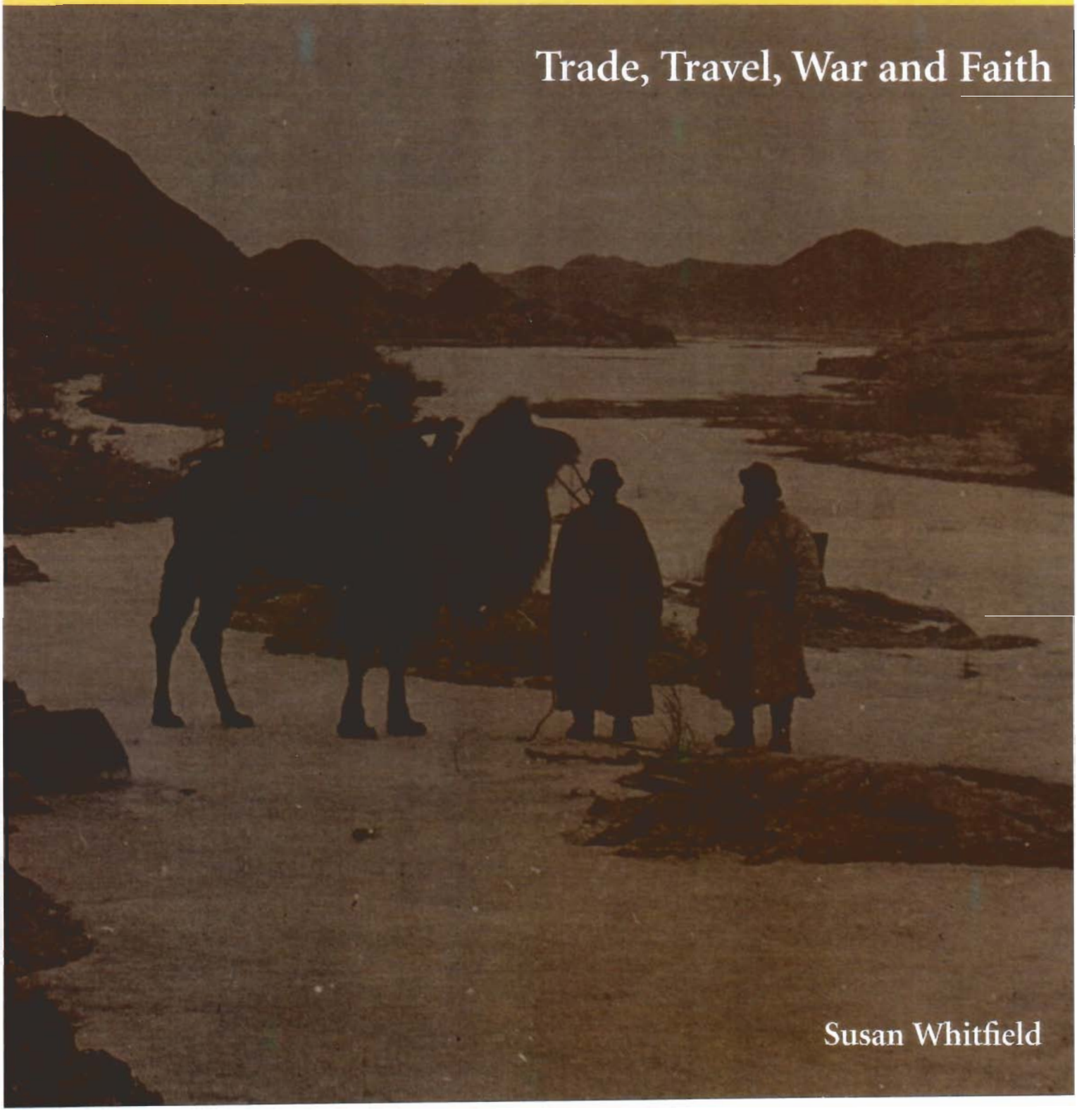
THE SILK ROAD

Trade, Travel, War and Faith



Susan Whitfield

"The Silk Road, Trade, Travel, War and Faith", ed. S. Whitfield, The British Library, 2004

Star Charts on the Silk Road:

Astronomical Star Maps in Ancient China

JEAN-MARC BONNET-BIDAUD
AND FRANÇOISE PRADERIE

Astronomy – with medicine – is probably the oldest human science. From the beginning of human life, men and women were confronted daily with the enigmatic view of the sky and they examined the stars to provide some answer to the meaning of their existence. This is certainly true today, when the most sophisticated instruments such as space telescopes peer into the universe, but it was even more true thousands of years ago. At that time astronomy was highly valued and critical knowledge. For the peasants, an ignorance of the basic laws of astronomy which determined the regularity of the seasons meant death: failing to match the planting of the seeds to the natural cycle of the seasons would inevitably result in famine and desolation. In the same way, for travellers on land or at sea, the inability to recognize the basic pattern of the stars caused shipwrecks and wanderings and also led to loss of life.

Astronomical knowledge was therefore always vital information. It is not surprising to find astronomical documents among the thousands of manuscripts uncovered in the Library Cave of Dunhuang on the Silk Road. The real surprise is however to find there one of the most valuable treasures of astronomy, the world's earliest manuscript map of the stars known today from any civilization. This spectacular document, entitled 'Treatise on heavenly bodies and meteors' and registered under the number Or.8210/S.3326 in the Stein Collection of the British Library (cat. 161), is an exquisite and complete representation of the Chinese sky. Together with two other major documents – a fragment of a circumpolar map and an astrological compilation of the Chinese constellations – also found in Dunhuang, it also provides a fascinating view of astronomical knowledge in ancient China.

Ancient Chinese astronomy: a pure political science

While in most other parts of the world, particularly in the Mediterranean region, the Heaven was the domain of gods and divinities dominating the world of human beings, the sky in China was always understood as part of the human world – to paraphrase a famous Mao Zedong sentence (taken from classical sources), 'the sky is the other half of the Earth' – and there was the unique preoccupation that sky and earth should be always kept in perfect harmony. In the Chinese tradition, as early as the first texts available (dating from before the fifth century BC), the sky was indeed a pure mirror of the human world. Each part of the sky was subdivided to correspond to the different regions of the terrestrial empire and omens were carefully examined to decide if celestial events were in agreement with terrestrial matters. In this sense, ancient Chinese astronomy can be considered a pure political science. It was a means of ruling the state and the emperors of successive Chinese dynasties maintained armies of astronomers to detect, examine and interpret all celestial changes. No state action could be undertaken without questioning the omens. Ancient scientists, both

astronomers and astrologers, had the same importance as diplomatic and military counsellors today. The heavy duty and the strategic importance of their task is illustrated by the precept stated in an apocryphal chapter of the 'Classic of History' (*Shujing*), dating from at least the second century BC, where the sad story of the two astronomers Xi and He failing to predict an eclipse is related:

> Hsi [Xi] and Ho [He] ... stupidly went astray (from their duties) in the matter of the heavenly appearances and rendered themselves liable to death appointed by the former kings. The statutes of government say, 'When they anticipate the time, let them be put to death without mercy; when (their reckoning) is behind time, let them be put to death without mercy.[1]

This was sometimes the price paid by ancient astronomers.

Over the centuries this constant celestial preoccupation within the relatively stable structure of the Chinese empire contributed to build an original science with no counterpart in the rest of the world. This pragmatic attitude led to important discoveries as demonstrated by the reference work of Needham.[2] Not only eclipses but comets, sunspots, novae and supernovae were first discovered and fully documented by the ancient Chinese astronomers, in fact so precisely that their ancient texts are sometimes used nowadays, in modern astronomy, to constrain and understand better the nature of these different phenomena.

Chinese astronomical science was based on a methodical and precise description of the sky, an essential condition for the precise positioning of unexpected phenomena.

The Chinese sky

The Chinese sky is intimately linked to the symbolism of the Middle Kingdom and has nothing in common with the West European description of Greek origin. It is divided into five great regions or palaces (*Wu Gong* 五宮), corresponding traditionally to the five Chinese cardinal points, East, North, West, South and Middle. The fifth cardinal point, Middle, is the most important one and corresponds to the circumpolar region which harbours the celestial image of the emperor, *Tian Zi* 天子, symbolized by the pole star, and surrounded by the different dignitaries of the court. Encircling them, the imperial palace (now called 'the Forbidden City' and also designated as the Purple Enclosure *Zi Wei* 紫微) is also marked by stars, including the surrounding external walls. This part of the sky, spangled with constellations such as 'the prince', 'the concubine' or 'the throne', is a lively illustration of the celestial mirror of the earth life. In the rest of the sky, the four other palaces group the equatorial constellations into the four usual geographical directions, also associated with an animal and a colour: East being the Blue Dragon, North, the Black Turtle, West, the White Tiger, South, the Red Bird.

The most important Chinese constellations are distributed in these four palaces, very approximately along the celestial equator. These are the twenty-eight *xiu* 宿 – translated as 'mansions' or 'lunar lodges'. Their origin is still an enigma and their relation to the moon is not documented. However, these constellations are constantly used throughout Chinese history as precise markers of the positions of heavenly bodies during the seasons. They are sometimes considered as an equatorial Chinese zodiac.

The grouping of the stars in China is also totally different from the Greek tradition. Instead of a relatively small number of large constellations based on mythological figures (forty-nine constellations are listed by the Greek astronomer Ptolemy (AD 150) and only eighty-eight are used today in modern astronomy for the whole sky), the stars in the Chinese tradition are associated in numerous asterisms (nearly 300), sometimes involving only one star, most of them referring to practical objects or persons. This very fine and detailed carving up of the sky was probably dictated by the need to provide accurate positions when precise coordinates were not available. The small size of most asterisms enables an event to be located with relative accuracy when only the name of the asterism is given. In the celestial rotation of the sky, these numerous celestial 'landmarks' were then also an appropriate measure of time and position.

The earliest catalogues

Lists of the Chinese constellations were maintained all through Chinese history and did not change much over time. The great divisions of the Chinese sky are transmitted to us by numerous ancient texts preceding the Dunhuang epoch. Unfortunately, many of the most precious texts were lost during the infamous 'burning of the books', ordered in 213 BC by the first Chinese emperor, Qin Shihuangdi. Happily, the Han-dynasty (206 BC–AD 220) historian, Sima Qian 司馬遷 (?145–86 BC), who tried to collect the missing information following this event, was also an astronomer. His *Historical Records* (*Shiji*),[3] considered the first historical encyclopaedic work in China, included a chapter entitled 'Book of Celestial Officials ('Tian Guan Shu' 天官書) devoted in its first part to a complete description of the Five Palaces. The text gives a detailed enumeration of the names of the different asterisms and stars with their relative locations in the sky, but with no mention of their relative brightness.

At the end of this fundamental work, dated 91 BC, one also finds the origin of the Chinese uranography as told by Sima Qian. According to him, the nomenclature and the first catalogues were created by different astronomers before and during the Warring States period (476–221 BC). Among them, the most important were Shi Shen 石申 of the state of Wei 魏, Gan De 甘德 of the state of Qi 齊 and Wu Xian 巫咸,[4] the last being of uncertain origin and date. These three ancient astronomers produced reference books describing heaven, the movement of the sun, moon and planets and the repartition of the stars with the different astrological predictions associated with them.[5]

None of these original texts has survived but numerous other ancient texts, such as the *Huainanzi*, a philosophical treatise presented to the emperor in 139 BC, independently corroborates the information contained in the *Shiji*. Though Sima Qian himself does not differentiate information from the three schools of astronomers, three distinct catalogues were maintained through the Han period and later combined by the astronomer Chen Zhuo 陳卓 (220–80). The tradition of attributing each asterism to a different school survived because of the demands of astrological prediction. The Chen Zhuo catalogue is lost but it is said to have contained a total of 1,464 stars separated into 284 constellations. The most complete and detailed description of the Chinese sky, including positions, given by coordinates in degrees, is later found in the *Astrological Treatise of the Kaiyuan Period* (*Kaiyuan Zhanjing*), a compilation attributed to the astronomer Qutan Xida 瞿曇悉達 in 729. Part of this information is also present in the astronomical chapters of the *History of the Jin* (*Jinshu*) and of the Sui (*Suishu*), both probably written by Li Chunfeng 李淳風 (602–70).[6]

The long tradition in China of searching the sky for celestial omens had therefore led to an early and unsurpassed precision in star catalogues. The first lists of stars were obviously available in China at least two centuries before the first Greek catalogue of Hipparchus (134 BC) and were continuously improved throughout the western Middle Ages. The precise location of each star with respect to the others in later catalogues evidently enabled the Chinese to make a star chart relatively early in their history. In fact, Chen Zhuo is said to have produced such a map[7] but no example dating from this period is extant. The Dunhuang manuscript Or.8210/S.3326 is therefore the earliest known star chart.

The Dunhuang charts

The discovery of a star chart among the Dunhuang manuscripts came as a surprise since a chart from such an early period had never been found previously in any civilization. The exceptional document is registered as Or.8210/S.3326 (S. for Stein), from the name of its discoverer, Aurel Stein, who first saw it in 1907 and selected it from among the manuscripts that were brought back by him to the British Museum, probably for its very spectacular aesthetic appearance. To our knowledge, the first mention of this chart in an astronomical context was made by Needham in 1959, in his book *Science and Civilisation in China*.[8] Surprisingly, since that time, it has been rather neglected. Though it has been used as an illustration in many works,[9] only very few publications have been devoted to it, all being in Chinese.[10] An extensive interpretation and scientific evaluation is in progress by the authors of this essay.

A complete view of the sky

The chart itself is 210 cm long by 24.4 cm wide and comprises the end part of the Or.8210/S.3326 scroll. The scroll is in good condition, except for small missing sections at the beginning and end. It is made of thin fine paper. It was completely lined with a thick paper after renovation work at the British Museum in the 1920s.

The first part of the document is a collection of predictions concerning the shape of the clouds and vapours and is composed of twenty-five drawings associated with sixty-two complete columns of explanatory text. The star chart itself continues from this and is composed of thirteen separate panels. The first twelve correspond to the complete coverage of the sky by zones centred on the equator extending on about 30 degrees in the west–east direction. The panels cover a zone of +40° to −40° in declination. Each vertical panel comes with its explanatory text in one or two columns to the left. The thirteenth and last panel is a circular chart of the North Pole region without accompanying text. The scroll ends with the drawing of an archer shooting an arrow.

The first impressive feature of this document is its comprehensiveness. Altogether, 1,345 stars are present on the maps, grouped in 257 asterisms. The stars are represented by different dots of similar sizes, either black or white circled black with some dots coloured in light red. The asterisms are materialized by black lines joining the dots and different annotations on the maps give the names of the main asterisms. This makes easy the comparison with other catalogues and we were able to identify all asterisms except a very few (fifteen),[11] with the available nomenclature derived from ancient catalogues.[12] In concrete terms, the Dunhuang map is the first known graphical representation of these different Chinese lists of stars whose antiquity and completeness have sometimes been questioned. The symbols used for the stars can be divided into three different groups, black, white and red and this is the first representation of the 'Three Schools' astronomical tradition of *Shi Shen Shi*, *Gan De Shi* and *Wu Xian Shi* as discussed above. Traditionally Gan De is associated with black, Shi Shen with red and Wu Xian with white and later yellow in the Tang dynasty (618–907).[13] The Or.8210/S.3326 chart mostly conforms to the tradition for Gan De but there are many inversions for the two other catalogues. We do not know the exact reason for this but it may mean that the latter catalogues were already beginning to merge.

All the classical twenty-eight Chinese *xiu* can be recognized on the Dunhuang maps, together with their leading stars, except for one *xiu* which is displayed only with its name (*wei* 胃 or belly). Also visible are the three main 'enclosures' or 'wall-systems' of stars, called *yuan* 垣 which look like city walls encircling areas of stars. There are no coordinates on these maps nor graphic representation of the equator or of the ecliptic but they are clearly hour-angle maps, with the northern celestial hemisphere in the upper half and the southern in the lower half of each panel. The maps do not overlap in general, except for one asterism (*shao wei* 少微) which shows up on two successive maps.

Figs. 1a, 2 and 3 show representative parts of the complete star map with the panels corresponding to the fourth (Orion constellation) and eighth lunar month (Bootes constellation) and the circumpolar section.

Fig. 1a Chart of the fourth month (region of Orion) from Or.8210/S.3326.

North is up, East is left and West is right. The map extends in declination from about 40° to – 40°. The map displays inter alia *Shen* and *Shenqi* (Orion) in the centre of the figure, with Betelgeuse (α Orionis) and Rigel (β Orionis). Asterisms *Wuche and Sanzhu* (Auriga or the Charioteer) are in the upper part, including the bright star Capella (α Aurigae).

The star *Yeji* (β Canis Majoris) is located too far north on the Dunhuang map, in the middle of a circle of red stars on the left.

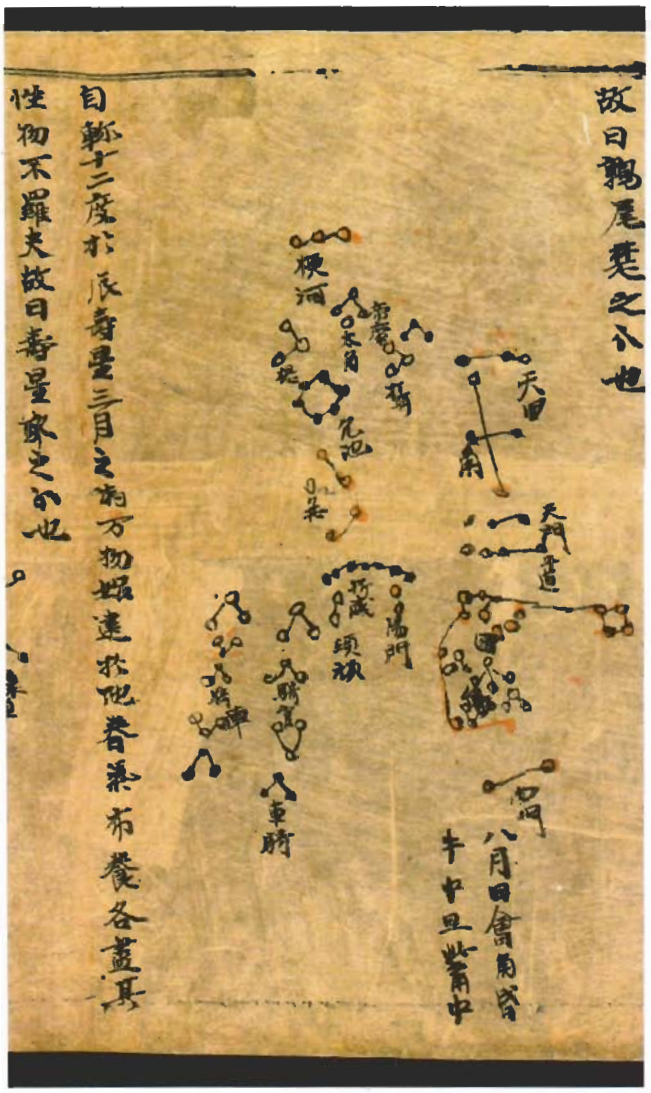
The British Library, Or.8210/S.3326 (detail)

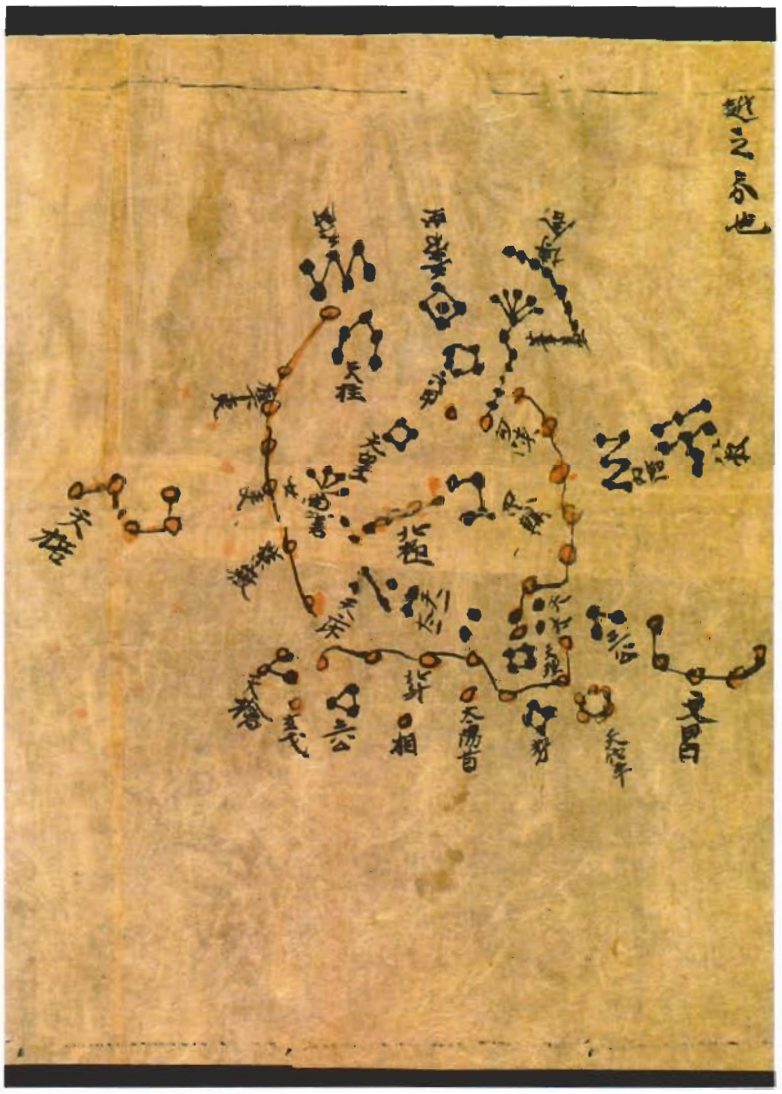
Fig. 1b A modern map computed for the date of 652 and plotted in a Mercator projection.

Courtesy of O. Hodasava

An accurate scientific document

The respective positions of the stars are in general quite accurate for a document drawn by hand. The whole document is exceptionally well preserved and it is clear that the author has taken a great deal of care in drawing the asterisms and the texts. Only one or two blots are visible and very few characters are badly formed. The relative positions of the asterisms are also quite correct with only a few errors. Most are identified with their Chinese name written on the map, which consolidates our identification in modern terminology. A complete evaluation by an exact comparison with modern positions is presently being undertaken but the relative accuracy is impressive, given the general abilities at this period. The overall quality of the document clearly demonstrates a mature technique so the chart was most probably produced as a copy of an earlier existing document. The absence of a visible grid, necessary to position the stars correctly, seems to confirm the hypothesis of a copy.





The document could have been derived from an original chart produced by the astronomer Chen Zhuo but also alternatively by Qian Lezhi 錢樂之 (fl. 435), who is known from some ancient texts to have produced a map with 1,464 stars and 284 constellations,[14] numbers close to those of the Or.8210/S.3326 manuscript.

One may ask why the first star chart seems to appear so late after the catalogues. The main difficulty of translating a catalogue into a chart is in fact the choice of a projection method which converts a sphere into a plane, reducing the three dimensions into two. A freehand drawing based on a direct vision will be highly distorted since the eyes see only a limited portion of the sky at a time. The only way is to use a systematic method to reproduce the relative positions of the whole sky. An analysis is underway to define the projection method used in Or.8210/S.3326 but it appears to be very close to a Mercator-style projection in which the sphere is projected onto a cylinder, as demonstrated by a comparison with a modern

Fig. 2 Chart of the eighth month (region of Bootes) from Or.8210/S.3326.

North is up, East is left and West is right. The chart displays inter alia the asterism *Jiao* with Spica (α Virginis) as the southern star in the group, and in the upper part, but grouped in a way which is totally unfamiliar to modern eyes, asterisms which altogether form the constellation Bootes with *Dajiao* (Arcturus, α Bootis) as the brightest star.

The British Library, Or.8210/S.3326 (detail)

Fig. 3 North circumpolar region map from Or.8210/S.3326.

This map is specially rich in stars. The polar star which symbolizes the celestial emperor is not drawn, as is the general case. The *Ziwei yuan* (Celestial Purple Palace) is the imperial palace displayed by two chains of red-drawn stars on the left and right of the chart and encloses the most northern stars. *Beidou* (the Northern Dipper or in modern terms the Great Bear) is easily seen at the bottom part of the chart (in red also). The not completely closed square of black stars near the centre is the asterism *Sifu* 四輔, four stars surrounding the North Pole.

The British Library, Or.8210/S.3326 (detail)

reconstruction (Fig. 1b). In this way, the general proportions are kept exact along the equator at the expense of large distortions near the pole. For this reason, the polar region is drawn separately. The composition of the Or.8210/S.3326 chart and its presentation are in fact extremely modern. They are similar in all points to our most modern geographical maps of the earth.

An astronomical almanac

The texts accompanying the charts contribute important complementary information. They give in a concise way the relation of each part of the static sky with the motion of the sun through the different epochs of the year. On the chart itself, annotations are written on all panels (except for three of them for which the notes are missing) to indicate the lunar month, the position of the sun and the culminating constellations at dusk and dawn, with respect to the different mansions (see Figs. 1 and 2).

Each panel text is repetitive and typically uses the same terms as the following example:

四月日會畢嘴昏翌中旦女中

The fourth (lunar) month, the Sun meets the mansions 'Bi' and 'Zui', at dusk the mansion 'Yi' culminates, at dawn the mansion 'Nü' culminates. (see Fig. 1a bottom middle).

Curiously, the information quoted here is extremely similar in style and content to the notations given in a much earlier astronomical text, the *Monthly Ordinances* (*Yue Ling*), dated approximately 300 BC. This is a direct indication that the charts are based on traditional texts and that they are possibly a reproduction of a much earlier version.

An explanatory text in columns associated with each of the first twelve panels of the chart describes with great accuracy the twelve divisions of the Chinese year and the attendant symbolism. A full explanation of Chinese calendrical science is beyond the scope of this essay but, in brief, the Chinese calendar is lunar-solar, with the months measured by the Moon and the year by the Sun. As in such a calendar, one year (365.25 days) contains slightly more than twelve lunar months (~29.5 days), an intercalary month is added every few years to keep the stability. To eliminate these variations, the Chinese tradition has defined a fixed division of the year in twelve parts which are called 'terrestrial branches' *dizhi* 地支 and are also related to the twelve 'stations' *ci* 次 of the planet Jupiter (according to its nearly twelve-year sidereal period). The text on the charts gives a full account on these correspondences for each month. For the eighth month, one reads (Fig. 2):

自軫十二度於辰, 壽星。三月之時, 万物始建於地,
眷氣布施, 各盡其性, 物不羅夫, 故曰壽星。鄭之分也。

From degree twelve of xiu '*Zhen*' one is at '*Chen*' (a terrestrial branch). This is '*Shouxing*' (a Jupiter station). At the third (lunar) month, the ten thousand living beings settle on Earth, the spring breaths spread and feed them... This is why it is called '*Shouxing*', the long life star. This is the part (of the country) of 'Zheng'.

The chart is also therefore a complete calendar tool describing the twelve divisions of the year in a concise and accurate way with a scientific notation in degrees revealing the precision reached by this period.

Dating the chart

Contrary to some other Dunhuang documents where a mention of a precise date is present or can be derived from the content of the document, as in calendars for instance, such a reference is not available for the Or.8210/S.3326 chart. The document was obviously meant to be used over a large interval of time. The importance of the chart has led several authors to conjecture about the exact date of the document. Needham quoted a date of 940 without giving any details and we have been unable to find the origin of this information.[15] More recent works by Chinese scholars like Ma Shichang[16] have considered the entire Or.8210/S.3326 document in which the charts are embedded and particularly the first section devoted to the cloud divination belonging to the category of *weishu* 緯書 (apocryphal texts from the Han dynasty),[17] namely literature with esoteric explanations. From arguments based on the style of clothing worn by the archer at the very end of the document, the style of writing and the taboo characters in the text, this author dates the document from 705–10. Deng Wenkuan and Liu Lexian[18] also recognized, in the divination text of the first section, the important phrase 'according to your servant Chunfeng' 臣淳風言 which can be interpreted as the signature of Li Chunfeng (602–70), author of the astronomical chapters in the *Jinshu* and *Suishu*.

The sky charts might thus well originate from the very early Tang period. To obtain or confirm this age with some accuracy, a dating by means of radioactive carbon (C^{14}) using the modern method of the particles accelerators is being considered.

Other astronomical documents in Dunhuang

The Or.8210/S.3326 star chart is by far the most impressive astronomical document among the Dunhuang manuscripts but not the only one. A number of other documents in Dunhuang have astronomical interest. In general they are calendars and divination or astrological texts with predictions according to atmospheric (winds, clouds, haloes, meteors, etc.) and astronomical (eclipse, occultations, planets, etc.) phenomena. Apart from these, only two other extant manuscripts have information comparable to Or.8210/S.3326.

The first is another similar star chart but showing only the circumpolar region, the Ziwei enclosure (*Ziwei yuan* 紫微垣) (Fig. 4).

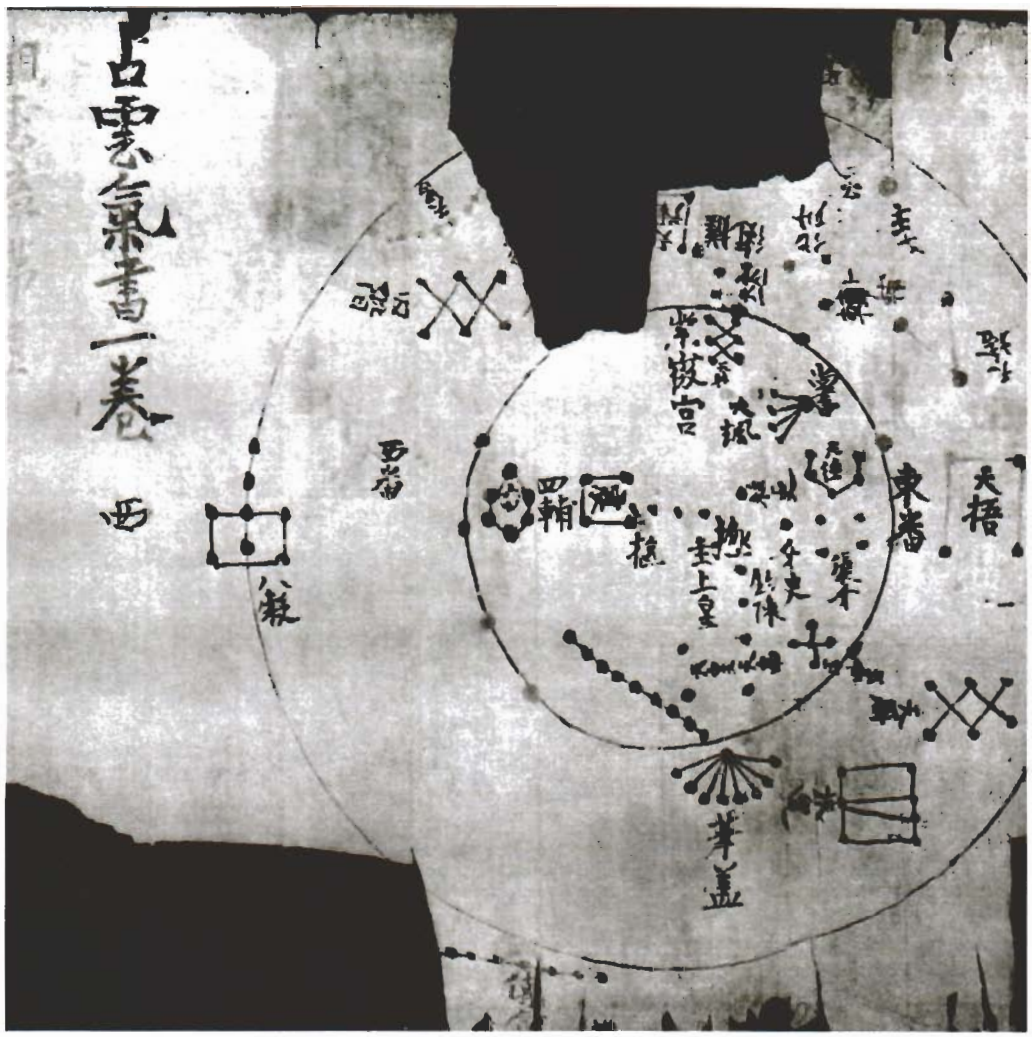


Fig. 4 North circumpolar region from a map in the Dunhuang County Museum.

Also found in Dunhuang caves, this map is more schematic than the Or.8210/S.3326 document. It is rotated by 180° with respect to the same region in Or.8210/S.3326. *Beidou* (the Northern Dipper) is located in the torn zone to the top, thus hardly visible. In the inner circle, left, a non-completely closed black square is the asterism *Sifu*.

By courtesy of the Dunhuang County Museum.

The document is labelled 'A Book of divination by clouds and vapours' (占雲氣書).[19] It is very probably a part of a complete sky map like Or.8210/S.3326 but a large portion has been lost. It is said to be drawn on the recto of a Tang geographical map. The general appearance is similar to Or.8210/S.3326 but with noticeable differences. The stars are distinguished by the use of the only two colours, red and black, and the polar region is shown inside two concentric circles of radius 13 cm and 26 cm for a total size of 31 cm. The document is now kept in Dunhuang County Museum.

The second is the manuscript registered as P.2512 and is kept at the Bibliothèque nationale de France in Paris. It has several sections, including a list of the *xiu* and a catalogue of stars. It comprises only text without drawing. The section labelled 'Treaty of stars according to the three schools of Master Shi, Master Gan, Master Wu Xian' 石氏甘氏巫咸氏三家星經 includes the complete lists of stars of the ancient astronomers Shi Shen, Gan De and Wu Xian. This manuscript has been studied first by Maspero and later by Deng Wenkuan and Liu Lexian.[20] The stars and constellations described there are globally the same as those drawn in Or.8210/S.3326, since the source seems to be the same.

The use of the star map

As we have seen, astronomy in China was considered an important affair of state and the distribution of astronomical documents was certainly strictly controlled.[21] Some of the Dunhuang documents, for example, can be considered as astrological handbooks intended for military use, and are thus very sensitive.[22] This might explain why very few copies of charts similar to Or.8210/S.3326 are found today. The star charts however have a much wider use and their presence in the large library built up in Dunhuang is by no means surprising. There is no indication that Dunhuang was the place where the astronomical observations were actually made. Most probably, they were conducted from places at or near the Chinese capitals, rather than from a remote place on the Silk Road such as Dunhuang. The document could have been brought there by a traveller or an official. The observations on which the charts are based extend from the Northern Pole to declination around 40 degrees South, indicating that they may have been obtained from

Chang'an (Xian) or Luoyang, both capitals under many dynasties during this period. Noticeably, the Or.8210/S.3326 charts record the presence of *Laoren* (α Carinae-Canopus), which is a much more southerly star than all the others displayed, and hardly observable from Chang'an or Luoyang. On the map corresponding to the fifth lunar month, *Laoren* 老人 is misplaced towards the north, closer to the equator than it is in reality. Despite its southern position, the star is however also included in the '*Tianguan shu*' by Sima Qian who indicates it symmetrically about *Tian Lang* 天狼 (Sirius) as 'a big star called "the old man of the south pole (*Nan ji lao ren*

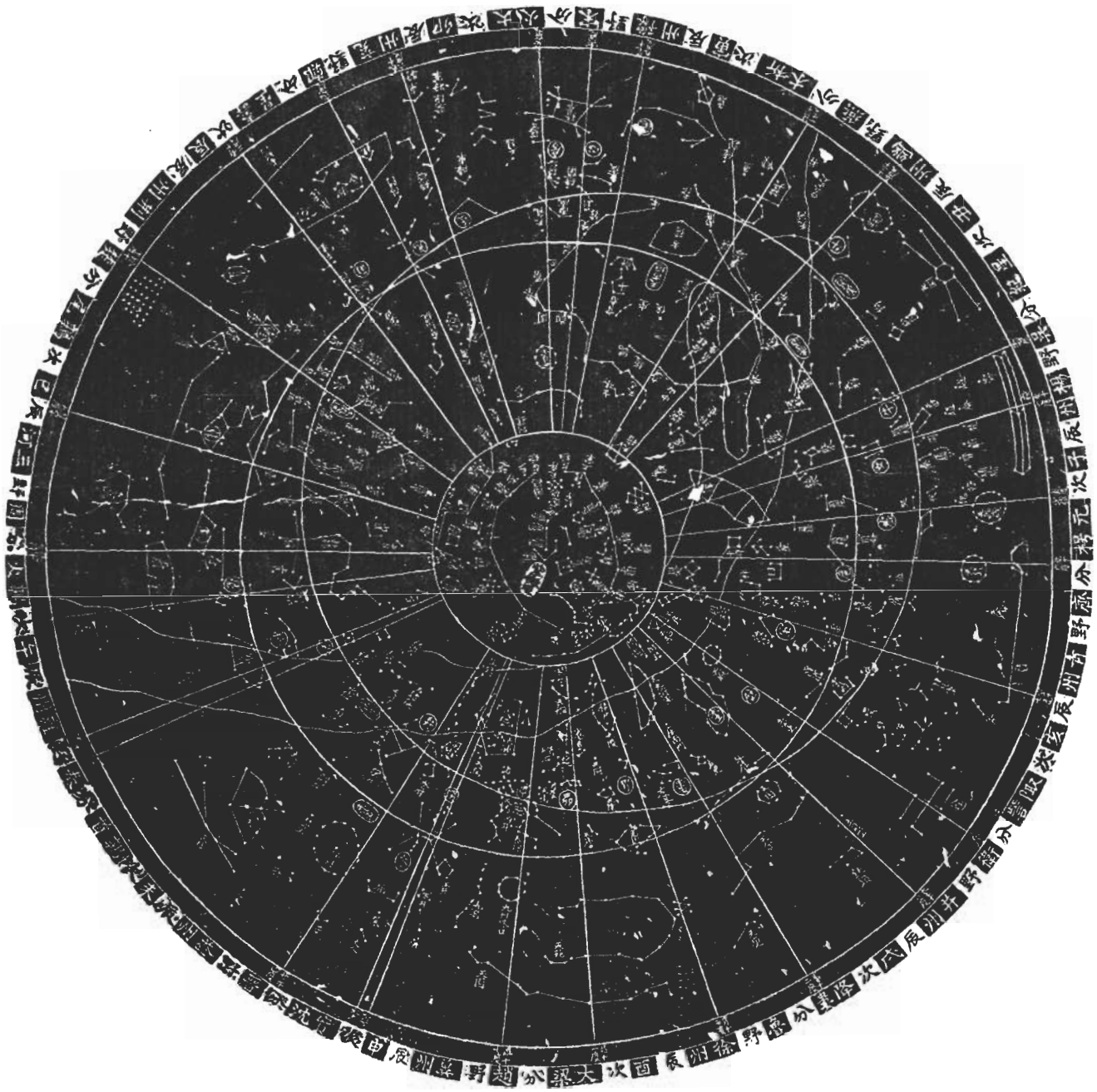


Fig. 5 The Suzhou planisphere.

This stone engraved representation of the sky is accompanied by a notice written for the instruction of a future emperor (notice not shown here). Composed around 1193 (Song dynasty), and transfered to stone in 1247, it is more complete than the Dunhuang maps. It shows radial grids corresponding to the Chinese lunar mansions, an inner circumpolar circle, the equator, and an outer circle beyond which stars are no more visible from the observation place. All these circles are centered on the pole. One also notes the ecliptic, which cuts the equator at the equinoxial points, and the Milky Way in the form of double lines crossing from the bottom of the figure around the circumpolar circle and then to the left.

By courtesy of the Wen Miao temple, Suzhou.

南極老人)'". If the charts are more recent than Li Chunfeng the possibility exists that the observations were made by Yi Xing 一行 (683–727), a Tang astronomer who re-measured the positions of many stars in the Chen Zhuo list and travelled south to Hanoi (Vietnam), where α Carinae is observable.

A European comparison

One will never know who really drew the first map of the sky. It may well have been one of the early Greek astronomers such as Hipparchus or Ptolemy but it is at least equally likely and perhaps even more probable that it was a Chinese astronomer. The Greeks had only a theoretical and mythological interest in the heavens and they concentrated their attention on the ecliptic band where sun and planets circulate. For them, the universe of stars was the last of the celestial spheres, perfect and unchanged. On the other hand, the Chinese had behind them a plethora of observations and numerous notes on the dispositions of the heavenly bodies with respect to the equator, accumulated over centuries. With a constant preoccupation to detect and locate any unexpected changes, the urgent need for a precise map was obvious.

Why is the oldest available map found in China? On this matter, one can be more positive. Needham summed it up in a brief phrase: 'everything that exists in China is either lost or printed': in other words, there was large-scale document production in China from an early period. If charts also existed in European antiquity they had less chance to survive because of a comparative lack of such large-scale document production. The invention in China of both paper and printing gave them a definitive advantage and the dry climate of the Silk Road and lucky circumstances tipped the balance. The early production of the Dunhuang charts was later continued and greatly improved in China. Perhaps the most famous planisphere is the one engraved on stone, still exposed in the Wen Miao temple at Suzhou (Jiangsu). It was drawn in 1193 and transferred to stone in 1247.[23] This celestial planisphere, called *Suzhou Tian Wen Tu* 蘇州天文圖, contains more than 1,565 stars[24] in a precise circular map with a polar projection (see Fig. 5). Recent archaeological findings have revealed different earlier star drawings, also engraved on stone but none of them are comparable in accuracy and completeness with the Dunhuang manuscripts. A drawing with stars and the Milky Way was discovered in 1973 on the ceiling of a Luoyang tomb dated 526 and two 1.9 m circular stone maps showing only the *xiu* and the pole star, were unearthed in 1965 from a tomb near Hangzhou (Zhejiang), dated from 941.[25] All these additional discoveries attest to the high level reached by Chinese observational astronomy in the Middle Ages.

By contrast, the same period in Europe is marked by a major stagnation, mostly dictated by the Aristotelian concept of a pure and perfect sky which made the observations of stars useless. Though celestial maps and globes are attributed to Greek astronomers, like Eudoxus of Cnidus, a contemporary of Plato, the oldest surviving globe, the famous Farnese atlas, dates from the second century AD and shows only very pictorial and poetic pictures of the Greek mythology without any mention or relation to the stars.[26] In the same way, a Carolingian manuscript (dated 818), drawn according to Aratus, and sometimes referred to as the earliest European star chart, shows only naïve drawings of a few constellation figures, without stars.[27] The flag of observational astronomy was later taken back by the Islamic astronomers. The great Persian astronomer, Al-Sufi (903–86) was probably responsible for the first accurately drawn star chart in the Western world. Based on the Ptolemy 'Almagest' catalogue, his *Book of Fixed Stars* was illustrated with pictures of each constellation including the brightest stars represented by dots. Unfortunately, no contemporary documents survived and the earliest extant copies are from the twelfth century. The tradition of representing the sky finally came to Europe during the early Renaissance. The oldest true star map in Europe is probably the Vienna manuscript (*c.*1440) which contains the main northern constellations with a limited number of stars, plotted in a polar projection from the ecliptic pole.[28]

Conclusions

The Or.8210/S.3326 atlas of sky maps is a marvellous testimony to ancient Chinese astronomy through its graphic quality as much as through its natural content. It includes the stars visible to the naked eye from central China, and although magnitudes are not indicated, the observers who produced the observational matrix of these charts were equally attentive to faint stars and to brighter ones. The absence on this chart of exceptional rare events such as novae or comets does not help the dating but consolidates the fact that the map was used as a standard reference material. Its most probable date makes it a remarkable document from the early Tang period (618–750). However the origin of its manufacture and its real use remain unknown. One can conjecture that it was used for military and travellers' needs, and probably also for uranomancy as suggested by the cloud divination texts preceding the charts.

It is obviously the spectacular outcome of a very long astronomical tradition of observations and catalogues. This chart supersedes all other ancient Chinese available sky maps until the eleventh century, maps which are all incomplete and more decorative than astronomically precise. It summarizes the knowledge accumulated during centuries of constant observations by means of instruments such as armillary spheres, which were more developed than in the Western world.

The authors acknowledge scholarly suggestions by M. Kalinowski and V. Durand-Dastès and graphic work by O. Hodasava.

Jean-Marc Bonnet-Bidaud works at the Commissariat á l'Energie Atomique, France and Françoise Praderie at the Observatoire de Paris, France.

NOTES

1 Couvreur, *Chou king*, 95. Legge, *The Chinese Classics*, 82–83, but see Needham, *Mathematics*, 189 and note a) who summarizes the research on this.
2 Needham, *Mathematics*.
3 Chavannes, *Les Mémoires Historiques*.
4 Ibid. 3: 402–403; Maspero, "L'astronomie", 267.
5 The lost texts were titled *Tian Wen* 天文 for Shi Shen and *Tian Wen Xing Zhan* 天文星占 for Gan De.
6 Needham, *Mathematics*, 197 and 201. The *Jinshu* is translated by Ho, *Astronomical Chapters*.
7 Ho, *Astronomical Chapters*, 67.
8 Extracts from the chart are shown as figs 99 and 100 in Needham, *Mathematics*, 264.
9 See for instance Chen, *Zhongguo Gudai Xingtu* and Chan, *Chinese Ancient Star Maps*.
10 Xi, *Dunhuang Xingtu*; Ma, *Dunhuang Xingtu de Niandai*; Pan, *Zhongguo Hengxing Guance shi*; Deng, *Dunhuang Tianwen*.
11 Our identifications are in general agreement with the ones also proposed by Deng, *Dunhuang Tianwen*.
12 See for instance Ho, *Astronomical Chapters*, Yi, *Correlative Star Catalogue*, Sun and Kistemaker, *The Chinese Sky*.
13 Maspero, "L'astronomie", 271; Needham, *Mathematics*, 263.
14 Maspero, "L'astronomie", 271 and 319; Needham, *Mathematics*, 265.
15 Needham, *Mathematics*, 264.
16 Ma, *Dunhuang Xingtu de Niandai*.
17 Sun and Kistemaker, *The Chinese Sky*, 23.
18 Deng and Liu, "Uranomancie", 76.
19 *Zhongguo gudai tianwen*.
20 Maspero, "L'astronomie", 272, n. 3; Deng and Liu, "Uranomancie", 76.
21 See Rong's paper in this collection for the role of Dunhuang officials in astronomy and also Whitfield, "Under the Censor's Eye", for a discussion of censorship of such documents at this period.
22 Ho, *Science and Civilisation*, 146.
23 Needham, *Mathematics*, 278; Chavannes, *Mémoires*, I: 19.
24 Chavannes, *Les Mémoires Historiques*.
25 *Zhongguo gudai tianwen*, 8, 72–73, see also Stephenson, "Stargazers of the Orient", 32.
26 Whitfield, *Mapping the Heavens*, 22–23.
27 Ibid., 24
28 Ibid., 68