The Cosmological-Redshift Explained by the Intersection of Hubble Spheres

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The cosmological redshift is described by the intersection of two Hubble spheres, where a *Hubble sphere* is defined as a range over which spherical, quantum-waves interact, specifically $R_u = 1.9 \times 10^{26}$ m.

Keywords: redshift, Hubble, quantum waves

1. Introduction

It becomes apparent when we are looking into the Universe at further distances from our reference point that the objects we observe are linearly-redshifted with distance. This has been interpreted as Hubble's Law which requires the use of standard candles such as Cepheid variables. There is little reason to doubt the standard candle concept – astrophysical concepts should be valid at all points of our Universe and the periodic nature of Cepheid variables should still be valid at cosmic distances. The interpretation of the red shift as a linear increase of velocity with distance, however, should be evaluated more closely, as there is another potential explanation for Hubble's Law that will be examined in this paper.

The following theory of Hubble spheres is advanced to explain the cosmological redshift, where the observed redshift is viewed as a decrease in intersecting volume and energy between two Hubble spheres, where a Hubble sphere is defined as the range over which spherically-symmetrical quantum waves propagate.

In wave-structure of matter (WSM) theory, "particles" are modelled as a combination of spherically-symmetrical quantum waves as described by *Milo Wolff* [1,3], where a particle is observed at the center of a set of "IN" and "OUT" spherical waves [1,4]. The particles in a Hubble sphere in turn define a mass-energy density that is the basis of the energy decrease as a function of distance between two intersecting Hubble spheres. Therefore, the elastic nature of the space fabric defines the energy exchange between two intersecting Hubble spheres, and this constant decrease in energy versus distance is shown to be a constant elastic force across the radius of each Hubble sphere. Although the quantum wave model of particles has been explored [1], the questions that remain pertain to the speed of the quantum waves and the elasticity of the space fabric in which the waves propagate, both of which will be determined in the theory that is developed.

2. Theory of Hubble Spheres

The Doppler interaction of two spherical quantum waves has been shown to describe the quantum and relativistic effects of the electron [1]. In this model, the "IN" waves which arrive from a distant point in our Universe interfere with the "OUT" waves leaving the center of what we observe as a particle, to create spherical standing-wave shells. The first maxima of the interference pattern are located at the wave center and the defining position of a particle. The resonance pattern between two electron quantum waves is the inter-modulation product of the waves, and this resonance pattern is the photon we view [1].

As the quantum wave amplitude attenuates as the inverse of distance from the electron being studied [1], the amplitude of the resonance pattern (inter-modulation product) between the two electron waves decreases with the inverse of distance-squared between the electrons. This is the fundamental reason why photons emitted from electron transitions at a distant point are redshifted relative to our position. The quantum waves from the electron that is transitioning at a distance relative to the electron in our local photosensor experience a decrease in energy by the time it reaches our sensor electron, and the photon that is induced as a result of resonance between the two electron waves is also reduced in energy. From $E = h\nu$, we know that the decrease in resonance energy of the photon translates to a decrease in wavelength as a function of distance.

As electrons are modelled as spherical standing waves in WSM theory [1], the attenuation of the resonance pattern between two quantum waves with distance can be modelled as the intersection of two spheres each of radius $R_u = 1.9 \times 10^{26}$ meters, as the quantum waves are assumed to attenuate quickly beyond this distance, similar to profile of the strong nuclear force at 10^{-15} meters. A plane that bisects the intersecting volume between the two spheres intersects a common line between the center of the spheres as show in Figure 1. This intersection point on the x-axis, if this axis is drawn through the center of both spheres, is equal to one-half the distance between the two electrons which are in resonance.

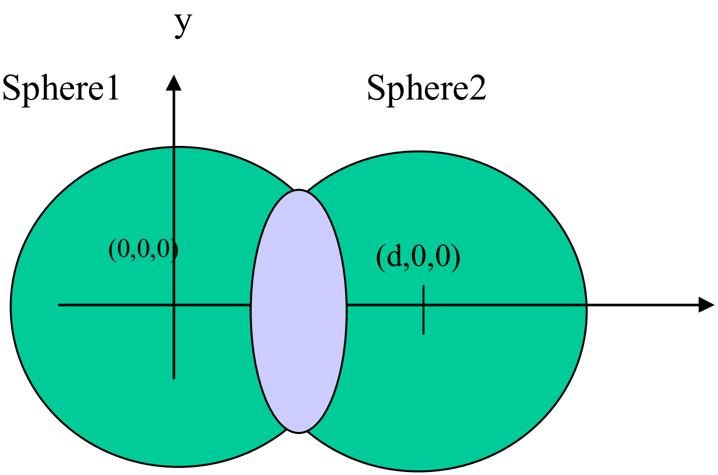

Figure 1. Hubble Sphere's 1 and 2 Share an Intersecting Volume

Figure 1 demonstrates this graphically, with the blue shaded area being the volume of intersection between the two Hubble spheres. Distance d is the x-coordinate of sphere 2 with respect to the origin of sphere 1 (our reference frame). This is the distance that we view from our local frame of reference to another object and the larger this distance, the smaller the amount of blue-shaded volume in Figure 1. When $d = 2\ R_u$ the spheres no longer have a common volume and the energy associated with the blue-shaded region in Figure 1 is zero.

When $d < 2R_u$ there is a finite, non-zero amount of energy as a result of the intersection of the spheres (the blue-shaded area representing this energy) and this intersecting volume of energy is now spread over both spheres equally when we observe an object at distance d from us. The energy density, ρ of our Hubble sphere can be evaluated as:

$$\rho = \frac{M_U c^2}{\frac{4}{3}\pi R_U{}^3} = 4.51\times 10^{-10}\,\text{Joules m}^{-3} \tag{1}$$

where: $M_u = 1.44 \times 10^{53}$ Kg, $R_u = 1.9 \times 10^{26}$ m, and $M_u c^2$ is the rest energy of all the matter in our Hubble sphere. For two spheres of radius R, the volume of the intersection between the two spheres can be found from:

$$V = \frac{\pi\,\left(16R^3 - 12dR^2 + d^3\right)}{12} \tag{2}$$

where: d is the distance between the centers of the spheres as shown in Figure 1. The volume found in (2) is proportional to the energy in common between the two spheres as both spheres are assumed to have an energy density given by (1). The partial derivative of (2) with respect to d is the change in intersecting volume that we observe as we look out into space as a function of distance d:

$$\frac{\partial V}{\partial d} = \frac{\pi}{12}\,\left(3d^2 - 12R^2\right) \tag{3}$$

where: $R = R_u = 1.9 \times 10^{26}$ meters and d is the distance we view into space from our reference frame.

We will assume that the energy density of our Hubble sphere in (1) is constant and uniform. In order to find the energy density as a function of distance d, we multiply (3) by (1) to get:

$$\frac{\partial\ \text{Energy}}{\partial d} = \frac{\pi}{12}\,\left(3d^2 - 12R^2\right)\,\left(4.51\times 10^{-10}\ \text{Joules m}^{-3}\right) \tag{4}$$

As can be seen by (4), the change in energy that we view in space as a function of decreasing distance as d increases. At our vantage point of $d = 0$, our sphere occupies the same sphere as other local matter and the energy due to redshift that we observe is maximum.

As we look farther into space and d increases, the energy we observe from emitted light decreases and finally becomes zero at d = 2R, which is what we saw in Figure 1 when the spheres have no common point of intersection at 2R.

The constant in (4) is evaluated when d = 0 and has units of force (energy per unit distance) with a value of $\pi(-12R^2)(4.51 \times 10^{-10}\ \text{J/m}^3)$, which when we substitute $R = R_u = 1.9 \times 10^{26}$ m produces a force constant:

$$\text{Force}\Big|_{\text{d=0}} = -\pi R^2 \left(4.51\times10^{-10}\ \text{Joules m}^{-3}\right) = -0.5\times10^{44}\ N \qquad (5)$$

Note the negative sign in (5), similar to the familiar force equation F = -kx. We now consider the energy of the Hubble sphere again as $M_u c^2$. From the discussion in the introduction about the space fabric being elastic so that spherical quantum waves are propagated in this elastic medium, there must be an elastic constant k for the space fabric. As the solution to a spherical wave equation is a scalar, the elastic constant of this fabric is also a scalar and the simplicity of scalar formulas may be used in the evaluation of force and energy relations for the fabric. From previous examinations of the four forces and the range of their "particles" we arrive at a value of $k = 7.18 \times 10^{17}$ N / m [2]. In addition, the scalar equation for the speed of waves in an elastic medium verifies the speed of the spherical quantum waves as c:

$$\text{speed} = \sqrt{\frac{F}{\sigma}} = c \qquad (6)$$

where: $F = kR_u$ and σ is the mass-per-unit length of the elastic space fabric, $\sigma = \dfrac{M_u}{R_u}$. Interestingly, since $H = c / R_u$, we find from (6) that

$$H = \sqrt{\frac{k}{M_U}} = 50 \text{ Km sec}^{-1} Mpc^{-1} \tag{7}$$

which is within the same order of magnitude of currently measured values of H. It can also been shown [2] that the rest-energy of the Hubble sphere, $M_u c^2$ is equal to the potential energy of the Hubble sphere when it's space fabric is compressed over the distance R_u:

$$Energy = M_U c^2 = \frac{1}{2} k \ R_U{}^2 \tag{8}$$

Substituting $x = R_u$ in (8) and using $k = 7.18 \times 10^{17}$ N/m and $R_u = 1.9 \times 10^{26}$ m, we find the differential energy per unit length of (8) as:

$$\text{Force}\Big|_{x=R_U} = \frac{\partial}{\partial x}\left(\frac{1}{2} kx^2\right) = kR_U = -1.36 \times 10^{44} \text{ N} \tag{9}$$

Compare this value of differential energy per unit distance to that found in (5) from the intersecting sphere model – within the same order of magnitude and within the error based on measured values of M_u and R_u.

Let us again examine (2), which is the formula giving the common volume between two intersecting Hubble spheres. If we take the ratio of this intersecting Hubble sphere volume (Volume_{com}) in (2) to that of the volume of our local Hubble sphere (Volume_{loc}) we obtain

$$\frac{(Volume)_{com}}{(Volume)_{loc}} = \frac{\dfrac{\pi\left(16R^3 - 12dR^2 + d^3\right)}{12}}{\dfrac{4\pi R_U^3}{3}} = 1 - \frac{3d}{4R} + \frac{d^3}{16R^3} \tag{10}$$

The resulting expression in (10) is the ratio of energy between intersecting Hubble spheres as a function of distance d to the energy existing in our sphere when d = 0. This is similar to the energy-per-length formulas derived from (4) through (9) except that instead of looking at how energy changes with distance, (10) compares the energy in our current reference frame (d=0) to the energy we view at some distance d when there is less intersection between our sphere and a neighboring one. As the expression in (10) is the ratio in the change of energy from d = 0 to a variable d, it can be related to E = hν and then the ratio in change of energy (as viewed at some distance d) to reference energy (d = 0) is found to be

$$\frac{\Delta\nu}{\nu} = 1 - \frac{3d}{4R} + \frac{d^3}{16R^3} \qquad (11)$$

This is the Hubble relation or what is commonly referred to as z from the perspective of ν. When d = 0 then we are looking in our own solar system or close proximity we observe (Δν/ν) = 1 which corresponds to zero-redshift and therefore no energy change. When d > 0, (11) evaluates to less than 1 and steadily approaches (Δν/ν) = 0.31 when $d = R_u$. Therefore, (11) shows that energy decreases as our viewing distance increases. Also, the redshift in (11) is essentially linear with d until d is large, consistent with observations as the current Hubble estimate is now found to be slightly non-linear at high z.

3. Conclusions

It is possible to model the current cosmological redshift as an energy decrease per distance based on the interaction of spherical quantum waves, which are postulated to define mass-energy density based on previous investigations [1]. In this paper, quantum waves are postulated to have a limited range of $R_u = 1.9 \times 10^{26}$ meters, which defines a Hubble sphere around a point of observation, where the observation of distant objects appears to be redshifted with reference to our local sphere. The redshift is due to the reduced interaction between quantum waves of our local sphere and the quantum waves of the sphere that is centered around the distant object. As we look further from our reference point, our sphere and surrounding spheres have less common volume which, based on a constant energy density in the spheres, results in a redshift in the emitted light from the distant object. The quantum waves are shown to propagate in an elastic medium at the speed of light where the energy between intersecting Hubble spheres is shown to be equivalent to the potential energy in the medium.

4. Acknowledgements

Thanks to Milo Wolff and Ioannis Haranas for their valuable comments and suggestions.

References

[1] Wolff, Milo, *Exploring the Physics of the Unknown Universe*, pp. 179-187, Technotran Press. (1990)

[2] Harney, Michael, "Quantum Foam," *Journal of Theoretics Comments Section* Vol. 6-5 (Oct/Nov. 2004) www.journaloftheoretics.com

[3] Schroedinger, Erwin. in Moore- *Life of Schroedinger*, p 327, Cambridge U. Press 1989.

[4] Wheeler and Feynman, "Interaction of the absorber as the Mechanism of Radiation", RMP, 17, 157-181,1945.