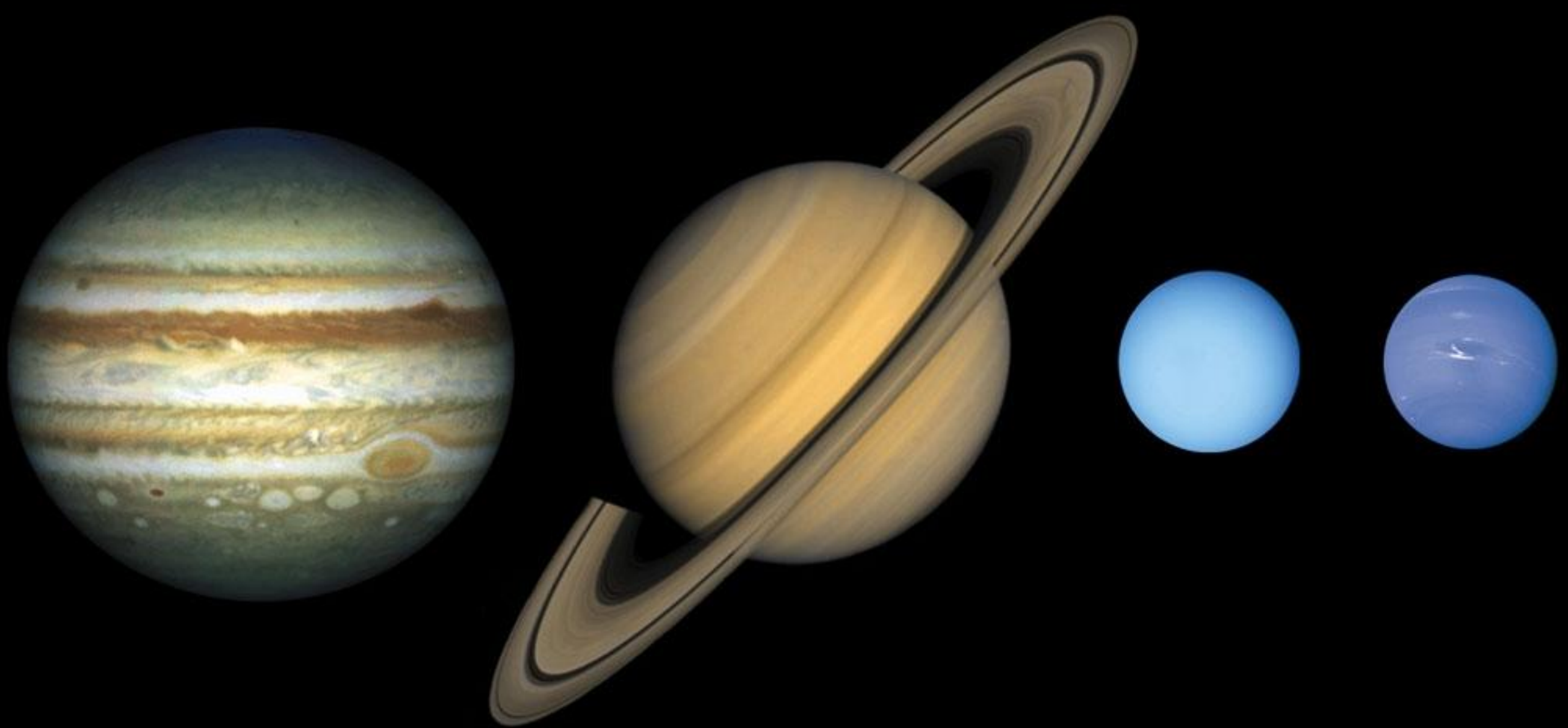


# The Solar System



## THE SUN

**Core:** It is a gravitationally bound stabilized fusion reactor, where energy is produced by conversion of hydrogen into helium according to Einstein's formula  $E=mc^2$ . Temperature=13,600,000 K, density=150 g/cm<sup>3</sup>.

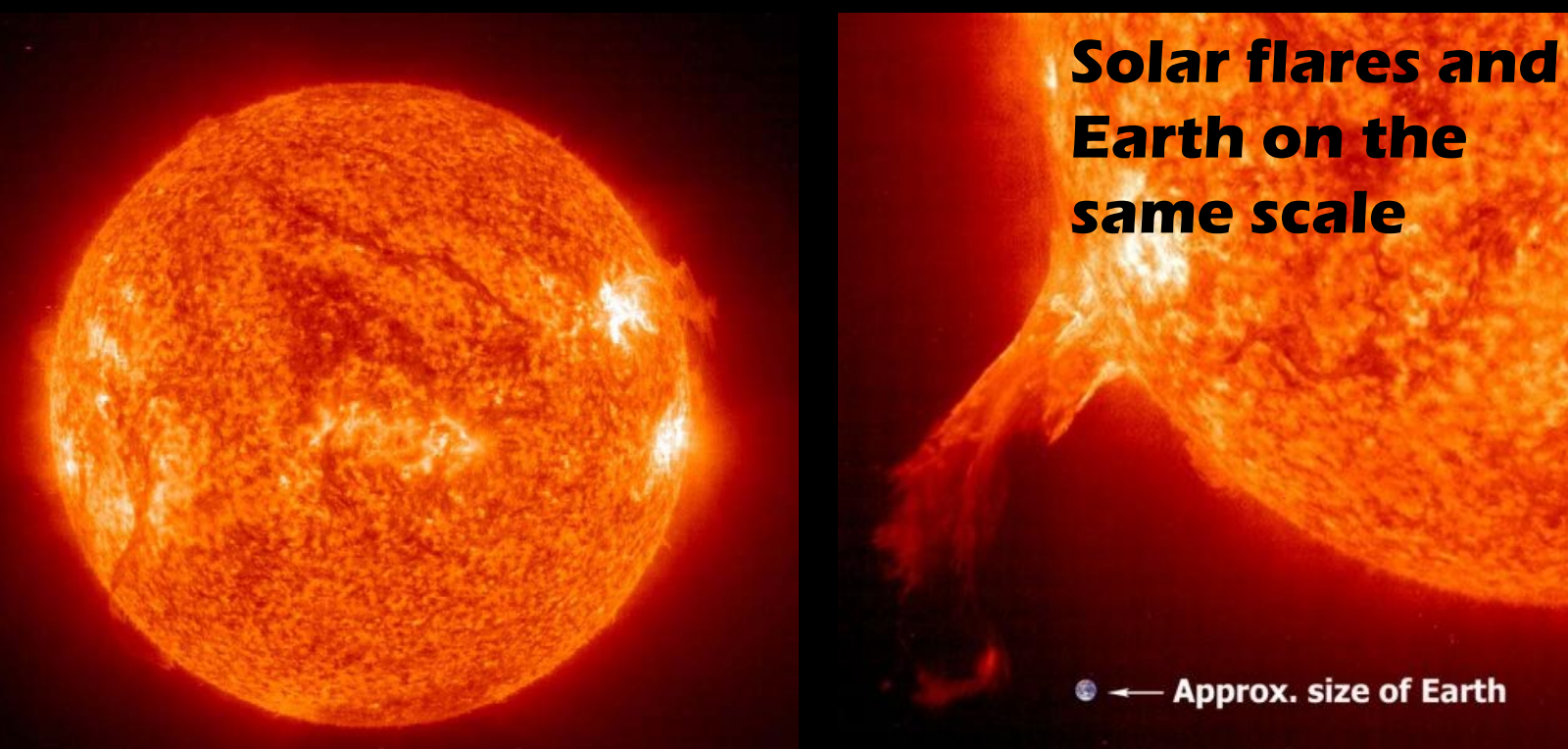
**Radiative zone:** From about 0.25 to about 0.7 solar radii, heat is transferred by radiation, temperature varies from 7,000,000 K to about 2,000,000 at the top of this zone.

**Convective Zone:** Forms outer shell of the Sun, starts from 0.7 solar radii to the bottom of the visible surface. Opaque to radiation; energy is transferred by convection. Density: 0.2 gm/cm<sup>3</sup>.

**Photosphere:** 500km thick layer above convection zone, opaque to visible light. Temperature: 5800 K, density is 0.1% of the density of air at sea level.

**Chromosphere:** A thin layer the Sun's atmosphere just above the photosphere, roughly 2,000 kilometres deep. More transparent than photosphere. It is visible during a full solar eclipse.

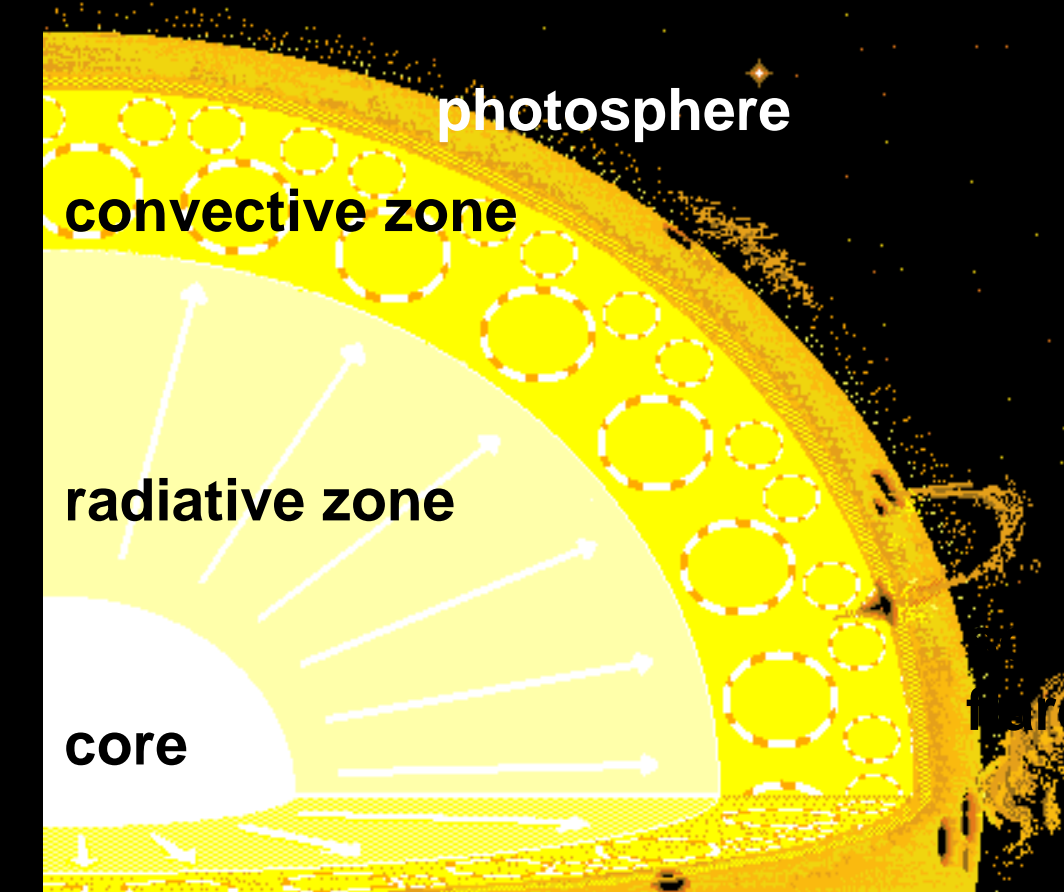
**Corona:** Extended outer atmosphere of the sun with extension up to ten solar diameters. Temperature is 200 times greater than at the visible surface of the sun.



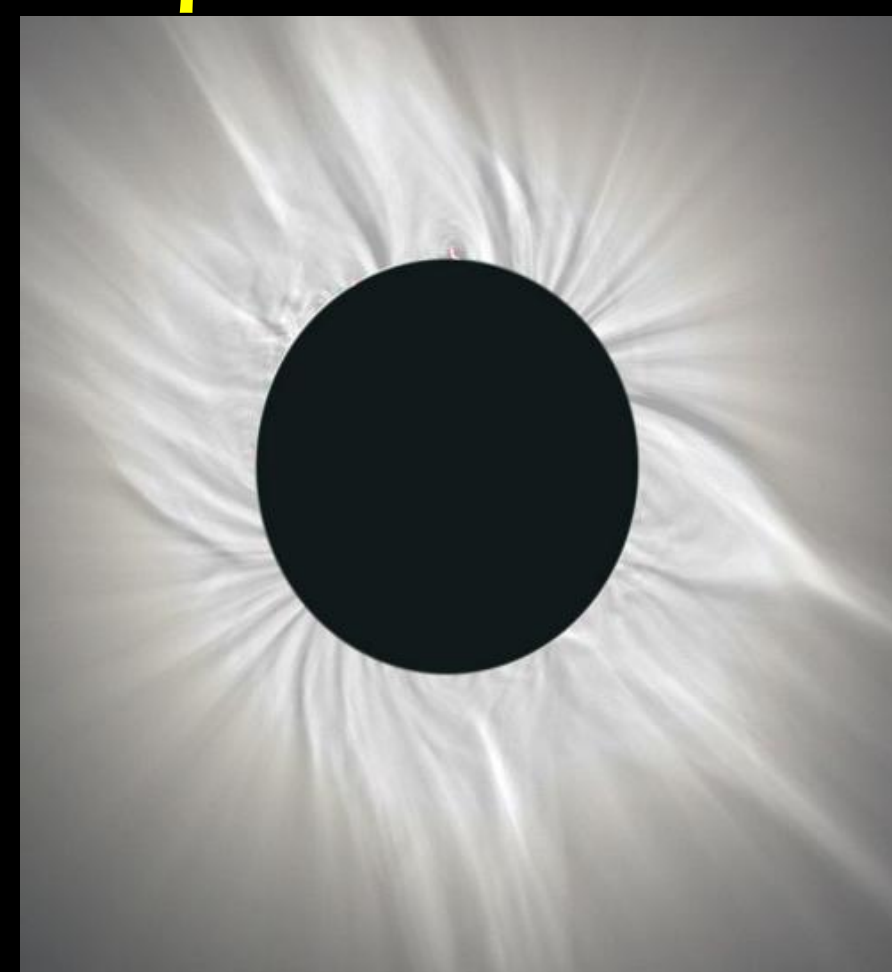
Solar flares and Earth on the same scale

Approx. size of Earth

## Different zones of solar interior



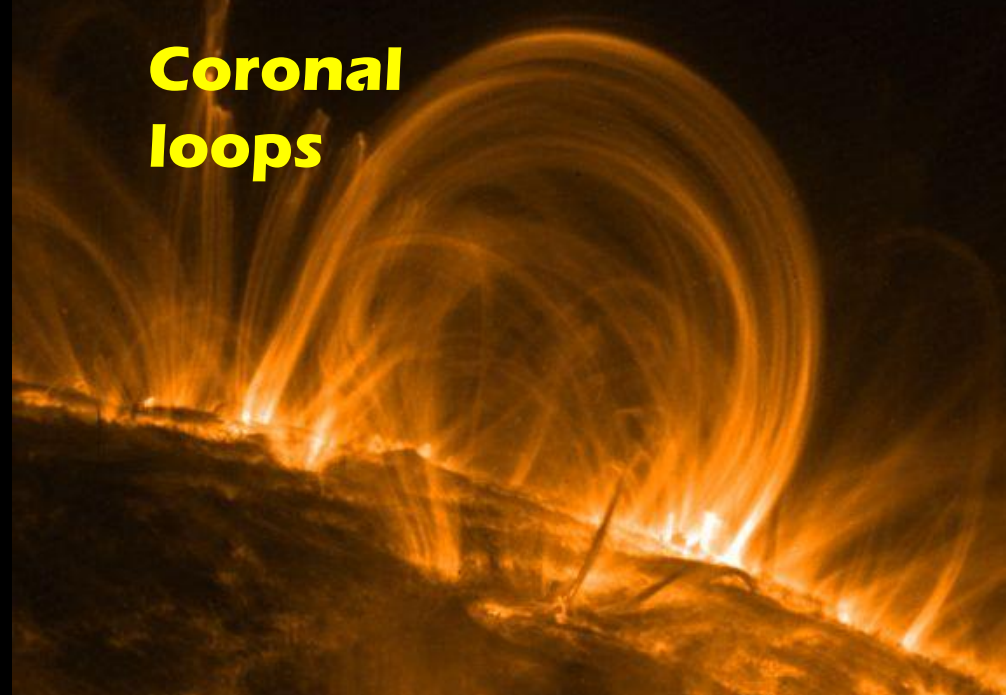
Corona visible during full solar eclipse



**Sun spots:** Dark blemishes on the photosphere. These are the cooler regions compared to their surroundings.



Earth and a sun spot on the same scale



Coronal loops

**MERCURY:** As the planet closest to the sun, Mercury's year (orbital period) is only about 88 Earth days. At a maximum angular separation of only 28° from the sun, Mercury gets lost in the sun's glare and thus cannot usually be seen with the naked eye. The smallest planet in the solar system, Mercury's surface gravity, it turns out, is too weak to retain any significant atmosphere. Without an atmosphere to retain heat, and a long day (spin period) of about 59 Earth days, the planet's temperature varies considerably between daytime, when it can be as high as 450°C, and nighttime, when it can drop to as low as -180°C. Its surface is cratered like that of the moon, but unlike the moon, Mercury possesses a relatively large iron core which generates a magnetic field similar to, but much weaker than, that of Earth.



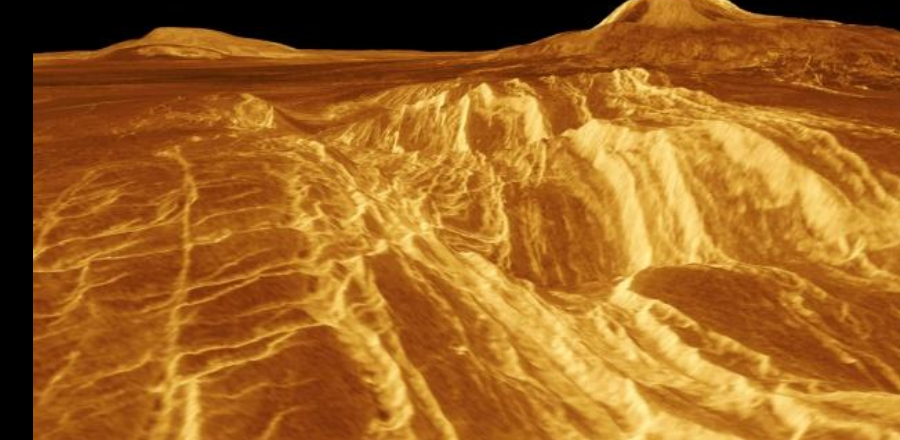
Mercury



Venus



Surface of Venus



Great Red Spot

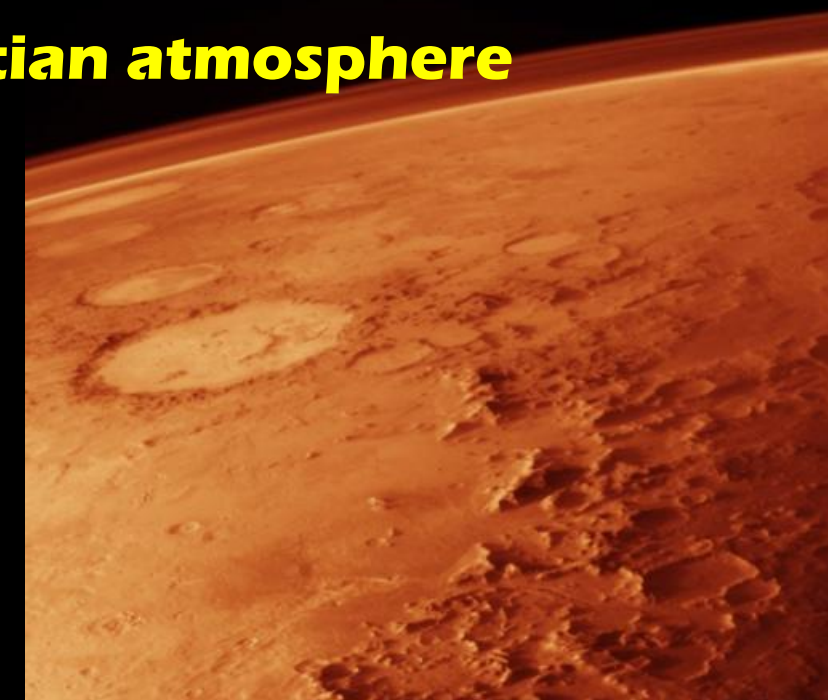


**VENUS:** The planet whose orbit brings it nearest to Earth, Venus is almost the same size and has nearly as much surface gravity as our planet. As its orbit is interior to our own, it has phases like those of the moon (first observed by Galileo); in fact, its smaller orbit means that it is always within about 47° of the sun in the sky, which is why it is known as the "morning star" and "evening star". At one point in its history, Venus might have been more Earth-like, but evaporation of water from its surface probably led to a runaway greenhouse effect; presently its dense carbon dioxide atmosphere and sulfur dioxide clouds trap much of the heat re-radiated by its surface, leading to a mean ground-level temperature of almost 500°C. Coupled with an atmospheric pressure almost 100 times that on Earth, Venus is far from paradise! Although Venus' dense clouds are opaque (in fact, they reflect most of the sunlight incident upon them, which is one of the reasons the planet is so bright), space probes have been able to gather information about the hidden surface underneath; we now know that much of it has been shaped by volcanism, which may still be ongoing.

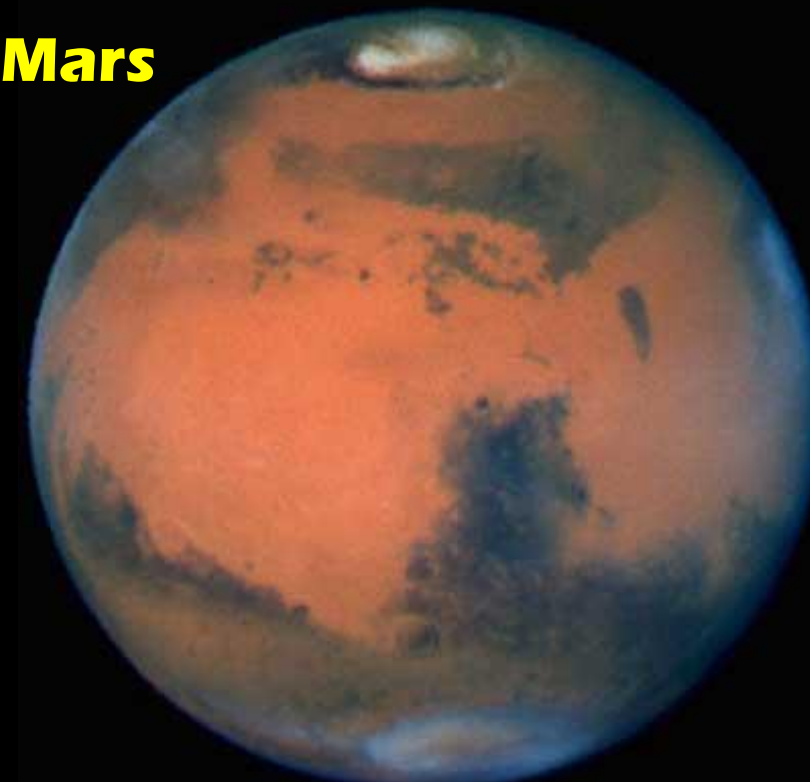


Earth

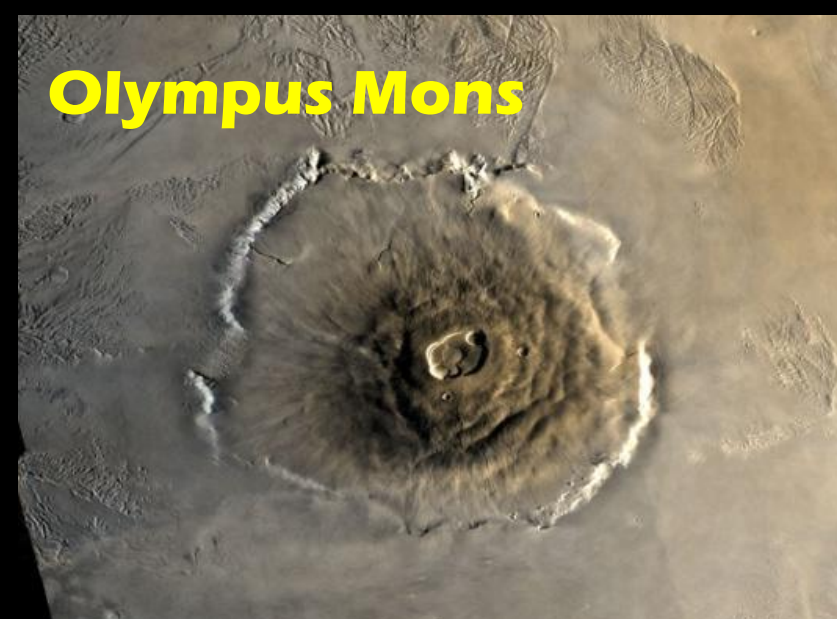
Martian atmosphere



Mars



Olympus Mons



**MARS:** With a diameter of about half, and mass of about 1/10 that of Earth, a 50 kg person on Mars would weigh only as much as a 19 kg child weighs on Earth. This low surface gravity helps make possible the existence of large variations in elevation, notably the (possibly extinct) volcano, Olympus Mons, which, at 3 times the height of Mount Everest, is the tallest peak in the solar system. Currently, Mars' temperature (from -87°C to -5°C) and atmospheric pressure (about 1% that of Earth) are too low to allow liquid water to exist for a long time on its surface, though ancient channels and other evidence accumulated by numerous spacecraft indicate that vast amounts of surface H<sub>2</sub>O once flowed on Mars. Today, water still exists in the polar ice caps, in the permafrost layer below the soil and perhaps, some scientists speculate, deeper underground. The presence of water suggests the possibility of life, but solid evidence for organisms on the Red Planet, alive or extinct, has not been found.

**ASTEROIDS:** Also called minor planets or planetoids, these are relatively small rocky bodies typically found in the inner solar system, in a region called the asteroid belt, situated between the orbits of Mars and Jupiter. Most of them are irregularly shaped, as self-gravity is usually too weak to have smoothed them into a spherical form. It is believed that most of the asteroids in this belt have been ejected from the solar system since its formation, leaving a collection whose total mass is only about 4% that of the moon. Though objects in the belt are thinly dispersed, collisions between asteroids occur rather frequently over astronomical timescales, and it is thought that planets form by the gradual accumulation of such objects. So why did the asteroids not form a planet? Blame the effects of Jupiter's strong gravitational field. Nevertheless, more than half the mass of the belt is contained in the 4 largest objects: Ceres, Vesta, Pallas and Hygiea, so some coalescence has occurred (Ceres, with a diameter of 950 km, is known as a dwarf planet).



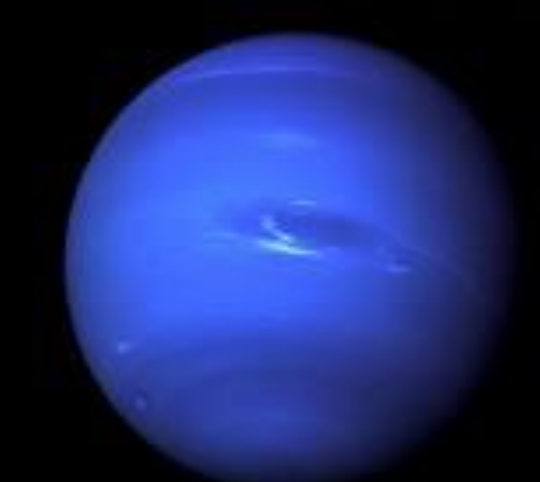
Asteroid



Major dusty ring of Saturn

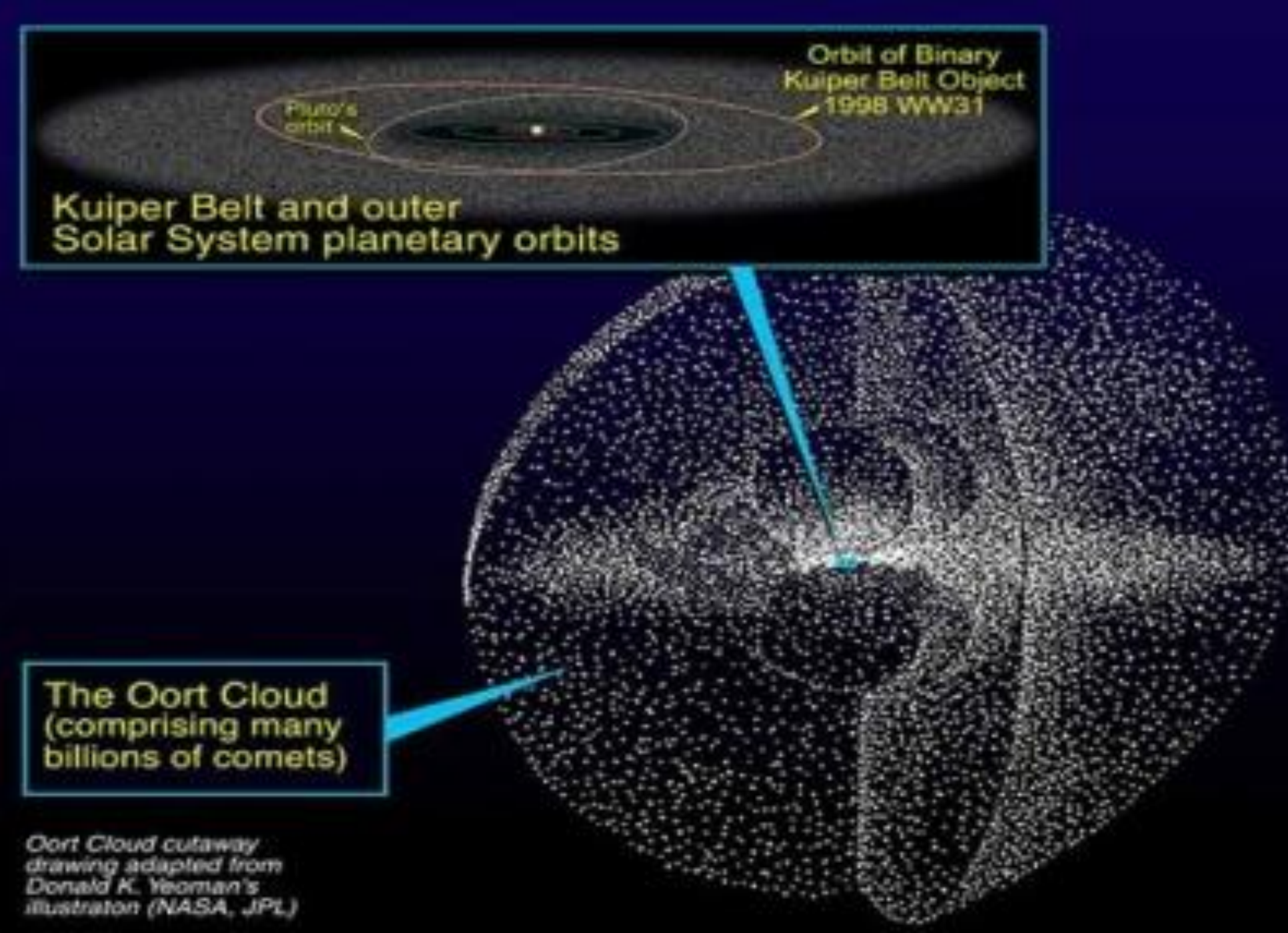


Uranus with its faint ring system (computer-generated)



Bluish tint of Neptune

**COMETS:** Loose collections of ice, dust and rock, these bodies measure a few hundred to tens of kilometers across, and in some cases are visible to the naked eye as they make a periodic pass through the inner solar system. Most comets exist in relatively stable orbits within two regions: the Kuiper belt, situated beyond the orbit of Neptune, and the Oort cloud, a vast spherical reservoir that lies tens of thousands of times farther from the sun than Earth. (Long included as a planet, Pluto is now classified as a dwarf planet, and probably the largest member of the Kuiper belt.) Occasionally, comets get perturbed gravitationally by a planet (Kuiper belt), or a passing star (Oort cloud), sending them on elongated orbits that bring them close to us. When near to the sun, solar radiation causes certain frozen materials within the comet to vaporize, resulting in a very thin atmosphere, or *coma*, and spectacular tails of gas and dust.



The Oort Cloud (comprising many billions of comets)

Oort Cloud cutaway drawing adapted from Donald A. Kessler's illustration (NASA, JPL)



Comets in the inner solar system



Jupiter after the impact of comet Shoemaker-Levy 9

**IMPACTS:** The moon's numerous craters are evidence that it has been bombarded by massive projectiles sometime in its past. Although most of the craters on Earth have been eroded away, Earth too has been subjected to a great number of collisions, large and small. Meteorites are rocks from space that make it all the way down to Earth's surface, and meteors are those that are so small that they burn up in the atmosphere (the latter are sometimes visible as "shooting stars"). In fact, the moon itself was created when a Mars-sized object struck Earth early in its history. A significant amount of the water on our planet was deposited by meteorites. Several large craters, it turns out, do exist on Earth, notably the 180 km diameter Chicxulub crater on the coast of Mexico, caused by the impact of a comet or asteroid some 10 km wide, 65 million years ago. That impact is thought to be the primary cause of the Cretaceous-Triassic extinction event that killed about 75% of all species including the dinosaurs. Although large impacts were more common in Earth's youth, they are still happening; in 1908, for example, an object a few tens of meters across exploded over a remote part of Russia, knocking down some 8 crore trees. More recently, in 1994, astronomers watched in suspense as the comet Shoemaker-Levy 9 broke apart spectacularly into several fragments and collided with Jupiter.

**URANUS and NEPTUNE:** Uranus is The first planet discovered by telescope. Its two largest moons are Titania and Oberon. Mean distance from the sun is 19.2 AU. It has 15 earths mass and 4 times the diameter of the earth. Its one year correspond s to 84 earth years and one day that of 17.23 earth hours. It has faint ring system and total number of moons equal to 27. It appears bluish as the presence of methane in its upper atmosphere absorbs red light and give it a blue tint. Calculated orbit of Uranus didn't seem to match the known laws of motion. This surprising discovery led to the eventual discovery of Neptune at a thrice distance that of Saturn from the sun with mass, radius and rotation period close to Uranus. It has four prominent rings and has bluish appearance for the same reason that of Uranus.

**SATURN:** Sixth planet, second largest, Saturn is light enough to float on water, famous for its spectacular ring structure, mass and diameter are 95 and 9.4 times that of earth. It is at a mean distance 9.54 AU from the sun with rotation and revolution period of roughly 10.57 hours and 29.46 years respectively. Its atmospheric composition is roughly 97% hydrogen and 3% helium. The ring systems are made up of dusty particles like so many tiny moons. The complete ring system is composed of thousands of ring which possess their own atmosphere. Up till now its total number of moons are 62 among which the biggest one is Titan which has been visited by spacecraft.

Ring system of Saturn