

# THE BEGINNING OF THE UNIVERSE

Universe is the name that we use to describe the collection of all the things that exist in space. It is made of billions of stars and planets and enormous clouds of gas separated by a gigantic empty space which is called the universe.

Astronomers can use telescopes to look at very distant galaxies. This is how they see what the universe looked like a long time ago. This is because the light from distant parts of the universe takes a very long time to reach us. From these observations, it seems the physical laws and constants of the universe have not changed.

Further observational improvements led to the realization that our Solar System is located in the Milky Way galaxy, which is one of many galaxies in the Universe. It is assumed that galaxies are distributed uniformly and the same in all directions, meaning that the Universe has neither an edge nor a center.

Discoveries in the early 20th century have suggested that the Universe had a beginning and that it is expanding at an increasing rate. Roughly eighty percent of mass in the Universe appears to exist in an unknown form called dark matter which cannot be directly observed.

Many people in history had ideas to explain the universe. Most early models had the Earth at the center of the Universe. Some ancient Greeks thought that the Universe has infinite space and has existed forever. They thought it had a set of spheres which corresponded to the fixed stars, the Sun and various planets. The spheres circled about a spherical but unmoving Earth.

Our universe was born about 13.7 billion years ago in a massive expansion that blew space up like a gigantic balloon. That, in a nutshell, is the Big Bang theory, which virtually all cosmologists and theoretical physicists endorse. The evidence supporting the idea is extensive and convincing. We know, for example, that the universe is still expanding even now, at an ever-accelerating rate.

Scientists have also discovered a predicted thermal imprint of the Big Bang, the universe-pervading cosmic microwave background radiation. And we don't see any objects obviously older than 13.7 billion years, suggesting that our universe came into being around that time.



**Halley's Comet** Halley, officially designated 1P/Halley is a short-period comet visible from Earth every 74–79 years.

As a whole, the universe is growing and the temperature is falling as time passes. Cosmology is the study of how the universe began and its development. Scientists who study cosmology agree that the Big Bang theory matches what they have observed so far.

Fred Hoyle called the theory the "Big Bang" on his radio show. He did not believe the Big Bang was correct. Scientists who did not agree with him thought the name was funny and decided to use it.

## Chronology and the Big Bang

Scientists base the Big Bang theory on many different observations. The most important is the redshift of very far away galaxies.

Redshift is the Doppler effect occurring in light. When an object moves away from Earth, its color rays look more similar to the color red than they actually are, because the movement stretches the wavelength of light given off by the object.

Scientists use the word "red hot" to describe this stretched light wave because red is the longest wavelength on the visible spectrum. The more redshift there is, the faster the object is moving away. By measuring the redshift, scientists proved that the universe is expanding, and they can work out how fast the object is moving away from the Earth.

With very exact observation and measurements, scientists believe that the universe was a singularity approximately 13.8 billion years ago. Because most things become colder as they expand, scientists assume that the universe was very small and very hot when it started.

At that point, they believe, the universe underwent an extremely brief and dramatic period of inflation, expanding faster than the speed of light. Soon, scientists may know for sure which theory — inflation or the cyclic model — is a better representation of reality.

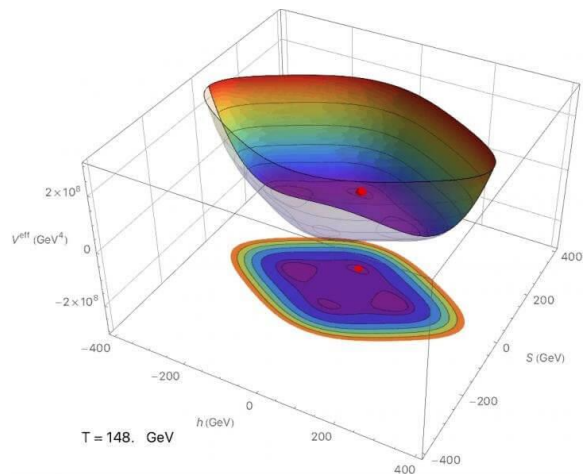
For example, inflation likely would produce much stronger gravitational waves than an ekpyrotic "bounce," Filippenko said. So researchers are looking for any signs of these theoretical distortions of space time, which have yet to be observed.

The European Space Agency's Planck satellite, which launched in 2009.

Other observations that support the Big Bang theory are the amounts of chemical elements in the universe. Amounts of very light elements, such as hydrogen, helium, and lithium seem to agree with the theory of the Big Bang.

Scientists also have found "cosmic microwaves background radiation". This radiation is known as radio waves, and they are everywhere in the universe. This radiation is now very weak and cold, but a long time ago it was very strong and very hot.

It could be said that time had no meaning before the Big Bang. If the Big Bang was the beginning of time, then there was no universe before the Big Bang, since there could not be any "before" if there was no time! Other ideas state that the Big Bang was not the beginning of time 13.8 billion years ago.

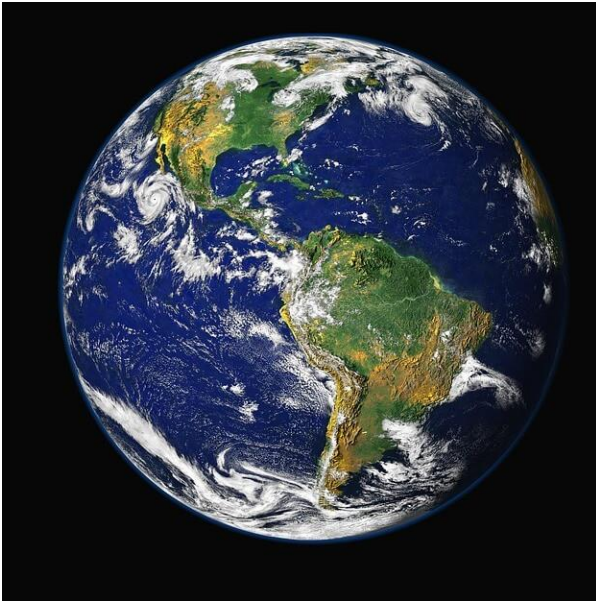


**Dark Matter** is a hypothetical type of matter distinct from baryonic matter (ordinary matter such as protons and neutrons), neutrinos and dark energy.

## Features of the model

The Big Bang theory depends on two major assumptions: the universality of physical laws and the cosmological principle. The cosmological principle states that on large scales the universe is homogeneous and isotropic.

These ideas were initially taken as postulates, but today there are efforts to test each of them. For example, the first assumption has been tested by observations showing that largest possible deviation of the fine structure constant over much of the age of the universe is of order  $10^{-5}$ .



**Earth and Moon** The history of Earth concerns the development of planet Earth from its formation to the present day. Nearly all branches of natural science have contributed to the understanding of the main events of Earth's past.

If the large-scale universe appears isotropic as viewed from Earth, the cosmological principle can be derived from the simpler Copernican principle, which states that there is no preferred (or special) observer or vantage point.

To this end, the cosmological principle has been confirmed to a level of  $10^{-5}$  via observations of the CMB. The universe has been measured to be homogeneous on the largest scales at the 10% level.

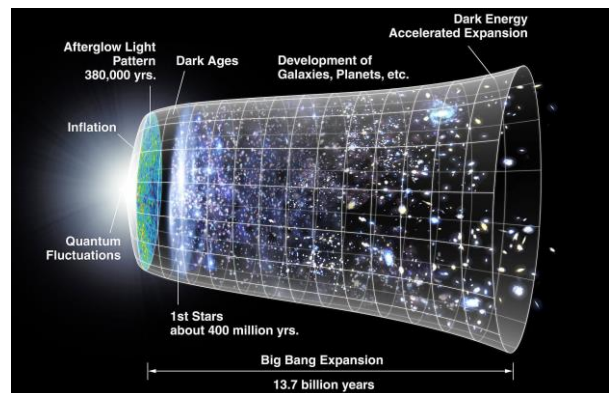
## Observational evidence

The earliest and most direct observational evidence of the validity of the theory are the expansion of the universe according to Hubble's law (as indicated by the redshifts of galaxies), discovery and measurement of the cosmic microwave background and the relative abundances of light elements produced by Big Bang nucleosynthesis.

More recent evidence includes observations of galaxy formation and evolution, and the distribution of large scale cosmic structures. These are sometimes called the "four pillars" of the Big Bang theory.

Precise modern models of the Big Bang appeal to various exotic physical phenomena that have not

been observed in terrestrial laboratory experiments or incorporated into the Standard Model of particle physics.



**Timeline of the metric expansion of space** where space is represented at each time by the circular sections. On the left, the dramatic expansion occurs in the inflationary epoch; and at the center, the expansion accelerates.

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Of these features, dark matter is currently subjected to the most active laboratory investigations.