Gravitational Cosmic Redshift with Variable Light Speed

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'Dissident' physicists have postulated various alternative explanations for the alleged cosmic expansion due to the Big-Bang-induced and dark-energy-sustained ever-increasing expansion of space(-time). Among these is the effect of gravity which allegedly 'stretches' light waves (and allegedly also bends them via gravitational lensing) as they pass large masses, such as stars, galaxies or galactic clusters. The stretching phenomenon is an increase in wavelength, and corresponding decrease in frequency, required by the assumption that light speed remains constant (within a medium). If light speed is variable, would there also be a gravitational cosmic redshift, i.e., one that alters light speed without affecting the waveform itself (i.e., no 'stretching')?

1. Introduction

The examination here does not make a case for or against gravity being the cause (or one of the causes) of the cosmic redshift, alleged by mainstream cosmology to be the sole result of an ever-expanding space(-time) started by the Big Bang and sustained by dark energy. 'Dissident' physicists have proposed alternate explanations, many of which fall into the 'tired light' arena, as well as some unique others, one of which I will discuss below. (For a comprehensive synopsis of the various 'tired light' theories, see Reference 1.) I reside in the skeptic camp regarding whether gravity affects light, somewhat influenced by the work of E.H. Dowdye, Jr., regarding inconsistencies in the general relativistic explanation for 'gravitational lensing.' [2] Nonetheless, for the purpose of this paper, I will assume gravity can affect light.

Gravity is alleged to 'stretch' light waves, resulting in longer wavelength and lower frequency, corresponding to a redshift under the constraint of constant light speed (within a medium). As explained by mainstream physics [3]:

> "The gravitational weakening of light from high-gravity stars was predicted by John Michell in 1783 and Pierre-Simon Laplace in 1796, using Isaac Newton's concept of light corpuscles … and who predicted that some stars would have a gravity so strong that light would not be able to escape. The effect of gravity on light was then explored by Johann Georg von Soldner (1801), who calculated the amount of deflection of a light ray by the sun, arriving at the Newtonian answer which is half the value predicted by general relativity. All of this early work assumed that light could slow down and fall, which was inconsistent with the modern understanding of light waves. Once it became accepted that light was an electromagnetic wave, it was clear that the frequency of light should not change from place to place, since waves from a source with a fixed frequency keep the same frequency everywhere. One way around this conclusion would be if time itself were altered—if clocks at different points had different rates. This was precisely Einstein's conclusion in 1911. He considered an accelerating box, and noted that according to the special theory of relativity, the clock rate at the bottom of the box was slower than the clock rate at the top ... Using the principle of equivalence, Einstein concluded that … the rate of clocks … at different heights was altered according to the gravitational field ... Einstein reproduced the incorrect Newtonian value for the deflection of light in 1909. But since a light beam is a fast moving object, the space-space components contribute too. After constructing the full theory of general relativity in 1916, Einstein … calculated the correct amount of light deflection – double the Newtonian value. Einstein's prediction was confirmed by many experiments, starting with Arthur Eddington's 1919 solar eclipse expedition. The changing rates of clocks allowed Einstein to conclude that light waves change frequency as they move, and the frequency/energy relationship for photons allowed him to see that this was best interpreted as the effect of the gravitational field on the mass–energy of the photon."

I have questioned the need for constraining light to a constant speed to explain the cosmological redshift and other alleged relativistic effects. [4-10] In my research, I recently discovered a quite unique explanation for the cosmic redshift that combines both aether theory and gravitational effects. I examine this briefly below to set the stage for my own analysis of the possibility of a gravitational explanation for the cosmic redshift unconstrained by a constant light speed.

2. Ranzan's 'Dynamic Steady State Universe'

On his website [11] and in his paper [12], Conrad Ranzan proposes a unique theory to explain the cosmic redshift which allows for expansion within 'cells' in a non-expanding universe. Naming this 'The Dynamic Steady State Universe" (DSSU), Ranzan describes how the "cosmic cell structure is … intimately tied to the mechanism of gravity. And this mechanism of gravity is an aether theory of gravity. In the context of the cosmic-scale cell structure, the theory essentially states that the space medium expands, flows, and contracts — with the expansion and contraction occurring in separate regions. It is these separate regions that define and sustain the universe's cellular structure ... The DSSU, as a model of the real universe, is structured as cosmic cells, … [which] induce a cosmic redshift on the light travelling through them. "

At the risk of overly simplifying Ranzan's explanation, his 'cells' are approximated as spheres "divided into regions of expanding space medium and contracting space medium.

According to DSSU theory, the two dynamics are balanced. The sphere itself neither expands nor contracts. Residing at the sphere's center is the galaxy cluster." Ranzan contends that the galaxy cluster causes an inflow (acceleration) of the aether, which acts to 'stretch' a light waveform (increase the wavelength) whether light is incoming (moving toward the galaxy cluster) or outgoing (moving away from the cluster) within a cell. The key is a differential between the 'front' (the part closest to the cluster) and 'back' (the part farthest from the cluster) of the waveform. The front part always experiences the greater acceleration due to the aether, which accelerates as it approaches the cluster, such that a differential is established across the wave, resulting in a 'stretching' that corresponds to elongating the wavelength (lowering the frequency), resulting in a redshift. Thus, as light traverses a cell, it is stretched throughout its passage, and light continuously 'reddens' as it travels from its source. Of course, this stretching is a consequence of light having a constant speed, which Ranzan accepts.

Figure 1 illustrates progressive wavelength elongation according to Ranzan's DSSU theory. His 'typical' galaxy cluster is based on Virgo, with an estimated mass of 1.2 x 10^{15} solar masses and radius of 7.2 x 10^{6} light-years (ly), each located at the center of a 'cell' 2 x 10^{8} ly wide.

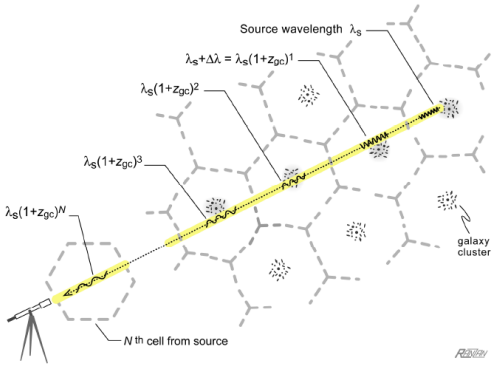

Figure 9. Progressive wavelength elongation in a cellular non-expanding universe. Each gravity cell has a nominal diameter of 200 million lightyears and imparts a proportional stretch to the propagating photon. The parameter z_{GC} is the redshift index across a typical cell.

FIGURE 1. Ranzan's Illustration of Progressive Wavelength Elongation as Light Traverses Multiple 'Cells' [12]

With these assumptions, Ranzan estimates an average inflow speed of aether within each cell toward the cluster of 2 x 10^{-5} km/s-ly. He then calculates the redshift from the DSSU model and compares it with that from the 'most popular version of the Big Bang' (the ΛCDM 'theory curve'). As shown in Figure 2, the agreement is excellent.

3. Cosmic Redshift Due to Gravity with Variable Light Speed

I attempt neither to confirm nor refute Ranzan's theory, but cite it as a starting point from which to consider a purely gravitational cause (with or without aether) for the cosmic redshift without the constraint of a constant light speed. I adopt Ranzan's cosmic geometry (indifferent to whether or not the cellular structure exists) to the extent that I consider galaxy clusters of mass 1.2 x 10^{15} solar masses each, 2 x 10^{8} ly apart, i.e., six clusters from position zero [from which light is emitted at speed c = (3 x 10^{5} km/s)(86400 s/y) = 9.46 x 10^{12} km/y = 1 ly/y] to 1 x 10^{9} ly. As soon as the light is emitted, it 'feels' a gravitational restraining force per unit mass (i.e., an acceleration) from the first (emitting) cluster of GM/D^2, where G = (6.67 x 10^{-11} m^3/kg-s)(86400 s/y)(0.001 km/m)^3/(9.46 x 10^{12} ly/y) = 2.10 x 10^{-12} km^3/kg-y; M = (1.2 x 10^{15})(1.99 x 10^{30} kg) = 2.39 x 10^{45} kg; and D = distance from point zero at time 't' in y.

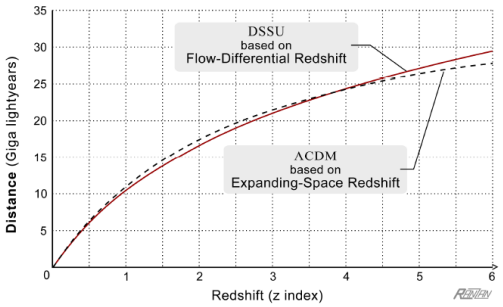

Figure 10. Cosmic redshift versus cosmic distance. The velocity-differential interpretation of cosmic redshift fits the narrow observational evidence just as competently as the expanding-space interpretation. The real difference lies with the fit to the broader evidence. The profound difference is that the first is based on the intrinsic cellular structure of the universe and the intrinsic properties of the photon, while the second requires an exploding universe —a wholly unnatural concept. (DSSU model specs: z_{GC} = 0.0134, D_{GC} = 200 Mly; ΛCDM model specs: H_0 = 70.0 km/s/Mps, Ω_M = 0.27, Ω_Λ = 0.73, distance is "now" distance.)

FIGURE 2. Ranzan's Comparison of Cosmic Redshift Based on DSSU Theory and the Big-Bang ΛCDM Model [12]

Simultaneously, it feels gravitational attractive forces per unit mass (accelerations) from each of the remaining five galaxy clusters of GM/D_i^2, where G and M are the same and D_i = distance from galaxy cluster 'i' (i = 2 through 6) in ly. The net force per unit mass (acceleration) is the sum of these six forces per unit mass (accelerations). Estimating the net acceleration in units of 10 ly (starting at 1 ly to avoid the complication of D = 0), I estimate the speed of light during each interval 'j' as V_j + (net acceleration)$_j$ x (time interval = 10 y), where V_0 = c. Naturally as light passes each galaxy cluster, previous attractive forces become restraining forces until the calculation is terminated just before the light reaches the sixth cluster (again avoiding the complication of D_6 = 0). I next repeat this calculation over the much greater distance of 1 x 10^{10} ly, spacing 'composite' galaxy clusters of mass 5M (1.19 x 10^{46} kg) each, 2 x 10^{9} ly apart, i.e., six composite clusters from position zero (from which light is emitted at c = 9.46 x 10^{12} km/y = 1 ly/y) to 1 x 10^{10} ly. The calculation parallels the previous.

Figure 3 presents the results from my two calculations. Both indicate very slight, but steady linear decreases in light speed over the cosmic distance, whether 1 x 10^{9} ly for the first case or 1 x 10^{10} ly for the second. (Note that Figure 3 plots decrease in light speed vs. distance – thus, the positive slopes indicate reduction in light speed.) Based on my postulate that light maintains its waveform unless refracted (see references 4-10) and the fact that 'color' (loosely using

this term to distinguish not only among the visible light spectrum but across the entire spectrum, from gamma to radio waves) is determined solely by frequency, I too indicate a cosmic redshift due solely to gravity. Given a constant waveform (i.e., invariant wavelength), any change in speed must be manifested by a change in frequency. Therefore, as light speed slows, frequency decreases and light 'reddens.'

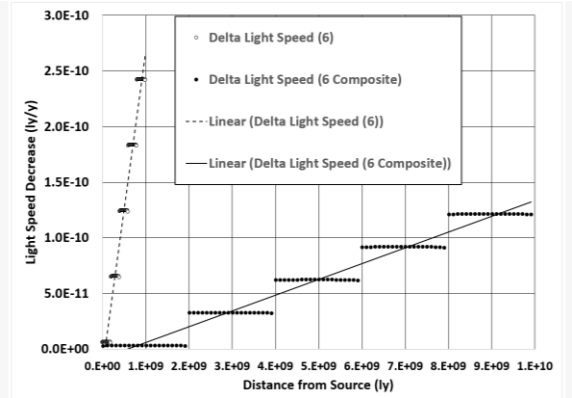

FIGURE 3. Decrease in Light Speed vs. Distance from Emitting Source due to Gravity

Commenting on the potential for gravity as an explanation for the cosmic redshift, Ranzan states [12]:

> "The gravitational redshift can be quite significant for massive, dense, compact stars or star-like objects. But for ordinary stars, as well as extended structures, it is a surprisingly weak effect …. [A] photon emitted from the [Sun's] surface … acquires a small redshift of only 2.1 parts per million … [A] photon that has escaped the gravity well of the Milky Way galaxy … [acquires a redshift of] 0.001 which is still rather small … A photon emitted from [the] nominal 'surface' … [of an entire galaxy cluster, say the rich Virgo cluster] will accumulate an astonishingly small redshift of only 2.5 parts per million — assuming, of course, that the 'general relativity' effect is the only one at play … Evidently the gravitational mechanism is far, far, too weak to serve as a realistic explanation for the cosmic redshift. *[my emphasis]*"

My results align with Ranzan's observation – for the two cases analyzed, the redshift is negligible (less than one part in a billion).

4. Conclusion

Current physics cites waveform 'stretching' as the effect of gravity that would cause the cosmic redshift, upholding the assumption that light speed is constant (within a medium). Ranzan has proposed a quite unique alternative theory for the cosmic redshift based on a cellular structure for the universe with accelerating aether. Using his geometry (indifferent to the cellular aspect), I attempted to show that a gravitationally-based cosmic redshift is possible without the constraint of constant light speed. Like Ranzan, my results show such a redshift would be negligible, unlikely to be the sole explanation for the cosmic redshift. Nonetheless, it demonstrates that the constraint of constant light speed (within a medium) need not be applied to explain at least one of the alleged causes of the cosmic redshift.

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