

Astronomy

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1 Lecture 1: The Study of Heaven in Ancient China: An Overview

1.1 *The Special Position of the Study of Heaven in Ancient Chinese Culture*

1.1.1 Three Special Annals on Study of Heaven in Official Histories of Dynasties

In the time when Sima Qian lived, and even long before that, knowledge was well developed of mathematics, metallurgy, textile, architecture, agriculture and physics, and some of them (for example, metallurgy and architecture) were closely related to the national economy and the people's livelihood. But, these branches of learning did not have a place in the *Eight Books of Records of the Grand Historian* written by Sima Qian. Instead, he showed a special preference to astronomy (or study of heaven) and devoted more than two treatises to the subject alone, like a single flower in blossom. Why?

If Sima Qian had been the only person who did so, this could have been explained as his special preference because of the profession of *Taishiling* (Grand Astrologer) passed down from his father. But, it is hard to understand why this practice became the traditional mode in the official history throughout the 2,000 years after him. Take the *Book of Former Han (History of Han)* for example. The *Ten Treatises* of the *Book of Former Han* correspond to the *Eight Treatises* of

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the Records of the Grand Historian. The titles of the two series are listed below for comparison in the original orders:

Eight Treatises on <i>Records of the Grand Historian</i>	Ten Treatise on the <i>Treatise on Former Han</i>
Treatise on Rites	Treatise on Bells and Almanac
Treatise on Music	Treatise on Rites and Music
Treatise on Bells	Treatise on Punishment and Law
Treatise on Almanac	Treatise on Food and Money
Treatise on Astronomy	Treatise on Sacrificial Offerings
Treatise on Religious Sacrificial Ceremonies	Treatise on Astronomy
Treatise on Rivers and Canals	Treatise on Wu Xing (the Five Elements)
Treatise on Price Stabilization	Treatise on Geography
	Treatise on Rivers and Canals
	Treatise on Literature

In the list, the Treatise on Bells and Almanac is a combination of the Treatise on Bells and the Treatise on Almanac, the Treatise on Rites and Music is a combination of the Treatise on Rites and the Treatise on Music, the Treatise on Economy and Finance is roughly equivalent to the Treatise on Price Stabilization, the Treatise on Sacrificial Offerings is equivalent to the Treatise on Worship of Heaven, the Treatise on Astronomy is another version of the Treatise on Constellations, the Treatise on Ditches and Canals equals the Treatise on Rivers and Canals. In addition, the rest four annals, namely, Treatise on Punishment and Law, Wu Xing (the Five Elements), Geography, and Catalogue of Works, are newly added to the *Treatise on Former Han*. Obviously, the content of the Treatise on Punishment and Law and the Treatise on Literature are clear, so we do not have to expound them. The Treatise on Geography is basically equivalent to modern human geography. What is worth attention is the Treatise on Wu Xing—the Five Elements. That is the literature on disastrous and auspicious omens. Still, its fundamental theory is interaction between heaven and mankind for rewards for kind deeds and punishments for the evil—in times of political darkness abnormality and disasters appear and in times of benevolent politics auspicious signs surface. It also contains a great deal of astrology, which roughly belongs to the scope of the ancient study of heaven. In the successive historical records compiled by later Dynasties, these three annals—Astronomy, Bells and Almanac, Wu Xing—are placed in adjoining volumes, only the sequence is different. Among the 25 histories, eighteen have annals. The three annals—Astronomy, Bells and Almanac (only Almanac is listed if Bells and Almanac separated), Wu Xing—in the eighteen histories are listed as follows (in the original order of each history):

- The Records of the Grand Historian:** Book of Almanac, Book of Astronomy
- History of Han:** Treatise on Bells and Almanac, Treatise on Astronomy, Wu Xing (the Five Elements)
- History of Eastern Han:** Treatise on Bells and Almanac, Treatise on Astronomy, Treatise on Wu Xing
- History of Jin:** Treatise on Astronomy, Treatise on Bells and Almanac, Treatise on Wu Xing

History of Song: Treatise on Almanac, Treatise on Astronomy, Treatise on Auspiciousness, Treatise on Wu Xing

History of Southern Qi: Treatise on Astronomy, Treatise on Auspiciousness, Treatise on Wu Xing

History of Wei's: Treatise on Sky Phenomena, Treatise on Bells and Almanac, Treatise on Miraculous Omens

History of Sui: Treatise on Bells and Almanac, Treatise on Astronomy, Treatise on Wu Xing

Old History of Tang: Treatise on Almanac, Treatise on Astronomy, Treatise on Wu Xing

New History of Tang: Treatise on Almanac, Treatise on Astronomy, Treatise on Wu Xing

Old History of the Five Dynasties: Treatise on Astronomy, Treatise on Almanac, Treatise on Wu Xing

New History of the Five Dynasties: Investigation into Astronomical Affairs

History of Song: Treatise on Astronomy, Treatise on Wu Xing, Treatise on Bells and Almanac

History of Liao: Treatise on Almanac and Phenomena

History of Jin: Treatise on Astronomy, Treatise on Almanac, Treatise on Wu Xing

History of Yuan: Treatise on Astronomy, Treatise on Wu Xing, Treatise on Almanac

History of Ming: Treatise on Astronomy, Treatise on Wu Xing, Treatise on Almanac

Draft History of Qing: Treatise on Astronomy, Treatise on Natural Calamities and Abnormalities, Treatise on Shixian Almanac

The treatises in these eighteen histories are not entirely the same as the ten treatises in the **History of Han**. But they have two points in common: One is that they have no place for mathematics, physics, metallurgy, textile, architecture, agriculture, medicine, al-chemistry, and other practical branches of science and technology; the other is that they give eminent place, even the first place, to the *three annals on study of heaven*.

When he wrote *The Records of the Grand Historian*, Sima Qian was bearing in mind that he was to establish his own style. If you say that he has a favor on study of heaven, I may agree reluctantly. However, the successive histories were written officially, representing the most orthodox historical and cultural viewpoint. All of them followed the same mode of *The Records of the Grand Historian*. How come? This indicates that emphasis on the Study of Heaven is not because of a personal inclination of Sima Qian. Instead, there must be an underlying reason. Then what is the reason?

Research on the ancient Chinese history of science and technology involves many disciplines and branches, namely, mathematics, physics, chemistry, medicine, agriculture, metallurgy, textile, architecture, etc. The historical materials of these branches have to be retrieved one by one from ancient literature as vast as the open sea, except for a few private monographs. *Brush Talks from Dream*

Brook, the book written by Shenkuo in the Song Dynasty, contains a bit more data than other works, so scholars cherish it as a priceless treasure. Only this branch considered as astronomy is out of the ordinary: Its historical data can be gotten in voluminous official histories, which are so systematic and abundant that other branches can hardly be a match. Such an astonishing fact is thought-provoking, isn't it? At least it indicates that in the ancient Chinese culture, this branch of learning, which can be called *study of heaven*, possesses extraordinary properties and occupies a vital place.

1.1.2 The Special Position in Political Affairs in Ancient Times

Book of Documents is a basic classic work of Confucianism. Today it can be considered as a collection of ancient political documents or their reports /adapted versions. The first part of *Book of Documents* is *Text of Yu*. The first chapter of *Text of Yu* is *Cannon of Yao*. The text of *Cannon of Yao* records the main administrative affairs in the reign of Emperor Yao, and Yao's instructions about assessing and cultivating his successor Shun. The whole text of *Cannon of Yao* is made of just 440 characters, and half of it tells about Yao's political merits, in 225 characters:

Emperor Yao was named *Fang-Xun*. He did everything dutifully and practiced strict economy. He knew the difference between right and wrong and governed the country skillfully. His demeanor was dignified and courteous. He was honest, gentle, and refined. He could recommend the worthy and give way to the capable. So his brilliance shone everywhere in the country, and his consideration includes the sky and earth. He appointed those who have both ability and political integrity to official positions. He made the people live amicably with each other. He commended benefaction of officials, and made all the nationalities closely united. Under the governance of Yao, civilians lived together in peace.

Emperor Yao ordered Xi and He to obey Heaven's intention respectfully in formulating the calendar based on the movement of the sun, moon, and stars, and with the calendar taught the people to devote themselves to productive activities. He ordered Xizhong to live at a place on the east sea named Yanggu, and wait respectfully for sunrise in order to determine the time of sunrises. He decided on the Spring Equinox as the date of equating day and night, and he decided on the middle spring according to the bird star seen in the south exactly. At that time, people should labor in the field, and birds and beasts reproduce.

He ordered Xishu to live at a place named Mingdu where the sun moves from north to south. It was Xi's job to observe the sequence of the sun moving toward south, in order to stipulate what to do in summer, and wait respectfully for the sun to come. He decided on the Summer Solstice as the date of the longest daylight, and he decided on the middle summer according to Mars seen in the south exactly. At that time, people should live in higher places, and birds and beasts begin to lose hair or feather.

In addition, he ordered Hezhong to live at a place in the west named Meigu, in order to respectfully measure the point of sunset when seeing the sun off. It was his job to observe the sequence of sunset to mountains. He should arrange the harvest of crops on the basis of his observation. He decided on the Autumnal Equinox as the date of equating day and night, and he decided on the middle autumn according to the virtual star seen in the south exactly. At that time, people leave high lands and live on plains to harvest, and birds and beasts grow fine hair or feather that can be used for making utensils.

Finally, he ordered Heshu to live at a place in the north called Youdu where he observed the sun moving from far south to north. He decided on the Winter Solstice as the date of the shortest day, and he decided on the middle winter according to the Pleiades seen in the south exactly. At that time, people hide in their house for warmth, and birds and beasts are coated with very thick hair or feather. Yao said: “Ah! Xi and He, listen! There are 365 days in a year. We must set up a leap month to settle the four seasons and calculate the yearly calendar. Only so doing, can we conform to the heavenly times and stipulate the duties of officials. That way, our efforts will achieve good effects.”

Of the 225 characters talking about Emperor Yao, 172 are about his engagement in heavenly affairs, accounting for 76 % of the total. The first paragraph is abstract praise, while the second paragraph is concrete exposition about the heavenly affairs. The whole article *Cannon of Yao* gives us the impression that the major and eminent merit of Emperor Yao is his arrangement for heavenly affairs. Doesn't it seem strange?

Let us ponder further and suppose that *Cannon of Yao* was written because Emperor Yao would soon abdicate and hand over the crown to Shun. Then why doesn't it deal with “serious matters”? The supreme ruler would soon hand over the state power to his successor, but *Cannon of Yao* does not mention state affairs, such as internal and foreign affairs, military, economy, or what so ever. Instead, it talks in great lengths about how to arrange heavenly affairs. Seen from the contemporary eyes, isn't it too absurd?

Circumstantial evidence can also be found to back up our question. For instance, Volume 15 of *The Records of the Grand Historian*, entitled *Biography of Five Virtuous Emperors*, records Emperor Shun acting as regent, saying: “When Emperor Yao is getting old, he tells Shun to act in capacity of the emperor so as to observe heaven's will. Emperor Shun started using astronomical instruments so that governmental affairs could be implemented according to astronomical phenomena. ...” As a matter of fact, this was rewritten by Sima Qian on the basis of *Cannon of Shun · Book of Documents*. It is true that after “started using astronomical instruments so that governmental affairs could be implemented according to astronomical phenomena,” a few other administrative merits are mentioned. However, the first thing is still heavenly affairs, and they are directly related to the mandate of heaven!

Another example: In *Xi Ci (Tied Diction) · Yi Jing (The Book of Changes)*, there is a simplified and idealized presupposition on the developmental

history of ancient civilizations. The series of monarchs is so listed: Baoxi (Fuxi)—Shennong—Yellow Emperor, Qi, and Shun. They successively created many businesses and concepts for a civilized society. Among them, the first contribution made by the first emperor is as follows: “In the old days when Baoxi was the king of the world, he looked up into the sky to observe heavenly phenomena, and looked down onto the earth to observe natural laws ...” The first contribution is study of heaven again! “Looking up into the sky” is the same kind of activity as “looking at the vast heaven, and observing heavenly bodies,” and “started using astronomical instruments so that governmental affairs could be implemented according to astronomical phenomena.”

If this kind of activity belongs to the astronomy in a modern sense, it would be really astonishing: The first virtuous monarch of ancient Chinese has nothing to mention about his political merits except his interest in astronomy. When the second virtuous monarch begins to act as regent, he cares for nothing except devoting himself to astronomical activities. As the originator of civilization, Fuxi makes his first contribution to human society not by solving the problem of basic necessities of life, but through going in for astronomy! Was astronomy so important to ancient Chinese people?

There has long been a prevalent saying that the ancient China was an agricultural country, and agriculture needs astronomy. So the ancient Chinese people attached great importance to astronomy. This theory sounds reasonable, but on second thought, we will find it full of loopholes. Here I would like to raise a few questions:

If agriculture needs astronomy, almost all nations have agriculture. Did astronomy ever occupy such an incredibly special status elsewhere as it did in the ancient Chinese culture?

Agriculture needs astronomy, and yet navigation needs astronomy more. The ancient Greek had agriculture, and they relied on navigation to a great extent. Did astronomy get a special position in the ancient Greek culture as it does in the ancient Chinese culture? How much exposition of astronomy can be found in *Homer Epic* or in *Herodotus' History*?

Agriculture needs astronomy, but to what extent? The greatest majority of farmers have no knowledge of astronomy, but what do they depend on to plant crops?

Of the *three annals on study of heaven* in the official histories of past Dynasties, the annals of astronomy is specialized to deal with astrology, and the annals of Wu Xing recounts disastrous and auspicious omens. Both of them are totally unrelated to agriculture. Why do they occupy such a special position?

Agriculture is related to astronomy, but it is obviously also related to manufacture of farm tools, breeding, soil improvement, field management, water conservancy, and so on, to a greater extent. However, knowledge of these areas did not get valued. Why?

In the final analysis, all these questions lead to the same question: Does the Study of Heaven in ancient China belong to the same branch of learning as the astronomy in the contemporary sense? If not, then what is its property?

1.1.3 The Special Position of Study of Heaven in Intellectual Pursuit in Ancient Times

Lü's Spring and Autumn Annals can be considered as quasi encyclopedia. This book “covers all things in the sky and the human world, and all affairs today and in the past.” It gives study of heaven a peculiar position. The first 12 volumes, i.e., the so-called 12 Almanacs, expound largely in the scope of politics, ethics, and philosophy. But the first chapter of each almanac talks about celestial phenomena and seasons. This theory prevailed in the Warring States Period, and the Qin and Han Dynasties. The first chapter of each of the 12 almanacs in *Lü's Spring and Autumn Annals* is similar to *Monthly Ordinances* of *The Book of Rites* and *Seasonal Regulations* of *Huainan Zi*. Furthermore, *Xi Xiaozheng* of *Dadai's Book of Rites*, *Youguan* of *Guan Zhong*, the third part of the silk book of Chu unearthed in Zidanku in Changsha, as well as relevant sections of *Book of Sun*, the Qin bamboo slips unearthed in Shuihudi Yunmeng are all literatures of the same category with the same property. Those literatures are another manifestation of the special status occupied by study of heaven in ancient political affairs.

In the knowledge system of *Huainan Zi*, there is no place for any subject of “science and technology” in the current sense. However, study of heaven is an exception: it occupies an impressive position. If we consider the Study of Heaven in ancient China as astronomy in the modern sense, and as parallel to physics and chemistry in nature, would not it be strange for the ancient Chinese people to have such a special favor on this branch of learning, which has no utility for the daily material life. In that case, this branch of learning would become a clear exception in the knowledge system of the ancient China, totally unable to harmonize with the whole system.

In the three books of classification—*Categories of Artistic Works*, *the Sea of Jades*, *Collection of Books in All Times*—study of heaven is put in the first place of all parts. This is not a coincidence. Actually, all the comprehensive books of classification put “Study of heaven” in the first place. It is true that ancient people tended to follow the old rules as a matter of routine, but there must had been some reasons for the old rules to be made. The reason is obviously the same as for *Treatise on Astronomy* to stay in the first place among all the treatises of official histories. This reason was well known to the noble and virtuous in ancient times; later fewer and fewer persons knew it, but the number of them was still considerable; in modern times, however, the reason is covered by misunderstandings and very few people know it. Unless we disclose the secret, it is really hard to know the reason.

1.1.4 The Special Position of Imperial Institutions on Study of Heaven

The special position of heavenly scientists and heavenly scientific institutions in the ancient Chinese society is first of all embodied in that the heavenly scientific institution is a department of the government, and the heavenly scientists working

in it are governmental officials who make up a part of the administration. They are entirely different in nature from gentleman of remedies and arts who were ordered to serve the imperial palace. The latter do not constitute a part of the administration or receive official ranking (regarding the few becoming high-rank officials because of their arts, it is completely another picture to be dealt with separately), though some of them receive official rankings or titular honors.

The practice that heavenly scientists were imperially appointed ranking officials began very early. *Cannon of Yao* in *Book of Documents* has the recording of Emperor Yao appointing heavenly scientists to be officials, reflecting a fact that back in remote ancient times, heavenly scientists were ranking officials of the imperial court. More evidence can be found in the book *Rites of Zhou*. Among various official positions listed in *Rites of Zhou*, *Ministry of Rites*, at least the following six rankings are related to study of heaven: "Minister of Rites," "Dream Interpreter," "Omen Reporter," "Grand Scribe," "Royal Astronomer," and "Royal Astrologer." The ranks and associates of these official posts are clearly stipulated:

Minister of Rites: minister—1 person.

Dream Interpreter: petty officer second class—2 persons, historical recorder—2 persons, apprentice—4 persons.

Omen Reporter: petty officer second class—2 persons, historical recorder—2 persons, apprentice—4 persons.

Grand Scribe: lower senior official—2 persons, petty officer first class—4 persons.

Royal Astronomer: petty officer second class—2 persons, petty officer third class—4 persons, treasury keeper—2 persons, historical recorder—4 persons, apprentice—8 persons.

Royal Astrologer: petty officer second class—2 persons, petty officer third class—4 persons, treasury keeper—2 persons, historical recorder—4 persons, apprentice—8 persons.

It is not so important whether the above list of official posts reflects the real situation of the Western Zhou Dynasty or not. But it does reflect the fact that there were officials and institutions on study of heaven in ancient times. Undoubtedly, the official posts listed in the book *Rites of Zhou* exerted significant influence on the composition of government organizations. The system of six organs recorded in *Rites of Zhou* basically includes the structure of the central government in the ancient Chinese society. In the system, the Minister of Rites and his subordinates evolved into the subsequent Ministry of Rites. Throughout 2,000 years, the institutions on study of heaven were under the leadership of the Ministry of Rites. Originally, the duties of the Grand Scribe included drafting documents for the imperial court, appointing high officials, recording military and national events, compiling history, supervising astrological divinations, preparing calendars, offering sacrificial ceremonies, and other affairs. Later on, these duties were assigned to different officials. Since the Wei and Jin Dynasties, the Grand Scribe became the fulltime leader in charge of the institution on study of heaven. Professional officials are equivalent to Omen Reporter, Royal Astronomer, and Royal Astrologer in *Rites of Zhou* became his subordinates. The institution on

study of heaven led by the Grand Scribe had various names, such as Taishi Jian (Directorate of Astrology), Taishi Ju (Astrological Service), Sitian Tai (Bureau of Astronomy), Sitian Jian (Directorate of Astronomy), Tianwen Yuan (Academy of Astronomy), and Taishi Yuan (Astrological Commission), and in the Ming and Qing Dynasties, it was renamed Qintian Jian (Imperial Directorate of Astronomy).

Concerning the composition and scale of the institution on study of heaven in ancient Chinese governments, we might as well choose a typical case in point. In the first year of Qianyuan (758 AD) during reign of Emperor Suzong in the Tang Dynasty, the situation of the Sitian Tai was as follows:

Grand Director—1 person, rank 3, lower class (3b)
 Vice Director—2 persons, rank 4, upper class (4a)
 Upper Aide—3 persons, rank 6, upper class (6a)
 Recorder—3 persons, rank 7, upper class, grade 1 (7a1)
 Secretary—2 persons, rank 8, lower class, grade 2 (8a2)
 Director of the Five Offices—5 persons, rank 5a1
 Vice Director of the Five Offices—5 persons, rank 6a1
 Gentleman for Imperial Observatory, rank 7a2
 Director of Calendric Calculations—5 persons, rank 7b1
 Supervisor of Water Clocks—5 persons, rank 8a1
 Astronomical Observer—5 persons, rank 8a2
 Manager of Calendar—5 persons, rank 8b1
 Timekeeper—15 persons, rank 9a2
 Ritual Apprentice—15 persons
 Clerkly Calligrapher—5 persons
 Daily Recorder—5 persons
 Erudite of Water Clock—20 persons
 Bell Manager and Time Drummer—350 persons
 Observer Student—90 persons
 Student of Astronomy—50 persons
 Student of Calendar—55 persons
 Student of Water Clock—40 persons
 Acting Attendant—10 persons

Though the official rank of Grand Astrologer is merely between the third and the fifth, he is the interpreter and conveyor of Heaven's will. He knows the profound mystery between heaven and mankind. He seems to be the emperor's teacher, so at critical moments in politics, the words of Grand Astrologer of the fifth rank may hold greater sway than those of a higher official of the top rank. Sometimes outstanding scholars on study of heaven win the emperor's favor and are appointed high-ranking official posts, other than posts in the institution on study of heaven. Their right to speak in heavenly affairs, however, is far more superior to that of Grand Astrologer and other officials.

How can scholars on study of heaven occupy such a vital place in politics? On the surface, the reason seems to be because they know astrology which the emperor or monarch believes in. But actually, there are more profound reasons.

1.1.5 Strict Prohibitions on Privately Learning Study of Heaven in Successive Dynasties

Since study of heaven in ancient China had such a vital position in official histories, in the comprehensive intellectual system, in administrative affairs, in imperial official organization and political operation, it would naturally become a branch of learning to be promoted and encouraged. But the fact is the opposite: Study of heaven was a forbidden branch of learning to the public mass! Successive Dynasties issued many strict prohibitions on collecting and studying privately the books on study of heaven. Several representative prohibitions of this kind are listed below:

(Third Year of Taishi) Study of star chart and prophecy is banned. (Volume 3: *Biography of Emperor Wu, History of Jin*)

Utensils for mysterious phenomena, books of astronomy, books of prophecies, books of military strategies, weekly calendar, supreme unit, Leigong shi (a divination art)—these things should not be kept in private possession. Anyone who violates the prohibition will be sentenced to imprisonment for 2 years. Those who learn study of heaven in private will be punished likewise. (*Notes and Comments on the Tang Dynasty's Laws*, Volume 9)

The number of persons who are versed in astronomy and physiognomy, sent from all prefectures, is 351. On the first day of December, (the second year of Taipingxingguo) Emperor Taizong in the Northern Song Dynasty decreed that 68 persons of them be dispatched to Sitian Tai (Bureau of Astronomy), and the rest branded in the face and banished to sea islands. (*A Long Continuation of Historical Events Retold as a Mirror for Government*, Volume 80)

In spring of the first year of Jingde, Emperor Zhenzong in the Northern Song Dynasty decreed: Books illustrating and calculating the movement of celestial bodies were prohibited by old regulations already, but they are still studied privately by many people, so now the prohibition must be restated strictly. From now on, if any civilian possesses utensils for heavenly phenomena, or books of esoteric study of auguries for prophecies, he must plead guilty, hand in the item, and have it destroyed by burning on the spot. Anyone who conceals a prohibited item in his possession will be sentenced to death. We post a reward of 100,000 coppers for anyone who informs of such a crime. Persons who are skilled at astrology and calculation should be sent to imperial palace. (*A Long Continuation of Historical Events Retold as a Mirror for Government*, Volume 56)

(21st Year of Zhiyuan) The following wrong doings are crimes: Collecting or studying privately diagrams of astronomy and books of prophecies, supreme unit, Leigong Shi, weekly calendar, diagrams of eclipse prediction, Calendar of Minority Director. Anyone who collects or studies these things in privacy will be considered a criminal and punished. (Chap. 10, *Biography of Shizu*, Volume 13, *History of Yuan*).

In the sixth Year of Hongwu Emperor Taizu decreed: (Directorate of Astronomy) Personnel in the directorate are not allowed to migrate. Their descendents shall

learn astronomy and calendric calculation only, and shall not practice any other profession. Those who refuse to obey will be exiled to the South Sea for penal servitude. (*Record of Laws and Systems of the Great Ming Dynasty*, Volume 223)

In early years of the Ming Dynasty, learning astronomy was strictly forbidden: Anyone who studied calendar would be sent to frontiers for penal servitude, and anyone who hands down an almanac would be sentenced to death. Later, Emperor Xiaozong relaxed the prohibition, and ordered to enlist recluses in mountains and forests versed in calendric system for governmental recruitment. But at last, nobody showed up to accept the offer. (Volume 20-*Calendar, A Compilation of Stories Acquired Unofficially in Wanli Times*)

The bans listed above are so rigorous that they seem to be unthinkable and unexplainable to the common sense of modern people. How should we explain these strange phenomena?

By analyzing further the above 7 items of records, we can find a latent regular pattern. The times of their promulgation are as follows:

Third year of Taishi, i.e., 267 AD, 3 years after the founding of Western Jin.

Second year of Yonghui, i.e., 651 AD, 33 years after the founding of Tang.

Second year of Taipingxingguo, i.e., 977 AD, 17 years after the founding of N. Song.

First year of Jingde, i.e., 1004 AD, 44 years after the founding of N. Song.

Twenty-first year of Zhiyuan, i.e., 1284 AD, 5 years after Yuan exterminated S. Song.

Sixth year of Hongwu, i.e., 1373 AD, 6 years after the founding of Ming.

Early years of the Dynasty, that is, the early years of the Ming Dynasty.

It is not hard to find that all the 7 items of prohibition were issued shortly after the founding of each Dynasty. That pattern brings forth another question: Why did the Dynasties attach great importance to prohibiting privately collecting and studying books on the Study of Heaven? Take for instance the situation in the Ming Dynasty: “In early years of the Ming Dynasty, learning astronomy was strictly forbidden” is not an empty regulation. Let me prove it with a cogent case in point. Volume 128—Biography of Liu Ji *History of Ming* says: “On arriving home, Liu Ji got seriously sick. He handed a *Book of Astronomy* to his son Zilian and said: It is most urgent that you submit this to the emperor and forbid our offspring to study it!” Liu Ji was a founding father who assisted Zhu Yuanzhang in winning state power, and he was Grand Astrologer (or “Astrological Commissioner” as some annals call him). His earnest warnings for his descendants against studying the *Book of Astronomy* can show that “learning astronomy was strictly forbidden” is truly fearful. In the reign of Emperor Xiaozong, he relaxed the prohibition, and ordered to enlist recluses in mountains and forests versed in calendric system for governmental recruitment. “But at last, nobody showed up to accept the offer.” That indicates the strictness of the earlier prohibition. “Nobody showed up to accept the offer” does not necessarily mean that nobody mastered the calendric system, but that actually “nobody dared to show up and accept the offer”.

1.2 *Properties of the Study of Heaven and Its Societal Functions*

1.2.1 Correspondence Between Man and Heaven, and the Concept of Mandate of Heaven

In the traditional Chinese culture, *the theory that man is an integral part of nature* is a concept with a wide variety of implications. Generally speaking, *heaven* is used to refer to the whole nature. In the ancient Chinese mind, this nature, or heaven, is a gigantic living being that possesses will and emotion that cannot be thoroughly understood, and whose way you must comply with and live together peacefully, instead of an object that has no will and emotion, that can be understood and transformed, just as in the *objective hypothesis* of the modern science. Perhaps this is the so-called *organic view of nature* as highly reputed by contemporary scholars in China and abroad. All the major principles of *harmony of man with nature* and *interaction of man with nature* come down to one point, that is, how could man coexist with heaven, or how to get to know the will of heaven, the destiny, how to follow the way of heaven, obey the act of providence, and how to enjoy a godsend.

In the mind of ancient Chinese people, heaven was personified. This conforms to the organic view of nature. Since there is Heaven's will and destiny, needless to say, heaven must be personified. Heaven's will and destiny were sought by members of the ruling class; the personified heaven, however, was deeply rooted in the inward eye of common classes, including ordinary citizens.

The concept of Heaven's will is an indispensable part of the political theory of Confucianism. The mandate of heaven has three properties: First, Heaven's will is ascertainable, for example, the Zhou Dynasty's destiny was known upon divination when King Cheng established the Dynasty. Second, Heaven's will is changeable, that is to say, "Heaven's blessing as the highest virtue will terminate someday." Third, Heaven's blessing belongs to someone who has morals, for instance, Xia, Shang, and Zhou—the three Dynasties bear the mandate of heaven successively, and their vicissitudes are determined by virtue, or by brutality.

1.2.2 A Political Concept: The Man Who Communicates with Heaven Is the King

In ancient China, a Lingtai (Platform Garden) was a place for observing astronomical phenomena and divination and a sacred shrine for learning about the heavenly intentions and for communication between heaven and man. So it had a significant symbolic meaning.

Dong Zhongshu wrote in his book *Chunqiu Fanlu (The Luxuriant Dew of the Spring and Autumn Annals)*, Volume 11 entitled *The King Way Connects Three Hierarchies*:

The creator of Chinese characters created the character 王(king) like this: Three horizontal strokes with a vertical stroke connecting the three. The three strokes stand

for sky, earth, and man. The connecting stroke in the middle denotes knowledge about the way. It is the king who runs through the centers of the three hierarchies. Who else is capable of doing this?

That story of creating Chinese characters is somehow reasonable, although it drew a forced analogy. The conception that Dong Zhongshu relies on is exactly the cream of the political thought in ancient times. “Knowledge about the way” means communicating between heaven, earth, man, and spirits. Only the commutator, who is capable of communicating between them, can become a king.

The complete set of heavenly affairs symbolized by the Lingtai, the hall where the imperial edicts were announced, and similar structures are the most important means for communication with heaven. Why could heavenly commuters obtain qualifications for the throne? Because they *had the foresight*, and the heaven that they had access to was a source of knowledge. Then what mechanism did they rely on to get foresight? How was the knowledge of heaven embodied? The answer is simple but clear: Reliance on the Study of Heaven. The large number of divine oracles in a bunch of astrological works are the knowledge passed down from heaven, in which there are the predictions about virtually all the military and state affairs, such as victory or defeat in wars, safety or danger of thrones, plenty or failure of harvests, disasters of floods or droughts, and so on.

In the final analysis, the calendar and numerology have the same properties and functions. The wizards who mastered astrological techniques—*Zhong, Li, Xihe, Wuxian*, and subsequent heavenly scientists—were all prophets with foresight. Each of them served a certain king, and assisted the king in acquiring the qualifications for and the right to rule. Emperor Yao has merely one political merit recorded in history, that is, he commissioned officials on study of heaven. How come? At the beginning of acting as regent, Emperor Shun ignored all the other things except using astronomical instruments so that governmental affairs could be implemented according to astronomical phenomena. Why? The reason is that they aimed at controlling the study of heaven.

1.2.3 Relationship Between the Study of Heaven and the Regal Power

In its early stages, study of heaven became a necessary condition for establishing monarchical power, and later, it gradually evolved into a symbol of kingship.

Mastery of communication with heaven is a necessary condition for obtaining monarchical power, and study of heaven is the most important and direct means of reaching heaven. Therefore, any person attempting to capture the throne must try to master the direct access to heaven so as to bear the mandate of heaven. Then, how should he declare publicly that he did bear the mandate of heaven and get confirmation from the common people? This task fell on stargazers who observe and point out omens in the sky and in the whole nature, and interpret them. These omens and the corresponding interpretations are the main content of ancient astrological works. Among those omens, celestial phenomena in the narrow sense (*heavenly scripts* as the ancients called) occupied an outstanding place. The

most popular story about transition of Heaven's will and change of Dynasties is *Wuwang fa Zhou*, i.e., King Wu of Zhou marshaled a crusade against Emperor Zhou of Shang. People of the Zhou Dynasty formed the earliest group in history to talk about the mandate of heaven systematically. As a result, many astronomical phenomena were recorded around the time of King Wu fighting Emperor Zhou. Stories like that were not all coinages; many were probably genuine phenomena recorded by official historians with due care and respect and then handed down.

More often than not, successive Dynasties declare strict prohibitions on learning privately the Study of Heaven. This regular pattern can hardly be found by reading records independently, but it can be discovered by juxtaposing a few records. This phenomenon is not accidental. Since study of heaven is a means of direct communication with heaven, monopoly of this means is closely related to imperial power: Study of heaven was a source of monarchical power in ancient times, and it evolved into a symbol of kingship later on. Naturally, when a new regime replaces the old, the rising newcomer would *pry about and steal the magical object*, in order to smash the monopoly of the old Dynasty over heavenly affairs, and build his own access to heaven to reap the new political authority. And the precedent is King Wen of the Zhou Dynasty building a Lingtai. Whenever feudal lords fight for the throne, private scholars secretly learning study of heaven rise to the occasion, and serve the new politicians who have the ambition to seize the state power. Surely, these scholars are considered criminals in the old Dynasty, but they are meritorious statesmen in the new Dynasty. Thus, the founding fathers of each Dynasty have this kind of scholars to serve them. Outstanding examples include: Wu Fan serving Sun Quan in the Three-Kingdom Period, Zhang Bin supporting Yang Jian at the beginning of the Sui Dynasty, Li Chunfeng standing behind Li Shimin in the early Tang Dynasty, Liu Bowen advising Zhu Yuanzhang to establish the Ming Dynasty, and so forth. The names recorded in history are successful heroes mainly. After politicians fight for the supremacy, the winner becomes a hero, and the losers become bandits. There are far more losers than winners, but the losers also have scholars following them. Consequently, the Study of Heaven that the old Dynasty tried to monopolize goes through a process of spreading. After seizing state power successfully, the victor follows the footsteps of the old Dynasty and maintains his privilege of monopoly over study of heaven. That is why the founding rulers of a new Dynasty prohibit learning privately the study of heaven. So it can be said that study of heaven is a necessity for politicians struggling for the throne, and yet it becomes his exclusive domain right after he grabs the state power. Actually, the varied measures of prohibition on learning the study of heaven are all new versions of cutting off the passage between sky and earth initiated by Emperor Zhuangxi of the remote ancient times, who ordered his grandsons Zhong and Li to cut off the passage between sky and earth so that divine beings could not come down to earth, and human beings could not go up to heaven.

Study of heaven is a necessity for politicians struggling for the throne, and yet it becomes his exclusive domain right after he grabs the state power. This has always been the truth throughout the long Chinese history since ancient times, and it just appeared to be more direct and obvious in early stages.

1.2.4 The Political Role that the Study of Heaven Plays

As early as in the Zhou Dynasty, the Son of Heaven (the emperor) promulgated the calendar of the following year to dukes and princes through a state ceremony, called “Bangao-Shuo,” so that dukes and princes could use the calendar issued by the Son of Heaven.

Since then, “Whose calendar should we accept as the authentic one?” has become a cardinal question of right and wrong politically. The practice that China promulgated and granted calendars to neighboring countries symbolized that she possessed suzerainties over these countries.

Ancient Chinese sages had a tradition of “designing a lesson with superstitious belief in gods.” They made use of special astronomical phenomena, solar eclipses, for example, to lend a touch of morality to some political activities (The eclipse was explained as indicating that heaven was unsatisfied with the politics in the human world). When an eclipse happens, the emperor solicits critical opinions from the subjects under his rule in the hope that heaven will relent and forgive his misconduct.

Additionally, there was *Shichuan-Shiyan*, meaning “history conveying and event verifying,” by combining Annals of Astronomical Phenomena, Chronicles of Political and Military Events, and Astrological Theories of previous Dynasties. *Shichuan-Shiyan* not only offers specific examples of using heavenly phenomena as auspicious or ominous signs, but also serves as textbooks for political moralization. Therefore, it occupies a vital place in *Treatises on Astronomy* and *Treatises on Waxing* in the official history of various Dynasties. Frankly speaking, *Shichuan-Shiyan* has nothing magical in it. The truth is that there are many types of astronomical phenomena, and a great number of historical events. When compiling such a book, you have leeway to choose from a variety of alternative cases so as to match an event with a phenomenon correspondingly. Really, the selection is not so hard. In fact, there have been numerous cases of mismatch between astronomical phenomena and event, and countless political events without any astronomical phenomena as omens to foretell them. However, you can ignore those facts, and write out a good book of “history conveying and event verifying,” and make the examples in it conclusive and convincing to the present and future generations.

1.3 An Outline of Astrology in Ancient China

1.3.1 A General Survey of Astrology in Ancient Civilizations: Two Categories

Astrology is an eye-striking component in almost all ancient civilizations. It can be divided into two categories, and the international academic world refers to them with two terms:

Judicial astrology—refers to the astrological system that takes these items for practicing divination: victory or loss in war, crop harvest or failure, reign rise or fall, safety and benevolence of emperor /monarch, and so on.

Horoscope astrology—refers to the prediction of a person's fortunes or misfortunes in his life by divining the heavenly phenomena when he was born.

The object of the former lies in important military and government affairs, while the time of birth is a feature of the latter.

The well-known ancient Babylon civilization is located in the two-river drainage area that was called Mesopotamia. This civilization can be traced back to the Sumerian people living in about 4000 BC. In the subsequent several thousand years, quite a few nationalities dominated the region successively, and these nationalities are referred to as the Babylon people. Up to the eighth century BC, the Ashur Empire became the ruler of the region. As far as we know, the astrology in the Babylon-Ashur period belongs to the judicial astrology. European museums now keep thousands of unearthed clay tablets with arrowheaded characters on them about astrology. It is said that none of them belongs to the horoscope astrology. The Babylon astrology pays special attention to the celestial phenomena formed by planets. The format is something like what is recorded by the following two articles in arrowheaded characters:

If Mars recedes into Scorpio, then the King should be on the alert. On this unlucky day, he should not go out of the palace.

If Mars is at a constellation to the left of Venus, the Akkadian will be ravaged.

In about seventh century BC, the two-river drainage area began to be ruled by the Chaldeans. Scholars think that the horoscope astrology started developing right in the hand of the Chaldeans. It was introduced to Greece and got further developed by scholars in Alexandria city. Since then, this kind of astrology, which predicts a person's fortunes or misfortunes in his life by divining the heavenly phenomena—mainly the position of the sun, the moon, the five planets in the ecliptic the moment he was born, has become the standard mode of the European astrology. The astrology that prevails in Europe is exclusively the horoscope astrology.

In the Renaissance period, this kind of astrology flourished unprecedentedly in European countries. Many famous astronomers, such as Tycho and Kepler, were master-hands in this field. They drew up many a fortune-telling horoscopes for the kings, lords, and noblemen in their times (that is, the ecliptic sky diagram) that became precious historical literature now kept in some well-known museums (as shown in Fig. 1).

Turning to another branch of ancient civilization—the ancient Egypt, we can see both the judicial and the horoscope astrology in the ancient Egyptian papyrus books and cultural relics. But compared to the history of ancient Egyptian civilization that can be traced back to as remote as 5000 BC, these data seem to be too recent. The two kinds of astrology, seen from these data, are thought to have been imported from Babylon. In the papyrus books, data of the judicial astrology are plentiful. Take for example a paragraph cited from the Cairo papyrus book No. 31222 (as shown in Fig. 2).

If Dog Star rises when Jupiter is positioned at Sagittarius, then the king of Egypt will rule his country as a whole. He will encounter enemies, but he will be able to extricate himself from them. Many people will betray the king. A flood will arrive in Egypt as it should. ...

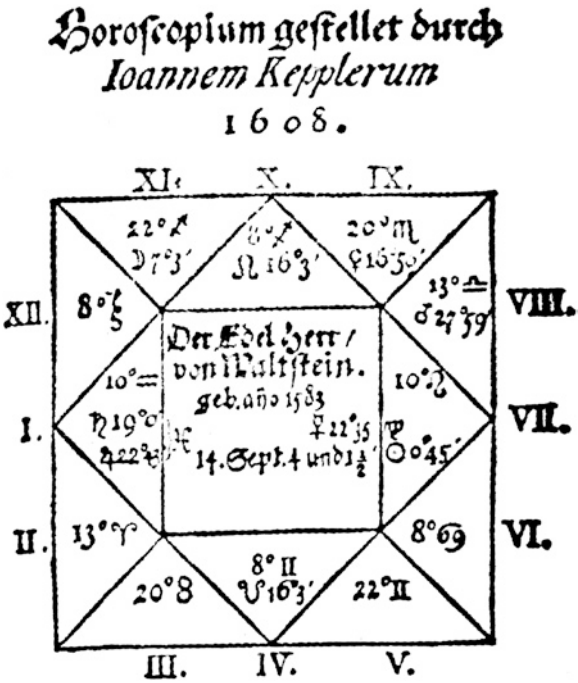


Fig. 1 A fortune-telling horoscope made by Kepler for Warenstein the Czech nobleman



Fig. 2 Cairo papyrus book No. 31222

Apparently, astrology in the ancient civilizations of the old world originated from Babylon, which is indeed meaningful (only the Study of Heaven in the ancient India might be an exception). As for the starting time, judicial astrology is older than horoscope astrology, which also is worthy of attention.

The situation of astrology in the old world to the west of China is roughly like that. In ancient China, however, a pure and complete system of judicial astrology stayed operative for at least 2,000 years.

The fortune-telling technique in ancient China proceeds from the date of birth and the eight characters of a horoscope, that is, the year, month, date, and hour—chronological record of events—correspond to the Heavenly Stem and Earthly Branch, eight characters in all. In spite of this, the eight characters of a horoscope merely record the point of time, not a diagram of the horoscope at that time. So the date of birth and the eight characters of a horoscope are not related to the real sky phenomena, either in essence or in form.

To sum up, it can be confirmed that the ancient China did not produce “a locally born” horoscope astrology. The Chinese technique of fortune-telling—which is characteristic of the date of birth and the eight characters of a horoscope—and the Western astrology of horoscope are two systems, totally different from each other. Of the Western horoscope astrology, a horoscope technique was introduced from India to China. It got popular for a while, and yet its influence was limited. From the Tang Dynasty on, if a Chinese citizen wants to know his fortune and misfortune in life, he does not care about sky phenomena—he is considered not qualified to do so, and he is afraid of relating his destiny to the sky, unless he is ambitious, casting greedy eyes on the throne.

1.3.2 Theory of Dividing Line

Since judicial astrology predicts important military and government affairs with heavenly phenomena, it will surely be faced with a problem: the world is so huge, and the situations at various places are so different from one another, but there is only one firmament. How should the good or ill luck shown on it be allocated to all the places? Any civilization on a vast land or with a vision broad enough to encompass the surrounding civilizations of other nations must solve this problem in its astrology first. The ancient Chinese solution was to create a “dividing line” theory, whereas the ancient Egyptian had their distinct solution.

The fundamental idea of the dividing line theory is to divide the sky sphere into dozens of sky zones to correspond to states, princedoms, prefectures, and districts on the earth. When a certain sky zone has a phenomenon occurring, its omen aims at the corresponding prefecture or princedom. This theory was established rather early. One of the official posts listed in *Rites of Zhou*, *Ministry of Rites* is Royal Astrologer, whose duty is:

To observe stars, planets, the sun, and the moon and record their movement, to see the variation in the world, and to identify good or ill luck there. With the star

plot, all the prefectures of China can be identified. Each fief (or feud) has a group of corresponding stars, whose pattern can be seen as indicating evil or auspicious signs. Twelve good and ill signs cover all the auspicious and evil omens in the world. ...

This paragraph deals with nearly all the main points of the dividing line theory. “Each fief has a group of corresponding stars” means that each of the 28 constellations or mansions corresponds to one individual prefecture and principedom on earth. “Ten plus two years” stands for the legendary Highest God, an imagined celestial body that moves from east to west in the sky, once every 12 years, at the same the speed of Jupiter known to people of that time but in the opposite direction. The orbit along the Jupiter is divided into “12 times,” each having a specific name; the belt along the Highest God is divided into “twelve two-hour periods” represented by the Twelve Earthly Branches. Each of the two ways of dividing has a complete set of techniques of corresponding to the 28 constellations, 12 principedoms, and 12 prefectures. Such a corresponding list appeared already in the *Treatise on Constellations of The Records of the Grand Historian*. The following quotation is from *History of Jin*, Volume 11—Annals of Astronomy, which is a complete record of its kind. The original work is a narration in texts. Here, we rewrite it in a table of 5 columns, named from the left to right: Names of 12 Times, 12 Earthly Branches, Principedoms, Prefectures, Zones of the 28 Constellations and Degrees (in Arabic digit):

Name of time	Earthly branch	Principedom	Prefecture	Zone of constellations and degrees
Canopus	Chen	Zheng	Yanzhou	Chariot 12, Horn Neck, Root 4
Antares	Mao	Song	Yuzhou	Root 5, Room, Heart, Tail 9
Kaus Australis	Yin	Yan	Youzhou	Tail 10, Winnowing-basket, Dipper 11
Altair	Chou	Wuyue	Yangzhou	Dipper 12, Ox, Girl 7
Sadalsuud	Zi	Qi	Qingzhou	Girl 8, Emptiness, Rooftop 15
Simmah	Hai	Wei	Bingzhou	Rooftop 16, Encampment, Wall, Legs 4
Hamal	Xu	Lu	Xuzhou	Legs 5, Bond, Stomach 6
Aldebaran	You	Zhao	Jizhou	Stomach 7, Hairy head, Net 11
Rigel	Shen	Wei	Yizhou	Net 12, Turtle-beak, Three Stars, Well 16
Alhena	Wei	Qin	Yongzhou	Well 16, Ghosts, Willow 8
Regulus	Wu	Zhou	Sanhe	Willow 9, Star, Extended net 16
Spica	Si	Chu	Jingzhou	Extended net 17, Wings, Chariot 11

The 28 constellations are now represented by a single character each, but a few of them were named with two characters in ancient times. The 5 constellations in the above list had two-character names: Dragging Ox (Ox), Waiting Girl (Girl), East-well (Well), Public Ghosts (Ghosts), and Seven Stars (stars). In addition, Encampment was often called Camp Room and Wall—East Wall, in ancient books. Dipper was called South Dipper, Turtle-beak Mansion—Turtle-beak Bodkin and Three Stars Mansion—Three Punishments sometimes (as shown in Fig. 3).

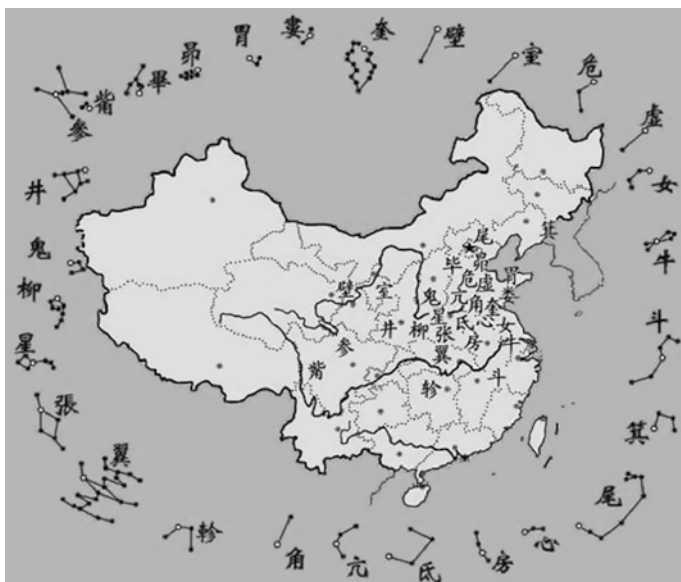


Fig. 3 The 28 mansions corresponding to the prefectures and princedoms on earth

Ancient China divided the great circle of the celestial sphere into 365 and 1/4 degrees (ancient Chinese degrees), differing from the Western tradition of 360 degrees from Babylon. In the coordination system of 28 constellations, each mansion covers a different number of degrees. The coverage is so uneven that the biggest mansion Well has 30°, whereas the smallest mansion Turtle-beak spans merely 2°. However, the 12 times divided the celestial sphere into 12 equal sections. So if we are to match the two precisely, some mansions must be cut apart. In the above list, the digit after the name of constellation indicates that the mansion is cut apart right there at that number of degrees, while a mansion without a digit to follow it indicates that the mansion entirely belongs to that Time. Take this Time Sadalsuud for example: It occupies the zone which starts at the eighth degree of Girl, crosses the whole mansion Emptiness, and stops at the fifteenth degree of Rooftop. The next zone, starting from the sixteenth degree of Rooftop, belongs to the Time Simmah. The rest can be obtained by analogy.

The names of princedoms in the above list leads to projection that the dividing line system was finalized possibly in the Warring States period when “The strongest power,” i.e., the state Jin had been divided into three states (namely: Han, Zhao, and Wei). But factually, the dividing line theory existed long before this period, when the state Jin had a position in the system. A record is a proof: *Remarks of Monarchs* Volume 10—*Remarks of Jin* records the divination that was expounded by a senior official of Jin named Dong Yin to a prince named Zhong Er, saying “The position of Shi-Chen is now occupied by Jin.” The Time of Shi-Chen was then the dividing line of state Jin, and later, it became the dividing line of state Wei. At that time, the ancestors of the state Wei were serving Zhong Er the prince of Jin loyally and devotedly.

The dividing line theory is necessary for astrology. The astrological technique is nothing but use of the celestial phenomena occurring in the constellation to practice divination about the terrestrial affairs happening in the corresponding region. Astrological knowledge needs to be used flexibly somehow, but roughly speaking, it is rather simple.

1.3.3 Things to Predict—the Main Task of Astrology

The task of judicial astrology is to predict victory or loss in war, crop harvest or failure, reign rise or fall, and so on. When fighting for the throne in a war, the need for astrology is really urgent, and the war and the harvest become the main subjects. In peaceful times, the task is “pointing to the phenomenon and expounding on the disaster to warn the monarch to be on the alert,” that is, explaining to the monarch the heaven’s political warning through the celestial phenomena. As for the troubled times at the end of Dynasties, the task is switched to “avoiding the misfortune,” including sustaining the life in recluse and abstaining from seeking fame and fortune, and turning to the new host and assist him in governing the country (a case in point is Zhuge Liang living in seclusion and becoming an official). All these things cannot be done without judicial astrology. Therefore, gentlemen—politicians—are consulted about state affairs, and they are committed to undertaking the task of practicing divinations.

Ancient people needed to practice divinations on occasions that are mostly related to major military and political decisions.

If we are to learn about the concrete affairs that the ancient Chinese astrology predicted, then the most direct method must be selecting a typical work on astrology and analyzing statistically the divine oracles in it. This job has been done previously by Liu Chaoyang on the *Treatise on Constellations of The Records of the Grand Historian*. The *Treatise on Constellations of The Records of the Grand Historian* has long been the earliest of its kind with verifiable year of completion. Though the length is not so great, its structure is complete. In the 1970s, a book copied on silk was excavated from the Han tomb at Mawangdui, which is dated earlier, but it is simple and incomplete in content (as shown in Fig. 4). Thus, the *Treatise on Constellations of The Records of the Grand Historian* is a good choice indeed. The statistics that I have done are classified into 20 categories which are listed in accordance with the number of divination items as follows:

Classified items	Number of divine oracles
(1) War	93
(2) Flood and drought disasters and crop harvest or failure	45
(3) Reign rise and fall	23
(4) Safety and danger of rulers	11
(5) Relation between monarch and ministers	10
(6) Death	10
(7) Territory lost and reclaimed	8
(8) Seize state power	7

Classified items	Number of divine oracles
(9) Lucky and unlucky (abstract)	7
(10) Disease	5
(11) Conditions of the people	4
(12) National subjugation	4
(13) Civil construction	3
(14) Permit of conduct	3
(15) Is the ruler wise or not	2
(16) Women received or lost	2
(17) Sound of crying	2
(18) Political reform	1
(19) A man coming back home	1
(20) Prices	1



Fig. 4 A book on silk excavated from the Han tomb at Mawangdui

Two characteristics can be seen here. First, the first three kinds of divination oracles make up 67 % of all the 20 categories. This indicates that subjects such as war, crop conditions, order, and disorder are greatly emphasized. Second, all the divinations belong to the scope of military and political affairs (death refers to the death of a monarch, king or duke; disease refers to the epidemic, and the like, not to individual affairs). The statistic results based on the *Treatise on Constellations of The Records of the Grand Historian* has a universal meaning. If statistics are to be done on other astrological works, these two characters will not change, though specific data may vary. It can be said that the classic judicial astrology in ancient China keeps its style.

1.3.4 Phenomena for Divination

Summing up astrological literatures passed down to the present, we know that a great number of celestial phenomena were given astrological meanings. Here we classify them into 7 categories and expound them as follows:

Solar—Category One

Solar eclipse itself

Eclipse-constellation divination (solar eclipses happen when the sun runs to different mansions in the 28 constellations, with different meanings);

The condition of the sun surface (including brightness, color variation, darkness, cloud and mist, jagged edges, thorn, solar halo, corona, solar prominence, hat wearing, embracing, bearing, red jade, straight, crossing, carrying, lattice, hold, and quite a few imaginations or illusions that cannot occur, totaling around 50 conditions).

Lunar—Category Two

Lunar eclipse itself

Eclipse-constellation divination (similar to solar eclipses);

Lunar eclipses because of 5 planets (not referring to the moon hiding any planet, but meaning that the moon gets eclipsed when it is located in the same mansion as a planet. The astrological indications vary depending on the different planets.

The condition of the lunar movement (the moving speed and the yellow belt variation);

The condition of the moon surface (including brightness, color variation, darkness, cloud and mist, jagged edges, paw and foot, horn, awn, thorn, lunar halo, corona, lunar prominence, hat wearing, bearing, red jade, day sight, the improper waxing and waning, and quite a few imaginations or illusions that cannot occur, totaling dozens of conditions).

The moon invading constellations (the moon approaches or hides one of the 28 constellations, with different indications);

The moon invading asterisms (the moon approaches or hides an asterism beyond the 28 constellations and hides it, with different indications);

The moon haloing constellations and asterisms (similar to the above two, but the moon has a halo occurring at the same time, with different indications).

Planets—Category Three

The brightness, color, size, and shape of planets;

A planet passes by or approaches a mansion or an asterism;

The condition of a planet moving (up or down the orbit, staying or laying there, and the yellow belt variation);

The mutual position of planets.

Stars—Category Four

The brightness and color of stars themselves;

A guest star appearing (a new star or a supernova bursting out, sometimes other celestial phenomena are mistaken as a guest star).

Comets, Meteors, Meteorites—Category Five

The brightness and color of a comet;

A comet approaches the sun, the moon, a mansion or an asterism;

Several comets appear at the same time;

Meteors;

Meteorites.

Auspicious and Demon Stars—Category Six

Auspicious Stars (6 kinds in all, cannot be used to precisely judge the celestial pattern);

Demon Stars (as many as over 80 kinds, cannot be used to precisely judge the celestial pattern).

Atmospheric Phenomena—Category 7

Clouds;

Qi, a kind of substance forming universe (rather mysterious, many of them are optical phenomena of the atmosphere);

Rainbows;

Winds;

Thunders, fogs, hazes, frosts, mists, hails, graupels, and dews.

So many celestial phenomena are given astrological meanings. Considering possible combinations of these phenomena, the number is so tremendous that at night on any date, you can see quite a few sky phenomena which have astrological meanings. Since different phenomena have different implications, it is indeed a mysterious and abstruse matter regarding how to accept or reject, balance, explain, and reconcile these phenomena. Because there is a large leeway that allows the astrologist to operate flexibly, he is always able to achieve success one way or another, provided that he is skillful enough.

1.3.5 Astrological Methods

Astrological methods in ancient times are far from each other in gradation. The astrological phraseology in astrological works as a theoretical basis of astrology and must be read intensively. But if a stargazer is capable of predicting fortune

or misfortune according to a sky phenomenon based on the relevant astrological phraseology, his proficiency will be considered as elementary. However, a master-hand in this profession ought to be very familiar with astrological phraseology and various astrological cases; in the meanwhile, he ought to be proficient in calendar, good at predicting celestial phenomena; beyond that, he must make use of his historical experience, social psychology, political, and military information (because he deals with great military and state affairs), and he must be able to synthesize, interpret and even draw a farfetched analogy. Therefore, astrological methods are used differently by different astrologists without strict stipulation. The only principle to follow is the inference made should be based on an astrological theory (If there are different sayings about the same thing, the one that is needed will be taken). A case in point is analyzed below, to show that the ancient people did not stick to one pattern in astrological method. This example is taken from *Remarks of Monarchs*, Volume 10—*Remarks of Jin*, Chap. 4:

Dong Yin went to the Yellow River side to meet Duke Wen Gong there. Wen Gong asked him: “Can I succeed?” Dong Yin replied: “The yearly star is at the great Liang, so Your Majesty can make use of the Way of Heaven to realize your great cause. If you take your place in Year One, the yearly star will be at Shi-Chen. The position of Shi-Chen is now occupied by Jin. Jin prospers from here. Now Your Majesty responds right to this sky phenomenon, so you will succeed for sure. When you went into exile, the yearly star was at the Big Fire that is E-Bo’s star, called Da-Chen. We can make use of it to do good things. Hou Ji observed it in order to lead the agricultural production. Tang Shu established our country Jin when the yearly star was at Da-Chen. The historical official records: The descendants of Jin follow the footsteps of their ancestors, just as grains grow, and they will live in Jin as their great manor. I have divined and got a lucky divination, and the variant dashes form 8 numerals. The explanation is that this is called Heaven and Earth matching each other to enjoy sacrifices offered to ancestors. Small ones go, and big ones come. Now this has come true. Who is to say you cannot succeed? Furthermore, you went abroad when the yearly star was at the Big Fire, and you come back home when the yearly star is at Shi-Chen. Both times are auspicious for Jin. As for Heaven, both Big Fire and Shi-Chen are vital periods. Surely, you will succeed, you will take the state power, you will hold dominant position among the dukes, and your offspring will depend on your supremacy. Do not be afraid!

In this case, Dong Yin made a point with the help of the dividing line theory in astrology. The dividing line of the great Liang is Zhao, and that of Shi-Chen is Wei. But in fact, there were no such states as Zhao and Wei then. The land belonged to Jin as a whole. Hence there was a saying: “The position of Shi-Chen is now occupied by Jin.” It was the end of the year. According to the yearly star calendar, the year was at the great Liang. If Prince Chong Er returned to Jin to take the place, then the next year would become the first year of Jin Wen Gong. Thus, it was said that “the Shi-Chen star is received in the first year.” Prince Chong Er lived in exile for 19 years, and now he was coming back home with the help of the Qin forces. Tracing back to 19 years ago, it was the year of the Big Fire.

From the Big Fire through Da-Chen to Tang Shu (the founding father of Jin), and consequently, there must be the state of Jin. That is indeed a farfetched analogy wisely drawn by Dong Yin.

What is said by Dong Yin conforms to the purport of astrology. Take the astrological phraseology for example. The book *Yi-Si Divination*, Volume 4—*The Yearly Star Divination* says: “In the place of the yearly star there is a benevolent duke who is blessed by heaven. Nobody can attack him. Whoever attacks him will suffer defeat and disaster. The duke can benefit from warfare, and he will overcome his enemy.” The so-called place is determined by the dividing line theory, and here it refers to Jin. Precisely, the Duke of Jin Wen Gong was aided by Qin forces in launching warfare to take power. Because of strong continuation of astrological theories in ancient China, it is not hard to deduce that there must have been similar sayings which are nearly the same as the divine conclusion in *Yi-Si Divination*, and they provide enough proofs for Dong Yin’s divine oracles.

As a senior official of Jin, Dong Yin has enough background knowledge and political information. Prince Zhong Er has always possessed a good reputation. Officials and officers under his leadership are elites of the time, and they all follow him loyally throughout his exile. In the 19 years of living abroad, he travels to various states, enriching his political experience. Monarchs of Qi, Chu, Qin and other major states make friends with him, predicting that he will rule the state of Jin someday in the future. Now a internal strife is happening in Jin. Taking this good chance, and with support from Qin’s forces, he returns home to take the throne. His success is a certainty. So Dong Yin’s divination is certain to lead to a prophecy of success. Even if the yearly star is not at the great Liang, Dong Yin will make another farfetched analogy and draw the same conclusion. Of course, seen by ancient people, Prince Zhong Er comes home at the end of the year when yearly star is at the great Liang, to inherit the monarchical throne, and this is the heaven’s will for him to revive the state of Jin. If he comes in another year, he will not succeed. Thus, Dong Yin’s prediction is only an explication of the heaven’s will, and later it comes true.

1.3.6 Celestial Phenomena: Recording and Fabricating

Because ancient people held the viewpoint of unity of heaven and mankind, and believed that sky phenomena were all warnings or approbations for human affairs, they would give these phenomena astrological meanings, and naturally, they attached great importance to observing and recording these phenomena. Theoretically, the imperial astrological institution should assign persons to monitor the sky day and night, and to record every sky phenomenon for report. Thanks to the great tradition of the state-operated study of heaven, the continuation of its activities was sustained and the needed manpower and supplies were guaranteed. As a result, a large part of the records on sky phenomena are kept well and handed down. This job of observing and recording has been continued for 2,000 years or maybe even longer (but the pre-Qin record is not kept systematically).

Heavenly scientists in ancient times recorded sky phenomena not because they had the scientific conscience as the modern astronomers do. Rather, they did this because they wanted to keep the astrological data, and record on file every event between heaven and mankind (these events had significant meanings to them). Little could they imagine that these astrological records on file would become valuable historical data. The object of the modern astronomical research is of large scale in time and space. The several hundred years between the birth of the modern astronomy in Europe and the present days is too short a period for research in modern astronomy. Astronomers need older records, and the astrological data from ancient China meet the need for the rich variety of celestial phenomena and the long period of time it encompasses. In view of this situation, Chinese scholars have completed a huge project—collecting and collating all the astrological records in official historical records, Real Records of Ming and Qing Dynasties, Ten General Histories, local chronicles, and other old books, to compile a book entitled *A Sylloge of Records of Celestial Phenomena in Ancient China*. The book includes:

Solar eclipses record, over 1,600 items,
Lunar eclipses record, over 1,100 items,
Moon hiding planets record, over 200 items,
New stars and supernovas record, over 100 items,
Comets record, over 1,000 items,
Meteors record, over 4,900 items,
Meteor showers record, over 400 items,
Meteorites record, over 300 items,
Sunspots record, over 270 items,
Polar lights record, over 300 items,
Other sky phenomena record, over 200 items.

In discussion about ancient people recording sky phenomena, a question has to be dealt with, that is, the fabrication of sky phenomena. Record of sky phenomena should be astrological files and astrology serves politics. It is well known that the political operation under a feudal autocratic ruling is full of cheating and violence. Questions and doubts are raised about the records of two kinds of sky phenomena that are significant in astrology. The first kind is called “Five planets gather in one mansion,” meaning that the five big planets appear within a small range in the sky. In the past 2,000 years since the Han Dynasty, nearly 20 times of “Five planets gather in one room” happened, and 10 of them could be observed clearly, but none of them are recorded. In fact, ancient people did not record these phenomena in detail, and those recorded were used to draw farfetched conclusions to conform to auspicious or destined matters, leading to fabrication of record in some cases. The other kind is called “Mars guarding the heart” (Mars stays around the mansion of heart). Searching through all the official histories, we have found 23 records of this kind. When traced back using the methods of modern astronomy, however, only 6 of them are real and the rest are coined. On the other hand, in the 2,000 years from 289 BC to 1638 AD, there are 32 occurrences of “Mars stays around the mansion of heart,” but none is recorded.

From the above two examples—“Five planets gather in one mansion” and “Mars stays around the mansion of heart”—we can infer that probably other kinds of records of celestial phenomena may also be fabricated or farfetched. The problem is serious in that many celestial phenomena cannot be traced back and tested. Instances such as comets, meteors, meteorites, and sunspots belong to this category. So, today people are unable to test their authenticity as we have done to “Five planets gather in one mansion” and “Mars stays around the mansion of heart.” Even for these two kinds of phenomena, ancient people dared to fabricate the data (The technique of tracing back to these two phenomena was mastered by ancient people already in the Warring States period. Although the technique back then was not so accurate as the modern method, reverse tracing and validating those two astronomical phenomenas do not require high accuracy). Imagine that for other celestial phenomena, which cannot be traced back, the probability of fabrication may be much larger. Therefore, contemporary scholars should be very cautious when they want to apply the records of celestial phenomena from ancient times to their research in modern astronomy.

1.4 A Survey on Study of Heaven Development in Successive Dynasties

1.4.1 Pre-Qin Period

Heavenly Stems and Earthly Branches: The historical world assumes that the system of Heavenly Stems and Earthly Branches for recording dates and years has never gone wrong since the Yin-Shang period. This assumption is the foundation of the chronology of Chinese history. Up to now, no evidence has been found to overthrow this assumption.

Birth of the 28 lunar mansions system: in 600 BC or so. Since then, it has long been used in ancient China as the celestial sphere coordinate system.

Birth of calendar and its progress: In 600 BC at the latest, the gnomon was initially used for measuring the annual variation of the sun shadow length to determine the moments of Winter Solstice and Summer Solstice (as shown in Fig. 5). Beginning in 589 BC, the law of 7 intercalary years out of every 19 years was mastered. There were “6 ancient calendars” in the pre-Qin period, namely: Calendar of Yellow Emperor, Calendar of Zhuanxu, Calendar of Xia Dynasty, Calendar of Yin period, Calendar of Zhou Dynasty, and Calendar of Lu state. Contemporary research has shown that the “6 ancient calendars” were formulated in the Warring States period and were not that old as their names indicated. Actually, all these 6 calendars are “quartering calendars”—a tropical year is 365 and 1/4 days long, and the difference lies in merely the time measured and the precision of measurement.

Recording and predicting celestial phenomena: Professional heavenly scientists began systematical observation of celestial phenomena. For instance, during

Fig. 5 The gnomon



the 242 years from the first year of Lu Yinggong (722 BC) to the 14th year of Lu Aigong (481 BC), 37 solar eclipses are recorded in the *Spring and Autumn*, of which at least 31 have been proven to be exact.

1.4.2 Qin and Han Dynasties

Five Planets Divination and planetary motion: *Five Planets Divination*, a silk book unearthed from a Han tomb at Mawangdui, indicates that the law of planetary motion was mastered quite well then.

The 24 seasonal division points: These are constituents of the solar calendar in the lunar-solar joint calendar. They are determined by the annual apparent solar motion on the ecliptic (In fact, it is the annual motion of the earth on the ecliptic). The 24 seasonal division points as a complete set appeared for the first time in *Huainanzi—Instruction on Astronomy*.

Primordial Calendar and the rule of intercalation: The *Primordial Calendar* was made in the former Han Dynasty when emperor Wu reigned. That calendar set the rule of intercalation, and it has been in use ever since.

Zhang Heng: Zhang Heng in the Eastern Han Dynasty was a famous astronomer and litterateur. He was appointed Grand Astrologer (in charge of the royal institution on study of heaven) twice. He wrote a book on study of heaven *Constitution of Spirit*, manufactured the “sphere-heavens instrument rotated by dripping water” for demonstrating celestial phenomena, and the “Seismoscope” for forecasting earth quakes (as shown in Fig. 6).

The sphere-heavens theory: The sphere-heavens theory became the dominating model of the universe in ancient China ever since.

Fig. 6 A photo of the restored Seismoscope



1.4.3 The Wei, Jin, Northern and Southern Dynasties

The asterism system got finalized. Chen Zhuo, a leading heavenly scientist in this period, served on officialdom in the Wu kingdom, Western Jin and Eastern Jin Dynasties. He gathered three astrological systems, i.e., the astrological systems of the Shi's, Gan's, and Wuxian's, since the Warring States period and formed a unified system of stars, which includes 283 asterisms, totaling 1,464 stars. This system was used in China for over a 1,000 years.

Continual reform of calendar and more precise mastery of the solar and lunar motion: Quite a few calendars emerged successively in the period, and some of them competed with one another, while others caught up from behind. In the Eastern Jin Dynasty, Yu Xi discovered the year difference. Zhang Zixin discovered the heterogeneity in the annual apparent solar motion and in the planetary motion.

In the ancient Chinese theory of planets, the planetary motion was thought to be at a uniform speed. Before 600 BC, the location in China of a planet at a random time was determined with the following technique: Make out a table of the dynamic state of planets in a synodic period. The table might be got through observation over many years, or composed with reference to data gathered from observation. Divide this synodic period into several sections of time, i.e., Shun(forward), liu (staying), ni (reverse), and fu (conceal), each section with a mean speed. If you want to know the location of a planet at a certain time, mark the place of the time in the synodic period. From the table, you get to know which section the planet is moving in, and how many degrees it has passed, and you will find its location. Because of the supposition that a planet moves at a uniform speed in each section, this method of predicting its location could not be very precise. It was not until the mid-sixth century when Zhang Zixin discovered the heterogeneity in the planetary motion that the table was revised with a proper treatment of motion at uneven speeds.

The Western astronomy was introduced via India and the Mid-Asia to China. In the Six Dynasties, Sui and Tang period, the spreading of the Western astronomy reached a climax. In the climax, knowledge of the Western astronomy was transmitted to China by way of India accompanying the Buddhism propagation. Significant relevant literatures such as *Secrets for Driving off Evils by Seven Luminaries* and the like were saved in the form of Buddhist Scriptures.

1.4.4 The Sui, Tang, and the Five Dynasties

More precise calculation and prediction of eclipses: In that period, China absorbed some astronomical techniques from Babylon and India, and improved the precision of calculating the movement of the sun, moon, and the five planets.

The *Treatise on Astrology of the Kaiyuan Era*: The present edition of the *Treatise on Astrology of the Kaiyuan Era* has 120 volumes in all. It was compiled by Gautama Siddha, the Indian astronomer who worked at the royal institution on study of heaven in the Tang Dynasty, from 718 to 728 AD. This book integrates the astrological theories of all schools before the Tang Dynasty and becomes the most important and complete data base of the ancient Chinese astrology. The book also keeps the data of stargazing from the remote times of ancient China, including the astrological literatures of three most ancient Chinese astrological schools we have ever known—the Shi, Gan, and Wuxian schools, and it records the basic data of all the calendars known in China before the eighth century. Additionally, the book records the Chinese translation of the ancient Indian calendar *Navagraha*. Moreover, the *Treatise on Astrology of the Kaiyuan Era* is a gathering pool of Wei (Longitudinal) books from ancient times. More than 80 Wei books are quoted, but most of the original books being cited are lost now, so it is really valuable.

Seng Yixing: A representative of heavenly scientists in the grand Tang period, and an eminent monk of the Tantra Buddhism (as shown in Fig. 7). In the Kaiyuan years, he supervised the extensive North–South astronomical measurement, and compiled the *Great Derivative Calendar*. This is one of the most important calendars in Chinese history. What is more, he manufactured jointly with Liang Lingzan the Water-driven Sphere-heavens (instrument for demonstrating sky phenomena) and the Ecliptic Movable Sighting Set (instrument for observing sky phenomena).

Emergence of the civilian *Small Almanac*: The *Almanac*, with day-to-day notes in it, reminds of “suitable or avoidable” activities, was a necessity for daily life of civilians. So book publishers printed and sold the almanac privately, and called them *Small Almanac*. Obviously, this was driven by business motivation, competing with the government for profits. The *Small Almanac* was not a copy of the official calendar issued by the imperial court. Instead, it was compiled, printed and sold by ordinary citizens who made it before the imperial court issued the official calendar. This practice did not comply with the decree that the imperial court ought to monopolize the Study of Heaven. Therefore, time and again, ministers

Fig. 7 A picture of Seng Yixing



reported it to the emperor and suggested that this sort of wrong doing be prohibited. But, this practice was never prohibited effectively. By the Ming and Qing Dynasties, it has evolved into overt business activities.

1.4.5 The Northern and Southern Song Dynasties

Constuction of huge instruments: The Northern Song Dynasty is considered as a climax of the traditional Chinese study of heaven. It built gigantic astronomical instruments one after another, including 6 large-scale armillary spheres, each weighing 10 tons or so. The Northern Song Dynasty also conducted 7 times of extensive measurement of stars. Those were unprecedented activities on study of heaven.

The Water-driven astronomical clock tower and its replication efforts in modern times: The Water-driven astronomical clock tower was built in 1092 during the Northern Song Dynasty. Su Song wrote a book *Principles of the New Astronomical Tower*, which is passed down. The book records all the parts of the clock tower, with dimensions and drawings, which makes it possible for modern researchers to restore the instrument that we believe to have existed. A replica was made in 1958 and now it is still kept in Beijing Museum of Chinese History. In the record, the Water-driven astronomical clock tower was a jumbo as high as 12 m (as shown in Fig. 8); but the replica in 1958 was reduced to 1/5 of the recorded dimension. Generally, a rule of machinery is that if a mechanical device runs normally, then after its dimension is enlarged, the larger replica will not necessarily

Fig. 8 A reproduction of the Water-driven astronomical clock tower



run normally; but usually, after its dimension is reduced, the smaller replica will have no trouble running. However, the down-sized copy of the tower cannot run, so it is bantered as “a model only for viewing its outer appearance.” Since then, no reproduction has been reported as capable of running normally for long.

1.4.6 The Yuan Dynasty

Guo Shoujing: He was the last summit of the traditional Chinese study of heaven. He compiled, *Calendar for Time Service*, the ultimate calendar in the traditional Chinese calendars, supervised the manufacturing of quite a few instruments, such as the abridged armilla, the scaphe, the height meter, the shadow definer, the direction-determining board, and the ingenious planetarium, and he conducted unprecedented measurements for study of heaven.

The merged utilization of the Arab and traditional Chinese study of heavens: In the Yuan Dynasty, the Bureau of Astronomy was established in the summer capital. It had a kinship with the Maragha observatory of the Ilkhanate Dynasty. It was led by Jamal al-Din, a famous Islamic astronomer, specialized in the Islamic astronomical work as its task. Undoubtedly, it has a vital place in history of the Islamic astronomy. As recorded in the *Annals of the Director of the Palace Library*, Volume 7, “On the 18th day of the leap 6th month, 10th year of Zhiyuan (1273 AD), the Grand Guardian passed on the imperial edict: Both the Hui’s Bureau of Astronomy and the Han Bureau of Astronomy were led by the Director of the Palace Library.” It is a very rare (if not the only one) case in the world history

of astronomy that two observatories belonging to entirely different astronomical systems were led by the same administrator—the Director of the Palace Library.

1.4.7 The Ming Dynasty

Relaxing the prohibition on “learning study of heaven privately”: In Wanli years of the Ming Dynasty, it became a fashion for princes, lords, and officials to talk about calendar, and some of them openly wrote books and set up theories. Zhu Zaiyu, the Imperial Prince of Zheng, contributed two books, namely the *Imperial Longevity Calendar* and *Mastery of Calendar*. Xing Yunlu, the Assistant Surveillance Commissioner of Henan Province, wrote two books, namely *A Survey of Ancient and Modern Calendars*, and *Textual Criticism on Beginning of Spring of Wushen Year*. Fan Qian, Minister of Rites, argued from time to time in favor of this sort of private learning of calendar. He suggested that the books by Zhu Zaiyu “should be sent to the Directorate of Astronomy for reference and tests. As the Imperial Prince, he is devoted to calendar learning, erudite about the past and the present, and he ought to be awarded.” The suggestion was proved by the emperor (*History of Ming*, Volume 31—*Annals of Calendar*, Book 1). Later he presented another report: “Calendar is a state affair. Literati and masters should be allowed to pursue it. It is not a private possession of calendar officials. The decree of calendar prohibits rumors of omens only. ... I beg the emperor to promote Yunlu to supervisor of the Directorate of Astronomy. He could lead the subordinates to measure celestial bodies carefully and complete a great calendar.” This suggestion was so bold as to propose that a private learner of calendar be promoted to leadership of the Directorate of Astronomy! This time the emperor did not make any comment, and the suggestion failed to realize (*ibid*).

Before Zhu and Xing had their books published, in 12th Year of Wanli (1584 AD), Fan Shouji, Director of Bureau of Operations, Ministry of War, manufactured an armillary sphere privately, violating the prohibition on private learning of astronomy. That was more serious than private learning of calendar. Fan wrote a book *Corrigenda of Asterism*. In the preface, he speaks in defense of his law-breaking behavior: The prohibition on private learning on study of heaven is applicable to the lower-class masses, but not to the literati and officialdom.

Generally speaking, in ancient China, before the first half of the Ming Dynasty, private learning on study of heaven was forbidden. As for the effectiveness of the prohibition, it is another question. However, in and after the middle Ming Dynasty, the prohibition was relaxed gradually. When it came to the Qing Dynasty, prohibition in this respect was virtually abandoned.

Controversy about altering the calendar and the making of *Chongzhen Imperial Almanac*: In the Ming Dynasty, errors in the official *Great Unified Calendar* accumulated gradually, resulting in failure to predict celestial phenomena time and again. Propositions of altering the calendar went on for many years. In 1629, officials from the Directorate of Astronomy predicted a solar eclipse with the old method but failed once more; while Xu Guangqi predicted with the Western



Fig. 9 Chongzhen imperial almanac

astronomical method and fitted the real measurement completely. So emperor Chongzhen ordered to set up a “Bureau of Calendar” led by Xu Guangqi to compile a new calendar. Xu invited Jesuit missionaries Nicholas Longobardi, Johann Terrenz Schreck, Johann Adam Schall von Bell, and Giacomo Rho to participate in work of the Bureau of Calendar. In 1629-1634, they worked jointly and completed the famous “encyclopedia of classic European astronomy” *Chongzhen Imperial Almanac* (as shown in Fig. 9).

The *Chongzhen Imperial Almanac* was made up of a great number of volumes, of which the part “Methods and Principles” or the theoretical part takes up 1/3 of the total. It introduces systematically the theories and methods of the classic Western astronomy, and expounds the research results of Ptolemy, Copernicus, and Tycho. Generally, it did not surpass the level of astronomy before the three laws of planetary motion by Kepler, but there is a little advanced content. Concrete calculations and numerous tablets of astronomy are based on the Tycho system. What and whose books are adopted for the *Chongzhen Imperial Almanac* to introduce the astronomical doctrines and works? I have found out most of them through textual research (Refer to Lecture Three for details).

1.4.8 The Qing Dynasty

The Directorate of Astronomy led by Jesuit missionaries coming to China: In March 1644, Li Zicheng’s uprising army entered Beijing. Emperor Chongzhen hanged himself. Soon after, Li Zicheng was defeated by the united army of Wu Sangui and Manchu. On May 1, the Manchurian army entered Beijing, and the great Ming Dynasty was doomed. At that time, Johann Adam Schall von Bell in

Beijing city decided to fully cooperate with the Manchurian power. The ill-fated *Chongzhen Imperial Almanac*, which had not been promulgated 10 years after its completion, now became a lavish gift of Bell to the Manchurian ruler who needed a new calendar to symbolize the transition of heaven's will and the "re-creator of heaven and earth." After revising, Bell submitted it to the Qing government that adopted it. Emperor Shunzhi autographed the title *Almanac with the New Western Method*, and issued it right away for publication.

Because of his contribution, and through his efforts, Johann Adam Schall von Bell was appointed principal of the Directorate of Astronomy, which started the tradition of the Qing Dynasty appointing Jesuit missionaries to administer the Directorate of Astronomy for nearly 200 years. Bell made the best use of the situation and realized his dream of entering the imperial court with knowledge of astronomy. Personally, Bell was very skillful at mixing with the court and the noblemen. In the late Ming Dynasty after he was made Director of the Beijing Metropolitan Parish, he extensively developed Catholic believers in the Ming Palace, converting 140 royal family members, 50 noblewomen, and over 50 eunuchs. After the Qing Dynasty was established, Bell won the favor of emperor Shunzhi, who often called him "Mafa" (meaning "Grandpa" in Manchurian), because he cured the disease of Xiaozhuang the empress dowager, who respectfully called him her adoptive father.

From then on, the Directorate of Astronomy in the City of Beijing has become the most important stronghold for Jesuit missionaries coming to China.

The traditional study of heaven with the Western astronomy as a tool: Starting in the Wanli years of the Ming Dynasty, Jesuit missionaries came to China one after another. They introduced the Western astronomy to the Chinese cause on study of heaven. They were trusted by Shunzhi, Kangxi, and other emperors, and led the Directorate of Astronomy for a long time. In spite of this, study of heaven in China did not change its nature and position radically. Although one change was quite noticeable, that is, study of heaven was no longer the exclusive domain of the imperial court. This change can be considered as continuation of the trend in the late Ming period. However, the sacred nature and function on study of heaven at the Directorate of Astronomy did not differ from previous times.

2 Lecture 2: Astronomical Observation and Calendar

2.1 *The Fundamental Question of the Ancient Astronomy*

2.1.1 The Fundamental Question

The fundamental question of the ancient astronomy was, in short, to calculate the positions of the sun, the moon, and the five planets on the celestial sphere at the given time and place. This question was common in the East and the West. The questions of spherical physics, which make up the main stream of the modern astronomy, did not exist in ancient times.

2.1.2 The Ways of Solving the Fundamental Question

With the law of universal gravitation, the modern Celestial Mechanics can calculate the position of the sun, the moon, and the five planets on the celestial sphere at any time. Before the modern Celestial Mechanics was born, there were only two ways of solving the fundamental question mentioned above: One was adopting geometrical models and the other was adopting digital models.

2.1.3 The Geometrical Model in Ancient Greece

Ancient Greek astronomers adopted geometrical models of the universe and Ptolemy epitomized them. His epicycle /deferent model can be used in deduction to calculate the position of the sun, the moon, and the five planets on the celestial sphere at any time. According to Ptolemy, this model is merely a geometrical expression of the universe, and it does not represent the real situation of the universe. After that, the varied models of the universe made by Arab astronomers in the Middle Ages, the Copernicus model of the universe, and the Kepler laws of planet movement are all geometrical models. Only after the birth of Newton's law of universal gravitation did the Western model of planet movement become a model of physics.

2.1.4 The Periodical Model of Babylon

The ancient Babylon had a well-developed mathematical astronomy. Through long periods of observation, Babylonian astronomers accumulated precise data, with which they constructed a series of periodic functions. Superimposing these functions, they were capable of fairly precisely calculating the position of the sun, the moon, and the five planets on the celestial sphere at any time.

2.1.5 The Periodical-Digital Model of China

The practice of the heavenly scientists in ancient China was essentially similar to that of Babylon, and they also made a kind of digital model. The method in ancient China was to observe the behaviors in a "synodic period" (forward motion, reverse motion, conceal, and staying), and describe in detail. Then, starting from an ideal point (i.e., the so-called "grand origin"), use the superimposing of "synodic periods" and calculate the position of the sun, the moon, and the five planets on the celestial sphere at any time.

In this digital modeling, the real situations of the universe may be avoided. So the Chinese study of heaven had the theory of sphere-heavens as its major model of the universe, but this model is not closely connected to concrete calculation of celestial phenomena. That is quite different from the geometrical model of ancient Greece.

2.2 *The Model of the Universe and the Coordination System of the Celestial Sphere*

2.2.1 Evaluation of Several Models of the Universe

In ancient China, there were six doctrines of the universe. Three of them had theoretical outlines, namely: the theory of sphere-heavens, the theory of canopy-heavens, and the theory of expounding appearance in the night sky.

Among these three theories, the theory of expounding appearance in the night sky has always been held in high esteem, starting with Dr. Joseph Needham. In his work, *Science and Civilisation in China*, volume on study of heaven, Needham sets a special section to deal with the “theory of expounding appearance in the night sky.” He appraises this model of the universe enthusiastically: “The openness and progress in this view of the universe is not inferior to any of its counterparts in Greece. ... The Chinese view that sparse celestial bodies are floating in the infinite space is far more advanced than the European concept of a crystal ball.” For historical material on the theory of expounding appearance in the night sky, refer to *Book of Jin · Annals of Astronomy*.

All the books publicizing the theory of expounding appearance in the night sky were lost, except a hearsay which was recorded by Xi Meng, Assistant in the Palace Library in the Han Dynasty. It is recorded that “The sky has no texture. When you look up at the sky, it seems high, remote, and limitless. You have blurred vision and feel dizzy. You are exhausted, so the space seems to be vast and boundless. It is just like when you look at the yellow hills far away, they appear green, and when you look down the deep valley, it appears dark. That green color is not the true color; that darkness is not the appearance of anything real. The sun, the moon, and the stars float in the vacant space naturally, and they move or stop depending on the atmosphere. Therefore, the Big Dipper seems now clear, now vague, sometimes in direct motion, sometimes in prograde motion; concealing and appearing are irregular, progressing, and regressing differ in the orbit. Because they are not rooted together or tied to each other, they behave differently. Thus, Stella Polaris is always at the fixed place, the Big Dipper does not sink down westward. Mufrid and Saturn move eastward by one grade each day and 13 grades each month at irregular speeds. So, it is thinkable that they are not tied to each other. If they were tied to a celestial body, they would not behave like that.”

First of all, this paragraph does not imply that the universe is limitless. Seeming to be “high, remote and limitless” refers to the limit of human eyesight. Secondly, Seven Luminaries (the sun, the moon, and the 5 planets) “conceal and appear irregularly, progress and regress differently in the orbit.” But the paragraph does not give even a simple narration about their motion. The reason for this deficiency is “because they are not rooted together or tied to each other,” which makes it clear that this model of the universe cannot lead to any practical conclusion.

Comparatively, the Western model of the universe before Copernicus—and even the crystal ball system in Aristotle’s doctrine—can lead to the orbits of Seven

Luminaries and the orbits can stand rigorous observation and verification. The former is merely a product of mental analysis by philosophers, although it is closer to the universe we know today. The latter is a product of empirical and scientific research, although it has a discrepancy from the universe we know today.

The “theory of expounding appearance in the night sky” did not lead to even a preliminary mathematical astronomical system—that is, the explanation or mathematical description of celestial phenomena, or the prediction of the future celestial phenomena. Seen from this viewpoint, the theory of expounding appearance in the night sky (not to mention the theory of bright heavens, the theory of vaulting heavens, and the theory of stable heavens) is not qualified to be placed in the same category as the theory of canopy-heavens and the theory of sphere-heavens. What really played a vital role and exerted major influences in ancient China are the two models of the universe—the theory of canopy-heavens and the theory of sphere-heavens.

The theory of canopy-heavens in the book *Zhoubi Suanjing*, as a geometrical model of the universe, is a bit inferior to the ancient Greek model of its kind in terms of “explaining the phenomena.” But it does give us a sense of science characteristic of ancient Greece. From the viewpoint of history of scientific thoughts, axiomatization was tried and practiced in the remote East 2,000 years ago—and this is meaningful indeed.

After *Zhoubi Suanjing*, the method of axiomatizing died out in China. We remain especially curious about whether its geometrical model of the universe is a result of some foreign influence, or a random mutation of the native science in China. Moreover, why did it last so briefly and die so quickly? These questions interest us, and yet we still do not know the answer.

Compared to the theory of canopy-heavens, the theory of sphere-heavens had a much higher standing in ancient China. Actually, it was a mainstay and dominating doctrine of the universe in ancient China. However, it does not have a book like *Zhoubi Suanjing* to systematically expound its theory. Usually, *Notes of Zhangheng’s Armillary Sphere* cited in *Treatise on Astrology of the Kaiyuan Era* Volume 1 is considered as a creed literature of the theory of sphere-heavens. This citation is short, as follows:

The sphere-heaven is like an egg. The sky body (meaning the “form of the heaven”) is shaped like a pellet. The earth is like the yolk, staying in an egg. The sky is large, and the earth is small. The sky has water in its skin. The water encloses the earth as the egg white encloses the yolk. The sky and the earth stand on the air, or float on the water. The great circle of the celestial sphere consist of $365\frac{1}{4}^{\circ}$, and can be divided into two halves, with $182\frac{5}{4}^{\circ}$ each—one half covers the earth, and the other winds the bottom. So the 28 constellations are half-seen and half-hidden. The two ends are so-called North Pole and South Pole. The North Pole is the center of the heaven; it is in the due north, 36° above the earth. The North Star is at the 72° upper radius, appearing forever, never hiding. The South Pole is the middle of the heaven; it is in south, 36° into the earth. The South Star is at the 72° lower radius, hiding forever, and never appearing. The two poles are $182\frac{1}{2}$ degrees from each other. The heaven rotates like a wheel, revolving endlessly; its shape is spherical, hence the sphere-heaven.

That is the basic theory of sphere-heavens. Its content is not so rich and detailed as the theory of canopy-heavens. But this model of the universe corresponds directly to “armillary sphere,” the major traditional Chinese instrument for astronomical observation. And those instruments for demonstration of sky phenomena, such as “celestial sphere” and “celestial globe”, simulate this model. So of the three theories of the universe, only the theory of sphere-heavens is compatible with the mathematical astronomy in the consequent 2,000 years in China.

2.2.2 Coordinates of the Celestial Sphere

The Western ecliptic coordinates. Traditionally, the Western astronomy always uses the ecliptic coordinates, that is, a coordinate system which takes the yearly apparent motion orbit of the sun (actually the orbit of the earth revolving around the sun) on the celestial globe as the datum. It was not until the late sixteenth century when Tycho renovated the astronomical instruments that Westerners began to use the equator coordinate system. Today most instruments adopted by the international astronomical world are the equator coordinate devices.

The Chinese equator coordinates. The ancient Chinese people always used the equator coordinates that is a coordinate system which takes the projection of the equator plane of the earth on the celestial sphere as the datum. The datum can be determined through observing the daily apparent motion of specific stars around the North Pole (actually the rotation of the earth). The traditional Chinese coordinate system of the celestial sphere is the “28 constellations” system, of which the “lunar lodge degrees” is equivalent to the right ascension, and the “pole-bound degrees” is equivalent to the declination in modern astronomy.

The “false ecliptic coordinates” in ancient China. The traditional Chinese study of heaven always used the equator coordinate system, but this does not mean that they did not know the ecliptic. The ecliptic as the motion orbit of the sun and moon was known to any person who had acquired astronomical knowledge to some extent. However, ancient Chinese people used a kind of ecliptic coordinates which is different from the Western system (as shown in Fig. 10). Modern scholars call it the “false ecliptic coordinates.” The “false ecliptic coordinates” has an ecliptic plane that conforms to the real situation, and yet it has never defined an ecliptic pole. The “false ecliptic coordinates” adopts the intersecting point of the right ascension line from the North Pole extending southward and the ecliptic plane to measure the position of celestial bodies. The values so gotten are different from the correct ecliptic longitude and latitude. The reason for this discrepancy is that geometry was not developed enough in ancient China.

2.2.3 The Coordinate System for the Celestial Spheres of the 28 Chinese Constellations and Its Origin

On the question of the origin of the 28 constellations system, Joseph Needham firmly holds the doctrine of Babylon origin. He thinks that “the 28 constellations

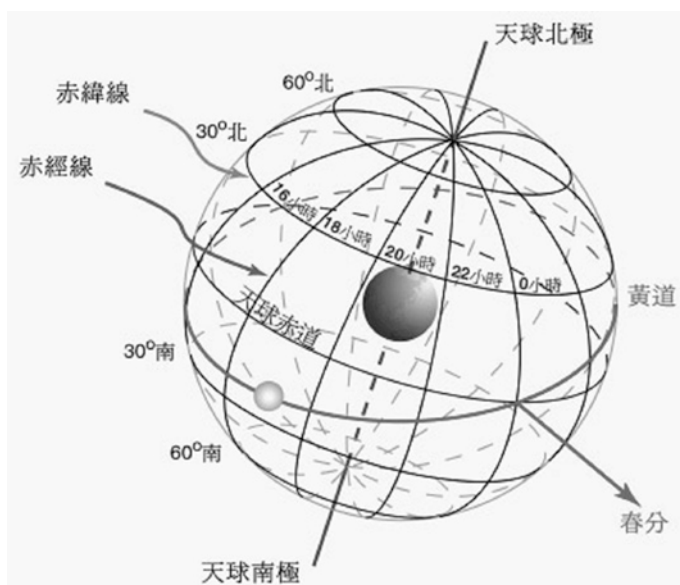


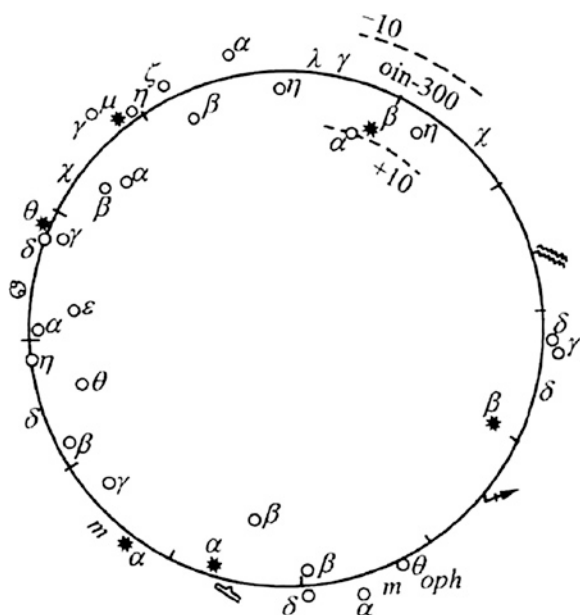
Fig. 10 A coordinate system of the celestial sphere

are commonly to the astronomy of the Chinese, Indian, and Arab peoples. The original might be none of the three places. Instead, their concept of 28 constellations was derived from the concept introduced from Babylon.” Of modern Chinese scholars who deal with the question of the origin of the 28 constellations, Guo Moruo and Zhu Kezhen are noticeable. Guo Moruo maintains that the Babylon study of heaven was introduced to China in the early Yin period or even before it and became a major part of the Chinese study of heaven. But he believes that the 28 constellations system originated from China. Zhu Kezhen had 4 papers published about the origin of the 28 constellations. He held the Chinese origin doctrine first, but later, he changed his mind and inclined to accept the Babylon origin doctrine.

If we do not adhere rigidly to the number 28, a coordinate system of the celestial sphere similar to the Chinese system of 28 constellations exists in the Babylon study of heaven. During the Seleucid period, two coordinate systems existed in the Babylon study of heaven. One is the universally acknowledged zodiacal signs and the other is not so noticeable. This method constitutes a frame of reference with 31 stars (as shown in Fig. 11) in order to describe the position of the moon and planets, and they are called the “standard stars.” This coordinate system has the following characteristics:

- (1) The ecliptic longitudes are arranged unevenly.
- (2) The ecliptic latitudes are arranged within the scope of $-7^{\circ}30'$, 10° .
- (3) The 31 stars are mostly bright stars.
- (4) Six of the 31 stars overlap with the 28 mansions in the Chinese system, as follows:

Fig. 11 The system of 31 standard stars in seleucid dynasty



β Ari (娄),
 μ Gem (井),
 θ Cnc (鬼),
 χ Vir (角),
 α Lib (氐),
 β Cap (牛),
 β Ari (Bond),
 μ Gem (Well),
 θ Cnc (Ghost),
 χ Vir (Horn),
 α Lib (Root),
 β Cap (Ox).

- (5) When using this system to describe the position of a celestial body, the angular distance is not needed. But the units of length are given as cubif and finger. One cubif = 30 fingers. Its relation to the angle is given as: 12 fingers = 1 degree.

Let us discuss briefly as follows:

Longitudes are distributed unevenly. This is exactly the most noticeable characteristic of the 28 mansions in China. The Western system of 31 standard stars has the same characteristic. Isn't it meaningful?

The question of the distribution of latitudes. Many scholars believe that the datum of the 28 mansions is equator. But the distribution of the determinative

star (the datum star) coincides with the elliptic better than with the equator. For instance, the declination of the determinative star of Stomach mansion is as large as 27° and more, and that of the determinative star of Tail mansion is as large as -37° and more. On the contrary, the ecliptic attitude of any determinative star can never be as large. Tracing back to 2400 BC, the determinative star coincided with the equator better than now, nearly as well as with the ecliptic latitude. Nevertheless, it is questionable whether the history of the 28 mansions could be traced back to so early a time. Compared to the ecliptic latitude distribution of the 31 standard stars, the distribution of the determinative stars of the 28 mansions more dispersed.

Most of the 31 standard stars are famous bright stars. This situation differs from the determinative stars of the 28 mansions.

Of the 31 standard stars, 6 overlap with determinative stars of the 28 mansions, accounting for about 20 % of the total. If this discrepancy is interpreted as a pure coincidence, the percentage will seem too large. If interpreted otherwise, it will be too small. This point gives us a ground for further research.

The lower limit of the age when the 28 mansions system was established in China has been determined now as 430 BC with physical historical materials. The names of all the 28 mansions are written on a Warring States lacquer box excavated from Zenghouyi Tomb at Leigudun, Suixian County, Hubei Province in 1978 (as shown in Fig. 12). Note that this judgment is only 30 years different from the presumption made by Zhu Kezhen about the first appearance of the 28 mansions system in China. As for the upper limit, it is hard to determine for the time being, as there are many factors undetermined.

Thus, logically we have three possible conclusions to choose from:

The 31 standard stars system originated from the 28 mansions system,

The 28 mansions system originated from the 31 standard stars system,

Both systems originated independently.

Unfortunately, all the research in this field up to now is far from enough to enable us to decide on any of the three conclusions.

Fig. 12 Warring states lacquer box excavated from Zenghouyi Tomb, at Leigudun, Suixian county, Hubei Province



2.3 *The Properties and Functions of Ancient Chinese Calendars*

2.3.1 Calendar · Chronicle · Almanac

A monthly calendar for daily use is called chronicle. This article has long existed from ancient times, such as the Chronicle of 1st Year of Yuanguang (134 BC) in emperor Wudi of the Han Dynasty, written on bamboo slips excavated from a Western Han tomb in Linyi City, Shandong Province. Early chronicles only have dates, the Heavenly Stem and Earthly Branch of each date, and a few notes in them. Later on, they grew more sophisticated, and each date was noted with auspicious or ominous things, while the length increased by dozens of times in comparison with the original chronicles. Finally, they evolved into almanacs. The difference between a typical chronicle and an almanac (for example, the chronicle of the 1st year of Emperor Wu of the Han Dynasty and the Huitian Almanac of the 4th year of Baoyou in the Song Dynasty) is so obvious that you cannot mix them up.

Problems occur with the word “calendar,” a phrase commonly used today. Apparently, this word should refer to the method of compiling chronicles and almanacs. Such an understanding is partially correct only. Today people call the content of *Treatise on Bells and Almanac* or *Treatise on Almanac* in official histories calendar (excluding the part on Bells of course). Actually, most of such content is not associated with compilation of chronicles and almanacs, or needed for compiling them. Besides, today people call a chronicle or almanac calendar, too, making the situation more complex. Ancient people often called a calendar, chronicle, or almanac by the joint name “calendar” or “calendric art.” That term is a little vague, and yet, it is invulnerable as long as the concept is concerned.

To make it convenient for discussion, we use the word calendar in the contemporary sense, that is, calendar refers to the content of *Treatise on Bells and Almanac* or *Treatise on Almanac* in official histories. But we must point out that this calendar is very different from the monthly calendar for daily use in concept.

As for chronicle and almanac, the difference between them is clear, as we have mentioned earlier. A calendar book with notes is called an almanac, while a simple tablet with dates and corresponding heavenly stems and earthly branches is called a chronicle. An almanac must contain all the elements of a chronicle, but a chronicle is not comprehensive enough to be called almanac.

2.3.2 Ancient Chinese Calendar: Mathematical Astronomy as a Tool

The so-called calendar in ancient China was not a calendar in the Western sense. If we are to express its meaning more exactly with a modern word, it should be “mathematical astronomy.”

2.3.3 Objectives Sought by Calendar

In the traditional Chinese study of heaven, an ideal calendar seeks precision as its final objective, apart from decoration with digital mysticism. The objectives include calculating the positions of the sun, the moon, and the 5 planets in the sky at any moment. The most severe test in this respect is calculation and forecast of solar eclipses as it requires an accurate mastery of the movement pattern of the sun and the moon (The motion of the sun is relatively simple, and yet the motion of the moon is complex). The calculation precision is directly related to the basic calendric parameters, such as the length of the tropical year and that of the lunar month. As the number of years using a calendar increased, errors were accumulated gradually, resulting in a gradual decrease in the precision of prediction. Therefore, calendars were modified from time to time in ancient China. In the past 3,000 years, more than one hundred and more calendars have left traces in records.

2.3.4 Relationship Between Calendar and Agriculture

The belief that in ancient China “calendar served agriculture” is popular and widely accepted in modern times. Almost everybody says so without questioning. This saying sounds reasonable, but in fact, it can hardly be testified. The trouble is caused by the assumption of the content of the calendar—people confused an ancient calendar with the current monthly calendar as a matter of course. The monthly calendar has dates, seasons, and solar terms on it, and farmers sow seeds and reap crops according to seasons. So calendar serves agriculture. Theoretically, the logic seems so simple.

However, the most part of the ancient Chinese calendar was not related to formulation of a chronicle. We can investigate a typical calendar which is representative. The traditional Chinese calendar can be traced back to very early times. The first calendar to have a complete written record is the *Three Sequences Calendar* of the late Western Han Dynasty. This calendar is thought to be a transformed version by Liu Xin of the *Primordial Calendar*. The basic content of the *Three Sequences Calendar* laid the general framework for Chinese calendars in the subsequent 2,000 years. So, we might as well investigate roughly the structure and content of the *Three Sequences Calendar*. This calendar is recorded in the *Treatise on Bells and Almanac* (2nd Half), Volume 21 of the *Book of Han*. It is divided into 6 chapters as follows:

Chapter 1 is data, called “Tongmu” (statistic elements) that consists of 87 data, of which 2/3 are related to planetary movements. These data are to be used for arithmetic operations in the following chapters. Many data are attached with mysticism meanings. For example, 7 leap years out of 19 years comes from the “ultimate number combining heaven and earth (*The Book of Changes*, *Xici*(1): Heaven one, earth two, heaven three, earth four, heaven five, earth six, heaven seven, earth eight, heaven nine, earth ten); “lunar and solar eclipses concur in

every 135 months” comes from “3 heavenly numbers 25 and 2 earthly number 30” (*The Book of Changes, Xici(1)*: Heavenly number 20 plus 5, earthly number 30); and so on.

Chapter 2 is entitled “Five steps.” It describes the regular pattern of motion of the 5 planets. Each planet moves in several phases, namely: morning first sight, forward motion, stationary, reverse motion, conceal, and evening first sight. The duration time and the average speed of each planet in each phase are given.

Chapter 3 is named “Tongshu” (statistic technique). It deals with items related to the solar and lunar motions, such as the first day of lunar month, solar terms, lunar eclipses, and other items related to the motion of the sun and the moon. This chapter has something to do with compiling chronicles.

Chapter 4 is named “Jishu” (Recording technique). It deals with supplementary items related to the previous two chapters.

Chapter 5 is named “Suishu” (year-counting technique). It calculates Tai Sui year designation, matches the 12 times with the 24 solar terms, and gives the degree of each mansion in the 28 constellations, etc.

Chapter 6 is entitled “Shijing” (Scripture of generations). It does chronological research on generations of monarchs since the former Han Dynasty. This chapter does not belong to the scope of calendar, at most it can be considered as application of calendar.

From the above introduction to the *Three Sequences Calendar*, we know that only Chap. 3 is closely related to compiling chronicles. That chapter takes up merely a small portion of the complete calendar, and its position is not the most important either.

Take for another example the *Great Derivative Calendar* for investigation.

The *Great Derivative Calendar* was compiled by Yixing in 15th Year of Kaiyuan in the Tang Dynasty. This is one of the most important calendars in Chinese history. Its structure became a model for the calendars of subsequent Dynasties. So investigating into it enables us to draw inferences about other calendars. The *Great Derivative Calendar* made improvements and adjustments on previous calendars. It is divided into 7 parts. According to *Old History of Tang*, Volume 34—Annals of Almanac 3 (and *New History of Tang*, Volume 28—Annals of Almanac 4 also recorded but simpler), we expound the calendar roughly as follows:

“Calculation of the middle and new moon” as the first chapter. “Calculation of divergence and convergence” as the second chapter. These two chapters are especially short. The chapter “Calculation of the middle and new moon” consists of 6 sections, and the chapter “Calculation of divergence and convergence” consists of 5 sections only. The former projects lunar phases as obscure, new, bowstring, and full moon. The latter predicts the 72 climates (corresponding to the 24 solar terms, phenomenological phases, and phenomena), 60 trigrams, five elements and utilities, and other items. These two chapters are needed for compiling chronicles and calendar notes.

The following 5 chapters constitute the main body of the calendar:

“Calculation of the solar degree of the zodiac” as the third chapter, consisting of 9 sections. This chapter is dedicated to discussing the apparent motion of the

sun. Both the depth and the precision exceed the need for compiling calendars, and the purpose is to serve the eclipse forecast.

“Calculation of the lunar equation” as the fourth chapter, a chapter made up of 21 sections. Because the lunar motion is far more complex than the solar motion, the number of sections and the total length exceed the foregoing chapter. This chapter is specialized in research on the lunar motion, and the purpose is similar to the foregoing chapter, that is, to lay a foundation for forecasting eclipses.

“Calculation of the orbit” as the fifth chapter, composed of 14 sections. This chapter is specialized in research on the problems concerning time service.

“Calculation of encounter” as the sixth chapter, consisting of as many as 24 sections. This chapter is devoted to solar eclipses, lunar eclipses, and related issues, based on the knowledge and method that are discussed in Sects. 3 and 4.

“Calculation of five planets” as the seventh chapter, consisting of as many as 24 sections too. This chapter studies the motion of the 5 planets, going to great lengths. The depth, carefulness and techniques here surpass the “Five Steps” in the *Three Sequences Calendar*.

By observing the structure and content of the *Three Sequences Calendar* and the *Great Derivative Calendar*, we get to know that their major part is research in the motion pattern of the sun, the moon, and the 5 planets. The main purpose is to provide the method and formula for predicting the position of these 7 great bodies at any moment. As for compiling chronicles, it is merely a concurrent job. This conclusion is true to all calendars in ancient China.

Thus, we can investigate into the relationship between calendar and agriculture:

To begin with, study the moon and the planets. Does the operation of these two kinds of celestial bodies have anything to do with agricultural production? If the relationship here refers to a connection that really exists in the material world, or a physical linkage, then the answer is totally negative. And then, study the remaining heavenly body—the sun. What is the relationship between the sun and agriculture? There is indeed a relation between them. However, the portion of ancient calendars studying the relation between the solar motion and agricultural production still needs further discussion. We will illustrate it in five points in the following part:

China is a country with a long-standing history of agriculture. So sayings like “Calendars serve agriculture,” “The astronomical calendar originated from the need of agricultural production” sound quite reasonable. To the contrary, seen from the known historical data, the research on solar motion developed extremely slowly among the elements in the Chinese calendar. For instance, ancient Greek astronomers were able to measure star coordinates, using the solar motion tablet as a datum and the moon as a medium. Ten-odd centuries later, China measured the position of the sun, using the star as a datum and the moon and planets as media. Another example, the Chinese mastered the unevenness of the annual apparent motion of the sun 1,000 years after ancient Babylons did. It is worthwhile to note that the Chinese development in the lunar and planetary motion theory was not so slow. This fact alone constitutes a serious threat to the doctrine “Calendar serves agriculture.” This is the first argument.

In ancient calendars, the only portion relevant to agricultural production is deduction of the 24 solar terms, a result of studying the annual apparent motion of the sun on the ecliptic. The complete set of names for the 24 solar terms is first seen in the work *Huainanzi—Astronomical Standards*. Some names in it are seen in the pre-Qin period classics. But appearance of certain solar terms does not necessarily indicate that the solar motion was already mastered then. On the other hand, our ancestors observed phenology directly, which is much easier. In the calendars that are passed down to us, when the 24 solar terms are listed, the corresponding 72 pentads are also listed under the solar terms. For example, the *Great Derivative Calendar* does so. This implies that the origin of the 24 solar terms is related to the observation of pentads by ancient people. This is the second argument.

It is true that the establishment of the 24 solar terms plays a role in guiding agricultural production, but endeavors to ceaselessly improve the calculation of the solar terms are irrelevant to agriculture. In the beginning, ancient people divided the time of a year into 24 equal parts. Each part was a solar term so-called “even term.” Later, they got to know that this treatment could not reflect exactly the annual solar motion because of unevenness of the motion, and they used division of the celestial sphere ecliptic into 24 equal parts. Whenever the sun moves across one part of arc, it is a solar term. As the sun moves at uneven speeds, the times for the terms are not the same, and are no longer constants as with the “even term.” So they are called “definite terms.” Actually, guiding the agricultural time does not require a high precision of the solar term, and precision to the day is good enough. In fact, observation of pentads alone can largely fulfill the task of guiding the agricultural time. Thus, the “definite term” is not so significant; as for seeking the precision to the minute or the second is simply meaningless to agriculture. This is the third argument.

Since Liu Chao proposed the “definite term” in the Sui Dynasty, all the calendars in the 1,000 years after him used the “definite term” to project the solar motion, while the “even term” is still used in compiling chronicles. This fact eloquently demonstrates that precise calculation of solar terms is not relevant to agriculture. The role played by solar terms in guiding the agricultural time must be realized through chronicles, of course. After the “definite term” method appears, calendric specialists still do not use it to make notes for chronicles or almanacs. This shows that it is not a necessity for daily life (including agricultural activities by farmers). This is the fourth argument.

In the early years of the Western Han Dynasty, a complete system of the 24 solar terms occurred. In the Sui Dynasty, the technique of calculating the solar terms was developed into the “definite term.” In the early Qing period, the “definite term” was used to annotate chronicles, improving the understanding of solar terms by ordinary citizens. But up to now, experts who do research on the history of ancient Chinese agriculture have never found any leap in agricultural production attributable to calendric improvement in the Han, Sui, or Qing Dynasties. This indicates that the saying of “Calendars serving agriculture” has exaggerated to a large extent, though the 24 solar terms, even though their relation to agricultural production is authentic. This is the fifth argument.

In summary, the situation is very clear: In the ancient Chinese calendar, the great amount of research on the lunar motion and planetary motion is totally unrelated to agriculture. As for the research on the solar motion, its relation to the agricultural production is very limited. The famous *Great Derivative Calendar*, as mentioned above, consists of 7 chapters, 103 sections, of which the content concerning the compiling of chronicles takes up less than 5 % of the total. If we admitted that, the saying that “Calendars serve agriculture” has something right, then the right part would take up no more than 5 % of the whole content.

Supporting the saying that “Calendars serve agriculture,” there may be another proof. In the *Book of Documents—Cannon of Yao*, the sentence “Celestial phenomena of the sun, moon, planets, and stars in the calendar provide people with the time service” or the so-called “Observe the celestial phenomena and provide the time service” does not implicate “arrange agricultural activities.” Instead, it refers to arranging the itinerary of important political affairs for the ruling class to follow.

2.3.5 The Relationship Between Calendar and Astrology

The ancient Chinese calendar is dedicated to research in the motion patterns of the sun, the moon, and the 5 planets, far beyond the need for compiling chronicles and almanacs, and the greatest part of its content is unrelated to agriculture, as said above. Then a big question is raised: What is the application of the calendar?

The ancient Chinese calendar did research with all its strength in the motion patterns of the sun, the moon, and the 5 planets for two purposes: One is to calculate and forecast solar and lunar eclipses. The other is to calculate and forecast the planetary motion.

Forecasting eclipses is needed because the imperial court would conduct magnificent and solemn ceremonies to avert disasters believed to accompany solar eclipses, not only in the capital, but also in other places (though the ceremonies might be simpler there). It would be impossible to organize such activities when the solar eclipse occurs in the sky. So, forecast was must, as preparations and arrangements were to be done 3 days ahead of the eclipse. Considering that places other than the capital would hold activities also to save the sun and moon, probably the forecast should be conveyed to all places.

Forecasting the planetary motion is purely for astrology. As the omens that heaven displays, planetary phenomena not only warn people of ominous things to happen, but also directly guide many significant affairs, in the mind of the Chinese—they are actually capable of controlling the political and military operations. So, it is not hard to understand why ancient people attached great importance to predicting and describing the planetary motion. Take the following case for example. It is recorded in the *Book of Wei*, Volume 35—*Biography of Cui Hao*:

Originally, one year before Yao Xing (King of the latter Qin state) died, the Grand Astrologer reported to the Emperor: The Mars was among Good Gourds, and then disappeared to nowhere overnight. Someone said: It set down to a state in peril

of death, allowing folk rhymes and heresies to arise, and then a great disaster will befall. Hearing this news, Emperor Taizong (Minyuan Di) was frightened. He called in master scholars, and asked them to discuss with the Historiographer (Chancellor of the Erudites) and interpret the implication. *Cui Hao* replied: “A case on file recorded in *Spring and Autumn Annals—Commentary of Zuo* says: The spirit landed in the state Shen. On his arrival, sacrifices were offered to him, and he was requested to predict on the basis of Heavenly Stems and Earthly Branches. He derived: In the evening of the geng-wu day and in the morning of the xin-wei day, there will be dark clouds in the sky; the death in the direction of Xin ought to happen within 2 days. Both gen and wei dominate the Qin state, and xin is a tribe in the west. Now Yao Xing lives in Xianyang, and the Mars enters the state Qin.” All the men present got angry, and they said: “When a planet disappears in the sky, how can a human being know its implication? He is driveling nonsense that cannot be testified!” *Cui Hao* smiled but did not reply. In the following 80 days, the Mars really appeared at East-well, stayed and lingered there. Then a big drought took place on the Qin plain and the land got parched; water in Lake Kunming dried out. Folk rhymes and rumors sprang up, and spread throughout the country. In the next year, Yao Xing died, and his two sons went into war. Three years later, the state fell and ended. At last, everybody admired him and said: We can never reach his capability.

If we are to understand the meaning of this matter completely, two technical details must be explained beforehand: First, according to the Dividing Line theory, East-well (i.e., mansion Well) belongs to the stellar time of Alhena, exactly the dividing line of Qin. Second, the astrological meaning of Mars appearing at the Well mansion is an omen of various events to happen in the latter Qin state in 2 years to come. Let me quote three divination oracles for example:

The Mars enters East-well, war takes place, terrible drought comes, and the state is disturbed. (*Treatise on Astrology of the Kaiyuan Era*, Volume 34—Quotation from Shi)

The Mars enters East-well, stays there for over 30 days, goes away, and then comes back. If it revolves around, forming a hook Si, then the monarch will die; if it rounds again, someone else will die. (ibid, quoted from *Divination in the sea*)

The Mars goes out and comes in, stays at East-well for 30 days and does not set down, indicating that the country will fall, and the king will die. (ibid, Quotation from Xi Meng)

In the astrological divination by *Cui Hao*, the Mars “stayed and hovered” precisely over East-well (According to the planetary motion theory in modern astronomy, this occurrence is not strange). This exposition is entirely the same as that in *Divination in the sea*. As a result, a terrible drought occurred in the year; the emperor died in the next year; the latter Qin was destroyed by the Eastern Jin in the 3rd year; and Yao Hong the last Emperor was escorted to Jiankang and executed.

Let us turn back to *Cui Hao*’s prophecy. What surprises “master scholars” most was his prediction about the whereabouts of Mars when it could not be seen, and 80 days later, the prediction came true. The secret is that *Cui Hao* mastered the motion pattern of Mars. He knew that Mars was in the “conceal” phase, that is,

moving in the direction close to the sun, so after dark, it set down below the horizon and could not be seen. He also knew that after this phase, it would move to the zone of Well mansion, and Well mansion corresponds to the state Qin exactly.

Of course, Cui Hao's capability is beyond this. Apart from mastery of Mars motion pattern, and proficiency with the astrological theory, he learned a lot about the latter Qin regime, because he was "often consulted about military and state affairs and held in high esteem by the monarch." His knowledge of history and experience in society enabled him to judge that the state Qing was coming to an end. Later, relying on a comet occurrence, he predicted successfully the usurpation of the Eastern Jin's state power by Liu Yu, using the same method.

On the contrary, the greatest difference between other "master scholars" and Cui Hao is that they know nothing about the planetary motion pattern, that is, they do not know calendar. Thus, they cannot know the time and place of Mars appearing and disappearing, and they are incapable of making any wise astrological prophesy.

To sum up, the famous astrological prophesy made by Cui Hao eloquently demonstrates that a successful and high-level astrological divination needs knowledge of astrological theories, political information, historical experience, and social psychology; in addition, calendar is necessary, and calculation of the motion of the sun, the moon, and the 5 planets plays a leading role. What is special is that the planetary astrology is the vital part of Chinese astrology. This strengthens the interaction between calendar and astrology.

Now, it can be concluded that we have found the object served by the ancient Chinese calendar, the most part that deals with calculation of eclipses and the motion of the 5 planets. That is to say, astrological divination needs calendar.

3 Lecture 3: Exchange and Comparison of Chinese and Foreign Astronomies

3.1 Early Exchange Between Chinese and Foreign Astronomies

3.1.1 The Origin of the Chinese Study of Heaven

The origin of the Chinese study of heaven is closely related to the origin of the Chinese civilization. In the past few hundred years, some Western and Japanese scholars have proposed a Western origin doctrine of the Chinese civilization and study of heaven.

Previously, we have inquired into the interwoven relation between the Study of Heaven and the monarchical power in ancient China, and thereby, expounded the cultural function of the Chinese study of heaven in ancient times. Besides, it is well known that the ancient Chinese study of heaven has strong characteristics of inheritance and tradition. Thus, it is possible to provide a foundation for discussing the issue regarding origin of the Chinese study of heaven.

In the opinion of most believers in the Western origin doctrine of the Chinese study of heaven, the position of Study of Heaven in the remote ancient Chinese civilization does not differ from that in the Greek civilization. Consequently, they assume, a priori, that the Study of Heaven in ancient China might have been imported from somewhere else, just as the other arts. For instance, King Wuling of the state Zhao adopted Hu tribe's clothing and learned their cavalry and archery, Emperor Wudi of the Han Dynasty sought the ferghana horse from the kingdom Dawan. In other words, study of heaven could be introduced from the West to China in ancient times after its own civilization was well developed.

However, all this sort of the Western origin doctrines (represented by Iijima Tadao who holds the theory of "introduction in the Warring States period") will collapse by themselves so long as the relation between the Study of Heaven and the monarchical power in ancient China is understood. The reason is simple: The cultural function of the ancient study of heaven determined that it could only be born at the same time with the Chinese civilization. It played such a significant role in the process of establishing the Chinese civilization that it would not wait to be introduced into China later.

However, another sort of the Western origin doctrines, which proposes that the Study of Heaven was introduced from the West into China early in the remote ancient times, is usually combined with the big theory that the Chinese civilization originated from the West. Thus, merely expounding the cultural function of the Chinese study of heaven seems an inadequate reason to negate it. Because according to this sort of doctrines, the Chinese civilization itself was developed on a branch of the Western culture, and the Study of Heaven was brought with it when that culture spread eastward (as Guo Moruo says); or perhaps, the Chinese civilization is a mixture of a certain Western culture and the local Chinese culture, and the Study of Heaven was brought to China by Westerners (as Vasilliyev the scholar of Soviet union has said). The Western origin on study of heaven came before the Chinese civilization was established or at the same time. This could avoid the contradiction with the above-mentioned cultural function of the ancient study of heaven.

Therefore, at least we can draw the following conclusions: The ancient Chinese study of heaven originated very early, and the possibility that this system was introduced from the West into China later on should be excluded; the origin of the Chinese study of heaven is tightly connected to the origin of the Chinese civilization. And these two questions are open to further discussions.

3.1.2 The Relationship Between the Canopy-Heavens Universe Model in *Zhoubi Suanjing* and the Indian Model of the Universe

The origin of the Chinese study of heaven is a tough question that is hard to answer with a definite conclusion, due to the long stretch of time and inadequate data. So by and large, it is a illusory picture. On the other hand, in later periods, when the ancient Chinese study of heaven was established in system and structure,

various Western studies of heaven were disseminated to China at varying degrees. Probably some content of these studies of heaven were absorbed and adopted by the Chinese system on study of heaven (as supplementary technical methods only), but did not exert a significant influence on the Chinese system on study of heaven. There are relatively more historical data in this aspect, and fewer theoretical questions are left. So compared to the picture of origin, this picture is more realistic and elaborate.

In this respect, *Zhoubi Suanjing* may well be a typical case in point.

According to convincing conclusions drawn by modern scholars, *Zhoubi Suanjing* was completed as a book around 100 BC. From ancient times up to now, it undoubtedly has always been considered as a purest quintessence of Chinese culture. Discussion of the question whether it contains foreign elements on study of heaven seems to be a flight of fancy. But if we expand our vision from the Study of Heaven in ancient China to the Study of Heaven in other ancient civilizations, and read the original text of *Zhoubi Suanjing*, then we will find surprisingly that the above question is not a fanciful illusion, and that it has profound meanings in the history of science and in scientific philosophy.

According to the explicit accounts in the original text of *Zhoubi Suanjing*, and the detailed explosion on several crucial questions in my publications, we know that the universe as canopy-heavens in *Zhoubi Suanjing* has the following features:

- (1) The land and the sky are circular planes parallel to each other and 40,000 km apart from each other.
- (2) In the center of the land, there is a columnar pillar (an armillary sphere 30,000 km in height, and its bottom diameter is 11,500 km).
- (3) The constructor of this model of universe has decided on a place of residence for himself on the circular land, and the place is not in the center but a bit southward.
- (4) The pillar in the center of the land extends to the sky, and the connecting point is the North Pole.
- (5) The sun, the moon, the stars, and the planets moves in a circular plane around the North Pole.
- (6) In the circular motion, the sun has multiple homocentric orbits, and it migrates between the orbits periodically every half year (completing one cycle in a year).
- (7) The sunlight radiates all around, and the radius limit is 83,500 km.
- (8) The above-mentioned mode of the solar motion illustrates to some extent the cause of day and night and some celestial phenomena in the annual apparent solar motion.
- (9) The circumference ratio π is assumed to be 3 in all calculations.

Most surprisingly, we have found that the above 9 features comply with the universe model in ancient India! This coincidence is not accidental and is worthy of our attention and investigation. Briefly, our research results are as follows:

The recording of the universe model in ancient India is kept in the book *Puranas* that is a series of sacred scriptures, and a historical record with an

encyclopedia touch. It is hard to determine the times of their completion, but the concept of the universe model may be traced back to the Vedas age—before 1000 BC, as scholar believe. Therefore, those books are very old. The universe model in *Puranas* can be sketched as follows:

The land is like a round plate with a flat bottom. In the center of the land, there stands the majestic mountain named Meru (also known as Sumeru, and translated into “须弥山” and “苏迷卢” in Chinese). The Meru Mountain is surrounded by circular land that is surrounded by a circular sea ... The circles spread out, and there are 7 circles of land and 7 circles of sea.

India is to the south of the Meru Mountain.

In the sky that is parallel to the land there is a series of sky wheels. The common axis of these wheels is the Meru Mountain. The summit of the mountain is the place of Dhruva (North Pole). The sky wheels carry various celestial bodies to revolve together around the axis. The celestial bodies include the sun, the moon, the stars, and the 5 planets—namely Mercury, Venus, Mars, Jupiter, and Saturn.

The Meru Mountain can be used to explain the alternation between day and night. The wheel which carries the sun has 180 orbits. The sun shifts one orbit a day; half a year later, it repeats the process in the opposite direction. The annual alternation of azimuthal angles of the sunrise can be described in that way. ...

Moreover, the *Local Topography of Sakiamuni* by Shi Daoxuan in the Tang Dynasty also records the universe model of the ancient India. The details supplement the above-mentioned record:

... The Meru Mountain, or Sumeru Mountain in the Buddhist Scriptures, is located in the sea. According to Kancana-mandala (Gold Wheel in Sanskrit), the upper half stands 80,000 yojana (1 yojana = 11.2 km) above the sea level. The sun and the moon revolve around its waist. Outside the mountain, there are seven gold hills surrounding. Between every two hills, there is seawater, holding eight merits and virtues.

In the Chinese translation of the Buddhist Scripture *The Worldly Analects of Abhidharma* (*Dazheng Newly Revised Tripitaka* No. 1644), Volume 5—“Sun and Moon Motion Property 19”, it is mentioned that sunlight has a limit, and the limit is used to illustrate the record of the apparent solar motion:

The radius of sunshine is 700,021,200 yojana, and the circumference is 2,100,063,600 yojana. The sun rises from India in the south, and sets in Uttarakuru in the north. It is high in the middle of the sky at Furvavideha in the east, and it is right at mid-night at Aparagodaniya in the west. So the world has four points of time because of the sun.

From this paragraph and the enormous astronomical data in the Buddhist Scriptures, it can be seen that the circumference ratio π adopted is precisely 3.

Based on these records, it can be judged that the universe model in ancient India is astonishingly similar to the universe model of canopy-heavens in *Zhoubi Suanjing*, as they are identical almost in all details:

- (1) In both models, the land and the sky are circular planes parallel to each other;
- (2) Both the “armillary sphere” and the “Meru Mountain” play the role of “heavenly column” in the center of the land;

- (3) Both the Zhou land and India are placed on the southern half of the circular land of the universe of each model, respectively;
- (4) The axis of rotation for celestial bodies—the North Pole—is positioned right above the “armillary sphere” and the “Meru Mountain”;
- (5) The sun, the moon, the stars, and the planets in the sky revolve on a circular plane around the North Pole.
- (6) If the “7 hills and 7 seas” outside the Meru Mountain conjure up the digits in the “7 rings and 6 intervals” in *Zhoubi Suanjing*, then the 180 orbits of the solar wheel in the Indian universe will comply completely with the 7 rings and 6 intervals (the solar motion back and forth is continually shifting between the 7 rings).
- (7) It is worth noticing that in *Zhoubi Suanjing*, the distance between sky and land is 80,000 li, while the Meru Mountain stands above the sea level as high as “80,000 yojana”, and sky wheels are situated above it. In both models, the distance between sky and land is 80,000 units. Could it be purely accidental?
- (8) In both models, the sunlight radiates within a limit, which helps illustrate the sunrise, sunset, four seasons, the alteration in the length of day and night, and other celestial phenomena related to the apparent solar motion.
- (9) In both models, the circumference ratio π is 3 for astronomical calculations.

Throughout history of human civilization, the multielement spontaneous generation of cultures is probable. Therefore, many civilizations have similarities that may be accidental coincidences. However, the universe model of canopy-heavens in *Zhoubi Suanjing* and that in ancient India are similar to a great extent—from the whole structure to many details, the consistence is prevalent. If we are to explain this situation with “accidental coincidence,” it will seem too farfetched.

3.1.3 The Surprising Knowledge of the 5 Frigid and Tropic Zones in *Zhoubi Suanjing*

In *Zhoubi Suanjing*, there is something that is equivalent to the knowledge of the 5 frigid and tropic zones on earth. This is a very surprising phenomenon—because in the past 2,000 years, the traditional Chinese astronomy has had no such knowledge, and it has not been believed in. The knowledge is found in section 9, Volume 3, *Zhoubi Suanjing*:

Under the North Pole, nothing grows there. How come? ... Around the North Pole, ice is not melted even in summer.

The middle ring is 75,500 li from Zhou land. Around the middle ring, there are grasses living even in winter, and they thrive in summer. Here Yang is strong and Yin is weak, so living beings do not die, and the five cereals grow ripe twice a year.

Around the North Pole, some plants grow in the morning and get ripe in the evening, and they are winter plants.

Here, we need some explanation in advance:

In the second passage cited above, the so-called “middle ring” is the zone located “outside the inner ring, inside the outer ring” as annotated by Zhao Shuang

in his notes. This zone corresponds exactly to the tropic zone on earth (between $23^{\circ}30'$ south latitude and $23^{\circ}30'$ north latitude), although the concept of earth is not established in *Zhoubi Suanjing*.

In the third passage cited above, it says that around the North Pole, “some plants grow in the morning and get ripe in the evening.” This must be associated with the ability of the theory of canopy-heavens in *Zhoubi Suanjing* to deduce and describe the polar day and polar night. The bottom diameter of the “armillary sphere” in the center of the circular land is 23,000 li, i.e., the radius is 11,500 li; the sunshine radiation limit set by *Zhoubi Suanjing* is 167,000 li. Thus, from the Spring Equinox to Autumnal Equinox each year, in the range of the “armillary sphere”, the polar day appears—with sunshine for the day and night; reversely, from the Autumnal Equinox to Spring Equinox, the polar night appears—the sunlight cannot illuminate the area within the range of “armillary sphere.” This is interpreted by Zhao Shuang in his annotation as: “Under the North Pole, it is daytime from the Spring Equinox to Autumnal Equinox, and nighttime from the Autumnal Equinox to Spring Equinox,” because half a year is day and half a year is night.

As for the knowledge of the 5 zones on earth from frigid to tropic, its correctness is undoubted. But this knowledge has not been a constituent of the traditional Chinese system on study of heaven in the past 2,000 years.

First, Zhao Shuang, who annotated *Zhoubi Suanjing*, did not believe this knowledge. For instance, when making notes for the sentence “Around the North Pole, ice is not melted even in summer”, he wrote: “Ice is not melted. From this, we can infer that on the Summer Solstice, under the outer ring it is winter when all things should die—on that day, winter and summer exist here and there. I doubt it, unless it is caused by Yin-Yang Qi (a kind of substance forming universe).” Moreover, concerning the tropic zone, in which “There are grasses living even in winter”, “Here Yang is strong and Yin is weak”, and “The five cereals grow ripe twice a year”, Zhao wrote: “This proposes that between the inner ring and the outer ring, summer stays forever. But constant summer on such a vast area, I have never heard of it.” He had never heard of that. Judging from the notes that Zhao Shuang made for the whole book *Zhoubi Suanjing*, we are sure that he was a qualified astronomer in his times, but how come he did not hear of the knowledge of the 5 zones? The only reasonable explanation seems to be that this knowledge was not a constituent of the traditional Chinese system of astronomy, and it was fresh to the majority of Chinese astronomers, ill-adapted to the old background knowledge, and therefore, incredible.

Second, the theory of sphere-heavens, the dominating astronomical doctrine in ancient China, did not have a correct concept of earth, and could not raise a question of 5 zones. In the late Ming Dynasty when Jesuit missionaries coming to China introduced 5 zones in their works to Chinese readers, who were then surprised by this fresh doctrine. It was these works in Chinese that made Chinese scholars to accept the doctrine of 5 zones on earth.

Now we are confronted with a series of sharp questions:

Since the theory of sphere-heavens did not have a correct concept of globe and could not raise a question of 5 zones, then why could *Zhoubi Suanjing*, which did not have a concept of globe either, record this knowledge?

If we say that the author of *Zhoubi Suanjing* lived in the north temperate zone, and he, relying on his experience that it is cold in the north and hot in the south, could derive the phenomena such as: around the North Pole “ice is not melted even in summer”, and in the tropic zone “the five cereals grow ripe twice a year”, then why could not the theorists of sphere-heavens deduce the same phenomena?

Furthermore, Zhao Shuang, who made notes for *Zhoubi Suanjing*, should be a receiver of the theory of canopy-heavens. But even he did not believe in that knowledge. How come?

Thus, it seems to be necessary to consider the possibility that this knowledge came from abroad.

Knowledge of the earth as a globe, geographic longitudes and latitudes, and the 5 zones of rigid to tropic, etc., is systematic and complete in works of ancient Greek astronomers, and it has been used up to now. The doctrine of 5 zones began in works of Aristotle. In the *Introduction to Geography* by Eratosthenes (275–195 BC), father of geography, a complete set of 5 zones was described: The tropic zone is between the southern latitude 24° and northern latitude 24° , the south and north rigid zones are within 24° of the polar areas, the south and north temperate zones are from the southern latitude 24° – 66° , from the northern latitude 24° – 66° , respectively. Regarding the time, ancient Greek astronomers established this knowledge before the book *Zhoubi Suanjing* was completed. Could it be that the author of *Zhoubi Suanjing* acquired this knowledge from ancient Greeks directly or indirectly? This is indeed a thought-provoking question.

3.2 *The Western Astronomy Brought to China with Eastward Spread of Buddhism*

3.2.1 Tracing Path of the Babylon “Zigzag Function” in China

To inquire into the relation of two things we often begin with comparing them. The past comparative study in the study of heavens in ancient Babylon and ancient China has been done almost all by Westerners and mostly with traditional humanistic methods, that is, through collecting relevant records scattered in ancient books, together with ancient drawings and paintings, sculptures, inscriptions, utensils, etc., using the research methods and findings in linguistics, philology, mythology, ethnography, history, geography, and other disciplines for textual criticism, analysis, and ratiocination. The situation is exhibited mainly in *Explanation of Heavenly Stems and Earthly Branches* by Guo Moruo. It was not until the multi-volume *Historical Data of Cuneiform Astronomy* (ACT) by O. Neugebauer and *Study of heaven and Related Historical Data in Late Babylon* (LBART) by A. Sachs were published in 1955 that the comparative study in the Study of Heavens in ancient Babylon and ancient China took to a more solid and deeper new path—mathematical astronomy research.

Adopting the method of mathematical astronomy, I have published a series of comparative studies in the *Study of Heavens* in ancient Babylon and ancient China, dealing with the solar motion theory, planetary motion theory, celestial coordinates, lunar motion, intercalation period, day length, and other issues, in the hope that I can provide new clues for the relation between the two. Let me outline my main findings as follows:

The Babylon ephemeris has a table of solar motion, recording the zodiacal sign in which the sun is located each month, the degrees of the sign on the new and full moon in that month, the ecliptic longitude degrees the sun passes in that month, and so on. This table possesses a rather complex mathematical structure: Secondary difference appears in the table, and a zigzag function is formed—that is the most eye-striking mathematical tool in Babylon astronomical literatures as almost all problems in mathematical astronomy are dealt with by using zigzag functions. Among the many mathematical properties of zigzag functions, periodicity is the most important. The zigzag function illustrates the change of the solar motion speed with time.

For a long period of time, the *Study of Heaven* in ancient China thought that the solar motion is of a uniform speed. It was not until the end of the fifth century that Chinese scholars began to recognize the heterogeneity in the motion. In the *Imperial Ultimate Calendar* completed by Liu Chao in 600 AD, the first table for correcting the heterogeneity of the solar motion (*List of the Solar Interval*) appeared. Compare this table with the Babylonian table of solar motion, and we will find the two mathematical structures of secondary difference and zigzag functions. This practice continued for about a century.

Both astrology in Babylon and that in ancient China gave planets the greatest importance. In their theories of planetary motion, the mathematical description of the planetary motion period and condition was attached emphasized. Babylonians took special care of the characteristic phenomena in planetary motion, such as opposition, stay, revival, and hiding (beginning of conceal), and they made use of various periods to predict the date and the ecliptic longitude for these celestial phenomena to happen. In the Seleucid kingdom period and the western Han Dynasty—both span roughly the same time—heavenly scientists of both sides simultaneously recognized a mathematical formula for the two periods of planets, with slight difference in expression. Both sides mastered the precise numbers related to these periods. Moreover, both sides made the same mistake on the planetary motion pattern—they thought that the sidereal period of both of the two inner planets (Venus and Mercury) is one year.

In the mathematical description of planetary motion, Babylon people took the lead. For example, they were able to treat the most difficult pattern of Mercury motion by dividing it into six sections, which include motion of uniform speed, variable speed and variable acceleration, and the third difference occurred (ACT, No. 310). In China, before the *Imperial Ultimate Calendar*, it was thought that all planetary motions are at uniform speeds. It was not until the *Imperial Ultimate Calendar* and the *Great Cause Calendar* that a method similar to the Babylon method appeared, which treated the motion at a

variable speed by dividing it into sections, but still it did not have a section of variable acceleration. In terms of the precision of mathematical description, the Babylonians was still in the lead.

In the Babylon ephemeris, the location of a planet chasing the sun is predicted beforehand, not a record of real measurement (Almost every Babylon ephemeris was made by prediction). Therefore, the use of interpolation is required—interpolating in the characteristic phenomena occurring at known moments and locations (ecliptic longitude) to get the remaining values. Judging from a “table of the ecliptic longitude and difference when Jupiter chases the sun” (ACT, No. 654–655), we know that the Babylonians started using nonlinear interpolation very early. In China, secondary interpolation began to appear in the *Imperial Ultimate Calendar*, but it is of the lowest class among methods of nonlinear interpolation.

3.2.2 Spreading of Arts of Seven Luminaries in China

The so-called seven luminaries refer to the sun, the moon, and the 5 planets (Mercury, Venus, Mars, Jupiter, and Saturn)—seven celestial bodies in all. Though these 7 celestial bodies were objects of investigation, research, and exposition by heavenly scientists in ancient China for thousands of years, the terms “seven luminaries,” “calendar of seven luminaries,” “art of seven luminaries,” and “calentric art of seven luminaries” refer to something by convention in Chinese history—they refer especially to a kind of study of heaven which was imported from abroad—mainly from India, and probably in the process of spreading to the east and to the north, acquired some elements of calendar, astrology and divination with a Mid-Asian color.

The arts of seven luminaries were prevailing in the Six Dynasties and the Tang and Song periods. But their first appearance in China can be traced back to the later years of the Eastern Han. When the Eastern Jin was replaced by the Song Dynasty, the arts of seven luminaries reappeared. About the same time, they appeared in the Northern Dynasties. Generally speaking, after they were introduced to China, the arts of seven luminaries were flourishing in the Southern and Northern Dynasties. In the Tang Dynasty, a new tide on study of heaven came from the West, and yet the previous arts of seven luminaries were still passed down till the Northern and Southern Song Dynasties. With the fall of the Song Dynasty, the arts of seven luminaries died in China. Since then, this term “arts of seven luminaries” has disappeared almost totally from historical books, annals, catalogues, and other literatures.

Here I would like to talk about the “Lectures in the Ever-spring Palace” delivered by emperor Wu Di of the Liang Dynasty and the Indian study of heaven.

The interaction of the universe model in *Zhoubi Suanjing* with India put on a new show when it came to emperor Wu Di of the Liang Dynasty, resulting in the famous “Lectures in the Ever-spring Palace.” Emperor Wu Di of the Liang Dynasty summoned ministers to the Ever-spring Palace and delivered lectures to

them. That is a great event which is worth paying attention to. It is recorded in old books such as *Book of Sui · Annals of Astronomy* (1):

When emperor Wu Di of the Liang Dynasty delivered lectures in the Ever-spring Palace, he fabricated new celestial bodies, and what he talked was entirely the same as the text of *Zhoubi Suanjing*. His purpose was to establish a new theory and repel the sphere-heavens theory. When Chinese and foreign scholars did research on this event in the past, they got some valuable results, but they did not expound its background and significance. Here we must clarify two important questions: (1) What's the universe theory proposed by Emperor Wu Di in his lectures? How about its relation to the Indian study of heaven? (2) Why did the *Book of Sui · Annals of Astronomy* say that the content of the lectures was "entirely the same as the text of *Zhoubi Suanjing*"?

The first question is quite easy to answer. The main content of the lectures by emperor Wu Di of Liang is kept in the *Treatise on Astrology of the Kaiyuan Era*, Volume 1. Emperor Wu Di began with a long paragraph of exaggerated narration to negate other universe theories:

Since ancient times, many persons have talked about the heaven. All of them have resorted to random fabrication without knowledge about celestial phenomena. Each school holds a different doctrine. A small discrepancy causes a big mistake. When someone wears a basin on his head, can he see the sky? It is like someone who lives in the horn of a snail and wants to talk about the vastness of the sky. Or it is like someone who lives in the shell of a clam and wants to measure the sea. This sort of person has no sense of quantity!

Such assertion can be called bold and arbitrary to the extreme. It is worth noticing that the sphere-heavens theory had taken the prevailing position and was accepted by most astronomers already. Emperor Wu Di of Liang denied it decidedly without providing any astronomical evidence. If it were not for his advantageous status as a monarch, it would be hard to convince the audience. And the universe model advocated by the emperor himself was nothing but an assertion made without any astronomical evidence:

Beyond the four great seas, there is a Warrior Mount, also called Iron Mount. To the north of Warrior Mount, there is a Black Mount. The sun and moon revolve around the mountains along the four sides, making circles day and night. When they are in the south, they appear; when they are in the north, they conceal. The sun descends to a low path in winter, and it ascends to a high path in summer. When the sun ascends, the day is longer, and when the sun descends, the day is shorter. The varied climates—cold and hot, dark and bright—all result from the shift.

Such a universe model and climatic doctrine seemed unthinkable to the sphere-heavens theorists in China. However, this doctrine by emperor Wu Di was based on the ancient Indian universe model seen in Buddhist Scriptures.

The second question can be answered on the basis of the first one. Since the universe model which emperor Wu Di proposed was of Indian origin, the judgment in the *Book of Sui · Annals of Astronomy* saying "entirely the same as the text of *Zhoubi*" is a correct statement, but it omitted the intermediary links.

3.2.3 The “Three Scholars on Study of Heaven” Coming from India to China

In the Chinese history, the Tang Dynasty was a magnificent empire that was highly open, highly self-confident, and highly prosper. Then the introduction of the Indian study of heaven to China reached a grand occasion. In that period, elites from all over the world served the Tang imperial court with high rankings. To the extreme, the Li imperial family of the Tang Dynasty had foreign bloodline. In this background, it is no wonder that generations of Indian astronomers served the court and led the royal institute on study of heaven. The Indian study of heaven introduced by them obtained the official status to some extent. *The Scripture of Mansions and Luminaries*, Volume One translated by Master Bukong is annotated by Yang Jingyun as:

If anybody wants to know the location of the 5 planets, he can use the Indian art of calendar to predict each of them. Now there are three Indian calendars by Kāsyapa, Gautama, and Kumāra respectively. They are kept on file at the Directorate of Astrology. But now the Calendar by Gautama is commonly used together with the Great Art of Calendar for mutual reference to serve the court.

Here I would like to expound the three scholars one by one as follows:

Kāsyapa: His study of heaven was once used together with the “Great Art of Calendar” (the orthodox technique of the Chinese study of heaven) for mutual reference.

Kumāra: Each of the two books *Old* and *New History of Tang* mentions him only once, and the *Old History of Tang* records in more details. His art was also used together with the Great Art of Calendar for mutual reference.

Gautama: He is the most eminent among the “three Indian scholars on study of heaven.” There are many records about the Gautama family, but the relation between the members was not clear. It was not until the year 1977 when a tomb inscription of Gautama was discovered in Beitian Village, Chang’an County, Shaanxi Province that the relation was clarified completely. Four generations of the Gautama family served the imperial court as officials on study of heaven, and they were all principals (Grand Astrologer, Directorate of Astrology) or important officials (Vice Director of Astronomy, Supervisor of Winter Supports) in the imperial organism on study of heaven till Gautama Yan, a member in the 4th generation. Records of the Gautama family in heavenly scientific activities in the Tang Dynasty exceed those of the other two families. The most outstanding member of the Gautama family is Gautama Shidda. His major merits left in history are translating and editing the *Navagraha* and compiling the *Treatise on Astrology of the Kaiyuan Era*.

3.2.4 The *Navagraha*: A History of Calendar Tracing from India to the Ancient Greek Astronomy

About the *Navagraha*, Book 4(2), Volume 28 *Annals of Calendar*, the *New Tang History* writes:

The *Navagraha* originated from the Western Regions. In the 6th year of Kaiyuan (718 AD), Gautama Siddha, Directorate of Astrology, was called into translate it all.

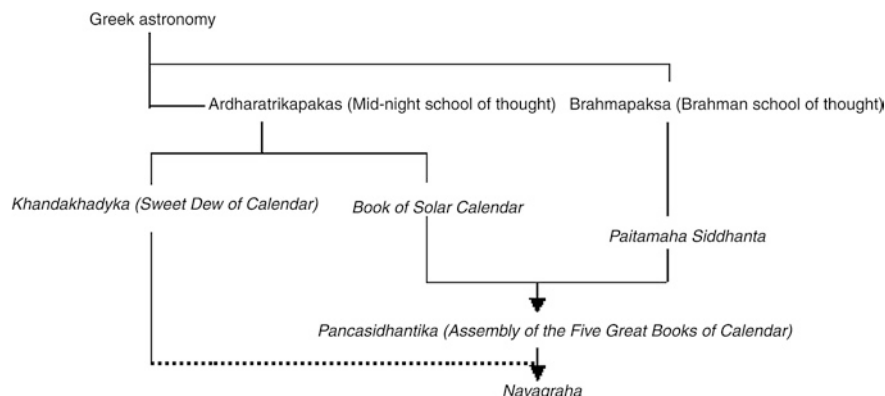


Fig. 13 Diagram of affiliation of the *Navagraha*

The word “Western Regions” used in the Tang Dynasty meant more than the present conventional usage. Actually, the whole ancient India was included in it, which can be proved by Master Xuanzhuang’s travel record entitled *Journey to Western Regions from the Great Tang*. The *Navagraha* was purely an Indian calendar, but seen from the ancient Chinese viewpoint, it might as well be said “originated from the Western Regions.”

The *Navagraha* is a translation by Gautama Siddha under orders of the emperor Tang Xuanzong. The translation text is collected in the *Treatise on Astrology of the Kaiyuan Era*, Volume 104, which is the only old book publishing the translation text of the *Navagraha*.

Probably the translating of the *Navagraha* was based on more than one original texts in Sanskrit. Rather, it extracted and compiled from several literatures on Indian study of heaven. The reference works on Indian study of heaven include *Assembly of the Five Great Books of Calendar* and *Sweet Dew of Calendar* as well. Quite a few schools of thought were involved, such as the Ardharatikapaksa at least (and perhaps the Brahman school of thought). All these works on Indian study of heaven and all theories of these schools of thought originated from Greek (as shown in Fig. 13).

Despite the various intermediary medium links, elements of the Greek astronomy in *Navagraha* are still readily discernible. The most obvious items are listed below:

- (1) The circumference is divided into 360°
- (2) The digit counting is of the 60 shifting system.
- (3) The ecliptic coordinates.
- (4) The apogee of the annual apparent solar motion (set to 10° before the Summer Solstice point, which conforms to the real sky phenomenon at that time).
- (5) Deducing the alteration in the apparent diameter of the moon.
- (6) The calculating technique with sine function and sine numeral table.

These items are not seen in the traditional Chinese system on study of heaven.

3.3 *The Exchange of Chinese and Arab Astronomy Brought About by the Great Empire of Mongolian Yuan*

3.3.1 *The Arab Instruments for Study of Heaven and Their Impact on China*

After Kublai, the fifth emperor of the Yuan Dynasty ascended the throne in 1267 AD, Islamic astronomer Jamal al-Din submitted 7 astronomical instruments from the Western regions. The phonetic and semantic translation of the names of the 7 instruments, their shapes and structures, and their applications are recorded in the *History of Yuan—Treatise on Astronomy*, arousing great interest in research among Chinese and foreign scholars. The originals of these instruments do not exist now, so scholars hold different opinions about their properties and uses. Here, I would like to match the phonetic translation and semantic translation (according to *History of Yuan—Annals of Astronomy*) of the 7 instruments with the original Arab text determined by W. Hartner, and briefly introduce the conclusions in major research literatures, as follows:

- (1) “Dhatu al-halaq-I means armillary sphere in Chinese”. Dr. Joseph Needham considers it as a parallactic sphere, and Chinese scholars consider it an ecliptic sphere, a classic instrument for astronomical observation in ancient Greece.
- (2) “Dhatu’ sh-shu ‘batai means instrument for measuring celestial stars and luminaries in Chinese”. Both Chinese and foreign scholars tend to consider it the organon parallacticon mentioned by Ptolemy in his work *Almagest*.
- (3) “Rukhamah-i-mu ‘-wajja—a room for measuring the shadow cast by the sun on the Spring Equinox and the Autumn Equinox in Chinese”. An instrument for measuring the precise time of the Spring Equinox and the Autumn Equinox, connected to an airtight room (having a slot open on the ridge in the due east-west direction) to form a whole.
- (4) “Rukhamah-i-mustawiya means a room for measuring the shadow cast by the sun on the Summer Solstice and the Summer Solstice in Chinese”. An instrument for measuring the precise times of the Summer Solstice and the Summer Solstice, connected to an airtight room (having a slot open on the ridge in the due south-north direction), to form a whole, similar to the above.
- (5) “Kura-i-sama means celestial globe in Chinese”. There is no disagreement among Chinese and foreign scholars,—it is a cosmo-sphere found in China and in the West as well.
- (6) “Kura-i-ard means geographic records in Chinese”. That is a tellurion. There is no disagreement among Chinese and foreign scholars, either.
- (7) “al-Usturlab means device for determining the hours of day and night in Chinese”. Actually it is an astrolabe popular in the Arab world and in Europe.

Of the above 7 instruments, (1), (2), (5), and (6) were formed and adopted in the ancient Greek astronomy, and passed down in a continuous line. It was inherited by Arab astronomers. Items (3) and (4) have obvious Arab features; Item (7)—astrolabe—was found in ancient Greece, but later it became a feature of Arab

astronomy in the Mid Ages, and the fine astrolabes made by Arab craftsmen have long enjoyed a good reputation. Introduction to China of the 7 instruments with such origins is more than meaningful.

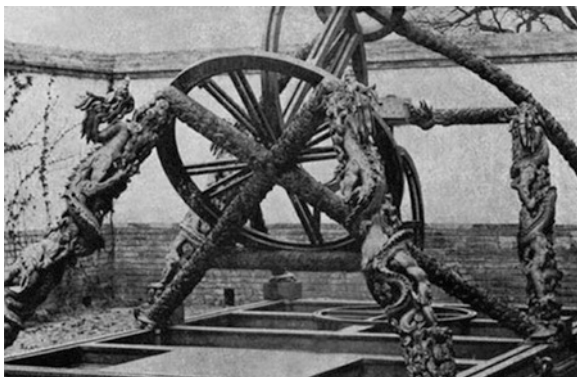
Nine years after Jamal al-Din submitted the 7 instruments from the Western regions, 5 years after the Bureau of Astronomy was established in the summer capital, three years after the Hui's Bureau of Astronomy and the Han Bureau of Astronomy were led by the same Director of the Palace Library by decree of the emperor, Guo Shoujing, one of the greatest astronomers in Chinese history, began to design and make a batch of astronomical instruments by the imperial edict, and completed three years later (1276–1279 AD). Of these instruments, the abridged armilla, the acaphe, and the direction-determining board have a lot of innovations in them. Because Guo Shoujing made instruments after Jamal al-Din submitted instruments, and the newly made instruments were not seen in China before, a question is raised naturally, that is, “Did Guo Shoujing make the instruments under influence from the Islamic astronomy?”

To this question, most domestic scholars hold a negative attitude naturally, on the ground that “the instruments Jamal al-Din contributed do not integrate with the traditional Chinese astronomy.” On the level of outer appearance, it is hard to find any influence by the Islamic astronomy in the instruments made by Guo Shoujing. Instead, traces of their succession from traditional Chinese astronomical instruments can be readily visible. I can give a very eloquent explanation to this.

The event that the Hui's Bureau of Astronomy and the Han Bureau of Astronomy were led by the same Director of the Palace Library is very important here, because this fact put Guo Shoujing and Jamal al-Din and their subordinate astronomers of Hui or Han nationality, on a stage of competition in the same profession. Since Guo Shoujing received the imperial decree to make astronomical instruments, of course he would do his best to repel influences from the opponent, and to show he is capable and superior. If he accepted influence from Islamic astronomical instruments, he would be accused of imitation and being inferior in technique. Then how could the “Han Bureau of Astronomy” stand on its own feet in the competition?

On the other hand, however, we should see that on indirect levels, Guo Shoujing did accept some influence from the Arab astronomy. Here I give two examples for illustration:

One is the abridged armilla (as shown in Fig. 14). The innovation of the abridged armilla lies in its simplicity—it does not pursue the overlapping rings and multiple functions in one instrument as in the traditional Chinese armillary sphere; instead, it is transformed so that one ring measures one couple of spherical coordinates. Actually, the abridged armilla consists of two independent instruments, i.e., equatorial armillary sphere and altazimuth, placed on one pedestal. This style of one instrument for one purpose is the traditional European style of astronomical instruments, which can be seen on the 7 instruments contributed by Jamal al-Din, and the 6 instruments made by Jesuit F. Verbiest in the Qing Dynasty under the orders of emperor Kangxi (now they are still kept intact in the Old Observatory in Beijing).

Fig. 14 The abridged armilla**Fig. 15** The gigantic height meter in Dengfeng, Henan

The other is the height meter. Among the 7 instruments contributed by Jamal al-Din, the “room for measuring the shadow cast by the sun on the Summer Solstice and the Summer Solstice” has the same function as the traditional Chinese gnomon, but the precision may be higher. Of course, Guo Shoujing would not bother to imitate it, and he set about by improving the traditional gnomon. He went to Dengfeng, Henan Province and built a gigantic height meter and sky measuring scale—actually a gigantic gnomon (as shown in Fig. 15). It is well known that “mega phenomena” is exactly a style characteristic of Arab astronomical instruments.

Of the above two examples, one is the European style conveyed by the Arab astronomy, the other is the Arab style formed by the Arab astronomy itself. Both styles can be considered as indirect influences of Islamic astronomy on Guo Shoujing.

With the rise of the Mongolian empire spanning the Euro-Asian continent, multiple nations, and multiple cultures underwent an integration, and the exchange between Chinese and foreign astronomy reached a new climax. About the contact between the Chinese astronomy and the Islamic astronomy in that period, we still lack clear clues and conclusions on quite a few concrete issues.

First of all, it is necessary to investigate the astronomical activities of Yelü Chucai and Qiu Chuji in the Middle Asian region. This issue is significant.

Yelü Chucai (1189–1243 AD) was a native of Qidan, a lineal kin descendant of the royal family of the Liao Dynasty. He served the Jin Dynasty as an official first, and then he was called to the Mongolian court. In 1219, he was appointed consultant of astrology and medicine by Genghis Khan and followed the great army in its expedition to the Western regions. On the journey to the Western regions, he argued with Islamic astronomers about lunar eclipse. The event is recorded in the *History of Yuan—Biography of Yelü Chucai* as follows:

Calendar experts in the Western regions reported: In May when the moon is full, there will be a lunar eclipse. Chucai said “No!” In the end, no eclipse happened at all. In the following year, Chucai said: In October there will be a lunar eclipse; Westerners said “No!” When the time came, really a lunar eclipse of 80 % took place.

This incident happened in the second year after Genghis Khan began his expedition to the West regions, i.e., 1220 AD. The story can be deduced from the record “In the Geng-chen year, emperor Taizu launched an expedition to the Western Regions. The prediction of a lunar eclipse in May failed.”... in the *History of the Yuan—Annals of Calendar*, Volume One. The place was Samarkand in the present-day Uzbekistan Republic, which can be inferred from the whereabouts recorded by Yelü, Yelü Chucai himself in his *A Journey to the West*.

Yelü Chucai achieved great attainments in the traditional Chinese astronomy. The Yuan Dynasty in its early years continued to use the *Great Bright Calendar* from the Jin Dynasty. Later on, errors repeatedly occurred; the above-mentioned failure to predict the lunar eclipse in May 1220 is a case in point. So Yelü Chucai compiled the *Yuan Calendar on Journey West in Geng-wu Year* (as recoded in the *History of Yuan—Treatise on Calendar*, Volumes 5 and 6). It treated the time difference caused by the geographical difference in longitudes. Perhaps this can be considered as an instance of influence of the Western astronomical method on the traditional Chinese astronomy system—because the problem of the difference in longitudes and in time were treated already in the ancient Greek astronomy, and in the Islamic astronomy, which had been derived from the same origin.

According to other literatures, Yelü Chucai had a good knowledge of the Islamic calendar himself. The book *Records of Ceasing the Plough in South Village*, Volume 9 “Madaba Calendar” by Tao Zongyi in the Yuan Dynasty writes:

Yelü Chucai is adept at calendar, divination, calculation, mental arithmetic, tonality, Confucianism, and Buddhism. He has read through all foreign books. It was said that the five planets in the Western calendar were unknown in China, so he made the “Madaba Calendar,” a calendar in Semirechhie (Uygur).

Considering that Yelü Chucai gained the upper hand in the two arguments with calendar experts in the Western Regions, we can infer that he knew about the

methods of both the traditional Chinese astronomy and the Islamic astronomy. So, he could know both himself and his opponents and win for sure.

At about the same time when Yelü Chucai made the expedition to the West Regions with Genghis Khan, another famous person Qiu Chuji (1148–1227 AD) was on the way to the Middle Asia. He had received the order from Genghis Khan to preach Taoism to the emperor. Qiu Chuji arrived in Samarkand at the end of the year 1221, virtually at the heels of Yelü Chucai. In the city, Qiu Chuji discussed with the local astronomers the partial solar eclipse that had happened in that May (May 23rd on the Gregorian calendar). *Westward Journey of the Changchun Immortal* Volume One records that event as:

Arriving in Samarkand ... When a local astronomer was present on the scene Master (Qiu Chuji) asked about the solar eclipse in May. The local man said: The eclipse took place in the Chen period, 60 % was shrouded, and then it ended. Master said: Earlier when we were at Luju River, we saw the total eclipse beginning in the Wu period; later we went southwest to Jinshan where people said the eclipse had taken place in the Si period, with 70 % out of the sun shrouded. Now I think when we saw the eclipse beginning, people in different regions saw different scenes. The farther apart they were, the greater the difference. It is just like a fan blocking your sight: In the shadow of the fan, there is no light, but as you get farther away from the fan, there will be more the light beams visible.

When he was on the long journey, Qiu Chuji was 73 years old already, but he did not forget to investigate astronomical issues. From this incident, we can get a glimpse of his interest in astronomy. His explanation and metaphor about different eclipse ratios seen at different geographical locations are entirely correct.

Both Yelü Chucai and Qiu Chuji contacted and exchanged with the local astronomers at Samarkand. This fact is not accidental. After 150 years, this place became the capital city of the newly established Timurid Dynasty. After Ulugh Beg ascended the throne, a magnificent observatory was built there in 1420. Under the supervision of Ulugh Beg, observation and calculation were carried out and the famous *Ulugh Beg Astronomical Table* was compiled, which includes the first independent table of stars within the 1,000 years after Ptolemy in the history of Western astronomy. Therefore, Samarkand seems to have a good tradition of astronomy.

In the middle of the thirteenth century, Hulagu (or Hulegu), grandson of Genghis Khan, went on a punitive expedition westward, and captured Bagdad in 1258 AD. The Khalifah regime of the Abbasid Dynasty collapsed. The Ilkhanate Dynasty sprang up. Assisted by Nasir al-Din al-Tusi, a famous Islamic scholar, Hulagu switched from military accomplishments to civil administration. In the capital Maragha (to the south of Tabriz, a city in northwest Iran) of the Ilkhanate Dynasty, a first-rate observatory was built in 1259. The equipment was sophisticated and the scale magnificent, and the library claimed to have 400,000 books in collection. The Maragha Observatory once became the scholastic center of the Islamic world, attracting scholars from all over the world to do research there.

C.M.D' Ohsson says in *A History of Mongolia* that some Chinese astronomers went with Hulagu to Persia, and that a Chinese scholar worked at the Maragha Observatory. Since then, the topic has often been mentioned by Western scholars. But up to now,

his name and life have not been found. The book records merely “Fao-moun-dji” the phonetic translation of his name. Since the life of the Chinese astronomer is unknown, we can only guess the three Chinese characters of his name from the sound. For example, Joseph Needham adopts these three characters “傅孟吉” as his name in Chinese.

The saying of C.M.D’ Ohsson came from an Farsi annals entitled *The Garden of Doyens*. That book was completed in 1317, divided into 9 volumes, and Volume 8 is *A History of Chine*, which records such a story as in the following paragraph:

In the Hulagu period, Chinese scholars and astronomers came with him to this place (Iran). Among them, there was a teacher named Tu Michi, from whom the scholar Nasr al-Din Talost learned the Chinese technique of astronomical deduction in compiling the *Ilkhanate Astronomical Table* under the order of Hulagu. Furthermore, when the Islamic monarch Ghazan Mahmud Khan ordered to write *A History of the Praised Ghazan*, Prime Minister Rashid al-Din called in Chinese scholars Li Dachi and Ni Kesun for assistance. Both were proficient in medicine, astronomy and history, and brought with them various books on these subjects. In addition, they lectured on chronological record of China, and they said the number of years and the stem-branch were undetermined.

The above paragraph of record is the earliest historical material we have ever found about the Chinese scholars working with the Maragha Observatory. The Chinese names of “屠密迟”, “李大迟”, “倪克孙” are all phonetic imitations of names recorded in Persian. There is no way of determining who they really are exactly. Perhaps “Tu Michi” is “Fao-moun-dji” (傅孟吉). Anyhow, the compilation of the *Ilkhanate Astronomical Table* is the most significant merit that Nasr al-Din Talost accomplished at the Maragha Observatory. Therefore, we get to know that Chinese astronomers made important contributions to the *Ilkhanate Astronomical Table* (another name is the *Ilkhanate Siddhanta*, and the original Persian name is *Zij Il-Khani*).

To determine who “Tu Michi” and “Fao-moun-dji” actually are, probably we can only hope for new discoveries in historical materials in Chinese.

3.3.2 Foreign Books in the Hui’s Bureau of Astronomy

Since the Hui’s Bureau of Astronomy in Xanadu has a kinship with the Maragha Observatory of the Ilkhanate Dynasty, and it is led by the Islamic astronomer Jamal al-Din, and specialized in Islamic astronomy, undoubtedly it occupies a vital position in the history of Islamic astronomy—it can be considered as a mid-way station between the Observatory and the Samarkand Observatory of the subsequent Timurid Dynasty.

What we know today about this significant observatory, however, is very limited. Of the limited information, a booklist in the *Annals of the Director of the Palace Library*, Volume 7 is especially worth noting—all the books were collected in the Hui’s Bureau of Astronomy. In the list, there are 13 works on astronomy, including:

- (1) *The Elements (of Geometry)* by Euclid, 15 parts (parts);
- (2) *Problem Solving Algorithmic Sections* by Hanlisuku, 3 parts;

- (3) *Various Algorithmic Sections and Ceremonies* by Savina Khan Daxiya, 17 parts;
- (4) *Technology of Making Astronomical Instruments* by Myzhesi, 15 parts;
- (5) *Determining Disasters and Blessings* by Akan;
- (6) *Rules of Divining* by Lan Muli;
- (7) *Proper Sense of Disasters and Blessings* by Mata Heli;
- (8) *Number of Spans for Exhausting Calendars* by Hayati, 7 parts;
- (9) *Various Algorithmic Methods* by Hexi Biya, 8 parts;
- (10) *Accumulated Scales of Calendars*, 48 parts;
- (11) *A Compilation of Stars* by Suwali Kewaqibi, 4 parts;
- (12) *Making Armillary Sphere and Incense Hourglass* by Sanadi Alatui, 8 parts;
- (13) *A Compilation of Important Rules* by Safeina, 12 parts.

Here “part” is equivalent to “volume” in old Chinese books. The numbers of parts for item 5, 6, and 7 are missing. But the note “This bureau finds 195 volumes of applicable books” gives us a hint. Detract the aggregated volumes of other 10 items from the total of 195, and we get the number of volumes for these three items—58.

What language are these books written in? We have not seen any record about it. Though we cannot exclude the possibility that they are in Chinese, but most probably they are in Persian or Arabic.

Of the above booklist, the names of books are semantic translations, and the names of persons are phonetic translations. Both are hard to be restored to the original text. So far, the progress of identification on these 13 items has been slow. Fang Hao thinks that Item 1 is the famous *The Elements (of Geometry)* by Euclid, on the ground that the number of parts, i.e., “15” conforms to the 15 volumes of *The Elements*. This hypothesis sounds believable. Some scholars think that Item 4 may well be *Almagest* by Ptolemy. This hypothesis sounds unbelievable, because *Technology of Making Astronomical Instruments* deals with manufacture of Astronomical Instruments, while *Almagest* is not a book specialized in making instruments; what is more, the book *Almagest* consists of 13 volumes, inconsistent with the “15 parts” mentioned here.

3.4 *The Late Ming Dynasty and Early Qing Dynasty:* *Large-Scale Introduction of the Modern Western Astronomy*

3.4.1 A “Direct Access to the Highest Authorities” for Jesuit Missionaries

At the end of the sixteenth century, Jesuit missionaries began to enter China. In 1582, Matteo Ricci arrived in Macao, China, and became a forefather of the Jesuit missionary cause. Through many years of activities and wide contact with Chinese persons from all walks of life, Ricci found a very effective way of preaching his religion, that is, the so-called “academic preaching.” In 1601, he was received in audience by the emperor Wanli, and permitted to live in the capital.

That symbolizes that Jesuit missionaries were accepted by the upper strata of the Chinese society, and the “academic preaching” policy became effective.

Although the “academic preaching” is often attributed to Ricci, the proposition of this policy cannot be separated from the entrenched Jesuit tradition. The Society of Jesus had always attached great importance to education, setting up various kinds of schools for example, in the 1720s and 1730s, the Society of Jesus ran 19 schools in Napoleon Province, 18 in Sicily, and 17 in Venice. Jesuits had to undergo strict education and training, so among them there were excellent scholars. For example, Matteo Ricci learned astronomy from Clavius, a famous mathematician and astronomer who was a colleague and friend of Kepler and Galileo. For another example, Johann Adam Schall von Bell (1592–1666) became the first Director of the Imperial Observatory of the Qing Dynasty. His teacher C. Grinberger was the successor of Clavius’s professorship at the College of Roma. For still another example, Jesuit Johann Terrenz Schreck (1576–1630) was an academician of the Accademia dei Lincei (predecessor of the Academy of Italy) himself, and he was also very intimate with Kepler and Galileo (both were academicians, too). Later, he participated in compiling the *Chongzhen Imperial Almanac*. It was the tradition of attaching importance to learning and education that made it possible for the Society of Jesus to propose and practice the “academic preaching” policy.

3.4.2 Outline of the European Astronomy Introduced by the *Chongzhen Imperial Almanac*

Supervised by Xu Guangqi and Li Tianjing successively, the *Chongzhen Imperial Almanac* was compiled and edited. The completed work was respectfully presented in 5 batches to emperor Chongzhen for approval. The whole work includes 44 categories and 137 volumes. Though the *Imperial Almanac* was not promulgated at the end of the Ming Dynasty, there was an edition published, which is called Ming-published edition. When the Qing army conquered Beijing, some press plates were found at Johann von Bell’s residence. *Almanac of the New Western Calendar* revised by Johann von Bell was re-engraved many times, producing quite a few editions. Two of them are relatively complete and representative: one is the edition in the 2nd year of Shunzhi which is now kept in the Imperial Palace Museum in Beijing, and the other is the edition kept in the Congress Library in the USA.

The *Chongzhen Imperial Almanac* was made up of a great number of volumes, of which the part “Methods and Principles,” or the theoretical part, takes up 1/3 of the total length. It introduces systematically the theories and methods of the classic Western astronomy, and expounds the research efforts of Ptolemy, Copernicus and Tycho. Generally, it does not surpass the level of astronomical writings before the three laws of planetary motion by Kepler, but there is a little advanced content. Concrete calculations and numerous astronomical table are based on the Tycho system. What and whose books are adopted for the *Chongzhen Imperial Almanac*

to introduce the astronomical doctrines and works? I have found out most of them through textual research. Now I would like to list the authenticated works as follows:

- Tycho
 - Astronomiae Instauratae Progymnasmata, 1602
 - De Mundi, 1588, i.e., *Illustration of Comets*
 - Astronomiae Instauratae Mechanica, 1589
 - De Nova Stella, The whole text was reprinted in *Introductory Astronomy*
- Ptolemy
 - Almagest
- Copernicus
 - De Revolutionibus, 1543
- Kepler
 - Ad Vitellionem Paralipomena, 1604
 - Astronomia Nova, 1609
 - Harmonices Mundi, 1619
 - Epitome Astronomiae Copernicanae, 1618–1621
- Galileo
 - Sidereus Nuntius, 1610
- Longomontanus
 - Astronomia Danica, 1622, Work on expounding Tycho's theory by Tycho's disciples
- Regiomontanus
 - Epitoma Almagesti Ptolemaei, 1496

Of the above 13 works of astronomy in Latin brought by Jesuits to China through rough journeys and cited for reference in compiling the *Chongzhen Imperial Almanac*, 10 are still kept in the Pei-Tang Library in Beijing now. The latest book was published in 1622, and all the books were published before the compiling work on the *Chongzhen Imperial Almanac* began.

3.4.3 Imitation of the Large European Astronomical Instruments

In 1673, under the order of emperor Kangxi, Jesuit missionary Ferdinand Verbiest built 6 large instruments for astronomical observation and they are now still kept intact in the ancient observatory in Jianguomen, Beijing. They are: spherical instrument, ecliptic armillary sphere, equatorial armillary sphere, Altazimuth, quadrant, and sextant. These 6 instruments are direct copies of the astronomical instruments made by Tycho in Europe nearly one century earlier (as shown in Fig. 16). In addition, Ferdinand Verbiest wrote a book *Records of Instruments on Observatory* to describe in detail the mechanical principles, manufacturing technology, and auxiliary equipment for the 6 instruments. The book becomes a valuable handbook of European technology in the sixteenth to seventeenth century. The book contains a bundle of fine sketches for illustration, which are also very rare literatures.

Fig. 16 An imitation of Tycho's sextant at the ancient observatory



Exhibited in the ancient observatory on Jianguomen in Beijing, there are two other large astronomical instruments: one is the altazimuth built in 1715, and the other is the elaborate equatorial armillary sphere built in 1744.

3.4.4 Wang Xichan, Mei Wending, and the European Astronomy

In the transition period between Ming and Qing, the Chinese astronomers in the real sense appeared (in fact, it was not until then that astronomers in the real sense of the word appeared). Two of them, named Wang Xichan and Mei Wending, are outstanding and famous for proficiency with both Chinese and Western astronomies. Wang considered himself an adherent of the Ming Dynasty. After the Ming fell, he refused to be appointed official and associated with Gu Yanwu and other scholars of the Ming Dynasty, living a poor life in recluse. Mei refused to accept any official position either, but he was a civilian friend of emperor Kangxi. Kangxi admired his knowledge in calendric calculation, bestowed him a board inscribed with “Investigate Minute Details with Meritorious Learning,” and even sent books written by himself to Mei for “advice.” Despite the great difference in fortune, Wang and Mei are highly praised by later generations for their learning in astronomy and calendar. Their research and improvement on Tycho's universe model can be considered as representative of Chinese astronomers in this kind of work.

In his work, *Interpretation of the Motion Degree of the 5 Planets*, Wang Xichan proposed such a universe model as follows:

The central sky of the 5 planets is within the solar sky. But the 5 planets are at the circumference of the central sky, while the sun stays in the center of the central

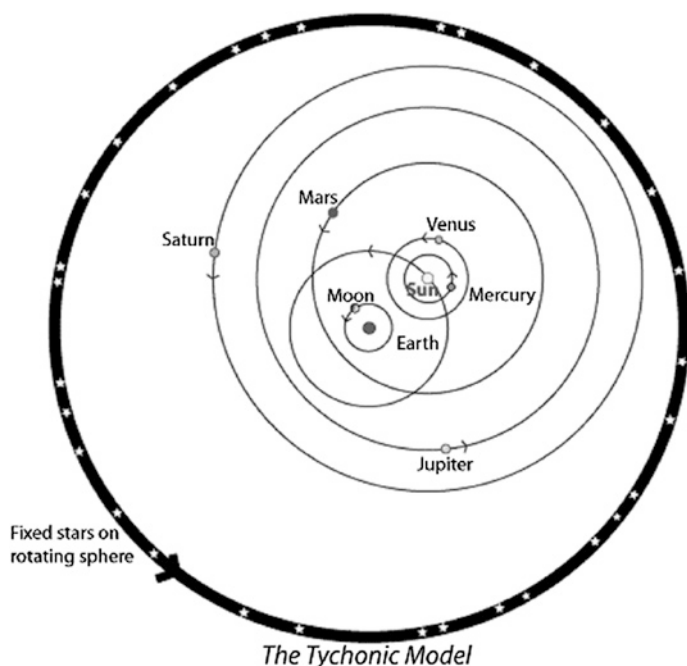


Fig. 17 Tycho's model

sky, tilted a bit to the upper hand. It revolves with the central sky, forming a circle of the solar motion.

He was not content with Tycho's universe model that is used as the theoretical foundation in the *Chongzhen Imperial Almanac*, so he wanted to replace it with the above model. However, the "central sky" mentioned by Wang is actually replaced with another concept. In the *Chongzhen Imperial Almanac* and other works discussing the Western astronomy, the "central sky" was a commonly used phrase that refers to the circumference, on which the celestial bodies move, i.e., it is equivalent to the "deferent" in the Ptolemy system. Nevertheless, the "central sky" in Wang's proposition puts the sun at an eccentric place. In concrete calculations of celestial phenomena, this "central sky" does not have any effect. What really counts is the "solar motion circle"—exactly the solar orbit in Tycho's model. Therefore, Wang's universe model does not differ from Tycho's model (as shown in Fig. 17). In commenting on Wang's model Qian Xizuo points out that it tries to differ itself from its Western counterpart, but the two are parallel and identical to each other.

Why would Wang Xichan want to be different from Westerners? It was because of his political background. Wang was a remnant from the Ming Dynasty. After the Ming fell, he refused to be appointed official or serve the Qing Dynasty. He was strongly resentful toward the Qing government that came to dominate China, promulgated and used the Western astronomy, and appointed Western missionaries to

lead the Bureau of Astronomy. Compared with methods of the traditional Chinese astronomy, the Western astronomy was evidently superior in predicting celestial phenomena, but Wang could not accept that fact. He firmly believed the reason for the traditional Chinese astronomical technique to be in the disadvantageous position was that China then did not have a master-hand to bring the potential power of the traditional technique into full play. Aiming at this, he wrote the *New Calendar of the Morning Convent*, the last classical calendar in the Chinese history, attempting to combine some concrete methods from the Western astronomy with the precondition of preserving the structure and form of the traditional Chinese calendar. But his attempt did not achieve the effect he had hoped. As a result, the *New Calendar of the Morning Convent* became a very difficult book to read.

The universe model that was acceptable to Mei Wending did not differ from Ptolemy's model in essence. He did not agree with Ptolemy only on whether there is a material orbit for the celestial body. He did not approve of the vital principle in Tycho's model, that is, the principle of planets moving around the sun. In his work, *Mei's Complete Calendar—Summery of the 5 Planets*, he expounds forcefully that "the central sky of the 5 planets is centered on the earth." In order not to go against Tycho's model "authorized by the emperor," Mei took the middle way between the two by proposing the doctrine of "surrounding the sun and presenting circular images"—taking Ptolemy's model as objective reality, and Tycho's model as the image presented to the human eye:

If we link up the points in the planet motion orbit on the yearly cycle, a circular image will be formed, surrounding the sun in the center. The new Western doctrine says that the 5 planets surround the earth in the center. Generally, the Western astronomy is based on this theory. However, the "surrounding the sun and presenting circular images" is formed by linking up the weekly positions on the yearly cycle, and the center of the yearly cycle moves along the circumference of the central sky. The central sky is centered on the earth. The three objects are locked in a stalemate. The two methods are not different from each other. ... Or if you do not understand this, you will say the sky of the 5 planets is centered on the sun and fail to grasp the true meaning of the theory.

Here the so-called "yearly cycle" mentioned by Mei is equivalent to the "epicycle" in Ptolemy's model. In the beginning, Mei Wending applied his proposition "surrounding the sun and presenting circular images" to the outer planets. Later, his student Liu Yungong proposed that the inner planets be treated likewise with the same theory and Mei was full of praise for him.

As long as the self-verification of a system is concerned, the mediating theory proposed by Mei was smart in form. He believed that his theory was consistent with Tycho's intention: "I tried by drawing to deduce the root on which Tycho established his method. Taking the earth as the center of the central sky, his doctrine is very clear." Later Jiang Yong praised Mei very highly. In his *Mathematics* Volume 6, Jiang Yong proved with geography that in Mei's model, calculating the apparent longitude can be done in two ways: putting the planets in the "yearly cycle" or at "surrounding the sun and presenting circular images." The results are the same, for the inner and outer planets alike.

But Jiang Yong did not prove the equivalence between Mei's model and Tycho's model adopted in the *Chongzhen Imperial Almanac*. Neither did Mei himself prove his model by observed or measured giving data (Mei did not do any astronomical observation or measurement himself). In fact, smart as Mei's model is, it is not consistent with Tycho's original intention. The distance between his model and the fact is larger than Tycho's model.

3.4.5 The So-Called Theory of “Western Doctrine with Chinese Origin”

Jesuit missionaries introduced the Western astronomy, mathematics and other science and technology, and some Chinese persons of the upper class—Xu Guangqi, Li Zhizao, Yang Tingjun and so on—admired them. After entering the pass, the Qing Dynasty changed the name of the *Chongzhen Imperial Almanac* to *Almanac with New Western Method*, promulgated it, and appointed Jesuit missionaries to lead the Directorate of Astronomy over a long period of time. Emperor Kangxi himself respected Jesuit missionaries as his teachers, and learned from them the Western astronomy, mathematics, and other branches of knowledge.

All this condition had a strong impact on the traditional belief and thought of the Chinese literati and officialdom. The so-called “Western doctrine with Chinese origin” theory, which was popular in the imperial court and the intellectual world, is a reaction to the above-mentioned impact. The “Western doctrine with Chinese origin” theory was aimed at astronomical calendars. Mathematics was also involved as it is closely connected to astronomy and calendar. Later in the late Qing Dynasty, the theory was popularized to almost all the other intellectual fields.

The “Western doctrine with Chinese origin” theory was started by remnants from the Ming Dynasty. The first person to propose the “Western doctrine with Chinese origin” thought was Huang Zongxi, and another pioneer was his contemporary Fang Yizhi. Huang and Fang proposed the “Western doctrine with Chinese origin” thought jointly, but they did not provide evidence to support this theory. When Wang Xichan came out, he began to expound the theory, and greatly pushed the theory forward.

In the Qin Dynasty, emperor Kangxi on the one hand indulged in the Western science and technology brought by Jesuit missionaries, and on the other hand, advocated the “Western doctrine with Chinese origin” theory. Kangxi published the *Imperial Trigonometry*, which contains the proposition “The ancient calendar spread to the West, and the Westerners studied and refined it.” That is about calendar. His exposition on “Western doctrine with Chinese origin” of mathematics drew more attention. A frequently cited historical material is his discussion about math with Zhao Hongxie in the 50th year of Kangxi (1711), which is recorded in *89th year of Kangxi in Record of Dong Hua*:

The Western algorithm is good. It was originally a Chinese algorithm called by Westerners alchubar—meaning spread from the East. Alchubar, also called alrebadā or alrebarā, is considered as a phonetic translation of algebra (originating

from Arabic Al-jabr), meaning algebra. But how could Kangxi get the meaning “algorithm from East”? We have no idea. As soon as Kangxi’s word came out, Mei Wending responded enthusiastically. Mei decided to supplement and improve the “Western doctrine with Chinese origin” theory with his proficiency “Investigate Minute Details with Meritorious Learning.” In his *Supplementary Questions in Calendar Studies*, he expounded the theory from the following three aspects:

First, demonstrate that “Theory of the Sphere and the Astrolabe” is the canopy-heavens theory in *Zhoubi Suanjing*. In the late Ming Dynasty, Li Zhizao wrote *Illustrated Explanation of the Sphere and the Astrolabe* and the Jesuit missionary Sabatino de Ursis wrote *Instruction on Elementary Astronomical Instrument*. The former discusses the projection of spherical coordinate system onto a plane, and introduced astrolabe and its use. The latter discusses an astronomical instrument named “Elementary Astronomical Instrument” whose principle is similar to astrolabe. Wielding “Theory of the Sphere and the Astrolabe” in his hand, Mei proceeds with his demonstration, saying:

When it comes to sphere and astrolabe, no people other than Rong Cheng or Li Shou could make them. If they are corresponding to what is described in *Zhoubi Suanjing*, it will be allowable to consider them as canopy-heavens instruments in *Zhoubi Suanjing*.

Of course, the starting point of Mei’s exposition is a big mistake. The relation between sphere-heavens theory and the canopy-heavens theory in ancient China is not like that between “statue” and “sketch” as he has said. Mei is proficient in astronomy, and it is impossible for him to misunderstand this. But he writes a far-fetched article purposefully. Explanation of his behavior as feudal literati and officialdom fawning over the monarch will not be convincing.

Second, supposing the channel and mode for the Chinese method to spread westwards. This link must be added for the “Western doctrine with Chinese origin” theory to stand. Starting with the story in *The Records of the Grand Historian—Treatise on Almanac*: “After Emperor Li and Emperor You, the Zhou royal family got weaker, so professionals dispersed either to all parts of China or to barbarian regions,” Mei wrote: “Probably in trying to escape from the turmoil, they went to strange places, and some of them took books and utensils with them on the long march.” Moreover, Mei came up with a better path. *Book of Documents—Cannon of Yao* has a legend: “Emperor Yao ordered Xi and He to obey Heaven’s intention respectfully when they were to do anything. He ordered Xizhong, Xishu, Hezhong, Heshu to live in different places.” Based on this legend, Mei put forth a supposition: in the southeast there are seas to stop migration, and in the far north there is the rigid climate. Only Hezhong was not hindered by anything when he migrated westwards.” He went as west as he could, thus introducing “Zhoubi theory of canopy-heavens” to the West. He further supposed that: Hezhong went westwards in an era when “the Chinese voice taught all countries.” So when Hezhong arrived in the West, the grand occasion was:

People in the remote regions look up to this great man and followed him. Some of them received his instruction, and others were presented with a new thing.

All these opened up a way of enlightening their awareness. Outstanding local persons discussed the novelties, and promoted their alteration.

Of course, compared with Wang Xichan's affirmation that the Western method was formed on "stealing" the Chinese one, Mei Wending's wording "Instruction" and "dissemination" sounds more placid.

Third, demonstrating the kinship between the Western calendar and the "Hui's calendar" i.e., the Islamic astronomy. It was more difficult for Mei to see clearly the kinship between the Western astronomy and the Islamic astronomy than we do today, because back then the Chinese scholars knew very little about the outside world. However, Mei confused the order of the two. It is true that the Western calendar was more "refined" than the Hui's calendar, but when traced back to the origin, the Hui's calendar originated from the Western calendar. In the three arguments made by Mei Wending on the "Western doctrine with Chinese origin" theory, only the third one has a bit scientific element.

With Kangxi's advocacy and Mei Wending's generous illustration, the "Western doctrine with Chinese origin" theory appeared to be complete, and its influence increased, taking on the trend of spreading to other disciplines of science. For example, Ruan Yuan of the Qing Dynasty said in his book *Three Books of the Scripture Study* Volume 3—*Instruction on Striking Clocks*, that the principle of striking clocks is the same as that of the water clock in ancient China. So the clock originated from China. That is the evidence of spread to mechanic technology. Mao Xianglin considered the Western surgical operation to be a kind of Hua Tuo's treatment; and since Westerners did not grasp the true skills of Hua Tuo, their rate of success was low (*Record with Surplus Ink*, Volume 7). That is the evidence of spread to medicine. So on and so forth. That sort of theories is most fabrication by laymen and is valueless academically.

The dilemma of the Qing rulers lies in: On the one hand, they need the Western science. they need the Western astronomy for making calendars; they need Jesuit missionaries to help them deal with foreign affairs (for example to sign treaties of Nerchinsk); they need the Western technology for manufacture of guns and other utensils; they need quinine to cure the "imperial diseases," etc. On the other hand, they need to pose as successors of the traditional Chinese culture accumulated over thousands of years, as "orthodox Chinese" and as "a heavenly dynasty and a super country." Therefore, regarding calendar the sacred matter and the symbol of monarchical power, "using the foreign methods to change China" increasingly becomes a headache to the emperor and the ministers alike.

Under this circumstance, Kangxi's advocacy of the "Western doctrine with Chinese origin" theory is really a smart move to get free: adoption of Western science and technology can be continued, and the suspicion of "using- foreign methods to change China" can be avoided. Excellent as the Western calendar may be, it is originated from China. It is not surprising that the student has surpassed the teacher. Now adoption of the Western method becomes "when the original rites is lost, we might as well welcome it back from overseas."

The "Western doctrine with Chinese origin" theory was welcomed widely among Chinese literati and officialdom and continued for as long as 300 years.

Another reason for this is that the advocator of this theory hoped to use it to raise the national self-respect and to strengthen the national self-confidence. The ruler was accustomed to posing itself as “a heavenly dynasty and a super country,” indulging in “the voice teaching remote nations,” and enjoying “foreign countries coming to pay respect.” Suddenly, his own country was left behind in many aspects now, so he felt embarrassed. The “Western doctrine with Chinese origin” theory is taken as a way of saving face.

3.4.6 Reasons for Being Unable to Develop as Europe Did—Kangxi’s Merits and Faults in History

Recent years have seen continuous rise in the positive evaluation in historical treatises of Kangxi. Some praise him for great talent and bold vision, similar to Louis-Dieudonné XIV, the French “Sun King”; others praise him as a wise sponsor for learning, and describe him as a first-class person like Cosimo Medici of Florence during the Renaissance period. The Jesuit missionaries who served Kangxi in the court did praise him frequently with words such as “benevolent,” “unbiased,” “generous,” “wise,” and “great, in letters and report sent to Europe.

Kangxi was interested in Western science and technology, and he was keen on learning Western science and technology enthusiastically. These are all facts. In the traditional Chinese feudal society, appearance of such an emperor was not easy. As an individual, he really was a Chinese with a broad forward vision and advanced knowledge. As a monarch of a big country, however, his merits and faults are open to discussion.

Let us examine this matter first: Kangxi recruited the Jesuit missionaries who had knowledge of science and technology to serve the court. This is often cited in treatises as a significant evidence of Kangxi “loving science” or “being enthusiastic in science.” But if we put this in the background of the long history of ancient China, Kangxi’s conduct is not different from the behavior of many Chinese monarchs before and after him. In Chinese dynasties, various people proficient in arts served the court. Mostly they were monks or Taoists. They served the monarch with their arts in astrology, divination, medicine, alchemy, calligraphy and drawing, music, etc. Generally, their status was approximate to “protégés,” and yet some of them took part in military and state affairs after obtaining the trust of the monarch. In fact, Jesuit missionaries serving the Kangxi court did not stray away from this traditional mode. Though they did not practice astrology or alchemy, Jesuits served the court with medicine, painting, music, and other arts. In addition, there were artists who operated the striking clock and other Western instruments, or designed aulic architecture of Western styles, and so on. Disregarding the difference in concrete art and affairs, the general mode was no different from previous ages. Ancient monarchs always took it as an honor to have strange people from remote regions serving the throne. “Loving science” was not the necessary condition.

Actually, more serious faults of Kangxi have been pointed out already by previous scholars, that is, Kangxi was keen on Western science and technology himself. However, he did not intend to propagate his interest to officials and civilians, or

even to do something as simple as selecting some offspring of the Eight Banners to follow the Jesuits serving the court and learn some knowledge of science and technology from them, not to mention setting up public schools for Jesuits to pass on the knowledge of Western science and technology, or sending youths to Europe for schooling—undoubtedly these were pleasant and easy undertakings for Jesuits.

At the germination of the modern science and technology, Kangxi encountered a very good chance that was presented to him, that is, a chance of putting China at the same starting line with Europe. As the respected Son of Heaven in a great empire who was on the throne for 60 years, he possessed all the conditions to carry out and promote this cause. But his thought as a whole still stayed in the old mode. What he said about broadening vision was merely on a shallow layer, and the only benefit is that he saw some rare articles which ordinary people could not see.

Kangxi did not see the twilight of the new world.

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A History of Chinese Science and Technology

Volume 1

Lu, Y. (Ed.)

2015, XV, 491 p. 187 illus., Hardcover

ISBN: 978-3-662-44256-2