EVOLUTION OF THE COSMOS

ADRIJA CHAKRABORTHY
Email ID: adrija.chakraborty2018@vitstudent.ac.in

Abstract
This document provides a brief discussion of the various theories and factors describing the evolution of the universe as a whole. We have discussed the various possibilities put forward by scientists concerning the formation of stars, galaxies, matter as well as the evolution of energy and extraterrestrial life. The document also throws light on the various problems we are facing today to answer some of the key questions about the evolution of the cosmos and how the unification of Physics can help us to solve these problems.
Keywords*: big bang, big crunch, red-shift, wormholes, general relativity, gravity.*

Introduction
The evolution of the universe – right from it's beginning, it's development and end – has been one of the most absorbing questions that human beings have thought of. We go about our daily activities, giving little thought to how the forces of nature work to give rise to sunrise and sunset, the lunar and solar eclipses, the changing of seasons, the formation of day and night and ultimately help to sustain our existence. Since the time, the earth-centric model was proposed by famous astronomers like Aristotle and Ptolemy, a number of theories have been proposed by several scientists for the beginning and end of the universe. In this paper, we wish to discuss some of those theories in detail.

The general theory of relativity together with quantum mechanics has been one of the most powerful tools to explain the mechanism of the evolution of the universe. Nevertheless, there are many discrepancies regarding the true nature of the universe as scientists still argue whether the universe did have a beginning or it existed all the time, whether it is static, chaotic, symmetrical or unsymmetrical, if it did have a beginning will it re-collapse again and what was there before the beginning of space and time, is it a universe or a multiverse that we live in and many more similar thought-provoking questions.

The answers to all these questions involve a thorough understanding of the nature of the infinitesimally small to the infinitely large. Recent breakthroughs in technology have given us valuable clues to answer these questions to some extent yet there is so much left to be discovered.

Another longstanding mystery is the presence of dark matter that occupies about 85% of the universe, along with the existence of black holes and gravitons. It is widely believed that all our misconceptions can be cleared and the mysteries can be unfolded if we are able to frame a complete unified theory of Physics that unifies all the fundamental forces of nature – the weak and the strong nuclear force, the electromagnetic force and the gravitational force. Out of these forces, the first three have been unified to form the Grand Unified Theory (G.U.T) whereas we have not been able to include gravity in it because the quantum theory of gravitons is not yet known.

The main difficulty of not being able to include gravity is that general relativity does not contain the main feature of quantum mechanics – the uncertainty principle. This makes the G.U.T unsatisfactory to explain the different phenomena of the universe. It may take us a long way to find a theory that unifies gravity with the other forces. Nevertheless, our deepest desire for knowledge is the sole justification for continuing this unending quest to completely understand the universe where we live.

ISBN: 978-93-92995-10-1

The reason for selecting this topic is to discuss the advantages and drawbacks of the various scientific theories that have been proposed to explain the evolution of the universe, keeping in mind that none of these theories can be completely approved or totally rejected without any firm physical and experimental evidence. The paper also takes an in-depth study of the formation of stars and galaxies as well as the evolution of life in other parts of the universe. Besides, the paper aims to draw the attention of the readers to how space-time continuum gives us a better understanding of the universe and it sultimate fate.

Literary Survey

The beginning of the universe [1]. Many physicists believe that the universe had gradually expanded from an intensely hot and dense point which is described in Fred Hoyle's famous Big Bang theory as the Big Bang singularity. Most of the energy in the universe is dominated by the presence of dark matter and dark energy while we have not been able to detect their presence experimentally, besides the various radiations and baryonic matter. Einstein had proposed a static and isotropic model of the universe and introduced the cosmological constant to solve his equations. However, his model turned out to be unstable.

Later Hubble proved that galaxies are moving apart, while some scientists have provided valuable data regarding galaxies moving faster than light's speed. As we look back in space and time, we notice a red-shift in the electromagnetic radiation wavelength and so we conclude from the Wien's Law that the temperature was very high at the early stage. It was found that during Big Bang, rapid nuclear reactions could take place only for a very short time. So this was a non-equilibrium process.

However, this theory of universe origin from a singularity is somewhat unjustified as no model to date has unified gravity with quantum mechanics. Observations show that most of the gravitational matter in the universe is weakly interacting which consists of the dark matter while dark energy act in opposition to it and cause the universe to accelerate. Besides, it has also been found out that a particle is found more commonly than the anti-particle. One explanation for this is high temperature during the grand unification.

A Cyclic Theory

[2].Scientists have also proposed a cyclic model of the universe where it begins with a big bang and again ends in a single point called the big crunch. From the beginning, we have arrived in a phase of accelerated expansion which dilutes entropy and density of the debris after the big bang. This acceleration then slowly ends and a period of de-acceleration follows it and finally a contracting phase and then the big-crunch. Thereafter, another phase will be resumed in a reversed sense, restoring the necessary conditions for a new big bang. Such a model had been approved by many scientists in the past.

But the theory received drawbacks after general relativity was proposed. Besides the problem of exactly defining the initial boundary conditions remain. It has been proposed that the universe is not closed but flat. The change from expansion to contraction is because of the negative potential energy and spatial curvature. In this way, the total entropy of the universe grows from cycle to cycle while the entropy density has a perfect cyclic behaviour as it gets created at each phase and gets diluted before the end of the phase.

Wormholes

[3].The existence of wormholes during the evolution of the universe is again a question of great interest. This idea was first put forth by Einstein and Rosen. According to the BIonic model, it is a channel for the flow of energy from the anti-universe-brane to the present universe and is responsible for the state of inflation.

After some time, it loses its energy, disappears and in this way the deceleration phase starts-off. As the separation decreases between the universe branes, tachyon (hypothetical particle moving faster than light) gets created. With decreasing separation, a second type wormhole called tachyonic wormholes are formed. In this way, we again get a connection between the two universe branes and the acceleration phase begins again.

Formation of Stars and Galaxies

[4].We know very little about the state of the universe around 10^6-10^9 years right after the big bang. It is assumed that the first stars to shine in the universe may have been formed out of un-magnetized pure hydrogen/helium gas, the reason being we find heavy elements in their interior.

[5].Star formation begins with dense regions of molecular clouds found in interstellar space. It is found that the longest-lived stars having low mass will run short of their hydrogen fuel, get transformed into white dwarfs and in this way within 10^{14} years, their temperature will become very low. On the other hand, stars having larger mass will require a shorter time to meet their end as a white dwarf or may turn into a black hole or a neutron star depending on their details of evolution.

It has also been studied that a planet gets detached from a star when it closely encounters with another star. The evolution of galaxies is rather a complicated process and scientists have not been able to understand it completely. A galaxy's central region may get collapsed to form a black hole along with evaporation of stars in its outer regions. These evaporated stars soon attain escape velocity and after about 10^{19} years get detached from the galaxy. It is not yet known how much matter of the galaxy finally collapses and how much escapes.

Due to accretion, different types of astrophysical sources bursts. By observing the radiations of X-rays in white dwarfs, we are able to study them in strong magnetic fields. Neutron stars, on the other hand, help us to study matter even under extreme density and magnetic field. The black hole binaries serve as a miniature model of super-massive black holes which are found at the centres of many galaxies and help us to study accretion.

[6].Observations show that certain stars provide us with valuable clues regarding the initial steps of the chemical evolution of our galaxy. In the early phase, we had only a few supernova sources and hence there was incomplete mixing of their ejecta. Besides, we find emission line being absent from dwarf galaxies whose metallic abundance is relatively less. The observed dispersion in abundance of various elements in blue compact galaxies arises because of chemical evolution of the first generation of stars.

Age of the Cosmos

[7].We can derive a new expression to find the age of our universe by taking an average of the deceleration parameter. Such a result holds in all aspects of cosmology. It is often argued by scientists that the decelerating stage must be compensated by the accelerating phase in order that the universe coasts forever. Therefore, this present stage of acceleration must be followed by a stage of deceleration.

ISBN: 978-93-92995-10-1

[8].The uniform expansion of the universe was proved from the observation of red-shift in distant galaxies. The present properties of the universe can be explained in terms of its development from a state of high temperature and density. The study of various atomic elements provides valuable information regarding the changes in the universe. For example, on comparing the decay periods of radioactive isotopes like samarium-148 and thorium-232 that decay in several thousand millions of years, with potassium-40 and uranium-235, that decay in about hundred million years, we find that the former elements were more abundant than the latter ones. By comparing their relative abundances, we can try to get a rough estimate of our universe's age.

Evolution of Life

[9].It is one of the major interests of scientists to search for extraterrestrial life in the cosmos. For this, they need to study how planets develop and how the conditions for the evolution of life are achieved.

It is suggested that extraterrestrial organisms could have in other parts of the universe at the same time when our Earth saw the first signs of life. Thus liquid water may have also persisted on other planets and it is widely believed that Mars and Europa have habitable conditions even now.

[10].It has been found that the distribution of intelligent beings in a galaxy depends on the rate at which stars are formed there, the number of stars having a planetary system, the mean of the habitable planets within each system and various other factors.

Findings

We have seen that different scientists have different opinions regarding the evolution of stars, galaxies and the universe as a whole. However, the big bang model, the cyclic model together with the big crunch model still remain the most popular and widely accepted ones and the reason being they support a number of theoretical observations. Besides, the inflationary stage has also been supported by ample physical evidence.

The concept of wormholes, on the other hand, is a very debatable one as we don't have any physical evidence for them. Most scientists believe that it is just a hypothetical concept and can be ignored for most calculations in cosmology and astrophysics.

The study of different elements, especially the radioactive ones, together with the composition of dust particles, radiations from different stars and galaxies have been studied intensely as they help to find the age of the universe and its properties to a good level of accuracy. Besides, it is widely believed that life must evolve and extraterrestrial species must exist in those parts of the cosmos which satisfy the conditions of life, especially the presence of liquid water.

Recommendations and Conclusion

In spite of all the efforts of the modern technology to get a clear picture of the evolution of the universe as a whole, problems still remain and several questionsare yet to be solved.

The best way to unfold all the unfolded mysteries is to find a theory that unifies all the laws of Physics as mentioned earlier, in other words, to find a theory that unifies quantum mechanics and the force of gravity. While intense work is still going on to find such a theory, we hope that in the future or maybe several years later we frame such a theory or at least get a new ray of light in that direction.

As a whole we can conclude that though everything lies within the boundaries of the uncertainty principle, we may not be able to solve all the questions to a remarkable degree of accuracy as nature itself forbids us from doing so but just try to make certain assumptions and arrive at some logical conclusions from our experiments and observations.

References

Audouze, J., & Silk, J. (1995). The first generation of stars: first steps toward chemical evolution of galaxies. The Astrophysical Journal Letters, 451(2), L49.

Bromm, V., Coppi, P. S., & Larson, R. B. (1999). Forming the first stars in the universe: the fragmentation of primordial gas. *The Astrophysical Journal Letters*, *527*(1), L5.

Dyson, F. J. (1979). Time without end: Physics and biology in an open universe. *Reviews of Modern Physics*, *51*(3), 447.

Gamow, G. (1948). The evolution of the universe. Nature, 162(4122), 680.

Lima, J. A. S. (2007). Age of the Universe, Average Deceleration Parameter and Possible Implications for the End of Cosmology. arXiv preprint arXiv:0708.3414.

Marais, D. D., & Walter, M. R. (1999). Astrobiology: exploring the origins, evolution, and distribution of life in the universe. *Annual review of ecology and systematics*, *30*(1), 397-420.

Motch, C., Wilms, J., Barret, D., Becker, W., Bogdanov, S., Boirin, L., ... & Haberl, F. (2013). The Hot and Energetic Universe: End points of stellar evolution. *arXiv preprint arXiv:1306.2334*.

Ratra, B., & Vogeley, M. S. (2008). The beginning and evolution of the universe. *Publications of the Astronomical Society of the Pacific*, *120*(865), 235.

Setare, M. R., & Sepehri, A. (2015). Stability of cylindrical thin shell wormhole during the evolution of the universe from inflation to late time acceleration. Journal of High Energy Physics, 2015(3), 79.

Steinhardt, P. J., &Turok, N. (2002). Cosmic evolution in a cyclic universe. *Physical Review D*, *65*(12), 126003.