A quantum gravitational model of redshifts

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July 31, 2013

Abstract

The main features of an alternative model of redshifts are described here. The model is based on conjectures about an existence of the graviton background with the Planckian spectrum and a super-strong character of quantum gravitational interaction. This model is connected with the assumed quantum mechanism of gravity. A behavior of two theoretical functions of a redshift z in this model - the geometrical distance $r(z)$ and the luminosity distance $D_L(z)$ - and an existence of two different cosmological horizons for any observer are discussed.

1 Introduction

A commonly accepted hypothesis about the Dopplerian nature of cosmological redshifts leads to a necessity to introduce dark matter and dark energy into consideration to explain kinematically the latest SNe 1a observations [1]. As it was shown by the author [2, 3], a very specific apparent dimming of supernovae may be interpreted in an essentially different way, without any kinematics. This new approach is based on a few simple, but partially unexpected, conjectures: there is the graviton background with the Planckian spectrum having a small effective temperature; gravitons are super-strong interacting particles; a cross-section of interaction of a graviton with any particle is a bilinear function of energies of both particles. It was also shown

[4] that these conjectures may underlay a quantum mechanism of classical gravity. It has a very interesting consequence: two fundamental constants - the Hubble constant and the Newton constant - *should be connected between themselves* in this approach. The main features of this model of redshifts are summarized in this short paper.

2 Redshifts as a quantum gravitational effect

The isotropic graviton background is considered in the model to be fulfilling a flat non-expanding universe. Gravitons should be super-strong interacting ones to give a full magnitude of cosmological redshifts. There are two effects due to collisions of photons with gravitons. Because of forehead collisions, there should exist a photon average energy loss that leads to a redshift z on a geometrical distance r :

$$z = \exp(ar) - 1,$$

where $a = H/c$, and for the Hubble constant H we have [2]:

$$H = (1/2\pi)D \cdot \bar{\epsilon} \cdot (\sigma T^4),$$

$\bar{\epsilon}$ is an average graviton energy, σ is the Stephan-Boltzmann constant, T is an effective temperature of the background, D is a new constant. It is assumed here that for forehead collisions, a cross-section $\sigma(E, \omega)$ of interaction of any particle with an energy E and a graviton with an energy ω is equal to:

$$\sigma(E, \omega) = D \cdot E \cdot \omega.$$

To have a reasonable value for the Hubble constant, it must be: $D \sim 10^{-27} m^2/eV^2$.

Another effect is caused by non-forehead collisions of photons with gravitons, and leads to additional relaxation of any photonic flux. This relaxation depends on the relaxation factor b which is equal to: $b = 3/2 + 2/\pi = 2.137$, as it is shown in details in my recent paper [5]. Both redshifts and this relaxation give the following dependence of the luminosity distance D_L on z :

$$D_L = a^{-1} \ln(1 + z) \cdot (1 + z)^{(1+b)/2} \equiv a^{-1} f_1(z).$$

This function fits well supernova observational data by Riess et al. [1] for small $z < 0.5$ (see [3]). Discrepancies for higher z would be understood as a result of deformation of any spectrum it this redshift model due to a non-zero value of an average graviton energy which is equal to $\sim 10^{-3}$ eV by $T = 2.7$ K. At present, there does not exist a full theoretical description of this third effect due to the graviton background.

The Newton constant G may be expressed in this approach via the same quantities as H, and we have the connection between them [4]. From the latter, we get for $H : H = 3.026 \cdot 10^{-18} s^{-1} = 94.576\ km \cdot s^{-1} \cdot Mpc^{-1}$ by $T = 2.7K$.

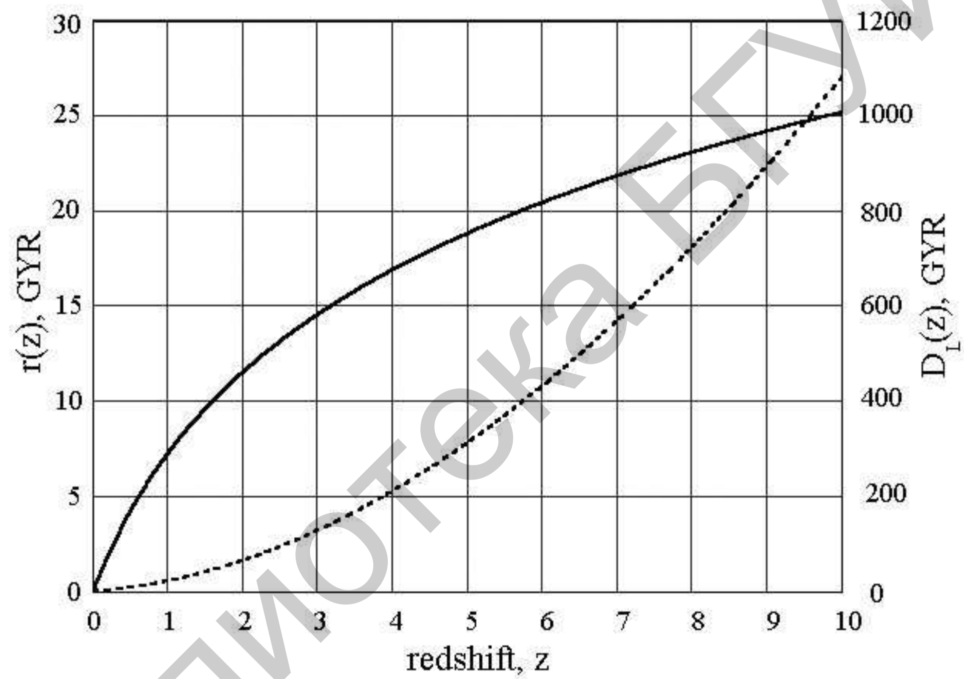

Figure 1: The geometrical distance, $r(z)$, (solid line) and the luminosity distance, $D_L(z)$, (dashed line) - both in light GYRs - in this model as functions of a redshift, z. The following theoretical value for H is accepted: $H = 3.026 \cdot 10^{-18} s^{-1}$.

By this value of H (then a natural light unit of distances is equal to $1/H \simeq 10.5$ light GYR), plots of two theoretical functions of z in this model - the geometrical distance $r(z)$ and the luminosity distance $D_L(z)$ - are shown on Fig. 1. As one can see, for objects with $z \sim 10$, which are observable now, we should anticipate geometrical distances of the order ~ 25 light GYR and luminosity distances of the order ~ 1100 light GYR in a frame of this model.

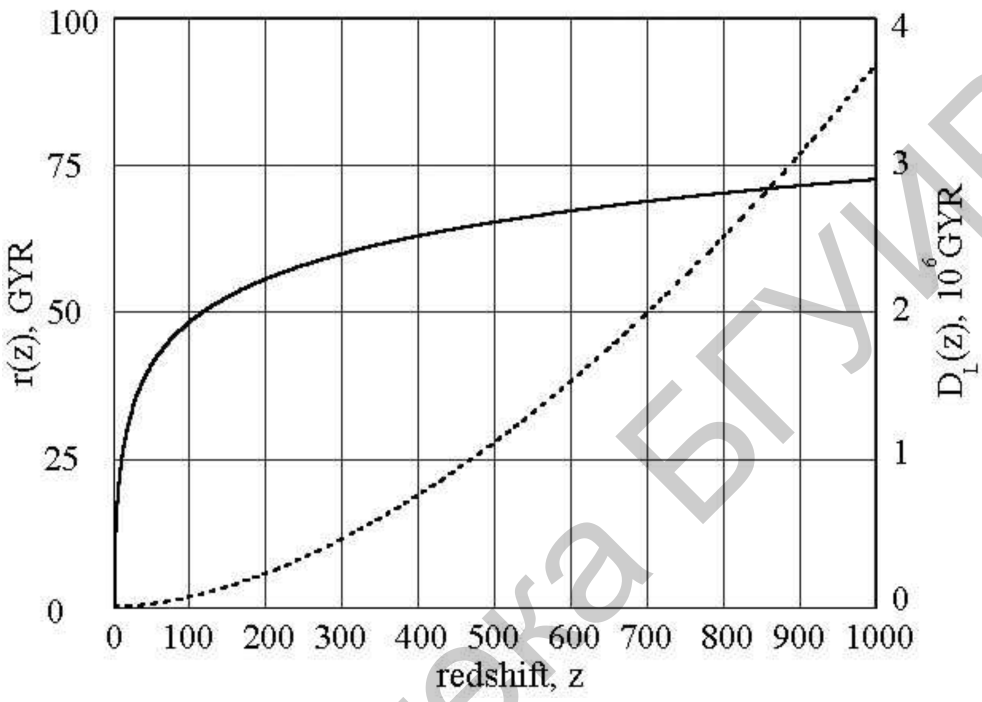

Figure 2: The same functions as on Fig. 1 (all notations are reserved), but for the huge range of z.

We can assume that the graviton background and the cosmic microwave one are in a state of thermodynamical equilibrium, and have the same temperatures. CMB itself may arise as a result of cooling any light radiation up to reaching this equilibrium. Then it needs $z \sim 1000$ to get through the very edge of our cosmic "ecumene" (see Fig. 2). Some other possible cosmological consequences of existence of the graviton background were described in [6, 4].

3 Conclusion

It is necessary to develop a theory of redshifts in this approach taking into account the quantum nature of red-shifting process and a non-zero value of an average graviton energy. Of course, a verification of redshift's origin on the Earth, which would be carried out with coming ultrastable lasers, will be of great importance. In a case of the waited Dopplerian nature of redshifts, one will get a negative result trying to detect a laser beam frequency shift after a delay line. If the considered conjecture about the gravitational origin of redshifts is true, a result will be positive.

It is interesting that in a frame of this model, every observer has two own spheres of observability in the universe. One of them is defined by maximum existing temperatures of remote sources - by big enough distances, all of them will be masked with the CMB radiation. Another, and much smaller, sphere depends on their maximum luminosities - the luminosity distance increases with a redshift much quickly than the geometrical one. An outer part of the universe will drown in a darkness.

References

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