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ZPF Gravity and Gravitational Waves

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ABSTRACT
According to the ZPF (zero-point fluctuation) gravity theory, the gravity can be created by an interaction between matter and the ZPF field in the vacuum. Thus, it is considered that the vacuum has an electromagnetic fluid-like property. From which, the gravitational wave propagates through space as a scalar wave. By using tensor equation, it can be revealed that the gravitational wave propagates at the faster-than-light speed. Maybe it propagates through space much faster than light speed. It also shows that there may be no Schwarzschild black hole in the universe.

Keywords: gravitation; zero-point energy; ZPF gravity; gravitational wave; black hole

INTRODUCTION

To explain the unexplained Doppler effect in the transmitted waves observed during the Pioneer 6 solar transit, F.L. Walker suggested in his paper [1] that space may be filled with an electromagnetic fluid rather than nothing. P.Tewari in India and F.M.Meno at the University of Pittsburgh in the U.S. have also proposed the idea that space is filled with an electromagnetic fluid (ether) [2], and that the velocity field of the ether vortex in space is the source of the electromagnetic and gravitational fields. Following their ideas, they reconsidered the electromagnetic phenomena in space by using a model in which the vacuum is filled with a compressible electromagnetic fluid (ether). Zero-point energy (ZPE) is the lowest possible energy that a quantum mechanical system may have. Unlike the classical mechanics, the quantum mechanics states that the vacuum is filled with zero-point electromagnetic fluctuation as described by the Heisenberg uncertainty principle (i.e., the ZPF field). Based on Sakharov's idea, Puthoff proposed a gravitation mechanism by an interaction between elementary particles and the ZPF field [3]. He considered that gravitational force is an induced effect associated with ZPF of the vacuum in much the same manner as the van der Waals and Casimir forces. But he didn't succeed to fully explain he mechanism of gravitation. The author proposed the gravity theory based on zero-point field of the vacuum. It can be described as follows:

GRAVITY THEORY BASED ON ZERO-POINT FIELD

We assume that virtual particles (most of them are virtual photons) created from the ZPF field in a vacuum push matter, then the momentum flux density of virtual particles can be shown as [4].

$$\nabla \cdot \vec{J} = -\rho_m / \tau_0 \tag{1}$$

where $J = \rho_E / c$ (ρ_E : energy density of the ZPF energy), ρ_m is an equivalent mass den- sity of the ZPF field and τ_0 is a retardation time. For the ZPF filed, we have the equation shown as

$$\frac{d}{dt}\vec{P} = -\lim_{r_1 \to 0} \int_S (\vec{p}_1 + \vec{p}_2)[(\vec{p}_1 + \vec{p}_2) \cdot \vec{e}_1] / \rho_m \cdot dS \tag{2}$$

If $\vec{\omega}$ is defined as $\vec{\omega} = c\vec{k}$ where $\vec{k}$ is a wave vector satisfying $k = \omega / c$, we can write $\vec{p} = \hbar\vec{\omega} / c$ and $\rho_m = \hbar\omega / c^2$, the amount of momentum created by the ZPF field can be shown as [5].

$$\frac{d}{dt}\vec{P} = -\lim_{r_1 \to 0} \int_S \frac{\hbar}{c}(\vec{\omega}_1 + \vec{\omega}_2)\frac{c^2}{\hbar\omega}[(\frac{\hbar\vec{\omega}_1}{c} + \frac{\hbar\vec{\omega}_2}{c}) \cdot \vec{e}_1]dS$$
$$= -\lim_{r_1 \to 0} \int_S \frac{\hbar\omega}{c^2}\left(\frac{c\vec{\omega}_1}{\omega} + \frac{c\vec{\omega}_2}{\omega}\right)\left[\left(\frac{c\vec{\omega}_1}{\omega} + \frac{c\vec{\omega}_2}{\omega}\right) \cdot \vec{e}_1\right]dS \tag{3}$$

where $\vec{\omega}_1$ and $\vec{\omega}_2$ are vectors of the radial frequency of the ZPF field at the point e, as shown in Figure 1.

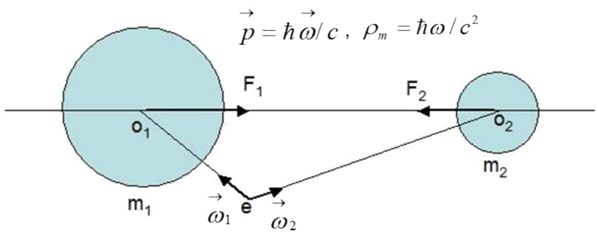

FIGURE 1: Two rest masses undergo the force generated the flow of ZPF energy.

According to the Jordan-Mbeutchou model, we have

$$(\vec{\omega}_1+\vec{\omega}_2)\cdot\vec{e}_1=\omega_1(r_1)+\omega_2(r_2)\frac{r_1-r\cos\theta}{\sqrt{r_1^2+r^2+2rr_1\cos\theta}} \qquad (4)$$

where θ is $\angle o_2o_1e$ and $o_1e=r_1$, $o_2e=r_2$ in Figure 1.

When we let $c\vec{\omega}_1/\omega\to v_1$ and $c\vec{\omega}_2/\omega\to v_2$, then the force at the point o_1 in Figure 1 be comes

$$\int_S \frac{\hbar\omega}{c^2}\left(\frac{c\vec{\omega}_1}{\omega}+\frac{c\vec{\omega}_2}{\omega}\right)\left[\left(\frac{c\vec{\omega}_1}{\omega}+\frac{c\vec{\omega}_2}{\omega}\right)\cdot\vec{e}_1\right]dS \qquad (5)$$

$$\to\frac{\hbar\omega}{c^2}\frac{4}{3}\frac{4\pi}{(4\pi\rho_m)^2}\frac{m_1m_2}{\tau_0^2}\frac{1}{r^2}\vec{e}_z$$

Then we have

$$F=\frac{d}{dt}P=\frac{\hbar\omega}{c^2}\frac{4}{3}\frac{4\pi}{(4\pi\rho_m)^2}\frac{m_1m_2}{\tau_0^2}\frac{1}{r^2}\vec{e}_z$$

$$=\frac{1}{3\pi}\frac{c^2}{\hbar\omega\tau_0^2}\frac{m_1m_2}{r^2}\vec{e}_z \qquad (6)$$

where a gravitational constant is given by

$$G=\frac{1}{3\pi}\frac{c^2}{\hbar\omega\tau_0^2}.$$

If the cutoff frequency of the ZPF field ω equals to the Plank frequency given by $\omega=1{,}855\times10^{43}(Hz)$, the retardation time can be estimated as $\tau_0=2.7\times10^{8}(\mathrm{sec})$.

The Equation. (6) shows that the gravitational force can be generated by an interaction between matter and the ZPF field in a vacuum. According to this equation, the Newtonian gravitational law can be obtained without ether flow in the vacuum. Hence it is considered that the gravity is an electromagnetic phenomenon induced by the ZPF field in the vacuum and it is not due to the curvature of space as claimed by Einstein.

TENSOR-LIKE EXPRESSION FORMULA FOR GRAVITY WAVES

From the ZPF gravity theory, the ZPF vacuum can be considered to have an electromagnetic fluid-like property consisted of electromagnetic fluctuation. Considering that the vector potential A of the electromagnetic field corresponds to the particle velocity, the distortion tensor is determined.

$$\Phi_{ij}=\frac{1}{2}\left(\frac{\partial A_{x_i}}{\partial x_j}+\frac{\partial A_{x_j}}{\partial x_i}\right) \qquad (7)$$

Next, from the correspondence with fluid theory, by assuming that the mass force (pressure) proportional to the spatial energy density and the stress tensor field associated with fluid deformation are always balanced, the electromagnetic stress tensor Ψ corresponding to the stress tensor of an elastic body can be determined as follows.

$$\Psi=\lambda\left(\nabla\cdot AI+\frac{2}{\mu}\Phi\right) \qquad (8)$$

where I is the unit tensor, λ is a constant related to the compressibility of the ZPF fluid, and μ is the magnetic permeability of the space.

The wave equation for this stress tensor is

$$\varepsilon\frac{\partial^2 A}{\partial t^2}=\nabla\cdot\Psi \qquad (9)$$

and the divergence of the tensor Φ is

$$\nabla\cdot\Phi=\left(\lambda+\frac{1}{\mu}\right)\nabla^2 A \qquad (10)$$

When we let $\theta=\nabla\cdot A$, from Maxwell's equations, we have

$$\varepsilon\frac{\partial^2}{\partial t^2}A-J=\frac{1}{\mu}\nabla^2 A-\nabla\left(\frac{1}{\mu}\theta+\varepsilon\frac{\partial\varphi}{\partial t}\right) \qquad (11)$$

where J is a current density, φ is a scalar potential ε is a dielectric constant of free space. Therefore, for the elastic field representation of electromagnetic waves and Maxwell's representation to be equivalent, it must hold.

$$\left(\lambda+\frac{2}{\mu}\right)\theta+\varepsilon\frac{\partial\varphi}{\partial t}=0 \qquad (12)$$

In this equation

$$\sqrt{\left(\lambda+\frac{2}{\mu}\right)\Big/\varepsilon}=v_l \qquad (13)$$

From which, if $\lambda > 0$, then we can see that

$$v_l > \sqrt{2}c$$

Then we have

$$\nabla \cdot A + \frac{1}{v_l^2}\frac{\partial \varphi}{\partial t} = 0 \tag{14}$$

This should be called the Lorentz condition for scalar waves (electromagnetic longitudinal waves). From this, the elastic expression of the electromagnetic field can be written as

$$\varepsilon \frac{\partial^2}{\partial t^2} A = \frac{1}{\mu}\nabla^2 A + \left(\lambda + \frac{1}{\mu}\right)\nabla\theta + J \tag{15}$$

In a vacuum, where $J = 0$, divergence and rotation of this expression can be given for scalar potential φ and magnetic flux density B as follows;

(non-rotating, longitudinal wave)

$$\nabla^2\varphi - \frac{1}{v_l^2}\frac{\partial^2}{\partial t^2}\varphi = 0 \tag{16}$$

(deformed, transverse wave)

$$\nabla^2 B + \frac{1}{c^2}\frac{\partial^2}{\partial t^2} B = 0 \tag{17}$$

From these equations, we know the following properties for traveling waves in a vacuum.

(1) The propagation speed of a scalar wave is not limited by the speed of light.

(2) The propagation speed of a transverse wave is the speed of light.

In the fluid-like ZPF vacuum, wave of gravity is created as a fluctuation of zero-point field and it is considered that the gravitational wave can be propagated as a scalar wave.

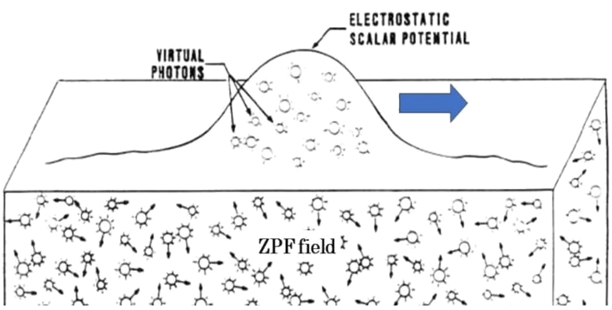

FIGURE 2: Scalar wave propagated in the ZPF vacum.

If we suppose $\kappa = 1/\lambda$, where κ is a parameter related to the rigidity of ZPF vacuum, then it can be seen that gravity wave (scalar wave) propagated in a vacuum as faster-than-light speed given by $v_l > \sqrt{2}c$ as shown in Figure 3 according to Eq.(13).

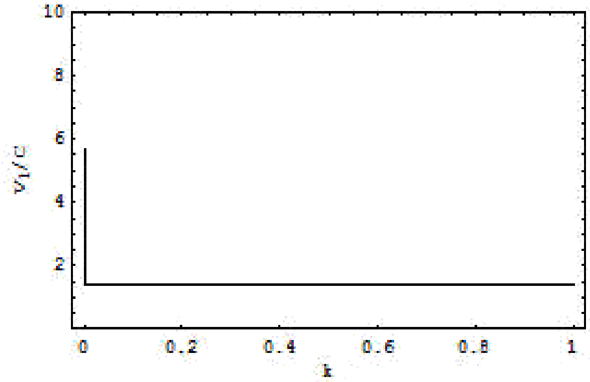

FIGURE 3: Graph of the gravity speed v_l / c vs. the parameter κ

From this result, the gravitational wave propagates much faster-than-light speed in the vacuum if the parameter κ has the value near zero. Frazer claimed that evidences from the motions of celestial bodies, from radar ranging, and from a binary pulsar leads to the conclusion that the speed of gravity is at least 20 billion times faster than the speed of light [6]. He also said that the gravitational forces of the Sun acting on the satellite from the present and retarded positions were calculated respectively, it has shown the speed of the gravitational forces is much larger than the speed of light in a vacuum.

IS THERE A BLACK HOLE IN THE UNIVERSE?

Time slows down near a black hole due to the extremely strong gravitational field of the black hole. According to the theory of general relativity, this phenomenon is due to the gravity of the black hole curving spacetime in a way that affects all measurements of time and space near the black hole. The general formula for the time dilation factor which is the ratio of proper time to the coordinate time can be given by [7].

$$\gamma = \frac{1}{\sqrt{-g_{\mu\nu}\frac{dx^\mu}{dt}\frac{dx^\nu}{dt}\frac{1}{c^2}}} \tag{18}$$

We consider the simplest types of black holes here, the Schwarzschild black hole, which are uncharged and non-rotating, Eq. (18) can be simplified as [7].

$$\gamma = \frac{1}{\sqrt{1-r_s/r}} \tag{19}$$

where is the radius of the event horizon and is the distance from the black hole.

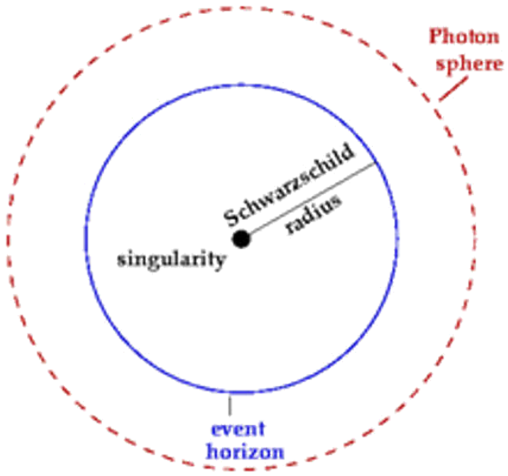

FIGURE 4: Structure of the Schwarzschild black hole.

Near the event horizon, the time becomes slower, the retardation time of the ZPF energy at the distance from the black hole can be shown as

$$\tau_0' = \gamma \cdot \tau_0 \tag{20}$$

where is a retardation time given by Eq. (1). Then the gravitational constant near the black hole can be written according to the ZPF gravity theory as

$$G = \frac{1}{3} \frac{c^2}{\pi\ \hbar \omega \tau_0'^2} \tag{21}$$

From which, when $r \to r_s$, τ_0' becomes infinity, then we have $G \to 0$. As we can write $r_s = 2GM / c^2$, where M is the mass of the black hole, it is concluded that r_s becomes zero when $r \to r_s$, which means the event horizon vanishes.

This result contradicts Einstein's general relativity theory and hence the general relativity theory is not correct from the standpoint of the ZPF gravity. Hence it is considered there may be no uncharged and non-rotating black hole in the universe according to the ZPF gravity theory. Hence the theory of black hole must be reconsidered.

CONCLUSION

From the theory proposed by the author on the gravitational mechanism based on the zero-point field, the gravitational wave can be propagated at the faster-than-light speed. This theory also shows that there may be no Schwarzschild black hole in the universe.

APPENDIX
(time dilation of the moving body)

The author proposed the time wave function of matter by using the Schrodinger equation in his paper [8]. The quantum dynamics of the matter can be described by

$$i\hbar \frac{\partial \psi}{\partial t} = H\psi \tag{A.1}$$

where ψ is a time wave function, $H = \sqrt{p^2c^2 + m^2c^4}$, p is a momentum, c is the light speed and m is a mass of the particle.

As we can write the energy of the particle as $E^2 = (pc)^2 + (mc^2)^2$, then we have

$$i\hbar \frac{\partial \psi}{\partial t} = E\psi \tag{A.2}$$

From (A.2), we have

$$\int \frac{d\psi}{\psi} = -\frac{i}{\hbar} \int E dt \tag{A.3}$$

Then we have

$$\psi = C \exp\left(-\frac{i}{\hbar} \int E dt \right) \tag{A.4}$$

where C is an arbitrary constant. As the energy can be written

$$E = \frac{mc^2}{\sqrt{1 - v^2 / c^2}} \tag{A.5}$$

where v is a velocity of the moving body.

For the static body, we have

$$\psi_0 = C \exp\left(-\frac{i}{\hbar} mc^2 \Delta t \right) \tag{A.6}$$

For the moving body, the wave function becomes

$$\psi' = C \exp\left(-\frac{i}{\hbar} E \Delta t' \right) \tag{A.7}$$

Supposing that $\psi_0 = \psi'$, i.e. the time wave function stays constant, then we have

$$\Delta t' = \sqrt{1 - v^2 / c^2}\, \Delta t \tag{A.8}$$

which is the equation of time dilation of the moving body. Hence, we can obtain the equation of time dilation without the special relativity theory.

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