Revealing the quantum origin of gravity

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Abstract

Some additional features of the low-energy quantum gravity model are described: the presence of anomalous deceleration, the many-valued nature of the luminosity distance, another possible distance dependence of the redshift and damping of radio waves, and the prohibition on the existence of black holes.

1 Introduction

Let us suggest that gravity is the quantum phenomenon as it is done in the model of low-energy quantum gravity [1, 2]. This gives the opportunity to compute the Newton constant, i.e. to occur deeper of general relativity in some sense. Three small effects of the model are described in my paper [3], two of them allow to abandon from the cosmological expansion and dark energy to interpret redshifts of remote objects and their dimming. It would be very important to verify some other predictions of the model which are unexpected from the accepted point of view: the existence of the anomalous deceleration of massive bodies due to collisions with gravitons, the multivalued character of the luminosity distance, another possible dependence on the distance of the redshift and of the attenuation for radio waves. The model has restrictions on the geometric language and forbids the existence of black holes.

2 Some additional features of the model

It is postulated in the model that the background of super-strong interacting gravitons exists. Due to forehead and backhead collisions of a massive body with gravitons, the body anomalous acceleration w by a non-zero velocity v had been found [2] to be equal to:

$$w = -w_0 \cdot 4\eta^2 \cdot (1 - \eta^2)^{0.5}, \tag{1}$$

where $w_0 \equiv H_0 c = 6.419 \cdot 10^{-10}\ m/s^2$, if we use the theoretical value of H_0 in the model, $\eta \equiv v/c$. As a result, there are no closed orbits on all scales in the model: bodies should inspiral to the center of attraction, but for the

Earth-like orbits this effect is very small [4]. The mass discrepancy in spiral galaxies is observed at very low accelerations less than $\sim 10^{-10}\ m/s^2$ [5], i.e. this boundary acceleration has almost the same order of magnitude as the maximum deceleration $|w|_{max} \sim 10^{-9}\ m/s^2$ in the model. Now it is unclear may these quantities be connected between themselves or not.

In this model, the luminosity distance/redshift relation has the following view:

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

where the "constant" b belongs to the range 0 - 2.137 ($b = 2.137$ for a very soft radiation, and $b \to 0$ for a very hard one). Because of this, the distance modulus should be a multivalued function of the redshift: for a given z, b may have different values for different kinds of sources. The graphs of theoretical distance moduli $\mu(b, z)$ for $b = 2.137$ and $b = 0$ (with the correction for the effect of time dilation of the standard model: $b \to b - 1$) are shown in Fig. 1; for comparison, the graph of $\mu_c(z)$ for the flat Universe with the concordance cosmology by $\Omega_M = 0.3$ and $w = -1$ is shown, too. The graph of the difference $\mu_c(z) - \mu(2.137, z)$ is shown in Fig. 2. Possibly, its positive low redshift values can be related to the H_0 tension in LCDM cosmology [6] if the function $\mu(2.137, z)$ describes the observations better. The maximum difference between $\mu_c(z)$ and $\mu(2.137, z)$ for $z \leq 10$ is equal to -0.54, it increases up to -0.87 for $z \leq 20$.

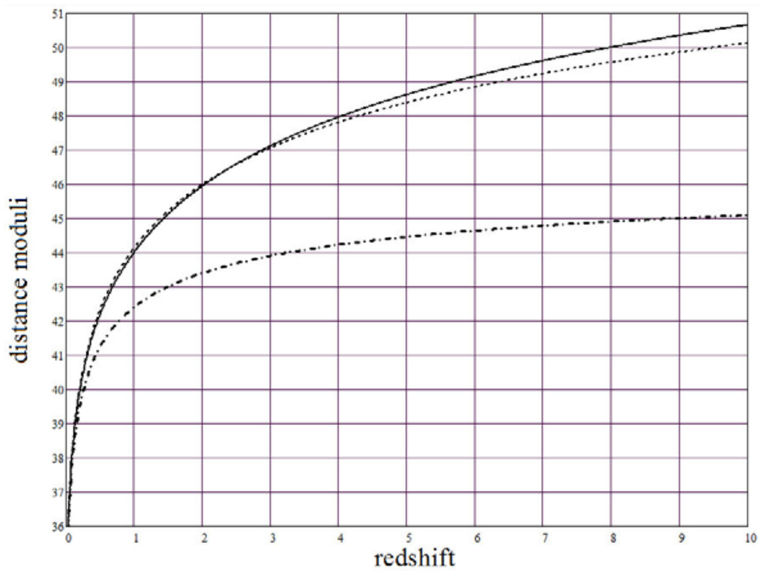

Figure 1: Three theoretical Hubble diagrams: $\mu(b, z)$ of this model with $b = 2.137 - 1$ (solid) and $b = 0 - 1$ (dash-dot) to take into account the effect of time dilation of the standard model; and for comparison, $\mu_c(z)$ for the flat Universe with the concordance cosmology by $\Omega_M = 0.3$ and $w = -1$ (dash).

Observations of gamma-ray bursts can be used to test the case of the very hard radiation with $b = 0$. The physics of these bursts is not currently well understood, and observations are usually calibrated against SNe Ia in the LCDM frame. Unfortunately, available data sets have very large spread of observational

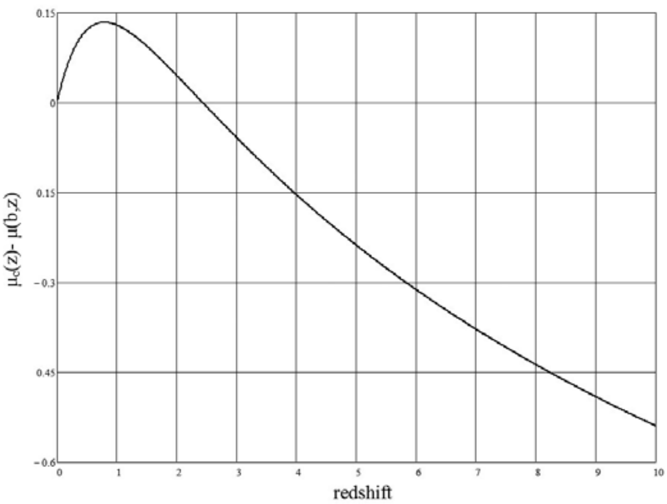

Figure 2: The difference $\mu_c(z) - \mu(b, z)$ with $b = 2.137 - 1$ and $\Omega_M = 0.3$, $w = -1$.

points (for example, [7]). Using the derived distance moduli of 140 GRBs from Table 4 of [7], I have attempted to fit them with the function of Eq. 2. The scatter of points does not allow distinguishing the values of b from 0 to 2.137; by the given point dispersions, all theoretical functions $\mu(b, z)$ with such b are approximated with the high probability when the value of H_0 is calculated as in Chapter 16 of [2]. To get $< H_0 >\sim 67\ km \cdot s^{-1} \cdot Mpc^{-1}$ by $b = 0$, it is necessary to reduce $\mu(z)$ values from table 4 of [7] for ~ 2.48. This means that the calibration with SNe Ia overestimates $\mu(z)$ in z range (1.4; 8.2) by ~ 2.48 on average, assuming that the Hubble diagram for gamma-ray bursts should correspond to $b = 0$.

In this model, the functions $r(z)$ and $D_L(z)$ are found for radiation consisting of photons with energies $\hbar\omega \gg< \epsilon >$, where $< \epsilon >$ is the average graviton energy. But for $\hbar\omega \ll< \epsilon >$, e.g. for the radio band, the situation is more complicated. In this case, only a small part of the background gravitons will transfer their momentum to photons in head-on collisions, and this momentum will often be of the same order as the photons' own momentum. This should lead to a large broadening of the emission spectrum towards the red, and its redshift as a whole will be much smaller than expected for high-energy radiation. From another side, all gravitons with energies $\epsilon > \hbar\omega$ are able to get the photon momentum in such the collisions that should additionally attenuate the radiation flux. This means that the known redshift z and the constant parameter b are not enough to describe the situation; this issue remains open. This feature of the model may be important for measurements of the redshifted 21-cm radiation, which are now of great interest [8].

3 Restrictions on geometric language and the ban on the existence of black holes

In this model, the cross section $\sigma(E, \epsilon)$ of the interaction of a graviton with energy ϵ with any particle with energy E was taken equal to: $\sigma(E, \epsilon) = D \cdot E \cdot \epsilon$,, where D is a new dimensional constant (its estimate is: $D = 0.795 \cdot 10^{-27} m^2/eV^2$). We obtain the inverse square law for bodies if the condition of large distances r is satisfied: $\sigma(E, < \epsilon >) \ll 4\pi r^2$, where E is the bigger energy of a pair of bodies. This leads to an important consequence: some "atomic" structure of matter is needed [2]. For microparticles, the property of asymptotic freedom arises at very small distances when this condition is violated.

But black holes have no structure, and this condition can only be satisfied at huge distances: for a solar-mass black hole, the condition would be satisfied at distances $r \gg 10^6\ AE$. On the other hand, in the model, screening of the background of superstrong interacting gravitons creates for any pair of bodies both an attractive force and a repulsive force due to the pressure of gravitons. This means that black holes that absorb any particles and do not re-emit them must have a much larger gravitational mass than the inertial one, i.e. for them, Einstein's equivalence principle will be violated. So, we have here a double ban on the existence of black holes. This could mean that the invisible supermassive objects at the centers of many galaxies, as well as other supposed black holes, are now misnamed.

4 Conclusion

Several effects that can be understood as the results of the described quantum origin of gravity are known in another interpretation: the inverse square law for massive bodies, the redshift of distant objects, and their dimming. The effect of light from nowhere [3] can be confirmed by the detection of a diffuse cosmic optical background [9]. It would be very important to check that the distance modulus is a multivalued function of the redshift; this requires a much better understanding of the physics of gamma-ray bursts. Future observations of SNe Ia at higher redshifts in the infrared may provide an opportunity to extend the Hubble diagram to a region where a difference from the LCDM can be seen.

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