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The Connection of the Theory of Time with the Direct and Reverse Flow of Time, Manifested in the Lorentz Transformations

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ABSTRACT

The article provides a derivation of dual equations of time. Based on the wave part, Lorentz transformations are derived and a transition is made to coordinate rotation formulas in a 4-dimensional pseudo-Euclidean space. Mathematical forms of direct and reverse flows are described based on the full dual equation, in which the postulate of the constancy of the speed of light in a vacuum is fulfilled.

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Introduction.

In the previous articles of the author [1, 2] the derivations of the basic equations of physics based on the theory of time were shown. In this article the derivation of formulas of the most important section of physics based on the special theory of relativity (STR) is continued. A. Einstein In 1905 published the special theory of relativity. Since then, it has not undergone any changes. Moreover, in the scientific world it is considered a theory verified in all aspects, and its application in modern physics is mandatory at relativistic speeds of motion. But attempts to refute it do not stop to this day. The reason for this is Einstein's postulate on the impossibility of overcoming the speed of light in a vacuum. This postulate is formulated in verbal form and does not appear directly in the formulas of STR. The basis of the theory is the Lorentz transformations. They relate the coordinates of space and time in a stationary and moving frame of reference. In this case, time is considered a one-dimensional parameter. Its nature is not studied. The author does not try to refute the STR in his work. Based on the theory of time, he proposes a new approach to the derivation of these transformations. But as shown in the article, the Lorentz transformations are only the observed part of the manifestation of the properties of time. Its internal structure is inaccessible to observations. But it can be studied by mathematical methods. The main method of description is a two-dimensional system of rectangular coordinates, in which the time vector is defined . The vector exists in two-time dimensions and, projected onto the coordinate axes, yields spatial and temporal projections.

The spatial projection ψ is understood as the proper time of space. Multiplied by the speed of light, it becomes a metric state and determines the spatial radius $l = c\psi$ of a spherical wave. It can be expressed through metric coordinates x,y,z. The temporal projection is understood as the proper time. Multiplied by the speed of light, it becomes a metric coordinate $s = c\tau$, which is always perpendicular to the coordinate l and is the fourth dimension of space-time. The position of the time vector relative to the coordinate axes plays a major role in deriving transformations. In the general theory of time, it is accepted that the vector has an angle of inclination to the proper time axis. However, in deriving we will use the angle β, which is adjacent to the angle and is measured from the spatial projection.

Criticism of the derivation of Lorentz Transformations

The section is taken entirely from the author's work [3]. Its inclusion in the article is necessary to show the differences in the classical and proposed approaches. "As is known, the special theory of relativity was created by A. Einstein based on two postulates. The first postulate states that in any inertial reference system, all physical phenomena under the same conditions proceed in the same way. The second postulate states that the speed of light in a 3-dimensional vacuum is always the same and does not depend on the speed of the source. Based on the postulates, it is proven that time and space change in a moving translational inertial reference system. To prove this, a situation with the emission of light by two sources is given. At the moment $t_1 = t_2 = 0$ a portion of light comes out from the common origin of coordinates of both systems K_1, K_2 and comes to the point M, having coordinates x_1, y_1, z_1, t_1 and x_2, y_2, z_2, t_2 .

The situation is shown in Figure 1 and described in many sources, for example, in [5].

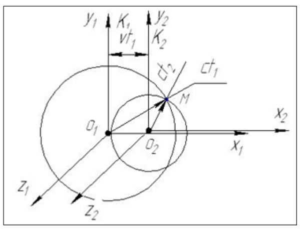


Figure 1: Propagation of two spherical waves according to STR

It is clear from the figure that time passes faster in the moving frame of reference than in the stationary one. Both wave fronts intersect at point M. The following equalities follow from the result obtained:

$$r_1^2 = x_1^2 + y_1^2 + z_1^2 = (ct_1)^2$$
$$r_2^2 = x_2^2 + y_2^2 + z_2^2 = (ct_2)^2$$

For reasons of symmetry $y_1 = y_2;\ z_1 = z_2$ Equalities are equal if their right and left sides are different:

$$0 = x_1^2 - (ct_1)^2 = x_2^2 - (ct_2)^2 \qquad (4.1)$$

The formulas of linear transformations of coordinates and time, which include unknown coefficients, are substituted into this equality. The values of the coefficients are found from the resulting equations, and the formulas take the form of Lorentz transformations. This is the classical approach to transformations. But the transformations themselves are not entirely correct. Let us criticize the derivation of Lorentz transformations from the well-known series of books [4]. It is based on the rotation of a 4-dimensional coordinate system x, y, z, t in 4-dimensional space. Let us quote the text from the book.

"Every rotation in 4-dimensional space can be decomposed into six rotations, namely:
xy , zy , xz , tx , ty , tz The first three of these rotations transform only spatial coordinates; they correspond to ordinary spatial rotations. Consider a rotation in the plane tx ; coordinates y and z do not change. This transformation must leave unchanged, in particular $(ct)^2 - x^2$ - square of "distance" from a point (ct, x) to the origin of coordinates. The relationship between the old and new coordinates in this transformation is given in the most general form by the formulas

$$x = x'ch\psi + ct'sh\psi, \quad ct = x'sh\psi + ct'ch\psi \qquad (4.2)$$

Where ψ is the "angle of rotation"; a simple check can easily verify that this will indeed be the case $(ct)^2 - x^2 = (ct')^2 - x'^2$ Formulas (4.2) differ from the usual transformation formulas when the coordinate axes are rotated by replacing trigonometric functions with hyperbolic ones. This is where the difference between pseudo-Euclidean geometry and Euclidean geometry is manifested.

We are looking for transformation formulas from an inertial reference frame K to the system K' ,which moves relatively K with speed V along the axis . In this case, obviously, only the coordinate x and time t are transformed. Therefore, this transformation must be of the form (4.2). It remains to determine the angle ψ ,which can depend only on the relative velocity V .

Let us consider the motion K in the coordinate system of the reference frame K' . Then $x' = 0$ and formulas (4.2) take the form:

$$x = ct'sh\psi, \quad ct = ct'ch\psi$$

or, dividing one by the other,

$$\frac{x}{ct} = th\psi,$$

But x/t there is, obviously, the speed of the system K' relative to K Thus,

$$th\psi = \frac{V}{c} \qquad (4.2)$$

From here

$$sh\psi = \frac{\frac{V}{c}}{\sqrt{1-\frac{V^2}{c^2}}} \qquad ch\psi = \frac{1}{\sqrt{1-\frac{V^2}{c^2}}}$$

Substituting into (4.2), we find:

$$x = \frac{x' + Vt'}{\sqrt{1-\frac{V^2}{c^2}}}, \quad y = y', \quad z = z', \quad t = \frac{t' + \frac{V}{c^2}x'}{\sqrt{1-\frac{V^2}{c^2}}}, \qquad (4.3)$$

These are the desired transformation formulas. They are called Lorentz transformation formulas, and are of fundamental importance for what follows.

Inverse formulas expressing x', y', z', t' through x, y, z, t are most easily obtained by replacing V with $-V$ (since the system K moves relatively K' with velocity $-V$ These same formulas can be obtained by directly solving equations (4.3) relative to x', y', z', t'

Unfortunately, the authors do not provide the inverse Lorentz transformations. And in vain. They have the form:

$$x' = \frac{x - Vt}{\sqrt{1-\frac{V^2}{c^2}}}, \quad y = y', \quad z = z', \quad t' = \frac{t - \frac{V}{c^2}x}{\sqrt{1-\frac{V^2}{c^2}}}, \qquad (4.4)$$

In the first formula of spatial transformation based on $\frac{x}{ct} = \frac{V}{c} = th\psi$ it follows that $x = Vt$ Hence $x' = 0$. That is, there is no spatial transformation.Then the temporal transformation leads to the result:

$$t' = \frac{t - \frac{V}{c^2}x}{\sqrt{1-\frac{V^2}{c^2}}} = \frac{t - \frac{V}{c^2}Vt}{\sqrt{1-\frac{V^2}{c^2}}} = \frac{t(1-\frac{V^2}{c^2})}{\sqrt{1-\frac{V^2}{c^2}}} = t\sqrt{1-\frac{V^2}{c^2}} \qquad (4.5)$$

From which follows the formula for time dilation in a stationary frame of reference:

$$t = \frac{t'}{\sqrt{1-\frac{V^2}{c^2}}} \qquad (4.6)$$

and the formula for the reduction of length from (4.6) in a moving frame of reference when multiplying both parts by the velocity V .

$$Vt' = x' = x\sqrt{1-\frac{V^2}{c^2}}$$

Here: $Vt' = x'$ is the length of the spatial interval in the moving system; $Vt = x$ is the length of the spatial interval in the stationary system.

From the analysis carried out it follows that the spatial Lorentz transformation does not take place. All changes in length and time are determined by the temporal Lorentz transformation."

From the presented material it follows that the purpose of the Lorentz transformations is to prove the invariance of the time-like interval $s > 0$,which replaces the zero value of the squares of the differences between time and space.

$$s^2 = (ct)^2 - x^2 = (ct')^2 - x'^2$$

At the same time, it is based on Einstein's verbal postulate about the constancy of the speed of light in a vacuum. Vacuum is a rarefied medium filling space. Therefore, the introduced postulate should be expressed mathematically when deriving this interval and take into account the speed of light in space, not in time. But there is no conclusion. There is a statement that the introduced designation is an invariant. Mathematical transformations are applied to it, which seem to correspond to the theory.

Time in the Space-Time World
In order to obtain the patterns inherent in our world, it is necessary to begin with the study of the spatial world. It is a projection of a time vector, the modulus of which can be written in the form

accepted in Euclidean geometry and time theory [1].

$$ct = \sqrt{l^2 + s^2} \tag{1}$$

Where $l = ct\sin\varphi,\ s = ct\cos\varphi$.

Here the angle φ is measured from the axis s We will be interested in the position of the time vector relative to the axis l characterized by the angle of inclination β The relationship between the angles is given by the dependence: $\varphi = 90° - \beta$ Substituting it into the connection formulas, we get them in the form we need:

$$l = ct\cos\beta = vt\,;\quad s = ct\sin\beta = ut\,;\quad s/l = tg\beta \tag{2}$$

Let us establish differential dependencies between the duration vector and its coordinates. Differentiating (1), we obtain:

$$dct = d\sqrt{s^2 + l^2} = \frac{2(sds + ldl)}{2\sqrt{s^2 + l^2}} = \frac{sds + ldl}{ct} \tag{3}$$

We bring it to a form that we will call the dual equation:

$$ct = \sqrt{s^2 + l^2} = \frac{sds + ldl}{dct} = \frac{sds}{dct} + \frac{ldl}{dct} = s\dot{s} + l\dot{l} \tag{4}$$

As we see, the duration vector module includes two derivatives, which we will call tempos. The first tempo is temporal $\dot{s} = ds/cdt$. The second is spatial $\dot{l} = dl/cdt$. We will solve (4) together, raising both parts to the square. After the transformation, we obtain a dual equation in the form:

$$s^2(1 - \dot{s}^2) + l^2(1 - \dot{l}^2) = 2(l\dot{l})(s\dot{s}) \tag{5}$$

It connects coordinates and tempos in space-time or the continuum of a horizontal hyperplane in a general form. But in this form the found regularity does not manifest itself, since nature has simplified the approach by setting the maximum speed in 3-dimensional space equal to the speed of light. This condition is fulfilled if the spatial tempo is equal to one.

$$\dot{l} = \frac{dl}{cdt} = 1 \text{ или } \frac{dl}{dt} = c \tag{6}$$

In this case, the dual equation is simplified:

$$s(1 - \dot{s}^2) = 2l\dot{s} \tag{7}$$

Tangential Equation of Tempos

From equation (7) we arrive at the tangential equation of rates in the horizontal hyperplane:

$$\frac{s}{l} = tg\beta = \frac{2\dot{s}}{1 - \dot{s}^2} \tag{8}$$

The equation is reduced to a quadratic equation and has two roots:

$$\dot{s}^2 + 2\dot{s}ctg\beta - 1 = 0$$

The first root determines the direction of the direct flow of time:

$$\dot{s}_1 = -ctg\beta + \frac{1}{\sin\beta} = \frac{-\cos\beta + 1}{\sin\beta} = \frac{2\sin^2\frac{\beta}{2}}{2\sin\frac{\beta}{2}\cos\frac{\beta}{2}} = tg\frac{\beta}{2} \tag{9}$$

The second is the direction of the reverse flow:

$$\dot{s}_2 = -ctg\beta - \frac{1}{\sin\beta} = -\frac{\cos\beta + 1}{\sin\beta} = -\frac{2\cos^2\frac{\beta}{2}}{2\sin\frac{\beta}{2}\cos\frac{\beta}{2}} = -ctg\frac{\beta}{2} \tag{10}$$

The roots define the dual equations of time flows.

Direct flow

$$\dot{s}_1 = -ctg\beta + \frac{1}{\sin\beta} = -\frac{l}{s} + \frac{ct}{s} = \frac{-l + ct}{s} \text{ или } ct = \sqrt{s^2 + l^2} = l + s\dot{s}_1 \tag{11}$$

Reverse flow

$$\dot{s}_2 = -ctg\beta - \frac{1}{\sin\beta} = -\frac{l}{s} - \frac{ct}{s} = \frac{-l - ct}{s} \text{ или } -ct = c\bar{t} = -\sqrt{s^2 + l^2} = l + s\dot{s}_2 \tag{12}$$

The sum of the roots is the sum of the tempos:

$$\dot{s}_1 + \dot{s}_2 = tg\frac{\beta}{2} - ctg\frac{\beta}{2} = -2ctg\beta = -2\frac{l}{s} \tag{13}$$

The product of the roots is:

$$\dot{s}_1 \cdot \dot{s}_2 = -1 \tag{14}$$

The obtained result indicates that the direct flow of time necessarily corresponds to the reverse flow. The flows interact, moving relative to each other. It should be noted that the tempo, taking into account the spatial derivative, can be written as:

$$\dot{s} = \frac{ds}{cdt} = \frac{ds}{dl} \cdot \frac{dl}{cdt} = \frac{ds}{dl} \tag{15}$$

Sinusoidal Equation of Tempo

Along with the tangential equation, there is a sinusoidal equation of tempos. It can be obtained on its basis. In fact, we will use the relationship formula $s = ct\sin\beta$ and apply the right-hand side of (11) to it:

$$\sin\beta = \frac{s}{ct} = \frac{s}{l + s\dot{s}_1} = \frac{1}{ctg\beta + \dot{s}_1} = \frac{1}{\frac{1 - \dot{s}_1^2}{2\dot{s}_1} + \dot{s}_1} = \frac{2\dot{s}_1}{1 + \dot{s}_1^2} \tag{16}$$

As a result, we obtained the connection between the tempo and the sine of the angle in the form of an equation, which we will call the sinusoidal equation of tempos. In order to reveal the presence of a second tempo, we will reduce it to a quadratic equation:

$$\dot{s}^2 - \frac{2\dot{s}}{\sin\beta} + 1 = 0 \tag{17}$$

Its roots satisfy Vieta's theorem:

$$\dot{s}_1 + \dot{s}_2 = \frac{2}{\sin\beta};\quad \dot{s}_1 \cdot \dot{s}_2 = 1 \tag{18}$$

As we see, the first and second rates are positive reciprocal quantities with the same signs. The solution of the equation leads to two roots:

$$\dot{s}_{1,2} = \frac{1}{\sin\beta} \pm \sqrt{\frac{1}{\sin^2\beta} - 1} = \frac{1}{\sin\beta} \pm ctg\beta \tag{19}$$

Where

$$\dot{s}_1 = \frac{1}{\sin\beta} - ctg\beta = tg\frac{\beta}{2} \tag{20}$$

$$\dot{s}_2 = \frac{1}{\sin\beta} + ctg\beta = ctg\frac{\beta}{2} \tag{21}$$

If we express (19) through coordinates, we obtain the roots in the form of a formula:

$$\dot{s}_{1,2} = \frac{ct}{s} \pm \frac{\sqrt{(ct)^2 - s^2}}{s} \tag{22}$$

It reduces to equations describing two non-Euclidean spatial metrics.
First metric:

$$ct - s\dot{s}_1 = \sqrt{(ct)^2 - s^2} = l_1 \tag{23}$$

The second metric

$$s\dot{s}_2 - ct = \sqrt{(ct)^2 - s^2} = l_2 \tag{24}$$

The first describes the direct flow, and can be obtained from the mathematical expression for the postulate of the constancy of the speed of light in a vacuum $dl_1 / d(ct) = 1$, where $l_1 = \sqrt{(ct)^2 - s^2}$.

where $l_2 = -\sqrt{(ct)^2 - s^2}$ After differentiation, we arrive at the dual equation with metric (24).

Thus, it is shown that the application of the postulate of the constancy of the speed of light in a vacuum leads not to a time-like interval *s*, used in STR, but to a spatial interval, which is the basis for the future transition to the interval *s*.

The tempo function of the cosine can be determined from two known tempo functions of the sine (16) and tangent (8):

$$\frac{l}{ct} = \cos\beta = \frac{\sin\beta}{tg\beta} = \frac{1 - \dot{s}_1^{\,2}}{1 + \dot{s}_1^{\,2}} = \frac{1 - tg^2\dfrac{\beta}{2}}{1 + tg^2\dfrac{\beta}{2}} \tag{25}$$

The formula can be expressed in terms of direct tempo:

$$\dot{s}_1 = tg\frac{\beta}{2} = \pm\sqrt{\frac{1-\cos\beta}{1+\cos\beta}} = \pm\sqrt{\frac{1-\dfrac{v}{c}}{1+\dfrac{v}{c}}} \tag{26}$$

It plays an important role in deriving the Lorentz transformations and will be applied below. In the form found, the direct tempo plays the role of the longitudinal Doppler effect when the source is removed.

Derivation of Lorentz Transformation Formulas from the Theory of Time

Let us proceed to the derivation of Lorentz transformations. As in the classical approach, we will consider the fixed and moving reference systems, which are placed in the Euclidean 4-dimensional space. We will give the following definitions.

4-dimensional Euclidean space-time is represented as a spherical wave of radius *ct* which is defined in the system of 2-dimensional metric chronocoordinates *l,s*

The Fixed Reference Frame (NSO) is a coordinate system $y_1x_1z_1$ that describes a 3-dimensional spherical spatial wave of radius *l* placed in a 4-dimensional space. The wave propagates at the speed of light in the proper time ψ of three-dimensional space, coinciding with the direction of the time vector and is described by the equation:

$$(od)^2 = l^2 = x_1^2 + y_1^2 + z_1^2 = (c\psi)^2$$

A Moving Frame of Reference (MFR) is a frame $y_2x_2z_2$ of reference that moves in 4-dimensional space with constant velocity along the metric time vector *ct* such that its axes are parallel to the axes of the stationary frame of reference $y_1x_1z_1$

The presence of a constant velocity *v* is equivalent to the cosine of the angle β between the projection direction ψ and the time vector *t*.

The wave motion diagram is presented in general form in Figure 2a, which shows projections *l,s* from the vector *ct.*

Based on this scheme, we will consider two cases that prove the validity of the Lorentz transformations. The first case is associated with the propagation of a spherical 3-dimensional wave in the NSO in the proper time of space ψ i.e. inside the wave in the NSO.

The second case is associated with the propagation of the same wave beyond the wave in the NSO.

Let us consider the derivation of the Lorentz transformations for the first case. We will take the relation formulas (2) as the basis for the derivation. Where will prove that the first formula $l = ct\cos\beta$ describes the processes of light emission by a moving source moving relative to a stationary source at a constant speed *v.*

Let us substitute into it the right (wave) part of the tangential dual equation (11).

$$l = c\psi = ct\cos\beta = (c\psi + c\tau\dot{s}_1)\cos\beta = c\psi\cos\beta + \dot{s}_1(c\tau \cdot ctg\beta)\sin\beta \tag{27a}$$

We introduce the following notations:
$v = c\cos\beta$ - constant speed of movement of the inertial reference system along the axis

coinciding with the direction of the time vector;

$c(\tau ctg\beta) = c\psi = l$ - spatial 3-interval as a vector projection ct .

Then the formula takes the form:

$$l = c\psi = c\psi\cos\beta + \dot{s}_1(c\tau \cdot ctg\beta)\sin\beta = v\psi + l\dot{s}_1\sin\beta \tag{27b}$$

Let us show that it is a formula for the spatial Lorentz transformation. Let us write it in the form:

$$l - v\psi = l\dot{s}_1 \sin\beta \tag{28a}$$

We introduce the following designations of spatial coordinates shown in Figure 4:

$od = ob = on = x_1 = l = c\psi$ - coordinate of 3-space in a fixed frame of reference (FFR);

$ak = b\mathring{a} = x_2 = l\dot{s}_1 = x_1\dot{s}_1$ coordinate of 3-space in a moving frame (PSO);

$\grave{a}b = \Delta x_1 = x_1 - v\psi = x_1 - r$ - increment of part of coordinate.

$op = ct = ob + bd = l + s\dot{s} = x_1 + ct_1$ - a time vector describing 3+1 space-time in metric form.

Then we can write:

$$x_2 = \frac{x_1 - v\psi}{\sin\beta} = \frac{\Delta x_1}{\sin\beta} = \frac{x_1 - v\psi}{\sqrt{1 - \dfrac{v^2}{c^2}}} \tag{28b}$$

The formula is presented graphically in Figure 2a. It can be seen from it that $\Delta x_1 = x_2 \sin\beta$

From the introduced notations it is clear that $x_2 = x_1\dot{s}_1$ or $x_1 \neq x_2$ due to the presence of the derivative $\dot{s}_1$. From the notation in the figure, it follows:

$$\frac{be}{ob} = \frac{x_2}{x_1} = \dot{s}_1 = \frac{ds}{dl} = tg\frac{\beta}{2}$$

Formula (26) shows that the derivative expresses the longitudinal Doppler effect as the source moves away.

$$\frac{x_2}{x_1} = \dot{s}_1 = tg\frac{\beta}{2} = \sqrt{\frac{1-\cos\beta}{1+\cos\beta}} = \sqrt{\frac{1-\dfrac{v}{c}}{1+\dfrac{v}{c}}} = \sqrt{\frac{c-v}{c+v}} < 1 \tag{29}$$

As we can see, the coordinate x_2 in a wave in a moving system is always less than the coordinate x_1 in a stationary system due to the longitudinal Doppler effect.

Let us proceed to the derivation of the Lorentz time transformation. We will use the wave part of the dual tangential equation of the direct time flow (11), representing it in the form:

$$t = \psi + \tau\dot{s}_1 = \frac{l}{c} + \frac{s}{c}\dot{s}_1$$

Let's express it l in the form:

$$l = c\psi = vt = v(\psi + \tau\dot{s}_1) = v\psi + v\tau\dot{s}_1$$

Substituting, we get:

$$ct = s\dot{s}_1 + l = c\tau\dot{s}_1 + (v\psi + v\tau\dot{s}_1) = \tau\dot{s}_1(c+v) + v\psi$$

Let's apply the tempo formula expressed through the longitudinal Doppler effect:

$$ct = \tau\dot{s}_1(c+v) + v\psi = \tau\sqrt{\frac{c-v}{c+v}}(c+v) + v\psi = \tau\sqrt{c^2 - v^2} + v\psi$$

From where we arrive at the time transformation taking into account the notation for $x_1 = c\psi = vt$

$$\tau = \frac{ct - v\psi}{c\sqrt{1-\dfrac{v^2}{c^2}}} = \frac{t - \dfrac{v}{c}\psi}{\sqrt{1-\dfrac{v^2}{c^2}}} = \frac{t - \dfrac{v}{c^2}(c\psi)}{\sqrt{1-\dfrac{v^2}{c^2}}} = \frac{t - \dfrac{v}{c^2}x_1}{\sqrt{1-\dfrac{v^2}{c^2}}} \tag{30}$$

Formulas (28b) and (30) are formulas very similar to the Lorentz transformations for coordinates and time in a moving frame of reference. They differ from the classical transformations in that the time t in (30) is not equal to the time ψ in (28b).

In classical formulas this difference is not taken into account. It is assumed there that. Then formula (28b) takes the form:

$$x_2 = \frac{x_1 - v\psi}{\sqrt{1-\dfrac{v^2}{c^2}}} = \frac{x_1 - vt}{\sqrt{1-\dfrac{v^2}{c^2}}}$$

But since $x_1 = vt$, we end up with a zero value x_2=0. This discrepancy follows from formula (4.4), the derivation of which is given in [4].

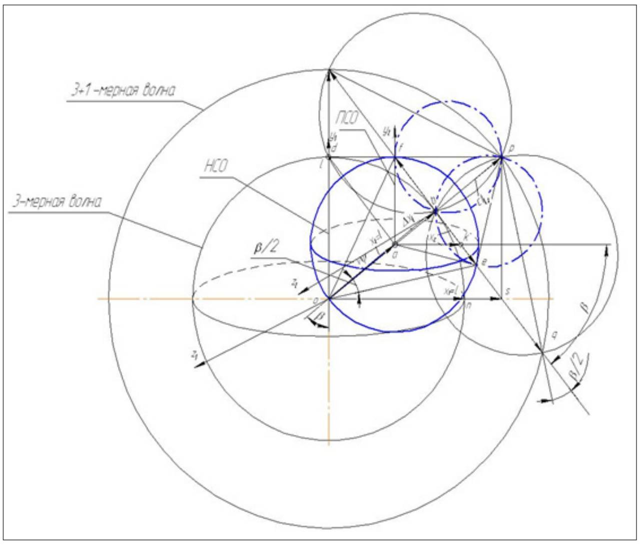


Figure 2: Diagram of the motion of a spherical light wave inside a 4-dimensional wave in fixed and moving reference systems.

Let us continue our study of formula (30). Substituting the expression for into it, we obtain:

$$\tau = \frac{t - \dfrac{v}{c^2}x_1}{\sqrt{1-\dfrac{v^2}{c^2}}} = \frac{t - \dfrac{v}{c^2}vt}{\sqrt{1-\dfrac{v^2}{c^2}}} = \frac{t(1-\dfrac{v^2}{c^2})}{\sqrt{1-\dfrac{v^2}{c^2}}} = t\sqrt{1-\frac{v^2}{c^2}} \tag{31}$$

From this follows the formula for the “slowing down” of time t compared to its projection τ :

$$t = \frac{\tau}{\sqrt{1-\dfrac{v^2}{c^2}}} \tag{32}$$

Let us consider the derivation of Lorentz transformations for the second case, i.e. beyond the 3-dimensional wave in the NPO. For this, we will use the condition (6) of the constancy of the speed of light $dl/cdt=1$. We consider it as a differential equation, for the integration of which we apply the following initial conditions: $l=0$; $ct(0)=ct_1$. After integration, we get:

$$l=ct-ct_1$$

We find t

$$t=\psi+t_1 \tag{33}$$

As we can see, the vector consists of two segments. The first segment describes time in the space of the 3-dimensional wave NSO. The second segment t_1 describes time outside this space. Then, multiplying the formula by the speed of light, we get taking into account $l=c\psi=x_1$

$$ct=c\psi+ct_1=l+ct_1=x_1+ct_1 \tag{34}$$

Where $ct_1 = b_p$ (see Figure2)

Substituting into the formula for the general time transformation (30), we obtain:

$$\tau=\frac{t-\frac{v}{c}\psi}{\sqrt{1-\frac{v^2}{c^2}}}=\frac{\psi+t_1-\frac{v}{c}\psi}{\sqrt{1-\frac{v^2}{c^2}}}=\frac{\psi+t_1-\frac{v}{c^2}c\psi}{\sqrt{1-\frac{v^2}{c^2}}}=\frac{\psi+t_1-\frac{v}{c^2}x_1}{\sqrt{1-\frac{v^2}{c^2}}}$$

Where

$$\Delta\tau=\tau-\frac{t_1}{\sqrt{1-\frac{v^2}{c^2}}}=\frac{\psi-\frac{v}{c^2}x_1}{\sqrt{1-\frac{v^2}{c^2}}}=\frac{\psi-\frac{v}{c^2}c\psi}{\sqrt{1-\frac{v^2}{c^2}}}=\frac{\psi-\frac{v\psi}{c}}{\sqrt{1-\frac{v^2}{c^2}}}=\frac{\psi-\psi\cos\beta}{\sqrt{1-\frac{v^2}{c^2}}}=\frac{\psi(1-\frac{v}{c})}{\sqrt{1-\frac{v^2}{c^2}}}=\psi\cdot tg\frac{\beta}{2} \tag{35}$$

Time can be found from it t_1 :

$$t_1=\tau\sin\beta-\psi\cdot tg\frac{\beta}{2}\sin\beta=2\tau\sin\frac{\beta}{2}\cos\frac{\beta}{2}(1-\frac{\psi\cdot\sin\frac{\beta}{2}}{\tau\cos\frac{\beta}{2}})=\tau\sin\beta(1-\frac{l\cdot tg\frac{\beta}{2}}{s})=\tau\sin\beta(1-ctg\beta\cdot tg\frac{\beta}{2})$$

We express the cotangent through a half angle:

$$t_1=\tau\sin\beta(1-\frac{1-tg^2\frac{\beta}{2}}{2tg\frac{\beta}{2}}\cdot tg\frac{\beta}{2})=\tau\sin\beta(1-\frac{1-tg^2\frac{\beta}{2}}{2})=\frac{1}{2}\tau\sin\beta(1+tg^2\frac{\beta}{2})=\tau\frac{\sin\beta}{1+\cos\beta}=\tau\cdot tg\frac{\beta}{2}$$

As we can see, the times t_1 and $\Delta\tau$ are a consequence of the Doppler effect:

$$\frac{\Delta\tau}{\psi}=\frac{t_1}{\tau}=tg\frac{\beta}{2}=\sqrt{\frac{1-\frac{v}{c}}{1+\frac{v}{c}}} \tag{38}$$

The obtained formula describes the case of a change in the proper time in the PSO due to the Doppler effect when the moving frame of reference is removed. We will show that the coordinate x_2 is expressed through time $\Delta\tau$ Multiplying both parts by the speed of light, we arrive at the previous notation for x_2 :

$$x_2=c\Delta\tau=c\psi\cdot tg\frac{\beta}{2}=x_1\cdot tg\frac{\beta}{2}=x_1\dot{s}_1$$

To prove the change in time in the PSO, we use the formula for changing the distance (28b). From it we find $\Delta\tau$:

$$\Delta\tau=\frac{x_2}{c}=\frac{x_1-v\psi}{c\sqrt{1-\frac{v^2}{c^2}}}=\frac{c\psi-v\psi}{c\sqrt{1-\frac{v^2}{c^2}}}=\frac{\psi-\frac{v}{c}\psi}{\sqrt{1-\frac{v^2}{c^2}}}=\frac{\psi-\frac{v}{c^2}c\psi}{\sqrt{1-\frac{v^2}{c^2}}}=\frac{\psi-\frac{v}{c^2}x_1}{\sqrt{1-\frac{v^2}{c^2}}} \tag{36}$$

The formula corresponds to the Lorentz time transformation for the PSO. In this case, the spatial transformation is given by formula (28b). As we can see, both transformations are a special case, following from the formulas of the theory of time.

But let us continue studying the general case, schematically depicted in Figure 2. In addition to the known transformations, the change in time t_1 that occurs after a light wave of radius l. follows from the scheme under consideration. Let us transform the resulting formula (35), writing it as an equation:

$$\Delta\tau=\tau-\frac{t_1}{\sqrt{1-\frac{v^2}{c^2}}}=\tau-\frac{t_1}{\sin\beta}=\psi\cdot tg\frac{\beta}{2} \tag{37}$$

The image $bp = ct_1$ in the form of a vector is shown in Figure 2. Together with the coordinate $bd = \pm c\Delta\tau$ it forms two symmetrical circular waves (depicted by dashed-dotted circles)

belonging to a 4-dimensional space. From the obtained relationship follows the relationship between $\Delta\tau$ and t_1 :

$$\Delta\tau = t_1\frac{\psi}{\tau} = t_1 \cdot ctg\beta \tag{39}$$

Let us establish the dependencies between times ψ and t_1, which follow from the definition of a time interval

$\Delta\tau$: $\Delta\tau = \psi \cdot tg(\beta/2) = t_1 ctg\beta$ Where

$$\frac{\psi}{t_1} = \frac{ctg\beta}{tg\frac{\beta}{2}} = ctg\frac{\beta}{2} \cdot ctg\beta = \frac{1-tg^2\frac{\beta}{2}}{2tg^2\frac{\alpha}{2}} \tag{40}$$

Multiplying by c we find the speed in a stationary system over time t_1

$$u_1 = \frac{c\psi}{t_1} = \frac{x_1}{t_1} = \frac{c \cdot ctg\beta}{tg\frac{\beta}{2}} = \frac{u_2}{\dot{s}} \tag{41}$$

Where $u_2 = c \cdot ctg\beta$ is the speed in time t_1 in a moving frame of reference.

Let's express u_2 it through the coordinate x_2

$$u_2 = c \cdot ctg\beta = \frac{x_1 tg\frac{\beta}{2}}{t_1} = \frac{x_2}{t_1} \tag{42}$$

Along with the found velocities in time t_1, which is the time of the future, flowing beyond the 3-space, there are velocities in time of the present, arising within the 3-space. These velocities are derived from the found Lorentz transformations by differentiation and lead to the known formulas for the addition of velocities [5]. We will give a derivation for the direction in time using (28b) and (36):

$$dx_2 = \frac{dx_1 - vd\psi}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{(\frac{dx_1}{d\psi} - v)d\psi}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{(v_{1x} - v)d\psi}{\sqrt{1-\frac{v^2}{c^2}}};$$

$$d(\Delta\tau) = \frac{d\psi - \frac{v}{c^2}dx_1}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{(1-\frac{v}{c^2}\frac{dx_1}{d\psi})d\psi}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{(1-\frac{vv_{1x}}{c^2})d\psi}{\sqrt{1-\frac{v^2}{c^2}}}$$

By dividing the first differential by the second, we find the desired formula.

$$v_{2x} = \frac{dx_2}{d(\Delta\tau)} = \frac{v_{1x} - v}{1 - \frac{vv_{1x}}{c^2}} \tag{43}$$

In this formula the speeds are equal to the speed of light $v_{2x} = v_{1x} = c$ This result follows logically from the considered motion of the light wave.

Transition from Euclidean to Non-Euclidean Geometry in Lorentz Transformations

The Lorentz transformation formulas considered above are obtained on the basis of trigonometric functions. This is how they differ from classical transformations, which use an approach using non-Euclidean geometry. Let us show that the theory of time allows us to translate trigonometric dependencies into hyperbolic ones, which completely coincide with the formulas of STR. To do this, let us consider the sinusoidal dual equation for the direct flow (23). Let us use the mathematical expression for the postulate of the constancy of the speed of light, considering it as a differential equation and integrating at $l(0) = 0$ and $ct(0) = R$ Where receive

$$l = ct - R$$

The result can be viewed as the wave part of the dual equation (23)

$$l = \sqrt{(ct)^2 - s^2} = ct - s \cdot \dot{s}_1 = ct - R \tag{44}$$

It follows from this that $s \cdot \dot{s}_1 = R$

Let us express the introduced notation through a direct tempo.

$$\dot{s}_1 = \frac{ds}{dct} = \frac{R}{s} \tag{45}$$

Integrating under the initial conditions $t(0) = 0$, $s(0) = R$, where *R=const,* we obtain a parabolic function:

$$\frac{s^2}{2R} + \frac{R}{2} = ct \tag{46a}$$

The lower parabola corresponds to it.

$$l_1 = ct - R = \frac{s^2}{2R} - \frac{R}{2} \tag{46b}$$

Similar functions follow from the joint solution of the dual equation.

Let us consider the inverse tempo: $R = s\dot{s}_1 = s/\dot{s}_2$

Where

$$\dot{s}_2 = \frac{ds}{cdt} = \frac{s}{R} \tag{47}$$

Integrating under the same initial conditions as above, we obtain a solution in the form of an exponential function:

$$s = Re^{\frac{ct-R}{R}} = Re^{(\frac{l}{R})} \tag{48}$$

Where $ct = R + l$ is the left-hand side of the dual equation (11).

As can be seen from the obtained formulas, they describe different behavior of time at direct and reverse tempos. If both tempos exist, they can be combined by substituting the reverse tempo function into the direct tempo function. Let's do this:

$$ct = \frac{s^2}{2R} + \frac{R}{2} = \frac{s}{2}(\frac{s}{R_1} + \frac{R}{s}) = \frac{s}{2}(e^{(\frac{l}{R})} + e^{(-\frac{l}{R})}) = s \cdot ch(\frac{l}{R}) \quad (49)$$

Where

$$\frac{s}{ct} = \sin\beta = \sqrt{1 - \frac{v^2}{c^2}} = \frac{1}{ch(\frac{l}{R})} \quad (50)$$

$$\frac{l}{ct} = \cos\beta = \sqrt{1 - \sin^2\beta} = \frac{v}{c} = \sqrt{1 - \frac{1}{ch^2(\frac{l}{R})}} = \frac{sh\frac{l}{R}}{ch(\frac{l}{R})} = th(\frac{l}{R}) \quad (51)$$

$$\frac{s}{l} = tg\beta = \frac{\sin\beta}{\cos\beta} = \frac{\sqrt{1 - \frac{v^2}{c^2}}}{\frac{v}{c}} = \frac{1}{ch(\frac{l}{R}) \cdot th(\frac{l}{R})} = \frac{1}{sh(\frac{l}{R})} \quad (52)$$

As we see, trigonometric functions become equal to inverse hyperbolic functions. Such dependencies can be expressed through the speed v :

$$\cos \quad = th(\frac{l}{R}) = \frac{v}{c} \quad \frac{1}{\sin\beta} = ch(\frac{l}{R}) = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \quad ctg\beta = sh(\frac{l}{R}) = \frac{v}{c\sqrt{1 - \frac{v^2}{c^2}}} \quad (53)$$

They correspond exactly to the coefficients (4.2a) included in the Lorentz transformations. Obtained using two-time rates, they lead to the occurrence of the proper time interval adopted in STR. Indeed, from the formulas it follows:

$$ct = s \cdot ch(\frac{l}{R}) \text{ и } l = s \cdot sh(\frac{l}{R})$$

Then we obtain the square of the proper time interval:

$$(ct)^2 - l^2 = s^2 \cdot ch^2(\frac{l}{R}) - s^2 \cdot sh^2(\frac{l}{R}) = s^2 \quad (54)$$

It occurs when the argument of the hyperbolic function changes in the proper time of space, i.e. its appearance is affected by the inverse tempo of time. The resulting interval follows from the sinusoidal equation of tempos, provided that the counting of the angle of inclination of the time vector will occur from the axis. Then its appearance will be associated with the constancy of the speed of light in time, and not in a vacuum. In the theory of time, such a postulate corresponds to the definition of homogeneity of time. From this we conclude that the basis of STR, based on the pseudo-Euclidean interval, is an incorrect postulate.

Let us apply the obtained formulas to the transformations of coordinates and time specified by formulas (28b) and (36), in which $x_1 = l$, $x_2 = c\Delta\tau = x_1 \cdot \dot{s}$

Inverse transformations have the form:

$$x_1 = x_2 \sin\beta + v\psi \quad (55)$$

or

$$\psi = \Delta\tau \sin\beta + \frac{v}{c^2} x_1 = \frac{x_2}{c} \sin\beta + \frac{v}{c^2} x_1$$

From where for (55) taking into account (56), we obtain:

$$x_1 = x_2 \sin\beta + v(\Delta\tau \sin\beta + \frac{v}{c^2} x_1) = \sin\beta(x_2 + v\Delta\tau) + \frac{v^2}{c^2} x_1$$

Or

$$x_1(1 - \frac{v^2}{c^2}) = x_1 \sin^2\beta = (x_2 + v\Delta\tau)\sin\beta$$

As a result, we arrive at the formula for the inverse transformation relative to the entered coordinates:

$$x_1 = (\frac{x_2 + v\Delta\tau)\sin\beta}{\sin^2\beta} = \frac{x_2 + v\Delta\tau}{\sqrt{1 - \frac{v^2}{c^2}}} \quad (57)$$

Substituting (55) into (56), we have:

$$\psi = \Delta\tau \sin\beta + \frac{v}{c^2} x_1 = \Delta\tau \sin\beta + \frac{v}{c^2}(x_2 \sin\beta + v\psi) = \sin\beta(\Delta\tau + \frac{v}{c^2} x_2) + \frac{v^2}{c^2}\psi$$

Or

$$\psi(1 - \frac{v^2}{c^2}) = \sin\beta(\Delta\tau + \frac{v}{c^2} x_2)$$

Then we arrive at the formula for the inverse transformation with respect to the entered time:

$$\psi = \frac{\Delta\tau + \frac{v}{c^2} x_2}{\sqrt{1 - \frac{v^2}{c^2}}} \quad (58)$$

Substituting hyperbolic functions into them, we arrive at the formulas:

$$x_1 = \frac{x_2 + v\Delta\tau}{\sin\beta} = (x_2 + v\Delta\tau)ch(\frac{l}{R}) = x_2 ch(\frac{l}{R}) + c\Delta\tau \cdot th(\frac{l}{R}) \cdot ch(\frac{l}{R}) = x_2 ch(\frac{l}{R}) + c\Delta\tau \cdot sh(\frac{l}{R})$$

(59)

$$\psi = \frac{\Delta\tau + \frac{v}{c^2} x_2}{\sin\beta} = (\Delta\tau + \frac{v}{c^2} x_2)ch(\frac{l}{R}) = \Delta\tau ch(\frac{l}{R}) + th(\frac{l}{R}) \cdot \frac{x_2}{c} \cdot ch(\frac{l}{R}) = \Delta\tau \cdot ch(\frac{l}{R}) + \frac{x_2}{c} \cdot sh(\frac{l}{R})$$

(60)

$$x_2 = \frac{x_1 - v\psi}{\sin\beta} = (x_1 - v\frac{l}{c})ch(\frac{l}{R}) = x_1 ch(\frac{l}{R}) - l \cdot th(\frac{l}{R}) \cdot ch(\frac{l}{R}) = x_1 ch(\frac{l}{R}) - c\psi \cdot sh(\frac{l}{R})$$

(61)

$$\Delta\tau = \frac{\psi - \frac{v}{c^2} x_1}{\sin\beta} = (\psi - \frac{v}{c^2} x_1)ch(\frac{l}{R}) = \psi ch(\frac{l}{R}) - th(\frac{l}{R}) \cdot \frac{x_1}{c} \cdot ch(\frac{l}{R}) = \psi ch(\frac{l}{R}) - \frac{x_1}{c} \cdot sh(\frac{l}{R})$$

(62)

Formulas (59) and (60) correspond to the formulas for the rotation of axes in pseudo-Euclidean space (see (4.2)). A simple check by substituting the found formulas can verify that condition (4.1) is satisfied when $t_1 = \psi$, $t_2 = \Delta\tau$:

$$x_1^2 - (c\psi)^2 = x_2^2 - (c\Delta\tau)^2 = 0 \quad (63)$$

That is, there is a zero value of the proper time interval, which is predicted by the conditions of the experiment on the emission of light in a stationary and moving frame of reference. The zero value means that there is no movement along the proper time coordinate. This means that only the proper time of space is taken into account, which is subject to the process of measurement by the clock. The obtained formulas differ from the generally accepted formulas in that time in a stationary coordinate system is the proper time of space, and not just a time parameter in a stationary system. In terms of STR, the obtained difference of squares is the basis for deriving formulas for the transition from one inertial system to another. The formulas are derived based on the linearity of the law for the transformations of space and time coordinates. As a result, the transformation formulas known as Lorentz transformations are obtained.

$$x_1 = \frac{x_2 + vt_2}{\sqrt{1-\frac{v^2}{c^2}}} \quad y_1 = y_2 \quad z_1 = z_2 \quad t_1 = \frac{t_2 + \frac{v}{c^2}x_2}{\sqrt{1-\frac{v^2}{c^2}}}$$

$$x_1 = \frac{x_2 + vt_2}{\sqrt{1-\frac{v^2}{c^2}}} \quad y_1 = y_2 \quad z_1 = z_2 \quad t_1 = \frac{t_2 + \frac{v}{c^2}x_2}{\sqrt{1-\frac{v^2}{c^2}}}$$

It is easy to verify that for the introduced time designations $t_1 = \psi$ and $t_2 = \Delta\tau$ the indicated formulas go into (59) and (60), but not into (28b) and (30). The latter provide for the appearance of a proper coordinate $s > 0$ (see (54). And for the first, this coordinate is equal to zero. A non-zero value of the coordinate in time theory is interpreted as motion in a 4-dimensional Euclidean space, and its zero value is interpreted as motion in a 3-dimensional space, in which the role of time is played by the proper time of the space. In STR, instead of $s > 0$ is used the notation $\bar{s}$, which is interpreted as an interval of events that is "the same in all inertial reference systems, i.e. is an invariant with respect to transformations from one inertial reference system to any other." [4]. It is obtained from equality (63), written in a time-like form, for events in a moving system that occurred at one point in space, i.e. at x_2=0

$$\bar{s}^2 = (c\psi)^2 - x_1^{\;2} = (c\Delta\tau)^2$$

The equality is satisfied when $t = \psi$ $c\Delta\tau = \bar{u}$ и $\bar{x}_1 = \bar{v}t < x_1$ In this case, the shape of the interval takes the form shown in Figure 2c, where $\bar{s} = s'$ and $\bar{v} = v'$

$$\bar{s}^2 = (ct)^2 - (\bar{v}t)^2 = (c\Delta\tau)^2 = (\bar{u}t)^2$$

Thus, STR is a special case of the theory of time, since all Lorentz transformations are performed only using the wave part of the dual equation. From the point of view of the theory, STR works only with three spatial dimensions, in which the spatial radius is defined, and the projection of the time vector onto space. The resulting hyperbolic dependences are functions of the parameter of the proper time of space, depending on the constant number R.

From the point of view of STR, it is a segment $ct_1 = R$ separating a 3-dimensional light wave from a 4-dimensional wave of radius ct.

Chronotrajectories of the Time Vector d in Forward and Reverse Tempos

Dual equation (11) consists of a left and a right part. To derive the Lorentz transformations, we used the right (wave) part. What does the use of the full tangential dual equation (11) with a direct tempo give us? It was previously proven that the lower parabola function (46b) was obtained from the joint solution, which is the deflection of space-time defined in NSO. The section of the parabola along the axis s at l=0 is a segment $s = R$. If we assume that this segment is proportional to the radius of the spatial circle $r = \sqrt{x^2 + z^2}$ then we can assume that this deflection is the cause of the movement of the end of the time vector along a helical line with an absolute velocity $v_{\text{абс}} = c$ To prove this, let us consider the modulus of vector (1), expressing it in terms of constant velocities.

$$ct = \sqrt{l^2 + s^2} = \sqrt{(vt)^2 + (ut)^2} = t\sqrt{v^2 + u^2} = v_{\text{абс}}t \qquad (64)$$

Where $\sqrt{v^2 + u^2} = v_{\text{абс}}$ - the absolute speed of the movement of the end of the time vector. Further, the end of the time vector will be called a point. In the physical sense, the end of the vector can be associated with a particle of time - a chronon.

Let a point move along an axis l with translational velocity $v = c\cos\beta$ and simultaneously perform a rotational motion with linear velocity $u = c\sin\beta$ about the axis l. Linear velocity is expressed by the formula:

$$u = c\sin\beta = \omega \cdot R$$

It follows from this:

$$R = \frac{c\sin\beta}{\omega} \qquad (65a)$$

Then the time coordinate will be written as:

$$s = ct\sin\beta = ut = \omega Rt = (\omega t)R = \theta R = \theta\sqrt{x^2 + z^2}$$

Where $\theta = \omega t$ there is an angle of rotation in time t with angular velocity ω

Then the radius of the circle can be represented as:

$$\frac{s}{\theta} = \frac{ct\sin\beta}{\omega t} = \frac{c\sin\beta}{\omega} = r = \sqrt{x^2 + z^2} \qquad (65b)$$

Where $x = R\cos\theta = R\cos(\omega t)$ and $z = R\sin\theta = R\sin(\omega t)$

Because speed $v = c\cos\beta = const$ then in t a second the point will move along the axis l by a distance

$$l = (c\cos\beta)t = vt$$

Then the equations of motion of the point will take the following form view [6]:

$$x = R\cos(\omega t) \quad z = R\sin(\omega t) \quad l = vt$$

The trajectory of a point in this motion is a helical line. To obtain the equation of the trajectory, we must exclude time t from the equations of motion. To do this, we express it through the angle $\theta = \omega t$ Where $t = \theta / \omega$. Substituting into the formula $l = vt$, we get:

$$l = vt = \frac{v}{\omega}\theta$$

Let the point move along the axis l during one revolution by a distance h which we will call the pitch of the helical line. Assuming $\theta = 2\pi$,we get:

$$h = \frac{v}{\omega}2\pi$$

Where

$$\frac{v}{\omega} = \frac{h}{2\pi} = \frac{l}{\theta}$$

And, therefore,

$$\theta = \frac{2\pi}{h}l$$

If we represent the angular velocity as a circular rotation frequency, i.e. express it through a period

$$\omega = \frac{\theta}{t} = \frac{2\pi}{\grave{O}}$$

then we get the pitch of the helical line in the form:

$$h = \frac{v}{\omega}2\pi = \frac{v}{\frac{2\pi}{T}}2\pi = vT = (c\cos\beta)T = cT\cos\beta = \lambda\cos\beta$$

In this form it can be interpreted as the wavelength of a chronon moving along a helical line. In this case, the step will be a projection of the wavelength moving at the speed of light.

Substituting the expression found for θ into the expressions for x and y, we obtain the parametric equations of the trajectory, i.e. the equations of the helical line

$$x = R\cos(\omega t) = R\cos(\frac{2\pi}{h}l) \; ; \; z = R\sin(\omega t) = R\sin(\frac{2\pi}{h}l)$$

We find the speed of the point. Differentiating the equations of motion, we obtain:

$$v_x = \frac{dx}{dt} = -\omega R\sin(\omega t)\ ;\ v_z = \frac{dz}{dt} = \omega R\cos(\omega t)\ ;\ v_l = v = \frac{dl}{dt}$$

We find the total absolute speed of the point's movement:

$$v_{aбc} = \sqrt{v_x^2 + v_z^2 + v_l^2} = \sqrt{(\omega R)^2 + v^2}$$

If we denote the angles of a vector $v_{aбc}$ with coordinate axes by α, γ, β, then

$$\cos\alpha = \frac{v_x}{c} = -\frac{\omega R}{\sqrt{(\omega R)^2 + v^2}}\sin(\omega t) \quad (66a) \qquad \cos\gamma = \frac{v_z}{c} = \frac{\omega R}{\sqrt{(\omega rR)^2 + v^2}}\cos(\omega t) \quad (66b)$$

$$\cos\beta = \frac{v_l}{c} = \frac{v}{\sqrt{(\omega R)^2 + v^2}} \quad (66c)$$

The last equality shows that $\beta = const$ Consequently, thehelical line intersects all the cylinder generators at the same angle. This angle β is called the angle of inclination of the helical line.

Let's move on to defining accelerations. We find the projections of acceleration on the coordinate axes:

$$w_x = \frac{dv_x}{dt} = -\omega^2 R\cos(\omega t) = -\omega^2 x\ ;\ w_z = \frac{dv_z}{dt} = -\omega^2 R\sin(\omega t) = -\omega^2 z$$

$$w_l = \frac{dv_l}{dt} = \frac{dv}{dt} = 0$$

Then the resulting acceleration is:

$$w = \sqrt{w_x^2 + w_z^2 + w_l^2} = -\omega^2\sqrt{x^2 + z^2} = -\omega^2 R \quad (67)$$

It has a minus sign and is perpendicular to the axis *l,* since $w_l = 0$ The minus sign indicates that the acceleration vector is directed toward the axis l , i.e. the acceleration has an attractive effect. It can be interpreted as gravitational. To do this, we should determine the radius of curvature of the helical line. Since the point moves with a constant absolute velocity, then, consequently, the tangential acceleration is zero. Therefore, the acceleration coincides with the normal acceleration. From this follows the equality:

$$\frac{v_{aбc}^2}{\rho} = \omega^2 R$$

Where *p*- radius of curvature of a helical line.

We find its value:

$$\rho = \frac{v_{aбc}^2}{\omega^2 R} = \frac{(\omega R)^2 + v^2}{\omega^2 R} = R + \frac{v^2}{\omega^2 R} \quad (68)$$

The resulting expression for the radius of curvature can be presented in a simpler form using the expression for the square of the sine of the angle β

$$\sin^2\beta = 1 - \cos^2\beta = 1 - \frac{v^2}{(\omega R)^2 + v^2} = \frac{(\omega R)^2}{(\omega R)^2 + v^2} \quad (69)$$

Where

$$\frac{\sin^2\beta}{R} = \frac{\omega^2 R}{(\omega R)^2 + v^2} = \frac{1}{\rho}$$

Hence,

$$\rho = \frac{R}{\sin^2\beta} \quad (70)$$

Since $\beta = const$ then $\rho = const$. Thus, the helical line is a line of constant curvature. It is a direct flow of time, transferring the chronal energy of the vacuum. To replenish the energy of the flow with a direct rate, there must be a reverse flow with an inverse rate in the form of gravitons. To determine its shape, we use the inverse hyperbolic function (50) for $\sin\beta = 1/ch(l/R)$ Substituting into (70), we obtain the radius of curvature for the inverse rate:

$$\rho = \frac{R}{\sin^2\beta} = Rch^2(\frac{l}{R}) \quad (71a)$$

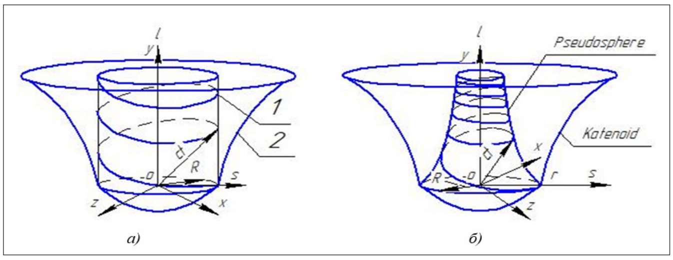
The resulting formula corresponds to the radius of curvature of the catenary. To derive its equation, we use formula (65b). We transform it into the form of a catenary function:

$$\frac{s}{\theta} = r = \sqrt{x^2 + z^2} = Rch(\frac{l}{R}) \quad (71b)$$

To fulfill the specified condition, it is necessary that the angle changes according to a certain law:

$$\theta = \frac{s}{r} = \frac{Re^{(\frac{l}{R})}}{Rch(\frac{l}{R})} = \frac{2e^{(\frac{l}{R})}}{e^{(\frac{l}{R})} + e^{-(\frac{l}{R})}} = \frac{2}{1 + e^{-2(\frac{l}{R})}} \quad (71c)$$

Thus, the reverse tempo leads to the curvature of the graviton flow. It takes the form of a catenary line, which, rotating around the axis, is a catenoid. Since the mass of chronons is greater than the mass of gravitons, an interaction occurs between the direct chronal flow and the reverse graviton flow. The first flow attracts the second. As a result, centers of curvature arise in the screw flow. Since the geometrical place of the centers of curvature is an evolute, the evolute of the catenoid is a pseudosphere. It is the form of the direct chronal flow when interacting with the reverse flow. The picture of the flows is shown in Fig 3.



a) 1. direct cylindrical screw flow; 2. reverse flow (catenoid).
b) pseudosphere as a resulting time flow.

Figure 3: Forms of time flows

Conclusion

The derivation of Lorentz transformations from the theory of time indicates that they are its special case, since they take into account only the wave part of the dual equation. The derivation eliminates the author's critical comments expressed in Section 1. The mechanism of transformations is more general than is accepted in STR. The reason lies in a fundamentally different approach to the concept of time. STR, being a more general theory than classical mechanics, operates with the concept of time accepted by Newton. In it, time is a parameter affected by the speed of movement. The counting is carried out using a clock that is at rest or moving. The Lorentz transformations obtained in it are symmetrical with respect to movement in the forward or backward directions of time. The theory of time considers time as a 4-dimensional vector that forms a 4-dimensional Euclidean space-time. Its projections create spatial and temporal directions in our world. When considering the full dual equation, solutions arise that visualize the forward and backward flow of time that occurs in Euclidean 4-dimensional space. The gravitational interaction of the flows allows us to determine the shape of the resulting forward flow as a pseudosphere, which can claim the geometry of an open universe if the postulate of the constancy of the speed of light in a vacuum is fulfilled.

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Conflict of Interest: This work was carried out by the author alone, at the request of the editorial board of the journal, based on personal scientific works: [1,2,3]. It uses literary sources from open databases, so permission for their publication is not required.

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