

徐光啓にみる改暦事業と儒教の論理

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XU GUANGQI : CONFUCIANISM AND SCIENTIFIC ENTERPRISE

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Abstract

We discuss Xu Guangqi's (1562-1633) initiative based upon his belief and pragmatic idea at the astronomical reform by means of the systematic introduction of European astronomy. Our main concern here is how to explain the 'relative success', as a whole, of European science at the Chinese acceptance through the attempts of the Catholic missionaries and their Chinese colleagues mainly in the late Ming period, i.e., the first half of the seventeenth century. Xu eventually took responsibility for the state enterprise of the systematic introduction of mathematical astronomy from Europe, aimed for calendar reform in the Chongzhen reign-period (1628-44). His approach to European mathematics and astronomy, among other things, can be regarded as the crucial issue for our discussion on this matter.

To make clear of the character of his effort, we have examined how Xu excelled in learning Western knowledge of mathematics and astronomy, so as to understand the structure of the knowledge from Europe in terms of Chinese conceptions. If we understand the process of his conceptualisation, then we can discuss the problem of why and how confidently he was able to inaugurate the state enterprise of the astronomical reform at the very last stage of his life. The reason why he was capable of succeeding in inaugurating such a big, crucial enterprise must be explained by his fundamental initiation concerning Confucianism as a high official of the state.

Keywords: Xu Guangqi Astronomical Reform European Mathematics and Astronomy
Chinese Acceptance Missionaries Confucianism State Enterprise

抄 録

本論は明末の徐光啓の崇禎改暦は、個人的な營利というより、組織的な國家の科學事業として遂行されたのだという側面を明らかにし、その中ではイエズス會宣教師によって齎されたヨーロッパ天文学の性格とその精度とが、導入する際の重要なクライテリオンを形成していたことを示し、またその科學事業の開始するにあたっては、『幾何原本』翻訳作業のなかでマテオ=リッチから會得した數學の知識が前提となっていたことを強調した。この改暦事業は儒教的論理のうえに成立するものであった。導入されたティコ=ブラへの宇宙體系の上になつた知識體系は清朝の時憲曆の天文學的基礎となった。

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We have discussed the scientific initiative of Xu Guangqi 徐光啓 (1562-1633), in terms of his belief and practical ideas, at the astronomical reform by means of the systematic introduction of European astronomy. Our main concern so far have been in how to explain the reasonable success, as a whole, of European science at the Chinese acceptance through the attempts of the Catholic missionaries and their Chinese colleagues mainly in the late Ming period, i.e., the first half of the seventeenth century. Since Xu Guangqi eventually took responsibility for the state enterprise of the compilation of huge materials of mathematical astronomy from the West for the basis of calendar reform in the Chongzhen 崇禎 reign-period (1628-44), his approach to European mathematics and astronomy, among other things, has been regarded as a crucial issue for our discussion.

For this purpose, we have examined how he at last formulated his ideas concerning the Western learning based on mathematics and astronomy par excellence, so as to understand the matrix of the knowledge from Europe in terms of Chinese conceptions for organizing the whole range of the system. If we understand the process of his conceptualisation, then we can discuss why and how confidently he was able to inaugurate the state enterprise of astronomical reform at the very last stage of his life as well as the dynasty itself.

0 . The Calendrical Reform and Confucianism

But, the problem here is how to explain the success in the eventual inauguration of such an institutional enterprise realized long after the establishment of the dynasty, cynically, almost at the end of the Ming period. At that stage Xu Guangqi had at last reached the status high enough to meet the long frustrated demand for the reform. Here we have to relate his strong determination to his own potentiality to promote the enterprise. For this purpose, we must pay our attention to his commitment to the practical learning (*shixue* 實學), as well as the framework of his belief system, as it were, for the initiation. As a matter of fact, it is in this connection for us to become necessary to discuss his religious background.

Although he had long been christened at that stage (in 1628. It was forty-one of his age when he was done so in 1603), after having worked together with Matthew Ricci,

among others, he must have been given some crucial motivation as the official literati of the state. Although it sounds curious, it was highly concerned with Confucianism. Otherwise, it was an impossible task for any one to deal with the matter of calendar, which had ideologically as well as institutionally related to the imperial order. As is well known, it had been the case all through Chinese history. Thus we can say that Xu Guangqi, at last, reached the status to take responsibility for proposing the commencement of such an enterprise by his initiative. Indeed, it was a well-organized enterprise. As a result, we can observe the massive introduction of renewed astronomical knowledge and instruments together with the compilation of so far translated achievements.

We must admit that, at the beginning of the Chongzhen reign-period (1628-1644), he was still able to be faithful enough to the emperor (or state) to solve this crucial (or created?) problem concerning the order of rule of the Ming house. Was it because he had taken so many years to pass the final stage of the state examination (*jinshi* 進士) for the officialdom, and he finally reached the highest position of the bureaucracy so late of his age? Indeed, it was forty-two years of his age when he at last succeeded in it. Even his life-long colleague, Li Zhizao 李之藻 (1566-1630), passed it at the much younger age of thirty-two.

Therefore, before we discuss the matter of the reform of calendar, we should like to begin our discussion with his motivation in relation to Confucianism as well as his religious background. As the Christian convert, Xu Guangqi was said to state the phrase of four characters, “*Jue fo bu ru* (絶佛補儒; Christianity banishes Buddhism, but complements Confucianism¹⁾”, as rendered by the Jesuit, João Monteiro, in his *Tianxue lüeyi* 天學略義 (ca. 1642)²⁾. But, we can observe that, already in his preface to the *Taixi shuifa* 泰西水法 [*Hydraulic Methods from the West*] in 1612³⁾, Xu himself stated it as “*Yi fo bu ru* (易佛補儒; Christianity can be exchanged with Buddhism, and complements Confucianism, or rather ‘Replace Buddhism by complementing Confucianism’⁴⁾”. The sentence of four characters of his own summarizes his locating

1) The English translation by Lionel Jensen, *Manufacturing Confucianism*, Durham, NC: Duke Univ. Press, 1997: 124.

2) Nicolas Standaert, “The Jesuits Did NOT Manufacture “Confucianism””, *EASTM*, 16, 1999: 115-132. The sentence is found in the *Tianxue lüeyi*, pp. 839-904 in the *Tianzhujiao dongchuan wenxian xubian* 天主教東傳文獻續編, vol. 2, Taipei: Xuesheng shuju, 1966: 899.

3) Wang Zhongmin 王重民 (ed.), *Xu Guangqi Ji* 徐光啓集, Shanghai, 1963: *juan* 2, p. 66.

Christianity in Confucianism as well as against Buddhism⁵⁾. “It implies a new form of syncretism”, as Professor Jacques Gernet has put it⁶⁾.

On the other hand, we can read a more detailed discussion concerning the matter carried out by him. His stance to Christian faith is clearly shown in connection with Confucianism. For Xu Guangqi, Christianity without doubt coincided with Confucianism. In his *Draft Memorial* to the Throne, titled the *Bian xue shu gao* 辯學疏稿 [*Of Discriminating Learning*, hereafter abbreviated as *BXSG*], var. *Bian xue zhang shu* 辯學章疏 (*BXZS*), in 1616, he writes as follows:⁷⁾

“They have come to the East several tens of thousands miles away from the West, because these religious people (*Jiaoren* 教人: Fathers) from those countries all try to cultivate themselves to serve the Lord of Heaven (*Tianzhu* 天主). On the other hand, having heard that the teaching of the Chinese Sage has also solely meant to let ourselves cultivate (*Xiushen* 修身) to serve the Sovereign on High (*Tian* 天). They understood that both principles are in exact agreement. They have therefore come here to China to make each mark in the evidence, running risks and dangers with hardship and difficulties. They wish people here to be virtuous and, at the same time, to praise the will of God (*Shangtian* 上天) who loves our human beings.”

According to Xu Guangqi, the basis of Christianity (*Zongben* 宗本) hinged on the belief that we should serve the God (*Shangdi* 上帝). And it is clear that he converted to Christianity understanding it in terms of Confucianism. As far as his understanding went, both of these religions were in good harmony. It is not only the matter of his representations in Chinese vocabularies of Heaven and God as well as Jesus Christ, but also the problem of the faith. But, first we must remind ourselves of this matter. His representations of them are in good accord with those by Matthew Ricci, who is said did not much mind about the exact terminology of them. In the *Tianzhu shiyi* 天主實義 [*True Meaning of the Lord of Heaven*, 1603] the *Tianzhu* stands for the Lord of Heaven. And Ricci preferably used the *Shangdi* 上帝 for God⁸⁾. On the other hand, he

4) Gernet, J. “A Note on the Context of Xu Guangqi’s Conversion”, Jami, C. et al (ed.), *Statecraft and Intellectual Renewal in Late Ming China*, Amsterdam: Brill, 2001: 188-192.

5) Cf. Wu Deduo 吳德鐸, “Shilun Xu Guangqi de Zongjiao xinyang yu xixue yinjinzhe lixiang 試論徐光啓宗教信仰與西學引進者的理想”, *Xu Guangqi yanjiu Lunwenji* 徐光啓研究 論文編, Shanghai: Xuelin chubanshe 學林出版社, 1986: 151-159, p. 154.

6) Gernet, *ibid.* p. 192.

7) Biblioteca Apostolica Vaticana: Borg. Cin. 324(13). Cf. *Xu Guangqi ji*: *juan* 9, pp. 431ff.

used the Sovereign of Heaven in terms of the *Tiandi* 天帝. Interestingly enough, Emmanuel Diaz Junior (Yang Mano 陽瑪諾), in the *Tianwenlüe* 天問略 (1615), represents the twelfth uppermost heaven beyond the eleventh heaven of the prime mover as the Heavenly Palace (*Tiantang* 天堂), where the *Tianzhu Shangdi* 天主上帝 presides. Here we would like to forget all about the Question of Rites raised later in Kangxi period.

Now, how did Li Zhizao locate the Christianity? In the preface of the second edition of the *Tianzhu xiyi* in 1607, he, interestingly enough, writes that it was not Ricci but Zhuzi 朱子 (Ziyang-shi 紫陽氏) who for the first time explained the meaning of the Lord of Heaven (*Tianzhu* 天主) by interpreting the *Di* 帝 [Supreme Ruler] in terms of the controlling power of Heaven (*Tian zhi Zhuzai* 天之主宰)⁹⁾. According to Fang Hao's interpretation, he mentions here that Christianity [Roman Catholicism; *Tianzhujiào* 天主教] had originated from the same root as Confucianism [*Rujiao* 儒教], and did not necessarily meet the Zhuzi's teaching (*Lixue* 理學), but that it could reject Buddhism¹⁰⁾. Such a statement of him had to expect the severe criticism against him from Buddhists. Li Zhizao on the same occasion made a clear-cut discussion concerning the distinction of Christianity and Buddhism. But, at least we can regard the religious connection between Li and Xu as such that the former obviously shared the same conviction with Xu Guangqi concerning Christianity as well as Confucianism. And, as is well known, Li and Xu, as well as Yang Tingyun 楊廷筠 (1557-1627), were the so called three pillars of Christianity, who protected the missionaries during the prosecution.

Xu Guangqi located Buddha's teaching [*Shishi zhi shuo*; 釋氏之說] as such that it had also been complimentary for Confucianism. However, he continued that "it was eighteen hundreds years since it had reached the East, but that people's mind had not been improved or civilized yet."¹¹⁾ And, here, he suspected that "their sayings sound like true, but not so in reality." It seems likely that his suspect must have originally

8) Matteo Ricci S.J., *The True Meaning of the Lord of Heaven*, translated with Introduction and Notes by D. Lancashire and P. Hu Kuo-chen, S.J., and edited by E.J. Malatesta, S.J., St. Louis, 1985: 57.

9) Li Zhizao's preface to the second edition to the *Tianshu shiyi*, collected in the *Tianxue quhan* edition in 1629, reprinted in Taipei in 1965.

10) Fang Hao 方豪, *Li Zhizao yanjiu* 李之藻研究, Taipei 臺北, 1966: 22-26.

11) *Xu Guangqi ji*, p. 432.

connected with no Buddhist family religious background and with his own conversion to Christianity. He also denounced the Chan sect (*Chanzon* 禪宗) together with Daoism. He seemed to deny all that sounded superstitious. In this sense he was a rationalist with practical mind. Anyhow we cannot deny the strong influence of the Jesuit, Matthew Ricci, on him.

As Ming Christian literati, Xu's knowledge of Buddhist doctrine, indeed, appears to have been rather poor or superficial, as Professor Zürcher has put it¹²⁾. In taking his stance against Buddhism, Xu was inspired from two different quarters, in which, however, his worldview was completely integrated. First he had adhered to the movement called "Practical (or "Solid") studies" (*shixue* 實學), and secondly he understood the "Heavenly Studies" (*Tianxue* 天學) as such that it was the studies of the combination of Christian belief with European science and technology introduced by the Jesuit missionaries, although he had once admitted the Heavenly Studies could be regarded as the *Jingjiao* (景教; Nestorian), which had been transmitted in the Tang period¹³⁾. It can be said that in his personal case these various elements constituted a consistent whole. In this connection, it may be interesting to quote Verbiest's viewpoint that "astronomy is, indeed, the administrative practice of the ministers of the court, and constitutes the solid learning of the scholar-officials."¹⁴⁾

According to Xu Guangqi (in the *BXSG*, presented in 1616), who believed that to serve the Heaven is the same as to be filial to the parents, in other words, both belong to the same act¹⁵⁾, in the course of many centuries the original teachings of Confucius, that is the "system of purely moral guidelines for the individual, state and society with some kind of monotheism", as Professor Zürcher has put it, had become both incomplete and degenerated. As Xu typically points out, the "fire of Qin" had destroyed part of the ancient wisdom, and whatever remained had become diluted and -literally- mystified by borrowing from Buddhism and Daoism. As a result, in some quarters Confucianism had been deflected from its practical aims of political and social

12) Zürcher, E., "Xu Guangqi and Buddhism", Jami et al (ed.), *op. cit.*, 157-171.

13) In Xu's preface to the *Tianxue quhan* 天學初函 collection (1629). Cf. Li Di (ed.) 李杕, *Zengding Xu Wendinggong ji* 增訂徐文定公集 (Shanghai, 1909), j. 6, 17a.

14) "夫天文者。朝廷之實政。儒者之實學 *Fu tianwen zhe, zhaoting zhi shizheng, ru zhe zhi shixue.*" Nan Huairen's 南懷仁 *Budeyibian* 不得已辨 in the *Tianzhujiao dongchuan wenxian* 天主教東傳文獻, ed. Fang Hao 方豪 (Taipei, 1965), p. 334.

guidance (*jingshi* 經世) and turned into a metaphysical system of theorizing and mystical introspection. Thus the Heavenly Studies were expected surely to serve to remedy the situation in various ways. They could serve to restore the original monotheism of China's golden past and thus fill the gaps in Confucianism (*buru* 補儒). And his experience made him convinced that the Missionaries, who primarily devoted to the religious and spiritual matter, were also comprehensive in practical knowledge. By emphasizing on scientific and technological knowledge brought by the missionaries and their attainments of such learning, Xu was thoroughly convinced of reinforcing the practical value of Confucianism-cum-Christianity for the state and society.

Xu Guangqi's personal involvement in anti-Buddhist polemics seems to have reached climax in between ca. 1615 and ca. 1620, i.e., the period that coincides with the first persecution of Christianity, launched by Shen Que 沈淮 (?-1624), the Vice-President of the Board of Rites in Nanjing [*Nanjing Libu-Shilang* 南京禮部侍郎]. But, now Xu himself became under attack, and the Jesuits were to be arrested. It was in the year of 1616. In response to Shen Que's memorial of impeachment, Xu, in defense of Christians during the persecution launched by Shen, wrote the "Draft memorial of discussing leaning (*Bianxue shugao*, var. *BX zhangshu*) in June / July 1616, and somewhat later he also drafted the text of the "Reply to Accusations" (*Jujie* 具揭) submitted by Diego de Pantoja and Sabbatino de Ursis in the same year.

As can be observed in one of these texts, Xu Guangqi's attitude against Buddhism became apologetic at this stage. He paid a considerable attention to Buddhism in relation to Christianity. Indeed, it is the matter of comparison. However, it is evaluated that these texts are quite different from the polemic texts dating from before 1616. Under the circumstance he had to operate cautiously¹⁵⁾, and he was intent on solving practical problems. He tended not to debate philosophical or theological matter, and attacking Buddhism he rather concentrated on concrete superstitious practices. Before and in the time when Xu Guangqi was serving as the state official, the Ming China had been facing serious domestic as well as foreign crises. We can just point out the affairs of both the Manchu invasion in progress and the Japanese pirates a few decades ago

15) Xu's preface to the *Tianzhu shiyi*, collected in the *Tianxue quhan*, in Li Di, *ibid.*, j. 5, 1a.

on top of the domestic parties' conflict and flood famines, with all of which he was much concerned as a statesman as well as a private person.

Through his petitions and memorials to the throne, we can repeatedly observe his Confucianistic attitude when he coped with such problems. It is particularly impressive in the memorial to read his attitude in terms of concrete or practical learning for coping with state administrative works¹⁷⁾. After all, he was playing the important part for the state as the high official in the preparation of the scientific enterprise of astronomical reform, which he was successfully to launch later on. In his writings, Xu emphasizes on what could be useful to the state and the people. Mathematics, and even Christianity, is considered from the angle of utility. "More generally such Chinese utilitarianism was quite common among converts and those sympathizing with the missionaries. To understand Xu Guangqi, it is essential to read his writings in the context of social requirement of his time,"¹⁸⁾ and thus we have to pay our attention to the social context, which we shall discuss below.

Xu Guangqi has left several works on Confucian classics, of which some are extant: three on the *Classic of Poem*, one on the *Classic of History* and on the *Zhouli*, respectively. The last of them are concerned with the *Explanation of the Chapter of the Winter Officials*, i.e., the technical officials, called the *Kaogongjijie* 考工記解. In general he tried to harmonize the Han studies [*Hanxue* 漢學] with the Song studies [*Songxue* 宋學]. In sum, all these studies by him show that there was no contradiction between Confucianism and Christianity for his rational and practical mind.

1. Xu Guangqi : His Career and the Director of the Astronomical Bureau

Astronomical phenomena as well as calendar reform still continued to be the subject matter of state concerns even in the very end of Ming dynasty. Every time when the solar eclipses occurred, the predictions were made beforehand and the observations were carried out. The exactness of prediction had been regarded as the indicator of the precision of the current, or candidate calendar system as a whole. Such actions—

16) Zürcher, *op. cit.*, p. 161.

17) *Ibid.*, 437-439.

18) Gernet, *op. cit.*, 190.

prediction, observation and memorials report—constituted the part of the rituals of the state religion, i.e., the practice of Confucianism. At the same time, they symbolized the order of the state foundation. It was the solar eclipse, which occurred on 21st June 1629, which initiated the inauguration of the delayed astronomical reform under the responsibility of Xu Guangqi, which we call here the Scientific Enterprise. The predictions by both the *Datong-li* 大統曆, official astronomical system of the Ming dynasty and the auxiliary *Huihui-li* 回回曆 [Islamic system] were inconsistent as reported in Xu's memorial concerning the phase and time of occurrence. And, only Xu's group was able to predict successfully, and the others turned out incorrect¹⁹⁾.

As a result, the (most prestigious) Board of Rites (*Libu* 禮部) immediately decided to establish the Astronomical Bureau in order to reform the calendar system, and Xu was recommended as the director of the Bureau (*Duxiu lifa* 督修曆法).²⁰⁾ He had returned from the temporal retreat to his hometown, Shanghai, to the Board of Rites as the Senior Vice-President (*Zuo-Shilang* 左侍郎) of the Board. We can say that he was now at the best position to realize the long delayed reform. On 29th August within two months after the eclipse had occurred, the Board of Rites petitioned to the throne the Imperial approval of the arrangement for the improvement of the calendar method (*Xiugai lifa* 修改曆法). Xu Guangqi, first of all, arranged the foundation of the Astronomical Bureau with detailed preparations. The arrangement was more or less similar as described in the memorial presented to the *Wangli* 萬曆 Emperor in 1612 after the occurrence of the solar eclipse. At that time, as the compiler of history at the Academy (*Hanlinyuan Jiantao* 翰林院檢討), Xu was to be made one of the five members responsible for the theoretical basis of the astronomical system. Li Zhizao was also the candidate to fill in the member of would-be bureau. At last the Astronomical Bureau (*Liju* 曆局) was established in the *Shoushan shuyuan* 首善書院 Institute located inside the *Xuanwumen* 宣武門 Gate in Beijing.

Now, as the Vice-President of the Board of Rites, Xu Guangqi proposed five principles concerning the astronomical reform. They consisted of the items as follows :

19) Liang Jiamian 梁家勉, *Xu Guangqi Nianpu* 徐光啓年譜 [A Chronicle of Xu Guangqi], Shanghai, 1981 : p. 163.

20) *Mingshi* 明史 37, *Lizhi* 曆志 1, p. 530 (Zhonghua shuju 中華書局 edition).

- 1) the arrangement of personnel (*Xuan renyuan* 選人員) ;
- 2) the adoption of European astronomy (*Yong xili* 用西曆) ;
- 3) the wide-ranged search for human resources, mathematical calculation, material instrumentation, and so on (*Bo fangqu* 博訪取) ;
- 4) the financial support (*Yong qianliang* 用錢糧) ; and
- 5) the evaluation of the achievements (*Kao chengji* 考成績).

The enterprise thus started with the well-organized bureau ready to work²¹⁾.

As far as the formality was concerned, the approval of these principles provided of the realization of the employment of the scientifically well-trained missionaries with scientific knowledge from the West such as J. Terrentius, Adam Schall von Bell, J. Rho, and so on, who all had volunteered to go to China with N. Trigault after the death of Father M. Ricci. Trigault had returned to Europe to collect scientific missionaries as well as materials in order to bring them back to China with him.

As to the astronomical system, they preferred to adopt the Tychonic system instead of the Ptolemaic and Copernican. It was just after the first condemnation of Galileo concerning the world system in 1616 in the West when Terrentius and Xu Guangqi decided the astronomical system to be based on in China. For, at that stage, only this system had been proved to be the most precise system. That was what was needed for the reform. But, if we see the European scene in the West, the Tychonic system did not contradict Galileo's new discoveries with the telescope. Even Christopher Clavius of Roman College at the very end of his life remained silence about which world system the Jesuits could adopt instead of the Ptolemaic.

For the accreditation, the proposal of the evaluation of the process of the reform was the fundamental matter, which Xu specified as the fifth principle for the enterprise. We understand that, together with the item 3), Xu emphasizes that he followed the ideal practice based on the *Zhouli* 周禮 in order to realize the goal. We can say that the *Zhouli* was the Confucian classic, which guided Xu Guangqi's works not only for the reform, but also all his political activities through his career.

When he proposed the improvement of the astronomical constants for the calendar,

21) The Memorial of the Board of Rites written by Xu Guangqi dated 29th August 1629. Cf. *Xu Guangqi Ji* : 324-329.

by singling out the precession (*suicha* 歲差), he emphasized the necessity of gradual improvement of the astronomical constants. For, he writes,

“Every movement of the heavenly bodies can be represented in terms of constant figures, but, they shall not be regular numerals [and thus subject to change] (*Tianxing you hengshu er wu qishu ye* 天行有恆而無齊數也).”²²⁾

What he meant by “constant” is the laws of nature such as the longest daylight at the summer solstice and the shortest at the winter solstice. And to “be not regular” means the day-by-day change of the length of the daylight within one year or changes according to the precession. In accord to observational results (and the theories), the astronomical numbers should be improved by the reform after the long neglected time span. Thus we can understand he believed in the necessity of the reform of the calendar from time to time. And it was the high time when the action had to be taken. Now he was very confident to carry out such a state enterprise, because of his rich experience of how to introduce European knowledge of astronomy.

At the initiation he was also confident of the collaboration with Catholic missionaries just after the severe religious suppression during the previous emperor, when the parties' conflicts obliged him to escape far from the centre of the power. Now he was an only candidate to be able to resume the power and come back to Beijing from Shanghai to the Board of Rites. The enterprise of the state, i.e., the astronomical reform, had thus been started under his comfortable, rather complete control.

2. Xu Guangqi at the Inauguration of the Astronomical Reform

Having studied various subjects and engaged in the translation of European works, Xu Guangqi became confident that, if anyone desired to exceed the previous methods (*yuqiu chaosheng* 欲求超勝), the mathematical knowledge of both Chinese and Western origins must be comparatively and thoroughly understood (*huitong* 會通). Through his experience of translations with Matthew Ricci and other Jesuit missionaries, he claimed that geometrical principles could be applied to various expertise (*pangtong* 旁通). He eventually declared his conviction at the beginning of the

22) *Xu Guangqi Ji*: 332-338.

compilation of his major work for the astronomical reform, the *Chongzhen Lishu* 崇禎曆書, which was inaugurated at last in 1629.

In his *Memorial* to the throne at the beginning of the reform in 1629²³⁾, although it was within the category formed by Ricci, he extended the list of such applications to mention as much as 10 items based on mathematical astronomy. But, here we must point out that Xu used the term, *dushu* 度數, to represent the measurement and number, or one may say that by it he meant “mathematical astronomy”, the term of which was obviously different from the way used by Matthew Ricci. As a matter of fact, Xu replaced mathematics [consisting of geometry and arithmetic] by mathematical astronomy, so as to emphasize the urgent necessity of the astronomical reform for the state by making use of the recent knowledge brought over from Europe.

Apart from the characteristic aspect of mathematics imported from the West, which had relevance to the astronomical context of the reform²⁴⁾, it is adequate here to show the 10 items of application of mathematical astronomy, i.e., *Dushu pangtong shishi* 度數旁通十事, mentioned by Xu Guangqi. They are as follows: weather forecast, surveying, music, military engineering, financial accountancy, civil engineering, water-mill, cartography, medical theory of *yunqi* 運氣, and clock and clepsydra manufacturing. We understand that these items in fact covered the sphere of technological applications of mathematical science of those days, for which he had to keep his mind on taking responsibility as a successful high official of the state. To emphasize the importance of applied sciences for administration purposes was very convincing for him to acquire a consensus among the officialdom, so as to commence the state scientific enterprise.

Our main concern here is how Xu Guangqi was able to establish the idea that the fundamental, mathematical knowledge was indeed the basis of the applied areas of technology. As we have seen above, he might have established it during his early stage of learning Western mathematics and astronomy mainly through Ricci. Then he might have recognized the essential part of traditional mathematics played for the purposes of practical application. For he mentioned the position of the mathematical classic, *Zhoubi Suanjing* 周髀算經, in the end of his Memorial, analogically writing as fol-

23) *Ibid.*

24) ‘*Ke Jihe yuanben xu*’ 刻幾何原本序: *Tianxue chuhan* edition, 4a.

lows.²⁵⁾

“By means of what Yu 禹 (the reputed founder of the high ancient Xia dynasty) was capable of governing under the heaven was the arts which had been derived from the principle of the *gougu* 句股.”

And he concludes his *Memorial* by phrasing as such that

“it is because the matter has both shape and quality in properties, the investigation of which solely based on the cultivation of the measurement and numerals (*gai fan wu you xing you zhi, mo bu zi yu dushu gu er* 蓋凡物有形有質，莫不資於度數故耳).”

Here, mentioning the measurement and numerals, he implicitly emphasizes the capacity of mathematical astronomy, which ought to be fully materialized.

We must remember that, in the early stage of the attempt of introducing European astronomy, Li Zhizao emphasized the novelty of Western astronomical knowledge listing up 14 items in his *Memorial* to the throne in 1613²⁶⁾. But, only to emphasize the novelty could not realize the replacement of the traditional system with the newly brought European astronomy, even if it was just after the Spaniard Jesuit, de Pantoja (1571-1618), had successfully calculated the solar eclipse occurred in 1610. Even if we have to admit that, as the initial attempt, it was an impossible task to do so. And we must also admit that it had been before the arrival of the Tychonic system in the 1620's. We must say that, if it was concerned with exact astronomy, the Jesuit missionaries had not been yet ready to take responsibility for it²⁷⁾.

Xu Guangqi, on the other hand, could have emphasized the accuracy of the newly arrived astronomical knowledge later at the beginning of the compilation of the *Astronomical Compendium* from the West, because, now, he had both scientific materials and missionaries at his disposal. In this context, we must read his phrasing, ‘to exceed the previous methods.’ This phrasing implies a conviction long shared by Chinese astronomers and scholars particularly at the time of necessity of astronomical reform, so as to emphasize the improved accuracy of proposed method. The present author has once discussed the Chinese conviction of the development of accuracy in

25) Cf. Wang Zhongmin 王重民 (ed.), *Xu Guangqi Ji* 徐光啓集, Shanghai, 1963 ; 373-378.

26) *Ibid.*

27) Cf. Hashimoto, K, *Hsü Kuang-ch'i and Astronomical Reform - The Process of the Chinese Acceptance of Western Astronomy 1629-1635*, Kansai UP, 1988 ; 8-28.

such terms particularly in astronomical matters throughout its history²⁸⁾.

In the framework of traditional astronomy in China, the repeated reforms for the supremacy of accuracy had resulted in the gradual improvement of astronomical theories and numerical data during more than a millennium before the seventeenth century. The conviction of the eventual development as such had always provided a sort of psychological drive to endeavour for improving the accuracy of the astronomical system. It had not only promised to promote the repeated reforms of the astronomical systems, but also guaranteed even the introduction of foreign knowledge of astronomy from time to time, when it was needed²⁹⁾. Indeed, he shared this conviction by demonstrating the accuracy of the Western methods. As one of the most typical examples, we can single out the endeavour of introducing European astronomy by Xu Guangqi.

He repeatedly tried quantitatively to compare the accuracy of both traditional Chinese and newly introduced Western systems in terms of the precision of prediction of eclipses. During the astronomical reform, the astronomers in charge observed heavenly phenomena in order to check the theoretical results by making use of the new instruments, including the telescope, which had been brought to China by Terrentius and Johann Adam Schall von Bell³⁰⁾. Xu's intention was to evaluate numerical results concretely, or quantitatively, if we can be permitted to use the expression, and to demonstrate how precisely the new system was being established against the traditional methods, so as to justify his intensive endeavour for the reform.

We also have to point out that Xu Guangqi, at the same time, was very conscious of classifying the groups of the astronomical treatises according to the contents, which ranged from the basic to the applied³¹⁾. He coordinated the project according to a kind of two-dimensional classification. First, every treatise carries one of the six items of

28) Hashimoto, K., "Seido no Shiso to Dento-Chugoku no Tenmongaku 精度の思想と傳統中國の天文學 (The Thought of Accuracy in the Traditional Chinese Astronomy)", *Bulletin of the Faculty of Sociology*, vol. 11-1, Kansai University, 1979; 93-114.

29) We can read this above in Xu's Memorial "Lishu zongmubiao 曆書總目表" in 1631. See n. 10).

30) See, for example, Hashimoto, K., "Sutei kaireki no seitoka to boenkyo no ichi 崇禎改曆の正當化と望遠鏡の位置 (The Justification of the Chongzhen Astronomical Reform through the Observational Results with the Telescope)", *Kyoto-Daigaku Jimbumkagaku-kenkyusho Kenkyu-hokoku* 京都大學人文科學研究所研究報告, Chugoku Kodai Kagakushi-ron 中國古代科學史論, 1989; 363-394.

31) See Jami, C., "Western Mathematics in China, Seventeenth Century and Nineteenth Century", Petijean, P. et al (ed.), *Science and Empires*, Kluwer Academic Publishers, 1992; 79-88.

the objects (*jieci liumu* 節次六目), which has been discussed in the present book. They are the solar motion (*richan li* 日躔曆), fixed stars (*hengxing li* 恆星曆), lunar motion (*yueli li* 月離曆), solar and lunar eclipses (*riyue jiaohui li* 日月交會曆), planetary motions (*wuweixing li* 五緯星曆), and planetary conjunctions and eclipses (*wuxing jiaohui li* 五星交會曆).

Secondly every treatises have been classified so as to belong to one of five fundamental, characteristic categories (*qiben wumu* 基本五目), that is, theories (*fayuan* 法原), astronomical constants and tables (*fashu* 法數), methods of calculation (*fasuan* 法算), instruments (*faqi* 法器), and applications (*huitong* 會通). The names of these fundamental categories can be observed on the title page of each treatise. Xu's endeavour to classify every treatise definitely based on his systematic presentation of the astronomical and mathematical knowledge from Europe. Such presentation was crucial to coordinate the large-scale scientific enterprise of the state.

Concluding Remarks

Lastly, in order to understand Xu's successful initiation, we must recognize the fact that his political status was high enough to realize the astronomical reform. He had so far established his scholarly achievements in this field as well. He had managed to survive the severe party conflicts in the early seventeenth century, and finally reached the highest status of the bureaucratic hierarchy of the Ming dynasty, when he proposed to inaugurate the reform. The formation of the organization, the Astronomical Bureau, *Liju* 曆局, was crucial to do so. We must say that he was, indeed, the successful organizer of the scientific enterprise in the end of the Ming dynasty.

At that time, nobody could have refused his proposal if he determined to begin the long-awaited programme of the reform. He prepared to justify the necessity of the state enterprise of astronomy. Xu Guangqi was quite ready to appeal to the belief of astronomers and literati that astronomy had developed and had not been deteriorated over time through the long history of China. Since we have already made clear of this aspect of the Chongzhen astronomical reform in our previous work, we have not repeated the argument any more³².

The problem is how Xu Guangqi was well motivated and confident of getting ready

to organize the astronomical bureau for this purpose in order to commence the enterprise. As to the organization, he must have been the scholar-official with the best position to take advantage of his power to dispose the personnel. As to the scientific capability, who else, including Jesuit missionaries, was able to dominate this field of state science in China at that time? This is the reason why we are interested in Xu's ideas concerning mathematical astronomy, which was needed for understanding of the knowledge in this area particularly from Europe, which, as a matter of fact, greatly contained the achievements out of the recent progress of the Scientific Revolution³³⁾.

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32) See n. 13) above.

33) See, for example, Hashimoto, K., "Galileo's Invention and Kepler's Optical Astronomy", *Bulletin of the Faculty of Sociology*, vol. 18-1, Kansai University, 1986: 255-281.