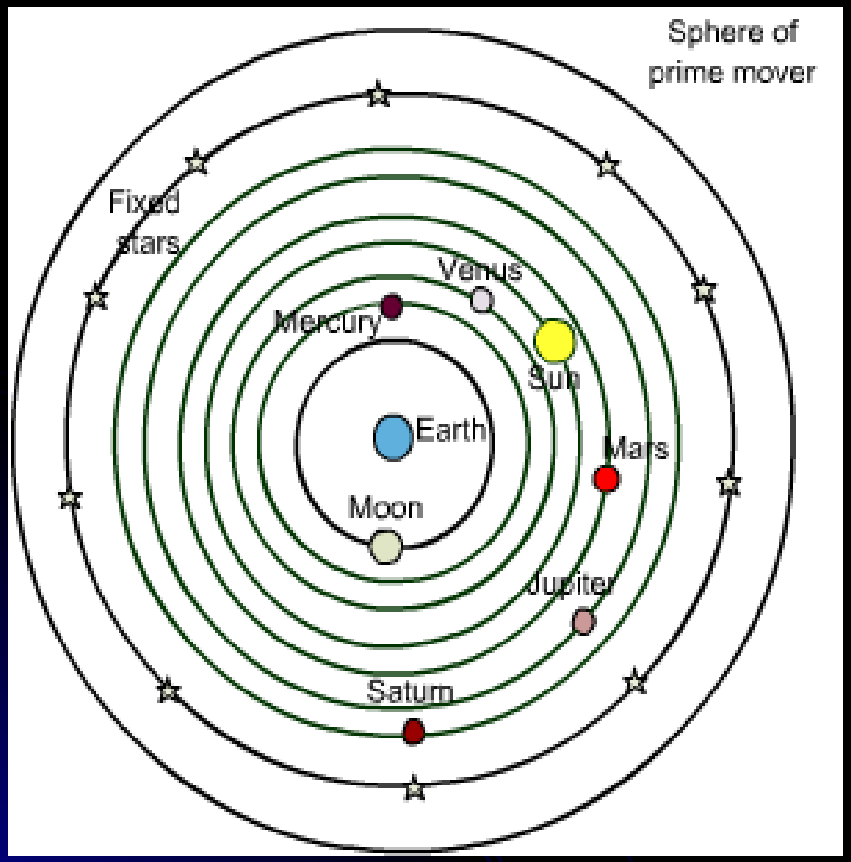
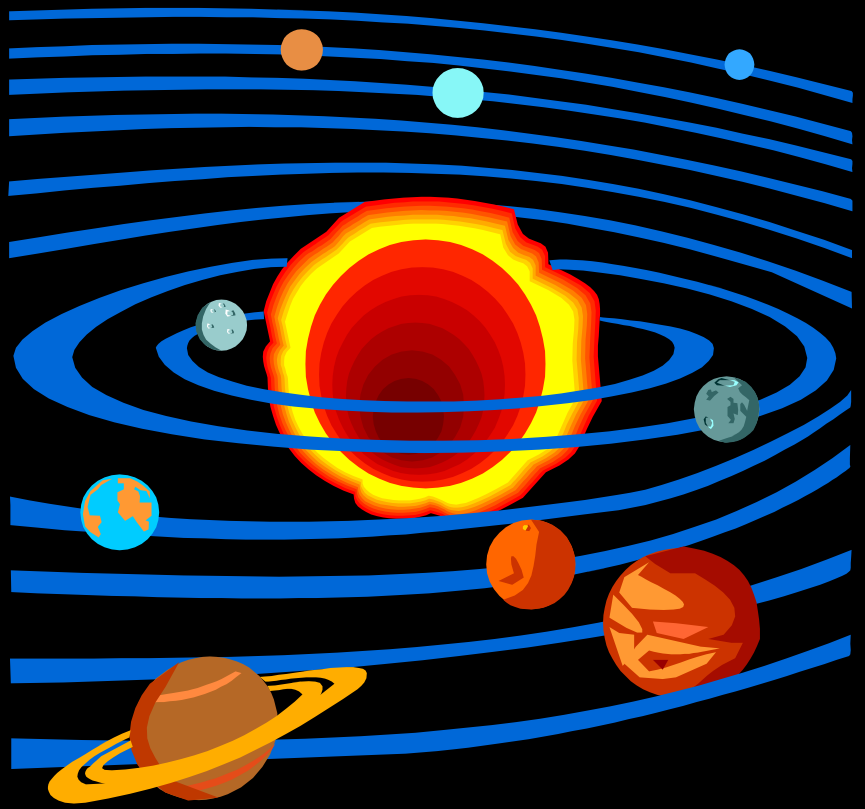
Geocentric vs Heliocentric

- "Geo" means Earth



- "Helio" means sun

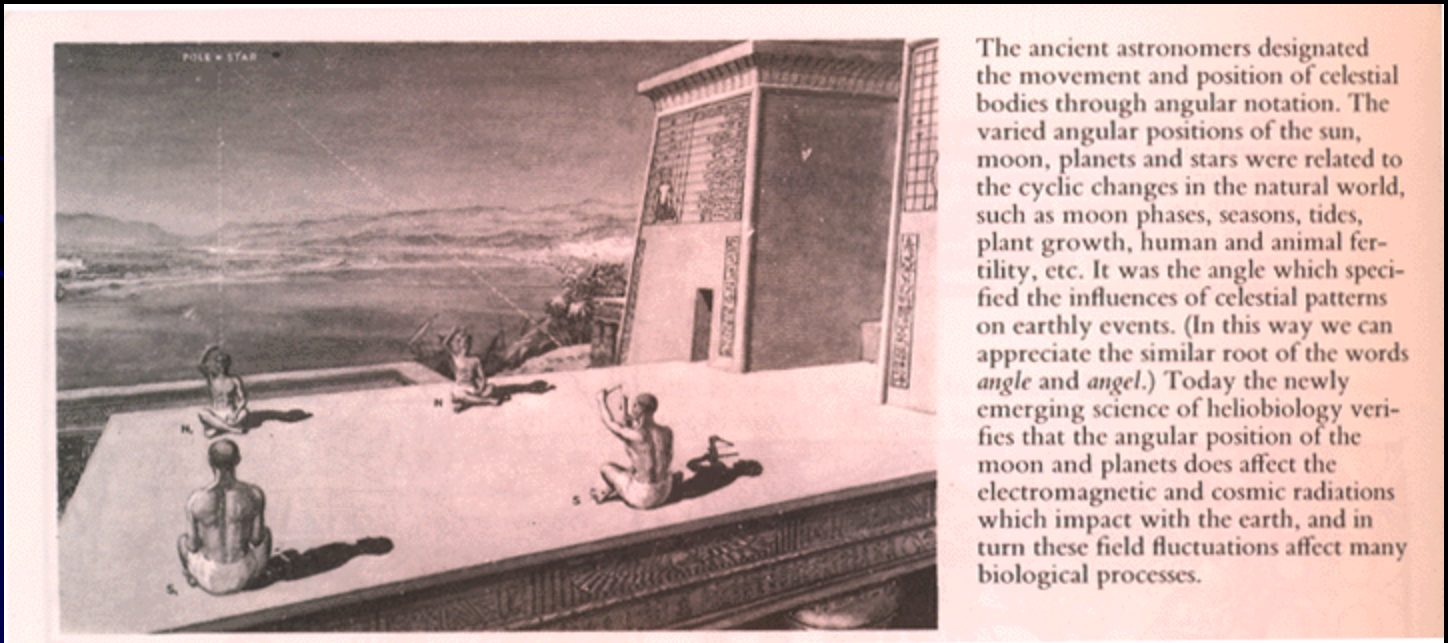


Ancient Observations

- The ancient Greeks observed the sky and noticed that the moon, sun, and stars seemed to move in a circle around the Earth.
- It seemed that the Earth was not moving and everything in the heavens revolved around the Earth.
- As it turned out, it was very difficult to prove that the planets did not revolve around the Earth without leaving the planet.

Wandering Stars

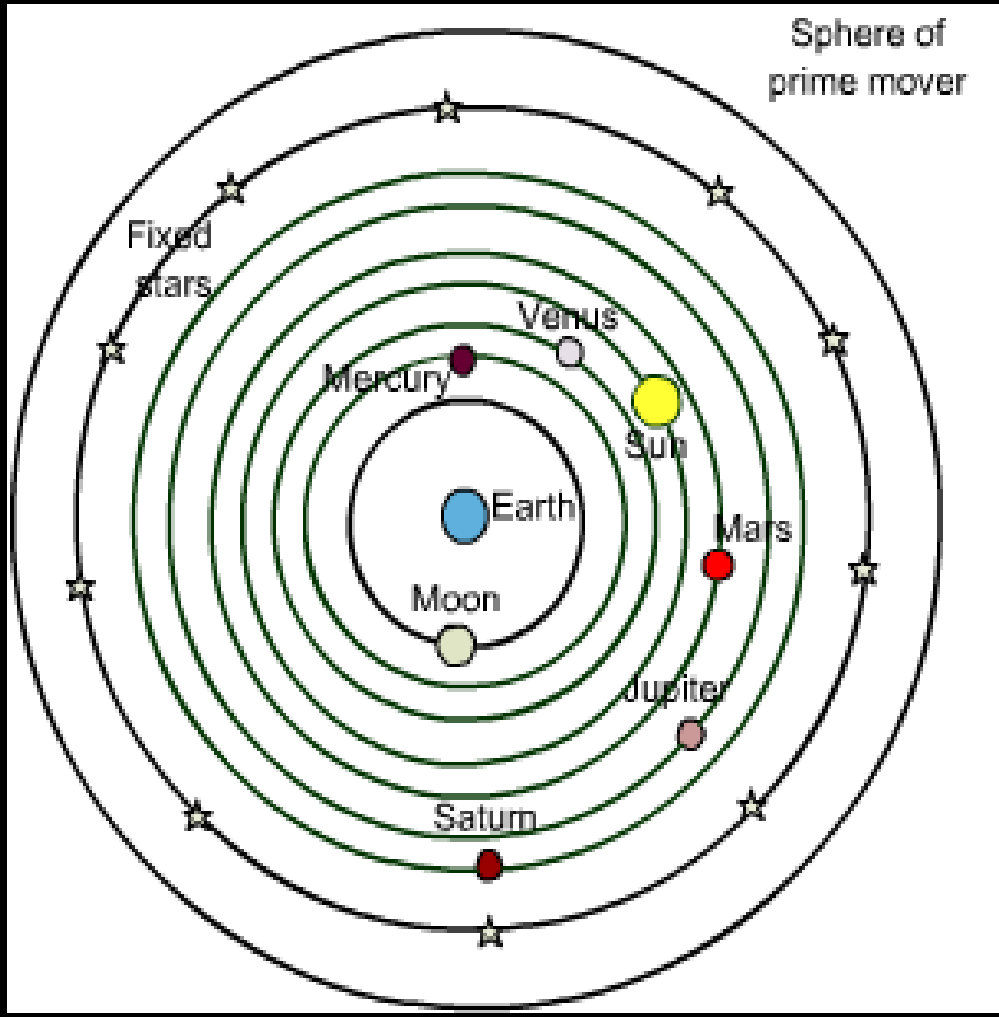
- The Greeks also noticed that while the stars move across the sky, their patterns do not change.
- But five points of light did move among the stars.
- The Greeks called these objects *planets*, which means “wandering star.”
- They made careful observations of these planets, which we call Mercury, Venus, Mars, Jupiter, and Saturn.



The ancient astronomers designated the movement and position of celestial bodies through angular notation. The varied angular positions of the sun, moon, planets and stars were related to the cyclic changes in the natural world, such as moon phases, seasons, tides, plant growth, human and animal fertility, etc. It was the angle which specified the influences of celestial patterns on earthly events. (In this way we can appreciate the similar root of the words *angle* and *angel*.) Today the newly emerging science of heliobiology verifies that the angular position of the moon and planets does affect the electromagnetic and cosmic radiations which impact with the earth, and in turn these field fluctuations affect many biological processes.

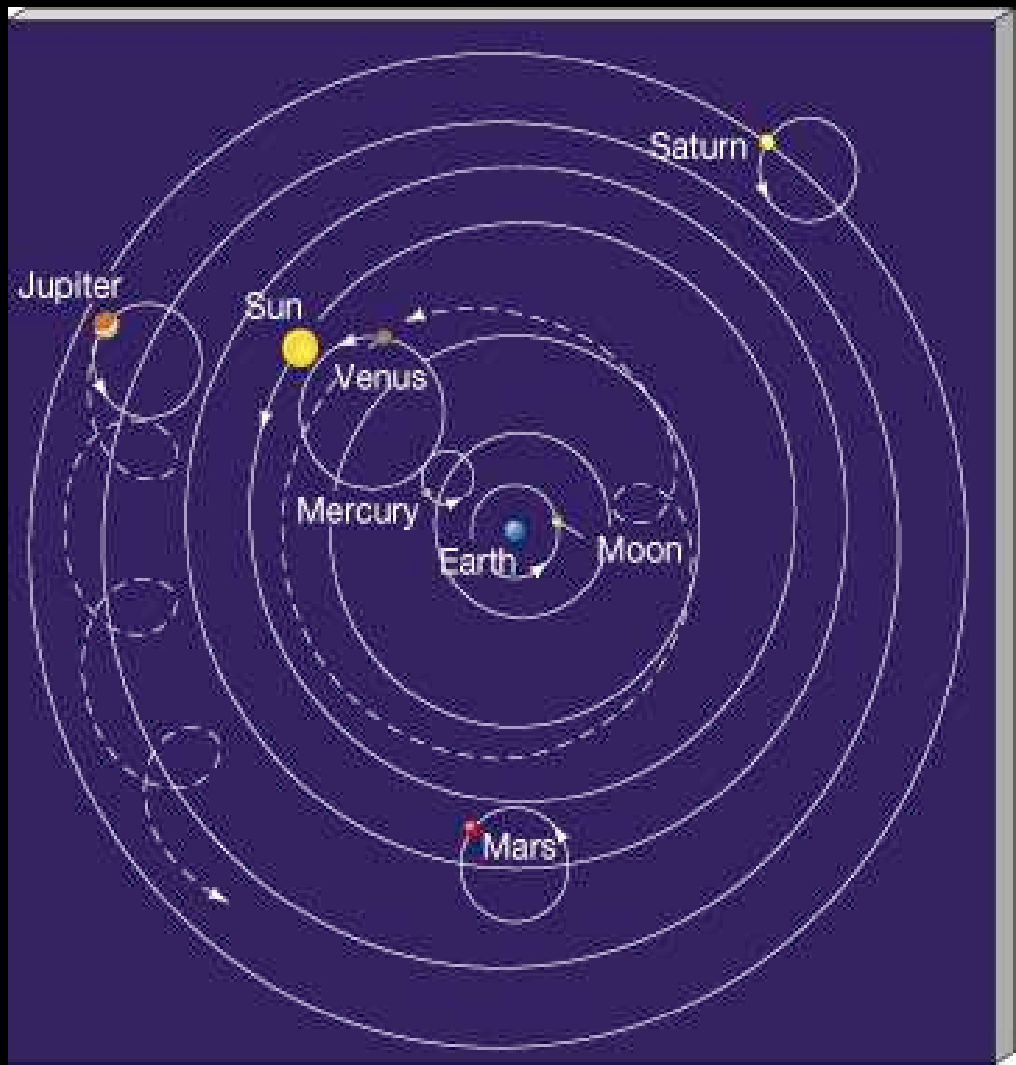
Geocentric Theory

- Ancient Greeks such as Aristotle believed that the universe was perfect and finite, with the Earth at the exact center.
- This is the geocentric theory, which stated, the planets, moon, sun, and stars revolve around the Earth.



Ptolemy (85-165 AD)

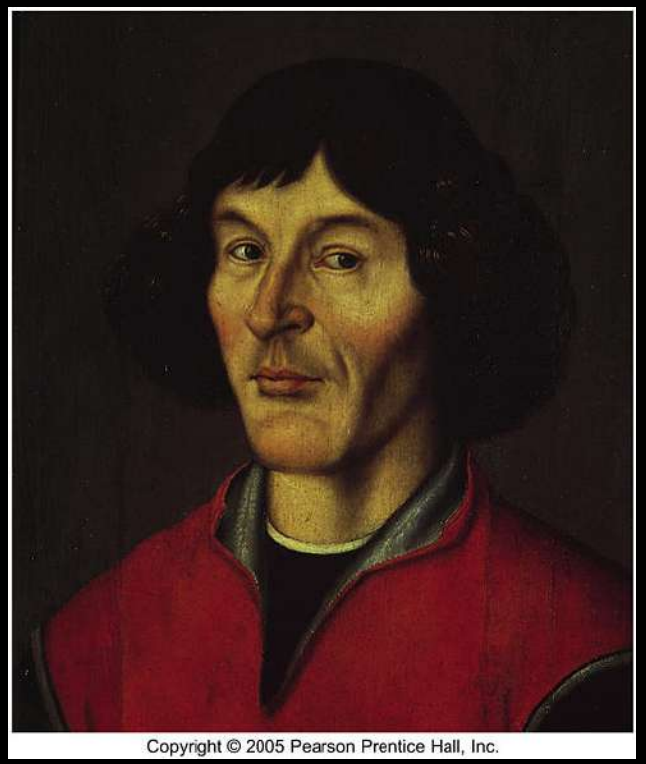
- In AD 140 the Greek astronomer Ptolemy revised the geocentric model to explain all the planetary motions.
- His model had the planets move in little circles that also moved in bigger circles.
- This belief persisted for about 1500 years.



Copernicus (1473-1543)

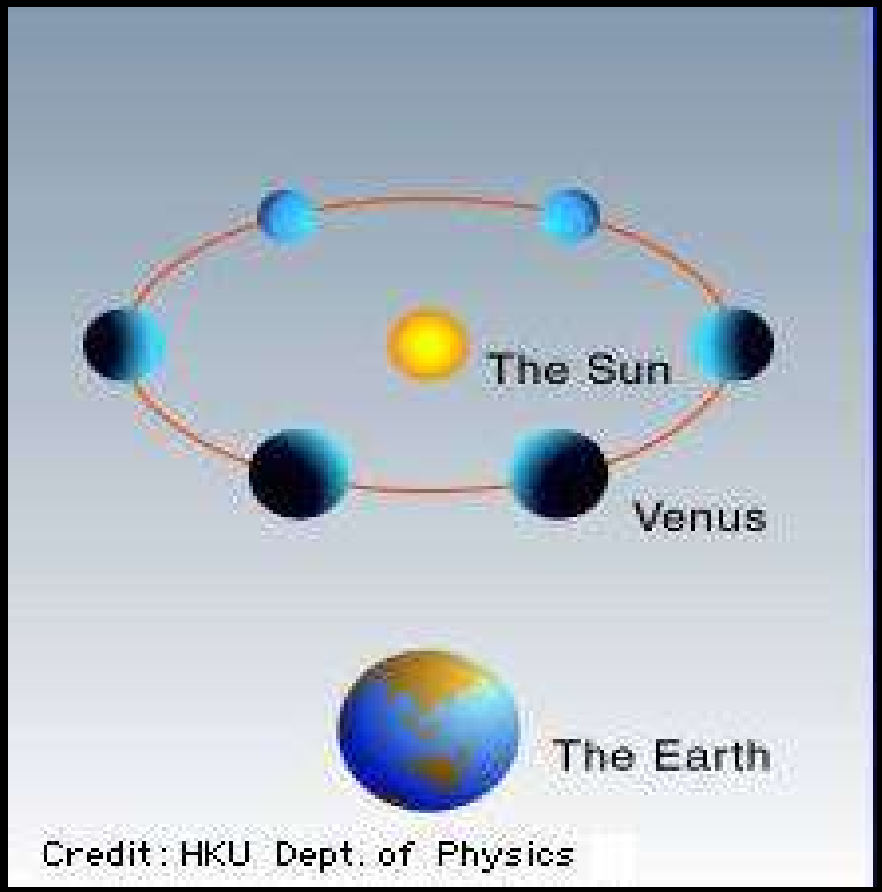
- In the early 1500's the polish astronomer Copernicus suggested that the Sun, not Earth, was the center of the solar system and the planets revolved around it.
- This is the Heliocentric Theory.

Helios means "sun" in Greek.



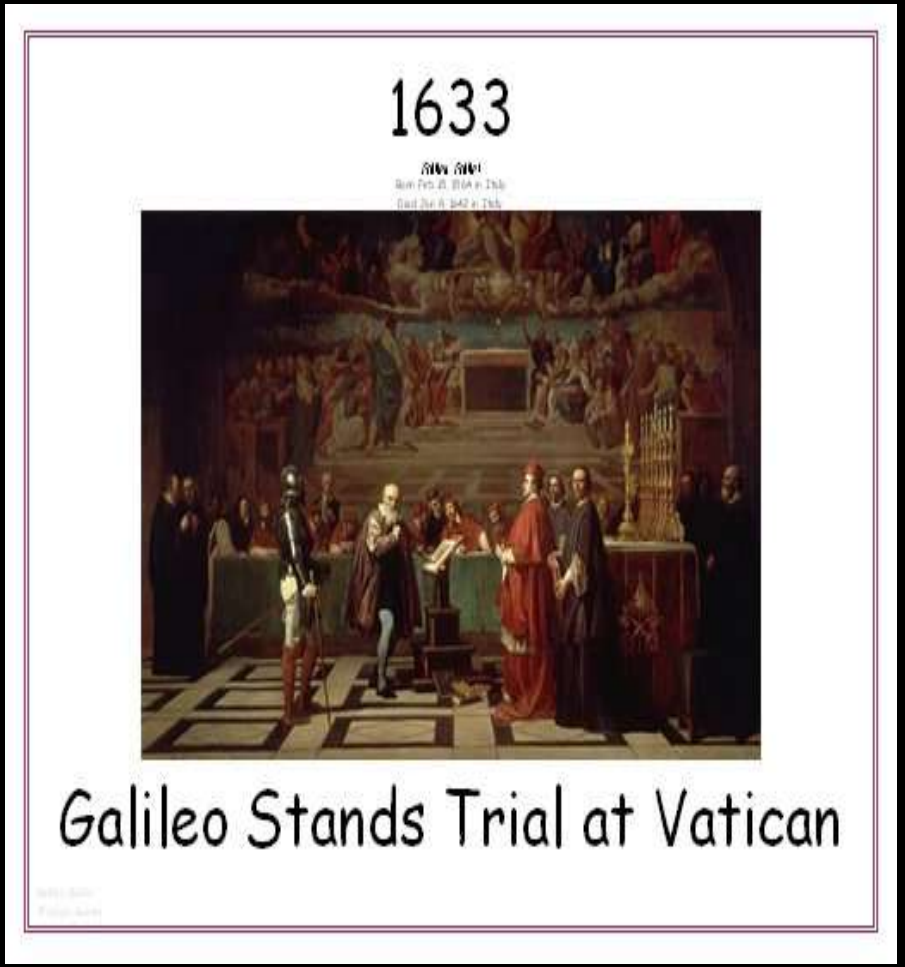
Problems with Geocentric Theory?

- Galileo first saw evidence that objects revolved around something besides the Earth when he found Jupiter's Moons
- Galileo also saw that Mercury and Venus went through phases, just like our moon. The outer planets Mars, Jupiter and Saturn did not.



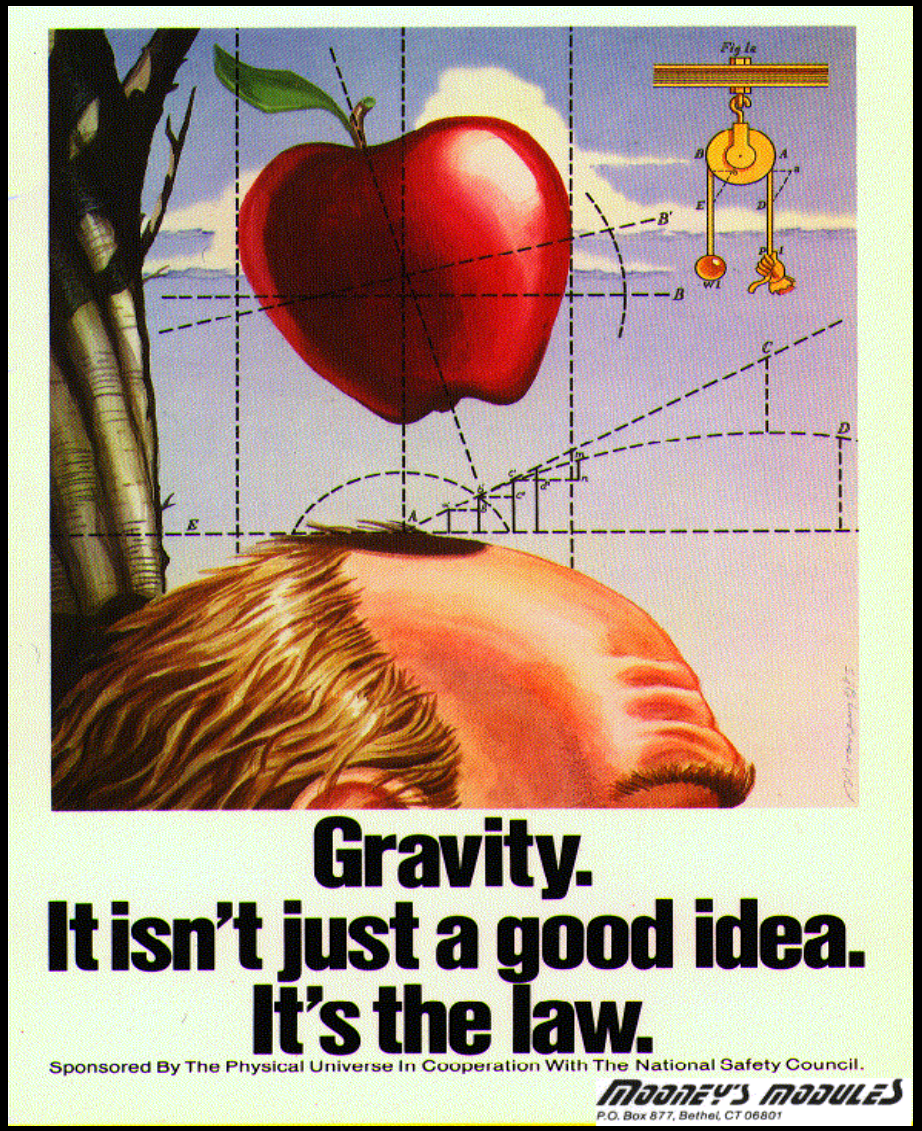
Heliocentric Theory Prevails

- Galileo supported Copernicus' theory which clashed with the religious views of the time, he underwent many trials and tribulations, and was even sentenced to house arrest for his remaining years.
- His view has withstood the test of time.
- Today we talk about our Solar System, **not** our Earth system



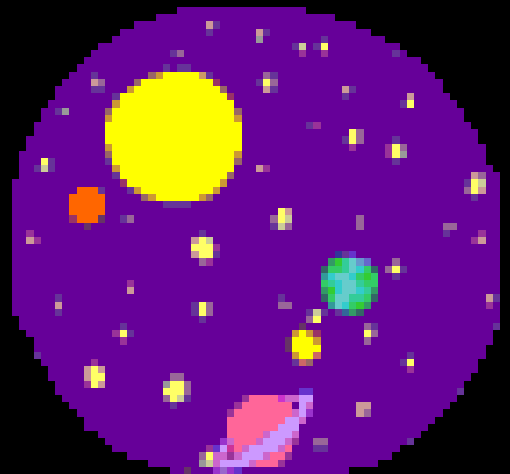
What's Gravity?

- Gravity is the force of attraction between any two objects with mass.
- The more mass, the more gravity.
- The further apart the two objects are, the less gravity.



What force keeps the planets in their orbits?

- Gravity acts on all objects on Earth, and the universe, even YOU!
- There is gravitational attraction between the sun and each planet.
- This gravitational attraction pulls the planets toward the Sun as they move through space. Instead of flying off into space, the planets move in orbits around the Sun.



Our Solar System

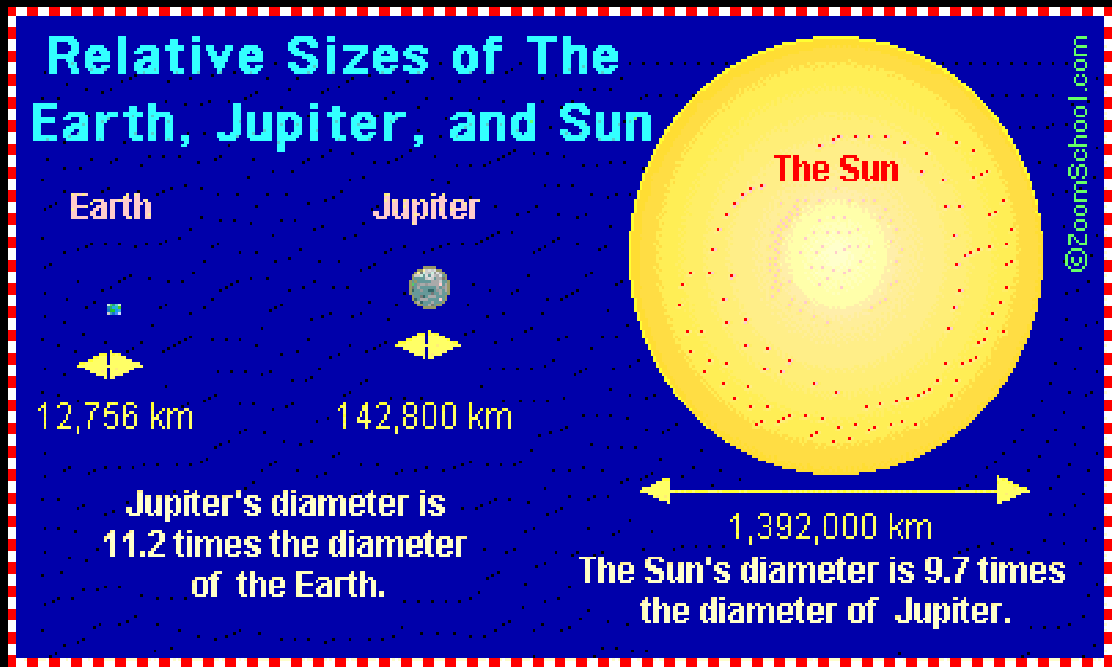
Our Solar System

Our solar system is mad up of:

- Sun
- Eight planets
- Their moons
- Dwarf Planets
- Asteroids
- Comets
- Meteors

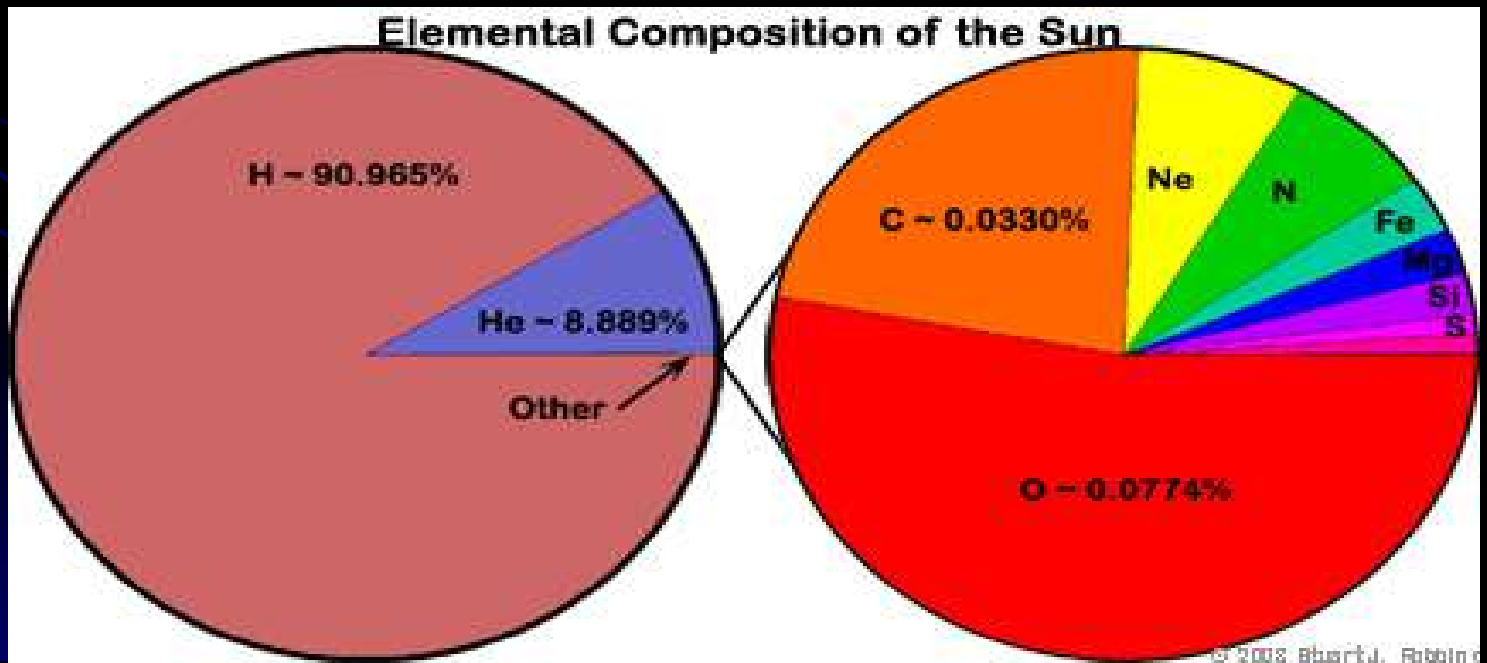
Getting to know our Sun!

- The sun is just a medium sized star or yellow dwarf. It is about 1.4 million kilometers in diameter
- It would take 10 Jupiter's or 109 Earths to fit across the Sun!
- Makes life on our planet possible by giving us great amounts of light and heat.



Composition of the Sun

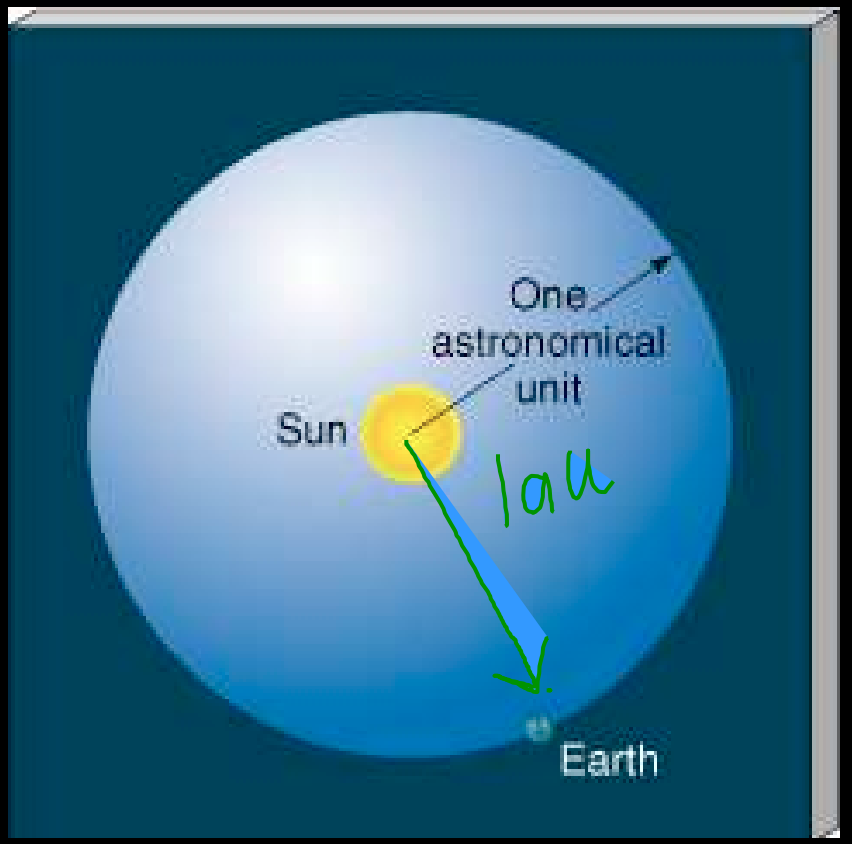
- The sun is mainly composed of hydrogen and helium.
- 90 % hydrogen
- 9 % helium
- Small amounts of other elements including oxygen, neon, and carbon are also found in the sun.



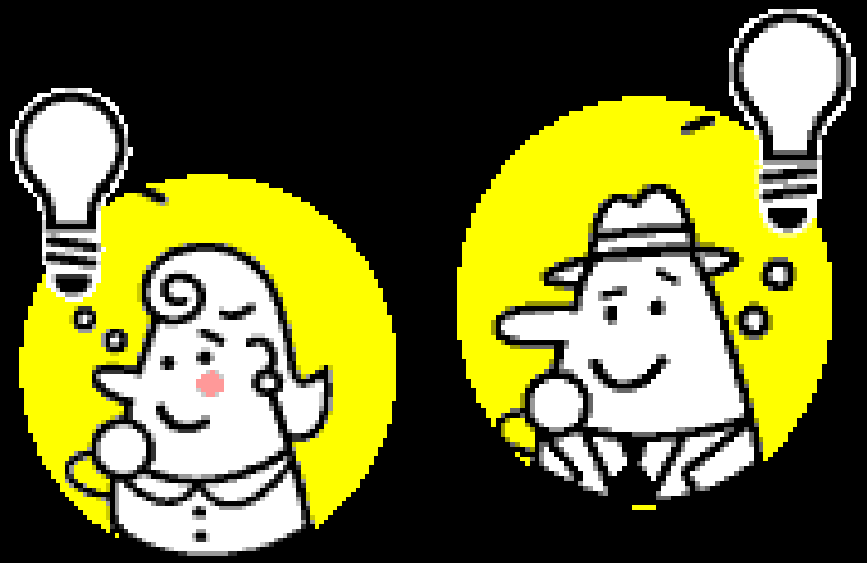
Distances in space are huge so they have a special measurement system.

Astronomical Units

- We use AU to measure distances in the solar system.
- The Earth is about 150,000,000-km (93,000,000 miles) on average from the sun.
- So we will call this distance 1 AU.



How can I remember the planets?

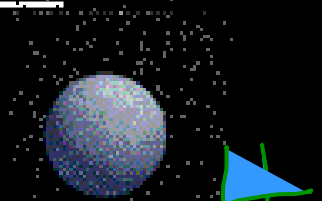


Planets Mnemonic

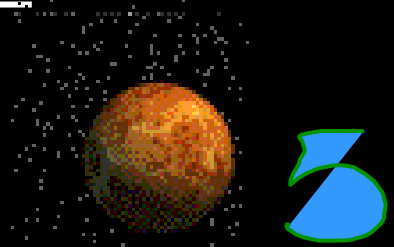
My Very Energetic Mother Just Served Us Nachos!

The 8 Planets

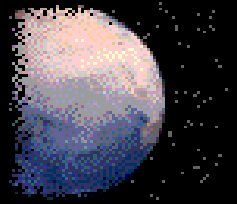
Mercury



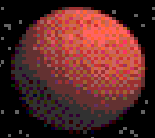
Venus



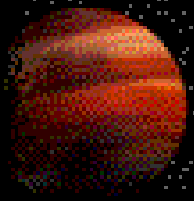
Earth



Mars

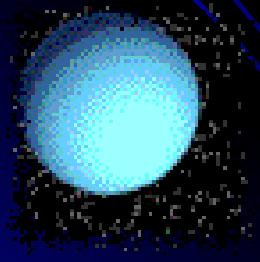


Jupiter

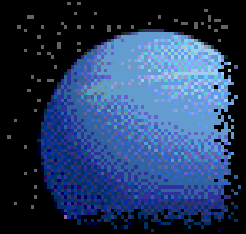


Saturn

Uranus

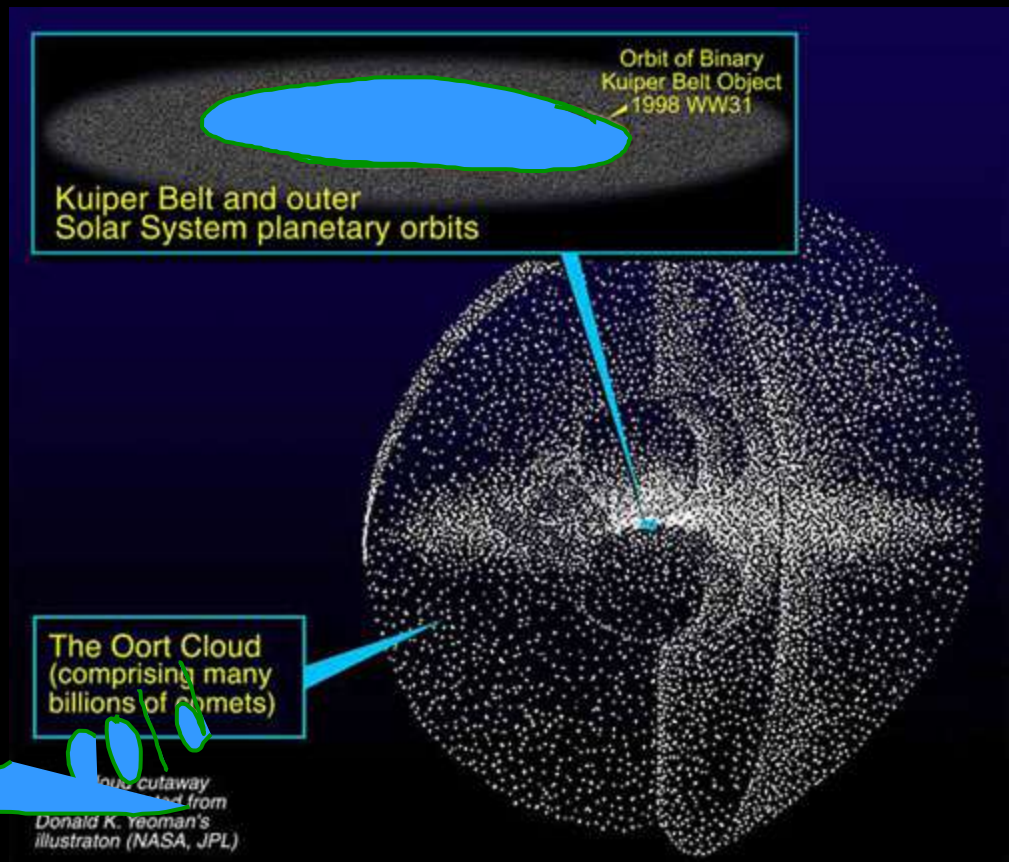


Neptune



Planetary Zones

- First Zone: Contains the rocky terrestrial planets Mercury to Mars.
- Asteroid belt divides the first and second zones.
- Second Zone: Contains the gas giants Jupiter through Neptune.
- Third Zone: Goes from the orbit of Neptune out to 50 AU. Includes Pluto and the “ice dwarfs” in the Kuiper Belt.

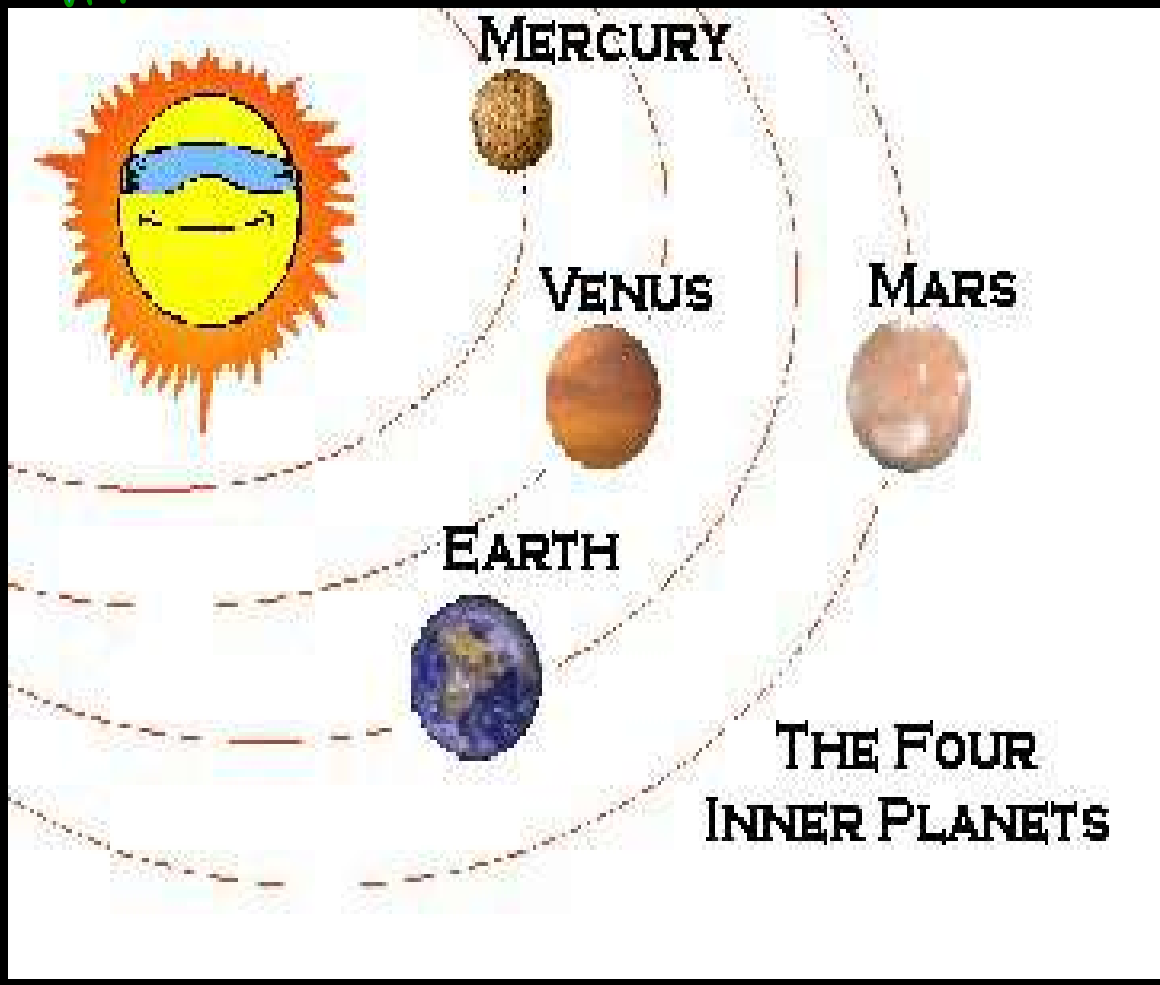


The Inner Planets

Description:

- Planets are rocky.
- Called terrestrial from the Latin word *terra*, which means Earth.

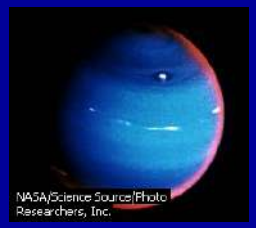
Includes:



The Outer Planets

Includes

upiter



Neptune

Pluto

aturn

- Called the Gas Giants
- Made of the lightweight elements Hydrogen, Helium, Carbon, Oxygen, and Nitrogen.

Uranus

The Dwarf Planet--Pluto, not a gas giant, but made of rock and extremely cold.

Mercury

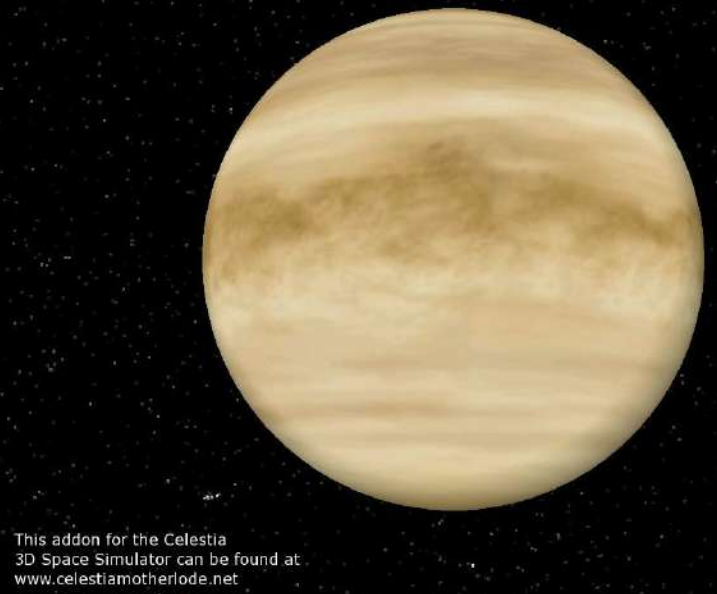
- Mercury has been known since ancient times.
- Johann Schroeter (1745 to 1816) was the first to observe the planet Mercury and record detailed drawings of Mercury's surface features.
- Mercury is the closest planet to our Sun and the fastest moving planet in our Solar System
- Mercury has a very elliptical orbit and a huge range in temperature. During the long daytime the temperature is hotter than an oven; during the long night the temperature is colder than a freezer.

Comparing Planets

- Size Relative to Earth: Smaller than the Earth
- Surface Features: Craters and High Cliffs
- Atmospheric Features: No atmosphere
- Relative Distance from Sun: 1st planet to sun/Closests to sun
- Ability to Support Life: No b/c no atmosphere
- Other: Inner Plannet, No moons, Rocky Surface, Extreme Temp. Range

Venus

- Venus is a planet on which a person would asphyxiate in the poisonous atmosphere, be cooked in the extremely high heat, and be crushed by the enormous atmospheric pressure. Venus was discovered by Ancient Greeks



- Venus is the second planet from the sun and the hottest planet in our solar system.

- Since Venus takes 7.5 Earth months to revolve around the sun and 8 months to rotate once on its axis, a day on Venus is longer than its year.
- Venus also rotates east to west, the only planet to do so. This retrograde rotation (backward) was probably caused by Venus being struck by a large object early in its history.
- Venus is the closest to Earth in size and mass of any of the other planets.

- Size Relative to Earth: Closest to Earth in size and mass. 12,104 km (7,521 miles)
- Surface Features: Hottest Planet. Can melt lead.
- Atmospheric Features: Very Thick Atmosphere, The clouds are acid. Enormous Pressure
- Relative Distance from the Sun: 2nd Planet
- Ability to Support Life: Very doubtful, the pressure and temperatures are too high.
- Other: Inner Planet, Earth's Twin, Spins Slowly, Spins Clockwise

Earth

- At the equator, the Earth's surface moves 40,000 kilometers in 24 hours. That is a rotational speed of about 1040 miles/hr (1670 km/hr).
- The Earth revolves around the Sun at a speed of about 30 km/sec.
- This compares with the Earth's rotational speed of approximately 0.5 km/sec (at middle latitudes - near the equator).

- Size Relative to Earth: 12,756 km or 1 Earth
- Surface Features: Canyons, Craters, Mnts, Volcanoes and 70% water
- Atmospheric Features: Contains Oxygen and Nitrogen
- Relative Distance from Sun: 2 Planet from sun
- Ability to Support Life: YES! Teeming with life. Planet is "just right" for life as we know it.
- Other: Inner Planet, Terrestrial and has one moon

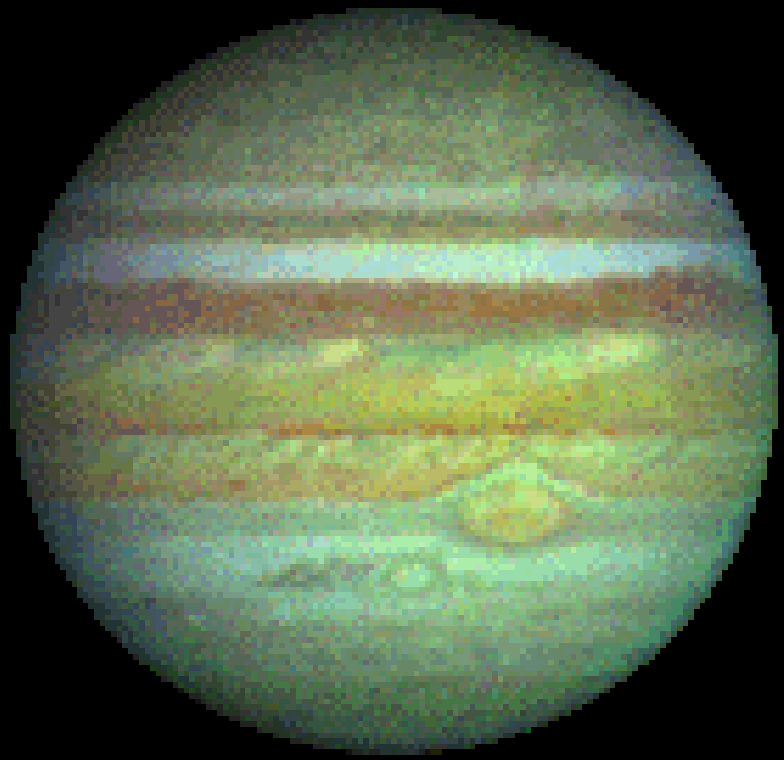
Mars

- Mars has been known since ancient times.
- Mars, the red planet, is the fourth planet from the sun and the most Earth-like planet in our solar system.
- Mars seems to have dried river and lake beds, deltas, and other features that make scientists think Mars had abundant water early in its history.
- If there was water it is possible that life could have existed on Mars, and still might.

- Size relative to Earth: ½ the size of Earth
- Surface Features: “Earth Like”, Rocky with once volcanoes, all water is frozen.
- Atmospheric Features: Thinner atmosphere than Earth. Mostly CO2
- Relative Distance from Sun: 4th Planet from Sun
- Ability to support life: Possibly ancient life when there was liquid water on the planet. Could still exist under the sand.
- Other: Inner Planet, Rocky, Called Red Planet, Has severe dust storms

Jupiter

- Jupiter has been well-known since ancient times.
- Jupiter is the fifth and largest planet in our solar system.
- Has a great red spot (which is a storm).
- Jupiter is made up of gases and liquids, so as it rotates, its parts do not rotate at exactly the same rate.



- Size Relative to Earth: Way larger than Earth. Jupiter is so big that all the other planets in our Solar System could fit inside Jupiter (if it were hollow).
- Surface Features: Made of gases and liquids
- Atmospheric Features: 90% Hydrogen, 10% Helium
- Relative Distance from the Sun: 5th Planet from sun
- Ability to Support Life: No
- Other: Outer Planet, Largest Planet, 63 moons, Great Red Spot (400 year old storm)

Saturn

- Saturn has been known since ancient times.
- Saturn is the sixth planet from the sun in our solar system. It is the second-largest planet in our solar system.

- Size Relative to the Earth: Larger than Earth. 764 Earths could fit inside a hollowed-out Saturn.
- Surface Features: A gaseous planet with a rocky core. Fluid Surface.
- Atmospheric Features: Hydrogen gas, helium, methane & ammonia
- Relative Distance from the Sun: 6th planet from Sun
- Ability to support life: No.
- Other: Outer Planet, Gasous Planet, 1 year = to 29 Earth years, Largest Ring System, 2nd largest planet

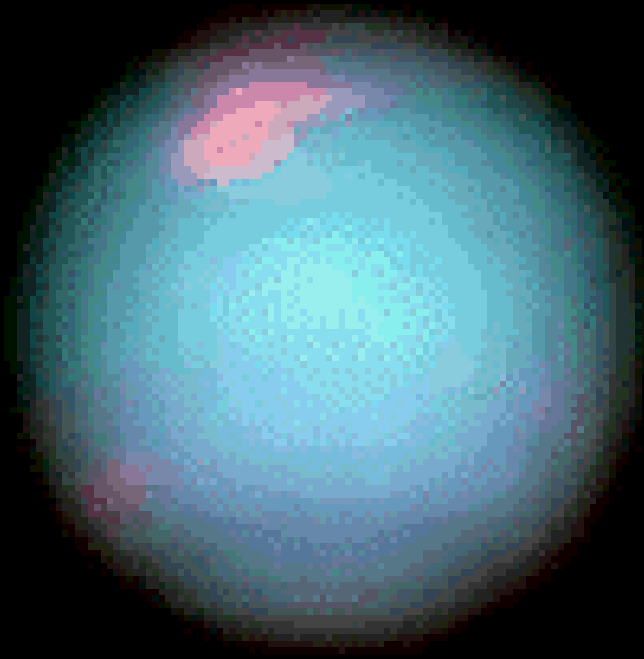
Uranus

- Uranus was discovered by the British astronomer William Herschel on March 13, 1781.
- Uranus' rotational axis is strongly tilted on its side (97.9°). Instead of rotating like all the other planets in our Solar System, Uranus rotates on its side. This tipped rotational axis causes extreme seasons on Uranus.
- This gas giant is the third-largest planet in our Solar System

- Size Relative to the Earth: Larger than Earth.
- Surface Features: Ice and Gas, no real surface. You would sink into icy gaseous center.
- Atmospheric Features: 83% hydrogen, 15% helium & 2% methane. Uranus' blue color is caused by methane in atmosphere
- Relative Distance from Sun: 7^{th} planet from sun
- Ability to Support Life: No
- Other: Outer Planet, Gasous, Tipped on its side.

Neptune

- Neptune was the first planet whose existence was predicted mathematically.
- The calculations were done independently by both J.C. Adams and Le Verrier. Neptune was then observed by J.G. Galle and d'Arrest on September 23, 1846.
- Neptune is the eighth planet from the sun in our solar system. This giant, frigid planet has a hazy atmosphere and strong winds.



- Size Relative to the Earth: Larger than Earth
- Surface Features: Coldest Planet, No Solid Surface, Large Storm systems.
- Atmospheric Features: Methane, Helium and Hydrogen
- Relative Distance from the Sun: 8th planet from sun.
- Ability to Support Life: No
- Other: Outer Planet, Gaseous, Has, Rings, Very Windy (over 200mph)

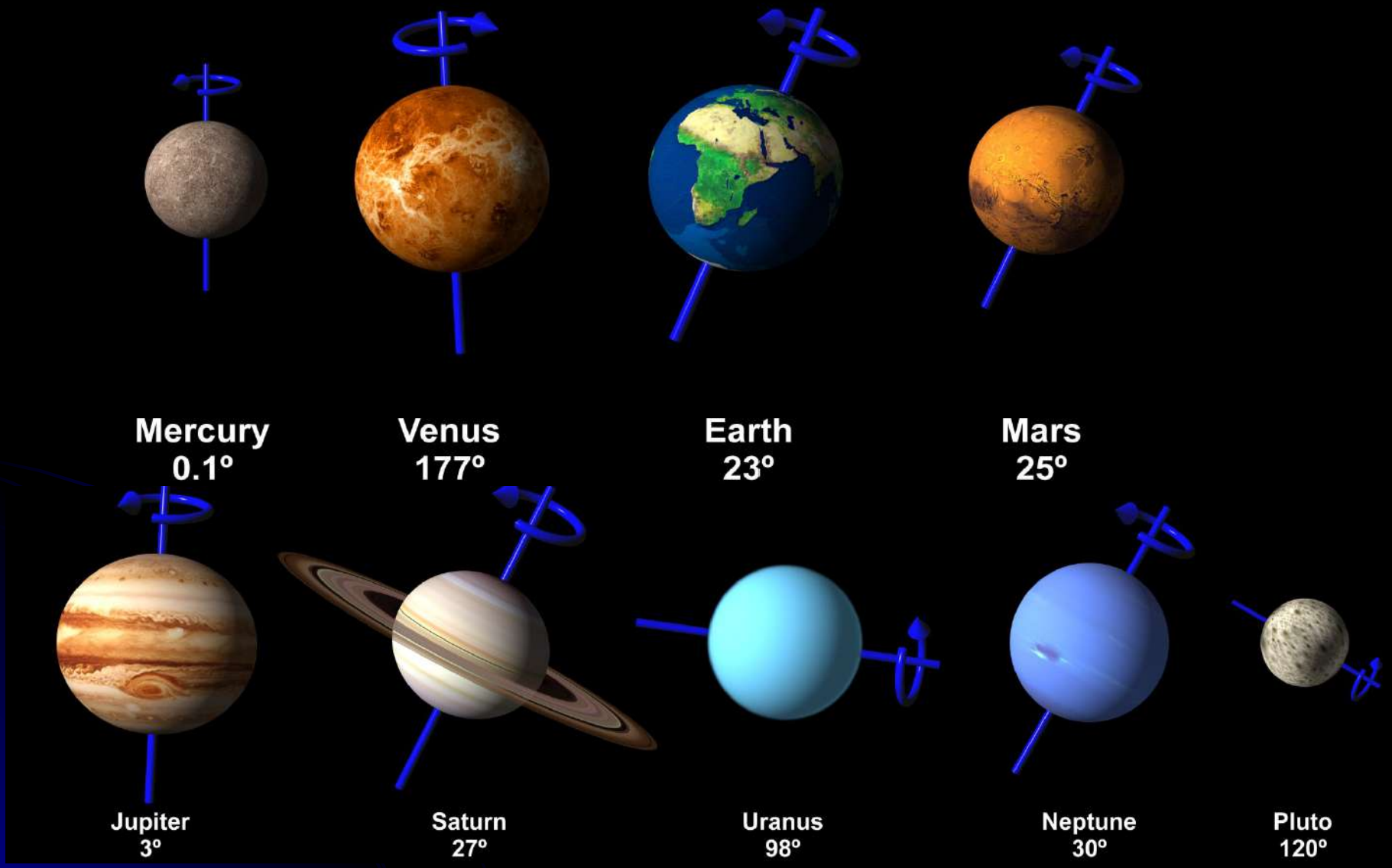
Pluto

- Pluto was found by the American astronomer Clyde W. Tombaugh in 1930.
- Occasionally, Neptune's orbit is actually outside that of Pluto; this is because of Pluto's highly eccentric (non-circular) orbit. During this time (20 years out of every 248 Earth years), Neptune is actually the farthest planet from the Sun (and not Pluto).

- Distance from the Sun: 39.53 AU
- Rotation: 6.39 Earth Days
- Revolution: 247.7 Earth Years
- Diameter: 2,274 km (1,413 mi) 1/5 the diameter of the Earth
- Atmosphere: probably mostly nitrogen with a little carbon monoxide and methane
- Surface Conditions: It is probably made up of about 70% rock and 30% water.
- Temperature: -396°F to -378°F (-238°C to -228°C)
- Life: Not that we know of, too cold.
- Rings: No
- Satellites: 1 Name: Charon

- Pluto’s atmosphere is definitely not breathable by humans. The atmosphere forms when Pluto is closest to the Sun and the frozen methane is vaporized by the solar heat. When it is farther from the Sun, the methane freezes again.
- Pluto's unusual orbit makes some scientists think that Pluto is not a regular planet. but a "minor planet"
- A mission was launched in January 2006 to send a spacecraft to Pluto in order to gather further information.

Planetary Tilt



Planetary Distances

- Mercury 0.4 AU
- Venus 0.7 AU
- Earth 1.0 AU
- Mars 1.5 AU
- Jupiter 5.0 AU
- Saturn 10.0 AU
- Uranus 19.0 AU
- Neptune 30.0 AU
- Pluto 39.0 AU

- Light travels through space at 300,000-km/s.
- So it takes about 8 minutes for light from the sun to travel 1 AU and reach us.
- How long would it take light from the sun to reach Pluto?
- 39 x 8 = 312 minutes, or 5.2 hours!

Solar System Project

- You will be divided into 9 groups
- Each group will be assigned a planet to research
- Groups will create a poster, including facts about your planet and drawings or pictures
- Each group will present their planetary research to the class
- Using the research from each group, every student will create a book of the planets

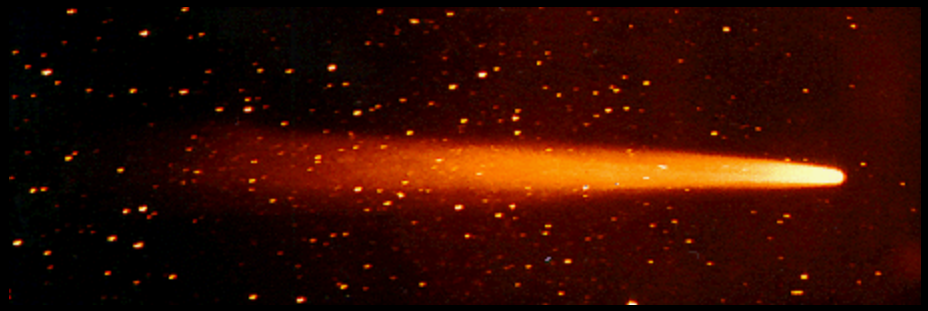
Research Requirements

- Use at least 3 sources, including books, encyclopedias, and Internet
- Compare/Contrast Planets
  - Size – relative to earth
  - Surface Features
  - Atmospheric Features
  - Relative Distance from Sun
  - Ability to Support Life

Comets, Asteroids, and Meteors

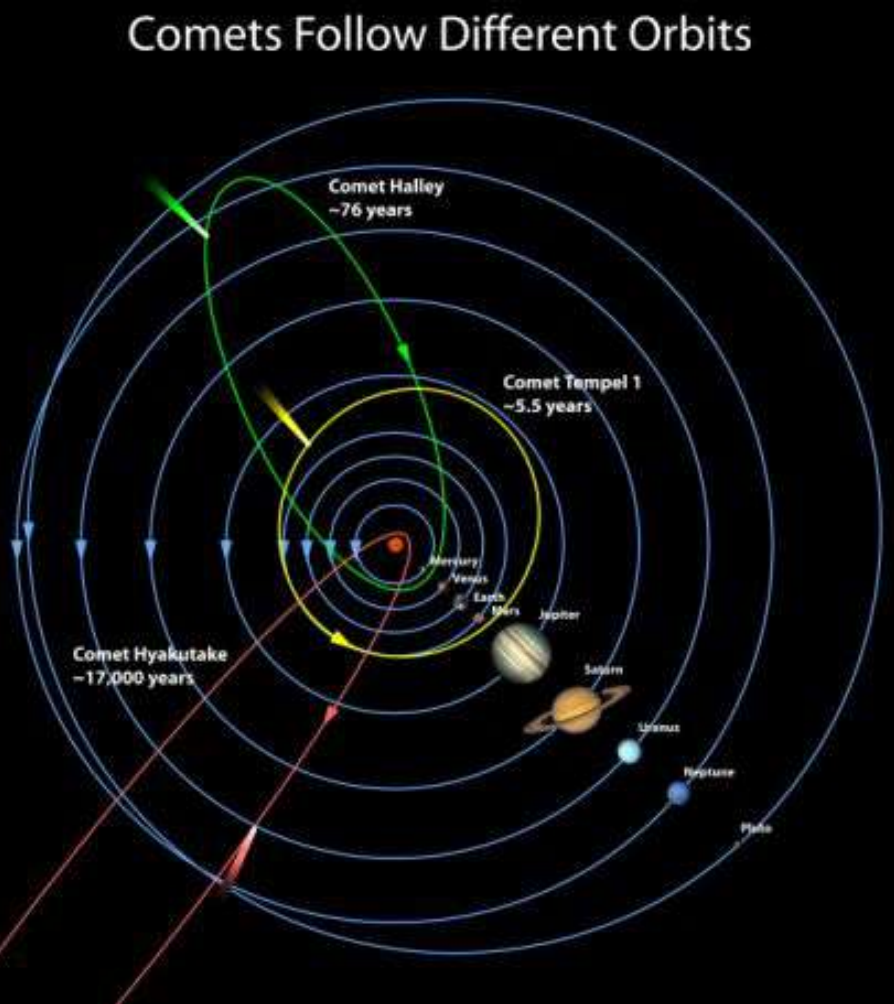
Comets

- Comets are chunks of ice and dust whose orbits are very long, narrow ellipses.
- Often thought of as dirty snowballs.



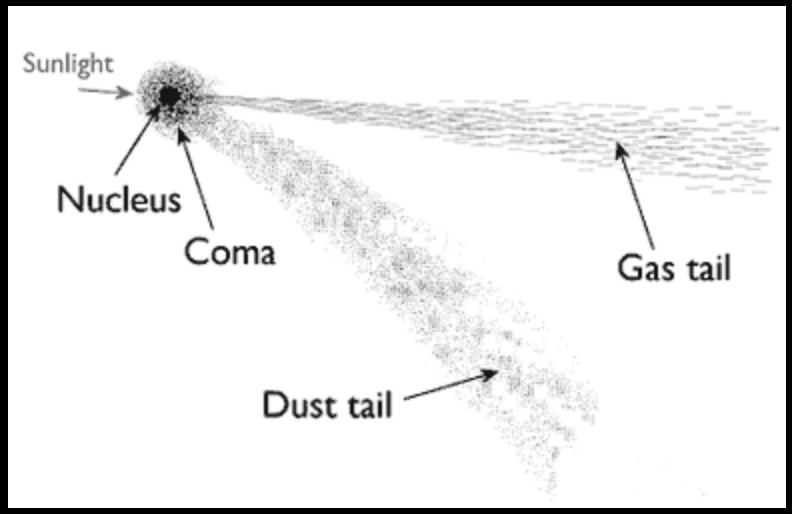
Comet Orbits

- Most comets are on very eccentric orbits that seldom pass near the Earth.



Comet Structure

- Nucleus: main solid core of the comet.
- Tail: gas and dust particles released by the comet. They are pushed by the solar wind away from the sun.
- Coma: gases and dust released by the comet when energy from the sun heats the comet and causes the solid materials to turn into a gas.

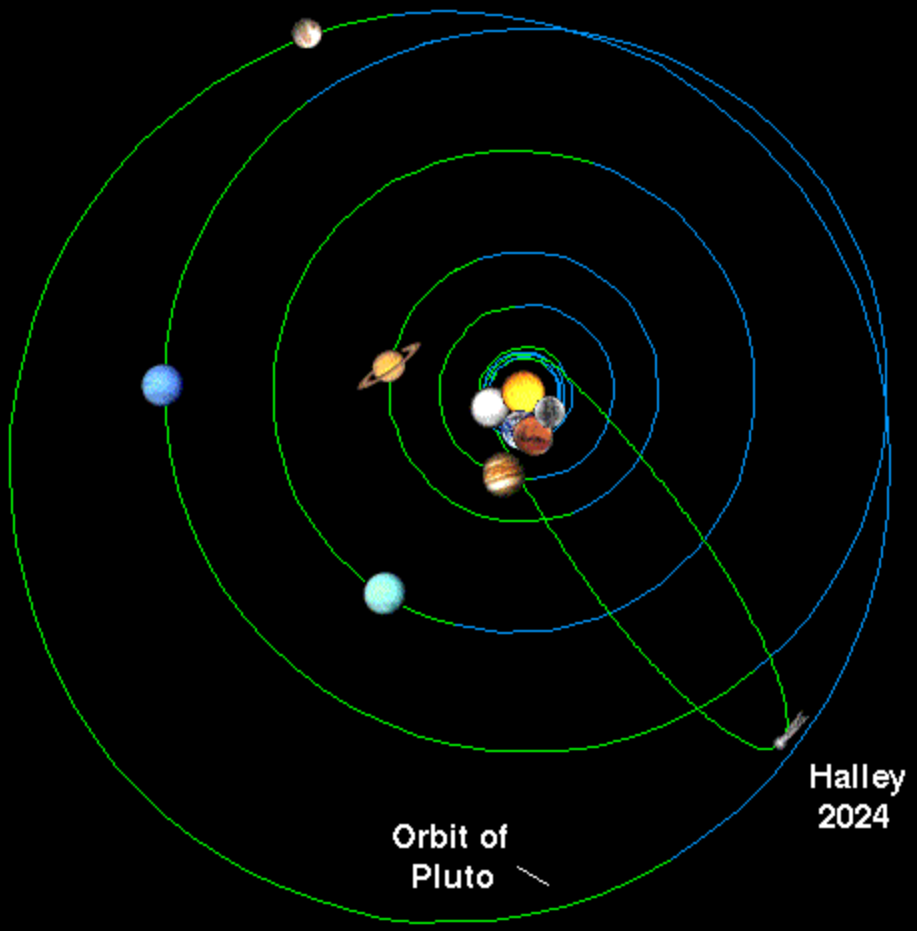


Periodic Comets

- Comets that repeatedly orbit into the inner solar system are periodic comets.
- Comet Halley is a famous, short period comet. It appears every 76 or so years.
- Nucleus of Halley's comet taken by the Giotto spacecraft.

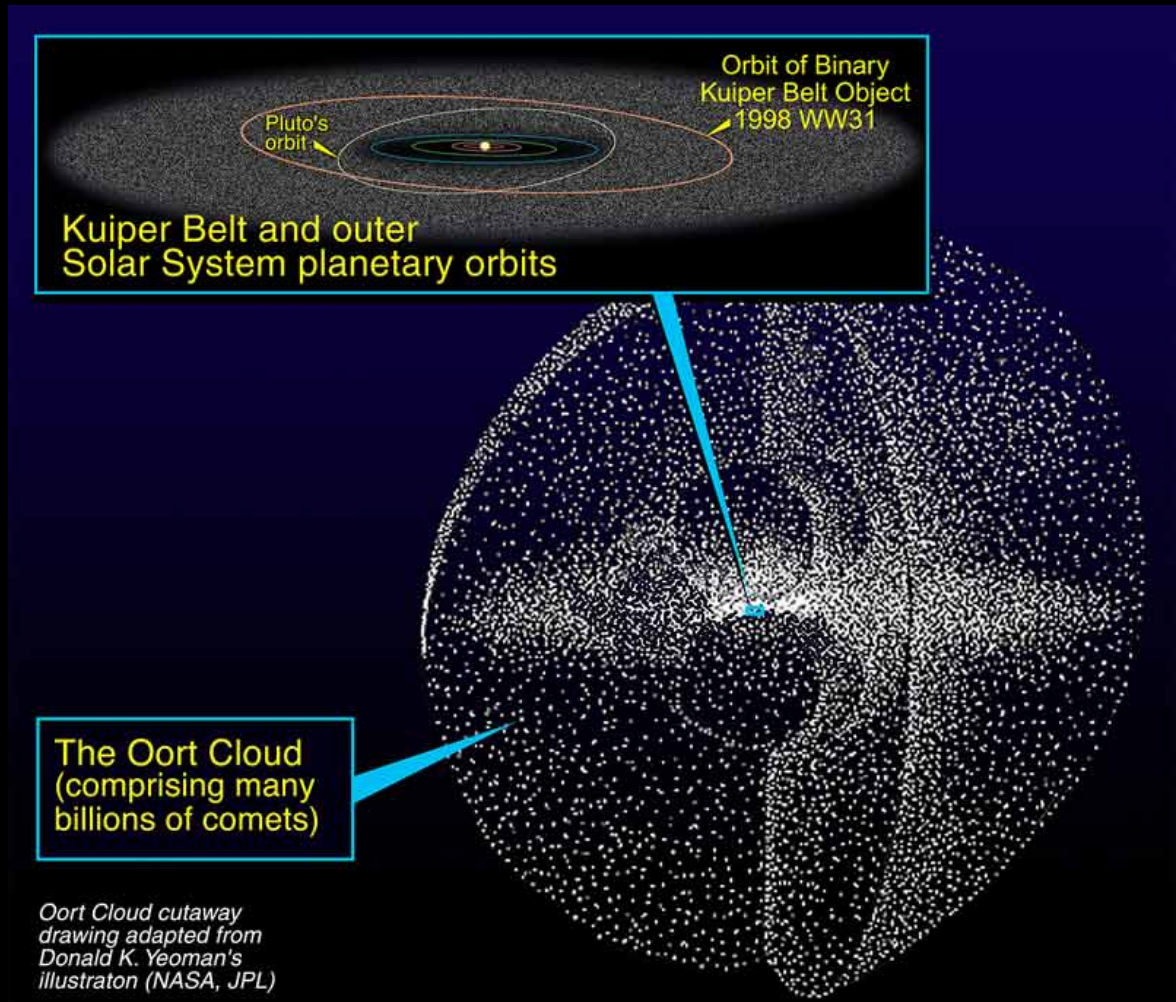
Halley's Comet

- Last appeared in 1985-86. Should appear again in 2061.
- Like most comets it has a very eccentric orbit.



Comet Clouds

- Most comets are from one of two clusters, the Kuiper Belt and the Oort Cloud.
- The Kuipier Belt is close to Pluto, from 30 to 50 AU from the sun.
- The Oort Cloud is material left over from the formation of the solar system and is more than 100,000 AU from the sun.



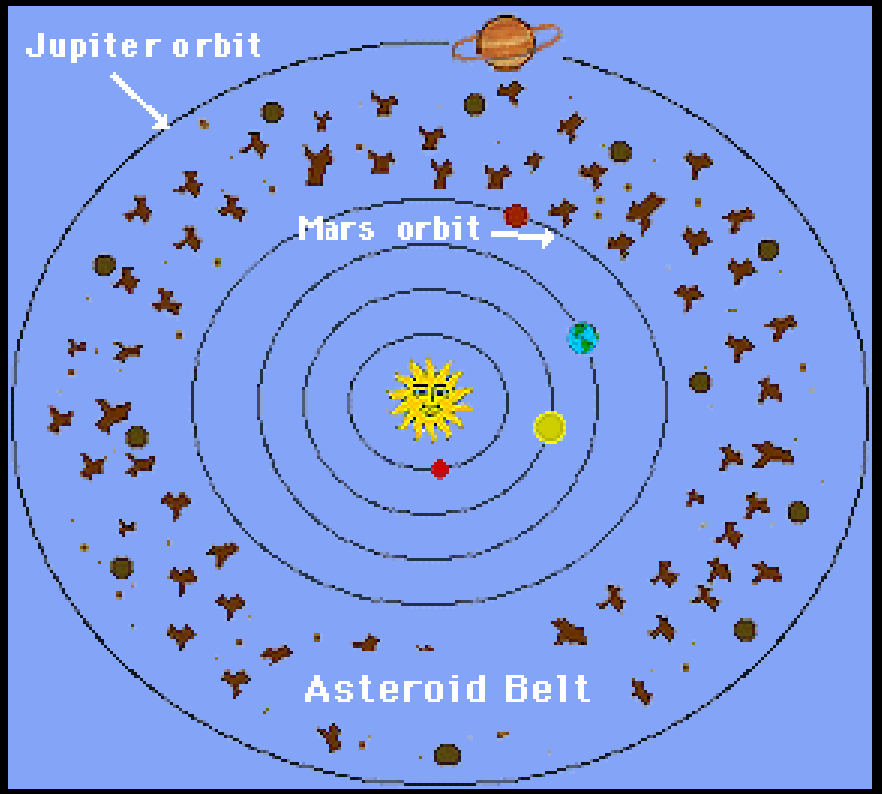
Oort Cloud cutaway drawing adapted from Donald K. Yeoman's illustraton (NASA, JPL)

Asteroids

- Asteroids are rocky or metallic objects, most of which orbit the Sun in the asteroid belt between Mars and Jupiter. A few asteroids approach the Sun more closely. None of the asteroids have atmospheres.
- Asteroids are also known as planetoids or minor planets.

Asteroid Belt

- The asteroid belt is a doughnut-shaped concentration of asteroids orbiting the Sun between the orbits of Mars and Jupiter, closer to the orbit of Mars.
- Most asteroids orbit from between 186 million to 370 million miles (300 million to 600 million km or 2 to 4 AU) from the Sun.
- The asteroids in the asteroid belt have a slightly elliptical orbit. The time for one revolution around the Sun varies from about three to six Earth years.



Number of Asteroids

- There are about 40,000 known asteroids that are over 0.5 miles (1 km) in diameter in the asteroid belt.
- About 3,000 asteroids have been cataloged. There are many more smaller asteroids.
- The first one discovered (and the biggest) is named Ceres; it was discovered in 1801.

Asteroid Size

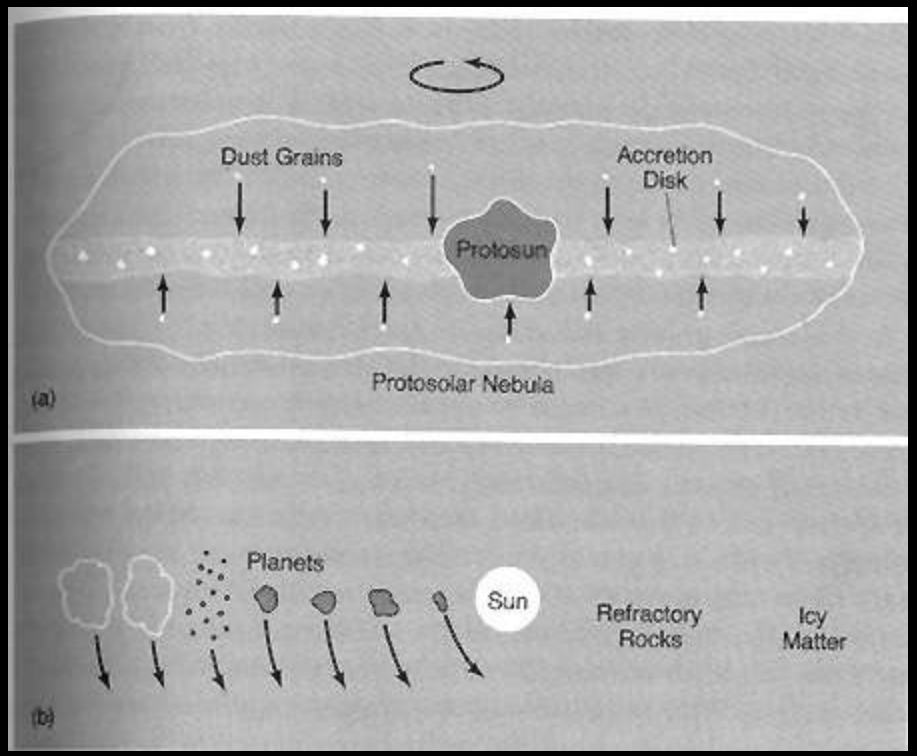
- Asteroids range in size from tiny pebbles to about 578 miles (930 kilometers) in diameter (Ceres).
- Sixteen of the 3,000 known asteroids are over 150 miles (240 km) in diameter.
- Some asteroids even have orbiting moons.

87 Sylvia and her Twins
(Artist's Impression)

ESO PR Photo 25b/05 (August 11, 2005) ©ESO

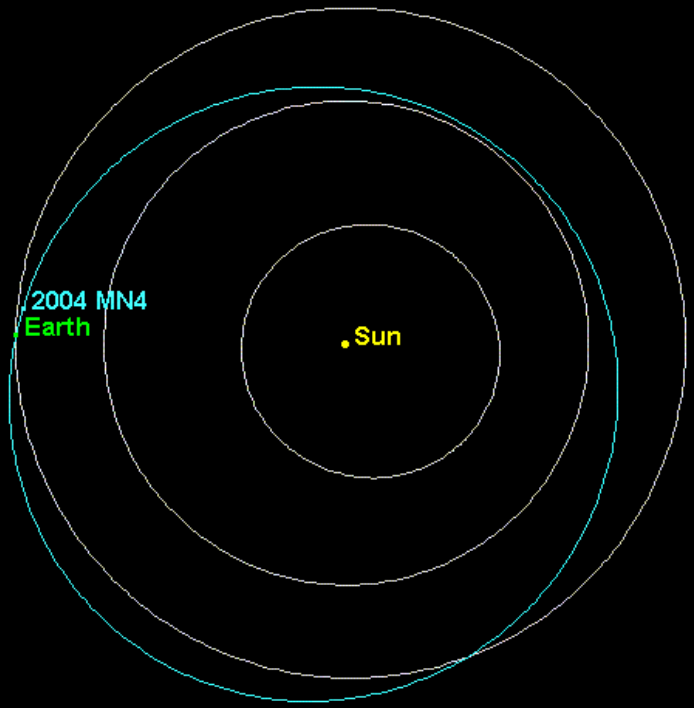
Origin of the Asteroid Belt

- The asteroid belt may be material that never coalesced into a planet, perhaps because its mass was too small.
- The total mass of all the asteroids is only a small fraction of that of our Moon (about 1/30th).
- A less satisfactory explanation of the origin of the asteroid belt is that it may have once been a planet that was fragmented by a collision with a huge comet.



Near-Earth Asteroids

- Asteroids whose orbits bring them within 1.3 AU of the Sun are called Near-Earth Asteroids (NEA) or Earth-Approaching asteroids.
- These asteroids probably came from the main asteroid belt, but were jolted from the belt by collisions or by interactions with other objects' gravitational fields (primarily Jupiter).



NEA Concerns

- About 250 NEAs have been found so far, but many, many more exist.
- The largest known NEA is 1036 Ganymede, with a diameter of 25.5 miles (41 kilometers).
- According to astronomers there are at least 1,000 NEA's whose diameter is greater than 0.6 miles (1 kilometer) and which could do catastrophic damage to the Earth.
- Even smaller NEA's could cause substantial destruction if they were to collide with the Earth.

Demise of the Dinosaurs?

- An asteroid impact with the Earth may have caused the extinction of the dinosaurs.
- The Alvarez Asteroid Theory explains the huge K-T mass extinction 65 million years ago by a large asteroid hitting the Earth off the Mexican Yucatan peninsula.
- This impact would have caused severe climactic changes leading to the demise of many groups of organisms, including non-avian dinosaurs.

Meteoroids

- Meteoroids are small chunks of dust and rock in space.
- Usually come from comets or asteroids.

Meteors

- When a meteoroid enters the Earth's atmosphere friction will cause it to heat up.
- It will leave a bright streak of light across the sky as it burns up.
- Are called meteors when they brightly fall to the Earth.
- Often occur in showers, with several sightings a minute.

Meteorites

- While the vast majority of meteors burn completely up, ones that are large enough pass through the atmosphere and hit the surface.
- Most look like stones, so they are not noticed. Some are easy to identify as they are made of iron or nickel.

Craters

- Meteorites create craters when they strike the surface of a planet.
- Our moon is covered with craters caused by meteorites, asteroids, and comets.
- Meteor Crater in Arizona is a famous crater found in the USA. Occurred 50,000 years ago.
- Hit with the force of 150 Hiroshima A bombs.