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Time Independent Generalized Special Relativity Quantum Equation and Travelling Wave Solution

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Abstract: The generalized special relativity, which accounts for the effect of fields through the potential, is used to derive anew Dirac relativistic quantum equation. This new quantum equation consists of a potential term which emerged naturally from the relativistic energy expression. The solution of this equation predicts the propagation of travelling wave inside fields without attenuation. Thus it can describe the electromagnetic wave propagation inside fields. It also predicts the existence of biophotons as stationary waves that spreads themselves, instantaneously through the surrounding media. It also shows that particles behave as harmonic oscillator inside atoms with rest mass energy equal to the zero point energy. These results agree with observations.

Keywords: Generalized special relativity, Dirac equation, Bio photons, rest mass energy.

Introduction

The special theory of relativity (S.R), published in 1905, is based on two postulate. The first states that the lows of physics must be the same in all inertial reference frames and the second postulate tells us that the speed of light in vacuum has the same value in all inertial frames, regardless of the velocity of the observer or the source emitting the light. Einstein published the “general” theory of relativity, which is a theory about gravity, about a decade later. This theory is more fundamental than the special theory of relativity; it is a theory of space and time in a curved space –time [1, 2,3] such theory, describes the gravitational phenomena using geometrical language [4, 5]. Both special relativity (SR) and general relativity (GR) succeeded in describing a wide variety of physical phenomena associated with mechanics, gravity and cosmology. In spite of these remarkable successes (SR) suffers from noticeable setbacks. First of all the energy of (SR) does not satisfy correspondence principle in the sense that it does not reduce to that of Newton in the cases when the speed is small. Special relativistic energy in this Newtonian limit gives rest mass beside kinetic energy only, which is not typical to that of Newton which consists of potential term beside the kinetic term [5,6].

The quantum relativistic equations potential terms does not stem from the relativistic energy expression which does not consist of potential term at all [7].

The potential terms are restricted only to electromagnetic field [8]. More over quantum relativistic equations have no full complete theory to describe the behavior of some recent physical phenomenon like biophotons phenomena [9].

This motivates some researchers to propose some models to cure some of these defects. But these need to extend these models to modify Dirac (SR) quantum theory (DSRQT) and to explain the behavior of biophotons [10, 11]. Such model is suggested in this paper where a modified (DSRQT) is developed on the basis of generalized special relativity (GSR) in section two. Section three is concerned with the behavior of bio photons. Sections four and five are concerned with discussion and conclusion.

Potential Dependent Dirac Quantum Equation

According to GSR model the linear energy is given by

$$E = g_{00}^{1/2}\, \beta m_o c^2 + g_{00}^{-1/2} c\alpha\,.\,p = \beta m_o c^2\left(1+\frac{V}{m_0\,c^2}\right) + c\left(1-\frac{V}{m_0\,c^2}\right)\alpha\ \cdot P \ (1)$$

Where

$$g_{00}^{1/2} = 1+\frac{V}{m_0\,c^2} \quad ,g_{00}^{-1/2} = 1-\frac{V}{m_0\,c^2}$$

Multiplying both side of equation (1) by ψ gives

$$E\psi = c\left(1-\frac{v}{E}\right)\alpha\,.\,p\psi + \left(1+\frac{v}{E}\right)\beta m_o c^2\,\psi$$

$$E^2\psi = cE\left(1-\frac{v}{E}\right)\alpha\,.\,p\psi + E\left(1+\frac{v}{E}\right)\beta m_o c^2\,\psi$$

$$\therefore\ E^2\psi = c(E-v)\alpha\,.\,p\psi + (E+v)\,\beta m_o c^2\,\psi \qquad (2)$$

$$E^2\psi = c\alpha\,.\,pE\psi - cv\alpha\,.\,p\psi + \beta m_o c^2\,E\psi + \beta m_o c^2\,v\psi$$

Where

$$E \to \widehat{H} = i\hbar\frac{\partial}{\partial t} \quad \text{and} \quad p = \hat{p} = \frac{\hbar}{i}\vec{\nabla} \qquad (3)$$

From equation (2) and (3)

$$-\hbar^2\frac{\partial^2\psi}{\partial t^2} = c\hbar^2\alpha.\vec{\nabla}\left(\frac{\partial\psi}{\partial t}\right) - c\frac{\hbar}{i}\,v\,\alpha.\vec{\nabla}\psi + i\hbar\,\beta m_o c^2\left(\frac{\partial\psi}{\partial t}\right) + \beta m_o c^2\,v\,\psi \ (4)$$

From (4), by suggesting a solution

$$\psi = u(\underline{r})e^{-i\omega_0 t} = ue^{-i\omega_0 t} = ue^{\frac{iE}{\hbar}t}$$

$$\frac{\partial\psi}{\partial t} = -i\omega_0\,\psi \quad , \quad \frac{\partial^2\psi}{\partial t^2} = -\omega_0{}^2\,\psi \qquad (5)$$

A direct substitution of (5) in (4) gives

$$\hbar^2\omega_0{}^2\,\psi = c\hbar^2\omega_0\alpha.\nabla\,\psi + ic\hbar\,v\,\alpha.\nabla\psi - \beta m_o c^2\,\hbar\omega_0\,\psi + \beta m_o c^2\,v\,\psi \quad (6)$$

Where

$$E = \hbar\omega_0 \quad , \quad E_0 = m_o c^2$$

$$E^2\,\psi = c\hbar E\alpha.\nabla\,\psi + ic\hbar\,v\,\alpha.\nabla\psi - \beta\,E\,E_0\psi + \beta E_0\,v\,\psi \qquad (7)$$

$$e^{-i\omega_0 t}(E^2u) = e^{-i\omega_0 t}(c\hbar E\alpha.\nabla\,u + ic\hbar\,v\,\alpha.\nabla u) + e^{-i\omega_0 t}(\beta\,E + \beta v)E_0 u \quad (8)$$

The time decaying exponential term can be cancelled on both sides to get

$$(E^2 - \beta(E+v)E_0)u = c\hbar(E + i\,v)\alpha.\nabla u \qquad (9)$$

This can be written as

$$c_1 u - c_2 v\,u = c_3\,\alpha.\nabla u + ic_4 v\,\alpha.\nabla u \qquad (10)$$

Where

$$c_1 = E^2 - \beta\,E\,E_0 \quad , \quad c_2 = +\beta E_0 \quad , \quad c_3 = c\hbar E \quad , \quad c_4 = c\hbar \qquad (11)$$

Travelling wave solution

$$\psi = Ae^{i(kr-\omega t)} \qquad (12)$$

But

$$\psi = e^{-i\omega t}u = e^{-i\omega t}u(\underline{r}) \qquad (13)$$

$$u = A\,e^{ikr} \quad , \quad \nabla u = iku \qquad (14)$$

$$c_1 u - c_2 v\,u = ik\,.\,[\alpha](c_3 + ic_4 v)u \qquad (15)$$

Equating coefficients of u and vu , yields

$$c_1 = i\ k\,.\,\alpha c_3 \quad , \quad k = \frac{-ic_1}{c_3\alpha\cos\theta} = -ik_0$$

From equation (11)

$$k = \frac{-i(E-\beta E_0)}{c\hbar\alpha\cos\theta} = -ik_0 \qquad (16)$$

$$c_2 = -i^2 k\,.\,\alpha c_4 = k\,.\,\alpha c_4 \qquad (17)$$

$$k\,.\,\alpha = k\alpha\cos\theta = \frac{c_2}{c_4}$$

$$k = \frac{c_2}{c_4\alpha\cos\theta}$$

$$k = \frac{\beta E_0}{c\hbar\,\alpha\cos\theta} = k_1 \qquad (18)$$

The first expression for k in equation (12) where $k = -i\mathrm{k}_0$ gives

$$\psi = \mathrm{A}e^{\mathrm{k}_0 r} e^{-i\omega t} \quad (19)$$

The second expression for k in equation (12) where $\mathrm{k} \to \mathrm{k}_1$ gives

$$\psi = \mathrm{A}e^{i(\mathrm{k}_1 r - \omega t)} = u(\underline{r})\, e^{-i\omega t}$$

$$u(\underline{r}) = u = \mathrm{A}e^{i\mathrm{k}_1 r} \quad (20)$$

Consider the outer most shell where electrons occupy this shell when the radius of the atom is a. In this case

$$|u(a)|^2 = 1$$

$$u(a) = 1$$

$$\cos \mathrm{k}_1 a + i \sin \mathrm{k}_1 a = 1 \quad (21)$$

Thus

$$\cos \mathrm{k}_1 a = 1 \quad , \quad \sin \mathrm{k}_1 a = 0 \quad , \quad \mathrm{k}_1 a = 2\pi n$$

There fore

$$\mathrm{k}_1 = \frac{2\pi n}{a} \quad (22)$$

Thus the momentum is given by

$$p = \hbar \mathrm{k}_1 = \frac{hn}{a} \quad (23)$$

Hence the energy takes the form

$$E^2 = c^2 p^2 + m_0{}^2 c^4 \quad (24)$$

$$E^2 = \frac{c^2 h^2 n^2}{a^2} + m_0{}^2 c^4 \quad (25)$$

The liner energy is given by

$$E = c\alpha . p + \beta m_0 c^2$$

$$E = \frac{c\alpha h n}{a} + \beta m_0 c^2 \quad (26)$$

It is very interesting to note that the velocity is given by

$$v_0 = \lambda_0 f = \frac{\omega}{\mathrm{k}_0} = \frac{\omega c_3\, \alpha \cos\theta}{c_1} \quad (27)$$

Becomes infinite when

$$c_1 = E(E - \beta E_0) = 0$$

$$E = \beta E_0 \quad (28)$$

Where equation (27) gives

$$v_0 = \infty \quad (29)$$

In this case equation (16) gives

$$\mathrm{k}_0 = 0 \quad (30)$$

Thus equation (19) become in the form

$$\psi = \mathrm{A}e^{i\omega t} \quad (31)$$

This represents a stationary oscillating wave. Fortunately equations (29) and (31) describe the behavior of biophotons which are stationary waves that spread themselves simultaneously through the surrounding media.

Discussion

The GSR Dirac equation (4) is based on GSR energy –momentum relation (1). This equation consists of linear differential time and spatial term, beside non linear time and time –space mixed differential terms. The time independent equation (10) however, is linear, in the sense that the spatial differential is linear. The travelling wave solution in section (3) shows many interesting properties-equation (19) represents standing wave solution, while equation (20). Shows that particles can move as travelling wave even, when a potential is applied. This can successfully describe electromagnetic wave propagation inside any field. However equation (18) is not compatible with the red shift phenomenon which predicts that the wave number should be affected by the potential. The fact that electrons exist inside atoms, requires that the probability is equal to unity as shown by equation (20).this constraint predicts that electrons acts as harmonic oscillators with frequency $f = \frac{c\alpha}{a}$ as shown by equation (26). Fortunately it confirms the existence of zero point energy proportional to the rest mass energy. The solution for k_0 in equation (19) can successfully describe biophotons behavior. This is since the biophotons appear as stationary waves [see equation (31)] spreading themselves instantaneously pointed out by equation (29).

Conclusion

The liner GSR quantum equation shows that the particles sometimes acts as travelling waves with quantized harmonic oscillator energy and zero point energy. It also predicts that bio photons are stationary simultaneously distributed waves.

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