

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

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Abstract

Hypothesis, allowing deriving a space-time with a Minkowski space metrics on Euclidean space with no time and dynamics is suggested. 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 were derived.

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 a vacuum and relativity. Ethereal theories have many problems which looks unresolvable, and there is only one main opportunity for derivation of theories. Is it possible to derive 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 in Euclidean space a hypersurface with a Minkowski space metrics? As S. Hawking, J. Ellis [1, p 55] show, in Euclidean space it is impossible to derive the refined hypersurface with a Minkowski spacetime metrics.

Is it possible to derive in Euclidean space a hypersurface with a metrics of the general theory of relativity? If it is impossible to derive more simple case, with a Minkowski space metrics, then it is obvious that it cannot be done.

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 spacetime metrics and in metrics of a general theory of relativity. Therefore, before considering the offered model, 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 time fields exist independently or are the manifestation of something more fundamental?

Let's assume that at the fundamental level time does not exist. 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 macrolevel, are difficult to call model with no time. More likely, such models can be called models with a numerous of times at the microlevel.

With no time and dynamics at the fundamental level the question now arises of how to coordinate it with dynamics and time observed in the nature. To answer this question, it is necessary to consider what the realism and idealism are based on.

Realism and idealism

The world view familiar to us says that the mind exists due to the changes of a matter state in time. The matter exists objectively and irrespective of our mind. But is it really so? At the moment, there is no evidence of materialism. Materialism is one of the realism concepts. The opposite concept stating that the world depends on the mind is called idealism. In the philosophy there is a continuous discussion about what is true realism or idealism. Each of these concepts has its arguments. Any of these philosophical concepts is not as of today scientific as there is no possibility of their falsification. Thereby, though practically all modern theories in physics are based on realism, there are no reasons for restrictions to derive theories on basis of idealism.

The following part describes model, based on idealism.

Model of hypothesis

Let us assume that there is a four-dimensional Euclidean space with some fields. No time or dynamics. Thereby, the fields also have no dynamics. It also means full determinism.

Let us assume that in this space we can build a series of noncrossing hypersurfaces on which somehow it is possible to build the fields precisely coinciding with the fields observed by us. Also let us assume there is a continuous transformation of the fields state Ψ on one hypersurface of L series to the 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.

Let us assume that the mapping of fields states on one hypersurface to the fields states on another hypersurface along the line of evolution corresponds exactly with the laws of physics observed by us, and 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.

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.

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

Mind

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

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

The observed space-time I will call 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 model 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.

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 more fundamental fields. Perhaps, they are a manifestation of the uniform field. Since this more fundamental fields or field are defined on space with no time and dynamics, they 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.

If the body is motionless with regard to the hyperplane, then it evolves along time vector. If the body has any speed with regard to the hyperplane, then it evolves along the vector consisting of the sum of time and speed vector. Vectors of time and speed are perpendicular to each other as the vector of speed 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 speed 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 speed of the body on the previous hyperplane.

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 speed as to the previous earlier simultaneous events can cease to be simultaneous.

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 speed is characterized by the vector consisting of time vector with a length equal to unit of time, and the speed vector with a length depending on speed. 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.

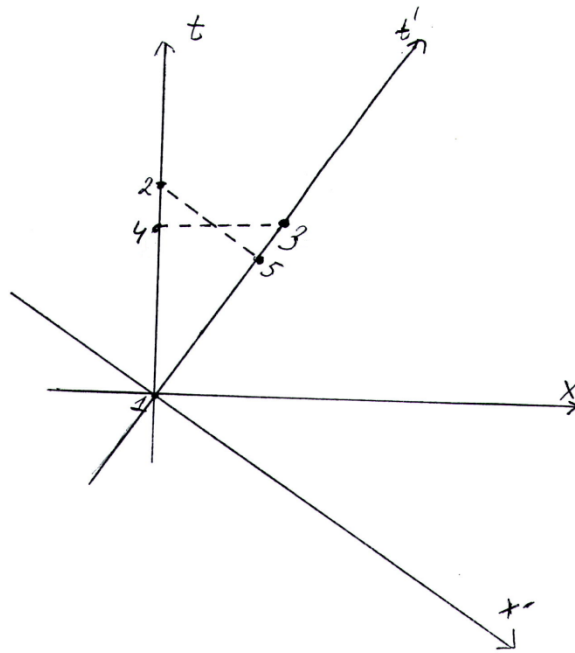
Energy

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, nor dynamics.

Special theory of relativity and Lorentz transformation

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 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 speed v along axis x , and



their origin points coincide.

The figure above shows the axes x and t for first frame of reference and axes x' and t' for second frame of reference. The second frame of reference, moving with relative velocity v , is tilted at an angle α relative to the first. 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.

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

Because v_t in all inertial frame of references is same, so $v = v_t \sin(\alpha)$

Let t be the time elapsed in the first reference frame from point 1, and t' - time elapsed in the moving reference frame during time t . Time duration t in first frame corresponds to the distance $v_t t$, this is distance between points 1 and 4. Same time span t in second frame of reference corresponds to 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 second, 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:

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

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 and see how point (x, y, z, t) will be transformed. 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:

$$y = y'$$

$$z = z'$$

Then, with usage of same method as above:

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

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

These equations become familiar if

$$v_t = c$$

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, I can say that the special theory of relativity with its Lorentz transformations is derived from the proposed model.

Let's consider question of how to calculate sum of velocities and what it is. From the equations above one can derive the equation of the relativistic velocity addition. This equation is different from the velocity addition equation, which can be obtained if we consider the sum of the velocities through the addition of angles. Is this difference a problem for the proposed hypothesis?

To answer this question, it is necessary to remember that all physics in this hypothesis is built around an observer. The observer will see the addition of velocities in accordance with the relativistic formula for the addition of velocities. If there is another observer in the second frame of reference, he will see his picture of events, and nothing says that this picture should be derivable from the picture of the first observer. Based on the above, I can conclude that the transition to another frame of reference is not isomorphic. The violation of isomorphism during the transition to another frame of reference means that for accelerating observer his past changing.

Let's consider a thought experiment. Two observers decided to observe some phenomena in some spatial area. Both observers meet, each takes a clean notebook where they will record the results of the observations. Then the first observer remains in same area, the second at some vehicle accelerates to near-light velocity. Each of them regularly records observable phenomena in the assigned region of space. Then the second observer returns, meets with the first observer, and they compare the results recorded in notebooks. Can there be different results in notebooks? To answer this question, it is necessary to remember that the space-time in this hypothesis is built around the selected observer, and is built with the requirement to satisfy to principle of causality. Therefore, for each of the observers, what he sees in the notebook should satisfy the principle of causality. This means that while observers may record different events, the causality principle must be followed for them. This means that for any observer the events during the transitions to another inertial frame of reference look isomorphic. However, if in any way the observer could see events at the same time in different reference frame, he would see that events in different reference frames are not isomorphic with respect to each other.

Thus, the Lorentz transformations are derived without any assumptions about the presence of the maximum velocity of interactions in emergent spacetime. It follows from the Lorentz transformations that the maximum speed of interactions exists, it is same in all inertial frames of reference and is equal to the length of a unit of 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. 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 speed. 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. Also, 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 speed of its change has to be precisely equal to the maximum speed of configuration change of the fields. This speed is equal to maximum speed 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. It is shown that its speed has to be equal with the maximum speed of interactions. This speed, as we know, is equal to the speed 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. For

example, 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.

Also 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 observed space, but at the same time in fundamental space singularities do not arise.

Conclusion

The hypothesis, based on subjective idealism, enabling to derive a space-time with a Minkowski spacetime metrics on Euclidean space with no time and dynamics is suggested. 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 were derived.

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