Possible alternative interpretations of the 'cosmological red shift' which can do away with the Dark Energy

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ABSTRACT

The currently popular 'Big Bang Theory' is based on 'Doppler Shift Interpretation' of the 'cosmological-red-shift'. But it is shown here that the value of Hubble-constant matches so perfectly with the strength-ratio of gravitational and electric forces, that such a coincidence is very un-likely. Secondly, if the expansion of the universe is accelerating, as the recent observations suggest, e.g.(Paal, G. *et al.* 1992, Adam G. Riess *et al.*1998, and Perlmutter, S. *et al.*1999)[1,2,3], then very large amount of dark-energy may be needed which is still not found. Therefore, it is proposed here that extra galactic photons may be loosing some of their energy through 'vacuum polarization', as described by Levine, I. (1997)[4] and Brown et al (1996)[5]. It is proposed here that: when an extra galactic photon is absorbed by either electron or positron of the virtual electron positron pair, then not only the 'electrostatic potential energy' of the pair is increased, but also its 'gravitational potential energy' as well; but when these 'potential energies' are released, then not only a photon, but also a graviton is emitted; so the input energy gets branched out. And we find here that the energy lost by the 'cosmologically red shifted photons' is strikingly proportional to the 'strength ratio' of gravitational and electric forces. Since, according to this new interpretation for the 'cosmological red shift, the red-shift is a function of distance traveled by the photon, rather than relative velocity of the galaxies; so this study will also do away with the need for 'dark energy'. In addition to this, four more alternative possibilities for the red shift are also indicated.

1. Introduction:

If the universe were expanding due to the big bang, then the value of Hubble-constant could have been any. But the measured value of Hubble-constant matches so strikingly with the strength-ratio of gravitational and electric forces, and some other constants, as this study reveals, that we get the strikingly interesting relations, as derived in the next section; which motivate us to consider alternative mechanisms for the 'cosmological red shift'. Alternative mechanisms for the 'cosmological red shift' have been rejected so far, under an assumption that they are not compatible with the observations of 'time dilation of super novae light curves'; but it was shown by this author in (Tank, H. K. Adv. Studies Theor. Phys., Vol. **7**, no. 18, 2013)[6] that any mechanism which can cause 'cosmological red shift', will also cause 'time dilation of super novae light curves'. The following derivations will indicate the need for reconsidering the Doppler shift interpretation of the 'cosmological red shift' and the 'Big Bang Theory'.

Interesting difference between the standard Doppler-shift-interpretation (in which red-shift is a function of relative velocity), and the proposed new one here, of branching-out of input-energy into gravitational and EM-waves, (in which red-shift is a function of distance traveled by the photon), is: that after every unit-distance, say one-light-year, the red-shifted-frequency *f* becomes the new input-frequency f_0 for the next unit-distance; making the red-shift-distance-curve non-linear, as observed by Perlmutter and Riess; like the telescopic-railway-fare, or like the reducing piano-frequency which gets divided by 1.104 with every key. So, according to this new explanation for the 'cosmological red shift', there is no need for any 'dark energy'. As soon as 'cosmological-red-shift' gets understood as a propagation-property of light, then 'gravity' can be understood as due to 'cosmological-red-shift-effect' on the photons exchanged between the particles.

2. The Derivations:

The cosmological red-shift, smaller than unity, is expressrd as:

$z_c = \Delta\lambda / \lambda_0 = H_0 D / c$.....(1).

i.e. $H_0 D / c = h H_0 / (h c / D)$.

Now, Weinberg has found an interesting relation that:

$m_p^3 = h^2 H_0 / c G$, where, m_p is mass of a fundamental-particle, pi meson.

i.e. $G m_p^2 / (h / m_p c) = h H_0$ . .....(2).

So, from the expressions 1 and 2, we get:

$z_c = \Delta\lambda / \lambda_0 = [G m_p^2 / (h / m_p c)] / [h c / D]$. ……...….....(3).

i.e. $z_c = \Delta\lambda / \lambda_0 = [G m_p^2 / h c] [D / (h / m_p c)]$.

i.e. $z_c = h \Delta\nu / h \nu = [G m_p^2 / h c] [D / (h / m_p c)]$. ……..….....(4).

That is, the reduction in energy of photon due to cosmological-red-shift is proportional to the strength-ratio of gravitational and electric forces.

Alternatively, let us define z_e as:

$z_e = [e^2 / r_e] – [e^2 / (r_e + D)] / [e^2 / (r_e + D)]$, where, *e* is electric-charge, r_e is 'classical radius of electron' and *D* is 'luminosity distance'.

i.e. $z_e = e^2 [r_e + D – r_e] [r_e + D] / [r_e (r_e + D) e^2]$.

i.e. $z_e = D / r_e$.

From Dirac's Large-Number-Coincidence, we know, that:

$(G\, m_e\, m_p / e^2) = (r_e / R_0) = (m_p / M_0)^{1/2} = 10^{-40}$, where, M_0 total mass and R_0 radius of the universe.

i.e. $z_e = 10^{40} (D / R_0)$. ……..(5).

Since $H_0 R_0 = c$, $z_c = H_0 D / c = D / R_0$. ……..(6).

Comparing the expressions (5) and (6), we get:

$z_c = 10^{-40} z_e$. ……...(7).

That is: 'cosmological-red-shift', at a distance D is $(G\, m_e\, m_p / e^2)$ times the reduction expected from the 'electrostatic potential energy' of an electron at that distance D.

Secondly, the 'self gravitational potential energy' of a fundamental particle also matches strikingly with the energy $h\, H_0$ as follows:

$G\, m_p^2 / (h / m_p\, c) = h\, H_0$, ……(8)

where, m_p is mass of pi-meson, h is Planck's constant, H_0 is Hubble constant, G is gravitational-constant, and c the speed-of-light. This relation is derived from the Steven Weinberg's famous formula, $m_p^3 = h^2 H_0 / c\, G$, where, m_p is mass of a fundamental-particle, pi meson.

Thirdly, in addition to the above, the ratios:

$(h\, H_0 / m_p\, c^2) \sim (G\, m_e\, m_p / e^2)$. ……..…(9).

These expressions can be made exactly equal by inserting masses of different fundamental particles in the expressions, e.g. $(G\, m_e\, m_p / e^2)$ or $(G\, m_p\, m_p / e^2)$, $(G\, m_e\, m_e / e^2)$ or $(G\, m_e\, m_{pi} / e^2)$…etc. Secondly, the currently measured value of Hubble constant may be lesser than the actual value, because, when the extra galactic photon enters our milky-way galaxy, the photon also experiences some gravitational blue shift; so we may be measuring lesser value of Hubble constant. We may need to launch Hubble like telescope out side our milky-way galaxy to get exact experimentally-measured value of Hubble constant!

The above relations strongly suggest that 'cosmological-red-shift' seems to be related to the strengths of gravitational and electric forces. One of the possible mechanisms for the 'cosmological red shift' may be the 'vacuum polarization'. It is well known that according to quantum field theory, the vacuum between interacting particles is not simply empty space. Rather, it contains short-lived "virtual" particle-antiparticle pairs which are created out of the vacuum in amounts of energy constrained by the Heisenberg uncertainty principle. After the constrained time, they then annihilate each other. These particle-antiparticle pairs carry various kinds of charges, such as color charge or the more familiar electromagnetic charge. In the case of Hawking-radiation, one of the particles of the pair gets swallowed by the black-hole, leaving the

other particle alone, which can be observed. Such charged pairs of virtual-particles act as an electric dipole. In the presence of an electric field of the extra-galactic-photon these particle–antiparticle pairs reposition themselves, thus partially counteracting the field. The field therefore will be weaker than would be expected if the vacuum were completely empty. During their long journey, the extra-galactic-photons are likely to interact with many virtual-particles. If a photon is absorbed by either electron or positron of the electron-positron-pair, then not only the electrostatic-potential-energy of the pair is increased, but also its 'gravitational potential energy' as well; but when these potential-energies are released, then not only a photon, but also a graviton has to be emitted; so the in-put energy gets branched-out. We found from the above derivations that the energy lost by the 'cosmologically red-shifted photons' is strikingly proportional to the strength-ratio of gravitational and electric forces.

3. Cosmological-red-shift, smaller than unity, when expressed as deceleration experienced by the photons, matches with so many different physical phenomena, other than the Doppler shift (Tank H. K. 2010)[6]:

The cosmological red shift,

$$z_c = \Delta f / f = (f_0 - f) / f = H_0 D/c \quad \ldots\ldots(10)$$

(Where: f_0 is frequency of light emitted by a distant star; f is frequency of light received on the earth; H_0 is Hubble's constant; D is luminosity-distance; and c is the speed of light in vacuum.)

We can write the expression-10 as:

$$h \Delta f / h f = H_0 D / c \,,$$

(Where, h is Planck's constant; so that $h \Delta f$ and $h f$ have the dimension of energy)

i.e. $$h \Delta f = (h f / c^2) \, \underline{(H_0 c)} \, D \quad \ldots\ldots(11)$$

That is, the loss in energy of the photon ($h \Delta f$) is equal to: its mass ($h f / c^2$) times <u>acceleration ($H_0 c$)</u> times the 'luminosity-distance' (D).

Now, Sivaram has noticed that (Sivaram, 1994)[8]:

$$G M_0/R_0^2 = G m_P / r_P^2 = G m_e /r_e^2 = G m_n /r_n^2 = G M_{gc} / R_{gc}^2 = G M_{gal} /R_{gal}^2 = G M_{cg} /R_{cg}^2$$

$$= H_0 c \quad \ldots\ldots(12)$$

(Here: M_0 and R_0 are mass and radius of the universe respectively, m_P and r_P are mass and radius of the proton, m_e and r_e are mass and radius of the electron, m_n and r_n are mass and radius of the nucleus of an atom, M_{gc} and R_{gc} are mass and radius of the globular-clusters, M_{gal} and R_{gal} are mass and radius of the spiral-galaxies, and M_{cg} and R_{cg} are mass and radius of the galactic-clusters respectively.)

And, the carefully measured values of accelerations experienced by the space-probes Pioneer-10, Pioneer-11, Galileo, and Ulysses are (Anderson, J.D., et. al. 1998)[9]:
For Pioneer-10, $a = (8.09 \pm 0.2) \times 10^{-10}$ meter/sec^2 ,

For Pioneer-11, $a = (8.56 \pm 0.15) \times 10^{-10}$ meter/sec^2,

For Ulysses, $a = (12 \pm 3) \times 10^{-10}$ meter/sec^2,

For Galileo, $a = (8.0 \pm 3) \times 10^{-10}$ meter/sec^2, and

For the cosmologically-red-shifted-photons: $a = 6.87 \times 10^{-10}$ meter/sec^2 = $H_0\, c$:

First of all, the matching of accelerations of four different space-probes, in spite of their different masses, speeds and directions, is itself a striking observation; and their matching with the deceleration of cosmologically-red-shifting-photons (Tank H. K.2010) [6], the 'critical-acceleration' of MOND, ($a_0 = 1.2 \times 10^{-10}$ meter/sec^2), and the 'accelerated-expansion' of the universe (= $H_0\, c$), can not be ignored by a scientific mind as an accidental coincidence.

4. Discussion:

This study raises a question: Can the big bang be so precise? If the universe were expanding due to the big bang, then the value of Hubble's constant could be any. The precise matching of Hubble's constant with the 'self gravitational potential energy' of a fundamental particle, as we found in the expression-2, and the energy lost by the 'cosmologically red shifting photons' at a distance D being equal to ($G\, m_e\, m_p / e^2$) times the reduction in electrostatic potential energy of an electron at that distance, as we found in the expression-7; are strikingly interesting! Secondly, the product $H_0\, c$ matches perfectly with the 'self gravitational accelerations' of the pi-meson, the nucleus, the globular clusters, the spiral galaxies, and the universe; and it also matches with the decelerations experienced by the inter galactic photon, Pioneer-10, Pioneer-11, Galileo, Ulysses space-probes, the 'critical acceleration of MOND, and the 'accelerated expansion of the universe'. Can the Big Bang be so precise, that Hubble constant matches so perfectly with so many gravitation-related quantities? Rather, this study may be found useful for finding theoretically predictable value of Hubble's constant. Currently measured value of Hubble constant may be lesser than the actual value, because, when the extra galactic photon enters our milky-way galaxy, the photon also experiences some gravitational blue shift; so we may be measuring lesser value of Hubble constant. We may need to launch Hubble like telescope out side our milky-way galaxy to get exact experimentally-measured value of Hubble constant!

Since according to this new interpretation, the ‘cosmological red shift’ depends on the distance traveled by the photon, rather than the relative velocity of the galaxy; so the red-shift-distance-curve becomes automatically non-linear, which can also do away with the need for ‘dark energy’.

Alternative Explanation for the ‘Cosmological Red Shift’ (Possibility-2):

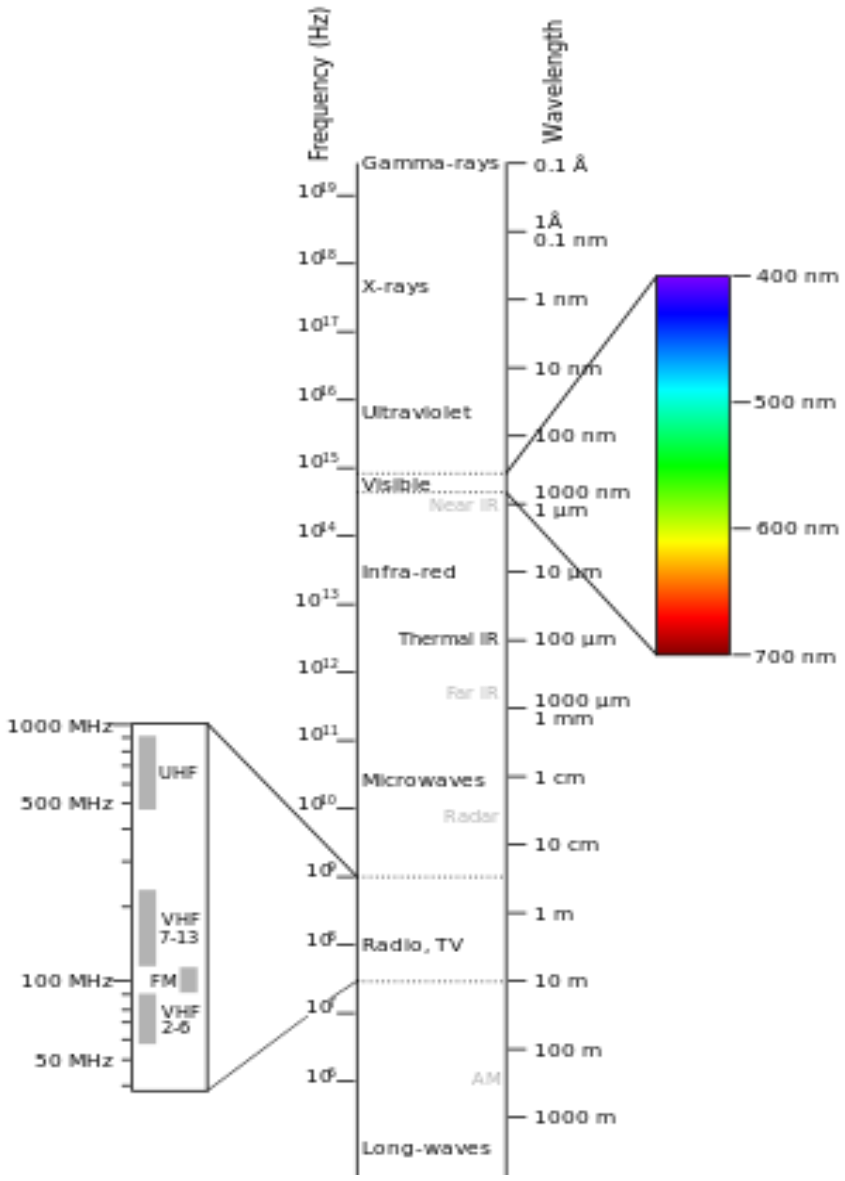

Fig.1: The electromagnetic spectrum

We know, that ‘light’ is a small band of the electromagnetic spectrum, as can be seen from the fig. 1: But in the experiments, always a ‘particle’, known as ‘photon’, is detected; which is localized in a very small region of space. So it can be mathematically represented as an impulse-function, shown in fig.2 below: (Lathi 1998, Tank 2011, 2013)

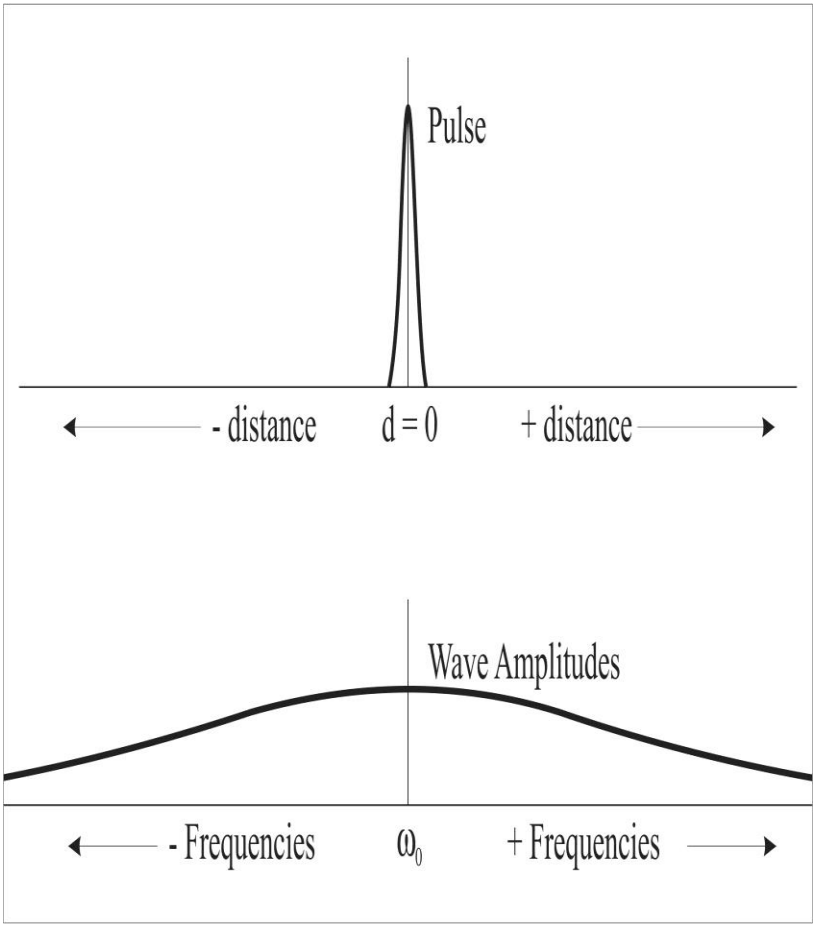

Fig.2: A single photon can be mathematically represented as impulse-function (top), which can be Fourier-transformed as a wide band of frequencies (bottom). So a ‘particle’ called ‘photon’ contains a wide band of frequencies.

If we take a small narrow band, of the total spectrum of the fig.2 (bottom), then we get a ‘wave packet’ as shown in fig.3.

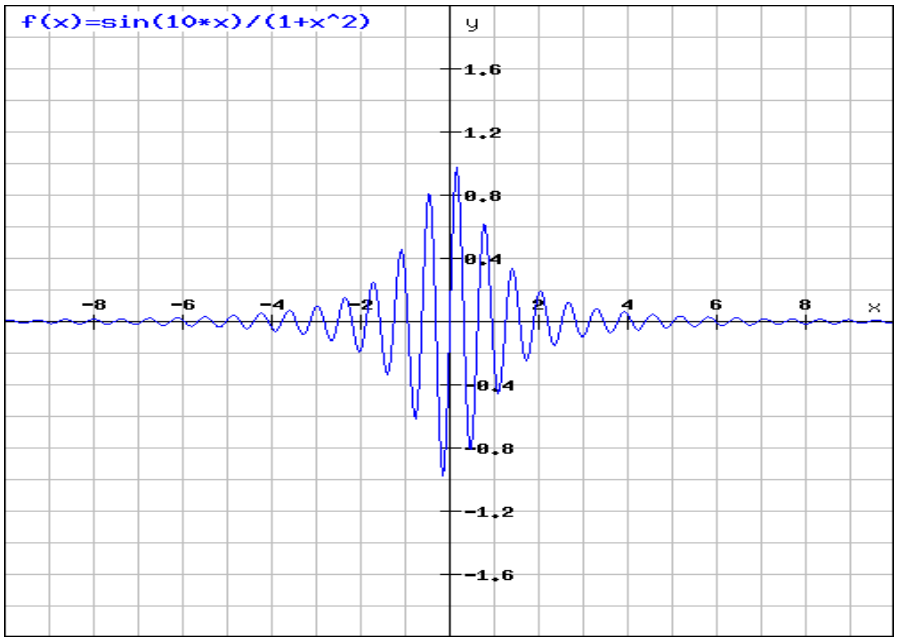

Fig.3: A small, narrow band, taken from the total wide band of the electromagnetic spectrum, looks like a wave-packet in the time domain.

From the fig.2 (top), we find that a single pulse has a continuous spectrum as shown in fig.2 (bottom). And a train of photons in space-domain or time-domain, as shown in fig.4 (top), when Fourier transformed, into frequency-domain, yields discrete spectral-lines within the same envelope, as shown in fig.4 (bottom):

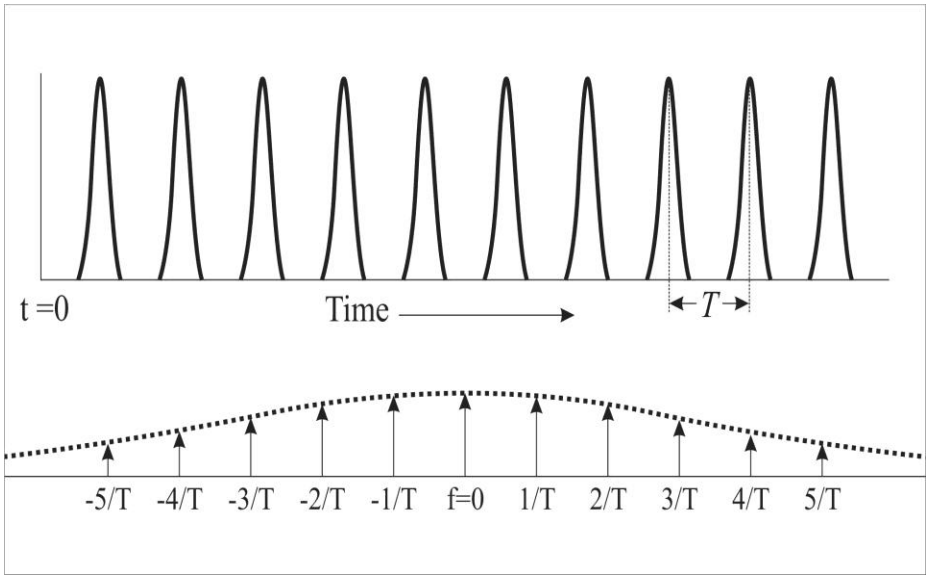

Fig.4: A train of ‘particles’ called ‘photons’ in time-domain (top), when Fourier-transformed, yields a set of discrete frequencies (bottom).

Now, as we move away from the source of light, the number of photons received in unit time and area goes on reducing, and its corresponding spectrum is expected to go on shifting towards the zero-frequency; as shown in fig.5:

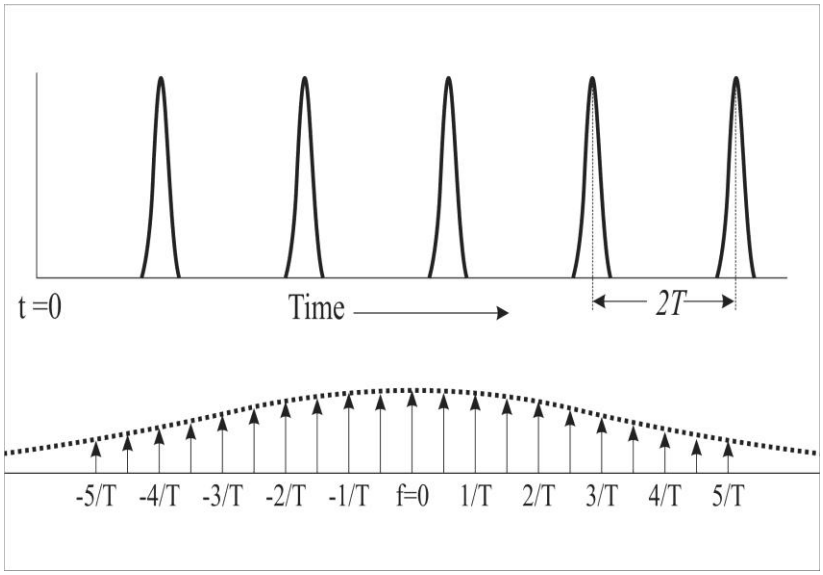

Fig.5: As the distance or time-interval *T* between the photons gets doubled, compared to the previous figure 4 (top), the corresponding ‘spectrum’ is mathematically expected to shrink, towards zero-frequency, as shown in fig.5 (bottom).

The figure-4 and 5 explain, why we observe the ‘cosmological red shift’. As the interval between the photons increase, their spectrum shifts toward zero frequency. This ‘shift-of-spectrum’ with distance would be a newly-proposed ‘propagation-property’ of spherically-expanding-light.

The intensity of light reduces with distance as:

Flux l = Luminosity L / 4 pi D^2 $(1+z)^2$,……....(1)

i.e. Flux $l\ \lambda^2$ = Luminosity L λ_0^2 / 4 pi D^2 …..…… …...(2)

Where: D is distance of a galaxy from us; and z is ‘cosmological red shift’, and λ_0 and λ wavelengths of light at the source and receiver respectively. From the expression-2 we get the

supportive evidence for our discussion based on fig. 5, that with the reduction of intensity of light, the rate of photons received by us go on reducing; and so its frequency-domain representation, goes on shifting towards zero frequency; which we have been thinking as the 'cosmological red shift'!

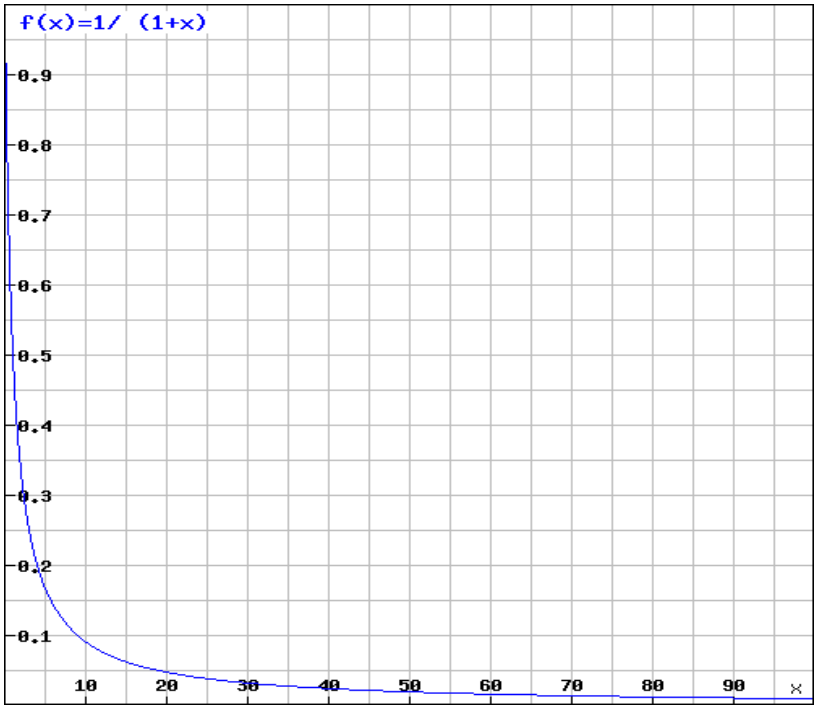

Fig.6: Intensity of light reducing with distance in wavelengths.

From the fig.6, we find that: most of the intensity gets reduced within a few wavelengths; and at very far astronomical distances the rate of reduction of intensity is very less; so we observe very less red shifts at astronomical distances. [4-5]

Alternative Explanation for the Cosmological red shift (Possibility-3)

We know that the star-light received on earth is a vector-sum of electric and magnetic fields emitted from more than one atom. Light from each atom propagates as waves in the form of concentric circles as shown in fig.4. Since there is a space-distance between emitting atoms, shown as source-1, source-2, source-3 in the fig.4, there is a phase-difference between those waves.

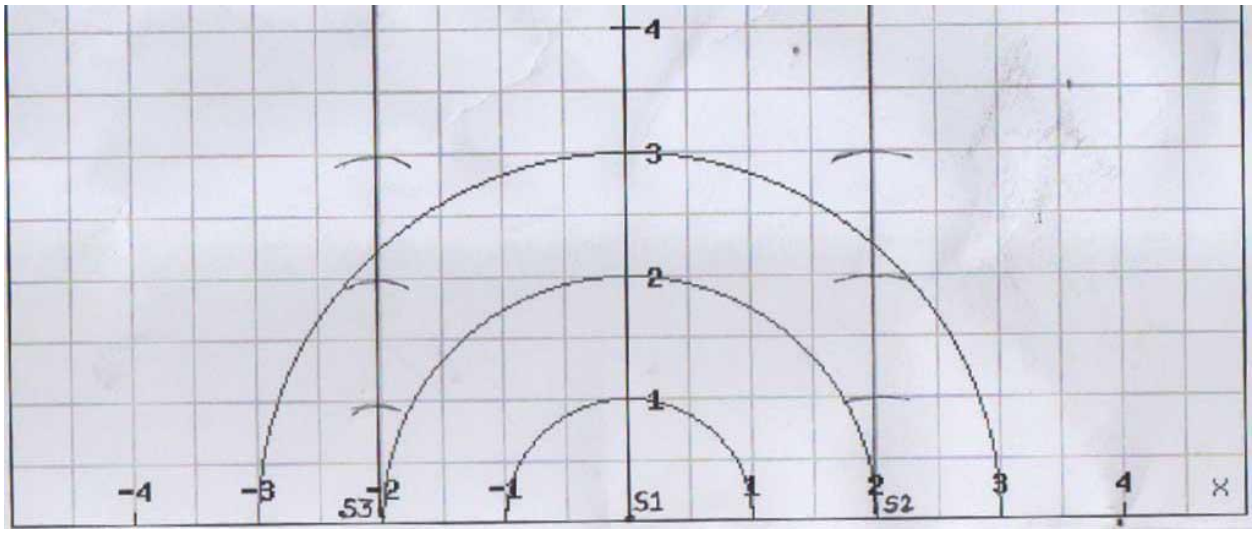

Fig.4: Showing peaks of electric fields from the source-1 at x = 0. There are two more sources of the same frequency and wavelengths located at x = 2 and x = -2 , generating electric fields like S-1.

Let us imagine that the electric field from the source-1 is a horizontal vector of 2 cm length; and electric field from source-2 is a vector at minus thirty degrees, and of 2 cm length. So, the vector sum of the two waves gets phase shifted by some angle theta. As these waves will progress in the y-direction, there will be different amounts of phase difference at different points; and different amounts of resultant phase of their superimposition at different points. And the cumulative phase alteration resulted due to multiple sources at different distances is expected to be the cause for the 'cosmological red shift'; as observed by Perlmutter (1999) and Riess (1998).

Alternative Explanation for the Cosmological red shift (Possibility-4)

The photon looks like a spindle-shaped-wave, in the time domain and space domain, as shown in fig.3; and it has a bell shaped curve in the frequency domain. Now, assuming that like any other waves, the amplitude of the spindle-shaped-wave of the photon reduces with distance. Then, like a chocolate melting in our mouth, and reducing in its size and length, the length of the spindle shaped wave of the photon would reduce as it travels in space. That is, the low-amplitude-ends of the spindle would become so low, that they are not visible on oscilloscope. And, from the Fourier transform we know, that if the duration of a pulse reduces in time domain, then its

spectrum gets widened in the frequency domain. Such a widening of the spectrum towards lower frequency, may be the reason for the observed 'cosmological red shift'.

Alternative Explanation for the 'cosmological red shift' (Possibility-5)

We know, that the electromagnetic waves of light received by us on earth, are superimposition of concentric waves generated by individual radiating atoms. For simplicity, let us consider only two concentric circles of waves produced by two sources, as shown in the fig.4 below:

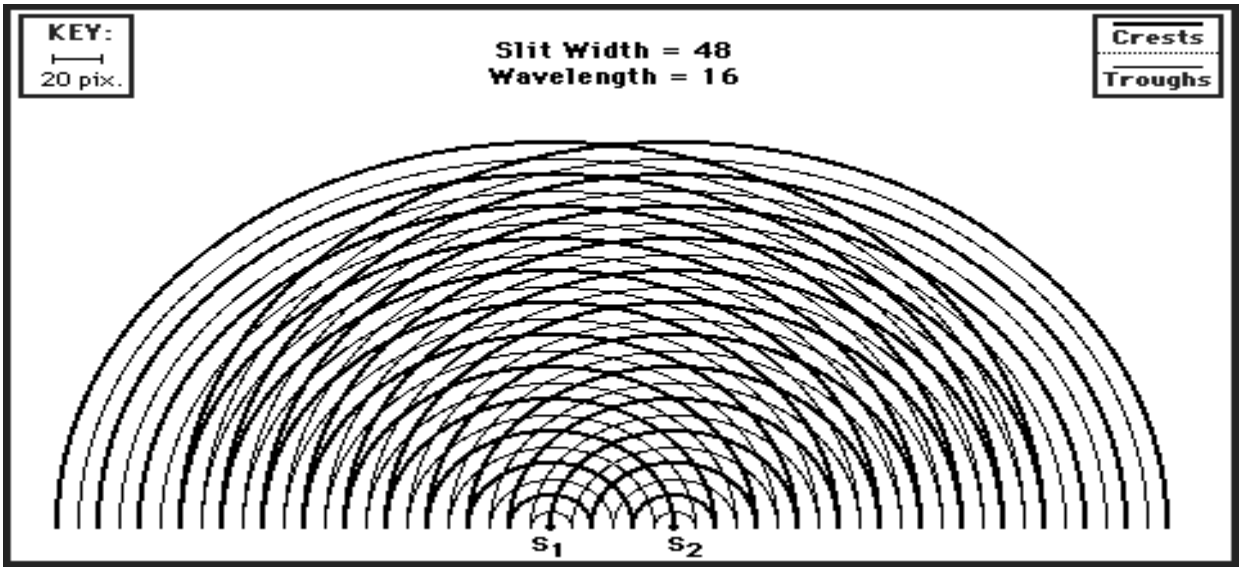

Fig.5: Concentric waves generated from the sources 1 and 2 interfering constructively at different points.

Please, carefully look at the interference of crests from the center of two sources in the y-direction, up-wards. At the close distance from the sources, the crests intersect each other at almost 90 degrees, so there is very small area of intersection. Whereas when we look at the top of the figure, where only one intersection of crests is shown, we find that the intersection of crests is spread over wide area; which means that the wave remains at the peak value for larger area in space, and time. Similarly, the troughs of the waves also remain low for larger area in space, and longer duration in time. It needs to be studied in detail, whether the 'stretching of wave', as observed in the 'cosmological red shift', is due to this effect.

Possibility-6: Spherically-Expanding-Wave of Light Viewed as an Expanding-Cavity-of-wave-guide:

Lord Rayleigh, in his 1897 paper [1], published in The Philosophical Magazine, titled: "On the passage of electric waves through tubes…" had, for the first time, derived the expression for group-velocity-of-EM-wave:

$$v_G = c\,[\,1 - (\,\lambda / 2\,a\,)^2\,]^{1/2}\,,$$

Where λ is wavelength of the EM-wave, and a is radius of the tube…….(1)

Albert Einstein, in his 1905 paper [2], published in Annalen der Physik, titled: "On the electrodynamics of moving bodies", he assumed v_G as relative-velocity of material objects. [It may be interesting to recall that Michelson-Morley-Experiment was performed in 1887, Lord Rayleigh's paper in 1897, and Einstein's paper in 1905]

Now, if we assume that velocity of a 'photon' is close-to-but-slightly-smaller-than-c, say, $10^{-40}\,c$, and visualize a as an 'expanding-radius-of-the-spherically-expanding-wave-front', then we can expect the wavelength λ to increase with the increase of a. After-all a 'photon' is a 'particle' carrying some energy, so its velocity can be slightly smaller than the velocity of electromagnetic-waves, so its wavelength:

$$\lambda = D\,[\,1 - (\,v_{\text{photon}}/c_{\text{velocity of EM waves}})^2\,]^{1/2}\ldots..(2)$$

Where, $[\,1 - (\,v_{\text{photon}} / c_{\text{velocity of EM waves}})^2\,]^{1/2}$ can be as small as 10^{-40}

Possibility-7: Spherically-Expanding-Wave of Light Viewed as Slightly-Mismatched-Transmission-Line:

Thirdly, it may not be a hundred-percent correct assumption, that there is no reflected-power during the transmission of light through intergalactic-space, because: the characteristic-impedance of free space is 377 ohms, but wave-impedance of a waveguide-cavity depends on cut-off frequency, which depends on radius of the cavity. Therefore, the wave-impedance of spherically-expanding-cavity keeps on changing with radial-distance from the source, and as we know, wherever there is a difference between in-put and out-put impedances, some of the power

gets reflected. So, there is a possibility of reduction of energy of the galactic photons, due to some power getting reflected back to the source.

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