International Journal of Recent Research and Review, Vol. XV, Issue 1, March 2022

ISSN 2277 – 8322

An Overview on Cosmological Models

Sana Saghir[1], Wajeeha Khalid[1], Mattiullah Shah[1], Nameeqa Firdous[2]

[1]*Department of Physics,University of Wah, WahCantt. Pakistan*

[2]*Department of Computer Science, GIFT University Gujranwala, Pakistan*

nameeqa@gift.edu.pk

***Abstract* - Cosmic evolution is the study of many varied developmental changes in composition of radiation to matter through the history of the Universe. These are the physical changes that have generally produced galaxies, stars, planets, and life afterwards. Human are always curious to know about their origin so they looked for different cosmological models for centuries. Before the 20th century there were two popular cosmological models i.e. Steady state universe and Lambda Cold Dark Matter cosmological model of the Universe (Lambda LCDM). In this article we will review these two models on the present experimental evidences.**

***Keywords-* Big bang, universe, evolution, cosmological model, steady state universe.**

I. INTRODUCTION

In the old times earth was considered as the focal point of the universe. This is an illustration of misguided judgments that might come about because of having perceptions just from a solitary area from the Earth. In the sixteenth century Nicolaus Copernicus was first to propose that sun was the focal point known as the heliocentric model of the universe. According to hum, Earth and different planets circled the Sun. This was the initial phase in moving us away from the focal point of the Universe. Quite later it was understood that neither the Sun, nor our world, lies at the focal point of the Universe. This example has prompted the Copernican rule: We don't involve a favored situation in the universe. This is firmly connected with the Cosmological standard: The universe is homogeneous and isotropic. Homogeneous implies that all areas are equivalent, so the universe seems a similar regardless of where you are. Isotropic implies that all bearings are equivalent, so the universe seems a similar regardless of which course you take a gander at. Isotropy alludes to isotropy regarding some specific area, however

1) From isotropy concerning one area and homogeneity follows isotropy as for each area, and

2) From isotropy as for all areas follows homogeneity.

The past few decades have seen an insurgency in our comprehension of everything from the advancement of the universe on its biggest scales to the imperceptible microorganism. Before the twentieth century there were two well-known cosmological models, one of them is steady state model and the other is known as the big bang model. In the steady state model, the thickness of issue known to mankind stays unaltered. The expansion of universe is explained by the argument that there is a continuous creation of matter. This model demonstrates that there is no is no any first beginning, and therefore the physical universe is eternal. So there is no beginning and no end universe was like this and it will remain it is forever. The second model was the big bang, which clearly states that there is a beginning of the universe.

In the last decade, a number of lines of evidence have pointed towards a consistent picture for the state of the Universe. The observational status is considered sufficiently strong that the term 'Standard Cosmological Model' is justified as a description of our understanding of the Universe and its contents [1].

II. STEADY-STATE UNIVERSE

Steady State Universe model states that the observable universe is practically the same at any time and any place, the universe has no beginning and no end, known as the perfect cosmological principle. This model justifies the expanding universe as the density of matter remains unchanged because of the continuous matter creation in the universe. It got support from scientific community until the mid-twentieth century. Unable to answer the experimental/ observational evidences it is rejected by majority of scientists including cosmologists, astrophysicists and astronomers as these evidences point to a finite age of the universe [2-3].

In the last part of the 1940s, British astrophysicist Fred Hoyle contended that space could be extending unceasingly and keeping a generally consistent thickness. It could only be possible by constantly adding new matter, with elementary particles suddenly springing up from space [4].

Particles would then combine to shape systems and stars, and these would show up at the perfect rate to occupy the additional room made by the extension of room. Hoyle's Universe was dependably limitless, so its size didn't change as it extended. It was in a consistent state or in other words in a steady state. That is why this model is named as steady state model. Despite the fact that Hoyle's model was at last precluded by cosmic perceptions, it was numerically predictable, tweaking the conditions of Einstein's overall hypothesis of relativity to give a potential component to the unconstrained age of issue. Same idea was promoted by Hermann Bondi, Thomas Gold in 1948 [5-6].

Albert Einstein initially supported the idea of Steady State expanding universe as indicated in a 1931 manuscript, many years before Hoyle, Bondi and Gold, However, he quickly abandoned the idea [7].

First serious issue arises in the late 1950's with the observation of bright radio sources know as quasars and radio galaxies, were found only at large distances. Because the steady-state model predicted that such objects would be found throughout the universe, including close to our own galaxy which contradicted the observations. Statistical tests, in 1961, based on radio-source surveys [8] had ruled out the steady-state model but some supporters from the scientific community insisted that the radio data were suspect.

The discovery of the cosmic microwave background radiation in 1964 was a turning point when most of the cosmologists refuted this model definitively.

The steady-state model explained microwave background radiation as the result of light from ancient stars that has been scattered by galactic dust. However, the cosmic microwave background level is very even in all directions, making it difficult to explain how it could be generated by numerous point sources, and the microwave background radiation shows no evidence of characteristics such as polarization that are normally associated with scattering.

In 1972, an eminent theoretical physicist and Nobel laureate Steven Weinberg wrote,

> "… the steady state model makes such definite predictions that it can be disproved even with the limited observational evidence at our disposal. The steady state model is so attractive that many of its adherents still retain hope that the evidence against it will eventually disappear as observations improve. However, if the cosmic microwave radiation is really black-body radiation, it will be difficult to doubt that the universe has evolved from a hotter denser early stage" [9].

Quasi-steady-state cosmology (QSS) was proposed in 1993 by Fred Hoyle, Geoffrey Burbidge, and Jayant V. Narlikar as a new incarnation of the steady-state ideas meant to explain additional features unaccounted for in the initial proposal. The model suggests pockets of creation occurring over time within the universe, sometimes referred to as mini bangs, mini-creation events, or little bangs [9]. After the observation of an accelerating universe, further modifications of the model were made [10]. The Planck particle is a hypothetical black hole whose Schwarzschild radius is approximately the same as its Compton wavelength; the evaporation of such a particle has been evoked as the source of light elements in an expanding steady-state universe [11].

Astrophysicist and cosmologist Ned Wright has pointed out flaws in the model [12]. These first comments were soon rebutted by the proponents [13]. Wright and other mainstream cosmologists reviewing QSS have pointed out new flaws and discrepancies with observations left unexplained by proponents [14].

Burbidge and Hoyle argued that the energy released in the synthesis of cosmic He from hydrogen is almost exactly equal to the energy contained in the cosmic microwave background radiation. This result strongly suggests that the He was produced by hydrogen burning in stars and not in the early stages of a big bang [15]. More details can be found in [16-19].

III. LAMBDA LCDM

In 1927, Georges Lemaître was first to note that an expanding universe could be traced back in time to an originating single point. On his idea of cosmic expansion scientists have developed model [20] from the earliest known periods through its subsequent large-scale evolution. Since the scientific community was once divided between supporters of these two different theories, the Big Bang and the steady state theory as discussed above, but a wide range of empirical evidence has strongly favored the Lambda LCDM also known as Big Bang which is now universally accepted [21].

Detailed measurements of the expansion rate of the universe place the Big Bang at around 13.8 billion years ago, which is thus considered the age of the universe [22].

After its initial expansion, the universe cooled sufficiently to allow the formation of subatomic particles, and later atoms. Giant clouds of these primordial elements (mostly hydrogen, with some helium and lithium) later coalesced through gravity, eventually forming early stars and galaxies, the descendants of which are visible today. Extrapolation of the expansion of the universe backwards in time using general relativity yields an infinite density and temperature at a finite time in the past. This singularity indicates that general relativity is not an adequate description of the laws of physics in this regime. Models based on general relativity alone cannot extrapolate toward the singularity beyond the end of the Planck epoch [23].

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 $10{-}5$ [24].

Also, general relativity has passed stringent tests on the scale of the Solar System and binary stars.

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 [25].

IV. EXPERIMENTAL EVIDENCES

Edwin Powell Hubble was an American astronomer. He played a crucial role in establishing the fields of extragalactic astronomy and observational cosmology.

Hubble proved that many objects previously thought to be clouds of dust and gas and classified as "nebulae" were actually galaxies beyond the Milky Way [26].

In 1929, from analysis of galactic red shifts, he concluded that galaxies are drifting apart; this is important observational evidence for an expanding universe. In 1964, the cosmic microwave background radiation was discovered. It was proved to be a crucial evidence in favor of the hot Big Bang model [27].

Since that theory predicted the existence of background radiation throughout the universe before it was discovered. Observations of distant galaxies and quasars show that these objects are red shifted which means the light emitted from them has been shifted to longer wavelengths. This can be seen by taking a frequency spectrum of an object and matching the spectroscopic pattern of emission lines or absorption lines corresponding to atoms of the chemical elements interacting with the light. These red shifts are uniformly isotropic, distributed evenly among the observed objects in all directions. If the red shift is interpreted as a Doppler shift, the recessional velocity of the object can be calculated.

In 1964 Arno Penzias and Robert Wilson serendipitously discovered the cosmic background radiation, an omni directional signal in the microwave band [28].

Their discovery provided substantial confirmation of the big bang predictions by Alpher, Herman and Gamow around 1950. Through the 1970s the radiation was found to be approximately consistent with a black body spectrum in all directions; this spectrum has been red shifted by the expansion of the universe, and today corresponds to approximately 2.725 K. This tipped the balance of evidence in favor of the Big Bang model, and Penzias and Wilson were awarded a Nobel Prize in 1978.

Using the Big Bang model it is possible to calculate the concentration of helium-4, helium-3, deuterium, and lithium-7 in the universe as ratios to the amount of ordinary hydrogen. The relative abundances depend on a single parameter, the ratio of photons to baryons. This value can be calculated independently from the detailed structure of CMB fluctuations.

The age of the universe as estimated from the Hubble expansion and the CMB is now in good agreement with other estimates using the ages of the oldest stars, both as measured by applying the theory of stellar evolution to globular clusters and through radiometric dating of individual Population II stars [29]. An important component to the analysis of data used to determine the age of the universe (e.g. from Planck) therefore is to use a Bayesian statistical analysis, which normalizes the results based upon the model [30].

V. CONCLUSION

Like any theory, as a result of the development of the Big Bang theory a number of mysteries and problems have arisen. Some of them have been resolved while others are still outstanding. Proposed solutions to some of the problems in the Big Bang model have revealed new mysteries of their own. For example, the horizon problem, the magnetic monopole problem, and the flatness problem are most commonly resolved with inflationary theory.

Although the Big Bang model cannot fully explain the origin of the universe yet it is obvious from the observations and experimental proofs that is the most acceptable cosmological model about the origin of the universe.

Also, major improvements are expected in data on several fronts. In the CMB, Planck promises measurements of the power spectrum to smaller scales than WMAP, as well as wider frequency coverage which should aid foreground subtraction.

VI. REFERENCES

[1] A. Heavens, "The Cosmological Model: an overview and an," *Journal of Physics: Conference Series 120 (2008) 022001 doi:10.1088/1742-6596/120/2/022001*, 2008.

[2] S. S. theory, "The Steady State theorists," *BBC Retrieved*, January 11, 2015.

[3] H. Kragh, Cosmology and controversy: The histrical development of two theories of the universe, Priceton University Press ISBN 978-0-691-02623-7, 1999.

[4] F. B. G. N. J. V. Hoyle, "A quasi-steady state cosmological model with creation of matter," *The Astrophysical Journal*, no. The Astrophysical Journal. 410: 437–457, p. 410: 437–457, 1993.

[5] H. Bondi and T. Gold, "The Steady-State Theory," *Bondi, Hermann; Gold, Thomas (1948). "The Steady-State Theory oMonthly Notices of the Royal Astronomical Society.*, no. 108: 252. Bibcode:1948MNRAS.108..252B., 1948.

[6] F. Hoyle, "A New Model for the Expanding Universe," *Monthly Notices of the Royal Astronomical Society*, no. 108: 372. Bibcode:1948MNRAS.108..372H., 1948.

[7] D. Castelvecchi, "Einstein's lost theory uncovered," *Nature*, Vols. Castelvecchi, Davide (2014). "Einstein's lost theory uncovered". Nature. 506 (7489): 418–419. , no. Bibcode:2014Natur.506..418C. doi:10.1038/506418a. PMID 24572403., 2014.

[8] R. a. Clarke, "An examination of the steady-state model in the light of some recent observations of radio sources," *MNRAW 122 (1961) 349*, 1961.

[9] S. Weinberg, Gravitation and Cosmology. pp. 495–464. ISBN 978-0-471-92567-5., John Whitney & Sons. pp. 495–464. ISBN 978-0-471-92567-5., 1972.

[10] J. V. Narlikar, R. G. Vishwakarma and G. Burbidge, "Interpretations of the Accelerating Universe," *Interpretations Publications of the Astronomical Society of the Pacific*, Vols. astro-ph/0205064.114.1092N. doi:10.1086/3423, no. Bibcode:2002PASP., 2000.

[11] F. Hoyle, "Light element synthesis in Planck fireballs," *Astrophysics and Space Science*, vol. 177–193. doi:10.1007/BF00644753. , no. S2CID 121245869, 1993.

[12] E. L. Wright, ""Comments on the Quasi-Steady-State Cosmology"," *Monthly Notices of the Royal Astronomical Society*, Vols. arXiv:astro-ph/9410070., no. Bibcode:1995MNRAS.276.1421W. doi:10.1093/mnras/276.4.1421. S2CID 118904109, 1994.

[13] F. Hoyle, G. Burbidge and J. V. Narlikar, "Note on a Comment by Edward L. Wright," Vols. arXiv:astro-ph/9412045, 1994.

[14] E. L. Wright, "Errors in the Steady State and Quasi-SS Models," *UCLA, Physics & Astronomy Department.*, 2010.

[15] G. H. F. ". O. o. H. a. t. O. L. E. T. A. J. 5. 1. D. 1. Burbidge, "The Origin of Helium and the Other Light Elements," *The Astrophysical Journal*, Vols. 509:L1–L3, 10 December 1998, 1998.

[16] F. Hoyle, G. Burbidge and J. V. Narlikar, "A Different Approach to Cosmology," *Cambridge University Press*, Vols. Cambridge University Press. ISBN 978-0-521-66223-9., 2000.

[17] S. Mitton, Conflict in the Cosmos: Fred Hoyle's Life in Science, Vols. ISBN 978-0-309-09313-2., Joseph Henry Press. ISBN 978-0-309-09313-2., 2005.

[18] S. (. Mitton, Fred Hoyle: A Life in Science, Aurum Press. ISBN 978-1-85410-961-3., 2005.

[19] J. Narlikar and G. Burbidge, Facts and Speculations in Cosmology, Cambridge University Press. ISBN 978-0521865043., 2008.

[20] F. B. G. N. J. V. Hoyle, "[1] Hoyle, F., Burbidge, G., NaA quasi-steady state cosmological model with creation of matter," *The Astrophysical Journal*, vol. 410: 437–457. .

[21] J. Silk, Horizons of Cosmology, Templeton Press. p. 208.., 2009.

[22] "Planck reveals an almost perfectuniverse"., PLANCK.ESA. 21 March 2013. Retrieved 15 April 2017.

[23] T. L. Chow, Gravity, Black Holes, and the Very Early Universe, Springer, 2017.

[24] A. V. Ivanchik, A. Y. Potekhin and D. A. Varshalovich, "The Fine-Structure Constant: A New Observational Limit on Its Cosmological Variation and Some Theoretical Consequences," *Astronomy and Astrophysics*, Vols. arXiv:astro-ph/9810166, 1999.

[25] J. Goodman, "Geocentrism Reexamined," *Physical Review D*, Vols. 52 (4): 1821–1827. arXiv:astro-ph/9506068, 1995.

[26] E. Hubble, "Extragalactic nebulae," *Astrophysical Journal.* , vol. 64 (64): 321–369, 1926.

[27] R. B. Partridge, 3K: The Cosmic MicrowaveBackground Radiation, Cambridge University Press. p. xvii.ISBN978-0-521-35808-8., 2007.

[28] A. A. R. W. Penzias, "A Measurement of Excess Antenna Temperature at 4080 Mc/s," *The Astrophysical Journal*, Vols. Penzias, A. A.,Wilson, R. W. (1965). "A Measurement of Excess Antenna Temperature at 4080 Mc/s". The Astrophysical Journal. 142: 419., 1965.

[29] B. Chaboyer, A Lower Limit on the Age of the Universe, Vols. Chaboyer, Brian (16 February 1996). "A Lower Limit on the Age of the Universe". Science. 271 (5251): 957–961. arXiv:astro-ph/9509115. Bibcode:1996Sci...271..957C. doi:10.1126/science.271.5251.957. S2CID 952053, A Science. 271 (5251): 957–961. arXiv:astro-ph/9509115. Bibcode:1996Sci...271..957C. doi:10.1126/science.271.5251.957. S2CID 952053, 1996.

[30] D. Spergel and e. al., "First-year Wilkinson Microwave Anisotropy Probe (WMAP) observations: Determination of cosmological parameters," *The Astrophysical Journal Supplement Series*, Vols. 148 (1): 175–194. arXiv:astro-ph/0302209. Bibcode:2003ApJS..148..17, 2003.