

Astronomy in the City

**Rosa M. Ros, Juan A. Belmonte, Beatriz García,
A. César González, Akihiko Tomita, Eder Viñuales**

***International Astronomical Union
Polytechnical University of Catalonia, Spain,
Institute Astrophysics Canarias, Spain,
ITeDA and Technological National University, Argentina,
Institute of Heritage Sciences, CSIC, Spain,
Wakayama University, Japan,
Zaragoza University, Spain***



ORIENTATION OF THE PYRAMIDS

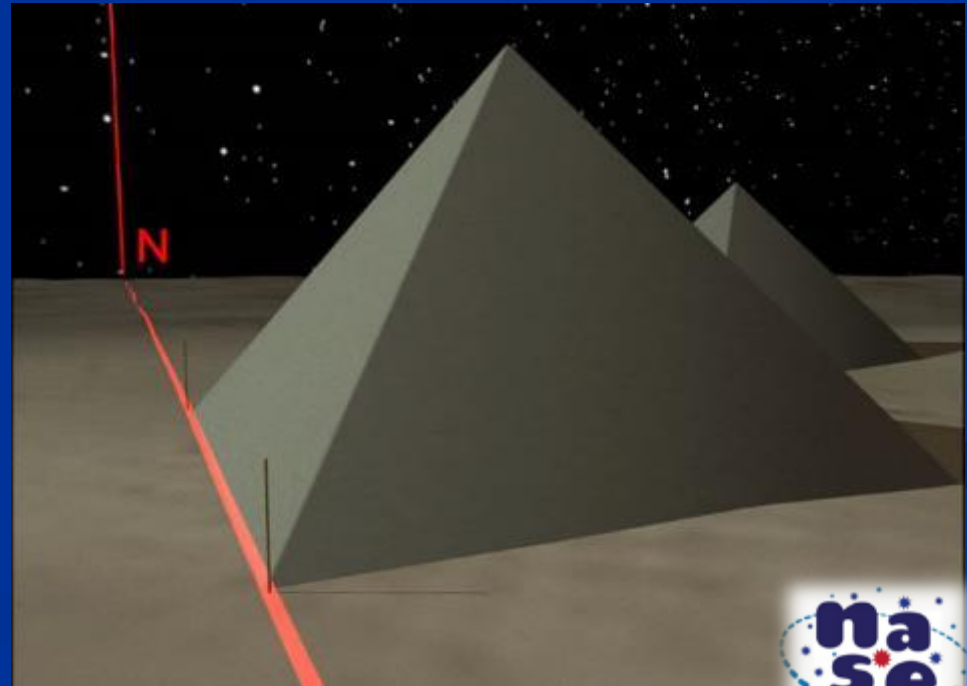
Giza, Egypt, Africa
2500 BC



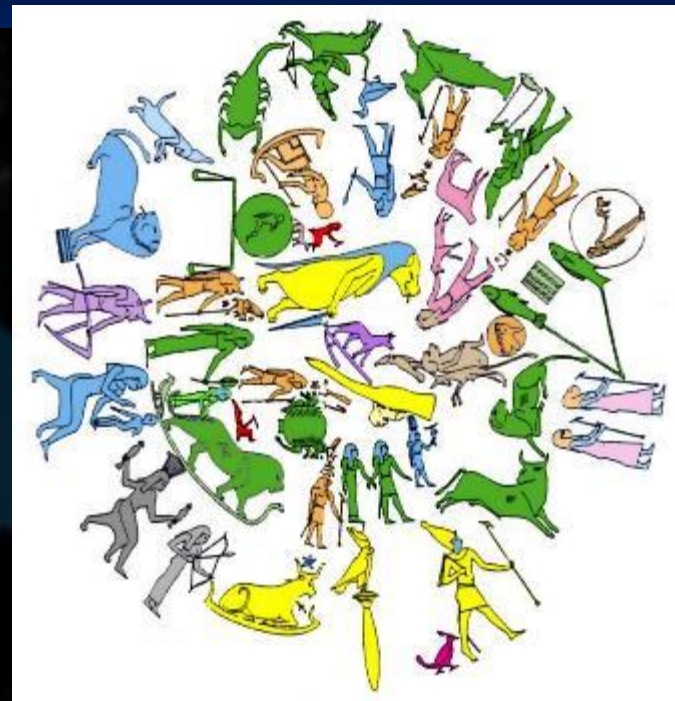
Not all of Egypt's pyramids are correctly oriented; in fact, only a few of the more than sixty well known have a precise orientation.

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



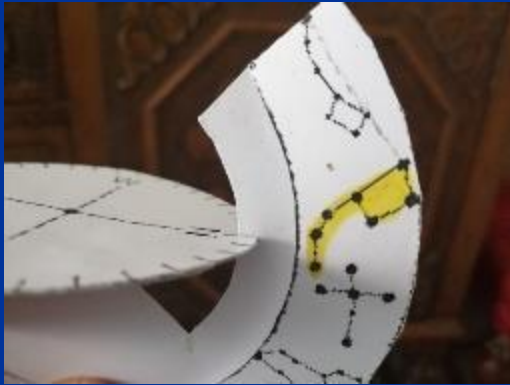
"Imperishable" constellation of the **Bull's Leg**



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



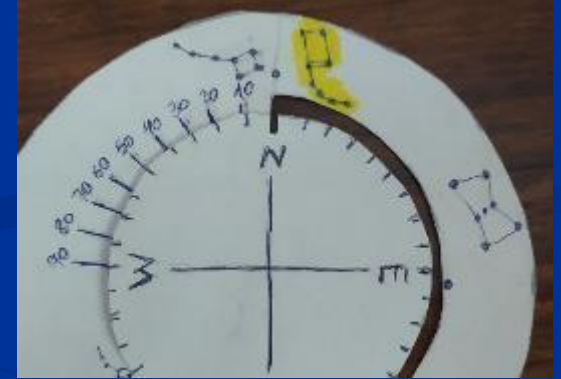
The placement of the pyramids responds to religious motivations. The Egyptians believed that the stars disappeared and reappeared, allowed to transcend death. **"The ducts of the pyramids face north because there were the stars that never disappeared from the sky, the circumpolar stars, which never died"**



Now 2000



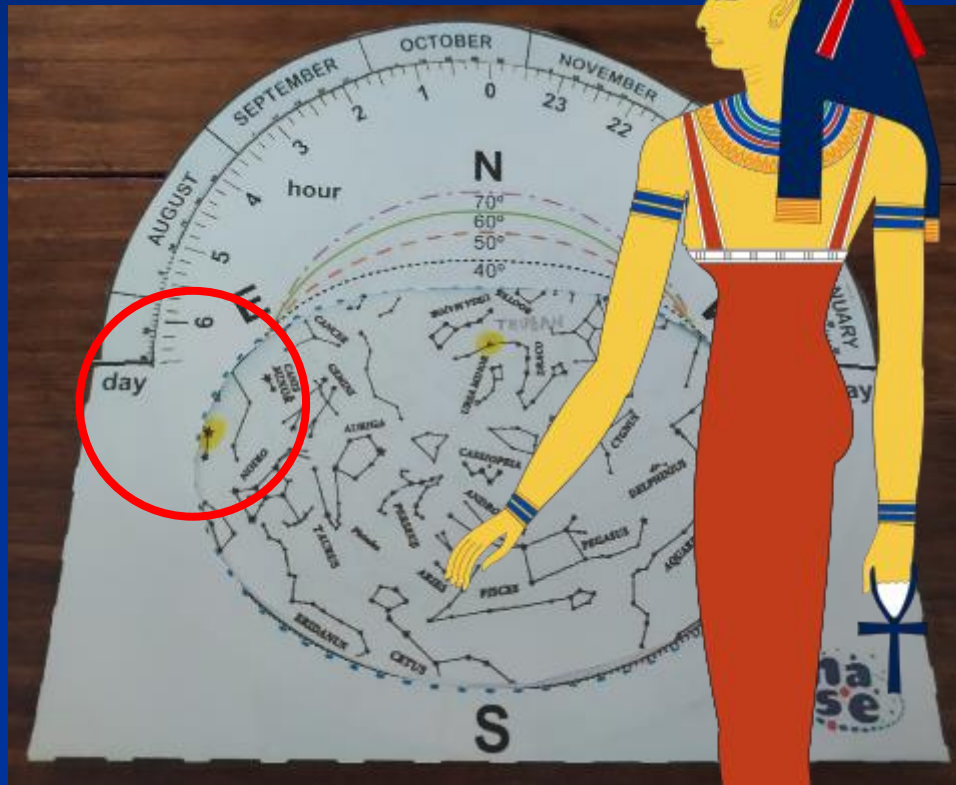
Before 2500 BC



Cairo latitude 30°N

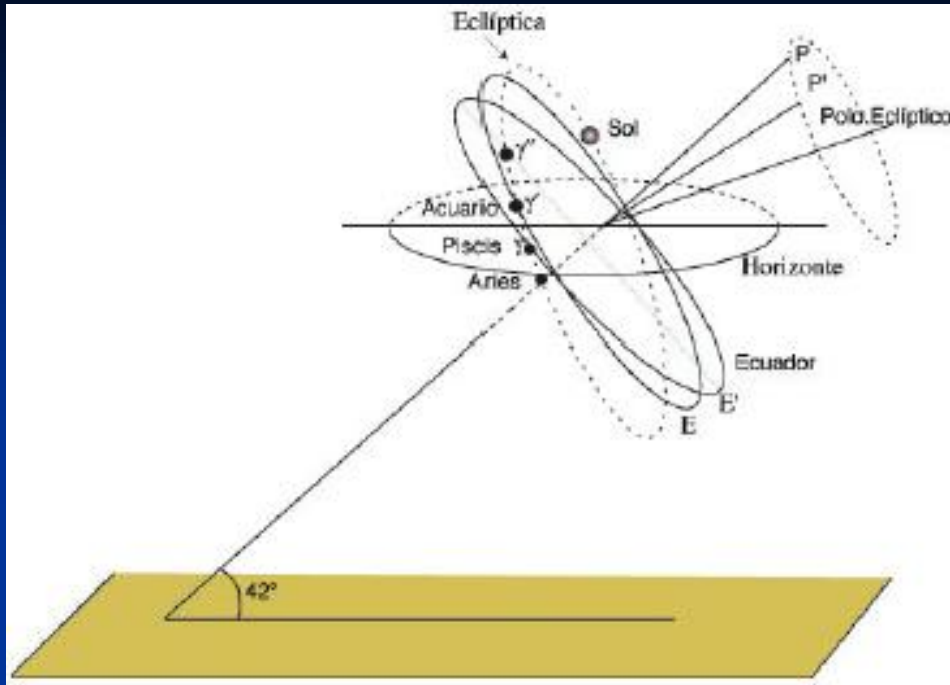
The access corridors were built with a slope such that this would facilitate the king's ascension to the northern skies, domain of the "undying stars".

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) and this moment of great importance in Egypt.

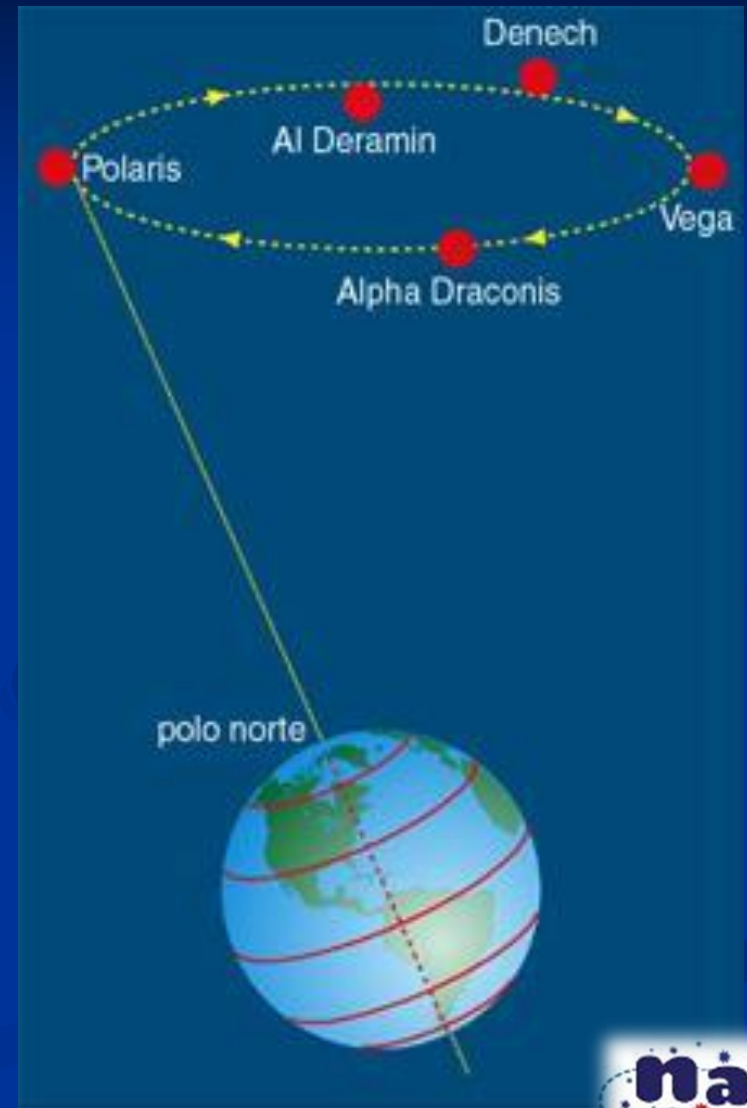


The star Sirius remained invisible for 70 days, the same time as in the mummification process, the bodies were immersed in natron salts to dehydrate them for 70 days and the body was subsequently removed.

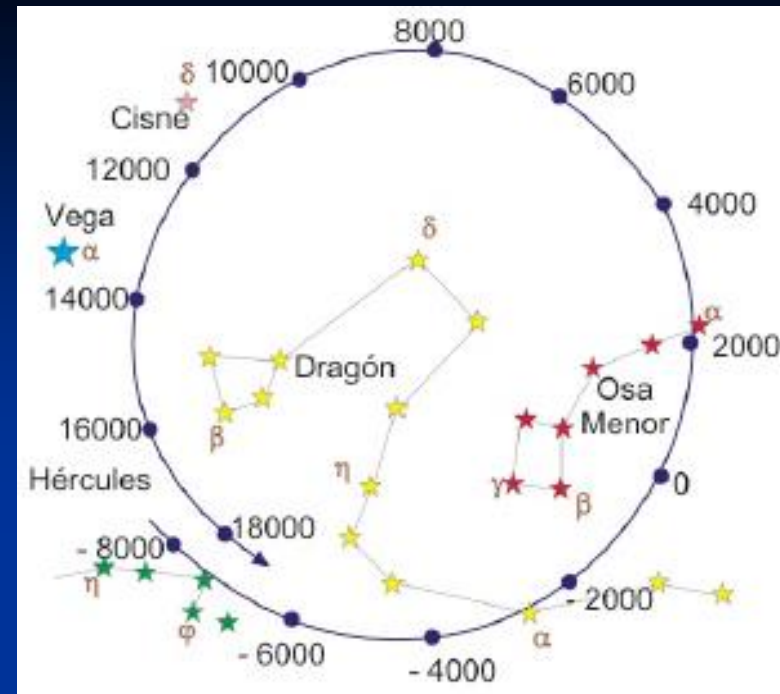




Due to the Precession of the Equinoxes, the point of intersection between the equator and the ecliptic, called the Aries point (because it was in this constellation) has moved to the constellation of Pisces.



Precessional motion of the Earth's axis of rotation (change of direction of the axis describing a circumference like a spinning top) takes place $50.29''$ /year (it turns in 25776 years). 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.



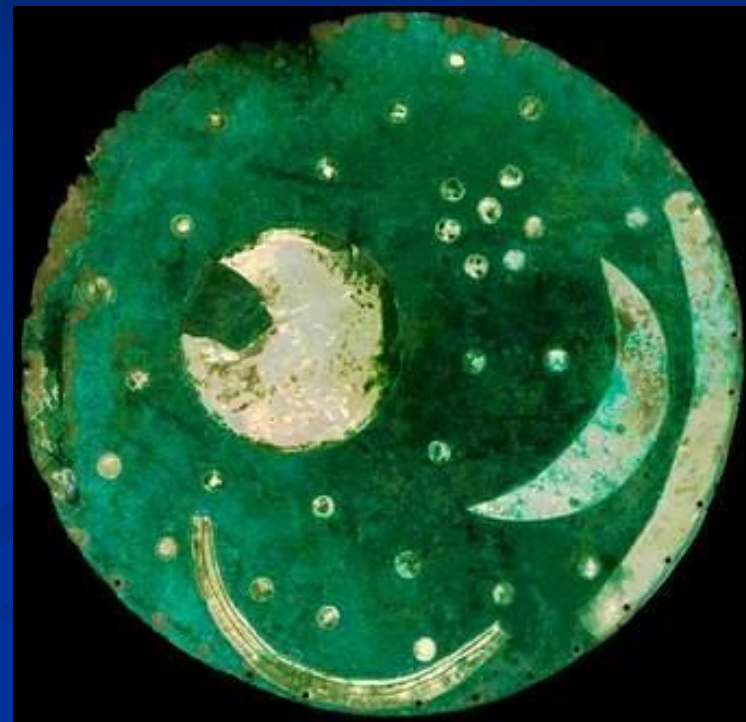
NEBRA DISC

Nebra, Germany, Europe
1500 B.C.



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

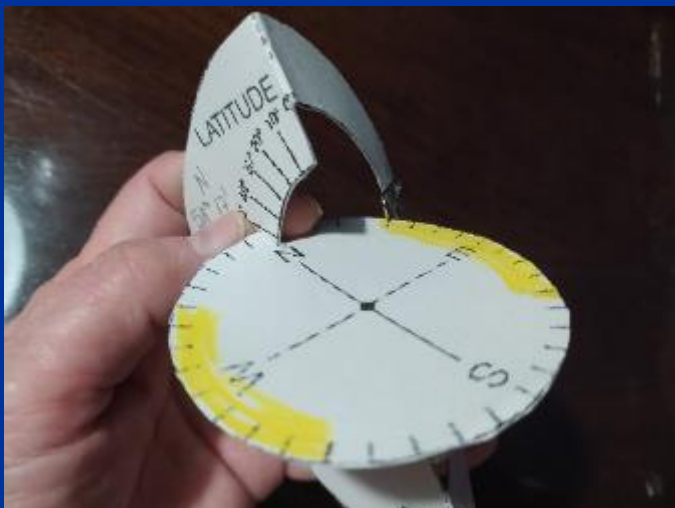
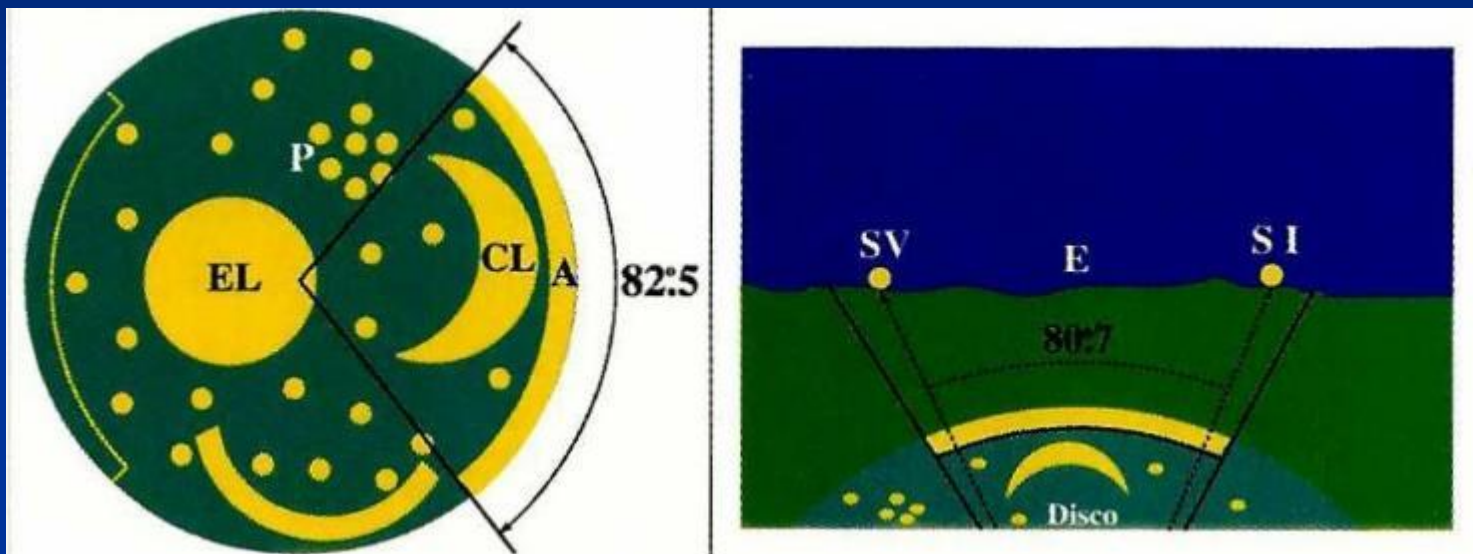
It is believed that the disc is a representation of the sky: the crescent Moon, the Sun, or the full Moon and stars. There is a group of 7 stars together that is interpreted as the Pleiades.



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.

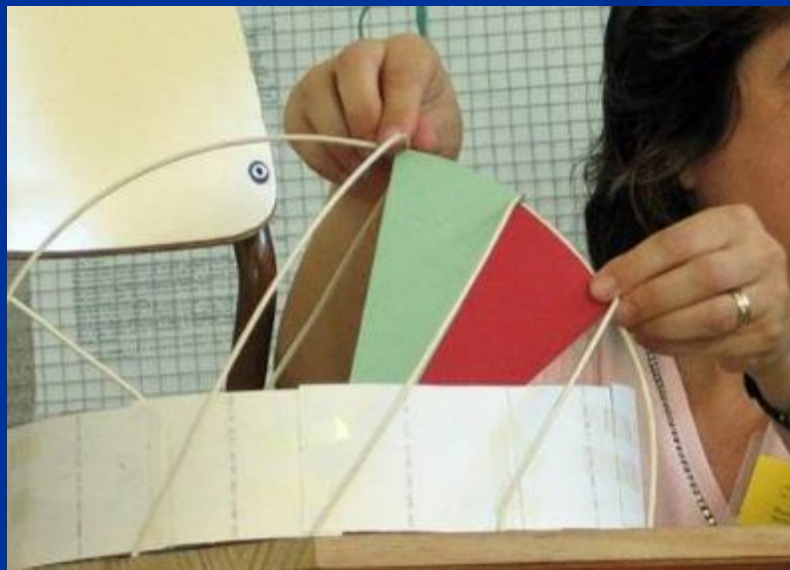


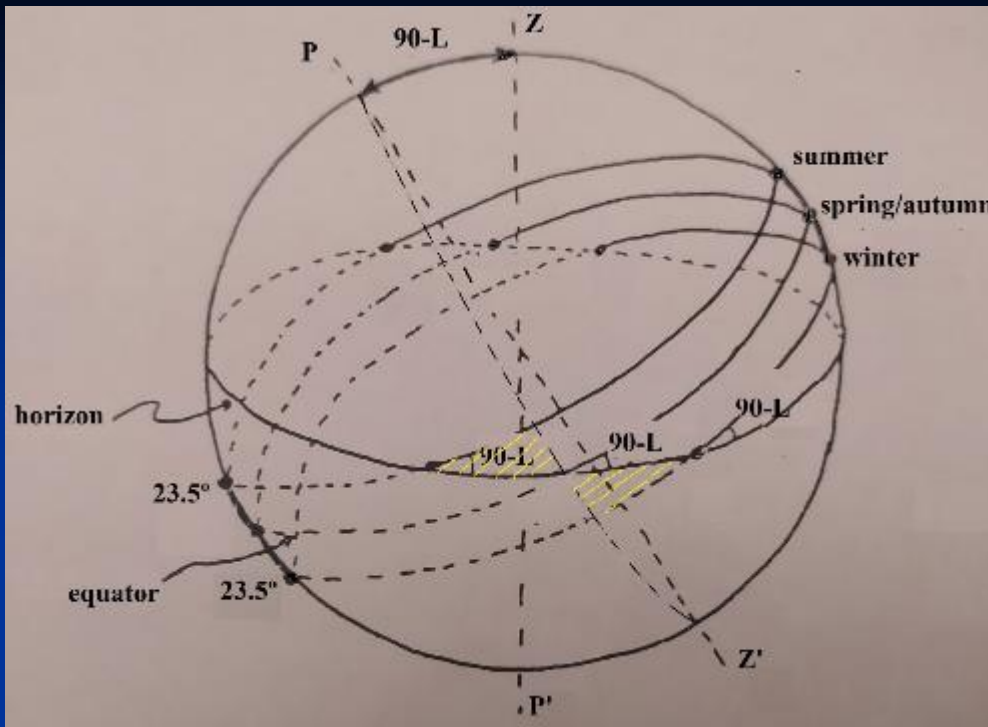
The two arches on the edge of the disk (one missing) seem to indicate the arc described by the Sun on the Eastern horizon between the Summer and Winter solstices rises: 82.5°



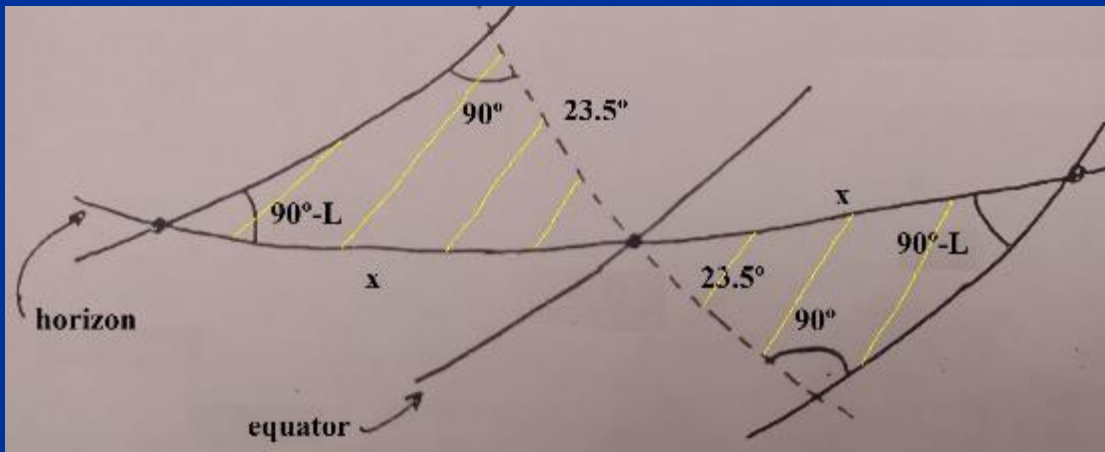
The disk was discovered in 1999 on Mount Mittelberg (near Nebra in Saxony, Germany) with a latitude of 51° N. Mount Mittelberg is rich in Bronze Age archaeological sites. It is accepted that the Disc corresponds to the Unetice culture, existed between 1600 B.C. and 1500 B.C.

The angular distance between two Solstices at the Equator is 47° but for the latitude in which the disk was found, this angular distance corresponds to 80.7°





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



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

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

ROMAN CITIES

Barcelona, Spain, Europe

10 BC

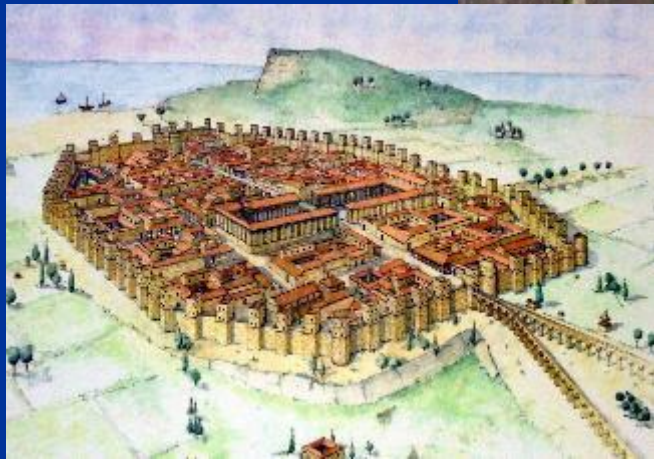
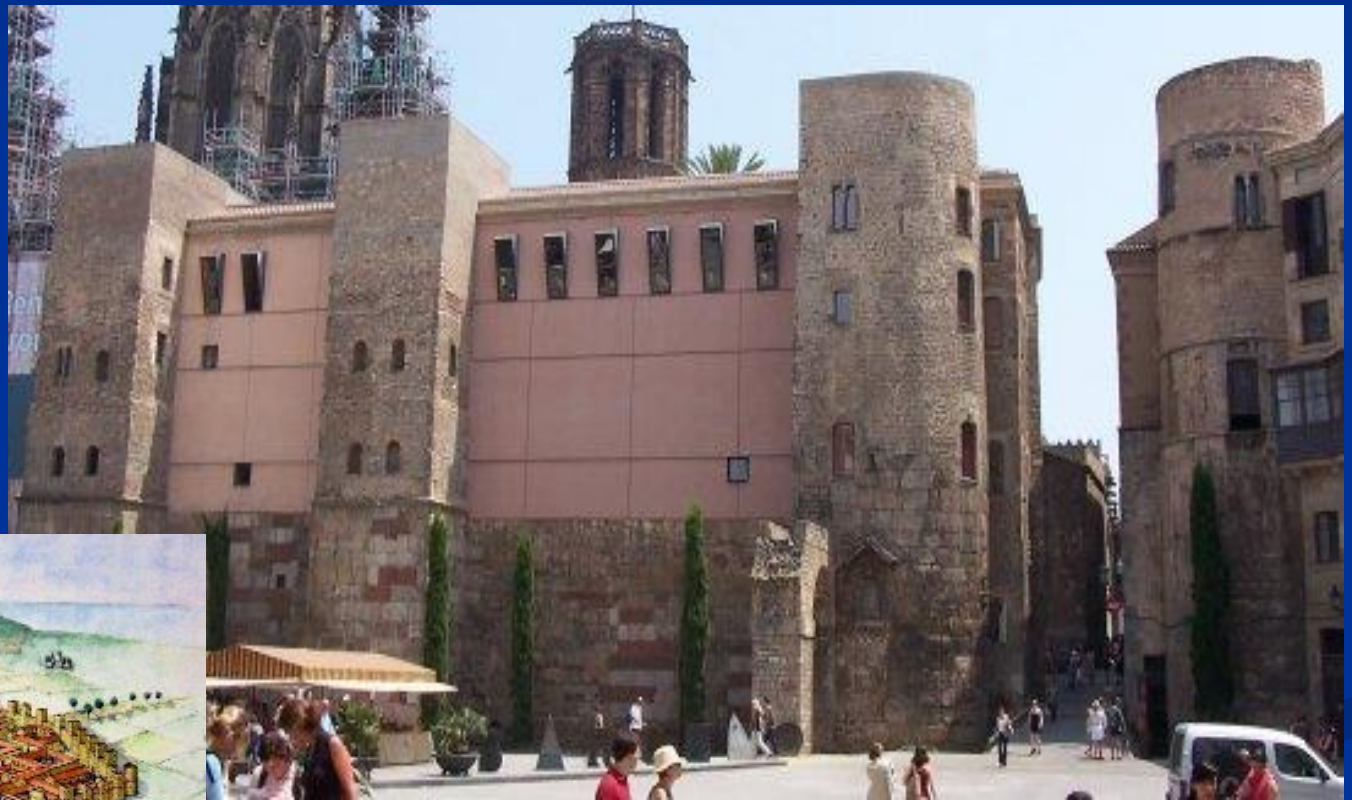


Barcelona was founded by the Roman Empire in the 1st century BC. (it was called Iulia Augusta Faventia Paterna Barcino) on a small hill called "Mons Taber".

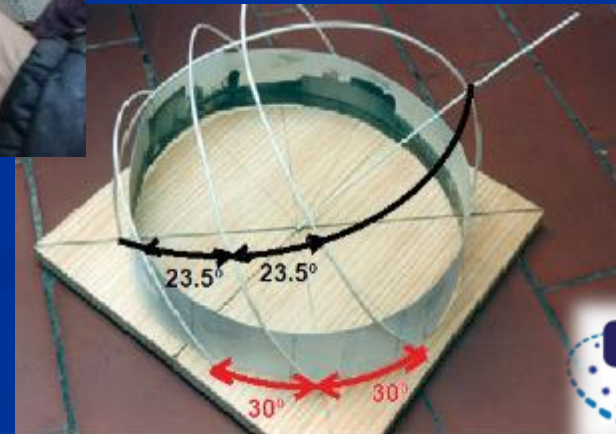
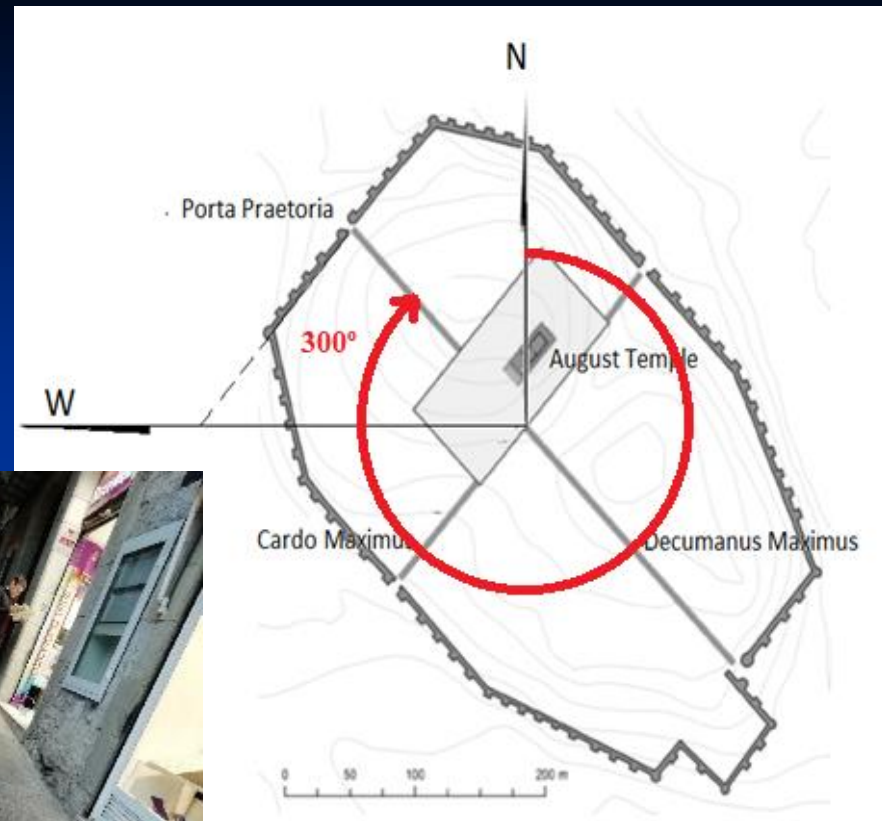
The Temple of Augustus was located at the highest point of Mons Taber



Barcino was crossed by the Decumanus maximus (main street with approximate orientation from East to West), and the Cardus maximus (from North to South) which crossed the city.



The Decumanus Maximus (East-West) is easy to find in present-day Barcelona and it is not difficult to calculate its angle to the West $300^\circ - 270^\circ = 30^\circ$ and compare the result obtained with the results of professional archaeoastronomers.



For example, the table summarizes the result of a study carried out by J. A. Belmonte on 270 urban structures and military settlements measured

Declination	Festivity	Zone
+23,5°	Sunset, Summer solstice June, 21st <i>Sol invictus, Appolus</i>	Cartago Nova Mediterranean Zone Galia and Germania
+7 °	Sunrise and Sunset March, 1st <i>Mars Festivity</i>	Britania, Limes Arabicus Limes Germanicus
0°	Equinox March, 21st September, 21st	Iberic origin North of Africa and nest to the East Berberes Group
-23,5°	Sunset, Winter solstice December, 21st <i>Saturnalias</i>	East and West of Rome

Documanus maximum is 30° from the West which in Barcelona (latitude 41°) corresponds to the summer solstice 23.5°



CHARTAQUI

Iran, Asia

200



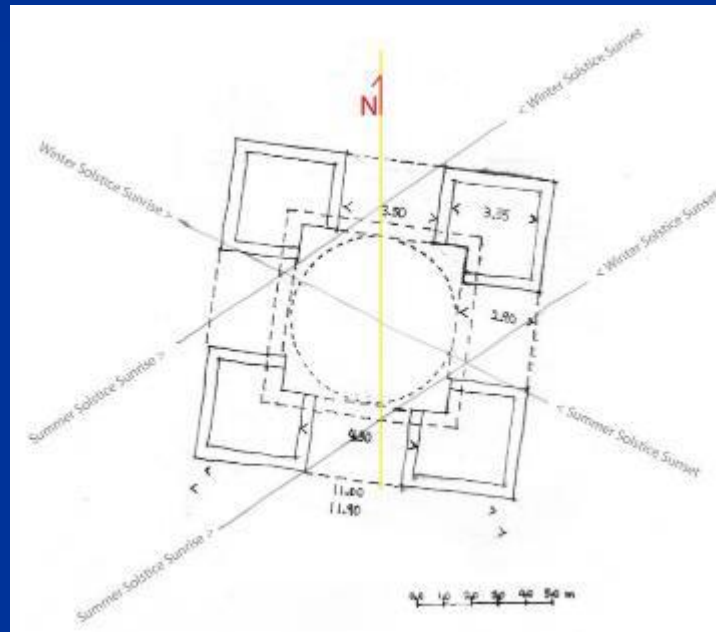
Chartaqi is a structure consisting of four pillars and four arches supporting a dome. (In plan chartaqi are a square surrounding a cross and a circle).



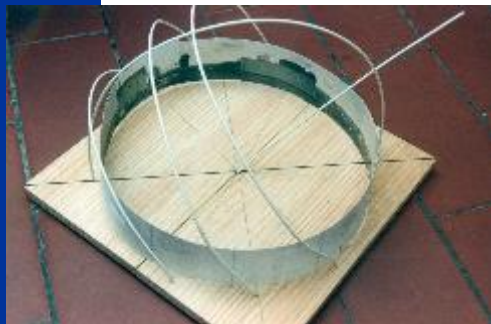
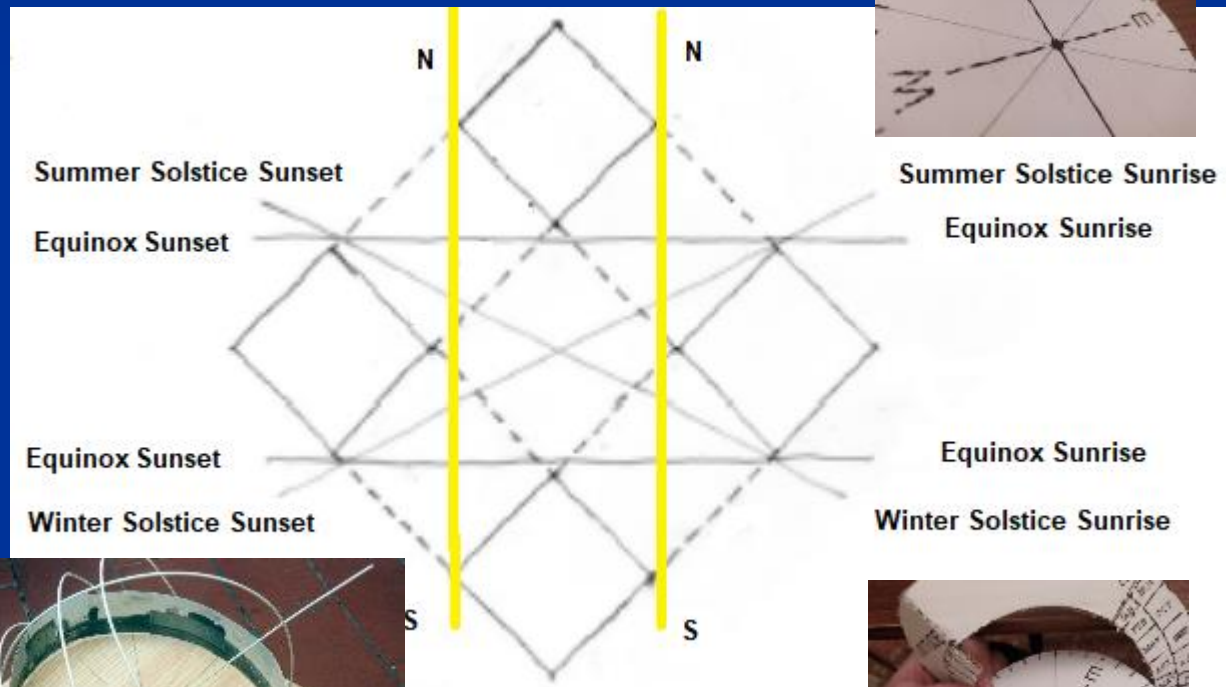
Chartaqi of Niasar (the best preserved)
Temple built by Ardashir I (180–242 AD)

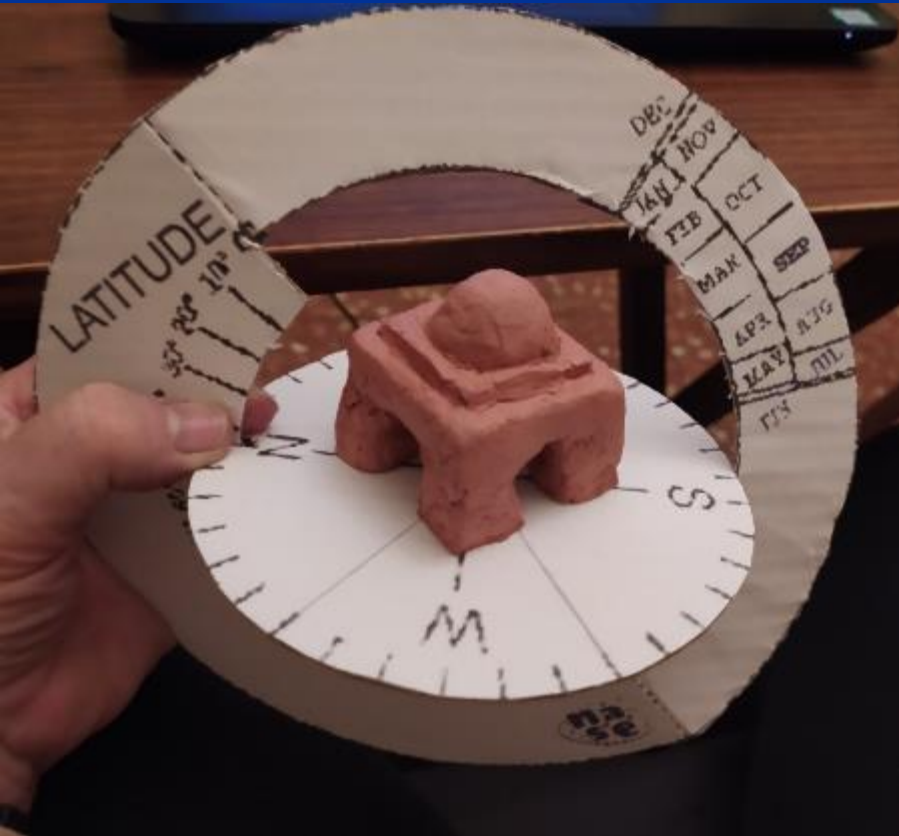
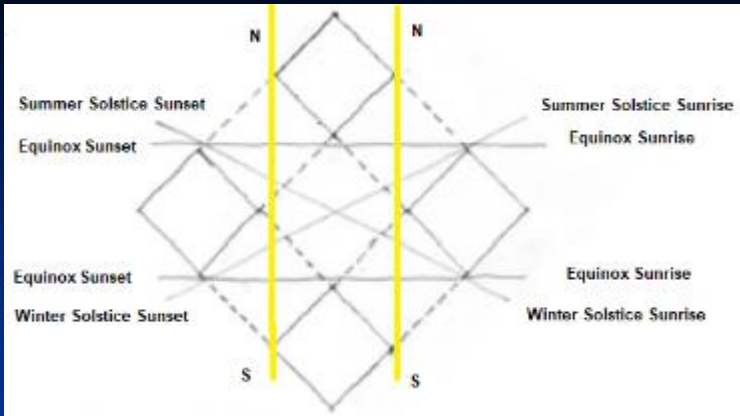


Scientific evidence shows astronomical alignment to the solstitial and equinoctial orientations



The chartaqi 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



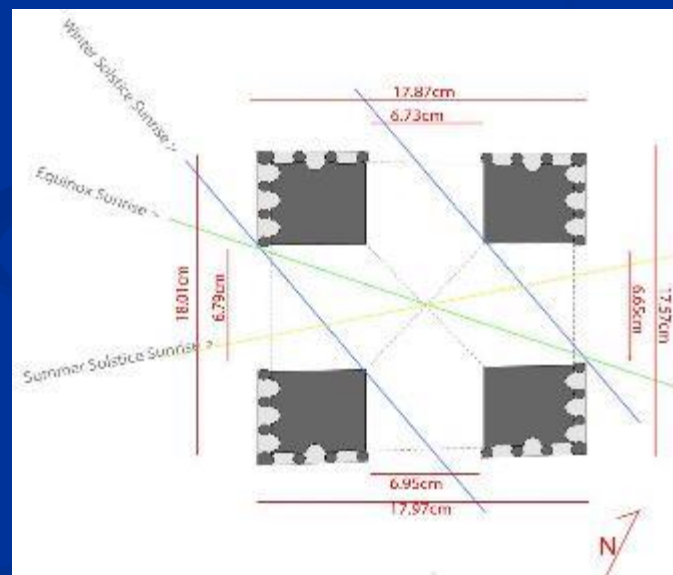


It is possible that the chartaqui are built according to an ancient cosmology that incorporates the symbol of the cross in architecture, which appeared even before the Parthian era, when experimented with dome structures. It looks that Romans borrowed elements from Iranian cosmology and chartaqui too.



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.



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 6th /7th centuries and in Japan in the 8th century.



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



July 7 and rain period



August 7



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 around August 7).



**SANT CLIMENT AND
SANTA MARIA DE TAÜLL**

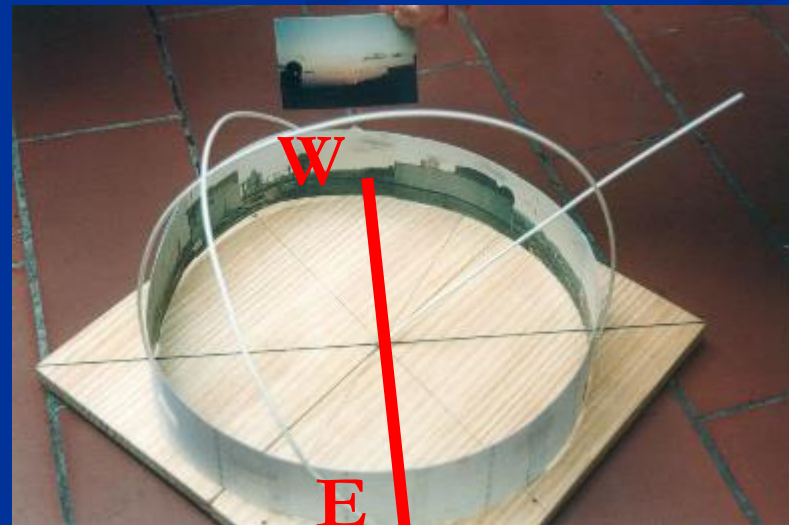
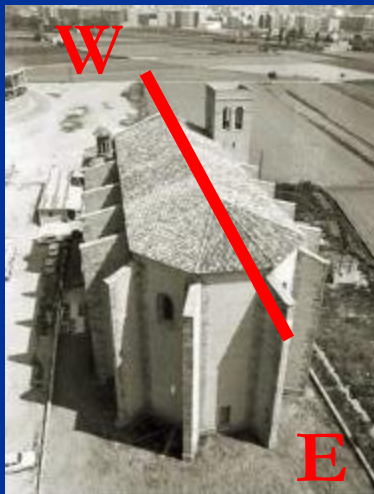
Taüll, Spain, Europe

1123



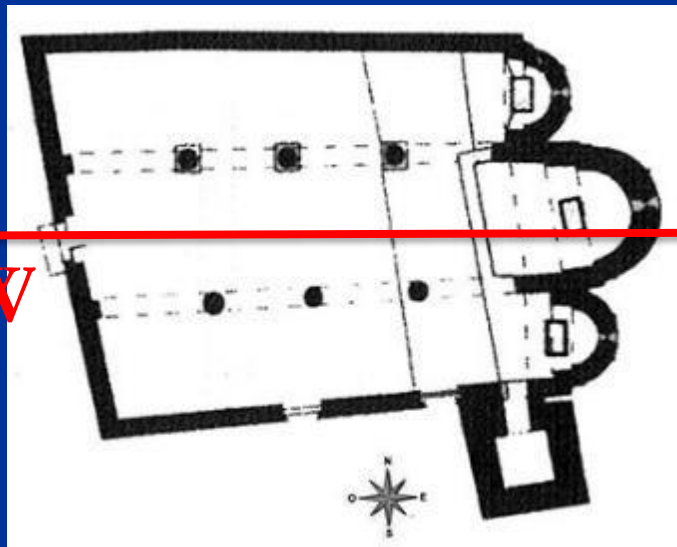
At the Council of Nicaea (325) it was determined that the apse of a church was to the East and the gateway to the West so that the priest would be facing East during the services.

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*)

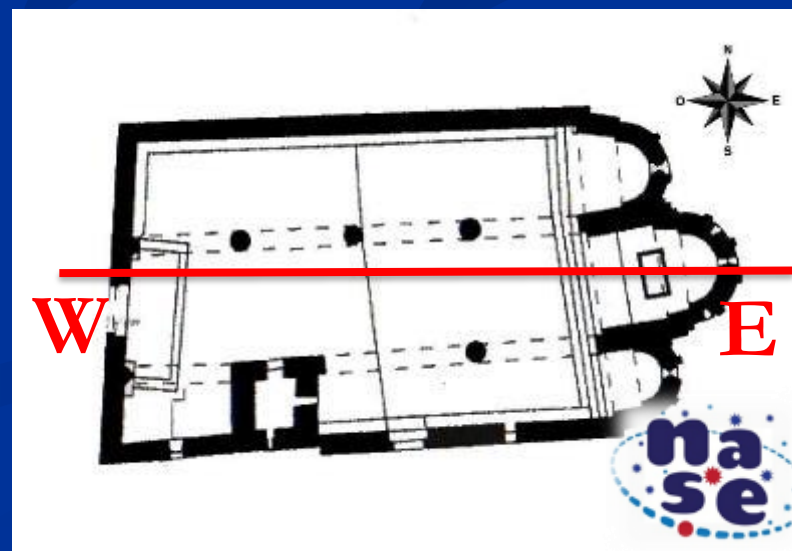




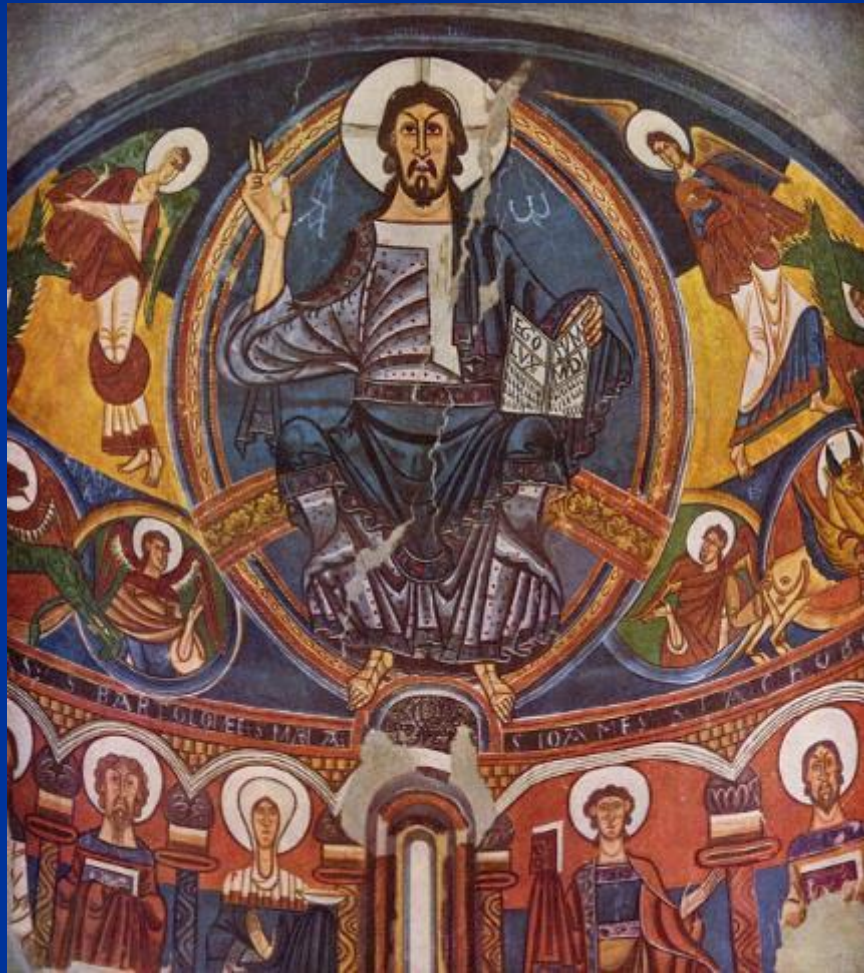
S. Climent de Taüll



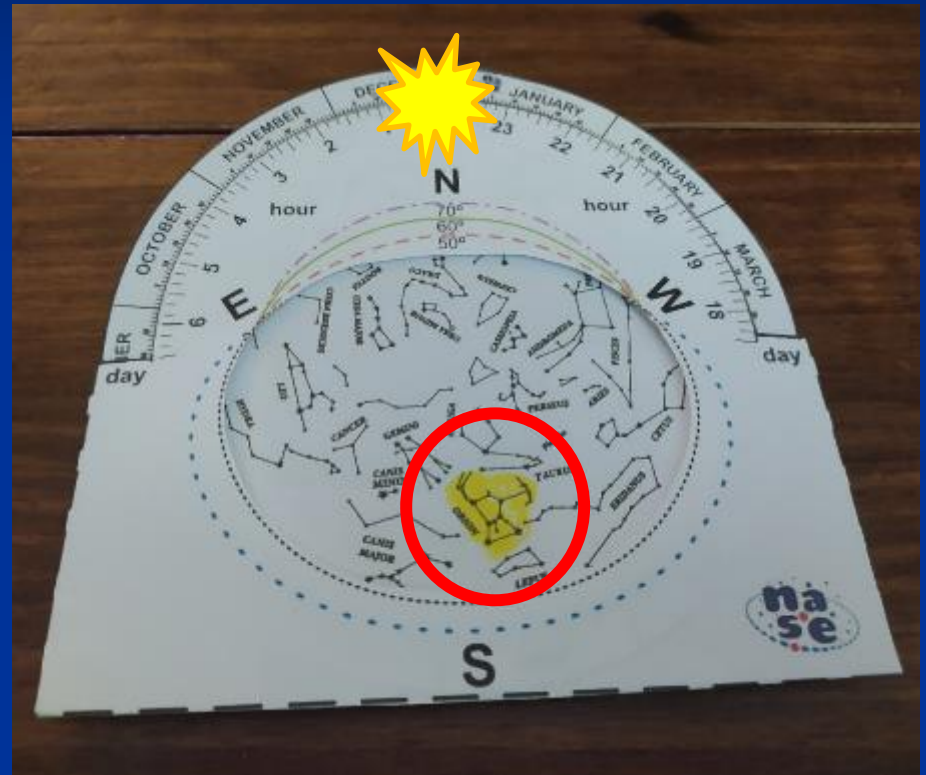
Santa Maria de Taüll



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 y Baltasar

Betelgueuse



Bellatrix

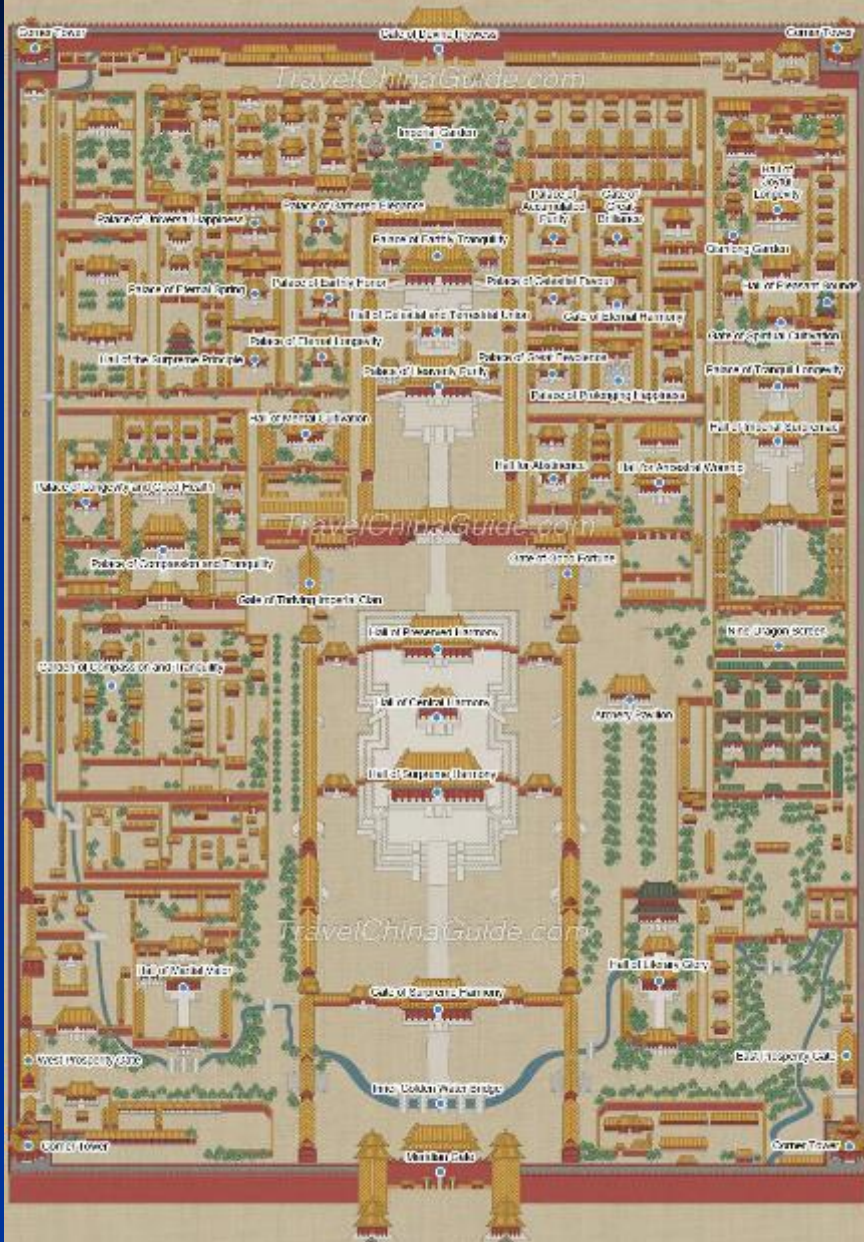
FORBIDDEN CITY

Beijing, China, Asia

1420



A Full Map of the Forbidden City

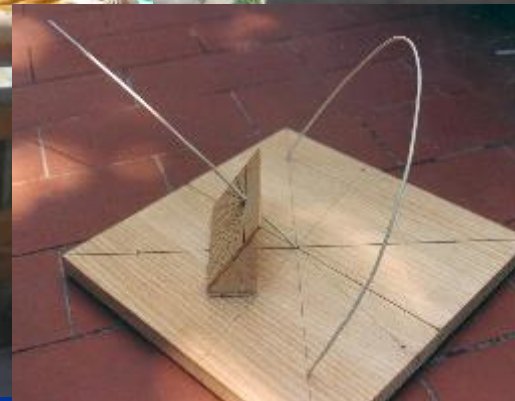


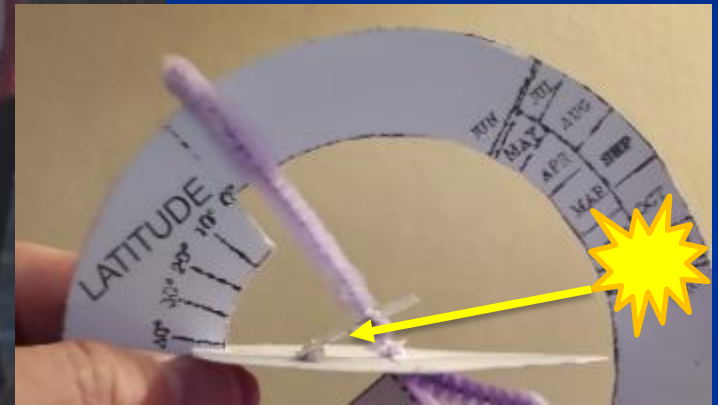
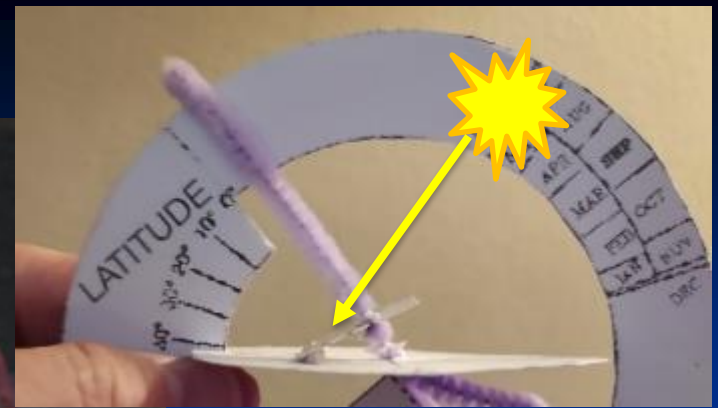
The full map is oriented
North-South
according the local meridian.

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



THE “PATIO DE LA INFANTA”
Zaragoza, Spain, Europe
1549



The “Patio de la Infanta”

Palace built in the mid-16th century (completed in 1550) by Gabriel Zaporta for his wedding with Sabina Santángel. In the courtyard of the palace the horoscope of the wedding date is represented, on June 3, 1549 at 7:00 p.m.



At that time, geocentrism had not yet been overcome and there was no clear line that separated Astronomy from Astrology



The 8 columns in the courtyard represent "the 7 planets (Sun, Moon and the 5 visible to the naked eye)" plus 1 extra column. In the decoration of the railing are the 12 works of Hercules (like the Sun) that correspond to the 12 signs of the zodiac

With the geocentric model the planets seen from Earth are Moon, Mercury, Venus, Sun, Mars, Jupiter and Saturn: 7 in total.





On the parapet there are 4 medallions and at each end a work of Hercules or an allegory. The footings of the central columns symbolize a sign of the zodiac (fire, earth, air, water)

Some works of Hercules and allegories represent place the zodiac



Scorpio



Unicorn = land = Virgo

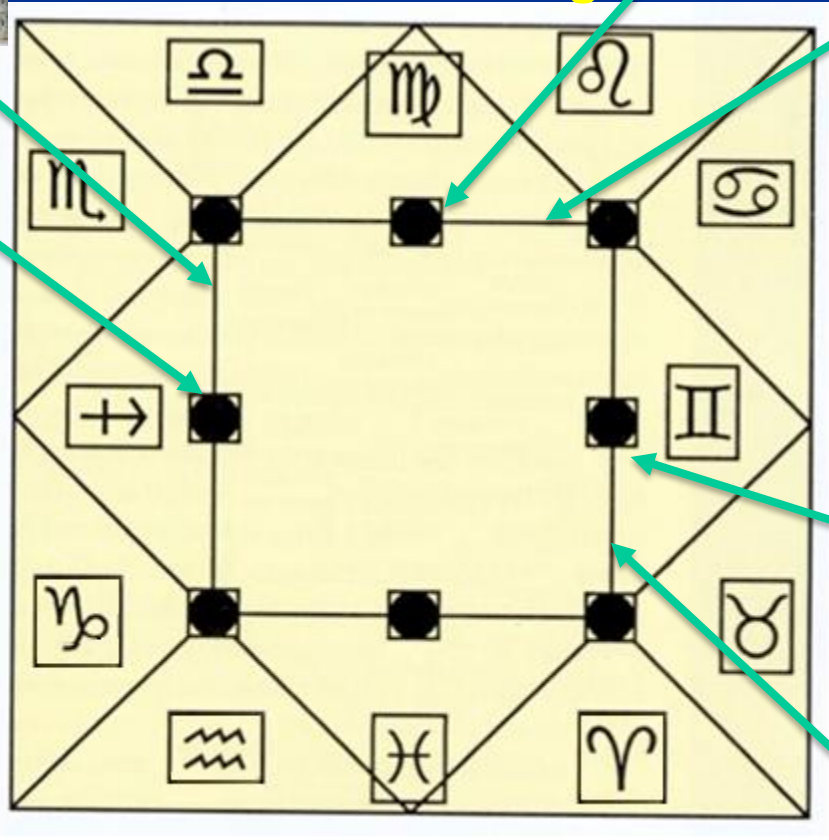


Leo

Eagle = air = Gemini

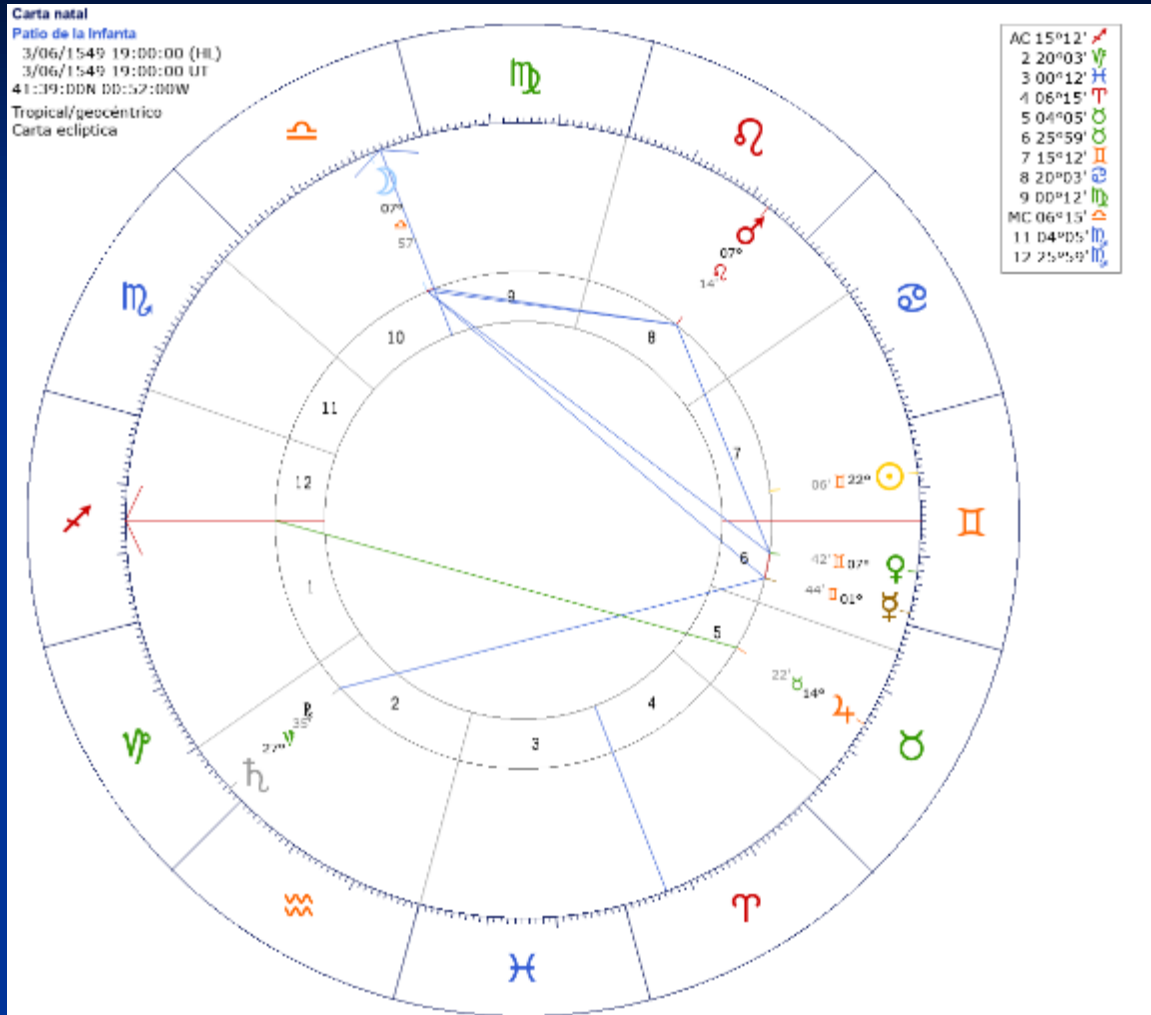


Taurus



Lion = fire = Sagittarius

Horoscope for June 3, 1549 at 7:00 p.m.



☉ Sol	♈ Arie
☾ Luna	♉ Tauro
☿ Mercurio	♊ Gén
♀ Venus	♋ Cáncer
♂ Marte	♌ Leo
♃ Júpiter	♍ Virgo
♄ Saturno	♎ Libra
	♏ Escorpio
	♐ Sagitario
	♑ Capricornio
	♒ Acuario
	♓ Piscis

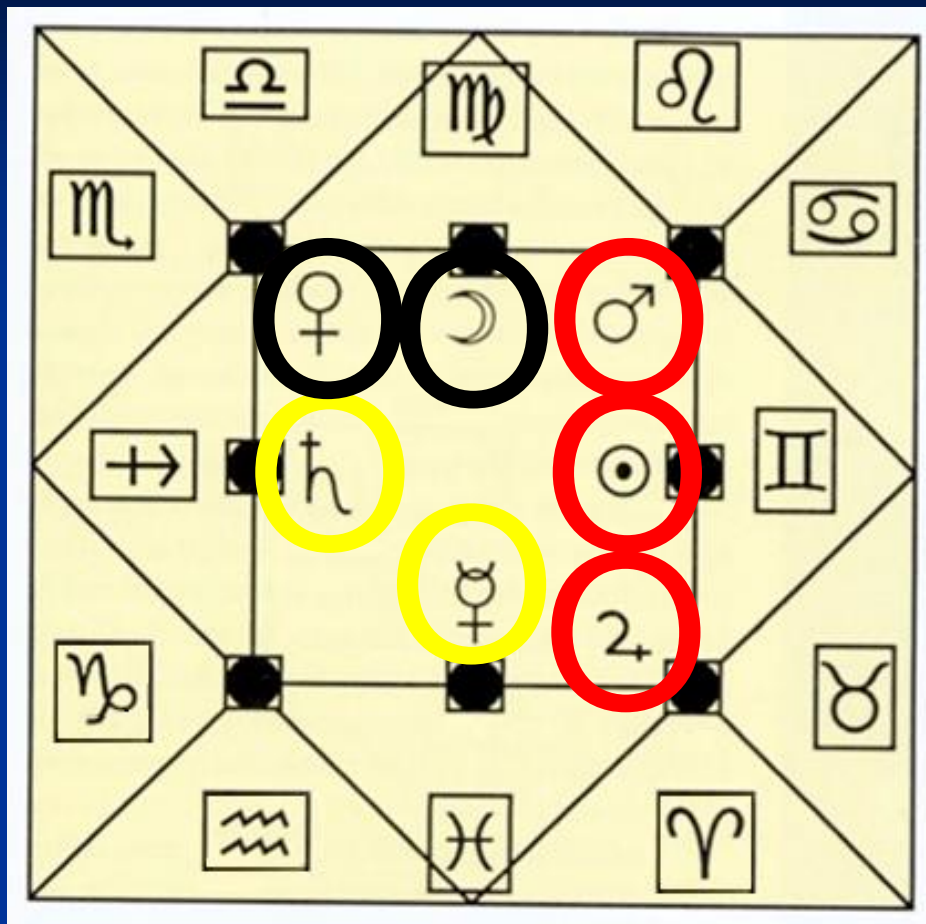
Sun - Gemini
 Moon - Libra

Mercury - Gemini
 Venus - Gemini

Marte - Leo
 Jupiter - Taurus
 Saturne-Capricorn



Horoscope for June 3, 1549 at 7:00 p.m.



Sun - Gemini

Moon – Libra (air)

– Virgo (next to)

Mercury – Gemini (air)

- Acuarius (air)

- Piscis (next to)

Venus – Gemini (air)

- Libra (air)

Mars – Leo

Jupiter – Taurus

Saturne – Capricorn (land)

-Sagitarium(next to)

land = Taurus, Virgo, Capricorn

air = Gemini, Libra, Acuarius

fire = Aries, Leo, Sagitarium

water = Cancer, Scorpius, Piscis



June 3, 1549 at 7:00 p.m.

Horoscope

Sun - Gemini

Moon – Libra

Mercury – Gemini

Venus – Gemini

Mars – Leo

Jupiter – Taurus

Saturne - Capricorn

Stellarium

Sun - Taurus

Moon – Virgo

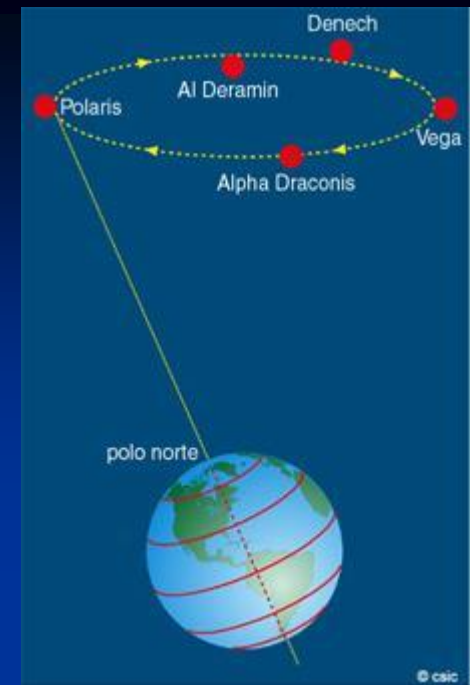
Mercury – Taurus

Venus – Taurus

Mars – Cancer

Jupiter – Aries

Saturne – Acuarius



For the Precession of the Equinoxes, as well as the point Aries is in Pisces, for that reason the Stellarium gives the planets a constellation before.



MONUMENT
“Mitad del Mundo”
Quito, Ecuador, America
1992

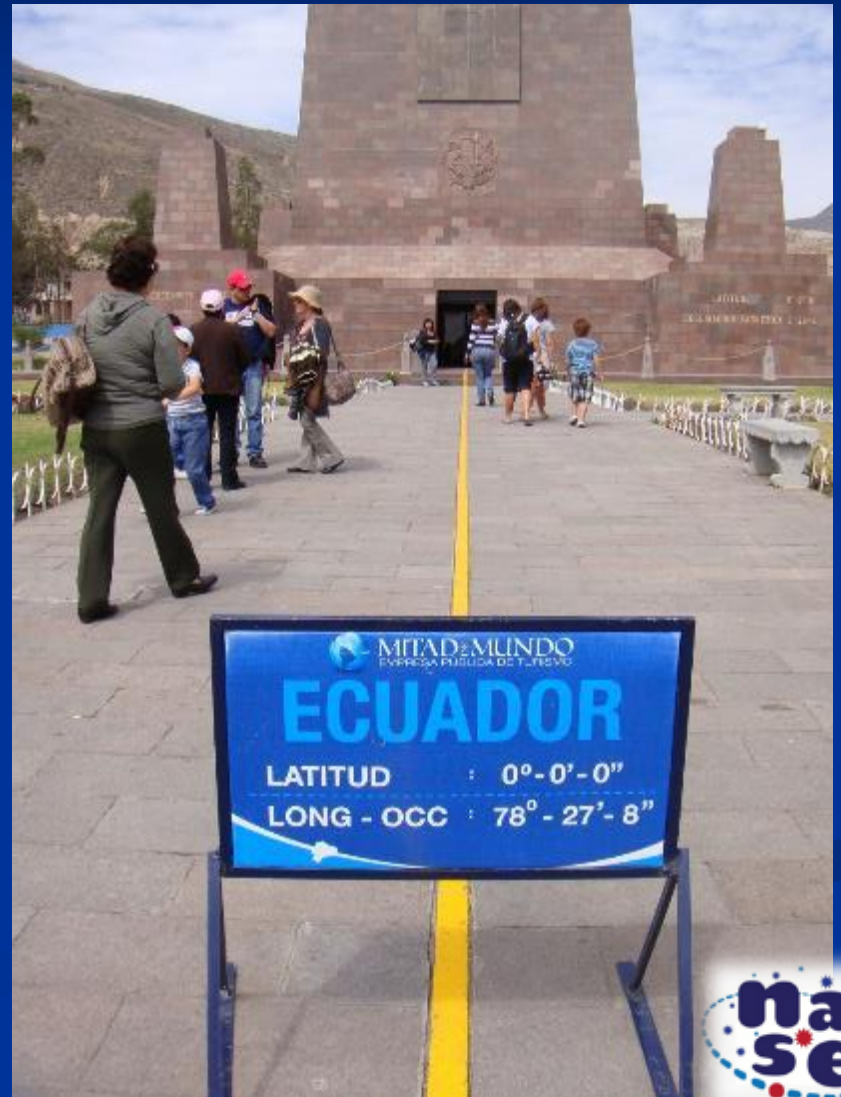


Equator Monument in the Equator line



Parallel Earth, with the Equator line on the top

The Equator line



Parallel Earth? a few weeks after equinox



There is a mistake with the position!!!

SOLAR PANELS

Ulaanbaatar, 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 !**

