About incompatibility of the conventionalist concept of simultaneity with the principle of relativity

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Abstract. *Considered the question of permissibility of non-standard clock synchronizations in inertial frames, declared by the conventionalist concept of simultaneity. It is shown that the introduction of a unified simultaneity for all inertial frames, permissible by this concept, leads to physical results in areas of electrodynamics, mechanics, optics, contradicting to the principle of relativity.*

Special relativity considers physical processes in inertial frames moving relative to each other with constant velocity in an isotropic space. Is used Einstein's clock synchronization in each frame. Its using is based on the assumption of independence in all frames of velocity of light in a vacuum from direction of propagation. The velocity of light is considered to be the maximum velocity of propagation of physical signals, owing to what a number of other synchronizations along with Einsteinian are admissible according to the known conventionalist concept of simultaneity [1-5]. Is permissible, in particular, the introduction of a unified simultaneity for all inertial frames.

The essence of the conventionalist concept consists in the following. Let light signal is sent at time t_1 from point A, and after reflection at point B is returned to A at the time t_3. The time of arrival of the signal at the point B can be considered as simultaneous with any moment t_2 at point A, satisfying the condition

$$t_2 = t_1 + \eta(t_3 - t_1), \tag{1}$$

where $0 < \eta < 1$ is the so-called synchronization parameter.

It is necessary to select among synchronizations, defined by the equality (1), one synchronization, in which the time t in the considered frame does not depend on the spatial coordinate $\boldsymbol{r}$ (vectors written here and below in bold). We suppose, that such synchronization is performed. We now introduce the time τ, that different from t by clock synchronization. It is necessary in this case take into account the following circumstance. Change of synchronization means execution of unequal for different points of space shift of start of timing. Therefore, the time τ differs from t on some function $f(\boldsymbol{r})$. That is

$$\tau = t + f(\boldsymbol{r}).$$

Since t does not depend on $\boldsymbol{r}$, then τ is a function of $\boldsymbol{r}$. If to operate with the time τ in the normal way, you can come to incorrect physical results. Consider a simple example. We suppose, that $f(\boldsymbol{r})$ is a linear function. In this case $\boldsymbol{\nabla} f = const$. We introduce a Cartesian coordinate systems x, y, z in the considered frame, so that the x direction coincides with the direction of the vector $\boldsymbol{\nabla} f$. We will consider the free rotation of a rigid body about the z-axis. We get for "angular velocity" of rotation $d\varphi/d\tau$

$$\frac{d\varphi}{d\tau} = \frac{\omega}{1 - \nabla f \omega r \sin\varphi},$$

where φ is the angle measured from the x axis, r is the distance of the considered point of the rigid body to the z-axis, $\omega = d\varphi/dt = const$. "Angular speed" $d\varphi/d\tau$ is dependent on the angle and on the distance from the axis of rotation.

We choose Einstein's synchronization condition only in one inertial frame K. We choose the synchronization condition in all other inertial frames depending on their velocity relative to the frame K so as to provide in these frames unified simultaneity with the frame K. We assume that one of the inertial frames K' moves relative to K with velocity $\boldsymbol{V}$. We introduce in K and K' the Cartesian coordinate systems with axes, respectively, xyz and $x'y'z'$ so that the direction of the coordinate axes x and x' coincided with the direction of the vector $\boldsymbol{V}$. We believe that the time t' in the frame K' differs by the amount $\frac{Vx'}{c^2}$ from the time τ' corresponding to the Einstein's synchronization in this frame

$$t' = \tau' + \frac{Vx'}{c^2}.$$

That is, the synchronization parameter η in K' is

$$\eta = \frac{1}{2}\left(1 + \frac{V}{c}\cos\vartheta'\right), \tag{2}$$

where θ' is the angle between the axis x' and the direction of light emission from point A. Is selected the synchronization condition in all other inertial frames same as in K'. This choice of synchronization condition is equivalent to Einstein's synchronization from the viewpoint of the conventionalist concept. But this choice of synchronization condition in the isotropic space means, in contrast to Einstein's synchronization, the introduction of time depending on the spatial coordinate x'. This choice of synchronization condition can be correct only in the anisotropic space with the corresponding character of anisotropy. But the anisotropy in such space must to manifest itself in physical processes. Let's see what the physical results are the consequence of the choice of the synchronization condition (2).

Transformations of spatial coordinates and time from K to K', corresponding to the synchronization condition (2), have the form

$$x' = \frac{x - Vt}{\sqrt{1 - V^2/c^2}}, \qquad y' = y, \qquad z' = z, \qquad t' = \sqrt{1 - V^2/c^2}\, t. \tag{3}$$

The transformation of time (3) is different from the Lorentz transformation of time by an amount $\frac{Vx'}{c^2}$. But the transformations (3) can also be considered as Lorentz transformations, since Lorenz did not recognize the relativity of simultaneity, and he believed that the time t', appearing in the transformations (3), is a true time and the aforementioned time τ' called, citing his, "no more than an auxiliary mathematical value" [6].

We obtain the transformations of components of the velocity $\boldsymbol{u}$ of the particle and the angle θ_u between vectors $\boldsymbol{u}$ and $\boldsymbol{V}$ using the coordinate transformations (3)

$$u'_x = \frac{u_x - V}{1 - V^2/c^2}, \qquad u'_y = \frac{u_y}{\sqrt{1 - V^2/c^2}}, \qquad u'_z = \frac{u_z}{\sqrt{1 - V^2/c^2}}, \tag{4}$$

$$\cos\theta'_u = (\cos\theta_u - \frac{V}{u})[(1 - \frac{V}{u}\cos\theta_u)^2 + \left(\frac{V^2}{u^2} - \frac{V^2}{c^2}\right)\sin^2\theta_u]^{-\frac{1}{2}} \tag{5}$$

where θ'_u - the angle between the velocity vector $\boldsymbol{u}'$ of the particle in the frame K' and the axis *x*'. We obtain for the speed of light in a vacuum in the frame K', by using the transformations (4), (5)

$$c' = \frac{c}{1 + \frac{V}{c}\cos\theta'} \tag{6}$$

where θ'- the angle between the direction of light propagation and the axis *x*'.

The equations of physical laws have the usual kind in the frame K, where selected Einstein's synchronization condition. We obtain the expression of the Lagrange function of a charged particle in an electromagnetic field in the frame K', writing the equation of the principle of minimal action in the frame K and performing in this equation the change of variables

$$L' = -mc^2\sqrt{(1 - \frac{\boldsymbol{V}\boldsymbol{u}'}{c^2})^2 - \frac{u'^2}{c^2}} + \frac{e}{c}\boldsymbol{A}'\boldsymbol{u}' - e\varphi' \tag{7}$$

where $\boldsymbol{u}'$ - the velocity vector of the particle, *m* is the mass, *e* is the charge, $\boldsymbol{A}'$ and φ' - vector and scalar potentials, which are associated with the corresponding values $\boldsymbol{A}$ and φ in the frame K by the equalities

$$A'_x = A_x\sqrt{1 - V^2/c^2}, \qquad A'_y = A_y, \qquad A'_z = A_z, \qquad \varphi' = \frac{\varphi - \frac{V}{c}A_x}{\sqrt{1 - V^2/c^2}}. \tag{8}$$

We have similarly for the generalized impulse $\boldsymbol{P}$ and energy $\mathcal{E}$ of a particle

$$P'_x = P_x\sqrt{1 - V^2/c^2}, \qquad P'_y = P_y, \qquad P'_z = P_z, \qquad \mathcal{E}' = \frac{\mathcal{E} - VP_x}{\sqrt{1 - V^2/c^2}}, \tag{9}$$

The expressions for $\boldsymbol{P}'$ and $\mathcal{E}'$ is written in the form

$$\boldsymbol{P}' = \frac{m[\boldsymbol{u}' + \boldsymbol{V}(1 - \frac{\boldsymbol{V}\boldsymbol{u}'}{c^2})]}{\sqrt{(1 - \frac{\boldsymbol{V}\boldsymbol{u}'}{c^2})^2 - \frac{u'^2}{c^2}}} + \frac{e}{c}\boldsymbol{A}', \tag{10}$$

$$\mathcal{E}' = \frac{mc^2(1 - \frac{\boldsymbol{V}\boldsymbol{u}'}{c^2})}{\sqrt{(1 - \frac{\boldsymbol{V}\boldsymbol{u}'}{c^2})^2 - \frac{u'^2}{c^2}}} + e\varphi'. \tag{11}$$

The equality is true for the kinetic energy $\mathcal{E}'_0$ of a particle moving under the action of the force $\boldsymbol{F}'$

$$\frac{d\mathcal{E}'_0}{dt'} = \boldsymbol{F}'\boldsymbol{u}',$$

Equation of dynamics can be written considering this equation and expressions (10) and (11) in the form

$$\frac{d}{dt'}\frac{m\boldsymbol{u}'}{\sqrt{(1 - \frac{\boldsymbol{V}\boldsymbol{u}'}{c^2})^2 - \frac{u'^2}{c^2}}} = \boldsymbol{F}' - \frac{\boldsymbol{V}}{c^2}(\boldsymbol{F}'\boldsymbol{u}'), \tag{12}$$

or

$$\frac{d}{dt'}\left[\frac{\mathcal{E}'_0}{c^2}\left(\boldsymbol{V} + \frac{\boldsymbol{u}'}{1 - \frac{\boldsymbol{u}'\boldsymbol{V}}{c^2}}\right)\right] = \boldsymbol{F}', \tag{13}$$

We introduce in K' electric $\boldsymbol{E}'$ and magnetic $\boldsymbol{H}'$ fields and produce in the equalities

$$\boldsymbol{E}' = -\frac{1}{c}\frac{\partial \boldsymbol{A}'}{\partial t'} - \boldsymbol{\nabla}\varphi', \qquad \boldsymbol{H}' = rot\boldsymbol{A}'$$

change variables by using the transformations (3), (8). At that, should take into account here and further that

$$\frac{\partial}{\partial t'} = \frac{1}{\sqrt{1 - V^2/c^2}}\left(\frac{\partial}{\partial t} + V\frac{\partial}{\partial x}\right),$$

since $\frac{\partial}{\partial t'}$ is calculated at constant x', which corresponds to

$$x = Vt + const\,.$$

The result is the transformations of electric and magnetic fields $\boldsymbol{E}$ and $\boldsymbol{H}$ in the form

$$E_x' = E_x\,, \qquad E_y' = \frac{E_y - \frac{V}{c}H_z}{\sqrt{1 - V^2/c^2}}\,, \qquad E_z' = \frac{E_z + \frac{V}{c}H_y}{\sqrt{1 - V^2/c^2}}\,,$$

$$H_x' = H_x, \qquad H_y' = H_y\sqrt{1 - V^2/c^2}\,, \qquad H_z' = H_z\sqrt{1 - V^2/c^2}\,, \tag{14}$$

We obtain the following equations for the frame K' from the second pair of Maxwell's equations, using the transformations (3), (14)

$$rot\boldsymbol{H}' = \left(1 - \frac{V^2}{c^2}\right)\frac{1}{c}\frac{\partial \boldsymbol{E}'}{\partial t'} + \frac{4\pi}{c}[\boldsymbol{j}' + (\rho' - \frac{\boldsymbol{j}'\boldsymbol{V}}{c^2})\boldsymbol{V}] - \frac{V}{c}\frac{\partial \boldsymbol{E}'}{\partial x'} - \frac{1}{c^2}\frac{\partial}{\partial t'}[\boldsymbol{V}\boldsymbol{H}']\,, \tag{15}$$

$$div\boldsymbol{E}' = 4\pi\left(\rho' - \frac{\boldsymbol{j}'\boldsymbol{V}}{c^2}\right) - \frac{1}{c^2}\frac{\partial \boldsymbol{E}'\boldsymbol{V}}{\partial t'}, \tag{16}$$

where ρ' is charge density, $\boldsymbol{j}'$ is current density.

The first pair of Maxwell's equations has in K' the same kind, as in K.

We define field of a motionless point charge in the frame K'. The expressions for fields of a charge moving in the frame K with constant velocity $\boldsymbol{V}$

$$\boldsymbol{E} = \frac{\left(1 - \frac{V^2}{c^2}\right)e\boldsymbol{r}}{r^3(1 - \frac{V^2}{c^2}sin^2\psi)^{1{,}5}}\,, \qquad \boldsymbol{H} = \frac{1}{c}[\boldsymbol{V}\boldsymbol{E}]\,. \tag{17}$$

We obtain the expressions for $\boldsymbol{E}'$ and $\boldsymbol{H}'$, doing change of variables in the expressions (17) using the transformations (3), (14),

$$\boldsymbol{E}' = \frac{e\boldsymbol{r}'}{r'^3}\,, \qquad \boldsymbol{H}' = \frac{1}{c}[\boldsymbol{V}\boldsymbol{E}']\,. \tag{18}$$

It follows from (18) that the magnetic field exists in the K' near motionless charges. It can be detected, for example, by the action on the conductors with an electric current. It follows from equation (16) and the equation of continuity, that conductor with a constant current, motionless in the frame K', contains electric charge with density

$$\rho' = \frac{\boldsymbol{j}'\boldsymbol{V}}{c^2}\,. \tag{19}$$

The force acts on the element $d\Omega'$ of this conductor in an electric field

$$d\boldsymbol{F}_1' = \frac{\boldsymbol{E}'}{c^2}(\boldsymbol{j}'\boldsymbol{V})d\Omega'. \tag{20}$$

Using the equality (18), (20), we obtain the expression for the force $d\boldsymbol{F}_2'$ acting from the motionless of the charges on the element $d\Omega'$ of conductor with a constant current

$$d\boldsymbol{F}_2' = \frac{\boldsymbol{V}}{c^2}(\boldsymbol{E}'\boldsymbol{j}')d\Omega'\,. \tag{21}$$

We write equation of dynamics for a homogeneous linear conductor of length L, mass m with a constant current $\boldsymbol{I}'$ in a uniform field generated by motionless charges. We obtain, substituting the expression (21) in the equation (12),

$$\frac{d}{dt'}\frac{m\boldsymbol{u}'}{\sqrt{(1 - \frac{\boldsymbol{V}\boldsymbol{u}'}{c^2})^2 - \frac{u'^2}{c^2}}} = \frac{\boldsymbol{V}L'}{c^2}(\boldsymbol{E}'\boldsymbol{I}')\left(1 - \frac{\boldsymbol{u}'\boldsymbol{V}}{c^2}\right). \tag{22}$$

It follows from equation (22), in particular, that initially motionless conductor begins to move under the action of the field with acceleration $\frac{\boldsymbol{V}L'}{mc^2}(\boldsymbol{E}'\boldsymbol{I}')$.

According to the equation of continuity for a homogeneous conductor with a constant electric current,

$$div\boldsymbol{E}' = 0.$$

Therefore, the conductor does not create an electric field around it. It follows from equations (16) and (19) that equation (15) for the magnetic field of a homogeneous conductor with a constant electric current must be

$$rot\boldsymbol{H}' = \frac{4\pi}{c}\boldsymbol{j}'.$$

Therefore, should be normal magnetic field, which is independent of speed $\boldsymbol{V}$, around a homogeneous conductor with constant current. Suppose a particle moves with an initial velocity $\boldsymbol{u}'_n$ in a constant and homogeneous magnetic field $\boldsymbol{H}'$ generated by the conductors with the electric current and oriented in the z' axis direction. We perform in the equation (13) variable change

$$t' = \tau' + \frac{Vx'}{c^2}$$

and get the equation of motion in the usual form

$$\frac{\mathcal{E}'_0}{c^2}\frac{d\boldsymbol{u}^*}{d\tau'} = [\boldsymbol{u}^*\boldsymbol{H}'] \,, \tag{23}$$

where

$$\mathbf{u}^* = \frac{\boldsymbol{u}'}{\mathbf{1} - \frac{\boldsymbol{u}'\boldsymbol{V}}{c^2}}.$$

The dependence is for the coordinate $\boldsymbol{r}'$ of the particle

$$\boldsymbol{r}' = \boldsymbol{r}'_0(\boldsymbol{r}'_n, \boldsymbol{u}^*_n, \boldsymbol{H}', \tau'),$$

where $\boldsymbol{r}'_0$ - the solution of equation (23) with the initial conditions: $\boldsymbol{r}'_0 = \boldsymbol{r}'_n$ and $\boldsymbol{u}^* = \boldsymbol{u}^*_n$. It follows from equation (23) [7]

$$x' = x'_0 + r\sin(\omega\tau' + \zeta), \qquad y' = y'_0 + r\cos(\omega\tau' + \zeta)\,, \qquad z' = z'_0 + \frac{u'_{zn}\tau'}{1 - \frac{\boldsymbol{V}\boldsymbol{u}'_n}{c^2}},$$

where

$$\omega = \frac{ecH'}{\mathcal{E}'_0}, \qquad \zeta, \qquad u'_{zn}, \qquad r = \frac{\mathcal{E}'_0 u^*_0}{ecH'} = \frac{mcu'_0}{eH'\sqrt{(1-\frac{\boldsymbol{V}\boldsymbol{u}'_n}{c^2})^2 - \frac{u'^2_n}{c^2}}}\,, \qquad u^*_0 = \sqrt{u^{*2}_x + u^{*2}_y}$$

are constants.

The particle moves along a spiral. The radius r of the spiral depends on the scalar product $\boldsymbol{V}\boldsymbol{u}'_n$, and the drift velocity along the z'-axis is proportional to $1 - \frac{\boldsymbol{V}\boldsymbol{u}'}{c^2}$ and, therefore, does not remain constant.

Let us consider some mechanical processes, in which the anisotropy of the space in the frame K' should have been manifest itself. We consider the motion of a particle in a force field perpendicular to the axis x'. Suppose that at the initial moment $u'_x(0) = 0$ and $\mathcal{E}'_0(0) = \mathcal{E}'_n$. We get from equation (13)

$$u'_x = -\frac{V(\mathcal{E}'_0 - \mathcal{E}'_n)}{\mathcal{E}'_0 - (\mathcal{E}'_0 - \mathcal{E}'_n)\frac{V^2}{c^2}}. \tag{24}$$

That is, the particle is deflected in the opposite direction to the vector $\boldsymbol{V}$, when its kinetic energy is increasing and - in the direction of the vector $\boldsymbol{V}$ when its kinetic energy decreases.

The equality binding the velocity of a particle with its kinetic energy follows from the expression (11)

$$u' = \frac{c\sqrt{\mathcal{E}'^2_0 - m^2c^4}}{\mathcal{E}'_0 + \sqrt{\mathcal{E}'^2_0 - m^2c^4}\,\frac{V}{c}cos\theta'_u}, \tag{25}$$

Hence it follows, for example, that angular velocity ω' of the rotator, that is, of a material point of mass m, which withheld by means of a weightless rigid rod at a constant distance from the center of rotation, will be at the free rotation

$$\omega' = \frac{c\sqrt{\mathcal{E}'^2_0 - m^2c^4}}{r'\left(\mathcal{E}'_0 - \sqrt{\mathcal{E}'^2_0 - m^2c^4}\,\frac{V}{c}sin\varphi' cos\psi'\right)}, \tag{26}$$

where r' - rod length, φ' - the angle between the rod and the projection of vector $\boldsymbol{V}$ onto the plane of rotation, ψ' - the angle between the plane of rotation and the vector $\boldsymbol{V}$. At that the energy $\mathcal{E}'_0$ of the particle remains constant. The observer located at the center of rotation can to fix the dependency of the angular velocity from the angles φ' and ψ'.

Formula (25) is fair, obviously, and for the velocity of the charged particle in a constant homogeneous magnetic field. And formula (26) is fair in the case of a flat rotational motion of this particle. At that $\boldsymbol{r}'$ should be understood as the radius-vector drawn from the center of rotation to the particle and φ' - as the angle between $\boldsymbol{r}'$ and the projection of vector $\boldsymbol{V}$ onto the plane of rotation.

We will consider some optical phenomena in which the anisotropy of the space in the frame K' should have been manifest itself. We define a change of direction of light propagation at the transition from the frame K' to the frame K" moving relative of K' with a constant velocity $\boldsymbol{u}'$ (the phenomenon of aberration). We assume that the vector $\boldsymbol{u}$ lies in the xy plane and its direction coincides with the direction of the x''-axis of the frame K". We introduce in the frame K another Cartesian coordinate system x_1, y_1, z , the axis z which coincides with the axis z of the existing coordinate system and the axis x_1 is oriented in the direction of the vector $\boldsymbol{u}$.

The angle of aberration $\qquad \Delta\theta = \theta_{c''v''} - \theta_{c'u'}\,,$

where $\theta_{c'u'}$ is the angle between the vector $\boldsymbol{c}'$ of the velocity of light in the frame K' and the vector $\boldsymbol{u}'$, $\theta_{c''v''}$ is the angle between the vector $\boldsymbol{c}''$ of the velocity of light in the frame K" and the vector $-\boldsymbol{v}''$ equal to the velocity of the frame K' relative to the frame K", but aimed in the opposite direction. We define the cosine of the angle $\theta_{c'u'}$ according to the formula

$$cos\theta_{c'u'} = \frac{\boldsymbol{c'u'}}{c'u'}.$$

We obtain, turning to the variables of the frame K using formulas (4), (6)

$$u' = \frac{\sqrt{(\boldsymbol{u}-\boldsymbol{V})^2 - \frac{V^2}{c^2}u^2 sin^2\theta_{uv}}}{1 - V^2/c^2}, \qquad c' = c\frac{1 - \frac{V}{c}cos\theta_{cv}}{1 - V^2/c^2},$$

where θ_{uv} - the angle between the vectors $\boldsymbol{u}$ and $\boldsymbol{V}$, and θ_{cv} - the angle between the vectors $\boldsymbol{c}$ and $\boldsymbol{V}$, and, finally,

$$cos\theta_{c'u'} = \frac{\frac{\boldsymbol{c}(\boldsymbol{u}-\boldsymbol{V})}{c^2} - \frac{\boldsymbol{uV}}{c^2} + \frac{V^2}{c^2}\left(1 - \frac{c_y u_y}{c^2}\right)}{\left(1 - \frac{V}{c}cos\theta_{cv}\right)\sqrt{\frac{(\boldsymbol{u}-\boldsymbol{V})^2}{c^2} - \frac{V^2u^2}{c^4}sin^2\theta_{uv}}}. \tag{27}$$

A similar expression is for $cos\theta_{c"v"}$. It differs from (27) by sign and the fact, that the magnitudes $\boldsymbol{u}$ and $\boldsymbol{V}$ are interchanged, respectively θ_{cv} is replaced by θ_{cu} - the angle between the vectors $\boldsymbol{c}$ and $\boldsymbol{u}$, $c_y u_y$ is replaced by $c_{y_1}V_{y_1}$. In addition, we must take into account that

$$-V^2 c_y u_y = -V^2\boldsymbol{cu} + (\boldsymbol{Vc})(\boldsymbol{Vu}), \qquad -u^2 c_{y_1}V_{y_1} = -u^2\boldsymbol{cV} + (\boldsymbol{uc})(\boldsymbol{Vu}).$$

As a result, we get for the difference of the cosines of the angles $\theta_{c'u'}$ and $\theta_{c"v"}$ with precision up to magnitudes of second degree with respect to *V/c* and *u/c*

$$cos\theta_{c'u'} - cos\theta_{c"v"} = \frac{|\boldsymbol{u}-\boldsymbol{V}|}{c}sin^2\theta_{cu-v}\left[1 + \frac{\boldsymbol{c}(\boldsymbol{u}+\boldsymbol{V})}{c^2}\right] - \frac{2(\boldsymbol{u}-\boldsymbol{V})}{c^3|\boldsymbol{u}-\boldsymbol{V}|}[\boldsymbol{u}(\boldsymbol{Vc}) - \boldsymbol{V}(\boldsymbol{uc})] \tag{28}$$

where θ_{cu-v} - the angle between the vectors $\boldsymbol{c}$ and $\boldsymbol{u}-\boldsymbol{V}$.

For small values of the angle of aberration $\Delta\theta$

$$cos\theta_{c'u'} - cos\theta_{c"v"} = \Delta\theta sin\theta_{c"v"}. \tag{29}$$

It follows from the formulas (4) in the first approximation on $\frac{V}{c}$ and on $\frac{u}{c}$

$$\boldsymbol{u}-\boldsymbol{V} \approx \boldsymbol{u}', \qquad \boldsymbol{V}-\boldsymbol{u} \approx \boldsymbol{v}'', \tag{30}$$

and in the zero approximation $\boldsymbol{c}'' \approx \boldsymbol{c}$. We get the following expression for $\Delta\theta$, substituting (29) in (28) and taking into account (30)

$$\Delta\theta = \frac{u'}{c}sin\theta_{c"v"}\left[1 + \frac{\boldsymbol{c}(\boldsymbol{u}+\boldsymbol{V})}{c^2}\right] + \frac{2\boldsymbol{v}''}{c^3v''sin\theta_{c"v"}}[\boldsymbol{u}(\boldsymbol{Vc}) - \boldsymbol{V}(\boldsymbol{uc})]. \tag{31}$$

The scalar product of the vector $\boldsymbol{v}''$ on the double cross product contains in the last summand in equation (31). We get, performing a cyclic permutation and replacing $\boldsymbol{c}$ on $\boldsymbol{c}''$,

$$\Delta\theta = \frac{u'}{c}sin\theta_{c"v"}\left[1 + \frac{\boldsymbol{c}(\boldsymbol{u}+\boldsymbol{V})}{c^2}\right] + \frac{2[\boldsymbol{v}''\boldsymbol{c}''][\boldsymbol{uV}]}{c^3v''sin\theta_{c"v"}}. \tag{32}$$

Thus the angle of aberration is equal to $\frac{u'}{c}sin\theta_{c"v"}$ in a first approximation, according to (32), which coincides with the usual expression for the angle of aberration [7]. The dependence of $\Delta\theta$ on the velocitys $\boldsymbol{V}$ and $\boldsymbol{u}$ of the frames K' and K" relatively K appears in the second approximation according to (32).

The magnitude of the Doppler effect in the frame K' also should have been depend on $\boldsymbol{V}$. We consider the general case when source and observer are moving both. We get the transformation of frequency using the transformations (3) and based on the invariance of the phase

$$\nu' = \nu\frac{1 - \frac{\boldsymbol{Vk}}{c}}{\sqrt{1 - V^2/c^2}}, \tag{33}$$

where ν - the frequency in the K, ν' - the frequency in the K', $\boldsymbol{k}$ – unit vector in the direction of the radiation in the frame K. The observed frequency, as follows from the formula (33), is equal

$$\nu_s = \frac{(1 - \boldsymbol{u}_s\boldsymbol{k}/c)\sqrt{1 - u_i^2/c^2}}{(1 - \boldsymbol{u}_i\boldsymbol{k}/c)\sqrt{1 - u_s^2/c^2}}\nu_i, \tag{34}$$

where ν_i - source frequency in the comoving frame, $\boldsymbol{u}_i$ and $\boldsymbol{u}_s$ - the velocitys in the frame K of source and observer, respectively. We will receive turning to the variables of the frame K' in equation (34) by using the transformations (4), (5)

$$\nu_s = \frac{\sqrt{(1 - \boldsymbol{V}\boldsymbol{u}_i'/c^2)^2 - u_i'^2/c^2}\,(1 - \boldsymbol{u}_s'\boldsymbol{k}'/c - \boldsymbol{V}\boldsymbol{u}_s'/c^2)}{(1 - \boldsymbol{u}_i'\boldsymbol{k}'/c - \boldsymbol{V}\boldsymbol{u}_i'/c^2)\sqrt{(1 - \boldsymbol{V}\boldsymbol{u}_s'/c^2)^2 - u_s'^2/c^2}}\nu_i. \tag{35}$$

Consider the experiment [8] for the detection of so-called "ether wind" as an example of the Doppler effect. The source and the absorber of radiation move around the circumference in this experiment, being on opposite ends of its diameter. The radiation comes from the source to the absorber along the chord at an angle to the diameter $\beta \approx \frac{u_i'}{c'}$. In this case

$$\boldsymbol{u}_s'\boldsymbol{k}'/_c = \boldsymbol{u}_i'\boldsymbol{k}'/_c = -\mathrm{u}_i'\sin\beta/_c \sim \frac{u_i'^2}{c^2}, \qquad \boldsymbol{V}\boldsymbol{u}_s'/_{c^2} = -\boldsymbol{V}\boldsymbol{u}_i'/_{c^2} + \frac{Vu_i'}{c^2}\beta\sin\theta_i',$$

where θ_i' - the angle between the vectors $\boldsymbol{V}$ and $\boldsymbol{u}_i'$. We get, by using decomposition in degrees of small parameters $\frac{u_i'}{c}$ and $\frac{V}{c}$ in the expression (35),

$$\frac{\nu_s}{\nu_i} = 1 - \frac{1}{2}\left(\frac{\boldsymbol{V}\boldsymbol{u}_i'}{c^2}\right)^2 - \frac{5u_i'^2\boldsymbol{V}\boldsymbol{u}_i'}{2c^4} - \frac{3u_i'^4}{8c^4}.$$

That is, the relative frequency change is the magnitude of the fourth degree of smallness according to the formula (35). Or, as we can easily see - third degree under the condition if the source and the absorber would be located on a circle at an angle different from zero and π on the magnitude of the order of unity.

We will define the change of temporal intervals at the transition from the frame K' to the frame K" moving relative of K' with a constant velocity $\boldsymbol{u}'$ using the transformation (3). Can be written time transformation in the form

$$t'' = \frac{\sqrt{1 - u^2/c^2}}{\sqrt{1 - V^2/c^2}}t', \tag{36}$$

where $\boldsymbol{u}$ – the velocity vector of the frame K" in the frame К. We get, going in the formula (36) from $\boldsymbol{u}$ to $\boldsymbol{u}'$ by using the transformations (4),

$$t'' = \sqrt{\left(1 - \frac{\boldsymbol{V}\boldsymbol{u}'}{c^2}\right)^2 - \frac{u'^2}{c^2}}\; t'. \tag{37}$$

Achieved very high accuracy when checking of the effect of time dilation in a fast moving frames in experiments with ultrarelativistic decaying particles [9]. Let t'' is the time in the frame K" of disintegration of the motionless in this frame particle. We can imagine the equality (37), using the expression (11) for the energy of the particle, also in the form

$$\frac{t''}{t'} = \frac{mc^2}{\mathcal{E}_0'}\left(1 - \frac{\boldsymbol{V}\boldsymbol{u}'}{c^2}\right). \tag{38}$$

We get, assuming $u' \approx c$ for ultrarelativistic particle,

$$\frac{t''}{t'} = \frac{mc^2}{\mathcal{E}_0'}\left(1 - \frac{V}{c}\cos\theta_u'\right). \tag{39}$$

That is, the effect of the first degree relative to *V/c* should be.

In conclusion we note that the choice of synchronization condition (2), meaning the introduction of a unified simultaneity in the frames K and K', is not consistent to the principle of relativity not only in the field of optics which corresponds to the hypothesis of the existence of luminiferous ether but also in other areas of physics.

We note also, based on the above, that permissible by the conventionalist concept of simultaneity an arbitrariness for selection of value of the synchronization parameter can lead to depending of time on the spatial coordinates. If we believe the correct synchronization (2), we thus believe that Einstein's synchronization introduces in the frame K' the time dependence from the spatial coordinate x' and, thus, recognize that Einstein's synchronization is incorrect. If we believe proper synchronization of Einstein, we must recognize incorrect synchronization (2) through which is introduced a unified simultaneity for frames K and K'. As follows from the above, different physical realities correspond to these both synchronizations. Permissible by the conventionalist concept introduction of a unified simultaneity for all inertial frames is equivalent to the assumption of existence of a physically highlighted frame.

References:

1. Пуанкаре А. Избранные труды А.Пуанкаре, т. 3, Измерение времени. М.: Наука, 1974. – 772 с.
2. Reichenbach H. The philosophy of space and time. New York: Dover Publications, 1958. – 296p.
3. Grunbaum A. Philosophical Problems of Space and Time. Boston.: Reidel, 1973. – 884p.
4. Suvorov S. G. Sov. Phys. Usp., v.22, p.528 (1979).
5. Sjodin T. Nuovo Cimento, v.51b, p.229 (1979).
6. Goldberg S. Amer. J. Phys., v.37, p.982 (1969).
7. Ландау Л. Д., Лифшиц Е. М. Теория поля. М.: Наука, 1988. – 512c.
8. Champney D. C. et al. Phys. Letters, v.7, p.241 (1963).
9. Bailey J. et al. Nature, v.268, p.301 (1977).