Deriving space-time in four-dimensional Euclidean space with no time and dynamics

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Abstract

The hypothesis, allowing deriving a space-time with a Minkowski space metrics on Euclidean space with no time and dynamics is suggested. This is a fundamental novelty, to the best of the author's knowledge, such an opportunity has never been considered before. This hypothesis also allows deriving the curved space-time with a metrics of the general theory of relativity. It was demonstrated that the principle of causality and the anthropic principle arise from the hypothesis. It was demonstrated that the strong principle of equivalence of gravitation and acceleration arises from the hypothesis. All principles and postulates, on which special and general theories of relativity are based are being derived, Lorentz transformations and the general theory of relativity equations were derived. It has been demonstrated that the principle of locality arises in such a hypothesis.

Introduction

There are two principal models of the nature at current time. The first model tries to use aether, the second model is based on physical vacuum and relativity. Aether theories have many problems, which seem unresolvable. This means that, in fact, there is only one main opportunity for derivation of theories. Is it possible to derive an entirely new model of the nature, different from the first two? Hypothesis with such model is offered in this article.

Is it possible to derive a hypersurface with a Lorentz space metrics in Euclidean space? As S.Hawking, J. Ellis [1, p 55] show, in Euclidean space, it is impossible to derive the enclosed hypersurface with both a Minkowski space-time metrics and in metrics of a general theory of relativity.

The demonstration of impossibility to derive the enclosed hypersurface with a special theory of relativity metrics in Euclidean space appears convincing, seems like it cannot be disproved. Any demonstration is based on some provisions, which are considered as true. If there is any possibility to call into question any of these provisions, then all conclusions, dependent on such provision, also become doubtful. The provision questioned in this article is realism.

Time participates both in a Minkowski space-time metrics and in metrics of a general theory of relativity. Therefore, before considering the offered hypothesis, let's consider what the time is.

Time is the phenomenon the effects of which we constantly observe. The physics still does not know the nature of time, the existing description of time and its properties is phenomenological. Special and general theories of relativity have established dependence between time, space and gravitation. It shows that time is not the independent phenomenon, and has the connection with space and matter causing gravitation. The physics has established the properties of time. However, there is no knowledge why there is time, why time is unidirectional, whether there are time quanta, why time has one dimension and whether it is possible to travel to the past.

Whether the space, time, matter and fields exist independently or are the manifestation of something more fundamental?

Let's assume that at the fundamental level time does not exist at all. Let's consider the arising consequences of this assumption

If at the fundamental level time does not exist, then there has to be no dynamics. Options when there is dynamics at the fundamental level, and time is emergent at the macro-level, are difficult to call model with no time. More likely, such models can be called models with a numerous of times at the micro-level.

With absence of time and dynamics at the fundamental level, the question now arises of how to coordinate it with dynamics and time observed in the nature.

Model of Hypothesis

Let us assume that there is a four-dimensional Euclidean space with some fields, defined on this space at each point. There is no time or dynamics. Thereby, the fields also have no dynamics. It also means full determinism. I will call these fields fundamental ones. I suppose that the fundamental fields are smooth and are described by certain partial differential equations. Each of the fundamental fields is independent of other fundamental fields. This means that there are no other fields in the equations describing any fundamental field. I think that fundamental fields the values belong to the set of real numbers at each point.

Let us assume that in this space, we can build a series of non-crossing hypersurfaces, on which fundamental fields have some values at each point, and some additional conditions are satisfied. Namely, let us assume that the projections of fundamental fields can be divided into several components. Each of these components is an effective field in this series of hypersurfaces. Also, let us assume there is a continuous transformation of the effective fields Ψ state on one hypersurface of L series to the effective fields state on another hypersurface L' of the same series.

Each point on one hypersurface is mapped to some point on other hypersurface. As the transformation is continuous, there is a curve consisting of mapping points on intermediate hypersurfaces, connecting a point on an L hypersurface to a point on an L' hypersurface. Let's call this curve the line of evolution.

It is possible to say that fields on hypersurfaces evolve along this line.

Further, I will use the word field mainly as a designation of an effective field. Where the type of the field will be ambiguously understood from the context, there will be a more complete designation.

In the presence of the mapping of fields states on one hypersurface to the fields states on another hypersurface along the line of evolution, the distance on this line serves as the time in the equations. In this case, we can talk about the time vector, and this vector is tangent to the line of evolution.

I believe that at the level of fundamental four-dimensional space, the preferred direction is absent; all directions are equal.

The question now arises of where time vector is directed.

In fundamental space, there is no preferred direction. Thereby, this vector has to be directed in the most symmetric way concerning a hypersurface. For the case of hyperplane, the greatest symmetry achieved, if time vector at each point of hyperplane is directed perpendicular to the hyperplane. For the hypersurface, the greatest symmetry achieved if the time vector is directed perpendicular to the tangent hyperplane. The time vector has a direction. I will return below to the question of finding its direction.

In such model of the hypothesis, the question arises as to what the consciousness is.

Consciousness

Within the suggested model, I am postulating that the consciousness is an epiphenomenon caused by the change of physical fields on hypersurfaces. Change occurs not in time, but in fundamental space, which differs from the observed space. The observed space corresponds to the space of hypersurfaces. It is necessary for the observed three-dimensional space that hypersurfaces also were three-dimensional.

The space, time and matter observed by us are the product of consciousness. Without observer, they are mathematical abstraction. Thereby, according to this hypothesis, they do not exist objectively, they exist subjectively.

I will call the observed space-time as the generated or emergent space-time.

Anthropic Principle

From the model of theory follows that the observer is necessary for existence of the Universe Thereby, the anthropic principle follows from the theory.

The anthropic principle was offered [2][3] for an explanation scientifically, why, in the observed Universe, there is a number of nontrivial relations between fundamental physical parameters, necessary for existence of intelligent life, takes place. There are various formulations; usually, the weak and strong anthropic principles are marked out.

The variant of the strong anthropic principle is the anthropic principle of participation stated by John Wheeler [4]:

> « *Observers are necessary to bring the Universe into being.*

In the suggested hypothesis, the anthropic principle of participation is a direct consequence of subjective existence of the observed space-time.

Principle of Causality

All models of intelligent life known to me require the principle of causality. Observers are necessary to bring the Universe into being. Only the rational being can be the observer. It means that intelligent life is necessary to bring the Universe into being. Based on this, hypersurfaces with the physical fields changing on them need to be built so that the principle of causality was achieved. Thereby, the principle of causality is a consequence of the anthropic principle of participation.

Time Vector Direction

In relation to the observed space-time, consciousness is primary in this hypothesis. Based on this, the direction of time should be such that consciousness can exist. Consciousness is directed from the past to the future, in one direction, it is unidirectional. Time should also be directed in one direction, and its direction should correspond to the vector of evolution of consciousness, in order for the above to be done.

Derivation of Hypersurfaces and Observer

The observer in the suggested model is that basis around which the emergent space-time is derived. There can be many observers on the same hypersurface. If for any observer a number of hypersurfaces is derived, it does not mean that the hypersurfaces are suitable for other observers. In this case, for some observers the subsequent hypersurfaces will differ.

Symmetry to the Translations of the Emergent Time and Space

To accomplish the principle of causality it is necessary to understand what properties in relation to translations of the emergent time and space physical laws have to have. In case there is no symmetry to the translations of the emergent time and space, there are no ways for accomplishment of the principle of causality. With that in mind, it follows that such symmetry, it is also could be called the uniformity, has to exist. It means that any decision with the emergent space-time has to contain such symmetries.

Observable Physical Fields

Observed physical fields, according to the suggested model, are some manifestation of one or more fundamental fields. The observable fields are effective fields.

Since this more fundamental field or fields are defined on space with no time and dynamics, the fundamental fields have no dynamics.

Inertial Frames of Reference

Let's call the inertial frames of reference the frames of reference moving directly and evenly relative to one another.

The question now arises of how to move from one inertial frame of reference into another. Let's consider a case when the emergent space is flat. In this case, instead of a hypersurface we can talk about the hyperplane.

For consideration, it shall be necessary to introduce the concepts of the body into this hypothesis. It is clear that, at the fundamental level, no bodies, according to this hypothesis, can exist. They can exist only upon observation, and be built on the basis of effective fields. How to build a body in this hypothesis? So far, I have not specified this in any way; for this, at a minimum, the construction of quantum mechanics is required within the framework of this hypothesis. Let us suppose there is some way to build a physical body, and let us consider the consequences.

If the body is motionless with regard to the hyperplane, then it evolves along time vector. If the body has any velocity with regard to the hyperplane, then it evolves along the vector consisting of the sum of time and velocity vector. Time and velocity are perpendicular to each other as the vector of velocity lies in the hyperplane.

I want to find out how to move into the frame of reference corresponding to a moving body. As the motionless body evolves along time vector, the movement to frame of reference corresponding to a moving body would be the movement to such hyperplane where the velocity is zero and a body evolves along time vector. For such movement it is necessary to make a turn of the hyperplane so that the time vector of the new hyperplane be parallel to a vector of time and velocity of the body on the previous hyperplane. It will be considered in more detail later in the article, how exactly to determine which turn to make.

Due to the consideration of movement from one frame of reference to another, we get a number of the consequences.

The first consequence, relativity of simultaneity. The events occurring on the hyperplane are simultaneously occurring. After the hyperplane turn upon movement to the frame of reference corresponding to the body moving with some velocity as to the previous earlier simultaneous events can cease to be simultaneous.

The other consequence – the observed difference of the clock rate in different frames of reference. As there is no preferred direction in fundamental space, the length corresponding to unit of time has to be constant and is not affected by turns. Before turn evolution of the body moving with some velocity is characterized by the vector consisting of time vector with a length equal to unit of time, and the velocity vector with a length depending on velocity. After the turn and movement to system where a body is motionless, evolution of a body goes along time vector with a length corresponding to the unit of time. As we can see, lengths of these vectors differ, as means the difference of the clock rate in different frames of reference.

The consequence of similarity of laws of nature. As there is no preferred direction at the level of fundamental space, it means that in the emergent space-time physical laws are identical in all inertial frames of reference.

Another consequence - space-time with its velocity space cannot be represented by a single hypersurface, it corresponds to a multitude of hypersurfaces.

Energy

Within this model, the question arises as to what energy is. Suggested answer: energy is the first integral of motion equations. At the fundamental level, there is no energy as there is neither time, nor the motion or dynamics.

Hyperplane Velocity and Angle of Rotation

Let there be a body moving with a velocity $\vec{v}$ relative to a certain hyperplane L. We need to find what angle of rotation α corresponds to this velocity.

I will call v_t the distance in the fundamental space corresponding to a time unit. The time vector $\overrightarrow{v_t}$ is perpendicular to the hypersurface to which it corresponds. After the rotation of the hyperplane L, this time vector module remains unchanged. Rotation by an angle α means rotation by an angle α of the time vector. Based on this, to find the velocity value, it is necessary to find the projection of the time vector onto the hyperplane L:

$$v = v_t \operatorname{tg}(\alpha)$$

To find the components $\vec{v}$, one can divide the rotation into relative to the axes rotations:

$$v_x = v_t \operatorname{tg}(\alpha_x)$$

$$v_y = v_t \operatorname{tg}(\alpha_y)$$

$$v_z = v_t \operatorname{tg}(\alpha_z)$$

where α_x, α_y and α_z – the rotation angles with respect to the x, y and z axes on the hyperplane L.

I will note that it is easy to obtain from the velocity formula that the velocity transformation does not satisfy the Lorentz transformations. It will be shown later in the article, how the Lorentz transformations and the special theory of relativity are obtained in this case. It will be shown later in the article that there is a limit transition in which space-time transformations, based on the equations written above, turn into Lorentz transformations.

Interactions Velocity Limit

Let us suppose that in this theory framework, elementary particles are obtained somehow. Can different particles have different maximum interactions velocities, is this velocity a constant or a function of anything?

Let the maximum interactions velocity be constant c_1 for some type of particles. If for some other type of particles, the maximum interactions velocity is c_2 and $c_2 > c_1$, then the interaction of such particles will violate the principle of causality. It will be similarly for the case when $c_2 < c_1$. Since, in order to fulfill the anthropic principle, it is necessary to fulfill the principle of causality, it follows from this that $c_2 = c_1$. I will mark the maximum interactions velocity as c.

Now we will consider whether this velocity is a constant or a functional relation of some particle parameters. Let us suppose, the maximum interactions velocity c is a functional relation of some particle parameters q_1: $c = c(q_1)$. For another particle q_2, the velocity should depend on this particle parameters: $c = c(q_2)$. At the same time, these velocities should be equal: $c = c(q_1) = c(q_2)$

Since q_1 and q_2 are arbitrary particles, they are independent of each other. This means that the only option when the equation above is satisfied is when $c = const$.

Since there is no distinguished direction in the proposed theory, all directions are equal; this means that this velocity should be the same in all inertial frames of reference.

Thus, it has been demonstrated that the maximum interactions velocity should exist in the proposed hypothesis, this velocity is constant and the same in all frames of reference.

Velocities transformation and non-conservation of cause-and-effect relations during the transition between frames of reference

I will focus on the question of how to switch from one frame of reference to another, and how the velocities are transformed in such a case. From the equations above, we can derive the equations of velocities addition. This equation is different from Lorentz transformations. Is this difference a problem for the hypothesis under consideration, does the result of Lorentz transformations contradict this?

To answer this question, we need to remember that all of the physics in this hypothesis is built around the observer. The observer will see the velocities addition in accordance with some formula for adding velocities. If there is another observer in the second frame of reference, then he will see his picture of events, and nothing in this hypothesis framework does not claim that this picture should be derived from the first observer's picture. Based on the above, we can conclude that the transition to another frame of reference is not isomorphic. Violation of isomorphism during the transition to another frame of reference means that the past is changing for an accelerating observer.

Let us consider a thought experiment. Two observers have decided to observe some phenomena in some spatial area. Both observers meet, each of them takes a blank notebook where he will record the observations results. Then the first observer remains, the second accelerates at something to near-light velocity. Each of them records the observed phenomena regularly in the agreed spatial area. Then the second observer returns, meets the first observer, and they compare the results recorded in the notebooks. Can there be different results in notebooks? To answer this question, we need to remember that space-time in this hypothesis is built around the chosen observer, and is built with the requirement of fulfilling the principle of causality. Therefore, for each observer, what he sees in the notebook must satisfy the principle of causality. This means that although the records of observers about events may vary, the principle of causality should be fulfilled for them. This means that for any observer, events upon transition to another frame of reference look isomorphic. However, if in some way, the observer could see events simultaneously in different frames of reference, he would see that events in different frames of reference are not isomorphic with respect to each other.

As can be seen from the above, it has been found that this theory does not contradict the Lorentz transformations.

Derivation of Lorentz transformations

To derive Lorentz transformations, one shall need:

1. Space and time homogeneity
2. Space isotropy
3. Presence of the maximum interactions velocity

All three components in this hypothesis are available. Accordingly, to show how the Lorentz transformations are derived in this hypothesis, one shall just need to choose one of several known methods for their obtaining. When deriving, I use the textbook Classical Field Theory, by L.D. Landau and E.M. Lifshitz [5]. In this hypothesis, there are no assumptions about what the maximum velocity is. I will assume that the maximum velocity is equal to the velocity of light. If the resulting equations coincide with the well-known Lorentz transformations, then this will mean that the maximum velocity is equal to the velocity of light.

Linearity of Transformations

Due to the homogeneity of space and time and the isotropy of space and the principle of relativity, the transformations from one IFR (inertial frame of reference) to another should be linear. The linearity of the transformations can also be inferred, assuming that if two objects have the same velocities relative to one inertial frame of reference, then their velocities will be equal in any other IFR as well (it is also necessary to use weak assumptions about the differentiability and mutual uniqueness of the transformation functions). If we use only the IFR "definition": if some object has a constant velocity relative to one inertial frame of reference, then its velocity will be constant relative to any other IFR, then we can only show that the transformations between two IFRs should be linear-fractional functions of coordinates and time with the same denominator.

Thus, if $\overrightarrow{x'}$ — is the space-time vector in the system S', and A - is the matrix of the desired linear transformation, then $\vec{x} = A\overrightarrow{x'}$. The transformation matrix can depend only on the relative velocity of the considered IFRs, i.e., $A = A(\vec{v})$.

Interval

The interval between arbitrary events is the square root of the following variable: $\Delta s^2 = c^2\Delta t^2 - \Delta x^2 - \Delta y^2 - \Delta z^2$

where $\Delta t = t_2 - t_1$, $\Delta x = x_2 - x_1$, $\Delta y = y_2 - y_1$, $\Delta z = z_2 - z_1$ — are the time and coordinates differences of two events.

If the interval between events is equal to zero in one IFR, this means that the time period Δt - is the time (in this IFR) of the light signal travelling over distance of l between the spatial coordinates of these points. In another IFR, it travels the distance between these points (the length of this distance - l') for some other time period $\Delta t'$, therefore, the velocity, multiplied by $\Delta t'$ should also be equal to l'. However, the light signal velocity is the same in all IFRs; therefore, in the second IFR, the interval will also be equal to zero. Thus, directly from the velocity of light equality in all frames of reference, follows the statement:

if $\Delta s^2 = c^2\Delta t^2 - \Delta x^2 - \Delta y^2 - \Delta z^2 = 0$, then in any other IFR $\Delta s'^2 = c^2\Delta t'^2 - \Delta x'^2 - \Delta {y'}^2 - \Delta z'^2 = 0$

For infinitely near events, we have $ds^2 = c^2dt^2 - dl^2$ and $ds'^2 = c^2dt'^2 - dl'^2$. Let us assume that $ds'^2 = a ds^2$. In particular, if $ds = 0$, then $ds' = 0$ as well. Due to the homogeneity and isotropy of space and time, a cannot depend on spatio-temporal coordinates, but can only depend on the relative velocity of frames of reference. It should also not depend on the direction of relative motion due to the isotropy of space. Due to the principle of relativity, the functional relation of the dependence on the relative velocity should be universal, it is the same for all IFRs. Let us consider three frames of reference S, S_1, S_2, where the movement velocity vectors S_1 and S_2 in the system S are equal to $\overrightarrow{v_1}$ и $\overrightarrow{v_2}$. Let us consider some interval in these three frames of reference:

$$ds^2 = a(\overrightarrow{v_1})ds_1^2\,,\ ds^2 = a(\overrightarrow{v_2})ds_2^2\,,\ ds_1^2 = a(\overrightarrow{v_{12}})ds_2^2$$

from here it follows that $a(\overrightarrow{v_{12}}) = a(\overrightarrow{v_2})/a(\overrightarrow{v_1})$

However, $\overrightarrow{v_{12}}$ depends not only on $\overrightarrow{v_1}$ and $\overrightarrow{v_2}$, but also on these vectors direction, therefore this ratio is possible only if the functional relation $a(v)$ does not depend on v at all, that is, it is some constant. It follows from the same ratio that $a = 1$. This means that the ratio is always satisfied:

$$ds^2 = ds'^2$$

Lorentz transformations themselves can be obtained from their linearity and the requirement of invariance of the interval.

For simplicity, we shall also consider the case of one-dimensional space. The invariance of the interval means that $x^2 - (ct)^2 = x'^2 - (ct')^2$. Let's substitute linear transformations into this formula:

$$x = a_{11}x' + a_{12}ct'$$

$$ct = a_{21}x' + a_{22}ct'$$

We obtain:

$$\begin{aligned} x^2 - (ct)^2 &= (a_{11}x' + a_{12}ct')^2 - (a_{21}x' + a_{22}ct')^2 \\ &= (a_{11}^2 - a_{21}^2)x'^2 - (a_{22}^2 - a_{12}^2)(ct')^2 + 2(a_{11}a_{12} - a_{21}a_{22})x'ct' = x'^2 - (ct')^2 \end{aligned}$$

Since x' and ct' are arbitrary, the coefficients of the left and right sides should be identically equal. Consequently

$a_{11}^2 - a_{21}^2 = 1, a_{22}^2 - a_{12}^2 = 1, a_{11}a_{12} - a_{21}a_{22} = 0$

It follows from the last equation that a_{22}/a_{11}=a_{12}/a_{21}. Let us mark the indicated relation as α. In addition, let us mark $a_{11} = \gamma$, $a_{21} = b$. Then $a_{22} = \alpha\gamma$, $a_{12} = \alpha b$. Then the first two relations can be written as follows:

$\gamma^2 - b^2 = 1, \alpha^2\gamma^2 - \alpha^2 b^2 = 1,$

from which it follows that, firstly, $\alpha^2 = 1$, and secondly, $\gamma^2 - b^2 = 1$, whence we can write

$$\gamma^2 = 1/(1 - b^2/\gamma^2)$$

Finally, for convenience, while introducing the designation $\beta = b/\gamma$, we obtain:

$A = \begin{pmatrix} \gamma & \pm\gamma\beta \\ \gamma\beta & \pm\gamma \end{pmatrix} = \gamma \begin{pmatrix} 1 & \pm\beta \\ \beta & \pm 1 \end{pmatrix}, \gamma = \pm\frac{1}{\sqrt{1-\beta^2}}$

moreover, the signs in the matrix are either positive or negative at the same time. The sign in the formula for γ should be chosen positive, because, at zero relative velocity of the systems, the matrix A should be unitary (the systems are identical in this case and the transformations are identical). In addition, if the coefficient in gamma had to be negative it would be impossible (the upper diagonal element would be -1, but should be 1). Therefore, we can clearly state that γ is a positive number.

As for the signs inside the matrix and, namely, the value of β, this can be established if we take the origin of coordinates of the system as S' - vector $(0, ct')$ and transform it to system S, and use the velocity of movement agreement as follows:

$\begin{pmatrix} vt \\ ct \end{pmatrix} = \gamma \begin{pmatrix} 1 & \pm\beta \\ \beta & \pm 1 \end{pmatrix} \begin{pmatrix} 0 \\ ct' \end{pmatrix} = \pm\gamma \begin{pmatrix} \beta ct' \\ ct' \end{pmatrix}$

Having divided the first equation of this system by the second, we obtain $\beta = v/c$.

As for the sign, in view of the positivity of time, it follows from the second equation that the sign should be positive. Thus, we finally obtain as follows:

$A = \gamma \begin{pmatrix} 1 & v/\mathrm{c} \\ v/\mathrm{c} & 1 \end{pmatrix}, \gamma = \frac{1}{\sqrt{1-v^2/\mathrm{c}^2}}$

Thus, Lorentz transformations have been obtained within the framework of the hypothesis under consideration.

Physical Meaning of Lorentz Transformations and STR (Special Theory of Relativity by Einstein)

In the hypothesis under consideration, time and space are displayed on a timeless system. Typical objections are known related to the consideration of time as another spatial coordinate. I will consider these objections.

Let us assume that in the frame of reference S, some event occurred at a point with coordinates $(\vec{r}, t)$. Let us consider the frame of reference S' moving relative to S with velocity v. This event in the frame of reference S', according to the STR (Special Theory of Relativity by Einstein) equations and Lorentz transformations, will occur at a point with coordinates $(\overrightarrow{r'}, t')$. It is not complicated to notice that Lorentz transformations differ from transformations where time is considered as the fourth spatial dimension. In order to find these differences, we can recall that in the geometric interpretation STR is described by Minkowski space.

As shown above, events that occurred in one frame of reference do not have to occur in another frame of reference; there is a violation of cause-effect relations when switching from one frame of reference to another.

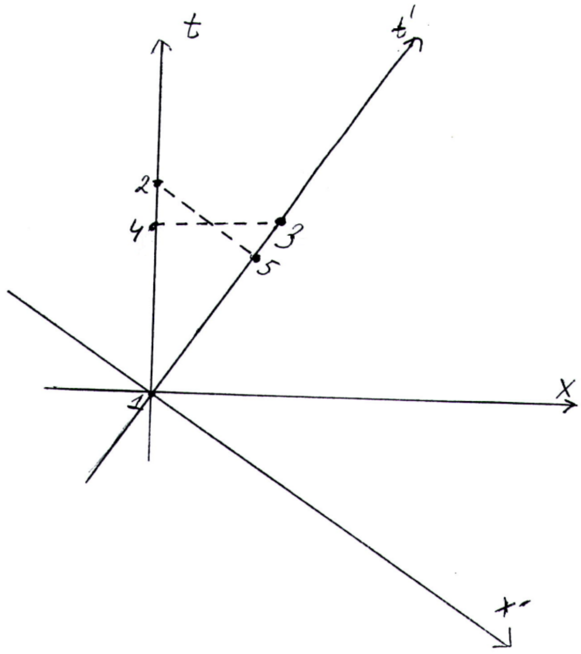
Such a mismatch of events in different frames of reference is a manifestation of the emergent nature of time, space and matter. In typical STR interpretations, space-time and matter are considered as objective main points independent of the observer. This is the reason why it is impossible to consider time in them as yet another spatial dimension and why the Minkowski space metrics is different from the 4-dimensional space metrics. In the hypothesis under consideration, the observer is an epiphenomenon caused by fundamental fields in space without time and dynamics. Nevertheless, at the same time, the observer is more fundamental than the Universe, the observer creates the Universe during observation. Thus, to describe the place of an event, it shall be necessary not only to indicate the place in the fundamental space where it has occurred. It shall also be necessary to indicate which observer is observing this event.

Space-Time Direct Transformation in the Hypothesis Framework.

What should be the space-time in the framework of the hypothesis under consideration at small angles? When the angle of rotation tends to zero, the loss of information should also tend to zero, since the fundamental fields should be smooth. Then, in this case, the space-time transformation should go over to the Lorentz transformations. Let's verify it.

Let's find ratio of the duration of time in two inertial frames of references, moving relatively to each other. I will name v_t the distance in fundamental space, equal to unit of time. As described above, this value is the same in all inertial reference systems.

Let there be two inertial frames of reference moving relative to each other with velocity v along axis x, and their origin points coincide.



The figure 1 shows the axes x and t for the first frame of reference and axes x' and t' for the second frame of reference. The second frame of reference, moving with relative velocity v, is tilted at an angle α relative to the first one. I would like to emphasize that the axis t is usual space axis in Euclidean space. Length l along this axis is related to the observed time by the following relation:

$$t = l/v_t$$

Simultaneous events are those events that occur on a same plane, perpendicular to the axis t.

There are several points in the figure. Point 1 is the beginning of the coordinate system. I consider a case, when the beginning of the coordinate system is the same for both systems.

Because v_t in all inertial frame of references is the same, so $v = v_t \,\mathrm{tg}(\alpha)$, where α – angle between t and t'.

Let t be the time elapsed in the first reference frame from point 1, and t' - time elapsed in the moving reference frame during the time t. Time duration t in the first frame corresponds to the distance $v_t t$, this is distance between points 1 and 4. The same time span t in the second frame of reference corresponds to the same distance; it is distance between points 1 and 5. Point 2 is the intersection of a line perpendicular to the axis t', and passing through the point 5. Similarly, point 3 is the intersection of a line perpendicular to the axis t, and passing through the point 4. In order to determine which time interval in the first frame of reference corresponds to the time t' in the second one, it is necessary to find the length of the hypotenuse of a triangle of points 1, 5 and 2. From the figure, it can be seen as follows:

$$t = \frac{t'}{\cos(\alpha)}$$

Now let us consider how these equations obtained above will behave when α tends to zero.

At small angles

$$\mathrm{tg}(\alpha) \approx \sin(\alpha)$$

From here, we get

$$\sin(\alpha) \approx v/v_t$$

Then, from the known value of the sine, we get:

$$\cos(\alpha) = \sqrt{1 - sin^2(\alpha)} = \sqrt{1 - \left(\frac{v}{v_t}\right)^2}$$

$$t = \frac{t'}{\sqrt{1 - \left(\frac{v}{v_t}\right)^2}}$$

From the same figure it can be seen

$$t' = \frac{t}{\cos(\alpha)} = \frac{t}{\sqrt{1 - \left(\frac{v}{v_t}\right)^2}}$$

Now consider the coordinate transformations. Let velocity v be directed along x-axis. Then, when you rotate the coordinate system to switch to moving frame of reference, y and z will remain unchanged:

$$y = y'$$

$$z = z'$$

In the second frame of reference, after rotation, $x' = x_0/\cos(\alpha)$

Then

$$x' = (x - vt)/\cos(\alpha) = \frac{x - vt}{\sqrt{1 - \left(\frac{v}{v_t}\right)^2}}$$

$$t' = \frac{t - (v/{v_t}^2)x}{\sqrt{1 - \left(\frac{v}{v_t}\right)^2}}$$

These equations become familiar if

$$v_t = \mathrm{c}$$

Here c – light velocity. This means that the distance corresponding to the unit of length of time is equal to the distance traveled by the light for the same time duration.

Thus, it was found that at small angles of rotation and in the absence of loss of information, rotation in 4-dimensional space turns into Lorentz transformations.

An additional consequence is that in order to perform such a transition, the condition $v_t = \mathrm{c}$ should be satisfied.

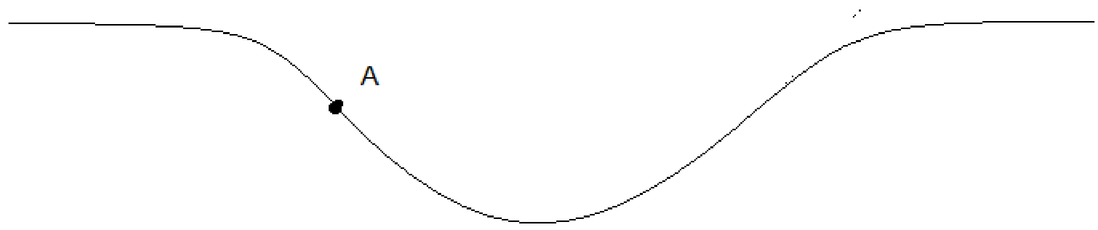
Principle of Locality

The fundamental fields in this hypothesis have no dynamics. The field value at each point affects the field values at all other points of the fundamental space. It is clear that the principle of locality in such conditions is absent at a fundamental level. At the level of observed space-time, the limiting interaction rate of effective fields and a special theory of relativity emerge. The appearance of the interactions velocity limit of effective fields leads to the emergence of the principle of locality in the observed space-time.

Curved Space-Time and Gravitation

In the deriving of hypersurfaces, the existence of curvature, in observance of the principle of causality and similarity of the occurred physical laws, can be required. Let's consider consequences of curvature on a hypersurface.

Let's consider curved hypersurface. In the figure below in horizontal direction you can see the distance along some line on a hypersurface, in vertical direction – curvature of a hypersurface. “A” point is marked in the figure 2. This hypersurface is mapped to the same or similar hypersurface located further in fundamental space.



“A” point will be mapped to points on the subsequent hypersurfaces which are over the intersection with the line of evolution of this point. In each point the time vector is tangent for this line. Then it is seen that in each subsequent point along the line of evolution of “A” point the tangent hypersurfaces will not be parallel. The curvature leads to the turn of the tangent hyperplane in fundamental space. According to the considered earlier, the hyperplane turn is equivalent to change of velocity. Therefore, the gradual turn is equivalent to acceleration. It means that the curvature of space-time, from the point of view of moving with the “A” point observer and provided that inhomogeneity of curvature are rather small, is indistinguishable from acceleration. It is the same process of turn of the tangent hyperplane in fundamental space.

Thereby, existence of curvature leads to emergence in the emergent space of the effective field equivalent to acceleration. In addition, it may be noted that effective fields in the emergent space are divided into two types:

- Fields which are some projection of fundamental fields on a hypersurface
- Field formed as result of curvature of a hypersurface.

The field formed as result of a curvature at a hypersurface depends on all other effective fields. This dependence arises from the fact that this field forms in such way so that the principle of causality for other effective fields can be achieved. Thereby, we can say that this field is universal in the emergent space and interacts with all other effective fields. As this field depends on a configuration of other fields, the velocity of its change has to precisely equal to the maximum velocity of configuration change of the fields. This velocity is equal to maximum velocity of interactions.

The field with such properties is known. It is gravitation.

For gravitation, the strong principle of equivalence holds. It was shown above that gravitation and acceleration are demonstration of the same process, the process of turn of the tangent hyperplane in fundamental space. Thereby, within the suggested model the strong principle of equivalence is derived. Itis shown that its velocity has to be equal with the maximum velocity of interactions. This velocity, as we know, is equal to the velocity of light. It is shown that gravitation is a universal interaction. Also gravitation in such model depends only on other effective fields, but not on itself.

In the general theory of relativity, gravitation complies with all the properties described above. There is only an energy-momentum tensor of other fields in it; there is no energy-momentum tensor of gravitation. Gravitation has universal character, as is predicted by the suggested model.

It may be noted that the above difference in types of fields means that many approaches applicable and being efficient for fields of the first type, will not work in the second case. As it is observed in attempts to apply quantization to gravitation.

In addition, I will note that in the suggested model there are no singularities at the level of fundamental space. Gravitation can result in gravitational singularities in the observable space, but at the same time in fundamental space singularities do not arise.

Mass and Inertia

For further consideration, it is necessary to introduce the concepts of mass and inertia. The derivation of mass and inertia is not considered in this article. Suppose that within the framework of the hypothesis under consideration, it is somehow possible to obtain inertial mass and inertia. Let us consider the consequences.

Hypersurface Space-Time Metrics

Above, a special theory of relativity has been obtained. From it, in particular, it follows that in the Cartesian coordinate system; the interval ds is determined by the formula [5, p 294]

$$ds^2 = c^2dt^2 - dx^2 - dy^2 - dz^2$$

Upon transition to any other inertial frame of reference, the interval, as we know, retains the same form. A hypersurface with curvature can be represented as inertial only locally, if we take a tangent hyperplane. It is a non-inertial frame of reference.

In a non-inertial frame of reference, the squared value of the interval is some quadratic form of the coordinates differentials:

$$ds^2 = g_{ik}dx^i dx^k$$

where g_{ik} – are some functions of the spatial coordinates x^1, x^2, x^3 and of the time coordinate x^0, summation is performed over repeated indices.

The four-dimensional coordinate system x^0, x^1, x^2, x^3 is thus, curved, when using non-inertial frames of reference. Variables g_{ik}, by defining all the geometry properties in each given curvilinear coordinate system, establish a space-time metrics.

Object Motion in a Gravitational Field

To find an object motion equation of in a gravitational field, one can use the generalization of the equation of an object free motion in the special theory of relativity. These equations say as follows $\frac{du^i}{ds} = 0$, or else $du^i = 0$, where $u^i = dx^i/ds$ is the 4th speed. Obviously, in curvilinear coordinates, this equation is generalized to

$$Du^i = 0$$

Using covariant differentiation, we obtain:

$$du^i + \Gamma^i_{kl}u^k dx^l = 0$$

Dividing this equation by ds, we obtain:

$$\frac{d^2x^i}{ds^2} + \Gamma^i_{kl}\frac{dx^k}{ds}\frac{dx^l}{ds} = 0$$

These are the desired motion equation.

What is new in obtaining these motion equations is that they are obtained in the framework of the hypothesis under consideration.

Gravitational Field Equations

Let us assume that there is a certain curved hypersurface and the corresponding space-time. What does the action S of some physical system look like in this space-time?

The action for a physical system in some field usually looks like:

$$S = S_m + S_f + S_{mf}$$

Here, S_m is that part of the action that depends only on the particles properties, i.e. the action for the free particles. S_{mf} is that part of the action that is due to the interaction between the particles and the field. S_f is that part of the action that depends only on the properties of the field itself.

The gravitational field in the model under consideration is the hypersurface curvature, necessary for the fulfillment of the principle of causality and the sameness of the laws of physics. This means that the gravitational field is determined by particles completely. It follows from this that there is no interaction between the gravitational field and particles, the particles configuration determines the gravitational field. Then, for the gravity and particles interaction

$$S_{mf} = 0$$

Consequently,

$$S = S_m + S_g$$

where S_g – gravity action.

Now we can proceed to the derivation of the gravitational field equations. These equations are obtained from the principle of least action $\delta S = 0$

$$\delta S = \delta(S_m + S_g) = \delta S_m + \delta S_g$$

Variation δS_g is equal to [5,p. 355]:

$$\delta S_g = -\frac{c^3}{16\pi k}\int (R_{ik} - \frac{1}{2}g_{ik}R)\delta g^{ik}\sqrt{-g}d\Omega$$

Variation δS_m is equal to [5, p. 355]:

$$\delta S_m = \frac{1}{2\mathrm{c}}\int T_{ik}\delta g^{ik}\sqrt{-g}d\Omega$$

where T_{ik} – energy momentum tensor.

Thus, from the principle of least action $\delta S = 0$, we obtain as follows:

$$-\frac{c^3}{16\pi k}\int \left(R_{ik} - \frac{1}{2}g_{ik}R - \frac{8\pi k}{c^4}T_{ik}\right)\delta g^{ik}\sqrt{-g}d\Omega = 0$$

Where, due to randomness δg^{ik}

$$R_{ik} - \frac{1}{2}g_{ik}R = \frac{8\pi k}{c^4}T_{ik}$$

These are the gravitational field equations in the model under consideration. These equations exactly coincide with the Einstein equations of the general theory of relativity, if we do not consider the cosmological constant. For the cosmological constant, within the framework of the hypothesis under consideration, one can also find a simple explanation, but this is not considered in this article.

It is possible to notice that one of the consequences of these equations is the equality of the inertial and gravitating mass.

Energy and Momentum Conservation

The laws of energy and momentum conservation follow from symmetries to time and space translations. The space-time curvature is added so that these symmetries are not broken.

In the absence of a gravitational field, the law of energy and momentum conservation is expressed by the equation as follows [5, p. 362]:

$$\frac{\partial T^{ik}}{\partial x^k} = 0$$

This equation generalization in the presence of space-time curvature is the equation: $T^{k}_{l:\,k} = 0$.

Let us verify:

$$T^{k}_{l:\,k} = \frac{1}{\sqrt{-g}} \frac{\partial (T_i^k \sqrt{-g})}{\partial x^k} - \frac{1}{2} \frac{\partial g_{kl}}{\partial x^i} T^{kl} = 0$$

As expected.

There is no contribution to the energy from the gravitational field here. It could be said that the law of energy and momentum conservation is violated in the general theory of relativity. However, for this it shall be necessary that the gravitational field itself have energy. In the hypothesis under consideration, the gravitational field is the space-time curvature for the principle of causality fulfillment. This is not a field in the typical sense. It cannot exist by itself; it is determined by the configuration of other effective fields completely. Thus, it does not have energy. This means that the law of energy and momentum conservation is also satisfied in the general theory of relativity.

Again about the Hypothesis

The fundamental novelty of the proposed hypothesis lies in the consideration of the deriving a space-time on the space with no time and dynamics. Prior to this hypothesis, as far as I know, such an opportunity has never even been considered. The rejection of time and dynamics at a fundamental level is not easy. We have to abandon almost all the well-established schemes of modern theoretical physics.

The rejection of well-established schemes of modern theoretical physics can seriously complicate the reading of this article. All modern physical theories are based on realism. This hypothesis is based on subjective idealism. This means that before applying any of these theories, firstly, it should be obtained in the framework of this hypothesis. For example, this hypothesis assumes that the values of the fundamental field (or fields) are described by some scalar quantity. One can try to refute this hypothesis by taking the statement from textbooks on field theory that scalar fields do not have enough degrees of freedom. However, this statement has been proven for the case of realism, but not proven for the model of this hypothesis.

In addition, the hypothesis has serious philosophical consequences. If the hypothesis is true, then this means that we live in a world of subjective idealism, and realism is erroneous. Thus, testing this hypothesis will be simultaneously testing the most crucial concepts of philosophy.

An interesting feature of the hypothesis is the fact that the anthropic principle follows from it. In all theories known to me, the anthropic principle, if used, is postulated. And only within the framework of the proposed hypothesis is it derived.

Gravity in the hypothesis under consideration is derived from other effective fields and does not have energy. This explains the absence of the contribution of gravity to the energy-momentum tensor in the Einstein equations.

In this hypothesis, gravitational singularities do not arise. More precisely, gravitational singularities are possible in the emergent observable space-time, but they are absent at the fundamental space level.

The hypothesis is built on the basis of such fundamental fields, where the field value at each point affects the field values at all other points. And at the same time, effective fields arise with a interactions velocity limit, and the principle of locality arises.

This article does not discuss the method of the quantum physics deriving within the frameworks of the proposed hypothesis. However, it can be noted that any deriving method will be based on super-determinism. This hypothesis suggests super-determinism. Super-determinism is a way to go around Bell's inequalities about hidden parameters. This allows us to say that the quantum mechanics deriving in this hypothesis may be possible.

This article discusses the space-time deriving in 4-dimensional fundamental space. It can be noted that

4-dimensional space is minimal for deriving 3-dimensional space with time. However, this hypothesis is well combined with the fundamental space with more than four dimensions. In this case, we take a 4-dimensional subspace, and we obtain a 3-dimensional observable space with time.

In addition, the article considers one or more fundamental fields. I think that in the quantum mechanics deriving, there will be only one fundamental field. Otherwise, since such fields are completely independent of each other, effective fields must be completely independent of each other. Nevertheless, if there are effective fields that do not affect each other in any way, then they can be considered only those effective fields that affect each other. In this case, we can talk about different observable space-times at one point in the fundamental space.

Why is it impossible to move in time in an arbitrary direction? This is one of the questions that may arise when reading this article. The answer to it is quite simple, when using the hypothesis logic. Within this hypothesis, the consciousness is an epiphenomenon, it cannot have any effect on a fundamental level. Consciousness is unidirectional. In order to return to the past, it shall be necessary to make a series of successive rotations of the hyperplane, which is equivalent to a sequential change in velocity by some variables. The transition to another frame of reference occurs with loss of information. Travel back in time shall be possible if constantly accelerated. However, when moving to another frame of reference, there is a loss of information and a transformation to a self-consistent form. Therefore, a traveler who decides to accelerate constantly will not be able to change anything in the past. He will either forget why he was accelerating, or he will have fatal problems when accelerating. Nothing can be changed in the past, since the values of the fundamental field (or fields) at each point of the fundamental space are unchanged, due to the lack of time and dynamics at this level.

Conclusion

The hypothesis, allowing deriving a space-time with a Minkowski space metrics on Euclidean space with no time and dynamics is suggested. This is a fundamental novelty, to the best of the author's knowledge, such an opportunity has never been considered before.

This hypothesis also allows deriving the curved space-time with a metrics of the general theory of relativity. It was demonstrated that the principle of causality and the anthropic principle arise from the hypothesis. It was demonstrated that the strong principle of equivalence of gravitation and acceleration arises from the hypothesis. All principles and postulates, on which special and general theories of relativity are based are being derived, Lorentz transformations and the general theory of relativity equations were derived. It has been demonstrated that the principle of locality arises in such a hypothesis.

References

[1] S. Hawking, J. Ellis, The Large Scale Structure of Spacetime, published by Mir, 1977

[2] G.M. Idlis - Main features of the observed astronomical Universe as the characteristic properties of the inhabited space system // Izv. Astroph. of the Institure of Kaz. SSR. 1958. 7. 7. P. 40-53.

[3] B. Carter - Coincidence of large numbers and the anthropological principle in cosmology // Cosmology. Theories and observations. M., 1978. P. 369-370.

[4] Wheeler J. A. Genesis and Observership//Foundational Problems in the Special Sciences. Dordrecht,1977. P. 27.

[5] L.D. Landau, E.M. Lifshitz, Field theory, vol II, izd. 7, Moscow "Nauka" 1988