COMPARATIVE ASPECTS OF THE INTRODUCTION OF WESTERN ASTRONOMY INTO CHINA AND JAPAN, SIXTEENTH TO NINETEENTH CENTURIES*

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It was in 1549 A.D. that Japan made its contact, through a Jesuit missionary, with European culture[1]. When St. Francis Xavier, one of the founders of the Society of Jesus, went to Japan and was preaching Christianity there, he observed in a letter to Rome that the Japanese were eager for knowledge about astronomy. In the end, because at this time Japan was upset by internal turmoil, he returned to Goa in India. Knowing that Japan was strongly under the influence of Chinese culture, he came to believe that successful missionary work in China was the key to favorable conditions in Japan. He sailed for China in 1552, but did not succeed in entering the mainland; he died that same year on a small island near Canton. But from then on, following in his footsteps, Jesuit missionaries came one after another to China and Japan. From the point of view of the propagation of Western astronomy, their success was achieved in China rather than in Japan.

The missionary who began the introduction of Western sciences, including astronomy, into China, was Matteo Ricci (known as Li Ma-tou 利瑪竇 in Chinese, 1583-1610). He and his colleagues compiled a group of Chinese tractates (mostly translations) on Western sciences and Christinaity under the collective title *T'ien-hsüeh ch'u-han* 天學初函 (First collection on the Heaven). The famous officials Hsü Kuang-ch'i 徐光啓 (1562-1633) and Li Chi-tsao 李之藻 (1565-1630), collaborated with them. The *T'ien-hsüeh ch'u-han* was divided into two parts: the Section on the Beneficial 利篇, which dealt with Christianity, and the Section on the Utilitarian 器篇, which dealt with Western sciences. The latter is chiefly made up of translations of Western mathematical and astronomical treatises. The important introduction to Aristotelian cosmology *Ch'ien-k'un t'i-i* 乾坤體儀 (On the figure of the universe), also translated by Ricci but not included in the *T'ien-hsüeh ch'u-han*, closely resembles the influential *Kenkon bensetu* 乾坤辨説 (Explication of the universe) of Japan. The former seems to be based upon the Commentary on Sacrobosco's *Sphaera* of Christopher Clavius, Ricci's teacher.

Hsü Kuang-ch'i and Li Chi-tsao, both Christian converts, were enthusiastic and strategically placed figures in the introduction of Western science. Hsü in particular promoted the compilation of a Western astronomical encyclopedia which could serve as the basis of a newly reformed official calendar. Accordingly, by the request of Matteo Ricci, many Jesuit missionaries whose astronomical training was the best Europe offered in the early seventeenth century were sent to China. Among these missionaries, Johann Schreck (Têng Yü-han 鄧玉函), Sabbatino de Ursis (Hsiung San-pa 熊三拔), and Johann Adam Schall von Bell (T'ang Jo-wang 湯若望), became most eminent. The compilation of the astronomical encyclopedia began in 1629 (second year of the Ch'ung-chên 崇禎 era) under the leadership of Hsü. After his death an official Li T'ien-ching 李天經 took charge. By 1634, the *Ch'ung-chên li-shu* 崇禎曆書 (Calendrical treatise of the Ch'ung-chên era), in more than 135 volumes, was completed. But by that time the Ming ruling house was in crisis, for its destruction by the Manchus was only a matter of time. In another decade, as the Ch'ing dynasty, they were to rule the territory of China.

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In 1644, the first year of the Shun-chih 順治 era of the Ch'ing, Adam Schall, now serving the new regime as Royal Astronomer, took charge of the calendar reform by Imperial order. The *Ch'ung-chên li-shu* was revised and reissued under the title *Hsi-yang hsin-fa li-shu* 西洋新法曆書 (Calendrical treatise according to the new Western methods), and a new calendar based on it was promulgated throughout the empire effective the next year.

From the modern point of view, a calendar reform has nothing to do with the destiny of a state or its ruling house. According to the theory of monarchy traditional in China since the Han dynasty, compilation of new astronomical tables and their accompanying calendar reform were considered indispensable in order to keep the political and cosmic orders in tune. It was in fact partly an attempt to restore this harmony (whose absence could be seen in the prevalent social unrest) that led to the compilation of the astronomical encyclopedia immediately before the fall of the Ming dynasty. The situation was the same in Japan; that is to say, the last calendar reform under the Tokugawa shogunate was carried out only twenty-six years before the Meiji restoration of 1868.

In spite of some years' interruption due to the protests of Chinese officials, Schall's new calendar remained official until the end of the Ch'ing period (1911). Although Adam Schall died in prison, his successor Ferdinand Verbiest (Nan Huai-jen 南懷仁) was greatly esteemed by the K'anghsi emperor, successor of the Shunchih monarch, and he was once again given control of the Royal Astronomical Bureau. Eventually, severe conflicts over missionary policy between the Jesuits and other sects whose representatives came to China later resulted in 1724 in an imperial proscription of Christian missions in China. Only a few missionaries, mostly Jesuits, were permitted to stay and serve in the Astronomical Bureau and in other technical posts.

Publication of the astronomical encyclopedia, which for the first time allowed a glimpse of the mathematical basis of astronomy, made possible the initiation of a generation of pioneering Chinese scholars. Among them Wang Hsi-shan 王錫闡 and Mei Wen-ting 梅文鼎 are particularly important, for they began the application of this new knowledge to the rediscovery and reevaluation of the native astronomical tradition. As Yoshio Mikami pointed out a generation ago, this renaissance was the only historically important direct consequence of the Jesuits' labors.[2] The *Li-hsiang k'ao-ch'êng* 曆象考成 (Compendium of calendrical astronomy, 1722) and the *Shu-li ching-yün* 數理精蘊 (Collected basic principles of mathematics, ca. 1706), the astronomical and mathematical parts of a great three-part compilation ordered by the K'anghsi emperor, demonstrate both significant aspects of early eighteenth century science in China. They are mainly new compilations by Chinese scholars of Western astronomy and mathematics conforming to their traditional pattern.

Ignatius Koegler (Tai Chin-hsien 戴進賢), who became Verbiest's successor as court astronomer in 1725, collaborated with a group of European and Chinese scholars in the compilation of the *I-hsiang k'ao-ch'êng* 儀象考成 (Compendium of observational astronomy, 1752) and a sequel (1742) to the *Li-hsiang k'ao-ch'êng*, in which he applied the elliptical theory of Kepler to the orbits of the sun and the moon, but despite the inclusion of post-Newtonian tables these books provided only a very distorted reflection of two centuries' progress in the West. After Koegler's time the astronomical bureau was continuously supervised by Christian missionaries until Sera (Kao Shou-ch'ien 高守謙) left China in 1837.[3] But Koegler's books represent the high point of the Jesuit contribution to mathematical astronomy, for once the Jesuits lost their freedom to proselytize, there was no reason to continue the broadcasting of European science.

Eventually, as a consequence of the Opium War, China was forced to open several of its ports to foreign trade, beginning in 1842. This situation can be compared to the opening of Japanese ports in 1854. Only fourteen years elapsed from the end of Japanese seclusion until, with the Meiji restoration, importation of Western science and technology became national policy. The corresponding period from the first treaty to the foundation of the Republic of China in 1912 was seventy years. In this considerably greater lapse of time we have a measure of the much greater distress which China experienced on the way to modernization. Many of the cultural differences which account for the disparity in the reactions of the two societies will be reflected in a comparison of the uses to which they put European mathematical astronomy.

As stated earlier, a Chinese calendar reform based on Western astronomy was carried out by Missionaries in the court in 1645. A Japanese calendar reform based on the astronomical tables of the Frenchman Lalande came in 1842 (thirteenth year of the Tempō era), two centuries later. Until then Japanese scientists used Chinese astronomical tables. A Calendar reform (1797) in the Kansei era, immediately before that of the Tempō era, made use of the *Li-hsiang k'ao-ch'êng* and its sequel, but from 1842 on, Japanese calendrical science could go its way independently of China. But from an early time we can see some fundamental differences between China and Japan concerning their attitudes toward the acceptance of modern science.

1. In the case of China, the work of introducing Western sciences and supervising the astronomical bureau was performed by missionaries. Many Chinese scholars came to appreciate the value of Western science and studied it, but their access was always indirect. They did not learn European languages and read scientific books in the original, but had to depend on missionary translations and paraphrases. This also meant that they could not play an independent major role in the transmission of ideas – or even independently carry out a major calendar reform. In Japan, on the contrary, the initiative was always Japanese. From the middle of eighteenth century Japanese scholars began to study European languages, especially Dutch, and translated Western scientific books on their own. When the time came for a calendar reform they were able to do it themselves.

2. As a natural result of the channeling of scientific education through the Catholic missionaries, many of the cosmological approaches and computational techniques which reached China were already obsolate in the west. As you know, propagation of the heliocentric system proposed by Copernicus was prohibited by order of the Congregation in Rome. The Ch'ungchên astronomical encyclopedia accordingly described only some of the peripheral features of the heliocentric system. Some missionaries in China privately accepted the basic ideas of Copernicanism, but were unable to discuss them fully and positively in China. In the case of Japan, the Copernican system was first introduced through the Dutch by the interpreter Motoki Ryōei 本木良永 early in 1774, and fully described nearly two decade later in a translation ultimately derived from George Adams' astronomical book (Dutch translation in 1770). From this time, Copernicanism was broadly disseminated by Shiba Kokan 司馬江漢 and others, who learned of and accepted post-Copernican developments in the West. Shizuki Tadao 志筑雄忠, born into a family of professional interpreters, rendered the Dutch version of a book of John Keil, a friend of I. Newton, into Japanese in 1802. Not only did he introduce Newton's conception of universal gravitation, but developed his own nebular hypothesis, which was independent of those of European scholars such as Kant. These new views of astronomy were conveyed almost exclusively by professional interpreters and amateur astronomers. In the case of official astronomers under the Tokugawa shogunate, the situation was somewhat different. They carried the weight of tradition as they focussed their endeavors on making better calendars on the old Chinese pattern, culminating in the unique reform of the Tempō era. Although they translated the recent writings of Lalande and others from Dutch, they did not show much interest in the heliocentric system. Under Tokugawa feudalism, the studies of the official astronomers were restricted in scope, not extending to the sort of free research for the sake of the advancement of the art which was going on in Europe. It must be noted here, however, that a department for the translation of

Western scientific books was created within the astronomical bureau in 1811. This department gradually evolved into one of the nuclei of Tokyo Imperial University.

The seclusion policy of the shogunate left only one window open, in Nagasaki, toward European civilization. Through this aperture Japan could absorb Western astronomy, but only by her own efforts. Before the Opium war, China was similarly reluctant to permit the entrance of foreigners. But there could be seen deep differences in the orientation toward Western science once it began to enter. One reason is the contrast of attitudes toward foreign culture in general in the two countries. Ever since the early period when Chinese culture was first imported, the Japanese showed an enthusiastic concern for foreign culture, whereas Chinese tended to reject any foreign idea or technique which did not promise to fully accord with and positively strengthen the traditional way of life. Another reason arises from the difference in social structures. In China the examination system made it at least possible for any educated person to move into the official elite – so long as he did not waste much time on heterodox topics such as modern science. In Japan, institutions and social distinctions were kept strictly hereditary. In the Edo period many members of the merchant class, although barred from advancement, attained great wealth and leisure to devote their lives to study if they wished. As a consequence, there was nothing to keep them from indulging their fancies, for in any case they could expect no worldly benefit. Many of them, as in Europe, chose science. Thus the severe system of hereditary restrictions upon which Tokugawa feudalism was based eventually forced many Japanese to study Western culture, and so ultimately was responsible for the Meiji Restoration which destroyed the shogunate.

NOTES

1. The first contact of Japan with Europeans occurred in 1543 when the Portuguese arrived at Tanegashima island in the southern sea and introduced guns.
2. Y. Milami, "The Ch'ou-Jen Chuan of Yüan Yüan," *Isis*, XI, 1928, p. 125.
3. The first name of Sera is Thomas. See Sueo Goto: *Chinese cultures in France* (in Japanese), p. 119, 1933.