



THE ORIGIN OF THE LIGHT ELEMENTS

BIG BANG THEORY

- One of the most popular models describing the early universe
- First proposed (though not named) by Abbé Georges Edouard Lemaître
- States that the universe emerged from a state of:
 - Enormous density
 - Extremely high energy



ORIGIN OF THE TERM BIG BANG

- The term “Big Bang” was coined in 1949
- Introduced by British astronomer Fred Hoyle
- The theory was developed in response to Albert Einstein’s work



EINSTEIN'S EARLY UNIVERSE MODEL (1917)

- **Proposed that the universe is:**
 - **Spatially bound (finite)**
 - **Uniform in matter distribution on very large scales**
- **This model led to various cosmological theories**
- **One of these models inspired Lemaître**



LEMAÎTRE'S CONTRIBUTION (1927)

- Argued that Einstein's model was not physically realistic
- Small variations in uniformity would cause:
 - Expansion
 - Contraction
- Proposed that the universe is:
 - Constantly expanding
 - Continuously cooling
- Universe is not static



EVIDENCE SUPPORTING THE BIG BANG THEORY

- **Three key observational evidences:**

1. Hubble or cosmic expansion

2. Cosmic microwave background (CMB)

3. Primordial or Big Bang nucleosynthesis (BBN)



MISCONCEPTION ALERT

- The Big Bang theory is not about the origin of the universe
- It is a model describing the early universe
- There already existed:
 - A packed state of density and energy
- It was not an explosion of matter
- NASA describes it as:
“A simultaneous appearance of space everywhere in the universe”



SCIENTIST OF THE TIME – GEORGES LEMAÎTRE

- Belgian cosmologist and priest
- Pioneer of the Big Bang model
- His work, combined with Hubble's observations:
- Increased interest in cosmology
- Led to Big Bang cosmology



LIFE AND CAREER OF GEORGES LEMAÎTRE

- Born in 1894, Charleroi, Belgium
- Interested in both theology and science
- Paused studies during World War I
- Studied theoretical physics afterward
- Worked with astronomer Arthur Eddington



ACADEMIC ACHIEVEMENTS OF LEMAÎTRE

- Described as bright, clear-sighted, and fast-learner
- Visited astronomical centers in the USA
- Earned a PhD in Physics from MIT
- Became a professor at age 31
- Taught at Catholic University of Louvain



LATER LIFE OF LEMAÎTRE

- Served as professor until World War II
- Became President of the Pontifical Academy of Sciences
- Served from 1960 until his death in 1966



EDWIN HUBBLE'S DISCOVERY



- **Early 1930s at Mount Wilson Observatory, California**
- **Used the 100-inch Hooker Telescope**
- **Identified Cepheid variable stars**
- **Studied spiral nebulae (now known as galaxies)**



HUBBLE'S LAW

- Discovered galaxies beyond the Milky Way
- Formulated with assistant Milton Humason

States:

- Galaxies move away from each other
- Speed is proportional to distance
- First observational evidence of the Big Bang

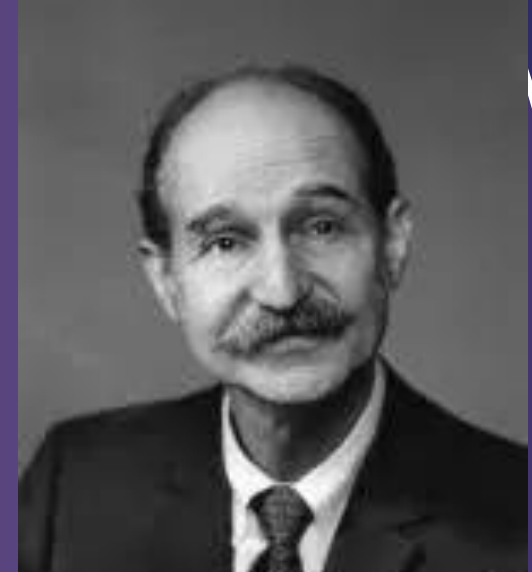


PREDICTION OF COSMIC MICROWAVE BACKGROUND

In the 1940s:

- George Gamow
- Robert Herman
- Ralph Alpher

-Predicted an
afterglow of
radiation
-Result of the
universe cooling
after the Big Bang



DISCOVERY OF THE CMB

- **Detected in 1964**

Discovered by:

-Arno Penzias

-Robert Wilson

- **Average temperature: 2.7 Kelvin**
- **Second most significant observation after Hubble's Law**



ACCIDENTAL DISCOVERY OF THE CMB

- **Penzias and Wilson detected unexplained radio noise**

Princeton scientists:

- **Robert Dicke**
- **Jim Peebles**
- **David Wilkinson**
- **Realized noise was cosmic microwave background radiation**



NOBEL PRIZE RECOGNITION

- **Two research groups published joint results**
- **Princeton group confirmed the findings**

In 1978, Penzias and Wilson:

- **Received the Nobel Prize in Physics**



PRIMORDIAL NUCLEOSYNTHESIS

Gamow, Herman, and Alpher proposed:

- **Nuclear reactions occurred in early universe**
- **Extremely high temperature allowed fusion**
- **Process called nucleosynthesis**

