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General Theory of Relativity of Einstein as Unified Field Theory

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Relying on a fundamental empirical identity of heavy and inertial mass it is proposed to bring a status of general theory of relativity (GTR) of Einstein up to a level of Unified Field Theory. To do this, a thoroughgoing revision of physical interpretation of energy-momentum tensor components within GTR is required.
Investigations demonstrated that physical meaning of spatial components of energy-momentum tensor within mechanics of special theory of relativity and in GTR equations may differ substantially. Taking into account this fact and a correct wording of a local principle of correspondence of GTR to Newtonian mechanics enables to implement **a unique** choice of Friedmann cosmological model from a class of isotropic ones. A new cosmological model differs fundamentally from "a standard one".
Within the two below sections of the paper an attempt to pass beyond the limits of the cosmological model is performed. In terms of qualitative assessments a rather interesting picture of hierarchical structure of the real universe is obtained. A complete system of equations for numerical simulation of the hierarchical structure on the basis of curvature tensor invariants is proposed. It is the author's opinion that this would enable to perform the total geometrization of **all** material structures, thereby raising the GTR status up to a level of Unified Field Theory.

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Introduction

An advantage and effect of gravitation, as an object of theoretical investigation, lies in its universality and informativity. Having an information about gravity potential of a particle and taking divergence of its gradient we would obtain all the necessary knowledge about the particle material structure. As for other physical fields, they cannot provide such a comprehensive information. Moreover, they cannot be simply and universally reduced to curvature of metrics of Riemannian space-time.

This very fact suggests an idea to use GTR mechanism for constructing Unified field theory in general and describing a structure of elementary particles in particular. On a path leading to this task implementation there is a problem of energy-momentum tensor in Einstein equations. This problem is associated, in its turn, with search of Lagrangian, which enables through the known formalism to construct the energy-momentum tensor of Unified theory.

The simplest structural unit of material world is the universe on the whole, approximated by an isotropic ***model of Friedmann***. Being almost trivial as for mathematic description, it provides a great range for ***unique*** choice of true, ***cosmological*** model. The way of implementing such a choice is shown within the first part of the paper. At the same time we have managed to destroy a deep-rooting illusion of ***Big Bang***. In the new conception "recession" of galaxies is replaced by deep and continuous structural evolution (towards complication) of the real universe.

A specific mechanism of the structural evolution is proposed and discussed within the second part of the paper. Consideration is performed at a level of physical assessments mainly. Even at this simplest level some interesting and rather convincing qualitative results on hierarchical world structure are obtained as well.

Later, within the third part of the paper a program of constructing a universal theory of matter on the basis of relativistic gravitational theory, which GTR of Einstein is, is stated. Such strong assertion may be made when analyzing a remarkable empirical equation of inertial and heavy masses, which Einstein took as a principle of GTR:

$$m_i = m_g \qquad \textbf{(1)}$$

Originality of the relation **(1)** lies in the fact that its component values have principally different physical nature. Inertial mass is a measure of inertia, a quantitative characteristic of matter materiality, revealing itself in its interconnection with ambient physical objects. Heavy mass is "a gravitational charge" of matter within Newtonian universal law of gravitation. But, though there is such essential physical difference, no difference of the relation m_i / m_g from one accurate within the extremely small value ~

10^{-14} is found even in very fine present-day experiments. We note that empirical accuracy of ***law of conservation of energy*** does not exceed $\cdot 10^{-6}$, i.e. much worse.

It gives ground to consider the expression **(1)** as an identity applied to all matter forms, having positively defined energy density. In particular, it follows the conclusion about uniqueness of Einstein GTR as relativistic gravitational theory. In fact, all material objects possess "gravitational charge", therefore their space-time paths in nonhomogeneous and all over penetrating gravitational field of the universe are curved in a varying degree. Moreover, globally, in space scopes, space curvature may become so considerable that it will lead to its total closure, having changed its topology qualitatively.

Consequently, within consequence gravitational theory there is no (even theoretically) such physical body, with which one may associate global flat 4D space of Minkowsky. That is the reason that alternative, ***field gravitational theories*** are a fortiori devoid of every physical basis. In GTR the gravitational field is completely geometrized, is reduced to change of space-time metrics. It has no local and positively defined energy density, which is obligatory for all other **physical** fields.

Let us to return to discussion of the identity **(1)**, focusing at the two statements:

1) According to the known relativistic relation of Einstein density of energy coincides with mass density accurate within the factor c^2. Any physical object is characterized with local, positively defined density of energy. Consequently, all material structures may be, finally, completely described through specifying the scalar density $\rho_i(t,\boldsymbol{r}) = \rho_g(t,\boldsymbol{r})$ at space-time continuum.

2) Charge is divergent condition of a field (electrical or gravitational). On the basis of these clear physical statements we are forming up a simple logic chain.

In GTR the gravitational field is completely geometrized, is reduced to changes in Riemannian space-time metrics. The gravitational field divergence is presented here with components of curvature tensor of Riemannian 4D space. They, in their turn, expressing density of "gravitational charge", are proportional to density of heavy mass. Heavy mass is identically equal to inertial mass. Density of inertial mass(energy) is linearly connected with components of energy-momentum relativistic tensor.

Omitting intermediates of this logic chain we obtain that the empirical identity **(1)** in mathematical aspect should be expressed in a form of agreement between components of curvature tensor and components of energy-momentum tensor. These are the very Einstein equations, in particular. Components of energy-momentum tensor in the right part of these equations are generally considered as physical values, expressing them through physical properties (for example, inertial mass density). Relying on the identity **(1)**, there are grounds to suppose, however, that the same components may be expressed geometrically as well, in a form of algebraic constructions from components of metric tensor and its derivatives. In other words, material world assumes alternatives of its mathematic description (simulation), physical and geometrical ones. It should be noted that geometrical method of description, as one that does not include arbitrary physical properties, presents itself to be ***more universal*** in terms of constructing Unified field theory.

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Conclusions

Let us recollect the basic problems considered in the proposed manuscript.

The physical interpretation of components of energy-momentum tensor in GTR of Einstein is revised. Appropriateness of using conventional formula **(3)** in the right part of Einstein equations for choosing a cosmological model out of a class of isotropic ones is called in question.

The principle of ***local*** correspondence between GTR of Einstein and Newtonian mechanics is stated. The invariant differential relation **(29)** between components of metric tensor of arbitrary gravitating system is get. It allows enlarging in a required way the system of Einstein equations, which are written as applied to the isotropic model of Friedmann. As a result it is possible to rather easily get a unique solution of the cosmological problem i.e. to perform a choice of a ***physical*** model (a closed one) approximating the real universe out of a wide ***mathematical*** class of isotropic models of Friedmann.

In new cosmological model **(35)** spatial curvature radius is linearly dependent on dimension time coordinate. Introducing the dimensionless time coordinate η with the relation **(36)** demonstrates unboundness of evolution process of the universe approximated by the cosmological model $a(t) = c\,t$. The last condition closes a question about the ***initial*** moment of evolution being traditionally difficult for cosmology.

Instead of the traditional concept of ***Big Bang*** an alternative variant is proposed, that is step-by-step evolution change of the universe structural elements oriented to their complication. That is just what leads to an apparent extending of the universe.

The physical interpretation of spatial components of energy-momentum tensor in GTR of Einstein is reviewed. The baselessness of using the conventional formula **(3)** for energy momentum tensor of continuum is shown.

The principle of ***local*** correspondence of GTR of Einstein to Newtonian mechanics is formulated and constructively implemented. The invariant differential relation **(27)**, generalizing the equation of Poisson **(4)** for the arbitrary gravitating system **(29)** is obtained. It enables to supplement the system of equations of Einstein, put down with reference to the isotropic model of Friedmann. As a result it is possible to obtain rather easily the unique solution of the cosmological model, i. e. to perform a choice of ***a physical*** model (a closed one), which approximates the real universe, out of the wide ***mathematical*** class of the isotropic models of Friedmann.

In the new cosmological model **(35)** the space curvature radius is linearly dependent on dimensional time coordinate. Introducing the nondimensional time coordinate η with the relation **(36)** shows the unboundedness of the universe evolution process, approximated by the cosmological model $a(t) = c\,t$. The last condition closes the traditionally complex for cosmology problem on ***the initial*** moment of the universe evolution.

Instead of the conventional concept of ***Big Bang*** we propose the alternative variant -- the gradual evolutionary change of the universe structural elements towards their complication. This very fact leads to the apparent universe expansion.

The task of the first and the second part of the paper is to destroy one of the deepest scientific fallacy of the twentieth century --- the idea of ***Big Bang***. In fact, "the red shift", interpreted as recession of galaxies is, evidently, a result of gradual evolutionary change of ***all*** the structural elements of the universe including subatomic. The universe itself turns to be, as a matter of fact, static, subjected to just structural evolution. It is the insight of the greatest physicist of our time that is worth applauding! Let us recollect the internal resistance with which Einstein refused the static universe and agreed with the idea of its expansion.

The second part of the manuscript presents the considerations on the opportunity of passing beyond the limits of the cosmological model on the basis of idea of the curvature waves focusing. At this process the geometry specific character of the new cosmological model "$a = ct$" is used. The picture of the world constructed on this basis (for the time present with the help of estimations) agrees on the whole with the hierarchical structure of the real universe. Specifying of the obtained picture is possible while performing numerical simulation of focusing states.

When implementing such not simple task (the third part of the paper) the problem on energy-momentum tensor in GTR, which can not, evidently, be completely solvable, has arisen. Nevertheless, we have managed to avoid this problem by constructing the total system of differential equations for global metrics of the real universe on the basis of the curvature tensor invariants. There are grounds to hope that this path would finally lead to transformation of Einstein GTR into the Unified field theory.

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