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NEUTRALITY OF THE LORENTZ TRANSFORMATIONS IN SRT

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Abstract: The Special Theory of Relativity (SRT), gives us two results, the dilation of time and the contraction of the Length, which have been refuted by many scientists. The solution to these kinematical effects has driven researchers to develop new methods. One of these methods is using the physical law equations and apply the principle of relativity to them. With this approach, we reformulated the SRT in a simple manner which has dynamical applications without using the Lorentz transformations (LT) and its kinematical effects. We obtained the results which require the invariant of Maxwell's field equations under the LT in a way different to that of Einstein. In the present paper, we get the LT from the Lorentz force. In contrast to Einstein's LT with its kinematical effects, the LT produced in this paper is simply a neutral transformation, containing no physical significance, i.e. LT and its kinematical effects do not explain any physical phenomenon.
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Keywords: Special Relativity Theory, Lorentz Transformation

Introduction

At end of the sixteenth century, Galileo's experiments showed that motion must be relative, in contrast to the accepted view. These experiments led him also to state what is now called the principle of Galilean relativity (the laws of mechanics are the same for a body at rest and a body moving at constant velocity). Newton also developed his laws of motion and his concept of relativity (the laws of mechanics must be the same in all inertial frames). Due to Galileo and Newton, the concept of absolute space became redundant, but absolute time was retained. The development of the electromagnetic (EM) theory in the nineteenth century demonstrated a problem with Newtonian relativity. It seemed inconceivable to physicists that EM waves could propagate without a medium (the ether). But as a consequence of Newtonian relativity, an observer moving through the ether with velocity u would measure the velocity of a light beam as (c + u). The Michelson-Morley experiment showed that no ether (absolute reference frame) existed for electromagnetic phenomena. This result opened the way for a new approach. Einstein's relativity [1] postulated that the speed of light is invariant in all inertial frames, which mathematically led to a new relationship between space and time i.e. the Lorentz transformation (LT). To remove the contradiction concerning the symmetrical properties of space-time between classical mechanics and electrodynamics, Einstein altered classical mechanics to make it compatible with LT. Einstein's method [1] in deriving LT contained the invariance of light speed, which was not included in the Galilean transformation. He considered the Cartesian points in the frame S to be the same in the frame S' providing that we maintain the constancy of light speed for the movement of this point in both frames. Then a particle with rest mass m_0 was replaced with the engineering point, and SRT succeeded in applying the principle of mass-energy equivalence

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to the moving particle (although this principle was earlier restricted to the electromagnetic field). By Einstein's method in deriving LT, LT remained no more neutral and several questions arise when examining Einstein's LT and its kinematical effects as well as many contradictions exist [2,3,4,5,6]. Moreover, SRT and particle dynamics are incompatible, since the dynamics of a moving particle are revised to accommodate LT. The incompatibility between SRT and particle dynamics arises because LT and its kinematical effects have primacy over the physical law in deriving the relativistic dynamical quantities and in the interpretation of relativistic phenomena. This incompatibility could be removed in the earlier works [7,8,9,10,11,12], which began with the following postulates, physical laws and the relativity principle.

Methods and Results

The Maxwell's Field Equations in frame (S) may be expressed as

$$\nabla \mathbf{E} = \frac{\rho}{\varepsilon_0} \text{ (a); } \nabla \times \mathbf{B} = \frac{1}{c^2}\frac{\partial \mathbf{E}}{\partial t} + \mu_0 \mathbf{J} \text{ (b)} \quad (1)$$

$$\text{(c); } \nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t} \text{ (d)}$$

In our earlier work [9], our intention was to derive the relativistic transformation of the electromagnetic field as well as the relativistic transformation of the charge and current density without using LT. In a source-free space

$$\nabla \mathbf{E} = 0 \quad \text{(a)} \; ; \; \nabla \times \mathbf{B} = \frac{1}{c^2}\frac{\partial \mathbf{E}}{\partial t} \text{ (b)} \quad (2)$$

$$\nabla \mathbf{B} = 0 \quad \text{(c)} \; ; \; \nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t} \text{ (d)}$$

by following the same reason as used in [9], we can now derive relativistic transformation of the electromagnetic field as

$$B'_x = B_x$$

$$\begin{matrix} B'_y = \gamma\left(B_y + \dfrac{u}{c^2}E_z\right) \\ B'_z = \gamma\left(B_z - \dfrac{u}{c^2}E_y\right) \end{matrix} , \quad \begin{matrix} E'_x = E_x \\ E'_y = \gamma\left(E_y - u\,B_z\right) \\ E'_z = \gamma\left(E_z + u\,B_y\right) \end{matrix} \quad \dots \quad (3)$$

In addition, we get Lorentz transformation relations

$$\frac{\partial}{\partial t'} = \gamma\left(\frac{\partial}{\partial t} + u\frac{\partial}{\partial x}\right), \quad \frac{\partial}{\partial y'} = \frac{\partial}{\partial y} \quad , \quad \frac{\partial}{\partial z'} = \frac{\partial}{\partial z} ,:$$

$$\frac{\partial}{\partial x'} = \gamma\left(\frac{\partial}{\partial x} + \frac{u}{c^2}\frac{\partial}{\partial t}\right) \quad (4)$$

It is known that the 3-vector for the electromagnetic field $\vec{E}$, $\vec{B}$ is represented by the scalar and vector potential φ, $\vec{A}$ as follows.

$$\vec{B} = rot\ \vec{A} \quad , \quad \vec{E} = -\vec{\nabla}\varphi - \frac{\partial \vec{A}}{\partial t} \quad (5)$$

Eqs.(5) define a second rank tensor $F_{\nu\mu}$, if we write it in 4-dimensional vectors as

$$F_{\nu\mu} = \frac{\partial A_\mu}{\partial x_\nu} - \frac{\partial A_\nu}{\partial x_\mu} \quad (6)$$

which is written in matrix form as

$$F_{\nu\mu} = \begin{pmatrix} 0 & B_z & -B_y & -\frac{i}{c}E_x \\ -B_z & 0 & B_x & -\frac{i}{c}E_y \\ B_y & -B_x & 0 & -\frac{i}{c}E_z \\ \frac{i}{c}E_x & \frac{i}{c}E_y & \frac{i}{c}E_z & 0 \end{pmatrix} \quad (7)$$

In the same manner as done previously [9], our purpose now is to derive Eqs. (5) and (7) from the Lorentz force without using LT and get Eq. (4) as a result of mathematical considerations only.

Derivation of the electromagnetic field tensor $F_{\nu\mu}$ from Lorentz Force

It is well known that SRT has removed the barrier between matter and energy, but it had created a new barrier which cannot be transcended according to this theory. This barrier separates what is known as the non-relativistic from relativistic physics domain. The physical laws appropriate for non-relativistic physics cannot transcend this barrier and hence they form classical physics. The physical laws appropriate for relativistic physics can cover the non-relativistic physics domain through approximation; and LT becomes a Galilean transformation. The more suitable method is to start with the laws of classical physics and make them conducive to all particle velocities, i.e. to expand the appropriateness of these laws to deal with relativistic domain. As demonstrated in [7,8], and contrary to what is often claimed in SRT, the relativistic expressions were derived starting from the relativity principle and the Lorentz force, i.e.

$$\boldsymbol{F} = q(\boldsymbol{E} + \boldsymbol{v} \times \boldsymbol{B})$$

So following the same approach as used in [7,8], we can obtain the relativistic transformation equation for electromagnetic field and velocity.

$$B'_x = B_x$$

$$B'_y = \gamma\left(B_y + \frac{u}{c^2}E_z\right) \qquad E'_x = E_x$$

$$E'_y = \gamma\left(E_y - u\,B_z\right)$$

$$B'_z = \gamma\left(B_z - \frac{u}{c^2}E_y\right), \qquad E'_z = \gamma\left(E_z + u\,B_y\right) \quad \ldots (8a)$$

and

$$v'_x = \frac{v_x - u}{1 - \frac{uv_x}{c^2}}, \quad v'_y = \frac{v_y}{\gamma(1 - \frac{uv_x}{c^2})}, \quad v'_z = \frac{v_z}{\gamma\left(1 - \frac{uv_x}{c^2}\right)} \ldots \quad (8b)$$

Some measurements depend on the relative coordinate system (x,y,z,t) of the observer, such as: the velocity of a test particle, Eq.(8b), and the components of an $\vec{E}$, $\vec{B}$ field, Eq. (8a). But some concepts are independent of the coordinate system. For example, a geodesic path with its associated geodesic parameter “proper time” of a test particle. We know that the Lorentz force describes the geodesic motion of a charged particle. So the motion of the particle obviously cannot change because it is a geodesic path. The path and the “proper time” along the path do not change, but the observed velocity changes (Eq. 8b), and the observed (E,B) field changes (Eq. 8a).

Therefore, to make Eq. (8a) and Eq. (8b) Lorentz invariant without using the Lorentz transformations for the space and time coordinates (which in turn involve the dilation of time and the contraction of length) and without using the Galilean transformations for the space and time coordinates, we introduced our method the physical law equations [7,8,9,10] and applied the principle of relativity to them.

Eqs (8b) are derived using the Lorentz transformations for the space time coordinates [1]. Later, many workers had derived them without using the Lorentz transformations [13,14]. Equations (8a) and (8b) were also derived by other workers [7,8,9] even without using the Lorentz transformations.

Contrary to what is often claimed in SRT, we had all the relativistic expressions in addition to the well known physical law, i.e.,

$$\frac{d\varepsilon}{dt} = q\mathbf{E}\mathbf{v}$$

without using LT and its kinematical effects, where the last equation represents the fourth component of

$$\frac{dP_\nu}{d\tau} = q\, F_{\nu\mu} \cdot v_\mu \qquad (9)$$

In the 4-vector formulation, $d\tau$ is the proper relativistic time, P_μ the 4-vector momentum, v_μ the 4-vector velocity, and $F_{\nu\mu}$ the electro-magnetic field tensor. In this way, we could formulate SRT starting from a mechanical base [10], i.e.,

$$\mathbf{F} = \frac{d\mathbf{p}}{dt}, \ \frac{d\varepsilon}{dt} = \mathbf{F}\mathbf{v} \qquad (10)$$

instead of restricting the formation of SRT to electromagnetic base alone. Eqs. (10) for the case of charged particle q moving with velocity $\mathbf{v}$ in the frame S, subject to an electric field **E** and a magnetic flux density **B**., have the form

$$\mathbf{F} = q(\mathbf{E} + \mathbf{c} \text{ x } \mathbf{B}),\ \mathbf{F}\mathbf{v} = q\mathbf{E}\mathbf{v} \qquad (11)$$

Now we use the four vectors approach. It operates with the concept of proper time. As we will show later on, the approach we propose leads in a natural way to the components of a four vector. The Cartesian components of Eqs. (11) in frame S are

$$F_x = q(E_x + v_y B_z - v_z B_y) \qquad (12a)$$

$$F_x = q(E_y + v_z B_x - v_x B_z) \qquad (12b)$$

$$F_z = q(E_z + v_x B_y - v_y B_x) \qquad (12c)$$

$$\mathbf{F}\mathbf{v} = q(E_x v_x + E_y v_y + E_z v_z) \qquad (12d)$$

Multiplying Eqs. (12a,12b,12c) by γ and Eq. (12d) by , then Eqs.(12) can be written in a matrix form as

$$\begin{pmatrix} \gamma F_x \\ \gamma F_y \\ \gamma F_z \\ i\frac{\gamma}{c}\mathbf{F}\mathbf{v} \end{pmatrix} = q \begin{pmatrix} 0 & B_z & -B_y & -\frac{i}{c}E_x \\ -B_z & 0 & B_x & -\frac{i}{c}E_y \\ B_y & -B_x & 0 & -\frac{i}{c}E_z \\ \frac{i}{c}E_x & \frac{i}{c}E_y & \frac{i}{c}E_z & 0 \end{pmatrix} \begin{pmatrix} \gamma v_x \\ \gamma v_y \\ \gamma v_z \\ i\gamma c \end{pmatrix} \qquad (13)$$

From Eq. (13), we can define the following.

$x_\mu = (x, y, x, i c t)$, μ=1,2,3,4 the coordinate system and $v_\mu = (\gamma \vec{v}, i\gamma c)$ is the 4-d velocity vector, and $f_\mu = \left(\gamma\mathbf{F}, \frac{i}{c}\gamma\, \mathbf{F}\mathbf{v}\right)$ is the 4-d force. By this 4-d notation, Eqs. (13) has the form

$$f_\nu = q\, F_{\nu\mu} \cdot v_\mu \qquad (14)$$

Where tensor $F_{\nu\mu}$ has the same form as in Eq. (7), i.e.,

$$F_{\nu\mu} = \begin{pmatrix} 0 & B_z & -B_y & -\frac{i}{c}E_x \\ -B_z & 0 & B_x & -\frac{i}{c}E_y \\ B_y & -B_x & 0 & -\frac{i}{c}E_z \\ \frac{i}{c}E_x & \frac{i}{c}E_y & \frac{i}{c}E_z & 0 \end{pmatrix} \qquad (15)$$

The Lorentz force i.e.; Eq. (14) describes the motion of a charged particle q under the action of an electromagnetic field represented by the tensor $F_{\nu\mu}$. As one knows that the rotation vector in the 4-vector formulation has the form

$$F_{\nu\mu} = \frac{\partial A_\mu}{\partial x_\nu} - \frac{\partial A_\nu}{\partial x_\mu} \tag{16}$$

where $\frac{\partial}{\partial x_\mu} = \left(\frac{\partial}{\partial \vec{x}}\rho;\ \frac{\partial}{\partial x_4} = \frac{\partial}{i\,c\,\partial t} \right)$. And if the function, A_μ has the form $A_\mu = \left(\overset{\rho}{A};\ \frac{i}{c}\varphi \right)$, then the component F_{14} could be written in terms of Eqs. (15) and (16) as

$$E_x = -\frac{\partial \varphi}{\partial x} - \frac{\partial A_x}{\partial t} \tag{17a}$$

By following the same approach, we find F_{24} and F_{34} as

$$E_y = -\frac{\partial \varphi}{\partial y} - \frac{\partial A_y}{\partial t} \tag{17b}$$

$$E_z = -\frac{\partial \varphi}{\partial z} - \frac{\partial A_z}{\partial t} \tag{17c}$$

In addition to the component F_{23}, F_{31} and F_{12} have the form

$$B_x = \left(\overset{\rho}{\nabla} \wedge \overset{\rho}{A} \right)_x = \frac{\partial A_z}{\partial y} - \frac{\partial A_y}{\partial z} \tag{18a}$$

$$B_y = \left(\overset{\rho}{\nabla} \wedge \overset{\rho}{A} \right)_y = \frac{\partial A_x}{\partial z} - \frac{\partial A_z}{\partial x} \tag{18b}$$

$$B_z = \left(\overset{\rho}{\nabla} \wedge \overset{\rho}{A} \right)_z = \frac{\partial A_y}{\partial x} - \frac{\partial A_x}{\partial y} \tag{18c}$$

We see now that the Eqs. (17) and (18) have the same vector form as Eq.(5), i.e.,

$$\overset{\rho}{B} = rot\ \overset{\rho}{A}\ ,\ \overset{\rho}{E} = -\overset{\rho}{\nabla}\varphi - \frac{\partial \overset{\rho}{A}}{\partial t}$$

Derivation of the Transformation Relations of A_μ and the Lorentz Transformations from Lorentz Force

We can now find the relativistic transformation of four-vector A_μ, as for the Lorentz transformation relations which will be derived as a result of mathematical considerations only. Therefore, writing the relations (17b) and (18c) in frame S', according to the relativity principle, i.e.,

$$E'_y = -\frac{\partial \varphi'}{\partial y'} - \frac{\partial A'_y}{\partial t'} \tag{19a}$$

$$B'_z = \frac{\partial A'_y}{\partial x'} - \frac{\partial A'_x}{\partial y'} \tag{19b}$$

On the other hand, we have also from Eq. (8)

$$E'_y = \gamma \left(E_y - u\ B_z \right) \tag{19c}$$

$$B'_z = \gamma \left(B_z - \frac{u}{c^2} E_y \right) \tag{19d}$$

Multiplying Eq. (17b) by γ and Eq. (18c) by $u\gamma$, then subtracting the second from the first, we get

$$-\gamma \left(\frac{\partial}{\partial t} + u \frac{\partial}{\partial x} \right) A_y - \frac{\partial}{\partial y} \gamma \left(\varphi - u\ A_x \right) = E'_y$$

By comparing the last relation with Eq.(19a), we then have

$$\frac{\partial}{\partial y'} = \frac{\partial}{\partial y}\ ,\ A'_y = A_y\ ,\ \varphi' = \gamma\left(\varphi - u\ A_x\right)\ ,\ \frac{\partial}{\partial t'} = \gamma \left(\frac{\partial}{\partial t} + u \frac{\partial}{\partial x} \right) \tag{20b}$$

Once again multiplying Eq. (17b) by $\gamma \frac{u}{c^2}$ and Eq. (18c) by γ, then subtracting the second from the first, we get

$$\gamma\left(\frac{\partial}{\partial x}+\frac{u}{c^2}\frac{\partial}{\partial t}\right)A_y-\frac{\partial}{\partial y}\gamma\left(A'_x-\frac{u}{c^2}\varphi\right)=B'_z$$

By comparing the last relation with Eq. (19b), we then have

$$A'_x=\gamma\left(A_x-\frac{u}{c^2}\varphi\right)\quad,\quad\frac{\partial}{\partial x'}=\gamma\left(\frac{\partial}{\partial x}+\frac{u}{c^2}\frac{\partial}{\partial t}\right)\qquad(20b)$$

In a similar way, we get

$$\frac{\partial}{\partial z'}=\frac{\partial}{\partial z}\quad,\quad A'_z=A_z\qquad(20c)$$

Discussion

Can we now see how great the misconception is? When we take the concepts [(length contraction, time dilation, a velocity component) for a geometrical point] which are used solely to solve the problem of the coordination of events, we may use them to predict the dynamical properties of a particle. Careful examination of Einstein's argument in his paper [1] leaves no doubt that LT is indeed transformation that describes the coordinates of Cartesian point. The error was in assuming that these transformations describe the coordinates of a material particle. The LT is actually transformation of the coordinates of a geometrical point and it doesn't have the power to make predictions about physical quantities (mass, energy, momentum….). Since the appearance of SRT [1], an important question has existed: in a frame containing matter (energy), is the power determining its dynamic laws within the matter (energy) itself, or is it within the reference frame containing the matter (energy)? In other words, are the laws described by SRT a property arising within matter (energy) or are they imposed on matter (energy)? Einstein adopted the hypothesis that the reference frame containing the matter (energy) is the influential power. He formulated the concept of space-time continuum, and expressed it by Lorentz transformation (LT). The space-time continuum becomes a complex of physical quantities obeying the relativity principle, in that space responds to the relativistic movement by contraction and time responds to the relativistic movement by dilation. The main objection to SRT is it's kinematical approach, where real dynamical processes are ignored and their kinematical projections are taken to explain the phenomenon at hand. In our papers[1,8,9,10] we show (and prove) that "Lorentz Transformations misrepresent reality and describe no physical effects. Moreover kinematical approach and relativistic Dynamics are incompatible" [11,12]. A satisfactory logical explanation should be based on dynamical feature [11,12], but not on kinematical approach such as the time dilation and length contraction. Thus, LT in [9] and in the present report is simply a neutral transformation, containing no physical significance, i.e., LT and its kinematical effects cannot be taken to explain any physical phenomenon.

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