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FASTER-THAN-LIGHT TRANSFER OF A SIGNAL IN ELECTRODYNAMICS

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It is shown that in electrodynamics there exist two mechanisms of transferring a signal: (1) with the help of electromagnetic waves and (2) via the standing waves of the own field of a charged particle. In the former case, the transfer of a signal is carried out by quanta of light (photons), and in the latter case, it is of a purely wave character and can occur with the superluminal velocity. Both these mechanisms work simultaneously and are capable of carrying energy and momentum in space. The existence of superluminal signals necessarily follows from the laws of electrodynamics as well as from the most general considerations. In the case of a point charged particle the contributions of faster-than-light excitations to the total electric field **E**, created by a particle, cancel each other, so the field **E** can transfer the excitations only with the speed of light. However, for a self-acting charged particle, in view of its extension in space, the contributions mentioned above cannot completely compensate each other and the superluminal transfer of a signal becomes possible. The role of the own field of a particle is that it transforms environmental space into a physical environment with the properties of an absolutely solid body. Any physical process, occurring in a region of space-time as small as is wished, results in the instantaneous excitation of the environment and becomes immediately "known" to the whole universe. The results of the paper do not contradict the special theory of relativity (STR) because the ban of superluminal transfer of a signal, following at the first sight from kinematic reasons, is lifted in a natural way by the detailed consideration of dynamics of the process that gives rise to the occurrence of faster-than-light excitations. The basic possibility of superluminal information transfer follows from the fact that the charged self-acting particles become spatially extended objects and, therefore, the events, separated by space-like intervals, cease to be physically independent, i.e. interdiction for an opportunity of influence of these events on each other is removed. The quantum theory of self-organization of electrodynamic systems indicative of the possibility of realization of superluminal transfer of a signal with the help of the own field of a particle can serve as the basis for creation of essentially new means and systems of communication.

1. Introduction

According to the generally accepted point of view, the speed of light in vacuum is the greatest possible speed of transfer of a signal existing in nature. This conclusion is formulated by A. Einstein as a consequence of the special theory of relativity (STR) as follows: "... There is no way of sending the signals which would propagate faster than light in vacuum " (see [1], p. 157).

The statement cited above does not mean that in nature there are no movements taking place at superluminal speed (superluminal movements). The numerous examples of superluminal movements are given by V. L. Ginsburg in [2].

At the same time astronomic observations carried out for the first time by N.A. Kosyrev [3-6] have shown that in nature there is some mechanism of action-at-a-distance of one body on the other resulting in the instantaneous transfer of a signal. Kosyrev"s conclusions were confirmed and have received further generalization and development by M.M. Lavrentjev, I.A. Eganova and others [7,8] and A.F. Pugatch and others [9].

An attempt to find in electrodynamics the physical mechanism of superluminal transfer of information is undertaken in [10]. It is noted here that the physical bearer of superluminal signals is the own field of an electrically charged particle. This field is of a dual nature: on the one hand, the own field is governed by the Maxwell equations and consequently it is an electromagnetic field and, on the other, it is created by a charged particle and cannot exist when the particle is absent, i.e. it represents in some sense a constituent part of a particle. The latter results in that the own field of a particle considerably differs by its physical properties from the field of electromagnetic waves: it is of a purely classical character and cannot be reduced to the set of photons. The function of the own field of a charged particle is to transform the environmental space to a physical medium with the properties of an absolutely solid body. One of the physical properties of this medium is that it is capable of transferring a signal about perturbation, occurring at some point of space, instantaneously to arbitrarily large distances.

We point out here the relativistic hadronic mechanics [11] developed by R. Santilly which offers new possibilities of investigating superluminal signals.

The purpose of the present work consists in substantiation and refinement of the results [10] relating to the superluminal transfer of information in electrodynamics. The main results of the paper are briefly outlined in [12-14].

In Section 2 the set of Maxwell"s equations for the electromagnetic field in vacuum is split into two independent subsets - for the vortex fields and for the potential field. The relationships are obtained describing the change in time of the energy density of the vortex and potential components of electromagnetic field, and also of the energy density connected with interference of the potential and vortex fields.

Section 3 deals with the expressions for the vortex $\mathbf{E}_\perp$ and potential $\mathbf{E}_\|$ components of the electric field $\mathbf{E}$ created by a point electron moving uniformly and rectilinearly relative to an inertial reference frame. It is noted that the vortex electromagnetic field which is split out of the Coulomb field of electron when it moves uniformly and rectilinearly is not an independent degree of freedom of electromagnetic field and cannot be reduced to the set of photons.

According to the results of Section 4, the transverse vortex electromagnetic field consists of two components significantly different from each other by their physical characteristics - the electromagnetic waves and the own field of charged particles. To these components of electromagnetic field there correspond two mechanisms of transferring a signal (information): (1) the superluminal transfer of a signal via the own field of charged particles, representing standing waves of matter rigidly linked with the particles and going from them to infinity or to other particles, the own field being capable of transferring a perturbation instantaneously; and (2) the transfer of a signal with the speed of light by means of electromagnetic waves which are emitted by particles at their accelerated motion and then separate from the particles. Both these mechanisms can result in the transport of energy, momentum and other physical quantities in space. The existence of superluminal signals necessarily follows from both the laws of electrodynamics and the most general considerations. The superluminal signals have their origin in self-action, i.e. in the back influence of particle"s own field upon the same particle, as a result of which the particle becomes a spatially extended system. By other words, the superluminal signals are indissolubly connected to the processes of self-organization, resulting in formation of the internal structure of charged particles. It is appropriate here to make mention of the electrodynamic dualism concept proposed in [15,16], according to which there is a simultaneous coexistence of instantaneous long-range and short-range interactions. The concept based on the separated-potential method seems to be correct merely for the non-point particles.

In Section 5 it is emphasized that causal relationships between the two events result from dynamics, and consequently they cannot be derived from purely kinematic considerations. The statement that the superluminal transfer of signals is impossible does not follow from STR and is an additional hypothesis, contradicting Maxwell"s equations. A phenomenon of relativity of physical processes caused by superluminal signals is predicted according to which the viewpoints of the observers, being located in various inertial reference frames, with respect to an event occurring at some space-time point can be essentially different. The effect is a consequence of the space-time geometry peculiarities which show up when superluminal signals are present.

In Conclusion the basic results of the paper are briefly formulated.

The results obtained can serve as a theoretical basis for an explanation of experiments on remote influence of space objects on earthly gauges carried out for the first time by N.A. Kosyrev [3-6]. As is seen from the received results, taking into account the self-action in quantum electrodynamics and, hence, the effects of self-organization of electrically charged matter opens up a way to the creation of the selfconsistent theory describing the superluminal transfer of signals. This theory will make a basis for the creation of essentially new means and systems of communication, using the own fields of charged particles as a carrier of information, and also of quantum generators and amplifiers of the coherent own fields.

2. Equations for the vortex and potential components of electromagnetic field

In the following, an important role is played by the vortex and potential components of a vector field. In this connection we shall remind that any vector field $\mathbf{A} = \mathbf{A}(\mathbf{r},\ t)$ can be represented as a sum of the vortex $\mathbf{A}_\perp$ and potential $\mathbf{A}_\parallel$ components: $\mathbf{A} = \mathbf{A}_\perp + \mathbf{A}_\parallel$, the quantities $\mathbf{A}_\perp$ and $\mathbf{A}_\parallel$ satisfying the following relations:

$$\vec{\nabla}\,\mathbf{A}_\perp = 0\,, \quad \vec{\nabla}\times\mathbf{A}_\perp \neq 0\,, \quad \vec{\nabla}\,\mathbf{A}_\parallel \neq 0\,, \quad \vec{\nabla}\times\mathbf{A}_{\ \parallel} = 0 \tag{1}$$

We exclude from consideration the homogeneous fields independent of $\mathbf{r}$, for which the equalities $\vec{\nabla}\,\mathbf{A} = 0\,,\quad \vec{\nabla}\times\mathbf{A} = 0$ hold true. The vector field components can be calculated by the following formulas

$$\begin{aligned} \mathbf{A}_\parallel(\mathbf{r},\ t) &= \ -grad\ div \int d\mathbf{r}'\,(4\pi)^{-1}\mathbf{A}(\mathbf{r}',\ t)/\mid\mathbf{r}-\mathbf{r}'\mid\,, \\ \mathbf{A}_\perp(\mathbf{r},\ t) &= \ curl\ curl \int d\mathbf{r}'\,(4\pi)^{-1}\mathbf{A}(\mathbf{r}',\ t)/\mid\mathbf{r}-\mathbf{r}'\mid \end{aligned} \tag{2}$$

Note an important peculiarity of relations (2): the vortex and potential components of the vector field $\mathbf{A}(\mathbf{r},\ t)$ are expressed nonlocally in terms of $\mathbf{A}(\mathbf{r},\ t)$.

We proceed from the Maxwell equations for the electric $\mathbf{E}$ and magnetic $\mathbf{B}$ fields created by electric charges and currents in vacuum[a] ($\partial_t = \partial\,/\,\partial\ t$):

$$\partial_t\mathbf{B} = -\vec{\nabla}\times\mathbf{E}\,, \quad \vec{\nabla}\,\mathbf{B} = 0\,, \quad \partial_t\mathbf{E} = \vec{\nabla}\times\mathbf{B} -\, 4\pi\mathbf{j}\,, \quad \vec{\nabla}\,\mathbf{E} = 4\pi\rho \tag{3}$$

where ρ and $\mathbf{j}$ are the charge and current densities. Decomposing the vectors entering into (3) into the vortex and potential components, we come to the two independent subsets of equations: for the vortex fields -

$$\partial_t\mathbf{B} = -\vec{\nabla}\times\mathbf{E}_\perp\,, \quad \vec{\nabla}\,\mathbf{B} = 0\,, \quad \partial_t\mathbf{E}_\perp = \vec{\nabla}\times\mathbf{B} -\, 4\pi\mathbf{j}_\perp\,, \quad \vec{\nabla}\,\mathbf{E}_\perp = 0 \tag{4}$$

[a]We use a system of units in which $c = 1$ (c is the velocity of light).

and for the potential field -

$$\partial_t \mathbf{E}_\| = -\,4\pi \mathbf{j}_\| \,, \quad \vec{\nabla}\, \mathbf{E}_\| = 4\pi\rho \,, \quad \vec{\nabla} \times \mathbf{E}_\| = 0 \tag{5}$$

Here we have taken into account that the magnetic field $\mathbf{B}$ does not contain a potential component: $\mathbf{B} = \mathbf{B}_\perp$.

Solution of the subset of equations (5) for the potential field can easily be received by calculating the potential components of the current density $\mathbf{j}$ and intensity of electric field $\mathbf{E}$ with the help of the former of formulas (2):

$$\mathbf{E}_\|(\mathbf{r},\ t) = -\vec{\nabla}\varphi(\mathbf{r},\ t), \tag{6}$$

$$\mathbf{j}_\|(\mathbf{r},\ t) = (4\pi)^{-1}\ \partial_t\vec{\nabla}\varphi(\mathbf{r},\ t), \tag{7}$$

$$\varphi(\mathbf{r},\ t) = \int d\ \mathbf{r}'\ \rho\ (\mathbf{r}',\ t)/\mid \mathbf{r} - \mathbf{r}' \mid \tag{8}$$

When deriving the relations (6) - (8) the continuity equation $\partial_t\rho + \vec{\nabla}\ \mathbf{j} = 0$ and the last of equations (3) were used. From equalities (6) and (7) the first of relations (5) follows which can be considered as a definition of the potential component of the current density vector $\mathbf{j}$: the component $\mathbf{j}_\|$ is defined in terms of the potential component of electric field $\mathbf{E}$. Note that the field $\mathbf{E}_\|$ determined by equalities (6) and (8) satisfies the set of equations (5) for the arbitrary value of charge density ρ.

From the set of equations (3) the wave equation

$$(\partial_t^2 - \vec{\nabla}^2)\mathbf{E} = -4\pi(\partial_t\,\mathbf{j} + \vec{\nabla}\rho) \tag{9}$$

follows which can easily be split into two independent relations: the wave equation for the vortex field

$$(\partial_t^2 - \vec{\nabla}^2)\mathbf{E}_\perp = -4\pi\ \partial_t\,\mathbf{j}_\perp \tag{10}$$

and the equality

$$(\partial_t^2 - \vec{\nabla}^2)\mathbf{E}_\| = -4\pi(\partial_t\,\mathbf{j}_\| + \vec{\nabla}\rho) \tag{11}$$

In appearance the last equality coincides with the wave equation for the field $\mathbf{E}_\|$. However this equality represents an identity, not the equation, in which the functions $\mathbf{E}_\|$ and $\mathbf{j}_\|$ are the known functionals (see (6) - (8)) dependent on an arbitrary function ρ. From here it follows that there are no waves of potential electric field propagating at the speed of light. The fact that the potential field waves do not exist and the field $\mathbf{E}_\|$ disappears when the electric charges are absent ($\mathbf{E}_\| = 0$ at $\rho = 0$, see (6) and (8)) means that the field $\mathbf{E}_\|$ is not an independent degree of freedom of the electromagnetic field. Evidently, in view of (5) and (6), equality (11) can be decomposed into two independent relations of the form:

$$\vec{\nabla}^2\mathbf{E}_\| = 4\pi\vec{\nabla}\rho\,; \quad \partial_t^2\,\mathbf{E}_\| = -\,4\pi\partial_t\,\mathbf{j}_\|$$

With the help of equations (4) and (5) it is easy to receive the following relations describing the change in time of the energy density of the field components:

$$
\begin{aligned}
-\partial_t w_\perp &= \overrightarrow{\nabla}\mathbf{\Pi}_\perp + \mathbf{j}_\perp \mathbf{E}_\perp \ , \\
-\partial_t w_\parallel &= \mathbf{j}_\parallel \mathbf{E}_\parallel \ , \\
-\partial_t \widetilde{w} &= \overrightarrow{\nabla}\widetilde{\mathbf{\Pi}} + \mathbf{j}_\parallel \mathbf{E}_\perp + \mathbf{j}_\perp \mathbf{E}_\parallel \ ,
\end{aligned}
\tag{12}
$$

where

$$
w_\perp = (8\pi)^{-1}\ (\mathbf{E}_\perp^2 + \mathbf{B}^2), \quad w_\parallel = (8\pi)^{-1}\ \mathbf{E}_\parallel^2, \quad \widetilde{w} = (4\pi)^{-1}\ \mathbf{E}_\perp \mathbf{E}_\parallel \ ,
$$
$$
\mathbf{\Pi}_\perp = (4\pi)^{-1}\ \mathbf{E}_\perp \times \mathbf{H}, \quad \widetilde{\mathbf{\Pi}} = (4\pi)^{-1}\,\mathbf{E}_\parallel \times \mathbf{H} \ .
$$

The quantities $w_\perp$ and $w_\parallel$ are the energy densities of the vortex and potential fields, respectively; the quantities $\widetilde{w}$ and $\widetilde{\mathbf{\Pi}}$ have the meaning of the energy density and energy flux density and describe the interference of potential electric and vortex electric and magnetic fields. Adding term by term the left and right sides of equalities (12), we obtain the usual Poynting equation. The energy density of electromagnetic field w and Poynting "s vector $\mathbf{\Pi}$ are given by

$$
w \ = \ w_\perp + w_\parallel + \widetilde{w}\,, \quad \mathbf{\Pi} = \mathbf{\Pi}_\perp + \widetilde{\mathbf{\Pi}} \tag{13}
$$

3. The own vortex electric field of a particle and its physical properties

Let us consider a point particle with charge e_0 moving at a speed $\mathbf{v}_0 = const$ relative to an inertial reference frame K. According to [17] the particle creates at a point $x = (\mathbf{r},\ t)$ an own field consisting of the electric $\mathbf{E}(x)$ and magnetic $\mathbf{B}(x)$ components:

$$
\mathbf{E}(x) = e_0(1 - v_0^2)\ (\mathbf{R}^* - \mathbf{v}_0 R^*)\ (R^* - \mathbf{v}_0 \mathbf{R}^*)^{-3}, \quad \mathbf{B}(x) = \mathbf{v}_0 \times \mathbf{E}(x)\ , \tag{14}
$$

where $\mathbf{R}^* = \mathbf{R}(t^*)\,,\ \mathbf{R}(t) = \mathbf{r} - \mathbf{r}_0(t)\,,\ \mathbf{r}_0(t) = \mathbf{v}_0 t\,,\ \mathbf{R}(t)$ is the radius-vector drawn from the point of particle location to the point of observation of the field, t^* is the retarded moment of time determined by equation

$$
t - t^* = R(t^*) \tag{15}
$$

Relations (14) can be derived by the method of retarded potentials. In the special case when the particle moves along the z-axis, $\mathbf{v}_0 = (0,\ 0,\ v_0)$, the solution to equation (15) can be written down as:

$$
t - t^* = \gamma^2\, v_0\, (z - v_0 t) + \gamma\, \widetilde{R}(t)\ ,
$$
$$
\widetilde{\mathbf{R}}(t) = (x,\ y,\ \gamma\,(z - v_0 t))\ , \quad \gamma = (1 - v_0^2)^{-\ 1/\ 2}.
$$

Taking into account the equalities

$$\mathbf{R}^* - \mathbf{v}_0\ R^* = \mathbf{R}(t)\ , \quad R^* - \mathbf{v}_0\ \mathbf{R}^* = \gamma^{-1}\ \widetilde{R}(t)\ ,$$

expression (14) for the field $\mathbf{E}(x)$ can be transformed to the form

$$\mathbf{E}(x) = e_0\ \gamma\ \mathbf{R}\ /\ \widetilde{R}^3\ , \quad \mathbf{R} = \mathbf{R}(t)\ , \quad \widetilde{\mathbf{R}} = \widetilde{\mathbf{R}}(t) \tag{16}$$

Let us calculate the potential component of the electric field $\mathbf{E}(x)$ (16). For this purpose we make use of the general relations (6) and (8). Choosing the current density 4-vector of a particle as

$$j(x) = (\rho(\mathbf{r},\ t)\ ,\ \mathbf{j}(\mathbf{r},\ t)) = e_0\ (1,\ \mathbf{v}_0(t))\ \delta(\mathbf{r} - \mathbf{r}_0(t)) \tag{17}$$

($\mathbf{v}_0(t) = d\mathbf{r}_0(t)\ /\ dt$) and putting here $\mathbf{r}_0(t) = \mathbf{v}_0 t$, $\mathbf{v}_0 = const$, we can derive:

$$\mathbf{E}_{\|}(x) = e_0\ \mathbf{R}\ /\ R^3 \tag{18}$$

With the decomposition $\mathbf{E} = \mathbf{E}_{\perp} + \mathbf{E}_{\|}$ and relations (16) and (18), we arrive at the following formula for the vortex component of electric field:

$$\mathbf{E}_{\perp}(x) = e_0(\gamma\ /\ \widetilde{R}^3 - 1\ /\ R^3)\mathbf{R} \tag{19}$$

In spherical coordinates $(R_x,\ R_y,\ R_z) = R(\sin\theta\cos\varphi,\ \sin\theta\sin\varphi,\ \cos\theta)$ the expression (19) is of the form:

$$\begin{gathered}\mathbf{E}_{\perp}(x) = e_0\, g(v_0,\ \theta)\, \mathbf{R}/R^3, \\ g(v_0,\ \theta) = (1 - v_0^2)/(1 - v_0^2 \sin^2\theta)^{3/2} - 1\end{gathered} \tag{20}$$

According to relations (18) and (20), the lines of force for both the potential and vortex electric fields, created by a point electric charge, when it moves uniformly and rectilinearly, are radial straight lines. The potential field $\mathbf{E}_{\|}$ remains spherically symmetric as for a charge at rest; it moves together with the charge being not deformed. The field $\mathbf{E}_{\perp}$ possesses axial symmetry. It vanishes on the surfaces of cones $\theta = \theta^*$ and $\theta = \pi - \theta^*$ where θ^* is a root of the equation $g(v_0, \theta^*) = 0$. The latter can be transformed into $\sin\theta^* = v_0^{-1}[1-(1-v_0^2)^{2/3}]^{1/2}$. When $v_0 << 1$, this equation yields: $\sin\theta^* \approx \sqrt{2\ /\ 3}$; it follows from this that $\theta^* \approx 54,7^0$. Note that $\theta^* \to \pi\ /\ 2$ when $v_0 \to 1$. In the case of electron (i.e. at $e_0 < 0$) the lines of force of the vortex field $\mathbf{E}_{\perp}$ point away from the particle inside the cones mentioned above, i.e. they are opposed to the lines of force of the potential field, and outside of the cones they are directed toward the particle. Because of this, spherical symmetry of the total electric field $\mathbf{E}$ is violated: inside the cones the field $\mathbf{E}$ is less in magnitude in comparison with the potential component, and outside of the cones it is greater then the potential one. The vortex and potential fields are related by equality

$$\mathbf{E}_{\perp} = g(v_0,\ \theta)\ \mathbf{E}_{\|} \tag{21}$$

The following relations are valid:

$$g(v_0,\ \theta) = \begin{cases} v_0^2\ (1 - 3\cos^2\theta)\,/\,2 \quad \text{at} \quad v_0 << 1; \\ -1 \quad \text{at} \quad v_0 \to 1 \quad \text{and} \quad \theta \neq \pm\pi/2\,; \\ \gamma - 1 \quad \text{at} \quad \theta = \pm\pi/2 \end{cases}$$

As appears from the above, at small speeds of motion of a particle the vortex field turns out to be relativistically small value of the order of v_0^2 in comparison with the total field, and $g(v_0,\ \pm\pi/2) \to \infty$ at $v_0 \to 1$. Hence, in the plane going through the particle perpendicularly to its velocity, the vortex electric field can considerably exceed in magnitude the potential one when the particle's velocity is large enough.

The Fourier transforms for the fields $\mathbf{E}_{\|}$ and $\mathbf{E}_{\perp}$ are as follows:

$$(\mathbf{E}_{\|}\,(\mathbf{r}),\ \mathbf{E}_{\perp}(\mathbf{r})\ ) = \int d\mathbf{k}\ (\mathbf{E}_{\|\,\mathbf{k}},\ \mathbf{E}_{\perp\,\mathbf{k}})\ \exp(i\mathbf{k}\mathbf{R}(t))\ , \tag{22}$$

$$\mathbf{E}_{\|\,\mathbf{k}} = -i\,e_0\,\mathbf{k}\,k^{-2}\,/\,(2\pi^2), \quad \mathbf{E}_{\perp\,\mathbf{k}} = -i\,e_0(\mathbf{k}\,\mathbf{v}_0)\,\mathbf{k}\times\mathbf{k}\times\mathbf{v}_0\,(k^{\,2} - v_0^2\,k_z^2)^{-1}\,k^{-2}$$

According to (22) the waves of the vortex field are transverse ($\mathbf{E}_{\perp\,\mathbf{k}} \perp \mathbf{k}$) and of the potential one longitudinal ($\mathbf{E}_{\|\,\mathbf{k}} \parallel \mathbf{k}$), the frequency of these waves being related to the wave vector $\mathbf{k}$ by the dispersion relation: $\omega = \mathbf{k}\mathbf{v}_0$.

Making use of the former of the relations (2), we can calculate the potential component of the current density $\mathbf{j}$ (17):

$$\mathbf{j}_{\|} = e_0(\mathbf{v}_0 - 3\mathbf{R}(\mathbf{v}_0\mathbf{R})R^{-2})\,R^{-3}\,(4\pi)^{-1}, \quad \mathbf{v}_0 = const \tag{23}$$

According to (23), in consequence of the nonlocal connection between $\mathbf{j}_{\|}$ and $\mathbf{j}$, the potential current is distributed over the whole space ($\mathbf{j}_{\|} \neq 0$ at $\mathbf{R} \neq 0$), though the total current $\mathbf{j}$ is distinct from zero only at a point where the particle is located (at $\mathbf{R} = 0$). The vortex current behaves similarly, the following relations being fulfilled

$$\mathbf{j} = 0\,, \quad \text{but} \quad \mathbf{j}_{\perp} = -\mathbf{j}_{\|} \neq 0 \quad \text{at} \quad \mathbf{R} \neq 0. \tag{24}$$

Note that both the potential and vortex components of the current density vector behave as $1\,/\,R^{3}$ at large distances from the charge.

To specify the physical nature of the vortex fields $\mathbf{E}_{\perp}$ and $\mathbf{B}$, created by the electron, we shall consider the reference frame K' moving with the speed $\mathbf{v}_0 = const$ relative to the frame of reference K, with the point particle being located at the origin of the reference frame K'. In the latter frame the particle is at rest, and so its own field is purely Coulombian: $\mathbf{E}' = e_0\mathbf{r}'/\,r'^{\,3}$, $\mathbf{r}' = (x',\, y',\, z')$, and the vortex fields are absent: $\mathbf{E}'_{\perp} = 0$, $\mathbf{B}' = 0$. However, if we look at this electron from the point of view of the reference frame K, then $\mathbf{E}_{\perp} \neq 0$ and $\mathbf{B} \neq 0$ (see equalities (14) and (20)). The vortex fields $\mathbf{E}_{\perp}$ and $\mathbf{B}$ are split out of the Coulomb field of the particle when it moves. Obviously, these fields cannot be interpreted as a flow of photons of electromagnetic field. Though these fields satisfy the subset (4) of Maxwell"s equations for the vortex fields, they do not represent an independent degree of freedom of electromagnetic field and qualitatively differ from the photon field: they are just as indissolubly connected to the electric charge and inseparable from it as the potential field. These fields are the standing waves of matter which are rigidly linked with the electric charge and go from it to the opposite charges or to infinity. It is natural to interpret them as the physical properties internally inherent in the electron.

4. The own field of electron and superluminal signals

Let us consider the electric field $\mathbf{E} = \mathbf{E}(\mathbf{r}, t)$ created by a point particle with charge e_0 which oscillates with some frequency in a vicinity of the origin of coordinates of the inertial reference frame K within the time interval $(0, T)$ and is at rest at the origin of coordinates outside of this interval. It is obvious that at the moments of time $t \leq 0$, when the particle is at rest, the electric field $\mathbf{E}$ is purely Coulombian:

$$\mathbf{E}(\mathbf{r},\ t) = e_0\mathbf{r} \,/\, r^{\,3} \equiv \mathbf{E}_0(\mathbf{r}) \tag{25}$$

We introduce the notation:

$$\triangle\, \mathbf{E}(\mathbf{r},\ t) = \mathbf{E}(\mathbf{r},\ t)\ -\ \mathbf{E}_0(\mathbf{r}) \tag{26}$$

The field $\triangle\, \mathbf{E}$ has the following physical meaning: this is that part of the electric field which is caused by the oscillations of electron. For any moment of time t, lying inside the interval $(0, T)$, the following equality is carried out

$$\triangle\, \mathbf{E}(\mathbf{r},\ t) = 0 \quad \text{at} \quad |\,\mathbf{r}\,| > \ t\ \equiv\ R_0 \tag{27}$$

since by the moment t the total field $\mathbf{E}$ has no time to come to the region $|\,\mathbf{r}\,| >\ R_0$ from the origin of coordinates.

Let us calculate the vortex $(\triangle\, \mathbf{E}_\perp)$ and potential $(\triangle\, \mathbf{E}_\|)$ components of the field $\triangle\mathbf{E}$. For this purpose, in formulas (2), we carry out the replacements: $\mathbf{A}_\perp \to \triangle\, \mathbf{E}_\perp$, $\mathbf{A}_\| \to \triangle\, \mathbf{E}_\|$, $\mathbf{A} \to \triangle\, \mathbf{E}$. By virtue of (27) the integration with respect to $\mathbf{r}'$ in formulas, received in the way mentioned above, can be limited by a sphere of radius R_0 centred at the origin of coordinates. In view of the nonlocal character of connection of the fields $\triangle\, \mathbf{E}_\perp$ and $\triangle\, \mathbf{E}_\|$ with the total field $\triangle\, \mathbf{E}$, the quantities $\triangle\, \mathbf{E}_\perp\, (\mathbf{r},\ t)$ and $\triangle\, \mathbf{E}_\|\, (\mathbf{r},\ t)$ calculated by these formulas will be, generally speaking, distinct from zero outside of the sphere in question. Thus, for $|\,\mathbf{r}\,| >\ R_0$ at any moment of time $t\ (0 < t \leq T)$

$$\triangle\, \mathbf{E}\,(\mathbf{r},\ t) = 0\,, \quad \textit{but} \quad \triangle\, \mathbf{E}_\perp\,(\mathbf{r},\ t) = -\triangle\, \mathbf{E}_\|\,(\mathbf{r},\ t) \neq 0 \tag{28}$$

From here it follows that (1) though the total field $\triangle \mathbf{E}(\mathbf{r},\ t)$ is propagated with the speed of light and has no time to reach the region $\mid \mathbf{r} \mid > \ R_0$ for the time t, this region turns out to be perturbed and (2) both the potential and vortex electric fields are capable of transferring a perturbation with the velocity greater than that of light.

To understand the physical mechanism of transferring a superluminal perturbation through the vortex and potential fields, we turn to the wave equation (10) for the field $\mathbf{E}_{\perp}$. As can be seen from (10), the vortex field $\mathbf{E}_{\perp}$ is created by the vortex current $\mathbf{j}_{\perp}$, which by virtue of relations (23) and (24) is not concentrated at the point of localization of the particle, as distinct from the total current $\mathbf{j}$, and is distributed over the whole space. Due to this the vortex field $\mathbf{E}_{\perp}$ is generated at the moment of time t ($t \ > 0$) at each point of space. In such a way the whole space is instantaneously endowed with the information about the point particle oscillations taking place at the origin of coordinates.

To specify the mechanism of transmitting a signal through the vortex field $\vec{E}_{\perp}$, we write down the solution of equation (10) with the help of the retarded Green function $G_r(x)$:

$$\mathbf{E}_{\perp}(\mathbf{r},\ t) = -4\pi\, \partial_t \int d^4x_1\ G_r(x - x_1)\, \mathbf{j}_{\perp}(x_1) \tag{29}$$

Using the representation

$$G_r(x) = (\,4\pi \mid \mathbf{r} \mid)^{-1}\, \delta(t - \mid \mathbf{r} \mid) \tag{30}$$

we arrive at the expression

$$\mathbf{E}_{\perp}(\mathbf{r}, t) = -\,\partial_t \int\limits_{-\infty}^{t} d\,t_1 \int d\mathbf{r}_1 \mid \mathbf{r} - \mathbf{r}_1 \mid^{-1} \delta(\,t - t_1 - \mid \mathbf{r} - \mathbf{r}_1 \mid\ )\,\mathbf{j}_{\perp}(\mathbf{r}_1,\ t_1) \tag{31}$$

Let us denote by Ω the spatial-temporary region, in which the particle oscillations occur during an interval $(0,\, t)$, i.e. the set of points with the coordinates $(t',\, \mathbf{r}_0(t'))$ at $\ 0 \leq\ t' \ \leq t$. We consider the vortex field (31) at a point P with coordinates $(t_P, \mathbf{r}_P)$ separated from the points of the region Ω by space-like intervals. It is seen from (31) that the light signals, generated by the currents $\mathbf{j}_{\perp}(t_1, \mathbf{r}_1)$, arrive at the point P from all the points $(t_1, \mathbf{r}_1)$, for which the following conditions are carried out

$$t_P - t_1 - \mid \mathbf{r}_P - \mathbf{r}_1 \mid = 0\,, \quad 0 \leq\ t_1 \leq t_P \tag{32}$$

i.e. from the points lying inside a sphere of radius $t_P\ =\ R_0$ centred at a point with the radius-vector $\mathbf{r}_P$, at which the vortex current $\mathbf{j}_{\perp} \neq 0$. The formula (31) describes, thus, the process of transferring an excitation via the vortex field $\mathbf{E}_{\perp}$, which occurs with the velocity of light. The same formula is indicative of one more mechanism of transferring the information, the mechanism, which corresponds to the instantaneous propagation of a signal. This mechanism is due to the fact that the vortex current $\mathbf{j}_\perp$, produced by a point particle, is not localized at the point, where the particle is placed, and is distributed over the whole space endowing the latter with the information about oscillations of the particle. Due to this the field $\mathbf{E}_\perp$, registered at the point P, contains information about the behaviour of particle in the region Ω, the transfer of this information occurring instantaneously.

To specify the physical mechanism of superluminal transfer of a signal, we turn to the potential electric field $\mathbf{E}_\|$. As is shown in Sec. 2, a distinguishing characteristic of the field $\mathbf{E}_\|$ is that there is no wave equation for it and, hence, there is no temporary dynamics. As is seen from (6) - (8), the field $\mathbf{E}_\|$ instantaneously reacts to any change in time of the charge density ρ of a particle, its connection with the charge density being nonlocal: the field $\mathbf{E}_\|$ can change in a region as removed as is wished from the region of the charge density change. According to (7) and (8), the potential current instantaneously "feels" any change in the state of a point particle at any distance from it. In view of equality $\mathbf{j}_\perp = \mathbf{j} - \mathbf{j}_\|$, the same is true of the vortex current. At the same time the vortex current $\mathbf{j}_\perp$ is connected with the vortex field $\mathbf{E}_\perp$ by equality (10), which represents not the wave equation but an identity for that component of the vortex field which is the own field of particle. This means that the vortex field $\mathbf{E}_\perp$, as well as the potential one $\mathbf{E}_\|$, instantaneously receives a signal about the change of the particle state. From this the conclusion results that the own field of a charged particle can transfer information instantaneously. Due to the own field any change of the point particle state becomes immediately "known" at any distance from the particle.

Thus, the own field of a charged particle endows the environmental space with the properties of an absolutely rigid body. The physical medium produced by a particle gains the capacity to instantaneously transfer an electromagnetic perturbation arising at some points of space to as is wished large distances.

According to the results received, two mechanisms of transferring a signal exist - with the help of electromagnetic waves and via the own field of charged particles. In the first case the signal is transferred by the photons with the velocity of light, and in the second - by the standing waves of the own field of a particle, which are rigidly linked with the particle and go from it to the other particles or stretch to infinity. The transfer of a signal in the second case is of a purely classical, wave character and can be carried out instantaneously. It is obvious that both these mechanisms of transferring a perturbation are connected with the transport of energy, momentum and other physical quantities, the first mechanism being caused by movement of photons in space, and the second being of a purely wave origin. The energy and momentum transport by the electromagnetic field, by both the electromagnetic waves and the own field of particles, is described by the Poynting equation. It should be stressed that both mechanisms of transferring information mentioned above work simultaneously as though duplicating each other.

It follows from the analysis given above that the vortex electromagnetic field generated by a moving charged particle consists of two components - of the own transverse vortex field, which is of a classical character and is not reduced to a photon flow, and of electromagnetic waves, which are emitted by a particle, when it moves with acceleration, and represent a set of photons. According to this the vortex electric field can be divided into two components:

$$\mathbf{E}_{\perp}(x) = \mathbf{E}_{\perp}^{(cl)}(x) + \mathbf{E}_{\perp}^{(ph)}(x) \tag{33}$$

$\mathbf{E}_{\perp}^{(cl)}(x)$ is the field of transverse standing waves of matter, which are intimately connected with a charged particle and go from the particle to infinity or to the other particles; $\mathbf{E}_{\perp}^{(ph)}(x)$ is the electromagnetic field subject to the wave-corpuscular duality (the electromagnetic waves propagating with the velocity of light). As is known, the presence of an environment capable of transferring an oscillation from one point of space to the other is a necessary condition for the existence of waves. Such an environment for electromagnetic waves is, apparently, the own vortex field $\mathbf{E}_{\perp}^{(cl)}$. The latter is similar to the elastic strings that bind electric charges to the environmental medium and endow it with the properties of an absolutely solid body. These strings are inseparable from a charged particle, they are not of a photon structure and consequently they cannot be destroyed without destroying the particle, which they are connected with. When a charged particle moves with acceleration, a photon field is split out of its own field, the vortex own field of a particle being deformed and losing its axial symmetry.

The question now arises of whether it is possible to register a perturbation in a space-time region, in which the vortex $\triangle\mathbf{E}_{\perp}$ and potential $\triangle\mathbf{E}_{\|}$ fields mutually compensate each other (see relationships (28)). It is obvious that a device can register a perturbation if it receives a large enough portion of energy $\triangle W$, the quantity $\triangle W$ being defined by the total electric field strength $\triangle\mathbf{E}$. It is impossible to register a signal in the regions with $\triangle\mathbf{E} = 0$. The above question can be reformulated as follows: if the movement of a particle occurs in a space-time region Ω, whether it is possible to find the manifestations of this movement observable in experiment at a point P separated from the region Ω by space-like intervals? From the point of view of the standard approach based on the assumption that the charged particles are point-like objects, it is impossible in principle to register a perturbation of this kind. The reason is that, as is known [18], in both classical and quantum theory of point particles the causality (locality) principle is carried out: the events separated by a space-like interval are physically independent, i.e. they cannot influence each other.

The situation changes drastically when taken into account that the charged particles are not the point objects. The basic possibility of superluminal transfer of information follows from the fact that the charged self-acting particles are spatially extended objects and, therefore, the events, separated by space-like intervals, cease to be physically independent.

The proton and the ions provide the obvious examples of nonpoint charged particles. As to the electron, it is supposed at the moment to be a structureless point particle. It should be emphasized, however, that this assumption, underlying the standard formulation of quantum electrodynamics, results in occurrence of serious difficulties (the divergence of self-energy of a point particle, the impossibility to explain its stability), which are indicative of the fact that the real charged particle cannot be point-like; the notion of the electron as a point particle is a rather rough approximation to reality. In papers [19-28], on the basis of synthesis of ideas of the self-organization theory of physical systems and standard quantum electrodynamics, the quantum theory of the electron is constructed, in which the ability of the particle to create the Coulomb field and to experience its back action are considered from the very beginning as the physical properties intrinsically inherent in the particle. At such an approach the electron becomes an open self-organizing system, the physical properties of which are described by the nonlinear and nonlocal quantum equation of motion similar to the Dirac equation.

According to [19], the electron represents a soliton - a clot of electrically charged matter having the physical properties of an absolutely solid body. It consists of the region of basic localization, the sizes of which are of the order of Bohr radius for the ground state of particle, of the tail, extending up to infinity, and of the own field. The presence of the tail manifests itself in that the charge density of the self-acting electron proves to be distinct from zero (though rather small in magnitude) far outside the region of basic localization of the particle. The oscillations of the charge density, occurring in this region, are instantaneously transferred along the tail via the own field of particle to any distances and excite the oscillations of electric and magnetic fields at each point of space. Owing to this the whole universe instantaneously obtains the information about a physical event occurring at some point. It can easily be shown that the quantities $\triangle\mathbf{E}_{\perp}$ and $\triangle\mathbf{E}_{\parallel}$ do not compensate each other completely, and so $\triangle\mathbf{E}\neq 0$ at any distances from the centre of mass of particle. As a result, the ordered oscillations of electromagnetic field induced by oscillatory process, in which the electron participates, are superimposed on the casual fluctuations of the field in environment. If the device destined for detecting the oscillations receives a large enough portion of energy $\triangle W$, it will operate and the oscillations will be registered. It should be emphasized that though the transfer of information about a physical process occurs instantaneously, the reception of a signal requires some time because each device, detecting a signal, has inertial properties. The device is characterized by the time of operation $\triangle T$, which is defined by the amount of a portion of energy $\triangle W$ required for the device to register the physical process. As was shown above, to an observation point P, where the receiver is located, come signals, transmitting energy and momentum from some spatial region, the points of which can be connected with the point P by light signal. The dimensions R of this region are defined by the time $\triangle T$: $R \sim \triangle T$. As a result, there is a delay of indications of the device in relation to the oscillations of the particle in the basic region of localization.

Note that the necessity of existence in electrodynamics of the physical mechanism of instantaneous transfer of signals follows from the most general reasons. As the self-field of electron is inseparable from the particle, electron and its self-field should be considered as a single physical system. In view of the long-range character of self-field, this system fills in the whole space. In order that such a system be stable, a physical mechanism should exist combining its parts into a unit. The instantaneous transfer of information via the potential and vortex components of the self-field of electron is, apparently, such a mechanism. It is natural to extend these reasons to the universe: owing to the long-range character of the gravitational field, the universe could not exist in the absence of signals propagating instantaneously which tie up its constituents in a single whole.

5. Superluminal transfer of a signal and STR

The inference made in Sec. 4 that it is possible to transfer a signal with the superluminal velocity via the self-field of charged particles is in the obvious contradiction with the standard point of view, which for the first time was formulated by A. Einstein as a consequence of the special theory of relativity (STR) [1].

A detailed analysis of the problem shows, however, that our conclusion is in agreement with STR. The standard point of view only seems to be true; it cannot be proved within the framework of STR. The statement that the transfer of signals with faster-than-light speed is impossible is in essence an additional postulate contradicting Maxwell"s equations, as it follows from analysing the transfer of a superluminal excitation through the self-field of a particle (see Sec. 4).

To explain the conclusions formulated above, let us first analyse the standard reasons for impossibility of the existence of superluminal signals.

Consider two physical events occurring at the points A and B separated by a space-like interval, i.e. the events which occur at different spatial points and cannot be connected between themselves with the help of a signal propagating with the speed $v \leq 1$. Denote by t_A and t_B the time coordinates of the points A and B in an inertial frame of reference K and assume that $t_A < t_B$ (i.e. from the point of view of the K-observer the event related to the point A occurs before the event related to the point B). Using the Lorentz transformations, one can readily show that there exists such an inertial frame of reference K', in which $t'_A > t'_B$, i.e. from the viewpoint of the K'-observer the event related to the point A occurs after the event related to B. This means that the concepts before and after are of a relative nature in respect to the events separated from each other by space-like interval. The reasoning given above is absolutely exact, it follows from the Lorentz transformations, i.e. it is a consequence of the STR kinematics.

Let us pass on to the second part of reasoning. Assume that the event B (i.e. the event occurring at the point B) is a response to the event A arising as a result of transfer of a superluminal signal from the point A, i.e. the event A is the reason of the event B. Because of the objective character of causal relations between two events, the event A (reason) should precede in time the event B (consequence) in any inertial reference frame. From the fact that such a reference frame was found in which the event A occurs after the event B it follows, obviously, that the superluminal transfer of a signal is impossible.

At the first sight, this conclusion is faultless as it is based on the requirement following from common sense that causal relations between two physical events should be of an objective character. The requirement that reason precede consequence in time in any reference frame is, certainly, true. However, the conclusion made above does not prove to follow from this requirement. The error in the above mentioned standard proof of impossibility of existence of superluminal signals is that the causal relationship between the two events is analysed in it within the framework of kinematics without using the equations of motion. The causality problem is, however, a problem of dynamics, because the case in point is the transfer of interaction from one event to the other. Hence, it can be solved only by the analysis of solutions of the equations of motion subject to proper boundary conditions. Remaining in the framework of kinematics, it is impossible in principle to solve the causality problem.

To be certain that the superluminal transfer of information does not result in violation of the objective character of causal relationships and is a consequence of the equations of electrodynamics, we shall consider a charged particle oscillating within an interval $(0, T)$ in a vicinity of the origin of the reference frame K. For simplicity, we assume that the oscillations occur along the z-axis, so that the radius-vector of a particle can be written down as $\mathbf{r}_0(t) = (0,\ 0,\ z_0(t))$ with $\mid \mathbf{v}_0(t) \mid = \mid\ dz_0(t)\,/\,dt \mid < 1$. Again, as in Sec. 4, we denote by Ω the space-time region in which the particle oscillations occur in the interval $(0, t)$. The point of observation of the field P with coordinates $(t_P, \mathbf{r}_P)$ will be considered to be separated from the points of the region Ω corresponding to the particle movement by space-like intervals, the moment of time t_P lying inside the interval $(0, T)$. Denote by $\triangle\,\mathbf{E}$ the contribution of the particle oscillations to the electric field, and by $\triangle\,\mathbf{E}_\perp$ and $\triangle\,\mathbf{E}_\parallel$ its vortex and potential components ($\triangle\,\mathbf{E} = \triangle\,\mathbf{E}_\perp + \triangle\,\mathbf{E}_\parallel$). According to the results of Sec. 4, at the point P are carried out the relations (28).

Consider now the relation between the reason (oscillations of the particle in the region Ω) and the consequence (occurrence of the fields $\triangle\,\mathbf{E}_\perp$ and $\triangle\,\mathbf{E}_\parallel$ at the point P) from the viewpoint of the reference frame K', moving relative to the reference frame K with the velocity $\mathbf{v} = const$. For simplicity, we believe the $x-$ and $y-$axes of the reference frame K to be parallel to the $x'-$ and $y'-$axes of the reference frame K', the $z-$ and $z'-$axes to coincide with one another, and the motion to occur along the $z-$axis. From the point of view of the K'-observer the particle oscillations occur at the moments of time t' lying in the interval $(0, \gamma T)$, $\gamma = (1 - v^2)^{-1/2}$. The coordinates of the observation point P are:

$$(\,t'_P,\, \mathbf{r}'_P) = (\gamma(t_P - v\,z_P),\, x_P,\, y_P,\, \gamma(z_P - v\,t_P)) \tag{34}$$

On the basis of the results of Sec. 4 one can draw the conclusion that the space-time region contributing to the vortex field $\triangle\,\mathbf{E}'_\perp$, caused by the particle oscillations, at the point P should satisfy the following two conditions: (1) the points of this region with coordinates $(t',\, \mathbf{r}')$ can be connected with the point P by the light signal, and (2) the vortex current component $\mathbf{j}'_\perp(t',\, \mathbf{r}')$ caused by the particle oscillations is distinct from zero at the points of this region. As the particle oscillations occur within the interval $(0, \gamma T)$, the second condition means that the moment of time t' should obey the inequality

$$0 \leq t' \leq t'_P \tag{35}$$

It is seen from (34) that if the reference frame K' is such that

$$T - v\,z_P < 0 \tag{36}$$

then from the viewpoint of this frame the observation point P is in the past in relation to the particle oscillations ($\,t'_P < 0$) and so condition (35) is not carried out. Hence, in this case $\triangle\,\mathbf{E}'_\perp = 0$ at the point P, i.e. the K'-observer cannot observe the particle oscillations at the point P.

So, if at a point P in a reference frame K the vortex field produced by the particle oscillations is distinct from zero ($\triangle\,\mathbf{E}_\perp \neq 0$), in the view of the K'-observer the vortex field is absent at the same point ($\triangle\,\mathbf{E}'_\perp = 0$). The question now arises as to whether or not this result will violate the requirement of objectiveness of the physical process. The requirement mentioned above can be formulated thus: if some physical process can be registered by devices in an inertial reference frame K, it must necessarily be registered in any other inertial reference frame K'.

Let us show that in the case at hand this requirement is not violated. It should be noted that in STR, because of interrelation between the time and spatial coordinates in different inertial frames of reference, the concept of simultaneity of two events is of a relative character: two events, simultaneous in one inertial frame of reference cease to be simultaneous from the viewpoint of the other reference frame. In the case being considered the event, consisting in observation of the vortex field $\triangle \mathbf{E}_{\perp}$ in the reference frame K, is simultaneous with one of the events, happening to the oscillating particle, and consequently the device registers the field $\triangle \mathbf{E}_{\perp} \neq 0$. However, from the viewpoint of the K'-observer, when condition (36) is carried out, the event, consisting in observation of the vortex field (as a response to the particle oscillations), precedes all the events, happening to the oscillating particle, i.e. in the view of the K'-observer at the moment of observation the event causing the response (the particle oscillations) has still to occur. Naturally, in the reference frame K' at the point P there is no response to the particle oscillations: $\triangle \mathbf{E}'_{\perp} = 0$. However, if the K'-observer is patient enough and waits until the condition $t'_P > 0$ is carried out, he will register the field $\triangle \mathbf{E}'_{\perp} \neq 0$. The latter does mean that the requirement of objectiveness of physical process is fulfilled.

The phenomenon of superluminal transfer of a signal is, thus, in agreement with STR. The analysis of dynamics of the process according to the equations of electromagnetic field in a natural way lifts the ban of superluminal signals which, at the first sight, follows from the kinematic considerations.

While investigating the oscillations of a particle being considered from the viewpoint of two inertial reference frames, a new physical effect was found to exist which can be described as follows. If the observers placed in different inertial reference frames moving relative to each other register an event at a space-time point P, their opinions on this event can be essentially different providing the event is a response to a physical process caused by a superluminal signal. This effect is a consequence of peculiarities of the 4-dimensional space-time geometry which manifest themselves when superluminal signals appear.

Note that the phenomenon in question is close in its physical nature to the effect of relativity of quantum processes predicted in [29,30]: the viewpoints of the observers, placed in inertial reference frames K and K' and studying independently of one another the scattering processes, on the character of quantum process in a fixed reference frame are different. However, the latter effect is of a purely dynamical origin. It is due to the realignment of energy spectrum of electronic system in external field and not to the presence of superluminal signals.

To make more precise some basic points, pass on again to the "proof" of impossibility of superluminal signals given at the beginning of this section. We consider the events A and B, occurring at the points separated from one another by a space-like interval with $t_A < t_B$ in the reference frame K. One can imagine that within the time interval $(t_A,\, t_B)$ a physical process occurs, caused by the event at a point A and giving rise to the event at a point B. Let the time coordinates of the points A and B be located in an inertial reference frame K' in the reverse order: $t'_A > t'_B$. Einstein considered it self-evident that to a physical process, occurring from the viewpoint of the reference frame K within the interval (t_A, t_B), there should correspond the physical process developing in K' back in time within the interval $(t'_A,\, t'_B)$. As this is, however, at variance with common sense, hence, the superluminal transfer of a signal is impossible.

What actually occurs in the view of the K'-observer within the time interval in question?

One should bear in mind that all inertial frames of reference are independent and equal in rights, and so for the $K-$observer the time t plays exactly the same role that is played by the time t' for the K'-observer. When it is assumed that the observers in all inertial reference frames describe physical processes, imposing on the solutions of the equations of electrodynamics boundary conditions corresponding to retarded interaction, then for each of them the evolution of a physical system goes forward in time. For the K'-observer within time interval $(t'_B,\ t')$, where $t' < t'_A$, the event A, causing the physical process, has not yet come and, consequently, in the time interval mentioned above there is no physical process as a response to the event A, which has not yet taken place, in complete conformity with the requirement of objectivity of causal relations. Thus, the following phenomenon takes place: a physical event is registered by the K-observer at a point B, but it is not registered at this point by the K'-observer. This effect is not in contradiction with the requirement of objectiveness of physical process in view of the fact that the physical events, connected by superluminal signals, are not point-like - they occur in the whole space-time and not at one point. Really, the role of the source of a superluminal signal, as is shown in Sec. 4, is played by the vortex current $\mathbf{j}_\perp$ (or the potential current $\mathbf{j}_\|$), distributed over the whole space, and the receiver is a region, the points of which can be connected to the point of observation by light signal. For this reason the physical event, created by the event A, will necessarily be registered in the reference frame K', but only at the moments of time t' following after the moment of time t'_A, at which the event A will occur.

6. Conclusions

Let us briefly formulate the main results of the paper.

The fundamental physical property of the electron is that it has an electric charge and, therefore, creates in the environmental space (in vacuum) a long-range own field, thereby transforming the vacuum into a medium capable to exert the back action on the particle. As the own field is governed by Maxwell"s equations, physical properties of this medium (we shall call it the physical vacuum) can be described by Maxwell"s equations. An analysis of solutions to these equations shows that the own field of a charged particle has the properties of an absolutely solid body: it can transfer signals about the change in the state of motion of a particle instantaneously and to any distances. However, in the case of a point charged particle it is impossible to register the superluminal signals for the reason that the vortex and potential electric fields, caused by the moving particle, mutually compensate each other at the points separated from the particle by space-like intervals.

According to [19,20], the back influence on the electron of its own field results in that the particle becomes spatially extended. Because of this the contributions to vortex and potential components of the electric field, caused by the moving electron, cease to compensate each other at the points separated from the centre of mass of the particle by space-like intervals and, as a result, it becomes possible to register the signals sent out by the moving particle at any distances from it.

It should be emphasized that the conclusion about the possibility of transferring a signal in electrodynamics with superluminal velocity results from that (1) the own field of the electron does not obey the wave-corpuscular duality and is of a purely wave nature and (2) the electron is not a point particle.

The results of the paper are in accord with STR. They essentially supplement and extend the existing physical notions about space and time and about the character of interaction between material bodies. One of the consequences of existence of superluminal signals is the possibility to predict the future behaviour of a physical system, if only the casual factors do not intrude upon its time evolution. One can easily show that this conclusion directly follows from the phenomenon of relativity of physical processes investigated in this paper. The other consequence is the photon teleportation - the disappearance of the particle in one place of space and its creation in the other separated by arbitrarily large distances [14].

The results of the investigations received in [19-28] and in this paper allow one to gain a more penetrating insight into the true nature of those factors which operate the world. As the electron, the tiniest brick of the microworld, is an open self-organizing system, which via the long-range own field is indissolubly connected to the whole universe, it is natural to make a conclusion that in nature a universal dynamic principle works - The Principle of Self-Organization, which can be formulated as follows: any material object represents an open self-organizing system, whose internal structures are formed with the participation of the whole universe. Apparently, the Principle of Self-Organization, incorporated in nature as one of the integral properties of matter, is nothing more nor less than a spirit (or absolute idea, or creator) which operates the world and creates all its variety. It seems to be physically meaningless, however, to tear the property mentioned above away from matter and to give it credit for a self-dependent existence independent of matter: it exists only to the extent to which the matter does [12].

As is seen from the results received, any physical process with the participation of charged particles is accompanied by emission in the environmental space of superluminal signals which transfer information about these processes to the neighbouring bodies. Apparently, such an information interchange between material objects provides a possibility of their stable coexistence and is, thus, the most important element of self-organization in the universe.

The ability of the electron for self-organization and for information interchange with the surrounding bodies, no matter how far they are spaced, points to the fact that the electron is an elementary microsystem to possess the rudiments of reason and all those properties which as a result of evolution of matter lead to the advent of life.

References

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