

The graviton background: a new way to quantum gravity

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Abstract

Graviton pairing and destruction of these pairs under collisions with bodies may lead to the Newtonian attraction. It opens us a new way to a very-low-energy quantum gravity model. In the model by the author, cosmological redshifts are caused by interactions of photons with gravitons of the background. Non-forehead collisions with gravitons lead to an additional relaxation of any photonic flux. Total galaxy number counts/redshift and galaxy number counts/magnitude relations are computed and found to be in a good agreement with galaxy observations.

1 Where does the land of quantum gravity lie?

After creation of quantum mechanics, many attempts were made to understand a quantum side of gravity. With time, a commonly accepted now opinion has been summed that quantum gravity is a high-energy phenomenon which should manifest itself only on a huge scale of energies of the order of the Planck energy $\sim 10^{19}$ GeV. An important difference of existing models of

quantum gravity from other quantum models of elementary particle physics is their primordially accepted *geometrical* base. Perhaps, many difficulties are conditioned namely by this circumstance. Poorness of the set of predicted or expected effects [1] is casted to an eye on the "output" of such the models, and I think that the very eloquent assertion by S. Carlip may summarize the situation: "... there is not yet any direct experimental evidence that gravity is quantized" [1].

Models with large extra dimensions [2, 3, 4] lead us to TeV-scale gravity, and, maybe, they appropinquate us to a real energy scale of quantum gravity. But the notion that all our world is not any more than a slice of a real and non-available (as a whole) for us world is not very reassuring. Extra dimensions are *necessary* to describe, for example, the composite fundamental fermions [5] when they may be interpreted as internal coordinates of the composite system, but their assignement to any "empty" point of space seems to me to be an excess.

But there exists another side of medal. Nesvizhevsky's team reported about discovery of quantum states of ultra-cold neutrons in the Earth's gravitational field [6]. Observed energies of levels (it means that and their differences too) in full agreement with quantum-mechanical calculations turned out to be equal to $\sim 10^{-12}$ eV. If transitions between these levels are accompanied with irradiation of gravitons then energies of irradiated gravitons should have the same order that is of 40 orders lesser than the Planck energy. Anderson's team reported about the anomalous acceleration of NASA's probes Pioneer 10/11 [7]; this effect is not embedded in a frame of the general relativity, and its magnitude is somehow equal to $\sim Hc$, where H is the Hubble constant, c is the light velocity. In the same 1998, two teams of astrophysicists reported about dimming remote supernovae [8, 9]; the one would be explained on a basis of the Doppler effect if at the present epoch the universe expands with acceleration. This explanation needs an introduction of some "dark energy" which is unknown from any laboratory experiment. But the last effect as well as the Pioneer anomaly may be explained as the additional manifestations of low-energy quantum gravity based on the idea of an existence of the graviton background [10, 11]. The main results of author's research in this approach are considered here (for more details, see [11]).

2 Do we live in the sea of gravitons?

We should observe the following effects in the see of gravitons: a redshift due to forehead collisions of photons with gravitons and an additional relaxation of any light flux due to their none-forehead collisions [11]. The first effect leads to the geometrical distance/redshift relation of the form: $r(z) = \ln(1+z)/a$, where $a = H/c$, H is the Hubble constant. The both effects give the luminosity distance $D_L(z) : D_L(z) = a^{-1} \ln(1+z) \cdot (1+z)^{(1+b)/2}$. This function fits supernova observations very well for roughly $z < 0.5$, that excludes a need of any dark energy to explain supernovae dimming. Total galaxy number counts $dN(z) \propto f_2(z) = \frac{\ln^2(1+z)}{z^2(1+z)}$ (see [12]). A graph of this function is shown in Fig. 1; the typical error bar and data point are added here from paper [13] by Loh and Spillar. There is not a visible contradiction with observations. Usually, one ascribes the decrease of galaxy number counts

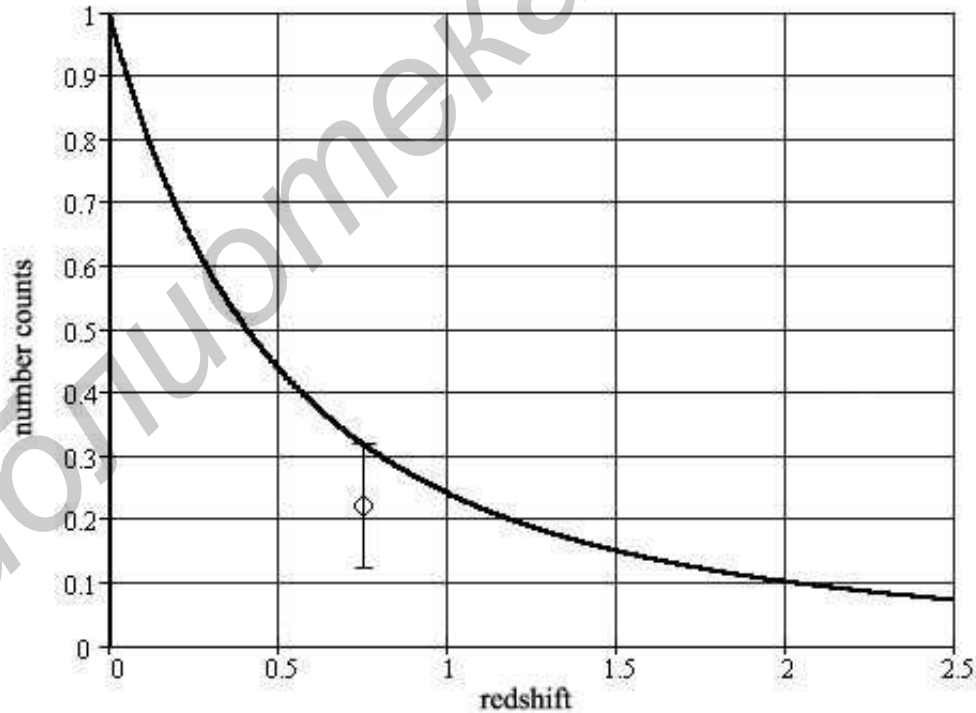


Figure 1: Number counts f_2 as a function of the redshift in this model. The typical error bar and data point are taken from paper [13] by Loh and Spillar.

per a "unit volume" to an expansion of the Universe. But *there is not any expansion in this model*.

The galaxy number counts/magnitude relation $f_3(m)$, m is a magnitude, in this model (see [12]), which takes into account the Schechter luminosity function [14], gives us another possibility to test a reality of the graviton background. To compare this function with observations by Yasuda et al. [15], we can choose the normalizing factor from the condition: $f_3(16) = a(16)$, where $a(m) \equiv A_\lambda \cdot 10^{0.6(m-16)}$ is the function giving the best fit to observations [15], $A_\lambda = \text{const}$. In this case, we have two free parameters of the Schechter distribution - α and L_* - to fit observations, and the latter one is connected with a constant $A_1 \simeq 5 \cdot 10^{17} \cdot L_\odot/L_*$. The ratio $\frac{f_3(m)-a(m)}{a(m)}$ is shown in Fig.2 for different values of A_1 by $\alpha = -2.43$. If we compare this figure with Figs.

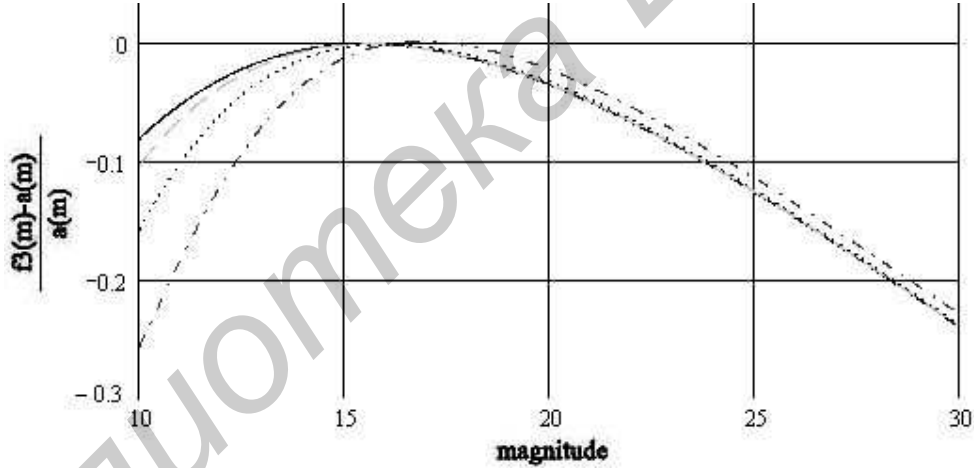


Figure 2: The relative difference $(f_3(m) - a(m))/a(m)$ as a function of the magnitude m for $\alpha = -2.43$ by $10^{-2} < A_1 < 10^2$ (solid), $A_1 = 10^4$ (dash), $A_1 = 10^5$ (dot), $A_1 = 10^6$ (dadot).

6,10,12 from [15], we see that the considered model provides a no-worse fit to observations than the function $a(m)$ if the same K-corrections are added (perhaps, even a better one if one takes into account positions of observational points in these figures by $m < 16$ and $m > 16$).

In all of the three cases - supernova dimming, total galaxy number counts/redshift and galaxy number counts/magnitude relations - we can see a good enough accordance of the theory with observations.

3 The main manifestation of the graviton background: the Newtonian attraction

The single graviton screening creates *equal* attractive and repulsive forces for any pair of usual bodies [11]. The forces are very big, about three order greater than the Newtonian force. The net force cannot be equal to zero in a case of black hole, and we have immediately a very important consequence: *the equivalence principle should be violated if black holes exist.*

It was shown by the author that graviton pairing may ensure the Newtonian attraction. In this model, the cross-section of interaction depends bilinear on particle energies; then, after destruction of graviton pairs in a collision with a body, single scattered gravitons give a repulsive force which is twice smaller than an attractive one due to a pressure of pairs. It turns out that one should consider a space distribution of gravitons and their pairs in a realization of flat wave to compute the Newton constant. Today this model is a semi-classical one, but it is an underlaying one relative to the Newtonian limit and the general relativity (the Newton constant is *computable* here). It is interesting and absolutely unexpected that the model needs an "atomic structure" of matter to be *workable*. The following condition of big distances is necessary to use a geometrical language in gravity: $\sigma(E, \langle \epsilon_2 \rangle) \ll 4\pi r^2$, where $\sigma(E, \langle \epsilon_2 \rangle)$ is the cross-section of interaction of a particle with an energy E and a graviton pair with an average energy $\langle \epsilon_2 \rangle$, r is a distance between them. For a proton, this condition leads to the restriction: $r \gg 10^{-11} m$. This limit length is many orders greater than the Planck scale of $\sim 10^{-33} m$. By distances smaller than $10^{-11} m$, the equivalence principle should be broken. This prediction may mean that any consideration of gravity in a geometrical language is nonsense in this forbidden scale.

4 Conclusion

In the considered model, we start from a micro level but we see immediately such the very important and long time observed cosmological effect as redshifts of remote objects. A deceleration of massive bodies (of the order of Hc), when they move relative to the graviton background, is an analog of this effect. A similar deceleration has been observed only for the Pioneer 10/11 spacecrafts [7], and the problem is open what is happen for big bodies. During almost a century (from 1922, when redshifts were first observed), no-

body thought that the cosmological redshift may be considered as an effect of low-energy quantum gravity. I would like to hope that in the future it will be recognized as the one in a shorter time.

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