Space-Time Transformations in the Presence of Information Isolation

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Abstract

A hypothesis that a physical body in different inertial frames of reference can vary so that it can exist in one frame of reference and not exist in another has been considered. This substantiates the need to modify the principle of causality, as the principle of causality becomes applicable for events considered in the same inertial frame of reference only. As a result, informational isolation of inertial frames of reference arises. It has been shown that within the framework of this hypothesis physical bodies, from the viewpoint of observer, have properties identical across all frames of reference, despite existing differences. The special theory of relativity has been obtained as space-time transformations from the viewpoint of observer. The equations of special theory of relativity remain unchanged. A new type of transformations of space-time-fields emerges, complementary to space-time and fields transformations from the viewpoint of observer. The hypothesis may be viewed as a generalization of the special theory of relativity for the case where the principle of causality is applicable to the events considered in the same inertial frame of reference only.

1. Introduction

Currently, it is generally accepted that physical bodies are identical across all frames of reference. A physical body may have certain properties contingent on the frame of reference, for example, kinetic energy. For a system of several physical bodies, space-time relations may change when switching between frames of reference, i.e., the distance between bodies. It is generally accepted that the physical bodies themselves exist in all frames of reference and share identical properties in all frames of reference.

It can be said that the last few centuries have spawned two main systems of views on space, time and physical bodies. The first frame of reference is Newton's absolute space. Newtonian space is a repository of physical bodies. Time is also absolute and independent. Prior to the advent of Einstein's special theory of relativity and before Minkowski reformulated the special theory of relativity in 4-dimensional space-time, space and time were considered as independent entities. The second frame of reference is Minkowski's space-time. Space ceases to be independent and becomes associated with time. Thus, we move on to the space-time concept. Space-time contains physical bodies, and all these bodies exist across all frames of reference.

Let is make an attempt to find a trend in changes in order to see the opportunity for a new system of views on space, time and physical bodies. Previously, new views emerged as new theories developed. Here, we set a goal to find possible changes in views on the nature of space, time and physical bodies by reversal, first to find the possible changes, then to look for the appropriate physical theories.

We have two approximation points, and each of them corresponds to its own frame of reference. The change between the first and second points is reduced to the fact that two entities, space and time, which were previously considered independent, were united within the framework of a new entity, space-time. Spatial and temporal intervals have become contingent on the frame of reference. Physical bodies remain independent entities, which exist in all reference frames. Physical bodies, taking into account general relativity (GR) effects, affect space-time, but have properties remaining identical in all reference frames.

Let us look for the next possible point. We use this approximation by two points to find ideas of what another system of views on space, time and physical bodies might look like. So, at first, space, time and physical bodies were independent. Then there was space-time and physical bodies, where space and time became united. Looking at this, an idea suggests itself that the next change in the system of views on space, time and physical bodies will lead to the unification of space, time and physical bodies, into space-time and physical bodies together.

This unification leads to the fact that not only spatial and temporal intervals may differ in different frames of reference, but also physical bodies may have significantly varying characteristics in different frames of reference. And significantly varying characteristics of physical bodies between inertial frames of reference mean a situation where a physical body has no properties that are the same across all inertial frames of reference. A special case of such significant difference is the situation where a physical body exists in one frame of reference and is absent in another, or vice versa. Thus, the basic assumption of the hypothesis proposed is derived - a physical body may have significant differences across different inertial frames of reference.

It is not clear how the idea of quantizing space-time may be obtained based on the search for a trend using the available data by two points. The related issues are not covered in this article.

We have no need for justifying the correctness of the trend search performed. It does not affect the proposed hypothesis in any way.

So, we obtained the basic assumption of the hypothesis - a physical body may have significant differences across different inertial frames of reference.

The hypothesis obviously touches on the very foundations of physics. Now we need to understand the way the hypothesis correlates to observations and modern theories.

Obviously, the hypothesis could be tested directly if it was possible to compare the properties of a physical body observed in different inertial frames of reference. We discuss whether it is possible further in the article.

All modern fundamental theories use special or general theories of relativity. Both SR and GR assume that physical body exist in all frames of reference and share the properties that are invariant with respect to transitions between inertial frames of reference. If a physical body can have significant differences across different frames of reference, this means that all modern theories are inaccurate. That said, modern theories describe observations quite well. Is it possible that they are inaccurate?

Recall the end of the 19th and the beginning of the 20th century. Many were convinced that physics had already been built, and all that remained was to clarify a number of small details. A little time passed, and quantum physics, SR and GR were discovered. And now we face a number of issues looming on the horizon of physics. This is a question of reconciling general relativity and quantum theories, dark matter and dark energy, and a number of other issues. Perhaps, these questions will be resolved over time without causing major changes in the foundations of physics. But it is possible that solving these questions will require such changes.

New theories usually contain previous theories as special cases. It is necessary to consider the following question: is it possible to obtain theory of special relativity (SR) within the framework of this hypothesis. Since SR is a well-tested theory, it would be best to obtain it without making any changes to the SR equations. If this is possible, then compatibility of all modern theories using SR with the hypothesis proposed can be expected. Moreover, such theories will be only considered special cases of some more generalized theories taking into account the significant differences between one physical body across different inertial frames of reference. The issue of compatibility of the hypothesis proposed with GR is not considered in this article. If this hypothesis contains SR as a special case, there is reason to believe that it may be compatible with GR. This is why we set the goal to obtain SR without making any changes to the SR equations within the framework of this hypothesis.

If we consider space-time and physical bodies, and a physical body may have significant differences when transiting between inertial frames of reference, then transformations of space-time and physical bodies arise in the transition between inertial frames of reference.

The properties of physical bodies and their dynamics are described by fields. What we are saying is that the properties of a physical body can vary significantly in different inertial frames of reference, and that a physical body can exist in one frame of reference and not exist in another as an option for such a significant difference. This entails a corresponding fields transformation. According to the basic assumption of the hypothesis, these are fields transformations that can lead to a significant change in the properties of a physical body, including the case where such physical body exists in one frame of reference and does not exist in another.

No assumptions are made as to the nature of these transformations within the framework of this hypothesis. Therefore, this hypothesis is unable to produce mathematical relations describing the transformations of space-time-fields. This will require a deeper theory.

If a physical body can have varying characteristics in different frames of reference, this means that the hypothesis is incompatible with both substantivalism and relationalism. Space-time cannot be a fundamental, independent entity, since it is contingent on physical bodies. Therefore, this hypothesis is incompatible with substantivalism. In relationalism, spacetime is derived from physical bodies. But if a physical body in different frames of reference can have significant differences, this means that the hypothesis is incompatible with relationalism.

It may seem that it is impossible to combine the SR equations, where a physical body has invariants during the transition between frames of reference, and the assumption of a hypothesis on significant differences in the properties of a physical body across different inertial frames of reference. We will show that such a contradiction can be resolved without making changes to the special theory of relativity equations. We will show that the basis for solving this contradiction is the consideration of physical bodies and events from the viewpoint of observer. It will be shown that, despite the significant differences in the properties of physical bodies in different inertial frames of reference, there is no such difference from the viewpoint of observer and the SR equations are exactly fulfilled, with no corrections required. Also, a new type of transformation of space, time and fields between different inertial frames of reference emerges.

To begin with, let us consider transformations of space-time and fields in the most general form.

2. Transformations of space-time and fields

Let us consider the requirements imposed by the basic assumption of the hypothesis on the transformations of space-time and fields. It follows from the assumption that a physical body cannot have properties which are identical in all frames of reference and from the assumption that it can exist in one frame of reference and not exist in another and vice versa, that transformations of space-time and fields should not be covariant in relation to the SR transformations. If they are covariant with respect to the SR transformations, this means that a physical body has properties which are identical in all frames of reference, contradicting the basic assumption of the hypothesis.

Based on the set goal to obtain the SR and SR equations without making any changes to the SR equations, the transformations of space-time and fields must be covariant with respect to the SR transformations.

Let us write down the resulting conditions:

1. Transformations of space, time and fields must be non-covariant with respect to the SR transformations.
2. Transformations of space, time and fields must be covariant with respect to the SR transformations.

At a first glance, there is a logical contradiction. The two conditions appear to be in direct contradiction to each other. However, it is possible to find a solution to such contradiction. For this, there must be two different transformations of space-time-fields, each of them satisfying one of the conditions. Further, we will find the types of transformations arising, show that they are two, and show that the transformations described in the second condition are transformations of space-time and fields from the viewpoint of observer. The first condition describes transformations, where we compare the actual values of the fields in different reference systems. In the meantime, let us consider only transformations satisfying the first condition.

Fields have values with space-time coordinates. The four fundamental fields known today have values at every point in space-time. Then the question arises, if physical bodies can have significantly different characteristics in different inertial frames of reference, how can physical fields describing physical bodies be characterized? Suppose we will describe them with space-time coordinates and values at each point of coordinates. But the fields can be different in different inertial frames of reference. The assumption that a physical body does not have properties that are identical in all frames of reference, means that physical fields that describe such body cannot have properties that are identical in all frames of reference. Then, obviously, the description of the fields must also indicate the inertial frame of reference. Since we do not yet have a theory that can describe the transformation of fields with a significant difference of a physical body in different frames of reference, we cannot say that the transformation of different fields can be considered independently. This means that all fields can take part in the transformation of space-time and fields; and transformations of a field cannot be considered independently of others. Perhaps the theory describing these transformations will allow to transform certain fields independently of each other. But until we have a theory, we cannot assume that the transformation of fields is independent of each other.

Assume that H is a set consisting of space-time coordinates and field values in the inertial frame of reference L. We want to obtain the values of the fields and their space-time coordinates in the inertial frame of reference L', moving at a nonzero speed relative to L. Consider the available options.

The first option is to obtain the values of the fields and their space-time coordinates in the second frame of reference based on the values of the fields and their coordinates in the first frame:

$$H' = BH \qquad (1)$$

Here, B is a certain operator that transfers space-time coordinates and field values from one system to another. The solution to the inverse problem, finding coordinates and values from H to H', looks quite obvious:

$$H = B^{-1}H' \qquad (2)$$

Where B^{-1} is the operator inverse to B.

One may notice that these equations can only be true if the coordinates and values of the fields in the second frame can be obtained based on the coordinates and values of the fields in the first frame. However, the assumption of the hypothesis has nothing from which this could follow. Therefore, it is necessary to consider another possibility that using the values of the fields and their space-time coordinates in one frame of reference, we cannot obtain the values of the fields and their coordinates in another frame of reference.

For this case, we can assume the existence of some fundamental entity, which is more fundamental than space-time and fields. Suppose H can be obtained using the following equation:

$$H = AQ \qquad (3)$$

Here, Q represents a set representing the state of a fundamental entity with unknown properties, A is the operator allowing to obtain space-time and field values for an inertial reference frame L from this entity.

Assume H' is a set consisting of coordinates and field values in the inertial reference frame L'. Then

$$H' = A'Q \qquad (4)$$

Can we obtain H' if we know H? If there is A^{-1}, the обратный оператор к A, then:

$$H' = A'A^{-1}H \qquad (5)$$

However, as noted above, nothing presupposes the existence of an inverse operator. It can be noted that the assumption of the existence of a fundamental entity, more fundamental than space-time and fields, is also compatible with the inverse operator, if the values of the fields and their coordinates in one frame of reference can be used find the values of the fields and their coordinates in another frame of reference.

In both options considered, the information is not saved during the transition between frames of reference. In the first case, where based on the values of fields with coordinates in one frame of reference it is possible to obtain the values of fields with coordinates in another frame of reference, preservation of information during the transition between frames of reference is possible. However, this preservation of information is not the same when it is assumed that there are field invariants and that events are identical across all frames of reference. If a physical body can exist in one frame of reference, and not exist in another, it is obvious that the events where this body takes part or takes no part can be different in different frames of reference. Since the preservation of information usually means the preservation of information in the presence of field invariants in different inertial frames of reference, and such preservation of information is not carried out. In the second case, where based on the values of fields with coordinates in one frame of reference it is impossible to obtain the values of fields with coordinates in another frame of reference, preservation of information during the transition between frames of reference is not carried out as in the case where the information is restored on the basis of the assumption of existing invariants fields in all reference systems, and for the case where information is restored from all values of the fields and their space-time coordinates. Further, non-preservation of information during the transition between inertial frames of reference will mean such non-preservation of information, where information is restored on the basis of the assumption of the existing field invariants in all frames of reference.

As a consequence of the above, information between reference systems cannot be transmitted undistorted.

It is impossible to write something more detailed on the topic of transformations of space-time and fields within the framework of this hypothesis. It is not even possible to list all the parameters influencing the operator A. A more fundamental theory is required to describe the equation in detail.

One might wonder: what point in space-time in one frame of reference corresponds to a point in space-time in another frame of reference?

The answer to this question can be given only if information from only one point of a frame of reference would be sufficient to obtain the properties of the fields at some point in the space-time of another frame of reference.

For equation 1, this does not hold in the general case, although a special case where it does is possible. Let the values of the fields at a point in space-time of one frame of reference can be used to find the values of fields at a point in space-time of another frame of reference. In this case, the condition that each of the fields has no invariants with respect to the SR transformations is satisfied. In this case, it is possible that while each of the fields taken separately has no such invariants, all fields taken together have such an invariant. Whether the presence of such an invariant contradicts the assumption of the hypothesis that a physical body has a significant difference in different inertial frames of reference is not yet clear.

For equation 3, it is impossible to find the values of the fields at a point in the space-time of one frame of reference from the values at one point in another frame of reference. The mapping of the set of space-time and field values from one frame of reference to another may be not surjective or injective. Obviously, this also means that obtaining the values of the fields at a point in the space-time of one frame of reference based on the values of the fields in another frame of reference is impossible. As a result, it turns out that it is impossible to map any points of space-time from different frames of reference.

If it is impossible to map the points of space-time between different inertial frames of reference, it follows that the principle of locality operates only within the framework of one inertial frame of reference. If we consider any phenomenon simultaneously across several frames of reference, the principle of locality from one frame of reference cannot be applied to another simply because it is impossible to map the space-time points.

To begin considering the compatibility of this hypothesis with existing widely accepted theories, let us first consider the observation and the observer.

3. Observation and observer

An observer can observe any phenomenon only in the frame of reference against which they are motionless. Just like any device, a person cannot observe events in the frame of reference against which they have a nonzero speed. An observer can receive information on what was observed by a certain device, for example, a satellite, in the corresponding frame of reference. However, the data from the satellite is also observed in the frame of reference against which the observer is motionless, and not against the frame of reference in which the satellite is motionless.

Informational isolation

Loss of information during the transition between different inertial frames of reference means some isolation of different inertial frames of reference. In different inertial frames of reference, a physical body may or may not exist, as well as the events in which this body is involved. For example, two electrons collided in one of the reference systems, and a photon was emitted. But in some reference frames this collision may not occur, and in some reference frames these electrons may not exist, and in some other reference frames there may be, for example, muons in place of these electrons.

The impossibility of transferring information undistorted between different inertial frames of reference can be called informational isolation of inertial frames of reference from each other.

4. Transformations of fields and human existence

Let us assume the fields in different inertial frames of reference, which have a nonzero velocity against each other, are completely independent. When accelerating or decelerating, we would move to another frame of reference, the fields in which would be completely independent of the first one. In this case, if a person exists in one of the frames of reference, there is no reason for the person to exists in any other frame of reference. Thus, the person can exist only in one frame of reference, and would disappear should their speed change. But this obviously contradicts our everyday experience - when the speed changes, our consciousness remains continuous, and the body continues to exist. Based on this, there should be a limitation on the extent in which the fields can differ in different frames of reference.

The difference of fields means such a difference of fields in various inertial frames of reference, which corresponds to a significant difference of one physical body in various frames of reference.

Let us assume that if the relative speed of inertial frames of reference approaches zero relative to each other, the difference in their fields should also approach zero. In this case, a certain dependence of the fields located in different inertial frames of reference from each other arises. With a sufficiently small difference in fields between frames of reference, a change in speed of a person will not lead to their disappearance in the frame of reference that has become their new frame of reference with zero relative speed. This condition is essential for human existence. Based on the above, if the speed difference approaches zero, the field difference should also approach zero.

5. Principle of causality

According to the principle of causality, a causal relationship between different events is possible. Does the principle of causality apply to events occurring in different inertial frames of reference? Can event A observed in one inertial frame, affect event B in another frame?

In this case, an event means certain interaction between physical bodies. These can be both elementary particles and larger objects.

In the hypothesis under consideration with information isolation, events in different reference frames have a significant degree of independence. An event cannot be the same in all frames of reference, since the physical body participating in such an event can exist in one frame of reference, and not exist in another.

A certain dependence of events in different frames of reference exists only because of the requirement of reducing the difference in fields if the difference in velocities approaches zero. Thus, events A and B cannot form a direct causal relationship.

Let us name the possible causal relationship between events caused by such a relationship a weak causal relationship. In this case, the smaller the difference in fields between different frames of reference, the more strongly the events in these frames of reference are connected with each other. Based on this, we can contemplate the probability that the event A in one frame of reference can affect event B in another frame of reference. In the presence of information isolation, the probability of any event from one inertial frame of reference to influence an event in another inertial frame of reference is always less than 1, if the relative velocities of the inertial frames are nonzero. This upper limit of probability approaches 1 as the difference between events in frames of reference decreases, which occurs if the relative speed of reference frames decreases as well.

The events observed in different frames of reference have only in a weak causal relationship. The transition to another frame of reference also means the transition to other cause-and-effect relationships. Based on this, when moving to another frame of reference, information undergoes a change in order to integrate into the cause-and-effect relationships of the new frame of reference.

The state described above means that changes need to be made to the principle of causality. Namely, in the presence of information isolation, one event can always affect another, only if they are considered in the same inertial frame of reference. If we consider an event that occurred in one frame of reference, and an event that occurred in another frame of reference, then we can only contemplate the probability of the influence of one event on another.

Formulation of the modification of the principle of causality: The principle of causality is applicable only to events considered in the same inertial frame of reference.

The basic assumption of the hypothesis showed to us that the principle of causality must be changed, otherwise it contradicts the assumption of the hypothesis. It can be noted that the basic assumption of the hypothesis follows directly from the modification of the causality principle. If events in different inertial reference systems can vary, this means that the physical bodies participating in these events can also vary. With a sufficiently large difference in events, this can lead to the fact that the physical body will exist in one frame of reference and not exist in another, or vice versa.

As discussed earlier, with the relative speed of reference frames approaching zero, the significant difference of the physical body should also approach zero. This can be reformulated through the principle of causality: if the relative speed of inertial frames of reference approaches zero, the difference between applying the principle of causality only to events considered in same frame of reference, using the principle of causality to events in all frames of reference, should approach zero.

6. Postulates of the hypothesis

We have considered various consequences of the assumption that physical bodies in different inertial systems can vary significantly. We were looking for other principles to be changed in order to obtain a self-consistent hypothesis. Having considered all this, we can describe the system of postulates of the hypothesis.

The hypothesis under consideration can be seen as a generalization of Einstein's special theory of relativity for the case of informational isolation between inertial frames of reference. Let us list the postulates of this hypothesis.

Postulate 1 (Einstein's principle of relativity). The laws of physics are the same for all observers in any inertial frame of reference relative to one another.

Within the framework of this hypothesis, this postulate could be changed as follows:

The observer, when passing from one inertial frame of reference to another, always observes physical processes that satisfy the laws of physics, identical from the viewpoint of observer.

According to this formulation, the laws of physics in different inertial reference frames may differ. Moreover, such a formulation also does not contradict this hypothesis and observations, as will be shown below. Informational isolation allows one to obtain the equality of the laws of nature from the viewpoint of observer, when they are actually different. In this case, it will additionally require some restriction on the degree of difference between the laws of physics in different frames of reference, so that a intelligent observer can change its speed to switch between frames of reference, preserving their existence and the core part of memory. This formulation of the postulate leads to the need to somehow coordinate different laws of physics in different frames of reference, and the means to do this are unclear. Therefore, within the framework of this hypothesis such a formulation is not used, although it seems acceptable.

Postulate 2: The speed of light in a vacuum is the same for all observers, regardless of their relative motion or of the motion of the light source.

This postulate is closely related to the first postulate. It is known that Lorentz-like transformations can be obtained without this postulate [1]. This postulate can be generalized in the same way which is described for the first postulate, and for the same reasons this hypothesis does not use the generalized formulation.

Let us describe the new postulates.

Postulate 3 (modification of the principle of causality): The principle of causality is applicable only to events considered in the same inertial frame of reference.

As discussed above, this postulate, a modification of the principle of causality, is consistent with the basic assumption of the hypothesis.

This postulate is less restrictive than the common principle of causality, which is applicable to events in all frames of reference. Therefore, the addition of this postulate does not limit, but expands the hypothesis, as compared to SR.

Postulate 4: when the relative speed of inertial reference frames approaches zero, the difference between the application of the principle of causality only to events considered in same reference frame and the application of the principle of causality to events in all reference frames should also approach zero.

The consequence of the postulate is that sets containing events from different inertial frames of reference should converge if the relative speed of frames of reference approaches zero.

The degree to which this postulate is needed is not entirely clear. The way this requirement arises has already been shown. Therefore, we can state that this statement is a consequence of human existence.

Also, a consequence of this postulate is that informational isolation is not absolute within the framework of the hypothesis under consideration. This postulate imposes a restriction on the degree of isolation of reference systems.

7. Principle of causality and events from the viewpoint of observer

As already discussed, an observer can observe phenomena and events only in the inertial frame of reference against which they are motionless.

According to the third postulate of the hypothesis, the principle of causality is applicable to events within same inertial frame of reference. Can a set of events in a frame of reference contain an event that follow from a not existing event? Obviously, this contradicts the principle of causality and the third postulate of the hypothesis. This means that the frame of reference cannot contain information on the events that did not occur in it.

The observer can observe phenomena only in the frame of reference against which they are motionless. The information available to the observer is limited by the information existing in this frame of reference. The frame of reference contains information only on those events that occurred in it. The observer can change the velocity and switch between frames of reference. Each time the information available to the observer will change so that the principle of causality is fulfilled in accordance with the third postulate of the hypothesis. The observer cannot notice that events in different frames of reference vary, because this would mean that the frame of reference of the observer contains information on the events that did not occur in this frame of reference. Therefore, events remain the same in all frames of reference from the viewpoint of observer.

This is one of the key consequences of the hypothesis, which will be further used to derive SR as a special case of the hypothesis.

8. Possibilities for hypothesis testing

The above conclusion that events in all frames of reference are the same from the viewpoint of observer, excludes the possibility for direct testing of the hypothesis, comparing events in different frames of reference.

Only indirect comparison methods remain available. These methods are based on physical theories that expect the same events in all frames of reference. If a collision of a pair of particles occurs in a frame of reference, modern physical theories expect that such a collision occurs in all frames of reference. The basic theory describing space-time transformations is Einstein's special theory of relativity. This theory is well tested. If it is possible to derive the special theory of relativity from this hypothesis without making any changes to the SR equations, this method of indirect comparison is inapplicable.

9. Types of space-time transformations and events

Two types of transformations of space-time and fields can be distinguished within the framework of the hypothesis under consideration.

The transformations of space-time and fields of the first type are based on the fields observed in different inertial frames of reference by observers motionless with respect to the corresponding inertial frames of reference.

The transformations of space-time and fields of the second type are transformations of space-time and fields from the viewpoint of observer. An observer can remain motionless with respect to one of the inertial frames of reference, they can change their velocity, but the events in all frames of reference will look the same for the observer according to the result above.

Let us consider these types of transformations and their differences in more detail.

First, consider the transformation of space-time and events from the viewpoint of observer. An observer can observe phenomena only in that inertial frame of reference against which they are motionless. All information on the events in other inertial frames of reference is indirect, and is reconstructed on the basis of observations in the observer's frame of reference. The observer observes phenomena, and based on the results of these observations, makes assumptions on the transformation of space-time. The observer can notice that all the physical laws are always the same for them according to their observations. Also, the observer can notice that the speed of light, when observed in their frame of reference, remains the same, even when they change their velocity and move to another frame of reference. The observer also sees that the events that they observe in one frame of reference also occur in other frames of reference. From this, the observer can conclude that if an event occurs in one frame of reference, it occurs in any other frame of reference. Hence the conclusion that a physical body exists in all frames of reference. Based on such observations and conclusions resulting from them, it is possible to construct transformations of space-time, fields and the corresponding theory. Let us name this type of transformation observable transformations of space-time and fields.

The second type of transformation of space-time and fields is transformation of space-time and fields based on the fields observed in different inertial frames of reference by observers remaining motionless with respect to the corresponding inertial frames. Due to informational isolation, observers are unable to obtain information on the events located in inertial frames of reference, moving with respect to them, and compare them directly. Let us name this type of transformations direct transformations of space-time-fields.

Having started considering the requirements that must be satisfied by transformations of space-time and fields, we obtained the following requirements for transformations:

1. Transformations of space, time and fields must be non-covariant with respect to the SR transformations.
2. Transformations of space, time and fields must be covariant with respect to the SR transformations.

We can now explain how the hypothesis simultaneously fulfills both conditions. Direct transformations of space-time and fields describe transformations that satisfy the first condition.

Transformations of space-time and fields from the viewpoint of observer should describe transformations that satisfy the second condition. Let us prove that they satisfy the SR.

10. Special theory of relativity as a special case

As noted above, when constructing this hypothesis, one of the tasks was to obtain the special theory of relativity without making any changes to the SR equations. It was found that this hypothesis gives rise to two types of transformations, transformations of space-time-fields from the viewpoint of observer, and direct transformations of space-time-fields.

Let us verify whether the special theory of relativity, taken together with the corresponding field transformations, is transformations of space-time-fields from the viewpoint of observer.

Let us list the conditions under which it will be possible to assert this univocally:

1. Equality of events in all frames of reference, from the viewpoint of observer
2. The principle of causality connects events in all frames of reference, from the viewpoint of observer
3. Physical laws are the identical in all frames of reference, from the viewpoint of observer
4. The speed of light in vacuum is the same in all frames of reference, from the viewpoint of observer

It can be easily seen that if we remove the addition "from the viewpoint of observer," the conditions listed above describe the explicit and implicit postulates of the special theory of relativity.

It was found above that events in all frames of reference are the same from the viewpoint of observer. Thus, the first condition is satisfied.

If the events are the same in all frames of reference from the viewpoint of observer, the principle of causality is also fulfilled for all frames of reference from the viewpoint of observer.

Conditions 3 and 4 are satisfied, since they are postulates of this hypothesis, postulates 1 and 2. Moreover, the postulates impose stricter restrictions than those from the viewpoint of observer only.

Therefore, we conclude that the special theory of relativity was obtained as a special case of space-time transformations within the framework of this hypothesis, and these space-time transformations are transformations from the viewpoint of observer. In this case, the SR equations required no changes.

SR transformations, space-time transformations, can be separated from field transformations since they can be obtained without considering the fields properties.

In this case, field transformations must be covariant with respect to the SR transformations. Space-time SR transformations and corresponding fields transformations form transformations of space-time and fields from the viewpoint of observer.

11. Transformations where the relative speed of frames of reference approaches zero

Let us consider the behavior of both types of transformations of space-time and fields when the relative speed of inertial frames of reference approaches zero.

When the relative speed of frames of reference approaches zero as per postulate 4, the difference in events should disappear. It appears that direct transformations of space-time and fields should become transformations where events are the same across all frames of reference. Transformations from the viewpoint of observer are such transformations where events are the same across all frames of reference. They correspond to the same postulates as direct transformations do, differing only in the fact that they are constructed based on the assumption that the principle of causality is correct for all frames of reference. Consequently, when the relative speed of reference frames approaches zero, direct transformations of space-time and fields should transform into transformations of space-time and fields from the viewpoint of observer, SR transformations and corresponding transformations of fields.

Despite the fact that we cannot obtain the very form of direct transformations without a more fundamental theory, we have obtained a limitation of their possible form.

12. Conclusions

An attempt to analyze the trend in changing views on the nature of space-time led to the emergence of a hypothesis that a physical body can vary significantly across different inertial frames of reference. At a first glance, this hypothesis contradicts observations. However, the analysis shows that this hypothesis does not contradict the observed similarity of physical bodies across all frames of reference.

The hypothesis indicates the possible existence of an entity, which is more fundamental than space, time and fields.

The hypothesis implies that there are two types of transformations of space-time-fields. The first type is direct transformations of space-time-fields. The second type is transformations from the viewpoint of observer.

One of the key results of the hypothesis is reaching the conclusion that events in different frames of reference seem the same from the viewpoint of observer, even if an actual difference in events is present.

Based on the postulates of the hypothesis, the special theory of relativity was obtained, as a transformation of space-time from the viewpoint of observer. No changes to the SR equations were required.

The exact form of direct transformation of space-time-fields within the framework of this hypothesis is impossible to obtain since it requires a deeper theory.

It follows from the fact that all modern physical theories imply the existence of a physical body in all frames of reference that they cannot be fundamental. They can consider phenomena from the viewpoint of observer, as shown for SR, but they do not consider phenomena taking into account the difference in events between the frames of reference. This means that if this hypothesis is correct, the existing theories must be replaced with more accurate ones, taking into account direct transformations of space-time-fields.

We can consider the solution of the problem of a particle possessing the energy sufficient to form a black hole [2], based on the assumption that a physical body in different inertial frames of reference can vary if the frames of reference have a nonzero relative velocity, as an example where the use of this hypothesis makes it possible to solve physics problems. If such a difference in different frames of reference exist, this may present a solution to the problem described - a black hole can be observed in one frame of reference, and be absent in another.

Finding the solution to many open problems in physics, such as the unification of gravity and quantum physics, may be impossible if we refuse to abandon the assumption that the principle of causality applies to events in all frames of reference.

Symmetry to SR transformations is one of the symmetries of the Standard Model. We have shown that SR transformations can be obtained as transformations from the viewpoint of observer. This allows us to pose the question: Are the other symmetries of the Standard Model fundamental symmetries, or symmetries from the viewpoint of observer?

References

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2. Hawking, Stephen W. (1971). "Gravitationally collapsed objects of very low mass". Monthly Notices of the Royal Astronomical Society. 152: 75.