Is the Lorentz Transformation a Physically Correct Solution of the Spacetime Interval Equation?

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In Special Relativity Theory (SRT), equations are written in a form that conserves the value of the space-time interval in the transition from one observer's system to another. The Lorentz Transformation (LT) is a generally known solution of the space-time interval equation such that the equations of SRT are invariant in relation to this transformation. According to the Four-dimensional Euclidean Reality (FER) model, there is another solution of this equation, and this solution allows one to draw some conclusions other than the conclusions obtained on the grounds of the LT. Derivation of the LT according to the FER model is still possible, but the derivation can be performed only at the cost of breaking certain physical laws. Therefore, although the Lorentz Transformation is mathematically correct, it is not correct from the physical point of view.

1. Introduction – Derivation of the LT

In the recent years, more and more articles about the Euclidean model of space-time have appeared [1-14]. In my papers, I show a geometrical interpretation of such a spacetime [1,3], which I have called the FER (Four dimensional Euclidean Reality). According to this interpretation, the physical reality is the four dimensional Euclidean space. None of the directions in FER can be assigned in advance as the space- or the time-dimension. The interpretation of directions in FER as a time- or the space dimension is possible only when a pair of bodies is considered: an observer and an observed body. In such a case, the direction in FER interpreted by the observer as the time dimension is the trajectory of the observer in FER, and the directions interpreted by the observer as the three space dimensions are the three directions perpendicular to the trajectory of the observed body. Finally, if we are observing the bodies surrounding us, we are under the impression that we exist in the three dimensional space, in which there is a flowing time with properties very similar to the three space dimensions.

With the help of the geometrical interpretation of FER we are able to derivate the Lorentz Transformation in a trivially simply way as follows:

Let us consider two inertial observers in FER. The observers move along their trajectories inclined to each other at angle φ, where $\sin\varphi$ is their relative velocity. Trajectories of bodies are, at the same time, the time-axes of their frames. Space-axes of the frames are chosen so as to be perpendicular to the trajectory of the observed body. In case of mutual observation of the observers, connected with the x,t and x',t' frames, the x-axis is perpendicular to the t'-axis and analogically the x'-axis is perpendicular to the t-axis. Axes of coordinates systems of both bodies are shown in Fig, 1.

A way of deriving the Lorentz Transformation is demonstrated as follows: Let us put a point P in frames of both bodies in Fig. 1. According to the picture, the x-co-ordinate of the point P is equal to:

$$x = OA / \cos\varphi$$

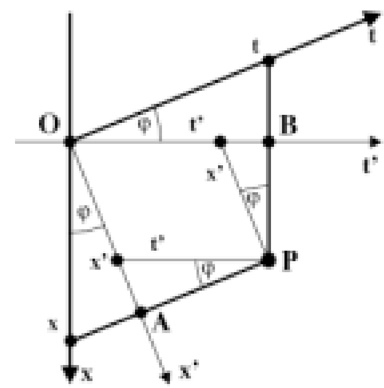

Figure 1. Coordinates x,t and x',t' of the point P and axes of frames x,t and x',t' in FER

then: $$OA = x' + t'\sin\varphi$$

so that if we remember that $\sin\varphi$ denotes the velocity $\mathbf{V}$, we can write:

$$x = \frac{x' + t'\sin\varphi}{\cos\varphi} = \frac{x' + t'V}{\sqrt{1-V^2}} \quad (1)$$

In the same way we can obtain the next equations:

$$t = OB / \cos\varphi$$

or $$OB = t' + x'\sin\varphi$$

$$t = \frac{t' + x'\sin\varphi}{\cos\varphi} = \frac{t' + x'V}{\sqrt{1-V^2}} \quad (2)$$

As shown above, the geometrical interpretation of FER allows one to derive the Lorentz Transformation in a very simple way. The rule of composition of velocities for point P automatically results from the Lorentz Transformation:

$$\nu = \frac{\nu' + V}{1 + \nu' V} \tag{3}$$

where $\nu = dx / dt$ is the velocity of the body (point P in Fig. 1) in the coordinates system of the observer at rest, $\nu' = dx' / dt'$ is the velocity of the body (point P in the Fig. 1) in the coordinates system of the observer in motion, and V is the magnitude of the relative velocity of the observers

2. New Rule for Velocity Composition and New Form of Coordinate Transformation

The FER model introduces the new rule of composition of the velocities. This rule has been derived independently in two papers [1,4]. In FER, the relative velocity of bodies is equal to the sine of the angle between the trajectories of the bodies; then the rule of composition of the velocities leads, according to FER, to adding the angles between the trajectories of the bodies in motion. This situation is shown in Fig. 2.

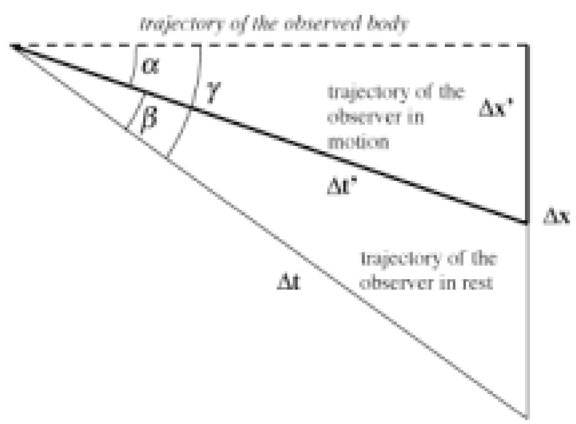

Figure 2. The trajectory of the observed body and the trajectories of the observers x, t i x', t' shown in FER. The velocities of the bodies are the sines of the angles between the trajectories of the particular bodies.

The velocities of the particular bodies are described as the sines of the angles between their trajectories in FER; therefore, according to the above consideration we are able to write the formulas describing the velocities of the bodies:

$$\nu = \Delta x / \Delta t = \sin\gamma \tag{4a}$$

is the velocity of the body in the coordinates system of the observer in rest

$$\nu' = \Delta x' / \Delta t' = \sin\alpha \tag{4b}$$

is the velocity of the body in the coordinates system of the observer in motion

$$V = \sin\beta \tag{4c}$$

is the relative velocity of the observers connected with the **xt** and x', t' frames.

The new rule of velocity composition results instantly from the above written formulas as follows:

$$\nu = \sin\gamma = \sin(\alpha + \beta) = \nu'\sqrt{1 - V^2} + V\sqrt{1 - \nu'^2} \tag{5}$$

This new rule, similar to the 'classical' one, does not allow for exceeding the speed of light but, as distinct from SRT, it allows one to achieve light speed as a result of composition of two velocities of magnitude lower than c. The difference between predictions of the different rules of composition of the velocities is shown in Fig. 3.

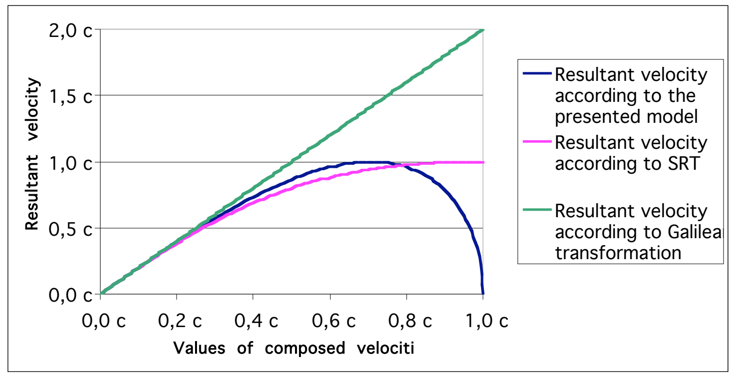

Figure 3. The resultant velocity as a function of composed velocities. Both composed velocities are equal. Three cases of composition of velocities are shown in the diagram: according to non-relativistic, Galilean transformation, according to SRT, and according to the theory presented here.

In SRT, the velocity composition rule is a consequence of the Lorentz transformation. If now the new rule, different from the hitherto one, has been derived, that means that a transformation of coordinates different from the Lorentz transformation should exist.

The new transformation of the coordinates can be derived directly from the dependences resulting from Fig. 2. The new transformation can be written, with the help of the angles between the trajectories of the bodies, in the following form:

$$\Delta t = \frac{\Delta t'}{\cos\beta} + \frac{\Delta x' \sin\beta}{\cos\beta\cos(\alpha+\beta)} \tag{6}$$

$$\Delta x = \Delta x' + \frac{\Delta t' \sin\beta}{\cos(\alpha+\beta)} \tag{7}$$

or with the help of velocities (4a, 4b, 4c):

$$\Delta t = \frac{\Delta t'}{\sqrt{1 - V^2}} + \frac{V \Delta x'}{\sqrt{1 - V^2}\left(\sqrt{1 - \nu'^2}\sqrt{1 - V^2} - V\nu'\right)} \tag{8}$$

$$\Delta x = \Delta x' + \frac{V \Delta t'}{\sqrt{1 - \nu'^2}\sqrt{1 - V^2} - V\nu'} \tag{9}$$

where, similarly to the LT, V denotes the relative velocity of the observers.

It can be seen that in the case of a small velocities $V, v << 1$ the transformation becomes the Galilean transformation, whereas in the case of higher velocities, we obtain a transformation different from the LT.

The basic feature of the new transformation is the absence of the Lorentz contraction that is predicted by the LT. It means that for the distances considerably higher than the dimensions of the observed object, the Lorentz contraction should not be directly observed – as, for instance, the time dilation is observed. In the case of interaction of particles, the effects described till now by the Lorentz contraction should be probably observed, but it is the result of the structure of the particle which is now treated as the space's disturbance [2]. The detailed answer for this question will probably appear soon as the result of the theory describing the structure of the elementary particle in FER.

As has been shown, both the classical LT and the new transformation of coordinates have been derived on the basis of FER. Both transformations fulfill the equation of the space-time interval conservation (in case of the new transformation the conservation of the space-time interval is a straightforward consequence of Fig. 2), but they exclude each other. One of the transformations must then be incorrect. But which one and why – where is the mistake?

3. Why the LT is Incorrect

At first glance, the derivation of the Lorentz transformation performed on the basis of Fig. 1 looks logical, and the derivation of the formulas is trivially simple. But it is necessary to ask a question that was not asked when the formulas were derived: what is the trajectory of the P point in the Fig. 1? According to FER, in order to define the space coordinates of any point, it is **necessary** to know the trajectory to which this point belongs. We can determine the space axes of the observer's coordinate system **only** if we know the trajectory of the observed object, and only in such a case we can determine the values of coordinates of this object.

Meanwhile, in Fig. 1 the space axes of the point P were chosen not for the case of the observation of the point P – because we don't know its trajectory – but for the mutual observation of the observers x,t and x',t'. And therefore:

In Fig. 1 the space axis x of the observer's coordinates system x,t was defined as perpendicular to the time axis (trajectory) of the observed body t'. Since in FER the space axis of the observer's coordinates system **must** be perpendicular to the trajectory of the observed body, then the measurement of the distance from the point P along the x-axis is equivalent to the assumption that the point P moves along the trajectory that is parallel to the time axis of the observed body t'. In other words: the point P is rigidly bound with the observer's coordinates system x',t'. This situation is described in Fig. 4.

On the other hand, in the same Fig. 1, the space axis x' of the coordinates system of the observer in motion was defined as perpendicular to the time axis (trajectory) of the resting observer t. Now the measurement of the distance from point P along this axis means that we are assuming that point P is moving along a trajectory parallel to the axis of time of the observer in rest. In other words: the point P is now rigidly bound with the observer's coordinates system x,t which remains in rest. This situation is described in Fig. 5.

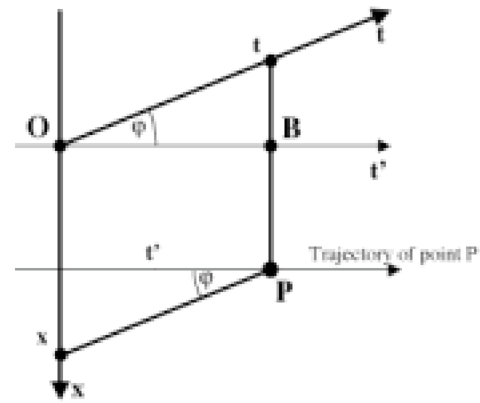

Figure 4. Measurement of the distance from point P along the space axis x of the observer's system xt, in rest, **(which is** perpendicular to the axis of time t′ of the frame in motion) is equivalent to accepting the assumption that the point P is moving along the trajectory parallel to the time axis **t′**.

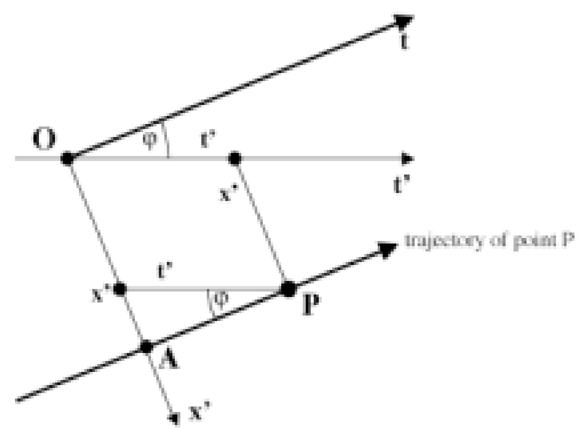

Figure 5. Measurement of the distance from point P along the space axis x' of the moving observer's system, x',t', (which is perpendicular to the axis of time t of the frame in rest) is equivalent to accepting the assumption that the point P is moving along the trajectory parallel to the time axis t.

The Figs. 4 and 5 represent two different situations. From the physical point of view, the observers x,t and x',t' are observing two different bodies that are moving along different trajectories. The observer x,t observes the body that moves along the trajectory as shown in the Fig. 4, the observer x',t' observes the body that moves along the trajectory as shown in Fig. 5. The only common feature for these two bodies is the point P being the intersection of both trajectories.

Fig. 1 was created as a composition of Figs. 4 and 5, but in the Fig. 1 only the point P was positioned, whereas the trajectory, along which the point is moving, was omitted. *It remains in accord with the conception of SRT* where the space coordinate of a body/point does not depend on its trajectory (in SRT it is the world line). In FER such an approach is not possible. The very defining of the point in FER is not enough to define its space coordinates. We ***must*** also know the trajectory that the point belongs to. Only the knowledge of the trajectory of the point makes it possible to find the space coordinates of this point, because the space axis x of the observer is chosen as perpendicular to this trajectory.

Therefore, the Lorentz transformation describes the problem of transformation of the coordinates correctly from the mathematical point of view, because for every single point in FER the transformation is correct. On the other hand, according to FER, the formulas of the Lorentz transformation *have no physical meaning*, because they describe the observation of two separate bodies moving along different trajectories, and are true only in the point that is the intersection of these trajectories: the x coordinate from formula (1) describes the body moving along the trajectory shown in the Fig. 4, and the x' coordinate from the formulas (1) and (2) describes locations of the body that moves along the trajectory shown in Fig. 5. Both formulas are simultaneously fulfilled only in point P being the intersection of trajectories shown in the Figs. 4 and 5, whereas in other points of trajectories the formulas are not valid. Therefore, the formulas of the Lorentz transformation cannot be used for describing the coordinates of bodies, although they fulfill the equation of the space-time interval conservation and, consequently, the shape of the equations in SRT is invariant in relation to the Lorentz Transformation.

To summarize: The formulas of the LT are correct if we are considering the physical problems using the mathematical apparatus only, but their non-physical character will sometimes lead to false conclusions. Derivation of the LT in the FER model is possible only if we break the basic rule of FER which says that in order to define the space coordinates of any point, it is necessary to know the trajectory of this point.

4. Conclusions

According to the FER model, the only correct formulas for the transformation of coordinates are the formulas (8) and (9). However, they are more complicated than the formulas of the LT. Moreover, lack of the Lorentz contraction effect in the formula (9) makes it impossible to justify the invariance of the light speed in moving frames in a way similar to the one usually used in SRT. It is not a problem any more, because the justification of the invariance of the light speed in FER is based on the fact that the propagation of EM waves in FER is described with a mechanism different than the motion of material bodies. It is described in detail in my previous papers [1,3]

Therefore, if the FER model is true, the formulas of the LT should lead sometimes to false conclusions. The alternative formulas for transformation of coordinates, derived in this paper, allow us to draw conclusions different than the ones resulting from the LT; *e.g.*, the lack of the Lorentz contraction during the observation of distant relativistic objects. This should make it possible to verify the predictions of the FER model in the way of experiment.

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