The Nature of the Lorentz Transformation

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The physical sense of the special theory of relativity is shown on the basis of model of the 4D Universe

The Lorentz transfomation (LT) is the kernel of the special theory of relativity (SR). It states that if there are two inertial reference frames K and K' moving with the velocity V one with respect to another, the distances and the times in its will be biased by the following relations

$$\begin{aligned} x &= \frac{x' + Vt'}{\sqrt{1 - V^2/c^2}} \\ y &= y' \\ z &= z' \\ t &= \frac{t' + Vx'/c^2}{\sqrt{1 - V^2/c^2}} \end{aligned} \qquad (1)$$

It is supposed that the velocity V of one reference frame, K,' is directed along the x axis of the other frame, K, and the directions of the axes in both systems are coincided. c is the light speed. Also it is supposed here that the stating points in both coordinate systems are chose coincided as well as the starting moments of time. In SR these relations are produced from the two postulates. One of them tells that the light speed is constant in all inertial reference frames and the other one that the laws of physics are the same in them.

To elucidate the sense of the LT let us write it in this form

$$\begin{aligned} x &= x'\sqrt{1 - V^2/c^2} + Vt \\ y &= y' \\ z &= z' \\ ct' &= -x'V/c + ct\sqrt{1 - V^2/c^2} \end{aligned} \qquad (2)$$

We used the so called reversed LT in the first equation when the sign at V and the dash symbols at x and t are changed. It also can be obtained by substitution t' from the fourth equation in (1).

While the LT in SR means the hyperbolic rotation in Minkovky' space-time, here one can see that (2) is the usual rotation of the 4D space around the plain (y,z) on the angle $\alpha = asin(V/c)$ as it shown on the Fig.1. This rotation can also be determined with the help of the following matrix

$$M = \begin{pmatrix} \cos\alpha & . & . & \sin\alpha \\ . & 1 & . & . \\ . & . & 1 & . \\ -\sin\alpha & . & . & \cos\alpha \end{pmatrix} \qquad (3)$$

In contrast with the 3D rotation, the rotation in 4D space leaves invariant the vectors in the plane, so we called it as the rotation around the plane but nor around the axis. Also as any rotation (3) leaves constant the length of the vector marked by the dash line on the Fig.1 with the coordinates (x, w) in one coordinate system and (x', w') in the other one where w=ct' and w'=ct. It means that its value, H, is invariant under the transformation (2)

$$H = \sqrt{x^2 + y^2 + z^2 + (ct')^2} = \sqrt{x'^2 + y'^2 + z'^2 + (ct)^2}$$

(3)

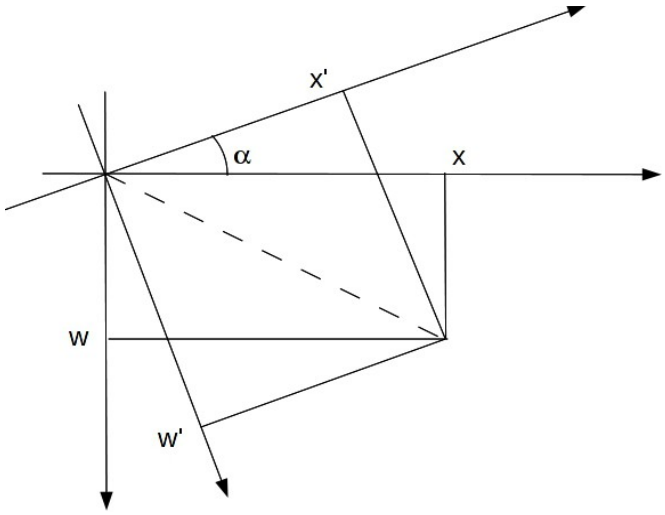
In this case, however, the dashed symbol in x' and ct' are related to the different coordinate systems, but we will show below why it so happened.

One can easily get the expression for the so called interval of SR from (3)

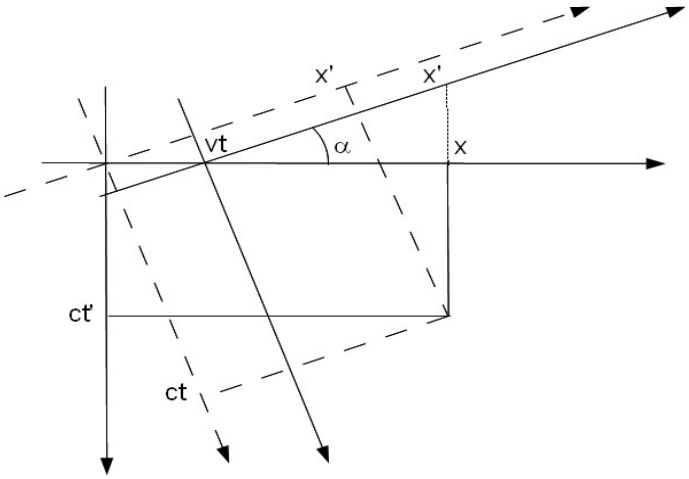
$$s=\sqrt{(ct)^2-x^2-y^2-z^2}=\sqrt{(ct')^2-x'^2-y'^2-z'^2}$$

(4)

Although the interval is invariant under LT as it stems from SR it has no any physical sense because it can take imaginary values. In contrast with it the vector H stems from the Pyphagoras' theorem and takes real value. The difference between time-like and space-like intervals is appropriate to those cases whether the vector H lies near to the axis w' or to the axis x.



We can take another representation of LT if to notice that the coordinate system K' is moved to the distance Vt for the time t along the axis x as it shown on the Fig.2. Thus the meaning of the LT becomes more clear and the coordinate systems can consider as the reference frames one of them connected with some object situated along the axis w and the other with one along the axis w'. So the dash symbols in the frames cast in the correspondence to the objects belonging to them.



But when we are moving the reference frame K' to the distance Vt we made the Galilean transformation (GT)

$$x'' = x - Vt$$
$$y' = y$$
$$z' = z$$
$$t' = t$$

(5)

where $x'' = x'\sqrt{1 - V^2/c^2}$ is the coordinate of the reference frame K' without such rotation as it has been used above, it is the projecture of x' coordinate on the motion direction.

So the LT can be consider as the result of the two operations, the rotation and the translation. As it is known they are not commute – we will get the different arrangement of the coordinates if we change the order of these operations. Really, for any 4D vectors $\boldsymbol{x}$ and $\boldsymbol{s}$ that don't lie on the plane (y,z) $M\,\boldsymbol{x}+\boldsymbol{s} \neq M\,(\boldsymbol{x}+\boldsymbol{s})$

So the picture shown on Fig.2 can be obtained by the translation on the distance Vt along the axis x and the rotation of system K' on the angle α. Therefore the LT for the space coordinate looks like GT because the rotation of the coordinate axis doesn't has any special meaning and the directions of coordinates can be chose freely without any dependence from each other.

But here the next paradox appears. The directions of the axis in both frames were already chose coincided in the very beginning. What the rotation is spoken about? And why this turning is occurred on the angle dependent from the velocity?

The first answer is that the proposed method of reducing of the LT to the GT is not correct and the second is that the whole theory of relativity is a fault because it leads to the rotation of the axes. But this turning of the axes is fully artificial and so the coordinate transformation based on it has no meaning.

We do not consider here these variants and take into account the next possibility.

As it known there are two kinds of any transformation, active and passive. The former is related to the changing of the position of some objects in the fixed coordinate system and the latter is the change of basis, the transition from one coordinate system to another. While there is no actual changing of the orientation axis to be implicated, the rotation by the matrix (3) must be fell into the first case. Then the other question is arose: what the object is involved in the rotation dependent from the velocity?

In the mathematics the points of the axis w can be taken as this object. But if we are considering the physical object moving along the axis x we are to conclude that this object is the body with whom the reference frame K' is tagged together. But in the contrast with the ordinary 3D body it has the extension to the fourth dimension. It looks like the string in the multidimensional string theory displacing in the empty space in the horizontal direction. Otherwise we can interpret it as the 4D whirl in some medium filled the bottom half space below the axis x. It is even the case considered in the model of the 4D medium [1].

In this model the Universe is the 4D matter situated in the closed region of the space. It has the spherical shape in general. So the pictures shown above are the local part of the Universe where one can ignore the curvature of the 3D surface. The fundamental particle is represented by the 4D vortex or roughly by the one-dimensional curve vortex line in the 4D matter. It will move if it has some slope from the direction of the normal to 3D surface. For the straight vortex line the velocity of movement V is equal to $c\sin\alpha$.

If there is no any real rotation of the coordinate axes, the distance x' in LT must be considered as fully imaginary. It is correspondent to the distance in the rotated coordinate system K' where the moving vortex line is situated normally to the new axis x'. But there is only one coordinate system where the vortexes are at the rest and situated normally to the 3D surface, the absolute reference frame K. There can not be another real 3D surface in the Universe. And therefore the time t' is not the real time lapsed in the moving frame.

What we have in the Universe when we consider the LT? There are two vortexes at rest at the distance x from one to another and one moving vortex passed the distance Vt from the common starting point. So the event of SR that is happened at the point x at the time t is nothing else as the approach of the vortex from one rest vortex to another. We consider the space-like situation here. The rest observer at the starting point sees that there left the distance x - Vt to pass for the moving body. Of cause, the same distance would be passed for the same time for the observer moving together with the moving vortex. Again only if the rotation of the coordinate system of the frame K' would be occurred the distances for moving observer enlarges by the factor $1/\sqrt{1-V^2/c^2}$. But there is no rotation and therefore there is no neither enlargement, nor contraction. Then the times needed to pass such distance will not be greater by this factor too and the famous time delay will not be happened.

Thus the sense of the LT and the SR on the whole lies in the same essence of the nature. The Universe we all are living has four spatial dimensions. Three of them are composed our visible World where the axes x,y and z can be taken as the basis and it is the boundary surface of the Universe. The fourth axis w is directed into the invisible part of the Universe. The 4D matter forms all Universe in contrast to the so called “dark matter” that is supposed to be concentrated near the galaxies. It also can't be associated with the “dark energy” that stems from the alleged “expansion of the Universe”. There is no any significant changing in the size of Universe if the explanation of the redshift for the distant galaxies given in [3] takes into account.

The alleged null result of the Mickelson-Morley experiment is the third order with respect to the ratio V/c as it was shown in [2]. So this experiment can not be considered as the evidence of the absence of the so called “ether wind”. The traditional 3D ether that was finding for so many time is the boundary surface of the Universe.

[1] V.Skorobogatov, SR and the model of 4D medium. (in Russian)
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[2] V.Skorobogatov, The Michelson-Morly experiment in the model of the 4D matter
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