The Physical Consequences of Using of the Energy-Momentum Transport Wave Function in the Gravitational and Electrostatic Interactions

Mirosław J. Kubiak

Zespół Szkół Technicznych, Grudziądz, Poland

Contemporary physics does not explain, how the energy and momentum are transported with the particle (body) by means of the elementary quanta of action, when the velocity of the particle has the speed of light or decrease from the relativistic case to the nonrelativistic. We applied simple model of the energy-momentum transport wave function for the elementary quanta of action connected with the gravitational and electrostatic interaction [1] and we have found **one equation**, which describes unification of the gravitation and electrostatic interactions.

elementary quanta of action, the energy-momentum transport wave function, unification of the gravitation and electrostatic interactions

INTRODUCTION

Relation between the energy E and momentum p for the body (particle) in the relativistic case has form

$$E^2 = p^2c^2 + m^2c^4 \tag{1}$$

where: mc^2 is *the rest energy* of the body, c – speed of light. For small velocities ($v/c << 1$), we have, expanding (1) in series in powers of v/c,

$$E \cong \frac{p^2}{2m} + mc^2 \tag{2}$$

which, except for the rest energy, equation (2) is the classical expression for *the kinetic energy* of a particle.

ENERGY-MOMENTUM TRANSPORT WAVE FUNCTION - RELATIVISTIC CASE

Relations between the energy E and momentum p for the particle in the relativistic case has form (1). But we don't know **how** the energy and momentum are *transported* in space-time with the particle by means of *the elementary quanta of action q* [1, 2, 3]. Let us assume that the energy and momentum are transported with the particle (along the path **r** during the time t) with *the energy momentum-momentum transport wave function* (EMTWF) [1] $\psi(\mathbf{r}, t)$ in the general form

$$\psi(\mathbf{r}, t) = \exp\left[\left(\frac{Et - \mathbf{pr}}{q}\right)\right] \tag{3}$$

and we also **postulate** that the energy E and the momentum p we can calculate from the $\psi(\mathbf{r}, t)$ by means of the following equations:

$$\begin{aligned}\mathbf{p}(\mathbf{r}, t) &= -q\nabla\psi(\mathbf{r}, t)\\ E(\mathbf{r}, t) &= q\frac{\partial\psi(\mathbf{r}, t)}{\partial t}\end{aligned} \tag{4}$$

Put equations (4) to the (1) we get

$$\nabla^2\psi(\mathbf{r}, t) - \frac{1}{c^2}\frac{\partial^2\psi(\mathbf{r}, t)}{\partial t^2} = -\frac{m^2c^2}{q^2} \tag{5}$$

Equation (5) – *the wave equation*, describes the transport of the EMTWF by means of the elementary quanta of action q for the relativistic case. For the elementary quantum of action connected with the gravitational interaction q has the form [1]

$$q = h_g = \frac{Gm^2}{c} \tag{6}$$

where: G is the gravitational constant, m is the mass of the two interacting bodies. Put the equation (6) to the equation (5) we get

$$\nabla^2\psi(\mathbf{r}, t) - \frac{1}{c^2}\frac{\partial^2\psi(\mathbf{r}, t)}{\partial t^2} = -\frac{1}{r_g^2} \tag{7}$$

where $r_g = Gm/c^2$ is *the gravitational radius*. For the elementary quantum of action connected with electrostatic interaction q has the form [1, 2, 3]

$$q = h_e = \frac{k_e e^2}{c} \tag{8}$$

and equation (5) has form

$$\nabla^2\psi(\mathbf{r}, t) - \frac{1}{c^2}\frac{\partial^2\psi(\mathbf{r}, t)}{\partial t^2} = -\frac{1}{r_e^2} \tag{9}$$

where: $r_e = (k_e e^2)/(m_e c^2)$ is *the classical electron radius*, m_e is the mass of the electron, $k_e = 1/4\pi\varepsilon_0$ is the Coulomb law constant in the SI system of units, ε_0 is the vacuum permittivity.

ENERGY-MOMENTUM TRANSPORT WAVE FUNCTION - NONRELATIVISTIC CASE

For small velocities ($v/c << 1$), we have, expanding (1) in series in powers of v/c, except for the rest energy, the classical expression for the kinetic energy of a body (2). Simple calculation, similar to the above, gives

$$\frac{\partial\psi(\mathbf{r}, t)}{\partial t} = \mu\nabla^2\psi(\mathbf{r}, t) + \frac{mc^2}{q} \tag{10}$$

Equation (10) – *the diffusion equation*, describes the transport of the EMTWF by means of the elementary quanta of action q for the nonrelativistic case, where $\mu = q/(2m)$ is the coefficient of diffusion. For the elementary quantum of action connected with the gravitational interaction the coefficient μ_g

$$\mu_g = \frac{h_g}{2m} = \frac{Gm}{2c} \tag{11}$$

and equation (10) has form

$$\frac{\partial \psi(\mathbf{r},t)}{\partial t} = \mu_g \nabla^2 \psi(\mathbf{r},t) + \nu_g \tag{12}$$

where $\nu_g = c/r_g$ is *the gravitational frequency of the own vibrations of the body*. For the elementary quantum of action connected with the electrostatic interaction coefficient μ_e

$$\mu_e = \frac{h_e}{2m_e} = \frac{k_e e^2}{2m_e c} \tag{13}$$

and equation (10) has form

$$\frac{\partial \psi(\mathbf{r},t)}{\partial t} = \mu_e \nabla^2 \psi(\mathbf{r},t) + \nu_e \tag{14}$$

where $\nu_e = c/r_e$ is *the electrostatic frequency of own the vibrations of the electron.*

FRACTIONAL (FRACTAL) DIFFUSION-WAVE EQUATION OF THE EMTWF

Let us consider two equations (5) and (10), where for the simplicity we have omitted two constants.

$$\nabla^2 \psi(\mathbf{r},t) - \frac{1}{c^2}\frac{\partial^2 \psi(\mathbf{r},t)}{\partial t^2} = 0 \tag{15}$$

$$\nabla^2 \psi(\mathbf{r},t) - \frac{1}{\mu}\frac{\partial \psi(\mathbf{r},t)}{\partial t} = 0 \tag{16}$$

Instead of a two equations (15) and (16), we can write them as **one equation** in the form

$$\nabla^2 \psi(\mathbf{r},t) - \frac{1}{\sigma^\beta}\frac{\partial^\beta \psi(\mathbf{r},t)}{\partial t^\beta} = 0 \tag{17}$$

If $\beta = 1$ (the nonrelativistic case), then we have the pure diffusion equation and $\sigma = \mu$. For $\beta = 2$ (the relativistic case) we have the pure wave equation and $\sigma = c$. For $1 < \beta < 2$ (the transition from the relativistic case to the nonrelativistic) we have the fractional (fractal) diffusion-wave equation [4].

THE ADVECTION EQUATION

Relations between the energy E and momentum p for the photon (or graviton) has form

$$E = pc \tag{18}$$

Put equations (4) to the (18) and we get

$$\nabla\psi(\mathbf{r},t) + \frac{1}{c}\frac{\partial\psi(\mathbf{r},t)}{\partial t} = 0 \tag{19}$$

The equation (19) is *the advection equation* of the EMTWF for the photon (or graviton), where the speed c is the same for the both particles. Now we can rewrite the equation (17) in the new form

$$\nabla^{\alpha}\psi(\mathbf{r},t) - \frac{1}{\sigma^{\beta}}\frac{\partial^{\beta}\psi(\mathbf{r},t)}{\partial t^{\beta}} = 0 \tag{20}$$

For $\alpha = 1$.

- If $\beta = 1$, then the transport of the EMTWF has the form of the **pure advection equation** and $\sigma = - c$.

For $\alpha = 2$.

- If $\beta = 1$ (the nonrelativistic case), then the transport of the EMTWF has the form of **the pure diffusion equation** and $\sigma = \mu$.
- If $\beta = 2$ (the relativistic case) the transport of the EMTWF has the form of **the pure wave equation** and $\sigma = c$.
- If $1 < \beta < 2$ (the transition from the relativistic case to the nonrelativistic) the transport of the EMTWF has the form of **the fractional (fractal) diffusion-wave equation** [4].

One equation (20) include all possible models of the transport of the EMTWF for the equations (1), (2) and (18) and for the elementary quanta of action connected with the gravitational and electrostatic interactions.

CONCLUSION

This model predicts **one equation** for the gravitational and electrostatic interactions

$$\nabla^{\alpha}\psi(\mathbf{r},t) - \frac{1}{\sigma^{\beta}}\frac{\partial^{\beta}\psi(\mathbf{r},t)}{\partial t^{\beta}} = 0$$

which include all possible kinds of the transport of the EMTWF for the equations (1), (2) and (18), and for the elementary quanta of action connected with the gravitational and electrostatic interactions.

Is this a step to the unification of the gravitation and electrostatic interactions? We also suppose (by the analogy) that the mechanism of transportation of the EMTWF by means of the elementary quanta of action for the strong and the weak interactions **should be the same**. But now it is the hypothesis only.

REFERENCES

1. M. Kubiak, *On Information Transfer in Nature with the Gravitational and Electromagnetic Interactions as Example*, Physics Essays, Vol. 5, No. 3, 1992.
2. L. Kostro, *Elementary Quanta of Action of the Four Fundamental Interactions*, in *Problems in Quantum Physics*, *Gdańsk '87*, World Scientific, Singapore, 1988, p. 187.

3. R. L. P. Wadlinger, G. Hunter, L. Kostro, D. Schuch, *The Quantum of Electrostatic Action and the Quantum Hall Effect*, Physics Essays, Vol. 3, No. 2, 1990.
4. S. Momani, *General Solutions for the Space-and Time-fractional Diffusion-wave Equation*, Journal of Physical Sciences, Vol. 10, 2006, p. 30.