History of Astronomy
天文学史

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1 Introduction 引言

- The history of astronomy is vast and complex and can not be summarized in a single talk. Therefore, we present only a few topics:
- 天文学史内容广泛而复杂，无法用简要的语言概括，这里仅就部分话题做简要阐述
- the heliocentric concept of the universe
- 日心说
- some astronomical knowledge from several great cultures and civilizations of the past
- 古代文化、文明中的有关天文学知识

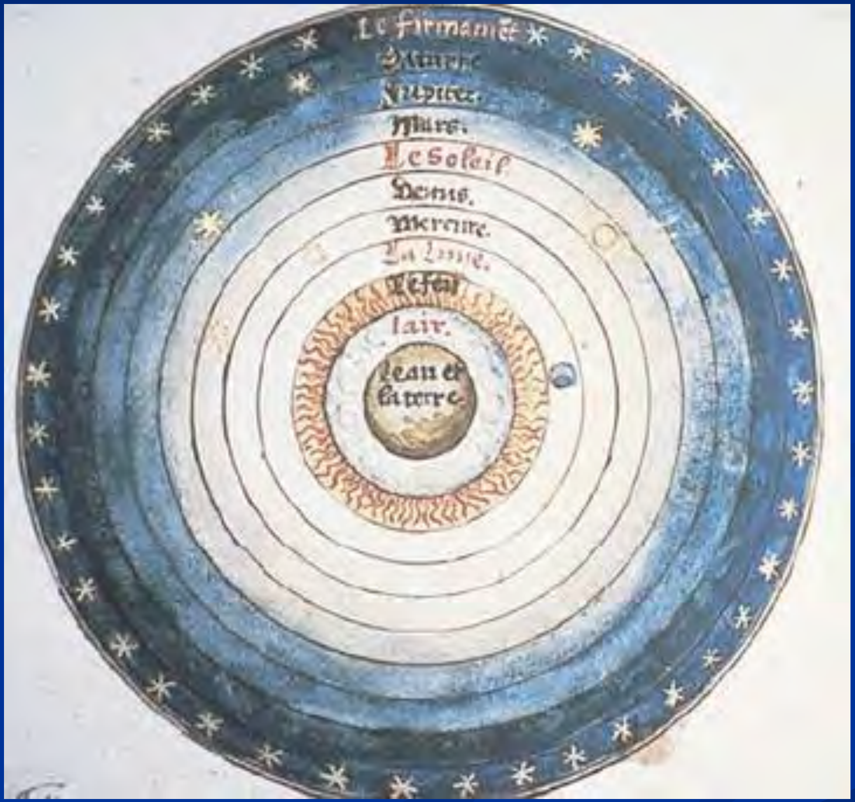
2 Astronomy from the ancient Greeks 古希腊天文学

- The planets appear to move slowly in one direction (from West to East) with respect to the background stars: direct movement.
- 相对于恒星背景，行星看起来在自西向东缓慢移动：顺行
- But sometimes, a planet moves in the opposite direction (from East to West) with respect to the stars: retrograde motion
- 但有时，相对恒星背景，行星看起来自东向西运动：逆行

Simulation with the Zeiss ZKP3/B planetarium projector of Williams College's Hopkins Observatory by Jay M. Pasachoff, Yariv Pierce, and Megan Bruck.

2 Astronomy from the ancient Greeks 古希腊天文学

- The ancient Greeks made theoretical models of the universe in order to explain the movement of the planets.
- 古希腊人制作宇宙理论模型，试图解释行星运动规律。
- To compare the duration of the retrograde motion of the planets, they ordered the celestial bodies with regards to distance.
- 通过比较行星逆行运动的时间，他们依据距离为天体排序。



2 Astronomy from the ancient Greeks
古希腊天文学

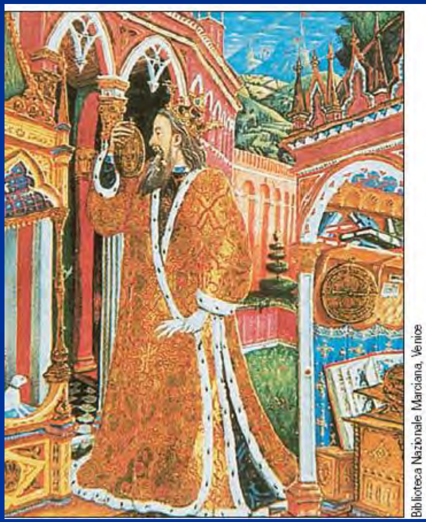
- Aristotle (350 BC) thought the Earth was definitely the center of the universe, and the planets, the Sun, and the stars revolved around Earth.
- 亚里士多德（公元前350年）认为：地球是宇宙的中心，行星、太阳和恒星都围绕地球转。
- According to Aristotle, the universe consisted of a set of 55 celestial spheres that are fitted one inside the other
- 参照这一理论，我们的宇宙由55个逐一嵌套着的天球组成。

2 Astronomy from the ancient Greeks 古希腊天文学

- The natural movement of each sphere was the rotation. The planets moved in some of the spheres and the movement of each sphere affect the other. Retrograde motion could be explained in this way.
- **每层天球都在自转。行星在某一层天球中运动，同时这些天球之间相互影响。这种模型可以解释逆行。**
- The outermost sphere corresponds to fixed stars. Outside this sphere, it was "the primary mechanism" causes the rotation of the stars.
- **最外层天球对应于固定的恒星，在最外层天球以外有"原初机制"推动全体恒星的运动。**
- Aristotle's theory dominated scientific thought for 1800 years, up to the Renaissance, and prevented that scientific work would consider new models.
- **亚里士多德的理论主导科学思想持续了1800多年，直到文艺复兴，这对于科学工作考虑新的模型起到了相当大的阻挠作用。**

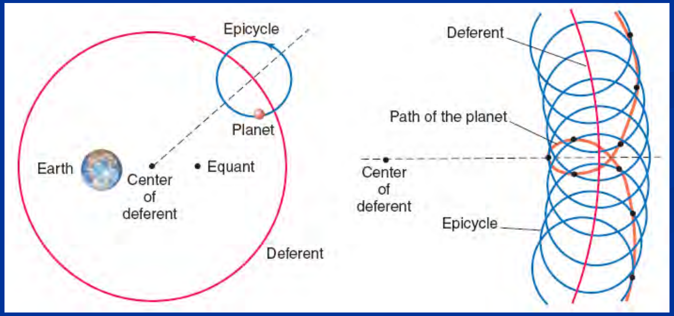
2 Astronomy from the ancient Greeks 古希腊天文学

- Around 140 A.D., the Greek scientist Claudio Ptolomy of Alexandria presented a detailed theory of the universe that explained the retrograde movement.
- 公元140年，希腊科学家托勒密提出了详细的解释逆行运动的理论
- Ptolemy’s model was geocentric (Earth in the Center), as was Aristotle's. To explain the retrograde motion of the planets, he conceived the planets traveling along small circles that move about larger circles of general orbits of planets.
- 托勒密的模型是地心模型（地球在中心），这也是亚里士多德的观点。为了解释行星的逆行，他认为行星围绕小圆轨道运行，小圆又围绕以地球为圆心的大圆运行。



2 Astronomy from the ancient Greeks 古希腊天文学

- To explain the retrograde movement, Ptolomy proposed that the planets traveled in small circles called epicycles; the larger circles are called deferents. 为解释逆行运动，托勒密提出：行星运动的小圆轨道称为本轮，大圆轨道称为均轮。
- The center of an epicycle moves with a constant angular velocity relative to the point called the Equant. 一个本轮的中心以恒定的角速度围绕均衡点运动。
- As it was believed that the circles were perfect forms, it seemed logical that planets should follow circles in their movements. 因为圆被认为是完美的形式，那么行星围绕圆形轨道应该是合理的。



2 Astronomy from the ancient Greeks 古希腊天文学

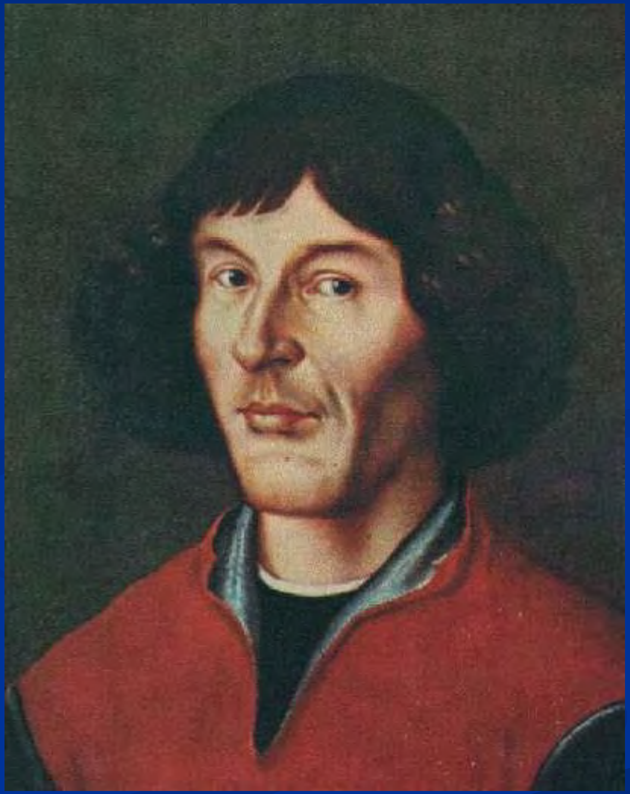
- Ptolemy's most important work *the Almagest* (translation: the greatest) were accepted for nearly 15 centuries, and contained not only his ideas but also a summary of the ideas of his predecessors
- **托勒密最重要的工作《天文学大成》被认可了近15个世纪，这其中不仅包含他的想法，也包含对前人观点的总结**
- His tables of planetary movements were reasonably accurate considering the era.
- **他的行星运动表在当时是相当准确的。**

3 The sun-centered universe
日心说

- In the 16th century Nicolás Copernicus, a Polish astronomer, suggested a heliocentric theory (with the Sun in the Center)
- 16世纪，波兰天文学家哥白尼，提出了日心说（以太阳为中心）。
- Aristarcus of Samos, a Greek scientist, suggested the heliocentric theory 18 centuries before Copernicus. We do not know, however, that early theory in detail.
- 希腊科学家萨默斯，在哥白尼之前18个世纪就提出日心说。然而我们恐怕无法考证其中的细节。

3 The sun-centered universe
日心说

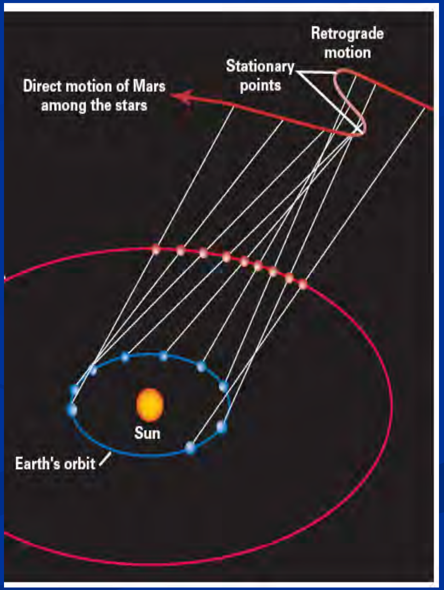
- Copernicus assumes that the planets move in circles, though the circles were not exactly focused on the Sun.
- **哥白尼假定行星都沿着圆轨道运行，尽管这些圆轨道不完全以太阳为焦点。**
- Copernicus used some epicycles in order that their predictions were better consistent with observations (and eliminated the equant.)
- **哥白尼用了一些本轮（同时淘汰了均衡点），以使得预测与实际观测结果更加吻合。**



3 The sun-centered universe
日心说

- This model explained the retrograde motion of the outer planets (as Mars) by projection effect:
- 这个模型通过投影效果解释了外行星（如火星）的逆行：

  - As Earth overtakes Mars, the projection of the line joining the Earth and Mars, shows an apparent movement of recoil among the stars, contrary to the actual direction of movement. **当地球超过火星时，地球火星连线的投影体现为在恒星背景中逆行，与其实际运行方向相反。**



  - Then, as Earth and Mars are still moving in its orbit, the projection of the line that joins the two planets seems to move again in the real sense of the movement. **之后，地球和火星在各自的轨道上运动，它们连线的投影则与其实际运行方向一致。**

3 The sun-centered universe
日心说

- With the idea that the Sun was approximately in the center of the Solar system, Copernicus:
- 哥白尼：太阳大概是太阳系的中心
  - Computed the relative distances of the planets scaled to Earth-Sun distance.
  - 参照日地距离，计算行星的相对距离
  - Inferred the time for each planet to orbit the Sun from observations.
  - 通过观测推断每个行星的绕日公转周期。

4 The sharp eyes of Tycho Brahe
第谷的火眼金睛

In the latter part of the 16th century, not long after the death of Copernicus, Tycho Brahe, a Danish nobleman began to observe Mars and other celestial bodies to improve their predictions of the positions from his observatory Uraniborg

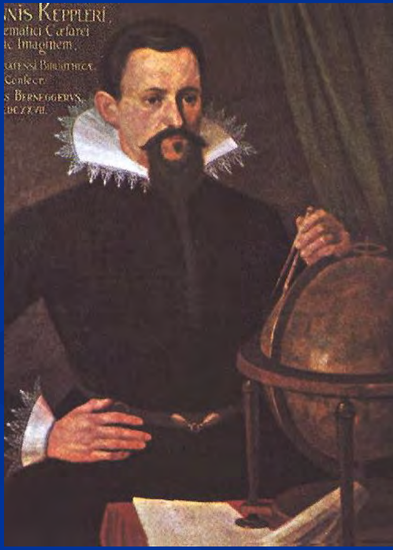
16世纪后半叶，哥白尼死后不久，丹麦贵族第谷开始从他的天文台观察火星和其他天体，改进它们的位置

4 The sharp eyes of Tycho Brahe
第谷的火眼金睛

- Since the telescope not had yet been invented, Tycho used giant observing instruments that had no precedent in terms of accuracy.
- 由于还没有发明望远镜，第谷用巨大的仪器观测，在精确度方面达到了史无前例的高度。
- Following Tycho's death in 1601, after some battles to access them, Johannes Kepler obtained the data.
- 1601年第谷去世后，经过一番努力，开普勒得到了这些数据。

5 Johannes Kepler and his Laws
开普勒和他的运动定律

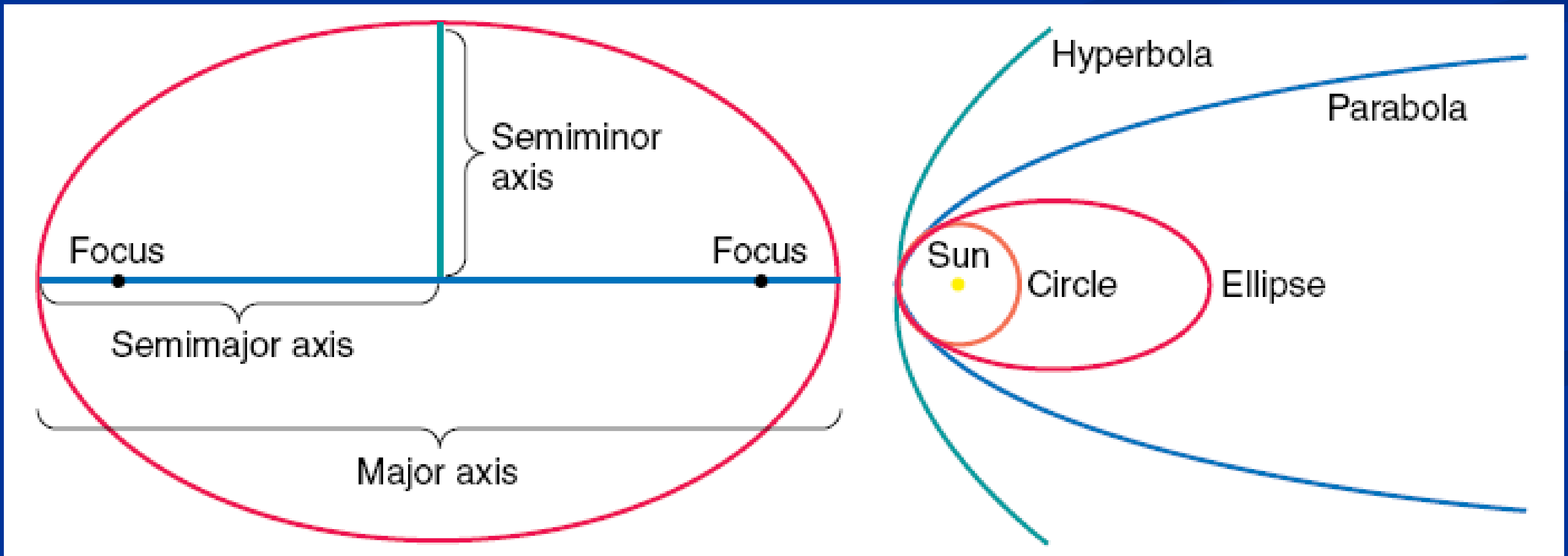
- The new, more reliable and precise observations of Tycho showed that the tables of the positions of the planets, in use at that time, were not very accurate.
- 第谷更新、更可靠和精确的观测结果表明，那个时期一直使用的位置信息并不是很精确。
- Tycho hired Kepler in 1600 to do detailed calculations to explain the planetary positions.
- 第谷聘用开普勒在1600年做了详细的计算，用于解释行星的位置。
- First, Kepler tried to explain the orbit of Mars using circles, then other shapes, before he found the answer.
- 起初在找到正确答案之前，开普勒试图用圆轨道来解释火星和其他行星的轨道。



5a Kepler's First Law
开普勒第一定律

- The Kepler's first law, published in 1609, says that the planets orbit around the Sun in ellipses, with the Sun at one focus.

开普勒第一定律，1609出版：
行星围绕太阳做椭圆运动，太阳是椭圆的一个焦点。

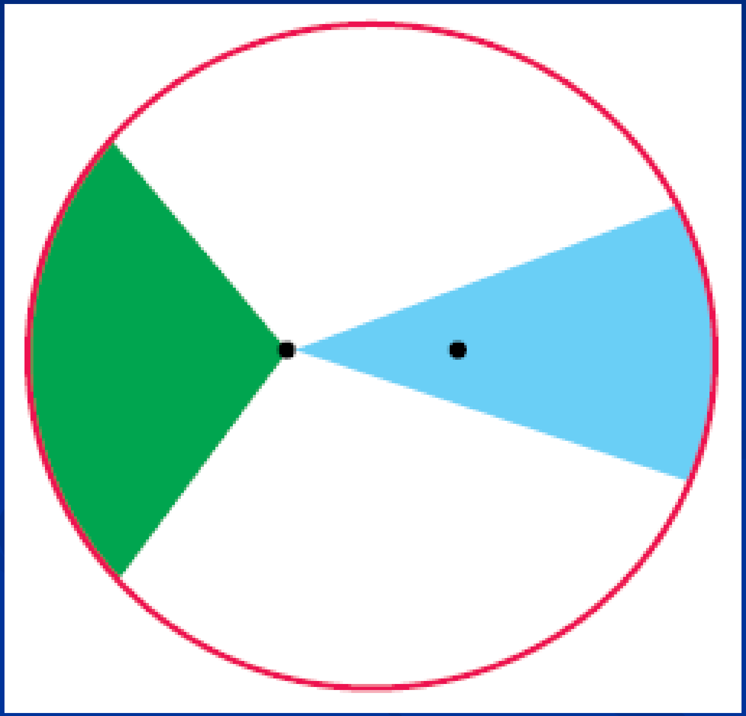


5a Kepler's First Law
开普勒第一定律

- The separation between the foci and a given length of string defines an ellipse.
- 通过给定的两个焦点及定长的一根绳子，就可以定义一个椭圆。
- The shape of the ellipse can be changed if you change the length of the string or the distance between the foci.
- 椭圆的形状，随着绳长的变化及两个焦点间距离的变化而变化。

5b Kepler's Second Law
开普勒第二定律

- Describes the speed with which the planets travel in their orbits:
- 描述了行星的轨道运行速度：
  - line joining a planet with the Sun describes equal areas in equal times.
  - 相同时间内，行星与太阳的连线扫过的面积相等。
  - This is also known as the law of equal areas.
  - 又称等面积定律



5b Kepler's Second Law
开普勒第二定律

- Kepler's second law is especially useful for the comets, which present highly eccentric elliptical orbits (i.e., flattened).
- 开普勒第二定律对那些轨道偏心率特别高（即，扁平）的彗星特别有用。
- For example, he showed that the Comet Halley is moving much more slowly when it is far away from the Sun, since the line that joins it to the Sun is very long.
- 例如，在哈雷彗星距离太阳较远时，其运动速度要慢得多，而这时的连线非常长。

5c Kepler's Third Law
开普勒第三定律

- Kepler's third law relates the period with a measure of the distance of the planet to the Sun.
- 开普勒第三定律表述了行星的公转周期与它到太阳的距离之间的关系。
- Specifically, says that the square of the period of revolution is proportional to the cube of the semi-major axis of the ellipse*:*
- 具体地说，公转周期的平方与轨道半长轴的立方成正比

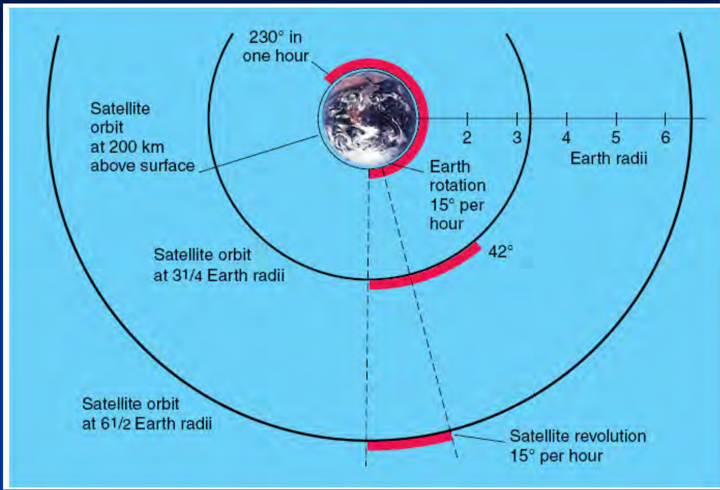
$$P^2 = kR^3, \text{ where } k \text{ is a constant } 其中k是常数$$

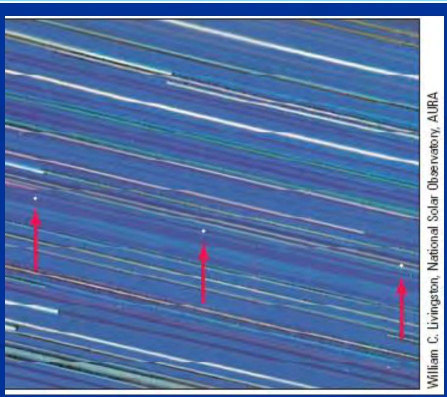
- That is, if the cube of the semi-major axis of the ellipse increases,

  the square of the period increases by the same factor.
- 如果椭圆半长轴的立方增加，周期平方也以相同的比例增加

5c Kepler's Third Law
开普勒第三定律

- A terrestrial application of Kepler's third law is in "geostationary satellites" which are at a distance where their orbital period is same as Earth's rotational period. They remain always above the same longitude on Earth.
- 地球同步卫星是开普勒第三定律在地球上的一个应用，它们的公转周期与地球的自转周期相同。它们一直在地球上相同的位置 。





- They seem that they float above the Equator (see picture, left), and they are used to relay signals for TV and telephone.
- 看上去他们好像一直漂浮在赤道上（见左图），它们可以中转电视和电话信号。

6 The fall of the Ptolemaic model: Galileo Galilei
托勒密模型的倒塌：伽利略

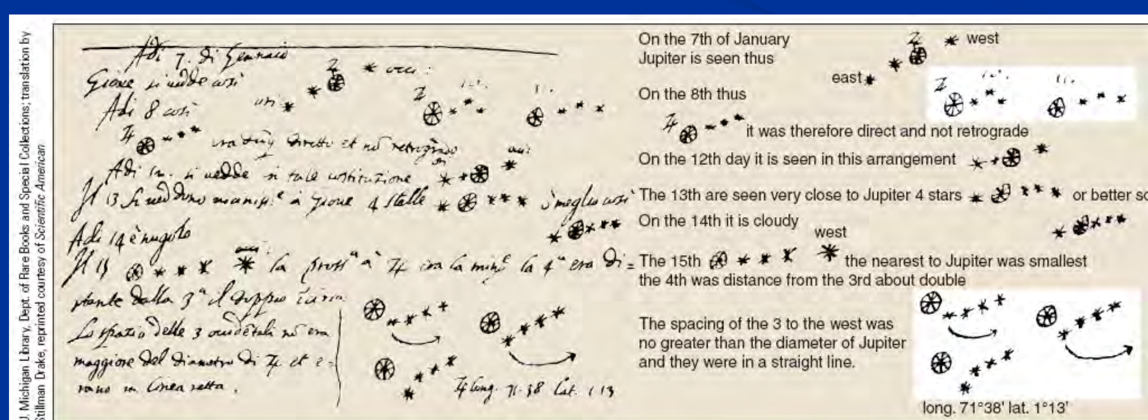
- In late 1609 Galileo was the first to use a telescope for systematic astronomical studies.
- 1609年晚些时候，伽利略成为第一个将望远镜用于天文学系统研究的人。

6 The fall of the Ptolemaic model: Galileo Galilei
托勒密模型的倒塌：伽利略

- In 1610, he published observations from his telescope: many more stars than one could see with the unaided eye.
- 1610年，伽利略出版了他用望远镜做的观测结果，比之前用肉眼能看到的恒星数量要多很多。
- The Milky Way contained numerous individual stars.
- 银河里有非常多的恒星。
- Mountains, craters and dark lunar "seas” on the Moon
- 月面上有山脉、环形山、黑暗的“月海”。

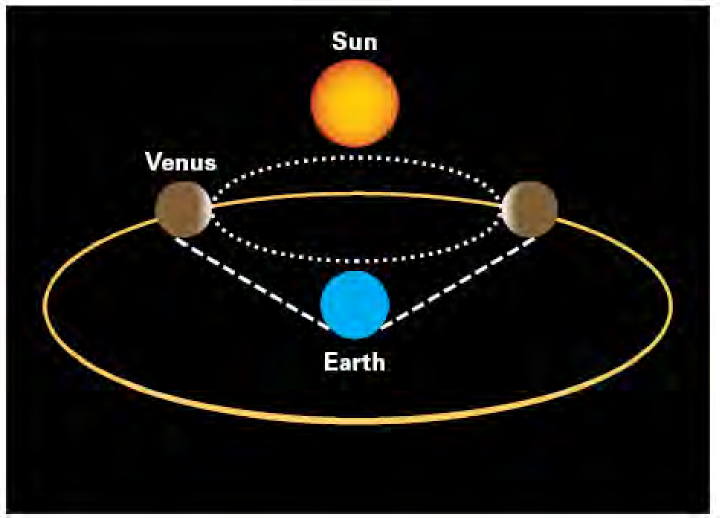
6 The fall of the Ptolemaic model: Galileo Galilei
托勒密模型的倒塌：伽利略

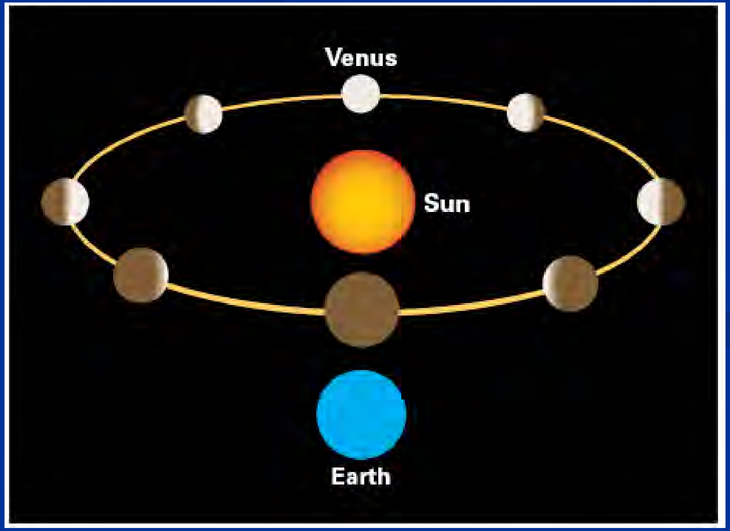
- 4 small bodies that orbit Jupiter (this proved that not all the bodies revolve around the Earth)
- 有四颗卫星在围绕木星旋转（这说明不是所有天体都围绕地球转）
- In addition, the 4 moons were not "left behind" while Jupiter moved suggesting that Earth should behave in a similar fashion without leaving objects behind it.
- 此外，这四个“月亮”随着木星的移动而移动，地球也应该具有相似情形。



6 The fall of the Ptolemaic model: Galileo Galilei
托勒密模型的倒塌：伽利略

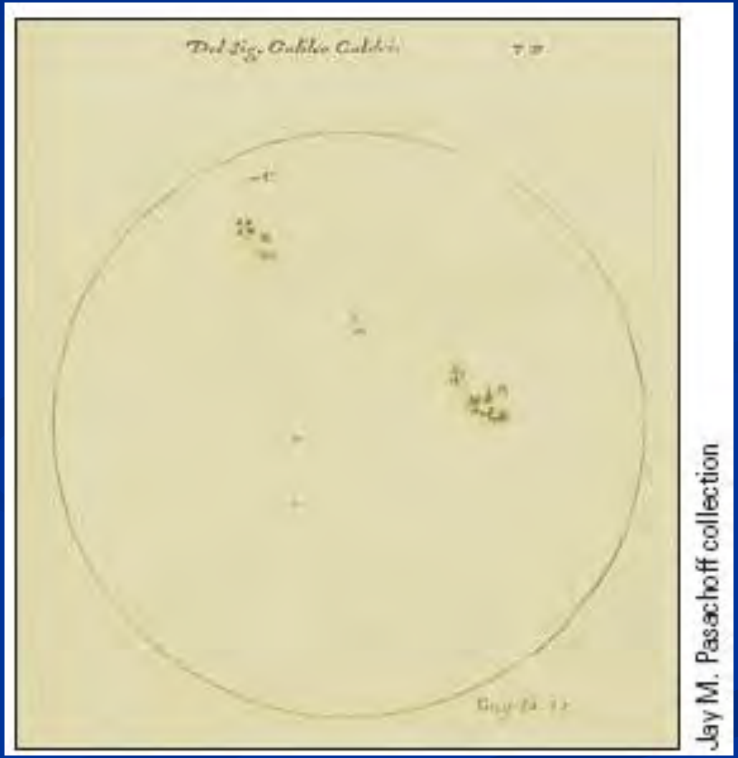
- Galileo also discovered that Venus presented a complete set of phases; this was not explained with the Ptolemaic system
- 伽利略还发现金星有完整的相位变化规律，这是托勒密系统所无法解释的。





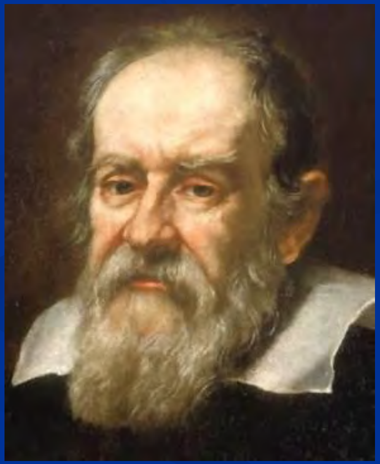
6 The fall of the Ptolemaic model: Galileo Galilei
托勒密模型的倒塌：伽利略

- In 1612 he described sunspots, (evidence that celestial objects were not perfect) showing that they move together across the surface of the Sun
- 1612年，他描绘了太阳黑子（证明天体不是完美的），它们在一起沿着太阳表面移动。



6 The fall of the Ptolemaic model: Galileo Galilei
托勒密模型的倒塌：伽利略

- In our era, about four hundred years after Galileo made his discoveries and more than four hundred years since his contemporary Giordano Bruno was burned at the stake in part by his vision of other worlds beyond our solar system, there prevails a peace between the Church and the scientists. For example, the Vatican maintains a modern Observatory staffed by several respected astronomers.



- 距离伽利略做出他的重大发现已有400年，距离布鲁诺因为将宇宙的研究范畴放眼到太阳系之外而被烧死已400多年，教会与科学之间才达成了现如今的平衡。例如，在一些受人尊敬的天文学家的努力下，梵蒂冈现今还保留着一座现代天文台。

7 On Shoulders of Giants: Isaac Newton
站在巨人的肩膀上：牛顿

- Only with the work of Isaac Newton 60 years later do we understand the physics behind the empirical laws by Kepler.
- 在开普勒定律问世后的60年，我们才通过牛顿的工作理解了其定律的物理规律。
- Newton was born in England in 1642, the year in which Galileo died.
- 牛顿1642年出生于英格兰，正是伽利略逝世的那一年。
- It was the greatest scientist of his time:
- 牛顿是当时世界上最伟大的科学家：
  - He worked in optics.
  - 他擅长光学研究

7 On Shoulders of Giants: Isaac Newton
站在巨人的肩膀上：牛顿

- He invented the reflecting telescope
- 他发明了反射式望远镜
- He discovered the decomposition of visible light into a spectrum of colors.
- 他发现可见光可以分解为不同颜色的光谱。
- But even more important was his work on motion and gravitation (for which he had to invent calculus)
- 当然最重要的是他在运动和引力方面的贡献（为此他创立了微积分）。

7 On Shoulders of Giants: Isaac Newton
站在巨人的肩膀上：牛顿

- *The Principia* contains Newton's three laws of motion.
- 牛顿运动三大定律
- The first law states that bodies in motion tend to stay in motion in a straight line at constant speed unless an external force acts upon them.
- 第一定律：运动中的物体会保持匀速直线运动，除非有外力作用于他们。

This is the law of inertia, which was actually discovered by Galileo.

这是惯性定律，这实际上是由伽利略提出的。

7 On Shoulders of Giants: Isaac Newton
站在巨人的肩膀上：牛顿

- The second law concerns the force associated with its effect on the acceleration (increase of speed) of a mass.
- 第二定律：涉及力及其对一个质点的加速度的影响

  A larger force will make that the same mass is accelerate more (F = ma, where F is the force, m is the mass, and a is the acceleration).

  一个更大的力将使相同的质量具有更大的加速度（F =ma，其中F是力，m是质量，a是加速）

7 On Shoulders of Giants: Isaac Newton
站在巨人的肩膀上：牛顿

- The third law is often enunciated as "For every action, there is an equal and opposite reaction.”
- 第三定律常被表述为：“作用力与反作用力是相互的，大小相等，方向相反。”

  Rocket motion is only one of many processes explained by this law.

  火箭的运动正是该定律应用的案例之一。
- *The Principia* also includes the Law of Gravity.
- 牛顿的重要发现，还包括引力定律。

  One application of Newton's Law of Gravity is the concept of weight.

  牛顿的万有引力定律的一个应用是重力。

7 On Shoulders of Giants: Isaac Newton
站在巨人的肩膀上：牛顿

One of the most famous stories of science is that an apple fell on Newton's head, leading to his discovery of the concept of gravity

一个最著名的科学故事：一个苹果砸在牛顿头上，导致他发现了万有引力的概念。

Although no apple fell on Newton's head, the story that Newton himself told, years later, is that he saw an apple fall and realized that just as the apple falls to Earth, the Moon is falling toward Earth, and keeps moving away from us. (In any short interval of time, the distance that the Earth’s Moon travels toward the distance is compensated by the Moon’s motion forward, the result over several such intervals is a stable orbit, rather than a collision with Earth.)

尽管没有苹果砸在牛顿头上，但多年以后牛顿本人讲，他看到苹果下落，联想到就像苹果落向地球，月亮也正落向地球。（在任何很短的时间间隔内，地球与月球之间相互运动的距离被月球自身公转运动产生的距离补偿了。把这些小间隔叠加累计在一起就形成了稳定的轨道，而不会发生地月相撞的情况。）

7 On Shoulders of Giants: Isaac Newton
站在巨人的肩膀上：牛顿

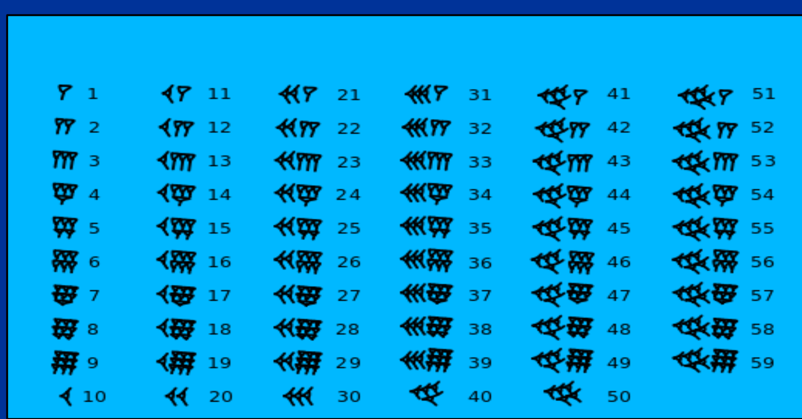
- One famous phrase from Newton is, **"If I have seen further it is by standing on the shoulders of Giants."**
- 牛顿格言：**"如果说我看的比别人远，那是因为我站在了巨人的肩膀上。"**

Optional slides
选讲

8 The roots of Astronomy : BABYLON 古巴比伦天文学

The roots of occidental Astronomy are in Caldea. The Caldeans used the sexagesimal system of positional notation (similar to the actual decimal system, but with base 60), this facilitated the development of algebra and arithmetic. From this ancient system, we have the division of the circle in 360 degrees, or the division of one hour in 60 minutes, and these into 60 seconds.

西方天文学的根源在迦勒底。迦勒底人使用的六十进制记数法（类似于实际的十进制系统，但以60为基数），促进了代数和算术的发展。这一古老的制度，将一周划分为360度，一个小时划分为60分钟一分钟60秒。

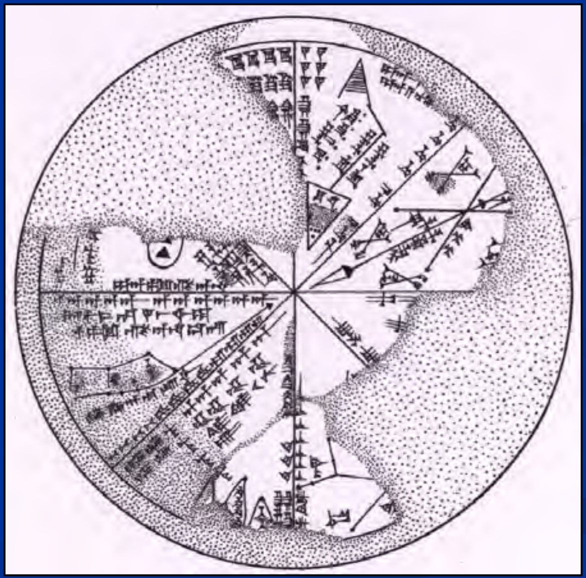


8 The roots of Astronomy : BABYLON
古巴比伦天文学

The Caldeans observed lunar eclipses and proposed the *Saros* series to predict the phenomena. Although they used the series only for lunar eclipses, it can be used to predict solar ones.

迦勒底人观察到月食，提出沙罗周期，用以预测月食现象。尽管他们只将此用来预测月食，然而实际上也可以用于日食。

Letter to the king Asurbanipal where is detailed a lunar eclipse.
在给Asurbanipal国王的信中，提到的月食细节。



Planisphere, Ninive Library of Asurbanipal (800 BC)
Asurbanipal图书馆里的星座图（公元前800年）

8 The roots of Astronomy : BABYLON
古巴比伦天文学

Five planets known by Caldeans
迦勒底人认知的五大行星

Codex of Amurabi
Amurabi法典

Name名字	Meaning含义	Planet行星
Neberu	The pivot	Jupiter木星
Delebat	Which proclaims	Venus金星
Sithu, Ishtar	The jumper	Mercury水星
Kayamanu	The constant	Saturn土星
Salbatanu	The reddened	Mars火星

8 The roots of Astronomy : EGYPT 古埃及天文学

The sky-goddess Nut covers Geb, the Earth-god.

Nut forms the limit between Earth and Heaven, the dead world.
天空女神Nut covers Geb， 大地之神。

她界定了地球、天堂、死亡世界的范畴

8 The roots of Astronomy : EGYPT
古埃及天文学

The Egyptians noted than when Sirius (called Sotis) rose just before the Sun (heliac) this was coincident with the river Nile’s overflow. The desert became fertile, and for this reason, Sirius is connected with the goddess of fertility, Isis.

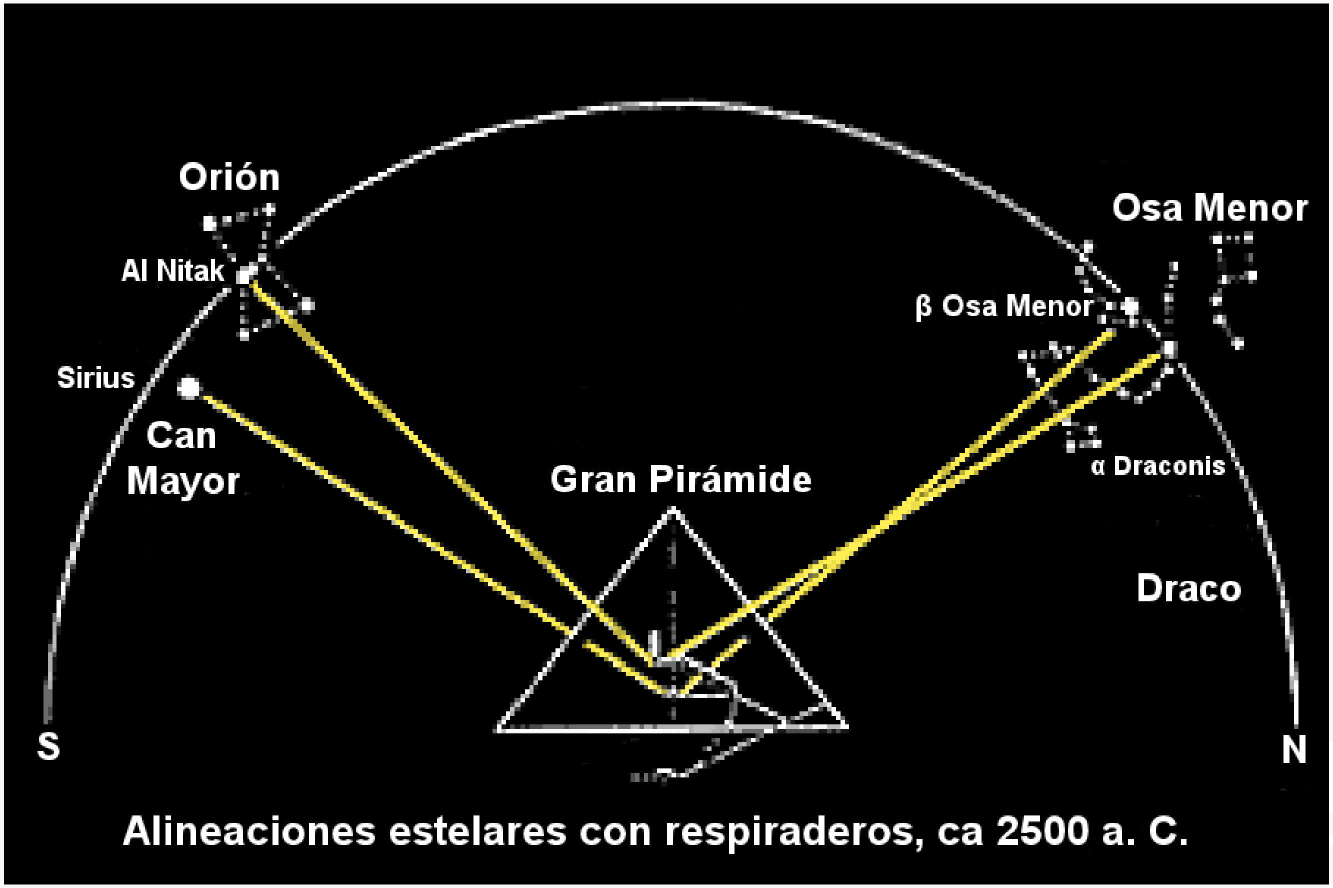
埃及人指出，当天狼星恰好在太阳升起之前升起的话，正是尼罗河的汛期。沙漠变得肥沃，基于此，天狼星被与生育女神伊西斯联系在一起。

8 The roots of Astronomy : EGYPT 古埃及天文学

The Egyptian constellations of the Hellenic period are on the roof of Hathor Temple in Denderah.
希腊时期的埃及星座图被刻画在邓德拉哈索尔神庙的屋顶。

The majority have disappeared, such as the crocodile and hippopotamus.
大多数已经消失，如鳄鱼和河马。

8 The roots of Astronomy : EGYPT 古埃及天文学



The buildings were oriented according to special positions of the Sun and the stars.

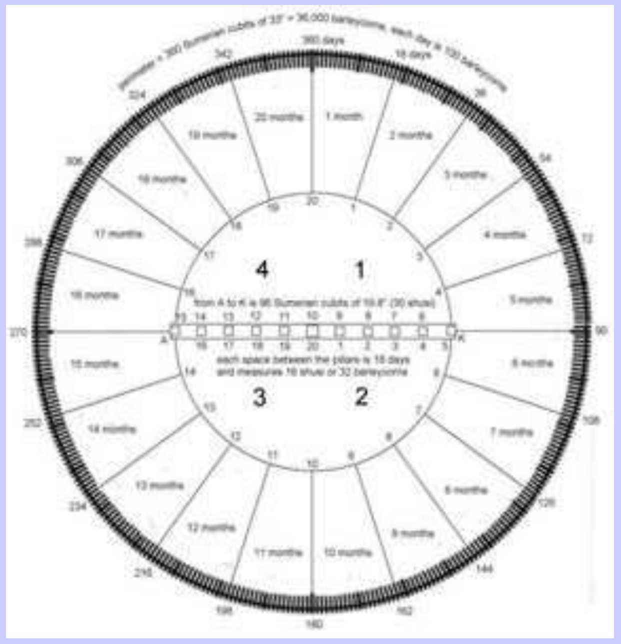
建筑是参照太阳和恒星的特殊位置进行方向设计的。

8 The roots of Astronomy: ÍNDIA
古印度天文学

The first textual mention of astronomical content is given in the religious literature of India (second millennium BC)
最早的天文内容记录出现于印度的宗教文献中（公元前第二个千年）
During the following centuries a number of Indian astronomers studied various astronomical aspects.
在之后的几个世纪中，印度天文学家们研究了天文学的各个领域。

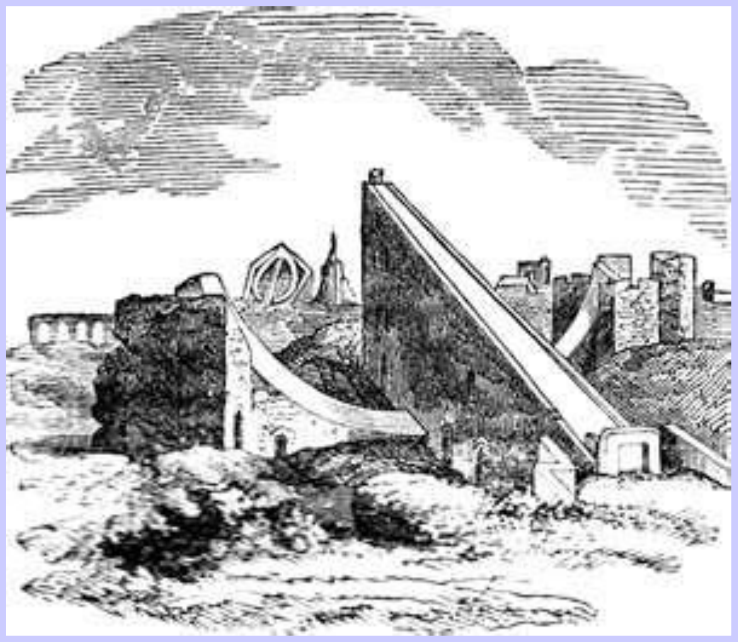
8 The roots of Astronomy: ÍNDIA 古印度天文学

The Hindu calendar used in ancient times has undergone many changes in the process of regionalization, and today there are several regional Indian calendars, as well as an Indian national calendar.
古代的印度历法在区域化的过程中经历了很多变化，今天有几个区域的印度历法，以及一个印度日历。
In the Hindu calendar, the day begins with sunrise. Assigned to five "properties" calls *angas*.
在印度教的日历中，一天开始于日出。把一天分为五个部分，每个部分叫做一个angas。



8 The roots of Astronomy: ÍNDIA
古印度天文学

The ecliptic is divided into 27 nakshatras which are variously called lunar houses or asterisms. These reflect the moon's cycle against the fixed stars, from 27 to 27 ¾ hours, the fractional part being compensated by an intercalary 28th nakshatra. Nakshatra computation appears to have been well known at the time of the Rig Veda
(second - first millennium BC.).



印度把一年分为27个月宫或星群，这反映了月球公转相对于恒星的周期是27天加0.75小时，小数部分则被算作第28个闰月。关于月的计算方法在梨俱吠陀时期（公元前2世纪至1世纪）是众所周知的。

8 The roots of Astronomy： ARABIA 阿拉伯天文学

Astronomical developments madein the Islamic world, particularly during the Islamic Golden Age (eighth – fifteenth centuries), and written in Arabic

天文学的发展在伊斯兰世界，特别是在伊斯兰黄金时代（第8~15世纪），用阿拉伯文书写。

Most were developed in the Middle East, Central Asia, Al-Andalus, North Africa, and later in Southeast Asia and India.

大多数是在中东，发达的中亚，安达卢斯，北非得到发展，之后在远东和印度。

8 The roots of Astronomy：ARABIA
阿拉伯天文学

The first systematic observations in Islam took place under the patronage of Al-Mamun (786-833) in many observatories from Damascus to Baghdad:

在Al-Mamun (786-833)时期，伊斯兰人进行了他们的第一次系统的天文观测，观测在从大马士革到巴格达的许多观测站进行：

- measured the degrees of longitude,
- 测量经度
- established solar parameters,
- 建立太阳参数
- made detailed observations of the Sun, Moon and the planets
- 记录太阳、月亮和行星的详细观测数据

8 The roots of Astronomy：ARABIA

阿拉伯天文学

A large number of stars in the sky (e.g., Aldebaran and Altair) and astronomical terms (e.g., alidade, azimuth, almucantar) are still cited by their Arabic names

大量的恒星在天空中（例如毕宿五和牛郎星）和天文学表达方式（例如照准仪，方位角，纬线圈）仍然被冠以阿拉伯语的名称

Tools 工具

- Celestial globes 地球仪
- Armillary spheres 浑仪
- Astrolabes 星盘
- Sundials 日晷
- Quadrants 象限仪

8 The roots of Astronomy : MAYA 玛雅天文学

The Maya were very interested in the zenithal passages, the time when the sun passes directly overhead.
玛雅人对太阳在天顶上中天非常感兴趣。
The latitude of most of their cities is below the Tropic of Cancer, these zenithal passages would occur twice a year equidistant from the solstice.
玛雅人生活的城市多位于北回归线以南，因此一年内太阳会发生两次在天顶上中天的现象。这两天距离夏至日的时长是相同的。
To represent this position of the sun directly overhead, the Maya had a god called "Diving God".

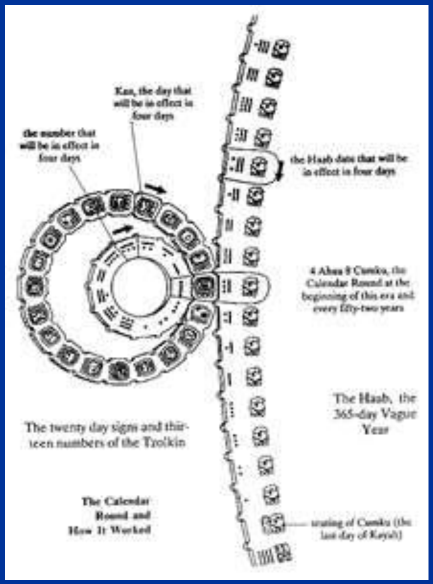
8 The roots of Astronomy : MAYA
玛雅天文学

Venus was the most important astronomical object for the Maya, even more than the Sun.
金星是玛雅人最重视的天体。在他们看来，金星的地位甚至超过了太阳。

The Maya civilization seems to be the only pre-telescopic that demonstrates knowledge of the Orion Nebula as a diffused, i.e., not a stellar point.
在前望远镜时代，玛雅人认识到：人们关于猎户大星云的知识，是它是一个光斑，而非一个恒星亮点。

8 The roots of Astronomy : MAYA 玛雅天文学

The Maya calendar is a system of calendars and almanacs used in the pre-Columbian Maya civilization, and in some modern Maya communities in the highlands of Guatemala and Oaxaca, Mexico. 玛雅历法是一个记日记年的历法系统，哥伦布发现美洲前一直被玛雅居民广泛使用。在危地马拉高地和瓦哈卡高地，一些现代的玛雅人聚集区也仍在使用这种历法 。



8 The roots of Astronomy : MAYA
玛雅天文学

Although the Mesoamerican calendar did not originate with the Maya, their subsequent extensions and improvements of it were the most sophisticated.
尽管中美洲的历法不是最先由玛雅人制定的，但玛雅人对历法的扩充和完善却是最精细的。

Together with those of the Aztecs, the Maya calendars are the best documented and most comprehensive.
结合阿兹特克人的历法，玛雅历法是最全面和综合的。

8 The roots of Astronomy : AZTECAS 阿兹特克天文学

From the thirteenth century the Valley of Mexico was the heart of Aztec civilization
13世纪以来，墨西哥山谷就成为阿兹特克文明的心脏地带。

They were ethnic groups of central Mexico, particularly those groups who spoke the Nahuatl language dominated much of Mesoamerica in the fourteenth, fifteenth and sixteenth centuries, a period known as the last post-classic period in Mesoamerican chronology.
阿兹特克人是墨西哥中部的一个族群，他们主要说纳瓦特尔语，在后古典时期（公元 15~16 世纪）统治中美洲。

8 The roots of Astronomy : AZTECAS 阿兹特克天文学

The Aztec calendar is the oldest monolith that remains of pre-Hispanic culture. (approx. 1479).

刻有阿兹台克日历的最古老的石碑，前西班牙文化（约1479）

The calendar is circular with four concentric circles. In the center stands the face of Tonatiuh (Sun God) holding a knife in his mouth.

日历由四个同心圆组成中心刻有托纳蒂乌（太阳神）的脸，嘴里有一把匕首。

8 The roots of Astronomy : AZTECAS
阿兹特克天文学

The four suns or earlier eras are represented by square-shaped figures flanking the central sun. The outer circle consists of 20 areas representing the days of each of the 18 months that comprised the Aztec calendar.

周围有四个方形的太阳或史前“世界”环绕着中心的大太阳，外围的圆环被分成了20个区域，代表每个月有20天。

To complete the 365 days of the solar year, the Aztecs incorporated five fateful days or nemontemi.

阿兹特克历把一年分为 18 个月，为了补齐回归年的 365 天，阿兹特克人把每年的最后 5 天叫做牺牲日或凶日。

8 The roots of Astronomy : AZTECAS
阿兹特克天文学

The Aztecs grouped bright stars into constellations :
阿兹特克人把亮星划归成了不同的星座：
Mamalhuaztli (Orion's belt猎户座腰带),
Tianquiztli (the Pleiades昴星团),
Citlaltlachtli (Gemini双子座),
Citlalcolotl (Scorpion天蝎座) and
Xonecuilli (The Little Dipper or the Southern Cross for others小熊座或南十字座), etc.

Comets were called "the stars that smoke.“
彗星被称作“冒烟的星星”。

8 The roots of Astronomy : INCAS 印加天文学

The Inca civilization is a pre-Columbian Andean Group. It starts at the beginning of the thirteenth century in the basin of Cuzco in Peru and then extends along the Pacific Ocean and the Andes, covering the western part of South America.

印加文明是前哥伦布时期的安第斯文明。它起源于 13 世纪的秘鲁库斯科流域，沿太平洋和安第斯山脉发展，覆盖了南美洲西部。

At its peak, it extends from Colombia to Argentina and Chile, through Ecuador, Peru and Bolivia.

全盛时期印加文明的传播范围从哥伦比亚延伸到阿根廷和智利，跨越了厄瓜多尔、秘鲁和玻利维亚。

8 The roots of Astronomy : INCAS
印加天文学

The Incas used a solar calendar for agriculture and other of moon to religious holidays .
印加人在农业生产中运用阳历，在宗教节日中运用阴历。

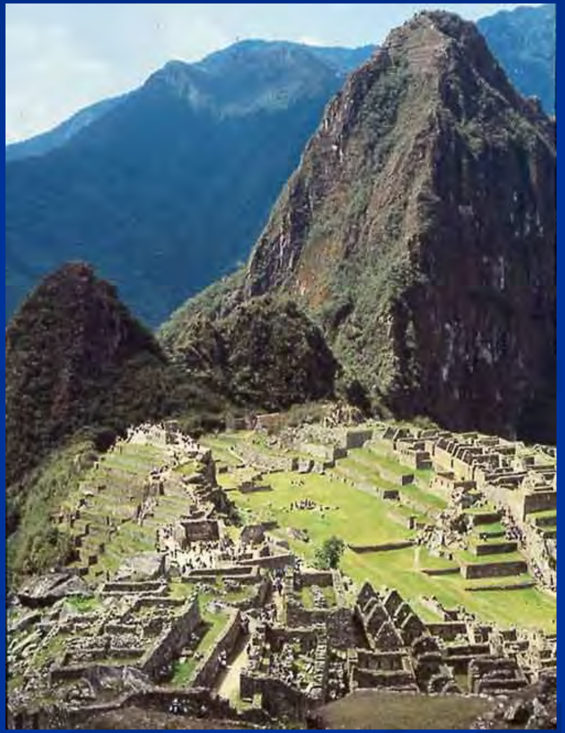
According to the chronicles of the Spanish conquistadors, on the outskirts of Cuzco was a large public calendar consists of 12 pillars of 5 meters, which could be seen from very far. With it, people could establish the date.
西班牙入侵者的编年志记载，在现今秘鲁库斯科的市郊曾有一个由12根5米高的立柱组成的巨大的公共日历，从远处就能看到。人们可以通过它来知晓日期。

8 The roots of Astronomy : INCAS 印加天文学

They celebrated two major parties, the Inti Raymi and Capac Raymi, the summer solstice and winter respectively. 印加人主要过两个节日，在夏至举行的太阳祭和冬至的丰年祭。

8 The roots of Astronomy : INCAS
印加天文学

The Incas considered their King, Sapa Inca, the "son of the Sun".
印加人尊称他们的国王萨帕·印卡为“太阳之子”。



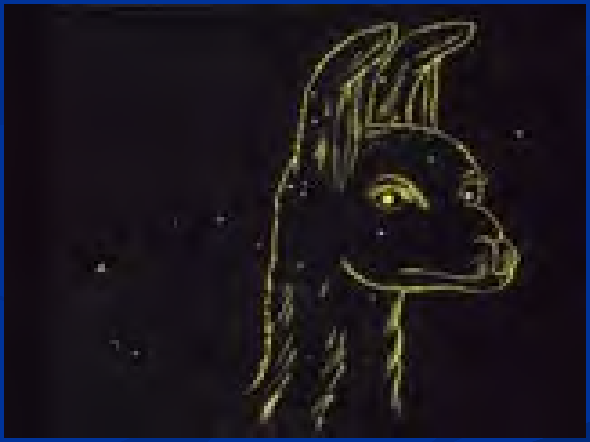
Major cities were drawn following celestial alignments using cardinal points.
主要的城市依据星空的排布可以用红点描绘出来。

They identified various dark areas or dark nebulae in the Milky Way as animals, “dark constellations,” and associated their appearance with the seasonal rains.
他的臣子将银河中的暗区和暗星云分成不同的动物，并把动物的出现和季节性降雨联系起来。

8 The roots of Astronomy : INCAS 印加天文学

The constellations, Yutu, one of the dark constellations, and the Flame of Heaven, were used by the Incas to keep pace with the seasons and events to mark the sacred events.

星座，如玉兔、天火，是印加人用来保持季节与重要事件的同步。



For example: In ancient Peru, sacrifices and black colored fires were scheduled for April and October, when the 'eyes of the Flame of Heaven' "Alpha and Beta Centauri" were opposed to and close to the Sun.

例如，在古代的秘鲁，每年4月和10月都会准备祭品和黑色的火焰，此时，“天火的眼睛”与“半人马双子”会彼此相对出现在太阳附近。

8 The roots of Astronomy：CHINA 中国古代天文学

The Chinese could be considered as the most persistent and accurate observers of celestial phenomena before the Arabs. 在阿拉伯人以前，中国被认为是最持久的和最精确记录天象的国家。

Detailed records of astronomical observations began during the 4th century BC. Elements of Indian astronomy reached China with the expansion of Buddhism during the dynasty of Later Han (25-220 AD), but more detailed incorporation of Indian astronomical thinking occurred during the dynasty of Tang (618-907)
最早的天文观测记录始于战国时期（公元前4世纪）。一些印度天文学的元素随着佛教从东汉（公元 25 - 220 年）传入中国，并在唐朝 （618 – 907 年）达到顶峰

8 The roots of Astronomy： CHINA 中国古代天文学

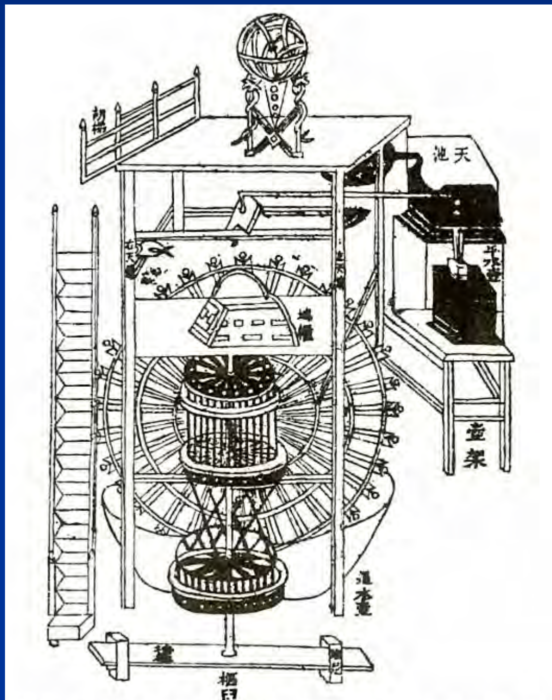


Fig. 651. General diagram of the works (*Hsin I Hsiang Fa Yao*, ch. 3, p. 4*a*). On the right, the upper reservoir tank (*thien chhih*) with the constant-level tank (*phing shui hu*) beneath it. In the centre, foreground, the 'earth horizon' box (*ti kuei*) in which the celestial globe is mounted; below, the time-keeping shaft and wheels supported in the mortar-shaped end-bearing (*shu chiu*). Behind, the main driving-wheel with its spokes and scoops; above, the left and right upper locks (*tso yu thien so*) with the upper balancing lever and upper link, curiously drawn, still higher.

Astronomy was revitalized under the stimulus of cosmology and Western technology after the Jesuits established their missions in the 16th century.
16世纪，随着耶稣传教使团的到来，中国天文学受到西方天文学和技术的冲击而再次复苏

<u>Tools 工具：</u>

Armillary sphere 浑仪
Celestial globe 天球仪
Sphere of hydraulic fittings水运仪
Celestial globe tower 天球塔

The telescope was introduced in the seventeenth century.
望远镜于17世纪被引入中国。

8 The roots of Astronomy：CHINA 中国古代天文学

Chinese scientist Shen Kuo (1031-1095) was the first to:
- describe the magnetic compass needle
- make an accurate measurement of the distance between the pole star and true north to be used in navigation

博学的中国科学家沈括（公元 1031 – 1095 年）不仅是历史上第一个描绘地磁偏角的人，还为了便于航海，准确的测量了北极星和真正的北天极之间的距离。

8 The roots of Astronomy：CHINA 中国古代天文学

Shen Kuo and Wei Pu established a nighttime astronomical project in a period of five consecutive years, a job that could rival the observations of Tycho Brahe. For this project also drew the exact coordinates of the planets in a star map and created theories of planetary motion, including retrograde motion.

沈括和卫朴经过五年连续的奋斗，建立了一个夜间天文观测项目，它的成果可以与后来欧洲第谷的工作相媲美。通过这个项目，他们在星图上绘制了行星的准确坐标并创立了包括逆行在内的行星运动理论。

8 The roots of Astronomy： CHINA

中国古代天文学

Chinese astronomy focused on observation.
相较于理论，中国天文学更重视观测。
They had data from the year 4000 BC, including the explosion of supernovas, eclipses and the appearance of comets.
中国的观测数据始于公元前4000年，有关超新星爆发、日月食、彗星等。

- at 2,100 B.C. they recorded a solar eclipse
- 公元前 2100 年记录了一次日食 。
- at 1,200 B.C. they described sunspots, calling them "*dark spots*" in the Sun.
- 公元前 1200 年记录了太阳黑子，称之为太阳里的“暗斑” 。
- at 532 B.C. They noted the appearance of a *supernova* in the constellation Aquila
- 公元前 532 年记录了天鹰座诞生了一颗超新星。
- at 240 and 164 B.C. observed Comet Halley
- 公元前 240 年和 164 年记录了哈雷彗星过境。

8 The roots of Astronomy： CHINA
中国古代天文学

Other observations:
其他观测记录：

- determined the *precession* of the *equinoxes* in one degree every 50 years
- 进入公历纪元后，中国人确定了二分点的岁差为每 50 年 1 度。
- they observed that comet tails always point in the opposite direction to the sun's position
- 发现了彗尾总是背向太阳。

8 The roots of Astronomy：CHINA 中国古代天文学

- in 1006 A.D. they noted the appearance of a supernova so bright that you could see at day
- 公元 1006 年，中国人记录了一颗在白天都可见的十分明亮的超新星，它是有史以来最亮的一颗 。
- in 1054, they observed the explosion of a supernova, which later gave rise to the *Crab Nebula*
- 1054 年观测到了一颗超新星，现在这颗超新星的遗迹被称为蟹状星云。

Many Thanks
for your attention!
谢谢！