

CHAPTER 4 STARS, GALAXIES & THE UNIVERSE

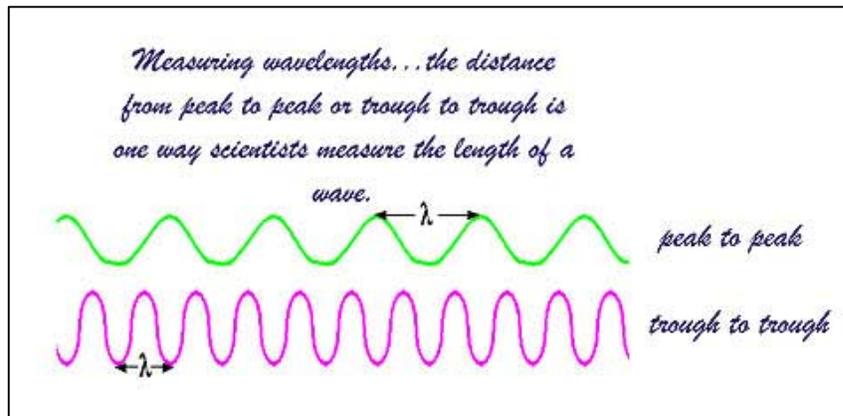
LESSON 1: TELESCOPES PG. 126

ALL TYPES OF ELECTROMAGNETIC RADIATION TRAVEL AT THE SPEED OF LIGHT... 186,000 miles per second!!

Electromagnetic Radiation = energy that travels through space in the form of waves

→ **Visible light** = light we see... it is one type of electromagnetic radiation

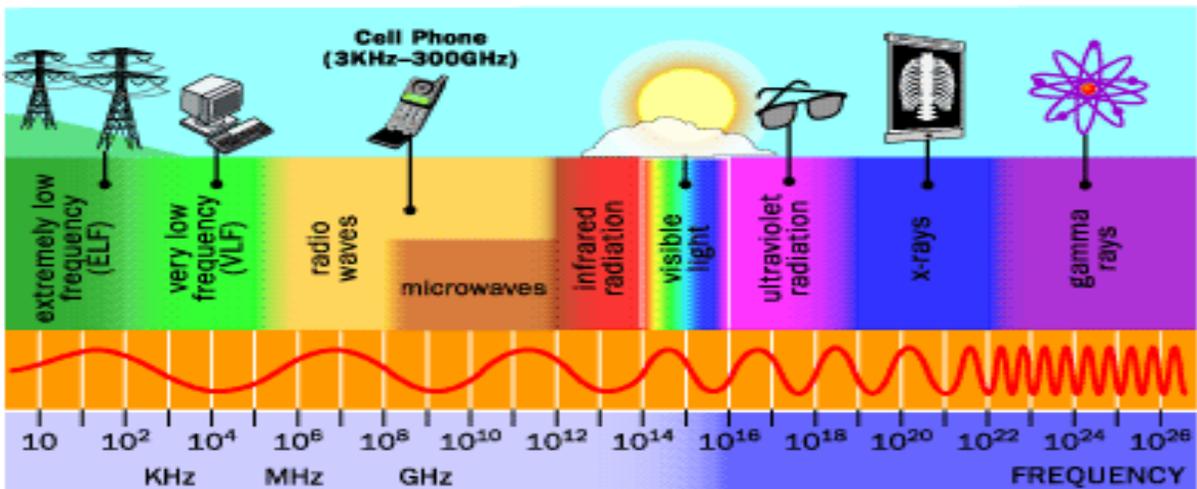
→ **Wavelength** = distance between the crest of one wave & crest of another



- Visible light has very SHORT wavelength

→ **Spectrum** = when light spreads out to make a range of diff. colors w/ diff. wavelengths (Use a prism to do this)

Colors are ... **ROY G BIV** (red, orange, yellow, green, blue, indigo, violet)



- **ELECTROMAGNETIC SPECTRUM ORDER** is:

Radio waves → Microwaves → Infrared Radiation → Visible light → Ultraviolet Radiation → X rays → Gamma Rays

(Ronald McDonald Is Visibly Ultra Xtra Great

TYPES OF TELESCOPES & FUNCTION

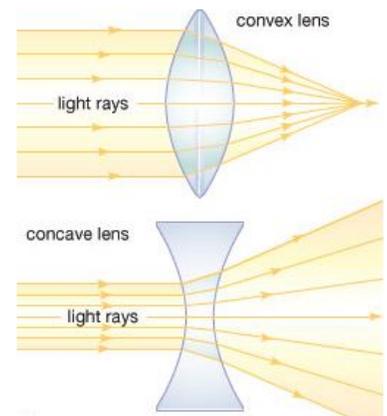
Telescope = instrument that collect & focus light & other forms of EM radiation.

→ Usually found in **observatories** = buildings that contain 1 or more telescopes... most are on tops of mountains or in space

Optical Telescope = uses LENSES OR MIRRORS to collect & focus light

- i. **Refracting Telescopes** = uses **CONVEX** (curved so middle is thicker than edges) **lens**
- ii. **Reflecting Telescopes** = built in 1668 by Isaac Newton, uses **CONCAVE** mirror

→ **Hubble Space Telescope is reflecting telescope**... it orbits around Earth (Launched 1990)



Differences btwn. REFLECTING & REFRACTING TELESCOPES:

TELESCOPE	OBJECTIVE	EYEPIECE	SIZE	LIGHT COLLECTION
Refracting	<i>Convex Lens</i>	<i>Lens</i>	<i>Smaller</i>	<i>Less- can't see as far into space</i>
Reflecting	<i>Concave Mirror</i>	<i>Lens</i>	<i>Larger</i>	<i>More- you see further!!!</i>

Radio Telescopes = detect radio waves from objects in space... have huge dishes to collect the very long wavelengths of radio waves.

→ Spitzer Space Telescope - in space.. takes pictures in infrared

→ Chandra X-ray Observatory - in space.. takes pictures in x-ray spectrum

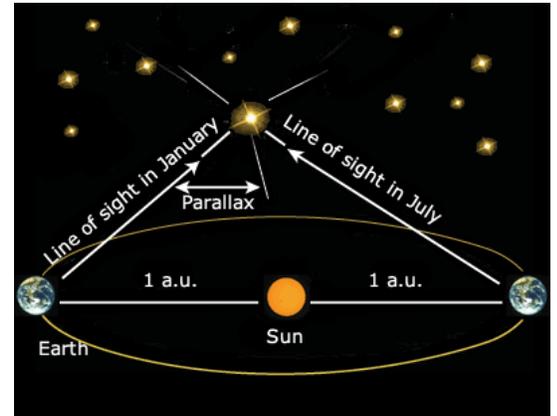
→ New telescopes correct problems w/ air temp & mirror shape.. to give clearer images

LESSON 2: THE SCALE OF THE UNIVERSE.. PG 132

MEASURING STAR DISTANCES:

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

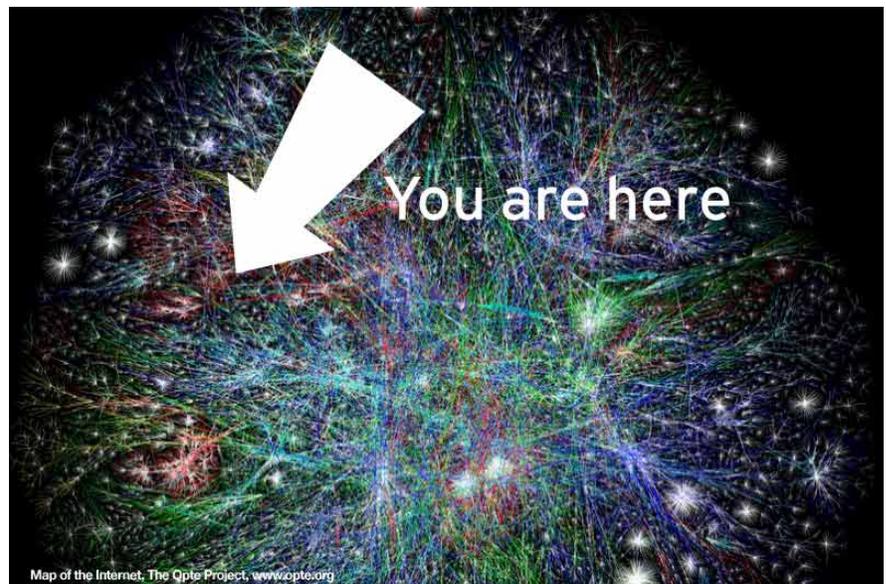
→ Look at a star when Earth is on one side of sun.. then look 6 months later.. measure how much they appear to move



The LESS the star appears to move = FARTHER AWAY

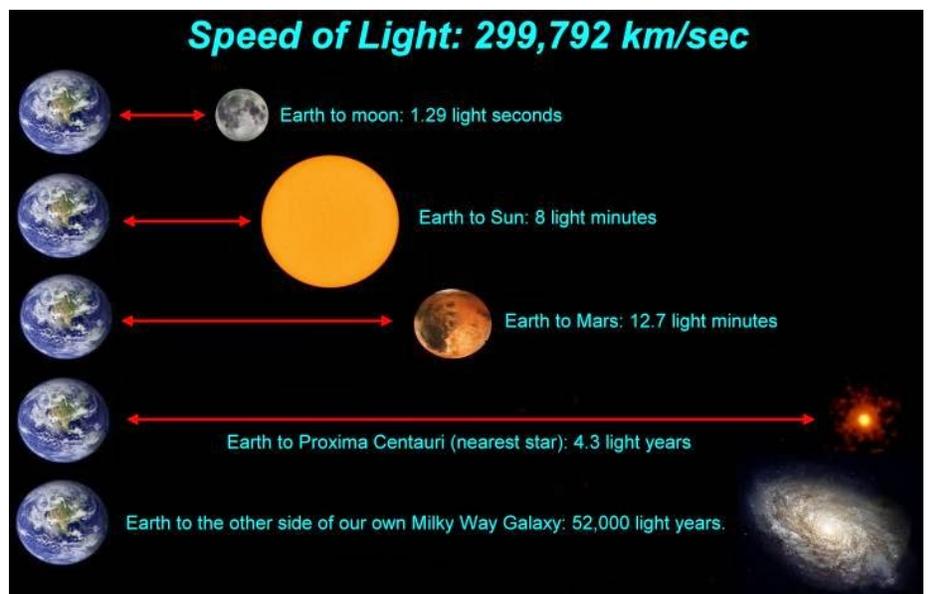
THE UNIVERSE:

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

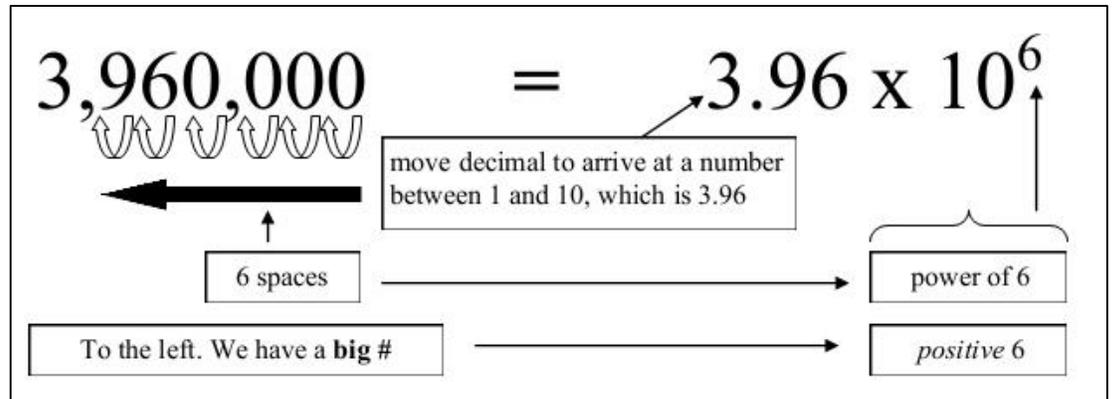
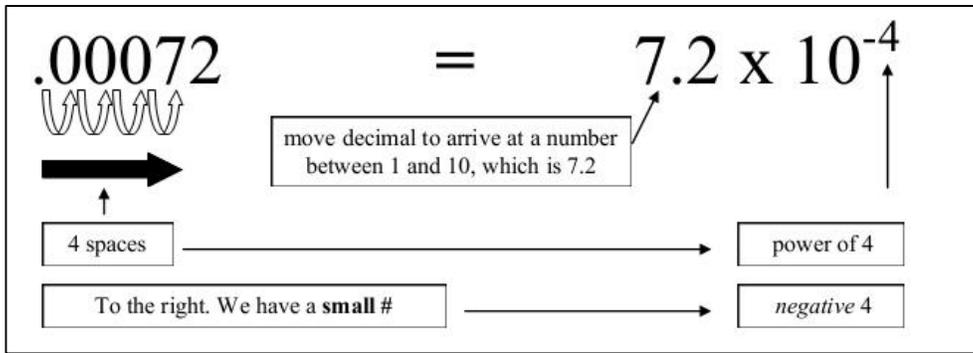


Light Year = distance that light travels in one year

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



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

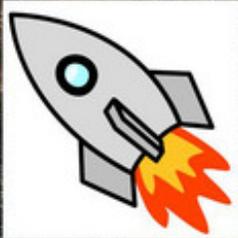


- **Nearest star to our sun is Alpha Centauri** (4.2×10^{16} meters away OR 4.3 light years away)
- **Nearest galaxy is Andromeda Galaxy** (2.4×10^{22} meters away or 2.2 million light years away)

How long does it take to fly to Alpha Centauri?

Speed of light: 186,000 miles per second
 Nearest star after the sun: Alpha Centauri at 4.3 light years.
 One light year = 6,000,000,000,000 (6 trillion) miles

Method of travel: X-15 rocket plane at one mile per second



- * 11.5 days to travel one million miles
- * 31.7 years to travel one billion miles
- * 760,000 years to reach Alpha Centauri

(Bring plenty of chips, bottled water and a good book!)

LESSON 3: CHARACTERISTICS OF STARS..PG 136

HOW ARE STARS CLASSIFIED?

1. Color & Temp

- 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

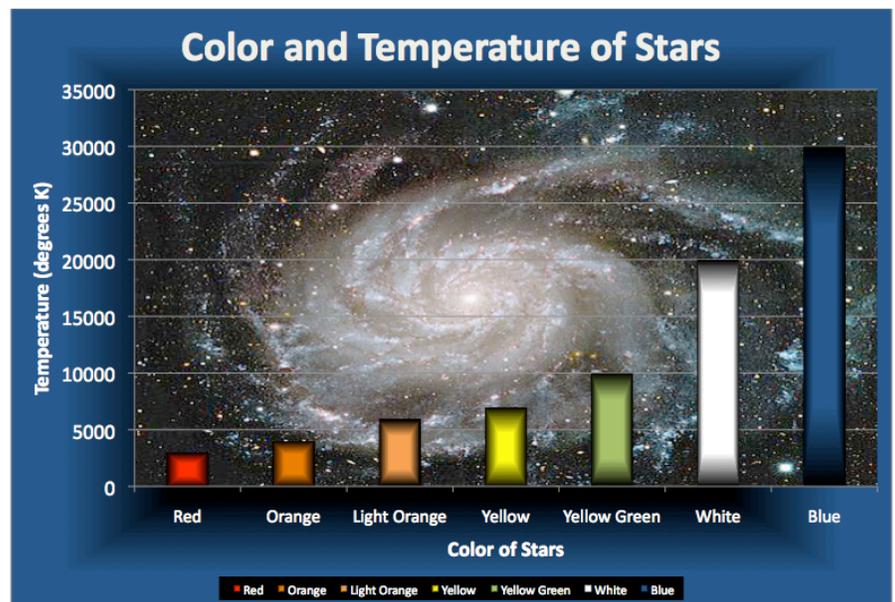
- a. Stars can be larger than our sun.. but many are smaller than our sun

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
 - i. 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



APPARENT MAGNITUDE



ABSOLUTE MAGNITUDE



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

BRIGHTER THE STAR

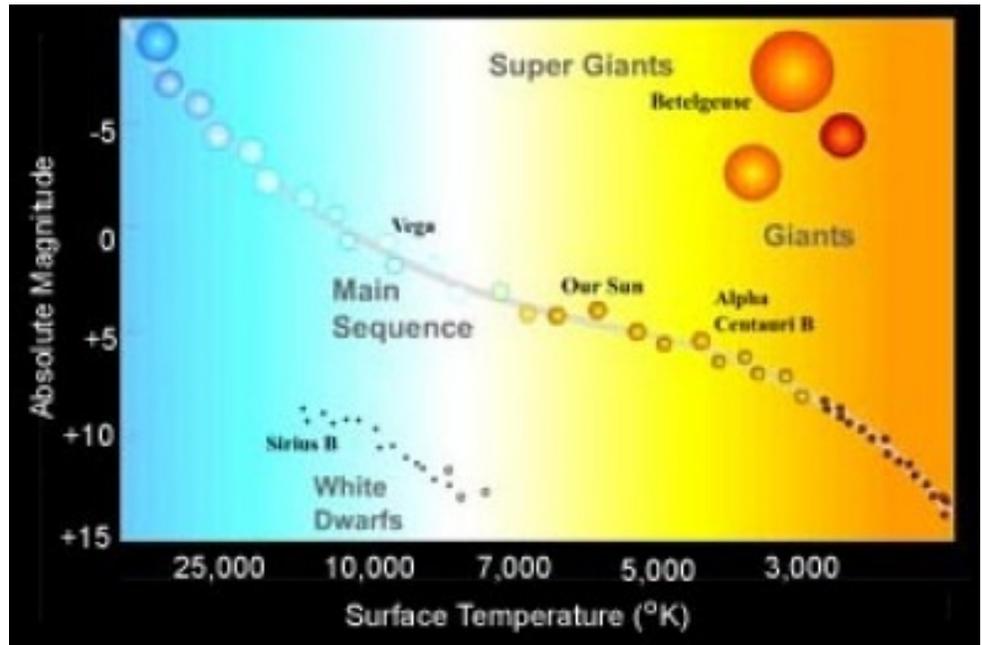
Example: Star with +2 magnitude/brightness is dimmer than one with -2 magnitude/brightness

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

THE H-R DIAGRAM

1. 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



LESSON 4: LIVES OF STARS.. PG 142

- A star is born when the contracting gas & dust from a nebula become so dense and hot that nuclear fusion starts. **How long a star lives depends on its mass.**

Start in **NEBULA** = large cloud of gas & dust spread out in an immense volume

- In densest part of nebula gravity pulls gas & dust w/ enough mass to make a **PROTOSTAR** = earliest stage of a star's life..... nuclear fusion begins in a protostar.

LENGTH OF A STAR'S LIFE.....

- Depends on star's mass
- **Bigger mass = shorter life span**... about 10 MILLION years
- **Our Sun (medium mass)** = 10 BILLION year life span... It is 4.6 billion years old now
- Small stars = about 200 BILLION year life span

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

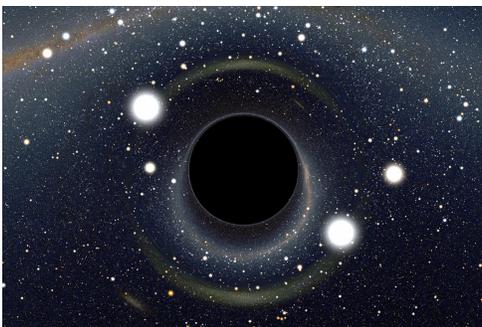
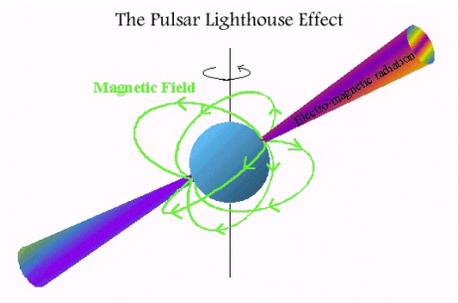
- About size of Earth.. but as much mass as sun
- Have no fuel but glow faintly due to leftover energy
- When it stops glowing = Black Dwarf

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

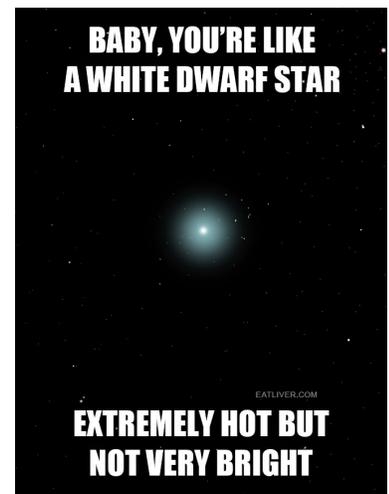
Material becomes part of nebula... astronomers think the matter in our sun & planets came from supernova explosion

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.



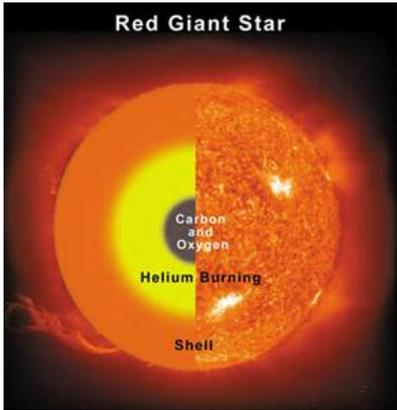
b. Most massive stars become Black Holes = object with gravity so strong that nothing can escape.



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..



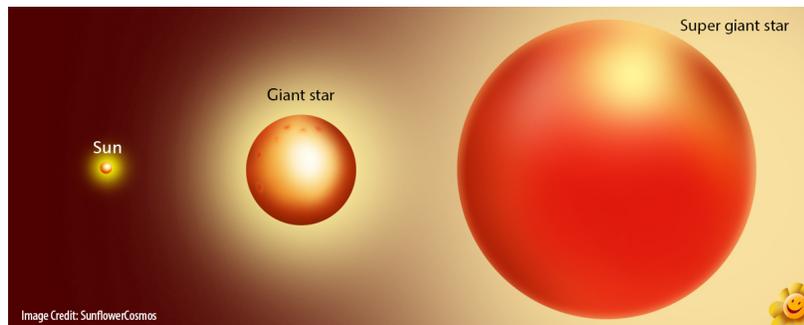
the core contracts & the outside puffs up

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

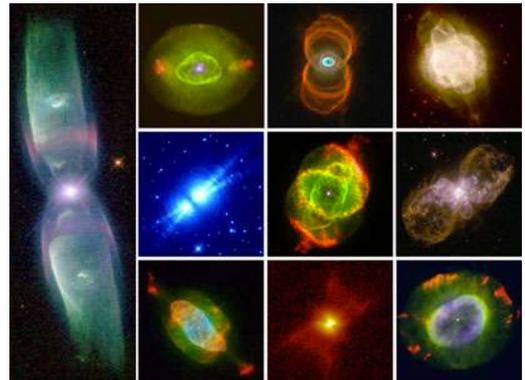
i. Big star with a core of **CARBON**

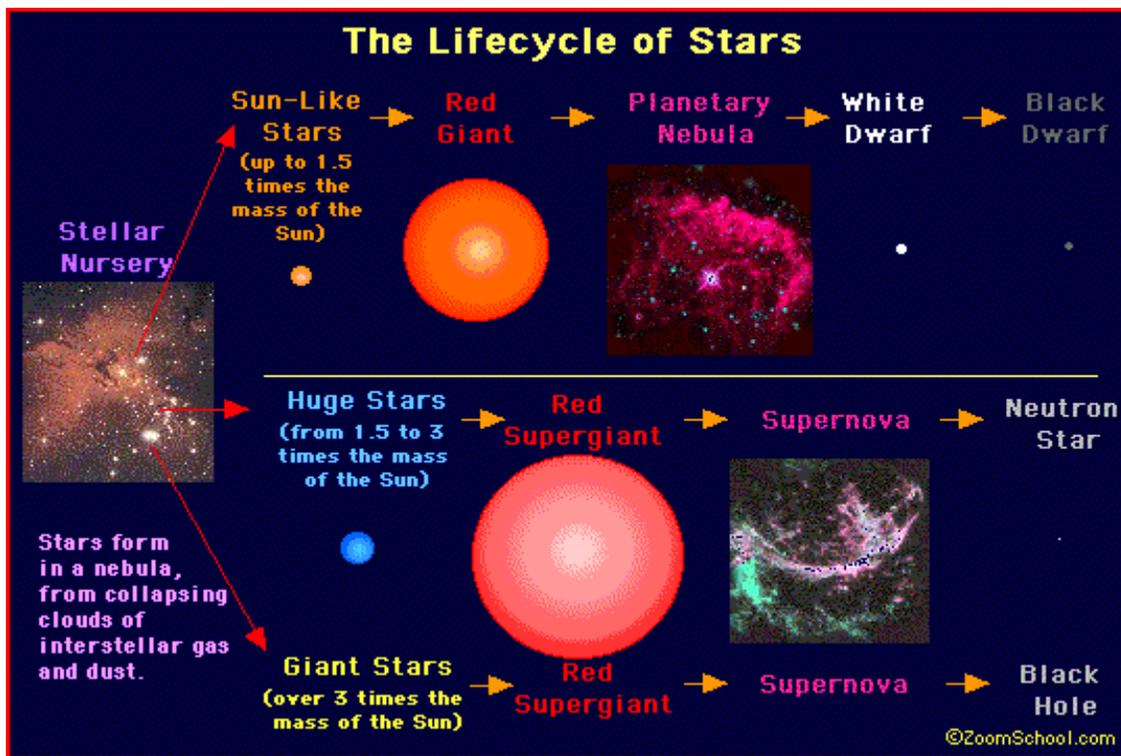
- c. **Supergiant** = happens after main sequence star that is **HIGH MASS**.

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.





LESSON 5: STAR SYSTEMS & GALAXIES.. PG 148

→ Most stars are members of groups of 2 or more stars called star systems.

STAR SYSTEMS

- a. **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
- b. **Eclipsing Binary** = one star blocks the light from another periodically



1. Planets Around Other Stars

- a. 1995 astronomers discovered first planet out of our solar system.

→ **As of 2018 we have confirmed 3,851 planets that exist outside of our solar system!!!**

2. Star Cluster Types:

- a. Open clusters = have loose, disorganized appearance... have a few thousand stars... have supergiants, gas & dust
- b. Globular clusters = older stars, round & packed w/ stars... have more than million.

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

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**

TYPE #2: Barred Spiral

Galaxy - have bar shaped area of stars & gas that pass through the center of the galaxy.

TYPE #3: 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 #4: Irregular Galaxy = no reg. shape, smaller than other types, have bright young stars & lots of gas & dust to make new stars.

Three Major Types of Galaxies



Spiral



Irregular

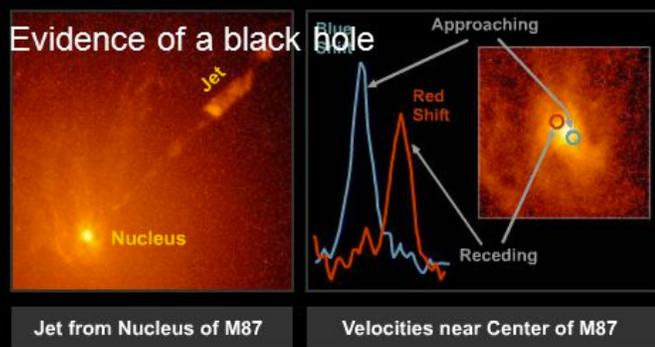
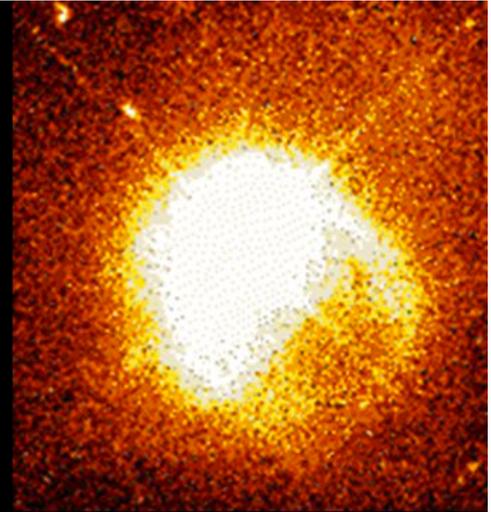


Elliptical

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

Quasars are extremely distant objects in our known universe. They are the furthest objects away from our galaxy that can be seen. Quasars are extremely bright masses of energy and light. The name quasar is actually short for quasi-stellar radio source or quasi-stellar object.

A quasar is believed to be a supermassive black hole surrounded by an accretion disk.



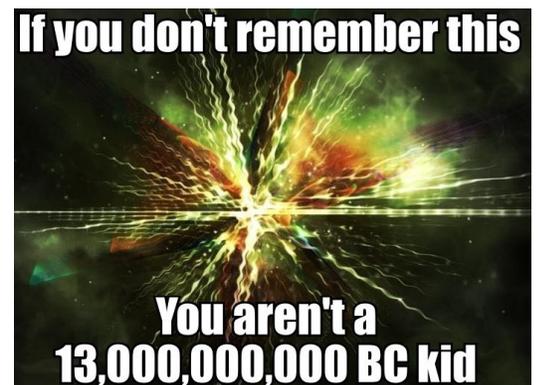
When we look at quasars which are 10-15 billion light years away, we are looking 10-15 billion years into the past.

LESSON 6: THE EXPANDING UNIVERSE..PG 154

→ Scientists think universe began 13.7 billion years ago

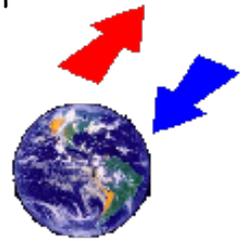
Big Bang = universe formed in an instant from a enormous explosion

- New data shows that the universe will likely expand forever.
- First stars & galaxies formed about 500 million years after the big bang.

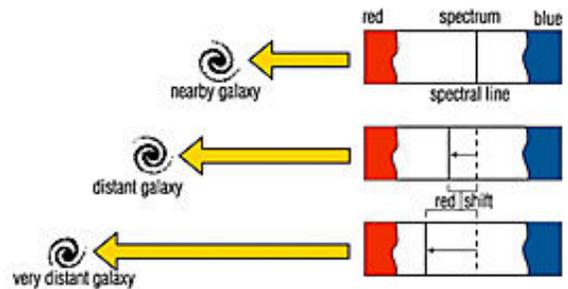


Edwin Hubble (1920's)- discovered evidence that supported the Big Bang Theory.

- 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.



Cosmic Background Radiation

- Leftover thermal radiation from the Big Bang.
- Uniform; from all directions.
- Weak microwaves that are very close in energy to predictions made by the Big Bang Theory.

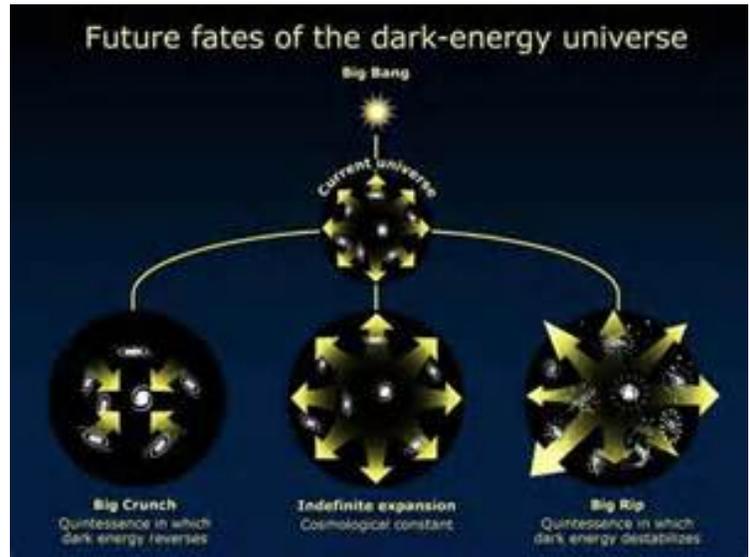
HELPED TO PROVE THE BIG BANG!!!!

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?!?

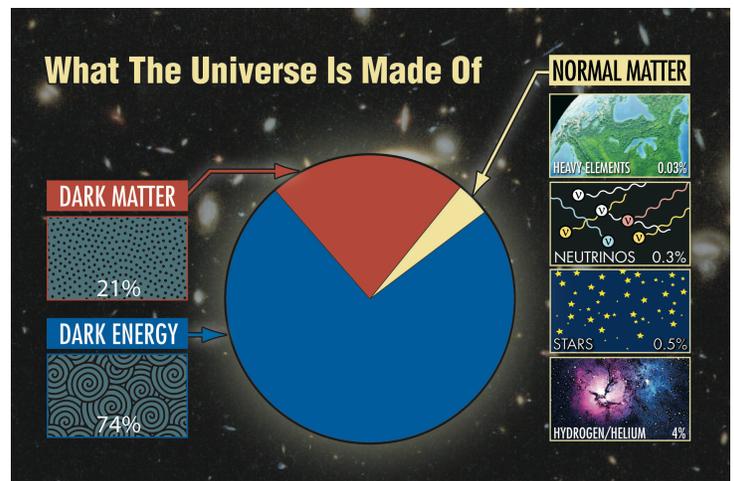
Possibilities:

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



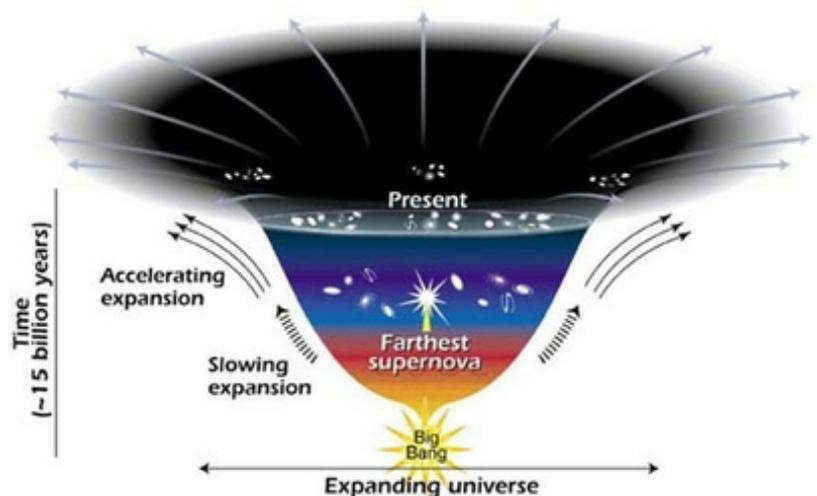
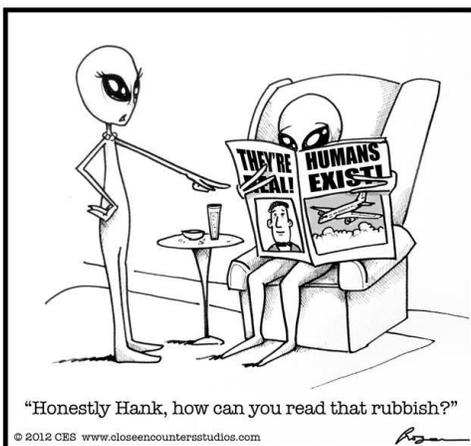
A. **Dark Matter** = matter that does not give off electromagnetic radiation... can find it by observing effect of its gravity on visible objects.

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. **Dark Energy** = mysterious new force which is causing the speeding up of the expansion.



The End!!

