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Does Relativistic Electrodynamics need (SRT)?-II

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Abstract

We show all facts that seem to require the invariance of Maxwell's field equations under Lorentz transformations [(Einstein's relativity), [1]] can be derived from assumptions different from those used by Einstein. In general, we start with the physical law equations [2,3,4] and apply the relativity principle to them. With this approach, Einstein's relativity (SRT) is reformulated in a simple manner that has dynamic applications [5,6] without using the Lorentz transformation (LT) and its kinematical contradictions.

1. Introduction

At end of the sixteenth century, Galilo's experiments showed that motion must be relative in contrast with 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 electromagnetic 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, he 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 Galilian 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 to the moving particle although this principle was earlier restricted to the electromagnetic field. SRT postulates various kinematical effects, like length contraction and tine dilation. Several questions arise when examining these kinematical effects and many contradictions exist. 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 can be neglected in my approach, which begins with the following postulates, physical laws and the relativity principle [2,3,4].

2- Electric-Magnetic fields Transformations; velocity transformations, and Lorentz-Transformations.

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

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

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

In paper [3], our intention was to derive the relativistic transformation of the electromagnetic field as well as the relativistic transformation of the charge and current density.

In the source-free case:

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

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

By Following the same reason used in [3], we now get the relativistic transformation of the electromagnetic field, i.e.;

$$\begin{aligned} B'_x &= B_x & E'_x &= E_x \\ B'_y &= \gamma\left(B_y + \frac{u}{c^2}E_z\right), & E'_y &= \gamma\left(E_y - u\,B_z\right) \ \ldots \ \mathbf{(3)} \\ B'_z &= \gamma\left(B_z - \frac{u}{c^2}E_y\right) & E'_z &= \gamma\left(E_z + u\,B_y\right) \end{aligned}$$

In addition, we get the Lorentz transformation relations:

$$\frac{\partial}{\partial t'} = \gamma\left(\frac{\partial}{\partial t} + u\frac{\partial}{\partial x}\right), \frac{\partial}{\partial y'} = \frac{\partial}{\partial y} \quad , \quad \frac{\partial}{\partial z'} = \frac{\partial}{\partial z} ,\!: \frac{\partial}{\partial x'} = \gamma\left(\frac{\partial}{\partial x} + \frac{u}{c^2}\frac{\partial}{\partial t}\right) \ \mathbf{(4)}$$

Our purpose is now to derive the 3 – vector velocity without LT in the same manner as in [2]. We start with the Lorentz force

$$\boldsymbol{F} = q\left(\boldsymbol{E} + \boldsymbol{v} \times \boldsymbol{B}\right) \ \mathbf{(5)}$$

Assume that a charged particle q moves with velocity v_x in frame S. The y-component of Eq. (5) is:

$$F_y = q(E_y - v_x B_z) \ \mathbf{(6a)}$$

Now by applying the relativity principle to Eqs. (6a), they will preserve their form in frame S' moving with velocity u parallel to their common x- axis as follows:

$$F'_y = q(E'_y - v'_x B'_z) \ \mathbf{(6b)}$$

But from Eqs.(6) we have

$$v_x = \frac{E_y}{B_z} \text{ (a) , } v'_x = \frac{E'_y}{B'_z} \text{ (b) } \mathbf{(7)}$$

Using Eqs.(3) in Eqs.(7), we get

$$v'_x = \frac{v_x - u}{1 - \frac{uv_x}{c^2}} \quad \mathbf{(8a)}$$

To obtain another relativistic transformation of velocity we assume that the velocity in frame S is in the form:

$$v^2 = v_x^{\ 2} + v_y^{\ 2} \quad \mathbf{(9a)}$$

Eq.(9a) in frame S' has the form:

$$v'^2 = v'^2_x + v'^2_y \quad \mathbf{(9b)}$$

Substituting Eq.(8a) in Eq.(9b) we have

$$v'^2_y = v'^2 - \left(\frac{v_x - u}{1 - uv_x / c^2}\right)^2$$

Or

$$v'_y\left(1 - \frac{uv_x}{c^2}\right) = \sqrt{v'^2\left(1 - \frac{uv_x}{c^2}\right)^2 - (v_x - u)^2} \quad \mathbf{(10)}$$

On the other hand, equation Eq.(8a) could be written as

$$\frac{1}{\sqrt{1 - \frac{v'^2_x}{c^2}}} = \frac{\left(1 - \frac{uv_x}{c^2}\right)}{\sqrt{1 - \frac{u^2}{c^2}}\sqrt{1 - \frac{v_x^2}{c^2}}} \quad \mathbf{(11)}$$

Or,

$$\frac{1}{1 - \frac{v'^2_x}{c^2}} = \frac{\left(1 - \frac{uv_x}{c^2}\right)^2}{\left(1 - \frac{u^2}{c^2}\right)\left(1 - \frac{v_x^2}{c^2}\right)} \quad \mathbf{(12)}$$

Now we start from Eq.(12), which may be written as

$$(\frac{v^2}{c^2}-1)(1-\frac{u^2}{c^2}) = (\frac{v'^2}{c^2}-1)(1-\frac{uv_x}{c^2})^2$$

Or,

$$\frac{v^2}{c^2}-\frac{u^2v^2}{c^4}+\frac{u^2}{c^2}-\frac{2uv_x}{c^2}+\frac{v_x^{\,2}u^2}{c^4} = \frac{v'^2}{c^2}(1-\frac{uv_x}{c^2})^2$$

Using Eq.(9a) in the last relation, after rearrangement, we have

$$v_y^{\,2}(1-\frac{u^2}{c^2}) = v'^2(1-\frac{uv_x}{c^2})^2-(v_x-u)^2$$

Or,

$$v_y\sqrt{(1-\frac{u^2}{c^2})} = \sqrt{v'^2(1-\frac{uv_x}{c^2})^2-(v_x-u)^2} \quad \textbf{(13)}$$

Comparing both Eqs.(10) and (13), we get:

$$v'_y = \frac{v_y}{\gamma(1-\frac{uv_x}{c^2})} \quad \textbf{(8b)}$$

The same result can be derived from the equations (9) if we assume that $v^2 = v_x^{\,2} + v_z^{\,2}$ and $v'^2 = v_x'^{\,2} + v_z'^{\,2}$ i.e.:

$$v'_z = \frac{v_z}{\gamma\left(1-\frac{u}{c^2}v_x\right)} \quad \textbf{(8c)}$$

It is obvious that our derivation process differs from that in SRT, since LT was not used in this process**.** As for the 3-vector relativistic velocity transformations, they were derived as a result of mathematical considerations only, without taking into account the definition of velocity as a rate of change of position with time. This seems natural, since the velocity of a particle is not a part of its intrinsic properties, but a measured quantity that could be redefined.

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

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

$$\vec{B} = rot\ \vec{A} \quad , \ \vec{E} = -\vec{\nabla}\varphi - \frac{\partial \vec{A}}{\partial t} \quad \textbf{(14)}$$

Eq.(14) defines a second rank tensor $F_{\mu\nu}$, if one write it in 4-dimensional vectors, i.e.;

$$F_{\mu\nu} = \frac{\partial A_\nu}{\partial x_\mu} - \frac{\partial A_\mu}{\partial x_\nu} \quad \textbf{(15)}$$

which is written in this coordinate system, $\frac{\partial}{\partial x_\mu} = \left(\frac{\partial}{\partial \vec{x}} \ ; \ \frac{\partial}{\partial x_4} = \frac{\partial}{i\ c\ \partial t} \right)$, as

$$F_{\mu\nu} = \begin{pmatrix} 0 & B_3 & -B_2 & -\frac{i}{c}E_1 \\ -B_3 & 0 & B_1 & -\frac{i}{c}E_2 \\ B_2 & -B_1 & 0 & -\frac{i}{c}E_3 \\ \frac{i}{c}E_1 & \frac{i}{c}E_2 & \frac{i}{c}E_3 & 0 \end{pmatrix} \quad \textbf{(16)}$$

It is well known that SRT removed the barrier between matter and energy, but it created a new barrier which can not 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 can not transcend this barrier and hence they form classical physics. The physical laws appropriate for relativistic physics can cover the domain of non-relativistic physics 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 the relativistic domain. It was demonstrated in [2] that relativistic expressions were derived beginning with the classical law, i.e. $\boldsymbol{F} = q\left(\boldsymbol{E} + \boldsymbol{v} \times \boldsymbol{B}\right)$, and the relativity principle**.** Contrary to what is often claimed in SRT, we had all the relativistic expressions in addition the well known physical law, i.e.;

$$\frac{d\varepsilon}{dt} = q\mathbf{E}\mathbf{v} \quad \textbf{(17)}$$

without using LT and its kinematical effects. where Eq.(17) represents the fourth component of:

$$\frac{dP_\mu}{d\tau} = q\ F_{\mu\nu} \cdot v_\mu \quad \textbf{(18)}$$

in the 4-vector formulation. And where τ is the proper relativistic time, P_μ the 4-vector momentum, v_μ the 4-vector velocity, and $F_{\mu\nu}$ the electromagnetic field tensor.

In this way, we could formulate SRT starting from a mechanical base [4],i.e.;

$$\mathbf{F} = \frac{d\mathbf{p}}{dt} \; , \; \frac{d\varepsilon}{dt} = \mathbf{F}\mathbf{v} \quad \textbf{(19)}$$

instead of restricting the formation of SRT to electromagnetic base alone.

In papers [5] and [6], we continue this method 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**. , and then Eqs. (19) has the form

$$\frac{d\mathbf{p}}{dt} = q(\mathbf{E} + \mathbf{v} \times \mathbf{B}) \; , \; \frac{d\varepsilon}{dt} = q\mathbf{E}\mathbf{v} \quad \textbf{(20)}$$

In the present paper we continue this method to get Eqs.(14) and (16), beginning with Eq.(20).

The Cartesian components of Eqs. (20) in frame S are

$$\frac{dp_x}{dt} = q(E_x + v_y B_z - v_z B_y) \quad \textbf{(21a)}$$

$$\frac{dp_y}{dt} = q(E_y + v_z B_x - v_x B_z) \quad \textbf{(21b)}$$

$$\frac{dp_z}{dt} = q(E_z + v_x B_y - v_y B_x) \quad \textbf{(21c)}$$

$$\frac{d\varepsilon}{dt} = q(E_x v_x + E_y v_y + E_z v_z) \quad \textbf{(21d)}$$

Multiplying Eqs.(21a,21b,21c)by γ and Eq.(21d) by $-i\frac{\gamma}{c}$**,** then subtracting, we have:

$$\begin{pmatrix} \gamma \frac{dp_x}{dt} \\ \gamma \frac{dp_y}{dt} \\ \gamma \frac{dp_z}{dt} \\ i\frac{\gamma}{c}\frac{d\varepsilon}{dt} \end{pmatrix} = q \begin{pmatrix} 0 & B_z & -B_y & -\frac{i}{c}E_x \\ -B_z & 0 & B_x & -\frac{i}{c}E_y \\ B_y & -B_x & 0 & -\frac{i}{c}E_z \\ \frac{i}{c}E_x & \frac{i}{c}E_y & \frac{i}{c}E_z & 0 \end{pmatrix} \begin{pmatrix} \gamma v_x \\ \gamma v_y \\ \gamma v_z \\ i\gamma c \end{pmatrix} \quad \textbf{(22)}$$

The Lorentz force equations, Eq.(21), describes the motion of a charged particle q under the action of an electromagnetic field represented by the tensor $F_{\mu\nu}$,where $x_\mu = (x, y, z, i c t)$, $\mu = 1,2,3,4$ is the coordinate system and $v_\mu = (\gamma\vec{v}, i\gamma c)$ is the 4-d velocity vector, and $P_\mu = \left(\vec{P}, \frac{i}{c}E\right)$ is the 4-d momentum vector. By this 4-d notation, Eq.(22) has the form:

$$\frac{dP_\mu}{d\tau} = q\ F_{\mu\nu} \cdot v_\mu \quad \textbf{(23)}$$

Where tensor $F_{\mu\nu}$ has the same form as in Eq.(16)i.e.;

$$F_{\mu\nu} = \begin{pmatrix} 0 & B_z & -B_y & -\frac{i}{c}E_x \\ -B_z & 0 & B_x & -\frac{i}{c}E_y \\ B_y & -B_x & 0 & -\frac{i}{c}E_z \\ \frac{i}{c}E_x & \frac{i}{c}E_y & \frac{i}{c}E_z & 0 \end{pmatrix} \quad \textbf{(24)}$$

As one know that the rotation vector in the 4-vector formulation has the form:

$$F_{\mu\nu} = \frac{\partial A_\nu}{\partial x_\mu} - \frac{\partial A_\mu}{\partial x_\nu} \quad \textbf{(25)}$$

where $\frac{\partial}{\partial x_\mu} = \left(\frac{\partial}{\partial \vec{x}} \ ; \ \frac{\partial}{\partial x_4} = \frac{\partial}{i\ c\ \partial t} \right)$. And if the function, A_μ has the form $A_\mu = \left(\vec{A}\ ;\ \frac{i}{c}\varphi \right)$, then the component F_{14} could be written in terms of Eqs.(24) and(25) as

$$E_x = -\frac{\partial \varphi}{\partial x} - \frac{\partial A_x}{\partial t} \quad \textbf{(26a)}$$

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

$$E_y = -\frac{\partial \varphi}{\partial y} - \frac{\partial A_y}{\partial t} \quad \textbf{(26b)}$$

$$E_z = -\frac{\partial \varphi}{\partial z} - \frac{\partial A_z}{\partial t} \quad \textbf{(26c)}$$

As well as the component F_{23}, F_{31} and F_{12} has the form:

$$B_x = \left(\vec{\nabla} \wedge \vec{A} \right)_x = \frac{\partial A_z}{\partial y} - \frac{\partial A_y}{\partial z} \quad \textbf{(27a)}$$

$$B_y = \left(\vec{\nabla} \wedge \vec{A} \right)_y = \frac{\partial A_x}{\partial z} - \frac{\partial A_z}{\partial x} \quad \textbf{(27b)}$$

$$B_z = \left(\vec{\nabla} \wedge \vec{A}\right)_z = \frac{\partial A_y}{\partial x} - \frac{\partial A_x}{\partial y} \quad \textbf{(27c)}$$

As one sees now that Eqs.(26) and (27) have the same vector form as Eq.(14) ,i.e.;

$$\vec{B} = rot\ \vec{A} \quad , \ \vec{E} = -\vec{\nabla}\varphi - \frac{\partial \vec{A}}{\partial t} \quad \textbf{(28)}$$

4- Derivation 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, they will be derived as a result of mathematical considerations only.

Therefore by writing Eqs.(26b) and (27c) in frame S' , according to the relativity principle, i.e.;

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

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

On the other hand we have also from Eq.(3):

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

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

and hence:

$$-\frac{\partial \varphi'}{\partial y'} - \frac{\partial A'_y}{\partial t'} = \gamma\left(E_y - u\ B_z\right) \quad \textbf{(29a)}$$

$$\frac{\partial A'_y}{\partial x'} - \frac{\partial A'_x}{\partial y'} = \gamma\left(B_z - \frac{u}{c^2}E_y\right) \quad \textbf{(29b)}$$

Multiplying both Eq.(29b) by $u\gamma$ and Eq.(29a) by γ, then adding both equations, we get

$$-\gamma\left(\frac{\partial}{\partial t'}-u\,\frac{\partial}{\partial x'}\right)A'_y-\frac{\partial}{\partial y'}\,\gamma\,(\varphi'+u\,A'_x)=E_y$$

By comparing the last relation with Eq.(26b), we then have

$$\frac{\partial}{\partial y}=\frac{\partial}{\partial y'}\ ,\ A_y=A'_y\ ,\ \varphi=\gamma\,(\varphi'+u\,A'_x)\ ,\ \frac{\partial}{\partial t}=\gamma\left(\frac{\partial}{\partial t'}-u\,\frac{\partial}{\partial x'}\right)\qquad(30a)$$

And now if we multiply both Eq.(29a) by $\gamma\dfrac{u}{c^2}$ and Eq.(29b) by γ, then adding both equations, we get

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

By comparing the last relation with Eq.(27c), we then have

$$A_x=\gamma\left(A'_x+\frac{u}{c^2}\varphi'\right)\ ,\ \frac{\partial}{\partial x}=\left(\frac{\partial}{\partial x'}-\frac{u}{c^2}\frac{\partial}{\partial t'}\right)\ \textbf{(30b)}$$

In a similar way, if we rewrite the relations (26c) and (27b) in frame S', according to the relativity principle, and taking into account relations (3), we get

$$-\frac{\partial\varphi'}{\partial z'}-\frac{\partial A'_z}{\partial t'}=\gamma\,(E_z+u\,B_y)\ \text{(31a)},\ \frac{\partial A'_x}{\partial z'}-\frac{\partial A'_z}{\partial x'}=\gamma\left(B_y+\frac{u}{c^2}E_z\right)\ \textbf{(31b)}$$

Multiplying the both Eq.(31b) by $-u\gamma$ and Eq.(31a) γ , then adding the both equations, we get

$$-\frac{\partial}{\partial z'}\gamma(\varphi'+u\,A'_x)-\gamma\left(\frac{\partial}{\partial t'}-u\,\frac{\partial}{\partial x'}\right)A'_z=E_z$$

By comparing the last relation with Eq.(26c), we then have

$$\frac{\partial}{\partial z}=\frac{\partial}{\partial z'}\ ,\ A_z=A'_z\ \ \textbf{(30c)}$$

A general requirement in SRT is that any physical theory should be written in 4-d form i.e."relativistically invariant" and then reduced to 3-d form. In my papers we start directly from the physical laws (written originally in 3-d form) to get the same results, without using the most important thing in 4-d form i.e. the metric tensor.

Conclusion

Can we now see how great is the misconception? If 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 a transformation that describes the coordinates of a photon. The error was in assuming that these transformations describe the coordinates of a material particle. The LT are actually transformation of the coordinates of a geometrical point and they do not have the power to make predictions about physical quantities (mass, energy, momentum….). LT by our alternative method is simply a neutral transformation, containing no physical significance [2,3,4,6].

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