Evidence for the Big Bang Theory

HAVE YOUR CORNELL NOTES HANDY!

"In the very beginning, there was a void, a curious form of vacuum, nothingness containing no space, no time, no matter, no light, no sound. Yet the laws of nature were in place and this curious vacuum held potential. A story logically begins at the beginning, but this story is about the universe and unfortunately there are no data for the beginnings—none, zero. We don't know anything about the universe until reaches the mature age of a billion of a trillionth of a second. That is, some very short time after creation in the big bang. When you read or hear anything about the birth of the universe, someone is making it up—we are in the realm of philosophy. Only God knows what happened at the very beginning."

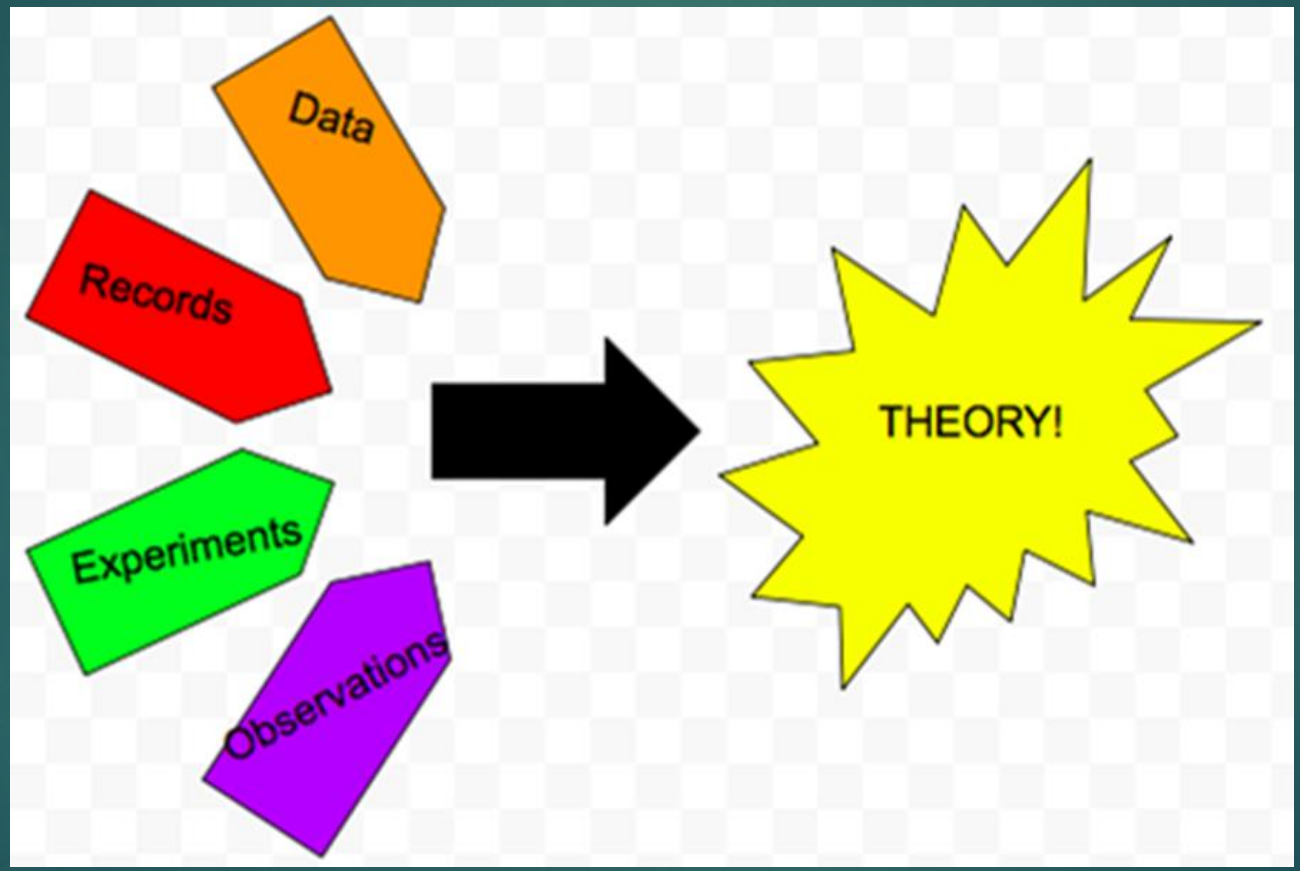
--Taken from *The God Particle* by Leon Lederman, a Nobel Prize winner

Learning Goal:

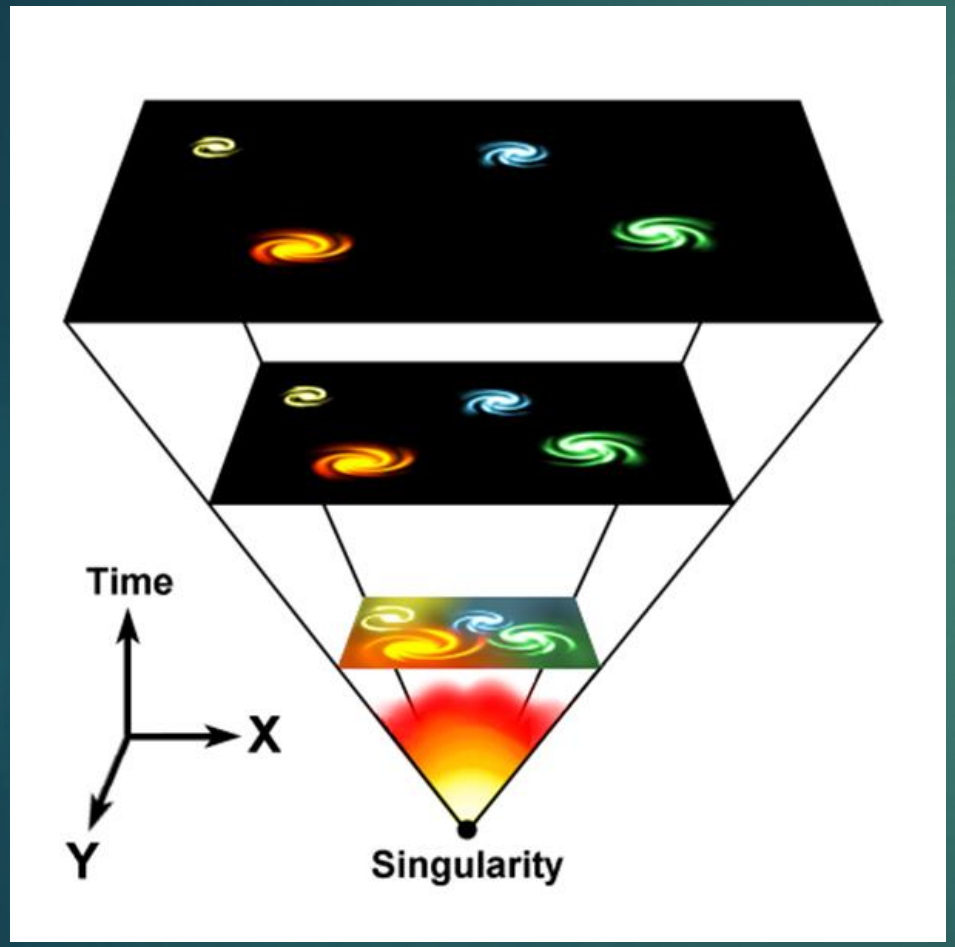
- By the end of this lesson, you will be able to explain three pieces of evidence for the Big Bang Theory:

1. Cosmic Microwave Background Radiation
2. Redshift of galaxies
3. Elemental composition of our universe

Let's Review… A Theory

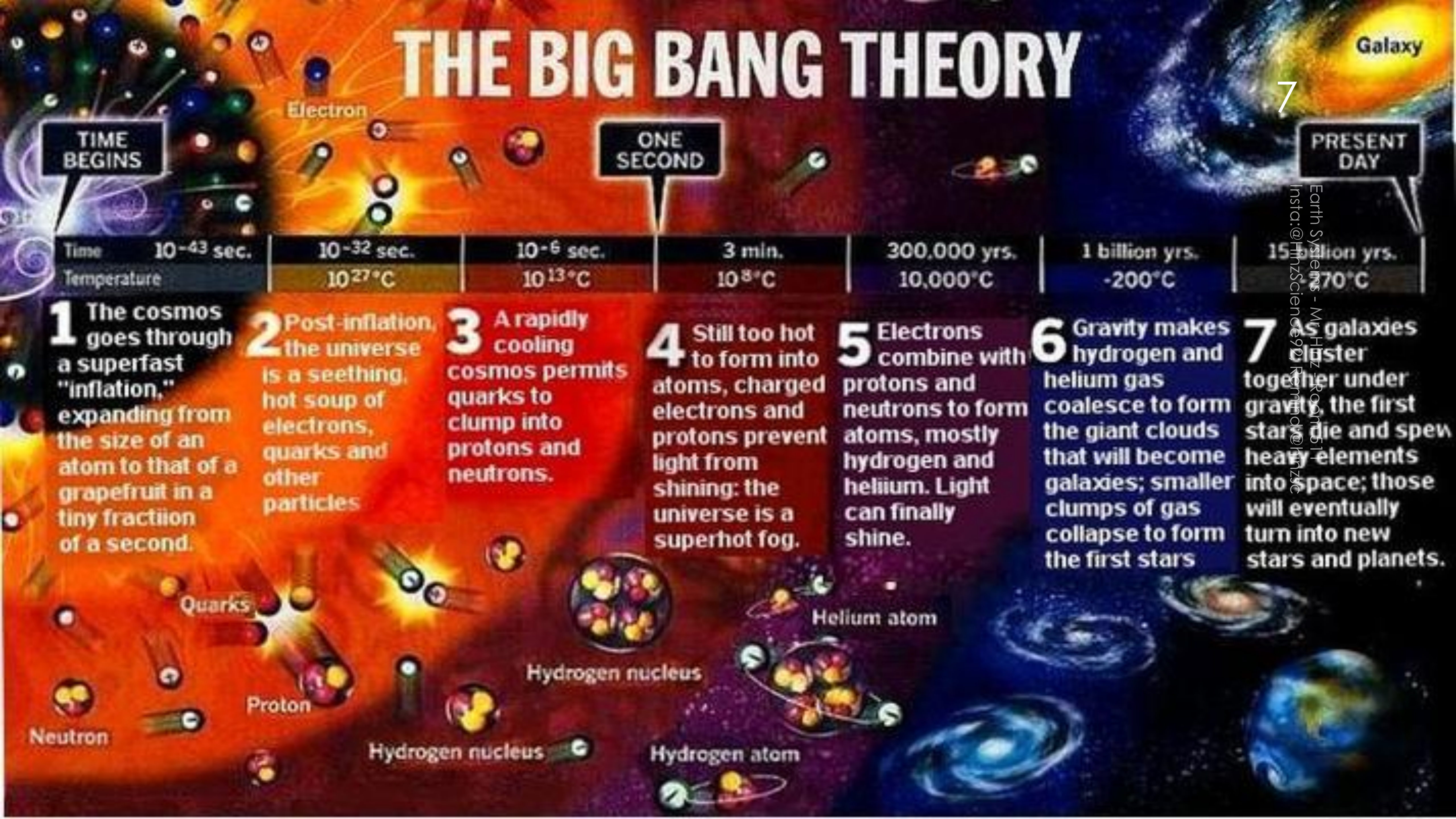


What is the Big Bang Theory?



- 1920's - George Lemaitre (a priest and physics professor)
- Proposed the theory of the expanding universe.
- It started from a single point – **The Singularity**
- 13.82 billion years ago, violent expansion occurred from a single point, the size of an atom.
- All matter and space were created

*The "Big Bang" was a name (mockingly) given to Lemaitre's idea – and it stuck ☺



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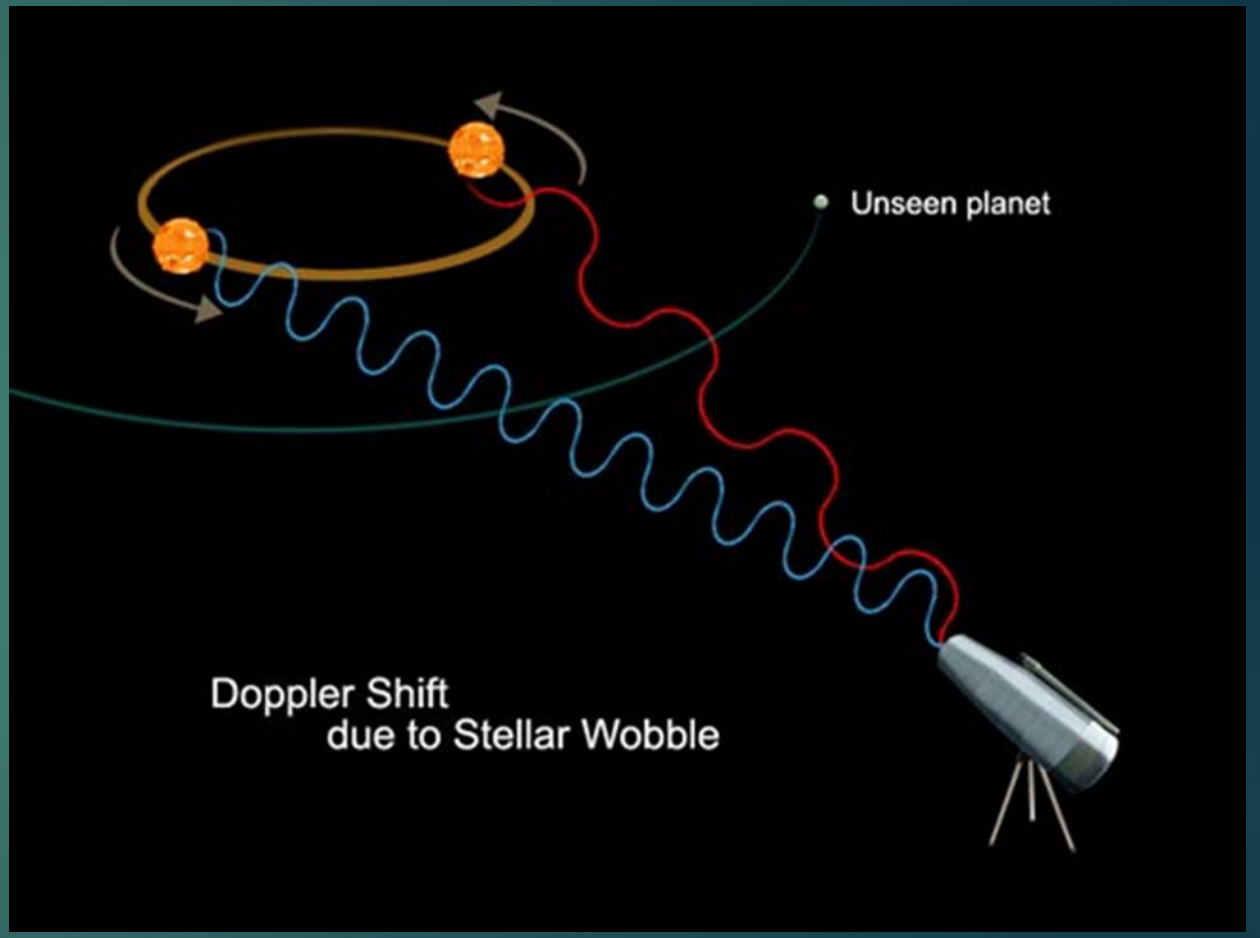
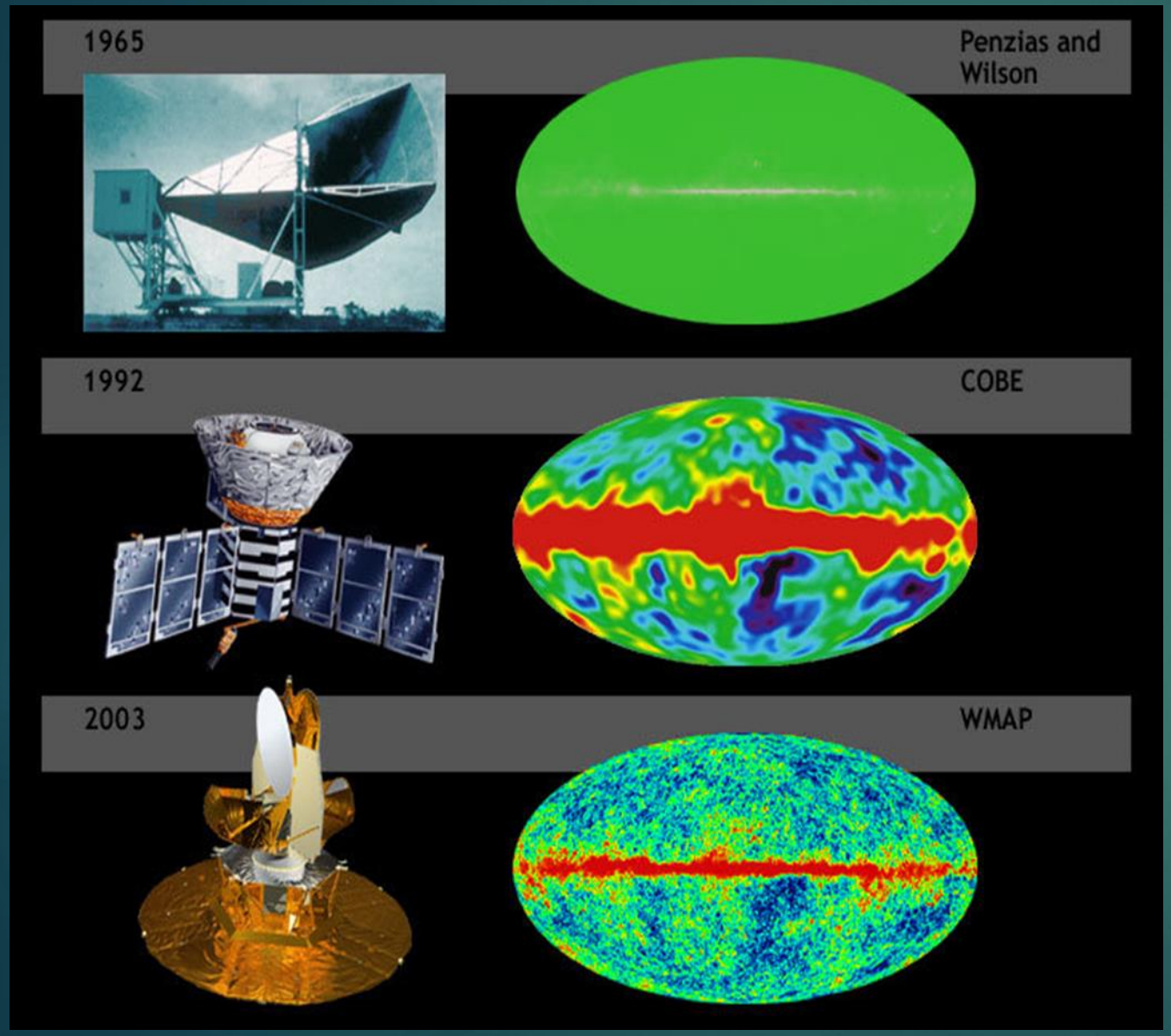
Edwin Hubble – Red Shift of Galaxies

- 1929 - Studied light given off by galaxies.
- Light shifted to the red end of the EM spectrum.
- Proposed **Hubble's Law**
  - "The rate at which a galaxy is moving is directly proportional to its distance from us."
  - The farther away a galaxy is from us, the faster it travels away from us.



The universe is expanding

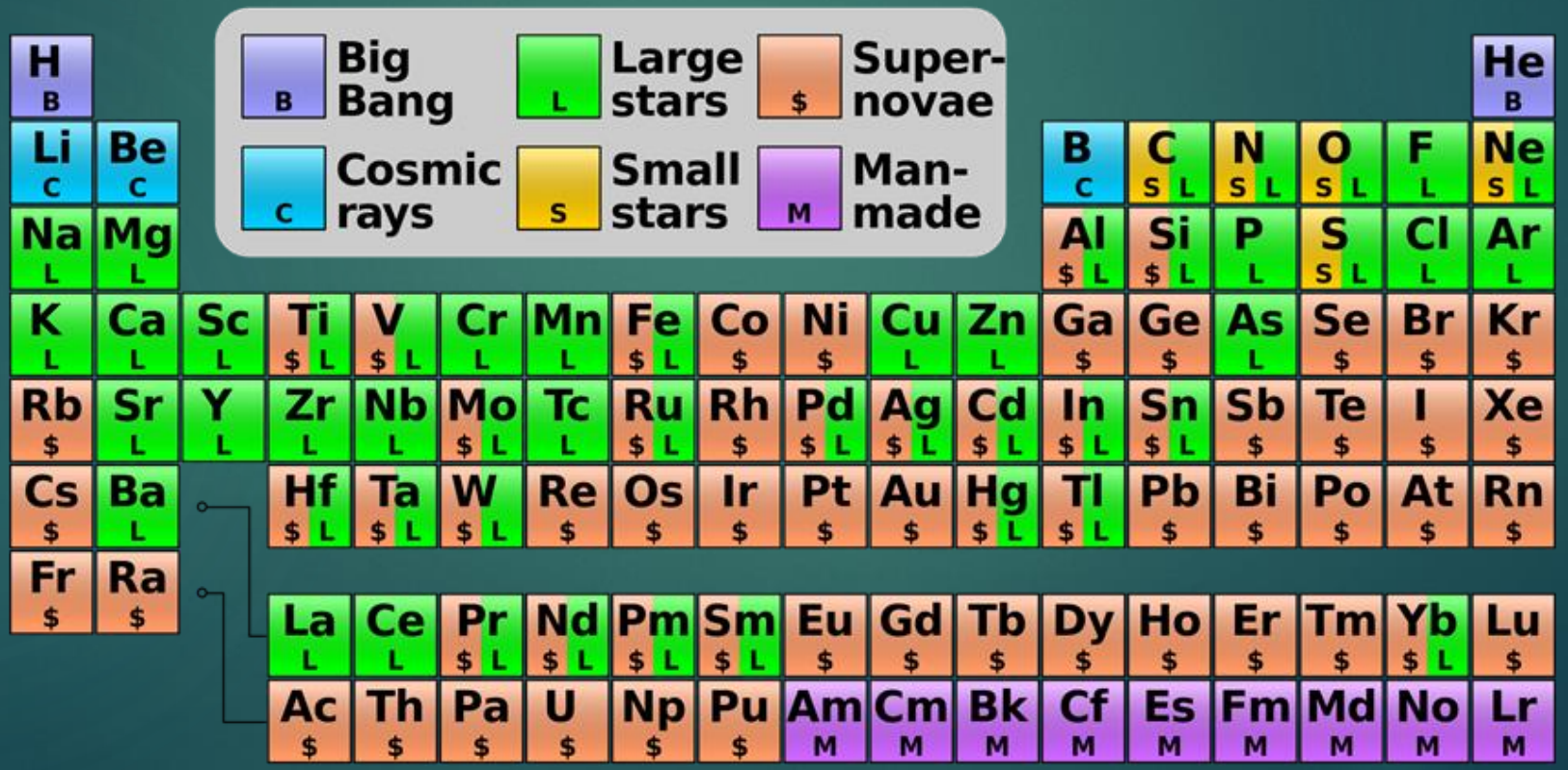
Cosmic Microwave Background Radiation



- CMB is the "after glow" or "leftovers" from the big bang that permeates (spreads) in all directions of the universe.
- CMB was leftover 'heat' in the form of microwave radiation, which was still cooling from the Big Bang
- The amount of cooling says how far the light has travelled, which determined the age of the universe: 13.82 billion years.

Mixture of Elements

- 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:

  "The universe began the size of an atom and violently exploded outwards, eventually cooling and creating larger atomic elements."

1. Expanding Universe: Galaxy red shift shows that they are moving away from each other.
2. CMB: Cosmic microwave background radiation extends in all directions of the universe, which verifies that the universe is cooling from a large, rapid expansion.
3. Primordial Elements: The abundance of small elements (H and He) in the Universe suggests that they first formed at the Big Bang and are the precursors for all other elements.