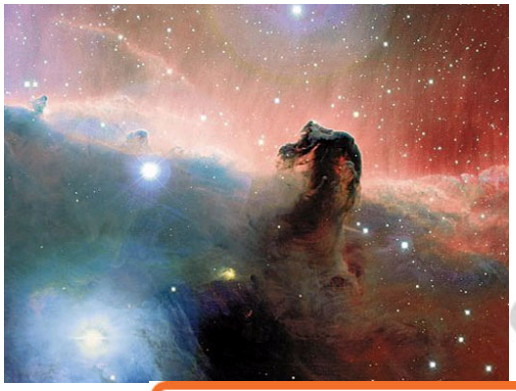
OUR SOLAR SYSTEM

The Formation of Our Solar System

Solar systems begin in the dust and gas clouds found in between the stars. The dust is composed of elements like iron and carbon. The gas is hydrogen and helium. These dusty clouds are called **nebulae**. Here these particles start to come together to form planets.



NASA image of Horsehead Nebula

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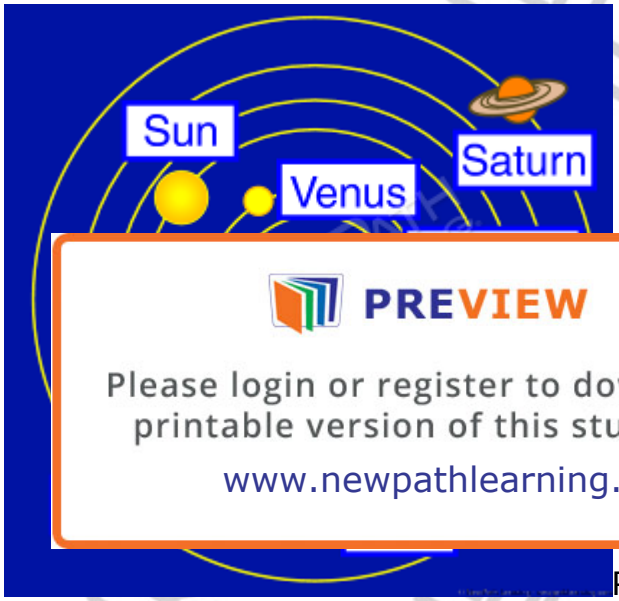
Close to the sun, the rocky planetesimals grew by accretion to become the rocky planets. In the outer reaches of the solar system, the gases like hydrogen and helium accreted to rocky cores forming planets called **gas giants**. There are no gas giants nearer the sun because it is too warm nearer the sun. The gas giant planets are massive layers of gas and *frozen* gas.

Starting with the planet nearest the sun, the rocky planets are Mercury, Venus, Earth, and Mars. The gas giants are Jupiter, Saturn, Uranus and Neptune. Until August 24, 2006, Pluto was included in the list of gas giant planets. After much international study and debate, Pluto was removed from the list of planets and reclassified as a **dwarf planet** in a region of the solar system known as the **Kuiper belt**. The rocky planets are also referred to as the **inner planets** and the gas giants as the **outer planets**.

Geocentric and Heliocentric Systems

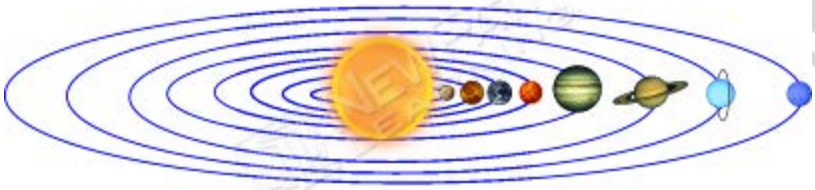
The earliest concepts about the solar system were based on observations that could be made from Earth without the aid of instruments like telescopes. Because the point of view or perspective of these early observers was from Earth itself, the solar system was described in relation to the Earth. In 140 CE, the Greek astronomer Ptolemy believed that the Earth was the center of the universe and that the sun and all other planets revolved around the Earth. This concept was believed to be true for many hundreds of years. This is the **geocentric** concept of the universe.



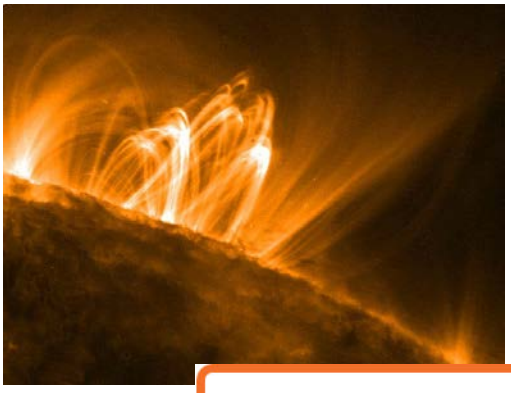
Ptolemy's universe

It would not be until the mid-16th century that this concept would be challenged. In 1543, Nicolaus Copernicus published a revolutionary theory about the universe. He claimed that the *sun* is the center of the universe and all the planets revolve around the sun. This is the **heliocentric** concept of the universe (*helios* is the Greek word for sun).

To be most accurate, Copernicus understood the sun to be the center of the *universe*. Though not accurate, this concept was an observation that moved our understanding closer to the truth that the sun is the center of our *solar system*, a collection of planets around a single star (the sun) within a galaxy called the Milky Way within a universe of galaxies.



The Center of our Solar System – The Sun



The sun is a burning ball of gas (mostly hydrogen and helium) that is held together by gravity. The sun is more than a mixed, uniform ball of burning gas. It has layers and structure.

NASA photo of Sun

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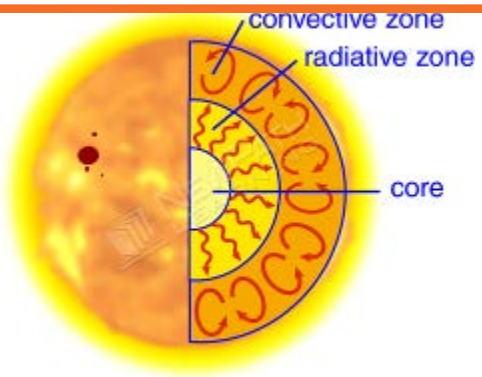
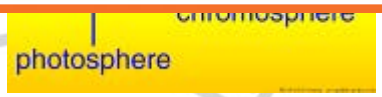


The sun's energy is produced by nuclear fusion reactions. In this process, hydrogen molecules undergo nuclear fusion. This creates Helium-3. Then Helium-3 molecules undergo another process of nuclear fusion. Each fusion process creates more energy. Keep in mind, the process is much more complicated than this simplified explanation.

The energy produced by these fusion processes is carried toward the surface of the sun by photons (light energy).

The outer layer of the sun is called the **convection zone**. In this layer, hot gases rise toward the surface where they cool sufficiently to descend back into the sun. This rising and falling of hotter and cooler gases produces currents near the sun's surface. This is the same physical process responsible for convection cells in the Earth's mantle (which drives plate tectonics) and convection cells in the atmosphere (which affect weather patterns).

The surface of the sun that we are able to see is called the **photosphere**. Beyond the photosphere is a region just a little thicker than the diameter of the Earth called the **chromosphere**. "Chromosphere" literally means "color sphere" because this layer, though more transparent than the photosphere, has a reddish color. This color can be seen very briefly during a solar eclipse when the moon covers over the sun.



here are cooler, dark areas on the sun's surface called **sunspots.** Sunspots are the result of the sun's magnetic field affecting the convection of heat in the sun.

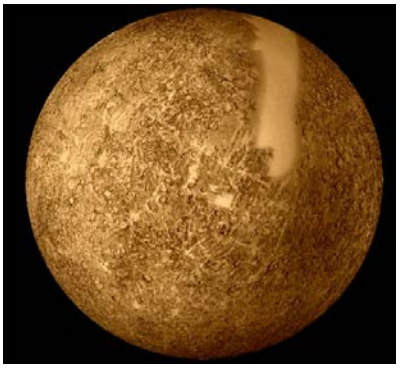
The sun's magnetic field can also create **solar flares**. These enormous "storms" of fire on the sun's surface can reach temperatures exceeding 5 million degrees Celsius!

The outer atmosphere of the sun, the **corona**, extends for millions of miles beyond the sun. This atmosphere is composed of gases and can only be seen during a total solar eclipse.

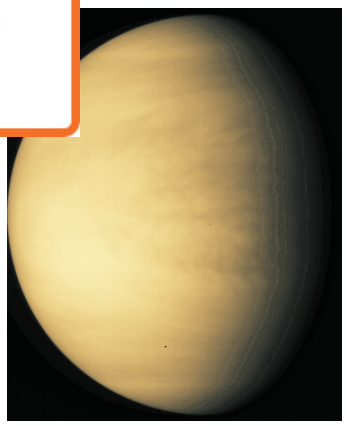
The Inner Planets

The inner planets are also known as the **terrestrial planets** and as rocky planets.

The terrestrial planets are Mercury, Venus, Earth and Mars. Mercury is the smallest of the terrestrial planets. Because it is closer to the sun its orbit around the sun takes only 88 Earth days. Its rotation on its axis is so slow that a single "Mercury day" is 59 Earth days long. Very little is known about Mercury. The only spacecraft to travel near Mercury was Mariner 10 in 1974 and 1975. Mariner 10 mapped less than half of Mercury's surface. What it revealed was that Mercury is similar to our Moon in that has many craters from meteorite impacts. Mercury has no atmosphere and no moon. Since it has a magnetic f



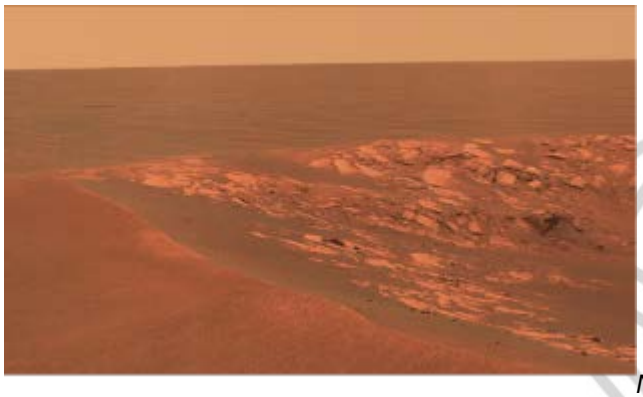
More is kn enus to revolve on **revolutio** "sister pla compositio above the North Pole, the Earth rotates counterclockwise. This is called **prograde** rotation. Venus rotates *clockwise*. This is called **retrograde** rotation. It has the densest atmosphere of the terrestrial planets, so dense in fact that a human standing on the surface would be crushed. The atmospheric pressure on Venus is 92 times that on Earth. The atmosphere on Venus consists of carbon dioxide and clouds of sulfuric acid.



Venus is extensively covered with meteor impact craters and many active volcanoes (the source of the sulfur and carbon dioxide in its thick atmosphere). It is considered, geologically speaking, a young planet.

The next terrestrial planet from the sun is our own, the **Earth**.

The next beyond Earth is **Mars**. A number of space probes have been sent to Mars, both to study it from an orbit around the "Red Planet" and also from rovers that travel across its surface. As a result, of all the other terrestrial planets we know the most about Mars.



NASA image of Mars Surface

Mars has had a very active volcanic history. Unlike Earth, however, it is not tectonically active so its volcanoes are larger than any on Earth. (This plane system, Olympus M wing evidence t er on Mars. The der its surface.

NASA image of Mars' Olympus Mons, a shield volcano

Mars is volcanically active, but it is not tectonically active (in other words, it does not have tectonic plates that are moving relative to one another). It also has the largest canyon in the solar system, Valles Marineris. Mars has a thin atmosphere. It takes Mars approximately 2 Earth years to revolve around the sun once. A single day on Mars is only slightly longer than a day on Earth. (Astronomers call a day on Mars a **sol**.) Mars also has two small moons.

The Outer Planets

Beyond Mars are the gas giant planets. These four outer planets (Jupiter, Saturn, Uranus, and Neptune) are also referred to as the **Jovian planets**.

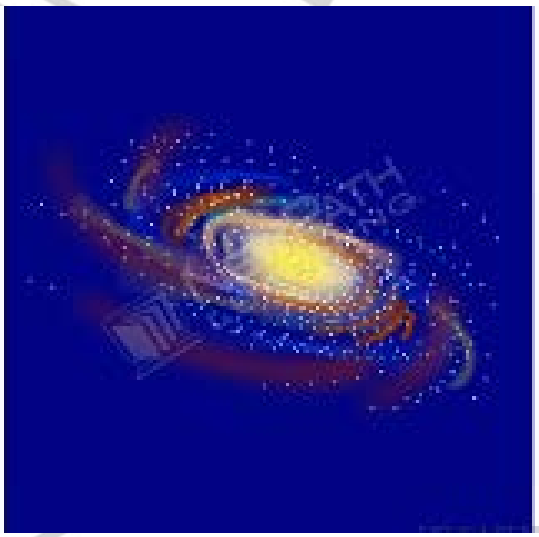
The first is **Jupiter** (as shown in this NASA image). Jupiter is the largest planet in our solar system. The Romans named this planet after their god, Jupiter. It likely has a rocky core, but Jupiter is mostly hydrogen and helium. The rocky core is assumed since it has a magnetic field. Jupiter is marked by a giant red spot in the southern hemisphere of the planet. This red spot is an enormous storm brewing in its atmosphere. It has over 60 moons; its four most prominent moons were d are known as t

The next g n god, Saturnus. stem. Scientists eceives from the s n. Winds can blow a turn is most easily recognized by its dramatic rings. The rings are mostly composed of ice particles with some dust and rocky particles mixed in. Sixty moons have been identified around Saturn.

Uranus is the next planet from the sun. It is visible to the naked eye, but due to its distance from the Earth (and consequently its dimness) it was not recognized as a planet until 1781. It was the first planet to be discovered with the use of a telescope. (Jupiter and Saturn, as well as the terrestrial planets are all visible to the naked eye under the right conditions – assuming you know what you are looking for!) It has layers of clouds. The atmosphere is, as with the other gas giants, hydrogen and helium. It has higher quantities of frozen ammonia, water and methane. It is therefore sometimes referred to as an "**ice giant**." Its axis of rotation is horizontal, that is, in the position where the equator would be for all the other planets. It also has a magnetic field. Like the other gas giants, Uranus has a number of moons.

The gas giant furthest from the sun is **Neptune**. Neptune is similar to Uranus in that it has a higher amount of frozen gases like methane, water and ammonia (and therefore sharing the title of "ice giant.") It was named after the Roman sea god. It has a rock and ice core surrounded by a large layer of ices and a layer of hydrogen and helium gas. The h ptune. Some have ur.

Until e sun. Intensive s d to the conclusion a planet. It is theref **anet** in a region of t nd other planetesimals left over from the formation of the solar system are found in this far distant portion of our solar system.



Comets, Asteroids and Meteors

Rocky bodies that circle the sun mostly in an area between Mars and Jupiter are called **asteroids**. This region between Mars and Jupiter is known as the **asteroid belt**. Asteroids are sometimes called **planetesimals** or **small solar system bodies**. Asteroids can be small or as much as nearly 100 kilometers in diameter.

Meteoroids are smaller pieces of interplanetary rock that have come from **asteroids**. A **meteorite** is a meteoroid that has struck Earth. The streak of light created by a meteoroid entering Earth's atmosphere and burning up is called a **meteor**.

A **comet** is a small body composed of a mixture of rocky material and ice that orbits the sun and has a tail of ice particles trailing behind it.

There are some meteorite impact craters still visible on the surface of the Earth, such as Meteor Crater in Arizona (pictured here). Though the processes of weathering, erosion and tectonics have obliterated most mete serve and others are geologists believe tha a massive meteorite