GRAVITATIONAL WAVES BACKGROUND, AS WELL AS SOME UFO, FRB AND SUPERNOVA FLARES, ARE DUE TO COMPRESSIBILITY OF THE SPACETIME (CoST)

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Abstract

The recently observed gravitational wave background is explained in terms of the quantum modification of the general relativity (Qmoger). Some UFO, FRB and supernova flares also can be explained in terms of Qmoger.

Keywords

Gravitational wave background, quantum modification of the general relativity, compressibility of the spacetime (CoST).

Introduction

Recently detected gravitational waves background (GWB) [1] remains a mystery, despite several suggested sources of it [1]. In this letter, GWB is naturally explained by the quantum modification of the general relativity (Qmoger), initiated in Ref. [2]. The essence of Qmoger is that the spacetime is not only curved (Einstein), but also compressible, which leads to new dynamics of matter/energy production/absorption by the quantum vacuum [2].

Mathematically, this effect is described by two additional terms in the Einstein equations of the general relativity (GR) [2]::

$$R_i^k - \frac{1}{2}\delta_i^k R = 8\pi G_* T_i^k + \lambda_N \delta_i^k,\ T_i^k = w u_i u^k - \delta_i^k p,\ w = \varepsilon + p, \tag{1}$$

$$\lambda_N = \lambda_0 + \beta\frac{d\sigma}{ds} + \gamma\sigma^2,\ \sigma = u^k_{;k} = \frac{\partial u^k}{\partial x^k} + \frac{1}{2g}\frac{dg}{ds},\ \frac{d}{ds} = u^k\frac{\partial}{\partial x^k}. \tag{2}$$

Here R_i^k is the curvature tensor, p, $\varepsilon = \rho c^2$ and w are pressure, energy density and enthalpy density, respectively, ρ is the mass density, G is the gravitational constant, $G_* = Gc^{-4}$(c- speed of light), u^k - components of velocity (summation over repeated indexes is assumed from 0 to 3, $x^0 = \tau = ct$), λ_0 is the cosmological constant (which we will put zero), σ is the covariant divergency, β and γ are nondimensional parameters (with particular physically special choice [2] $\beta = 2\gamma = 2/3$, when some solutions conserve energy) and g is the determinant of the metric tensor. With $\beta = \gamma = 0$ we recover the classical equations of GR. Let us note that curvature terms in the left hand side of (1) and additional terms $d\sigma/ds$ and σ^2 all contain second order (or square of first order) derivatives of metric tensor, which make these terms compatible. The importance of σ also follows from the fact that it is the only dynamic characteristic of media, which enters into the balance of the proper number density of particles $n : dn/ds + \sigma n = q$, where q is the rate of particle production (or absorption) by the vacuum. So, if n is constant (see the exact analytical solution below) or changing slowly, than the σ-effect is, certainly, very important in quantum cosmology. The σ-terms were introduces [2] with such physical argumentation on base of previous works [3-5]. Later, in the case $\beta = 2\gamma$, equations (1, 2) were derived from the variational principle by simply replacing the cosmological constant λ_0 (in the Lagrangian) by $\lambda = \lambda_0 - \gamma\sigma^2$[6]. Indeed, the variation of $\int d^4x\,(-g)^{1/2}\,\sigma^2$ with respect to the metric tensor produces the two σ-terms in (1,2) [6]. But, the system is not Hamiltonian, the vacuum is feeding the universe, so, the standard approach is not appropriate. Parameters (β, γ), generally, depend on the equation of state [7].

Some exact analytical solutions of equations (1, 2) where obtained in Ref. 2. On the basis of these solutions, it was concluded that the effect of CoST (σ-terms) explains the accelerated expansion of the universe and for negative σ (collapse) the same effect can prevent formation of singularity. Equations (1,2) reproduce Newtonian gravitation in the nonrelativistic asymptotic.

Qmoger was also supported by simple consideration [8], indicating that presence of the quantum vacuum is hardly consisted with exact conservation of energy, which is for classical general relativity (see, for example, textbook [9]) . Developments and applications of Qmoger are in good quantitative agreement with cosmic data, including the accelerated expansion of the universe and recently observed early galaxies, without fitting parameters [6,7,10-13]. Particularly, we got exact analytical solution in Qmoger for the scale factor: $\alpha(t) = \alpha_0 \exp[H_0 t - 2\pi G\rho_0 t^2]$, where subscript 0 indicates present epoch and H_0 is the Hubble constant. This formula was also obtained [7] from dimensional consideration and analogy with the logarithmic modulation in the theory of turbulence [14]. Only geometrical factor 2π in the second term in the bracket had to be calculated from equations (1,2). The simplicity of this formula, which is in a good quantitative agreement with cosmic data, is an additional argument in,favor of Qmoger.

Gravitational waves in Qmoger

It is reasonable to expect, that feeding the universe, connected in Qmoger with CoST, should create gravitational waves, not unlike waves on a lake in a rainy day. Indeed, in Qmoger, in the weak-field limit, we have two types of plane gravitational waves [6]. Consider the following representation of the metric tensor for the weak-field limit:

$$g_{ik} = g_{ik}^{(0)} + h_{ik} + 0(h^2), g = g^{(0)}[1 + h + 0(h^2)], h = h_i^i, h_0^0 = 2c^{-2}\varphi, h_\alpha^\beta = -2c^{-2}\varphi_1\delta_\alpha^\beta, \tag{3}$$

where $\alpha, \beta = 1, 2, 3; g_{\alpha\beta}^{(0)} = -\delta_{\alpha\beta}; g_{00}^{(0)} = 1; g_{00}^{(0)} = 0$. In difference with the classical waves [9], taking into account that in Qmoger equations we have additional σ-terms, potentials φ and φ_1 are not equal generally. Starting from (3), the procedure, similar to used for classical waves [9], with $\beta = 2\gamma$ (see above) and the equation of state $p = \varkappa\varepsilon$ ($\varkappa$ is constant), produced dispersion equation [6]:

$$\left[\alpha^2(1 - 3\gamma(1 + \varkappa)) - 1\right]^2 = 9\gamma^2\alpha^4, \tag{4}$$

where $\alpha = \omega/kc$; ω, k are frequency and wave number of plane waves. This equation corresponds to possibility of two types of waves. One is classical waves, connected with spacetime curvature, with $\omega/kc = \pm 1$. For another type of waves, connected to CoST, we have $\omega/kc = \pm[1 - 6\gamma(1 + \varkappa)]^{-1/2}$. For stability of these wave we need condition $6\gamma(1 + \varkappa) < 1$ and if we wont speed of these waves to be lesser than c , the condition is even stronger: $6\gamma(1 + \varkappa) < 0$. Some speculation are possible for these conditions, but in the context of this paper, particularly with $\gamma = 1/3$, these condition are nonphysical and these waves in the linear approximation are unstable, which could be anticipated. Indeed, collision of matter/energy jets from the hidden quantum vacuum with the visible universe should have some nonlinear stage (following by ordinary gravitational waves), similar to a splash of water, when the rain jets hit the surface of a lake. It seems natural, that this second type of waves in Qmoger creates the observed stochastic GWB permeating the universe. In a detailed observations, we can expect to see some flashes in GWB.

Conclusion

GWB is natural in the Qmoger and connected to CoST. In future, it will be interesting to consider indicated above special gravitational waves in a nonlinear approximation for a more detailed comparison with observations of GWB and other phenomena, which could be related to CoST. One such phenomenon, which seems to need CoST for explanation, is recently observed minute-duration optical flares in "Tasmanian devil"[15]. Some UFO [16] also could be related to CoST, as well as some FRB [17].

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