On the Mechanism of Particle Motion in Space and Time

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On the basis of a hypothesis about spiral motion of particles in space and time, It is derived from the theoretical expression for Planck constant and the De Broglie wave formulas and suggested a new physical constant.

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Let's consider the particle rotating at the speed of light along a circle with radius r_0 centered on the origin of a frame of reference K_0 . Then the coordinates of the particle can be written as parametrical equation of complex cylindrical spiral:

$$x' = r_0 Cos\omega_0 t_0 \qquad (1)$$

$$y' = r_0 Sin\omega_0 t_0 \qquad (2)$$

$$ct' = ct_0 \omega_0 h_0 \qquad (3)$$

Here h_0–a coefficient with a dimension that is the time. It is obvious that h_0 is equal to the period of rotation of the particle in frame of reference K_0 .

Let's consider the motion of particle In frame of reference K_0 moving along the x axis of frame of reference K at velocity V. Then the coordinates of the particle in frame of reference K according to Lorentz transformations:

$$x = \frac{r_0 Cos\omega_0 t_0 + Vct_0 \omega_0 h_0}{\sqrt{1-\frac{V^2}{c^2}}} \qquad (4)$$

$$y = r_0 Sin\omega_0 t_0 \qquad (5)$$

$$ct = \frac{ct_0 \omega_0 h_0 + \frac{V}{c} r_0 Cos\omega_0 t_0}{\sqrt{1-\frac{V^2}{c^2}}} \qquad (6)$$

In this case the components of energy momentum 4–vector can look like as follows[1]:

$$p_x = \frac{-m_0 r_0 \omega_0 Sin\omega_0 t_0 + Vm_0 \omega_0 h_0}{\sqrt{1-\frac{V^2}{c^2}}} \qquad (7)$$

$$p_y = r_0 m_0 \omega_0 Cos\omega_0 t_0 \qquad (8)$$

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$$p_t = \frac{m_0 c\omega_0 h_0 + m_0 \frac{V}{c} r_0 \omega_0 Sin\omega_0 t_0}{\sqrt{1-\frac{V^2}{c^2}}} \qquad (9)$$

Wave length of particle in frame of reference K_0 is equal

$$\lambda = ch_0 = c\frac{2\pi r_0}{c} = 2\pi r_0; \qquad (10)$$

and the wave number of the particle:

$$k_0 = \frac{2\pi}{\lambda} = \frac{1}{r_0} \qquad (11)$$

Using these relations, we obtain:

$$m_0 r_0 \omega_0 = m_0 r_0 \frac{2\pi}{h_0} = m_0 c; \quad (12)$$

and

$$m_0 r_0 \omega_0 = \frac{m_0 c r_0}{r_0} = m c r_0 k_0 = \frac{m_0 c^2 k_0 h_0}{2\pi} \quad (13)$$

$$m_0 h_0 = \frac{m_0 c^2 h_0}{c^2} \quad (14)$$

Let's introduce a denotation

$$\hbar = m c^2 h_0$$

Substituting this in (7)-(9) we obtain:

$$p_x = \frac{\hbar k_0 Sin\omega_0 t_0 + \hbar\omega_0 \frac{V}{c^2}}{\overline{1-\frac{V^2}{c^2}}} \qquad (15)$$

$$p_y = \hbar k_0 Cos\omega_0 t_0 \qquad (16)$$

$$p_t = \frac{\hbar\omega_0 c + \hbar k_0 \frac{V}{c} Sin\omega_0 t_0}{\overline{1-\frac{V^2}{c^2}}} \qquad (17)$$

Let's define values ω_0 , h_0, k_0 in frame of refrence K

$$\omega = \frac{\omega_0}{\overline{1-\frac{V^2}{c^2}}}; \qquad (18)$$

$$k = \frac{k'_0}{\overline{1-\frac{V^2}{c^2}}} \qquad (19)$$

$$h = \frac{h_0}{\overline{1-\frac{V^2}{c^2}}} \qquad (20)$$

It is necessary to notice that a projection of a vector k on the Ox axis in the frame of reference K equals

$$k'_0 = \frac{k_0 \frac{V}{c}}{\overline{1-\frac{V^2}{c^2}}} \qquad (21)$$

following expression ,for module of energy momentum 4–vector:

$$| p |^2 = h^2 \; -c^2 {k'_0}^2 + \omega^2 \quad 1 - \frac{V^2}{c^2} \; = m_0^2 c^4 \quad (22)$$

In Eq.(22) $h^2 \; 1 - \frac{V^2}{c^2} \; = h_0$ and h_0 remains to a constant at any frame of reference. Thus the $\hbar$ can be identified with Planck constant. Then expression (22) it is possible to consider as a theoretical derivation of the De Broglie formulas:

$$E = h_0 \omega \;\; u \;\; p = h_0 k$$

For length of a wave of the resting particle, we shall receive following expression

$$\hbar = m_0 c^2 h_0 = m_0 c^2 \frac{\lambda_k}{c} = m_0 c \lambda_k$$

So we have received the well-known formula for the Compton[2] wave length of particle

$$\lambda_k = \frac{h_0}{m_0 c^2} \qquad (23)$$

From (12) we obtain

$$m_0 r_0 c == m_0 c^2 \frac{h_0}{2\pi} = \hbar;$$

It means that

$$m_0 r_0 = const$$

or, that the center of mass of the moving particle is constant.

Results received from this work can be useful for understanding the mechanism of wave-particle duality and the quantum nature of motion following expression ,for module of energy momentum 4–vector:

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