

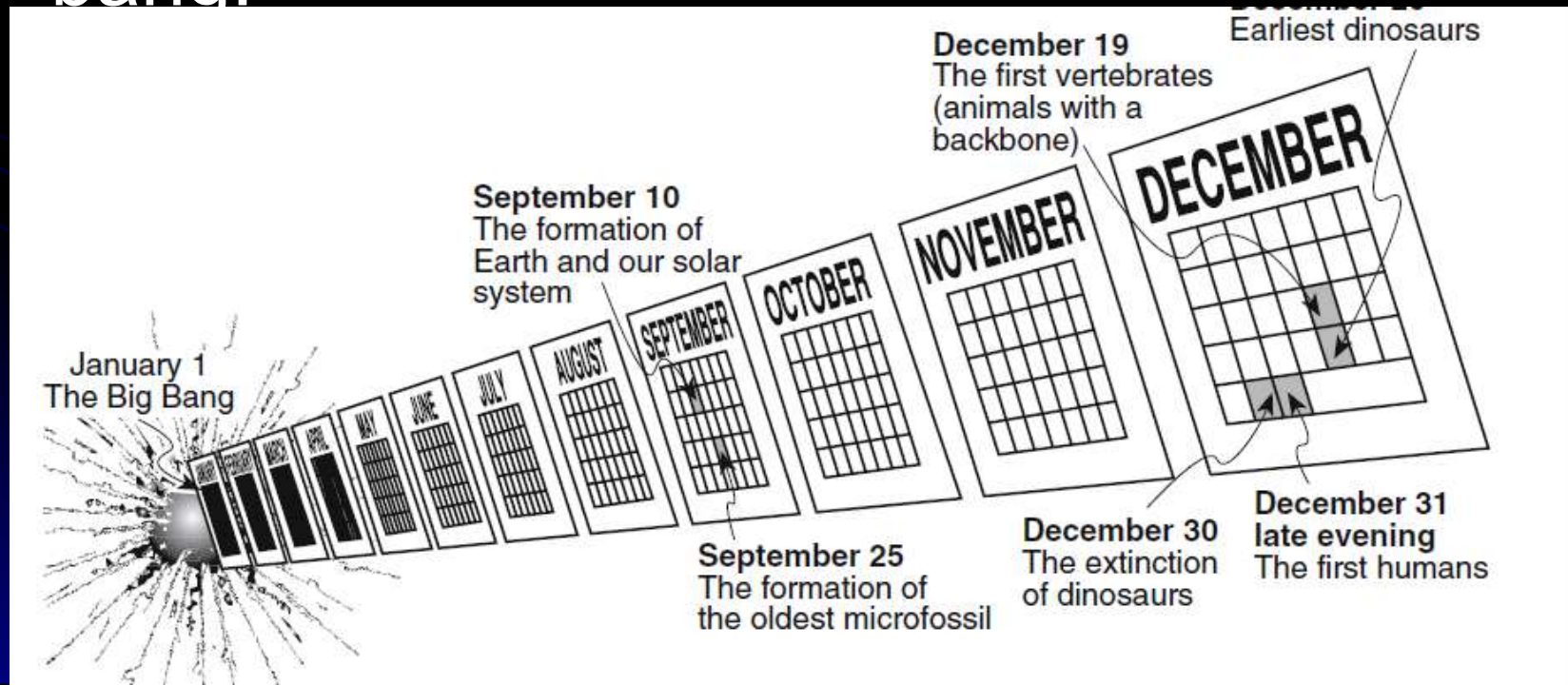


# The Big Bang

Evidence of creation and expansion of the Universe through Background Radiation and Investigating Spectra (color)

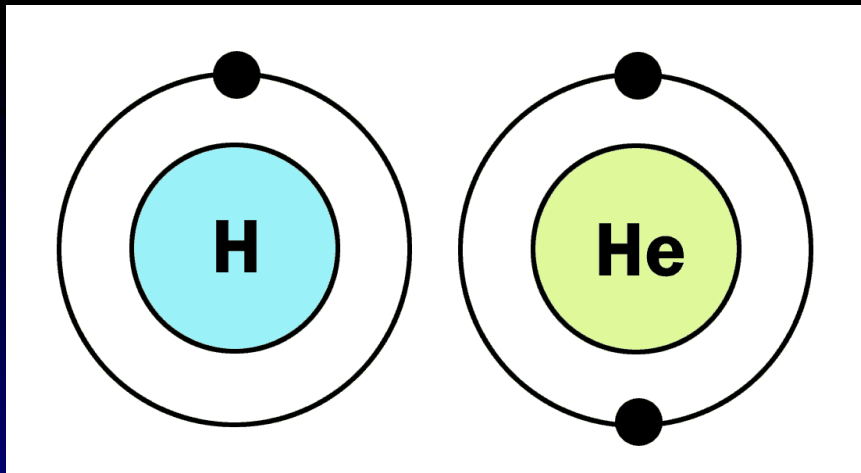
# The Big Bang Video Link

- Scientists have evidence that the universe is **13.7 billion** years old
- But it all came from one point...the big bang!



# The Big Bang Theory

- States that all matter and energy started out concentrated in a small area, **smaller than an atom**
- After Gigantic Explosion, matter organized itself into **subatomic particles** and later atoms
- The first atoms to form were **Hydrogen** and **Helium**



Periodic Table of the Elements

1 H Hydrogen 1.01																	2 He Helium 4.00
3 Li Lithium 6.94	4 Be Beryllium 9.01											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18
11 Na Sodium 22.99	12 Mg Magnesium 24.31											13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.06	17 Cl Chlorine 35.45	18 Ar Argon 39.95
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.88	23 V Vanadium 50.94	24 Cr Chromium 51.99	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.38	31 Ga Gallium 69.72	32 Ge Germanium 72.63	33 As Arsenic 74.92	34 Se Selenium 78.97	35 Br Bromine 79.90	36 Kr Krypton 84.80
37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.95	43 Tc Technetium 98.91	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.6	53 I Iodine 126.90	54 Xe Xenon 131.29
55 Cs Cesium 132.91	56 Ba Barium 137.33	57-71 Lanthanides	72 Hf Hafnium 178.49	73 Ta Tantalum 180.95	74 W Tungsten 183.85	75 Re Rhenium 186.21	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.97	80 Hg Mercury 200.59	81 Tl Thallium 204.38	82 Pb Lead 207.2	83 Bi Bismuth 208.98	84 Po Polonium [208.98]	85 At Astatine [208.98]	86 Rn Radon 222.02
87 Fr Francium 223.02	88 Ra Radium 226.03	89-103 Actinides	104 Rf Rutherfordium [261]	105 Db Dubnium [261]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [265]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [281]	111 Rg Roentgenium [280]	112 Cn Copernicium [285]	113 Nh Nihonium [286]	114 Fl Flerovium [289]	115 Mc Moscovium [289]	116 Lv Livermorium [293]	117 Ts Tennessine [294]	118 Og Oganesson [294]
57 La Lanthanum 138.91	58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium 144.91	62 Sm Samarium 150.36	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.05	71 Lu Lutetium 174.97			
89 Ac Actinium 227.03	90 Th Thorium 232.04	91 Pa Protactinium 231.04	92 U Uranium 238.03	93 Np Neptunium 237.05	94 Pu Plutonium 244.06	95 Am Americium 243.06	96 Cm Curium 247.07	97 Bk Berkelium 247.07	98 Cf Californium 251.08	99 Es Einsteinium [254]	100 Fm Fermium 257.10	101 Md Mendelevium 258.10	102 No Nobelium 259.10	103 Lr Lawrencium [262]			

Legend: Alkali Metal, Alkaline Earth, Transition Metal, Basic Metal, Metalloid, Nonmetal, Halogen, Noble Gas, Lanthanide, Actinide

# What needed to change in order for the creation of atoms (combining of electrons, protons and neutrons)?

Data Table

Stage	Description of the Universe	Average Temperature of the Universe (°C)	Time From the Beginning of Universe
1	the size of an atom	?	0 second
2	the size of a grapefruit	?	$10^{-43}$ second
3	"hot soup" of electrons	$10^{27}$	$10^{-32}$ second
4	Cooling allows protons and neutrons to form.	$10^{13}$	$10^{-6}$ second
5	still too hot to allow the forming of atoms	$10^8$	3 minutes
6	Electrons combine with protons and neutrons, forming hydrogen and helium atoms. Light emission begins.	10,000	300,000 years
7	Hydrogen and helium form giant clouds (nebulae) that will become galaxies. First stars form.	-200	1 billion years
8	Galaxy clusters form and first stars die. Heavy elements are thrown into space, forming new stars and planets.	-270	13.7 billion years

# Where is our evidence for this Theory?

1.) Energy created by this explosion **expanded** along with the matter

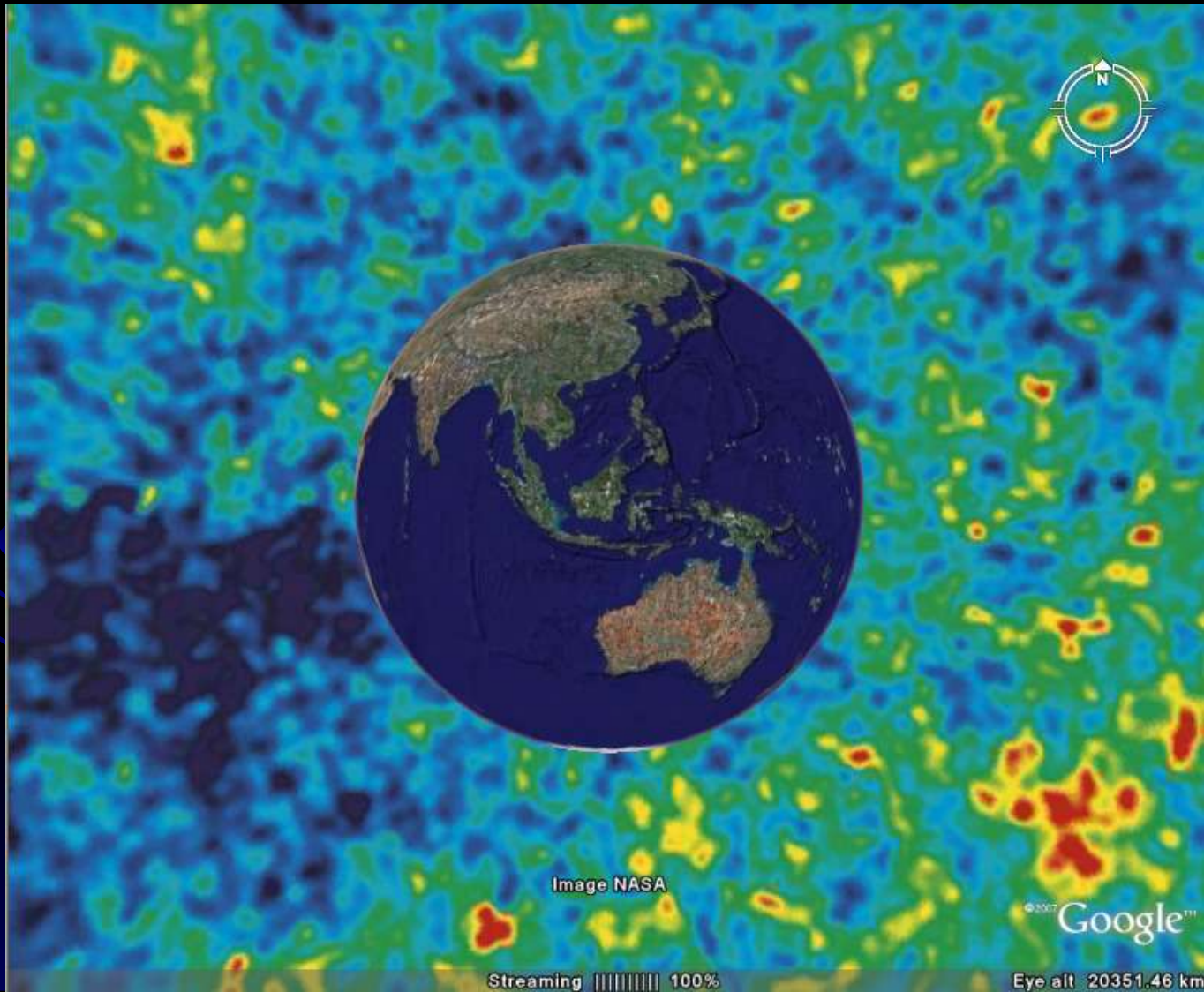
This radiation has been traveling **outwards** in the **universe** and **cooling** over billions of years, but can still be measured and observed.

- This original radiation is called:

**Cosmic background radiation (CMB)** which is long-wave **microwave** radiation that appears to be coming from everywhere in the universe!

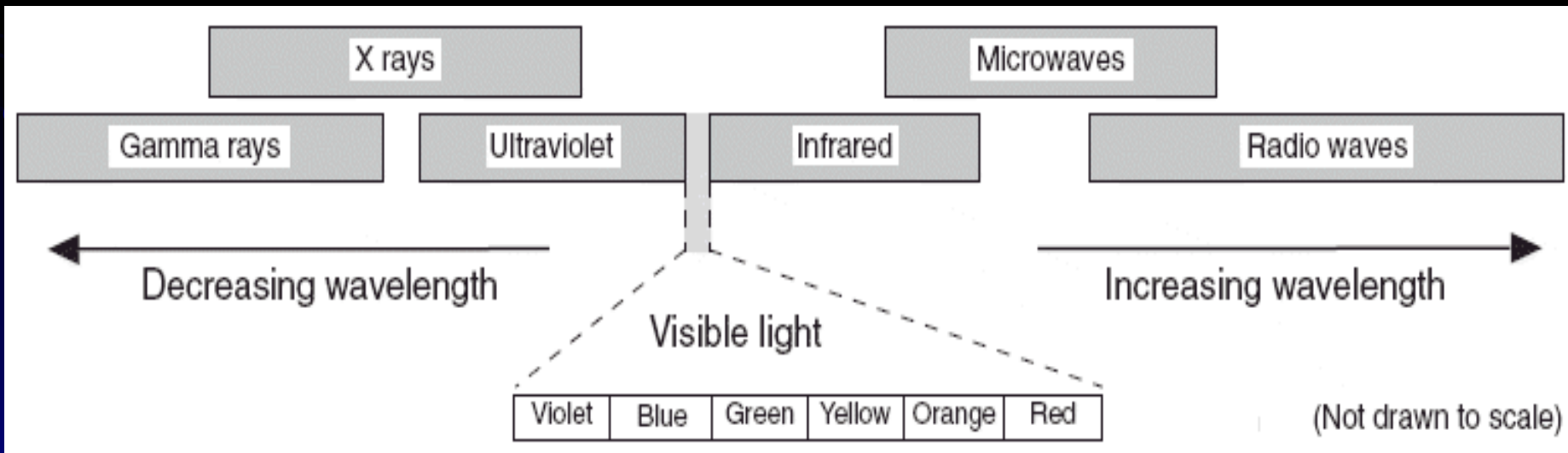
# Cosmic Background Microwave Radiation

## Cosmic Background Radiation Video Link



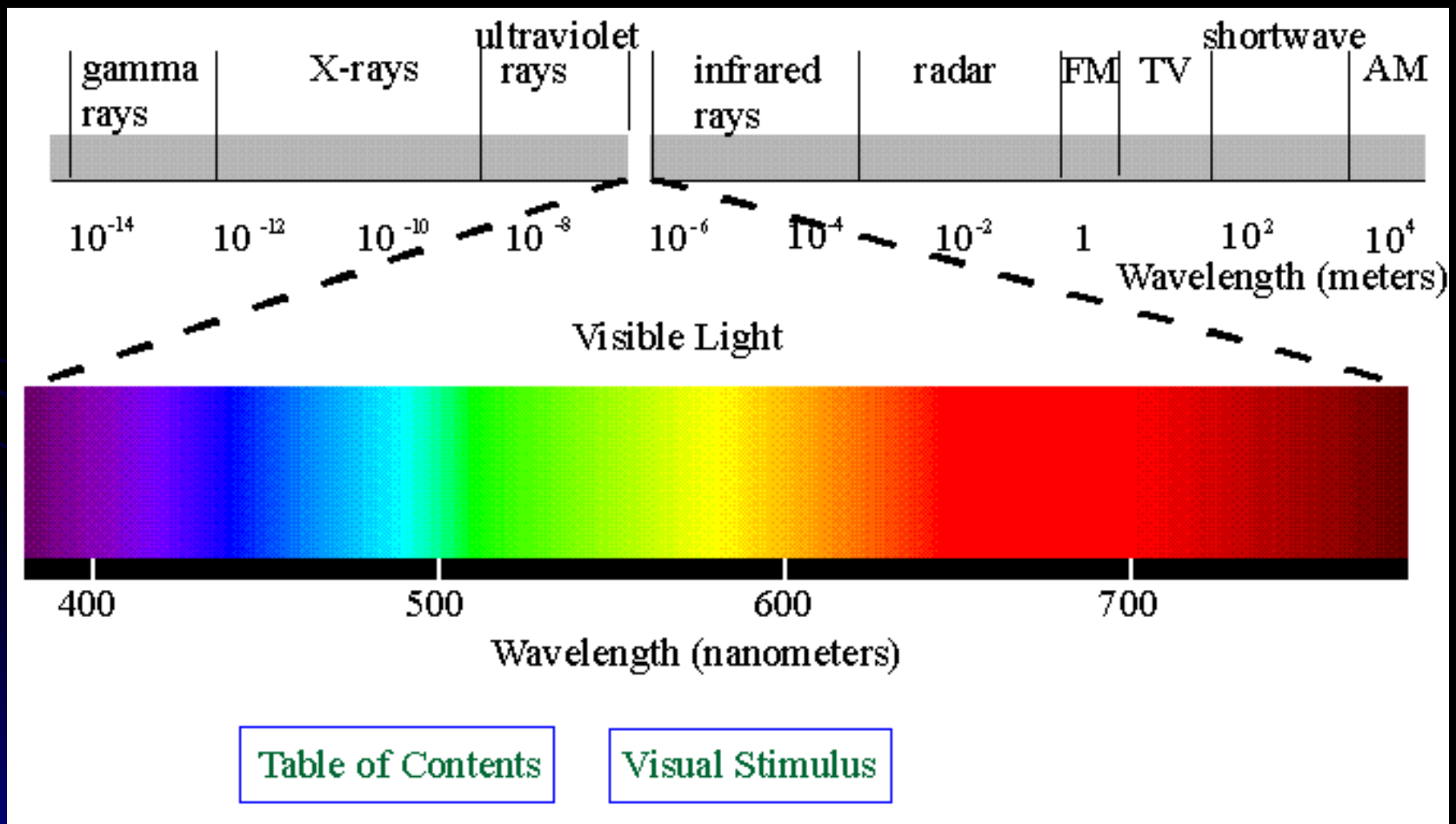
## 2.) Red Shift Exhibited by observing the spectrum of distant galaxies and stars over time

- pg. 14 of your ESRT displays the electromagnetic spectrum, or all energy produced by the sun and transmitted through radiation



**Red**= longest wavelength  
**Violet/Blue**= shorter wavelengths

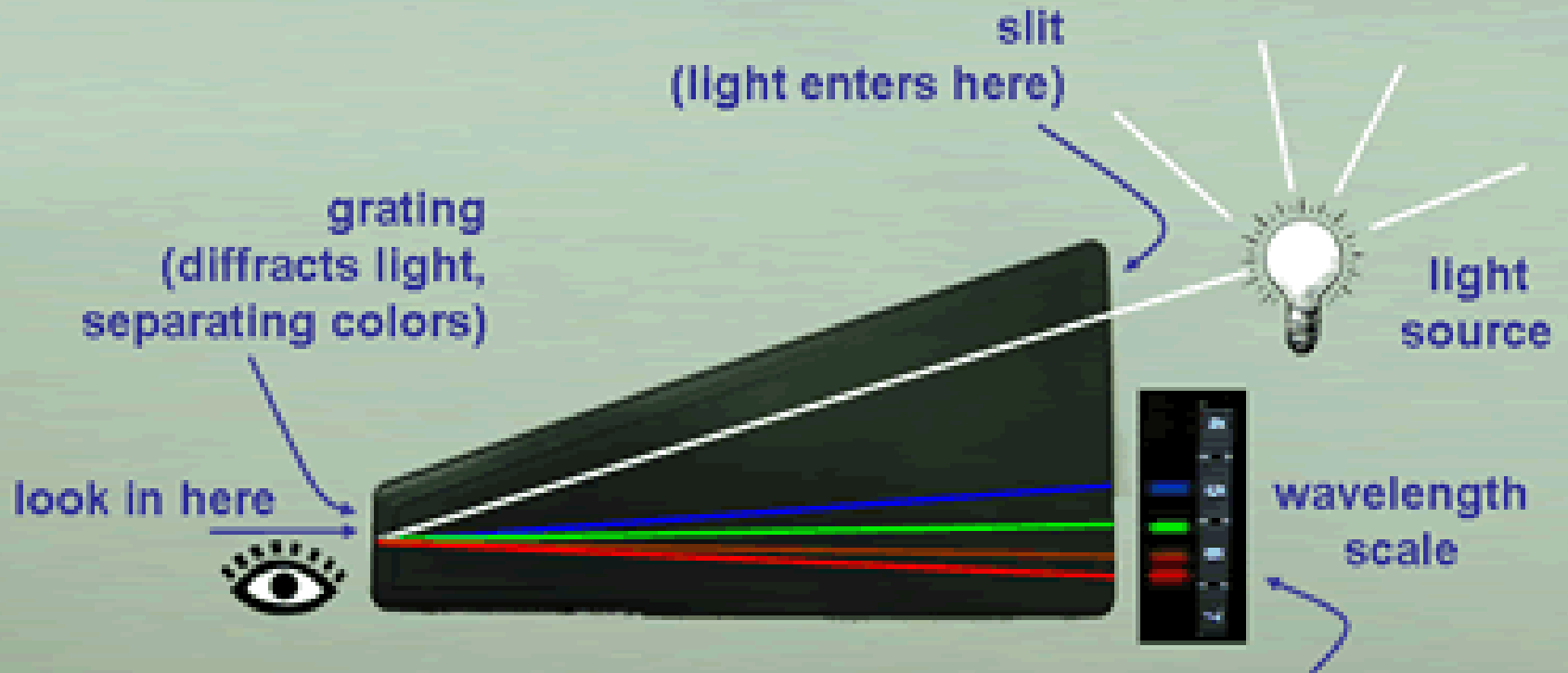
*Analyzing Red Shift in Stars video link*





# Understanding the Spectrum

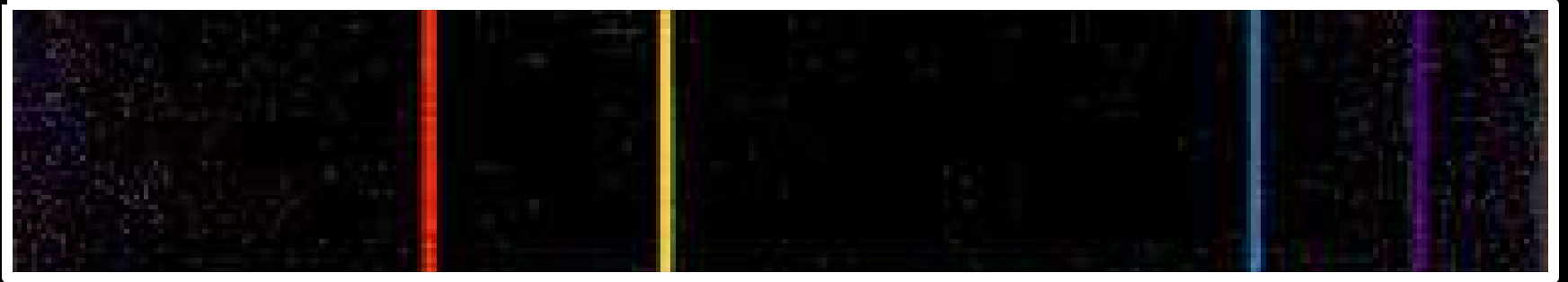
- Each element in the universe emits energy in different wavelengths
- The human eye observes different wavelengths of visible light in the form of COLORS
- We can look at the spectral signatures of stars and infer 2 things:
  - 1.) Their Composition; which elements they are composed of
  - 2.) If they are moving towards or away from us (if the spectral lines shift position with time)



This is the spectrum you would observe if you used a spectroscope to look at a white computer screen.

## How a spectroscope works

This is what lithium gas in a tube would look like through a spectroscope (The lines or “signature” tell us this is Lithium)



Each element has its own “spectrum” of color. If we saw this signature in a distant galaxy, we would know that lithium existed there

# The Doppler Effect Explained

## (video link)

- The position of wavelengths (spectral lines), are shifted to either the

1.) shorter wavelength/BLUE side or to the

2.) longer wavelength/RED side.

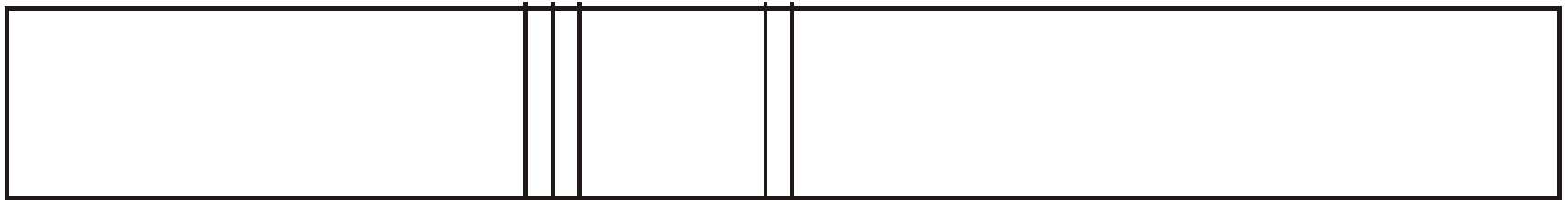
- Because the universe is expanding, objects that are moving apart from one another will cause the wavelengths of energy to stretch or become longer, causing what's known as a **RED SHIFT**

- **MOST GALAXIES SHOW A RED SHIFT**

Violet

Normal Spectral lines of an element

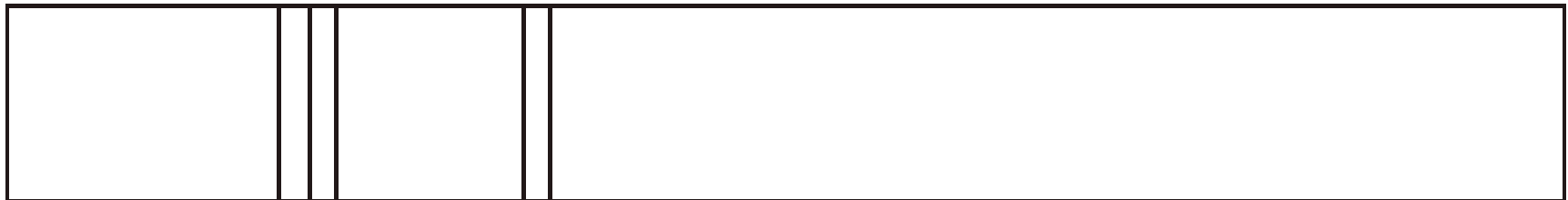
Red



If the object were moving TOWARD us, the spectral lines would shift left (toward violet/blue end of the spectrum)

Violet

Red

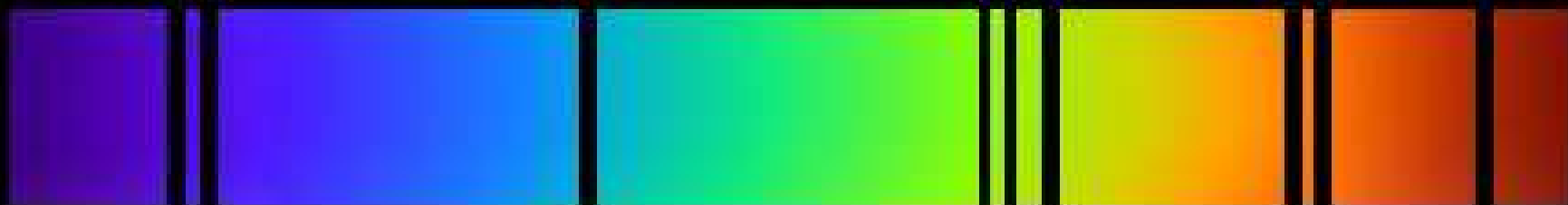


If the object were moving AWAY from us, the spectral lines would shift right (toward red end of the spectrum)

Violet

Red





**UNSHIFTED**



**REDSHIFTED**



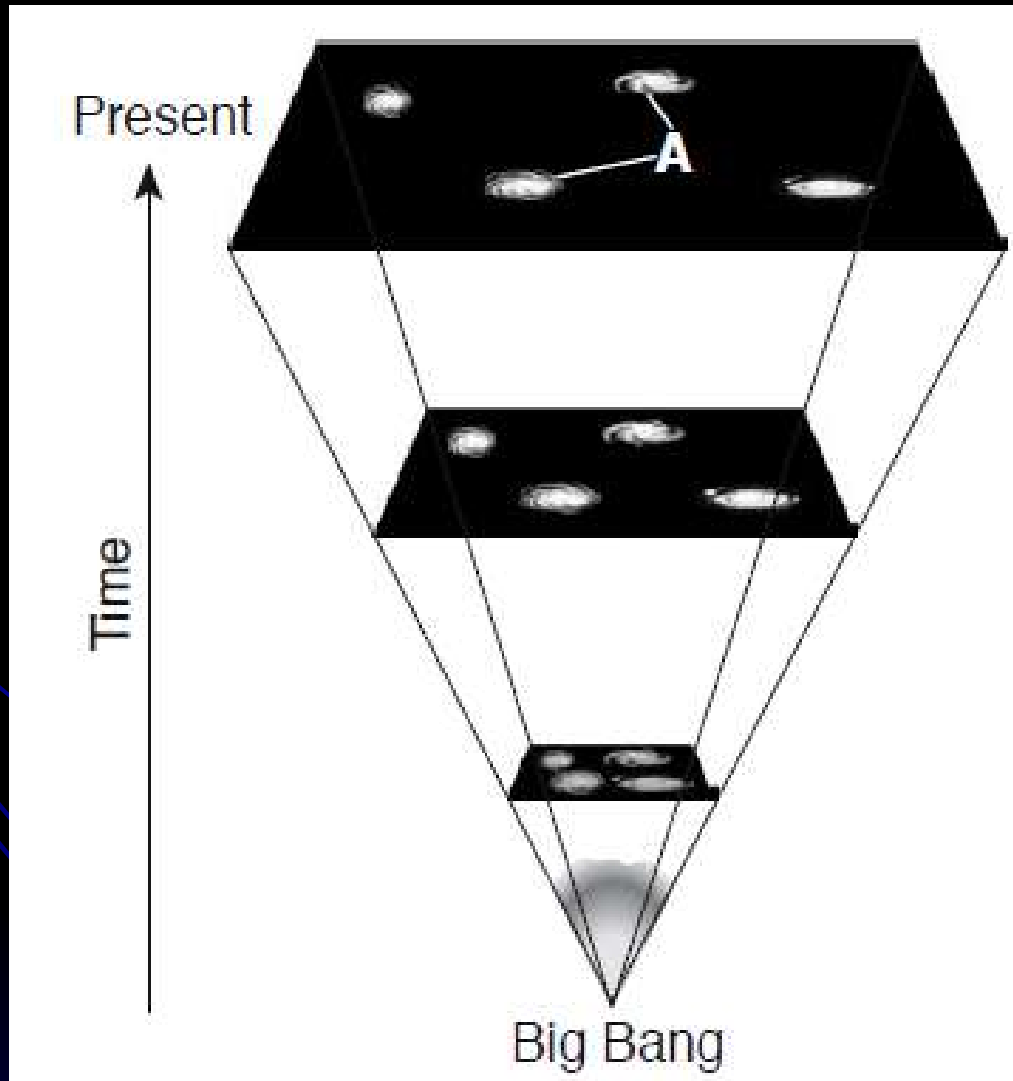
**BLUESHIFTED**

# Are there any galaxies that would appear to have a blue shift?

- The **Andromeda galaxy** will merge with ours in the future
  - It's spectra is thus **blue-shifted** with time
- **Hubble's Law** : States the Universe is Expanding!
- The **faster** it's expanding, the greater the **red shift** (further the spectral lines are shifted in the spectrum)!

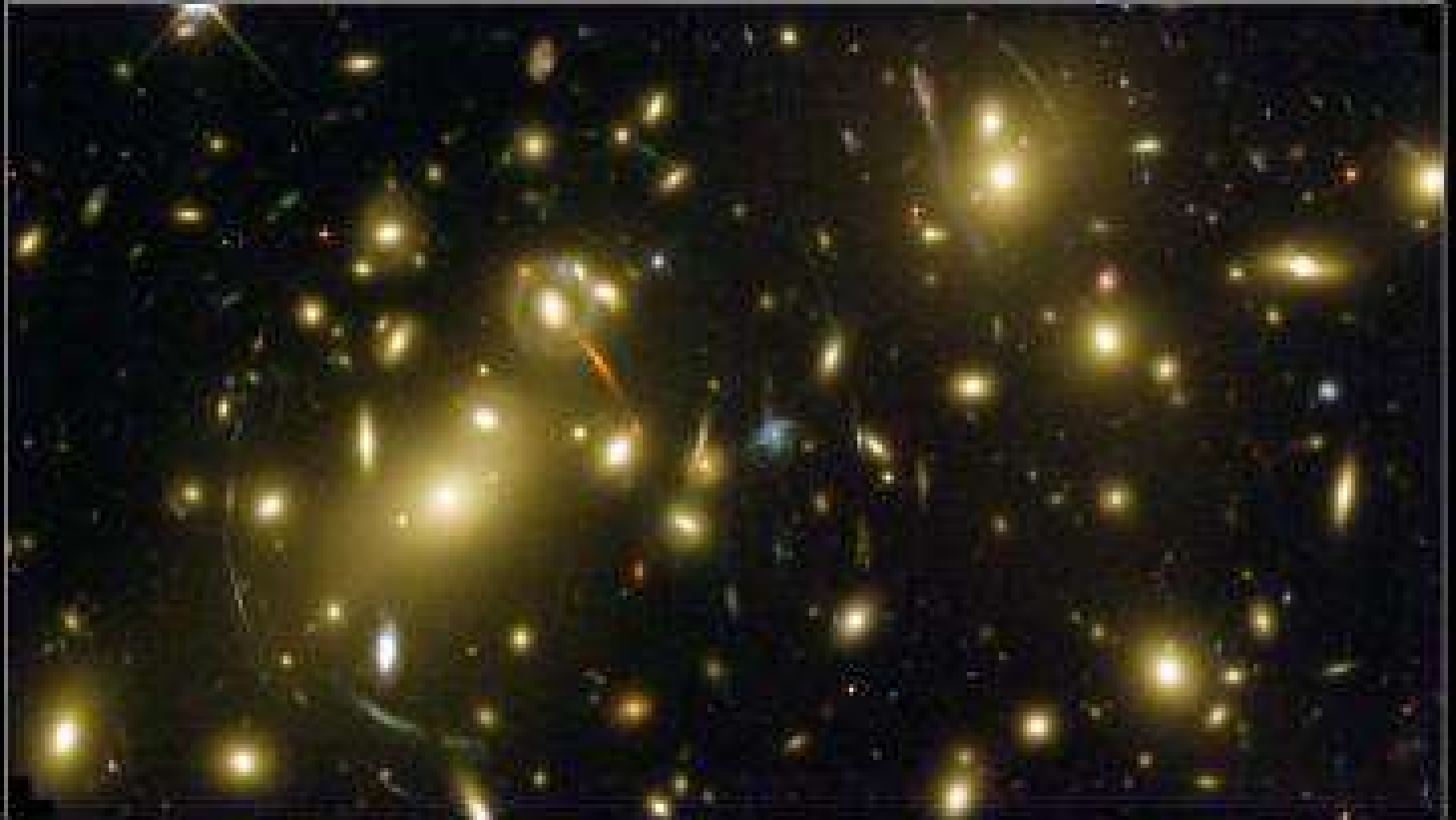
# Expansion of Universe

Galaxies move further apart over time





# Part II: GALAXIES



**Galaxy Cluster Abell 2218**

**HST • WFPC2**

NASA, A. Fruchter and the ERO Team (STScI, ST-ECF) • STScI-PRC00-08

# A Galaxy: is a collection of billions of stars

- Stars and gases are held together by gravity
- An Average galaxy will have over 100 billion stars
  - Each star (or two) with its own planetary system
- Estimated to be over 100 billion galaxies in the universe!

# Galaxies are categorized by shape into 3 types

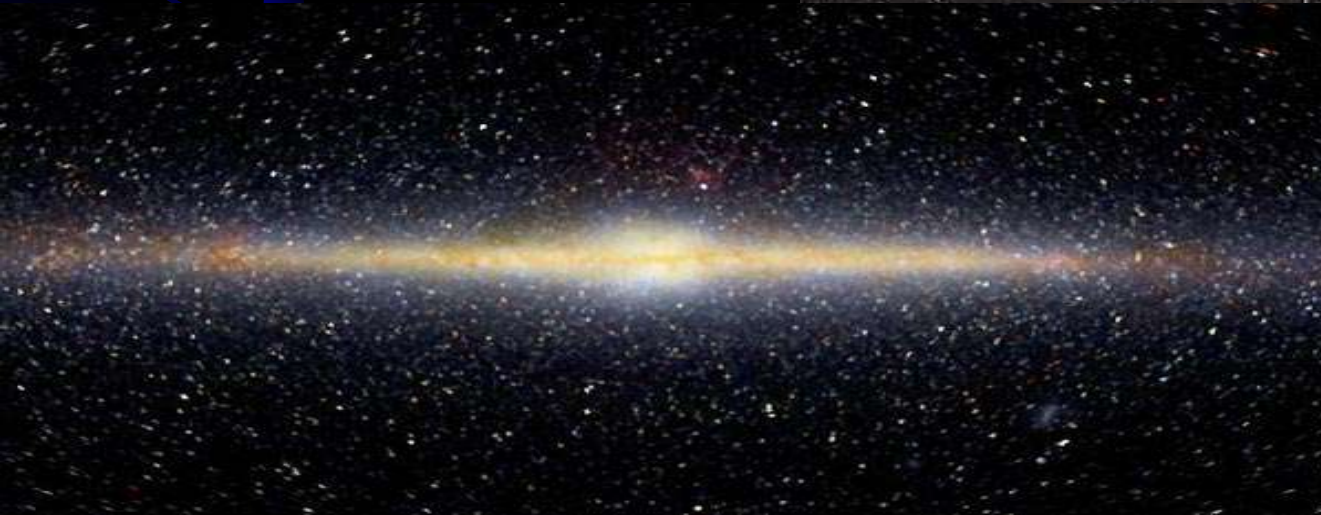
- 1.) Elliptical (round → football shaped)
  - Make up 60% of galaxies in the universe
  - little to no star formation and little rotation



## 2.) Spiral Shaped Galaxies

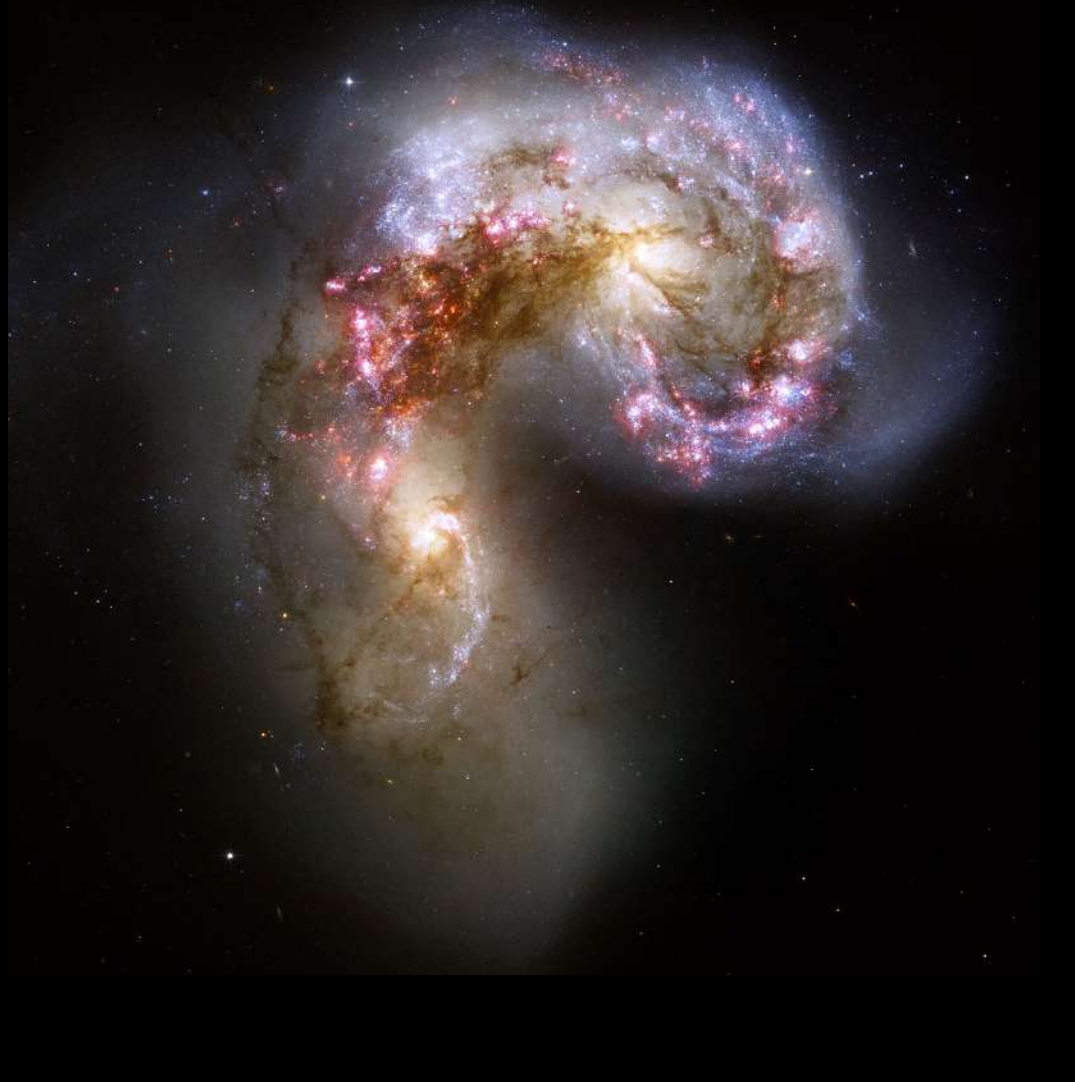
Sub groups are Spiral vs. Barred Spiral

- 30% of galaxies , contain very old and new stars
- Average size is very large
  - (25- 125 thousand
  - light years across!)



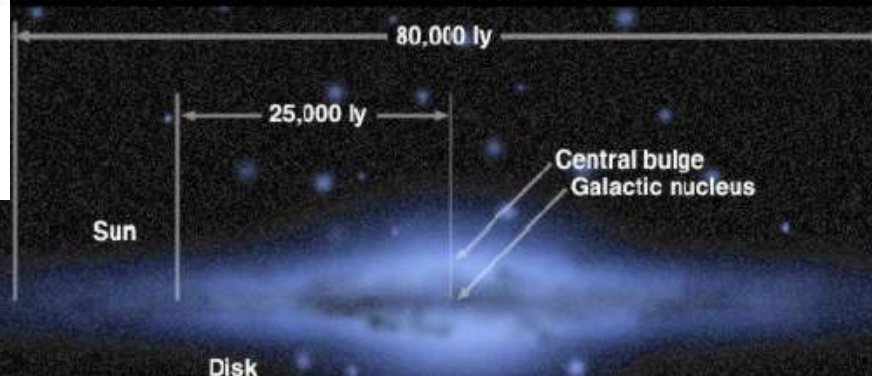
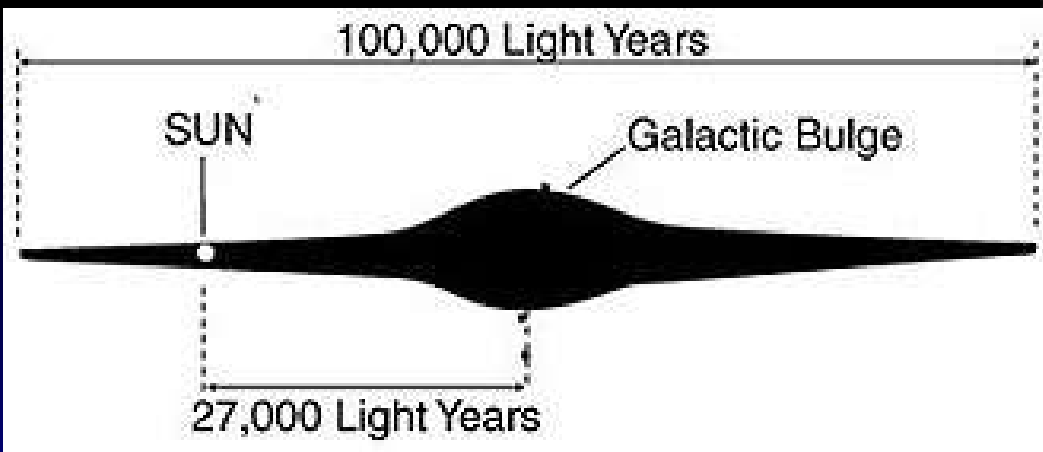
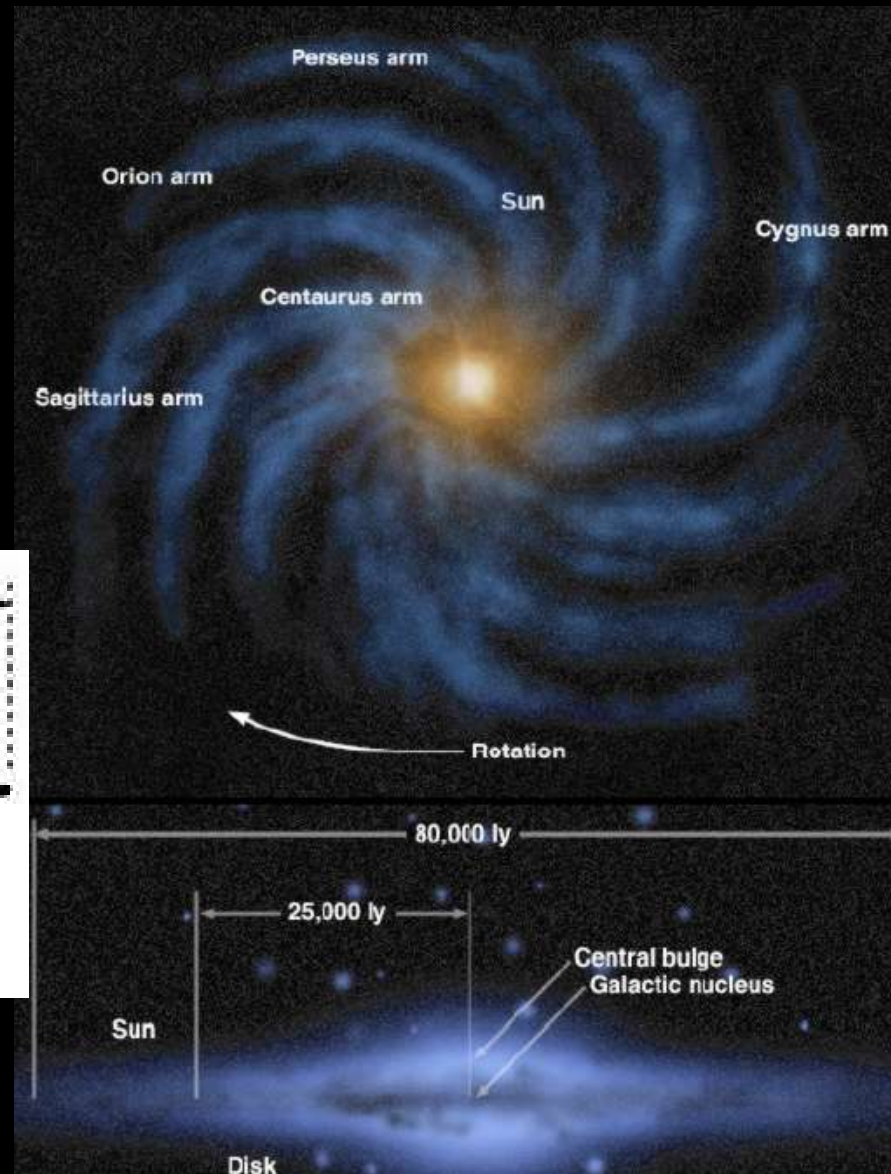
# 3.) Irregular Galaxies

- 10% of galaxies form “irregular galaxies”
- They have no known shape
- Also contain large amounts of NEW stars



# Our Galaxy: The Milky Way

- We are a **spiral galaxy** located on the **outer edge** of one of the galactic arms!



# Galaxy Clusters

Like stars, galaxies can also be in clusters!



# Hubble Space Telescope Gallery

