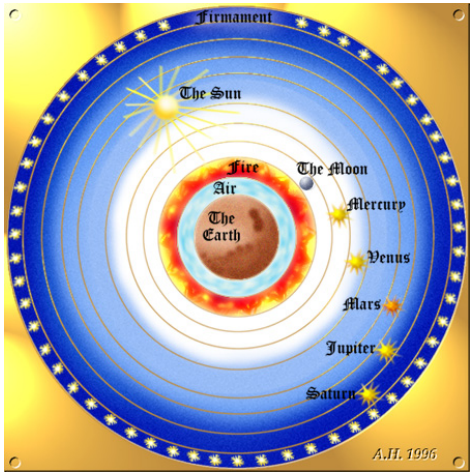
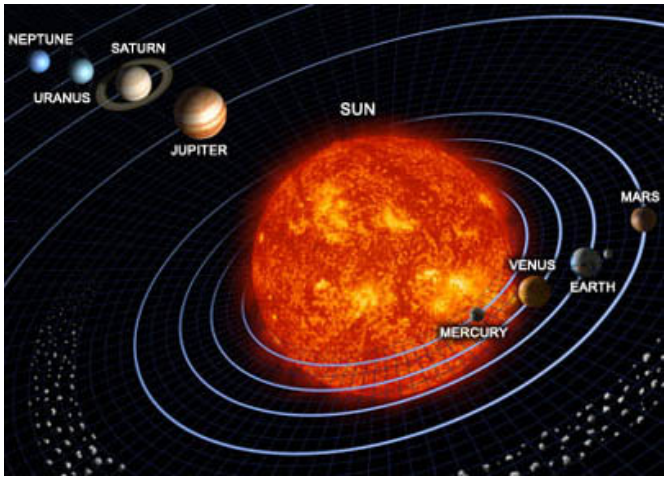
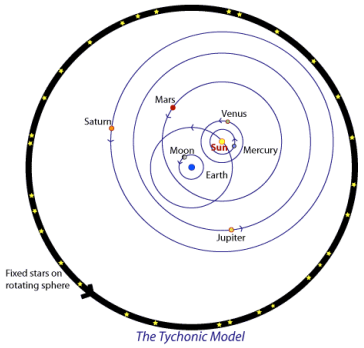
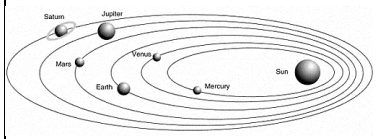
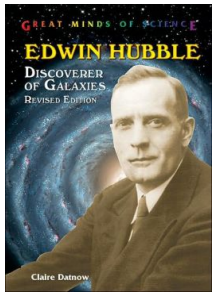
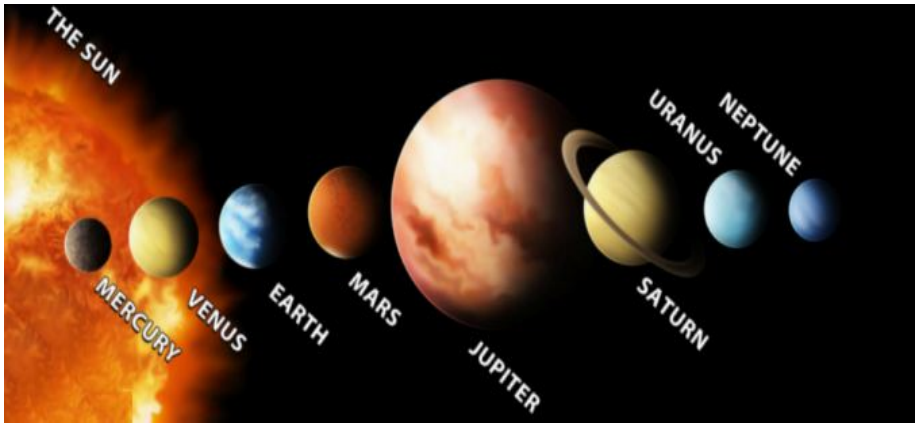
ASTRONOMY NOTES CHAPTER 3: THE SOLAR SYSTEM

LESSON 1: MODELS OF THE SOLAR SYSTEM

GEOCENTRIC MODEL	HELIOCENTRIC MODEL
= Earth is at the center of the revolving planets & stars	= Earth and other planets revolve around the sun.
1. Early observers thought Earth was at center of universe a. Early Chinese thought Earth was under a dome of stars b. Early Greeks thought that Earth was inside rotating spheres nested inside each other. 2. **Ptolemy's Model** a. 140 A.D. Ptolemy (Greek) further developed geocentric model. b. Said that **Earth was at center** of universe, and all the planets & stars orbit our planet. c. Geocentric model accepted for 1500 years!!  	1. Copernican Revolution (1543)….Given credit for HELIOCENTRIC MODEL even though a Greek first proposed it. → **Nicolaus Copernicus**- worked out the arrangement of the known planets…and how they move around the sun. CHANGED SCIENCE FOREVER!!… **THE SUN IS THE CENTER** 

Brahe- **HYBRID MODEL** (late 1500s)	**Johannes Kepler**- Shape of Planets Orbits (1609)… was Brahe's assistant	**Galileo's** Evidence (1610)	**Isaac Newton** (1687)	**Edwin Hubble** (1924)
a. **Tycho Brahe**- he thought that the earth is at rest in the middle of the universe. The moon obviously goes around the earth and so does the sun and the stars. All the other planets, however, go around the sun.  *The Tychonic Model*	a. Kepler said that the orbit of each planet is an **ellipse-** (oval shape) b. Sun is slightly offset in the orbits c. **Planets closer to sun orbit faster than those further out**… you are older on Mercury than on Earth  	Used a telescope to discover 4 moons around Jupiter. Proved that not everything in sky revolves around Earth. Found that Venus goes through series of phases like moon's.. also proved that planets are solid bodies like Earth. 	Explained WHY we orbit the Sun & the moons orbit the planets.  Sun contains 99.9% of mass of our solar system.. exerts huge gravitational pull.	Proved that the Milky Way galaxy isn't the only one out there….are other galaxies in the universe. 

LESSON 2: INTRODUCING THE SOLAR SYSTEM



1. **Solar system** = consists of the sun, planets, their moons & variety of smaller objects.
   a. Sun is at center… everything orbits around it.
   b. **Force of gravity holds solar system together.**

   c. Distances in Solar System
      i. **Astronomical Unit (AU)** = average distance between Earth & Sun = 150 million kilometers
      ii. Solar system extends more than 100,000 AU from the Sun.

Sun	--------
Mercury	0.4 A.U.
Venus	0.7 A.U.
Earth	1.0 A.U.
Mars	1.5 A.U.
Jupiter	5.2 A.U.
Saturn	9.5 A.U.
Uranus	19.2 A.U.

WHAT MAKES UP THE SOLAR SYSTEM

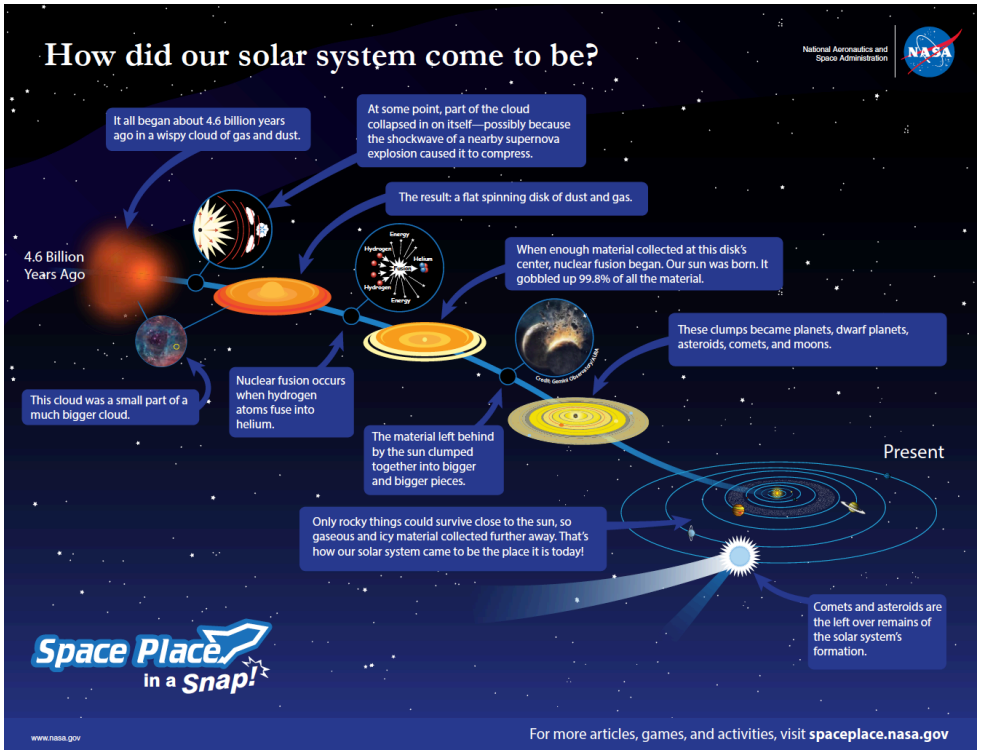
1. Our Sun	1. Planets	2. Dwarf Planets	3. Natural Satellites (Moons)	4. Smaller Objects found in our Solar System
a. About 99.9% of mass of solar system is contained in our sun b. Sun is ordinary—mid sized star c. Will last for 5 billion more years	**Planet** = Round, orbit the sun & have cleared out region of the solar system along its orbit. →8 planets in our solar system	**Dwarf planet** = object that orbits the sun & has enough gravity to be spherical, but has NOT cleared the area of its orbit. →5 dwarf planets in our solar system	→ Except for Mercury & Venus.. every planet in solar system has at least 1 moon (satellite).	→ Asteroids → Comets

A. SOLAR SYSTEM FORMATION!

1. Formed about 4.6 billion years ago
   a. Gravity pulled cloud's material together… started spinning.. temp & pressure got so high that NUCLEAR FUSION started… Sun gave off light.

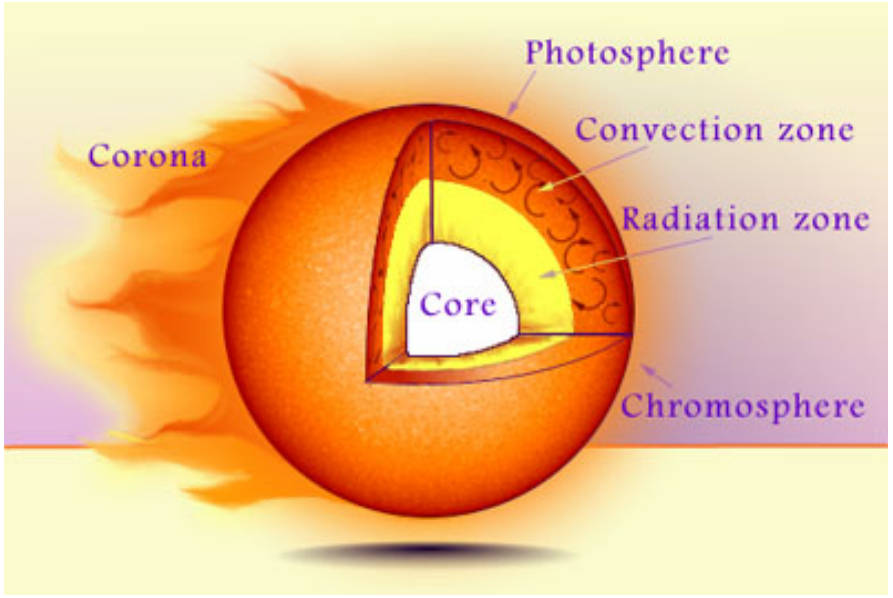
b. Away from sun.. planets started to form.

c. Gravity pulled rock, ice & gas together formed **PLANETESIMALS** = small asteroid like bodies that formed the planets
   i. Inner Planets – Low in mass, small & rocky
   ii. Outer Planets- Gas giants… had strong gravity.



LESSON 3: THE SUN

1. Sun has an interior and an atmosphere. The interior includes the core, radiation zone & convection zone.
2. Layers of Sun
   a. The **Core** = central region, hottest part
      i. Enormous amount of energy produced
      ii. **Nuclear Fusion**= hydrogen atoms join to form helium..needs high temps & pressures
   b. **Radiation Zone** = tightly packed gas where energy moves mainly in the form of electromagnetic radiation.
      i. Energy can take more than 100,000 years to move through it.
   c. **Convection Zone** = outermost layer of sun's interior
      i. Hot gases rise & cool gases sink, forming loops of gas that move energy toward Sun's surface.



3. Sun's Atmosphere
   a. **Photosphere** = inner layer of sun's atmosphere
      i. when you look at image of sun you see the photosphere "Sun's surface layer"
   b. **Chromosphere**= middle layer of sun's atmosphere
      i. "color sphere" of the sun
   c. **Corona** = outer layer.. looks like white halo around Sun.
      i. Extends into space for millions of km, see it during solar eclipses
      ii. Thins into streams of charged particles = **Solar Wind**

* ORDER OF SUN'S INTERIOR AND ATMOSPHERE

CORE → RADIATION ZONE → CONVECTION ZONE → PHOTOSPHERE →CHROMOSPHERE → CORONA

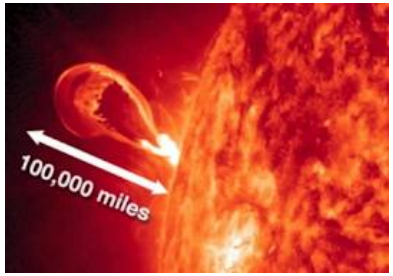
What Features Can You See On the Sun??

1. **Sunspots** = areas of gas on sun's surface that are cooler than areas around them
   → Occur in 11 year cycles

→We are currently in a SOLAR MAXIMUM … increased solar activity

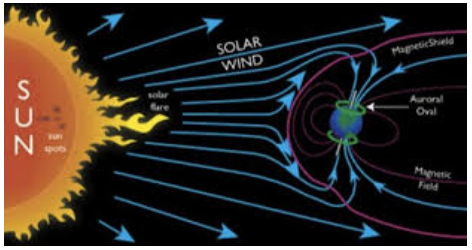
→**SOLAR MINIMUM** is predicted to start possible around 2020. Have caused Ice Ages in the past.

2. **Prominences** = huge loops of gas that link north & south poles of sunspots



3. **Solar Flares** = eruptions of gas from the sun into space, happens when loops in sunspots slide & connect together.

4. Solar Wind



a. Solar flares can increase solar wind… these particle can enter Earth's atmosphere at poles →Aurora's (Northern Lights).
b. Can cause magnetic storms that disrupt cell phone service, radio/TV transmissions.

Sunspots-Effects on Earth

- Studies of rock strata (layers) have suggested that the solar cycles have been active for hundreds of millions of years, if not longer; precambrian sedimentary rock has revealed changes in layer thickness, with a pattern approximately repeating every eleven layers.
- Analysis of tree rings has revealed a detailed picture of past solar sunspot cycles for the last 11,400 years
- Sunspot activity affects weather and plant growth

What can happen when solar flares hit earth???

1. THEY CAN CAUSE HEAVY ENVIRONMENTAL DISTURBANCES LIKE GEOMAGNETIC STORM,SOLAR RADIATION STORMS, RADIO BLACKOUT, CELLPHONE DISRUPTION, GPS AND SATELLITE DISRUPTION.
2. LARGE SOLAR FLARES CAN CAUSE AURORAS.
3. EARTHQUAKES CAN BE ATTRIBUTED TO LARGE SOLAR ACTIVITY.
4. BIRDS AND MARINE LIFE ARE AFFECTED.

LESSON 4: INNER PLANETS

SMALL……DENSE……ROCKY

→ rocky- have metallic minerals (iron & silicon)

➔ All have some atmosphere EXCEPT Mercury

1. **Terrestrial planets** = another name for 4 inner planets.

	MERCURY	VENUS	EARTH	MARS
SIZE & COMPOSTION	Small, solid & rocky -1 day = 59 Earth days -1 year = 88 Earth days	-Earth's twin for size -1 day = 8 Earth months ** rotates & orbits opposite of all the other planets. * Sun rises in West her	3 layers- crust, mantle, core	-Sept 2015- liquid water on Mars -June 2008- ice was discovered at poles -1 day= 25 Earth hours
ATMOSPHERE	**MERCURY** No atmosphere	**VENUS** Dense clouds of CO_2 Drops of sulfuric acid fall from sky	**EARTH** N_2, O_2, and other gases	**MARS** Very Thin atmosphere (95% CO_2)
TEMPS	Day= 800 F Night= -280 F	Day & Night = 870 F ** Greenhouse Planet-Known for Greenhouse Effect= trapping of heat	Vary from pole to pole	Day = 60 F Night = -130 F

		near planets surface by gase		Goes thru seasons
SURFACE FEATURES	Craters & cliffs	Cracks & cliffs & 10,000 volcanoes	70% covered w/ H_2O	"Red Planet" Craters, volcanoes Olympus Mons- largest volcano in solar system.
MOONS	NO MOONS	NO MOONS	(1) "Moon" - lunar cycle= 29.5 days - waxing and waning lunar phases	(2) Moons Phobos- orbits every 7 hrs has Stickney Crater Deimos- one of the smallest moons in the solar system (8 miles wide)
SPACE PROBES	MERCURY Mariner 10 (1974 & 1975) Messenger (2009- 2015)	VENUS Venera 7 (1970) Magellan (1990)	EARTH NO PROBES … We live here!!!!	MARS The most studied planet Twin Rover (2003) Mariner 9 Viking 1 & 2 Many others!!

LESSON 5: THE OUTER PLANETS

a. What do the Outer Planets have in Common?

- ➔ Much larger & more massive than Earth, do NOT have solid surfaces
- ➔ Have huge amount of gravitational force
- ➔ Each is surrounded by a set of rings

  -> Gas Giant = name often given to outer planets

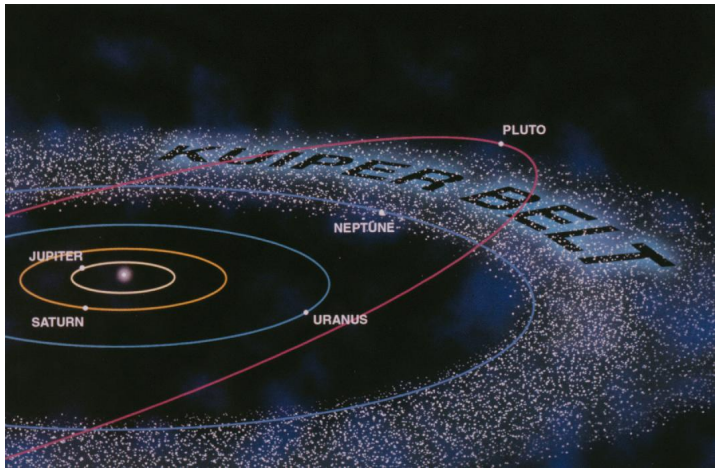
	JUPITER	SATURN	URANUS	NEPTUNE
SIZE & COMPOSITION	Large & Gaseous & Has Rings Largest in Solar system- fit 1300 Earth's	2nd largest … think Saturn is still forming	Discovered by William Herschel 1781	Twin of Uranus
ATMOSPHERE	Water, methane & ammonia	Very much like Jupiter	Methane, ammonia, H_2O	
BELOW ATMOSPHERE	Super high pressure … w/ a solid core	Solid core … similar to Jupiter	Rocky core Rain down diamonds	Rain down diamonds

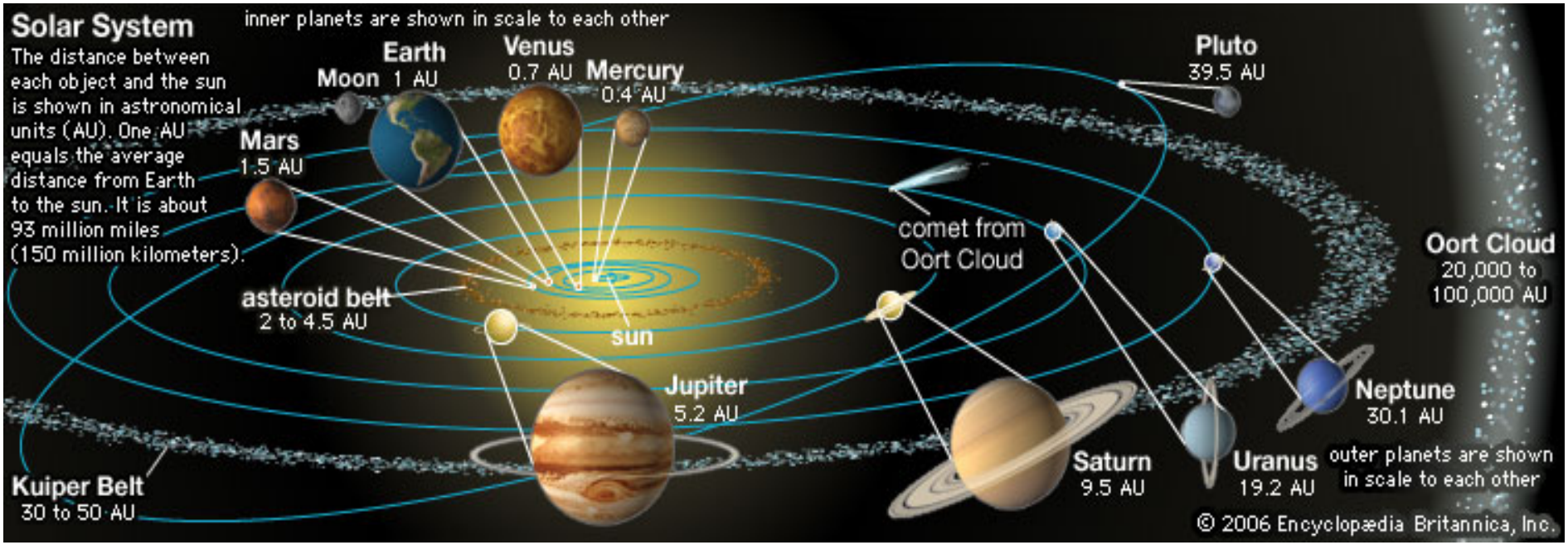
	JUPITER	SATURN	URANUS	NEPTUNE
NOTABLE FEATURES	Great Red Spot- 400 yr old storm	Has Rings Lowest density of ALL planets	Thin, dark rings Blue-green color (methane) Tilted 90 degree (on its side)	Blue-green color Clouds of methane ice. Great Dark Spot- large storm that is now gone.
MOONS	(63) Io- volcanoes- tons & tons of them. Europa- could be an ocean of liquid under icy crust Ganymede- Largest moon in SS, has thin O_2 atmosphere Callisto- icy surface w/ craters, has thin atmosphere of CO_2	(61) Titan- Super thick atmosphere, given off by hydrocarbons Mimas & Tethys- Have giant craters & trenches Enceladus- ice & water geysers Iapetus- light & dark areas	(27) Cordelia- innermost moon of Uranus- found in 1986 Ophelia- icy & cratered moon- found in 1986 Miranda- used to have lots of earthquakes?	(13) Triton- coldest object in space - ice volcanoes
SPACE PROBES	Voyagers, Galileo	Cassini, Huygens, Voyagers	Voyagers	Voyager

LESSON 6: SMALL SOLAR SYSTEM OBJECTS

→Categories: Dwarf Planets, Comets, Asteroids, Meteoroids

1. Areas of the Solar System
   a. **Asteroid Belt** = region of the solar system between Mars & Jupiter
   b. **Kuipers Belt** = beyond Neptune's orbit is this region which extends about 100 times Earth's distance from the sun.
   c. **Oort's Cloud** = stretches out more than 1000x's the distance btwn sun & Neptune

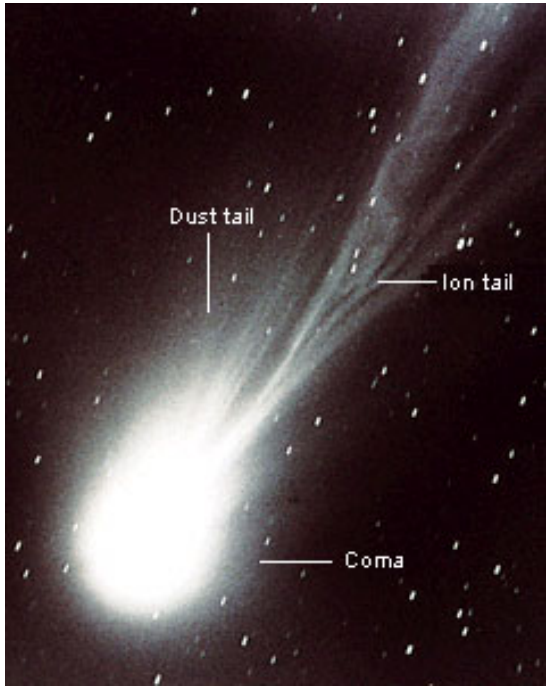


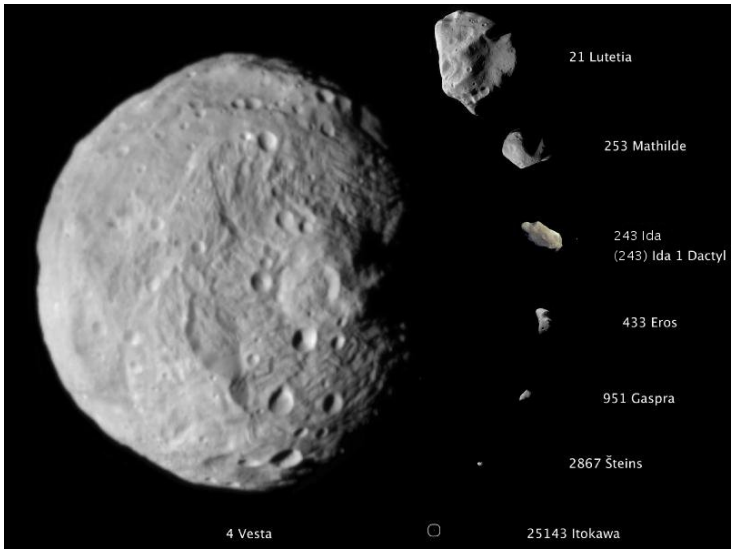


2. **Dwarf Planets**: Pluto, Eris, Makemake, Haumea, **Ceres** (Dawn probe orbiting now)
   a. **Eris** is largest dwarf planet so far… it has 1 moon Dysnomia
   b. **Pluto** has 5 moons : Charon, Nix , Hydra, Styx, Kerberos
   c. **Haumea** has 2 moons.. Hi'iaka & Namaka
   d. **Makemake** has 0 moons

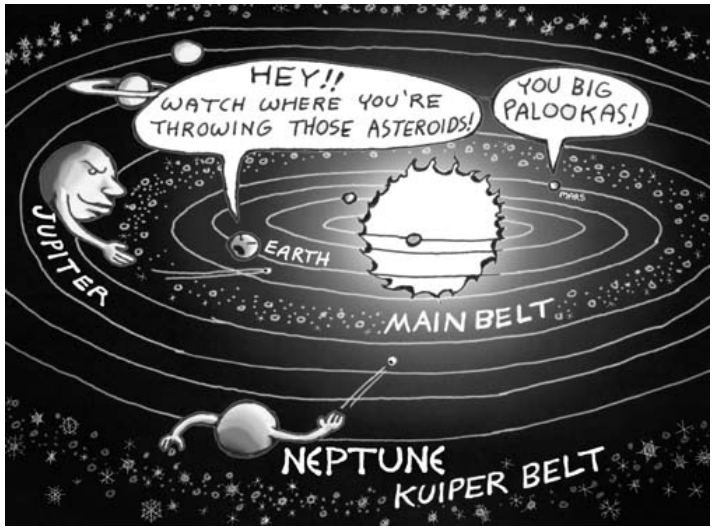
3. Kuiper Belt Objects- **all the dwarf planets except Ceres orbit beyond Neptune in Kuiper's Belt.**

4. **Comets** = ice, dust and small rocky particles whose orbits can be ellipses
   a. **Most comets originate in Oort Cloud**
   b. Comet's Head
      i. **Coma**= fuzzy outer layers of comet
      ii. **Nucleus**= solid inner core of comet
   c. Comet's Tail- have gas tail & dust tail

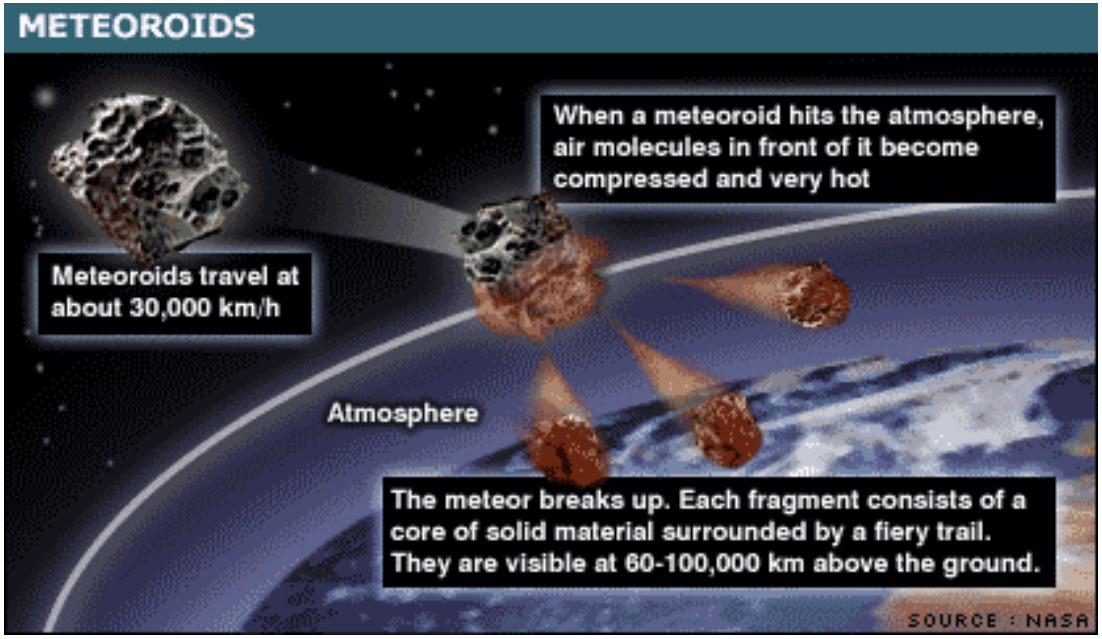




5. **Asteroids** = rocky objects that orbit the sun… but are too small to be considered planets or dwarf planets.
   a. They are **probably leftover pieces of our early solar system.**



6. MeteoROIDS = chunks of rock or dust that are SMALLER than asteroids… found in space.
   a. Meteor is streak of light in our sky (shooting stars)
      i. Famous meteor showers that occur each year: Perseids, Geminids, Orionids



   b. MeteoRITE= when meteor passes thru earth's atmosphere & strikes Earth.
      i. Meteor Crater (a.k.a Barringer Crater) in Arizona (50,000 yr old impact crater)

Meteoroid (chunk in space) → Meteor (burns up in space)
→ Meteorite (if it strikes Earth).

BARRINGER/METEOR CRATER… in Arizona