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Evidence for a Steady-State Universe

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Abstract

A simple gravitational alternative to the Hubble-Lemaitre Law is presented. Measured redshifts are attributed to gravitation rather than recessional velocity. The measured redshift-distance data fits a gravitational potential with constant mass. Redshift is then a measure of the gravitational potential and the space-time curvature of the early universe. The redshift-distance data is fitted to a constant mass of 3.8×10^{53} kg (1.8×10^{23} M_{sol}) which is 2.4 times the estimated total mass of ordinary matter in the current universe. The expanding and accelerating universe is not predicted and the speculation of dark energy is no longer required.

Keywords

Cosmology, Early Universe, Large Scale Structure of Universe, Gravitation

1. Introduction

The Hubble-Lemaitre Law has shaped our understanding of the universe for the past century [1]. Lemaitre was the first to develop the theoretical model for the expanding universe in his Ph. D. of 1925 [2]-[6]. Hubble was then the first to report that the nebulosities observed in the sky were galaxies like our own Milky Way. Early large telescope observations combined with spectroscopy showed that more faint galaxies appeared to have greater redshifts. The observed redshifts were attributed to recessional velocities and the Hubble-Lemaitre Law was created [1] [7]. Hubble and his colleague Humason were in fact looking for curvature in space-time from their observations [8]. It should be noted that Hubble was reticent to solely attribute the measured redshifts to a Doppler effect [9]. Current consensus is that the redshift-distance curves, Hubble plots, are interpreted as an increasing velocity with distance in an expanding and accelerating universe [1] [10]-[12].

The "standard model" of big bang cosmology, the Lambda Cold Dark Matter

(Lambda-CDM) model [13] is founded on the Hubble expansion of the universe [1] [14]-[17] and the interpretation using general relativity [18]-[23]. The accelerating universe has added experimental evidence in support of the existence of dark energy [10] [24].

The expanding universe has led to the requirement that dark energy, dark matter and stretched space be hypothesized. The introduction of these conjectural physical parameters has led to the presentation of a number of alternatives to the standard model. The hypothesis of dark energy has been introduced to understand the accelerating expansion of the universe which is purported to occur under the influence of the force of dark energy. Rotating space has been suggested as an alternative to dark energy and matter [25] [26]. In this model, the dark matter is the kinetic energy of rotation. Another model, the tired photon hypothesis presented by Fritz Zwicky in 1929, was proposed as a possible explanation for the observed redshifts of distant galaxies [27]. According to this model the photons lose energy (redshift) due to their propagation through space. However, this idea has been discredited on the basis that no blurring of images is observed, the light curves, brightness and spectral characteristics, of the type 1a supernovae and violation of the laws of energy conservation are consistent with an expanding universe.

Several recent papers have questioned the "standard" Lambda-CDM model of cosmology in view of the experimental data from the Planck Legacy 2018 measurements of the cosmic microwave background [28]-[30]. There also exists an earlier body of data by Arp *et al.* that shows that the measured redshifts are not due to a Doppler effect alone [9] [31]-[33]. A number of interacting galaxies and their associated quasars have been shown to have significantly differing redshifts [33]. In many cases the ejected objects have redshifts that differ significantly from their galaxy. The quasar redshifts are all larger that the ejecting galaxy and are not attributable to their ejection velocity as none are blue shifted. Essentially, a single astronomical object has components with redshifts that differ from each other and that of the host galaxy. Despite showing that the measured redshifts cannot be singularly attributed to recessional velocity, these results have been largely overlooked by the astrophysics community [9] [31]-[34]. A number of alternatives to recessional velocity have been suggested by Arp [31]-[33] and Radcliffe [9] who suggested that an "intrinsic" redshift of the quasars was responsible. Possibly the only effect that generates redshift that is consistent with all the observations and criteria outlined by Arp and Ratcliffe is that of gravitation. This would require that the estimated masses and/or radii of the quasars differ from the current estimates. Apparent quantisation of the redshifts is also potentially explained by gravitational effects where the mass of the objects generating the intrinsic redshifts have discrete values [9] [32] [33].

More recently Seifert *et al.* have questioned the foundations of current cosmological models (Λ-CDM) by suggesting that dark energy be replaced by a kinetic gravitational energy [35].

The current belief that redshifts are manifestations of the Doppler effect means that observed redshifts greater than 1 suggest velocities greater than that of light which are due to "Stretched Space" [36]. A gravitational interpretation of redshift data avoids this issue as redshifts greater than 1 do not imply a velocity exceeding that of light. Gravitational redshift also effectively removes the Hubble tension problem [37]-[39].

The requirements of the Λ-CDM model; dark matter, dark energy and stretched space suggest that an alternative to the expanding universe should be considered as outlined below.

2. Theory and Analysis

The measured redshifts are composed of a Doppler and gravitational contribution:

$$z = z_D + z_G \tag{1}$$

where z is the measured redshift, z_D is the doppler redshift and z_G is the gravitational contribution. Note that redshift is the normalised energy change of the photon. As such it is a thermodynamic property that is additive as written in Equation (1). In the early universe, $z_D \ll 1$ and the measured value of z is equal to the gravitational redshift, z_G, as shown in Figure 1. In the local region of the later universe, $z_G \sim 0$ and z tends to the Doppler value as is shown in Figure 1 below.

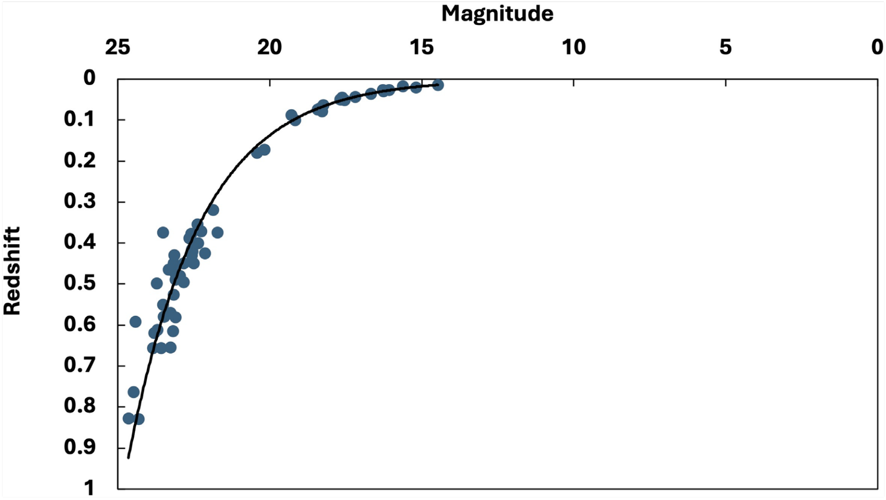

Figure 1. Measured redshift versus magnitude data for SN 1a taken from Perlmutter *et al.* [14] showing the nature of the gravitational potential (Equation (4)) and space-time curvature. Note the solar system is at the origin with the data between zero and brightness 14 (not shown) being along the horizontal axis. The data presented by Rout and Karachentsev shows that there is significant scatter in the redshift distance data in the local universe (between magnitude 14 and 0) [9].

Figure 1 reveals that there is a rapid decrease in redshift at an effective brightness of 15 - 25. In the local region of the universe the redshift values are relatively small. It is worth noting that the curvature seen in the gravitational potential of the early universe is precisely the space-time curvature that Hubble and Humason were looking for in their early measurements [8].

The data of Perlmutter *et al.* [14] [17] [40] [41] Schmidt *et al.* [15] [42] for type 1a supernovae and the compiled data presented by Shirokov *et al.* [16] (SN1a and LGRB's) are consistent with a power law relating the redshift and distance:

$$z \sim R^n \tag{2}$$

where z is the redshift and R the distance from the gravitational mass evident in the logarithmic plot in **Figure 2**. The extended data set that includes high redshift long gamma-ray burst (LGRB) data presented by Shirokov *et al.* [16] extends the observed range of redshift values to ten. All three data sets reveal similar behaviour.

The data of Perlmutter *et al.* [14] yields n = −0.90 ± 0.1 while that of Schmidt *et al.* [15] yield a value of n = −1 ± 0.1 (data not shown) for the R vs z^n while the higher redshift data presented by Shirokov *et al.* [16] yields a slightly lower number of n = −0.8 ± 0.1 (data not shown).

Uncertainty in the distance measurements has recently been discussed [43]. Measurement of SN 1a magnitude as used by Perlmutter *et al.* [14] and Schmidt *et al.* [15] appears to be a relatively robust measure of distance. General Relativity shows that both length and time change in high field strengths give rise to a gravitational redshift without modifying the measured intensities [18] [44] [45].

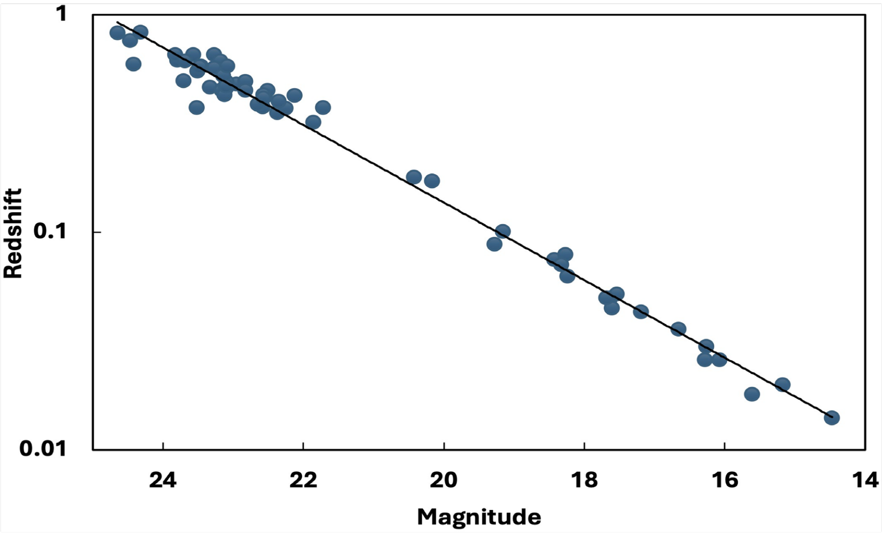

Figure 2. The data of **Figure 1** presented on a logarithmic plot giving an exponent of n = −0.90 ± 0.1 (Equation (4)) with $R^2 = 0.9355$. Magnitude is related to distance by: $M_{eff} = 5 \log D_L + M_B$ where M_{eff} is the effective magnitude, D_L is the distance and M_B the measured magnitudeas detailed in Perlmutter *et al.* [14].

Gravitational redshift was first proposed by Einstein theoretically and has been observationally verified [18] [44]-[46]. The gravitational redshift has been measured for a number of nearby astronomical objects including the sun [47] and a number of local cosmological objects outside the solar system at low redshift [48]. Indeed, the measured gravitational redshift has been considered to be a confirmation of the theory of General Relativity [20]. The calculated intrinsic gravitational redshifts from various cosmological objects, galaxies, quasars and AGN's are of order 10^{-7} to 10^{-5}.

Calculation of the general relativistic gravitational redshift for a spherically symmetric gravitating body has been shown to be of the form [18]-[21] [44]-[46]:

$$1+z=\left(1-2GM/c^{2}R\right)^{-1/2} \tag{3}$$

where M is the gravitational mass and R the distance from the source, G is the gravitational constant and c the speed of light.

The Newtonian limit for the relativistic field is then [46]:

$$z=GMR^{-1}c^{-2} \tag{4}$$

The redshift data of Perlmutter *et al.* [14] and Schmidt *et al.* [15] is consistent with Equation (4) assuming a constant mass M as discussed below. The measured redshift data in the higher redshift region presented by Shirokov *et al.* [16] shows behaviour more consistent with Equation (3) where the value of $n = -0.80$ shows deviation from the Newtonian limit as expected at ever increasing field strengths. In short, the observed redshift distance behaviour fits a constant-mass gravitational potential. This is consistent with a general relativistic approach that limits to the Newtonian form [45] [49].

Assuming that the current age of the universe is 13.787 Gyr [30] and the radius is then 1.3×10^{26} m to enable an estimate of $R = 0$ to be made. The data is taken from Perlmutter where the magnitude is 25 at $z = 1$ corresponding to a distance from earth of 7.1×10^{25} m. This number is subtracted from the radius of the universe to give the number for the radius at which the potential is causing the redshift. Using Equation (4) the calculated gravitational mass giving rise to the redshifts is then 1.8×10^{23} M_{sol}. This value is 2.4 times the estimated value for the mass of the current universe at 6×10^{22} solar masses [30]. The value obtained here is the new estimate of the total mass of the early universe. Alternatively, fitting the data using the current estimate of the gravitational mass of the universe (6.0×10^{22} Ms_{ol}) requires a distance correction of 2 Gyr to fit the data. This is a significant correction to the distance scale that does not appear to be realistic.

Data plotted over the complete range of redshifts shows that z is relatively small in the later universe, our local region as shown in **Figure 1**. [17]. From **Figure 1** it is readily seen that the universe is effectively gravitationally flat in the local region for approximately one quarter of the total time of the universe has elapsed. A review of the blue and redshift data in the local region shows distinctly random behaviour that is scattered around zero redshift [9] [50]. The data presented by Rout [11] and Karechentsev [42] shows that there is significant scatter in the redshift distance data in the local universe and that the Hubble Law is not obeyed [9]. It is posited here that the local universe is in a state of diffusional Brownian motion of the galaxies in the local region as is consistent with the random nature of the observed red and blue shifts [9] [50] [51]. The significant body of blueshift data is also not consistent with Hubble's Law.

A physical interpretation is that photons are ejected from their source, SN 1a and LGRBs, that are associated with galaxies. The galaxies are in the gravitational potential of the early universe and the photons are redshifted due to the gravitational potential. The observed gravitational redshifts arise from photons escaping from the gravitational field of the primal universe that has a gravitational mass that is approximately 2.4 times that calculated for the current universe. The difference between the effective mass calculated here and the mass of the universe estimated in the current epoch may be due to the conversion of matter into energy (radiation) as the universe evolves. This value is in accord with estimates of the baryonic energy being of order of the total baryonic mass.

The gravitational interpretation suggests that the mass of the universe is being fed from a constant mass of approximately 2.4 times that of the estimated mass of the current universe. Galaxies initially evolve and reach a mature state over the distance of the gravitational potential. We postulate that the steady state universe is then in a state of dynamic equilibrium where the entropy of the galaxy distribution is opposed to the gravitational attraction in a manner similar to that posed by Hoyle [52]. We note that Einstein also originally considered the universe to be static and "similar to the molecules in a gas". He reluctantly changed his view when Hubble's interpretation became known [45] [49]. Entropy and gravitation are then postulated as the driving forces for the evolution of the universe that is tending to an equilibrium state in the limit of time. The cosmological constant, Λ, is then a measure of the entropy of the universe [45] [49] [53]. We can then write;

$$\Lambda = TS \tag{5}$$

where T is the absolute temperature and S the entropy.

3. Conclusion

We have shown that attribution of the measured redshifts to gravitation, assuming a constant mass of 1.8×10^{23} M_{sol} fits the data. This value is 2.4 times the estimates of the current mass of the universe. The gravitational interpretation implies space-time curvature of the early universe that extends for approximately three quarters of the radius of the current universe. The Hubble-Lemaitre Law and the expanding universe is replaced by a gravitational model. Interpreting the measured redshifts as gravitational redshifts also negates the requirement of dark energy to understand the accelerating universe. The cosmological constant Λ, is a measure of the entropy of the universe.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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