not everyone is as persistent as Zuo Chengsi and Zuo Chengye. As the *Register* shows, Zuo Yudeng

⁶⁶ Ibid., vol. 28, 16.

⁶⁷ Ibid., vol. 28, 14–15.

⁶⁸ Schall, *Minli puzhu*, 2–3.

⁶⁹ Wenxian congbian, 28:14.

⁷⁰ Schall et al., *Chongzhen lishu*, 2063–65.

左允登 and Zuo Yuhe 左允和 became erudites in the Ming era, and they stayed in Schall's Astronomical Bureau. Furthermore, Zuo Youqing 左有慶, who might be a younger Zuo family descendant, was raised from student astronomer to erudite in December 1653—presumably because of his knowledge of the New Method.⁷¹ Nonetheless, no Zuo endorsed Schall's treatise. The absence of the surname Zuo in the *Response* suggests that more than eighteen years after Schall's New Method became the norm for calendar making, resistance to Schall's administration persisted among some Astronomical Bureau staff.

However, blame for the Astronomical Bureau's factionalism does not rest with the old Ming mathematician families alone. The *Register* shows a sharp difference in career development between two groups of the Bureau staff. The first group consisted of the officials who had become student astronomers in the Ming era. This group hardly received any promotion since Schall became the head of the Bureau. The *Register* has records for twenty-eight Calendar Section erudites, thirteen of which had similarly frozen careers. They all entered the Astronomical Bureau as student astronomers and had advanced to erudites by April 1645. However, they were still erudites when the *Register* published their records in April 1660. These officials were leftovers from the Ming era, and their expertise in the Great Concordance system was useless for Schall's Astronomical Bureau. Although they could keep their jobs, their careers were dead.

The second group of officials was those who entered the Astronomical Bureau as Confucian students (*rushi* 儒士) after Schall's takeover. *Rushi* was not an official degree or title but a label that Schall constantly used for his disciples since he ran the Ming Calendar Department. This group consisted of Schall's disciples, and many of them had advanced to

⁷¹ Wenxian congbian, 28:15.

higher positions of the Astronomical Bureau before the *Register* was published. For instance, Zhang Sheng became a secretary-general in July 1646; Song Fa, the supervisor of the Autumn Office in July 1646; and Yin Kai, a calendar collator in October 1658.⁷²

A memorial submitted by the Ministry of Personnel in February 1663 further illustrates how promotion opportunities bypassed the leftover Ming officials and gave favor to Schall's adherents:

According the consultation given by the Astronomical Bureau to the Ministry of Rites, the vacancy left by Liu Youtai after he was promoted from seal keeper to the supervisor of the Middle Office should be filled by calendar collator Yin Kai. The vacancy of calendar collator should be filled by the Calendar Section erudite Bao Yingqi, and the vacancy of erudite by Liu Yunde 劉蘊德, who is an assistant at the Bureau and an erudite candidate currently on the stipend of Confucian student.⁷³

A promotion in the Astronomical Bureau did not come often. It usually had to wait until some high official died or retired because of serious illness. The above chain of promotions was triggered by the possible death of Jia Liangqi in late 1662.⁷⁴ Liu Youtai filled Jia's seat. Like Jia, Liu was from an old mathematician family, but he had successfully converted to the New Method. Yin Kai and Bao Yingqi were Schall's disciples from the Ming era. Liu Yunde's name was not included in the *Register* or the *Response* but appeared in Schall's recommendation list to Dorgon. In short, everyone promoted in the above memorial was Schall's personal disciple.

Another group that was absent from the *Response*'s endorsers was the Muslim Section. The Muslim Section was an independent section of the Ming Astronomical Bureau responsible for producing its own calendar and divination for comparison to the official Great Concordance calendar. Namely, the Muslim system and the Great Concordance system had coexisted without

⁷² Ibid., 28:14.

⁷³ IHP 091306.

⁷⁴ Qu, "Qingdai Qintianjian," 49. The last time Jia's name appeared on the official calendar was the second year of Kangxi. Therefore, Jia should have left his post between late 1644 and February 1645.

conflict in the Ming Astronomical Bureau for more than two centuries. The adopting of the New Method threatened not only the Muslim calendar but also the careers of the Bureau's Muslim officials. According to the transitional measure proposed by the Ministry of Rites in 1644, five Muslim officials were allowed to stay, but five of the eight Muslim student astronomers were dismissed.⁷⁵ Among the discharged was Wu Mingyao 吳明耀, a brother of Wu Mingxian 吳明炫, the Muslim Section supervisor of the Autumn Office.⁷⁶ Moreover, the three remaining Muslim student astronomers were ordered to convert to the New Method. Without student astronomers devoted to learning the Muslim calendar, the end of the Muslim Section was inevitable. After losing the solar eclipse prediction competition of September 1, 1644, the Muslim Section was forbidden from submitting future eclipse predictions. In 1646, the court announced that the Muslim calendar was no longer needed. In 1652, the Muslim Section was forbidden to report its reading of summer celestial signs.⁷⁷ Before Wu Mingxian was ousted from the Bureau in April 1654, the Muslim Section already lost its status in Astronomical Bureau.⁷⁸

Wu Mingxian, a tenacious fighter for Muslim interests, was not ready to give up. In May 1657, Wu submitted a memorial to the Shunzhi emperor. In addition to criticizing Schall's New Method, Wu hoped that the emperor could take the Muslim Section's long history of service into consideration. Wu argued that Chinese dynasties had employed his ancestral families from the Far West as Astronomical Bureau officials because of their expertise in calendar making for

⁷⁵ IHP 185045-05.

⁷⁶ Wu Mingxian 吳明炫 also appears as "Wu Mingxian" 吳明燦 in documents published after 1662 to avoid the naming taboo of the Kangxi emperor. For a more detailed discussion about the Wu brothers' names, see Huang Yi-Long 黃一農, "Wu Mingxuan yu Wu Mingxuan—Qingchu yu xifa kangzheng de yidui Huihui tianwenjia xiongdi?" 吳明炫與吳明燦—清初與西法相抗爭的一對回回天文家兄弟? *Dalu zazhi* 大陸雜誌 84, no. 4 (1992): 137–60.

⁷⁷ QHD KX 7751.

⁷⁸ Huang, "Wu Mingxuan," 145.

1,059 years. They had the independent expertise to compute planetary orbits and interpret celestial signs. Wu begged the Shunzhi emperor to restore him to the Bureau “so that my Section can be preserved and its unique learning can be transmitted [to future generations].”⁷⁹ June 1657 saw another eclipse prediction competition between Wu’s Muslim calendar and Schall’s New Method, but the result was inconclusive. In September 1657, the visibility of Mercury became the critical test between Wu’s and Schall’s methods. Wu failed miserably, however, not because of poor calculation but because his Muslim colleagues at the observatory retracted their testimony during the trial.⁸⁰

Under Schall, mastering the New Method become the means to develop a career at the Astronomical Bureau. After 1653, a new group of erudites emerged. Zou Youqing 左有慶, a descendant of the old Zou family, and Xu Hu 徐瑚, probably a brother of Schall’s early disciple Xu Huan 徐煥, both became erudites in November 1653. However, not everyone welcomed such reform. It was not hard for a fresh, new student astronomer to begin learning with the New Method, but it was not as easy for those who had already devoted years to the study of the Great Concordance or the Muslim system. Almost half of the erudites who were experts in the outdated Great Concordance system received no promotion since Schall ascended to the top of the Astronomical Bureau. That is the likely reason why only five of the thirteen Calendar Section erudites endorsed Schall’s *Response*. Dissatisfaction among the older staff accumulated. Wu Mingxuan’s resistance in 1657 was just the beginning. After the death of Schall’s greatest sponsor, the Shunzhi emperor, in February 1661, Schall and the New Method soon faced a severe challenge.

⁷⁹ SL 3:853.

⁸⁰ Huang Yi-Long 黃一農, “Qingchu Tianzhujiao yu Huijiao tianwenjia Jjian de zhengdou” 清初天主教與回教天文家間的爭鬥, *Jiuzhou xuekan* 九州學刊 5, no. 33 (1993): 55–59.

Chapter 4

Kangxi Calendar Dispute

Between 1665 and 1667, the Qing court abandoned the New Western Method of calendar making that it had used for two decades and returned to the traditional Great Concordance calendar. While this incident, often called the Kangxi Calendar Dispute 康熙曆爭, might seem a short and temporary delay to the assimilation of European mathematics in Qing China, it forever changed the constitutions of the Astronomical Bureau. Some of the oldest Han mathematician families that had worked for the Bureau since the Ming era left after the Calendar Dispute. Muslim mathematicians also lost their last few posts in the Bureau. In contrast, the Qing court added Banner officials to the Bureau to learn mathematical astronomy and to share the administrative responsibility that had been monopolized by European missionaries in the Shunzhi reign. Despite the fact that the New Western Method was reinstalled as the official astronomical system of calendar making in 1668, this chapter claims that the Kangxi emperor did not give his decisive endorsement to the New Method until 1676. Moreover, it shows that the Great Concordance system probably was not regarded as completely hopeless until 1688 when the Kangxi emperor finally decided to suppress its supporters.

4.1 A Failed Attempt to Return to the Great Concordance System

The Kangxi Calendar Dispute began when the emperor was still too young to rule in person. The Kangxi emperor (r. 1662–1722) succeeded the throne when he was merely eight years old. A regency council was set up to rule the Qing Empire. The regency council revised several Shunzhi policies, but Schall's status at the court and the relationship to the imperial

house seemed intact. Before his death, the Shunzhi emperor gave Schall a special honor by ordering him to adopt a grandson. In October 1661, the regents extended this honor by granting Schall's adopted grandson an admission to the Imperial College.¹ However, in August 1664, regents accepted the accusation of Yang Guangxian 楊光先 (1597–1669), one of the most aggressive advocates of the Great Concordance system. In November 1664, the court arrested Johann Adam Schall, his European colleagues, and Chinese disciples.² By mid-1665, Yang became the director of the Astronomical Bureau. Although it was too late to recalculate the calendar for the coming year according to the Great Concordance system, the court decided that the phrase “According to the New Western Method” 依西洋新法 should be removed from the calendar cover.³ Schall was only saved from execution by a timely earthquake and the negotiation from Grand Empress Dowager, the Kangxi emperor's grandmother. He died a year later under house arrest.⁴

During the Calendar Dispute, the Qing court returned to the Great Concordance calendar and purged followers of the New Western Method from the Astronomical Bureau. Schall's most important disciples and the supervisors of the Calendar Section—Song Kecheng 宋可成, Li Zubai 李祖白, Liu Youtai 劉有泰, Song Fa 宋發, and Zhu Guangxian 朱光顯—were beheaded. Their family members were stripped of all properties and banished to distant places. The same punishment even extended to family members of deceased officials such as Liu Youqing 劉有慶, Jia Liangqi 賈良琦, and Zhou Yin 周胤. After appointed the Bureau director, Yang fiercely persecuted the rest of Schall's adherents. Yang discharged Li Guanghong 李光宏 and Huang

¹ Chen, *Zhongguo Tianzhujiao*, 501.

² Ibid., 166.

³ Wu, *Qingguo shi*, 4:624; QHDSL QL 625:139.

⁴ Ibid., 503–4.

Chang 黃昌, who had worked at the observatory for decades, because he suspected them of fabricating observation results to support the New Method.⁵ Calendar Collator Bao Yingqi 鮑英齊, who had worked with Schall since the Ming era, was banished to Ningguta 寧古塔, a remote town on the northeast border, under accusation of receiving bribes when purchasing printing paper.⁶ By the time that the Kangxi emperor began ruling in person and discharged Yang from the directorship in 1669, more than twenty officials of the Astronomical Bureau had been purged (see table 6).

It is noteworthy that the Calendar Section suffered the most, though the other two sections were also affected. In the Calendar Section, almost all staff above the erudite rank were executed or banished. The other two sections fared only slightly better. The past service of Water Clock Mangers Yang Hongliang 楊弘量 and Du Ruyu 杜如預 in constructing several imperial tombs saved them from death penalty.⁷ Observatory Managers Zhang Qichun 張其淳 and Li Quangxian 李光顯 found themselves promoted to director and vice director at the beginning of the purge because all the officials above them were ousted. Li managed to keep his post throughout the Calendar Dispute, but Zhang soon lost his job. Many erudites of the Section of Heavenly Signs—Huang Gong 黃輦, Huang Chang 黃昌, and Li Guanghong 李光宏—were also discharged on Yang's suspicion that they had fabricated observation results to favor the New Method.⁸

⁵ For the Li and Huang families' service record at the Observatory, see Shi, "Qing Qintianjian Tianwenke," 36–37. For their discharge, see Chen, *Zhongguo Tianzhujiao*, 514–15.

⁶ Chen, *Zhongguo Tianzhujiao*, 520–21.

⁷ SL 4:220.

⁸ Chen, *Zhongguo Tianzhujiao*, 514–15.

Table 6. Purged Officials of the Astronomical Bureau during the Kangxi Calendar Dispute

Names		Title
Bao Yingqi	鮑英齊	Calendar collator
Du Ruyu	杜如預	Water clock manager
Huang Gong	黃鞏	Observatory manager
Huang Chang	黃昌	Erudite, Section of Heavenly Signs
Li Guanghong	李光宏	Erudite, Section of Heavenly Signs
Li Zubai	李祖白	Supervisor of the Summer Office
Liu Biyuan	劉必遠	Erudite, Calendar Section
Liu Youtai	劉有泰	Supervisor of the Middle Office
Si Ergui	司爾珪	Erudite, Water Clock Section
Song Fa	宋發	Supervisor of the Autumn Office
Song Kecheng	宋可成	Supervisor of the Spring Office
Song Kecheng	宋可立	Erudite, Calendar Section
Yang Hongliang	楊弘量	Water clock manager
Yin Kai	殷鎧	Seal keeper
Zang Yuqing	臧餘慶	Official observer
Zhang Huafeng	張化鳳	Erudite, Water Clock Section
Zhang Qichun	張其淳	Observatory manager
Zhang Wenming	張問明	Seal keeper
Zhou Yin	周胤	Senior vice director
Zhu Guangxian	朱光顯	Supervisor of the Winter Office

Source: Chen Fangzhong 陳方中, ed., *Zhongguo Tianzhu jiao shiji huibian* 中國天主教史籍彙編 (Taipei: Furen daxie chubanshe, 2003), 523–24.



Figure 5. Qing Timely Modeling Calendar, the Kangxi reign.

Left: The first page of the calendar of the forty-fourth year of the Kangxi reign (1705). *Right:* The front cover of the Seven Governors Calendar 七政時憲曆 of the eighteenth year of the Kangxi reign (1679). After the explosion of the Kangxi Calendar Dispute, the phrase “According to the New Method” was removed from the calendar.

Reprinted from “大清康熙四十四年歲次乙酉時憲曆,” Taipei National Central Library, accessed October 11, 2014, <http://catalog.digitalarchives.tw/item/00/07/ec/e0.html>, and “Da Qing Kangxi shiba nian qizheng jingwei chandu shi xianli,” Austrian National Library, accessed October 11, 2014, <http://data.onb.ac.at/ABO/%2BZ43208904>.

Yet, a return to the Great Concordance system failed for several reasons. First, Yang did not have mathematical knowledge required for calendar making and said so himself during the trials against Schall. Yang testified, “[I] only know the principles of calendar but not the mathematics of the calendar.” When one minister asked him to evaluate three illustrations of solar eclipses, he testified again, “I did not learn the methods of calculating eclipses. I really do not know [how to evaluate them].”⁹ Yang repeatedly tried to convince the Kangxi regents that he was not qualified for the Bureau directorship. The regents forced the job on him anyway. Yang soon memorialized again and described his difficulty learning mathematics: “There are only slightly more than forty fundamental rules for calculating calendars, but it has been four months since I was appointed [a post at the Astronomical Bureau] and I still could not remember them all.”¹⁰ While Yang might have exaggerated his aging and bad memory to avoid responsibility, it would be amazing to the Bureau officials that their new vice director did not even know the most fundamental rules of calendar making.

Indeed, a problem no less serious than Yang’s incompetence in mathematical astronomy is that he was unable to mobilize support within the Astronomical Bureau, particularly the support from the families that used to master the Great Concordance system. In his famous treatise attacking the New Method and Christianity, *I Have No Alternative* (*Budeyi* 不得已), Yang complained about the offspring of old mathematician families:

I have no alternative but to look forward to the officials who inherited the traditional profession of Xi 羲 and He 和.¹¹ However, they are young and all have betrayed the craft

⁹ Wu, *Tianzhujiao dongchuan wenxian xubian*, 1264.

¹⁰ Ibid., 1268.

¹¹ According to the *Canon of Yao* in *Book of Document*, Yao 堯 commanded Xi 羲 and He 和 to observe heaven and to make a calendar.

handed down in the family. They take the enemy as their fathers. Shaking tails under the feet of the bandits, they reverse to bark at their own ancestors.”¹²

After becoming the director, Yang complained again:

How excited and encouraged the calendar officials of Xi and He shall be! Now they shall demonstrate their ambition so that they can repay the emperor's great consideration of readopting their family craft. However, they have different thought. . . . Those who know all about calculating eclipses and planetary orbits pretend that they have not practiced those methods for a long time, and it is not possible to review them immediately. Those who know one or two of those methods pretend to know none at all. Today an examination was held to choose the ones to fill the posts of supervisors of the Five Offices at the Calendar Section. However, the Calendar Section did not ask critical calculation questions about the eclipse but trivial ones. Their intention is to aim for a temporary promotion, and they will shrink from their responsibility in the future with the excuse of not knowing anything.¹³

According to Yang's complaints, the old mathematician families were not as excited as he was about the reinstallation of the Great Concordance system and appeared uninterested in giving their full support to Yang.

The case of Ge Jiwen 戈繼文 provides some insight into the hesitation of the old mathematician families in supporting Yang. Ge Jiwen was from a prosperous mathematician family of the late Ming Astronomical Bureau.¹⁴ On the one hand, unlike other old mathematician family erudites whose careers stalled after Schall's takeover, Ge advanced from erudite to calendar collator in July 1646.¹⁵ Ge, to certain extent, might have converted to the New Western Method. In order to keep advancing in Schall's Astronomical Bureau, Ge and his family members might indeed have been devoted themselves to learning the New Method rather than practicing the old Great Concordance system for the previous two decades.

¹² Wu, *Tianzhujiao dongchuan wenxian xubian*, 1197.

¹³ *Ibid.*, 1285–87.

¹⁴ See section 3.1.

¹⁵ *Wenxian congbian*, 28:14.

On the other hand, although Ge became the supervisor of the Spring Office shortly after Yang's coup, the responsibility of calendar calculation might have seemed terrifyingly heavy to him and his family. Ge obtained his new position because his colleagues recently lost their heads. A career at the Astronomical Bureau used to be stable and secure, but now one might lose property and even life simply because he had followed a calculation system that the court pronounced it wrong. Even Director Yang repeatedly told the emperor that working for the Astronomical Bureau would eventually cost him his life. How was it possible that officials like Ge Jiwen would feel secure enough to cooperate with Yang?¹⁶ Ge could not know if the court would again decide one day to replace the Great Concordance system and punished its supporters. No wonder Ge Jiwen and the other Calendar Section officials were cool to Yang and the return of the Great Concordance system.

Unlike Schall, who was able to bring in his own team of specialists in the New Method to the Astronomical Bureau, Yang was incapable of gathering help from outsiders. To be sure, the imperial regents let Yang bring in new people to the Astronomical Bureau. In 1666, the number of Han student astronomers was increased from 66 to 160. The number of erudites also increased by two.¹⁷ However, three years after becoming the Bureau director, Yang requested a discharge because he could not find adequate experts in the ancient method of Waiting for Qi (*Houqi* 候氣), which he believed could improve the Great Concordance system.¹⁸ Worse, the public was not particularly fond of Yang. In *I Have No Alternative*, Yang Guangxian complained that the

¹⁶ Yang memorialized four times in 1647, requesting to be released from the posts of vice director and director.

¹⁷ QHD KX 7749.

¹⁸ SL 4:379.

earthquake that interrupted Schall's execution made the Beijing residents praise Schall as a "true saint."¹⁹ By contrast, people easily believed every street rumor that reticulated him.²⁰

One of the few helpers that Yang gathered was Muslim mathematician Wu Mingxian 吳明炫. By mid-1668, Wu Mingxian was back to the Astronomical as its vice director.²¹ However, Wu was more interested in restoring the Muslim system than helping Yang to fix the Great Concordance system. In October 1668, Wu successfully challenged the accuracy of Ge Jiwen and Chen Yuxin 陳聿新's calendar. The court ordered that the calendar of 1670 should be calculated according to Wu's Muslim method.²² Nonetheless, Wu's triumph did not last long.

By the end of 1670, the Kangxi emperor, who had assumed personal rule in August 1667, had been looking for a chance to break the power of his ambitious regents. In January 1669, Jesuit missionary Ferdinand Verbiest (Chinese name Nan Huairan 南懷仁, 1623–1688) submitted a memorial to attack Vice Director Wu Wingxun.²³ According to Verbiest's calculation, Wu's calendar for 1670 contained so many mistakes that even the intercalary month was set up incorrectly. The Kangxi emperor grasped this chance and decreed that comparison tests between different methods of calendar calculation be repeated for three days in a row. These tests gave Verbiest the opportunity to demonstrate the accuracy of the New Method. Within a month, Kangxi transferred the commission for the 1671 calendar from Wu to Verbiest. The emperor then demanded the regents give him a detailed report of why their previous decision against Schall did not actually contradict the current situation.²⁴ Both Wu and Yang

¹⁹ Wu, *Tianzhujiao dongchuan wenxian xubian*, 1287–88.

²⁰ *Ibid.*, 1277–78.

²¹ SL 4:365.

²² SL 4:370.

²³ SL 4:382–83.

²⁴ SL 4:386.

were dismissed, while Verbiest became the vice director and then the Bureau director. In June 1669, The Kangxi emperor arrested regent Oboi 鰲拜 (ca. 1610–1669). Yang, considered a member of Oboi's faction, was sentenced to death, though the emperor pardoned him because of his advanced age. At the same time, the court restored Schall's title and civil service rank and returned the chapel and property to the Jesuits.²⁵

The rehabilitation of Chinese Christian mathematician families working for the Astronomical Bureau did not come as soon. Purged officials were given back their original jobs if they were still alive. For those who were already dead, their families did not receive compensation. In fact, the officials received the confiscated properties only after the emperor ordered a thorough reinvestigation of the cases because Verbiest had submitted a memorial on behalf of erudites Bao Yinghua 鮑英華 and Bao Xuan 鮑選 in August 1671.²⁶ In the memorial, Yinghua and Xuan claimed that their brother Bao Yingqi 鮑英齊, who was still banished, had been an innocent victim of Yang Guangxian's false accusations. The Ministry of Punishment, however, refused to admit any wrongdoing in this case. Bao received a pardon only after application of a special regulation regarding accomplished student astronomers.²⁷ Bao Yingqi eventually became the vice director of the Astronomical Bureau, and his descendants continued to serve the Bureau until the beginning of the nineteenth century.²⁸

²⁵ SL 4:417.

²⁶ Chen, *Zhongguo Tianzhujiào*, 520–25.

²⁷ Yao Yuxiang 姚雨蓀 and Hu Yangshan 胡仰山, eds., *Da Qing luli huitong xinzuan* 大清律例會通新纂, CKSB 211:381–82. As in previous dynasties, if a student astronomer had already mastered the mathematical studies, he could exchange the banishment for reduced corporal punishment so that he could remain in Beijing and continue working for the Astronomical Bureau.

²⁸ According to Qu's "Qingdai Qintianjian," Bao Yingqi was the vice director from 1677 to 1707. Bao Duo 鮑鐸, a possible descendant of the Bao family, was listed as a student astronomer in a routine memorial written in August 1807. See IHP 170472.

By contrast, some old families like the Ge decided to withdraw from the Bureau. Ge Jiwen's name disappeared from historical records after Wu Mingxian criticized him for miscalculation in October 1668.²⁹ It is not clear whether Ge Jiwen happened to die around the time, retired voluntarily, or lost his job because of Wu's attack. The surname Ge never again appeared among the high officials of the Qing Astronomical Bureau. After Ge Zhangzhen 戈掌鎮, who was an erudite of the Section of Heavenly Signs between 1679 and 1684, no other Ge family member seemed to work for the Bureau.³⁰ Similarly, there is no record of the Zuo 左 family, which still had several members at the Bureau in the Shunzhi reign, after the Calendar Dispute came to light.

In the end, Dorgon's policy of not dismissing the officials trained in the Great Concordance system seems correct. Wu Mingxian, the Muslim mathematician ousted from the Bureau by Jesuit missionary, fought fiercely for the Muslim calendar and the few official positions traditionally reserved to his community. Most members of the old mathematician families, however, would abandon the craft handed down in the family or bear with stagnant careers rather than risk their lives and family properties. Similar to Dorgon, the Kangxi emperor did not dismiss the Bureau officials who supported the Great Concordance system during the Calendar Dispute. The following chapters will show that some descendants of those officials would become important mathematicians not only to the Astronomical Bureau but also to the development of Qing mathematics. Before returning to this storyline, the next section examines the permanent mark left by the Calendar Dispute: the reorganization of the Astronomical Bureau.

²⁹ SL 4:371.

³⁰ Shi, "Qing Qintianjian Tianwenke," 37.

4.2 *Ethnically Based Reorganization*

The horrifying turmoil of the Calendar Dispute led the Qing court to the awareness that its ignorance of calendar making could cause political and social instability. When Yang Guangxian's charge against Schall was still under investigation in late 1664, the persecutors reported, "The system of calendar making is so profound that it is difficult to make immediate distinction."³¹ Shortly after, the court began to discuss the necessity of adding Manchu officials to the Astronomical Bureau. The discussion was finalized in 1665 and Banner officials were added to every section of the Astronomical Bureau.³² From then on, all three ethnic groups of Bannermen—Manchu, Mongol, and Han-Martial—occupied a certain number of posts in the Bureau. The Astronomical Bureau was no longer an institution that consisted of Han Chinese alone.

It is noteworthy that at this time the lowest-level position given to Bannermen was erudite. The prerequisite was excellent knowledge of both the Manchu and Chinese languages. No previous knowledge in mathematics or astronomy was required; yet Bannermen skipped the trainee stage—namely, the position of student astronomer—and became a Bureau official directly. Doubtlessly, a Banner official could become a capable mathematician during his long stay at the Astronomical Bureau, but that did not seem to be the main intention of the court. The court added Bannermen to the Bureau for to have the Han professional mathematicians closely watched over rather than to let Bannermen take over the Han officials' works.

However, the Qing rulers eventually found that spying on professional mathematicians' works would be an impossible task without mathematical knowledge. In October 1670, the Kangxi emperor reflected after the Calendar Dispute was mostly settled. He decreed,

³¹ SL 4:229; QHDSL GX 798:393

³² QHDSL GX 798:393.

Astronomy is critical [to the dynasty]. It is necessary to have proper people selected and to have them concentrate on studying so that they can completely master it. Select them from the public school students and have them study with Han student astronomers. If any of them is able to master [the knowledge of Astronomy], he can obtain one of the vacancies in the Astronomical Bureau by passing the examination. Relevant ministries should devise an exact scheme on how to select the students and to make them learn [mathematics]. Memorialize the conclusion to me.³³

The Kangxi emperor's decree shows his realization that merely installing Banner officials in the Astronomical Bureau could not solve the intellectual crisis or prevent it from happening again. Banner officials had to have sufficient mathematical knowledge before they could control the Astronomical Bureau. To stabilize Manchu rule, the imperial state had to have some Bannermen trained in mathematics. The emperor approved the ministers' deliberation that each Banner should select six Manchu and four Han-Martial public school students as student astronomers.³⁴ On September 8, 1676, the emperor even gave a specific decree that "in the case of transferring [from the Astronomical Bureau] to other ministries or bureaus, the post shall only be given to the learned one. Those unwilling to learn are absolutely prohibited from transferring out of the Astronomical Bureau."³⁵ Although five years later, the numbers of Banner student astronomers was reduced to two Manchu and one Han-Martial from each Banner, Banner student astronomers became a permanent fixture of the Astronomical Bureau.³⁶

Nonetheless, a Banner Bureau official's career path was different from that of a Han official. The key factor responsible for the difference is the administrative regulations based on different ethnic groups' career mobility. Since the earliest *Collected Statutes of the Great Qing* compiled in the Kangxi reign, the regulations for selecting Manchu and Han officials had been divided into in two separated chapters. The fact that the chapter regulating Manchu officials'

³³ IHP 278678-22.

³⁴ QHD KX 7749. Later the number of Han student astronomers was also reduced to eighty.

³⁵ IHP 091507.

³⁶ QHD KX 7750.

promotion is further divided into three sections—Manchu, Mongol, and Han-Martial—suggests that different ethnic groups followed distinct career ladders. Whenever a vacancy arose in an institution, the first thing to consider was the candidate's ethnicity. Talent and job performance certainly were important. However, a person only needed to compete with the candidates from the same ethnic groups. Figures 6 to 9 illustrate the possible career ladders for the officials of different ethnic groups as regulated in the *Collected Statutes*.

Comparing the career ladder of Han officials with that of the other three ethnic groups makes this important difference more obvious. Figures 6, 7, and 8 show that the career path of a Banner official—no matter if he was a Manchu, a Mongol, or a Han-Martial—transverses all three sections. For instance, in figure 8, a Han-Martial student astronomer from the Section of Heavenly Signs could become an erudite at the Calendar Section. After that, instead of becoming a manager at those two sections, he would become a manager at the Water Clock Section, a section he had no previous training in and that required a different set of knowledge. Similarly, figure 7 shows that every Mongol official began with the Calendar Section, and then the state-designed career path would bring him to the post of water clock manager. He would then become an observatory manager and finally the supervisor of the Five Offices at the Calendar Section.³⁷ In contrast, figure 9 shows that a Han official most likely would stay within the same section for

³⁷ Some exceptions existed. Ming'antu 明安圖 and Mingtu 明圖 were Mongols but they became vice directors and then directors.

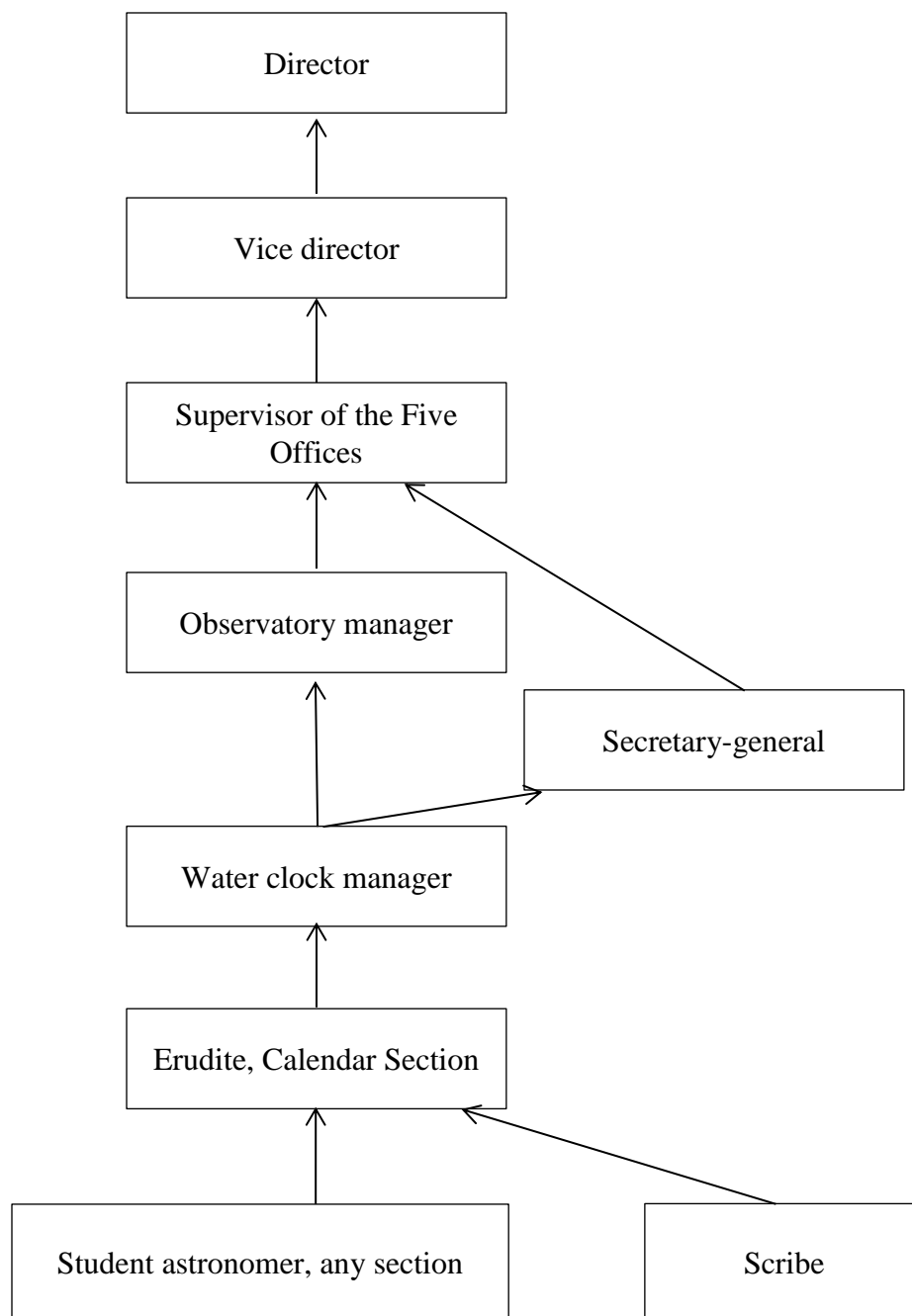


Figure 6. Career ladder for a Manchu official at the Astronomical Bureau.

Adapted from QHDSL GX 798:339–40.

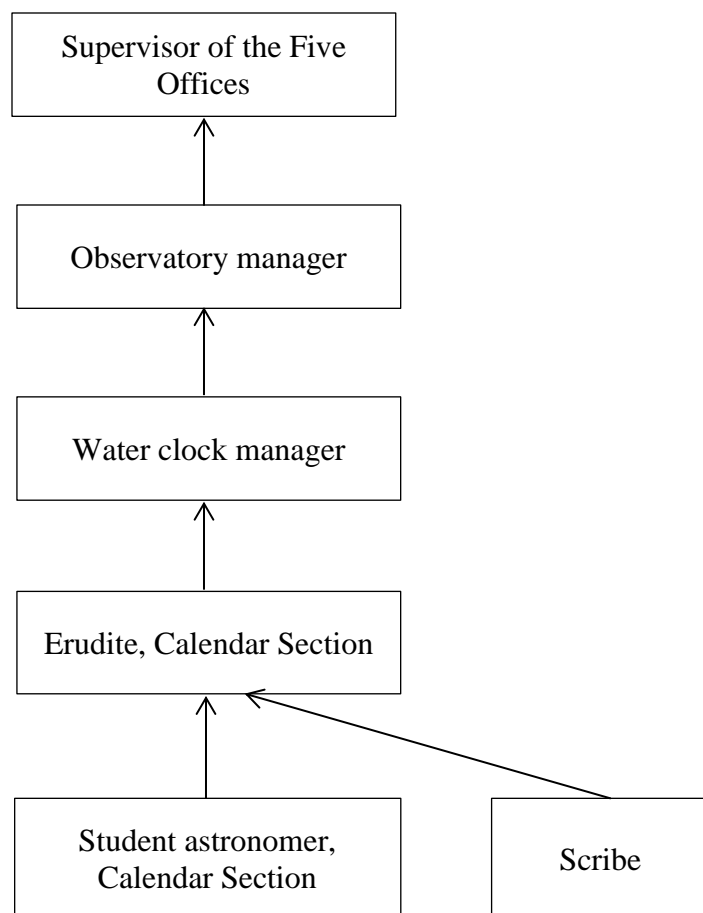


Figure 7. Career ladder for a Mongol official at the Astronomical Bureau.

Adapted from QHDSL GX 798:339–40.

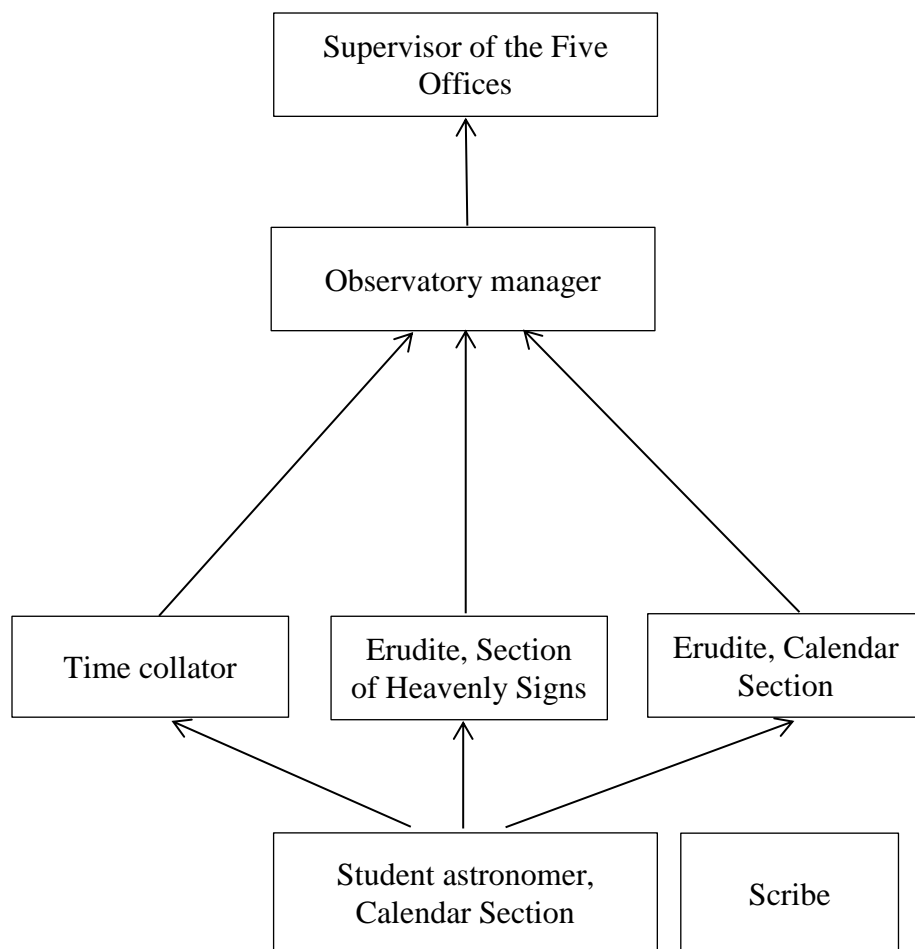


Figure 8. Career ladder for a Han-Martial official at the Astronomical Bureau.

Adapted from QHDSL GX 798:340.

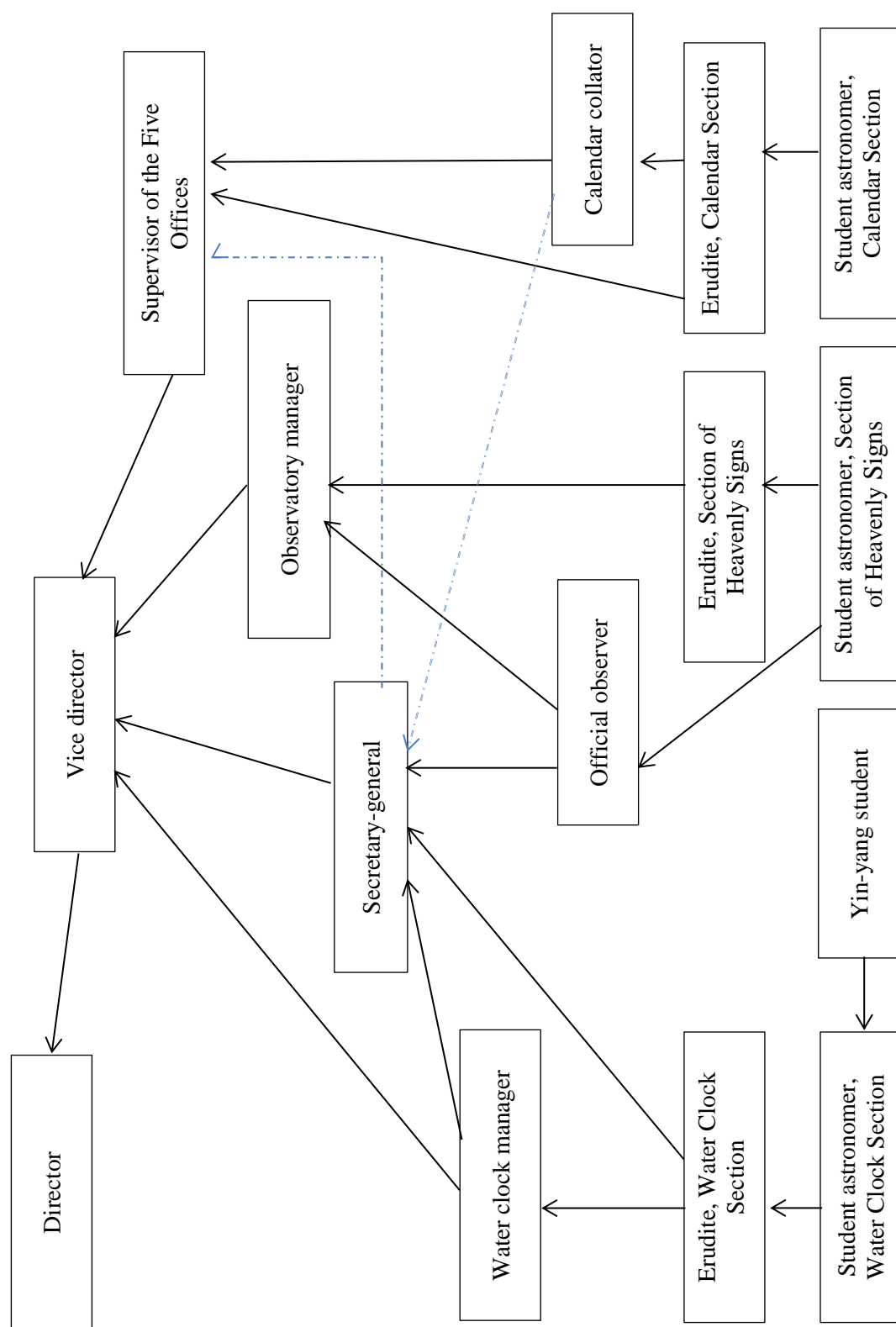


Figure 9. Career ladder for a Han official at the Astronomical Bureau.

Adapted from QHDSL GX 798:346–55.

the entire career life at the Astronomical Bureau.³⁸ The peculiar design of the career ladders suggests that the court did not expect Banner officials to acquire the same level of professional knowledge and skills as Han officials did.

The following case shows that the emperor's expectation of Banner officials' mathematical knowledge was indeed less strict than that of the Han officials. In 1689, the Ministry of Personnel nominated two candidates, Chang'e 常額 and Sanpao 三保, to the position of Manchu vice director. The Kangxi emperor decreed that they should take an examination. The examination had two parts: translation and calendar computation. Chang'e, the first candidate, scored poorly in both parts and his computation of an upcoming eclipse had a startling error of nine days. The Kangxi emperor therefore gave the vice directorship to the second candidate, Sanpao.³⁹ However, he did not punish Chang'e, then the supervisor of the Five Office, for his poor knowledge of calendar computation. Two years later, Chang'e became the vice director. By 1696, Chang'e was made the Manchu director and he remained this position until 1709.⁴⁰

Although after October 1670 Bannermen who entered the Astronomical Bureau had to start as student astronomers, the number of Banner student astronomers was significantly fewer than that of the Han student astronomers (see table 7). The Section of Heavenly Signs and the Water Clock Section each had only two Manchu student astronomers and no Mongols or Han-Martials. The Calendar Section, at first sight, appeared to have a sufficiently large number of Banner student astronomers. It had twenty Banner student astronomers and forty-three Han student astronomers. However, the quota of Banner student astronomers was equally divided

³⁸ It was possible for a secretary-general from the Water Clock Section or the Section of Heavenly Signs to become one of the supervisors of the Section of Calendar, but very few cases have been found.

³⁹ Zhongguo diyi lishi dang'an guan, *Kangxi qijuzhu*, 7.

⁴⁰ Qu, "Qingdai Qintianjian," 50–51.

Table 7. Posts, ethnic quota and civil service ranks

Title	Rank	Seats				Total
		Manchu	Mongol	Han-Martial	Han	
Director	5A	1			1	2
Vice director	6A	2			2	4
Supervisor of the Five Offices	6A				5	5
Supervisor of the Five Offices	6B	2	2	1		5
Observatory manager	7B	2	1	1	4	8
Secretary-general	8A	1			1	2
Water clock manger	8B	1	1		2	4
Calendar collator	9A				1	1
Official observer	9A				1	1
Time collator	9B			1		1
Erudite						
Calendar	9B	4	2	1	15	22
Heavenly Signs	9B				2	2
Water Clock	9B			1	7	8
Scribe		11	4	2		17
Student Astronomer						
Calendar		8	4	8	43	63
Heavenly Signs		2			31	33
Water Clock		2			6	8
Yin-yang student					10	10
Total		36	14	15	131	196

Source: QHDSL GX 798:325–58, 393–94.

among the eight Banners.⁴¹ Therefore, every Banner could only send one Manchu and one Han-Martial to be a student astronomer in the Calendar Section.

The small number of Banner student astronomers had two effects. First, working at the Astronomical Bureau might appear more attractive to Banner student astronomers because they, in general, did not have to wait as long as Han student astronomers did to become erudites. A successful Banner official could finish his service at the Astronomical Bureau while still young enough to begin a second career with greater prospects. Second, the limited quota given to each Banner made the formation of long-lasting hereditary mathematician families difficult. Even if a child of a Banner Bureau official had learned mathematics from his father, the Bureau might not have a position available for him. It would also be difficult for a Banner official to send several children to work for the Bureau and thus make being a professional mathematician a family craft.

The quota system placed upon Banner officials was kept until the end of the dynasty. It suggests that the court indeed expected Banner officials to oversee rather than take over Han colleagues' works. If Han professional mathematicians were encouraged to devote not just an individual but also a family to regenerate the knowledge and skills for the imperial state, Banner Bureau officials' duties were to oversee the Han professional mathematicians' loyalty.

4.3 Early Generations of the He Family

During the devastating Kangxi Calendar Dispute, one of the most influential hereditary mathematician families in the Qing period emerged. The He family was relatively insignificant in the Ming era and the Shunzhi reign. Some He family members, however, grasped the career opportunities presented in the Calendar Dispute and forever changed their family fortune. By

⁴¹ QHD KX, 7750.

Yongzheng times, the younger generation of the He family had become important court mathematicians.

This section describes how the early generations of the He family navigated the Calendar Dispute and distinguished themselves. Moreover, it shows that, after the Calendar Dispute, the Kangxi emperor continued to take advantage of the He family members' mathematical expertise to counterbalance Jesuit mathematicians' control of the Astronomical Bureau.

Compared to other old hereditary mathematician families, the He family did not have significant status in the Ming Astronomical Bureau. The surname He is not among the officials listed on the Ming Great Concordance calendar. Nor did it ever appear on the memorials collected in the *Books on Calendrical Astronomy of the Chongzhen Reign* (*Chongzhen lishu* 崇禎曆書) or the *Books on Mathematics According to the New Method* (*Xinfa suanshu* 新法算書). There is no record to show that the He family played any significant role in the late-Ming power struggle between the Great Concordance system and the New Method. In fact, the presence of the He family in the Ming Astronomical Bureau would be in question if the *Register of Capital Officials in the Shunzhi Reign* did not contain records of officials with the surname He.

According to the *Register*, He Qiyi 何其義 and He Luoshu 何雒書 began their services at the Bureau as student astronomers, and as of the third month of the second year of the Shunzhi reign—namely, April 1645—they were Calendar Section erudites.⁴² The third month of the second year of the Shunzhi reign was the time that all Astronomical Bureau officials re-registered their status as civil servants with the newly founded Qing dynasty. Considering the long period that student astronomers had to wait before advancing to erudites, He Qiyi and He Luoshu should have joined the Astronomical Bureau by the end of the Ming dynasty.

⁴² Wenxian congbian, 28:14–15.

The Qing court's adoption of the New Method could dishearten He Qiyi and He Luoshu. As colleagues of the Ming Astronomical Bureau, they spent years or even decades learning mathematical astronomy for making the state calendar. However, before they could use their knowledge to pursue higher rankings and fortunes, the Ming dynasty ended and the new Manchu rulers decided to adopt a completely different astronomical system. He Qiyi and He Luoshu did not lose their jobs after Schall's takeover, but their expertise became obsolete. The fact that their *Register* records were never updated suggests that they remained in the same position of erudite throughout the Shunzhi reign.

He Qiyi and He Luoshu took different approaches to counter career stagnation. It is not known how well He Qiyi learned the New Method, but it is reasonable to assert that he maintained a good relationship with Schall. He Qiyi endorsed Schall's *Response*. Furthermore, the *Response* shows that He Qiyi's civil service rank had been elevated to higher than an ordinary erudite, placing him at the same status as Schall's disciples Bao Yingqi 鮑英齊 and Jiao Yingxu 焦應旭.⁴³ Higher civil rank brought an official a slight increase in salary and food stipend. Although Schall seemed to advance only his own disciples to higher positions, he might have rewarded erudites such as He Qiyi for their cooperation by elevating their civil ranks.

On the other hand, He Qiyi's cooperation with Schall could not have been too close. He Qiyi remained an erudite during the Calendar Dispute.⁴⁴ His name was not seen among the supporters of the New Method in Yang Guangxian's purge (see table 6). Therefore, He Qiyi's relationship to Schall had not been good enough to let Yang consider him an adherent of Schall so he was to be demoted or ousted.

⁴³ Schall, *Minli puzhu*, 2–3.

⁴⁴ Qu, "Qingdai Qintianjian," 48.

He Qiyi's slow career advancement indicates his neutral attitude between rival factions. When the Jesuits again took leadership of the Astronomical Bureau in 1670, He Qiyi finally was elected calendar collator.⁴⁵ He earned this career advancement not because he supported any faction but because he stayed in the Bureau long enough. He Qiyi remained in this position without further advancement until his career ended around 1677.⁴⁶

He Luoshu, to the contrary, was hostile to Schall and the New Method. He Luoshu did not endorse the *Response*. Moreover, some historical records suggest that before the Jesuits' removal, Yang Guangxian and He Luoshu had been communicating. One of Yang's attacks on the New Method made in the famous treatise *I Have No Alternative* referred to He Luoshu's solar eclipse prediction, which had been calculated and illustrated according to the Great Concordance system (see figures 10, 11, and 12). Recall that Yang frankly admitted his ignorance of mathematical astronomy. If some insiders from the Bureau did not assist Yang in calculation and obtaining data, Yang could not even know how to calculate an eclipse prediction according to the Great Concordance system, not to mention how to compare it with the New Western Method.

⁴⁵ Ibid., 49.

⁴⁶ Ibid., 49–50.

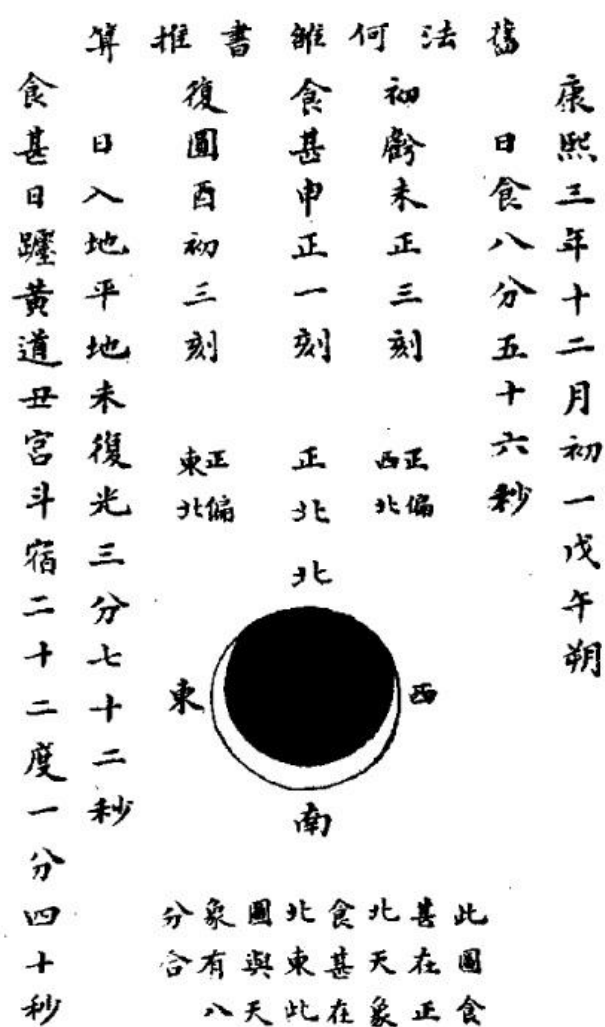
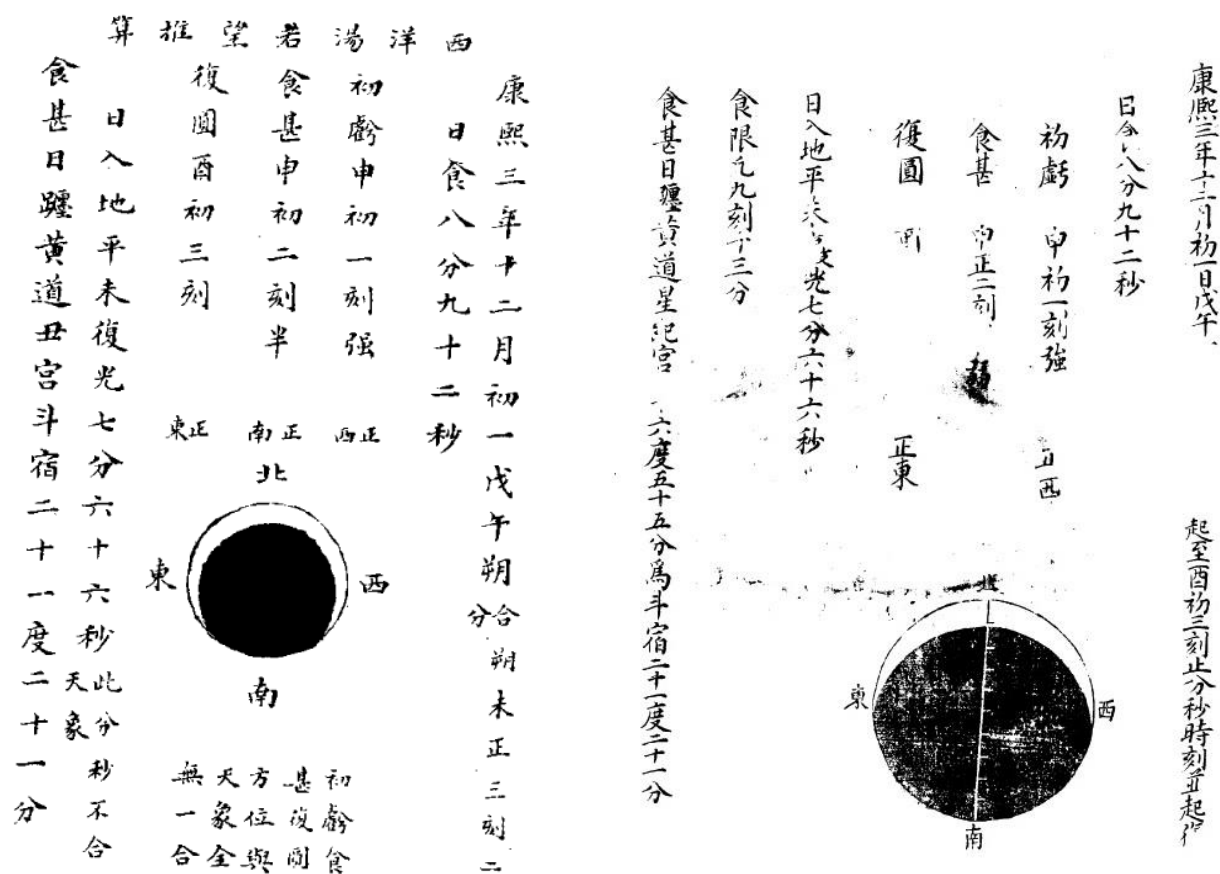


Figure 10. He Luoshu's prediction of the solar eclipse of January 16, 1665, in *I Have No Alternative*. The illustration was titled "Calculated by He Luoshu according to the Ancient Method." At the bottom Yang commented, "Eighty percent of this illustration agreed with celestial phenomenon."

Reprinted from *Tianzhujiao dongchuan wenxian xubian*, ed. Wu Xiangxiang (Taipei: Taiwan xuesheng shuju, 1964), 1251.



Reprinted from *Tianzhujiao dongchuan wenxian xubian*, ed. Wu Xiangxiang (Taipei: Taiwan xuesheng shuju, 1964), 1250 and IHP 155896.

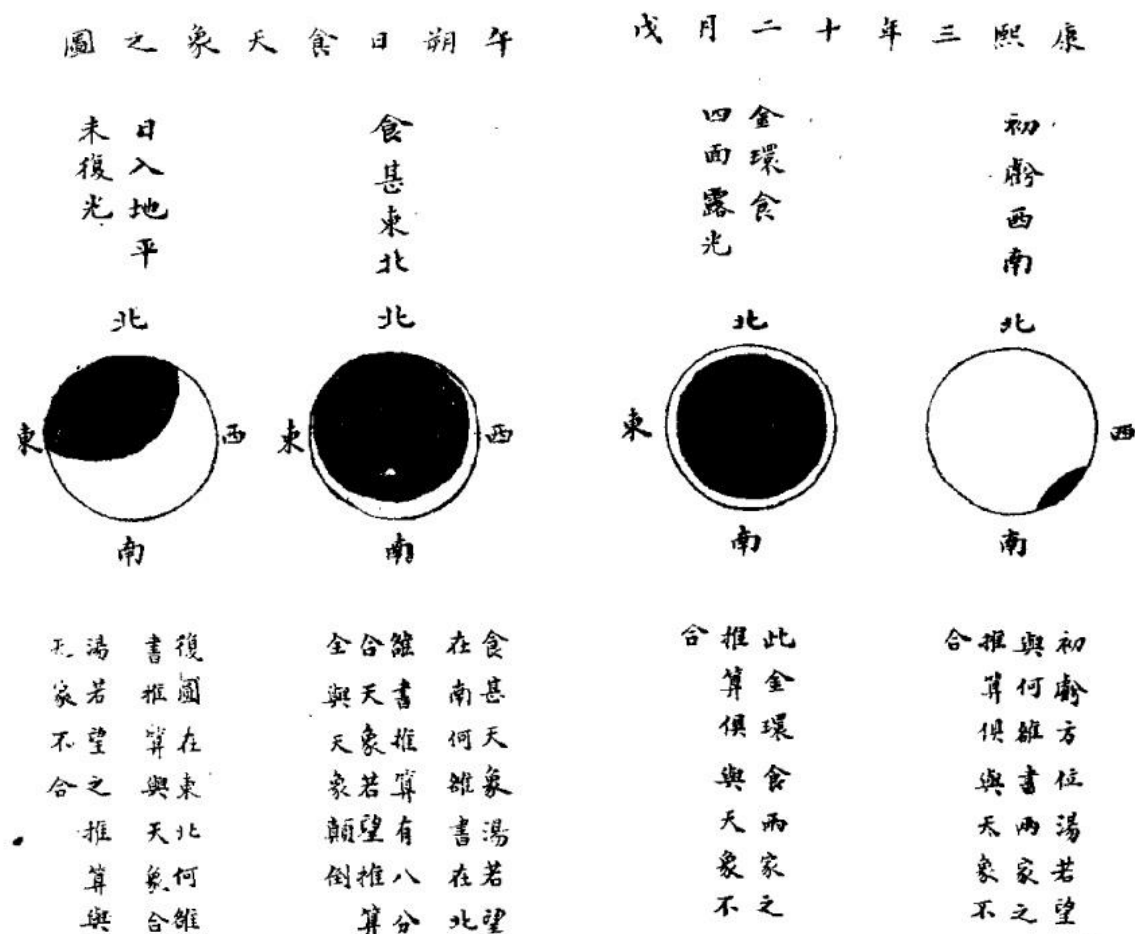


Figure 12. Yang Guangxian's observation of the solar eclipse of January 16, 1665. *Right to Left*: initial obscure, annular eclipse, maximum obscure, recover. Yang comments at the bottom of the first two eclipse phases that both Schall's and He's calculations disagreed with the observation results. For the third one, maximum obscure, Yang comments that He's prediction had 80 percent agreement with the observation result, while Schall's had none. For the last phase, Yang comments that He's prediction agreed with the celestial phenomenon, while Schall's did not.

Reprinted from *Tianzhujiao dongchuan wenxian xubian*, ed. Wu Xiangxiang (Taipei: Taiwan xuesheng shuju, 1964), 1252 53.

He Luoshu's alliance with Yang Guangxian brought him rewards in terms of career development. Soon after becoming the Bureau director, Yang Guangxian inspected the observatory with some high courtiers. Upon examining the sundial, Yang scolded Li Guanghong 李光宏, an erudite of the Section of Heavenly Signs, for having purposely manipulated the instrument to favor Schall's prediction. Yang said, "If the solar eclipse was measured on this tilted sundial, how would it be possible that Calendar Section Erudites He Luoshu and Ma Weilong 馬惟龍 did not lose [in the competition of predicting eclipses]?"⁴⁷ Within a year, Yang had demoted Li Guanghong and had discharged several erudites. Meanwhile, Yang elevated He Luoshu from erudite to fill one of the vacancies left by the beheaded supervisors of the Five Offices. In March 1669, the Kangxi emperor decided to reinstate the New Method and kicked Yang out of the Astronomical Bureau. He Luoshu, however, was not punished, and he remained the supervisor of the Summer Office until 1684.⁴⁸

While He Qiyi and He Luoshu illustrated how different choices could affect their careers, a more crucial figure to the future of the He family was He Junxi 何君錫. He Junxi's name was not in the *Register*. Therefore, Junxi, at best, was a student astronomer at the end of the Shunzhi reign. Historian Qi Han claims that He Junxi was Yang Guangxian's disciple based on a letter written by Antoine Thomas 安多.⁴⁹ However, judging from the fact that Yang had to use He Luoshu's calculation in his treatise and that he had testified that he "only knew the principles of calendar but not the mathematics of the calendar."⁵⁰ It is highly unlikely that Yang had taught He

⁴⁷ Ibid., 1282–83.

⁴⁸ Qu, "Qingdai Qintianjian," 49–50.

⁴⁹ Han Qi, "'Zili jingshen' yu lisuan huodong—Kang-Qian zhiji wenren dui Xixue taidu zhi gaibian ji qi Beijing" '自立精神'與曆算活動—康乾之際文人對西學態度之改變及其背景, *Studies in the History of Natural Sciences* 自然科學史研究 21, no. 3 (2002): 210–21.

⁵⁰ Wu, *Tianzhujiao dongchuan wenxian xubian*, 1264.

Junxi mathematics and calendar making. Instead, He Junxi might have entered the Bureau during the mass recruitment of student astronomers and erudites for re-establishing the Great Concordance system in 1666 because of He Luoshu's or He Qiyi's recommendation.⁵¹

Either way, Junxi's career advanced with surprising speed during the Calendar Dispute. In the annual calendar of 1671, He Junxi was listed as the supervisor of the Winter Office, in contrast with He Qiyi, who was listed lower as calendar collator.⁵² The timing of He Junxi's appointment as supervisor of the Winter Office easily leads to the assumption that he knew and supported the New Western Method. Indeed, except for He Junxi and He Qiyi, all the officials added to the calendar of 1671 had been purged by Yang. However, the following reveals that He Junxi was an adherent of the Ancient Method. Furthermore, it turns out that the New Western Method had not fully convinced the Kangxi emperor yet.

It is noteworthy that the Kangxi emperor did not completely lose interest in the Great Concordance system when the Calendar Dispute ended in 1669. Evidence supporting such an assertion is that the emperor let He Luoshu, who supplied Yang Guangxian his Great Concordance-calculated results in *I Have No Alternative*, remain the supervisor of the Summer Office. The Kangxi emperor's decision might be both political and intellectual. The Calendar Dispute stimulated the emperor's interest in mathematics, and he would eventually take mathematical lessons from the Jesuits. However, at this time the emperor probably was not confident enough to make a final choice between the New and Ancient Methods. Politically, as long as the adherents of the Great Concordance system did not become troublemakers like Yang

⁵¹ QHD KX 7749. One hundred Han student astronomers and two erudites were added to the Astronomical Bureau.

⁵² Qu, "Qingdai Qintianjian," 49.

Guangxian or Wu Mingxian, keeping them in the Astronomical Bureau could counterbalance the power of European mathematicians.

In March 1675, the emperor instructed Manchu Vice Director Antai 安泰 directly: “The Ancient Method shall not be abandoned. You can learn from He Junxi.”⁵³ That the emperor pointed to He Junxi instead of He Luoshu implies not only that Junxi had better knowledge of the Great Concordance system than anyone else in the Astronomical Bureau but also that the Kangxi emperor paid great attention to the Bureau staff. Beyond simply keeping Great Concordance experts employed in the Astronomical Bureau, the Kangxi emperor used them to initiate a new challenge to the New Western Method.

One year later, a timely solar eclipse became the test case. In March 1676, the Astronomical Bureau informed the emperor that a solar eclipse would take place on the first day of the fifth month.⁵⁴ Both Antai and Verbiest submitted their predictions. Antai’s prediction, calculated according to the Great Concordance system, predicted that more than half of the sun would be obscured during the eclipse. Verbiest’s New Method predicted the eclipse would barely be visible. On the first day of the fifth month, a verification observation was dutifully performed on the observatory. However, to both parties’ surprise, the result favored neither of them. The eclipse was clearly visible but far less reaching half the size of the sun. Neither system matched the observatory results well enough to win immediately. Since the late Ming period, eclipse observations were repeatedly held to compare the accuracy of the two methods. This one, however, was the most inclusive, not because the Great Concordance method was incorrect again but because the New Method prediction was undeniably inaccurate.

⁵³ Wu, *Qingguo shi*, 4:625.

⁵⁴ Wu, *Qingguo shi*, 4:625; SL 4:790.

Instead of waiting for another eclipse to compare the accuracy of the two methods again, the Kangxi emperor decided to accept Verbiest's explanation for the failure of the New Method prediction. Verbiest wrote in his memorial to the emperor:

The number deduced by the Ancient Method was wildly off target, but the New Method also appeared not completely close [to the observation] because of humidity. . . . Humidity can refract a small object into a larger one and make an object appear higher than its real position. . . . The thicker the humidity is, the larger the eclipse appears to be. The pre-calculated number cannot be as accurate as gel stuck to a column.⁵⁵

Neither the *Official History of the Qing* nor the *Veritable Records* mentions whether the supporters of the Ancient Method had provided any explanation; only the Verbiest explanation was recorded. The ability to explain away the prediction's failure rather than the accuracy of prediction itself seems to have won the Kangxi emperor's trust. After reviewing Verbiest's report, the emperor ordered "the relevant departments [to] learn this [explanation]."⁵⁶

Three months later, in August 1676, the emperor's final verdict ended the last hope of the Great Concordance system:

Previously, there were disputes over the rightness or wrongness of the New and Ancient Methods. Now the correctness of the New Method was already known. The Manchu officials in your bureau, who have the duty to study astronomy and calendar making, shall be particularly diligent. From now on, only those who study well will be granted promotion. Those who do not study will not be granted any promotion.⁵⁷

This was the least conclusive yet the last critical test performed. The final verdict clearly was political rather than scientific in nature. The He family was left to cope with the imperial verdict. The last time that the names of He Qiyi and He Luoshu appeared on the official calendar was in 1677 and 1685, respectively.⁵⁸ No further record about their later years has been found.

⁵⁵ SL 4:790.

⁵⁶ Ibid.

⁵⁷ SL 4:804.

⁵⁸ Qu, "Qingdai Qintianjian," 50.

He Junxi would continue in the Bureau for three more decades, but the Kangxi emperor made sure that he did not have a chance again to advocate the Ancient Method. In March 1688, He Junxi's rival, Acting Director Ferdinand Verbiest, died. Because the Kangxi emperor did not create a new office for Verbiest but let him use the quota reserved for Han Chinese, He Junxi legally had the right to succeed to the directorship. The Ministry of Rites put He Junxi on the list of nominations with Bao Yingqi 鮑英齊, a long-time adherent of Jesuit missionaries, and let the Kangxi emperor select between them. The emperor, however, chose neither; the seat of Han director went to another European missionary.⁵⁹ If the Kangxi emperor's choice meant only that he preferred a European director to a Han Chinese, the following incident demonstrates his determination to suppress He Junxi. Less than two months after Verbiest's death, the Han vice directorship became vacant, and He Junxi was again nominated to succeed the post. According to the records of April 10, 1688 in the *Imperial Diary*, the Kangxi emperor made specific comments with respect to He Junxi in front of several grand ministers.

The Ministry of Personnel memorialized regarding the vacancy left by the vice director of the Astronomical Bureau, Li Guanghong. The Ministry nominated He Junxi to fill that vacancy. The emperor decreed, "Previously I had He Junxi come to the palace and calculate a solar eclipse. Attempting to meddle, he absurdly presented to me a result calculated according to the Ancient Method that the eclipse magnitude would be three *fens* [three-tenths of the diameter]. I know everything about the New and Ancient Methods, and I knew that his result was wrong. Therefore, I sent people to every place to observe the eclipse. According to current regulations, there is no need to submit a routine memorial if an eclipse is less than two *fens* [two-tenths of the diameter]. Indeed, after the eclipse, nobody memorialized me. From this incident, I know he is unbearable. Find another person for this post."⁶⁰

⁵⁹ Wu, *Tianzhujiao dongchuan wenxian xubian*, 1739–40.

⁶⁰ *Zhongguo diyi lishi dang'an guan, Kangxi qijuzhu*, 1747. See Glossary A.2 for the terminology related to eclipse.

The emperor's words diminished He Junxi's any hope of making further career advancement. He remained a supervisor of the Calendar Section for the rest of his career at the Astronomical Bureau and never advanced beyond that position.

In the long run, He Junxi's career setback was temporary to the family fortune. He Luoshu and He Junxi lost the battle of advocating the Great Concordance system of calendar making, but they won for themselves and their family higher positions in the Astronomical Bureau. More importantly, He Junxi had impressed the Kangxi emperor with his mathematical expertise. The next chapter will show, when the political tide turned against the Jesuits in later years, He Junxi's sons who inherited his mathematical talent would become imperial favorites and would push the whole family to a more prosperous status.

Chapter 5

Emperors and the He Brothers

In 1713, the Kangxi emperor invited senior civilians from all over the country to Beijing to enjoy a series of festivals in celebration of his sixtieth birthday. According to *The First Collection of the Imperial Birthday Ceremony* (*Wanshou shengdian chuji* 萬壽盛典初集), in which the proceedings of the birthday celebration were recorded in detail, among the guests sitting in the first row of the emperor's celebratory banquet was one seventy-year-old official from the Astronomical Bureau called He Junxi 何君錫.¹ He Junxi spent his entire life working for the Astronomical Bureau, and he had reached the highest position in the Calendar Section four decades earlier.² However, because the Kangxi emperor did not appreciate He's passion for the Ancient Method—namely, the Great Concordance system of calendar making—he never advanced into the Bureau directorate.

In contrast to He Junxi's stagnant career, imperial grace was currently shining on his sons. *The First Collection of the Imperial Birthday Ceremony* mentions three of He Junxi's sons: He Guozhu 何國柱, He Guozong 何國宗, and He Guodong 何國棟. One paragraph describes a special envoy to Joseon 朝鮮 (1392–1897) for which Calendar Collator He Guozhu was one of the members handpicked by the emperor.³ In another section, “Praises Written by Courtiers of the Studio for Cultivating the Youth (*Mengyangzhai* 蒙養齋),” He Guozong, a Hanlin Academician 翰林院庶吉士, and He Guodong, a Provincial Graduate (*juren* 舉人, “elected

¹ Wang Shen 王掞 et al., *Wanshou shengdian chuji* 萬壽盛典初集, SKQS 653:196–99.

² Qu, “Qingdai Qintianjian,” 49.

³ Wang et al., *Wanshou shengdian*, 653:174.

person”), presented their poetry.⁴ In the last decade of the Kangxi reign, the emperor himself led a team of young mathematicians to work on the assimilation of Western mathematical sciences. Guozhu, Guozong, and Guodong were among the earliest and principal members of that team. By the end of the Kangxi reign, the He brothers had started to show promise in their careers and the future of the He family could not seem brighter. If the career stagnation had ever disheartened He Junxi, the Kangxi emperor’s appreciation of his sons’ mathematical talent might have been a considerable source of comfort in the last few years of his life.

This chapter analyzes the power interaction between the monarch and the hereditary mathematician families.⁵ There is no doubt that such an interaction was mostly controlled by the monarch, and as such the mathematician families had to cater their specialty to suit the monarch’s need. Nonetheless, this chapter intends to show that in addition to individual talents, family background was a significant contributing factor to a monarch’s selection of his servants. Family was such a critical factor that a person’s career development not only depended on his own talent but also was strongly affected by his familial relations.

This chapter begins with an analysis of the imperial mathematical project in the last decade of the Kangxi reign. Through the mathematical project, a new generation of the He family won the Kangxi emperor’s attention due to the talent, reliability, and loyalty that they had inherited from the older generation. The chapter then proceeds to examine how the Kangxi emperor shaped the He brothers’ careers to suit his plans to strengthen imperial mathematics and train a new group of young Chinese mathematicians. The second half of the chapter turns to an investigation of the Yongzheng emperor’s manipulation of the He family members in particular

⁴ Ibid., 654:480–82.

⁵ See Jonathan D. Spence, *Ts’ao Yin and the K’ang-hsi Emperor: Bondservant and Master* (New Haven: Yale University Press, 1988) for the example of a bondservant family Cao 曹, which rose to its heyday during the late Kangxi period yet fell after the Yongzheng emperor came to the throne.

and the administration of the Astronomical Bureau in general. It shows that the Yongzheng emperor's fear of factionalism allowed him to limit the expansion of the He family and impede the development of the Guozhu brothers' careers.

5.1 Imperial Empowerment

The Kangxi emperor's favor toward the Jesuits declined after the mid-1700s. To a large part, the success of Jesuit China mission during the late Ming and early Qing periods was due to the contribution of the Rules of Matteo Ricci 利瑪竇規矩, who interpreted the sacrifices to ancestors as social rites that were wholly compatible with Christianity. However, not all missionaries agreed with such an interpretation, and the debates that were prevalent in China and Europe gradually evolved into the Rites Controversy 禮儀之爭. In 1704, the papal court decided to forbid the Chinese rites and sent a legate to communicate this decision to the Kangxi emperor and Chinese Christians. The Kangxi emperor met with the papal legate several times between 1705 and 1706, but he was so irritated by the papal decree that the papal legate was expelled. This incident greatly undermined the emperor's trust in the Catholic mission and even the court Jesuits.⁶ In a secret meeting that took place in November 1706, the Kangxi emperor told two of his closest courtiers, Li Guangdi 李光地 and Xiong Culü 熊賜履,

Did you know that the Westerners have become troublemakers? They even condemned Confucius. The reason that I have been treating them well is merely to utilize their skills. The calendric and mathematical skills [introduced by the Westerners] are indeed great. You both are scholars. When meeting with local officials and those who can understand the reasons, let them know my true intention.⁷

⁶ Jami, *Emperor*, 253–55.

⁷ Li Guangdi 李光地, *Rongcun yulu; Rongcun xu yulu* 榕村語錄 榕村續語錄, ed. Chen Zuwu 陳祖武 (Beijing: Zhonghua shuju, 1995), 643.

The Kangxi emperor had employed the Jesuits to make the state calendar for more than three decades, and he had personally acquired sufficient mathematical knowledge from them. He studied intensively under Verbiest's direction for more than five months in 1675⁸ and then from 1690 to the mid-1690s, under the mentorship of Joachim Bouvet (Chinese name Bai Jin 白晉, 1656–1730) and Jean-François Gerbillon (Zhang Cheng 張誠, 1654–1707), Antoine Thomas (An Duo 安多, 1644–1709), and Tomás Pereira (Xu Risheng 徐日升, 1645–1708).⁹ The Kangxi emperor was famous for his interest in personally carrying out astronomical observations. However, his growing suspicion of the Jesuits may well have motivated his interest in verifying the astronomical calculations they had produced.

By mid-1711, the Kangxi emperor's suspicion had turned into anger when he found that the Jesuits had attempted to cover up mistakes that they had made in calculating the summer solstice.¹⁰ In response to a palace memorial submitted by Director Philippus Maria Grimaldi (Min Mingwo 閔明我, 1639–1712,) and Vice Director Bernard-Kilian Stumpf (Ji Lian 季理安, 1655–1720) on June 27, 1711, that sought to explain why the emperor's calculation and observation did not match the Astronomical Bureau's, the Kangxi emperor angrily wrote, "How despicable you are!"¹¹ The emperor did not keep the anger and distrust to himself. In September 1711, after reading a palace memorial submitted by Hesu 和素, who had been in charge of delivering the communication between the emperor and Jesuit missionaries, he warned, "Nowadays the Westerners' words have become inconsistent. All of you shall take precautions

⁸ Jami, *Emperor*, 75–78.

⁹ Ibid., 139, 141–44, 180.

¹⁰ Zhongguo diyi lishi dang'an guan 中國第一歷史檔案館, ed., *Kangxichao Manwen zhupi zhouzhe quanyi* 康熙朝滿文朱批奏摺全譯 (Beijing: Zhongguo shehui kexue chubanshe, 1996), 723, 724, 1675.

¹¹ Ibid., 1675.

on them.”¹² On November 25, 1711, Grimaldi requested the emperor to permit him to retire due to his old age. Although most Astronomical Bureau directors remained in their posts until they died and Grimaldi was once a trusted courtier, the Kangxi emperor immediately approved the old man’s request.¹³ In what was likely a gesture of warning to the Jesuits, the Kangxi emperor publically commented on the incident of the summer solstice:

I have constantly paid attention to astronomy and the method of calendar making. The principles of the Western system are correct, but in the long run, detailed measurements are bound to have some errors. This summer solstice, the Astronomical Bureau memorialized me that it [the calculated prediction] would occur at the seventh *ke* of the *wu* hour 午正三刻. I carefully measured the sun’s shadow and [the summer solstice] was three *ke* and nine *fen* of the *wu* hour 午初三刻九分. At this moment, the error is little, but I am afraid that several decades later, the accumulated error will become excessive. . . . This point indeed was proved, and it is not like the compositions written by scholars that shrink away from responsibility by empty words. Now, let us wait and see how the coming winter solstice will be.¹⁴

It is unknown how well the Jesuits’ prediction of the winter solstice satisfied the Kangxi emperor; however, by the end of the next winter, the Kangxi emperor had begun to take the whole issue of ensuring the imperial state had a reliable supply of mathematical knowledge into his own hands.

Between late 1711 and 1713, the Kangxi emperor organized a new group of mathematicians. He ordered the Ministry of Rites to hold special examinations to recruit court mathematicians, who later were referred to as members serving in mathematics (*xiaoli suanfa ren yuan* 效力算法人員).¹⁵ There are not enough historical records to provide a clear understanding of exactly how many times the examinations were held and what the content of these examination were. Nonetheless, according to the statement on a résumé written by an

¹² Ibid., 741.

¹³ Kugena 庫勒納 et al., *Qingdai qijuzhuze, Kangxi chao* 清代起居注冊, 康熙朝 (Taipei: Lianjing chubun, 2009), T10998.

¹⁴ Ibid., T11004–5.

¹⁵ Wu, *Qingguo shi*, 4:625–26.

official who had passed the examination, the first examination probably took place in April 1712.¹⁶ *The First Collection* also suggests that the scale of the recruitment was larger than that of the entrance examinations held by the Astronomical Bureau. A drawing in *The First Collection* illustrating the process of the imperial parade shows that a long list of candidates who had passed the examination of members serving in mathematics was displayed on the street while members serving in mathematics gathered at a temple to pray for the emperor's longevity (see figure 13).¹⁷ The drawings suggest that the Kangxi emperor's favor of the newly recruited members serving in mathematics was well known among his courtiers and that they were given a notable spot in the birthday celebration.

In addition to holding public examinations, the Kangxi emperor also recruited mathematicians through his courtier's personal network. For instance, as a result of Li Guangdi's recommendation, the Kangxi emperor summoned Chen Houyao 陳厚耀 (1648–1722) to Beijing in early 1709.¹⁸ Mei Juecheng 梅穀成 (1681–1764), a grandson of Mei Wending 梅文鼎 (1633–1721), the famous mathematician of the Qing period, was also summoned to join the group of members serving in mathematics in July 1712.¹⁹

The Kangxi emperor's personal involvement in the process of recruiting and training members serving in mathematics greatly elevated their social status. When the first examination took place, the Kangxi emperor personally tested the examinees and chose forty-two of them as members serving in mathematics.²⁰ To attend a test that was personally administered by the

¹⁶ QGLL 13:532.

¹⁷ Wang et al., *Wanshou shengdian*, 653:598.

¹⁸ Jami, *Emperor*, 257–59.

¹⁹ Zhongguo diyi lishi dang'an guan 中國第一歷史檔案館, ed., *Kangxichao Hanwen zhupi zhouzhe huibian* 康熙朝漢文硃批奏摺彙編 (Beijing: Dangan chubanshe, 1985), 4:323.

²⁰ Wu, *Qingguo shi*, 4:626.

monarch was an honor similar to attending the final stage of the civil service examination, in which the monarch chose the essay questions and decided the ranks of those admitted. This process built a symbolic teacher-student relationship similar to that between the emperor and

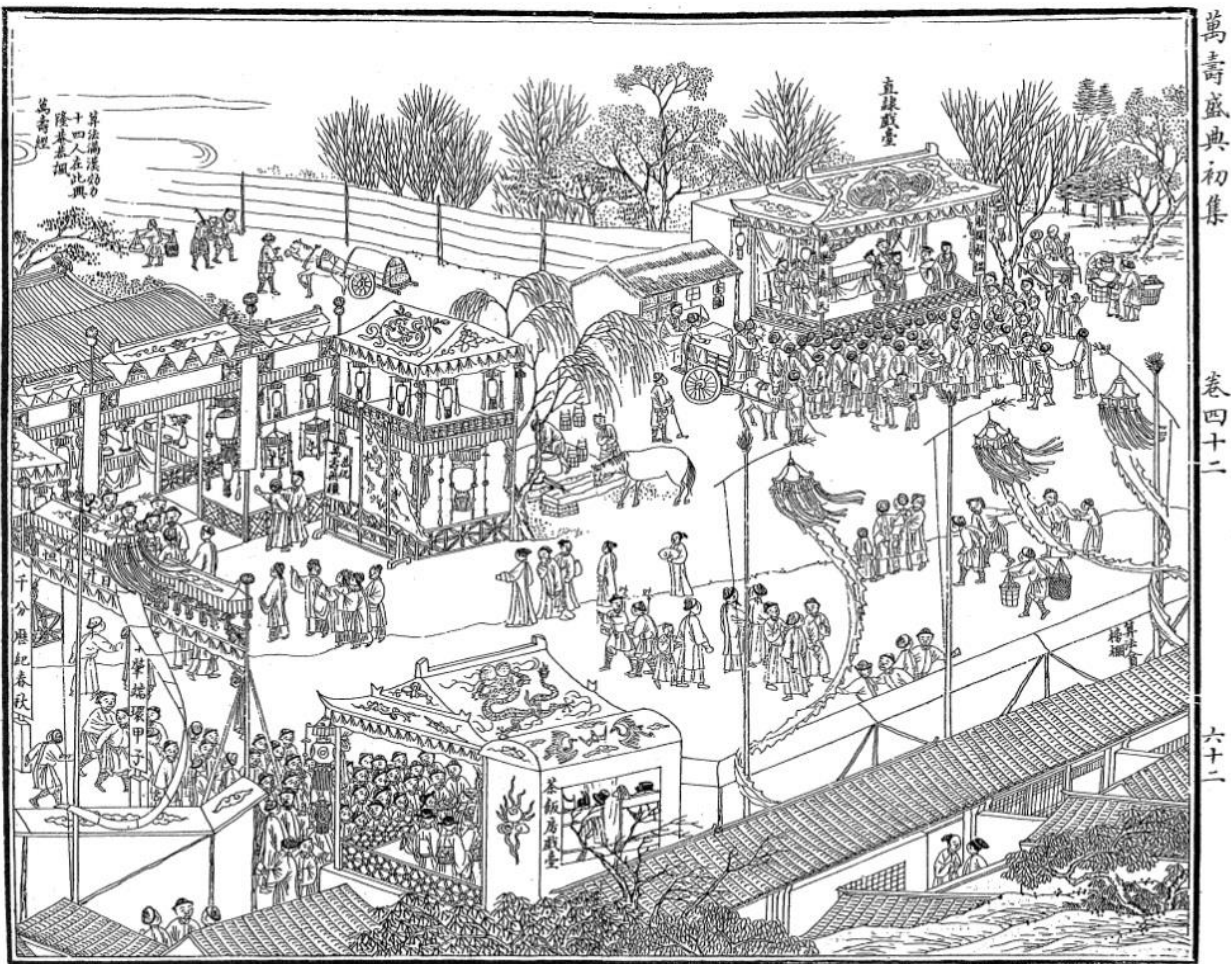


Figure 13. Members serving in mathematics in The First Collection of the Imperial Birthday Ceremony.

Reprinted from Wang Shan 王掞 et al., *Wanshou shengdian chuji* 萬壽盛典初集, SKQS 653:598.

successful candidates of the examination. In the case of members serving in mathematics, as shown in the following discussion, the Kangxi emperor was indeed personally involved in their education and training.

In the summer of 1712, the emperor brought a small group of mathematicians to the Chengde Summer Palace 承德避暑山莊.

In the fifth month of the fifty-first year [June 1712], the emperor went to the Summer Palace. Chen Houyao, a prefecture professor, Guozhu and Guozong, sons of the supervisor of the Five Offices of the Astronomical Bureau He Junxi, Ming'antu, a public school student chosen by imperial order, and Chengde 成德, the former vice director of the Astronomical Bureau, were ordered to go with him.²¹

In Chengde, the Kangxi emperor personally directed their mathematical training and chose mathematical treatises from his own collection as their study materials. He even allowed them to ask him questions directly, just as students would interact with their common teachers. Such an intimate teacher-student relationship gave them a prestigious status. In later times, these mathematics disciples always took the opportunity to mention in their autobiographies and résumés that they had been “chosen and taught” 指授 by the Kangxi emperor.

After gathering enough mathematicians around him, the Kangxi emperor formally began his project of compiling mathematical treatises. In 1713, the Kangxi emperor commended his third son, Prince Cheng 誠親王 (Yunzhi 允祉, 1677–1732), to begin compiling treatises on music and mathematics at the Studio for Cultivating the Youth (*Mengyangzhai* 蒙養齋). The compilation team consisted of members serving in mathematics. The emperor regularly took interest in the contents of the treatises in compilation and continued to enjoy teaching his

²¹ Ibid.

students. As late as March 1719, a special examination was still held to recruit additional members for compiling the treatises.²²

In July 1722, the compilation project was finished. The output was a mathematical encyclopedia, the *Origins of Mathematical Harmonics and Astronomy* (*Luli yuanyuan* 律曆淵源), which was composed of three treatises: *Thorough Investigation of Astronomical Phenomena* (*Lixiang kaocheng* 曆象考成), *Essential Principles of Mathematics* (*Shuli jingyun* 數理精蘊), and *Exact Meaning of the Pitch-pipes* (*Lulu zhengyi* 律呂正義).²³ The first two treatises would become the guidebook and textbook used in the Astronomical Bureau. The Kangxi emperor appeared to be very pleased with the accomplishments made by the project team. Therefore, he joyfully promised that he would write a preface for the treatise.²⁴ Moreover, the emperor instructed that special rewards should be given to members serving in mathematics:

They were all chosen by me. I ordered them to learn mathematics and to work in the inner court. They were different from those serving at the outer-court offices. Moreover, the office of compiling mathematics treatises was very strict. Whoever worked there had to be very diligent. Grade the members listed on the memorial according to their contribution and report back to me.²⁵

Although the Kangxi emperor passed away before he finished the preface of the *Origins of Mathematical Harmonics and Astronomy*, he left his successors a group of trained mathematicians and a set of new mathematics textbooks for the Astronomical Bureau. From then on, the staff members of the Astronomical Bureau did not have to learn directly from the Jesuits. Instead, they were able to learn from the *Thorough Investigation of Astronomical Phenomena* and the *Essential Principles of Mathematics* and claim the intellectual lineage from the Kangxi

²² Ibid.

²³ Ibid.

²⁴ Ibid., 4:626–27; SL 10:1197–99.

²⁵ QHD YZ 261–63.

emperor instead of the Jesuits. The Jesuits still occupied some seats in the Bureau directorate, but they became the colleagues of Han and Banner officials as opposed to their teachers.

5.2 *A Promising Start for the He Brothers*

The compilation project led by the Kangxi emperor in the last decade of his rule changed the lives of many individuals and their families. One such transformation can be seen in the example of He Junxi's family. This section explores the lives of three of He Junxi's sons—Guozong 國宗, Guozhu 國柱, and Guodong 國棟—and uses their stories to illustrate the possible career outlooks afforded to descendants of mathematician families.

He Junxi was a well-learned professional mathematician at the Astronomical Bureau. However, he was barred from the Bureau directorship because he had a history of supporting the Great Concordance system. He remained a Calendar Section supervisor until his death in 1714.²⁶ Unlike in the Ming era, the descendants of the Qing Astronomical Bureau mathematician families could take any profession they liked. Preparing descendants for the career of a professional mathematician was thus more of a choice than an obligation or mandate. It is quite understandable that, considering his own stagnant career, He Junxi would not want to tie his family's future completely to the Astronomical Bureau. Although he had taught Guozong and his brother mathematics in their youth, Junxi sent only Guozhu to the Astronomical Bureau and let Guozong and Guozhu pursue careers as regular government officials by taking the civil service examinations. If the Kangxi emperor had not wanted to cultivate a group of Chinese mathematicians and had subsequently noticed their mathematical talent, Guozong and Guozhu's whole careers probably would not have had any connection with mathematics.

²⁶ See section 4.3.

He Guozong was the most successful member of the He family. During a civil service career that lasted fifty years, he served three emperors as a high-ranking court official. Although Guozong never became one of the inner-court high ministers who assisted the emperors in making critical political decisions, his specialty in mathematics continued to win the emperor's attention. Projects involving a geographical survey, for instance, were one important area in which the emperors had a use for He Guozong's mathematical knowledge. The Yongzheng emperor sent him to inspect flooding in the Grand Canal and Yellow River, and the Qianlong emperor sent him to produce a map of the newly conquered Xinjiang.²⁷ He Guozong's most indisputable value to the court was his administration of the publication of the imperial mathematical treatises. With the exception of the treatises written by the Jesuits, most early Qing official compilation projects of mathematical works were under He Guozong's supervision. He Guozong's excellent mathematical knowledge was undoubtedly the biggest contributory factor to his successful career.

However, He Guozong's original career goal was not related to mathematics. He did not intend to inherit Junxi's profession as an official mathematician at the Astronomical Bureau. According to the *General History of the Capital Region* (*Jifu tongzhi* 畿輔通志), He Guozong obtained the degree of Provincial Graduate in 1708, when he was merely twenty-two years old.²⁸ Within the three-level civil service examination system, passing the middle-level examination and obtaining the Provincial Graduate degree was a critical achievement. At such a young age, Guozong had plenty of opportunities to pass the top-level examination and set his goal to become a high courtier. Even if he failed, he could still become a magistrate or county professor.

²⁷ SL 7:520; SL 15:150.

²⁸ Li, *Jifu tongzhi*, SKQS 505:606. He Guozong's age is calculated from his own statement that he was sixty-one years old in April 1747. See IHP 023912-001.

Either way, Guozong could bring more fame and income to his family by staying in the system of regular civil servant than working for the Astronomical Bureau. On the other hand, because preparing for the civil service examination was tremendously demanding, it is highly unlikely that He Guozong had the time or energy to work at the Astronomical Bureau in his early years. Indeed, no record ever mentions that He Guozong had spent his youth studying or working at the Astronomical Bureau.

Guozong's training and accomplishment in the civil service examination gave him access to an extended social circle and afforded him a more prestigious status than those who spent their entire working lives in the Astronomical Bureau. For instance, perhaps Guozong developed his talent of calligraphy while preparing for the civil service examination and became a famous calligrapher. Mei Yi 梅鈞, son of mathematician Mei Juecheng, was known to have learned calligraphy from He Guozong.²⁹ He Guozong status gave him the opportunity to learn calligraphy from Zhang Zhao 張照 (1691–1745), a grand minister and one of the most famous calligraphers during the Qing period, and to build up their friendship.³⁰ Such friendship not only was helpful to He Guozong's career in the Qianlong period but also passed on to their descendants. He Guozong's daughter, who was the wife of the seventieth generation Duke Yansheng 衍聖公, married her daughter to Zhang Zhao's son, Zhang Yingtain 張應田.³¹

Guozong's career had progressed in a different direction by May 1712. In April 1712, the Kangxi emperor and his high ministers went through a long process of choosing Metropolitan

²⁹ Lifan Fang 李放, ed., *Huangqing Shushi* 皇清書史, Liaohai Congshu 遼海叢書 (Shenyang: Liaoningsheng xinhua shuju, 1985), 5:1454.

³⁰ Zhao, *Qingshigao*, 13889.

³¹ Kong Qingyu 孔慶餘, ed., *Kongshi dazong zhipu* 孔氏大宗支譜 (Qufu, 1873), accessed October 2014, <https://familysearch.org/pal:/MM9.3.1/TH-1961-32134-1433-71?cc=1787988&wc=SKY9-VZ2:1023275501,1021934502,1021935202,1021961401,1023344401>. In the Qing era, the direct descendant of Confucius inherited the title of Duke Yansheng.

Graduates (*jinsshi* 進士) degree candidates.³² However, after diligently reading hundreds of examination essays written by Provincial Graduates, the emperor still felt that he had not found enough well-qualified candidates. He ordered the ministers to recommend and to re-examine the failed essays, “particularly those written by the Provincial Graduates working at the book compilation departments for some of them were very knowledgeable.”³³ The purpose of the civil service examination was, after all, not to reward the best scholars but to select government officials who could best serve the emperor’s needs. Therefore, it was perhaps through recommendations from courtiers like Li Guangdi, who knew the Kangxi emperor’s intention to recruit a group of mathematicians and who had been closely involved in the process of grading the essays and choosing candidates, that He Guozong was given a special permission to take the palace examination 殿試 alongside the other candidates.³⁴ Guozong successfully passed the palace examination and earned the Metropolitan Graduate degree. Soon the emperor granted him more honor by admitting him to the Hanlin Academy 翰林院.³⁵

He Guozong was one of the earliest members serving in mathematics to receive honorable treatments in obtaining the civil service degrees. Such an imperial honor indicates that the Kangxi emperor had decided to groom He Guozong to become one of the core members of mathematical projects and thus might not want him to spend further effort in preparing for the civil service examination. After Guozong, Mei Juecheng was given the honorable Provincial Graduate degree in 1713 and then the Metropolitan Graduate degree in 1715.³⁶ Wang Lansheng 王蘭生 (1679–1737), a young mathematician and disciple of Li Guangdi, was also awarded the

³² Kugena, *Qingdai qijuzhu*, T11301–34.

³³ *Ibid.*, 11332.

³⁴ Li, *Jifu tongzhi*, SKQS 505:501; SL 6:473.

³⁵ SL 6:475.

³⁶ Wu, *Qingguo shi*, 6:501.

Provincial Graduate degree in 1713. Despite the fact that Wang failed the metropolitan examination in 1721, the Kangxi emperor allowed him to take the palace examination directly.³⁷ Both Mei Juecheng and Wang Lansheng passed the palace examination and became Hanlin Academicians 翰林院庶吉士. Unlike other members serving in mathematics who gained a temporary favorable status from the Kangxi emperor's personal empowerment, the high civil service degree ensured that He Guozong benefitted from a far better and more powerful career starting point, which afforded him many more chances to navigate the bureaucratic system. When the Kangxi emperor formally commenced the project of compiling the *Origins of Mathematical Harmonics and Astronomy*, he placed He Guozong right under Prince Cheng and above all the other members serving in mathematics.³⁸ He Guozong became the leader of the group of imperial mathematicians.

He Guozhu 何國柱, another son of He Junxi, was also a mathematics disciple of the Kangxi emperor. Due to the scarcity of surviving documents, much of Guozhu's life is the subject of speculation. Guozhu's name first appears on records that describe the Kangxi emperor's summer retreat to Chengde in 1712, in which he and Guozong were referred to as "sons of the supervisor of the Five Offices of the Astronomical Bureau."³⁹ Because Guozhu's name precedes that of Guozong, perhaps Guozhu was older than Guozong. However, Guozhu's name does not appear among the degree holders listed in the *General History of the Capital Region*. This means that even if Guozhu had studied for the civil service examination, he did not become a degree holder like Guozong. More likely Guozhu had chosen to follow in his father's

³⁷ Ruan, *Chouren zhuan*, 719.

³⁸ SL 6:524.

³⁹ The same description about Guozhu and Guozong can be seen in Zhao, *Qingshigao*, 1668.

footsteps to become a professional mathematician and had started working at the Astronomical Bureau in his youth.

Several pieces of evidence suggest that He Guozhu had distinct talent and ability. First, it is worth noting that Guozhu was not the only member of the He family who worked at the Astronomical Bureau around 1712. For instance, He Guochen 何國宸, another son of He Junxi, states in his official résumé that he became a student astronomer in 1704 and then a Calendar Section erudite in 1710.⁴⁰ The fact that the Kangxi emperor picked Guozhu, not Guochen, to go to the Summer Palace suggests that Guozhu possessed mathematical ability superior to that of his brothers. Second, both the annual calendar published in 1713 and *The First Collection* list He Guozhu as a calendar collator.⁴¹ Therefore, besides years of qualified work at the Astronomical Bureau, Guozhu must have successfully demonstrated his mathematical knowledge in calendar making to be awarded the post of calendar collator in 1712.⁴² Third, according to the description of the special envoy to Joseon in *The First Collection*, Guozhu was a calendar collator of civil service rank five, an unusually high rank equivalent to that of the Astronomical Bureau director.⁴³ There is no known historical record to explain how He Guozhu acquired his rank. However, it is reasonable to assert that his professional performance greatly exceeded requirements.

The envoy to Joseon is worthy of further analysis. The *Veritable Records of the Joseon Dynasty* 朝鮮李朝實錄 states that having a calendar collator included in the envoy was

⁴⁰ QGLL 11:453.

⁴¹ Wang et al., *Wanshou shengdian*, 653:174.

⁴² Qu, “Qingdai Qintianjian,” 52.

⁴³ Wang et al., *Wanshou shengdian*, 653:174.

“something that never happened before.”⁴⁴ Moreover, recall that the Kangxi emperor had doubted the usefulness of including an Astronomical Bureau official in a diplomatic envoy and had allowed such a regulation to be neglected.⁴⁵ Therefore, the emperor sent Guozhu not for the purpose of diplomacy but for special missions that needed his mathematical expertise. As usual, Qing state records do not mention what He Guozhu and the other members of the envoy had done in Joseon. In contrast, Korean records provide insight into Guozhu’s Joseon trip. Guozhu was sent in a geographical inspection role. Upon arriving in Seoul, the Qing envoy requested to see the Joseon map.⁴⁶ The Joseon court hesitated, concerned for its national security, and this hesitation did not come as a surprise to the Qing envoy. The Qing ambassadors showed the Joseon court a map of the entire Joseon kingdom they had brought from China and demanded that the Joseon courtiers provide a comparison. Guozhu probably did not draw the map brought from China, but he would undoubtedly have had the ability to compare the accuracy between two different maps. It is even possible that Guozhu had performed similar assessments all the way along the route from Beijing to Seoul to verify the map’s accuracy.

He Guozhu also met with Joseon mathematicians in a more relaxed atmosphere. In the beginning, the Qing ambassador introduced He Guozhu’s mathematics as “the fourth best under heaven” and attempted to provoke competitions between both parties.⁴⁷ The mutual challenges continued for several days, but the rivalry served to strengthen the communication between Qing and Joseon official mathematicians. According to the *Veritable Records of the Joseon Dynasty*, a Joseon minister suggested that the next envoy to the Qing should include mathematician Heo

⁴⁴ Wu, *Chaoxian Li*, 4315.

⁴⁵ Zhongguo diyi lishi dang’an guan, *Kangxi qijuzhu*, 836.

⁴⁶ Wu, *Chaoxian Li*, 4318.

⁴⁷ Horng Wann-Sheng 洪萬生, “Shiba shiji dongsuan yu zhongsuan de yiduan duihua: Hong Zhengxia vs. He Guozhu” 十八世紀東算與中算的一段對話：洪正夏 vs. 何國柱, *Hanxue yanjiu* 漢學研究 20, no. 2 (2002): 70.

Won 許遠 because “when the calendar collator came here, Heo Won learned mathematical methods and instruments [from him].”⁴⁸ Moreover, Heo Won could remind He Guozhu of his promise that “after I go back [to Beijing], I will find the treatises and instruments that your country does not have and give them to you.”⁴⁹ In the next chapter, we will see how the He family continued to play an important role until the mid-eighteenth century.

He Guozhu’s performance during the Joseon trip had so pleased the Kangxi emperor that he made an exceptional arrangement for Guozhu’s career. On November 10, 1713, the Kangxi emperor told the Minster of Revenue:

In your ministry, the calculation of finance and food supply was done by clerks. They are only able to give a rough calculation. Astronomical Bureau official He Guozhu currently serves me at the inner court. His mathematics is excellent. I will make him an official of your ministry. This arrangement shall be beneficial to the calculation of finance and food supply. No matter if the affair is complicated or superfluous, he can understand it instantly. I cannot guarantee his personal integrity, but he seems a prudent and honest person. He shall be an extra assistant department director 員外郎 until a vacancy arises. Have him work at both places [the Ministry of Revenue and the Astronomical Bureau] concurrently.⁵⁰

The Kangxi emperor’s words show that he thought mathematics should not be limited to calendar making and music. Finances and resource management of the government, for instance, could benefit from better execution of mathematical calculations, and a clear-minded mathematician could be a good official, even though he did not hold any civil service degree. Therefore, instead of turning the Studio for Cultivating the Youth into a permanent scientific research institution like the French Royal Academy of Science, the Kangxi emperor might have intentionally kept the Studio for Cultivating the Youth as a temporary organization so that after the mathematical treatises were finished he could send his disciples to various positions in the

⁴⁸ Wu, *Chaoxian Li*, 4321.

⁴⁹ *Ibid.*

⁵⁰ Kugena, *Qingdai qijuzhu*, T12378–79.

government. Probably due to his distinct ability in mathematics, the emperor chose He Guozhu as a test case.

Other records further prove the Kangxi emperor's interests in what a mathematician could contribute to the government. In early 1714, Guozhu and Guozong's father, He Junxi, died. Because Guozhu held two jobs concurrently, the Ministry of Personnel asked the Kangxi emperor whether He Guozhu should take the normal mourning leave of three years as a regular official or the shortened mourning leave of three months that the regulations specially prescribed for officials of the Astronomical Bureau.⁵¹ The Kangxi emperor replied,

Have Assistant Department Director of the Ministry of Revenue He Guozhu take leave for the mourning leave as a regular official. *He is quite familiar with calculation. If the Ministry has any case that needs to be calculated, ask him to come to do the calculation as usual.* He Guozhu's household finance is fragile. Give him the stipend as usual.⁵²

Certainly, the emperor's words again show that he valued He Guozhu's mathematical ability and that he held the He family in high esteem. More importantly, the emperor's reply affirms that he did not want to interrupt the experiment of extending the use of mathematics into regular governmental institutions.

However, the Kangxi emperor's ministers did not always share his interest in extending the use of mathematicians in the government. When He Guozhu finished the mourning leave in late 1716, the Kangxi emperor again told the ministers that He Guozhu's excellent mathematical ability could be useful. The emperor demanded that the Minister of Revenue, Zhao Shenqiao 趙申喬, produce a detailed report on why he did not appreciate having a mathematician such as He Guozhu serving at his ministry. The Kangxi emperor decreed the following:

⁵¹ QHDSL QL 620:189.

⁵² Zhongguo diyi lishi dang'an guan, *Kangxi qijuzhu*, 2071. Italics mine.

I gave He Guozhu exceptional promotion to second-class secretary 主事 because he is good at calculation. Previously, I had asked [the Minister of Revenue] Zhao Shengqiao whether such an arrangement was beneficial to the accounting tasks of the Ministry of Revenue. Zhao Shengqiao said that in his ministry, everything related to money and food supply had to be calculated according to fixed rules. Other officials also know how to calculate and verify [the results]. There is no use for him [He Guozhu]. Is it because He Guozhu has done something else wrong? Have Zhao Shengqiao answer my question and temporarily withhold the post that should be given to He Guozhu.⁵³

Although Zhao Shengqiao did not seem to appreciate Kangxi giving him a mathematician as helper, Kangxi kept trying. He Guozhu kept his dual responsibilities, and other members serving in mathematics were dispatched to different governmental departments when the compilation project was completed.

He Guodong 何國棟, another brother of He Guozong, was three years younger than Guozong.⁵⁴ It seems unlikely that Guodong would have accompanied the Kangxi emperor to the Chengde Palace in the summer of 1712 because the *History of the Qing* does not mention him. Nonetheless, as with his two brothers, Guodong's mathematical talent attracted the emperor's special attention. He also became a member serving in mathematics and worked at the Studio for Cultivating the Youth. In December 1714, Prince Cheng suggested re-calculating the height of the North Pole by sending people to take measurements at various spots. The Kangxi emperor picked seven people from those who worked at the Studio for Cultivating the Youth for such tasks and gave He Guodong the responsibility of carrying out the task in Guangdong.⁵⁵

Like Guozong, Guodong did not originally intend to work at the Astronomical Bureau and had instead commenced his career as a regular civil servant. Guodong indeed had a

⁵³ Ibid., 2322.

⁵⁴ QGLL 19: 275–76. Calculated from He Guodong's own statement that he was 78 years old in March 1767.

⁵⁵ SL 6:571.

promising start to his career in civil service. He became a Provincial Graduate in 1713.⁵⁶ The Kangxi emperor did not give Guodong an honorable Metropolitan Graduate degree; however, this was probably because he had already given one to Guozong and did not want to treat the He brothers with too much favors. The death of He Junxi in 1714 and the intense work involved in compiling the *Origins of Mathematical Harmonics and Astronomy* might have delayed Guodong's pursuit of the Metropolitan Graduate degree. Nonetheless, the Provincial Graduate degree was high enough to set a solid foundation for He Guodong's future career in civil service.

When the compilation of the *Origins of Mathematical Harmonics and Astronomy* was finished, He Guodong was rewarded the position of Dingzhou prefect 汀州知府.⁵⁷ The importance of the Provincial Graduate degree can be further appreciated by comparing the new job offered to He Guodong with the one afforded to Ming'antu. Ming'antu made no less of a contribution to the compilation of the *Origins of Mathematical Harmonics and Astronomy* but held only the degree of District Graduate (*shengyuan* 生員). At the end of the compilation project, Ming'antu was rewarded with the position of supervisor of the Five Offices at the Astronomical Bureau. In contrast, He Guodong became a prefect, whose civil service rank of 4A was even higher than that of the Astronomical Bureau director. Not to mention that a prefect could accumulate a significant fortune for himself and his family much easier and faster than a bureau director could.

When the Kangxi emperor died in December 1722, the future of the He brothers' careers looked promising. He Guozong was a Hanlin Academician. Guozhu was both a high official of the Astronomical Bureau and a middle-ranking official in the Ministry of War, and Guodong was

⁵⁶ Li, *Jifu tongzhi*, 505:606, 609.

⁵⁷ *Dingzhou fuzhi*, Qianlong ed. (Taipei: Chengwen chubanshe, 1967), 247.

a prefect. The He family's strategy to send some members to work for the Astronomical Bureau while others pursued civil service degrees worked out well. Surely, the family's past service records had deepened the emperor's trust, and the mathematical knowledge that the family exhibited significantly expedited their career progression. However, just as the unfinished preface, the future of the He family and the brothers' careers would depend on the next emperor. In the rest of this chapter, we will see how the Yongzheng emperor, who ruled with a focus that differed with the preceding emperor, changed the He family's fortune.

5.3 The He Brothers under the Yongzheng Emperor's Rule

The last two decades of the Kangxi reign was a time of severe competition between the royal princes for the throne. The rivalry was so intense that even their father, the Kangxi emperor, had difficulty controlling it. Immediately after returning from the summer retreat of 1712, the Kangxi emperor placed the crown prince (Yinreng 胤礽, 1674–1725) under permanent house arrest.⁵⁸ The aged Kangxi emperor managed to maintain social and political stability to the last day of his life, at which point he was succeeded by Yinzhen 胤禛, known as the Yongzheng 雍正 emperor. However, even today, historians still have not been able to confirm whether the Kangxi emperor did indeed to appoint Yinzhen on his deathbed.

The influences of the struggle for the throne to the development of imperial mathematics surely is worthy of notice but should not be exaggerated. Most importantly, as already shown in the previous section, it was the Kangxi emperor, not Yongzheng, who had disbanded the Studio for Cultivating the Youth. The Kangxi emperor's intention was to send the mathematicians he trained to serve in various government departments. The Jesuits might have informed the Kangxi

⁵⁸ SL 6:486.

emperor about the European scientific research institutions, but the Mathematics Office at the Studio for Cultivating the Youth was a temporary organization for book compilation. It was founded due to the emperor's distrust to the Jesuits instead of taking up their advice. In short, Yinzen's succession to the throne did not cause immediate change in the imperial state's policy on mathematics and sciences.

Nonetheless, the Yongzheng emperor had to act cautiously in order to ensure that his competitors did not rise in fame and strength. In this case, the leader of the group of young and capable mathematicians was Prince Cheng. While the members serving in mathematics were dispatched to various local and central governmental institutions according to their individual contribution to the *Origins of Mathematical Harmonics and Astronomy*, the publication of the treatise itself was delayed. When the treatise was printed in 1724, its contents appeared to be intact, and the names of the people responsible for compiling it were proudly listed with their new official titles. However, the name of the chief leader, Prince Cheng, was moved to second place. Prince Zhuang 莊親王 (Yunlu 允祿, 1685–1767), a much younger yet trusted brother of the new emperor, was listed and referred to as the chief leader of the compilation project.⁵⁹ Through this act, the Yongzheng emperor clearly displayed his intention and authority. From then on, Prince Zhuang replaced Prince Cheng as the chief leader in scientific and engineering projects that court mathematicians such as He Guozong and Jesuit missionaries worked on. Only by providing satisfactory service to the new emperor could He Guozong and the other disciples of the late Kangxi emperor continue their prosperous careers.

While the Kangxi emperor focused on the grand policy of imperial mathematics, Yongzheng paid more attention to the details of management. Historians of the Yongzheng

⁵⁹ Yunlu et al., *Yuzhi lixiang kaocheng*, 5–7.

period were mostly concerned with the ban on Christianity. In the aspect of Chinese sciences, this was roughly equivalent to terminating the importation of new knowledge and skills from Europe that had greatly stimulated the scientific development in the early Qing dynasty. The rest of this chapter is concerned with a different aspect, not the external stimulation, but the internal bureaucratic administration. Using the He brothers as examples, this section focuses on the Yongzheng emperor's management of the group of young mathematicians. Moreover, it will again demonstrate how the familial relationships fared under a different monarch's alternative political focus.

The He brothers' career development in the early years of the Yongzheng reign might seem as great as it was in the last decade of the Kangxi reign. In February 1724, He Guozhu's position within the Astronomical Bureau reached the highest level a Han official could obtain at that time—that of senior vice director.⁶⁰ His post as a regular civil servant also advanced. By December 1723, Guozhu was a department director of the Ministry of War.⁶¹ He Guozong's career also continued to advance as fast as any high degree-holder could wish. In February 1723, the Yongzheng emperor chose Guozhu as one of the imperial diarists 日講起居注官. This gave Guozhu plenty of opportunity to observe the monarch and his high ministers. By April 1725, he was appointed Secretary Concurrently the Vice President of the Ministry of Rites 內閣學士兼禮部侍郎.⁶² He Guodong seemed to be doing as well as his brothers Guozhu and Guozong. In December 1723, Guodong's superiors, Superintendent of Zhejiang and Fujian 閩浙總督 Manbao 滿保 and Governor of Zhejaing 福建巡撫 Huang Guochai 黃國材, felt that Guodong's job

⁶⁰ GYQX 1701.

⁶¹ GYGL 4:2173.

⁶² SL 7:466.

performance as the Dingzhou Prefect was so outstanding that he deserved a special recommendation to the Yongzheng emperor. In a periodical review that he was obligated to give on all his subordinates, Manbao described Guozhu as follows:

He Guodong is capable and he abides by the laws. Minor officials and people respect and obey him. . . . [He Guodong and the other three] are all incorrupt and capable officials. Their names are attached to the list of recommendations, although they have not yet fulfilled the requirement of holding offices for more than three years. Please consider having the relevant departments make a note of their excellence and grant them a special audience.⁶³

However, the He brothers' fortune gradually began to take a different turn. Soon after He Guozhu became the senior vice director of the Astronomical Bureau, the Yongzheng emperor began to limit the He family's expansion. In April 1724, the Ministry of Personnel submitted a routine memorial to the Yongzheng emperor requesting to promote He Guoan 何國安 from erudite to water clock manager. The Yongzheng emperor rejected the request and told the Astronomical Bureau and the Ministry of Personnel, "It is improper to let He Guozhu's family occupy so many seats at the Astronomical Bureau."⁶⁴ Within just six months, for reasons unfounded in archival records, He Guozhu lost both his jobs at the Astronomical Bureau and at the Ministry of War.⁶⁵ The damage to the He family did not stop here. The sudden discharge of He Guozhu signified that the He family was no longer in the imperial favor, and it had a negative impact on his brothers' careers.

Guodong became the next victim of the Yongzheng emperor's suspicion. In July 1724, Manbao received a secret message from the Yongzheng emperor: "I heard that He Guodong is too young and frivolous and not familiar with the affairs of Personnel Management. Is it really

⁶³ GYGL 5:2465.

⁶⁴ GYQX 1994.

⁶⁵ GYQX 2985.

so?”⁶⁶ The emperor named He Guodong and several other officials subordinate to Manbao.

Manbao quickly responded to the emperor that, for various reasons, his impeachments to all but He Guodong had been, or would be, submitted to the proper departments. However, Manbao had made a special recommendation for He Guodong just months earlier; he hesitated about how to answer the emperor’s question on Guodong. Cautiously Manbao replied the emperor:

It is true that He Guodong is not very experienced and capable because he is young and this is his first post [as civil servant]. However, he is very determined to learn the proper ways. . . . Indeed, he does not take advantage of his position to do anything unethical. Could it be possible to allow me some more months to reinvestigate him? . . . I never had any special connection to He Guodong’s family. I dare not favor him.⁶⁷

Manbao tried to avoid contradicting his previous recommendation on He Guodong and hoped his words would buy more time to reinvestigate not only He Guodong but also the Yongzheng emperor’s real intention. Manbao’s declaration of his fairness is noteworthy, for he mentions not the individual He Guodong but the whole He family. It suggests that the He brothers’ fame had spread among contemporaries and that the weight of the familial relation factored in the evaluation of a person.

Ironically, the Yongzheng emperor, who in the case of He Guoan 何國安 had worried about the overexpansion of the He family, now made a contradictory statement. The emperor once again wrote to Manbao, this time stating that he was only concerned with a person’s job performance, not with his familial relation:

Do not wrongly impeach He Guodong simply because you heard about the case of He Guozhu. Not to mention that currently I have great use of He Guozong. I never considered whether they were brothers or even father and son. I only care if the

⁶⁶ Zhongguo diyi lishi dang’an guan, *Yongzhengchao Hanwen*, 3:128.

⁶⁷ Ibid., 3:130.

individual person has done the right things or not. Handling it fairly is the way to win my appreciation.⁶⁸

Rather than believing the emperor's words, Manbao decided to impeach He Guodong. Manbao submitted the impeachment on November 6, 1724, stating that He Guodong "has completely changed" from what he was in the previous year and that "now he does everything capriciously and impatiently." Manbao claimed that the impeachment was necessary because "an impatient person like him should not be tolerated because he will bungle the local administration."⁶⁹

It turns out that the Yongzheng emperor would use the case of Manbao and He Guodong as a public declaration that "in this way, all of you know that I have no prejudice."⁷⁰ The Yongzheng emperor did not react to Manbao's impeachment until May 1725. After consulting another of He Guodong's superiors, Huang Guochai, the Yongzheng emperor decreed, "Since Huang Guochai claims that Prefect He Guodong neither has any voracious action nor any financial deficit, it is suitable to have He stay at his post. The appropriate ministry is to take note on [my verdict]."⁷¹ Afterward, Manbao confessed that the impeachment was nothing but an effort to please the emperor after receiving the news that He Guozhu had been discharged. As a punishment, the Yongzheng emperor reduced his civil ranking.⁷² He Guodong was able to keep his post as Dingzhou Prefect but only for a short time. According to the *Gazetteer of the Dingzhou Prefecture* (*Dingzhou fuzhi* 汀州府志), a new prefect had replaced him by the end of that year.⁷³ In the end, neither Manbao nor He Guodong won the Yongzheng emperor's appreciation. Guodong's career as a prefect ended.

⁶⁸ Ibid., 3:412.

⁶⁹ GYGL 12:6994.

⁷⁰ SL 7:478.

⁷¹ GYGL 12:6994, 6996.

⁷² GYGL 12:7123.

⁷³ Dingzhou fushi, 247.

On the other hand, the Yongzheng emperor did have a use for He Guozong. In the same way as previous dynasties, the flood control of the Yellow River and the maintenance of the Grand Canal were crucial to the economic and social stability of the Qing. During the Kangxi emperor's six trips to South China, the inspection of flood preventive work was always an important part of his visit. He even personally conducted the geographical measurements to verify the correctness of his courtiers' suggestions on the construction work and to demonstrate his superior mathematical knowledge. The Yongzheng emperor did not have sufficient mathematical knowledge to carry out the same kind of performance. Therefore, the inspection of flood control work became a task similar to writing a preface for the *Origins of Mathematical Harmonics and Astronomy*: the Yongzheng emperor had to find someone else to do it for him. He Guozong, a court mathematician with sufficient classical training, was an obvious choice for the Yongzheng emperor. In May 1725, around the same time that he rejected Manboa's impeachment of He Guodong, the Yongzheng emperor made He Guozong a Secretary 學士. Three months later, he ordered He Guozong to organize a small team of metropolitan officials to inspect the Canal and Yellow River in the Shandong and Henan area.⁷⁴ Guozong was allowed to choose two assistants from the Astronomical Bureau officials and to bring whatever instruments he needed for the survey. He's team left Beijing on September 26, 1725. For several months, they traveled along the Canal and the Yellow River to survey the river course. The goal of He's team was to find methods to improve flood control and the traffic of the Canal while not hampering the famers' need for irrigation. In February 1726, the emperor told the Grand

⁷⁴ SL 7:520.

Secretariat that He Guozong's reports on the situation of the Canal were very detailed and clear.⁷⁵ He's efforts seemed to have pleased the Yongzheng emperor.

However, the Yongzheng emperor had only revealed part of his thoughts about He Guozong. In fact, He Guozong's inspection tour did not proceed without problems. He Guozong's team seriously disagreed with Henan Governor 河南巡撫 Tian Wenjing 田文鏡, one of the most trusted favorites of the Yongzheng emperor. In a secret memorial to the emperor, Tian bitterly criticized He for rushing to conclusions without listening to the local peoples' and officials' opinions on the construction work. Unlike the occasion when he pretended to be a just ruler in front of Manbao, the Yongzheng emperor allowed Tian to know his distrust of He Guozong. "He Guozong and the others [of the team of river course inspection] originally were just despised low officials," the emperor said. "They were not appointed by me. I merely utilize their ability of inspection."⁷⁶ On a different occasion, the emperor warned He Guozong directly, "You [and the rest of the team] originally were just contemptible low officials. Do not forget diligence and caution even for a moment."⁷⁷ Eventually, the emperor decided to adopt Tian's suggestion on the flooding problem rather than He's because he believed that Tian, as a local governor, would produce more reliable observations and solutions.⁷⁸ In the next five years, the Yongzheng emperor kept He Guozong among the high courtiers and sent him to various flood-prevention projects. However, in May 1732, when Tian Wenjing once again accused He of making serious mistakes in previous surveys and claimed that these errors had caused terrible

⁷⁵ SL 7:586.

⁷⁶ NPM 4202006973.

⁷⁷ NPM 402007513.

⁷⁸ SL 7:692.

damage to local people, the Yongzheng emperor stripped He Guozong of all his titles and never employed him again.⁷⁹

From 1713 to 1722, Guozhu, Guozong, and Guodong were rising stars in the officialdom. They won the Kangxi emperor's attention not only because they were assiduous and talented but also because they were from a family that had served the emperor for generations. Because the emperor's attitude toward the Jesuits itself had changed, the He family's past records of resisting Jesuit mathematics became a guarantee of the Guozong brothers' loyalty to the newly constructed imperial mathematics. He Guozong and his brothers thus enjoyed a more personal and trusting connection to the Kangxi emperor than other members serving in mathematics. It was not a coincidence that the Kangxi emperor made special career arrangements for them.

From 1723 to 1731, the Kangxi emperor's successor, the Yongzheng emperor, dissolved the prestigious status of the He brothers one by one. Lack of personal interest in mathematics did not hamper the Yongzheng emperor's ability to recognize the importance of it. However, the cautious emperor would not easily forget that the He brothers had been working closely for years with his rival in competition for the throne. He discharged Guozhu and Guodong before utilizing Guozong's mathematical specialty. The sequential discharge of He Guozong in 1731 would have been a heavy blow to the He family. Just years earlier, He Junxi's plan for having some of his children pursue civil service degrees could not have seemed more successful; now it had devastatingly fallen apart. In the end Guozhu, Guozong, and Guodong were all without official jobs. The He family would have to be supported by the other members who still worked at the Astronomical Bureau. These individuals are the focus of the next section.

⁷⁹ SL 8:392.

5.4 The Yongzheng Emperor's Administration Policy of the Astronomical Bureau

The Yongzheng emperor continued the Kangxi emperor's efforts to institutionalize imperial mathematics by rectifying the administration of the Astronomical Bureau. The Kangxi emperor was famous for his mathematical talent, but he tended to let the Astronomical Bureau take care of its own daily administration. By contrast, the Yongzheng emperor's interest was not in mathematics but in the details of the administration of officialdom.⁸⁰ The previous section has illustrated how the Yongzheng emperor's distrust led to the downfall of the He Guozong brothers. However, the Yongzheng emperor did not suppress other members servicing in mathematics. Mei Juecheng and Ming'antu, for example, were left to continue their careers without disturbance. Therefore, the Yongzheng emperor's attitude toward the He Guozong brothers was one important aspect but not the totality of his managing policy on mathematics and mathematicians. It is necessary to further investigate the administration of the Astronomical Bureau in general and the adjustment induced by the Yongzheng emperor in particular. This section revisits the case of He Guoan 何國安. Not restricted to the He or mathematician families, it analyzes the Yongzheng emperor's influence on the administration of the Qing Astronomical Bureau.

The memorial the Yongzheng emperor viewed in March 1724 regarding the promotion of He Guoan appears as routine as any other memorials delivered to the emperor. After beginning the memorial with his full official title, Minister of Personal Longkeduo 隆科多 wrote,

[We] sincerely memorialize for the issue of filling out an official's vacancy. We have delivered that the vacancy left by Shenxu 沈旭, who was promoted from water clock manager to vice director, shall be filled by He Guoan 何國安, an erudite of the Water

⁸⁰ Feng Erh-k'ang 馮爾康, *Yongzheng zhuan* 雍正傳 (Beijing: Renmin chubanshe, 1995), 139–92.

Clock Section, according to the suggestion from it [the Astronomical Bureau]. We sincerely memorialize and wait for Your Majesty's decree.⁸¹

Observe the limited role the emperor was supposed to play in the above personnel arrangement.

The Astronomical Bureau and the Ministry of Personnel had already decided who should be given the position, and they provided the emperor with very little knowledge about how they reached the decision and who the chosen person was. They simply informed the emperor that He Guoan was currently an erudite of the Water Clock Section. No additional information was provided, such as He Guoan's past job performance, personality, or ability, to help the emperor decide whether he should approve this personnel arrangement or not. If not for the similarity of their names, the Yongzheng emperor may not even have noticed that He Guoan and He Guozhu were from the same family.

Although water clock manager was a petty position and Longkeduo had been so close to the emperor that "Uncle" 舅舅 was made part of his official title, the Yongzheng emperor wanted to retain full control of the bureaucratic system. He replied to the Ministry of Personnel at length:

[Your memorial suggests to] fill this vacancy of water clock manager completely according to the recommendation from the Astronomical Bureau. Is the recommendation based on the seniority of candidates' service or the excellence of job performance? [Your memorial] includes no explanation. In addition, it is not proper to let He Guozhu's family occupy so many posts. From now on, the Ministry of Personnel shall carefully examine the officials recommended by the Astronomical Bureau before sending in the routine memorial on filling posts.⁸²

It is noteworthy that the Yongzheng emperor did not order an investigation into the nomination process of He Guoan. Whether He Guoan himself might indeed be a qualified candidate for the position was not the only issue with which the Yongzheng emperor was concerned. Rather than

⁸¹ GYQX 1994.

⁸² Ibid.

treat this as a discrete incident, he saw it as a weakness in the administration system that had to be removed.

The Yongzheng emperor clearly intended to prevent potential malfeasances from occurring. His attention went beyond limiting the expansion of the He family. At the time in question, with the exception of He Guozhu, all other members of the He family were at the level of erudite or student astronomer.⁸³ By contrast, in the early Kangxi era, three members of the He family served as high-level officials of the Calendar Section at the same time.⁸⁴ Therefore, it was not that the He family had already overly expanded that motivated the Yongzheng emperor to constrain them. However, He Guozhu was not an ordinary senior vice director; he concurrently held a directorship at the Ministry of War. His brothers, Guozong and Guodong, were also high officials. The He brothers' combined influence could easily place the He family in dominant positions in the Astronomical Bureau. Worse, similar situations could happen to any other lower-level bureaus in the government. If there were no proper mechanism to closely examine the process of distributing lower-level positions, such positions would soon be occupied by the friends and relatives of influential officials.

Later in the same year, the Ministry of Personnel again received a list of nominated officials from the Astronomical Bureau. This time, the Ministry of Personnel wrote a much longer and more detailed routine memorial to the emperor:

My ministry requested the Astronomical Bureau to send in the evaluation of the candidates for promotion. Then my ministry went together with the Astronomical Bureau officials to interview the candidates and to decide the best and the second one. Along with the ones recommended by high-level court officials, their names were all listed on

⁸³ Qu, "Qingdai Qintianjian," 53–54; Shi, "Qing Qintianjian Tianwenke," 39.

⁸⁴ Qu, "Qingdai Qintianjian," 49–50; Shi, "Qing Qintianjian Tianwenke," 37–38.

the routine memorial waiting for Your Majesty's decision. Please select one for each post from the two candidates or from high-level court officials' recommendations.⁸⁵

Following this, the nomination process became more systematic and the emperor was more informed in detail. For a vacant position in the Astronomical Bureau, the Bureau and the Ministry of Personnel had to suggest two potential candidates and provide the emperor with a brief job evaluation together with personal information such as place of origin and age. Such information was far from comprehensive, but the point was that the presentation of an alternative candidate gave the emperor more power in the decision-making process. Even though, in most cases, the emperor chose the first candidate nominated by the Bureau, the uncertainty of the two-candidate system was an important showcase of imperial authority.

Audiences were another important means through which Yongzheng and other Qing emperors demonstrated their authority. During the Qing period, most personnel orders for granting government positions were finalized only after imperial audiences, unless the positions were regarded as too insignificant to deserve the emperor's attention. Due to the large amount of audiences held every day, most of them were ceremonial and the emperor would simply approve the suggestions submitted by the Ministry of Personnel. However, diligent emperors, such as Yongzheng, aggressively utilized audiences to select qualified officials.

There are plenty of examples in archival records that demonstrate how audiences could affect an individual's career. In November 1726, two Manchu seats of observatory managers became vacant and the Astronomical Bureau and the Ministry of Personnel presented the Yongzheng emperor with two candidates for each post. Usually, the Yongzheng emperor selected the first candidate suggested by the Ministry of Personnel. This time, however, after the audience, the emperor decreed that one of the first candidates was "not good enough," and he

⁸⁵ GYQX 2986.

awarded the post to one of the second candidates.⁸⁶ In a case in April 1725, the Yongzheng emperor approved the Ministry of Personnel's suggestion to fill the vacant vice directorship with the first candidate; however, he added a reminder: "[The second candidate] is too unqualified for any promotion. Never send him in [for the audience] again."⁸⁷ Apparently, the candidate's poor performance during the audience cost him not only his current promotion but also all future hope for career progression. Furthermore, a failed audience could lead the emperor to suspect the integrity of the officials involved in the nomination process. Feeling that the candidate for the Manchu water clock manager was too unqualified after an audience given in September 1728, the Yongzheng emperor scolded the Minister of Personnel: "On what ground did [the Astronomical Bureau] select him as the first candidate? Your ministry has to fully investigate and memorialize me the results."⁸⁸ The emperor's reproach was a warning to the Ministry of Personnel and the Astronomical Bureau that they would be penalized if the investigation report did not satisfy the emperor.

To summarize, the Yongzheng emperor treated the Astronomical Bureau as a regular institution of the central government. He neither downplayed nor emphasized the technical expertise of the Astronomical Bureau, which he was not familiar with in any case. His focus was on the administration of its officials. Just as Jesuit mathematicians continued to be named the directors, Bureau officials continued to be allowed to bring their offspring to work for the Bureau. However, the situation that a powerful director alone, such as Johann Adam Schall, could determine candidates for all the posts of the Astronomical Bureau was not something the

⁸⁶ GYQX 6949–50.

⁸⁷ GYQX 3826.

⁸⁸ GYQX 10261.

Yongzheng emperor would tolerate.⁸⁹ By systematizing the administrative process, the

Yongzheng emperor looked to prevent corruption and factions in the Astronomical Bureau.

⁸⁹ Chen, *Zhongguo Tianzhujiao*, 363–64.

Chapter 6

The Solar Eclipse of 1730

In January 1730, response to the Astronomical Bureau's prediction that a solar eclipse would occur on the first day of the sixth month of that year (July 15, 1730), the Yongzheng emperor made a public announcement:

Never did the abnormality of a solar eclipse occur since I ascended to the throne seven years ago. According to the memorial submitted by the Astronomical Bureau, on the first day of the sixth month of the *gengxu* 庚戌 year [1730], the sun will be obscured up to nine *fen* 分 and twenty-two *miao* 秒 [nine-tenths and twenty-two-thousandths of its diameter]. My heart is deeply frightened. I think that my faults in government or personnel affairs might be the cause. Maybe ministers and officials have not carefully fulfilled their duties with sincerity and respect, and civilians have not yet been able to communicate [their needs to the government] easily. Therefore, heaven sends this warning sign.¹

While the Yongzheng emperor's announcement aimed to show his respect to heaven, this solar eclipse did indeed turn out to be a critical milestone in the history of mathematics in the Qing period. Before the eclipse occurred, the Qing state calendar was based on the Tychonic system. Afterward, it followed the Newtonian system. Unlike the Kangxi Calendar Dispute caused social and political turbulence, this change took place almost in secrecy. In fact, there are very few records of it within Qing state documents. The next two chapters analyze the different concerns of the parties that were involved in the process of transforming the state calendar from the Tychonic to the Newtonian system—the monarchy, the mathematician families at the Astronomical Bureau, and the Jesuit missionaries who held the directorship at the Bureau. Together, they shaped the state policy of managing and reproducing mathematical knowledge in

¹ Zhongguo diyi lishi dang'an guan 中國第一歷史檔案館, ed., *Yongzhengchao qijuzhuce* 雍正朝起居注冊 (Beijing: Zhonghua shuju, 1993), 3385.

the Yongzheng and Qianlong reigns. This chapter focuses on each party's political priorities when the state calendar was secretly changed.

6.1 Challenges from Heaven

Since antiquity, Chinese people have regarded celestial phenomena as enciphered messages from heaven. Over time, the decryption of heavenly messages developed into a special branch of knowledge that was known as *Tianwen* 天文, which means “celestial language” or “celestial signs.” Nonetheless, anyone who dared to boast of his knowledge of *Tianwen* or to interpret celestial phenomena in public could easily offend those in positions of authority.² In fact, even owning astronomical instruments constituted a crime at the time of the Qing dynasty.³

Of all the celestial phenomena, the one deemed most critical was the solar eclipse. According to *Tianwen* interpretation, the sun represented the monarch, Son of Heaven 天子, thus the solar eclipse represented a divine evaluation of the current emperor's personal ethics and rightness of government. An unexpected solar eclipse or an eclipse that exceeded the predicted magnitude was perceived to be a sign that heaven was angry at the earthly ruler's malfeasance and the public could, and would, take it as a sign that the dynasty was losing the heavenly mandate 天命. If there were any celestial phenomena that an emperor would like to hide from his subjects, it was the solar eclipse. However, the solar eclipse was a phenomenon that all people under heaven could see with their own eyes and interpret as they wished. The emperor had no means of keeping this occurrence secret. The Yongzheng emperor's concern about the upcoming solar eclipse and the way in which it would be interpreted was well grounded. Although the

² Yao and Hu, *Da Qing luli*, 1485–86.

³ *Ibid.*, 1437.

cause of the eclipse was no longer a myth, the Yongzheng emperor had to handle his first solar eclipse carefully so that it did not threaten his regime.

As the government institution asked for assistance for the emperor in handling the eclipses, the Astronomical Bureau followed a sophisticated protocol that not only required astronomical knowledge but also political wisdom. According to the Qing statutes and survival records, the Astronomical Bureau had to communicate with the emperor at least three times for each eclipse. The first communication took place approximately five months before the eclipse, when the Astronomical Bureau had finished calculating various data about the upcoming event, including the time, duration, magnitude, and position of the eclipse.⁴ Recall that Schall gave Dorgon a good first impression of the New Western Method because he calculated the eclipse for every province.⁵ Therefore, unlike in the Ming era, when such calculations were performed only for viewers in the capital region, the Qing court required the Astronomical Bureau to produce predictions for every province. As they originated from an area outside the traditional Chinese territory, Qing rulers knew an eclipse prediction calculated according to the capital was not accurate enough to convince residents of other areas. No matter how far the subjects lived from the political center, the eclipse prediction issued by the Astronomical Bureau should demonstrate the authority of the imperial state.

After the emperor reviewed the data provided by the Astronomical Bureau, the Ministry of Rites would notify the provinces that needed to hold the Rescue Ritual (*jiuhu* 救護) on the day of eclipse. The Rescue Ritual was determined by the eclipse magnitude, which was defined as

⁴ QHD GX 719.

⁵ IHP 006903.

the fraction of the sun's diameter that was obscured by the moon.⁶ In the Shunzhi and Kangxi reigns, the Rescue Ritual was held in a province if the predicted eclipse magnitude exceeded one-tenth.⁷ Afterward, the requirement was reduced to three-tenths but was eventually changed back to one-tenth in 1749.⁸ The Qianlong emperor explained the political concern behind this change in no uncertain terms:

The occurrences of solar and lunar eclipses can be known from computation. According to the examples set by the *Spring and Autumn Annals* 春秋, only solar eclipses need to be recorded. My only concern is that a [celestial] phenomenon so obvious and bright will lead people to look up to it. Even among all celestial movements, [eclipses] occur frequently. They cannot be compared with the constantly shining fixed stars that cause no apprehension. They have to be dealt with sincerely.⁹

Not wanting to see his subjects irritated by a celestial phenomenon, the Qianlong emperor ordered the government officials to attend the Rescue Rituals as frequently as necessary. After all, keeping subjects content was crucial to maintaining political stability. Calculating the occurrences of the solar eclipse was only the foundation for dealing with the phenomenon. Political performances, such as the rituals and decrees that showed the sincerity of the emperor to local officials, were necessary to pacify people's restlessness.

The Yongzheng emperor's decree of January 1730 was in the same vein. Perhaps the Astronomical Bureau's prediction had alarmed him because the magnitude of the expected eclipse would be close to that of a full eclipse. Instead of waiting to react to any damage after the eclipse occurred, the Yongzheng emperor hoped to prevent disturbances from happening in the first place. A routine notification from the Ministry of Rites about holding the Rescue Rituals

⁶ See Glossary A.1.

⁷ QHD KX 7744-45

⁸ QHDSL QL 625:141.

⁹ Ibid.

was not sufficient. The Yongzheng emperor's decree in January 1730 constituted a warning to local officials that they should handle the next eclipse with extra caution.

Between a month and two weeks before the eclipse, the Astronomical Bureau was required to send a reminder of the upcoming celestial event to the emperor.¹⁰ This reminder was accompanied with an illustration of the eclipse. As figure 14 shows, the illustration provided the emperor with information on the period during which the eclipse would be visible, how its shape would change, and when its magnitude would reach its maximum.

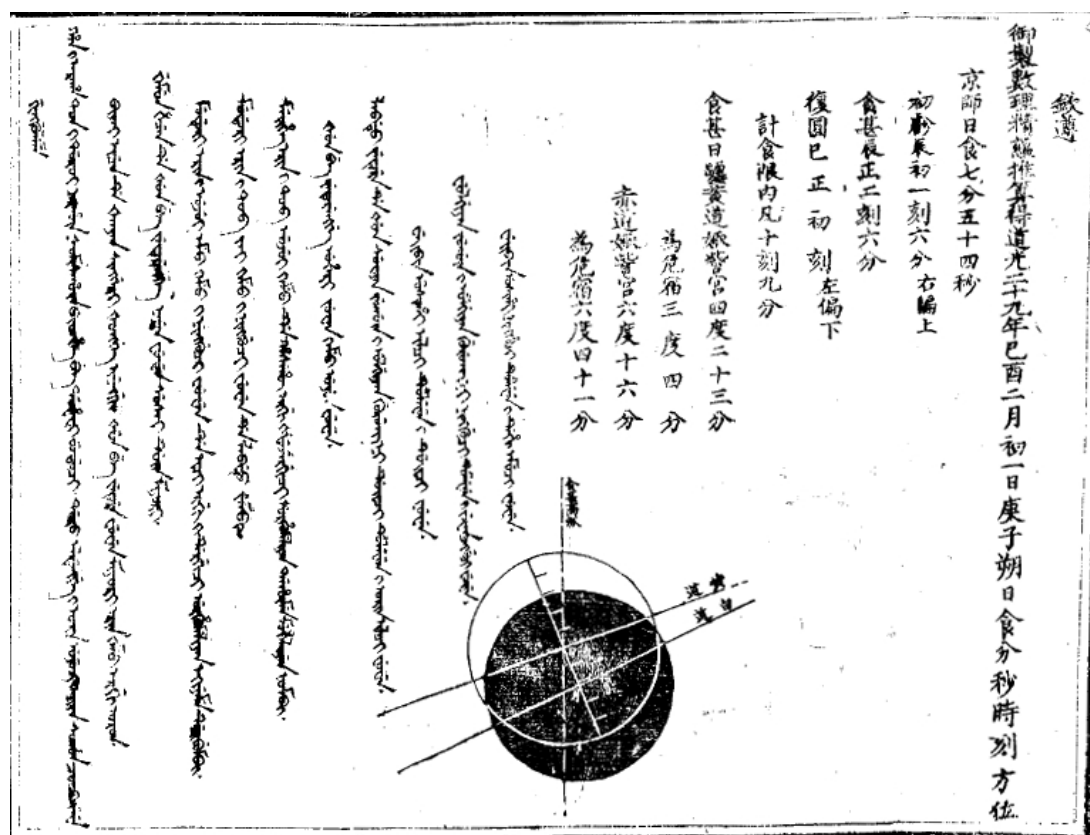


Figure 14. A solar eclipse prediction produced by the Astronomical Bureau, 1849.

Reprinted from IHP 163354.

¹⁰ QHD GX 719. The statutory laws only required the Astronomical Bureau to send the emperor a reminder. No precise deadline was set.

Indeed, the illustrations produced by the Astronomical Bureau were sufficiently clear and detailed so as to give the emperor a remarkable experience of astronomical observation as long as that was he was interested in it. Although the emperor did not attend the Rescue Ritual, he often kept the illustration of the eclipse that was submitted with the reminder for his own reference. This allowed the emperor to personally verify the Astronomical Bureau's calculation by observing the eclipse and comparing it with the illustrations.

On the day of the solar eclipse, all government bureaus sent representatives to the Rescue Ritual held at the Ministry of Rites. At the same time, the Ministry of Rites sent some officials to the observatory, where the dynasty's best astronomical instruments were located, to observe the eclipse with the Astronomical Bureau superintendent and directors. Together they confirmed the accuracy of the Bureau's calculation. After the eclipse, the Astronomical Bureau submitted a final report to the emperor.

However, in contrast to the detailed and informative prediction submitted in previous communications, the final report from the Astronomical Bureau was not particularly scientifically oriented. The report consisted of two parts: observation results and divination. The divination was mainly based on the celestial positions of the eclipse, particularly the start and end positions relative to the constellations.¹¹ Because no rigid set of rules or references was employed to interpret the heavenly signs, it is understandable that Bureau officials would not risk their jobs or lives to write an offending divination report. The observation results were more remarkable. While the previous memorials always included illustrations, the final report contained only numerical descriptions of the eclipse. These numbers appeared to be copied from previous calculations and not to be accurate records of the actual measurement of the eclipse.

¹¹ For example, see IHP 155895 for the divination on a lunar eclipse in 1670, and NPM 154748 for a lunar eclipse occurred in 1903.

The Astronomical Bureau was not the only institution that was responsible for fabricating the final report. The mismatch between the predicted eclipse and observed eclipse not only exposed the Astronomical Bureau officials' malfeasance but also threatened the dynasty's authority. Unless the difference between prediction and observation was too severe to be concealed, neither the Astronomical Bureau nor the imperial state was willing to admit its existence. As such, the emperor always accepted the Astronomical Bureau's final report without any question. To be sure, the mismatch did not always go entirely unnoticed. For example, in September 1802, Song Shu 宋澍 accused the Astronomical Bureau of miscalculating the solar eclipse.¹² According to Song's own observation, the maximum magnitude of the eclipse did not even reach seven *fens* and was therefore much less than the nine *fens* and thirty-four *miaos* predicted by the Astronomical Bureau. Song complained that such an error was too severe to be tolerated. The Jiaqing 嘉慶 emperor forwarded the case for further investigation but eventually decreed that Song's impeachment was not sustained because "Princes, grand minsters, and the officials attending the Rescue Ritual at the capital saw it with their eyes and they all have no objection."¹³ It is noteworthy that none of the metropolitan officials positively testified that the eclipse magnitude was in the range of the Astronomical Bureau's prediction. Those officials that did attend the Rescue Ritual reported that they did not hear anyone arguing that the eclipse was seven or nine *fens*, while those who stayed in offices claimed that they had been unable to clearly recognize the eclipse magnitude. All government members distanced themselves from this case, including the emperor. As long as the inaccuracy of the eclipse prediction did not cause political

¹² SL 29:368–69; IHP 223343.

¹³ IHP 223343.

or social disturbance, the emperor had no objection to the Astronomical Bureau officials and other courtiers covering up their colleagues' mirror malfeasance.

The solar eclipse of 1730, however, presented a more severe challenge than the above protocol could completely subdue. The *Thorough Investigation of Astronomical Phenomena* finished less than a decade ago did not help to slow down the deterioration of the Timely Modeling system. The next section will discuss how, in the early Yongzheng reign, the Timely Modeling system had become so unbearably inaccurate that even neighboring Joseon noticed the errors.

6.2 The Joseon Astronomical Bureau and the He Family

In recent years, Korean sources have attracted increased attention from Qing history scholars. In fact, historians of Qing history need little additional training to begin utilizing Korean sources for their research because most Korean sources were written in Chinese. In “An Eighteenth Century Sino-Korean Dialogue on Mathematics: He Guozhu vs. Hong Jeong-Ha” 十八世紀東算與中算的一段對話：洪正夏 vs. 何國柱, for example, Wann-Shang Horng analyzes He Guozhu's level of mathematical knowledge by scrutinizing the *Gu Il Jip* 九一集, in which Korean mathematician Hong Jeong-Ha 洪正夏 recorded how his conversation with He Guozhu had occurred during He's envoy to Seoul.¹⁴ He Guozhu and the other He family members participated in the majority of the compilation projects of the Qing official mathematical treatises, but they left no personal work. Anecdotes, such as the one in the *Gu Il Jip*, provide valuable insights into the connection between Qing and Korean mathematicians.

¹⁴ Horng Wann-Sheng, “Shiba shiji,” 68–76.

One of the goals of this section is to examine how, for generations, the He family played an important role in transmitting European mathematical astronomy to the Joseon dynasty.

Korean sources, such as the *Veritable Records of the Yi Dynasty* (*Li chao zhilu* 李朝實錄), are crucial to this research. The Korean kingdom of Joseon was founded in the late fourteenth century by Yi Seonggye 李成桂 and lasted until the end of the nineteenth century. Joseon was a vassal state of the Ming and Qing dynasties. The unequal statuses between these two states are clearly delineated in the *Veritable Records of the Yi Dynasty* entries. For instance, the Qing documents routinely recorded what benevolence the Qing court had bestowed to the Joseon envoys coming to Beijing to pay respect to the Qing monarchs but rarely described what the Qing envoys had demanded of the Joseon court. The *Veritable Records of the Yi Dynasty*, however, recorded Qing ambassadors' extortions and insults in detail. They also included numerous records that disclosed the intelligence about the Qing that the Joseon envoys had gathered. While the Qing state historians omitted or altered the records that could potentially embarrass their dynasty, Joseon court historians had no need to do so for the Qing. The deterioration of the Timely Modeling calendar is one example of an incident in which the Joseon records were of particular use.

From the mid-seventeenth century, the Qing Astronomical Bureau at Beijing had been an important channel through which Koreans could import European mathematics and astronomy.¹⁵ As a vassal state, the Yi court had no choice but to adopt the calendar issued by the Qing.¹⁶

¹⁵ For a survey of the transmission of Western astronomy from China to Korea, see Jun Yong Hoon 全勇勳, "朝鮮における時憲曆の受容過程とその思想的背景", *Toho Gakubo* (Kyoto) 東方學報 84 (2009): 302–81, and Yunli Shi, "The Yuzhi Lixiang Kaocheng Houbian in Korea," in *The Jesuits, the Padroado and East Asian Science (1552–1773)*, ed. Luís Saraiva and Catherine Jami (New Jersey: World Scientific, 2008).

¹⁶ QHDSL GX 803:77.

However, Joseon mathematicians were not compelled receivers; they learned the Timely Modeling calendar with eagerness. As early as June 1645, Schall's name appeared on the *Veritable Records of the Yi Dynasty* as the producer of the new calendar.¹⁷ Soon the Yi court decided to dispatch Astronomical Bureau officials with the regular emissaries to Beijing to gather more information about the New Western calendar, even though "The central state 中原 [China] forbids foreign countries to make calendars."¹⁸ By March 1648, a Joseon Astronomical Bureau official managed to meet with Schall. However, because collecting treatises on calendar making or learning them was strictly forbidden at that time, the Joseon official only obtained brief oral instructions from Schall.¹⁹ Nevertheless, by the early 1650s, Joseon mathematicians were fully versed in the techniques used to calculate the civil calendar.²⁰ However, the calculation of the seven governors—namely, the sun, moon and five planets, would take much more time to master. Joseon mathematicians did not make a significant breakthrough until 1705, when Heo Won 許遠, an Astronomical Bureau official, came to Beijing and managed to meet with He Junxi 何君錫.²¹ The instruction that He gave to Heo helped Joseon mathematicians to make profound progress in their understanding of the methods used to compute planetary motions. Finally, the Joseon Astronomical Bureau knew how to calculate the Seven Governors Calendar 七政時憲曆.

The factors that caused this long delay are worthy of further analysis. The Joseon Astronomical Bureau had reported that its officials only learned the method of calculating the

¹⁷ Wu, *Chaoxian Li*, 3749.

¹⁸ *Ibid.*, 3754.

¹⁹ *Ibid.*, 3771.

²⁰ Shi Yunli 石雲里, "'Xifa' chuan Chao kao" '西法' 傳朝考, *Guangxi minzu xueyuan xuebao (ziran kexue ban)* 廣西民族學院學報 (自然科學版) 10, no. 1 (2004): 31.

²¹ Jun Yong Hoon, "朝鮮における時憲曆の受容過程とその思想的背景," 291n50.

solar orbit from Schall because “when questioning through written communication, words could not deliver the meanings effectively.”²² Joseon and Chinese officials, to a certain degree, could communicate directly through writing without the need to involve an interpreter. This statement, however, suggests that European missionaries could not effectively deliver their mathematical knowledge to Joseon officials; this was probably because Schall and other missionaries had limited knowledge of written Chinese.

Furthermore, the difference in mathematical background might have been the cause of communication difficulties during the meeting of Joseon officials and European missionaries. Joseon mathematicians were trained in traditional Chinese mathematics and the Great Concordance system of calendar making. He Junxi, too, was an expert in the Great Concordance system. His strong empathy toward the Great Concordance system even cost him his promotion to the Bureau directorate.²³ However, after the Kangxi emperor’s decree of August 1676, He was required to learn the New Method.²⁴ By the time of the meeting with Heo Won, He should have mastered the New Method. He’s experience of converting from the Great Concordance system to the New Method could easily imply that he knew exactly what the Joseon Astronomical Bureau officials needed. He taught and cooperated with Joseon mathematicians more effectively than European missionaries.

The He family continued to be involved in the transmission of Western mathematical astronomy to Korea. Recall that the Kangxi emperor chose He Junxi’s son, He Guozhu 何國柱, to participate in a special envoy to Joseon in 1713.²⁵ Beside Hong Jeong-Ha, the author of the *Gu Il Jip*, He Guozhu also met with Heo Won. He Guozhu taught Heo Won some calculation

²² Wu, *Chaoxian Li*, 3801.

²³ Zhongguo diyi lishi dang’an guan, *Kangxi qijuzhu*, 1747.

²⁴ SL 4:804.

²⁵ Wang et al., *Wanshou shengdian*, 653:174.

methods and promised, “I will find the books and instruments that your country does not have and send them to you when I return to Beijing.”²⁶ Because of the friendship that had been established between Heo and the He family, the Yi court once again sent Heo to Beijing. Unfortunately, when Heo arrived in Beijing, He Junxi had died and Guozhu was on mourning leave.²⁷ Historians remain unsure as to whether the calendar collator that Heo met was He Guozhu or He’s successor, Shao Yunlong 邵雲龍.²⁸ Regardless, Heo successfully obtained nine treatises on the calculation of eclipses and calendar making in addition to the six instruments for calculation and measurement.²⁹

By the time the inaccuracy of the Timely Modeling system became obvious in the early Yongzheng reign, Joseon mathematicians had developed a good grasp of the New Method. They were confident enough to assert that the errors they observed were not due to mistakes in their own computation but in the calendar-making system. In November 1728, the Joseon Astronomical Bureau found that “the computational system is not as good as it used to be. The predictions of twenty-four solar terms 節氣 and the new and full moons become erroneous.”³⁰ Six months later, the Joseon Astronomical Bureau sent the Joseon king a more detailed report for his attention:

Since last year, the Qing civil calendar had many errors. This was because the celestial motion gradually accumulates difference. The Timely Modeling system uses the *wuchen* 戊辰 year of the Chongzhen reign [1628] as the starting point of calendar calculation. That was already one hundred and two years ago. Computation, measurement, revision, and correction are the general method and recognized principles for maintaining [the accuracy of] the calendar. However, our country does not have the instruments needed for various measurements. We can only follow their collections and use their

²⁶ Wu, *Chaoxian Li*, 4321.

²⁷ He Guozhu was on mourning leave from early 1714 to 1716 (see section 5.2).

²⁸ Wu, *Chaoxian Li*, 4329; Qu, “Qingdai Qintianjian,” 52–53.

²⁹ Wu, *Chaoxian Li*, 4329.

³⁰ *Ibid.*, 4429.

guidebooks. . . . We have no choice but to regularly send one Bureau official [to Beijing] to obtain whatever has been missing and to learn the usage [of the guidebooks]. Then we can calculate the seven governors completely by ourselves.³¹

In November 1730, one ambassador told the Joseon king before he left for Beijing,

I worked at the Astronomical Bureau. I heard that our calendar-making method is based on the *Kangxi lixiang kaocheng* 康熙曆象考成, and it has gradually become erroneous. Each year it has at least six or seven errors. I will bring a Bureau official so that we can obtain the method of calendar making.³²

As a result of the deterioration of the Timely Modeling calendar, Joseon officials repeatedly requested that their king dispatch mathematicians to Beijing to acquire new treatises and instruments. The fact that the Joseon mathematicians kept coming up with questions on the accuracy of the Timely Modeling calendar, however, should be alarming, if not terrifying, to the Qing Astronomical Bureau officials, particularly to members of the He family, who had been in contact with Joseon mathematicians for decades. It is unlikely that the Qing Bureau officials had not yet noticed the deterioration of the calendar system themselves. Rather, the arrival of Joseon mathematicians entailed that the deterioration had worsened to the extent that the discrepancies would soon be noticed elsewhere.

The Yongzheng emperor's lack of mathematical expertise did not mean that the Astronomical Bureau officials could easily manipulate him. In fact, it might be harder to make him understand the causes of the inaccuracy. Even if he understood, whether or not the emperor was willing to admit that the Timely Modeling system and the *Thorough Investigation*, compiled under the Kangxi emperor's leadership, were no longer feasible was another question. It is highly possible that a strict sovereign like the Yongzheng emperor would simply make Bureau officials

³¹ Ibid., 4431.

³² Ibid., 4436.

and court mathematicians scapegoats and punish them for failing to provide an accurate prediction.

In November 1729, the Astronomical Bureau officials submitted their prediction, which was calculated according to a method that they already knew was inaccurate. Unless the officials knew how to correct the current system, they had no alternative but to wait in fear of the possible penalty and political consequence. Their future and the prosperity of their families depended on the Yongzheng emperor's judgment.

6.3 The Yongzheng Emperor's Political Performance

The prediction of the 1730 solar eclipse turned out to be a blessed failure. Shortly after the solar eclipse, officials' congratulations flew to the throne from all over the country. A palace memorial written by some metropolitan officials exemplified what people had seen on that day and how they had interpreted it:

The eclipse began at the *wu* 午 hour. After the eclipse reached two *fens*, suddenly clouds covered and a heavy rain fell. After the clouds had vanished and the rain had stopped, the eclipse barely reached three *fens*. At the third *ke* 刻 of the *wei* 未 hour, the eclipse was three *fens*; yet the sun began to return to roundness. Everyone witnessed it. Everyone said that this was definitely a response from heaven to the emperor's honest self-reflection.³³

Governor of Zhejiang Province, Li Wei 李衛, submitted a similar palace memorial. The Ministry of Rites had informed him that in Hangzhou, the city where the provincial government was located, the eclipse magnitude would be seven *fens* and nineteen *miaos*.³⁴ However, according to Li and other local officials' observations, the magnitude was less than five *fens*, and the eclipse ended much earlier than had been predicted: "Not only did I witness [this phenomenon] very

³³ Zhongguo diyi lishi dang'an guan 中國第一歷史檔案館, ed., *Yongzhengchao Manwen zhupi zhoushe quanyi* 雍正朝滿文朱批奏摺全譯 (Hefei: Huangshanshushe, 1998), 1984.

³⁴ Zhongguo diyi lishi dang'an guan, *Yongzhengchao Hanwen*, 18:878.

clearly, everyone in the city—officials, clerks, soldiers, commoners, monks, Daoist priests and others—did. Thousands of eyes witnessed it together.”³⁵ Li concluded that the emperor’s assiduousness and self-reflection must have reached heaven.

The way in which Li and other officials responded to the failed prediction is not difficult to understand. If the observation had minor deviations from the prediction, it could conventionally be ascribed to observer error. However, this time the deviation was so large that a different explanation had to be employed. Fortunately, an eclipse less severe than the prediction had long been regarded as an auspicious omen from heaven. Instead of questioning whether the Astronomical Bureau had miscalculated the eclipse, the officials decided to acknowledge this eclipse as a miraculous representation of the emperor’s greatness.

For instance, Fujian Governor Gao Qizhuo 高其倬 resonated in detail in his palace memorial written two days after the solar eclipse. Gao first described that he had observed this unusual celestial phenomenon with hundreds of thousands of the commoners under his administration. He then reminded the emperor that, in previous generations, the phenomena that the sun did not eclipse as much as predicted were always caused by miscalculation or inaccurate measurements produced by the Astronomical Bureau. This time Gao claimed,

However, the measurement and computational method used by our dynasty were drawn from the best parts of previous generations and then combined with Western mathematics. They had been further perfected by the Kangxi emperor’s sagely wisdom given by heaven. For more than sixty years, all the measurements conducted in provinces and other countries did not have the slightest inaccuracy. None of the inaccurate methods used by previous generations can be compared to [the method of our dynasty].³⁶

Gao’s argument assumed that the computational method drawn up by the Kangxi emperor would be perfect and methodical. Therefore, this solar eclipse could be nothing but a miraculous

³⁵ Ibid.

³⁶ Ibid., 18:840–41.

heavenly sign. However, did the Yongzheng emperor also think that the Kangxi emperor's works were always correct and should not be challenged or modified?

This was not the first time that the Yongzheng emperor heard a similar argument. In 1725, Prince Zhuang and He Guozong submitted a list of ten suggestions related to the newly published treatise, the *Origins of Mathematical Harmonics and Astronomy* 律曆淵源. One of their suggestions, in effect, requested the Yongzheng emperor to remove Ignaz Kögler (Chinese name Dai Jinxian 戴進賢, 1680–1746) from the position of the Administrator of the Calendrical Methods 治理曆法.³⁷ Prince Zhuang's and He Guozong's argument was similar to Gao Qizhuo's. They claimed that the *Thorough Investigation of Astronomical Phenomena* composed by the Kangxi emperor would not possibly need any more administration. Thus, Ignaz Kögler's title and duties in the Astronomical Bureau should be changed. The Yongzheng emperor approved the majority of Prince Zhuang's and He's suggestions. However, instead of discharging Kögler from the Astronomical Bureau, the Yongzheng emperor appointed him as the Bureau director. He Guozong's plan to remove Kögler from the Astronomical Bureau failed and the He family never obtained the Bureau directorship.

The Yongzheng emperor was a smart and sophisticated ruler. He knew the importance of showing respect for his father's authority. But at the same time, he would not let the courtiers use that respect to manipulate him. Probably feeling that Gao was trustworthy, the Yongzheng emperor left a brief response on his memorial: "These predictive numbers that the officials had

³⁷ Zhongguo diyi lishi dang'an guan, *Yongzhengchao Hanwen*, 31:490. This memorial seems to be the one Andreas Pereira referred to in his letter of November 20, 1732. See Guo Shirong 郭世容 and Li Di 李迪, "Putao ya chuanjiaoshi Xu Maode zai Qintianjian de tianwen gongzuo" 葡萄牙傳教士徐懋德在欽天監的天文工作, *Journal of Shandong University of Science and Technology* 山東科技大學學報 13, no. 2 (2011): 23, and Han, "Zili Jingshen," 216.

received were from the old and inaccurate computational method.”³⁸ This comment indicates that the Yongzheng emperor knew that the prediction had been miscalculated soon after or even before the solar eclipse occurred. Hence, it was not a lack of astronomical knowledge but a political concern as to whether it was proper to admit publicly that such an auspicious omen was nothing more than a miscalculation. With the exception of Gao, the emperor replied to the memorials that attributed the unusual phenomenon to the emperor’s sincere self-reflection with a simple word: “viewed” 覽. As such, while the Yongzheng emperor appeared uninterested in his officials’ praises, he did not in fact deny them.

The Yongzheng emperor waited until the end of the month to stage the last political performance. He issued a lengthy decree regarding the miraculous solar eclipse.³⁹ The emperor began by naming two officials, both of whom had congratulated him for this miraculous eclipse, and announced that he had severely rebuked them for flattering him. Interestingly, the original memorial submitted by one of those two officials has survived. A quick examination shows that the emperor’s only comment on the memorial was on the word “viewed.”⁴⁰ In fact, as already mentioned, there is no evidence to indicate that the Yongzheng emperor had rebuked any officials. Rather than a statement of facts, the emperor’s announcement was nothing more than a political performance that was designed to demonstrate his humbleness.

The Yongzheng emperor then recalled the solar eclipses that he had observed with his father, the Kangxi emperor. To make his point clear, he quoted the Kangxi emperor’s decree on the eclipse of February 21, 1697: “Although people can calculate solar eclipse beforehand, since antiquity emperors all take it as a fearful warning because that is the way to respect heavenly

³⁸ Zhongguo diyi lishi dang’an guan, *Yongzhengchao Hanwen*, 18:841.

³⁹ SL 8:280.

⁴⁰ Zhongguo diyi lishi dang’an guan, *Yongzhengchao Hanwen*, 18:821.

omens and repair administrative affairs.”⁴¹ What Yongzheng had learned from his father was not the ability to calculate the solar eclipse but how to use the occasion of the solar eclipse to stage a proper political performance. The call for suggestions on administrative affairs was an act that was purposely designed to demonstrate the humble virtues of the sovereign. Even when the eclipse could not be observed because of poor weather, as Yongzheng learned from his father’s handling of the case of February 19, 1712, the emperor should dutifully perform such demonstration to win his subjects’ respect instead of celebrating it as an approval from heaven.⁴²

If, after the performance of being a humble sovereign, some officials still insisted that the observed eclipse magnitude was less than the prediction, the Yongzheng emperor taught them where to point the finger. “If the eclipse magnitude indeed was less than predicted,” the emperor said, “then the Astronomical Bureau must have calculated it wrong.”⁴³ Recall that in the 1802 case, the Jiaqing emperor ruled in favor of the Astronomical Bureau because Song Shu was the only individual to exhibit dissent. In the current case, however, the Yongzheng emperor was ready to sacrifice the Astronomical Bureau if his address did not satisfy the public. The threat to the Bureau officials could not be more terrifying. They had no choice but to act as cooperative assistants in this imperial political performance.

Around the time that he delivered the long decree, the Yongzheng emperor quietly approved the Astronomical Bureau Director Mingtu’s request to repair the calendar-making system.⁴⁴ Mingtu’s memorial suggests that the Astronomical Bureau not only knew that the

⁴¹ SL 8:281.

⁴² Ibid.

⁴³ Ibid.

⁴⁴ Yunlu 允祿 et al., *Yuzhi lixiang kaocheng houbian* 御製曆象考成後編 [1742], Yingyin Zhaizaotang siku quanshu huiyao 景印摛藻堂四庫全書薈要 (Taipei: Shujie shuju), 270:3. Note that Han Qi 韓琦 misidentifies Mingtu 明圖 as Ming’antu 明安圖 in “‘Shuli gezhi’ de faxian—Jianlun shiba shiji Niudun xiangguan zhuzuo zai Zhongguo de chuanbo” 《數理格致》的發現—兼論 18 世紀牛頓相關著作在中

prediction could be inaccurate but had already held a comparison test on the day of solar eclipse.

Mingtu stated,

Director Dai Jinxian 戴進賢 [Ignaz Kögler] and Vice Director Xu Maode 徐懋德 [Andreas Pereira] had found minor differences between computation and observation. . . . As foolish as I am, without verification, I dare not memorialize you. Now, careful observation conducted on the solar eclipse of the first day of the sixth month of the Yongzheng reign [July 15, 1730] confirmed that the measured results did not match the calculated magnitude.

Mingtu's memorial concluded by requesting the emperor let Kögler and Pereira lead work to rectify the system. In January 1732, Mingtu presented new tables of the solar and lunar orbits 日躔月離表 made by the Jesuits.⁴⁵ These two tables were added to the *Thorough Investigation* as if they were merely updated reference tables. None of the other officials in the Astronomical Bureau knew the dynasty's official method of calendar making had been changed from a Tychonic to a Newtonian system.

It is noteworthy that allowing the method of calendar making to be changed under such secrecy was unprecedented. Dorgon could promptly decide to adopt the New Western method because it had been repeatedly tested in the previous dynasty. However, publicizing the deterioration of the existing calendar-making system was almost equivalent to challenging the works of the sagely Kangxi emperor. The Yongzheng emperor himself had approved the publication of the *Thorough Investigation*. Later, under He Guozong and Prince Zhuang's suggestion, he even had the declaration on the cover of the official calendar changed to "calculated according to the *Imperially Composed Thorough Investigation of Astronomical*

國的傳播, *China Historical Materials of Science and Technology* 中國科技史料 19, no. 2 (1998): 78. Mingtu was the Bureau director between 1710 and 1739, whereas Ming'antu did not become the director until about 1759.

⁴⁵ IHP 011779.

Phenomena.⁴⁶ Even though a proper replacement had been found, it could not deliver any benefit to the Yongzheng emperor. In light of the potential political implications, it is highly likely that the Yongzheng emperor decided that the modification of the current system of calendar making should progress silently, if not secretly.

Chinese Astronomical Bureau officials and mathematicians, such as He Guozong, kept their silence because of their involvement with the *Thorough Investigation*. They likely soon found out that the method of calendar making had been changed. However, admitting that the *Thorough Investigation* had already become inaccurate would not be in their best interest. Worse still, the Chinese Bureau officials had not found a way to improve the system. Although the Yongzheng emperor did not punish anyone for the inaccuracy of the 1731 eclipse immediately, his trust in the mathematical capabilities of He Guozong and the other Chinese mathematicians may have suffered. In May 1731, the Yongzheng emperor dismissed He Guozong from all official positions. When the emperor started a new mathematical education program in 1734, he did not recall He Guozong to service.

Up to the Qianlong reign, Joseon official mathematicians continued to seek help from the He family members.⁴⁷ By the end of 1734, the Joseon court had found out that the Qing had modified the system of calendar making and had managed to obtain a copy of the new tables of the solar and lunar orbits.⁴⁸ The He brothers, however, seemed to have lost their value to the imperial state. He Guozong was barely fifty years old when the Yongzheng reign ended. He was not yet too old to lose all ambitions about the future. For himself and for his family, He Guozong

⁴⁶ QHDSL QL 625:140; Zhongguo diyi lishi dang'an guan, *Yongzhengchao Hanwen*, 31:491. This was one of the ten suggestions that He Guozong and Prince Zhuang made in 1725.

⁴⁷ Wu, *Chaoxian Li*, 3749. In 1733 a Joseon Astronomical Bureau official met with He Guoxun 何國勳 in Beijing.

⁴⁸ *Ibid.*, 4477–78.

had to patiently wait a few more years and figure out a new way to sell his mathematical talent to the succeeding Qianlong emperor.

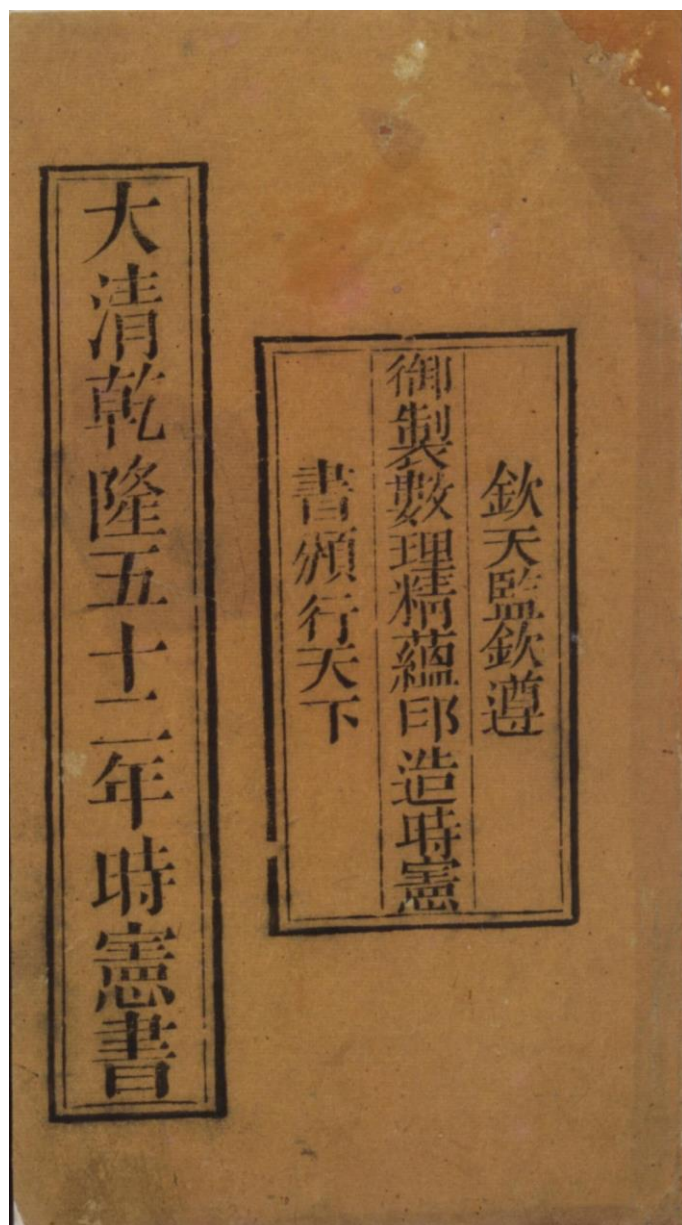


Figure 15. Qing Timely Modeling calendar, the Qianlong reign. The front cover of the calendar of the fifty-second year of the Qianlong reign (1790). After the *Origins of Mathematical Harmonics and Astronomy* was published, the sentence printed on the calendar cover was changed again. In the Yongzheng reign, it was “calculated according to the *Thorough Investigation of Astronomical Phenomena*.” In the Qianlong reign and afterward, it was “calculated according to the *Essential Principles of Mathematics*.”

Reprinted from “大清乾隆五十二年歲次丁未時憲書,” National Central Library, Taiwan, accessed October 12, 2014, <http://catalog.digitalarchives.tw/item/00/07/ec/ed.html>.

Chapter 7

Knowledge Reproduction

7.1 Amending the Timely Modeling System

In May 1737, a Manchu nobleman Gucong 顧琮 (1685–1755) warned the new emperor Qianlong that a calendar crisis would impact the imperial state in the future if the court failed to take preventive measures at this moment.¹ The dynasty's official method of calendar making, the Timely Modeling system, was based on the *Books on Calendar Making According to the New Method* 新法曆書,² translated by Xu Guangqi 徐光啟 in the late Ming from various Western mathematical treatises. Nevertheless, Gucong claimed, most often the meanings, illustrations, and reference tables of the *Books on Calendar Making* were obscure and inconsistent. As such, the Kangxi emperor had to recruit a group of officials to research its method in detail and compile the work *Thorough Investigation of Astronomical Phenomena* 曆象考成. Gucong then continued to point out where the potential crisis lay. In the previous reign, under the excuse of maintaining the accuracy of calendar making, two new tables of the solar and lunar orbits 日躔月離表, in effect, had already replaced those presented in the *Thorough Investigation*. However,

These tables come with neither explanation nor any computational method. According to my knowledge, the author of these tables was [the Astronomical Bureau] Director and Honorary Vice President of the Ministry of Rites 禮部侍郎, Westerner Dai Jinxian 戴進賢 [Ignaz Kögler]. Only Vice Director, Westerner Xu Maode 徐懋德 [Andreas Pereira], and the Supervisor of the Five Offices, Ming'antu 明安圖, know how to use these tables. *Except for these three, nobody understands them.* If [these tables] were not amended and clarified, how could they be transmitted to the future? Our descendants will have no way

¹ Yunlu et al., *Yuzhi lixiang kaocheng houbian*, 270:4–5.

² This treatise originally was called Chongzhen Books on Calendar Making 崇禎曆書 or Books on Calendar Making According to the New Method 西洋新法曆書. It was renamed Books on Mathematics According to the New Method 算法新書 when it was collected into the Four Treasures 四庫全書.

to find the computational method. *It will turn out to be the same as if they had never been compiled.*³

Gucong's memorial exposed a shocking fact about the imperial state-monopolized business of astronomy. The imperial state staffed the Astronomical Bureau with 200 employees. However, the success of the entire business was in fact determined by just three people. None but these three understood the two essential reference tables used to calculate the planetary orbits. Two of them were European missionaries and the only Qing official might not know the theory required to regenerate the reference tables. Even though Gucong did not explicitly spell out the risky situation that the dynasty found itself in, his warning was clear: if European missionaries died before transmitting related knowledge to the Chinese or if they decided to cease serving the Qing imperial state, the court would lose the ability to produce accurate calendars and astronomical predictions.

The Qianlong emperor took immediate action. He approved Gucong's suggestion to commence annotating the tables of solar and lunar motion and correcting the *Thorough Investigation*. Moreover, instead of letting Ignaz Kögler supervise the project as Gucong had suggested, the emperor assigned the responsibility of coordinating and supervising the whole project to Gucong.⁴ A month later, upon Gucong's request, the Qianlong emperor added Mei Juecheng and He Guozong as project supervisors with Kögler and Pereira. Soon an office was established and 31 additional officials began working on the project. Perhaps in order to ensure that the project was under more secure supervision, the emperor later named his uncle, Prince Zhuang, the supervisor-general 總理 of the work.⁵

³ Ibid. Italics mine.

⁴ Yunlu et al., *Yuzhi lixiang kaocheng houbian*, 270:5.

⁵ Ibid., 5–7.

In June 1738, the Qianlong emperor received a carefully constructed primary report from the project's supervisors. To avoid any possible accusation of disdaining previous emperors, the report began by eulogizing the *Thorough Investigation* by declaring, "Although the long period of time may produce deviation and occasional adjustments [to the astronomical constants] become necessary, no other method [of calendar making] will surpass it."⁶ Next, the report explained Kögler and Pereira's new method, which was adopted from inventions that had recently been made in the West. Giovanni Cassini and John Flamsteed, the supervisors claimed, "extended what Digu 第谷 (Tycho) had implied in his incomplete theory."⁷ The recent inventions fell into three categories. The first two recommended that the astronomical constants were adjusted, and the third suggested that the planetary orbits were modified from circular to elliptic. The supervisors then evaluated the benefits of adopting these inventions, "Although using ecliptic orbit makes calculation more difficult, modifying old constants to match celestial motions is rather new and skillful."⁸ Rather than directly pointing out the fact that switching from circular to elliptical orbits would be a dramatic theoretical impact, the supervisors downplayed the importance of such a modification by placing it in the last category, describing it as nothing more than a slight increase in the difficulty associated with calculation. At the end of the report, they suggested keeping the *Thorough Investigation* intact while putting the new theory and reference tables into a separate volume entitled the *Later Part of Thorough Investigation of Astronomical Phenomena* (*Lixiang kaocheng houbian* 曆象考成後編).⁹

⁶ Ibid., 6.

⁷ Ibid. Here Giovanni Cassini was translated to "Ga Xini" 噶西尼 and John Flamsteed, to "Fa Lande" 法蘭德.

⁸ Ibid., 7.

⁹ Ibid., 7–8.

Most historians see the compilation of the *Later Part* as a one-directional knowledge transmission process in which Jesuit missionaries taught while Qing mathematicians learned. For instance, when evaluating the theoretical achievements of the *Later Part*, Guo Shirong 郭世榮 and Li Di 李迪 praised Kögler and Pereira by saying, “Although its theory has serious flaws, in China it is already a relatively advanced treatise based on Western astronomy and methods of calendar making.” In contrast, Guo and Li asserted that He Guozong and Mei Juecheng “probably did not do any substantive scientific research work” and “only Ming’antu’s work is worthy of affirmation and praise.”¹⁰ Here, Guo and Li seem to suggest that Qing mathematicians, with the exception of Ming’antu, were more interested in sharing the credit of the project than in learning the new Western knowledge.

Nevertheless, the Jesuit role in the knowledge transmission process should be carefully reexamined. Kögler and Pereira surely made the most significant contribution to the contents of the *Later Part*. If they refused to cooperate, the *Later Part* would not have come into existence. However, one should not forget that Kögler, Pereira and the other Jesuit missionaries were recipients of the astronomical theories, not their original inventors. Jesuit teachings contributed greatly to the process of transmitting Western theories into China, but the Jesuits were not the ones who had developed those theories. After all, they were not much different from Chinese mathematicians. Jesuits selected and repacked the astronomical theories before transmitting them to the Chinese, just as the supervisors of the *Later Part* project had to choose a better way to persuade the Qianlong emperor. Whether the complaint often seen in Qing documents that Westerners secretly kept their methods within themselves 自秘其術 was true or not, it should be noted that Jesuit missionaries, in the same way as the Qing court, had their own concerns in

¹⁰ Guo and Li, “Putao ya chuanjiaoshi Xu Maode,” 22.

relation to the diffusion of knowledge. This section analyzes the social and political contexts of the birth of the *Later Part*. It will describe the Qing mathematicians' awareness of the need to take ownership of the knowledge and explain how they pushed the Jesuits into revealing the new astronomical theories that eventually brought the *Later Part* into existence.

The first issue worth considering is what motivated Gucong to initiate such a project. Was Gucong's action a favor to the Jesuits? Gucong was an outsider of the Astronomical Bureau. In February 1736, he became the Governor of Jiangsu but soon was forced to leave that position for mourning leave and he returned to Beijing. In May 1737, a month before submitting the project proposal to the Qing emperor, Gucong had been temporarily assigned to the role of Assisting Minister of Personnel.¹¹ His position and official responsibility were completely unrelated to the Astronomical Bureau and astronomy.

Moreover, the Jesuits did not need Gucong to act as their proxy. Jesuits were the Bureau directors and the original authors of the tables of solar and lunar motions. If they decided the time had come to break their silence and reveal the theory behind the two reference tables, the Jesuits could memorialize the emperor directly. In March 1674, Ferdinand Verbiest memorialized and presented the *New Treatise on the Instruments at the Observatory* (*Xinzhi lingtai yixiang zhi* 新製靈台儀象志) to the Kangxi emperor.¹² Later, in 1744, Kögler also memorialized the Qianlong emperor directly concerning an amendment to the *New Treatise on the Instruments at the Observatory*.¹³ These examples show that as a director of the Astronomical Bureau, Kögler had no need to use an outsider, such as Gucong, to initiate the project for the Jesuits.

¹¹ Wu, *Qingguo shi*, 6:468.

¹² Ferdinand Verbiest, *Xinzhi lingtai yixiang zhi* 新製靈台儀象志, XXSK 1031:647–49.

¹³ Yunlu 允祿 et al., *Qinding yixiang kaocheng* 欽定儀象考成, SKQS 793:2–3.

On the other hand, Gucong was no stranger to Mei Juecheng and He Guozong. In 1711, Gucong passed the examination held by the Kangxi emperor and become a member serving in mathematics 效力算法人員.¹⁴ In the next decade, Gucong studied and worked with He Guozong and Mei Juecheng at the Studio for Cultivating the Youth. Gucong should have done relatively well in mathematics, for his name was listed alongside that of Ming'antu and He Guodong in the section of observers (*kaoce* 考測).¹⁵

Based on the fact that Gucong only recommended one Chinese mathematician, Ming'antu, in his first memorial, Guo and Li asserted that Gucong might have displeased the Chinese mathematicians and thus might have been pressed to add Mei and He Guozong to the team of supervisors.¹⁶ However, this section argues that Gucong might have consulted or might have even been persuaded by Han mathematicians such as Mei Juecheng and He Guozong *before* proposing the project to the emperor. As an outsider, Gucong would only have knowledge of the situation involving the Astronomical Bureau through private connections, such as those he may have had with his former colleagues. Neither Mei nor He worked at the Bureau at that time. Nonetheless, according to the 1738 spring rosters of Han metropolitan officials, the He family had at least four members working at the Astronomical Bureau, including Supervisor of the Middle Office, He Guochen 何國宸, and Calendar Collator He Junhui 何君惠.¹⁷ The new tables of solar and lunar motion had been in place for five years.¹⁸ If none of the Astronomical Bureau officials, Ming'antu and the He brothers included, could have figured out the theories beyond the

¹⁴ Wu, *Qingguo shi*, 4:625–26.

¹⁵ Yunlu, *Yuzhi lixiang kaocheng*, 5–6.

¹⁶ Guo and Li, “Putaoia chuanjiaoshi Xu Maode,” 21. Catherine Jami also holds the same view. See Jami, *Emperor*, 378–79.

¹⁷ Luo Zhenyu 羅振玉, ed., *Qingchu shiliao congbian* 清初史料叢編, CKSB 32:710–16, 797–803. These two rosters did not include the junior student astronomers and yin-yang students.

¹⁸ IHP 011779.

tables, the situation was indeed worrisome. Under the Kangxi emperor's full support, the *Thorough Investigation* still took ten years to finish. The length of time involved may have provided Gucong with an insight into the difficulties that scholars encountered when attempting to absorb Western mathematics. Moreover, similar to He Guozong and Mei Juecheng, Gucong might have been influenced by the Kangxi emperor's growing distrust of the Jesuits.¹⁹ He Guozong could easily take advantage of that distrust to convince Gucong to force the Jesuits to explain the theory in detail.

Gucong's involvement was critical for He Guozong and his family's future. Mastering mathematical astronomy is the key for a mathematician family's career success. However, the He family members in the late Yongzheng and early Qianlong reigns faced a situation similar to what their ancestors experienced in the Shunzhi reign. The family's future was in danger if the Jesuits continued to keep the secret of astronomical computation to themselves. Unfortunately, He Guozong had lost all official posts after 1731, while Guodong probably only held a part-time job as a mathematics assistant professor at the public school. Neither of them was in a suitable position to make any direct proposal to the emperor. In fact, the emperor might suspect the sincerity of Gucong's proposal if he recommended the unemployed He Guozong brothers in the first memorial. He Guozong and Mei did not have enough political power to press Gucong, but they could have utilized past personal connections and Gucong's sympathy for the He family to command his attention and persuade him that proposing the project was in the best interest of the imperial state.

In the same way as his father before him, He Guozong became the emperor's tool to counterbalance the Jesuit control of mathematical knowledge. Guozong's career as a civil

¹⁹ Han, "Zili jingshen," 215–19.

servant restarted with the task of amending the Timely Modeling system. In the following few years, the Office of Amending the Timely Modeling System grew into a series of book compilation projects, all of which were completed under He Guozong's supervision. In 1744, the Qianlong emperor rehabilitated He Guozong by placing him at the third level of the civil service ranks.²⁰ The reward most important to the He family came in April 1745, when He Guozong became the head of the Astronomical Bureau.²¹ He Guozong's official title was "Concurrently in Charge of the Affairs of the Astronomical Bureau Director." However, because Guozong's civil service rank was higher than the rest of the directorate, he virtually became the Bureau superintendent. On the official roster, He Guozong and the Manchu superintendent's names always preceded other Bureau officials', including Manchu and European directors.²² Working for the Astronomical Bureau once again constituted a promising career for the He family. As the next chapter shows, by the mid-Qianlong period, the He family had established a dominant position in the Astronomical Bureau.

The power struggle within the Astronomical Bureau involved a continuous process of negotiation. Until the early Kangxi reign, writing new treatises and studying mathematical sciences provided the means through which Jesuits could attract Chinese mathematicians.²³ The compilation of the *Origins of Mathematical Harmonics and Astronomy* changed this situation. From then on, Bureau mathematicians knew they should study the *Essential Principles of Mathematics* and the *Thorough Investigation* instead of Jesuit treatises and that they should follow the authority of the Kangxi emperor, not the Jesuits. Despite the fact that the Jesuits successfully demonstrated that they were the best court mathematicians by presenting the new

²⁰ IHP 023912.

²¹ Wu, *Qingguo shi*, 6:484.

²² For example, see IHP 021541, 045891, and 023895.

²³ Han Qi, "Fengjiao," 382–84.

reference tables to the Yongzheng emperor, their control of the Astronomical Bureau had substantially declined. Keeping the theory secret might have become the Jesuits' last means of defending themselves. Descendants of earlier Chinese Christians—for instance, supervisor of the Winter Office Bao Qinhei 鮑欽輝—still worked at the Bureau. However, either the Jesuits did not trust them enough to teach them the new theory or members of the Chinese Christian families were no longer interested in learning from the Jesuits. Following Gucong's proposal, the Jesuits were compelled to cooperate. Afterward, Europeans in the Qing Astronomical Bureau were not much different from any other ethnic group.

In the past, when Joseon mathematicians came to Beijing to find solutions for astronomical problems, they privately sought out the He family members for help. In 1744, however, they met with He Guozong and Ignaz Kögler at the same time. Although there are no official records of this meeting in Qing state documents. The fact that it took place suggests that the power negotiation between Chinese mathematicians and Jesuit missionaries had reached a new balance. He Guozong was almost sixty years ago when the *Later Part* was finished. He had helped his family get back on track in the profession of official astronomers. With the exception of continuing to supervise the studies and works of his family members, there was not much left for Guozong to do for the family. For Jesuits, slowing down the decline of their status and prolonging their stay in the Qing court entailed maintaining a friendly relationship with He Guozong and the other Bureau mathematicians. The golden days of Jesuit missionaries' domination of the Qing Astronomical Bureau were over.

7.2 Short-Lived Yongzheng Mathematics Program

Toward the end of his reign, the Yongzheng emperor tried out a new educational policy. In 1734, Prince Guo 果親王 (Yunli 允禮, 1697–1738) obtained imperial permission to begin a mathematics program in the Eight Banners Public Schools.²⁴ This mathematics program lasted only four years. By the end of 1738, the new emperor decided to replace it with the College of Mathematics 算學, which would continue until the end of the dynasty. Few records about the short-lived Yongzheng mathematics program have survived, and most historians have misunderstood or ignored them. For instance, historians Fan Hao 方豪 and Catherine Jami both misinterpreted a 1734 record in the *Collected Statutes and Precedents* and confused the founding of Yongzheng mathematics program with the mathematical activities that took place at the Studio for Cultivating the Youth in the last decade of the Kangxi reign.²⁵ This led Jami to further suggest that the Kangxi emperor attempted to institutionalize the study of mathematics by setting up an academy of mathematics that was connected to the Imperial College.²⁶ In fact, the team of mathematicians that studied and worked at the Studio for Cultivating the Youth was disbanded when the compilation project finished, while teaching mathematics courses in the Eight Banners public schools was a late-Yongzheng invention. Moreover, the successor of the Yongzheng mathematics program, the College of Mathematics, was an affiliated school of the Imperial College, but neither the Studio for Cultivating the Youth nor the Yongzheng program had connections with the Imperial College. Such a misunderstanding is not just the fault of historians

²⁴ Wenqing 文慶 et al., *Guozijian zhi* 國子監志, XXSK 751:651.

²⁵ QHDSL GX 813:299; Fang Hao 方豪, *Xhongxi jiaotong shi* 中西交通史 (Shanghai: Shanghai renmin chubanshe, 2008), 2:519–20; Catherine Jami, “Learning Mathematical Sciences during the Early and Mid-Ch’ing,” in *Education and Society in Late Imperial China, 1600–1900*, ed. Benjamin A. Elman and Alexander Woodside (Berkeley: University of California Press, 1994), 238.

²⁶ Jami, “Learning,” 238.

but also reflects the Qing court's changing views on the purpose and range of public mathematics education. Therefore, in order to study the ways in which the court managed the reproduction of mathematical knowledge, this section analyzes the transition from the Yongzheng mathematics program to the Qianlong College of Mathematics.

The Yongzheng mathematics program was ambitious. Each Banner public school was assigned two mathematics instructors. The instructors only came to the public school every other day, but they were highly qualified. For instance, Supervisor of the Winter Office Bao Qinhei 鮑欽輝 was the mathematics assistant professor (*Jiaoxi* 教習) at the Plain Blue Banner public school.²⁷ Each school had to select at least thirty students who were “clever and keen” to participate in the mathematics program. The selected students studied mathematics from the *wei* 未 hour to the *shen* 申 hour.²⁸ On average, each of the Eight Banners public schools had around seventy or eighty students, meaning that nearly half of the public school students were enrolled in the mathematics program, and they spent almost half of the day studying mathematics. In sum, the mathematics program had sixteen instructors and more than 240 students.²⁹ In comparison, the Astronomical Bureau had only twenty-four Banner student astronomers and eighty Han student astronomers.

Although Prince Guo's proposal did not mention a specific goal for the program, what the Yongzheng emperor and Prince Guo arguably had in mind was to make mathematics a part of the general education for Banner officers rather than to train specialists in mathematics. Several facts support this assertion. First, as mentioned above, the scale of the mathematics

²⁷ QGLL 13:189.

²⁸ In 1738, Sun Jiagan 孫嘉淦 stated in his routine memorial that mathematics courses were from the *wei* 未 hour to the *shen* 申 hour. Other records indicate that the daily study of mathematics was for *wei* and *shen* hours. See Wenqing, *Guojin zhi*, 751:651, 752:475.

²⁹ *Ibid.*, 752:475.

program far exceeded the requirement for the number of Astronomical Bureau apprentices and students. Second, the difference between Banner student astronomers and the students of the mathematics program was significant. The former were selected from public school students. After being selected, they became student astronomers of the Astronomical Bureau and no longer studied at the public school. Those who were selected to participate in the mathematics program, however, stayed at their original public schools. With the exception of the time set aside for mathematics studies, they followed the same curriculum—riding and archery, translation, and Chinese classical study—as the other students. The imperial state decided to select them to study mathematics not because mathematics seemed a better path for them, but because they were considered talented enough to take the additional course. Third, the administrative responsibility of the mathematics program was not to the directors of the Astronomical Bureau but to Chengde 成德, a Manchu high official who had studied at the Studio for Cultivating the Youth.³⁰ This arrangement ensured that both organizations operated independently from each other.

The initiation of the mathematics program at the Eight Banners Public Schools suggests that the Yongzheng emperor felt the need to cultivate more officers who had mathematical expertise. The Kangxi emperor left him a group of young civil servants like He Guozong, Mei Juecheng, and Chengde, whose mathematical talents could service the imperial state beyond the Astronomical Bureau. After more than a decade of rule, perhaps Yongzheng had come to the same realization as his father: mathematics was useful in various kinds of government institutions. In this vein, the Yongzheng mathematics program can be viewed as an attempt to institutionalize what the Kangxi emperor had done at the Studio for Cultivating the Youth.

³⁰ Wu, *Qingguo shi*, 4:626.

Although Yongzheng did not have his father's ability to teach mathematics in person, he could relegate this task to the best court mathematicians.

Unfortunately, the Yongzheng emperor died a year after the mathematics program was started. Worse, the addition of mathematics courses into the general curriculum did not seem to be welcome among his contemporaries. In June 1736, high courtiers and the emperor rejected Mei Juecheng's suggestion to include mathematics in the civil service examinations and give special rewards to those who excelled at answering mathematical questions.³¹ Without a clear purpose and reward, the Yongzheng mathematics program deteriorated into failure.

In 1738, Sun Jiagan 孫嘉淦, the supervisor of the Imperial College, submitted a plan that detailed how the Eight Banners public schools could be improved. One of his suggestions was to terminate the mathematics program. Sun claimed that the public schools should be focused on producing future Banner officers who were trained in translation and Chinese classical study. The art of mathematics, Sun argued, was "too delicate for the youth to understand in a short period."³² Under the current system, the public school students were distracted from their original goal and failed to acquire adequate mathematical knowledge. Sun stressed, "Mathematics is a business belonging to the Astronomical Bureau."³³ He concluded that the teaching of mathematics should be carried out by the Astronomical Bureau, not by the Eight Banners public schools.

After having some courtiers discuss Sun's suggestion, the Qianlong emperor agreed to transform the mathematics program into a specialist school. Chengde 成德, the chief supervisor of the public school mathematics program, was appointed the chief supervisor of the new

³¹ Yunlu et al., *Yingyin Zhaizaotang siku quanshu huiyao*, 270:3–4.

³² Wenqing, *Guozijian zhi*, 752:476.

³³ *Ibid.*

mathematics school. As with Gucong, Chengde was a former colleague of He Guozong.

Chengde was the vice director of the Astronomical Bureau around 1711.³⁴ In 1712, the Kangxi emperor ordered Chengde and He Guozong to accompany him to the Summer Palace.³⁵

Afterward, Chengde worked at the Studio for the Cultivation of the Youth. It is not surprising that, as with Gucong, Chengde nominated Mei Juecheng and He Guozong as the assistant supervisors of the College of Mathematics.³⁶

The College of Mathematics officially commenced in December 1739.³⁷ Although the Qing official records always included the Yongzheng mathematics program when tracing the origin of the College of Mathematics, the College of Mathematics bears little resemblance to its predecessor. The Yongzheng mathematics program was part of the general education provided for future Banner officials. In contrast, the College of Mathematics aimed to produce mathematics specialists to work for the Astronomical Bureau. He Guozong won the seat to supervise the College of Mathematics. However, the Qing court forever lost the vision of cultivating officials who were both scholars in classics and mathematicians, such as He Guozong and Mei Juecheng.

7.3 College of Mathematics

Instead of being a new educational institution or program, the College of Mathematics functioned more like an expansion of the Astronomical Bureau. Prior to the formation of the College of Mathematics, the training and education of the Bureau's officials were rather informal and unsystematic. As already described in previous chapters, The Qing court's swift decision to

³⁴ Qu, "Qingdai Qintianjian," 52.

³⁵ Wu, *Qingguo shi*, 4:626.

³⁶ SL 10:280–1.

³⁷ IHP 020636.

adopt the New Western Method did nothing to increase the attractiveness of a career as a professional mathematician. Until the last years of the Shunzhi reign, Schall, the head of the Astronomical Bureau, still had difficulty finding staff. The Calendar Dispute that occurred in the first decade of the Kangxi reign only served to increase the Bureau's lack of appeal as a place to work. In that period, any Han Chinese who were willing and had the basic ability to learn mathematics were able to obtain the position of student astronomer without much difficulty. Indeed, when the earliest Bannermen were added to the Bureau in 1665, they started as erudites, despite lacking any previous experience in mathematics.³⁸ The situation seemed to have gradually improved after the Kangxi emperor decreed in August 1676 that the Bureau officials could only earn promotion by mastering the New Method.³⁹ Although seeming to teach in an informal setting, Ferdinand Verbiest claimed he had 160 to 200 disciples in the Astronomical Bureau.⁴⁰ After the College of Mathematics was founded, mathematics students became a bottom layer below the student astronomers. Newcomers to the Bureau were rerouted to the College of Mathematics first. Only after passing the graduation examination did they obtained the license of student astronomers.

Although this rerouting delayed one's career progression, it did have its rewards. Previously, most Banner student astronomers started their career at the Astronomical Bureau with little experience in mathematics. They were required to remain with the Astronomical Bureau even if they made little progress in learning mathematics. After the College of Mathematics was founded, a public school student who was considering a career at the Astronomical Bureau could transfer to the College of Mathematics, where he would receive

³⁸ SL 4:229.

³⁹ SL 4:804.

⁴⁰ Jami, "Learning," 237–38.

mathematics lessons. His monthly student stipend and his rights to take the civil service examinations stayed the same. He could choose to transfer back to the public school if he felt that mathematics was not his destiny.⁴¹

The College of Mathematics also was beneficial to Han Chinese. Han Chinese could enter the College of Mathematics by passing the entrance examinations held by the College of Mathematics or the Astronomical Bureau. In the first few years of operation, the College of Mathematics had only thirty-six students: twelve Manchus, six Mongols, six Han-Martials, and twelve Han Chinese.⁴² These students were called mathematics students (*suanxue sheng* 算學生). In 1745, the Astronomical Bureau decided that maintaining a separate program to train its own apprentices, called astronomy apprentices (*yiye tianwensheng* 肄業天文生), was redundant.⁴³ It was decreed that the apprentices of the Water Clock Section should remain in the Bureau but those who belonged to the other sections should study at the College of Mathematics. In 1756, the quota of astronomy apprentices was fixed at thirty; among them, twenty-four were called mathematics apprentices (*suanxue yiyesheng* 算學肄業生), for they were sent to study at the College of Mathematics.⁴⁴ The twelve Han mathematics students and twenty-four mathematics apprentices together constituted the most significant difference between the College of Mathematics and the Yongzheng mathematics program. The Yongzheng mathematics program was part of the public educational system for Bannermen, which excluded Han Chinese. The College of Mathematics was an institution that aimed to recruit and train future officials for the Astronomical Bureau. Because the Astronomical Bureau needed Bannermen and Han Chinese,

⁴¹ Guozijian 國子監, *Qinding Guozijian zeli* 欽定國子監則例, 1037–38, 1041–42.

⁴² Ibid., 1035.

⁴³ Ibid., 1027.

⁴⁴ IHP 133172.

the College of Mathematics was open to both. In fact, it had more Han Chinese students than Banner students.

It is noteworthy that the benefits offered to the Han mathematics students and to the apprentices of astronomy were different. Han mathematics students were basically treated as public school students. They were given a stipend and were allowed to wear the same robes and decorations as public school students when attending an official ceremony.⁴⁵ Apprentices of astronomy, however, were not given a stipend.⁴⁶ This is probably because apprentices of astronomy were not regarded as formal students of the College of Mathematics but as apprentices of the Astronomical Bureau. With the exception of the stipend, courses and periodical examinations were administered to mathematics students and apprentices alike, and there seemed to be no difference in the academic requirements imposed on each group.⁴⁷

Before the College of Mathematics was founded, a Han Chinese student without a family history of serving the Astronomical Bureau would have to begin working and studying at the Astronomical Bureau as an informal apprentice of astronomy. There was no standardized course for teaching the apprentice, and he would not receive any stipend until he passed the examination for the position of student astronomer. After the College of Mathematics was founded, a Han Chinese with sufficient mathematics knowledge could become a mathematics student, and in this capacity he received a monthly stipend while he prepared for the student astronomer examination. If the person's mathematical knowledge was not yet sufficient to qualify him as a mathematics student, he could still become a mathematics apprentice, and in this capacity he had access to the teaching at the College of Mathematics.

⁴⁵ Guozijian, *Qinding Guozijian zeli*, 1038.

⁴⁶ QHDSL QL 625:131.

⁴⁷ IHP 129743.

Although the College of Mathematics had one or two superintendents directly appointed by the emperor, the individual in charge of its day-to-day teaching and administration was the associate professor (*Zhujiu* 助教).⁴⁸ Under the associate professor were two assistant professors (*Jiaoxi* 教習) and three teaching assistants (*Xietongfenjiao* 協同分教).⁴⁹ The position of associate professor was honorable, not only because of the administrative responsibility involved but also because of the difficulty associated with obtaining the role. A teaching term at the College of Mathematics was five years. Thus, the vacancy of mathematics associate professor did not arise often. Once the position was available, the Astronomical Bureau held an examination that all erudites and mathematics assistant professors could sit and the post of associate professor was rewarded to the individual who performed the best in the examination.⁵⁰ After fulfilling the five-year teaching term, the associate professor surpassed other senior colleagues and became the supervisor of the Five Offices at the Calendar Section as soon as a seat was available. Namely, the associate professorship was a great opportunity for Bureau mathematicians to make faster career advancement. One such case was that of He Guodong.

Just as the amendment of the Timely Modeling system restarted He Guozong's career, the founding of the College of Mathematics was critical to the career of He Guodong. He Guodong seemed unable to obtain a decent position after he lost the position of Dingzhou Prefect in 1725. He likely had taught at the Eight Banners public schools' mathematics program. Therefore, when the program was reorganized into the College of Mathematics, he obtained one of the assistant professorships.⁵¹ After one teaching term of assistant professorship and one

⁴⁸ Guozijian, *Qinding Guozijian zeli*, 1023.

⁴⁹ Ibid., 1025–1029.

⁵⁰ SL 4:804.

⁵¹ Wenqing, *Guozijian zhi*, 752:204.

associate professorship, He Guodong became supervisor of the Middle Office in 1751.⁵² Such a position came with far less political power and financial benefits than the prefect that he held twenty-five years ago. Nonetheless, it was so stable and easy that Guodong repeatedly requested an extension to his tenure. He did not transfer to another institution until 1767, at which point he was already seventy-eight years old.⁵³

He Guodong was not the only one to benefit from taking up a teaching position at the College of Mathematics. Zhaohai 照海 was a Provincial Graduate and one of the earliest members serving in mathematics. In December 1714, the Kangxi emperor sent He Guodong to Guangdong to measure the height of the North Pole, while Zhaohai was sent to Zhejiang.⁵⁴ After the *Thorough Investigation* was finished, Zhaohai became an assistant department director at the Ministry of Works.⁵⁵ The fact that Zhaohai and He Guodong both had to serve three additional years after finishing the first teaching term of the assistant professorship as proof of their diligence indicates that Zhaohai, like He Guodong, had lost his job in the previous reign.⁵⁶ In April 1748, Zhaohai finally obtained the post of observatory manager.⁵⁷ He stayed in this position for the next ten years.⁵⁸

He Guodong and Zhaohai obtained the associate professorships because they previously had been associate professors in the Yongzheng mathematics program.⁵⁹ Afterward, the Astronomical Bureau held examinations of student astronomers to select the assistant professors for the College of Mathematics, while teaching assistants were senior or graduated mathematics

⁵² Qu, “Qingdai Qintianjian,” 56.

⁵³ QGLL 19: 275–76.

⁵⁴ SL 6:571.

⁵⁵ Yunlu et al., *Yuzhi lixiang kaocheng houbian*, 270:6.

⁵⁶ IHP 051694; NPM 002237.

⁵⁷ NPM 002237.

⁵⁸ QGLL 29:390; Shi, “Qing Qintianjian Tianwenke,” 39.

⁵⁹ Guozijian, *Qinding Guozijian zeli*, 1035.

students who were specifically chosen to share the professors' teaching load.⁶⁰ A mathematics associate professor's salary and food stipend was the same as that of an associate professor of the Eight Banners public schools.⁶¹ However, neither the associate professorship nor teaching assistantship brought as much career advantage as the associate professorship. Unless he was a civil service degree holder, after finishing the teaching term, an associate professor was normally rewarded with a seat of erudite in the Calendar Section or the Section of Heavenly Signs. Zhaohai obtained the post of observatory manager because he held the Provincial Graduate degree. However, it might be the lower civil ranks and the hardship of working at the observatory that led He Guodong to choose to work the five-year term of assistant professorship so that he could become one of the supervisors at the Calendar Section. For the teaching assistants who were still mathematics students, they had to take periodical examinations with the rest of the students, and they were not given additional monthly stipends or any special promotion after completing the teaching terms.⁶²

Very few records describe exactly how the teaching activities were conducted at the College of Mathematics. Unlike the civil service examinations that were held according to a fixed schedule, the College of Mathematics and the Astronomical Bureau held entrance examinations whenever they accumulated a certain amount of vacancies.⁶³ The official curriculums prescribed a five-year program. The first three years, the students learned mathematics from the textbook the *Essential Principles of Mathematics*. The last two years, they

⁶⁰ Wenqing, *Guozijian zhi*, 751:652. The requirement seemed to change to the student astronomer license holders. See IHP, 119130.

⁶¹ Ibid., 281, 282, 1032, 1037, 1038.

⁶² Wenqing, *Guozijian zhi*, 751:652.

⁶³ IHP, 152974, 080794, 26237, 226534, 099857.

studied astronomy.⁶⁴ A late-Qing document indicated that students might have been divided into three classes 堂, a possible imitation of the Six Classes 六堂 system implemented in the Imperial College, and then assigned to different professors.⁶⁵ The graduation examination was held every five years and all but the first-year students could take it. Thus, some might have studied at the College for less than five years.⁶⁶

In sum, the College of Mathematics founded in the early Qianlong era was the opposite of the Yongzheng mathematics program in almost every aspect. Its goal was relatively moderate yet clear: to train mathematics specialists who would work for the Astronomical Bureau. Within the government organizational chart, the College of Mathematics was subordinated to the Imperial College 國子監. This affiliation made the College of Mathematics a state-level public school and gave its teachers and students certain benefits and social status. However, the College of Mathematics had its own campus, administrative system, channels of recruiting students, and curriculum. These two institutions, in fact, had very limited connections. On the other hand, the goal of the College of Mathematics was to be aligned with the Astronomical Bureau. Its teachers were chosen from the Bureau officials and students aimed to enter the Bureau after graduation. Often the emperor assigned the superintendency of the College of Mathematics and the Astronomical Bureau to the same person. In the late Qing period, the Han Astronomical Bureau directors often concurrently worked as the assistant superintendents of the College of Mathematics.

⁶⁴ QHDSL QL, 625:131.

⁶⁵ *Juezhi quanlan Guangxu jiachen Ronglutang ban* 爵秩全覽 光緒甲辰榮祿堂版, CKZB 130:263.

⁶⁶ IHP 020636.

Chapter 8

Maintaining a Familial Career

8.1 Specialty

By mid-1745, He Guozong obtained the superintendency of both the College of Mathematics and the Astronomical Bureau.¹ Guozong's new position placed him above European and Manchu Bureau directors. Although European missionaries would stay with the Qing Astronomical Bureau until 1826, the extent to which they had the power to influence the Bureau and the court was diminishing. Mathematician families reached their heyday in the Qianlong and Jiaqing reigns, not in the sense of scientific achievements but in the degree of power and control that they had over the Astronomical Bureau.

He Guozong held the superintendency until May 1757, at which point the Qianlong emperor stripped him of all government positions following the accusations that Guozong had behaved dishonorably by recommending his own brother, Guodong, in the Metropolitan Inspection.² While recommending one's own relatives was indeed improper, the emperor's punishment appears somewhat harsh. The system in the Astronomical Bureau differed from the rest of the bureaucratic system in that it did not forbid members of the same family from working in the same institution. In fact, as described in previous chapters, family members were actually encouraged to join the Bureau. Therefore, it was not a single misconduct but rather a series of incidents that had occurred over the preceding months that led to Guozong's discharge. The worst of which took place when the Qianlong emperor wrongly accused the Astronomical Bureau of failing to report the first thunder of the year on time. Following an investigation, the

¹ IHP 023912.

² Wu, *Qingguo shi*, 6:484; GHDSL GX 799:320.

Astronomical Bureau was cleared of all charges. However, the emperor seemed to feel that his authority had been violated and that He Guozong should still be punished for attempting to cover up another department's mistake.³

Fortunately, the emperor's anger did not prevail. A month after He Guozong's discharge, the Qianlong emperor pardoned him on the grounds that "He Guozong has been idle and doing nothing at home. Mathematics, after all, is a specialty that his family has mastered generation after generation."⁴ He Guozong lost the superintendency of the Astronomical Bureau and the College of Mathematics, but neither Guodong nor any other He family member was punished.⁵ Their reputation as mathematicians saved He Guozong and his family. By the time Guozong retired completely from public service in 1762, the He family was again flourishing, if not dominating, within the Astronomical Bureau.

The official rosters of the annual calendar testify to the He family's rise and fall throughout the Qing dynasty. Figure 16 shows how the number of high officials obtained by the He family changed throughout the Qing dynasty. There are three high points in figure 16. The first one occurred around 1675 and corresponds to the rise of the earliest generation of the He family in the Kangxi Calendar Dispute. This rise was not sustained because the court no longer appreciated the He family's specialty in the Great Concordance system, and He Junxi was in the process of moving the family into the new profession of civil servant. Subsequently, the Yongzheng emperor suppressed the He family, and it fell into a decline. However, the He family climbed to its second high point in the early Qianlong era when He Guozong was appointed superintendent of the Astronomical Bureau in 1744. During this period, three of Guozong's

³ IHP 197213.

⁴ Wu, *Qingguo shi*, 6:484.

⁵ Ibid.

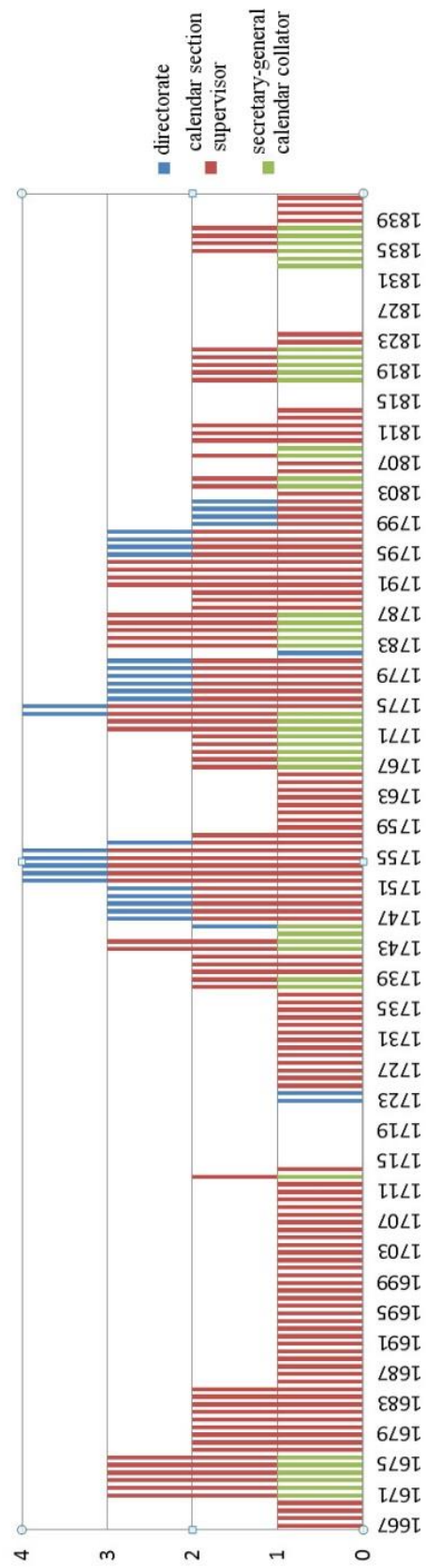


Figure 16. The rise and down of the He family.

Source: Qu Chunhai 屈春海. "Qingdai Qintianjian ji Shixianke zhiguan nianbiao," *China Historical Materials of Science and Technology* 中國科技史料 18, no. 3 (1997): 45–71.

brothers or cousins—Guoxiu 國秀, Guoqing 國卿, and Guodong 國棟—advanced to the positions of supervisors of the Five Offices. The He family constantly held two seats, sometimes three, of the five supervisors of the Five Offices reserved for Han Chinese.⁶

Until the end of the Jiaqing reign (1796–1820), the surname He frequently appeared on records related to the Calendar Section. Guozong's brothers and cousins—namely, members of the generation that had the character *guo* 國 in their names—retired by the mid-Qianlong reign. By that time, a new generation had worked at the Bureau long enough to enter its upper echelon. When Supervisor of the Middle office He Guodong left the Bureau in 1767, his post was succeeded by He Tinglu 何廷祿.⁷ Soon more names from the *ting* 廷 generation appeared on the official roster of annual calendar: He Tingxu 何廷緒, He Tingxuan 何廷瑄, and He Tingxuan 何廷璿, to name but a few.⁸ Before the Qianlong emperor abdicated in favor of his son, the Jiaqing emperor, in February 1796, six more members from later generations of the He family had served as supervisors of the Five Offices. Three of them advanced to vice director. In sum, this research found that more than forty He family members served at the Astronomical Bureau between the Qianlong and Daoguang reigns (1736–1850).⁹ Although the He family gradually went into decline during the Jiaqing reign, it managed to produce four more supervisors of the Five Offices and continued to hold at least one seat of the Han supervisors of the Five Offices until 1808.¹⁰

⁶ Ibid., 55–56.

⁷ QGLL 19:275; Qu, “Qingdai Qintianjian,” 57.

⁸ Qu, “Qingdai Qintianjian,” 57–58. He Tingxuan 何廷璿 is recorded as He Tingxuan 何廷璇 in Qu's table. See He Tingxuan's résumé in QGLL 21:336 and IHP 053505.

⁹ See Appendix B.3.

¹⁰ Ibid., 57–61.

The He family built and maintained its status on the basis of the superior mathematical talent of its members. The earliest members earned their fame during the Kangxi Calendar Dispute by lending their knowledge and support to the opponents of the European Tychonic system. Decades later, He Guozong 何國宗 and his brothers became the core members of the Kangxi emperor's compilation project of the *Origins of Mathematical Harmonics and Astronomy* 律曆淵源, part of which became the textbook for the College of Mathematics and the guidebook for the Astronomical Bureau. It was not surprising to see that the two earliest assistant professors of the College of Mathematics were from the He family: He Guoqing 何國卿 and He Guodong 何國棟.¹¹ With special insight into the intellectual foundation of the Qing Astronomical Bureau, the best career strategy for the He family surely was to send its descendants to the most mathematically demanding section, the Calendar Section, and then to the Section of Heavenly Signs.

The He family was typical of many mathematician families in that the majority of its members clustered in the same section. For instance, among all the officials found in archival documents that had the surname Huang 黃, a surprisingly high proportion belonged to the Section of Heavenly Signs. The surname Huang is too popular to assume that all of them were from the same family. Nevertheless, some assertions based on the name patterns and their service periods are possible. First, the similarity of the given names suggests that Huang Daohua 黃道化 and Huang Daolong 黃道隆 were brothers or cousins. Other records show that they had worked for the Section of Heavenly Signs since the Ming period and that they were observatory

¹¹ Wenqing, *Guozijian zhi*, 752:204.

managers in the Shunzhi reign.¹² When Huang Daolong died on a business trip to Fujian in 1658, his son, Huang Chang 黃昌, had already started working at the Bureau as a student astronomer.¹³ The name Huang Gong 黃鞏 appeared on archival documents around the same period as Huang Chang. It is highly likely that Huang Gong and Huang Chang were cousins. Both of them became observatory managers by 1677.¹⁴ From the mid-Kangxi reign to the end of the Yongzheng reign, no other Huang official is named in the archival documents. Therefore, it is hard to assert that the group of Huang officials mentioned in state papers of the Qianlong and Jiaqing periods were related to the earlier Huang members who served in the Shunzhi and Kangxi reigns. Nevertheless, four of the five Huang officials named in later documents served in the Section of Heavenly Signs. Moreover, the similarity between the names of Huang Dequan 黃德泉 and Huang Deyuan 黃德源, two observatory managers during the late Daoguan period, suggests that they were brothers.¹⁵

A family had to avoid competition among its own members. Sending its members into the same section helped to preserve a family's expertise, but the number of manager-level positions in each section was very limited. Overclustering within a section in which the family was already established would not help a family to gain more control. A reasonable arrangement in such a situation was to send some descendants to develop their career within an alternative section. It is noteworthy that He Guoan 何國安, He Tingxu 何廷緒, and He Tingchen 何廷琛

¹² For Huang Daohua, see Xu, *Xinfa suanshu*, 99, and Shi, "Qing Qintianjian Tianwenke," 36–37. For Huang Daolong, see Wenxian congbian, 28:15, and Shi, "Qing Qintianjian Tianwenke," 36–37.

¹³ IHP 085861; Johann Adam Schall et al., "Zou Shu. Rapports Officiels" 奏疏, Bibliothèque nationale de France, Département des manuscrits, Chinois 1326, accessed October 2014, <http://gallica.bnf.fr/ark:/12148/btv1b9002724r>.

¹⁴ Shi, "Qing Qintianjian Tianwenke," 37.

¹⁵ Ibid., 44. Huang Dequan was an observatory manager from 1839 to 1845, while Huang Deyuan served in the same capacity between 1846 and 1867.

belonged to the Water Clock Section, not the Calendar Section or the Section of Heavenly Signs.¹⁶ Among them, Guoan should have obtained the post of water clock manager if the Yongzheng emperor did not suspect that the He family had overexpanded. Tingxu and Tingchen were water clock managers. Afterward, both became secretary-generals.

On the other hand, it is also possible that a family might change its specialty over the course of serving the Astronomical Bureau. The example of the Si 司 family, whose members began their careers at the Astronomical Bureau before the Ming-Qing transition, can be used to illustrate such a point. The names of the Si family members are among the earliest to appear on the records related to the Water Clock Section. Si Ergui 司爾珪, Si Ermao 司爾瑁, and Si Ercheng 司爾璵 were yin-yang students when Johann Adam Schall took over the Astronomical Bureau (see Appendix B.2). Si Ergui seemed to maintain a good relationship with the Jesuits. He endorsed Schall's *Response to Concerns about the Notes on Civil Calendar* and lost his job during the Kangxi Calendar Dispute (see tables 5 and 6). In 1689, Si Ermao became the first Si family member to obtain the vice directorship.¹⁷ Throughout the Qing dynasty, more than twenty people from the Si family worked for the Astronomical Bureau.¹⁸ The Si family produced at least five water clock managers; among them, three advanced to the vice directorship or even directorship. However, by the late Qianlong reign, the Si family diverted some of its members from the Water Clock Section to the Calendar Section. In the late Qianlong and Jiaqing reigns, Si Tinggan 司廷幹 worked as an observatory manager while Si Tingdong 司廷棟 was the supervisor of the Winter Office. Some Si family members continued to work at the Water Clock Section, but Si became one of the frequently seen surnames in records related to the Calendar

¹⁶ GYQX 1994.

¹⁷ Qu, "Qingdai Qintianjian," 51.

¹⁸ See Appendix C.4.

Section. In 1867, Si Yitian 司以田, an erudite of the Calendar Section, won special recommendation for his excellent performance in the triennial examination.¹⁹ During the Daoguang reign, Si Yipei 司以培 was the supervisor of Summer Office and Si Yisun 司以埴 was a calendar collator.²⁰

Mastering the mathematical specialty needed for at least one section was key to a mathematician family's ability to survive in the Astronomical Bureau. However, to maintain steady career progression, a family needed more than mathematical knowledge and skills alone. The next section will discuss one of the most important tactics that a mathematician family as a whole employed to prolong its status within the Bureau.

8.2 *Remaining in the Astronomical Bureau*

One of the biggest differences between the Ming and Qing Astronomical Bureaus was that Han officials of the Qing Astronomical Bureau could transfer out of the Bureau to work for other government departments. Originally, only Banner officials who had reached the top of their career ladders at the Bureau were rewarded with higher-ranking positions in other departments. When a Han official reached the upper echelon of the Bureau, his civil service rank and salary continued to rise, but he had to remain in the Astronomical Bureau for his entire life. This restriction was designed to help the Astronomical Bureau to retain proficient mathematicians. However, it became a concern to some potential candidates who did not spend their whole lives working for the Astronomical Bureau. After the compilation of *Origins of Mathematical Harmonics and Astronomy* went on for several years, the Kangxi emperor felt that more

¹⁹ IHP 182598.

²⁰ QGLL 27:686; Qu, "Qingdai Qintianjian," 67–68.

mathematicians were required. In 1719, the emperor decreed that Han Bureau officials should be bestowed similar abilities to transfer as Banner officials. Following that, a vice director was allowed to leave the Bureau to become an assistant department director 員外郎 of the Six Ministries, and a Calendar Section supervisor could obtain a post that was equivalent to second-class secretary 主事.²¹

However, historical records reveal that not all officials of the Astronomical Bureau appreciated the option to transfer to other government departments. Two decades after the transfer regulations were introduced, Luoerzhan 羅爾瞻, a newly appointed Manchu vice director, reported a worrisome phenomenon to the Qianlong emperor. In November 1739, Luoerzhan wrote,

When an official was at the juncture of being promoted by transferring [to other institutions], he often wrote on the résumé that he prefers having the title elevated but remaining in the current position 陞銜留任. Currently, within the two vice directors and five supervisors of Five Offices of my bureau, five have already applied to elevate the titles while remaining in current positions. If in the future any other official applies to stay, senior officials will occupy the Bureau as their nursing home and care only about their descendants. In that case, junior officials' career progression will be slowed down and they will not have a chance to test their talent.²²

Based on the date the memorial was written, the five officials named by Luoerzhan should be Vice Director Li Tingyao 李廷耀 and the Calendar Section Supervisors: Qin Ning 秦寧, He Guochen 何國宸, Fang Gu 方穀, and Bao Qinhuai 鮑欽輝.²³ Moreover, other historical records help us to further examine the phenomenon of elevating the title while remaining in the current position.

²¹ QHD YZ 534–36.

²² IHP 194605.

²³ See the official roster of IHP 048439 submitted in March 1737.

The résumés used for the imperial audiences of four of the five officials mentioned above are still available. A brief recounting of the contents of these résumés is necessary to understand the career development of the individuals involved. After fulfilling the role as supervisor of the Middle Office for five years and ten months, He Guochen, a younger brother of He Guozong, received the order to transfer to the Ministry of Punishment as an assistant department director in October 1729.²⁴ Guochen did not specifically state on his résumé that he would like to remain in the Astronomical Bureau; however, he did disclose that he was dull and without experience, thus he found the prospect of the potential transfer to be as terrifying as being thrown into deep ice.²⁵ Li Tingyao originally worked as a water clock manager before becoming the vice director in 1732.²⁶ Less than a year and a month later, Li received the transfer order. On his audience résumé, Li begged to remain in the profession of *xiangdu* selection, stating that he was not familiar with the law and administrative affairs.²⁷ Qin Ning was a District Graduate (*shengyuan* 生員) before becoming a member serving in mathematics. After the *Origins of Mathematical Harmonics and Astronomy* was completed, Qin entered the Astronomical Bureau as a Calendar Section supervisor. The Yongzheng emperor granted his request to continue to stay in the Bureau in March 1734.²⁸ Eight months after Qin's request was approved, another supervisor, Bao Qinhui, received the transfer order. Bao was from a Christian family that Jesuit missionaries had brought into the Astronomical Bureau. Qinhui's grandfather was a younger brother of Vice Director Bao Yinqi, who was Johann Adam Schall's disciple. On his résumé to the Yongzheng emperor,

²⁴ GYLL 11:448.

²⁵ GYLL 11:453.

²⁶ GYQX 10799; Qu, "Qingdai Qintianjian," 54–55.

²⁷ GYLL 12:667, 672.

²⁸ GYLL 13:64–65.

Qinhui wrote, “I worry about my stupidity. Except the knowledge of calendar making, there really is not anything that I can contribute.”²⁹

The diverse background of the above four officials suggests that applying for an elevated title but remaining in one’s current position was a career strategy broadly adopted by the professional mathematicians of the Astronomical Bureau. These four officials were Han Chinese. However, famous Mongolian mathematician Ming’antu also applied for permission to remain in the Astronomical Bureau. Ming’antu did not leave the Bureau until illness forced him into retirement around 1764.³⁰ Why did the high officials at the Astronomical Bureau not want to transfer to other institutions? Almost all Bureau officials appealed to stay on the premise that they were unfamiliar with administrative affairs 不曉吏治. Is this indeed the reason that led them to think that it would be safer to “occupy the yamen [Bureau] as their nursing home,” as Luoerzhan put it? A reconstruction of the career path of Liu Yuxi 劉裕錫 provides a starting point from which a number of questions can be explored.

Liu Yuxi was one of the five Astronomical Bureau officials recorded in the *Gangzhi* 岡誌, a local history of the Beijing Muslim community that was published in the Qianlong period.³¹ The *Gangzhi* described Liu as “calm, elegant, and fond of studying; well learned in astronomy and medicine; and particularly good at making instruments and fanciful things.”³² However, according to his audience résumé, Liu’s career at the Astronomical Bureau got off to a slow start. Liu joined the Astronomical Bureau to learn calendar making in 1691, but he did not obtain the

²⁹ GYLL 13:189–90.

³⁰ Qu, “Qingdai Qintianjian,” 57; Wu, *Qingguo shi*, 12:891.

³¹ *Gangzhi*, 191–96. Besides Liu Yuxi 劉裕錫, the other four were Liu Yuduo 劉裕鐸, Wu Mingxuan 吳明炫, Xue Zongjun 薛宗雋, and Zue Zongwei 薛宗偉. Liu Yuduo was Liu Yuxi’s brother. Xue Zongjun was a supervisor of the Summer Office in the mid-Kangxi period, and Zue Zongjun was his younger brother.

³² *Ibid.*, 194.

lowest-level position, student astronomer, until 1709.³³ At that time, he was already thirty-three years old. Liu's résumé did not explain why it took him so long to obtain an official position at the Astronomical Bureau. One could only wonder as to whether the fact he was a Muslim had any effect.

Nevertheless, Liu attracted special attention from the Kangxi emperor and then the Yongzheng emperor. Liu claimed on his résumé that he was able to “pay a tribute to the profound depth of imperial learning” of the Kangxi emperor because he was ordered to work at an inner-court study room of the imperial garden Changchun Yuan 暢春園, where the emperor had personally taught him mathematics.³⁴ Liu also worked at the Studio for Cultivating the Youth for some years, presumably for the compilation of the *Origins of Mathematical Harmonics and Astronomy*. Following this, probably due to his knowledge of Muslim calendar, Liu was given the responsibility to translate the Mongolian and Tibetan calendars. Liu continued to serve in the inner court after the Yongzheng emperor ascended to the throne. The Yongzheng emperor allocated him to a range of geographical projects such as drawing up maps of river courses and imperial tombs. In March 1725, the Yongzheng emperor bypassed another candidate and elevated Liu to the position of supervisor of the Winter Office.³⁵

Liu Yuxi's career took an unfortunate turn between 1731 and 1732. In January 1731, Liu received a transfer order. Liu begged the Yongzheng emperor to allow him to remain in the Astronomical Bureau. He explained, “Although I am capable of financial and resource accounting, I am not able to understand the law or regulations in detail. Since my heart does not have self-confidence, how dare I try it out rashly? I humbly beg Your Majesty to save me kindly

³³ QGLL 2:191.

³⁴ Ibid.

³⁵ GYQX 7:3737–38.

by considering my ability and to allow me to stay at the Astronomical Bureau.”³⁶ The Yongzheng emperor did not accept Liu’s appeal. In just six months, Liu made mistakes that were serious enough to cost him his job. The Yongzheng emperor kindly allowed him to return to the Astronomical Bureau as an erudite, but Liu seemed too depressed to concentrate on his work. He was dismissed from the Astronomical Bureau after the triennial Metropolitan Inspection in 1732.³⁷

Liu Yuxi was not able to regain a government position until the compilation of the *Thorough Investigation of Instruments and Phenomena* (*Yixiang kaocheng* 儀象考成) began. In August 1745, He Guozong and the other directorate requested that the Qianlong emperor re-employ Liu. They told the emperor that Liu had voluntarily worked at the Office of Instrument Production 儀器造辦處 and had been “industrious and careful.”³⁸ More importantly, Liu’s calculation ability and special talent for instruments would be particularly suitable for teaching the Bureau officials and students. The Qianlong emperor did not approve their petition immediately, but this was not too surprising if one recalls that He Guozong and Guodong had to work at the Office of Compiling Mathematical Treatises and the College of Mathematics for years before regaining civil service ranks and posts. When the treatise *Thorough Investigation of Instruments and Phenomena* was completed in 1754, Liu Yuxi was listed at the end of the contributor roster with the title “Erudite of the Astronomical Bureau.”³⁹ However, at that time, Liu was already seventy-eight years old. There is no evidence to suggest that Liu had ever advanced to any position higher than erudite. The second half of Liu’s life was ruined by the

³⁶ QGLL 2:192.

³⁷ IHP 022183.

³⁸ Ibid.

³⁹ Yunlu et al., *Qinding yixiang kaocheng*, 18.

mistakes he made at his new workplace. He probably would have enjoyed a more stable and comfortable life if the transfer regulations had not forced him to leave the Astronomical Bureau.

Surviving historical records are not sufficient to provide a complete analysis of the career developments after officials were transferred out of the Astronomical Bureau; however, at least two aspects deserve attention. First, Liu Yuxi was not the only individual whose career suffered an unfortunate turn after he was transferred out of the Astronomical Bureau. In the Jiaqing period, former supervisor of the Winter Office Si Tingdong 司廷棟 lost his new job at the Ministry of Revenue within a year because a fire destroyed the storage under his supervision. Following a petition from his former colleagues, the emperor allowed Si to return to the Astronomical Bureau as a student astronomer. Si was already fifty-eight years old but had to re-climb the career ladder from the bottom.⁴⁰ Because the promotion system in the Astronomical Bureau had been revised in the early Daoguang reign, Si's career advanced at a rapid pace.⁴¹ As such, Si was luckier than Liu Yuxi, but Si wasted almost a decade regaining his original position as a Calendar Section supervisor.⁴²

Second, it was highly likely that career life span remaining was not sufficient for an official to build a brilliant new career once he had transferred out of the Astronomical Bureau. Table 8 shows that most officials were more than fifty years old when they left the Bureau. Some of them lived long enough to receive promotions twice or three times after the transfer, but none seemed to advance beyond the level of department director 郎中. The Kangxi emperor initiated this regulation probably because he believed that mathematicians could be good civil servants. However, succeeding emperors did not seem to share his belief that such individuals could

⁴⁰ IHP 065595.

⁴¹ See chapter 9.

⁴² Qu, "Qingdai Qintianjian," 63.

Table 8. Officials' ages and positions when receiving the order to transfer out of the Astronomical Bureau

Name	Date	Age	Position
Shao Yunlong 邵雲龍	Oct. 1726	47	S
Min Chang 閔昶	Sep. 1728	51	V
He Guochen 何國宸	Sep. 1729	42	S ^a
Liu Yuxi 劉裕錫	Feb. 1731	55	S ^b
Li Tingyao 李廷耀	Feb. 1733	59	V ^a
Qin Ning 秦寧	Feb. 1734	59	V ^a
Bao Qinhuai 鮑欽輝	Oct. 1734	46	S ^a
Meng Taiyan 孟泰巖	Oct. 1738	46	S
Sun Shiying 孫士英	Oct. 1742	71 ^c	V ^a
Mao Jiazi 毛嘉梓	Oct. 1745	45	S
He Guoxiu 何國秀	Feb. 1748	55	S ^a
Chen Jian 陳諫	Dec. 1750	63	S ^b
Chen Zhiquan 陳世銓	Sep. 1751	51	V
Liu Yuqi 劉毓圻	Jul. 1753	58	V
He Guoqing 何國卿	Nov. 1755	52	S
Qi Kechang 齊克昌	Feb. 1758	73	V
Bao Huairan 鮑懷仁	Feb. 1760	52	S
He Guodong 何國棟	Mar. 1767	78	S
Liu Chaoyu 劉朝玉	Feb. 1768	55	S
Xu Pongnian 徐彭年	Sep. 1768	51	V
Du Zhaoxiong 杜兆熊	Oct. 1777	51	S
He Tingxuan 何廷璿	Oct. 1781	61	V
Li Tianyuan 李天垣	Oct. 1789	52	S
Jin Guangyi 金廣義	Feb. 1793	61	S
Si Hong pu 司鴻溥	Feb. 1794	60	V
He Yuanhao 何元浩	Feb. 1797	50	S
Guo Rangjie 郭讓傑	Feb. 1780	55	S

Name	Date	Age	Position
He Tingyin 何廷瑛	Feb. 1802	63	V
Gu Zhixiong 古之雄	Feb. 1805	71	S
He Yuanfu 何元富	Feb. 1808	56	S
Qi Chun 齊焞	Oct. 1808	54	V
He Yuantai 何元泰	Feb. 1814	55	S
Xu Han 許翰	Sep. 1815	50	S
Chen Lun 陳倫	Sep. 1816	68	V
Si Tingdong 司廷棟	May 1818	56	S
Jia Defu 賈德輔	Sep. 1828	58	S
Chen Qisheng 陳啟盛	Sep. 1850	57	V
Du Xiyin 杜熙英	Sep. 1854	47	S
Du Xiling 杜熙齡	Sep. 1857	44	S
Si Zhi 司智	Feb. 1861	55	V
Tong Shiliang 童世樑	Mar 1862	49	S
Ku Xiangfeng 古祥鳳	Sep. 1877	57	V
Du Xidong 杜熙棟	Sep. 1884	52	S
Si Yipei 司以培	Sep. 1887	56	S
Du Chunlin 杜春霖	Sep. 1896	53	S

Note: S = Han supervisor of the Five Offices, V = vice director.

Sources: *Qingdai guanyuan lilü dang'an quanbian* 清代官員履歷檔案全編, ed. Qin Guojing 秦國經 (Shanghai: Huadong shifan daxue chubanshe, 1997).

^a Petition to stay at the Astronomical Bureau was permitted.

^b Petition to stay at the Astronomical Bureau was rejected.

^c Estimation.

improve government accounting and the handling of finance and resources. The professional mathematicians of the Astronomical Bureau were sent out too late. No wonder some officials would rather turn inward to cultivate family interest within the Astronomical Bureau as opposed to taking the risk of starting a new career outside the Bureau.

Finally, it should be stressed that the Qianlong emperor and his predecessors were also responsible for this nursing home phenomenon. Despite Luerzhan's warning, the Qianlong emperor continued to approve Bureau officials' requests to receive elevated titles yet remain in their current positions. For instance, the official roster of a routine memorial of February 1766 indicates that Wang Deming 王德明, the supervisor of the Summer Office, should have transferred to become a second-class secretary at the Ministry of Revenue, but the emperor permitted him to remain in the Bureau.⁴³ No further evidence is available to provide insight into why Wang's request was granted, but the Qianlong emperor's comments on the case of Senior Vice Director Sun Shiyin 孫士英 revealed his concerns. Sun Shiyin received the transfer order in September 1742 after serving the Astronomical Bureau for fifty-four years. It is likely that Sun was already over seventy years old.⁴⁴ The Bureau directorate together petitioned the emperor for Sun's retention, not on the grounds of his irreplaceable mathematical knowledge but on the basis of his long and diligent service at the Bureau. The Qianlong emperor replied, "It seems Sun Shiyin is not up to the job of assistant department director at the Ministry of Punishments. His request to receive an elevated title yet remain as the vice director is granted."⁴⁵ Approving the petition submitted collectively by the Bureau directorate was a way to demonstrate imperial benevolence. Instead of forcing a senior member of the Astronomical Bureau to leave for a new

⁴³ IHP 079206.

⁴⁴ IHP 127466.

⁴⁵ Ibid.

institution, the emperor would rather win the mathematician families' loyalty by allowing him to remain in the Bureau.

Throughout the history of the Qing Astronomical Bureau, it is common to see examples of a vice director or a supervisor of the Calendar Section remaining in the same position for more than a decade. It seems that as long as the Bureau as a whole could fulfill its duties, the emperor did not pay close attention to the aging problem within the Astronomical Bureau. Nonetheless, Luerzhan's warning that younger officials did not have enough opportunities to test out their mathematical talent gradually came into fruition during the Qianlong and Jiaqing reigns. A reformation in the administrative system was necessary to stop the Bureau's deterioration.

8.3 The Social Status of Mathematics Students

In March 1831, Zhili Governor Nayan 那彥 delivered two suspects, Han Fangyu 韓方瑜 and Tian Yangzhong 田養中, to the Ministry of Punishments for further investigation. Nayan caught Han and Tian attempting to gain tax benefits by using fake mathematics student licenses. Following Nayan's inquiries, Tian admitted that he had purchased a fake license from an acquaintance the previous year. Han, however, insisted that he had taken and passed the College of Mathematics entrance examination in October 1827 at the Imperial College. Han claimed that because no vacancy had been available at that time, he was given the license and permitted to return to his hometown. Both Tian's and Han's faked license declared that they had earned the privilege of "wearing and using the uniforms of Imperial College students," meaning that they were no longer ordinary civilians but, in effect, held the same status as Imperial College students. Unsure about the official status of mathematics students, Nayan did not immediately throw Han

and Tian in jail. He requested an explanation from the College of Mathematics first before sending the suspects to Beijing for further investigation.⁴⁶

The above case shows that the title of mathematics student was a socially recognized identity in the Qing period. The College of Mathematics was not a new invention. Previous dynasties had set up the College of Mathematics whenever they could afford it and believed it to be desirable. It is the historical existence of mathematics students that prompted some commoners, such as Tian Yangzheng, to accept fake mathematics student licenses, though their original intention was to obtain the licenses of Imperial College students.

However, Nayan's caution in handling this case suggests that even high officials, who should have been more familiar with the civil service examination system, did not fully understand the statuses of the College of Mathematics and its students. In fact, the producers of the fake licenses did not know them either. Within the civil service examination system, the status of a mathematics student was lower than that of an Imperial College student and roughly equivalent to that of Banner public school students. The entrance examination of the College of Mathematics was indeed held at the Imperial College, but that was only because the College of Mathematics was a subordinate school of the Imperial College. As with Banner public school students, mathematics students had to pass a further examination on classical studies to become Imperial College students.⁴⁷ While the status of a mathematics student was high enough to merit paying for it, the mistakes on the fake licenses suggest that the career of a mathematics student was not well understood.

⁴⁶ IHP 225728.

⁴⁷ QHDSL QL 625:131.

Records in the *Collection of the Qing Vermillion Ink Examination Papers (Qingdai zhujuan jicheng 清代硃卷集成)* further testify to mathematics students' ambivalent social status. During the Qing era, civil service degree holders often printed the essays composed during the examination into booklets. These booklets were called *Zhujuan* 硃卷 because of the vermillion ink examination paper used in the examination grading process. Customarily, a *Zhujuan* always began with a simplified genealogy that showcased the family's previous achievements in the civil service. A survey of the surviving *Zhujuan* reveals that official positions at the Astronomical Bureau and College of Mathematics were included in these genealogies, even when the individuals involved were merely mathematics students or apprentices at those two institutions. For instance, a Metropolitan Graduate of the Daoguang reign found having an astronomy apprentice among his cousins was worth mentioning in the *Zhujuan* genealogy.⁴⁸ Another person from the same period counted two student astronomers of the Song dynasty (960–1279) among his ancestors.⁴⁹ A Provincial Graduate of the Jiaqing reign did not find it too insignificant to report that his wife's great-great-grandfather had been a student astronomer.⁵⁰

On the other hand, only a small number of *Zhujuan* genealogies contain records related to Astronomical Bureau mathematicians. Moreover, while a *Zhujuan* genealogy might easily contain hundreds of entries, it rarely has more than two entries that are relevant to the profession of official astronomer. Not to mention the fact that the majority of the entries are lower-level positions such as mathematics student or student astronomer.

⁴⁸ ZJJC 6:395.

⁴⁹ Ibid., 7:87.

⁵⁰ Ibid., 93:206

受萬		字印廷號子若一號仲卿行一又行二	
威豐乙卯年二月初六日吉時生係直		隸遵化直隸州豐潤縣學廩膳生民籍	
始祖堂	原籍河南徙居山	一世胞伯祖	璣字子
始祖妣氏	王	二世胞伯祖	仲信字機
二世祖	仲義字宜之	三世胞伯祖	文登字龍軒
二世祖妣氏	張	縣志	文魁字垣軒
三世祖	文科字榮第	三世堂叔伯祖	文士字乙
三世祖妣氏	楊	四世胞叔伯祖	攀景字
四世祖	攀望字輔周	聲和字克韻和字濟五	聲和字克韻和字濟五
四世祖妣氏	吳	四世堂叔伯祖	攀龍字海
五世祖		秉衡字鼎望攀尹字騰	
五世祖妣氏		五世嫡堂叔伯祖	
六世祖		兆璜字黃玉武庠生	
六世祖妣氏		起華字三聘起盧起	
太高祖		五世從堂叔伯祖	
太高祖妣氏		施留施舍義田數處事	
高祖		六世堂叔伯祖	
高祖妣氏		中斌度秩	
曾祖		六世從堂叔伯祖	
曾祖妣氏		胞叔太	
祖		從堂叔太	

Figure 17. Genealogical records on a mid-nineteenth-century *Zhujuan*. In this fourteen-page genealogical record, only two entries were relevant to the Astronomical Bureau.

These characteristics suggest that for families that had brilliant records in civil service, diverting some of their members to attend the College of Mathematics did not necessarily mean they intended to enter the career of professional mathematicians. Similar to Han and Tian, these families perhaps just wanted to differentiate their members, particularly those who had little hope of succeeding in the civil service examinations, from ordinary civilians by ensuring that they obtained some type of officially recognized status. The license of mathematics student, after all, was easier to obtain than other civil service degrees.

The reason why few families were seriously interested in their members pursuing a career at the Astronomical Bureau is not hard to understand. A career at the Astronomical Bureau might be stable and secure, but it could hardly bring political power or splendid incomes to the family. Take He Junxi as an example. He had been the supervisor of the Calendar Section for four decades. Yet, upon his death, the Kangxi emperor gave extra provision to his son, Guozhu, because the emperor knew the He family was on tight budget.⁵¹

For a civil service degree holder, transferring to the profession of official mathematician almost entailed that his previous effort in classical studies was in vain. Ostensibly, civil service degree holders enjoyed several special benefits. After graduating from the College of Mathematics, a Provincial Graduate could skip the level of student astronomer and advance to erudite directly.⁵² Similarly, a mathematics assistant professor could obtain the post of water clock manager after finishing a teaching term if he were a District Graduate and observatory manager if he was were a Provincial Graduate.⁵³ However, these benefits were hardly attractive. Gaining a Provincial Graduate degree was the watershed for those who competed in the civil

⁵¹ Zhongguo diyi lishi dang'an guan, *Kangxi qijuzhu*, 2071.

⁵² QHDSL 625:131.

⁵³ QHDSL 625:130.

service examinations in the pursuit of governmental jobs. A District Graduate was merely an officially licensed scholar. Many District Graduates sustained their lives by tutoring, and it is not unusual to see a District Graduate living in poverty. In contrast, a Provincial Degree came with the right to request an official post. Thus, honor and financial income fell almost instantly to the degree holder. Therefore, it is impractical to expect that a Provincial Graduate, who was already a successful civil service examination candidate, would have much interest in transferring to a less popular profession—not to mention the fact that a transfer would force him to accept the degraded status of a mathematic student. A late-Qing author gave an explicit analysis of the educational reformation:

The Imperial College includes the program for study astronomy and mathematics . . . but even from the point of view of encouragement, the reward for a Provincial Graduate who passed the examination [for graduating from that program] is merely the Astronomical Bureau erudite. Erudite is just a petty official with the lowest civil service rank. How can it be possible that a Provincial Graduate will give up his qualification of a county magistrate and turn to spend many years on counting sticks just for obtaining that desolate position?⁵⁴

Those civil service examination candidates who had not obtained the Provincial Graduate degree were more likely to consider a transfer to the career of professional mathematician. But, ironically, no special treatment was given to a District Graduate or an Imperial College student.

The career of Wang Lai 汪萊 (1768–1813), a mathematician of the Qianlong-Jiaqing period who was famous for his interest in Western methods, highlights another problem in the recruitment rules that governed the Astronomical Bureau. Wang became a District Graduate when he was merely fifteen years old. His excellent scholarship in classical study and mathematics had been well known among his contemporaries, but he never obtained the Provincial Graduate degree and lived in poverty. In 1807, Wang won the Tributary Scholarship

⁵⁴ Zhong Qi 鐘琦, *Huangchao suoxuelu* 皇朝瑣屑錄, CKZB 532:748–49.

(*Gongshi* 貢士), a degree that entitled him to fulfill some minor civil service positions. Thus, Wang came to Beijing to look for a job. Wang's knowledge in mathematics would easily qualify him for a role as a high official at the Astronomical Bureau, but there simply was no way for him to secure a position there. He went on to become an assistant professor at the Eight Banners public schools. Through other courtiers' recommendations, Wang also participated in the amendment of the state astronomical monograph. When the monograph was complete, Wang was rewarded with a county professorship. In 1813, Wang Lai tried the provincial examination again but soon died of illness and exhaustion.⁵⁵ Wang Lai's case demonstrates that any mathematical knowledge acquired before entering the Astronomical Bureau bureaucratic system was worthless to one's career advancement. With the exception of the last decade of the Kangxi reign, the Qing state rarely held special examinations to recruit mathematicians. During the majority of the Qing period, civil degree holders received some special rewards for joining the Astronomical Bureau, but self-trained mathematicians did not. This was certainly discouraging to anyone who was considering serving the imperial state with his mathematical knowledge.

By design, the recruitment rules favored descendants of mathematician families. The candidates of student astronomers were divided into four groups. Two groups were newcomers to the Astronomical Bureau: astronomy apprentices and mathematics students. The other two groups were hereditary students who were divided according to the generations their families had served the Bureau. Together, these four groups took turns filling the vacancies of student astronomers.⁵⁶ A hereditary student supposedly should have learned the craft as part of the education provided by his family; he did not have to go through any formal training at the

⁵⁵ Ruan, *Chouren zhuan*, 669.

⁵⁵ QGLL 13:189.

⁵⁶ NPM 185064.

College of Mathematics. Conversely, the biggest challenge preventing an astronomy apprentice or a mathematics student from becoming a student astronomer was not the graduate examinations but the long wait until a position became available.

In sum, the founding of the College of Mathematics was beneficial to mathematician families. Newcomers began as mathematics students; their status was equivalent to that of the Eight Banners public school students. In contrast, hereditary students could begin with a higher-level position, student astronomers, without much difficulty. The status of hereditary students was raised and had little impact on their employment prospects.

8.4 Families in Decline and Criminal Charges

A number of events were symptomatic of the decline of a mathematician family. The first and most obvious sign of decline was the loss of the ability to obtain higher-level positions in the Bureau. At this stage, younger generations still could obtain entrance-level positions at the Bureau because of the quota reserved for hereditary students. In fact, it is common to find that a certain surname lingered on lower-level positions such as yin-yang students and student astronomers several decades after it had disappeared from the roster of higher officials. However, the career of these members progressed at a slow pace. They could no longer distinguish themselves through periodical examinations and no longer won extra promotions. Eventually, some would fail the examinations and have their jobs suspended. The worst ones were even involved in petty crimes.

The Zang 臧 family was one of the oldest mathematician families at the Qing Astronomical Bureau. Like He Qiyi 何其義, Zang Wenxian 臧文顯 was already an erudite

before the Ming dynasty ended.⁵⁷ After Schall took over the Astronomical Bureau, the Zang family coped with the new leadership and gradually converted to the New Method. Zang Wenxian's name was seen among the endorsers for Schall's *Response to Concerns over the Notes on Civil Calendar*, published in 1662.⁵⁸ In November 1653, Zang Yuqing 臧餘慶 became an official observer of the Section of Heavenly Signs. Around the same time, Zang Fangxiu 臧樊修 obtained the post of erudite.⁵⁹ The Zang family appeared to have sided with the Jesuits in the Kangxi Calendar Dispute. Zang Yuqing eventually lost his job after refusing Yang's request to endorse the Great Concordance system.⁶⁰ After the Calendar Dispute ended, the Zang family gradually returned to their former prominence. For some years in the late Kangxi period, both Han vice directors were from the Zang family. Zang Jide 臧積德 was elevated to junior vice directorship after serving as an observatory manager for thirty years.⁶¹ He held the vice directorship from 1707 to 1717.⁶² Zang Bichang 臧必昌, perhaps from the Water Clock Section, was the senior vice director from 1711 to 1724.⁶³

Afterward, however, the Zang family never reached the vice directorship again. The Yongzheng period saw only one Zang Yuzhong 臧裕仲, who briefly held the post of observatory manager.⁶⁴ In the mid-Qianlong period, Zang Dening 臧德寧 from the Water Clock Section became secretary-general, but he made no further advancement.⁶⁵ By this time, the Zang family

⁵⁷ Wenxian congbian, 28:14.

⁵⁸ Schall, *Minli puzhu*, 3.

⁵⁹ Wenxian congbian, 28:15.

⁶⁰ Chen, *Zhongguo Tianzhujiao*, 524.

⁶¹ Shi, "Qing Qintianjian Tianwenke," 37–38.

⁶² Qu, "Qingdai Qintianjian," 51.

⁶³ Ibid.

⁶⁴ Shi, "Qing Qintianjian Tianwenke," 39.

⁶⁵ Qu, "Qingdai Qintianjian," 57.

was already in decline. In the triennial examination of January 1765, Erudite Zang Cunren 臧存仁 performed so badly that his future career advancement was suspended.⁶⁶ The last Zang related to the Astronomical Bureau to be featured in archival documents is a yin-yang student called Zang Xianming 臧顯名. In December 1802, the Astronomical Bureau sent Zang Xianming to the Ministry of Punishments for stealing a bronze tank from the water clocks in the water tower.⁶⁷

Cases that involved criminal charges, like Zang Xianming's, were rare among the declining mathematician families. Few families were reduced to such a miserable status. After all, the routine tasks of the Astronomical Bureau provided little opportunity for illegal profit and thus the possibility that crimes would be committed was low. Continuous failures in the triennial examinations were alarming enough to make a family consider refraining from sending new members to the Astronomical Bureau. For example, as we will see in the next chapter, the famous He family withdrew from the Bureau during the Daoguang reign after younger family members continued to fail terribly on the periodical examinations. It is noteworthy that petty crimes committed by an individual official did not necessarily affect other family members' career advancement. Liu Zhimao 柳芝茂, an official observer from 1758 to 1768, failed in the same triennial examination of January 1765 as Zang Cunren. The Bureau punished Liu for his poor grade by banning him from advancement.⁶⁸ Liu finally lost his job in August 1768 for forging sick leave and engaging in civil dispute.⁶⁹ Around the same time, Liu Zhimao's elder brother, Liu Zhifang 柳芝芳, was an observatory manager. Being in the same family and working at the same section, nobody could have known Zhimao better than Zhifang. Zhifang

⁶⁶ IHP 025061.

⁶⁷ IHP 195479.

⁶⁸ IHP 025061.

⁶⁹ IHP 081308.

testified against his brother during the investigation of the case.⁷⁰ This incident did not have a negative impact on Zhifang's career. He went on to become the vice director the next year.⁷¹ Nevertheless, the Liu family did not prosper at the Astronomical Bureau. No further record related to the Liu family dated after the years of Zhifang and Zhimao is found.

After the Kangxi Calendar Dispute, no criminal charge of the Astronomical Bureau officials was fatal enough to bring down a mathematician family in a short time. There were some occasions when the emperor scorned the Astronomical Bureau for failing to interpret abnormal celestial phenomenon on time, but these incidents did not result in serious punishments of the Bureau directorate. Because such events tended to occur in the early years of a reign, it was highly likely that such threats were designed to demonstrate imperial authority. For instance, in April 1677, the Kangxi emperor addressed the Ministry of Rites on the importance of respecting heavenly signs and ordered the Astronomical Bureau officials be investigated for neglecting the duties of interpreting heavenly signs. After Ferdinand Verbiest and others were charged with neglecting their duties, however, the emperor pardoned them all.⁷² It is noteworthy that the Kangxi emperor initiated this case. By then he should have known that the Jesuits disliked Chinese traditional divination and astrology. Rather than showing Verbiest personal favor by pardoning them, the emperor instigated the whole case to warn Verbiest that while he had accepted the Western Method of calendar making, Verbiest, in return, had to make sure the Bureau fulfilled their every duty, whether the Jesuits liked it or not.

⁷⁰ Ibid.

⁷¹ IHP 082724.

⁷² SL 4:846.

From the mid-Qianlong reign to the early Daoguang reign, the Qing imperial state left the management of the Astronomical Bureau in the hands of the mathematician families. The Astronomical Bureau was no longer the institution that had caused political turbulence in the early Qing era. Although it had its own specialty and administrative system, the Bureau appeared to be very similar to other government institutions. High officials, such as He Tingxuan 何廷瑄, He Tingzan 何廷瓚, and Yuanzi 何元滋, obtained the first grade in the Metropolitan Inspection, but they were not known for distinguished mathematical achievements. Except for Si Tingdong 司廷棟, no other Bureau official made any achievements that were significant enough for his name to be recorded in the *Monograph on Calendar of the Qing Official History*.⁷³ The Astronomical Bureau would need rejuvenation.

⁷³ Zhao, *Qingshigao*, 1671–73.

Chapter 9

Imperial Agency Jingzheng

9.1 *The Departure of European Missionaries*

In July 1773, Pope Clement XIV signed a decree to dissolve the Society of Jesus. This decree struck a severe blow to the Catholic mission in Qing China to the extent that upon receiving the papal order, Augustin von Hallerstein (Chinese name Liu Songling 劉松齡, 1703–1774), a Jesuit missionary and European director of the Qing Astronomical Bureau, died of excessive depression.¹ Furthermore, quarrels and anxiety spread among the different missionary groups present in China. In the following decades, the missionaries residing in the Beijing area spent more energy on resolving conflicts among themselves than they did on attempting to improve, or even maintain, their status in the Qing court by introducing new scientific knowledge to China. By mid-1777, the chaos had become so overwhelming that some missionaries repeatedly sought assistance from the Qing court to settle their disagreements over the division of properties.²

The Qing court, however, appeared disinterested in becoming involved in the conflict between Catholic missionaries. In fact, the Qing ministers in charge of managing Western missionaries made little attempt to learn or understand the complex factors underlying the conflict. As late as January 1781, European missionaries still had to explain to the ministers the meaning of the papal decree, the different nationalities and religious orders to which the

¹ Louis Pfister, *Zaihua Yesu huishi liezhuan ji shumu* 在華耶穌會士列傳及書目, trans. Feng Chengjun 馮承鈞 (Beijing: Zhonghua shuju, 1995), 785.

² Zhongguo diyi lishi dang'an guan 中國第一歷史檔案館, ed., *Qing zhongqianqi xiang Tianzhu jiao zaihua huodong dang'an shiliao* 清中前期西洋天主教在華活動檔案史料 (Beijing: Zhonghua shuju, 2003), 312–23.

missionaries belonged, the sources of incomes for purchasing the properties, and the previous processes by which those properties had been managed.³ Even though the missionaries' explanations seemed consistent and credible, the ministers of the Qing court found handling such quarrels annoying. "If the Westerners serving in Beijing can obey the rules," the ministers wrote in an investigation report to the emperor, "then there is no need for us to handle their household affairs for them."⁴ Moreover, the ministers argued, "The Western papers held by missionaries can hardly be trusted. Even if they are authentic, it is irrational to expect papers from hundreds of thousands of miles away to convince everyone."⁵ The official disregarded the Western papers regardless of whether they were decrees from the Pope or European kings and proposed a new property management method to the missionaries.

The ministers' impatience and disinterest were a reflection of the declining status of the Catholic missionaries. This was not the first time that conflicts had arisen among the missionaries. A century earlier, the Kangxi emperor had summoned the missionaries and had personally tried to resolve their conflicts.⁶ He wrote to the Pope and even sent some Jesuit missionaries back to Europe as his ambassadors.⁷ As a sovereign of China, the Kangxi emperor would not take orders from the Pope, but he was willing to communicate with the papal court. However, such incidents only occurred when the Qing emperor had a use for Jesuit scientific knowledge and skills. Namely, the Jesuits earned their status at the Qing court because they made special contributions to the dynasty, not because that they had converted the emperors or Manchu high noblemen to their religion. After the mid-Qianlong period, the Western

³ Yan Zonglin 閻宗臨, *Chuanjiaoshi yu zaoqi hanxue* 傳教士與早期漢學 (Zhengzhou: Daxiang chubanshe, 2003), 218–27.

⁴ Ibid., 223.

⁵ Ibid.

⁶ Zhongguo diyi lishi dang'an guan, *Kangxichao Manwen*.

⁷ Zhongguo diyi lishi dang'an guan, *Qing zhongqianqi*, 14.

missionaries made little contribution to the dynasty's imperial mathematics, and they no longer appeared more capable than the Chinese court mathematicians did. No wonder the Qing ministers felt no need to pay special respect to the likes of people who could not even maintain order within their own household.

Nonetheless, the Qing court continued to follow the Chinese traditional policy of “cherishing men from afar” 懷柔遠人 by of reserving some posts at the Astronomical Bureau for European missionaries. By then, assistance from the European missionaries was no longer crucial to ensuring that the Astronomical Bureau could successfully fulfill its duties.⁸ Nevertheless, retaining their presence at the Astronomical Bureau would by no means bring any harm to the court. Moreover, the court considered such an act to represent an imperial benevolence to foreigners, in the same way that it allowed the mathematicians who specialized in the outdated Great Concordance calendar or the Muslim calendar to remain in the Bureau. Soon after Augustin died, the Qianlong emperor filled the post with another Jesuit missionary.⁹ Whether the Society of Jesus had been dissolved was not a concern to the Qing emperors. It was not until José Bernardo de Almeida (Chinese name Suo Dechao 索德超), the last Jesuit director of the Astronomical Bureau, died in November 1805 and there were no Jesuits remaining in Beijing that the directorship finally passed to a Franciscan, Alexandre de Gouveia (Tang Shixuan 湯士選).¹⁰ By that time, the Catholic Church had ruled that Lazarites should take over the work of the Jesuit China missions. Afterward, all succeeding European directors and vice directors were Lazarites. Unlike the Jesuits, the Lazarites focused on training Chinese missionaries rather

⁸ See James Hevia, *Cherishing Men from Afar: Qing Guest Ritual and the Macartney Embassy of 1793* (Durham: Duke University Press, 1994) for an extensive discussion on this traditional diplomatic policy.

⁹ Pfister, *Zaihua Yesuhuishil*, 785.

¹⁰ IHP 060732; Lin Hua 林華 et al., *Lishi yihen : Limadou ji Ming Qing xifang chuanjiaoshi mudi* 歷史遺痕: 利瑪竇及明清西方傳教士墓地 (Beijing: Zhongguo renmin daxue chubanshe, 1994), 141–42.

than on introducing science to Qing China.¹¹ As such, the relationship between the missionaries and the Qing court did not improve after the arrival of the Lazarites.

Meanwhile, the Qing court had become increasingly alarmed by, if not hostile to, Catholic missionary activities during the Jiaqing reign. Up until this point, the Yongzheng emperor's ban on Christianity had not been seriously implemented in the capital area. However, the situation changed dramatically in late 1804, after a provincial governor caught a Chinese Christian attempting to deliver letters and maps to Macao for Adeodato di Sant' Agostino 德天賜, a missionary who currently served as a painter at the Qing court.¹² Adeodato claimed that he sent the maps to seek the papal court's input on the way in which missionaries' quarrels over the division of properties and parishes should be settled. However, the Qing court considered his behavior to constitute both a crime and a threat to national security.¹³ Furthermore, the emperor and the prosecutors were shocked by the number of court officials and Bannermen involved in this case. The Jiaqing emperor issued an angry decree for being irritated by the individuals whose behavior indicated that they would rather be banished to the remote borderland than relinquish their belief in Christianity. In June 1805, the court outlined a new set of regulations that strictly confined and monitored the activities of the missionaries.¹⁴

The Jiaqing emperor's attitude toward Christianity greatly reduced the European missionaries' status at the Qing court. It is noteworthy that in his decree, the emperor described the missionaries as people who had "come to the capital for the purposes of learning the craft [of

¹¹ Geng Sheng 耿昇, "Qianshihuei Chuanjiaoshi Zaihua Huodong Kaoshu" 遣使會傳教士在華活動考述, *Zhongxi wenhua yanjiu* 中西文化研究 1 (2008): 17–18.

¹² *Zhongguo diyi lishi dang'an guan*, *Qing zhongqianqi*, 829–30.

¹³ *Ibid.*, 832–34.

¹⁴ *Ibid.*, 852–55.

astronomy].”¹⁵ Apparently, European missionaries were no longer indispensable astronomers to the court and had been relegated to the status of mere craftsmen whose lives and career prosperities were bestowed by the imperial grace. Another case testified to the missionaries’ loss of imperial favor during the Jiaqing reign. In 1811, the Astronomical Bureau Director Domingo Joadchim Fereira (Fu Wengao 福文高) and Vice Director Monteiro da Sena (Gao Shouqian 高守謙) accused some county clerks of stealing from their country retreat mansion and kidnapping their tenants.¹⁶ The court immediately investigated this case but with a distinct focus on ascertaining whether the tenants were Christian and identifying whether any recovered item was related to missionary work. At the end of the investigation, no one from the county yamen was punished, while all recovered religious items were destroyed and the Christian tenants were forced to abandon their religion. Usually, the emperors would exempt Western directors and vice directors from punishments as a special treatment to foreigners; however, this time the Jiaqing emperor ordered that their civil service ranks be reduced by four.

Although European missionaries still held positions in the Astronomical Bureau directorate, their importance was also decreasing. While the description of the missionaries as foreigners in Beijing who wished to learn the craft of astronomy was an exaggeration, even Louis Pfister, a scholar of Jesuit China missionaries, admitted that the later missionaries “did not compile astronomical records or compute anything. . . . [They] only checked and corrected the computations done by Chinese officials.”¹⁷ In contrast, the Han and Banner officials seemed able to fulfill the essential duties of the Astronomical Bureau. They either had learned to perform the astronomical computations for calendar making and had sufficiently mastered the predictions on

¹⁵ Ibid., 846.

¹⁶ IHP 119761.

¹⁷ Pfister, *Zaihua Yesuhuishi liezhuan*, 934.

solar and lunar eclipses, or had somehow managed to cover their faults. The need to cooperate and learn from the European directorate seemed greatly reduced.

Accompanying the loss of importance of the European missionaries was the Han officials' attempts to oust the European missionaries from the Bureau directorate. Recall the regulation set up at the beginning of the dynasty that European directors were counted as part of the quota originally set aside for the Han directors. Even though the seats of directors and vice directors had been adjusted several times up until the Jiaqing reign, the Astronomical Bureau still had no Han director. Therefore, when José Bernardo died in November 1805, the Han Bureau officials attempted to acquire the post he left behind. In the memorial that nominated candidates of the directors, José Bernardo was listed under the title of Han Director, as opposed to Western Director. Moreover, a Han vice director was nominated alongside two Western missionaries.¹⁸ Although Han officials failed to seize the directorship this time, European missionaries would voluntarily give up their seats in the Qing Astronomical Bureau two decades later.

After the mid-Qianlong period, the number of European missionaries in Beijing gradually decreased. In late 1780, there were sixteen missionaries living in Beijing.¹⁹ Following the case of Domingo Joadchim Fereira and Monteiro da Sena in 1811, the emperor ordered that all missionaries, with the exception of those who held government positions or who were too old to travel, should be sent to Guangdong and then to Europe.²⁰ After this deportation, only seven missionaries remained in Beijing. When European Director Joseph Ribeiro (Li Gongchen 李拱辰, 1767–1826) died in 1826, the last two European vice directors probably felt that the Bureau

¹⁸ IHP 060732.

¹⁹ Yan, *Chuanjiaoshi yu zaoqi hanxue*, 225.

²⁰ Zhongguo diyi lishi dang'an guan, *Qing zhongqianqi*, 923–24.

was no longer a possible base for missionary work.²¹ They requested the Daoguang emperor let them retire and return to Europe. The emperor promptly approved their requests and ordered that they be sent to Guangdong under heavy guard so that they would not have to stop on the road or make contact with the local people.²² Although afterward one of them decided to stay in Beijing to protect the properties of the church, where he remained until his death in 1838, the European missionaries' service at the Qing Astronomical Bureau had finally come to an end.²³

9.2 Stagnation of the Imperial Mathematical Institutions

In July 1826, Jingzheng 敬徵, the superintendent of the College of Mathematics and the Astronomical Bureau, submitted a memorial to the Daoguang emperor. In his memorial, Jingzheng stated that in the preceding year a new set of administrative rules had been established to improve the lethargic status of the College of Mathematics. Since then, he had closely supervised the graduation and entrance examinations of the College and had repeatedly told the associate professors and assistant professors to take their teaching responsibilities seriously. However, Jingzheng accused Zhang Deyuan 張德源, the associate professor of the College of Mathematics, of “neglectful trifle with official business.”²⁴ Jingzheng wrote,

When questioned [about why none of the teachers and students were at the College of Mathematics], associate professor Zhang Deyuan answered that due to the summer heat, he had told students to meet for class only once during this month and had cancelled the rest of the eight class meetings. . . . Zhang has the duty to direct and lead [the College of Mathematics], but he does not think about diligently disciplining students. . . . He

²¹ IHP 292204-004.

²² SL 34:740, 749.

²³ Lin, *Lishi yihen*, 145–46.

²⁴ IHP 129844.

reduced the required class schedule and curriculum at will. His neglectful trifling with the official business means that he is not suitable for the position of associate professor.²⁵

The College of Mathematics was the training ground for future officials of the Astronomical Bureau. Jingzheng's memorial no doubt revealed the astonishing stagnation that these two institutions were exhibiting at the time he was appointed superintendent. On the other hand, it also showed that Jingzheng had been striving to rejuvenate these two institutions. What difficulties Jingzheng had encountered, how successful his efforts were, and what impacts Jingzheng's reform brought to the mathematician families will be discussed in the rest of this chapter.

In the Qing dynasty, examinations and seniority were the two factors used to determine an official's career advancement in the Astronomical Bureau. As the balance between these two factors went through several adjustments, it deserves a brief review here. In the Shunzhi reign, seniority had very little influence on a Bureau official's career advancement. Schall, the head of the Astronomical Bureau, used examinations to ensure that new student astronomers learned the New Method and to deny promotion to staff members who would not learn. As described in chapter three, such a system resulted in the explosion of the Kangxi Calendar Dispute and the reorganization of the Astronomical Bureau. In 1676, the emperor decreed that promotions should be given to the best-learned candidates, and then in 1681, new regulations specified that Han and Banner officials were required to obtain their positions by examinations.²⁶ However, it is not clear how the Bureau chose the examination candidates and what the contents of the examinations were.

²⁵ Ibid.

²⁶ IHP 091507; QHD KX 8:291.

The triennial examination system was not established until 1745.²⁷ Before that, examinations were held when vacant positions arose. The purpose of the triennial examinations was different; it provided a means by which the progress of officials and trainees could be measured. Therefore, the triennial examinations did not include Calendar Section supervisors, observatory managers, water clock managers, secretary-generals, and of course the directorate. In contrast, officials from the calendar collators down to the student astronomers and yin-yang students all had to take and pass the triennial examinations.²⁸ After the examinations, the best performers were rewarded with special promotions. Conversely, those who failed the examinations had their rights of promotion suspended and repeated failure resulted in the loss of their jobs.

The first handful of examinations seemed to have been implemented rather dutifully. For instance, the report of the examination held in January 1765 informed the emperor in detail that one examinee should be given a special promotion, four examinees should be suspended, and one examinee who had made sufficient progress since the previous examination should have his suspension removed.²⁹ It is noteworthy that the person who received special promotion was Chen Jixin 陳際新, who indeed would prove his mathematical talent in the future by completing Ming'antu's *Quick Methods for the Circle's Division and Precise Ratio* (*Geyuan milü jiefa* 割圓密率捷法).³⁰

²⁷ QHDSL QL 625: 149–50.

²⁸ IHP 216304.

²⁹ IHP 025061.

³⁰ Ming'antu and Chen, *Geyuan milü jiefa*, XXSK 1045:1–2.

Table 9. Triennial examinations, the Qianlong and Jiaqing reigns

	Qianlong		Jiaqing
	1764	1792	1802
Pass	?	118	120
Excellence	1	4	0
Reinstall	1	0	0
Fail	4	0	1
Suspend	4	0	0
Demote	0	0	1
Discharge	0	0	0
Examinees	?	118	121

Sources: IHP 025061, 092494, 157745.

However, by the end of the Qianlong reign, the examination system seemed to have deteriorated into being simply formulaic and its effectiveness became questionable. None of the examinees failed the examination of 1792, for example; yet four officials were recommended. The examination of 1804 failed only one examinee and made no recommendation.³¹ With the exception of only one person, everyone who attended these two examinations passed. Moreover, the person who failed the examination of 1804 was an erudite.³² One can only wonder how he had passed previous examinations and had advanced from the position of student astronomer to his current role. The potential power of the examination system for managing the Bureau officials was clearly not in use. Similarly, the examination system had lost its rewarding power. The four officials who won recommendations in 1792 included one official of the erudite level

³¹ IHP 157745.

³² Ibid.

from each section and one student astronomer. That student astronomer, in fact, had already won the recommendation in a previous examination; however, because no position had become available over the previous three years, he had not been able to receive any promotion.³³ The fact that no suitable position had become available in three years indeed confirmed what Luoerzhan had described and warned the emperor about in 1739: “Junior officials’ career progression will be slowed down and they will not have a chance to test their talent.”³⁴

A lethargic Astronomical Bureau could not retain potential mathematicians effectively. The case of Luo Shilin 羅士琳 demonstrates this. Luo was the author of the *Sequel to the Biographies of Mathematicians* (*Xu chouren zhuan* 續疇人傳), to which he added several mathematicians of the Astronomical Bureau, including Ming’antu and Chen Jixin. It is highly likely that Luo was familiar with the achievements of the Bureau mathematicians because he had been a student astronomer in the late Jiaqing period. In the early years, Luo’s interests were in Western learning (*xixue* 西學) rather than in traditional Chinese mathematics. However, according to the *History of the Qing* (*Qingguo shi* 清國史), Liu was not able to advance his career at the Bureau because his colleagues were too jealous of his excellent mathematical knowledge.³⁵ Luo left Beijing discouraged and eventually lost his passion for Western mathematics. He turned his efforts to studying the newly rediscovered *Jade Mirror of the Four Unknowns* (*Siyuanyujian* 四元玉鑑), the highest-level treatise on Chinese algebra that had been

³³ IHP 092494.

³⁴ IHP 194605.

³⁵ Wu, *Qingguo shi*, 12:702.

written by Zhu Shijie 朱世傑 in 1303. For the rest of his life, Luo advocated the power of traditional Chinese mathematics.³⁶

From the late Qianlong era to the end of Jiaqing reign, the Astronomical Bureau and the College of Mathematics were on a downward spiral. These two institutions were not yet dysfunctional when the Daoguang emperor ascended to the throne in 1820. However, if the lethargy continued, the mathematician families and the two institutions where they earned a living were unlikely to escape a miserable end.

9.3 Attending to Details and Efficiency

Similar to his predecessors, Jingzheng (1784–1851) was a trustful minister who was handpicked by the emperor to be the superintendent of the Astronomical Bureau and the College of Mathematics. Jingzheng's father, Yongxi 永錫, was the sixth-generation Prince Su 肅親王.³⁷ Yongxi was also a superintendent of these two institutions during the last two years of his life.³⁸ When Yongxi died in 1821, the first year of the Daoguang reign, Jingzheng's elder brother inherited the title of Prince Su. Nonetheless, Jingzheng's administrative ability soon made him an indispensable assistant to the new emperor. By the end of 1823, besides being the Vice Minister of Works, Jingzheng was also managing the Imperial Household 內務府 and the Yuanming Garden 圓明園 for the Daoguang emperor. In May 1824, the Daoguang emperor gave Jingzheng the responsibility of managing the Western missionaries and superintending the Astronomical Bureau and the College of Mathematics.³⁹ Throughout his career, Jingzheng often

³⁶ Written by Zhu Shijie 朱世傑 in 1303, *Siyuanyujian* brought Chinese algebra to its highest level.

³⁷ Wu, *Qingguo shi*, 9:627.

³⁸ Qu, "Qingdai Qintianjian," 62.

³⁹ Wu, *Qingguo shi*, 9:627.

concurrently managed several accounting offices and engineering projects that the emperor had assigned to him.⁴⁰

Jingzheng reformed the Astronomical Bureau steadily but not hastily. Three months after becoming superintendent, Jingzheng sent the first warning signal to the Astronomical Bureau officials. He discharged the Manchu Director E'edengbu 額爾登布, who had been too sick to come into the office. Since E'edengbu was almost seventy years old, Jingzheng suggested to the emperor that the court not wait for the old man's recovery and E'edengbu be forced into retirement.⁴¹ Unlike the Han directors, Manchu directors were not required to remain in the Astronomical Bureau their whole lives. The fact that E'edengbu had been the director for fourteen years without transferring to other institutions was not unique but was highly suspicious.⁴² Recall the memorial submitted by the directorate in September 1742 that begged the emperor to let the aged Senior Vice Director Sun Shiyin 孫士英 remain in the Bureau.⁴³ Perhaps, E'edengbu, similar to Sun Shiyin, had felt too old to learn the required skills for alternative positions. The discharge of E'edengbu did not necessarily mean that Jingzheng wanted to strictly implement the transfer requirements as Luoerzhan had suggested. Nonetheless, he did use it to warn the staff that the Astronomical Bureau had no position for those who could not contribute.

In January 1826, Jingzheng reported to the emperor that the administrative system of the College of Mathematics was in terrible disarray and had to be rebuilt.⁴⁴ First of all, a new official stamp of the associate professor had to be made because the current one was nowhere to be

⁴⁰ IHP 206711.

⁴¹ IHP 162826.

⁴² Qu, "Qingdai Qintianjian," 61–62.

⁴³ IHP 127466.

⁴⁴ IHP 119130.

found and the associate professor, Zhang Deyuan, did not even know if it ever existed. Second, Jingzheng found that the College of Mathematics had stopped updating its accounting records before 1755 and there was no way to know if the stationaries that should be given to students and teachers had indeed been distributed and to whom. Therefore, Jingzheng suggested that beginning that year, the College of Mathematics had to submit its accounting records together with those of the Imperial College for verification. Third, the College of Mathematics needed a new clerk because the current one was not knowledgeable enough to help resolve the above issues. In fact, he was not even hired according to the official procedure. Finally, Jingzheng found that a teaching assistant received no salary if he had graduated from the College of Mathematics but had not yet assumed the official post of student astronomer. During such a period, Jingzheng suggested, the teaching assistant should be given the salary of a mathematics student so that their studies would not be interrupted.

After attempting to rebuild its administrative system, Jingzheng turned his attention to the teachings of the College of Mathematics. In July 1826, Jingzheng had Zhang Deyuan demoted from associate professor to assistant professor after finding out that the classes of the College of Mathematics did not meet on schedule.⁴⁵ Eight years later, Zhang's name appeared again in a job review that had been written by the Manchu Director of the Astronomical Bureau on behalf of Jingzheng, who had been sent by the emperor to survey some provincial construction projects. "Zhang worked diligently," the Director wrote to the emperor, "but his teaching of the students assigned to him did not always bring satisfactory achievements."⁴⁶ The director did not recommend a promotion for Zhang, as would normally be awarded to those who had successfully completed their teaching terms. Instead, he suggested that Zhang should remain in

⁴⁵ IHP 129844.

⁴⁶ IHP 131038, 129844.

his current post for one more term. The emperor approved the suggestion without further ado. Since there is no further mention of Zhang in the archival documents dated after 1834, we can only guess that Zhang probably ended his career as a disgraced mathematical assistant professor.

Jingzheng was an administrator who paid great attention to detail. Rather than adopting large-scale reformation at once, he focused on ensuring that every stage of the administrative processes was precisely and effectively implemented. Such a focus did not require the supervisor to have distinct mathematical knowledge, but it certainly consumed a great deal of time and energy. However, that was exactly what a trustful and capable supervisor like Jingzheng could do for the emperor.

Jingzheng's most important contribution to the administrative system of the Astronomical Bureau was his attention to the triennial examination system. During his superintendency of the Astronomical Bureau, Jingzheng administrated the triennial examinations seven times. The results of four of the seven examinations are preserved in the IHP archive. Table 10 summarizes the results of those four examinations together with an additional examination that was held during a later period. Jingzheng held his first triennial examination in May 1825, just one year after being appointed the role of superintendent. However, in comparison to the previous examinations listed in table 9, the results of the 1825 examination contained a higher number of examinees who passed with excellence or failed. The triennial examination was designed to monitor and maintain the level of mathematical knowledge that was deemed essential to the success of the Astronomical Bureau. However, as Table 9 shows, by the end of the nineteenth century, the triennial examinations had become formulaic and thus had little effect on a person's career progression in the Astronomical Bureau. The 1825 examination, nonetheless, began to resume the practice of adjusting the Bureau staff members' positions according to their

Table 10. Triennial examinations, the late Qing period

Year	Daoguang				Tongzhi
	1825	1828	1837	1843	1867
Pass	120	97	120	107	95
Excellence	4	8	6	5	11
Reinstall	0	1	1	0	0
Fail	6	24	7	14	0
Suspend	4	11	5	11	0
Demote	1	4	2	0	0
discharge	1	9	0	3	0
Examinees	126	121	127	121	95
Absence	?	5	21	18	32

Sources: IHP 170696, 205793, 197248, 216304, 182598.

mathematical knowledge. It rewarded the best four examinees with special promotions and punished the worst six with suspension, demotion, and even discharge.

As if the Bureau officials and students had already been given enough time to polish their knowledge, the outcomes of later triennial examinations administrated by Jingzheng were even more severe than the one held in 1825. The 1828 examination failed twenty-four examinees; eleven of them were banned from future promotion, and nine were discharged directly.⁴⁷ Recall that the report of the 1792 examination mentioned a person who had not yet received the promotion due to him from the previous examination because no suitable position had become available. This was clearly no longer acceptable, and it was only through discharging incompetent members that the Astronomical Bureau could ensure vacant positions were

⁴⁷ IHP 205793.

available to the capable officials and trainees. Similarly, banning incompetent officials or students from promotion prevented them from advancing to higher positions of seniority alone and thus made those positions available to other officials.

To make the triennial examination system more powerful, Jingzheng submitted a proposal to the Daoguang emperor soon after the 1828 examination was held. Originally, the examination results had no impact on the student astronomers who passed but did not win the special promotion, because their career advancement depended on their seniority of service alone. Jingzheng claimed that these student astronomers needed further stimulation so that they would not neglect their studies. Therefore, Jingzheng stated, he had discussed the issue with the Bureau directorate and had identified a fairer way of utilizing the triennial examination system. Together they proposed that student astronomers should be divided into two groups according to their examination grades. Within each group, members were still ordered according to seniority. However, only after all the members of the first group had advanced to erudites or higher-level positions could the members of the second groups begin to receive promotion.⁴⁸ The Daoguang emperor approved this new rule, and it was put into effect immediately.

Jingzheng introduced very few rules to the administrative system of the Astronomical Bureau and the College of Mathematics. In particular, he did not change the system of employing the hereditary mathematician families. Nonetheless, his attention to detail and efficiency would not allow an individual or a family that did not contribute to remain in the Astronomical Bureau. The next section will describe how Jingzheng's administration led to the downfall of the He family and the rise of new mathematician families and how it engendered new mathematical achievements within the Astronomical Bureau

⁴⁸ NPM 060148.

9.4 *The Downfall of the He Family and the Rejuvenation of the Astronomical Bureau*

The case of He Yuanpu 何元溥 illustrates the lethargic status of the Astronomical Bureau in the late Qianlong and Jiaqing reigns. The 1802 examination failed only one person, He Yuanpu. At that time, He Yuanpu was already an erudite. However, he did not just fail the examination; he failed it so badly that he was not suspended but was demoted from erudite to senior student astronomer. For more than two decades, Yuanpu remained in the position of senior student astronomer. One could only wonder whether He Yuanpu might have remained at the Astronomical Bureau for the rest of his life if Jingzheng had not become the superintendent of the Astronomical Bureau. However, Jingzheng administrated his first triennial examination in 1825 and He Yuanpu was demoted to junior student astronomer as a result of “making too many mistakes during the examination.” In 1828, he was finally dismissed.

The triennial examinations, particularly the first two examinations, held during Jingzheng’s superintendency struck the decaying He family severely. In the 1825 examination, two out of the six people who failed the examination were from the He family. In the 1828 examination, the performance of the He family did not improve but deteriorated. Out of the twenty Han examinees who failed, seven were from the He family (see table 11). According to Jingzheng’s report on the 1828 examination, He Yuangan 何元淦, though already an erudite, “was not versed in the principles of mathematics” and should be demoted to the entry-level position of junior student astronomer.⁴⁹ He Yuanpu and He Yuanrun 何元潤 had made so many mistakes on the examination sheets that they “should be discharged to set a warning to others.”⁵⁰ Erudite He Yuanqi 何元淇, who had already failed the 1825 examination and was in suspension,

⁴⁹ IHP 205793.

⁵⁰ Ibid.

Table 11. The He family members who failed the 1828 examination

Title	Name	Punishment
Erudite, Calendar Section	He Yuangan 何元淦	Demotion
Erudite, Calendar Section	He Yuanqi 何元淇	Suspension
Senior student astronomer	He Liangcheng 何良成	Demotion
Official observer	He Yuandu 何元渡	Suspension
Junior student astronomer	He Yuanpu 何元溥	Discharge
Junior student astronomer	He Yuanrun 何元潤	Discharge
Junior student astronomer	He Yuanhui 何元洄	Suspension

Source: IHP 205793.

could not demonstrate enough improvement to be reinstated. In fact, He Yuanqi's examination performance never seemed to improve. His name was not seen among those who failed the 1837 examination, but he did fail the 1843 examination.⁵¹ Moreover, by 1843, He Yuangqi had already been demoted to the position of senior student astronomer and the examination outcome resulted in his suspension once again.⁵² Worst, He Yuanqi was not the only member of the He family to fail the 1837 and 1843 examinations. In 1837 yin-yang student He Liangkai 何良楷, probably a brother or cousin of He Liangcheng, failed the triennial examination.⁵³ In 1843, He

⁵¹ IHP 197248; IHP 216304.

⁵² IHP 216304.

⁵³ IHP 197248.

Jun 何均, a junior student astronomer of the Section of Heavenly Signs, failed the examination and was suspended.⁵⁴

It is important to note that some early nineteenth-century He family members still took the study of mathematics seriously. For example, Erudite He Yuanying 何元瀛 won special promotion by passing the 1816 examination with excellence. He Liangtang 何良棠 and He Shuben 何樹本 passed the 1825 and 1828 examinations with excellence, respectively. Around the same period, He Liangkui 何良奎, originally a Calendar Section erudite, held the associate professorship of the College of Mathematics between 1826 and 1831.⁵⁵

Nevertheless, being a professional mathematician no longer seemed a suitable career for the descendants of the He family. It is noteworthy that besides He Guoqing 何國卿 and He Guodong 何國棟, He Liangkui was the only mathematics associate professor from the He family from 1751 onward.⁵⁶ In 1835, He Shuben was the senior vice director of the Bureau, He Liangkui held the post of the supervisor of the Winter Office, and He Liangkai served as observatory manager. In the past, their high positions would have offered those family members who were not competent enough to hold their positions great protection. However, the strictly administrated examinations that had become the norm in recent years reduced this level of protection. None of the He family members was able to pass the 1837 or 1843 examination with excellence. By this time, the He family should have been aware that the end of its career at the Astronomical Bureau was approaching.

⁵⁴ IHP 216304.

⁵⁵ Wenqing, *Guozijian zhi*, XXSK 752:205.

⁵⁶ Ibid. 752:204–5.

By contrast, some new mathematician families rose to power and the Astronomical Bureau enjoyed a rejuvenated period under Jingzheng's superintendency. The Du 杜, for example, became a prominent hereditary mathematician family of the Astronomical Bureau. Before the 1820s, only one supervisor of the Spring Office had the surname Du.⁵⁷ With the exception of only one year, the official roster of the annual calendar between 1842 and the end of the dynasty included at least one member of the family.⁵⁸ Since the Daoguang reign, the Du family produced eight Calendar Section supervisors of the Five Offices.

On the other hand, Chen Jie 陳杰 made a significant contribution to the most important astronomical achievement of the Astronomical Bureau, and this most likely would not have come into existence if Jingzheng had not been the superintendent of the Astronomical Bureau. Chen passed the entrance examination of astronomer apprentice in July 1821 and afterward voluntarily worked for the Calendar Section. Jingzheng noticed Chen's talent after he became the superintendent in May 1824, and began to look for opportunities to promote Chen. A year later, Jingzheng felt he had enough evidence to make a special recommendation for Chen. After holding the 1825 examination, he wrote to the Daoguang emperor:

Because my bureau was calculating the coming solar and lunar eclipses from 1826 to 1835, I ordered [Chen Jie] to submit a copy of his own calculations. Surprisingly, his calculations were accurate to the second. Moreover, the periodic examination has just been held for officials of the Bureau. The examiners interviewed and questioned [all the officials] when grading their answer sheets. This official's calculation was very detailed. It proved that he indeed was good at mathematics.⁵⁹

The emperor agreed that Chen should immediately become a staff member of the Astronomical Bureau and awarded him the post of student astronomer. Henceforth, according to *The Third*

⁵⁷ Qu, "Qingdai Qintianjian," 58. Du Zhaoxiong 杜兆熊 held the position of supervisor of the Spring Office from September 1771 to October 1777. See also IHP 043162 and QGLL 20:641.

⁵⁸ Qu, "Qingdai Qintianjian," 58–69.

⁵⁹ IHP 129743.

Addition to the Biographies of Mathematicians written by Zhu Kebao 諸可寶, Chen worked concurrently at the Calendar Section and the Section of Heavenly Signs, specializing in astronomical observation, and “higher officials relied heavily on him.”⁶⁰ In May 1836, Chen Jie, then an erudite, obtained the associate professorship of the College of Mathematics.⁶¹ Sources differ on what happened to Chen afterward. According to Zhu Kebao, Chen retired from the Astronomical Bureau in 1839 due to some leg problems.⁶² However, the *Veritable Records* state that Chen was discharged from the College of Mathematics in November 1838 because of malfeasance in administrating the examination.⁶³ Either way, Chen returned to his hometown and continued to teach mathematics. He wrote *The Great Achievements of Computational Methods* (*Suanfa dacheng* 算法大成), and his faith in the Western mathematics used in the Astronomical Bureau never wavered.⁶⁴

Meanwhile, the rejuvenated Astronomical Bureau was able to absorb Chen’s mathematical achievements. By the time Jingzheng retired from public service in 1845, the Astronomical Bureau had managed to repair the instruments of the observatory, update the astronomical constants based on Chen’s work, and publish them with new stellar tables in the *Addition to the Thorough Investigation of Instruments and Phenomena* (*Yixiang kaocheng xubian* 儀象考成績編). The *Addition to the Thorough Investigation of Instruments and Phenomena* was the last mathematical treatise published by the Qing Astronomical Bureau. Its roster of contributors was populated by the members of newly empowered hereditary mathematician families. The Du and Si families, for instance, each had four members listed in

⁶⁰ XXSK 516:554.

⁶¹ IHP 224166.

⁶² XXSK 516:554.

⁶³ SL 37:918.

⁶⁴ XXSK 516:554–55.

the roster. However, unlike a significant proportion of the contributors to the imperially commissioned mathematical treatise published in earlier times, the roster did not contain anyone of the surname He.

In April 1846, the Astronomical Bureau nominated two erudites—He Weimin 何維敏 and He Liangtong 何良桐—to fill the vacant position of water clock manager. By then, He Shuben, He Liangkai, and He Liangtang either had died or had left the Astronomical Bureau.⁶⁵ The Daoguang emperor appointed He Weimin water clock manager, but neither Weimin nor Liangtong ever reached any higher position. No record related to the He family dated after this nomination has been found.

⁶⁵ Qu, “Qingdai Qintianjian,” 63-64; Shi, “Qing Qintianjian Tianwenke,” 44.

Chapter 10

Conclusion

Research of a hereditary mathematician family working for the Qing Astronomical Bureau can begin by locating the family's genealogy, then searching the archives to collect data related to family members so that the story can be enriched, challenged, or even reconstructed. However, this research proceeded in a reverse order. It did not wait for the emergence of a genealogy to begin the investigation and did not let a found genealogy determine the research framework or the possible storyline of the family. Instead, it began by examining the archives that contain records of the Qing Astronomical Bureau, abstracting the data on the Bureau mathematicians, and then rebuilding the possible familial relations among them. It then located the possible mathematician families of the Qing Astronomical Bureau, found their common patterns or distinct characteristics, and was able to construct some of these family histories simultaneously. As a result, this research contributed to the cultural history of the Qing Astronomical Bureau.

This dissertation develops its narrative mainly by following the history of the He family, but its research results open up the possibilities for investigating many more mathematician families who had worked through successive generations at the Astronomical Bureau. Whether these were the Christian Bao family, the Huang family of the Section of Heavenly Signs, or the Si family whose members were employed by the Bureau from the first to the last day of the Qing dynasty, each family had its distinct trait that this dissertation could only touch on briefly. These families and many others who have not been mentioned all deserve their own complete research.

This dissertation establishes hereditary mathematician families as among the important actors in the history of mathematics in the Qing dynasty. In contrast with the emperor's interest

in maintaining his rule or European missionaries' goal of spreading Christianity, professional mathematicians of the Qing Astronomical Bureau sought family prosperity, and they achieved that goal by mastering the knowledge and skills needed to fulfill their professional duties. The hereditary mathematicians of the Astronomical Bureau obtained state patronage because they embodied the sovereign's vision of imperial mathematics, which was not static but changed from time to time. By tracing the rise and fall of different mathematician families from the late Ming period to the early Kangxi reign, this dissertation describes how mathematician families strove to balance protecting their own interests with adjusting to the state's changing demands for their mathematical specialties. Moreover, hereditary mathematician families did not just passively react to the state's demands. This dissertation shows that they were the critical contributing factors in the reconstructed stories of the Kangxi Calendar Dispute and the amendment of the Timely Modeling calendar in the early Qianlong reign.

However, since their profession was patronized by the state, the Bureau mathematicians had to perform functions that were not just science oriented. Such characteristics are best revealed by closely examining how the Qing court handled the solar eclipse incidents. This dissertation repeatedly points out that observing an eclipse was a highly politicized event involving the monarch, court ministers, local governors, petty officials, and all people under heaven. Before an eclipse occurred, the Bureau officials' duties were indeed scientific; they marshaled all their mathematical knowledge to provide the emperor with a prediction as accurate as they could produce. However, during and after the eclipse, their tasks became politically sensitive. Publicizing the discrepancy between prediction and observation might disturb social and political stability, a situation that the emperor would definitely not want to happen. Therefore, historians should recognize that the Bureau officials were not only mathematicians

but also government bureaucrats responsible for assisting the monarch in maintaining social and political stability, no matter if it was accomplished by scientific knowledge or by political performance. Instead of considering the cover up of the discrepancy as malfeasance, historians should notice that the Bureau mathematicians were compelled to do so to a certain extent. Such compromise was the price that a scientist who chose a state-patronized profession had to pay, which might have become a survival tactic that the Bureau mathematicians learned secretly within their families.

This dissertation also reasserts the Yongzheng emperor's role in the history of mathematics in the Qing dynasty. The research found that the lack of Qing state records of the 1730 solar eclipse was phenomenal, revealing the incident's political sensitivity rather than the Yongzheng emperor's indifference to mathematics. The inaccurate prediction of the 1730 solar eclipse exposed the Yongzheng emperor to a crisis of mathematical astronomy that his father, the Kangxi emperor, had already foreseen. However, neither the Kangxi emperor's *Thorough Investigation of Astronomical Phenomena* (*Lixiang kaocheng* 曆象考成) nor the group of young mathematicians he trained was able to resolve the crisis. The Yongzheng emperor had to seek help from Jesuit mathematicians whose loyalty had been in doubt since the Kangxi era and whose missionary work he himself had banned. The Yongzheng emperor was in a difficult situation because he had to maintain his father's and his own authority by not arousing any suspicion of the validation of the *Thorough Investigation*. The Yongzheng emperor resolved the crisis by concealing the fact that he knew the prediction would fail and by accepting his subjects' interpretation that the unexpected eclipse was a heavenly approval of his rule. Furthermore, to improve the accuracy of future predictions, he accepted the Jesuits' suggestion to replace the Tychonic system of calendar making that the dynasty had been using with the new Newtonian

system. However, the replacement was not publicized and even the Bureau mathematicians were not taught the new system.

On the other hand, by the end of his reign, the Yongzheng emperor seemed to have come to a similar realization as his father did of the imperial state's need for a new generation of trustworthy mathematicians. Mathematics courses were added to the curriculum of the Eight Banner public schools. In contrast to the College of Mathematics founded in the Qianlong period that aimed at training mathematics specialists to work at the Astronomical Bureau, the Yongzheng mathematics program, if it succeeded, aimed to produce a group of Manchu officials who could serve at different government departments. Unfortunately, the Yongzheng emperor died in 1735 and his mathematics program was closed in 1738. The succeeding emperors never again had the vision of cultivating officials who were both scholars in Confucian classics and mathematicians, such as He Guozong and Mei Juecheng.

In the succeeding Qianlong reign, the Qing dynasty reached its heyday; so did the mathematician families' control of the Astronomical Bureau. Soon after the Qianlong emperor ascended the throne, Jesuit missionaries were forced to teach the Newtonian astronomy to their Chinese colleagues at the Bureau. Afterward, the Jesuits stopped introducing new European mathematics to China, and their status at the Qing court declined. By the end of the eighteenth century, the Astronomical Bureau had become stagnant. Although it continued to produce the calendar for the state, its astronomical theories and instruments were not updated. At that point, it seemed that the Qing Astronomical Bureau would follow the same fate as its predecessor in the Ming Dynasty by becoming the property of the hereditary mathematician families and gradually losing the ability to provide the state with satisfactory predictions of eclipses.

However, the story of the Qing Astronomical Bureau ended with a different twist when Jingzheng, a capable minister, was appointed superintendent in 1824. Instead of forging a large-scale reformation, the strongest means Jingzheng adopted to rejuvenate the Bureau were merely to reinforce the periodical examination system that had existed since 1745. New and more proficient families replaced the old and incompetent ones, such as the He family. By the time that Jingzheng retired from public service in 1845, the Astronomical Bureau had managed to repair the instruments of the observatory and had published the *Addition to the Thorough Investigation of Instruments and Phenomena* (*Yixiang kaocheng xubian* 儀象考成績編) with updated astronomical constants. The achievements of Jingzheng's superintendency remind historians of Chinese mathematics to carefully evaluate the relationship between the Bureau's administration and the hereditary mathematician families. The Astronomical Bureau relied heavily on its members' familial relations to recruit and train new employees, but it might have been prone to corruption precisely because of such relations. Thus, a powerful administrative system could not be more important. It turned out that the examination system could effectively stimulate learning and competition, if not among the individual staff members, than at least among the different mathematician families of the Bureau.

On February 3, 1912, nine days before the last Qing emperor abdicated, the Astronomical Bureau dutifully submitted the next year's calendar for imperial approval.¹ Among the names of officials listed on that calendar was Vice Director Si Bingjun 司秉鈞. The Si family had served the Qing court since the day it was established in Beijing. However, in the last decade of the

¹ NPM 184913.

Qing dynasty, only Bingjun's name could be found on the Bureau's official rosters.² Perhaps the changing social and political conditions had made the Si family consider the profession of being an Astronomical Bureau mathematician much less attractive than before. The first Opium War (1839–42) ended before Jingzheng left the Astronomical Bureau. In the following decades, the political, social, and scientific crises that Qing China encountered were far more severe than compiling a new treatise or training new mathematicians could resolve. In fact, the Qing court never included the Astronomical Bureau and its professional mathematics in its reformation efforts. Although the hereditary mathematician families served the Qing court until its last day, their story had become part of the past and ceased before this dynasty ended.

² *Guangxu wushen Juezhi quanlan Rongbaozhai ban* 光緒戊申爵秩全覽 榮寶齋版, CKZB 380:298–302, 1148–51; Neige Yinzhujū 內閣印鑄局, ed., *Xuantong sannian dongji zhiguanlu* 宣統三年冬季職官錄, CKZB 290:523–37.

Appendix A
Qing Official Résumés

臣何國宸順天府大興縣人年四十二歲康熙
四十三年十一月內考補欽天監曆科天文生
康熙四十九年四月內考授博士雍正元年十
二月內陞授中官正令於雍正七年八月分籤
掣刑部廣東清吏司主事缺竊臣父子兄弟世
受

國恩臣父何君錫原任欽天監春官正臣兄何國
宗現任內閣學士兼禮部侍郎臣以至愚極陋
備員曆曹察祿日深毫無報効欽惟我

立上

載中建極

儲一統猷

至德咸孚欣翊含璧聯珠之應

太和期洽疊見履霜嘉懷之祥世已躋於昇平人

咸登於安阜乃勤求日愆奉

聖心之詰張而銳業時深於庶官訓迪多方敷

皇極之精授而儆戒不遺於一命凡屬臣寮之奉守

惠遵

帝則為稽歸臣質等驚駭識同管蠡附鵠班而思齋

敢渝犬馬之忱念蛟負而自斲實切淵冰之懼

部曹任重虞閑越以貽羞

寵錫恩深質旦明而益惕謹緣履歷恭呈

御覽臣曷勝惶悚惕息之至謹

奏

雍正元年朔月 貳拾玖 日

臣鮑欽輝安徽徽州府休寧縣人年四十六歲
 由欽天監天父生於康熙五十二年陞授習科
 博士雍正九年陞授冬官五堅係二十一年令
 除俸推陞掣得工部都水司主事欽此惟
 皇上
 天縱至聖
 人與或能
 躬已魯敬禮圖開之乾坤
 政順璇衡齊熙臨之日月固已六府三事皆被聲
 歌四海九州同下俾率臣賀本蕭愚躬逢
 盛世報測術業仰沐
 恩榮自臣祖鮑英肇原任欽天監博士臣伯祖英齊
 原任主監副臣父可畏原任天父生臣叔可成
 原任春官正祖孫父子世習骨法均蒙
 國恩臣於五十七年陞授署志効力五年蒙
 恩陞叙加二級雍正八年陞授骨法掌
 恩陞叙加一級本年四月奉
 旨派充正監填算法正教習臣夙夜兢懼唯恐隨越
 今以論俸推陞臣自揣愚昧骨法之外實無寸
 長可以報効臣謹將歷次實奏
 聞仰祈
 天恩仍留本監効力以盡犬馬之忱臣曷勝歡欣惶
 悚之至謹
 奏
 雍正拾貳年玖月 初壹 日

A.3 Chen Jian's Résumé, 1750

臣陳謙順天府大興縣人年陸拾叁歲由欽天
 監天文生於雍正陸年陸搜博士乾隆拾壹年
 陸搜五官司書乾隆拾伍年伍月陸搜中官正
 本年捌月籤陸工部營繕司主事缺伏念臣世
 習術業粗知算法在監肆拾叁年監中推步尚
 能踴躍部曹吏治實未經歷仰懇
 聖恩准以陸銜留任臣不勝感激之至謹
 奏
 乾隆拾伍年拾壹月初柒日

Reprinted from QGLL 17:4.

A.4 He Guodong's Résumé, 1767

臣何國棟順天府大興縣人康熙五十二年舉
 人年七十八歲現任欽天監中官正今籤陸工
 部屯田司主事缺敬繕履歷恭
 呈
 御覽謹
 奏
 乾隆三十二年二月初二日

Reprinted from QGLL 19:275–76.

Appendix B

Official Rosters

B.1 Minli Puzhu Jiehuo 民曆鋪註解惑

勅賜徽教頭光祿大夫從一品通政使司通政使兼欽天監計陽書監纂著											
加正四品左監副又加一級劉有慶	加正四品右監副又加一級周胤	加從六品主簿又加一級李秉	加從五品春官正宋可成	加正五品夏官正又加一級李祖白	加正四品中官正又加一級賈良琦	加正五品秋官正又加一級宋發	官銜		加正五品冬官正又加一級朱光顯	加正七品五官保章正又加一級劉有泰	五官保章正張問明
加監正街骨相度事又加一級杜如預	五官靈臺郎加一級張其淳	五官靈臺郎黃華	五官掣壺正加一級楊弘量		加正八品五官司曆又加一級戈繼文						

五 官 司 曆 殷 鍾											
加正七品博士又加一級張光祥	加從七品博士又加一級臧文顯	加從八品博士又加一級焦應旭	加從八品博士又加一級鮑英齊	加從八品博士又加一級孫有本	加從八品博士又加一級周士昌	加從八品博士又加一級李光大	官銜		加從八品博士又加一級何其義	加從八品博士又加一級薛文炳	加從八品博士又加一級司爾珪
博士		博士		博士		博士		博士		博士	
士戈國琦共參		士鮑英華									

B.2 Shunzhi Yuping Jingguan Mingce 順治御屏京官職名冊

欽天監	燕山右衛經歷加一級傳國政浙江吏員順治十一年二月陞授
監正加二品頂帶通政使司管欽天監事加一級湯若望	
左監副劉有慶順天天文生順治三年六月題補	
右監副周胤浙江天文生順治二年三月照舊	
主簿掌乘順天儒士順治三年六月題補	
中官正賈良琦順天天文生順治二年三月照舊	
春官正宋可成順天府生員順治十年十月陞授	
夏官正李祖白順天副榜監生順治十年六月題補	
秋官正朱發順天儒士順治三年六月題補	
冬官正朱光顯順天天文生順治三年六月題補	
保障正張問明順天天文生順治十五年九月補授	
保障正陳正諫順天天文生順治十年十月陞授	
御屏京官職名冊	
司曆戈繼文江南天文生順治三年六月陞授	
司曆殷鎧順天儒生順治十五年九月補授	
博士左允和順天天文生順治二年三月照舊	
博士鮑英華江南儒士順治十五年九月補授	
博士孫有本順天儒士順治三年六月除授	
博士焦應旭順天儒士順治元年十二月除授	
博士戈國琦江南人順治十三年十一月除授	
博士鮑應齊順天儒士順治三年六月除授	
博士宋可立順天儒士順治三年六月除授	
博士張光祥順天天文生順治二年三月照舊	
博士臧文顯江南天文生順治二年三月照舊	
博士左允登順天天文生順治二年三月照舊	
博士周士昌浙江天文生順治二年三月照舊	
十四 文 獻 彙 編	

博士周士泰浙江天文生順治二年三月照舊	
博士周士萃浙江天文生順治二年三月照舊	
博士周統浙江天文生順治二年三月照舊	
博士何其義浙江天文生順治二年三月照舊	
博士何維書浙江天文生順治二年三月照舊	
博士薛文炳江南天文生順治二年三月照舊	
博士薛文煥江南天文生順治二年三月照舊	
博士董一鳴山西天文生順治三年六月除授	
博士劉應昌順天天文生順治十三年十一月補授	
博士賈良慶順天天文生順治二年三月照舊	
博士李光宏順天天文生順治十五年九月補授	
博士賈文英順天天文科順治六年二月題補	
博士臧懋修江南儒士順治十年十月題補	
御屏京官職名冊	
博士徐瑚順天儒士順治十年十月題補	
博士黃鞏順天天文生順治十五年九月題補	
博士左有慶順天天文生順治十年十月題補	
博士劉必遠順天天文生順治十二年正月題補	
博士何維圖浙江天文生順治十二年十月題補	
天文科五官靈臺郎李之貴順天天文生順治二年三月照舊	
天文科五官靈臺郎李光顯順天人考中博士順治十五年九月補授	
靈臺郎黃道隆順天天文生順治二年三月照舊	
靈臺郎張其淳福建天文生順治十年三月題補	
五官監候臧餘慶江南天文生順治十年十月題補	
博士王燁順天天文生順治二年三月照舊	
博士李光大順天天文生順治二年三月照舊	
漏刻科五官挈壺正杜如預順天訪舉順治五年七月題補	
十五 文 獻 彙 編	

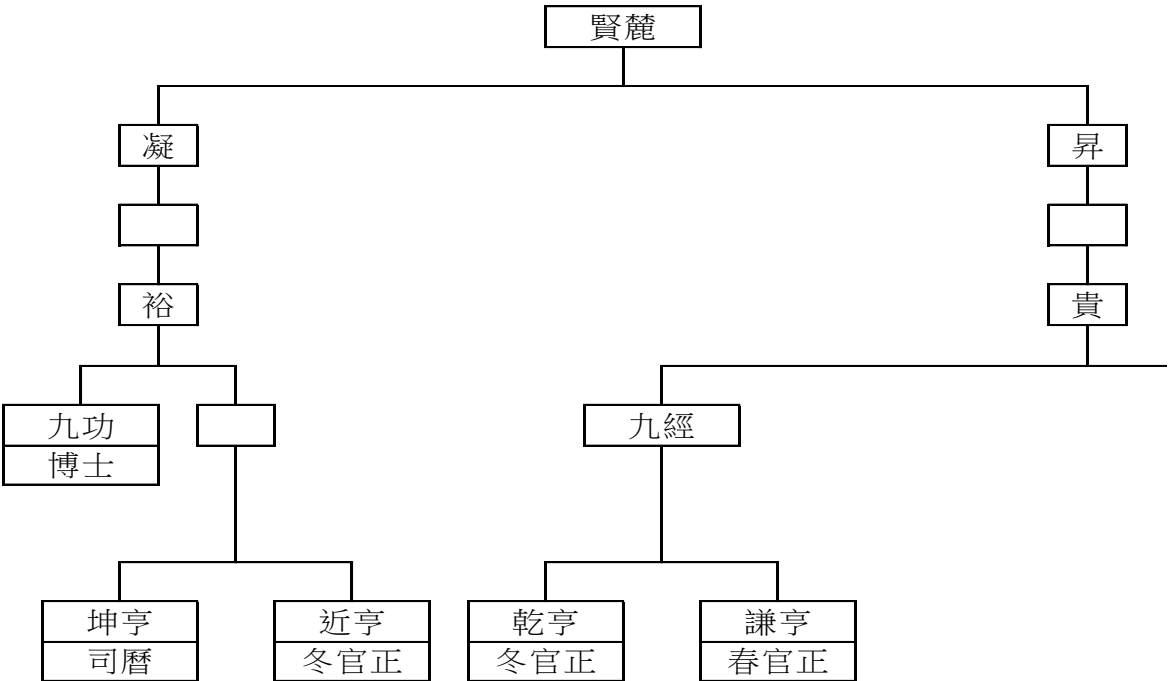
欽天監博士 _臣 周有慶	副收掌	欽天監食俸天文生 _臣 周鴻賓	欽天監食糧天文生 _臣 陳希良	推算	欽天監五官監候 _臣 張榮第	欽天監博士 _臣 古祥鳳	欽天監博士 _臣 郭照墉	欽天監食俸天文生 _臣 杜春融	欽定儀象考成績編	職名	干	欽天監食俸天文生 _臣 李璋	欽天監食俸天文生 _臣 陳希齡	欽天監漢軍天文生 _臣 裕瑞	欽天監蒙古天文生國子監算學教習 _臣 約奎	欽天監食糧天文生國子監算學分教 _臣 王奎照
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Reprinted from *Qinding yixiang kaocheng xubian* 欽定儀象考成績編, XXSK 1035:271-72.

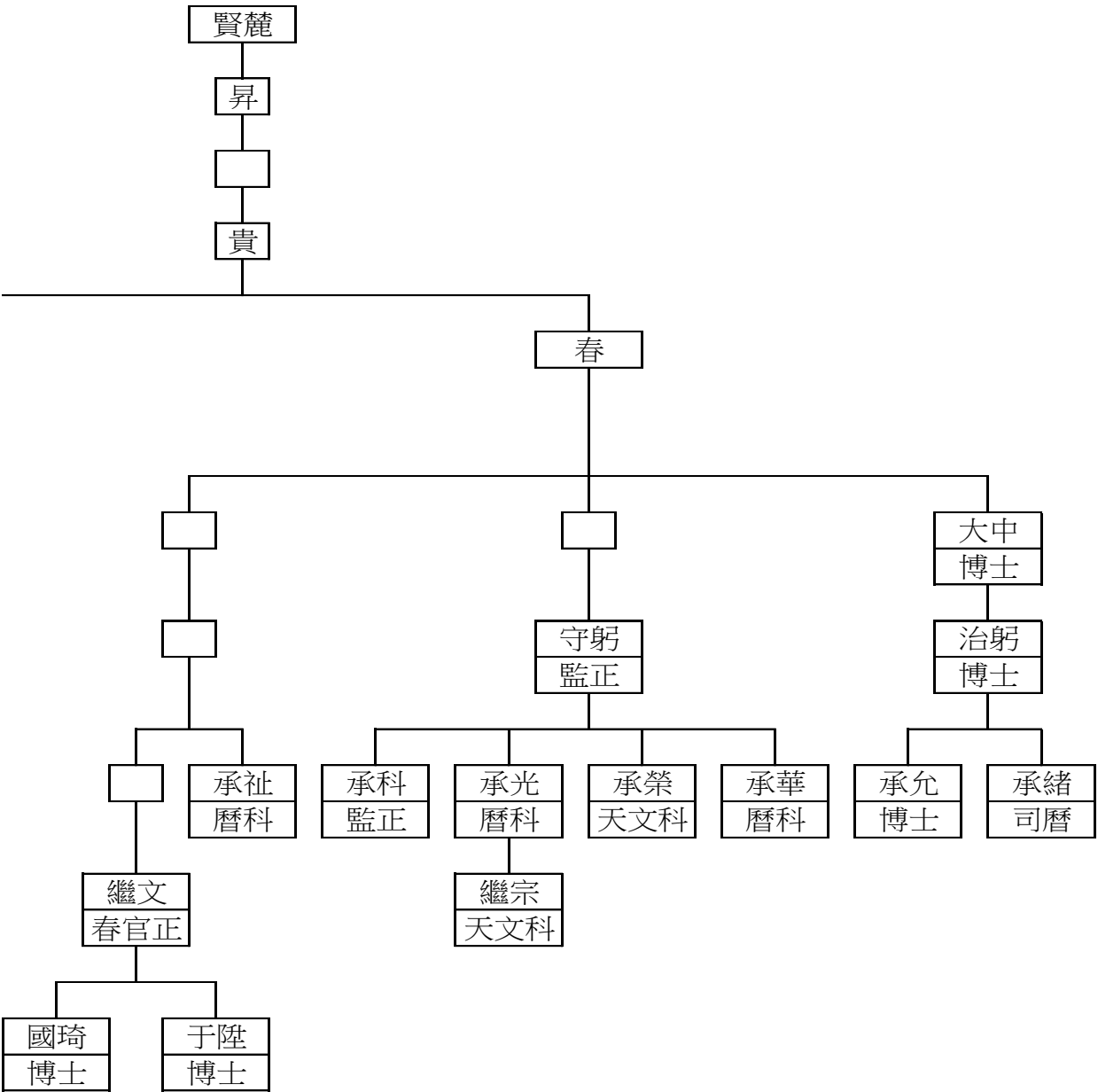
Appendix C

Mathematician Families in the Ming-Qing Astronomical Bureau

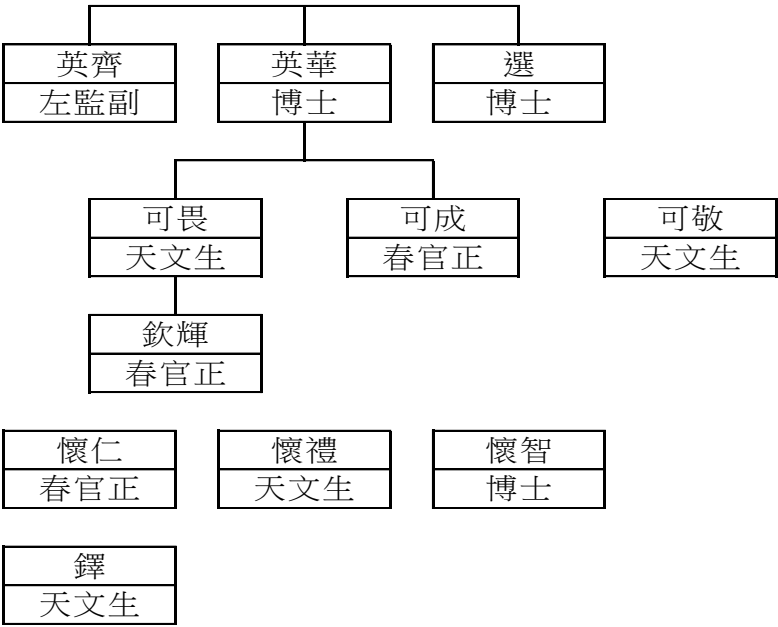
C.1 Partial Reconstruction of the Ge 戈 Family Tree



C.1 Partial Reconstruction of the Ge 戈 Family Tree (cont.)



C.2 Partial Reconstruction of the Bao 鮑 Family Tree



C.3 The He 何 Family

Given name	Highest position	Active period	Section
Qiyi 其義	Calendar collator	1644–1659	C
Luoshu 雒書	Supervisor of the Summer Office	1644–1658	C
Luotu 雒圖	Erudite	1655	C
Junxi 君錫	Supervisor of the Spring Office	1670–1713	C
Junfan 君藩	Erudite	1719	HS
Junhui 君惠	Supervisor of the Spring Office	1712–1731	C
Guozhu 國柱	Vice director	1711–1724	C
Guozong 國宗	Superintendent	1687–1766	
Guoan 國安	Erudite	1724	WC
Guochen 國宸	Supervisor of the Middle Office	1688–1744	C
Guodong 國棟	Supervisor of the Middle Office	1690–1767	C
Guoxiu 國秀	Supervisor of the Summer Office	1694–1758	C
Guoqing 國卿	Supervisor of the Spring Office	1739–1755	C
Guozheng 國政	Student astronomer	1738–1742	C
Guoxun 國勳	Student astronomer	1741	HS
Guoxiang 國相	Erudite	1755	
Tingxu 廷緒	Secretary-general	1704–1771	WC
Tinglu 廷祿	Vice director	1741–1774	C
Tingxuan 廷璿	Vice director	1721–1789	C
Tingxuan 廷瑄	Supervisor of the Winter Office	1771–1777	C
Tingchen 廷琛	Secretary-general	1777–1786	WC
Tinging 廷瑛	Vice director	1740–1810	C
Tingzan 廷瓚	Supervisor of the Summer Office	1781–1795	C
Bangjun 邦俊	Supervisor of the Summer Office	1774–1778	C
Tianfu 天福	Observatory manager	1769–1781	HS
Tiangui 天貴	Erudite	1764	
Yuanze 元澤	Erudite	1781	

Given name	Highest position	Active period	Section
Longwu 隆武	Erudite	1793–1799	
Yuanji 元濟	Erudite	1793	C
Yuanhao 元浩	Supervisor of the Middle Office	1748–1798	C
Yuanfu 元富	Supervisor of the Middle Office	1803–1819	C
Yuantai 元泰	Supervisor of the Summer Office	1758–1813	C
Yuanyong 元湧	Erudite	1802–1815	C
Yuanpu 元溥	Erudite	1804–1828	C
Yuanhai 元海	Supervisor of the Winter Office	1808–1811	C
Yuanzi 元滋	Calendar collator	1807–1821	C
Yuanying 元瀛	Supervisor of the Summer Office	1810–1823	C
Yuangan 元淦	Erudite	1814–1828	C
Yuanzhun 元淮	Secretary-general	1812–1826	HS
Yuanqi 元淇	Erudite	1825–1842	C
Yuandu 元渡	Official observer	1816–1828	HS
Yuanrun 元潤	Student astronomer	1828	
Yuanhui 元洵	Student astronomer	1828	
Liangkui 良奎	Supervisor of the Winter Office	1821–1838	C
Liangtang 良棠	Observatory manager	1825–1837	HS
Liangcheng 良成	Student astronomer	1828	
Liangkai 良楷	Yin-yang student	1837	WC
Liangtong 良桐	Erudite	1843–1846	WC
Shuben 樹本	Vice director	1816–1841	HS
Weimin 維敏	Water clock manager	1846	WC
Jun 均	Student astronomer	1843	

Note: C = Calendar Section, HS = Section of Heavenly Signs, WC = Water Clock Section.

C.4 The Si 司 Family

Given name	Highest position	Active period	Section
Ergui 爾珪	Erudite	1647–1669	WC
Ermao 爾瑁	Vice director	1649–1701	WC
Ercheng 爾埕	Erudite	1656	WC
Jing 敬	Erudite	1715–1725	HS
Mu 牧	Erudite	1725	
Wenyu 文郁	Erudite	1725	
Wenjing 文靖	Secretary-general	1712–1718	WC
Hongze 鴻澤	Student astronomer	1677	WC
Hongpu 鴻溥	Vice director	1735–1724	WC
Hongying 鴻英	Director	1807–1834	WC
Tinggan 廷幹	Observatory manager	1782–1807	HS
Tingdong 廷棟	Supervisor	1763–1834	C
Tingben 廷本	Erudite	1839–1840	C
Zhi 智	Vice director	1807–1861	WC
Jin 晉	Supervisor	1837–1858	C
Yan 晏	Erudite	1841	WC
Yong 永	Erudite	1845	
Yipei 以培	Supervisor	1832–1887	C
Yitian 以田	Erudite	1845–1874	C
Yisun 以埴	Calendar collator	1884–1899	C
Bingjun 秉鈞	Vice director	1890–1911	

Note: C = Calendar Section, HS = Section of Heavenly Signs, WC = Water Clock Section.

GLOSSARY

*A. Units Used in the Qing Era**A.1 Time*

日 *ri* = day

時 *shi* = double hours; 1 *ri* = 12 *shi*

Double hours	Modern time
子 <i>zi</i>	11 p.m.–1 a.m.
丑 <i>chou</i>	1 a.m.–3 a.m.
寅 <i>yin</i>	3 a.m.–5 a.m.
卯 <i>mao</i>	5 a.m.–7 a.m.
辰 <i>chen</i>	7 a.m.–9 a.m.
巳 <i>si</i>	9 a.m.–11 a.m.
午 <i>wu</i>	11 a.m.–1 p.m.
未 <i>wei</i>	1 p.m.–3 p.m.
申 <i>shen</i>	3 p.m.–5 p.m.
酉 <i>you</i>	5 p.m.–7 p.m.
戌 <i>xu</i>	7 p.m.–9 p.m.
亥 <i>hai</i>	9 p.m.–11 p.m.

刻 *ke* = quarter; 1 *shi* = 8 *ke*

<i>ke</i>	Time in a double hours
初 初刻	first quarter
初 一刻	second quarter
初 二刻	third quarter
初 三刻	fourth quarter
正 初刻	fifth quarter
正 一刻	sixth quarter
正 二刻	seventh quarter
正 三刻	eight quarter

分 *fen* minute; 1 *ke* = 15 *fen*

秒 *miao* second; 1 *fen* = 60 *miao*

A.2 Eclipse Magnitude

In Qing court documents, the solar eclipse's magnitude is defined as the fraction of the Sun's diameter covered by the Moon. Similarly, the Moon eclipse's magnitude is the fraction of the Moon's diameter covered by the Earth's shadow.

1 分 *fen* = 1/10 diameter

1 秒 *miao* = 1/100 分 *fen*

B. Chinese-English Terminology in Translation

算學 *Xuanxue* College of Mathematics
 助教 *Zhujiao* associate professor
 教習 *Jiaoxi* assistant professor
 協同分教 *Xiutongfenjiao* teaching assistant
 算學生 *Xuanxuesheng* mathematics student

欽天監 *Qintianjian* Astronomical Bureau
 時憲科 *Shixian ke* (曆科 *Li ke*) Calendar Section
 天文科 *Tianwen ke* Section of Heavenly Signs
 漏刻科 *Louke ke* Water Clock Section
 回回科 *Huihui ke* Muslim Section
 監正 *Jianzheng* director
 監副 *Jianfu* vice director
 左監副 *Zuo Jianfu* senior vice director
 右監副 *You Jianfu* junior vice director
 主簿 *Zhubu* secretary-general
 筆帖式 *Bitiexhi* scribe
 春官正 *Chunguanzheng* supervisor of the Spring Office
 夏官正 *Xiaguanzheng* supervisor of the Summer Office
 秋官正 *Qiuguanzheng* supervisor of the Autumn Office
 冬官正 *Dongguanzheng* supervisor of the Winter Office
 中官正 *Zhongguanzheng* supervisor of the Middle Office
 五官正 *Wuguanzheng* supervisor of the Five Offices
 司書 *Sishu* (司曆 *Sili*) calendar collator
 博士 *Boshi* erudite
 天文生 *Tianwensheng* official astronomer, student astronomer
 靈台郎 *Lingtailing* observatory manager
 監候 *Jianhou* Official observer
 挈壺正 *Qiehu Zheng* water clock manager
 司晨 *Sichen* time collator
 陰陽生 *Yinyangsheng* (陰陽人 *Yingyangren*) yin-yang student

大統曆 *Datong li* [calendar made following] the Great Concordance system]
 時憲曆 *Shixian li* [calendar made following] the Timely Modeling system]
 授時曆 *Shoushi li* [calendar made following] the Season Granting system]
 西洋新法 *Xiyang xinfa* New Western method
 新法 *Xinfa* New Method
 舊法 *Jiufa* Old Method
 古法 *Gufa* Ancient Method, Old Method
 西學 *Xixie* Western learning

翰林院 *Hanlin Yuan* Hanlin Academy
 國子監 *Guozijian* Imperial College
 監生 *jiansheng* student of Imperial College
 生員 *Shengyuan* (秀才 *xiucaì*) district graduate
 舉人 *Juren*, provincial graduate (lit. “elected person”)
 進士 *Jinshi* metropolitan graduate (lit. “advanced scholar”)

吏部 *Li Bu* Ministry of Personnel
 戶部 *Hu Bu* Ministry of Revenue
 禮部 *Li Bu* Ministry of Rites
 兵部 *Bing Bu* Ministry of War
 刑部 *Xing Bu* Ministry of Punishments
 工部 *Gong Bu* Ministry of Works

大學士 *Daxueshi* grand secretary
 學士 *Xueshi* secretary
 尚書 *Shangshu* president, minister
 侍郎 *Shilang* vice president, vice minister
 郎中 *Langzhong* department director
 員外郎 *Yuanwailang* assistant department director
 主事 *Zhushi* second-class secretary

效力算法人員 *Xiaoli suanfa renyuan*
 members serving in mathematics

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