Introduction

For many thousands of years, man has attempted to make sense of the sky by naming and grouping stars into recognisable patterns. At the turn of the twentieth century, Marc Aurel Stein, a Hungarian-born, British archaeologist uncovered the world's oldest existing star chart in a Buddhist cave complex in Dunhuang, China. The chart, now known as the Dunhuang Star Atlas and probably dating from before AD 700, was just one of a large number of important manuscripts, printed documents and paintings which were found at the site, and which tell us much about social, religious and political issues in medieval China and Central Asia. But the Star Atlas – now held at the British Library in London – is also proving important for our current understanding of astronomical history due to the accuracy and detail it provides about the sky seen from China from such an early period.

This resource aims to:

- Introduce the Dunhuang Star Atlas and explain its importance as a historical and scientific document
- Offer an introduction to astronomy and explain the place it has occupied in Chinese history and culture.
- Introduce the most important Chinese constellations and the myths associated with them.
- Look at the links between Chinese astronomy and astrology and explore the Chinese 'zodiac'.
- Offer ideas for classroom activities and downloadable resources for teachers.
- Link to related websites and other sources of information.

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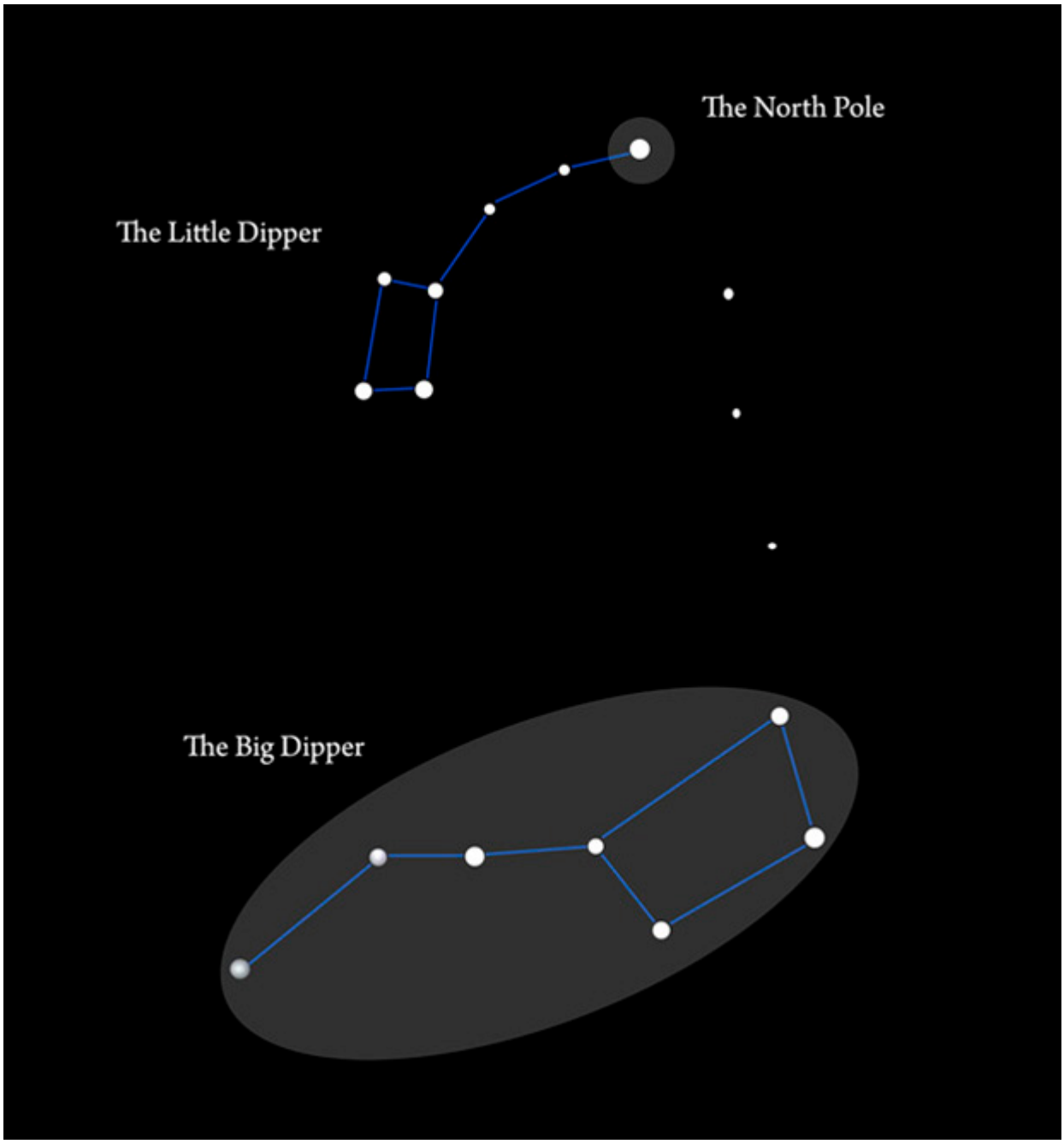
Introduction to Astronomy

For thousands of years, man has used the sky to help him find his way, tell the change of season and the time of day. But to the untrained eye, the sky can seem a random, confusing place. In fact, the stars and planets above us can be mapped in much the same way as we map landmarks and places on earth. Throughout time, man has recognised patterns in the sky by relating different stars to one another in groups or clusters that we call constellations. These patterns not only help us to remember certain stars but also to find them again with relative ease among the many thousands of others in the sky that together form the galaxies. Constellations are often recorded in the form of star maps, also called star charts or star atlases. In the same way that land maps help us find or place landmarks on earth by placing them in countries, cities and towns, star charts can help us place stars as well as other objects in the sky by describing their position within certain constellations or regions.

Stars

What are stars? Put simply, a star is a bright, glowing ball of gas. The energy of a star, created by a complex process of nuclear fusion, causes the star to radiate light that enables us to see it from the earth. Stars are often said to 'twinkle' in the sky, but this effect is in fact due to turbulence in the earth's atmosphere and interstellar space that causes the light of the star to flicker. While the energy of stars can vary enormously, their brightness can also be an indication of their distance from earth. The light of a star can take many years to reach us, even travelling at the tremendous speed of light (300,000 km per second), since most stars are very far away. Usually, astronomers use light-years as a measure to describe distances in the sky that are too large for us to write down in conventional measuring units. A light-year is the distance that light can travel in one year, and is just a little less that ten trillion kilometres. Using light-years we can calculate just how far away different stars are from the earth. Even the stars closest to us can be more than 75 light years away. On nights with good visibility, more distant stars in the galaxies become visible and those in one galaxy appear grouped together in a hazy band through the sky referred to as the Milky Way.

Grouping stars into recognisable patterns, or constellations, does not mean that stars of a given constellation are grouped together at the same approximate distance. Most of the time, these stars are at very different distances from one another but just appear together by superposition on the sky. Constellations help us to remember the position of stars in relation to one another as we view the sky, but they also enable us to use them for navigation. For example, we can always find north by identifying the north pole, sometimes called the pole-star or the north-star which is aligned in the sky with the northern end of the earth's rotational axis. This is done by first locating the constellation known as the Big or Northern Dipper (sometimes also called The Great Bear), which looks like a giant ladle or a chariot. The North Pole is aligned with the two stars that form the back of the chariot (see diagram below). By following the direction in which these stars point, and measuring a distance upwards of five times their separation, we end at the Pole star, as seen here:



The Big Dipper is a constellation common to many different cultures but it is important to note that most constellations are not universal. Over time, different cultures have recognised many different patterns in the sky, and identified their own constellations accordingly. As a result Chinese constellations are largely quite different to those we might recognise from western star maps. Likewise, different cultures have developed very different mythologies or beliefs around the stars and planets, a tradition better known as astrology. While in many cultures, astronomy and astrology were intricately linked for many years, we now recognise astronomy as a purely scientific discipline, entirely separate to astrology.

Planets

Planets are large spherical celestial bodies that orbit the sun. Planets do not radiate light in the same way as stars but they do reflect the light of the sun, which is how we are able to see them. The planets, including the earth and the moon, are more or less visible at different times, and while some can be seen by the naked eye at certain times, others are visible only through a telescope.

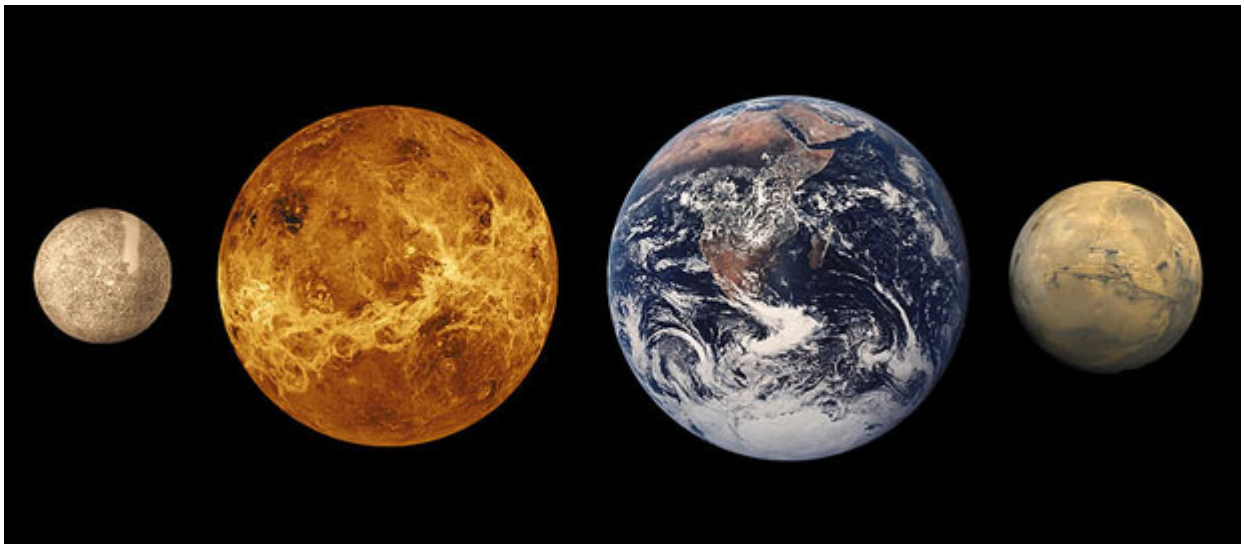


Diagram showing the approximate relative sizes of the planets Mercury, Venus, Earth and Mars from left to right. Distances between these planets are not shown to scale. Source image is from NASA's Solar System Exploration multimedia gallery.

Comets

Aside from stars and planets, comets are the largest objects in our solar system, measuring up to ten miles in diameter with tails that can extend millions of miles into space.

An image of Halley's Comet photographed by Yerkes Observatory in April 1910. Source image is from *The New York Times* which first published the photograph on 3rd July 1910.

Comets are objects made of solid particles and frozen gases that orbit the sun like tiny planets. Comets have a solid centre or nucleus made up of frozen rock particles which melt and turn to gas as the comet moves closer to the sun. This gas, and the particles which are released from the nucleus as it thaws, form the hazy tail that trails behind the comet. Comets can only be seen from earth at certain times in their orbit but because of records made by astronomers throughout history we are able to predict their return with a certain degree of accuracy.

The discipline of astronomy is concerned with the study of all celestial objects, their behaviour, and any events that occur outside of the earth's atmosphere. Astronomers study these things in order to understand the workings and origins of the universe. It is a quest that has preoccupied people all over the world from ancient times until the present day and historical evidence of events in the sky is still proving useful for modern astronomers in this quest.

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History of Astronomy in China

In China, as in many other cultures, there is evidence of interest and observation of the sky from many years earlier than written documentation suggests. Examples of pottery now held at the Beijing Ancient Observatory and dated to the Neolithic period (over 5000 years ago) show images of the sun, and intricately carved animal shells and bones depict images of the stars as well as astronomical events such as star explosions which may date back as far as 1400 BC.

It is possible that the observation of the sky in a scientific sense was first undertaken as a way of marking time and recording events within a recurring pattern in order to create a calendar. A calendar marks the seasons and helps farmers to know when to plant and harvest their grain. Like many ancient societies, China based its calendar upon the phases of the moon but then added extra months. This was because a solar year is not evenly divisible by an exact number of lunar months – there are about 12.37 lunar months during a solar seasonal year – so without the extra months the seasons would drift each year. This is called a luni-solar calendar. The Chinese calendar therefore had a thirteen-month year every two or three years. In May 2005, some relics of this early astronomical activity were uncovered with the discovery of the oldest astronomical observatory known in China today. This structure is located in the Shanxi 山西 province of China and dates from the *Longshan* 龙山 period (2300–1900 BC). This vast carved platform, measuring sixty metres in diameter, was used to locate the rising of the sun at the different periods of the year.

As tradition dictated that the rulers of China, first kings and later emperors, should receive their political mandate from the sky, astronomy soon became a dominant science in China. The main responsibility of political power was to keep the Earth in total harmony with the sky. This obligation was called the 'Mandate of Heaven' and the emperor himself was called Tian Zi 天子, the *Son of Heaven*. The stars themselves were bestowed with astrological meaning, both enabling predictions that influenced daily life as well as major political strategies, and thus astronomy swiftly became a powerful political tool.

One very positive consequence of the Mandate of Heaven on Chinese history was the appointment of a special group of imperial officers who included astronomers, astrologers and meteorologists. These officials were ordered by the emperor to monitor the sky, looking for astrological omens and astronomical phenomena. Unlike any other country, China is the only place where astronomical observations took place uninterrupted for 4000 years and this surveillance led to many important astronomical discoveries. Special care was taken in China to record the appearance of unexpected events in the sky, such as eclipses, comets or star explosions. The most ancient document known to exist on comets is a spectacular drawing, now called the *Silk Atlas of Comets* that was found in a tomb from the Mawangdui site near Changsha, in Hunan province, south China in 1973. The Atlas dates from around 185 BC, and is now held at the Hunan Provincial Museum. It depicts a variety of comet formations that demonstrate careful observations made over several centuries earlier, including astronomical phenomena such as 'cloud vapour divinations' and 'star divinations' which would have aided the prediction of victory or defeat in battle. Different kinds of comet heads and tails are painted on the manuscript, showing that comet observation at this time was already very precise, and done according to scientific classification.

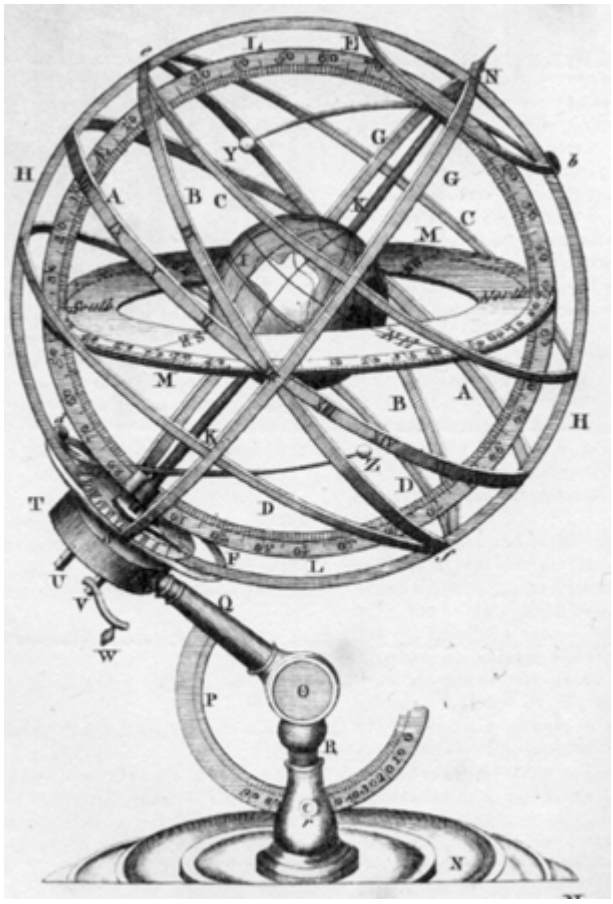
Silk Atlas of Comets from the Hunan Provincial Museum

Source image taken from *Album of Relics of Ancient Chinese Astronomy*, Zhongguo Gudai Tianwen Wenwu Tuji, CASS (Chinese Academy of Social Sciences, Institute of Archaeology), 1980. Beijing. 8, 57.

Regular observations also led to the discovery of star explosions. Known today as 'supernovae', these explosions, that signal the death of a star, are visible only briefly in the sky, appearing as a transitory 'new' star that suddenly appears and then fades after a few weeks. Ancient Chinese astronomers poetically named these explosions 'guest stars' and a full catalogue of them, maintained over centuries, carefully notes their various appearances and offers accurate information about their positions which has enabled modern astronomers to find remnants of these explosions in the sky today.

To locate events such as these easily, Chinese astronomers took care to describe the visible stars with great accuracy. The first star catalogues may have been produced during the Warring States period (475–221 BC) and were transmitted to us by the famous historian Sima Qian 司马迁, from the early *Han* dynasty. From this period we can first date the division of the sky into numerous small constellations, all associated with memorable images from the Chinese empire. Using simple instruments known as armillary spheres, a combination of a sighting tube with graduated circles that enabled measurement of the positions of the stars, astronomers first produced lists of stars with associated numbers which corresponded to their positions in the sky.

Armillary sphere at the Beijing Ancient Observatory. Image taken from Wikipedia



An armillary sphere, dated 1771, from plate LXXVII of the 12th edition of the Encyclopedia

Britannica.

Later on, the first star maps were also produced. These showed the relative positions of the stars as they appeared in the sky as a drawing. But evidence for drawn star maps does not appear until many years later. In historical texts, an early star map is attributed to the astronomer Chen Zhuo 陈卓 living in the third century AD but unfortunately this map has not survived. At the turn of the twentieth century, Marc Aurel Stein, a Hungarian-born, British archaeologist uncovered a hand drawn star chart in a Buddhist cave complex in Dunhuang 敦煌, China. This chart, now known as the Dunhuang Star Atlas and probably dating from before AD 700, is the earliest known preserved star map in existence in the world.

The long tradition of mapping the sky in China continued with the production of other spectacular star maps. Preserved today in the city of Suzhou 苏州 is a carved stone example that was designed in AD 1193 as a teaching aid for the young future emperor Ningzong 宁宗 (1168–1224).

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The Chinese Sky

In ancient China, it was believed that events in the sky directly reflected events on earth. If, for example, a comet suddenly appeared in the sky it was thought that something important and unexpected was about to happen on earth, perhaps something like a major battle. The emperor was believed to be the Son of Heaven who had been given the Mandate, or right to rule, by Heaven itself. It was vital that he could prove that he retained this right by predicting the movements of the sky accurately. His astronomers were therefore expected to watch the sky very carefully and they kept accurate records of the movements of the stars and planets, recording events such as Halley's comet and various eclipses of the sun and moon.

Halley's comet appears in the sky every seventy to seventy-five years, so very few people see it more than once in their lifetime. Over time, Chinese astronomers recorded every instance of Halley's comet from 3000 years ago, the only civilisation in the world to have done so. They also made drawings of how the comet looked each time.

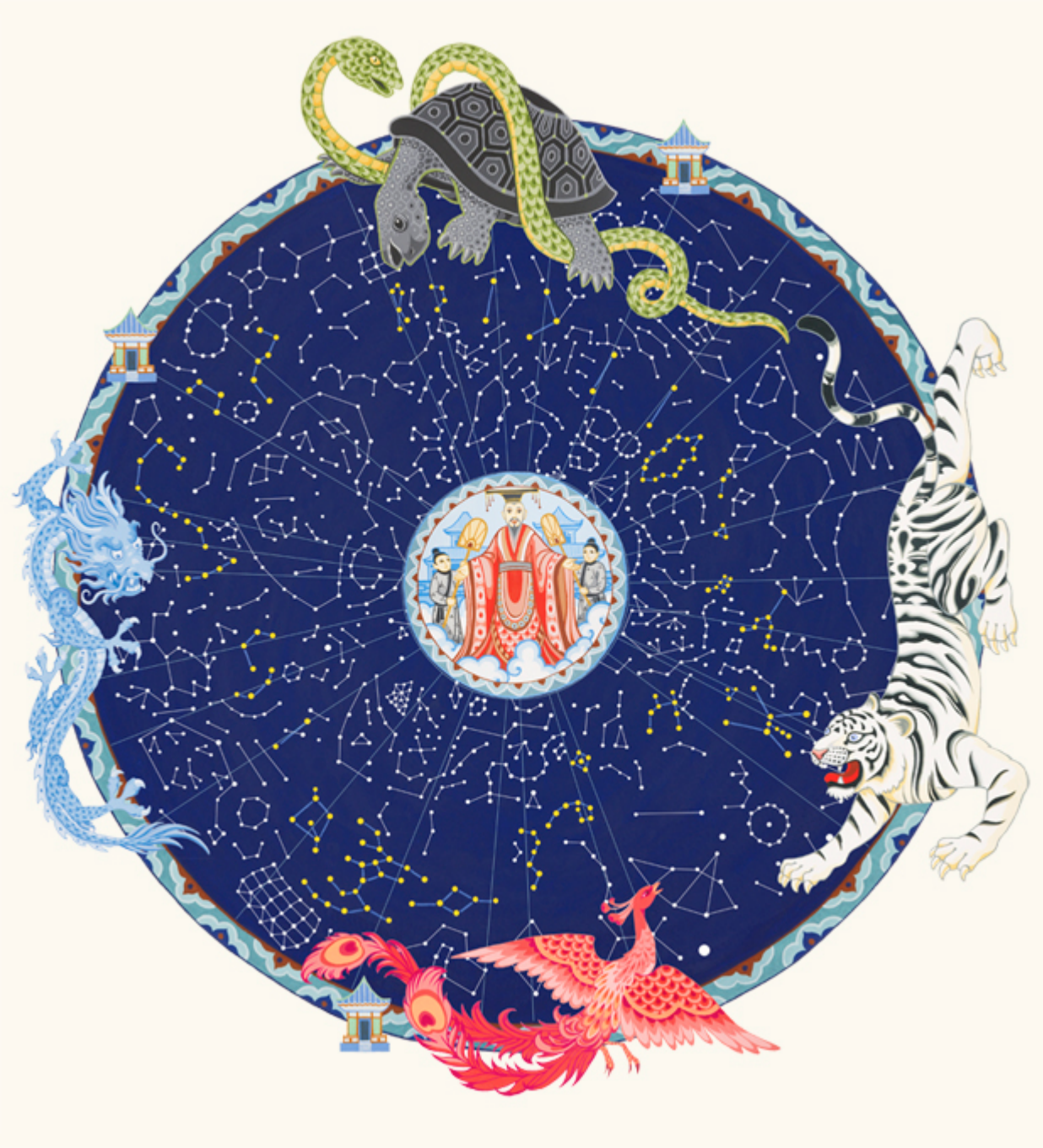
Silk Atlas of Comets from the Hunan Provincial Museum

Source image taken from *Album of Relics of Ancient Chinese Astronomy*, Zhongguo Gudai Tianwen Wenwu Tuji, CASS (Chinese Academy of Social Sciences, Institute of Archaeology), 1980. Beijing. 8, 57.

The emperor's astronomers were also responsible for producing the calendar each year, a document commonly known as an almanac. No one else was allowed to calculate a calendar. It contained predictions of major events in the sky, which affirmed the emperor's divine link to the heavens and ultimate power. Royal astronomers were in a difficult position. If they failed to predict an event like an eclipse then the emperor's power might appear diminished and political rivals could take it as an opportunity to rebel. When dynasties fell, it was therefore believed that Heaven had directly intervened to give the responsibility of rule – or mandate - to a more worthy line. The job of royal astronomer therefore carried both huge responsibility for informing important political decisions, and severe penalties for mistakes.

The Regions of the Sky

The Chinese sky was divided into five great regions or palaces called *gong* 宫. These were equated with the directions north, south, east and west and also with a middle region. The middle region was the most important as it housed among its stars the celestial image of the emperor surrounded by his family and civil and military officials. This part of the sky has constellations such as 'the prince', 'the concubine', and 'the throne' and is a reflection of life on earth.



The rest of the sky contains the equatorial constellations grouped in the four directions, each associated with an animal and a colour. In addition, Chinese astronomers identified twenty-eight segments in the sky known as mansions or lunar lodges and called *xiu* 宿 in Chinese. The exact origin of the mansions is not known. It is possible that they once marked coordinates through which the moon passed during its monthly journey around Earth and served as a way of tracking the its progress. However, later the mansions were used rather to measure the coordinates of celestial bodies along the equator in the Chinese system. Many of the most important Chinese constellations are situated within these twenty-eight mansions.

The Chinese tradition of associating animals with the four points of the compass has a long history. The animals of the four directions are first mentioned in an ancient Chinese manual of divination, *The Book of Changes* (Yijing 易经). Here, a map of the heavens, *Sifang* 四方, shows mystical animals holding court over not only the directions of the earth, but also over the seasons of the year.

On a Chinese star map each of the four directions contains seven of the twenty-eight mansions and

together with the central region of the sky, synonymous with the emperor, and therefore China itself, these regions make up what are known as the five cardinal points. It is important to note that these four animals are entirely unrelated to the twelve animals of the Chinese zodiac but they do have their own important associations and properties:

- The Black Tortoise, *Xuan wu* (玄武), represents both north and the winter; A symbol of longevity, the tortoise of the north is often depicted together with a snake. The union of these two creatures was thought to have created the earth. It is also associated with the element water.
- The Blue Dragon, *Qing long* (青龙), represents both east and the spring; Unlike in western mythology, the dragon is rarely depicted as a malevolent force but generally considered to be both benevolent and auspicious. It is also often associated with the emperor and therefore linked to the Red Bird, whose own association is with the empress. The dragon is associated with the element wood.
- The Red Bird, *Zhu que*, (朱雀) represents the south and the summer; The bird is sometimes seen as a phoenix and associated with good fortune. It is also often paired with the dragon. It is associated with the element fire.
- The White Tiger, *Bai hu*, (白虎) represents the west and the autumn; The tiger is often seen as a protector and was thought to guard over the armies of the emperor and protect the spirits of the dead. It is associated with the element metal.

You can see how the constellations appear to form the shapes of the four animals here:

Discussion

- Look at the images of the Chinese sky above. Having read about which animal represents which direction, you may have noticed that the directions east and west (on the left and right of this chart) appear to be on opposite sides to those you might have expected, or seen on land maps. Can you explain why this might be the case?
-
- This chart is a flat picture of the sky above your head. You might think that east and west seem to be on the wrong sides of the chart, but they are not. If you hold the chart above your head, with north and south pointing the right way, then east and west will be on the correct sides — try it!
-
- An astronomical star chart, like this one, shows us how stars are seen when we look up into the sky. Charts and maps in the west are normally oriented with north at the top and east to the right. In China, land and star maps are oriented with the north at the bottom and therefore east to the left. Therefore this chart shows the view you would have if you were looking up at the sky and facing towards constellations in the south.
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The Constellations

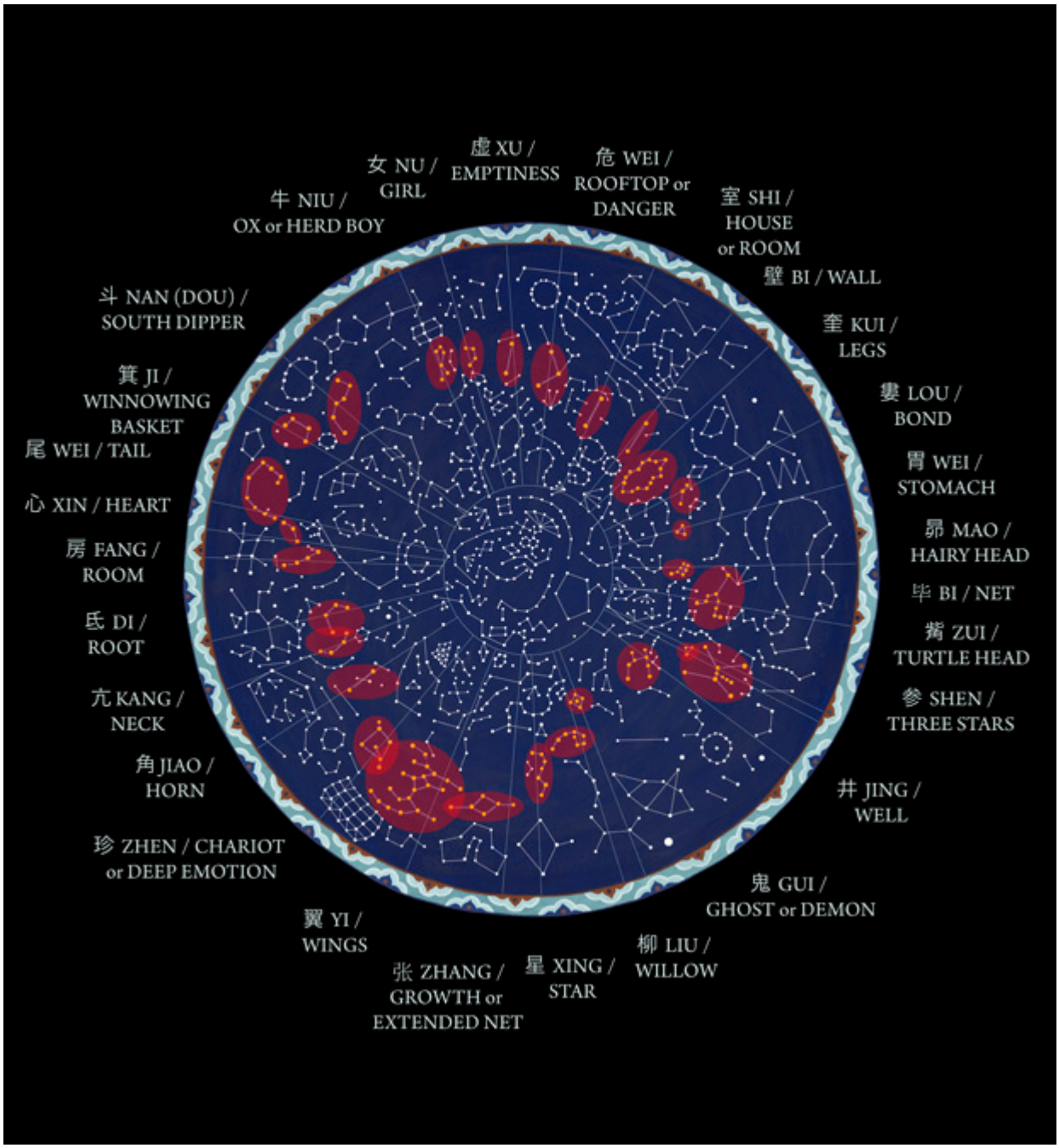
Looking at the map of the sky in the section above, we can see how the Chinese constellations are grouped into four directions, and also fall within one of the twenty-eight segmental divisions known as ‘mansions’ or lunar lodges. The most important Chinese constellations are situated very approximately along the celestial equator within the twenty-eight mansions and are seen highlighted in yellow. Although some of these constellations correlate loosely in appearance to groupings recognised in Europe, largely the patterns are quite different, as comparison with these western star maps will show.

Apian's Star Chart from *Astronomicon Caesareum*, 1540.
Maps C.6.d.5 © The British Library

Honter's Star Charts, 1541.
Maps c.1.c.2(2) © The British Library

The twenty-eight constellations of the Chinese sky are also important for astrological divination and have various linked meanings and associations. The first is the name of a famous general. According to legend, a terrible battle once broke out between two warring kingdoms. Twenty-eight great warriors came to the aid of the general. Although they were defeated, their names were given as a mark of respect to the heavenly constellations. Each constellation is also associated with an animal, and also with a particular day of the lunar cycle. It is believed that when the moon moves through these constellations on their designated days, fortunes relating to auspicious and inauspicious activities for the day should be observed. These associations are well documented in popular Chinese books and help advise people which days will prove the best for important plans such as marriage, burial, the watering of crops or the building of houses.

Take a look at the following image and the table below to identify the twenty eight circumpolar constellations and learn more about their associations and meanings.



REGION	CHINESE NAME	LOCATION ON MAP	ENGLISH NAME	WESTERN EQUIVALENT NAME	ASSOCIATED DATE	ASSOCIATED ANIMAL
The Blue Dragon of the East	Jiao	角1	Horn	a Virg	Thurs 1st	Crocodile
	Kang	亢2	Neck	k Vir	Fri 2nd	Dragon
	Di	氐3	Root	a^2 Lib	Sat 3rd	Badger
	Fang	房4	Room	p Sco	Sun 4th	Hare
	Xin	心5	Heart	s Sco	Mon 5th	Fox
	Wei	尾6	Tail	m^1 Sco	Tue 6th	Tiger
	Ji	箕7	Winnowing basket	g Sgr	Wed 7th	Leopard
The Black Tortoise of the North	(Nan)Dou	斗8	South Dipper	f Sgr	Thurs 8th	Unicorn
	Niu	牛9	Ox /Herd boy	b Cap	Fri 9th	Buffalo
	Nü	女10	Girl	e Aqr	Sat 10th	Bat

	Xu	虚11	Emptiness	b Aqr	Sun 11th	Rat
	Wei	危12	Rooftop	a Aqr	Mon 12th	Swallow
	Shi	室13	House	a Peg	Tue 13th	Pig
	Bi	壁14	Wall	g Peg	Wed 14th	Porcupine
	Kui	奎15	Legs	h And	Thurs 15th	Wolf
	Lou	婁16	Bond	b Ari	Fri 16th	Dog
The White Tiger of the West	Wei	胃17	Stomach	^{41} Ari	Sat 17th	Pheasant
	Mao	昴18	Hairy Head	h Tau	Sun 18th	Cockerel
	Bi	毕19	Net	e Tau	Mon 19th	Crow
	Zui	觜20	Turtle	1^{1} Ori	Tue 20th	Monkey
	Shen	参21	Three stars	z Ori	Wed 21st	Gibbon
	Jing	井22	Well	m Gem	Thurs 22nd	Tapir
	Gui	鬼23	Ghost	q Cnc	Fri 23rd	Goat
	Liu	柳24	Willow	d Hyd	Sat 24th	Stag
The Red Bird of the South	Xing	星25	Star	a Hyd	Sun 25th	Horse
	Zhang	张26	Extended Net	e^{1}Hyd/m Hyd	Mon 26th	Ox
	Yi	翼27	Wings	a Crt	Tue 27th	Snake
	Zhen	珍28	Chariot	g Crv	Wed 28th	Worm

Activity

- Familiarise yourself with these twenty-eight constellations by making your own star-finder. Visit the Classroom Ideas and Activities page to download a template and instructions.
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- You can also download a free wallchart illustrating the Chinese sky and all the constellations.
-

The Sun and Moon

Because one of the main purposes of astronomical observation in ancient China was timekeeping, the sun and moon were very important. The Chinese used a calendar system based on the phases of the moon (measured through observing the position of the stars in the twenty-eight mansions) and the time of the solar year, or season.

The superstitious belief that linked events on earth to those in the heavens made people very wary of events in the sky. Solar eclipses in particular were regarded with fear, and a common belief was that these occurred because a great dragon was attempting to devour the sun. The forewarning of such an event was therefore imperative so people could gather to shout, strike gongs, and scare away the dragon. Over generations of observation, astronomers discovered a relationship we now know as the *Saros* cycle, a cycle in which sun, moon and earth are aligned in a particular way approximately every 18 years, 11.3 days. This enabled them to predict solar and lunar eclipses with some accuracy but it was not an infallible system. In 2136 BC there was an unpredicted eclipse. Documentation about this event dates it as the earliest recorded eclipse in history but it also tells us about the fate of the court astronomers Xi 羲 and He 和 who failed to predict it in advance. Given the belief that such celestial events reflected events on earth and should be predicted by the emperor, complete accuracy was expected of court astronomers, and failure meant only one fate – execution.

The belief which linked celestial activity to that on earth is illustrated in an description of lunar behaviour by a court astronomer, Shishen 石申, in the fourth century BC :

> When a wise prince occupies the throne, the moon follows the right way. When the prince is not wise and the ministers exercise power, the moon loses its way. When the high officials let their interests prevail over public interest, the moon goes astray toward north or south. When the moon is rash, it is because the prince is slow in punishing; when the moon is slow, it is because the prince is rash in punishing.

H. Maspero, *'L'astronomie chinoise avant les Han' ['Chinese Astronomy before the Han Dynasty']*, T'oung Pao 26 (1929): 288

The sun and moon have always had a special significance in Chinese folklore and various symbolism and myths surround them. The mid-Autumn, or Moon Festival is perhaps the second most important traditional festival in China after Chinese New Year. It is held on the fifteenth day of the eighth lunar month when the moon is said to be at its largest, roundest, and brightest of the year. The shape of the moon is said to represent completeness and perfection and its celebration is an important family occasion each year. Special round cakes, called moon cakes, are made to eat during the festival.

The sun and moon have developed a particular iconography in China. The red sun is often pictured with a three-legged crow and the moon features a white hare or rabbit, pounding a pestle and mortar. The association of the hare and the moon is common to folklore all over the world. One Buddhist *jataka* – stories about the Buddha in his earlier lives – tells that he was once a hare and sacrificed himself to the god Indra who was suffering from hunger. As thanks for his selflessness, Indra then immortalised the hare by placing his image on the moon for all to see. Another story tells of a white hare serving Chang E 嫦娥, the Queen of the moon. There are several versions of this myth that may explain the origin of these motifs.

Visit our myths page to learn more about these myths and other legends relating to the sky.

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The Dunhuang Star Atlas

The Dunhuang Star Atlas, the last section of Or.8210/S.3326. © British Library

In the early twentieth century, a secret cave, now known as the 'Library Cave', was discovered in the Buddhist Mogao cave complex (Mogaoku 莫高窟), just outside the Silk Road town of Dunhuang in northwest China. This cave had been sealed for a thousand years and contained around forty thousand manuscripts, paintings and printed documents on silk and paper. Among them, was a manuscript containing the oldest manuscript star atlas known today from any civilisation, probably dating from around AD 700. It shows a complete representation of the Chinese sky in 13 charts with over 1300 stars named and accurately presented. The chart contains much information that has proved very useful for modern astronomers.

The Dunhuang Star Atlas was not the only astronomical document found in the Dunhuang Library Cave. Along with a fragment of a circumpolar star map and an astrological compilation of the Chinese constellations, the discovery of these documents revealed a fascinating snapshot of astronomical knowledge in ancient China. Its discovery was a huge surprise since such an early chart had never before been seen from any civilization. But the first mention of the chart in an astronomical context appears to be made by Joseph Needham as late as 1959 in his *Science and Civilisation in China* .

The atlas itself forms the second part of a longer scroll (Or.8210/S.3326) that measures 210 cm long by 24.4 cm wide and is made of fine paper in thirteen separate panels. The first part of the scroll is a manual for divination based on the shape of clouds. The twelve charts showing different sections of the sky follow these. The stars are named and there is also explanatory text. The final chart is of the north-polar region. The chart is detailed, showing a total of 1345 stars in 257 clearly marked and named asterisms, or constellations, including all twenty-eight mansions. For a hand-drawn document the positioning is very accurate and stands up well to comparison with modern charts.

Because astronomy was considered a matter of state, the distribution of documents like this would have been strictly controlled and limited to military and governmental use. This may explain why so few charts of this sort exist today. As Dunhuang, the place of discovery, is a remote town where it is unlikely astronomical observations would have been recorded, it seems likely that the chart was brought to Dunhuang by an official from the Chinese capital.

The importance of the chart lies in both its accuracy and graphic quality. The chart includes both bright and faint stars, visible to the naked eye from north central China, and was probably used as a reference material. Its origins and real use remain unknown.

The Dunhuang Star Atlas is now held at The British Library in London along with many other items from the Library Cave and other ancient Silk Road sites. These unique items tell fascinating stories of

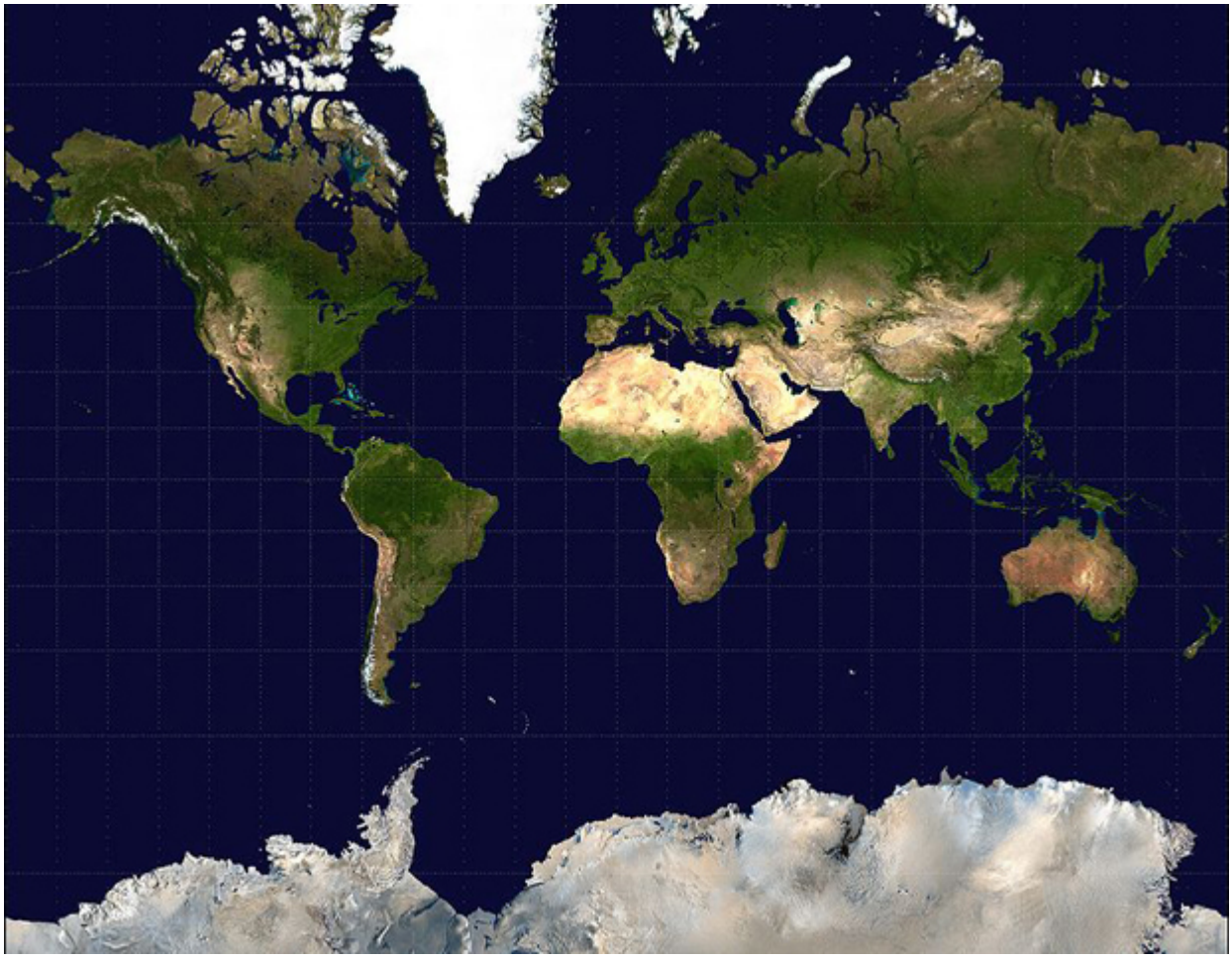
life on the Silk Road from 100 BC to AD 1400. Most of these collections were dispersed to institutions worldwide in the early twentieth century, making it difficult to study them as a whole. The International Dunhuang Project (IDP) based at the British Library is now making these resources freely accessible to all via this multi-lingual website.

Read about in more detail about the Dunhuang Star Atlas on our research pages.

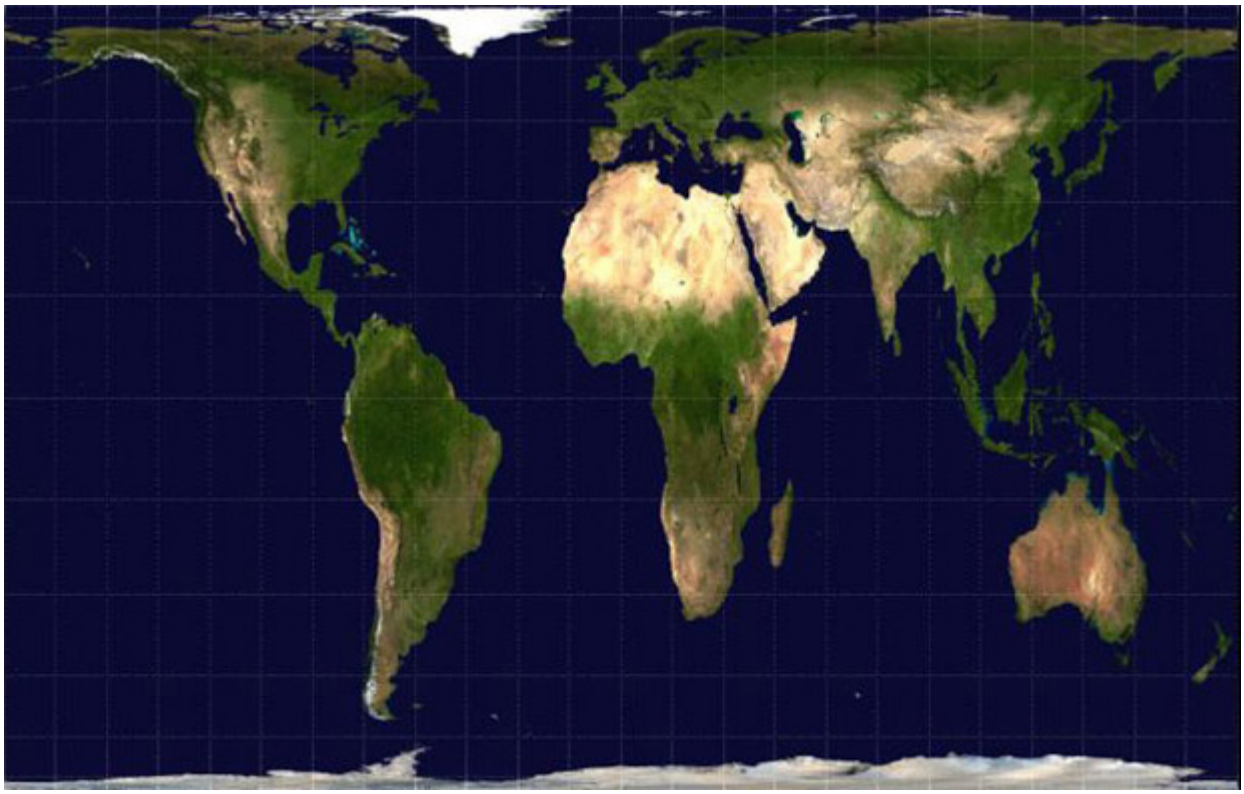
Map Projection

The Dunhuang Star Atlas was drawn from accurate observation, but drawing maps can be a complicated process. Like the earth, the sky is not flat but a sphere. The sky we see above us is a dome. If it is cut into sections they will be both triangular, like the slices of a cake, and also curved. Map makers of both the earth and the sky had to find a way to show these sections on rectangular and flat surfaces, as on the Dunhuang chart. This process of converting, or projecting, points from a spherical object onto a flat piece of paper involves complicated mathematics and is known in map making as 'projection'.

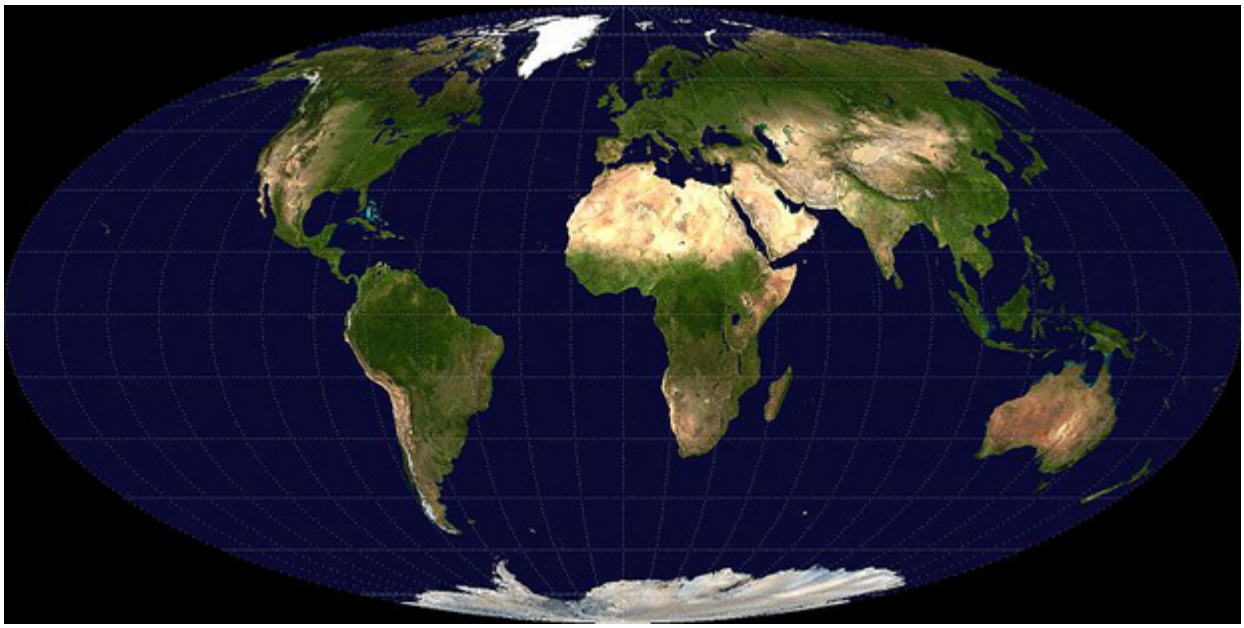
One of the first accurate projections in Europe was calculated by a man called Geradus Mercator in 1569. The Mercator Projection is still used by many map makers. However, all projections result in some distortion and on the Mercator projection, the continent of Africa and the sub-continent of India appear small in relation to Europe. Many other projections, such as those developed by Gall-Peters, Mollweide, Winkel-Tripel and Robinson have produced very different world maps as we can see here:



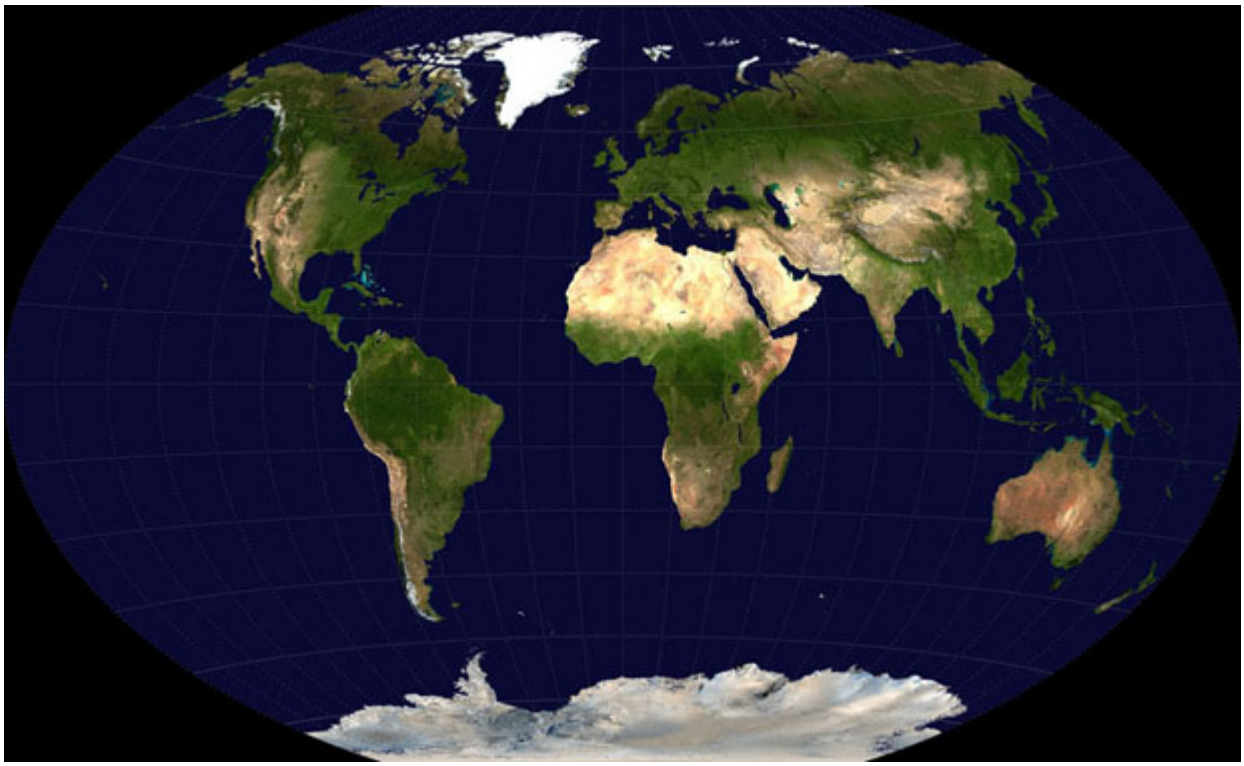
Mercator projection of the Earth. Source image is from NASA's Earth Observatory *Blue Marble* series.



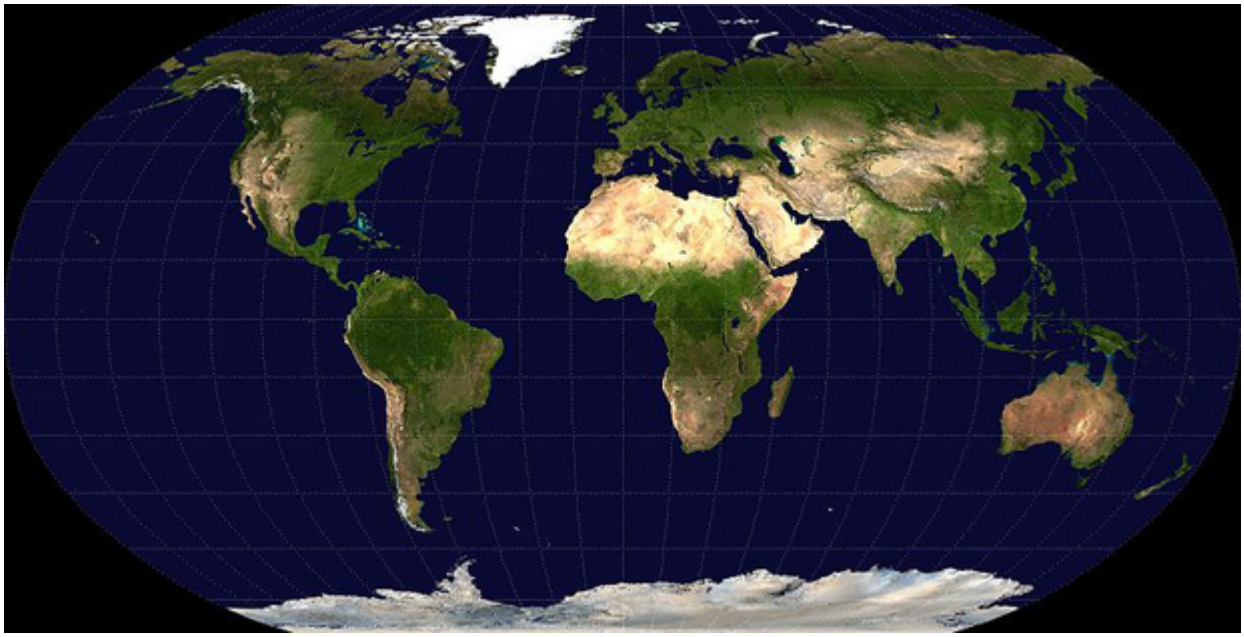
A Gall-Peters projection of the Earth. Source image is from NASA's Earth Observatory *Blue Marble* series.



A Mollweide projection of the Earth. Source image is from NASA's Earth Observatory *Blue Marble* series.



A Winkel Tripel projection of the Earth. Source image is from NASA's Earth Observatory *Blue Marble* series.



A Robinson projection of the Earth. Source image is from NASA's Earth Observatory *Blue Marble* series.

Activity

- Familiarise yourself with the concept of projection by making your own flat map of the Earth.
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- Visit the Classroom Ideas and Activities page to download instructions and images.
-

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Astronomy and Astrology

Historically, the development of astronomy and astrology have been closely related throughout the world. In China however, the two have always retained links far stronger than in Europe where they have largely been regarded as completely separate disciplines since the eighteenth century. Today, astronomy is recognised as a scientific discipline based on the observation of objects and events beyond the earth's atmosphere. Astrology, by contrast, is a practice more typically defined as a form of 'divination' and has largely to do with making predictions about life on earth by studying the position of celestial bodies in the sky. This assumes that there is a link between events on earth and in the sky and as such is a discipline which is taken very seriously by some, and derided by others.

According to Chinese astrological thought, a person's destiny can be determined a number of complex factors including the position of the major planets, sun, moon and comets in the sky at the exact hour of a person's birth and the year in which they were born. In China each year is associated with one of twelve animals and one of the five elements, making a sixty-year cycle. An accurate astrological prediction is a complex process, although it is by no means scientific, and is regarded very seriously by some people. By contrast, the knowledge of one's year sign is something known well by most Chinese, and is commonly referred to especially in relation to compatibility with others, but it is no longer used seriously in important decision making.

The Chinese Almanac

A Chinese almanac dating from c.956 by *Zhai Fengda* Or.8210/s.95 . © British Library

Many Chinese households will regularly consult an almanac (or calendar) based on the lunar year that provides a set of guidelines to promote or advise against certain tasks or events being undertaken on certain days. Claims for the origins of this book go back over 4200 years to 2256 BC, from which date it is said to have been in constant publication. Originally produced solely by the imperial palace whose supposed link to the Heavens offered the ultimate authority on all matters celestial, the almanac is now freely published, but a certain ritual still surrounds its use. In its handling, clean hands and a degree of reverence are required. Old almanacs must be disposed of by burning, either at a temple or with care by each family, in order to release their powers back to Heaven and the almanac must always be stored with respect and never placed on the floor or beneath a table. Despite the lighthearted treatment of astrological suppositions surrounding the zodiac, the respect afforded to the almanac reveals the ongoing belief afforded to the more complex arts of astronomy and divination and their importance in Chinese society.

The Chinese Years & The Zodiac

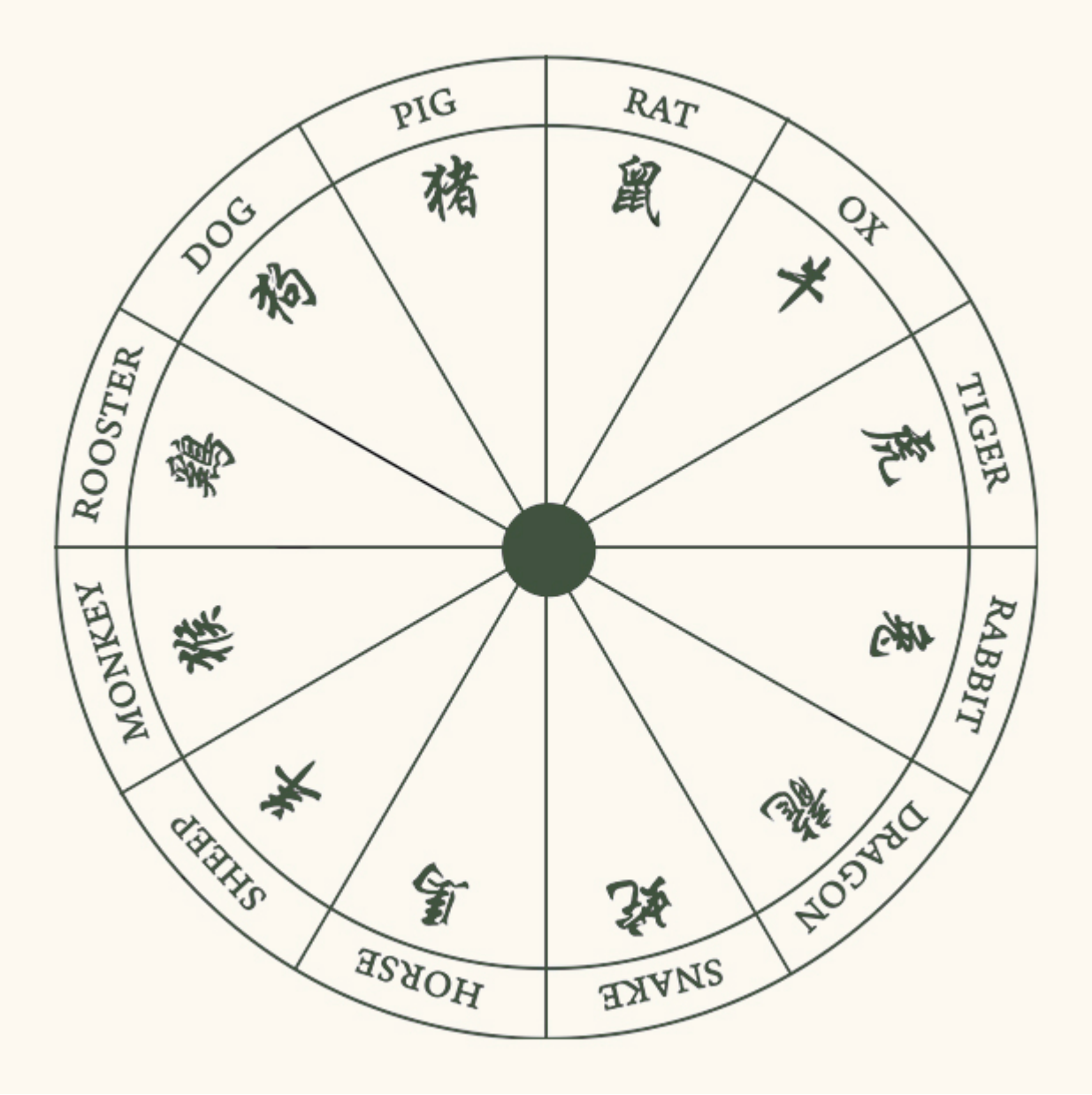
Detail of almanac showing the zodiac animals Or.8210/P.6. © British Library

Some of the more popular and better-known elements of Chinese astrology are the superstitions relating to the Chinese year signs. The Chinese zodiac animals make up a twelve-year cycle used for dating the years based on a lunar system. In the lunar calendar the beginning of the year falls somewhere between late January and early February of the solar calendar. The Chinese have adopted the solar calendar since 1911, but the lunar calendar is still used for festive occasions such as the Chinese New Year and many Chinese calendars will print both the solar and the lunar dates.

The twelve animals that appear on the Chinese zodiac calendar — a rat, ox, tiger, rabbit (or hare), dragon, snake, horse, sheep (or goat), monkey, rooster, dog and pig — are the topic of countless legends embedded in Chinese mythology. The same zodiac animals are also used in many neighbouring cultures to China. You can read more about the mythology surrounding the zodiac animals by visiting our Astrology and Myths page.

In Chinese folklore horoscopes have developed around the animal signs, much like monthly horoscopes have been developed for the different moon signs (Pisces, Aries, Capricorn etc.). The signs are all allocated different qualities and attributes and horoscopes derived from these are largely regarded as light-hearted fun. However, the year signs are also each connected to one of the different five elements - water, earth, wood, fire or metal – each year in a sixty year cycle - and also with varying amounts of *yin* 阴 or *yang* 阳 (the forces of life – male and female, positive and negative). The combination of these elements is said reveal a person's character, and this kind of information was traditionally a contributing factor in decisions about employment and marriage; for while some signs are seen to be naturally compatible, the combination of others is believed to signal disaster.

The simple characteristics of the animals themselves and the relationships they suggest are enduringly popular and well known and are commonly displayed in a wheel, representing the cyclical nature of the calendar. The cycle always begins with the rat and ends with the pig and should be read in a clockwise direction:



Do you know which year you were born in the Chinese zodiac calendar?

Find your birth year in the chart below to discover your Chinese zodiac animal and read on to see if you have the typical characteristics of your sign:

Rat	**1924**	**1936**	**1948**	**1960**	**1972**	**1984**	**1996**	**2008**
Yang	Wood	Fire	Earth	Metal	Water	Wood	Fire	Earth

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Those born under the sign of the Rat are inclined to be clever, quick-witted and hardworking. Though thrifty, they can be generous to those they love and can be charming company. Rats should resist the temptation to be quick-tempered and critical.

Ox	**1925**	**1937**	**1949**	**1961**	**1973**	**1985**	**1997**	**2009**
Yin	Wood	Fire	Earth	Metal	Water	Wood	Fire	Earth

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Those born under the sign of the Ox are strong leaders, who inspire confidence in others. As a result they dislike failure, or opposition and like things to be done their own way. Oxen are often very practical as well as being generous and big-hearted.

Tiger	**1926**	**1938**	**1950**	**1962**	**1974**	**1986**	**1998**	**2010**

Yang	Fire	Earth	Metal	Water	Wood	Fire	Earth	Metal

Those born under the sign of the Tiger are of a playful nature and are sensitive, emotional, and capable of great love. They are loyal and expect the same of others. Tigers are also adventurous and brave but a tendency to get carried away.

Rabbit	**1927**	**1939**	**1951**	**1963**	**1975**	**1987**	**1999**	**2011**
Yin	Fire	Earth	Metal	Water	Wood	Fire	Earth	Metal

Those born under the sign of the Rabbit are affectionate, obliging and good-natured. Rabbits have ambition but can be trusted. Although often clever and talented, Rabbits can tend toward sentimentality.

Dragon	**1928**	**1940**	**1952**	**1964**	**1976**	**1988**	**2000**	**2012**
Yang	Earth	Metal	Water	Wood	Fire	Earth	Metal	Water

Those born under the sign of the Dragon are full of intelligence, vitality and enthusiasm. The Dragon is a revered sign that appears confident but can be gentle inside. Dragons are generally popular although, being perfectionists, can be too direct or demanding of others.

Snake	**1929**	**1941**	**1953**	**1965**	**1977**	**1989**	**2001**	**2013**
Yin	Earth	Metal	Water	Wood	Fire	Earth	Metal	Water

Those born under the sign of the Snake are wise and charming. Snakes are often romantic and deep thinking and are strongly guided by their intuition. Snakes should avoid indecision and a tendency to vanity.

Horse	**1930**	**1942**	**1954**	**1966**	**1978**	**1990**	**2002**	**2014**
Yang	Metal	Water	Wood	Fire	Earth	Metal	Water	Wood

Those born under the sign of the Snake are hard working, cheerful characters who are popular and perceptive. Horses are very independent, can be stubborn and may have a strong temper.

Sheep	**1931**	**1943**	**1955**	**1967**	**1979**	**1991**	**2003**	**2015**
Yin	Metal	Water	Wood	Fire	Earth	Metal	Water	Wood

Those born under the sign of the Sheep are generally peaceful, charming company and are gentle and patient with friends. Sheep can appear timid, and may avoid leadership responsibility but are often elegant and artistic individuals. Sheep can have a tendency to complain about things.

Monkey	**1932**	**1944**	**1956**	**1968**	**1980**	**1992**	**2004**	**2015**
Yang	Water	Wood	Fire	Earth	Metal	Water	Wood	Fire

Those born under the sign of the Monkey are very intelligent and inventive. Monkeys are often charismatic and well liked. As an opportunist, the Monkey is versatile and quick witted, but can be strong willed or impatient as a result.

Rooster	**1933**	**1945**	**1957**	**1969**	**1981**	**1993**	**2005**	**2016**
Yin	Water	Wood	Fire	Earth	Metal	Water	Wood	Fire

Those born under the sign of the Rooster are hard workers, excellent timekeepers, decisive and outspoken. Roosters are loyal but enjoy their own company and can often be seen as dreamers.

Dog	**1934**	**1946**	**1958**	**1970**	**1982**	**1994**	**2006**	**2017**
Yang	Wood	Fire	Earth	Metal	Water	Wood	Fire	Earth

Those born under the sign of the Dog are loyal, hard working and born to lead. They can be trusted with secrets but can appear distant. Dogs have a playful character, and are not motivated by money. They can have a tendency to find fault and worry over small things.

Pig	**1935**	**1947**	**1959**	**1971**	**1983**	**1995**	**2007**	**2019**
Yin	Wood	Fire	Earth	Metal	Water	Wood	Fire	Earth

Those born under the sign of the Pig are good companions, with great inner strength. Pigs are often studious or intellectual individuals who enjoy setting themselves difficult goals. Pigs are kind, sincere, tolerant, and honest but by expecting the same from others, can sometimes be naive.

Which signs are compatible in the Chinese zodiac?

Looking at the Zodiac wheel, the three animals which are most evenly spaced from one another are generally considered to be the best matches: Rat, Dragon and Monkey; Ox, Snake and Rooster; Tiger and Horse and Dog; Rabbit, Sheep and Pig.

The signs that are opposite each other in the Zodiac Circle chart are thought to be poor matches. Generally it is believed that a Rat and Horse; Ox and Goat; Tiger and Monkey; Rabbit and Rooster; Dragon and Dog; Snake and Pig will not get along with each other either in love, in the family or in business.

But, each person is a combination of the sign of the year in which they were born as well as of the sign which influences the time of day and month in which they were born. So, while you may find that a person was born in a year that would seem to make you and they a poor match, the other influences that you share may balance the ill effects of incompatible signs and make for a very good relationship. Likewise, these influences can also cause problems in a match of even the most compatible signs.

The animal signs above, assigned by the year of your birth, represent what others perceive you as being or how you present yourself.

The month of your birth assigns your 'inner animal'. This affects your motivations, love life and inner personality and it is vital to the understanding of your compatibility with other signs.

Tiger	1st month of lunar calendar	**Monkey**	7th month of lunar calendar
Rabbit	2nd month of lunar calendar	**Rooster**	8th month of lunar calendar
Dragon	3rd month of lunar calendar	**Dog**	9th month of lunar calendar
Snake	4th month of lunar calendar	**Pig**	10th month of lunar calendar
Horse	5th month of lunar calendar	**Rat**	11th month of lunar calendar
Sheep	6th month of lunar calendar	**Ox**	12th month of lunar calendar

The hour of your birth assigns your 'secret animal' and is the true sign upon which your personality is based. The hour itself is not based on local time but mapped according to the sun's location.

Activity/Discussion

- Visit our Classroom Resources and Activities Page to download printable versions of the Zodiac Wheel.
-
- Work out your animal sign and those of your friends from the table above. Can you recognise yourselves in the descriptions? Do you get on well with those the zodiac says you should? If not, write your own descriptions or horoscopes. How would you describe yourself and your friends?

-
- There are a number of legends which recount the selection of the zodiac animals. Visit the Astrology and Myth Page to read a popular version and then discuss the tale with your class. You might want to think about the following questions:
- Do you think the selection process was fair?
- Do you think any other animals should have been included and why?
- How would you have chosen to name the months of the calendar?
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Astrology and Myth

There are many Chinese myths and legends that relate to the stars and planets. The following are popular versions of some of the most well known tales in Chinese folklore.

The Herd-Boy and the Weaver-Girl

This story, of which there are many versions, goes back to the sixth century BC and can be found in the first known book of Chinese poetry, *The Book of Songs* (Shijing 诗经).

A very long time ago, when the King of the Sky created the heavens, he decorated it with stars and asked his beautiful daughter to help him by weaving the clouds and mists. It was a long task and when the king noticed his daughter looking tired and drawn, he ordered her to take a break and go out to play among the stars. The princess headed down towards the Milky Way to bathe, whereupon she came across a handsome herd-boy grazing his water buffalo by the banks of the stream. Distracted by the boy the princess lost track of time and returned home to her work long after the curfew her father had set. The King, upon discovering the reason for her late return was very angry and forbade her to visit the boy again. In case she disobeyed him, the King poured thousands more stars into the Milky Way until it was no longer a stream but a flowing river that the princess and the herd-boy could not cross. Without a bridge, the two were stranded on opposite sides of the Milky Way forever more. The Princess, who had fallen in love with the herd-boy, was distraught, and cried until her father relented. The King and his daughter reached an agreement that he would allow her to spend one day of each year with her herd-boy if she worked hard all year round. To this day, on the seventh day of the seventh month of every year the King sends a flock of magpies over the Milky Way to form a bridge. The weather must be clear on this evening or the lovers cannot cross the celestial river to meet each other. If it rains the pair must wait another year. On a clear night you can see their two bright stars together in the sky. If it rains it is said that the drops falling to earth are the tears of the Weaver-Girl Princess.

Chang E, or The Archer and the Moon Goddess

Once upon a time, there were ten suns that took turns to circle the earth each day of the lunar week (10 days in the Chinese lunar calendar) – the suns took the form of black crows which rose in a mulberry tree in the east and landed in a mulberry tree in the west, before travelling home each night through an underground valley. The suns were the children of the Jade Emperor but they were lonely in their work and one day, all ten of the suns came out together, scorching the earth and causing panic. The emperor of earth prayed to the Heavens for mercy and in anger, their father the Jade Emperor ordered them to behave. When they would not, he asked the great archer Lord Houyi 后羿 to reason with them and gave him leave to punish his sons. When Houyi saw the damage they had done he was very angry. He tried to reason with the children but when they would not listen to him, Houyi shot down nine of the ten sons in desperation, leaving one behind to serve alone as the sun. The Jade Emperor was very angry when he learned of the death of his sons. In a rage, he summoned Houyi and banished him and his wife Chang E to live on earth as ordinary mortals on earth.

Houyi was very much in love with his wife Chang E. Seeing that she was miserable as a mortal, Houyi set out to find a way back to the Heavens and to immortality. Travelling far to Kunlun Mountain, Houyi visited the Queen Mother of the West who gave him a vial of elixir to share with his wife. The vial contained enough elixir for both Houyi and his wife to become immortal but was the last of its kind, and the Queen warned Houyi that it must be shared between the archer and his wife as it was the last elixir for thousands of years. On his return home, Houyi was obliged to pay his respects to the emperor of earth, but first he went straight home to give the vial to his wife for safekeeping. Chang E had been so miserable after losing her immortality that she could not control her curiosity and opened the bottle. Raising it to her lips she considered what would happen if she took the elixir all for herself. Chang E decided to summon a fortune-teller. Reassured that she should take the elixir for herself, Houyi returned home to find his wife floating out the window and up into the sky. Seeing the empty vial, Houyi was angry and heartbroken at her betrayal and raising his bow to the sky aimed to shoot her down. But he could not bring himself to do so. Chang E floated all the way up to the moon where she settled to live. She missed her husband terribly although she had two companions on the moon. One was a jade rabbit that pounded a pestle and mortar day and night to find the elixir of everlasting life. The other was woodcutter Wu Gang吴刚 who had offended the gods and was banished to the moon. He was only allowed to leave if he managed to cut down a tree that grew on the moon. He spent his time doing this, but each time he cut the tree down, it would grow back again, therefore condemning him to live on the moon forever.

Left alone on earth Houyi was later honoured for his bravery and protection and welcomed back to the Heavens. Some versions of this tale say that Houyi built himself a palace on the sun as *Yang* (the male principle), while Chang E is *Yin* (the female principle). Once a year, on the 15th day of the full moon, Houyi is able to visit his wife and on this night the moon is especially full and beautiful.

Legend of the Twelve Zodiac Animals

Detail of almanac showing the zodiac animals Or.8210/P.6. © British Library.

Various tales have grown up surrounding the origin of the animal signs of the zodiac. According to one popular Chinese legend, the Jade Emperor decided to name the months of the calendar after twelve animals from his kingdom. This is the tale of how the animals were decided.

The animals of the forest were quarrelsome, and could not decide among themselves who would be included in the Emperor's new calendar. The Emperor, who wanted to be fair, decided to hold a contest. Upon his mark, whichever twelve animals were first to race to the opposite bank of the river would win a place in the calendar. The winner would come first, and the rest of the animals would receive their years according to their finish.

All the twelve animals gathered at the riverbank and jumped in. The cat was afraid of water and hitched a ride on the Ox's back. They was were joined by the rat who halfway across the river summoned all her strength and pushed the unsuspecting cat into the water. As the ox was about to jump ashore, the rat leapt over his shoulders to the floor and scurried the last few yards to win the race.

Following closely behind the Ox came the tiger, whose strength had helped her to battle the strong river currents that dragged at her fur. Fourth, came the rabbit, who washed to shore on a drifting log looking very surprised.

The Emperor was surprised to see the mighty dragon come in at fifth place. The dragon, whose great wings should have helped him to win the race with ease explained that he had been delayed by the rescue of a helpless, floundering rabbit clinging to a log and heading downstream. Stopping to blow the log to the shore with a mighty breath, he was beaten to the riverbank by four other animals, including the rabbit.

Behind the dragon came the horse who was a very good swimmer. However, just as the horse was about to cross the finish line, the snake slithered out of his mane and crossed in sixth place.

The sheep, monkey and rooster arrived at the riverbank together, having constructed a raft out of logs. They politely ushered each other up to the finish line to finish in eighth, ninth and tenth positions.

The dog, enjoying her swim so much and quite distracted by a floating log, had almost forgotten the reason she was in the water and only just made it to the bank in time to take eleventh place when she saw the pig swimming by.

Finally, claiming the twelfth place, came the pig, who had stopped to eat some acorns on the other bank and then been overtaken by the need for a nap.

The cat, who had eventually managed to save herself from drowning reached the finishing line too late to win any place in the calendar, and thereupon vowed to be the enemy of the rat forever after.

That is why the rat is the first year of the animal cycle, the ox second, and the pig last.

Another legend holds that the animals of the forest were all summoned to the deathbed of the Buddha in order that he could bid them farewell. The first twelve to reach him were honoured with immortality by their places in the zodiac, but taking a nap, and too lazy to move the cat was late to arrive and therefore missed out on being included. Other versions state that the cat's exclusion was in fact a punishment for killing the rat that *Maya*, the mother of *Sakyamuni* (the historical Buddha) had sent as medicine for her son.

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Classroom Ideas and Activities

In this area you can find various downloads and ideas for classroom or family activities. These activities are aimed at a general audience but can be adapted for use as part of a more simple or complex lesson/activity as required.

Downloads

- Download a free classroom wallchart (PDF 7.9MB) showing the Chinese constellations and the main regions of the sky.
- Download an image of a Western Star Chart from 1541, by *Honter* (Jpeg 768 KB) for projection in the classroom. This image is not suitable for printing.
- Download a template and instructions (PDF 2.9MB) to make your own *Starfinders*. See activity below.
- Download the Chinese Zodiac Wheel and Calendar (Jpeg 780KB).
- Download a template and instructions (PDF 340 KB) to make your own *Sundial*. See activity below.

Classroom activity - Learning about Constellations.

Familiarise your class with the twenty-eight constellations by making your own star-finders.

Download a template and instructions (PDF 2.9MB) and follow the discussion points below. You will need scissors, paper, pens and star shaped stickers or glow-stars.

Lesson plan/discussion points

- Discuss key astronomical terms with your class – star, planet, comet, constellations. Establish how 'classification' helps our understanding of the world.
- Discuss the notion of constellations as groupings of stars with your class – point out that different cultures recognise different constellations, but the stars contained within them are still the same. Why might assigning names and characteristics to groups of stars be useful? You can use the analogy of searching for an address to help explain.
- Show your class an image of a western star chart. (you can download an image suitable for projection or viewing on a computer from this page (Jpeg 768 KB). Highlight some familiar western constellations and ask if anyone can identify them. Then show the Chinese star chart (you can download a free printable wall chart from this page (PDF 7.9MB). Ask your class to look at the two and stress how difficult they are to compare. Explain how this attachment of certain characteristics to groups of stars has led to various myths and superstitions about their

importance and meanings.

- Divide your class into four groups corresponding to the four directions of the sky. Students should make and use the star finders in pairs to choose a constellation and discover its meaning. Each person in a group should focus on a different constellation, and then locate it on the large star chart.
- In groups, ask your class to use paper and glow stars or stickers to plot these constellations in relation to one another. Ask what the shapes of the constellations remind people of? Ask your class to think of their own ways to remember them better? Get your students to draw images around their constellations and then compare the drawings, as a whole class, with the images that the Chinese used.
- Look at some of the constellations and their meanings and myths. Examine the differences between astronomy and astrology, and how the two are linked in traditional Chinese culture.

Classroom activity – Make Cup Projectors

For this activity you will need a room that can be completely darkened, with a blank ceiling. This activity is best done with a group of students. Each student will need to choose one constellation.

If you have not already done so, download a wallchart (PDF 7.9MB) showing the Chinese constellations from this page. You will need one disposable cup and one torch per student, plus pens and pencils.

Lesson plan/discussion points

- Ask your students to each choose a constellation from the star chart and draw it on the top of a cardboard or styrofoam cup.
- Using a pen or sharpened pencil, instruct them to punch a small hole into each star that they have drawn. The holes need to be small to keep the projection focused. Make sure that the holes are no wider than a few millimetres in diameter.
- Give each student a torch and, referring to the wallchart, ask them to arrange themselves in the right position for their chosen constellation. This may take a little coordination! Ask each student to hold their cup upside down over the torch so the base of the cup is facing straight up to the ceiling.
- Make sure all curtains and blinds are pulled. Turn off the main light in the room and ask your students to turn on their torches. Rotate any cups until all the projections are facing in the right direction. As coordinator, you may need to direct the students to get this right. Students can move cups upwards to enlarge constellations, or lower them down to reduce the size.
- Ask your students to identify each other's constellations and try to give information about their associations. You can also ask students to swap projectors and try to find their new positions to test their knowledge of the sky. Try this exercise with Chinese and European constellations and see which they know best.

Classroom activity - Make a Sundial

Before the invention of the clock, people used the sky to help them find their way and tell the time of day or season. Sundials, or *rigui* 日晷 in Chinese, were basic instruments with a mounted arm called a *gnomon* which cast a shadow on a bronze or stone dial when the sun shone upon them. The shadow indicated the time of day. The earliest sundial of China, according to historical documents, was the flat horizontal dial plate, or the horizontal sundial invented in AD 574.

Make a sundial with your class to explain how shadows cast by planets (the sun in this case) can help us to tell the time.

Download a template for your sundial (PDF 340KB). You will also need scissors, glue, a compass, sellotape, a craft knife and some cardboard.

Lesson plan/discussion points

- Ask your students to stick the two templates onto sheets of cardboard or old cereal packets to reinforce them.
- Take the main template. Ask the students to carefully cut down the central line of the dial (along the cut here line) using the craft knife. Make sure the template is on a cutting mat or hard surface and make sure they are careful not to cut themselves.
- Take the template for the arm or gnomon. Cut out the shape of the gnomon and fold it along the line to firm a flap at the base.
- Insert the folded flap of the gnomon inside the slit you made in the main sundial template. Make sure the right-angle of the arm is in line with the bottom of the sundial (the point where all the lines meet on the template).
- Stick the bottom of the gnonom to the base of the sundial with tape to hold it in place.
- Take your class outside (on a sunny day!) with their sundials. Help your class to find north using the compass.
- Ask your students to place their sundials on a flat surface, and line up the arrows on the top of the sundials to point north.
- Ask your students to tell the time by reading where the shadow is cast on the flat dial.
- Visit a local sundial. Many cities offer trails of local sundials. See what is available in your area at Sundials on the Internet

Classroom activity – Understanding Map Projections

A globe is the most accurate way of representing the earth or the sky. However, flat maps are more convenient to use and to store. Maps of the earth or of the sky are also sometimes called projections because map-makers have needed to project a three dimensional surface onto a two dimensional surface in order to make them. Since a map is two-dimensional representation of a three-dimensional world, it is understood that most projections contain certain compromises to accuracy. Different maps, or projections, differ in their relative accuracy in depicting area, the shapes of objects, actual distances, and compass direction. A map-maker (or cartographer) may therefore choose to focus on the accuracy of one feature (actual distance for example), to the detriment of others (shape of land masses for example).

Make individual maps of the world with your class to illustrate the difficulties of projection and help them understand the difference between various projections.

You will need a globe (you can buy inflatable globes relatively inexpensively), marker pens, a knife, and an unwaxed orange for each student (or small group of students). You may also want some kitchen towel or wipes for sticky fingers.

Lesson plan/discussion points

- Show students the globe and explain to them that because the Earth is spherical, a globe is the only real way to accurately represent Earth in its correct proportions. Discuss the advantages and disadvantages of globes. (Consider storage and transport, size, geographical detail shown and cost). Ask students to consider why we might choose to use maps instead of globes.
- Ask students if they can explain that while maps are very useful, they are not perfect as representations of earth, other planets or the sky. Explain that when a spherical object is made flat, there are often distortions in distance, direction, shape, or area that will mean that distances

or sizes may not be entirely accurate.

- Give each student (or small group) an orange and a marker pen. Using the globe as a reference, ask students to find and mark, on their oranges, the locations of the North and South Poles, the Equator, some lines of longitude, and the major continents. These do not have to be perfect!
- Use a knife to split the skin of the orange, pole to pole. (You may prefer to do this for your students). And then ask students to use their fingers to peel the skin off the fruit trying to keep it as intact as possible.
- Once peeled, students should flatten their orange skins to create a map that is flat and readable. As students attempt to create their maps they will find that the orange skin stretches or tears. They may be able to choose where to tear or stretch the skin, but they should be aware that if they try to avoid tearing continents, they will unavoidably make changes to the seas and oceans instead. There is no way to avoid this distortion. This should help them to understand some of the difficulties that cartographers face when trying to make accurate, flat representations of Earth.
- Ask students to show their finished orange maps to the class. Discuss as a class the difficulties they encountered in trying to create an accurate map. Look at the way their maps look now, in comparison to how they did on the 'globe'. Students should observe that it is impossible to flatten a curved surface without some stretching or tearing. Explain how this is also problem for cartographers, who, although using more complex methods, also need to make certain compromises (stretching, or compressing areas on their maps) to create a two dimensional image. Explain to students that there are several types of map projections that are used to represent earth, each with certain advantages and disadvantages. No one version is better than another.
- Discuss why different types of projection might be developed. Think about the different uses to which maps might be put. Think about airline navigation, sailors navigating the sea, or the calculations of companies such as oil refineries needing to lay pipes. What other uses can you think of?
- Finally, look again at a map of the world and at a globe. Ask students what they have understood about the term 'projection' following this exercise. Discuss their responses and look at various different projections on an overhead projector to illustrate the concept. Compare these projections looking for details such as relative distances between different elements and the shape and size of land masses. The GEOSTAC website has useful images and explanation of different types of projection to use.

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Glossary

Almanac:
: an annual publication containing tabular information in a particular field or fields often arranged according to the calendar. Almanacs often contain astronomical data and information such as the times of the rising and setting of the sun and moon, eclipses, hours of full tides as well as predications.

Asterism:
: a group of stars that may form a picture. Asterisms are like constellations but generally contain fewer stars.

Asteroid:
: any of numerous small celestial bodies that revolve around the sun. Sometimes called a minor-planet.

Astrology:
: a form of divination through observation of the movements and relative positions of celestial bodies.

Astronomy:
: the study of the physical universe beyond the earth's atmosphere.

Celestial:
: a description of things positioned in, or relating to the sky or outer space, as observed in astronomy.

Chinese Zodiac:
: a rotating twelve year calendar based on the cycles of the moon. Each year is represented by a different animal. In astrology, the year of your birth determines your zodiac sign, each of which has a number of different personality traits.

Comet:
: a frozen mass of gas and particles that orbits the sun.

Constellation:
: a group of stars that seem to form a picture in the sky.

Divination:
: the attempt to gain a foresight of future events, or insight into a question or situation by way of a standardized process or ritual. Often dismissed as superstition.

Eclipse:
: a lunar eclipse happens when the earth moves between the sun and the moon, blocking part of the sun's light from reaching the moon. A solar eclipse happens when the moon moves between the earth and the sun. The sky slowly gets dark as the moon moves in front of the sun. A total eclipse happens when the moon and sun are in a perfect line. These are very rare. Most people only see one in their lifetime.

Galaxy:
: a collection of stars, planets, dust and gas held together by gravity.

Light Year:
: the distance light can travel in one year. Approximately 9,500,000,000,000 kilometres.

Mansion:
: the lunar mansions are 28 divisions of the sky used in China to mark the progress of the moon

on its orbit around Earth.

Milky Way:
: sometimes called simply the galaxy, is the galaxy in which our solar system is located. It is one of billions of galaxies in the observable universe.

Nova:
: a type of stellar explosion where a star ejects some of its material in the form of a cloud and become more luminous in the process.

Orbit:
: the path followed by a planet, comet or satellite in its revolution around another object.

Planet:
: a non-luminous celestial body that revolves around the sun. A planet is larger than an asteroid or comet and illuminated by light from a star, such as the sun.

Projection:
: A map projection is any method of representing the surface of a sphere or other shape on a flat or two-dimensional plane.

Star:
: a huge exploding sphere of hot gas (mostly hydrogen and helium) Stars shine by a process of nuclear reaction at their core that means they are constantly releasing energy. After a star runs out of fuel, it ejects much of its material back into space. New stars are formed from this material. So the material in stars is recycled.

Star Chart or Star Atlas:
: a map of the stars and planets.

Sun spot:
: a sunspot is a region on the surface of the sun—called the photosphere—that is temporarily cool and dark compared to surrounding regions.

Supernova:
: a star that explodes and becomes extremely luminous in the process.

Yin and Yang:
: in Chinese cosmology, the forces of nature are on a continuum between two forces male and female, negative and positive, dark and light, hot and cold etc. – everything contains a mixture of both, but one is usually dominant.

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Further Reading

Bonnet-Bidaud, Jean-Marc & Praderie, Françoise, *Star Charts on the Silk Road: Astronomical Star Maps in Ancient China*, in Whitfield and Sims-Williams 2004, pp81-91.

Huon de Kermadec, Jean-Michel, *The Way to Chinese Astrology*. The Four Pillars of Destiny. London: Unwin Paperbacks, 1983.

Needham, Joseph, *Science and Civilisation in China: mathematics and the sciences of the Heavens and the Earth*. Vol. III. Cambridge: University Press, 1959.

Pattie, T. S., *Astrology: as illustrated in the collections of the British Library and the British Museum*. London: The British Library, 1980.

Sun, Ruth Q, *The Asian Animal Zodiac*. Charles E. Tuttle Company, Inc. of Rutland, Vermont & Tokyo, Japan, 1974.

Sun Xiaochun and J. Kistemaker, *The Chinese Sky during the Han: Constellating Stars and Society*. Leiden, 1997.

Whitfield, Roderick, Whitfield, Susan, and Agnew, Neville, *Cave Temples of Dunhuang: Art and History on the Silk Road*. London: The British Library, 2000.

Whitfield, Susan, *Life Along the Silk Road*. London: John Murray, 1999.

Whitfield, Susan and Sims-Williams, Ursula (eds), *The Silk Road: Trade, Travel, War and Faith*. London: The British Library, 2004.

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Useful Websites

On Chinese Astronomy

The Dunhuang Star Atlas: View the Dunhuang Star Atlas on the IDP database.

The University of Maine: Comprehensive resource on all aspects of Chinese Astronomy.

Silk Road Project: Interactive 'Create a Constelllation' resource.

Space Today : China in Space - Accessible resource covering a brief history of astronomy In China and current astronomical developments.

Hong Kong Space Museum: Interactive Chinese and Western Star Maps available to download.

Shooting Stars: The UK-China Leonid Meteor Shower Observation Project: Useful resource on China's astronomical legacy.

Ephemeris : Website devoted to information about time and motion in the universe. Learn about the History of Astronomy in Ancient China.

History for Kids: Astronomy in Ancient China for Kids

Astronomy for Kids Online: Discoveries and accomplishments of ancient Chinese Astronomy.

General Sites on Astronomy

The International Year of Astronomy 2009: Comprehensive website with multi-media resources and useful links.

Kids Astronomy: Great website explaining basic terms and concepts with interactive games and downloadable resources.

ThinkQuest: Kids astronomy site with a virtual telescope for viewing western constellations.

StarChild : Learning centre for young astronomers by NASA.

NASA Kids Club : Resources for students and teachers on all aspects of astronomy.

The Nine Planets: A comprehensive information site featuring the planets of our solar system.

National Geographic: Useful tutorials explaining map projections in detail and offering lesson plans for US grades 6-8 (Ages 11-14) and 9-12 (Ages 14-18).