Transformations of space-time and information barrier

Smirnov A. N.

andreysxxxx@gmail.com

Annotation

A hypothesis that physical fields in different inertial reference frames may differ, whereby the mapping of the states of the fields in one inertial reference frame against the states of the fields in the other inertial reference frame is not mutually identical, has been considered. Within this hypothesis between different inertial reference frames an information barrier arises. This also leads to a need to modify the principle of causality and introduce a weak causal link.

It has been shown that there is no experimental evidence that the transformation of fields in different inertial reference frames is mutually identical.

It has been suggested that the special theory of relativity should be generalized. Generalization is carried out by adding a postulate that the mapping of the states of the fields in one inertial reference frame against the states of the fields in the other inertial reference frame is not mutually identical. In fact, this postulate is a refusal to accept an implicit postulate of the special theory of relativity rather than a new one. Therefore, the number of postulates in the suggested generalization of the special theory of relativity is fewer than in the original one.

When considering the implications of the hypothesis, no contradictions with observations have been found.

Presence of the information barrier is an indication that if the basic assumption of the hypothesis is correct, then some more fundamental structure with space-time and events to be deduced from should exist. Also, if additional assumptions are made, then some local symmetry with all known fundamental fields to be in accord with should exist.

If the hypothesis is correct, then the Lorentz transformations are transformations of space-time only from the perspective of the observer being stationary against some inertial reference frame.

On the basis of the symmetry an attempt to find some fundamental structure of space-time and physical fields may be made. The hypothesis with some further assumptions about the fundamental structure of space-time made may be rebutted if the absence of any existed symmetry of the predicted type is proven. Then it will be an indirect evidence that events in different inertial reference frames coincide.

Introduction

Let us consider an elementary particle which has enough velocity and energy to form a black hole. Such energy is roughly equivalent to the Planck energy [1]. With this energy, the black hole consists only of a single particle. Thus, in the reference frame where a particle has such energy a microscopic black hole should be observed. But in the inertial reference frame where a particle is stationary it has not enough energy in order to remain a black hole. A paradox arises. This paradox shows the limits of the applicability of modern physical theories. It is expected that some new theory will eventually solve this problem.

In attempts to build such theories numerous methods have already been tried. And though it may seem that all possible methods are already known, only some details of these methods are unknown, an attempt to find new ways to solve this paradox may be made.

Let us consider two inertial reference frames moving with some non-zero velocity against each other. May there be some states of some field, for instance, gravitational or electromagnetic, in one reference frame. Knowing the states of the field in one reference frame, may the states of the field in the other reference frame be obtained? The answer to this question seems to be obvious. We take the field equation which should be covariant regarding the Lorentz transformations, move to the other reference frame, obtain a new value of the field.

Let us consider this in detail. There are two inertial reference frames, K и K', having a non-zero velocity v against each other. In each of them there is an observer being stationary against the corresponding reference frame. Observer A is stationary against K, observer A' is stationary against K'. Let us suppose that in the reference frame K, at some point in time t, observer A is observing the field in some states W_1. Transform the field to the expected states W_1' in the reference frame K' at the point in time t' by using Lorentz transformations $L(v)$ for the field:

$$W_1'(t') = L(v)W_1(t)$$

May now observer A', at the corresponding point in time t', be observing the field in some states W_2'. Transform the field to the expected states W_2 in the reference frame K:

$$W_2(t) = L(-v)W_2'(t')$$

Let us ask the following question. Are the following equations carried out:

$$\begin{cases} W_1'(t') = W_2'(t') \\ W_1(t) = W_2(t) \end{cases} \qquad (1)$$

And again the answer seems to be obvious. A may apparently know that A' is observing by having exchanged information with it However, why do we think that the signal which observer A will receive carries the same information that A' has sent, and vice versa? The basic assumption of the hypothesis which is being considered in the article is that both equations in equation 1 are not carried out. It will be shown that such assumption does not contradict the observations, and that the failure in equations 1 is impossible to identify via the information exchange between the observers.

I would like to immediately stress that this hypothesis does not deny the Lorentz transformations. Within this hypothesis, only the interpretation of the Lorentz transformations is questionable. If the assumption described above is correct, it means that the Lorentz transformations are the transformations of the field only from the perspective of the observers' stationary against one of the reference frames.

For brevity, I will further call the difference between the states of the field in the reference frame and the expected states according to Lorentz transformations $W_1'$and W_2' in the example described above, a difference in fields.

If there is a difference in fields in different inertial reference frames, then it can be a solution to the paradox described above - a black hole may be observed in one reference frame, and be missing in the other reference frame.

If there is a difference in fields in different reference frames, then it may also mean that there is some other structure which is more fundamental than space-time and known fundamental fields. In this case, the fields which are now considered to be fundamental are effective fields. In this case, gravitational, electromagnetic, strong, weak interactions are effective fields, rather than fundamental ones. The mathematical structures used to describe space-time, in all their diversity, do not allow the difference in fields described above. It is an indication that if the basic assumption of the hypothesis is correct, then some more fundamental structure with space-time and effective fields to be deduced from should exist. Within this article, no assumptions regarding what kind of structure it is are suggested.

The difference in fields in different inertial reference frames may seem to be contrary to everyday experience and observations. Because if fields in different reference frames differ, then it may probably be evident in numerous experiments. While considering the possibility of differences in fields in different reference frames, it should be explained why it has so far not been discovered in experiments. Assuming that fields in different reference frames may differ, then a question as to how much they may differ arises. Are there any limits on the difference in fields?

Before proceeding any further, I will point out that any observer always observes events only in the reference frame in which the velocity is equal to zero. Neither any device nor human can observe events in the reference frame against which it has a non-zero velocity. An observer can obtain information about what some device, for instance, a satellite observed in the relevant reference frame. However, data from the satellite are observed in the reference frame against which the observer is stationary rather than the one against which the satellite is stationary.

Let us assume that fields in different inertial reference frames having a non-zero velocity against each other are entirely independent. When speeding up or slowing down, we would move to another reference frame where fields would be entirely independent. In this case if there is a human in one of the reference frames, then there are no reasons for him to be in any other reference frame. Therefore, a human could exist only in one reference frame and would disappear when changing his velocity. But it is obviously contrary to everyday experience - when changing the velocity, our consciousness remains uninterrupted and the body continues to exist. This being the case, a limit as to how much fields in different reference frames differ should exist.

Let us assume that if the relative velocity of inertial reference frames against each other tends to zero, the difference in fields between them should also tend to zero. In this case some dependence between fields which are in different inertial reference frames against each other occurs. If the difference in fields between reference frames is small enough, the velocity change by a human will not lead to his disappearance in the reference frame which became his new reference frame with a zero relative velocity. Based on the description above, if the difference in the velocity tends to zero, the difference in fields should also tend to zero.

May in the hypothesis under consideration the fields in one reference frame be calculated on the basis of the fields in the other reference frame, and vice versa? In other words, is the transformation of fields during transition from one inertial reference frame to the other one, surjective, injective or bijective? No reasons for a required availability of a bijective mapping of fields in different reference frames are seen. That's why, in general, the transformation of fields may be neither surjective nor injective. Thereby, it is necessary that after the transformation of fields during transition from one inertial reference frame the reverse transformation should transform the fields to the initial ones.

Let us consider first the possibilities for verification of the basic assumption of the hypothesis. Then we consider some implications of the made assumption regarding the difference in fields in different inertial reference frames, then the postulates of the hypothesis will be written.

Fields in different inertial reference frames

The basic assumption of the hypothesis is an assumption that fields in different inertial reference frames may differ. How is this compatible with observations? Is there any evidence that fields in different inertial reference frames coincide, namely that the equations described above, equation 1, are carried out? Does the basic assumption of the hypothesis contradict any observations? What experiments may explicitly rebut the basic assumption of the hypothesis? Let us consider these questions.

First we consider what experiments may explicitly rebut the basic assumption of the hypothesis. The answer to this question is easy to formulate: these are experiments in which direct comparison of fields in different inertial reference frames occur. It may seem that it is easy to conduct such an experience. Take two devices moving with some velocity against each other, adjust them for recording observations in some identical area of space. Then compare the recordings of the devices taking into consideration Lorentz transformations. We notice that the observations coincide. From here we deduce some limits on the difference in fields in different inertial reference frames.

Further it seems that there is a possibility to rebut the basic assumption of the hypothesis combining the theory and the experiments. From the equations of the general theory of relativity and the quantum field theory an attempt to find a limit on the maximum difference in fields in different inertial reference frames may be made. Both the general theory of relativity and the quantum field theory are well tested. We seek on the basis of the theory in which experiments the best limit on the maximum difference in fields in different inertial reference frames may be obtained. We obtain some limit on the maximum difference in fields in different inertial reference frames. The maximum difference in fields in different inertial reference frames will probably be absolutely minimum.

In all the verification methods described above there is one drawback - none of them involves comparison of fields in different inertial reference frames. They are compared neither directly nor indirectly.

Let us consider the first case with two devices. Two devices are moving against each other with non-zero velocity. May both of the devices measure anything in the common reference frame? Ways of doing that are not seen. Each device makes measurements in the reference frame against which it is stationary. Let us consider a case when devices continuously transmit each other information about observations. The information is encoded as some states of the field. During transmission the transition from one inertial reference frame to the other one, from the reference frame of the transmitting device to the reference frame of the receiving device occurs. Thereby, there is a difference in the states of the fields in different reference frames and, therefore, a difference in information in different reference frames. How is it possible to compare whether the same events were observed in different reference frames? For such a comparison the transition between reference frames should be removed. Let us consider a case when devices first observed something, then recorded the results, then changed the velocity so that their relative velocity became zero. May a comparison of the results be made in order to verify the difference in the results of the observations in inertial different reference frames? In order to do so, it should be verified - whether there is a transition between reference frames. If there is a transition, it means that according to the hypothesis there may be a difference in information in different reference frames and the comparison is incorrect. It is obvious that there is a transition - it occurs during the velocity change.

It turns out that in the experiment described above the results of the observations in different inertial reference frames are not compared. Therefore, it may be concluded - there is no possibility of a direct comparison in different inertial reference frames.

Now we consider a method of comparison involving the theories. There may be noted that in all existing physical theories known to the author there is an implicit postulate that results of observations in different inertial reference frames coincide within the accuracy of the Lorentz transformations. May any limit on the maximum difference in results of observations in inertial reference frames moving with a non-zero velocity against each other on the basis of the existing theories be obtained? Let us take some theory. We make calculations that if there is some difference in events between reference frames, then it may lead to certain effects. Everything is probably obvious, an easy way of verification. However, what will be compared? Some predictions of the theories where there would be no direct or indirect transition between reference frames are needed. And such predictions are not known to the author. There is always either direct or indirect transition between reference frames.
One observer being stationary against one reference frame sends a signal to the other one being stationary against the other reference frame. Reference frames are moving with non-zero velocity against each other. If equations 1 fail to be met, it means that the information sent is subject to changes.
Therefore, it may be concluded that there is no possibility to obtain the upper limit on the difference in fields in different reference frames on the basis of the existing theories.
The only limit on the difference in fields arises from the human existence, as described above. This is a limit on the degree of independence of fields in different reference frames on the basis of a weak anthropic principle.

Information barrier

The absence of mutually identical mapping between sets representing the states of the fields in different inertial reference frames means some isolation of different inertial reference frames. In different inertial reference frames different events may occur. For instance, in one of the reference frames a collision between two electrons involving a photon emission have occurred. But due to the absence of mutually identical mapping, in some reference frames this collision may not occur, in some reference frames there may be no electrons, and in some reference frames there might be, for instance, muons instead of electrons.

Therefore, on the basis of the states of physical fields in one reference frame, it is impossible to define the states of physical fields in other reference frames by using the Lorentz transformations. While sending a signal from one observer to the other, the signal is encoded through the states of the fields. This being the case, it is impossible to define what information will be obtained on the basis of the information transmitted.

May the occurring loss of information be considered as just additional noise? If it may be considered as additional noise then duplication of information in the signal may just be added, and if the level of duplication is sufficient, the information will be transmitted without distortions. However, among the assumptions considered there is no assumption that during the transition between reference frames the states of the fields is randomly changed. That is why, methods of saving information when sending a signal designed for a random noise, are not suitable for testing this hypothesis.

Inability to transmit information without distortions between different inertial reference frames may be called an information barrier.

Postulates of the hypothesis

The hypothesis considered may be considered as generalization of Einstein's special theory of relativity for a case when there is an information barrier between inertial reference frames. We write down postulates of this hypothesis.

Postulate 1 (principle of Einstein's relativity). Laws of nature are identical in all inertial reference frames moving directly and evenly against one another.

Within this hypothesis the postulate could be changed to the following:

The observer during the transition from one inertial reference frame to the other one, always observes physical processes meeting the identical, from the perspective of the observer, laws of nature.

In this formulation laws of nature in different inertial reference frames may differ. Thereby such formulation does not contradict observations for the reasons already described. The information barrier allows to obtain the sameness of laws of nature from the perspective of the observer while having a factual difference between them. In this case an additional limit on the degree of distinction between laws of nature in different reference frames will be required so that a reasonable observer could move between reference frames maintaining his existence and the main part of memory. Such formulation of the postulate leads to a need to somehow harmonize different laws of nature in different reference frames, and it is not clear how this should be done. That is why, although within this hypothesis such formulation looks acceptable, it is not applied.

Postulate 2: The velocity of light in a vacuum is identical in all inertial reference frames moving directly and evenly against one another.

This postulate is closely related to the first one. As is known, the Lorentz-like transformations can be obtained without this postulate [2]. This postulate may be generalized similar to the first one, and for the same reasons the generalized formulation in this hypothesis is not applied.

This postulate is usually formulated as follows: "The velocity of light in a vacuum is identical in all coordinate systems moving directly and evenly against one another". The principle of Einstein's relativity is also usually formulated through coordinate systems. Here the formulation is given through inertial reference frames so that an inertial reference frame could be included into the formulations of all postulates of this hypothesis.

Now we consider new postulates.

Postulate 3: The observers being stationary against inertial reference frames moving with a non-zero velocity against each other may observe significantly different states of physical fields. Thereby the mapping of the states of the fields in different inertial reference frames having a non-zero velocity against each other may be neither bijective nor surjective and nor injective.

A significant difference in the states of fields mentioned in this postulate – is a difference between the states of the fields and the expected one according to the Lorentz transformations.

This postulate is a refusal to accept the existing implicit postulate of the special theory of relativity that events in different reference frames should coincide rather than a new postulate. In the special theory of relativity the simultaneity of events and coordinates of events may change, but the events themselves remain unchanged. For instance, if in one reference frame a collision between a pair of electrons has occurred, then in the special theory of relativity it should occur in all reference frames. This is an implicit postulate of the special theory of relativity. That is why adding this postulate to the hypothesis considered reduces the number of the made assumptions and postulates compared to the special theory of relativity.

Postulate 4: If the relative velocity of inertial reference frames tends to zero, the difference in fields between them should also tend to zero.

To what extent this postulate is needed is not quite clear. It was already shown above how this requirement arises. That is why it may be said that this statement is an implication of a weak anthropic principle.

The implication of the postulate is the sets containing information about the states of the fields from different inertial reference frames should converge if the relative velocity of reference frames tends to zero.

Also, implication of this postulate is that within the hypothesis considered the information barrier is not absolute. The requirement involving convergence of the sets of the fields states when the relative velocity of inertial reference frames tends to zero sets a limit on the isolation degree of reference frames.

Principle of causality

According to the principle of causality, a causal link may be between different events. Is the principle of causality applied to the events that occurred in different inertial reference frames? May the event A, that was observed in one reference frame influence the event B in the other reference frame?

In the hypothesis considered involving an information barrier events in different reference frames have a considerable degree of independence. There is some dependence of events in different reference frames only due to the requirement involving convergence of the sets of events. That is why events A and B may not have a direct causal link.

I will call a potential causal connectivity of events caused by the requirement involving convergence of the sets, a weak causal connectivity. Thereby, the smaller the difference in fields between different reference frames is, the closer the events are connected between themselves in these reference frames. This being the case, it may be spoken about the probability that the event A in one reference frame can influence the event B in the other reference frame. When there is an information barrier, the probability that any event from one reference frame will influence an event in the other reference frame is always lower than 1, if relative velocities of inertial reference frames are non-zero. This upper probability boundary tends to 1 as the difference between fields in reference frames is decreasing which happens when the relative velocity of reference frames is getting lower.

Events observed in different reference frames have a mutual weak causal link. The transition to another reference frame also means the transition to other causal links. This being the case, the information during transition to other reference frame is changed in order to integrate into the causal links of a new reference frame.

It was already mentioned above that information is not changed randomly. Here it has been found by us that it changes in a way that in each inertial reference frame the principle of causality could be implemented.

The described above means a need to introduce an amendment to the principle of causality. Namely, when there is an information barrier, one event may always influence the other only if they are considered in the identical inertial reference frame. In case when both the event occurred in one reference frame and the event occurred in the other reference frame are considered, it may only be spoken about the probability of influence of one event to another.

Dedicated reference frame

Can the observer observe the events occurring in the different reference frame, not the one against which he is stationary? Not a single way how to directly observe events occurring in the reference frame which is moving with a non-zero velocity against the observer is known to the author.

Let us assume that there is a device recording some results of the observation. May this device either have a mapping which shows the results of the observation or transmits the results of its observations some other way. It is obvious that in the hypothesis considered the result the observer will see on the mapping of this device will depend on the observer’s reference frame. Thereby, generally speaking, if the equations 1 fail to be met, the observed device may not be observed in all inertial reference frames moving against the device. It turns out that the observer observes the events occurring in the reference frame against which he is stationary.

Proceeding from this a conclusion may be made that it is impossible for the observer to observe the events occurring in reference frames different from the one against which he is stationary.

It turns out that for each observer there is a dedicated reference frame. This is a reference frame where the observer is stationary. Numerous observers being stationary against one another have an identical dedicated reference frame as there is no information barrier between them.

A dedicated character of this reference frame lies in the fact that this is the only reference frame where events may directly be observed. About the events occurring in other reference frames a reasonable observer may only make a guess on the basis of observations within his dedicated reference frame.

Change of observer's frame of reference

The observer may accelerate, and then his frame of reference may change. What will then happen to the information available to him?

It is obvious that it will change in accordance with the rules of transformation of space-time and fields. The smaller the change of space-time, in accordance with the requirement involving the convergence of sets is, the smaller the information change is. All information, including the one about the past events, is changed.

Information exchange between observers

May there be two reasonable observers A and B. They are stationary against each other and their rest frame coincides. They have decided to observe some area of space. That being the case, the observer A will remain stationery, the observer B will accelerate to some velocity against A. After that, both observers will observe the agreed area within the agreed period of time, write down the results. Then, by using signals they will exchange information about the results of the observation. After that, the observer B will change its velocity in order to become stationery against observer A. And they will again exchange information about the results of the observation.

Let us consider this situation in detail.

As soon as the rest frames of both observers coincide, there is no information barrier.

Then the observer B changes its velocity. His rest frame changes. Let us consider a case when changes during transformation of space-time to a new rest reference frame are not too big so that the observer after the change of velocity could not cease its existence. The observer during the transition to a new reference frame has a change of causal links including memory about the past, his information about what should be observed and where it should be done is also subject to a change.

Then, after the observation the observer B sends a signal with the results of the observation and receives a signal with the results of the observation from A. During the exchange of signals there is an information barrier. Everything that A receives should fit into causal links in his reference frame. Similarly for B. May B, in his rest frame, observe something that does not fit into causal links in rest frame A. He sends a signal with such information. A, in his rest frame, receives this signal after the transformation of space-time and the transformation of fields. These transformations change the signal to the one which is integrated into the causal links of rest frame A. As a result, A will not obtain information about any failure of causal links, an information barrier is in effect. Similarly for B.

Then B changes its velocity so that his rest frame begins to coincide with rest frame A. And again the transformation of space-time and fields occurs with a change of memories for B about the past. This transformation also applies to his notes if they are available. After reference frames A and B coincide, an exchange of information will occur without an information barrier. But by this moment, memory B after the transformation of space-time will have been in accord with causal links of the new rest frame. Thereby, during an exchange of information no discrepancies which are not fitting into causal links should occur.

Based on the described above, no ways how to directly verify the compliance of events in different inertial reference frames are shown. Any direct comparison of events, as can be seen, should show their unity in different reference frames.

Observations

According to the described above, on the basis of observations in some reference frame, it is impossible to say exactly what events will be in other reference frames.

It means that any observation, any experiment gives results specific for the reference frame in which observation is made. Two different observers which are in different reference frames may see different results of the same experiment.

Types of transformations of space-time and fields

Within the hypothesis considered two types of transformations of space-time and fields can be distinguished. The first type of transformations, these are transformations of space-time and fields from the perspective of the observer, stationary against one of inertial reference frames. The second type, these are transformations of space-time and fields on the basis on the states of the fields observed in different inertial reference frames by observers being stationary against relevant inertial reference frames. Let us consider these types of transformations and the differences between them in greater detail.

First we consider transformations of space-time and fields from the perspective of the observer being stationary against one of inertial reference frames. The observer may observe only in the reference frame against which he is stationary. All information about events in other inertial reference frames is indirect, and restored on the basis of observations in the dedicated reference frame. The observer observes and on the basis of the results of his observations makes assumptions as to what transformations of space-time should occur. The observer may notice that all physical laws for an observer, according to his observations, are always the same. Also the observer may notice that the velocity of light during the observation in his dedicated reference frame even when he changes the velocity and moves to other reference frame is always the same. The observer also sees that the events which he observes in one reference frame occur in other reference frames. Based on this observation transformations of space-time and a corresponding theory may be built. The special theory of relativity is exactly such a theory as during an exchange of information between observers no information barrier is involved in it. I will call this type of transformations the observed transformations of space-time. Within the hypothesis considered, transformations of the special theory of relativity are the observed transformations of space-time.

The second type of transformations of space-time and fields, these are transformations of space-time and fields on the basis of the states of the fields observed in different inertial reference frames by observers being stationary against the corresponding inertial reference frames. Due to an information barrier, it is impossible for observers to obtain information about the states of the fields which are in inertial reference frames moving against them, and to compare directly these states. I will call this type of transformations the observed transformations of space-time-fields.

If there is space-time, invariant against the first type of transformations, then it is also obviously invariant against the second type of transformations if in transformations of space-time-fields there is no failure of equation 1. But if there is a failure of equations 1, it is obvious that space-time may not be invariant against both types of transformations. Here some structure more fundamental than space-time is needed so that there could be a difference in fields in different inertial reference frames.

Let us assume that there is some structure invariant against the second type of transformations. This structure as considered above cannot be space-time, it is more fundamental. Then, the Lorentz transformations cannot be applied to this structure as the Lorentz transformations – the transformations of space-time. It turns out that first some operator to the fundamental structure is applied. On the basis of the results space-time and fields are obtained in the needed inertial reference frame. In order to obtain space-time and fields in other reference frame a corresponding operator to the fundamental structure is applied, space-time and fields are obtained. In this case the information barrier conceals from observers a factual difference in fields in different inertial reference frames. Later transformations of this type will be considered in detail.

Gravity and transformations of space-time-fields

Are the conclusions based on such consideration applied to gravity?

The general theory of relativity is based on space-time. If space-time is not fundamental, some structure is more fundamental, so this also applies to the curved space-time and gravity. That is why implications of the considered hypothesis are also applicable to gravity.

Transformations of space-time-and fields

Unlike the special theory of relativity, transformations based on this hypothesis, transformations of the second type, change not only space-time coordinates but also fields. It is obvious that if there is no information barrier, when events in different inertial reference frames coincide, these transformations also coincide.

May H is a set consisting of coordinates and values of fields at some point in time t in inertial reference frame L. May there be some fundamental structure, more fundamental than space-time. Let us assume that H may be obtained by using the following equation:

$$H = AQ \tag{2}$$

Here Q represents a fundamental structure with unknown properties, A is the operator allowing to obtain from this structure space and states of fields for inertial reference frame L at the point in time t.

May H' is a set consisting of coordinates and values of fields at some point in time t' in inertial reference frame L'. Then

$$H' = A'Q$$

Knowing H may H' be obtained? If there is A^{-1}, the reverse operator to A, then:

$$H' = A'A^{-1}H$$

However, the existence of the reverse operator does not proceed from anywhere. Within the hypothesis considered there no obvious reasons why the reverse operator should always exist.

If the reverse operator does not exist, it means that having all information about the fields in one reference frame it is impossible to explicitly calculate the states of the fields in the other inertial reference frame.

It also follows from this that it is impossible to calculate values of fields at the point (x', t') in the inertial reference frame L' knowing states of fields at the point (x, t) of the inertial reference frame L. It is easy to notice that if it is possible, it would mean the existence of the operator A^{-1}.

Try to find the answer to the following question: to which point (x', t') in the inertial reference frame L' applies the point (x, t) in the inertial reference frame L ?

May R is a set of all points belonging to space of the inertial reference frame L at the point in time t. May B be an operator allowing from fundamental structure to obtain space for the inertial reference frame L at the point in time t:

$$R = BQ$$

For inertial reference frame L' we obtain:

$$R' = B'Q$$

Then:

$$R' = BB^{-1}R$$

Where B^{-1} is an operator reverse to B, R' is a set of all points belonging to space of the inertial reference frame L' at the point in time t'. For the same reasons as before there no reasons to demand that the operator B^{-1} exists. This leads to inability of direct comparison of two points of space-time belonging to different inertial reference frames. Only one indirect way remains – to make such a comparison so that a difference in fields was minimal to implement the fourth postulate of the hypothesis. That is why I call this transformation the transformation of space-time-fields.

It is impossible to write something more detailed about equation 2 and connected equations. It is even impossible to enumerate all parameters the operator A depends on. For a detailed description of the equation a more fundamental theory describing the fundamental structure the signs of which are shown in this hypothesis is needed.

Fundamental structure

Let us assume that the hypothesis considered is correct, and there is a significant difference in fields between different inertial reference frames. In this case it can be stated that there is some structure more fundamental than space-time. This structure should be more fundamental than space-time because the used mathematical structures of space-time do not allow a difference in events between different reference frames. As the known physical fields are defined on space-time, and space-time is not fundamental, then the known physical fields cannot be fundamental. Thereby, this fundamental structure should be fundamental not only for space-time, but also for physical fields. I will call this fundamental structure of the space-time fundamental structure.

What else can be said about this fundamental structure?

Equation 2, although the operator A in it is unknown, sets a number of limits on the possible space-time fundamental structure. The search for a fundamental structure may be limited to finding all possible structures that satisfy equation 2 and on their basis to somehow choose the appropriate one. Minkowski space with certain fields on it cannot be the space-time fundamental structure because a difference of events in different reference frames is impossible in it. Perhaps, a part of this fundamental structure is some space different from Minkowski space. But an option that this space-time fundamental structure is based on something more unusual than a topological space cannot be excluded.

All known fundamental interactions are invariant against the Lorentz transformations. If the Lorentz transformations are only the observed transformations of space-time, in the meaning described above, and they differ from transformations of space-time-fields, then all fields invariant against the Lorentz transformations and not invariant against transformations of space-time-fields cannot be fundamental. This is an additional argument to the fact that if space-time is not fundamental, then no fields defined on space-time can be fundamental. It turns out that all four fields considered as fundamental should be deduced from a fundamental structure. If during the transition from one reference frame to the other, a fundamental structure has some invariants, then these invariants should be in the observed fields, in the fundamental structure.

For a common case, not making any additional assumptions about a fundamental structure, finding invariants in a fundamental structure is problematic. Let us assume that a fundamental structure is some manifold with a some field on it without time and dynamics. May the field be the one where its value at each point is determined by the values of the fields at surrounding points. As the fundamental structure has neither time nor dynamics, then this field as a part of the fundamental structure has no dynamics either. May the connection between space-time and the fundamental structure be the one where the transition to other reference frame is aligned with a turn in a topological space of the fundamental structure, and whereby each point of space-time in an inertial reference frame is aligned with some point of the fundamental variety. In this case, if a transition between inertial reference frames at some point of space-time is made, some local symmetry should appear.

Indeed, we make a turn at some point of the fundamental structure. That being the case, this point is mapped at some points of space-time in different inertial reference frames. The point in space-time, according to the assumption described above, also remains unchanged. The value of the field in the fundamental structure also remains unchanged. Then it means that there is a local symmetry. That being the case, the symmetry is hidden – only the value of the field is unchanged, while the derivative effective fields may change. So, in this model, only effective fields may be observed, the symmetry becomes hidden.

May a fundamental structure contain some physical field, as was described above. There are no reasons to state that this fundamental field will be aligned with only one observed effective field. Perhaps, this field will turn into some observed effective fields. In any case, this leads to occurrence of a local symmetry within effective fields, a symmetry to transformations of space-time-fields. This symmetry may be hidden because the information barrier conceals the difference in fields in different inertial reference frames. Each fundamental field which is a part of a fundamental structure may be aligned with a set of observed effective fields defined on space-time which correspond to it. Not every effective field but a set of effective fields corresponding to one fundamental field should have the symmetry predicted by this hypothesis under the described additional assumptions. As space-time should be deduced from a fundamental structure, then space-time should also participate in a hidden symmetry. As there are only 4 observed fields, gravitational, electromagnetic, weak, strong, then there may be no more than four fundamental fields.

It can be expected that transformations within a fundamental structure corresponding to the transition from one inertial reference frame to the other one are continuous. Then the corresponding local symmetry group is also continuous.

We try to define the properties of the predicted symmetry more precisely. Space-time is not fundamental; it is somehow deduced from a fundamental structure. Strong, weak and electromagnetic fields are defined on space-time. A gravitational field is an implication of a curved space-time. This leads to the conclusion that gravity equations should have the predicted symmetry. If within a fundamental structure only one fundamental field is defined, then the predicted symmetry should be possessed by a set of all the remaining three fields.

Hypothesis verification options

Perhaps, this hypothesis may be verified in general, without additional assumptions about a fundamental structure. However, the verification of this option requires additional research. The example given with the additional assumptions shows that in individual specific cases the hypothesis may be verified.

As was shown above, if the hypothesis considered is correct, and the additional assumptions made about the fundamental structure are also correct, then physical fields along with space-time should have some local symmetry, probably a hidden one. The symmetry may be unavailable on the level of some field, and be shown on the level of a set of fields and space-time.

Within this article there no predictions regarding the type of this symmetry. All structures which may be a fundamental structure in which the Lorentz transformation on the level of space-time occurs with a possibility for a difference in fields in different inertial reference frames may be found. The transition from one inertial reference frame to the other one on the level of a fundamental system should be aligned with some transformation. It can be expected that the fundamental system is invariant against such transformation. This invariance means some new local symmetry predicted by this hypothesis for the fundamental system considered. As was already said, this symmetry may be hidden. Further we verify whether this symmetry is available in the known physical fields and space-time. If it is available, and if such symmetry occurs only in one of the possible fundamental structures, then it means that the fundamental structure of space-time and fields has been found.

Another approach is also possible – to search for hidden local symmetries in the existing fields which occur only if there is an information barrier. If such symmetry is found, it will mean that a part of properties of the fundamental structure is found. This symmetry should be the one which is possessed by all observed physical fields. Whereby, invariance under the Lorentz transformations is not suitable as this common symmetry group, for the reasons described above.

If the fact that there is no symmetry of such type in fields and space-time may be proven, then it will mean the rebuttal of this hypothesis for the additional assumptions made and an indirect proof that events in all reference frames coincide.

Conclusion

A way to solve the paradox with a particle with the Planck energy on the basis of the assumption that the states of physical fields at some point of space-time of one inertial reference frame is impossible to define by the states of the fields at the corresponding point of space-time of the other inertial reference frame if the reference frames have a non-zero velocity has been considered.
If there is such a difference in fields in different reference frames, then it may be a solution to the described paradox – a black hole may be observed in one reference frame and be unavailable in the other.
It was shown that there is no experimental evidence that in different inertial reference frames the results of the observations coincide.
The space-time structure involving availability of a difference in fields in different inertial reference frames has been considered. A case when the difference in fields and the difference in velocities of inertial reference frames tend to zero has been considered. Within this hypothesis between reference frames an information barrier occurs. Also it leads to a need to modify the principle of causality and to introduce a week causal link.

It has been suggested that the special theory of relativity should be generalized for the case when there are differences in events in different inertial reference frames.

When considering the implications of the hypothesis, no contradictions with observations have been found.

Presence of the information barrier is an indication that if the basic assumption of the hypothesis is correct, then some more fundamental structure with space-time and events to be deduced from should exist. Also additional assumptions about the fundamental structure involving the existence of a local symmetry which all known fundamental fields should meet, including gravity, have been provided.
Symmetry can be hidden by the information barrier.

If the hypothesis is correct, then the Lorentz transformations are transformations of space-time only from the perspective of the observer stationary against some reference frame.

The hypothesis predicts a new local symmetry under some additional assumptions. On the basis of the symmetry an attempt to find some fundamental structure of space-time and physical fields may be made. The hypothesis with some further assumptions made may be rebutted if the absence of any existed symmetry of the predicted type is proven. Then it will be an indirect evidence that events in different inertial reference frames coincide.

References

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