Asymptotic freedom in low-energy quantum gravity

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Abstract

It is suggested in the model of low-energy quantum gravity by the author, that the background of super-strong interacting gravitons exists. It is shown here that micro-particles at very small distances should be almost free if the gravitational attraction is caused by a pressure of these gravitons.

In the model of low-energy quantum gravity [1], the Newtonian attraction arises as a result of the two stochastic processes: a pressure of graviton pairs and a repulsion due to single scattered gravitons after destruction of these pairs. A force of attraction of two bodies due to pressure of graviton pairs, F_2, is equal to (in notations of [1]):

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

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

where I_2 is a constant. Here, a portion of screened gravitons *for big distances between the bodies* is described by the factor $\sigma(E_2, <\epsilon_2>)/4\pi r^2$, which should be much smaller of unity. A net force is attractive, and it is equal to $F_2/2$. For small distances, the condition $\sigma(E_2, <\epsilon_2>) \ll 4\pi r^2$ will be broken. For example, $\sigma(E_2, <\epsilon_2>) \sim 4\pi r^2$ for two protons and $<\epsilon_2>\sim 10^{-3}\ eV$ at distances $r \sim 10^{-11}\ m$. This quantity is many orders larger than the Planck length. I noted in [1] that the screened portion may tend to a fixed value at super-short distances, and it will be something similar to asymptotic freedom of strong interactions [2, 3] - and there I stopped.

But when I compute a pressure force of graviton pairs in the limit case of super-short distances I was surprised: it turns out that this force almost vanishes. For this limit case, we should replace the factor $\sigma(E_2, <\epsilon_2>)/4\pi r^2$ by 1/2 if a separation of interacting particles has a sense. Of course, it is an idealization because this factor depends on a graviton energy. If we accept this replacement, we get for the pressure force (acting on body 1) instead of (1):

$$F_2 = \int_0^\infty \frac{1}{2} \cdot 4\sigma(E_1, <\epsilon_2>) \cdot \frac{1}{3} \cdot \frac{4 f_2(2\omega, T)}{c} d\omega = \frac{8}{3} \cdot \frac{D(kT)^5 E_1}{\pi^2 \hbar^3 c^3} \cdot I_5, \tag{2}$$

where I_5 is the new constant:

$$I_5 \equiv \int_0^\infty \frac{x^4 (1 - \exp(-(\exp(2x) - 1)^{-1}))(\exp(2x) - 1)^{-3}}{\exp((\exp(2x) - 1)^{-1}) \exp((\exp(x) - 1)^{-1})} dx = 4.24656 \cdot 10^{-4}. \tag{3}$$

Then the corresponding limit acceleration is equal to:

$$w_{lim} = G \frac{\pi}{D(kT)c^2} \cdot \frac{I_5}{I_2} = 3.691 \cdot 10^{-13}\ m/s^2, \tag{4}$$

where G is the Newton constant (which is computable in the model).

This extremely small acceleration means that at very small distances (which are meantime many orders of magnitude larger than the Planck length) we have in this model the property which never has been recognized in any model of quantum gravity: almost full asymptotic freedom.

References

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