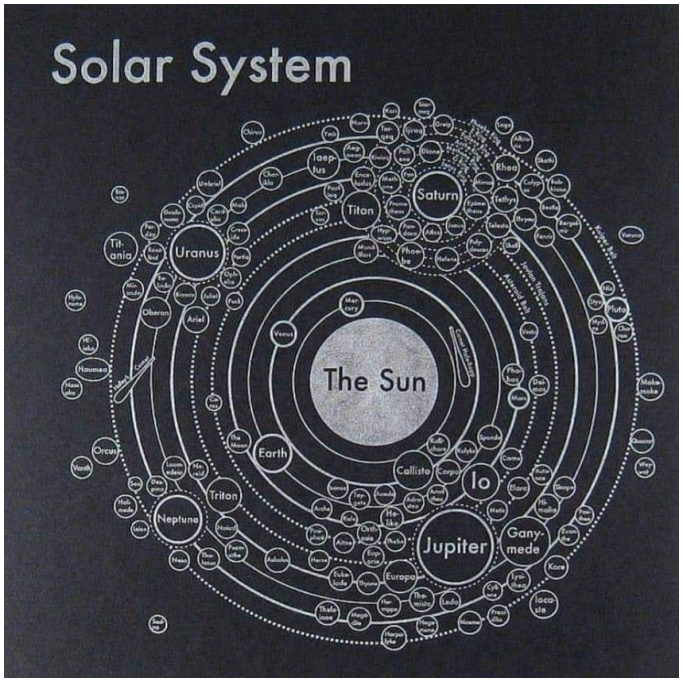
TOPIC 12: SOLAR SYSTEM & THE UNIVERSE

LESSON 1: SOLAR SYSTEM OBJECTS PG. 537-540

UNDERSTANDING 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. **GRAVITY holds solar system together!**

➔ The strength of gravity depends on the masses (big size = more gravity) & the distance between them (if you are further away = less gravity)

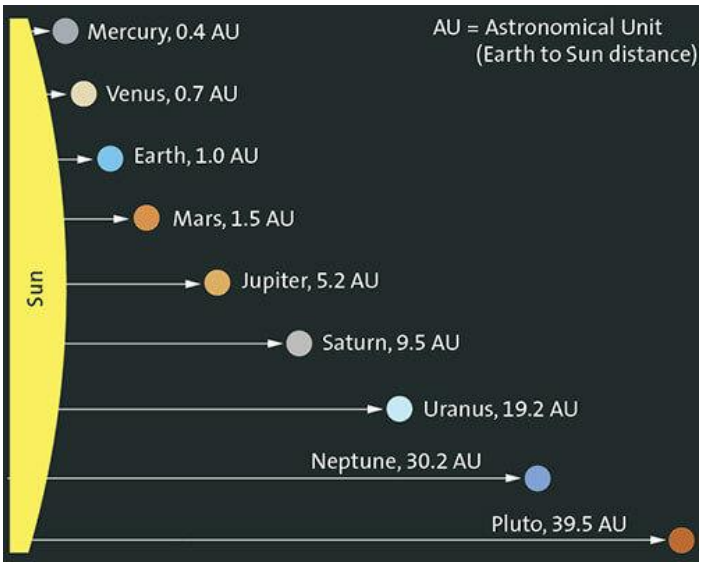


DISTANCES IN THE SOLAR SYSTEM……

Distances are so huge in our solar system we have a special way to measure them.

➔ Astronomical Unit (AU)= average distance from Sun to the Earth (150,00,000 km or 93 million miles) = **1** AU

➔ Our Solar System extends more than 100,000 AU from the Sun.



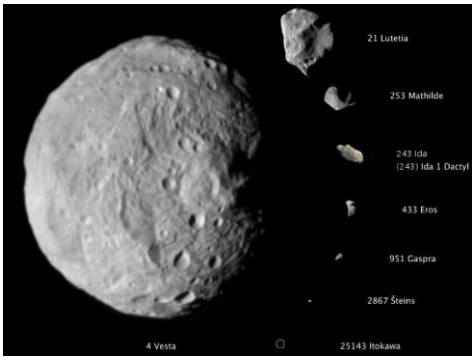
WHAT MAKES UP OUR SOLAR SYSTEM??

1.)Our Sun	2.)Planets	3.)Dwarf Planets	4.)Natural Satellites (Moons)
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: Pluto, Eris, Ceres, Makemake, Haumea	→ Except for Mercury & Venus.. every planet in solar system has at least 1 moon (natural satellite).

5.)Asteroids= rocky objects that orbit the sun… but are too small to be considered planets or dwarf planets.

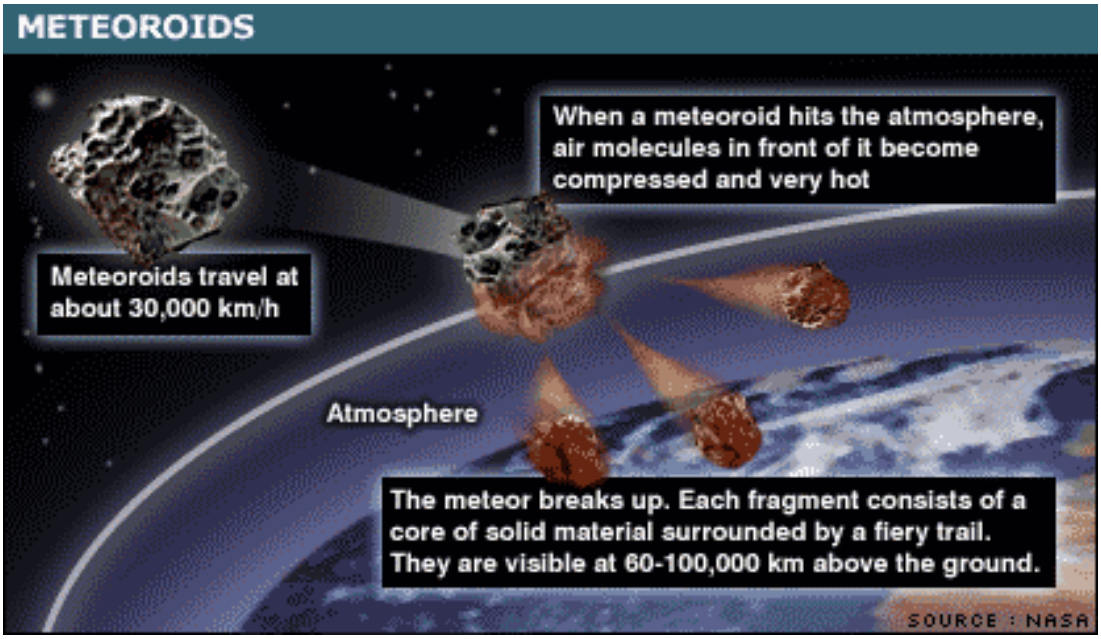
→ Many asteroids are found between orbits of Mars & Jupiter

→Asteroids are probably leftover pieces of our early solar system.



6.Meteoroids

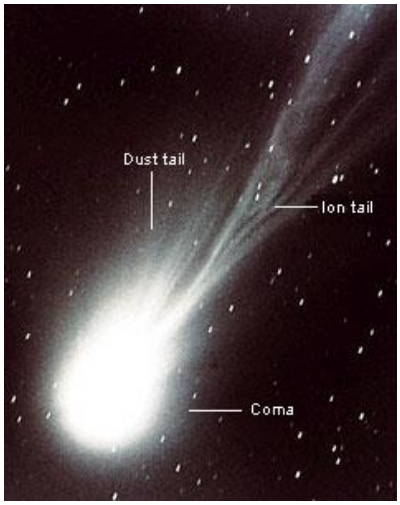
= chunks of rock or dust that are smaller than asteroids…. When they get caught in Earth's gravitational field and are pulled to Earth & burn they are called **Meteors**.. if they strike Earth they are called **Meteorites**!



- Famous meteor showers that occur each year: Perseids, Geminids, Orionids

Meteor Crater (a.k.a Barringer Crater) in Arizona (50,000 yr old impact crater)

7.) Comets = ice, dust and small rocky particles whose orbits can be ellipses



a. Most comets originate in ***Oort Cloud*** (icy comets that surround our Solar System)
   i. Coma= fuzzy outer layers of comet
   ii. Nucleus= solid inner core of comet

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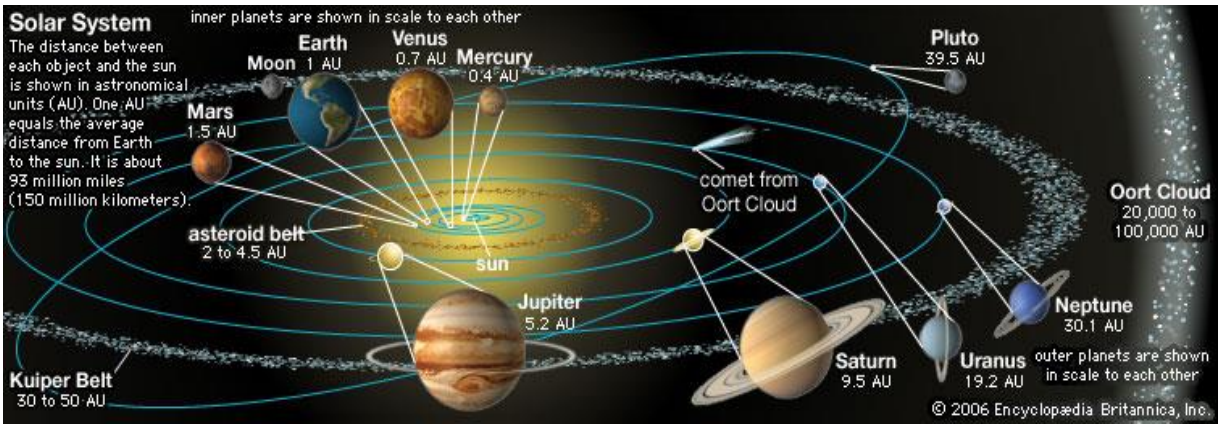
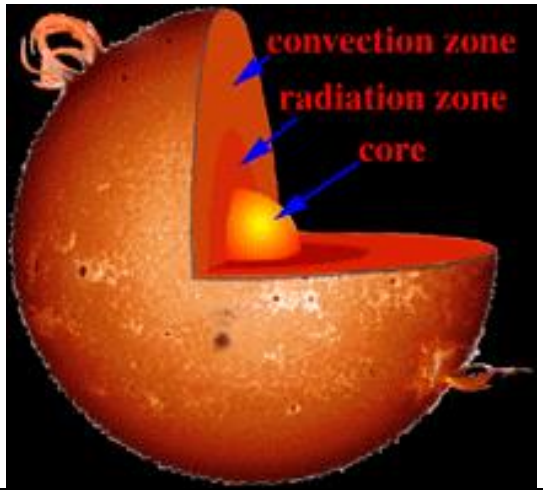
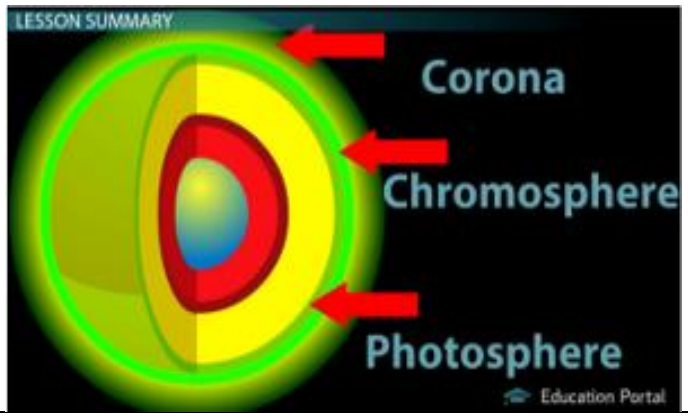
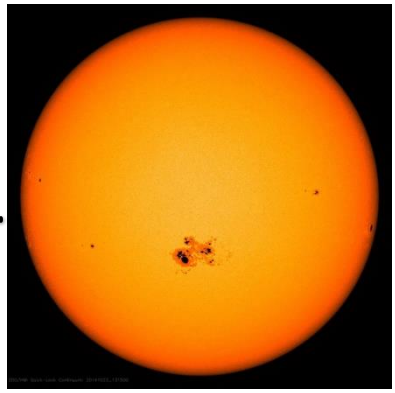


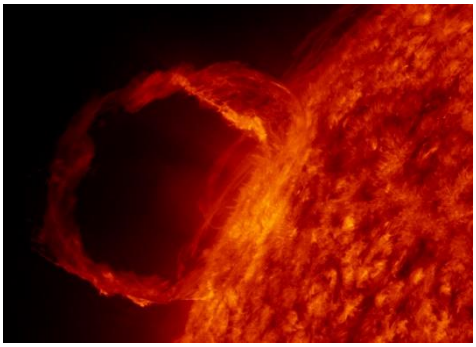
Structure of the Sun pgs. 541-543

Interior of the Sun (Inside to Outside)	The Sun's Atmosphere (Inside to Outside)
•**Core:** Center of the sun, produces enormous amount of energy through NUCLEAR FUSION •**Radiation Zone:** Carries out energy from the core through electromagnetic radiation. •**Convection Zone:** Outermost layer of the sun, heated by the radiative zone rising up to the surface. Cooling plasma then sinks and creates a convection loop of energy. 	• **Photosphere**: Inner layer of Sun's atmosphere, visible surface of the Sun. • **Chromosphere:** (Chroma = color) A reddish glow around the edge of the photosphere**.** • **Corona:** Outer layer of the atmosphere that looks like a white halo which extends into the atmosphere for millions of kilometers. 

Features of the Sun

1. **Sunspots** = dark areas on the Sun's surface due to cooler plasma.
2. **Prominences** = Link different sunspots, creating huge loops of plasma
3. **Solar Flares** = The release of large amounts of magnetic energy after two sunspot regions connect.

1 

2 

3 

We are currently in a SOLAR MINIMUM (low solar activity).. it is the least activity the sun has seen in 100 years!!!

STOP

Inner Planets pg 544

Terrestrial planets – small, dense and have solid, rocky surfaces.

- All terrestrial planets have atmospheres **except** Mercury
- Inner planets have relatively high densities.
- Rich in rocky and metallic materials including iron and silicon
- Earth is the only planet with a suitable temperature range and atmosphere for living things to survive.

Planet	Mercury	Venus	Earth	Mars
Diameter (km)	4,879	12,104	12,756	6,794
Period of rotation (Earth days)	58.9	244	1.0	1.03
Average distance from sun (AU)	0.39	0.72	1.0	1.52
Period of revolution (Earth days)	88	224.7	365.2	687
Number of moons	0	0	1	2

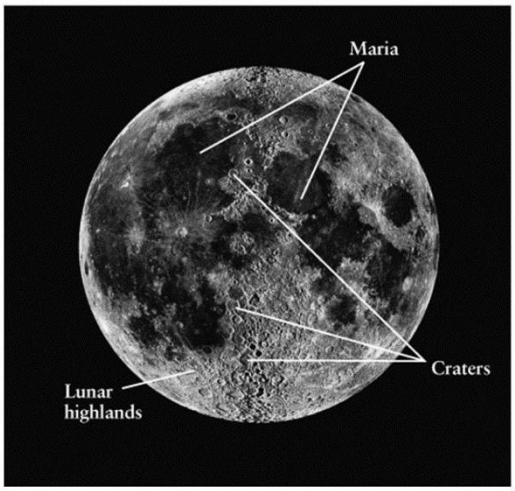
STOP

Earth's Moon Surface Features

Maria – Dark, flat areas formed from huge lava flows.

Craters – Large round pits formed from meteoroids hitting the moon, can be hundreds of km across.

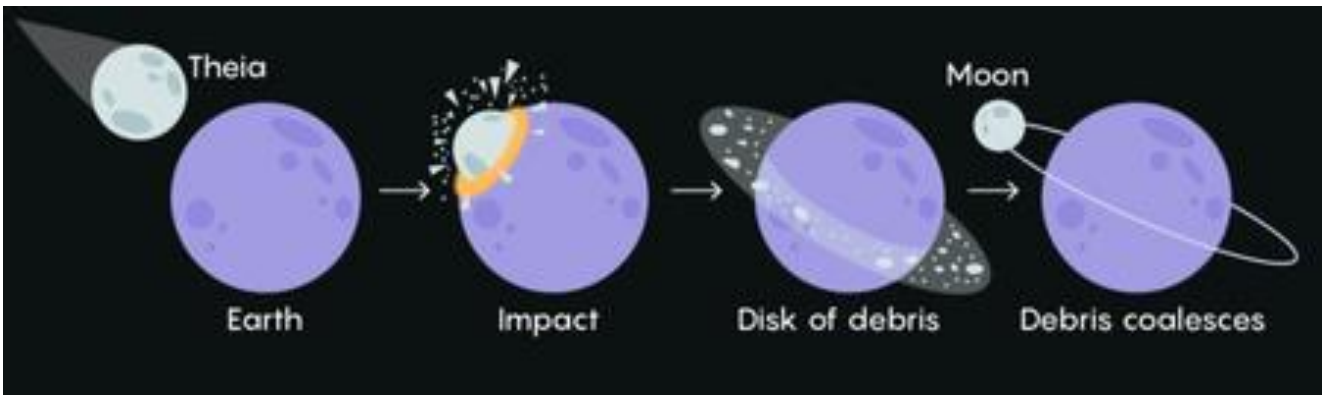
Highlands – Mountains on moons surface, light colored features – cover most of moon's surface



	Size and Density	Temperature	Atmosphere	Water
Earth	12, 756 km diameter	-128.6° F – 159° F	Thick Atmosphere	71% of the Earth's surface
Moon	3, 476 km diameter 1/8th of Earth's mass 1/6th of Earth's gravity	Range from 266 ° F to -338 ° F	No Atmosphere	No water, except small amounts of ice

Origin of the Moon

Collision Ring Theory – About 4.5 million years ago when earth was very young a planet size object collided with earth. Material from the object and Earth's layers was ejected into orbit around Earth where it formed a ring. Gravity caused the material to clump together to form the moon.



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Outer Planets pg. 545

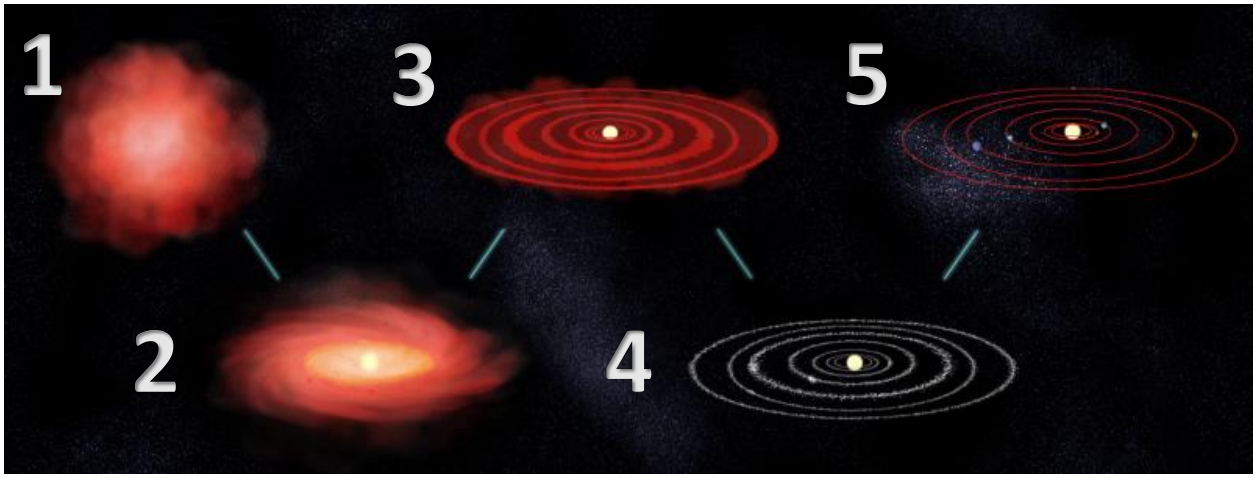
Gas Giants – Massive compared to Earth and do not have solid surfaces

- Jupiter and Saturn are mainly composed of hydrogen and helium
- Uranus and Neptune contain some of these gases, but also ammonia and methane.
- Because of their massive mass, they exert strong gravitational force, keeping the gases from escaping, forming the thick atmospheres.
- Each gas giant is surrounded by a set of rings. Saturn's are the largest and most complex.
- Ring – thin disk of small particles of ice and rock.

Planet	Jupiter	Saturn	Uranus	Neptune
Diameter (km)	142,984	120,536	51,118	49,528
Period of rotation (Earth hours)	9.9	10.7	17.2	16.1
Average distance from sun (AU)	5.20	9.54	19.2	30.07
Period of revolution (Earth years)	11.9	29.5	83.8	163.8
Number of moons	at least 63	at least 61	at least 27	at least 13

Solar System Formation pg 546

- Happened 4.6 Billion Years Ago from a cloud of hydrogen, helium, rock, ice and other materials were pulled together by GRAVITY



Lesson 2: Learning About the Universe

Electromagnetic Spectrum pg. 551

Electromagnetic radiation = Energy that can travel in the form of waves – all objects in space emit this energy.

Visible Light = The light you can see

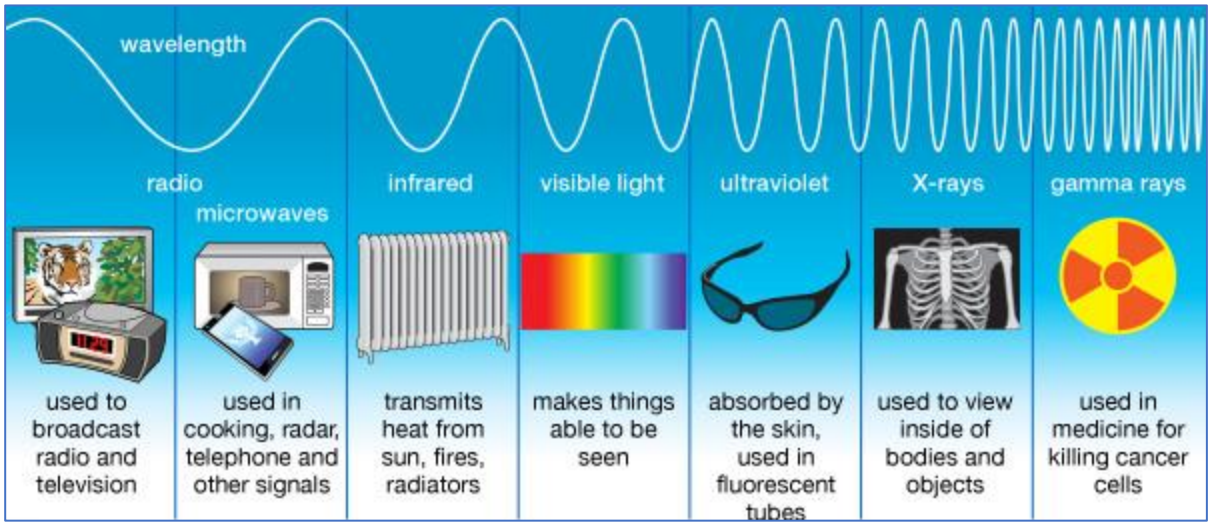
(Red **O**range **Y**ellow **G**reen **B**lue **I**ndigo **V**iolet)

Spectrum = The range of wavelengths of electromagnetic waves

Wavelength = The distance between the crest of one wave and the crest of the next wave.

Electromagnetic spectrum order = Radio Waves → Microwaves → Infrared Radiation → Visible Light → Ultraviolet Radiation → Gamma Rays

Ronald McDonald Is Visibly Ultra Xtra Great



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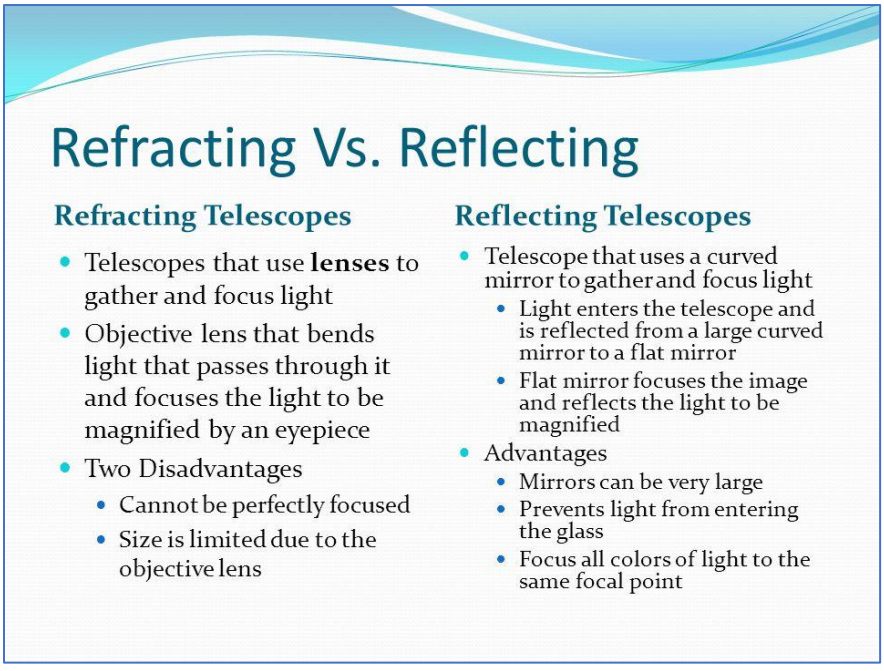
TELESCOPES & SPACE PROBES PG. 552-553

Telescopes = instruments that collect & focus light & other forms of EM radiation

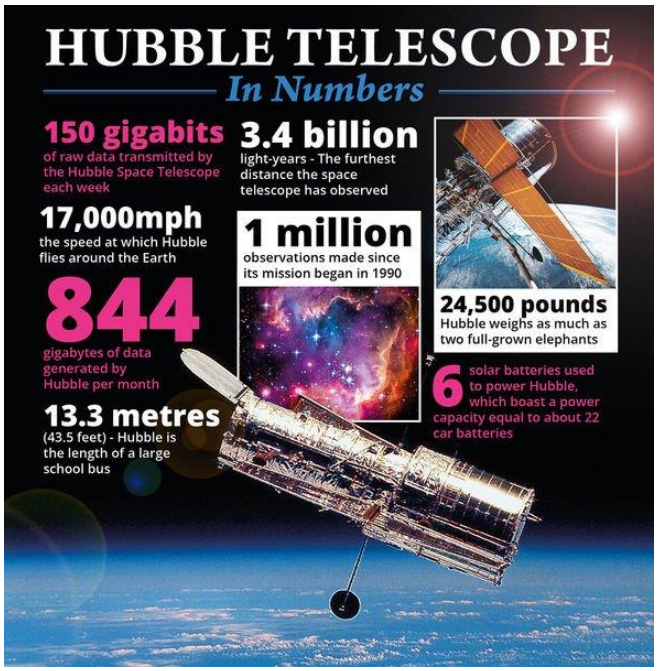
- Some telescopes are on Earth… others float in space

OPTICAL Telescopes

•Use lenses & mirrors to collect & focus VISIBLE light

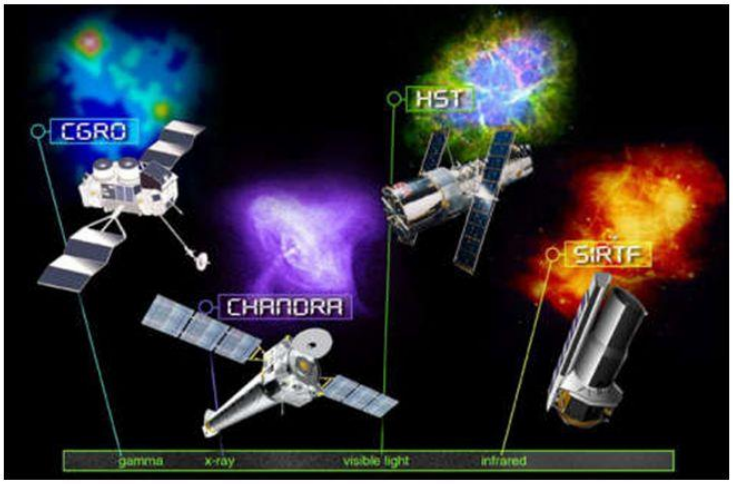


MOST FAMOUS OPTICAL (REFLECTING TELESCOPE)



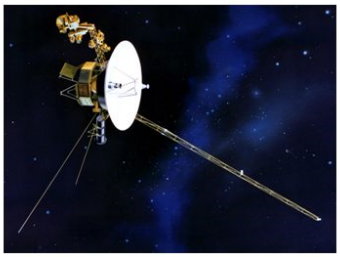
NONOPTICAL TELESCOPES

- Nonoptical telescopes detect radiation that cannot be seen by the human eye
  - Astronomers study the entire electromagnetic spectrum because each type of radiation reveals different clues about an object
- On the ground we can have radio telescopes because radio waves can penetrate the atmosphere
- For higher frequency radiation, which as x-rays and gamma rays, the telescope needs to be placed in space.



Space Probes

- Unmanned spacecraft that travels through space to collect information and send back data
- Used to study Earth, planets, stars, galaxies, or measure properties of space with telescopes or other instruments
- Most famous space probe is Voyager 1
  - Launched in 1977
  - Has travelled further than any other man-made object
  - Sent to study Jupiter and Saturn, then to continue to the edge of our solar system
  - Currently in interstellar space (about 11 billion miles away)



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HISTORY OF SPACE EXPLORATION PGS 554-557

- For specific details see textbook.. these are the biggies to get us to the moon

1957 **Sputnik 1** launched (1st satellite in space)

(USSR satellite)

→

1958 **Explorer** launched

(USA satellite)

→

April 1961

Yuri Gagarin 1st human in space (Russian).. did 1 orbit around Earth

May 1961

Alan Shepard 1st American in space

→

1962

John Glenn – 1st human to orbit Earth 3 times & spend 5 hrs

→

July 20, 1969

Apollo 11 landed on the moon: **Michael Collins, Buzz Aldrin, Neil Armstrong**

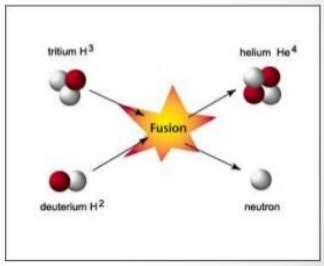
STOP

Lesson 3: Stars (pg. 561)

- All stars begin as **Nebulas** = large, clouds of gas & dust containing lots of material
- In the densest part of nebula, gravity pulls gas & dust together.. it makes a baby star = **Protostar**

Nuclear Fusion

- Nuclear fusion is the process by which two nuclei combine to form a heavier element.
- New stars initially will fuse hydrogen nuclei together to form helium



Life Expectancy of a Star

- The Mass of a star determines the length of it's life. More Mass = Higher energy used = shorter life.
  - **Low Mass Star**
    - 200 Billion years
  - **Medium Mass Star** (our Sun)
    - 10 Billion years
  - **High Mass Star**
    - 10 Million years

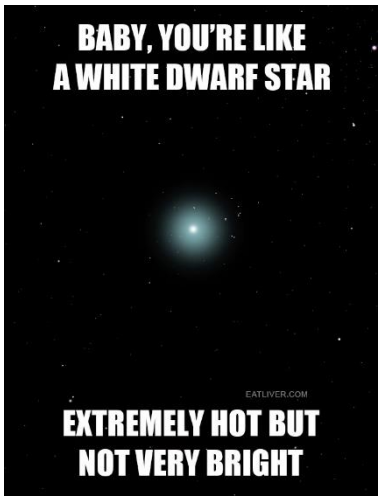
STAR LIFE CYCLE.....

What Happens to a Star When it Runs Out of Fuel?

➔ Core shrinks & it runs out of fuel & becomes a white dwarf, neutron star or black hole.

White Dwarf= blue-white core of the star that is left behind & cools… very hot, but dim brightness

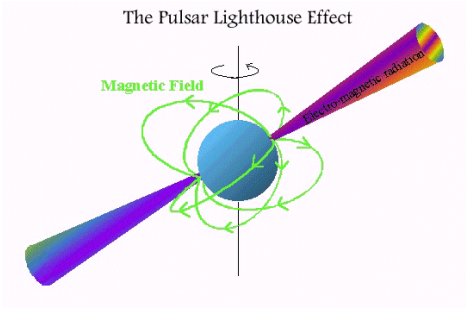
→About size of Earth.. but as much mass as sun

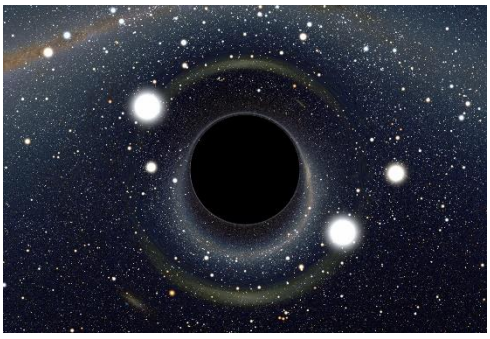


High mass Stars evolve into bright Supergiants.. when it runs out of fuel it can explode = **Supernova**

Material becomes part of nebula… astronomers think the matter in our sun & planets came from supernova explosion

a. After supernova explosion some material left behind makes **Neutron Star** = small, dense remains of high-mass star.
   - Size of city & super dense. 1 teaspoons weighs as much as Mt. Everest.
   - 1967 Jocelyn Bell discovered **Pulsars** = rapidly spinning neutron stars that give off radio waves.



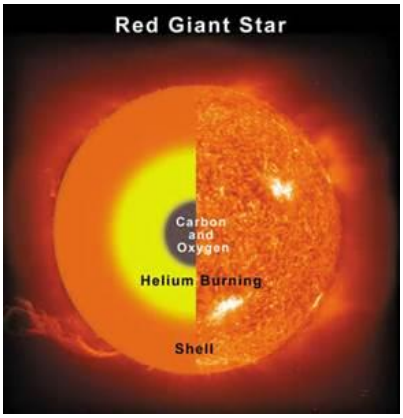


b. Most massive stars become **Black Holes**= object with gravity so strong that nothing can escape.

Other Types of Stars……

a. **Main Sequence** = **90 % of all stars are main sequence…SO IS OUR SUN!!**

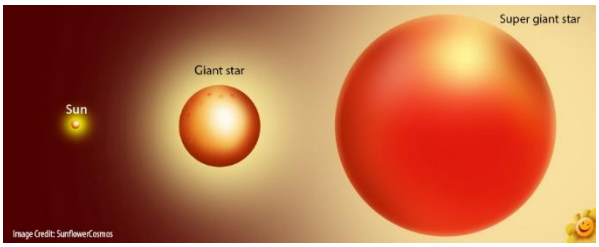
i. Temp & pressure are balanced in this phase… when hydrogen fuel is used up..



the core contracts & the outside puffs up

b. **Red Giant** = happens after main sequence star that is LOW MASS.

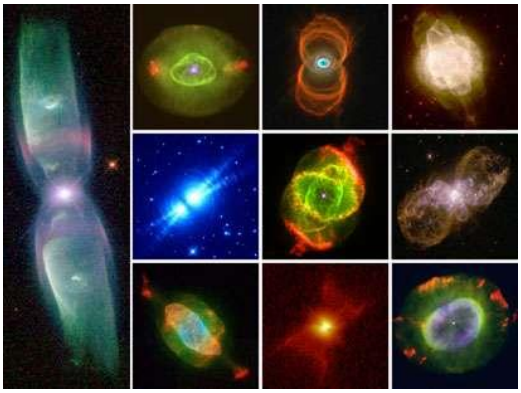
i. Big star with a core of CARBON

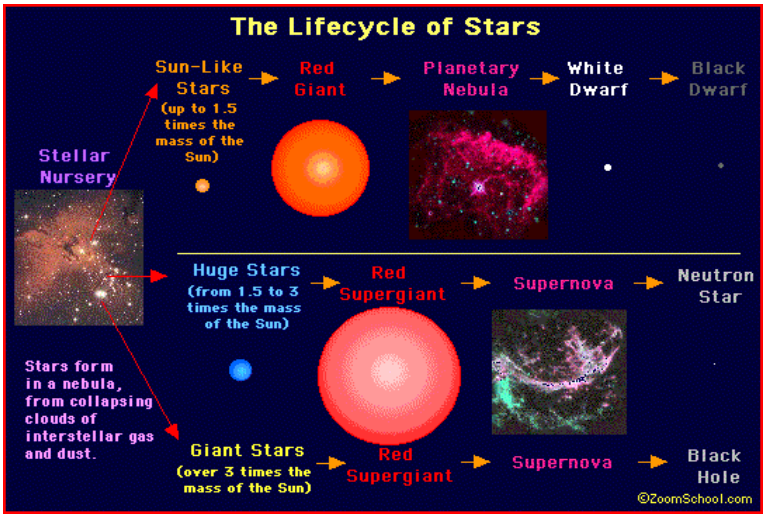


c. **Supergiant** = happens after main sequence star that is HIGH MASS.

i. HUGE star that has higher temps & has core of IRON (super dense)

d. **Planetary Nebulas** = Remaining hydrogen in a shell of gas that drifts away from a white dwarf formation.





Our Sun is a Low Mass.. Main Sequence star.. It will eventually puff up & become a Red Giant which will burn up our planet… in about 5 billion years

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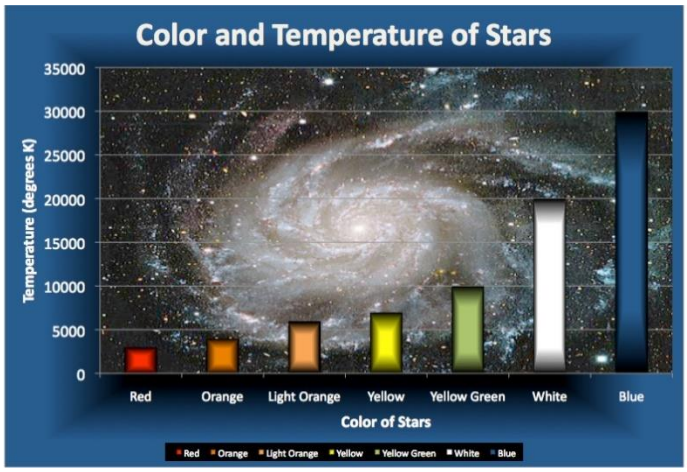
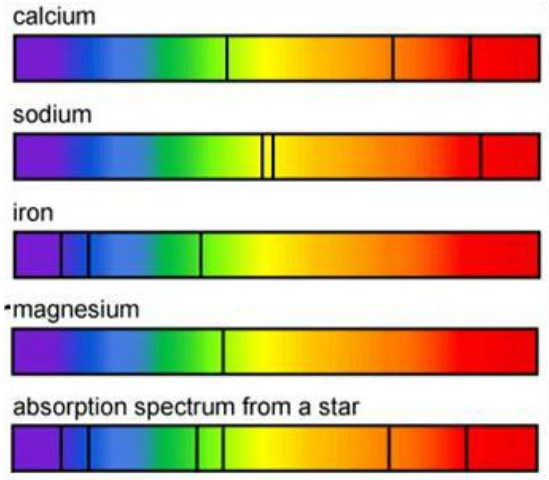
STAR PROPERTIES PG. 565-568



1. **Color.....Temperature**
   a. Cooler stars are Reddish (3200 C or 5792 F) & hottest (20,000 C or 36,032 F) are Bluish.

→Our Sun is yellow (medium temp 5500 C or 9932 F)

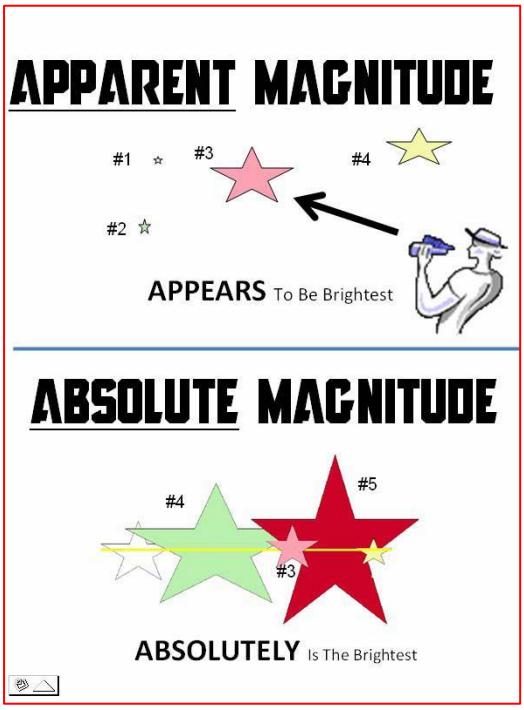
2. **Size**
   a. Stars can be larger than our sun.. but many are smaller than our sun
3. **Chemical Composition**
   a. Most it is 73% hydrogen, 25% helium, 2% other
   b. **Spectrograph** = instrument used to determine elements in stars



4. **Brightness**... depends upon both its size & temp
   a. Apparent brightness = its brightness as seen from Earth

→ even though our sun looks bright.. its only average... its because we are close to it that it seems so bright.

   b. Absolute brightness = brightness a star would be at a standard distance from Earth....its the true measure of the stars brightness/magnitude



Brightness is measured by numbers… The SMALLER (more negative) the number =

BRIGHTER THE STAR

Example: Star with +2 magnitude/brightness is dimmer than one with -2 magnitude/brightness

THIS SCALE IS USED FOR BOTH ABSOLUTE & APPARENT MAGNITUDES!!!!

The H-R Diagram

Hertzsprung-Russell Diagram (H-R) = graph used to classify stars & to understand how stars change over time.

→90% of all stars fall into main sequence category

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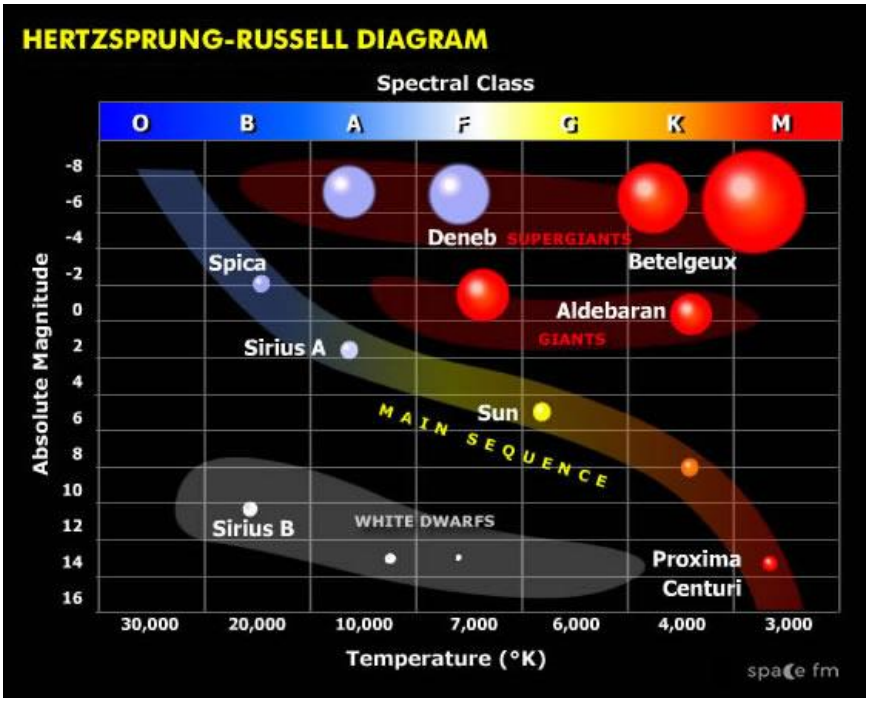
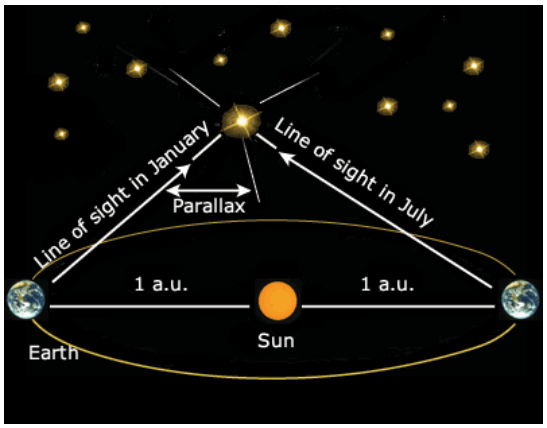


Lesson 4 Galaxies (pg 570).....

MEASURING STAR DISTANCES:

Parallax = apparent change in position of an object when you look at it from diff. places

→ Look at a star when Earth is on one side of sun.. then look 6 months later.. measure how much they appear to move



LESS the star appears to move = FARTHER AWAY

Star Systems……

Binary Stars = have 2 stars……those w/ 3 are triple stars

i. Usually 1 star in the pair is brighter & more massive
ii. Can find the other star cuz it causes a wobble

Eclipsing Binary = one star blocks the light from another periodically

Planets Around Other Stars……

1995 astronomers discovered first planet out of our solar system.

→ As of 2019 there are 4,109 planets that exist outside of our solar system!!! Last year (2018) we only knew about 3,851.

Two types of star clusters

- **Open clusters:** young, contain up to several thousand stars and are found in the disk of the galaxy.
- **Globular clusters:** old, contain hundreds of thousands of stars, all closely packed together. They are found mainly in the halo of the galaxy.

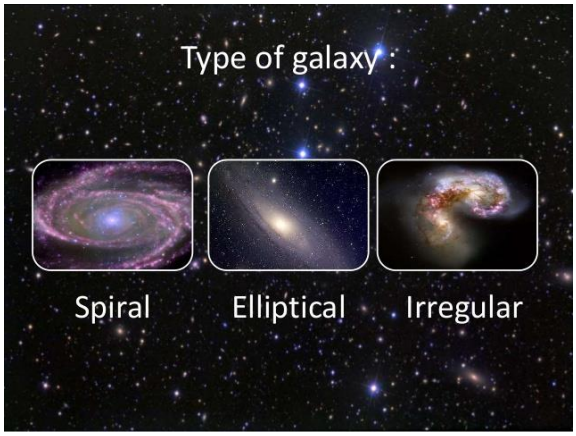
MAJOR GALAXY TYPES (pg. 573)…..

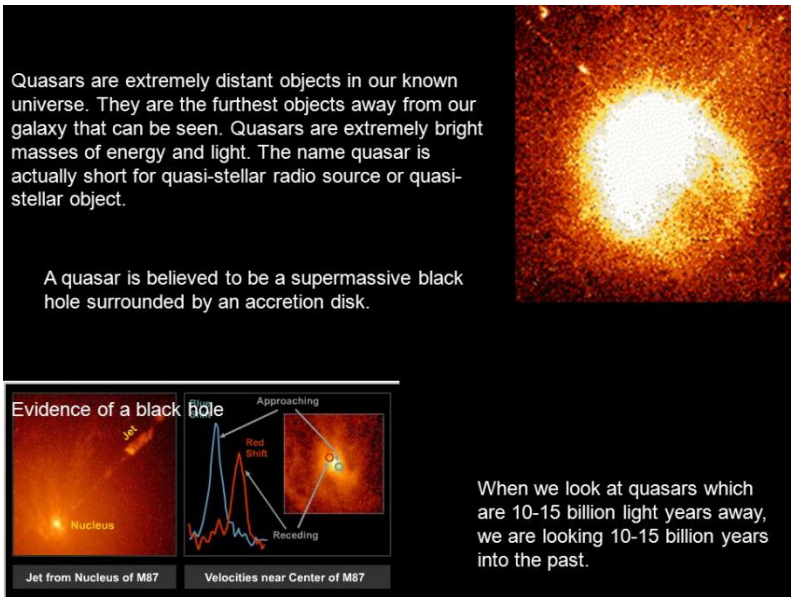
Galaxy = huge group of single stars, star systems, star clusters, dust & gas bound together by gravity.

TYPE #1: Spiral Galaxy= bulge in middle & spiral arms… Our **MILKY WAY GALAXY IS SPIRAL…..** Barred Spiral Galaxy – have bar shaped area of stars & gas that pass through the center of the galaxy.

TYPE #2 Elliptical Galaxy = rounded, have billions of stars but little gas or dust… stars are no longer forming in these galaxies, ……**Most common shaped galaxy**

TYPE #3: Irregular Galaxy= no reg. shape, smaller than other types, have bright young stars & lots of gas & dust to make new stars.





FORMING GALAXIES: Quasars = active young galaxies w/ Black Holes at their centers… discovered in 1960s

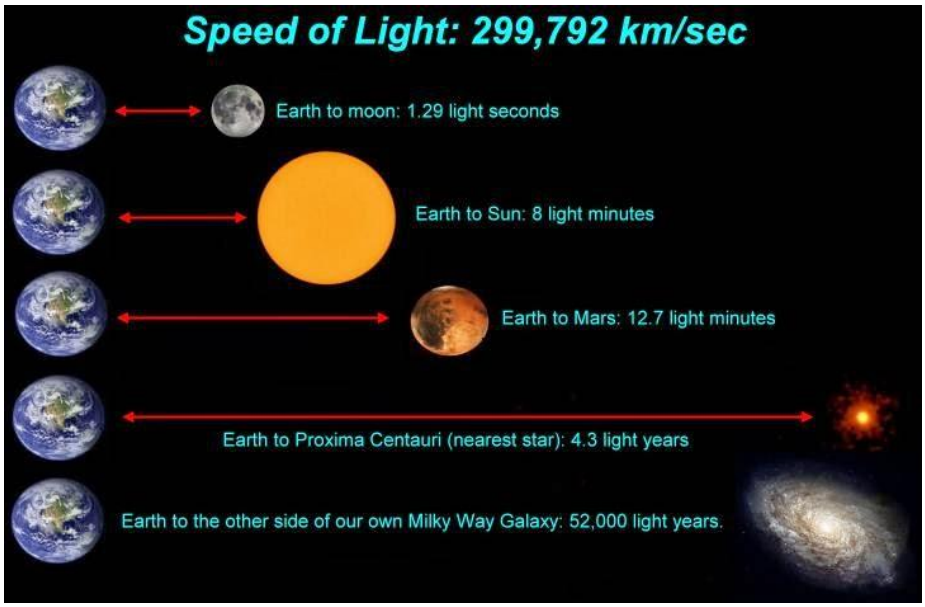
STOP

THE UNIVERSE: (PG 574).....

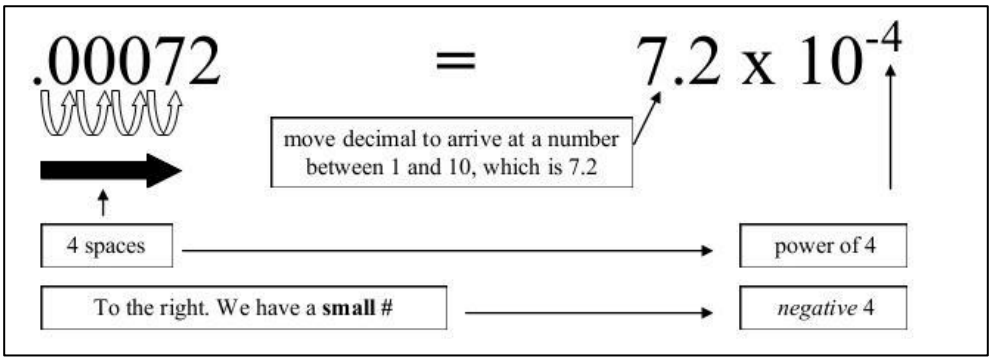
Universe = all of space & everything in it.. the whole enchilada!!

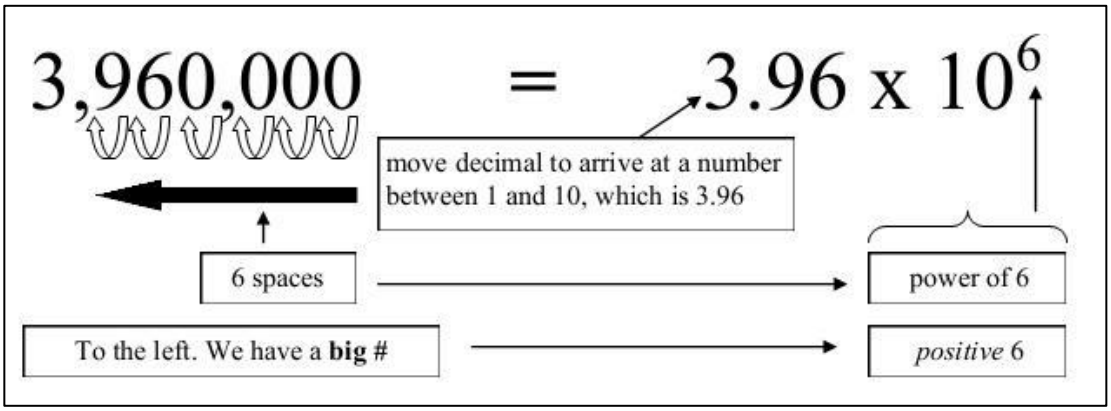
Light Year = distance that light travels in one year

- ~300,000 meters per second OR 186,000 miles per second

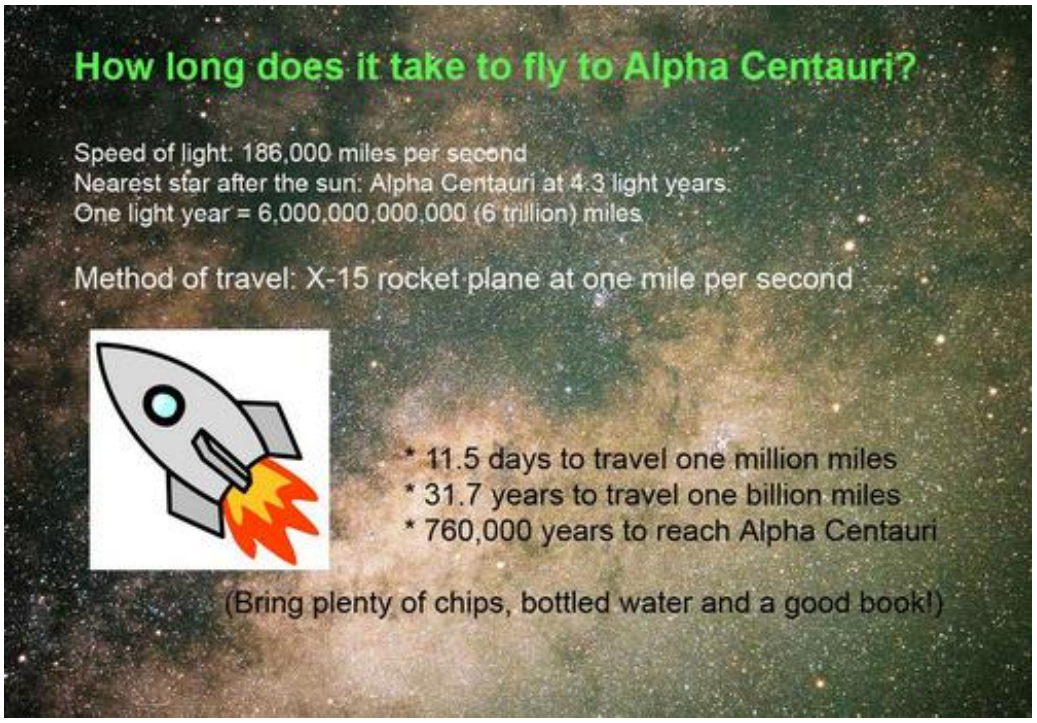


Scientific Notation = powers of 10 to write very large or small numbers





- **Nearest star to our sun is Alpha Centauri** (4.2 x 10^{16} meters away OR 4.3 light years away)
- **Nearest galaxy is Andromeda Galaxy** (2.4 x 10^{22} meters away or 2.2 million light years away)



STOP

UNDERSTANDING THE UNIVERSE PG. 576-577

➔ **Scientists think universe began 13.7 billion years ago**

Big Bang = universe formed in an instant from a enormous explosion

➔ New data shows that the universe will likely expand forever.

➔ First stars & galaxies formed about 500 million years after the big bang.

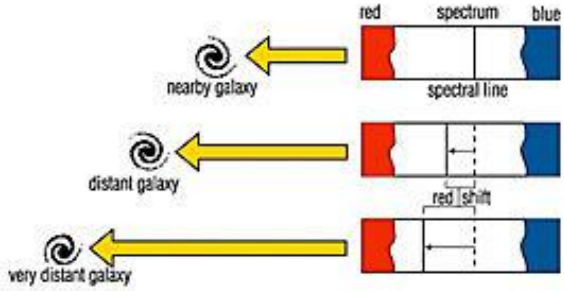
Edwin Hubble (1920's)- discovered evidence that supported the Big Bang Theory.

i. He examined figured out how fast a galaxy was moving & whether it was moving toward our galaxy or away from it.

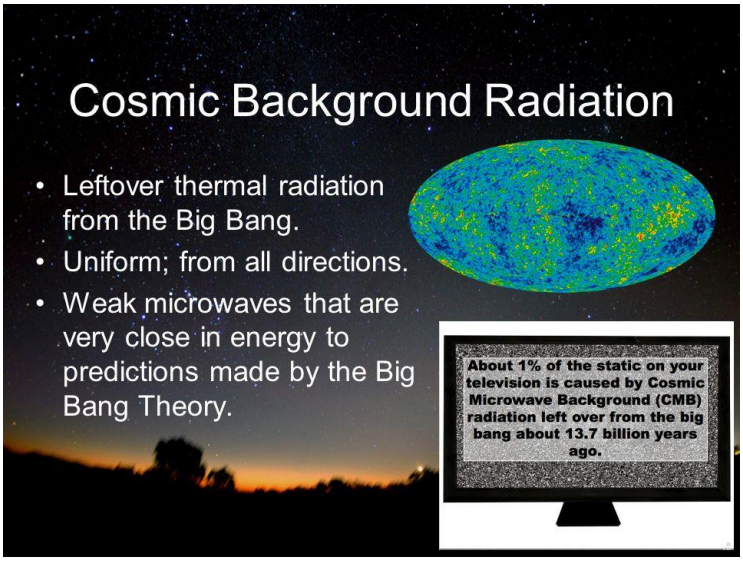
ii. **He found that almost all galaxies are moving away from us & from each other… EXCEPT for Andromeda Galaxy**.. in 3 billion years it will collide with our galaxy and possibly reshape us into an Elliptical Galaxy.

iii. Starlight moving **TOWARD** Earth shift to Blue end of spectrum. → Blue Shift

iv. Starlight moving ***AWAY*** from Earth shifts to Red end of spectrum.--> Red Shift

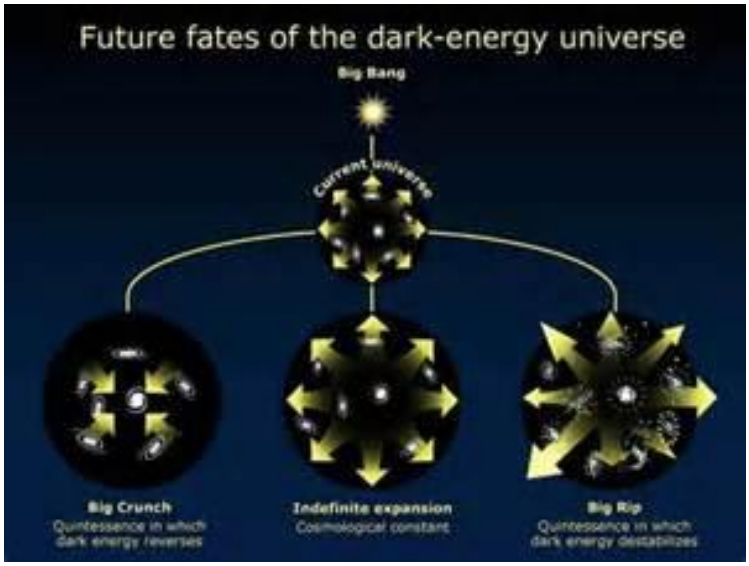


v. **Hubble's Law** = states that the FARTHER away a galaxy is, the FASTER it is moving away from us.



HELPED TO PROVE THE BIG BANG!!!!

1965 Arno Penzias & Robert Wilson detected faint radiation coming from all directions on a radio telescope… it was **Cosmic Background Radiation** = leftover thermal energy from the big bang.

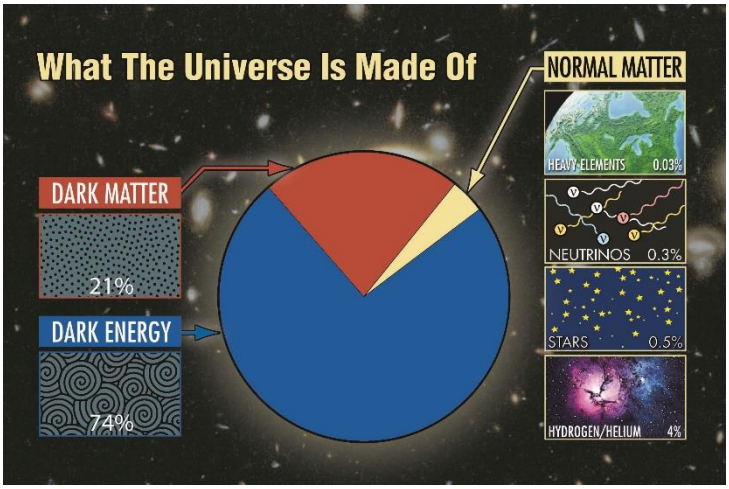


Future of Universe?!?

Possibilities:

1. It will continue to expand forever… stars will run out of fuel → Cold, Dark Universe
2. Big Crunch – galaxies will start rushing back towards each other → Black Hole

A. **Dark Matter** = matter that does not give off electromagnetic radiation… can find it by observing effect of its gravity on visible objects.
   1. Vera Rubin → discovered that a portion of the mass of universe is made of dark matter



B. Accelerating Expansion

1. In late 1990s found that the expansion of universe was speeding up.
2. **<u>Dark Energy</u>** = mysterious new force which is causing the speeding up of the expansion.