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Maria de Jesus Espada

PLAN

TEXTE

1. Introduction

In the history of interchange between civilisations there seems no parallel to the arrival in China in the 17th century of a group of Europeans so inspired by religious fervour as were the Jesuits, and, at the same time, so expert in most of those sciences which had developed with the Renaissance and the rise of capitalism [1].

1 China has made considerable progress in the field of science and technology since the 1st century BC, by inventing paper, and in the 1st century AD, by developing the world's first water-powered armillary

sphere, detecting for the first time in the world a supernova on 185 AD, and creating the seismometer. Among all Chinese inventions, it is commonly accepted that three of them would change the world: together with paper, woodblock prints (8th century) would transform the face of literature; gunpowder (9th century) of war; and the magnetic compass (12th century) of navigation.

2 But although China has made significant scientific and technological advances very early, it is said that it has not experienced a knowledge revolution, similar to what Europe experienced after the publication of *De revolutionibus orbium coelestium* ("On the Revolutions of the Heavenly Spheres"), in 1543, by Nicolaus Copernicus (Ge-Bai-Ni in Chinese, 1473-1543), presenting an alternative model of the universe to the geocentric system of Ptolemy (c. 100-c. 170 AD)[2].

3 First and foremost, in what concerns astronomy and cosmology, one must consider that the period of the Warring States (475-221 BC) and that of the Han Dynasty (206 BC-220 AD) were characterized by speculation in both fields[3]. Second, we must bear in mind the fact that China remained an imperial feudal society until late (around the beginning of the 20th century) and this system retained control of its political structures, as well as Confucian principles, determining the difficulty of bringing about transformational change.

4 This situation caused China to lose ground to Europe in the path of the development of science and technology. It is generally considered that this state of affairs would only suffer significant changes in the 16th century, with the arrival of the Jesuits in Chinese territory and their effort of transmission of mathematical and astronomical knowledge[4], and this deserves a detailed analysis, in our opinion. The Jesuits saw astronomy and mathematics as a privileged way to introduce Christianity in China, due to their specific official characteristic in this country that resulted from the importance of the Calendar, which was proclaimed by the Emperor every year and used by the entire Empire and vassal states as an instrument of weather forecast and future foretelling.

5 The question of why China did not develop a science to theorize and structure the knowledge that led to its technological inventions, like Europe did, has been analysed by several scholars, namely on what concerns Chinese early opposition to the knowledge the Jesuits at-

tempted to transmit in the 16th century. Four centuries later, in the first half of the 20th century, Joseph Needham, a biochemist from the UK addressed this matter and ended up reformulating this question as to "Why did China never experience a scientific revolution as Europe". His studies led to a monumental work series named "Science and Civilisation in China"[5]. As Needham puts it:

> Astronomy seems to have shared in the general decline of science during the Ming dynasty. Apart from the work of Wang Wei (…) there was that of Wang Kho-Ta somewhat later, e.g. his *Hsiang Wei Hsin Phien* ("New Account of the Web of Stars"). After the coming of the Jesuits, astronomy re-awakened, and there was a burst of publications[6].

6 Despite this, it is clear the three Chinese inventions mentioned previously have facilitated the transformation of Europe and the transition from the Middle Ages to the Modern Age. Shortly after, Europeans would travel to Asia and transfer Western science to China through the Jesuits. To understand this phenomenon, one must remember that, in 1498, Vasco da Gama arrived in India, paving the way for the Portuguese to reach China in 1513 (Guangzhou). The Portuguese expansion was, since its early start, surrounded by the idea of absorption of infidels into Christianity, which explains the papal bulls that gave the Portuguese power over non-Christian peoples, even before Portuguese travels reached Asia[7].

7 In 1452, Pope Nicholas V would write the Bull *Dum Diversas*, and in 1455 the *Romanus Pontifex*, by which he would authorize the construction of churches by the Portuguese in their new territories, and any others conquered in the future, allowing Portugal to also appoint missionaries for them. These decisions would be later confirmed by Pope Callistus III, in 1456, with the Bull *Inter Caetera*, giving the Order of Christ spiritual jurisdiction to these lands[8]. The Order of Christ was a military religious group founded by King Denis of Portugal, in 1319, to replace the then recently suppressed military Order of the Templars[9].

8 Altogether, these bulls led to the creation of the Portuguese *Padroado* (Patronage) of the Orient[10]. This set of ecclesiastic documents would later culminate in the Papal Bull *Praecelsae Devotionis* in 1514[11]. The

missions of evangelization have been integrated into the work of the Portuguese Padroado of the East, which can be described as "a combination of rights, privileges and duties granted by the pope to the Portuguese king as head of the Roman Catholic Church in wide areas of Asia and Brazil" [12].

9 In the 16th century, the Padroado's jurisdiction covered the Catholic churches in the East and all the ecclesiastics and missionaries displaced in Asia were thus subordinated to the King of Portugal, which meant that the influence and power of Portugal (both religious and commercially) took place namely in China and Japan. The spectacular development of the Portuguese missionary presence in Asia commenced with the arrival of the Jesuits, who would reveal to be the most powerful representatives and defendants of the Padroado over the next two centuries.

10 In Europe, a simultaneous process occurred that would determine the flow of events in the Orient. Indeed, in 1543, the scientific revolution began with the first publication of works by Nicolaus Copernicus [13], and Andreas Vesalius (1514-1564) [14].

11 The scientific revolution would consequently be a process of dramatic change in people's beliefs and thoughts, and also of social structures and knowledge systems, that affected all knowledge dimensions, from mathematics and astronomy, to biology and physics. Scholars and thinkers were concerned for the first time to find the truth without interference of God. A verifiable truth that formulated the laws of nature unchanged by social circumstances [15]. On the other hand, the scientific revolution in Europe also meant the construction of a "new intellectual community" [16], that managed to survive outside the Church and its old structures, something never seen before in Europe.

12 Nevertheless, it was still the Church that influenced change in Chinese knowledge of astronomy and this happened through the presence of Jesuits in China. For nearly two centuries, Jesuits worked as astronomers in China and even worked as directors of the Beijing Astronomical Observatory. This Observatory was built in 1442, during the Ming Dynasty (1368-1644), and it is one of the oldest observatories in the world [17].

13 This paper aims to analyse this reality from the point of view of the transmission of knowledge by Jesuit astronomers in Beijing in the 17th century, articulating it with the development of the concept of a planetary system and with simultaneous events unfolded in Europe within the study of the subject of Astronomy.

14 To understand the occasional resistance of the Chinese astronomers to the Jesuit input to the conceptualization of the planetary system, it is important to revisit the initial conceptual structures. They were erected by Chinese astronomers, as early as the 3rd century BC, and they would linger as a widely accepted view of the sky in Chinese astronomical *corpus* of knowledge until the time the Jesuits arrive in China, in the second half of the 16th century.

2. A Brief Overview of Astronomy in China from a Historical Perspective

15 Although the study of astronomy in China seems to date back to the 4th century BC, the first conceptions of a solar system come later with representations shaped by three main schools: the *Pei Chou*, also called *Kai Thien*, which means "celestial cover"; the *Hun Thien*, *i.e.* the "celestial sphere"; and the *Hsüan Yeh*, translated as "brightness and darkness".

16 While these early Chinese studies of Cosmology already carried with them important notions of space and time, they occasionally still brought along traditional epochal ingenuousness attached to mythological elements, as we will now see [18].

2. 1. The *Kai Thien* (蓋天), or *Chou Pei* (周髀): "a hemispherical dome"

17 It is considered as the most archaic of the three schools and its origin would have been posterior to the 3rd century BC. It represented the heavens as a hemisphere covering the earth – "the heavenly cover" (*Kai Thien*) – and the earth as an overturned bowl, producing two concentric domes. It is also known as "*Chou Pei*", which is the name of

the oldest mathematical astronomical work[19], which was also the most important text of the *Kai Thien* School, and it means "the gnomon and the circular paths of the sky"[20].

18 It is believed that the first reference to this theory can be found in the 3rd century BC extensive body of work *Lü Shih Chhun Chhiu* (or *Lüshi chunqiu* 吕氏春秋) translated as "Spring and Autumn of Master Lü", sometimes also called *Lülan* 吕覽, *i.e.* "Lü's examinations". This is a collection of treatises on cosmological matters from the late Warring States period. It is generally assumed that the *Lüshi chunqiu* is the product of a large group of authors[21].

19 Later on, the School of *Kai Thien* would be described in the works of Wang Chhung, in the *Lun Hêng*, in 83 AD; Yao Hsin's *Hsin Thien Lun* ("Discourse on the Diurnal Revolution"), from around 250 AD; Yü Sung, in 265 AD, *Chhiung Thien Lun* ("Discourse of the Vastness of Heaven"); and of Tsu Keng-Chih, in the 5th century AD, namely in *Thien Wen Lu* ("Astronomical Résumé")[22].

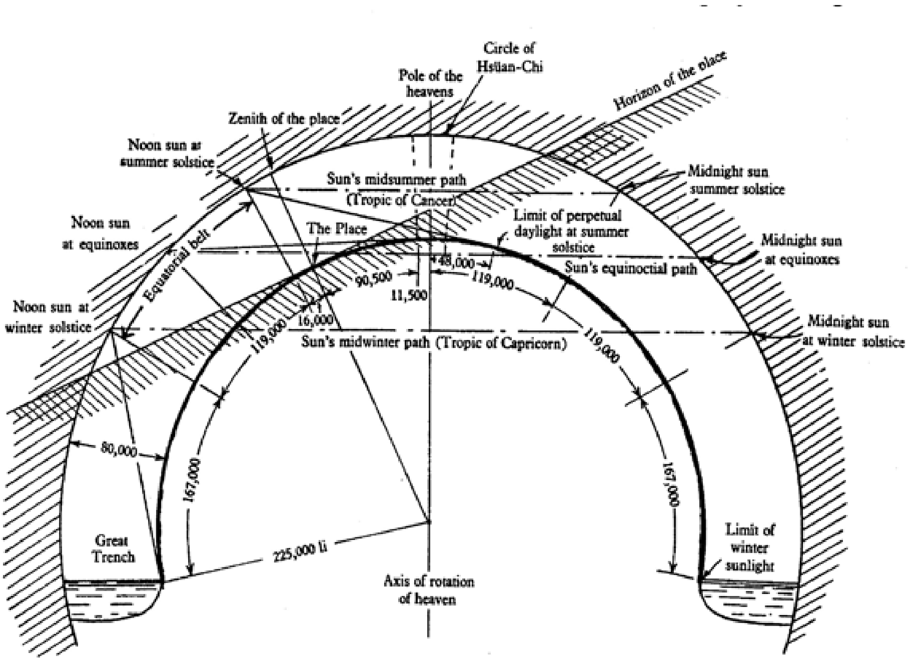
20 According to the *Kai Thien* school, the sky is round like an open umbrella and the earth is square like a chessboard. The heavens turn laterally to the left and the sun and the moon both move to the right. The movements of the sun and the moon are slow, while the sky moves very fast. The stars are however motionless in the sky. The sun can only illuminate a certain area and the people who live outside this area will say that the sun did not rise yet[23]. The sun was therefore perceived as a circumpolar star with a sort of light beam capable of illuminating one or the other part of the Earth and changing position between the winter and summer seasons.

21 This theory of the celestial sphere with "double vault" would have originated in Babylon, from where it travelled to the Greeks and the Chinese[24]. In China, this representation includes three lights that are the sun, the moon and the stars, and they are sometimes concealed and sometimes bright, giving day and night. Both the sun and the moon are attached to the sky, and heaven drags them along as it moves[25].

22 In the 20th century, Herbert Chatley would draw a model of the *Kai Thien* cosmology, using the calculations of the mathematical book *Chou Pei*, sustaining that this cosmological model had just enough

veracity in it to make it acceptable in the eyes of contemporary geometers[26].

Fig. 1. Reconstruction of the *Kai Thien* cosmology (after Herbert Chatley)



(Herbert Chatley, "The Heavenly Cover", *The Observatory*, Vol. 61, n° 764, Jan. 1938. This image is used with the kind permission of the editors.[27])

23 The theory of *Chou Pei* had some points in common to those of some of the western thinkers like Vitruvius, one century earlier, as well as *Timaeus* of Plato, around 360 BC, and a Roman astrologer, Nigidius Figulus, in 44 BC[28].

2. 2. The *Hun Thien* School (渾天): "the Celestial Globe"

24 Although it is considered that this theory must have been known in China in the 4th century BC, by the time Shih Shen shaped his list of stars[29], the oldest full description was penned down by the astronomer Chang Hêng, in the 1st century AD, in his *Ling Hsien* ("Spiritual Constitution of the Universe"), where he states:

> Formerly the sage-kings, wishing to trace (*pu*) the ways of heaven (*thien lu*), and to fix the sublime tracks (*ling kuei*) (the paths of the heavenly bodies), and to ascertain the origins of things, first set a celestial sphere (*hun thi*), thus rectifying their instrument and establishing degrees (*chêng I li tu*), so that the imperial pole was fixed. All turned round the heavenly axis in a reliable way which could be studied [30].

25 As we can see, the Emperor was the model for the categorization and designation of the constellations and the pole corresponded to the Emperor himself [31]. The West would not use a system with an equatorial polar reference until 1585, with Tycho Brahe (designated Di-gu in China, 1546-1601) [32].

26 This school introduced in the process of formation of a Chinese concept of a solar system the image of spherical movements centered on the earth, with heavenly bodies maintaining a uniform circular rotation. The sky combined the three *chhen* (*i.e.* phenomena, presumably the sun, the moon and the stars) and the earth comprised the three *hsing* (that is to say forms, like earth, water and air). Heaven has nine positions (*wei*), and earth has nine continents (*yü*) [33].

27 Chang Hêng also makes reference to the method for calculation of this cosmological model:

> The measurements are made with the graduated hun instrument (armillary sphere) (*thung erh tu chih tsê shih hun i*). For calculations the method of two right-angled triangles is used. The shadow of the gnomon faces the heavens and (explains the) meaning of the spheres celestial and terrestrial (*hun ti chih i*). A difference of a thousand miles south or north in the gnomońs position means a difference of one inch in the shadow’s length [34].

28 Phenomena and forms could be observed and measured. The sphere is held together by a bond (*wei*) and nobody knows what exists beyond it, but a name was found for it and that unknown place was called the “cosmos” [35]. In the sky, the two symbols (the sun and the moon) dance around the ecliptic, surrounding the polar star located in the North Pole. The South Pole is not visible, so no name has been given to it.

29 In his writings titled *Hun I Chu* ("Commentary on the Armillary Sphere"), Chang Hêng describes the model more accurately, calling it an "egg", saying that the earth is like the yolk and lies in the center and is smaller than heavens, which are supported by vapor (*chhi*) and have water in their lower part. The sky acts according to a principle of normality and never loses its center. The *Hun Thien* School gives us a conception of a spherical land, with antipodes, at the same time that it perceives and conceptualizes, for the first time, the infinity of space.

30 This theory would be followed by other Chinese astronomers in the 3rd Century AD, like Yang Chhüan, in his work *Wu Li Lun* ("Discourse on the Principles of Things"), and Wang Fan in *Hun Thien Hsiang Shuo* ("Discourse on Uranographic Models"), as well as Ko Hung in his *Chin Shu* [36]. It seemed to have been generally accepted at the end of the Han Dynasty [37], although Wang Chhung himself raised his own doubts as to what concerns the implication of the sun moving through water, even though, as a contemporary author, Ko Hung, would put it: "this was not impossible, for dragons, which are very Yang, can live in water [38]".

2. 3. The Teachings of *Hsüan Yeh* (宣夜): "the Infinite Empty Space"

31 It is thought that all the books related to this school may have been lost and that there remains only the memory of a disciple of what his masters have told him. His name was Chhi Mêng and it is possible that he was a contemporary of Chang Hêng. He was a librarian who remembered what *Hsüan Yeh*'s masters taught him. They taught him that the heavens were void and empty of substance. The sun, the moon and the stars floated in empty space, moving or remaining motionless, and they are only condensed vapor. Their speed depends on their individual nature because they are attached to nothing.

32 These ideas can be found in the "History of the Jin Dynasty" (*Jin Shu*) of the alchemist Ko Hung (Ge Hong), written in the 4th century AD. It is he who says that:

> The books of the Xuan Ye school were all lost, but Qi Meng, one of the imperial librarians, remembered what its masters before his time

> had taught concerning it. They said that "the heavens were entirely empty and void of substance. When we look up at them we can see they are immensely high and far away, without any bounds. It is like seeing yellow mountains sideways at a great distance, for then they all appear blue, or when we gaze down into a valley a thousand fathoms deep, it seems somber and black. But the blue of the mountains is not a true color, nor is the dark color of the valley really its own. The sun, moon and company of stars float freely in empty space, moving or standing still, and all of them are nothing but condensed vapor [39].

33 Amongst the scholars who followed this school of thoughts was Yü Shi, who discovered the precession of the equinoxes, in his *An Thien Lun* ("Discussion of whether the Heavens are at Rest"), although Ko Hung and the 7th century astronomer and mathematician Li Shun-Fêng (currently known as Li Chunfeng) are the most important sources of its views. Despite the absence of theoretical conceptions, this school has permeated Chinese thought to a great extent. Its thoughts would resonate throughout the ages, regardless of the lack of theory resulting from the absence of deductive geometry.

34 In this representation, the stars were not attached to the *Kai Thien* hemisphere nor to the *Hun Thien* spheres. On the other hand, the *Kai Thien* system would last as a generally accepted model until the 6th century AD and it was officially adopted at some point in the history of astronomy of China. However, in the 5th and 6th centuries, efforts were made to reconcile the *Kai Thien* and the *Hun Thien*, insisting that only half of the model was true.

35 From this moment on, it is generally accepted in China that the *Hun Thien* sphere is the only correct vision, until the time when the neo-Confucian philosophers, like Chang Tsai (Zhang Zai, 1020-1077), mentioned the emptiness of the heavens, as a result of the *Hsüan Yeh* tradition: the earth composed of pure *Yin*, solidly condensed in the center of the universe; the heavens turning left on the periphery; and the fixed stars carried endlessly.

36 This means that Chinese astronomers were still distant from the restrictive orthodoxy of Hellenistic and medieval Europe and the assumption that celestial bodies were attached to a series of concentric spheres with the earth as the center [40]. On the other hand, the pole

continued to be a fundamental base of Chinese astronomy. In fact, the celestial pole corresponded to the position of the emperor on earth, around which naturally turned the vast system of the Chinese bureaucratic agrarian state.

37 These concepts preserved their validity until the moment of fusion with modern science after the arrival of the Jesuits. *Hsüan Yeh's* thought would persist until the time of the coming of Matteo Ricci (known as Li Madou in China, 1552-1610) arriving in Macao, in 1582, and in Beijing, in 1601, but "there would be a close resemblance between *Hsüan Yeh* and the system introduced by (post-Jesuit) Europeans[41]".

3. The Influence of the Jesuits

38 China had a period of great development in Astronomy with the first detailed records of astronomical observations beginning as early as the 4th century BC[42], and it observed and recorded celestial phenomena, such as solar and lunar eclipses[43], novae and supernova, comets and sunspots[44]. Then, during the Former Han Dynasty, between 206 and 9 AD, important developments were made in the structuring and conceptualization of our solar system, as described above, and the Board of Astronomy was created as an official department of the Chinese Imperial Government.

39 The Chinese Board of Astronomers depended on the Tribunal of Rites (*Le-Poo* or *Ly-poo*) and it was formed by three sections, the most important being the one in charge of the Calendar, and the others consisting on the department responsible for the auspicious days for performance of the rites and the one setting the prediction of the weather, as well as natural phenomena like earthquakes[45]. The relevance of this structure in China resulted from the fact that: "According to the Chinese political theory, the emperor ruled the Middle Kingdom[46] at the pleasure of Heaven, so events in the heavens signified approval or disfavor of an imperial regime"[47].

40 Let us pause our course of thought briefly on the notion of the "rites" in China. The Chinese society was based on a family system that honored ancestors and that kept ritual sacrifices at the center of it, while it maintained celebrations to the cult of State Confucianism, in-

volving the use of candles and incense. The importance of these rituals was such that it assured status and power to the emperor and governors of China [48]. For this reason: "Emperors [...] became heavily invested in ensuring that the important political and social rituals in a given year take place at favorable points on the astronomical calendar" [49].

41 When the Jesuits arrived in China, the Ming Dynasty (1368-1644) ruled the country and the sciences in general had suffered a considerable decline. They would find, particularly, astronomy and mathematics in a bad condition, almost oblivious of the brilliant discoveries of the past. As such, the Jesuits were able to demonstrate the superiority of Western astronomy, which would lead them to undertake the reform of the Calendar, and then enter the Board of Astronomers.

42 The Jesuit missions in China of the 16th and 17th centuries introduced Western science and astronomy in China, also at the moment when it was in a state of profound transformation in Europe. They made efforts to translate Western works into Chinese; they made countless astronomical observations and succeeded to finish the first modern cartographic work in China; they also learned to appreciate the scientific achievements of Chinese ancient culture and to make them known in Europe. Through their correspondence, European experts discovered Chinese science and culture for the first time.

43 The Jesuits first entered China through the Portuguese colony in Macao, where they settled and founded St. Paul's College. The first two Jesuits who entered mainland China were Italians, Michele Ruggieri (1543-1607) [50] and Matteo Ricci, who learned the Chinese language and became familiar with Chinese poetry and philosophy. They presented themselves as being willing to share the scientific achievements of the West, especially regarding Mathematics and Astronomy.

3. 1. The Jesuits and the reform of the Calendar

44 After entering mainland China, in 1588, Ruggieri would return to Rome to ask the Pope to send an embassy to Emperor Wanli [51] (1563-1620) to allow Jesuits to reach Beijing, but he would never return to China after that. Italian Jesuit Matteo Ricci arrived in Beijing in 1601,

together with Spanish Jesuit Diego de Pantoja (1571-1618), after having been invited by Wang Tso, an officer of the Nanjing Tribunal of Rites, to work on the reform of the Calendar. He would then offer his skills to work with astronomy, geography and mathematics to Emperor Wanli. In China, Ricci counted with the help of Xu Guanqi (Hsü Kuang ch'i, 1562-1633), a scholar converted to Christianity, who collaborated with him in the Chinese translation of the first six books of Euclid [52], and Li Zhizao (Li Chih Tsao, 1565-1630), also converted to Christianity.

45 Realizing the significance of Astronomy for the Chinese Emperor, Ricci would write to Rome asking for missionaries with knowledge in this subject to be sent to Beijing. Consequently, in 1607, an Italian Jesuit, Sabatino de Ursis (1575-1620), would arrive in Beijing to help Ricci in his astronomical work. Most of their teachings, at this time, still involved mainly Greek and Muslim Astronomy, using above all the Ptolemaic System. It was this view of the universe that Ricci would pass to his students in China.

46 However, a simultaneous process was taking place in Europe, with the so-called "Galileo Affair" [53] which began around 1610, when Galileo (Jia-li-lüe in Chinese, 1564-1642) published his Sidereus Nuncius (Starry Messenger) describing the observations he had made with the new telescope, namely the surface of the Moon, the stars never seen before with the naked eye, and the Medicean Stars (later known as the Galilean moons) that appeared to be circling Jupiter (*i.e.* the four largest moons of Jupiter: Io, Europa, Ganymede, and Callisto). With these observations, he promoted the heliocentric theory of Nicolaus Copernicus and ended up being trialled and condemned, in 1633, by the Church. After the Galileo affair, the Roman Catholic Jesuit order decided to follow geocentrism and ignore the Heliocentric teachings of Copernicus and his followers, even though they were becoming the generally accepted model in European astronomy.

47 The year of the Galileo affair was also the year that Matteo Ricci passed away. Following Ricci's death, in 1610, his work was followed by the Portuguese Jesuit Manuel Dias (known in China as Yang Ma-Nuo, 1574-1659), who in 1615 published a Chinese compendium of the Ptolemaic system (*Tianwenlüe* 天問略). Although he doesn't advocate

the heliocentric system in this book, Dias describes Galileo's discoveries for the first time in China and the use of the telescope.

48 Based on a successful prediction of an eclipse by Sabatino de Ursis, Xu Guanqi, then a member of the Tribunal of Rites, asked the other members to appoint the Jesuits responsible for the reform of the Calendar. Nevertheless, in 1616, Sabatino de Ursis was expelled from Beijing to Macao, after a surge of animosity of the locals towards the Jesuits led to a persecution of Christians at the instigation of Shen Ho (Shěn Hè, 沈隺, vice minister of rites in Nanking, d. 1624), where he died in 1620 [54].

49 In 1619 three Jesuits arrived in Macao: Johann Schreck (known as Terrentius or Terrenz in Europe and Deng Yu-han in China, 1576-1630); Wenzeslau Kirwitzer (1588-1626); and Johann Adam Schall (named Tang Ruo-wang in Chinese, 1591-1666). Terrenz had been accepted at the Accademia dei Lincei with Galileo [55]. He would offer a telescope to the Emperor of China, in 1634, and then write to Galileo, inviting him to work in China, without success.

50 Terrenz would then be appointed to fill the job of the reform of the Calendar and Nicholas Longobardo (1559-1654) would help him in this task. In 1629 the wish of Xu Guanqi materialized in a moment when his position was stronger as a member of the imperial council, and the Jesuits are named responsible for the reform of the Calendar. In this year, a Calendrical Bureau (*Liju*) is established for the introduction of contemporary Western calendrical knowledge, using tools from mathematics and mechanical sciences [56].

51 Johann Adam Schall and Giacomo Rho (1593-1636) will succeed Terrenz after his death in 1630. It is important to note that Schall had probably had the opportunity to meet Galileo and that he had been active in the field of astronomy, precisely determining the difference in longitude between Rome and Beijing. Giacomo Rho would play also an important role in the transmission of European knowledge, in parallel with the reform of the Calendar.

52 Although the Jesuits initially shared an Earth-centered and largely pre-Copernican astronomy vision with their Chinese hosts (*i.e.* the Ptolemaic-Aristotelian views of the Hellenistic period) [57], Jesuits like Giacomo Rho would present later the model of Tycho Brahe as a

standard cosmological model. The Chinese were often fundamentally opposed to it because, as we have seen, they had long believed (according to the ancient doctrine of Hsüan Yeh) that celestial bodies floated in the emptiness of an infinite space. It is important to point out that although this contradicts the Aristotelian view of solid concentric crystalline spheres, where there was no void, but a mass of air between the celestial bodies. Nevertheless, the subject of the void would be debated in Europe, and amongst the Jesuits in the 17th century. The Jesuits would put forward a complex set of arguments, according to which they did not follow thoroughly late medieval theologians and the idea of a vacuum infinite space created by God beyond the world, and whereas instead they recognized the existence of an infinite space beyond heaven [58].

53 There were other Jesuits in favor of Copernican theory, such as Jan Mikołaj Smogulecki (1610-1656) and Venceslaus Pantaleon Kirwitzer (1588-1626). However, Copernican views were still not widespread or fully accepted in China at that time. Eventually, the views of Copernicus, Galileo and Tycho Brahe would triumph in European science, and these ideas slowly permeated in China despite Jesuit efforts to curb them after the "Galileo Affair". In 1627, Polish Jesuit Michael Boym (1612-1659) enthusiastically presented Johannes Kepler's [59] (1571-1630) tables in Beijing's Ming court. In the Chinese Handbook of Astronomy, written in Chinese by Adam Schall von Bell, in 1640, the names of Copernicus, Galileo and Tycho Brahe were officially introduced in China.

54 Schall finally completed the reform of the calendar in 1638. He would then be appointed director of the Observatory in 1645 by the new Manchu emperor Shun Chih (1638-1661) [60], who launched the Qing Dynasty in 1636 and conquered Beijing in 1644.

Fig. 2. Johann A. Schall Astronomer and Mandarin

(Unknown author, public domain [61])

55 Schall's Calendar for 1645 was also approved and officially proclaimed. Once he became responsible for this task, he would reduce the number of existing Calendars from five to two: the first was aimed for the Imperial administration and listed the events of the Sun, the Moon and the planets, together with astronomical observations; the second contained every day information for the general use of the population, namely the auspicious days and weather forecast [62].

56 The precision of these calendars resulted from the use of European astronomical tables: the "Alfonsine Tables", from 1252; the "Ephemerides Brandeburgicae", published in 1609; the "Tabulae Frisicae", from 1611; the tables included in *Astronomia Danica*, from 1622, by C.S. Longomontanus (using Tycho Brahe's system); *Tabulae Motuum Coelestium Perpetuae*, from 1632, by Phillipus Lanbergius (also by means

of the Brahe's system); and the *Tabulae Rudolphinae* published by Kepler in 1627, and used by Schall in his calculations as of 1646 [63].

3. 2. The Board of Astronomy and the Observatory

57 In China, the positions of director of the Astronomical Observatory in Beijing and President of the Board of Astronomy gave the holder the statute of Mandarin that carried significant influence with them. For almost two hundred years, these positions were filled by successive Jesuit missionaries.

58 Before Schall's reform, one of the most important of the four departments of the Board of Astronomy (Qintianjian, also called Bureau or Tribunal of Astronomy) was the one in charge of the calendar. After Schall was appointed director of the board, he reorganized its structure, dividing the astronomers into two schools: Chinese and Muslim. He tried to create also a Western school of astronomical thought but eventually abandoned the project [64]. In 1658, he was designated "Mandarin of first class" by the emperor, making him the most influential Westerner in the history of China [65].

59 Schall would rely on the Italian Jesuit mathematician Ludovico Buglio (1606-1682), the Portuguese Gabriel Magalhães (1610-1677), the Polish Jan Mikołaj Smogulecki and the Austrian missionary Johan Grueber (1623-1680) as collaborators in his astronomical work. He would teach European science to Chinese astronomers, build astronomical instruments, and publish approximately thirty books on astronomy in Chinese, one of which was devoted to the telescope and others to the theory of solar and lunar eclipses, as well as catalogues of stars and a summary of European astronomy, integrating the works of Copernicus, Tycho Brahe, Galileo and Kepler.

60 Nevertheless, there were some setbacks. In 1649, missionaries Buglio and Magalhães would write to Rome accusing Schall of working with superstitious elements related to the Calendar in China, particularly the prediction of lucky days. Rome responded with the formation of a commission to study the case, which would later proclaim a favorable decision, in 1659, confirming the pope's approval of the work of Schall

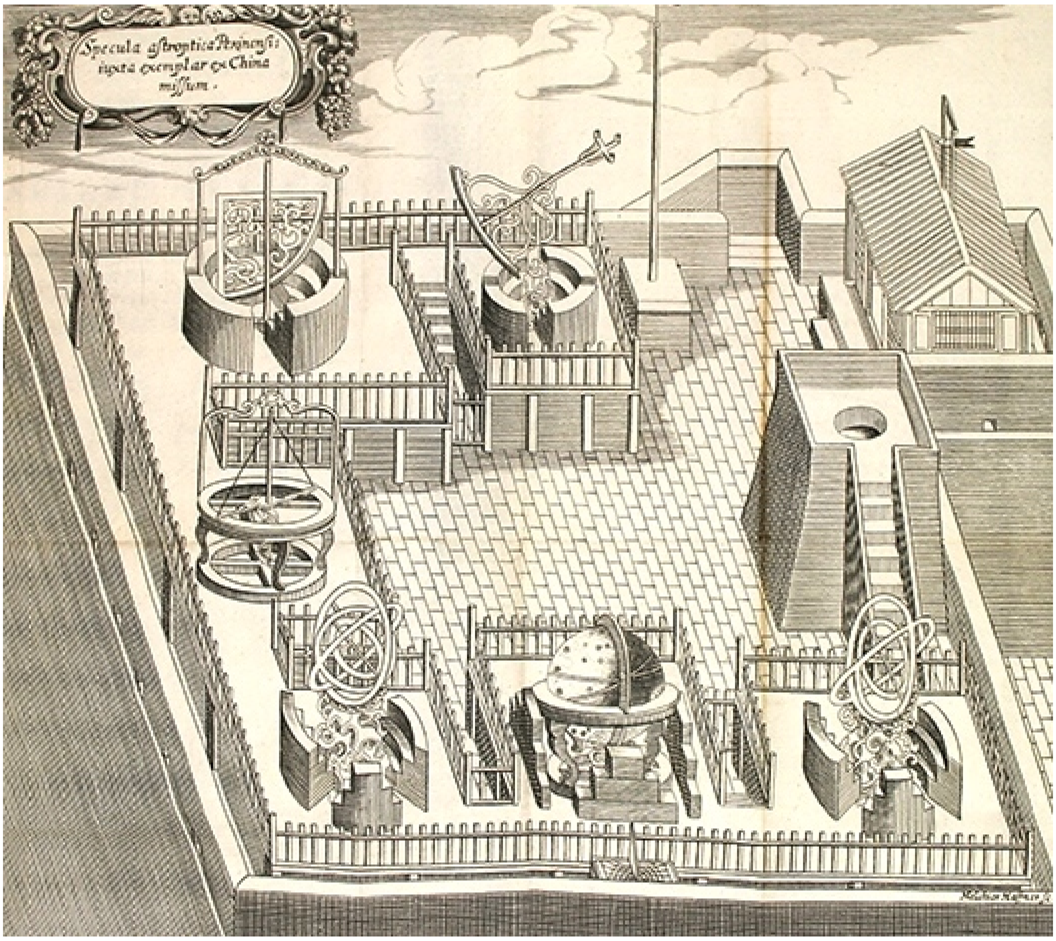
in the Observatory and his condition as Mandarin of the Chinese court.

61 The considerable amount of success achieved by Schall in the Chinese court led to strong hostility from some Chinese astronomers, especially two named Yang kuan hsien and Uming Huen. After the early death of emperor Sun chih and the succession in the throne by a council of regents, Schall was attacked by his enemies who accused him of conspiracy, danger to society and promotion of wrong astronomical knowledge. Schall and his collaborators were imprisoned during the seven months of trial. Schall would be sentenced to death and the others two to exile. Only an earthquake that destroyed part of Beijing would convince the judges of his innocence, because the Chinese believed calamities to be a sign of the government's wrongdoing. Schall would die in 1666 and his innocence would be proclaimed in 1669 [66].

62 The work of Schall would be followed by Ferdinand Verbiest. In 1669, he would start to replace the instruments on the platform of the Observatory, all cast in bronze, and these are the same instruments visitors can find there till today.

63 The Beijing Ancient Observatory consists of a platform and it is equipped with eight astronomical instruments built during the Qing Dynasty (1644-1912): Equatorial armilla (赤道经纬仪); Sextant (纪限仪); Altazimuth (地平经纬仪), Azimuth Theodolite (地平经仪), Ecliptic armilla (黄道经纬仪), Celestial globe (天体仪), Quadrant (象限仪), New armillary (玑衡抚辰仪／清代浑仪) [67]. These instruments were built according to Chinese technology and using European knowledge transferred to China through the Jesuits, namely Ferdinand Verbiest (1623-1688).

Fig. 3. The Astronomical Observatory of Beijing in the 17th century



(Unknown author, copy from a drawing by Louis Le Comte, in *Nouveaux mémoires sur l'état présent de la Chine*, t. I, 1696 [68])

64 This equipment is described in Ferdinand Verbiest's book *De Theoria, Usu et Fabrica Instrumentorum Astronomicorum et Mechanicorum*, from 1673. It may be assumed that the founding of a new Astronomical Observatory with instruments of the tychonian tradition was being planned as early as 1664, but these plans were interrupted by the *Yang Guangshang* episode and the Jesuit trial between 1665 and 1669 [69].

65 In 1673, Jesuit astronomers Filippo Grimaldi (1639-1712) and Tomas Pereira (1645-1708) arrived in Beijing, and in 1688 Verbiest died and was buried near the tombs of Ricci and Schall in the Jesuit cemetery. From then on, the Jesuits will continue to occupy the position of Director of the Astronomy Council and will succeed in continuing their work of publishing works in astronomy and building astronomical in-

struments, although they would participate in the controversy surrounding rites, specifically in requesting permission for the Christians to participate in the ceremonies of respect for the ancestors and for Confucius.

66 The Jesuits maintained the position of Director of the Board until 1805, with the exception of the period between 1665 and 1668, when Schall and his collaborators were being trialled. This fact was more relevant when we think that the Society of Jesus would be suppressed in 1773 and that the work would have been maintained by four ex-Jesuits until 1805.

67 Their work would still matter in the years after the suppression of the Society. In 1782, Manuel Dias' study Tianwenlüe would be included in the Complete Library of the Four Treasures (*Siku quanshu* 四庫全書), commissioned by Qianlong Emperor (1736-1795), even though the editors decided to erase the preface and its references to Christianity, as well as the text related to the observations of Galileo and the telescope [70].

4. Conclusion

68 The process of transmission of European astronomical knowledge to China was possible due to a series of simultaneous events:

- the European discoveries in Asia initiated by the Portuguese;
- the travels of missionaries and their sense of duty of conversion together with the fact that the Jesuits saw in astronomy a privileged way to introduce Christianity in Asia;
- the scientific revolution in Europe;
- the fact that until then knowledge was concentrated in the Church; the need felt by the Chinese central power to learn European skills in Astronomy in order to correct mistakes in the calendar, aiming to achieve accurate weather previsions and predictions of catastrophes.

69 Together these fortuitous facts led to a monumental change in both worlds in scientific terms: East and West.

70 Although relevant, the concept of solar system adopted during this process is not the only significant detail of this course of events: the geometric analysis of planetary movements, the idea of the spherical

Earth and its division by meridians and parallels, together with the method to predict eclipses, were some of the central scientific developments introduced by the Jesuits in China in the field of astronomy.

71 Amongst their publications, on the other hand, were catalogues of stars, observations of planets and satellites of Jupiter. One of them stood out from the others: the *Tianwenlüe* of Manuel Dias, in 1615, is seen today as more than a translation of astronomical knowledge to Chinese, as it gives us details of Chinese contemporaneous environment and the priorities at the time, namely solar and lunar eclipses. It also "marks a new stage in the Jesuit scientific presence in Asia, a change from the initial presenting Western science *to* China to writing Western science *in* China"[71].

72 Therefore, it is generally acknowledged that Jesuits have had a positive effect on the development of science and astronomy especially in China, considering that they arrived at a less positive moment. Even after the prohibition of the heliocentric theory, they still used the works of Copernicus, Kepler and, later, Newton (1643-1727), in mathematics, namely calculating the relative positions of celestial bodies[72].

73 Even so, the Jesuits are sometimes pointed the finger at for having failed to transfer knowledge of the heliocentric system of Copernicus. These ideas were used by the Jesuits in China (alongside with the work of Tycho Brahe and Kepler and the traditional system of Ptolemy) until 1616, when they were banned by the Catholic Church. After 1635, the writings of the Jesuits cease to mention the Copernicus system and they show preference for Brahe. The Aristotelian philosophy of nature would be preserved by the Jesuits in the communication with the locals until conclusive proof of the movement of the Earth was presented[73]. But the events in Europe and the subsequent restraint of the Copernicus cosmological view were not the only obstacle to the transmission and adoption of modern thoughts by the Chinese who were actually still opposed to them as well. As we have seen, they were strong believers in the ancient doctrine of *Hsüan Yeh* that stated that celestial bodies floated in a void of infinite space.

74 It was not until 1750 that the Jesuit R. J. Boscovich (1711-1787) accepted the Copernican system in public. The church will then lift the ban on

works defending the heliocentric theory in 1757. In 1764, King Joseph I of Portugal would sign an edict dissolving the Society of Jesus. In 1773, the Society was suppressed by Pope Clement XIV but four ex-Jesuits continued in the position of directors of the Board of Astronomers in Beijing until 1805. In 1814, Pope Pius VII reestablished the Jesuits as an order, and they continue their missionary work to this day.

75 All in all, the history of astronomy in China shows how important political systems are for scientific development. The Jesuits therefore had the role of educating Chinese astronomers, affecting positively their interest in these sciences, helping them in the prediction of eclipses, teaching the geometry of Euclid, registering the movements of celestial bodies, and using new astronomical instruments, such as the telescope. China, on the other hand, was the Jesuit mission with best results. Despite this effort and the fact that they managed to develop their evangelization actions far from the Portuguese censorship, the Jesuits are sometimes accused of forcing Ptolemaic astronomy on the Chinese, and that would delay the acceptance of the Copernican system, even if it is not completely true, because the Jesuits in China spoke more of Tycho than of Ptolemy.

76 Generally speaking, the reality is that although astronomical teachings of the Jesuit in China were held back by the Galileo affair, the Jesuits were still able to manoeuvre through obstacles and difficulties to reach the heart of the Empire and convert people to Christianity, transmitting at same time modern astronomical knowledge, even if there was resistance to the acceptance of new concepts of the solar system.

77 In fact, in the 18th century, Chinese astronomers would still refuse the astronomy of Copernicus, accusing it of incoherence. It was only at the moment the news of the end of the Church's suppression of heliocentric theory (1757) arrived in China that a manuscript written by the Jesuit Michel Benoist (1715-1744) and published in 1802 that included an explanation of the structure of the cosmos wherein the Copernican heliocentric model figures as a central issue was published in Beijing. His account on the planetary system and the Chinese reactions thereof would have to be covered some other time and subject to a subsequent analysis.

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NOTES

1 J. Needham, *Science and Civilization in China*, (Cambridge: Cambridge University Press, Vol. III: Mathematics and the Sciences of Heavens and Earth, 1959), p. 437.

2 C. Ptolemy (Ptolemaeus in Latin) was a mathematician, astronomer, geographer and astrologer, born in 100 AD in Alexandria, Egypt. The Ptolemaic System or geocentric model puts Earth in the center of the Universe. It also conceived a cosmological view where planets moved on a small sphere or circle, called an epicycle, that moved in larger circles, called deferent. It was the predominant system in ancient civilizations, like Greece (Vd. M. Boas Hall, *The Scientific Renaissance* 1450-1630 (New York: Dover Publications, 1994)), but also in China, after the Portuguese Jesuit Manuel Dias publishes, in 1614, a compendium of the Ptolemaic system in Chinese. Cf. A. Udías, "Jesuit Astronomers in Beijing, 1601-1805", *Quarterly Journal of the Royal Astronomical Society*, Vol. 35, N° 4, 1994, p. 466.

3 J. Needham, *op.cit.*, p. 210.

4 The Jesuit Order was created by a Spanish priest, Ignatius de Loyola, in 1534. Its members would take vows of poverty and chastity and work for the conversion of Muslims, vowing to the Pope for apostolic work. In September 1540, Pope Paul III approved Ignatius' outline of the Society of Jesus. The Jesuits were often persecuted by authorities of the lands where they practiced conversion, but in China they were welcomed as men of wisdom and science. Cf. R. Jacques, *De Castro Marim à Faifo: Naissance et développement du Padroado portugais d'orient des origines à* 1659 (Lisbon: Calouste Gulbenkian Foundation, 1999).

5 J. Needham, *op.cit.*

6 *Ibidem*, p. 209.

7 C. R. Boxer, O *Império Marítimo Português*, 1415-1825 (Lisbon: Edições 70, 2001), p. 38-40.

8 *Ibidem*, p. 38-39; R. Jacques, *op.cit.*, p. 51.

9 C. R. Boxer, *op. cit.*, p. 228.

10 L. M. R. Saraiva, J. Catherine (eds.), *History of Mathematical Sciences: Portugal And East Asia III – The Jesuits, the Padroado and East Asian Science*

(1552-1773) (Singapore: World Scientific Publishing, 2008), p. 9.

11 C. R. Boxer, *op. cit.*, p. 227-228.

12 *Ibidem*, p. 227.

13 The publication by Copernicus of *De revolutionibus orbium coelestium*, just before he died in 1543, is considered as an utterly relevant event of the world scientific development, as it marked the beginning of the Copernican Revolution and it contributed to the European scientific revolution itself.

14 In the decades of 1530 and 1540 Vesalius would publish his groundbreaking work on human anatomy, namely *The Humani Corporis Fabrica*, in 1543.

15 N. Sivin, "Why the Scientific Revolution did not Take Place in China – or didn't it?", *Chinese Science*, Vol. 5, 1982, p. 16.

16 *Ibidem*, p. 17.

17 Xiao Jun and X. Chen (eds.), *Beijing Ancient Observatory* (Beijing: Chunming Society Cultural Communication Co. Ltd., 2017), p. 5-7.

18 L. Fang, Y. Zhou, "Concepts of Space and Time in Ancient China and in Modern Cosmology", in D. Fan, R. S. Cohen (eds), *Chinese Studies in the History and Philosophy of Science and Technology*, Boston Studies in the Philosophy of Science, vol 179. Springer, Dordrecht,1996.

19 The *Chou Pei Suan Ching* (周髀算经), currently known as *Zhoubi Suanjing*. Vd. C. B. Boyer, A *History of Mathematics* (New York: Wiley International Edition, 1968).

20 A gnomon is the rectangular piece of a sundial that marks the hours of day according to the length of its shadow. Vd. S. Gandz, "The Origin of the Gnomon or the Gnomon in Hebrew Literature", Proceedings of the American Academy for Jewish Research, New York City, The Yeshiva College, Vol. 2, 1930-1931, p. 23-38.

21 Vd. J. D. Sellmann, *Timing and Rulership in Master Lu's Spring and Autumn Annals (Lushi chunqiu)* (New York: State University of New York Press, 2002).

22 J. Needham, *op. cit.*, p. 211-216.

23 *Ibidem*, p. 211.

24 *Ibidem.*, p. 212.

25 *Ibidem*, p. 214.

26 H. Chatley, *The Development of Mechanics in Ancient China*, Transaction of the Newcomen Society, 1941, p. 117.

27 Cited in J. Needham, *op. cit.*, p. 212.

28 *Ibidem*, p. 214, 216.

29 The Chinese astronomer Shi Shen wrote the *Astronomy* (石氏天文, *Tianwen*), later known as *Shi's Catalogue of Stars* (石氏星經, *Shishi Xingjing*).

30 H. Chang, *Ling Hsien*, as cited in J. Needham, *op. cit.*, p. 216.

31 *Ibidem*.

32 A. Udías, *op. cit.*, p. 464. Tyge Ottesen Brahe was a Danish nobleman, astronomer, and writer known for his astronomical and planetary observations. The Tychonic system saw the Moon orbiting the Earth, and the planets orbiting the Sun, but erroneously considered the Sun to be orbiting the Earth. In his *De nova stella* ("On the New Star"), from 1573, Tycho refuted the Aristotelian belief of an unchanging celestial realm. Cf. R. Cowen, "Danish astronomer argues for a changing cosmos", *Science News*, Washington, Society for Science and the Public, N° 156, 1999.

33 J. Needham, *op. cit.*, p. 216.

34 H. Chang, *Ling Hsien*, as cited in J. Needham, *op.cit.*, p. 217.

35 Although the idea of an infinite universe would appear in Europe with the Epicurean poet Lucretius (Tito Lucretius Carus, died mid-50's BC), it would resurface with the German philosopher, Nicholas of Cusa (1401-1464), who tried to reconcile a "positively" infinite God with a "relatively" infinite universe, and with the Italian Dominican Friar Giordano Bruno (1548-1600), who depended only on logical and metaphysical arguments to advocate this concept. These inputs would influence the German Jesuit Athanasius Kircher (1601-1680), who would replicate some of the thoughts of Bruno. Cf. I. D. Rowland, "Athanasius Kircher, Giordano Bruno, and the Panspermia of the Infinite Universe", in P. Findlen (Eds), *Athanasius Kircher: the Last Man who Knew Everything* (Hove: Psychology Press, 2004), p. 201.

36 Currently known as Ge Hong (283-343), he was a scholar and an alchemist that lived in the Jin Dynasty (265-420) in Jurong, modern Jiangsu. His master work was *Baopu Zi* (抱朴子), *i.e.* "Master who embraces simplicity". Cf. D. Knechtges, T. Chang (eds.), *Ancient and Early Medieval Chinese Literature (Vol. I): A Reference Guide, Part One, Handbook of Oriental Studies. Section 4 China* (Boston: Brill, 2010), p. 269-271.

37 J. Needham, *op. cit.*, p. 219.

38 *Ibidem*, p. 219.

39 *Encyclopedia of Cosmology (Routledge Revivals): Historical, Philosophical, and Scientific Foundations of Modern Cosmology* (Routledge: Norriss S. Hetherington, 2014), p. 66.

40 J. Needham, *op.cit.*, p. 223.

41 A. Wylie, *Notes on Chinese Literature* (Shanghai, 1867), p. 86 as cited in J. Needham, *op. cit.*, p. 220.

42 Vd. C. Cullen, *Heavenly Numbers: Astronomy and Authority in Early Imperial China*, (Oxford: Oxford University Press, 2017).

43 Vd. S. T. Won, "A Statistical Survey of Solar Eclipses in Chinese History", *Popular Astronomy*, Vol. 42, Northfield, Minnesota, Carleton College, 1934, p.136.

44 Ho Peng Yoke/Ho Ping-Yü. "Ancient and mediaeval observations of comets and novae in Chinese sources", *Vistas in Astronomy*, 5, 1962, p.127-225.

45 A. Udías, *op. cit.*, p. 468.

46 Middle Kingdom is the Chinese name for China. It means literally the "Country of the Middle" – Zhongguo, 中国.

47 C. H. Parker, *Global Interactions in the Early Modern Age*, 1400-1800, (Cambridge: Cambridge University Press, Essential Histories, 2010), p. 215.

48 C.R. Boxer, *op. cit.*, p. 235-236.

49 C. H. Parker, *op. cit.*, p. 215.

50 Ruggieri would arrive in Macao, in 1579, where he learned to read and write Chinese. He received permission, in 1582, to establish a mission in mainland China, and in 1583, together with Ricci, he settled in Zhaoqing, starting a slow ascent to Beijing from there. Vd. R. P.-C. Hsia, *Matteo Ricci and the Catholic Mission to China*, 1583-1610: A *Short History with Documents* (Indianapolis: Hackett Publishing, 2016), p. 57-60.

51 Emperor Wanli was the 14th emperor of the Ming Dynasty and reigned from 1572 to 1620. The direct translation of "wanli" is ten thousand calendars.

52 Euclid (Eukleides in Greek) of Alexandria (c. 325-c. 270 BC) was a Greek mathematician, considered to be the father of Geometry, who influenced

the work of Newton.

53 The “Galileo Affair” (denominated, in Italian, “il processo a Galileo Galilei”) was a sequence of events, after the publication of Galileo’s telescopic observations, where the Church accuses Copernican theories of heretical due to the contradiction of interpretation of the Bible, that culminated with the trial and condemnation of Galileo Galilei by the Roman Catholic Inquisition, in 1633, for his support of heliocentrism. Cf. D. P. Scotti, *Galileo Revisited: The Galileo Affair in Context* (San Francisco: Ignatius Press, 2017), p.115.

54 C. Jami, P. Engelfriet, G. *Blue*, *Statecraft and Intellectual Renewal in Late Ming China. The cross-cultural synthesis of Xu Guangqi* (1562-1633) (Boston: Brill, 2001), p. 209.

55 The Lincean Academy was founded in Rome, at the Palazzo Corsini, in 1603. It is one of the institutions created at the time to study natural sciences and make new discoveries, as well as to publish its findings. Cf. S. Drake, *Galileo Studies: Personality, Tradition, and Revolution* (Michigan: University of Michigan Press, 1981), p. 34. Galileo would have joined this academy in 1611, after publishing his *Starry Messenger* in 1610.

56 N. Golvers, “Ferdinand Verbiest, S.J. (1623-1688) and the Astronomical Bureau in Beijing”, *Revista de Cultura*, Macao, Instituto Cultural de Macau, n° 21, 1995, p. 201-212.

57 The Aristotelian-Ptolemaic system conceived a universe with the earth in the center, composed of four elements: Earth, Water, Fire and Air. In this cosmology, the earth stands still, and it is surrounded by ten concentric spheres made of a perfectly transparent substance known as “quintessence”. These spheres revolve around the earth, carrying the other celestial bodies. Vd. A. Romano, “La Compagnia di Gesù, Cristoforo Clavio, La Scienza Moderna (1560-1610)”, in P. Vasconi *et.al.*, *Cristoforo Clavio e la cultura scientifica del suo tempo: Atti del Convegno tenutosi presso il Liceo Ennio Quirino Visconti 18 ottobre 2012* (Roma: Gangemi Editore Spa, 2012).

58 L. M. Carolino, “Astronomy, Cosmology and Jesuit Discipline”, in I. G. Zupanov (eds), *The Oxford Handbook of the Jesuits* (Oxford: Oxford University Press, 2019), p. 683.

59 Johannes Kepler was a German astronomer and mathematician best known for his laws of planetary motion, and his books *Astronomia nova*, *Harmonices Mundi*, and *Epitome Astronomiae Copernicanae*. He is a key figure in the 17th-century scientific revolution, although he incorporated religious arguments and reasoning into his work, motivated by the religious

conviction and belief that God had created the world according to an intelligible plan that is accessible through the natural light of reason. Cf. P. Barker and B. R. Goldstein, "Theological Foundations of Kepler's Astronomy", *Osiris*, Vol. 16, "Science in Theistic Contexts: Cognitive Dimensions", The University of Chicago Press, 2001, p. 88-113. In his model, planets executed elliptical orbits around the Sun. This marked a decisive break with the tradition in astronomy, from the pre-Socratics through Ptolemy and down to Copernicus, according to which celestial motions should conform to the most perfect of geometric figures, the circle. Kepler's theory of elliptical orbits appeared in his Astronomia Nova in 1609. Vd. M. do Rosário Monteiro, M. S. Ming Kong, M. J. Pereira Neto, *Utopia(s) – Worlds and Frontiers of the Imaginary: Proceedings of the 2nd International Multidisciplinary Congress* (Lisbon: CRC Press, 2016), p.62.

60 Emperor Shun Chih occupied the imperial throne after Emperor Chongzhen (1611-1644) committed suicide in 1644 ending the Ming Dynasty and starting the Qing Dynasty. Cf. A. Udías, *op. cit.*, p. 468.

61 "P. Adam Schall Germanus I. Ordinis Mandarinus" ("Father Adam Schall, the German mandarin of the first order"), 1667, from A. Kircher, *Tooneel van China...*, trans. J. H. Glazemaker (Amsterdam: Johannes Janssonius van Waesberge, 1668), p. 138, online: https://commons.wikimedia.org/wiki/File:Adam_Schall.jpg; cited in A. Udías, *Jesuit Contribution to Science: A History* (Berlin: Springer, 2014), p. 88.

62 A. Udías, "Jesuit Astronomers", *op. cit.* p. 468.

63 *Ibidem*, p. 469.

64 *Ibidem*, p. 468.

65 *Ibidem.*

66 *Ibidem*, p. 470.

67 Xiao Jun, X. Chen (eds.), *op. cit.*, p. 5-7.

68 Online: https://commons.wikimedia.org/wiki/File:VerbiestBeijingObservatory.jpg. Cited in F. Verbiest S. J., *Astronomia Europaea sub Imperatore Tartaro Sinico Cam Hy appellato ex umbra in lucem revocata*, (Dillingen: Joannis Caspari Bencard, 1687).

69 N. Golvers, *op. cit.*, p. 202.

70 L. M. R. Saraiva, J. Catherine (eds), *op. cit.*, p. 12.

71 *Ibidem*, p. 11.

72 *Ibidem*, p. 476.

73 A. Udías, “Jesuit Astronomers”, *op. cit.*, p. 475.

RÉSUMÉS

English
It is generally recognized that Christian missionaries have played a fundamental role in propagating the ideas of the scientific revolution, such as the conceptual, methodological and institutional approaches of the natural world. In doing so, the thoughts and practices that ultimately brought modern science were transported by the ways of faith across seas and continents. Knowledge in mathematical sciences, astronomy, optics and geography has been brought to China, one of the few places at that time where natural phenomena have been analyzed with no connection to the divine, but the tradition is broken with the arrival of the Jesuits.
The members of the Society of Jesus (Jesuits) founded in 1540 by Ignatius Loyola never succeeded in converting the Chinese population to Catholicism as they wished, but they would present the telescope and discoveries of Galileo, introduce the Chinese calendar, among many other scientific contributions to Chinese knowledge.
Between the first successful visit, in 1582, by Mateus Ricci and the stays of the Spanish Diego Pantoja, in 1601, the Portuguese Tomás Pereira, in 1673, or the French Jean de Fontaney, in 1688, many others visited China and translated European scientific books into Chinese, exchanging instruments, books, objects and letters with the Chinese scientific community. In 1701, there were 82 Jesuit missionaries in China.

Français
Il est généralement reconnu que les missionnaires chrétiens ont joué un rôle fondamental dans la propagation des idées de la révolution scientifique, telles que les approches conceptuelles, méthodologiques et institutionnelles du monde naturel. Ce faisant, les pensées et les pratiques qui ont finalement amené la science moderne ont été transportées par les voies de la foi à travers les mers et les continents. Des connaissances en sciences mathématiques, en astronomie, en optique et en géographie ont été apportées à la Chine, l’un des rares endroits à ce moment-là où les phénomènes naturels ont été analysés sans lien avec le divin, mais la tradition s’est rompue avec l’arrivée des jésuites.
Les membres de la Compagnie de Jésus (jésuites), fondée en 1540 par Ignace de Loyola, n’ont jamais réussi à convertir la population chinoise au catholicisme comme ils le souhaitaient, mais ils présenteraient le télescope et les découvertes de Galilée, introduiraient le calendrier chinois, parmi beaucoup d’autres contributions scientifiques, à la connaissance chinoise.

Entre la première visite réussie, en 1582, par Mateus Ricci, et les séjours de l'Espagnol Diego Pantoja, en 1601, le Portugais Tomás Pereira en 1673, ou le fFançais Jean de Fontaney, en 1688, de nombreux autres visitèrent la Chine et traduisirent des livres scientifiques européens en chinois, échangeant aussi des instruments, livres, objets et lettres avec la communauté scientifique chinoise. En 1701, il y avait quatre-vingt-deux missionnaires jésuites en Chine.

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