

# Four thousand years of Chinese astronomy

## The celestial officers

*"If in the whole cycle from the beginning to the end and from antiquity to modern times the changes which take place at fixed epochs have been observed deeply and their details and totality examined, then (the science) of the Governors of Heaven is complete"*

*Shiji, Historical memoirs of the historian-astronomer  
Sima Qian (the year –108 or 109 BC)*



## Foreword

### *Four thousand years of Chinese astronomy*

This book has its origins primarily in a personal story. It is not so easy to “encounter” Chinese astronomy and more generally ancient Chinese science. In Europe, it is most generally presented in a very insignificant and superficial way. Often illustrated using very anecdotal and exotic engravings, Chinese astronomy is presented most of the time as a rudimentary science of the calendar, associated moreover with an incomprehensible way of representing the constellations.

For my part, it took a combination of very special circumstances for a veil to be lifted and for me to become aware of the phenomenal activity of Chinese astronomers, uninterrupted for almost five thousand years, and of the fundamental discoveries made in this part of the world.

As an astrophysicist, I study the death of stars, one of the rare moments when astrophysical time meets human time. We now know that stars live a luminous existence for billions of years. When there is no more fuel in the stellar boiler, the end of a star's life occurs in an extremely brief interval of time for a celestial phenomenon: in a few fractions of a second, the enormous bubble of gas which constitutes the star collapses on itself. The ensuing explosion is spectacular. Its luminous glow makes it visible in the sky for about a month as a super "new" star, a "supernova", sometimes as bright as the full moon. After the explosion, the core of the star generally remains as a tiny, extremely dense star that spins very quickly on itself like a frenetic top: a “pulsar”. This compact star is surrounded by swirls of hot gas, remnants of the cataclysm, which are difficult to detect because after a few hundred years, they only emit very little visible light. It is only for a few decades that astronomers have been able to locate them, thanks to the radio waves that the gases emit and, also starting from 1967, by their emission of X and gamma rays only detectable from space. These explosion remnants are of vital importance for modern astrophysics not only because they disperse the chemical atoms necessary for life in space, but also because they reveal essential information about the star that exploded and also represent a natural laboratory where matter is at densities impossible to reach on Earth.

In 1968, a particularly spectacular “pulsar” was discovered in the constellation of Taurus, at the centre of a remnant baptized the “Crab Nebula” because of the shape of its volutes which evoke the animal's claws. Today, all astrophysics students learn that to determine the exact date of this explosion, modern astronomers did not make complex computations, but

simply used information provided by Chinese "colleagues" ... who lived almost a thousand years ago, in the year 1054! The writings that relate all the details of this cosmic explosion are the work of imperial astronomers of the Song dynasty, contemporaries of the Capetians and William the Conqueror, who, on that date, witnessed the cataclysm live. Apart from a few Japanese astronomers of the same period, Song astronomers were the only ones on the surface of the globe to observe the extraordinary phenomenon and to provide a detailed description of it. The precision and rigor of their information made it possible today not only to precisely date the explosion, but also to understand its exact unfolding.

This discovery was a profound enlightenment for me. It was therefore in none of the countries usually associated with astronomy, Greece, Mesopotamia, Egypt, Arabia or Persia, that the memory of Heaven was kept, but in China. This is where you could find all the cosmic records over millennia.

How could they be so precise in these ancient times? Who were these people who already had such a rigorous scientific method, similar to the one we use today? What were their motivations? In what context did they work? What instruments did they use?

All these questions and this very legitimate curiosity had great difficulty in being satisfied. The examination of encyclopaedic works was particularly disappointing and even catastrophic. For example, reading the "Atlas of the Sky", an enormous and excellent encyclopaedic work published in 1985 by the French *Encyclopaedia Universalis*, revealed to me a very long saga of the world history of astronomy, developed on several tens of pages. In this review, the Chinese contribution was entitled in all and for all only to a very short paragraph where was only mentioned in a concise way some concern for celestial phenomena in this part of the world. Many other encyclopaedias completely ignored it. English-language searches were equally disappointing. Apart from the few writings of erudite sinologists versed in the ancient texts, there exists in the modern literature of Western Europe practically no works devoted to Chinese astronomy. Only a small booklet, by the French publisher "Le Seuil" in 1973, first published in English, opened up interesting horizons. "*Chinese science and the West*" was signed by the English biologist and sinologist Joseph Needham, who delivered a summary of his disproportionate effort to try to emerge from oblivion, not only astronomy or Chinese mathematics, but all discoveries and techniques that Europeans owe to ancient Chinese scientists. This work, now recognized as an absolute reference, is declined in a series of large volumes published starting from 1954. The third "*Mathematics and the Sciences of the Heavens and the Earth*", devoted largely to astronomy, was completed in 1959. Since Needham's death in 1995, a group of his colleagues of different nationalities have continued the task and 24 volumes have already been published.

The information provided by Needham on Chinese astronomy is based on a rigorous use of a very large number of original texts preserved by successive Chinese dynasties over

almost five thousand years. It is a remarkable synthesis by the quality of the sources but also by the implacable honesty of its author, who abstains from any risky interpretation, favouring the pure presentation of this incalculable amount of information collected.

Needham's text remains unavoidable today. Nevertheless, since 1959, many additional sources, sometimes crucial, have been added, especially for the most remote periods of Chinese history. Following excavation campaigns undertaken from the early 1970s, when China began to emerge from its long period of political isolation, new original documents were discovered, mostly in tombs. Their remote dating has often profoundly modified our ideas on Chinese astronomy.

Thanks to the diplomatic opening of the early 1980s, an international congress of astrophysics was organized for the first time since the establishment of the People's Republic of China, in May 1986 in Nanjing. The theme was precisely the death of the stars. My participation in this congress and the contacts that I was able to establish with Chinese astrophysicists subsequently enabled me to carry out a scientific stay in Beijing from 1988 to 1989. It was this first immersion in Chinese culture that allowed me to finally lift this heavy veil of opaque silk which covers Chinese science in Europe, much more effectively than the famous iron curtain.

Beijing was not at that time the city of skyscrapers, infernal circles of peripheral highways and suffocating car traffic, but a charming capital, somewhat provincial with its parks and shady alleys. It was sort of a world upside down. On each main avenue, only a narrow central lane was reserved for the rare trucks, taxis and company vehicles, while on either side in each direction, it was on two or three lanes that the innumerable bicycles circulated only perceived by their rustling. It was in this calm atmosphere that I was able to begin to familiarize myself with the very long Chinese astronomical tradition and discover its incredible richness, with the help of researchers from the Institute for the History of Natural Science in Beijing.

Like a modern Marco Polo, I then became aware of the surprising discoveries made in China. It was to Chinese astronomers that we owed the observation of the first star explosion of which humanity has kept memory, the discovery of spots on the Sun, the establishment of the first catalogues of comets and even... the invention of the mount for modern telescopes! So many subjects which all seemed natural to my Chinese colleagues, but which was for me reason of absolute wonder.

This work could therefore be a very modest "*Books of Astronomical Marvels of the Word*". It attempts to present an overview of the activity of astronomers in the distant Middle Kingdom that Europe still pretends to ignore. For several thousand years, Chinese scientists,

organized in impressive imperial observatories, noted with the greatest precision, day after day, month after month, all the celestial phenomena. And the thousands of preserved texts cover periods ranging from the 5<sup>th</sup> century before the modern era until the end of the last dynasty of the Qing in 1911. A large part of these sources has not yet been truly studied, not to mention that the discovery of numerous archaeological sites and objects continue to enrich this heritage. A real treasure, still very poorly known in Europe and, incomprehensibly, largely ignored by the modern history of science.

The sky is at the very source of Chinese civilization. Since the most ancient times, it has been the basis of the political organization of a country which calls itself the "Land under Heaven" and makes its emperor the "Son of Heaven". Surprising as it may seem, the political role of astronomy has marked not only the history of ancient China but also its most recent history.

### ***When the lights went out in Tiananmen***

As luck would have it, the end of my first long stay in Beijing in 1989 coincided with one of the most impressive recent political upheavals in China: the major student demonstrations in the spring of 1989 and the intervention of the army in Tiananmen Square.

In Beijing before the economic boom of the 1990s, the evenings were absolutely calm. In the *Zhongguancun district*, a few steps from Beijing's largest university, *Beijing Daxue* (Beida), along the grounds of the Friendship Hôtel where the "foreign experts" were gathered, the evening of 15 April 1989 was disturbed by a strange sound. Entire clusters of students, without banners or slogans, were walking towards the centre of Beijing singing the Internationale, the communist revolutionary song, the height of the incongruous in this China where, apart from a few statues of Mao in courtyards factories, all traces of political references to Maoism had already disappeared. This April 15 marked the start of major student demonstrations. I learned the next day that they had been triggered by the death of Hu Yaobang, one of the Chinese leaders who had supported the opening of China before being sidelined. Thereafter, almost every evening, a few thousands, then millions of Chinese would occupy the arteries of Beijing, then seizing the emblematic square of the city, *Tiananmen Square*, until the dramatic intervention of the army on the evening of June 3, 1989.

Contrary to appearances, it is no coincidence that the central square of the Chinese capital, the center of the center of the Middle Kingdom, is called *Tian-An-Men*, the Gate of Heavenly Peace, just as it is not is no coincidence that one of the central characters of this

“Spring of Democracy” in China was the astronomer Fang Lizhi from the Beijing Observatory. Less known abroad than the dissident Wei Jinsheng, famous for his action during the Wall of Democracy in 1979, Fang Lizhi had encouraged his compatriots to “*Bringing down the Great Wall*”<sup>1</sup>, during public conferences throughout the country, a few months before the Spring of 1989. He thus pleaded for the opening of China to the outside world. He had even dared to write a letter to Deng Xiaoping, Mao's successor, to ask him for the pardon of Wei Jinsheng, then imprisoned, suggesting that he draw inspiration from the ideals of liberty, equality and fraternity of the French Revolution, whose bicentennial was to be celebrated shortly. Throughout these demonstrations, he alone would symbolize the opposition of society and intellectuals to political power, for which he would later pay dearly.

Fate would have it that on the day of the military intervention, June 3, 1989, I was meeting Fang Lizhi at the end of the morning in his office at the Beijing observatory for a long discussion about Chinese science<sup>2</sup>. Without our knowing it yet, this day was going to end in dramatic conditions. The same evening, the Chinese army entered Tiananmen Square in force, causing several hundred deaths in the process. Only 100 m from the square, in an adjacent street, I watched this inconceivable event all night long. Just before dawn, the lights went out abruptly for the evacuation of the square. The next day, Fang Lizhi took refuge in the United States Embassy in Beijing to remain a recluse there for more than a year, totally deprived of stars. Without direct external contacts, the “Chinese Sakharov”, obtained in 1990 the right to emigrate to the United States on the condition of not being engaged in any political commentary<sup>3</sup>. Fang Lizhi died on April 6, 2012, still in exile in the United States awaiting an amnesty that never came.

The discussion that we had together on June 3, 1989 came from a scientific article that we had just published together on the frequency of star explosions in our Galaxy<sup>4</sup>. This data is essential because it determines the enrichment of the Universe in heavy elements at the base of life. Thanks to the exclusive use of ancient Chinese data, we were able to calculate this rate for the first time in the last two millennia. No other country in the world can provide ancient scientific data so precise as to be used even today. Results of the same importance can be obtained on the frequency of comets, the variation of sunspots or the duration of the terrestrial day. This finding raises a host of questions.

---

<sup>1</sup> *Bringing down the Great Wall*, Fang Lizhi (2001), see also the account of the events of 1989 in “The Eve of explosion”, Fang Lizhi (2004) *China Rights Forum* No. 2, p. 13-18 ([http://iso.hrichina.org/download\\_repository/2/a1\\_OnTheEve6.2004.pdf](http://iso.hrichina.org/download_repository/2/a1_OnTheEve6.2004.pdf))

<sup>2</sup> Bonnet-Bidaud (1990) “China under the eye of Fang Lizhi” in *La Recherche*, April 1990, vol. 220, p. 480-486

<sup>3</sup> Bonnet-Bidaud (1990) “Fang Lizhi: a dissident astrophysicist deprived of stars” in *Liberation* of May 2, 1990, p. 28

<sup>4</sup> Fang Lizhi, Jiasheng Huang, Jean-Marc Bonnet-Bidaud (1991) “A historical supernova's lower limit to the galactic stellar collapse rate”, *Astrophysics and Space Science*, vol. 184, p. 221-225

What is the specificity of ancient Chinese astronomy? How and why does it differ from other approaches? How did the Chinese discoveries influence the rest of the world? Is there a different way of thinking about science in China? How to explain that despite these spectacular advances in the past, China has participated so little in the development of modern science? All these questions can only be answered by examining the ancient history of China.

Astronomy has always been central to the legitimacy of power in China. Totally immersed in modern science, Fang Lizhi was aware of the contribution of his culture to this knowledge, and of the delicate position that Chinese astronomers have always occupied in relation to power. On its own, it once again symbolized the eternal opposition of scholars to the Chinese central power. Fang Lizhi could lay claim to his illustrious predecessors, the astronomers against whom the first emperor of China ordered the burning of books or those who were condemned to death for having dared to challenge the power of the emperor in their philosophical works.

The history of China has been profoundly marked by its dialogue with Heaven and by the political role of astronomy. It is through this history that the richness of Chinese thought is revealed.

This work then proposes to follow the evolution of astronomy in China during its very long history. Starting from the most distant traces in archaic China, it will first expose the succession of the three great ancient dynasties, the Xia (-2100 – -1600), the Shang (-1600 – -1045) and the Zhou (-1045 – -255) which will establish the rules of the "heavenly mandate", this particular relationship of China with the Sky. The most important milestone will then be brought by the Han dynasty (-220 – +220), which will organize astronomical knowledge from the point of view of observation and cosmological concepts. Then will come the Tang (+618 – +907) under which an important mathematical knowledge will be used to establish celestial maps and measure the globe. To this already imposing building, the Song (+960 – +1279) will bring their mechanical talent leading to astonishing astronomical clocks. With the Mongol conquest of the Yuan (+1271 – +1368), will then come the time of the first exchanges of China with the West, which will mark a decisive turning point when the fusion of Persian and Chinese geniuses will lead to the first giant observation instruments, prefiguring the instruments of modern astronomy. At the end of the Ming (+1368 – +1644), the last great Han-dominant dynasty, the astronomy of the Middle Kingdom will meet European astronomy when the Jesuits bring with them the beginnings of the modern scientific revolution. China will then be plunged into innumerable political upheavals, which will put it aside for a time from its dialogue with the Sky. Today, however, the economic boom brings again celestial concerns to the fore.



Fang Lizhi will not have had time to see what the whole planet was able to contemplate in December 2013: a small Chinese robot, baptized “Jade Rabbit”, deposited on the Moon by a Chinese rocket.

### **Convention**

To keep universal references, the dates are given in the astronomical convention according to which there is a year 0 corresponding to 1 BC. The year +1 corresponds to 1 AD. AD and the year –1 corresponds to 2 BC. This convention makes it easy to calculate the number of years elapsed between two dates by simple subtraction, but it introduces a shift of one unit with common European usage. Thus, the accession of the first Chinese emperor which took place in 221 BC. J.-C. corresponds to the year –220. In the case of centuries, the common notation BCE (Before the Common Era) and CE (Common Era) is used.

Except in a specific historical context, the terms "west" and "east" are used solely for their astronomical and geographical meaning and not in their historical-political sense. The terms 'Western world' or 'Western culture', meant to be associated with Europe, are meaningless and geographically inappropriate in the case of Asian culture. China, being located to the west of the United States of America, should then also be considered a “western” country.

When it is necessary to avoid any ambiguity, particularly for proper names, Chinese characters are indicated and noted preferably in their so-called “simplified” form. In literature, some characters can indeed have two scripts, the "simplified", resulting from the writing reform of 1956 and the oldest used on the island of Taiwan. They are transcribed in Latin characters according to the official phonetic transcription of pinyin, and in italic characters, except for common names of regions or cities.

# 1 The kingdom of Xia

## *Gonggong Mythology*

Twice as large as Europe today, China has a unique history in the world: spanning several millennia, it has an exceptional cultural and linguistic continuity.

China was long believed to be the cradle of humankind, after the discovery in the 1920s of *Homo erectus* in Zhoukoudian, a southwestern suburb of Beijing. "Peking Man", the human fossils, dating back almost a million years, impressed the whole world, and in particular several European intellectuals including the Jesuit Teilhard de Chardin, and for several years, the "Peking Man" was considered the oldest known ancestor of man. The discovery of the Australopithecus "Lucy" in 1974 in the horn of Africa pushed back the age of our ancestors to three million years, and the hominid remains of Ardi and Toumaï, discovered in Chad in 1992 and in the Afar desert in 2000, have now pushed it back to six/seven million years.

The Peking man still testifies to a very ancient settlement in China. Even if anthropology is not able yet to definitively establish whether this branch of humanity is in direct descent from its oldest African congeners or whether it developed separately, we can affirm that the human settlement which took its rise in China was probably vigorous enough to migrate northward to reach the more boreal areas of the Eskimos, and probably also eastward to reach North America, presumably passing through Bering Strait. The common traits of the Eskimo and Native American populations could suggest such a swarming.

Between these distant beginnings and the first attested traces of Chinese civilization around the year -2000, there is only scattered information hidden within myths and legends. Sometimes fragile, these fragments of history have nevertheless been transported through the centuries carried by these symbolic stories in an astonishing way and almost as surely as the pollen of plants dispersed by the wind which makes it possible to date climatic periods. For a long time, the existence of the first Chinese dynasties, was doubted and remained mostly mythical until very recent discoveries confirmed their existence.

The oldest dynasty of the Xia (-2100 to -1600) still has an uncertain origin. Its remains were first sought in western China, in the region of the city of Xian. Finally, the first traces of its ancient capitals were unearthed from 1978, further east, in the Yellow River valley, at the site of Erlitou in Henan. From a geographical point of view, China is a vast basin watered by two large rivers, the Yellow River (*Huanghe*) to the North and the Blue River (*Yangzi*) to the South, and surrounded to the West by the desert depression of the Taklamakan and further to the South by the impassable range of the Himalayas. It is therefore a natural enclosed space in which Chinese culture develops in relative isolation.

The Chinese cosmic conception was already elaborated under this first ancient dynasty of the Xia. The very existence of this dynasty has sometimes been questioned. According to the oldest Chinese texts, it would have been established by Emperor Yu who would have succeeded in taming the disastrous consequences of a deluge by the establishment of a system of canals. Surprisingly, geological research published in June 2016 may have identified the cause of this mythical deluge in the upper valley of the Yellow River. The remains of a massive landslide, possibly caused by an earthquake, have been discovered. It would have caused a blockage of the Yellow River and then a gigantic flooding of the region. Its dating, around the year – 1921, makes it correspond well to the Xia period. Traditionally, the list of Chinese sovereigns begins with the earlier period known as the “three Sovereigns and five Emperors” (–2800 to –2100), but this chronology remains entirely theoretical.

### **BOX: Cosmology of the Imperial City**

Extreme attention was paid to the choice of places and their geographical orientation in ancient China since the Neolithic era.

The Erlitou archaeological site, near the city of Luoyang in Henan, was discovered in 1959. As early as 1978, the remains of ancient buildings were discovered. In 2001, the site finally revealed a complex interweaving of palaces, the oldest of which were dated to the period -2100 to -1800, corresponding to the Bronze Age and the first historical dynasty of the Xia. The ruins of these palaces all show a similar geometry, square or rectangular, oriented north-south with the main opening to the south. This layout will be preserved throughout history until the last of the great Chinese capitals erected by the Ming in 1403, the current Beijing (Beijing 北京– capital of the North) with the Forbidden City at its centre.

The main opening to the Forbidden City is the Gate of Heavenly Peace ( *Tian An Men* ) exactly to the south. Inside his palace, the Chinese emperor always sat facing south while his visitors faced north. The cosmological layout of the imperial capital was very strictly in accordance with the cardinal points. Unlike European tradition, ancient China always considered the cardinal points to be five in number, not four. To the four directions North, East, South, West, was added the Centre, a point around which the other four were organized. In Beijing, the Forbidden City symbolizes this centre of the Middle Kingdom. It is framed by four temples in the four geographical directions associated with the four seasons:

- to the east, the *Ri Tan* (日坛), the temple of the Sun dedicated to spring,
- to the south, the *Tian Tan* (天坛), the temple of Heaven dedicated to summer,
- to the west, the *Yue Tan* (月坛), the temple of the Moon dedicated to autumn
- in the North the *Di Tan* (地坛), the temple of the Earth dedicated to winter.

The three temples of the Earth, the Moon and the Sun have now become simple parks, but the Temple of Heaven has retained a preponderant importance, with in its centre the imposing circular structure of the *Qi Nian Dian* (祈年殿) , the invocation hall for good harvests, one of the most beautiful monuments of the Chinese capital. Each season, the emperor came to celebrate very specific ritual ceremonies in each of these temples.

Even today, the inhabitants of the Chinese capital traditionally meet at the Temple of the Earth on the evening of the Chinese New Year to celebrate the New year and the end of winter.

## Gonggong Mythology

*“There was a beginning.*

*There was a beginning in the beginning.*

*There was a beginning at the beginning of the beginning*

*There was being.*

*There was non-being.*

*There was what preceded non-being.*

*There was what preceded what was not yet non-being. »*

*Huai Nan Zi* , (Treatise of the Prince of Huai Nan), 2nd century BCE .

This is how Chinese thought tells the myth of creation. The description of the very first moments of the world cited here is taken from a Taoist treatise of the 2nd century BCE. Although the founding text of this Eastern philosophy, *Daodejing* (The Way and the Virtue) by Lao Zi, dates only from a few centuries before the modern era, Taoism inherits much older beliefs dating back, through the myths, to the Xia period. It inherits in particular the association of reverses, the harmonization of opposites, the complementarity of antagonistic symbols. Thus, the great Chinese cosmogonic principles invoke the opposition of the great polarities of *yin* and *yang* :

*“The dao of the sky is said to be round, that of the Earth square. The square reigns over darkness, the circle over light. The light is what expectorates the breaths; this is why it is said of fire that it is an exteriorized brilliance. Darkness is what absorbs the breaths; this is why water is said to be internalized brilliance. What expectorates breaths diffuses them, what absorbs them transforms them. It is that the yang diffuses, while the yin transforms.*

*Those of the breaths ejected by the sky which are irritated constitute the winds; those of the breaths absorbed by the earth which are temperate constitute the rain. When yin and yang overlap each other, they get excited and constitute thunder. When they surge, they constitute lightning, when disturbed, fog. When the yang breaths prevail, they dissipate to form rain and dew. When the yin breaths prevail, they coagulate to form hoarfrost and snow <sup>5</sup>.*

*Huai Nan Zi* (Treatise of the Prince of Huai Nan), 2<sup>nd</sup> CENTURY BCE

---

<sup>5</sup> *Taoist Philosophers* , Volume II. – “Huai Nan Zi”, chap. III, "Celestial Signs", p. 102-103, translation R. Mathieu, Pléiades library, NRF, Gallimard 2003.

These explanations run through all of Chinese history. They attempt to provide an interpretation of Nature and form a permanent base on which all Chinese civilization is rooted, even if other external influences will subsequently be added over the centuries.

As in most civilizations, the first Chinese astronomical knowledge is embedded in the beginning in legendary stories whose origin is lost in the mists of time. Thus the enigma of the inclination of the axis of the Earth, at the origin of the inequality of the seasons and of an incalculable number of astronomical complications, is explained by a banal cosmic accident and by the clumsiness of the unfortunate *Gonggong* :

*“Once when Gonggong fought against Zhuanxu to be made emperor, he in his anger gored Buzhou Mountain, the “Uncircular”. The celestial column smashed and the earthly mooring broke. The sky tilted to the northwest; the sun, the moon, the stars and landmarks are walled in this direction. The land was fuller to the south-east; the waters and the runoff, the ashes and the dust then converged there. »*

*Huai Nan Zi* (Treatise of the Prince of Huai Nan), 2<sup>nd</sup> CENTURY BCE

The mythological rulers of the Xia would be responsible for other crucial facts for China. The great Yu would thus have tamed the floods of the great capricious rivers that are the Yellow River (*Huang He*) and the Blue River (*Yangzi Jiang*), a crucial point for the development of China.

From these early moments in China's legendary history, astronomy occupied such a central position that the country itself would be named *Tianxia* (天下), the "land under the sky" and later the celestial empire.

## **The Heavenly Mandate**

From the emergence of political power in China, around the second millennium before the modern era, the legitimacy of power has always relied directly on the mastery of astronomical rhythms and on the control of celestial events. In no other country in the world has astronomy been as important as in China because the ruler was considered the mediator of Heaven. Its primordial and symbolic function was to keep Heaven and Earth in harmony. A crushing charge which condemned him to be responsible not only for the good order of the kingdom, but also for the good functioning of the heavens, a sign of the approval that Heaven grants to wise and virtuous rulers. Referred to as "*Tianzi* ,天子", the son of Heaven, he was in a way the intermediary between men and the cosmos. Here we find the duality specific to Chinese civilization. Sky and Earth are not separated, but united in their opposition forming an inseparable global whole over which reigns the first of the Chinese. The sovereign therefore had to speak the language of the stars to make the message from Heaven intelligible. This

peculiarity will raise the science of the sky in China to the rank of science of state and government.

Not only did Chinese astronomy provide the essential rules of the calendar very early on, but it also continually concerned itself with the state of the sky and the slightest changes that could occur there. Because in a mirror position, Heaven and Earth are the reflection of each other: any event in Heaven, even the smallest, has a consequence in the conduct of the State as important as terrestrial phenomena. Each region of the Chinese earthly empire is in direct correspondence with a particular region of the sky. Any appearance of a celestial phenomenon (conjunction of planets, eclipses, comets, new star, etc.) then has a particular significance for the corresponding terrestrial region. The Earth is in a way under the permanent gaze of the Heavens!

Although we can find here a relationship with astrology in the European sense of the term, in China the concern for divination does not freeze the heavens in constellations dedicated to deities outside earthly life. This point of view is very specific to Chinese thought. In many other cultures, Heaven is a separate space, usually the domain of the Gods. The ancient Greeks, like the philosopher Aristotle for example, had made it the domain of pure geometric perfection, that of the immutable celestial spheres. At the same time, Heaven was a rigid space, separated from man, reduced to a simple overwhelming decor. In China, on the contrary, one reads one's destiny there daily because, to paraphrase Mao Zedong, "*Heaven is the other half of the Earth*". The close correspondence between celestial phenomena and political activities, those of the elites, but also of the population in general, is perceived as a kind of global participation in a universal order. It is the conception of an "organic" cosmos, within the framework of what the sinologist Joseph Needham, designated under the name of "Chinese organicist thought": a world perceived as a whole, in which each part is in resonance with the other as illustrated by one of the most famous ancient Chinese historians:

*"The Duke Grand Astrologer said: From the time when the people first existed, was there ever a time when, from generation to generation, rulers did not observe the sun and the moon, the planets, and the stars. Then in the time of the five emperors and three dynasties, [these observations] were continued and made clear; inside, there were those who put on the cap and the belt; outside, [the barbarians] I and Ti. The Middle Kingdom was divided into twelve provinces. Raising the head, one determined the forms which are on the sky, lowering the head, one determined the forms which are on the Earth. In the sky, there is the sun and the moon; on earth there is yin and yang. In the sky, there are the five planets; on earth, there are the five elements. In heaven there are the various mansions, on earth there are the territories of the provinces... If in the whole cycle from the beginning to the end and from antiquity to modern times one has deeply observed the changes which take place at fixed epochs and if we have examined the details and the whole, then [the science] of the Governors of Heaven is complete"*

Through the interplay of mirror correspondence between Heaven and Earth, astronomy finds itself at the centre of power. To fulfill his role as "son of heaven", the emperor relies on an entire class of officials capable of monitoring and decoding celestial messages. Like the members of a modern scientific institute, they will form a large family (“*jia*”家), the officials of the signs of heaven (天文家– *Tianwenjia*), the first body of astronomers so well organized on Earth. In the imperial city, hundreds of astronomers work, trained every night to interpret all the cosmic changes. The observatory is a city within the city where everyone has their role, defined very precisely in the oldest Chinese texts:

*Feng Xiang Shi* (The Imperial Astronomer)

*“He studies the twelve years [the orbital cycle of Jupiter], the twelve months, the twelve hours and the positions of the 28 stars (xiu) [the Chinese zodiac]. He distinguishes them and orders them in order to establish the order of the heavens. He observes the Sun at the winter and summer solstice and the Moon at the spring and autumn equinoxes in order to determine the succession of the four seasons”.*

*Bao Chang Shi* (The Imperial Astrologer)

*“He examines the stars of the sky and observes the changes and movements of the planets, the Sun and the Moon in order to study the changes of the terrestrial world and to distinguish good from evil. It divides the territories of the nine regions of the empire according to their relationship with the celestial regions. All fiefdoms are related to distinct constellations and from these their prosperity or misfortune can be predicted.*

*Zhou Li, (Rites of the Zhou), 4TH AEC –*

These scientists, both astronomers and astrologers, instructed the emperor on what to do, just like today's diplomatic and military advisers. However, this privileged position is sometimes unenviable. All Chinese astronomers knew the terrible fate of the oldest of their predecessors, Xi and He, who under the Xia dynasty had gotten a little confused in their calculations for the prediction of an eclipse:

*“Hi (Xi) and Ho (He) are disordered in their conduct...they have grossly mistaken the celestial phenomena, and have deserved the death penalty decreed by the ancient rulers. In the laws of the government, it is said: “he who precedes the time, will be put to death without remission; whoever does not arrive in time will be put to death without remission”*

*Shu Jing* (书经- Classic of Documents), VII ° AEC

The astronomer in China certainly had an envied position but also a very perilous one! The Ministry of Astronomy was then as important as the Ministry of War, and sky maps were as valuable as maps of the General Staff. Astronomers were therefore most often subject to absolute secrecy. At the end of one of the greatest dynasties, the Tang, marked by tumultuous conflicts between the emperor and his eunuchs, an edict stated:

*“If it should come to our knowledge that astronomical officials, or their subordinates, entertained relations with officials of any other government department, or the common people, it would be considered by us as a violation of the security regulations to which we must adhere rigidly. Consequently, the astronomical functionaries have the duty not to mix under any pretext with the civil servants and, in general, with the common people. Let the censor do its due diligence. »*

*Tang Shu (Book of Tang) – 9<sup>th</sup> century CE*

Unlike ancient Greece, where the observation of the sky is reserved for a handful of isolated philosophers and quickly without heirs, in China it is the concern of the greatest minds and of society as a whole. For more than 4,000 years and without interruption, the various dynasties of emperors perpetuated this activity, thus building an authentic astronomical civilization. The first European observers, the Jesuits, were dumbfounded by this intense activity. The Frenchman Louis Lecomte, who visited the observatory of the Ming dynasty in Beijing in 1698, testified amazed at what he saw:

*“Five mathematicians spend all their nights on the tower (of the observatory) observing what is happening in the sky; the first fixes the zenith, the second looks towards the east, the third towards the west, the fourth towards the south and the fifth towards the north, so that nothing that happens in the four corners of the world can escape them. With extreme vigilance, they take note of the winds, the rain, the air, unusual phenomena such as eclipses or the oppositions and conjunctions of the planets, fires, meteors and anything else that may be useful. In the morning, they make a very exact account of all these phenomena and take it to the superintendent of mathematics who transcribes it in his registers.*

*New memoirs on the present state of China, L. Lecomte (1696).*

He did not know, moreover, that these observations had not been interrupted for more than forty centuries!

### **Taosi Observatory (–2100) – China's Stonehenge**

Among the oldest remains of ancient Chinese capitals, the site of Taosi, northeast of the city of Xianfen ( *Shanxi* ), has particularly caught the attention of researchers. Archaeological excavations carried out since the end of the 1970s had already uncovered nine tombs of sovereigns or high figures, filled with various ritual



objects in ceramics, stone, jade and wood. In 2001, research led to the discovery of a gigantic rectangular enclosure, built in earth and delimiting an area of more than 280 hectares. Distant ancestor of the Great Wall, it is the longest enclosure of this type in Chinese prehistory. The entire site contains more than a thousand tombs of different sizes and several objects which have demonstrated that it was inhabited during the period (–2300 to –2000). It most certainly represents the capital of one of the first Chinese "kingdoms", probably that of the legendary King Yao, whose existence was hitherto only reported by later texts.

In 2004, archaeologists discovered in the southern part of the site, under a thick layer of earth, a vast stone platform in the shape of a semicircle 60 m in diameter. It is the oldest astronomical observatory currently known in China. In the centre is delimited an observation point, a depression 25 cm in diameter, and along the outside perimeter, twelve notches in the ground, rectangular or trapezoidal in shape, were most probably occupied by wooden or stone posts serving as alignment marks. The orientations noted indicate that the observatory was used primarily to measure the direction of sunrise, particularly at the winter solstice, which formerly marked the beginning of the Chinese year. The orientation of the winter solstice is compatible with that which could have been observed around the year -2020 approximately. The alignments with the sunrise made it possible to measure the length of the year and the seasons, thus fixing the regularity of the calendar. Just like Stonehenge, the famous circle of megaliths located in the North West of England and dating from approximately the same period, the exact astronomical use remains nevertheless difficult to specify.

Controlling the rhythms of Nature, fixing with precision the length of the year and the seasons, represented an absolute priority for the first agricultural societies, because planting at the wrong time was synonymous with an insufficient harvest often leading to deadly famine. The Chinese sovereign therefore had to ensure exact control of the calendar. According to legend, it was the ruler Yao who first hired astronomers to observe the passage of the stars and thus regulate the first lunisolar calendar with a year of 366 days (see Chap.4, BOX "The Chinese calendar", p. **Erreur ! Signet non défini.**)

### **BOX: The Celestial Tiger and Dragon – The vision of Heaven under the Xia**

The archaeological discovery of the Puyang tomb in Henan in 1988 confirmed the importance of representations of Heaven since the earliest history of Chinese civilization. Dated to around 2500 BCE, Tomb 45 at the Xishuipo site contained four human skeletons. The central body was surrounded by three designs made using shells and carefully arranged, representing a dragon to the east, a tiger to the west and what could represent the great constellation *Beidou* (the Big Dipper) to the north. It is the oldest known representation of the traditional description of the sky in China, which then lasted for more than 4,000 years. It divides the celestial vault into five regions according to the Chinese cardinal points by associating them with mythical animals and colours according to the theory of the five elements: in the centre the region of the pole attributed to the yellow Unicorn, to the east the Blue-green Dragon, to the west the White Tiger, to the north the Black Tortoise, to the south the Red Bird (see Chap. 4, BOX "The Five Elements theory, p. **Erreur ! Signet non défini.**) .