The sea of super-strong interacting gravitons as the cause of gravity

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Abstract

The Newtonian attraction turns out to be the main statistical effect in the sea of super-strong interacting gravitons, with bodies themselves being not sources of gravitons - only correlational properties of *in* and *out* fluxes of gravitons in their neighbourhood are changed due to an interaction with bodies. Other quantum effects of low-energy quantum gravity are the following ones: redshifts, their analog - a deceleration of massive bodies, and an additional relaxation of any light flux.

1 Introduction

It is easy to name a few dominant recepts in modern physics up to the present time: any interaction may be described as a local one; gravity is a strong interaction only on the Planck scale of energies; the Universe is expanding. It is strange but the value of the Planck energy $\sim 10^{19}$ GeV has been got only from dimensional reasonings. A locality of interaction means that every particle is a source of some field which carries out an

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interaction. In particular, any pair of particles been placed in an empty region of space should interact between themselves due to such a field. An example of such the successful class of local models is QED - the most exact physical model up today. Of course, it has its own difficulties which are deep buried beyond the aglisten foreside: the divergencies which are connected with our presentation about point-like carriers of the charge; the renormalization of charge and mass allows to hide them - but not to avoid. In attempts to build up a quantum theory of gravity, a few of tendencies are formulated with namely the same above-mentioned common place: quantum properties of the gravitational field may manifest themselves only under huge energies of particles or in super-strong gravitational fields. An expansion of the Universe is the cornerstone of any version of standard cosmological models. It leads to other hypotheses such as the Big Bang one.

In this paper, I would like to describe a model of low-energy quantum gravity in which all of these three recepts are denied (for more details, see [1]). The sea of *external* super-strong interacting gravitons is a source of gravity in the model. The effective temperature T of the graviton background should be equal to the one of CMB, i.e. quantum properties of gravity manifest themselves by very low energies of the order of $\sim 10^{-3}$ eV. The main manifestations of the background are described: redshifts of remote objects, a fast growth of the luminosity distance with a redshift, a deceleration of massive bodies, and the Newtonian limit of the gravitational attraction. Also some possible methods to verify the main conjectures of this new approach in space as well as on the Earth are directed.

2 The graviton background as a main element of the Universe

We deal here with the uniform non-expanding universe with the Euclidean space. Due to forehead collisions with gravitons, an energy $E(r)$ of any photon should decrease when it passes through the sea of gravitons: $E(r) = E_0 \exp(-ar)$, r is a geometrical distance from a source, and a is a constant. Then we have for $r(z)$, z is a redshift: $r(z) = ln(1+z)/a$. None-forehead collisions of photons with gravitons of the background will lead to an additional relaxation of a photon flux, so that the luminosity distance D_L is equal to: $D_L = a^{-1} \ln(1+z) \cdot (1+z)^{(1+b)/2} \equiv a^{-1} f_1(z)$, where

$f_1(z) \equiv \ln(1+z)\cdot(1+z)^{(1+b)/2}$, and the factor b may be calculated: $b \simeq 2.137$.

We can compare this predicted dependence $D_L(z)$ with the latest observational supernova data by Riess et al. [2]; let us introduce distance moduli $\mu_0 = 5\log D_L + 25 = 5\log f_1 + c_1$, where c_1 is an unknown constant (it is a single free parameter to fit the data); f_1 is the luminosity distance in units of c/H, H is Hubble's constant. The predictions fit observations very well

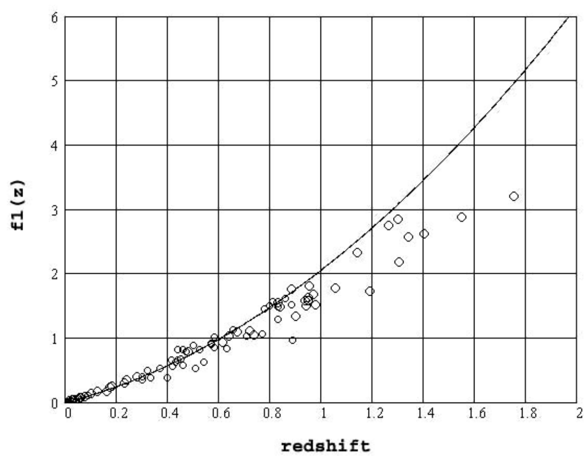

Figure 1: Predicted values of $f_1(z)$ in this model (solid line) and observations (points) from [2] transformed to a linear scale as $\mu_0 \rightarrow 10^{(\mu_0 - c_1)/5}$

for roughly $z < 0.5$ (see Fig. 1). It excludes a need of any dark energy to explain supernovae dimming. Let us introduce a new dimensional constant D, so that: $\sigma(E,\epsilon) = D \cdot E \cdot \epsilon$, $\sigma(E,\epsilon)$ is a cross-section of interaction by forehead collisions of a photon with an energy E and a graviton with an energy ϵ. Then we get for the Hubble's constant: $H = (1/2\pi)D \cdot \bar{\epsilon} \cdot (\sigma T^4)$.

A result of interaction of any massive body with the graviton background is a body deceleration w which will be directed against a body velocity v *relative to the background:* $w = -ac^2(1 - v^2/c^2)$. It has the same order of magnitude as a value of the observed additional acceleration $(8.74 \pm 1.33) \cdot 10^{-10} m/s^2$ for NASA probes Pioneer 10, 11 [3].

3 Graviton pairing and Newtonian gravity

A pressure force of single gravitons is of three order greater than the Newtonian force between any pair of bodies, but it is compensated by a repulsive force due to scattered gravitons - for usual bodies. But for black holes which absorb any particles and do not re-emit them, this repulsive force is equal to zero. It means that Einstein's equivalence principle would be roughly violated for black holes. To ensure an attractive force to be not equal to a repulsive one, graviton correlations should differ before and after collisions with a body. Single gravitons of a running flux may associate in pairs which are destructed in collisions. Then we have for the Newton constant, G :

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

where $I_2 = 2.3184 \cdot 10^{-6}$. It follows from this expression that by $T = 2.7K$ the constant D should have the value: $D = 0.795 \cdot 10^{-27} m^2/eV^2$. We can establish a connection between the two fundamental constants, G and H, in this approach:

$$H = (G \frac{45}{64\pi^5} \frac{\sigma T^4 I_4^2}{c^3 I_2})^{1/2},$$

and then evaluate H : $H = 2.14 \cdot 10^{-18}\ s^{-1}$, or in the units which are more familiar for many of us: $H = 66.875\ km \cdot s^{-1} \cdot Mpc^{-1}$. Here $I_4 = 24.866$. To have the condition of big distances: $\sigma(E_2, < \epsilon >) \ll 4\pi r^2$ be fulfilled, it is necessary to accept an "atomic structure" of matter - a unique case for models of gravity.

4 What and how may be verified

To verify the considered conjecture about the origin of NASA probes' additional acceleration, one could re-analyze radio Doppler data for the probes. Perhaps, such the re-analysis will be done soon by Toth and Turyshev [4]. The observed value of anomalous acceleration of Pioneer 10/11 relative to the Earth should represent the vector difference of the two accelerations: an acceleration of the probe relative to the graviton background, and an acceleration of the Earth itself relative to the background. Possibly, the last one is displayed as an annual periodic term in the residuals of Pioneer 10 [5]. An additional acceleration of the Sun should influence on the Earth orbit, too.

Every of these accelerations should be directed - in a frame of this model - against a body velocity *relative to the background.* Any new space mission devoted to a verification of a direction and of a magnitude of this anomalous acceleration will be very important: this small effect leads us beyond the general relativity. One may attempt to observe anomalous *periodic* residuals of the order Hc in the orbital motion for big bodies of the solar system.

From another side, it is possible to verify my basic conjecture about the quantum gravitational nature of redshifts in a ground-based laser experiment [6]: a red-shifted satellite line should appear in a stable laser radiation spectrum after a delay line. Satellite's position must be fixed, and its intensity should linear rise with a time delay. Of course, if we have a Moon-based station (let us dream), this experiment of great significance for cosmology and physics would be carried out on the Moon with a much bigger path of laser photons that it is possible to achieve in a vacuum tube on the Earth. A new proposal to evaluate a dependence of the Hubble constant on a direction of supernova observation and its correlation with the CMB anisotropy [7] may be used to establish a connection between the graviton background and CMB.

5 Conclusion

Here we deal with gravitons as with usual particles. A future theory must be non-local in the sense that it should take into account the *external* sea of gravitons. Any divergencies, perhaps, would not appear in such the model because of natural smooth cut-offs of the graviton spectrum from both sides. Due to a destruction of graviton pairs in outer regions of big systems such as galaxies, the strength of gravity may decrease in their inner parts that could be connected with the problem of dark matter. In this case, gravity cannot be described with one even *running* Newton "constant", it would depend on an environment and on a direction. On bigger scales such as clusters of galaxies, a process of graviton pairing should play a more important role, and the final picture will be much more complicated than one may expect today.

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