THE HISTORY AND FATE OF THE UNIVERSE

Eight major stages in the evolution of the universe are illustrated below. The Big Bang occurred everywhere in the universe. Here one region has been illuminated and followed through time. The expansion is far greater than can be shown here.

**Cosmology and Relics of History**

**Cosmology**
The study of the universe as a whole. As it expands, the universe cools and becomes more distant. As temperatures lower, they are able to detect more distant objects. On large scales, the universe looks the same in all directions and at all places. There is no preferred direction. Our current understanding of the early universe is called the Big Bang model. Much more will be learned from astronomical observations and from acceleration-based experiments in the coming years.

**Relics of the Early Universe**

A relic from the Early Universe

**The Cosmic Microwave Background (CMB)** is the remnant of light from the hot early universe. They are smoothed by the expansion of space. In particular, the CMB is the same in all directions, where you look (it is isotropic). The uniformity of the CMB (shown in figure) is evidence of the seeds that later formed galaxies and larger structure.

**Age of the Universe**

A prediction from the big bang model is that the age of the universe is about 14 billion years from adding up the expansion and the lifetimes of stars and by using measurements.

**History of the Universe**

Three major eras in the expansion history followed the hot, dense conditions of the earliest universe. During each era, the emphasis was on the conditions of the universe at that time.

**Era 1: Acceleration Inflation**

**Inflation**

**Inflation**

Observations suggest that the very early universe expanded incredibly rapidly, multiplying its size by a factor of 10 billion. This is called inflation. The rate of inflation is about 1 second inflation expanded each part of space by a factor of 10 billion. Before inflation, the density of matter in the universe was smooth. The inflationary model proposes that the universe expanded rapidly to a smaller size and then began to expand and form galaxies and other structures.

**Nucleosynthesis**

The first stage of the universe, 10 minutes after the Big Bang, is the time when matter and energy are first separated. At this time, the universe is still dominated by matter and energy, and the radiation is very hot. Nucleosynthesis occurs, or the synthesis of matter, in the universe, leading to the formation of elements up to iron.

**First Stars and Galaxies**

**Stars**

The first stars and galaxies formed about 100 million years after the Big Bang, and they were the first sources of light in the universe.

**Cosmic Address**

Our sun is one of 10 billion stars in the Milky Way galaxy, which contains more than 100 billion galaxies, including our local supercluster. The Milky Way galaxy is a spiral galaxy, spanning 100,000 light-years in width, with a diameter of 100,000 light-years. The universe is thought to contain about 100 billion galaxies. Each galaxy contains about 100 billion stars, and each star contains about 100 billion atoms.