

# Astronomy and Culture 天文与文化

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# ORIENTATION OF THE PYRAMIDS

Giza, Egypt, Africa

2500 BC

金字塔的方向  
吉萨，埃及，非洲  
公元前2500年



**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.**

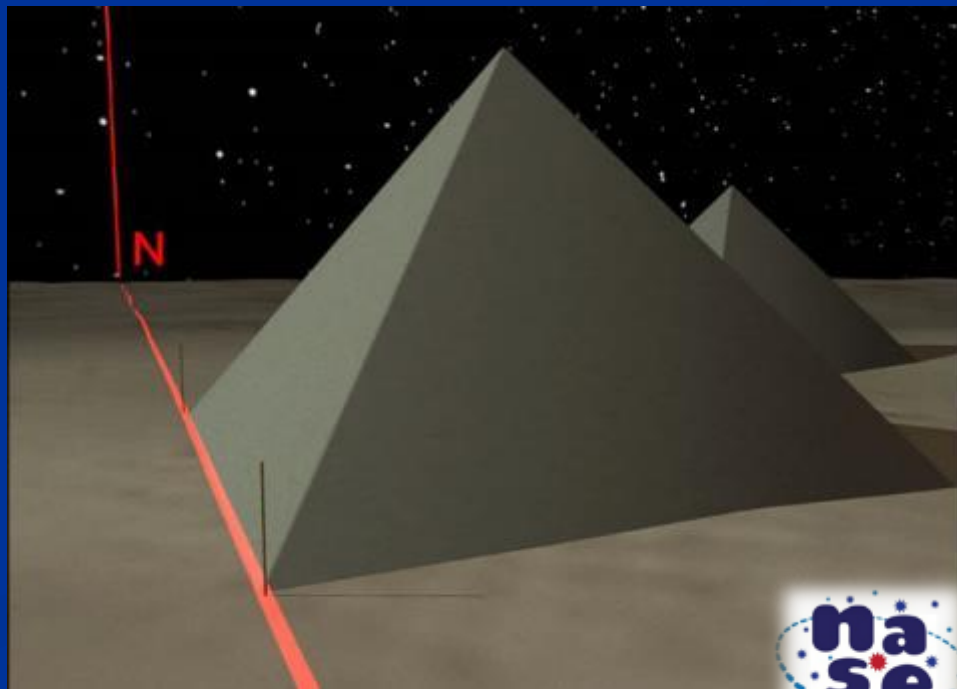
**不是所有的埃及金字塔都有正确的朝向；实际上60余座著名的金字塔中只有几座拥有精准的朝向。**

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

**位于达舒尔和吉萨的第四代王朝法老的金字塔是朝向最精准的，偏差只有15'甚至更少。**

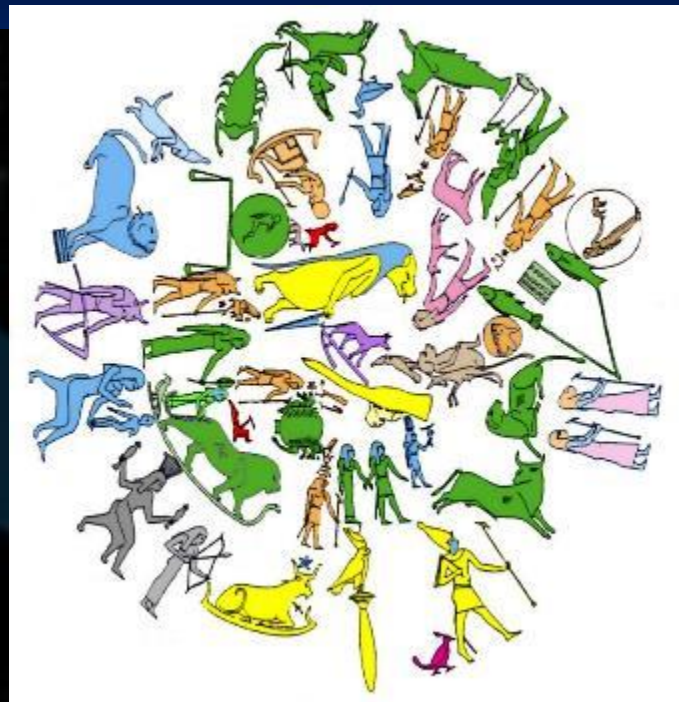
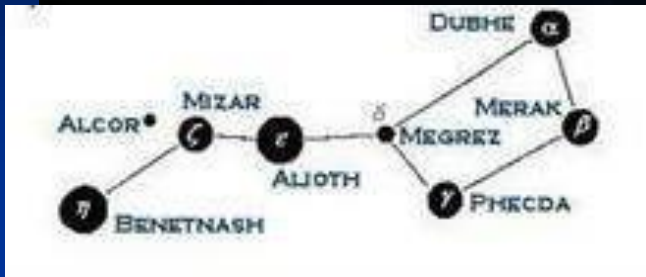
**Astronomical alignment of the pyramid of Kefren (around 2545 BC) towards the meridian transit of Megrez and Phecda of the constellation Meskhetyu (The Leg of the Bull), equivalent to Ursa Major partially**

**Kefren金字塔（公元前2545年）朝向北斗七星中的天权和天玑上中天的方向，埃及称北斗为Meskhetyu，意为公牛的腿，相当于大熊座的一部分**



# "Imperishable" constellation of the Bull's Leg

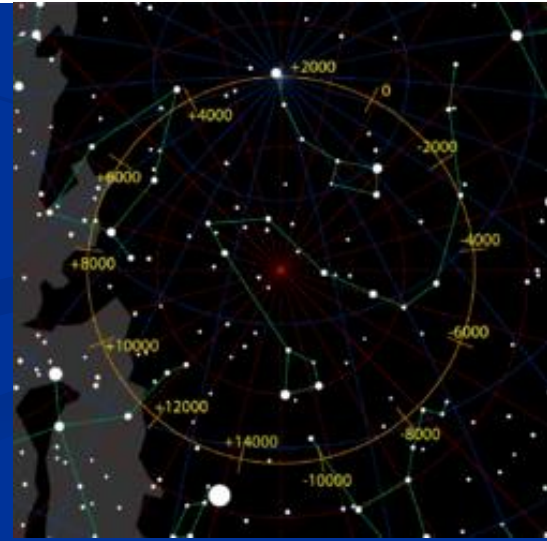
公牛的腿——不朽的星座



Currently Merak and Dubhe indicate the position of the polar at  $2^\circ$  from the pole.

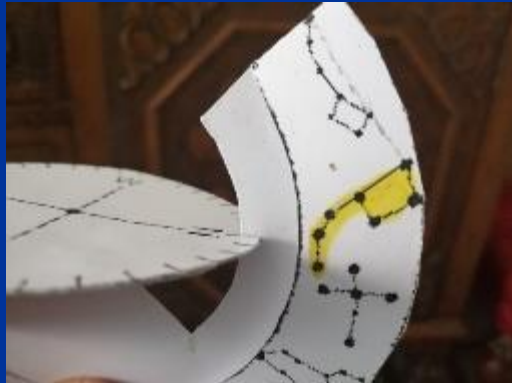
Formerly Megrez and Phecda determined the situation of Thuban that in 2787 B.C. which was only  $2'$  from the pole  
现在天璇和天枢两颗星作为指极星，指示北极星所在，其距离北天极2度

此前则是由天权和天玑指出天龙座阿尔法的位置，在公元前2787年，天龙座阿尔法距离北天极只有 $2'$

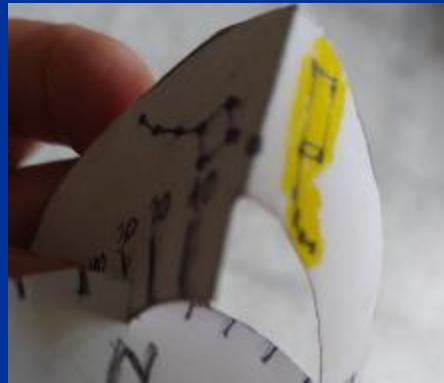


The placement of the pyramids responds to religious motivations. The Egyptians believed that the stars disappeared and reappeared, allowed to transcend death. **"The ducts of the pyramids face north because there were the stars that never disappeared from the sky, the circumpolar stars, which never died"**

金字塔的布局与宗教动机相应。埃及人相信恒星会消失复现，允许超越死亡。“金字塔的通道朝北是因为这个方向有恒星永不会从天空消失，也就是拱极星，永远不会死亡。”



Now 2000 现在2000年



Before 2500 BC 此前公元前2500年

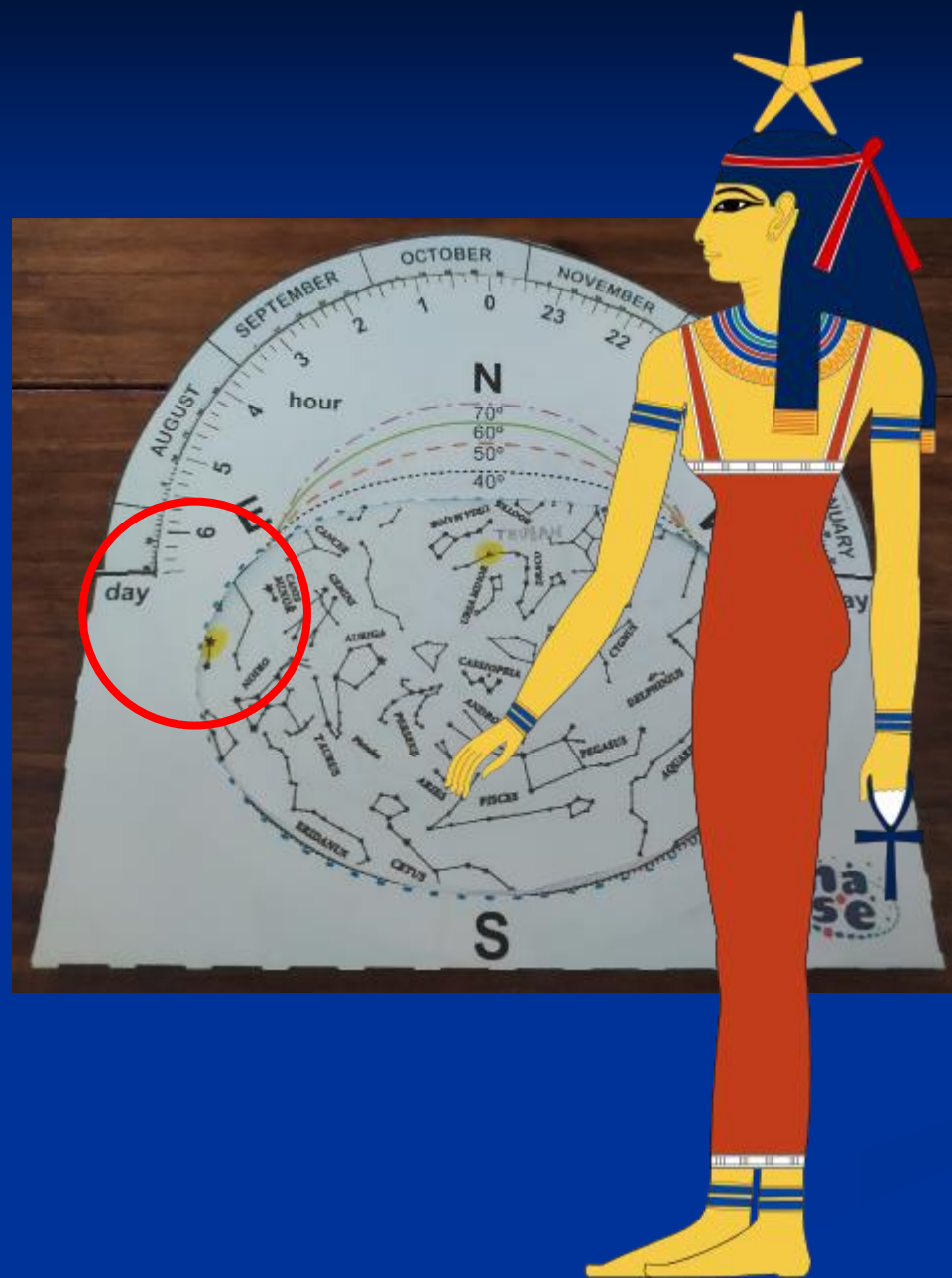


Cairo latitude 30°N  
开罗 北纬30度

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".

通道的入口建有斜坡，以便于国王升上北方天空，那里是“不死恒星”的领域。





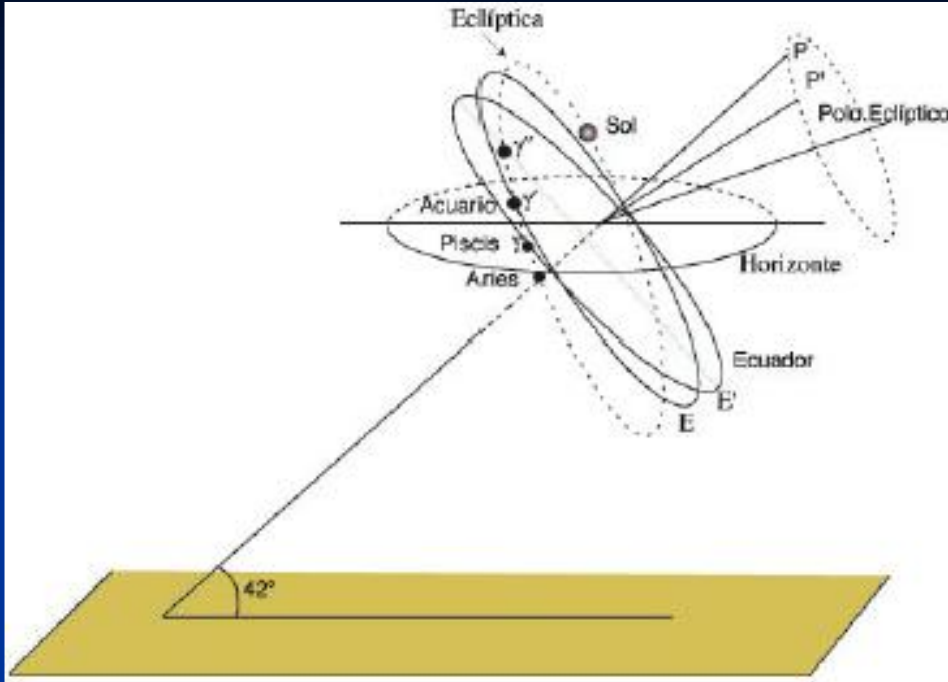
The Sirius star, called Sopdet by the Egyptians, announced the arrival of the flood of the Nile, with its first annual appearance at dawn, the so-called heliacal rising (the first day it becomes visible just before sunrise about July 25th) and this moment of great importance in Egypt. 天狼星被埃及人称为索普戴特，每年当它第一次出现在黎明时，就标志着尼罗河洪水的到来，亦即偕日升（7月25日天狼星第一次刚好在日出前可见），这个时刻在埃及是至关重要的。

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.

接下来的70天，天狼星依旧可见，刚好是尸体木乃伊化所需的时间，把尸体泡在泡碱盐中70天就可以脱水，之后再把尸体转移。

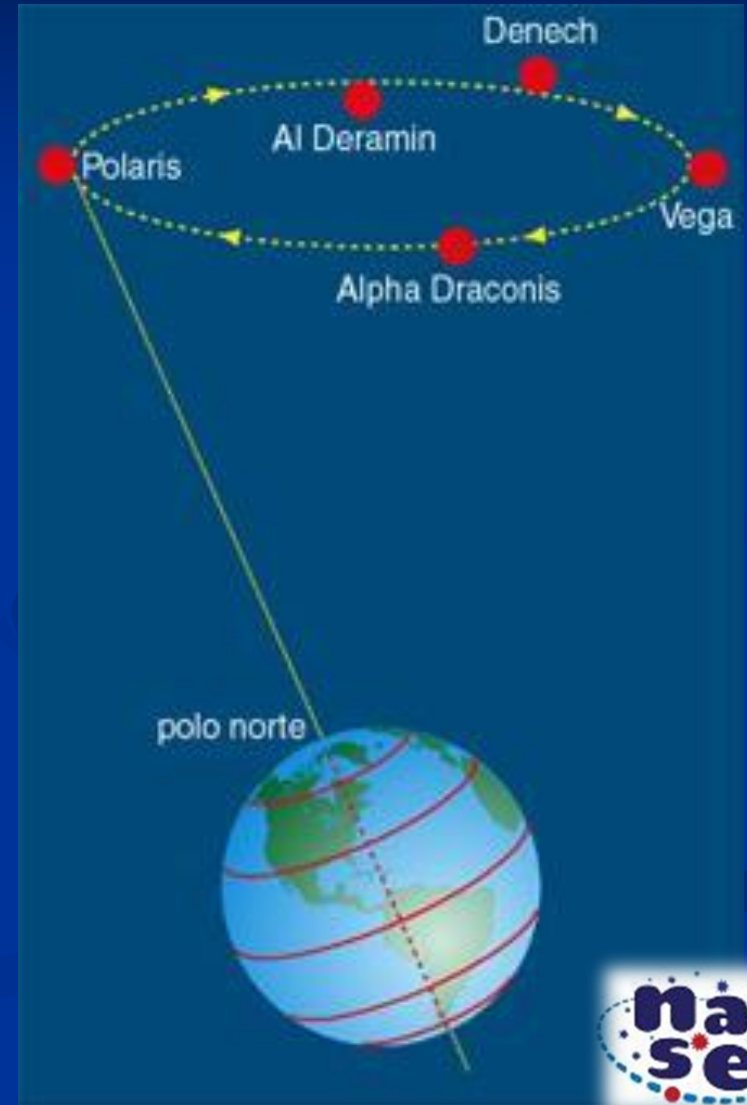


## Precession of the Equinoxes 春分点进动



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.

由于春分点进动，黄道和赤道的交点曾被称为白羊座点（因为此前交点位于白羊座），但它已经移动到双鱼座了。



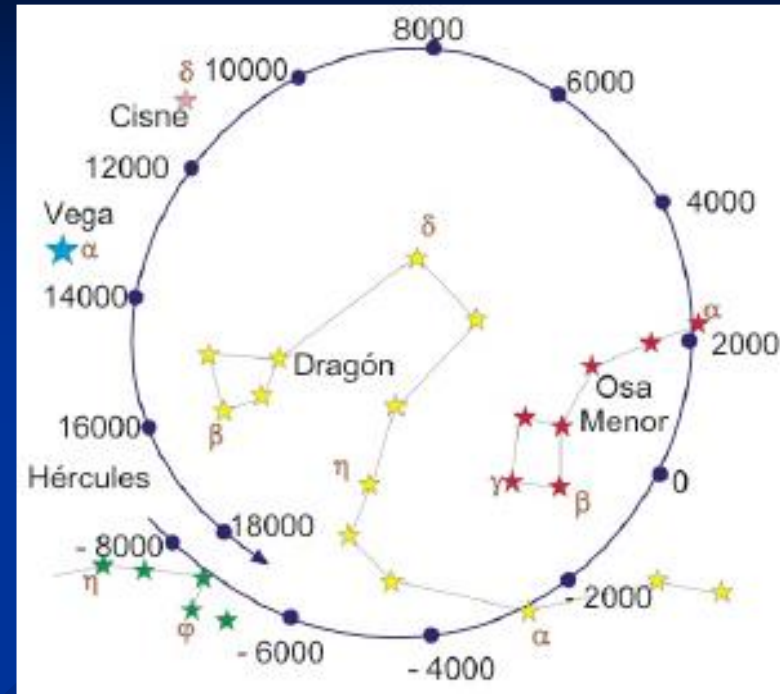


## Precession of Equinoxes 春分点进动

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.

进动是指地球自转轴方向的变化，每25776年完成一个圆周的运动（或者说方向每年改变50.29角秒）好像转动的陀螺一样。

天赤道也同样会产生摇摆，其与黄道的交点位置也相应变化。



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. 依巴古在公元前147至127年时观测到这一现象（大约是2000年前）。彼时黄赤交点被称为白羊座点（因为交点位于白羊座），而今交点已经运动到双鱼座，北天极的位置也发生了变化。

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

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

例如现在的北天极在小熊座的北极星附近，而2000年前的北极星则是天龙座阿尔法。



NEBRA DISK

内博拉星盘

Germany, Europe

1500 BC

德国，欧洲

公元前1500年

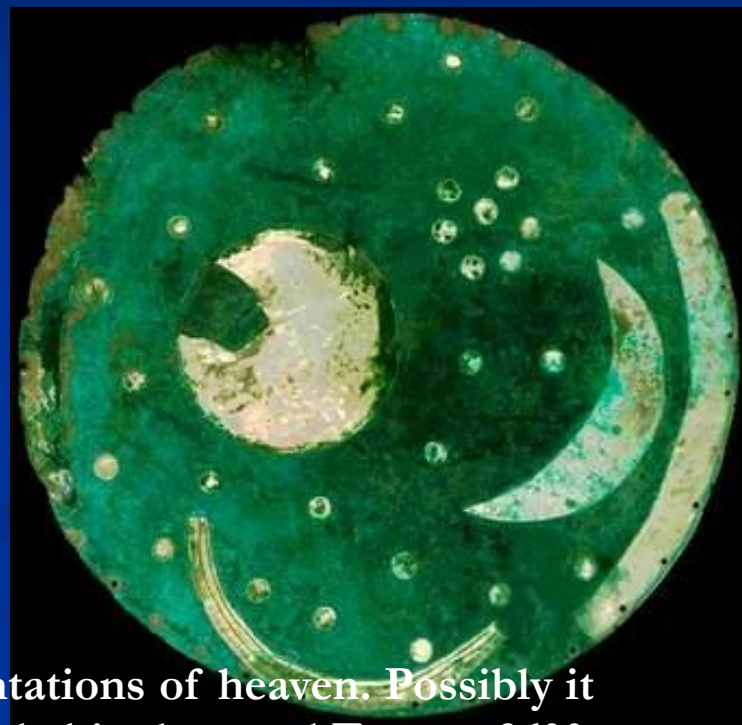


Nebra's disc is a bronze disk, 32cm in diameter and inlaid with gold: 3 arches (one missing), a crescent Moon, one large circle and 30 minor ones.  
内博拉星盘，直径32厘米的铜盘，上有三个金质的圆弧（其中一个遗失不见），一个月亮，一个大圆圈和30个小圆圈。

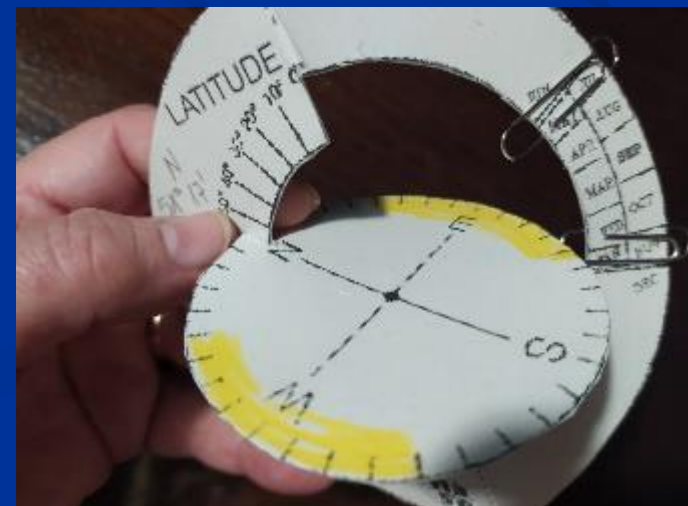
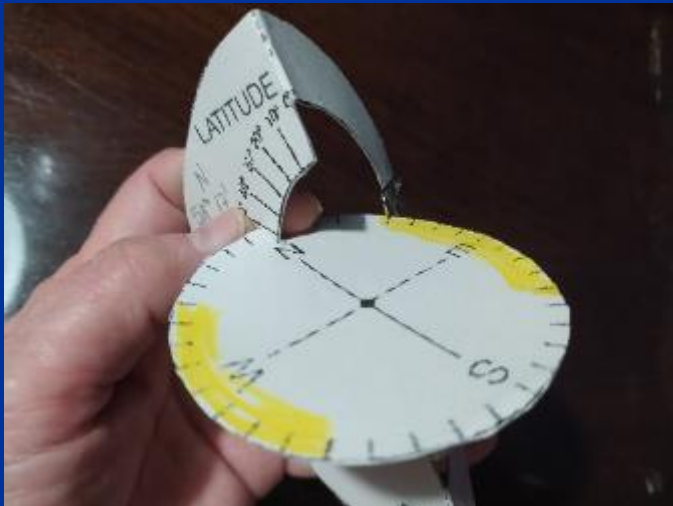
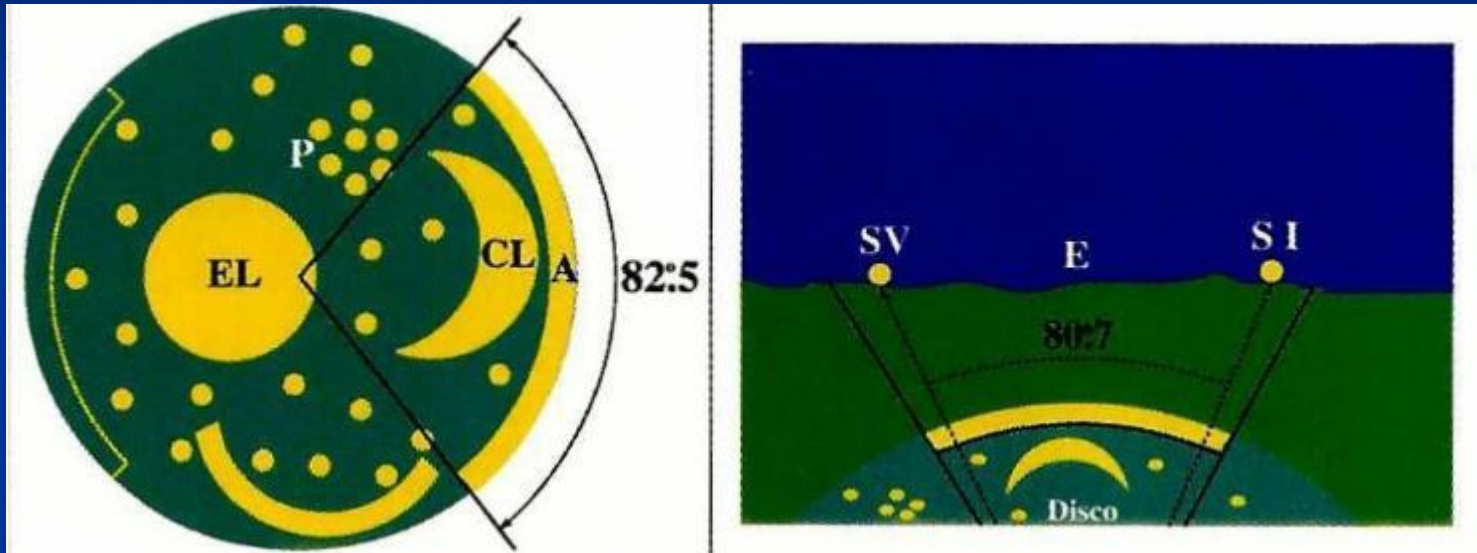
It is believed that the disc is a representation of the sky: the crescent Moon, the Sun, or the full Moon and stars. There is a group of 7 stars together that is interpreted as the Pleiades.  
研究者认为内博拉星盘表达的是星空：新月、太阳或者满月以及恒星。有一组由7颗恒星聚集在一起的图像，代表昴星团。

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.

内博拉星盘可能是已知最古老的星空表达。很有可能被生活在3600年前欧洲中部的人们用在典礼仪式中。



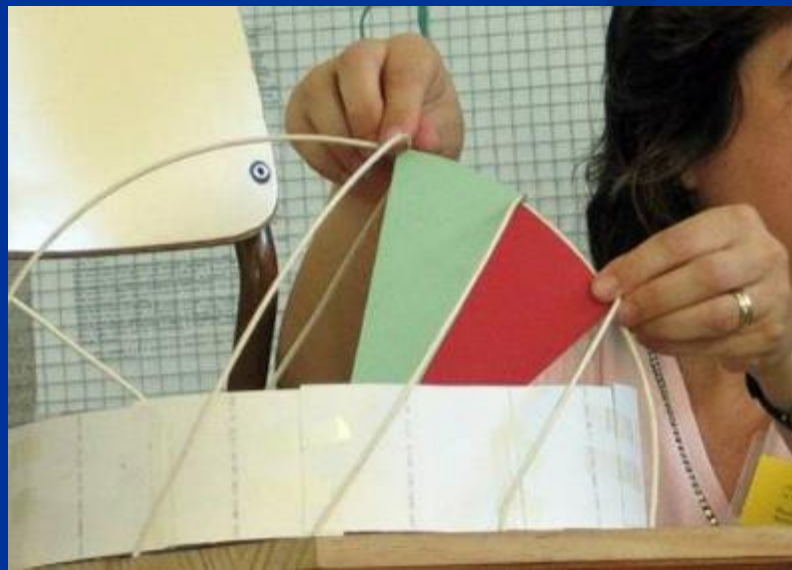
The two arches on the edge of the disk (one missing) seem to indicate the arc described by the Sun on the Eastern horizon from the Summer and Winter solstices rises:  $82.5^\circ$   
星盘边缘的两段圆弧（其中一段遗失不见）似乎表示东方地平线处太阳的位置在夏至和冬至时刻的差距为 $82.5^\circ$

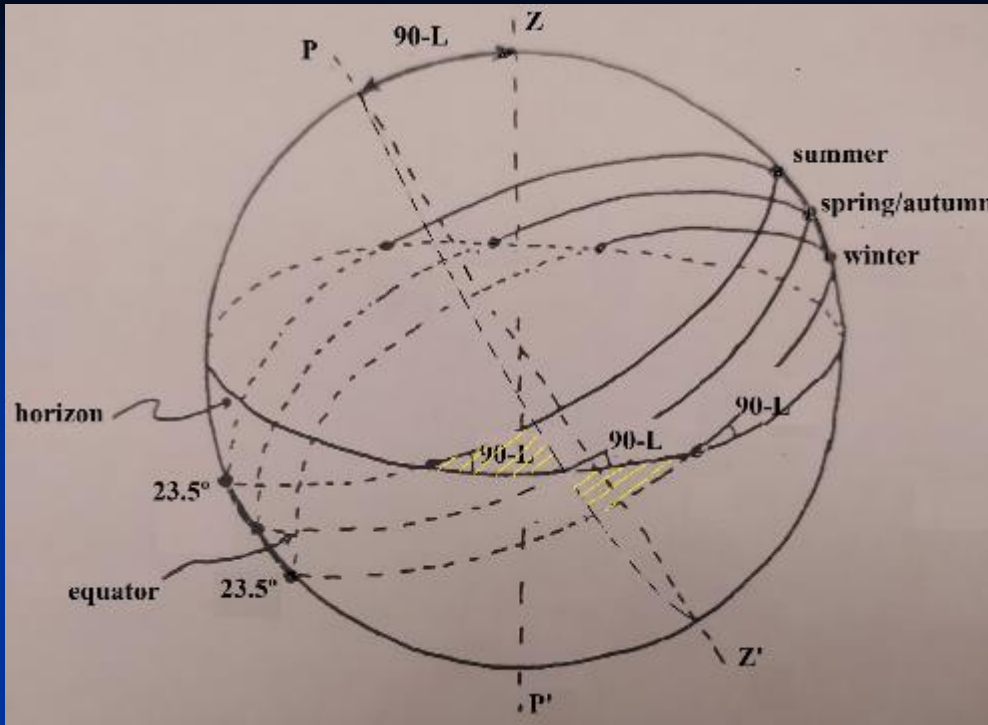


The disk was discovered in 1999 on Mount Mittelberg (near Nebra in Saxony, Germany) with a latitude of  $51^{\circ}$  N. Mount Mittelberg is rich in Bronze Age archaeological sites. It is accepted that the Disk corresponds to the Unetice culture, existed between 1600 B.C. and 1500 B.C.

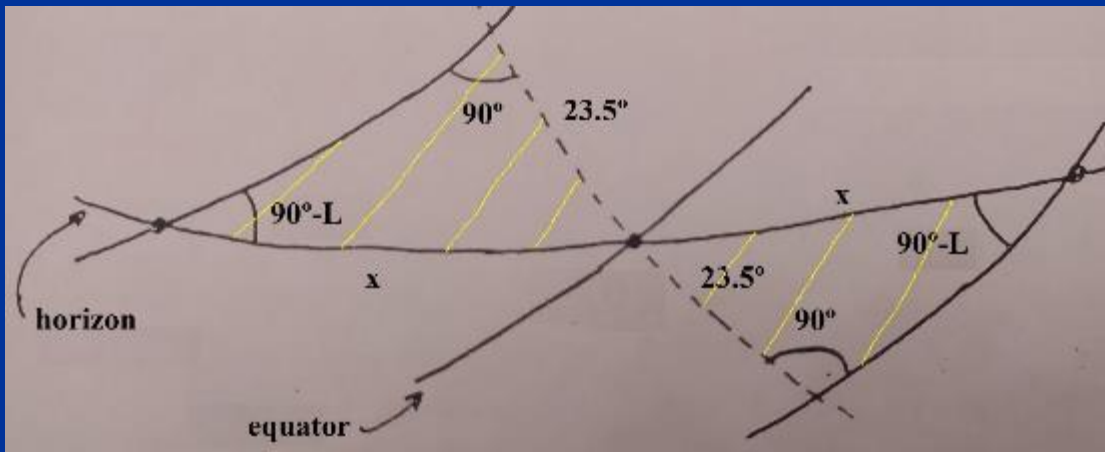
内博拉星盘于1999年在米特伯格山发现（德国萨克森内博拉附近），那里的地理纬度是北纬51度。米特伯格山是考古学确认的青铜时代富庶的地方。内博拉星盘应该与存在于公元前1600至1500年的乌尼蒂茨文明有关。

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  $80.7^{\circ}$   
赤道处二至日时日出的角距离为47度，但在发现内博拉星盘的地理纬度，角距离则应为80.7度。





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



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

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



# CHARTAQUI 四拱顶

Iran, Asia  
伊朗，亚洲  
公元200年



*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).

四拱顶是一种建筑，由四根柱子和四个拱门共同支撑一个圆顶（平面图中四拱顶是由一个十字和一个圆圈围绕的正方形）



Chartaq of Firuzan (the best preserved)

Temple built by Ardashir I (180–242 AD)

阿尔德希尔一世（公元180~242年）建造的尼尔撒四拱顶神庙（保存最好的）





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

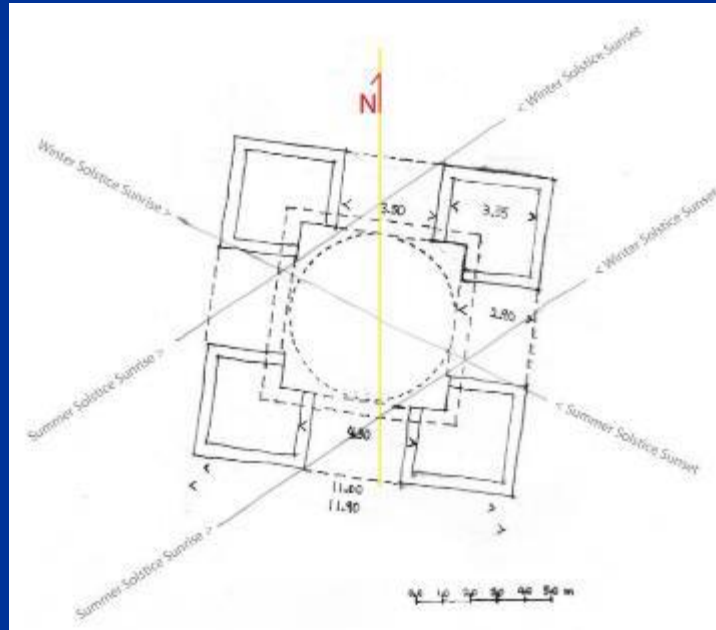
科学证据显示四拱顶的天文方位与二分二至相对应



Summer solstice sunset  
夏至日落



Summer solstice sunrise  
夏至日出



Winter solstice sunset  
冬至日落

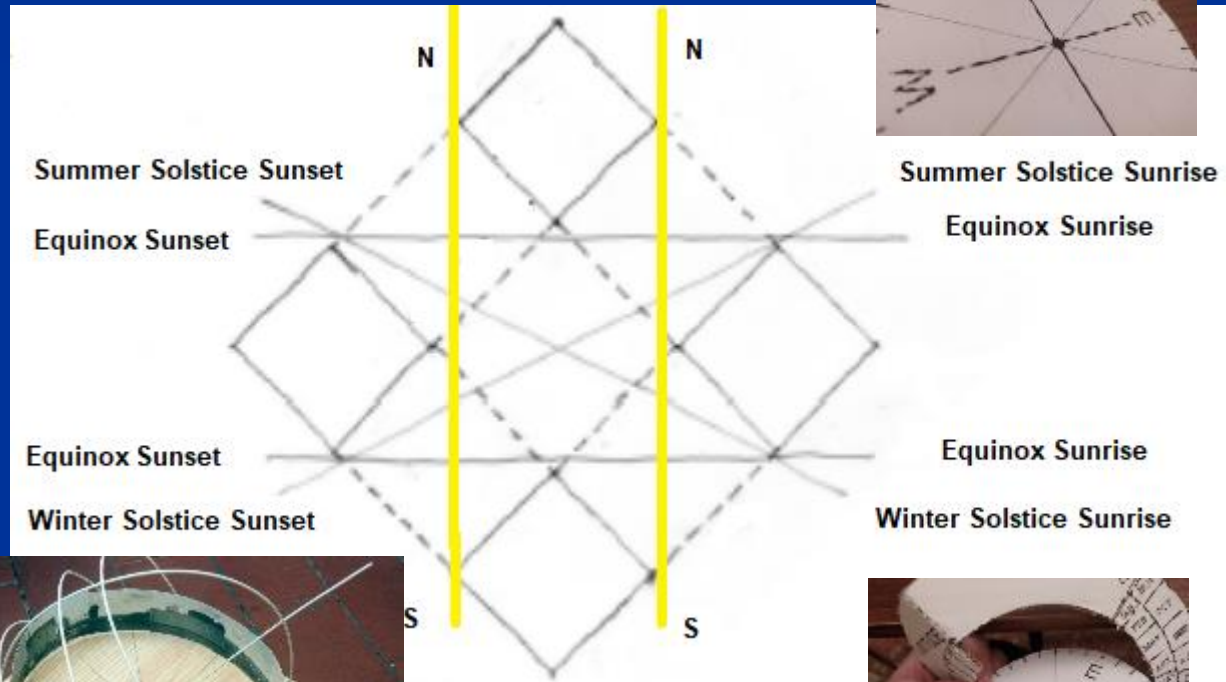


Winter solstice sunrise  
冬至日出



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

Khaneh-i-Div四拱顶有助于我们理解其建筑理念，因为它位于不易到达的位置，更好地与山脉天际线表示二分二至的方位

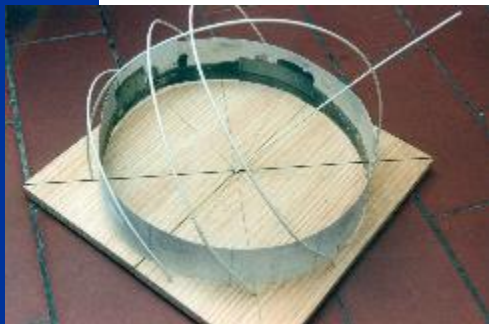
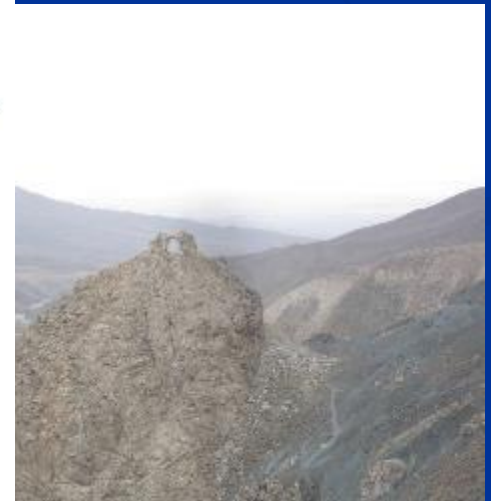


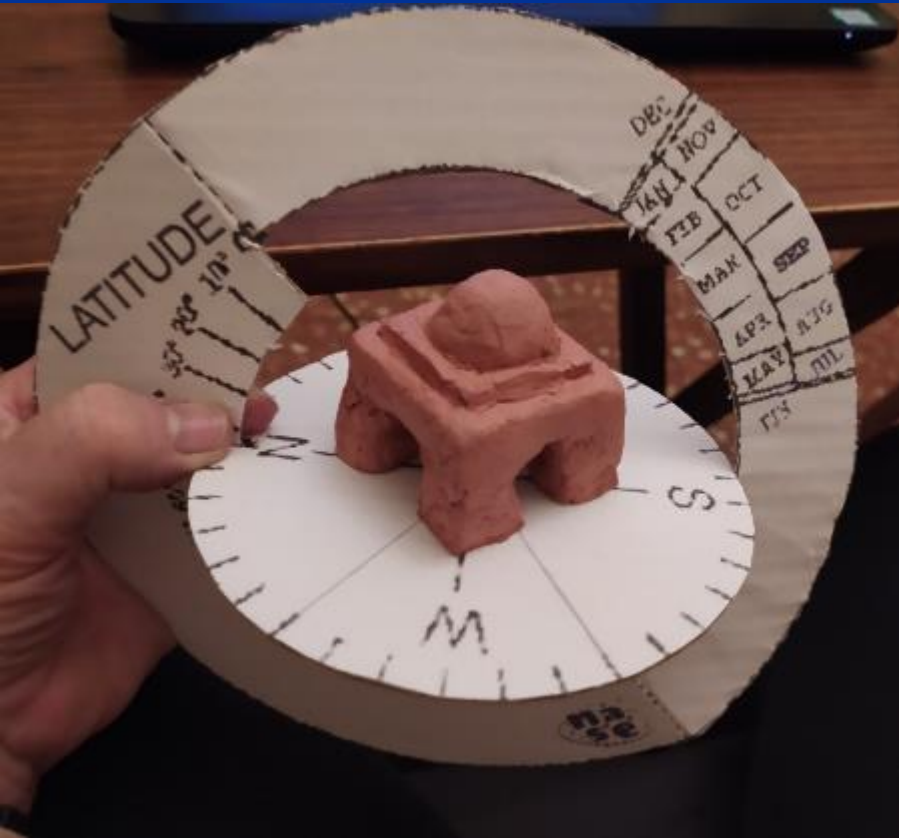
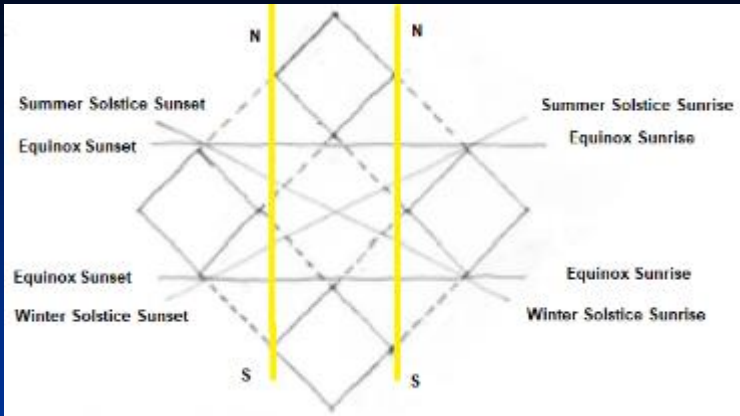
Summer Solstice Sunrise

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.

很可能四拱顶的建筑是依据古老的宇宙观，即建筑中要体现十字标志，这一点甚至在帕提亚时代前就已经出现了，后来又在穹顶结构中得以应用。看起来罗马人从伊朗人的宇宙学和四拱顶中借鉴了很多元素。

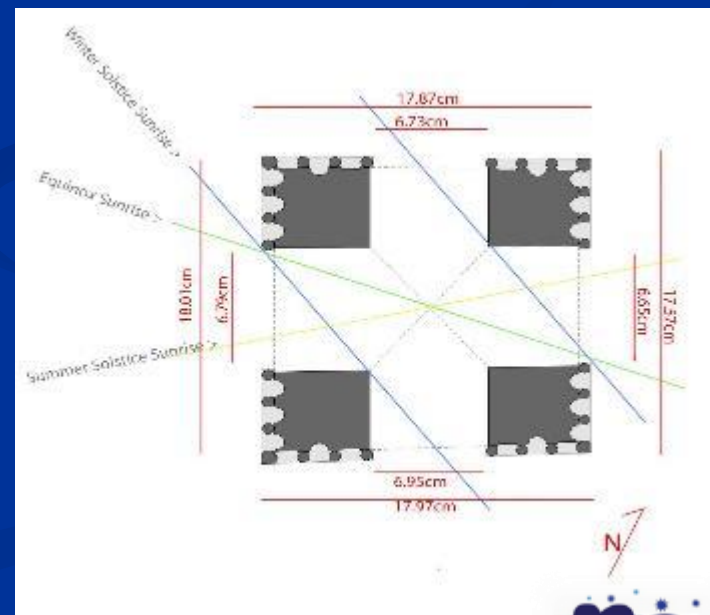


Roman coin showing Nero and the Arch of Nero with statue of a four-horse chariot on top. Wildwinds, 罗马硬币，图像是尼禄和尼禄拱门，上面是四匹马拉的二轮战车，狂风



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.

两面神拱门是罗马唯一保存至今的四拱门。拱门的四面标志着重要的会议地点和公元前4世纪的十字路口。原本拱门上有一阁楼，但在19世纪时被毁，因为人们以为它是中世纪加盖的。



ANCIENT EAST ASIAN CITIES,

Xi'an, China, Asia

Kyoto, Japan, Asia

618 and 794

古代东亚城市，中国西安，亚洲

京都，日本，亚洲

618和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.

在中国和日本的古都，城市是南北向和东西向的，设计成一系列的街道，彼此成直角。

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.

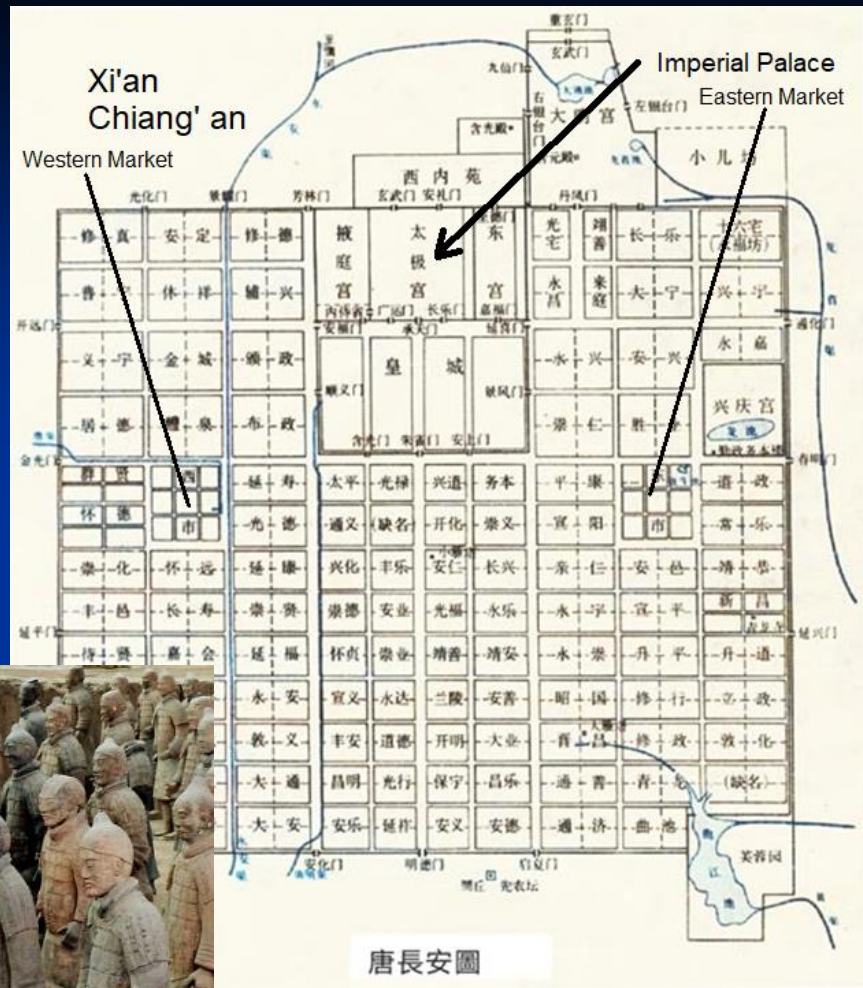
这似乎是基于古老的阴阳哲学，以及四个大方向上的四个守护神。阴是指月亮和阴性原则。阳是指太阳和阳性原则。

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  
几个世纪以来，这种具有正交轴线的城市模式构成了中国和其他国家建设新城市的主要文化参考。



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.

长安城的形状是一个长方形按照基本点的方向排列。宫殿坐北朝南。山脉朝北，水流朝南，坡度较缓。该城有城墙防御。



Chang'an was build close to the Mausoleum of Qin Shi Huang  
长安城建在秦始皇陵附近





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

网格模型首先在长安（西安）使用，长安是618年至907年中国唐朝的首都。长安，是中国和日本古代城市的模式（在这些没有防御工事的城市中）。



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

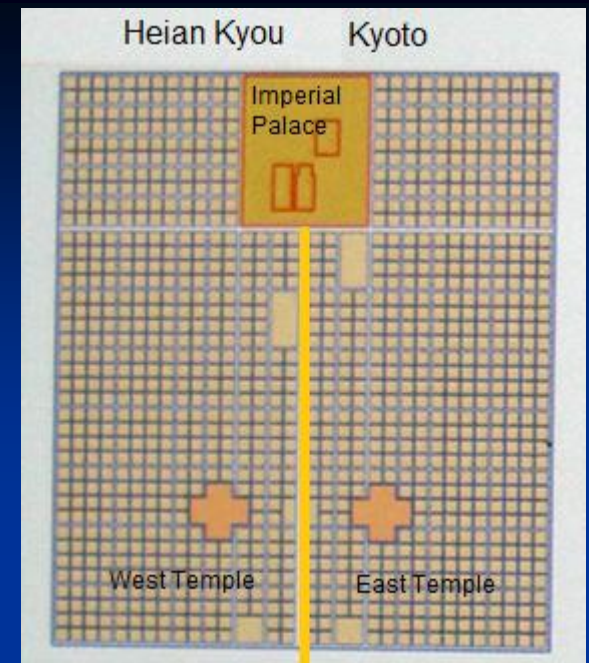
例如日本的奈良和京都或韩国现在的庆州（庆州）。



**Kyoto** was founded in 794 in relation to the normative principles of the Chinese city. 京都是在794年建立的，与中国城市的规范原则有关。

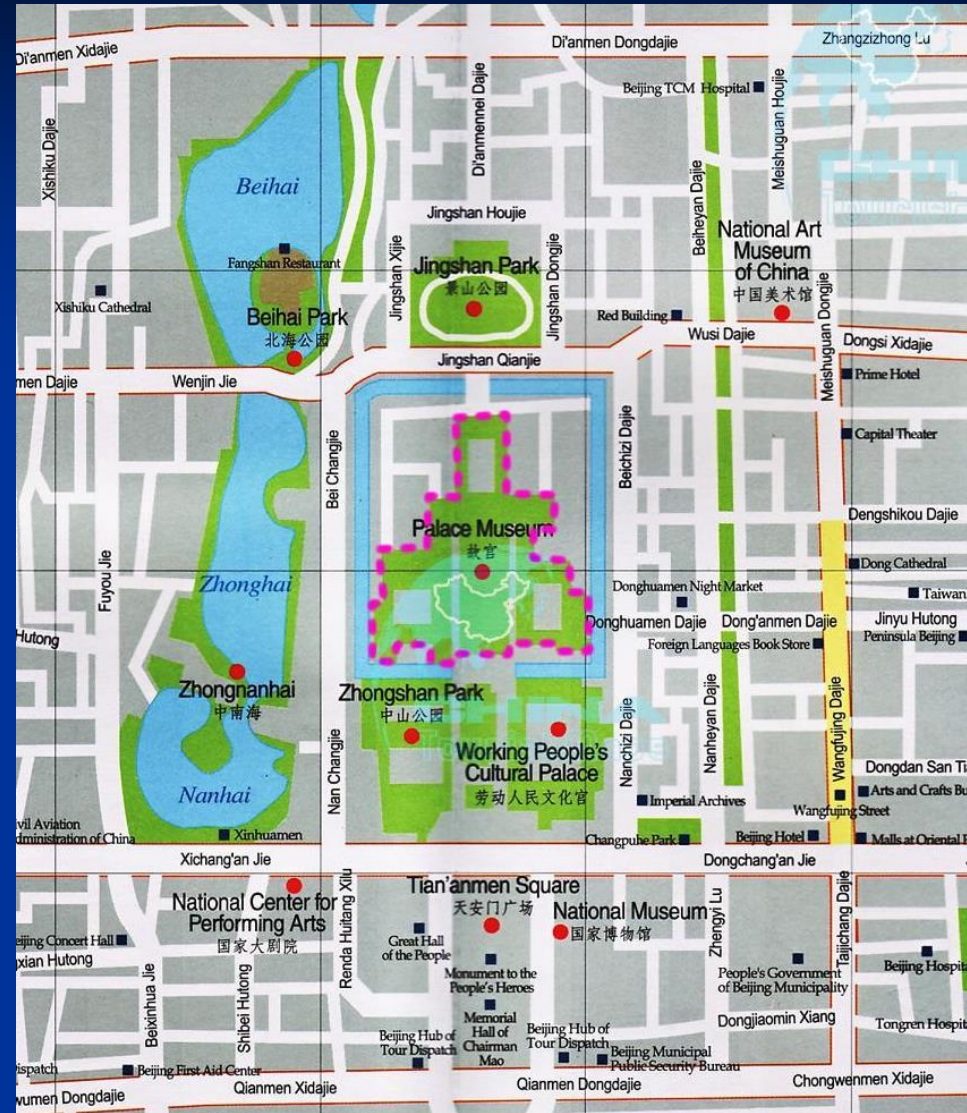
The imperial palace was located on the north side of the city, and from there the Suzaku main street was heading directly south and represents the universal column that unites the earth to the sky and that looks at the North Star. At the heart of the composition is the Emperor, associated with the Pole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

皇宫位于城市的北面，从那里开始，朱雀主街直接向南，代表着连接天地的宇宙柱，它朝向北极星。构图的核心是天皇，与北极星有关，北极星标志着永恒的中心和永不下落之点。



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.

紫禁城建于1406年至1420年间。这个建筑群是中国传统建筑的典范。它的中轴线向南延伸至天安门广场及其他地方。北面是景山公园，这是一座用从护城河和附近湖泊中挖出的泥土建造的人工山。



S



STAR FESTIVAL

星星的节日

Malang,

玛朗

Indonesia, Asia

印度尼西亚，亚洲

公元700年



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

佛教寺庙，Eng-An-Kiong，玛朗，印度尼西亚

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.

织女（织女星）是天帝的女儿，她嫁给了贫穷良善的牛郎（牛郎星）。但结婚后，年轻的夫妻变得懒惰了。天帝大怒，将这对恋人用一条大河（银河）隔开，他们每年只有在7月7日那天才有一次见面的机会。



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.

这一天织女星和牛郎星当然会隔银河相聚了



July 7 julio and rain period

7月7日是雨季



August 7

8月7日



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).

按照格利高里历，7月7日对应的是8月7日（在日本，7月7日对应雨季，现在大约是8月7日）



SANT CLIMENT AND  
SANTA MARIA DE TAÜLL  
圣克莱蒙特和圣玛利亚德塔乌尔

Spain, Europe

1123

西班牙，欧洲  
公元1123年



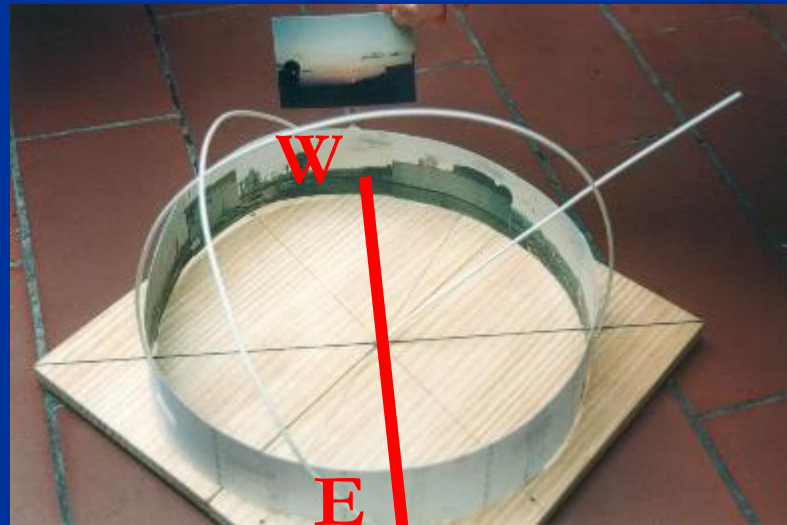
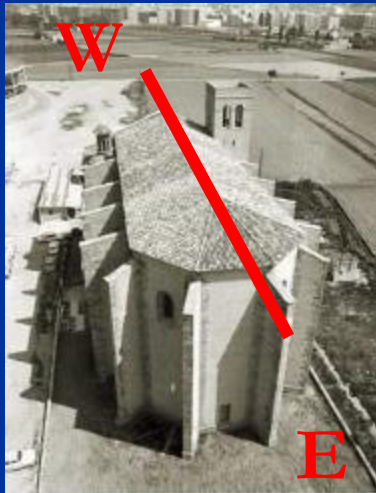


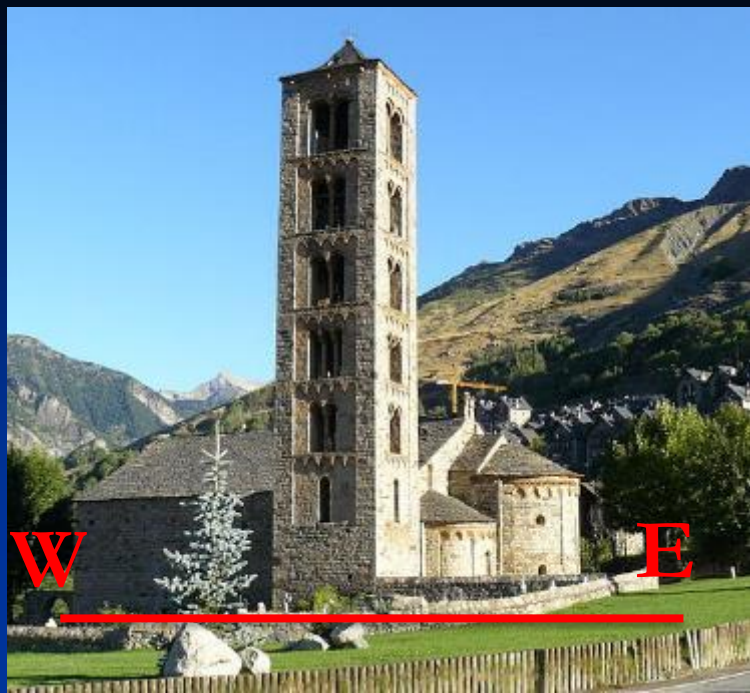
At the Council of Nicaea (325) it was determined that the apse of a church was to the East and the gateway to the West so that the priest would be facing East during the services.

尼西亚议会（325年）决定教堂的拱点朝东大门朝西，这样教士在布道时就可以面朝东方。

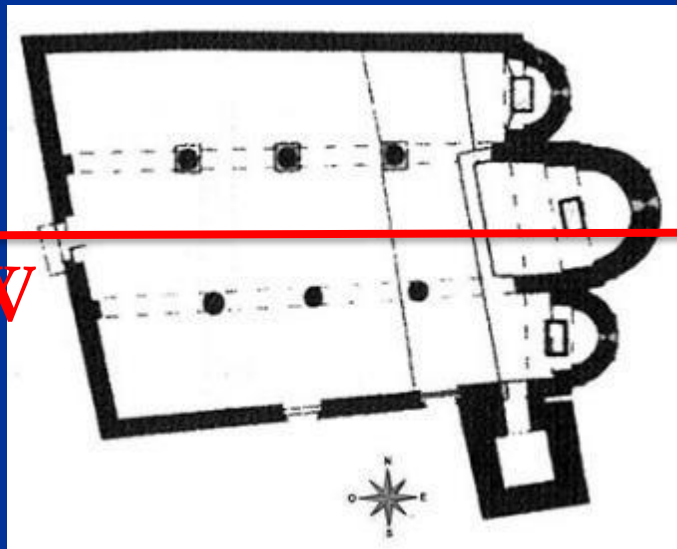
Thus the priest and the participants would be directed towards the East, from where Christ, the Sun of Justice, will shine at the end of time (ecclesiarum situs plerumque talis erat, ut fideles facie altare versa orientem solem, symbolum Christi qui est sol iustitia et lux mundi intererentur)

这样教士和教徒可以朝向正东，那里是基督，正义之子之末日时闪耀的地方。

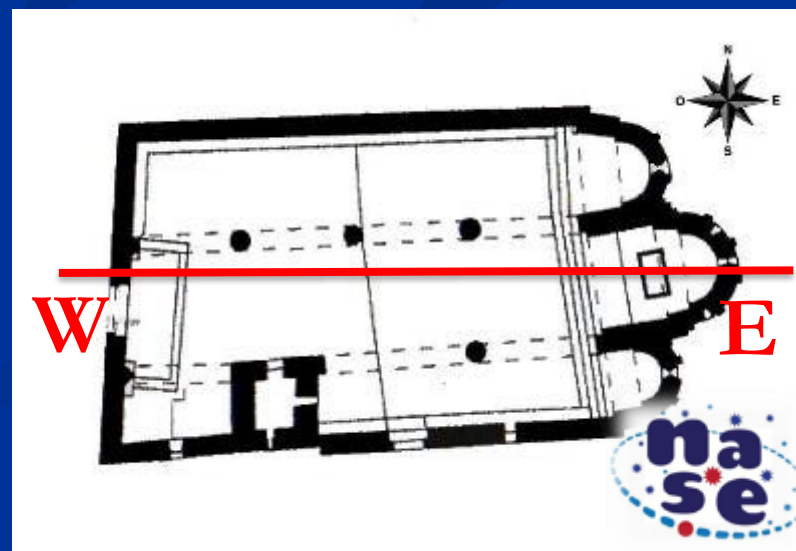




S. Climent de Taüll

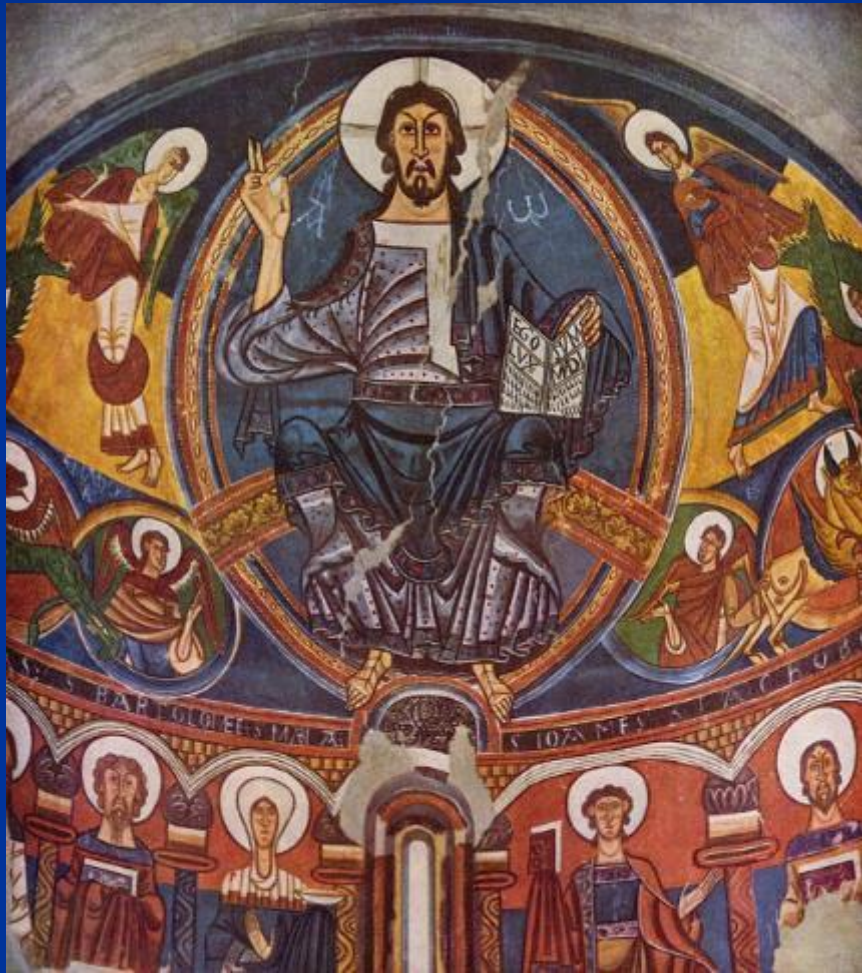


Santa Maria de Taüll

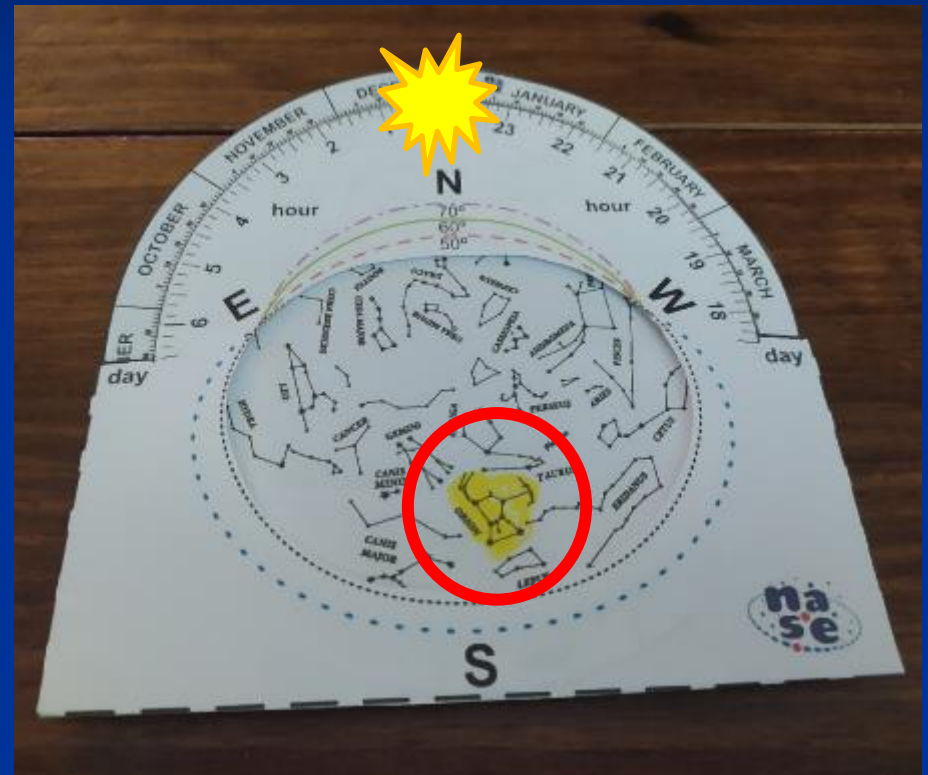


On December 10, 1123, Sant Climent de Taüll was consecrated. One day later on December 11, Santa Maria de Taüll was consecrated, after finishing the works and the interior wall paintings.

1123年12月10日，圣克莱蒙特得塔乌尔升天。一天后，也就是12月11日，圣玛利亚德塔乌尔完成了内部壁画的工作，也升天了。



Taüll is in the Pyrenees at Latitude 42° N 塔乌尔位于比利牛斯，北纬42度



Orion is on the Southern horizon on December 25, at Christmas  
12月25日圣诞节时，猎户座位于南方地平线



Astrophysical observation 1123  
公元1123年的天体物理观测



三王3 kings: Melchior,  
Baltasar

Gaspar and

Betelgueuse



Bellatrix



# FORBIDDEN CITY

China, Asia

1420

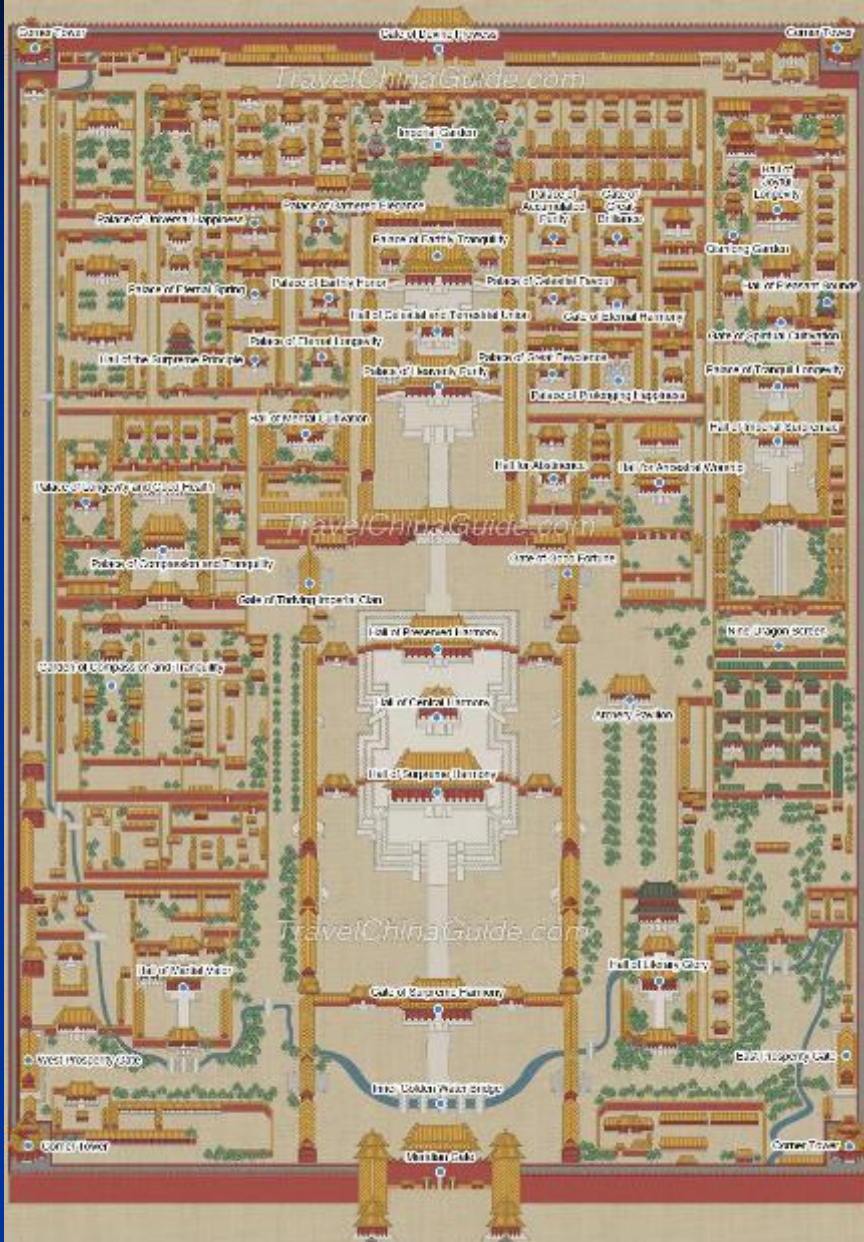
紫禁城

中国，亚洲

1420年



A Full Map of the Forbidden City



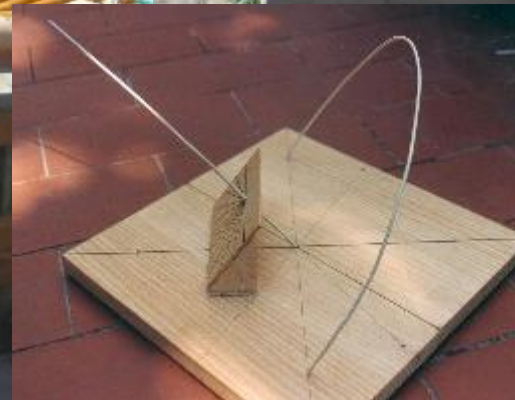
The full map is oriented North-South according the local meridian.  
全图按照当地子午线呈南北向

Location Map of Forbidden City and Tiananmen Square

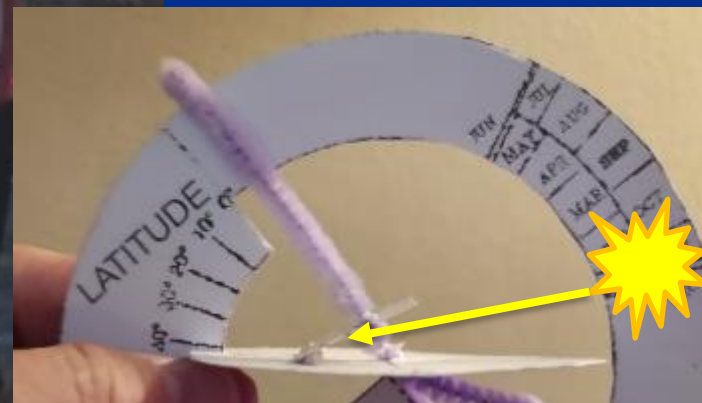
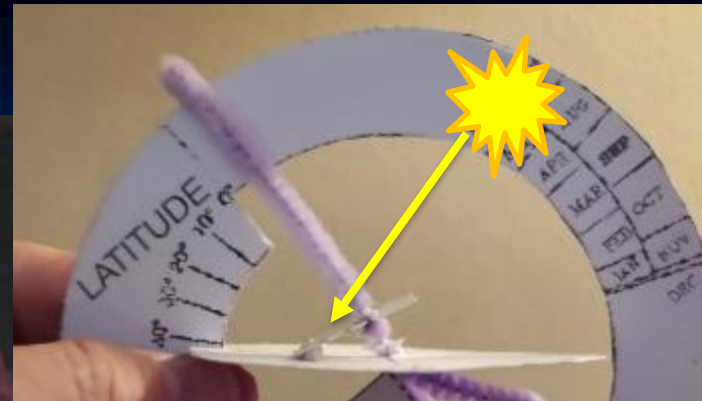


There is a collection of  
equatorial sundials  
aligned with the local  
meridian

各种按照当地子午线方  
向建造的赤道式日晷







The plane of sundial is parallel to the equator and the gnomon is according the terrestrial rotation axe  
日晷的晷面与赤道平行，  
晷针与地球自转轴方向一致



MONUMENT  
“Mitad del Mundo”  
Ecuador, America  
1992

Mitad del Mundo纪念碑  
厄瓜多尔，美洲  
1992年



# Equator Monument in the Equator line 赤道标志线上的赤道纪念碑



Parallel Earth?, with the Equator line on the top  
平行地球？赤道线位于顶端

The Equator line  
赤道标志线



Parallel Earth? a few weeks after the equinox  
平行地球？春分后几周



There is an error in  
position !!!!  
位置有误!!!

**CONSTELLATIONS  
FOR FISHING AND PLANTING**

**Philippines, Asia**

**2005**

捕鱼耕种的星座

菲律宾，亚洲

2005年





Teruday  
Lat 7°N



# TEDURAY 特杜瑞

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.

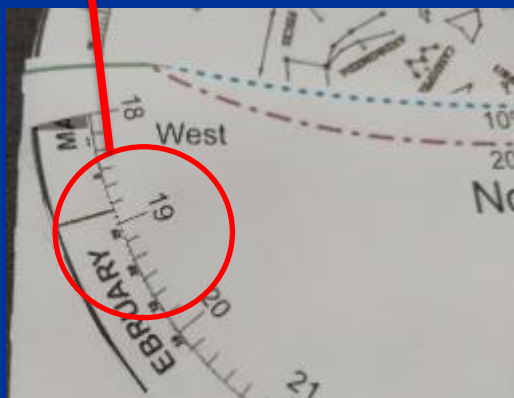
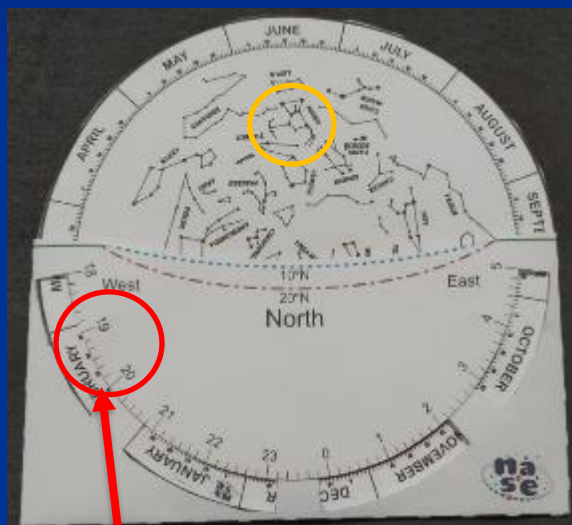
来自棉兰老岛的特杜瑞人将猎户座称为“希瑞塔”，认为他是个猎人。猎户的腰带是希瑞塔的身体，他的左手则是参宿七。猎户的短剑则被视为希瑞塔的itak



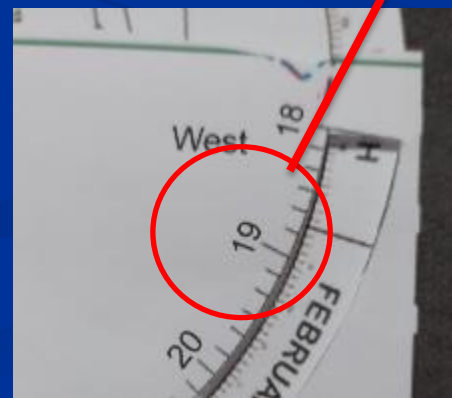
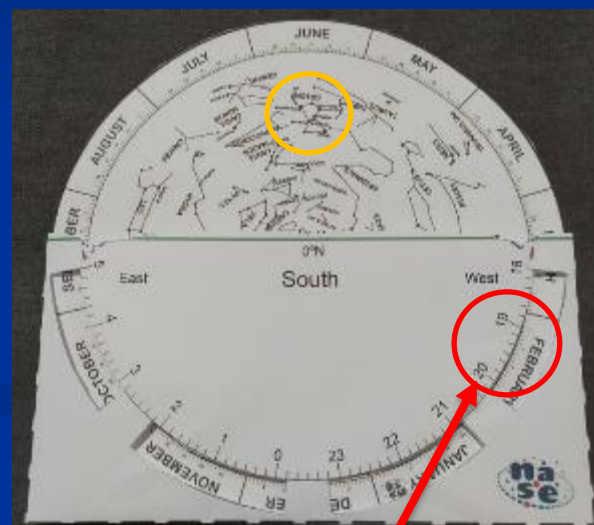


# Teduray **The Sunset is at approx. 18:00h and the night starts at 19:00h**

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  
 塔威塔威省，  
 北纬5度



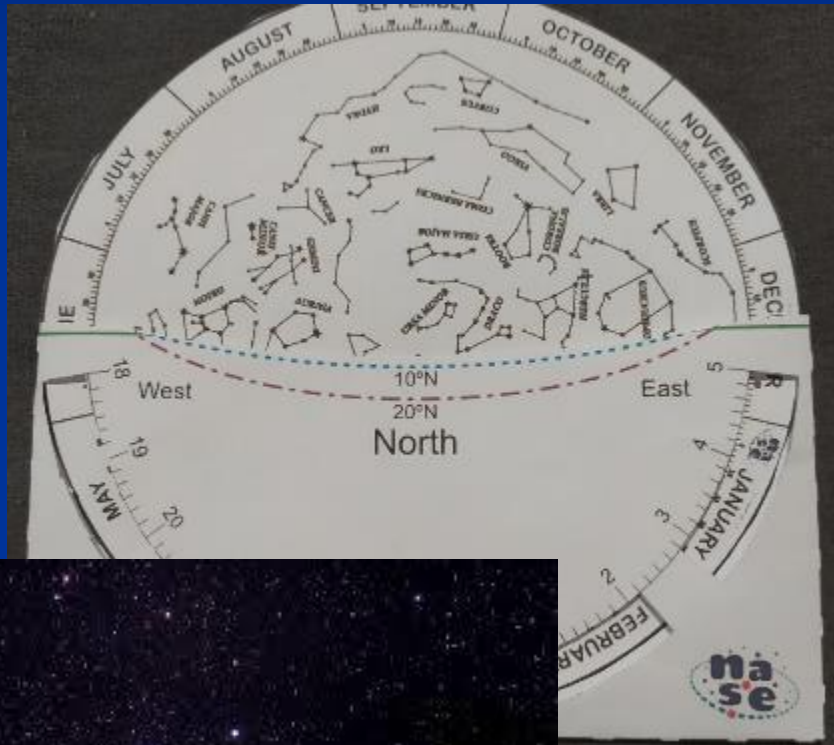
In Tawi-Tawi, the Big Dipper is a constellation that resembles a fish trap. They use it to determine good results for fishing. If many stars are seen inside the "cage", then the weather conditions are suitable for fishing.

在塔威塔威，北斗七星的形象是个捕鱼网。人们用它来确定捕鱼是否有好收成。如果“篮子”里有很多星，那就意味着天气条件适合捕鱼。



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.

在塔威塔威，北斗七星的另一重要部分是勺柄，对应的是捕鱼网形象中的“绳子”。如果绳子朝东，萨马人就相信水流湍急。



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**

太阳能板

蒙古，亚洲

2019年



With solar panels ... with different orientations?  
太阳能板朝向不同的方向吗？



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

在乌兰巴托，太阳能板总是按照太阳的路径，朝着同一个方向





Direction N-S with the inclination = site latitude  
南北方向与太阳能板的夹角=地理纬度



# Best sits in the Bus 大巴车上最好的座位

# From Ulaanbaatar to Tsetserleg 从乌兰巴托到车车尔格勒



Latitude 48°N

Sunny part on the South part (on the left), that is to say it is better to sit on the right  
阳光总是在南边（左边），所以最好是坐在车内右边的位置





**Many Thanks  
for your attention !  
感谢聆听！**

