Hypothesis

On the Anisotropy of Space in Reference Frames Moving Relative to the CMB

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Abstract: Consideration of physical processes in the reference frame K' moving relative to the CMB, provided that clocks synchronization in this frame ensures the independence of time from spatial coordinates, leads to the conclusion about the existence in the K' of spatial anisotropy which should manifest itself in the dependence of physical effects on the speed vector V of the frame relative to the CMB. Some of these effects in the fields of electrodynamics and optics are considered. In particular, it is shown that weak magnetic fields proportional to the vector V should exist in this frame around motionless electric charges. Experimental verification, according to our assessment, is apparently possible.

Keywords: CMB; spatial anisotropy; clocks synchronization; Tangherlini transformations

1. Introduction

It is known that the Universe and the cosmic microwave background (CMB) are isotropic with a high degree of accuracy [1, 2]. However, in reference frames moving relative to the CMB, according to modern experimental data [2, 3], there should exist the so-called dipole anisotropy of the CMB caused by the motion of the reference frame relative to the CMB and manifested in the Doppler effect for the CMB. Such anisotropy was found in the reference frame associated with the Solar System together with the Galaxy and the local group of galaxies [2, 3], which moves relative to the CMB at the speed $V \approx 627$ km / s [4].

Dipole anisotropy is not anisotropy of space, and its discovery does not imply a rejection of the principle of relativity. Nevertheless, as noted in [5], after the discovery of the dipole anisotropy of the CMB, one of the types of Paralorentz transformations of coordinates – Tangherlini transformations were used in many works instead of Lorentz transformations for the transition from the CMB to reference frames moving relative to it. As shown below, these transformations really need to be applied for such a transition instead of Lorentz transformations, although this means, in our opinion, abandoning the principle of relativity.

The use of Tangherlini transformations assumes that space is isotropic and Einstein's synchronization is carried out in the privileged reference frame K. When clocks are synchronized in the reference frame K', which moves relative to the K at the constant speed V, it is assumed that the speed of light in vacuum in the K' [5 – 8]

$$c'(\theta') = \frac{c}{1 + (V/c)\cos\theta'},\qquad (1)$$

where θ' is the angle between the direction of propagation of light and the vector V. Respectively, when clocks are synchronized in the frame K' by light signals, it must be assumed that the signal propagation time over a distance l' is $l'/c'(\theta')$, but not l'/c, as provided by Einstein's synchronization. This means the existence of spatial anisotropy in the frame K'. But the authors do not assume the possibility of experimental detection of this anisotropy.

We will assume that the reference frame K associated with the CMB, and Einstein's synchronization is carried out there. Cartesian coordinate systems are introduced in the frames K and K'. The x and x' axes are parallel to the vector V.

Tangherlini transformations from the frame K to the frame K' are written as

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

where t is time in the K, t' is time in the K'. As well as Lorentz transformations, they assume Lorentz time dilation and body contraction in the K'. These transformations differ from Lorentz transformations only by the choice of the clocks synchronization condition in the K'. Time τ', corresponding to Einstein's synchronization in the K', is related to time t' by the equality

$$\tau' = t' - \frac{Vx'}{c^2}. \tag{3}$$

However, a change in clocks synchronization can lead to the appearance of a dependence of time on spatial coordinates and to physical results that do not correspond to reality. For example, we will consider the simplest physical processes in an arbitrary inertial reference frame. Assume that synchronization is performed so that time t is independent of spatial coordinate *r*. Let us now turn to time τ which differs from t by clocks synchronization. A change of synchronization is shifts of start of time different for different points of space. Therefore, time τ differs from t by some function $f(\boldsymbol{r})$

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

We suppose that *f(r)* is a linear function. In this case ∇f = const. We introduce the Cartesian coordinate system x, y, z in the considered reference frame so that the x-axis direction coincides with the direction of the vector ∇f. We will consider free rotation of a rigid body around the z-axis. We get for the "angular speed" of rotation $d\varphi/d\tau$ the following formula

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

where φ – the angle measured from the x-axis, r - the distance of the considered point of a rigid body to the z-axis, $\omega = d\varphi/dt$ = const.

We see that the "angular speed" $d\varphi/d\tau$ depends on the angle and the distance from the axis of rotation. If $f(\boldsymbol{r})$ is a non-linear function, then, for example, the "speed" $d\boldsymbol{r}/d\tau$ of a freely moving particle depends on *r*.

Thus, in order for the considered physical quantities to have a real physical meaning, time should not depend on spatial coordinates. Any time transformation must not contradict this requirement. It is obviously that Einstein's synchronization condition in isotropic space satisfies this requirement. In an anisotropic space, the correct choice of the synchronization condition depends on the nature of the anisotropy.

It follows from equality (3) that if time in the K' does not depend on spatial coordinates for one of the considered synchronizations, then it depends on x' for the other. Time t in the frame K does not depend on spatial coordinates due to Einstein's clocks synchronization in the isotropic space of the K. According to transformations (2), time t' at every point in space is proportional to time t with a constant coefficient of proportionality. Consequently, time t' also does not depend on spatial coordinates, and time τ' depends linearly on x'. Therefore, the speed of light in vacuum in the frame K' should indeed be determined by equality (1), which corresponds to the presence of spatial anisotropy in the K'. This anisotropy, as shown below, should manifest itself in physical processes, which makes it possible to detect it experimentally.

2. Transformations of physical quantities

We obtain the transformations of the components of the speed $\boldsymbol{u}$ of a particle from transformations (2)

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

Equations of physical laws have a usual kind in the frame K, where selected Einstein's synchronization condition. We obtain the expression of Lagrange function L' of a charged particle in electromagnetic field in the frame K' writing the equation of the principle of minimal action in the frame K

$$\delta \int_{t_1}^{t_2} \left(-mc^2 \sqrt{1 - \frac{u^2}{c^2}} + \frac{e}{c}\boldsymbol{A}\boldsymbol{u} - e\varphi \right) dt = 0$$

and performing in this equation replacement of variables using transformations (2, 4)

$$L' = -mc^2 \sqrt{(1 - \frac{\boldsymbol{V}\boldsymbol{u}'}{c^2})^2 - \frac{u'^2}{c^2}} + \frac{e}{c}\boldsymbol{A}'\boldsymbol{u}' - e\varphi', \tag{5}$$

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

$$A'_x = A_x\sqrt{1 - V^2/c^2}, \ \ A'_y = A_y, \ \ A'_z = A_z, \ \ \varphi' = \frac{\varphi - \frac{V}{c}A_x}{\sqrt{1 - V^2/c^2}}. \tag{6}$$

The expressions for the generalized momentum $\boldsymbol{P}'$ and energy $\mathcal{E}'$ are written in the form

$$\boldsymbol{P}' = \frac{m[\boldsymbol{u}' + \boldsymbol{V}(1 - \boldsymbol{V}\boldsymbol{u}'/c^2)]}{\sqrt{(1 - \boldsymbol{V}\boldsymbol{u}'/c^2)^2 - u'^2/c^2}} + \frac{e}{c}\boldsymbol{A}', \tag{7}$$

$$\mathcal{E}' = \frac{mc^2(1 - \boldsymbol{V}\boldsymbol{u}'/c^2)}{\sqrt{(1 - \boldsymbol{V}\boldsymbol{u}'/c^2)^2 - u'^2/c^2}} + e\varphi'. \tag{8}$$

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

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

The equation of dynamics can be written considering this equation and expressions (7) and (8)

$$\frac{d}{dt'} \frac{m\boldsymbol{u}'}{\sqrt{(1 - \boldsymbol{V}\boldsymbol{u}'/c^2)^2 - u'^2/c^2}} = \boldsymbol{F}' - \frac{\boldsymbol{V}}{c^2}(\boldsymbol{F}'\boldsymbol{u}'), \tag{9}$$

or

$$\frac{d}{dt'}\left[\frac{\mathcal{E}'_0}{c^2}\left(\boldsymbol{V} + \frac{\boldsymbol{u}'}{1 - \boldsymbol{V}\boldsymbol{u}'/c^2}\right)\right] = \boldsymbol{F}', \tag{10}$$

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

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

the change of variables by using transformations (2), (6). 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

$$x = Vt + \text{const}.$$

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

$$E'_x = E_x, \quad E'_y = \frac{E_y - H_z V/c}{\sqrt{1 - V^2/c^2}}, \quad E'_z = \frac{E_z + H_y V/c}{\sqrt{1 - V^2/c^2}},$$

$$H'_x = H_x, \quad H'_y = H_y\sqrt{1 - V^2/c^2}, \quad H'_z = H_z\sqrt{1 - V^2/c^2}, \tag{11}$$

We obtain the following equations for the frame K' from the second pair of Maxwell's equations, using (2), (11)

$$\text{rot}\boldsymbol{H}' = \left(1 - \frac{V^2}{c^2}\right)\frac{1}{c}\frac{\partial \boldsymbol{E}'}{\partial t'} + \frac{4\pi}{c}\left[\boldsymbol{j}' + \left(\rho' - \frac{\boldsymbol{j}'\boldsymbol{V}}{c^2}\right)\boldsymbol{V}\right] - \frac{\boldsymbol{V}}{c}\frac{\partial \boldsymbol{E}'}{\partial x'} - \frac{1}{c^2}\frac{\partial}{\partial t'}[\boldsymbol{V}\boldsymbol{H}'], \tag{12}$$

$$\text{div}\boldsymbol{E}' = 4\pi\left(\rho' - \frac{\boldsymbol{j}'\boldsymbol{V}}{c^2}\right) - \frac{1}{c^2}\frac{\partial \boldsymbol{E}'\boldsymbol{V}}{\partial t'}, \tag{13}$$

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

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

We obtain such equalities on the basis of transformations (11) and the corresponding transformations of special relativity

$$\boldsymbol{E}'_0 = \boldsymbol{E}', \qquad \boldsymbol{H}'_0 = \boldsymbol{H}' - \frac{1}{c}[\boldsymbol{V}\boldsymbol{E}'], \tag{14}$$

where $\boldsymbol{E}'$ and $\boldsymbol{H}'$ - intensities in the K' of electric and magnetic fields respectively according to (11), $\boldsymbol{E}'_0$ and $\boldsymbol{H}'_0$ - intensities of electric and magnetic fields in the K' under the assumption of isotropy of space in this reference frame according to special relativity.

3. Field of motionless charges

Equalities (14) allow to determine the electric and magnetic fields $\boldsymbol{E}'$ and $\boldsymbol{H}'$ if the values $\boldsymbol{E}'_0$ and $\boldsymbol{H}'_0$ are known. In particular, we have for the field of a motionless point charge in the frame K'

$$\boldsymbol{E}' = \frac{e\boldsymbol{r}'}{r'^3}, \quad \boldsymbol{H}' = \frac{1}{c}[\boldsymbol{V}\boldsymbol{E}']. \tag{15}$$

It follows from equalities (15) that magnetic field should exist in the K' near motionless charges. We cannot consider this field as formal. It can be detected, for example, by action on conductors with electric current. It follows from equation (13) and the equation of continuity that a homogeneous conductor with constant current, motionless in the frame K', contains electric charge with density

$$\rho' = \frac{\boldsymbol{j}'\boldsymbol{V}}{c^2}. \tag{16}$$

The force acts on an element $\mathrm{d}\Omega'$ of such conductor in electric field

$$\mathrm{d}\boldsymbol{F}'_1 = \frac{\boldsymbol{E}'}{c^2}(\boldsymbol{j}'\boldsymbol{V})\mathrm{d}\Omega'. \tag{17}$$

We obtain the expression for the force $\mathrm{d}\boldsymbol{F}'_2$ acting from motionless charges on an element $\mathrm{d}\Omega'$ of a conductor, using (15), (17)

$$\mathrm{d}\boldsymbol{F}'_2 = \frac{\boldsymbol{V}}{c^2}(\boldsymbol{E}'\boldsymbol{j}')\mathrm{d}\Omega'. \tag{18}$$

We write the equation of dynamics for a homogeneous linear conductor of length L, mass m with a constant current $\boldsymbol{I}'$ in uniform field generated by motionless charges. We obtain, substituting expression (18) in equation (9)

$$\frac{\mathrm{d}}{\mathrm{d}t'}\frac{m\boldsymbol{u}'}{\sqrt{(1 - \boldsymbol{V}\boldsymbol{u}'/c^2)^2 - u'^2/c^2}} = \frac{\boldsymbol{V}L}{c^2}(\boldsymbol{E}'\boldsymbol{I}')\left(1 - \frac{\boldsymbol{u}'\boldsymbol{V}}{c^2}\right). \tag{19}$$

It follows from (19), in particular, that an initially motionless conductor should begin to move under action of field with the acceleration

$$\frac{\mathrm{d}\boldsymbol{u}'}{\mathrm{d}t'} = \frac{\boldsymbol{V}L}{mc^2}(\boldsymbol{E}'\boldsymbol{I}').$$

4. Movement of a charge in a magnetic field

We note further that only ordinary magnetic field, independent of $\boldsymbol{V}$, should exist according to equations (12), (13) around homogeneous conductors with constant electric current. It follows from (13) and (16) that equation (12) for magnetic field of a homogeneous conductor with constant electric current must be

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

That is, magnetic field is independent of $\boldsymbol{V}$ in this case. The same result follows from (14).

In addition

$$\mathrm{div}\boldsymbol{E}' = 0,$$

and hence there is no electric field around the conductor.

We consider motion of a charged particle at the initial speed $\boldsymbol{u}'_0$ in the constant and homogeneous magnetic field $\boldsymbol{H}'$ generated by homogeneous conductors with constant electric current and oriented in the z'-axis direction. We perform in equation (9) the replacement of variable

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

and get the equation of motion in the usual form

$$\frac{\mathcal{E}'_0}{c^2}\frac{\mathrm{d}\boldsymbol{u}^*}{\mathrm{d}\tau'} = [\boldsymbol{u}^*\boldsymbol{H}']\,, \tag{20}$$

where

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

The dependence for the particle coordinate $\boldsymbol{r}'(\boldsymbol{r}'_0,\boldsymbol{u}^*_0,\boldsymbol{H}',\tau')$ is the solution of equation (20) with the initial conditions: $\boldsymbol{r}' = \boldsymbol{r}'_0$ and $\boldsymbol{u}^* = \boldsymbol{u}^*_0$. It follows from equation (20) [9]

$$x' = x'_0 + r\sin(\omega\tau' + \zeta),\ \ y' = y'_0 + r\cos(\omega\tau' + \zeta),\ \ z' = z'_0 + \frac{u'_{z0}\tau'}{1 - \boldsymbol{V}\boldsymbol{u}'_0/c^2}\,,$$

where

$$\omega = \frac{ecH'}{\mathcal{E}'_0}\,,\ \ \zeta,\ \ u'_{z0}\,,\ \ r = \frac{\mathcal{E}'_0 u^*_0}{ecH'} = \frac{mcu'_0}{eH'\sqrt{[1-(\boldsymbol{V}\boldsymbol{u}'_0)/c^2]^2 - u'^2_0/c^2}}\,,\ \ u^*_0 = \sqrt{u^{*2}_x + u^{*2}_y}$$

are the constants.

A particle must move along the spiral. The radius r of the spiral should depend on the scalar product $\boldsymbol{V}\boldsymbol{u}'_0$, the drift speed along the z'-axis must be proportional to $1 - \boldsymbol{V}\boldsymbol{u}'/c^2$ and, therefore, should not remain constant, but should oscillate.

5. Doppler effect

We consider the general case when the source and the observer are moving both. We obtain the frequency transformation on the basis of phase invariance using transformations (2)

$$\nu' = \nu\frac{1 - \dfrac{\boldsymbol{V}\boldsymbol{c}}{c^2}}{\sqrt{1 - V^2/c^2}}\,, \tag{21}$$

where ν - the frequency in the K, ν' - the frequency in the K'. The observed frequency by (21)

$$\nu_a$$

$$= \frac{(1 - \boldsymbol{u}_a\boldsymbol{c}/c^2)\sqrt{1 - u^2_s/c^2}}{(1 - \boldsymbol{u}_s\boldsymbol{c}/c^2)\sqrt{1 - u^2_a/c^2}}\nu_s\,, \tag{22}$$

where ν_s - the source frequency in the comoving frame, $\boldsymbol{u}_s$ and $\boldsymbol{u}_a$ - the speeds in the frame K of the source and the observer respectively. We perform the transition in equality (22) to the variables of the K' by means of transformations (4). We obtain for this purpose the transformation of the angle θ between the vectors $\boldsymbol{c}$ and $\boldsymbol{V}$ believing $u = c$ in transformations (4)

$$\cos\theta' = \frac{\cos\theta - V/c}{1 - (V/c)\cos\theta}\,.$$

The inverse transformation

$$\cos\theta = \frac{\cos\theta' + V/c}{1 + (V/c)\cos\theta'}\,,\ \ \sin\theta = \frac{\sin\theta'\sqrt{1 - V^2/c^2}}{1 + (V/c)\cos\theta'}\,. \tag{23}$$

We believe that the y - axis in the frame K is in the same plane with the vectors $\boldsymbol{V}$ and $\boldsymbol{u}_a$. Then we can write using transformations (23)

$$1 - \frac{\boldsymbol{u}_a\boldsymbol{c}}{c^2} = 1 - \frac{u_{ax}}{c}\cos\theta - \frac{u_{ay}}{c}\sin\theta = \frac{1 - V^2/c^2}{1 + \boldsymbol{V}\boldsymbol{c}'/c^2}\left(1 - \frac{\boldsymbol{u}_a'\boldsymbol{c}'}{c^2} - \frac{\boldsymbol{u}_a'\boldsymbol{V}}{c^2}\right). \qquad (24)$$

where $\boldsymbol{u}_a'$ - the speed of the observer in the frame K′. Analogically

$$1 - \frac{\boldsymbol{u}_s\boldsymbol{c}}{c^2} = \frac{1 - V^2/c^2}{1 + \boldsymbol{V}\boldsymbol{c}'/c^2}\left(1 - \frac{\boldsymbol{u}_s'\boldsymbol{c}'}{c^2} - \frac{\boldsymbol{u}_s'\boldsymbol{V}}{c^2}\right). \qquad (25)$$

where $\boldsymbol{u}_s'$ - the speed of the source in the frame K′. We get in addition, turning to the variables of the frame K′

$$\sqrt{1 - u_a^2/c^2} = \sqrt{1 - V^2/c^2}\sqrt{(1 - \frac{\boldsymbol{V}\boldsymbol{u}_a'}{c^2})^2 - \frac{u_a'^2}{c^2}}, \qquad (26)$$

$$\sqrt{1 - u_s^2/c^2} = \sqrt{1 - V^2/c^2}\sqrt{(1 - \frac{\boldsymbol{V}\boldsymbol{u}_s'}{c^2})^2 - \frac{u_s'^2}{c^2}}. \qquad (27)$$

We obtain the formula for the Doppler substituting expressions (24 – 27) into equality (22)

$$\nu_a = \frac{\sqrt{(1 - \boldsymbol{V}\boldsymbol{u}_s'/c^2)^2 - u_s'^2/c^2}\,(1 - \boldsymbol{u}_a'\boldsymbol{c}'/c^2 - \boldsymbol{V}\boldsymbol{u}_a'/c^2)}{(1 - \boldsymbol{u}_s'\boldsymbol{c}'/c^2 - \boldsymbol{V}\boldsymbol{u}_s'/c^2)\sqrt{(1 - \boldsymbol{V}\boldsymbol{u}_a'/c^2)^2 - u_a'^2/c^2}}\,\nu_s. \qquad (28)$$

In the case of the CMB, the source is motionless in the reference frame K. Therefore, by (4)

$$\boldsymbol{u}_s' = -\frac{\boldsymbol{V}}{1 - V^2/c^2},$$

and equality (28) can be written as

$$\nu_a = \frac{\sqrt{1 - V^2/c^2}\,(1 - \boldsymbol{u}_a'\boldsymbol{c}'/c^2 - \boldsymbol{V}\boldsymbol{u}_a'/c^2)}{(1 + \boldsymbol{V}\boldsymbol{c}'/c^2)\sqrt{(1 - \boldsymbol{V}\boldsymbol{u}_a'/c^2)^2 - u_a'^2/c^2}}\,\nu_s. \qquad (29)$$

In addition to the usual Doppler dependence on the direction of radiation, there should be a dependence of the observed frequency on the angle between the vectors $\boldsymbol{V}$ and $\boldsymbol{u}_a'$, which is a manifestation of spatial anisotropy in the K′. But, as follows from (29), this is only a third-order effect with respect to V/c and u_a'/c.

6. Discussion and *conclusions*

All considered effects contradict the principle of relativity and Einstein's clocks synchronization in *the* frame *K′. At present there are no experiments that do not agree with Einstein's synchronization in the K′. However, experiments that contradict Tangherlini transformations are also missing.* As noted in [5], these transformations are widely used currently in different fields of physics and they do not contradict famous experiments to test the principle of relativity.

For example, the modern analogs of Michelson's experiment [10 – 13] were based on the assumption that the total time of propagation of microwave radiation into a resonator in the forward and reverse directions should vary depending on the orientation of the resonator. But it follows from formula (3) that $t' = \tau'$ independently of the orientation if the radiation passes along a closed circuit.

It follows from equality (28) that manifestation of spatial anisotropy in the Doppler effect - a quantity of third or higher order. Its detection, in principle, would be possible, for example, in experiment [14], where the source and absorber move in a circle at opposite ends of the diameter. Their linear speed is determined from the angular speed of rotation of the installation. But obtaining the result would require very high speed. When performing this experiment, it was assumed that this is a second-order effect and the speed is sufficient to detect it. Since the radiation in this experiment comes from the source to the absorber along the chord at a small angle to the diameter $\beta \approx u_a'/c$, then

$$\frac{\boldsymbol{u}_s'\boldsymbol{c}'}{c^2} = \frac{\boldsymbol{u}_a'\boldsymbol{c}'}{c^2} \approx -\frac{u_s'^2}{c^2}$$

and according to (28) this is an effect of the order of $\frac{u_s'^3 V}{c^4}$.

The Doppler shift of the emission frequency of fast moving particles was measured in the Ives - Stilwell experiment and in its modern analogs [16, 17]. In these experiments, it is possible to control only the energy of the particles passing the certain potential difference, and determine the speed as a function of energy. For this case, equality (28) at $\boldsymbol{u}_a' = 0$ can be written using formula (8) for energy, in such form

$$\nu_a = \frac{mc^2}{\mathcal{E}_0'(1 - \frac{u_s^*}{c}\cos\psi')}\nu_s \,, \tag{30}$$

where ψ' is the angle between the vectors $\boldsymbol{u}_s'$ and $\boldsymbol{c}'$, and

$$u_s^* = \frac{u_s'}{1 - \frac{\boldsymbol{V}\boldsymbol{u}_s'}{c^2}} \cdot$$

The formula for the kinetic energy of a particle can be written in the form

$$\mathcal{E}_0' = \frac{mc^2}{\sqrt{1 - u_s^{*2}/c^2}} \cdot$$

If we express hence u_s^* via the energy $\mathcal{E}_0'$ and substitute this expression in (30), then we get

$$\nu_a$$

$$= \frac{mc^2}{\mathcal{E}_0' - \cos\psi'\sqrt{\mathcal{E}_0'^2 - m^2 c^4}}\nu_s \,.$$

The same dependence is valid in the isotropic space of the frame K. Consequently, the deviation from the Lorentz formula of time dilation in the frame K' is absent in these experiments and could not be detected despite very high accuracy of experiments [16, 17].

It is assumed in the experiment the possibility of the existence of the privileged reference frame in which light in free space propagates with a constant speed c rectilinearly and isotropically. It is also assumed that time t' in the frame moving at the speed V relative of the privileged frame is related with time t in the privileged frame by the transformation

$$t' = bt + \frac{\boldsymbol{\epsilon r}}{c} \,, \tag{31}$$

where b is the function of V^2, $\boldsymbol{\epsilon}$ is the vector depending on V, which determines the synchronization of the clock in the moving frame. Transformation (31) generalizes Lorentz transformation for time taking into account the possibility of deviation from the special relativity. The dependence of b on V^2 was presented in the form

$$b = 1 + (\alpha - 1/2)\frac{V^2}{c^2} + O\left(\frac{V^4}{c^4}\right) \,,$$

where α is the so-called Robertson-Mansouri-Sexl parameter characterizing deviation from Lorentz formula of time dilation. It was established in the experiment that $|\alpha| \leq 1.1 \times 10^{-8}$.

This experiment confirms with high accuracy value of the coefficient $b = \sqrt{1 - V^2/c^2}$ in transformation (31) and the coefficient of proportionality for time transformation in (2). But in this case, there is not any conclusion about the value of the coefficient $\boldsymbol{\epsilon}$ in transformation (31) which, according to transformations (2), must equal zero which ensures the independence of time in the frame K' from spatial coordinates.

An experimental verification of the above described effect of the existence in the *frame* K' near motionless electric charges of weak magnetic fields proportional to the speed V, is apparently possible. If we assume $V = 627$ km/s, according to [4], then H' field, according to (15), should reach the magnitude of approximately 0.7×10^{-2} Oe at the electrostatic field $E' = 10^5$ V/m, if E' is perpendicular to V. This is 1.4% of the mean magnitude of the Earth's magnetic field equal to 0.5 Oe.

This test or other possible experiments to test Tangherlini transformations can validate the existence of spatial anisotropy, but not only anisotropy of the CMB, in reference frames moving relative to the CMB. Given that time t' in these transformations does not depend on spatial coordinates, it can be expected that such experiments should give a positive result.

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