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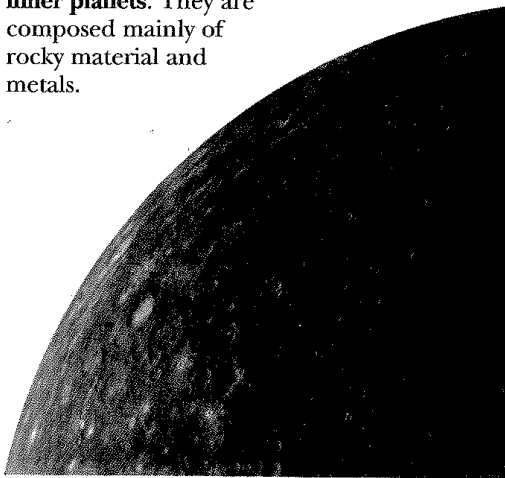
A Closer Look at the Planets

Space probes have flown close to all the planets except Pluto, sending back images that allow us to see details of those planets for the first time.

We can group the planets into two main categories, those that are nearest to the Sun and those that are much farther from the Sun. Let's go on a photo journey to look at the planets in order.

The Inner Planets

The four planets closest to the Sun are Mercury, Venus, Earth, and Mars. They are all small, and their densities are about 5 g/cm^3 , which is roughly the density of rocks. Because these planets resemble Earth, they are called the **terrestrial planets** (from the Latin for Earth: *terra*). These planets are also known as the **inner planets**. They are composed mainly of rocky material and metals.

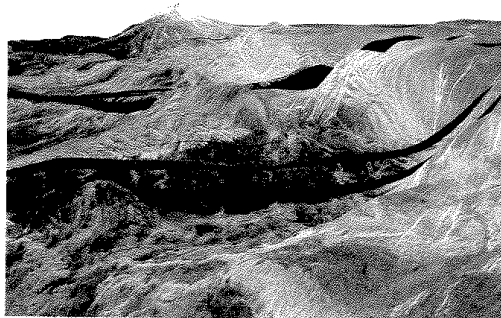


Mercury

- Mercury, the closest planet to the Sun, receives sunlight about 10 times brighter than Earth does, giving daytime temperatures over 400°C . However, it has no atmosphere to trap heat, so nighttime temperatures fall to -180°C .
- Craters were caused by chunks of rock colliding with Mercury.
- Mercury might be seen only a few times during the year just before sunrise or after sunset.
- Because Mercury is so close to the Sun, it is rarely visible in our night sky.

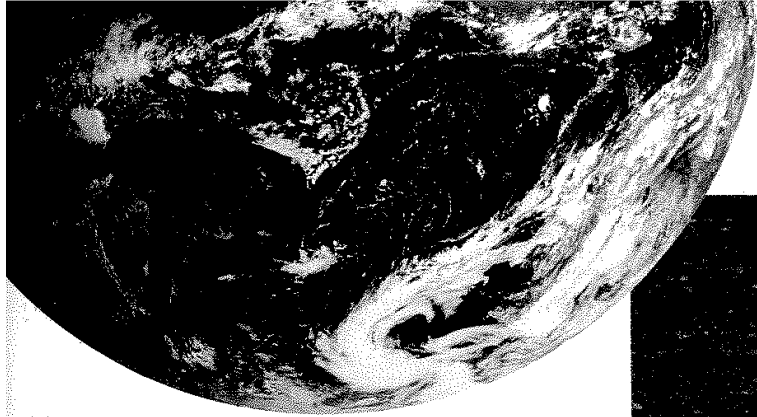
Did You Know ?

Aerobots are space probe balloons used to explore planets, such as Venus, that have an atmosphere. Scientists are designing a balloon that may be used to float above the surface of Mars and to take photographs. This will be a technological challenge because of the low density of Mars' atmosphere.



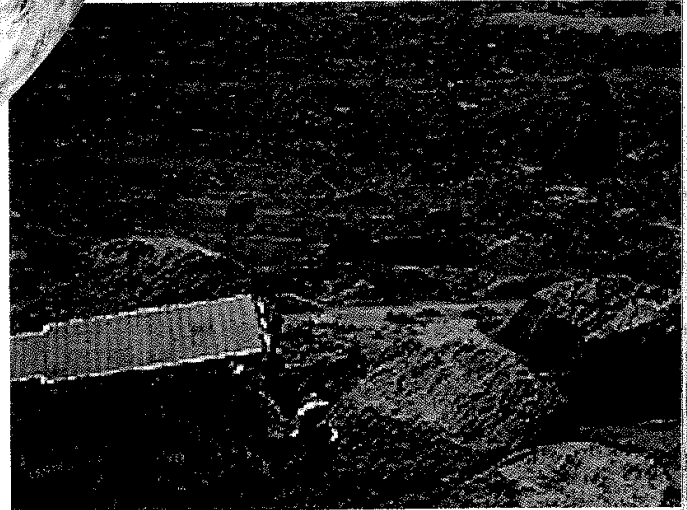
Venus

- This view of the surface of Venus shows a volcano that is 1.7 km high. Lava from the volcano has flowed hundreds of kilometres across the surface.
- After the Sun and Moon, Venus is the brightest object we can see in the sky because of its closeness to Earth and because its thick atmosphere reflects sunlight.
- The atmosphere is made mainly of carbon dioxide. This gas acts like the glass of a greenhouse, keeping the surface temperatures high enough to melt lead.
- Exploring the surface of Venus is not easy. This image was provided by the space probe *Magellan*. It had special radar cameras that could penetrate the thick atmosphere.



Earth

- From our point of view, the conditions on Earth are ideally suited for life, but we should remember that it is actually the other way around: life is ideally suited for Earth.
- Earth's unique atmosphere contains mostly nitrogen, oxygen, and water vapour. There is also a small amount of ozone in the atmosphere which filters some of the damaging radiation from the Sun, but lets enough through to support life. It also keeps the temperatures relatively constant between day and night, although there is a wide variation of temperatures between the poles and the equator (-85°C to about 65°C).
- Vast amounts of liquid water in the lakes, rivers, and oceans cover over 70% of the planet's surface.
- Much of the land surface has soil, resulting from erosion and organic material, covering the solid rock. This is an ideal medium for the growth of land plants.
- There are some active volcanoes and earthquakes changing the face of the planet, but it is mostly considered to be stable.

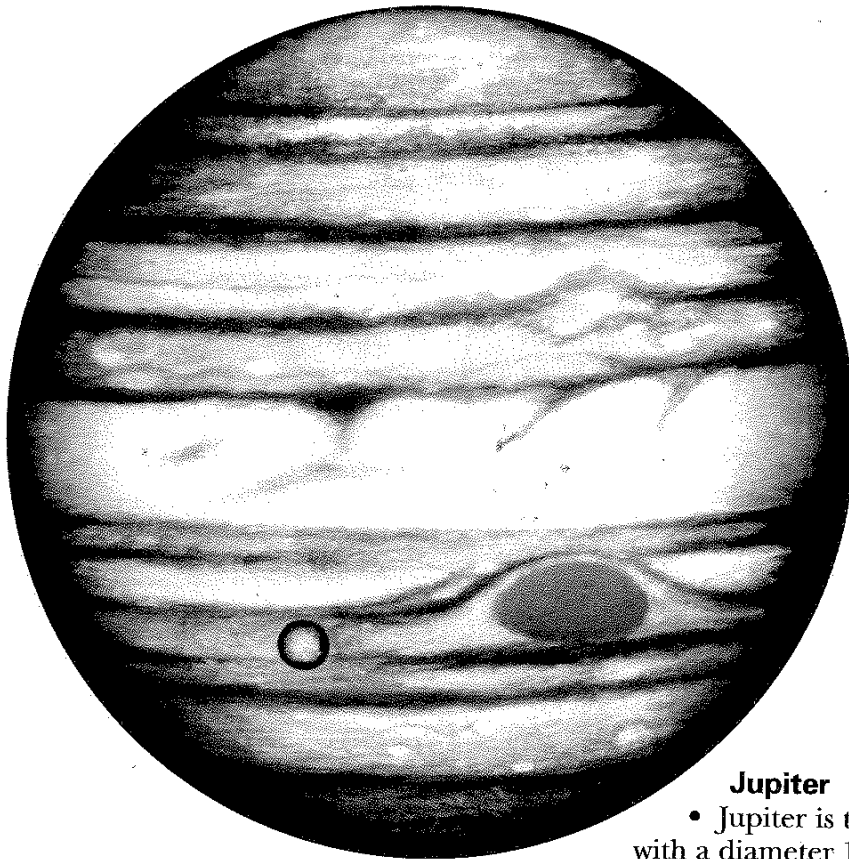


Mars

- Mars is one of the brighter objects in the sky and is sometimes called the red planet because of the reddish colour of its rusty soil.
- In 1997 the space probe *Pathfinder* landed on Mars, carrying a small vehicle called the *Sojourner* rover, which drove around exploring, sending images back to Earth, and collecting all kinds of data.
- Although it is very dry and barren now, there is evidence that Mars once had volcanoes, glaciers, and floods of water. Scientists have been especially interested in the possibility of some form of life there, and they have studied Mars more closely than any other planet, except Earth. No signs of life have yet been found, however.

The Outer Planets

Lying in the vast regions of the solar system beyond the four inner planets are the remaining five planets. They are called the **outer planets**. Four of these, Jupiter, Saturn, Uranus, and Neptune, are large, and their atmospheres consist mainly of the gases hydrogen and helium, which have low densities. For this reason, these four planets are called the **gas giants**. The gas giants appear to lack solid surfaces. Deep inside the atmosphere of these giant planets, the gases may become more dense, eventually becoming liquids and solids. The cores of these planets may contain metals, as those of the inner planets do. The outermost planet, Pluto, is unique among the outer planets.



Did You Know ?

A space probe launched toward Neptune now would take about 30 years to get there. Why, then, did *Voyager 2* take only 12 years to travel the distance? The reason is that Jupiter, Saturn, Uranus, and Neptune were lined up in a way that allowed their forces of gravity to increase the probe's speed. This alignment occurs only once every 176 years!

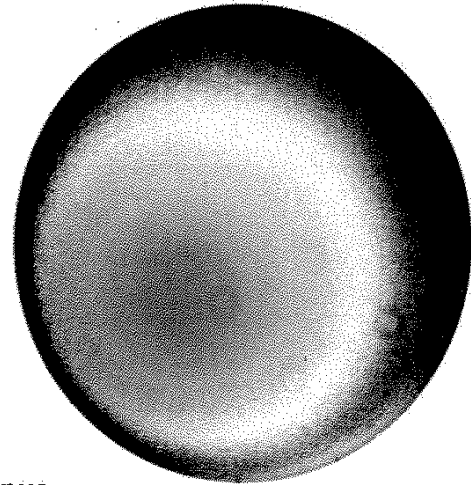
Jupiter

- Jupiter is the largest of all the planets: with a diameter 11 times that of Earth it has a greater mass than all the other planets combined. Its large size, plus the large amount of light reflected by its clouds, makes Jupiter very bright in the night sky.
- Jupiter's most interesting features are its coloured bands and the Great Red Spot, a huge hurricane fed by constant high winds. Larger than the size of two Earths, this hurricane already existed hundreds of years ago, when people first looked at Jupiter through telescopes, and it still shows no sign of dying away.
- Jupiter and its 16-or-so moons have been observed from close range by several space probes: *Pioneers 10* and *11*, *Voyagers 1* and *2*, and *Galileo*. You might even be able to see four of these moons—Io, Europa, Ganymede, and Callisto—through binoculars. What you can't see from Earth, however, are Jupiter's orbiting rings of rocks.



Saturn

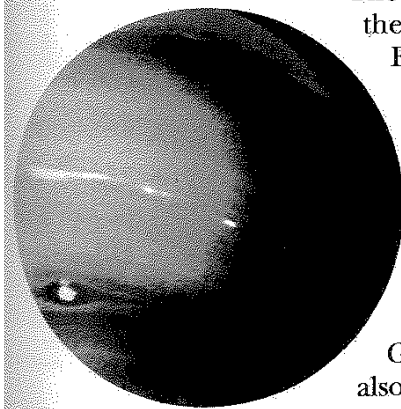
- Saturn, at about five-sixths the diameter of Jupiter, is the second largest planet in the solar system. The least dense of all the planets, it is possible that it has no solid core.
- Saturn's atmosphere is cloudy and, because of its quick rotation, windy. Saturn is farther from the Sun than Jupiter, so its average temperature is lower: about -180°C .
- For hundreds of years, people thought that Saturn was the only planet with rings. Detailed images sent by *Pioneer 11* and the two *Voyager* space probes showed that there are actually over 1000 separate rings. Astronomers are not certain whether the rings formed at the same time as the planet or are the crumbled remains of one of Saturn's many moons or some other object that came too close to the planet.



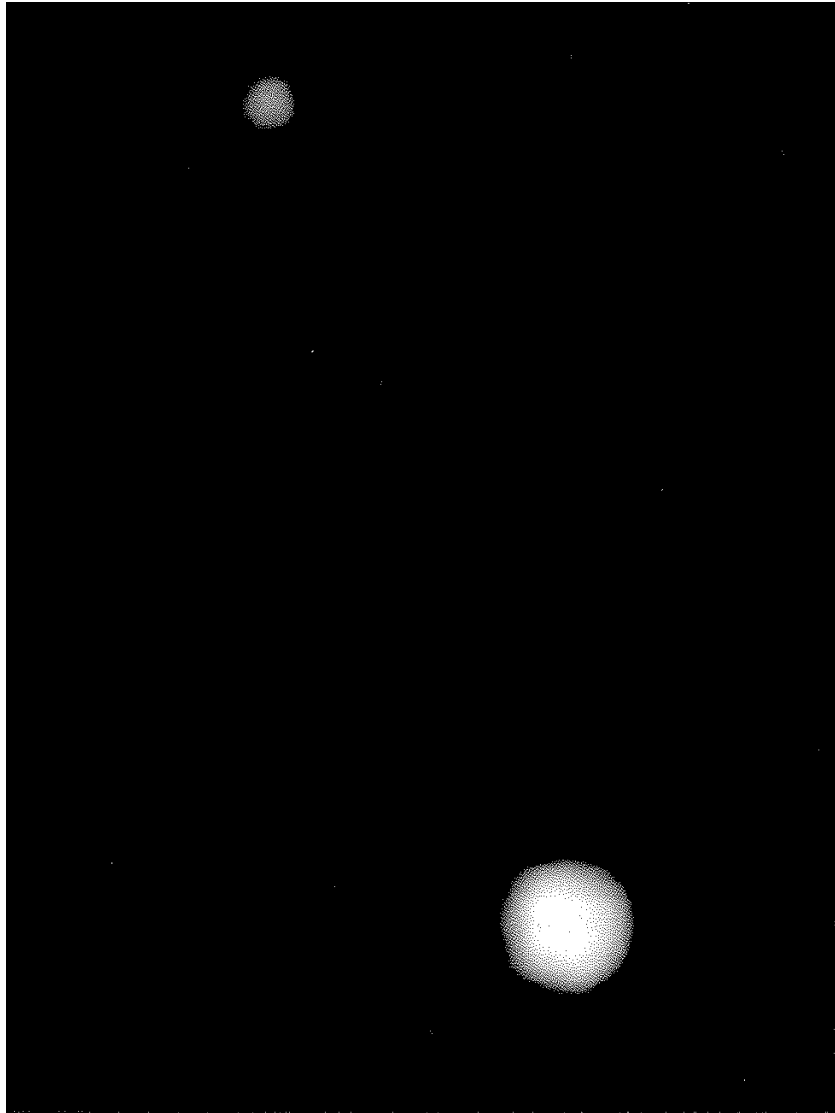
Uranus

- Although Uranus's diameter is almost four times that of Earth, it is so far away that it looks like a faint star. It was actually thought to be a star until its motion was discovered in 1781.
- Astronomers gathered considerable data about Uranus when *Voyager 2* passed near it in 1986.
- Uranus is unusual because its axis of rotation is in nearly the same plane as its orbit. This means that Uranus rotates on its side; the orange patch in the computer-enhanced photograph is a polar hood over the south pole.
- The atmosphere of Uranus is made up mostly of hydrogen, with some helium and methane. It has winds that blow up to about 500 km/h.

Neptune



- The story of the discovery of Neptune, the second farthest planet from the Sun, is one of great scientific achievement. Neptune is so far from Earth that it is barely visible, even through powerful telescopes. After 19th-century scientists established that Uranus was a planet and not a star, they studied its orbit and discovered that the orbit was not a smooth circular path. They hypothesized that some other object must be "tugging" on Uranus, causing its uneven orbit. Using detailed calculations, they predicted where this hidden object must be, searched, and discovered the "missing" planet in 1846.
 - In 1989, computer-enhanced images from *Voyager 2* revealed that Neptune has bright blue and white clouds, and a dark region—the Great Dark Spot—that appears to be the centre of a storm. *Voyager 2* also uncovered the existence of at least eight moons and some thin rings orbiting Neptune.



Pluto

- Pluto is an unusual planet because it is not a gas giant and it does not seem to be terrestrial. It was discovered in 1930 after a painstaking search.
- Pluto is so far away that it takes 248 years to orbit the Sun. Although astronomers haven't yet observed a complete orbit, they have seen enough to detect that Pluto's orbit is elliptical and not quite centred on the Sun. Pluto actually passed within the orbit of Neptune, making it the eighth planet from the Sun, from January 1979 until February 1999. Pluto's unusual orbit has led some astronomers to suggest that it may have been a moon of Neptune at one time.
- Images taken by the Hubble Space Telescope have given us our best information yet about tiny, cold, distant Pluto and its moon, Charon.

Understanding Concepts

1. Why are the four closest planets to the Sun called the "terrestrial planets"?
2. Describe two features that make Earth unique among the planets, and two that make it similar to other planets.
3. Why is Jupiter easy to see in the night sky (when viewing conditions are right)?
4. There may be other groups of planets similar to our solar system, but they are very difficult to detect. Why?
5. How would the tilt of Uranus affect its seasons?

Making Connections

6. What are some features of a roving robot you would design for exploration on Mars?
7. List five or six ways that humans have had an impact on Earth and mention how each has had positive and negative results on life on Earth.

Exploring

8. Research the orbits of Mercury and Earth around the Sun. Draw a diagram to illustrate them and use it to explain why Mercury is so difficult to see from Earth.

Reflecting

9. List the steps that were followed in discovering Neptune. How do these steps relate to the process of scientific discovery?