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Quantization of Gravitational Wave by Klein-Gordon Equation

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Abstract: *In the general relativity theory, we find gravitational matter wave by Klein-Gordon wave equation. Specially, this article is that Quantization of gravitational wave is made by Klein-Gordon wave equation. We assume this matter wave as Dark Matter.*

Keywords: *General relativity theory, Gravitational Wave; Klein-Gordon wave equation; Gravitational matter wave; Dark matter*

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1. Introduction

In the general relativity theory, our article's aim is that we find the quantization of gravitational wave by Klein-Gordon wave equation.

At first, gravitational wave equation is

$$(\nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2})h_{\mu\upsilon} = 0 \tag{1}$$

The solution, gravitational wave function $h_{\mu\upsilon}(x)$ is

$$h_{\mu\upsilon}(x) = a_{\mu\upsilon}\exp(ik_\lambda x^\lambda) + a^*_{\mu\upsilon}\exp(-ik_\lambda x^\lambda) \tag{2}$$

In this time,

$$k_\lambda k^\lambda = -\frac{\omega_0^{\ 2}}{c^2} + k_0^{\ 2} = 0,\ k_\lambda = (\frac{\omega_0}{c}, \vec{k}_0), k^\lambda = (-\frac{\omega_0}{c}, \vec{k}_0) \tag{3}$$

The constant tensor $a_{\mu\upsilon}$ is the polarization tensor.

$$a_{\mu\upsilon} = a_{\upsilon\mu} \tag{4}$$

Harmonic coordinate condition is

$$(\nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2})\varepsilon_\upsilon = \frac{\partial h^\mu{}_\upsilon}{\partial x^\mu} - \frac{1}{2}\frac{\partial h^\mu{}_\mu}{\partial x^\upsilon} \tag{5}$$

$$k_\mu a^\mu{}_\upsilon = \frac{1}{2}k_\upsilon a^\mu{}_\mu \tag{6}$$

The coordinate transformation is

$$x'^\mu = x^\mu + i\varepsilon^\mu \exp(ik_\lambda x^\lambda) - i\varepsilon^{*\mu}\exp(-ik_\lambda x^\lambda) \tag{7}$$

According to Eq(7), the transformation of the polarization tensor is

$$a'_{\mu\upsilon} = a_{\mu\upsilon} + k_\mu \varepsilon_\upsilon + k_\upsilon \varepsilon_\mu \tag{8}$$

2. QUANTIZATION OF GRAVITATIONAL WAVE BY KLEIN-GORDON EQUATION

The speed of Gravitational wave is light speed. If we make matter by Gravitational space-time, this matter moves as the usual matter. We consider the matter interacting only gravity. Hence, we assume this matter as Dark Matter.

At first, gravitational matter wave equation is

$$(\nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2})h_{\mu\upsilon} = \frac{m_0^{\ 2} c^2}{\hbar^2} h_{\mu\upsilon} \tag{9}$$

The solution, gravitational matter wave function $h_{\mu\upsilon}(x)$ is

$$h_{\mu\upsilon}(x) = a_{\mu\upsilon} \exp(ik_\lambda x^\lambda) + a^*_{\mu\upsilon} \exp(-ik_\lambda x^\lambda) \tag{10}$$

In this time,

$$-k_\lambda k^\lambda = \frac{\omega_0^{\ 2}}{c^2} - k_0^{\ 2} = \frac{m_0^{\ 2} c^2}{\hbar^2}, E = \hbar\omega_0, \vec{p} = \hbar\vec{k}_0,$$

$$k_\lambda = (\frac{\omega_0}{c}, \vec{k}_0), k^\lambda = (-\frac{\omega_0}{c}, \vec{k}_0) \tag{11}$$

The constant tensor $a_{\mu\upsilon}$ is the polarization tensor.

$$a_{\mu\upsilon} = a_{\upsilon\mu} \tag{12}$$

Harmonic coordinate condition is in gravitational matter wave by Eq(5),Eq(6)

$$k_\mu a^\mu{}_\upsilon - \frac{1}{2} k_\upsilon a^\mu{}_\mu = \frac{m_0^{\ 2} c^2}{\hbar^2} \varepsilon_\upsilon = (\nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2})\varepsilon_\upsilon \tag{13}$$

3. CONCLUSION

We find the gravitational matter wave by Klein-Gordon wave equation. We find the quantization of gravitational wave by Klein-Gordon wave equation.

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