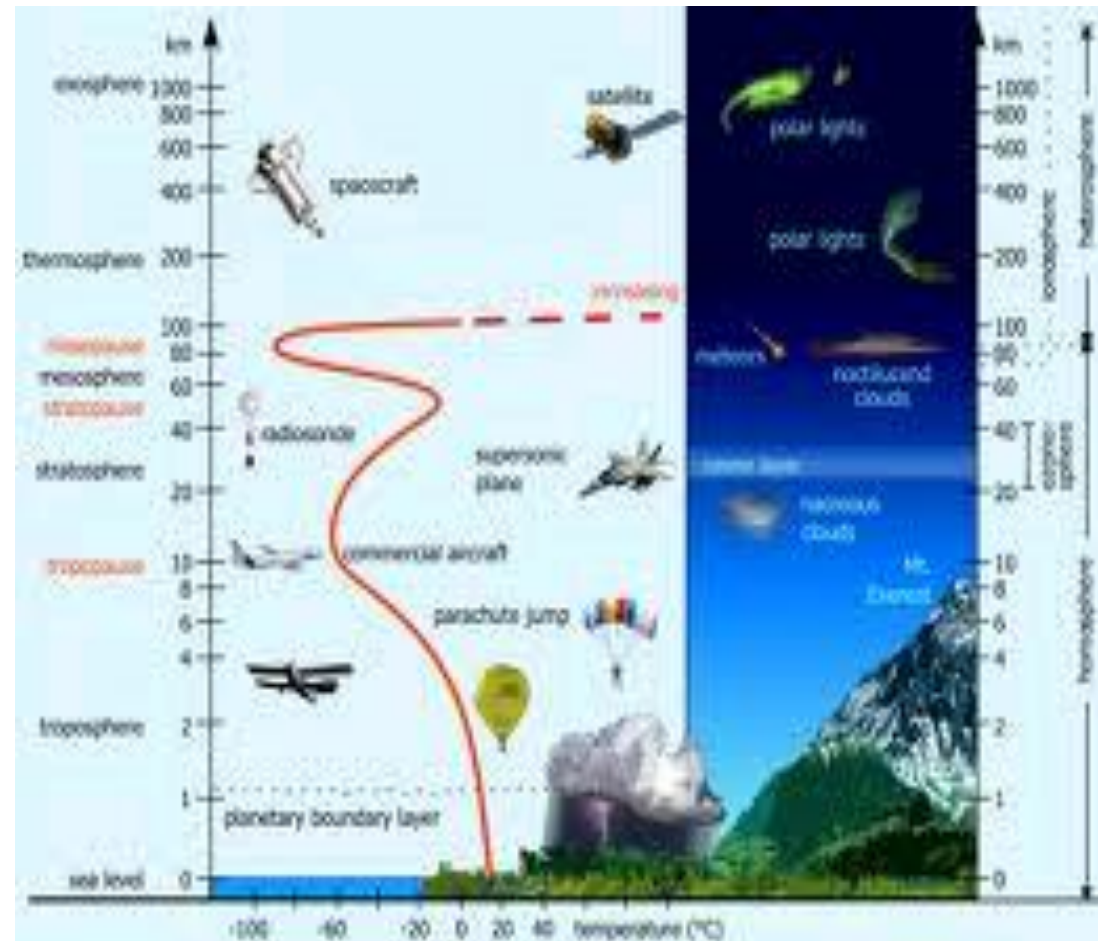


Space Science and Environment: Solar System

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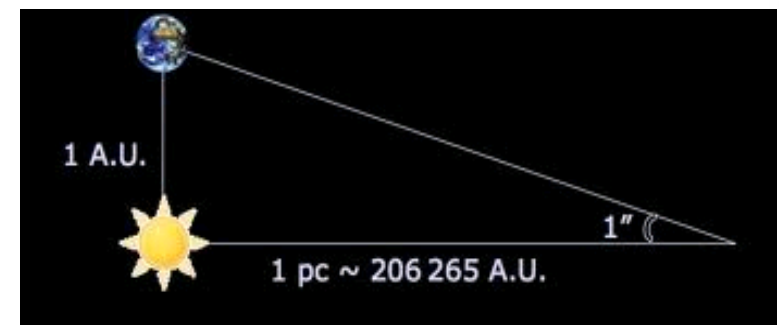
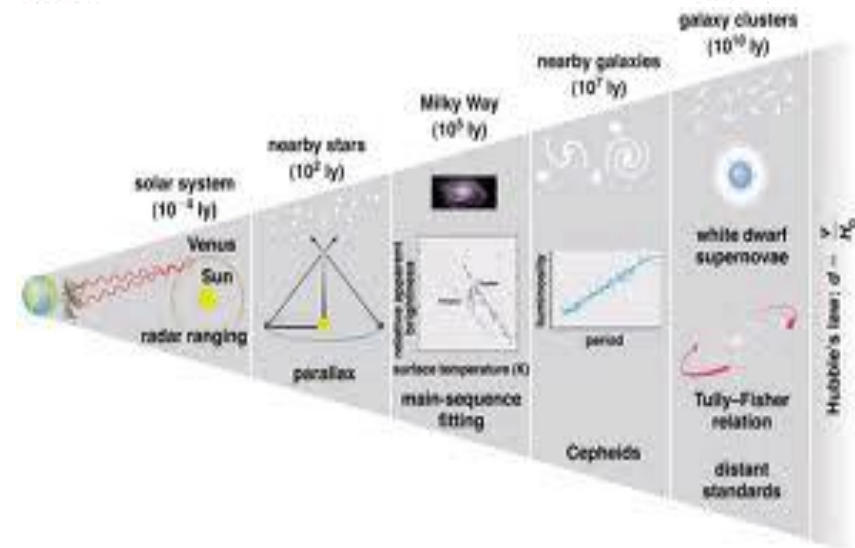
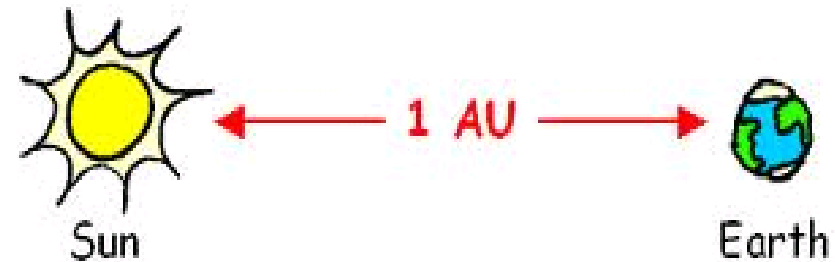
Definition of Space

- Legal definition of space starts around 100 miles (160 km)
- Up to 1000 Km of altitude, the effects of molecular flow and drag can be felt on spacecraft.
- Above 1000 km, microgravity conditions exist.



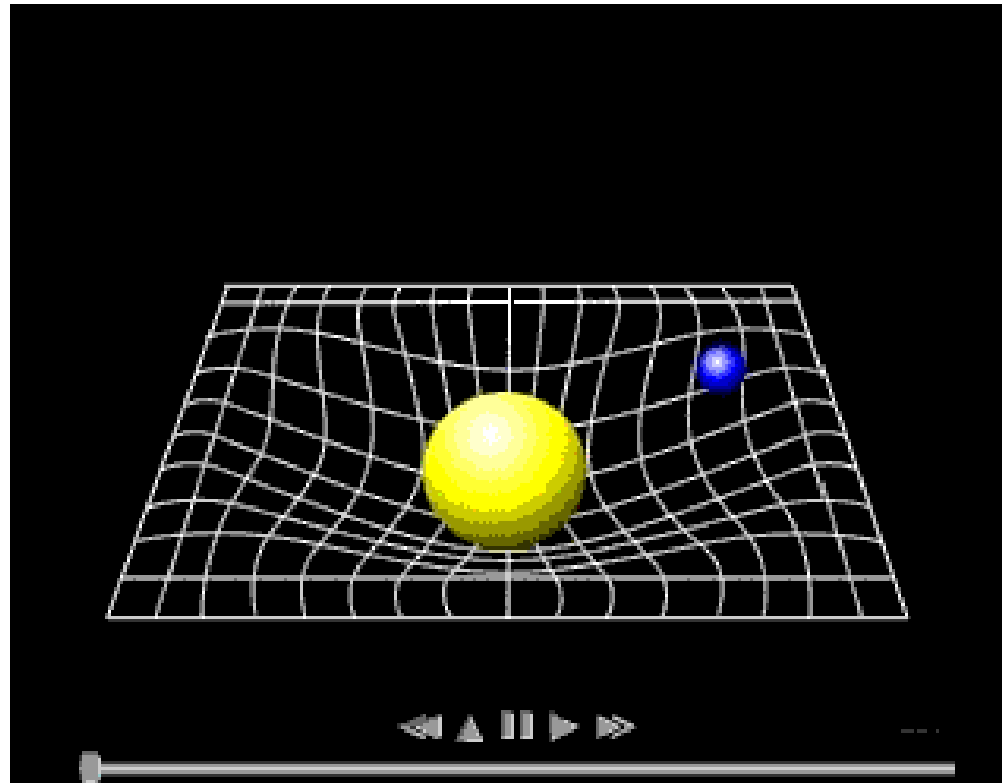
Space Science Distance Definitions

- **One Astronomical Unit (AU)** is the distance from the Sun to the Earth. It is 149,597,870.7 kilometers (92,955,807.3 mi).
- **One Light Year (ly)** is the distance that light travels in vacuum in one year. Equal to 10×10^{15} meters = 63.24×10^3 AU
- **Parsec (pc)** is equal to 3.26 light years (3.1×10^{13}) km. It is 206,265 AU



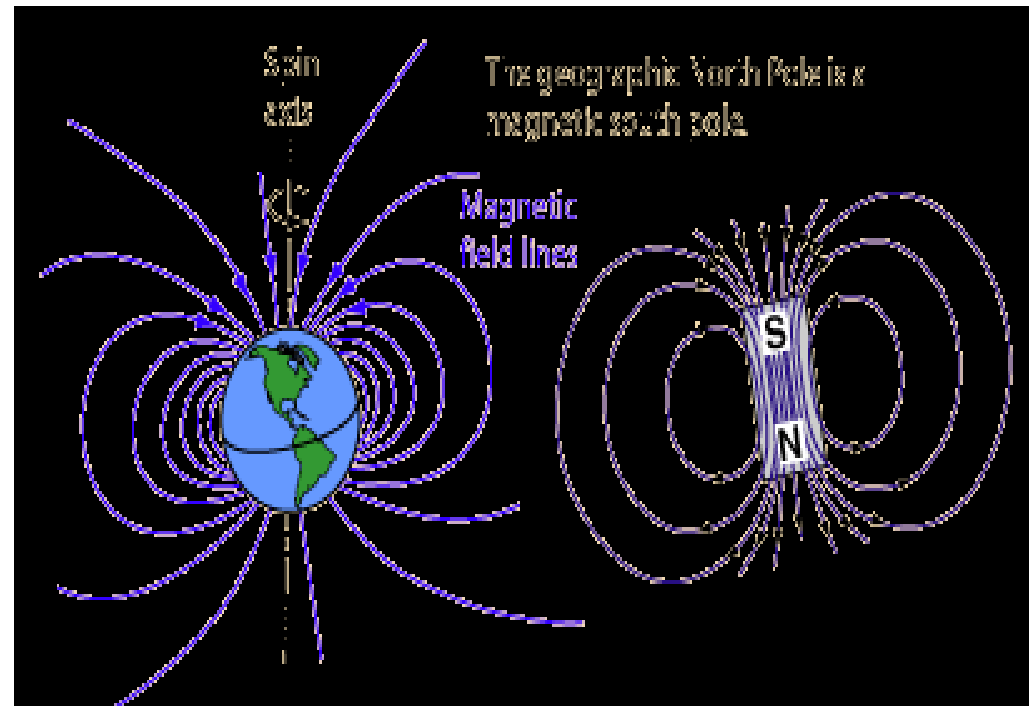
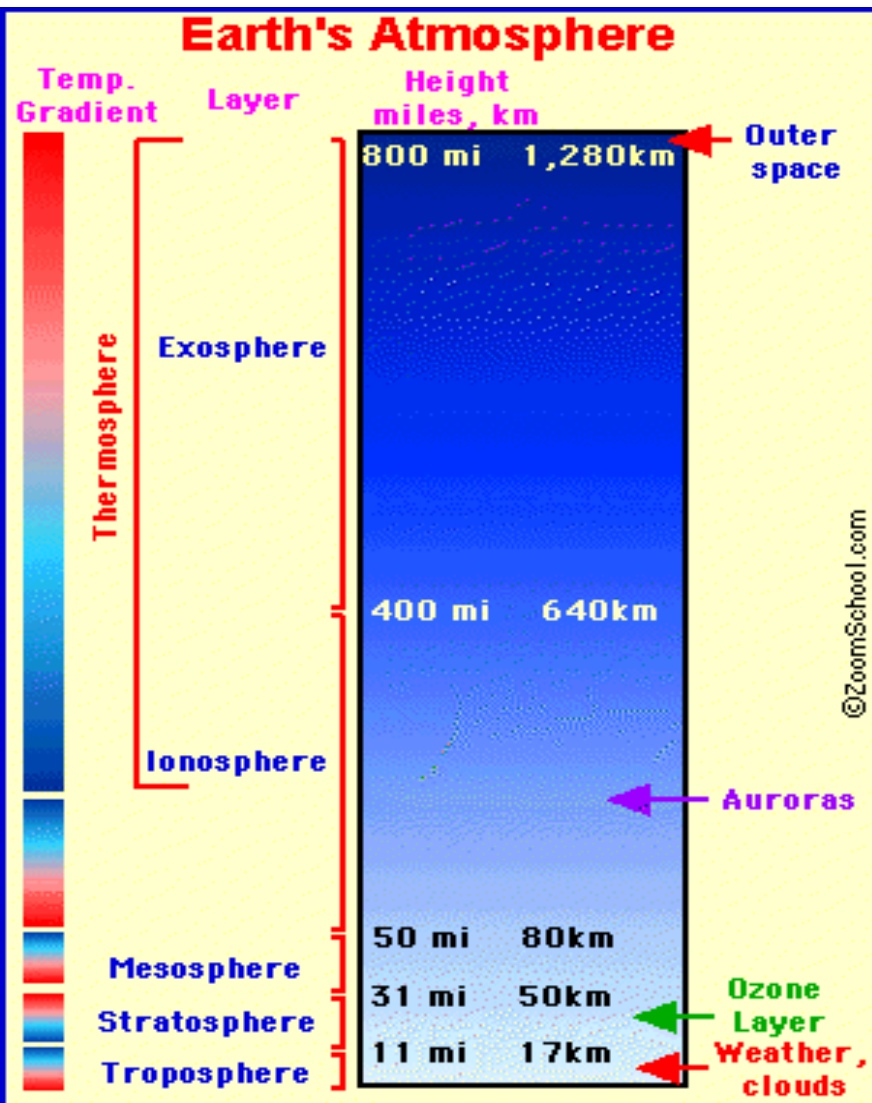
Gravity

- Gravity can be described as the curvature of space-time continuum.
- Microgravity is when the gravity is present but mostly negligible.



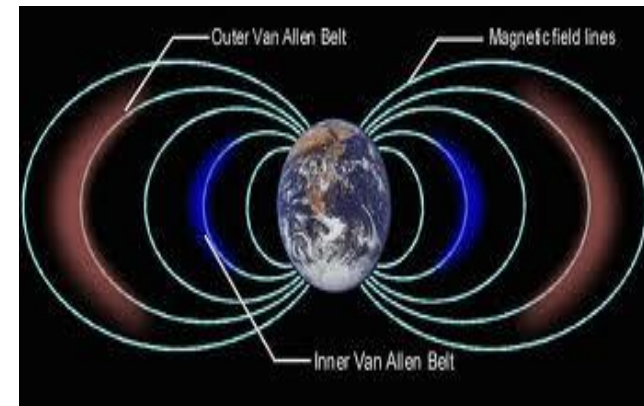
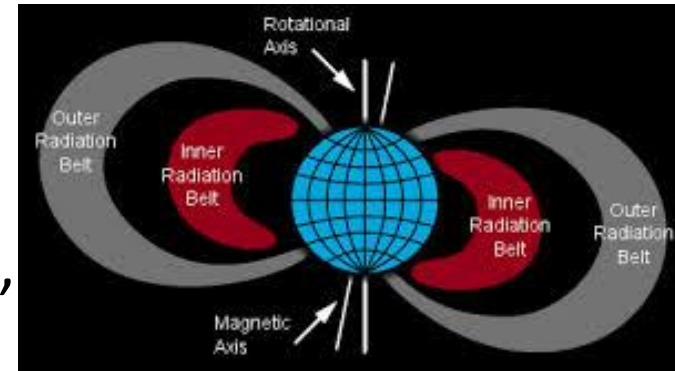
Planet Earth

- Planet Earth is our first stop in space.



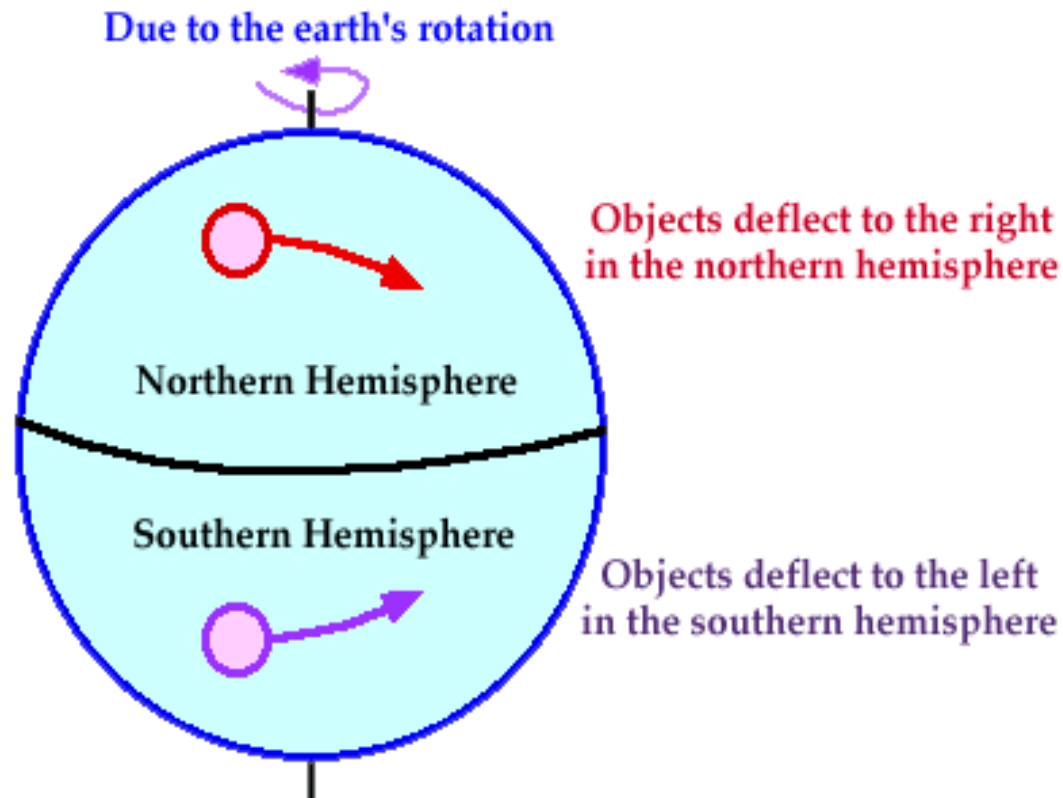
Van Allen Radiation Belts

- Van Allen Radiation Belts, two zones encircling the earth in which there are relatively large numbers of high-energy (fast-moving) charged particles. The particles are mainly protons and electrons, which are trapped within the belts by the earth's magnetic field.
- The Van Allen radiation belts are centered along the earth's magnetic equator in a region of the upper atmosphere called the magnetosphere, or exosphere. The inner and more intense belt extends from roughly 600 miles (1,000 km) to 3,700 miles (6,000 km) above the earth; the outer belt, from roughly 9,300 miles (15,000 km) to 15,500 miles (25,000 km) above the earth.
- Scientists believe most of the particles that form the belts come from the solar wind



Coriolis Effect

- . The Coriolis effect is caused by the rotation of the Earth and the inertia of the mass experiencing the effect



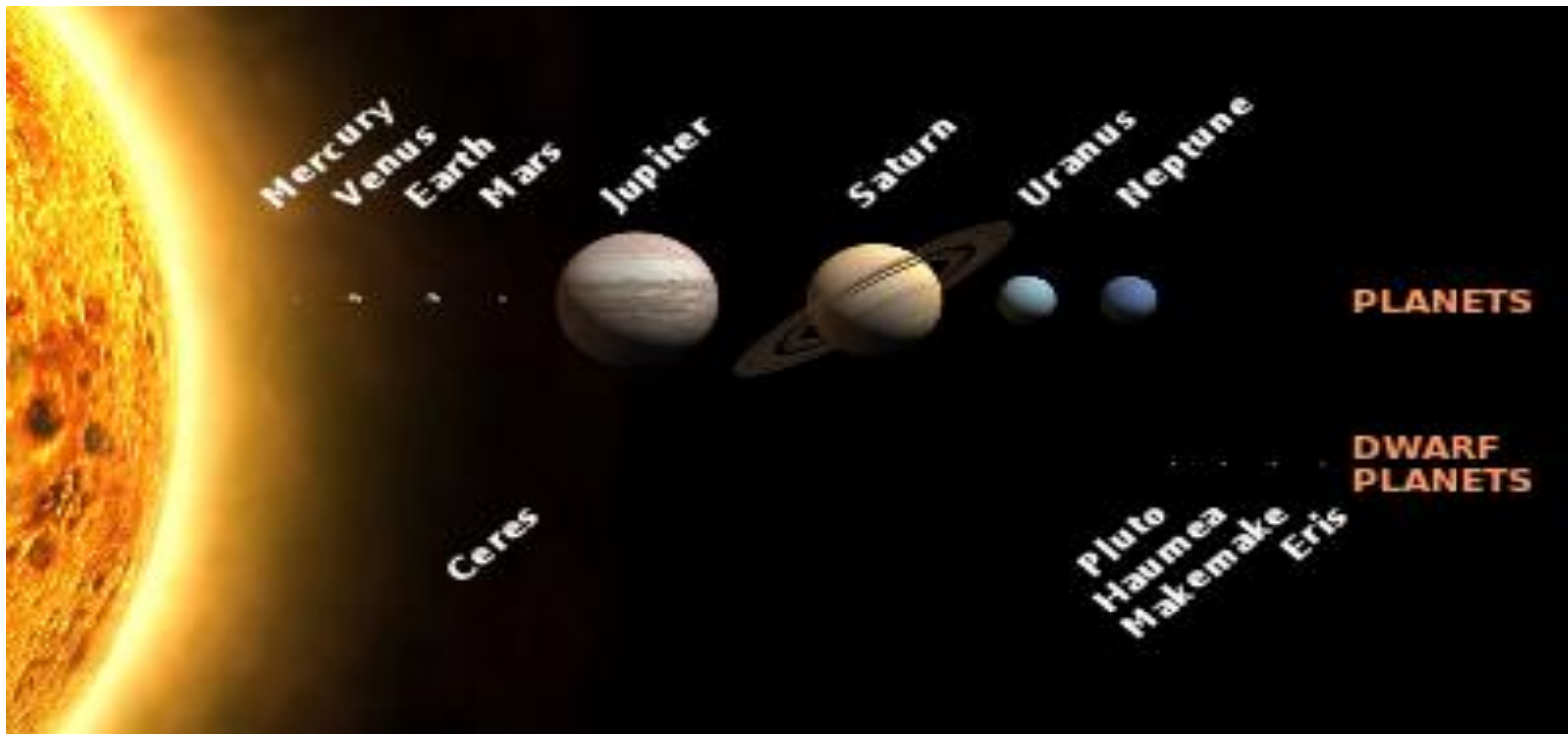
Moon

- Moon is our planet's natural satellite. It is also the fifth largest satellite in the Solar System. Its properties are:
- - Quarter diameter of the Earth
- $\frac{1}{6}$ of the gravitational pull
- Its rotation is synchronous (same face toward Earth)
- Perigee :362,570 km
- Apogee: 405,410 km
- It has no atmosphere or magnetic field.



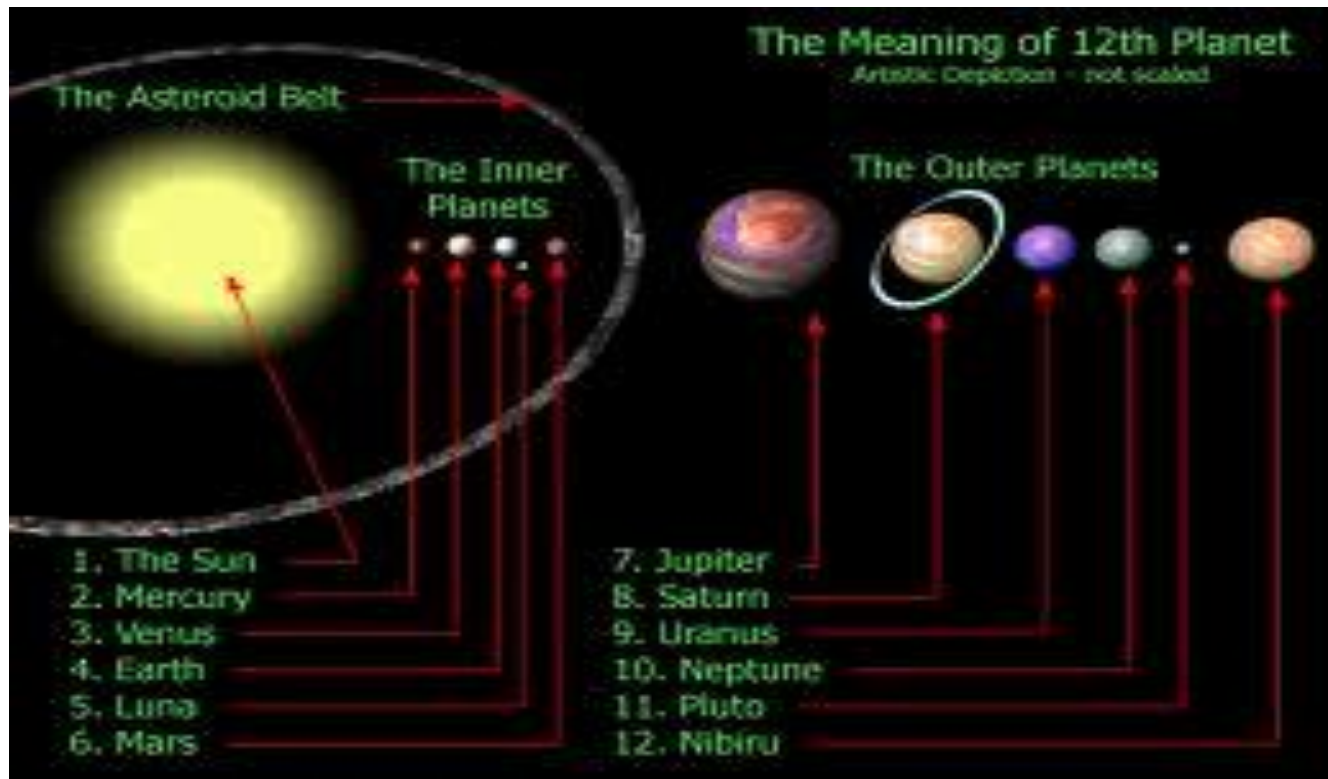
Solar System

- Our solar system is a very unique structure with its 9 planets, inner & outer belts as well as its originality in the nearby star systems



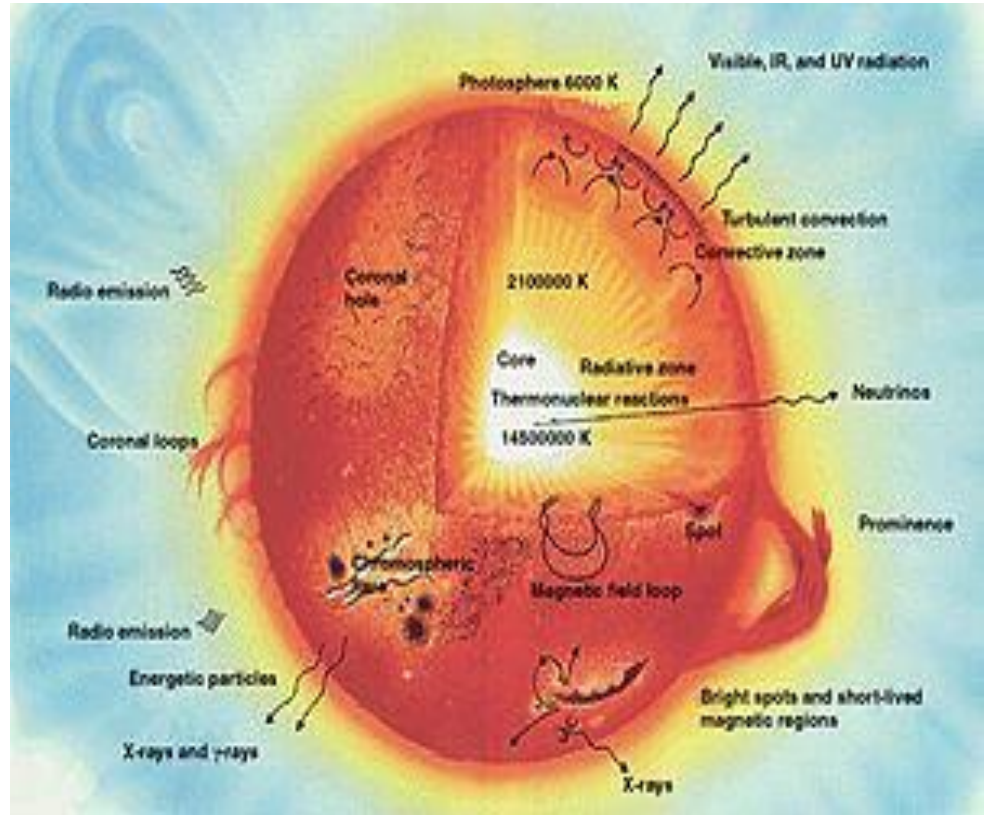
Solar System

- The overall structure of the charted regions of the Solar System consists of the Sun, four relatively small inner planets surrounded by a belt of rocky asteroids, and four gas giants surrounded by the outer Kuiper belt of icy objects.



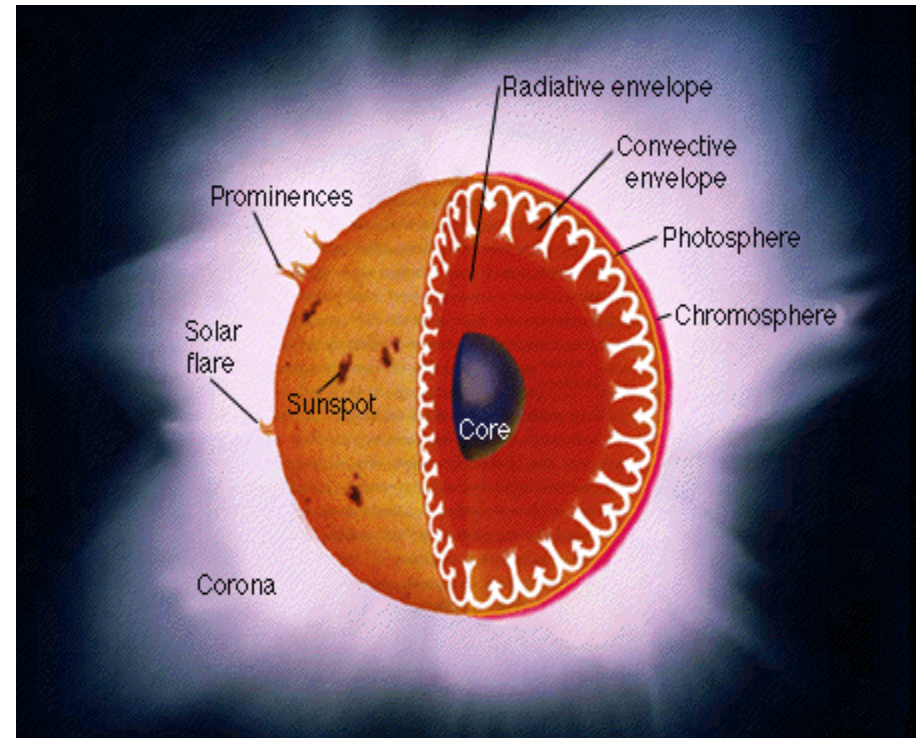
Sun

- Sun is the main component of our solar system, as all planets, planetoids, comets, meteors, asteroids, moons and other bodies orbit around it.
- Its 109 times the size of Earth
- 75% is Hydrogen, 23.31 % is Helium and 1.69% is made up of oxygen, carbon, iron and other elements.
- It works by fusion (converting Hydrogen to Helium) with 620 million metric tons of Hydrogen fusing into Helium releasing light, energy and heat of the sun.
- Sun rotates around the galactic center with a period of 225 million years

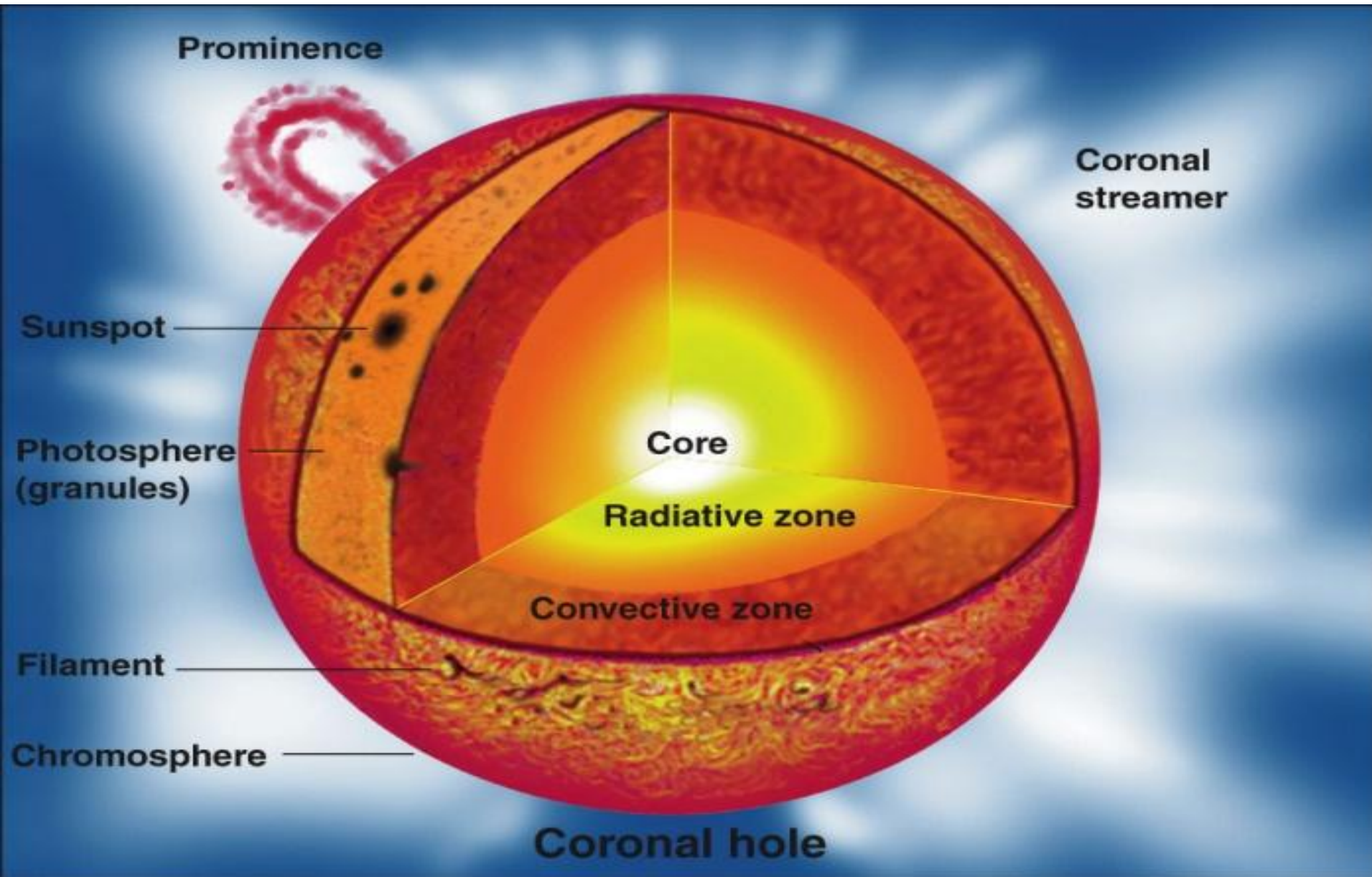


Layers of the Sun

- **The Core:** The innermost layer of the sun is the core. With a density of 160 g/cm^3 , 10 times that of lead. (but in plasma state)
- **Solar Envelope:** The solar envelope puts pressure on the core and maintains the core's temperature.
- **Photosphere:** The photosphere is the zone from which the sunlight we see is emitted. The photosphere is a comparatively thin layer of low pressure gasses surrounding the envelope. It is only a few hundred kilometers thick, with a temperature of 6000 K.
- **Chromosphere:** In an eclipse, a red circle around the outside of the sun can sometimes be seen. This is the chromosphere. Its red coloring is caused by the abundance of hydrogen.
- Convection cells nearer to the outside are smaller than the inner cells. The top of each cell is called a **granule**. Seen through a telescope, granules look like tiny specks of light

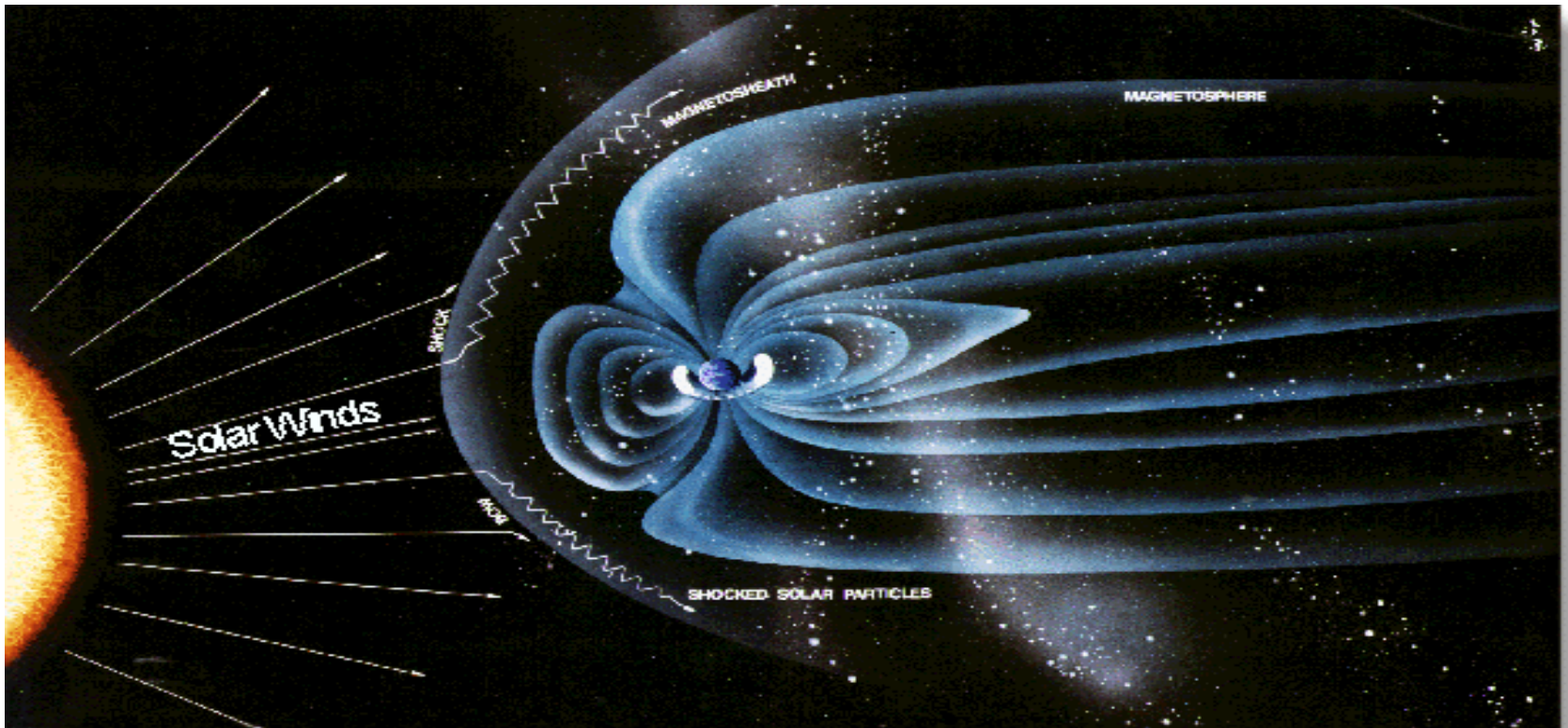


Layers of the Sun



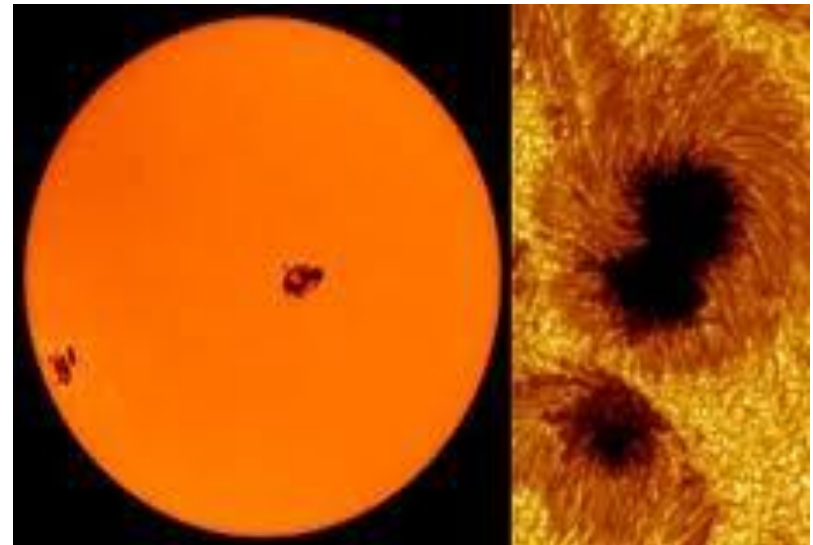
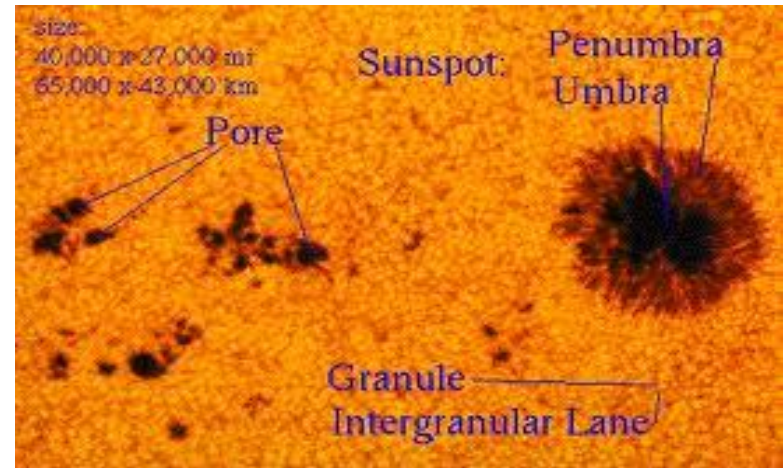
Solar Wind

- The **solar wind** is a stream of charged particles (plasma) released from the upper atmosphere of the Sun. It mostly consists of electrons and protons.
- The solar wind streams off of the Sun in all directions at speeds of about 400 km/s (about 1 million miles per hour)



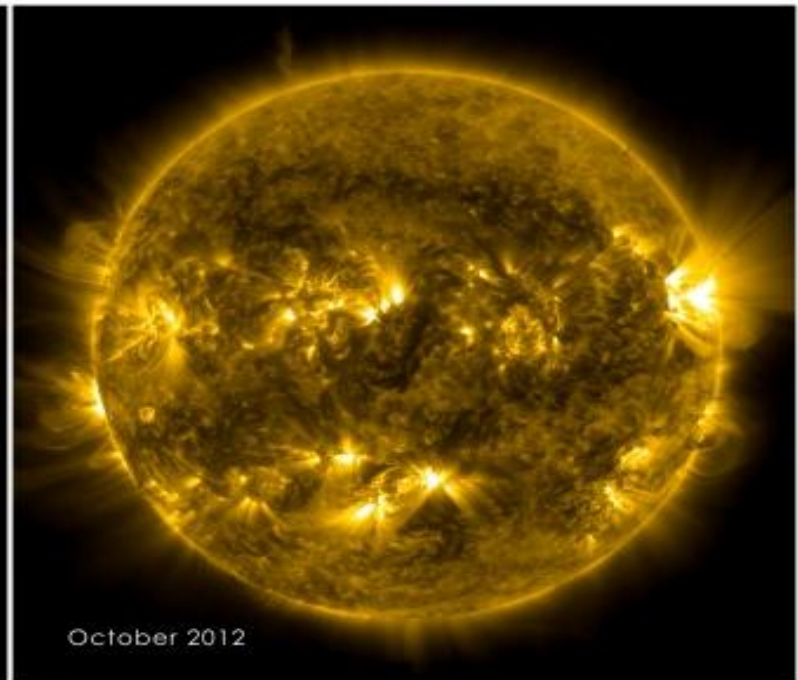
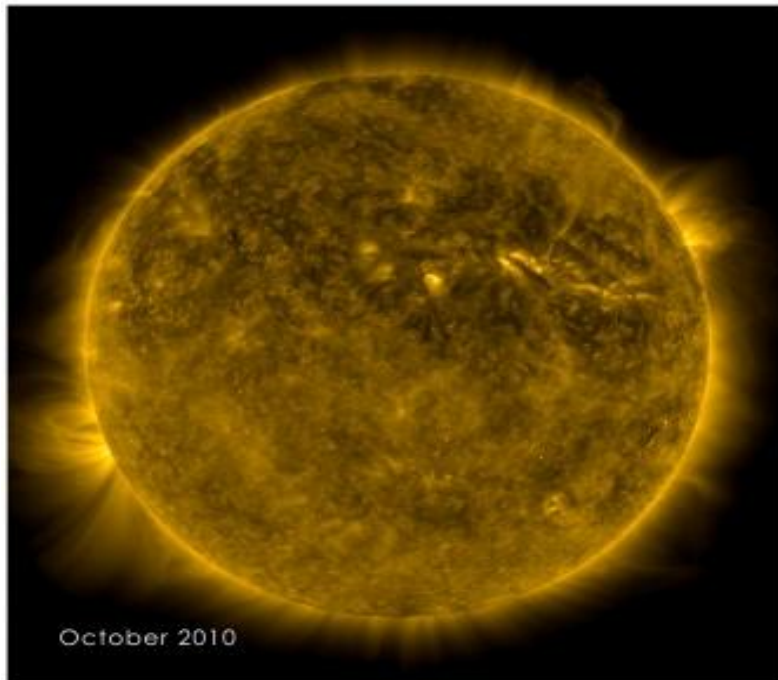
Sun Spots

- Sunspots are regions on the solar surface that appear dark because they are cooler than the surrounding photosphere, typically by about 1500 K (thus, **they are still at a temperature of about 4500 K**, but this is cool compared to the rest of the photosphere). They are only dark in a relative sense; a sunspot removed from the bright background of the Sun would glow quite brightly.
- The largest sunspots observed have had diameters of about 50,000 km, which makes them large enough to be seen with the naked eye.
- Sunspots develop and **persist for periods ranging from hours to months**, and are carried around the surface of the Sun by its rotation
- A typical sunspot consists of a dark central region called the ***umbra*** and somewhat lighter surrounding region called the ***penumbra***



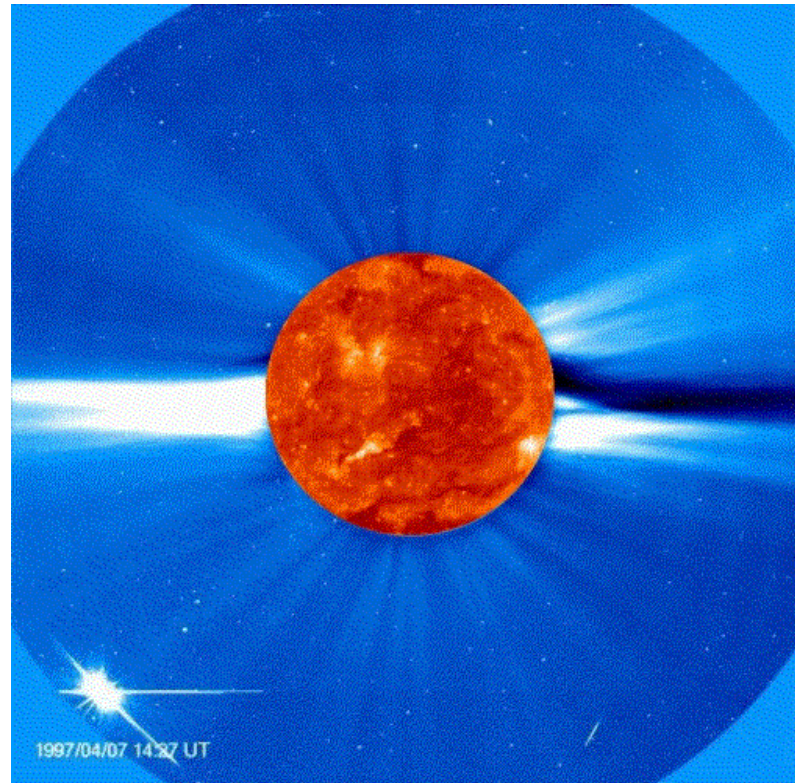
Solar Minimum and Solar Maximum

- The sun goes through a natural solar cycle approximately every 11 years. The cycle is marked by the increase and decrease of sunspots -- visible as dark blemishes on the sun's surface, or photosphere.
- The greatest number of sunspots in any given solar cycle is designated as "***solar maximum***." The lowest number is "***solar minimum***."



Coronal Mass Ejections

- A coronal mass ejection is a massive burst of solar wind and magnetic fields rising above the solar corona or being released into space.



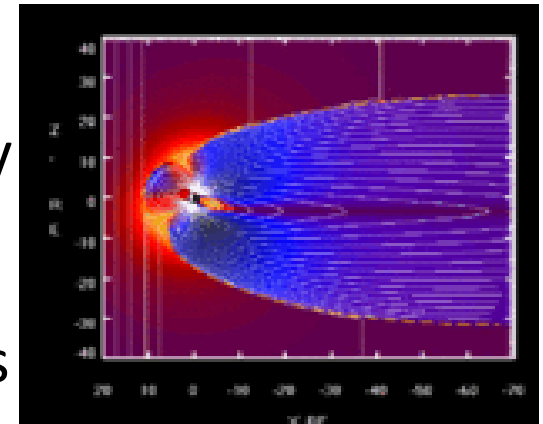
Properties of the Sun

Computer Model of the Sun at 4.5 Billion Years

% radius	Radius (10^9 m)	Temperature (10^6 K)	% Luminosity	Fusion Rate (joules/kg-sec)	Fusion Power Density (joules/sec- m^3)
0	0.00	15.7	0	0.0175	276.5
9	0.06	13.8	33	0.010	103.0
12	0.08	12.8	55	.0068	56.4
14	0.10	11.3	79	.0033	19.5
19	0.13	10.1	91	.0016	6.9
22	0.15	9.0	97	0.0007	2.2
24	0.17	8.1	99	0.0003	0.67
29	0.20	7.1	100	0.00006	.09
46	0.32	3.9	100	0	0
69	0.48	1.73	100	0	0
89	0.62	0.66	100	0	0

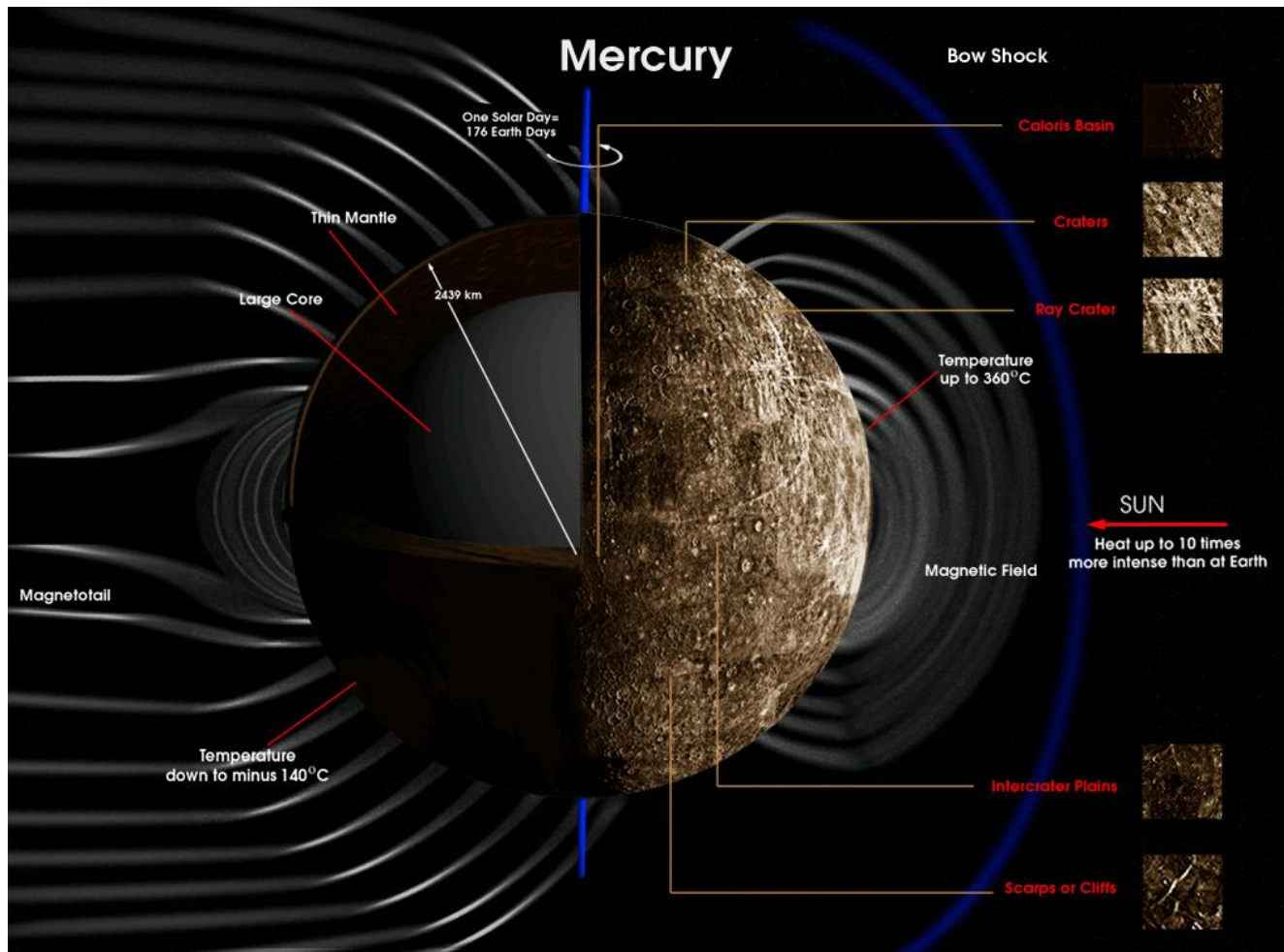
Interplanetary Magnetic Field

- The **interplanetary magnetic field (IMF)** is the term for the solar magnetic field carried by the solar wind among the planets of the Solar System.
- Since the solar wind is a plasma, it has the characteristics of a plasma, rather than a simple gas. For example, it is highly electrically conductive so that magnetic field lines from the Sun are carried along with the wind.
- Magnetohydrodynamic (MHD) theory predicts that the motion of a conducting fluid (e.g. the interplanetary medium) in a magnetic field, induces electric currents which in turn generates magnetic fields, and in this respect it behaves like a MHD dynamo.



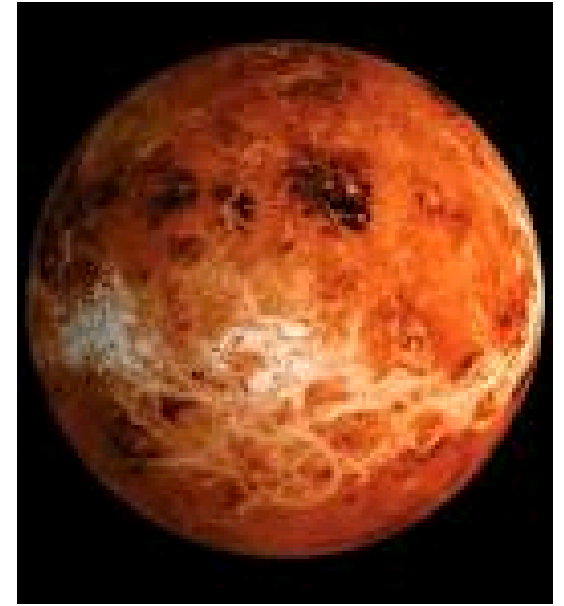
Mercury

- Mercury is a planet that is closest to the sun and it is slightly larger than our moon.
- Mercury has a very little atmosphere of escaped atoms due to sun's rays.
- It orbits the sun in 88 days and it is scorching hot on the day side and it is freezing on the night side.



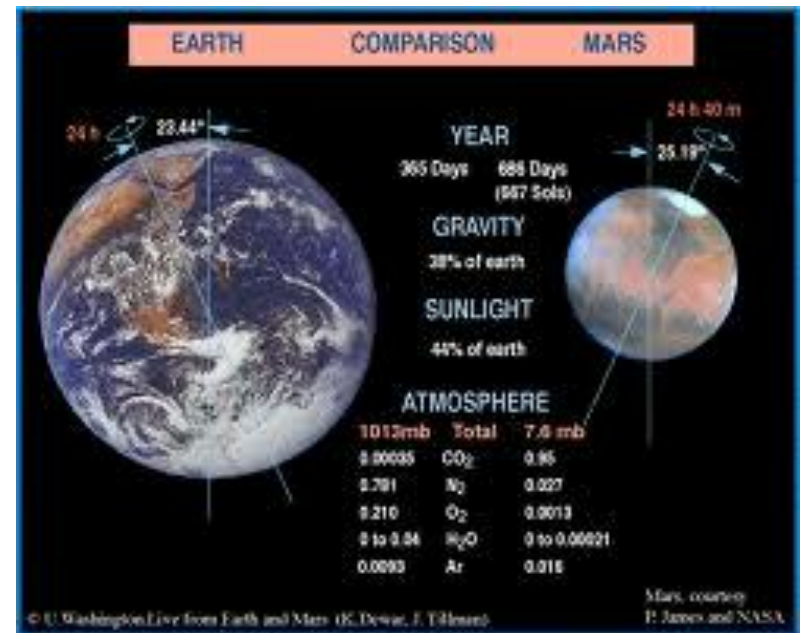
Venus

- Venus is a dim world of intense heat and volcanic activity
- Similar in structure and size to Earth, Venus' thick, toxic atmosphere traps heat in a runaway "greenhouse effect." As a result, The scorched world has temperatures hot enough to melt lead.
- Venus orbits the sun in 225 days.
- Venus' atmosphere consists mainly of carbon dioxide, with clouds of sulfuric acid droplets
- Surface temperature is around 470 Celsius



Mars

- Mars is a rocky planet with half the size of Earth
- Red appearance of Mars is caused by abundance of iron oxide.
- Martian atmosphere is about 95 % of CO₂ and 3 % of Nitrogen along with trace gases.
- The mean pressure is 0.6 kPa which is less than 1 % of Earth atmospheric pressure (101.3 kPa)
- It rotates around the sun in 687 days.
- Its two moons are Phobos and Deimos



Jupiter

- Jupiter is the biggest planet in our solar system and it is a gas giant (composed of dense gases)
- It is made up of mostly hydrogen and helium as well as ammonia
- Jupiter has a total of 50 moons with Io, Europa, Ganymede and Callisto as the larger ones.
- Jupiter has a very powerful magnetic field at least 20,000 times more than Earth
- It completes an orbit around the sun in 11.86 years.



Saturn

- It is the second largest planet in the solar system.
- Saturn's interior is probably composed of a core of iron, nickel and rock and the outer layer is hydrogen and helium.
- Saturn has a ring system that consists of nine continuous main rings and three discontinuous arcs, composed mostly of ice particles with a smaller amount of rocky debris
- Saturn has 63 moons with Titan the largest. (Titan is the second largest moon and it is the only moon in the Solar System with an atmosphere)
- It takes a 29.5 years for Saturn to complete one orbit around the sun.



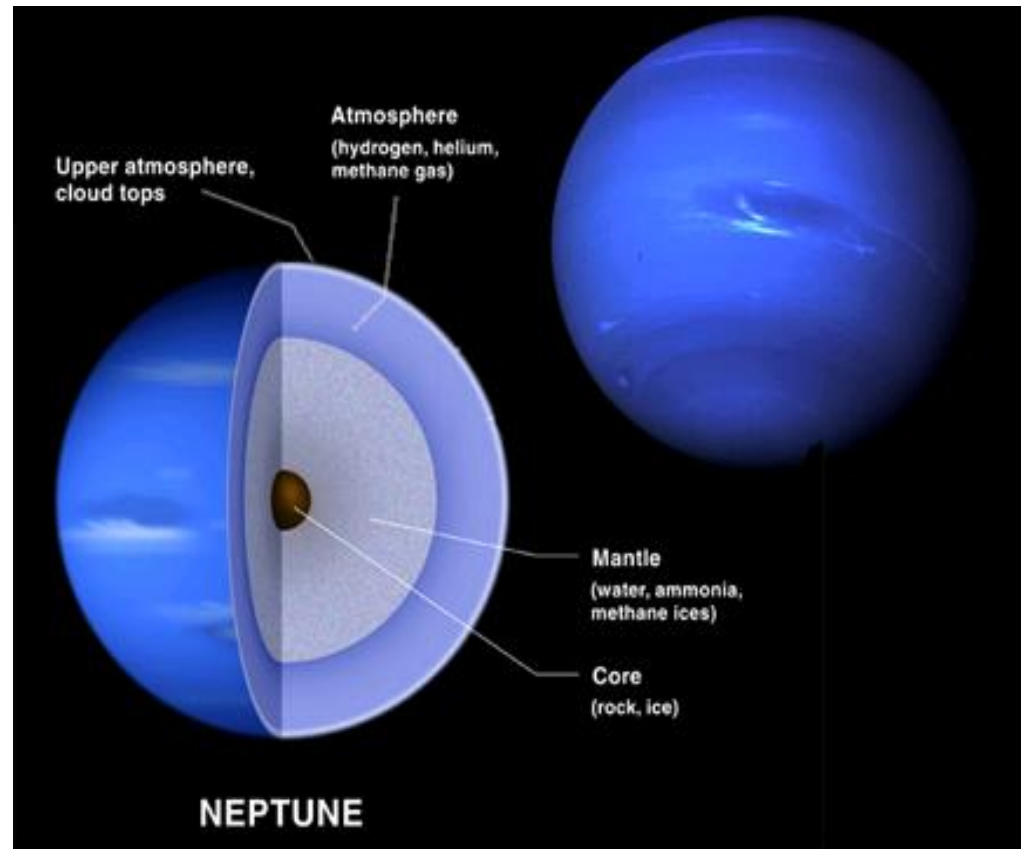
Uranus

- Uranus has an atmosphere of methane, hydrogen and helium. It is the methane which gives it the blue color.
- Like Venus, Uranus rotates east to west.
- It is an ice giant with two sets of rings
- It has 27 moons with Miranda being the famous one.



Neptune

- Neptune is an ice giant planet.
- It is 4.5 billion km away from the sun and it rotates around the sun in 165 years.
- Neptune also has large amounts of hydrogen, helium and methane in frozen form
- Neptune has a surface temperature of -235 C and it has 13 moons.
- The blue color comes from Methane



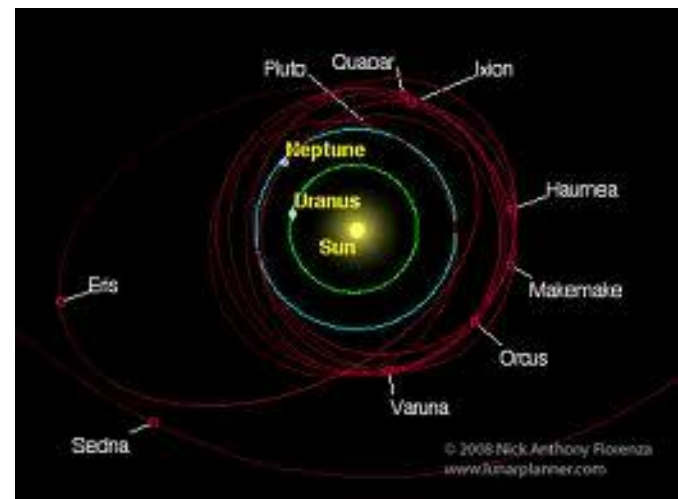
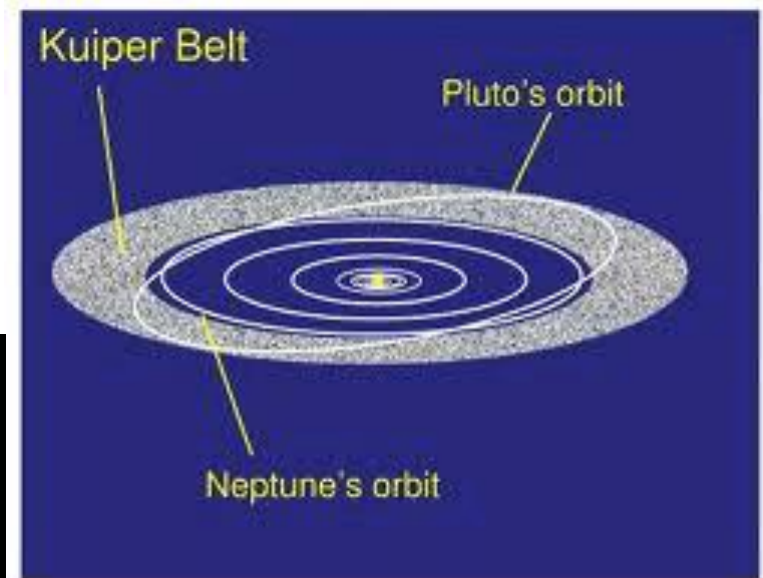
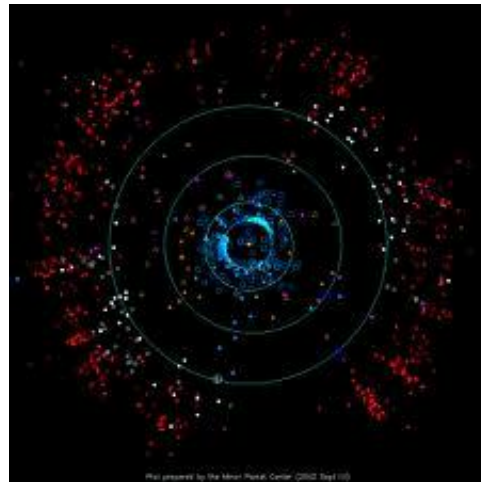
Pluto

- Pluto is a dwarf planet.
- It is fifth of the mass of Earth's moon
- Until 2006 it was a full planet
- It rotates around the sun in 248 years
- It consists of rock and ice
- Temperature is around -230 C and its atmosphere consists of nitrogen, methane and carbon dioxide



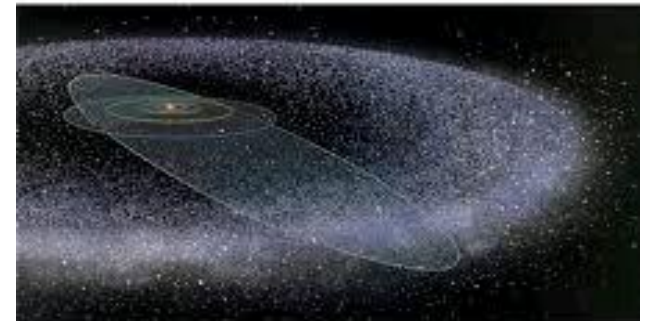
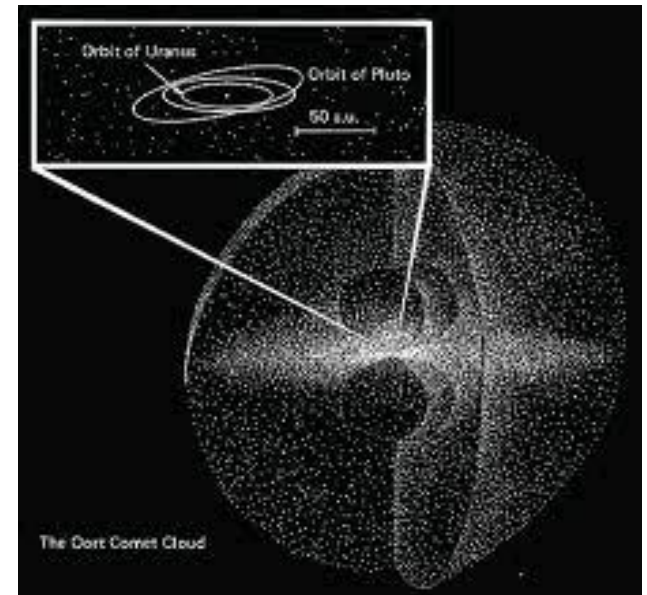
Kuiper Belt

- Kuiper Belt is the outer region of our solar system which consists of thousands of rocks and asteroids
- It consists of rock, ice and metal
- Starts at 30 AU and continues until 50 AU
- It contains the remnants of pre solar system formation



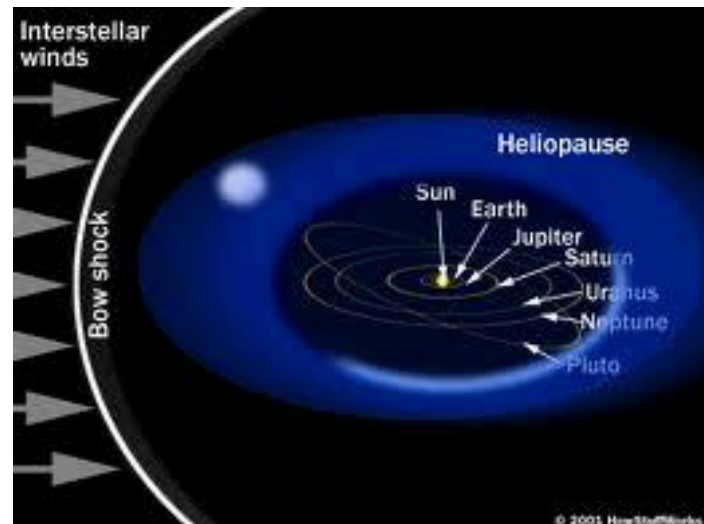
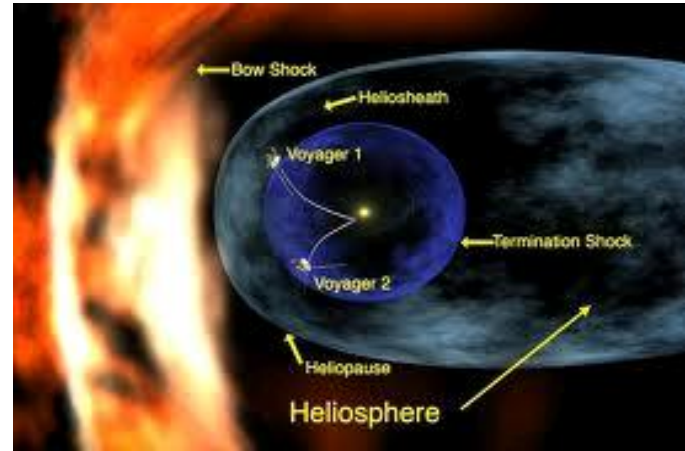
Oort Cloud

- It is the spherical region around the Sun whose radius is about 50,000 AU
- Oort Cloud consists of blocks of ice of varying shape and sizes.
- Some of these ice blocks move toward the inner solar system and they will have elongated orbits to become comets
- The outer layer of Kuiper Belt coincides with the Oort Cloud



Heliopause

- The **heliopause** is the theoretical boundary where the Sun's solar wind is stopped by the interstellar medium; where the solar wind's strength is no longer great enough to push back the stellar winds of the surrounding stars
- It is hypothesized that the Sun also has a bow shock produced in its travels within the interstellar medium
- It is about 230 AU away from the sun



Solar System and Interstellar Space



THANK YOU

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