The constancy of the ratio $H(z)/(1+z)$ as a sign of low-energy quantum gravity

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Abstract

The model of low-energy quantum gravity by the author is based on the conjecture on an existence of the graviton background with the average graviton energy of the order of 10^{-3} eV. An interaction of photons and moving bodies with this background leads to small additional effects having essential cosmological consequences. Here, redshifts of remote objects and the additional dimming of them may be interpreted without any expansion of the Universe. The theoretical luminosity distance of the model fits the observational Hubble diagrams with high confidence levels (100% for the SCP Union 2.1, 43% for JLA compilations, 99.81% for long GRBs, and 13.73% for quasars). In the model, the ratio $H(z)/(1+z)$ should be equal to the Hubble constant. This conclusion is confirmed with 99.9999% C.L. by fitting the compilation of 40 $H(z)$ observations from the paper by Zhang and Xia [arXiv:1606.04398].

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1 Introduction

In my model of low-energy quantum gravity [1, 2], gravity is considered as the screening effect. It is suggested that the background of super-strong interacting gravitons exists in the universe. Its temperature should be equal to the one of CMB. Screening this background creates for any pair of bodies both attraction and repulsion forces due to pressure of gravitons. For single gravitons, these forces are approximately balanced, but each of them is much bigger than a force of Newtonian attraction. If single gravitons are pairing, an attraction force due to pressure of such graviton pairs is twice exceeding a corresponding repulsion force if graviton pairs are destructed by collisions with a body. This peculiarity of the quantum mechanism of gravity leads to the difference of inertial and gravitational masses of a black hole. In such the model, the Newton constant is connected with the Hubble constant that gives a possibility to obtain a theoretical estimate of the last. We deal here with a flat non-expanding universe fulfilled with super-strong interacting gravitons; it changes the meaning of the Hubble constant which describes magnitudes of three small effects of quantum gravity but not any expansion or an age of the universe.

In this model, the geometrical distance/redshift relation is:

$$r(z) = \ln(1+z) \cdot c/H_0, \tag{1}$$

where H_0 is the Hubble constant, c is the velocity of light, z is a redshift. The luminosity distance/redshift relation has the view:

$$D_L(z) = c/H_0 \cdot \ln(1+z) \cdot (1+z)^{(1+b)/2} \equiv c/H_0 \cdot f_1(z), \tag{2}$$

where $f_1(z) \equiv \ln(1+z) \cdot (1+z)^{(1+b)/2}$; the "constant" b belongs to the range 0 - 2.137 ($b = 2.137$ for very soft radiation, and $b \to 0$ for very hard one). In the model, the constant deceleration w of massive bodies exists due to forehead collisions with gravitons. It is an analog of the redshift in this model. We get for the body acceleration w by a non-zero velocity v:

$$w = -cH_0(1 - v^2/c^2). \tag{3}$$

2 The Hubble diagram of this model

Data set	b	χ^2	C.L., %	$< H_0 > \pm\sigma_0$
SCP Union 2.1 [4]	2.137	239.635	100	68.22 ± 6.10
JLA [5]	2.365	30.71	43.03	69.54 ± 1.58
109 long GRBs [6]	2.137	70.39	99.81	66.71 ± 8.45
44 long GRBs [7],	2.137	40.585	57.66	69.73 ± 37.23
the Amati calibration	**1.885**	39.92	60.57	60.31 ± 31.93
44 long GRBs [7],	2.137	43.148	46.5	70.39 ± 38.79
the Yonetoku calibration	**1.11**	32.58	87.62	38.84 ± 18.55
quasars [8]	2.137	23.378	13.73	69.53 ± 10.87

Table 1: Results of fitting the Hubble diagram with the model of low-energy quantum gravity. The best fitting values of b for 44 long GRBs are marked by the bold typeface.

To fit this model, observations should be corrected for no time dilation as: $\mu(z) \to \mu(z) + 2.5 \cdot \lg(1+z)$, where $\lg x \equiv \log_{10} x$. In my paper [3], results of fitting the Hubble diagram for different data sets of remote objects with the model of low-energy quantum gravity are summarized in Table 1; its part is shown here. For best fitting values of b in a case of 44 long GRBs, values of distance moduli are overestimated in both calibrations: on ~ 0.225 for the

Amati calibration, and on ~ 1.18 for the Yonetoku calibration. It leads to the corresponding underestimation of the Hubble constant.

3 The Hubble parameter $H(z)$ of this model

If the geometrical distance is described by *Eq.* 1, for a remote region of the universe we may introduce the Hubble parameter $H(z)$ in the following manner:

$$dz = H(z) \cdot \frac{dr}{c}, \tag{4}$$

to imitate the local Hubble law. Taking a derivative $\frac{dr}{dz}$, we get in this model for $H(z)$:

$$H(z) = H_0 \cdot (1 + z). \tag{5}$$

It means that in the model:

$$\frac{H(z)}{(1+z)} = H_0. \tag{6}$$

The last formula gives us a possibility to evaluate the Hubble constant using observed values of the Hubble parameter $H(z)$. The weighted average value of the Hubble constant may be calculated by the formula:

$$< H_0 >= \frac{\sum \frac{H(z_i)}{1+z_i} / \sigma_i^2}{\sum 1/\sigma_i^2}. \tag{7}$$

The weighted dispersion of the Hubble constant may be found with the same weights:

$$\sigma_0^2 = \frac{\sum (\frac{H(z_i)}{1+z_i} - < H_0 >)^2 / \sigma_i^2}{\sum 1/\sigma_i^2}. \tag{8}$$

The χ^2 value is calculated as:

$$\chi^2 = \sum \frac{(\frac{H(z_i)}{1+z_i} - < H_0 >)^2}{\sigma_i^2}. \tag{9}$$

In [3], I have done these calculations for two data sets of $H(z)$. Here I repeat them for the bigger data set of 40 observations of $H(z)$ from paper [9]. We have for this case:

$$< H_0 > \pm \sigma_0 = (62.082 \pm 4.092) \ km \ s^{-1} \ Mpc^{-1}. \tag{10}$$

The weighted average value of the Hubble constant with $\pm\sigma_0$ error bars are shown in Fig. 1 as horizontal lines; observed values of the ratio $H(z)/(1+z)$ with $\pm\sigma$ error bars are shown in Fig. 1, too (points). The value of χ^2 in this case is equal to 10.69. By 40 degrees of freedom of this data set, it means that the hypothesis described by *Eq.* 6 cannot be rejected with 99.9999% C.L.

Some authors try in a frame of models of expanding universe to find deceleration-acceleration transition redshifts using the same data sets. The above conclusion that the ratio $H(z)/(1+z)$ remains statistically constant in the available range of redshifts is model-independent.

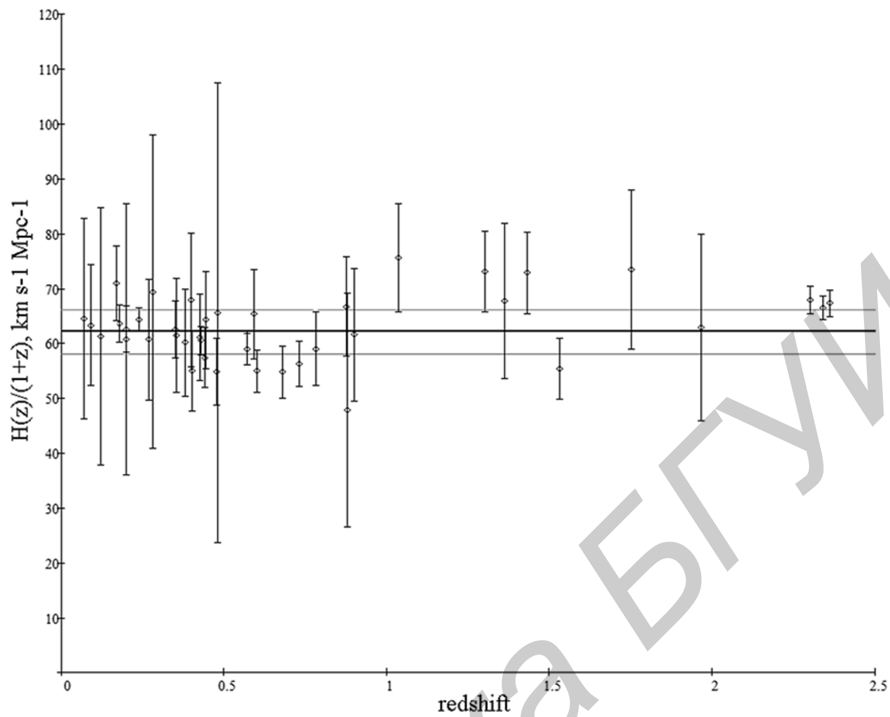

Figure 1: The ratio $H(z)/(1+z) \pm \sigma$ and the weighted value of the Hubble constant $< H_0 > \pm \sigma_0$ (horizontal lines). Observed values of the Hubble parameter $H(z)$ (40 points) are taken from Table 1 of [9].

4 Conclusion

The Hubble diagram for GRBs may differ in the model from the diagram for SNe Ia, and some signs of this difference are seen, perhaps, in the case of the 44 long GRBs data set. In the model, space-time is flat, and the geometrical distance as a function of the redshift coincides with the angular diameter distance. The geometrical distance $r(z)$ of this model is very different from the one of the standard model; for example, GRB 090429B with $z = 9.4$ took place 24.6 Gyr ago in a frame of this model; the age of the Universe of the standard model: ~ 13.5 Gyr corresponds here to $z \simeq 2.6$.

The considered small effects are beyond general relativity. Gravitons in this model are usual particles, not geometrical objects. It is difficult to imagine that paired gravitons may be introduced starting from the geometrical basis.

When gravitational physicists desire to find at least some very tiny experimental manifestations of quantum gravity, cosmologists pile up huge dark pieces of matter claiming them to be discoveries in the current paradigm. The above results show that the mainstream-accepted picture of the universe based on the

Big-Bang conjecture may be very far from reality.

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