Relation of Gamma-ray and Yukawa Wave Function, Wave Equation

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ABSTRACT
Unstable atom’s nucleus radiate alpha-ray, beta-ray and gamma-ray. We study the relation of Yukawa wave function (new definition from Yukawa potential) and the gamma-ray for this unstable nucleus. We make Klein-Gordon equation (is satisfied by Yukawa potential) 4-dimensional wave equation of Yukawa wave function.

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1. Introduction

Unstable atom’s nucleus radiate $\alpha$-ray, $\beta$-ray and $\gamma$-ray. We study the relation of Yukawa wave function from Yukawa potential) and the $\gamma$-ray for this unstable nucleus. We make Klein-Gordon equation (is satisfied by Yukawa potential) 4-dimensional wave equation of Yukawa wave function.

At first, Yukawa potential $V$ describes nucleus’s combine force in semi-classical method.

$$ V = -\frac{kQ}{r} \exp\left(-\frac{m_{\pi} r c}{\hbar}\right) $$

$m_{\pi}$ is the meson’s mass

(1)

Klein-Gordon equation is satisfied by Yukawa potential $V$.

$$ \partial_\mu F^{\mu\nu} + \frac{m^2 c^2}{\hbar^2} A^\nu = -\partial_\nu V + \frac{m^2 c^2}{\hbar^2} V = -\nabla^2 V + \frac{m^2 c^2}{\hbar^2} V = 0 $$

$$ V = -\frac{kQ}{r} \exp\left(-\frac{m_{\pi} r c}{\hbar}\right) $$

(2)

2. Yukawa wave function and wave equation from Klein-Gordon equation

If we focus Klein-Gordon equation make 4-dimenstional partial differential equation about Yukawa potential,

$$ \frac{m^2 c^2}{\hbar^2} \dddot{A}^\nu = \frac{m_c^2 c^2}{\hbar^2} \dddot{V} = \frac{1}{c^2} \frac{\partial^2}{\partial t^2} \dddot{V} = \nabla^2 \dddot{V} $$

(3)

Hence, the 4-partial differential equation do the 4-dimensional wave equation. Therefore, Yukawa potential $V$ do Yukawa wave function $\dddot{V}$.

$$ \dddot{V} = -\frac{kQ}{r} \exp\left(\frac{m_{\pi} c}{\hbar} i(t - \frac{r}{c})\right) = -\frac{kQ}{r} \exp\left[i\omega(t - \frac{r}{c})\right] $$

Frequency $\omega = \frac{m_{\pi} c}{\hbar}$, $i$ is imaginary number

(4)

Absolutely, if we calculate, Eq(3) is satisfied by Eq(4). Because Yukawa wave function $\dddot{V}$ is the complex number, we can use Yukawa wave function $\phi$.

$$ \phi = -\frac{kQ}{r} \sin\left(\frac{m_{\pi} c}{\hbar} (t - \frac{r}{c})\right) = -\frac{kQ}{r} \sin\omega(t - \frac{r}{c}), \text{ Frequency } \omega = \frac{m_{\pi} c}{\hbar} $$

(5)

According to Eq(4), Yukawa wave function $\dddot{V}$ spreads in light velocity. Therefore, first, Yukawa potential is concerned to nucleus force, second, Yukawa wave function spreads in light velocity.

Hence, we think Yukawa wave function represent $\gamma$-ray of unstable nucleus.

3. Conclusion

We found Yukawa wave function is maybe $\gamma$-ray.

References
