Screening the graviton background, graviton pairing, and Newtonian gravity

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Abstract

It is shown that screening the background of super-strong interacting gravitons creates for any pair of bodies as an attraction force as well an repulsion force due to pressure of gravitons. For single gravitons, these forces are approximately balanced, but each of them is much bigger than a force of Newtonian attraction. If single gravitons are pairing, a body attraction force due to pressure of such graviton pairs is twice exceeding a corresponding repulsion force under the condition that graviton pairs are destructed by collisions with a body. If the considered quantum mechanism of classical gravity is realized in the nature, then an existence of black holes contradicts to Einstein's equivalence principle. In such the model, Newton's constant is proportional to H^2/T^4, where H is the Hubble constant, T is an equivalent temperature of the graviton background. The estimate of the Hubble constant is obtained $H = 2.14 \cdot 10^{-18}\ s^{-1}$ (or $66.875\ km \cdot s^{-1} \cdot Mpc^{-1}$).

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1 Introduction

It was shown by the author in the previous study [1, 2] that an alternative explanation of cosmological redshift as a result of interaction of a photon with the graviton background is possible. In the case, observed dimming of supernovae Ia [3] and the Pioneer 10 anomaly [4] may be explained from one point of view as additional manifestations of interaction with the graviton background. Some primary features of a new cosmological model, based on this approach, are described in author's preprint [5].

In this paper, forces of gravitonic radiation pressure are considered which act on bodies in a presence of such the background. It is shown that pressure of single gravitons of the background, which run against a body pair from infinity, results in mutual attraction of bodies with a magnitude which should be approximately 1000 times greater than Newtonian attraction. But pressure of gravitons scattered by bodies gives a repulsion force of the same order; the last is almost exact compensating this attraction. To get Newton's law of gravity, it is necessary to assume that gravitons form correlated pairs. By collision with a body, such a pair should destruct in single gravitons. Flying away gravitons of a pair should happen in independent directions, that decreases a full cross-section of interaction with scattered gravitons. As a result, an attraction force will exceed a corresponding repulsion force acting between bodies. In such the model, Newton's constant is connected with the Hubble constant that gives a possibility to obtain a theoretical estimate of the last. We deal here with a flat non-expanding universe fulfilled with superstrong interacting gravitons; it changes the meaning of the Hubble constant which describes magnitude of three small effects of quantum gravity but not any expansion.

The considered fine quantum mechanism of classical gravity differs from a generally admitted one. In the full analogy with quantum electrodynamics, it had been shown already in the first works in quantum gravity [6, 7] that Newton's law may be explained as a result of exchange with virtual longitudinal gravitons, sources of which are attracting bodies.

A conjecture about a composite nature of gravitons was considered by few authors with other reasons (see short remarks and further references in [8], and also the papers [9, 10]). The main idea of works [11, 12]), where composite gravitons were considered as correlated pairs of photons, seems to be the most interesting for the author.

2 Screening the graviton background

In author's papers [1, 2], a cross-section $\sigma(E, \epsilon)$ of interaction of a graviton with an energy ϵ with any body having an energy E was accepted to be equal to:

$$\sigma(E, \epsilon) = D \cdot E \cdot \epsilon, \tag{1}$$

where D is some new dimensional constant. The Hubble constant H should be proportional to D :

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

where $\bar{\epsilon}$ is an average graviton energy, σ is the Stephan-Boltzmann constant, T is an effective temperature of the graviton background. The interaction should be super-strong to cause the whole redshift magnitude - it is necessary to have $D \sim 10^{-27} m^2/eV^2$.

If gravitons of the background run against a pair of bodies with masses m_1 and m_2 (and energies E_1 and E_2) from infinity, then a part of gravitons is screened. Let $\sigma(E_1, \epsilon)$ is a cross-section of interaction of body 1 with a graviton with an energy $\epsilon = \hbar\omega$, where ω is a graviton frequency, $\sigma(E_2, \epsilon)$ is the same cross-section for body 2. In absence of body 2, a whole modulus of a gravitonic pressure force acting on body 1 would be equal to:

$$4\sigma(E_1, <\epsilon>) \cdot \frac{1}{3} \cdot \frac{4 f(\omega, T)}{c}, \tag{3}$$

where $f(\omega, T)$ is a graviton spectrum with a temperature T (assuming to be planckian), the factor 4 in front of $\sigma(E_1, <\epsilon>)$ is introduced to allow all possible directions of graviton running, $<\epsilon>$ is another average energy of running gravitons with a frequency ω taking into account a probability of that in a realization of flat wave a number of gravitons may be equal to zero, and that not all of gravitons ride at a body.

Body 2, placed on a distance r from body 1, will screen a portion of running against body 1 gravitons which is equal for big distances between the bodies (i.e. by $\sigma(E_2, <\epsilon>) \ll 4\pi r^2$):

$$\frac{\sigma(E_2, <\epsilon>)}{4\pi r^2.} \tag{4}$$

Taking into account all frequencies ω, an attractive force will act between bodies 1 and 2 :

$$F_1 = \int_0^\infty \frac{\sigma(E_2, <\epsilon>)}{4\pi r^2} \cdot 4\sigma(E_1, <\epsilon>) \cdot \frac{1}{3} \cdot \frac{4f(\omega, T)}{c} d\omega. \tag{5}$$

Let $f(\omega, T)$ is described with the Planck formula:

$$f(\omega, T) = \frac{\omega^2}{4\pi^2 c^2} \frac{\hbar\omega}{\exp(\hbar\omega/kT) - 1}. \tag{6}$$

Let $x \equiv \hbar\omega/kT$, and $\bar{n} \equiv 1/(\exp(x) - 1)$ is an average number of gravitons in a flat wave with a frequency ω (on one mode of two distinguishing with a projection of particle spin). Let $P(n, x)$ is a probability of that in a realization of flat wave a number of gravitons is equal to n, for example $P(0, x) = \exp(-\bar{n})$.

A quantity $<\epsilon>$ must contain the factor $(1 - P(0, x))$, i.e. it should be:

$$<\epsilon> \sim \hbar\omega(1 - P(0, x)), \tag{7}$$

that let us to reject flat wave realizations with zero number of gravitons.

But attempting to define other factors in $<\epsilon>$, we find the difficult place in our reasoning. On this stage, it is necessary to introduce some new assumption to find the factors. Perhaps, this assumption will be well-founded in a future theory - or would be rejected. If a flat wave realization, running against a finite size body from infinity, contains one graviton, then one cannot consider that it must stringent ride at a body to interact with some probability with the one. It would break the uncertainty principle by W. Heisenberg. We should admit that we know a graviton trajectory. The same is pertaining to gravitons scattered by one of bodies by big distances between bodies. What is a probability that a single graviton will ride namely at the body? If one denotes this probability as P_1, then for a wave with n gravitons their chances to ride at the body must be equal to $n \cdot P_1$. Taking into account the probabilities of values of n for the Poisson flux of events, an additional factor in $<\epsilon>$ should be equal to $\bar{n} \cdot P_1$. I admit here that

$$P_1 = P(1, x), \tag{8}$$

where $P(1, x) = \bar{n}\exp(-\bar{n})$; (below it is admitted for pairing gravitons: $P_1 = P(1, 2x)$ - see section 4).

In such the case, we have for $< \epsilon >$ the following expression:

$$< \epsilon >= \hbar\omega(1 - P(0,x))\bar{n}^2 \exp(-\bar{n}). \tag{9}$$

Then we get for an attraction force F_1 :

$$F_1 = \frac{4}{3}\frac{D^2 E_1 E_2}{\pi r^2 c}\int_0^\infty \frac{\hbar^3\omega^5}{4\pi^2 c^2}(1 - P(0,x))^2\bar{n}^5 \exp(-2\bar{n})d\omega = \tag{10}$$

$$\frac{1}{3}\cdot\frac{D^2 c(kT)^6 m_1 m_2}{\pi^3\hbar^3 r^2}\cdot I_1,$$

where

$$I_1 \equiv \int_0^\infty x^5(1-\exp(-(\exp(x)-1)^{-1}))^2(\exp(x)-1)^{-5}\exp(-2(\exp(x)-1)^{-1})dx = \tag{11}$$

$$5.636 \cdot 10^{-3}.$$

If $F_1 \equiv G_1 \cdot m_1 m_2/r^2$, then the constant G_1 is equal to:

$$G_1 \equiv \frac{1}{3}\cdot\frac{D^2 c(kT)^6}{\pi^3\hbar^3}\cdot I_1. \tag{12}$$

By $T = 2.7K$:

$$G_1 = 1215.4 \cdot G, \tag{13}$$

that is three order greater than Newton's constant G.

But if gravitons are elastic scattered with body 1, then our reasoning may be reversed: the same portion (4) of scattered gravitons will create a repulsive force $F_1^{'}$ acting on body 2 and equal to

$$F_1^{'} = F_1, \tag{14}$$

if one neglects with small allowances which are proportional to D^3/r^4. The last ones are caused by decreasing of gravitonic flux running against body 1 due to screening by body 2 (see section 5).

So, for bodies which elastic scatter gravitons, screening a flux of single gravitons does not ensure Newtonian attraction. But for gravitonic black holes which absorb any particles and do not re-emit them (by the meaning of a concept, the ones are usual black holes; I introduce a redundant adjective only from a caution), we will have $F_1^{'} = 0$. It means that such the object would attract other bodies with a force which is proportional to G_1 but not to G, i.e. Einstein's equivalence principle would be violated for it. This conclusion, as we shall see below, stays in force for the case of graviton pairing too. The conclusion cannot be changed with taking into account of Hawking's quantum effect of evaporation of black holes [13].

3 Graviton pairing

To ensure an attractive force which is not equal to a repulsive one, particle correlations should differ for *in* and *out* flux. For example, single gravitons of running flux may associate in pairs. If such pairs are destructed by collision with a body, then quantities $< \epsilon >$ will distinguish for running and scattered particles. Graviton pairing may be caused with graviton's own gravitational attraction or gravitonic spin-spin interaction. Left an analysis of the nature of graviton pairing for the future; let us see that gives such the pairing.

To find an average number of pairs $\bar{n}_2$ in a wave with a frequency ω for the state of thermodynamic equilibrium, one may replace $\hbar \to 2\hbar$ by deducing the Planck formula. Then an average number of pairs will be equal to:

$$\bar{n}_2 = \frac{1}{\exp(2x) - 1}, \tag{15}$$

and an energy of one pair will be equal to $2\hbar\omega$. It is important that graviton pairing does not change a number of stationary waves, so as pairs nucleate from existing gravitons. The question arises: how many different modes, i.e. spin projections, may have graviton pairs? We consider that the background of initial gravitons consists two modes. For massless transverse bosons, it takes place as by spin 1 as by spin 2. If graviton pairs have maximum spin 2, then single gravitons should have spin 1. But from such particles one may constitute four combinations: $\uparrow\uparrow$, $\downarrow\downarrow$ (with total spin 2), and $\uparrow\downarrow$, $\downarrow\uparrow$ (with total spin 0). All these four combinations will be equiprobable if spin projections $\uparrow$ and $\downarrow$ are equiprobable in a flat wave (without taking into account a probable spin-spin interaction).

But it is happened that, if expression (15) is true, it follows from the energy conservation law that composite gravitons should be distributed only in two modes. So as

$$\lim_{x \to 0} \frac{\bar{n}_2}{\bar{n}} = 1/2, \tag{16}$$

then by $x \to 0$ we have $2\bar{n}_2 = \bar{n}$, i.e. all of gravitons are pairing by low frequencies. An average energy on every mode of pairing gravitons is equal to $2\hbar\omega\bar{n}_2$, the one on every mode of single gravitons - $\hbar\omega\bar{n}$. These energies are equal by $x \to 0$, because of it, the numbers of modes are equal too, if the background is in thermodynamic equilibrium with surrounding bodies.

The above reasoning does not allow to choose a spin value 2 or 0 for composite gravitons. A choice of namely spin 2 would ensure the following proposition: all of gravitons in one realization of flat wave have the same spin projections. From another side, a spin-spin interaction would cause it.

The spectrum of composite gravitons is proportional to the Planck one; it has the view:

$$f_2(2\omega, T)d\omega = \frac{\omega^2}{4\pi^2 c^2} \cdot \frac{2\hbar\omega}{\exp(2x) - 1} d\omega \equiv \frac{(2\omega)^2}{32\pi^2 c^2} \cdot \frac{2\hbar\omega}{\exp(2x) - 1} d(2\omega). \quad (17)$$

It means that an absolute luminosity for the sub-system of composite gravitons is equal to:

$$\int_0^\infty f_2(2\omega, T)d(2\omega) = \frac{1}{8}\sigma T^4, \quad (18)$$

where σ is the Stephan-Boltzmann constant; i.e. an equivalent temperature of this sub-system is

$$T_2 \equiv (1/8)^{1/4} T = \frac{2^{1/4}}{2} T = 0.5946T. \quad (19)$$

It is important that the graviton pairing effect does not changes computed values of the Hubble constant and of anomalous deceleration of massive bodies [1]: twice decreasing of a sub-system particle number due to the pairing effect is compensated with twice increasing the cross-section of interaction of a photon or any body with such the composite gravitons. Non-pairing gravitons with spin 1 give also its contribution in values of redshifts, an additional relaxation of light intensity due to non-forehead collisions with gravitons, and anomalous deceleration of massive bodies moving relative to the background [1, 2].

4 Computation of Newton's constant

If running graviton pairs ensure for two bodies an attractive force F_2, then a repulsive force due to re-emission of gravitons of a pair alone will be equal to $F_2^{'} = F_2/2$. It follows from that the cross-section for *single additional scattered* gravitons of destructed pairs will be twice smaller than for pairs themselves (the leading factor $2\hbar\omega$ for pairs should be replaced with $\hbar\omega$ for single gravitons). For pairs, we introduce here the cross-section $\sigma(E_2, <\epsilon_2>)$, where $<\epsilon_2>$ is an average pair energy with taking into account a probability of that in a realization of flat wave a number of graviton pairs may be equal to zero, and that not all of graviton pairs ride at a body ($<\epsilon_2>$ is an analog of $<\epsilon>$). This equality is true in neglecting with small allowances which are proportional to D^3/r^4 (see section 5). Replacing $\bar{n} \rightarrow \bar{n}_2, \hbar\omega \rightarrow 2\hbar\omega$, and $P(n,x) \rightarrow P(n,2x)$, where $P(0,2x) = \exp(-\bar{n}_2)$, we get for graviton pairs:

$$<\epsilon_2> \sim 2\hbar\omega(1 - P(0,2x))\bar{n}_2^2 \exp(-\bar{n}_2). \tag{20}$$

This expression does not take into account only that beside pairs there may be single gravitons in a realization of flat wave. To reject cases when,instead of a pair, a single graviton runs against a body (a contribution of such gravitons in attraction and repulsion is the same), we add the factor $P(0,x)$ into $<\epsilon_2>$:

$$<\epsilon_2> = 2\hbar\omega(1 - P(0,2x))\bar{n}_2^2 \exp(-\bar{n}_2) \cdot P(0,x). \tag{21}$$

Then a force of attraction of two bodies due to pressure of graviton pairs F_2 - in the full analogy with (5) - will be equal to [1]:

$$F_2 = \int_0^\infty \frac{\sigma(E_2, <\epsilon_2>)}{4\pi r^2} \cdot 4\sigma(E_1, <\epsilon_2>) \cdot \frac{1}{3} \cdot \frac{4 f_2(2\omega, T)}{c} d\omega = \tag{22}$$

$$\frac{8}{3} \cdot \frac{D^2 c (kT)^6 m_1 m_2}{\pi^3 \hbar^3 r^2} \cdot I_2,$$

where

$$I_2 \equiv \int_0^\infty \frac{x^5 (1 - \exp(-(\exp(2x) - 1)^{-1}))^2 (\exp(2x) - 1)^{-5}}{\exp(2(\exp(2x) - 1)^{-1}) \exp(2(\exp(x) - 1)^{-1})} dx = \tag{23}$$

$$2.3184 \cdot 10^{-6}.$$

[1] In initial version of this paper, factor 2 was lost in the right part of Eq. (22), and the theoretical values of D and H were overestimated of $\sqrt{2}$ times

The difference F between attractive and repulsive forces will be equal to:

$$F \equiv F_2 - F_2' = \frac{1}{2}F_2 \equiv G_2 \frac{m_1 m_2}{r^2}, \tag{24}$$

where the constant G_2 is equal to:

$$G_2 \equiv \frac{4}{3} \cdot \frac{D^2 c (kT)^6}{\pi^3 \hbar^3} \cdot I_2. \tag{25}$$

As G_1 as well G_2 are proportional to T^6 (and $H \sim T^5$, so as $\bar{\epsilon} \sim T$).

If one assumes that $G_2 = G$, then it follows from (25) that by $T = 2.7K$ the constant D should have the value:

$$D = 0.795 \cdot 10^{-27} m^2/eV^2. \tag{26}$$

An average graviton energy of the background is equal to:

$$\bar{\epsilon} \equiv \int_0^\infty \hbar\omega \cdot \frac{f(\omega, T)}{\sigma T^4} d\omega = \frac{15}{\pi^4} I_4 kT, \tag{27}$$

where

$$I_4 \equiv \int_0^\infty \frac{x^4 dx}{\exp(x) - 1} = 24.866$$

(it is $\bar{\epsilon} = 8.98 \cdot 10^{-4} eV$ by $T = 2.7K$).

We can use (2) and (25) to establish a connection between the two fundamental constants G and H under the condition that $G_2 = G$. We have for D :

$$D = \frac{2\pi H}{\bar{\epsilon}\sigma T^4} = \frac{2\pi^5 H}{15k\sigma T^5 I_4}; \tag{28}$$

then

$$G = G_2 = \frac{4}{3} \cdot \frac{D^2 c (kT)^6}{\pi^3 \hbar^3} \cdot I_2 = \frac{64\pi^5}{45} \cdot \frac{H^2 c^3 I_2}{\sigma T^4 I_4^2}. \tag{29}$$

So as the value of G is known much better than the value of H, let us express H via G :

$$H = (G \frac{45}{64\pi^5} \frac{\sigma T^4 I_4^2}{c^3 I_2})^{1/2} = 2.14 \cdot 10^{-18} s^{-1}, \tag{30}$$

or in the units which are more familiar for many of us: $H = 66.875\ km \cdot s^{-1} \cdot Mpc^{-1}$.

This value of H is is in the good accordance with the majority of present astrophysical estimations [3, 14], but it is lesser than some of them [15] and than it follows from the observed value of anomalous acceleration of Pioneer 10 [4] $w = (8.4 \pm 1.33) \cdot 10^{-10}\ m/s^2$. Any massive body, moving relative to the background, must feel a deceleration $w \simeq Hc$ [1, 2]; with $H = 2.14 \cdot 10^{-18} s^{-1}$ we have $Hc = 6.419 \cdot 10^{-10}\ m/s^2$.

The observed value of anomalous acceleration of Pioneer 10 should represent the vector difference of the two acceleration: an acceleration of Pioneer 10 relative to the graviton background, and an acceleration of the Earth relative to the background. Possibly, the last is displayed as an annual periodic term in the residuals of Pioneer 10 [16]. If the solar system moves with a noticeable velocity relative to the background, the Earth's anomalous acceleration projection on the direction of this velocity will be smaller than for the Sun - because of the Earth's orbital motion. It means that in a frame of reference, connected with the Sun, the Earth should move with an anomalous acceleration having non-zero projections as well on the orbital velocity direction as on the direction of solar system motion relative to the background. Under some conditions, the Earth's anomalous acceleration in this frame of reference may be periodic. The axis of Earth's orbit should feel an annual precession by it.

5 Why and when gravity is geometry

The described quantum mechanism of classical gravity gives Newton's law with the constant G_2 value (25) and the connection (29) for the constants G_2 and H. We have obtained the rational value of H (30) by $G_2 = G$, if the condition of big distances is fulfilled:

$$\sigma(E_2, <\epsilon>) \ll 4\pi r^2. \tag{31}$$

Because it is known from experience that for big bodies of the solar system, Newton's law is a very good approximation, one would expect that the condition (30) is fulfilled, for example, for the pair Sun-Earth. But assuming $r = 1\ AU$ and $E_2 = m_\odot c^2$, we obtain assuming for rough estimation $<\epsilon> \rightarrow \bar{\epsilon}$:

$$\frac{\sigma(E_2, <\epsilon>)}{4\pi r^2} \sim 4 \cdot 10^{12}.$$

It means that in the case of interaction of gravitons or graviton pairs with the Sun in the aggregate, the considered quantum mechanism of classical gravity could not lead to Newton's law as a good approximation. This "contradiction" with experience is eliminated if one assumes that gravitons interact with "small particles" of matter - for example, with atoms. If the Sun contains of N atoms, then $\sigma(E_2, <\epsilon>) = N\sigma(E_a, <\epsilon>)$, where E_a is an average energy of one atom. For rough estimation we assume here that $E_a = E_p$, where E_p is a proton rest energy; then it is $N \sim 10^{57}$, i.e. $\sigma(E_a, <\epsilon>)/4\pi r^2 \sim 10^{-45} \ll 1$.

This necessity of "atomic structure" of matter for working the described quantum mechanism is natural relative to usual bodies. But would one expect that black holes have a similar structure? If any radiation cannot be emitted with a black hole, a black hole should interact with gravitons as an aggregated object, i.e. the condition (31) for a black hole of sun mass has not been fulfilled even at distances $\sim 10^6$ AU.

For bodies without an atomic structure, the allowances, which are proportional to D^3/r^4 and are caused by decreasing a gravitonic flux due to the screening effect, will have a factor $m_1^2 m_2$ or $m_1 m_2^2$. These allowances break the equivalence principle for such the bodies.

For bodies with an atomic structure, a force of interaction is added up from small forces of interaction of their "atoms":

$$F \sim N_1 N_2 m_a^2/r^2 = m_1 m_2/r^2,$$

where N_1 and N_2 are numbers of atoms for bodies 1 and 2. The allowances to full forces due to the screening effect will be proportional to the quantity: $N_1 N_2 m_a^3/r^4$, which can be expressed via the full masses of bodies as $m_1^2 m_2/r^4 N_1$ or $m_1 m_2^2/r^4 N_2$. By big numbers N_1 and N_2 the allowances will be small. The allowance to the force F, acting on body 2, will be equal to:

$$\Delta F = \frac{1}{2N_2}\int_0^\infty \frac{\sigma^2(E_2, <\epsilon_2>)}{(4\pi r^2)^2} \cdot 4\sigma(E_1, <\epsilon_2>) \cdot \frac{1}{3} \cdot \frac{4 f_2(2\omega, T)}{c} d\omega = \qquad (32)$$

$$\frac{2}{3N_2} \cdot \frac{D^3 c^3 (kT)^7 m_1 m_2^2}{\pi^4 \hbar^3 r^4} \cdot I_3,$$

(for body 1 we shall have the similar expression if replace $N_2 \to N_1$, $m_1 m_2^2 \to m_1^2 m_2$), where

$$I_3 \equiv \int_0^\infty \frac{x^6 (1 - \exp(-(\exp(2x) - 1)^{-1}))^3 (\exp(2x) - 1)^{-7}}{\exp(3(\exp(x) - 1)^{-1})} dx = 1.0988 \cdot 10^{-7}.$$

Let us find the ratio:

$$\frac{\Delta F}{F} = \frac{DE_2kT}{N_2 2\pi r^2} \cdot \frac{I_3}{I_2}. \tag{33}$$

Using this formula, we can find by $E_2 = E_{\odot},\ r = 1\ AU$:

$$\frac{\Delta F}{F} \sim 10^{-46}. \tag{34}$$

An analogical allowance to the force F_1 has by the same conditions the order $\sim 10^{-48} F_1$, or $\sim 10^{-45} F$. One can replace E_p with a rest energy of very big atom - the geometrical approach will left a very good language to describe the solar system. We see that for bodies with an atomic structure the considered mechanism leads to very small deviations from Einstein's equivalence principle, if the condition (31) is fulfilled for microparticles, which prompt interact with gravitons.

For small distances we shall have:

$$\sigma(E_2, <\epsilon>) \sim 4\pi r^2. \tag{35}$$

It takes place by $E_a = E_p,\ <\epsilon>\sim 10^{-3}\ eV$ for $r \sim 10^{-11}\ m$. This quantity is many order larger than the Planck length. The equivalence principle should be broken at such distances.

Under the condition (35), big digressions from Newton's law will be caused with two factors: 1) a screening portion of a running flux of gravitons is not small and it should be taken into account by computation of the repulsive force; 2) a value of this portion cannot be defined by the expression (4).

Instead of (4), one might describe this portion at small distances with an expression of the kind:

$$\frac{1}{2}(1 + \sigma(E_a, <\epsilon>)/\pi r^2 - (1 + \sigma(E_a, <\epsilon>)/\pi r^2)^{1/2}) \tag{36}$$

(the formula for a spheric segment area is used here [17]). Formally, by $\sigma(E_a, <\epsilon>)/\pi r^2 \to \infty$ we shall have for the portion (36):

$$\sim \frac{1}{2}(\sigma(E_a, <\epsilon>)/\pi r^2 - (\sigma(E_a, <\epsilon>)/\pi)^{1/2}/r),$$

where the second term shows that the interaction should be weaker at small distances. We might expect that a screening portion may tend to a fixing value at super-short distances. But, of course, at such distances the interaction will be super-strong and our naive approach would be not valid.

6 Conclusion

It is known that giant intellectual efforts to construct a quantum theory of metric field, based on the theory of general relativity, have not a hit until today (see the recent review [18]). From a point of view of the considered approach, one may explain it by the fact that gravity is not geometry at short distances $\sim 10^{-11}\ m$. Actually, it means that at such the distances quantum gravity cannot be described alone but only in some unified manner, together with other interactions including the strong one.

It follows from section 5 of the present work that the geometrical description of gravity should be a good idealization at big distances by the condition of "atomic structure" of matter. This condition cannot be accepted only for black holes which must interact with gravitons as aggregated objects. In addition, the equivalence principle is roughly broken for black holes, if the described quantum mechanism of classical gravity is realized in the nature.

Other important features of this mechanism are the following ones.

• Attracting bodies are not initial sources of gravitons. In this sense, a future theory must be non-local to describe gravitons running from infinity. Non-local models were considered by Efimov in his book [19]. The idea to describe gravity as an effect caused by running ab extra particles was criticized by the great physicist Richard Feynman in his public lectures at Cornell University [20], but the Pioneer 10 anomaly [4], perhaps, is a good contra argument pro this idea.

• Newton's law takes place if gravitons are pairing; to get preponderance of attraction under repulsion, graviton pairs should be destructed by interaction with matter particles.

• The described quantum mechanism of classical gravity is obviously asymmetric relative to the time inversion. By the time inversion, single gravitons would run against bodies forming pairs. It would lead to replacing a body attraction with a repulsion. But such the change will do impossible graviton pairing. Cosmological models with the inversion of the time arrow were considered by Sakharov [21]. Penrose reasoned about a hidden physical law determining the time arrow direction [22]; it will be interesting if realization in the nature of Newton's law determines this direction.

• The two fundamental constants - Newton's and Hubble's ones - are connected with each other in such the model. The estimate of Hubble's constant has been got here using an additional postulate $P_1 = P(1, 2x)$ for pairing gravitons.

• It is proven that graviton pairs should be distributed in two modes with different spin projections.

• From thermodynamic reasons, it is assumed here that the graviton background has the same temperature as the microwave background. Also it follows from the condition of detail equilibrium, that both backgrounds should have the planckian spectra. Composite gravitons will have spin 2, if single gravitons have the same spin as photons. The question arise, of course: how are gravitons and photons connected? Has the conjecture by Adler et al. [11] (that a graviton with spin 2 is composed with two photons) chances to be true? Intuitive demur calls forth a huge self-action, photons should be endued with which - but one may get a unified theory on this way. To verify this conjecture in experiment, one would search for transitions in interstellar gas molecules caused by the microwave background, with an angular momentum change corresponding to absorption of spin 2 particles (photon pairs). A frequency of such the transitions should correspond to an equivalent temperature of the sub-system of these composite particles $T_2 = 0.5946T$, if T is a temperature of the microwave background.

A future theory dealing with gravitons as usual particles having an energy, a momentum etc ("gravitonics" would be a fine name for it) should have a number of features, which are not characterizing any existing model, to image the recounted above features of a possible quantum mechanism of gravity.

The main results of this work were poster presented at MG10 and Thinking'03 [23, 24].

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