THE ORIGIN AND THE FUTURE OF THE UNIVERSE

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INTRODUCTION

What is the Universe made of ? How did the Universe come to be the way it is? How old is the Universe? And what is the ultimate fate of the Universe? Scientists and Philosophers have long been asking these questions. But we still do not know anything that could be called the final answer. But progress in answering these questions has rapid in the last few decades.

The scientific study of large scale properties of the Universe as a whole is called **cosmology**. Cosmology uses the scientific method to understand the origin, evolution and ultimate fate of the Universe. In the mid 1950's a new theory of how the Universe formed emerged. This new theory is known as The **Big Bang theory**. The Big Bang cosmological theory is almost universally accepted as the most reasonable theory for the origin and evolution of the Universe. In fact it is so well accepted that virtually every media article, story or program that touches on the subject of astronomy or cosmology presents the Big Bang theory as a virtually proven fact. Most of the scientists of the world accept the Big Bang theory as a scientific fact.

According to the Big Bang theory, all the matter, energy and space that exist were, at some time in the past, compressed in to a single point. The compressed state of matter, energy and space was then blown apart like immense explosion, called the Big Bang, giving all the observable matter and space. Scientists believe that light nuclei like hydrogen, helium, lithium began to form one minute after the Big Bang. After these formations other matter began to form and atoms of hydrogen and helium, under the influence of gravity started to clump together, starting the formation of galaxies and starts

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WHERE DID THE BIG BANG OCCUR?

From the point of view of our present universe, there is no position in space to which we can point and say the Big Bang happened there. It happened everywhere. The space appeared after the Big Bang. Before the Big Bang there was no space. In fact, there was 'no before the Big Bang'. The time also started with the Big Bang. Everything that we see in the universe including the space and time began with that creation event. The Big Bang is the beginning of space and time itself, i.e. space and time both are the part of that creation.

HUBBLE LAW

In 1920s, American astronomer Edwin Hubble found the strange correlation between the distance and speed of the galaxies. He analyzed the motion of galaxies by using the shifting of the wavelength of the light (**red shift**) emitted from the galaxies. He found that all the galaxies are moving away from us and the speed of the galaxies increases proportional to the distance; i.e. recession speed = H_0 X distance of the galaxy, where H_0 is a constant called '**Hubble constant**'.

According to Hubble's finding all the galaxies are moving away with increasing velocity. We interpret the recession of the galaxies to mean that the universe is expanding. Hubble law is consistent with the hypothesis that the universe began with the Big Bang and that has been expanding for ever.

HOW OLD IS THE UNIVERSE?

Until recently, scientists estimated that the Big Bang occurred between 12 and 14 billion years ago. Scientists estimate the age of the universe in two ways: 1) by looking for the oldest stars and 2) by measuring the expansion rate of the universe.

Scientists can place the lower limit to the age of the universe by studying **globular clusters**. Globular clusters are a dense collection of roughly a million stars. All of the stars in a globular cluster formed at roughly the same time, thus they can serve as **cosmic clocks**. The study of the globular cluster suggests that the oldest globular clusters are between 11 and 18 billion years old. The Universe is, thus, at least as old as the oldest globular clusters that resides in it.

An alternative approach to estimating the age of the Universe is to measure the Hubble constant. The Hubble constant is a measure of the current expansion

rate of the Universe. Many cosmologists are working hard to measure the Hubble constant using a variety of different techniques. Until recently, the best estimates of the Hubble constant with best value shows that the Universe is 12 and 14 billion years old.

WHAT IS THE UNIVERSE MADE OF?

All matter which we see are made up of protons, neutrons and electrons. Protons and neutrons are bound together into nuclei and atoms are nuclei surrounded by a full component of electrons. Hydrogen, helium, carbon, iron, lead, uranium and all matter which we see are composed of atoms. Scientists like to call all materials made up of protons, neutrons and electrons, the '**baryonic matter**'. Until about twenty years ago scientists thought that the Universe was composed almost entirely of this baryonic matter. However, in the past decades, there has been ever evidence accumulating that suggests there is something in the universe that we can not see and touch. Perhaps this may be the new form of matter. This mysterious matter is now called '**dark matter**'. Scientists estimate that 90 to 99 percent of the total mass of the universe is due to this dark matter.

WHAT IS THE ULTIMATE FATE OF THE UNIVERSE? WILL THE UNIVERSE EXPAND FOREVER OR RECOLLAPSE?

"Some say the world will end in fire, other say in Ice".

Just as Robert Frost imagined cosmologists also believe two possible fates for the Universe; endless expansion or the **Big Bang crunch**.

In fact, gravitational attraction between the objects plays an key role on this matter. Gravitational attraction between the objects should slow the expansion of the Universe; but by how much? If these attractions are strong enough, the Universe should expand more and more slowly, eventually stop, and then begin to contract. Finally the entire universe should be compressed to a single point and ready for another Big Bang to occur. On the other hand, if the gravitational forces are much weaker, they slow the expansion only a little and the universe should continue to expand forever.

This depends on the average density of the matter of the Universe. If the density of matter of the universe is greater than a certain density called **critical**

density the expansion eventually stop and make the universe contract again. This leads the end of the Universe to a hot crunch. If the average density of the matter of the Universe is equal to or less than the critical density, the expansion should continue forever. The value of the critical density is very small; it is roughly six hydrogen atoms per cubic meter. Scientists are trying to calculate the average density of the Universe. The current data suggest that the average density is less than or equal to the critical density. So the Universe will expand forever.

Moreover, the space in the Universe is increasing continuously but the matter in it is constant. As a result the average density of matter of the Universe is going on decreasing. This decrease in the density implies that the Universe expands forever.

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