

Astronomy in the Edo(江戸) Period

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I was asked by Dr. Soma(相馬) to talk about an aspect of the history of Japanese astronomy in some specified time, only as a brief review. I would like to give a general talk about astronomy in the Edo Period, and also I want to talk about the studies in which I have been engaged with my coworkers.

In the Edo Period when Japan gradually settled down, the import of Chinese science began active, and studies of the *Shoushi li* (授時曆), for example, flourished among citizens and the motivation for calendar reform grew up both officially and privately.

Moreover, some of the Western culture was introduced through Nagasaki (長崎). The *Kenkon-bensetsu* (乾坤辨説), a translation of a Portuguese book by Ferreira (沢野忠庵, Sawano Chuan) in 1659 and the *Nigi-ryakusetu* (二儀略説) written by Kobayashi Kentei (小林謙貞) in 1667 described the Aristotelian natural philosophy and cosmology. The *Tianjing Huowen* (*Tenkei-wakumon* in Japanese 天經或問) by Youyi (Yūgei in Japanese 游藝) was not so highly regarded in China, but it gave a big influence on Japanese astronomers such as Shibukawa Harumi (渋川春海) as a convenient digest of the Western astronomy.

Concerning the *Tianjing Huowen* there are some studies on it, including that of Yoshida Tadashi (吉田忠). Modern researchers' evaluation about its influence on astronomy of the Edo Period is almost the same as that mentioned above. However, as the result of our

seminar on this book which were held monthly more than about 30 years ago in Doshisha University, in which Prof. Yabuuti Kiyosi (藪内清) participated regularly, it became clear that this book was a result of a compromise of the new Western astronomical knowledge and Chinese traditional astronomy, and that mostly they are degenerate with incomplete quotations of some books published in China. Even when the outline of the solar

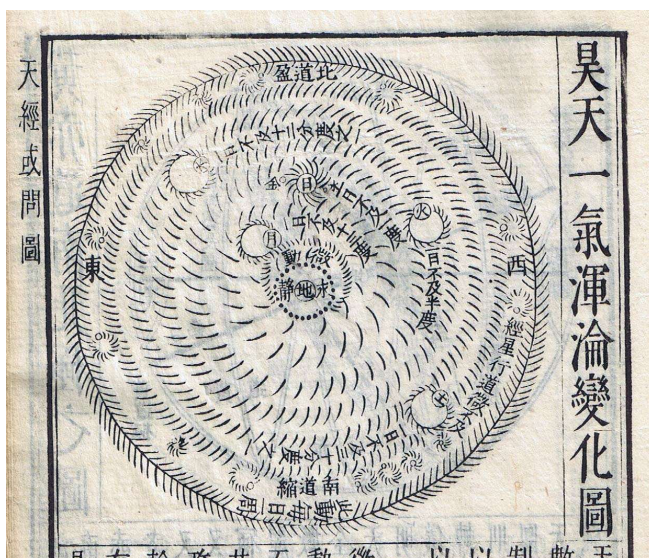


Fig.1.The figure in the first Volume.

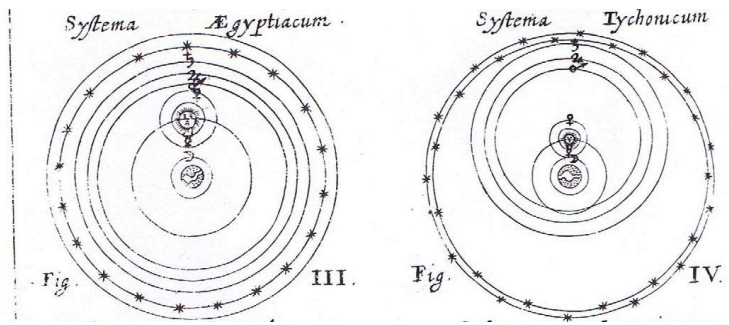


Fig.2.The so-called Egyptian system and the Tychoonic system.

system of Tycho Brahe was translated, the figure in the first volume (首卷) (Fig.1) was not the solar system of Tycho but it is rather close to the so-called Egyptian system. This shows the poor understanding of Youyi.

Let us give another example of his wrong understanding in this book. Figure 3 shows the structure of a model that depicts the sun and the moon revolving around the earth.

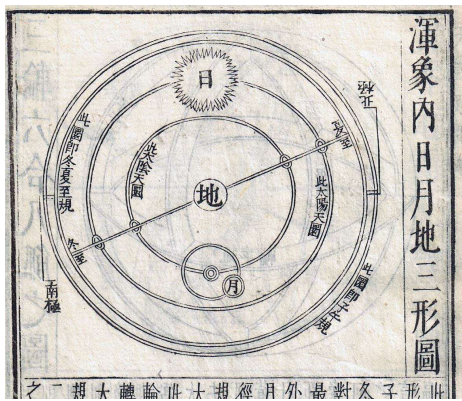


Fig.3.

However, if the sun and the ringlet carrying the moon around are placed at the positions as shown in this figure, neither surface of revolution of these heavenly bodies includes the earth. It is fundamentally wrong. Moreover, the phrase for explanation is misplaced and the description is wrong. Such system cannot explain the apparent motions of the sun and the moon and contradicts the meaning intended in the second volume of the book. This shows not only the poor understanding of Youyi, but also the lower scholastic ability of Nishikawa Masayoshi (西川正休) who reproduced the original book uncritically and incorrectly. In fact, this figure is based on the figure in *Hungai tongxian tushuo* (渾蓋通憲圖說), drawn by Li Zhizhao (李之藻), which is an abridged translation of Clavius' book, and Youyi just copied uncritically the mistake of the original drawing.

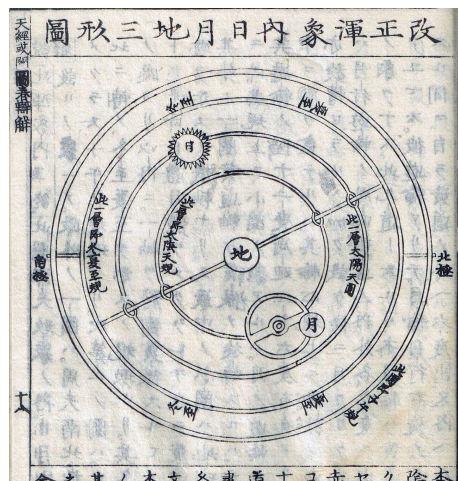


Fig.4.

Irie Takahiro (入江脩敬) pointed out the incorrectness of this figure in his *Tenkei Wakumon Chūkai Zukan* (天經或問註解圖卷) and offered his own figure (Figure 4). However,

this again shows that the motions of the sun and the moon were not correctly understood. In the second volume (天卷), the changes of the distance and angular velocity of the moon, and

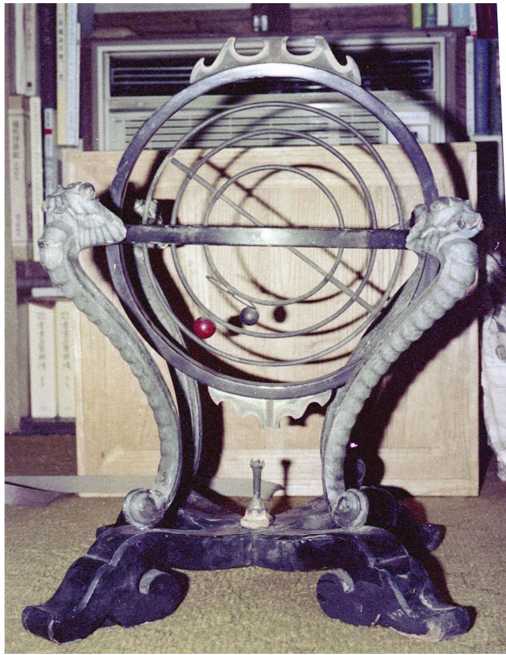


Fig.5.

the change of the inclination of the lunar orbit (白道) to the ecliptic, that is, the change in the ecliptic latitude, are described. The period of the change of the lunar distance is the anomalistic month, the period of the moon moving from the ascending or descending node to the same node is the draconic month, and the period of the moon going along the lunar orbit is the sidereal month. These periods are different each other. In the case of the instrument whose figure is drawn in Irie's book, we can express the difference of the anomalistic month and the draconic month from the sidereal month if we slightly change the rotational period of the big ring and that of the ringlet carrying

the moon. The change of the distance is essentially relative to the change of the angular velocity and thus his system can offer a qualitative explanation. However, the anomalistic month and the draconic month would have the same period in his system, although they are actually different. In addition, an instrument exists (Figure 5) that is considered to have been made according to the figure in Irie's book. However, in the case of this instrument, the ringlet carrying the moon is attached to a big ring perpendicularly. This system can explain the change of the moon's latitude to the north and the south and also the change of its speed, but cannot explain the difference of the period of the two nor the change of the distance.

In this seminar we prepared a translation and notes of the first and the second volume(図巻・天巻) of the book, but it was not published. At present a new work group headed by Hiraoka Ryuji (平岡隆二) is preparing a new translation and notes of the second volume. Kazu Tsuguto (嘉数次人), myself and some others have been participating in it. Recently a new document was discovered by Hiraoka, which will be included in the new publication.

The *Xuanmin li* (宣明曆) was used since A.D.862 until the Edo Period, when the gap between calendar and natural phenomena became conspicuous. The two persons were especially responsible for calendar reform. One is Shibukawa who was a go (碁) teacher of the Shogunate, and the other is Seki Takakazu (関孝和) who established Wasan(和算). In 1685 Shibukawa prepared the *Jyōkyō-reki* (貞享曆) using the *Shoushi li* as a model and based on his own observations. The *Jōkyō-reki* was officially used in place of *Xuanmin li*

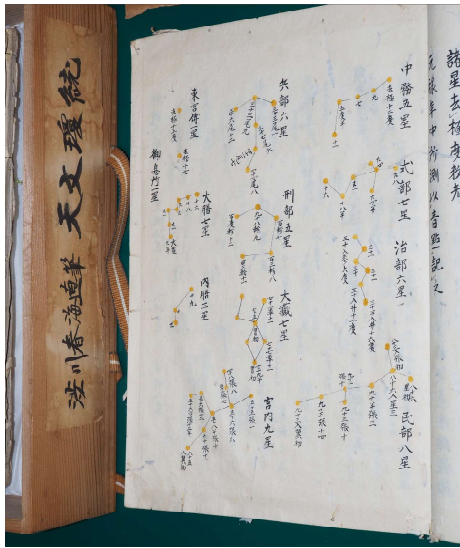


Fig.6. The *Tenmon-keitō* possessed by the author.

drawings of new constellations. In 1698, he wrote them down as the *Tenmon-keitō* (天文瓊統, Figure 6), where the celestial map titled *Tenmon-seishō* (天文成象) was contained, and he published it next year by the authorship of his son. All the positions of the stars in this map were based on his own observations.

After the calendar reform of Jōkyō, the astronomical bureau called Tenmonkata (天文方) was established in the Shogunate, and Shibukawa was appointed the first Director General. After that it became customary that the annual calendar was edited in the Tenmonkata who sent it to the Onmyōryō in Kyoto. They were published with annotations which we now regard as superstition. This astronomical bureau is the origin of today's National Astronomical Observatory.

The eighth Shogun Tokugawa Yoshimune (徳川吉宗) admitted the excellence of Western astronomy, and in 1720 he lifted the embargo of the foreign books, and Dutch studies began flourishing. He expected official use of a calendar based on the Western astronomy, but since the staffs of the Tenmonkata were incompetent, Tsuchimikado Yasukuni (土御門泰邦), the Secretary of Onmyōryō, took back initiative and he was successful in the enforcement of the *Horyaku-reki* (宝曆曆).

This calendar was not based on the Western astronomy and of inferior quality. Therefore, Takahashi Yoshitoki (高橋至時), a disciple of Asada Goryū (麻田剛立) was appointed to a staff of astronomical bureau and he put in practice the enforcement of the Kanseireki (寛政曆) in 1799 with Hazama Shigetomi (間重富), a senior fellow disciple. It was the first calendar in Japan that used the Western astronomy, but it was still a luni-solar calendar.

About Asada Goryū there are studies by Fujii Jun'ichirō (藤井準一郎) and Watanabe

which used for 823 years. It was the first original Japanese calendar officially used in Japan.

Shibukawa published two celestial maps, one is called *Tenshō-retsujī no zu* (天象列次之図) and the other *Tenmon-bun'ya no zu* (天文分野之図) which referred to Korean *Cheonsang Yeolcha Bun'ya Ji Do* (*Tenshō-retsujī-bun'ya no zu* in Japanese 天象列次分野之図). In the latter he newly set a Japanese *bun'ya* (分野) that is the correspondence between the places on the earth and in the sky.

He applied the idea of correspondence between human affairs and celestial phenomena to the Japanese social system and offered

Toshio (渡辺敏夫) etc. About 20 years ago the Oita Board of Education asked Suenaka Tetsuo (末中哲夫), Kage Toshio (鹿毛敏夫) and myself to collect Asada's documents and to write a critical biography. Because I was busy, I wrote only a critical biography. Although Asada's contribution is great in the history of Japanese astronomy, we cannot take everything affirmatively. The theory so-called "Shōchōhō" (消長法), namely, the change of the astronomical constants with time, is correct qualitatively, but not at all quantitatively. Koide Chōjūrō (小出長十郎) also pointed out this already in those days. I think that the evaluation of Asada should be made taking into account this point.

Historical materials were handed down for generations by the Hazamas (羽間家) which was a collateral of Hazamas (間家) and the historical documents that Heizaburo (平三郎) collected had been kept as "Hazama-Bunko" (羽間文庫). About 20 years ago, they were donated to Osaka Museum of History. They were designated as an important cultural property together with the historical documents in the Osaka Municipal Library in 2016. Yoshida Tadashi, Kazu, Hiraoka, myself, and others continue to study them as "Research Group of Hazama-Bunko".

The *Lixiang Kaucheng* (曆象考成), in two volumes, described the solar systems of Tycho Brahe, and the *Lixiang Kaucheng Houbian* (曆象考成後編) adopted Kepler's law for the movement of the sun and the moon although it is essentially geocentric. The *Kanseireki* (寛政曆) was a calendar at this level. Takahashi Yoshitoki (高橋至時) was not satisfied with this. He translated and studied the *Astronomia of Sterrekunde (Astronomie)* by la Lande aiming at further calendar improvement, but he died with the work unfinished. Ino Tadataka (伊能忠敬), who prepared the precise map of whole Japan (大日本沿海輿地全図, 1821) (completed posthumously), was a pupil of Takahashi.

Motoki Yoshinaga (本木良永), an interpreter in Nagasaki, prepared the translated book *Tenchi-nikyū-yōho* (天地二球用法) in 1774 that described the Copernican theory. Shiba Kōkan (司馬江漢) a painter and science writer, introduced to the people the Copernican theory in his *Oranda-tensetsu* (和蘭天説) published in 1796 and the *Kopperu-Tenmonzukai* (刻白爾天文図解) in 1808. Shizuki Tadao (志筑忠雄), an interpreter in Nagasaki, published a translated book *Rekishōshinsho* (曆象新書) in 1798-1802 and introduced the Newtonian dynamics. In addition, Yamagata Bantō (山片蟠桃), a merchant in Osaka, wrote about the Copernican theory and a solar calendar in the work *Yumenoshiro* (夢の代) in 1820. However, the main interest of official astronomers was the calendar system that followed the traditional values of China, and their interest in Copernican theory was limited to the calendrical precision.

Kageyasu (景保), the elder son of Yoshitoki died in prison as he was involved in the Siebold affair, but the younger son Kagesuke (景佑) was adapted to the Shibuka family and

he inherited the chair of Director of Tenmonkata and performed the Tenpō calendar reform (天保改曆). This calendar increased the accuracy of the position of the five planets because it used Kepler's law. It is the last luni-solar calendar in Japan.

Japan began using the Western calendar date after 1873 and shifted to the solar calendar, but since the wordings of the decree that determined the leap year were not sufficient, it was revised in 1899, and it turned into the correct Gregorian calendar.

In addition, Buddhism had the unique cosmology Shumisensetsu (須弥山説). But the criticism against this cosmology and Buddhism itself increased when the Western science was introduced. The campaign for protecting Buddhism or the revival of the Buddhist calendar became popular among the Buddhists who urgently felt danger against Western cosmology. The priests Mon'nō (文雄) and Entsū (円通) were especially active.

Entsu wrote *Bukkoku Rekishohen* (佛國曆象編), in which he insisted that all the world calendrical systems originated in India. He devised the Shumisengi (須弥山儀) and the Shukushōgi (縮象儀), and propagated the world-view of Mt. Sumeru. This movement showed a considerably big upsurge and continued until about 1880.

Since 2003 I organized a study group on the five volume *Bukkoku Rekishohen*, held regular meetings in Doshisha University, and prepared a translation with notes. After my official retirement, Hayashi Takao (林隆夫) succeeded my work, and, after his retirement, the meeting place of this group moved to the Institute for Research in Humanities of Kyoto University. We finished whole of the translation with notes in 2015. At present we are revising it for publication.

When we read *Bukkoku Rekishohen* we can point out the following three points. (1) Logical gaps are often seen in some important places. (2) Entsū repeatedly points out that there are two theories in the Western astronomy, namely, the new (Copernican theory) and the old (Ptolemaic theory), and he insists that he cannot believe in the Western astronomy since the two are mutually different. This means that he did not admit the scientific progress. (3) He ascribes the reason why Shumisen (i.e. Mt. Sumeru) cosmology does not accord with the practically observed phenomena to the insufficient ascetic practices of people, if one obtains 'divine eyes (Tengen 天眼)' by practices, one can see it. This is against his original purpose of the book, namely, providing scientifically correct interpretation of the Shumisen cosmology.

Japan was under the overwhelming influence of Chinese science until the early Edo Period. Later when Western science reached Japan, and its superiority became evident, people changed the policy and became depending upon Western science. Such a historical circumstance seemed to have made Japanese scientific characteristics that it depends upon the foreign country in the original study.