Where to search for quantum gravity

Michael A. Ivanov
Physics Dept.,
Belarus State University of Informatics and Radioelectronics,
6 P. Brovka Street, BY 220027, Minsk, Republic of Belarus.
E-mail: michai@mail.by.

November 2, 2013

Abstract

The well known expectations to unify general relativity with quantum mechanics did not give some essential results up to now. If quantum gravity has such a poor set of tiny effects as in existing models, it may not be of great interest for physics. But there is another approach to quantum gravity, in which it seems to be a common ground of general relativity and quantum mechanics rather than their consequence. Important features of the author's model of low-energy quantum gravity, such as the quantum mechanism of classical gravity, the quantum mechanism of redshift and the specific relaxation of any photonic flux, are described here. In the model, the Newton and Hubble constants may be computed, but the latter is not connected with any expansion. The model fits SN1a and GRB observations very well without dark energy. Some possibilities to verify the model in ground-based experiments are discussed.

1 Introduction

An expected theory of quantum gravity as a unification of general relativity and quantum mechanics has not any experimental or observational basis. Many people expect that dimensional reasonings are sufficient to establish the Plank scale as a far area of applicability of this future theory. But it may be wrong if classical gravity itself is an average result of quantum gravity, while quantum mechanics reveals deviations from this average. In the model of low-energy quantum gravity by the author [1, 2], the Newtonian gravitational attraction is just the main effect and the Newton constant may be computed as a function of the temperature of the external graviton background. Contrary to all expectations, an interaction of gravitons with any particle should be super-strong, but their mean energy is very small, of the order of $10^{-3}\ eV$. Other effects of the model are small, but the ones lead to very important cosmological consequences: there is not any need in the expansion of the Universe nor dark energy. I consider here these effects and possibilities to verify the model.

2 Observable effects of low-energy quantum gravity

In the model, classical gravity arises as the screening effect: the graviton background is screened by bodies, and the pressure force of destructed graviton pairs pushes bodies to each other [1]. The theoretical value of the Newton constant G as a function of the temperature T of the graviton background is:

$$G = \frac{4}{3} \cdot \frac{D^2 c (kT)^6}{\pi^3 \hbar^3} \cdot I_2, \tag{1}$$

where D is the new dimensional constant: $D = 0.795 \cdot 10^{-27} m^2/eV^2$, and the integral $I_2 = 2.3184 \cdot 10^{-6}$. The Newton constant is proportional to T^6, and its dynamical nature in the model may be revealed through its variations connected with directional changes of T.

Forehead collisions of photons with gravitons of the background lead to the small, but very important, effect: an energy of any photon should decrease when it passes through the sea of gravitons - without any expansion of the Universe. In this case, a geometrical distance from a source r depends on a redshift z as:

$$r(z) = \frac{c}{H} \cdot ln(1+z), \tag{2}$$

where H is the Hubble constant. This constant may be computed in the model, too:

$$H = \frac{1}{2\pi} D \cdot \bar{\epsilon} \cdot \sigma T^4, \tag{3}$$

where $\bar{\epsilon}$ is an average graviton energy, σ is the Stephan- Boltzmann constant.

Another small effect is an additional dimming of any light flux due to non-forehead collisions of photons with gravitons connected with a deviation of a part of photons from a source-observer direction. This dimming is characterized in the model by the relaxation factor b; for soft radiation we have: $b \simeq 2.137$. Both these small effects lead to the following theoretical luminosity distance D_L :

$$D_L = \frac{c}{H} \ln(1+z) \cdot (1+z)^{(1+b)/2}, \tag{4}$$

which fits SN1a and GRB observations very well without dark energy if observational data are corrected for no time dilation [2].

Due to forehead collisions with gravitons, the universal deceleration of massive bodies arises in the model as an analog of the redshift. For small velocities of bodies relative the graviton background, this deceleration has the value [1]:

$$w \simeq -Hc, \tag{5}$$

i.e. of the same order of magnitude as a value of the observed additional acceleration of NASA probes [3] (the Pioneer anomaly). This universal deceleration may be connected with the problem of missing mass in galaxies, but the question is not investigated.

3 Possibilities to verify the model

The Newton constant G is measured with relative standard uncertainty $\sim 10^{-4}$; usually one refers on difficulties of more precise measurements. In this model, G depends on the temperature of the graviton background (Eq. (1)), and their uncertainties are connected as:

$$\frac{\Delta G}{G} = 6\frac{\Delta T}{T}$$

(here ΔT is a variation of the temperature of the *isotropic* background). The graviton background should have the same temperature as CMB, small deviations from the mean value will take place in opposite directions for this two backgrounds. If these deviations have the same order of magnitude in both cases, then $\Delta T/T \sim 6 \cdot 10^{-4}$, but now we deal with *anisotropic* variations. It means that $\Delta G/G \leq 6 \cdot 10^{-4}$. This estimate may be verified in ground-based experiments devoted to precise measurements of G. It is important that measured values of G may depend on an orientation of two bodies relative remote objects, and this dependence should correlate with CMB anisotropies.

Another very important consequence of an existence of the graviton background might be its possible connection with foundations of quantum mechanics. In quantum mechanics, one emphasizes a role of measurements; but stochastic behavior of any micro particle may arise due to interactions with gravitons of the background. To verify this very long-playing possibility, one may attempt to modify the controlled double-slit experiment (such as [4]) to have a chance to see an influence of external gravitons on the diffraction pattern. It is necessary to plan some fast temporal variations of placing a movable mask in front of a double-slit to see something new.

The standard cosmological model is based on the conjecture about the non-local mechanism of redshifts. Contrary to that, in the considered model redshifts are caused by the local quantum effect. This assumption may be verified in a ground-based laser experiment [1]. The satellite of main laser line should arise after passing the delay line; it will be red-shifted at $\sim 10^{-3}\ eV/h$, where h is the Planck constant, and its position will be fixed – on a very small way in the delay line only a small part of photons may collide with gravitons of the background. An intensity of this satellite should be proportional to the delay time. This experiment is not simple, but it would be a fundamental one for cosmology and physics.

There is also a chance to distinguish this model from others when an independent of SN1a calibration of GRB observations will be possible, because a multivalued character of the Hubble diagram is expected in this model: the factor b should be smaller for gamma rays than for low-energy photons.

4 Conclusion

The accepted non-local mechanism of redshifts of the standard model is its holding pivot: if this conjecture is false, all other assumptions (the Big Bang, inflation, dark energy etc) become absolutely needless. But this mechanism is not verified in any manner, it is only a theoretical possibility, given general relativity is true very far from its verified scale of distances. From another side, we know nothing about the real energy scale of quantum gravity; the known dimensional reasonings about it have not any experimental confirmation. It would be better to keep our minds open for new ideas based on remarkable new observations to understand the real nature of gravity. We need new experiments in the field, and the ones cannot be based only on accepted models: an experimentalist should have courage and intuition to set a non-standard test of accepted "forever" hypotheses - but we should give him a chance to do it. I have described here possible verifications of my model of low-energy quantum gravity, some of them are very expensive and difficult in the realization. But the model might benefit much more of any expenses excluding dark energy and opening the way to quantum gravity.

References

[1] Ivanov, M.A. In the book "Focus on Quantum Gravity Research", Ed. D.C. Moore, Nova Science, NY - 2006 - pp. 89-120; [hep-th/0506189], [http://ivanovma.narod.ru/nova04.pdf].

[2] Ivanov, M.A. Selected papers on low-energy quantum gravity. [http://ivanovma.narod.ru/selected-papers-Ivanov11.pdf].

[3] Anderson, J.D. et al. *Phys. Rev. Lett.* 1998, *81,* 2858; *Phys. Rev.* 2002, *D65,* 082004; [gr-qc/0104064 v4].

[4] Roger Bach et al. *New J. Phys.* 2013, *15,* 033018.