Late analysis of the paper “On the electrodynamics of moving bodies“ – kinematical part

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Abstract
The paper presents detail analysis of the original text of special relativity theory and brings surprising results. The paper shows that the proof of the length contraction contains basic mistakes in both mathematical deduction and physical interpretation. The physical meaning of the time dilatation was not generalized in legitimate way. The proof of the light velocity invariance was misinterpreted. The proof shows a change of physical effect in the transformation instead of the light velocity invariance. There is no possibility to fulfil all necessary physical features of the relativity transformation together from the mathematical point of view. The serious physical use of the transformations is excluded. The mathematically valid transformation does not support relativistic effects.
Alternative explanation of the Michelson experiment results is presented without use of the special relativity theory as an example.

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1 Introduction

The paper “On the Electrodynamics of Moving Bodies” (EMB) was published 100 years ago [1]. Are the ideas of the special relativity theory valid or not? It is not clear yet.
The EMB paper is the background of one specific field of modern physics. Many papers are based on the ideas described in the EMB text. Many papers are dealing with the relativity and directly or indirectly use the ideas of the EMB text.
General relativity [2] is directly based on the EMB conclusions. Relativity theory is an ordinary part of physical courses and scientific research.
The papers and the discussions impeaching validity of the special relativity still exist [3, 4, 5] on the other site.
Two groups of experts exist. One group believes in correspondence of the EMB ideas with real world. The other group believes in the opposite.
Some measurable effects exist which can be interpreted as the indirect prove of EMB validity. The effect could be explained the different way as well. Existence and validity of a different explanation of the effects was not disproved. No direct generally accepted experimental proof of EMB validity exists. Many attempts were made; many teams were working on many scientific projects focused on the direct proof of relativity theory. None was successful yet. Remember the experiments with travelling atomic clocks [6] or the gravity waves detection experiments [7] as examples. Many experiments are interpreted as an experimental proof of special relativity theory by one group of experts and the other experts disagree with the interpretation.
Results of my gravity measurements [8] can be interpreted as disproving of general relativity theory. It was the reason I had made a decision to try to find the place where a mistake could be.
It was the reason for my analysis. I made the decision to start from the roots, from the original EMB paper. I tried to understand special relativity theory in detail. I started the analysis of the EMB text and its background.
The analyse results surprised me. They are very different from everything I read. It was the reason for publishing the analysis result.

The following analysis deals only with essential statements of the EMB text. The description of statements deduction in the EMB text is not supposed to be essential part of EMB.
The analysis has its own logic. Some parts of the EMB text, namely the most important ones are used repeatedly in different analyses.
The analysis deals with the kinematical part of the EMB text.

The analysis refers many times to very specific parts of the original EMB paper. The specific parts of the EMB text are not unambiguously identified in the original EMB text. The following chapter contains selected parts of original EMB paper used in the later analysis with unique identifiers. The identifiers EMBxx (where xx is unique number) will be used in the analysis to link specific parts of the EMB text.

2 Original Quotes

- Page 40, §1. Definition of Simultaneity

We have so far defined only an "A time" and a "B time." We have not defined a common "time" for A and B, for the latter cannot be defined at all unless we establish *by definition* that the " time " required by light to travel from A to B equals the "time" it requires to travel from B to A. Let a ray of light start at the "A time" t_A from A towards B, let it at the "B time" t_B be reflected at B in the direction of A, and arrive at A at the "A time" t'_A
In accordance with definition the two clocks synchronize if

$$t_B - t_A = t'_A - t_B \qquad \text{(EMB1)}$$

- Page 40, §1. Definition of Simultaneity

We assume that this definition of synchronism is free from contradictions, and possible for any number of points; and that the following relations are universally valid:-

1. If the clock at B synchronizes with the clock at A, the clock at A synchronizes with the clock at B.

(EMB2a)

2. If the clock at A synchronizes with the clock at B and also with the clock at C, the clocks at B and C also synchronize with each other.

(EMB2b)

- Page 41, §2. On the Relativity of Lengths and Times

The following reflexions are based on the principle of relativity and on the principle of constancy of the velocity of light. These two principles we define as follows:-
1. The laws by which the states of physical systems undergo change are not affected, whether these changes of state be referred to the one or the other of two systems of coordinates in uniform translatory motion.

(EMB3a)

2. Any ray of light moves in the "stationary" system of co-ordinates with the determined velocity *c*, whether the ray be emitted by a stationary or by a moving body.

(EMB3b)

- Page 41, §2. On the Relativity of Lengths and Times

$$velocity = \frac{light\ \ path}{time\ interval} \qquad \text{(EMB4)}$$

- Page 41, §2. On the Relativity of Lengths and Times

We now inquire as to the length of the moving rod, and imagine its length to be ascertained by the following two operations:-

(a) The observer moves together with the given measuring-rod and the rod to be measured, and measures the length of the rod directly by superposing the measuring-rod, in just the same way as if all three were at rest.

(b) By means of stationary clocks set up in stationary system and synchronizing in accordance with § 1, the observer ascertains at what points of stationary system the two ends of the rod to be measured are located at a definite time. The distance between these two points, measured by the measuring-rod already employed, which in this case is at rest, is also a length which may be designed "the length of the rod."

(EMB5)

- Page 42, §2. On the Relativity of Lengths and Times

$$t_B - t_A = \frac{r_{AB}}{c - v} \quad \text{and} \quad t'_A - t_B = \frac{r_{AB}}{c + v} \tag{EMB6}$$

- Page 43, §3. Theory of the Transformation of Co-ordinates and Times from a Stationary System to another System in Uniform Motion of Translation Relatively to the Former

Let us in "stationary" space take two systems of co-ordinates, i.e. two systems, each of three rigid material lines, perpendicular to one another, and issuing from a point. Let the axes of X of the two systems coincide, and their axes of Y and Z respectively be parallel. Let each system be provided with a rigid measuring-rod and a number of clocks, and let the two measuring-rods, and likewise all the clocks of the two systems, be in all respects alike.

Now to the origin of one of the two systems (k) let a constant velocity v be imparted in the direction of the increasing x of the other stationary system (K), and let this velocity be communicated to the axes of the co-ordinates, the relevant measuring-rod, and the clocks. To any time of the stationary system K there then will correspond a definite position of the axes of moving system, and from reasons of symmetry we are entitled to assume that the motion of k may be such that the axes of moving systems are at time t (this "t" always denotes a time of stationary system) parallel to the axes of stationary system.

We now imagine space to be measured from stationary system K by means of the stationary measuring–rod, and also from the moving system k by means of measuring-rod moving with it; and that we thus obtain the co-ordinates x,y,z and ξ, η, ζ respectively. Further, let us the time t of the stationary system be determined for all points thereof at which there are clocks by means of light signals in the manner indicated in §1; similarly let the time τ of the moving system be determined for all points of the moving system at which there are clocks at rest relatively to that system by applying the method, given in §1, of light signals between the points at which the latter clocks are located.

(EMB7)

- Pages 43+44, §3. Theory of the Transformation of Co-ordinates and Times from a Stationary System to another System in Uniform Motion of Translation Relatively to the Former

To any system of value $x,y,z,t,$ which completely defines the place and time of an event in stationary system, there belongs a system of values ξ, η, ζ, τ determining that event relatively to the system k, and our task is now to find system of equations connecting these quantities.

(EMB8)

- Page 44, §3. Theory of the Transformation of Co-ordinates and Times from a Stationary System to another System in Uniform Motion of Translation Relatively to the Former

$$\frac{1}{2}\left[\tau(0,0,0,t) + \tau\left(0,0,0,t + \frac{x'}{c - v} + \frac{x'}{c + v}\right)\right] = \tau\left(x',0,0,t + \frac{x'}{c - v}\right) \tag{EMB9}$$

- Page 46, §3. Theory of the Transformation of Co-ordinates and Times from a Stationary System to another System in Uniform Motion of Translation Relatively to the Former

$$x^2 + y^2 + z^2 = c^2 t^2 \tag{EMB10}$$

- Page 46, §3. Theory of the Transformation of Co-ordinates and Times from a Stationary System to another System in Uniform Motion of Translation Relatively to the Former

$$\xi^2 + \eta^2 + \zeta^2 = c^2\tau^2 \tag{EMB11}$$

- Page 47, §3. Theory of the Transformation of Co-ordinates and Times from a Stationary System to another System in Uniform Motion of Translation Relatively to the Former

$$\begin{aligned} t' &= \Phi(-v)\beta(-v)(\tau + v\xi/c^2) = \Phi(v)\Phi(-v)t, \\ x' &= \Phi(-v)\beta(-v)(\xi + v\tau) \quad = \Phi(v)\Phi(-v)x, \\ y' &= \Phi(-v)\eta \qquad\qquad\qquad = \Phi(v)\Phi(-v)y, \\ z' &= \Phi(-v)\zeta \qquad\qquad\qquad = \Phi(v)\Phi(-v)z. \end{aligned} \tag{EMB12}$$

- Page 48, §3. Theory of the Transformation of Co-ordinates and Times from a Stationary System to another System in Uniform Motion of Translation Relatively to the Former

$$\Phi(v) = 1 \tag{EMB13}$$

- Page 48, §3. Theory of the Transformation of Co-ordinates and Times from a Stationary System to another System in Uniform Motion of Translation Relatively to the Former

$$\begin{aligned} \tau &= \beta(t - vx/c^2) \\ \xi &= \beta(x - vt) \\ \eta &= y \\ \zeta &= z \end{aligned} \tag{EMB14}$$

where

$$\beta = 1/\sqrt{(1 - \mathrm{v}^2/c^2)}$$

- Page 48, §4. Physical Meaning of the Equations Obtained in Respect to Moving Rigid Bodies and Moving Clocks

$$\xi^2 + \eta^2 + \zeta^2 = R^2 \tag{EMB15}$$

- Page 48, §4. Physical Meaning of the Equations Obtained in Respect to Moving Rigid Bodies and Moving Clocks

…at the time t=0 is

$$\frac{x^2}{\left(\sqrt{(1 - v^2/c^2)}\right)^2} + y^2 + z^2 = R^2 \tag{EMB16}$$

- Page 48, §4. Physical Meaning of the Equations Obtained in Respect to Moving Rigid Bodies and Moving Clocks

A rigid body which, measured in a state of rest, has the form of a sphere, therefore has in a state of motion – viewed from the stationary system – the form of an ellipsoid of revolution with the axes

$$R\sqrt{(1 - v^2/c^2)}, R, R \tag{EMB17}$$

- Page 49, §4. Physical Meaning of the Equations Obtained in Respect to Moving Rigid Bodies and Moving Clocks

.., we have, evidently, $x = vt$ and…

(EMB18)

- Page 49, §4. Physical Meaning of the Equations Obtained in Respect to Moving Rigid Bodies and Moving Clocks

$$\tau = t\sqrt{(1 - v^2/c^2)} = t - \left(1 - \sqrt{(1 - v^2/c^2)}\right)t \tag{EMB19}$$

- Page 50, §5. The Composition of Velocities

$$\xi = w_\xi \tau, \eta = w_\eta \tau, \zeta = 0 \tag{EMB20}$$

- Page 50, §5. The Composition of Velocities

$$\begin{aligned} x &= \frac{w_\xi + v}{1 + v w_\xi / c^2} t \\ y &= \frac{\sqrt{(1 - v^2 / c^2)}}{1 + v w_\xi / c^2} w_\eta t \\ z &= 0 \end{aligned} \tag{EMB21}$$

- Page 50, §5. The Composition of Velocities

$$\begin{aligned} V^2 &= \left(\frac{dx}{dt}\right)^2 + \left(\frac{dy}{dt}\right)^2 \\ w^2 &= w_\xi{}^2 + w_\eta{}^2 \\ \alpha &= \tan^{-1} w_y / w_x \end{aligned} \tag{EMB22}$$

- Page 50, §5. The Composition of Velocities

$$V = \frac{w + v}{1 + vw/c^2} \tag{EMB23}$$

- Page 51, §5. The Composition of Velocities

It follows from this equation that from a composition of two velocities which are less than *c*, there always results a velocity less than *c*.

(EMB24)

- Page 51, §5. The Composition of Velocities

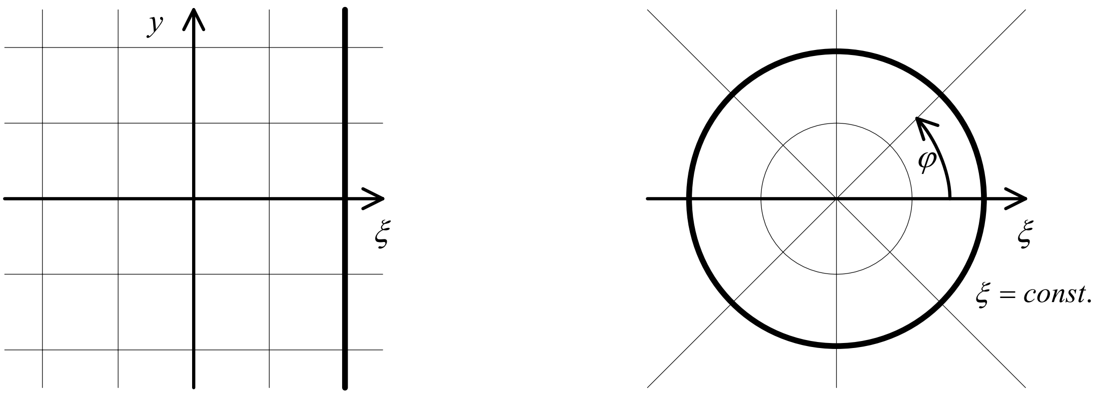
It follows, further, that the velocity of light *c* cannot be altered by composition with a velocity less than that of light. For this case we obtain

$$V = \frac{c + w}{1 + w/c} = c \tag{EMB25}$$

3 Length Contraction

The EMB text in §4 (EMB17) includes the statement that the equation (EMB16) describes the ellipsoid of revolution without any proof. The statement must be valid in the coordinate system, where (EMB15) is equation of the sphere. In our case it must be valid only in the coordinate system *k* (EMB7). The equation (EMB16) need not describe the ellipsoid in the coordinate system *K*. It must be proved if the EMB statement is true or false.

It is not generally true that the same geometrical configuration is described by the same equation in any coordinate system. It is impossible to declare that the equation of the ellipsoid in one coordinate system must be the equation of the ellipsoid in second coordinate system. We can illustrate it on the following example. The equation $\xi = const.$ can be the equation of a line in the Cartesian coordinate system if ξ is one of the coordinate axes. The same equation $\xi = const.$ can be the equation of a circle in the cylindrical coordinate system, if ξ is distance from the origin. We are in the two-dimensional spaces for simplicity in the both cases.

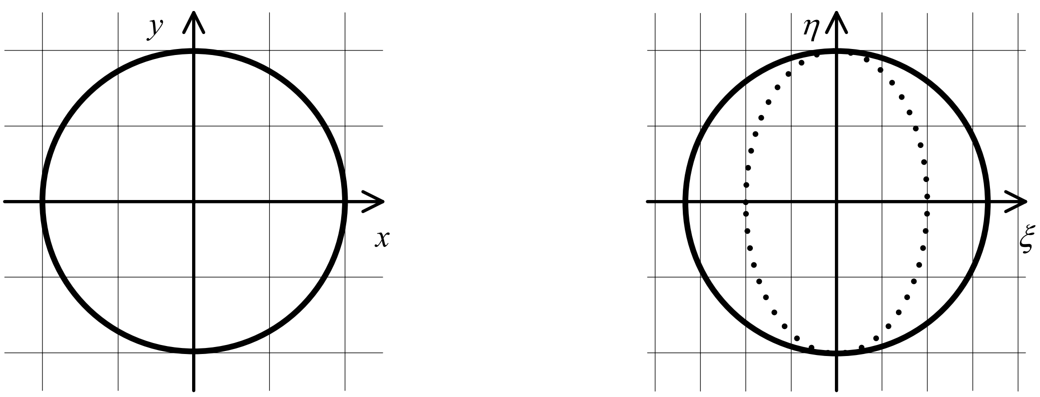


$\xi = const.$

Figure 1. The example of the different geometric shapes of the same equation in the different coordinate systems. The Cartesian coordinate system is on the left. The cylindrical coordinate system is on the right.

The different coordinate systems are used for description of the different geometrical tasks in common engineer praxis. The special coordinate system can be used with the advantage in analytical solving of the specific task dealing with the related geometrical configuration. The use of the cylindrical coordinate system should be advantageous for solving of the axis symmetrical tasks (like solving of electromagnetic field in a coaxial cable). Use of the Cartesian coordinate system should be advantageous for solving a flat geometry configuration (like solving electrical field of a plate capacitor).

We can imagine the specific transformation mapping one Cartesian coordinate system with three coordinates measured in meters into the second Cartesian system where two axes are measured in meters and third axis is measured in feet. The similar transformation equation to (EMB14) describes the transformation in this case (without the time transformation). We can imagine using of the same procedure as described in EMB in §4 for our case. This procedure gives the same results, i.e. the sphere equation is transformed into "ellipsoid" equation. We know from experience that the transformation does not change the real sphere. The sphere is unchanged, but the equation describing the same sphere in the second coordinate system is different from the equation in the first coordinate system.



$x^2 + y^2 = R^2$

—— $\dfrac{\xi^2}{\gamma^2} + \eta^2 = R^2$

.... $\xi^2 + \eta^2 = R^2$

Figure 2. The example of the circle transformation with the scale change in one axis. The scale of the coorinare axis ξ is γ times smaller than the scale of the coordinate axes x, y, η. The original circle on

the left is transformed into the circle on the right. The equation on the left looks like the equation of the circle and it describes the circle. The equation on the right looks like the equation of the ellipse and describes the circle (the solid line). Another equation on the right looks like the equation of the circle and it describes the ellipse (the dotted line).

It is not possible to tell what geometrical configuration is described by the equation in the specific coordinate system without the knowledge of the coordinate system features. **The isolated equation cannot be used for any statement dealing with the geometrical configuration.**

3.1 Revolving Cylinder

Let us observe the relativistic length contraction in the following imaginary experiment. The experiment is similar to EMB description in §4.

Let us have two coordinate systems k and K, the same as used in EMB (EMB7). We have the circle cylinder in the coordinate system k. The cylinder has the width w suitable to be supposed as a solid body. The cylinder is made from a solid material. Its radius is R. The cylinder is oriented the way its symmetry axis is equal with the ζ axis of the coordinate system k. The cylinder has the dimensions $\langle -R, R\rangle$ in ξ axis direction, $\langle -R, R\rangle$ in η axis direction and $\langle -w/2, w/2\rangle$ in ζ axis direction.

The cylinder revolves slowly around its symmetry axis (around ζ axis). The mark is placed on the cylinder edge. Let us suppose the mark crosses the axis $+\xi$ (at place $+R$) at time t_1 and axis $+\eta$ (at place $+R$) at time t_2 etc. The observer in the coordinate system k observes the revolving body.
We identify what does the observer observe in the coordinate system K (the coordinate system K moves relatively to k with speed $-v$).
With respect of EMB §4 (EMB17) the observer should observe the moving elliptic cylinder with the width w and the axis $R\sqrt{\left(1-v^2/c^2\right)}, R$, where the shorter ellipse axes is oriented in the movement direction.
The EMB text in §4 describes the solid sphere. The sphere is independent on time. The result must be valid at time t_1 and t_2. Therefore our observer observes the revolving elliptic cylinder moving with speed $-v$. The cylinder revolves slowly and the mark moves on the edge with respect to the axis. The observer in the coordinate system K must observe the mark movement too.
The mark is at the position $+R$ on axis ξ at time t_1. Therefore the mark must be on the axis x at the distance $R\sqrt{\left(1-v^2/c^2\right)}$ or $R/\sqrt{\left(1-v^2/c^2\right)}$ from the cylinder centre in direction $+x$. The two values arise from the transformation equations (EMB16), (EMB17) (for $t=0$) or from the inverse transformation to (EMB14) (for $\tau=0$) – see chapter 3.2 Ambiguous Length Contraction.
The mark is at the position +R on η axis at the time t_2. Therefore the mark must be at the distance $+R$ from the cylinder centre in direction $+y$ at t_2.
The mark is fixed to the cylinder on the cylinder edge. Therefore the observer observes the elastic elliptic cylinder. The cylinder is steady oriented. The longer (shorter) cylinder axis is orthogonal to the movement direction and the shorter (longer) axis is parallel to the movement direction all the time. The mark is moving on the cylinder edge. All atoms of the cylinder mass are moving together with the mark and create revolving of the cylinder.
The distance of the mark from the cylinder centre is changed. The distance between atoms in the cylinder mass must be changed (by revolving in time period from t_1 to t_2). No force, no energy is needed. We are in the inertial system. The ratio of the longer and the shorter axes can be any number in the range $(0,1\rangle$. The ratio is dependent only on the observer speed relatively to the cylinder.
We have questions: What physical effect causes the described behaviour? Is it an unknown solid body deformation effect, caused without any force and any energy? Can the deformation exceed the strength ceiling and is it reversible? Does the body volume change? Does the material specific density change? Or is it only some virtual image caused by the observing method? Is it something like a slant view of the revolving cylinder?

3.2 Ambiguous Length Contraction

We study the ambiguous results of the ellipse size in the x direction. The mark is at the distance $R\sqrt{\left(1-v^2/c^2\right)}$ from the cylinder centre according to the equation (EMB16) for $y=z=0$. It is confirmed by (EMB17). The mark is at the distance $R/\sqrt{\left(1-v^2/c^2\right)}$ from the cylinder centre according to the transformation equation (EMB12), (EMB13) (with respect of β in (EMB14)) for $\eta=\zeta=\tau=0$. $y=z=0$ is valid in this case.
But the transformed time at the cylinder centre is different from the time at the mark location. The effect will be discussed later in chapter 6 Event Transformation.
The essential fact is as follows. We return to the EMB text §4 describing the sphere and the ellipsoid. The time is defined in the coordinate system K at the every point on the surface described by equation (EMB16). It is valid for $t=0$ and $x\neq 0$ that $\tau\neq 0$ according to (EMB14). The points where $x\neq 0$ exist on the surface described by (EMB15), therefore $\tau\neq 0$ must be valid at those points in the coordinate system k. The points where $x=0$ exist on the surface, therefore the points where $\tau=0$ exist too. It means the equation (EMB15) describes the set of points existing at the different times τ. The equation (EMB15) can not describe the solid sphere at the specific time in the coordinate system k. Every time difference causes distance difference between the stationary and moving coordinate systems.
This "effect" was caused by the definition $t=0$ in (EMB16) (in the coordinate system K) and by the space dependency of the time transformation in (EMB14). **It causes the simultaneity liquidation in the coordinate system *k*.** This fact is not described in the EMB text.

We can find in the equation (EMB16) deduction from (EMB15) that **the equation for the time transformation from (EMB12) or (EMB14) is not used**. The time transformation is omitted without any valid reason.
This is the basic difference from the transformation of (EMB10) into (EMB11). The time transformation is used in this case. Unused time transformation is the cause of the different results of those two sphere transformations.
It can be illustrated by the following thought. The light propagation as described in (EMB10) and (EMB11) forms the sphere at any specific time. The sphere has fixed radius in the coordinate system K. The sphere is transformed according to EMB text ((EMB10) and (EMB11)) into the sphere with the fixed radius in coordinate system k.
But the sphere with the fixed radius in the coordinate system k is transformed according to (EMB15), (EMB16) and (EMB17) into the ellipsoid in the coordinate system K. It is not essential for the coordinate transformation if the set of points is gained as the result of the light propagation or as the set of the points on the solid sphere surface. The only interesting is if the set of points are the same points at the same time. This is valid for any coordinate transformation, where the result is independent on the history. The EMB text does not describe any dependence of the transformation on any previous state.

4 Composition and Transformation of Velocities

The point position transformation equation (EMB14) and the velocity transformation equation (EMB21) can not be independent, if they are used for the transformation in physics. The relations between the position transformation and the velocity transformation must be independent on the sequence of the transformation and the differentiation. The result must be the same if we count the velocity first by the differentiation and transform the velocity or if we transform the positions and the time first and then count the velocity. It can be described by the equation

$$\frac{dT_p(x,t)}{dt}=T_v\left(\frac{dx}{dt}\right),$$

where T_p is the position transformation, T_v is the velocity transformation and x is the position of a point.
Let us deduce the equations for T_v from (EMB14) and compare the result with the EMB velocity transformation equation (EMB21).

We are working in the inertial system, in system with the constant velocities. We can use differences for simplicity. We deduce the velocity transformation per components (with respect of the transformation direction).

$$v'_\xi=\frac{\Delta\xi}{\Delta\tau}=\frac{\xi_2-\xi_1}{\tau_2-\tau_1}=\frac{\beta(x_2-vt_2)-\beta(x_1-vt_1)}{\beta(t_2-vx_2/c^2)-\beta(t_1-vx_1/c^2)}=\frac{\frac{x_2-x_1}{t_2-t_1}-v}{1-\frac{v}{c^2}\frac{x_2-x_1}{t_2-t_1}}=\frac{w_x-v}{1-w_xv/c^2}$$

$$v'_\eta=\frac{\Delta\eta}{\Delta\tau}=\frac{\eta_2-\eta_1}{\tau_2-\tau_1}=\frac{y_2-y_1}{\beta(t_2-vx_2/c^2)-\beta(t_1-vx_1/c^2)}=\frac{1}{\beta}\frac{\frac{y_2-y_1}{t_2-t_1}}{1-\frac{v}{c^2}\frac{x_2-x_1}{t_2-t_1}}=\frac{w_y\sqrt{1-v^2/c^2}}{1-w_xv/c^2} \qquad (1)$$

$$v'_\zeta=\frac{\Delta\zeta}{\Delta\tau}=\frac{\zeta_2-\zeta_1}{\tau_2-\tau_1}=\frac{z_2-z_1}{\beta(t_2-vx_2/c^2)-\beta(t_1-vx_1/c^2)}=\frac{1}{\beta}\frac{\frac{z_2-z_1}{t_2-t_1}}{1-\frac{v}{c^2}\frac{x_2-x_1}{t_2-t_1}}=\frac{w_z\sqrt{1-v^2/c^2}}{1-w_xv/c^2}$$

We gather the velocity transformation directly deduced from (EMB14) is equal to (EMB21) (the opposite transformation direction is reflected by the sign change of the coordinate system velocity v as used in the EMB text). The velocity transformation (EMB21) corresponds to the position transformation (EMB14) as usual in physics. Therefore the analysis results based on the velocity transformation describe features of the position transformation and vice versa.

Every coordinate system useable in physics must include the composition (addition) operation of distances and velocities (plus accelerations).
The composition operation in the first coordinate system must be strictly separated from the transformation operation between two coordinate systems and from the composition operation in the second coordinate system. The composition is the feature of the relevant coordinate system (the first and the second). The transformation is the common feature of both coordinate systems. The composition exists in one coordinate system independently on the other one. The transformation exists only if two (or more) coordinate systems exist. This is valid for the position composition or the position transformation and for the velocity composition or the velocity transformation.
It is not generally possible to use the same mathematical equation for the composition of the velocities in the cylindrical coordinate system as in the Cartesian one if we want to receive the physical equivalent results. It is not possible to mishmash the velocity transformation with the velocity composition.

Those three basic operations are not systematically distinguished in the EMB text. The velocity compositions in both coordinate systems (K and k) are not explicitly described in the EMB text or it is not clear if the velocity composition in the specific coordinate system is described. Moreover the classical Galileo transformation and the relativistic transformations are mixed in the text.
The EMB text does not clarify if equations in §5 (EMB21), (EMB23), (EMB25) describe composition in the specific coordinate system (K or k). This interpretation is supported by the §5 title and the (EMB24) and (EMB25) texts.
The text does not clarify if the equations describe the transformation between two coordinate systems. This interpretation is supported by the equations described in §5 (EMB20), (EMB21) and by the previous velocity transformation deduction (1) based on the position and time transformation (EMB14). It is clear from the EMB text that (EMB14) describes the position and time transformation between K and k coordinate systems. The (EMB14) doesn't describe the position or time composition in the one coordinate system.

We will suppose that the variant is valid where the classical vector addition is defined in the Cartesian coordinate systems k and K. The variant is based on the classical Euclidian metric and on the classical differentiation definition and on the classical velocity definition. The constant velocity is defined as the quotient of the position difference and the time interval. This is supported by some parts of EMB text (e.g. (EMB4), (EMB6), (EMB20), (EMB22)). The equations (EMB21), (EMB23), (EMB25)

describe the velocity transformation between two coordinate systems in this case. The equations can not be used for the velocity composition in any coordinate system. This variant will be used in the following analysis.
The opposite variant will be analysed later in chapter 4.2 Perpendicular Velocity Composition.

4.1 Three Light Sources

Let us analyse the velocity composition and the velocity transformation in the following imaginary experiment.
We have three light sources named *A, B* and *C*. The sources are moving relatively to each other. The coordinate system where the light source *A* is stationary is named *KA* and the light source *A* is placed at the origin of the coordinate system *KA*. The observer in the coordinate system *KA* observes moving of the light source *B* with the velocity *vBA* and moving of the light source *C* with the velocity *vCA*. Both light sources are moving in the direction of the axis *+x* as usual in EMB.

We will try to answer questions:

I. What velocity does the light source *C* have against the light source *B*?
II. What velocity do photons emit from the light sources *A, B* and *C*?

We try to answer the first question now. What velocity does the light source *C* have against the light source *B*?

There exist two correct answers according to EMB.

- The first answer is based on the velocity definition as the quotient of the position difference and the time interval (EMB4) i.e. the position difference measured by the light path and the time difference between the position measurements. The deduced velocity is in this case
$$vCB=vCA-vBA.$$
It is the velocity composition in the coordinate system *KA*. It is the classical vector addition in one direction.
- The second answer is based on the velocity transformation equation in the *x* axis direction (EMB23). The deduced velocity is in this case
$$vCB=\frac{vCA-vBA}{1-vCA\cdot vBA/c^2}.$$
The equation is deduced from the transformation of the velocity *vCA* into the coordinate system *KB*. *KB* is the coordinate system where the light source *B* is stationary and it is placed at the origin. The velocity of the light source *C* against the light source *B* is equals to the velocity of the light source C in the coordinate system *KB* i.e. the transformed velocity *vCA*. Similarly transformation of the velocity *vBA* into the *KC* coordinate system gives the velocity of the light source *B* against the light source *C*. *KC* is the coordinate system where the light source *C* is stationary and it is placed at the origin. The deduced velocity is in this case
$$vBC=\frac{vBA-vCA}{1-vBA\cdot vCA/c^2}.$$

The two answers give different velocities.

We can try to use the modified EMB proposition from §2 dealing with two different lengths (EMB5). The relativistic effect of two different velocities could be explained similar way i.e. by existence of the “stationary” velocity and by the “moving observer” measurement like in (EMB5). It is not very forcible explanation in case of the velocities. The only difference is the number of moving points. The distance between the moving point and the origin of the coordinate system is measured in the first case. The distance between the two moving points is measured in the second case. One moving point exists in both cases. We need to measure the distance of the moving point with respect of (EMB5-(b)) in both cases.

Now we try to answer the second question. What velocity do the photons emit from the light sources *A, B* and *C*? What is the velocity of electromagnetic waves emitted from every light source? It means the light velocity relative to the light source.

It is possible to operate with the velocity transformation according to EMB (e.g. (EMB21) or (EMB23)) in case of one or maybe two sources of light. We can not use it in our case. We will have minimally two light sources moving in any coordinate system. We have to use another method.
We start with premise that the stationary source of light emits the light with the velocity *c* in any direction. The premise agrees with the classical Galileo physics and with the EMB text.

The light is propagated from the moving light source with the velocity *c* according to the second EMB postulate (EMB3b). Therefore the light must be emitted from the moving light source with the different velocity than *c*. Nonzero light source velocity is composed with the velocity of the light emission and the sum of velocities must be *c* to respect the second EMB postulate in the specific coordinate system. The distance composition is used.

Let us deduce the velocities of all three light sources in the three different coordinate systems *KA*, *KB* and *KC*. We will use the equation (EMB23) for the velocity transformation. We will use the velocity composition operation (based on the distance composition) in the specific coordinate system for the relative emission velocity deduction. We will respect the second EMB postulate (EMB3b) in all cases. It means the different light emission velocity of the moving light source.
We will deduce the velocities in both directions of the *x* axis (+*x*, -*x*). We will not use the other two dimensions *y* and *z* orthogonal to the movement direction.
The deduction results of the emission velocity in the all coordinate systems are in the following table 1.

Table 1. The light emission velocities

Light source/ coordinate system	A	B	C
KA	+c ; -c	+c-vBA ; -c-vBA	+c-vCA ; -c-vCA
KB	+c+vBA; -c+vBA	+c ; -c	$+c-\frac{vCA-vBA}{1-vCA\cdot vBA/c^2}$; $-c-\frac{vCA-vBA}{1-vCA\cdot vBA/c^2}$
KC	+c+vCA; -c+vCA	$+c+\frac{vCA-vBA}{1-vCA\cdot vBA/c^2}$; $-c+\frac{vCA-vBA}{1-vCA\cdot vBA/c^2}$	+c ; -c

We can see from the results:

- The light is emitted with five different velocities from every light source (independently on direction).
- The light is emitted by the light velocity only in that coordinate system where the light source is stationary. The emission velocity is independent on the direction only in this case.
- The light is emitted with two different velocities dependent on the direction in all other coordinate systems.
- The number of those velocity pairs is proportional to the number of the light sources moving with the different velocities or on the number of the moving observers (with the different velocity).
- The total number of the different light emission velocities is seven in this example.

Very unusual result is that the number of the light emission velocities increases with the number of the moving light sources (with the different velocities) included into the analysed system. How is it possible? What is the physical meaning of the dependency?

4.2 Perpendicular Velocity Composition

We return to the opposite variant of §5 interpretation

In case of this variant the equations (EMB21), (EMB23), (EMB25) are the equations of the velocity composition in the specific coordinate system. The equation describing the velocity transformation is missing in the EMB text. The velocity composition does not agree with the velocity definition used in the EMB text (EMB4), (EMB22) and with the position and time transformation (EMB14). We know from (1) that the velocity equation (EMB21), (EMB23) and (EMB25) are equal to the position and time transformation (EMB14) with respect of classical velocity definition (EMB4). The distance composition in one Cartesian coordinate system is different from (EMB14). The time is synchronized in one coordinate system. This case is in the conflict with the symbols used in EMB §5.
By contrary this variant is directly supported by the (EMB24) and (EMB25) text.

The (EMB24) and (EMB25) text deduces from the premise, that it is not possible to compose velocity greater than light velocity *c*.
The statement about the velocity limit *c* is in conflict with the velocity definition (EMB4) in specific coordinate system. The ratio of the distance and the time can by any number. The other question is if the velocity is the physical object velocity or some abstract velocity.

We can describe the example. Let us calculate the relative velocity of the opposite edges of the light spherical wave. We use the equation (EMB10) to describe the spherical wave. The distance between opposite edges of the sphere is equal to diameter of the sphere. The sphere diameter *d* described by the (EMB10) is $d=2ct$. The calculated velocity is from the known distance and from velocity definition (EMB4)

$$v = \frac{\Delta d}{\Delta t} = \frac{2ct_2 - 2ct_1}{t_2 - t_1} = 2c\ .$$

In the following text we suppose that relation (EMB21), (EMB23) and (EMB24) are relations describing velocity composition in one specific coordinate system. We will solve the composition problem of two orthogonal velocities. We have two orthogonal velocities *v* and *w* in one coordinate system.
We will analyse two different compositions with the different sequence of the velocities. The first composition is named I and it is based on the reference velocity v. It can be described symbolically as $v+w$. The second composition is named II and it is based on the reference velocity w. It can be symbolically described as $w+v$.

The case I. We orient the coordinate system *k* in the parallel way with the reference velocity *v* as usual in the EMB text. The velocity components of both velocities are in this case $v_\xi=v$, $v_\eta=0$, $w_\xi=0$, $w_\eta=w$.
We gain from (EMB21) and (EMB22)

$$w_x = \frac{w_\xi + v}{1 + vw_\xi/c^2} = \frac{0+v}{1+v0/c^2} = v$$

$$w_y = \frac{\sqrt{\left(1 - v^2/c^2\right)}}{1 + vw_\xi/c^2} w_\eta = \frac{\sqrt{\left(1 - v^2/c^2\right)}}{1 + v0/c^2} w = w\sqrt{\left(1 - v^2/c^2\right)}$$

$$|w+v| = \sqrt{{w_x}^2 + {w_y}^2} = \sqrt{v^2 + w^2\left(1 - v^2/c^2\right)} = \sqrt{v^2 + w^2 - w^2v^2/c^2}$$

The case II. We orient the coordinate system *k* in the parallel way with the reference velocity *w*. The velocity components of both velocities are in this case $v_\xi=0,\ v_\eta=-v,\ w_\xi=w,\ w_\eta=0$. We gain from (EMB21) and (EMB22)

$$v_x = \frac{v_\xi + w}{1+wv_\xi/c^2} = \frac{0+w}{1+w0/c^2} = w$$

$$v_y = \frac{\sqrt{\left(1-w^2/c^2\right)}}{1+wv_\xi/c^2} v_\eta = \frac{\sqrt{\left(1-w^2/c^2\right)}}{1+w0/c^2} v = v\sqrt{\left(1-w^2/c^2\right)}$$

$$|w+v| = \sqrt{v_x{}^2 + v_y{}^2} = \sqrt{w^2+v^2\left(1-w^2/c^2\right)} = \sqrt{v^2+w^2-w^2v^2/c^2}$$

We can see from both cases that the composed velocity magnitude is equal in both cases. The magnitude is different than the velocity magnitude of the composed velocities based on Euclidean composition of distances divided by the time interval.
The specific velocity component magnitudes are different in both cases. The composed velocity component in the *v* velocity direction is greater in the case I than in the case II. By contrast the composed velocity component in the *w* velocity direction is smaller in the case I than in the case II. The direction of composed velocities must be different in both cases.
It is interesting that the composition of orthogonal velocities changes the magnitude of orthogonal component of the composed velocity.

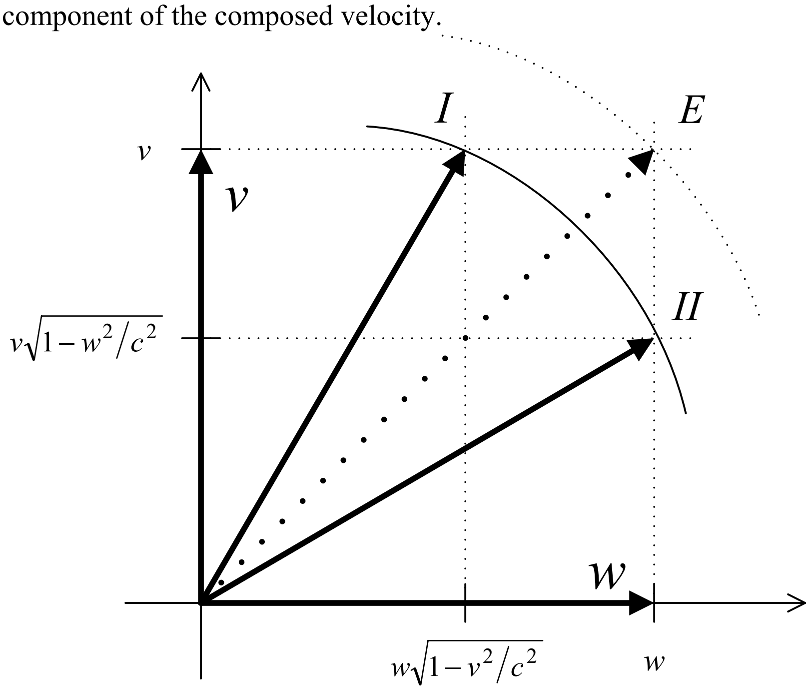


Figure 3. Two results of the velocity composition. Vector I describes the *v+w* EMB velocity composition result (case I). Vector II describes *w+v* EMB velocity composition result (case II). The dotted vector E describes the velocity composition result *v+w* and *w+v* based on Euclidean distance composition and the velocity definition.

We see that the equations (EMB21), (EMB23), (EMB25) describe vector operation which is not commutative. The result of the operation is dependent on the vector sequence. This feature is not acceptable in the velocity composition in physics.
The result implies that interpretation in the EMB text describing equations (EMB21), (EMB23), (EMB25) as the velocity composition in one coordinate system is wrong. The statements in (EMB24) and (EMB25) text can be valid only for transformation into the moving coordinate system. **No maximal velocity limit in one specific coordinate system can be deduced from any equations described in EMB text.**

5 Time Transformation

The time transformation is the background of the EMB transformations. The time transformation basically distinguishes the EMB transformations from the other coordinate transformations used in physics or in technology. It is the reason why great attention is paid to the time perception in the EMB text.
The time is described in EMB §1. (EMB1) describes definition of "synchronized clocks". Physical meaning of the concept is not clearly described. It is only possible to intuitively speculate on the exact physical meaning of the described concept.

5.1 Synchronized clock

The definition (EMB1) is followed by the assertions dealing with the synchronized clock features (EMB2). The assertions are described without any proof. The assertions are not valid in all cases. The assertion (EMB2) is symmetric. Intuitive understanding of synchronized clocks is symmetric. The definition (EMB1) is not symmetric.
We can describe example of the asymmetry.
Let us have two points A and B. The point A is stationary and point B is moving with the velocity v. The clock placed at A synchronizes with the clock placed at B according to the definition (EMB1). The clock placed at B does not synchronize with the clock placed at A according to the same definition (EMB1).
It results from the second EMB postulate (EMB3b). The light velocity is c. The light travels the distance $A\text{->}B$ *at* the same time as the distance $B\text{->}A$ because both distances are the same.

Contrary of the light emitted from the point B with the velocity c to the point A. The point B moves from B_1 to B_2 with the velocity v during the time period the light needs to travel the distances $B_1\text{->}A$ and $A\text{->}B_2$. The distances $B_1\text{->}A$ and $A\text{->}B_2$ are different. Therefore the time needed for return of the light is different from the original one (if the point B velocity $v>0$ or the point B is not equal to the point A). We see that the case exists where the relation (EMB2a) is not valid.

It is possible to construct the situation where the relation (EMB2b) is not valid. It is possible to add the stationary point C to the previous example. In this case the clock at B does not synchronize with the clock at C (the same situation like B and A), but the clock placed at A synchronizes with the clock at B and with the clock at C.

The definition of the "synchronized clock" is not exact and unique. It is not possible to recognize from the EMB text how does the synchronized clock measure the time, what time unit is used. It is unknown if it is sufficient to complete the definition (EMB1) only in one case (only for one event at A and B) or if the condition must be completed at every moment (for any event at A and B). It is not possible to recognize if the time values used in the definition are results from the relevant tested clock or if they are used the values measured another way.
Different interpretations of the EMB text give different results.

In the case if one event when the clocks complete (EMB1) is sufficient to the clock synchronization, the clocks placed at the point A and B can run with the different speeds (they can use the different time units) and they will be the "synchronized clocks" according to the definition (EMB1). The measured results can not be comparable without knowledge of the time units and the time shift.
Even more it is valid that exactly one moment exists where the condition (EMB1) is completed for any pair of the clock with any time shift and any different time units. It is caused by the fact that the one moment exists when the difference between the times measured by pair of clocks is any value in this case. Of course the physical meaning of that difference has no sense.

In opposite case if the clocks at A and B use exactly the same time unit and they are shifted each other by the nonzero time difference, the condition (EMB1) can not be completed at any moment. The clock pair is intuitively understood as the synchronized clocks. In that case the time difference has physical sense and it can be easily eliminated.

We keep the question of the synchronized clock open. We will try to find the time transformation features other way.

5.2 Time Dilatation

Let us analyse the time transformation described in EMB by other way. We can find four different descriptions of the time transformation in the EMB text. They are:

1. The definition of "synchronized clock" – (EMB1)
2. The coordinate transformation – (EMB14)
3. Physical meaning description of the time transformation – (EMB19)
4. The velocity transformation – (EMB21)

The equations look different ways:

$$\tau = \beta(t - vx/c^2)$$

where (EMB14)

$$\beta = 1/\sqrt{(1 - v^2/c^2)}$$

$$\tau = t\sqrt{\left(1 - v^2/c^2\right)} \qquad \text{(EMB19)}$$

$$y = \frac{\sqrt{(1 - v^2/c^2)}}{1 + vw_\xi/c^2} w_\eta t \qquad \text{(EMB21)}$$

The time transformation can not be seen in (EMB21) explicitly. The time is "included" inside the velocity. We can deduce the time transformation from comparing of (EMB21) with (EMB14) for the η axis (we use the velocity definition (EMB20)).

$$\eta = y \qquad \text{(EMB14)}$$

$$\eta = w_\eta \tau \qquad \text{(EMB20)}$$

We get

$$t = \beta\left(1 + vw_\xi/c^2\right)\tau$$

by substitution (EMB14) and (EMB20) into (EMB21). We change the equation to the inverse transformation (2) to enable comparing of the transformations between the same coordinate systems in the same direction.

$$\tau = \beta\left(1 - vw_x/c^2\right)t \qquad (2)$$

We modify the equation (EMB19) into the equation (3).

$$\tau = t\sqrt{\left(1 - v^2/c^2\right)} = \beta\left(1 - v^2/c^2\right)t \qquad (3)$$

The result is surprising. We have three different equations for the time transformation (EMB14), (2), and (3).

$$\tau = \beta(t - vx/c^2) \qquad \text{(EMB14)}$$

$$\tau = \beta\left(1 - vw_x/c^2\right)t \qquad (2)$$

$$\tau = \beta\left(1 - v^2/c^2\right)t \qquad (3)$$

We can recognize from the more detail analysis that the different equations do not disagree each other. Every equation describes the different features of the same time transformation in the different situations. **It is caused by the space dependency of the time transformation**.

We will describe it in the three different situations:

- The space dependency of the time transformation for the stationary point relative to the stationary coordinate system is described by (EMB14). The value of the transformed time is linearly dependent on the point position in the direction of the *x* axis i.e. in the moving direction of the moving coordinate system.
- If the point moves with the velocity *v* in the direction of the *x* axis and it is at the moment $t=0$ at the position $x=0$ (EMB18) the time transformed into that point is described by the equation (3). The point is placed at the origin of the moving coordinate system. The equation (3) is the same one as used in EMB §4 for description of well known relativistic effect called "time dilatation" (EMB19).
- If the point moves in the general direction and with the general velocity (the different direction and the different velocity than the moving coordinate system) the time transformation is described by the equation (2). It could be surprising that in case of moving in the direction of the *y* or *z* axes the time is transformed other way than the unitary transformation and the transformation is dependent on the *x* axis velocity component i.e. on the orthogonal velocity component. We can discover from more detail analysis, that it is caused only by the space dependency of the time transformation in the *x* axis direction (EMB14), by the space geometry (Euclidian metric), by the velocity transformation limiting maximum velocity included in (EMB21) and by the relative moving of the coordinate systems in the *x* axis direction.

5.3 Physical Meaning

The time transformation with the space dependence can be supposed as nonsense. Similar time "transformation" is used in real life. It is local solar time on the Earth surface. The time increases from west to east by 1hour per every 15° of longitude. Physical meaning of this transformation is quite different from the EMB text in §4.

We will analyse the physical meaning in more detail.
The first question is comparing of the time scales and the origins before and after the transformation (in both coordinate systems). The question of the origin is solved in EMB by the premise of the equivalence of the origins in both coordinate systems. The discussion of a situation with the shifted origins at time or at position is missing in the EMB text. The proof of the equivalence or the non-equivalence of the time scales in both coordinate systems is missing too. The EMB §1 text dealing with the simultaneity is ambiguous and attempts to exclude less probable variants were not successful. We are not able to proof the unity of time scales in both coordinate systems.
It is only possible to come to the conclusion that the time measurements in the first coordinate system are not comparable with the time measurement in the second one. It can be deduced from the synchronism of the clocks in the stationary coordinate system and from the position dependency in the time transformation in (EMB14). It causes that the specific transformed time in the moving coordinate system must have different values at the different places. The time comparison results from the different places have to give different values.
It is possible to interpret physical meaning of the (EMB19) result that the position dependency of the "local" time is the same as in case of motion of the observer across "time zones" (as in known case of the local solar time).
If we move the clock from the time zone at *A* to the different time zone at *B* with the velocity *v* it does not mean that the clock displays the right time in time zone at *B*. If we move the clock from *A* to *B* the clock will display the right time like in "its home time zone" at *A* (in case the clock uses physical effects invariant to replacement). If the clock displays the right time in time zone at *B* the clock should be supposed as broken or as specially designed to display the local time. In our solar time analogy the atom clock will display at *B* time from *A* and the solar clock will display local time from *B*. It is very strange to explain the time "shift" of the solar clock by the time dilatation effect.

The EMB text describes in §4 the polygonal line and its transfer to a closed curve. The idea has nothing to do with physics in the physical range of the other EMB text. The idea changes the constant velocity supposed in the EMB premises into the accelerated movement. The result described in the EMB text as the result of the transformation (EMB19) that the clock returning into A (A and B

coincide) will be $\frac{1}{2} t v^2/c^2$ second slow is unsupported physical idea and it does not imply from the EMB transformations.
The reason is not only the accelerated movement, but also the positional dependence of the time transformation in (EMB14). The transformation (EMB14) and (EMB19) can not give two different correct results for two clocks at the same point. It has the simple reason. The transformation is not dependent on the state (on a history). The result of the transformation is dependent only on the position and the time. **The previous travelling of the clock has no influence to the time transformation result.**

5.4 Time Transformation Features

We can ask: Does any place exist where the time in the stationary coordinate system *K* is equal with the time in the moving coordinate system *k*? Is the place stationary or moving?

We suppose for the analysis that the time scales in both coordinate systems are equal. We find the answer from (EMB14) where we set $\tau \equiv t$ i.e. $t = \beta(t - vx/c^2)$. We get

$$x = (1 - \sqrt{1 - \frac{v^2}{c^2}})\frac{c^2}{v} t \cong \frac{1}{2} vt$$

by modification. The approximation $x = vt/2$ of the equation

$$x = (1 - \sqrt{1 - \frac{v^2}{c^2}})\frac{c^2}{v} t$$

is useable for the small values of v/c. The error is smaller than 7% for $v/c<0.5$.

This implies, the situation $\tau=t$ exists in the plane perpendicular to the x axis moving with the velocity approximately $v/2$. The plane moves with the velocity approximately $-v/2$ in the moving coordinate system. It is approximately at the halfway between the origins of both coordinate systems.
The times in both coordinate systems are $\tau>t$ for all points with the x (ξ) coordinate smaller than the plane position and they are $\tau<t$ for all points with the x (ξ) coordinate greater than the plane one. Therefore the event exists (at $t>0$) for any point with constant $x>0$ when the transformed time is equal to the original one. Before this event the transformed time is smaller than the original one and after the event it is up side down. The similar effect exists in the moving coordinate system for $\xi<0$.
The transformed time at the origin of the moving coordinate system *k* is $\tau<t$. It agrees with known equation (EMB19) for all positive times. Transformed time at the origin of the stationary coordinate system *K* is $\tau>t$. It is the opposite situation. The equation (EMB19) is not valid there. It results from (EMB14) for the origin of the stationary coordinate system where $\tau=\beta t$, so

$$\tau = t/\beta(1 - v^2/c^2) = t/\sqrt{(1 - v^2/c^2)}$$

i.e. the opposite situation to the “time dilatation”.
We can see that $t=\tau$ is valid at the origins of the coordinate systems only at $t=\tau=0$. The time transformation features of EMB transformation are equivalent with the different time scales of the clocks in different places.

5.5 Two Light Sources and Mass Point

We can illustrate some EMB time transformation features on the following virtual experiment.
Let us have two light sources *SA* and *SB*. Both light sources are stationary (in the stationary coordinate system *K*). The source *SA* is placed at the distance *a* from the *K* coordinate system origin in the direction $+x$. The source *SB* is placed at the distance *a* from the *K* coordinate system origin, but in the direction $-x$. There exists the mass point *P*. The point is stationary in the *K* coordinate system and it is placed at the distance *a* from the *K* coordinate system origin in the direction $+y$. The points *SA, P, SB* and the origin of the coordinate system *K* create the pair of the isosceles rectangular triangles in the plain perpendicular to the *z* axis. The triangles have hypotenuses *SA-P* and *SB-P*.

The light beams are emitted from both light sources at time $t=0$. We deduce the time when the beam shines the mass point P and time interval need for propagation of the light (we will need distinguish those two times for later analysis comparison).
We will use different methods for the deduction. We will use the distance between the light source and the mass point. We will use resolving into the coordinate axes x or y components.
It is not surprising that the results are equal for all used methods in this case. See the table 2.

Table 2. The times in the stationary coordinate system K

Calculation method	velocity	distance	propagation time Δt	emission time t_0	shine time t_R
SA- x axis	$-c/\sqrt{2}$	-a	$a\sqrt{2}/c$	0	$a\sqrt{2}/c$
SA- y axis	$c/\sqrt{2}$	+a	$a\sqrt{2}/c$	0	$a\sqrt{2}/c$
SA- hypotenuse	c	$a\sqrt{2}$	$a\sqrt{2}/c$	0	$a\sqrt{2}/c$
SB- x axis	$c/\sqrt{2}$	+a	$a\sqrt{2}/c$	0	$a\sqrt{2}/c$
SB- y axis	$c/\sqrt{2}$	+a	$a\sqrt{2}/c$	0	$a\sqrt{2}/c$
SB- hypotenuse	c	$a\sqrt{2}$	$a\sqrt{2}/c$	0	$a\sqrt{2}/c$

We will deduce how the moving observer observes the same situation in the moving coordinate system k. The coordinate system k moves with the velocity v in the direction $+x$ as usually. The light sources and the mass point move with the velocity $-v$ in the coordinate system k.
We use the velocity transformation (EMB21) and the position and time transformation (EMB14). We will deduce the answer to the same question as in the stationary coordinate system K in previous text. We use the same methods for deduction. The results are in the following table 3 and table 4.

Table 3. The times in the moving coordinate system k – part 1

Calculation method	velocity	distance	propagation time $\Delta\tau$
SA-ξ axis	$-\frac{c/\sqrt{2}+v}{1+v/c\sqrt{2}}$	$-\frac{a}{\sqrt{1-v^2/c^2}}-v\tau$	$\frac{a\sqrt{2}}{c}\frac{1+v/c\sqrt{2}}{\left(\sqrt{1-v^2/c^2}\right)^3}$
SA-η axis	$\frac{c}{\sqrt{2}}\frac{\sqrt{1-v^2/c^2}}{1+v/c\sqrt{2}}$	$+a$	$\frac{a\sqrt{2}}{c}\frac{1+v/c\sqrt{2}}{\sqrt{1-v^2/c^2}}$
SA- hypotenuse	c	$\beta a\sqrt{2}\sqrt{1+\frac{v^2}{2c^2}+\frac{v\tau}{\beta a}+\frac{v^2\tau^2}{2\beta^2a^2}}$	$\frac{a}{c}\frac{\sqrt{2-v^4/c^4}+v/c}{\left(\sqrt{1-v^2/c^2}\right)^3}$
SB-ξ axis	$\frac{c/\sqrt{2}-v}{1-v/c\sqrt{2}}$	$-\frac{a}{\sqrt{1-v^2/c^2}}+v\tau$	$\frac{a\sqrt{2}}{c}\frac{1-v/c\sqrt{2}}{\left(\sqrt{1-v^2/c^2}\right)^3}$
SB-η axis	$\frac{c}{\sqrt{2}}\frac{\sqrt{1-v^2/c^2}}{1-v/c\sqrt{2}}$	$+a$	$\frac{a\sqrt{2}}{c}\frac{1-v/c\sqrt{2}}{\sqrt{1-v^2/c^2}}$
SB- hypotenuse	c	$\beta a\sqrt{2}\sqrt{1+\frac{v^2}{2c^2}-\frac{v\tau}{\beta a}+\frac{v^2\tau^2}{2\beta^2a^2}}$	$\frac{a}{c}\frac{\sqrt{2-v^4/c^4}-v/c}{\left(\sqrt{1-v^2/c^2}\right)^3}$

Table 4. The times in the moving coordinate system k – part 2

Calculation method	emission time τ_0	shine time τ_R

SA-ξ axis	$\frac{-va/c^2}{\sqrt{1-v^2/c^2}}$	$\frac{a}{c}\frac{\sqrt{2}+v^3/c^3}{\left(\sqrt{1-v^2/c^2}\right)^3}$
SA-η axis	$\frac{-va/c^2}{\sqrt{1-v^2/c^2}}$	$\frac{a\sqrt{2}}{c}\frac{1}{\sqrt{1-v^2/c^2}}$
SA- hypotenuse	$\frac{-va/c^2}{\sqrt{1-v^2/c^2}}$	$\frac{a}{c}\frac{\sqrt{2-v^4/c^4}+v^3/c^3}{\left(\sqrt{1-v^2/c^2}\right)^3}$
SB-ξ axis	$\frac{va/c^2}{\sqrt{1-v^2/c^2}}$	$\frac{a}{c}\frac{\sqrt{2}-v^3/c^3}{\left(\sqrt{1-v^2/c^2}\right)^3}$
SB-η axis	$\frac{va/c^2}{\sqrt{1-v^2/c^2}}$	$\frac{a\sqrt{2}}{c}\frac{1}{\sqrt{1-v^2/c^2}}$
SB- hypotenuse	$\frac{va/c^2}{\sqrt{1-v^2/c^2}}$	$\frac{a}{c}\frac{\sqrt{2-v^4/c^4}-v^3/c^3}{\left(\sqrt{1-v^2/c^2}\right)^3}$

The correspondence of the shine time τ_R in the η axis direction for both light sources *SA* and *SB* is notable. It is interesting that the light velocity component in the η axis direction and propagation times $\Delta\tau$ are is different each other and the distance is the same, but the shine time τ_R is equal. It is caused by the different emission time τ_0 at *SA* and *SB* in the coordinate system *k*. The emission time τ_0 was computed by the time transformation of $t=0$ at *SA* and *SB* from the coordinate system *K*.
It is interesting that the result of the time transformation of the shine time t_R from the coordinate system *K* into the coordinate system *k* at *P* is equal to the τ_R computed for the η axis in the coordinate system *k*.

Other methods give different results. The light velocity components, the propagation times and the shine times are dependent on the deducing method.
The results show that the light beams propagate to the position corresponding with the point *P* at different time with respect of the direction of the components (in *x* axis, *y* axis or hypotenuse directions). This situation is totally different in the coordinate system *k* than in the coordinate system *K*.
The result can be interpreted that the transformation from coordinate system *K* into the coordinate system *k* changes the light beam direction. The similar deduction is described in the EMB §7 text (law of aberration).
The direction change can be interpreted that the perpendicularly components to the coordinate system moving direction conserve times with respect of the time transformations between the coordinate systems and the parallel component completes the velocity to conserve the total light velocity to value *c*.
The interpretation implies that the beams in the coordinate system *k* miss the point *P* in our case and never shine the *P* mass point. The both beams shine the mass point in the coordinate system *K*. The physical effects are different in both coordinate systems. Where the problem is? Why it exists? Where the truth is?

6 Event Transformation

The event transformation is a great question of EMB.
The EMB text does not describe correspondence of the coordinate system transformation with the physical events. The events are described only in the first postulate (EMB3a) and in (EMB8). The postulate does not describe events but laws by which the events are described. The postulate does not

describe if it deals with the analytical (mathematical) description of physical laws (in different coordinate systems) or with the general validity of physical laws. It is well known fact, that experimentally proved physical laws have different mathematical description in different coordinate systems (e.g. in the Cartesian coordinate system or in the spherical one). The different mathematical description does not affect physical validity of the physical law. On the other hand the same mathematical description of the physical law in different coordinate systems should cause disagreement with real world. The coordinate transformation invariant forms of mathematical description of physical laws can exist as well.

It is not explicitly described in EMB text if the result of the event transformation computed by the (EMB14) (and others) is the same event or the different one (EMB8). The position and the time in the stationary coordinate system *K* create the event in the stationary coordinate system *K*. The transformation (EMB14) transforms the event into the moving coordinate system *k* (described by the position and the time). The questions are: Is the event in the moving coordinate system *k* the same event as the original one in the stationary coordinate system *K*? Or, is the transformed event different from the original one? What we must do, if we want to transform the event from the stationary coordinate system *K* into the same event in the moving coordinate system *k*?
The EMB text does not describe the answer. The EMB text describes only "system of equations connecting" the events (EMB8).We can speculate only.

6.1 Two Light Sources

Let us study the following virtual experiment. The experiment differs from previous one.
We have two Cartesian coordinate systems *K* and *k* with the equal scales. The coordinate system *K* is stationary; the coordinate system *k* is moving. Both coordinate systems have the origins at the same position at the zero time. The coordinate system *k* moves with the velocity *v* in direction of the *+x* axis. It is the usual EMB situation.
We have two light sources *SK* and *sk*. The light source *SK* is placed at the *K* coordinate system origin. It is stationary. The light source *sk* is placed at the *k* coordinate system origin. It is moving with the speed *v* in the direction *+x*.
We analyse what will happen with the light beams emitted from both light sources at the time $t=\tau=0$ in direction of the *x* axes after the time period *T*.

- We analyse the situation in the stationary coordinate system *K* for the stationary light source *SK* first. The light beam will be at the *A* point at the time *T*. The *A* point coordinate is $A_x=c.T$ where *c* is the light velocity.
  It is not need to solve any physical problems in this case. The result is deduced directly from the velocity definition (EMB4), from the distance composition in the Cartesian coordinate system and from the presumption that the axes scales of the coordinate system *K* correspond to the scales of velocity and time. We can deduce the same result in the classical Galileo physics.

- We analyse the situation in the stationary coordinate system *K* for the moving light source *sk* now. We need to know the light velocity of the moving light source in this case. The second EMB postulate (EMB3b) gives answer directly. The speed must be *c*. The light beam will be at *B* at the time *T*. The *B* point coordinate is $B_x=c.T$. The point *B* is equal with the point *A*. The result is different from the Galileo transformation in this case. The result of the classical Galileo physics is $B_{Gx}=(c+v).T$.

- We analyse the same situation in the moving coordinate system *k*. We analyse the beam emitted from the *sk* source. The *sk* light source is stationary relative to the *k* coordinate system. The light beam will be at *B'* at the time *T*. The *B'* point coordinate is $B'_\xi=c.T$. The light beam velocity is *c*. The coordinate is measured from the coordinate system *k* origin. The result is equal to the classical Galileo physic.
  The origin of the coordinate system *k* is at *C* at the time *T*. The *C* point coordinate in the *K* coordinate system is $C_x=v.T$. If the time *T* is equal in both coordinate systems, the *B'* point

coordinate in K is $B'_x=B'_\xi+C_x=(c+v).T$. It is the same position as result of the Galileo transformation of source *sk* beam in K coordinate system $B'_x=B_{Gx}$. It is different position of *sk* beam deduced from EMB $B'_x \neq B_x$ for the nonzero velocity v.

- We analyse the stationary light source *SK* in the moving coordinate system k. The *SK* source is moving in the k coordinate system with the velocity $-v$. The second EMB postulate (EMB3b) and the symmetry principle give the light velocity c in this case. The light beam will be at A' at the time T. The A' point coordinate is $A'_\xi=c.T$. The position of A' point is the same as B' point. In case of the Galileo physics we have different result $A'_{G\xi}=(c-v).T$.

The results are:

- The both light beams from the both light sources will be at the same point at the time T in every coordinate system with respect of EMB. The points where the light beam is at the time T have the same coordinates in its own coordinate system in both coordinate systems. The corresponding points are at different positions in the space with respect of used coordinate systems.
- Every light beam from the every light source will be at different points at the time T in the Galileo physics in the specific coordinate systems. The coordinates of the points are different in the different coordinate systems. Every point is at the same position in the space independently on the coordinate system.

Let us note no coordinate transformation from EMB was used in previous analysis. Every result is based only on the general space (time-space) features, the distance composition, the general velocity definition as relation of the distance and the time and on use of the second EMB postulate (EMB3b).

Let us study the EMB event transformation features and compare them with the results from the previous part geometry analysis.

We can transform the event at the time T at A (event A $A_t=T,\ A_x=cT$) from the stationary coordinate system K into the moving coordinate system k. We use directly (EMB14).

$$A_\tau = \beta(T - vA_x/c^2) = \beta(T - vcT/c^2) = \beta T(1 - v/c)$$
$$A_\xi = \beta(A_x - vT) = \beta(cT - vT) = \beta T(c - v)$$

The event is transformed into the different position and the different time than it results from the previous geometry analysis. The same is valid for the event at the time T at B (event B).
We transform other events at the time T at other places. The light source *SK* is at D. The point D is at origin of coordinate system K (event D $D_t=T,\ D_x=0$). We get from (EMB14):

$$D_\tau = \beta(T - vD_x/c^2) = \beta(T - 0\cdot T/c^2) = \beta T$$
$$D_\xi = \beta(D_x - vT) = \beta(0 - vT) = -\beta Tv$$

The light source *sk* at the time T is at C. The point C is at the origin of the coordinate system k (event C $C_t=T,\ C_x=vT$). We get from (EMB14):

$$C_\tau = \beta(T - vC_x/c^2) = \beta(T - v^2\cdot T/c^2) = T/\beta$$
$$C_\xi = \beta(C_x - vT) = \beta(vT - vT) = 0$$

We can see that any event at the time T at any point in the coordinate system K is not transformed by (EMB14) to the event at the time T in the coordinate system k. Moreover every event time in coordinate system k is different each other. The positions of the points A, B and D are different from the results in the previous geometry analysis. Only the point C position is equal. See table 5 and table 6 for the results comparison.

Table 5. The events in different coordinate systems – geometry analysis.

Event [distance, time]	K EMB[a]	K G[b]	k EMB[c]	k G[d]	kS EMG[e]	kS G[f]

A[g]	$c.T, T$	$c.T, T$	$c.T, T$	$(c-v).T, T$	$(c+v).T, T$	$c.T, T$
B[g]	$c.T, T$	$(c+v).T, T$	$c.T, T$	$c.T, T$	$(c+v).T, T$	$(c+v).T, T$
C[g]	$v.T, T$	$v.T, T$	$0, T$	$0, T$	$v.T, T$	$v.T, T$
D[g]	$0, T$	$0, T$	$-v.T, T$	$-v.T, T$	$0, T$	$0, T$

[a] K EMB – the stationary coordinate system *K*, EMB physics based on postulate (EMB3b).
[b] K G – the stationary coordinate system *K*, Galileo physics.
[c] k EMB – the moving coordinate system *k*, EMB physics based on postulate (EMB3b).
[d] k G – the moving coordinate system *k*, Galileo physics.
[e] kS EMB – the moving coordinate system k EMB results recalculated into the stationary coordinate system *K* by the coordinate origin shift at time *T*.
[f] kS G – the moving coordinate system k G results recalculated into the stationary coordinate system *K* by the coordinate origin shift at time *T*.
[g] A,B,C,D – the same events as in the text.

Table 6. The events in different coordinate systems – (EMB14) transformation.

Event [distance, time]	K EMB[a]	k1 EMB[b]	k1S EMB[c]	vK EMB[d]	vk1S EMB[e]
A[f]	$c.T, T$	$\beta(c-v).T,\ \beta T.(1-v/c)$	$\beta c-v(\beta-1).T,\ \beta T.(1-v/c)$	c	$c(1-v/c+v/\beta c)/(1-v/c)$
B[f]	$c.T, T$	$\beta(c-v).T,\ \beta T.(1-v/c)$	$\beta c-v(\beta-1).T,\ \beta T.(1-v/c)$	c	$c(1-v/c+v/\beta c)/(1-v/c)$
C[f]	$v.T, T$	$0,\ T/\beta$	$v.T,\ T/\beta$	v	βv
D[f]	$0, T$	$-\beta v.T,\ \beta T$	$(1-\beta)v.T,\ \beta T$	0	$(1/\beta-1)v$

[a] K EMB – the stationary coordinate system *K*, EMB physics based on postulate (EMB3b).
[b] k1 EMB – the moving coordinate system *k*, EMB transformation (EMB14).
[c] k1S EMB – the moving coordinate system k1 EMG results recalculated into stationary coordinate system *K* by the coordinate origin shift at time T.
[d] vK EMB – velocity calculation from K EMB events based on the (EMB4) velocity definition.
[e] vk1S EMB – velocity calculation from k1S EMB events based on the (EMB4) velocity definition.
[f] A,B,C,D – the same events as in the text.

We can see different velocities of the coordinate system origins (events C and D) in one coordinate system. We can see the origin of the moving coordinate system *k* (event C) at one position at two different times in the stationary coordinate system *K*. We can see the origin of the stationary coordinate system *K* (event D) with nonzero position coordinate in the coordinate system *K*. The results impeach the EMB transformation definiteness.
We can see different velocities of the light beams (events A and B) in one coordinate system. The result impeaches correspondence of the (EMB14) transformation with the (EMB3b) postulate.
Does (EMB14) enable the event transformation between coordinate systems? Does EMB conserve the events in the transformation? Previous analysis impeaches it.

7 Light Velocity Invariance

The text EMB in §3 describes the equation (EMB11) as result of the (EMB10) transformation. It is described as a proof of the EMB transformation correspondence with the light velocity invariance postulate (EMB3b).

$$x^2 + y^2 + z^2 = c^2 t^2 \qquad \text{(EMB10)}$$

$$\xi^2 + \eta^2 + \zeta^2 = c^2 \tau^2 \qquad \text{(EMB11)}$$

The equation (EMB10) is interpreted as the equation describing the spherical wave propagated with the velocity *c* in the coordinate system *K*. The equation can describe the parametric sphere with the centre at the origin of the coordinate system *K*. The equation can describe the wave propagated from $t=0$ with the velocity *c*.
The equation (EMB11) is interpreted similar way. It is interpreted as the equation describing the spherical wave propagated with the velocity *c* in the coordinate system *k*. The equation can describe the wave propagated from $\tau=0$ with the velocity *c*. It is interpreted in EMB as the proof of the light velocity invariance.

Let us analyse the proof in more detail.
We deduce situation where the centre of the sphere wave is not equal with the origin of the coordinate system (in the time or in the position or both) first.
The situation is described by modified (EMB10) equation

$$(x-x_0)^2+(y-y_0)^2+(z-z_0)^2=c^2(t-t_0)^2$$

in coordinate system *K*. We use (EMB14) to transform this equation into the coordinate system k. The result is

$$(\xi-\beta(x_0-vt_0))^2+(\eta-y_0)^2+(\zeta-z_0)^2=c^2\left(\tau-\beta\left(t_0-vx_0/c^2\right)\right)^2.$$

According to (EMB14) is valid:

$$\begin{aligned}\tau_0&=\beta\left(t_0-vx_0/c^2\right)\\ \xi_0&=\beta(x_0-vt_0)\\ \eta_0&=y_0\\ \zeta_0&=z_0\end{aligned}$$

We gain the transformed equation in the coordinate system *k*:

$$(\xi-\xi_0)^2+(\eta-\eta_0)^2+(\zeta-\zeta_0)^2=c^2(\tau-\tau_0)^2.$$

We can see the more general equations than (EMB10) and (EMB11). We deduced agreement of the transformation between (EMB10) and (EMB11) with (EMB14). We can see the analogous relation between the shifted sphere waves as in case (EMB10) and (EMB11). It does not matter if the centre of the sphere wave is shifted in direction of the axes x, *y, z* or at the time *t*. The shift agrees with the EMB event transformation (EMB14).

Let us analyse the equations (EMB10) and (EMB11) in more detail.
Equation (EMB10) describes the parametric set of the spheres with the radius *c.t* and with the centre at the origin of the coordinate system *K* in the Cartesian coordinate system *K* with the axes *x,y,z*. The equation can be used for description of the spherical wave propagated with the velocity *c*.
It is not sure if the equation (EMB11) describes parametric set of the spheres in coordinate system *k*. The EMB text does not contain any proof of this interpretation of (EMB11). It is not possible to deduce from the same mathematical form that the described geometrical entity is the same. It is well known fact (see chapter 3 Length Contraction).

Let us assume existence of the proof. In this case the equation (EMB11) describes the parametric set of the spheres in the coordinate system *k* with the axes ξ,η,ζ with the radius $c.\tau$ and with the centre at the origin of the coordinate system *k*.
Let us determine how is one sphere with the radius *ct* in the coordinate system *K* transformed into the coordinate system *k*. What is the radius of the transformed sphere? If the spheres have the same radiuses $R=c.t=c.\tau=r$ in both coordinate systems and the light velocity *c* is the same in both coordinate systems, it must be valid $t=\tau$ at every point of the sphere surface.
If we suppose the spherical wave, the equation $t=\tau$ must be valid for all *t* and all τ at any point of the sphere. The set of those points is whole space. It is in the contradiction with the analysed features of the time transformation (EMB14) analysed in the previous chapter (see 5.4 Time Transformation Features). We know that the equation $t=\tau$ is valid only in the plane perpendicular to the moving coordinate system velocity direction at approximately half of the distance between the coordinate systems origins. It is valid $t\neq\tau$ at all other positions. We have two possibilities:

- the result of the spherical wave transformation from the stationary coordinate system is not the spherical wave in the moving coordinate system,
- the light velocity *c* is not equal in both coordinate systems. The light velocity is dependent on the point position on the sphere surface.

Let us look at the sphere centres. Every sphere from the set of spheres included in propagated spherical wave in the coordinate system *K* has the centre at the origin of the coordinate system *K* according to (EMB10). Every sphere from the set of spheres included in propagated spherical wave in

the coordinate system k has the centre at the origin of the coordinate system k according to (EMB11). The origin of the coordinate system K is equal to the origin of the coordinate system k only at the time $t=\tau=0$. The centre of the transformed sphere is at the other place than the centre of the original one at any other time. **The spheres can not be identical.** The spheres must have the different centres moving each other with the velocity v.
The transformation of the spheres is valid for all shifted spheres. The result is valid for every shifted sphere. It is not possible to find spherical wave with equal centres at any time in both coordinate systems.
Let us note the equation describing the transformed spherical wave or the sphere with the centre at the origin of the coordinate system K can be described in the Cartesian coordinate system k by equation

$$(\xi + v\tau)^2 + \eta^2 + \zeta^2 = c^2\tau^2$$

or if we consider the scale transformation in ξ, τ axes the equation could be

$$(\xi + v\tau)^2 + \beta^2\eta^2 + \beta^2\zeta^2 = c^2\tau^2 .$$

Compare it with (EMB11).

We summarize. **Every spherical wave propagated with the light velocity is transformed by (EMB14) into the different wave with the different centre**.
Equations (EMB10) and (EMB11) **do not describe the same physical effect and they do not prove the light velocity invariance** of the transformations described in EMB. No other proof of the light velocity invariance is described in EMB.

8 Transformation and Linear Algebra

Let us analyze the EMB transformation from mathematical point of view.
Different kinds of transformations are used in practice. One group of transformations is mapping from one space into another different space. The group of transformations includes e.g. Fourier transformation mapping periodical time dependence into frequency spectrum, Laplace transformation mapping differential equations into polynomials, Hough transformation mapping points in the space into parameter value count. The other group of transformations is mapping from one space into the same space e.g. vector transformations. The vector transformation can conserve the point position or can change the point position. The vector transformations conserving the point positions are very interesting for physics. We will analyse the transformations described in the EMB text as a vector transformation.
The mathematic area dealing with vector transformation is part of linear algebra (vector algebra, tensor algebra). We can read in linear algebra textbooks, that the basis of the coordinate system and the origins are essential part of the transformation. We can read [9 – chapter 3.4, chapter 5.1], [10], [11], [12] that the coordinate transformation is unambiguously related with the coordinate systems bases and origin shift.
Let us try to find the bases of both coordinate systems K and k described in the EMB text. The basis of any coordinate system is not described in the EMB text. The coordinate systems are described in §3 (EMB7). The definition directly describes that both coordinate systems K and k are the Cartesian coordinate systems, they have three coordinate axes x,y,z and ξ, η, ζ. The EMB text can be probably interpreted from algebra point of view as one three-dimensional (3D) space described by two 3D coordinate systems. The time is not described in the coordinate system description as an independent axis.
The EMB text (EMB7) describes clocks "be in all respects alike". It can be understand from the mathematical point of view as both 3D coordinate systems are parameterized by the time attribute at any point. The note "this "*t*" always denotes a time in stationary system" can be understand as the attribute of the stationary coordinate system is named "*t*". The value of the attributes t and τ at different points is referred to the EMB §1 text.
We can summarize the EMB description from mathematical point of view:

- Two 3D coordinate systems K and k are defined in one 3D space
- Both coordinate systems have the orthogonal basis where all unit vectors have the same length and relevant axes are parallel.

- Both coordinate systems are linear (not curvilinear).
- Every point in both coordinate systems has one attribute (time). The attribute value is described by an external function described in the EMB §1 text.
- The attribute value can be different in the different coordinate system
- The attribute value can be different at the different points in the specific coordinate system.
- The transformation includes shift of origins (translation).
- The distance between the origins of both coordinate systems is function of time (the function of the attribute) indirectly described by the velocity *v*. The distance between the origins is not exactly described in the EMB text. The relation between the velocity and distance can be interpreted as usually i.e. as the well known product of the velocity and the time interval plus a starting offset at the zero time (it agree with the sense of (EMB4), (EMB20), (EMB22)).
- A selection of the point used for the distance calculation between the coordinate systems origins is missing. If the attribute value is not global the attribute can have different values in different points. It is needed to respect the fact in the origins distance determination.

General vector space (geometry) transformation consists of origin shift (translation) and change of basis [13]. Translation can be described by translation matrix [14].

$$\begin{bmatrix} \xi \\ \eta \\ \zeta \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & T_x \\ 0 & 1 & 0 & T_y \\ 0 & 0 & 1 & T_z \\ 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix} \tag{4}$$

General transformation can be described by general transformation matrix [15]

$$\begin{bmatrix} \xi \\ \eta \\ \zeta \\ 1 \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & a_{13} & T_\xi \\ a_{21} & a_{22} & a_{23} & T_\eta \\ a_{31} & a_{32} & a_{33} & T_\zeta \\ 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$

Where **a** is basis change matrix and *T* is translation vector in result coordinate system. We use EMB notation where coordinates in the original coordinate system *K* are *x,y,z* and coordinates in the result coordinate system *k* are ξ,η,ζ (we will not use names "stationary" and "moving" coordinate systems in the algebra analysis).

8.1 3D Transformation

We use the mathematical apparatus to analyse (EMB14) transformation features in 3D space. We name the distance of the coordinate systems *K* and *k* origins in the coordinate system *K* as ΔK and the same distance in the coordinate system *k* as Δk.
We can write directly from (EMB14) the transformation the matrix **b** in general transformation matrix form

$$\begin{bmatrix} \xi \\ \eta \\ \zeta \\ 1 \end{bmatrix} = \begin{bmatrix} \beta & 0 & 0 & \Delta k \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$

where $\Delta k = -\beta vt$. We can see that the (EMB14) transformation is similar to the translation (4) but it is not simple translation. The transformation includes bases change as well.

Let us find the inverse mapping to (EMB14). We solve inverse matrix $\mathbf{c}=\mathbf{b}^{-1}$. We need determinant det(**b**). We calculate det(**b**)=β. Determinant is sometimes called scale factor for volume. We see that the (EMB14) transformation changes scale of volume because det(**b**)≠1 (for $v>0$].

Inverse matrix **c** is

$$\begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix} = \begin{bmatrix} \frac{1}{\beta} & 0 & 0 & -\frac{1}{\beta}\Delta k \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} \xi \\ \eta \\ \zeta \\ 1 \end{bmatrix}$$

We can write from the inverse matrix **c**

$$x=\xi/\beta+\Delta K= \xi/\beta-\Delta k/\beta,$$

where $\Delta K=-\Delta k/\beta=vt$ and from the original matrix **b**

$$\xi=\beta x+\Delta k=\beta x-\beta\Delta K.$$

Let us verify if all base vectors are orthogonal.
We can describe unit vectors of the coordinate system *k* base in coordinate system *K* from inverse matrix **c**. The unit vectors are free vectors. The coordinate system *k* unit vectors described in the coordinate system *K* (placed in the origin of coordinate system *K*) are

$$e_\xi=(1/\beta, 0,0),\ e_\eta=(0,1,0),\ e_\zeta=(0,0,1) \tag{5}$$

The unit vector lengths are

$$|e_\xi| = \sqrt{1/\beta^2} = 1/\beta \quad |e_\eta| = 1 \quad |e_\zeta| = 1$$

We compute dot products of every pair of unit vectors of the coordinate system *k* base. We find out that all dot products are zero. Every base vectors pair of coordinate system *k* is orthogonal. Every base vector is orthogonal to every other.

We can make the first general conclusions:

- The (EMB14) transformation can be only combination of translation and scale change. It is impossible to be simple translation only.
- All coordinate axes are mutually orthogonal in both coordinate systems.
- One base vector changes its length. The transformation changes scales in one direction.

EMB transformation works with t and τ attributes. Both can be supposed as attributes of every point in the 3D space. The equation $\tau=\beta(t-vx/c^2)$ from (EMB14) can be interpreted as relation between both attributes.
We analyse dependency of the origins translation on the *t* attribute value.
We find from ΔK and Δk definition and from translation definition applied to the (EMB14) the relation $\Delta K=vt$ (in coordinate system *K*). It implies directly that exists only one value of the *t* attribute for every specific ΔK or Δk. It implies directly, that every point in the space has to have the same value of its *t* attribute (only one translation exists for every point in the space – see translation definition [14]).
We can write direct and inverse transformation

$$\xi=\beta x-\beta\Delta K=\xi=\beta x-\beta vt=\beta(x-vt)$$
$$x=\xi/\beta+\Delta K= \xi/\beta+vt$$

Let us note different scales in both coordinate systems.

We know the *t* attribute value in both coordinate systems. It is the attribute of the point in the space. This transformation is valid in every point in 3D space. The τ attribute is not used in this transformation. We can see that our equation is different from the equations (EMB12 and (EMB13). Inverse mapping does not include τ variable as in EMB text.

We have additional general conclusions:

- The equality of the *t* attribute value at every point of space is directly caused by the translation existence and by translation definition.

- The transformation is valid at any point of the space if it uses only t attribute (no τ attribute is used).

Let us analyse transformation features linked with the τ attribute. We use the relation between both attributes $\tau=\beta(t-vx/c^2)$ from (EMB14). The relation $\tau=\beta(t-vx/c^2)$ describes slant line where τ value decreases with increasing x. We know that the t value has to be constant. Therefore we always can find the specific coordinate x where the relation is valid for any τ value independently on t value (if $v>0$).
It means, we can select any τ value independently on t value and use it in inverse transformation even in the product $v_k\tau$ (the k index distinguishes the v_k constant value in the coordinate system k linked with τ attribute from the v constant value linked with the t attribute in the original coordinate system K).
It implies there exists that x where the product $v_k\tau$ has any value independently on the t attribute value for every selected value i.e. if the value of τ or v_k is selected it is impossible to uniquely determine the value of t or more precisely for any value of τ exist specific x where the relation $\tau=\beta(t-vx/c^2)$ is valid for any t value.
If the product $v_k\tau$ is the coordinate system translation described in coordinate system k as described in (EMB12), it has to be only one specific distance valid in whole validity scale of the transformation. It means the τ attribute has to have only one specific value in the inverse transformation validity scope if v_k is constant.
There exists only one value of x coordinate where the τ attribute has the specific value. The value of the τ attribute has to be different at any other point with the different x (ξ) coordinate. Therefore the inverse translation dependent on the τ attribute is valid only in the plain perpendicular to the x (ξ) axis.

Let us find the position of the plain. We know from the distance between origins comparison in different coordinate systems $\Delta k=\beta\Delta K$ (scale change must be applied to the distance description in different coordinate systems), then

$$v_k\tau=\Delta k=\beta\Delta K=\beta vt.$$

We gain the inverse translation validity condition

$$\tau=\beta tv/v_k.$$

The inverse translation has to fulfil two conditions dealing with the relation between τ and t in its validity scope i.e. relation

$$\tau=\beta(t-vx/c^2)$$

and the condition

$$\tau=\beta tv/v_k.$$

We solve the position where both equations are valid

$$\beta tv/v_k=\tau=\beta(t-vx/c^2).$$

The solution is

$$x=tc^2(1/v-1/v_k).$$

We see that the plain position is dependent on the t attribute value (i.e. on the distance between the origins) and on the relation of both constants v and v_k. We can choose the ratio $\alpha=\tau/t=\beta v/v_k$. The plain position can be described

$$x=\left(1-\frac{\alpha}{\beta}\right)\frac{c^2}{v}t\ .$$

We get general inverse transformation

$$x=\xi/\beta+vt=\xi/\beta+v_k\,\tau/\beta=\xi/\beta+v\tau/\alpha. \qquad (6)$$

We gain $\alpha=\beta$, $x=0$ and $\tau=\beta t$ for $v=v_k$. The inverse transformation is

$$x=\xi/\beta+v_k\,\tau/\beta=\xi/\beta+v\tau/\beta.$$

We gain $\alpha=1$, $v_k=\beta v$ and

$$x=(1-\frac{1}{\beta})\frac{c^2}{v}t=(1-\sqrt{1-\frac{v^2}{c^2}})\frac{c^2}{v}t\cong\frac{1}{2}vt$$

for $\tau=t$. The inverse transformation is

$$x = \xi/\beta + v_k\ \tau/\beta = \xi/\beta + v\tau.$$

We have infinite number of choices to select α (relation between v and v_k i.e. relation between τ and t) and we have to respect the position of the plain. Or we can choose the plain position and we have to respect the relation between τ and t (v and v_k) in this case.
All selections are equivalent from mathematical point of view.
We can see that the inverse transformation is different from the equation described in EMB text (EMB12) and (EMB13).

We have additional specific conclusions valid in the case of using the τ attribute in inverse transformation:

- The inverse translation is valid only in the plain perpendicular to the x (ξ) axis. It can not be valid in every point in 3D space.
- The position of the plain can be chosen. The plain position is unambiguously linked with the relation between the t and τ attributes and with relation between v and v_k constants. The relation of the t and τ attribute values can be understood as the τ attribute scale selection.
- The general inverse transformation exists for every value of the α ratio.
- The inverse transformation is different from the equation described in EMB text (EMB12) and (EMB13).

We can see the situation for $\tau=t$ i.e. $\alpha=1$ on the figure 4.

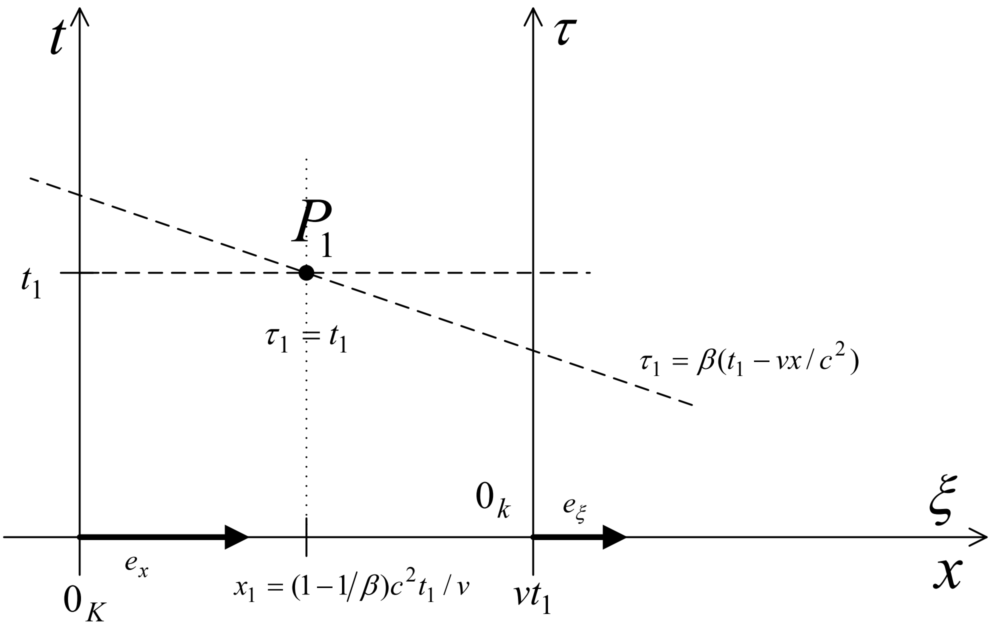


Figure 4. Schematic drawing of the validity scope of 3D EMB origins translation. Only one coordinate system dimension and the t and τ attribute value are shown on the figure. Coordinate system k at time t_1 is drawn in the coordinate system K. The coordinate system k origin 0_k is placed at position vt_1 (measured in coordinate system K scale). The plain P_1 is placed perpendicularly to the x (ξ) axis (it is drawn as a point – axes y and z is not drawn in the figure). It is valid $t_1=\tau_1$ in the plain P_1.

8.2 4D Transformation

We can formulate a 4D hypothesis. It is possible to do it. Some parts of EMB text can be understand this way (EMB8), (EMB9), (EMB14). The point in our 4D space is an event.
General transformation in 4D space can be described by general transformation matrix

$$\begin{bmatrix} \tau \\ \xi \\ \eta \\ \zeta \\ 1 \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & a_{13} & a_{14} & T_\tau \\ a_{21} & a_{22} & a_{23} & a_{24} & T_\xi \\ a_{31} & a_{32} & a_{33} & a_{34} & T_\eta \\ a_{41} & a_{42} & a_{43} & a_{44} & T_\zeta \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} t \\ x \\ y \\ z \\ 1 \end{bmatrix}$$

We can write directly from (EMB14) the transformation matrix **b** in general transformation matrix form

$$\begin{bmatrix} \tau \\ \xi \\ \eta \\ \zeta \\ 1 \end{bmatrix} = \begin{bmatrix} \beta & -\beta v/c^2 & 0 & 0 & 0 \\ -\beta v & \beta & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} t \\ x \\ y \\ z \\ 1 \end{bmatrix}$$

We can see that the (EMB14) transformation includes zero translation vector T. The transformation includes only bases change. The (EMB14) transformation in 4D space does not shift the coordinate system origins.

Let us find the inverse mapping to (EMB14). We solve inverse matrix **c**=**b**$^{-1}$. We need determinant det(**b**). We calculate det(**b**)$=\beta^2(1-v^2/c^2)=1$. Determinant is sometimes called scale factor for volume. We see that the (EMB14) transformation does not change scale of volume because det(**b**)=1 (for $v<c$). Inverse matrix **c** is

$$\begin{bmatrix} t \\ x \\ y \\ z \\ 1 \end{bmatrix} = \begin{bmatrix} \beta & \beta v/c^2 & 0 & 0 & 0 \\ \beta v & \beta & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} \tau \\ \xi \\ \eta \\ \zeta \\ 1 \end{bmatrix}$$

We can write from the inverse matrix **c**

$x=\beta v\tau+\beta\xi=\beta(\xi+v\tau)$ and $t=\beta\tau+\beta v\xi/c^2=\beta(\tau+v\xi/c^2)$.

The inverse matrix **c** gives the same results as the EMB text in (EMB12) and (EMB13).

Let us verify if all bases vectors are orthogonal.
We can describe unit vectors from the coordinate system k base in coordinate system K from inverse matrix **c**

$$e_\tau=(\beta, \beta v,0,0),\ e_\xi=(\beta v/c^2,\beta, 0,0),\ e_\eta=(0,0,1,0),\ e_\zeta=(0,0,0,1) \tag{7}$$

The unit vector lengths are

$$|e_\tau| = \sqrt{\beta^2+\beta^2 v^2} = \beta\sqrt{1+v^2},\quad |e_\xi| = \sqrt{\beta^2\, v^2/c^4+\beta^2} = \beta\sqrt{1+v^2/c^4},\quad |e_\eta|=1 \quad |e_\zeta|=1$$

We compute dot products of every pair of unit vectors. We find out that all dot products but one is zero. Every base vectors but one pair is orthogonal. The exception is e_τ and e_ξ.

$$e_\tau .\ e_\xi=\beta^2 v/c^2+\beta^2 v=\beta^2 v(1+1/c^2)$$

We can make general conclusions:

- The (EMB14) transformation is not translation. It is only bases change.
- Two unit vectors change theirs size. Two unit vectors have the same size.
- The coordinate axes are not multiply orthogonal. Coordinate axes τ and ξ are not independent each other.
- The inverse transformation is equal with the EMB transformation (EMB12) and (EMB13).

We note the space we are using is not metric space. It is affine space. It is not possible to measure the distances or the angles in this space. The value of the dot product $e_\xi \cdot e_\tau$ has no physical meaning in affine space (the same is valid for the unit vector length). Zero value is important for perpendicularity test. It is possible to test perpendicularity in our case.
We can change our space into the metric space for better clearness. We can multiply both "time" axes t and τ by any velocity v_0. We gain the metric space. We can measure the distances and the angles in that space. We get in this case

$$e_\xi \cdot e_\tau = \beta^2 v/v_0 + \beta^2 v v_0/c^2$$

$$|e_\tau| = \beta\sqrt{1+v^2/{v_0}^2}, \quad |e_\xi| = \beta\sqrt{1+v^2{v_0}^2/c^4}, \quad |e_\eta| = 1 \quad |e_\zeta| = 1$$

and we can measure the angle between the ξ and $v_0\tau$ axes (between the e_ξ and e_τ basis vectors). It is

$$\cos\left(e_\xi \cdot e_\tau\right) = v/v_0\left(1+{v_0}^2/c^2\right)\Big/\left(\sqrt{1+\left(vv_0/c^2\right)^2}\sqrt{1+\left(v/v_0\right)^2}\right).$$

We can see the angle is dependent on the ratio v/v_0 and on the ratio v/c. We get

$$\cos\left(e_\xi \cdot e_\tau\right) = 1$$

for $v=v_0=c$. It means that the ξ and τ axes ($v_0\tau$ axes) are parallel in this case. The 4D space is reduced into the 3D space with one "integrated space-time axis" plus the two standard space axes.

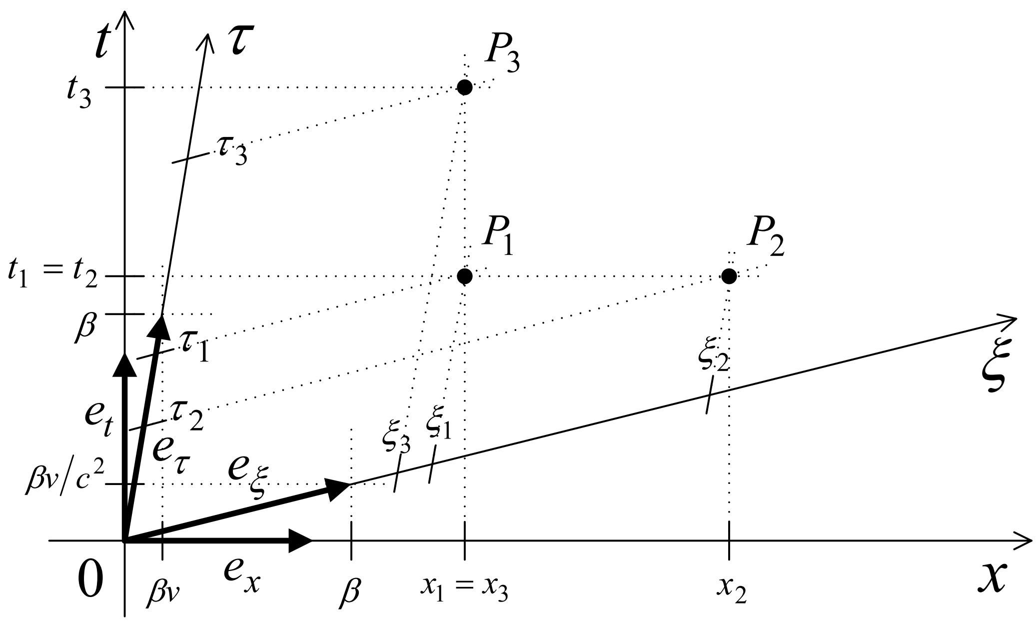


Figure 5. The schematic drawing of the 4D EMB transformation. Only the two dimensions are shown in the figure. The unit vectors of the both coordinate systems K and k, coordinate axes and the three points P_1, P_2 and P_3 describing the three different events in the coordinate system K are drawn. The points P_1 and P_3 describe position of the stationary mass point at the different time moments. The points P_1 and P_2 describe the two synchronous events at the two different localities. The coordinates in the coordinate systems K and k are drawn. We can see if the mass point is stationary in the coordinate system K, the coordinate ξ decreases its value and the coordinate τ increases its value in the coordinate system k with the growing time t. The two synchronous events have the different coordinate value τ in the coordinate system k. We can see from the figure that the coordinate value x in the coordinate system K is different from the coordinate value ξ in the coordinate system k. We can see the decreasing coordinate value τ with the increasing coordinate value x for the synchronous events.

8.3 Algebra Conclusions

3D transformation has the basic features:

- It is translation of origin.

- It is scale change in the x axis direction.
- It has all coordinate axes orthogonal
- If the variable τ is used with relation described in EMB text the transformation can exist only in the plain perpendicular to the x axis direction.
- The inverse transformation is different from EMB text
- Direct and inverse transformations are not symmetrical.

4D transformation has the basis features:

- It is not translation of origin. It is bases change only.
- Two unit vectors change its size in the transformation.
- All coordinate axes are not orthogonal. Axes ξ a τ are not orthogonal.
- The transformation exists at every point in the 4D space.
- The inverse transformation is the same as described EMB text
- Direct and inverse transformations are symmetrical.

No algebra interpretation of the EMB transformation (EMB14) fulfils the features described in the coordinate system description (EMB7). Separate interpretations fulfil only some features and fail in other ones. Both interpretations change scale at least in one axis.

8.4 Physical Implications

Let us analyse physical implications in 3D case.
We can analyse relativistic effects in the transformation validity scope (in the plain P) for $\tau=\alpha t$ where α is chosen constant:

- Length contraction – the length doesn't exist in the x direction. The distance is conserved in the y and z directions. Length contraction doesn't exist.
- Time dilatation – It is valid $\tau=\alpha t$ at any point in the plain P where α is chosen constant. Time dilatation doesn't exist. Only time scale change can exist.
- Velocity transformation – we can substitute the velocity of the P plain

  $$w_x = (1-\alpha/\beta)\frac{c^2}{v}$$

  into velocity transformation equation (in the y (η) direction) (EMB21)

  $$w_\eta = \frac{\sqrt{\left(1-v^2/c^2\right)}}{1-vw_x/c^2}w_y \ .$$

  We gain

  $$w_\eta = \frac{\sqrt{\left(1-v^2/c^2\right)}}{1-v(1-\alpha/\beta)\frac{c^2}{v}\Big/c^2}w_y = \frac{\sqrt{\left(1-v^2/c^2\right)}}{\alpha/\beta}w_y = w_y/\alpha \ .$$

  We can see identity. No velocity limit exists in the EMB transformation. The velocity transformation includes only time scale factor α.
- Events transformation – events exist only in the P plain at the time relevant to the distance between the origins ($\tau=\alpha t$). Events are conserved (position $\eta=y$, $\zeta=z$). No other event exit.
- Limited light velocity proof – the spheres (EMB10) and (EMB11) are placed out of the validity scope independently on the plain position. The proof is irrelevant.

The EMB translation transformation features in the validity scope are equivalent to the classical Galileo transformation features. The EMB translation transformation validity scope is the plain, Galileo validity scope is 3D space.

We analyse physical meaning of the v_k. It is a constant from algebra point of view. It should be velocity from the physical point of view. The velocity is defined in (EMB4) as quotient of distance and time. It is the distance between origins and the time in case of v_k.

We know that the transformation is valid only in the plain orthogonal to the *x* axes and therefore it is valid in the plain orthogonal to the distance between origins. We want to use the τ attribute as a time. We know that the τ attribute value is dependent on the position in the *x* axis direction. We know that the τ attribute value is different in different points of the distance used in the quotient. The quotient must give different results if we use the τ attribute value from different points. It is not possible to select if the use of "time" attribute τ from the coordinate system *K* origin is better than to use the same attribute but from the origin of the coordinate system *k* or if it is better to use the τ "time" attribute from the plain where $\tau=\alpha t$ is valid. But every variant gives different result. It is valid for the difference as well ($\Delta\tau=\beta\Delta t-\beta\Delta xv/c^2$). It is not possible to interpret v_k as a velocity. **It is not possible to interpret the τ attribute as a time in velocity v_k definition.**

We know that direct transformation is not symmetrical with inverse one in the 3D space case. It means from physical point of view we have to distinguish between the coordinate systems and select the right direction of the transformation. The general coordinate system can not be recognizable in physics.

No relativistic effects exist in this case. **The transformation with validity range limited to the plain cannot be use in physics.** We know that the inverse transformation (6) in 3D space is not identical with the EMB text (EMB12) and (EMB13).
The 3D case is the only case where the EMB transformation includes origin translation (shift). The time dependent origin shift is cornerstone of special relativity theory.

Let us analyse physical implications in 4D case.
Let us analyse the physical meaning of the used 4D space and the coordinate systems first. The 4D space as defined in the previous text is the affine vector space from the mathematical point of view. There is no common physical unit in all axes. It is not possible to measure the distance or the angle. The time axis is one of the coordinate axes. The point in the space (space-time) is the event. Therefore every point in our 4D space is the event. The event exists only at exactly one specific moment. The moment is described by the time coordinate of the point. The event does not exist at any other moment. It is the feature of the event i.e. it is the feature of the points in our space.
We have a philosophical problem with the coordinate system existence. The origin of the coordinate system is the point. It is the event. The event exists only at the zero time. The event does not exist at any other time. The origin exists at the different time than the other events. We need to know the coordinates of any event in the space i.e. distance of the point from the origin. How is it possible to determine the coordinates if the origin and the event do not exist at the same time?
We have the same problem with the basis of the coordinate system. All basis vectors do not exist at the same time on top of that. The unit time exists at the different moment than all other distance unit vectors. How is it possible to use the basis to determine the coordinate of the event if the basis exists at the different moment than the event? The event exists when the basis does not exists and vice versa.

The time is one dimension of 4D space. The time is the attribute of 3D space. The difference between 3D and 4D spaces has serious mathematical and physical consequences.
There are questions: How the velocity is defined in our 4D space-time? What the definition mean? Can be the definition mathematically valid?
The velocity definition (EMB4) is mathematically debatable. It is the ratio of two distances in our 4D vector space. The distance in denominator is the distance in different direction than the distance in numerator. The distance in the vector space is a vector. The ratio of two vectors is mathematically undefined vector operation.
The velocity definition (EMB22) is based on differential velocity definition. It is very frequently used velocity definition in physics. The derivative existence is based on the existence of continuous set of points satisfying specific conditions according to the mathematical definition. The event is point in our 4D space. The derivation existence is conditioned by existence of continuous set of events satisfying specific conditions. There is a question: What does the set of events mean in physics? What physical events describe coordinate system moving?

If the set exists and if it has some physical meaning, the derivative used in the velocity definition (EMB22) has specific geometrical meaning in our 4D vector space. The velocity is specific kind of partial derivative in time direction. The event set slope in specific direction is the meaning of the velocity definition. The slope is measured in the specific physical units (e.g. m/s). The slope of the same set of events is measured in other units (e.g. radian) in the different directions. How can be the slopes in different directions composed? What physical meaning of the slopes is? Do the slopes have different physical meaning in different directions? How it corresponds with the symmetry principles? Our 4D space is affine space. Angle and slope are not defined in affine space. Can the velocity exist in our 4D space?

Let us suppose that the described philosophical, mathematical and physical problems had been solved successfully and we can use the coordinate system origin and the basis at any time and we know how the velocity is defined and we know how to manipulate with the velocity.
We can find physical implications of the mathematical analysis of transformation in the 4D space.

The transformation (EMB14) conserves the physical event in 4D only if (7) is valid. The result of the transformation describes the same physical effect as the input of the transformation. **The ξ and τ axis are not orthogonal each other** and they are not parallel with the x and t axes respectively. Therefore **it is not possible to measure the distances on ξ or τ axis in physical units.** Both axes have the time and the distance components. No physical unit exists to enable measurement on the ξ axis or τ one. The coordinate ξ is not possible to interpret as the position coordinate. The coordinate τ is not possible to interpret as the time coordinate.

We can not talk about the light velocity invariance. No velocity can be computed from the ξ and τ coordinates. The fraction ξ/τ is physical nonsense in this case.

The EMB transformation is not origin translation in 4D space. The origins of both coordinate systems are equal.

It is theoretically possible to interpret the EMB transformation another way. The axes ξ and τ can be supposed as orthogonal each other and parallel with the axes x a t. The scales can be defined as the same as original one. Therefore it is possible to measure the distances on the ξ axis in length units (e.g. meters) and the distances (time period) on the τ axis in time units (e.g. seconds). In this case the transformation (EMB14) from EMB text has to **transform the original events into the different physical events** i.e. it transforms the specific physical effect into another physical effect. It is not possible to compare the original physical effect with the result of the EMB transformation. The comparison is irrelevant in this case.
The transformation describes only virtual image of the physical effect in this case like the image of the real world in a mirror. It is false to believe that the funny person behind the crooked mirror is a real one.

These results are very interesting and very important. Now we can try to explain questions from the previous chapters 3.1 Revolving Cylinder, 4.1 Three Light Sources, 5.5 Two Light Sources and Mass Point, 6.1 Two Light Sources. We can answer the questions by using the described variants. The common problem was mixing of all variants in our mind and use of the equation out of the validity scope. The problem is the use of the transformation (EMB14) and believing that all features are valid together, but they are exclusive. The problem is to believe that coordinate system description (EMB7) and coordinate system transformation (EMB14) are consistent. Now we know that the belief is false.

Let us note. The only translation transformation conserving the point position and use equal scales based on the EMB7 coordinate systems definition where an inverse transformation exists in 3D space is the classical Galileo transformation with the global time attribute.

9 Michelson Experiment

An experimental background for creation of the EMB paper and other ideas dealing with the absolute light velocity and the relative one (e.g. [16]) was based on result of the Michelson experiment [17] interpreted as the negative or zero result. The Michelson (Michelson-Morley) experiment was designed to measure the absolute Earth velocity by the light beams interference. No significant interference was observed in any repeated measurements.
It is experimentally proved that the Earth is moving relative to the other astronomic objects e.g. the Sun, other planets. Therefore the Michelson experiment is supposed as the experimental proof of non-existence of the “Luminiferous Aether”.
The disagreement of the assumed theoretical results with the experiment results motivated searching of other theoretical explanations of the measured results. The second EMB postulate (EMB3b) should be one of the possible theoretical backgrounds of the Michelson experiment result interpretation. The postulate can easily clear out the experiment result by the constant light velocity of every light source in case of any velocity of the observer (the coordinate system).
This interpretation of the Michelson experiment results is not the only possible one.

We describe another possible explanation based on the known and experimentally proved physical effects.
It is well known that the light velocity is dependent on the material the light comes through. It is possible to explain it by an electromagnetic interaction of the light beam with the electromagnetically active particles of the material the light beam comes through.
The other material dependent effects in electromagnetism are known. The effects are described by the material dependent coefficients ε,μ (permittivity and permeability) in the Maxwell equations. The material dependent effects were many times experimentally proved. They are used reproducible in industry and in real life (e.g. capacitors, magnets, transformers, electric motors).
The effects can be explained by the electromagnetic interaction of mass particles with an external electromagnetic field. The material dependent effects of a remote interaction with the external electromagnetic field are experimentally proved and they are used in real life (e.g. Yagi antennas, waveguides).
Therefore it is well known that the mass particles interact with the electromagnetic field and the interaction can be remote. It is known that the mass particles interacts with the light beam and modify the light velocity. The light is the electromagnetic wave. We have to take into account the remote interaction of the mass particles with the light beam and the remote modification of the light velocity. There exist real devices using the physical effect that can be explained as the remote modification of the light velocity by material features (gradient optical fibres).
We know and we can describe the very near interaction of the material with the electromagnetic waves (the distance should be comparable with wavelength). We do not know values describing the weak remote interaction and we don’t know how the interaction is dependent on the distance and on the other material parameters. More precisely the dependence was not experimentally proved.
We know from the Maxwell equations and from experiments that the electromagnetic interaction is generally inversely proportional to the distance (linearly or quadratic). Therefore we know that the material located more closely to the point has greater influence than the same material located more distant.
We can use the facts for the Michelson experiment result explanation. The dominate influence to the light velocity has the material placed on the Earth surface. The material placed in other planets, in the Sun has much less influence. It is caused by the distance between the material and the place of the experiment. The correspondence of the light velocity in all directions in the Michelson experiment can be explained by the symmetry and by the size relation of the experimental light tracks to the size of the Earth.

10 Conclusions

We summarize knowledge from the analysis.

10.1 Kinematical part

- The length contraction described in the EMB text is not supported by the facts. The different result from the sphere wave transformation is caused by wrong deduction, by missing time transformation equation in the deduction. The length contraction as described in the text is not a feature of the EMB transformations.

- The EMB position transformation equations and the velocity ones are mutually equivalent and compatible. The velocity transformation equations are directly caused by the position transformation equations and by the principle of the derivative and transformation exchange in the physical coordinate systems.

- The EMB position and velocity transformation between the coordinate systems is not identical with the velocity and position composition in the separate coordinate systems. Wrong use can give multivalent and contradictory results.

- No velocity limit existence in one specific coordinate system can be deduced from the equations described in the EMB text. The velocity equation interpretation described in the EMB text is false. The equations can be applied only to the transformation between two or more coordinate systems.

- The synchronized clock definition in the EMB text is ambiguous. The EMB propositions do not agree with the synchronized clock definition in every case.

- The EMB time transformation depends on the position of the point. The different equations describing the time transformation in the EMB text are mutually compatible. The right equation should be used in the different specific situation.

- The generalization of the time dilatation in the moving coordinate system described in the EMB text is not legitimate. The commonly used equation (EMB19) is valid only in a plane perpendicular to the moving direction and passing the origin of the moving coordinate system. The different time transformation is valid at other positions.

- The plane exists where the time values in both coordinate systems are equal. The plane is located approximately at the middle between the origins of the coordinate systems and it is perpendicular to the moving direction. The time at the points placed outside of the plane is different. The time in the one half-space is "faster" and in the second one is "slower". The plain moves with the velocity which is about one half of the velocity of the moving coordinate system. Therefore exactly one moment exists at which the times in both coordinate systems equal each other for any point.

- The EMB text about different times measured by stationary clock and the clock moving in any closed polygonal line has no physical background.

- Situations where it is questionable how to interpret the results exist in the event transformation according to the EMB text. The results can be interpreted either as the geometry change caused by the coordinate system transformation or as the nonobservance of the events.

- There are situations where the geometry change explanation cannot be used. The explanation that the EMB transformation does not conserve the events must be used i.e. the selected event in the first coordinate system is transformed into the different event in the second coordinate system. The event in the second coordinate system describes the different physical effect than the original event in the original coordinate system.

- The spherical wave with the propagation velocity *c* described in the EMB text can be generalized into any spherical wave with the propagation velocity *c* with any origin (any shift of the location or of the time). The transformation can be used for any sphere with any radius and any centre.

- The EMB text of the light velocity invariance proof does not prove the light velocity invariance in the EMB coordinate transformation. The transformation result should be interpreted as it proves the change of the physical effects in EMB transformation. The described transformation must change the position of the spherical wave centre.

10.2 Mathematical analysis

- The EMB text allows interpreting of the EMB transformation either as the 3D or as the 4D vector transformation.

- In case of the 3D metric space, the EMB transformation includes the origin translation (shift) and the scale change (5).
- The use of the Cartesian coordinate systems with the equal scales (measuring-rods) in all axes excludes the possibility to conserve the position of the points in the EMB transformation i.e. it excludes the position invariance.
- The inverse coordinate transformation (EMB12) to the direct transformation (EMB14) is not valid in the 3D space. There exists another inverse transformation (6). It is valid only in the plain perpendicular to the x axis. The inverse transformation does not exist in any other point in the 3D space.
- No relativistic effects exist in this case. No length contraction, no time dilatation, no velocity limit.

- In case of the 4D space is not possible to use the metric space. The affine space must be used for the transformation described in the EMB text.
- The 4D EMB transformation is possible only if the ξ and τ axes are dependent to each other (they are not orthogonal). The transformation exists only if the ξ and τ axes meet the exactly defined conditions (5) dependent on the velocity of the "moving" coordinate system. The transformation conserves positions of the events; the events are invariant in that case.
- The EMB transformation does not shift the origin of the "moving" coordinate system in this case. Both origins are at the same place.
- The relativistic effects are virtual ones; they are based on the geometrical features of the slant coordinate axes in this case.
- There exists another interpretation where the ξ and τ axes are orthogonal. This interpretation excludes the conservation of the event position in the EMB transformation. The event in the first coordinate system is changed into another event in the second coordinate system in this case. The transformed event should have another position or another time or both than the original one.
- The transformation is not translation of origin in this case.

- It is irrelevant to verify the light velocity invariance in every 4D interpretation. No fact included in the EMB transformation exists to support basic relativity postulate (EMB3b)

The results of the mathematic analysis explain the ambiguity and peculiarity in the physical analysis. The physical analysis is based on the idea of the orthogonal coordinate systems, on idea that the ξ and τ axes are the distance and time axes respectively, all scales are the same, the transformation is valid at any point of the space and physical effects are invariant with regard to the transformation. The physical analysis is based on the idea that the origin of the moving coordinate system is translated from the stationary one.
The interpretation of the transformation where there are two sloping space-time ξ and τ axes and where the position of the axes is dependent on the "moving" coordinate system velocity does not give any

sense in physics. Moreover the transformation does not change the coordinate system origin. The "moving" coordinate system has its origin at the same place as stationary one.
There is a basic difference between the transformation conserving position of the points in the space and the transformation moving the positions of the points in the space from the physical point of view. The transformation moving the position can not be used for invariant description of real physical world or as a theoretical background for experimental verification.
The physical analysis is based on idea of the coordinate system origins translation. The translation interpretation of the transformation is mathematically valid only in the moving plane. The physical analysis needs validity in the 3D space.

We can resume. **No interpretation of the EMB transformation can be used in physics. There is no possibility how to fulfil all required physical features of the transformation in one variant of the interpretation.** There exists no combination of the orthogonal coordinate system with the equal scales and translating the origin conserving the position of the points at any point in the EMB transformation. The all possibilities of the 3D or 4D transformation are mathematically excluded.

10.3 Electrodynamical part

Similar analysis of the EMB electrodynamical part text can be made. The electrodynamical part is based on the kinematical part results. Other maybe surprising facts can be deduced.

10.4 Experimental physics

There exists experiments interpreted as the experimental proofs of the special relativity theory and they are supposed as proving the EMB text conclusions. The previous analysis shows the ambiguity of the EMB transformation interpretation. It can not be surprising, that many results can be explained by some favourite variant of the EMB interpretation. But none can be valid. The experiment results should be interpreted other way. The known physical effect should explain the results or maybe some undiscovered effects could be included. Alternative possibility how to explain the well known Michelson experiment results without the special relativity theory is described as the example.

10.5 Overall conclusion

It is useless to try to experimentally prove the special relativity theory described in the EMB text. It can not be successful. It can be only a game with words.
It is better to focus scientific effort to humility measurement in very different experiments. It is better to try to find a different interpretation of the experimental results. It is possible to discover new undiscovered and maybe quite surprising effects and new physical laws describing the world more exactly.
It would be very interesting to explain every experiment interpreted as a proof of the special relativity theory with respect of the EMB text analysis result. It is possible, that some of them can open the way to undiscovered physical law.
The EMB text influenced thinking of several generations of physicists. It would burden their minds and their physical imagination for next several years. It is the time to change the status and open a new space for a new discovery.
The conclusion does not decrease other very important contribution of A. Einstein to modern physics.

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