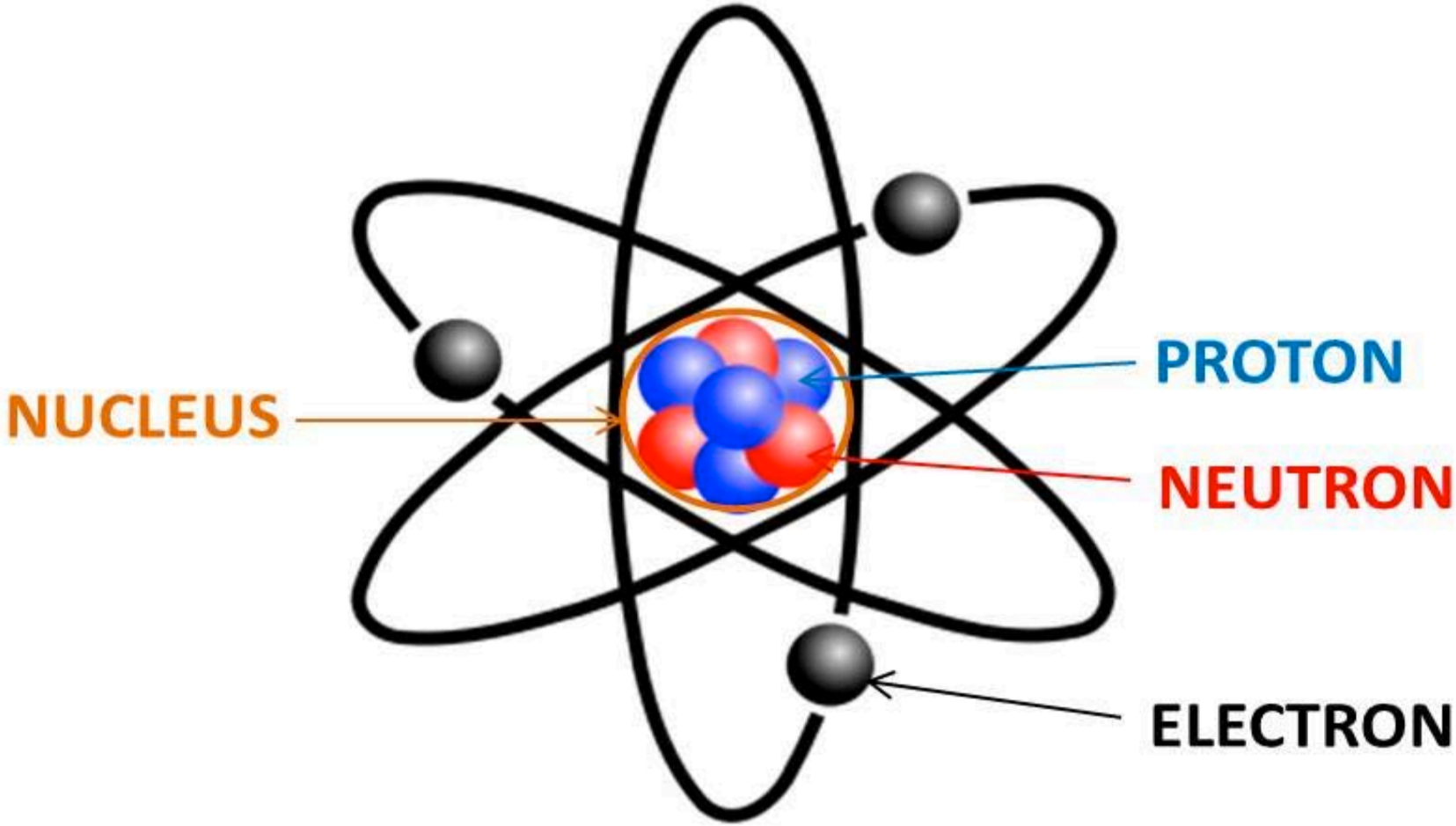
Where did atoms come from?

The first atoms of hydrogen and helium were created during the big bang.



Atoms from Helium to Iron are made by fusion in the core of big stars.

Atoms larger than Iron are made during super nova events- exploding stars (more on this later).

IUPAC Periodic Table of the Elements

Key:

atomic number
Symbol
name
conventional atomic weight
standard atomic weight

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 **H** hydrogen 1.008 [1.0078, 1.0082]																	2 **He** helium 4.0026
3 **Li** lithium 6.94 [6.938, 6.997]	4 **Be** beryllium 9.0122											5 **B** boron 10.81 [10.806, 10.821]	6 **C** carbon 12.011 [12.009, 12.012]	7 **N** nitrogen 14.007 [14.006, 14.008]	8 **O** oxygen 15.999 [15.999, 16.000]	9 **F** fluorine 18.998	10 **Ne** neon 20.180
11 **Na** sodium 22.990	12 **Mg** magnesium 24.305 [24.304, 24.307]											13 **Al** aluminium 26.982	14 **Si** silicon 28.085 [28.084, 28.086]	15 **P** phosphorus 30.974	16 **S** sulfur 32.06 [32.059, 32.076]	17 **Cl** chlorine 35.45 [35.446, 35.457]	18 **Ar** argon 39.948
19 **K** potassium 39.098	20 **Ca** calcium 40.078(4)	21 **Sc** scandium 44.956	22 **Ti** titanium 47.867	23 **V** vanadium 50.942	24 **Cr** chromium 51.996	25 **Mn** manganese 54.938	26 **Fe** iron 55.845(2)	27 **Co** cobalt 58.933	28 **Ni** nickel 58.693	29 **Cu** copper 63.546(3)	30 **Zn** zinc 65.38(2)	31 **Ga** gallium 69.723	32 **Ge** germanium 72.630(8)	33 **As** arsenic 74.922	34 **Se** selenium 78.971(8)	35 **Br** bromine 79.904 [79.901, 79.907]	36 **Kr** krypton 83.798(2)
37 **Rb** rubidium 85.468	38 **Sr** strontium 87.62	39 **Y** yttrium 88.906	40 **Zr** zirconium 91.224(2)	41 **Nb** niobium 92.906	42 **Mo** molybdenum 95.95	43 **Tc** technetium	44 **Ru** ruthenium 101.07(2)	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 127.60(3)	53 **I** iodine 126.90	54 **Xe** xenon 131.29
55 **Cs** caesium 132.91	56 **Ba** barium 137.33	57-71 lanthanoids	72 **Hf** hafnium 178.49(2)	73 **Ta** tantalum 180.95	74 **W** tungsten 183.84	75 **Re** rhenium 186.21	76 **Os** osmium 190.23(3)	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 [204.38, 204.39]	82 **Pb** lead 207.2	83 **Bi** bismuth 208.98	84 **Po** polonium	85 **At** astatine	86 **Rn** radon
87 **Fr** francium	88 **Ra** radium	89-103 actinoids	104 **Rf** rutherfordium	105 **Db** dubnium	106 **Sg** seaborgium	107 **Bh** bohrium	108 **Hs** hassium	109 **Mt** meitnerium	110 **Ds** darmstadtium	111 **Rg** roentgenium	112 **Cn** copernicium	113 **Nh** nihonium	114 **Fl** flerovium	115 **Mc** moscovium	116 **Lv** livermorium	117 **Ts** tennessine	118 **Og** oganesson

57 **La** lanthanum 138.91	58 **Ce** cerium 140.12	59 **Pr** praseodymium 140.91	60 **Nd** neodymium 144.24	61 **Pm** promethium	62 **Sm** samarium 150.36(2)	63 **Eu** europium 151.96	64 **Gd** gadolinium 157.25(3)	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	90 **Th** thorium 232.04	91 **Pa** protactinium 231.04	92 **U** uranium 238.03	93 **Np** neptunium	94 **Pu** plutonium	95 **Am** americium	96 **Cm** curium	97 **Bk** berkelium	98 **Cf** californium	99 **Es** einsteinium	100 **Fm** fermium	101 **Md** mendelevium	102 **No** nobelium	103 **Lr** lawrencium

ATIONAL UNION OF
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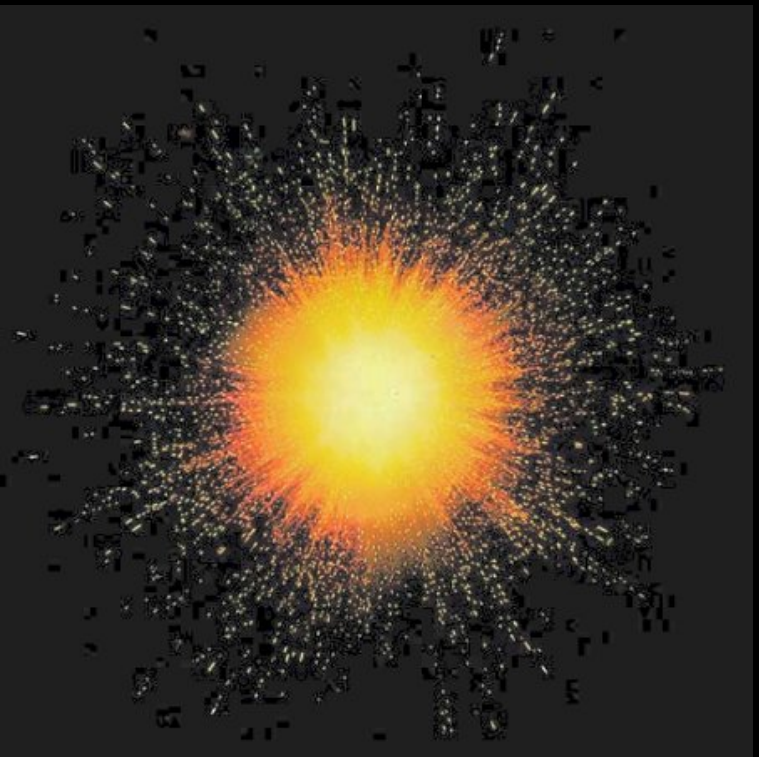
WHAT EXACTLY IS THE BIG BANG THEORY?

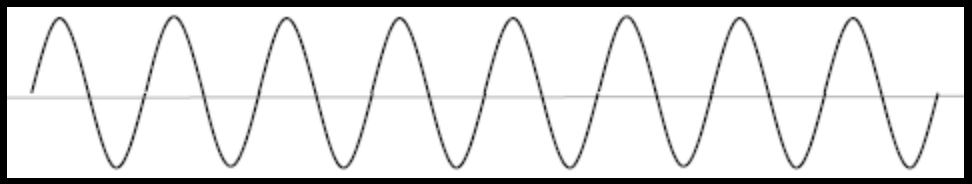


Scientists have calculated that the universe is approximately 13.7 billion years old.

How do we know this?

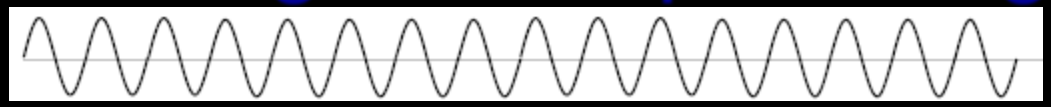
- Currently, most things in the universe are moving apart (expanding) at a constant rate.
- If this expansion was reversed and everything in the universe started to move toward one another (contract) it would take 13.7 billion years for everything to come back together.

How do we know that most objects are moving away from us?

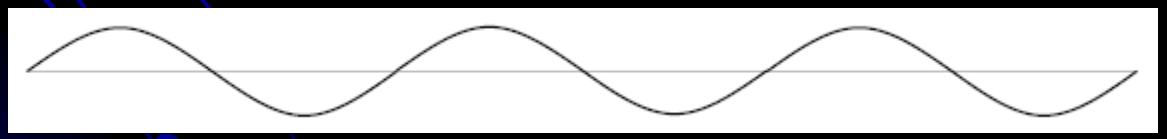


← **Normal wave**

- When a wave is moving toward you, the wavelengths compress together.

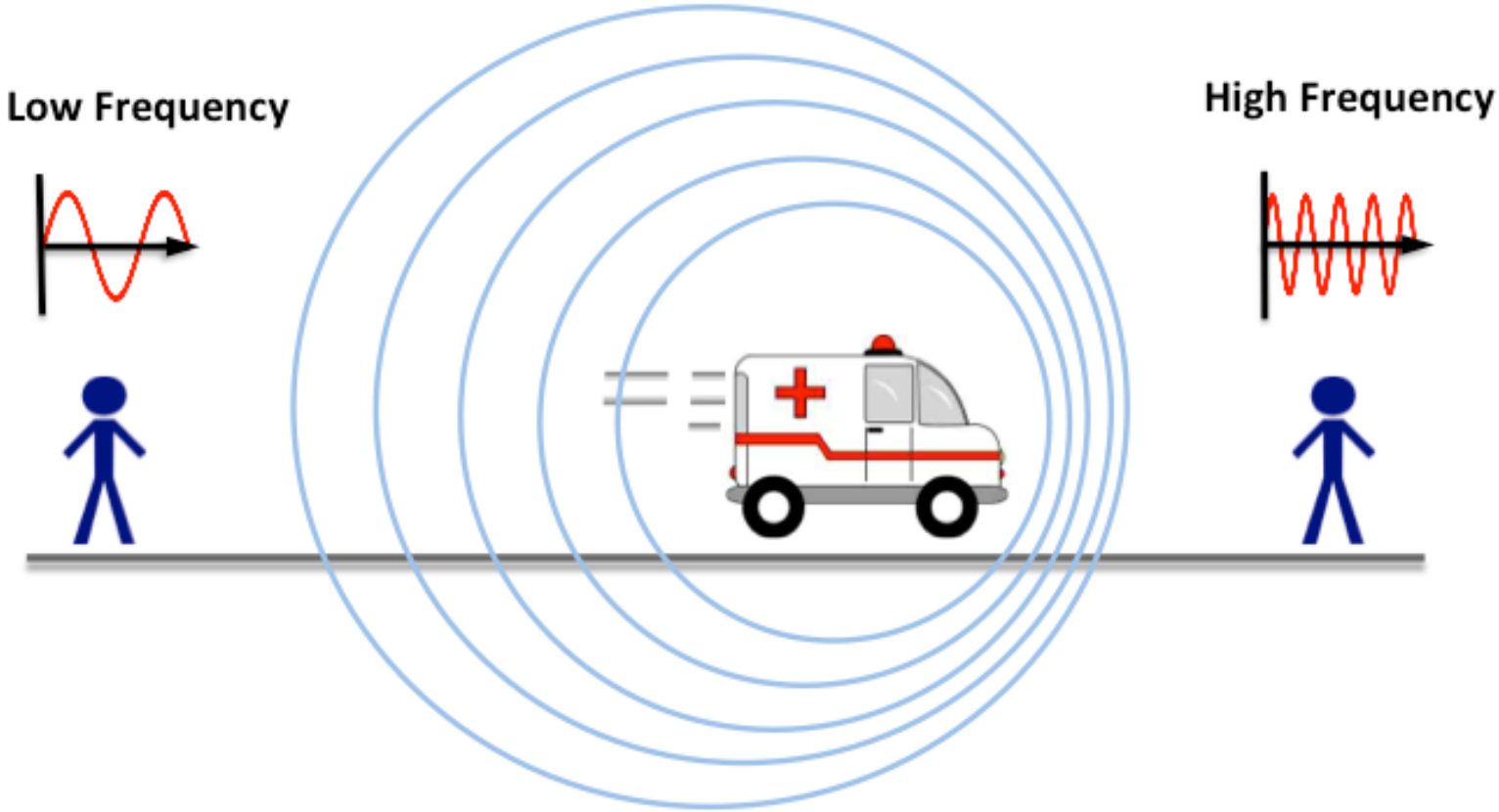


- When a wave is moving away from you the wavelengths expand.



- This happens in light & sound waves

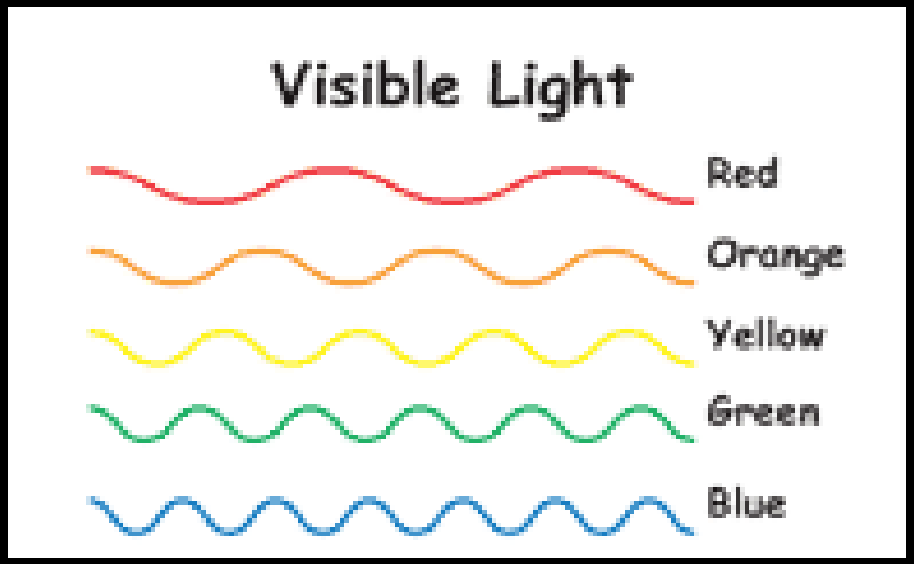
Doppler Effect



Doppler effect sound wave:
https://www.youtube.com/watch?v=p-hBCcmCUPg

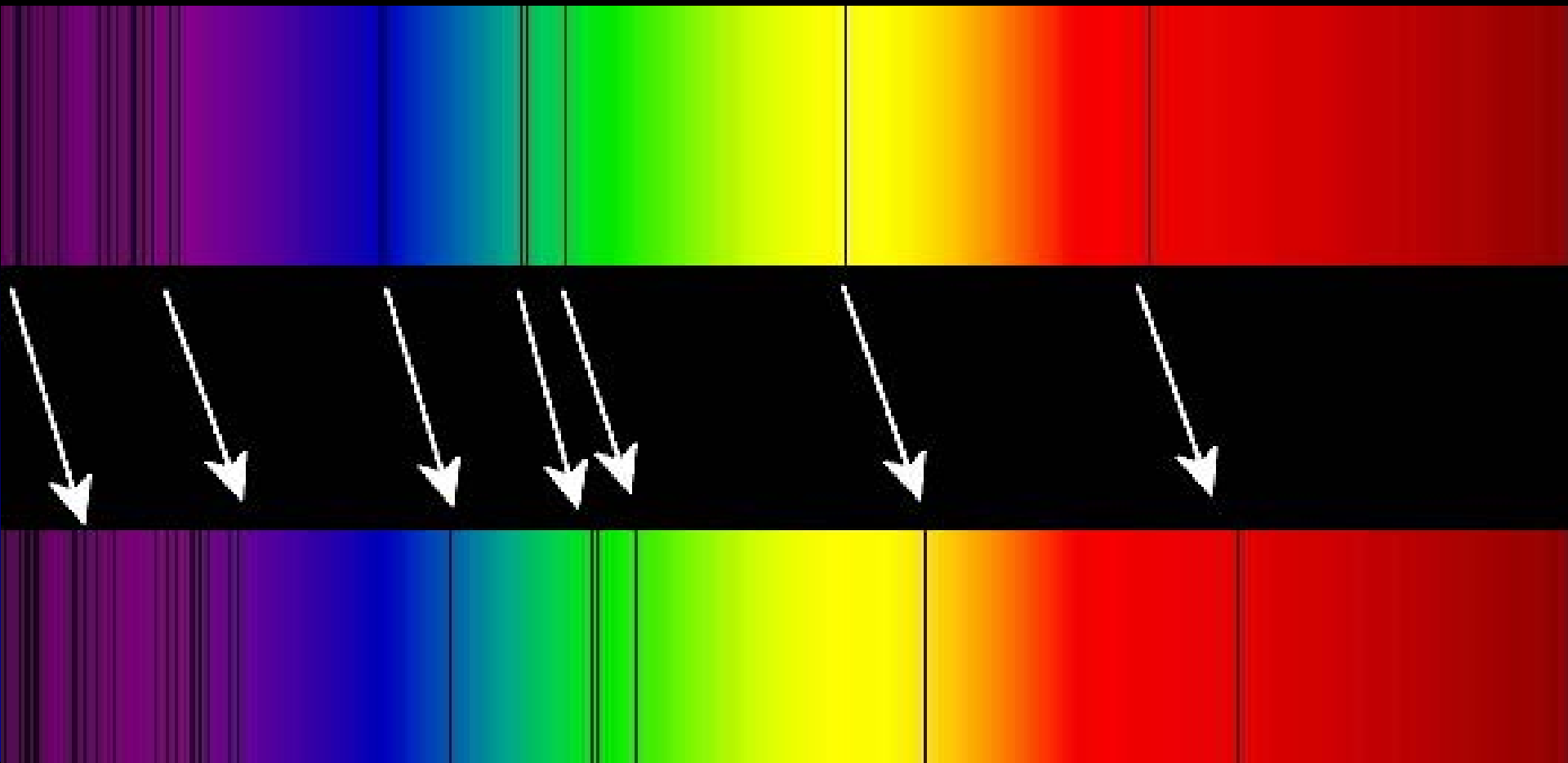
Red Shifts:

- Light coming from most stars appears to be moving away from us.
- When light waves are expanded they change color toward the red end of the color spectra.



Red Shift

A stars spectra lines move into the red end of the color spectrum because the wavelengths are extended.



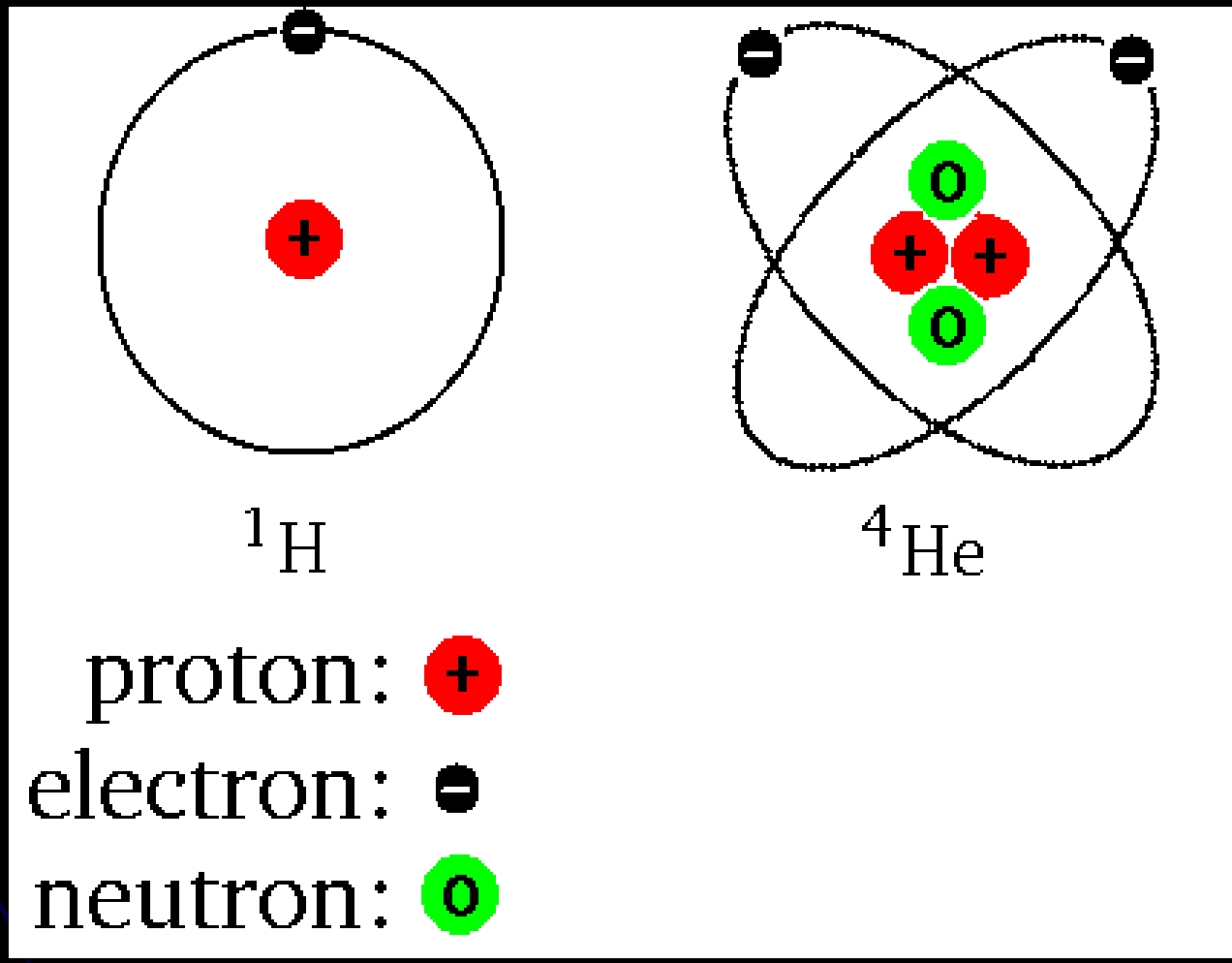
What is the Big Bang?

- **(Step 1)** Approximately 13.7 billion years ago, all the matter & energy in the universe was concentrated into a region smaller than a pen head.

- This region then began to expand & cool at an incredibly rapid rate.

How could the entire universe be squeezed so small?

- Astronomers believe that atoms, as we know them, did not exist.



ATOM:

- The atoms were broken into their smallest pieces- quarks.
- The quarks can be stacked very close together, without all of the empty space that atoms usually have.
- This allowed the entire universe to be squeezed down to the size of a pin head!

What started the expansion?

- **(Step 2)** The 4 fundamental forces came together in the **Unified Force Theory!**

The 4 Forces

1) **Strong Atomic Force-** holds the nucleus of the atom together (likes repel)
2) **Electromagnetic-** the force between particles with charge/magnetism (opposites attract)
3) **Weak Atomic Force -** controls the radioactive decay of atomic nuclei
4) **Gravitation – attraction/force** between particles with mass

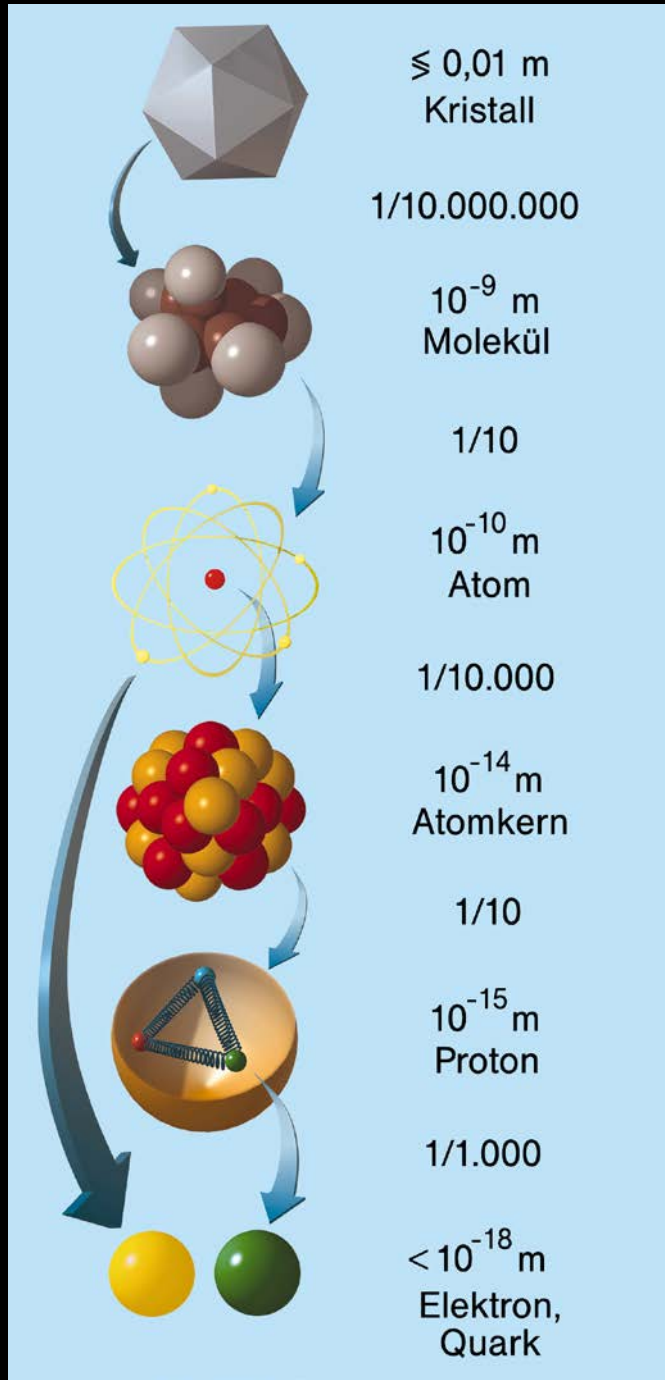
Have scientists combined any of these forces?

Yes!

We have combined electromagnetism & the weak nuclear force. This forms a z-particle, this it is called the electroweak force.

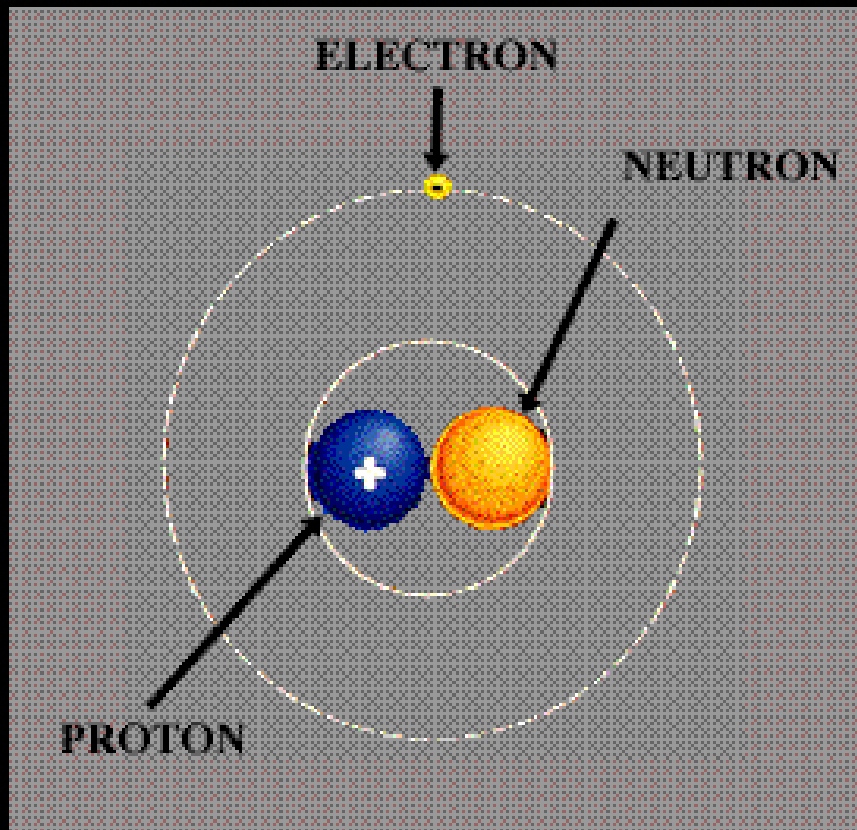
Step 3:

- **<u>Quarks</u>** were produced- the most elementary particles of atoms.



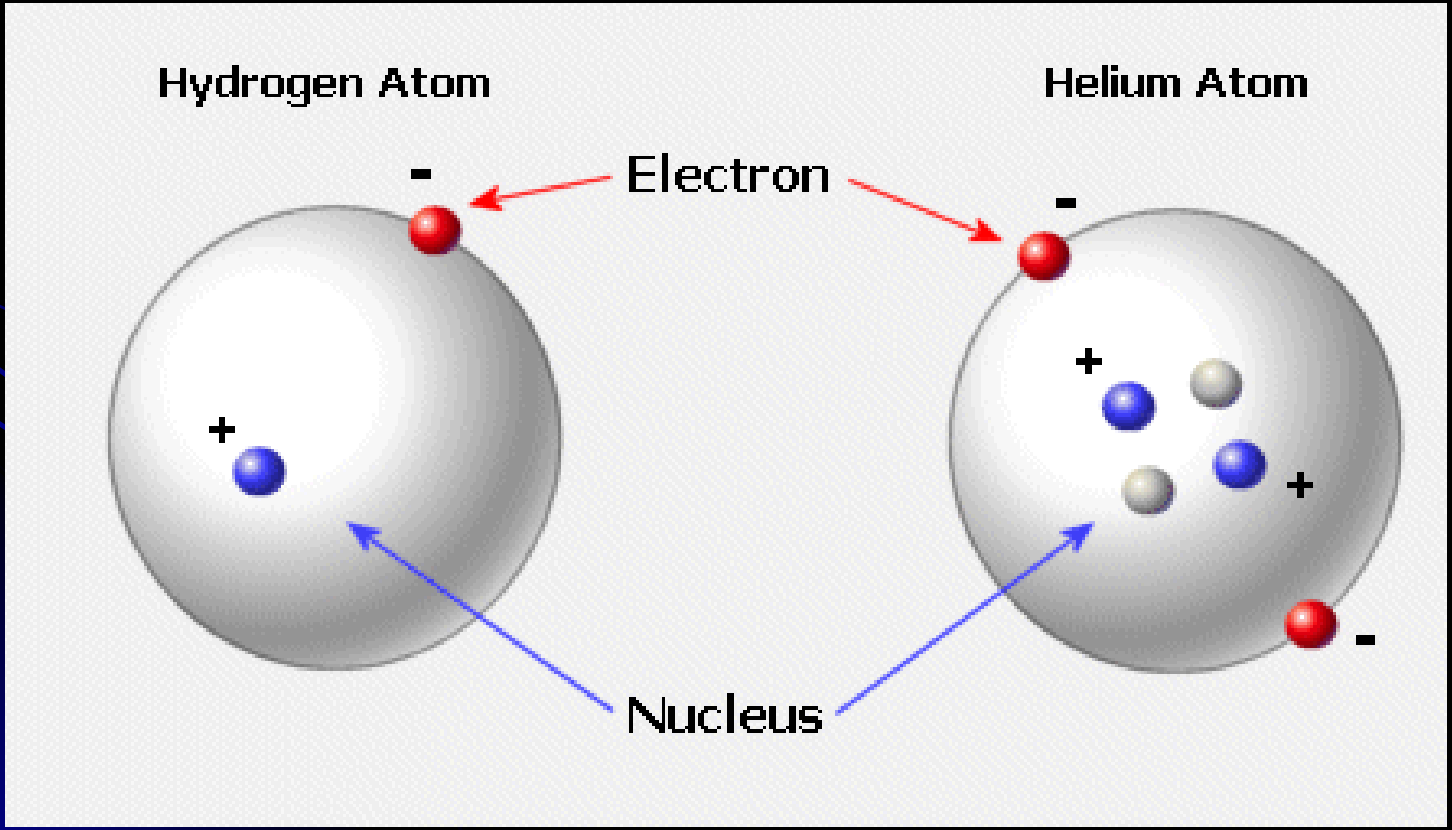
Step 4:

- Quarks combine to form protons (p), neutrons (n) & electrons (e-)

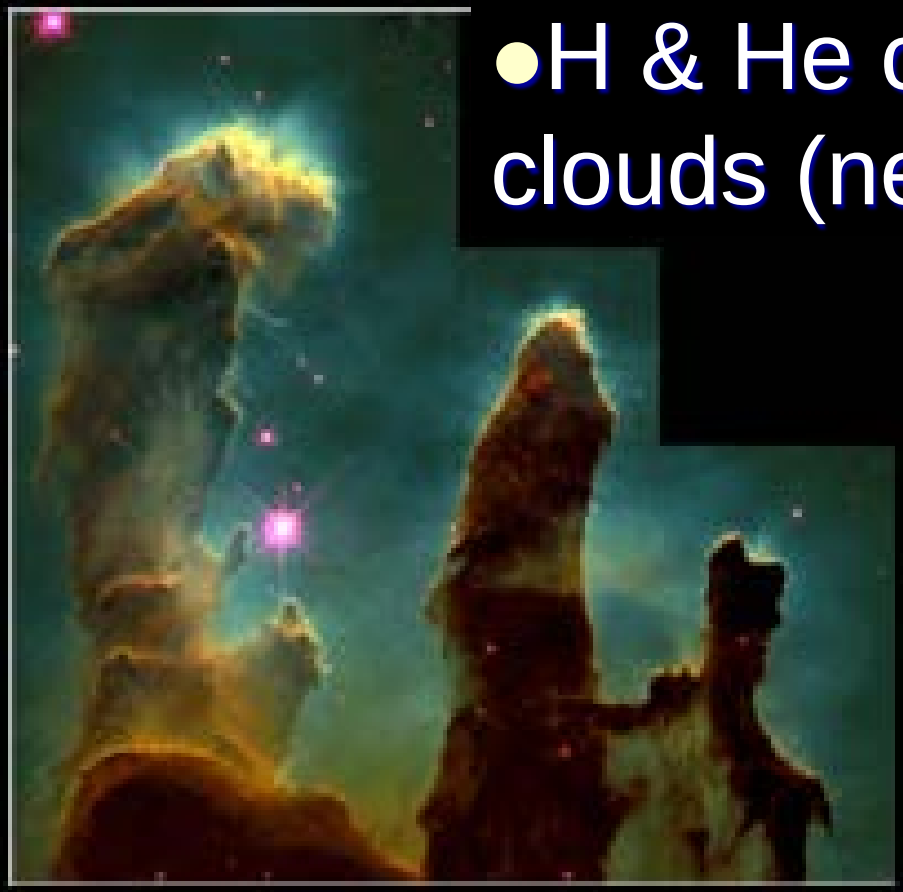


Step 5

- p^+, n, & e- combine & form Hydrogen (H) & Helium (He)



Step 6

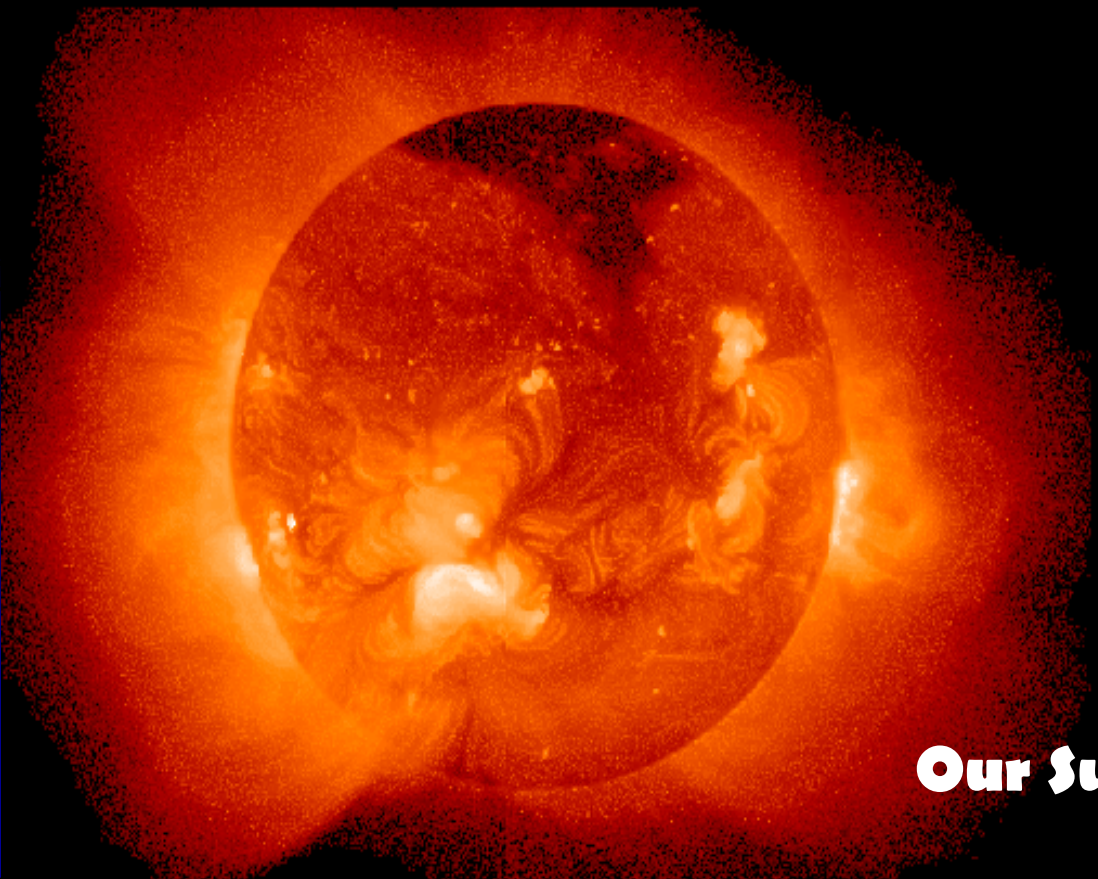


- H & He condense into gas clouds (nebulas)

Eagle Nebula (gas cloud)
7,000 light-years from Earth
The left tower is 3 LY long.
One LY is 5,800,000,000 miles

Step 7

- The gas clouds evolve into stars.



Our Sun

Step 8

- Stars combine into billions & billions of galaxies!

A spiral galaxy

This is the Andromeda Galaxy, our nearest large neighbor galaxy.
NASA