15 Final Provisions

This paper presents the main provisions of electrodynamics of oriented point built on the principle of real relativity [2]. The equations of new electrodynamics are L-covariant, i.e., do not change their form at active transformations of coordinates and fields between real reference frames. It is shown that in the limiting case, in which the real reference frame that is associated with the charge (the proper reference frame of the charge) becomes a quasi-inertial one, the found equations reduce to the equations of classical electrodynamics.

The equations of new electrodynamics are formulated in $4D$ form for an arbitrary proper reference frame of the charge through the components of L-tensor of the electromagnetic field. Two major cases of exercising a proper reference frame of the charge have been considered: a frame accelerating in a translational motion and a frame rotating in a circular orbit. The first case involved the $4D$ rotation of the reference frame in plane XOT, which resulted in time variation of the pseudo-Euclidean orientation angle of the system

$$\frac{d\theta_x(t)}{dt} = \frac{1}{1 - v_x^2/c^2}\frac{dv_x(t)}{c\,dt}. \tag{223}$$

In the second case, the $4D$ rotation was reduced to an ordinary rotation in plane XOY, that is, to the variation of one of the orientation angles of $3D$ space with angular velocity

$$\Omega(t) = \frac{d\varphi(t)}{dt}. \tag{224}$$

It was shown that the system of equations of new electrodynamics in its general $4D$ form for any real reference frame in the above special cases can be written in terms of components of the electric and magnetic fields relative to the stationary observer. The systems of equations thus obtained are different from one another: they differ on account of dynamic characteristics of the moving charge.

For the first case, i.e. for nonrelativistic motion of the charge with a translational acceleration, the equations for the fields have been investigated in the wave zone. It is shown that there exists a solution consisting of plane monochromatic electromagnetic waves. A general dispersion relation between wave frequency ω and wave vector $\mathbf{k}$ is found, which was solved in a particular case of the wave propagating in the direction of the charge motion. The obtained plane electromagnetic waves differ from the plane waves of classical electrodynamics by the presence of the factor $\exp(-\dot{\beta}_x x/c)$. The maximum frequency at which the attenuation is visible on the appropriate wavelength ($\dot{\beta}\lambda/c \approx 1$ should hold for this) depends on the magnitude of the accelerating electric field:

$$\omega_{max} = 2\pi \frac{E_x}{E_S} \frac{c}{r_e}. \tag{225}$$

For an electron in the accelerating field $E_x = 3 \cdot 10^6$ V/m, which is fourteen orders of magnitude less than the limiting magnitude of the electric field of classical electrodynamics E_S, the maximum frequency to observe the effect of attenuation is $\omega_{max} \approx 7 \cdot 10^9$ Hz.

The second, more common case of exercising the proper reference frame of the charge — in its circular nonrelativistic motion — appeared to be more interesting in view of emerging qualitatively new effects.

It is shown that there is a solution for a free electromagnetic field in the form of a set of plane electromagnetic waves. In a particular case of the plane wave propagating perpendicular to the plane of rotation of the charge, the dispersion relation between the wave vector and the frequency of the wave is obtained, which has four solutions (two for each direction of propagation). In the forward direction, two monochromatic waves with different wavelengths and, consequently, with different phase velocities are generated at each fixed frequency: $v_{phase} < c$, holds for the slow wave, $v_{phase} > c$ holds for the fast wave. As a result, the remote observer at rest will register **the effect of the dual signal**, which involves different times of arrival of the fast and slow waves, emitted at the same time.

A permanent free electromagnetic field in the form of **a plane monochromatic wave of zero frequency** is shown to be possible.

It is shown that a quasi-static (at $\omega \ll \Omega$) free electromagnetic field has special properties: it is noninductive and does not exert any electromotive force in a plane perpendicular to the wave vector. This property is different from a classical free electromagnetic field, which should vary in time and have an inductive electromotive force in the transverse plane. The examined quasi-static field should have a high penetrating ability in conducting media (that is be **superpenetrative**) because it does not perform any work with free charges and, therefore, does not dissipate in conductors.

Three ways of generating a permanent (static) electromagnetic field in a circular motion of the nonrelativistic charge are investigated. The first two modes (a circular motion of the charge in vacuum, and a circular motion of the charge in a conductor) lead to the classical expressions for the permanent electric and magnetic fields. The third way of generating a permanent electromagnetic field is shown to exist in electrodynamics of oriented point — in a unidirectional circular motion of all the positive and negative charges with the same density, with the same angular velocity. With this mode of generation both total charge density and total current density are zero, but the system of equations for the static electromagnetic field has nonzero solutions due to the sources of a vacuum origin:

$$\nabla^2 \mathbf{A} = (T^{1'}_{\ 2'0'})\,[\mathbf{i}_z \, \mathrm{grad}\Phi] - (T^{1'}_{\ 2'0'})^2\,[\mathbf{i}_z[\mathbf{i}_z\mathbf{A}]], \tag{226}$$

$$\nabla^2 \Phi = (T^{1'}_{\ 2'0'})\,\mathrm{div}[\mathbf{i}_z\mathbf{A}]. \tag{227}$$

Here $T^{1'}_{\ 2'0'} = \Omega/c$ is one of the Ricci rotation coefficients, which takes a non-zero value in a real reference frame rotating in a circular orbit with angular velocity Ω.

Thus, electrodynamics of oriented point makes it possible to generate the electromagnetic field possessing special properties and certain energy through the interaction of charges and currents with a subtle structure of physical vacuum — the torsion field. The torsion field (the field of Ricci rotation coefficients $T^{a'}_{\ b'c'} \neq 0$) manifests itself in any real reference frame while it makes the $4D$ rotation [2, 3].