Does the Time Dimension has to be Perpendicular to the Space-Dimensions?

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Abstract

Introduction: Considered are doubts regarding the choice of the time dimension as perpendicular to the three spatial dimensions of an observer.

Objectives: To solve this problem, it is necessary to compare the description of the current model of reality with a model that assumes that the time dimension is linearly independent of the spatial dimensions of the coordinate system of an observer.

Methods: It was necessary to examine and compare the properties of two models of reality that fulfilled the rule of space-time interval conservation, the first where the time dimension is perpendicular to the space dimensions of the coordinate system of an observer, and the second where the time dimension is linearly independent of the space dimensions of the coordinate system of an observer..

Results: The approach that assumes that the time dimension is linearly independent of the spatial dimension of the coordinate system of an observer leads to a Euclidean picture of reality, where it is possible to connect the absolute character of reality with the relativity of motion of bodies.

Conclusions: Rejecting the assumption regarding the perpendicularity of the time dimension to the spatial dimensions of the observers' reference frame seems to be a way to solve unsolved problems for 120 years and extend the capacity of the model of reality.

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Introduction

We describe our three-dimensional space using three-dimensional coordinate systems in which all axes are perpendicular to each other. Therefore, it is not surprising that by creating the four-dimensional model of Minkowski space-time, the axis of time was assumed to be perpendicular to the space axes of an observer's coordinate system. However, to describe our three dimensional space, it is sufficient to apply any linearly independent three dimensional coordinate system. It is not true that to describe our space, the dimensions of the coordinate system must be perpendicular to each other. We use such a coordinate system for practical and economic reasons, as well as applied tools, building design methods, and the simplicity of everyday calculations. The orthogonal system was the most comfortable. However, this does not result from any other property of the space. Therefore, when introducing the fourth time dimension, it should be considered whether it was necessary to adopt such a strong assumption as perpendicularity of the time dimension to the space dimensions, or whether it would be sufficient to assume only linear independence of the dimension of time. In particular, if applying the orthogonal coordinate system is very comfortable in three-dimensional space, its application in four-dimensional space-time causes significant complications in the description of events.

Considering the problem

First, let us consider the current model of reality – the Minkowski space-time. Here, the time dimension is perpendicular to the spatial dimensions of the observer's coordinate system.

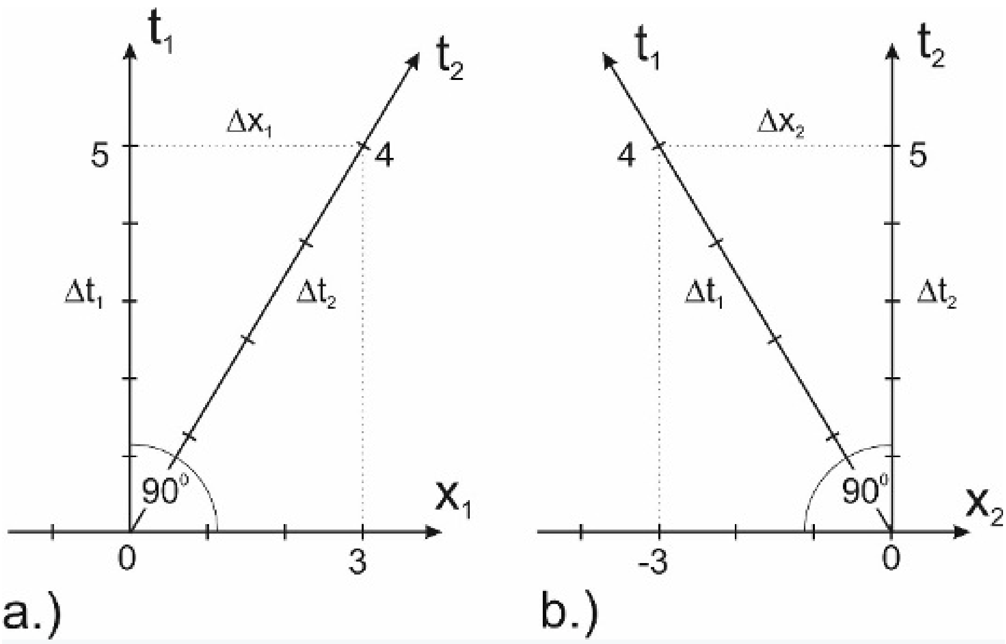

Fig.1. Mutual observation of observers x_1t_1 and x_2t_2 for a plane case y=z=0 and c=1. For simplicity space axis of the observed body was not presented.In the Fig.a observer x_1t_1 observes body x_2t_2 and in the Fig.b observer x_2t_2 observes body x_1t_1. For better illustration of changing the scale of observed body's axes, there were applied typical "school" values of sides of a right triangle 3,4, and 5 as the values of times and space distances.

This approach, referred to as the first, is presented in Fig.1. The time axes were assumed perpendicular to the spatial axes of the coordinate system of the observer. In Fig.1a, observer x_1t_1 observes the body x_2t_2. For such observations, the equation of the space-time interval takes the form

$$\Delta t_2^2 = \Delta t_1^2 - \Delta x_1^2 \qquad (1)$$

If we now consider that the observer is a body x_2t_2 (Fig.2b), then the equation of the space-time interval takes the following form:

$$\Delta t_1^2 = \Delta t_2^2 - \Delta x_2^2 \qquad (2)$$

From (1), (2), and Fig.1, we see that the rule of conservation of the space-time interval equation forces the deformation of the axis of time of an observed body's reference frame. This is the cost of assuming perpendicularity of the time axis to the space axes of the coordinate system of the observer. In Fig.1a, body x_1t_1 is an observer and axis t_2 is deformed. A change in the observer's frame from x_1t_1 to x_2t_2 causes a change in the axes of the frame of the observed body, such as x_1t_1 which is deformed (see (2) and Fig.1b). The deformation of the time axis indicated a slower time flow in the reference frame of the observed body.

According to the first approach, deformation of the axes of the observed body is responsible for the occurrence of relativistic effects.

From the above we see, that we can present process of observation only from point of view of a specific observer. The worldlines of all bodies are not stable but depend on the choice of an observer; therefore, they cannot be related to any independent coordinate system connected with the space-time. Hence, any motion can be considered only as relative motion in relation to another body.

However, as mentioned earlier, any linearly independent coordinate system is sufficient to describe the three-dimensional space. An orthogonal coordinate system is a special case of a linearly independent coordinate system, which is applied exclusively for convenience.

Therefore, we should also consider what would happen if, in four-dimensional space, we reject the condition of perpendicularity of the axes of the coordinate system, which is indeed convenient in three-dimensional space, but causes significant complications in four-dimensional space. Hence, considering a four-dimensional space, we attempt to describe this space using the time dimension, defined merely as a linearly independent coordinate of the observer's coordinate system.

The case where the fourth time dimension is described by a linearly independent coordinate is referred to as the second approach. In such a coordinate system, the condition of space-time interval conservation necessitates changing the angles between the space axes and the time axis of the observer's coordinate system, as shown in Fig.2. It should be noted that, in this case, there was no deformation in the coordinates. Instead of the condition of perpendicularity of the time dimension of the observer's reference frame, we have the condition that the spatial dimensions of the observer's reference frame must be perpendicular to the time axis of the reference frame of the observed body [1].

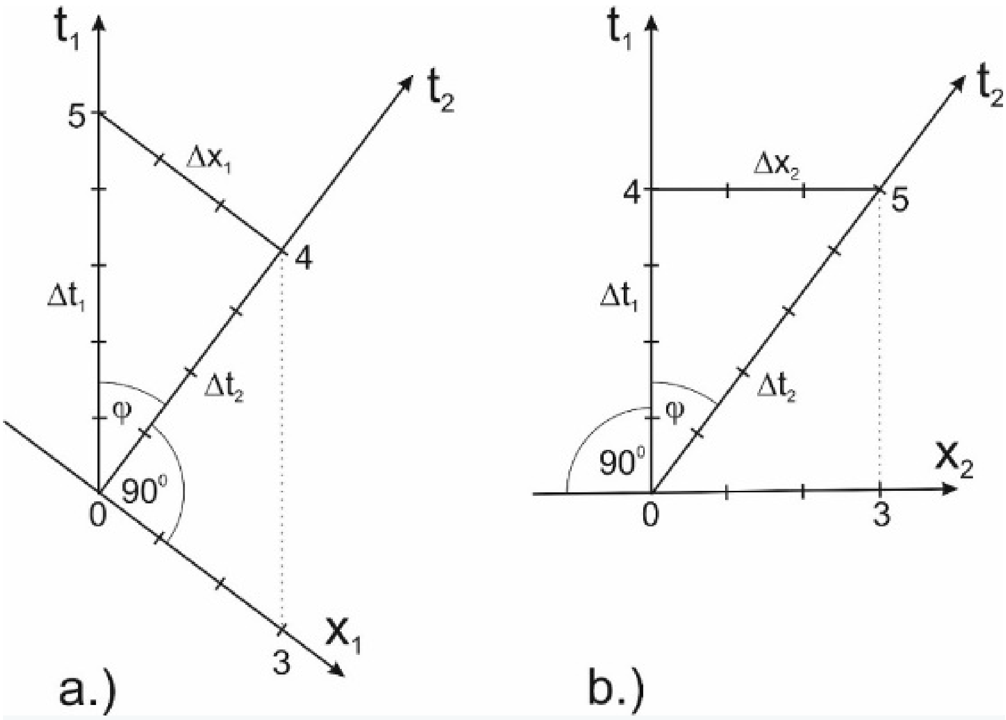

Fig.2. Mutual observation of observers x_1t_1 and x_2t_2 like in Fig.1 (Fig.a –x_1t_1- an observer, Fig.b – x_2t_2 - an observer) for the case of the time axis linearly independent to the space dimensions of an observer. In this case the rule of conservation of the space-time interval forces the right angle between space dimensions of observer and time dimension of the observed body's coordinate frame. The plane of the diagram is Euclidean and it can be a model of reality. From the right triangle formed by the space and time distances automatically result basic relativistic dependencies (3), (4)

As we see, form the right triangle formed by the time axes of both observers and the space axis of the observer instantly result basic relativistic dependencies regarding the observed time dilation (4) and the limitation of the relative velocity of bodies (3):

$$V = \frac{\Delta x_i}{\Delta t_i} = \sin\varphi \leq 1; i = 1, 2 \qquad (3)$$

$$\Delta t_i = \Delta t_k \cos\varphi = \Delta t_k\sqrt{1 - \sin^2\varphi} = \Delta t_k\sqrt{1 - V^2}; (i \neq k) \in (1, 2) \qquad (4)$$

As shown in Fig.2, the change in the observer is related only to the change in the direction of the spatial axis of the observer's coordinate system. The spatial axes of the observer were chosen perpendicular to the time axis of the observed body. The scale of the axes of all the reference frames did not change. The change in time observed in the observer's coordinate system is the result of a change in the spatial dimension of the observer's coordinate system. Such a defined space can be Euclidean, whereas the coordinates of the observer coordinate system are only in certain directions in this Euclidean space. Moreover, a very important is the fact that the time axes of the reference frames of bodies do not change and do not depend on the choice of an observer. Therefore, we can treat them as absolute directions in Euclidean space (represented in Fig.2 by the surface of the diagram), whereas the absolute flow of time is the absolute motion of the bodies along their time axes.

Comparing of the two approaches

We can see that both approaches – the first, which assumes perpendicularity of the time axis to the space dimensions, and the second, which assumes that the fourth dimension of reality has to be only linearly independent–fulfill the rule of conservation of the space-time interval. Therefore, we expect that both approaches yield identical formulas that describe reality and relativity. This is not the whole truth, because both approaches, although fulfilling the same rule of the space-time interval satisfying, give different interpretations of the construction of reality and the mechanism responsible for relativistic phenomena. This leads to a completely different picture of the reality.

As an result, the most important differences between the two approaches are:

1. The first difference between the first and second approaches is the source of relativistic effects. According to the first approach, in the Minkowski space-time, the source of the relativistic effects is the deformation of dimensions in the reference frame of the observed body, that is, the body in motion. The reality defined in this manner is Lorentzian, and cannot be described using any Euclidean set of coordinates.
   According to the second approach, the source of relativistic phenomena is the change in the angle of inclination of the spatial axes to the time axis of the observer's reference frame while their scale remains unchanged. These spatial axes must be perpendicular to the time axis of the observed body [1]. If we assume that the axes of the reference frames of bodies are not the true dimensions creating reality, but merely the directions in reality perceived by us as the dimensions of space and time, then we can assume that reality is Euclidean (not Lorentzian).
2. The next difference concerns the definition of an absolute reference frame. According to the first approach, a change in the observer causes a change in all the coordinates of the observer and the observed body's reference frames, and there is no possibility of connecting the reference frame of any body with any point of the space-time. Therefore, all the motions must be treated as relative motions.
   Simultaneously, according to the second approach, we observed that the change in the observer did not change the time axes of the reference frame of the observer or observed body, as shown in Fig.2. This means that the time axes of all bodies in Euclidean reality presented in fig.2 are absolute. Therefore, we can define the time axes as absolute routes in reality and the time flow as motion along the time axes (routes) in the Euclidean reality. According to, the flow of time is identical for all bodies (only for inertial motions [2][3]), whereas the observed time dilation is the result of a change in the spatial axis along which observation is performed. Such time dilation is only an effect of observation, and is symmetrical to both observers (fig.2). However, true dilation requires a change in the velocity of one of the bodies [4]. This change in velocity (value or direction) transforms the observed mutually symmetric change in time into a real change in time in the reference frame of the body, which changes the velocity.
3. According to the first approach, the relativity of motion is the result of an empty space where there are no reference points connected with space-time.
   According to the second approach, the motion of bodies along their time axes can be absolute. However, the velocity of the surrounding bodies was observed as a sine of the angle of inclination of the trajectories of the bodies to each other according to the formula $V = \sin\phi$. Therefore, the observed velocity is a function of the angle between the body

trajectories. In Euclidean reality, no distinguished direction exists; therefore, to define the velocity, or, in other words, to define the angle of inclination of the trajectory of the body, the choice of the reference trajectory, that is, the trajectory of another body, is needed. Hence, the observed velocity can only be defined relative to the trajectory of another body, that is, the velocity of one body can only be measured relative to another body. Identical conclusion like in the classical Theory of Relativity.

Discussion

Thus, we have two alternative approaches, both fulfilling the rule of conservation of the space-time interval.

The first assumption, currently adopted by science, is that the dimensions of the coordinate system of a body in motion are deformed (Fig.1). In this case, that is, in Minkowski space-time, while describing events, we operate with the dimensions of time and space being directly observed in our surroundings.

Here, we have a simple model of observation and a complicated description of reality in which we must consider the unintuitive deformation of bodies in motion.

The second approach assumes that the mechanism responsible for the relativistic effect relies on a change in the inclination angle of the time dimension to the spatial dimensions of the observer's reference frame.

Therefore, the situation is opposite to the first assumption. The reality described that way is in practice Euclidean and absolute what is very easy to describe, whereas the mechanism of observation is unintuitive because the dimensions of time and space perceived by us are not the dimensions creating reality, but are merely certain directions in the Euclidean space, which are additionally changing as a function of the motion of an observed object.

The second approach significantly changed our understanding of reality. According to this approach, reality can be described as four-dimensional absolute Euclidean reality. Treating Euclidean space as an absolute means that space can play a role similar to that of Ether considered by scientists before 1905. In addition, all bodies can be described as moving in Euclidean space along their routes, interpreted as their time axes, with a constant velocity. We assume that it is equal to unity and that V=1 (for inertial motions [2][3]). This absolute motion of the bodies can be interpreted as time flow, and the path traveled by these bodies can be interpreted as the time passed in the reference frames of these bodies (only for inertial motions). For inertial motion, time flows with identical speeds for all bodies; however, as a result of observation performed along directions perpendicular to the axis of times of observed bodies, the bodies observing each other register a time dilation in the reference frames of the bodies in motion. Directions perpendicular to the axis of times of the observed bodies were interpreted by the observer as their spatial dimensions. This is illustrated in fig.2.

The absolute motion of bodies along their time axes (routes) in Euclidean four-dimensional space is unrelated to their relative velocity, which is equal to the sine of the angle between the routes of bodies in Euclidean reality. As shown in Fig.2, while the two bodies move along their time axes t_1 and t_2 with identical absolute velocities, their relative velocity is a function of the inclination angle of their time axes. Therefore, any attempt to combine the relative velocity of bodies and absolute velocity in Euclidean space (Ether in the 19-the century) has no sense. This automatically explains the negative results of the Michelson-Morley experiment.

The above-mentioned properties of four-dimensional Euclidean reality, especially the constant absolute motion of bodies, allow one more benefit: we can now describe particles directly as waves of space moving with constant velocity depending on the physical properties of the space.

These are very promising ideas[2][3] and [5]; although perhaps more or less speculative and probable, they are interesting and worthy of detailed consideration.

Conclusions

This study shows that the cure for the current problems with a description of reality and a way to extend the capacitance of reality models can be by rejecting the assumption about the perpendicularity of the time dimension to the three spatial dimensions of an observer's coordinate system.

I am aware that considering such an approach can make it difficult for physicists accustomed to the "classic" Theory of Relativity. Moreover, the Theory of Relativity has been supported by 120 years of development, whereas the new approach does not yet describe so many problems already described and solved by TR. However, the second approach seems promising and significantly changes our picture of reality, which can have significant consequences for understanding the mechanisms responsible for the observed phenomena. On the other hand, apart from any other arguments, it is very important to give an unequivocal answer to the question that should be asked almost 120 years ago, when the foundations of the Theory of Relativity were formulated: Should we consider the fourth dimension to be linearly independent, whether orthogonal to our three-dimensional space.

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