



# How West met East in Chinese astronomy

The development of early modern astronomy in China is filled with fascinating characters and strange tales. **Richard de Grijs** reveals details of research into the people behind this tumultuous period that has, until now, been known to only a handful of dedicated scholars

Ask almost anyone in the West what they know about ancient Chinese astronomy, and the chances are you won't get an answer. At best, you may be told how the Chinese kept records of solar and lunar eclipses or how they saw the supernova explosion of 1054. Yet there is so much more to the early days of modern astronomy in China than most outsiders realize. In particular, China made rapid advances at the very time that new ideas in Europe were being suppressed by the Church – think of the vitriolic reactions to Galileo Galilei's view that the Earth circles the Sun or to Giordano Bruno's idea that the universe is infinite.

That the Chinese should have made such advances is not surprising as they have a very long tradition

in astronomy, having observed, recorded and interpreted celestial events since the 13th century BC. The Chinese emperors – and their advisers – were responsible for making predictions in astronomy (and astrology, as the two were closely linked at the time, just as they were in Europe). Yet before the 16th century little was known about the Chinese empire in Europe and the first truly accurate accounts only began to emerge in the late 16th century with the arrival of Jesuit missionaries – a Catholic religious order that sought to convert the Chinese to Christianity.

These early Jesuit missionaries quickly realized that the Ming empire (1368–1644) was very differ-

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**Side by side** Matteo Ricci (left) and Xu Guangqi, a prominent Chinese convert to Christianity.

ent from other territories they were active in, such as South America. China was a vast and ancient place, with a highly developed society, government, culture and language. In fact, China was in many ways technologically equal or superior to Europe, with the Chinese respect for books and scholarship having been noted since the time of Marco Polo at the turn of the 13th century. Not surprisingly, science quickly became an important tool for the Jesuits in their missionary work as it was a topic of mutual interest to both the Chinese and Europeans, with the Jesuits introducing many new (and not-so-new) ideas to the Chinese.

But who were these Jesuits, what did they do and what did they learn? These are questions that have intrigued me since I made my own move from Europe to China in early 2010 and so, to find out more, I recently interviewed two leading scholars – Noël Golvers from KU Leuven in Belgium and Claudia von Collani from the University of Würzburg in Germany. They have devoted their lives to studying two pivotal early Jesuit missionaries named Johann Adam Schall von Bell (1592–1666) and Ferdinand Verbiest (1623–1688) and their historical research has led to previously unknown and unexpected insights into the personalities and scientific achievements of both Jesuits.

Gaining such information about Schall and Verbiest has not been easy. No personal letters survive and there is nothing that these missionaries may have sent to their families back in Europe. Indeed, when a Jesuit priest died, his personal papers were usually burnt. We know that some Jesuits (including Verbiest) did keep diaries, but these no longer exist

either. We depend instead on books from the day and on official correspondence between the mission in China and the order back in Europe. Unfortunately, these are coloured by the prevailing perspective at the time, leaving no unbiased sources to complement the Jesuits' writings.

### Europe's first Jesuits arrive

Despite their sincere interest in some aspects of Chinese culture and society – and the fact that they learned to read, speak and write Chinese – the early Jesuits were never fully “assimilated” but generally acted as intermediaries between West and East. The most illustrious Jesuit of all was the Italian priest Matteo Ricci (1552–1610). As the predecessor of both Schall and Verbiest, Ricci is widely regarded as the founder of Western “sinology” – the study of Chinese literature, language and history. Ricci's linguistic talents, prodigious memory and skills in cartography, mathematics and music – along with his kindly demeanour and respect for Chinese culture – gave him unprecedented access to many people and places. For example, he introduced the Western system of longitude and latitude, determining in particular that Beijing lies at a latitude of 40°N. In 1602 he also made the first world map in Chinese, which was widely copied. Indeed, many foreign place names used in China today trace their origin to his early maps.

Having originally been trained in Rome by the eminent Jesuit mathematician Christopher Clavius, Ricci arrived in the Portuguese trading post of Macau on the South China Sea in 1582. He obtained permission the following year to settle permanently in Zhaoqing in mainland China after its governor had heard of Ricci's skills as a mathematician and cartographer. He quickly became a sought-after figure by officials and local gentry, with Ricci noting his visitors' great curiosity about the unusual items he kept in his rooms, which included maps, Western clocks, prisms, oil paintings, picture books and astronomical instruments. While in China, Ricci wrote a famous *Treatise on Friendship*, translated the first six books of Euclid's *Elements* into Chinese and published influential texts on memory techniques, East–West ethics and mathematics. He also created the first Chinese–Western dictionary and built examples of Western musical instruments for his hosts. Indeed, his letters and notes to Europe were to become the foundation for the field of Chinese studies.

Ricci was a flamboyant and outgoing person, who dealt with everyone – high or low – in the same way and was a font of knowledge to the local Chinese people. He stayed in Zhaoqing until 1589, when he was expelled by a new viceroy who did not like foreigners, eventually ending up at the imperial court in Beijing. Once the emperor had noted his scientific expertise, though, Ricci became the first Westerner with almost unfettered access to the imperial place, known as the Forbidden City. He had an unsurpassed influence on the development of astronomy, mathematics and cartography in the far East, and was the first scientific ambassador from Europe during the Renaissance to an increasingly open China, with his

influence boosting Chinese science and giving the country a new dominance.

Ricci's work was built upon by his two most important successors: first Schall and then Verbiest. Although Ricci's contributions are generally understood by scholars in the field – if perhaps not by the wider scientific community – the stories of his successors are less well known. To bring them to wider attention, my colleagues and I at Peking University, the Beijing Planetarium and the Beijing Ancient Observatory have recently been granted funding from the National Natural Science Foundation of China to produce a video documentary on the human aspects of Chinese astronomy, including Ricci, Schall and Verbiest. Here are just some of the fascinating details I have found.

### Johann Adam Schall von Bell: Ricci's successor

When Ricci died in 1610 at the age of 57, the superior general of the Jesuit mission in China – Nicolò Longobardo – sent his Flemish subordinate Nicolas Trigault back to Europe to seek the next generation of Jesuits who could work in China. On arriving in Europe, Trigault went first to Rome to secure permission from the Pope to have the Bible and the Eucharist translated into classical Chinese, as well as to wear the *Jijin* (the traditional Chinese hat) during mass. He then embarked on a tour of Europe, visiting different princes' courts as well as the Frankfurt book fair, where he bought many scientific volumes for the Jesuits' library in Beijing.

Trigault was particularly keen to recruit new missionaries with scientific backgrounds, and it was in Rome that he met Schall, who was originally from Cologne and who had then almost finished his education at the Jesuits' headquarters at the Collegio Romano. Schall was keen to take up a missionary role in China not only because he wanted to convert the Chinese population, but also because he was interested from a scientific point of view in calendar reform, which in China was the sole purview of the emperors. Schall eventually arrived in Macau in 1619 at the age of 27, but was at first barred from entering mainland China.

The problem was that Longobardo had not been as cautious as Ricci in trying to convert the Chinese population and had aroused the suspicion of Chinese officials, which led to some Jesuits being persecuted and expelled. Xu Guangqi – a senior official at the imperial court and a former collaborator of Ricci – had continued Ricci's pioneering efforts in the background, but Schall had to wait for more than a decade until the persecution of European missionaries ceased before he could enter the country. He was eventually called to Beijing in around 1630–1633 and, when Xu Guangqi died in 1633, Schall was the only person capable of taking over the imperial astronomical duties. Indeed, Schall saw his role as astronomer as a heavenly calling because when Beijing was conquered by rebels and the Manchus in 1644, most of the city was destroyed by fire – apart from the Jesuit mission and the house containing various astronomical tables, both of which were spared.

Schall went on to become director of the newly



**Heavenly calling** Johann Adam Schall von Bell dressed as a mandarin of the Imperial Bureau of Astronomy.

founded Imperial Bureau of Astronomy. However, his acceptance of this office led to long quarrels with his Jesuit colleagues, predominantly because Christians saw work on calendar reform as linked to superstition. Christians were allowed to engage in certain astrological tasks, but were to refrain from “bad superstition”, such as using horoscopes, assigning special days for special rites, or using heavenly phenomena for earthly purposes – all of which were seen as interfering with free will. Schall did, though, engage in some of these activities – in fact, in 1649 he used “bad astrology” for a good purpose when he helped the new Qing emperor, Shunzhi (1638–1661), who was then only 11, to stop his uncle Dorgoon from effectively usurping power. The uncle had sought to do this by building a new imperial palace, but Schall – who was rumoured to be something of a grandfatherly figure to the father-less emperor – helped him by saying that the proposed location for the new building was affected by bad *feng shui* and the palace was not built.

As an astronomer, Schall held one of the official (or “mandarin”) positions at the Chinese imperial

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## How accurate were the ancient Chinese records?

Science Photo Library/La Science Illustrée 1889



**New tools** This bronze celestial sphere at the Beijing Observatory was made in 1674 by Ferdinand Verbiest as part of a programme of updating astronomical machines in China.

The Chinese kept many records of astronomical events, such as the position and motion of comets as well as solar and lunar eclipses, but I have long been intrigued by how accurate they were. I therefore put this question to historian Noël Golvers from KU Leuven and religious scholar Claudia von Collani from the University of Würzburg (see main text), who told me it is tremendously difficult to answer. Jesuit texts did not contain much information about traditional Chinese astronomical methods, but overall the Jesuits of the time believed that the methods used by the Chinese astronomers were poor.

The priest Ferdinand Verbiest did not like the calculations performed by the Chinese at the time, which he felt were not accurate enough, being based as they were on wrong or out-of-date Arabic ephemeris tables. These calculations were, however, poor merely because of the deficient data and in fact the Chinese had obtained superior recent observations with better telescopes. Verbiest also said that Western observations such as those of Tycho Brahe were not always very accurate either. Although we would need to compare in detail the Chinese and Western methods to know for sure how accurate they were, it is clear that the latter were always better, which is why they were so liked by Chinese contemporary astronomers.

court. But as Jesuits were not allowed to take such senior roles without first securing permission from Rome, he became embroiled for more than 15 years in several cases against him, including accusations that he had practised bad astrology and had been in a gay relationship with his servant. In fact, due to the long time it took letters to travel between Europe and China, these issues were resolved in his favour only after his death. Schall's problems probably arose partly because he was not universally liked, particularly by other Jesuit missionaries who saw him as a complicated person with a strong personality. He lived in Beijing on his own, did things in his own way and rarely gave people an easy time.

The fall-out from these personal accusations turned quite ugly. From about 1664, under the reign of the emperor, Kangxi (1662–1722), Schall was accused by one Chinese Confucian scholar, Yang Guangxian, of delivering poor work, thus causing bad *feng shui*. He was concerned that the Europe-



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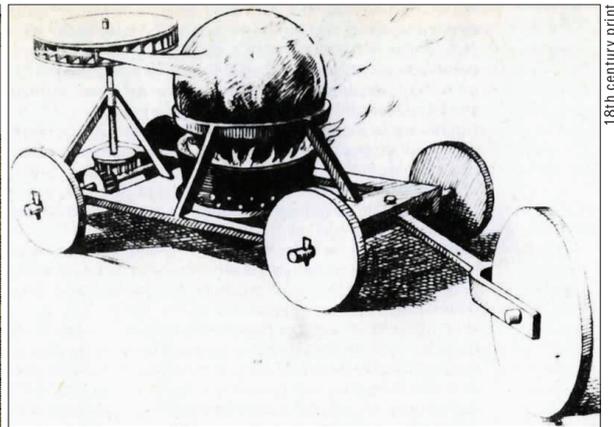
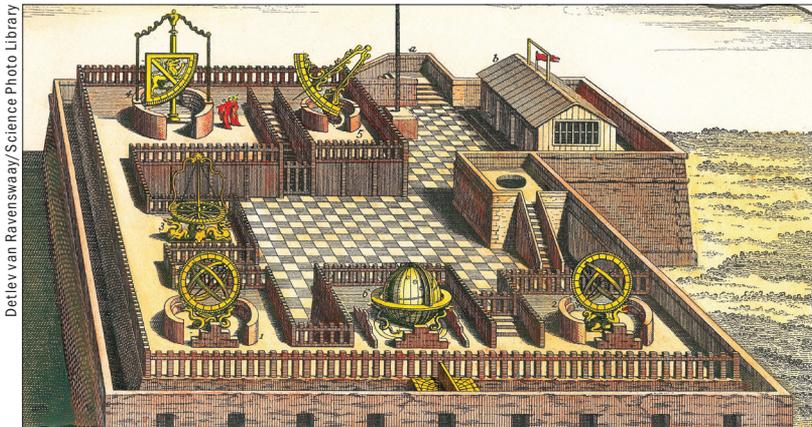
**Long legacy** Ferdinand Verbiest in an illustration from a 1736 volume about China by French Jesuit Jean-Baptiste du Halde.

ans, who were responsible for making calendars, had too much power in China and Schall was eventually imprisoned and sentenced to death, despite his successor, Verbiest, defending him in court. Fortunately for Schall, various heavenly omens – including earthquakes and fires – sustained his defence and were eventually taken as proof that he was innocent. He was released after an earthquake in 1665, but his health had suffered while in prison and, within a year of gaining his freedom, Schall was dead.

**Ferdinand Verbiest: reluctant imperial astronomer**

So much for Schall – but what of Verbiest? Born in Flanders (part of present-day Belgium) in 1623, he was a gifted mathematician and astronomer who was ordained as a Jesuit priest in 1655. Despite ending up as Schall's successor as imperial astronomer, Verbiest had originally wanted to join the Jesuits' mission in what is now Peru. A spell at this overseas Spanish outpost was not especially odd as Flanders was then part of the Spanish empire. What is more, Europe was at the time ravaged by numerous religious conflicts now known as the Thirty Years War and many young Europeans sought to escape the desperate situation that had engulfed the continent. However, the Spanish were not keen on northern Europeans, who they feared would not serve their faith truthfully, and Verbiest's attempts to join the Jesuits' mission in South America all proved unsuccessful.

By the mid-1650s the Jesuits' focus had shifted to China, probably because of the impact of Italian priest Martino Martini. He had spent most of the previous decade in China and, after returning to Europe, his stories of the country enthralled young Jesuits, who *en masse* applied for a stint in China. And so it was that in 1659 Verbiest arrived in Xi'an, where he began missionary work with the poor, which he later said was one of the most satisfactory periods in his career. Schall called Verbiest to Beijing in 1660 when the emperor needed someone to succeed Schall. Ver-



**More engineer than astronomer** The Imperial Astronomical Observatory in Beijing was given a thorough modernization by Ferdinand Verbiest, who added several new bronze instruments (left). Verbiest was a bit of an inventor, for example designing a blueprint for a primitive steam automobile (right).

Verbiest already had a good reputation as a mathematician and, since he and Schall were both northern Europeans, who approached their religion quite differently from southern Europeans, Schall probably felt that he might get along better with Verbiest.

From that moment in 1660, Verbiest dealt with the imperial court only. He was locked into the rituals of the court, although at one point he said he would have preferred to deal with the poor, as he had in Xi'an. The source of this latter statement is a fascinating letter that he wrote on 23 January 1670 to a colleague in Guangzhou called François de Rouge-mont. The formal parts of the letter are written in Latin, but it also includes bits in Dutch, which was then used as a “secret language” for communicating private feelings and opinions. Details of this letter are not widely known and a rough translation from the Renaissance Dutch goes thus:

“My dear Father Franciscus, be assured that although the Emperor has honoured me greatly, and although I have been appointed to the office of Great Mandarin, in my heart I would have much preferred to live the life of our late father Xaerius Faber...who dealt directly with the mission and engaged with poor Christians as well as Mandarins. However, I have now taken this path [of imperial astronomer] and I cannot and may not backtrack from this direction.”

Whether he liked it or not, Verbiest was part of the imperial court with all of its prescribed rituals – but he would have much preferred to be a simple missionary. However, his position at the imperial court was of great importance for the long-term future of the Jesuit mission in China, so he could not refrain from his court duties. Verbiest often wrote that he was overburdened with work, needing to teach astronomy, check calculations using the prevailing tables and so on. Verbiest was a caretaker at the astronomical observatory and only kept records because it was required for the job; he added nothing of scientific merit and showed no scientific creativity. He was, in fact, more the emperor's engineer than his astronomer, designing hydraulic systems and building many devices and instruments. Verbiest is even credited

with designing an early predecessor of the modern car, although his primitive blueprint is not that useful for anyone wishing to build such a contraption!

In his writings, Verbiest tried to suggest to his audience that he and the then young emperor were close, but – given the court rituals that ruled life in the palace – this probably did not fairly reflect their relationship. He had, though, been instructed by the emperor in 1675–1676 to explain to him Western mathematics, including Euclidean geometry, surveying and calendar science. Verbiest's personal spiritual notes that he scribbled in his books were found in his rooms at the Jesuit mission in Beijing after he died in 1688 by Antoine Thomas, who served as his temporary successor. Thomas used these annotations to write an obituary of Verbiest, although they were later burnt according to the Jesuits' customs.

However, some of Verbiest's correspondence survives, including several letters from Thomas that had been dictated and signed by Verbiest soon after Thomas arrived to act as his private secretary. We also have access to many of Verbiest's astronomical documents, in Chinese and Manchu, addressed by and in the hand of Thomas, who was concerned about publicizing Verbiest's works. Finally, it appears from careful research that Thomas was responsible for helping Verbiest to open China up to the French Jesuits, who at the time were outsiders and wanted to find a way into the emperor's good books. It appears that Thomas was very much the power behind Verbiest in the final five years of his life.

### Step-change in science

What we can learn from this pain-staking research, pieced together by Golvers and Von Collani, is that the arrival of the European Jesuits in Ming-dynasty China boosted scientific progress in the country (see box opposite). Despite their underlying aim of converting the local population to Christianity, many of these priests were genuinely interested in a two-way exchange of information. The Jesuits were a scientific force to be reckoned with and their efforts contributed significantly to China's first opening up to outside influences. It is to the dedicated efforts of the Jesuits that modern astronomy in China, which is now so successful, owes its due. ■