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A Scholarly Imprint: How Tibetan Astronomers Brought Jesuit Astronomy to Tibet*

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Abstract: The European Jesuits' mission to China during the seventeenth and eighteenth centuries is considered a world-historical event that played an important role in the transmission of knowledge between the West and the East. In spite of its historical significance, it was long assumed that the Jesuit mission to China and its scientific scholarship had never reached the mountainous regions of Tibet. As I have described elsewhere, this was not

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the case. Between the eighteenth and nineteenth centuries, Tibetans not only translated a large number of the Jesuits' works into Tibetan, they also reformed the Tibetan calendar in accordance with the Jesuit-influenced calendar of the Qing. How did it happen and in which way? It was a twofold process achieved partially with Qing imperial sponsorship and partially on the Tibetans' own initiative, sometimes even in a low-key, indirect and secretive way. In this article, I shall look at how a Tibetan Buddhist astronomer at the imperial court in Beijing wrote a manual for predicting solar and lunar eclipses. I will also look at how some Tibetan astronomers brought this imperial knowledge, apparently without explicit imperial approval, to the monasteries in Amdo, the North-East of Tibet, which mostly lies today in the Chinese provinces of Qinghai and Gansu, as well as how Tibetan astronomers in this region reformed their calendars according to the Jesuits' astronomical system. Finally, I will describe how this tradition, in spite of recent political upheaval and tragedies, is still alive and practiced in Tibet.

Background

Before going into a detailed history of how Tibetans in Amdo (a mdo),[1] the North-East of Tibet, brought Jesuit-inspired astronomical and calendrical science to Tibet, some concepts about the history of astronomical, almanac traditions in Tibet, as well as some astronomical terminology, need clarification. This will set the historical background to the transmission of the Jesuit-inspired calendrical tradition, and the impact it had on the time-reckoning system in Amdo. In historical terms, Tibet has a long tradition of studying and engaging with astronomical works; however, it is difficult to pinpoint exactly when Tibetans began studying celestial motions and producing almanacs. During the Tibetan Empire, roughly between the seventh and ninth centuries, Tibetans had extensive engagement with neighboring countries like China and India on astronomical works (Sherab and Jamling 2012: 23). For example, in the reign of Khri Srong lde brtsan (r. 755-797), the imperial court invited a Chinese astronomer, Ha'a ra nag po, and his Tibetan disciple Khyung nag shag dar to spread the Chinese methods of astrological calculation in Tibet (Huang and Chen 1987: 313). The arrival of Kalācakra astronomy from India in the eleventh century can be considered as the beginning of intellectual engagement with astronomical

[1] In what follows the Wylie transliteration is used for Tibetan terms and names, except for those that are habitually spelt differently in English; thus I write 'Amdo' rather than 'a mdo'; in such cases the Wylie transliteration is added between brackets at first occurrence.

works in Tibetan. The Kalācakra is not only a descriptive tantric text but also includes practical mathematical methods for calculating the movements of the planets, the movements of stars, and eclipses (Henning 2007). This text and its commentaries provided the astronomical references which later Tibetan scholars relied on to study the heavens. It also introduced the system of reckoning time. Based on the Kalācakra, several Tibetan scholars devised and wrote calendars, the best-known systems being *phug lugs* (*phug pa* tradition) and *tshur lugs* (*tshur phu* tradition). In principle, these two calendar systems are considered to be the major astronomical traditions in Tibet (Schuh 2012). Sde srid Sangs rgyas rgya mtsho (1653-1705), the regent of the fifth Dalai Lama (1612-1682), improved these Kalācakra-based calendar systems by writing the influential astronomical work known as *Bai ḍūrya dkar po* (The white beryl) and *Bai ḍūrya gya'a sel'* (The eradication of rusted beryl).

There were two kinds of Chinese calculations (*rgya rtsis*) in Tibet: the first, known as 'the old Chinese astronomy' (*rgya rtsis rnying ma*), was brought to Tibet by the Chinese Princesses Wencheng 文成 and Jincheng 金城 during the imperial period of the seventh and eighth centuries. According to the great Tibetan scholar, Tshe tan zhabs drung (Tseten Zhabdrung, 1910-1985), this type of calculation did not include astronomy or calendar-making science, and largely focused on the reading of astrological signs and symbols (2007: 371). The second *rgya rtsis* is known as 'the new Chinese calculation' (*rgya rtsis gsar ma*), or as *Huangli* 皇曆 'the imperial calendar'. It first came to Tibet in 1715 through the imperial Qing court (Huang and Chen 1987: 316). The origin of this method of calculation was neither India nor China; it was brought by Jesuits who came to China between the sixteenth and eighteenth centuries.

In the seventeenth century, when Europe expanded its trade relations all over the world, European missionaries, driven by religious fervor, followed to preach Christianity. At that time a group of Jesuits went to China, adopting an accommodationist attitude in order to preach their religion. As a strategy to convert the elite scholarly officials, these learned missionaries introduced them to European scientific knowledge, which was undergoing a fundamental shift at that time (Dunne 1962). As Europeans who were interested in China, they also introduced China to Europe. In that way, they played an important role in the transmission of cultural knowledge between the East and the West. Joseph Needham emphasized the significance of this event:

> In the history of intercourse 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. (Needham 1959: 437)

Due to their scientific skills, from the late Ming dynasty the imperial court in Beijing employed some of these Jesuits to reform the calendar (Hashimoto 1988). After the Manchu conquest of China, the Qing (1644-1911) court continued to employ some of them, and adopted a calendar that relied on the system of the Danish astronomer Tycho Brahe (1546-1601). The Jesuits also mapped the empire and provided new geographical information to the Chinese (Jami 2012). During the late Ming dynasty, there seems to have been no interaction between Tibetans and Jesuit missionaries. However, after the Manchus took Beijing in 1644, Tibetan Lamas and Jesuits found themselves at the same court serving the same emperors. When the fifth Dalai Lama visited Beijing in 1652, he was aware that Schall was working there. He wrote:

> When we crossed the bridge of a town called Chinghong, Uijing Chin Wang (Jirgalang, the emperor's uncle, 1599-1655) was sent by the emperor to welcome me. … the next day, Wang gave an effusive banquet in the Chinese manner. That day there was a great snowstorm. I heard that he was impressed by a prediction and praised it, saying this was exactly what the heretical Indian forecaster Thangshi Wang (Tang Ruowang 湯若望/Adam Schall) predicted.[2] (Karmay 2014: 294)

Of course, Johann Adam Schall von Bell (1592-1666) was not an Indian,[3] but the Dalai Lama did refer to Schall as a heretic, and good at predicting the weather and heavenly signs. This suggests he was aware of at least one European who was working at the imperial court.

During the Kangxi reign (1662-1722), the emperor took an interest in the Jesuits and their work. In 1714, Kangxi asked several Tibetan Buddhist Lamas to translate some of the Jesuits' mathematical and calendrical works into Mongolian, and he was very pleased with the result. Again, in 1715, he asked the people involved in the Mongolian translation to translate some of these works into Tibetan (*rGya rtsis chen mo:* 1715, *spar byang*, f. 2r). The result

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[2] There is no evidence that suggests Tibetan Buddhists felt that the Jesuits were a threat to their own religious missionary work at the court. In contrast, as in the case of Johann Adam Schall von Bell's animosity towards the fifth Dalai Lama's visit to Beijing, the Jesuits felt that the presence of Tibetan Buddhists at the imperial court was a danger to their evangelizing mission (Väth 1991: 174-175).

[3] There must be a printing error in the text. Tibetans referred to China as Rgya nag, to India as Rgya gar, and to Europe as Rgya ser. The Dalai Lama knew about Europe: his autobiography mentions that he received gifts from Europe several times; they were brought by Galdan Boshugtu Khan (1644-1697, a leader of the Zunghar Khanate); he also had contacts with Russians.

of their work was entitled *The Tibetan translation of the Kangxi emperor Chinese astronomical works* (*'Jam dbyangs bde ldan rgyal pos mdzad pa'i rgya rtsis bod skad du bsgyur ba*), or in short *The great Chinese astronomical compendium* (*rGya rtsis chen mo*). This is a compilation of thirty-two texts in about eight hundred Tibetan *dpe cha* style folios. In brief, it contains all the important Jesuit astronomical works in Chinese. For example, it is easy to see that two 'Tables of the orbit of the Sun' (*Nyi ma myul ba'i glegs bam*) were a translation of *Richan biao* 日躔表, the author of which was the Italian Jesuit Giacomo Rho (1593-1638). These tables are part of the late Ming astronomical compendium *Chongzhen lishu* 崇禎曆書 (*Astronomical writings of the Chongzhen reign*; Chan 2002: 311-12). This established an initial stage of transmission that led finally to the adoption of Jesuit calendrical science in the Tibetan Buddhist world.

In their astronomical writings, these Tibetan scholars never mentioned the Jesuits or their roles at the Qing court. This Jesuit astronomy is known as *Huangli, rGya rtsis gsar ma* and *Gong ma'i ser rtsis gongmai sertsi* (Imperial yellow astronomy), and sometimes its name is even given as 'the astronomy of emperor Mañjuśrī' (*'Jam dbyangs gong ma'i rtsis*), without any mention of the history of the Jesuits and their role in calendar reform at the imperial court. This is puzzling. At that time in Beijing, Tibetan Lamas who were involved with the translations of the *rGya rtsis chen mo* and authored the *rGya rtsis rnying bsdus* (*Collected works on the essence of Chinese astronomy*), must have known that the originators of this astronomy were Jesuits, and that the Qing adopted the imperial calendar according to their mathematics. Among monk astronomers in Amdo, and particularly in Labrang (*bla brang*) Monastery, one of the largest Gelugpa (*dge lugs pa*) monasteries in Tibet, this type of r*Gya rtsis gsar ma* was widely known as 'astronomy of heretics' (*mu stegs pa'i rtsis*), a name which implied that it did not originate from China (Yongdan 2015: 176).

Why did they not write about the Jesuits and their roles in calendar-making science at the Qing imperial court? There are several possible explanations for this. Firstly, it might be that those involved with translating, writing and transmitting information to Beijing deliberately misled Tibetans about the history of this calendrical system because they feared that Tibetans might reject it if they found out it was written and inspired by Jesuit missionaries, and not Buddhists. In promoting these works as originating from the Qing emperors, who were often referred to as Mañjuśrī, the symbol of Buddhist transcendent wisdom, they might have believed that this made it easier for Tibetans to accept and study this astronomical knowledge. In this case, it may have been a deliberate attempt by those who were initially involved with this project of transmission to obscure the origin of the information.

Secondly, it may have happened that the people who brought this knowledge to Tibet, as well as the people who studied it, did not care much

about the origin or the authors of this astronomical system as long as it worked better than the existing systems. Astronomy was an integral part of Tibetan culture, and was one of the ten fields of Tibetan knowledge systems (Roesler 2015: 36-37). Anyone, whether Buddhist or not, who aspired to become a Bodhisattva, a Buddhist saint, had to study all fields of knowledge. This liberal and inclusive way of thinking might have helped open the path to studying these subject areas, without caring about their origin or authorship.

Thirdly, like *rGya rtsis chen mo*, if this work was produced under direct order, in other words "imperially commissioned", there was no reason to mention the names of Jesuits and their role. The court used this kind of knowledge to exert influence on its subjects. It would be a fascinating topic to pursue if sources were to be found to support this claim. So far, however, I have not found a single source to suggest that the Qing emperors, except Kangxi, used this Jesuit knowledge to exert influence in Tibet. On the other hand, I have found that Tibetans used a variety of ways, both open and secret, to bring this knowledge to Tibet. Therefore, a scenario whereby Jesuits themselves brought astronomical systems to Tibet is unlikely. It is far more plausible that Tibetans brought this knowledge system to Tibet and adopted it as their own. Importantly, nobody challenged its usefulness, and all astronomers widely accepted that its system, in terms of predicting solar and lunar eclipses, was better than the existing Tibetan astronomical system.

In this article, I shall engage with the second phase of how the Jesuits' astronomy came to Tibet, and how it was studied and used by Tibetan astronomers in subsequent years.

In doing so, I shall first describe how a Tibetan Buddhist astronomer in Beijing wrote a manual for predicting solar and lunar eclipses, how it was secretly transmitted, and how this astronomical work became the basis for Jesuit style astronomical activity in Amdo. Secondly, I shall examine the impact of this Jesuit-inspired work on the traditional calendrical science and time-reckoning systems in Amdo. Finally, I shall look briefly at the proliferation of Jesuit-inspired literary works in Tibetan, and how this continues as a living tradition, in spite of the loss of so many Tibetan traditions in recent Tibetan history.

A Tibetan Buddhist Astronomer in Beijing

The initial Tibetan engagement with the Jesuits' astronomy occurred in the early eighteenth century in Beijing, and was by imperial order. The translation into Tibetan of some of their treatises under the title *rGya rtsis chen mo* in 1715 played an important role in the dissemination of astronomical ideas into Tibetan Buddhist worlds, both in Tibet and

Mongolia.[4] In practical terms, however, the result of this translation was not that fruitful, largely due to a lack of fluency in the language. Moreover, the idioms often did not make sense because it seems that the translators did not fully understand the texts that they were translating (Huang and Chen 1987: 605). So, until 1744, there is no evidence to suggest that Tibetans had studied deeply or engaged with the Jesuits' works. This circumstance totally changed, however, during the Qianlong reign (1736-1795). In 1744, a Tibetan Buddhist astronomer who lived at the Yonghe Gong 雍和宫 monastery in Beijing wrote a manual for predicting solar and lunar eclipses in Beijing and Amdo.

The full title of the work is 'From a section of Chinese astronomy, the study manual on solar and lunar eclipses mainly in the great imperial city of Beijing' (*rGya rtsis las rgyal khab chen po'i Be jing gnas ba'I yul gru gtso bor byas te nyi zla gza'a 'dzing brtags tshul*). Unlike the *rGya rtsis chen mo*, this work is not a translation. Rather, it was a practical booklet to predict solar and lunar eclipses. As I shall describe later, its cosmology and mathematical procedures are essentially Jesuit astronomy. This book appears to be sections of Chinese astronomical treatises, because it says *rGya rtsis las*. In Tibetan, *las* is an ablative case particle, which indicates this might be part of a larger work.

This book is also known by its short title, *rGya rtsis rnying sdus.* Like other Tibetan astronomical works, it is written in the form of stanzas; each stanza is made up of four lines of seven syllables. In simple language and style, it describes practically the mathematical calculations and tables for predicting solar and lunar eclipses according to the Jesuits' methods. It is not a long text: in the modern edition it has about eleven large pages. It begins with a short prayer paying 'homage to the master', and goes on to describe mathematical applications of predictions of solar and lunar eclipses. In doing so, firstly, it talks about the movements of the sun and moon, which it divides into yearly revolution (*spyi 'khor*) and rotation (*rang 'gros*), and how these movements correspond to numbers. From these principal movements, the text goes on to describe how years, months, days and hours in Beijing are calculated in relation to celestial movements. Then it describes the mathematics of solar and lunar eclipses, explaining how these are determined mathematically in relation to the geographical location of Beijing. Finally it goes on to discuss issues relating to the longitude and latitude of Lhasa. There are no descriptions of the shape of the earth, sun, moon and stars in the text, and no explanations for cosmological models. Overall, it mainly focuses on the mathematical aspects of astronomy, especially calculation. It is fair to say

[4] For the detailed background of the translation of and the translation and contents of the *Rgya rtsis chen mo,* see Yongdan (2015).

that this work led to the beginning of the transmission, adoption and finally the spread of the Jesuit-reformed calendar in Tibet.

The question remains, however, as to how a Tibetan Buddhist was able to learn the Jesuits' astronomy. It had to do with the imperial court's decision to train natives, including Manchus, Mongols and Tibetans in the system of astronomy used by the Jesuits. As early as the 1660s, Kangxi began to promote knowledge of astronomy. In 1712, he established the Office of Mathematics (Suanxueguan 算學館) and appointed his third son, Yinzhi 胤祉 (1677-1732), as its head. The role of this office was to compile authoritative works on mathematics and astronomy, a way for him, so to speak, to share his mathematical knowledge with Chinese literati (Jami 2012: 260-283). Kangxi's policy and practice were continued after his death. During the Qianlong reign, Tibetan Lamas were deeply involved with studying and producing calendars at the court. Along with specialists such as Minggantu 明安圖 (d. 1763?), a Mongolian astronomer, a Lama from Tibet also studied advanced European mathematical knowledge (Han 2014: 1223). The creation of the Yonghe Gong monastery in Beijing institutionalized and legitimized the study of the Jesuits' astronomy by Tibetan Buddhists. This monastery played a key role in transmitting the Jesuits' works to the Tibetan Buddhist world: it became the center of learning for this astronomy.

The Yonghe Gong was the former residence of Yinzhen 胤禛 (1678-1735), or Prince Yong 雍, Kangxi's fourth son. In 1722, after Prince Yong ascended the throne as the Yongzheng emperor (r. 1723-1735), he converted half of the building to a Buddhist temple. Driven by filial piety and the influence of Tibetan Buddhism, in 1735, in order to commemorate the deceased Yongzheng emperor, the Qianlong emperor converted this temple into a Tibetan Gelugpa monastery known as Yonghe Gong in Chinese and Dga' ldan bying chags gling in Tibetan. As an imperial project, the monastery attracted many great scholars from the Tibetan Buddhist world. In order to train young monks, in 1744 Qianlong ordered Chankya Rolpai Dorje (Lcang skya Rol pa'i rdo rje, 1717-1786), a Tibetan Buddhist polymath at the imperial court, to invite Lamas and teachers from Tibet to the monastery. He consequently invited eighteen *dge bshes* (those who had attained the highest Buddhist degree in the Gelugpa tradition of Tibetan Buddhism) to teach there (Tuken Chökyi Nyima 1989: 220).

This monastery consisted of several colleges, each specializing in particular subjects. For example, the debate college studied Buddhist philosophy, while the students of the medical college studied Tibetan medicine. 'Kalācakra College' (*Dus 'khor grwa tshang*) focused on the study of the *Kalācakra tantra,* which was associated with astronomy and calendar making. It was the students of this college who studied mathematics and astronomy. One of the great scholars attracted to the monastery was its first abbot, A kya'a Blo bzang bstan pa'i rgyal mtshan (1708-1768), a Tibetan

astronomer from Amdo. He not only actively participated in the monastic education system, but also wrote extensively on many subjects, including several pieces on *rgya rtsis.* He also introduced Tycho Brahe's cosmographical model and the Pythagorean theorem to Tibet (Blo bzang bstan pa'i rgyal mtshan 2000).[5]

All this indicates that the college was heavily involved with studying Jesuit mathematics and producing imperial calendars. In 1950, when the Chinese government took over monasteries, the Beijing City Government ordered all the possessions of the Yonghe Gong monastery to be catalogued, including its astronomical instruments. Yi Shitong 伊世同 (1931-2008), a Chinese scholar, assisted with an inventory of the astronomical and mathematical instruments and other cultural relics kept at the Kalācakra Hall, also known as Hall of Mathematics (*Shuxue dian* 数学殿) in the monastery. In the course of this assignment, he found a European celestial globe, an armillary sphere and a sundial. He attributed all these instruments to Johann Adam Schall von Bell. He also claimed that the presence of these instruments there shows that the monks had frequent academic contact with the Astronomical Bureau (Qintianjian 欽天監) and shared the responsibility of making calendars. He moreover stated that the Qianlong emperor twice ordered, in 1744 and 1754, the production of two celestial globes for the Imperial Observatory in the Yonghe Gong monastery (Yi 1998). In the winter of 2008, I also saw an armillary sphere of European style at the Kalācakra Hall there.[6]

While most Tibetan scholars agree that the *rGya rtsis snying bsdus* was produced in the Yonghe Gong monastery, there is great debate and controversy over the author of this work. The main reason is that there are two contradicting colophons in the text, the first stating that Rtsis rams pa Bzod pa rgyal mtshan was the author, the second questioning the reliability of the first. To date no one has been able to identify its real author. The first colophon states:

> ཞེས་རྒྱལ་ཁབ་ཆེན་དོ་དེའི་ཨིང་གནས་པའི་ཡུལ་ཐུ་གཙོ་བོར་བྱས་ཏེ་ཉིའི་གཟའ་འཛིན་བརྒྱས་ཚུལ་འདི་ནི་དཔའ་རིས་མཐུ་ཡང་དགོན་གྱི་བཙོད་པ་རྒྱལ་མཚན་གྱིས་སྦོན་དོར་ན་མཐས་པའི་ངག་སྦོས་ལ་བརྟེན་ནས་ཅི་ནའི་ཚེས་གཉིང་རི་བཞིན་དོན་འགྲུར་བྱས་ནས་བིས་འདི་ཉིད་ས་སྐྱེང་གུན་དུ་འཕེལ་གྱར་ཅིག།
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> This book, which focuses on solar and lunar eclipses in Beijing and its surrounding places, was written by Rtsis rams pa (a person who has a mathematical degree) Bzod

[5] I discuss these in detail in my forthcoming article on the introduction of the Pythagorean theorem to Tibet in the mid-eighteenth century.

[6] In 2014, when I returned to the monastery, the European armillary sphere was no longer there. It is extremely difficult to find out anything more about these instruments. Are these instruments permanently lost along with the astronomical education in the monastery?

> pa rgyal mtshan from Ma'a yang monastery in Dpa'a ris. He studied these mathematical works from the masters who know a great deal about Chinese mathematics. This treatise mainly focuses on Chinese astronomical ideas and hopefully this treatise will spread throughout the world. (*rGya rtsis snying bsdus* 2006: 1386)

This colophon clearly states that the author was Ma'a yang Bzod pa rgyal mtshan. However, the second colophon states:

> རྒྱ་རྩིས་འདི་མ་ཡང་རྩིས་དཔེ་ཪྩོག་ནས་བཏུས་བྱང་ཡང་འདི་བཞིན་སྣང་ཀཱཔྷན་ལེའི་ཨིང་ཡུང་དགོན་དང་སོག་ཡུལ་དུ་ཡང་རྩིས་འདི་དར་སོ་ཆེ་བས། དགེ་དུའི་ཚེའི་རྩིས་མགོའི་ཚ་དང་རྒྱ་འཛོམས་འདི་ཁོ་ན་ཤུར་འདྲག་པ་བདག་གིས་མཐོང་ཁོང་ཚོས་འདི་སྐྱོན་ཡུང་དགོན་རྩིས་རམས་པ་མཁས་པ་ཞེས་ཏེ་དེའི་ཚལ་ཚེར་ལ་སྣུར་བྱང་མི་སྣང་ངོ།
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> This work was transcribed from the astronomical collection of Ma'a yang Bzod pa rgyal mtshan. The colophon also said that it was written by Ma'a yang. However, this kind of astronomy was widely practiced at the Yonghe Gong in Beijing, and in Mongolia. I also saw that the astronomical books from these places (Beijing and Mongolia) used similar beginnings of the year and computation tables. According to some people [who studied these books], this work was said to be written by a Mathematician at the Yonghe Gong monastery. Most of the books [which I saw in Beijing and Mongolia] did not have colophons. (*rGya rtsis snying bsdus* 2006: 1386)

Thus, the author of this second colophon questions whether Ma'a yang Bzod pa rgyal mtsan was in fact the author. In general, in the Tibetan literary tradition, the colophon was not a part of the work, and therefore was not written by the author himself. So, without question, neither of the two colophons were written by the author himself; hence the uncertainty about the authorship.

By following the first colophon, Huang Mingxin 黄明信, commonly known in Amdo as Bsod nam rgya mtsho, a Tibetan former monk of Labrang Monastery, and Chen Jiujin 陈久金 participated in this debate. They speculated as to who the author of this important text might be, and in the Tibetan version of their bilingual work, which is slightly different from the Chinese one, named several possible authors. They wrote:

> རྩིས་ལུགས་འདི་བོད་ཡིག་དུ་འབེལ་བས་མཁན་བཙོང་པ་རྣམས་མཚན་ཡིན་མིན་དང་། ཚོ་རྩོམ་རིག་མ་ཐག་དང་པོའང་ཡིན་ཀ་མེད་པ་གང་ཞེག་རྩིས་སྐྱིང་བསྡུས་ཞེས་བའི་དུས་ཚོད་གི་མིང་དེ་གཞན་དང་འདྲལ་པ་སེལ་ཕྱིར། སྐབས་ཀྱང་ཚོས་སྣུར་ན་མི་འཐད་པ་མེད་སྣམ་དུ་སེམས།
>
> There have been disagreements about whether Ma'a yang Bzod pa rgyal mtshan was the person who wrote it in Tibetan, and when this work actually was composed. Whatever the case, prior to this work, this (kind of work)

> did not exist in Tibetan; we think that there will not be any disagreement if we say this work has the characteristics of Ma'a yang. (Huang and Chen 1987: 606)

Then they go on to describe the background of this Lama, including his monastery. In short, they characterize this work as 'Ma'a yang astronomy', and attribute this work totally to Ma'a yang Bzod pa rgyal mtshan. The latter was commonly known as Ma'a yang Paṇḍita; Ma'a yang is the name of a monastery and 'Paṇḍita' is the short title for scholars who have mastered several Buddhist subjects. This monastery is located in the historical Dpa'a ris region of Amdo.[7] However, I have found a nineteenth century Tibetan document that suggests that Ma'a yang Bzod pa rgyal mtshan was not the author of this text. According to the autobiography of Blo bzang rgyal mtshan seng ge (1757-1849), an important *tulku* and the head of the Gtsos dgon pa Monastery in today's Gannan 甘南 prefecture in Gansu, in 1840 he invited Ma'a yang Bzod pa rgyal mtshan to teach Chinese astronomy and Tibetan poetry at his monastery; the latter stayed at the monastery for one year (Blo bzang rgyal mtshan seng ge: 170). This clearly suggests, therefore, that Ma'a yang Bzod pa rgyal mtshan could not have been the astronomer who wrote the *rGya rtsis snying bsdus* in 1744.[8]

Although this work was the most important book on Jesuit astronomy in Tibetan, to my knowledge, it was never carved on woodblocks in Tibet or elsewhere, even though it was readily available in most monasteries in Amdo. Usually, it was hand-copied by people if they wanted to have a copy. In Labrang Monastery, for example, the book was readily available to anyone who wanted to study it, but a student would have needed to borrow the work from other students. In 1987, Huang Mingxin and Chen Jiujin translated this text into Chinese, annotating it and researching the astronomy in it (Huang and Chen 1987, pp. 353-689). They did the same with *Rig ldan snying thig* (The heart of Shambhala Kingdom), an astronomical work based on the Kalācakra traditions of astronomy, written by a scholar named Phyag mdzod Gsung rab (Huang and Chen 1987, pp. 2-349).

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[7] This lies in today's Mayingxiang 马营乡 Township in Minhe Hui 民和回 and Tu 土 Autonomous County in Qinghai province.

[8] Ma'a yang Bzod pa rgyal mtshan appears to have lived a long life. In 1889, he met a British missionary named Arthur T. Polhill-Turner (1862-1935) in Amdo, and they had interesting debates about Christianity and Buddhism. Both kept notes on these debates in their respective languages.

A Spherical Earth in Tibet[9]

How did the *rGya rtsis snying bsdus* differ from other astronomical and calendrical works in Tibet? This question involves complex astronomical and mathematical computations as well as knowledge of the history of the science of Tibetan calendar making. This subject itself is very complex and multi-dimensional, so it is not my intention to go into it fully in this article. However, in order to make it easier to understand, some astronomical and mathematical concepts can be used to demonstrate how this system differed from the Tibetan system. First of all, as mentioned earlier, the *rGya rtsis snying bsdus* is a European-inspired work; therefore its astronomical model is European. Although some Jesuits also introduced the Copernican system to China (Sivin 1973), the imperial court adopted the Tychonic system, a cosmographical model developed by Tycho Brahe. According to this system, the earth lay motionless at the center of the Universe: the sun and moon orbited around it, while the Five Planets in turn orbited around the Sun (Hashimoto (1988)).

As early as 1715, the names of Tycho Brahe and Johannes Kepler were already mentioned in one of these mathematical translations.[10] However it appears that none of the Tibetan astronomers had further explored the difference between the Tychonic system and the heliocentric system, which Kepler upheld like Copernicus. Thus, the Tibetan model more likely to have been adopted was geocentric rather heliocentric. Still, the idea of a spherical earth, which was alien to the Kalācakra cosmological system, was introduced into Tibet at the time. The nineteenth century astronomer Thub bstan Rgya mtsho, of Labrang monastery, wrote:

འཇིག་རྟེན་ས་གཞི་རྒྱམ་པོ་འདིའི།ཞེང་ཐད་ཀྱི་ཆ་གཅིག་སྐར་རྣམས་བསྟེགས་ཚུལ་འགོར་བའི་འགྲོས་དཀའ་གིས།།ཆ་བཞག་ཏེ། མ་སྤྲོས་པར་འདོད་ཀ།།ཆ་ས་གཞི་ཀྱི་མ་རྣམས།།ཁང་དྲང་བའས་ཚོ་ས་གཞི་ཡིས།།ཁྱེའུ་མ་དཀྱིལ་འགོར་ལ་ལོག་པར།།ཆ་འཛིན་སྣང་བ་ཟླུང་བར་སེམས།།

[9] Based on a 1938 article by the scholar Dge 'dun chos 'phel (1903-1951) for the Tibetan-language newspaper *Me long*, published by the Tibetan Christian Khunu Tharchin (Khu nu Mthar phyin, 1890-1976), many western scholars assume that Tibetans believed in the 'flat earth theory' even in the face of all modern geographical knowledge. However, this is far from the truth. In reality, it was Dge 'dun chos 'phel who ignored and did not understand *rgya rtsis*. Had he studied *rgya rtsis* and seen the large spherical globe painted on the wall of the Kye rdor grwa tshang in Labrang Monastery, he would not have made this error.

[10] See *Bsnol bar 'dzin pa'i ngos 'dzin*, vol. Pa (9), f. 1: when discussing European works on triangle measurement (trigonometry), this work mentions the name of Johannes Kepler (1571-1630): 'Kepler, a friend of Tycho' (ཁེ་བ་ཨེལ་ཏི་གུའི་ཐོག་པོ།, *Khe pa el Ti gu'i grogs po*).

> The physical earth is spherical; the sun, moon, and stars orbit above and below it. Because of this rotation, the sun is blocked by the moon, and a solar eclipse occurs; when the sun, moon and earth rotate into a straight line, the earth's shadow blocks the moon and a lunar eclipse occurs. (Thub bstan Rgya mtsho 2003, vol. 3, p. 96)

Secondly, unlike the Tibetan time-reckoning system, the system introduced in the *rGya rtsis snying bsdus* divides the year into twenty-four solar periods, known as *dbugs skang nyer bzhi* in Tibetan and *jieqi* 節氣 in Chinese. These twenty-four seasonal markers divide the ecliptic circle into as many sections of 15° each (Tshe tan zhabs drung 2007, vol. 7: 341). Six of these periods make up a season, which corresponds to 90° on the ecliptic circle. The ecliptic circle is also divided into *du'u* 'degrees'. In the Chinese traditional system, there were 365.25 of these, which Adam Schall replaced with 360 degrees, using angular measures (Elman 2005: 203). The Chinese name *du* 度 was kept, while its meaning changed; adopting the new system thus entailed accepting that the ecliptic circle was divided into 360 degrees instead of 365.25 *du*.

Thirdly, just as the Jesuits did, the *rGya rtsis snying bsdus* also treats Beijing as the prime meridian, the imaginary line adopted as the zero of longitude. From this imaginary line, the difference between local time and time at the prime meridian was calculated:

> དེ་ཤར་ན་བོད་ཡུལ་ཨེད་རྒྱལ་ཁབ་ནས་ཧོ་སྨད་ཀྱི་ཚར་གཏོགས་པས།འཆར་ཀྲའ་ཀུང་འདི་ལ་སྔང་ཟད་འཕྱི་འདུ་ཞིང་།ས་ཆ་འདིར་ཉེན་ཉེད་རྟའི་དགུས་གུ་ཉི་མ་འཛོན་རིང་ན་བོད་དུ་ཉེན་ཉེད་སྔང་མ་སྐེབས་པའི་སྐུལ་ཀྱི་དུས་ཉི་མ་འཛོན་པར་མཐོང་བ་དང་།འདིར་ནམ་ཉེད་ཀྱི་བའི་དགུས་ཤ་ཏུར་རྟ་བ་འཛོན་པའི་ཚེགོང་དུ་སོང་ལགོར་ཡག་གི་དུས་འཛོན་པ་འོང་།

> As it is, Tibet is located to the lower southern (*sic*) side of this imperial city (Beijing), so rising and setting times will be later. If this place (Beijing) is at noon, Tibet is not at noon yet. So, if a solar eclipse occurs at the middle of horse hour (12.00 noon) here, it will occur at the snake hour (9 a.m. to 11 a.m.) in Tibet (Lhasa). (*rGya rtsis snying bsdus* 2006: 1386)

This shows the difference between times and locations in Beijing and Lhasa.[11] In doing so, it also points out the difference in longitude because the

[11] The exact location of Lhasa was a mystery to Europeans until it was calculated by the British in 1866 through the observations made by the Pundit Nain Singh. Based on the Pundit's earlier observations at Lhasa, Thomas George Montgomerie had concluded that Lhasa lay at Longitude 90° 59′ 30 (Montgomerie 1867: 172, Waller 1990: 124). He also concluded that was these observations were one of the great achievements of these Pundits, and Singh received the Gold Medal from the Royal Geographic Society in London ten years later "for his great journeys and surveys in Tibet and along the upper Brahmaputra, during which he determined the position of

difference in time is equivalent to the difference in longitude (there is a one hour time difference for every 15 degrees of longitude). The longitude of Beijing is 116.3833° E and that of Lhasa is 91.1167° E, which means that the time difference between Beijing and Lhasa is about one hour and a half (Goldstein 2007: 217).

Thus, from both the mathematical and cosmological points of views, without any doubt, the *rGya rtsis snying bsdus* is a work on European astronomy written by a Tibetan Buddhist author. As mentioned earlier, it was written in simple language and style, it was detailed and provided practical calculations and tables for predicting solar and lunar eclipses. Thus, anyone who studied and used this work could follow all the mathematical procedures required to predict solar and lunar eclipses according to the Jesuits' methods. The arrival of this knowledge to Tibet, and how Tibetans actively studied and used it, represents the firm establishment in Tibet of the Jesuits' astronomy.

How did the *rGya rtsis snying bsdus* come to Tibet?

It is difficult to know how, when and by whom this introduction to imperial calendrical science came to Tibet. In the nineteenth century, when Tibetans were openly discussing its history, all the Tibetan scholars who have written on this subject were of the opinion that, unlike the *rGya rtsis chen mo,* the *Rgya rtsis snying bsdus* was brought to Tibet secretly by a Tibetan astronomer, at considerable personal risk. There was no question about the Kangxi emperor's involvement in the translation of the *rGya rtsis chen mo*, as it was done openly with Mongolian and Tibetan scholars. Whether it was just because Kangxi was interested in astronomy or because he hoped that he could exert political power over Tibetans, this translation was done by his order, with a clear mandate. We know the names of these scholars and, in some cases, their biographies (Yongdan 2015). If we compare this case with the writing of the *rGya rtsis snying bsdus* and how it was brought to Tibet, we notice that two differences emerge. Firstly, in the latter case we do not even know the name of the author. Secondly, there are no historical sources indicating clearly how the *rGya rtsis snying bsdus* was brought to Tibet. Since the second half of the nineteenth century, however, Tibetan scholars have largely been of the opinion that the document was transmitted by confidential means.

In general, the making of the calendar was a very serious undertaking at the imperial court, as the calendar could not be made without imperial

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Lhasa and added largely to our knowledge of the map of Asia"(Hanbury-Tenison 1993: 61).

approval. The right of producing calendars and predicting solar and lunar eclipses belonged solely to the emperors and the imperial court (Elman 2005: 62). During the Kangxi reign, the imperial court was more open to studying and engaging with calendrical astronomy, but it would be an exaggeration to say that there were no restrictions. Even in the early eighteenth century, while ordering the translation of some astronomical works based on European methods into Mongolian and Tibetan, Kangxi strove to retain imperial arbitration on this field of knowledge (Jami 2012). In the nineteenth century, almost a century and a half after the booklet was said to have been produced in the Yonghe Gong monastery, Tibetan scholars have debated how it was transmitted to Tibet. The Tibetan scholar Gser tog blo bzang tshul khrims rgya mtsho (1845-1908) discussed the general development of *Huangli* in China, and how it was distributed during the Qing dynasty (without mentioning the Jesuits). In talking about its coming to Tibet, he wrote:

> དེས་ན་འཕྲོང་ས་འཕྱལ་བ་རྣམས་ཀྱི་ནང་ནས་ཆོས་ཞེས་པ་འདི།ཡུལ་ཕྱོགས་གང་གི་རྒྱལ་ཁབ་ཅན་ཆེན་པོའི་ཐེམ་པ་ལས་མི་འདའ་བའི་ཚེས་ཡིན་པའི་གནད་ཀྱིས།རང་ཙག་ཚའ་འབའ་ཞིག་རྒྱ་ཡོངས་ལ་ཤེས་རྒྱའི་དགོས་དོན་རྒྱ་ཙམ་ཡང་མེད་པའི་ཕྱིར་མཚན་གྱིས།

> Since this element of imperial astronomy in China could not be taken out beyond the steps of the imperial palace, we ordinary monks and lay people [in Tibet] need not know about it at all. (Gser tog blo bzang tshul khrims rgya mtsho 2000-2011, vol. 7, p. 122)

This statement referred to the *Huangli*, and how it was brought to Tibet. And it appears that its author was uncomfortable about it.

Thub bstan Rgya mtsho, the nineteenth century astronomer of Labrang Monastery mentioned above, wrote a popular commentary known as *The Flower Offering of* Mañjuśrī (*'Jam dbyangs mchod pa'i me tog*). In the colophon to this book, after mentioning the translation of the *rGya rtsis chen mo* during the Kangxi reign, he comments on the person who brought this type of astronomy to Amdo as follows:

> བོད་ཀྱི་རྒྱལ་ཁབ་ཐོག་བྱང་ཆེར་ངོ་མཚར་གཏོག་ལག་དེར་ཤུང་བ་ཕུར་བའི་སྤོ་ཕུན་ཞིག་ཚམས་པའི་ལག་རྩལ་བཞག་པ་མཛོང་།

> At the Imperial Palace, someone who had a great talent and far-sighted vision as well as expertise on this subject left this scholarly imprint here.

He continues:

> མི་མཐུན་རྒྱ་རྟག་ཚེས་ཀྱི་ཡུ་མིན་དུյད་གོང་བའི་ཁུང་ལིའི་ཐེམ་ལས་མི་འདའ་མོད།ཞེས་ན་ཡོག་པས་འཆོས་པར་རིགས།

> This special calendar known as the imperial calendar was produced at the Astronomical Bureau so it could not be

> taken out beyond the steps of the imperial palace. In engaging with this, I might have committed some crimes, please forgive me, those who know the system. (Thub bstan Rgya mtsho 2006: 1401)

Still, the clearest reference comes from the colophon of Bsam 'phel dbang gi rgyal po (China's astronomical treatise known as the wish-fulfilling king), written by Mkhyen rab nor bu (1883-1962).

> འཕགས་ལེན་དུ་མེད་ཐབས་མེད་པའི་ཉེ་རྒྱ་གཟའ་འཛིན་གཙོ་བོ་སྒོར་པའི་ས་རིམ་འདི་བཞིན་རྒྱལ་ཁྲིམས་སུ་བཙང་པ་རྣམས་དངོས་ནས་བཀག་རུང་དམ་བསྒགས་ཤིན་ཏུ་ཆེ་ཡང་།ཏ་འདོད་ནང་ཙམ་ནས་དང་སྤྱོད་ཀྱི་ཐབས་སྣ་ཚོགས་ལ་བརྟེན་ནས་ཞི་རིམ་བཞིན་འདུག་པ།།
>
> This manual on solar and lunar eclipses, in great demand, was strictly controlled by imperial law [in Beijing], so Chinese masters on this subject put great restriction on its use. However, through open and secretive methods and dedications, from Rab 'dod (1747-1806) this Chinese astronomy was transmitted into the Amdo area (Mkhyen rab nor bu 2006: 1425).

All this suggests that both open and secretive means were used to transmit this knowledge to Amdo. It also suggests that the *rGya rtsis snying bsdus* manual and its knowhow might have been brought to Amdo after it was composed in Beijing in 1744. If we follow these nineteenth century scholars, since this knowledge was strictly controlled by the imperial court, secrecy appeared to be the only way to bring this knowledge to Tibet. It is worthy of note that it was not only Tibetans who tried to acquire this Qing knowledge clandestinely. Secrecy was also used by Korean astronomers in the seventeenth and eighteenth centuries. They came with a Korean embassy in order to obtain the astronomical knowledge which was kept under the watchful eyes of the Qing Astronomical Bureau (Lim 2014). Whatever the case, if astronomical knowledge was brought to Amdo without imperial permission, this would most likely have been considered dangerous.

While we do not know who first brought the *rGya rtsis snying bsdus* to Amdo nor how it spread to the monasteries, we do know that it initially came to the Dpa'a ri region of Amdo. The Dpa'a ri region of Amdo was a multi-ethnic and cross-cultural space where several groups—Chinese, Mongols and Muslims—had lived for centuries. It was considered as a corridor to Xinjiang, Mongolia and China. Many important Gelugpa monasteries were located in this area, and imperial Lamas such as Lcang skya Rol pa'i rdo rje (1717-1786), and Btsan po No mon han (1779-1839), the author of the world geography text known as the *'Dzam gling rgyas bshad* came from this area (Yongdan 2011). Thus, it is not surprising that the *rGya rtsis snying bsdus* came to this region first. From there, it spread all over Amdo.

When it came to Amdo, Tibetan astronomers were already engaging in discussions about cosmological and calendrical reforms. This work became the catalyst to accepting the Qing imperial time-reckoning system in Amdo. It also provided crucial calendar-making techniques for predicting solar and lunar eclipses according to the imperial calendrical system. As elsewhere in Tibet, there was no unified or central authority in the early eighteenth century for calendar making in Amdo. The time-reckoning system was left to monasteries such as Labrang and Kumbum (Sku 'bum), who produced their own calendars. Among these calendars, two systems were well known: the *phuk* tradition and the *tshur* tradition. However, at the beginning of the seventeenth century, as Gelugpa monasteries were quickly being built and the influence of central Tibet was increasing, the *phug lugs* calendar system also became influential in these monasteries in the Amdo region. At the same time, there were also great debates about the accuracy of these calendars, and what kind of calendar system should be used in monasteries such as Gönlung (Dgon lung) and Kumbum.

We can see these debates and discussions from the point of view of the Buddhist scholar Sum pa ye shes dpal 'byor (1704-1788), commonly known as Sum pa Mkhan po. He descended from an Oirat family established in Amdo. He studied in Lhasa and travelled a great deal in Mongolia and China. He was a great scholar, well known as the author of a new Gelugpa calendar.[12] As he explained in one of his responses to a scholar in Kumbum monastery:

> ཕྱིས་སུ་རྩིས་ལ་གོ་བ་ཟབ་ཐུན་ཆགས་ནས་ཉིན་མོ་ས་རིས་ཕྲིས་ནས་མཚན་མོ་ཞག་ཕུང་དུ་མར་མིག་གིས་གཟའ་ཟླ་བ་གཟའ་ལྷ་སོ་སོ་ནི་རྒྱུ་སྐར་ཉེར་བདུན་དང་ཇི་ལྟར་འགྲོག་པ་དང་ཕྱིར་ལོག་སོགས་བྱེད་ཚུལ་ལ་བལྟས་ནས།...རང་ལུགས་ཐུན་མོང་མིན་པ་བཞག་ལ།...དེ་ལ་དགའ་ལྡན་རྩིས་གསར་དུ་མིང་དུ་བཏགས་པས་ཕྱིས་པཎ་ཆེན་རིན་པོ་ཆེ་བློ་བཟང་དཔལ་ལྡན་ཡེ་ཤེས་པས་ལྷ་སར་མཁས་མང་འདུས་པ་དང་སྔན་དུ་མདོ་སྔགས་ཀྱི་འཆད་ཉན་མཛད་སྐབས་ཤིག་ཏུ་དགའ་ལྡན་རྩིས་གསར་ཟེར་ཞེས་བའི་ལུང་བསྟན་ཡོད་ཅེས་གསུང་འདུག་པས་སེམས་སྐྱོ།
>
> After gaining some understanding of mathematics in the daytime, I did my calculations, and for many nights I observed the moon and other planets with my eyes... I created my own system of astronomy... which I call the new Gelugpa astronomy. Later on, the Panchen Lama (Blo bzang dpal ldan Ye shes, 1738-1780) told a gathering of many thousands of scholars in Lhasa that the creation of a new Gelugpa astronomy was prophesied in the past (in a book entitled *rJe sprul ba'i glegs bam* (The magical volume

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12 For him, this could have been a political issue, because he was known as a supporter of the Oirats in Mongolia rather than of the Manchus.

> of Je)).[13] I was so happy to hear that. (Sum pa Mkhan po 2015, vol. 6, p. 258)

His new Gelugpa calendar system improved on some mathematical computations, but the time-reckoning system was the same as in the *phug lugs* calendar. Thus, in spite of his popularity in Amdo monasteries, none of the monasteries adopted his as their official calendar.

Recognizing the problems of the calendars produced in China, at one point Sum pa Mkhan po suggested that the people in Amdo should follow the new Gelugpa calendar instead of the one from Beijing. He wrote:

> དེས་མཚོན་པའི་དབྱར་དགག་དབྱེ་སོགས་འདུལ་བའི་དུས་འཛེལ་ཀྱི་ཡས་གང་དང་གང་དཀྲས་གཙང་དུ་སྐར་ཚེས་བྱས་བ་ནི་
> འཁྲིག་ལ་ཁམ་མདོའི་ཡུལ་རྒྱ་རིས་དང་བསྟུན་པ་ལ་མི་འཕྲིག་པ་མང་པོ་ཡོད་པའི་རྒྱུ་མཚན་ནི།
>
> In terms of the summer retreats, the dates of hindrances and others which are related to monastic discipline should be observed using the central Tibet-based calendar. I see many reasons why the people in Amdo should not continue using the Chinese calendar system. (Sum pa Mkhan po 2015, vol 6, p. 221)

In pointing to the times of specific days for Buddhist ritual fasting, Sum pa Mkhan po suggested that the people in Amdo should follow the *phug lugs*-based calendar instead of using the Beijing one.

Besides these intellectual reasons, there may have been political reasons to accept the Jesuit-inspired astronomy in Amdo. While I have not been able to find any documents to suggest that the Qing authorities forced Tibetan Buddhists in Amdo to accept the imperial calendar, it is quite possible that the Qing policies also created opportunities for those scholars who advocated acceptance of the Qing imperial calendar. The 'Great War of Water-Rabbit Year'(*Chu yos dus 'grug chen mo*), also known as Lobsang Tendzin's (Blo bzang Bstan 'dzin) war, might have further fuelled the issue, as it was the year Amdo was incorporated into the Qing realm. In 1723, the leaders of Amdo went to war against the Qing dynasty, and the Qing army crushed the Mongol-Tibetan alliance. The Qing court then incorporated Amdo into the Qing domain, reorganizing the political systems in Amdo while reducing the influence of the large monasteries and local leaders (Perdue 2005: 310-314).

This suggests that accepting the imperial calendar was equal to accepting Qing sovereignty, so it is quite possible that the war encouraged some people in Amdo to accept the Qing imperial calendar system. However, the main reason was still most likely that it was Tibetan scholars who initiated and spread it in their teachings, rather than a decision of the Qing court.

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[13] I think this is a quotation from the author as the book title is not written in the Tibetan quotation above.

In any case, in the mid-eighteenth century, someone brought the *rGya rtsis snying bsdus* and its knowledge secretly to the Dpa'a ris region of Amdo. Gradually, some monks in the region not only started to learn this type of astronomy and its calculation, but also started to produce calendars according to this method. It also came to the region when Tibetan astronomers were already debating their own astronomy and methods of calculation. This Jesuit-inspired astronomy and its mathematics were more accurate and sophisticated than Tibetan astronomy, so Tibetans in this region were encouraged to accept it.

The Spread of the Study of Jesuit Astronomy

In the early nineteenth century, this imperial astronomy became public knowledge in Amdo. Many of the large monasteries not only followed the years, months and days of the imperial calendar, but were also making calendars and predicting solar and lunar eclipses according to the imperial calendrical system. This symbolized the final adoption of Jesuit imperial calendrical works in Tibet. Two scholars from Dpa'a ris played important roles in disseminating this knowledge to the monasteries in Amdo. One of these scholars was Ma'a yang Paṇḍita, discussed earlier. Although he was not the author of the *rGya rtsis snying bsdus,* there is no question about his role in promoting the Jesuits' astronomy in Amdo. As already mentioned, he not only went to different monasteries to teach *rgya rtsis,* but also, along with Ser chen zhabs drung, an astronomer, promoted the Jesuits' astronomy as their own astronomical system.

Ser chen zhabs drung was probably born in the early nineteenth century; he was a *tulku* (*sprul sku*) of Zhwa dmar bKra shis chos gling Monastery in the Dpa'a ris region of Amdo. He became very well known among Tibetan astronomers (Tshe tan zhabs drung 2007, vol. 1: 109). In 1861, he wrote a astronomical treatise entitled *Tsi na'i lugs kyi rtsis gzhung bsam 'phel dbang gi rgyal po* (China's astronomical treatise known as the wish-fulfilling king). This book is considered as one of the most important works on *rgya rtsis gsar ma*.

By the mid-nineteenth century, this Jesuit-inspired astronomy was no longer the domain of a few individual monks who studied it. It had spread to other parts of Amdo, too. The monks in Labrang and Rep gong studied *rgya rtsis* and produced calendars according to this method. Among these scholars, Thub bsten rgya mtsho was particularly well known, since he was secretary to an important *tulku* Lama from Labrang Monastery. He wrote several works on *rgya rtsis,* which became the standard textbooks on this subject in this monastery.

The most significant development in the study of the Jesuit-inspired calendar, however, must be the establishment in 1879 of the Kyedor Dratsang (Kye rdor grwa tshang) in Labrang Monastery, a monastic institution which was created solely for the study of *rgya rtsis* and to make calendars according to this method. This monastic college was established by the fourth 'Jam dbyang bzhed pa, also known as Skal bzang Thub bsten dbang phyug (1856-1916). He was the fourth reincarnation of the fourth 'Jam dbyang bzhed pa Nga dbang btson 'grus (1648-1721), the founder of Labrang Monastery. He was instrumental in the revival and spread of the reformed calendar in Labrang. In addition to the study and production of calendars, he also asked monks to make copies of the *rGya rtsis chen mo*. Moreover, he commissioned a large globe for the front of the Kyedor Dratsang. Unfortunately, the original temple caught fire from a butter lamp in 1956 and the new building no longer has this globe.

There were two monastic colleges in Labrang Monastery, 'Kalācakra College' (dus 'khor grwa tshang) and Kyedor Dratsang (kye rdor grwa tshang), that made calendars for each New Year. Every New Year, both colleges had to display their respective calendars in front of the Great Hall or Tsokchen Dukhang (btsog chen du khang) where everybody could see them. There was fierce competition between the colleges over the accuracy of their calendars; in order to produce better and more accurate calendars, they not only measured the time and location (*yul dus*) of the monastery, but also young mathematicians were sent to different parts of Tibet to make measurements, bringing the results back to Labrang. The astronomical calculations were done and the calendars made on the basis of this data. The results would be kept secret until the beginning of the New Year. Then each college had to produce two versions of their calendar, for external and internal audiences. The former was intended for the general public. This was the calendar displayed in front of the Great Hall in the monastery so that everyone could see it. The internal calendar was produced for 'Jam dbyang bzhed pa, the head of the monastery, and his office. This version was very detailed and had all elements of the calendar that the emperor would have enjoyed.

By the early twentieth century, this type of astronomy was not only used in the Amdo area, but had also spread to Lhasa. In 1922, Mkhyen rab Nor bu (1882-1962), a great Tibetan physician and the head of Lhasa Medical and Astrological Institute (*Smen rtsis khang*) asked a visiting scholar, Dgu rong 'jigs bral chos dbyings rdo rje (1877-1932), an important Lama from Amdo, to promote this type of astronomy in Lhasa. In order to teach this method to his students, Mkhyen rab Nor bu also published Ser chen zhabs drung's work with a new colophon. From then on, students in Lhasa Medical and Astrological Institute have used the *rGya rtsis gsar ma* methods and computations to calculate solar and lunar eclipses. Unlike Amdo, Lhasa

scholars kept the old time-reckoning *phug lugs* system, but they used Jesuit mathematics and cosmology to predict eclipses.

The book titled 'Catalogue of some books of flawless white crystal beads' (*Bod kyi bstan bcos khag cig gi mtshan byang dri med shel dkar phreng ba*), also known as the *Labrang Catalogue*, lists more than seventy works on *rGya rtsis gsar ma*. This long list includes the names of the works that make up the *rGya rtsis chen mo*. While most are surely Jesuit-inspired astronomy, some may not be: seventy is my lowest estimate. This *Catalogue* was compiled by several scholars in 1962, suggesting that *rgya rtsis* was not only widely studied, but also transmitted among Tibetan and Mongolian scholars for over two hundred years. Thus, before 1958, Jesuit-inspired mathematics and cosmology was not a peculiar or secret tradition in Amdo. Rather, it was widely studied and used in the monasteries of the region. In August 1958, the Chinese government closed down all monasteries in Amdo and most scholars were arrested, executed or sent to long-term labor camps throughout China. Many were sent to collective farms and nomadic camps as workers and farmers. Bsod nams rgya mtsho, for example, who was Chinese and a former monk at Kyedor Dratsang, was arrested and sent to a labor camp in Xinjiang. From 1958 to 1979, the government essentially perpetrated the dissolution of the monasteries, converting them into large farms or work units (*danwei* 单位). Monastic institutions and traditions were completely wiped out. The calendar-making tradition was totally banned.

Fortunately, when the Chinese government allowed monasteries to re-open in 1979, some scholars were still alive, and they were able to teach these calendar-making techniques to a new generation of young scholars. Among these were 'Jigs med rigs pa'i blo gros, commonly known as Tshe tan zhabs drung (1910-1985), Bsam grub rgya mtsho (1923-2006) and Blo bzang sphyin pa, also known as sMad sog bdzra (1918-2006), all of whom played a critical role in reviving this tradition. Currently, there are some monks who still study this tradition in monasteries in Amdo and make calendars. Thus, it is still a living tradition in Tibet.

Conclusion

The translation of the Jesuits' astronomical works into Tibetan and their transmission to Amdo raise several important questions regarding the Jesuits' mission to China and its impact in Tibet, which are of significance to the history of science.

Firstly, when speaking of the Jesuit mission to China in the seventeenth and eighteenth centuries, we are engaging with the complex history of the interactions of religion and science between the East and the West, and with the politics of the Qing imperial court. However, to date, studies on the

Jesuits' mission to China have, in the main, focused on how the Jesuit missionaries brought some of the emerging European scientific knowledge to China and how they introduced China and its great civilization to Europe. If we look at the context of Tibetan engagement with the Jesuits' works, however, the Jesuits' mission to China had another dimension. The Jesuits themselves did not participate in these cultural exchanges, but their knowledge and ideas were freely exchanged among unintended audiences. The translations of the Jesuits' works into Mongolian and Tibetan, and particularly the Tibetans' efforts at calendar reform in Amdo, suggest that this two-way model between the Chinese and Jesuits may need to be reexamined and revised.

Secondly, although there are many Jesuit works in Tibetan, they have never received the scholarly attention they deserve. Furthermore, the translation of the Jesuits' scientific works into Tibetan and the reform of the Tibetan calendar are much-neglected subjects, both by scholars of the Qing Empire and of the history of science. As far as I know, with the exception of Huang Mingxin and Chen Jiujin's work, there is no research that deals with the impact of this astronomical tradition on Tibetan Buddhist scholars, nor on how Tibetans studied this astronomy before the twentieth century. All of which suggests that this relatively new field of study has great potential that needs to be explored further.

Thirdly, this intellectual history of Tibet is something unusual and somewhat different from other similar contexts. Often, the transmission of European scientific knowledge to the non-western world is attributed to European colonial powers, and is discussed in the context of native responses to these imperialist powers. In the case of the Jesuits' mission to China, the transmission of knowledge was not due to colonial powers, but was associated with European missionaries. In the case of Tibet, this model of transmission did not apply. There were no European powers or Jesuit scientific activities in Tibet. In particular, no Jesuits worked in Amdo. This cross-cultural exchange of ideas, therefore, was motivated purely by intellectual curiosity. It did not involve elements of violence or the presence of European Jesuits. It was initiated by a Manchu emperor and completed by Mongolian and Tibetan scholars. This also suggests that scientific knowledge did not need to be brought by European colonial powers themselves, or acquired through direct involvement with Europeans like missionaries. Indirectly, without any European involvement, Tibetans successfully introduced and adopted these scientific ideas that were famously associated with European missionary and colonial powers.

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