Space-Time Transformations in the Presence of Information Isolation

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Abstract

A hypothesis that the principle of causality is applicable to events in the same inertial frame of reference only has been considered. This means that if two events are causally related in one inertial frame of reference, they may not be causally related in another inertial frame of reference. Moreover, an event that takes place in one inertial frame of reference may not exist in another inertial frame of reference. As a result, informational isolation of inertial frames of reference arises. It has been shown that within the framework of this hypothesis events, from the point of view of observer, are identical in all frames of references, 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 the events described by the principle of causality are identical in all inertial frames of reference. For a system of several events, space-time relations may change when switching between frames of reference, i.e., the distance. It is generally accepted that the events themselves exist in all frames of reference. But what if they don't?

Let us assume that the principle of causality is applicable only to events in the same inertial frame of reference. This is the basic assumption of this hypothesis.

We will show later that this assumption leads to the fact that if in one inertial frame of reference two events are connected by causal relationship, they may not be causally related in another inertial frame of reference. Moreover, an event that takes place in one inertial frame of reference may not exist in another inertial frame of reference.

Let us consider whether the assumption of the hypothesis contradicts existing widely accepted theories in physics and observations.

Obviously, the hypothesis could be directly tested if it was possible to compare events 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 events exist in all inertial frames of reference, and the principle of causality is applicable to events in all frames of reference. If this is not the case, 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 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 this hypothesis. 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.

Physical systems and their dynamics are described by fields. What we are saying is that the properties of events can vary in different inertial frames of reference. This entails a corresponding fields transformation.
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 much deeper theory.
It may seem that it is impossible to combine the SR equations, where fields have invariants during the transition between frames of reference, and different events in different inertial frames of reference as a consequence of the assumption of the hypothesis. 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 events from the viewpoint of observer. It will be shown that, despite the significant differences of events in different inertial systems, the events in all frames of reference coincide 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.
We do not consider phenomena in the accelerated frames of reference, since they are not relevant to the hypothesis. The hypothesis considers phenomena only in the inertial frames of reference. We do not consider various phenomena caused by quantum fluctuations, since they are not relevant to the hypothesis.

2. Events and basic assumption of the hypothesis

The basic assumption of the hypothesis is that the principle of causality is applicable only to events in the same inertial frame of reference. The question may arise what an event is. It should be noted here that the definition of an event in the principle of causality is rather vague. Probably, the concept of interaction of some physical bodies (for example, the interaction of elementary particles) is the closest to the definition of an event in the principle of causality. The definitions of an event in the principle of causality and in the special theory of relativity differ significantly, since in SR event is actually a point in space-time.
In order to make the main idea of the hypothesis very clear, we shall present several equivalent formulations of the basic assumption of the hypothesis. It can be noted that from any such formulation another equivalent formulation can be obtained.
The first such formulation is as follows: a physical body can vary significantly across different inertial frames of reference. 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 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. Obviously, such a formulation is equivalent to the basic assumption of the hypothesis. If every physical body existed in all frames of reference, it would be involved in the same interactions in all frames of reference. This means that the events would be the same, which contradicts the basic assumption of the hypothesis. At the same time, we are not saying that the significant difference of the physical body is limited to elementary particles only. With a sufficiently big difference in events, the Moon can exist in one frame of reference and be absent in another.
Another formulation: cause-and-effect relationships in different inertial frames of reference may differ. It is clear that if the events differ, then the cause-and-effect relationships, in which these events are involved, are also different. If cause-and-effect relationships are different, it is not quite clear how events can be the same in all frames of reference.

3. Some explanations

This article contains only a few references. The latest referenced paper was published approximately 50 years ago. Therefore, it can be difficult to understand the context of this work. Discussion of the ideas of this hypothesis in the process of working on the hypothesis also showed the need for description of the context and some additional explanations.

First, a few words about references to the literature. This hypothesis is completely original. According to the search, the idea of this hypothesis has never been discussed neither in scientific literature, nor in publications on philosophy. The principle of causality in all the analyzed literature is described as something rigid and deeply fundamental. Therefore, there is no relevant literature to refer to.

The idea of this hypothesis arose when considering the question of how to build up a theory based on fields in physics that would be non-covariant to the SR transformations and at the same time non-contradictory to SR. It may seem that the answer to this question lies in the question itself, and the answer is that it is impossible. It seems impossible, because it is probably impossible to simultaneously satisfy two mutually exclusive requirements. The requirement not to conflict with SR means that the fields should be covariant with respect to the SR transformations. And at the same time, we consider fields that are non-covariant with respect to the SR transformations. Perhaps this is the reason why the ideas of this hypothesis have never been considered before - such an opportunity was dismissed at the stage of formulating the question. Another possible reason is that there is no easy solution to the described contradiction. In order to resolve it, the principle of causality had to be modified.

In this article there is not a single equation of quantum physics, and no quantum phenomena are considered. We consider the principles that must be satisfied by field equations, including quantum fields. This hypothesis should also be applicable to gravity and GR equations, although the issue of compatibility of GR and the hypothesis is not considered in this paper. When considering, there is no need to use the equations of quantum physics. The hypothesis is a generalization of SR. When deriving SR, the equations of quantum physics and the like are not needed, it is enough to consider the postulates of SR. This hypothesis differs from SR in that two additional postulates are added to the SR postulates. One of the additional postulates has already been mentioned – it is the basic assumption of the hypothesis. It will be shown later that this postulate is not enough, and one more postulate is needed for the theory to correspond with the observations. Usually, adding postulates to a theory imposes some additional restrictions on it. We will add such postulates to SR that will make the hypothesis more general than SR.

This hypothesis belongs to theories outside the Standard Model because the phenomena it predicts are unlikely to have any meaning for relatively low energies. As will be shown below, the hypothesis implies two types of transformations of space-time and fields. The first type is transformations from the viewpoint of observer, and these are SR transformations. The second type is transformations of a new type - direct transformations. If the hypothesis is correct, then the unified field theory should correspond to the transformations of this hypothesis.

The word “observer” was mentioned above. As noted, upon seeing this word, many readers immediately come to a conclusion that this article deals quantum fluctuations. No, quantum fluctuations are not considered here. Let us give the following definition of an observer, which will be used later in this article: it is a rational person, a physicist who perceives the world through his sense organs and tries to describe the world based on his observations. Yes, this is somewhat different from the typical definition, but this means that a lot of unnecessary text won’t be written each time an observer is mentioned.

4. Transformations of space-time and fields

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

Let us consider the requirements imposed by the basic assumption of the hypothesis on the transformations of space-time and fields. Since the principle of causality is applicable only to events in the same frame of reference, the fact that some events occurred in one frame of reference does not infer that these events occurred in some other frame of reference. It turns out that an event can exist in one frame of reference and not exist in another, or vice versa. It follows from the fact that an event 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 events are the same 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 paragraph are transformations of space-time and fields from the viewpoint of observer. The first paragraph 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, how can physical fields 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 frames of reference, as events can be different. Physical fields cannot have properties that are identical in all frames of reference. If such a property exists, this means the presence of some invariant to the SR transformations, which contradicts the condition for the considered type of transformations. Then, obviously, the description of the fields must also indicate the frame of reference. Since we do not yet have a theory that can describe the transformation of fields with different events 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 of reference:

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

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 of reference can be obtained based on the coordinates and values of the fields in the first frame of reference. 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 is 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 frame of reference L based on this entity.

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

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

Can we obtain H' if we know H? If there is A^{-1}, which is inverse operator to A, then:

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

However, 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. 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 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. At the same time, 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 basic assumption of the hypothesis 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 non-surjective or non-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 compare any points of space-time from different frames of reference.

If it is impossible to compare the points of space-time between different 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 compare 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.

5. 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.

Information 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, and, accordingly, the events in which this body participates differ. 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.

6. 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 previous one. In this case, if a person is present in one of the frames of reference, there is no reason for them to find themselves 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 and, accordingly, events can differ in different 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 events in them 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 events 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 events difference approaches zero, the field difference 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 one frame of reference, using the principle of causality to events in all frames of reference, should approach zero. This is another postulate of the hypothesis in addition to the basic assumption.

7. Postulates of the hypothesis

We have considered various consequences of the assumption that the principle of causality applies only to events in the same inertial frame of reference. 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 when the principle of causality is applicable only to events in the same inertial frame of reference. Let us list the postulates of this hypothesis.

Postulate 1 (Einstein's principle of relativity): The laws of nature remain the same in all inertial reference systems moving rectilinearly and uniformly relative to each other.

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 nature, identical from the viewpoint of observer.

According to this formulation, the laws of nature 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 nature in different frames of reference, so that a reasonable observer can 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 nature 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 vacuum is the same in all inertial reference frames in rectilinear and uniform motion with respect to one another.

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.

This postulate is the basic assumption of the hypothesis.

This postulate is less restrictive than the usual principle of causality, which applies to events in all frames of reference. Therefore, the addition of this postulate does not limit, but expands the hypothesis, in comparison with 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 one frame of reference and the application of the principle of causality to events in all frames of reference 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.

8. 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 the same inertial frame of reference. Can a set of events in a frame of reference contain an event that follows from a non-existent 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 he is 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. 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.

9. 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 mainly 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.

One can try to find other ways of indirect testing of the hypothesis. There are several options for indirect testing. One option is to build a theory based on a hypothesis. Then, one could test the predictions of the theory. Another option is to try to find upper and lower bounds on how much events can differ in different inertial frames of reference. It is not entirely clear how exactly this could be done, but some observations can be made. A person changes his speed within a fairly wide range. Moreover, a person exists in all these frames of reference. Using this fact, as well as various models about how events change between inertial frames of reference (by chance or in some other way) it is possible to obtain an upper bound on how much the events differ between inertial frames of reference. This idea of indirect verification is quite easy to find. This may mean that a number of other indirect methods of testing the third postulate of the hypothesis can be found.

A detailed analysis may allow us to find ways to find also the possibilities for testing the lower bound.

10. 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 them 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 his frame of reference, remains the same, even when he changes his velocity and moves 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. Based on this the observer can conclude that if an event occurs in one frame of reference, it occurs in any other frame of reference. Hence it follows that a physical body exists in all frames of reference, the events are the same in all inertial 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 of reference. 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.

11. Special theory of relativity as a special case

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.

12. 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 frames of reference approaches zero, direct transformations of space-time and fields become 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.

13. Fundamental and observable fields

As can be noted, the fields, considered by transformations of space-time-fields from the viewpoint of observer, acquire properties that are absent in the same fields, but considered by direct transformations of space-time fields. We have found that considering fields that lack symmetry to the SR transformations, we get the symmetry to the SR transformations from the viewpoint of observer in these fields. Fields gain new properties. Let us name the fields corresponding to the observed transformations as observable fields. Fields that correspond to direct transformations are fundamental fields. Obviously, observable fields are only a manifestation of fundamental fields.

14. Symmetries of the Standard Model

Symmetry to the SR transformations is one of the symmetries of the Standard Model. We have shown that the SR transformations can be obtained as transformations from the viewpoint of observer. Moreover, it is not required that a fundamental field has this symmetry. This poses the question: Are the rest of the Standard Model symmetries fundamental symmetries or they are symmetries from the viewpoint of observer?

15. Philosophy or science?

A possible objection to this hypothesis is the statement that this hypothesis is not related to science, it is solely philosophy. Let us consider this objection. This hypothesis is an alternative view of how the principle of causality is applied. The established view is that the principle of causality is applicable to events in all inertial frames of reference. All modern physical theories are built in accordance with the established view. The principle of causality has not previously been questioned. The new alternative view proposed by the hypothesis allows building new physical theories and, possibly, solve problems that were previously unsolvable. Physical theories based on this hypothesis can eventually lead to new, experimentally testable predictions. Therefore, this hypothesis is not a philosophy.

Within the framework of the hypothesis a mathematical model has been built up that allows comparison with experimental data. Yes, the formulas are not mathematically detailed. But even in this form all equations of the special theory of relativity were obtained as a special case within the framework of the hypothesis. All the postulates of the special theory of relativity as a special case were gained. The process of derivation of the SR equations is omitted, since their derivation from well-known postulates can be found in many textbooks. So it can be argued that for one of the special cases the hypothesis has a mathematical model that can be compared with experimental data. Weak point of this model is that it describes only a particular case (the equations coincide with the SR equations) and cannot be used to predict new phenomena. And here we return to the consideration of whether the hypothesis can lead to new, experimentally testable predictions.

It can be argued that the hypothesis opens the way to building up a whole class of new theories. These theories can be based on fields that are non-covariant to the SR transformations, and at the same time do not conflict with the SR transformations. It is obvious that a large number of such theories can be built up. The limitation for such theories is the fact that it is necessary to obtain results consistent with the GR, with standard model, or with both theories.

Therefore, in order to assert that this hypothesis cannot lead to experimentally testable results, it is necessary to prove that this entire new class of theories cannot lead to experimentally testable results.

16. Conclusion

The hypothesis that the principle of causality is applicable only to events in the same inertial frame of reference has been considered. This leads to the fact that events in different inertial reference systems may differ. At a first glance, this hypothesis is in contradiction with the observations. However, the analysis shows that this hypothesis does not contradict the observations.

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 an event 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 as an example where the use of this hypothesis makes it possible to solve physics problems [2]. 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.

To test this hypothesis it is necessary to find ways to test the applicability of the principle of causality to events in different inertial frames of reference. Some observations on this topic have been considered. We can see the possibility of how to carry out upper-bound estimation of the difference of events. Further analysis may allow us to find more ways to find the lower-bound estimate.

The main result of this hypothesis in science terms is the possibility of building up new theories based on this hypothesis. Such theories will take into account the postulates of this hypothesis. Without such a hypothesis it was impossible to build up theories with fields that are non-covariant with respect to the SR transformations, without violating SR.

References

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