The Role of Angular Momentum on the Accelerated Expansion of the Universe

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Abstract: The galaxies are generating a large amount of energy which in turn is increasing the angular momentum of the galaxies. We, in this paper assume that the total energy of a galaxy is proportional to the angular momentum of the galaxy and thereby derive the famous Hubble law of expansion of the universe. We also show the reason why some of the galaxies are receding away and the others like the Milky Way and the Andromeda galaxies are approaching towards each other. And ultimately we can explain the origin of the cosmological constant in the General Theory of Relativity of Einstein, which can be used to explain the accelerated expansion of the universe without assuming the existence of dark energy and dark matter

Keywords: Gravitation, Red shift, Galaxy, Distance Modulus, Cosmology

1. INTRODUCTION

The accelerated expansion of the universe is a great mystery of today's cosmological studies.

After the discovery of the accelerated expansion of the universe by Perlmutter, S., et al, extensive researches are going on both theoretical as well as experimental level to find the underline case of this expansion in theoretical researches the expansion is attributed to the existence of the dark matter and dark energy of repulsive nature. On the other hand a lot of experimental research projects are carried out all over the world to detect this peculiar dark matter and dark energy. At Stanford laboratory, the scientists have constructed the LUX dark matter detector filled with a third of ton of cooled super dense liquid xenon. The powerful detectors surround the xenon liquid to detect the feeblest flashes of light or electrical charge emitted if there is any weakly interacting particle interacts with a xenon atom. The Stanford laboratory is located nearly a mile beneath the rock and inside a 72,000 gallon high purity water tank which shields the high energy cosmic rays and other radiations suspected to interfere with dark matter signal. In July 2012 it had started working and in May of 2016 LUX completed its search for dark matter and again it did not actually find such elusive particles. The race to direct detection dark matter is still on and LUX-ZEPLIN a next generation detector will soon replace the LUX experiment. In spite of all these efforts all over the world the existence of dark matter or dark energy is not confirmed experimentally.

In this context, we propose a new simple theory that the angular momentum of the galaxies are proportional to their respective energies and consistently explain the origin of the Hubble law, the explanation of the existence of Einstein's cosmological constant (Λ) , the cause of the flat galaxy rotation curves and the most important Tully-Fisher relations. It is widely accepted that the origin of the universe is Big Bang from a singular point and from its very beginning of the universe the quantum mechanical effects played very important roles. From these perspective it is plausible to assume that the total energy of the galaxies are proportional to their respective angular momentum. In case of quantum mechanics, the quantized energy of the subatomic particles are in units of h w/2π, where h is the unit of angular momentum and w is the angular frequency. In a similar fashion for macroscopic large matters likes galaxies, black holes and the massive stars, according to Bohr's correspondence principle, should obey the rules E(total energy) =ΩL, where L is the total angular momentum and Ω is a constant explained later on. Though the detailed mechanism of how the energy of the galaxies being exhausted to contribute to the increase of the angular momentum of the galaxies are not known and further theoretical as well as experimental researches are required in this regard. We will show in subsequent chapters that though the detailed mechanism is not known but this simple assumption can explain the basic unsolved problems of the accelerated expansion of the universe without the existence of so called unknown dark matter and dark energy which have not been found experimentally till date. Moreover the origin of the Hubble law and the cosmological constant have been traced in this paper in a straightforward way as it will be shown that the constant Ω is related to the Hubble constant H and the very smallness of the cosmological constant Λ is well justified.

The center of the galaxies are generators of the energies i.e., chemical energy, heat energy, nuclear energy, gravitational energies which in turn generates rotational kinetic energies. These types of fuels help to accelerate the universe. If we assume that the total energy of the galaxy is proportional to the angular momentum of the galaxy, the observed acceleration of the galaxy can be easily explained. If the same assumption is applied to the pulsar and the galaxy rotation curves the observed phenomena can be explained. If this is assumed to be the fundamental property of the curved space time in general relativity. The role of angular momentum on the recession of the galaxies is investigated here. The accelerated cosmological expansion of the galaxies and the underline cause of its acceleration is a matter of great debate for the decades particularly after the experimental results of recently discovered la supernovae expansion. Since the discovery of Hubble expansion law it has been hypothesized that the role of dark matter and dark energy which pervades all of the universe is responsible for this observed phenomena. But the bizarre hypothetical dark matter and dark energy which has negative pressure, repulsive property and constant energy density has not been traced so far in spite of extensive research all over the world for a long time. The universe is thought to be born out of Big-Bang phenomena. The initial stage of the expansion of the universe was dependent largely on the quantum mechanical effects like gravity etc. came into existence.

2. Theory: Let us assume that the total energy of the galaxy is proportional to the total energy of the galaxy, i.e.

$$E = \Omega L = \Omega mvr \qquad (1)$$

Where Ω is a constant, L is the magnitude of the total angular momentum of the galaxy, m is the mass and v is the receding velocity of the galaxy. From equation (1) we can write from Newton's laws of motion,

$$\frac{1}{2}m\,v^2 - \frac{GMm}{2R^3}(3R^2 - r^2) = \Omega\, mvr \qquad (2)$$

Where R is the radius of the observable universe and r is the point of the space inside this universe (See Fig.1).

Or $$v^{\,2} - 4\pi G\rho_c R^2\left(1 - \frac{r^2}{3R^2}\right) - 2\,\Omega\, vr = 0 \qquad (3)$$

Solving equation (3) for v we get,

$$v = \Omega\, r\,[1 \pm \{1 + \frac{3\rho_c}{2\rho_\Lambda}\left(\frac{1}{X^2} - \frac{1}{3}\right)\}^{\frac{1}{2}}] \qquad (4)$$

Where $\rho_\Lambda = \frac{3\Omega^2}{8\pi G}$ and ρ_c is the critical density of the universe. The above equation (4) quite resembles to the Hubble law of expansion $v = H\,r$, if we identify,

$$\text{H} = \Omega\;[1 \pm \{1 + \frac{3\rho_c}{2\rho_\Lambda}\left(\frac{1}{X^2} - \frac{1}{3}\right)\}^{\frac{1}{2}}] \qquad (5)$$

Where X=r/R Now when matter energy density $\rho_c = \rho_\Lambda$ (we call it dynamical energy density or so called vaccum energy density) and $X = 1$,

$$\text{H} = \Omega\;[1 \pm \left\{1 + \frac{3}{2}\left(1 - \frac{1}{3}\right)\right\}^{\frac{1}{2}}] = \Omega\,(2.886)\;\; or - \Omega(.886)$$

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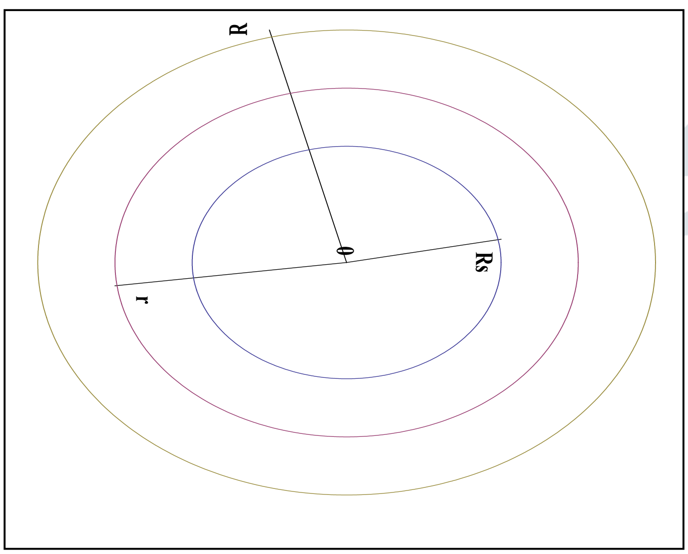

Fig.1 The central sphere represents the star itself. The outer sphere is the sphere of Hubble radius $(\frac{c}{H_0})$. The potential inside point of a sphere at a distance r is shown.

The equation[5] suggests that the velocity of the galaxies may be positive or negative. Or in other words the galaxies may be receding away or approaching towards each other like the andromeda and the milky way galaxies are scheduled to collide in future.

3.Galaxy Rotation Curves:

We also can explain the flat rotation curves of the spiral galaxies very easily. The rotation curve of a galaxy defines the variation of the circular orbital speed of the stars in a galaxy at different distances from the center of the galaxy. In case of a rotating solid disk the velocity of each particle increases with the increase of the distances from the center of the solid disk. The most of the mass of a galaxy is concentrated at the center and the velocity of the stars decreases with the increase of the distances of the stars from the center of the galaxy. According to the Kepler's laws of the planetary motions of our solar system, it is known as Kasparian decline which is obvious from the formula, $\frac{mv^2}{r} = GM\frac{m}{r^2}$ or $v = \left(\frac{GM}{r}\right)^{\frac{1}{2}}$.

A flat galaxy rotation curve, the velocity of the stars is constant over some range of radii, is a mystery commonly attributed to the so called elusive dark matter and dark energies. The striking features the most of the galaxies show that the rotation curves resemble that of a solid body rotation near about the center and thereafter a slow increase to a constant value in the outer parts of the galaxy. Therefore, a flat rotation curve is quite strange and this feature can be quite explained in our theory. Because in our theory $E = \Omega L = \Omega Mvr$ and so $v^2 = \frac{GM}{r} = GM\,\Omega Mv/E$ or $v = \frac{GM^2\Omega}{E}$ = a constant.

4. Tully-Fisher relation (TFR):

The Tully-Fisher relation in astronomy is an important empirical relation between the mass

Or intrinsic luminosity of a spiral galaxy or its asymptotic rotational velocity or emission linewidth. The astronomers R. Brent Tully and J. Richard Fisher first published this empirical relation in 1977. Astronomers define the brightness of the stars in terms of apparent magnitude of brightness, i.e., how bright the stars look when it is viewed from the earth and the absolute magnitude of brightness is termed as the brightness if it is looked from a standard distance of 10 parsecs or from a distance of 32.6 light years. The luminosity of the galaxy is obtained by multiplying its apparent brightness by $4\pi\, r^2$, where r is its distance from us, and the spectral-line width is measured by long slit spectroscopy. There are other different forms of Tully Fisher relations associated with the measurements of mass, luminosity or rotation velocity of the galaxies we want to relate with them. Tully and Fisher have established the relation using optical luminosity, but later works show that the relation is even tighter when used from microwave to infrared (K band) radiation (a good proxy for the mass of the stars), and even tighter when luminosity is replaced by the galaxy's total baryonic mass (the sum of its mass in stars and gas). This latter form of the relation is known as the Baryonic Tully Fisher relation (BTFR), and states that baryonic mass is proportional to the power of roughly 3.5 to 4 of velocity.

The TFR is important in determining the distance of the galaxies by calculating luminosity of the spiral galaxies to be determined directly by line width measurement. The distance can be estimated by comparing its luminosity to its apparent brightness. Thus the TFR establishes a cosmic distance ladders to standardize for the measurement of more direct distance measurement techniques of higher and higher distance of galaxies.

In the dark matter paradigm, a galaxy's rotation velocity (and hence line width) is primarily determined by the mass of the dark matter halo in which it lives, making the TFR a manifestation of the connection between visible and dark matter mass. In Modified Newtonian dynamics (MOND), the BTFR (with power-law index exactly 4) is a direct consequence of the law effective at low acceleration. The analogues of the TFR for non-rotationally-supported galaxies, such as elliptical, are known as the Faber–Jackson relation and the fundamental plane.

The TFR law can be derived easily from the Stefan's radiation law $L(Luminosity) = \sigma T^4$. Assuming $E = kT = \Omega mvr$ we get $T \propto v$ and so intrinsic luminosity $L \propto v^4$ which is Tully-Fisher law.

5. Conclusion: The striking features of the Universe can be explained on the basis of the assumption that the total energy of the galaxy and angular momentum is proportional. The important empirical laws of the galaxy rotation curves, Tully-Fisher laws and the cosmological constant are explained without the assumption of the dark matter and dark energy. The smallness of the cosmological constant is understood and the fact that some of the galaxies are approaching towards each other instead of receding away is realized on the basis of the theory.

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