Term paper on dark matter and dark energy

Law, Evidence

Abstract

The universe contains 100 billion galaxies. Each of these galaxies has billions of stars, great gas and dust clouds with others having scads of moons and planets. The stars release an abundance of energy either from radio waves, X-rays or from other forms of energy that run at a speed of light across the universe. However, all that can be seen is like the tip of the cosmic iceberg and accounts for a small portion of the total energy and mass in the universe. About one-quarter portion of the universe is made up of dark matter that does not release any detectable energy. However, the dark matter exerts a gravitational pull on the visible matter that is in the universe. The dark energy, on the other hand, pushes the visible matter outward. While the dark energy reveals itself only on the biggest cosmic scale, the dark matter puts its influence on each galaxy individually and the universe.

Introduction

The energy density that accumulates in the universe may cause the expansion of the universe to stop expanding or from recollapsing. When this matter is little, the expansion of the universe cannot stop. However, gravity plays a crucial role in controlling the expansion of the universe. Universe is filled with matter, and the force of attractive by gravity pulls together all matter. In astronomy and cosmology fields of study, dark matter refers to a type of matter that is hypothesized to explain a large portion of the total mass that occupies the universe. It is not possible to see dark matter directly with telescopes. Dark energy in astronomy and physical cosmology are defined as an energy form that is hypothetical and diffuses all of space has a tendency to accelerate universe expansion (Peebles & Ratra, 2003).

The dark matter evidently does not absorb or emit radiations such as electromagnetic radiations in any significant way (Trimble, 1987). The existence and the properties of dark matter are inferred from the gravitational effects that they cause on radiations, visible matter as well as on the large-scale structure of the whole universe. Out of all the matter that is in the universe, dark matter constitutes an estimate of 84%, and in the total energy density, it consists of an estimate of 23%. The rest portion of the energy density is made up of the dark energy (Hinshaw, 2012).

The existence of dark matter captured the attention of the astrophysicists due to divergences that had occurred. This was between the mass accounted for by large astronomical objects and was determined from the gravitational effects caused by these objects and the mass that is calculated from the luminous matter contained in these masses such as gas, stars and dust. The phenomenon was initially postulated, in 1932, by Jan Oort accounting for the velocity of the stars on their orbital in the Milky Way. In 1933, Fritz Zwicky accounted for the missing mass witnessed in the orbit velocities of the galaxies that are in the clusters. There have been other observations that have indicated that there is dark matter in the universe. These include the galaxies rotational speeds, gravitational lensing by galaxy clusters of background objects like the Bullet Cluster, and the distribution of temperature of the hot gas in galaxies, as well as, clusters of galaxies. According to consensus made by the cosmologists, the composition of dark matter is primarily made of types of subatomic particles that are yet to be characterized (Copi, Schramm, & Turner, 1995). The search of subatomic particle is currently being done through a number of means and has been one of the main endeavors in particle physics (Bertone, Hooper, & Silk, 2005).

The dark matter existence is accepted generally by the scientific community although there is no direct evidence that is available to show its existence. There are other proposed theories to help in explaining the anomalies that are explained by the dark matter. These theories include the quantum gravity, super-hyper-strings, interpretational errors in measurements as well as the hyper-dimensional interactions that take place at supra galactic distances. Dark matter takes a central part in state-of-the-art modeling of galaxy evolution and structure formation. There are also indications of a distinguished effect on the anisotropies that are observed in the background of the cosmic microwave. All these are lines of evidence that suggest that clusters of galaxies, galaxies, as well as, the universe contain far greater matter than the one that have an interaction with electromagnetic radiation (Siegfried, 1999).

The first person who interpreted the evidence behind dark matter was a Dutch astronomer called Jan Oort. This occurred when he was studying motions of stellar in the local galactic neighborhood where he found the mass in the galactic plane to be much more that the material that was being seen. Fritz Zwicky who studied galaxy clusters in 1933, gave similar inference. Zwickys obtained evidence of presence of the unseen mass by applying in to the Coma galaxies cluster the virial theorem. Zwicky made an estimation of the total mass of the cluster with the number of galaxies as well as the overall clusters brightness. This comparison revealed that the estimated mass was approximately 400 times than the mass was visually observable. The gravity resulting from the visible galaxies that are in the cluster for such fast orbits is thus supposed to be far too small. Therefore, something extra was needed in order to explain the missing mass problem. From these conclusions, Zwicky deduced that non-visible matter is present to provide enough mass as well as gravity that can hold the cluster together. Most of the presence of dark matter evidence is seen in the analysis of the galaxies motions (Freeman & McNamara, 2006).

Many of the evidences of the dark matter seem to be uniform in a fair way. Therefore, the use of virial theorem, the overall kinetic energy can be half the whole energy of gravitational binding of the galaxies. However, experimentally, the overall kinetic energy is much greater than the expected. In particular, it is assumed that the gravitational mass results from the visible matter that is in the galaxy, those stars that are at a distance from the galaxy centers have much greater velocities than the velocities predicted through the virial theorem. It is not possible to explain the galactic rotation curves that show the rotation velocity against the length from the galactic center using the visible matter alone. The assumption that the visible matter makes up just a small portion of the cluster can be the only straight forward manner in which this can be accounted. Galaxies reveals signs that it is made up of mostly of a spherically symmetric that is rough in nature, concentrated at the centre at the halo of dark matter. The brightness on the low surface from the dwarf galaxies plays a significant role in providing important information in the study of dark matter. This is because they have a low ratio of the visible matter to the dark matter that is not common and have a low number of stars that are bright at the center. These stars may spoil the rotation curve observations made by the outlying stars. The observation of galaxy clusters through gravitational lensing allow for direct estimation of the gravitational mass observations of galaxy clusters allow direct estimation of the gravitational mass grounded on its effect on light coming from background galaxies. This is because the large collections of matter whether dark or not will deflect light gravitationally. Such clusters such as the Abell 1689, the lensing observations, have confirmed that there is considerably more mass than the one indicated by the light of the clusters alone. Using the Bullet Cluster, the lensing observations indicated that there is a lot of lensing mass that is separated from the baryonic mass that X-ray radiations. Lensing observations have also been used in the identification of dark matter filament that occurs between two galaxy clusters as predicted by the cosmological simulations (Dietrich, et al., 2012).

Dark energy has been adopted as the acceptable hypothesis that can explain observations that show that the universe is undergoing expansion at an accelerating rate. Using the standard model of cosmology, out of the total mass-energy that is in the universe, 73% is accounted for by the dark energy. There are two forms of dark energy that have been proposed cosmological constant and scalar fields. The cosmological constant refers to the constant energy density that fills the space homogeneously (Carroll, 2001). The scalar fields include the quintessence or moduli and are dynamic quantities with energy density that may vary in both time and space. The constant contributions that are made by scalar fields in the space are also added up in the cosmological constant, which is physically equal to the vacuum energy. The scalar fields that do not change in space are difficult to distinguish from a cosmological constant since the change may be slow. There is a need for high-precision measurements for the universe expansion in order to understand how expansion rate changes over time. The evolution of the rate of expansion in general relativity is parameterized using the cosmological equation of the state, which shows the relationship between pressure, temperature, energy, vacuum energy density, as well as, combined matter for any space region. The exercise of measuring the state equation for dark energy has been one of the major endeavors in observational cosmology currently. Addition of the cosmological constant to the standard FLRW metric of the cosmology results in to the Lambda-CDM model. The model has been regarded as the standard model of cosmology. This is because of the way it agrees precisely with observations. There has been use of dark energy as a crucial ingredient in attempts to develop a cyclic model for the universe (Baum & Frampton, 2007).

A supernova, which is an explosion of a big supergiant star, may shine with brightness of more than 10 billion suns. The supernovae are grouped into two groups based on light curve shape and the nature of the spectra. The measurements of the gravitational lensing, the large-scale structure of the cosmos, cosmic microwave background, and improved supernovae measurements have been consistent with the measurements using Lambda-CDM model. There has been an argument that the only suggestion of the dark energy existence is through the observation distance measurements and the associated redshifts. The baryon acoustic oscillations and the cosmic microwave background anisotropies are the only observations that show that the redshifts are bigger than the expected from the local measured Hubble constant (Durrer, 2011).

Supernovae are very useful in cosmology since they are splendid standard candles that go across cosmological distances. The supernovae allow the measurement of history of expansion of the Universe by focusing on the relationship that is there between the redshift of an object and the distance to the object. This shows how fast the object is drawing back from us. This relationship is roughly linear using the Hubble's law. Although it is relatively easy get the measurement of the redshift, it is more difficult to find the distance to an object. The astronomers on general occasions use standard candles, which are objects for which the absolute magnitude or the intrinsic brightness is known. The standard candles allow the object distance be measured from apparent magnitude or its actual observed brightness. Some of the recent supernovae observations are consistent with a universe that makes up 71. 3% of dark energy as well as 27. 4% that combines the dark matter with the baryonic matter (Kowalski & Rubin, 2008).

The existence of dark energy is the needed in order to reconcile the geometry of space measured with the accumulative matter that is in the universe with an aim to explain. The cosmic microwave background anisotropies measurements using the WMAP spacecraft gave the indication that the universe is close to flat. In order for the universe shape to be flat, the mass/density value of the universe has to be equal to a given critical density. However, the total amount of matter (inclusive of dark matter and the baryons) in the universe that was measured by cosmic microwave background can only accounts for approximately 30% of the critical density.

These results imply that there exist a more forms of energy to may account for the rest 70 %.

Conclusion

Dark matter refers to a type of matter that is hypothesized to explain a large portion of the total mass that occupies the universe. It is not possible to see dark matter directly with telescopes. Dark energy is defined as an energy form that is hypothetical and diffuses all of space as a tendency to accelerate universe expansion. The dark matter exerts a gravitational pull on the visible matter that is in the universe. The dark energy, on the other hand, pushes the visible matter outward. While the dark energy reveals itself only on the biggest cosmic scale, the dark matter puts its influence on each galaxy individually and the universe. Various mechanisms have been employed to give existence evidence of the bark energy and dark matter.

Reference List

Baum, L., & Frampton, P. (2007). Turnaround in Cyclic Cosmology. Physical Review Letters, 98(7).

Bertone, G., Hooper, D., & Silk, J. (2005). Particle dark matter: Evidence, candidates and constraints. Physics Reports, 405, 279–390.

Carroll, S. M. (2001). The Cosmological Constant. Living Rev. Relativity, 4(1).

Copi, C. J., Schramm, D. N., & Turner, M. S. (1995). Big-Bang Nucleosynthesis and the Baryon Density of the Universe. Science, 267(5195), 192–199.

Dietrich, J. P., Werner, N., Clowe, D., Finoguenov, A., Kitching, T., Miller, L., & Simionescu, A. (2012). A filament of dark matter between two clusters of galaxies. Nature, 487(7406), 202-216.

Durrer, R. (2011). What do we really know about dark energy? Phil. Trans. Roy. Soc. A., 369, 5102–5114.

Freeman, K., & McNamara, G. (2006). In Search of Dark Matter. New York: Springer.

Hinshaw, G. F. (2012). What is the Universe Made Of? Retrieved March 11, 2013, from http://map. gsfc. nasa. gov/universe/uni_matter. html

Kowalski, M., & Rubin, D. (2008). Improved Cosmological Constraints from New, Old and Combined Supernova Datasets. The Astrophysical Journal, 686(2), 749–778.

Peebles, P. J., & Ratra, B. (2003). The cosmological constant and dark energy. Reviews of Modern Physics, 75(2), 559–606.

Siegfried, T. (1999). Hidden Space Dimensions May Permit Parallel Universes, Explain Cosmic Mysteries. Retrieved March 11, 2013, from http://www. physics. ucdavis. edu/~kaloper/siegfr. txt

Trimble, V. (1987). Existence and nature of dark matter in the universe. Annual Review of Astronomy and Astrophysics, 25, 425–472.