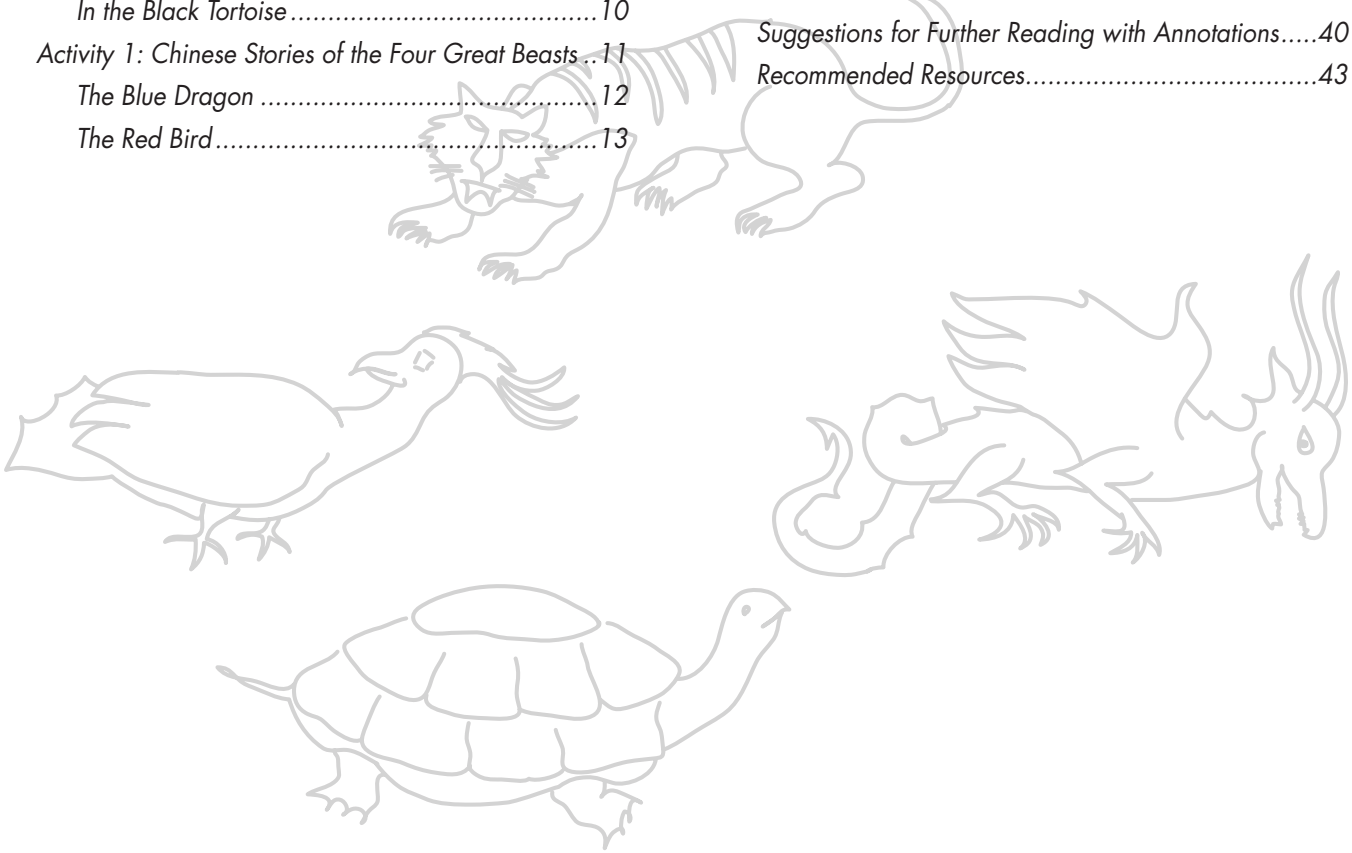
A Collection of Curricula for the STARLAB® Ancient Chinese Seasons Cylinder (The Four Beasts)

Including:

The Skies of Ancient China I: Information and Activities
by Jeanne E. Bishop

Curriulum Guide Contents



The Skies of Ancient China I: Information and Activities

for the Ancient Chinese Seasons Cylinder

Contributed by Jeanne E. Bishop

Introduction and Background Information

by Jeanne E. Bishop

Ancient Chinese astronomy was different from Western (Greek-Roman) astronomy in a number of ways.

- First, the observations and forecasts based upon those observations were intimately tied to the government and to the ruling Emperor, called the Son of Heaven. Astronomers were government officials, who were warned not to discuss "classified matters" (astronomical observations) with officials of other government departments, their subordinates, or even with one another. In contrast, Greek astronomers were free-speaking and free-writing individuals, often at odds with government ways.
- Second, the most ancient Chinese astronomy was based on four huge constellations that were roughly centered on the celestial equator: the Blue Dragon, the Red Bird, the White Tiger, and the Black Tortoise. Each beast was in a seasonal palace: The Blue Dragon in the Spring Palace, the Red Bird in the Summer Palace, the White Tiger in the Autumn Palace, and the Black Tortoise in the Winter Place. In each of these beasts, there were seven sections called "Houses" or "Mansions," which roughly define the path of the moon. The Four Beasts were not created to show the path of the sun. However, the space of the Four Beasts included the ecliptic, since the House sections identify the moon's path. The moon's path includes the ecliptic.

The Four Beasts parade with the earth's rotation in a direction opposite to the order of the seasons. This is explained by the way in which the very ancient Chinese (probably circa 15,600 BC) used these constellations to mark their seasons. Stars of the Blue Dragon of Spring and the White Tiger of Autumn were observed rising in the east before the sun — a situation called "heliacal risings." The Red Bird of Summer and the Black Tortoise of Winter were observed rising in the east at sunset.

The 12 animals of the Chinese zodiac ("the Yellow Road of the Sun"), assigned to different years in a 12-year cycle in Chinese astrology and seen today on place mats and trinkets, was developed about 200 BC. This set of figures which roughly correspond with those of the Western zodiac, developed late in Chinese astronomy/astrology. The figures of the Chinese zodiac had far less impact than the Four Beasts and other ancient sky figures. For this reason, and also because the lunar Houses and other figures are so numerous, the Chinese zodiac has not been included on either of the two Chinese STARLAB cylinders — the combination would be confusing. In Chinese astronomy, the number 12 appears to have gained significance from the 12 years it that it takes the planet Jupiter to make one 360-degree journey about the sky, rather than from the number of months in a year.

- As a third point of difference, most of the Chinese patterns (not counting the Four Beasts) are much smaller than Greek-Roman ones, and consequently, there are many more of them. In addition to the 28 lunar Houses within the beasts, there are 185 small figures known as either "co-risers" or "paranatellons." Each one is an asterism (a sky figure that is within another larger figure). Sometimes the small asterisms consist of a single star!
- Fourth, the stories of Chinese figures (that is, of the ethnic Chinese who refer to

themselves as "Han" and today make up about 95 percent of the people within Chinese borders) were usually much more matter-of-fact than classical Greek myths. There are some beautiful exceptions, but most were simple reminders of a particular office, task, or place. China's bureaucratically organized society was thought to be governed by a bureaucratically organized sky. And it was imperative for astronomers and astrologers to determine what the Sky Emperor and his sky bureaucracy wanted the Chinese Emperor and his subjects to do.

John Ferguson, quoted by Julius Staal in *Stars of Jade* (p. 1), said, "The Chinese powers of observation were remarkable, but what they saw was observed rather than analyzed. They studied natural phenomena not for the purpose of seeking an explanation of their origin, but chiefly to know the effect of these upon human life. They were a very practical people in all matters relating to facts of daily life, while at the same time, they gave loose rein to their imagination in interpreting these facts."

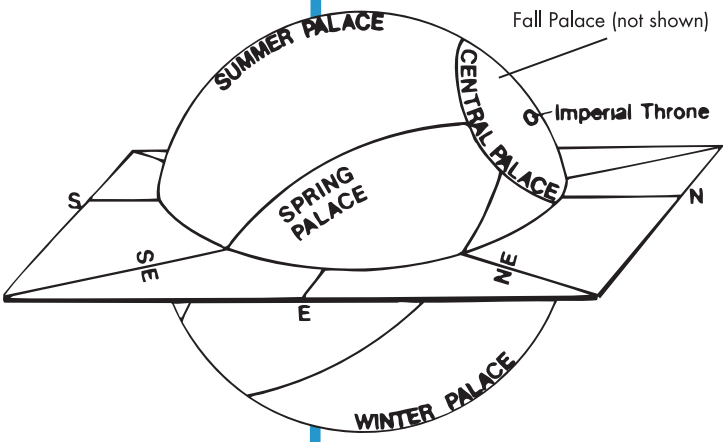
A general history of science translated by P. Mailla, also noted by Julius Staal in *Stars of Jade* (p. 115), described three different types of astronomical instruments possessed by astronomers in about 2285 BC: the template, the armillary sphere, and the equalizer. The equalizer was a type of sighting tube and the template was a view of the stars (a little like a planetarium).

In at least two ancient sources, a particularly beautiful armillary sphere was described. The Emperor Choun, shortly after 2285 BC, afraid that his astronomers would neglect their work and information would be lost, instructed them to make a great armillary sphere. He told them that they should make him a machine representing the sphere of Heaven, divided into degrees, with the earth in the center, and the sun, moon, planets, and stars where they should be. (It is interesting that the idea of a spherical earth must have been accepted.) Choun gave the scholars precious stones to mark the celestial poles, sun, moon, and planets, and pearl to make the stars. They succeeded to the extent that Choun was very happy with it and rewarded them for their work. Choun also had the astronomers construct a sighting tube of gems, and it was used to observe the gem-studded armillary sphere (!), as well as the real sky.

The appearance of the first stars of each of the Four Beasts in the east at a particular time, was the ancient reminder to prepare for certain seasonal weather and a particular time in the cycle of planting. The appearances of the asterisms in particular directions at certain times of the year were reminders of family, occupational, and government duties that should be performed. The brightness or dimness (due to atmospheric conditions) and the nearness of a comet, planet, or "guest star" (nova or supernova) greatly influenced the meaning that was attached to their appearance.

Astrologers used the court astronomers' observations to forecast weather, deaths, and invasions. Astrologers also used oracle bones, the bottom of tortoise shells or bones of cattle into which they thrust heated metal rods. They interpreted the patterns of cracks which resulted to make forecasts. With sky observations and oracle bones to guide them, the astrologers made recommendations to the emperor, the court, and ordinary people on what actions they should take.

The Shang, the oldest dynasty known with certainty, began in 1766 BC. Shang Dynasty records note the importance of the circumpolar constellations moving about the fixed north point, the north celestial pole. They referred to the north circumpolar region as the Central Palace. The Central Palace joined the quadrants of the sky holding the Four Beasts. See the figure at left.



The drawing of the Chinese sky palaces is from "The Stars of Primeval China," The Planetarian, Spring/Summer, 1974.

The text of the Shu Ching of the eighth century BC reports that a legendary emperor named Yao, living in 2357 BC, before the Shang, gave detailed instructions which relate certain circumpolar stars to certain equatorial stars. Emperor Yao's instructions show that the change in Chinese astronomy, adding the Imperial Palace to the Four Beasts, had occurred a while before his reign.

The Shang wrote that the universe exists on three levels: the heavens on top, the world of humans between, and the earth below. The idea that human society imitated the parade of northern stars was in use by Shang time. The Earth (Chinese) Emperor has a role on earth (in China or "the Middle Kingdom") like the Sky Emperor had above. The Heavenly Emperor occupied the Imperial Throne, an area of the sky either at the north celestial pole or near it. Just as north circumpolar stars moved about the Sky Emperor, court advisors and subjects all moved about the Earth Emperor. The Earth Emperor, the Son of Heaven, ruled because he had a Mandate from Heaven, permission from the Sky Emperor. People believed that heavenly gods and creatures (particularly the Blue Dragon of Spring) helped their ruler in planning for good crops and in defeating enemies. If the ruler did not produce good crops or have victories in battles, he lost the Mandate of Heaven. Then the people approved the overthrow of the earthly emperor and the beginning of a new dynasty.

Precessional change of the sky is a very important factor in understanding ancient Chinese astronomy. (Precession is the cycle of changing direction of the north celestial pole and position of the sun at the vernal equinox, which takes 25,800 years.) Julius Staal (1917-1986), a planetarium director and an outstanding Chinese astronomy scholar, demonstrated that the Four Beasts probably have the age of three-quarters of a precessional cycle originating in about 15,600 BC.

Using the precessional ability of the large Zeiss planetarium projector at the Fernbank Science Center in Atlanta, Georgia, Staal discovered that trying to follow the legendary commission by Emperor Yao in 2357 BC to set the seasons by particular stars, the required star line-ups would not coincide with seasonal observations of the Four Beasts for the precessional epoch of 2357 BC. It was necessary for Staal to precess the Zeiss projector back to 15,600 BC, before the meridian passages dictated in the commission correctly connected with those of the season named for each beast.

Due to precession, the marking properties of the four beasts have changed drastically since their first use and formation. For instance, the heliacal rising (rising just before the sun) of the stars Arcturus and Spica in the Blue Dragon, originally marked the beginning of Chinese spring and the New Year (which can occur from the third week of January to the third week of February). And the heliacal rising of Antares, the heart of the Blue Dragon, marked the spring equinox in 15,500 BC.

Now the Blue Dragon stars of Arcturus and Spica are visible in the spring sky in the evening after sunset, rather than in the morning. And the heart star Antares is a star in the summer evening sky. For about the year 2500 BC, the full moon, Arcturus and Spica rose at about sunset when spring began at 35° N. latitude, Spica a little after Arcturus. The ecliptic and moon's path against the stars were closer to Spica than Arcturus. (The author checked this observational situation with the assistance of Dr. Dale Smith and the precessional capability of the large Minolta planetarium at Bowling Green State University, Ohio.)

The still-current cultural parade of the dragon following the pearl, seen at the close of three-day festivities in the February Chinese New Year celebration, represents the full moon caught in the horns of the Blue Dragon. A figure of a dragon reaching for a pearl has been an important Chinese symbol. It was carved on the thrones of emperors and embroidered on their robes. The flag of the Chinese government that fell in 1911 contained a dragon with a pearl.

Yet the full moon in the sky dragon's horns will not now work to announce a February New Year and spring beginning! In February, Arcturus and Spica rise long after a full moonrise. Currently the new moon is used to mark the beginning of the three-day Chinese New Year celebration. The sky dragon's horns appear a long time after sunset. Precession keeps changing the relationship of the rising of beast stars to the seasonal year.

The Chinese New Year currently starts with the new moon which is in the constellation known in the west as Aquarius. It is the modern constellation of the rat in China. This is the beginning of the first lunar month. The Chinese calendar is based on twelve lunar months with each month having either 29 or 30 days. Sometimes a special month is added to keep the lunar calendar in line with the solar calendar. The Chinese calendar consists of a sixty-year cycle. Within the larger cycle are five smaller cycles each lasting 12 years.

Arcturus, which the Chinese call TA-KIO or the Great Horn, was especially important in ancient Chinese astronomy.

The Chinese people observed that the handle of the controlling Imperial Palace stars of the Big Dipper, which they call PEI-TOU, the Northern Bushel, points to Arcturus like a fishing line. The Great Horn of the Blue Dragon shares highest esteem with the Northern Bushel, due to this apparent spatial connection.

Over the long histories of moon-house asterisms contained within the Four Beasts, and the co-risers asterisms that are found near the beasts, there have been changes in the patterns' meanings. And along with the evolution of meanings, some completely new figures have appeared (including the solar zodiac of 12 constellations) and others have disappeared.

There is a feature that ancient Chinese astronomy shares with many other early agricultural societies: the cyclic concept of time. That is, major or specific events that happen in any period are believed to have happened before and will happen again. We do not know how old cyclic time ideas are in China, but writings about them can be found in records from the Shang, Chou (beginning in 1122 BC.), and Han (beginning in 202 BC). Babylonians, Sumerians, ancient Greeks, and Mayans all had detailed cyclic cosmologies as well. The concept of cyclic time shared by these peoples contrasts with the Western view of linear time. From a Western philosophical perspective (as well as the scientific one of the Big Bang), there is a single beginning to everything. To the Chinese, beginnings occurred over and over. Perhaps this deep cultural belief facilitated the cycle of dynasties: birth, expansion, decay, and a new dynasty's birth.

A knowledge of the four animals, moon Houses, and co-riser sky figures can help us understand the natural history of Chinese lands, including climate, crops, and animals. They can also help us understand attributes of the ancient Chinese people — their government, their social and military organization, their occupations, rituals, tools and materials. The patterns can illustrate discussions of historical events, such as flood control by an early emperor. Students can learn a great deal about ancient China from lessons with the two STARLAB Chinese Cylinders.

Note

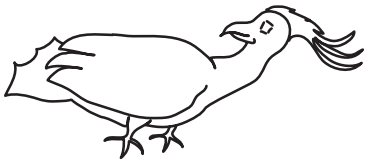
See "Suggestions for Further Reading" on pages 40-42 for more information.

The Four Beasts

The Blue Dragon

Descriptions and drawings of the Blue Dragon and other Chinese dragons show much embellishment on a probable real single reptile or reptile hybrid (crocodile-snake-lizard?). Chinese have claimed that fossils of dragons are found in high mountain caves. Some records refer to the sky dragon as green, or partly green, although blue is the predominantly reported color. Both ancient and more recent Chinese strongly believed in dragons and in their power for good. Chinese emperors adopted dragons, particularly the Blue Dragon of Spring, with its supposedly important control of spring rains, as an official symbol. The Blue Dragon is called "the Blue Dragon of Spring" and is said to live in the Spring Palace.

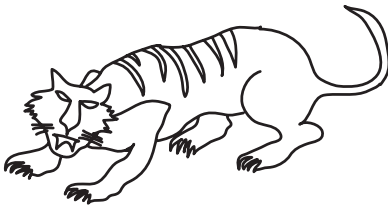
The Chinese word for the Blue Dragon was TSHANG-LUNG. Stars of the western constellations of Virgo, Libra, Scorpius and Sagittarius are found in the Blue Dragon.



The Red Bird

Like the Blue Dragon, the Red Bird may represent a hybrid of some birds seen in China. Records mention quail, and the idea that it had the beak shaped somewhat like a chicken and feet like a chicken is correct for quail. Quail were connected to the idea of the phoenix — the mythical bird that is the essence of summer heat. Today one main type of quail found in the valleys of the Huang He or Yellow River, where agriculture and astronomy are likely to have developed, is the Chinese Painted Quail. Other quail found in China during part of the year are European Migratory Quail and the Japanese Quail. All of these could have inspired the celestial Red Bird, but detailed descriptions show that it, like the Blue Dragon, is a creation of the Chinese culture. The Red Bird is called "the Red Bird of Summer" and is said to live in the Summer Palace.

The Chinese word for the Red Bird of summer is TCHOU-NIAO. Stars of the western constellations of Gemini, Cancer, Hydra, Crater, and Corvus are found in the Red Bird.



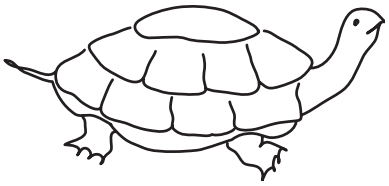
The White Tiger

The Chinese believed that a tiger turned white if it became 500 years old. However, white or creamy fur, instead of orange or yellow fur, is a genetic trait, a mutation. White tigers are not albinos. The creamy variety of tiger that we call "white" and which are now bred in captivity and seen in zoos, has not been given a separate subspecies classification. The Bengal subspecies from India is the type that has produced the "white" variety.

In China, tigers once were very common. But now their numbers are small. Three subspecies are known, none of them the Bengal. One wonders about these possibilities: a) if white Bengals were once seen in China, b) if one of China's present three subspecies (mainly the Siberian and South Chinese) had a creamy genetic variety long ago, or c) if the Chinese superimposed a mythical idea of "white" upon the celestial tiger marking autumn. White might have been suggested by upcoming winter snow. The White Tiger is called "the White Tiger of Autumn" and is said to live in the Autumn Palace.

The Chinese name for the White Tiger is PAI-HOU. Stars of the western constellations of Andromeda, Aries, Taurus, and Orion are found in the White Tiger.

The Black Tortoise



The Chinese probably were aware that tortoises mature slowly and can live to be very old. Tortoises keep growing throughout life, but only on Pacific islands do we find really large tortoises like the Chinese imagined the celestial tortoise to be. It is likely that the black color is symbolic, recognizing that the days are short and much time is spent in darkness during the winter. Since tortoises can become very old, it was believed that they could also be very wise and forecast the future. The use of bottoms of tortoise shells as oracle bones grew out of this belief.

There are three species of tortoise in China, one in the deserts known as Horsfield's Tortoise. The desert tortoise has four claws on each of its two front limbs, while the other two species have five claws. But neither match the description of the heavenly tortoise, with his eight feet and six eyes! Again, the Chinese have created a mythical animal. The Black Tortoise is called "the Black Tortoise of Winter" and is said to live in the Winter Palace.

The Chinese name for the Black Tortoise is HIOUEN-WOU. Stars of the western constellations of Sagittarius, Capricornus, Aquarius, and Pegasus are found in the Black Tortoise.

The Houses of the Moon

The Chinese Houses of the Moon are ordered from west to east (right to left), the direction of the moon's movement, within each of the Four Beasts. However, the moon would pass from House 7 of the Blue Dragon to House I of the Black Tortoise; then House 7 of the Black Tortoise to House I of the White Tiger; then House 7 of the White Tiger to House I of the Red Bird. This apparently strange situation occurs because the Four Beasts have their seasonal order in the sky from east to west, opposite the direction of the moon's motion.

In the Blue Dragon

House I	KIO	The House of the Horn
House 2	KANG	The House of the Forecourt
House 3	TI	The House of the Foundation
House 4	FANG	The House of the Sun
House 5	SIN	The House of the Heart
House 6	WI	The House of the Tail
House 7	KI	The House of the Manuring or Winnowing Tray

In the Red Bird

House 1	TSING	The House of the Well
House 2	KOUI	The House of the Spirits
House 3	LIEOU	The House of the Willow
House 4	SING	The House of the Asterism
House 5	TCHANG	The House of the Net
House 6	YI	The House of the Wing
House 7	TCHIN	The House of the Chariot

In the White Tiger

House 1	KOUI	The House of the Sandal
House 2	LEOU	The House of the Reapsters
House 3	WEI	The House of the Grainstore
House 4	MAO	The House of the Setting Sun
House 5	PY	The House of the Net (different from that in the Red Bird)
House 6	TSOUI	The House of the Head
House 7	TSAN	The House of the Supreme Commander (constellation Orion)

In the Black Tortoise

House I	TEOU	The House of the Bushel
House 2	NIOU	The House of the Ox
House 3	NIU	The House of the Virgin
House 4	HIU	The House of the Funeral Mound
House 5	WEI	The House of the Rooftop
House 6	CHI	The House of the Pyre
House 7	PI	The House of the Wall

Many cultures and religions utilized lunar calendars. As an example, the Ancient Olympic Games (776 BC to 395 AD were held at the time of a full moon . . . in July every 4th year).

Activity 1: Chinese Stories of the Four Great Beasts

Background Information

In China, the family often would gather around an older woman or man, a grandmother or grandfather, who would relate family history and cultural stories. You can assume the role of grandmother or grandfather. Put on a simple costume (robe; perhaps a beard for a man). Tell students that all of the family would listen with great respect. Of course, the students are expected to assume the proper family role!

There is one story for each of the four beasts. As you tell each story, rotate the STARLAB Ancient Chinese Seasons Cylinder ¼ of a turn toward the east. This direction is backwards compared to the direction of the earth's rotation. To avoid giving students the wrong idea about the direction of rotation, do not let the turning motion be seen.

> **Note**
>
> *In this planetarium activity, text that is in italics is suggested script for the teacher to use.*

Objective

Learn cultural stories of China that relate to the four beast constellations.

Approximate Time Needed

35 minutes

Suggested Levels for this Tested Presentation

K-12

> **Note**
>
> *The props work particularly well with younger grades.*

Integrated Subjects

- Literature
- History
- Science

Process Skills

Listening • observing • inferring • applying

Terms to be Discussed

The four ancient Chinese seasonal constellations: Blue Dragon, Red Bird, White Tiger, Black Tortoise, Oracle bones

Preparation

Set up the STARLAB dome and projector. Place the Ancient Chinese Seasons Cylinder on the cylinder platform. Position the projector for mid-latitude. Rotate the cylinder so that the Blue Dragon is in the center of the sky. Have the nail and flat piece of brittle clay ready for the fourth story, the Black Tortoise story. Optional: Put on the storyteller costume. Prepare cassette or other source for soft Chinese music. Have a small amount of glow-glitter ready in your hand for the first story, the Blue Dragon story.

MATERIALS

- STARLAB Portable Planetarium
- Ancient Chinese Seasons Cylinder
- arrow pointer
- flashlight or other projected "sun"
- a nail
- a flat, hardened piece of brittle clay

Optional

- costume of a Chinese storyteller
- gentle Chinese music to play softly as background
- glow-in-the-dark glitter (available from craft stores)
- different types and colors of feathers
- crashing thunderstorm sounds from a tape or pans struck by students
- two stones to rub together
- a flickering Christmas-tree light
- slides of a tortoise or turtle shell and/or an actual shell

As time gets close to when the dragon goes to the sky, illuminate the glitter with a flashlight in your closed hand. Have feathers for the second story, the Red Bird story. Have thunderstorm sounds (tape or sounds made by hitting pans — students can do this) and flickering electric light ready for the third story, the White Tiger story. Have slides or a tortoise or turtle shell and/or an actual shell ready for the fourth story, the Black Tortoise story.

Suggested Post-Activity

Students draw or express in other art forms the ideas of one or more of the stories presented. If they are told before the lesson begins that they will be expected to do this, they are likely to listen/observe in a more focused manner during the lesson.

Procedure

- After the students are seated, start music if you have it, tuck hands together (in a robe, if you have it) and bow in all directions. Tell students that they are about to hear stories of the four great beasts as they would have been told to a family by a respected elder.
- Turn dome lights down and fade in the stars.

The Blue Dragon

Long ago there lived a great king, whose name was Yu. He was a king of the people. He was very strong. He worked day and night to dam up the flood waters. As he worked out in the hot sun, his face was tanned as dark as the bottom of a frying pan, charcoal black from long use. One day he looked all around the land and all around the sky. Yu made special note of the fact that the sun rose on the east side of Heaven. He said to his ministers, "I must make the rivers flow to the east, where the burning sun rises. If I can cool the sun as it rises, maybe people can then live in the east. Also, the sun will be cooled off by the time it reaches our part of China. People and plants will no longer be harmed by the terrible sun."

Shine a "sun" in the east.

Yu saw that floods were then occurring in the southern part of China. He decided to move boulders to stop the floods. For three days and three nights, Yu piled boulders in baskets on the ends of his shoulder pole and carried them from the highest mountain in Shantung. Altogether there were 90 loads, which paid 9 enormous heaps. Today we call these 9 heaps the Long White Mountains. They stopped the floods.

Now Yu needed a way to channel the water over to the east, to cool the burning sun. He said to his people, "I want two deep river beds through which the water will flow easily to the eastern side of Heaven." Yu spoke magic words and the largest dragon of the land appeared. It was a brilliant blue, and its scales glowed in the sunlight. The four feet were each as big as a huge tree, and on their ends were curved, sharp claws. It had a long coiling tail and when it breathed, mists and clouds appeared. Geysers of water erupted from its nostrils. The Blue Dragon twisted and turned its body in all directions.

Yu said, "You will serve my purpose well." Then Yu spoke more magic words. The largest snake of the land appeared. The snake was green and was so long that you could not see its end. The snake's tongue was thick and tapering, and it shot in and out of his hissing mouth. Said Yu, "You also will serve my purpose well."

To the Blue Dragon and the Green Snake, Yu now said, "Each of you is to dig a deep ditch, one on either side of the Long White Mountains."

Ask the students: "How do you think Yu expected each of these animals to make a ditch?" Answers will vary. Go on with the story.

The Blue Dragon began to work at once. Into the ground at one end of the mountains it dug

its long curved claws. It made a very deep bed. The dragon swished its body every way possible, widening, and smoothing a great, deep channel. Water would flow here very fast and easily. As it worked, the Dragon huffed clouds, puffed mists, and spurted geysers from his nostrils. He was tired but he continued to make the perfect channel for King Yu's floodwaters.

The Green snake rolled and slithered a little while in the ground. Soon it had made a small river bed. With each roll the channel got a little deeper. But the snake did not concentrate on rolling in the same place. He rolled all over the place, making only shallow marks on the land. After a short time the snake said, "That is good enough. I am tired of working." He hissed loudly, "I am finished King Yu." He added slyly, "And I am done before the Blue Dragon."

"I am finished, also, King Yu," roared the Blue Dragon, very tired, clouds and mists rising slowly from his head.

"Good," said Yu. "I will come to inspect your work." First Yu went to where the dragon had toiled so hard. "You have made an excellent place for my river," smiled Yu. "I will reward your fine efforts."

Then Yu went to the poor bed of the Green Snake. He saw the wide shallow depression that the snake had made by merely rolling from side to side a few times.

Yu frowned. "Shame on you, Green Snake, for doing such poor work."

"Green Snake," said Yu, "I order you to go to the deep ocean and stay there where the waves will pound you without stopping as punishment for making such a poor water bed." The snake slithered off into the ocean.

"Blue Dragon," said Yu, "I will reward you for your excellent work. I will place you in Heaven, where you will live forever and direct the rains that fall." With great respect, Yu spoke magic words over the dragon. With a burst of mist, clouds, and geysers, the Blue Dragon was no longer on the land.

Throw the flashlight-illuminated glow-glitter high into the air (not above the STARLAB equipment or directly over students).

The Blue Dragon went into the sky. That is where we can see the dragon now. Just look up.

Turn down the dome lights. The Blue Dragon should be clearly visible. Point out parts of the beast.

The Blue Dragon went to the Spring Palace. He governed the rains that began in the spring.

The Red Bird

Rotate the cylinder (toward east, without showing stars) so that the Red Bird is in the center of the sky. Turn down the dome lights.

The Red Bird is the King of Birds, the Bird of the Sun. He was called the Red Bird, because red is identified with the sun. Everyone admires the King of the Birds.

On a day long ago, all the birds were excited because they were invited to a birthday party of the King of Birds in Heaven. The King, of course, put on the best feathers he had to attend the party. Although we see an all-red bird here, he sometimes dresses in very special feathers. For its birthday, the King wore feathers that were dark green. On his throat, he placed beautiful purple feathers. On his wings he added steel blue feathers. On his back he wore white feathers. And on his head he put a crown of green feathers that danced with gold.

To attend the birthday party of the King of Birds, the other birds put on the best feathers they had, too. But there was one bird who had no pretty feathers. It was Wu-ling-tzu. He said, "I have no feathers. I will not look nice at the birthday party for the King of Birds. And I'm so

cold." Wu-ling-tzu cried and cried.

Finally the King of Birds heard him crying. He looked down from his perch in Heaven and thought of a way to help Wu-ling-tzu. He sent an order to the Middle Kingdom (the earth) for all the birds to each give Wu-ling-tzu a feather. The birds obeyed, and soon Wu-ling-tzu looked very beautiful in his gift feathers.

Show different types and colors of feathers if you have them. (If you have enough, you can give one to each student at the start of this story, saying that the students are like the birds with feathers to give. Have them give the feathers to you (as Wu-ling-tzu and the King of Birds) and take them back at the appropriate times)

But instead of being grateful, Wu-ling-tzu just felt conceit. "I am now as beautiful as the King of Birds," he said. "I will go to the party with my beautiful feathers and sit with the King of Birds on his perch in Heaven."

The time for the party came. Wu-ling-tzu flew up and sat on the perch of the King of Birds in Heaven. The King was receiving the other birds as guests and did not notice until other birds told him that Wu-ling-tzu had taken the royal perch. But soon all the birds were talking about it. The King was annoyed.

"Take away his feathers," said the King of Birds. "Wu-ling-tzu does not know how to receive a gift. Yes, he will be poorly dressed and cold, but this will teach him a lesson."

Soon Wu-ling-tzu was stripped of all the pretty feathers. He flew down from Heaven, ashamed of himself. The party went on, and each guest gave the King of Birds the feather first given to Wu-ling-tzu. Now the King of Birds is more magnificent than ever.

Ask the students: "Do you think he is beautiful?"

Note

The Chinese do not now know which bird was Wu-ling-tzu.

The White Tiger

Rotate the cylinder (toward east, without showing stars), so that the White Tiger is in the center of the sky. Keep the stars off and dome lights on low.

Ask the students: "Why do people live in houses? Why does the White Tiger live in the sky or the hills? The story I am about to tell explains these things."

Long, long ago, so long that no one can remember when, people lived in caves with tigers. One day the sky turned as black as night without stars.

Turn the dome lights way down without turning on the cylinder.

Wild winds howled and rain blew fiercely.

Turn on loud, crashing thunderstorm sounds if you have them.

The storm was so bad in one place in China that only a young man, a dragon, and a tiger survived. The three hid beneath a huge rock and were saved. All the caves were flooded, so there was no place for the three to live. "We must build a house," said the young man.

"Yes, we must," growled the dragon and the tiger. Dragon leaped about looking for logs. He rolled the logs to one place. Tiger gathered an enormous pile of grass and twigs. The young man used stones as knives and vines as ropes to cut pieces and lash them together. Working together, the young man, dragon, and tiger soon had a house that was dry and warm.

For a while, the three lived together in the dry, warm house. But then they began arguing. Things got worse, and they decided that they could not go on living together. Only one of them

could stay in the house. The tiger said, "Let us have a test to see which one keeps the two others out the house. The one who wins will keep the house."

The dragon and young man agreed. First the dragon tried. The dragon began piling black clouds in the sky. He growled and swished and created a terrible downpour, just around the house. The young man and the tiger were frightened, but not frightened enough to run away from the house.

"Now it is my turn," said the tiger. He leaped from the house. He shook his tail and growled so that grass and trees shook. Sand and rocks fell. The house shook, too. The young man and the dragon huddled in the corner of the house. They were frightened, but not frightened enough to run outside.

"Finally, it is my turn," said the young man. With the two animals inside, he went out of the house and picked up two stones. He began rubbing them together.

Turn up the dome lights. Demonstrate rubbing two stones together, if you have them.

Ask the students: "Does anyone know what the young man was going to do?" Answers will vary. Go on with the story.

Soon the friction of the rocks created a flame and a lot of smoke. The young man put a little dry grass close to the house and burned it. Inside, the animals coughed and choked. Show a flickering electric light if you have it. They ran out of the house. The young man put out the small grass fire and walked into the house. "Oh well," said the dragon, "I can go up to Heaven and visit my cousin the Blue Dragon when I need a place to stay." And the dragon left.

"I will go up, too," said the tiger. He climbed up into the hills. After living there for a very long time and having many, many offspring that still live in the hills most of the year, this tiger climbed even higher — into an empty region of the sky. Because he passed his 500th year, the tiger turned white. And that is why we see a white tiger in the sky today."

Turn on the cylinder.

Ask the students: "Do you see him there today?"

The young man, of course, lived in the house. And all his children and grandchildren lived in the house. And even today, people still live in houses.

The Black Tortoise

(This discussion is more a description of it than a story about it.)

Rotate the cylinder (toward the east, without showing stars) so that the Black Tortoise is in the center of the sky. Turn down the dome Lights.

West of the great mountains lies the Lake of Stars. The heavenly Black Tortoise lives in the Lake of Stars. He is very, very old, older than tortoises on the land, which grow to be very old. We know that somewhere on his back there is an outline of the Northern Bushel.

Point out the Big Dipper, which had "the Northern Bushel" as one name.

The back of the tortoise is round, like the sky shape. The bottom of the tortoise is square, the shape of the flat earth. We know that somewhere on the heavenly Black Tortoise's stomach are outlines of five great mountain peaks and four canals to control the floods, important places on the earth. The tortoise walks along in the sky, turning its head to the west in the evening and its head to the east in the morning to see an important sky object.

Ask the students: "What do you think the tortoise is looking at in the evening and morning?" (The sun.)

Since the Black Tortoise has so many true things represented on his body, we know that he is very smart. He can tell what will happen in the future. Long ago people asked questions of the tortoise. A priest thrust a very hot metal rod into the bottom of a tortoise shell after asking a question. The way that the shell cracked was interpreted for answers.

Procedure

- Turn up the dome lights.
- Prepare to force a nail into a flat piece of hardened clay
- Ask students, adapting to the grade level: "Do any of you wonder about the outcome of something that will happen later today, something that you do not know now, such as, will it rain after school? What will my lunch be? Will the test this afternoon be hard? Will my friend be able to talk to me on the phone this evening?" Get a specific question from a student.
- With the nail, try to inscribe the question on the flat piece of clay without breaking it. "Such a question would be answered like this."
- Force the nail into the clay with a hammer or other method. Observe safety needs. (Shield the clay so that pieces do not fly away. Watch that you do not hit a close student who may shift position as you hit the nail.) Show everyone the cracks.
- "Hmmm. The Heavenly tortoise answers that . . ." (Complete the sentence for the question.)

These pieces were called 'oracle bones.' The answer, like the one I just made up, was written with the question on the tortoise shell. We can learn a lot about the life of our ancestors by reading the instructions on oracle bones — like what they had for lunch and if tests that they gave were hard(!) The Black Tortoise in the sky reminds us that he has been helping us for a long time.

Turn down the dome lights and again show the Black Tortoise.

Extension Class Activities

See the suggested post-activity above, to be mentioned at the start of this presentation. Have students search books on Chinese art (or view art at an art museum) to see how the Four Beasts have been incorporated in art. (They will find many dragons and birds and a few tigers and tortoises. They may find pictures of the tortoise shells used as "oracle bones.")

Activity 2: Views of the Four Beasts from Different Places in China

Background Information

The northernmost point of China is Heilongjiang Province, which is at a latitude of 53°, 31 minutes N. The southernmost point is Zengmu Shoal in the Nansha Islands, which is at a latitude of 4° N. Although the Chinese people all revere the great beasts, the beasts would certainly have different seasonal meanings at different latitudes for a particular time in history. When Chinese at Heilongjiang are experiencing ice and snow, the people of Hainan Dao Island off the southern coast of the mainland are busy planting crops, especially rice. And on Nansha Island, these Chinese are sweltering under a tropical sun. The valleys of the Huang He or Yellow River are thought to be the "cradle" of Chinese civilization. These valleys are at approximately 35° N. latitude.

> **Note**
>
> *In this planetarium activity, text that is in italics is suggested script for the teacher to use.*

Objective

Learn how the sky paths vary between the northernmost and southernmost locations in China.

Approximate Time Needed

25 minutes

Suggested Levels for This Tested Presentation

Grades 4-5, Middle School, High School

Integrated Subjects

- Geography and Map Skills
- Science

Process Skills

Observing • listening • identifying • marking • inferring • discovering • distinguishing

Concepts to be Applied

The four ancient Chinese seasonal constellations: Blue Dragon, Red Bird, White Tiger, Black Tortoise; Latitude

Preparation

Set up the STARLAB dome and projector. Place the Ancient Chinese Seasons Cylinder on the cylinder platform. Position the projector for about 35° N. latitude. Place the dragon in the center of the sky (on the celestial meridian). Have the slide or transparency of the map of China ready to show. Have penlights and sections of plastic with pieces of glow-tape ready for each student.

Procedure

After the students are seated, pass out penlights and sections of plastic with glow-

MATERIALS

- STARLAB Portable Planetarium
- Ancient Chinese Seasons Cylinder
- arrow pointer
- bright flashlight
- slide or transparency of a map of China with the Yellow River and parallels of latitude shown.

For each student

- penlight
- a section of plastic, such as a 6" plastic ruler, with 2 small pieces of glow-in-the-dark tape. Make the glow-tape by painting masking tape with fabric paint. Use one color (the yellow-green works best) for one student piece and label it with a prominent (black marker) "1." Use another color (orange will contrast; it is not quite as bright for the same illumination) for the other student piece and label it with a prominent "2."

tape. (If you think it best, delay handing these out until after the discussion with the map and a cylinder rotation to review the Four Beasts.) The discussion below assumes that the students have had some introduction to the Four Beasts. If they have not, incorporate discussion of the constellations, and lengthen the time allowed for the program to include this. Turn on the slide/overhead projector with the map of China.

From this map of China, we can get an idea of how large China is. China covers about one-fifteenth the total land surface of the world. From east to west, it covers about a sixth of the world's circumference (50° of longitude). From this map, determine the latitude that is farthest north and the latitude that is farthest south.

Answers should be close to 55° N and 5° N. Point out their locations with arrow. "What is the span of latitude in China?" 50°.

Notice the Yellow River, also called the Huang He River. Point out its location. In the valley regions of this river, Chinese civilization began. The ideas of the Four Sky Beasts probably also began here. What is the approximate latitude here? About 35° N. The planetarium will now show the sky as it can be seen near the Yellow River, 35° N.

Turn down the dome lights and turn on the cylinder.

We'll watch a parade of the four sky animals of the ancient Chinese people, with the earth's rotation, at the latitude of 35° N.

Turn the cylinder around once. Review the Four Beasts. (They are in reverse order compared to the seasons.) Use the arrow to show how high and how low each beast extends in altitude as their top and bottom parts cross the meridian. Stop when the Blue Dragon is back on the meridian.

Did you notice that the stars of each of the beasts filled about the same region when they came to the middle of the sky? The low places and high places of each were close to each other. (The tiger's tail is a little farther north than the highest altitude for the other animals.) If we concentrate on places where the parts of one beast are as it comes to the middle of the sky, we'll also be finding places close to where the other animals pass.

We are going to outline the dragon seen from the Yellow River region, about 35° N. Turn on your penlight and shine it on the piece of tape that is marked "1."

Procedure

- After discussing safety and procedure, which will vary with the group, have students place their pieces of tape along the outline of the dragon. Put dome lights on low. (A further focus can be introduced by asking each student to memorize the part of the dragon he/she marked with the first piece of tape. Then at the next latitude have each student place the second piece of tape on the same dragon part.) Turn your bright flashlight on the tape for 20 seconds and then turn down the dome lights. The "tape dragon" should glow nicely.
- With the dome lights up so that the star dragon cannot be seen, tip the cylinder to a latitude of about 5° N. "We're now in the tropical zone of China, the Nansha Islands. We are at the most southern position in China, about 5° north of the equator." Show the map of China and point out this location.

What do you think will happen to our view of the star dragon (not the "tape dragon," which will not move on the dome) here at the Nansha Islands, at only 5° N. latitude?

Do not give the answer. Turn down the dome lights. Students will discover if they are right or wrong. (The star dragon is at a higher altitude.)

We are going to outline the dragon on the dome again, but this time for the way we see it from the Nansha Islands. Turn your penlight on the piece of tape marked "2," so that when we use it, it will glow.

Procedure

- Ask students to place this second piece of tape along the outline of the dragon as they see it now. Turn your bright flashlight on this second "tape dragon" for about 20 seconds. It should glow nicely. Illuminate both tape dragons. Students should distinguish the outlines of the overlapping dragons, since the first (higher altitude, from 35° N.) is a brighter yellow-green color and the second (lower altitude, from 5° N) is a darker orange color.
- Keep the dome lights low enough to view the glowing tape dragons.

You can see the difference in positions of the dragon at 5° N. and 35° N. From this observation, can you predict what will happen to the position of the dragon (not the "tape dragon," but the picture and stars) when we look from a latitude of 55° N?

Answers will vary. Some students will probably infer the correct position. Do not give the correct answer.

Now we'll go the part of China that is farthest north, Heilongjiang Province.

Procedure

- Show the map of China and point out this location.
- With the dome lights up so that the dragon cannot be seen, tip the cylinder to a latitude of about 55° N. Turn down the dome lights. Students discover if they were right or wrong. (The star dragon is at a lower altitude.) Shine your bright flashlight on the two "tape dragons." The students can see the star dragon for 55° N and the tape dragons for 35° N. and 5° N. all together.
- While the glow of the tape dragons is still visible, let the cylinder turn slowly to show all Four Beasts during an earth rotation at 55° N.

Remember that the "tape dragons" show about the same spaces where the other beasts would be seen at 35° and 5° N, as they come to the middle of the sky. So your tape shows the approximate place of each beast at those places. Compare your taped regions to the place where each of the animals are now moving across the sky.

Extensions

If there is time, this lesson can be extended to mark the places of another beast at different latitudes. Remove the tape used for the dragon and place it back on the pieces of plastic. If this is done, do not spend time noting the similarity of highest and lowest altitudes of the beasts at their meridian passages.

This lesson also can be extended by going to an additional latitude in China. A high school world history teacher could supply a list of places of interest in his/her course, and another intermediate latitude could be added. A piece of glow-tape in blue color could be used to mark the dragon at this latitude.

Geography of China

Activity 3: What's Rising? The Four Great Beasts as Ancient Seasonal Markers

Background Information

There is strong evidence that the four beasts originated as seasonal markers in about 15, 600 BC., long before the earliest written Chinese records. We continue to refer to the four beast constellations by names appropriate to their seasonal positions 15,600 years ago. Three of the animals, the red quail, the white tiger, and the tortoise (1 desert and 2 other), are real and can still be found in China today. The dragon is mythical.

> **Note**
>
> *In this planetarium activity, text that is in italics is suggested script for the teacher to use.*

Objective

Learn the names, times visible, and seasonal meanings to the ancient Chinese of four primary constellations.

Approximate Time Needed

50 minutes

Suggested Levels for This Tested Presentation

Grades 4-5 (with deletion of some sun motion detail), Middle School, High School

Integrated Subjects

- Science
- History

Process Skills

Observing • listening • inferring • predicting • discovering • drawing • plotting • interpreting

Terms to be Discussed

The four ancient Chinese seasonal constellations: Blue Dragon, Red Bird, White Tiger, Black Tortoise; Heliacal rising

Concepts to be Applied

(Lessons on Rotation and Revolution with the STARLAB Starfield Cylinder could precede this lesson):

Rotation

Revolution

Preparation

Duplicate Activity 3 Worksheet in this booklet. Set up the STARLAB dome and projector. Place the Ancient Chinese Seasons Cylinder on the cylinder platform. Position the projector for about 35° N. latitude. (Polaris will be less than halfway from the north horizon to the zenith.) Turn the cylinder so that the head and horns of the Blue Dragon are just below the eastern horizon. Turn up the lights.

MATERIALS

- STARLAB Portable Planetarium
- Ancient Chinese Seasons Cylinder
- arrow pointer
- flashlight

For each student

- Activity 3 Worksheet
- pencil
- clipboard
- penlight

Optional

- a movable projected sun or a glow-paint disk and Velcro back with positions of sunrise, noon, and sunset during the year marked with Velcro on the dome. (Use the flashlight to show the sun in many positions if you do not have either of these.)
- an overhead projector with transparencies or a slide projector with slides of correctly drawn sections of the worksheet.

Procedure

After the students are seated, pass out worksheets, pencils, clipboards, and penlights.

Many thousands of years ago, when Chinese culture was in its early stages, four huge constellations helped keep a calendar. We are going to see at what times these constellations were visible to the ancient Chinese and learn what significance they had to them. On the back of your worksheet you can see drawings of these constellations on a star chart. What animals do they seem to be?

Students will find a dragon, a bird, a tiger, and a tortoise (or turtle).

The Chinese referred to these as the Azure or Blue Dragon, the Red Bird, the White Tiger, and the Black Tortoise.

Ask the students: "In which direction does the sun rise?" East. Explain and point out that the actual position, east or north or south of east, changes during the year. In the east, either shine a bright flashlight in the eastern position, produce a projected sun, or attach a flashlight-activated glow disk to the velcro spot on the dome.

When the sun rises, stars fade. Stars are still present in the sky, but the atmosphere does not permit us to see them. A long time ago, at the beginning of Chinese spring, the sky was like this just before sunrise.

Turn down the lights and turn on the Four Beasts Cylinder. "Which animal do you see in the sky before sunrise in spring?" Red Bird. "The Chinese said that the Red Bird was the constellation which marked summer. They said that the Blue Dragon was the constellation which marked spring. Look at your worksheet and look at the sky. Can you figure out where the Blue Dragon is at sunrise in spring?" Students can see on the dome that the sun is east of the Red Bird. They can see on their worksheets that the Blue Dragon is east of the sun. They should infer that the Blue Dragon is just beneath the eastern horizon. Do not give the correct answer. Get different student responses and ask students to explain their reasoning.

Let's see if your prediction is correct.

("Hypothesis" is a better term for high school students.)

We will let the Earth rotate. The sun would rise higher in the sky. Outdoors the stars would not be visible in the daytime. However, in the planetarium we will be able to see those stars that rose after sunrise.

Remove the sun indicator from the east position. With a flashlight or pointer, show how the sun would rise higher with earth rotation. Turn the cylinder so that the Dragon's head and horns slowly rise in the east.

To remember what we see, we'll record our observation. Look at the first sketch on your worksheet, Horizon Drawing 1. See the directions?

Ask the students: "Where is east?" Left side.

Draw a disk with rays for the sun just above east. Draw the dragon's head directly underneath as you see it in the sky.

Students draw. If possible, project the correct Horizon Drawing 1 with an overhead or slide projector, so that students may check their work.

We'll also record where the sun is on the star chart. Put a disk of the sun between the Red Bird and the Blue Dragon. Write the word "spring" on the line near your drawing.

If possible, project the star chart with the correct disk and label.

It was important to know when spring began. There were crops to be planted and rituals to

be performed to welcome the sun coming back from a low winter path. Now watch the sun move across the daytime sky at the start of spring. Watch the dragon rise. Remember that the dragon could not really be seen when the sun was in the sky, but the Chinese figured out that it was here."

Procedure

- Use a flashlight to show the sun's daily motion while the dragon is filling the sky. When it is noon, the sun will be about halfway above the southern horizon. (If it were the spring equinox for 35° north latitude, the sun would be at 55° altitude. But the "beginning of spring" was in mid-February, which will mentioned later.) The dragon will be in the east. Let the cylinder continue to rotate. At sunset, the tortoise will be in the east and the dragon will be in the west.
- Turn up the lights and turn the cylinder so that the head of the dragon is back beneath the eastern horizon. Then turn dome lights on low. (Don't show the stars backing up; it gives the wrong idea about the direction of earth rotation.)

Let's watch another day at the beginning of spring. In order to tell that it was spring, the Chinese watched for the appearance of two stars in the light of dawn. We call these stars Arcturus and Spica. A star that is seen in the east while it is fading in the sunlight is said to have a 'heliacal rising.' We will watch for the heliacal rising of the bright star Arcturus and then the heliacal rising of the bright star Spica."

With dome lights on low, observe the heliacal risings and identify the stars Arcturus and Spica. Arcturus is at the tip of one horn and blue Spica is shown in the jaw.

Throughout the spring other dragon stars had heliacal risings.

Let the cylinder continue to rotate. Point out the heliacal risings of the remainder of Blue Dragon stars.

See the red star we call Antares.

Point out red Antares inside the dragon.

The heliacal rising of Antares was the ancient Chinese marker of the spring equinox. The Chinese said that the spring equinox was the middle of their spring. The ancient Chinese began their spring in February with the first sighting of the dragon's head.

Ask the students: "What date is the beginning of our spring?" March 20 or 21, the spring equinox.

The ancient Chinese said that the Blue Dragon lives in the Spring Palace. Even today the Blue Dragon is called the Blue Dragon of Spring. Each of the other large animals is identified with another seasonal palace. The Chinese thought dragons were beneficial as well as powerful. Dragons were adopted by Emperors as their special symbol of power. Clothing and other things that belonged to the Emperor and were used by him frequently were decorated with dragon symbols. The Chinese said that dragons laid eggs that took 1000 years to hatch. When they did hatch, big floods occurred. In parts of China there were big floods in spring. Since some real reptiles' eggs do hatch in flood water, people probably got the idea that floods and dragons were connected. Another natural event that helped this idea is that crocodiles, which may have looked like dragons, rose out of mud when spring rains began. The Blue Dragon was said to come in the spring with the rains and the floods.

Rotate the cylinder until the entire dragon is visible.

During the months of ancient Chinese spring, the sun passed through the stars of the Blue Dragon, like this. Remember that the movement against the Blue Dragon could not be seen due to bright sunlight.

Demonstrate the west-to-east movement of the sun through the dragon, passing from Antares to the tail.

How do you think the Chinese knew that the sun was passing through the dragon?

Answers will vary. They saw the heliacal risings of successive dragon stars.

The eastward moton of the sun against the stars is due to earth's revolution. Earth revolution is opposite the direction that earth rotation causes the sun to move. (That direction is westward.) In any season, the earth moves a quarter of its orbit about the sun. The sun appears to pass through one fourth of the sky. Each quarter of the sky is the length of one Chinese beast.

Shine a flashlight "sun" in the east, behind the tail of the dragon.

Notice that the sun is behind the dragon. Spring is over. It is the beginning of summer. Look at the star chart. Draw a disk and write 'summer' behind (east of) the dragon.

If possible, project a sketch of the star chart with the sun disk and label in the correct positions.

Ask the students: "What beast is on the other side of the disk you drew?" The Black Tortoise. "Do you remember which beast has the Summer Palace? Was it the Black Tortoise?" The Red Bird has the Summer Palace; no.

We will now watch a heliacal rising of stars at the beginning of summer.

With a "sun" in the northeast, rotate the cylinder. The stars rise to show the head of the tortoise.

Ask the students: "Does anyone have an idea at what time of day the Red Bird of Summer was seen?" Discuss ideas. Students can see on the star chart that the Red Bird is opposite the Black Tortoise. Someone may suggest that the Red Bird would have been seen when the sun is on the opposite side of the sky, when it sets.

Recommendation

Do not acknowledge that this is the correct answer. Instead, let the tortoise and then the tiger move across the sky with the earth's rotation, the flashlight moving ahead of the tortoise. Pass the "sun" high above the southern horizon at noon. Show a sun near northwest at sunset. Review that the stars the students see could not really be seen while the sun was above the horizon.

Now watch as the sun sets and the summer evening stars rise in ancient China.

Remove the sun. Rotate the cylinder so that the head of the bird rises.

Ask the students: "When was the Red Bird visible in the summer? Was your prediction right? How did the Red Bird mark the beginning of summer?"

Evening and night; variable. When part of the Red Bird became visible in the east in the evening just as the sun set, the Chinese knew that summer had arrived. Summer began in May for the ancient Chinese (circa 15,600 BC). All seasons began a month earlier than equinoxes and solstices.

We'll record the marker information for summer on Horizon Drawing 2 on your worksheet. Draw a sun disk on the horizon in the northwest. Then draw the head of the Red Bird in the east.

If possible, project a correct Horizon Drawing 2 with an overhead or slide projector, so students may check their work.

Also draw a sun disk on your star chart and write 'summer' near the head of the Red Bird.

If possible, project a sketch of the star chart with a sun disk and label in the correct positions.

As the Red Bird rises, the hours of evening would pass. The Red Bird would have been visible throughout the summer night.

Let the cylinder rotate. The dragon will rise and be in the east at sunrise. You can note that the dragon is seen at night, but it had no meaning as a marker for summer.

In ancient China the Red Bird represented heat, the heat of summer. It was identified with the Chinese phoenix, a mythical bird that renews itself in fire. The Red Bird is described as having the head and beak of a chicken, a neck like a serpent, and feathers which overlapped like the scales of a tortoise. It had wonderful colors and was called the 'King of the Birds.'

Let the cylinder rotate until the tortoise begins to rise.

It is the beginning of another day in summer. Throughout summer the sun moved eastward through the stars of the Black Tortoise while the Red Bird was visible at night.

Place a "sun" at the east direction. Rotate the cylinder until the tortoise tail is visible in the east.

By the end of summer, the beginning of autumn, the sun appeared at the end of the tail of the Black Tortoise at dawn. The beginning of autumn occurred in August. Draw a disk for the sun on your star chart at the end of the tail of the Black Tortoise. Write 'autumn' (or 'fall') on the line near your disk.

If possible, project a sketch of the star chart with a sun disk and label in the correct positions.

Ask the students: "Can you tell from your star chart which stars have a heliacal rising in autumn?" Students will see that the White Tiger is behind the Black Tortoise. "Now watch to see if you were correct."

Let the cylinder rotate until the tail of the tiger rises. Dome lights are still on low. Let the cylinder continue to turn so that students can see the full tiger. Students will see that it is a tiger from the stripes even before the head rises.

By the time the face of the White Tiger was above the horizon at the beginning of autumn, the sun was at its noon position.

Shine the flashlight sun about halfway above the southern horizon. Turn up the lights and rotate the cylinder back so that just the tail of the tiger is visible. Project a "sun" in the east.

Although you have seen the full tiger, the tail was all that could be seen at dawn as autumn started. The heliacal rising of these stars was the marker for getting ready for fall. Find Horizon Drawing 3 on your worksheet. Draw a sun disk and tiger tail above the eastern horizon.

If possible, project a correct sketch of Horizon Drawing 3.

The White Tiger was an appropriate marker for autumn. Tigers appeared in the open countryside at the beginning of fall. Winds picked up at this time of year and forced tigers from their homes in woods and mountains. The idea developed that winds were caused by the White Tiger, like the idea that spring floods were caused by the Blue Dragon. The White Tiger, a ferocious animal, foretold the coming of ferocious fall thunderstorms. The Chinese believed that tigers lived to be very old. When a tiger became 500 years old, they said, it turned white. Today we realize that white tigers are a particular color variation of tiger, with the normal orange or yellow mutated to be a creamy white color.

Ask the students: "We have seen how three of the beasts marked the seasons. What is the fourth beast?" The Black Tortoise.

We saw that heliacal risings of stars of the tail of the White Tiger and stars of the horns of the Blue Dragon announced autumn and spring. We saw that the appearance of the head of the Red Bird in the evening announced summer. Can you determine how the Black Tortoise was used to announce winter? Was the head of the Black Tortoise seen at dawn? Or was it seen at sunset? Study all of your drawings to try to figure this out.

Procedure

- Some students should conclude that the rising of the Black Tortoise's head in the east in the evening was the marker for the beginning of winter. Either now or after letting students discover they were right or wrong, discuss the reasoning: the sun moves eastward through the White Tiger so that it is at the head of the Red Bird at sunrise at the beginning of winter. The stars opposite the Red Bird are those of the Black Tortoise, which would rise when the Red Bird set.
- Have dome lights on low. Rotate the cylinder so that the tiger and bird are above the horizon. Move the flashlight "sun" eastward through the tiger stars to a place between the tiger head and the bird head, to show earth revolution during the fall. Then rotate the cylinder and move the flashlight "sun" east-to-west together to show earth's rotation at the beginning of winter. Move the "sun" so that it is about $^{1}/_{3}$ of the way above the southern horizon at noon and it sets in the southwest. (November, rather than the solstice, was considered the beginning of ancient Chinese winter.) The bird sets at sunset. Rotate the cylinder a little more; the tail of the tortoise rises.

On your worksheet, find Horizon Drawing 4. Draw a sun disk in the southwest, where you saw the sun set. Now copy the drawing of the head of the Black Tortoise we see rising in the evening in the east.

If possible, project a correct sketch of Horizon Drawing 4.

On the star chart draw a sun disk and write 'winter' between the tail of the Blue Dragon and the head of the Black Tortoise.

If possible, project a sketch of the star chart with the sun disk and label in correct positions.

Ask the students: "Why do you think that a tortoise was chosen to mark the beginning of winter?" Students probably will know that tortoises and turtles are slow creatures. They should connect this fact with the knowledge that winter is a cold, sluggish time of year, when few green things grow and people try to stay indoors to be warm.

Real tortoises bury themselves during the winter, showing everyone that winter has come. This activity matched with the appearance of the Black Tortoise in the sky. The ancient Chinese said that there was an immense old tortoise which existed before the beginning of the earth and the sky. It was born from the dragon, they said, at the moment the universe was organized. Look at the sky.

Ask the students: "Is there something about positions of the Blue Dragon and the Black Tortoise that might have suggested this origin for the tortoise?" Students should see that the tail of the dragon is ahead of the tortoise, suggesting a birth order.

Rotate the cylinder so all the seasonal beasts circle the sky. Review their names, characteristics and marker properties.

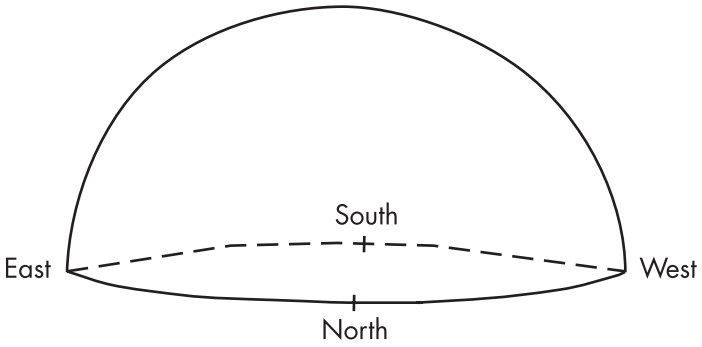
Extension Discussion

Notice that as the earth rotates, the Beasts circle in an opposite direction to that of the sun during the year. The Winter Tortoise follows the Spring Dragon, which follows

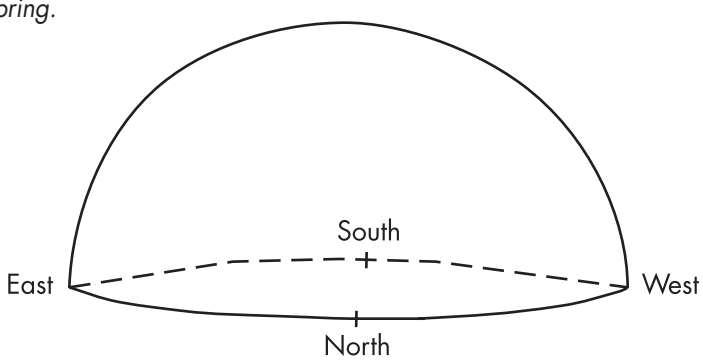
the Summer Bird, which follows the Autumn Tiger. The western zodiac constellations are named in an order that go with the direction of the sun's movement through them, toward the east.

Name_____ **Date**_____

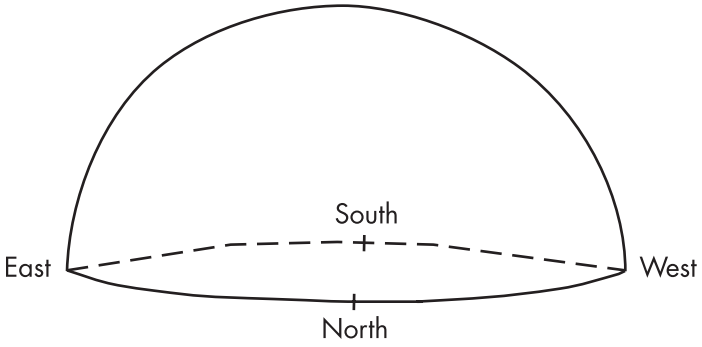
Activity 3: Worksheet
What's Rising? The Four Great Beasts as Ancient Seasonal Markers



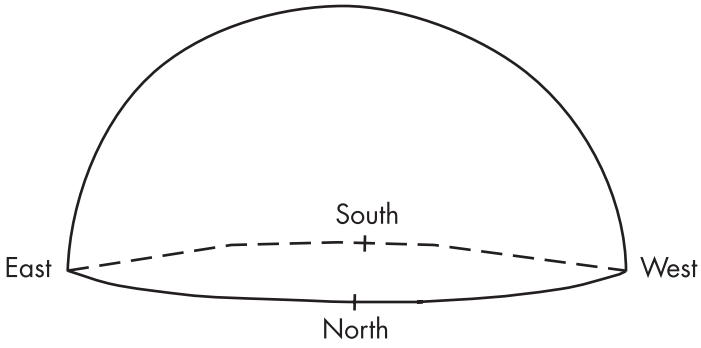
Horizon Drawing 1: Morning at the beginning of spring.



Horizon Drawing 2: Evening at the beginning of summer.

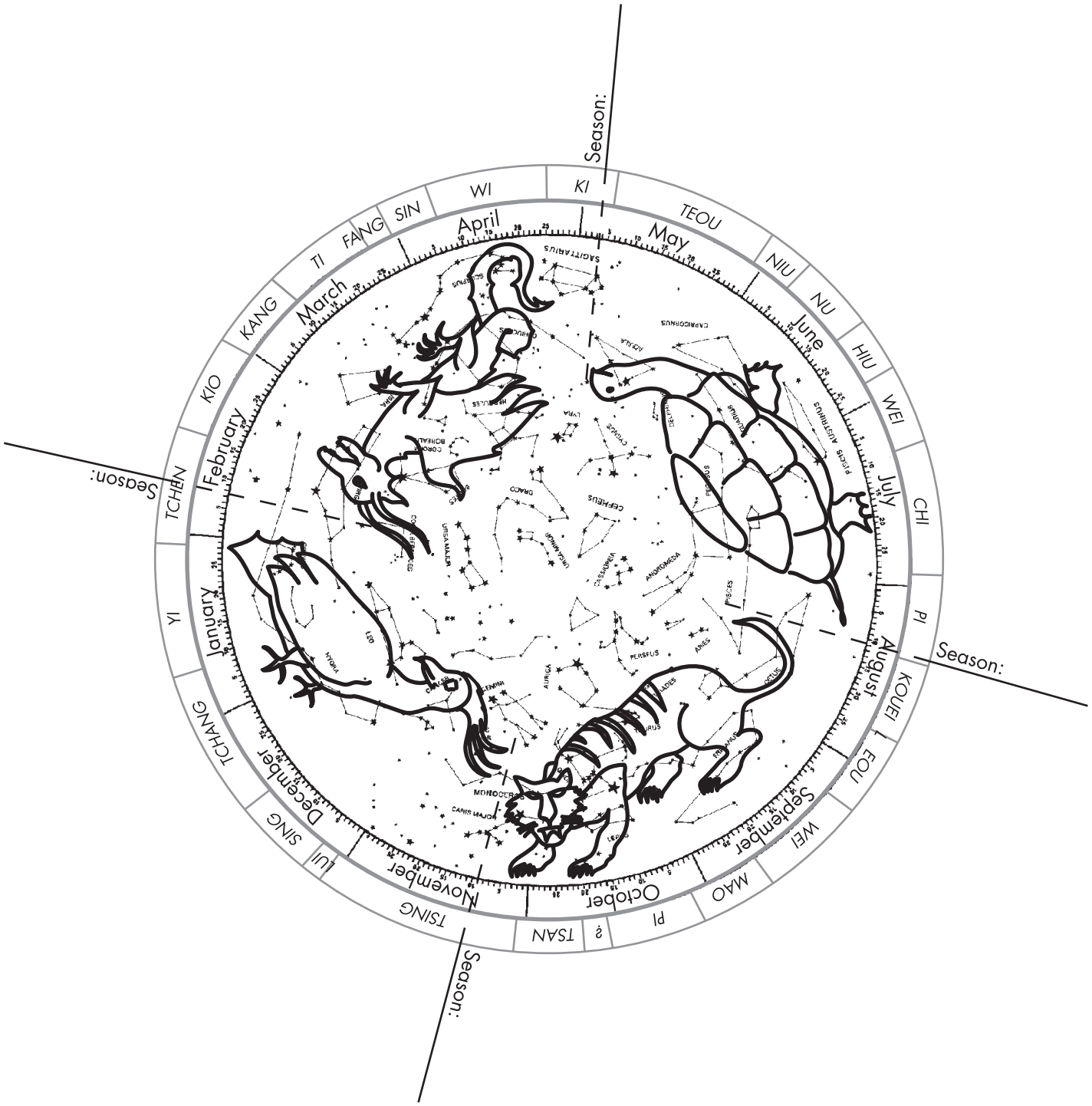


Horizon Drawing 3: Morning at the beginning of autumn.



Horizon Drawing 4: Evening at the beginning of winter.

Star Chart for Activity 3



MATERIALS

- STARLAB Portable Planetarium
- Ancient Chinese Seasons Cylinder
- arrow pointer
- bright flashlight
- one or more strips of glow-in-the-dark tape, each about 20 feet long, each loosely wrapped around a wide rod or a rectangle of wood or plastic so that the tape sticks only to the wood or plastic and not to itself
- a slide or another method for showing that two points determine a line. Try glow-chalk with two glow dots on a small portable chalkboard, with a bright flashlight

Activity 4: The Northern Bushel and Beast Stars

Background Information

By 3000-2000 BC, Chinese astronomers were concentrating on relationships between the Big and Little Dippers, and stars near the celestial equator. The North Circumpolar Stars were the most important area of the sky, where the Celestial Emperor lived with his advisors in the Imperial Palace. The controlling characteristics of this area were linked to the older seasonal markers, the Four Beasts. See the figure below which shows relationships recorded in Chinese records. There is no historical record for the Red Bird. You and your students can try to find a relationship between the northern stars and the Red Bird. The stars are numbered, so you can use the numbers instead of the Greek letter.

Note

In this planetarium activity, text that is in italics is suggested script for the teacher to use.

Objective

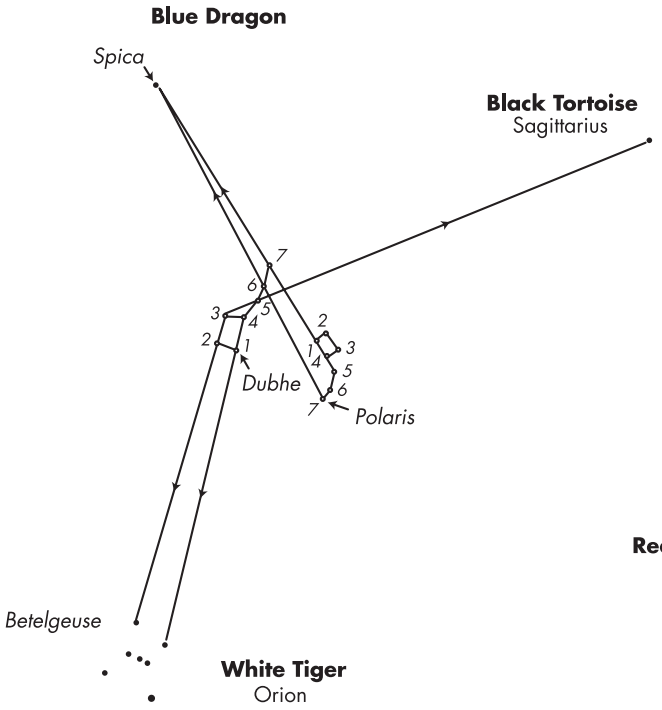
Learn how the Big and Little Dippers were used to find stars in the Four Beasts, starting about 3000-2000 BC

Approximate Time Needed

45 minutes

Suggested Levels for this Tested Presentation

3-12



Integrated Subjects

- Geometry
- History
- Science

Process Skills

Observing • listening • discovering • extending • pattern-finding

Concepts to be Applied

The four ancient Chinese seasonal constellations: Blue Dragon, Red Bird, White Tiger, Black Tortoise

Two points determine a line — only one line can be extended from a segment that passes through two points.

Preparation

Set up the STARLAB dome and projector. Place the Ancient Chinese Seasons Cylinder on the cylinder platform. Position the projector for 35-40° N. latitude. Have the prop to illustrate that two points determine a line, the rod(s) or rectangle(s) holding the glow-strip(s),

and the bright flashlight ready to use.

Procedure

After the students are seated, turn down dome lights and review or introduce the Four Beasts. The discussion below assumes that students have some understanding of the nature and importance of the figures.

The Four Beasts were the most important constellations in China for a long time. They were used to mark the seasons. After a while, due to a wobbling motion of the earth (called precession), the Four Beasts did not mark the seasons any longer. Northern constellations became more important. But the Four Beasts were considered to be of value, too. Therefore Chinese astronomers found a way to connect northern stars to the beasts. Today we're going to do what they did.

Ask the students: "Do you know the pattern of stars that we call the Big Dipper?" Hint where they are, show them with the arrow, and count them from 1 to 7, starting with Dubhe, the star at the lip of the cup where the handle is not connected. Depending on their age, have students point and count with you.

The Chinese began calling these stars 'the Northern Bushel' in about 3000 BC. The Bushel was seen by the peasants as a measure of grain. The astronomers thought of these stars as a balance, which balanced the year as it swung about in the north. The Northern Bushel or Balance was an indicator of the seasons. Nearby stars were helpers in showing the seasons.

Ask the students: "Do you know the pattern of stars that we call the Little Dipper?" Hint where they are, show them with the arrow, and count them from 1 to 7, starting with Kochab, the star at the lip of the cup where the handle is not connected.

Remember that we counted the stars in each Dipper beginning from the lip of the cup to the end of the handle. We'll keep using these numbers.

Point to Polaris and ask the students: "This is Polaris, the star we call the North Star. In what direction do we see it?" North.

As the earth turns, all the other stars turn around it. Although this star (point to Thuban, third star from the end of Draco's tail) was the North Star in 3000 BC, the stars moved around it as we are about to see the stars move about Polaris.

Turn the cylinder, ending with the dragon near the celestial meridian and ask the students: "Does the North Star move while the earth turns?" No.

Watch the Big and Little Dippers change positions as the earth turns. Also, notice the changing positions of the Four Beasts. The Chinese astronomers realized that the way some stars of the north pointed led them to stars in the beasts. There is an important idea about points and a line that we should know.

Present the concept of two points determining a line. This is best done as a discovery. Adapt the discussion to the age of the students: Turn up the dome lights. Show two illuminated glow-dots on a portable chalkboard.

Ask: "How many lines can you draw between the dots?" (Answers may vary; draw it with glow-chalk; and illuminate it; only one.)

Then ask, "If we extend the line and keep it straight, do we still have just one line or more? (Answers may vary; extend the line with glow-chalk and illuminate it; still just one.)

Turn down the dome lights.

Ask: "Now we can see the Blue Dragon in the center of the southern sky. Can you see a way of drawing a line through any two star dots of the Big and Little Dipper

to find a star in or near the Blue Dragon?" Students may have trouble starting this process, but after you hint gently, there may be many suggestions. Try out a few suggestions, pointing them out slowly with the arrow.

Records tell us that between 3000 and 2000 BC, Chinese astronomers used this alignment between northern stars and the Blue Dragon: From the North Star (Little Dipper star 7) through Big Dipper star 6 (second from the end of the handle), down in the south to this star we call Spica. Let's mark this on the dome.

Procedure

- Spica is the blue star in the cylinder picture of the dragon. First show the alignment slowly with the arrow. If any student also saw this, acknowledge it. Turn the dome lights on low. Unwrap the length of glow-tape, and with student help, stretch it through these stars. Shine the bright flashlight on it for 20 seconds. Turn down the dome lights. The "connection" should shine nicely. Remove the glow-tape and wrap it back loosely on the rod or rectangle.
- Rotate the cylinder in the normal direction of earth rotation to look for alignments from the Dippers to the heads of the Black Tortoise, the White Tiger, and last, the Red Bird. (The animals come into view in this order, earth rotation does not make the Four Beasts turn in correct seasonal order, due to reasons taught in Activity lesson 3.) Between quarter earth rotations and observations of each beast, remove and re-wrap or partly re-wrap the glow-tape, if you have just one piece, so that it will not get tangled. If you have four pieces, you could put them aside to rewrap later. Use the arrow to point out alignments that student suggest. Mark the stars 3 and 5 of the Big Dipper, and extend the produced line to the head of the Black Tortoise. (The Chinese recorded a connection to the star theta Sagittarii in the head of the Black Tortoise.) Mark the stars 3 and 2 of the Big Dipper, and extend the produced line to the red star Betelgeuse in the head of the White Tiger. The Chinese recorded this connection.
- Look for an alignment between Big and Little Dipper stars and the Red Bird, for which there is no noted historical record. (See if star 1 in the Little Dipper and star 1 in the Big Dipper produce a line which extends to the center of the Red Bird. When you observe an alignment for which there is student agreement, mark it with the glow-tape).

You might say:

Today we've improved the Chinese system, because we found a marker for the fourth beast that does not appear in ancient records. Good for you! Would you like to have worked as an astronomer in ancient China?

Extensions

Today a lot of astronomers use a system called "star hopping" to help find stars, both with the unaided eye and with the telescope. In star hopping, one estimates angular distances and angles formed by stars, as well as extends lines formed by two stars. Have older students find books and articles about this process and practice what they learn.

Activity 5: The Moon in Its Houses

Background Information

During the month, the moon moves around the celestial sphere along a path that is close to the Western zodiac constellations. The ecliptic, the plane of the earth's orbit (which is inclined 23½° to the celestial equator), passes through the zodiac. The moon's orbit is inclined an average of 5° to the ecliptic. The intersection positions of the ecliptic and the moon's orbit are the nodes. The nodes slide or regress completely around the sky in a period of 18.6 years. Because the nodes constantly shift, the moon's orbit changes in its angle of inclination with the celestial equator. The maximum inclination of the moon to the celestial equator is 23½ + 5 = 28½°. The minimum inclination of the moon to the celestial equator is 23½ – 5 = 18½°. These variations cause the moon to pass in different places with respect to the Chinese House asterisms during the 18.6-year cycle of regression of the nodes. (The changing inclinations also are responsible for very different rising, setting, and highest-altitude positions of the moon.)

One would expect the Chinese Moon Houses to roughly match with the ecliptic and the western zodiac. They do match in the Blue Dragon, in most of the White Tiger, and in the Black Tortoise. But there is great discrepancy within the Red Bird (only the Red Bird's head is close to the ecliptic), and in House 7 of the White Tiger (TSAN, the Supreme Commander, which is the classical constellation of Orion). All these houses are way below the ecliptic. It therefore seems that the Chinese tried to select the places in the four beasts closest to where the moon passed, rather than really identifying the moon's path.

Students can learn something about the priorities of the Chinese, that the Four Beasts were more important than actual moon locations against the stars, if the discrepancy is pointed out. This is not mentioned in the lesson discussion below, however. It is appropriate for older students.

The Moon Houses do not look like the figures for which they are named (See the list, "The Houses of the Moon," page 8). In fact, most of the asterisms are so stick-like with very few stars, that they seem quite different from the classical constellations. The names of many of these groups seem applied as an honor (such as TSAN, the House of the Supreme Commander) or the position within one of the Four Beasts (such as SIN and WI, Houses of the Heart and Tail within the Blue Dragon).

The Chinese moon goddess has names other than Heng O, used in the lesson myth. She is also called Heng HO, Chang-o, and Chang-ngo, and there are different versions of the story. Heng O is the special goddess of women and water. In China, many festivals are related to the phases of the moon.

Annually, the mooncakes, or "Cakes for the Queen of Heaven," are made from the first to the 15th day of the eighth month (near the autumnal equinox) and given and eaten on the evening of the 15th, the full moon. The festival is the festival of mooncakes, and it is called Yue-Ping. Most moon cakes are circular, some as large as a foot across. But there are other moon phase shapes and smaller sizes. They are decorated with different pictures, many with one of Heng O in the cinnamon trees on one side and a rabbit on the other.

Note

In this planetarium activity, text that is in italics is suggested script for the teacher to use.

MATERIALS

- STARLAB Portable Planetarium
- Ancient Chinese Seasons Cylinder
- arrow pointer
- a way to indicate the moon: a flashlight moon (improved if it is a device with a small filament that can be used with lens coverings of different moon shapes)
- glow-painted moon-phase shapes held against the Houses projected on the dome or placed with Velcro on the dome
- a slide projector with slides of the moon in different phases, that can be slewed (operated by a simply-constructed lever arm) or pointed in different directions
- pictures/slides of different lunar phases, and of a solar eclipse and of the sun

For each student

- pencil or markers
- clipboard
- paper (preferably with a circle for the outline of the moon already on it)

Additional optional materials listed on next page.

Optional

- small, mostly crumbless cookies (vanilla wafers are inexpensive and work well as "cakes for the Queen of Heaven.")
- materials to model the moon going about the earth, lighted by the sun (a bright light for the sun and spheres for the earth and moon). The moon sphere (a Ping-Pong ball or larger) should be white to reflect light. The out-in-space view of moon movement and the reasons for phases and eclipses can be modeled. A slide of the in-space perspective could also be used.

Objective

Learn that the moon moves around the sky from west to east, roughly through the Houses identified by the ancient Chinese astronomers, in about 28 days. Learn that the time from one full moon to the next is about two days longer than the revolution period of the moon. Learn Chinese cultural ideas of the moon. Represent a Chinese cultural idea of the moon in a drawing.

Approximate Time Needed

45 minutes

Suggested Levels for this Presentation

2-12 (much more astronomy of the moon's orbit can be discussed with older students)

Integrated Subjects

- Science
- (Simple) Math
- Literature
- History
- Art

Process Skills

Observing • listening • counting • concluding • drawing

Concepts to be Applied

The four ancient Chinese seasonal constellations: Blue Dragon, Black Tortoise, White Tiger, Red Bird; month; culture

Terms and Concepts to be Discussed

cycle

the 28 Chinese Houses of the Moon

moon orbit, phases, solar eclipse

Preparation

Set up the STARLAB dome and projector. Place the Ancient Chinese Seasons Cylinder on the cylinder platform. Position the projector for 35-40° N. latitude. Turn the cylinder so that the Blue Dragon is in the center of the sky.

Ask the students: "Do you know how many days are in a month?" Students probably will know that there are differences, 30 or 31 except for February. The memory verse could be recited: "Thirty days hath September, April, June, and November; All the rest have 31, except for February, which has 28 except for leap years, when it has 29."

Ask: "How do you think that a month got a period of 28-30 days?" Student answers will vary. Someone probably will mention the moon, perhaps only because the word "month" is close to "moon."

The moon revolves about the earth every month.

Procedure

A presentation of how the moon moves about the earth, illuminated by the sun, can be made. For high school students, the difference between the sidereal month of $27^1/_3$ days and the synodic or phase month of 29½ days can be modeled and discussed here.

During the time that the moon revolves about the earth, it passes through phases.

Show pictures/slides of the moon in different phases.

Ask: "The moon's revolution and its phases were important to the ancient Chinese. Why do you think they were important?" Student answers probably will include the idea that the change of light in the sky was a big factor in how well people could see — lighting up things on the ground and hiding important sky figures like the stars of the Four Beasts and the Northern Stars when the phases were full and near-full. Point out that this effect would be especially important without electric lights which we use at night. If you use a slide projector to show slides of different lunar phases, ask students to notice the difference in how many stars they can see when the slide projector is on compared with when it is off. The effect is similar to differences without electric lights during the month.

Now we will see how the ancient Chinese marked the passing of time during the cycle of the moon. Look at the Blue Dragon. Notice the small line figures inside the Blue Dragon. See if you can find seven figures. The seventh figure is actually behind the tail.

Point out the figures as you name them.

The Chinese called the small figures 'Houses of the Moon' or 'Lunar Mansions.' They were named The House of the Horn, the House of the Forecourt, the House of the Foundation, the House of the Sun, the House of the Heart, the House of the Tail, and the House of the Manuring Tray or Winnowing Tray. In Chinese, these names are KIO, KANG, TI, FANG, SIN, WI, and KI.

Use a flashlight, glow-moon, or slide for the full moon, and shine it against the House of the Horn, KIO, and then move it in order to shine in the other houses.

This is the full moon. If the moon were in the sky near KIO and full, then the next day it would be in or near KANG and a little less than full (waning gibbous). The next day it would be in TI, the next in FANG, the next in SIN, the next in WI, and the next in KI. By the time it was near the stars of KI, the tray, the phase would be a last (third) quarter moon, like this.

- Show a picture/slide of the last quarter moon.
- Rotate the cylinder to bring the Black Tortoise to the center of the sky.

Ask: "How many stick figures, also Houses of the Moon, do you see in the Black Tortoise?" Students should count seven.

The moon moves from the Blue Dragon to Houses in the Black Tortoise. They are named the House of the Bushel, the House of the Ox, the House of the Virgin, the House of the Funeral Mound, the House of the Rooftop, the House of the Pyre, and the House of the Wall. The Chinese names are TEOU, NIOU, NIU, HIU, WEI, CHI, AND PI. The day after the moon is near the tray, it is in the bushel. Each day later, the moon is in one house further east."

- Use the flashlight or other moon model to show the moon passing from one house to the next.
- Rotate the cylinder to bring the White Tiger to the center of the sky. Have students try to find the houses. It may be harder to determine these houses than the ones in the Blue Dragon and Black Tortoise, due to the tiger's stripes. Point them out and give their names. They are, from tail to head (west to east): the House of the Sandal, the House of the Reapsters, the House of the Grainstore, the House of the Setting Sun, the House of the Net, the House of the Head, and the House of the Supreme Commander. The Chinese names are KOUI, LEOU, WEI, MAO, PY, TSOUI, AND TSAN. TSAN has more stars than most houses. It is the western constellation of Orion. (This is one lunar house that is very far below the ecliptic.)

When the moon passes from theWall PI of the Black Tortoise, to the Sandal KOUI, the first house of the White Tiger, it has the phase called new. We see the waning crescent (show a picture of this) but we do not usually see the new moon. All of the moon's lighted half is then turned away from the earth. This is an excellent time to view stars; moonlight does not interfere. There is only one time when we can see the new moon—during an eclipse of the sun (solar eclipse). Since the sun must be above the horizon, the eclipse and the new moon are in the daytime sky. The sun is covered by the disk of the dark moon.

Show a picture or a slide of a solar eclipse. If you have model materials, demonstrate the reason for a solar eclipse.

In ancient China people believed that an eclipse of the sun was really a dragon eating the sun. The dragon was invisible, but everyone saw what he did. The ancient Chinese thought that if people made a lot of noise, they would frighten the dragon away. Scientists know that an eclipse will begin and end regardless of what people say or do. But if you would like to imagine that you are back in ancient China where everyone thought the noise was important, clap your hands loudly ten times.

As students clap, remove the picture or a slide of the eclipsed moon, replace it with a picture or a slide of the uneclipsed sun. If you have a set of slides showing stages of an ending eclipse, use them.

Optional

It was very important for Chinese astronomers to watch the sky and let the Emperor know if an eclipse was happening. The Emperor then performed a special ceremony to make sure that the eclipse would end. Such a ceremony was thought essential for 'saving the sun.' A story is told that two astronomers, Hi an Ho, did not perform their duty of watching the sky well enough. An eclipse occurred, and Hi and Ho did not see it. The Emperor was not notified. He had Hi and Ho put to death."

Keeping track of events in Chinese history was partly based on eclipse events.

- Use the flashlight or other moon model to show the moon passing through the remaining houses of the White Tiger. Show a picture or slide of a waxing crescent for the moon in any house, 2-7, of the White Tiger.
- Rotate the cylinder until the Red Bird is in the center of the sky. Have students try to find the seven houses. Give their names: The House of the Well, the House of the Spirits, the House of the Willow, the House of the Asterism, the House of the Net (another one from that in the White Tiger), the House of the Wing, and the House of the Chariot. The Chinese names are TSING, KOUI, LIEOU, SING, TCHANG, YI, AND TCHIN.
- Use the flashlight or other moon model to show the moon in the the first house of the Red Bird TSING, the House of the Well.

When the moon is in TSING, its phase is first quarter.

Show a picture or slide of a first quarter moon. Use the moon model to show the moon passing through the Red Bird.

As the moon passes through each of the remaining houses of the Red Bird, its phase grows toward full moon.

[Optional, with age]:

The phases between first quarter and full are called gibbous.

- Show a picture or slide of a middle gibbous moon for the moon in any house, 2-7, of the Red Bird. Also optional: Point out where the moon actually travels (along the ecliptic, which is well above houses 2-7 of the Red Bird), and discuss the Chinese choice of keeping the lunar houses within their Four Beasts rather

than along an accurate average path of the moon.

- Use the flashlight or other moon model to show the moon moving from the last house of the Red Bird back to the first house of the Blue Dragon, KIO.

Ask: "The moon has made one revolution in its orbit and gone once around our sky. How many different Houses did the moon pass through during that time?" Help students to remember the Four Beasts, each with 7 Houses, so they conclude that the number is 28.

Ask: "The moon goes from one house to the next in about one day. So how many days have passed?" 28. Actually, the revolution period of the moon against the stars, a siderial month, is $27^{1}/_{3}$ days.

Ask: "Why do you think a month is about 28 days in length?" Answers will vary. Students should grasp the idea that the moon's revolution around the sky is probably the origin of the month.

Ask: "The moon keeps on going through the houses again. The moon's motion is an example of a cycle. A cycle is a set of things that happen over and over in the same way. Can you name some other cycles?" Student answers will vary.

Use a flashlight or other moon model and a slide of the moon in gibbous phase.

Ask: "The moon has revolved once and is back in KIO of the Blue Dragon. Notice the phase. Is it full, as it was when it was last in KIO?" No.

Ask: "For the phase to be full again, the moon has to move along the houses for two more days. Since the moon goes from one house to the next in one day, where will the moon be in the Blue Dragon when it is full?" Students should conclude that the moon will be in TI, House 3, the House of the Foundation.

Shine the flashlight/moon model and a slide of the full moon in house 3 of the Blue Dragon.

Ask: "The time from full moon to the next full moon is about 29½ days. Do you think this cycle of time was more or less important than the cycle of the moon revolving to get back to the same house in fixing the length of a month in the calendar?" Student answers may vary. However, the phase month (also called the synodic month) has had more importance in the Chinese and other calendars throughout history.

As you view the full moon, notice the dark areas. Use your imagination and try to see an animal or a person. See the dark areas against the white background. (Allow about half a minute for this.) The ancient Chinese saw different pictures. One is a rabbit pounding rice. Another is a three-legged toad. Still another is an Old Man, bent over, who is responsible for good marriages. But the most important idea in China is of the moon goddess, Heng O. I will now tell the story of how Heng O got to the moon.

Long ago the best person in all of China at shooting arrows with a bow was the Excellent Archer. The Excellent Archer did many wonderful deeds for the Emperor, such as shooting down nine suns from the sky that had made the land much too hot. The Excellent Archer could also fly, jumping on breezes to chase his arrows and go on important trips.

One day great floods began and the Emperor sent for the Excellent Archer. The Excellent Archer went to a river where the floods were highest. Just as he suspected, the flood demon Ho Po was there with all his family causing the trouble. The Excellent Archer shot an arrow into the river, and Ho Po and his family scrambled away. The floods stopped. The Excellent Archer saw a beautiful lady fleeing, and he aimed an arrow at the top coil of her braided hair. The woman stopped and came back. She was Heng O, the young sister of Ho Po. He and all the family were now gone. The Excellent Archer took her back to the court of the Emperor. The two fell in love and were married.

One day the powerful goddess Chin Mu came to the Emperor's court to see the Excellent Archer. She said to him, "Here is a reward for your many good deeds. It is a pill of immortality. If you eat it, you will live forever. It will also make you fly."

"I can already fly," he said, "and I don't know if I want to live forever."

"Take it anyway," said Chin Mu. "I will give you a sign for a time to use it yourself or give it away." The pill was about as big as the fingernail of your smallest finger. The Excellent Archer took it and hid it under a roof rafter.

He was called away on an emergency. His wife Heng O was bored. She was walking around the house when she saw a light coming from the roof and smelled a delicious odor. With the aid of a ladder, Heng O reached up and found the pill of immortality her husband had hidden. It smelled so good, she popped it into her mouth and swallowed it. Immediately she discovered that she could fly. She flew out the window and up, up, up to the sky. She flew to the huge, cold, glassy moon. Only cinnamon trees grew on the moon, so Heng O could only eat cinnamon at first.

The Excellent Archer tried to fly to her, but a big black cloud got in the way. As he was flying, Chin Mu called to him that his wife had been foolish, but had become an immortal. She would live forever on the moon. As a reward for the Excellent Archer, she said, "You shall have the palace on the sun, and you will also be an immortal."

So the Excellent Archer lives on the sun, and his wife Heng Ho lives on the moon. On the 15th day of each month, the Excellent Archer visits Heng Ho. He has built her a warm palace of cinnamon trees. For the rest of the month Heng Ho has only a rabbit for company.

To avoid getting burned by the sun's heat, the Excellent Archer must eat special little cakes given to him by Chin Mu. He takes some of these cakes to Heng Ho when he visits her. In China there is an important festival of the moon that takes place on the night of full moon near the beginning of fall. Everyone eats little cakes, called "Cakes for the Queen of Heaven." As a cake is eaten, a little bow is made toward the full moon, which is called "congratulating" the moon.

Optional Activity

I have a small "cake for the queen of heaven" for each of you now. Do not eat yours until I tell you to. (Pass out the wafers.) Now we are ready. Bow toward the moon and say "Congratulations, Heng O." (Do this.) Now you may eat your mooncake. Please watch so that you do not make crumbs. (Check with teachers about diets of the children, particularly diabetics).

Pass out clipboards, paper, and pencils or markers. Have the slide of the full moon still showing against the third house of the Blue Dragon.

Look carefully at the full moon. Draw the dark areas where you see them. Also remember the ideas of the story: Heng O, the cinnamon trees, and the rabbit. Make a drawing of the moon that combines what you see with what the Chinese people imagined.

As time permits, have some students share their pictures, describing what is intended in each part. If students do not finish, collect the papers and have the teacher take them back to the classroom to finish later. Collect pencils or markers and clipboards.

Other Activities

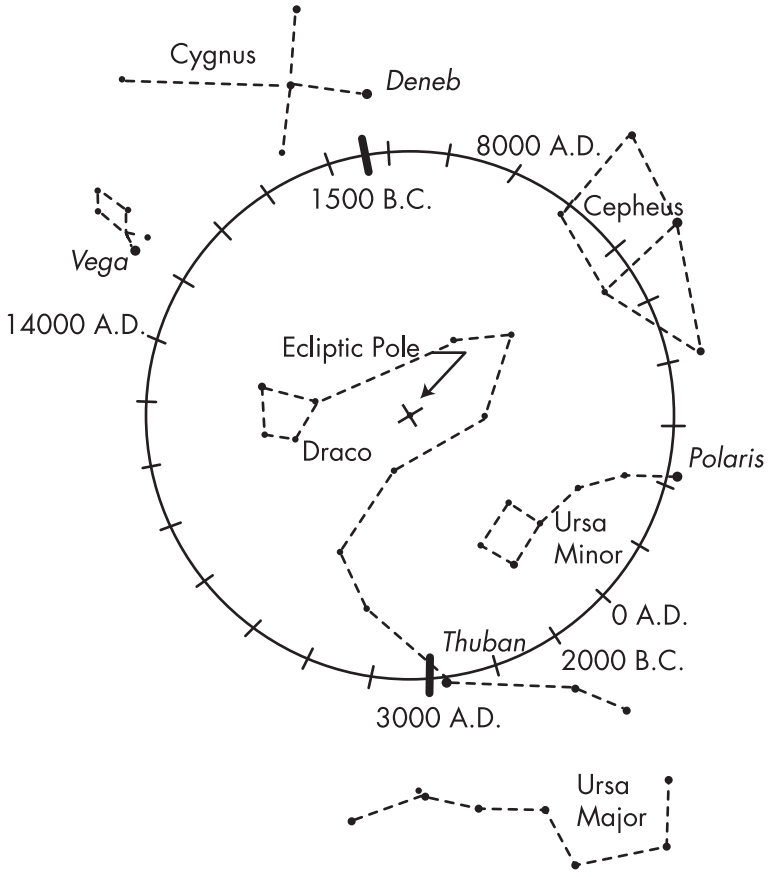
1. With the outer rim of the circle of flashlight light, or other projected circle, demonstrate the circle through which the North Celestial Pole moves during precession. Project the center of the light on the North Ecliptic Pole in Draco.

Currently, the North Celestial Pole is very close to Polaris. It was near Thuban (third star from the end of Draco's tail) at the time there was a major reorganization of Chinese astronomy (3000-2000 BC). It was close to Deneb when Chinese astronomy using the Four Beasts probably began (about 15,600 BC). See the figure at right.

2. Write and act out a probable scene in which ancient priest-astronomers watch for the heliacal rising of the horns of the Blue Dragon to announce spring in the distant past. Or, write and act out a probable scene in which astronomers watched for the rising of the full moon at sunset between the stars Arcturus and Spica, in the Blue Dragon. These were two different ways, as precession changed the sky, of marking the beginning of spring. Certainly much anticipation, preparation, and care must have accompanied the observations.
3. Find Chinese myths of creation, the sun, the moon, and other natural topics that include the sky. Use a projected sun or moon (or glow-paint disk, attached with tape or velcro to the dome). Tell the stories in the STARLAB. One very nicely illustrated children's story is *How the Ox Star Fell from Heaven* by Lily Toy Hong (Albert Whitman and Co., 1991). Combine the telling of this story with a science discussion of meteors and supernovae, which may have had a part in the story's origin. (See the reading list.)

Note

All stories told in the planetarium can be made more interesting with a few embellishments. Some possibilities are: recorded sound effects and/or speaking parts of one or more characters, students reading some of the speaking parts (with flashlights), and pictures, models (perhaps glow-painted), and actual artifacts related to the stories. For instance, in How the Ox Star Fell from Heaven, a bowl of rice (not cooked), a few artificial vegetables, and a pair of chopsticks, are good additions, since eating three meals per day is a main point of the story.



Suggestions for Further Reading with Annotations

Abell, G. O., Morrison, D., and Wolff, S. C. Exploration of the Universe, (many editions). Saunders College Publishing, Philadelphia. Astronomy textbook which contains very good explanations of astronomy relevant to the activities — the ecliptic and western zodiac, constellations, astrology, and moon motions, phases, and eclipses.

Aveni, Anthony F. "Ancient Asia's Stellar Bureaucracy," in Ancient Astronomers. St. Remy Press and Smithsonian Institution, 1993, pp. 75-89. Excellent scholarly background on Chinese astronomy. Aveni is a well known archeoastronomer.

Birdsey, Tom. A Song of Stars. 1990. Illustrated adaption of the story of the Weaving Princess and the Royal Herdsman.

Clark, David H. and Stephenson F. Richard. The Historical Supernovae. Pergamon Press, Oxford, England, 1977. Very interesting book detailing the nature and discovery of supernovae in history.

The Forbidden City. (No author given.) Amro Bank, Amsterdam, 1990. This remarkable book of 245 pages was prepared for an exhibit from China in the Netherlands, covering the court culture of the Chinese emperors, 1644-1911. Although this shows a relatively recent time as compared with the earliest-probable time of Chinese astronomy (15,600 BC), the wonderful illustrations depict many things that relate to ancient Chinese culture and the figures on the STARLAB Chinese cylinders.

Harley, Timothy. Moon Lore. Charles E. Tuttle Co, Inc. Rutland, VT and Tokyo, Japan. 1970. Reprinted in Japan from an English book first published in 1835. Contains a wealth of multicultural ideas about the moon.

Hong, Lily Toy. How the Ox Star Fell from Heaven. Albert Whitman and Co., 1991. Beautifully illustrated children's story, which can be combined with a scientific discussion of meteors and supernovae.

Huff, Toby E. The Rise of Early Modern Science: Islam, China, and the West. Cambridge University Press, New York, 1993. In paperback in 1995. Contains a wonderful description of the ancient Chinese ways of doing science and reasons for ancient Chinese science not progressing.

Jagendorf, M.A. and Weng, Virginia. The Magic Boat and Other Chinese Folk Stories. Vanguard Press, New York., 1980. Contains stories identified as Han Chinese and minority Chinese groups.

Ji, Zhao, General Editor, with authors Guangmei, Zheng, Huadong, Wang, and Jialin Xu, authors. The Natural History of China. McGraw-Hill Publishing, New York, 1990. One of the best books about the natural history of China. Contains some information on geography, as well as facts about animal species such as tigers and tortoises.

Lee, Jeanne M. Legend of the Milky Way. Henry Holt and Co., New York, NY, 1982. Story of the Weaving Princess and the Royal Herdsman, beautifully told and illustrated.

Lum, Peter. Stars in Our Heaven: Myths and Fables. Pantheon Press, New York, 1948. Outstanding collection of constellation mythology from many cultures, including Chinese. All stories and discussions are beautifully presented. There is some inaccuracy in reference to the time of years certain stars are seen: allowance was not made for thousands of years of precessional change. Example: the use of Arcturus and Spica in the spring.

Krupp, E. C. "The Long Shadow of Winter," Sky and Telescope, December 1994, pp. 64-5. Discussion of how ancient Chinese astronomers determined the winter solstice.

Ming, Li Xiao, and Ming, Wu Shan. The Mending of the Sky and Other Chinese Myths. Oyster River Press., Durham, NH, 1989. Short (one page) versions of many stories.

Schlein, Miriam. Juju-Sheep and the Python's Moonstone and Other Moon Stories from Different Times and Different Places. Albert Whitman and Co., Chicago, 1973. Very nice collection of moon stories from different countries. The story of Heng O as retold in Activity #5 is in this book. Schlein adapts it from Myths and Legends of China by E.T.C. Werner, Harrap and Co., London, 1922.

Sky and Telescope. April, 1991, p. 385. An illustration showing an ancient Chinese classification scheme for comets, reproduced from the book, The Origin of Comets.

Staal, Julius D. W. The New Patterns in the Sky: Myths and Legends of the Stars. The McDonald and Woodward Publishing Co., Blacksburg. VA., 1988. Another excellent collection of constellation mythology. Fine drawings of how different cultures thought of different constellations are included.

Staal, Julius D. W. "The Stars of Primeval China," in The Planetarian, Vol. 3, Nos. 1 & 2, Spring/Summer, l974, pp. 20-29. Illustrated discussion of ancient Chinese astronomy. A forerunner article to Staal's major research work, Stars of Jade.

Staal, Julius D. W. Stars of Jade. Writ Press, Decatur, GA., 1984. An outstanding piece of research on ancient Chinese astronomy. Staal copied the French research treatises by the sinologist Gustave Schlegel, two volumes entitled Uranographie Chiniose. Schlegel wrote in 1875, translating from many Chinese documents, and proposing an early establishment of Chinese culture (15,800 BC). Staal revived and supported Schlegel's theory. Although Staal did rearrange Schlegel's material in a more manageable style, the book is still difficult to read. For those brought up with a western knowledge of constellations, it is difficult to "see" such different patterns. It would have been useful if Staal had included more western pattern boundaries with his Chinese work. Staal worked in planetariums for thirty years, and he was Planetarium Department Head at Fernbank Science Center near Atlanta, Georgia, near the end of his career. He died in 1986. He is proof that a planetarian can wear more than one hat. His hat as an ancient Chinese astronomy expert forms the basis upon which the STARLAB Chinese cylinders are based.

Starr, Eileen M., Project Director, Humanities and the Stars: Interpreting the Astronomy and Mythology of Other Cultures. Chinese Planetarium Packet. Ten different planetarium program packages were prepared at Eastern Washington University, Cheney, WA with assistance from Eastern Washington University and a grant from the National Endowment for the Humanities (Grant No. Gp-21041-83). Although not dated, the project

was completed about 1980. A group of 500 sets of script packets with cassette tapes and slide sets were sent to the U.S. State Endowment for the Humanities Offices, and they were sold to two planetariums in the state for a package cost of $500. By contacting state offices, one could learn who has these packages.The script packets are very useful. The slides are under copyright and cannot be copied.

Recommended Resources

Advertisement by Lockheed Corporation, which sponsored a Nova PBS program about China. The two-page advertisement appeared in a number of magazines in June-July, 1994. It is a very good, thought-provoking piece which asks what advances the Chinese might have made if the Ming Dynasty Emperors had not suddenly banned exploration in the 1400s. Because of a reversal in emperor policies to rigid isolationism, the foremost science and technology in the world decayed. Europeans, rather than Chinese, "discovered" the American, Australian, and Antarctic continents.

Company: Poster Education: Box 8774, Asheville, NC 28814, 1-800-858-0969. Carries very nice posters on China, including "Chinese Festivals" (No. 48-303, $10.95) and "Ancient China" (shows a scene of the Great Wall with land and sky, No. 43-129, $3.95), and "Children of China" (two Chinese elementary children in native clothing, No. 43-211, $1.95).

Company: Art and Artifact, 2541 East Enterprise Parkway, Twinsburg, OH 44087. 1-800-231-6766. Carries decorative items from different cultures. Has dragon items, Chinese people figures, and masks.

Slide set: "Chinese Art Treasures." 20 slides with a very detailed curriculum guide for teachers. There is a small charge, which increases with inflation. Available from the Cleveland Museum of Natural History, 11150 East Blvd., Cleveland, OH 44106. Included is some Chinese solar zodiac art, which was invented long after the 4 beasts, the 28 moon houses, and the other asterisms of the STARLAB cylinders.

"Sun/Moon: A Celestial Engagement Calendar for 1995," published by The Nature Company. Contains many art and text descriptions of the sun and moon including some from China.

Theme Park in Florida near Disney World: Splendid China. Included in the wonderful building reproductions of China is the Ancient Star Observatory. The actual star observatories were seven and one-half times larger. The real building was built in 1279 AD, long after the beginning of Chinese astronomy, however, the work done here had its foundation in earlier centuries.