New ideas about the structure of reality, or how to connect relative motion with an absolute reference frame and describe relativistic effects without Einstein's postulates

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Abstract

The paper presents a new approach to space-time problems that is completely different from the approach used for over 100 years. The essence of the changes are two new ideas that can be treated as a complement to the theory of relativity. The first is the description of reality as a four-dimensional Euclidean space. What we observe as space-time dimensions are directions in objective (Euclidean) space, and these directions are not constant but depend on the pair of bodies – the observer and the observed body. Depending on the choice of body pair, the same direction in objective Euclidean space can be interpreted as a temporal or spatial dimension of the observer's coordinate system. The new model allows the body to be described directly as a wave and allows for a connection of the ideas of absolute space and the relativity of motion. The second idea binds the transmission of signals (quanta) to the systems of sending and receiving particles. As a result, the motion of the quantum is always constant in the system of the sending and receiving particle. This justifies the constancy of the speed of light regardless of the relative velocity of the bodies. Quanta are no longer independent particles but are disturbances of particles, which are treated as waves.

The proposed changes simplify the description of relativistic phenomena, eliminate the need to apply Einstein's postulates by introducing mechanisms describing the relative motion and propagation of quantum, bind the description of relativistic and quantum phenomena by describing bodies directly as waves, extend the range of phenomena described within one model and solve many problems impossible to solve within the theory of relativity.

The paper compares the descriptions of particular problems in the Theory of Relativity with the descriptions of the same issues in the new model. In most cases, the predictions of both models are similar, but the differences in the construction of the models give different conclusions in some cases, which is the basis for proposing specific experiments allowing verification of the proposed approach. Some of the proposed experiments can be carried out with the use of existing experimental devices.

1 Introduction

One of the fundamental problems in the development of physical models, which has already been considered in the past, is the question, valid practically at every stage of the development of sciences, about the relationship between the coordinate system that we use to describe reality and the actual shape of this reality.

When creating a new model of reality, we initially use the coordinate system that we use every day to describe our immediate surroundings to describe reality. However, it may happen that the coordinate systems we have used thus far are not an appropriate tool for describing all phenomena and correctly describe only a certain class of phenomena occurring in our immediate environment. The use of an improper coordinate system may lead to obtaining correct results, but at the cost of excessive complications of the mathematical description and the need to introduce all sorts of nonintuitive assumptions, the only justification of which is to obtain correct results. This has already happened in the past, for example, in the case of the geocentric model, when a coordinate system was used to describe the motion of the planets, previously used only to describe phenomena on the Earth's surface. The use of an improper coordinate system – bound to the Earth and not to the Sun – allowed us to obtain correct results consistent with astronomical observations, but at the cost of the abovementioned necessity to significantly complicate the mathematical description and introduce such creations as Epicycles, Deferents and Equants – artificial, nonintuitive and forgotten concepts, but successfully used to predict the position of the planets in the firmament for over 15 Centuries. The obtained model was overly complicated and referred to unnatural body motions that we had not observed in our surroundings and that did not conform to the laws of body motion known at the time.

Such historical experience regarding errors in model construction should sensitize us to cases when the model we are currently constructing begins to be overly complicated. In such cases, it would be advisable to check whether the complication of the model does not have its source in erroneous assumptions made during the construction of the model, even if the model in its current complex form allows us to obtain correct experimental results confirming the predictions of this model.

Between 1905 and 1916, the theory of relativity, describing relativistic phenomena, was created. The model was based on dimensions that determine the temporal and spatial distances that we measure in our direct surroundings. The addition of the fourth dimension to the existing model of three - dimensional space made it possible to treat four - dimensional space-time as an integral whole, however, at the cost of a significant complexity of mathematical description. While three-dimensional space is a Euclidean space, four-dimensional uncurved space-time is a pseudo-Euclidean space, in which distances are calculated according to different rules than in three-dimensional Euclidean space. This greatly complicated the mathematical apparatus necessary to describe reality.

The theory of relativity has been working correctly for over 100 years and has been experimentally confirmed many times, but this does not remove all doubts about the construction of the model. The fact that the construction of Minkowski's four-dimensional space-time is much more complicated than the construction of the three-dimensional Euclidean space in which we live is at odds with the conviction of a part of the scientific community, confirmed many times during the development of science, that reality takes the simplest possible forms. Therefore, if reality is four-dimensional, then perhaps it should also be Euclidean.

This belief has inspired a relatively large number of papers aimed at describing space-time with a four-dimensional Euclidean model of spacetime and pointing out errors and inaccuracies in the Theory of Relativity that have not been taken very seriously by reviewers [1-56,58], but nevertheless, some of these papers have been published in reputable journals. However, unsuccessful attempts to describe reality with the help of the Euclidean model of four-dimensional space-time have led to the conviction that the Euclidean model of reality built from the dimensions of time and space is impossible to construct.

However, there is still an open question about the relationship between the space-time dimensions used to describe reality and the actual dimensions that make up reality. We are now describing reality with the Minkowski space-time model, which excludes the existence of a description independent of the observer's system. Nevertheless, I wanted to try to analyze what transformations need to be made in the Euclidean space, which we are used to when observing our immediate surroundings, to obtain a description of spacetime that satisfies the equation for the conservation of the space-time interval.

2 The two reality models conserving the space-time interval.

2.1 Objective and observed reality

Unlike the creators of the Theory of Relativity, who, when creating a new model, were only determining its features, which then needed many years for experimental confirmation, we are richer in knowledge about the properties of space-time, which must be preserved independently of the model of reality underlying the space-time description, and thanks to this, we can look at the problem of the construction of space-time from a certain distance, which was not available to the creators of RT.

First, we will separate the concepts – objective coordinates – describing hypothetical reality as it actually is, regardless of what we observe and measure – let us call it *"objective reality"* and the reality we observe, built from the temporal and spatial distances that we record with our measuring devices – let us call it *"observed reality"*. Of course, according to the theory of relativity, the objective reality that allows the description of phenomena regardless of the choice of the observer cannot be determined, but this issue will be discussed later in the article.

We will assume that the *"objective reality"* is described by the four-dimensional Euclidean space E4 with dimensions a^1, a^2, a^3, a^4; however since most of the discussed issues can be reduced to two dimensional problems in practice, for the time being, to simplify considerations, it is enough to zero two dimensions in E4 and analyze only its two-dimensional subspace E2 built from points with coordinates a_i^1, and a_i^2 then, if necessary, we will expand the solutions for E4 space.

In E2, we can specify certain distances, but at first, we should not assign the meaning of temporal or spatial distances to these distances. These are simply distances, and whether we express them in meters or seconds – this will result from future considerations. In practice, the representation of such a space can be the plane of our drawings. In the Euclidean subspace E2, we can determine the distances between its points, but these distances do not depend on the choice of the coordinate system, which can be constructed from axes determined by any two linearly independent vectors (Fig. 1). In this case, if we have the axes of the coordinate system in E2 marked as a^1 and a^2 inclined to each other at an angle α, then the distance between the two points s in E2 is equal to:

$$s^2 = (\Delta a^1)^2 + (\Delta a^2)^2 - 2\Delta a^1 \Delta a^2 cos(\alpha) \tag{1}$$

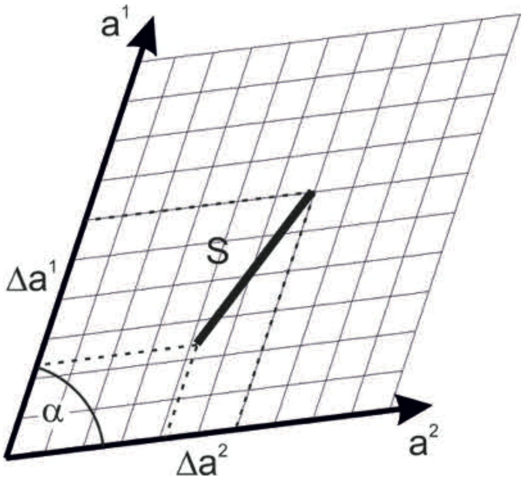


Figure 1: Euclidean space can be described by any coordinate system determined by linearly independent vectors.

Since the choice of angle αdoes not affect the value of the distance s, to simplify the calculations, it is most convenient to use the rectangular coordinate system -see Fig. 2. Taking the angle $\alpha = 90^0$, the distance can be calculated in the simplest way:

$$s^2 = (\Delta a^1)^2 + (\Delta a^2)^2 \quad (2)$$

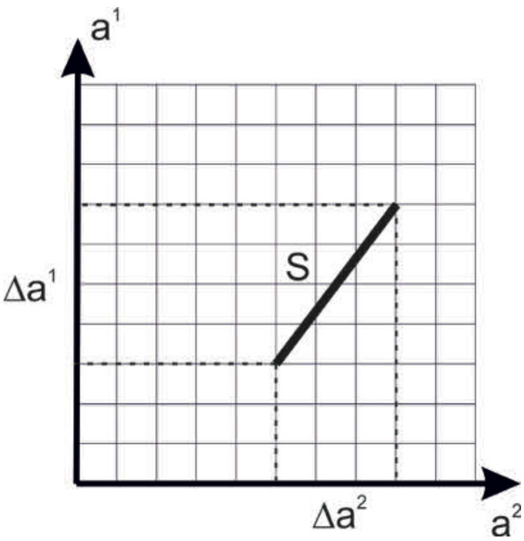


Figure 2: In Euclidean space, the choice of orthogonal coordinates is dictated solely by the simplification of distances describing formulas and the associated convenience of use.

At the same time, it is not a form resulting from the properties of the E2 space but only a form that is more convenient for calculations and directly corresponds with the environment that we observe every day.

Therefore, to begin with, we have an *"objective reality"* that we can describe as Euclidean space and an orthogonal coordinate system in this space defined by axes, which we will denote further as a^1 and a^2. Living in such an *"objective reality"*, i.e., for now, in the space of E2, we measure the temporal and spatial distances between events. The measured distances and times create the picture of reality that we observe. We will call it *"observed reality"*. Distances are defined in our reference frame using *t,x* coordinates. For simplicity, we write the dimensions of time and space in the form *ct,x*, which means that the dimensions of both time and space are presented in the same units. In this case, we can define these dimensions as x^0 $(= ct)$ and $x^1(= x)$, but for now it will be more illustrative to use the existing designations: ct, x.

Now, we will try to determine the relationship between the *"observed reality"* described by the coordinates ct, x and the objective reality described by a^1, a^2.

If we now want to describe the nonrelativistic relations of the position in space to time, then as in the case of the description of distances in the space E2, we can choose the axes *ct* and in E2 inclined to each other at any angle, but then again we have to use the inconvenient conversion of the measured values of the coordinates of time and space that make up the *"observed reality"* into the coordinates of the space E2 that define the *"objective reality"*. In addition, we have related difficulties in determining the relationships between the dimensions of space E2 and the observed dimensions of time and space because at any orientation of the *ct*- and *x*-axis, the dimensions a^1 and a^2 are different combinations of dimensions of time and space, and the description of objective reality is very different from the observed reality – Fig. 3.

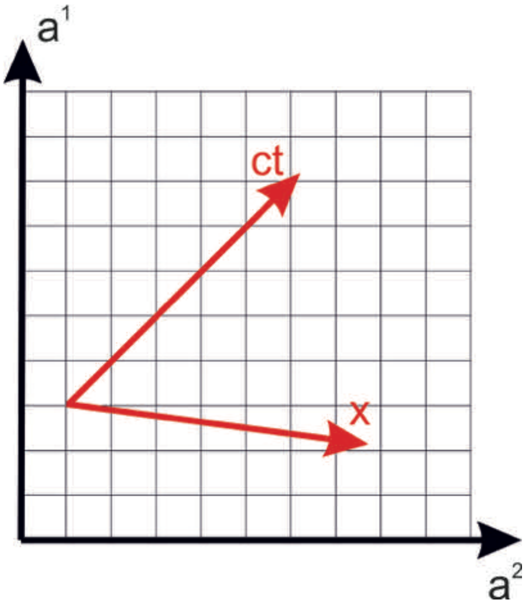


Figure 3: In the most general case, the dimensions of time and space do not have to be perpendicular to each other.

However, it does not have to be that way. It is enough to select the x-axis along the a^2 axis of objective reality, for example, and the ct time axis along the a^1 axis. Thus, now, the coordinates describing objective reality a^1 and a^2 correspond to the observed coordinates ct and x, respectively – Fig. 4.

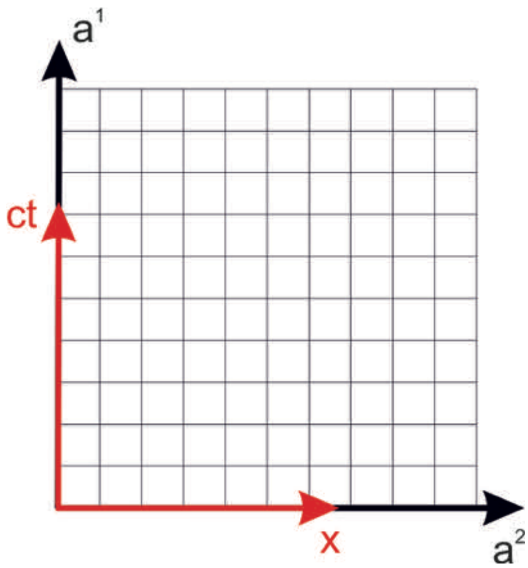


Figure 4: In a nonrelativistic reality, we assume that the dimensions describing objective space are identical to the dimensions of time and space describing the observed reality.

With such a choice of coordinates, the *"observed reality"* is identical to the *"objective reality"*, but this choice was dictated only by the greatest simplicity of the description of reality, which does not exclude other orientations of the *ct*- and x-axis in relation to E2 - Fig. 3 - omitted only due to the greater complexity of the model construction. Thus, we now use a system of *"observed coordinates"* to describe reality, and we can assume that *"objective reality"* – independent of the observer – exists and is reality exactly as we see it. However, this form of reality correctly describes only nonrelativistic cases.

In summary, for a nonrelativistic model, we can assume that there is an *"objective reality"* independent of any observer, whose dimensions a^1 and a^2 are orthogonal and identical to the dimensions ct and x registered in the observer's coordinate system.*"Objective reality"*, independent of the observer, means that, for example, we can describe such an *"objective reality"* using the concept of the Aether – the medium that fills such reality and allows us to determine an absolute reference frame.

2.2 The first reality model conserving the value of the space-time interval

If we want to include relativistic cases in the description, we must consider the fact that space-time distances must satisfy the principle of conservation of the space-time interval. Therefore, we need to modify our description so that the time and space coordinates for the observer and the observed body satisfy the equation for the conservation of the space-time interval:

$$c^2{dt_1}^2 - {dx_1}^2 = c^2{dt_2}^2 - {dx_2}^2 \tag{3}$$

We will now base our reasoning on one of the applications of the space-time interval – when we limit the space-time interval to the description of the mutual observation of two bodies. This limitation will allow us to draw some conclusions that will allow us to take a new look at the problems of space-time interval and coordinate transformation.

Let us consider two bodies with coordinate systems ct_1, x_1 and ct_2, x_2 moving relative to each other in space-time. If the observed body is the body ct_2, x_2 and the observer is the body ct_1, x_1, and since in the observed system $dx_2 = 0$, our equation will take the form:

$$c^2{dt_1}^2 - {dx_1}^2 = c^2{dt_2}^2 \tag{4}$$

On the other hand, if we take as an observer body 2 - then $dx_1 = 0$ - and our equation looks like this:

$$c^2{dt_1}^2 = c^2{dt_2}^2 - {dx_2}^2 \tag{5}$$

If we start from the model of nonrelativistic reality described above, in which the time coordinate is perpendicular to the spatial coordinate, then for these equations to be satisfied, the time axis of the coordinate system of the body assumed to be observed must be stretched, and a slightly more detailed analysis shows that the space axis of the system of the observed body should also be deformed. Deformations of the time axis depending on the observer's choice for exemplary values of coordinates equal to 3, 4, and 5 are shown in Fig. 5, while a general scheme describing the deformations of space-time dimensions in the system of the body observed as a function of velocity relative to the observer's system is presented in Fig. 6.

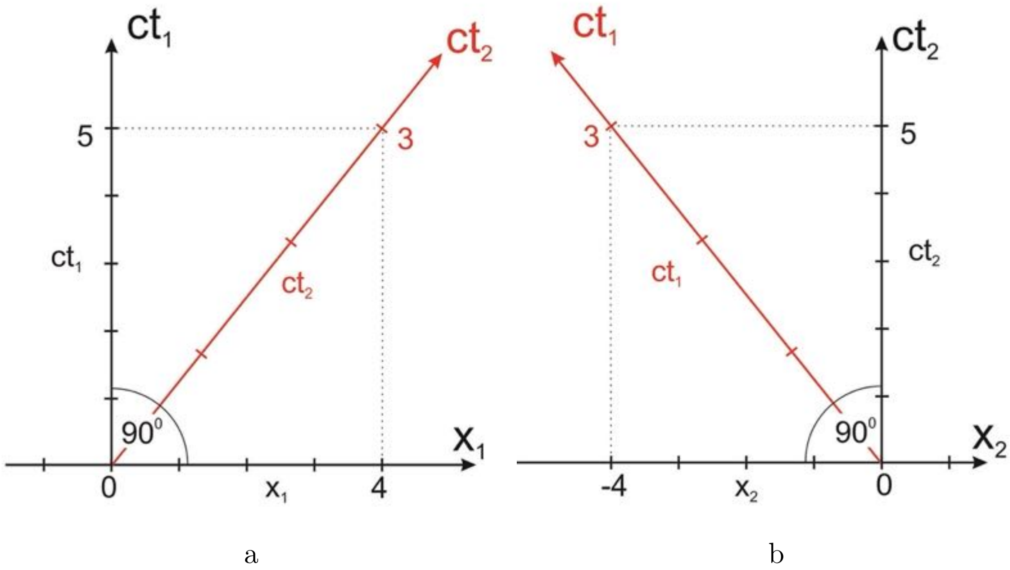


Figure 5: Deformations of the coordinate system time axis depending on the observer's choice. In Fig. a the observer is the body ct_1, x_1, while in Fig. b the observer is the body ct_2, x_2. Deformations are shown for exemplary values of temporal and space coordinates equal to 3, 4, and 5.

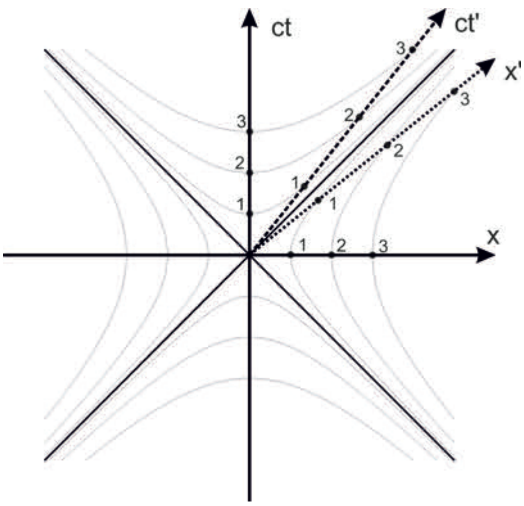


Figure 6: Deformations of coordinate systems of the observed body ct', x' as a function of velocity relative to the observer ct, x.

However, the problem of deformation of the coordinates of a body in motion is symmetrical for both observers, and the swapping of the observer causes deformations of the coordinates of the body previously considered an observer. Thus, if the deformation of the coordinates ct, x depends on the choice of the observer, then the problem arises whether it is possible to determine a coordinate system a^1, a^2 common to all observers and at the same time allowing us to determine the coordinates ct, x dependent on the choice of the observer. Lorentz tried to tackle this problem by creating the theory of the Aether, but it generated many other problems. The problem was solved in 1905 by Einstein by simply rejecting the existence of such a structure as objective space independent of the observer – in this case, the E2 space – and limiting the description only to space-time coordinates ct, x, which describe the time and space distances measured in the system of a particular observer. Consequently, Einstein accepted all motions as relative. Of course, in his first works, Einstein did not yet know the principle of conservation of space-time interval, which we apply here already at the basic stage of considerations, but as I wrote at the beginning, we allow ourselves to use information unknown to the authors at the time of creating the Theory of Relativity.

In this way, Einstein solved the problem of the existence of the Aether, which simply ceased to be necessary to describe reality.

To sum up:

According to the first approach described above, the space-time dimensions that determine the time and space distances we observe are treated as dimensions that create reality. The space-time dimensions of the observer coordinate system are orthogonal coordinate systems and must be associated with the featured observer. A description of reality is possible only from the system of the distinguished observer. There is no objective reality or coordinate system in which phenomena can be described regardless of the observer's choice. The principle of conservation of the space-time interval is the result of the deformation of the axes of coordinate systems of bodies in motion.

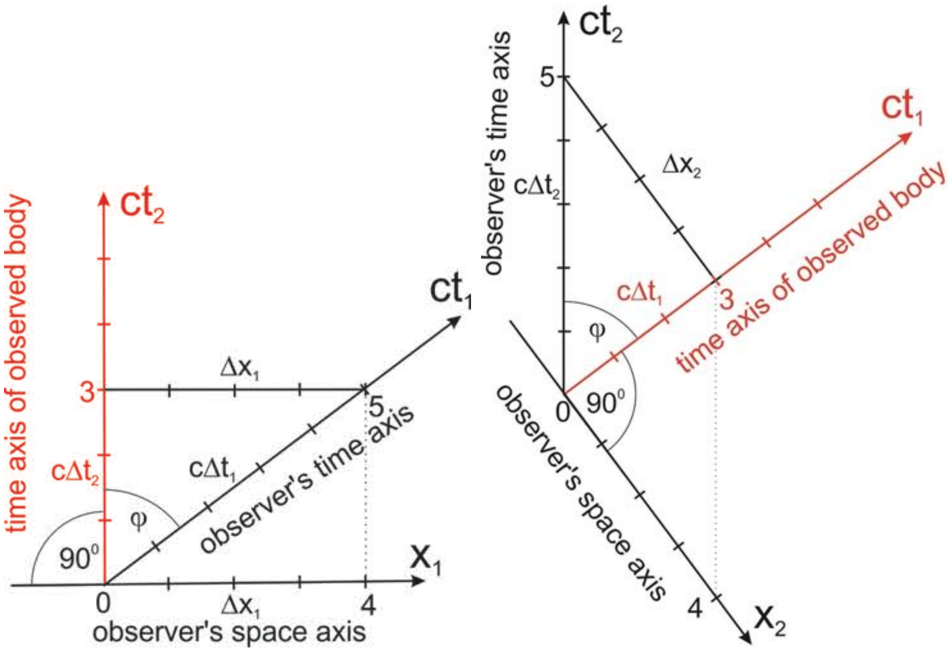
Let us now try to approach the issue from a completely different point of view, which was not available before the publication of Minkowski's works. In fact, the second approach presented below could not have been published and developed until after the de Broglie hypothesis was announced in the mid-1920s, but that was the time when the Theory of Relativity was triumphant, and any revision of the theory was probably of no interest to anyone at the time.

2.3 The second model of reality that conserves the value of the space-time interval

As I wrote above, if we assume the existence of *"objective reality"* – here described for a moment by means of the space E2 with coordinates a^1, a^2, then theoretically, as I mentioned before, we can assume that the ct, x axes can be selected not necessarily as perpendicular to each other (Fig. 3). The choice of perpendicular axes is consistent with the image of reality that we observe locally in our immediate nonrelativistic environment, in which right angles are dominant in architecture and result from the direction of gravity perpendicular to the plane of the Earth's surface. If we observe width, height, and depth and describe them mathematically as perpendicular dimensions, which is the most convenient way of describing them from our point of view, then when we add a fourth dimension to the description, we also take for granted that it should be perpendicular to the other three dimensions. However, as I mentioned earlier, the space-time axes ct, x can be represented on the E2 plane as axes inclined to each other at arbitrary angles (Fig. 3).

Therefore, if we allow ourselves to freely draw the axes ct, x on the plane described by the (objective) space E2, we will notice that the fulfillment of the space-time interval equation in the form described by equations (4,5) for the case of mutual observation of two bodies will be possible, also when the space axis of the observer's coordinate system is chosen as perpendicular to the time axis of the coordinate system of the observed body.

In that case, the time axis of the reference frame of the observed body and the time and space axes of the observer form a right triangle in E2 - (Fig. 7).



a b

Figure 7: Axes of space-time reference frames of the observer and the observed body presented in the E2 space. In Fig. 7a, the observer's system is the axes of body 1 - ct_1, x_1, while in Fig. 7b, the observer's system is the axes of body 2 - ct_2, x_2.

From this right triangle, they immediately derive:
1. Definition of relative velocity in the form:

$$V = \frac{\Delta x_1}{c\Delta t_1} = \frac{\Delta x_2}{c\Delta t_2} = sin\varphi \tag{6}$$

and
2. dependencies (4) – Fig. 7a and (5) – Fig. 7b
which can now be written in the form, respectively:

$$c\Delta t_2 = c\Delta t_1 cos\varphi = c\Delta t_1\sqrt{1 - sin^2\varphi} = c\Delta t_1\sqrt{1 - V^2} \tag{7}$$

and

$$c\Delta t_1 = c\Delta t_2 cos\varphi = c\Delta t_2\sqrt{1 - sin^2\varphi} = c\Delta t_2\sqrt{1 - V^2} \tag{8}$$

In addition, I would like to emphasize that while in Minkowski spacetime we could present the observation only in the reference frame of one of the bodies, in E2 we can assemble both observation schemes from Fig. 7a and 7b and present them in one drawing in the space E2, where we can see simultaneously the diagram of observation of body 1 by body 2 and vice versa – body 2 by body 1 – Fig. 8. Thus, the change in the reference frame conserves the coordinates of the bodies in E2, i.e., the space E2 (and of course E4) can be treated as an objective and at the same time absolute reality – nonexistent in the previously presented approach described by Minkowski spacetime.

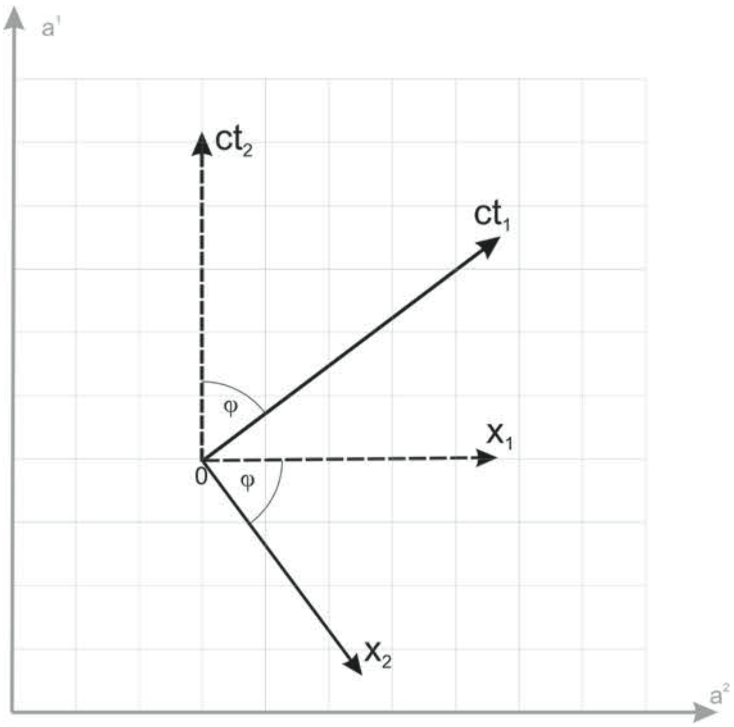


Figure 8: In E4 we can represent the mutual observation of bodies in a way that is independent of the observer's choice. There are 2 orthogonal directions associated with each body (the four orthogonal directions in E4) – the first direction interpreted by this body as the time axis and the second direction perpendicular to the time axis of this body, which in turn is interpreted as the space-dimension (three space-dimensions in E4) of the coordinate systems of all observers observing this body. A change in the relative velocity of the observers means the rotation of one of the orthogonal systems relative to the another by an angle φ

Note that regardless of the relative velocity of the observers – that is, the sine of the angle between the time coordinates of the two bodies, in the case of mutual observation of two bodies – we always have two systems of rectangular coordinates: the first ct_1x_2 composed of the time coordinate of one of the bodies and the direction perpendicular to this time direction, which the second observer interprets as his space-axis x_2, and the second, an analogous ct_2x_1 composed of the other two orthogonal dimensions. The change in the relative velocity of these systems consists only of the rotation of one such orthogonal system ct_1x_2 relative to another ct_2x_1 by an angle that is a measure of the relative velocity of one such system relative to the other (6).

Such a concept of Euclidean space – the so-called *"mixed spaces"* – was proposed in an article by A. Gersten [1] in 2003. However, we can see that the dimensions defined in this way cannot be the dimensions that create the "true" reality – as A. Gersten assumed in his article. For the choice of space-time axes shown in Figs. 7 and 8 to make sense, we must assume that the space-time axes of both bodies depicted in the drawings in objective space E2 are not dimensions that create reality but only directions in E2 (and in fact in E4), which we interpret as space-dimensions and a time-dimension when observing the bodies around us. However, these directions are not constant but depend on both the observer and the body observed.

As mentioned above, it is clear from Fig. 8 that there are two orthogonal directions associated with each individual body in E2: the direction that determines the time-axis of the observed body and the direction perpendicular to the time-axis of that body, and this direction is interpreted as the space direction when observing that body by all observers observing that particular body. The case presented in Figs. 7 and 8 is already a representation of the space-time axes as directions in objective space E2. In E4, the space direction shown in Figs. 7 and 8 actually corresponds to any direction in subspace E3 perpendicular to the time axis of the body observed in E4.

The topic of observation will be developed in the discussion of the concept of space and on some other topics.

Therefore, let us summarize the assumptions of the second model.

According to the second model, E4, there is an *"objective reality"*, which is a four-dimensional Euclidean space in which distances do not have a predetermined meaning of time- or space distances. Time and space distances are measured along certain directions in E4, which we interpret as temporal or spatial dimensions that are not constant but depend on the currently observed body. The directions interpreted as the space dimensions of the observer are perpendicular to the time axis of the coordinate system of the currently observed body, i.e., they are different for the observation of different bodies. Despite the existence of *"objective space"*, i.e., in practice, an absolute coordinate system and the related absolute nature of the coordinates of bodies in E2, the determination of relative velocity, which is a measure of the angle between the directions of the observers' time axes, allows motion to be defined as a relative value measured solely depending on the selected body. The mechanism responsible for the conservation of the space-time interval is as follows: in practice for the occurrence of relativistic effects, is the change of directions in E4 (in Figs. 7 and 8 in this work – in E2), interpreted as space-dimensions for the observation of various bodies. Note that the introduction of an absolute coordinate system in space E2 (in practice in E4) will also allow us to return to the Aether hypothesis, which will be discussed later.

Thus, in practice, we have two alternative models – the Minkowski space-time model and the four-dimensional Euclidean space model – let us call it the "E4 model" – both of which justify the principle of conservation of the space-time interval, but for the time being only to the extent limited to the mutual observation of two bodies. Since the concept of space-time interval is broader than the dependencies underlying the above reasoning (4,5), in the following chapters, we will compare the interpretation and scope of application of concepts such as time, space, motion, and the scope of application of the space-time interval in both models presented.

If both models satisfy the same relationships resulting from formulas (4,5), then the same solutions to problems related to relativistic problems can be expected in both models – Minkowski and E4. However, the different conceptions of reality underlying these models, the much wider scope of application of the space-time interval equation in the theory of relativity than that resulting from formulas (4,5), and the different understandings of some basic concepts lead in some places to different results, which in turn can be used for experiments confirming or negating any of these models.

3 Interpretation of different concepts in the Minkowski model and in the E4 model

3.1 Time

3.1.1 Minkowski space-time model

Time in Minkowski's space-time is the fourth dimension of space-time, but it is a difficult concept to interpret. The flow of time can be imagined as the motion of a body along the time dimension in four-dimensional space-time. However, this "motion" depends on relative motion and on the gravitational field, which change the scale of the time dimension (Fig. 6), making it virtually impossible to unambiguously interpret the flow of time as the motion of bodies in four-dimensional reality. The lack of a precise understanding of the concept of time leads to various speculative conclusions, such as going back in time, which could theoretically occur if time as a dimension were consistently treated. Aristotle, on the other hand, treated time as motion. However, for the time being, the theory of relativity, based on the Minkowski spacetime model, does not definitively explain the problem of time. Instead, it gives us the tools to accurately determine the impact of the relative motion of bodies and the curvature of space-time on the running of clocks (which is used on a daily basis, for example, in GPS systems), and it makes a significant contribution to technological progress.

3.1.2 Model E4

An alternative description of reality proposed by the E4 model allows for a more precise determination of the nature of time.

If we assume that the flow of time can be represented as the motion of a body along its time-axis in E2, then because, according to Fig. 7, 8, the choice of the observer does not affect the change of the properties of the time-axis of the body, such as the direction or scale of the axis in E2 and consequently in E4 (regardless of whether we are talking about the time-axis of the observed body or the observer), so the motion of the body along its time-axis can be interpreted directly as absolute motion in E4. Since there is no reason to treat different bodies differently, we can assume that the motion of all bodies along their trajectory in E4 is constant, and the easiest way is to assume that this motion takes place with the velocity $V = 1$. In this case, the proper time of a given body can be identified with the path that this body travels in E4.

Since all dimensions in E4 are on the same scale and the distance traveled by the body in E4 is equal to the time indicated by the body clock, it is no longer advisable to mark the time-axis by ct. From this point on, we denote time only as t, and of course, this will further lead to the fact that the speed of light is also equal to unity here – as will be discussed in the following chapters. Thus, in the following part of the text, the notation in which $c = 1$ will be used, both in relation to the E4 model and in relation to the Minkowski spacetime model.

We do not consider here non inertial motions, for which the distance traveled in E4 and the elapsed time in the system of the particle will differ, but in this article, we deal only with inertial motions.

Unlike Minkowski's model, the time-axis of a body is not a dimension but merely the path along which the body moves in E4 (similar to a train moving on tracks where the tracks play the role of a time-axis). Therefore, for example, going back to your previous position in E4 does not mean traveling

backward in time, because the time is the way you have traveled in E4 regardless of the direction of motion. The body clock in E4 plays a role similar to the odometer in a car, which does not return when we turn around and drive in the opposite direction to the previous one. Consequently, in E4, the notion of time travel loses its meaning.
It is a pity . . .

Thus, the particle can be imagined as moving – in this article only along rectilinear paths (trajectories) in E4 with a constant velocity $V = 1$. This is a motion relative to E4, i.e., an absolute motion. With the motions of the bodies in E4 along rectilinear trajectories, the distance of any two points on the trajectory in E4 is the difference in the times indicated by the body clock at these two points in the trajectory. Thus, for the time being, we can deal with the definition of time as the distance between points in E4 without introducing the additional concept of absolute time, in relation to which we would determine the velocity of the E4 bodies – which will prove necessary in the case of non inertial motions – not discussed in this article.

The problem of mutual observation of time dilation does not lie in the deformation of the time dimension but in the change of direction interpreted as the space-dimension of the observer, which causes the observed path (time) of the body in motion in E4 to seem shorter than in the observer's system – this is shown in Fig. 7 and formulas (7,8). As long as the bodies are moving in rectilinear paths, this effect is symmetrical, and both observers observe an identical dilation of time in the system of the other body. For the mutually symmetric time dilation in a system of bodies to become an actual contraction of time, one of the bodies must change the velocity (value or direction), as described in [54,55].

In summary, the bodies in E4 move along certain paths at a constant velocity relative to E4. The direction of motion of the bodies in E4 is interpreted by the bodies as the time-axis of their coordinate system, while the very fact of motion in E4 is interpreted by the bodies as the flow of time.

In E4, it is not possible to distinguish a single time dimension common to all bodies. Therefore, there is no such thing as a dimension of time. The time dimension in the E4 model is only an observed value.

3.2 Space

3.2.1 Minkowski space-time model

If we have a particle producing a field, then the field permeates three-dimensional space, and the field causes interactions to occur. Thus, we can define a space in Minkowski spacetime as a subspace in which interactions propagate. Since we know reality by means of interactions, we observe only a three-dimensional subspace when we interact with bodies. If the interactions propagate in the fourth dimension – time – we could interact with events in the future or the past, i.e., simply observe both past and future events, but we do not observe such interactions.

Thus, space made up of space distances that we measure with the methods available to us is an integral component of space-time. Space dimensions are identical to the directions of propagation of interactions in Minkowski space-time. The observer uses the same spatial coordinate system to observe all surrounding bodies.

3.2.2 Model E4

As stated above, according to the E4 model, the directions interpreted by the observer as space dimensions are perpendicular to the time axis of the body (trajectory) of the observed body. Since we identify space dimensions with the directions of propagation of interactions, the above sentence means that **the interactions are emitted perpendicular to the trajectory of the observed body**. The fact that, as I wrote previously, there are two groups of directions associated with each body: the direction of motion interpreted as the time-axis of the body and 3 directions perpendicular to the direction of motion of the body interpreted as space-directions common to all observers of this body, allows us to represent the body as moving in E4 with an absolute velocity equal to unity and emitting interactions in directions perpendicular to its direction of motion in E4.

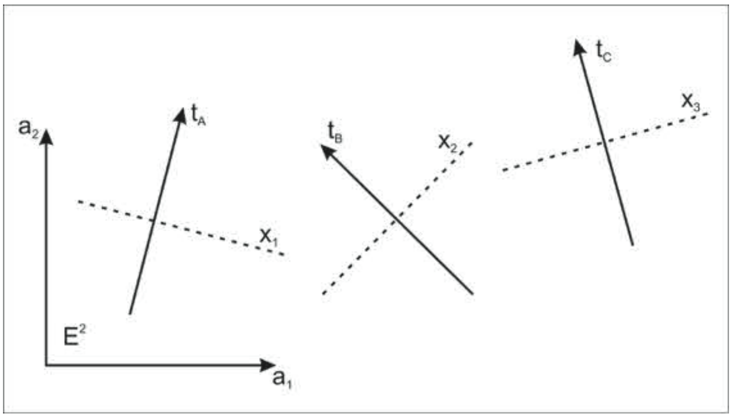


Figure 9: Three bodies watching each other. Each body interprets a different direction in E2 as its space dimension when observing other body. If one observer, e.g., tA, observes two bodies tB and tC, then observing each of these bodies interprets a different direction in E2 as the space-dimension of its coordinate system – these are directions perpendicular to the time-axes of the observed bodies – x_2 and x_3, respectively. In turn, all observers observing the same body interpret the same direction (perpendicular to the trajectory of the observed body) as their space dimension. For example, both observers t_A and t_B observing the body t_C treat the x_3 direction as the space-dimension of their coordinate systems.

As seen in Fig. 9, when one observer observes several particles, he interprets the different directions in E4 (in Fig. E2) as his space dimensions. The spatial direction shown in Fig. 9 as a one-dimensional line represents, in E4, the subspace E3 orthogonal to the time axis of the observed body. The only information that reaches the observer is information about the motions of the bodies, which the observer observes along directions perpendicular to the time axes of specific bodies. The observer builds a picture of reality by combining observations of different bodies made at different points at different times into one common image. It can be compared to observing an image on a computer monitor, where observing millions of pixels shining in different places and at different times, we see one coherent and stable image.

Due to the absence of any absolute observable frames of reference, the observer is unable to notice the differences between these directions in E4, and these differences are perceived by the observer as relativistic effects.

However, living in a nonrelativistic reality on a daily basis, we observe surrounding bodies as moving along parallel trajectories in E4, and then the directions perpendicular to the trajectories of these bodies, interpreted as space-dimensions, overlap with each other. Thus, in practice, we observe reality as Euclidean four-dimensional space-time, and this image of space-time determines our idea of the structure of reality.

In summary, **there are no space-time dimensions in E4**. The concepts of time and space are the result of observation, not the actual construction of reality. Which of the E4 directions are interpreted by the observer as three-dimensional space is determined by the choice of the observed body. The observer selects a different set of directions in E4, interpreted as the space-dimensions of his coordinate system, for each observed body.

We learn about the existence of space by analyzing the motions of the bodies around us. These bodies emit interactions in directions perpendicular to the directions of their motion in E4 (i.e., to the time axis of the system of the observed body), and in turn, we are able to observe the motions of these bodies along the directions of propagation of the interactions. Hence, when observing different bodies, we interpret the different directions in E4 as space dimensions.

The discussed mechanism referred to the most common way of conducting observations – by means of the exchange of interactions carried by energy quanta, which makes us able to observe the reality around us. However, as I have shown in my other works [56], for very small distances, it may be difficult or even impossible to determine the spatial direction, and in such cases, the whole process should be considered only in E4 coordinates, and only the result obtained in this way can be described using space-time coordinates.

3.3 Motion

3.3.1 Minkowski space-time model

In Minkowski's space-time, there is one concept of motion – it is a change in the position in space of a body or quantum as a function of time. The definition of velocity is the same for light quanta as for nonzero mass bodies. This made it necessary to introduce a mechanism aimed at reconciling the variable speed of mass bodies with the constant speed of light quanta. Initially, it was the theory of the Aether, but Einstein presented a model without the use of the Aether, which was made possible by recognizing the relativity of motion.

In summary, motion in Minkowski space-time is defined as a change in position in space with respect to time. Motion is specified identically for all objects, regardless of their type. This motion is relative, i.e., it can only be determined with respect to another body.

3.3.2 Model E4

The E4 model assumes the existence of an absolute Euclidean coordinate system defined by the E4 space.

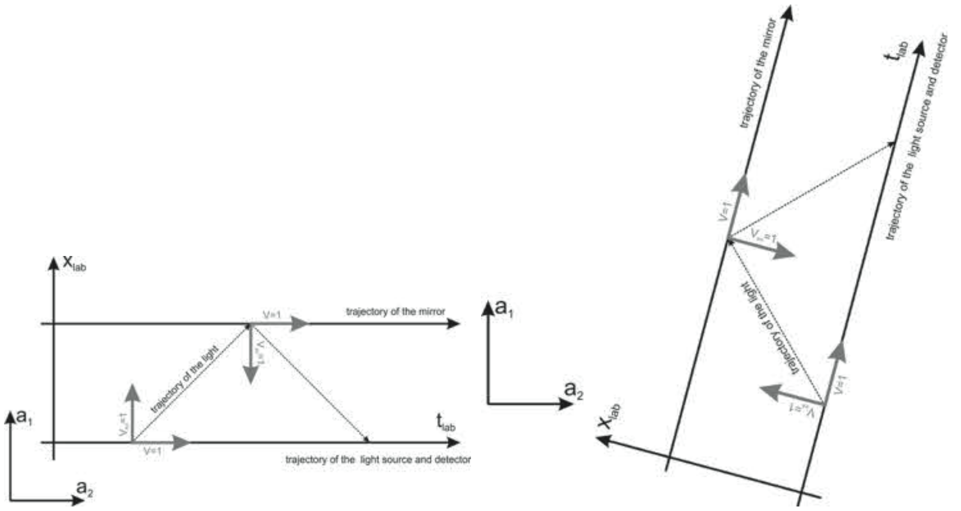
In the E4 model, there are three types of motions:

1. The absolute motion of bodies along their trajectory in E4. In the case of rectilinear trajectories, it is an absolute motion with a constant velocity $V = 1$. This motion is perceived by observers as the flow of time, while the distance traveled in E4 along the trajectory (for rectilinear trajectories) is a measure of the time that has elapsed in the coordinate system of the body.

2. Relative motion of bodies with nonzero mass. What we observe as the relative velocity of the bodies is the sine of the angle between the trajectories of the two bodies – this is shown in Fig. 7. The velocity is described by formula (6). Since there is no distinguished direction in the absolute space E4, the angle between the trajectories, or in other words, the velocity of the body, can only be determined in relation to the trajectory of another particle, i.e., the angle defined in this way, and thus the velocity, are relative, regardless of the fact that the space E4, in which we define these angles, is absolute.

3. Motion (propagation) of interactions. If bodies send interactions in a direction perpendicular to their trajectories, and we assume (which I will justify later) that in the rest frame of the body, the velocity of propagation of these interactions is equal to $V_{int} = 1$ (in a system in which $c = 1$), it means that the resultant motion of the interactions in E4 is the result of the combination of two perpendicular components of the velocity: the aforementioned velocity $V_{int} = 1$ and the velocity of the body along its trajectory in E4 equal to $V = 1$. From the combination of these two velocities, it follows that the trajectory of the light quanta (not the world line, because in E4 there is no concept of space-time as a property of reality) is always inclined at an angle of 450 to the trajectory of the body sending the interaction. This means that the speed of propagation of the interactions is always constant in the coordinate system of the particle sending or receiving the interaction. Fig. 10 shows a diagram of measuring the speed of light in a laboratory setup. For parallel trajectories, the change in the speed of the measuring system, which is the rotation of this system in E4, does not affect the measurement result or the propagation of interactions between the elements of the measuring system. Thus, an attempt to

determine the influence of the velocity of the measuring system, defined as the angle between trajectories, on the velocity of quanta (e.g., in the Michelson–Morley experiment) cannot give any results. The relative speed and the speed of light are the result of separate phenomena, described by different mechanisms, which is also shown in Fig. 10. Fig. 10 shows the case of measuring the speed of light for parallel trajectories, i.e., the case in which all elements of the measuring system remain at rest relative to each other. The case for nonparallel trajectories will be discussed later in the article.



a b

Figure 10: Fig. 10 Measurement of the speed of light in a laboratory system. The light source and detector are in one place. A pulse of light emitted from the source is reflected off the mirror and goes to the detector. In Fig. a the measuring system is shown "at rest", while in Fig. b the measuring system moves relative to the system in Fig. a at a speed of 0.966 c. Note that while in the case of the trajectory of light, the velocity $V = 1$ corresponds to the trajectory of light inclined to the trajectory of the laboratory system at an angle of 45^0, in the case of relative motions of bodies with a nonzero mass, the velocity $V = 1$ corresponds to the motion along a trajectory inclined at an angle of 90^0. This illustrates the difference between the types of relative motion of non-zero-mass bodies and the motion of quanta.

To sum up: In E4, we have three types of motions − absolute motion relative to E4 perceived by the body as the flow of time, relative motion defined by the angle between the trajectories of bodies moving relative to each other, and the third – the motion of signals/quanta by means of which we observe reality, which is absolute motion along trajectory permanently related to the trajectory of the body sending/receiving the signal (more on this later in the article).

3.4 Space-time interval

3.4.1 Minkowski space-time model

In analyzing the fulfilment of the equation for the conservation of the space-time interval, we have limited ourselves to the form of the interval describing the mutual observation of two bodies (4,5).

The general equation for the conservation of the space-time interval for the plane case for multiple t_i, x_i observers (in the coordinate system where $c = 1$) has the form:

$$dt_1{}^2 - dx_1{}^2 = dt_2{}^2 - dx_2{}^2 = ... = dt_n{}^2 - dx_n{}^2 \tag{9}$$

However, as you can see, the concept of interval in Minkowski spacetime has a broader meaning and can generally refer to any *distance* ds in space-time. The equation for the behavior of the space-time interval written in the form (9) can be applied to any coordinate systems of observers in space-time moving relative to each other. The object of observation of all these observers can be any hypothetical space-time distance ds not necessarily related to the observation of a particular body. In this case, the space-time interval equation simply describes the deformation of space-time as a function of the motion of any observer of the event described by the ds value. The deformation of dimensions ensuring the conservation of the space-time interval as a function of velocity in Minkowski spacetime is shown in Fig. 6. What is important is that the Minkowski spacetime model does not provide any additional constraints or conditions for equation (9).

In summary, in Minkowski space-time, the principle of conservation of space-time interval applies to the conservation of any distance in spacetime when the frame of reference changes.

3.4.2 Model E4

In the case of the E4 model, space or time dimensions are not integral components of physical reality. Space-dimensions are only observed directions in E4, perpendicular to the trajectory of the observed body.

To be able to record time dimensions, we need to know the trajectories of the observers in E4. Determining the space dimension, on the other hand, requires the choice of the observed body because without knowing the trajectory of the observed body, we cannot determine the space dimensions of the observers (which must be perpendicular to the trajectory of the observed body). Thus, in formula (9), ds must be equal to the proper time of the observed body dt', and the space axes of all observers of the same body t' must overlap.

In the Minkowski model of space-time, we had space dimensions determined by the observer's coordinate system and independent of the fact of observing a particular body. Thus, the space-time interval equation could describe any spacetime distance ds not necessarily related to the selected observed body.

Meanwhile, the condition linking the direction, interpreted as spatial, as perpendicular to the trajectory of a particular observed body causes equation (9) to take the form:

$$dt_1{}^2 - dx_1{}^2 = dt_2{}^2 - dx_2{}^2 = ... = dt_n{}^2 - dx_n{}^2 = dt'^2 \tag{10}$$

In other words, equation (9) has the additional limitation $dx' = 0$.

This condition restricts the use of the space-time interval to observations of the distinguished body only. Since it is not possible to determine space-dimensions in E4 without indicating the observed body, the space-time interval equation can now not determine any arbitrary space-time distance but only the distances lying on the trajectory of the selected body.

A graphical representation of Equation (10) is shown in Fig. 11.

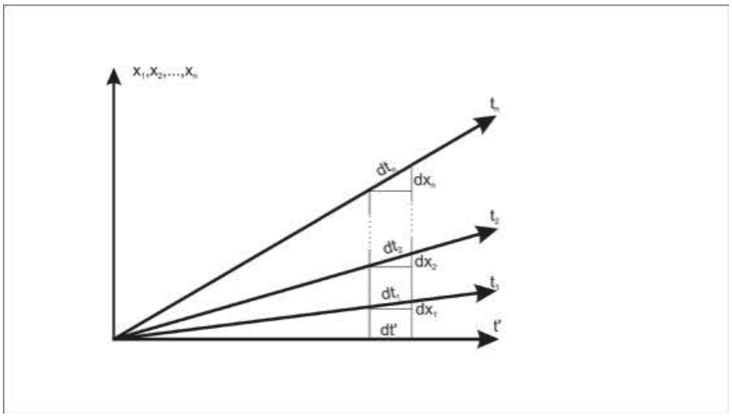


Figure 11: The equation for the conservation of the space-time interval in E4 concerns the observation of the selected body by different observers. According to the fact that as a space-dimension we interpret the direction perpendicular to the trajectory of the observed body and the directions interpreted by all observers as their space-dimensions (at the time of observing the body t'), coincide.

To sum up: In E4, since the selection of the observed body is needed to determine the directions interpreted as space-dimensions, the space-time interval equation makes sense only for the observation of that body. In the empty space E4, where space-dimensions cannot be determined, the space-time interval equation makes no sense.

Apparently, the difference between equations (9) and (10) is small, but its consequences will be presented in the next chapter.

3.5 Coordinate transformation.

3.5.1 Minkowski space-time model

In Minkowski space-time, a space-time interval can refer to any distance in space-time. The LT is a solution to the equation for the conservation of space-time intervals for SR and has the form:

$$x' = \frac{x - tV}{\sqrt{1 - V^2}} \tag{11}$$

$$t' = \frac{t - xV}{\sqrt{1 - V^2}} \tag{12}$$

Since the form of the space-time interval does not depend on whether we observe a body or not, the resulting form of coordinate transformation depends solely on the relative velocity of the observers, and it does not matter whether the coordinates of the observers' systems refer to the observation of a particular particle or not.

It is assumed that the LT is a solution to the space-time interval equation, and there are many different methods in textbooks to derive this transformation from the interval equation.

However, in practice, when looking for a solution to the space-time interval equation, one can find an infinite number of solutions that can theoretically also describe the transformation of coordinate systems. For example, a pair of equations of the form:

$$t' = \frac{td - xe}{\sqrt{d^2 - e^2}} \tag{13}$$

$$x' = \frac{xd - te}{\sqrt{d^2 - e^2}} \tag{14}$$

satisfies the equation of conservation of space-time interval for any values of the variables d and e because when these values are substituted into the interval equation, these values are always reduced. Therefore, whatever we substitute for d and e, whether values or functions or even images, these equations will always satisfy the equation of conservation of the space-time interval.

And so:

If we substitute $d = 1$ and $e = V$, we obtain the Lorentz transformation.

If we substitute $d = cosh\psi$ and $e = sinh\psi$, we obtain a system of equations:

$$t' = tcosh\psi - xsinh\psi \tag{15}$$

$$x' = xcosh\psi - tsinh\psi \tag{16}$$

which are used as one of the methods to supposedly derive the Lorentz transformation from the space-time interval equation, interpreting the solution as a kind of "rotation" in spacetime t, x [57].

Thus, the LT satisfies the principle of conservation of the space-time interval, but it is not its only solution but only one of an infinite number of such solutions. The fact that the values of d and e in formulas (11,12) can be arbitrary means that the relative velocity of the bodies ($e = V$) used in the Lorentz transformation does not follow in any way from the equation of conservation of the space-time interval, as is generally assumed, and is assumed simply to obtain a solution in the form of the Lorentz transformation.

In summary, in Minkowski spacetime, the LT satisfies the equation of conservation of the space-time interval. However, it is actually one of an infinite number of solutions, so within STR, one cannot assume equivalence between the interval conservation equation and the Lorentz transformation. This transformation refers only to the relative velocity of the systems of observers, so in practice, it refers to changes in the geometry of space-time.

3.5.2 Model E4

In the case of the E4 model, we cannot determine any space-time distance because the dimensions of time and space are not dimensions that make up reality but only directions interpreted in E4 as space-time dimensions, only when observing the distinguished body. Thus, to be able to talk about space dimensions, it is first necessary to determine the observed body because it is its trajectory in E4 that determines the three orthogonal (precisely linearly independent) directions perpendicular to this trajectory, and only these directions are interpreted by all observers of this body as the space dimensions of their reference frames. This situation has already been shown in Fig. 11. If we now limit the number of observers from Fig. 11 to only two, then we have a scheme for observing any distance, but only between the points of trajectory of the observed body – Fig. 12.

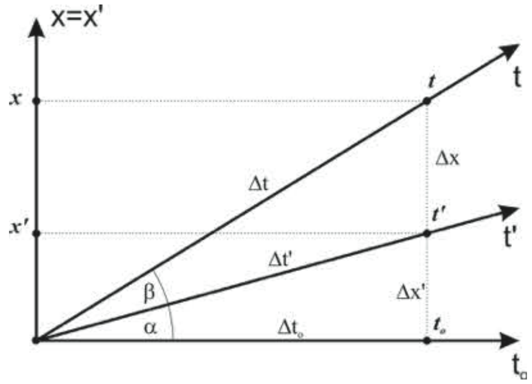


Figure 12: Case of two observers x, t and x', t' observing the same body x_0, t_0. The angle β is a measure of the relative speed of observers x, t and x', t' : $V = sin\beta$. The angle α describes the velocity of the observed body x_0, t_0, relative to the observer x', t' and $\alpha + \beta$ describes the velocity of the observed body x_0, t_0, relative to observer x, t.

The transformation of the coordinates of the observer systems results immediately from the simple geometrical relations of the drawing, and as a result, we obtain formulas for the transformation of the coordinates in the form:

$$t' = \frac{t}{cos\beta} - \frac{xsin\beta}{cos\beta cos\alpha} \tag{17}$$

$$x' = x - \frac{tsin\beta}{cos\alpha} \tag{18}$$

And the inverse transformation:

$$t = \frac{t'}{cos\beta} + \frac{x'sin\beta}{cos\beta cos(\alpha + \beta)} \tag{19}$$

$$x = x' + \frac{t'sin\beta}{cos(\alpha + \beta)} \tag{20}$$

where

$$sin\beta = v' \tag{21}$$

is the relative velocity of the observer x', t' in the coordinate system of the observer x, t,
and

$$sin\alpha = v' \tag{22}$$

is the relative velocity of the observed body x_0, t_0 in the coordinate system x', t'.
Consequently,

$$cos\beta = \sqrt{1 - V^2} \tag{23}$$

and

$$cos\alpha = \sqrt{1 - v'^2} \tag{24}$$

Now, we can rewrite equations (17)-(20) with the help of the two velocities (21) and (22), and the transformations take the form:
The new transformation of coordinates:

$$t' = \frac{t}{\sqrt{1 - V^2}} - \frac{xV}{\sqrt{1 - V^2}\sqrt{1 - v'^2}} \tag{25}$$

$$x' = x - \frac{tV}{\sqrt{1 - v'^2}} \tag{26}$$

And the inverse transformation:

$$t = \frac{t'}{\sqrt{1 - V^2}} + \frac{x'V}{\sqrt{1 - V^2}(\sqrt{1 - v'^2}\sqrt{1 - V^2} - v'V)} \tag{27}$$

$$x = x' + \frac{t'V}{\sqrt{1 - v'^2}\sqrt{1 - V^2} - v'V} \tag{28}$$

Note that in such a transformation, we can see that the time dilation in the observer's system is identical to the time dilation resulting from the Lorentz transformation (27), but in the case of space dimensions, we see that the contraction of length will not occur (28).

In addition, the coordinate transformation does not depend solely on the relative velocity of the observers, as is the case with the Lorentz transformation. It also depends on the velocity of the observed body relative to both observers. Thus, the transformation of the coordinates is not related to a change in the geometry of space-time but is only the result of the way observations are carried out along the directions of propagation of interactions in E4, which are perpendicular to the trajectories of bodies in E4.

In summary, in E4, the coordinate transformation satisfying the space-time interval conservation equation has a different form than the LT. It predicts time dilation, does not predict length contraction, and relativistic effects depend not only on the relative velocity of the observers but also on the velocity of the body observed in both of their coordinate systems. Relativistic effects are now the result of the way observations are made in E4, rather than the result of deformation of the geometry of Minkowski spacetime.

3.6 Composing velocities

Since the rule of composing velocities results from the transformation of coordinates, then having two different coordinate transformations resulting from two alternative models, we should get different rules of composing velocities, and these in turn can give basis to experiments, which can be a test of which model to choose, or indicate yet another way of describing relativistic effects than those presented in this article.

3.6.1 Minkowski space-time model

The topic here is generally known. The formula for the composing velocities resulting from the Lorentz transformation is as follows:

$$V = \frac{v_1 + v_2}{1 + \frac{v_1 v_2}{c^2}} \tag{29}$$

If, for example, we compose two velocities where $v_1 = v_2$ and plot a graph of the dependence of the resultant velocity on the sum of these velocities, the graph looks like this:

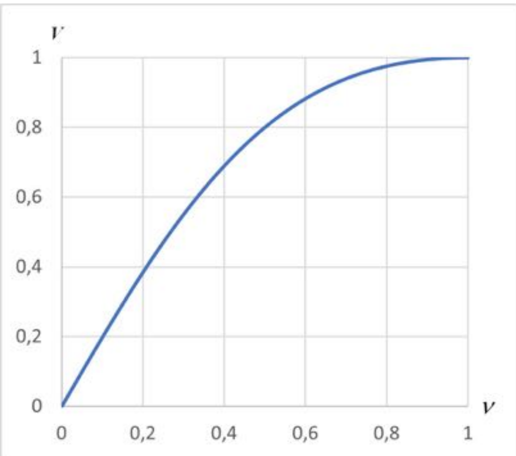


Figure 13: Resultant velocity V as a result of composing two identical component velocities v. On the horizontal axis, the value of the component velocities, on the vertical axis, the resultant velocity V.

Of course, the resultant velocity will never exceed the speed of light.

3.6.2 Model E4

In the E4 model, the measure of relative velocity is the angle of inclination of the trajectory, and the relative velocity equals the sine of the angle between the trajectories of the bodies. Therefore, the composition of velocities here involves adding angles between trajectories – this is illustrated in Fig. 14.

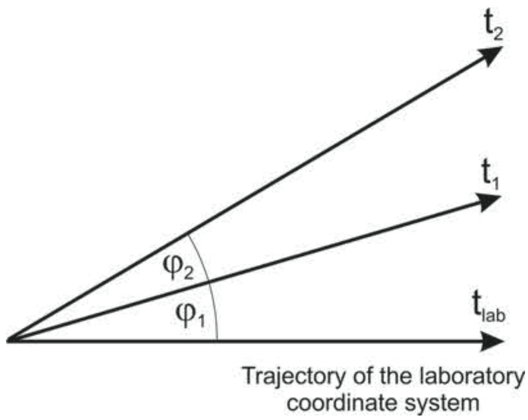


Figure 14: Composition of velocities in the E4 model. The bodies t_1 and t_2 move relative to the laboratory system and relative to each other. The measure of relative motion is the angle between the trajectories related to the observed velocity by formula $V = sin\varphi$ (6). The motion of the body t_1 relative to the laboratory system is determined by the angle φ_1, while the relative motion of the bodies t_1 and t_2 is determined by the angle φ_2 Thus, the measure of the motion of the body t_2 relative to the laboratory system is the angle $\varphi_1 + \varphi_2$ which corresponds to the velocity $V = sin(\varphi_1 + \varphi_2)$

In this case, if the velocity of body No. 1 in a laboratory system is:

$$v_1 = sin\varphi_1 \tag{30}$$

The velocity of body 2 relative to body 1 is:

$$v_2 = sin\varphi_2 \tag{31}$$

Then, according to Fig. 14, the resultant velocity of body 2 relative to the laboratory system should be equal to the sine of the sum of the angles $\varphi_1 + \varphi_2$ and equals:

$$V = sin(\varphi_1 + \varphi_2) = sin\varphi_1 cos\varphi_2 + sin\varphi_2 cos\varphi_1 = v_1\sqrt{1 - {v_2}^2} + v_2\sqrt{1 - {v_1}^2} \tag{32}$$

As seen in the diagram – Fig. 15, the speed of light will not be exceeded, while the speed interpreted as the speed of light is reached at one of the points in the diagram after composing two specific values of speed, each of which is less than the speed of light. A more detailed analysis of the graph will be presented in the chapter on the proposal of an experiment testing the behavior of both models in special cases.

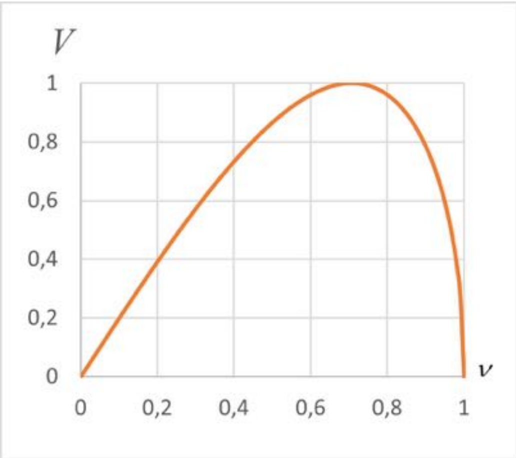


Figure 15: Result of composing velocities according to model E4. The velocity composing principle does not allow to achieve a velocity greater than unity (the speed of light), but for certain values of the combined velocities v, the resultant velocity can reach the value of $V = 1$, which is impossible in the case of composing velocities in the Minkowski spacetime model.

3.7 Wave properties of the particle

3.7.1 Minkowski space-time model

In Minkowski's space-time model, the basic assumption important at this point is that the dimensions of time and space we observe are the actual dimensions that make up reality and that all motions are relative and there is no objective reality in which we can describe all events in a way that is independent of the observer's choice of coordinate system.

Although bodies demonstrate wave characteristics under certain conditions, due to the lack of medium and the relativity of the motion of the bodies, we cannot describe the bodies directly as waves. The equations of quantum mechanics and wave functions are applied for the description, which allow us to describe the influence of the wave character of waves on the image of physical phenomena at short distances. The wave function, which is the solution of Schrödinger's equations, takes the form:

$$\Psi = e^{-\frac{i}{\hbar}(Et-pr)} \tag{33}$$

In summary, according to the Minkowski spacetime model, bodies move in relative motion and demonstrate wave properties under certain conditions, but it is not possible to describe a body directly as a wave.

3.7.2 Model E4

In the case of the E4 model, all bodies move along their trajectories at constant speeds relative to E4, so it is possible to describe the body directly as a wave. Let me remind you that relative motion has nothing to do with the absolute motion of the bodies in E4 because relative motion is only a function of the angle of inclination of the trajectory of the observing bodies (in E4). It is the relativity of determining the angle of inclination of the trajectory that speaks about the relativity of the motion, not the very fact of the motion of the bodies in E4.

The wave function in the form described by formula (33) is a solution of the Schrödinger equation, which is nonrelativistic, so we treat the energy and momentum in this function as nonrelativistic values. However, let us now transform the wave function using relativistic forms of momentum and energy. Then, we obtain (for a system of units in which $c = 1$):

$$\Psi = e^{-\frac{i}{\hbar}(Et-pr)} = e^{-\frac{i}{\hbar}(m_0\frac{dt}{ds}t-m_0\frac{dr}{ds}r)} = e^{-i\frac{m_0}{\hbar}(\frac{d(t^2)}{2ds}-\frac{d(r^2)}{2ds})} = e^{-i\frac{m_0}{\hbar}(\frac{d(t^2-r^2)}{2ds})} = e^{-i\frac{m_0 d(s^2)}{\hbar\, 2ds}s} = e^{-i\frac{m_0}{\hbar}\frac{2ds}{2ds}s} = e^{-i\frac{m_0}{\hbar}s} \tag{34}$$

Knowing that

$$\omega_0 = \frac{m_0}{\hbar} \tag{35}$$

and that in E4, the sense of the value of the interval s is limited to the value of the proper time of the observed body t', we can see that formula (33) rewritten for the description of the particle in E4 has the form:

$$\Psi = e^{-i\omega_0 t'} \tag{36}$$

Or writing the formula differently, we have:

$$\Psi = cos(\omega_0 t') - isin(\omega_0 t') \tag{37}$$

We can see that the wave function, describing an abstract function in Minkowski spacetime, which can only be considered using the equations of quantum mechanics, in E4 is a combination of two flat waves – one with a real amplitude and the other with an imaginary amplitude. In the E4 model, it is assumed that the imaginary number distinguishes the direction of motion of the particle in E4, i.e., describes the time-axis of the particle system (by analogy with the method used to calculate alternating current electrical circuits, where the values associated with time are defined as imaginary). The other three directions perpendicular to the particle's trajectory are assumed to be real.

According to this interpretation, the wave described by equation (37) is a combination of a longitudinal wave along the direction of motion of the wave in E4 and a transverse wave in the direction perpendicular to this direction of motion (the time-axis). In other words, it is a vortex in the plane determined by the dimension of time of the wave and the direction perpendicular to this dimension of time. The use of complex notation does not mean that the E4 space is a complex space. The imaginary number distinguishes the direction in E4 interpreted as the time dimension of the particle, denoted as imaginary, from the three remaining directions perpendicular to the time-axis of the observed body, marked as real and interpreted by the observer observing this body as its space-dimensions of his reference frame x, y, z.

If we wanted to describe the particle as a wave in E4, then to obtain the finite energy of the particle, it would be necessary to put on it the amplitude having maximum at the center of the wave and decreasing with the distance. The shape of the amplitude is not yet determined. For now, we assume an exemplary amplitude of $A(r)$. The wave function describing the particle now has the form:

$$\Psi = A(r)[cos(\omega_0 t') - isin(\omega_0 t')] \tag{38}$$

Equation (38) describes a particle in a system bound with the particle moving along the particle's trajectory with velocity $V = 1$. Since it is an absolute motion and the trajectories of the particles are absolute, we can also describe the particle in the absolute coordinate system bound with E4. To do so, we need to add a factor to describe the motion of the particle along its trajectory in E4. The function now takes the form of:

$$\Psi = A(r)\{cos(\omega_0 t') - i[t' + sin(\omega_0 t')]\} \tag{39}$$

We know that the imaginary part of the function describes the longitudinal oscillations along the direction of motion of the particle in E4 interpreted as the time-axis of the body t'. The real part describes the oscillations along one of the other x, y, z directions interpreted by the observer of this body as the space dimensions of the observer's coordinate system. All these dimensions x, y, z lie in a subspace perpendicular to the trajectory of the particle - t' -in E4. Let us assume that the real part of the function (39) describes the oscillations in the direction interpreted by the observer as the x coordinate. In this case, the distance r is the distance measured from the trajectory of the particle in the plane perpendicular to the trajectory of the particle formed from the two remaining dimensions: y, z in the observer's coordinate system, so formula (39) can now be written as:

$$\Psi = A(\sqrt{y^2 + z^2})\{cos(\omega_0 t') - i[t' + sin(\omega_0 t')]\} \tag{40}$$

Since our formula describes the shape of a four-dimensional particle, we need to zero one of the dimensions to plot its shape. Let us assume that the dimension $z = 0$; then, the shape of our wave can be represented as in Fig. 16. The direction r here is directed along the y-axis of the observer's coordinate system.

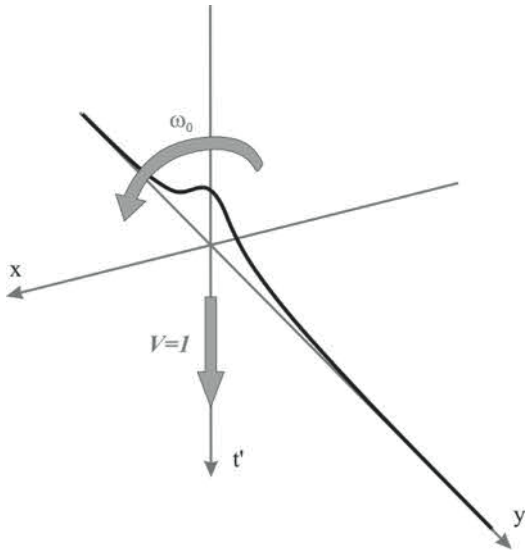


Figure 16: A function that describes a wave as a deformation of space according to formula (39). An exemplary amplitude shape is assumed. A wave, as a combination of longitudinal and transverse oscillations, is in practice a vortex – in the figure it is a vortex in the t, x plane. The vortex-wave travels along the t' axis in E4 with an absolute velocity of $V = 1$.

Note that the real part of the particle in formula (39) describes the ridge of the wave, i.e., the directions perpendicular to the trajectory of the particle in E4. Since the interactions propagate perpendicular to the trajectory of the particle, it follows that they propagate along the ridge of the wave. To enable such propagation of interactions, let us expand the equation of our particle by adding the phase velocity of the wave along the ridge of the waves. In this case, it is logical to assume that this phase velocity is equal to the speed of wave propagation in E4, i.e., $V_{phase} = \pm 1$.

Thus, the final equation of such a wave/particle presented in the absolute coordinate system in E4 has the form:

$$\Psi = A(r)\{cos\omega_0(t' \mp r) - i[t' + sin\omega_0(t' \mp r)]\} \tag{41}$$

To represent the shape of the function graphically, analogously to formula (40), we assume that the real part of formula (41) determines the oscillations along the x direction, i.e., We write function (42) analogously to formula (40), and we have:

$$\Psi = A(\sqrt{y^2 + z^2})\{cos\omega_0(t' \mp r) - i[t' + sin\omega_0(t' \mp r)]\} \tag{42}$$

If we now zero the z coordinate, the shape of our function will be as shown in Fig. 17.

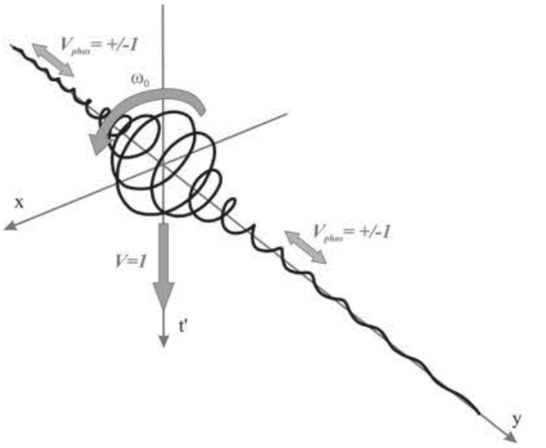


Figure 17: The wave described by equation (41,42) is represented in t', x, y coordinates. The wave is now a vortex moving in E4 with an absolute velocity of $V = 1$ along its trajectory (time-axis) of the wave. At the same time, the phase at the ridge of the wave moves toward-, and outwards- the center of the wave with velocity $V_{phas} = \pm 1$. Any disturbance of the wave propagates in E4 along the ridge of the wave with the absolute velocity, being a composition of the velocities $V_{phas} = \pm 1$ and $V = 1$.

We can see that now the wave, which in Fig. 17 is represented in the space E4, makes a rotational motion in the plane t', x. In turn, if in formula (42) we zero the real part corresponding to the direction perpendicular to the trajectory interpreted by the observer as dimension x, then we can show what the ridge of the wave looks like in the subspace t', y, z, which is now described by the equation:

$$\Psi = -iA(\sqrt{y^2 + z^2})[t' + sin\omega_0(t' \mp r)] \tag{43}$$

The shape of the ridge of the wave for $Re(\Psi) = 0$ is shown in Fig. 18a, which shows two such wave exchange interactions.

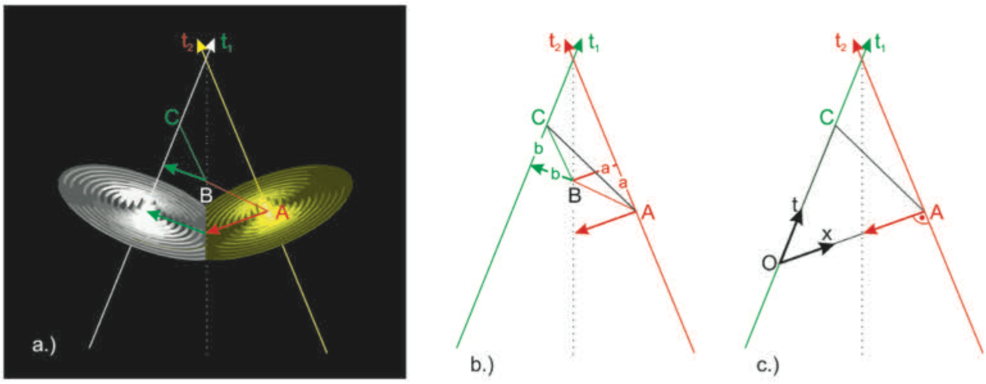


Figure 18: Observation mechanism. Fig. a shows the ridges of the wave while exchanging interactions, the directions of information transmission along the ridges of the waves and the actual path of the signal in E4 (between the ABC points) resulting from the combination of the motion of the waves in E4, and of the motion of disturbances along the ridges of these waves. Fig. b. It shows the segments that the signal travels (along the trajectory of the waves and their ridges) – these are two segments a and two segments b. In Fig. c, the directions interpreted by the observer as axes of his coordinate system x, t during the observation of body t_2 are presented. The CA segment is the path that the observer thinks the signal takes, and the OA segment is the direction interpreted by the observer as the spatial axis (spatial dimension) of his coordinate system. In the case where the trajectories have a common point where the bodies have met or will meet, segments a and b (Fig. b.) are equal to each other, and the angle between segment OA (space-axis of the observer) and the trajectory of the observed body t_2 is a right angle (Fig. c.).

Therefore, to represent one four-dimensional wave, we need to use two figures – 17 and 18a – showing the intersection of a four-dimensional wave with a plane. In Fig. 17, the plane $z = 0$, and in Fig. 18a, the intersection of the same wave with the plane $x = 0$.

The direction of phase motion along the wave ridge depends on the sign in formula (41) for the phase velocity. We can see that the particle described by formula (41) rotates in a specific plane (here t', x) and has a specific direction of the phase – Fig. 17.

Now, if our particle is to receive and send disturbances along its ridge, then its basic component should be not a single wave but a combination of two waves described by equation (41) – one with the phase velocity sign plus and the other with the minus sign. As a result, to represent one component of a particle, we need a combination of two such fundamental oscillations.

Since the rotations of such a particle take place only in one plane – in

Figs. 17 and 18a it is the t', x plane, so to describe a particle having identical properties in all three space-dimensions of the observer's system, it is necessary to combine three pairs of such oscillating particles – or rather rotating not only in the t', x plane but also in t', y and t', z ones.

Thus, the fundamental particle should consist of six such fundamental oscillations described by formulas analogous to formula (41).

Now that we have an idea of the approximate wave shape of the particles, we can now describe the process of exchanging information between bodies. Interactions/signals are transmitted by means of disturbances propagating along the ridges of the waves with phase velocities in the system of each particle/wave. The process of transmitting interactions/signals is shown in Fig. 18.

Fig. 18a shows the ridges of the two waves. Waves move along trajectories that have a common point. The angle between trajectories is a measure of the relative velocity of waves/bodies according to formula (6).
A wave traveling along a trajectory t_1 is an observer wave, i.e., it receives a signal.
A wave traveling along trajectory t_2 is an observed body, i.e., it sends a signal.
Fig. 18a shows the path of the signal propagating along the ridges of the waves. This are the ABC segments.

The observed body t_2 sends a signal at point A. The signal travels along the ridge of the wave with a velocity of $V_{phas} = 1$, and together with the wave t_2, it moves along the trajectory with a velocity of $V = 1$. Thus, the signal travels on a trajectory inclined at an angle of 45^0 to the trajectory of the observed body t_2.

At point B, the signal catches up with the ridge of the observer's wave t_1, moves to the ridge of the observer's wave, and from that time propagates along the ridge of the wave receiving the signal (observer), now with a phase velocity of $V_{phas} = -1$, and together with the wave along trajectory t_1 with a velocity of $V = 1$. Eventually, the signal travels now at an angle of 45^0, but already to the trajectory t_1 of the body - the observer.
The distance traveled along the ridges of both waves by the signal is shown in Fig. 18b.
The distance traveled along the ridge of the sending wave is equal to a, and the same is true for the distance traveled by the sending wave along its trajectory.
The same goes for the receiving wave.
The signal travels along the ridge of this wave at a distance b and is the same along the trajectory of the wave receiving this signal.

Thus, the method of transmitting information treated as disturbances moving along the ridges of waves with a phase velocity equal to unity causes that regardless of the angle between the trajectories of the observer and the observed body, i.e., the relative velocity of the observers, the path traveled by the signal measured along the trajectory of the bodies from the moment of sending to receiving the signal is:

$$t = a + b \tag{44}$$

and is equal to the path of the signal traveled by this signal along the ridges of the waves.

$$s = a + b \tag{45}$$

As a result, the speed of signal propagation is constant and equal to unity regardless of the relative velocity of the bodies (i.e., the angle between their trajectories) – Fig. 18b

$$V = \frac{s}{t} = 1 \tag{46}$$

The observer does not observe the trajectory of the signal. The true trajectory of the signal shown in Figs. 18a and 18b, represented by segments AB and BC, is not available for observation.
The observer can only know point A where the signal was sent and point C where the signal was received. Hence, the observer has the impression that the path traveled by the signal is segment AC – Fig. 18c.

Given the path AC, own trajectory, and the information that the path traveled by the light along the space-direction is equal to the time elapsed from the moment of sending to receiving, and this time is equal to the segment OC, the observer can determine the segment OA (which must be equal to the segment OC), which for him is the space-axis of his coordinate system.

It is a simple geometrical task. We have to plot an equilateral triangle with base CA (Fig. 18c) and one of the sides pointing along the trajectory of observer t_1. The solution relies on plotting the height of the equilateral triangle perpendicular to the base CA. The intersection of the height of the triangle and the trajectory of the observer gives point O – the vertex of the equilateral triangle. Now, the OC segment describes the time measured in the observer's system from the moment the signal is sent from point A to the moment of receiving at point C, while the OA segment with a length equal to the OC segment is interpreted by the observer as a spatial distance that determines the direction interpreted by the observer as the space direction. Therefore, the observer also registers the speed of propagation of signals equal to $V = OA/OC = 1$.

Here, we have a very interesting property. Only in the case where the trajectories have a common point where the waves have met or will meet in the future does the direction interpreted by the observer as the space dimension of OA coincide with the ridge surface of the wave sending the signal (observed), i.e., the space direction is perpendicular to the trajectory of the observed body (sending the signal). However, the case of motion along trajectories having a common point is a special case of motion. In addition, what about particles moving along trajectories that do not have such a common point, i.e., those for which the OA segment is not perpendicular to the trajectory of the observed body?

The relativistic equations for such particles, such as the equation determining the time dilation (7,8), will have a different shape than the known relativistic relationships. Is the special case the norm then? Note that the Big Bang theory assumes that all particles move along trajectories having a common origin. Thus, the "special case" becomes the norm, and the relativistic formulas, as we know them, become the evidence of the Big Bang. However, if in distant regions of the Universe as a result of the expansion of the Universe and various kinds of motions of matter, there have been significant deviations from the motion along the original trajectories, then we should sooner or later observe some deviations from the known relativistic principles.

Thus, **within the E4 model, starting from the wave function being the solution to the Schrödinger equation, we came to the justification of the constancy of the speed of light and proved the existence of the Big Bang**. Other consequences of this fact, such as Hubble's law, will be discussed in the following chapters.

In addition, the model of a body described as a wave allows for a natural definition of the particle's own clock, which can simply be the number of oscillations of the wave that makes up the particle. More on this subject in the papers [56,58].

At the end of this subsection, it is worth interjecting an important piece of information. Let us draw attention to the fact that in Fig. 18.c for the observer t_1 the points O and A (lying on its spatial axis) are simultaneous. However, the condition that the trajectories of the bodies must have a common point where they meet or will meet, combined with the assumption that the velocity of the bodies along their trajectories is identical, says that in E4, simultaneous are the points on the bodies' trajectories that are equally distant from the common point of the trajectory. Thus, points O and A are not simultaneous in E4. The problem of simultaneity is described in detail in the paper [8]. In this paper, I present bodies moving along trajectories having a common origin. Such a presentation of the observation problem is not necessary, but a different presentation of the problems would require an additional discussion of the simultaneity problems, which I wanted to avoid in order not to overcomplicate the paper, whose main purpose is to present the most important mechanisms of the proposed approach. The common origin of the trajectories simply clearly defines the simultaneity problem in E4 and this is the only reason why such a presentation of the problems is used in the figures.

To sum up: In E4, bodies can be described directly as waves that are oscillations of space. The waves are moving in E4. In the case of rectilinear trajectories, the speed of the waves is constant and equal to unity. Disturbances of the waves travel along the ridges of these waves with the velocity $V_{phas} = 1$, which justifies the mechanism of the phenomenon of constancy of the speed of light and the fact of interpreting directions perpendicular to the trajectory of the body in E4 as space-dimensions of the observer's coordinate system. At the same time, the number of periods of such a wave can play a role in the particle's own clock indications. An additional conclusion can be the proof of the existence of the Big Bang.

3.8 Conditions for observing the bodies around us

3.8.1 Minkowski space-time model

In this case, the matter is obvious. Interactions are carried by quanta, which are independent particles propagating in space-time along spatial dimensions at the speed of light, regardless of the motion of bodies: sending and receiving the quanta. According to Einstein's first postulate, phenomena do not depend on velocity relative to the observer. On the other hand, the constancy of the speed of light is ensured by Einstein's second postulate.

This is basically the main mechanism of our communication with the world around us proposed by the theory of relativity.

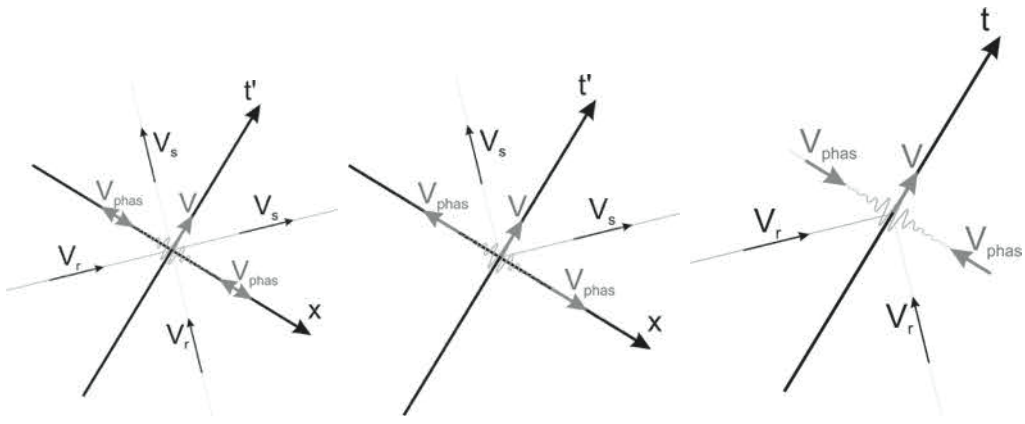
3.8.2 Model E4

In the case of the E4 model, the construction of reality itself is very simple, while the observed image transmitted between bodies.

The exchange of information proposed in the E4 model is discussed in the previous chapter. It involves the exchange of disturbances between particles treated as waves. With such a representation of particles, the disturbance moves along the ridges of the waves – the observer and the observed particle. Initially, the disturbance moves along the ridge of the wave sending the signal and then reaches the ridge of the receiving wave, and it moves along the ridge of the wave receiving the signal, i.e., the observer (Fig. 18).

As already mentioned in the chapter *"The two reality models conserving* *the space-time interval"*, there are two types of directions associated with each body in E4, which are constant for a given body and do not depend on the observer's choice. These are – the direction of motion of the body in E4 interpreted as the time-axis of the coordinate system of this body – t' – and the three directions perpendicular to the time-axis of this body, which all observers of this body interpret as the space-axes of their reference frames. As we already know, these three directions are determined by the ridges of the waves describing the bodies.

However, due to the motion of the body in E4 at absolute velocity $V = 1$ along its trajectory in E4 and the motion of the disturbance along the ridge of the particle at the phase speed of the wave $V_{phas} = \pm 1$, there are also directions of signal propagation in E4. We denote them as V_s – the direction of the signal sent by the observed body and V_r – the direction of the signal received in the observer's system. These directions are also constant in E4, and their trajectories are inclined at an angle of 45^0 to the time-axis (trajectory) of each body. As absolute directions, they also do not depend on the choice of the observer's system. The speed of signal propagation in E4 is a combination of two mutually perpendicular velocities: $V_{phas} = \pm 1$ and $V = 1$, so the speed of signal propagation in E4 is constant and is $V_s = V_r = \sqrt{2}$. All these absolute directions bound with the particle are shown in Fig. 19.



a b c

Figure 19: The absolute directions bound with the particle in E4 are presented for the case of observing bodies moving along trajectories having a common origin. All directions are resented in Fig. a. In Fig. b are shown directions that are important for sending signals, i.e., for the observed particle. In Fig. c are shown directions that are important for the particle receiving the signals – the observer. V- it is the speed of wave propagation along the particle's trajectory in E4; $V = 1$. V_{phas} – it is phase velocity, with which disturbances propagate along the wave ridge; $V_{phas} = \pm 1$. V_r, V_s the are the speeds of the signals sent and received. The signals travel on trajectories inclined at an angle of $\pm - 45^0$ to the trajectory of the body sending/receiving the signal. The signals travel at an absolute speed equal to $\sqrt{2}$. Signals are disturbances related to the motion of the wave-bodies in E4.

The exchange of information proposed in the E4 model is based on the exchange of disturbances between particles treated as waves. According to the E4 model, disturbances, treated as quanta, are not separate particles (as is currently assumed), but they are disturbances related to the wave structure of the particles.

Since the observer is moving along its trajectory at absolute speed $V = 1$, for the signal sent by the observed body to be registered by the observer, this signal must first catch up with the ridge of the observer's wave and then move along the ridge of the observer's wave. For this to be possible, the projection of the signal's velocity onto the time-axis (the observer's trajectory) V_s' must be greater than one, or in the case of parallel trajectories, equal to one. This situation is illustrated in Fig. 20.

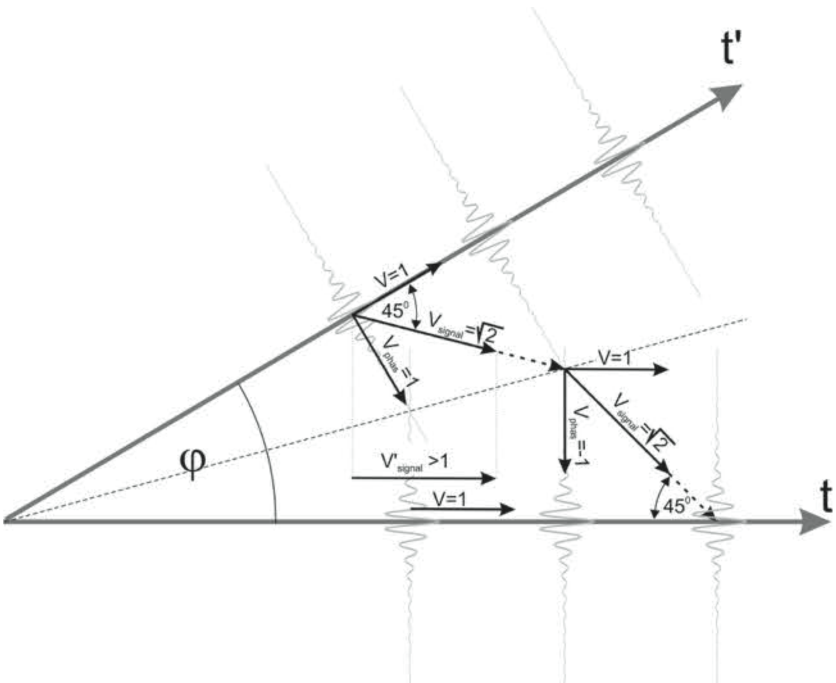


Figure 20: The observed body t' sends a signal that propagates at the speed of $V_{signal} = \sqrt{2}$. The signal moves relative to trajectory t' at an angle of 45^0. The body t – the observer – moves with velocity $V = 1$. For the signal to be received by the t-body, it must catch up with it. Therefore, it is necessary that the projection of the signal velocity (V'_{signal}) on the trajectory of body t is greater than 1. When the angle $\varphi = 90^0$ is exceeded, the projection of the velocity of the signal on trajectory t will be less than one, i.e., the signal will never catch up with the observer's wave ridge, and it will not be possible to register it by the observer. The figure shows a case where the signal catches up with the ridge of body/wave t and then propagates along the ridge of this wave at an angle of 45^0 to the trajectory of observer t.

Thus, if the trajectories of the observed body and the observer are inclined to each other at an angle φ, then the condition of observation of the body by the observer can be written as:

$$V'_{signal} = V_{signal} cos(\varphi - 45^0) = \sqrt{2} cos(\varphi - 45^0) \geq 1 \tag{47}$$

A projection of the signal's velocity onto the observer's time-axis V'_{signal} with a value of < 1 means that the signal will never *"catch up"* with the observer's wave-ridge, so simply observing such a body is not possible. It is easy to see that for the case in Fig. 20, the angle between the trajectories between 90^0 and 270^0 describes the trajectories of bodies that cannot be observed with quanta and probably do not interact with surrounding bodies in the way we know from our observable World. Examples of experiments using this mechanism will be discussed later in this paper.

The problem of signal propagation is described in more detail in [56,58]. Animations showing the way the disturbance propagates –, i.e., the method of mutual observation in the described case – are available in presentations at YouTube.com [58].

3.9 Chapter Summary

The main assumptions of the alternative model of reality are presented, and the meaning of basic concepts and the description of basic phenomena are compared with analogous ones in the Minkowski space-time model. In addition, the method of observation proposed in the E4 model, different from the method of observation adopted in the Minkowski spacetime model, predicts the occurrence of various effects not predicted by previous models.

If the new approach is accepted, the scope of the resulting changes will be much wider than it results from the above descriptions. The adoption of the E4 model eliminates the need for covariant notation. On the other hand, interpreting bodies directly as waves will most likely result in a departure from such concepts as field, mass or electric charge and will eliminate the need to use the current tools of quantum mechanics. This will cause replacing the equations of field theory or quantum mechanics with the simple interaction of waves treated as deformations of space. These are serious, one could say revolutionary, changes in relation to the previous approach, which will require a lot of work related to the creation of new tools adequate to the new approach. However, while the model presented above may be an alternative to the current model, it is not known whether the proposed approach is correct.

Therefore, before continuing any further considerations, it is advisable to check which of the proposed approaches is correct – if, in fact, any of these models can ever be considered as the final form of description of a certain class of phenomena. Both models of reality, by satisfying the equation of conservation of the space-time interval, should theoretically lead to identical conclusions, but the different models of reality underlying both models impose slightly different limitations on both models. These differing constraints cause some of the predictions of the Minkowski model to differ slightly from those of the E4 model. The differences resulting from the above mentioned properties of the two models lead to different results in some special cases, which gives rise to the proposal of experiments verifying each of these two approaches.

4 A proposal for experiments to determine which of the models is correct.

The new transformation of the coordinates and the resulting new principle of composing velocities, which is different from the composing velocities principle resulting from the theory of relativity, should give different results, which should give measurable effects under specific conditions.

4.1 Two Rules of Composition of Velocities

Figs. 13 and 15 show two different velocity composition rules for Minkowski spacetime (29) and for the E4 model (32). A comparison of these two principles is shown in Fig. 21.

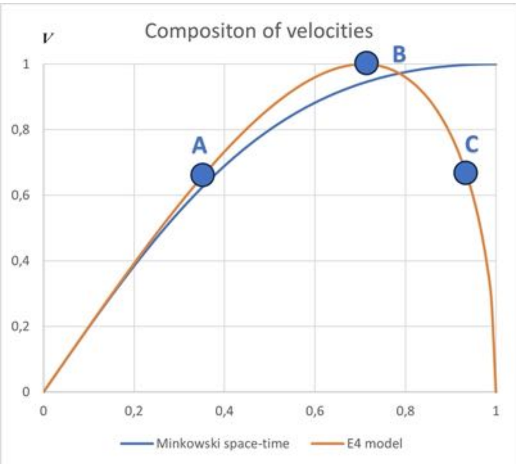


Figure 21: Comparison of velocity composition results for the Minkowski spacetime model and the E4 model. On the curve showing the results for the E4 model, three characteristic points are marked: Point A shows the result of the velocity composition giving the resulting velocity less than one, corresponding to the motions of the bodies that are observable. Point B – the limit point at which the body ceases to be observed and the resultant velocity is equal to unity, point C – showing the composition of higher velocities than are needed to obtain the resulting velocity equal to the speed of light, describing the motions for which the body cannot be observed and the velocity as we know it ceases to describe the actual motions of the body.

We see that in both models, a velocity equal to unity (which corresponds to the value of the speed of light) is not to be exceeded. However, in the case of the E4 model, the combination of two strictly defined velocities results in a resultant velocity equal to unity, which is impossible to achieve in Minkowski spacetime because there is a singularity in this model. Then, as the component velocities increase, the resultant velocity decreases to zero. This is purely the result of applying the formula for composing velocities, but the concept of velocity is not applicable here to describe the motion of bodies. Here, we can only discuss the motion of bodies based on the analysis of the trajectories of bodies. Facilitating the analysis of the problem here is the possibility of illustrating the phenomenon in diagrams and drawings made in Euclidean space. Graphical illustration allows a better understanding of the phenomenon than the analysis available only on the basis of considering formulas describing the abstract and impossible to imagine structure of reality, as in Minkowski space-time or Quantum Mechanics.

Since the curve relating to Minkowski space-time is beyond doubt, we will only analyze the curve for velocity composition for the E4 model. There are three characteristic points on this curve showing three distinct types of body motions:

1. Point A – showing the result of the velocity composition giving the resulting velocity less than one

2. Point B shows the result of composing the velocities giving the resulting velocity equal to one – that is, the speed interpreted as the speed of light.

3. Point C – showing the composition of higher speeds than needed to obtain the resulting speed equal to the speed of light.

At point A, the results of velocity composing in E4 or Minkowski spacetime differ little – Fig. 22.

According to the principle of velocity composing shown in Fig. 14, angles that are measures of the relative velocities of the bodies v_1 and v_2 are added together when the velocities are composed. For this part of the trajectory, the sum of the angles is less than 90^0. In this case, according to formula (47), the projection of the velocity of the signal sent by body v_2 on the observer's time axis is greater than unity, i.e., it is possible to transmit the signal from the observed body to the observer according to the diagram shown in Fig. 20. Thus, a body can be observed if it moves along trajectories satisfying condition (47) or (48).

$$V_s' = \sqrt{2}cos(\varphi_1 + \varphi_2 - \frac{\pi}{4}) \geq 1 \tag{48}$$

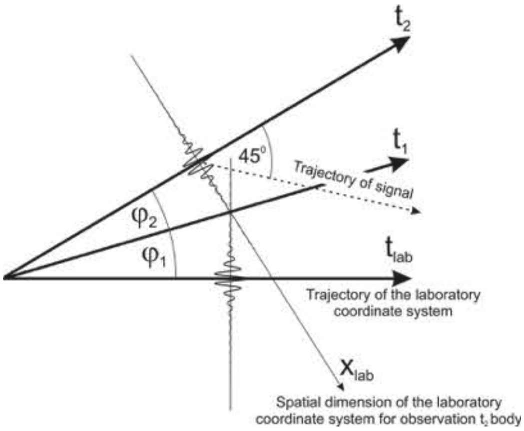


Figure 22: If the sum of the angles corresponding to the composed velocities $\varphi_1 + \varphi_2$ is less than $\pm 90^0$, then the signal propagating along the ridge of the observed wave t_2 will, after some time, catch up with the ridge of the observer wave and can also be registered by the observer.

At point B, the projection of the signal's velocity on the observer's time axis (trajectory) is equal to unity, i.e., it is equal to the observer's velocity away in E4 from the observed body. Thus, the signal will never catch up with the observer's wave ridge, i.e., the observer at this point ceases to notice the existence of this body - Fig. 23.

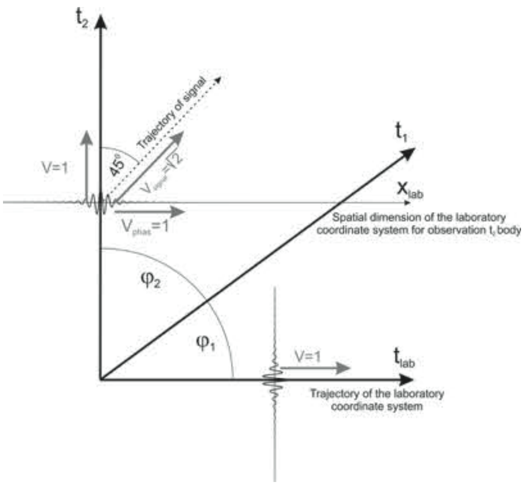


Figure 23: If the sum of the angles corresponding to the composed velocities $\varphi_1 + \varphi_2$ is equal to angle 90^0 (or in general, the body is moving relative to the observer along such a trajectory), then the signal propagating along the ridge of the observed wave t_2 moves parallel to the observer's wave with the same speed as the observer's velocity along the trajectory in E4. It can be seen that the signal will never catch up with the observer wave, so the observer t_{lab} in the laboratory system will not be able to register the signal sent by the t_2 wave. Therefore, from the point of view of the observer t_{lab}, body t_2 cannot be observed. In other words, the body cannot be observed because the intersection point between the observer's spatial axis and the observer's time axis lies at infinity.

Point C, on the other hand, represents the situation for an angle between the trajectories between 90^0 and 270^0. For such angles, the signal moving along the ridge of the observed wave will never catch up with the ridge of the observer wave, and this body is not observed. Since fields are the result of the exchange of quanta, for this body, all kinds of interactions carried by quanta, such as gravitational or electromagnetic interactions, should disappear. Such a body can only be registered as a result of a direct collision with the detector, but due to the motion opposite to that of any other particles, such collisions are very unlikely.

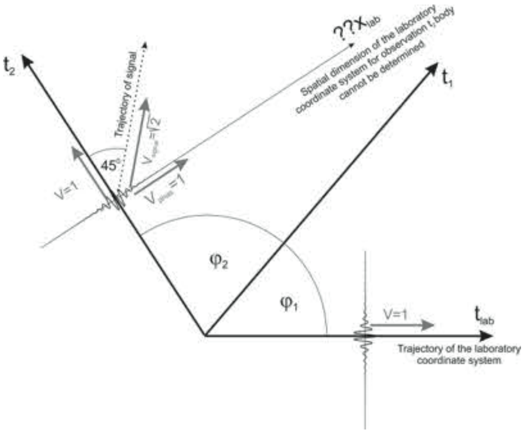


Figure 24: If the sum of the angles corresponding to the composed velocities $\varphi_1 + \varphi_2$ is greater than 90^0 and less than 270^0, then the signal propagating along the ridge of the observed wave t_2 will never catch up with the ridge of the observer wave and therefore will not be observed by the observer. From the point of view of the observer t_{lab}, body t_2 does not exist.

The motion of particles along trajectories inclined to each other at angles of $90^0 - 270^0$ is not mutually observable for particles emitted at a single point. However, for particles emitted at different points, different mechanisms take place.
If we consider two opposing beams of particles, for example, in a particle collider, these three points look differently in the system of a particular particle than in the laboratory system. Let me remind that in E4, we can represent the motion of particles both in the laboratory system and in the system of each particle, while the relative velocity of particles is determined by the angle between their trajectories regardless of the reference system in which we represent them.
Thus, for two opposing beams, **point A** is as follows: In the system of one of the particles, the relative velocity of the other is less than 1, i.e., the velocity interpreted as the speed of light.

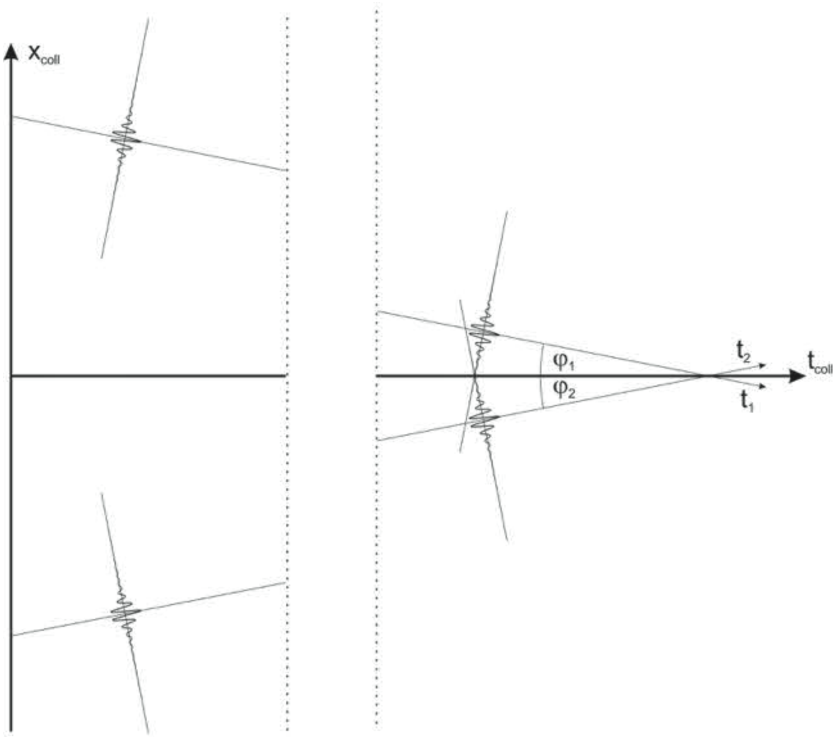


Figure 25: In the case of two opposing beams for a sum of angles $\varphi_1 + \varphi_2$ smaller than 90^0, we have a typical velocity composition scheme that can be described both in the Minkowski spacetime and in the E4 model. However, as seen from Fig. 21, the relative velocities of the particles for the same component velocities will be different according to the Minkowski spacetime model and according to the E4 model.

Point B: In the case where the sum of the angles of the trajectories in the laboratory system is equal to 90^0 – Fig. 24 - we have the theoretical case of reaching the speed of light of one particle in the system of the other particle. However, in contrast to the current interpretation, there are no singularities here - this is a physical case, but one that is impossible to describe within the framework of classical RT. According to RT, the relative velocity of the particles is less than the speed of light in such a case – Fig. 21.

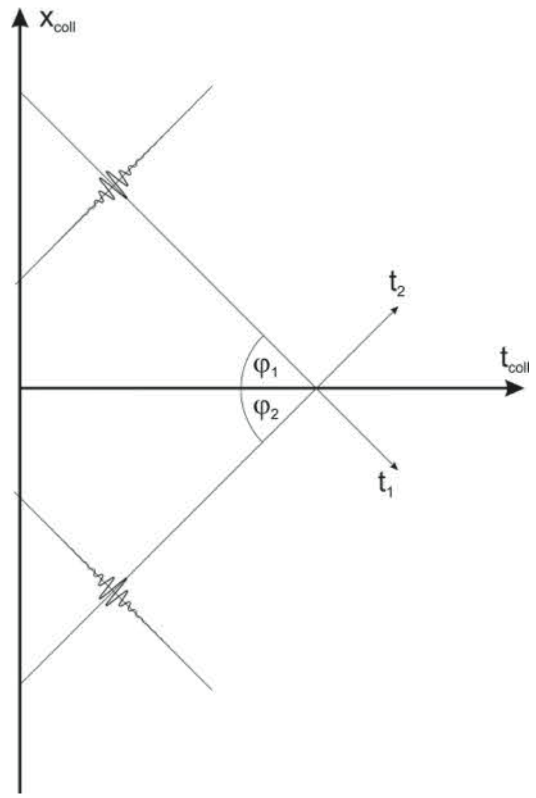


Figure 26: In the case of two opposing beams for a sum of angles $\varphi_1 + \varphi_2$ equal to 90^0, we have a case of the relative velocity of particles equal to unity. Thus, the particles move relative to each other with a speed interpreted as the speed of light.

Point C: In this case, in the range of angles 900-2700, particles can interact and observe each other, but only up to the point of collision - after that, any exchange of information and interaction between particles becomes impossible.

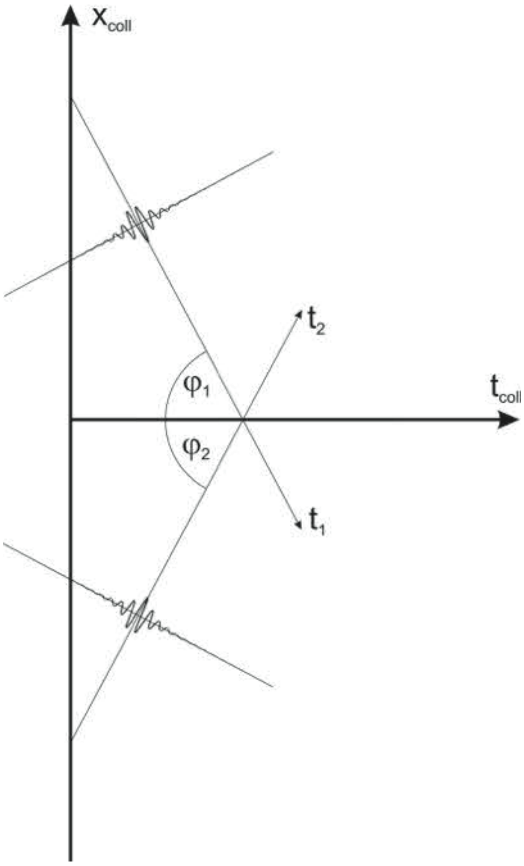


Figure 27: In the case of two opposing beams for a sum of angles $90^0 \leq \varphi_1 + \varphi_2 \leq 270^0$, we have a velocity case in the range marked C in Fig. 21. Although in the case of particles emitted at a single point, for such a sum of angles corresponding to the particle velocities, the particles cannot observe each other, it can be seen that the particles from emission to collision can interact with each other because the signal propagating along the ridge of one of the waves has the possibility of transferring to the ridge of the other wave.

The above examples can be the basis for proposing experiments for parameters where the predictions of the Minkowski space-time model and the E4 model differ.

4.2 Example 1 - rocket with constant acceleration.

Let us consider the motion of a hypothetical rocket moving with constant acceleration and constant mass - not changing during flight. This acceleration must be the result of the propulsion system associated with the rocket.

According to the theory of relativity, the motion of such a rocket can be described as follows:
Starting from the equation for rocket motion, where the initial velocity is zero $V_0 = 0$:

$$FVm = Ft \tag{49}$$

which should be fulfilled regardless of the choice of observer system, we obtain:

$$V = \frac{Ft}{m} = \frac{Ft}{m_0}\sqrt{1 - (\frac{FT}{m})^2} \tag{50}$$

After transformations, we obtain the following formula:

$$V = \frac{\frac{Ft}{m_0}}{\sqrt{1 + (\frac{Ft}{m_0})^2}} = \frac{at}{\sqrt{1 + (at)^2}} \tag{51}$$

Meanwhile, in the E4 model, motion is not defined by velocity but by the angle of the trajectory. Thus, constant acceleration (a) here does not mean a constant increase in velocity but a constant increase in the value of the angle between the bodies' trajectories. Therefore, according to the E4 model, the formula for velocity in motion with constant acceleration can be written in the form:

$$V = sin(at) \tag{52}$$

A comparison of the dependence of the velocity described by formulas (51) and (52) as a function of acceleration is shown in Fig. 28. For velocities $V > 0.5$, the observed velocity of the rocket should be clearly different for both models. According to the E4 model, the rocket should be accelerating faster than what the theory of relativity implies. An interesting moment is when the rocket reaches a velocity equal to 1, which is possible according to the E4 model. For an observer on Earth, this moment will not be observed. As seen in Fig. 23, when reaching a velocity equal to unity, the point of intersection of the direction interpreted by the observer on Earth as a space-dimension, with the observer's time axis, goes to infinity. This means that the rocket will be observed for an infinite time as it approaches the speed of light, but this is not the result of a physical limitation on the trajectory of the rocket but only the result of a way of observing in which the direction perpendicular to the trajectory of the observed body is interpreted as the space dimension of the observer's coordinate system. In E4, travel through the point where $V = 1$ is possible, and if the travelers manage to return to Earth, they will observe themselves traveling in the rocket for the rest of their lives, although the image will be increasingly faint and farther away from Earth.

A decrease in velocity after reaching a maximum equal to unity means that the body's trajectory is inclined at an angle between 90^0 and 270^0; however, due to the way of observing and the fact that the body is moving in E4 in the opposite direction to the observer, any mutual observation is impossible, and using the concept of velocity in the sense of a change in observed position along spatial directions makes no sense here.

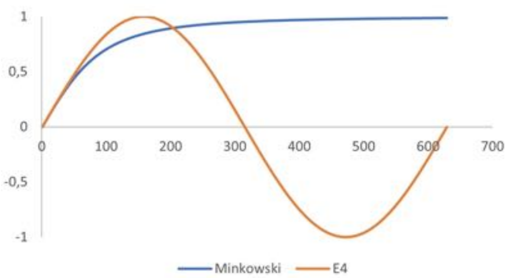


Figure 28: Observed velocity of a rocket of constant mass moving with constant acceleration for the Minkowski space-time model and the E4 model. For the E4 model, only the initial part of the diagram - with values from $V = 0$ to $V = 1$ - relates to the rocket's observable motion. A more detailed analysis, possible on the basis of the considerations made thus far, shows that the further parts of the graph for model E4 concern motions that cannot be described using velocity terms. These motions are describable but only use the concept of trajectory in E4.

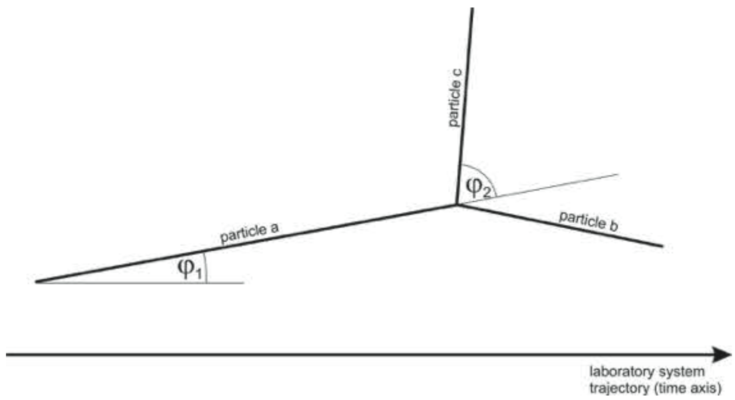
This results in a second effect that can be the basis for designing a specific experiment.

4.3 Example 2: Disappearing energy (neutrino?)

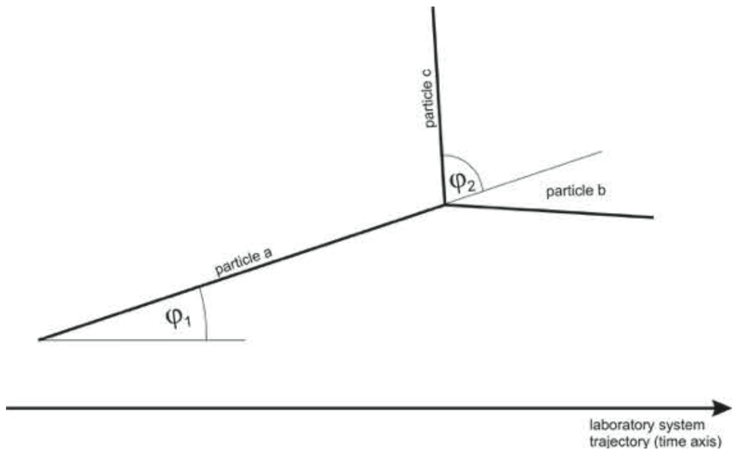
If we have a particle that decays spontaneously and one of the decay products is a relativistic particle, as shown in Fig. 29.a, then if this decaying particle is accelerated to a suitable velocity, then according to the Minkowski space-time model, the decay product of such a particle will always have a velocity less than 1 (in a system where $c = 1$) according to equation (29).

However, if we consider the same problem in E4, then the velocity will never exceed unity (as shown in Fig. 21), but it can happen that the angle of the trajectory of one of the particles exceeds the value of 90^0 in the laboratory system, which, according to the observation conditions discussed earlier, causes one of the decay products to cease to be observable and, in addition, to cease to interact with the other particles in the laboratory system, regardless of whether the original decay product was a particle with an electric charge or a neutral particle. The properties of such a hypothetical particle correspond to neutrinos, and it is very likely that a neutrino could be such a particle.

To verify this hypothesis, it is enough to study the decay of such a particle as a function of the speed of the decaying particle, in which one of the products is a relativistic particle. If the sum of the angles in E4 corresponding to the velocity, in the laboratory system, of the decaying particle and the velocity of the decay product in the decaying particle system give a value greater than 90^0 – Fig. 29.b – then for such a speed of the decaying particle, one of the decay products should be a neutrino or another particle with properties very similar to neutrinos.



a



b

Figure 29: Decay of a particle in a laboratory system. A case of particle decay in which the sum of angles does not exceed 90^0 – Fig. a. The case of a particle decay in which the sum of the particle angles exceeds an angle of 90^0 is shown in Fig. b. For this case, the c-particle should not be observable.

In practice, to achieve the desired effect, the velocity of the relativistic particle being the decay product must be determined. Given the velocity, we determine the angle φ_2 in relation to the system of the decaying particle, according to formula (6), and then accelerate the decaying particle to the velocity (53) – Fig. 29.b:

$$V > sin(\varphi_1) = sin(\frac{\pi}{2} - \varphi_2) \tag{53}$$

Experimental confirmation of this effect would prove **the falsity of Einstein's first postulate**, according to which decay products should not depend on the speed of the decaying particle.

4.4 Example 3. Comparison of cross-sections for collisions of particles for the case of collision particles with a stationary target (beam-target) and in the case of collisions of opposing particle beams (beam-beam).

According to the theory of relativity, measurements of cross-sections of particle collisions should not depend on whether we are making measurements using the method of collisions of a beam of particles with a stationary target or the method of collisions of opposing beams of particles in a collider. The relativistic principle of velocity composition ensures that identical relative particle energies can be achieved regardless of the method used, while the choice of method is mainly determined by the available particle energy range, which is different for both methods.

In the case of the E4 model, the situation is different because instead of velocity, we use a much broader concept of the angle between particle trajectories, and the velocity can only be determined for certain angles of these trajectories. According to the E4 model, the collision of particles with a stationary target under laboratory conditions corresponds to the values of the angle of the trajectory of the impacting beam relative to the trajectory of the target in the range $0 - 90^0$, wherein the angle of 90^0 corresponds to particles moving at the speed of light. The description of this case in E4 is identical to that in the Theory of Relativity. However, in the case of opposing beams, according to E4, the right angle between the beam trajectories is achieved at the angle of each beam equal to 45^0, which in the case of protons corresponds to the energy of each beam in the collider equal to approximately 1.326532322 GeV.

This means that, according to both models (Minkowski space-time and E4), measurements of the collision cross section for interactions of the particle beam with a stationary target (beam-target) should be identical. On the other hand, the predicted results of measurements performed with the collider for two opposite proton beams with an energy of 1.326532322 GeV each, will differ for these two models.

If the Minkowski space-time model is correct, then measurements of cross sections with the collider for two opposing proton beams with energies of 1.326532322 GeV each will give identical results to measurements in the beam-target configuration for a proton beam energy of 2.814 GeV. If, on the other hand, the E4 model is correct, then in the region of the proton beam energy of 1.326532322 GeV (when the relative velocity of both beams is equal to unity), there should additionally appear clear anomalies in the form of a sharp peak of very small width, which is not present for beam-target measurements of the cross section (attempts to estimate the width of such a peak proved impossible on an ordinary computer due to insufficient calculation accuracy to 15 digits). Since the width of the peak is small, in the case of insufficient energy uniformity of the beams making it impossible to record such a peak, larger statistical errors of measurement should appear in this region. In the collider, on the other hand, for energies of each beam higher than 1.326532322 GeV, due to a different trajectory geometry than for beam-target cases - Fig. 27, the measurement results should probably differ slightly from beam-target measurements [11]. Since we do not yet have data on the mechanism of the interactions in this energy range, a model of the interactions will only be possible to create after experiments in this particular energy range have been performed with both methods.

This is a proposal for an experiment that unequivocally eliminates one of the models, but due to the very narrow energy region in which such a clear effect can occur, it may not be possible to discover such correlations by chance.

4.5 Hubble's Law and the dark side of the Universe

According to the E4 model, when observing particles/bodies, we interpret the direction perpendicular to the trajectory of the body observed in E4 as the space dimension of the observer.

Thus, if we consider several bodies moving along trajectories that have a common origin, these bodies will observe that the velocity of other bodies is proportional to the distance from these bodies.

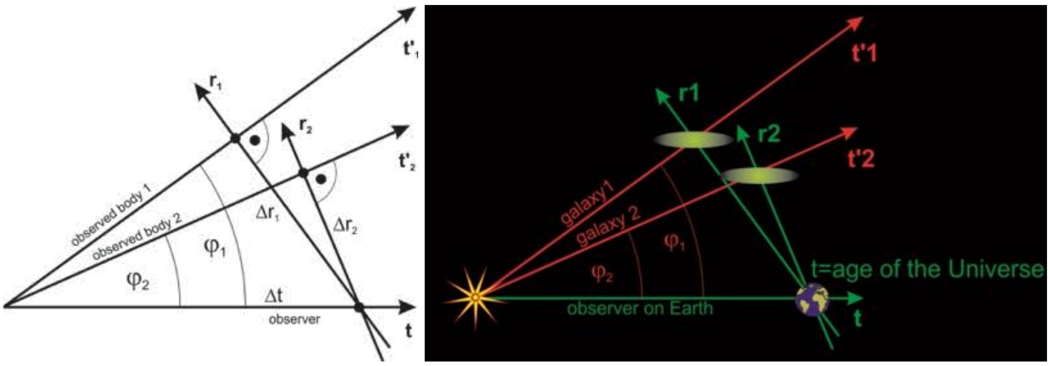
The problem is illustrated in Fig. 30. It can be seen from Fig. 30a that an observer at time Δt from the point where the bodies meet, observing the bodies along directions perpendicular to their trajectories, sees that for each observed body, the relative velocity is:

$$V_i = \frac{\Delta r_i}{\Delta t} = sin(\varphi_i) \tag{54}$$

Thus, the observed velocity is proportio nal to the distance from the observed body, while the proportionality factor is the inverse of the elapsed time since all bodies meet at a single point E4. The experimental confirmation of this effect predicted by the E4 model has been known for almost 100 years as Hubble's law [16]. In this case, the common point of all bodies is the place and moment of the Big Bang, while the Hubble constant is the inverse of the time elapsed from the moment of the Big Bang to the moment of observation, i.e., practically the inverse of the age of the Universe (55)

$$V_i = \frac{\Delta r_i}{\Delta t = age\ of\ the\ Universe} = H\Delta r_i = sin(\varphi_i) \qquad (55)$$

- see Fig. 30b. Unfortunately, the fact that the evidence supporting the way of observing described here emerged much earlier than the model itself justifying such an effect, significantly weakens the importance of the evidence supporting the validity of the model.



a b

Figure 30: Motion of bodies along trajectories having a common origin. Fig. a. shows the observation principle along directions perpendicular to the trajectories of the observed bodies for the case of motion along trajectories having a common origin. Fig. b. shows the observation principle from Fig. a. applied to derive Hubble's law.

However, all is not lost - the aforementioned way of observing along directions perpendicular to the trajectory allows another conclusion to be drawn.

Assuming that the Big Bang caused a relatively symmetric filling of E4 space with matter and knowing the limitation of making observations only to directions inclined to the observer's trajectory at an angle less than 90^0, we come to the conclusion that we are only able to observe half of the existing Universe - Fig. 31a.

However, the Earth's motion around the Sun means that the boundaries of the observed Universe should change depending on the season of the year - fig. 31b. Due to the relatively low velocity of the Earth in its motion around the Sun (approximately 30 km/s), this effect is small and only affects objects thus far out of the observation range. The recently discovered H1 galaxy moves at a speed causing a redshift by a factor "z" equal to approximately 14 [59], while it can be easily calculated based on formula (56) that for such an effect to occur (for a maximum difference in the velocity of the Earth relative to celestial bodies of approximately 60 km/s), the factor "z" should be no less than 100. However, based on the progress of work related to observations of the Universe, we can expect that we should soon obtain results that will make it possible to verify the predicted effect of the disappearance of some objects depending on the season.

$$z = \frac{\sqrt{1 + \frac{c-2v}{c}}}{\sqrt{1 - \frac{c-2v}{c}}} - 1 \tag{56}$$

(v - the speed of the Earth as it moves around the Sun).

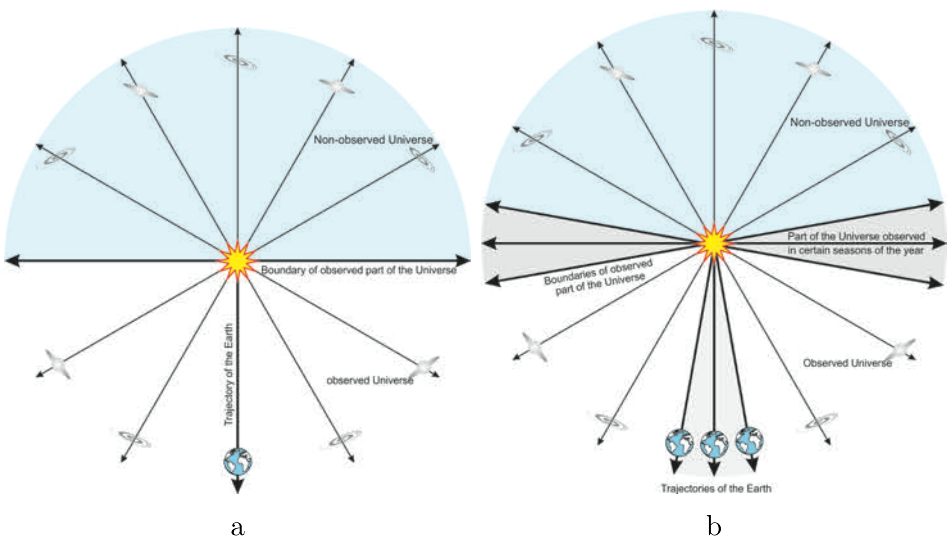


Figure 31: The invisible part of the universe without taking into account the Earth's motion around the Sun - Fig. a. When the Earth's motion around the Sun is taken into account, the boundaries of the observable universe will change – Fig. b.

4.6 Deviations from the predictions of the Theory of Relativity in distant regions of the Universe.

The condition for obtaining relativistic relations as they are recorded in our surroundings is the assumption of perpendicularity of the spatial direction to the time axis (trajectory) of the observed body. This, in turn, is fulfilled only if the trajectories of the bodies have a common point in the past or future and, in addition, at this common point, the bodies must meet. The assumption of the existence of the Big Bang means that the trajectories of all bodies have a common origin being such a common point. However, during the expansion of the Universe as a result of the various motions of galaxies, stars, and planets, this condition may have been disturbed. It is not yet known whether there are any laws of behavior that maintain the condition of perpendicularity of the spatial axis to the trajectories of the observed particles. If such rules do not exist or exist in a limited way, it may happen that trajectories of particles in some regions of the Universe no longer have a common point and then relativistic relations have a different form than the one valid in our surroundings.

Thus, it may be expected that in distant regions of the Universe, relativistic phenomena such as time dilation, for example, may give different values than those resulting from the well-known form of the Theory of Relativity. Such deviations may be interpreted as a consequence of a different speed of light than that measured in our surroundings, but from the construction of the model, such a conclusion should be wrong because the value of the speed of light results from the properties of space and waves in that space, which should be the same throughout the Universe.

5 Conclusions

Two models of reality are presented here, both of which satisfy the principle of conservation of the space-time interval and therefore lead to an almost identical description of relativistic phenomena. The first model is the theory of relativity, in which we describe reality with the help of the dimensions of time and space to which we are accustomed, but the description is only possible once the observer system is chosen. The second is a description using a four-dimensional Euclidean space in which, during mutual observation, the observer interprets certain directions in E4 as the time and space dimensions of his reference system, where the choice of these directions is determined individually for each observer-observed body pair. Unlike the theory of relativity, the E4 model describes the motions of all bodies in a common absolute reference system, where the relativity of motion is ensured by the relativity of the angle of inclination of the trajectory of the observed body to that of the observer.

Contrary to the first impression, the E4 model is not a negation of the theory of relativity but can be seen as an extension and completion of it. When Einstein created RT, he started from a model of reality in which bodies and waves were different beings. Meanwhile, the E4 model starts from the description of a body directly as a wave – something that only became possible after 1925 and thus 20 years after the publication of the foundations of the Theory of Relativity. On the other hand, at the basis of the E4 model is the principle of conservation of the space-time interval resulting from the theory of relativity as formulated in 1907. Additionally, in the E4 model, the wave equation describing the particle is an extension of the wave function, which is a solution of the Schrödinger equation. This function is written in the E4 coordinate system and is completed by the amplitude distribution and phase velocity along the ridge of the wave. The existence of the phase velocity of this wave allows us to justify the phenomenon of the constant speed of light.

Constructed in this way, the E4 model makes use of the results of Relativity Theory and Quantum Mechanics as they exist today. Thus, the E4 model is a common basis for describing both relativistic and quantum effects. The wave structure, which is an extension of the wave function native to quantum mechanics, ensures the constancy of the speed of light and relativistic effects. At the same time, the description of a particle directly as a wave provides the basis for the description of interactions, treated not as the result of the existence of fields and charges of unknown origin but directly as the result of wave interactions being oscillations of space. Various possible types of oscillations, a wave being a complex of transverse and longitudinal oscillations, two possible types of deformations of space - densification and dilatation, a particle being a complex of many elementary waves, and possibly various other as yet undescribed types of oscillations of space, provide great opportunities for development and interpretation of the theory and possibly for explanation of the Standard Model. As a result, the E4 i model may provide a starting point for a unified field theory not based on a multiplication of time or space dimensions but based on a description of reality using dimensions that are not the observed dimensions of time and space.

The capabilities of the E4 model seem large and promising. However, does this reasoning even make sense? Is the resignation from describing reality using the dimensions of space-time, and replacing the description with some abstract Euclidean space, the right path for the development of science, or just another dead end? In such cases, it is the experimental tests that play a decisive role in determining the right direction for the development of science.

The E4 model provides an opportunity for such experimental verification. It predicts several effects not predicted by the Theory of Relativity. The first of these is Hubble's law, predicted only now by the E4 model but discovered almost 100 years ago. Thus, invoking this law is unlikely to be an argument of much weight any more, although the simplicity of the explanation of this problem should make an impression. However, the mechanism explaining

Hubble's law is also responsible for predicting the existence of the invisible half of the Universe whereby, as a result of the Earth's motion around the Sun, part of the observed Universe would only be available for observation at certain seasons of the year. This applies to celestial bodies that are for the time being out of the observational range, which are moving away at a speed that causes a redshift by a factor of $z \geq 100$, whereas currently, for the most distant objects observed, the z-factor does not exceed a value of 20.

Further effects, such as a discrepancy of results of measurements of cross sections for collisions of particles, in systems of collisions of a beam with a fixed target and collisions of opposing beams or a change of effects of the decay of a relativistic particle after exceeding a certain velocity of the decaying particle, are already possible; however, they require strictly defined energies, which rather exclude an accidental detection of such effects.

Certain properties of the relativistic equations obtained from the E4 model suggest the possibility of deviations from the predictions of the Theory of Relativity in remote regions of the Universe, and these deviations may be misinterpreted as deviations from the principle of constancy of the speed of light.

Thus, the concept of Euclidean space presented here, completed by the process of observation and the wave–particle equation, can provide a common platform for relativistic phenomena, quantum phenomena and the theory of particle structure and types of interaction, i.e., the expected Unified Field Theory.

Only does it truly provide? I hope that the proposed reasoning will encourage at least one research institute to carry out experimental tests to confirm, or deny, the model discussed here.

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