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LETTERS FROM AUGUSTIN HALLERSTEIN, AN EIGHTEENTH CENTURY JESUIT ASTRONOMER IN BEIJING

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Abstract: Augustin Hallerstein (1703-1774) was the last astronomer sent to Beijing by the Society of Jesus. He left Europe for China in his mid-thirties, and continued to send letters back home until he died thirty-five years later. These letters and reports contained important information on Chinese astronomy, and were read in the courts of Europe; many were also published. Hallerstein was one of the most important European astronomers in Beijing, his European publications surpassing those of his predecessors.

Keywords: Hallerstein, Jesuits, Ljubljana, China, history of astronomy.

1 INTRODUCTION

The famous astronomer, Ferdinand Augustin (or Avguštin) Haller von Hallerstein was born in Ljubljana (now in Slovenia) on 27 August 1703, admitted to the priesthood in Vienna on 27 October 1721, and died in Beijing on 29 October 1774 (Dehergne, 1973: 122). He arrived in Beijing in March 1739, and while there was known by his Chinese names, Liu Sung-Ling and Lieou Song-Ling K'iao-Nien. Hallerstein was the last of the old Society of Jesus astronomers sent to Beijing, and without his contribution the story of the Jesuits' success in China would be incomplete (see Figure 1).

During his thirty-five years in Beijing, Hallerstein sent relatives back home a succession of letters and reports. These provide invaluable information on the life and times of the European astronomers based in the Chinese capital, as documented in this paper.

2 HALLERSTEIN DESCRIBES HIS BEIJING PREDECESSORS TO HIS BROTHER

Hallerstein regularly corresponded with his brother Janez Vajkard Baron Hallerstein (1706–1780), who was the confessor of the Empress Maria Theresia's brother-in-law, Prince Charles Alexander of Lorraine. Janez Vajkard lived in Brussels which was the capital of the Habsburg Netherlands and the source for modern science which the Empress needed in her southern lands (including Hallerstein's native Carniola). Augustin Hallerstein's letters to his brother were widely read in the European courts.

Hallerstein learned all about the works of his Jesuit predecessors in Beijing. In 1743 he reported to his brother about the writings of the Italian Jesuit, Matteo Ricci (1552–1610) (Dehergne, 1973: 219; Hallerstein, 1781: 5), who was Clavius' student at the *Collegio Romano* until 1577. From 1577 until 1582 Ricci was a missionary in India. According to Hallerstein's report mailed to Janez Vajkard, after 1601 Ricci was a missionary in China under the Emperor Wan Li (Chintsong), and he began the Jesuit mission. Before Ricci, the Muslims calculated the ephemerides according to Arabic tables in the first class of the Beijing Astronomical Bureau. The Muslim Bureau for Astronomy was established in 1268 and made use of trigonometry, which was not popular among the Chinese. In the second class (of the three classes, or departments) were the Mandarins who observed the sky (Montucla, 1799, 1: 474-475; Huff, 1993: 241).

Ricci translated into Chinese Euclid's first six books, Clavius' tractate and the shortened extract from Clavius' works. In 1607 he wrote the very first trigonometry text published in Chinese (Needham and Ling, 1959, 3: 110). With the introduction of the sign for equivalence and other algebraic elements, the Jesuits brought comparatively new European concepts to China (Needham and Ling, 1959, 3: 114).

Besides Ricci, Hallerstein also described to Janez Vajkard the work of the architect-astronomer Johann Adam Schall von Bell,[1] who studied mathematics with Christoph Grienberger (1564–1636), Clavius' successor at the *Collegio Romano*. In 1619 von Bell arrived in Macao. The Emperor Chongzhen[2] invited him and Giacomo Rho to continue to make changes to the inaccurate calendar which was used for the wrong prediction of an eclipse in 1630. The Jesuits Giacomo Rho (1592–1638) and von Bell had sailed for China in 1618 and the latter eventually succeeded Johannes Schreck (1576–1630) who was also known as Terrentius (Dehergne, 1973: 215, 241).

Figure 1: In 2003 this Slovenian stamp was printed to commemorate Hallerstein's important contribution to Beijing astronomy.

Von Bell and Rho were supposed to continue the reform of the calendar of the Chinese Catholic, Paul Xu Guangqi (1562–1633), who had collaborated with Ricci between 1604 and 1607. Von Bell also researched earthquakes (Hallerstein, 1781: 5), and in 1640 he developed a portable sundial with a compass (Needham and Ling, 1959, 3: 312). Sundials were one of the main research areas of the Jesuits, especially of Kircher in Rome in the following years.

Von Bell lived in China for forty-seven years, and with his collaborators he wrote 150 Chinese astronomical books about eclipses, telescopes, gnomonics, trigonometry, and the calendar. He also corrected the calendar and the ephemerides. In 1644, when the new Manchu Qing Dynasty came to power, von Bell became the (temporary) Director of the Astronomical Bureau, inheriting Schreck's position (Montucla, 1799, 1: 469-470). Von Bell became a teacher of the first Manchu Emperor of the Qing Dynasty, Shunzhi, who assumed power in 1651, after the regent's death, even though he was not old enough. In 1658 von Bell became a mandarin of the first rank, but the Emperor died just three years later, when he was only 23 years of age. The new Emperor, Kangxi, did not like von Bell as he had wrongly predicted the suitable marriage date of one of the Emperor's family members, which was considered high treason. At the trial, von Bell managed to avoid the worst possible fate as his group was able to over-shadow their Chinese competitor's prediction of the solar eclipse of 16 January 1665.

Von Bell's duties in Beijing were then assigned to his assistant, Ferdinand Verbiest.[3] On 15 May 1665, Verbiest and the Emperor's grandmother arranged for von Bell to return to Beijing, and he died there in the following year. Immediately after his death, A. Kircher (1667, 110-112) published the complete story, and it was included in modern histories, without making use of Chinese sources. Troubled times continued for the Jesuits until early 1669, and only ended when Verbiest's calculations of planetary positions and comparative shadow length predictions proved the superiority of Western astronomy.

The Jesuits brought about 7,000 printed scientific works with them when they came to China. For example, Ricci's collaborator in Beijing, Niklaas Trigault (1577–1628), brought Agricola's *De re metallica* to China (see Dehergne, 1973: 274), and in von Bell's time this book was translated into Chinese (1638-1640) and given to the Emperor. The Emperor wished to use it as the handbook for mining in China, but the Minister of Finance, Ni Yuanly, opposed the idea, fearing that the development of mining would damage the Chinese farmers. The quarrel only ended with the Manchu occupation of Beijing on 4 June 1644.

Hallerstein did not mention the Croatian missionary and astronomer Ivan Ureman (1583–1620) in the letters that he mailed to Europe. Ureman landed in China in 1615, and lived mainly in Macao. In Rome, Kircher published Ureman's letters about magnetic declination (see Dehergne, 1973: 277).

Before Hallerstein's time, Ferdinand Verbiest (1623–1688) worked at the Astronomical Bureau. He had arrived in Macao in 1658, and made his way to Beijing two years later. Verbiest published three theological and nine philosophical and natural history works in the Chinese language. He was the first in China to use a steam engine to drive a ship, many years before Robert Fulton. In 1670 he measured the expansion of air with a thermometer similar to Galileo's, which was also sensitive to changes in atmospheric pressure. Meanwhile, his hygrometer used the inner organs of animals, whereas the Chinese had earlier used carbon for this purpose (Needham and Ling, 1959: 466, 470). The Chinese astronomers accused Verbiest of getting rid of older Chinese astronomical instruments and replacing them with European ones, but Verbiest had left Europe too early to be aware of the achievements of astronomers like Gian Domenico Cassini, Edmund Halley, John Flamsteed or Jean Picard (Montucla, 1799, 1: 470).

Kilian Stumpf (1655–1720) made a quadrant from material derived from old Chinese astronomical instruments, and when the Chinese historian of mathematics, Mei Ku-Chhëng (1681–1763), complained about this (Jami and Qi, 2003; Sivin, 1965; Wong, 1763), Stumpf defended himself by saying that a Mandarin had bought a melted artifact of brass which he had just used, and he could prove it (see Dežman, 1881; Needham and Ling, 1959, 3: 380, 452). Mei Ku-Chhëng was the influential grandson of the famous mathematician, Mei Wending (1633–1721), whose second edition of mathematics, *Lisuan quanshu*, was published in 1723. Mei Ku-Chhëng collaborated with He Guozong, and refused to change the mathematical methods of his grandfather, because he believed in the strength of the Chinese astronomical tradition. He separated astronomy from astrology on the basis that astronomy was a Confucian discipline and astrology was not. Mei Ku-Chhëng's work was discussed in Chourenzhuan's *Biography of the Great Astronomers and Mathematicians*, issued in four volumes in 1810, which included an appendix containing von Bell's notes (recorded in 1645) about Western astronomers (Chu, 2003).

On 27 October 1765 Hallerstein reported to his brother how Ignatius Kögler (1680–1746) and Andrés Pereyra (1689–1743) faced an accusation similar to the one levelled at Stumpf, but successfully defended themselves (see Steska, 1918: 146). To get some peace, Kögler invited the Emperor into the Jesuit College and gave him some Brazilian bottled tobacco, which apparently was very well received (Hallerstein, 1781, 45)!

3 THE PORTUGUESE MISSION, AS DESCRIBED IN HALLERSTEIN'S LETTERS TO HIS BROTHER

On 1 March 1739 Hallerstein arrived in Beijing, and lived there for the last thirty-five years of his life as Court Astronomer and Mathematician. Among his friends were Florian Joseph Bahr and Anton Gogeisl, both of whom were trained astronomical observers. Gogeisl was appointed a mathematician, and Bahr was employed as a musician (Dežman, 1881, 10; Laimbeckhoven, 1740: 424). More than thirty Jesuit priests and some Russian Orthodox clergy were in Beijing at that time, and Verbiest stated that 105 Jesuits worked in China between 1551 and 1681 (Dežman, 1881: 1). We also know that 920 Jesuits went to China between 1580 and 1773 (Standaert, 2008). In 1701 a maximum of 96 Jesuits lived in China, with French Jesuits forming the largest group (ibid.), but they represented only a small percentage of the 22,000 Jesuits worldwide. Between 1731 and 1743, French Jesuits predominated in China, whereas between 1748 and 1767 Chinese Jesuits predominated, with French Jesuits only out-numbering them in 1755 (Koláček, 1999; Standaert, 1991). In the mid-eighteenth century, Chinese Jesuits formed a third of all the missionaries in China (Standaert, 2008). On average, Jesuits stayed in China for 20.5 years (Koláček, 1999; Standaert, 1991). A quarter of the Chinese Jesuits were of noble European origin (Duteil, 1994).

Hallerstein described his new collaborators in letters that he sent to his brother in 1739 and 1740. Among the most interesting Jesuits in Beijing at the time was Franciscus Stadelin (1658–1740) (Dehergne, 1973: 260; Hallerstein, 1781: 54; Hallerstein, 1737: AS 730, Manor Dol, fasc. 194: 844) who studied horology in Switzerland and in large European cities for eighteen years. Between 1689 and 1700 he was the 'director for watches' in Breslau (Wroclaw) and later in Brünn (Brno), Liegnitz (Legnica in Poland) and elsewhere. In 1707 he arrived in Beijing, where the Emperor and his court found Stadelin's instruments very amusing. Some Chinese liked to observe European mechanical watches, forgetting that they were a development of one of their own eighth century inventions. Before his first Chinese Christmas, Hallerstein moved to a residence near the church of Saint Joseph, where he lived with Bahr and several other Jesuits (while still others, including Pereyra, Felix de Rocha, Kögler and Gogeisl stayed in the Portuguese Jesuit College—see Dežman, 1881: 11; Šmitek, 1995: 101, 102).

Hallerstein's scientific supervisor, Kögler, continued Ricci's work in Beijing, producing accurate numerical tables that attracted the attention of the Emperor. As Laimbeckhoven (1740: 430) remarked: "Mathematics was besides astronomy highly praised in all the missions of China and in particular the astronomical calculations." (cf. Hallerstein, 1750: 894). Between 1712 and 1714, Kögler had been Professor of Mathematics at the University of Ingolstadt in Germany, before arriving in China on 30 August 1716.[4]

Andrés Pereyra was Kögler's assistant, and he was the only Jesuit in Beijing who was of English descent. He came from a family of wine-traders that moved to Porto (Oporto) and accepted Portuguese citizenship (Needham and Ling, 1959, 3: 448). Pereyra was a good friend of Kangxi's successor, the Emperor Yongzheng (Yung-cheng), who ended missionary activities in 1724 but allowed Pereyra to remain in his post (Šmitek, 1995: 133).

4 THE FRENCH JESUITS IN BEIJING ACCORDING TO HALLERSTEIN'S REPORT TO HIS BROTHER

According to a letter that Hallerstein sent to his brother on 12 February 1764, in 1739 there were thirteen people in the French Jesuit residence in Beijing, including Antoine Gaubil,[5] two Chinese priests (Šmitek, 1995: 102), and a court painter, Jean-Denis Attiret (1702–1768) (cf. Amiot, 1943: 472; Koláček, 1999: 27). Four years later, in 1743, the French residence housed just six Jesuit priests and four brothers (Hallerstein, 1781: 44).

In his letters, Antoine Gaubil (1748: 316-319) several times highly praised the measurements of his young friend Hallerstein. On 16 March 1730 Gaubil became a foreign member of the Petersburg Academy. He was a botanist, astronomer, and cartographer, and between 1742 and 1748 was the superior of the French residence. Gaubil had studied in Paris with G.D. Cassini and Cassini's nephew, Giacomo Filippo Maraldi, and he was the first to inform the Europeans of the existence of ancient Chinese astronomical records (see Ho, 1970: 261; Laplace, 1982: 280). Almost a century later, Laplace published Gaubil's manuscripts about ancient Chinese observations of the lengths of the Sun's shadow at the equinoxes, precession and other astronomical observations (Needham and Ling, 1959, 3: 173, 761).

One of the most important French Jesuit astronomers was Michel Benoist,[6] who served for thirty years under the Emperor Qianlong. Benoist had studied in Dijon and in Saint Sulpice in Paris, and after three years of repeatedly asking to be sent to the Chinese missions he was finally successful. Before departing, he completed his astronomical studies in Paris under Joseph Nicolas Delisle, The Abbe de Lacaille and Pierre Le Monnier, later exchanging many letters with his former teachers. In 1745 Benoist received the title of the Emperor's Mathematician (Aimé-Martin, 1843, 4: 122; Benoist, 1767). When Benoist arrived in China the missionaries were experiencing troubles in Beijing, but because of his superior knowledge Benoist made himself indispensible at the court. For example, he was hired to build a huge system of fountains in the Emperor's gardens, as Hallerstein reported to his brother in a letter dated 28 November 1749 (Hallerstein, 1781: 28-29; Šmitek, 1995: 113). Benoist worked successfully on that project for many years. He erected European-style houses in the gardens and installed an interesting water clock in front of an Italian-style house. In designing this he made use of local Chinese motifs: the Manchus marked the 24 hours of the day with 12 animals of different kinds, so on two sides of the tri-angular water reservoir Benoist put statues of three different animals. Guided by a mechanical tool, the water flowed every two hours from the mouth of a different animal. On 21 May 1766 Benoist and Attiret visited the court to obtain information about the paintings that would adorn the Emperor's palace (Amiot, 1943: 470). In order to comply with an Imperial request, Benoist invented new methods for paper-wetting and the use of ink. King Louis XV of France asked Benoist to make copies of the sixteen copperplates of the Emperor's battles for him.

In the company of such important scientists, Hallerstein was ready to make a meaningful scientific contribution in Beijing, but as a newcomer he first had to learn the Chinese language and script from his Chinese converts. He also received support from a new Chinese visitor, Giacomo Filippo Simonelli (Laimbeckhoven, 1740: 427; Needham and Ling, 1959, 3: 454; Šmitek, 1995: 109, 136; Steska, 1918: 147). The Emperor was pleased to see how quickly Hallerstein learned the Chinese language (Hallerstein, 1761: 851). On 6 November 1740 Hallerstein sent his computations of solar and lunar eclipses to his brother, and these were read with great care in Brussels. Hallerstein was soon recognized as an excellent organizer, and someone who knew how to choose the right collaborators from the Portuguese college. Initially, his travel companion, Gogeisl, was most helpful to him, but in 1751 Felix de Rocha and Jose d'Espinha arrived in Beijing from the Pyrenean peninsula. Then on 1 November 1754 the talented Jean-Joseph-Maria Amiot[7] arrived in China, and of the French Jesuits he soon became Hallerstein's closest collaborator. Amiot translated a book about Chinese wars and maps, and he improved on Thomas' 1702 measurement of the meridian of Beijing, according to a letter Hallerstein wrote to his brother on 29 October 1761 (see Hallerstein, 1761: 851, 852; Hallerstein, 1781: 37, 38, 42; Montucla, 1799, 1: 478; Šmitek, 1995: 114). In 1760 Amiot published Confucius' biography entitled

Vita Confucii. Although he did not publish theological papers, Hallerstein carefully reported on his own experiences with "… Mohamedians, political circumstances in China, and his work at the court." (Hallerstein, 1761: 852). As a high court official, Hallerstein certainly took every opportunity to obtain news from Europe. According to a letter he sent to his sister, there were twenty-eight European merchant vessels anchored at Canton on 15 October 1753, and Hallerstein (1756: 885-886) made a point of visiting all of the French and English ships.

There were too many problems with the authorities in Beijing during Hallerstein's time, and the Jesuits were not very successful in converting the local Chinese to the Catholic faith (Forgeot, 1747: 918). However, they were much more successful in teaching the Chinese about important discoveries made by European scientists, and especially astronomers. Yet this knowledge did not have much influence on the Chinese social system (see Huff, 1993: 361).

5 HALLERSTEIN'S DESCRIPTIONS OF CHINESE ASTRONOMY IN LETTERS TO HIS SISTER

Hallerstein's Chinese collaborators were listed in the register of the officials of the Emperor's Astronomical Observatory in 1754. The first President of the Observatory was Yun Lu (Yin-Lou), the second Prince Zhuang (Heshouzhuang, Tchoang, Chuang, Yün-lu, 1695–1767), the sixteenth son of the Emperor Kangxi. During the time of his father's reign he was not on good terms with his half brothers. Together with his half brother, the thirteenth son of the Kangxi Emperor named Yin-hsiang, he supported Yongzheng (Yung-cheng) when he ascended to the Imperial Throne. Therefore, early in 1723 the new Emperor, Yongzheng, named Yun Lu as the successor of Boggomo, the first Prince Zhuang (Chuang). Boggomo was the grandson of Emperor Taizeng (T'ai-tsung), but he had no descendants. Yun Lu studied music and mathematics, and led the commission for the new edition of the encyclopedia *Lü-li yüan-yüan*, and probably also for the *Gujin tushu zhicheng* (*Ku-chin T'u-shu chi-cheng*) (Chu, 1994: 293; Hummel, 1944: 926).

The second President of the Emperor's Observatory was Ngo Eul-Tai (E Ertai), a Duke of the Third Range, the former Minister and the President of the Military Tribunal. The third President of the Observatory was Zhang Zhao (Tchang-Tchao, 1691–1745). He was a famous calligrapher, and between 1733 and 1742 served as the Vice-President and President of the Tribunal for Punishments. In 1736 he fell into disgrace and was sentenced to death but his especially-fine handwriting eventually saved him and the Emperor pardoned him, because nobody else in China was his equal in calligraphy. Zhang Zhao collaborated in the work of the Emperor's Observatory as the expert for music (Pirazzoli-t'Serstevens, 2007: 104).

Besides three Presidents, the Observatory also had two Vice-Presidents. The first was Kio-Lou-Le-Eul-Chen, the Vice-President of the Court Tribunal and substitute for the Marshal of the flags of the Red Coins among the Manchu. The second Vice-President was He Guozong (Ho Kuo Tsung), a mathematician and the editor of the *Lü-li yüan-yüan*, published for the first time in 1723. In 1739 He Guozong (Ho Kuo-Tsung, Ho Kouo-Tsung) became the head teacher at the Emperor's Academy in Beijing. In 1755 and 1756, he collaborated with Espinha in mapping the land of the Eleuts and Tartars. At the beginning of 1757 Guozong became President of the Ministry (tribunal) for the Rites, and between 1757 and 1759 he taught mathematics in the Palace for Princes (Nan-shu-fang, Shang-shu-fang) (Amiot, 1943: 436, 438; Chu, 1994: 287; Hummel, 1944: 286; Jami, 1994: 241).

The astronomers of the Emperor's Observatory were Kögler (President of the Bureau and the candidate for the Vice-President's title in the Ministry for Rites), his successor President Hallerstein, and Vice-President Gogeisl. In 1755, Rocha joined them, after Hallerstein intervened in his favour when accusations were made against him, as Hallerstein (1750: 894) proudly stated in a letter to his sister.

In addition to the afore-mentioned personnel, nine people had the status of 'experts' for calculations (Tsuchihashi, Chevalier, 1914, II). Foremost among them was Ming'antu (Ming Antu, 1712–1764), who was in charge of the seasons of the year at the Astronomical Bureau. Already in 1721 he worked in the Calendar Department. Between 1756 and 1760 he collaborated with Rocha and Espinha in mapping Xinjang (Xinjiang Uygur, Sinkiang), the province that the Emperor just invaded. Later, between 1759 and 1762, he and Hallerstein served jointly as the second (Manchu-Mongolian) President (Jianzheng) of the Astronomical Bureau. Later, in 1774, he wrote a book about the rapid computation of trigonometric functions and squaring the circle which proved popular and was reprinted as late as 1839. In this book, he used the infinite series for the first time in China (see Jami, 1990: 39, 156).

In 1754 Ming'antu headed the group of three specialists in charge of the seasons of the year: spring, summer, and winter. In addition, they employed five computing experts, each of which used a title equivalent to a European Ph.D. (Boshi, Bo Shi) (Zhang, 2002).

Finally, the Observatory had five students (Tian Wen Sheng). Among them was the famous painter Changgong (Tchang Kong, Chang keng, 1685–1760), who after his studies with Chen Shu published several books about the history of painting (ibid.). Another painter, and three other students, also worked in the Observatory (ibid.).

6 HALLERSTEIN'S ADVICE TO KOREAN SCIENTISTS AS RELATED IN A LETTER TO HIS BROTHER

During Hallerstein's time in Beijing, Europeans were not able to visit Japan or Korea (Park, 2004). Japan was largely isolated between 1616 and 1720, then in 1725 the first modern astronomical observatory was opened under the Directorship of Nakane Genkei (1661–1733) who completely accepted Copernican ideas (Nakayama, 1969: 171).

Koreans learned about European science, technology and religion from the books published in the classical Chinese language, but Western mathematics, astronomy and technology interested them much more than cosmology (Grayson, 2002: 132).

Due to incorrect computations, errors in the Korean calendar were numerous and predictions of astronomi-

cal events in ephemerides were no longer accurate. As every type of calendar had its errors, the Koreans changed their calendar several times. They also had to redraw their star maps, as the evening and the morning stars were no longer in their computed places. Han Hungil (1587–1651) obtained a book in Beijing that explained the Western calendar, but even after studying it for a decade the Koreans were still unable to generate a completely accurate calendar (Needham et al., 1998: 178).

Between 370 BC and AD 1742, the Chinese made one hundred calendars or editions of astronomic tables with constants for the measurement of the solstices, the movements of planets, and the length of the day, month and year. By 1637 they had come to accept Western ways for computing the calendar. Later, the new Chinese calendar influenced neighboring Korea (Moon, 2008). As foreign citizens, Koreans were not allowed to examine the computation of the Chinese calendar. As a way around this, the Koreans obtained copies of new ephemerides from the translators at the Bureau of Astronomical Observations, and they were then able to study the methods used for calendar computation (ibid.).

Kim Yuk (1580–1658), one of the highest-ranking administrators in Korea (Choson), supported the use of the new Western technology for the computation of the calendar. In 1645, as the Director of the Bureau of the Astronomy and Meteorology in Korea, he successfully convinced the ruler to accept Western calendar science, and from 1653 Koreans were able to compute the calendar according to the new Western methods (see Needham et al., 1998: 178). However, admiration of the Western calendar did not necessarily imply admiration of all Western culture: Koreans were willing to accept Western technology, but not European philosophy or theology since technical experts were answerable to Confucian teachers (Moon, 2008).

Ricci, however, was successful in convincing some Confucian scientists to accept some European concepts. Accurate geography first reached Korea with the work titled *World Geography* (Zgifang waiji, Chih-fang wai-chi), written by the Italian Jesuit, Giulio Aleni (1582–1649) in 1623 (Needham and Ling, 1959, 3: 584). Along with an accurate description of peoples and cultures of the world he included Renaissance maps. The Korean philosopher Yi Ik (1681–1763) was glad to have the new information, and he prepared the Koreans to accept it. Just like Kim Manjung before him, Yi also introduced Aleni's work as an improvement on old Confucian geographical traditions.

According to Korean ideas, the Earth was in the center of the spherical cosmos. The Earth did not move, but the cosmos made one turn every day. Because the cosmos was huge, a great centripetal force was needed to keep all the stars in their positions (Moon, 2008). Therefore the old Korean concept of cosmology was closer to Ptolemy's ideas than to those promoted by Copernicus.

Koreans were only able to meet Europeans when they visited China. During a diplomatic visit to China in 1631, Chong Tuwon met Joao Rodrigues (1561–1633), a Catholic missionary from the Japanese Jesuit province who presented him with several European books and other gifts. Eventually Chong Tuwon brought these back to Korea, and among them was a telescope—but Tuwon was more interested in its military potential than in its astronomical use. In 1632, before the Manchu invasion, Rodrigues moved to Macao (Needham et al., 1998: 159, 176).

Early in the eighteenth century, the Korean Yi Imyong (Yun Inyong) visited Kögler and Joseph Suárez (1656–1736) in the Beijing Portuguese Mission, and discussed Western astronomy and religion with them.

In 1708 a Korean named Tyentung Sanguiko published an important book which contained descriptions of unusual events seen in the eastern sky (Needham, Ling, 1959, 3: 683), then in 1741 the Korean astronomer An Kuk-pin (Kuk-bin) broadened his astronomical knowledge by visiting the Beijing Jesuit College along with Pereyra. Kuk-pin and Pyon Chunghwa were Korean ambassadors in China, and Kögler gave them ephemerides of the Sun, the Moon and the planets; tables of logarithms; a list of solar and lunar eclipses; several papers about mathematics; and a copy of Kögler's planisphere (Needham et al., 1998: 178-179; Šmitek, 1995: 117).

Hallerstein had a particularly favorable opinion of the clever Koreans, who supposedly asked questions all the time but never answered if they were asked, as he waggishly reported to his brother on 12 October 1757 (Hallerstein, 1781: 36; Juznic, 2007: 9). Hallerstein did not mention any Koreans in particular, but he was probably thinking to Kuk-pin and Pyon Chunghwa.

In 1766 a Korean named Hong Taeyong (1731–1783) visited Hallerstein and Gogeisl in Beijing where they discussed astronomy—which interested the Koreans— and theology—which interested the Jesuits. Hong Taeyong liked to carry out scientific research, but he also served in minor government posts and eventually became a county judge. His uncle was the Korean ambassador to China so Hong Taeyong was in an unusual position in that he was able to visit China. During his 1766 visit he researched the foundations of Korean cosmology and philosophy, presenting his questions as a dialogue between traditional neo-Confucians and a comparatively free-thinking man from the mountain Iwulu in the province of Liao-ning near the Chinese-Korean border (Needham et al., 1998: 113, 171). Neo-Confucianists believed that the Earth was not only spherical, but that it also rotated each day around its polar axis. This supposition was not completely Copernican in that it did not move the Earth from the center of the Universe. Hong Tae-yong did not propose any scientific reasons for the rotation of the Earth—he simply put forward the philosophical supposition without introducing any observational evidence, thereby showed the new way of Korean thinking as a result of European influence.

Between 1759 and 1761 Taeyong erected a private observatory in Korea, where he used gravity to drive his *sphaera armillaris* and clock. His observatory was eventually repaired after Hallerstein's death in 1777 (Needham et al., 1998: 98, 113-114, 168; Qi, 2007).

7 CONCLUDING REMARKS

Ferdinand Augustin Haller von Hallerstein was the last of the important European astronomers sent by the Society of Jesus to serve in their Portuguese mission in

Beijing (Juznic, 2008), and he surpassed all his predecessors with his numerous and well-received publiccations. Hallerstein (1750: 894) proudly told his sister that the Chinese Emperor urgently needed him! After he had a stroke on 29 July 1774 Hallerstein offered his resignation, but the Emperor gracefully ordered that he should continue his work as much as possible (as Hallerstein's brother reported to his cousin; see Hallerstein, 1775: 574-575). Hallerstein's death on 29 October 1774 ended almost two centuries of Jesuit astronomy in Beijing.

Even now, more than two hundred years after his death, Hallerstein's success is well remembered in his native Slovenia where the author of this paper helped arrange the issue of an official commemorative stamp on 23 January 2003 (see Figure 1 on page 219).

8 NOTES

1. Von Bell was also known by his Chinese names, Tang Ruowang, T'ang Jo-wang and Tao-Wei. He was born in Colonge on 1 May 1592, admitted to the priesthood in Rome on 21 October 1611 and died in Beijing on 15 August 1666 (Dehergne, 1973: 241).
2. In a letter to Janez Vajkard dated 6 October 1743, Hallerstein gave this Emperor's name as 'Chuntsci'.
3. Verbiest was also known by his Chinese names, Nang-hoai-gin, Nan Huai-Jen and Nan Houai-Jen Touen-Pei. He was born in Pitthem near Bruges in Belgian Flanders on 9 October 1623, admitted to the priesthood in Malines (Mechelen), Belgium, on 29 September 1641, and died in Beijing on 28 January 1688 Beijing (Dehergne, 1973: 288-289).
4. Kögler's student, Nicasius Grammaticus (1684–1736), although just four years his junior, replaced him in Ingolstadt. Grammaticus studied in both Ingolstadt and Freiburg, and subsequently taught grammar and poetry high school classes at Trient College and theology at the Lyceum of Amberg. In 1720 he became Professor of Hebrew and Mathematics at the University of Ingolstadt, and taught his own version of Newton's and Copernicus' ideas. King Philip V then invited him to the new seminary for nobles in Madrid, where he taught mathematics. After three years there, Grammaticus returned to Ingolstadt. From 1730 to 1732 he was Professor of Moral Theology at the Lyceum in Amberg, and he then went to Regensburg. Kögler translated Grammaticus' tables of the eclipses of the Moon into Chinese (Dehergne, 1973: 136-137).
5. Gaubil was also known as Gobil, Gaubille, Song Kiun-Yong K'i-Ying, Song Junrong Qi Ying and Sun Kiun-yung. He was born in Langedoc on 14 July 1689, admitted to the priesthood in Toulouse on 13 September 1704, and died in Beijing on 24 July 1759 (Dehergne, 1973: 106).
6. Benoist was also known as Benoît and Tsiang Yeou-Jen Tö-Yi. He was born in Dijon on 8 October 1715, admitted to the priesthood in Nancy on 19 March 1737, arrived in Beijing on 12 July 1744, and died there on 23 October 1774 (Dehergne, 1973: 30).
7. Amiot was also known by his Chinese name, Ts'ien té-ming jo-ché. He was born in Toulon on 8 February 1718, admitted to the priesthood in Lyon on 27 September 1737, and died in Beijing on 8 or 9 October 1793 (Dehergne, 1973: 12).

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