Small effects of low-energy quantum gravity

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Abstract

Small effects of quantum gravity on the scale $\sim 10^{-3}$eV and their cosmological consequences are discussed and compared with observations of supernovae 1a, gamma-ray bursts and galaxies.

Our knowledge of the nature is restricted for many reasons, but sometimes we attack it with a view of victors being sure that we know enough to go ahead namely in the given way. An attempt to introduce dark energy to rescue the picture of expanding universe seems to me to be such the case.

I would like to show here that small effects of very-low-energy quantum gravity (on the scale $\sim 10^{-3}$eV) [1] can give an alternative explanation of supernovae 1a, gamma-ray bursts and galaxy number counts observations. The new picture has the very dramatic consequence: nor dark energy nor any expansion of the universe exist in it.

There are two small effects in the sea of super-strong interacting gravitons [1]: average energy losses of a photon due to forehead collisions with gravitons and an additional relaxation of a photonic flux due to non-forehead collisions of photons with gravitons. The first effect leads to the geometrical distance/redshift relation: $r(z) = \ln(1+z) \cdot c/H$, where H is the Hubble constant. The both effects lead to the luminosity distance/redshift relation: $D_L(z) = c/H \cdot \ln(1+z) \cdot (1+z)^{(1+b)/2}$, where the "constant" b belongs to the range 0 – 2.137 [2] ($b = 2.137$ for a very soft radiation, and $b \to 0$ for a very hard one). For an arbitrary source spectrum, a value of the factor b should be still computed. It is clear that in a general case it should depend on a rest-frame spectrum and on a redshift. Because of this, the Hubble diagram should be a multivalued function of a redshift: for a given z, b may have different values for different kinds of sources. Furthermore, the Hubble diagram may depend on the used procedure of observations: different parts of rest-frame spectrum will be characterized with different values of the parameter b.

In Figure 2 of my paper [1], the Hubble diagram $\mu_0(z)$ with $b = 2.137$ is shown; observational data (82 points) are taken from Table 5 of [3]. The predictions fit observations very well for roughly $z < 0.5$. It excludes a need of any dark energy to explain supernovae dimming. Improved distances to nearby type Ia supernovae (for the range $z < 0.14$) can be fitted with the function $\mu_c(z)$ for a flat Universe with the concordance cosmology with $\Omega_M = 0.30$ and $w = -1$ [4]. The difference $\mu_c(z) - \mu_0(z)$ between this function and distance moduli in the considered model for $b = 1.52$ has the order of ± 0.001 in the considered range of redshifts [2]. Results from the ESSENCE Supernova Survey together with other known supernovae 1a observations in the bigger redshift range $z < 1$ can be best fitted in a frame of the concordance cosmology in which $\Omega_M \simeq 0.27$ and $w = -1$ [5]; the function $\mu_c(z)$ for this case is almost indistinguishable from distance moduli in the considered model for $b = 1.405$: the difference is not bigger than ± 0.035 for redshifts $z < 1$.

Theoretical distance moduli $\mu_0(z) = 5 \log D_L + 25$ are shown in Fig. 1 for $b = 2.137$ (solid), $b = 1$ (dot) and $b = 0$ (dash). If this model is true, all observations should lie in the stripe between lower and upper curves. Theoretical distance moduli $\mu_c(z)$ for a flat Universe with the concordance cosmology with $\Omega_M = 0.27$ and $w = -1$, which give the best fit to gamma-ray bursts observations [6], are very close to the Hubble diagram $\mu_0(z)$ with $b = 1.1$ of this model. GRB observational data (+, 69 points) are taken from Table 6 (μ^a) of [6] by Schaefer.

The galaxy number counts/magnitude relation in this model $f_3(m)$, m is a magnitude, in this model (for more detail, see [7]), which takes into account the Schechter luminosity function, is based on the same two small effects. To compare this function with observations by Yasuda et al. [8], we can choose the normalizing factor from the condition: $f_3(16) = a(16)$, where $a(m) \equiv A \cdot 10^{0.6(m-16)}$ is the function giving the best fit to observations

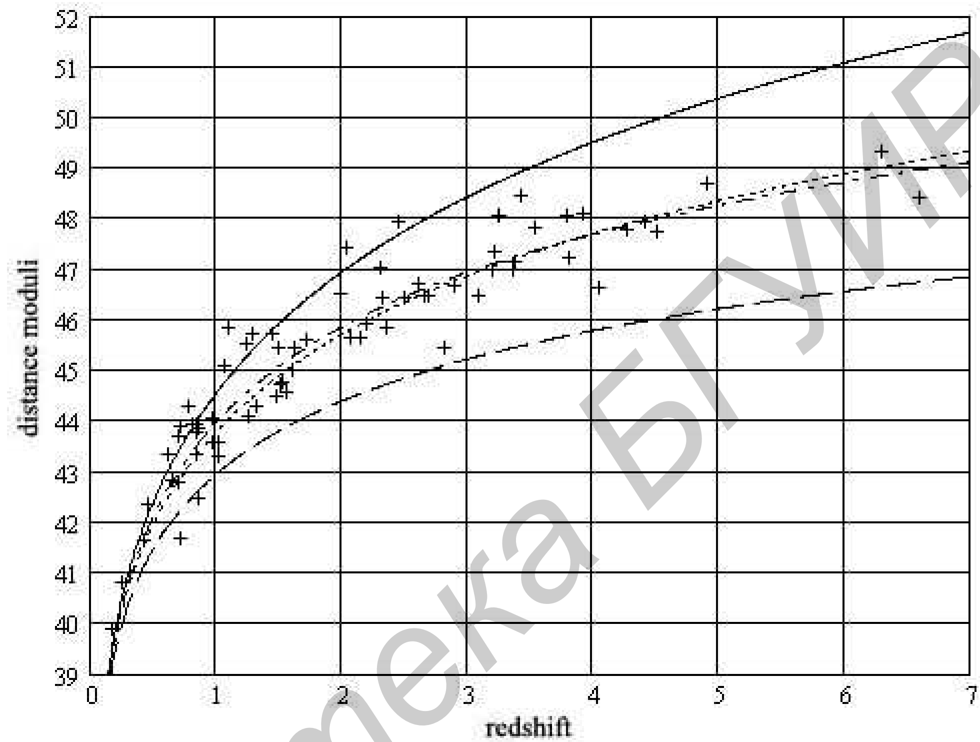

Figure 1: Hubble diagrams $_0(z)$ with $b = 2{:}137$ (solid) and $b = 0$ (dash); the Hubble diagrams $_0(z)$ with $b = 1{:}1$ of this model (dot) and the one of the concordance model (dadot) which is the best t to GRB observations [6]; GRB observational data (+, 69 points) are taken from Table 6 (^{a}) of [6] by Schaefer.

[8], A = const: The ratio $\frac{f_3(m)\ a(m)}{a(m)}$ is shown in Fig. 2 for di erent values of the constant A_1 ’ 5 10^{17} L=L by = 2:43 and $b = 2{:}137$: If we compare this gure with Figs. 6,10,12 from [8], we see that the considered model provides a no-worse t to galaxy observations than the function a(m) if the same K-corrections are added.

The considered e ects of low-energy quantum gravity are very small on micro level, but they may be the basic ones for cosmology. The ones are beyond the general relativity, and astrophysical observations seem to stay an unexpected tool of quantum gravity laboratory.

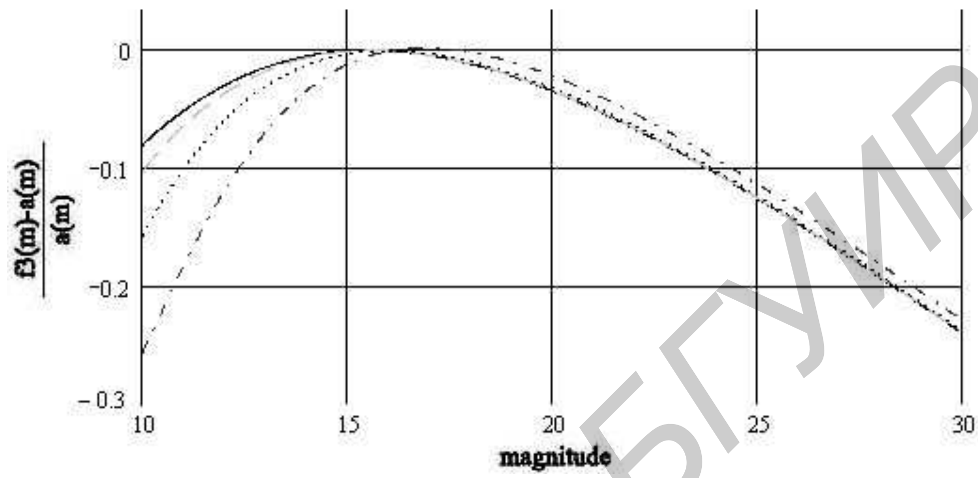

Figure 2: The relative difference $(f_3(m) - a(m))/a(m)$ as a function of the magnitude m for $= 2.43$ by $10^{-2} < A_1 < 10^2$ (solid), $A_1 = 10^4$ (dash), $A_1 = 10^5$ (dot), $A_1 = 10^6$ (dadot).

References

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