Lorentz-Invariant Gravitation Theory

Chapter 1. Introduction. Statement of problem

1.0. The place of gravitation theory in a number of other physical theories

The consequence of observation and experiments is a series of statements that allow us to make important conclusions about the nature of gravity.

First of all, let us define and explore some important terms and conceptions.

Material objects whose behaviour, in practice, does not reveal their wave nature, are referred to as macro-objects; otherwise the objects are called micro-objects. Sciences regarding macro-objects are called classical. Sciences regarding micro-objects are called quantum. Objects of the macrocosm consist of the objects of the microcosm (although, due to the wave nature of elementary particles, the boundary between macro-objects and micro-objects is not clear, but in practice it does not cause too much difficulty). The laws of the microworld are Lorentz-invariant. The properties of matter of microcosm do not differ from the properties of matter of the macrocosm

The first classical mechanics theory was created by Newton. Two types of laws of mechanics exist: laws of motion of material bodies under the action of forces, and laws that define these forces (which are often called equations of sources). In frames of Newton's theory, his second law is the primary law of motion, while Newton's gravitational law defines the force of gravity.

It should also be mentioned that during the further development of mechanics, numerous mathematical formulations of the original laws of Newtonian mechanics were found, which are physically almost equivalent, including the ones that use energy characteristics of the motion of bodies, rather than force.

As was revealed later, Newtonian mechanics is valid for speeds, well below the speed of light $c \cong 300000$ km/sec. Mechanics, which is valid for speeds υ from zero to the speed of light was conditionally named relativistic mechanics. The deviation of relativistic mechanics from non-relativistic is usually of second order to υ/c (Pauli, 1981)). Under the condition $\upsilon << c$, Newton's laws have very high accuracy.

2.0. Relativistic theories

The definition "relativistic" is equivalent to the requirement "to be invariant under Lorentz transformations". Therefore we will use the definition of "relativistic" equally with the definition of "Lorentz-invariant (briefly "L-invariant"). Let us emphasize that these transformations were obtained by Lorentz on the base of research of invariance of the laws of the EM field - Maxwell's equations.

In relativistic mechanics, there are also several forms of equations of motion and equations of sources. As the relativistic law of motion (including the theory of gravity) the relativistic Hamilton-Jacobi equation is often used.

2.1. How non-relativistic mechanics is related to the relativistic mechanics

Let us note one important feature of any Lorentz-invariant (relativistic) theories in comparison to non-Lorentz-invariant (non-relativistic) theories.

Non-relativistic theories give correct predictions at speeds much less than the speed of light. The relativistic theories give exact values in the entire range of speed from R until the speed of light c = 300 000 km/sec. The inaccuracy of non-relativistic theories compared to the relativistic can be attributed to the Lorentz factor $\gamma_L = 1/\sqrt{1-\upsilon^2/c^2}$, a factor of the Lorentz transformation (see in reference book the diagram of Lorentz-factor as a function of speed). Most amendments to the non-relativistic theory are determined not by the Lorentz factor of the first degree, but of the second degree, which makes the corrections even less.

As seen from the graph, factor is not very different from the unit, up until the velocity of the particle reaches the 1/10 of the velocity of light. The maximum speeds of the planets and the massive bodies on the Earth and in the solar system are: projectile - 1.5 km/s, the rocket - 10-12 km/s, meteorites - 18-25 km/s, the Earth around the Sun - 30 km/s, the Sun in the direction to the galactic center - 200 km/s, our galaxy - up to 400 km/s. Higher speed is achieved only by elementary particles in cosmic space or in accelerators, but they do not play any role in the theory of gravity. If we talk about non-mechanical applications, the velocity of the electrons in the home appliances (e.g., in wires) is comparable to the velocity of thermal motion of atoms and molecules (fraction of km/s).

Thus, the value υ^2/c^2 in real problems of mechanics is very small. This means that the Lorentz factor is not very different from unit. Perhaps the only case we need to use the relativistic equations in real life is in spectroscopy in the study of the emission of very fine lines.

This means that Newtonian mechanics is valid in practical applications with great accuracy. Any corrections thereto, regarding relativism, are insignificant and mainly caused by curiosity of scientists than the practical needs of society. Given that the technical calculations are made with an accuracy of no more than three decimal places, apparently, there is no meaning in this life to enter the so-called relativistic corrections.

This was already understood by one of the founders of the Lorentz-invariant physics – A. Poincare, who had warned (Poincaré, 1908):

"*I tried in a few words to give the fullest possible understanding of new ideas and explain how they were born ... In conclusion, if I may, I express a wish. Suppose that in a few years, this new theory will be tested and come out victorious from this test. Then, our school education is in serious danger: some teachers will undoubtedly want to find a place to new theories .... And then [the students] will not grasp the usual mechanics*.

Is it right to warn students that it gives only approximate results? Yes! But later! When they will be permeated by it, so to speak, to the bone, when they will be accustomed to think only with its help, when there will not be a risk that they forget how to do this, then we can show them its borders. They will have to live with the ordinary mechanics, the only mechanic that they will apply. Whatever the success of automobilism would be, our machines will never reach those speeds where ordinary mechanics is not valid. Other mechanics is a luxury, but one can think about a luxury only when it is unable to cause harm to the necessary."

3.0. The general theory of relativity

The modern theory of gravitation, conventionally called the general theory of relativity (GTR or GR), refers to classical mechanics. As the equation of source is considered to be the Einstein-Hilbert equation (EHE) of general theory of relativity (GTR), which was found by these researchers almost independently and almost simultaneously (Pauli, 1981; Vizgin, 1981). As the basis for theory building, Hilbert used a variational principle. The approach of Einstein was heuristic, emanating from the experimental fact of equality of gravitational and inertial masses (note that this equivalence is also valid in nonrelativistic theories).

A very difficult question, is whether the GTR and its equation are relativistic in terms of the Lorentz invariance. Strictly speaking, it is not. Einstein assumed that the general covariance of the equations of general relativity includes special relativity. Indeed, (Katanaev, 2013, p. 742):

«*Lorentz metric satisfies the Einstein's vacuum equations* . [But] *"in GTR is postulated that space-time metric is not a Lorentz metric, and is found as a solution of Einstein's equations. Thus, the space-time is a pseudo-Riemanian manifold with metric of a special type that satisfies the Einstein equations*."

As is known, EHE is very different from other equations of mechanics, since it is based on the Riemann geometry in general covariant system of coordinates. For this reason, it is not compatible with the laws of quantum mechanics.

Besides, EHE has several disadvantages, which have not been overcome to date (see critics in the works of V. Fock, A. Logunov, etc (Fock, 1964; Logunov, 2002; Rashevskyi, 1967)). These disadvantages have been for many years the cause of searching the new relativistic source equation of gravity. The L-invariant theory of gravitation is regarded as one of the basic, because it could completely eliminate the disadvantages of the GTR. (see, e.g., the Lorentz-invariant theory of A. Logunov with scholars (Logunov, 2002)).)

It should be noted that GTR showed that the cause of gravity is matter in the form of concentrated and unconcentrated material field. The first type of matter is usually called a massive body or an 'island matter' (e.g., massive elementary particles and bodies, composed of them). The second type is, properly, called a field. According to modern concepts, the fields also consist of elementary particles - quanta of this field (as, for example, the electromagnetic field, which consists of massless elementary particles - photons).

Both kind of matter are characterized by the energy, momentum, mass, current of mass and other dynamic characteristics (Fock, 1964). Moreover, the majority of these characteristics may be defined either as integral features - namely, energy, momentum, mass, and current of mass, etc., or in form of differential characteristics, such as densities of these parameters of matter.

Obviously, within the framework of LIGT, the reason of gravity is also matter in the above sense.

As we noted, the question about why the search for other theories of gravity still continues, is due to the fact that general relativity has a number of peculiarities and drawbacks (see Fock, 1964; Logunov, 2002; Rashevskyi, 1967, etc.), that impede its relationships with the rest of physics. Let us enumerate them.

3.1. The peculiarities and drawbacks of GTR

1) The left side of the nonlinear equations of general relativity (in fact it is a short record of 10 equations) has no physical meaning, but only a geometric meaning.

The right side includes a pseudo-tensor of energy-momentum (Landau and Lifshitz,1975), which has a conditional physical sense (Logunov et al.). the choice of this tensor is quite arbitrary. For this reason, in general relativity the law of conservation of energy is absent.

Recall that Einstein spoke about his gravitational field equations in the book "Physics and Reality» (Einstein, 1936):

"[GTR] *is similar to a building, one wing of which is made of fine marble (left part of the equation), but the other wing of which is built of low grade wood (right side of equation). The phenomenological representation of matter is, in fact, only a crude substitute for a representation which would correspond to all known properties of matter*."

2) In 1918, Schrodinger (Schroedinger, 1918) first showed that by the appropriate choice of coordinate system all components, characterizing the energy-momentum of the gravitational field in the interpretation of Einstein, can be turned to zero.

This was confirmed by D. Hilbert and other scientists. For example, in the book (Landau and Lifshitz, 1975, page 283), we can read the following:

"*On the other hand, from the vanishing of a pseudo-tensor at some point in one reference system it does not at all follow that this is so for another reference system, so that it is meaningless to talk of whether or not there is gravitational energy at a given place. This corresponds completely to the fact that by a suitable choice of coordinates, we can "annihilate" the gravitational field in a given volume element, in which case, from what has been said, the pseudotensor ttk also vanishes in this volume element*."

3) Due to the strong nonlinearity of the equation, the exact analytical solution of GR is obtained and experimentally verified only for a small number of tasks, and, by ideally setting them - in a vacuum, out of the source of gravity.

4) GTR has no connection with quantum field theory (i.e., with the theory of elementary particles - the smallest particles of matter, capable to produce the gravitational field). Some prominent scientists even argue that gravity is some independent object of nature, which has no connection with the rest of physics.

4.0. Statement of the problem

Our goal is to build a non-geometric Lorentz-invariant gravitation theory (LIGT), which will be based on the quantum field theory (QFT). Such a theory could make it possible to overcome all the shortcomings of general relativity.

Since the Hilbert-Einstein equations give proven results, obviously, we have to show that such a LIGT gives equivalent results.

Our additional goal will be to explain the features of general relativity within the framework of nongeometric physics.

For the purity of the theoretical conclusions of LIGT we will not use anywhere GTR or similar metric theory as the basis of our theory (this does not apply to those cases, in which we will compare the results of these theories).

In the book we shall use the CGS system of units, in particular, the system of units of Gauss, since here all units are expressed in terms of a unified system of mechanical units and therefore this system is the most common among theoretical physicists.