Big Bang

Dana Desonie, Ph.D.
Learning Objectives

- Explain and give evidence supporting the Big Bang theory.
- Describe what occurred after the Big Bang.

How did everything begin in the Big Bang?

The time when the Universe began is the explosion known as the Big Bang. Everything in the Universe was part of that explosion, although not in its current form.

The Big Bang Theory

There is a great deal of evidence that the Universe started with a big bang. The Big Bang theory is the most widely accepted cosmological explanation of how the Universe formed. Think about the expanding Universe, then reverse it. If we start at the present and go back into the past, the Universe gets smaller. What is the end result of a contracting Universe? A point.
According to the Big Bang theory, the Universe began about 13.7 billion years ago. Everything that is now in the Universe was squeezed into a point. It was all in a single, hot, chaotic mass. Then an enormous explosion—a big bang—took place. The big bang caused the Universe to start expanding rapidly. All the matter and energy, even space itself, came out of this explosion (Figure 1.1).

What came before the Big Bang? There is no way for scientists to know, since there is no remaining evidence.

**After The Big Bang**

In the first few moments after the Big Bang, the Universe was unimaginably hot and dense. As the Universe expanded, it became less dense. It began to cool. After only a few seconds, protons, neutrons, and electrons could form. After a few minutes, hydrogen came together. There was so much energy that nuclear fusion began. This created helium.

Clumps of matter were held together by gravity. Eventually, these clumps formed stars. There are now countless trillions of stars, billions of galaxies, and other structures that form the visible Universe.

The galaxies at the edge of the Universe are a great distance away. But they are something else that is distant. Because it takes so long for light from so far away to reach us, they are also very far back in time (Figure 1.2).
Background Radiation

The Big Bang hypothesis was not immediately accepted. But an important line of evidence for the Big Bang was discovered in 1964. In a static Universe, the space between objects should have no heat at all. The temperature should measure 0 K (Kelvin is an absolute temperature scale). But two researchers at Bell Laboratories used a microwave receiver to measure the background radiation in the Universe. They discovered that it is not 0 K, but 3 K (Figure 1.3). This tiny amount of heat is left over from the Big Bang. Nearly all astronomers and cosmologists now accept the Big Bang theory.

Science Friday: How to Make Quark Soup

What is a quark soup? Why is understanding a quark soup important to understanding the early universe? In this video by Science Friday, physicist Paul Sorensen explains what a quark soup is and some of the information it tells us about the early universe.

Summary

- The Big Bang theory states that the Universe began as a point and expanded outward.
- No one can know what came before the Big Bang.
- The tiny bit of background radiation in the Universe is energy remaining from the Big Bang.

Review

1. If the Universe is now expanding, why must it once have been a point?
2. What evidence is there that the Universe began in a big bang?
3. What happened in the first minutes after the Big Bang?
Explore More

Use the resource below to answer the questions that follow.

1. When did the Big Bang occur?
2. What did not exist before the Big Bang?
3. Describe the early Universe.
4. What was created at the Big Bang?
5. What happens when matter and antimatter collide?
6. Why is there a Universe at all?
7. When did the Universe become visible?

References

2. Courtesy of NASA, ESA, S. Beckwith (STScI) and the HUDF Team. Far away objects show us what the Universe was like not long after the Big Bang . Public Domain
3. Courtesy of NASA/WMAP Science Team. One piece of evidence that supports the Big Bang theory is background radiation . Public Domain