The Solar System
太阳系

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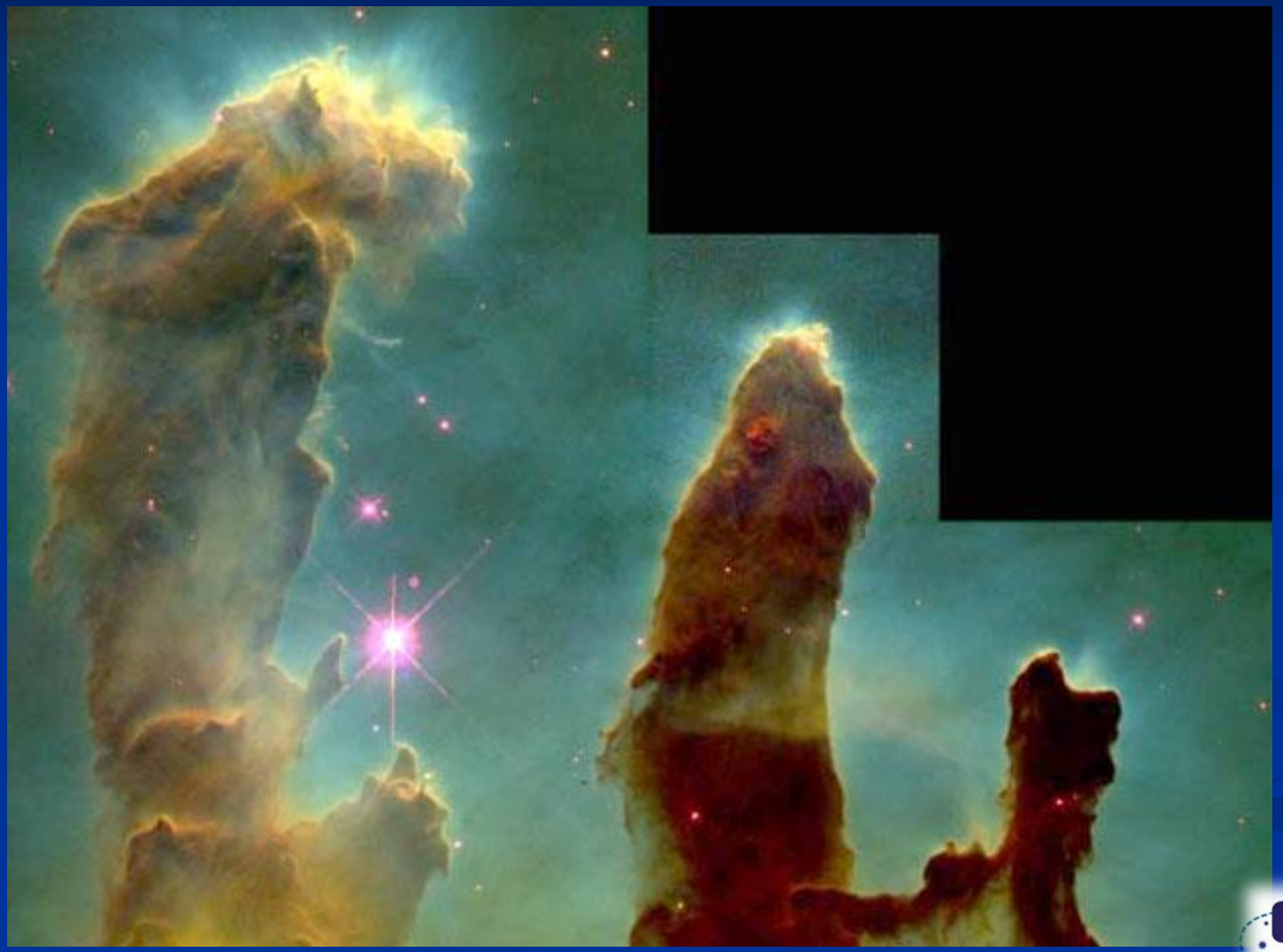
Here is where stars are born
恒星诞生之处



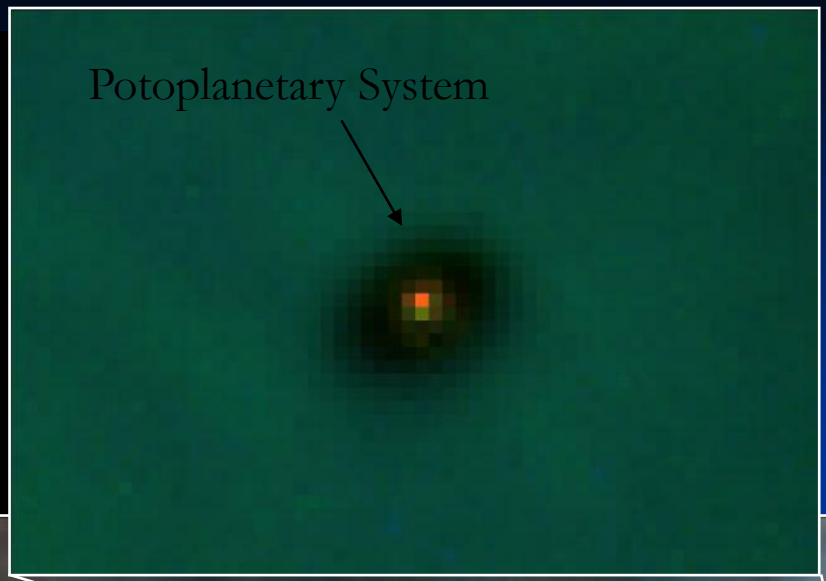
Messier 16, Pillars of creation.
Credit: Hubble Space Telescope

The Orion Nebula

猎户星云

and here

看这里！



The planets in the past: the naked eyes visibles
过去，用肉眼观测行星

水星Mercury
金星Venus
Mars火星
Jupiter木星
Saturne土星

Visible at sunset or surise
在日落或日出时可见

Planetary alignement, May- 2002

The Solar System today 今天的太阳系

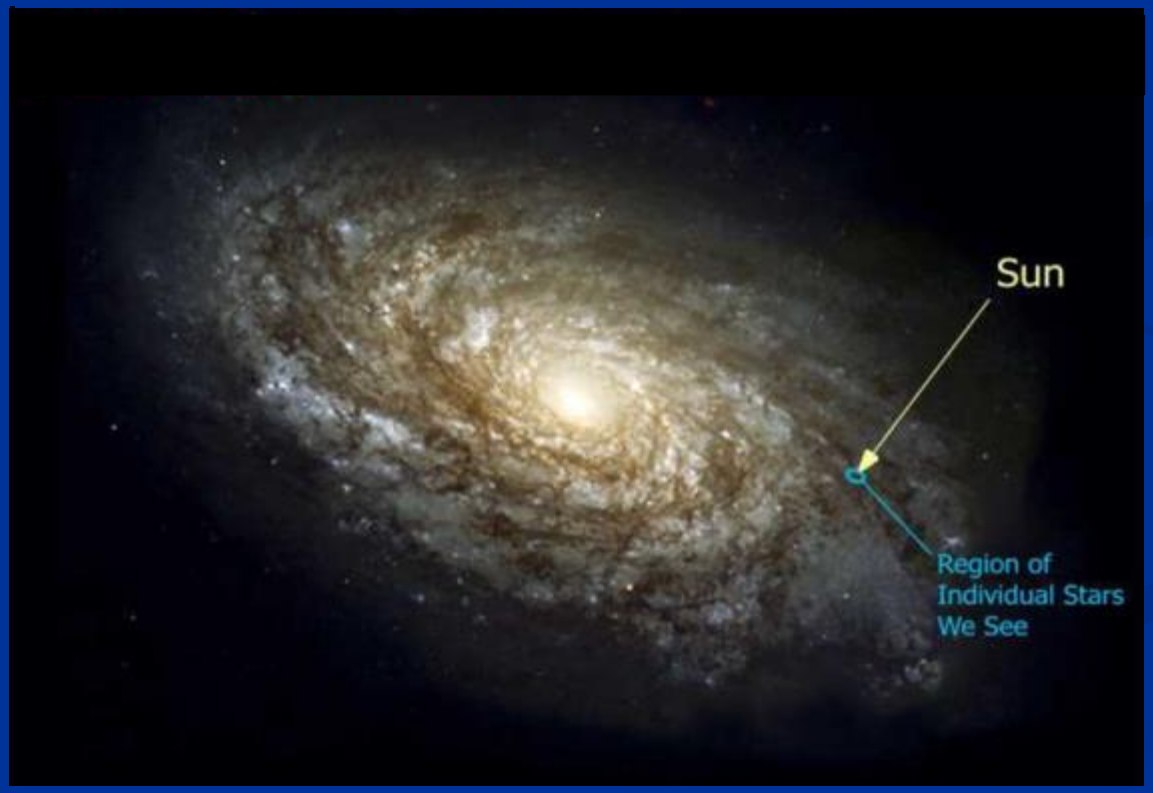
It is constituted by the Sun and all the bodies that revolve around it, under the action of gravity:受引力作用，太阳系由太阳和围绕太阳旋转的所有天体构成：

- 8 planets 8大行星
- Hundred of natural satellites of planets数百颗行星的自然卫星
- Tenths of dwarf planets (between them Ceres, Pluto, Haumea, Makemake and Eris)矮行星（谷神星、冥王星、妊神星、鸟神星和阋神星）
- An unknown number of minor bodies: asteroids, comets and transneptunians (debris of the processes of the planet formation).未知数量的小天体：小行星、彗星和海外天体（行星形成过程的碎片）。

Where is the Solar System?
太阳系在哪？

It is in Orion arm, one of the Milky Way arms.

太阳系位于猎户臂上，这是银河系的一条旋臂。



The Milky Way has about 200,000 millions of stars and its diameters is about 100,000 l.y.

银河系有大约2千亿颗恒星，直径约为10万光年

The Solar System is located at a distance of ~25,000 light years from the center of the Galaxy (~ half the radius), and takes 250 millions years to complete a rotation around the center. The speed is 220 km/s (800.000 km/h)太阳系距离银河系中心约25,000光年（是银河系半径的一半距离），需要2.5亿年绕银心公转一周，速度为220 km / s（800.000 km / h）

Model of the Milky Way, from the infrared observations by Spitzer (2005); our Galaxy is a barred spiral.
左侧为银河系模型;是根据斯皮策红外望远镜（2005）在红外波段的观测得到的， 可见我们的银河系是一个棒旋星系。

Solar System formation 太阳系的形成

- According to the standard theory, about 4.6 billion years ago the solar system was formed from the gravitational contraction of an interstellar gas and dust cloud. The collapse of the cloud started from a strong perturbation (possibly a supernova burst), which caused the gravitational force to overcome the pressure of the gases.

根据标准理论，大约在46亿年前，星际气体和尘云受到引力作用，开始塌缩，从而形成太阳系。尘云的塌缩是受到了强烈的扰动（可能是超新星爆发）才开始的，这导致了重力作用超过了气体压力的作用。

Solar System formation 太阳系的形成

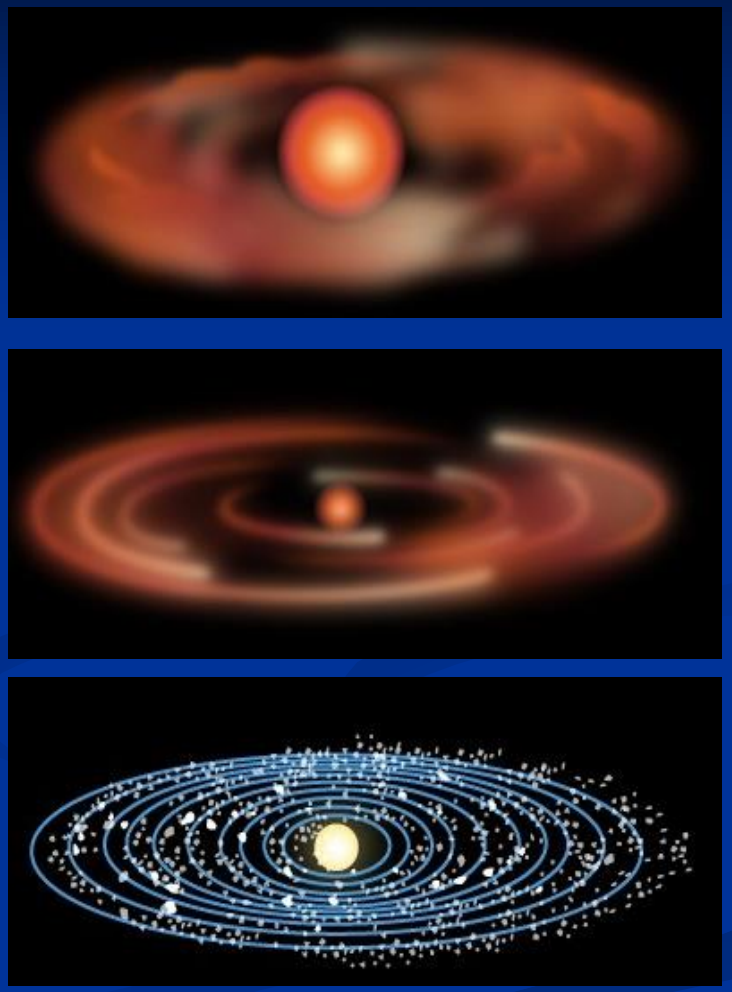
- The conservation of the angular momentum caused the nebula to turn faster and faster, to flatten out, and to give rise to a protosol at its center, and to a protoplanetary disk of gas and dust around it.

角动量守恒使得星云转得越来越快，也不断变平，后来，在中心形成了一个原太阳，并在它周围形成一个由气体和尘埃构成的原行星盘。

Solar System formation 太阳系的形成

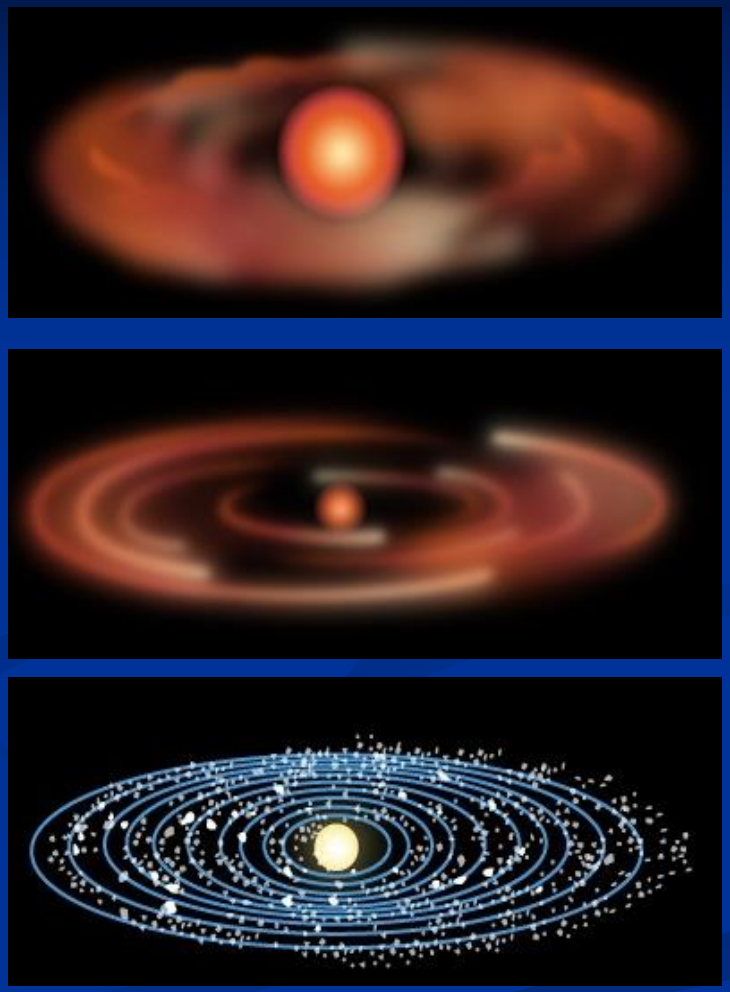
- In the protoplanetary disk condensed small solid nuclei (planetesimals), which then were accumulated by an accretion process to form the planets.

在原行星盘上凝聚了小的固体核（星子），它们会通过吸积过程，一步步积累形成行星。



Solar System formation 太阳系的形成

- The standard theory described above is accepted for having found, through high resolution radio images, protoplanetary systems around many young stars and due to the possibility of explaining the formation of planets within those systems.
  上面描述的标准理论已经被广为接受，因为通过高分辨率的射电图像，已经发现了很多年轻恒星周围的原行星系统，而且标准理论也能够解释那些系统中行星的形成。

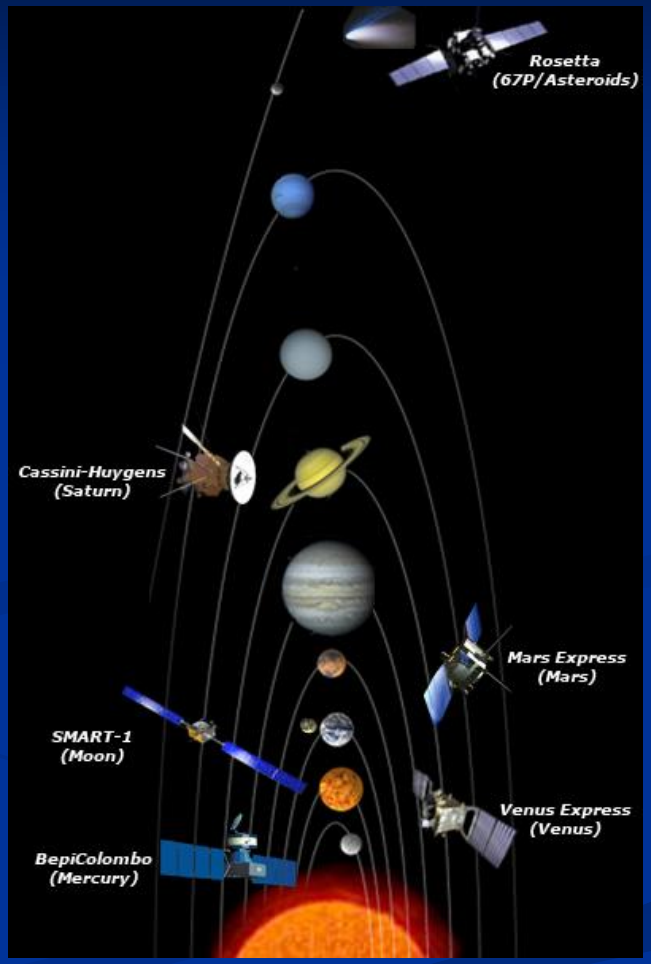


- **Confirmed in the last years by observations of several planetary systems around other stars.在过去几年中，通过对其他恒星周围的行星系统的观测证实了上述理论。**

Solar System Studies 太阳系的研究

The Sun concentrates more than 99.8% of the mass of the SS, while 98% of the angular momentum is found in the orbital movements of the planets.
太阳系中99.8%以上的质量集中在太阳上，而98%的角动量分布于行星的轨道运动中。

Currently, the study of solar system bodies is done from Earth, but also through space telescopes, sending missions to space and even descending on its surface.
目前，对太阳系天体的研究不仅在地面上开展，太空望远镜也在同时进行观测，科学家将探测器发送到太空甚至在天体表面降落。



Credit: NASA

Our star: The Sun
我们的恒星:太阳

- With an age of 4,600 million years, the Sun is approximately in the middle of its life cycle.

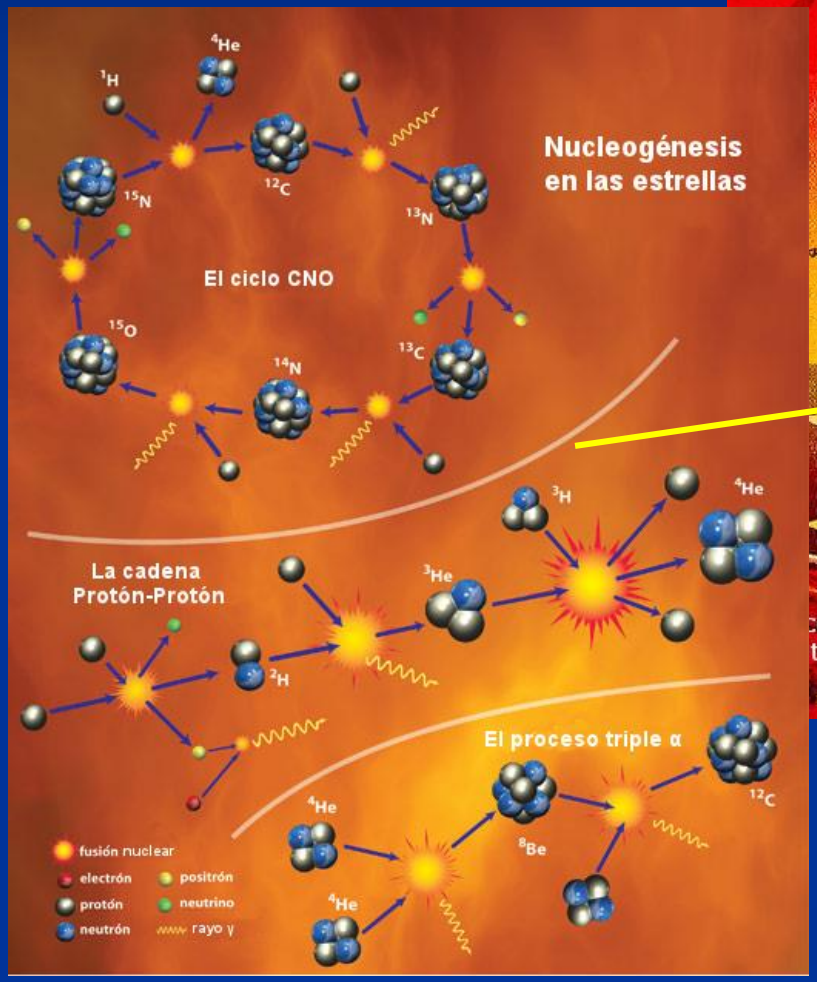
太阳年龄为46亿年，正处于中年期。

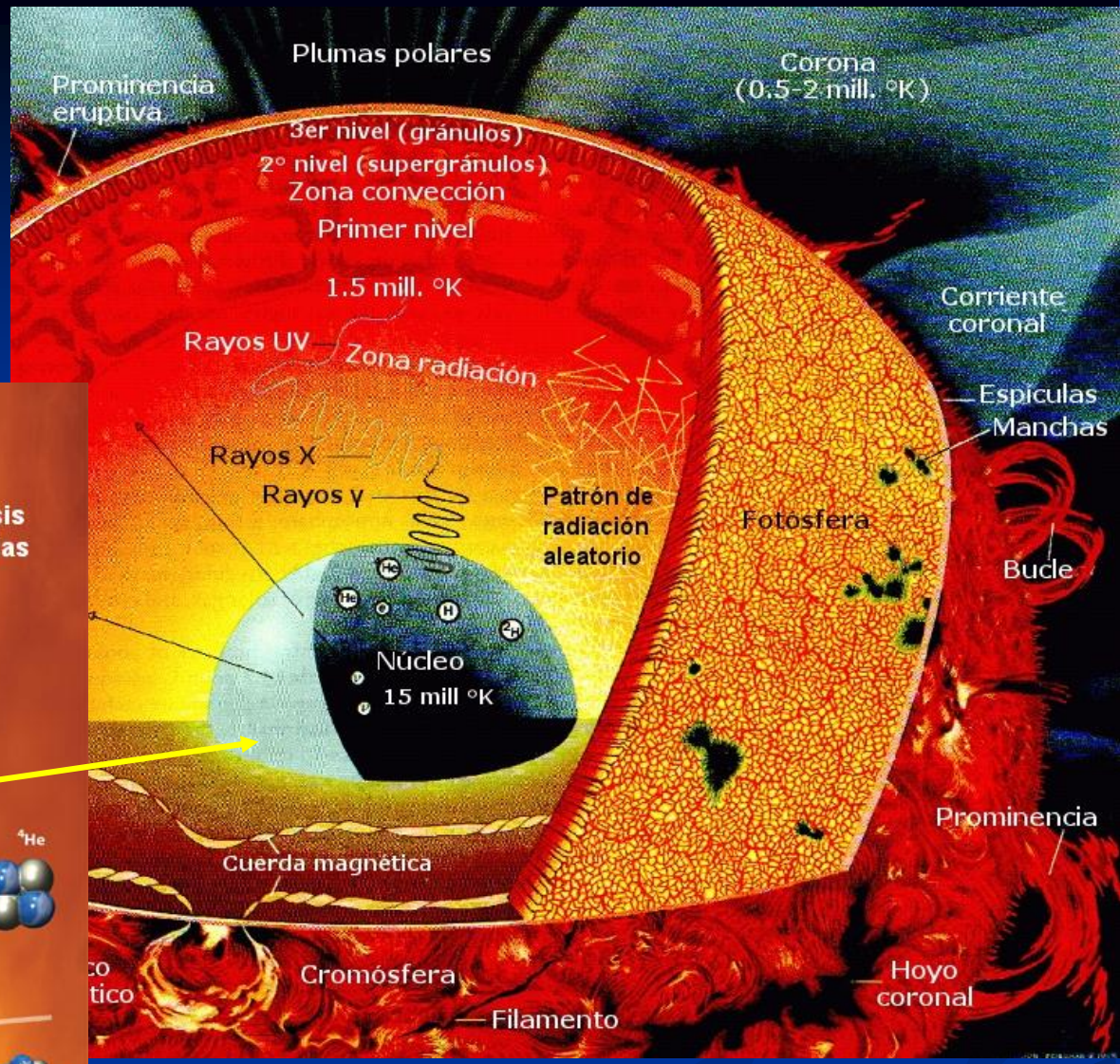
- Every second, in the Sun's core, 4 million tons of matter are converted into energy, generating a large number of neutrinos, positrons and radiation.

太阳中心每秒有4百万吨的物质被转换成能量，产生大量的中微子和辐射。

74% of the Sun is H, 25% is He, the rest are heaviest elements.太阳组分：74%氢，25%氦，其余为重元素

Sun structure
太阳的结构

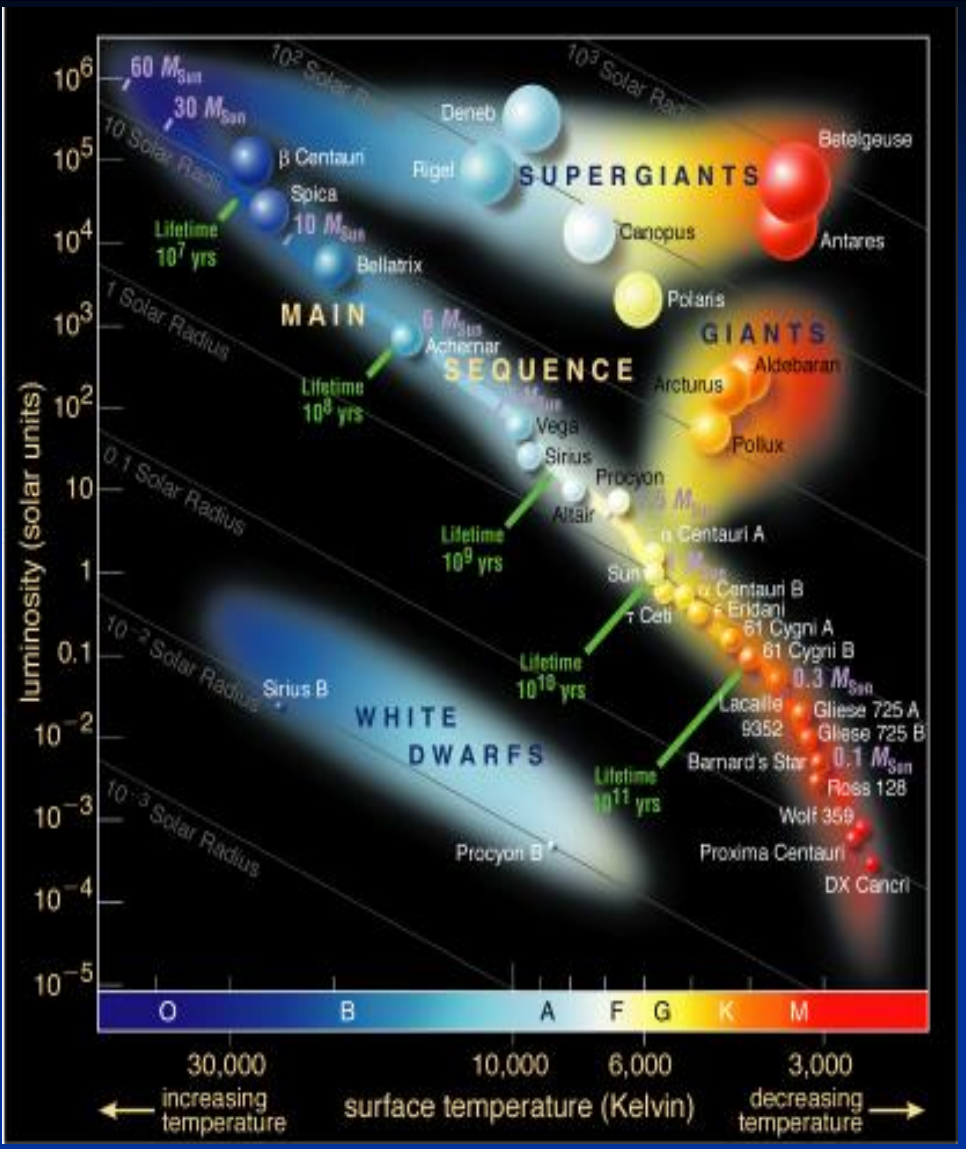


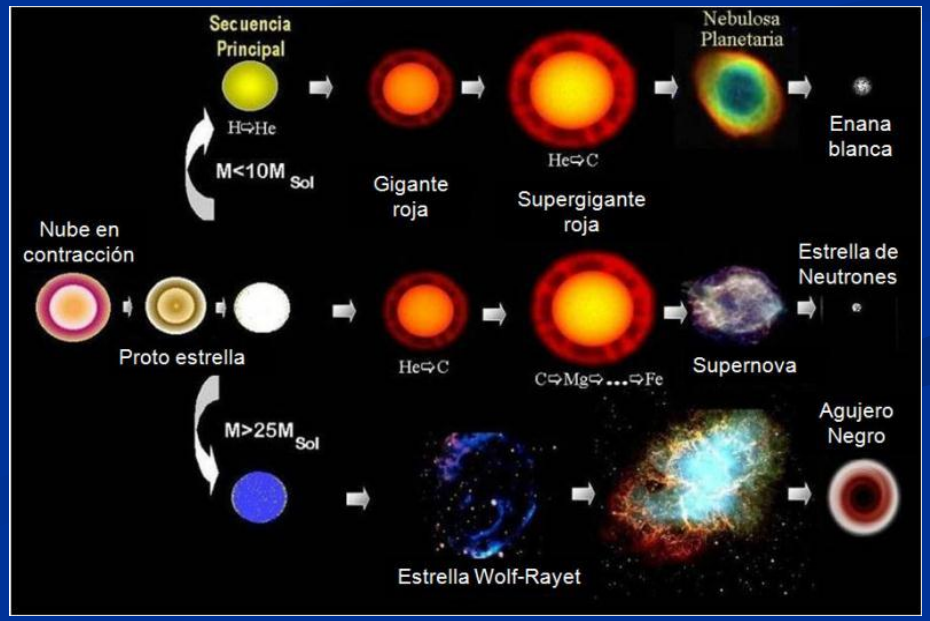


Energy production: fusion in the core.能源来源：核心聚变

The life of the stars depens on their masses

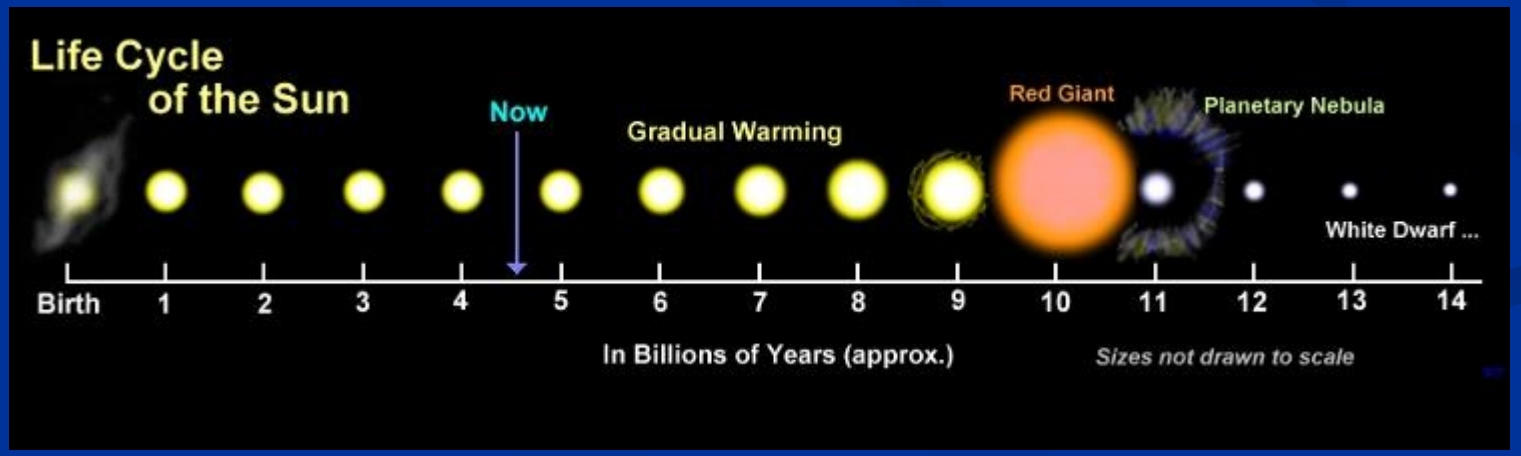
恒星一生的演化与其质量相关





Life cycle of the Sun 太阳的一生

Within 5,000 million years, the Sun will swell and become a red giant. Then it will expel the outer layers, creating a planetary nebula, and in the center there will be a small star called white dwarf, which will slowly cool down.
50亿年后，太阳将成为一个红巨星，它将抛射出它的外层，随后变成一个行星状星云，内核将变成一颗小小的白矮星，缓慢地冷却。



The Planets 行星

XXVI IAU-AG Resolution, Praha, 2006:

In the SS, a "planet" It is a celestial body that: 太阳系中，"行星"的定义是：

- It is in orbit around the Sun. 围绕太阳转
- It has enough mass for its self-gravity (which is a central force) to impose itself on the cohesive forces of a rigid body so that it assumes a form in hydrostatic (quasi-spherical) equilibrium. 质量足够大，来克服固体引力以达到流体静力平衡的形状（近于球体）
- It has cleared other objects the neighborhood along its orbit. 清除轨道附近区域

The Planets 行星

XXVI IAU-AG Resolution, Praha, 2006:

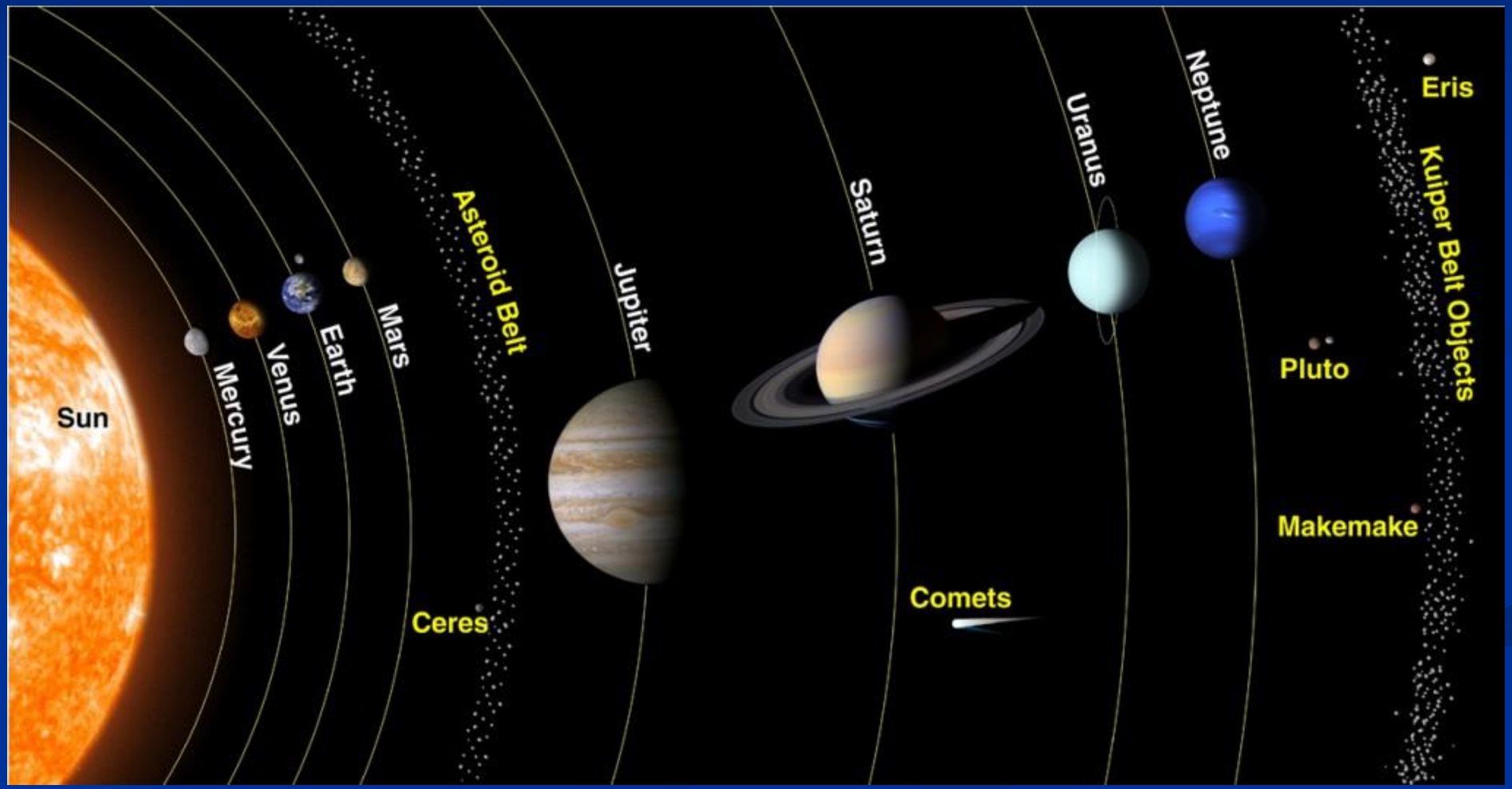
A body that meets only the first two criteria, and that is not a satellite, is classified as a "dwarf planet".

只符合前两个标准的天体，且不是卫星，被归类为“矮行星”。

A body that meets only the first criteria, and that is not a satellite, is called "small body (or minor body) of the SS.

只符合第一个标准的天体，且不是卫星，被称为“太阳系小天体”

The Solar System today
今天的太阳系
(bodies in size scale)

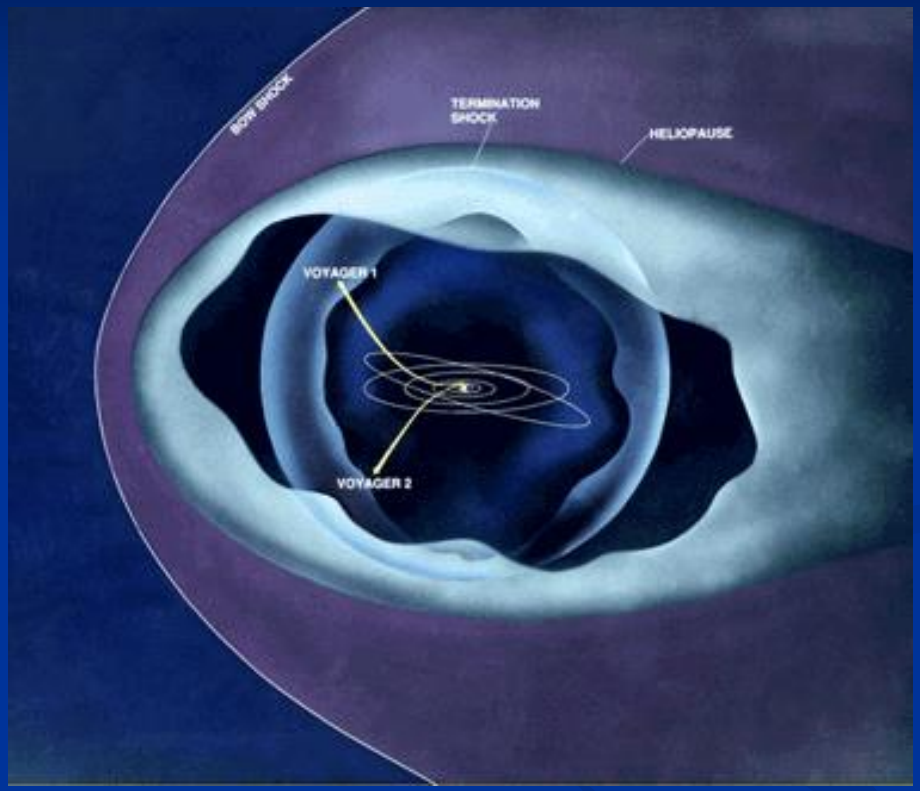


The limit of the Solar System
太阳系的边界

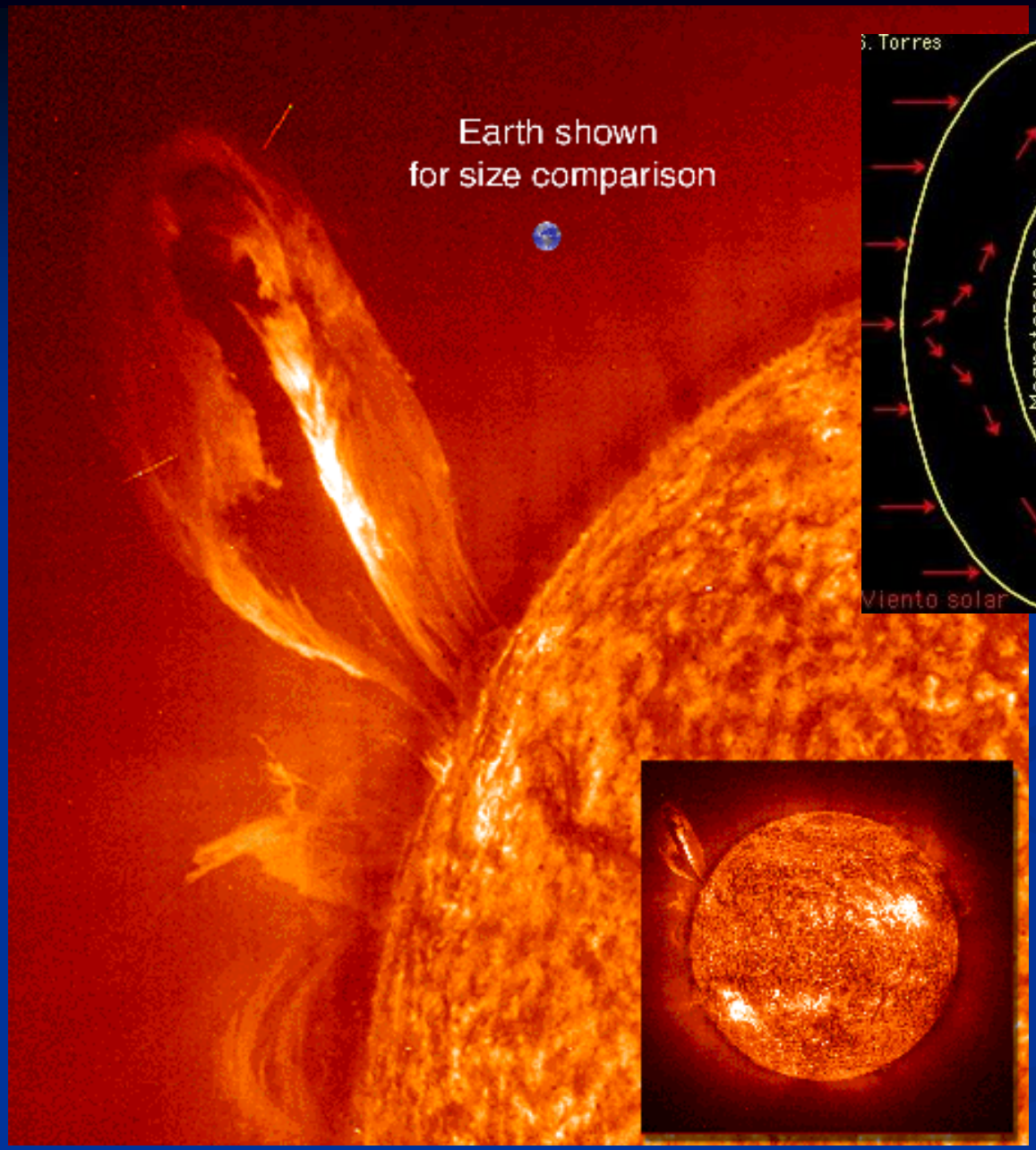
All planetary orbits lie within the Heliosphere, a region of space that contains magnetic fields and plasma ("wind") of solar origin.所有的行星轨道都在日球层内，这是一个充斥着太阳磁场和等离子体（太阳风）的空间区域。

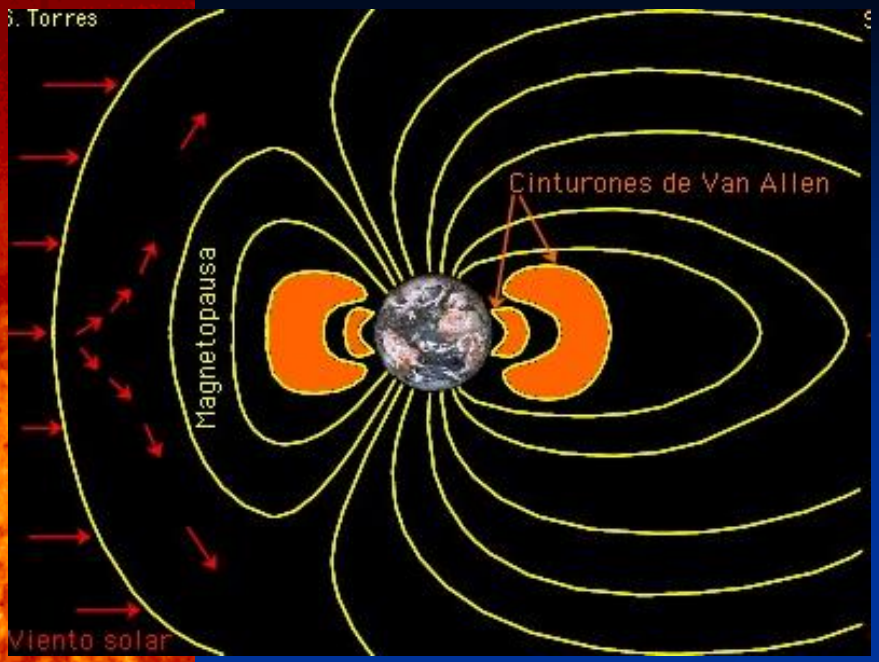
The Heliopause is the limit of the Heliosphere, where the solar wind merges with the interstellar medium.

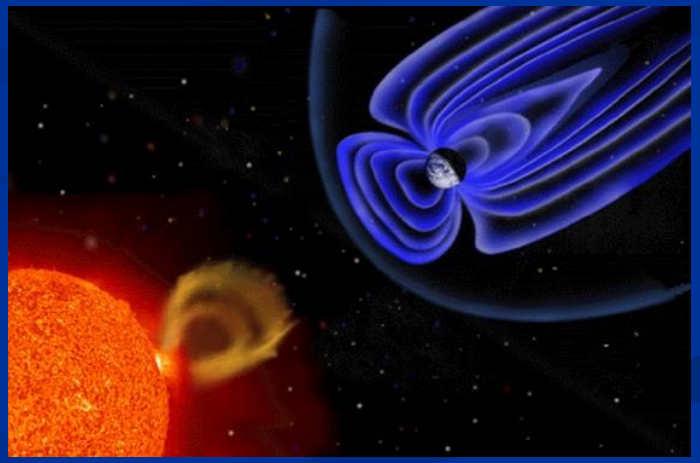
日球层顶是日球层的边界，在那儿太阳风会与星际介质交融。



In 2012, the Voyager 1 space probe crossed the Heliopause at a heliocentric distance of more than 100 A.U. 2012年旅行者1号穿过了日球层，距离日心100 A.U.以上。



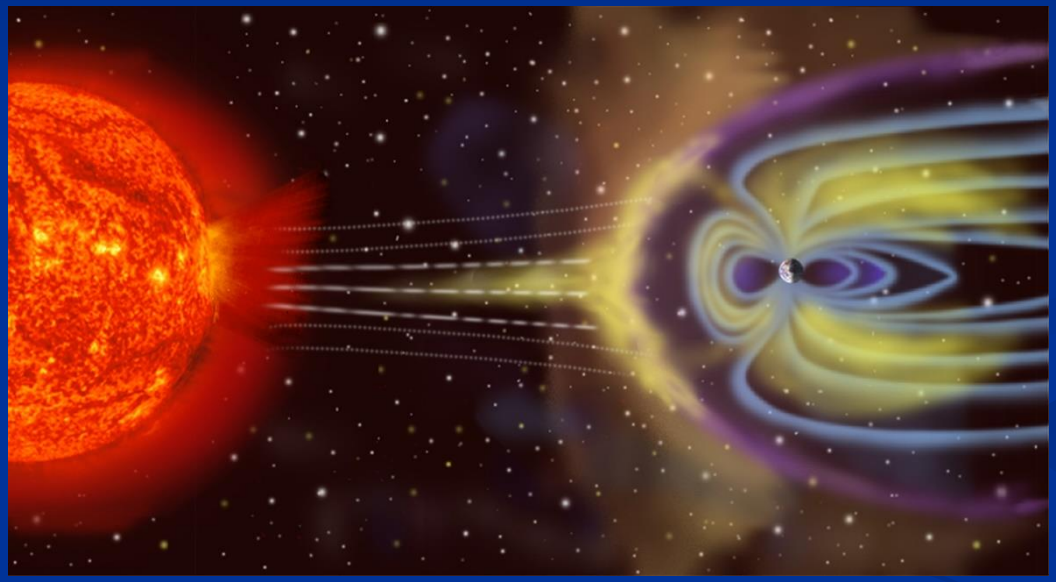




Sun-Earth environment 日地空间环境

The Interplanetary Medium 行星际介质

The Sun emits electromagnetic radiation and solar wind (a continuous flow of charged particles, plasma).
太阳发出电磁辐射和太阳风（连续的带电粒子流，等离子体）。



This dissipates at a speed of 1.5 million km / h, creating the heliosphere, a fine atmosphere that bathes the entire SS up to approx. 100 A.U., marking the heliopause.
太阳风速度达150万公里/小时，吹出了一个半径为100AU的稀薄气泡，包裹了太阳系的主要天体。

The Earth‘s magnetic field protects the atmosphere from the solar wind and gives rise to the polar auroras (boreal and austral)地球的磁场保护地球大气免受太阳风的影响，并产生极光（北极和南极）

The heliosphere ensures a partial protection to the SS of the cosmic rays, protection that is stronger in the planets with magnetic field.日球层也能部分地保护太阳系免受宇宙线的攻击，而有磁场的行星受到的保护更强。

The “space weather” is monitoring 24 hs
“太空天气”24小时监测

SpaceWeather.com -- News and information about meteor showers, solar flares, auroras, and near-Earth asteroids - Mozilla Firefox

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http://www.spaceweather.com/

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spaceweather.com

News and information about the Sun-Earth environment

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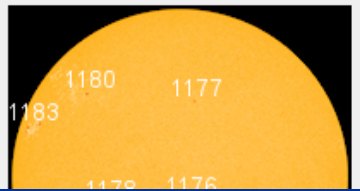
Current Conditions

Solar wind
speed: **347.4** km/sec
density: **1.1** protons/cm^3
explanation | more data
Updated: Today at 0546 UT

X-ray Solar Flares
6-hr max: **B8** 0032 UT Mar29
24-hr: **B8** 0032 UT Mar29
explanation | more data
Updated: Today at: 0500 UT

Daily Sun: 28 Mar 11



What's up in space

Tuesday, Mar. 29, 2011

Metallic photos of the sun by renowned photographer Greg Piepol bring together the best of art and science. Buy one or a whole set. They make a stellar gift.

SOLAR RADIO STORM: Did you know sunspots can make noise? Consider the following: "Over the past few days, I have been recording a sustained solar radio storm at 180 MHz," reports amateur radio astronomer Thomas Ashcraft of New Mexico. "It consists of Type I radio bursts and sounds like ocean surf. Here is an audio sample from March 27th at 1930 UT. The sun seems to be entering a new phase of dynamism."

Radio emissions like these are caused by plasma instabilities in the sun's atmosphere above sunspots. With the sun becoming 'radio-active,' it's no coincidence that sunspots are emerging in abundance. Leading the way is behemoth active region AR1176, shown here in a photo taken yesterday by Larry Alvarez of Flower Mound, Texas:

archives
March
29
2011
view

space toys.com

Averted Imagination
ASTROPHOTOGRAPHY

The Planets 行星

The 8 planets of our SS can be divided into:八大行星分类：

- 4 Earth planets, in the innermost region (Mercury, Venus, Earth and Mars). Rocky, with approximate densities between 4 and 5 g / cm^3.

4个类地行星，位于内部区域（水星、金星、地球和火星），岩质，密度在4~5 g / cm^3

- 4 Giant planets, in the outermost region, which in turn are divided into:4个巨行星，在外部区域，可进一步分类：
  - Gaseous Giants: Jupiter and Saturn. Richer in H and He, with a chemical composition similar to solar.气态巨行星：木星和土星。富含H和He，化学成分类似于太阳。
  - Ice Giants: Uranus and Neptune. Ice predominates with respect to gases. Its chemical composition differs a lot from solar.冰质巨行星：天王星和海王星。冰占主导 。化学成分与太阳有很大区别。

They were not formed "in situ", there was a migration caused by the exchange of angular momentum between the giant planets in formation and the planetesimals that were swept to other regions of the SS or ejected from the SS

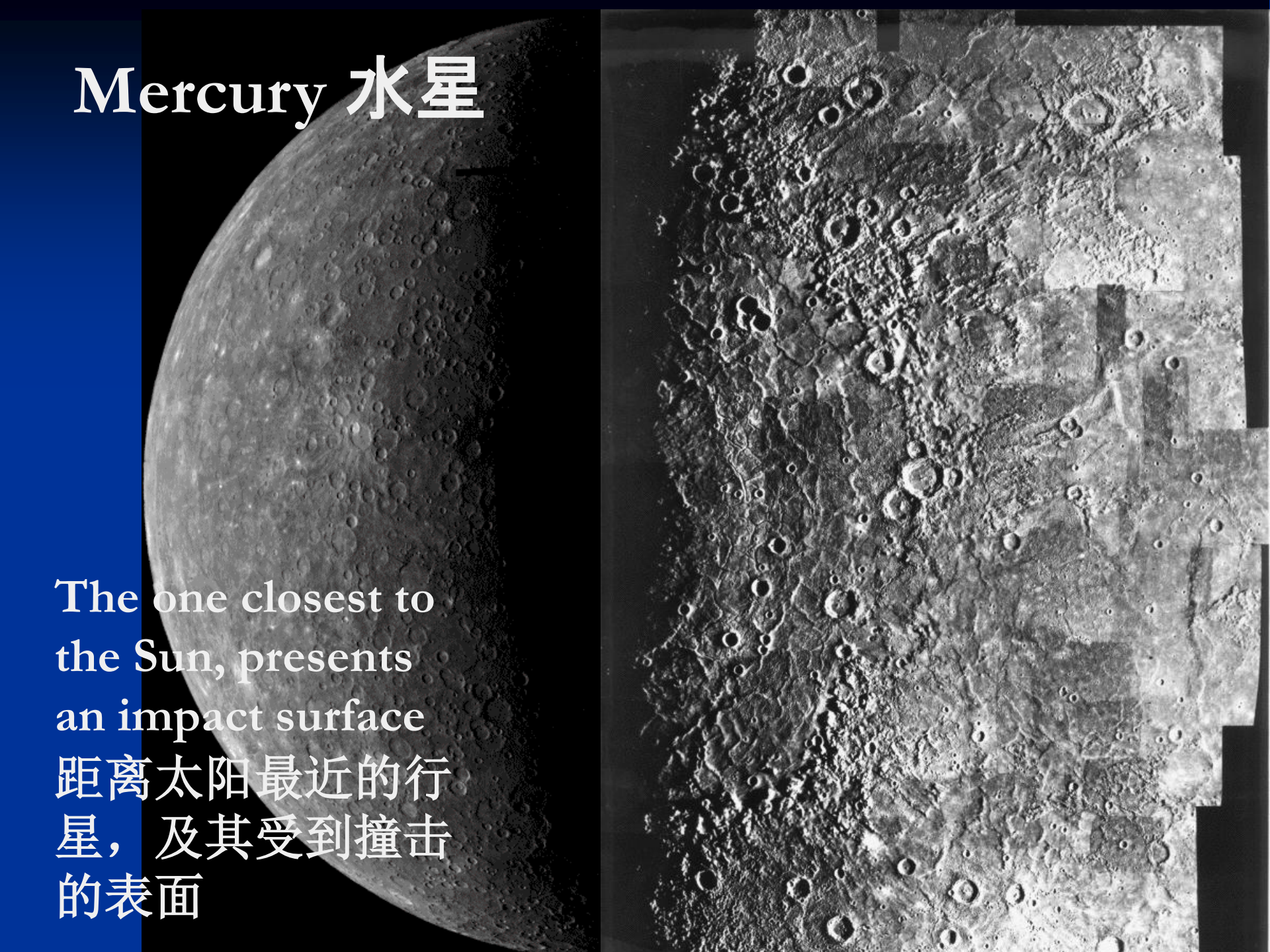
它们不是“原地”形成的，而是迁移来的：巨行星在形成过程中的角动量交换会导致其移动，而且星子也曾被太阳系其他区域弹出或俘获。

Earth 地球

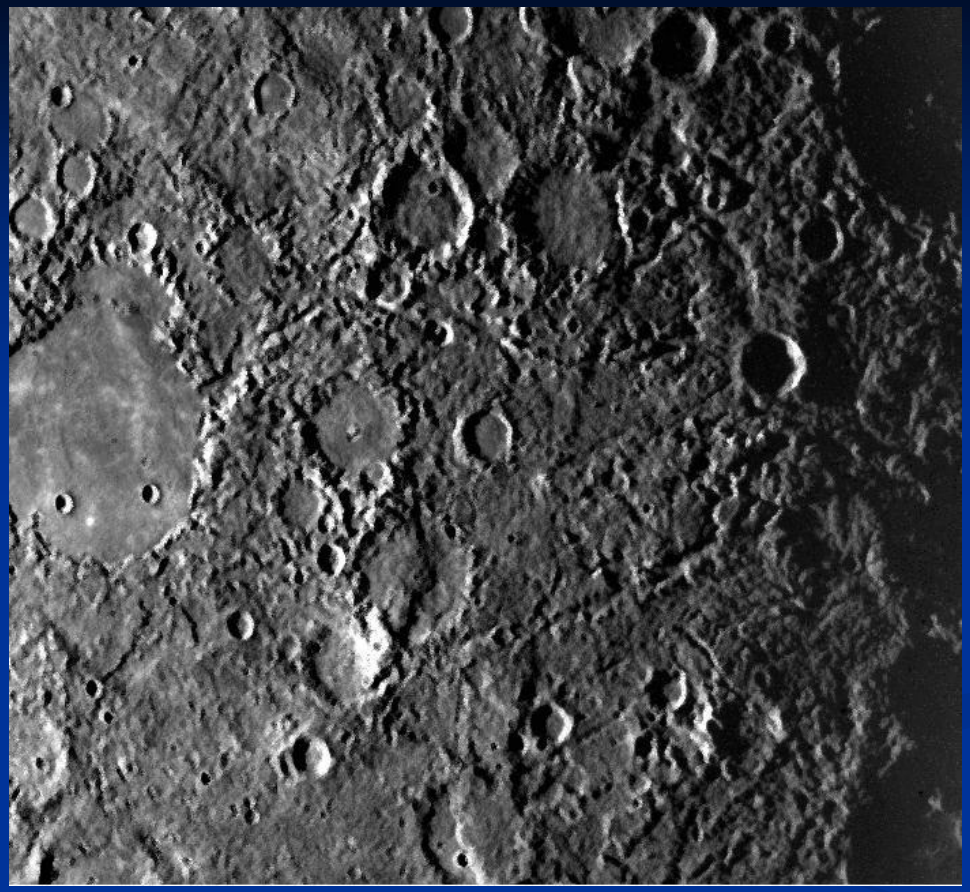
Earth-Moon system, photographed by the Galileo spacecraft, on its way to Jupiter (1998)
地月系统。这是由前往木星路上的伽利略号拍摄的（1998年）

April 12, 1961
First circumnavigation flight to Earth by Yuri Gagarin
1961年4月12日，第一次进入太空环绕地球飞行
尤里·加加林

Mercury 水星



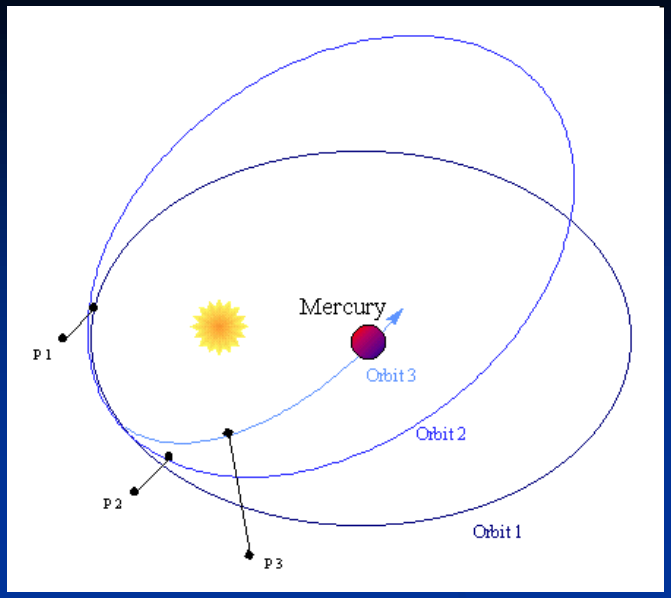
The one closest to the Sun, presents an impact surface
距离太阳最近的行星，及其受到撞击的表面



The most important crater is "Caloris Basin" (1,500 km in diameter): the impact that originated it produced waves that broke the surface at the antipodes.

最著名的环形山是“卡路里盆地”（直径1500公里）：一次撞击带来的冲击毁坏了原始的表面结构，形成了现在的样子。

The precession of perihelion of Mercury水星近日点的进动

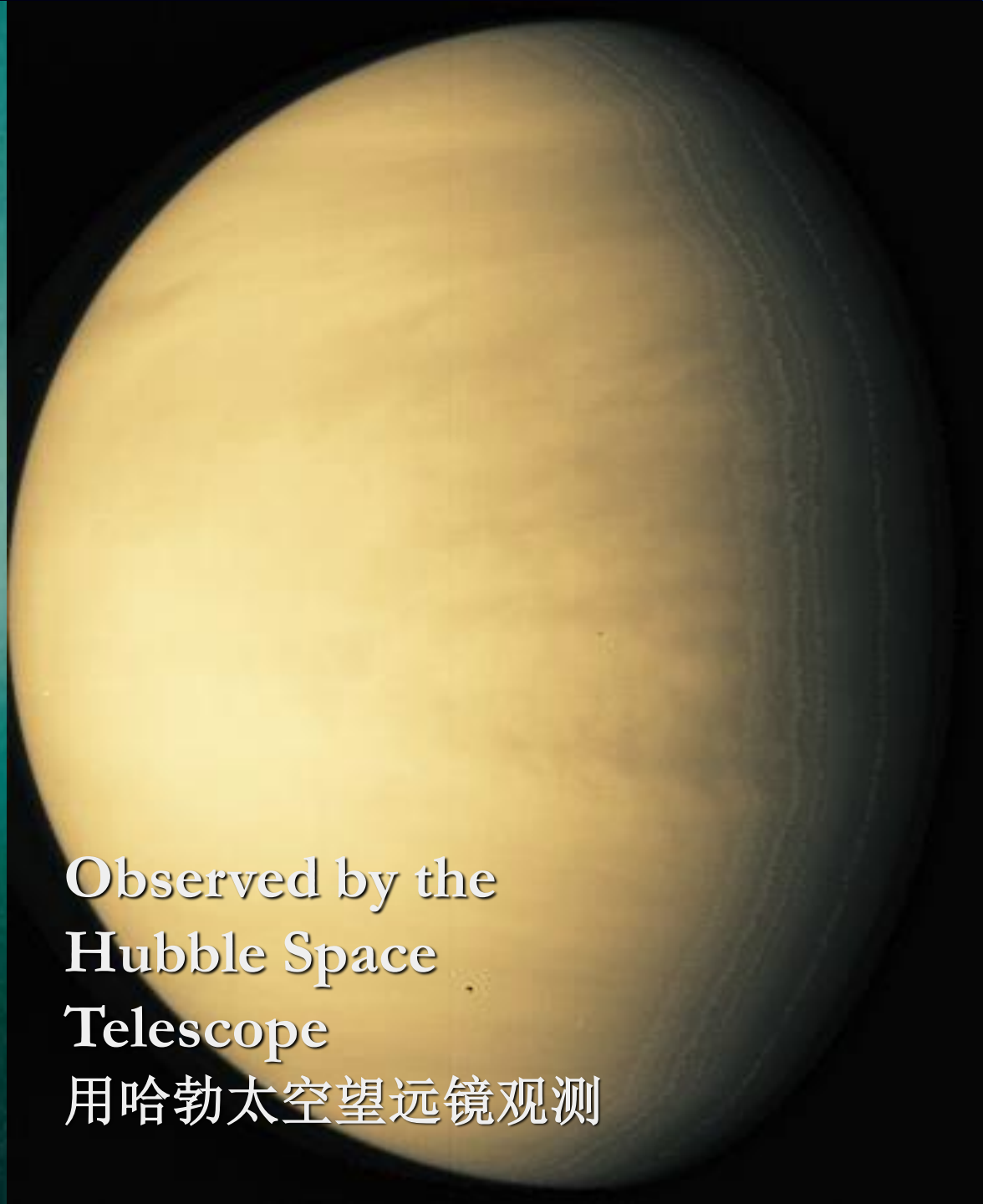


The precession of Mercury's perihelion is faster than the predictions of Newton's classical celestial mechanics.
水星近日点的进动速度比经典力学预言的要快。

That advance of perihelion was predicted by Einstein's General Theory of Relativity.
It is due to the curvature of the space caused by the Sun. It was a definitive proof of that Theory.
用爱因斯坦的广义相对论可以成功解释水星近日点的进动，认证了天体的质量引起的空间弯曲。

Venus 金星

Observed on Earth with an small telescope
在地球上用小望远镜观测



Observed by the Hubble Space Telescope
用哈勃太空望远镜观测

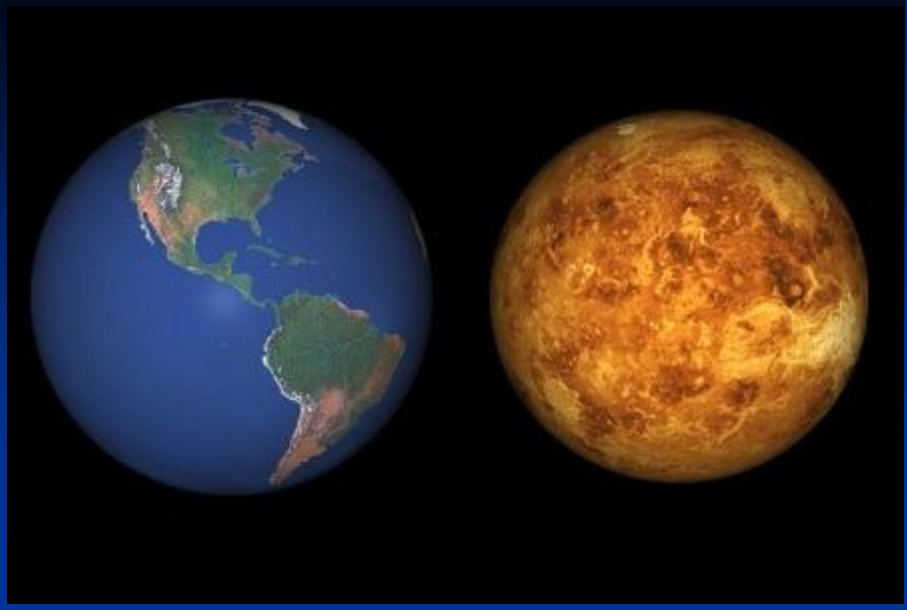
VENERA (1976)

Magellans (1990-1994)

With dimensions and geological structure similar to those of the Earth, it was visited by several missions

由于金星大小和地质结构与地球相似，所以已有多个太空探测器对其探访

Venus and Uranus are the only planets with retrograde movement (they turn on themselves in the opposite direction to how they revolve around the Sun).金星和天王星是唯一逆行的行星（自转与公转方向相反）。

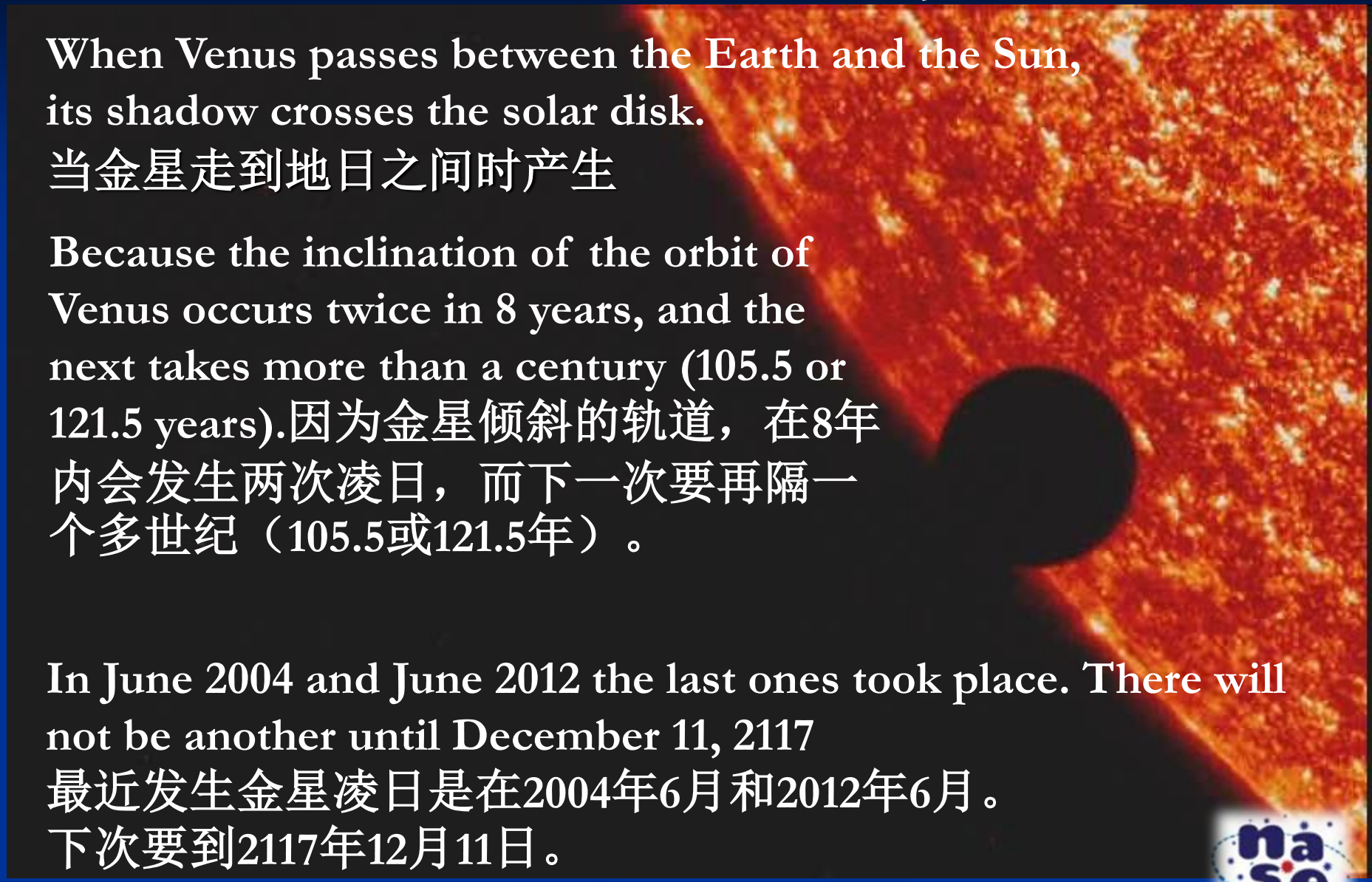


- Venusian year金星年 = 224 Earth days地球日
- Venusian day金星日 = 243 Earth days地球日

The mixture of CO_2 and dense clouds of sulfur dioxide create the greatest greenhouse effect of the entire SS, with temperatures reaching 460º C, higher than that of Mercury.二氧化碳和稠密的二氧化硫云的混合物在金星上造出了整个太阳系最大的温室，温度达到460摄氏度，比水星还高。

The atmospheric pressure is 100 times the Earth's pressure, there are clouds and perhaps rain of sulfuric acid.金星上大气压力是地球上的的100倍。金星上有云层，或许还有硫酸雨。

Venus Transit金星凌日

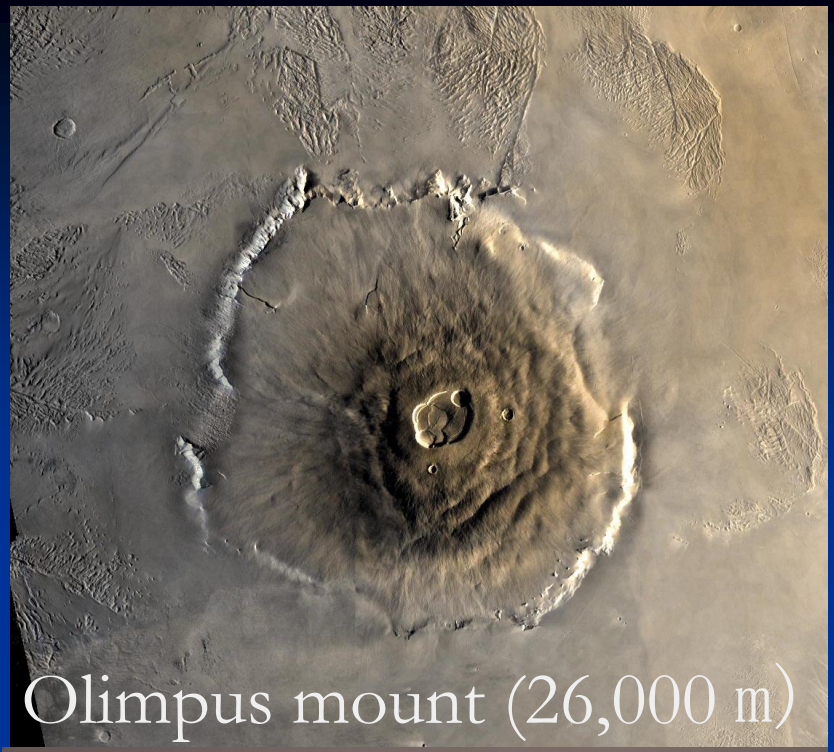


When Venus passes between the Earth and the Sun, its shadow crosses the solar disk.
当金星走到地日之间时产生

Because the inclination of the orbit of Venus occurs twice in 8 years, and the next takes more than a century (105.5 or 121.5 years).因为金星倾斜的轨道，在8年内会发生两次凌日，而下一次要再隔一个多世纪（105.5或121.5年）。

In June 2004 and June 2012 the last ones took place. There will not be another until December 11, 2117
最近发生金星凌日是在2004年6月和2012年6月。
下次要到2117年12月11日。

Mars 火星



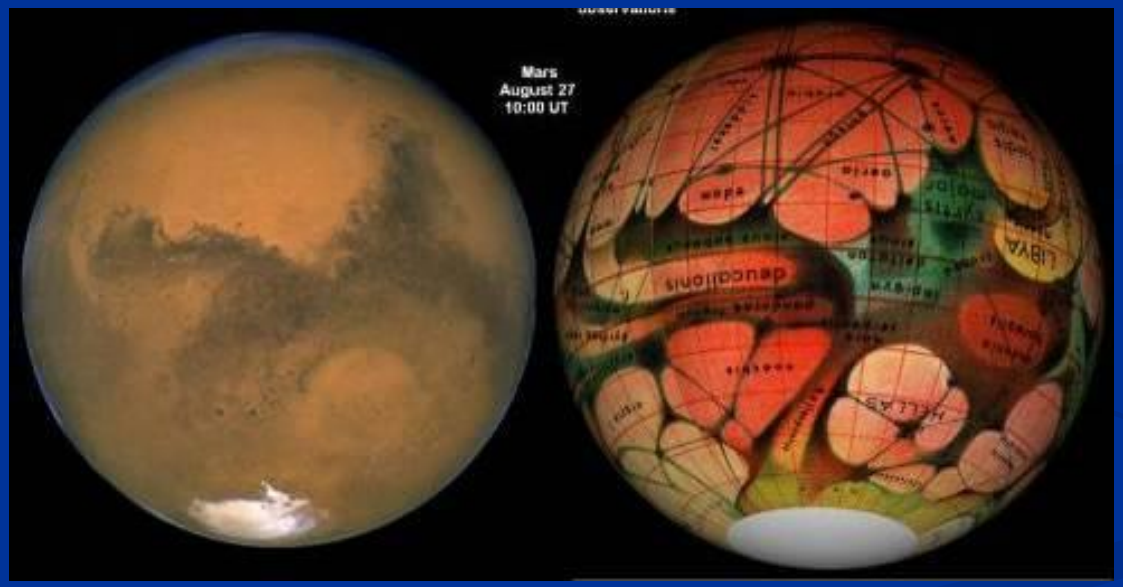
Olimpus mount (26,000 m)

It has a fine atmosphere, composed mainly of CO^2. The atmospheric pressure is one hundredth of the Earth's.它有完好的大气，主要由二氧化碳组成。 大气压力是地球上的百分之一。

Primera imagen de
marte; Viklgo I, 1976

First photo on Mars
surface Viking I, 1976
火星表面的第一张照片

Source of inspiration for many science fiction authors ("extraterrestrial" = "Martian"), due to the famous "canali" observed by Giovanni Schiaparelli at the end of the 19th century: the term was translated into English as "canals" as if they were human constructions.很多科幻作家(“地外的”=“火星的”)的灵感源自19世纪末乔万尼·夏帕雷利观测到的著名的火星“沟渠”:这个意大利词汇被翻译为英语的“运河”一词，造成了其为人工建筑的假象。

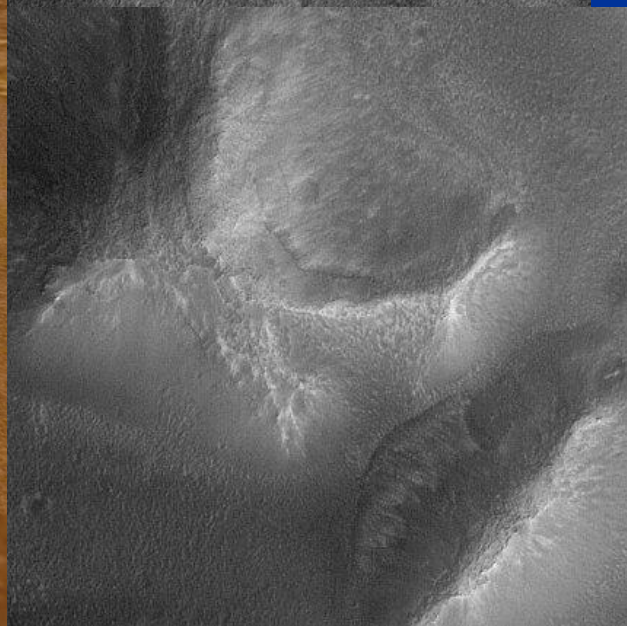


Its red color is due to the oxide of Fe (hematite), which is found in surface minerals
它的红色来源于Fe（赤铁矿）氧化物，这种物质存在于表面矿物中

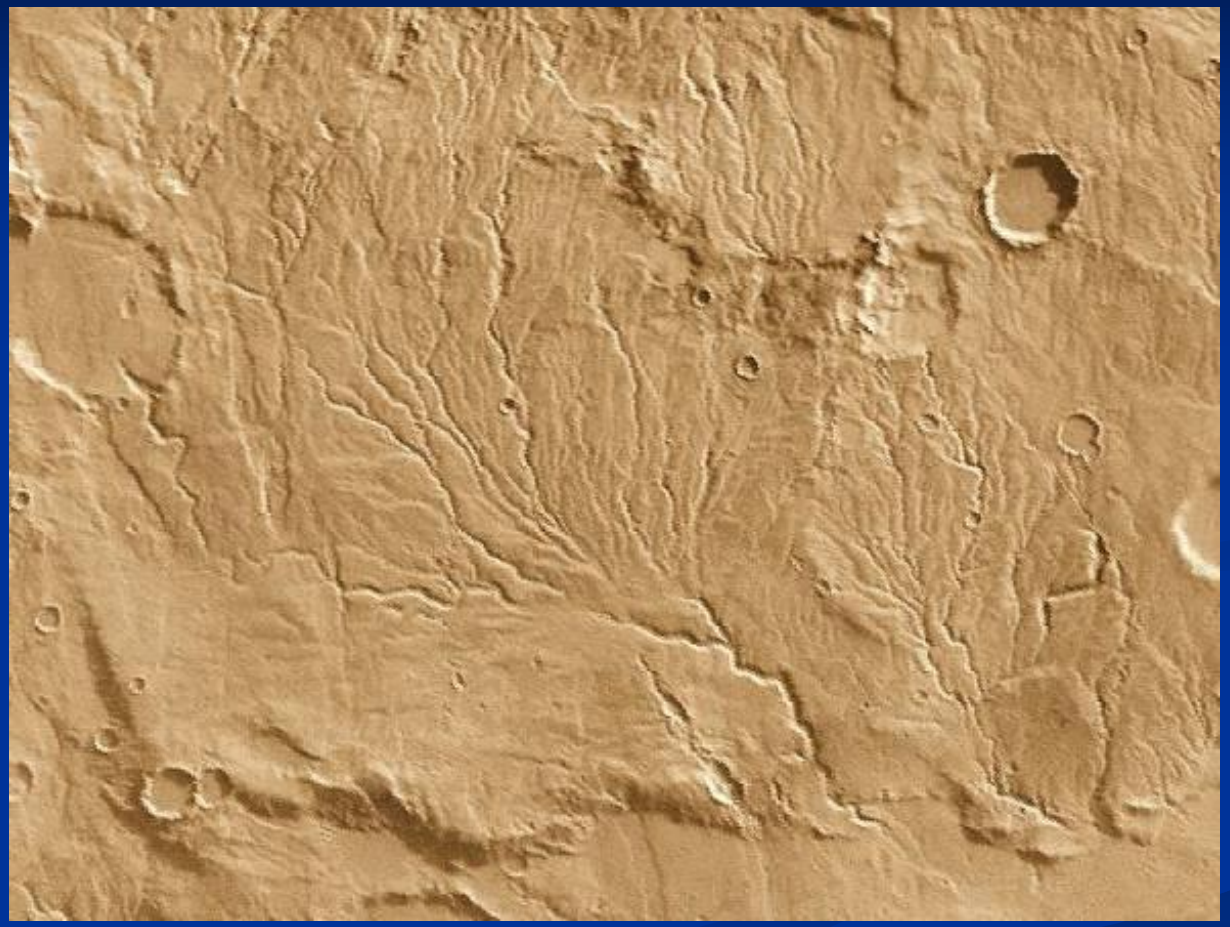

Cydonia – Viking I, 1976


Cydonia
Mars Global Surveyor 1998


Cydonia -Mars Express – Sep., 2006
© ESA/DLR/FU Berlin (G. Neukum), MOC (Malin Space Science Systems)

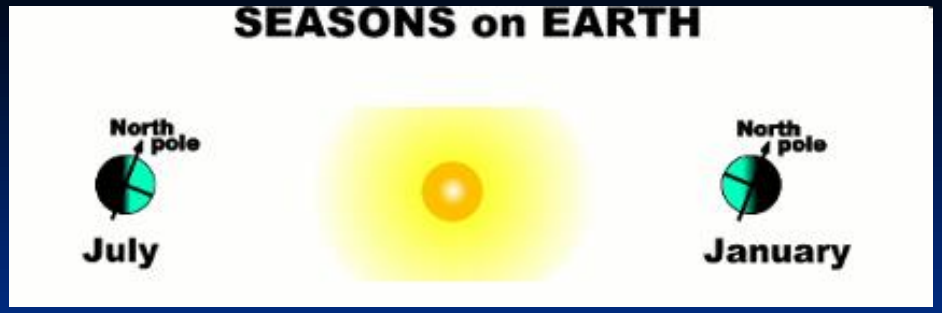


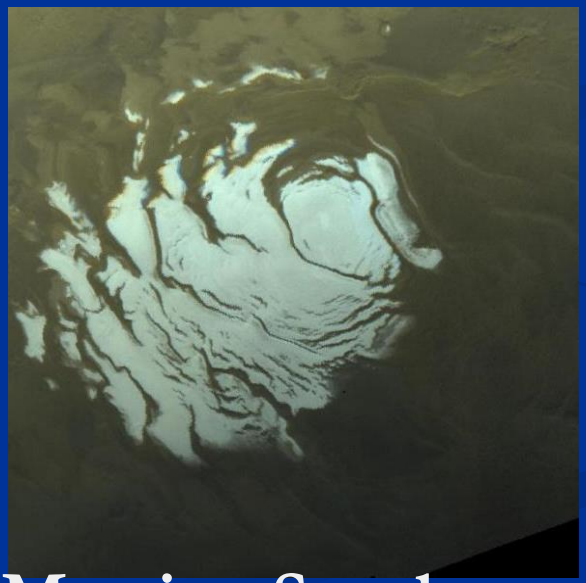
There are traces that indicate that there was water on Mars.有痕迹表明火星上有水。



The water may now be frozen in the subsoil.
水现在可能被冻在地下

As on Earth, there are stations on Mars because the axis of rotation is inclined with respect to the orbital plane, and because the planets move around the Sun keeping constant
the inclination of the axis.
与地球类似，因为火星自转轴与轨道平面也存在夹角，且夹角大小稳定不变，所以火星上也有季节。

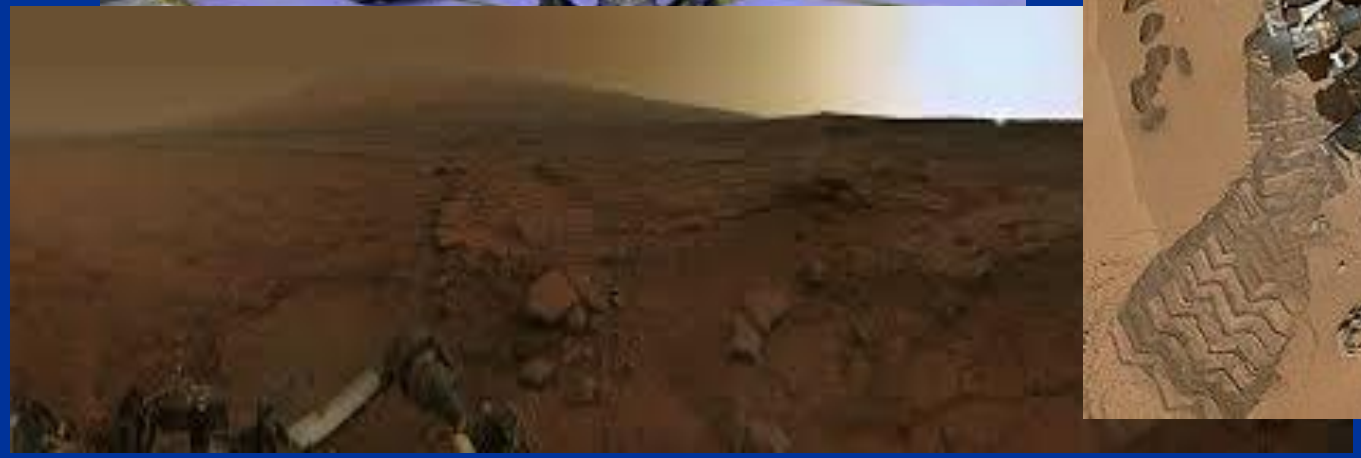




Martian Southern Pole火星南极

It has two ice caps, ice and CO_2 whose extension varies with the seasons.
火星有两个冰冠，由冰和二氧化碳构成，范围会随季节变化。

Curiosity on Mars (2004-present): a successful history of science and technology: a microbiology laboratory火星上的好奇号（2004年至今）：科学和技术的成功史：微生物实验室



Insight: arrives on Mars on Nov 28, 2018
洞察号：2018年11月28日抵达火星

InSight (Interior Exploration using Seismic Investigations, Geodesy and Heat Transpor)
洞察号（使用地震勘探、大地测量和热传输进行内部勘探）

OBJECTIVE: to place a geophysical robot, equipped with high-tech instruments to study the interior, subsoil, heat transmission and movements of the Martian soil and analyze the early geological evolution of the planet.目的：放置一个地质探测机器人，配备有高科技仪器来研究火星内部、土壤、热传导以及运动，分析火星早期地质演化。

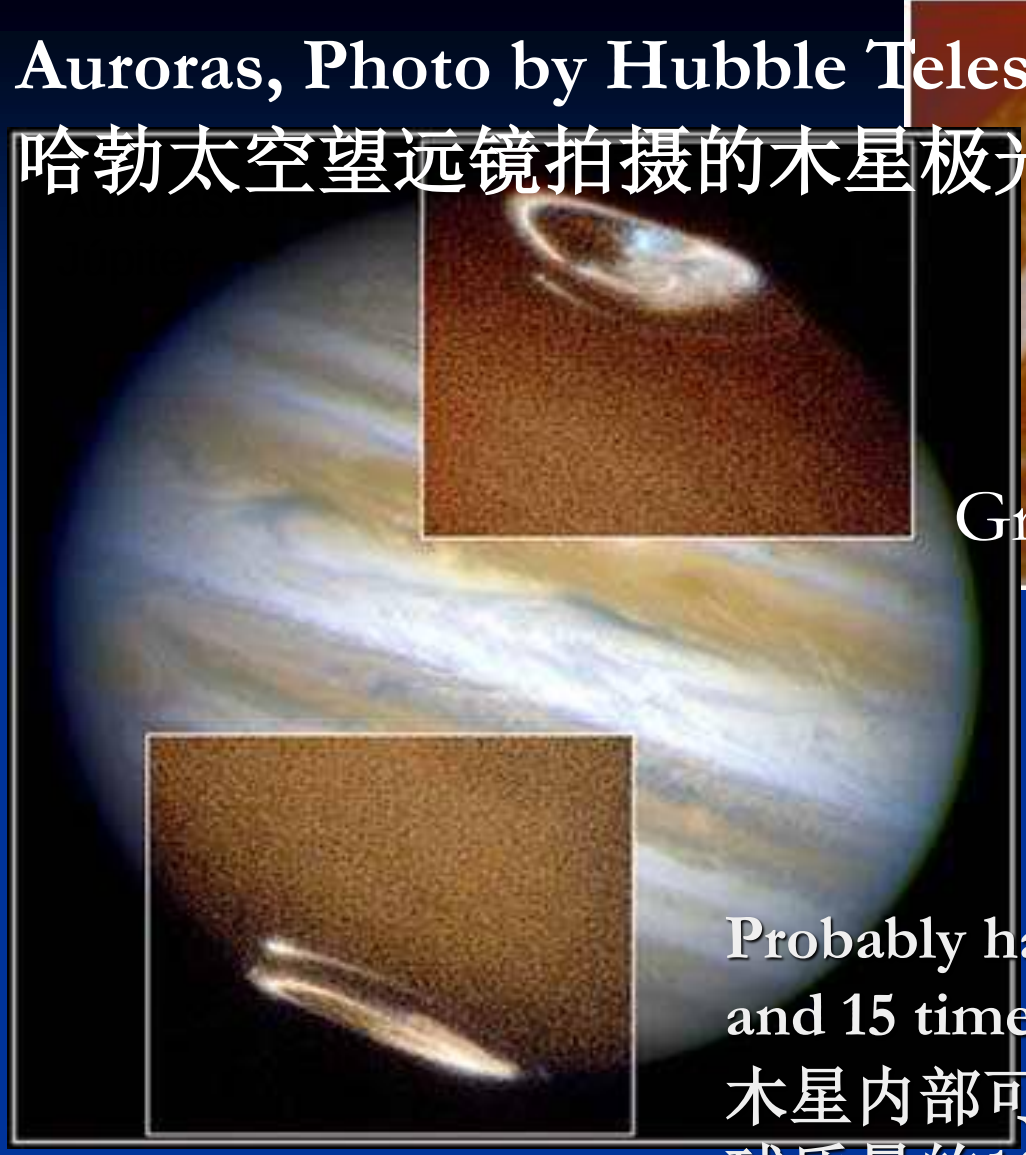
Jupiter 木星

The most massive planet of the SS, has more than 60 moons. In 1610 Galileo observed for the first time 4 of them that he called "Mediceas". That same year Simon Marius baptized them as Io, Europa, Ganymede and Callisto.

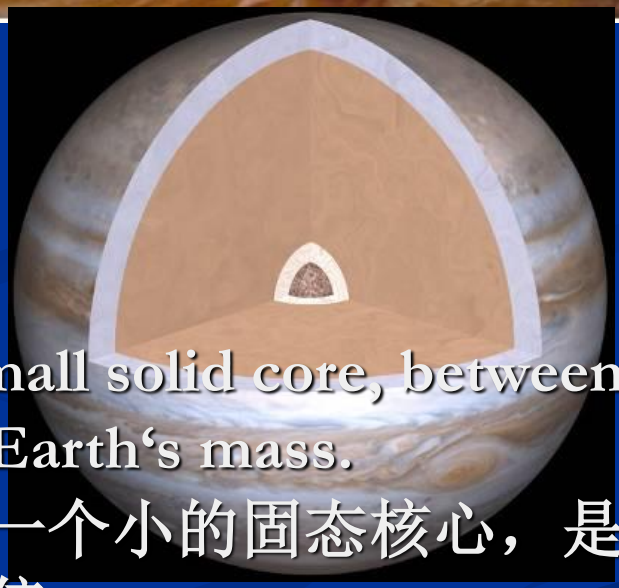
木星是太阳系质量最大的行星，有超过60个卫星。 1610年，伽利略第一次观察到其中4个，被称为“Mediceas”。 同年，西蒙·马里乌斯给它们命名：Io，Europa，Ganymede 和 Callisto。

Auroras, Photo by Hubble Telescope

哈勃太空望远镜拍摄的木星极光



Grand point rouge (un cyclone)



Probably has a small solid core, between 10 and 15 times the Earth‘s mass.

木星内部可能有一个小的固态核心，是地球质量的10到15倍。

Anillos de Júpiter

Rings system

Saturn 土星

The less dense planet of the SS.
太阳系内密度最小的行星

It has more than 60 moons and some of them are between the rings, dynamically organizing the system, they are called "shepherd satellites"它有60多个卫星，其中一些在环之间，是个动态的系统，它们被称为"牧羊犬卫星"

System of Rings, formed by dust and very small pieces of ice.
土星的环由尘埃和非常小的冰块组成。

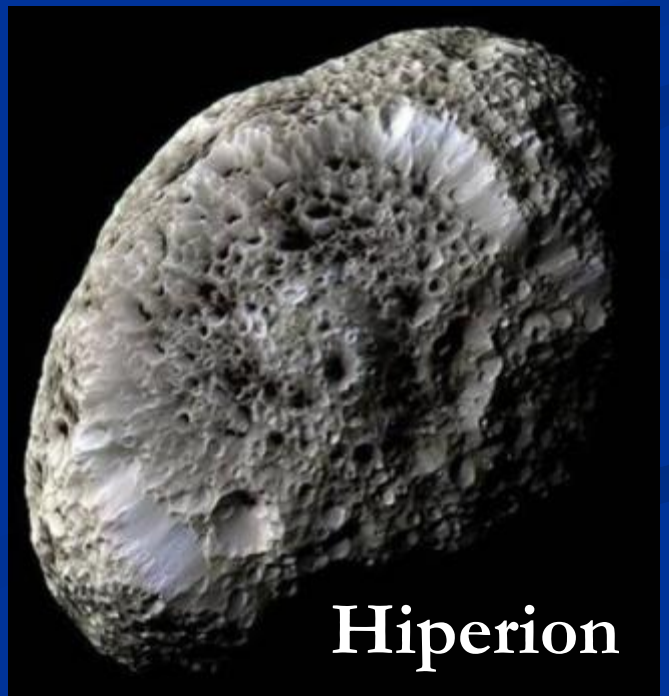
Aurora in Saturn, fhoto by the Hubble Space Telescope
哈勃太空望远镜拍摄的土星极光

- Saturne has more than 60 satellites but 7 are large enough to take a spherical shape.

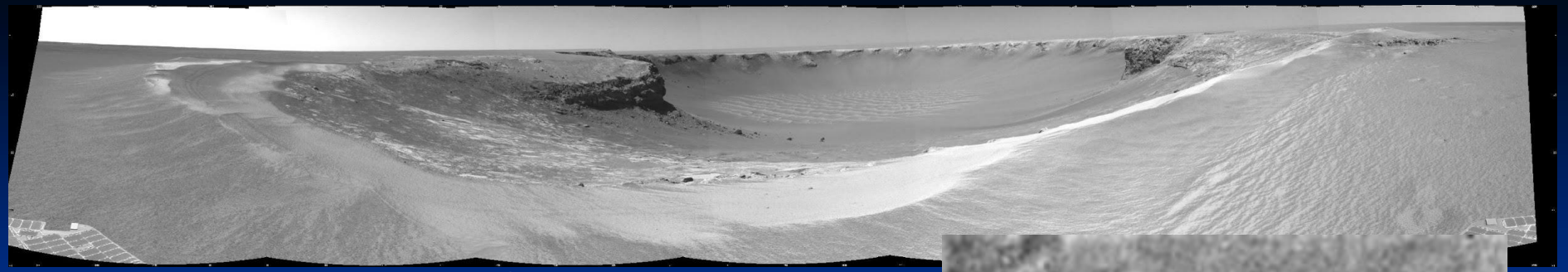
土星有60多颗卫星，只有7颗足够大，可以形成球型。

- Titan is the largest (larger than Mercury and Pluto) and the only one in the SS with a dense atmosphere.

土卫六是其中最大的（比水星和冥王星都大），也是太阳系唯一具有浓密大气的卫星。

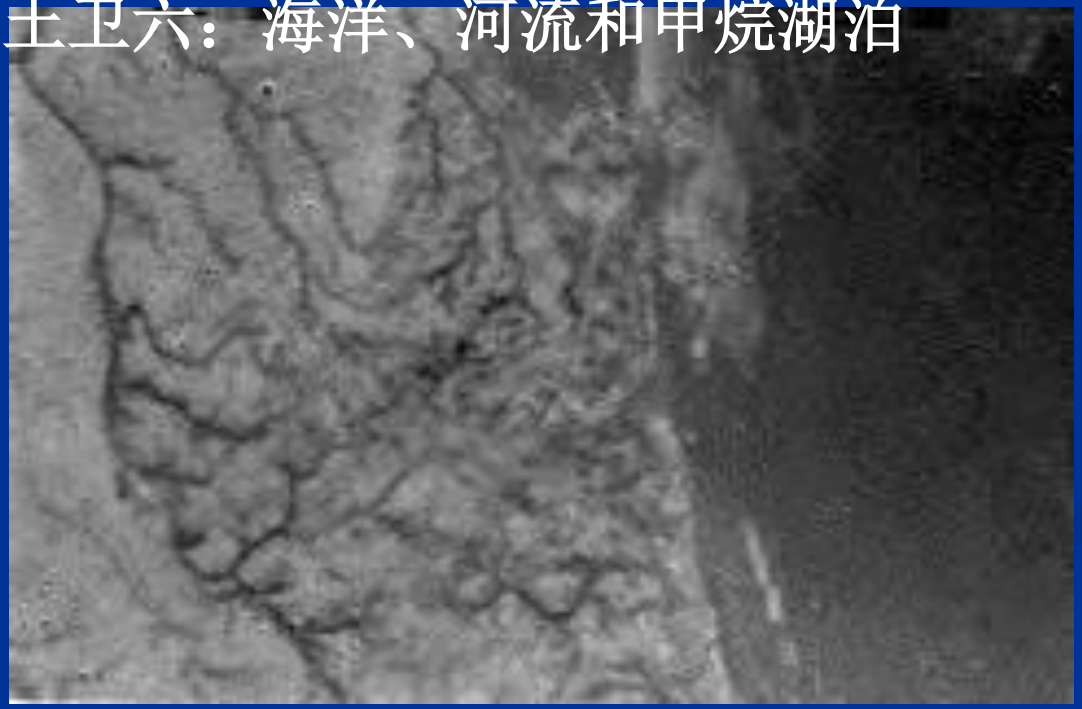


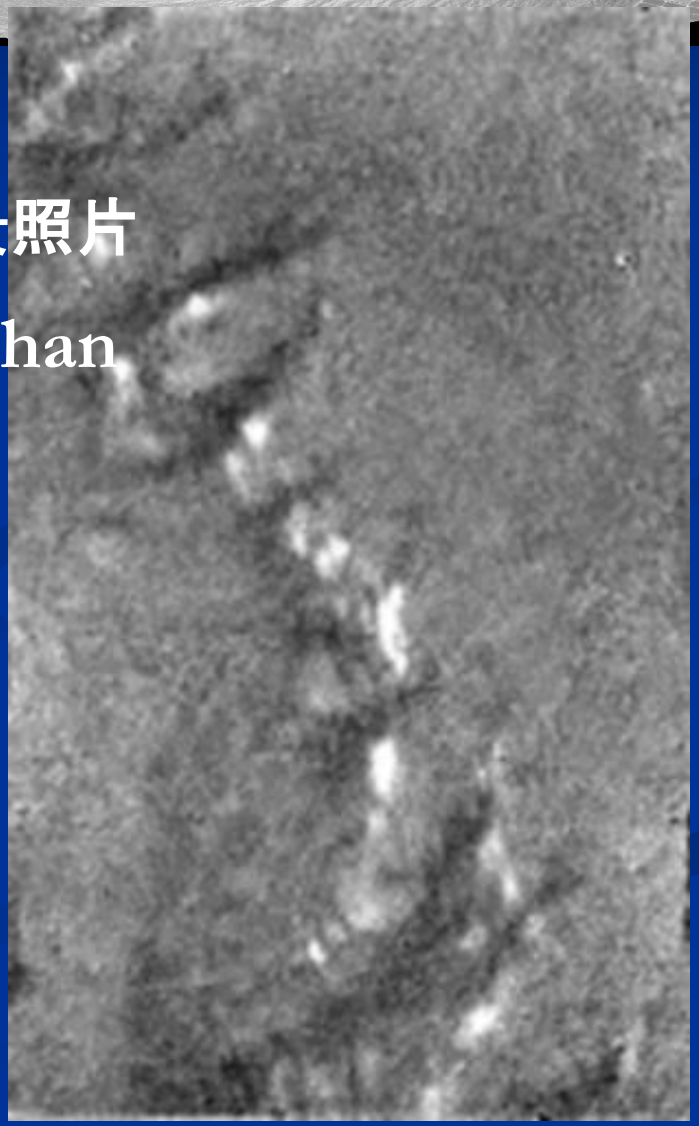

Cassini-Huygens Mission
卡西尼-惠更斯号土星探测器
Huygens probe
descending on Titan
(artistic vision)
惠更斯探测器降落土卫六
（艺术图）



Sonda Huygens on Titan
(first panoramic photo, 2004)
惠更斯探测器拍摄的第一张土卫六全景照片

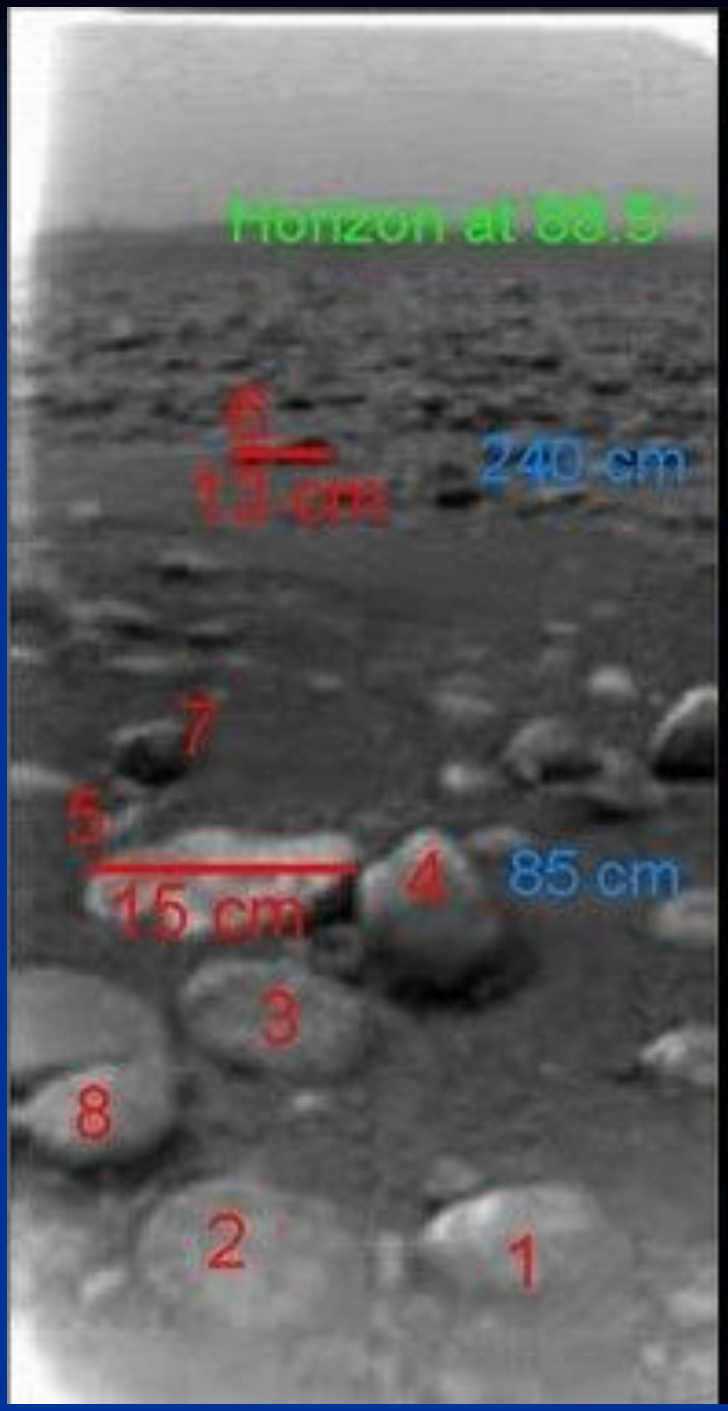
Titan: seas, rivers and lakes of methan
土卫六：海洋、河流和甲烷湖泊





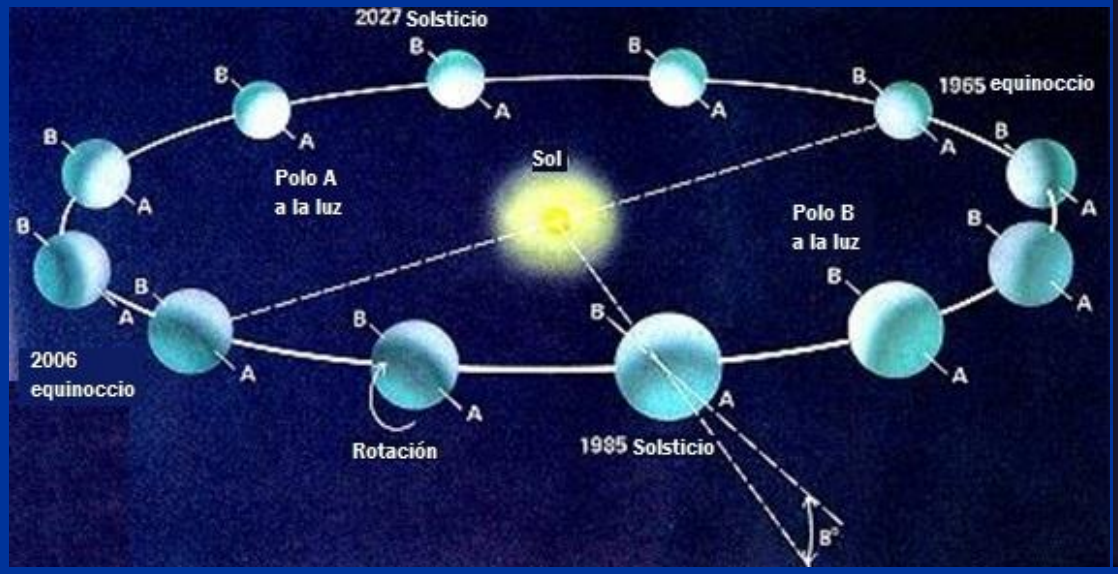
Last photo on Titan surface, Huygens probe

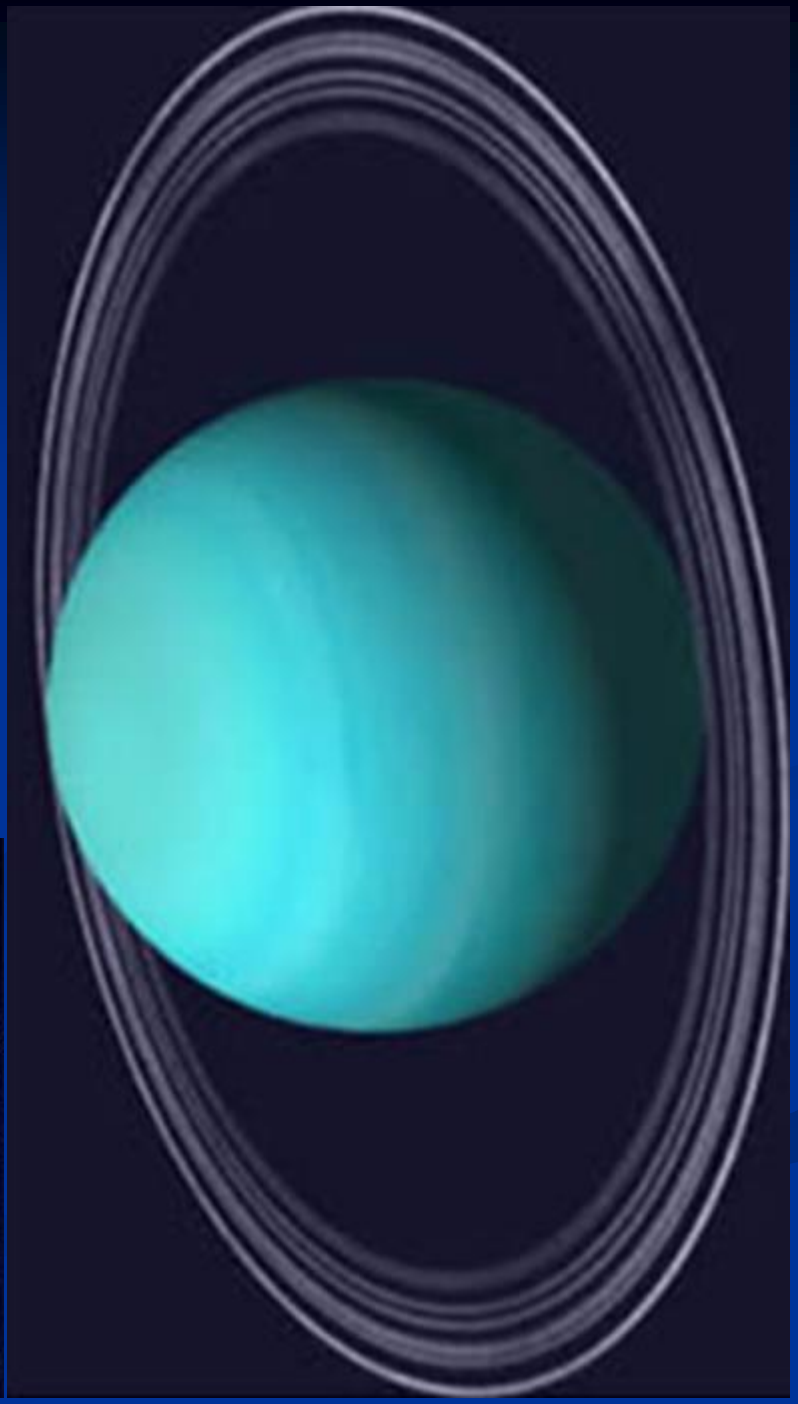
惠更斯探测器拍摄的土卫六表面的最后一张照片



Uranus 天王星

Its axis of rotation is practically in its plane of translation天王星的自转轴几乎躺在公转平面上

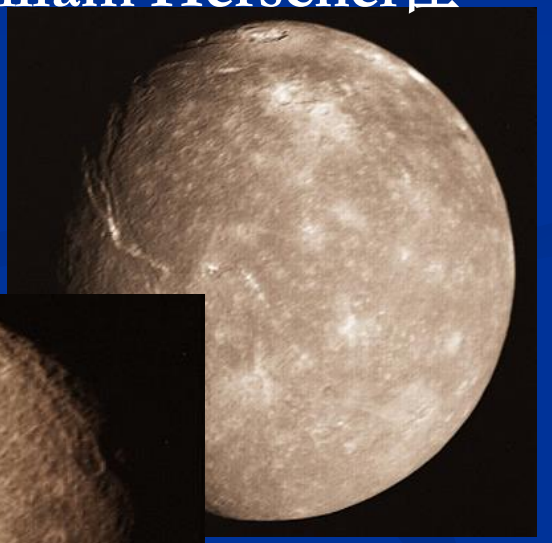




Rings system of Uranus天王星的环

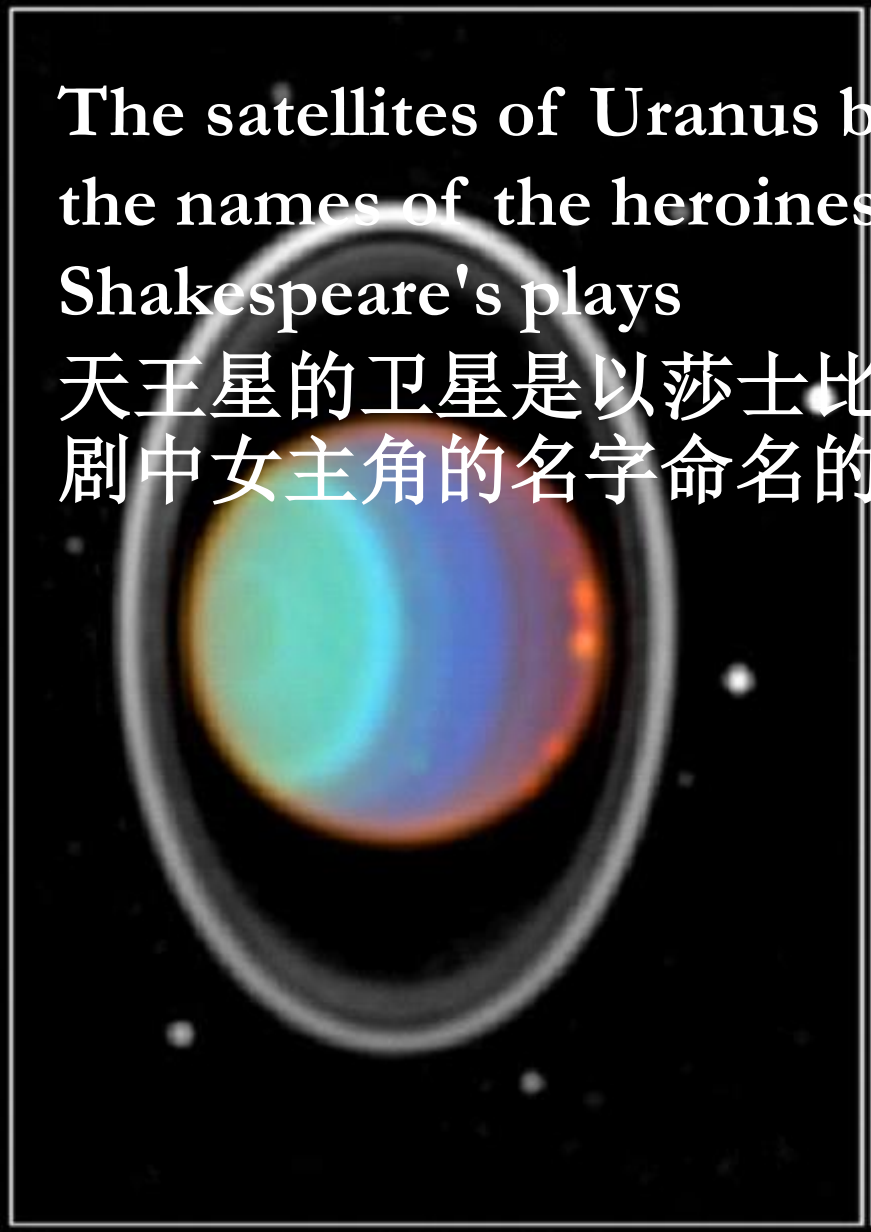
Uranus has at least 27 natural satellites.天王星拥有至少27颗自然卫星。

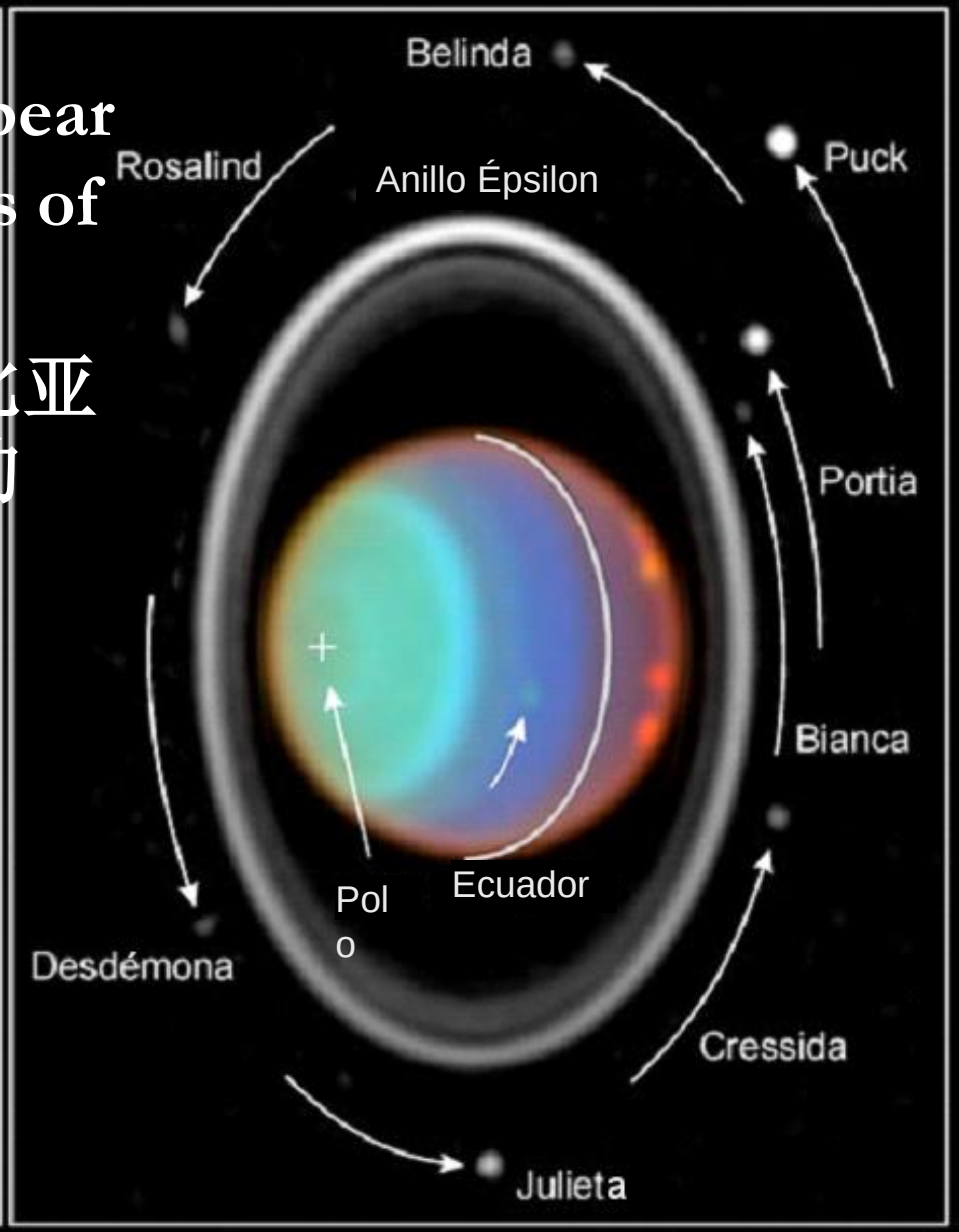
The first two were discovered by William Herschel in 1787: Titania and Oberon.最早发现的天卫三和天卫四，是William Herschel在1787年发现的。



The satellites of Uranus bear the names of the heroines of Shakespeare's plays

天王星的卫星是以莎士比亚剧中女主角的名字命名的





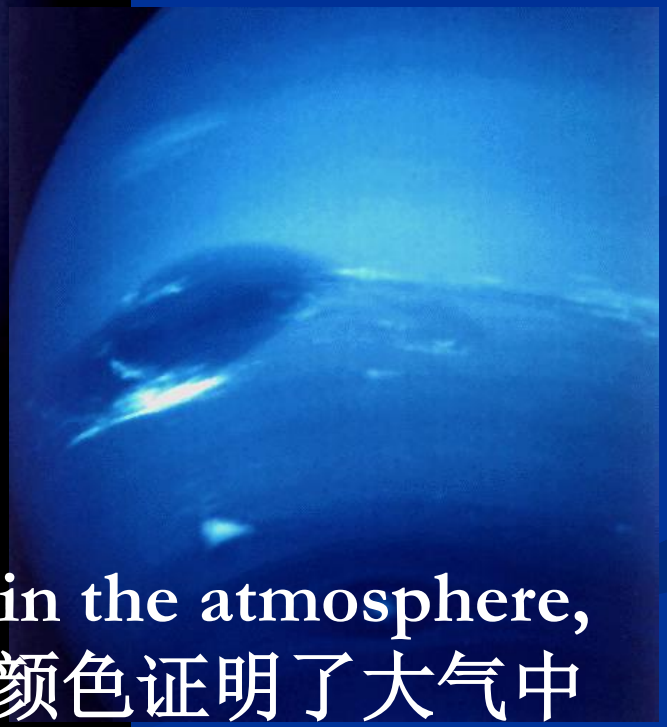
Urano ◦ Julio 28, 1997

HST • NICMOS

PRC97-36a • November 20, 1997 • ST ScI OPO

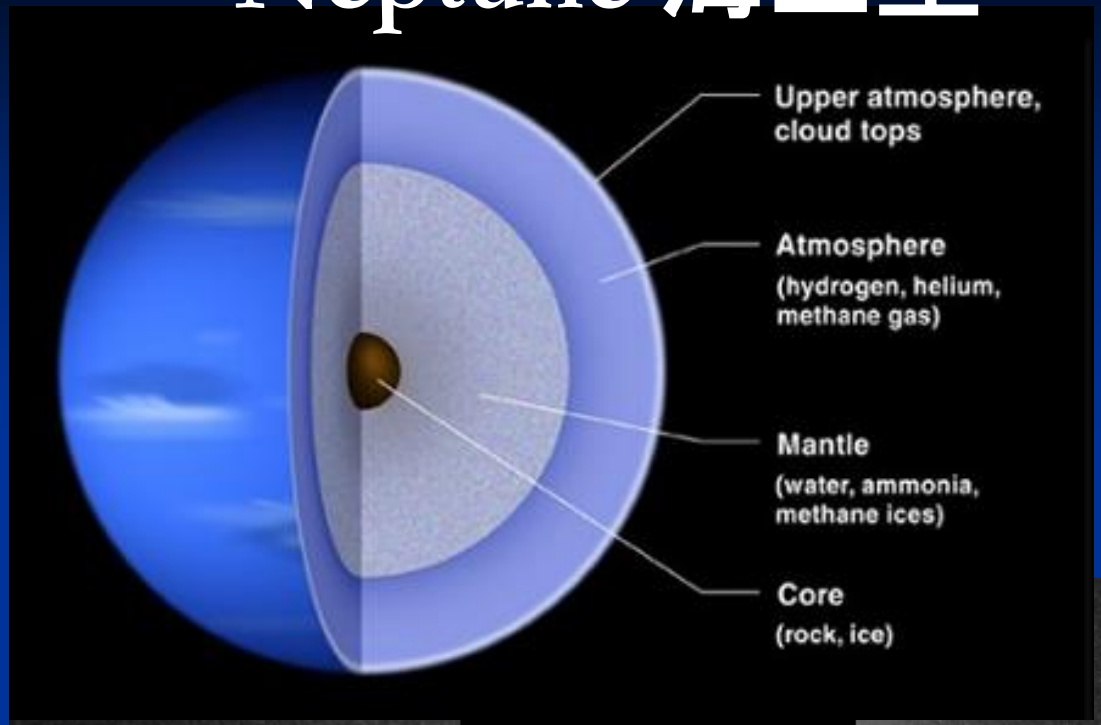
E. Karkoschka (University of Arizona Lunar & Planetary Lab) and NASA

Neptune
海王星



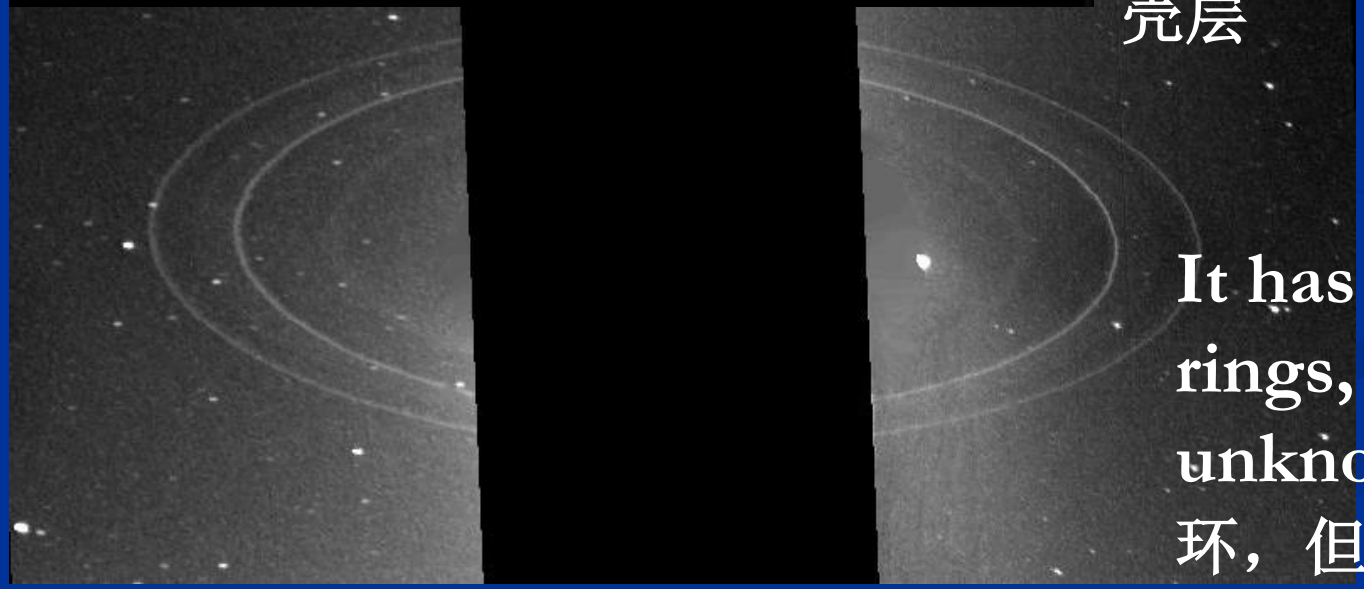
Its color to the presence of methane in the atmosphere, which absorbs red and infrared.它的颜色证明了大气中甲烷的存在，甲烷会吸收红光和红外波段的辐射。

Neptune 海王星



It is believed that it has a solid core of silicates and iron, almost as large as Earth.一般认为它有硅酸盐和铁组成的固态核，几乎和地球一样大。

Above the core is a shell of ice, methane, H and a little He 固态核外层是一层由冰、甲烷、氢和少量氦组成的壳层



It has several dark rings, with origin unknown.它有几个暗环，但起源未知。

Clyde Tombaugh, discovered Pluto on February 18th, 1930.

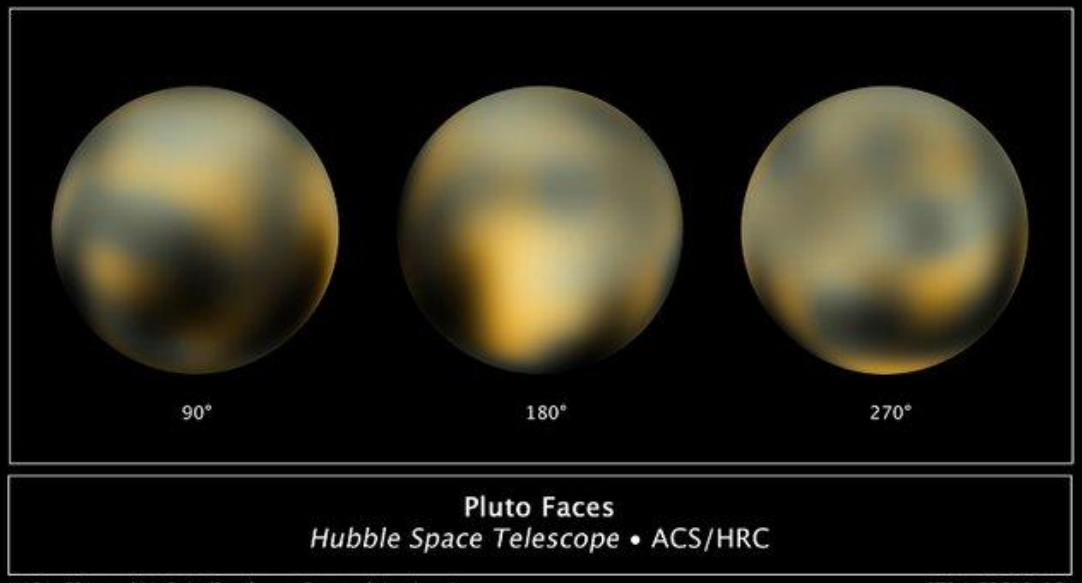
汤博在1930年2月18日发现了冥王星。

Image of the discovery. (1930)

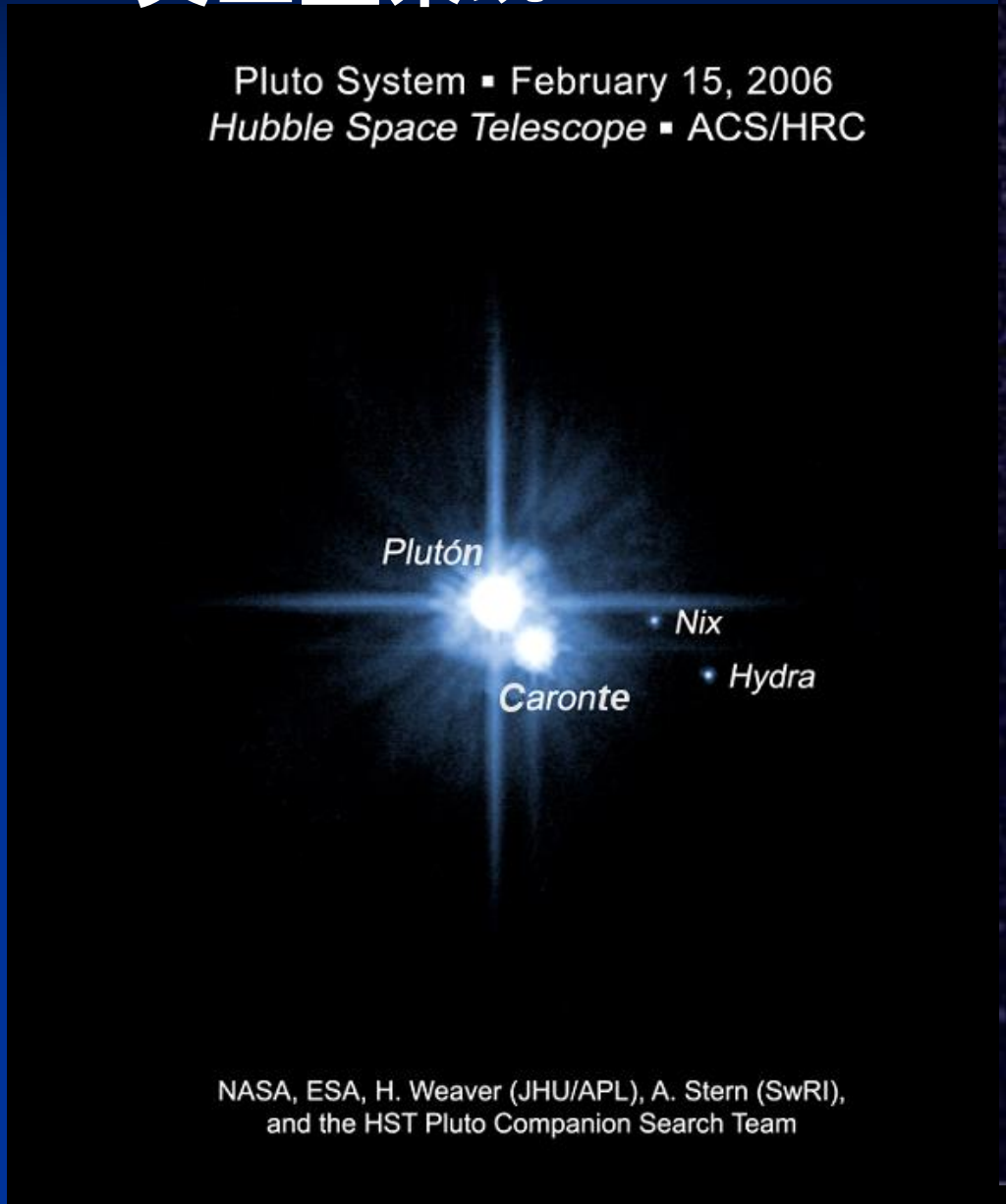
Pluto is too small to disturb Neptune's orbit long enough to betray its presence, however much Lowell has calculated to locate it. Clyde Tombaugh found Pluto (magnitude ~ 13.5) photographing in a systematic way the plane of the SS.

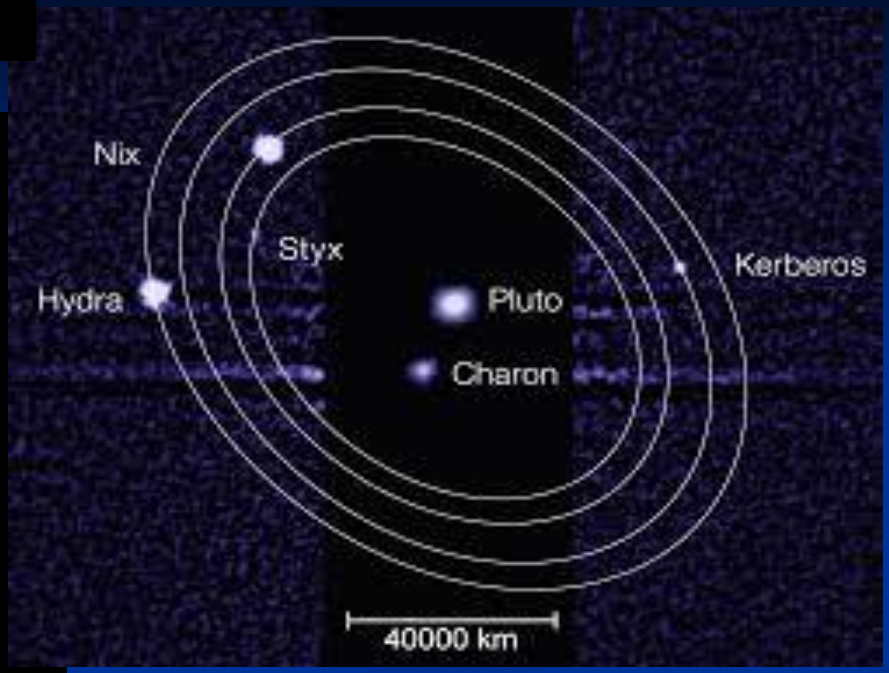
由于冥王星太小，不足以长期扰动海王星的轨道使之发生变动，但是洛厄尔已经意识到了它的存在。后来，汤博在照片中发现了移动的目标——冥王星（~13.5星等）

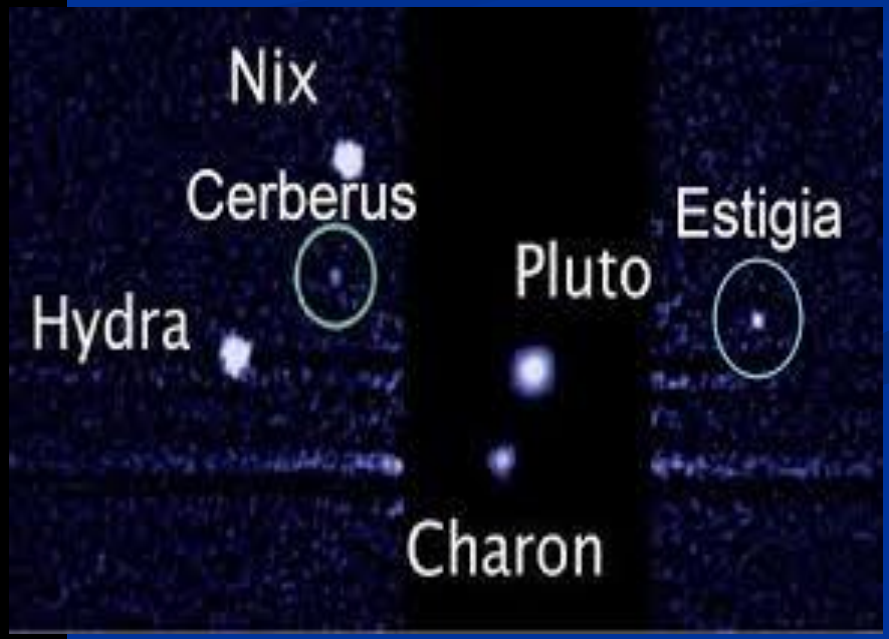
Pluto and Charon
Hubble Telescope
1999
冥王星和冥卫一
哈勃太空望远镜
1999

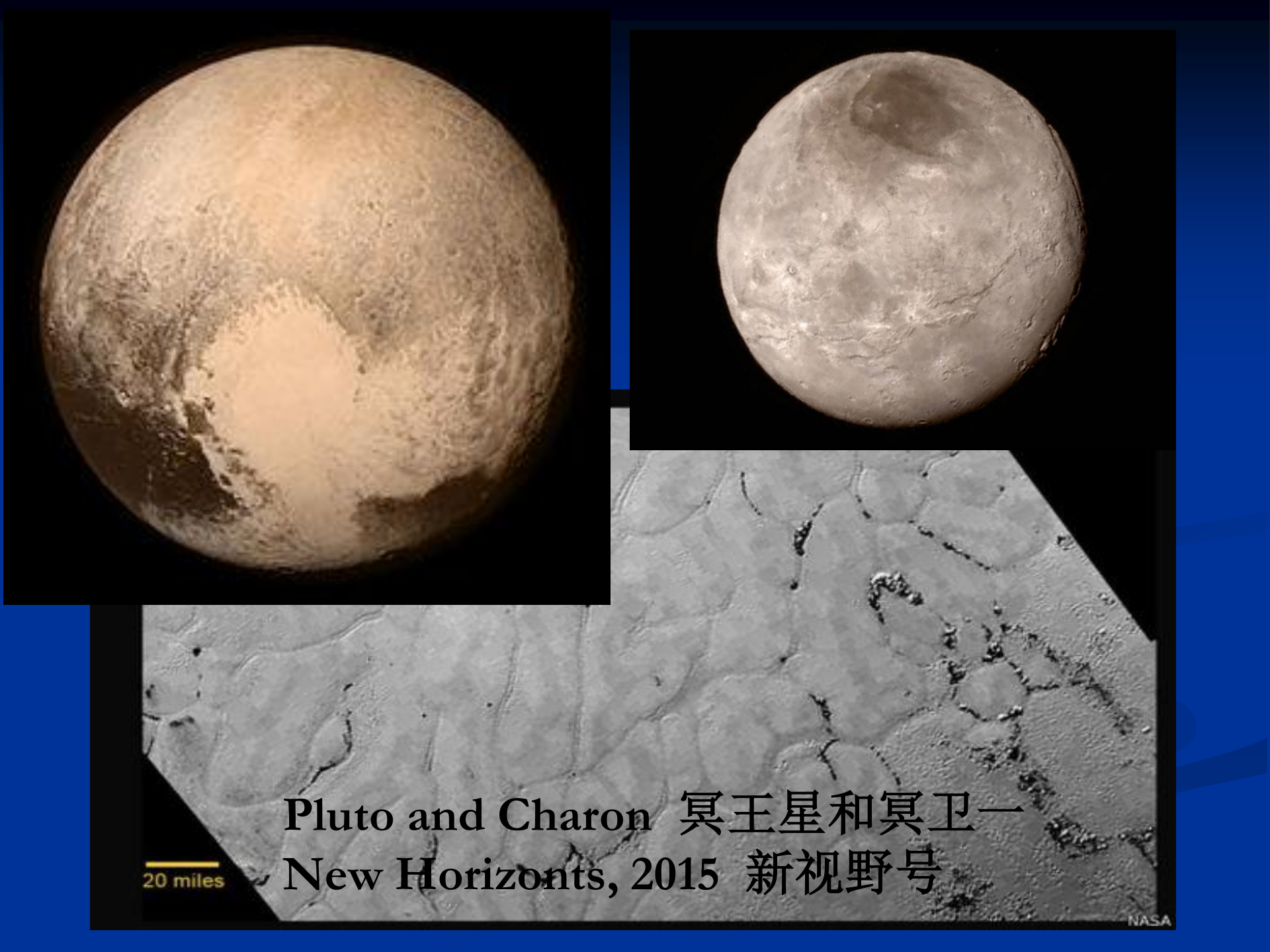


Pluto System, 2011-2012
冥王星系统

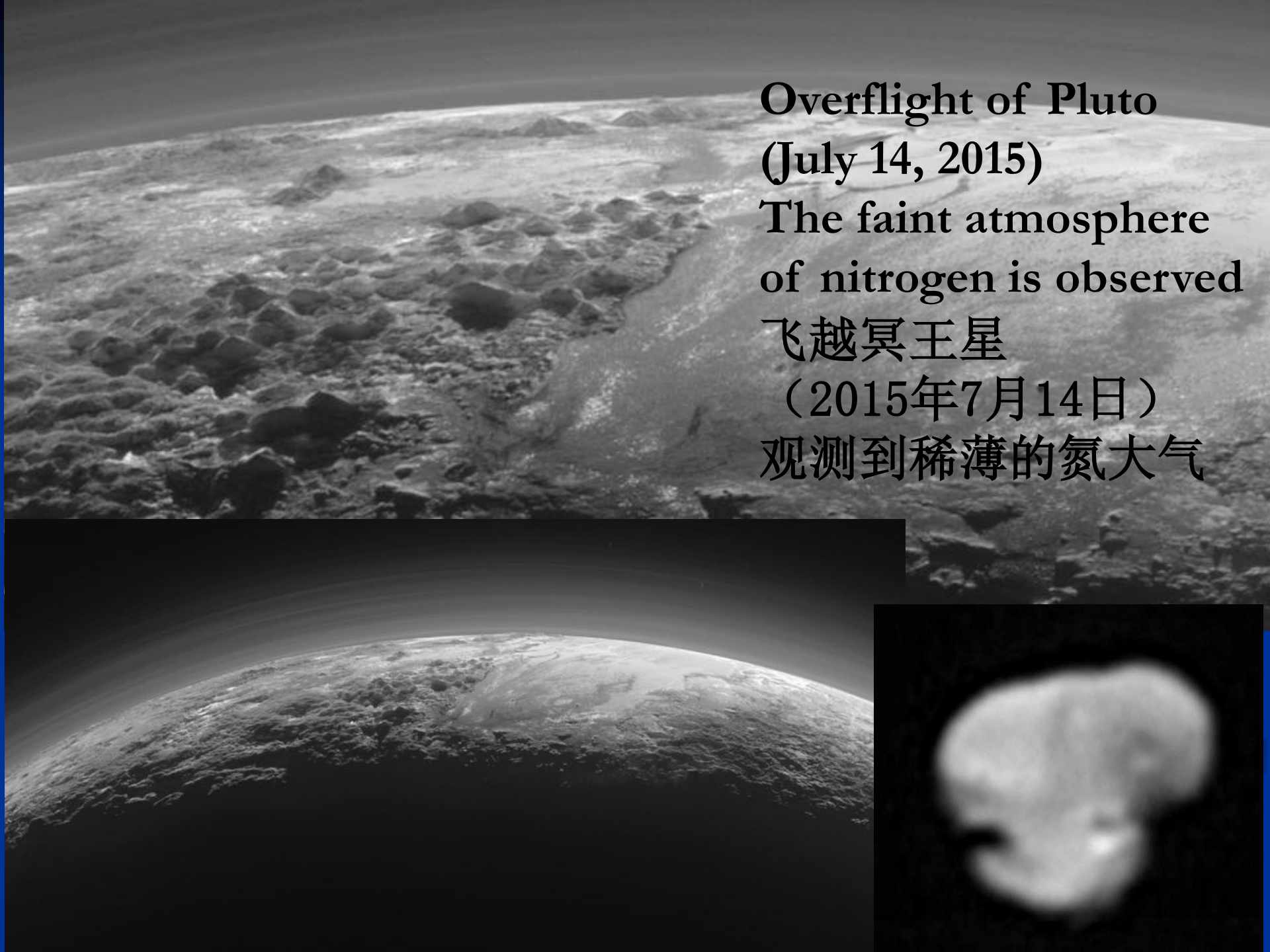






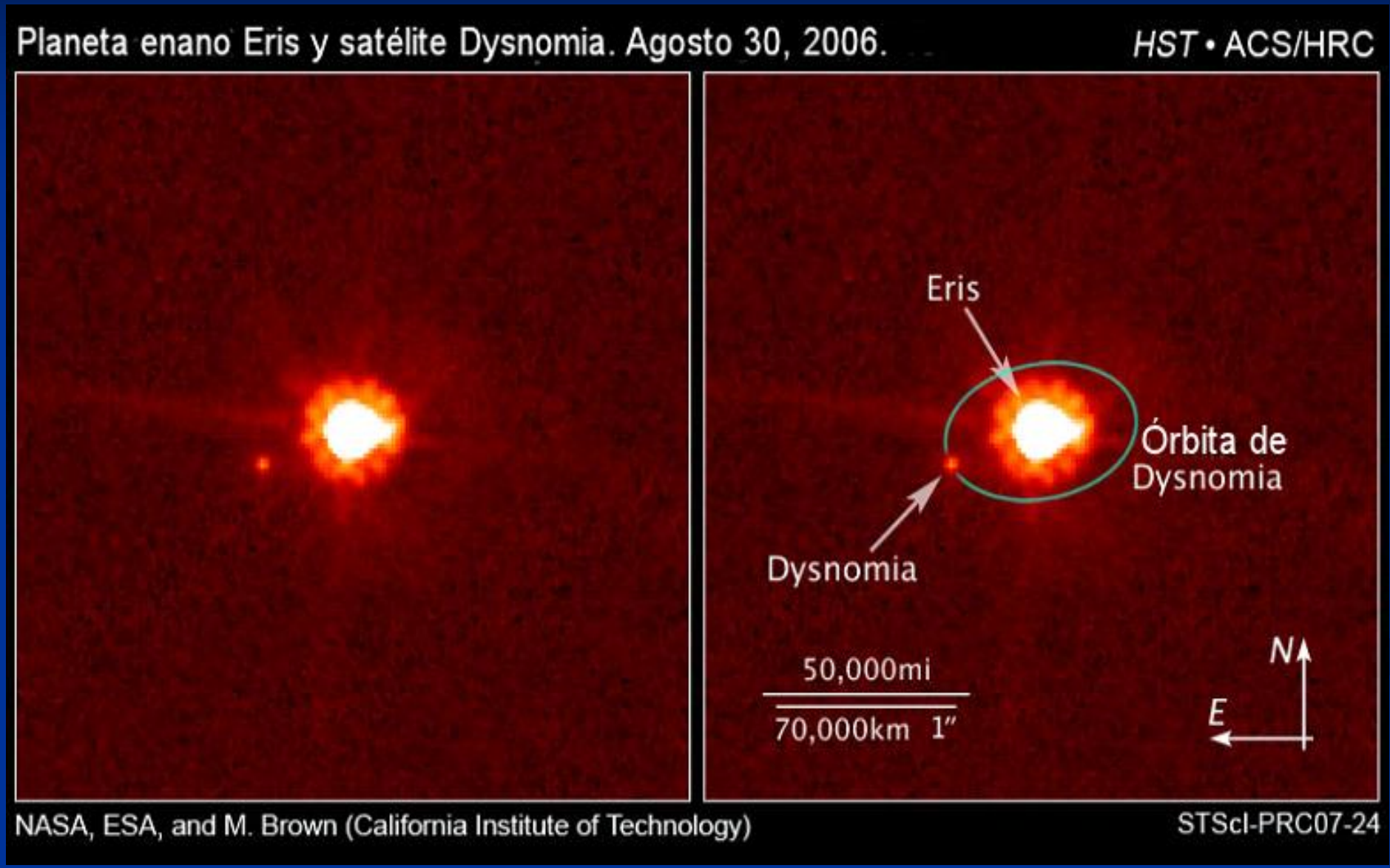


Pluto and Charon 冥王星和冥卫一
New Horizonts, 2015 新视野号



Overflight of Pluto
(July 14, 2015)
The faint atmosphere
of nitrogen is observed
飞越冥王星
（2015年7月14日）
观测到稀薄的氮大气

Eris Discovery 阋神星的发现



Minor bodies of the Solar System
太阳系内小天体

- They are the remnants of the planetary accretion.
  它们是行星吸积的遗迹。
- They comprise diverse populations of asteroids, comets and transneptunian objects.
  它们包括不同种类的小行星、彗星和海外天体。
- The asteroids are essentially rocky and metallic, while the comets are more fragile and porous objects, formed basically by ice (predominantly water) and dust particles.
  小行星基本上由岩石和金属组成，彗星相对来说更加易碎和多孔，基本上由冰（主要是水）和尘埃颗粒构成

Minor bodies of the Solar System
太阳系内小天体

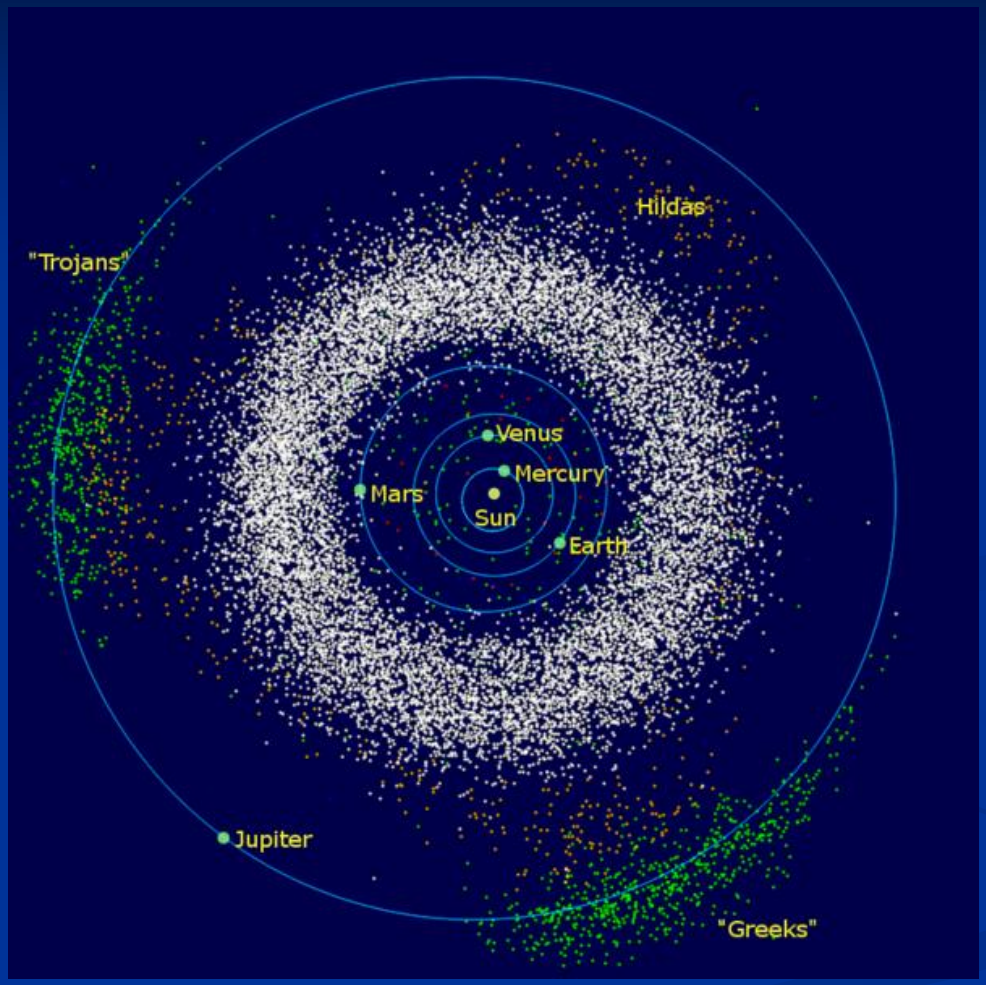
- The vast majority of asteroids lie in a region between the orbits of Mars and Jupiter, known as the "Asteroid Main Belt.“

绝大多数小行星位于火星和木星轨道之间的区域，称为“小行星主带”。

- Transneptunian objects will contain significant amounts of ice, and are located in a region beyond the orbit of Neptune, known as the "Transneptunian Belt" (or Kuiper Belt, in recognition of one of the first to predict its existence).

海外天体往往含有大量的冰，位于海王星轨道以外的区域，被称为“柯伊伯带”。

Asteroids Main Belt小行星主带

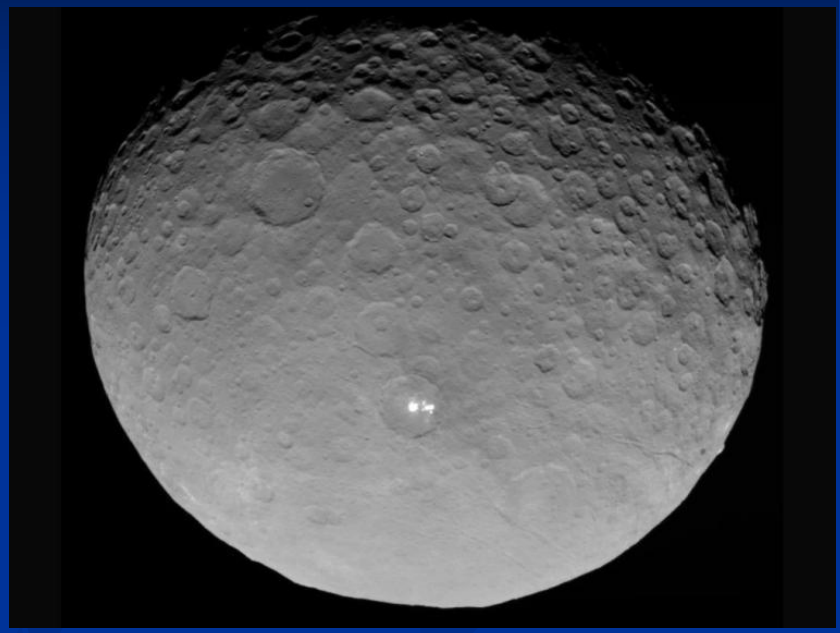


There are hundreds of thousands or millions, and the total mass would not exceed one thousandth of the Earth.数量有数十万或数百万，总质量不会超过地球的千分之一。

The size of the asteroids ranges from several hundred km to meters and fractions of m.小行星的大小从几百公里到几米不等。

Ceres 谷神星

Discovered in 1801 by Giuseppe Piazzi, it was considered a planet until 1850 when many other similar objects were found.
1801年由Giuseppe Piazzi发现，直到1850年前都被认为是一颗行星，后来才发现了更多类似的天 体。

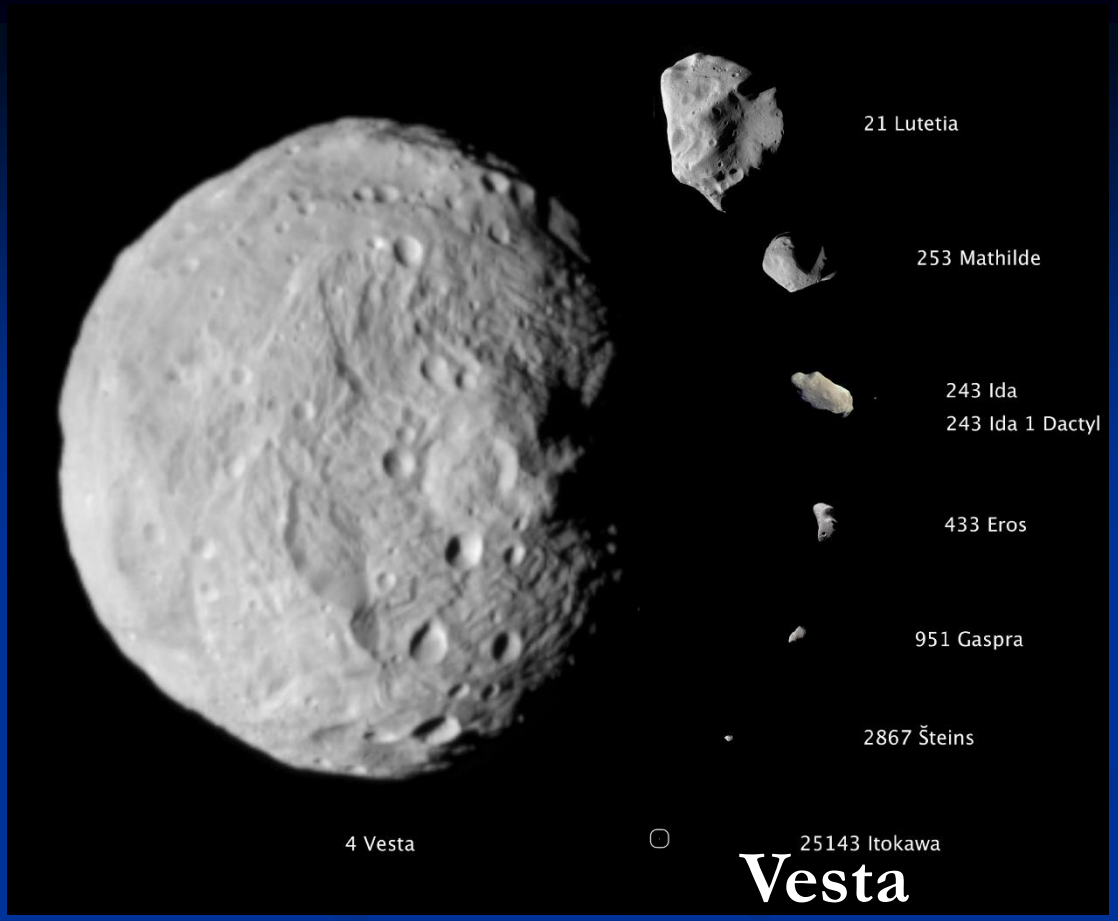


With a diameter of almost 1,000 km, it is large enough for its gravity to give it a spherical shape.
直径近1000公里，它的引力够大，得以形成球型。

It is the largest body of the asteroid belt, and the only one of them cataloged in 2006 as a dwarf planet.它是小行星带里最大的天体，也是其中唯一一个在2006年被确认为矮行星的。

All other asteroids are considered small, irregular bodies, although some of them like Pallas and Vesta could be classified as dwarf planets if they are shown to reach hydrostatic equilibrium

所有其他小行星都被认为是小且不规则的天体。但是如果它们能达到流体静力平衡，就像灶神星和智神星一样，就可被归类为矮行星。



Vesta
灶神星

Pallas
智神星

Reservoirs of minor bodies in the SS
太阳系小天体聚集区

The reservoirs are relatively stable regions, where objects can remain for times comparable to the SS age, until some perturbative force changes their orbit.
聚集区是一片相对稳定的区域，其中的天体在受到扰动改变轨道之前都能保持它们在太阳系诞生之初时的状态。

There are three large reservoirs in the SS:
太阳系里有三个大型聚集区：

The **Main Asteroid Belt** Other populations would come from this region, such as the asteroids that approach Earth (known as NEAS by its acronym in English).
小行星主带 例如接近地球的小行星就是来自这个区域。

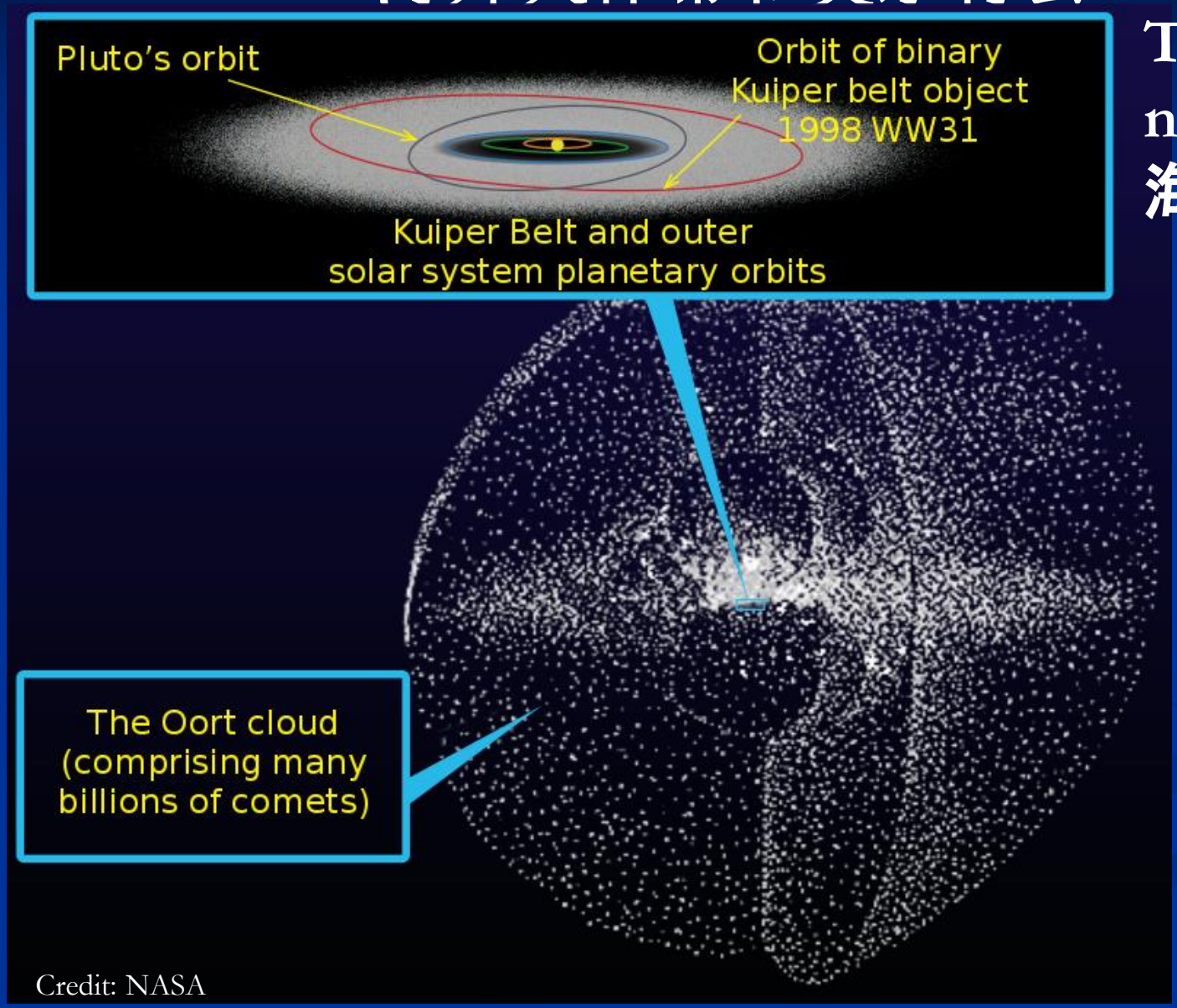
Reservoirs of minor bodies in the SS
太阳系小天体集中区

- The **Transneptunian Belt**. It is the region where short-period comets come from.
- **海外天体带**。 这是短周期彗星的来源地。
- The **Oort Cloud**. It has a spherical distribution and is formed by the frozen planetesimals swept out by giant planets during the formation of the SS. Thanks to perturbations due to the close passage of stars or giant molecular clouds, or to the galactic tides, the orbits of some of these objects can change deviating towards the interior of the SS, transforming into long-period comets.
- **奥尔特云**。 它呈球形分布，是在太阳系形成之初，巨行星抛出的冻结星子形成的。 由于附近的恒星、巨大的分子云或银河系潮汐流带来的扰动，改变了这些天体的轨道，使之变成了长周期彗星。

日期 Data at April 17, 2019.
来源 Source: NASA/JPL https://ssd.jpl.nasa.gov

- Total of known Asteroids: 798,130. Including:
  已知小行星总数： 798,130。其中包括：
  - Main belt: 705,913 主带
  - Troyans of Jupiter: 7,236 木星-特洛伊带
  - Asteroids with inner Mars orbits: 3,573 火星轨道内小行星
  - NEAs: 19,996 近地小天体
  - Partial dangereuses Asteroids (PHAs): 1,973 潜在威胁小行星
- Comets: 彗星：
  - Elliptical: 420 long periodo (P>200 years) + 860 short periodo (P<200 years). 椭圆轨道彗星：420个长周期（周期长于200年）+860个短周期（周期小于200年）
  - Parabolics: 1,837 抛物线轨道彗星
  - Hyperbolic: 347 (extra-solar origen) 双曲线轨道彗星
- Trans-neptunians (TNOs): 3,218 海外天体

Transneptunian belt and Oort cloud
海外天体带和奥尔特云



Trans neptunians
海王星轨道外

The biggest ones are dwarf planets
最大的是矮行星

Largest known trans-Neptunian objects (TNOs)

Credit: NASA

Comets 彗星

- Are small bodies of a few km, made mainly of volatile materials (water ice, carbon dioxide, methane, ammonia, etc.) and dust particles.

  几公里大小的小天体，主要由挥发性物质（水冰，二氧化碳，甲烷，氨等）和尘埃颗粒组成。
- When they approach the Sun they can be visible.

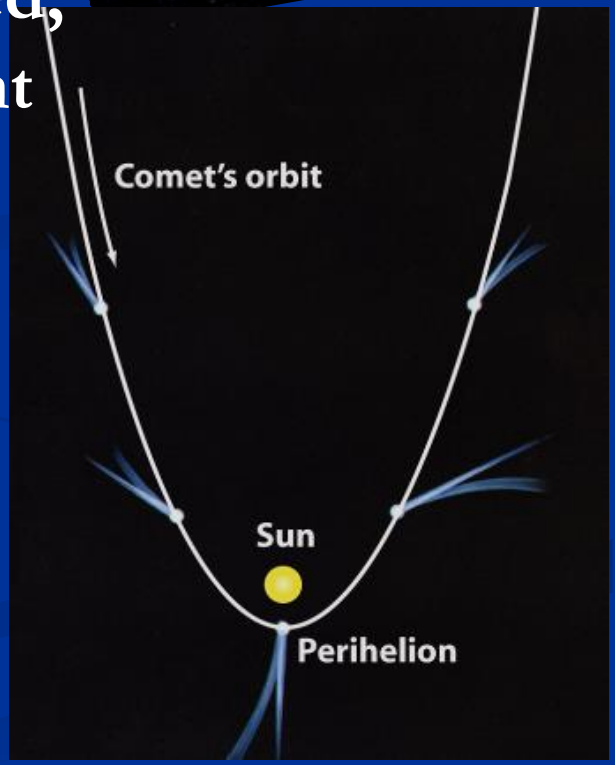
  当它们接近太阳时变得可见
- It is thought that H_2O on Earth could come from them.

  一般认为地球上的水可能来自它们。

- In general comets have quite eccentric orbits. Those of long period have random inclinations and may have retrograde or direct orbits: those of short period have generally small inclinations and their orbits are direct.

一般来说，彗星轨道的偏心率较大。那些长周期彗星往往具有随机的轨道倾角并且可能顺行或者逆行；短周期彗星通常轨道倾角较小并且是顺行。

- When approaching the Sun, the superficial ice of the comet is sublimated creating a coma or "hair", and the "tails": a dust tail formed by dust particles dragged by the gas, and an ionic tail formed by the atoms and ionized molecules that interact with the solar wind. The powder tail is curved, while the bluish ionic tail points straight and opposite the Sun



当彗星接近太阳时，表面的冰升华，形成彗发和彗尾；受气体拖拽作用，尘埃粒子形成尘埃彗尾；与太阳风作用后，原子和电离分子形成离子尾 。尘埃彗尾是弯曲的，而蓝色的离子尾呈直线并指向太阳相反的方向。

Halley: the most famous of the comets
哈雷：最著名的彗星

It was named in honor of Edmond Halley, who predicted his approach to the Sun, applying the Law of Universal Gravitation and the calculation of disturbances. Halley did not see his prediction confirmed.It returns every 76 years.
它的命名是为了纪念埃德蒙德·哈雷，他基于万有引力定律和对扰动的计算预见到了哈雷彗星会向太阳运动。 但哈雷没有看到他的预测成真。这颗彗星每76年回归一次。

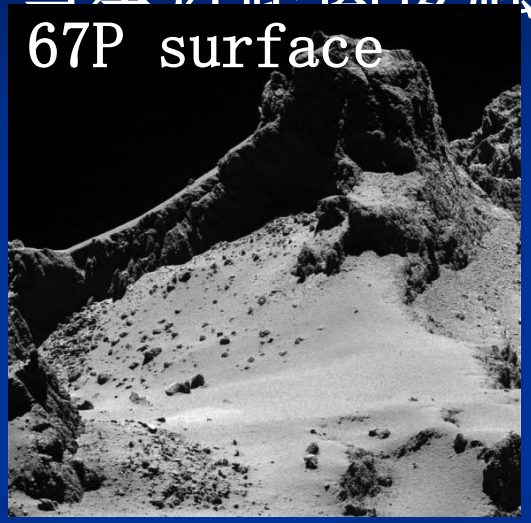
In 1986 was the first comet visited by a probe: the Giotto. It photographed the nucleus. 1986年，乔托行星际探测器第一次造访了哈雷彗星，并拍摄了彗核

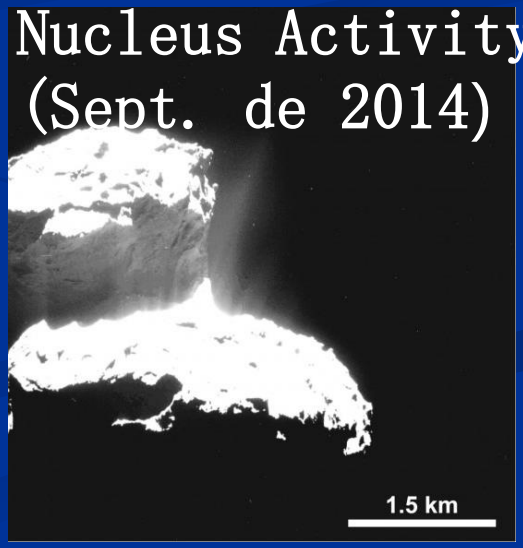
Rosetta Mission: close encounter with the comet 67P/Churyumov-Gerasimenko

罗塞塔任务：与丘留莫夫–格拉西缅科彗星近距离接触

Philae descends on the comet on Nov 12, 2014

菲莱于2014年11月12日降落在彗星上

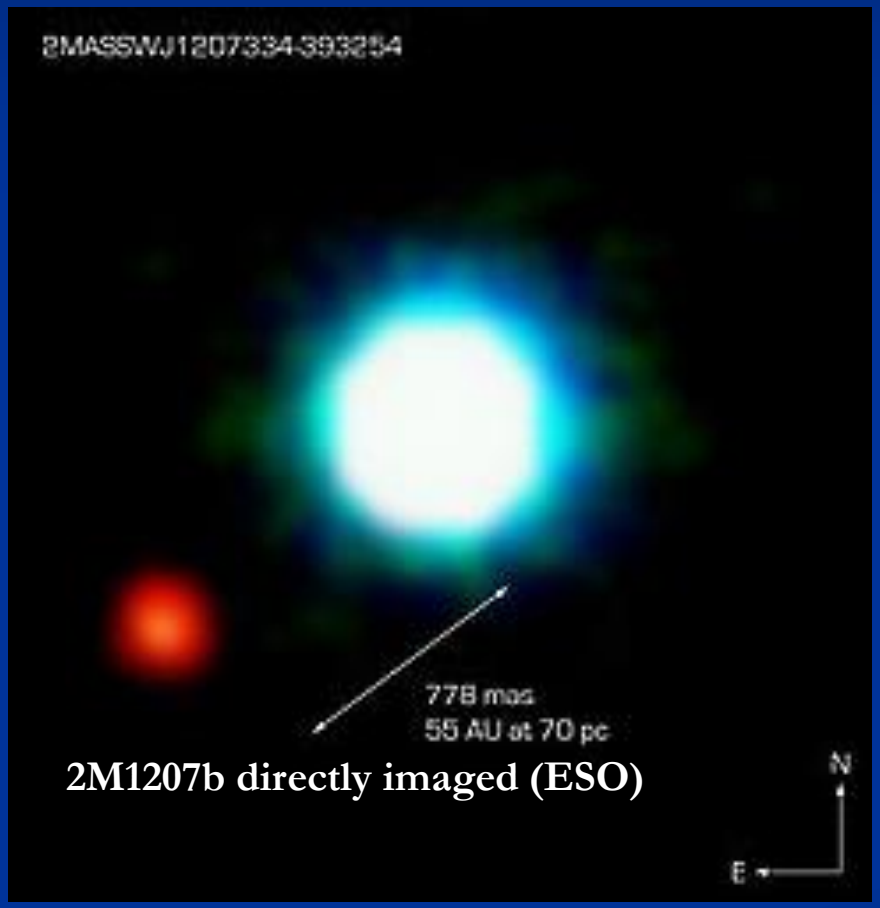




Camera OSIRIS/ESA

Other Planetary Systems
其他行星系统

In 1995 the Swiss astronomers Michel Mayor and Didier Queloz announced the detection of an exoplanet orbiting 51 Pegasi.
1995年，瑞士天文学家米歇尔·马约尔和迪迪埃·奎洛兹宣布探测到一颗围绕 51 Pegasi 绕转的系外行星。

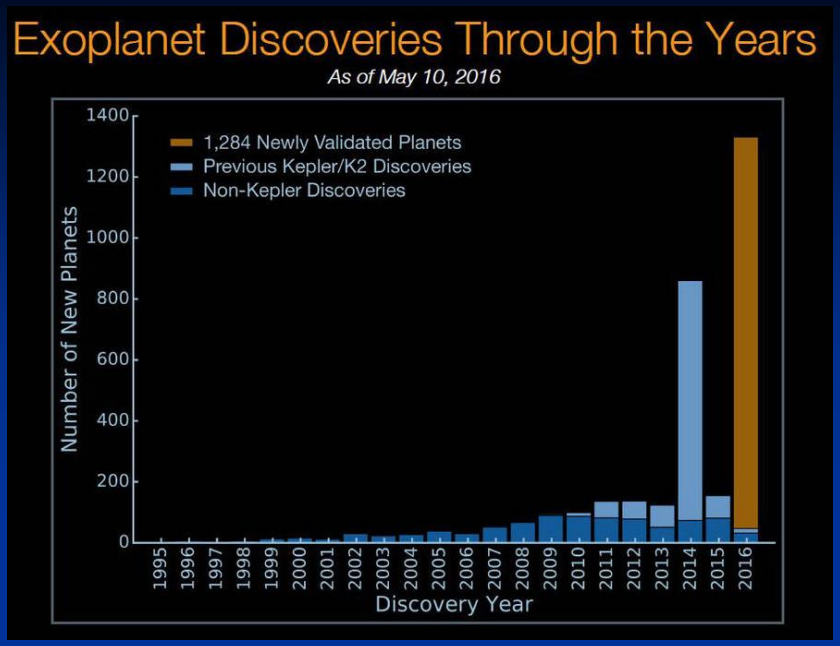


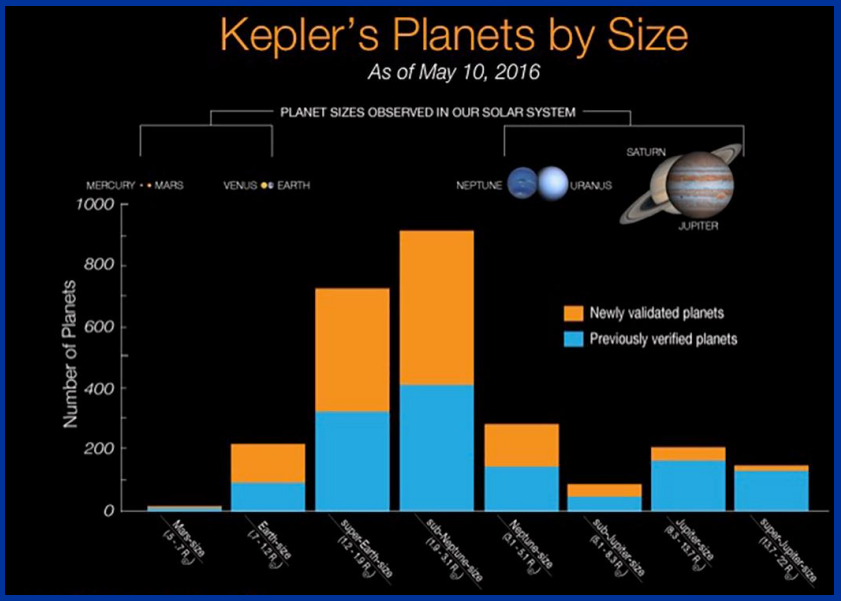
2M1207b directly imaged (ESO)

- This star and its planet were baptized as Helvetios and Dimidio in 2015, after a public vote promoted by the IAU.

经过IAU组织的一次公众投票后，这颗恒星及行星分别在2015年被命名为Helvetios和Dimidio。

1st photo of an extrasolar planet around a brown drwaf 2M1207. March 16, 2003
围绕着褐矮星2M1207公转的系外行星的第一张照片。 2003年3月16日





Credit: NASA

Kepler (March 2009), is NASA's first mission to find potentially habitable planets, the size of Earth.

开普勒计划(2009年3月)是美国航天局寻找系外宜居类地行星的第一个项目。

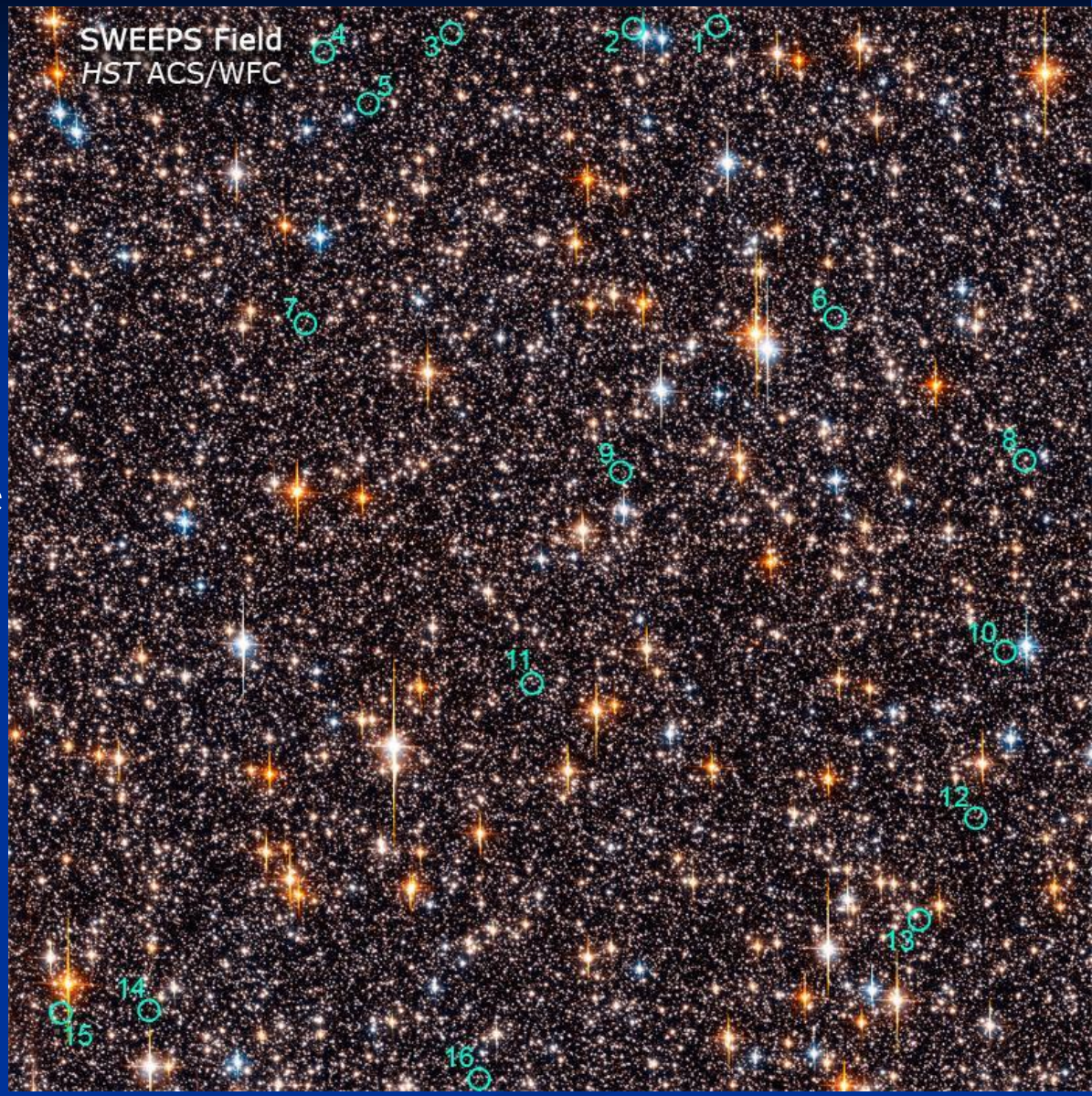
On May 10, 2016, he announced the largest exoplanet collection for which news is available.

2016年5月10日，项目组宣布找到了最大的系外行星样本。

Out of a total of about 5,000 candidates, more than 3,200 have been verified, and 2,325 of these were discovered by the Kepler telescope.

在总共约5000个候选体中，已经核实了3200多个系外行星，其中2325个是开普勒望远镜发现的。

Since 2018, the NASA satellite “Transiting Exoplanet Survey” will use the same method as the Kepler telescope to monitor 200,000 nearby bright stars and search for planets, especially the size of Earth or greater (the super Earths).自2018年以来，NASA凌星系外行星巡天望远镜使用与开普勒望远镜相同的方法，监测着附近20万颗明亮的恒星并搜寻行星，尤其关注那些和地球大小差不多或者更大些的超级地球。



How many stars have planets?

有多少恒星有行星？

How many of those planets are habitable?

这些行星有多少适合居住？

In how many developed some form of life?

又有多少产生了生命？

Questions that astronomy seeks to answer

天文学试图回答这一切

Many Thanks for your attention!

谢谢！