Humans have always been curious about the universe...

https://www.pbs.org/video/futurestates-the-6th-world-a-future-friday-premiere/

WE ARE JUST AN ADVANCED BREED OF MONKEYS ON A MINOR PLANET OF A VERY AVERAGE STAR. BUT WE CAN UNDERSTAND THE UNIVERSE. THAT MAKES US SOMETHING VERY SPECIAL.

STEPHEN HAWKING

WHOISSTEPHENHAWKING.COM

When we try to pick out anything by itself,

we find it hitched to everything else in the

Universe.

- John Muir

Just a single drop in the vast cosmic ocean.

@PeteSkeptic

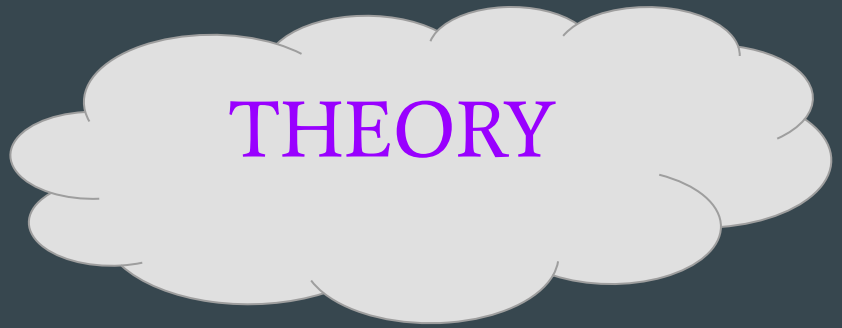
Think, Pair, Share:

Think about the experiences you have had that shape your understanding and curiosity of the universe. Were you told stories about the night sky? The sun? What do you think about when you look up on a clear night?

The Big Bang Theory

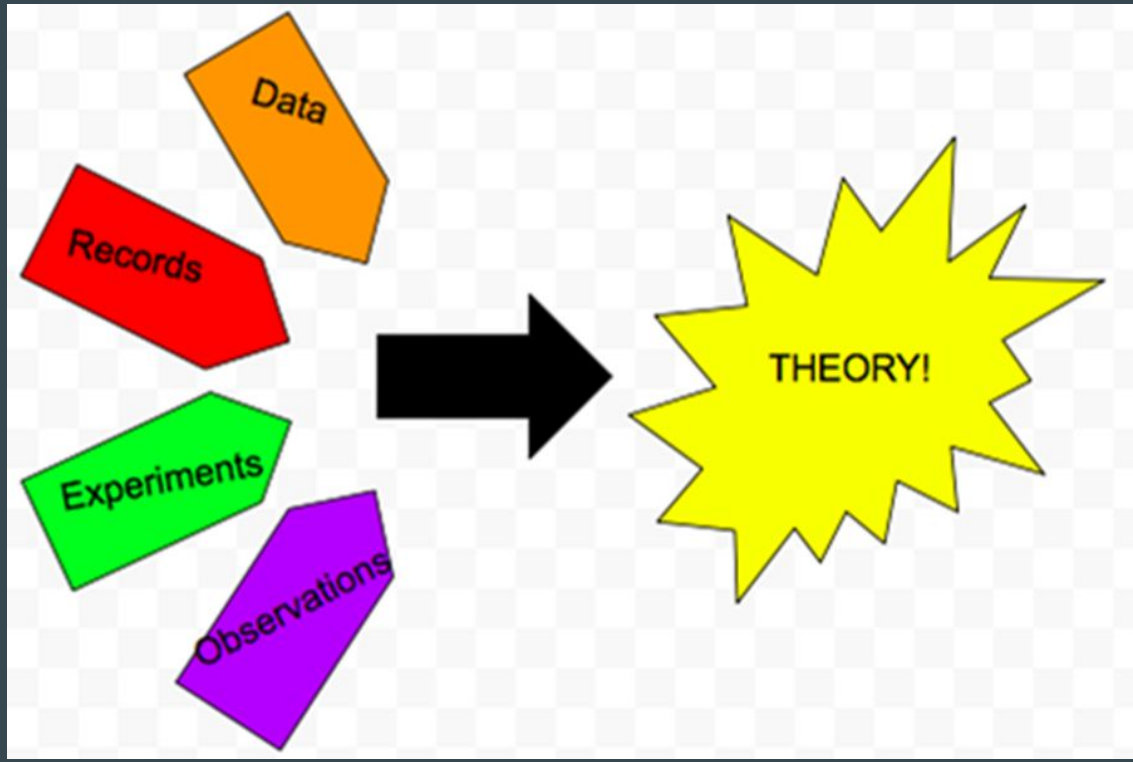
...

Partner Brainstorm: What is a theory?



A THEORY IS...

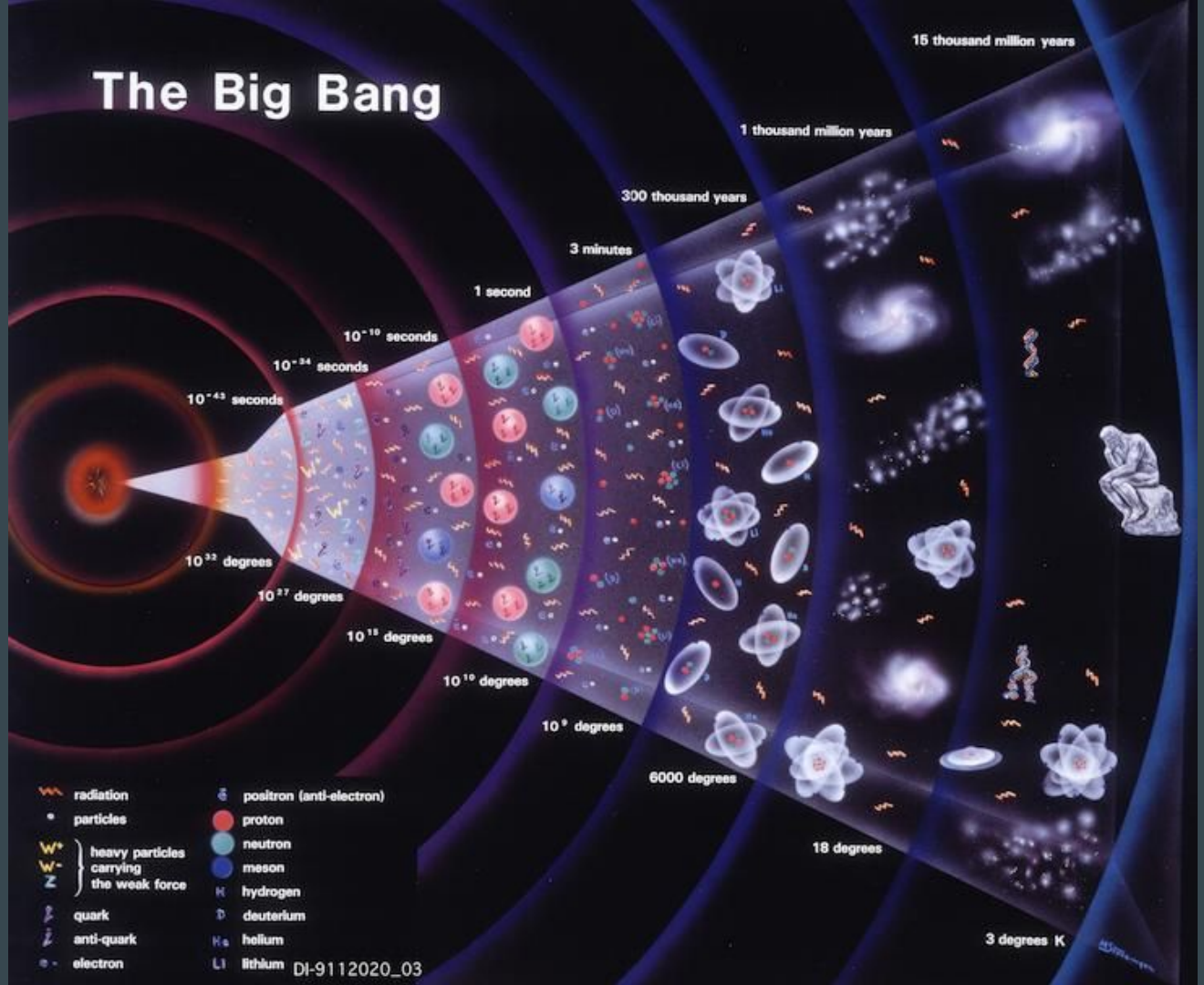
- An explanation of a phenomenon based on many observations and investigations.
- Theories can be changed or discarded if new data arises that contradict the existing theory.



Timelapse of the Formation of the Universe

The Big Bang Theory

- George Lemaitre (a priest and physics professor) proposed the theory of the expanding universe.
- 13.8 billion years ago, violent expansion occurred from a single point, the size of an atom.
- All matter and space were created; first quarks, electrons, protons, neutrons, atoms and larger elements.

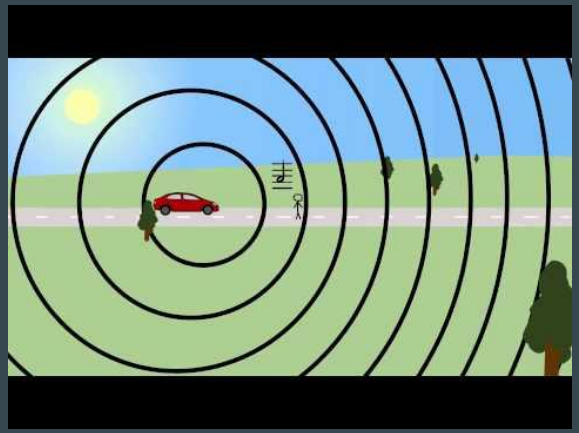

The Big Bang
15 thousand million years
1 thousand million years
300 thousand years
3 minutes
1 second
10^{-10} seconds
10^{-34} seconds
10^{-43} seconds
10^{32} degrees
10^{27} degrees
10^{15} degrees
10^{10} degrees
10^{9} degrees
6000 degrees
18 degrees
3 degrees K
radiation
particles
W+
W-
Z
heavy particles carrying the weak force
quark
anti-quark
electron
positron (anti-electron)
proton
neutron
meson
H hydrogen
D deuterium
He helium
Li lithium
DI-9112020_03

3 Pieces of Evidence for The Big Bang Theory:

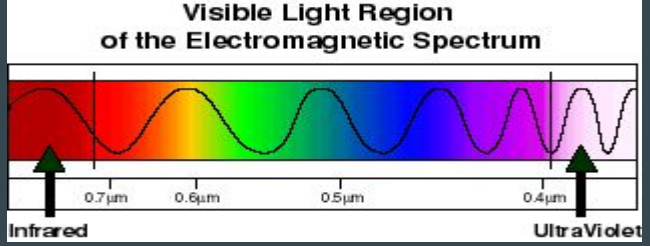
1. Redshift of galaxies
2. Cosmic microwave background (CMB) radiation
3. Elemental composition of our universe

1. Redshift of galaxies

- Doppler Effect: (Tub of water and moving pencil demo)
  - Example: ambulance siren
    - Moving towards you, sounds waves compressed, shorter wavelength = higher pitch
    - Moving away from you, sound waves lengthened, longer wavelength = lower pitch



1. Redshift of Galaxies

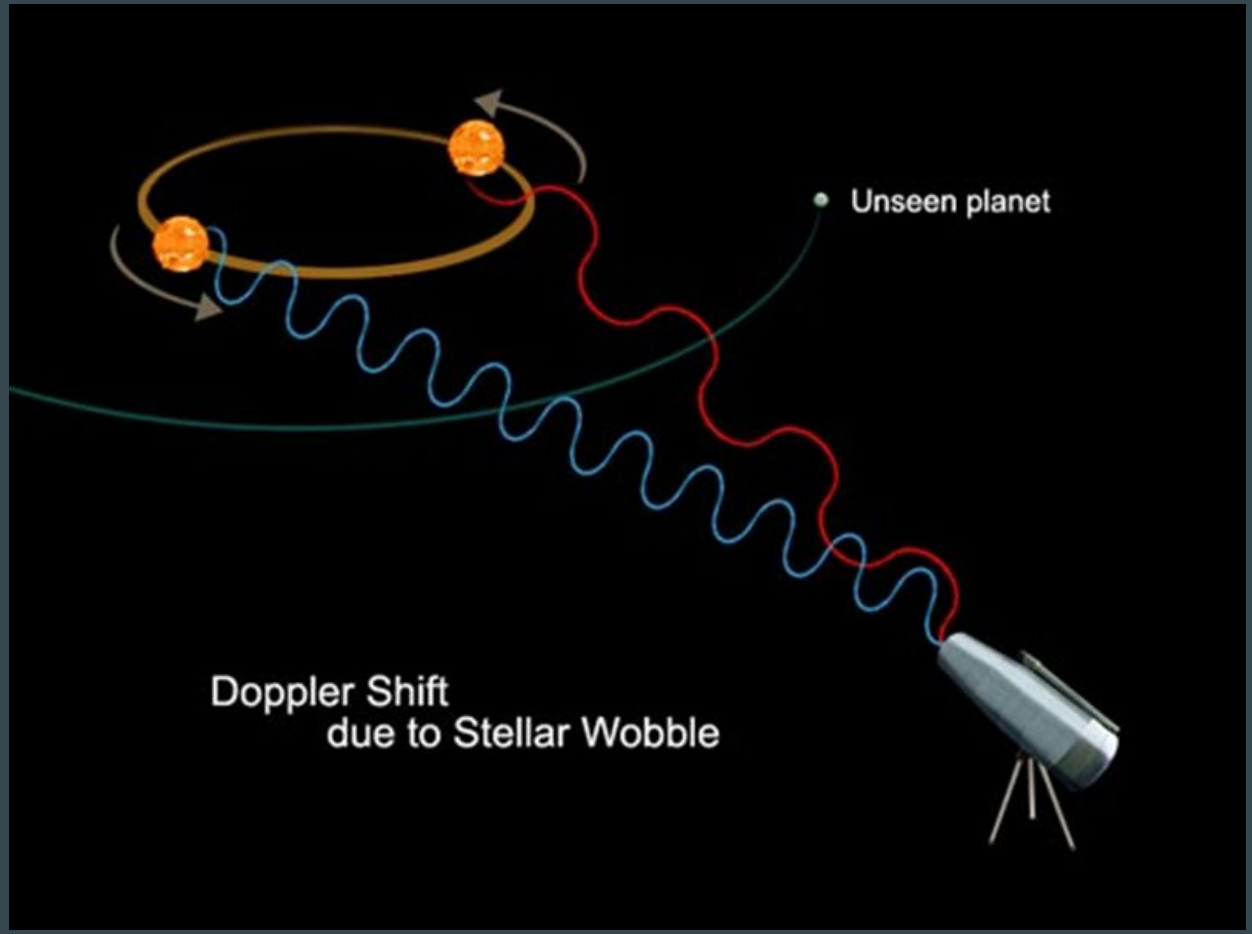


- Doppler effect with light waves: remember light waves with different wavelengths are different colours (ROYGBIV)

- Edwin Hubble (American astronomer) noticed that the spectral lines of galaxies were displaced from their normal positions (Doppler Effect).

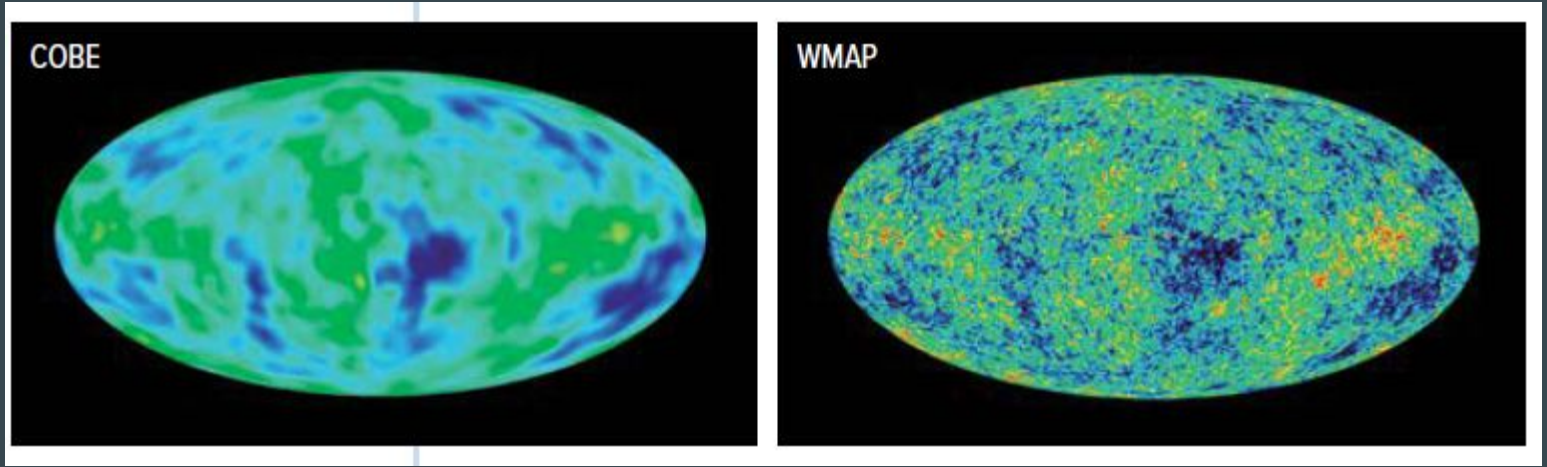
- He noticed that the spectral lines of most distant galaxies are **redshifted**
  - Redshifted: for objects moving away from an observer (wavelengths lengthened towards red end)
  - Blueshifted: for objects moving toward an observer (wavelengths shortened towards blue end)
- Textbook page 355 - example of redshift and blueshift spectral lines

- This means that most galaxies are moving AWAY from us and each other (evidence the universe is expanding)


Unseen planet
Doppler Shift
due to Stellar Wobble

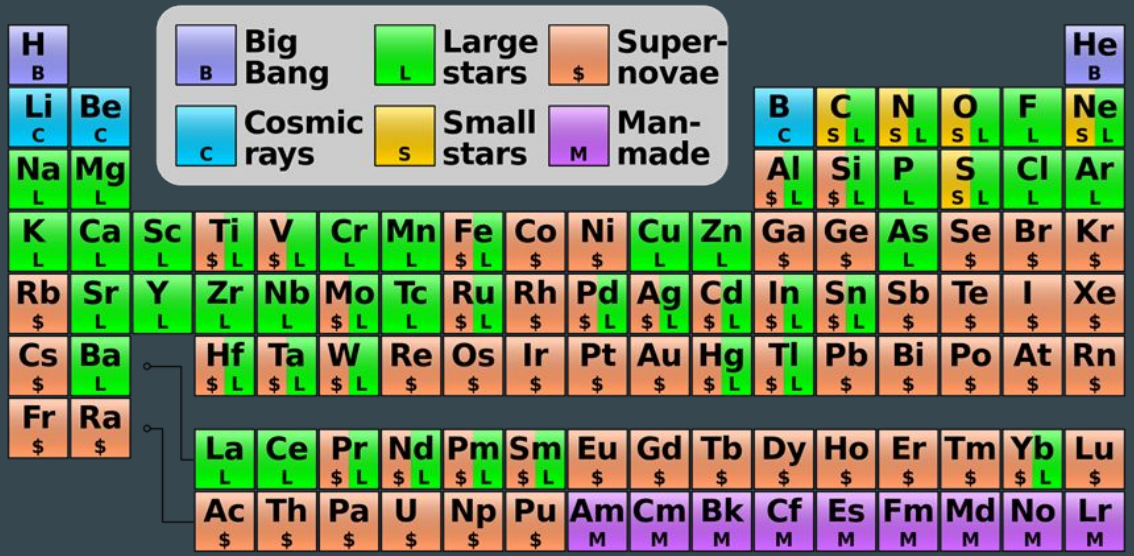
2. Cosmic Microwave Background (CMB) Radiation

- Radiation left over from the big bang
- COBE (COsmic Background Explorer) and WMAP (Wilkinson Microwave Anisotropy Probe) are NASA satellites that measure cosmic microwave background radiation.



3. The Elemental Composition of our Universe

- The matter in the universe is about 75% hydrogen & 25% helium.
- The abundance of H & He supports a particular process of past atomic creation, where the larger elements formed from the smaller elements.



Summary

- The big bang theory states the universe began the size of an atom and violently exploded outwards, eventually cooling and creating larger atomic elements.
- Hubble's galaxy redshift observations shows that most galaxies are moving away from each other.
- The distribution of cosmic microwave background radiation extends in all directions of the universe, which verifies predictions of universe cooling from a titanic, rapid expansion.
- The abundance of lighter elements in the Universe, which suggests that these first elements (hydrogen and helium) were formed at the Big Bang and are the precursors for all other elements.