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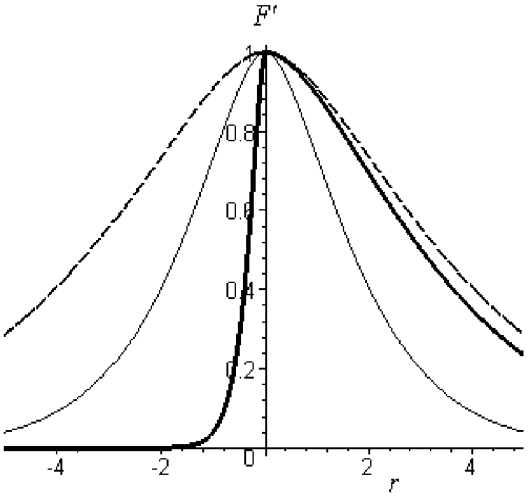
Spacetime & Substance

International Physical Journal



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Spacetime & Substance

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THE EQUATIONS OF THE GRAVITATIONAL FIELD

A. Einstein

Published as *Die Feldgleichungen ger Gravitation.* Sitzungsber. preuss. Akad. Wiss., 1915, **48**, 2, 844–847

The correct equation of gravitation with the tensor $T_{\alpha\beta} - 1/2 g_{\alpha\beta} T$ occurs for the first time in this work. The introduce of the second term has liberated, at last, Einstein from necessity to impose on the tensor $T_{\alpha\beta}$ requirement $T = 0$. It finished the creating the General Theory of Relativity.

I have specified in two recently appeared a brief article, which way it is possible to derive the equations of the gravitational field accordance to a postulate of the general theory of relativity, i.e. covariant in a general view in relation to any replacement the space-time variables.

The course of enunciating was the following. First of all I have found the equations, which contained the theory of Newton as approach and were covariant in relation to arbitrary transformations with the determinant is equal to 1. From here I have found, that these equations is generally covariant, if the scalar (track) of the tensor of energy of "substance" is equal to 0. The frame was chosen then with the help of simple rules so that $\sqrt{-g}$ was converted in 1, due to what the equations of the theory became considerably simpler. Thus, as it was mentioned, to introduce the hypothesis about to convert in a zero the track energy substance tensor was necessary.

Lately I have come to inclining, that is possible to manage without the guesses about a energy substance tensor if it introduce into the field equations by a little bit other way, than it was made in both my the brief article. Thus the field equations for empty space, on which I based the explanation of the Mercury perihelion motion, remain constant. I shall give here the all derivation once again not to force the reader to be converted all time to early works.

The following covariant of the 2 rank it is possible to derive from a well known Riemann tensor of the 4-th rank:

$$G_{ik} = R_{im} + S_{im}, \tag{1}$$

$$R_{im} = -\sum_l \frac{\partial \left\{ \begin{matrix} il \\ l \end{matrix} \right\}}{\partial x_l} + \sum_{l\rho} \left\{ \begin{matrix} il \\ \rho \end{matrix} \right\} \left\{ \begin{matrix} m\rho \\ l \end{matrix} \right\}, \tag{2}$$

$$S_{im} = \sum_l \frac{\partial \left\{ \begin{matrix} il \\ l \end{matrix} \right\}}{\partial x_m} - \sum_{l\rho} \left\{ \begin{matrix} im \\ \rho \end{matrix} \right\} \left\{ \begin{matrix} \rho l \\ l \end{matrix} \right\}. \tag{3}$$

We shall receive ten generally covariant equations of a gravitational field in space, where there is no "substance", if we assume that

$$G_{im} = 0. \tag{4}$$

These equations are easy for establishing, if a frame of reference to pick so that $\sqrt{-g} = 1$. Then by virtue of the formula (4) S_{im} is converted in zero and instead of (5) is gained

$$R_{im} = -\sum_l \frac{\partial \Gamma^l_{im}}{\partial x_l} + \sum_{l\rho} \Gamma^l_{i\rho} \Gamma^\rho_{ml} = 0, \tag{5}$$

$$\sqrt{-g} = 1. \tag{6}$$

Here we have assume that

$$\Gamma^l_{im} = -\left\{ \begin{matrix} im \\ l \end{matrix} \right\}. \tag{7}$$

These values we consider as "components" of the gravitational field.

If in viewed space there is "substance", then on the right in the equations (5) or (6) appear a tensor of energy.

Let's assume

$$G_{im} = -\left(T_{im} - \frac{1}{2} g_{im} T \right), \tag{8}$$

where

$$\sum_{\rho\sigma} g^{\rho\sigma} T_{\rho\sigma} = \sum_\sigma T^\sigma_\sigma = T. \tag{9}$$

Here T is the track of an energy "substance" tensor; the right member of equality (2) is a tensor.

Again by usual way we shall choose a frame; thus instead of (2) we shall receive the equivalent equations

$$R_{im} = -\sum_l \frac{\partial \Gamma^l_{im}}{\partial x_l} + \sum_{l\rho} \Gamma^l_{i\rho} \Gamma^\rho_{ml} =$$

$$= -\left(T_{im} - \frac{1}{2} g_{im} T \right), \tag{10}$$

We shall accept, as always, that the divergency of the energy substance tensor (in sense of an absolute differential calculus) is converted in zero (the law of the momentum and energies conservation). At a select of coordinates, according to (7), from here follows, that T_{im} should obey

$$\sum_{\lambda} \frac{\partial T_{\sigma}^{\lambda}}{\partial x_{\lambda}} = -\frac{1}{2} \sum_{\mu\nu} \frac{\partial g^{\mu\nu}}{\partial x_{\sigma}} T_{\mu\nu}, \tag{11}$$

or

$$\sum_{\lambda} \frac{\partial T_{\sigma}^{\lambda}}{\partial x_{\lambda}} = -\frac{1}{2} \sum_{\mu\nu} \Gamma_{\sigma\nu}^{\mu} T_{\mu}^{\nu}. \tag{12}$$

The equation (10) multiply by $\partial g^{im}/\partial x_{\sigma}$ and sum on i and on m. Then with the account (11) and correlation

$$\frac{1}{2} \sum_{im} g_{im} \frac{\partial g^{im}}{\partial x_{\sigma}} = -\frac{\partial ln\sqrt{-g}}{\partial x_{\sigma}} = 0,$$

following from (7), we gain a joint conservation law for substance and gravitational field as

$$\sum_{\lambda} \frac{\partial}{\partial x_{\lambda}} \left(T_{\sigma}^{\lambda} + t_{\sigma}^{\lambda}\right) = 0, \tag{13}$$

where t_{σ}^{λ} ("the tensor of energy" gravitational fields) is set by equality

$$t_{\sigma}^{\lambda} = \frac{1}{2} \delta_{\sigma}^{\lambda} \sum_{\mu\nu\alpha} g^{\mu\nu} \Gamma_{\nu\alpha}^{\alpha} - \sum_{\mu\nu\alpha} g^{\mu\nu} \Gamma_{\mu\sigma}^{\alpha} \Gamma_{\nu\alpha}^{\lambda}. \tag{14}$$

The bases which have compelled me to introduce the second term in right members of the equations (2) and (10), for the first time have come to light from the following reasons completely similar given in just indicated place (page 785).

Let's multiply the equation (10) by g^{im} and sum on coefficients i and m. Then after the prime calculations we shall receive

$$\sum_{\alpha\beta} \frac{\partial^2 g^{\alpha\beta}}{\partial x_{\alpha} \partial x_{\beta}} - (T + t) = 0, \tag{15}$$

where, according to (9), for short we have assume

$$\sum_{\rho\sigma} g^{\rho\sigma} t_{\rho\sigma} = \sum_{\rho} t_{\sigma}^{\sigma} = t. \tag{16}$$

It is easy to see that our additional term gives that the gravitational field and substance energy tensors enter the equation (15) equally, that is not present in the equation (21) of the mentioned work.

Further, way, indicated in quoted work, equation (22) in same work in view of the law energy conservation can be shown as:

$$\frac{\partial}{\partial x_{\mu}} \left[\sum_{\alpha\beta} \frac{\partial^2 g^{\alpha\beta}}{\partial x_{\alpha} \partial x_{\beta}} - (T + t) \right] = 0. \tag{17}$$

Our additional term gives that these equations do not contain any new requirements in comparison with the equation (15), so about an energy substance tensor is not made any guesses, except those that correspond to the law of energy and impulse conservation.

Thus, at last, build-up of a general theory of relativity as logical circuits is completed. The postulate of a relativity in it most general form, which deprives of physical sense the space-time coordinates, gives with iron necessity in the quite particular theory of gravitation explaining a motion of a Mercury perihelion. Together with what the general theory of relativity can not to give us about substance of remaining natural phenomena anything, that would not be already known in a special theory of relativity. My judgement expressed recently in this connection, was in this respect error. It is possible through an absolute differential calculus to include each physical theory compatible to the special theory of relativity, in the plan of a general theory of relativity, and the latter does not give any test of an admissibility of the physical theory.

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SOLITONS OF INDUCED SCALAR FIELD AND THEIR STABILITY

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Exact particle-like static, spherically and/or cylindrically symmetric solutions to the equations of interacting scalar and electromagnetic field system have been obtained. We considered Freedman-Robertson-Walker (FRW) space-time as an external homogenous and isotropic gravitational field whereas the homogeneous and anisotropic Universe is given by the Gödel model. Beside the usual solitonian solutions some special regular solutions know as droplets, anti-droplets and bags (confined in finite interval and having trivial value beyond it) have been obtained. It has been shown that in FRW space-time equations with different interaction terms may have stable solutions while within the scope of Gödel model only the droplet-like and the hat-like configurations may be stable, if they are located in the region where $g^{00} > 0$.

1. Introduction

The concept of soliton as regular localized stable solutions of nonlinear differential equations is being widely utilized in pure science [1]. One of the fields to apply the soliton concept is the elementary particle physics, where the soliton solutions of nonlinear field equations are used as the simplest models of extended particles [2, 3]. Development of general relativity (GR) and quantum field theory (QFT) leads to the increasing interest to study the role of gravitational field in elementary particle physics. To obtain and study the properties of regular localized solutions to the nonlinear classical field equations is motivated mainly by a hope to create a consistent, divergence-free theory. These solutions, as was remarked by Rajaraman [4] give us one of the ways of modeling elementary particles as extended objects with complicated spatial structure. In such attempts it is natural to treat the field nonlinearity not only as a tool for avoiding the theoretical difficulties (such as singularities) but also as a reflection of real properties of physical system. It should be also emphasized that the complete description of elementary particles with all their physical characteristics (e.g., magnetic momentum) can be given only in the framework of interacting field theory [5]. Let us remark that the choice the field equations is one of the principle problems in nonlinear theory. At present there is no criterion for the selection of interaction Lagrangian and any Lorentz-invariant combination of field functions can be considered as such Lagrangian.

The purpose of this paper is to present some new results (anti-droplets and hats), in addition to those illustrated in [6] for an interacting system of scalar and electromagnetic fields, confining ourselves to static, spherically and/or cylindrically symmetric configurations since the effect of gravitational fields on the properties of regular localized solutions significantly depends on the symmetry of the system.

2. Fundamental equations

So that the field equations possess regular solutions it is necessary to introduce nonlinear terms, describing the field interactions, in the Lagrangian. We consider the nonlinear generalization of the theory that is related to the introduction of direct interaction between neutral scalar and electromagnetic fields. The decay process like $\pi^0 \to 2\gamma$, described by the effective Lagrangian [7]

$$L_{\rm int} = \varphi_{\pi^0} F_{\alpha\beta} F^{*\alpha\beta},$$

indicates to the possibility of such generalization. Thus we consider a system with the Lagrangian

$$L = \frac{1}{2}\varphi_{,\alpha}\varphi^{,\alpha} - \frac{1}{16\pi} F_{\alpha\beta}F^{\alpha\beta}\Psi(\varphi), \tag{2.1}$$

where $\Psi(\varphi)$ is some arbitrary function characterizing interaction between the scalar (φ) and electromagnetic $(F_{\mu\nu})$ fields takes the form

$$\Psi(\varphi) = 1 + \lambda\Phi(\varphi).$$

As is seen, for $\lambda = 0$, $\Psi(\varphi) \equiv 1$ and we have the system with minimal coupling. Note that the Lagrangian

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(2.1) describes the system of fields with positive definite energy if $\Psi(\varphi) \geq 0$. This kind of interaction has been thoroughly discussed in [8].

Let us write the scalar and the electromagnetic field equations corresponding to the Lagrangian (2.1)

$$\frac{1}{\sqrt{-g}}\frac{\partial}{\partial x^\nu}\left(\sqrt{-g}g^{\nu\mu}\frac{\partial\varphi}{\partial x^\mu}\right)+\frac{1}{16\pi}F_{\alpha\beta}F^{\alpha\beta}\Psi_\varphi = 0, \quad (2.2)$$

$$\frac{1}{\sqrt{-g}}\frac{\partial}{\partial x^\nu}\left(\sqrt{-g}F^{\nu\mu}\Psi(\varphi)\right) = 0, \quad (2.3)$$

where $\Psi_\varphi = \partial\Psi/\partial\varphi$.

The corresponding energy-momentum tensor reads

$$T^\nu_\mu = \varphi_{,\mu}\varphi^{,\nu} - \frac{1}{4\pi}F_{\mu\beta}F^{\nu\beta}\Psi(\varphi) - \delta^\nu_\mu L. \quad (2.4)$$

3. Spherically symmetric configurations

3.1. Solutions in FRW Universe

As an external homogenous and isotropic gravitational field we choose the FRW space-time. This Universe is very important as the corresponding cosmological models coincides with observation. The interval in the FRW Universe in general takes the form [9, 10]

$$ds^2 = dt^2 - R^2(t)\left[\frac{dr^2}{1-kr^2} + r^2\{d\vartheta^2 + \sin^2\vartheta d\phi^2\}\right]. \quad (3.1)$$

Here $R(t)$ defines the size of the Universe, and k takes the values 0 and ± 1. We consider the simple most case putting $R(t) = R =$ constant, which corresponds to the static FRW Universe. In static case $k = 0$ corresponds to usual Minkowski space, $k = +1$ describes the close Einstein Universe [11] and $k = -1$ corresponds to the space-time with hyperbolic spatial cross-section. Note that the velocity of light c has been taken to be unity.

As was mentioned earlier, we seek the static, spherically symmetric solutions to the equations (2.2) and (2.3). To this end we assume that the scalar field is the function of r only, i.e. $\varphi = \varphi(r)$ and the electromagnetic field possesses only one component $F_{10} = \partial A_0/\partial r = A'$.

Under the assumption made above, the solution to the equation (2.3) reads

$$F^{01} = \bar{q}P(\varphi)\frac{\sqrt{1-kr^2}}{R^3r^2}, \quad (3.2)$$

where $\bar{q}$ is the constant of integration and $P(\varphi) = 1/\Psi(\varphi)$.

Putting (3.2) into (2.2) for the scalar field we obtain the equation with "induced nonlinearity" [12, 13]

$$(1-kr^2)\varphi'' + \frac{2-3kr^2}{r}\varphi' - \frac{2q^2}{R^2r^4}P_\varphi = 0, \quad (3.3)$$

where we denote $q^2 = \bar{q}^2/16\pi$. This equation can be written in the form

$$\frac{\partial^2\varphi}{\partial z^2} - \frac{2q^2}{R^2}P_\varphi = 0 \quad (3.4)$$

with the first integral

$$\frac{\partial\varphi}{\partial z} = \frac{2q}{R}\sqrt{P + C_0}, \quad (3.5)$$

where we substitute $z = \sqrt{1/r^2 - k}$. Here C_0 is the constant of integration, which under the regularity condition of T^0_0 at the center turns to be trivial, i.e., $C_0 = 0$.

Finally we write the solution to the scalar field equation in quadrature

$$\int\frac{\partial\varphi}{\sqrt{P}} = \frac{2q}{R}(z - z_0). \quad (3.6)$$

In accordance with (3.2) and (3.5) from (2.4) we find the density of field energy of the system

$$T^0_0 = \frac{4q^2P}{R^4r^4} \quad (3.7)$$

and total energy of the material field system

$$E_f = \int T^0_0\sqrt{-^3g}d^3\mathbf{x} = -8\pi q\int\sqrt{P}d\varphi. \quad (3.8)$$

Thus, we see that the energy density T^0_0 and total energy E_f of the configurations obtained do not depend on the conventional values of the parameter k. As one sees, to write the scalar (φ) and vector (A) functions as well as the energy density (T^0_0) and energy of the material fields (E_f) explicitly, one has to give $P(\varphi)$ in explicit form. Here we will give a detailed analysis for some concrete forms of $P(\varphi)$.

Let us choose $P(\varphi)$ in the form

$$P(\varphi) = P_0\cos^2\left(\frac{\lambda\varphi}{2}\right), \quad (3.9)$$

with λ being the interaction parameter. Inserting (3.9) into (3.4) we get the sin-Gordon type equation [14]

$$\frac{\partial^2\varphi}{\partial z^2} + \frac{\lambda q^2P_0}{4R^2}\sin(\lambda\varphi) = 0 \quad (3.10)$$

with the solution

$$\varphi(z) = \frac{2}{\lambda}\arcsin\tanh[b(z+z_1)], \quad b = \frac{\lambda q\sqrt{P_0}}{R} \quad (3.11)$$

with z_1 being the constant of integration. Let us analyze the solution (3.11). It can be shown that $\lim_{r\to 0}\varphi = \pi/\lambda$ for all k. As one sees, the solution possesses meaning only in the region where $z = \sqrt{1/r^2 - k} > 0$. It means, in case of $k = +1$ the configuration confines in the interval $0 \leq r \leq 1$. Then the asymptotic behavior of the solution (3.11) can be written as

$$\varphi \to \begin{cases} 0, & k=-1, \quad z_1=-1, \quad r\to\infty, \\ 0, & k=0, \quad z_1=0, \quad r\to\infty, \\ 0, & k=+1, \quad z_1=0, \quad r\geq 1. \end{cases} \quad (3.12)$$

From (3.8) we find the total energy of the system $E_f = -16\pi q\sqrt{P_0}/\lambda$.

For the choice of $P(\varphi)$ in the form

$$P = \lambda(a^2 - \varphi^2)^2 \tag{3.13}$$

with λ being the coupling constant and a being some arbitrary constant, from (3.4) we obtain

$$4\lambda a^2\varphi - 4\lambda\varphi^3 + \frac{\partial^2\varphi}{\partial z^2} = 0. \tag{3.14}$$

The equation (3.14) can be seen as an MKdV one. Indeed, a KdV equation

$$\frac{\partial u}{\partial t} + \alpha u^p \frac{\partial u}{\partial x} + \beta\frac{\partial^3 u}{\partial x^3} = 0 \tag{3.15}$$

can always be converted to

$$-Du + \alpha\frac{u^{p+1}}{p+1} + \beta\frac{d^2u}{dz^2} = 0 \tag{3.16}$$

if one looks for stationary solution of the form $u = u(z)$ where $z = x - Dt$. In our particular case $p = 2$ and the equation (3.14) is an MKdV one.

The scalar field function in this case has the form

$$\varphi(z) = a\tanh[\sqrt{\lambda}ab(z + z_2)], \quad b = \frac{2q}{R}. \tag{3.17}$$

Taking into account that $z = \sqrt{1/r^2 - k}$ one sees that at the origin $\lim_{r\to 0}\varphi = a$ whereas at the asymptotic region for different value of k we get

$$\varphi \to \begin{cases} 0, & k = -1, \quad z_2 = -1, \quad r \to \infty, \\ 0, & k = 0, \quad z_2 = 0, \quad r \to \infty, \\ 0, & k = +1, \quad z_2 = 0, \quad r \geq 1. \end{cases} \tag{3.18}$$

From (3.8) we find the total energy of the system to be $E_f = -16\pi q\sqrt{\lambda}a^3/3$.

A specific type of solution to the nonlinear field equations in flat space-time was obtained in a series of interesting articles [15]. These solutions are known as droplet-like solutions or simply droplets. The distinguishing property of these solutions is the availability of some sharp boundary defining the space domain in which the material field happens to be located, i.e., the field is zero beyond this area. It was found that the solutions mentioned exist in field theory with specific interactions that can be considered as an effective one, generated by initial interactions of unknown origin. In contrast to the widely known soliton-like solutions, with field functions and energy density asymptotically tending to zero at spatial infinity, the solutions in question vanish at a finite distance from the center of the system (in the case of spherical symmetry) or from the axis (in the case of cylindrical symmetry). Thus, there exists a sphere or cylinder with critical radius r_0 outside of which the fields disappear. Therefore the field configurations have a droplet-like structure [12, 15, 16].

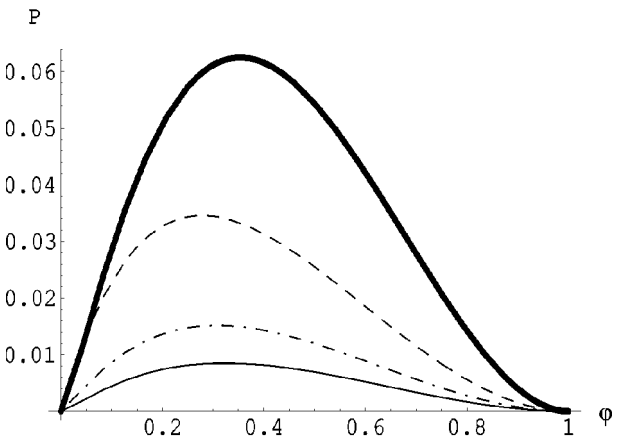

Figure 1: Perspective view of interaction function $P(\varphi)$ providing (anti-)droplet like configurations for different values of σ. Here (and later on) the thick-line, dash-line, dash-dot-line and thin-line correspond to the value of $\sigma = 3, 5, 7, 9$ respectively

To obtain the droplet-like configuration we choose a very specific type of interaction function $P(\varphi)$ which has the form [17] [cf. FIG. 1]

$$P(\varphi) = J^{2-4/\sigma}\left(J^{2/\sigma} - 1\right)^2, \tag{3.19}$$

where $J = \lambda\varphi$, $\sigma = 2n + 1$, $n = 1, 2\cdots$. Putting (3.19) into (3.6) one gets

$$|J^{2/\sigma} - 1| = \exp\left[\pm\frac{4q\lambda}{R\sigma}(z - z_0)\right]. \tag{3.20}$$

Let us consider the case when $|J^{2/\sigma} - 1| = 1 - J^{2/\sigma}$. Taking the sign in exponent to be "minus" one from (3.20) we obtain

$$\varphi(z) = \frac{1}{\lambda}\left[1 - \exp\left(-\frac{4q\lambda}{R\sigma}(z - z_0)\right)\right]^{\sigma/2}. \tag{3.21}$$

Recalling that $z = \sqrt{1/r^2 - k}$ from (3.21) we see that at $r \to 0$ the scalar field φ takes the value $\varphi(0) \to 1/\lambda$ and at $r \to r_c = 1/\sqrt{z_0^2 + k}$, the scalar field function becomes trivial, i.e., $\varphi(r_c) \to 0$. It is obvious that for $r > r_c$ the value of the square bracket turns out to be negative and $\varphi(r)$ becomes imaginary, since σ is an odd number. Since we are interested in real φ only, without loss of generality we may assume the value of φ to be zero for $r \geq r_c$, the matching at $r = r_c$ (i.e., $z = z_0$) being smooth [cf. FIG. 2]. Note that, for $k = +1$, the scalar field is confined in the region $0 \leq r \leq 1$, as it was in previous two cases. The total energy of the droplet we obtain from (3.8) has the form

$$E_f = \frac{4\pi q}{\lambda(\sigma - 1)}. \tag{3.22}$$

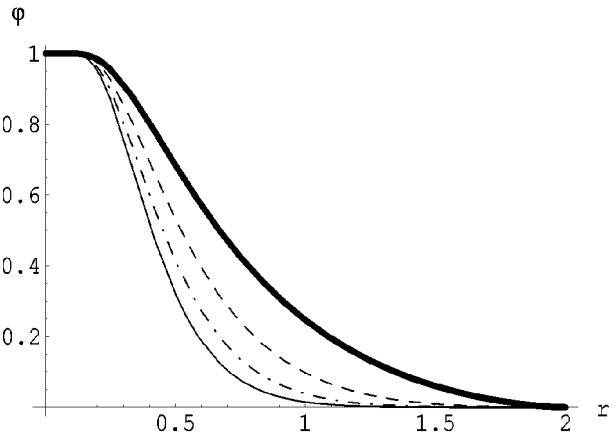

Figure 2: Perspective view of droplet-like configurations

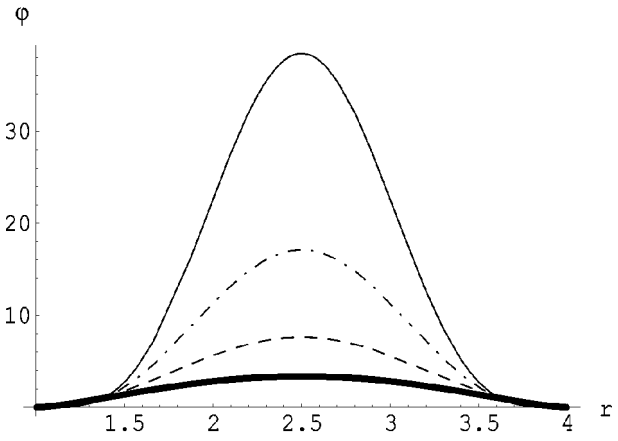

Figure 3: Perspective view of the hat-like configurations

As is seen from (3.22), the value of the total energy does not depend on the size of the droplet, it means droplets of different linear size share the same total energy.

Let us now back to (3.20) again and consider the sign in exponent to be "plus". In this case we find

$$\varphi(z) = \frac{1}{\lambda}\left[1 - \exp\left(\frac{4q\lambda}{R\sigma}(z - z_0)\right)\right]^{\sigma/2}. \tag{3.23}$$

Contrary to the droplet this configuration possesses trivial value up to $r = r_c = 1/\sqrt{z_0^2 + k}$, then begins to increase taking maximum value at spatial infinity:

$$\varphi = \frac{1}{\lambda}\left[1 - \exp\left(\frac{4q\lambda z_0}{R\sigma}\right)\right]^{\sigma/2} \leq 1.$$

Note that the total energy of the anti-droplet (3.23) is equal to that of the droplet.

Finally we consider another very interesting case putting

$$P(\varphi) = \frac{\sigma^2}{4} Q^{2-4/\sigma}\left(A^2 - 4Q^{2/\sigma}\right), \tag{3.24}$$

where $Q = R\varphi/2q$, $\sigma = 2n + 1$, $n = 1, 2 \cdots$. Putting (3.24) into (3.6) one gets

$$\varphi(z) = \frac{2q}{R}\left[(z - a)(b - z)\right]^{\sigma/2}, \tag{3.25}$$

where we put $A = b - a$ and $2z_0 = b + a$. As one sees this configuration is completely localized in the interval $r \in (1/\sqrt{b^2 + k}, 1/\sqrt{a^2 + k})$ having trivial value out of it [cf. FIG. 3]. The total energy of this configuration is trivial.

3.2. Stability problem

To study the stability of the configurations obtained we write the linearized equations for the radial perturbations of scalar field assuming that

$$\varphi(r, t) = \varphi(r) + \xi(r, t), \quad \xi \ll \varphi. \tag{3.26}$$

Putting (3.26) into (2.2) in view of (3.3) we get the equation for $\xi(r, t)$

$$\ddot{\xi} + 3\frac{\dot{R}}{R}\dot{\xi} - \frac{1 - kr^2}{R^2}\xi'' - \frac{2 - 3kr^2}{rR^2}\xi' + \frac{q^2 P_{\varphi\varphi}}{R^4 r^4}\xi = 0. \tag{3.27}$$

The second term in (3.27) is zero since we assume the FRW space-time to be static one putting $R =$ constant. Assuming that

$$\xi(r, t) \approx v(r)\exp(-i\Omega t), \quad \Omega = \omega/R \tag{3.28}$$

from (3.27) we obtain

$$(1 - kr^2)v'' - \frac{2 - 3kr^2}{r}v' + \left[\omega^2 - \frac{q^2 P_{\varphi\varphi}}{R^2 r^4}\right]v = 0. \tag{3.29}$$

The substitution

$$\eta(\zeta) = r \cdot v(r), \quad \zeta = \frac{1}{\sqrt{k}}\arcsin(\sqrt{k}r) \tag{3.30}$$

leads the equation (3.29) to the Liouville one [18]

$$\eta_{\zeta\zeta} + (\omega^2 - V(\varphi))\eta = 0,$$

$$V(\varphi) = -k + \frac{q^2 P_{\varphi\varphi}}{R^2\zeta^4}\left(\frac{\sqrt{k}\zeta}{\sin(\sqrt{k}\zeta)}\right)^4. \tag{3.31}$$

For the interaction term (3.9) we see that $V(\varphi) > 0$ if and only if

$$\tanh^2 b(z + z_1) > \frac{k\zeta^4 R^2}{P_0 q^2 \lambda^2}\left(\frac{\sin(\sqrt{k}\zeta)}{\sqrt{k}\zeta}\right)^4 + \frac{1}{2}. \tag{3.32}$$

Thus we find that the equations with trigonometric nonlinearity contain stable solutions. Given $P(\varphi)$ in the form (3.13) we find that $V(\varphi) > 0$ if

$$\tanh^2 b(z + z_2) > \frac{k\zeta^4 R^2}{12q^2\lambda}\left(\frac{\sin(\sqrt{k}\zeta)}{\sqrt{k}\zeta}\right)^4 + \frac{a^2}{3}. \tag{3.33}$$

As is seen from (3.33) the equations with polynomial type of nonlinearity too contain some stable solutions.

For the droplet-like configurations, i.e., for the interacting term $P(\varphi)$ given by (3.19), it can be shown that the potential

$$\lim_{r\to 0} V(\varphi) \to +\infty, \quad \lim_{r\to r_c} V(\varphi) \to +\infty \tag{3.34}$$

beginning with $\sigma \geq 5$. It means that the droplet-like configurations (3.21) with $\sigma \geq 5$ are stable for the class of perturbation, vanishing at $r = 0$ and $r = r_c$. The same can be concluded for the solutions (3.23) and (3.25).

4. Cylindrically symmetric configurations

4.1. Solutions in Gödel Universe

In the previous section we studied the possibility of formation of regular localized configuration in homogenous and isotropic FRW Universe. Let us now continue our study in the homogenous but anisotropic Universe. In particular we consider the model proposed by Gödel. The linear element of Gödel Universe in cylindrical coordinates reads [19]

$$\begin{aligned} ds^2 &= dt^2 - d\rho^2 + \frac{1}{\Omega^2}[\sinh^4\Omega\rho - \sinh^2\Omega\rho]d\phi^2 - \\ &\quad -\frac{\sqrt{8}}{\Omega}\sinh^2\Omega\rho d\phi dt - dz^2, \end{aligned} \tag{4.1}$$

where the constant Ω is related with the angular velocity ω: $\omega = \sqrt{2}\Omega$. This form of linear element of the four-dimensional homogenous space S directly exhibits its rotational symmetry, since the $g_{\mu\nu}$ do not depend on ϕ. It is easy to find

$$\lim_{\Omega\to 0}\sqrt{-g} = \lim_{\Omega\to 0}\frac{1}{2\Omega}\sinh(2\Omega\rho) \to \rho,$$

i.e. at $\omega \to 0$ Gödel Universe transfers to the flat one.

As in spherically symmetric case, here too we seek the static solutions to the equations (2.2) and (2.3) assuming the scalar field to be the function of ρ only, i.e., $\varphi = \varphi(\rho)$ and the electromagnetic possesses only one component $F_{10} = \partial A_0/\partial\rho = A'$.

For the electromagnetic field in this case we find

$$F^{01} = 2\Omega DP/\sinh(2\Omega\rho), \quad D = \text{const}. \tag{4.2}$$

The scalar field equation (2.2) with regards to (4.2) reads

$$\frac{\partial^2\varphi}{\partial\rho^2} + 2\Omega\coth(2\Omega\rho)\frac{\partial\varphi}{\partial\rho} = \frac{8q^2\Omega^2 P_\varphi}{\sinh^2(2\Omega\rho)}, \tag{4.3}$$

where $q^2 = D^2/16\pi$. Putting $y = \frac{1}{2\Omega}\ln\tanh(\Omega\rho)$ from (4.3) one gets

$$\frac{\partial^2\varphi}{\partial y^2} - 8q^2\Omega^2 P_\varphi = 0 \tag{4.4}$$

with the first integral

$$\frac{\partial\varphi}{\partial y} = \pm 4q\Omega\sqrt{P + D_0}. \tag{4.5}$$

Here D_0 is the constant of integration, which under the regularity condition of T_0^0 at the center turns to be trivial, i.e., $D_0 = 0$. Finally we write the solution to the scalar field equation in quadrature

$$\int\frac{\partial\varphi}{\sqrt{P}} = 4q\Omega(y - y_0). \tag{4.6}$$

In accordance with (4.2) and (4.5) from (2.4) we find the density of field energy and the total energy of the system

$$T_0^0 = \frac{16q^2\Omega^2 P}{\sinh^2(2\Omega\rho)}, \tag{4.7}$$

$$E_f = 8\pi q\int\sqrt{P}d\varphi. \tag{4.8}$$

As in the previous case, to write the scalar (φ) and vector (A) functions as well as the energy density (T_0^0) and energy of the material fields (E_f) explicitly, one has to give $P(\varphi)$ in explicit form. Here again we will thoroughly study the solutions obtained for different concrete forms of $P(\varphi)$.

Choosing $P(\varphi)$ in the form (3.9), i.e.,

$$P(\varphi) = P_0\cos^2\left(\frac{\lambda\varphi}{2}\right) \tag{4.9}$$

with λ being the interaction parameter, from (4.4) we get the sin-Gordon type equation

$$\frac{\partial^2\varphi}{\partial y^2} + 4\lambda q^2\Omega^2 P_0\sin(\lambda\varphi) = 0. \tag{4.10}$$

The solution to this equation can be written in the form

$$\varphi(\rho) = \frac{4}{\lambda}\left[\arctan\left(\frac{\tanh\Omega\rho}{\Omega\rho_0}\right)^\alpha - \frac{\pi}{4}\right], \tag{4.11}$$

here, $\alpha = \lambda q\sqrt{P_0}$ and ρ_0 is the constant of integration, giving the size of the system. Without losing the generality we can choose $\alpha > 0$. Then one finds $\lim_{\rho\to 0}\varphi = -\pi/\lambda$. For $\rho > 0$ the field φ steadily increases up to π/λ. In particular, at spatial infinity we get $\lim_{\rho\to\infty}\varphi = 0$. In this case $P(\varphi_\infty) = 1$ which corresponds to the exclusion of interaction at spatial infinity. The total energy of the system in this case coincides with that of in FRW Universe, i.e., $E_f = -16\pi q\sqrt{P_0}/\lambda$.

Choosing $P(\varphi)$ in the form (3.13), i.e.,

$$P = \lambda(a^2 - \varphi^2)^2 \tag{4.12}$$

from (4.4) we as in FRW case again obtain MKdV type equation with the solution

$$\varphi(\rho) = a\frac{\tanh^\alpha(\Omega\rho) - 1}{\tanh^\alpha(\Omega\rho) + 1}, \quad \alpha = 4aq\sqrt{\lambda}. \tag{4.13}$$

From (4.13) it is clear that $\lim_{\rho\to 0}\varphi \to -a$ and $\lim_{\rho\to\infty}\varphi \to 0$ From (4.8) we find the total energy of the system to be $E_f = -16\pi q\sqrt{\lambda}a^3/3$ as it was in FRW case.

The choice of the interaction term $P(\varphi)$ in the form (3.19), i.e.,

$$P(\varphi) = J^{2-4/\sigma}\left(1 - J^{2/\sigma}\right)^2, \tag{4.14}$$

where $J = \lambda\varphi$, $\sigma = 2n+1$, $n = 1, 2\cdots$, leads to the following expression for scalar field

$$\varphi(\rho) = \frac{1}{\lambda}\left[1 - \left(\frac{\tanh(\Omega\rho)}{\tanh(\Omega\rho_0)}\right)^{\alpha}\right]^{\sigma/2}, \ \alpha = \pm\frac{4\lambda q}{\sigma}, \tag{4.15}$$

where ρ_0 is an arbitrary constant. For $\alpha > 0$ the solution possesses physical meaning at $\rho < \rho_0$ and becomes meaningless at $\rho > \rho_0$. Outside the cylinder $\rho = \rho_0$ one can put $\varphi \equiv 0$. This trivial solution is stitched with the solution at $\rho = \rho_0$ under condition $\varphi'(\rho_0) = 0$, which fulfills if and only if $4\lambda|q| > \sigma$. Consequently, at $\rho > \rho_0$ the Lagrangian becomes physically meaningless, however its limiting value at $\rho \to \rho_0 - 0$ is equal to zero. Continuing it at $\rho > \rho_0$, one can consider the field be totally trivial in this area. Thus we get the droplet-like configuration. The field φ steadily decreases from $\varphi(0) = 1/\lambda$ to $\varphi(\rho_0) = 0$ with $\varphi'(0) = 0$ (for $\sigma \geq 3$) and $\varphi'(\rho_0) = 0$. The total energy of the "droplet" is defined as

$$E_f = \frac{4\pi q}{\lambda(\sigma - 1)}, \tag{4.16}$$

which remains unaltered even in flat space-time ($\Omega = 0$). It means that the "droplet" does not feel Gödel gravitational field. On the other hand, for $\alpha < 0$ we obtain the configuration (anti-droplet) possessing trivial value at $\rho \leq \rho_0$. Starting from $\rho = \rho_0$ it begins to increase and at spatial infinity takes maximum value: $\varphi(\infty) \leq 1/\lambda$.

Finally we consider the case providing hat-like configuration. Putting

$$P(\varphi) = \frac{\sigma^2}{4}Q^{2-4/\sigma}\left(A^2 - 4Q^{2/\sigma}\right), \tag{4.17}$$

where $Q = R/4q\Omega$, $\sigma = 2n+1$, $n = 1, 2\cdots$. Inserting (4.17) into (4.6) one gets

$$\varphi(y) = 4q\Omega\left[(y-a)(b-y)\right]^{\sigma/2}, \tag{4.18}$$

where we put $A = b - a$ and $2y_0 = b + a$. As one sees the configuration is completely localized in the interval $y \in (a, b)$ with trivial total energy.

4.2. Stability problem

Let us now study the stability of the configuration obtained. In doing so we consider the perturbed scalar field $\delta\varphi = \chi(\rho, t)$ that leaves the cylindrical-symmetry of the system unbroken. The linearized equation for the perturbed scalar field looks

$$\frac{1}{\sqrt{-g}}\frac{\partial}{\partial x^\mu}\left(\sqrt{-g}g^{\mu\nu}\chi_{,\nu}\right) + \frac{q^2}{2(-g)}P_{\varphi\varphi}\chi = 0. \tag{4.19}$$

Since, for the case considered, $g^{00} = \frac{(1-\sinh^2\Omega\rho)}{\cosh^2\Omega\rho}$, it is clear that the type of equation (4.19) changes on the surface where $\sinh\Omega\rho = 1$. The Cauchi problem for (4.19) is incorrect by Hadamard in the region, where $g^{00} < 0$. In connection with this only the droplet-like and hat-like solutions can be stable by Lyapunov, if they are located in the region where $g^{00} > 0$ [12]. Assuming that

$$\chi(\rho, t) = v(\rho)\exp(-i\varepsilon t) \tag{4.20}$$

from (4.19) we get

$$v'' + 2\Omega\coth(2\Omega\rho)v' + \\ + \left[\frac{1-\sinh^2\Omega\rho}{\cosh^2\Omega\rho}\varepsilon^2 - \frac{2\Omega^2 q^2}{\sinh^2(2\Omega\rho)}P_{\varphi\varphi}\right]v = 0. \tag{4.21}$$

The substitution

$$\eta(\zeta) = \xi(\rho)\cdot v(\rho), \tag{4.22}$$

where

$$\zeta = \int\frac{\sqrt{1-\sinh^2\Omega\rho}}{\cosh\Omega\rho}d\rho,$$
$$\xi = \left[4\sinh^2\Omega\rho(1-\sinh^2\Omega\rho)\right]^{1/4}$$

leads the equation for perturbed field to the Liouville one

$$\frac{\partial^2\eta}{\partial\zeta^2} + \left[\varepsilon^2 - V\right]\eta = 0. \tag{4.23}$$

Here the effective potential $V(\varphi)$ takes the form

$$V(\varphi) = \frac{\Omega^2}{(1-\sinh^2\Omega\rho)}\Big\{\frac{q^2 P_{\varphi\varphi}}{2\sinh^2\Omega\rho} + \\ + \frac{(4\sinh^6\Omega\rho - 16\sinh^4\Omega\rho + 3\sinh^2\Omega\rho - 1)\cosh^2\Omega\rho}{4\sinh^2\Omega\rho\,(1-\sinh^2\Omega\rho)}\Big\}.$$

For the interaction function, chosen in the form (3.19), one finds

$$P_{\varphi\varphi} = \lambda^2\left(\frac{2\sigma^2 - 12\sigma + 16}{\sigma^2 J^{4/\sigma}} - \frac{4\sigma^2 - 12\sigma + 8}{\sigma^2 J^{2/\sigma}} + 2\right).$$

Taking into account that $\lim_{\rho\to 0} J \to 1$ and $\lim_{\rho\to\rho_0} J \to 0$, it can be shown that

$$\lim_{\rho\to 0} V(\varphi) \to +\infty \quad \text{for} \quad \sigma < 4q\lambda,$$

$$\lim_{\rho\to\rho_0} V(\varphi) \to +\infty \quad \text{for} \quad \sigma \geq 5.$$

Here we used the fact that $g^{00} > 0$, i.e., $\sinh\Omega\rho < |1|$. Thus, as in the previous case we find that the droplet like configurations are stable for $5 \leq \sigma < 4|q|\lambda$. Analogically, we can conclude that the hat-like configurations are also stable beginning with $\sigma \geq 5$. Here it should be emphasized that, contrary to the droplets (anti-droplets) where σ may be big enough, in case of hat-like solutions σ should be small. Otherwise φ itself may be large. Nevertheless, one can always choose P in such a way, e.g.,

$$P = (1/4)(\sigma Q)^{2-4/\sigma}\left[A^2 - 4(\sigma Q)^{2/\sigma}\right],$$

that φ takes reasonable value.

5. Conclusion

We obtained the regular particle-like solutions to the scalar field equations with induced nonlinearity in external gravitational fields described by Freedman-Robertson-Walker and Gödel Universes respectively. Beside the usual solitons, a special type of regular localized configurations, known as droplets, have been obtained. It has been shown that the droplet-like configurations possess limited energy density and finite total energy and the droplets of different linear sizes up to the soliton share one and the same total energy. It is noteworthy to notice that in the spherically symmetrical case (i.e., in the FRW Universe) at $r_c \to \infty$ for $k = 0$ droplet transfers to usual solitonian solution, while for $k = \pm 1$ this is not the case. It has also been shown that in FRW space-time equations with different type of nonlinearities may contain stable solutions, whereas in case of Gödel Universe only the droplet-like and hat-like configurations may be stable. It is noteworthy to remark that in FRW space-time with $k = +1$ the field function is confined in the region $0 \leq r \leq 1$ independent to the choice of interaction function $P(\varphi)$.

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References

[1] Scott, A.C., Chu, F.Y.F., and McLaughlin, D.W. (1973). *Proc. IEEE* **61**, 1443.

[2] Perring, J.K. and Skyrme, T.H.R. (1962). *Nuclear Physics* **31**, 550.

[3] Rybakov Yu.P. (1985). *Particle Structure in Nonlinear Field Theory* (Moscow, PFU).

[4] Rajaraman, R. (1982). *Solitons and Instantons: An introduction to Solitons and Instantons in Quantum Field Theory* (North Holland Publ. Corp., New York).

[5] Bogoliubov, N.N. and Shirkov, D.V. (1976). *An Introduction to the Theory of Quantized Fields* (Nauka, Moscow).

[6] Saha, B. (1998). gr-qc/9806010.

[7] Marshak, R.E. and Sudershan, E.C.G. (1961). *Introduction to Elementary Particle Physics* (Int. Sci. Pub. Inc., New York).

[8] Bronnikov, K.A., Melnikov, V.N., Shikin, G.N., and Staniukovich, K.P. (1979). *Annals of Physics* **118**, 84.

[9] Weinberg, S. (1972). *Gravitation and Cosmology* (John Wiley and Sons, Inc., New York).

[10] Birrell, N.D., and Davies, P.C. (1982). *Quantum Fields in Curved Space* (Cambridge University Press, London).

[11] Einstein, A. (1917). *Sitz. Preuss. Akad. Wiss.* 142.

[12] Bronnikov, K.A., Rybakov, Yu.P., and Shikin, G.N. (1991). *Izvestia VUZov, Physics* **34**(5), 24.

[13] Bronnikov, K.A. and Shikin G.N. (1977). *Izvestia VUZov, Physics* **20**(9), 25; (1991). *Itogi Nauki i Techniki: Classicheskaya teorya polya i teorya gravitatsii* **2**, 4.

[14] Shikin, G.N. (1995). *Theory of Solitons in General Relativity* (URSS, Moscow).

[15] Werle, J. (1977). *Physics Letters B* **71**, 367.

[16] Rybakov, Yu.P., Saha, B., and Shikin, G.N. (1994). *Communications in Theoretical Physics* **3**, 67; (1998). *Gravitation & Cosmology* **4** (2) 114; (1997). *International Journal of Theoretical Physics* **36**, 1475.

[17] Rybakov, Yu.P., Saha, B., and Shikin, G.N. (1995). *JINR Preprint E2-95-197.*

[18] Kamke, E. (1959). *Differentialgleichungen Lösungsmethoden und Lösungen* (Leipzig)

[19] Gödel, A. (1949). *Review Modern Physics* **21**, 447.

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ANALYSIS OF *HIP* #54268 PHENOMENON AS THE EARLIEST FROM CANDIDATES TO GRAVITATIONAL MICROLENS

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The analysis of the characteristics of *HIP* #54268 phenomenon, which according to data of *ESA HIPPARCOS* catalogue is a short-time non-repeated brilliance strengthening of *FH Leo* star, as the earliest from the known phenomena of the gravitational microlensing.

1. Experimental Research of Gravitational Microlenses and Photometrical Basis of Hipparcos Data

This paper is devoted to the analysis of photometrical data of *HIPPARCOS* experiment with the aim of candidate searching to the gravitational microlens.

At present some investigators have already determined more than a half hundred of such candidates. The main signs of the gravitational microlesing consist [1 - 4] in the following.

The microlensing phenomenon, due to the smaller probability of its realization, can be observed as a single amplification of a star brilliance during sufficiently long observation time. The phenomenon repetition ought to relate any type of variability.

The brilliance changing temporary diagram, in the quantitative respect, must comply with the theoretical model, considered thoroughly enough, for example [1 - 3]. This diagram must possess an axle-symmetry of growing and falling branches. Besides, a brilliance changing diagram must own an achromatism. Its kind must not depend on the radiation wave length, on which one performs an observation.

If there is a totality of microlensing phenomena observation, then to the enumerated criteria one adds statistical criteria. In such a way, the microlensing phenomena distribution on the diagram colour - stellar magnitude must correspond to the distribution of the whole of observed stars on the same diagram. The distribution of maximum values of gravitational lenses amplification coefficient must correspond to the uniform distribution of minimum values of stellar magnitude of lensed stars. Besides, the amplification factor maximum value and a typical time of microlensing must be non-correlative ones.

The main limitation for the gravitational microlenses observation is put on by a small probability of a microlensing phenomenon discovery. Using a simulation method of modeling and supposing, that microlenses are spread uniformly in the space, their mass has a degree distribution, and a velocity in relation to the observer has a normal one, Mao and Paczinsky [5] have offered a mathematical model for the frequency calculation of microlensing phenomena in the course of the preset time of observations at the certain amount of the regularly observed stars.

This frequency depends on the optical thickness of the observed area of the stellar sky, determined by a part of the observed space solid angle, covered by Einstein - Chwolson circles of microlenses. The optical thickness is supposed to be the largest in the direction of the Large and the Small Magellanic Clouds, Galaxy bulge and Andromeda nebula.

On the basis of Mao-Paczinsky model A.F. Zakharov and M.V. Sazhin [4], applying to the observations in the direction of the Large Magellanic Cloud determined, that for lenses with masses of the interval from 0,01 till 10 of solar with the typical microlensing time from a week till a year the detection at least one microlensing phenomenon requires watching on the radiance of some millions of stars in the course of at least one year with the observation interval of some days. Roulet and Mollerach [1 - 2] have gained the approximate value for the observations of the Galaxy bulge and a disk.

The immediate observations in the direction of the Large and the Small Magellanic Clouds were performed by the French *EROS* group (Expérience de Recherche d'Objets Sombres) [6 - 8], at the observatory *ESO La*

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Cilla (Chile), Australian - American *MACHO* (*Massive Astrophysical Compact Halo Objects*) [9 - 12] group at the observatory *Mount-Stromlo* (Australia) and *PLANET* group (*Probing Lensing Anomalies NETwork*) at the observatories *Perth* in *Beeckley* and *Hobbarth* (Australia) at *Southernlend* (South African Rebublic) and that of *ESO La Cilla* (Chile).

The *EROS* group, in the course of the first series of observations of more than 80 000 stars during 10 months, did not any microlensing phenomenon. The, in the course of subsequent observations with the duration of 3 years brilliance curves of more than 3,3 *mln* of stars were investigated and two microlensing phenomena with the typical period of 23 and 29 days were discovered. Further, in the course of observations with the duration of about 10 months the brilliance curves of 5,3 *mln* of stars were researched in the direction of the Small Magellanic Cloud and one microlensing phenomenon was discovered with the typical period of 62 days.

During two years *MACHO* group was investigating about 8 *mln* of stars for each of them from 300 till 800 measurements of the brilliance were carried out. There were discovered eight phenomena, satisfying the above enumerated criteria.

The discovered phenomena could be either by stars of the Small [8] or the Large [14] Magellanic Clouds, halo objects of our Galaxy, including an unseen mass [13], or by dim stars of its disk [7 - 8, 10 - 11, 13, 15 - 17], or hypothetical dwarf galaxy [18], located between our Galaxy and the Large Magellanic Cloud.

The observations in the direction of the Galaxy bulge were performed by the Polish - American *OGLE* (*Optical Gravitational Lens Experiment*) group [19 - 23] in Las-Campamanas, alredy mentioned *MACHO* group [24] and French *DUO* (*Disk Unseen Objects*) group at the observatory *ESO La Cilla* (Chile).

During the observations of more, than 1 *mln* of stars in the course of two years by *OGLE* group eleven candidates to microlenses were discovered.

MACHO group in the course of 190 days of observations of 12,6 *mln* of stars had determined 45 phenomena of microlensing.

The discovered phenomena, as in the previous case, could be caused either by dim stars of our Galaxy disk, or by objects of its spheroid, halo [1 - 2], including the Galaxy bulge [1 - 2, 19, 23, 25 - 28], having, as supposed a bar form [25, 29].

The observations in the direction of the Great Andromeda Galaxy were performed by *AGAPE* groups (*Andromeda galaxy and Amplified Pixel Experiment*) [30 - 31] in the observatory *Pick-du-Midi* in the Pyrénées (France) [4], *COLUMBIA-VATT* on the telescope of Vatican in Arizona and *SSAI* (*Sternberg State Astronomical Institute*, Russia) at the observatory *Mount-Maidanak* (Uzbekistan) [32].

The group of the scientists of Sternberg institute in the course of 1,5 years of observations has discovered about 75 phenomena, probably connected with microlensing. In the course of the first series of observations and in the course of 57 night observations *AGAPE* group didn't register any microlensing phenomenon. The observations complexity is conditioned with the difficulty in the solution of separate stars of Andromeda galaxy, as a result of which the integral star radiance of the galaxy areas was under the observations [31, 33 - 34].

The microlensing phenomena one associates with the halo of our Galaxy and also with the disk, the spheroid and the hypothetical halo of the Galaxy itself [4, 34].

The enumerated microlensing phenomena are connected directly with the problem of universe dark mass, the objects of which perform the microlensing function. To such objects, consisting of baryon mass and called *MACHO*, according to Carr survey data [35], in particular one refers snow balls [35 - 39], brown dwarves [40 - 42], dim red stars (*M-dwarfs*) [5, 43], molecular hydrogen clouds [44 - 45], thick gas clouds [46], neutron stars and black holes [35]. The unseen mass can be also a non-baryon one [35, 47 - 48]. The non-baryon substance, called *WIMP*s (*Weakly Interacting Massive Particle*) can form axions, light neutrinoes and neutralinoes [49].

It is supposed, that in case with the baryon substance the [22, 50] brown dwarves, dim red stars and white dwarves can be microlenses. In case with the non-baryon substance microlenses can consist of the particles of the neutralino type.

It is supposed, that up till 90...99 % galaxies substance is unseen [1] and is concentrated in the spherical subsystem (halo). By means of the gravity of *MACHO* bodies, forming the halo, on the spreading electromagnetic radiance one determined the choice as radiance sources the objects of the Large Magellanic Cloud, Andromeda galaxy and Galaxy bulge for the search of the gravitational lenses.

In [3 - 4] the total observations exposition at various experiments for their comparison is given *star·years*. Evidently, the expected microlensing frequency can be estimated in the *star·years* of observations *for the phenomenon*. In the enumerated experiments similar estimation equaled from $(0,15\ldots5,0)\times10^6$ *star·years·phenomenon*$^{-1}$.

Mentioned above allows to suppose, that if the summarized exposition of the regular observations of the stars brilliance, performed at different time in the course of the realization of various scientific programs, is not lower the shown values, then there is a certain probability of the discovery of at least one gravitational microlensing phenomenon at the additional data analysis of these observations.

Expedient to point out, that similar observations can be carried out in the directions, characterized by

lower optical thickness in comparison with the observations in the directions mentioned above. Hence, according to Bahcall data [43], the brown dwarves, to considerable extent, forming a halo and being one of the most probable candidates to microlenses at the observations in the mentioned directions, do not exceed 15 % of the stars mass of Galaxy disk. Therefore, if in the areas of the luminosity there is a considerable contribution of stars, which can be lensed only with the dark matter of the Galaxy disk, the shown values of total exposition for the phenomenon will require correction for increasing.

A vide data base of stars luminosity observations is in the catalogue *"Hipparcos"* [51], compiled by *European Space Agency* according to data, gained from the satellite of the same name. In the course of the flight there were performed numerous measurement of luminosity of 118 218 stars in the course of 3,4 years with the total amount of 13 *mln* of single measurements.

The summarized exposition, in such a way, equaled $0{,}4 \times 10^6$ *star·years*, that allows to hope for at least one microlensing phenomenon.

We'll analyse satellite's data.

2. *HIP* #54268 Phenomenon

The *ESA HIPPARCOS* satellite was launched into the orbit on august 8, 1989 and functioned up till august 15, 1993. The astrometric observations were carried out since november 1989 (epoch 1989,85) up till march 1993 (epoch 1993,21).

Among 118 218 stars, the luminosity of which was observed regularly one has determined a variability of luminosity for 3 794. A brilliance periodicity periodicity was determined for 2 967 of them. Among the rest of 827 curves of brilliance one determined a phenomenon, *HIP* #54268, which can be considered as a result of microlensing action.

The *HIP* #54268 phenomenon is a single observed in the course of 1083 days, short-time, with the duration about 21 days, the brilliance increasing of *FH Leo* star, shown in the fig.1 according to the catalogue "*Hipparcos*" [51].

Analyse this phenomenon as a supposed result of star gravitational microlensing.

FH Leo star, according to data of this catalogue, has coordinates: right ascension $11h$ 06' 07,43", declination $+07^0$ 02' 01,0", relates to the spectral class *F*8, has a colour index 0,503, calculated in photometrical Johnson *UBV*-system measured by the method of double-coloured *TYCHO* - interferometry, performed from the satellite.

The star has the stellar magnitude *V*=8,48, which is calculated by means of correction of median stellar magnitude $H_{\bar{p}}$, measured in Hipparcos - photometrical system, taking into account the index of colour and

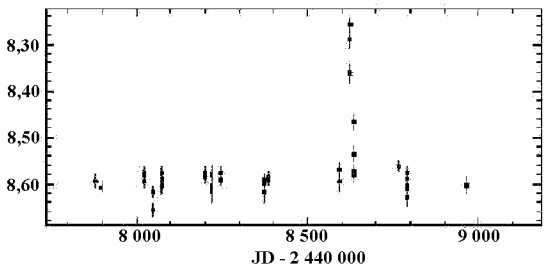

Figure 1: *HIP* #54268 phenomen according to *Hipparcos* data [51]

spectral class.

FH Leo is a double stellar system, having in CCDM catalogue (*Catalogue of Components of Double and Multiple Stars*) [52] number 11061+0702. The system components are apart from each other for the angular distance 8,310" and are characterized by a difference of stellar magnitudes equaled 1,58 in Hipparcos photometrical system. The star was observed as a single object, solution of which was performed by correlative methods on the basis of the brilliance analysis. The qualitative solution was estimated as a good one. The orbital period was estimated as considerably surpassing in observations duration, which from the view point of the catalogue authors can point out on the physical disconnectness of the system components.

The curve, shown in fig.1 represents a temporary diagram of stellar magnitude changing of the object of observation. Abscissa axis is graduated in *JD* (*Julian days*). The determined short-time decreasing of the stellar magnitude of given star depicts variability of the character of its brilliance, for the first time detected by *ESA HIPPARCOS* satellite. This variability is regarded to the variability of the undetermined type.

Decreasing of the stellar magnitude, as supposed microlensing production, was observed directly during January 2...14, 1992, while up till now the first of candidates candidate to the gravitation lenses was considered *OGLE* #10 phenomenon, observed in the direction of the Galaxy bulge. The minimum of the stellar magnitude in the course of *OGLE* #10 phenomenon was reached on June 29, 1992. The information [19] about the discovery of this phenomenon was delivered only in 1994 due to that, that the process of its discovery, also as in the case with the detection of here described *HIP* #54268 phenomenon, was connected with the latest treatment of the considerable observation information received earlier. Besides *OGLE* #10 phenomenon the *OGLE* group on summer 1992 has detected and fixed six more phenomena of gravitation microlensing.

Because of the considerable duration of the experimental data treatment by *OGLE* group the first which declared about gravitation lenses detection were *MA-*

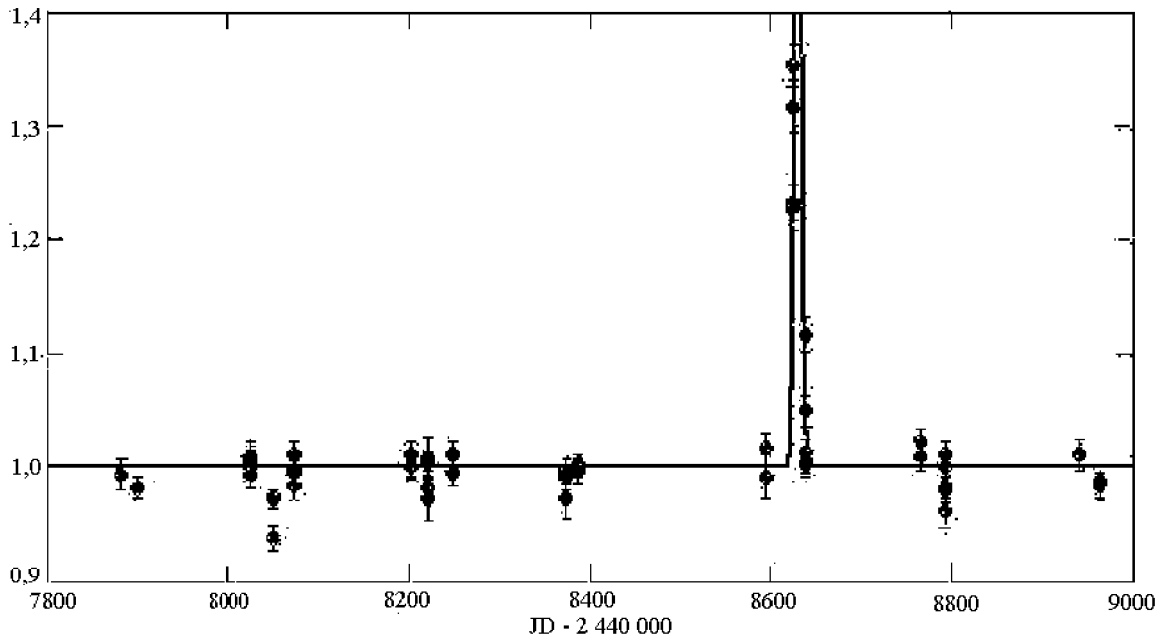

Figure 2: Temporal (in JD) diagram of luminosity strengthening coefficient

CHO [9] and *EROS* [6] groups, which detected changes of brilliance curves in Large Magellanic Cloud by gravitation of dark halo bodies of our Galaxy. The brilliance maximum in the first of microlensing phenomena, detected by these two groups fell on the decade of March 1993.

In such a way, a short-time decreasing of the stellar magnitude of *FH Leo* in the course of *HIP* #054268 phenomenon realization can be considered as the earliest candidate for the gravitation microlens.

At the analysis of phenomena-candidates for microlenses *MACHO* group has used selection criteria, according to which the brilliance curve must be followed with the considerable luminosity increase in brilliance maximum in comparison with the brilliance outside the area of its strengthening, and outside the strengthening area the luminosity must be approximately constant.

We'll analyse the luminosity curve of *HIP* #54268.

3. Luminosity Curve

Having used the known formula:

$$A = 2,5 \log \frac{H_p}{H_{\bar{p}}} \qquad (1)$$

determine coefficient A of the luminosity strengthening of the observed candidate for the gravitation microlens, where H_p - current stellar magnitude of *FH Leo* star, measured in *Hipparcos* photometrical system; $H_{\bar{p}} = 8,5860$ - median stellar magnitude. The dependence of value A on time is shown in fig.2. The dependence is based on the data base of 52 luminosity satellite measurements [51]. Two results of measurements were ignored in the same way as it was done by the *Hipparcos* catalogue compilers at the calculations of median stellar magnitude $H_{\bar{p}}$. As a reason for this one uses the estimation of one of the measurements results of the luminosity, as a consequence of light interference of *FH Leo* star and a certain object, appeared in the observation area of the devices. At gaining of other ignored result the upper limit of the calculated range of background radiation appeared to be exceeded, which possibly is a consequence of the Earth radiation areas effect on the control devices while satellite motion.

In fig.2 is shown a curve, gained by the method of the least squares

$$A = \frac{1}{2}\left[\sqrt{p^2 + \left(\frac{t - t_{\max}}{t_0}\right)^2} + \frac{1}{\sqrt{p^2 + \left(\frac{t - t_{\max}}{t_0}\right)^2}}\right], \qquad (2)$$

by means of this curve it is accepted [22, 33, 53] to approximate a curve of the brilliance strengthening, where p - dimentionless aimed parameter, which is a part of Einstein - Chwolson angle, cut by the least angular distance between a light source and a deflector; t_{max} - time moment, to which corresponds maximum of strengthening factor; t_0 - characteristic time of microlensing, equaled half of the stay time duration of the source inside Einstein - Chwolson circle. It is advisable to point out, that *MACHO* [22] group, differed from the rest of the investigators, considers to be characteristic the microlensing time the whole duration period of the source presence inside of Einstein - Chwolson circle

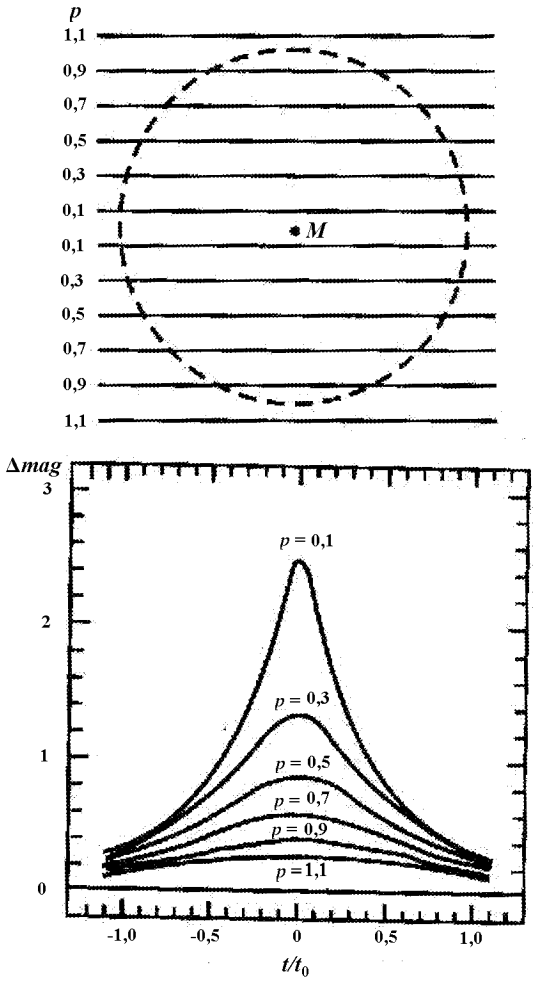

Figure 3: Increase (according to Paczinsky, [22]) of stellar magnitude in the course of time t/t_0; ($t_{max} = 0$) of crossing a circle of Einstein-Chwolson deflector M at various values of aiming parameter p

and hence, in Pachinsky terminology, t_0 - half of the characteristic time of microlensing.

The physical sense of parameters p, t_0, t_{max} is shown in fig.3 from Paczinsky paper [22].

The approximation of the time diagram of the brilliance strengthening factor of the curve (2) allows to refer maximum of the phenomenon to January 7, 1992 (time t_{max}), beginning - to December 28, 1991, completion - to January 17, 1992 at the characteristic time t_0 of microlensing equaled 10,6 days and aimed parameter $p = 0,23$. Maximum of the luminosity strengthening factor equaled 2,29. For the comparison we'll remind, that in *MACHO* experiment, for instance, phenomena, in which the factor of luminosity strengthening exceeded 1,75, were considered to be statistically significant.

It should be specified, that direct observations of the luminosity referred to the initial and final stages of the phenomenon, when a maximum value of luminosity strengthening did not exceed 1,35. The observation of the phenomenon maximum were impossible, as the object of the observation at this time beyond visibility of the satellite equipment. A.F.Zakharov, has shown [3], that at the location of the source inside Einstein - Chwolson circle the strengthening factor of the gravitational lens exceeds 1,34. Hence, if the examined luminosity burst is considered directly observed inside of Einstein - Chwolson circle, then even at the worst of the estimations the object should be considered to be observed directly inside of Einstein - Chwolson circle.

For comparison in fig.4 there are depicted brilliance curves, referring to various spectral ranges, of the candidates into gravitational microlenses, gained in *MACHO* experiments [11].

Quality of correspondence for the gained brilliance curve of the microlensing theory, are illustrated by fig.5 in which time dependence of brilliance measurement H_p, calculated in stellar magnitudes, is shown. Axis of ordinates of this fig. corresponds, in such a way, to axis of ordinates in fig 1. The theoretical curve, shown in the diagram, corresponds to the luminosity curve (2), shown in fig.2 calculated into the brilliance with the use (1).

Calculations show, that the mean square deviation of measured in the course of examined phenomenon values of star brilliance regarding ordinates of the theoretical curve (see fig.5) equal 0,05. This result corresponds analogues values, gained in the course of *OGLE* experiments and equaled 0,09; 0,10; 0,13 [22], and also 0,03; 0,04; 0,07 [20].

The significance of the star brilliance in maximum of the phenomenon exceeds, according to approximation data, median value of brilliance $H_{\bar{p}}$ for 0,90 of the stellar magnitude. In the course of the direct observations, limited by the initial and final stages of the phenomenon the brilliance increase for 0,33 of the stellar magnitude was determined. The brilliance increase for 0,32 of the stellar magnitude [3] corresponds to the crossing by a star of Einstein - Chwolson radius.

The available experimental sampling is insufficient for the analysis of the symmetry of the brilliance curve. Therefore, we'll pass to the estimation of its achromatism.

4. Estimation of brilliance curve achromatism

As at the observations of *FH Leo* star parallel colorimetrical measurements were not performed, we'll carry out the estimation of the phenomenon achromatism, grounding upon the chromatism of the time dependence of sensitivity of the photometrical measuring converter in a satellite.

As a radiation satellite receiver one used a photon counter on the base of CCD-camera [51]. In the course

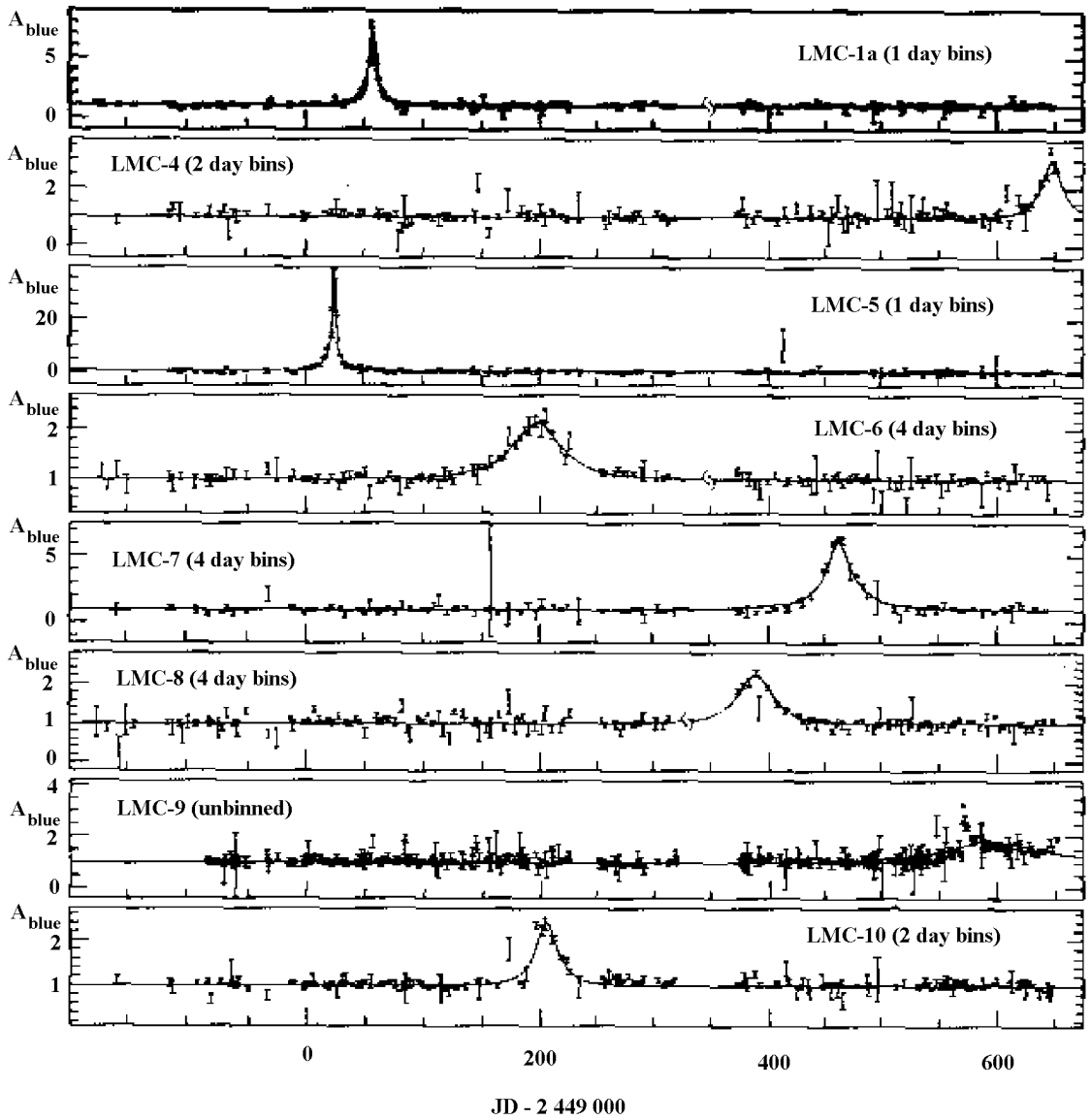

Figure 4: Brilliance curves of candidates in gravitational microlens, gained in the course of *MACHO* [10] experiment

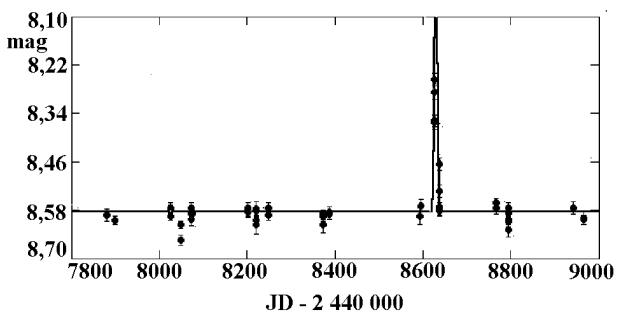

Figure 5: Approximation of temporal (in *JD*) brilliance (in *mag*) diagram of *FH Leo Star* (see fig.1)

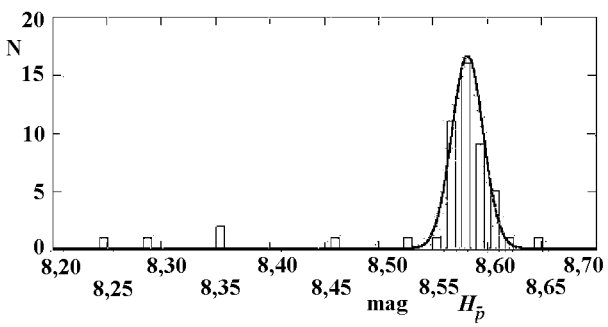

Figure 6: Normality of brilliance H_p distribution out of area of supposed microlensing

of the observations counter series data were received, which included clusters of 2 560 single calculations, carried out in the period of 1/1 200 s. On the base of data, contained in every series one estimated intensities I_s of radiation of stars observed and background intensity I_b.

Background intensity I_b was formed by an incidental light-striking of the receiver, dark current CCD-camera, and also by the influence of the Earth radiation belts. In case of the radiation background increase, causing increase of I_s over the range $20 \ldots 70$ c^{-1} the result of the star brilliance measure was considered having serious error and was always recommended to be ignored, and it was done at the formation of sampling of brilliance measure results in the course of *HIP* #054268 phenomenon.

The estimations of intensity I_s were used for results calculations of single measurements of brilliance H_p, of stars observed through the formula:

$$H_p = 2,5 \log I_s + const. \tag{3}$$

The error $\sigma(H_p)$ of the determination of brilliance H_p was calculated through error $\sigma(I_s)$ the estimations of intensity I_s according to formula:

$$\sigma\left(H_p\right) \approx \frac{\sigma\left(I_s\right)}{I_s} \approx \frac{1}{\sqrt{I_s T}}, \tag{4}$$

where T - part of the observation time, falls at tracing a certain star motion, conditioned with that, that in the field of view some stars could be simultaneously, and tracing was performed for one of them.

Value T depended on star brilliance, for weak stars was set a larger one, and for bright - a smaller one, and equaled on an average 4 s. Value I_s constantly decreasing in the course of the satellite flight due to optics aging. This decreasing had possessed an achromatism. It is known [51], that for stars of the eighth stellar magnitude with colour index $(V-I)_c = 0,5$ decrease I_s equaled from 6 600 till 4 000 s^{-1}, and for stars with colour index $(V-I)_c = 2,5$ this decrease equaled from 5 500 till 4 000 s^{-1}.

The analysed decrease caused an increase of the systematic and incidental error of the measure of brilliance H_p. The systematic error was excluded in the course of the flight by means of the comparison of measured brilliance of some stars with the standard values of their brilliance. The incidental character of the residual error of measuring results of brilliance Hp is illustrated with the normality of distribution (fig.6) of single measurements results with median value $H_{\bar{p}} = 8,586$ (deviation of normality of brilliance H_p distribution is watched of area of supposed microlensing).

The incidental error $\sigma(H_p)$ of measuring of brilliance H_p according to (4) kept in the course of time systematic changes, corresponding to systematic measurements I_s, conditioned with optics aging. In fig.7

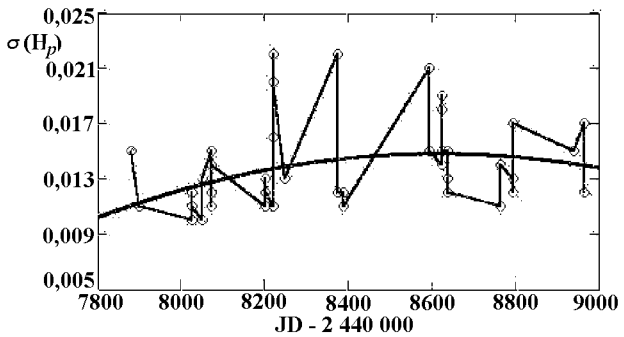

Figure 7: Systematic constituent of temporal dependence of accidental error $\sigma(H_p)$ of brilliance H_p measurement

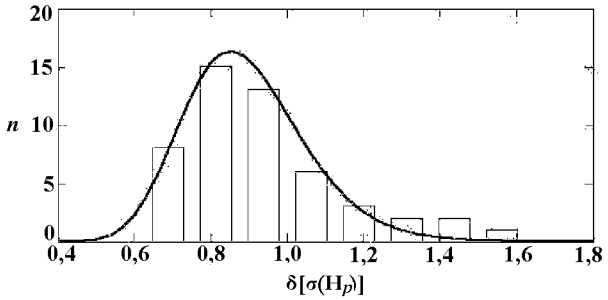

Figure 8: Lognormality of distribution of error $\sigma(H_p)$ deviation (for the unit of the error one accepted ordinates of the approximating curve of fig.7) of measurement of brilliance H_p regarding an approximating curve

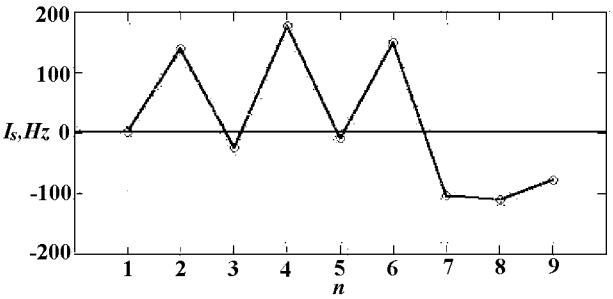

Figure 9: Sequence of rests precipitation of value I_s, Hz in the course of the supposed microlensing

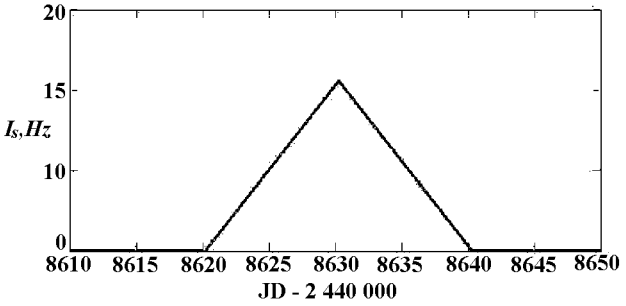

Figure 10: Approximation of temporal (in JD) dependence rests of value I_s, Hz with rectilineal segments

it is shown a time dependence of irregular constituent of error $\sigma(H_p)$ of star *FH Leo*. In the figure it is also shown a diagram of approximating this dependence of polynominal function, limited with the second order. The analysis of the figure shows, that the incidental error constituent, as it was supposed, had in the course of the satellite flight a trend to the increase.

The mentioned allows to consider, that the results of measures of brilliance H_p inside of the area of the supposed microlensing could be a consequence of three phenomena:

– systematic changes of value I_s, conditioned in fact with changes of brilliance H_p, corresponding to the microlensing theory and causing deviations of the measured values of brilliance H_p from normal distribution (see fig.6);

– systematic changes of value I_s, caused by chromatism of the brilliance curve and conditioned by the described above chromatism of the sensitivity of the satellite measuring equipment;

– and also with the incidental measures of value I_s, conditioned by the main error of the measuring device.

For the last from the mentioned phenomena the chance of measurements of value I_s is supposed due to smallness of the analysed phenomenon duration in comparison with the general observation duration of star *FH Leo*, and also because of slowness of changes of value I_s, conditioned by optics aging (see fig.7) and bringing a systematism into changes of I_s outside the supposed microlensing area. The chance of changes of value I_s, conditioned by the main error of the measuring device is confirmed also by a lognormality of distribution (fig.8) of error deviation $\sigma(H_p)$ of brilliance measuring H_p regarding the approximating curve of fig.7 (for the unit of error $\sigma(H_p)$ at the construction of graph of distribution the ordinates of approximating curve were adopted).

In fig.9 the sequence of falls precipitation of value I_s is shown for the time moments of the supposed microlensing process. These falls are gained as differences of the experimental and theoretical magnitudes of value I_s, calculated on the basis (3) at the condition of constant permanency of the right side, in accordance with the measured values of brilliance H_p and values of brilliance (2) - (1), satisfying that microlensing curve (see fig.2), that is to say, that of the first of three enumerated factors of changing value I_s. In case of achromatism of the supposed deviation phenomenon of parts of falls analysed sequence from zero must have an accidental circumstance, that is, this sequance mustn't be subjected to the trend, which could be ascribed to the second factor, that is, to the phenomenon chromatism.

As the experimental sampling is insufficient for the character setting of falls distribution, then for checking of trend availability there were used non-parametrical criteria of series and inversions, the first of which is more strong at the determination of monotonous trend,

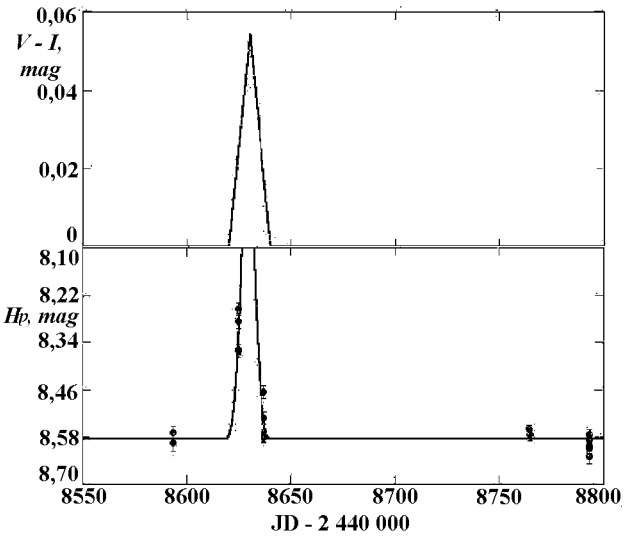

Figure 11: Temporal (in JD) dependensces of estimated color index and brilliance increment in the Course of *HIP* #54268 phenomenon

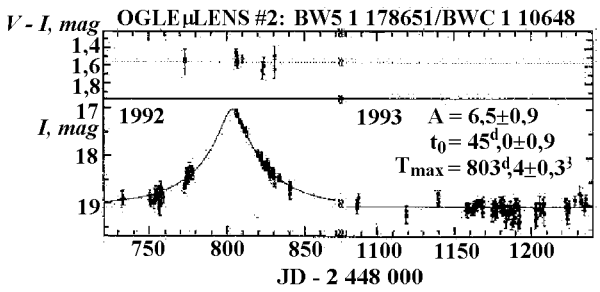

Figure 12: Temporal dependences of color index and brilliance in the course of *OGLE* #2 phenomenon [19, 22]

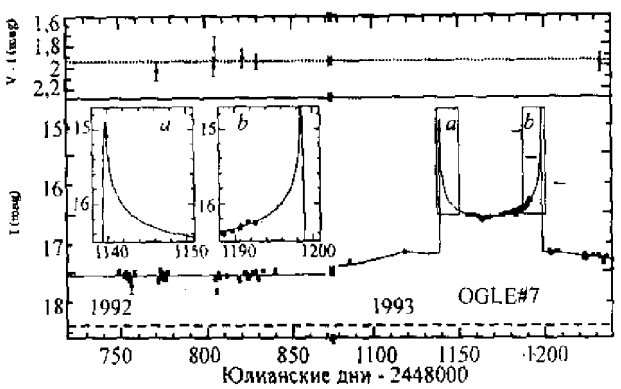

Figure 13: Temporal dependences of color index and brilliance in the course of *OGLE* #7 phenomenon [20]

and the second - at the determination of oscillating trend [54].

Both criteria with significance level with more than 99 % allow to accept the hypothesis of trend absence in the sequence of falls value I_s . The adoption of this hypothesis, but doesn't allow to draw a conclusion about complete absence of systematic changes I_s , not adding to the concept, as such dependence, even being significant from the view point of phenomenon chromatism analysis, may "sink" in fluctuations of value I_s , conditioned by the action of the measurement accidental error.

We'll value the upper limit of the chromatism production in the analysed phenomenon. For this purpose we approximate the temporal dependence of falls I_s by a non-accidental function. In the simplest case as a non-accidental function we make use of two symmetrical length sections (fig.10), resting upon the point time axis, corresponding the valued time moments of the beginning and the end of the supposed microlensing.

Heading for the presented above numerical values of value I_s we gain, that sensibility I_s to the color index decreased from 550 *Hz* for the stellar magnitude at the beginning Hipparcos mission till zero at its end. For gaining further values we'll consider, that the sensitivity decreased according to the linear law at the moment of maximum brilliance $JD = 2\,448\,629$, that is at expiration of 64,6 % the mission duration equaled 35 % of maximum sensitivity or 195 *Hz* for the magnitude.

The corresponding diagram of color index changing is shown in fig.11. In fig. we've shown the temporal dependence of brilliance in the course of the phenomenon *HIP* #54268. For the comparison in fig.12 - 13 the analogue pairs of curves for phenomena *OGLE* #2 and *OGLE* #7 (example of a nonstandard curve of microlensing, stipulated incompactness of a deflector) are presented, the confident ascription of which to microlensing is performed at color index oscillations within the limits of 0,2...0,4 of stellar magnitude.

The utmost change of color index for *HIP* #54268 phenomenon is estimated according to fig.11 in 0,06 of stellar magnitude. In such a way, even if the received rough estimation of the color index appeared to be understated fives times as less as the real value, nevertheless, and in this case the chromatic phenomena at the brilliance strengthening allow to analyse this strengthening as traditional microlensing. Thanks to this the suppositions moved in this paper, regarding the approximation of the temporal dependence of color index, sensitivity of the photometrical transformer to the index of color and a character of its changing in the course of time correspond to the estimation rough enough, which, nevertheless, is an acceptable one.

5. Conclusion

Let's draw a conclusion to the expressed above.

The analysis of the astro-metrical base of the catalogue *ESA "Hipparcos"* in the sense of the searching gravitational microlensing phenomena allows to extract *HIP* #54268, which represents once observed phenomenon in the course of 1 083 days, short-time brilliance strengthening of *FH Leo* star with the duration of about 21 days.

The analysis of these literary sources shows, that for the determonation of at least one microlensing phenomenon in the most favourable conditions, when measures are carried out in the directions of stellar sky with the utmost estimated optical density one needs a total exposition from $0,15 \times 10^6$ till $5,0 \times 10^6$ of *star·years*. The data base of Hipparcos catalogue corresponds to the total exposition of $0,4 \times 10^6$ of *star·years*. Having taken into account that, that satellite observation directions differed from the optimal ones, the cautious estimation allowed to suppose for the whole of data base not more than one microlensing phenomenon, which, possibly, *HIP* #54268 phenomenon is.

The approximation of the temporal diagram for changing coefficient of brilliance of standard for a microlensing phenomenon curve relates utmost phenomenon to January 7, 1992.

Maximum of strengthening coefficient of a star luminosity, according to the results of approximation, equaled 2,29 multiple, that satisfies, for instance, the criterion of *MACHO* group, which considered microlensing phenomenon statistically significant, in which a coefficient a luminosity strengthening exceeded 1,75.

In the course of the direct observations one determined changing of the star brilliance at the initial and final stages of the phenomenon, when brilliance changing didn't exceed 1,35 multiple, that exceeds the strengthening minimum, allowing to consider the lensed star, crossed a circle of Einstein - Chwolson deflector.

The mean square deviation of measured values for the brilliance of *FH Leo* star relating ordinates of the theoretical curve equals 0,05, that agrees with the analogue values, gained in the course of *OGLE* experiments and equaled from 0,04 till 0,13.

The insufficiency of the experimental sampling doesn't allow a brilliance curve of the analysed phenomenon to subject to the determination for the correspondence a criterion of symmetry of the standard brilliance curve at microlensing.

In the course of the "*Hipparcos*" experiments the measurements of a star colour index were not carried out. That is why the degree of chromatism manifestation in the analysed phenomenon was determined by means of statistical methods. In this case the utmost index changing of colour of *FH Leo* star in the considered phenomenon is estimated as 0,06 of the stellar

magnitude. The gained estimation is considered as a rough enough, but even at the understate of the estimated colour index as five times the real value of the colour index corresponds to the phenomena achromatism, identified with microlensing in the *OGLE* experiments.

The single character of the discovered phenomenon in data base of "Hipparcos" catalogue doesn't allow to subject the experimental data to the determination for correspondence to the statistical criteria of microlensing standard characteristics distribution.

The stated arguments allow regarding *HIP* #54268 phenomenon the use of the conclusion, expressed by *EROS* [8] group and repeated by A.F.Zakharov and M.V.Sazhin [4], about that, that in the astrometrical base of *ESA "Hipparcos"* catalogue *FH Leo* star was characterized by the brilliance curve, which best of all could be interpreted as microlensing phenomenon by the unseen object. The determined candidate in microlens is the earliest among known at present.

It is worth while mentioning, that one of the long-term elaboration of the European Cosmic Agency from the position of the further development of *ESA HIPPARCOS* satellite program is a planned for the realization supposing in 2012 mission *"Global Astrometric Interferometer for Astrophysics"(GAIA)* [55 - 56], in the course of which it is supposed to carry out photometric observations for more than one milliard of stars. Hence, at the rest equal conditions the supposed satellite observations for the stars brilliance will allow to discover the phenomena of gravitational microlensing at the amount not less than some hundred and even thousand.

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References

[1] E. Roulet and S. Mollerach, *Astro-ph.*, **9603119**, (1996).

[2] E. Roulet and S. Mollerach, *Phys. Rep.*, **279**, 2 (1997).

[3] A.F.Zakharov, "Gravitational Lenses and Microlenses", Janus-K, Moskow, 1997 (in Russian).

[4] A.F.Zakharov and M.V.Sazhin "Gravitational Microlensing", *UFN*, **168**, No 10, 1041 – 1081, (1998) (in Russian).

[5] S. Mao and B. Paczinsky, *Astro-ph.*, **9604002**, (1996).

[6] E. Aubourg et al., *Nature (London)*, **365**, 623 (1993).

[7] C. Magnevill, in: "Annals of the New-York Academy of the Sciences", eds. H. Böhringer, G.E. Morfill and J.E. Trümpler, *The New-York Academy of the Sciences*, New-York, USA, **759**, 664 (1995).

[8] N. Palanque-Delabrouille et al., *Astro-ph.*, **9611059**, (1996).

[9] C. Alcock et al., *Nature (London)*, **365**, 621 (1993).

[10] W. Sutherland et al., *Astro-ph.*, **9611059**, (1996).

[11] W. Sutherland et al , in: "Proc. of 1st Intern. Workshop on the Indefication of Dark Matter", eds. N.J. Spooner, *World Sci.*, Scheffild, UK, 200 (1996).

[12] C. Alcock et al., *Astro-ph.*, **9606165**, (1996).

[13] C. Alcock et al., *Astro-ph.*, **9603158**, (1996).

[14] K. Sahu, *Nature (London)*, **370**, 275 (1994).

[15] D.P. Benett et al., *Astro-ph.*, **9606012**, (1996).

[16] D.P. Benett, *Nucl. Phys. B. (Proc. Suppl.)*, **51B**, 152 (1996).

[17] C. Flynn, A. Gould, J. Bahcall *Astrophys. J.*, **466**, L55 (1996).

[18] H.S. Zhao, *Astro-ph.*, **9606166**, (1996).

[19] A. Udalski et al. *Acta astron.*, **44**, 165 (1994).

[20] A. Udalski et al. *Astrophys. J.*, **436**, L103 (1994).

[21] A. Udalski et al. *Acta astron.*, **44**, 165 (1994).

[22] B. Paczinsky, *Astro-ph.*, **9604011**, (1996).

[23] A. Udalski et al. *Acta astron.*, **44**, 227 (1994).

[24] C. Alcock et al., *Astro-ph.*, **9512146**, (1995).

[25] B. Paczinsky et al., *Astrophys. J.*, **435**, L113 (1994).

[26] K. Stanek et al., *Astrophys. J.*, **429**, L73 (1994).

[27] H. Zhao, R.M. Rich and D.N. Spegel, *Astrophys. J.*, **440**, L13 (1995).

[28] H. Zhao, D.N. Spegel and R.M. Rich, *Astro-ph.*, **9512065**, (1996).

[29] M. Kiraga and B. Paczinsky, *Astrophys. J.*, **430**, L101 (1994).

[30] R. Ansari, in "Particle Astrophysics", Eds G. Fontaine and J.Tran. Thanh Van, *Edition Frontieres*, Gif-sur-Ivett, France, 243 (1993).

[31] R. Ansari, in: "Annals of the New-York Academy of the Sciences", eds. H. Böhringer, G.E. Morfill and J.E. Trümpler, *The New-York Academy of the Sciences*, New-York, USA, **759**, 608 (1995).

[32] V.V. Shulga, M.V. Sazhin and N.P. Gorbatko, *Astron. Astrophys. Trans.*, **10**, 187 (1996).

[33] A.P.S. Crotts, *Astrophys. J.*, **399**, L43 (1992).

[34] P. Baillon et al. *Astron. Astrophys.*, **277**, 1 (1993).

[35] B. Carr, *ARA&A*, **32**, 531 (1994).

[36] D.J. Hegyi and K.A. Olive, *Phys. Lett. B*, **126**, 28 (1983).

[37] E.R. Wollman, *Ap. J.*, **392**, 80 (1992).

[38] E.S. Phinney, *Astrophysical Counterfeit*, **17**, L1 (1985).

[39] A. De Rujula, Ph. Jetzer and E. Masso, *Astron. Astrophys.*, **254**, 99 (1992).

[40] C. Low and D. Linden-Bell, *MNRAS*, **176**, 367 (1976).

[41] F. Palla, E.E. Salpeter and S.W. Stahler, *Ap. J.*, **271**, 61 (1983).

[42] A. De Rujula, Ph. Jetzer and E. Masso, *MNRAS*, **250**, 348 (1991).

[43] J.M. Bahcall et al., *Astro-ph.*, **9406019**, (1994).

[44] D. Pfenniger, F. Combes and L. Martinet, *Astron. Astrophys.*, **285**, 79 (1994).

[45] F. de Paolis et al., *Phys. Rev. Lett*, **74**, 14 (1995).

[46] O. Gerhard and J. Silk, *Astro-ph.*, **9509149**, (1995).

[47] M. Spiro, *Nuclear. Phys. B (Proc. Suppl.)*, **43**, 100 (1995).

[48] L.M. Krauss, in "Particle Astrophysics", Eds G. Fontaine and J.Tran. Thanh Van, *Edition Frontieres*, Gif-sur-Ivett, France, 227 (1993).

[49] B. Sadoulet, in "Particle Astrophysics", Eds G. Fontaine and J.Tran. Thanh Van, *Edition Frontieres*, Gif-sur-Ivett, France, 257 (1993).

[50] B.V. Komberg, *Astronomichesky Journal*, **72**, 457 (1995) (in Russian).

[51] "The Hipparcos and Tycho Catalogues: Astrometric and Photometric Star Catalogues derived from the ESA Hipparcos Space Astrometry Mission.", A Collaboration Between the European Space Agency and the FAST, NDAC, TDAC and INCA Consortia and the Hipparcos Industrial Consortium led by Matra Marconi Space and Alenia Spazio, *European Space Agency*, **SP1200**, (June 1997).

[52] J. Dommanget and O. Nys, "Catalogue of Components of Double and Multiple Stars", *Comm. Obs. R. de Belg.*, **Serie A, No 115**, (1994).

[53] A.M. Cherepashchuk, "Gravitational Microlensing and Dark Mass Problem", *Soros Educational Journal*, No 3(28), 92 – 99, (1998) (in Russian).

[54] J.S. Bendat, A.J. Piersol "Random Data. Analysis and Measurement Procedures", Eds J. Wiley & Sons, *Wiley-Interscience Publication*, New York, USA; Chichester, UK; Brisbane, Australia; Toronto, Canada; Singapore, (1989).

[55] L. Lindegren, M.A.C. Perryman, U. Bastian, J.C. Dainty, E. Høg, F. van Leeuwen, J. Kovalevsky, A. Labeyrie, F. Mignard, J.E. Noordam, R.S. le Poole and F. Thejll Vakili, "1993. GAIA - Global Astrometric Interferometer for Astrophysics: proposal a Cornerstone Mission concept submitted to ESA in October 1993", *European Space Agency*, (1993).

[56] http://astro.estec.esa.nl/SA-general/Projects/GAIA

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GRAVITATIONAL VISCOSITY AND GEODETIC CURVATURE OF THE UNIVERSE

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It is shown that the Universe is not a conservative system. This property is showing physically as tractate resistance of material bodies termed as gravitational viscosity, and as diminution of light frequency with distance known as redshift, i.e. as a loss (dissipation) of its energy. This property is showing geometrically as geodetic curvature of the Universe. The generalized transformations of Galilei are given, and the invariance of the new equation of a free motion of a material body concerning these transformations is shown.

1. Introduction

The modern geometrized theories of space, time and gravitation are founding on concept of parallel translation of a vector and have four basic sources:

1) Riemann (1854) has developed the general form of the non-Euclidean geometry, in which the veering of vector is taken into account at parallel translation in curvilinear space, and Einstein and Grossmann (1913) used it for the General Relativity (GR);

2) Weyl (1918) has offered to take into account also a change of vector length at parallel translation in a curvilinear four-dimensional spacetime, with the help that he hoped to include in GR also an electromagnetism;

3) Caluza (1921) used only veering of vector at parallel translation in curvilinear spacetime, but he has added the fifth measuring, with which he hoped to include electromagnetism in GR too;

4) Cartan (1922) used a torsion, i.e. difference of tensors at a rearrangement by places of their indexes, and he hoped thus also to extend GR, having included other interactions in it.

If we shall analyze the first direction, we shall see that in spacetime all events are representing from positions of the Einstein impinging lift, in which the speed of light is constant always. From this point of view it is possible to analyze all events in immediate proximity from the observer, but he will see other objects on large distances through a prism of his gauges of spacetime, i.e. in a garbled view.

Use of concept of a geodetic line is characteristic for this direction. And the geodetic line is on definition such line, the geodetic curvature along which is equal to zero. The motion along such line does not suppose a dissipation of energy namely these processes are most typical for the majority of natural phenomena of the nature. Therefore gravitational forces are representing as conservative forces. The variation principle is used for such forces.

The second and third directions were interlinked to desire of the scientists to include an electromagnetism in GR too. Unfortunately, it should be stated that after finishing of eighty years the above-stated problem has remained unsolved.

With the fourth direction many scientists (and those who are engaged in a fundamental science, and those who solves applied problems) pin one's many hopes. On this basis the concept of the torsion field was born. However many methodological problems, bound with the theories of this direction, do not call trust to any their results.

Moreover, the majority of modern works in a channel of above- stated directions can be termed, most likely, mathematical balancing act, than physical theories, as they are not bound nor with a results of observations of natural phenomena, nor with results of physical experiments.

Notably that in 1906 in paper "On the Dynamics of the Electron" [11] Poincare for the first time has stated idea of build-up of the relativistic theory for all physical forces, including a gravitation, in the flat four-dimensional spacetime. He also marked, that the gravitational field should be spread with speed of light, and as the retardation of interactions is supposed, should be and its material carrier, i.e. some medium or field.

Thus, already in the beginning XX of century two ways were designated precisely in exposition of gravitation: geometrized way and field way. Some of scientists consider theirs as alternative ways, and others scientists

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consider theirs as complementary ways (as, for example, undular and matrix form of the quantum mechanics). However with making GR the preferred development was received with the first way, and about second way as if have forgotten.

Short of the G.D. Birkhoff's work (1944) [2], which situated aside and in which the equations of a gravitational field are simply postulated, only since 1961 from the work of W. Thirring [12] the revival of the rigorous field approach to the gravitation theory began. The revival of this way is bound, most likely, with inability of GR in the usual form to answer numerous problems, including the field of cosmology.

Now in physics it is possible to allocate three basic directions, which adjoin to idea of Poincare concerning gravitation:

1. Field theory of gravitation as terrain clearance alternative for GR. This theory is shaped on a background of flat (Euclidean) space. For an example it is possible to give the works of Yu.V. Baryshev, M. Moshinsky and, in judgement of Yu.V. Baryshev, G.D. Birkhoff, W. Tirring, G. Kalman, S. Deser, R. Feynman and even H. Poincare [1, 2, 4, 5, 7, 9, 12].

2. Field theory of gravitation as alternative for GR supposing geometrical interpretation. For an example it is possible to give the Relativistic Theory of Gravitation of A.A. Logunov. The approach is supported Yu.M. Loskutov, M.A. Mestvirishvili, Yu.V. Chugreev, A.V. Genk, Yu.P. Vyblyi and others physicists [8].

3. Field theory of gravitation as other mathematical form of GR. This point of view was always supported by Ya.B. Zeldovich, V. Ginzburg, L.P. Grishchuk, A.N. Petrov, A.D. Popova [6] and me [13-23]. Mentioned above W. Tirring, and S. Deser [4, 12] stated about this, in my judgement.

Further we shall stay on the third direction, as length of vector at parallel transport varies there too. And this change, as against the mentioned above theories, has quite definite physical sense, bound with a dissipation of energy at a motion of material bodies and at spread of fields. And in a geometrical sense this change is interlinked to geodetic curvature, which not always mention even in the special literature on GR.

2. Gravitational viscosity of the Universe

In Refs. [13, 14, 19] the field formulation of GR is developing. The global properties of the Universe are used for this purpose: flatness, homogeneity and isotropy. The first property has shown that the equations of GR without the cosmological term are untrue. The combined equations with the cosmological term became complete at adding four equations reflecting homogeneity and an isotropy by the Universe. It was simplified at the expense of exposition of gravitation as perturbations on a background of the flat spacetime. And the cosmological term has ceased to be a constant and has received new physical explanation. As has appeared, it takes into account gravitational connection of any material body with all other bodies of the Universe.

The combined equations are obtained as the generalized Klein-Gordon equations. And the solution is found for a stable material body as Yukawa potential. Actual universal gravity law has received for two interacting bodies as:

$$F = G\frac{m_1 m_2}{r^2} e^{-r/R_0}\left(1 + \frac{r}{R_0}\right), \tag{1}$$

where there is a radius of gravitational interactions, which is determined through relative speed of light c' between bodies and medial density of the Universe under the formula

$$R_0 = c'\sqrt{\frac{3}{4\pi G\rho_0}}, \tag{2}$$

As it is visible from the formula (1), the attractive forces between bodies are short-range the same as also forces between atomic nucleus. However radius of gravitational interactions R_0 is very large (approximately 10^{26} m) as against radius of nuclear interactions (approximately 10^{-10} m).

Besides the law (1) is the relativistic law as against the Newton gravitation law. Really, if one body will move off from other body with velocity v, the relative speed of light becomes equal $c' = c - v$. It will give in more prompt decrease of an attractive force with distance, than at absence of such motion. It to show best if to consider the ratio of an actual attractive force to force calculated on the formula of the Newton gravitation law, i.e. $F' = F/F_N$, where $F_N = Gm_1m_2/r^2$ (see thick line in the left-hand half of the Fig. 1).

If the body will move towards to other body, the relative speed of light will increase, the curve of an attractive force becomes more flat, and the interaction between bodies will amplify (see thick line in the right-hand half of Fig. 1).

But if to view a motion of a material body concerning set of other bodies of the Universe, it appears, that of equal in effect all gravitational forces is not equal to zero or that gravitational potential acts on this body. The author managed to find receptions and to show that the quantity of this potential is equal $(-c^2)$. Let's term, as it's the gravitational potential of the Universe.

The braking force arises under activity of gravitational potential. As result, the law of a free motion of bodies (the inertia law) along coordinate was conversed to a view

$$\frac{d^2X}{dt^2} + H\frac{dX}{dt} = 0, \tag{3}$$

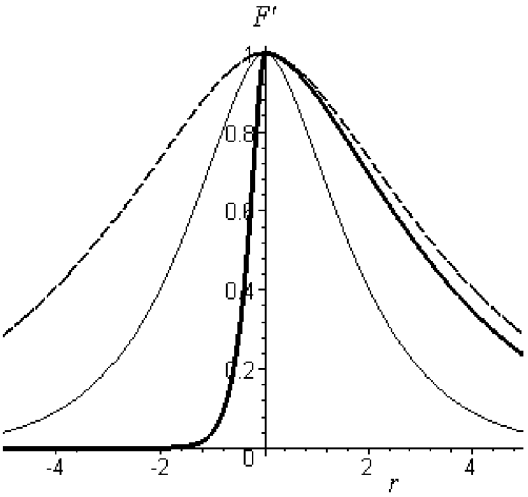

Figure 1: Comparison of the gravitation laws for different velocities (the light line for $v = 0$, thick line for $v = 0.8c$ — body goes from left to right, the dashed line is a limit of a a contrary motion with velocity $v = c$)

where the label is entered

$$H = \sqrt{\frac{4\pi G\rho_0}{3}}, \tag{4}$$

which corresponds to the Hubble constant, but has other physical sense. It now reflects a dissipation of energy at a motion of material bodies and, as will be shown further, at spread of fields. The Hubble constant is very small and equal approximately $10^{-18}\ c^{-1}$.

As the diminution of velocity of a moving body according to the equation (3) is proportional to the velocity that is proper in a motion of bodies in any viscous fluid or gas, by analogy to them such property is termed gravitational viscosity of the Universe.

Some numerals should be given for an example. So, the pedestrian inhibiting action from activity of forces of gravitational viscosity equal approximately $10^{-18}\ m/c^2$. For a motion with speed of light it still a little and equally only $10^{-10}\ m/c^2$. Obviously, that local gravitational and the electromagnetic interactions are many times stronger than gravitational viscosity, and they are concealing its existence. However fact of existence of gravitational viscosity strictly follows from the new stationary cosmological model, which confirm about thirty objective performances of the real Universe. In particular, the proof of identity of inertial and gravitational masses on the basis of new model of the Universe is a strongest reason of existence and gravitational viscosity [18-20, 22].

In a limit at a motion with speed of light (it is possible only for light and perturbations of a gravitational field) gravitational potential of the Universe accepts their maximum value . It gives that the light frequency decreases under the law

$$\nu = \nu_0 e^{-r/R_0}. \tag{5}$$

The law (5) completely explains a nature, numerical performances and character of allocation of background microwave radiation. Actually it not relic of the Big Bang, but aggregate radiation of all stars of the stationary Universe. On the other hand, on the basis of an actual law of gravitation (1) it was possible to prove identity of inertial and gravitational masses [18-20, 22] that is strongest argument of its validity. The large-scale and middle-scale allocation of a substance in the Universe also corresponds to the formulas (1-4). Thus, all apparent natural phenomena and the results of physical experiments confirm presence of gravitational viscosity of the Universe.

3. Parallel translation of vector in four-dimensional spacetime

The concept of the parallel transfer of a vector is fundamental in the non-Euclidean geometry. It allows one to introduce, in a natural way, the affine connectedness and covariant derivative. However here we assume that such introductions have already been made. Then, with the help of the parallel vector transfer, we can study only the geodesics and also some consequences which are following from them.

So, let the affine connectedness Γ^k_{lm}, curve X_k and parameter t be given (indices run values 0, 1, 2, 3 unless otherwise specified). Then the vector dX_k/dt will point to the direction of the motion in each point of the curve, i.e. the vector will be tangent. Let us study the transfer of the vector from a point X_k to the nearest point, $X_k + dX_k$. It is reasonable to assume that in the most general case the length of the tangent vector is not constant. Let us assume that in the nearest point it is proportional to the initial length of the vector and the function $1+\varphi(t)\,dt$ is the coefficient of proportionality,

$$\frac{dX_k}{dt} - \Gamma^k_{lm}\frac{dX_l}{dt}dX_m = \\ = (1+\varphi(t)\,dt)\left(\frac{dX_k}{dt} + \frac{d^2X_k}{dt^2}dt\right). \tag{6}$$

If we divide the two-hand sides of equation (6) by dt, we get

$$(1+\varphi(t)\,dt)\frac{d^2X_k}{dt^2} + \Gamma^k_{lm}\frac{dX_l}{dt}\frac{dX_m}{dt} = \\ = \frac{1+\varphi(t)\,dt - 1}{dt}\frac{dX_k}{dt} = \varphi(t)\frac{dX_k}{dt}. \tag{7}$$

Since $1+\varphi(t)\,dt$ differs from the unity only by the value of the order of dt (which is an infinitesimally small quantity), the difference can be neglected. Then expression (7) becomes

$$\frac{d^2X_k}{dt^2} + \Gamma^k_{lm}\frac{dX_l}{dt}\frac{dX_m}{dt} = \varphi(t)\frac{dX_k}{dt}. \tag{8}$$

This is the equation of the parallel vector transfer in the most general form. However, the argument t has been chosen arbitrarily. Therefore, the question arises: what will happen if another argument, for example $\tau = \tau(t)$, is taken?

Let us treat such a case having made a preliminary transformation

$$\frac{d^2X_k}{dt^2} = \frac{d}{dt}\frac{dX_k}{dt} = \frac{d}{dt}\left(\frac{dX_k}{dt}\frac{d\tau}{d\tau}\right) =$$

$$= \frac{d}{dt}\left(\frac{dX_k}{d\tau}\frac{d\tau}{dt}\right) = \frac{dX_k}{d\tau}\frac{d^2\tau}{dt^2} + \frac{d\tau}{dt}\frac{d^2X_k}{dtd\tau} =$$

$$= \frac{dX_k}{d\tau}\frac{d^2\tau}{dt^2} + \frac{d\tau}{dt}\frac{d^2X_k}{dtd\tau}\frac{d\tau}{d\tau} =$$

$$= \frac{dX_k}{d\tau}\frac{d^2\tau}{dt^2} + \left(\frac{d\tau}{dt}\right)^2\frac{d^2X_k}{d\tau^2}. \tag{9}$$

Let us substitute expression (9) in equation (8) and then multiply the remaining terms of the equation and divide them by $d\tau$ so many times as dt is found,

$$\frac{d^2X_k}{d\tau^2}\left(\frac{d\tau}{dt}\right)^2 + \frac{dX_k}{d\tau}\frac{d^2\tau}{dt^2} + \Gamma^k_{lm}\frac{dX_l}{d\tau}\frac{dX_m}{d\tau}\left(\frac{d\tau}{dt}\right)^2 =$$

$$= \varphi(t)\frac{dX_k}{dt}\frac{d\tau}{dt}. \tag{10}$$

Then we can divide expression (10) by $(d\tau/dt)^2$, having first transferred the second item to the right-hand side

$$\frac{d^2X_k}{d\tau^2} + \Gamma^k_{lm}\frac{dX_l}{d\tau}\frac{dX_m}{d\tau} = \frac{\varphi(t)\frac{d\tau}{dt} - \frac{d^2\tau}{dt^2}}{\left(\frac{d\tau}{dt}\right)^2}\frac{dX_k}{d\tau}. \tag{11}$$

The obtained equation (11) of the parallel vector transfer has the zero right-hand side,

$$\frac{d^2X_k}{d\tau^2} + \Gamma^k_{lm}\frac{dX_l}{d\tau}\frac{dX_m}{d\tau} = 0 \tag{12}$$

only if the following equality holds

$$\varphi(t)\frac{d\tau}{dt} - \frac{d^2\tau}{dt^2} = 0. \tag{13}$$

Equality (13), for its part, represent a differential equation in turn represents a differential equation of the second order whose solution in the most general case has the form

$$\tau = \int_{t_0}^{t} exp\left\{\int_{t'_0}^{t'}\varphi(t'')\,dt''\right\}dt'. \tag{14}$$

As can be seen from this expression, a new variable τ depends not only on the magnitude of the old variable, but also on its two initial values, corresponding to the lower limits of two integrals. This, for its part, determines the general form of solution

$$\tau = a\tau_0 + b, \tag{15}$$

in which the variable τ is given to within the linear transformation with constant coefficients a, b and eigenvalue τ_0, which conforms to the solution of equation (14) with the zero lower limits of integrals.

Thus, we have obtained two forms of the equation of the parallel vector transfer. Equation (8) characterizes the motion of nonconservative physical systems. In the equation, the second item points to the degree of the normal curvature of the space and the right-hand side points to a change in the length of the parallel vector being transferred, that is, it points to the existence of the energy dissipation if the transfer is treated as a physical process.

If now one introduces the designation

$$K_k(t) = \frac{d^2X_k}{dt^2} + \Gamma^k_{lm}\frac{dX_l}{dt}\frac{dX_m}{dt}, \tag{16}$$

the change in the vector's length with the parallel transfer will be specified by the geodesic curvature (which is very seldom mentioned in literature on the general theory of relativity)

$$K(t) = \sqrt{g^{kl}K_k(t)K_l(t)}, \tag{17}$$

where g^{kl} is the metric tensor of the four-dimensional spacetime.

By definition, a line is called geodesic if its geodesic curvature is equal to zero [10]. Therefore, equation (12) from the formal mathematical point of view represents the equation of the geodesic. In other words, the equation should describe the motion of conservative physical systems without any energy losses. Equations (11) and (8) are equivalent, but we have shown above that equation (8) features a counter behavior. It turns out that the system is both conservative and nonconservative simultaneously. However, this is impossible. Therefore a mistake has been made in reasoning..

In fact, the change in the vector's length is typical for the motion of nonconservative system with the parallel transfer. But this variation can be made absolutely inconspicuous, if the spatial scale (the parameter of a curve) is varied proportionally to the changing of the length. This is precisely the case since when we use equation (12) as a change in the variable τ obviously is of a non-linear nature due to the exponent under the integral sign.

In other words, the conclusion can be drawn that a line is geodesic only if $\varphi(t) = 0$. From the physical point of view, a transformation like (14) does not result in the appearance of the geodesic at all. However, the opposite assertion is found in literature [3] practically without any exception.

4. Geodetic curvature of the Universe

Let us treat now what kind of nature characterizes the parallel vector transfer in the actual Universe (of course, we eliminate consideration of local interactions). The first assumption that comes to mind is that the Universe is a conservative physical system, i.e., that $\varphi(t) = 0$. We drop this conventional case because it is discussed practically in any literature. If the Universe does represent a nonconservative system, the following question arises: what is the form of the function $\varphi(t)$?

To answer this question, we use experimental facts like Euclidean properties of the Universe on a global scale, i.e., its homogeneity and isotropy. The first property results in equation (8) being simplified to the form:

$$\frac{d^2 X_k}{dt^2} = \varphi(t)\,\frac{dX_k}{dt}. \tag{18}$$

The second and the third properties (having regard to the first one) mean that the function $\varphi(t)$ cannot be anything else than only a constant, which we designate by H. In fact, if we recall what the given function is, i.e., that it signifies that its magnitude changes in $1 + \varphi(t)\,dt$ time with the parallel transfer of a vector, the need of linearity of the transformation of the magnitude of a vector becomes apparent. If we take into account the nonconservatism of the system, i.e., the existence of losses of energy with the vector transfer, the sign of the function also becomes clear. In other words, the function $\varphi(t)$ should to be chosen in the form

$$\varphi(t) = -H, \quad H > 0. \tag{19}$$

After that, integrals in expression (14) can be easily calculated. The internal integral is equal to

$$\int_{t_0'}^{t'} \varphi(t'')\,dt'' = \int_{t_0'}^{t'} H\,dt'' = -H\,(t' - t_0)\,. \tag{20}$$

Finally, we will have

$$\tau = \int_{t_0}^{t} e^{-H\left(t'-t_0\right)}\,dt' = \int_{t_o}^{t} e^{-Ht'} e^{Ht_0'}\,dt' =$$

$$= e^{-Ht_0'} \int_{t_0}^{t} e^{-Ht'}\,dt' = -\frac{1}{H} e^{Ht_0'} e^{-Ht'} \Big|_{t_0}^{t} =$$

$$= -\frac{1}{H} e^{Ht_0'} \left(e^{-Ht} - e^{-Ht_0}\right). \tag{21}$$

As has already been pointed out above, the result obtained can be presented in the form of a linear combination

$$\tau = a\tau_0 + b, \tag{22}$$

in which the components τ_0, a and b are determined by expressions

$$\tau_0 = e^{-Ht}, \tag{23}$$

$$a = -\frac{1}{H} e^{Ht_0'}, \tag{24}$$

$$b = \frac{1}{H} e^{Ht_0'} e^{-Ht_0}. \tag{25}$$

From all the possible cases, the case of equality $t_0' = t_0 = 0$ arouses the greatest interest, since this is our right to choose this or that frame of reference. Thus we acquire

$$\tau = \frac{1}{H}\left(1 - e^{-Ht}\right). \tag{26}$$

It is necessary to note, that the equation (18) is equivalent to the equation (13), and under condition of (19) becomes

$$\frac{d^2 X_k}{dt^2} + H\frac{dX_k}{dt} = 0. \tag{27}$$

One of the solutions to equation (27) for the time component τ is expression (26) and the solution for the spatial component is expressions

$$X = \frac{v_0}{H}\left(1 - e^{-Ht}\right), \tag{28}$$

$$v = v_0 e^{-Ht}, \tag{29}$$

which describe changes in the coordinate X of the point of the attachment of the tangent vector whose initial length in the direction of the changes was equal to ν_0. What a surprising proportion is observed between coordinate (28) and the pace of the course of time (26), is not it? One is forced to conclude that the speed of the motion of the vector and its length are constant, i.e., that the system is conservative.

Indeed, combining equations (26) and (28) one gets

$$X = v_0\tau, \tag{30}$$

from which a false conclusion follows. (The equivalence of the equations (13) and (27) promotes to this conclusion).

On the other hand, a similar procedure for the length of the vector v already to such conclusion does not give. In the beginning we shall find parameter t from (26)

$$t = -\frac{1}{H} ln\,(1 - H\tau)\,. \tag{31}$$

If we substitute t from expression (29) to expression (31), we gain

$$v = v_0 e^{-Ht} = v_0 e^{-H\left[-\frac{1}{H} ln(1-H\tau)\right]} =$$

$$= v_0 e^{ln(1-H\tau)} = v_0 (1 - H\tau) . \tag{32}$$

First, we have found that the length of the vector, with its parallel transfer, decreases proportionally to the parameter τ. Second, the conclusion is drawn from the result obtained that there is such a value of τ that equals

$$T_0 = \frac{1}{H}, \tag{33}$$

at which the length of the vector becomes equal to zero. Note that this value is finite in contrast to the variable t, which should tend to infinity (so that, in agreement with (29), the length of the vector reduces to zero).

It is also necessary to emphasize that at a small value H one comes to approximations

$$X = \frac{v_0}{H}\left(1 - e^{-Ht}\right) \approx \frac{v_0}{H}(1 - 1 + Ht) = v_0 t, \tag{34}$$

$$\tau = \frac{1}{H}\left(1 - e^{-Ht}\right) \approx \frac{1}{H}(1 - 1 + Ht) = t, \tag{35}$$

which are equivalent to the relevant relations of nonrelativistic, or classical mechanics.

Thus, from the physical point of view the variable t is the equivalent to the proper time in the motionless frame of reference and τ represents the proper time in the moving frame of reference. However, what is the geodesic curvature of the Universe equal to?

Using equations (16) and (8), we may write

$$K_k(t) = \varphi(t)\frac{dX_k}{dt}. \tag{36}$$

For the flat spacetime

$$g^{kl} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 \end{bmatrix}. \tag{37}$$

Then the geodesic curvature on the scale of spacetime of an observer who is motionless in relation to some frame of reference will be defined by expression

$$K = \sqrt{g^{kl} K_k(t) K_l(t)} =$$

$$= \sqrt{(-H)^2\left(c^2 - \frac{dX}{dt}\frac{dX}{dt} - \frac{dY}{dt}\frac{dY}{dt} - \frac{dZ}{dt}\frac{dZ}{dt}\right)} =$$

$$= K_0\sqrt{1 - \frac{v^2}{c^2}}, \tag{38}$$

in which the labels are adopted:

$$v^2 = \left(\frac{dX}{dt}\right)^2 + \left(\frac{dY}{dt}\right)^2 + \left(\frac{dZ}{dt}\right)^2, \tag{39}$$

$$K_0 = Hc. \tag{40}$$

In a word, for an observer who is on the average, motionless in respect the Universe, the curvature is equal to K_0, we can call it a static component of the geodesic curvature. If someone (or something) moves with a velocity v, then on the scale of spacetime of the motionless observer the geodesic curvature of the Universe is defined by expression (38) for a moving observer. The moving observer will determine that the geodesic curvature of the Universe is equal K_0 in his frame of reference (because first, in the full formula for the geodesic curvature, dt should be replaced with $d\tau$ and second, in one's own frame of reference the velocity of motion is always equal to zero).

Therefore, the geodesic curvature, like many other characteristics of the Universe, is a relative notion that depends on relative to what we determine it. The static component of the geodesic curvature is constant and according to the author's estimations, is approximately equal to 10^{-10} m/s^2.

5. Generalized Galilean transformations

The equation of free motion (3) is noninvariant in relation to the Galilei transformations. It has turned out to be invariant with regard to the group of transformations

$$X' = \frac{v_0}{H}\left(1 - e^{-Ht}\right), \quad t' = t, \tag{41}$$

that could be called the group of generalized Galilei transformations. Indeed, in a thin space when $H \to 0$, we have

$$X' = X - v_0 t, \tag{42}$$

i.e., we obtain the conventional Galilei transformations.

So, what is the essence of the invariance of equations (3) in relation to the generalized Galilei transformations? Let us make transformations

$$X = X' + \frac{v_0}{H}\left(1 - e^{-Ht}\right);$$

$$\frac{dX}{dt} = \frac{dX'}{dt} + \frac{v_0}{H}He^{-Ht} = \frac{dX'}{dt} + v_0 e^{-Ht};$$

$$\frac{d^2X}{dt^2} = \frac{d^2X'}{dt^2} - Hv_0 e^{-Ht};$$

$$\frac{d^2X}{dt^2} + H\frac{dX}{dt} =$$

$$= \frac{d^2X'}{dt^2} - Hv_0 e^{-Ht} + H\frac{dX'}{dt} + Hv_0 e^{-Ht} =$$

$$= \frac{d^2X'}{dt^2} + H\frac{dX'}{dt} = 0. \tag{43}$$

Thus, the obtained equation is exactly equivalent to equation (3) by its form. It is here that the whole of the invariance is.

It is necessary, however, to pay attention to one circumstance: in a completely empty space (i.e., at $H = 0$), even the conventional Galilei transformations do not hold since in this case from transformations (41) follow

$$X = X', \quad t = t'. \tag{44}$$

In other words, there should be no mass, inertia, motion, or time in a completely empty Universe. This is one more manifestation of the General Relativity.

6. Conclusion

Gravitational viscosity and geodetic curvature are completely new properties of the Universe, which are detected "on pen tip", i.e. which set on the basis of existence others of its properties. However they explain middle-scale structure of the Universe, bound with formation of galaxies, presence of the chosen reference system, directedness of course of physical processes, absence of huge velocities of a motion of stars and galaxies, and as well stationarity of the Universe. The experiment on direct measuring of cosmological redshift is unique cosmological experiment on confirmation of presence of gravitational viscosity and geodetic curvature of the Universe [17, 19, 21, 23]. It is termed as fundamental experiment, and it can be conducted in earth laboratory. The author considers that the inventory of LIGO-laboratory is the most appropriate inventory for this purpose.

References

[1] Yu.V. Baryshev, "Field Theory of Gravitation: Desire and Reality." *Gravitation*, **2**, 2, 5-20 (1996).

[2] G.D. Birkhoff, "Flat space-time and gravitation." *Proc. Nat. Acad. Sci.*, **30**, 324 (1944).

[3] S. Chandrasekhar, "The mathematical Theory of Black Holes," Part 1. Clarendon Press Oxford, Oxford Univ. Press, New York, 1983.

[4] S. Deser, "Self-interaction and gauge invariance." *Gen. Rel. Grav.*, **1**, 9 (1970).

[5] R. Feynman, "Quantum theory of gravitation." *Acta Phys. Pol*, **24**, 697 (1963).

[6] L.P. Grishchuk, A.N. Petrov, A.D. Popova, "Exact Theory of the (Einstein) Gravitational Field in an Arbitrary Backgraund Space- Time." *Comm. Math. Phys.*, **94**, 379-395 (1984).

[7] G. Kalman, "Lagrangian formalism in relativistic dynamics." *Phys. Rev.*, **123**, 384 (1961).

[8] A.A. Logunov, M.A. Mestvirishvili, "The Relativistic Theory of gravitation." Moskow, Nauka, 1989, pp.304 (in Russian).

[9] M. Moshinsky, "On the interactions of Birkhoff's gravitational field with the electromagnetic and pair fields." *Phys. Rev.*, **80**, 514 (1950).

[10] S.P. Novikov, A.T. Fomenko, "Elements of differential geometry and topology." Moskow, Nauka, 1987, pp. 432 (in Russian).

[11] H. Poincaré, *Rendikonti Del Circolo matematico di Palermo*, **21**, 129-176 (1906).

[12] W. Thirring, "An alternative approach to the theory of gravitation." *Ann. Phys.*, **16**, 96 (1961).

[13] N.A. Zhuck, "Metamorphoses of cosmology." In: "The Relativity Theory: for and against," FENID, Gomel, **3**, 89 (1991) (in Russian).

[14] N.A. Zhuck, "The new stationary model of the Universe." The Gamov memorial international conference "The Univerce of Gamov: original ideas in astrophysics and cosmology" (GMIC'99), Odessa, August 16-22, 1999, Abstracts, p. 37.

[15] N.A. Zhuck, "Cosmic equilibrium electromagnetic radiation," *Kharkov Univ. Public.*, **456/2**, 2000, p. 244 (in Russian).

[16] N.A. Zhuck, "The Microwave Background Radiation as aggregate radiation of all stars." The XVII international conference "Actual problems of anagalactic astronomy", Puschino, Moscow region, Russia, April 12-14, 2000 (in Russian).

[17] N.A. Zhuck, "The axiomatic theory of the Microwave Background Radiation." The Joint European and National Astronomical Meeting "European Astronomy at the Turn of the Millennium" (JENAM-2000), Moskow, Russia, May 29 - June 3, 2000, Abstracts, p. 48.

[18] N.A. Zhuck, "About identity of inertial and gravitational masses." The Joint European and National Astronomical Meeting "European Astronomy at the Turn of the Millennium" (JENAM-2000), Moskow, Russia, May 29 - June 3, 2000, Abstracts, p. 168.

[19] N.A. Zhuck, "Cosmology," Kharkov, Model Vselennoy Ltd, 2000, 464 pp. (in Russian).

[20] N.A. Zhuck, "Field formulation of the General Relativity." The Ukrainian-Russian conference "Gravitation, cosmology and relativistic astrophysics" (GRAV-2000), Kharkov, Ukraine, November 8-11, 2000, Abstracts, p. 37.

[21] N.A. Zhuck, "Cosmological effects in bulky Michelson-Morley interferometers." The Ukrainian-Russian conference "Gravitation, cosmology and relativistic astrophysics" (GRAV-2000), Kharkov, Ukraine, November 8-11, 2000, Abstracts, p. 73.

[22] N.A. Zhuck, "The identity of inertial and gravitational masses is proved!" *Spacetime & Substance*, **1**, 1, 23-28 (2000).

[23] N.A. Zhuck, "The Microwave Background Radiation as aggregate radiation of all stars." *Spacetime & Substance*, **1**, 1, 29-34 (2000).

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THE KEPLER'S THIRD LAW IN GRAVITATIONAL MANEFF'S FIELD

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Starting with the two body problem in gravitational Maneff's field and considering that here α is a small parameter, the form of the Kepler's third law is established. For $\alpha = 0$ this is reduced to the classical Kepler's third law.
The anomalistic period in Maneff's field is evaluated and it is related to the orbital period, these two periods being equal for $\alpha = 0$.
As a practical application, for some concrete kinds of binary systems the values of the parameter α are estimated. In addition, the differences between the orbital period in Maneff's field and the corresponding Newtonian field are computed. Also the differences between the anomalistic period and orbital period in Maneff's field are considered.

1. Introduction

In the two-body problem, the motion of two masses, under the mutual Newtonian attraction is studied, the force function being given by:

$$U = G\frac{Mm}{r} \tag{1}$$

Here M and m ($m < M$) are the corresponding masses, r is the distance between the two material points, while G is the Newtonian gravitational constant.

According to the Kepler's first law, the equation of the orbit, of the mass m in its relative motion around M is:

$$r = \frac{p}{1 + e\,cos\,v} \tag{2}$$

where p is the parameter of the corresponding conics, e stands for the orbital eccentricity, while v is the true anomaly. In the case of an elliptical motion we have $p = a(1 - e^2)$, where a represents the corresponding semi-major axis of the orbit.

In the year 1924, from some physical considerations, G. Maneff has introduced the following force function:

$$U = G\frac{Mm}{r}\left[1 + \frac{3G(M+m)}{2c^2 r}\right] \tag{3}$$

where c is the speed of light. So he has extended the Newtonian gravitational field through a post-Newtonian non relativistic field. Recently, the two-body problem in Maneff gravitational field was studied (Mioc, Stoica, 1995; Stoica, Mioc, 1997). Also, the three classical tests of General Relativity were analysed (Ureche, 1998,1999,2000). The equation of the relative motion (the case of the noncollisional orbits) can be writen (Ureche, 1999):

$$r = \frac{C^2(1-\alpha)}{G(M+m)} * \frac{1}{1 + e\,cos\sqrt{1-\alpha}\,v} \tag{4}$$

where C is the constant of areas, while α is given by:

$$\alpha = \frac{3G^2(M+m)^2}{c^2C^2} \tag{5}$$

For $0 < e < 1$ and $\alpha << 1$, Eq. (4), approximately, represents an ellipse.

In Table 1 are listed the values of α for different binary systems which are representative in astrophysics.

Table 1: The values of α

Binary system	α
Earth-Moon	$3.5 * 10^{-11}$
Mars-Phobos	$1.5 * 10^{-10}$
Large binary system-70 Ophiuchi	$2 * 10^{-9}$
Sun-Earth	$2.9 * 10^{-8}$
Sun-Mars	$1.9 * 10^{-8}$
Our Galaxy-Large Magellan's Cloud	$4.7 * 10^{-7}$
Close binary system-$V_{1647}Sagittarii$	$2 * 10^{-6}$
Binary pulsar-PSR 1913+16	$2.3 * 10^{-3}$

2. The Kepler's third law in Maneff's field

In the present section we shall establish the relationship for the Kepler's third law, when the equation of the orbit is given by (4). In order to do so, from the integral of areas:

$$r^2\frac{dv}{dt} = C \tag{6}$$

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it follows that the corresponding period will be given by:

$$P = \frac{C^3(1-\alpha)^2}{G^2(M+m)^2} * \int_0^{2\pi} \frac{dv}{\left(1+e\,cos\sqrt{1-\alpha}\;v\right)^2} \quad (7)$$

or, after some algebraical computations, we can write:

$$P = \frac{2a^{\frac{3}{2}}(1-\alpha)^{\frac{3}{2}}}{\sqrt{G(M+m)}}\left(arctg\frac{-\pi\alpha}{2\sqrt{\frac{1+e}{1-e}}} + \frac{e\sqrt{1-e}\,\pi\alpha}{2\sqrt{1+e}}\right) \quad (8)$$

Since we have $\alpha << 1$, after some simple computations, and having in view only the first power of the parameter α, we have:

$$\frac{P^2(M+m)}{a^3} = \frac{4\pi^2}{G}\left\{1-\left[3+(1-e)^{\frac{3}{2}}(1+e)^{-\frac{1}{2}}\right]\alpha\right\} \quad (9)$$

Therefore, Eq.(9) represents the relationship for the Kepler's third law in Maneff's gravitational field.

Remark: For $\alpha = 0$, Eq. (9) becomes:

$$\frac{P^2(M+m)}{a^3} = \frac{4\pi^2}{G}$$

that is, the Kepler's third law from Newtonian gravitational field is again found.

3. The expression of the anomalistic period in Maneff's field

As it is known, the anomalistic period represents the time interval between the two consecutive passages (transits) of the mass m through the perihelion. In the case of a Maneff's field, where the equation of the corresponding orbit is given by (4), during an anomalistic period we have: $0 \leq \sqrt{1-\alpha}\;v \leq 2\pi$ whence $0 \leq v \leq \frac{2\pi}{\sqrt{1-\alpha}}$.

Here we have: $\frac{1}{\sqrt{1-\alpha}} \approx 1+\frac{1}{2}\alpha$ and consequently

$$0 \leq v \leq 2\pi\left(1+\frac{1}{2}\alpha\right)$$

In such conditions the expression for the anomalistic period is:

$$P_{anom} = \frac{1}{C}\int_0^{2\pi\left(1+\frac{1}{2}\alpha\right)} r^2 dv \quad (10)$$

that is:

$$P_{anom} = \frac{1}{C}\int_0^{2\pi} r^2 dv + \frac{1}{C}\int_{2\pi}^{2\pi+\pi\alpha} r^2 dv \quad (11)$$

The first integral from (11) represents the orbital period P_{orbit}. Now, if we have in view Eq.(4), the expression (11) becomes:

$$P_{anom} = P_{orbit} + \frac{C^3(1-\alpha)^2}{G^2(M+m)^2} * \int_{2\pi}^{2\pi+\pi\alpha} \frac{dv}{\left(1+e\,cos\sqrt{1-\alpha}\,v\right)^2} \quad (12)$$

or

$$P_{anom} = P_{orbit} + \frac{2\pi a^{\frac{3}{2}}(1-e)^{\frac{3}{2}}}{\sqrt{G(M+m)(1+e)}}\alpha(1-\alpha)^{\frac{3}{2}} \quad (13)$$

If we are keeping only the first power of α we can write:

$$P_{anom} = P_{orbit}\left[1+(1-e)^{\frac{3}{2}}(1+e)^{-\frac{1}{2}}\alpha\right]. \quad (14)$$

From the equations (9), (14) we obtain:

$$\frac{P_{orbNewt}-P_{orbMan}}{P_{orbNewt}} = \frac{3+(1-e)^{\frac{3}{2}}(1+e)^{-\frac{1}{2}}}{2}\alpha \quad (15)$$

and

$$\frac{P_{anomMan}-P_{orbMan}}{P_{orbMan}} = (1-e^{\frac{3}{2}})(1+e)^{-\frac{1}{2}}\alpha \quad (16)$$

where the abreviations are obvious.

Remarks: 1. For $\alpha = 0$ we have $P_{anom} = P_{orb} = P_{orbNewt}$.

2. For the binary systems given in Table 1 we have computed:

$$\frac{P_{orbNewt}-P_{orbMan}}{P_{orbNewt}}$$

and

$$\frac{P_{anomMan}-P_{orbMan}}{P_{orbMan}}.$$

The numerical results are listed in Table 2, where

$$A = \frac{P_{orbNewt}-P_{orbMan}}{P_{orbNewt}}$$

and

$$B = \frac{P_{anomMan}-P_{orbMan}}{P_{orbMan}}.$$

The value of $P_{orb\,Newt}$ for the binary system: Our Galaxy-Large Magellan's Cloud (L.M.C.) was computed with classical third Kepler's law.

3. If we have in view the expression of the areas constant C, from Eq.(5) it follows:

$$\alpha = \frac{3G(M+m)}{c^2a(1-e^2)} \quad (17)$$

Further, if R_g and $R_g^{'}$ are the gravitational radii of the two components of a binary system, we can write:

Table 2: Numerical results

Binary system	A	B
Earth-Moon	$6.81 * 10^{-11}$	$3.13 * 10^{-11}$
Mars-Phobos	$2.98 * 10^{-10}$	$1.46 * 10^{-10}$
Large binary system	$3.29 * 10^{-9}$	$0.58 * 10^{-9}$
Sun - Earth	$5.75 * 10^{-8}$	$2.85 * 10^{-8}$
Sun - Mars	$3.64 * 10^{-8}$	$1.57 * 10^{-8}$
Our Galaxy-L.M.C.	$9.4 * 10^{-7}$	$4.74 * 10^{-7}$
Close binary system	$3.38 * 10^{-6}$	$0.76 * 10^{-6}$
PSR 1913+16	$3.66 * 10^{-3}$	$0.43 * 10^{-3}$

$R_g = \frac{2GM}{c^2}$ and $R_g^{'} = \frac{2Gm}{c^2}$. In such conditions Eq. (14) leads to:

$$\alpha = \frac{3}{2} \frac{R_g + R_g^{'}}{a\,(1-e^2)}. \tag{18}$$

The difference $P_{orb\,Newt} - P_{orb\,Man}$ is of the order of α. The expression (18) shows that the analysed effect becomes sensible for close binary systems consisting from compact components.

References

[1] Maneff, G., 1924: C. R. Acad. Sci. Paris, 178, 2159.

[2] Mioc, V., Stoica, C., 1995: C.R. Acad. Sci. Paris, 320, 645.

[3] Stoica, C., Mioc, V., 1997: Bull. Astr. Soc. India, 25, 217.

[4] Ureche, V., 1998: Rom. Astr. J., 8, No.2, 119.

[5] Ureche, V., 1999: Studia Universitatis Babes-Bolyai, Math., *XLIV*, No.1, 101.

[6] Ureche, V., 2000: Studia Universitatis Babes-Bolyai, Math., *XLV* (in press).

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COSMOGONY AND EVOLUTION OF COMET AND METEOR SUBSTANCE IN THE SOLAR SYSTEM

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Peculiarities of meteor radiation — dependence of radiated spectra on meteor's velocity, change of meteor spectrum along its path in accordance with Wien's Law, final flares typical for fast meteor showers etc. — allow us to imagine the physical picture of entering the Earth atmosphere by Near-Earth Objects and to estimate the results of such impacts more accessibly. Newest experimental data give us a possibility to make a conclusion about additional, comparably with the classical data, encrease of Earth' mass, wchich are not object to classical description of heat flow of planets ans Sun, existence of similar to ester all-penetrating particles, etc. Given data allow us to make a conclusion about the persistant arising of scattering substance. One of the results of this process observing in the Solar system are short-period comets, minicomets, large meteoroids, observational slow sporadic meteors etc. Unity in the evolution of scattering substance is confirmed by spectral observations and by direct measurements from space stations. Total wave nature of both, the musical proportions and geometrical constructions of Solar system according to J. Kepler, enable us to make conclusions about its cosmogony and distribution of bodies of this system.

1. The phenomenological description of meteor

The conception of meteor phenomena was created in I.S.Astapovich's work [1]. Meteor luminescence, according to I.S.Astapovich, appears in the middle of a meteor's path. There , the meteor enters rather dense atmosphere layers, when the length a molecule' free path becomes comparable with a meteor body dimension.

As for basic physical conceptions the meteor phenomenon can be analyzed additionally because an important number of factors are not as a rule taken into consideration when describing in special literature the physical picture of meteor phenomenon. For instance, when applying classical appropriateness in order to determine parameters characterizing the meteor, quantity and quality differences in spatial and temporal description of meteor phenomenon are not taken into account. Every point of meteor path if it's considered to be stationary, characterizes only spatial distribution of radiating substance. However, every point on meteor's path is also the source of temporal development of meteor phenomenon. In this case the radiation of meteor plasma is described on the basis of temporal correlation, e.g. by kinetic equations [13].

While calculating the different parameters characterizing particular meteor phenomenon, averaged constants for all meteor data are used. Here the individual peculiarities of a separate meteor, those of its shape, of its structure, of its chemical content, the change of radiation along its path etc. are not taken into account. For example, the meteor "spectral lines" used in investigating the meteor spectrograms, first of all characterize monochromatic image of meteor radiating volume. The application of its photometric profiles for spectrum interpretation is not correct.

When studying the photometric curves of meteors, appeared in the integral light, the peculiarities of spectrum sensitivity of used photographical system are usually not taken into consideration, which turns to the distortion of the light curve.

The observed phenomenon — meteor luminescence — is determined in the atmosphere by a number of facts defining the necessary conditions of meteor' emission observation. Thus, for visual registration of a meteor, the definite power of radiation is needed.

If a star with magnitude $m = +6^m$ is observed visually it means that this star creates illumination E, determined from the equality m = -13.89 - 2.5 lgE_*. Here 13.89 the quantity of one lux.

Hence $E_* = 1,107 \cdot 10^{-8} lux$. Luminous flux $\Phi = Es$, where s - is an area of illuminated site. As 1 Lumen in the area of maximum eye sensitivity is equal to $1.47 \cdot 10^{-3}$ Wt, the flux density is $E = 1,627 \cdot 10^{-11} Wt/m^2$.

However, the difference between the velocity of star image movement along the sky and that of meteor

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movement is about $10^3 - 10^4$ times. That's why the flux density of radiation of weak meteor $\Phi_\downarrow$ for keeping the same influence on the eye retina as from a star with magnitude 6 should be consequently higher and should be equal to not less than $E_\downarrow = 2 \cdot 10^{-7} Wt/m^2$ at every point of luminescence.

The same calculations may be carried out also for the glow of separate spectral lines in the case of photography or observation of meteor spectra. If the distance to a meteor is $R = 100\ km$, we can get radiating power at every point of meteor's path, being equal to $4\pi R^2 \Phi_\downarrow = 2,5.10^3 Wt$.

It's clear, that the observed luminescence of meteor plasma occurs due to warming up, vaporization and consequent excitation, and ionization of vapour of meteoroid which forms the meteor plasma.

Let's consider the average velocity of a meteor equal to velocity of Perseid shower v= $6 \cdot 10^4 m/s$. Then at the height of 100 km the meteor encounters nitrogen molecule flow equal to $3 \cdot 10^{-4} g/s$ through cm^2, and at the height of 80 km every square centimeter of meteoroid' cross-section encounters the flow $1.2 \cdot 10^{-2}$ g/s.

At other words, every square centimeter of meteoroid' cross-section encounters 10^{18} particles/s at the height of 100 km and $5 \cdot 10^{20}$ particles/s at the height of 80 km. It is the energy releasing in collisions of atmosphere' particles with meteoroid' surface that leads to its warning up, boiling and luminescence of evaporated meteor plasma. In this case the temperature of heated meteoroid must be not less than the boiling temperature of iron 3023 K, as iron is a constituent element almost of all meteoroids.

Thus, at the height of 80 km at meteor velocity v, the energy of interaction reaches

$$W_\downarrow = wN_a = 42 \cdot 10^3 \frac{J}{cm^2 s}, \tag{1}$$

where w is kinetic energy of nitrogen molecule, N_a is encountering flow of particles.

Further, while the meteor is penetrating into the dense layers of the atmosphere, in boiling the saturated vapour is formed from solid phase of a meteoroid. It is not difficult to find its density and concentration, e.g. for nitrogen, from correlation:

$$\rho = \frac{p\mu}{RT} = 1.5\ kg/m^3, \tag{2}$$

where ρ is the pressure of saturated vapour of nitrogen at boiling temperature 77 K, μ is mass of nitrogen kilomole, R is universal gaseous constant.

Hence, the molecule concentration of saturated vapour of nitrogen is $3.2 \cdot 10^{25}$ particles/m^3. It may be noticed, that the energy lossed for melting meteoroid follows expenditure of energy of collisions for forming meteor plasma (the specific melting heat of iron is 270 kJ/kg , for nitrogen - 25.7 kJ/kg).

Photometric measurements of spectrograms along the meteor path confirms that maximum energy distribution along the meteor spectrum shifts from long-wave part of 6000Åto short-wave part of 4000Åin accordance with energetic interactions due to collision with atmosphere particles so far as energetic interactions are increased while a meteor penetrates into dense layers of the atmosphere. More over, maximum radiation is often formed at the final flare of a meteor.

According to Wien's Law, the temperature course varies from 4800 go 7100 K in this case [13].

Wien's Law:

$$\lambda_{max} T = b, \tag{3}$$

allows us to determine from experimental data the length of wave, corresponding to maximum of energy distribution along spectrum λ_{max} and more over it gives us values (in high approximation) of the corresponding temperature of meteor' T radiation.

If we assume the velocity of movement of meteor fractions together with its parental body equal to $v = 6 \cdot 10^4$ m/s, then the corresponding temperature for nitrogen molecules is:

$$T = \frac{mv^2}{3k} = 404 \cdot 10^4, K, \tag{4}$$

where m is the mass of molecule, k is the Boltzsmann's constant. At such temperature not only solid and liquid meteor' phase cannot exist but also the maximum of energy distribution along the spectrum shifts to the x-ray part of the spectrum with $\lambda_{max} = 7$ Å.

As such a phenomenon during meteor glow really isn't observed, we have to believe that evaporated meteoroid particles are slowed down up to velocity not higher than $2.5 \cdot 10^3$ m/s. Just these velocities of movement of meteor plasma particles create radiation at temperature $4 \cdot 10^3 - 7 \cdot 10^3$ K. It is such radiation that corresponds to visible spectrum of a meteor.

The inertia of main mass of a meteoroid is high as compared with that of evaporated meteoroid particles. That's why the velocity of a meteoroid during its movement decreases much slower than that of evaporated meteoroid particles slowed down by encountering gas flow while colliding. Within some determined limits velocity v may be believed as permanent. Being slowed down the particles of meteor plasma lag the meteor body, forming its coma and train. Within the time limit the t particles' concentration in each point of meteor' movement is changing according to the Law, which is explaining by the kinetic equality (Smirnov V.A., 1995, 2000).

Such scattering of the meteoroid' substance with further radiation of meteor' plasma occur up to the entire mass' loss.

For time interval $\Delta t = 0.1sec$ that is equal to the averaged time of meteor movement the maximum heat conductivity of soil with superficial sand is:

$$q = \frac{Ql}{S\Delta t\Delta T} = 1,72.10^{-4}\frac{J}{mm.^{\circ}K}, \quad (5)$$

where $\Delta T/l$ is temperature gradient, $S = 1\ m^2$.

With such comparatively low heat conductivity values of substances including those of a meteoroid it is possible to explain the "long-life" of its solid phase during its movement in the atmosphere and conservation of its sluggishness.

As we can see, while determining heat conductivity of a meteoroid it is necessary to consider temporal factor t. During the "momentary" exposure time of a meteor $10^{-3}s$ heat from the bombarded surface manages to penetrate into the meteor body for fractions of a micrometer.

However, as the distance to a meteor decreases, the process of heat conductivity accelerates. So, in each point of meteor' movement the conditions of interaction of meteor and atmosphere are differ from other points along the meteor' path.

2. About the mechanisms of evolution of scattering substance in Solar Sistems

Meteor is the most prevalence, accesible for mass-scale observations and the typical object of Solar System. Due to above mentioned phenomenological description of this phenomenon we may judge about physics, evolutions and the physical properties of other objects of Solar System, optical investigations of which present difficulties compared with meteor investigations.

The spectral examinations of small bodies and microparticles in Solar System display their common nature, chemical composition and fundamental physical properties. Along with that, these convincing experimental facts and these observations show the existence of accelerated processes of evolution and the short-term changes of the physical properties of the objects of Solar System. Such phenomena as "infrared cirrus," minicomets, macroscopic plasma heterogeneities in ionosphere, "Soap bubbles" – slow sporadic meteors, the wave movements of egections out of comet' nucleus (for example, comet of Jon Bennet 1969 "i") and other phenomena confirm hypothesis of S.K. Vsekhsvyatsky about continuing cosmogony the process of the creating of new objects in Solar System [5].

As it is known, by means of space station SOHO actuated on the December, 2, 1995 for 4 years, it was able to discover more than 100 unknown comets. Due to this the many cases of the death of comets in the atmosphere of Sun were observed [11].

Usually, according to the Second principle of thermodynamics the process of evolution in Solar system is connected with the processes of breakdown, disintegration of comets and asteroids at the expense of the collisions, egections, conversions of the latter into the smallest objects of Solar System and eventually into scattering substance.

However, together with the processes of disintegration exist reverse processes, like antientropic processes of the organisation of substance into bigger forms. This is follows at least out of the real fact of existance both, the elastic and unelastic collisions between particles. The similar processes are based and described in work of K.Alfven and G.Arrhenius [2].

The experimental measurements of the geophysical parameters of planets by Veselov K.E. and others [4] showed, that duration of earth's day for the year increases upon 10^{-4} s, the radius of Earth for year increases on 1 cm, the period of the turning of Moon round Earth decreases on 10^{-3} s per year, the perihelions of planets for 100 year old are displaced at Mercury - on 43 arc.s., Venus - on 8.4 arc.s., Earth - on 3.8 arc.s., Mars - on 1.3 arc.s., etc.

These facts allowed Moscow' geophysicists to make conclusions about the continuous growth of the masses of planets at the expense, as to the assumption of authors, of the energy of surrounding gravity vacuum. The increasing of the mass of planets occurs according to Law:

$$\Delta m = \frac{4\gamma m_1 M\varepsilon}{c^2 a\,(1-\varepsilon^2)}, \quad (6)$$

where γ is constant of gravitation, m_1 is the mass of planet, the orbit of which has eccetricity ε, great semi-axis a, c is velocity of light, M is the mass of Sun.

Earlier, the theoretical explanation of the increase of the masses of planets based on the calculation "surplus" of the heat flows according to one-field theory by Blekett was made by G.I. Kuzjmenko [8, 9, 10].

Theoretical conclusion about the growth of the masses of cosmic objects was confirmed by geophysical experimental data.

The mechanism of the growth of masses by Veselov K.E. is defined at the expense of the interaction of acceleratedly moving object with gravity vacuum. Under gravity vacuum is understood material environment filled in with chaotic moving with the velocity of light particles - gravitons. With the change of the velocity of body the part of gravitons enters the resistant structure of body. In this case the change of the mass of body is proportionally to quantity of the work done. The body mass grows independently from, whether body breaks or accelerates when moving on orbit. Such definition removes contradictions in known hypothesis of Lesage. The authors of works on gravidynamic believe, that processes of gravitational interaction resulting to the

increasing of usual substance, are widely circulated in nature.

Certain interest represent the views of the author of work devoted etheredynamics [3]. Using the conclusion of ancient philosophers about endless structure of matter "deep and upwards," author examined vacuum as a certain gasiform environment, full of "amers" (term introduced by Demokrit).

Such mechanical approach allows author to calculate the inner energy of the cubic metre of ether which turns out to be larger on 17 points than energy appearing at the explosion of a megaton nuclear bomb!

Author consideres the microobjects as the chains of vortexs inside the ether. (Similar point of view in 20th was supported by physicist N.K.Kasterin and others).

The types of interactions are described by various ways of amers' movements. The continuous growth of masses is explaned by the ether absorption.

Similar mechanical approach overcomes the difficulties of the coordination of the theory of gravity with quantum mechanics. So, if we apply the correlation of indeterminesses by W.Heisenberg to phenomenon occurring in vacuum at a distance 10^{-15} m, indeterminess in the quantity of energy or impulse should turn to its fluctuations. According to the common theory of relativity where must form the virtual black holes, but space-time upon "planck" distances greatly bands, forming "foam". The energy of similar fluctuations is equal to $10^{28} eV$ and is named "planck" energy.

Received result is only on 4 points less than quantity of the inner energy of the cubic metre of gasiform ether, calculated by V.A.Atsiukovsky.

To overcome the difficulties of the quantum theory of field and the explanation of the properties of strongly interacting particles-hadronics in the middle of 60th was created the theory of superstrings. In this case were introduced 6 additional measurements. In three-dimensional world the "string" behaves as point-particle.

Out of the quantum equivalence of wave and particle followed, that gravity wave corresponds, according to the theory of superstring, the particle - graviton.

The number of the configurations of string, the fluctuating mode of common string define all known elementary particles [12]. The space of the possible configurations of strings is considered as the development of ideas of usual space. Its geometry is a type of the string field. In theory were considered closed and open strings. When open string encounter, they may interact, uniting its ends.

Obviously, that in the basis of the evolution of the various objects of Solar System lies pattern of superstrings.

According to the principle of the unity of the laws of nature, evidently, that not only the equation of Schrdinger E., but also pattern of superstring with corresponding modes can describe the history of formation and the existence of macrobodies of Solar System. The example of such cosmogonic pattern is presented below.

Here were used the ideas of J.Kepler, described in his work "The Harmony of Universe," where was given the description of Universe on the base of not only astronomical and mathematical regularities, but also musical proportions [15, 16].

3. About one supplement of the "Garmony of Universe by J. Kepler"

In the book by J. Kepler "Welt Harmonik" (Munchen-Berlin 1939, Verlag R. Oldenbourg) the musical proportions are united with geometrical means of building Platoon's inscribed and described figures. From this construction of geometrical figures in the scales of Solar system J. Kepler receives the method of the detectings of the distances of planets from Sun, when the orbits of planets are equal with geometrical figure built accordingly inscribed or described around another.

J. Kepler even introduces the conception of "contrapoint of planets" comparing the movement of planets with certain musical intervals and notes and forming on the such approach the laws of planets' movement.

Proportions, received by J. Kepler, are possible in the case of formations of standing waves in the space of Solar system, when the place of the formation of planets (according to J. Kepler, constucted Platoon's figures) conforms the main surfaces of standing waves having as the source the central luminary of Solar system. If such model, coming out of the idea of J.Kepler, takes place, when during the formation of standing waves scattered substance in Solar system must pour on the main surface and then stick together to assemble into planet body.

Similarly in experiments of Chladny, during the formation of standing wave on the planes of fluctuating plate scattered along its particles are collecting together, getting from points, which fluctuate with maximal amplitude, to the points, the amplitude of fluctuations of which is equal to zero, filling in the main lines. (On space this will be the "main surfaces"). In such a way will form symmetrical figures, which are making sometimes wonderful picture.

So, if we will consider the central luminary the source of gravitational waves, which, reflecting from less densible environment, surrounding scattering substance of Solar system in the period of its initial evolution, then standing gravitational wave with certain points of maximum displacement and main points will form.

Such equation for one-dimension case being solution to corresponding of the description of this type of the motion of wave equation in particular derivative, maybe used for the detecting of the coordinates of main points.

Table 1: The table of the distance of planets from Sun expressed across the nodes of standing gravitational wave

Planet	True distance	Calculated distance
Mercury	0.39	0.39
Venus	0.72	$0.39 + 0.50\ \lambda = 0.65$
Earth	1.00	$0.39 + 1.50\ \lambda = 1.17$
Mars	1.52	$1.00 + 1{,}00\ \lambda = 1.52$
Asteroids	2.90	$1.00 + 4.00\ \lambda = 3.08$
Jupiter	5.20	$1.00 + 8.00\ \lambda = 5.16$
Saturn	9.54	$1.00 + 16.0\ \lambda = 9.32$
Uranus	19.20	$1.00 + 35.0\ \lambda = 19.20$
Neptun	30.10	$1.00 + 56.0\ \lambda = 30.12$
Pluton	39.50	$1.00 + 74.0\ \lambda = 39.48$

These coordinates, count off from the source of wave, must correspond to the distances of planets from Sun, explaining the physical sense of Bode' rule.

If we would mark the coordinate, along which the wave through Y will form, then for one-dimension standing wave the coordinates of main points correspond to points defined from the condition:

$$Y = \frac{2n+1}{4}\lambda. \tag{7}$$

In this formula n is whole numerals 0, 1, 2,... However significance n=0, we would believe appropriate source of the formations of standing wave along with point formation initial main point. Then for Mercury shall admit n = 1. In such condition for the length of gravitational wave λ we receive significance 0.52 AU. Substituting for Venus n=2, for Earth n=3, receive the corresponding to the lengths of waves 0.58 AU and 0.57 AU.

The most accuracy of the detecting of the length of wave, evidently, gives the planet residing on nearest distance from the source of waves, i.e. Mercury. We shall adopt the length of main gravitational wave ("basic tone") $\lambda = 0.52$ AU. Then planet' orbits of Solar system must be located in main lines and points, being away from numerals, which are multiple $\lambda/2$.

From such condition it may be received the "theoretical" distances of planets from Sun. In Table are presented such distances in compare with true distances.

Based on presented data "center of gravity" of the system of the belt of asteroids, as well as of Saturn maybe defined more precisely.

Certainly, during the formation of planets bodies larger role, aside from the intended stream of the energy of gravitational waves, could play the forces of another nature, for example, electromagnetic, which could carry in process of forming of planets additional effects, that could change the position of Venus and Earth relatively to the source of waves.

As it can be seen from Table, together with the distance increasing from the central body, the scale of filling of "main surfaces" in space, or points in above mentioned one-dimension case, grows almost in geometrical progression.

Obviously, here we can see the mechanics of "gold section," ensuring the harmonious building of this natural formation.

References

[1] Astapovich I.S. "Meteor phenomena in the Earth's atmosphere." State Publishers of physical-mathematical literature. M. 1958, 640 pp.

[2] Alfven H., Arrhenius G. "Structure and Evolutionary History of the Solar System." Kiev, Naukova dumka, 1981, 30 pp.

[3] Atsiukovsky V.A. "Common etherodynamic. The modelling of the structures of substance and fields on insight into gasiform ether." M. Energoatomizdat, 1990, 278 pp.

[4] Veselov K.E., Karus E.V., Savinsky K.A., Dolitskaya T.V. "Physics-geological bases of conception of global riftogeneses." Publishers MGU, 1993, 128 pp.

[5] Vsekhsvyatsky S.K. "Physical characteristics of comets." Fiz-mat literature. M. 1958, 575 pp.

[6] Vsekhsvyatsky S.K., Ilchishina N.I. "Physical characteristics of comets 1965-1970." Nauka. M. 1974, 110 pp.

[7] Kepler Johannes. Welt-Harmonik. Munchen-Berlin, 1939, 403 pp.

[8] Kuzjmenko G.I. "New geocosmological factors." The collection of articles "Gravity and electromagnetism." Minsk, 1998, pp. 123–129.

[9] Kuzjmenko G.I. "Geophysics and gravity." *Dopovidi Nationalnoi Academy sciences of Ukraine.* No. 12, 1999, pp. 123–126.

[10] Kuzjmenko G.I., Postan M.Y. "The energetics of transport future." VINITI. The collection of general information. Transport. Science, technician, management. N 2. M. 2000, pp. 26–29.

[11] *COSPAR Information Bulletin.* No. 147. April 2000.

[12] Schwarz J. "Dual-Resonance Models Elementary Particles." *Scientific American.* February, 1975.

[13] Smirnov V. A. "The spectra of transient atmospheric light phenomena: meteors." Fiz-mat literature. M. 1994, 207 pp.

[14] Smirnov V.A. Spatio-Temporal variations of density of the particles generating the optical emission of meteor plasma. "Earth, Moon and Planets." 68, 1995, pp. 515–522.

[15] Smirnov V. A. Music Theory and the Harmony Method in J. Kepler's Work the Harmony of the Universe. "Astronomical and Astrophysical Transaction," **18**, 1999, pp. 521–532.

[16] Smirnov V. A. About one supplement of the "Harmony of Universe" by J. Kepler. Gamow Memorial International Conference "The Universe of Gamow: Original Ideas in Astrophysics and Cosmology." Abstracts. Odessa, August 16–22, 1999, p. 31.

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PHILOSOPHICAL PROBLEMS OF FUNDAMENTAL CONCEPTS: "PERPETUITY", "GRAVITATION"

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In the article on an example of two fundamental concepts of a cosmology, – "perpetuity" and "gravitation" – the authors show unfitness of conventional general world outlook and general philosophical doctrines in build-up of the consistent theories and models of the Universe, pattern of the world as a whole. They also show an inconsistency and unauthenticity of a conventional method abstract view for formation of concepts ostensibly reflecting an objective reality, material world. The authors of the article put a problem on "insuperable" inconsistencies and problems revealing in all fundamental concepts and theories of a modern science and making of a consistent alternate world science, pattern of the world as a whole.

1. Introduction

1.1. Universe as whole is the most general cosmological object of a cosmology. The Universe including all substance is characterized by non-creative and non-reach ability, infinite variety of properties, connections, forms of life and tendencies of development. Thus, the Universe as whole is perpetual. The modern sights on the Universe as on infinite cosmological object are founded on general world outlook and general philosophical doctrine *about perpetuity*, which reflects unbounded variety of the material world in space and time [4, pages 205, 44, 76; 3, volume 3, page 476].

1.2. For build-up of the theories and models of the Universe in a cosmology the basic physical theories describing laws of a substance motion are used as the data of astronomical observations and experimental physics. *In physics*, according to a statement about interactions of material objects, *gravitation* concerns one of fundamental types interaction. This statement is based on general world outlook and general philosophical doctrine about the motion as universal property of a substance including, besides other motion forms, gravitational interaction of material objects, bodies [3, volume 2, page 476, volume 1, page 263; 4, pages 65, 105].

1.3. Indicated general world outlook and general philosophical doctrine are problematic, contain "unsolvable" inconsistencies, and that's why can not be used as conceptual basis for a world science, including cosmology. The scientists, following general world outlook and general philosophical doctrines, general science views and concepts, without connecting with them of a cosmology problem, are inclined to repeat and reproduce errors and contradictions made in these doctrines and approaches.

1.4. In the article the authors show, what "unsolvable" contradictions contain fundamental concepts – "perpetuity" and "gravitation" used in a cosmology, indicate on problematic further critical use of these concepts in a science, show unfitness of a abstract view method for formation of any concepts. Besides, the authors put a problem on reforming general view and general philosophic doctrines and concepts, elimination of inconsistent definitions of fundamental concepts, development of a consistent alternate world science, including consistent cosmological theories and models of the Universe.

2. "Perpetuity"

2.1. According to conventional definition, the concept "perpetuity" reflects general character of the material world as its unbounded variety in space and in time. Nevertheless, in a view general world outlook and general philosophical doctrine about material ability of the world, about a substance as objective reality existing outside and irrespective of human consciousness and reflected by it, it is impossible to form concept "perpetuity", which could reflect all infinite variety of the material world [5, page 57; 4, page 44].

2.2. The substance on definition, though envelops an infinite set of really existing material objects and systems, does not exist differently, as in the particular forms of these material objects and systems. Each object of the material world is terminating and has particular boundaries – spatial, time, quantitative, qualitative etc. Outcoming of this, an objective reality, material world and substance have no infinite objects. It

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means the presence of restricted variety of material objects and systems as object practical and knowledge activity in the material world only. Hence, the concept "perpetuity", which ostensibly reflects "unbounded variety of the material world in space and in time", concerns something other, but in any way to the material world, which variety is restricted and has the end. Besides "the infinite variety" as the object cannot be ended, restricted, spotted and to learnt it can't be referred to the reality included in to the activity and used in any way [4, page 252; 5, page 349].

2.3. Besides problems with infinite objects, the concept "perpetuity" contains difficulties, connected with the operation of infinite objects' reflection. The concept "perpetuity" on definition reflects unbounded variety of the material world in space and in time. The technology of the reflection concept requires the presence of primacy and independence of the material object reflection in relation to the reflecting subject, which is secondary and can not reflect the material object in concept, which is not existing outside and irrespective of the subject. Obviously, that no subject can generate knowledge about "infinite variety of the material world", which would correspond the concept "perpetuity" with the help of technology and concept of reflection. The principle of process adequacy of reflection requires the result correspondence of reflection to the reflected object. In case with infinite variety of the material world and its reflection in the concept "perpetuity", the indicated principle of the adequacy is not fulfilled, as it is impossible to receive correspondence of reflection to the reflected in a view non-reach ability, indeterminacy, immensity of the last. Certainly, the particular restricted part of infinite variety of the material world can be reflected, but then the *complete* infinite variety of the whole material world loses, as a minimum, knowledge and also ontological, world outlook value as not relevant to the reality. The concept "perpetuity" as reflection "of infinite variety of the material world" of a non adequately reflected reality – the material world, which concerning the reflecting subject always appears as a particular restricted part of an objective reality. So the concept "perpetuity" does not reflect infinite variety of an objective reality [4, pages 454-455; 2, volume 1, pages 14-20, volume 2, pages 10-24].

2.4. As it is visible, the concept "perpetuity" is formed outside of any dependence from an objective reality, material world, and as outside of the technology and reflection concept and the principle of reflection adequacy to the reflected one. Most likely, the concept "perpetuity" reflects the objects, appearances or processes, which there are no in an objective reality, material world. And it is already general science problem, which becomes obvious after detection of inconsistencies made in the definition of the concept "perpetuity".

2.5. In this connection the authors of the article offer to formulate some problematic questions *on perpetuity*, which solution is capable to change fundamental general world outlook and general philosophical doctrines and general science views on an objective reality, material world etc.: 1) What the "infinite variety", if not the material world concerns? 2) For what the concept "perpetuity" is set and used?

3. "Gravitation"

3.1. According to conventional definition, the concept "gravitation" reflects a universal and fundamental type of interaction between any kinds of a physical substance, material objects, bodes [1, volume 2, page 513].

3.2. According to general world outlook and general philosophical doctrine about the material unity of the world, there is nothing in the world that would not be the particular form of a substance, its property or development of its properties and interrelations. The material unity of the world is exhibited in universal connection of appearances, available at all kinds of a substance of such universal and global properties, as a motion, space, time, ability to self-development etc. The universal connection of appearances represents the result of universal and global interaction of all subjects and appearances of the material world. This connection expresses structural interior unity of all elements and properties in each system, as well as indefinitely manifold connections and relations of the system with other systems, surrounding it, or appearances [4, page 136].

3.3. Thus, indicated general world outlook and general philosophical doctrine about the material unity of the world requires to view any type of a motion and interaction, to which the gravitational interaction concern also, exclusively as essential and universal properties of a substance as a whole, material objects, systems and bodies in particular [4, page 136]. However further viewing of this doctrine shows an inconsistency and impossibility of a statement that the motion and interaction of bodies, in particular gravitational interaction, are essential properties of these bodies and systems of bodies. On the contrary, the forces causing all kinds and types of motion and interaction act outside material objects systems and bodies.

3.4. On definition the gravitational interaction, as well as any other, represents the process of mutual influence of material objects, bodies on each other by substance and motion transfer. The interaction determines the existence and structural organization of any material *system*, its properties, its integrating along with other bodies in system of the greater order. From the concept of universal interaction of material objects or bodies with each other it, follows, that in the material world there is no and there can not be such objects or bodies, which could be outside any system, outside

any interactions [4, page 65]. Any system, in its turn, is characterized by plurality of elements being in relations and connections among themselves and forming a particular wholeness, unity [4, page 408]. Any material objects, bodies comprising any system, represent *elements* of this system. The elements of the system always are considered as indivisible [4, page 535]. They have no properties of the system. Thus, gravitational interaction, changing bodies position – system elements – each relevant other, changes properties of the system, that is the relation and connection between system elements, but is not affected up on a state and property of bodies remaining constant and indivisible as elements of the system. Besides the material objects, bodies being the system elements of objects, bodies, can not initiate the change of natural properties and system properties, which they make. The system of material objects, bodies also can not change the properties of itself on definition. The systems of material objects, bodies being the systems elements of the greater order, are indivisible as elements of these systems and have no structural organization and other properties of the system as such one. That's why the change of system properties of the greater order can not determine the change of systems properties of the smaller order being the systems elements of the greater order.

3.5. So, despite of the statements of general world outlook and general philosophical doctrines about the material unity of the world and about a motion and interaction as universal properties of a substance, the gravitational interaction can be the property neither material objects and bodies, nor systems consisting of them. As the properties of the system and its component elements can not cause and determine interaction of this system elements and change of properties of the system. Accordingly, the properties of bodies, system elements, (energy, mass, density etc.) and properties of bodies system (interrelation and the laws of interrelations between bodies) can not determine interaction and motion (approaching, retardation) of bodies within the framework of the system.

3.6. Thus, if system of material bodies and its elements do not cause a motion and any type of interaction, for example gravitational, and the motion and interaction do not influence upon the properties of material bodies, so the motion, and any type of interaction, including gravitational, belongs to something exterior, concerning neither to system of material bodies, nor to its elements. However, the statement about belonging of a motion and interaction to something exterior, not concerning the material world both discredits general world outlook and general philosophical doctrine about material unity of the world and about a motion and interaction as universal property of a substance.

3.7. Outcoming of this, the authors of the article offer following problematic questions *on a gravitational interaction*, which solution is capable to change fundamental general world outlook and general philosophical the doctrines and general science views on an objective reality, material world etc.: 1) The property of which is "gravitational interaction", if it can not be the property of material objects, bodies? 2) What is the concept "gravitation" is set and used? 3) What determines "gravitational interaction" of material objects, bodies?

4. "Abstraction"

4.1. According to above-stated general world outlook and general philosophical doctrines, the concepts "perpetuity" and "gravitation" could be obtained as a result of application of an abstract view method. However this method does not give the complete knowledge of an objective reality, or does not give knowledge of the material world at all.

4.2. The doctrine about infinite variety of the material world restricts the opportunities of reflection during formation of concepts: it is impossible practically to reflect *infinite variety* of the material world. Nevertheless, for the confirmation of the indicated doctrine about infinite variety of the material world, the scientists traditionally use an abstract view method. The abstract view method consists in forming images of the actual world (imaginations, concepts, judgements) by means of abstraction and replenishing (operations), that is by use (or mastering) only a part from a set of the relevant data and addition to this part of the new information which is not outcoming from these data [5, pages 6-7]. The concepts formed by an abstraction from a series of the properties of reflected material objects or by allotment them by new properties, neither in that, nor the other case will reflect adequately the data of material objects. So, the unity of properties of any material objects means and determines its quality. The quality of any material object is interlinked to it as with whole, contains plurality of all its properties and, thus, determines its life [4, pages 186-187]. Therefore at formation of the concept about the material object by an abstract view method, it is impossible to receive in result the concept, which would reflect *this material object*. As a result of an abstraction from a series of properties of the material object or allotment it with new property the new quality, new life, *new object*, – is not the same for which the operations of abstract view were conducted. Thus, the concepts obtained by application of an abstract view method, can not be interlinked to an objective reality though its reflection in the data concepts. Therefore concepts "perpetuity" and "gravitation", which, obviously, are formed with the help of an abstract view method, can not have relation to an objective reality, material world, despite of general world outlook and general philosophical doctrine restriction on existence of something outside of the material world.

4.3. The authors of the article offer the following problematic *on an abstract view method*, which solution is capable to change fundamental general world outlook and general philosophical doctrines and general science views on an objective reality, material world etc.: 1) What do the concepts reflect, it they do not reflect really existing things and appearances (objective world, substance)? 2) How to learn the objective world, substance, if the method of an abstract view does not allow to learn it?

5. Conclusion

5.1. Thus, from viewing two of all fundamental concepts of a cosmology – "perpetuity" and "gravitation" it is visible, that they and their definitions are sustained in strict correspondence with general world outlook and general philosophical doctrines and contain the same inconsistencies and errors, as these doctrines. The indicated fundamental concepts can reflect everything, except an objective reality, which declare the indicated doctrines. No hypothetical and experimental attempts of physicists, cosmology scientists and other scientists within the framework of private sciences in former and new times, probably, are not capable to overcome explicit, and for them very difficult inconsistencies contained in fundamental concepts and doctrines.

5.2. The authors, as a matter of fact, have already begun operation on severe and multifold reforming of all world science. This paper represents one more step. In it the authors on an example only of two concepts ("perpetuity", "gravitation") and method of abstract view apply a new author's method of detection of intolerable inconsistencies in fundamental concepts and doctrines. Certainly, the fundamental errors of a world science do not lie on a surface, – they are well latent and are not visible neither with first, nor with second or third view etc. There is a general impression, that the errors and inconsistencies so are well latent and disguised purposely, with the particular purpose, which, in its turn, latent.

5.3. So and otherwise, but in a modern world science, obviously, there are no methods of intolerable inconsistency detection in fundamental concepts and doctrines, their possible engagement. Therefore new author's method, the results of which applications are shown in this article, can be used with success for development of a new consistent alternate world science.

5.4. The answers to problematic questions posed in the article can be obtained as a result of application of a new author's method. But they are already the following step on the way of severe and multifold reforming of a world science. The authors of this article offer scientists, science officers, everyone, who will accept the solution fully to be acquainted with a new author's method and to take part in the development of a new consistent alternate world science, to appeal to them to the indicated address and telephone.

5.5. Pay attention the publications! In the following issues of the magazine the authors intend to consider the following fundamental concepts: "space", "time", and method of experiment.

References

[1] "The Major encyclopedic dictionary: In 2 vol."/ Chief editor A. M. Prokhorov – M.: The encyclopedia of the Soviet Union, 1991.

[2] "Materialistic dialectics: In 5-th vol."/ Under general edition by F. V. Konstantinov and V. G. Marakhov, responsible edition F. F. Vyakerev – M.: Mysl, 1981.

[3] "The Physical encyclopedia"/ Chief editor A. M. Prokhorov. Editorial team D. M. Alekseev, A. M. Baldin, A. M. Bonch-Bruevich, A. S. Borovik-Romanov etc. – M.: The encyclopedia of the Soviet Union, 1988.

[4] "The Philosophical dictionary: 6-th editions processed and added"/ Under edition I. T. Frolov – M.: Politizdat, 1991.

[5] "The Philosophical encyclopedic dictionary"/ Editorial team: S. S. Averintsev, E. A. Arab-Ogly, L. F. Ilyichev etc. – M.: The encyclopedia of the Soviet Union, 1989.

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THE UKRAINIAN-RUSSIAN CONFERENCE "GRAVITATION, COSMOLOGY AND RELATIVISTIC ASTROPHYSICS"

(November 8-11, 2000, Kharkov, Ukraine)

SCIENTIFIC PROGRAM

Wednesday, NOVEMBER 8

11.00-13.00 — GRAVITATION AND INTEGRATED THEORIES (Chairman P.I. Fomin):

— **Vladimirov Yu.S.** GRAVITATION AND PROBLEM OF INTEGRATING OF PHYSICAL INTERACTIONS (30+5 min);
— **Krasnoholovets V.V.** Space Structure and Quantum Mechanics (30+5 min);
— **Grebeniuk M.A.**, **Ivashchuk V.D.**, **Melnikov V.N.** Multidimensional classical and quantum gravity with p-branes (20+3 min);
— **Abdildin M.M.** On the Interpretation of Einstein's equations in General Relativity (18+3 min).

13.00-14.00 — lunch break

14.00-16.00 — GRAVITATION AND INTEGRATED THEORIES (Chairman Yu.S. Vladimirov):

— **Fomin P.I.**, **Shtanov Yu.V.** FIELD THEORY IN BRANCHING SPACES (20+5 min);
— **Bezerra de Mello E.R.**, **Bezerra V.B.**, **Khusnutdinov N.R.** VACUUM POLARIZATION OF MASSLESS SPINOR FIELD IN GLOBAL MONOPOLE SPACETIME (15+5 min);
— **Gershun V.D.** T-DUALITY OF STRING MODELS IN THE BACKGROUND GRAVITY AND ANTISYMMETRIC FIELDS (15+5 min);
— **Gladush V.D.** THE BIRKHOFF THEOREM IN FIVE-DIMENSIONAL GRAVITATION AND THE KALUZA-KLEIN THEORY (15+5 min);
— **Kudrya Yu.N.** "GEOMETRICAL OPTICS" OF MASSLESS FIELDS OF A SPIN 3/2 IN GR (15+5 min);
— **Kalinin D.A.** NONCOMMUTATIVE RIEMANNIAN GEOMETRY FOR QUADRATIC ALGEBRAS (12+3 min);

16.00-16.30 — coffee break

16.30-18.30 — GRAVITATION AND INTEGRATED THEORIES (Chairman M.P. Korkina):

— **Kassandrov V.V.**, **Trishin V.N.** PENROSE TWISTOR TRANSFORM AND EINSTEIN-MAXWELL SYSTEM (20+5 min);
— **Sannikov-Proskurjakov S.S.**, **Cabbolet M.J.F.T.** Renormalized Newtonian Conctant against equivalence principle (20+5 min);
— **Kiekhoven D.** GRAVO-INERTIAL FIELD THEORY — A NEW IDEA ABOUT GRAVITATIONAL PHYSICS (15+5 min);
— **Popov A.A.**, **Sushkov S.V.** VACUUM POLARIZATION OF A SCALAR FIELD IN WORMHOLE SPACETIMES (15+5 min);
— **Kolpakov D.N.** POLARIZATION WAVES AND PROBLEM OF THE GRAVITATION (20+4 min);
— **Shil'nov Yu.I.**, **Chytov V.V.** INFLUENCE OF THE SPACE-TIME CURVATURE ON THE CHIRAL SYMMETRY BREAKING IN THE MODEL WITH A FOUR FERMIONS INTERACTION (10+1 min).

18.30-20.00 — POSTERS "GRAVITATION AND INTEGRATED THEORIES" AND GENERAL DISCUSSION:

1. **Baranov A.M., Bardushko N.M.** ALGEBRAIC CLASSIFICATION OF KALUZA 5D-SPACE WITH KRISHNA RAO WAVE METRIC GENERALISATION.
2. **Baranov A.M., Tegai S.F.** FIXED SINGULARITIES IN THE KERR-SCHILD SPACES.
3. **Belousova S.A., Maksimenko N.V.** THE DESCRIPTION FOR THE SPIN POLARIZABILITIES OF HADRONS BASED ON THE COVARIANT LAGRANGIAN.
4. **Kurbanova V.R.** POLARIZATION-TIDAL MODELS OF BIREFRINGENCE IN THE GRAVITATION FIELD.
5. **Litvinov D.A.** INFLUENCE OF THE OWN GRAVITATIONAL FIELD ON THE MODEL SYSTEMS WITH FERMION AND ELECTROCTATIC FIELDS.
6. **Mychelkin E.G.** THE EQUATIONS OF A SCALAR GRAVITATION.
7. **Mychelkin E.G.** THERMODYNAMICS OF A SCALAR FIELD.
8. **Sharypov O.V., Pirogov E.A., Grishin S.G.** RELATIVISTIC QUANTUM-GRAVITATIONAL HYPOTHESES AND SPACE-TIME STRUCTURE.
9. **Shumakov F.T.** THEORETICAL RESEARCHES OF A RELATIVISTIC GRAVITATION.
10. **Suslikov F.G.** THE DYNAMICS OF THE COLORED PARTICLES IN THE FIELD OF GRAVITATIONAL RADIATION.
11. **Vergeles S.N.** THE NEW APPROACHES TO QUANTIZATION OF GRAVITATION IN D = 2,4 DIMENSIONALITIES.

Thursday, NOVEMBER 9

09.00-11.00 — GRAVITATION AND INTEGRATED THEORIES (Chairman V.P. Frolov):

— **Pelykh V.A.** THE CORRELATION BETWEEN SPINOR AND TENSOR METHODS IN THE POSITIVE GRAVITATION ENERGY PROBLEM (25+5 min);
— **Khusnutdinov N.R.** GROUND STATE ENERGY OF MASSIVE SCALAR FIELD INSIDE A SPHERICAL REGION IN THE GLOBAL MONOPOLE BACKGROUND (15+2 min);
— **Sushkov S.V.** DOMAIN WALLS IN A WORMHOLE SPACETIME (15+2 min);
— **Noskov V.I.** RELATIVISTIC VARIANT OF FINSLERIAN GEOMETRY AND ELECTROMAGNETIC "RED" SHIFT AT THE MODEL OF ENCLOSED SPACES (20+3 min);
— **Rvachev V.L. and Avinash K.** QUADRATIC RED SHIFT LAW AND THE NON-ARCHIMEDEAN UNIVERSE (15+5);
— **Gladush V.D., Konoplya R.A.** ON INSTABILITY OF THE SPHERICALLY- SYMMETRIC METRIC IN THE KALUZA-KLEIN THEORY (7+1 min);
— **Sharafiddinov R.S.** ON THE GRAVITATIONAL FIELD OF THE ELECTRIC CHARGE (10+1 min).

11.00-11.30 — coffee break

11.30-13.00 — GRAVITATION AND INTEGRATED THEORIES (Chairman M.M. Abdildin):

- **Chernitskii A.A.** The possibility of unification for gravitation and electromagnetism in nonlinear electrodynamics (20+3 min);
- **Olyeynik V.P.** SELF-CONSISTENT SYSTEMS OF MAXWELL-DIRAC-YANG-MILLS FIELDS WITH SPHERICALLY SYMMETRIC GRAVITATIONAL FIELD (15+2 min);
- **Zhuck N.A.** Field formulation of the General Relativity and cosmology (25+3 min);
- **Sinitsyn K.N.** The Binary Model of distribution of the substance density and Nature of Gravity (10+1 min);
- **Parnovsky S.L., Gaydamaka A.Z.** Influence of scalar fields with the ununderload relations on timelike singularities properties (10+1 min).

13.00-14.00 — lunch break

14.00-16.00 — COSMOLOGY (Chairman V.P. Frolov):

— **Fomin P.I., Shtanov Yu.V., Barabash O.V.** QUASICLOSED WORLDS AND QUANTUM CREATION OF A CLOSED UNIVERSE (30+5 min);

— **Dragovich B.**, **Neshich Lj.** ADELIC QUANTUM COSMOLOGY (20+3 min);
— **Chashihin J.V.** QUANTUM SOLUTION OF SINGULARITIES PROBLEM IN GENERAL RELATIVITY (15+5 min);
— **Chervon S.V.**, **Zhuravlev V.M.** MODELS OF COSMOLOGICAL INFLATION SUPPOSING A NATURAL OUTPUT ON RADIATION-DOMINANT STAGE AND ERA OF A DOMINANCE OF SUBSTANCE (20+2 min);
— **Verozub L.V.**, **Kochetov A.Y.** ACCELERATION OF THE UNIVERSE AS A CONSEQUENCE OF GRAVITY PROPERTIES (18+2 min);

16.00-16.30 — coffee break

16.30-18.30 — COSMOLOGY (Chairman P.I. Fomin):

— **Arifov L.Ya.** TO A PROBLEM ON COSMOLOGICAL ROTATION (20+3 min);
— **Zhuravlev V.M.** COSMOLOGICAL MODELS With a VARIABLE EQUATION OF SUBSTANCE STATE (20+3 min);
— **Cherny A.N.** SPACE-TIME SCALE DIFFERENCES AS ACCELERATION SOURCE OF PONDERABLE MATTER (20+3 min);
— **Korkina M.P.**, **Turinov A.N.** MODEL OF "VOIDS" IN FRIEDMAN UNIVERSE (20+3 min);
— **Khodyachich M.F.** COSMOLOGICAL PERIODICITIES AND MODELS OF THE UNIVERSE (15+2 min);
— **Saveliev E.V.**, **Kattsyn D.V.** CORRESPONDENCE BETWEEN SOLUTIONS OF THE EINSTEIN EQUATIONS FOR MANY-DIMENSIONAL UNIVERSE MODELS FIILED BY THE MATTER (10+1 min).

18.30-20.00 — POSTERS "COSMOLOGY AND PHILOSOPHICAL PROBLEMS" AND GENERAL DISCUSSION:

1. **Guts A.K.** INDETERMINACY PRINCIPLE FOR RADIUS OF THE UNIVERSE, DIFINIENDUM BY VELOCITY OF DOINGS DISORGANIZATION IN SPACE-TIME.
2. **Khokhlov D.L.** ON THE FLATNESS AND HORIZON PROBLEMS.
3. **Klafas E.A.** THE STRUCTURE OF THE COSMOS AND ANTICOSMOS AND THEIR GRAVITATIONAL COMPOSITIONS.
4. **Koryukin V.M.** THE NEUTRINOS OF UNIVERSE AND THE GRAVITATION INTERACTION.
5. **Minakov I.V.** QUANTUM COSMOLOGY: TO A METAPHYSICAL CONDITION OF KNOWLEDGE.
6. **Shumakov F.T.** CREATION OF THE RELATIVISTIC GRAVITATIONAL CONCEPT OF MODEL OF THE UNIVERSE.
7. **Snagoschenko A.V.**, **Bondarenko S.V.** PHILOSOPHICAL PROBLEMS OF FUNDAMENTAL CONCEPTS: "PERPETUITY", "GRAVITATION".
8. **Zhukova A.F.**, **Zhelonkina N.** THE UNIVERSE IS THE GRAVITATION CLOCK. 9. Gumanyuk Yu.Yu. IDEA AND GRAVITATION.
9. **Gumanyuk Yu.Yu.** IDEA AND GRAVITATION.

Friday, NOVEMBER 10

09.00-11.00 — COSMOLOGY (Chairman L.Ya. Arifov):

— **Burlikov V.V.**, **Korkina M.P.** T-SOLUTIONS FOR THE SPHERICAL ANISOTROPIC FLUID IN GR (25+5 min);
— **Minakov A.A.**, **Vakulik V.G.**, **Vasiljev S.A.** SPATIAL AND TEMPORAL DISTORTIONS OF A SOURCE LIGHTCURVE IN PROPAGATION OF LIGHT THROUGH A GRAVITATIONAL LENS-GALAXY (25+5 min);
— **Vakulik V.G.**, **Dudinov V.N.**, **Zheleznyak A.P.**, **Konichek V.V.**, **TsvetkovaV.S.**, **Sinelnikov I.Ye.**, **Minakov A.A.**, **Artamonov B.P.**, **BruevichV.V.**, **Hamitov I.M.** PHENOMENON OF GRAVITATIONAL LENSING; INVESTIGATION OF VARIABILITY IN GRAVITATIONAL LENS SYSTEM Q2237+0305 (THE EINSTEIN CROSS) (25+5 min);

— **Alexandrov Yu.V.** TO QUECTION OF THE CONTEMPORARY EVOLUTION OF THE UNIVERSE (15+2 min).
— **Korukhov V.V.** ON THE PROBLEM OF INITIAL PARAMETERS OF UNIVERSE (12+1 min);

11.00-11.30 — coffee break

11.30-13.00 — COSMOLOGY (PHILOSOPHICAL PROBLEMS) (Chairman I.Z. Tsekhmistro):

— **Pavlenko A.N.** WHETHER IS THE COSMOLOGICAL THEORIES SCIENTIFIC FICTION (30+5 min);
— **Tsekhmistro I.Z.** ABOUT THE LOGICAL NATURE OF QUANTUM CORRELATION (25+2 min);
— **Ivanchenko G.E.** EINSTEIN POSTULATE ABOUT A CONSTANCY OF SPEED OF LIGHT AND ITS PHYSICAL CONTENTS (15+2 min);
— **Tararoev J.V.** PHILOSOPHICAL ASPECTS OF THE SPACE AND TIME PROBLEM IN QUANTUM COSMOLOGY (10+1 min).

13.00-14.00 - lunch break

14.00-16.00 — RELATIVISTIC ASTROPHYSICS (Chairman M.P. Korkina):

— **Frolov V.P.** HAWKING RADIATION FROM A FLUCTUATING BLACK HOLE (30+5 min);
— **Golubiatnikov A. N.**, **Chukin S.S.** ON THE CALCULATION OF STRONG RELATIVISTIC EXPLOSION (20+3 min);
— **Sinitsyn K.N.** "BLACK HOLES" AND NATURE OF "DARK MATTER" IN BINARY MODEL OF DISTRIBUTION OF THE SUBSTANCE DENSITY (16+2 min);
— **Grigorjev S.B.** THE STATIC SOLUTIONS With HOMOGENEOUS And ANISOTROPIC PRESSURE (10+1 min);
— **Kontorovich V.M.**, **Pasyuga V.N.** ULTRA RELATIVISTIC EXPLOSION IN A GRAVITATIONAL FIELD OF THE CENTRAL-COMPACT OBJECT AND SUPERLUMINAL RADIO JETS (10+1 min);
— **Zakharov A.V.**, **Dusakova L.R.** ON SMALL PERTURBATIONS IN THE COSMOLOGICAL PLASMA WITH COMPTON DIFFUSION (10+1 min);
— **Bannikova E.Yu.**, **Verozub L.V.** SPHERICALLY AND SYMMETRIC ACCRETION ON OBJECT WITHOUT HORIZON OF EVENTS (10+1 min).

16.00-16.30 - coffee break

18.30-20.00 — POSTERS " RELATIVISTIC ASTROPHYSICS" AND GENERAL DISCUSSION:

1. **Alaverdyan G.B.**, **Harutyunyan A.R.**, **Vartanyan Yu.L.** ON SMALL MASS HYBRID STARS WITH QUARK CORE.
2. **Baranov A.M.**, **Baranov D.A.** STATIC STAR MODEL AND MATHIEU FUNCTIONS.
3. **Baranov A.M.**, **Lukonenko M.V.** EXTENSIVE CLASS OF STATIC STARS SIMULATION WITHIN ONE APPROACH.
4. **Bogdanov A.S.**, **Guziy S.**, **Shlyapnikov A.** PROBLEM OF THE SEARCH OPTICAL CANDIDATES ON THE IDENTITY WITH GRB.
5. **Guziy S.**, **Panko E.A.**, **Shlyapnikov A.** THE OPTICAL RESEARCHING OF 30 GRB-AREAS.
6. **Kozhanov T.S.**, **Zhukina A.B.** TO DYNAMICS OF THE REVOLVING AND ASYMMETRICALY COMPRESSIBLE PROTOGALAXY.
7. **Schetchikov P.V.** NON-STATIONARY GRAVITATIONAL FIELDS AND STOCHASTIC ANOMALIES IN RELATIVISTIC KINETIC SYSTEMS.
8. **Shikin I.S.** EXACT SOLUTIONS OF STELLAR WIND TYPE IN RELATIVISTIC GAS DYNAMICS IN SCHWARZSCHILD'S SPACE-TIME.
9. **Shumakov F.T.** THE SUBSTANTIATION OF THE PULSATORY RELATIVISTIC GRAVITATIONAL CONCEPT OF A GENESIS OF ENERGY OF ASTRONOMICAL OBJECTS.
10. **Zheleznyak O.A.** FEATURES OF A STABILITY AND EQUILIBRIUM SELF-GRAVITATING OF CONFIGURATIONS.
11. **Zykunov V.A.** SPIN EFFECTS OF THE W-PRODUCTION IN HADRON-HADRON COLLISIONS.

16.00 — conference dinner

Saturday, NOVEMBER 11

09.00-11.00 — RELATIVISTIC ASTROPHYSICS (Chairman M.M. Abdildin):

— **Zhuravlev V.M.**, **Kornilov D.A.** NONUNIFORM COSMOLOGICAL MODEL WITH A CHARGED SCALAR FIELD AND IDEAL FLUID (20+3 min);
— **Chashihin J.V.** DIMINUTION OF COSMIC DISTANCES SOLVES PROBLEMS OF SUPERLUMINAL EXPANSION AND OF GALACTIC HALOS (15+5 min);
— **Vishnevskaya I.V.**, **Guziy S.**, **Zelenskaya E.A.**, **Shlyapnikov A.** RESULTS OF THE OPTICAL OBSERVATIONS X-RAY TRANSIENTS XTE J1859+226 AND XTE J1118+480 (12+1 min);
— **Kontorovich V.M.**, **Shelyag S.I.** THE GALAXY CLUSTER EVOLUTION, DEPEND ON GRAVITATIONAL INTERACTION AND MERGING OF GALAXIES IN CLUSTER (15+2 min);
— **Abdildin M.M.**, **Omarov M.S.**, **Abishev M.E.** ON THE ORBITAL STABILITY OF THE MOTION PROBLEMS IN GR (12+1 min);
— **Abdildin M.M.**, **Abishev M.E.** INTEGRATION OF THE EQUATION OF ROTATION MOTION IN PROBLEM OF TWO ROTATED BODIES IN GR (IN CASE OF INFINITE MOTION) (10+1 min).
— **Orlyansky O.Yu.** SMALL BODIES MOTION PECULIARITY IN THE ROTATION STAR SYSTEMS (10+1 min);
— **Alexandrov Yu.V.**, **Portyankina A.V.** APPROXIMATION OF ASTEROIDS GRAVITATION FIELDS BY THE GRAVITATIONAL DOUBLET (10+2).

11.00-11.30 — coffee break

11.30-13.00 — RELATIVISTIC ASTROPHYSICS (Chairman A.A. Minakov):

— **Abdildin M.M.**, **Omarov M.S.**, **Komarov A.A.** ON THE RELATIVISTIC TWO-BODY PROBLEM ACCOUNTING TIDES (20+5 min);
— **Zima I.I.**, **Bogdanov G.F.** CORONAL OF THE HOLE AND ROTOR MAGNETIC WAVES (20+5 min);
- **Abdildin M.M.**,**Omarov M.S.**, **Komarov A.A.** OPTIMIZATION OF CHOICE OF VECTOR ELEMENTS WITHIN THE ADIABATIC MOTION GR THEORY (20+5 min);
— **Patsera Yu.I.**, **Yemets V.M.** DRAGGING EFFECTS OF INERTIAL FRAMES OF REFERENCE-PERSPECTIVE OF GROUND-BASED EXPERIMENTS (12+3 min).

13.00-14.00 — lunch break

14.00-16.00 — GRAVITATIONAL EXPERIMENTS (Chairman Z.G. Murzakhanov):

— **Omelyanchuk A.N.** SUPERCONDUCTIVITY AND GRAVITATION (20+3 min);
— **Daishev R.A.**, **Balakin A.B.** LUNAR TEST AND ALTERNATIVE RESOLUTION IN THE THEORY OF RESPONSE OF ELECTRO-ELASTODYNAMIC DETECTOR OF GRAVITATIONAL FIELD LOW-FREQUENCY VARIATIONS (25+5 min);
— **Alexeev A.D.**, **Bronnikov K.A.**, **Kolosnitsyn N.I.**, **Konstantinov M.Yu.**, **Melnikov V.N.**, **Sanders A.J.** TEORETICAL ANALYSIS OF SEE PROJECT ON DETERMINATION OF PARAMETERS OF GRAVITATIONAL INTERACTION ON A SATTELITE BOARD (25+5 min).
— **Izmailov G.N.**, **Ozolin V.V.** LABORATORY EXPERIMENT ON CHECK OF ANISOTROPY OF LIGHT SPEED (15+5 min);
— **Gorelik I.Yu.** GRAVITY-THERMAL COIL (25+2 min).

16.00-16.30 — coffee break

16.30-18.10 — GRAVITATIONAL EXPERIMENTS (Chairman V.V. Ozolin):

— **Daishev R.A.**, **Levin S.F.**, **Murzakhanov Z.G.**, **Skochilov A.F.** PROCESSING OF RESPONSE SIGNAL OF GRAVITATION WAVE DETECTOR (20+5 min);

— **Grunskaya L.V.**, **Isakevich V.V.**, **Vinogradov D.V.** EXPERIMENTAL INVESTIGATIONS OF THE ELF VARIATIONS OF THE EARTH ELECTROMAGNETIC FIELD AND GRAVITATIONAL WAVE RADIATION (20+4 min);

— **Kolosnitsin N.I.** ABOUT PERFORMANCE OF EXPERIMENT FOR DETECTION OF NEW LONG-RANGE FORCES (15+2 min);

— **Levin S.F.** METROLOGICAL SUPPORT OF MEASURING PROBLEMS OF IDENTIFICATION FOR GRAVITATION AND OPTICAL MEASUREMENT SIGNALS (15+2 min);

— **Ozerov M.F.**, **Kochetov A.E.**, **Verozub L.V.** AABOUT GRAVITY FORCE EXPERIMENTAL TESTING IN THE METRIC-FIELD GRAVITATION EQUITIONS (15+2 min).

18.10-19.00 — POSTERS "GRAVITATIONAL EXPERIMENTS" AND GENERAL DISCUSSION:

1. **Alpin T.Yu.**, **Balakin A.B.** GRAVITATIONAL RADIATION AND OPTICAL ACTIVITY IN THE ANISOTROPIC MEDIA.
2. **Bogdanov Yu.A.** CORRELATION OF GRAVITATIONAL POTENTIAL AND ELECTROMAGNETIC RADIATIONS IN PLACES OF THE EARTH'S CRUST BREAKS.
3. **Chashihin J.V.** AN IDEA FOR DIRECT EXPERIMENTAL MEASUREMENT OF THE SPEED OF GRAVITATIONAL INTERACTION.
4. **Mizrakhy V.M.** BIOGRAVITATION PHENOMENON MANIFESTED BY A HUMAN BEING.
5. **Trushenev A.Ya.** ABOUT AN OPPORTUNITY OF MAKING A VORTICAL ELECTROMAGNETIC FIELD FOR GENERATION OF GRAVITATIONAL WAVES.
6. **Zhuck N.A.** COSMOLOGICAL EFFECTS IN BULKY MICHELSON INTERFEROMETERS.

19-00 — closing of the Conference

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DISCUSSION

Editorial Council accepts also a response on articles, published in the journal "Spacetime & Substance". They should be no more than 1 journal page in length and should not contain figures but only to refer to the already published materials. But they can contain the formulas. The recalls are publishing in section "Discussion".

General forms of the discussion (example):

From:	N.A. Zhuck[1]
To:	N.D. Kolpakov
Article:	N.D. Kolpakov, The discovery of polarization waves and problems of physics
Journal:	Vol. 1 (2000), No. 1, p. 35
Data:	Juny 15, 2000

The proton model is unconvincing (see Fig. 2). I recommend the proton model from Ref. [1].

(Text of the response 1).

References

[1] B.V. Bolotov, N.A. Bolotova, M.B. Bolotov, "Structure foundations of substance (the physicochemical Bolotov isosteres table)," Zaporozhie, SIA, 1996, 110 pp.

In 2001 we begin to consider on pages of Journal following problems on the published papers:

1. Whether rights an Einstein, stating, what a Body Mass depends on velocity of its motion?

2. Whether can Binary Geometrophysics unit a gravitation and electromagnetism?

3. Whether the identity of Inertial and Gravitational Masses is proved and what this implies?

4. Whether the proofs of existence of the Universe Big Bang are univalent?

5. Whether can Polarization Waves be spread faster than light?

6. Whether it is possible in mathematician and physics to do without Imaginary Unity?

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NEW BOOKS

Research and publishing Ltd "Model Vselennoy" (Kharkov) in 2000 was issued the monography "Cosmology", which can be ordered in the publisher. The cost of the monography together with the cost of transfer by mail in limits of Ukraine is equal 25 hryvnyas. The banking essential elements of the publisher, requirement of payment and answers to problems are sent by E-mail under the first requirement of the interested persons. The summary on the indicated book is given below.

Zhuck N.A. Cosmology. - Kharkov: Model Vselennoy, Ltd, 2000, 464 pp. ISBN 966-7875-00-8. (in Russian).

The nonconventional enunciating of bases of a cosmology is given in the monography with use of a field statement of the General Relativity and designed author of the new stationary model of the Universe.

It is shown, that the world law of gravitation, 1-st, 2-nd and 3-rd Newton's laws, law of distribution of light and other laws of physics are only approaches of the more common physical laws, in which the mutual gravitational communication of all objects of the Universe is taken into account. The identity of inert and gravitational masses is proved spirit of the Mach principle. The unknowns earlier gravitational viscosity and geodetic curvature of the Universe are described. Redshift of galaxies radiation are in a new fashion explained, cosmic microwave background radiation, Doppler effect, widescale structure of the Universe and much other. The plan of fundamental experiment of measuring medial density of the Universe is offered.

The communication of new discoveries with abnormal natural phenomena, the problem of UFO, key opportunity of making of the controllable gravitational screen and construction of a flight vehicle by the way "flying saucers" is shown. The communication of a cosmology with a microcosm, electromagnetism and distribution of life in the Universe is surveyed by way of a discussion.

For the scientist of a physical and physical-technical directory, astronomers, teachers, post-graduate students, students.

Spacetime & Substance
International Physical Journal

INFORMATION FOR AUTHORS

The Editorial Council accepts the manuscripts for the publication only in an electronic variant in the format for LATEX 2.09. They should be completely prepared for the publication. The manuscripts are accepted by e-mail or on diskettes (3.5"). The manuscripts can be adopted in other view only for familiarization.

The original manuscripts should be preferably no longer then 6 pages. They should contain no more than 4 figures. Length of the manuscript can be up to 10 pages only in exclusive cases (at arguing problems of primary importance). If the length of the manuscript exceeds 10 pages, it should be divided by the author into two or more papers, each of which should contain all pieces of a separate paper (title, authors, abstracts, text, references etc.). The Editorial Council accepts for the publication the brief reports too.

The payment for the publication of the manuscripts is not done. Each author gets the electronic version of that Journal edition, in which his paper was published free of charge.

An E-mail message acknowledging the receipt of the manuscript will be sent to the corresponding author within two working days after the manuscript receipt. If a message is not received please contact *zhuck@insurance.kharkov.ua* to inquire about the manuscripts.

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References

[1] F.W. Stecker, K.J. Frost, *Nature*, **245**, 270 (1973).

[2] V.A. Brumberg, "Relativistic Celestial Mechanics", Nauka, Moskow, 1972 (in Russian).

[3] S.W. Hawking, in: "General Relativity. An Einstein Centenary Sutvey", eds. S.W. Hawking and W. Israel, *Cambr. Univ. Press*, Cambridge, England, 1979.

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