

A Distinctive Way of Integration: The Main Portion of Xue Fengzuo's *Lixue huitong* Revisited

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Introduction

Scientific exchanges between the Jesuits and Chinese literati began in the late Ming dynasty, when European science was first introduced into China by Jesuit missionaries. Although some Chinese scholars recognized the advantages of European science, most of them believed that there still were many strong points in the Chinese tradition, and suggested that it was best to integrate Chinese and Western science. Therefore, “integration” (*huitong* 會通) became an important issue in the discussions of Western science during the late Ming and early Qing period. However, different people integrated Chinese and Western science in different ways. Among them, Xue Fengzuo's 薛鳳祚 (1600-1680) method of integration stands out to be very distinctive.¹

Xue Fengzuo was an eminent astronomer in the early Qing dynasty. Born in Zibo 淄博, Shandong Province, he was firstly a student of Lu Shanji 鹿善繼 (1575-1636) and Sun Qifeng 孫奇逢 (1584-1675) of the “Learning of Mind” (*xinxue* 心學) school, which gained popularity after the mid-Ming dynasty. Then he studied traditional Chinese astronomy, mathematics, and astrology from Wei Wenkui 魏文魁 (1557-1636), a prominent astronomer known for his anti-Western stance during Xu Guangqi's 徐光啓 (1562-1633) astronomical reform. In that period, however, Xue Fengzuo also began to read astronomical works composed by the Jesuits in China. In 1652, he moved to Nanjing where he became a disciple of the Polish Jesuit Nicolaus Smogulecki (1611-1656, also known as Mu Nige 穆尼閣 in Chinese), and they completed the *Tianbu zhenyuan* 天步真原 (True Principles of the Pacing of the Heavens, 1653) in collabo-

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¹ For Xue Fengzuo, see: Shi Yunli, “Nikolaus Smogulecki and Xue Fengzuo's *True Principles of the Pacing of the Heavens*: Its Production, Publication, and Reception,” *East Asian Science, Technology, and Medicine* 27 (2007), 63-126.

ration. This book consisted of both astronomical and astrological parts. While the astrological part was based on Cardano's commentaries on Ptolemy's *Tetrabilos*,² the astronomical part was basically an adaptation of the *Tabulae motuum coelestium perpetuae ... Item theoreticae motuum coelestium novae et genuinae...* (Perpetual Tables of Celestial motions... also New and True Theories of Celestial Motions..., 1632) by the Belgian Philippe van Lansberge (1561-1632).³

More than ten years later, Xue Fengzuo completed his major work, the voluminous collectanea *Lixue huitong* 曆學會通 (An Integration of Calendrical Learning, 1664) in three major parts: Main Portion (*Zhengji* 正集), Portion on Tests (*Kaoyan bu* 考驗部), and Portion on Applications (*Zhiyong bu* 致用部). While the Portion on Applications deals with the application of mathematical studies to a variety of fields such as astrology, musical harmonics, medicine, hydraulics, mechanics, military strategics, fortification, and gunnery, the Portion on Tests provides Xue Fengzuo's digest of the systems of calendrical astronomy laid out in the *Shoushi li* 授時曆 (Time Granting System of Calendrical Astronomy, 1280) contrived by Guo Shoujing 郭守敬 (1231-1316); the *Huihui lifa* 回回曆法 (Chinese-Islamic System of Calendrical Astronomy, 1384) compiled in the early Ming dynasty; the *Chongzhen lishu* 崇禎曆書 (Chongzhen-reign Treatises on Calendrical Astronomy, 1634) compiled during the calendar reform under the leadership of Xu Guangqi and officially adopted by the Qing dynasty under the new title *Xiyang xinfa lishu* 西洋新法曆書 (Treatises on Calendrical Astronomy according to the New Western Method); and the *Tianbu zhenyuan*. The Main Portion presents the result of his integration of these systems, a new system of his own to which he refers either as the "Integrated Chinese Method" (*huitong zhongfa* 會通中法) or the "New Chinese Method" (*xin zhongfa* 新中法).

At first glance, the Main Portion is nothing more than an adaptation of the astronomical section of the *Tianbu zhenyuan*, and therefore does not contain anything which can be counted as an "innovation" in the calendrical astronomy of the period. For such reasons, Xue Fengzuo has been deemed a less innovative astronomer as compared with Wang Xichan 王錫闡 (1628-1682), another leading astronomer in the early Qing dynasty. From a positivist perspective, this kind of judgment may sound reasonable. However, it ignores the actual intention of the Main Portion and its real significance in the contemporary social and cultural contexts. This paper tries to re-analyze Xue Fengzuo's new system in the Main Portion in order to shed some new light on the

² Nicolas Standaert, "European Astrology in Early Qing China: Xue Fengzuo's and Smogulecki's Translation of Cardano's Commentaries on Ptolemy's *Tetrabilos*," *Sino-Western Cultural Relations Journal* 中西文化交流史雜誌, XXIII (2001), 50-79.

³ Shi Yunli 石雲里, "Tianbu zhenyuan yu Gebaini tianwenxue zai Zhongguo de zaoqi chuanbo" 《天步真原》與哥白尼天文學在中國的早期傳播, *Zhongguo keji shiliao* 中國科技史料 21:1 (2000), 83-91.

feature of his work.

Xue Fengzuo's New System

The Main Portion of the *Lixue huitong* consists of 12 volumes, and its contents can be roughly divided into three parts on mathematics, theories, and practical calculations. The mathematical part includes three volumes on the mathematical tools necessary for astronomical calculations: volume 1 *Zhengxian* 正弦 (On Sine), a discussion of the computation of sine as the basis for the construction of trigonometric tables; volume 2 *Sixian* 四線 (On the Four Trigonometric Lines) or *Zhongfa sixian* 中法四線 (On the Four Trigonometric Lines in Chinese Method), a *Bili sixian xinbiao* 比例四線新表 (New Table of Logarithms of the Four Trigonometric Lines), i.e. sine, cosine, tangent, and cotangent; and volume 12 *Duishu* 對數 (On Logarithms), a table of logarithms for 1 to 100,000. This part is largely based on European sources such as the *Hypomnemata mathematica* (1608) by Simon Stevin (1548-1620) and the *Arithmetica logarithmica* (1628) by Adriaan Vlacq (1600-1667).⁴ The theoretical part includes three volumes (volumes 3 to 5), devoted to the *Taiyang taiyin jingwei fayuan* 太陽太陰經緯法原 (Theoretical Principles of the Longitude and Latitude of the Sun and the Moon), *Wuxing jingwei fayuan* 五星經緯法原 (Theoretical Principles of the Longitude and Latitude of the Five Planets), and *Jiaoshi fayuan* 交食法原 (Theoretical Principles of the Luni-solar Eclipses), where the geometric models for the motions of the sun, the moon, and the five planets are discussed respectively. The remaining six volumes (volumes 6 to 11), i.e. the *Zhongli* 中曆 (Chinese Calendar), the *Taiyang taiyin bing siyu* 太陽太陰並四餘 (Tables of the Sun, the Moon, and the Four Imaginary Stars), the *Wuxing licheng* 五星立成 (Tables of the Five Planets), the *Jiaoshi licheng* 交食立成 (Tables of the Luni-solar Eclipses), the *Jingxing jingwei xingqing* 經星經緯性情 (Tables of the Fixed Stars), and *Bian zhufa yitong* 辨諸法異同 (A Comparison of the Similarities and Differences of the Four Methods), are devoted to the algorithms and pre-calculated tables needed in the practical astro-calendrical calculations. In the last volume, Xue Fengzuo applies his own system together with the *Shoushi li*, the *Huihui lifa*, and the *Chongzhen lishu* to the calculation of two solar eclipses to show the superiority of his own system.

From Xue Fengzuo's perspective, the most important task for Chinese astronomers of the time was to integrate the Chinese and Western astronomical systems, now that

4 Chu Longfei 褚龍飛, "Xue Fengzuo lifa gongzuo yanjiu" 薛鳳祚曆法工作研究 (Ph.D. dissertation, University of Science and Technology of China, Hefei, 2014), 134-135; Yang Zezhong 楊澤忠, "Xue Fengzuo 'Zhengxian' yishu yanjiu" 薛鳳祚《正弦》一書研究, *Shandong shehui kexue* 山東社會科學 6 (2011), 44-50.

the Chinese astronomical system had turned out to have so many limits and shortcomings and Chinese astronomers were not able to win the ongoing dispute with the proponents of the Western system by using “lame arguments and rhetoric pretexts.” “The key here is for us to first stand on an infallible ground. Only by then can our way [of doing astronomy] become venerable. And that is why the integration cannot be delayed.”⁵ He also did not think that this task had been finished by the compilers of the *Xiyang xinfa lishu* because, in his eyes, the work still contained a lot of deficiencies caused by (1) the misinterpretation of Western terms and texts, and (2) the obsolescence of the Tychonic system adopted in the work as compared to more recent and advanced European works. As for how to integrate the two systems, he explained:

Though the numbers of the two astronomical systems are different, their principles are basically accordant. One cannot benefit from both of them without absorbing the merits of both. But the [Chinese and Western] astronomers have been sticking to their established opinions and contradicting with each other. The reason why they have worked separately for several centuries and no one has been able to think of a way to combine the two systems into a uniform one is the difficulties involved in the integrating work. To achieve an integration, one must collect extensive sources and analyze all the details. Only after that can one draw an eclectic solution from various theories, and this cannot be accomplished without a profound comprehension of the principles and numbers involved in the work.⁶

Apparently, Xue Fengzuo believed that he had eventually fulfilled the task of integration, as he claimed: “Now the *Tianbu zhenyuan* comes in addition, and the ‘true principle’ method from the Great West has been integrated with the Chinese methods.”⁷ That is why he made his new system the Main Portion of the *Lixue huitong*, and called it the “New Chinese Method” and the “Integrated Chinese Method.”

According to Xue Fengzuo, eight- or nine-tenths of this new system “are taken from the *Shoushi* [li] and the *Tianbu zhenyuan*, whereas both Islamic [*Huihui lifa*] and European [*Xiyang xinfa lishu*] systems are occasionally drawn on as supplements.”⁸ A quick scan of the system can show that the system as a whole is basically a transplantation of, and therefore mathematically equivalent to, what is contained in the *Tianbu*

⁵ Xue Fengzuo 薛鳳祚, “Zhengji xu” 正集敘, *Lixue huitong zhengji* 曆學會通正集, in Bo Shuren 薄樹人 ed., *Zhongguo kexue jishu dianji tonghui tianwen juan* 中國科學技術典籍通彙天文卷, vol. 6 (Zhengzhou: Henan jiaoyu chubanshe, 1993), 619.

⁶ Xue Fengzuo, “Kaoyan xu” 攷驗敘, *Lixue huitong kaoyan bu* 曆學會通考驗部, in Han Yuqun 韓寓群 ed., *Shandong wenxian jicheng* 山東文獻集成, vol. 23, part II (Jinan: Shandong daxue chubanshe, 2008), 410.

⁷ Xue Fengzuo, “Jin xifa xuanyao xu” 今西法選要序, *Lixue huitong kaoyan bu*, 364.

⁸ Xue Fengzuo, “Zhengji xu,” 619.

zhenyuan. In the meantime, however, many differences remain. For example, logarithm is not used in the astronomical part in the *Tianbu zhenyuan*, but it was applied to the astronomical calculations in his “New Chinese Method.”⁹ This is one of Xue Fengzuo’s major modifications, and is mentioned as well in his “Xifa huitong canding shiyize” 西法會通參訂十一則 (Eleven Items Concerning the Integration of the Western Method) at the beginning of the Main Portion.¹⁰ Moreover, Xue Fengzuo also points out that the Western sexagesimal angular system is not as convenient as the Chinese centesimal system in expressing angles, while the Western ninety-six-*ke*-per-day system was not as good as the Chinese hundred-*ke*-per-day system. As a result, the Chinese styles are adopted in the Main Portion instead of the Western ones. These are all of Xue Fengzuo’s adjustments known to previous scholars.¹¹ However, what Xue Fengzuo has done is far more than these three aspects. For instance, in volume 1 on the *Zhengxian*, Xue Fengzuo includes the “Secret Method for Extracting a Square Root” (*kaifang mifa* 開方秘法), a method that he learned from Wei Wenkui.¹² In the theoretical part, the order of the chapters was rearranged deliberately as compared with the original order in the *Tianbu zhenyuan*. Nevertheless, the most significant part in the Main Portion is the part on practical calculations, which reflects the primary characteristics of Xue Fengzuo’s integrating work.

In the part on practical calculations, Xue Fengzuo appropriated contents from many different sources. For example, from Xing Yunlu’s 邢雲路 (c. 1549 - c. 1621) *Gujin lili kao* 古今律曆考 (A Study of the Works on Musical Harmonics and Calendrical Astronomy from Antiquity to the Present, 1600), he borrowed the “Linian jiazi” 歷年甲子 (Table of Years Arranged in the Sexagesimal Cycles), “Tuwang yongshi” 土王用事 (Governance of the King of Earth), “Qihou” 氣候 (Solar Terms and Related

⁹ Xue Fengzuo, *Lixue huitong zhengji*, 841-844.

¹⁰ Xue Fengzuo, *Lixue huitong zhengji*, 625.

¹¹ On Xue Fengzuo’s works on logarithm, see: e.g. Han Qi 韓琦, “Duishu zai Zhongguo” 對數在中國 (Master’s thesis, University of Science and Technology of China, 1988); Guo Shirong 郭世榮, “Xue Fengzuo de shuxue chengjiu xintan” 薛鳳祚的數學成就新探, in Ma Laiping 馬來平 ed., *Zhongxi wenhua huitong de xianqu: Quanguo shoujie Xue Fengzuo xueshu sixiang yantaohui lunwenji* 中西文化會通的先驅: 全國首屆薛鳳祚學術思想研討會論文集 (Jinan: Qilu shushe, 2011), 354-358; Ma Laiping, “Zhongxi wenhua huitong de xianqu: ping Xue Fengzuo de zhongxi kexue huitong moshi” 中西文化會通的先驅—評薛鳳祚的中西科學會通模式, in Ma Laiping ed., *Zhongxi wenhua huitong de xianqu*, 151-152. On the centesimal angular system in Xue Fengzuo’s works, see: e.g. Hu Tiezhu 胡鐵珠, “Huitong zhongxi lisuan de Xue Fengzuo” 會通中西曆算的薛鳳祚, in *Shandong gudai kexuejia* 山東古代科學家 (Jinan: Shandong wenyi chubanshe, 1992), 310; Ma Laiping, “Zhongxi wenhua huitong de xianqu,” 152.

¹² In the “Zhongfa sixian yin” 中法四線引 (Preface to the *Four Trigonometric Lines in Chinese Method*) of the Main Portion, Xue Fengzuo mentioned he had learnt the method for extracting a square root from Wei Wenkui, see: Xue Fengzuo, *Lixue huitong zhengji*, 638.

Phenology), “Zhisu” 直宿 (the On-duty Lunar Mansion), “Jianri” 建日 (Day of Establishing), and “Nayin” 納音 (Matching Sounds). From the *Xiyang xinfā lishu*, he adapted “Shicha” 時差 (Equation of Time), “Qingmengcha” 清蒙差 (Astronomical Refraction), “Ri ju di banjingcha” 日距地半徑差 (Solar Parallax), “Xifa chunqiu fen ce ridufen” 西法春秋分測日度分 (Using Western Method to Determine the Time When the Sun Moved to the Spring or Autumn Equinox), and “Ce taiyang zuigao ji liangxin zhi cha ce chunqiu fen” 測太陽最高及兩心之差測春秋分 (Observing in the Spring or Autumn Equinox to Determine the Apogee and Eccentricity of the Sun’s Orbit). From the *Tianbu zhenyuan* he took the “Erzhi ce rigaodu” 二至測日高度 (Measuring the Sun’s Altitude at the Summer and Winter Solstices), “Xiaoqi qu rigao lingshu” 小器取日高零數 (Using Small Instruments to Measure the Sun’s Altitude), and “Zhuri ce taiyang jingdu” 逐日測太陽經度 (Measuring the Sun’s Longitude Day by Day). In the meantime, other sections, such as the “Nanbei zhengxiang” 南北正向 (Determining the South-North Direction) and “Dingshi” 定時 (Determining the Time), are combinations of the relevant contents from both the *Xiyang xinfā lishu* and the *Tianbu zhenyuan*.¹³ In the same part, Xue Fengzuo also used a number of pre-calculated tables, which, though important, were absent in the *Tianbu zhenyuan*. For example, the “Wuxing chenxi fujian biao” 五星晨夕伏見表 (Table of the First Invisibility and Visibility of the Five Planets at Dawn and Dusk) and “Wuxing huangchidao shengdu biao” 五星黃赤道升度表 (Table of Transforming the Longitude Value of the Five Planets from Ecliptic into Equatorial) were taken from the *Xiyang xinfā lishu*, while the “Taiyin lingfan shike licheng” 太陰凌犯時刻立成 (Table of the Occultation Time of the Moon with the Planets and the Fixed Stars) was added by Xue Fengzuo following the example of the *Huihui lifa*.¹⁴ These examples show that in constructing his new system in the Main Portion, he was actually carrying out his strategy of integration, namely, “casting materials from various schools into the mould of my own learning” (鑄各方之材質, 入吾學之型範).¹⁵

Preserving the Format of Chinese Traditional System

Xue Fengzuo tried very hard to make his new system “Chinese.” For this purpose he preserved the format of the traditional Chinese system, and many Western concepts were expressed in traditional Chinese terminology. For example, in the *Tianbu*

¹³ Chu Longfei, “Xue Fengzuo lifa gongzuo yanjiu,” 137.

¹⁴ Xue Fengzuo, *Lixue huitong zhengji*, 784-786, 788-789; Xu Guangqi 徐光啓, et al., *Xiyang xinfā lishu* 西洋新法曆書 [*Gugong zhenben congkan* 故宮珍本叢刊, vols. 383-387 (Haikou: Hainan chubanshe, 2000)], vol. 385, 255-256, 258-259; Beilin 貝琳, *Huihui lifa* 回回曆法 (1477), *juan* 5, 36-38.

¹⁵ Xue Fengzuo, “Zhengji xu,” 619-620.

zhenyuan, the terms for the epoch longitudes of the mean motions of the sun, the moon and the five planets are called “*genshu*” 根數 (radix), a new phrase coined by the compilers of the *Chongzhen lishu*.¹⁶ In the Main Portion, however, they are replaced by terms used in the *Shoushi li* and the *Datong li* 大統曆 (Great Unification System of Calendrical Astronomy, 1384), such as “*duying*” 度應 (degree interval constant), “*qiying*” 氣應 (interval constant of the solar terms), “*liying*” 曆應 (argument interval constant), “*tianzheng jingshuo*” 天正經朔 (mean new moon of astronomical new year), “*runyu*” 閏餘 (intercalary surplus), etc.¹⁷ In addition, Xue Fengzuo also renamed some terms concerning the motions of the sun, the moon, and the five planets. For instance, in the solar theory of the *Tianbu zhenyuan*, the terms for the mean motions of the vernal equinox and the center and apogee of the sun’s deferent are called “*chunfen pingxing*” 春分平行 (mean motion of the vernal equinox), “*taiyang xinxing*” 太陽心行 (motion of the solar center), and “*taiyang zuigaoping*” 太陽最高行 (motion of the solar apogee), respectively. In the Main Portion, however, these terms are changed into “*taiyang huangchidao jiaodu*” 太陽黃赤道交度 (motion of the node of the ecliptic on the celestial equator), “*taiyang yingsuo xinxingdu*” 太陽盈縮心行度 (motion of the center of the expansion and contraction of the sun), and “*taiyang yingsuo xingdu*” 太陽盈縮行度 (motion of the expansion and contraction of the sun), in the scheme of traditional Chinese nomenclature.¹⁸ Likewise, the “*taiyin zixing*” 太陰自行 (lunar intrinsic motion) in the lunar theory is changed into “*yuezhuan chiji*” 月轉遲疾 (slackening and hastening of the lunar revolution), and the “*qianjun*” 前均 (former inequality) and “*houjun*” 後均 (latter inequality) in the planetary theory are replaced by “*yingsuo jiajiandu*” 盈縮加減度 (addition and subtraction degree of the expansion and contraction) and “*juri jiajiandu*” 距日加減度 (addition and subtraction degree of the distance from the sun).¹⁹ These terminological adjustments did not concern the actual calculation of the motions of the celestial bodies, but they did make Xue Fengzuo’s “Integrated Chinese Method” look and sound more like a Chinese system.

Apart from the terminological alterations, Xue Fengzuo also made some other adaptations. Firstly, the astronomical epoch in the *Tianbu zhenyuan* is January 1, 1 AD, following the example of Lansberge’s *Tabulae motuum coelestium perpetuae*, a practice popular in European astronomy at that time. In the “Integrated Chinese Method,” however, Xue Fengzuo moved the date to the winter solstice of the twelfth year of the Shunzhi 順治 reign-period, namely, December 21, 1655,²⁰ in line with the Chinese

¹⁶ Xue Fengzuo, *Lixue huitong kaoyan bu*, 413.

¹⁷ Xue Fengzuo, *Lixue huitong zhengji*, 738-789.

¹⁸ Xue Fengzuo, *Lixue huitong zhengji*, 748-750.

¹⁹ Xue Fengzuo, *Lixue huitong zhengji*, 758-781.

²⁰ Xue Fengzuo, *Lixue huitong zhengji*, 723.

convention of using winter solstice as the astronomical epoch. He also moved the starting point of the longitude from the spring equinox to the winter solstice, again to adapt a European practice to Chinese tradition.²¹

Secondly, Xue Fengzuo added some new tables into the Main Portion to make his “Integrated Chinese Method” consistent with the traditional Chinese system. For example, the time of the “invisibility and visibility of the five planets” (*wuxing fujian* 五星伏見) was an important issue in Chinese astronomy but not in European astronomy. In the *Xiyang xinfa lishu*, however, a “Wuxing chenxi fujian biao” is calculated with European data and procedures to meet this Chinese need. Not surprisingly, this table was incorporated by Xue Fengzuo into the Main Portion in order to calculate a set of planetary phenomena significant in Chinese astronomy.²² In the same vein, the Main Portion also includes such tables as the “Ershisiqi hengxing chumo zaizhong licheng” 二十四氣恒星出沒在中立成 (Table of the Rising, Setting, and Culminating of the Fixed Stars in the Twenty-four Solar Terms) and the “Ershisiqi taiyang churu zhouye hundan kafen” 二十四氣太陽出入晝夜昏旦刻分 (Times of the Sunrise and Sunset and the Length of the Day and Night in the Twenty-four Solar Terms), for the calculation of the “length of the day and night” (*zhouye louke* 晝夜漏刻), “times of the sunrise and sunset” (*richuru shike* 日出入時刻), and “calculating the culminating star” (*bu zhongxing* 步中星) were all indispensable topics in traditional Chinese astronomy.²³

Thirdly, Xue Fengzuo even adjusted the order of the five planets. In the *Tianbu zhenyuan*, the five planets were arranged in descending order according to their distances from the sun: Saturn, Jupiter, Mars, Venus, and Mercury, following the Western astronomical tradition. In the Main Portion, however, the order returned to the Chinese tradition: Jupiter, Mars, Saturn, Venus, and Mercury. In brief, Xue Fengzuo made great efforts to transform Smogulecki’s “New Western Method” (*xin xifa* 新西法, i.e. *Tianbu zhenyuan*) into the format of Chinese traditional system.

Emphasizing the Application on Astrology

Xue Fengzuo saw astrology as an important—even the most important—part of the study of the heavens. Comparing with the astronomical part of the *Tianbu zhenyuan*, the astrological application is emphasized in Xue Fengzuo’s “Integrated Chinese Method.” That is the reason why he included in his new system chapters on the procedures for the calculation of such things as “*tuwang yongshi*,” “*qihou*,” “*zhisu*,” “*jianri*” and “*nayin*”—they are all related to the “*lizhu*” 曆注, the astrological notes

²¹ Xue Fengzuo, *Lixue huitong zhengji*, 738-789.

²² Xue Fengzuo, *Lixue huitong zhengji*, 784-785.

²³ Xue Fengzuo, *Lixue huitong zhengji*, 819-829.

in the almanac.²⁴ In traditional Chinese astrology, “*tuwang yongshi*” referred to the days under the governance of the king of earth,²⁵ in which breaking ground (*dongtu* 動土) was a taboo as described in the *Qinding xieji bianfang shu* 欽定協紀辨方書 (Imperial Endorsed Treatise on Harmonizing Times and Distinguishing Directions).²⁶ “*Qihou*” was related to the solar terms (*jieqi* 節氣), and every solar term corresponded to three phenology (*hou* 候). Chinese ancients arranged their plans of agricultural activities according to the degree of correspondence between the solar terms and related phenology.²⁷ “*Zhisu*” was a method to predict each day’s auspiciousness and inauspiciousness according to which one of the 28 lunar mansions was “on duty.”²⁸ “*Jianri*,” or the day of establishing, was the name of the first day of a divinatory cycle consisting of twelve days. This was used to denote the auspiciousness and inauspiciousness of a day.²⁹ “*Nayin*” was an astrological theory combining the “*wuyin*” 五音 (the Chinese pentatonic scale) with the “*ganzhi*” 干支 (heavenly stems and earthly branches) to calculate a person’s fortune.³⁰ All these were necessary in the calculation of the astrological notes in an almanac.

Secondly, some tables in the Main Portion have a strong connection with astrology. For example, the table “*Taiyin lingfan shike licheng*” is obviously related to the calculation of the occultation of the moon with the five planets and the fixed stars, a category of important portent in Chinese astrology. Actually, the table of the longitude and latitude of the fixed stars in the volume of *Jingxing jingwei xingqing* is also related to astrology. In the *Tianbu zhenyuan*, the table of the fixed stars is in fact an excerpt with some omissions from the *Hengxing jingwei biao* 恆星經緯表 (Table of the Longitude and Latitude of the Fixed Stars) of the *Xiyang xinfa lishu*.³¹ As the “*Jingxing xu*” 經

²⁴ Xue Fengzuo, *Lixue huitong zhengji*, 727-728.

²⁵ Chen Yongzheng 陳永正, *Zhongguo fangshu dacidian* 中國方術大辭典 (Guangzhou: Zhongshan daxue chubanshe, 1991), 273.

²⁶ Yun Lu 允祿, et al., *Qinding xieji bianfang shu* 欽定協紀辨方書, in *Yingyin wenyuange siku quanshu* 景印文淵閣四庫全書 (hereafter SKQS), vol. 811 (Taipei: The Commercial Press, 1983), 459.

²⁷ Zhang Peiyu 張培瑜, Xu Zhentao 徐振韜, and Lu Yang 盧央, “*Lizhu jianlun*” 曆注簡論, *Nanjing daxue xuebao* 南京大學學報 1 (1984), 105-106.

²⁸ Zhang Peiyu 張培瑜 and Zhang Jian 張健, “*Riben lishu de zhisu*” 日本曆書的直宿, *Zhongguo keji shiliao* 22:3 (2001), 281-287; Kong Qingdian 孔慶典 and Jiang Xiaoyuan 江曉原, “11-14 shiji huihuren de ershibaxiu jiri” 11-14世紀回鶻人的二十八宿紀日, *Xiyu yanjiu* 西域研究 3 (2009), 9-21.

²⁹ Chen Yongzheng, *Zhongguo fangshu dacidian*, 292.

³⁰ Chen Yongzheng, *Zhongguo fangshu dacidian*, 35; Lu Yang 盧央, *Zhongguo gudai xingzhanxue* 中國古代星占學 (Beijing: Zhongguo kexue jishu chubanshe, 2008), 333-334.

³¹ Xu Guangqi, et al., *Xiyang xinfa lishu*, vol. 384, 374-398 and vol. 385, 1-24.

星敘 (Preface to the Section on the Fixed Stars) explains:

Among those who are good at this field (i.e. the theory of the fixed stars), Tycho Brahe (1546-1601) holds the highest position. His method was prepared in the “Current Western Method” (*jin xifa* 今西法, i.e. *Xiyang xinfā lishu*). ... I’m inferior to him [in this field], so Tycho’s method is preserved [in the *Tianbu zhenyuan*].³²

However, the longitudes of the fixed stars in the Main Portion are not the same as the ones in the *Tianbu zhenyuan*. Compared with the values in the *Tianbu zhenyuan*, the longitudes of the fixed stars in the Main Portion are 0.39 degree larger. Since the annual precession of the equinoxes in the *Tianbu zhenyuan* is 52 seconds, an extra 0.39 degree is equivalent to the motion of the fixed stars in 27 years. The longitudes of the fixed stars in the *Tianbu zhenyuan* correspond to the epoch of the *Xiyang xinfā lishu*, which was the first year of the Chongzhen reign-period (i.e. 1628), and Xue Fengzuo’s adjustment makes them consistent with the epoch of his “Integrated Chinese Method” (i.e. 1655).

The table of the fixed stars in the *Tianbu zhenyuan* and the Main Portion only included the stars that were comparatively bright or those whose ecliptic latitudes are less than 8 degrees.³³ Why did Xue Fengzuo choose the stars within this zone? His own answer is that “the occultation of the moon or the five planets with the fixed stars could only happen in the area whose ecliptic latitude was less than 8 degrees.”³⁴ Apparently, Xue Fengzuo considered its application to astrology when he compiled the table, just as he pointed out in the “Jingxing xu”: “the stars also have colors, and the man with superior wisdom could distinguish the properties of the stars by their colors to predict the heaven time and human affairs, which always would come true.”³⁵

Moreover, Xue Fengzuo added the motions of “*siyu*” 四餘, “four imaginary stars,” in the lunar theory, which did not appear in the *Tianbu zhenyuan*. In the “Xifa huitong canding shiyize,” he also discussed the locations of the Three Stars mansion (Shenxiu 參宿), the Turtle Beak mansion (Zixiu 觜宿), and of Rahu 羅睺 and Ketu 計都. He also asked whether the Purple Pneuma (Ziqi 紫氣) should be omitted or not, and he insisted that these questions should follow the Chinese astronomical tradition when considering their astrological meaning.³⁶

³² Xue Fengzuo, *Lixue huitong kaoyan bu*, 564.

³³ Xue Fengzuo, *Lixue huitong zhengji*, 809.

³⁴ Xue Fengzuo, *Lixue huitong kaoyan bu*, 784.

³⁵ Xue Fengzuo, *Lixue huitong kaoyan bu*, 564.

³⁶ Xue Fengzuo, *Lixue huitong zhengji*, 626. On these questions, see: e.g. Wang Gang 王剛, “Lun Xue Fengzuo de tiandaoguan” 論薛鳳祚的天道觀, in Ma Laiping ed., *Zhongxi wenhua huitong de xianqu*, 94.

In this manner, Xue Fengzuo added a considerable amount of astrological discussion on the basis of the “New Western Method,” and this was the most important aspect of his integrating work.

The Context of Xue Fengzuo’s Integrating Work

Xue Fengzuo’s integrating work can be better understood in the context of the period in which he lived. In the late Ming dynasty, Chinese calendrical astronomy was experiencing a crisis because the official system of calendrical astronomy had been found to be outdated and not precise enough. Seeing this as an excellent opportunity to promote Christianity in China, Jesuit missionaries and their Chinese converts tried very hard to introduce European astronomy, hoping to win the favor and support of the Chinese emperor through their work in astronomical reform. After the failure of a reform based on the traditional Chinese system, the Ming dynasty launched a new reform on the basis of the European system in 1629.

As the leader of this reform, Xu Guangqi proposed two famous precepts: “if we want to surpass [the Westerners], we have to integrate [their knowledge with ours]” (欲求超勝, 必須會通) and “cast their [Western] materials into the mould of the *Datong* [official Chinese] system” (鎔彼方之材質, 入大統之型模).³⁷ However, the word “integrate” meant different things to different people. As a result, the product of Xu Guangqi’s integrating work, the *Chongzhen lishu*, could not satisfy all Chinese scholars. The *Chongzhen lishu* was explicitly rejected by some early Qing scholars, and in their eyes it was not really cast into the mould of the *Datong* system. For instance, Wang Xichan criticized the *Chongzhen lishu*:

At the beginning of the translation of the books, [Xu Guangqi] talked about taking the materials of the Western system to cast them into the mould of the *Datong* system. Who would have thought that the original principles would be entirely discarded, and that the Western method would be used exclusively as it is today?³⁸

In addition, the German Jesuit Johann Adam Schall von Bell (湯若望, 1591-1666), the head of the Imperial Astronomical Bureau (*Qintianjian* 欽天監) since the beginning of the Qing dynasty, used all kinds of tactics to change the Bureau into a Catholic institute by arranging converted astronomers to take over most of the positions in the

³⁷ Xu Guangqi, et al., *Zhili yuanqi* 治曆緣起, in Pan Nai 潘籟 ed., *Chongzhen lishu: fu Xiyang xinfa lishu zengkan shizhong* 崇禎曆書: 附西洋新法曆書增刊十種 (Shanghai: Shanghai guji chubanshe, 2009), 1558.

³⁸ Wang Xichan 王錫闡, “*Xiaolan xinfa zixu*” 曉庵新法自序, in Bo Shuren ed., *Zhongguo kexue jishu dianji tonghui tianwen juan*, vol. 6, 434.

Bureau.³⁹ His deliberate purge of the astronomers who worked on the *Datong* or the *Huihui* system must have aggravated the Chinese scholars' dissatisfaction with the *Chongzhen lishu*.⁴⁰ The integration of Western and Chinese systems of calendrical astronomy was far from accomplished in the eyes of some scholars at that time.

Moreover, one of the reasons why every Chinese government paid great attention to calendrical astronomy was its application on astrology to predict auspiciousness and inauspiciousness of events.⁴¹ As a result, the question of how to coordinate European astronomy and Chinese astrology became unavoidable. This question emerged during the astronomical reform of the Chongzhen reign. Chongzhen 崇禎 Emperor (1611-1644) ordered Li Tianjing 李天經 (1579-1659) to resolve this question: "In the memorials [to the throne], the calculation of the luni-solar eclipses, solar terms, etc. are using the new [method] (i.e. the Western method), but the calculation of the calendrical spirits (*shensha* 神煞), the monthly ordinances (*yueling* 月令), etc. are using the old [method] (i.e. the Chinese method). [You] must try to compromise between the two methods and unify them for the most suitable [situation]."⁴²

After the Qing dynasty was established, Schall failed to understand the complexity of the relation between Chinese calendrical astronomy and astrology. Some of his arrogant alternations of the civil calendars, such as the interchange of the locations of the Three Stars mansion and the Turtle Beak mansion and of Rahu and Ketu, as well as the omission of the Purple Pneuma, damaged the prediction of the Chinese astrologers and thus naturally met fierce opposition.⁴³ Even some unofficial civil calendars based on the old method were circulated in folk society, in which the traditional arrangement of the locations of the Three Stars mansion and the Turtle Beak mansion and of Rahu

³⁹ Huang Yinong 黃一農 (Huang Yi-Long), "Tangruowang yu Qingchu xili zhi zhengtonghua" 湯若望與清初西曆之正統化, in Wu Jiali 吳嘉麗 and Ye Hongsa 葉鴻灝 ed., *Xinbian Zhongguo keji shi* 新編中國科技史 (Taipei: Yinhe wenhua shiye gongsi, 1990), vol. 2, 465-490.

⁴⁰ Huang Yinong, "Qingchu Qintianjian zhong geminzu tianwenjia de quanli qifu" 清初欽天監中各民族天文家的權力起伏, *Xinshixue* 新史學 2:2 (1991), 75-108; Huang Yinong, "Qingchu tianzhujiao yu huijiao tianwenjia jian de zhengdou" 清初天主教與回教天文家間的爭鬥, *Jiuzhou xuekan* 九州學刊 5:3 (1993), 47-69.

⁴¹ Huang Yinong, "Zeri zhi zheng yu 'Kangxi liyu'" 擇日之爭與康熙曆獄, *Qinghua xuebao* 清華學報 21:2 (1991), 247-280.

⁴² Xu Guangqi, et al., *Zhili yuanqi*, 1725.

⁴³ Yang Guangxian 楊光先, *Budeyi* 不得已, in Bo Shuren ed., *Zhongguo kexue jishu dianji tonghui tianwen juan*, vol. 6, 923; Huang Yinong, "Qing qianqi dui Zi Shen liangxiu xianhou cixu de zhengzhi: shehui tianwenxueshi zhi yi ge'an yanjiu" 清前期對紫、參兩宿先後次序的爭執——社會天文學史之一個案研究, in Yang Cuihua 楊翠華 and Huang Yinong ed., *Jindai Zhongguo keji shi lunji* 近代中國科技史論集 (Taipei: Academia Sinica, 1991), 71-94.

and Ketu were adopted, as well as the hundred-*ke*-per-day system.⁴⁴ Although the Western method had been adopted by the Qing government as the official system of calendrical astronomy, it was not fully accepted by the Chinese society.

It was in this context that Xue Fengzuo started his integrating work. It was clear that Xue Fengzuo's distinctive way of integration was a response to the period in which he lived. Although the Main Portion of the *Lixue huitong* was based on the astronomical part of the *Tianbu zhenyuan*, Xue Fengzuo's "Integrated Chinese Method" was definitely a new system in his view. He believed that his task was more difficult than Xu Guangqi's: "the former integration was in the [Calendar] Bureau (which was established by Xu Guangqi in the astronomical reform of the Chongzhen reign), and the current integration was more complicated. Was the difference between the difficulties [of the two kinds of integrations] not particularly remarkable?"⁴⁵ His precept, "casting materials from various schools into the mould of my own learning," was by nature an inheritance and development of Xu Guangqi's famous precept mentioned above, i.e. "casting their [Western] materials into the mould of the *Datong* [official Chinese] system." Moreover, Xue Fengzuo expressed the same disapproval toward the situation of the calendar during the Ming dynasty in which the *Datong* and the *Huihui* systems worked separately for several centuries. Xu Guangqi had pointed out that, if the Chinese and the Western methods continued to be used separately, then "the *Datong* system could not change itself, and the Western method also would not be properly used by us, which was like the situation of the two systems over the last two hundred years."⁴⁶ However, Xue Fengzuo's understanding of the word "integrate" was quite different from Xu Guangqi's. His goal was a new system of calendrical astronomy that would be better than the *Chongzhen lishu*—an integration of the different systems, both Chinese and Western, ancient and recent.

Conclusion

We have seen that Xue Fengzuo's integration concentrated mainly on three aspects. First, he integrated the four major systems, including the *Shoushi li*, the *Huihui li*, the *Chongzhen lishu*, and the *Tianbu zhenyuan* into a whole, to correct the faults of the *Chongzhen lishu* in which "the Western method was used exclusively." Second, his "Integrated Chinese Method" preserved the format of the Chinese traditional system, to fulfill the promise of "into the mould of the *Datong* system." Finally, because

⁴⁴ Huang Yinong, "Cong Tangruowang suobian minli shixi Qingchu zhongou wenhua de chongtu yu tuoxie" 從湯若望所編民曆試析清初中歐文化的衝突與妥協, *Qinghua xuebao* 26:2 (1996), 189-220.

⁴⁵ Xue Fengzuo, "Zhengji xu," 620.

⁴⁶ Xu Guangqi, et al., *Zhili yuanqi*, 1558.

he also paid great attention to astrology, the applications of the calendrical astronomy on astrology were included in his new system, such as the astrological notes in the almanac and the astrological influence of the two mansions (i.e. the Three Stars and the Turtle Beak) and the four imaginary stars.

Nevertheless, Xue Fengzuo's integration endeavor was not duly appreciated by later Chinese scholars. Mei Wending 梅文鼎 (1633-1721), arguably the most important Chinese astronomer of the early Qing period, deemed Xue Fengzuo's system not original, and he considered that Xue Fengzuo's achievements in calendrical astronomy were inferior to those of Wang Xichan.⁴⁷ Ruan Yuan 阮元 (1764-1849), a scholar-official of renown in the mid-Qing China prior to the Opium War, commented on Xue Fengzuo's works as follows:

[Xue Fengzuo] clung too much to the established method of Mu Nige (i.e. Smogulecki). He only derived [the integrated system] from the latter's constants and danced to his tune, and therefore did not reach a deeper understanding."⁴⁸

Judgment of this sort had a powerful influence, and even some modern scholars accepted it.⁴⁹ In fact, the focus of Xue Fengzuo's calendrical works was integration, not originality, and as a result there were almost no innovations in his new system. Later scholars, such as Mei Wending and Ruan Yuan, who remarked on Xue Fengzuo's calendrical works from the standpoint of originality, naturally could not recognize the significance of Xue Fengzuo's integrating work, and underestimated it without paying attention to the historical context.

The evaluation on Xue Fengzuo's work started to change only in the twentieth century. For example, in the *Qingshiqao* 清史稿 (Draft History of the Qing dynasty), published in 1928, Ruan Yuan's viewpoint was criticized as "not a definitive comment," and Xue Fengzuo was praised as "the biggest contributor of the *chouren* 疇人 (i.e. mathematicians and astronomers) in the whole dynasty indeed, who integrated the compendiums of the Chinese and Western [calendrical astronomy]."⁵⁰ Especially in recent years, as study on Xue Fengzuo's works developed, the importance of his

⁴⁷ Mei Wending 梅文鼎, *Wu'an lisuan shuji* 勿庵曆算書記, SKQS, vol. 795, 964, 982; Mei Wending, *Jixuetang shiwenchao* 績學堂詩文鈔, in *Xuxiu siku quanshu* 續修四庫全書, vol. 1413 (Shanghai: Shanghai guji chubanshe, 2002), 429.

⁴⁸ Ruan Yuan 阮元, *Chouren zhuan* 疇人傳, in *Chouren zhuan huibian* 疇人傳彙編 (Yangzhou: Guangling shushe, 2009), 406.

⁴⁹ Hu Tiezhu, "Huitong zhongxi lisuan de Xue Fengzuo," 316.

⁵⁰ Zhao Erxun 趙爾巽, et al., *Qingshi gao* 清史稿 (Beijing: Zhonghua shuju, 1977), *juan* 506, 13934.

thought on integrating Chinese and Western astronomy has been widely approved.⁵¹

In conclusion, the *Lixue huitong* was an extraordinary work integrating different systems of calendrical astronomy, both Chinese and Western, ancient and recent. Its author, Xue Fengzuo, who spent most of his life carrying out the enterprise of integrating, was a remarkable scholar in the history of the astronomical exchanges between China and Europe.

⁵¹ For instance, Ma Laiping disagreed Ruan Yuan's remarks on Xue Fengzuo's works, and he approved Xue Fengzuo's contribution on integrating Chinese and Western systems. See Ma Laiping, "Zhongxi wenhua huitong de xianqu," 154-156.

Abstract

In his voluminous collectanea *Lixue huitong* 曆學會通 (An Integration of Calendrical Learning), the famous astronomer and mathematician, Xue Fengzuo 薛鳳祚, tried to integrate different systems of calendrical astronomy, both Chinese and Western, ancient and recent. The result of his integration is the “New Chinese Method” (*xin zhongfa* 新中法) in the Main Portion of the *Lixue huitong*. Three aspects in Xue Fengzuo’s integrating work attract our attention. First of all, his “New Chinese Method” is an integration of the four major systems: the *Shoushi li* 授時曆, the *Huihui li* 回回曆, the *Chongzhen lishu* 崇禎曆書, and the astronomical part of the *Tianbu zhenyuan* 天步真原. Secondly, in the “New Chinese Method”, Xue Fengzuo makes as many adjustments as possible to make the system “Chinese.” Finally, he adds the procedures needed in the calculation of the astrological notes (*lizhu* 曆注) in the almanac and other astrological applications. In fact, Xue Fengzuo’s integration had close connection with the age he lived, and his distinctive way of integration is a response to the dissemination of European astronomy and astrology in China.

Keywords: Xue Fengzuo, *Lixue huitong*, New Chinese Method, integration