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Mende Transformations in the Concept of Scalar-Vector Potential

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Strictly as per the compliance and regulations of:

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I. Introduction

The special theory of relativity (STR) was developed by Albert Einstein in 1905. Its basis are the postulates, one of which (the so-called second postulate) says, that the speed of set is invariant, i.e., it does not depend on observation system. This means that under no circumstances the speed of light cannot exceed its standard value, which in the vacuum is equal 299 792 458 ± 1,2 m/s (it is rounded 300000 km / s). Second postulate STR contradicts the common sense, since the speed is a value relative. Passenger, edushchiy in the railroad car of train, with respect to the railroad car is fixed, whereas according to the relation to the station buildings he moves with the speed of train. In STR this not thus. If inside the railroad car light beam moves with the standard speed, then with respect to the station buildings it moves with the same speed.

From the moment of creation STR were carried out the numerous experiments, in which the experimenters attempted to prove the inaccuracy of the second postulate. For this they used radiation sources, which moved with respect to the observation system with the given speed, but, values of the speed of light in the observation system obtained in such experiments always proved to be equal to the standard value of the speed of light [1-9].

Such experiments in the diverse variants were carried out and outstanding scientific Michaelson, with the aid of the invented by it interferometer, but also these experiments also ended by failure.

Michelson interferometer was invented by American physicist by Albert Abrakhamom by Michaelson at the beginning of past century. A number of important scientific and applied problems was solved with the aid of this interferometer, the speed of light was in particular with the high accuracy measured. However, in the experiments, carried out by Michaelson, that are concerned checking second postulate STR, were significant errors. It completed these errors, then it attempted to prove that the speed of electromagnetic (EM) wave is added to the speed of its source, which would contradict the second postulate. Michaelson considered to the end of his life that there is an elastic medium (ether), in which are extended EM of wave. Therefore the results of the experiments, which it conducted together with Morley [10] for the detection of this medium, were for it large unexpected contingency, since ether was not discovered. Attempting to improve experiment, it attempted as the radiation source to use light of star, but it it here awaited still large failure. Studies showed that the measured speed of light, does not depend on the speed of star and is equal to the previously measured by it standard value.

In the works [11,12] it is shown that for similar studies the Michelson interferometer is unfit, with which and were connected its errors. And only after the invention of interferometer with the mechanical division of ray became possible the correct checking of the second postulate of STR [11]. The results of this checking are represented in the work [12], which they showed that the speed of light is added to the rate of radiation source, which corresponds to the conversions of Galileo, but not to the conversions of Lorenz. But if this then the conversions of Lorenz are erroneous, then should be searched for them replacement. To this question is dedicated the proposed article.

II. Mende Transformations in the Concept of Scalar-Vector Potential

Let us explain for the solution of the problem presented, what dynamic potentials and fields generate the moving charges. The first step, demonstrated in the works [13-15], was made in this direction a way of the introduction of the symmetrical laws of magnetoelectric and electromagnetic induction. They are written in the following form [16-20]:

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$$\int \mathbf{E}'dl' = -\int \frac{\partial \mathbf{B}}{\partial t} d\mathbf{s} + \int [\mathbf{v} \times \mathbf{B}] dl'$$
$$\int \mathbf{H}'dl' = \int \frac{\partial \mathbf{D}}{\partial t} d\mathbf{s} - \int [\mathbf{v} \times \mathbf{D}] dl' \quad (2.1)$$

or

$$rot\mathbf{E}' = -\frac{\partial \mathbf{B}}{\partial t} + rot[\mathbf{v} \times \mathbf{B}]$$
$$rot\mathbf{H}' = \frac{\partial \mathbf{D}}{dt} - rot[\mathbf{v} \times \mathbf{D}] \quad (2.2)$$

For the constants fields on these relationships they take the form:

$$\mathbf{E}' = [\mathbf{v} \times \mathbf{B}]$$
$$\mathbf{H}' = -[\mathbf{v} \times \mathbf{D}] \quad (2.3)$$

In relationships (2.1)-(2.3), which assume the validity of the Galileo conversions, prime and not prime values present fields and elements in moving and fixed IRS respectively.

The relationships (2.1)-(2.3), which present the laws of induction, do not give information about how arose fields in initial fixed IRS. They describe only laws governing the propagation and conversion fields on in the case of motion with respect to the already existing fields.

The relationship (2.3) attest to the fact that in the case of relative motion of frame of references, between the fields $\mathbf{E}$ and $\mathbf{H}$ there is a cross coupling, i.e., motion in the fields $\mathbf{H}$ leads to the appearance fields on $\mathbf{E}$ and vice versa. From these relationships escape the additional consequences, which were for the first time examined in the work [13,15, 21].

If the charged rod has a linear charge g, its electric field $E = \frac{g}{2\pi\varepsilon r}$ decreases according to the law $\frac{1}{r}$, where r isdistance from the central axis of the rod to the observation point. If we in parallel to the axis of rod in the field E begin to move with the speed Δv another IRS, then in it will appear the additional magnetic field $\Delta H = \varepsilon E \Delta v$. If we now with respect to already moving IRS begin to move third frame of reference with the speed Δv, then already due to the motion in the field ΔH will appear additive to the electric field $\Delta E = \mu\varepsilon E (\Delta v)^2$. This process can be continued and further, as a result of which can be obtained the number, which gives the value of the electric field $E'_v(r)$ in moving IRS with reaching of the speed $v = n\Delta v$, when $\Delta v \to 0$, and $n \to \infty$. In the final analysis in moving IRS the value of dynamic electric field will prove to be more than in the initial and to be determined by the relationship:

$$E'(r, v_\perp) = \frac{gch\frac{v_\perp}{c}}{2\pi\varepsilon r} = Ech\frac{v_\perp}{c}.$$

If speech goes about the electric field of the single charge e, then its electric field will be determined by the relationship:

$$E'(r, v_\perp) = \frac{ech\frac{v_\perp}{c}}{4\pi\varepsilon r^2},$$

where $v_\perp$ - normal component of charge rate to the vector, which connects the moving charge and observation point.

Expression for the scalar potential, created by the moving charge, for this case will be written down as follows:

$$\varphi'(r, v_\perp) = \frac{ech\frac{v_\perp}{c}}{4\pi\varepsilon r} = \varphi(r)ch\frac{v_\perp}{c}, \quad (2.4)$$

where $\varphi(r)$- scalar potential of fixed charge. The potential $\varphi'(r, v_\perp)$ can be named scalar-vector, since it depends not only on the absolute value of charge, but also on speed and direction of its motion with respect to the observation point. Maximum value this potential has in the direction normal to the motion of charge itself. Moreover, if charge rate changes, which is connected with its acceleration, then can be calculated the electric fields, induced by the accelerated charge.

During the motion in the magnetic field, using the already examined method, we obtain:

$$H'(v_\perp) = Hch\frac{v_\perp}{c}.$$

where $v_\perp$ - speed normal to the direction of the magnetic field.The same result can be obtained by another method.

Let us designate field variables in the fixed frame of reference without the prime, and in the mobile – with the prime.In the differential form let us write down the formulas of the mutual induction of electrical and magnetic fields on in the mobile frame of reference as follows:

$$dH' = \varepsilon E' dv_\perp, \quad (2.5)$$

$$dE' = \mu H' dv_\perp. \quad (2.6)$$

Or otherwise,

$$\frac{dH'}{dv_\perp} = \varepsilon E', \qquad (2.7)$$

$$\frac{dE'}{dv_\perp} = \mu H', \qquad (2.8)$$

where (2.7) it corresponds (2.5), and (2.8) it corresponds (2.6).

After dividing equations (2.7) and (2.8) on E and H, we will obtain respectively:

$$\frac{d(H'/E)}{dv_\perp} = \varepsilon \frac{E'}{E}, \qquad (2.9)$$

$$\frac{d(E'/E)}{dv_\perp} = \mu \frac{H'}{H}. \qquad (2.10)$$

Differentiating both parts (2.10), we have:

$$\frac{d^2(E'/E)}{d^2 v_\perp} = \mu \frac{d(H'/E)}{dv_\perp}. \qquad (2.11)$$

After substituting (2.9) in (2.11), we will obtain:

$$\frac{d^2(E'/E)}{d^2 v_\perp} = \mu\varepsilon \frac{E'}{E}. \qquad (2.12)$$

The function is the general solution (2.12) of differential equation

$$\frac{E'}{E} = C_2 ch\left(\frac{v_\perp}{c}\right) + C_1 sh\left(\frac{v_\perp}{c}\right), \qquad (2.13)$$

where c – the speed of light, C_1, C_2 – arbitrary constants.

Since with $v_\perp = 0$ must be made $E' = E$, that from (2.13) we will obtain:

$$C_2 = 1. \qquad (2.14)$$

After substituting (2.14) in (2.13), we finally have the general solution, into which enters one arbitrary constant C_1:

$$\frac{E'}{E} = ch\left(\frac{v_\perp}{c}\right) + C_1 sh\left(\frac{v_\perp}{c}\right).$$

Selecting $C_1 = 0$, we obtain

$$E' = Ech\left(\frac{v_\perp}{c}\right).$$

If we apply the obtained results to the electromagnetic wave and to designate components fields on parallel speeds IRS as $E_\uparrow$, $H_\uparrow$, and $E_\perp$, $H_\perp$ as components normal to it, then conversions fields on they will be written down [1-3, 9]:

$$\begin{aligned}
\mathbf{E}'_\uparrow &= \mathbf{E}_\uparrow, \\
\mathbf{E}'_\perp &= \mathbf{E}_\perp ch\frac{v}{c} + \frac{Z_0}{v}[\mathbf{v}\times\mathbf{H}_\perp] sh\frac{v}{c}, \\
\mathbf{H}'_\uparrow &= \mathbf{H}_\uparrow, \\
\mathbf{H}'_\perp &= \mathbf{H}_\perp ch\frac{v}{c} - \frac{1}{vZ_0}[\mathbf{v}\times\mathbf{E}_\perp] sh\frac{v}{c},
\end{aligned} \qquad (2.15)$$

where $Z_0 = \sqrt{\frac{\mu_0}{\varepsilon_0}}$ - impedance of free space, $c = \sqrt{\frac{1}{\mu_0\varepsilon_0}}$ - speed of light. Let us name conversions (2.2) the Mende transformation.

We derive them in the matrix form [22, 23] and show that the form of the transformations is determined by the law of addition of velocities (classical or relativistic).

Let us examine the totality IRS of such, that IRS K_1moves with the speed Δv relative to IRSK, IRS K_2moves with the same speed Δv relative to K_1, etc. If the module of the speed Δv is small (in compare IRSn with the speed of light s), then for the transverse components fields on in IRSK_1K_2,. . . we have:

$$\begin{aligned}
\mathbf{E}_{1\perp} &= \mathbf{E}_\perp + \Delta\mathbf{v}\times\mathbf{B}_\perp & \mathbf{B}_{1\perp} &= \mathbf{B}_\perp - \Delta\mathbf{v}\times\mathbf{E}_\perp / c^2 \\
\mathbf{E}_{2\perp} &= \mathbf{E}_{1\perp} + \Delta\mathbf{v}\times\mathbf{B}_{1\perp} & \mathbf{B}_{2\perp} &= \mathbf{B}_{1\perp} - \Delta\mathbf{v}\times\mathbf{E}_{1\perp} / c^2.
\end{aligned} \qquad (2.16)$$

Upon transfer to each following IRS of field are obtained increases in $\Delta\mathbf{E}$ and $\Delta\mathbf{B}$

$$\Delta\mathbf{E} = \Delta\mathbf{v}\times\mathbf{B}_\perp, \qquad \Delta\mathbf{B} = -\Delta\mathbf{v}\times\mathbf{E}_\perp / c^2, \qquad (2.17)$$

where the fields $\mathbf{E}_\perp$ and $\mathbf{B}_\perp$ relate to current IRS. Directing the Cartesian axis x along $\Delta\mathbf{v}$, let us rewrite (2.17) in the components of the vector

$$\Delta E_y = -B_z \Delta v, \qquad \Delta E = B_y \Delta v, \qquad \Delta B_y = E_z \Delta v / c^2. \qquad (2.18)$$

Relationship (2.18) can be represented in the matrix form

$$\Delta U = AU\Delta v \qquad \begin{pmatrix} 0 & 0 & 0 & -1 \\ 0 & 0 & 1 & 0 \\ 0 & 1/c^2 & 0 & 1 \\ -1/c^2 & 0 & 0 & 0 \end{pmatrix} \qquad U = \begin{pmatrix} E_y \\ E_z \\ B_y \\ B_z \end{pmatrix}$$

If one assumes that the speed of system is summarized for the classical law of addition of velocities, i.e., the speed of final IRS $K' = K_N$ relative to the initial K is $v = N\Delta v$, then we will obtain the matrix system of the differential equations

$$\frac{dU(v)}{dv} = AU(v), \qquad (2.19)$$

with the matrix of the system v independent of the speed A. The solution of system is expressed as the matrix exponential curve $\exp(vA)$:

$$U' \equiv U(v) = \exp(vA)U, \qquad U = U(0), \quad (2.20)$$

here U - matrix column fields on in the system K, and U' - matrix column fields on in the system K'.

Substituting (2.20) in the system (2.19), we are convinced, what U' is actually the solution of the system (2.19):

$$\frac{dU(v)}{dv} = \frac{d[\exp(vA)]}{dv}U = A\exp(vA)U = AU(v)$$

It remains to find this exponential curve by its expansion in the series:

$$\exp(va) = E + vA + \frac{1}{2!}v^2A^2 + \frac{1}{3!}v^3A^3 + \frac{1}{4!}v^4A^4 + ...$$

where E - unit matrix with the size 4×4. For this it is convenient to write down the matrix A in the unit type form

$$A = \begin{pmatrix} 0 & -\alpha \\ \alpha/c^2 & 0 \end{pmatrix}, \qquad \alpha = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}, \qquad 0 = \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}.$$

Then

$$A^2 = \begin{pmatrix} -\alpha^2/c^2 & 0 \\ 0 & -\alpha/c^2 \end{pmatrix}, \qquad A^3 = \begin{pmatrix} 0 & \alpha^3/c^2 \\ -\alpha^3/c^4 & 0 \end{pmatrix},$$

$$A^4 = \begin{pmatrix} \alpha^4/c^4 & 0 \\ 0 & \alpha^4/c^4 \end{pmatrix}, \qquad A^5 = \begin{pmatrix} 0 & -\alpha^5/c^4 \\ \alpha^5/c^6 & 0 \end{pmatrix}$$

And the elements of matrix exponential curve take the form

$$[\exp(vA)]_{11} = [\exp(vA)]_{22} = I - \frac{v^2}{2!c^2} + \frac{v^4}{4!c^4} - ....,$$

$$[\exp(vA)]_{21} = -c^2[\exp(vA)]_{12} = \frac{\alpha}{c}\left(\frac{v}{c}I - \frac{v^3}{3!c^3} + \frac{v^5}{5!c^5} - .....\right),$$

where I - the unit matrix 2×2. It is not difficult to see that $-\alpha^2 = \alpha^4 = -\alpha^6 = \alpha^8 = ... = I$; therefore we finally obtain

$$\exp(vA)=\begin{pmatrix} Ich\ v/c & -c\alpha sh\ v/c \\ \left(\alpha sh\ v/c\right)/c & Ich\ v/c \end{pmatrix}=$$

$$\begin{pmatrix} ch\ v/c & 0 & 0 & -csh\ v/c \\ 0 & ch\ v/c & csh\ v/c & 0 \\ 0 & \left(ch\ v/c\right)/c & ch\ v/c & 0 \\ -\left(sh\ v/c\right)/c & 0 & 0 & ch\ v/c \end{pmatrix}.$$

Now we return to (2.20) and substituting there $\exp(vA)$, we find

$$E'_y=E_y ch\ v/c-cB_z sh\ v/c, \qquad E'_z=E_z ch\ v/c+cB_y sh\ v/c,$$
$$B'_y=B_y ch\ v/c+\left(E_z/c\right)sh\ v/c, \quad B'_z=B_z ch\ v/c-\left(E_y/c\right)sh\ v/c$$

Or in the vector record

$$\mathbf{E}'_\perp=\mathbf{E}_\perp ch\ \frac{v}{c}+\frac{v}{c}\mathbf{v}\times\mathbf{B}_\perp sh\frac{v}{c},$$
$$\mathbf{B}'_\perp=\mathbf{B}_\perp ch\ \frac{v}{c}-\frac{1}{vc}\mathbf{v}\times\mathbf{E}_\perp sh\frac{v}{c} \qquad (2.21)$$

This is Mende transformation (2.15).

Appears a regular question; therefore they are differed from the appropriate conversions fields on in the classical electrodynamics, indeed in it with the low speeds $\Delta\vec{v}$ occur initial relationships (2.16) and (2.17). The fact is that according to the relativistic law of addition of velocities, are added not speeds, but rapidities (https://ru.wikipedia.org/wiki/ Быстрота). According to definition the rapidity is introduced as

$$\theta=c\ arth\frac{v}{c}. \qquad (2.22)$$

Precisely, if the rapidity of the systems K_1 and K, K_2 and K_1, K_3 and K_2, etc., they are distinguished to $\Delta\theta$, then rapidity the rapidity IRS $K'=K_N$ relative to K is $\theta=N\Delta\theta$. With the low speeds $\Delta\theta\cong\Delta v$. Therefore formula (2.17) it is possible to write down so

$$\Delta\mathbf{E}=\Delta\theta\times\mathbf{B}_\perp, \qquad \Delta\mathbf{B}=-\Delta\boldsymbol{\theta}\times\mathbf{E}_\perp/c^2,$$

where $\boldsymbol{\theta}=\theta\frac{\mathbf{v}}{v}$. System (2.19) taking into account the additivity of rapidity, but not speed, it is substituted by the system of equations

$$\frac{dU(\theta)}{d\theta}=AU(\theta).$$

Thus, all computations will be analogous given above, only with the difference that in the expressions instead of the speeds will figure rapidity. In particular formulas (2.21) take the form

$$\mathbf{E}'_\perp=\mathbf{E}_\perp ch\ \frac{\theta}{c}+\frac{\theta}{c}\boldsymbol{\theta}\times\mathbf{B}_\perp sh\frac{\theta}{c},$$
$$\mathbf{B}'_\perp=\mathbf{B}_\perp ch\ \frac{\theta}{c}-\frac{1}{\theta c}\boldsymbol{\theta}\times\mathbf{E}_\perp sh\frac{\theta}{c},$$

or

$$\mathbf{E}'_\perp=\mathbf{E}_\perp ch\ \frac{\theta}{c}+\frac{v}{c}\mathbf{v}\times\mathbf{B}_\perp sh\frac{\theta}{c},$$
$$\mathbf{B}'_\perp=\mathbf{B}_\perp ch\ \frac{\theta}{c}-\frac{1}{vc}\mathbf{v}\times\mathbf{E}_\perp sh\frac{\theta}{c}, \qquad (2.23)$$

Since

$$ch\frac{\theta}{c}=\frac{1}{\sqrt{1-th^2\left(\theta/c\right)}}, \qquad sh\frac{\theta}{c}=\frac{th\left(\theta/c\right)}{\sqrt{1-th^2\left(\theta/c\right)}} ,$$

That substitution (2.22) in (2.23) leads to the well-known conversions fields on

$$\mathbf{E}'_{\perp}=\frac{1}{\sqrt{1-v^2/c^2}}\left(\mathbf{E}_{\perp}+\mathbf{v}\times\mathbf{B}_{\perp}\right)$$
$$\mathbf{B}'_{\perp}=\frac{1}{\sqrt{1-v^2/c^2}}\left(\mathbf{B}_{\perp}-\frac{1}{c^2}\mathbf{v}\times\mathbf{E}_{\perp}\right) , \quad (2.24)$$

with the small relative conversion rates (2.21) and (2.24) differ, beginning from the terms of the expansion of the order v^2/c^2.

We show how to use therelationships (2.2) it is possible to explain the phenomenon of phase aberration, which did not have within the framework existing classical electrodynamics of explanations. We will consider that there are components of the plane wave H_z, E_x, which is extended in the direction y, and primed system moves in the direction of the axis x with the speed v_x. Then components fields on in the prime coordinate system in accordance with relationships (2.2) they will be written down:

$$E'_x=E_x,$$

$$E'_y=H_z sh\frac{v_x}{c},$$

$$H'_z=H_z ch\frac{v_x}{c}.$$

Thus, is a heterogeneous wave, which has in the direction of propagation the component E'_y.
Let us write down the summary field E' in moving IRS:

$$E'=\left[\left(E'_x\right)^2+\left(E'_y\right)^2\right]^{\frac{1}{2}}=E_x ch\frac{v_x}{c}. \quad (2.25)$$

If the vector $\mathbf{H}'$ is as before orthogonal the axis y, then the vector $\mathbf{E}'$ is now inclined toward it to the angle α, determined by the relationship:

$$\alpha\cong sh\frac{v}{c}\cong\frac{v}{c} . \quad (2.26)$$

This is phase aberration. Specifically, to this angle to be necessary to incline telescope in the direction of the motion of the Earth around the sun in order to observe stars, which are located in the zenith.

The Pointing vector is now also directed no longer along the axis y, but being located in the plane xy, it is inclined toward the axis y to the angle, determined by relationships (2.26). However, the relation of the absolute values of the vectors $\mathbf{E}'$, $\mathbf{H}'$ in both systems they remained identical. However, the absolute value of the very vector of Pointing increased. Thus, even transverse motion of inertial system with respect to the direction of propagation of wave increases its energy in the moving system. This phenomenon is understandable from a physical point of view. It is possible to give an example with the rain drops. When they fall vertically, then is energy in them one. But in the inertial system, which is moved normal to the vector of their of speed, to this speed the velocity vector of inertial system is added. In this case the absolute value of the speed of drops in the inertial system will be equal to square root of the sum of the squares of the speeds indicated. The same result gives to us relationship (2.25).

Is not difficult to show that, if we the polarization of electromagnetic wave change ourselves, then result will remain before. Conversions with respect to the vectors $\mathbf{E}$, $\mathbf{H}$ are completely symmetrical, only difference will be the fact that to now comes out the wave, which has to appear addition in the direction of propagation in the component H'_y.

Such waves have in the direction of its propagation additional of the vector of electrical or magnetic field, and in this they are similar E, H of the waves, which are extended in the waveguides. In this case appears the uncommon wave, whose phase front is inclined toward the Pointing vector to the angle, determined by relationship (2.26). In fact obtained wave is the superposition of plane wave with the phase speed $c=\sqrt{\frac{1}{\mu\varepsilon}}$ and additional wave of plane wave with the infinite phase speed orthogonal to the direction of propagation.

Let us examine one additional case, when the direction of the speed of the moving system coincides with the direction of propagation of electromagnetic wave. We will consider that there are components of the plane wave E_x, H_z, and also component of the speed $\pm v_y$. Taking into account that in this case is fulfilled the relationship $E_x=\pm Z_0 H_z$, we obtain:

$$E_x{}' = E_x\left(ch\frac{v_y}{c} - sh\frac{v_y}{c}\right) = E_x \exp\left(\mp\frac{v_y}{c}\right),$$

$$H_z{}' = H_z\left(ch\frac{v_y}{c} - sh\frac{v_y}{c}\right) = H_z \exp\left(\mp\frac{v_y}{c}\right).$$

I.e. amplitudes fields on exponentially they diminish or they grow depending on direction of motion.

The wave of the strength of an electrical (or magnetic) field of the type satisfies wave equation

$$E(t,y) = E_0 \sin(\omega t - ky),$$

where $k = \frac{2\pi}{\lambda}$ - wave number.

Upon transfer into the inertial system, which moves with the speed $\pm v_y$, is observed Doppler frequency shift.

The transverse Doppler effect, who long ago is discussed sufficiently, until now, did not find its confident experimental confirmation. For observing the star from moving IRS it is necessary to incline telescope on the motion of motion to the angle, determined by relationship (2.26). But in this case the star, observed with the aid of the telescope in the zenith, will be in actuality located several behind the visible position with respect to the direction of motion. Its angular displacement from the visible position in this case will be determined by relationship (2.26). But this means that this star with respect to the observer has radial it sped, determined by the relationship

$$v_r = v \sin\alpha.$$

Since for the low values of the angles $\sin\alpha \cong \alpha$, and $\alpha = \frac{v}{c}$, Doppler frequency shift will compose

$$\omega_{d\perp} = \omega_0 \frac{v^2}{c^2}. \tag{2.27}$$

This result numerically coincides with results SR, but it is fundamentally different from it results in that the SR deemed that the transverse Doppler effect, defined by (2.27) actually exists, where as in this case it is only an apparent effect.

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III. Conclusion

In the article, field transformations are obtained in the transition from one ISO to another. In contrast to the Lorentz transformations, the basis of such transformations are Galileo transformations and symmetric induction laws. In this case, complete derivatives that take into account their convective part are used. This made it possible to explain the phenomenon of phase aberration of light and to find out the causes of the transverse Doppler effect, which is only an apparent effect.

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