A TENTATIVE EXPLANATION OF COSMOLOGICAL RED SHIFT

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ABSTRACT

In this paper we suggest a possible alternative explanation of cosmological red shift . We consider that there exists a background field in the universe, and that light (the photon) has an extremely weak interaction with this background, and as result, experiences an energy loss. By analogy with damped oscillations, we introduce a dumping term with the first derivative with respect to time in the wave equation. *The solution yields a linearly reduced frequency of the* light with travel distance. The purpose of this exercise is to demonstrate how a simple alternative interpretation of the Hubble relation can be generated.

1. Introduction

In 1929 E.Hubble discovered a roughly linear relation between red shift and distance for extragalaxies.[1] This relation was comfirmed by later observations. Hubble relation can be written as

$$z = (\lambda_0 - \lambda_1)/ \lambda_0 = (H_0/c)\ d \qquad (1)$$

where z is the red shift , λ_0 is the observed wavelength , λ_1 is the emitted wavelength, c is the constant of the speed of light,d is the distance between the observed galaxy and the earth. H_0 is known as the Hubble constant, which is given by[2]

$$50\ km/sec/Mpc < H_0 < 130\ km/sec/Mpc \qquad (2)$$

The interpretation of the red shift as a cosmological Doppler effect has been accepted through the decades since its conception stands. With this interpretation, the universe is in a continuous expansion. Below we explore a non-Doppler interpretation of this effect in this paper.

2. Some Physical Thinking

From modern physics, we know that space is not empty, which is permeated with fields such as the gravitational field, microwave radiation background, neutrino field and so on. These fields could in general constitute a background field . It is easily imagined that there would be some unknown extremely weak interaction between light (the photon) and the background field. We assume that propogation of photons through this field results in an energy loss. The interaction is presumed to be too weak to be detected on the scale of our galaxy , but it could become evident on cosmological scale (10^9 light years). Therefore, we assume mathematically that such an interaction will provide a damping term into the wave equation. We recall the case of damped oscillations, where an additional term 2bdx/dt is included in the the equation for simply harmonic oscillation: $d^2x/dt^2 + \omega^2 x = 0$. By analogy, we propose the following one dimensional wave equation here for light propagation:

$$\frac{\partial^2 \psi}{\partial x^2} - f(\mu\, ct)\frac{2\mu}{c}\frac{\partial \psi}{\partial t} - \frac{1}{c^2}\frac{\partial^2 \psi}{\partial t^2} = 0 \qquad (3)$$

The second term in Eq.(3) is the assumed interaction term, where the coefficient $\mu = H_0/c$. The function $f(\mu\, ct)$ could be a polynomial: $1 + \Sigma\, a_n(\mu\, ct)^n$; t is the travel time.

3. Solution and Discussion

We expect that the solution of eq.(3) has the following properties: (1) the speed of light should be constant, independent of the frequency; (2) the frequency should be linearly reduced with the travel time. Thus we suggest a trial solution as follows:

$$\psi = \psi_0 \sin[\omega(1 - \mu\, ct)(t - x/c + \delta)] \qquad (4)$$

where ψ_0 and δ are two integration constants; ω is the proper frequency. It is found that if we choose $f(\mu\, ct) = (1 - \mu\, ct)^{-1}$, then

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Eq.(4) is a solution of the following equation:

$$\frac{\partial^2 \psi}{\partial x^2} - \frac{2\mu}{c(1-\mu ct)}\frac{\partial \psi}{\partial t} - \frac{1}{c^2}\frac{\partial^2 \psi}{\partial t^2} = 0 \qquad (5)$$

From the solution, Eq.(4), the physical meaning is clearly as follows

$$x = ct \qquad (6)$$

for the propogation of the light, and

$$\omega' = \omega\ (1 - \mu ct) \qquad (7)$$

Eq.(7) could lead to the Hubble's relation: $(\omega - \omega')/\omega = \mu x = (H_0/c)d$.

According the above approach, the universe is not in a state of expansion although galaxies have random motion. If a photon travels a distance $R = 1/\mu$, it would lose all of its energy. From this sense, R is not the radius of the universe, but is an important constant which indicates the intensity (or weakness) of the interaction. Naturally, we need to identify the nature of the interaction, however, it may be premature to speculate on possible physical models which could give rise to this kind of interaction at the present stage.

Our primary objective in this brief communication is to introduce the concept as a posibility and to see if any arguments are forthcoming which eliminate the idea as a plausible alterative to current thinking.

References

[1] E.P.Hubble, Proc.Nat.Acad.Sci., **15**, 168 (1929).

[2] A. Sandage, Physics Today, Feb. p.34 (1970).

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