New and old constants characterizing low-energy quantum gravity

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Abstract

A model of low-energy quantum gravity by the author involves an unusual set of constants, such as the temperature T of the graviton background, a new dimensional constant D defining a cross-section of interaction by forehead collisions of any particle with a graviton, the Newton and Hubble constants which are computable here. The set of used constants of this model and links between them are considered in this paper.

1 Introduction

In a model of low-energy quantum gravity by the author [1, 2], gravity is considered as a result of a stochastic process of interactions of bodies with the low-temperature graviton background. It is assumed that gravitons of this background are super-strong interacting particles. The specific quantum mechanism of classical gravity considered in the model is based on the graviton pairing. The one demands an atomic structure of matter and leads to the time asymmetry. The model predicts such the small additional effects as: a redshift of spectra of remote sources; an additional relaxation of any photon flux; a deceleration of massive bodies of the order of Hc, where H is the

Hubble constant and c is the velocity of light. The model has the property of asymptotic freedom at very short distances leading to an interesting restriction on black hole masses. These effects may be important for cosmology and astrophysics. A few constants are used to describe main effects of the model. Some of them are new, and some old "constants" may be calculated or re-interpreted in the model. I would like to describe here a set of used constants of this model and links between them.

2 Main constants of the model

The temperature T of the graviton background is a very important new parameter of this model which has not any analog in other models of gravity. Such known constants as the Newton and Hubble ones depend on this temperature. The temperature T has been evaluated in the model implicitly: its average value should coincide with the average temperature of CMB because these two backgrounds must be in the dynamical equilibrium. From another side, it means that T may fluctuate in the same range as the temperature of CMB, but these fluctuations should be observed in opposite directions relative to CMB. Taking into account the measured values of CMB fluctuations and a character of dependence on T, one can evaluate possible uncertainties of the Newton and Hubble constants in the model.

If $\sigma(E, \epsilon)$ is a cross-section of interaction by forehead collisions of any particle with an energy E and a graviton with an energy ϵ, then a new constant D of the model is introduced to have:

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

By $T = 2.7K$, the constant D should have the value: $D = 0.795 \cdot 10^{-27} m^2/eV^2$. Then the Hubble constant H may be computed in the model as:

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

where $\bar{\epsilon}$ is an average graviton energy (it is $\bar{\epsilon} = 8.98 \cdot 10^{-4} eV$ by $T = 2.7K$, that is very far from the Plank scale on which many people are expected to find manifestations of quantum gravity), σ is the Stephan-Boltzmann constant. But here the Hubble constant has not any relation to an expansion of the universe; the one describes the redshift arising due to forehead collisions of photons with gravitons, and its natural dimension is s^{-1}. Its theoretical estimate in the model is: $H = 2.14 \cdot 10^{-18}\ s^{-1}$, that is equivalent to $H = 66.875\ km \cdot s^{-1} \cdot Mpc^{-1}$. This value of H is in good accordance with the majority of present astrophysical estimations. In the model, the redshift has an interesting analog: any massive body should experience a constant deceleration of the order of $Hc = 6.419 \cdot 10^{-10}\ m/s^2$ if it moves relative the frame in which the graviton background is isotropic. This effect may be connected with the Pioneer anomaly and with the problem of missing mass in galaxies.

This estimate has been got via a comparison of H with the known value of the Newton constant G which can be computed in the model as:

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

where $I_2 = 2.3184 \cdot 10^{-6}$ is one of the integrals arising in the model. From this expression we have for relative uncertainties of G and T:

$$\frac{\Delta G}{G} = 6 \cdot \frac{\Delta T}{T}. \tag{4}$$

If the relative uncertainty of T has the order of 10^{-6} - the same as of the temperature of CMB - then the one for G will be of 10^{-5}; perhaps it might explain why measured values of G have so big (no better than 10^{-4}) relative uncertainties.

Additional photon flux's average energy losses arise due to non-forehead collisions with gravitons. These losses are connected with a rejection of a part of photons from a source-observer direction. Both the redshift and this additional relaxation lead in the model to the following luminosity distance D_L as a function of a redshift z :

$$D_L = c/H \cdot \ln(1+z) \cdot (1+z)^{(1+b)/2}, \tag{5}$$

where b is a new "constant". The theoretical value of this relaxation factor for a soft radiation is: $b \simeq 2.137$. This function fits SN 1a and GRB observations very well without any dark energy or expansion of the universe if one corrects them for no time dilation of this model. There is the very important circumstance: the factor b is not constant for different radiation frequencies - for a very hard radiation $b \rightarrow 0$. For an arbitrary source spectrum, a value of the factor b should be still computed. It is clear only that $0 \leq b \leq 2.137$. Due to it, the Hubble diagram in this model is a multivalued function of a redshift: for a given z, b may have different values. It may be crucial to distinguish this model from others: given an independent of supernovae 1a calibration of the GRB data, we may get different Hubble diagrams for supernovae and GRBs.

The model has the property of asymptotic freedom at very short distances. A transition to asymptotic freedom is not universal, but the one obeys the scaling rule: the range of this transition in units of $r/E^{1/2}$, where r is a distance between particles and E is an energy of the screening particle, is the same for any micro-particle. This range for a proton is between $10^{-11} - 10^{-13}$ meter, for an electron it is between $10^{-13} - 10^{-15}$ meter. This property leads to the unexpected consequence: if a black hole arises due to a collapse of a matter with some characteristic mass of particles, its full mass should be restricted from the bottom. For usual baryonic matter, this limit is of the order $10^7 \cdot M_{\odot}$. Additionally, if the considered in the model quantum mechanism of classical gravity is realized in nature, then an existence of black holes contradicts to the equivalence principle: the gravitational mass of a black hole should be much greater than its inertial mass.

3 Conclusion

The considered model of quantum gravity is in a deep and irremovable contradiction with the current standard cosmological paradigm: we do not need any expansion of the universe to explain observable redshifts or the Hubble diagram in the model. Astrophysical observations are indeed very important as a tool to confirm an existence of very tiny effects of this model. From another side, there exists a possibility to verify the mechanism of redshift in a ground-based laser experiment. If this model is true, gravity on the quantum level is a super strong interaction that is absolutely unexpected. The model has not divergences because the spectrum of gravitons of the external - relative to interacting particles - background is smoothly cut off from both sides.

References

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