

# Astronomy in the city

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# ORIENTATION OF THE PYRAMIDS

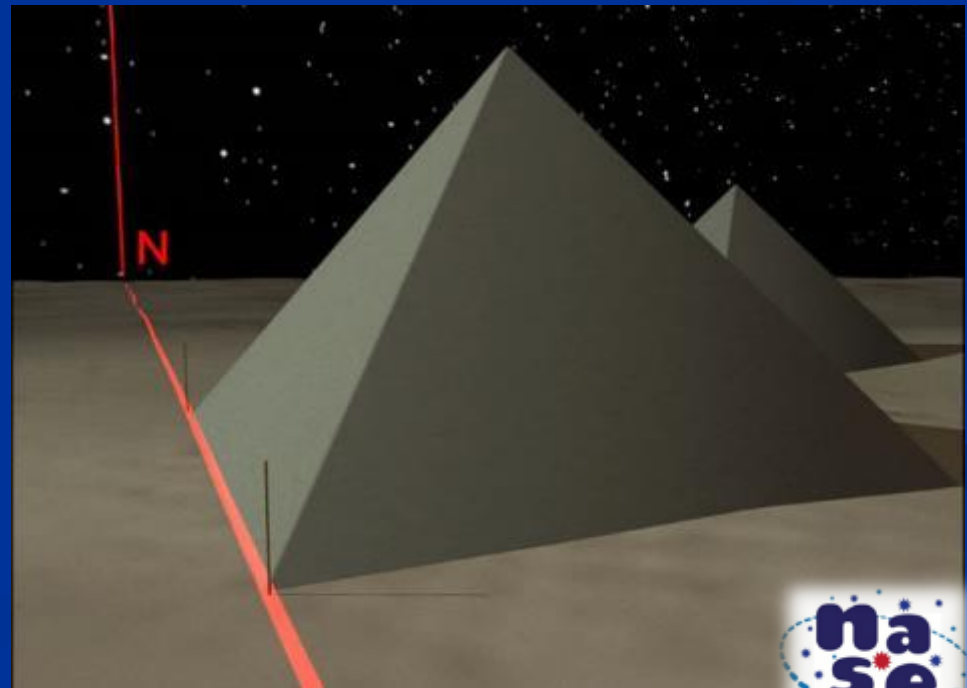
Giza, Egypt, Africa  
2500 BC



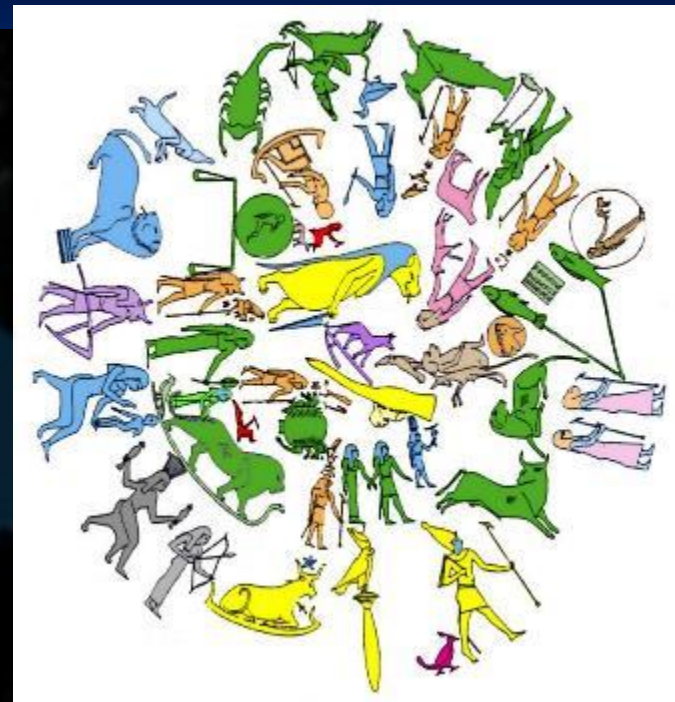
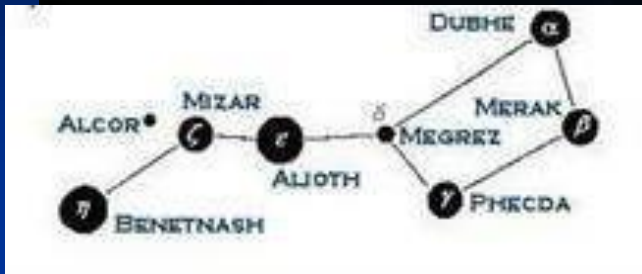
Not all of Egypt's pyramids are correctly oriented; in fact, only a few of the more than sixty well known have a precise orientation.

The pyramids of the pharaohs of dynasty IV in Dahshur and Giza are the best oriented, with errors of 15' or less.

Astronomical alignment of the pyramid of Kefren (around 2545 BC) towards the meridian transit of Megrez and Phecda of the constellation Meskhetyu (The Leg of the Bull), equivalent to Ursa Major partially



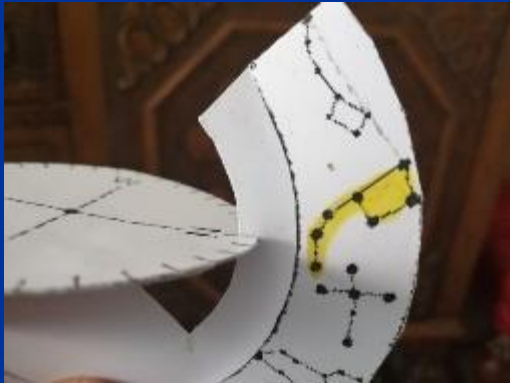
# "Imperishable" constellation of the **Bull's Leg**



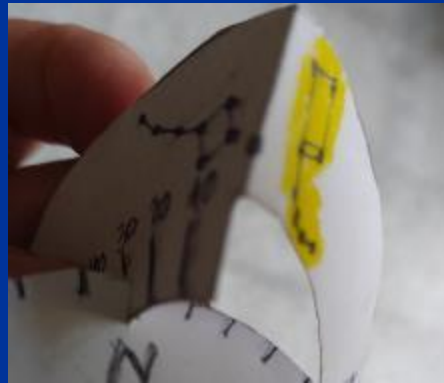
Currently Merak and Dubhe indicate the position of the polar at  $2^\circ$  from the pole. Formerly Megrez and Phecda determined the situation of Thuban that in 2787 B.C. which was only  $2'$  from the pole



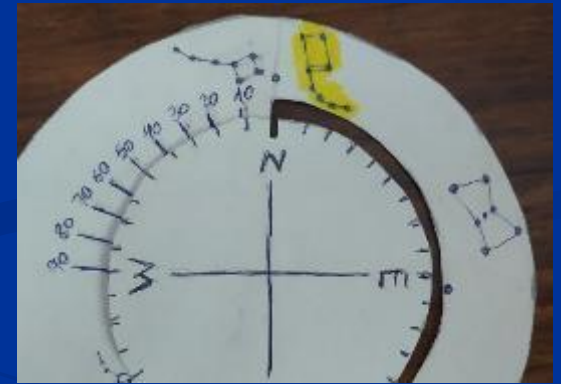
The placement of the pyramids responds to religious motivations. The Egyptians believed that the stars disappeared and reappeared, allowed to transcend death. "The ducts of the pyramids face north because there were the stars that never disappeared from the sky, the circumpolar stars, which never died"



Now 2000



Before 2500 BC

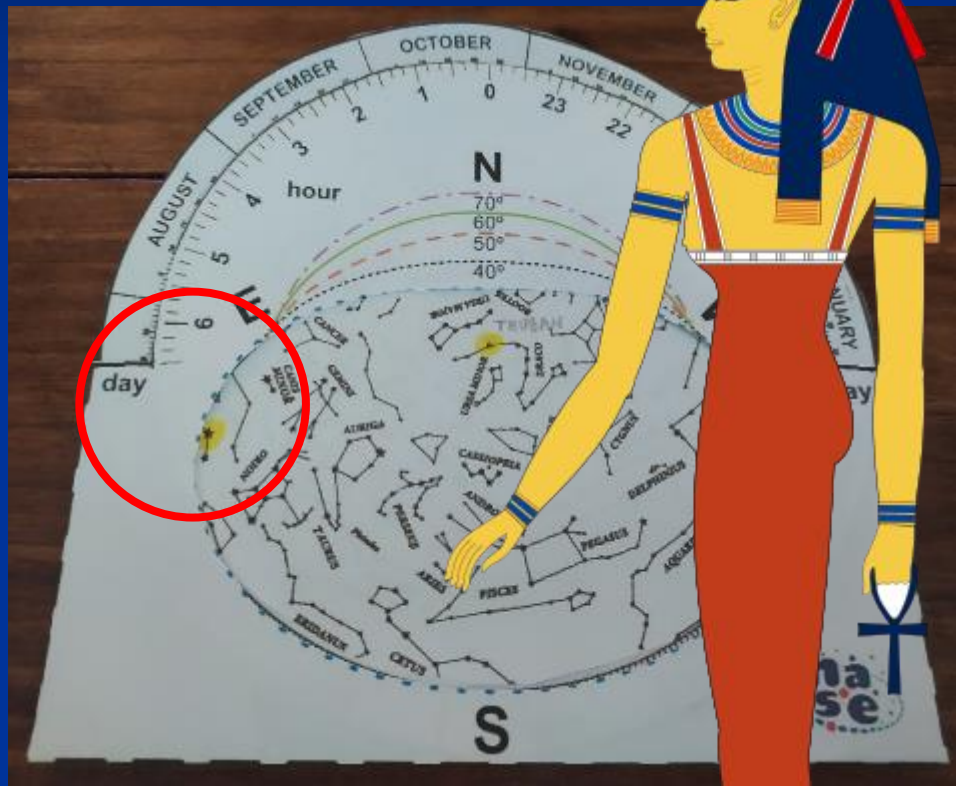


Cairo latitude 30°N

The access corridors were built with a slope such that this would facilitate the king's ascension to the northern skies, domain of the "undying stars".



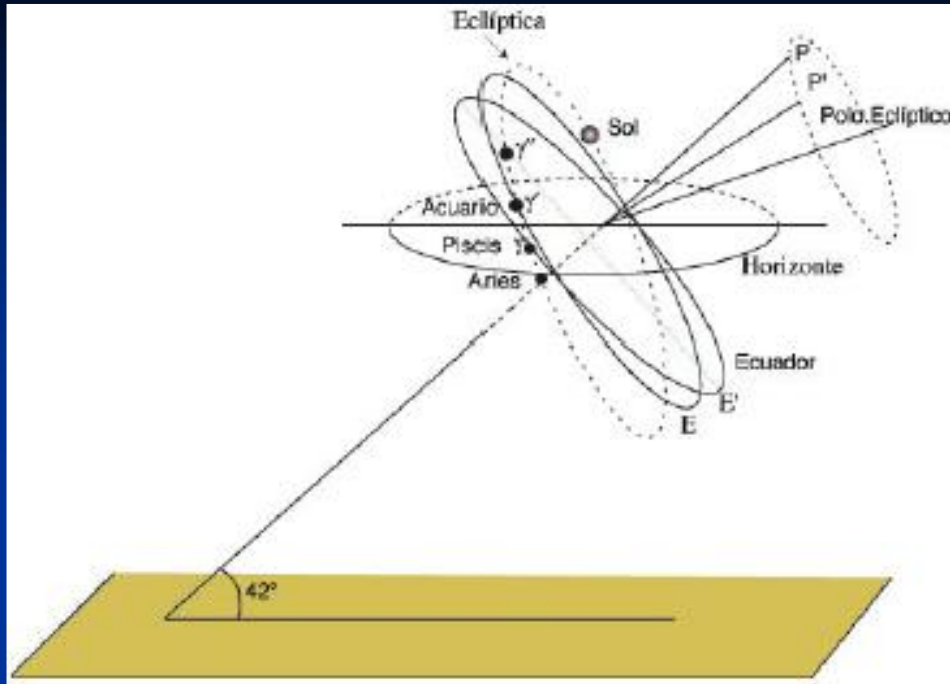
The Sirius star, called Sopdet by the Egyptians, announced the arrival of the flood of the Nile, with its first annual appearance at dawn, the so-called heliacal rising (the first day it becomes visible just before sunrise about July 25th) and this moment of great importance in Egypt.



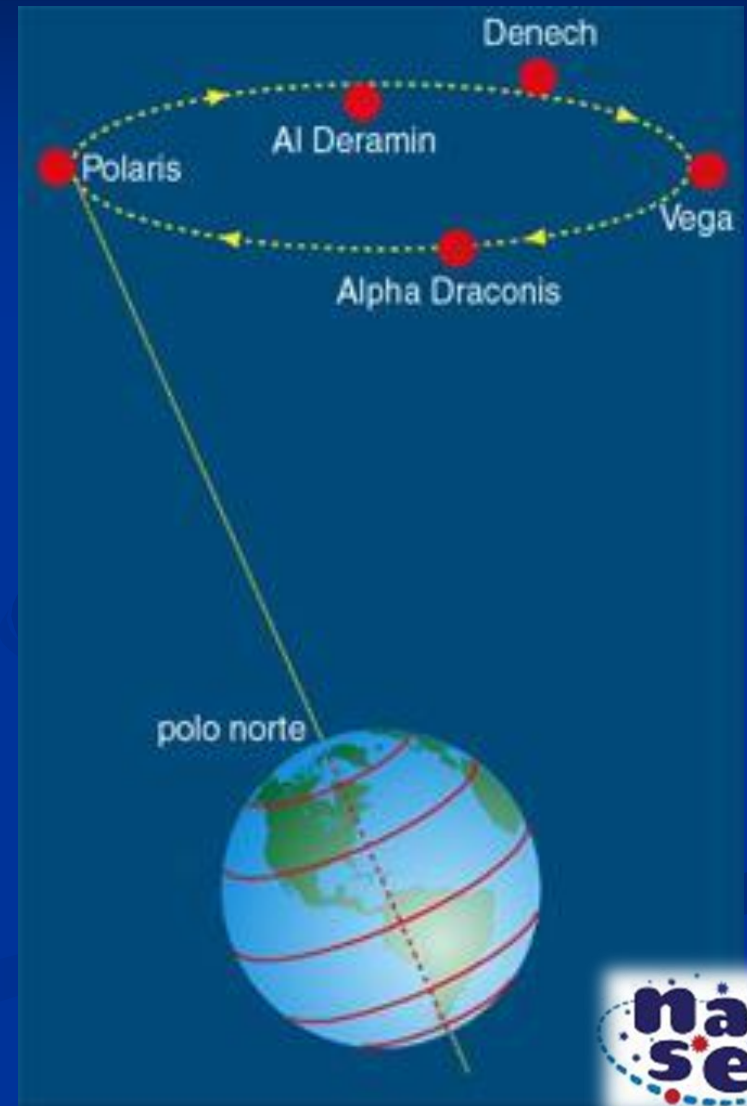
The star Sirius remained invisible for 70 days, the same time as in the mummification process, the bodies were immersed in natron salts to dehydrate them for 70 days and the body was subsequently removed.



# Precession of the Equinoxes



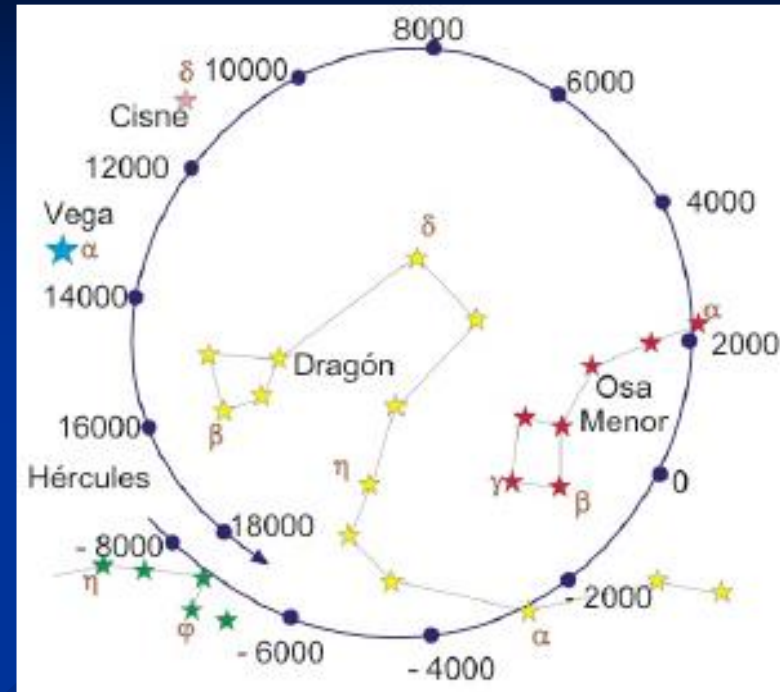
Due to the Precession of the Equinoxes, the point of intersection between the equator and the ecliptic, called the Aries point (because it was in this constellation) has moved to the constellation of Pisces.





# Precession of Equinoxes

Precession is the motion of change of direction of the Earth's axis of rotation describing in 25776 years a circumference (or  $50.29''/\text{year}$ ) like a spinning top. The celestial equator also wobbles and its intersection with the ecliptic varies.



Hipparchus observed it between 147 and 127 BC, (about 2000 years ago). Then the point named Aries point (because it was in that constellation) has moved to the constellation of Pisces and the north pole has changed.

$$50.29'' \times 2000 = 100580'' = \text{approx. } 28^\circ \text{ a zodiac sign}$$

**For example, now the North Pole is on the Polaris of Ursa Minor and 2000 years ago it was Thuban in the Draco.**

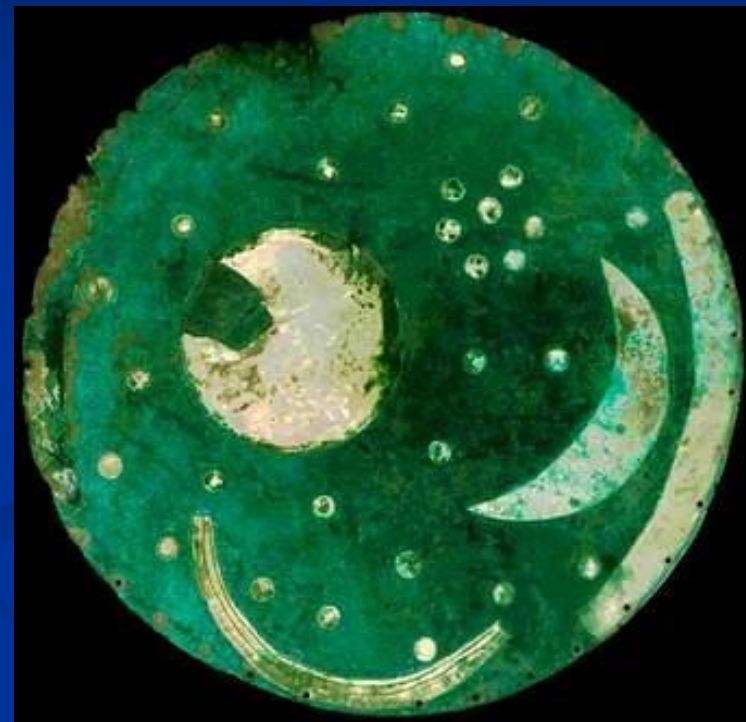


**NEBRA DISK**  
**Germany, Europe**  
**1500 BC**



Nebra's disc is a bronze disk, 32cm in diameter and inlaid with gold: 3 arches (one missing), a crescent Moon, one large circle and 30 minor ones.

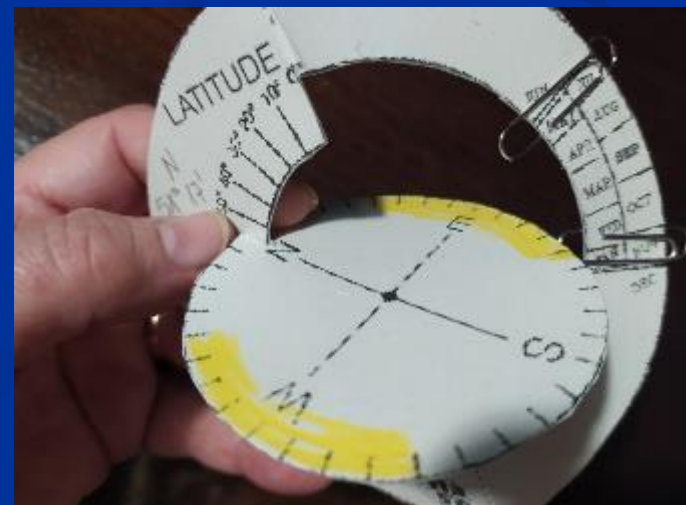
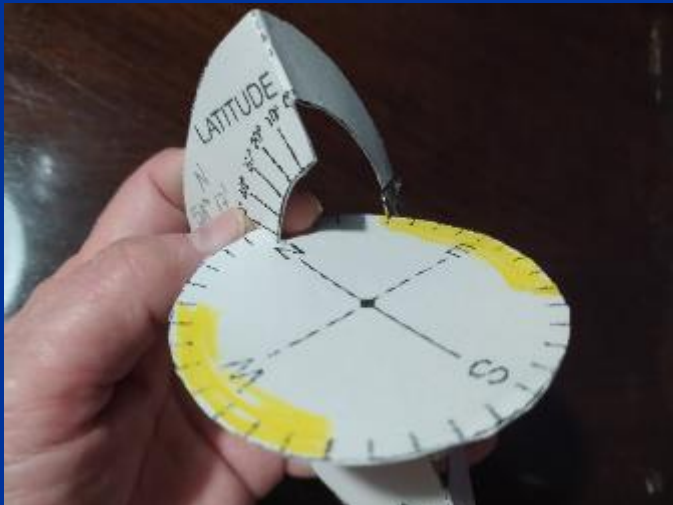
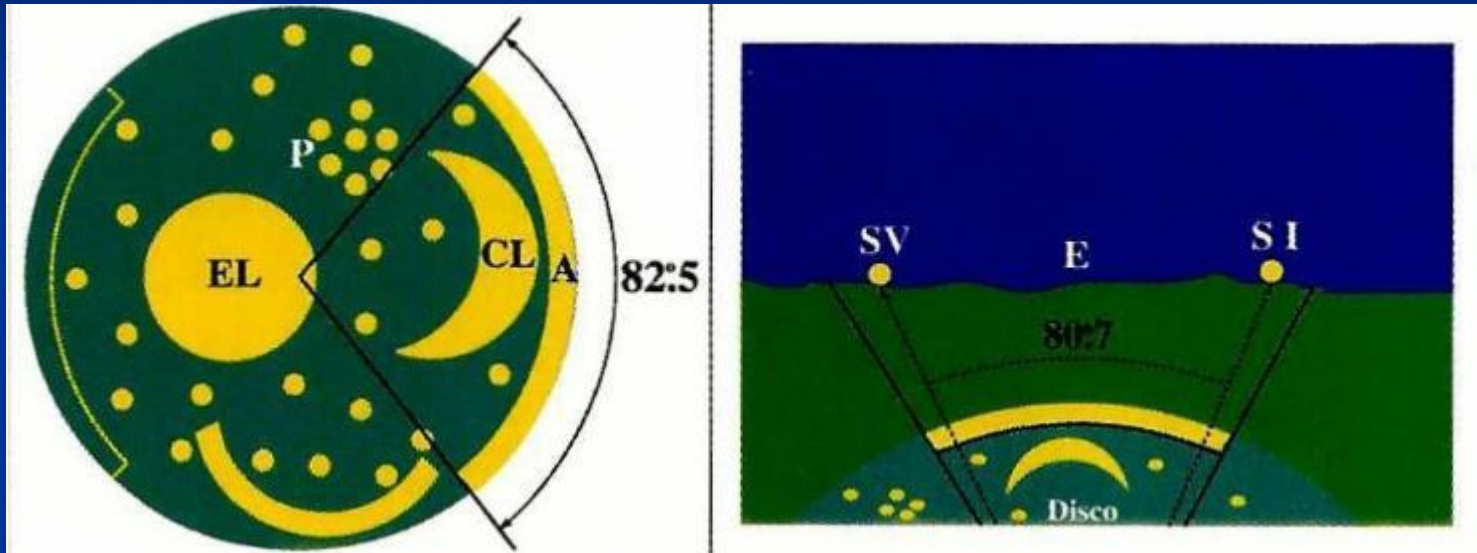
It is believed that the disc is a representation of the sky: the crescent Moon, the Sun, or the full Moon and stars. There is a group of 7 stars together that is interpreted as the Pleiades.



Nebra's disk may be one of the oldest known representations of heaven. Possibly it was used in ceremonies and rites of the people who inhabited central Europe 3600 years ago.



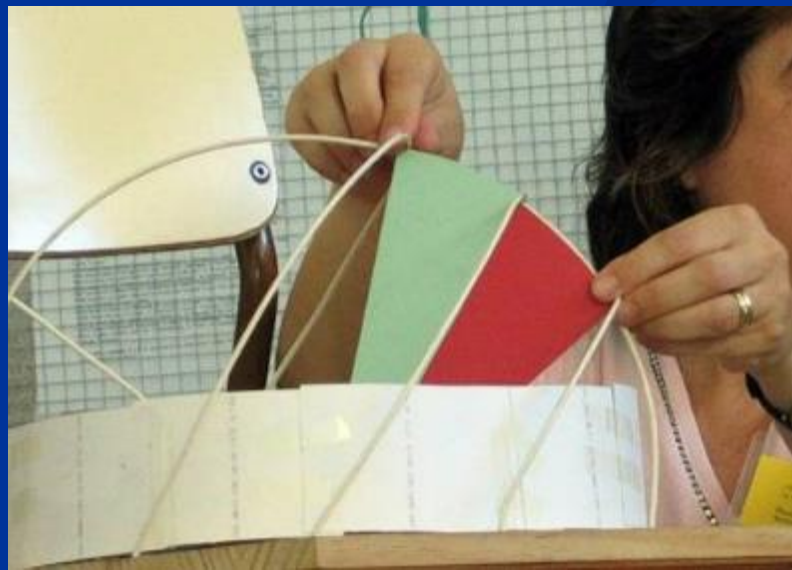
The two arches on the edge of the disk (one missing) seem to indicate the arc described by the Sun on the Eastern horizon from the Summer and Winter solstices rises:  $82.5^\circ$

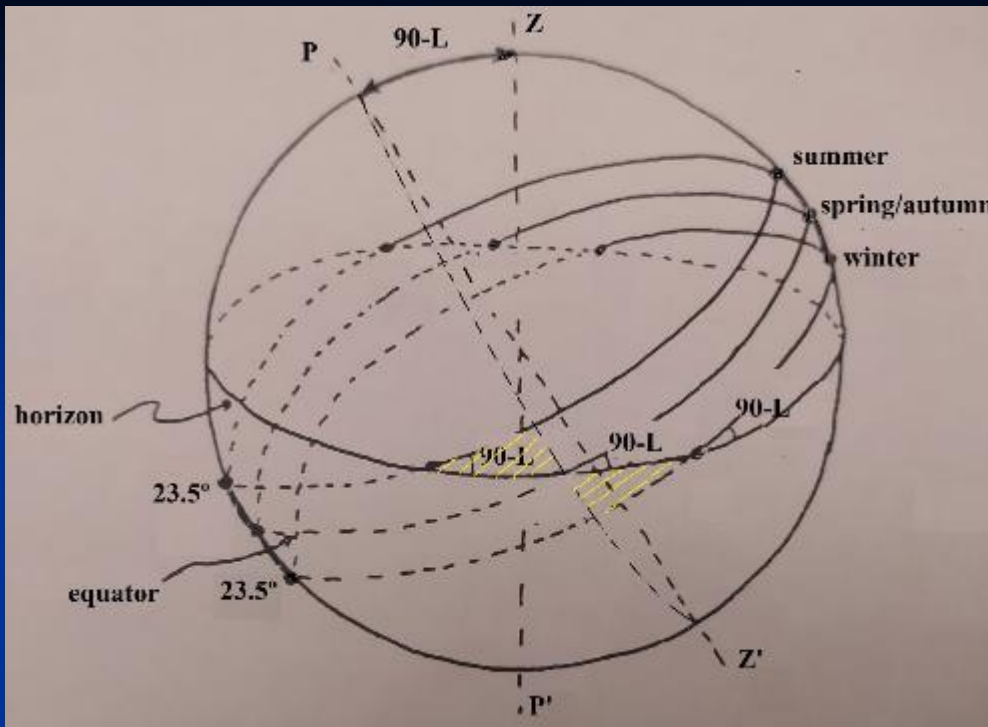




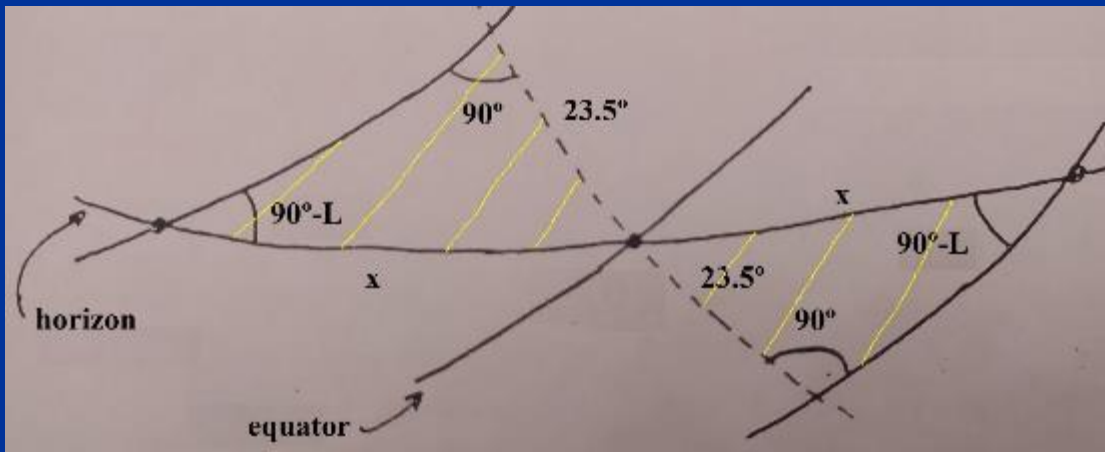
The disk was discovered in 1999 on Mount Mittelberg (near Nebra in Saxony, Germany) with a latitude of  $51^{\circ}$  N. Mount Mittelberg is rich in Bronze Age archaeological sites. It is accepted that the Disk corresponds to the Unetice culture, existed between 1600 B.C. and 1500 B.C.

The angular distance between two Solstices at the Equator is  $47^{\circ}$  but for the latitude in which the disk was found, this angular distance corresponds to  $80.7^{\circ}$





$$\sin x = \sin 23.5^\circ / \cos L$$



$$\sin x / \sin 90^\circ = \sin 23.5^\circ / \sin (90^\circ - L)$$

Latitude L	X°
0°	23,5°
10°	24°
20°	25°
30°	27°
40°	32°
50°	40°
60°	53°

# CHARTAQUI

## Iran, Asia

### 200



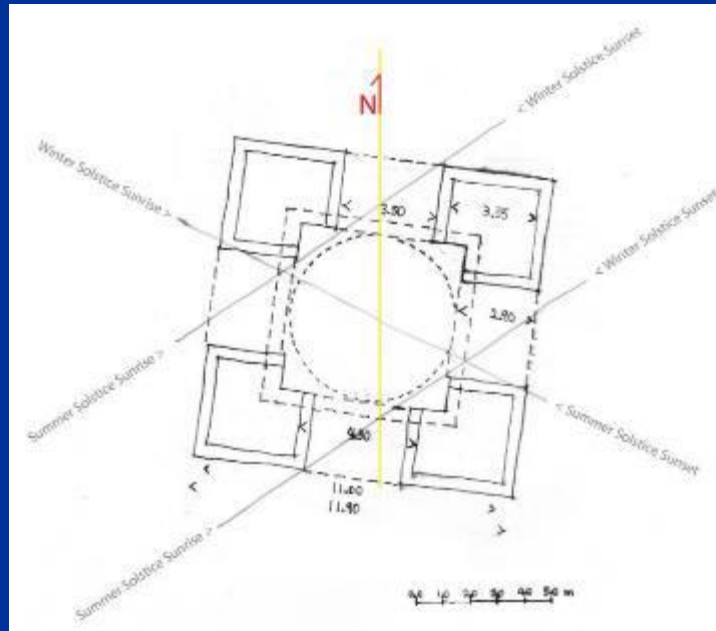
*Chartaqi* is a structure consisting of four pillars and four arches supporting a dome. (In plan chartaqi are a square surrounding a cross and a circle).



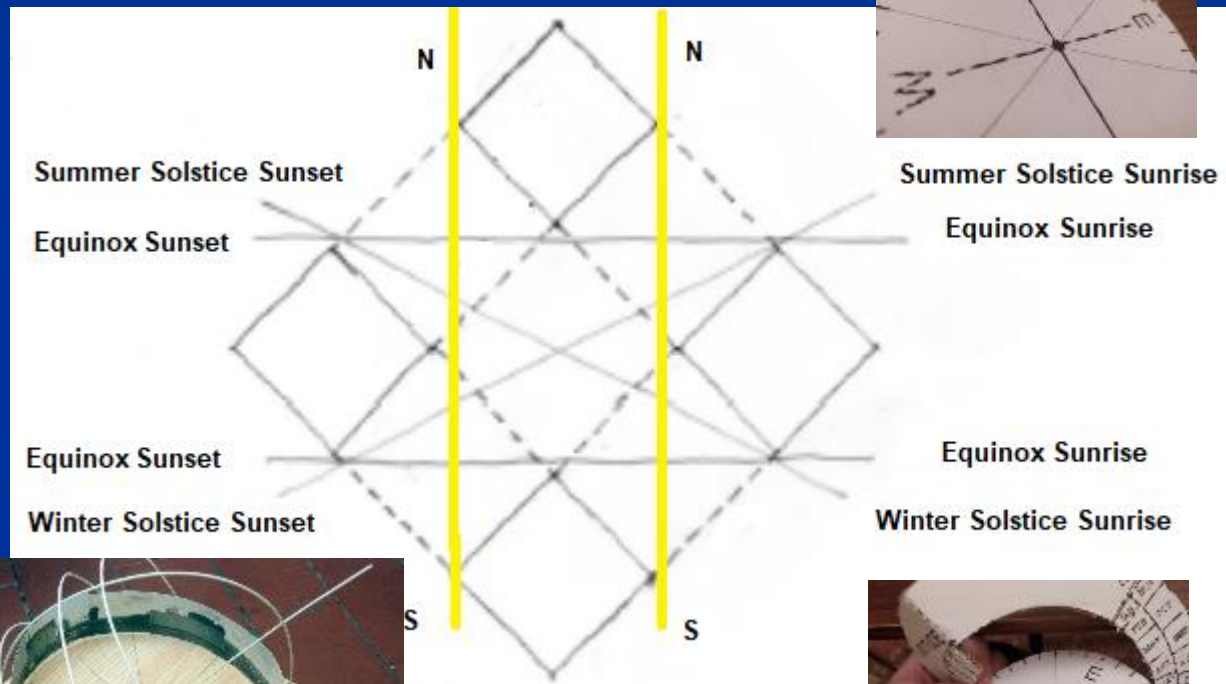
**Chartaqi of Niasar (the best preserved)**  
Temple built by Ardashir I (180–242 AD)



# Scientific evidence shows astronomical alignment to the solstitial and equinoctial orientations



The chartaqa Khaneh-i-Div helps to understand the architectural concept because it was not located in an accessible place but in a better location for equinoctial and solstitial alignments in the mountainous skyline

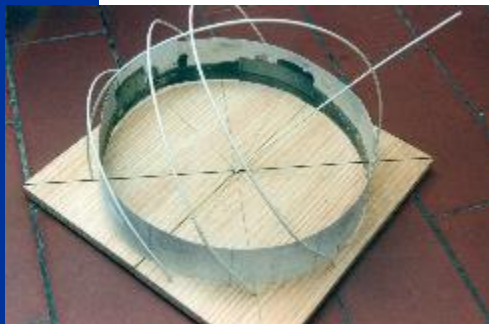
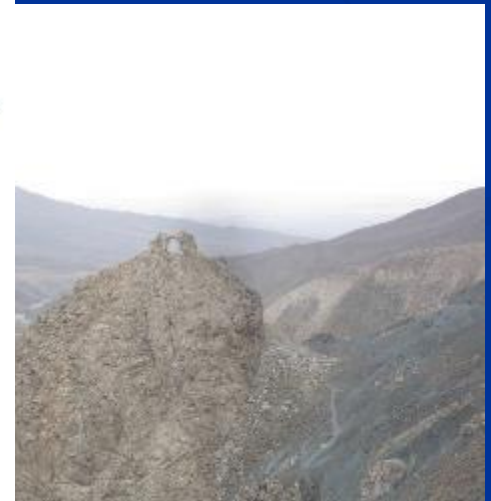


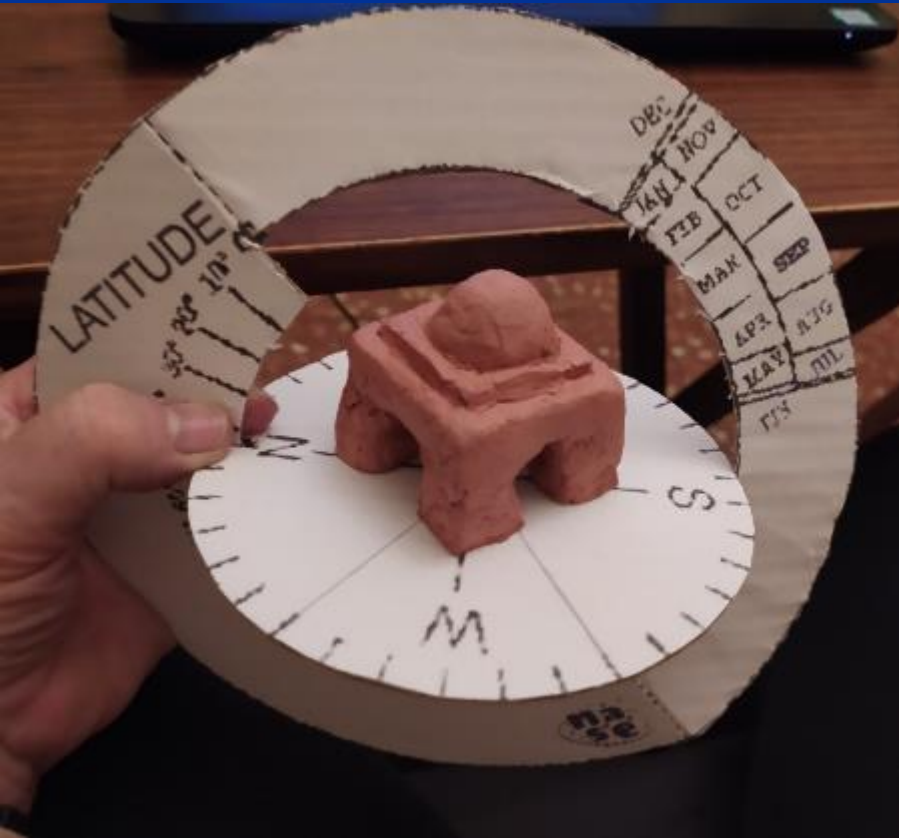
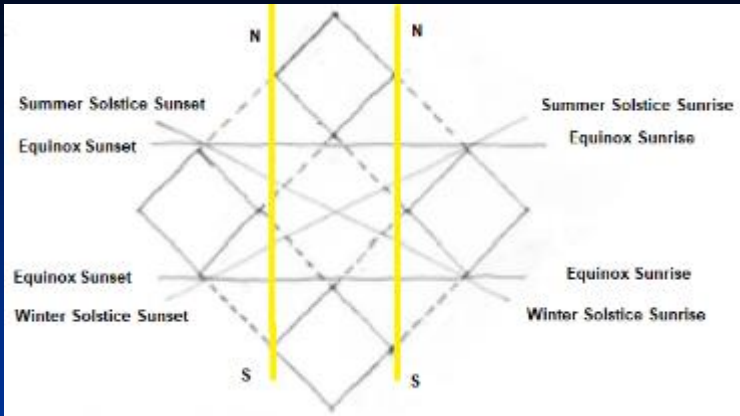
Summer Solstice Sunrise

Equinox Sunrise

Equinox Sunrise

Winter Solstice Sunrise





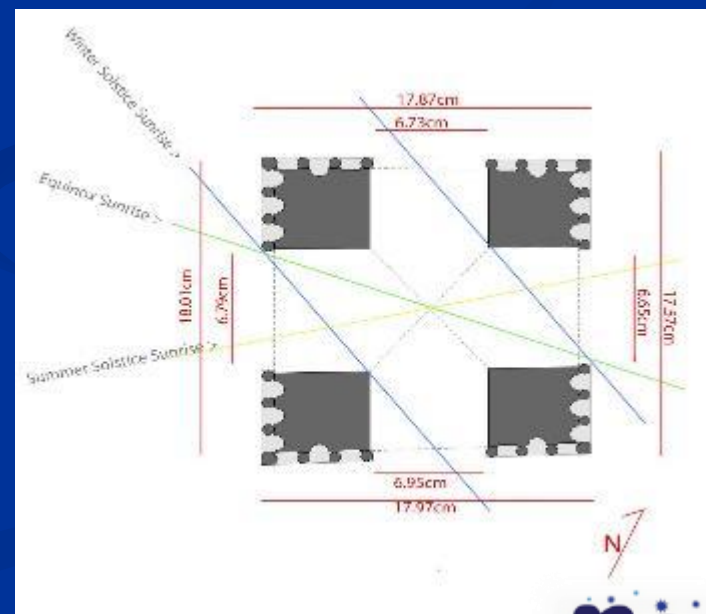
It is possible that the chartaqui are built according to an ancient cosmology that incorporates the symbol of the cross in architecture, which appeared even before the Parthian era, when experimented with dome structures. It looks that Romans borrowed elements from Iranian cosmology and chartaqui too.



Roman coin showing Nero and the Arch of Nero with statue of a four-horse chariot on top. Wildwinds,



The arch of Janus is the only quadrifrons arch preserved in Rome. This arch with four facades marked an important meeting place and crossroads in 4th century BC. Originally the arch supported a penthouse, which was destroyed in the 19th century because the people thought that it was a medieval addition.



# ANCIENT EAST ASIAN CITIES,

Xi'an, China, Asia

Kyoto, Japan, Asia

618 and 794



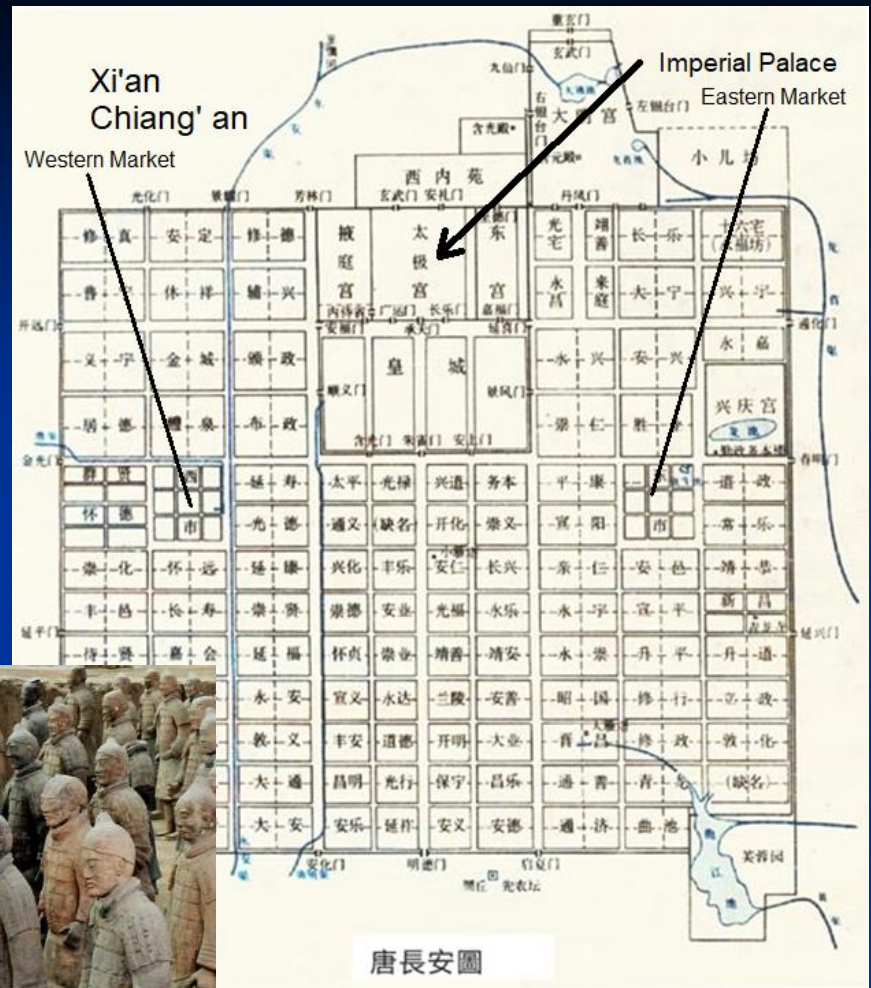
In the ancient Chinese and Japanese capitals, the city was N-S and E-W oriented and designed with a series of streets running at right angles to each other.

This seems to be based on the old philosophy of Yin-Yang, and the four guardian gods in the four cardinal directions. The "yin" means the Moon and the feminine principle. The "yang" means the Sun and the masculine principle.

For centuries, this urban model, with orthogonal axes, had constituted a major cultural reference for the construction of new cities in China and other countries



The shape of the city as **Chang'an** was a rectangle oriented according to the cardinal points. It had the palace to the north looking south. The mountains are located to the north, there was a stream of water to the south with a gentle slope. The city was defended by walls.



Chang'an was build close to the Mausoleum of Qin Shi Huang



The grid model was first used in Chang'an (Xi'an), the Chinese capital of the Han dynasty from 618 to 907. Chang'an, was the model of ancient Chinese and Japanese cities (in these without fortification)



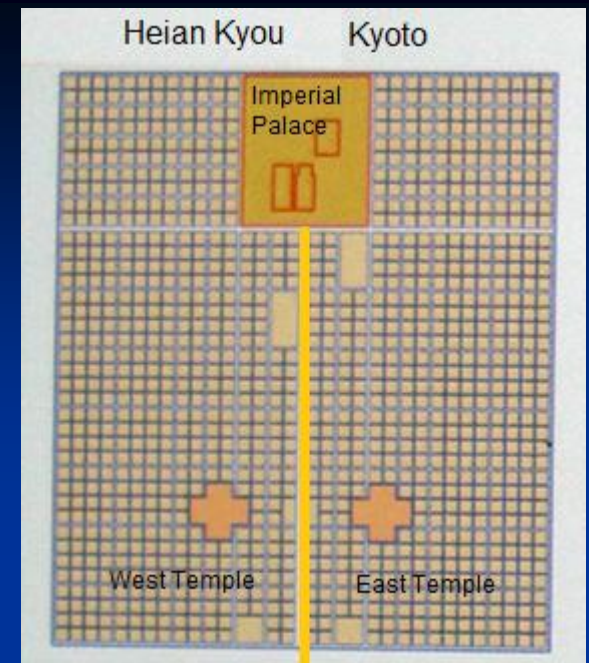
For example  
Heijou Kyou  
(Nara) and Heian  
Kyou (Kyoto) in  
Japan or the  
current Kyongju  
(Gyeongju) in  
Korea



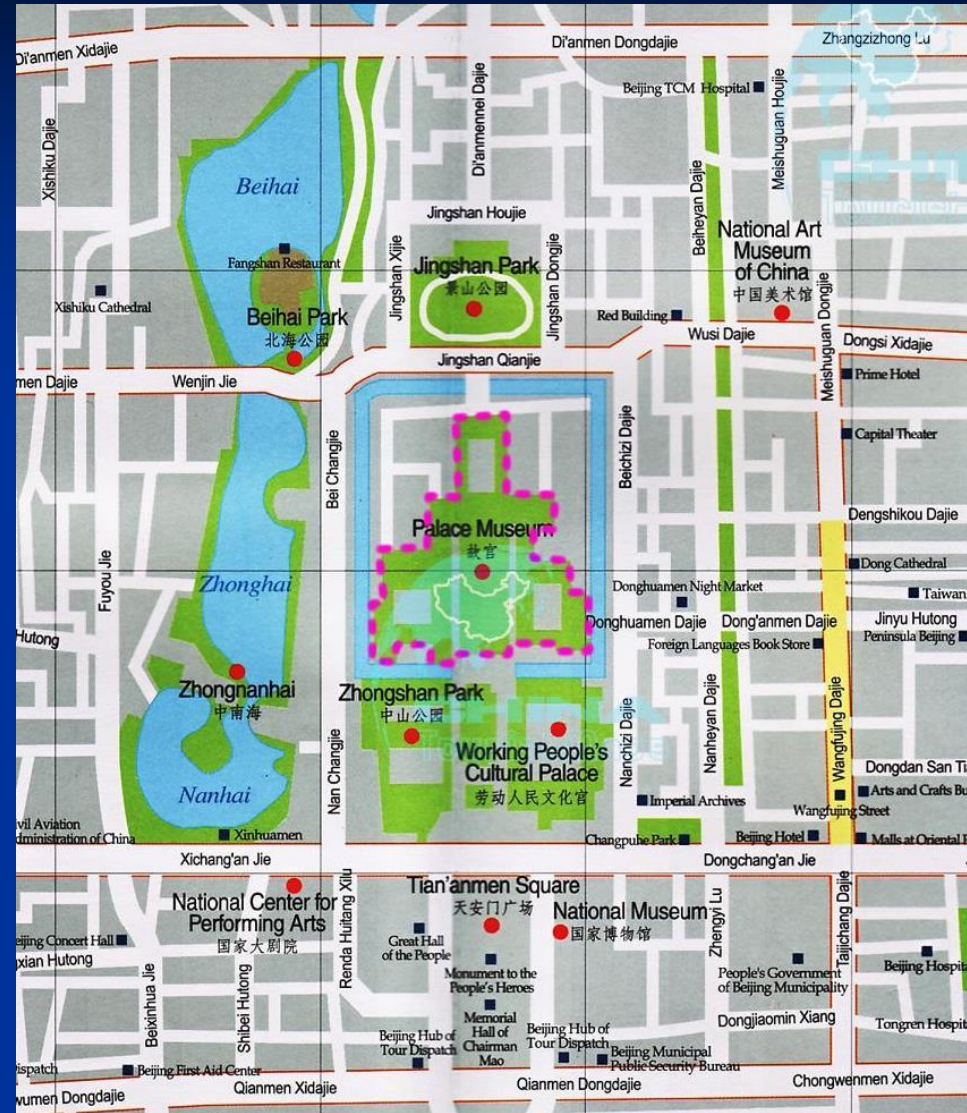


**Kyoto** was founded in 794 in relation to the normative principles of the Chinese city.

The imperial palace was located on the north side of the city, and from there the Suzaku main street was heading directly south and represents the universal column that unites the earth to the sky and that looks at the North Star. At the heart of the composition is the Emperor, associated with the Pole Star, the sign of the perpetual center and the never-descending point.



The **Forbidden City** was built between 1406 and 1420. The ensemble exemplifies traditional Chinese architecture. It has an axis south to Tian'anmen Square and beyond. To the north comes Jingshan Park, an artificial hill created with the earth extracted from the moat and the nearby lakes.



S



**STAR FESTIVAL**

**Malang,**

**Indonesia, Asia**

**700**





## Buddhist temple, Eng-An-Kiong, in Malang, Indonesia

The weaver princess (the Vega star), daughter of the sky king, married a tough and great cowherd (the Altair star). But, once married, the young couple became lazy. Angry, the king of heaven separated the two lovers with a large river, the Milky Way, and allowed the two to meet only once a year, on the seventh day of the seventh month.





This day, a flock of magpies made a bridge with their wings over the Milky Way so they could meet.

This day, in Japan, wishes are written on small pieces of paper and hung. At night, people search for the two stars with their friends and family.



This story was described in China in 6<sup>th</sup> /7<sup>th</sup> centuries and in Japan in the 8<sup>th</sup> century.



This day, Vega and Altair, they would undoubtedly meet on the Milky Way river.

July 7th and rain period



August 7th



Altair

Vega

July 7 corresponds today, according the Gregorian calendar, to August 7, (in Japan July 7 corresponded to a period of rain and now it is arround August 7).



**SANT CLIMENT AND  
SANTA MARIA DE TAÜLL**

**Spain, Europe**

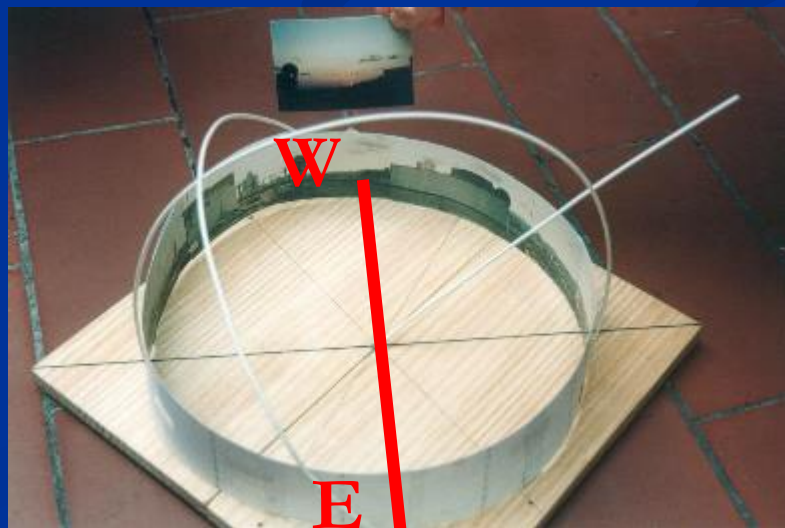
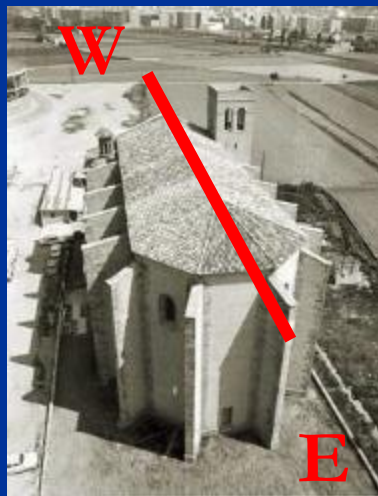
**1123**



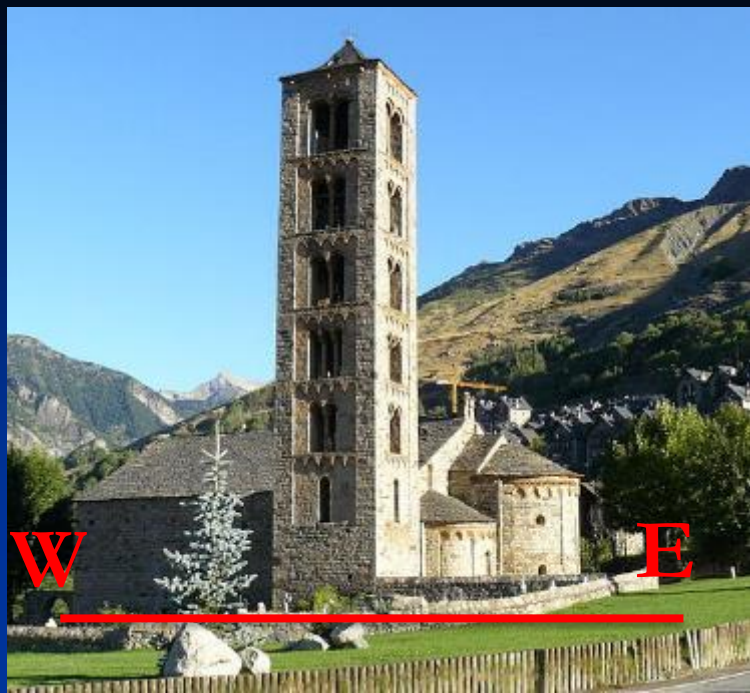


At the Council of Nicaea (325) it was determined that the apse of a church was to the East and the gateway to the West so that the priest would be facing East during the services.

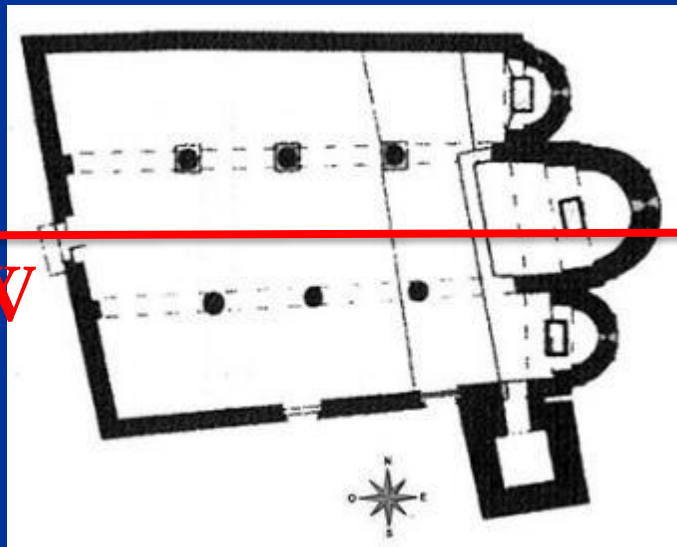
Thus the priest and the participants would be directed towards the East, from where Christ, the Sun of Justice, will shine at the end of time (*ecclesiarum situs plerumque talis erat, ut fideles facie altare versa orientem solem, symbolum Christi qui est sol iustitia et lux mundi intererentur*)



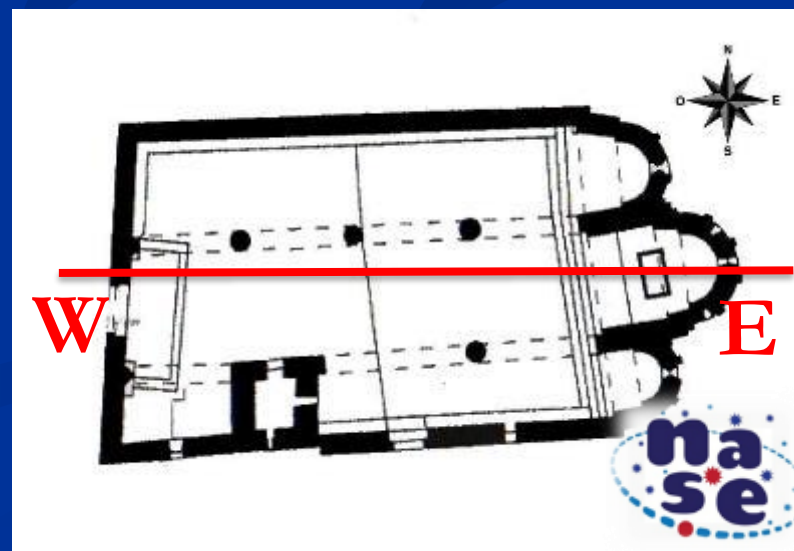




S. Climent de Taüll

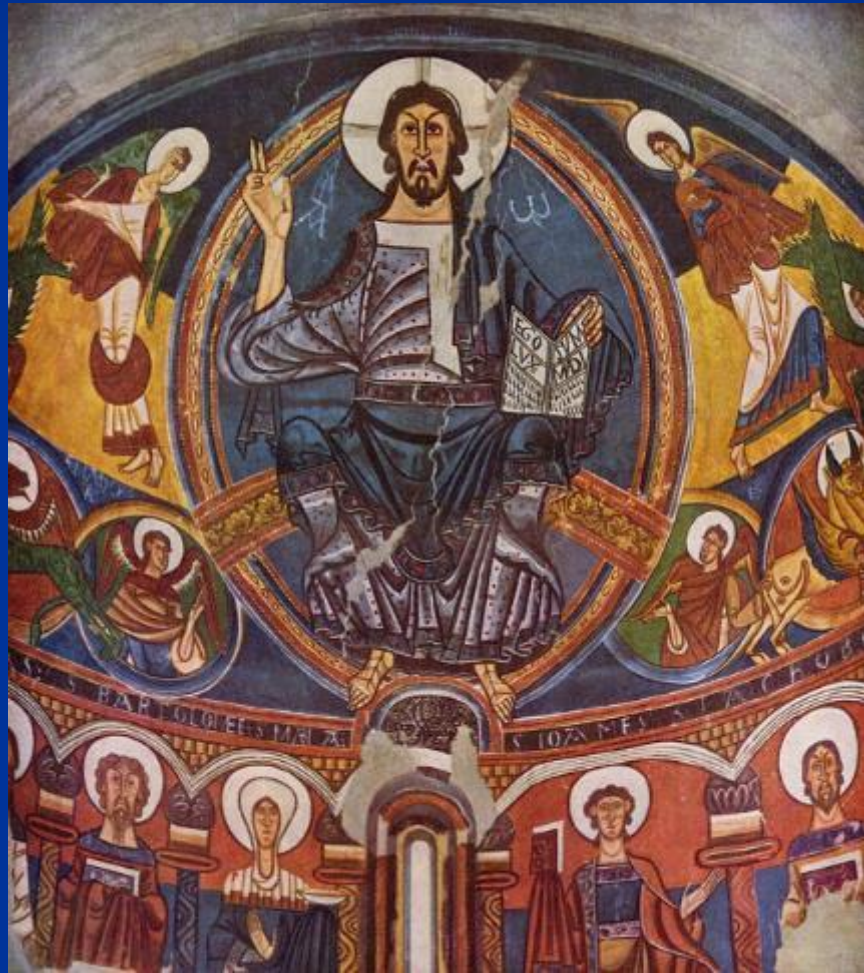


Santa Maria de Taüll

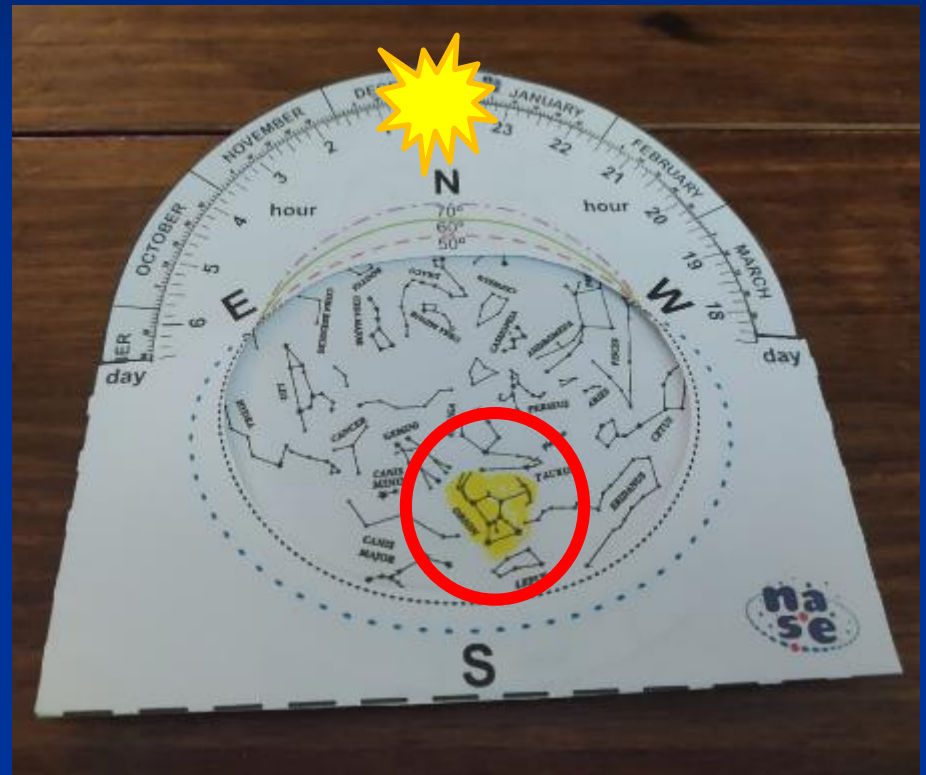




On December 10, 1123, Sant Climent de Taüll was consecrated. One day later on December 11, Santa Maria de Taüll was consecrated, after finishing the works and the interior wall paintings.



# Taüll is in the Pyrenees at Latitude 42° N



Orion is on the Southern horizon on  
December 25, at Christmas





# Astrophysical observation 1123



3 kings: Melchior,

Gaspar and Baltasar

**Betelguese**

**Bellatrix**





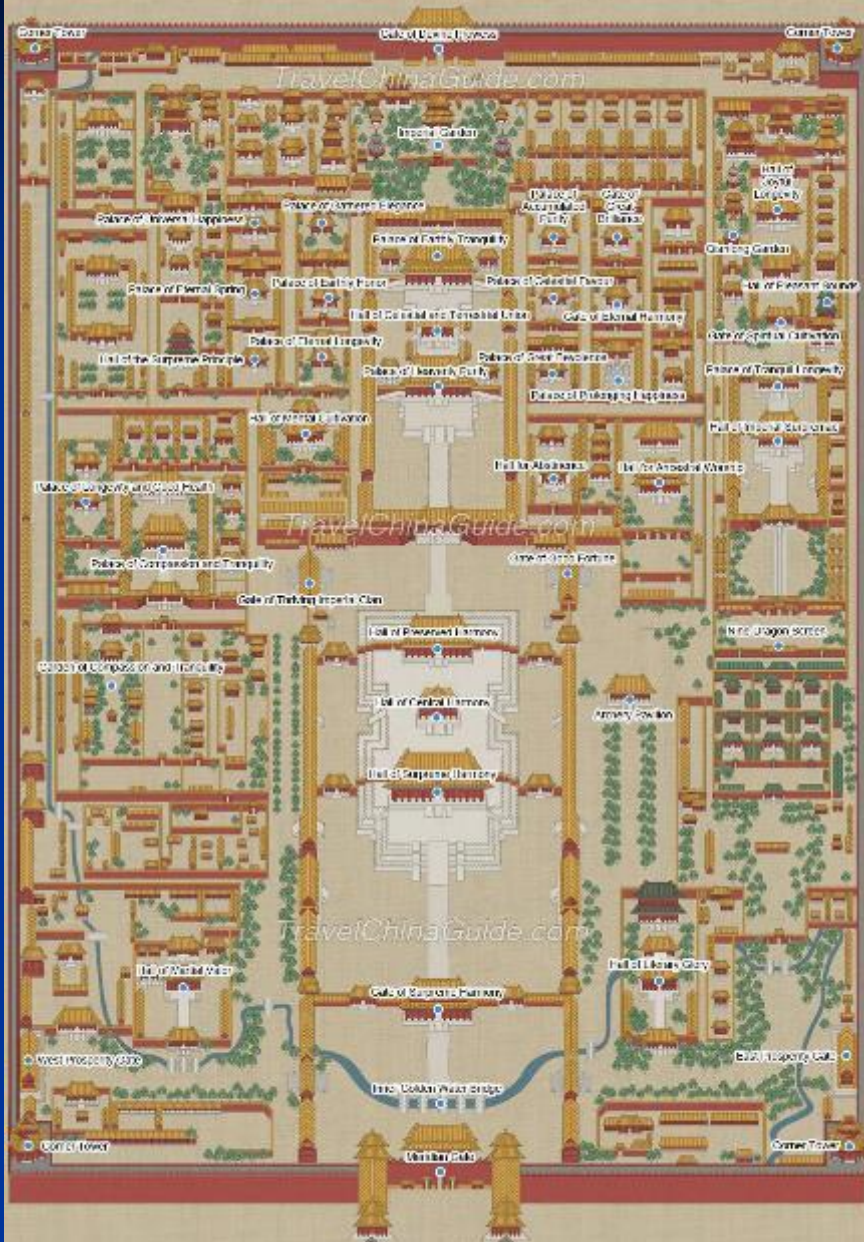
# FORBIDDEN CITY

China, Asia

1420



A Full Map of the Forbidden City



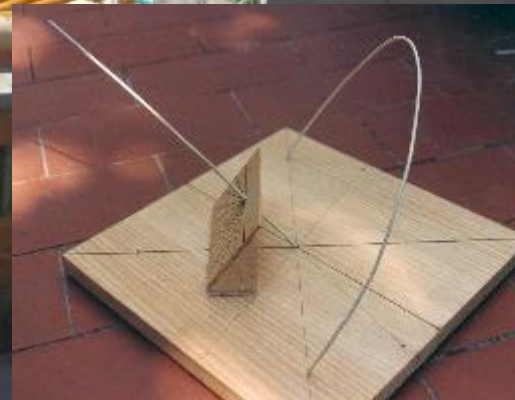
The full map is oriented  
North-South  
according the local meridian.

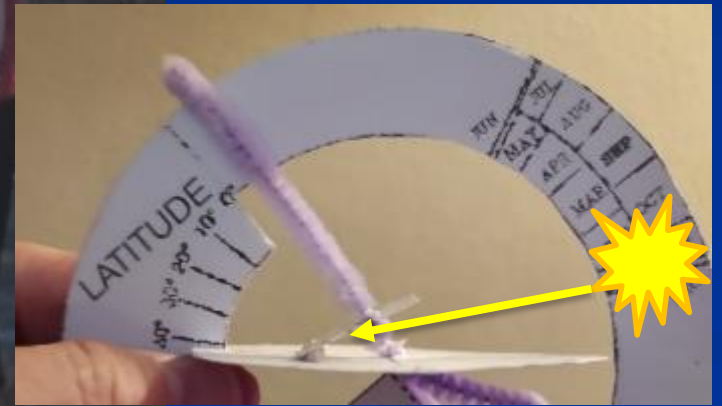
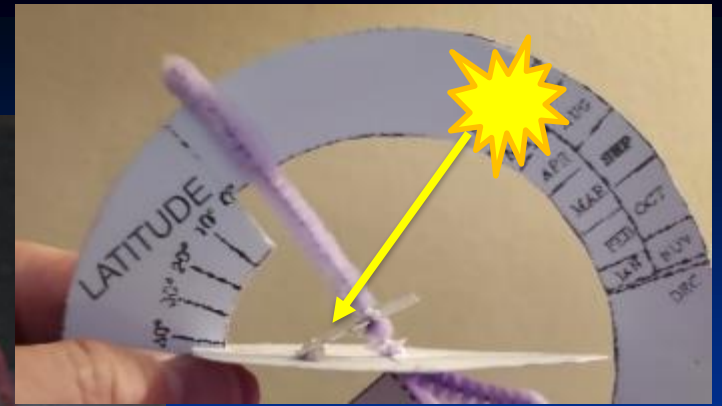
Location Map of Forbidden City and Tiananmen Square





There is a collection of equatorial sundials aligned with the local meridian





The plane of sundial is parallel to the equator and the gnomon is according the terrestrial rotation axe





**MONUMENT**  
**“Mitad del Mundo”**  
**Equador, America**  
**1992**



# Equator Monument in the Equator line



Parallel Earth?, with the Equator line on the top

# The Equator line





# Parallel Earth? a few weeks after the equinox



There is an error  
in position !!!!

**CONSTELLATIONS  
FOR FISHING AND PLANTING  
Philippines, Asia  
2005**





Teruday  
Lat 7°N





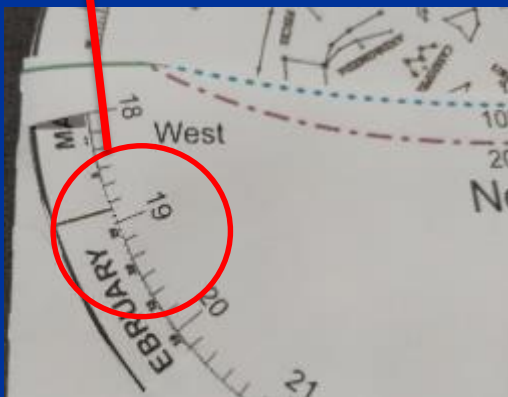
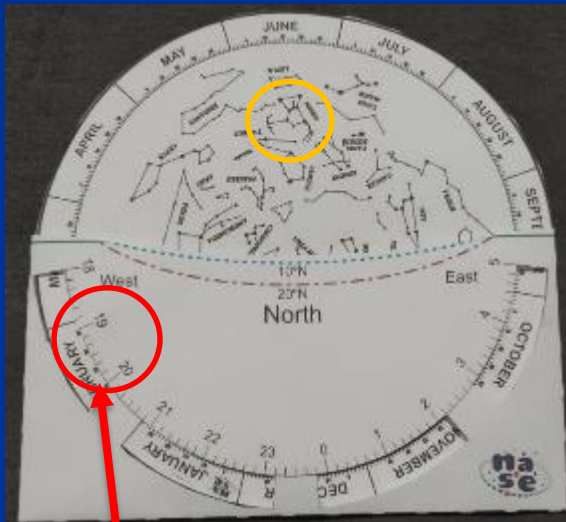
# TEDURAY

For the Teduray, a group from Mindanao, Orion is called "Seretar", and they consider him a hunter. They see Seretar's body on Orion's belt, his right hand on Betelgeuse, and his left hand on Rigel. The Sword of Orion was interpreted as the itak of Seretar.

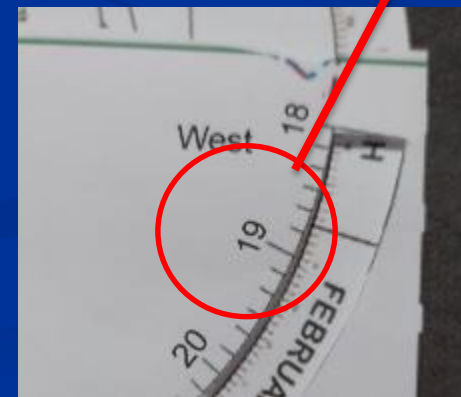
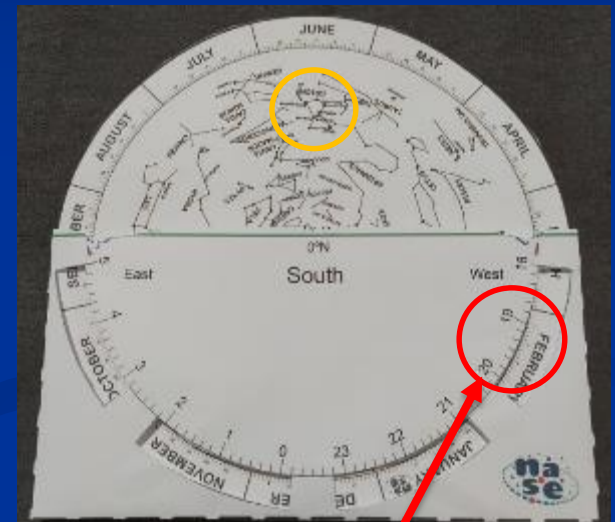


# Teduray **The Sunset is at approx. 18:00h and the night starts at 19:00h**

The Teduray use Seretar to know when they can start planting. They call "kemuda" or "riding a horse" to the zenith. They imagine a circle of about 20° in diameter that surrounded the kemuda, which was called "ranga" or "hen's nest". When Seretar enters the ranga, the agricultural season begins.



**Orion is at the zenith at 19:00 p.m. at the end of February and the Tedurays begin planting**





Tawi Tawi  
Lat 5°N

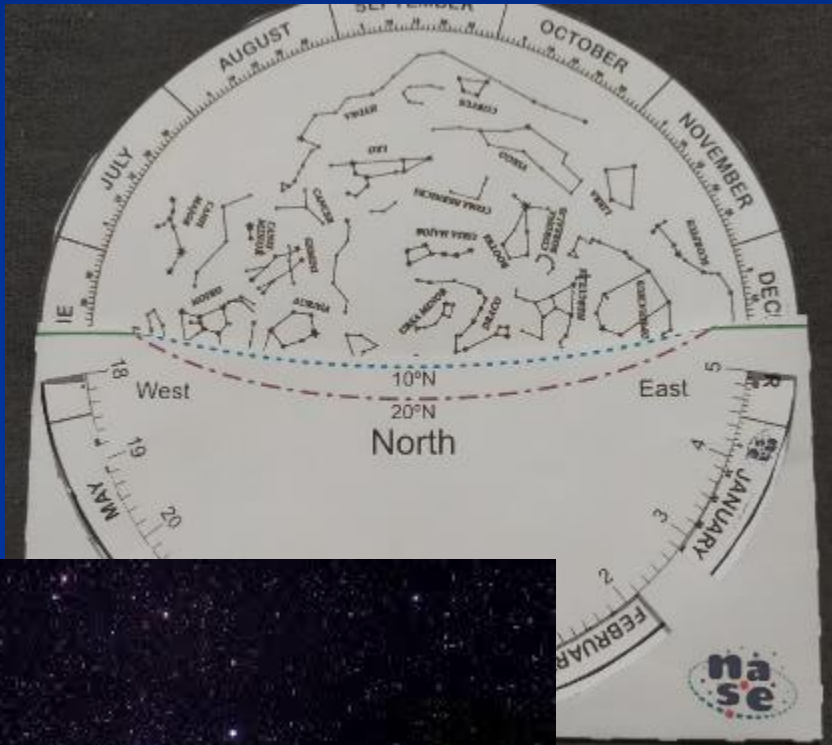




In Tawi-Tawi, the Big Dipper is a constellation that resembles a fish trap. They use it to determine good results for fishing. If many stars are seen inside the "cage", then the weather conditions are suitable for fishing.



In Tawi-Tawi another significant part of the Big Dipper is the handle, or in the case of the trap, “the rope”. If it was facing East, the Sama believe that the current will be strong.



The handle of the Big Dipper is to the East when the Sun is on the vernal equinox and the Lion is on the Southern horizon at night.



# SOLAR PANELS

## Mongolia, Asia

### 2019





With solar panels ... with different orientations?



In Ulaanbaatar **ALWAYS** the same orientation according the solar path!!





Direction N-S with the inclination = site latitude





# Best sits in the Bus

From Ulaanbaatar to Tsetserleg



Latitude 48°N

Sunny part on the South part  
(on the left), that is to say  
it is better to sit on the right





**Many Thanks  
for your attention !**

