# A NEW THEORY OF GRAVITY

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We proceed from the fact that at the quantum level Einsteinian equivalence principle is invalid (it was demonstrated in our previous contribution). In connection with this we have to look for another physical principle for description of gravity at elementary particle level. The principle we consider is already found. It is ether.

PACS: 13.75Gx

The situation about ether is very complicated. First of all, we would like to recall that Einstein in the beginning of 20 century rejected the ether from physics. But Newton, Maxwell, Lorentz considered that ether is very useful and necessary physical substance which causes all properties of observed world. Soon after this Einstein understood that our physical space-time may not exist without ether and he introduced it again. Hereby he identified ether with metric $g_{\mu\nu}$ of space-time continuum. So according to Einstein we have

**ether = metric = gravity.**

We have to pay attention that in Einsteinian theory metric is created by observed matter. Hence, the ether is created by observed matter, too. It is typical confusion of ideas, not admitted indeed.

Meantime, there is already present mathematical theory in which the ether is a special entity, underlain the elementary particle level and observed world. In the theory the ether is the bi-Hamiltonian dynamical system hidden in the isolated point of space-time discontinuum and described by non-Lagrangian field *f(x)* grown from the point [1]. This dynamical system is the base of elementary particle existence and arising of all their interactions [1].

1. In new theory gravity is originated from flexibility (elasticity or degeneration [1]) of field $f(x)$, which described by deformation of its coordinates $x_\mu$ written in the form [2,3]:

$$x_\mu \to x'_\mu = x_\mu + a_\mu(x). \tag{1}$$

Non-deformed ether field $f(x)$ obeys the equation [1]

$$p_\mu \frac{\partial}{\partial x_\mu} f(x,\varphi) = 0. \tag{2}$$

It is the master equation of the ether, solution of which is written in the form of [1]

$$f(x,\varphi) = e^{ipx} f_0(\varphi). \tag{3}$$

Here $p_\mu = \bar{\varphi}\sigma_\mu\varphi$ ($p^2 = 0,\ p_0 = \bar{\varphi}\varphi > 0$, the latter is very important property of ether) is 4-momentum of ether quantum $f$ ($x_\mu, p_\mu$ are variables inside the point, $\varphi$ are own variables of ether).

Obviously, at deformation (1) ether field becomes

$$f'(x,\varphi) = e^{ipa(x)} f(x,\varphi) \tag{3′}$$

and obeys the equation [2]

$$p_\mu \frac{\partial}{\partial x_\mu} f'(x,\varphi) = i h^{(0)}_{\mu\nu}(x) T^{(f)}_{\mu\nu}(x), \tag{2′}$$

where

$$T^{(f)}_{\mu\nu}(x) = p_\mu p_\nu f'(x,\varphi) \tag{4}$$

is symmetric energy-momentum tensor of ether quantum $f$ and

$$h^{(0)}_{\mu\nu} = \frac{1}{2}\left(\frac{\partial a_\mu}{\partial x_\nu} + \frac{\partial a_\nu}{\partial x_\mu}\right) \tag{5}$$

is a symmetric tensor field playing the role of gravity.

As ether deformations take place in the point (in the fiber, where there exists only «vertical» motion), only «transversal» deformations $a_\mu(x)$ are considered. They obey the «Lorentzian» gauge $\frac{\partial a_\mu}{\partial x_\mu} = 0$ and, hence, the spur of tensor $h^{(0)}_{\mu\nu}$ is equal zero

$$h^{(0)}_{\mu\mu} = 0. \tag{6}$$

As these deformations are spontaneous, they have no sources. Therefore D'Alambertian is zero: $\Box a_\mu(x) = 0$ and conditions

$$\frac{\partial}{\partial x_\nu} h^{(0)}_{\mu\nu} = 0 \tag{7}$$

are fulfilled. Conditions (6)–(7) play very important role in the theory (see further).

Obviously, symmetric tensor $T^{(f)}_{\mu\nu}(x)$ (4) satisfies all these conditions too:

$$T^{(f)}_{\nu\mu} = 0, \quad \frac{\partial T^{(f)}_{\mu\nu}}{\partial x_\nu} = 0. \tag{8}$$

Further we may go over from special $h^{(0)}_{\mu\nu}$ to the more general functions $h_{\mu\nu}$ conserving all these conditions and having sources. Hereby the integral $\tilde{a}_\mu = \int_\Gamma^x h_{\mu\nu}\, dx_\nu$ will depend on final point $x$ and else on contour $\Gamma$ coming in $x$. (It is interesting to notice that since the space of coordinates $x$ is a vector space so the exact forms exhaust all closed differential forms on it: it is the well known Poincare lemma, see for example [4]). Due to the Stocks theorem we may write

$$\oint_\Gamma h_{\mu\nu}\, dx_\nu = \int_S h_{\mu[\nu\rho]} dS_{\nu\rho} \tag{9}$$

where $S$ is a surface limited by the closed contour $\Gamma$ and $dS_{\nu\rho} = dx_\nu \wedge dx_\rho$ ($\wedge$ is external multiplication). So we come to the tensor $h_{\mu[\nu\rho]} = \frac{\partial h_{\mu\nu}}{\partial x_\rho} - \frac{\partial h_{\mu\rho}}{\partial x_\nu}$ (hereat

$h^{(0)}_{\mu[\nu\rho]} = \frac{\partial}{\partial x_\mu}(\frac{\partial a_\nu}{\partial x_\rho} - \frac{\partial a_\rho}{\partial x_\nu})$). Functions $h_{\mu\nu}$ and $h_{\mu[\nu\rho]}$ are called to be potentials and strengths of gravity correspondingly

2. As usually equation (2′) describes only perception process of gravity (term $h^{(0)}_{\mu\nu}(x)T^{(f)}_{\mu\nu}(x)$). There is no equation of the type $\Box h^{(0)}_{\mu\nu} = \gamma T^{(f)}_{\mu\nu}$ yet, which describes the creation process of gravity, because for fields *f(x)* there is no Lagrangian [1].

However if to build coherent states [1]

$\varphi(x) = \int f(x)\, d\mu_f(\varphi)$

from ether fields $f(x)$, integrating over own variables $\varphi$ with measure $d\mu_f(\varphi)$ (details see in [1]), we get the fields with zero mass and positive energies (see above; such fields may not be quantized [1]), for which there is already Lagrangian in the form

$$L_\varphi = \frac{i}{2}(\bar{\varphi}\overset{+}{\sigma}_\mu \frac{\partial}{\partial x_\mu}\varphi - (\frac{\partial}{\partial x_\mu}\bar{\varphi})\overset{+}{\sigma}_\mu \varphi) \tag{10}$$

(in the case of spin 1/2) or in the form

$$L_\varphi = \frac{\partial \bar{\varphi}}{\partial x_\mu}\frac{\partial \varphi}{\partial x_\mu}$$

(in the case of zero spin).

From point of view of coherent states ether is two component gas: spinor and scalar. This gas is a pre-matter from which our Universe consists of before the first Big Bang.

Equation for spinor states $\varphi$ is

$$\overset{+}{\sigma}_\mu \partial_\mu \varphi = 0 \tag{11}$$

(here $\partial_\mu = \partial/\partial x_\mu$). It looks like the well-known Weyl equation, although here $\varphi$ is not neutrino field but it is coherent state of ether. At ether deformation (1) this equation transits into the equation with interaction

$$\overset{+}{\sigma}_\mu \partial_\mu \varphi = h^{(0)}_{\mu\nu}\overset{+}{\sigma}_{(\mu}\partial_{\nu)}\varphi \tag{12}$$

here $\overset{+}{\sigma}_{(\mu}\partial_{\nu)} = \frac{1}{2}(\overset{+}{\sigma}_\mu \frac{\partial}{\partial x_\nu} + \overset{+}{\sigma}_\nu \frac{\partial}{\partial x_\mu})$ is a symmetric tensor (compare with (2’), (skew symmetric part, due to the condition

$$(\overset{+}{\sigma}_\mu \frac{\partial}{\partial x_\nu} - \overset{+}{\sigma}_\nu \frac{\partial}{\partial x_\mu})\varphi \approx (p_\mu p_\nu - p_\nu p_\mu)\varphi = 0,$$

see [5], does not work).). Hereby, the interaction term $L_i = h^{(0)}_{\mu\nu}T^{(\varphi)}_{\mu\nu}$ arises in Lagrangian in which energy-momentum tensor is (in the case of spin 1/2)

$$T^{(\varphi)}_{\mu\nu} = \frac{i}{2}(\bar{\varphi}\overset{+}{\sigma}_{(\mu}\partial_{\nu)}\varphi - \partial_{(\nu}\bar{\varphi}\overset{+}{\sigma}_{\mu)}\varphi). \tag{13}$$

So, the field system $\{\varphi, h\}$ is quasi-Lagrangian one (canonical momentum of this system is obviously $\{\bar{\varphi}, \frac{1}{4\pi\gamma}(\frac{\partial h_{\mu\nu}}{\partial t} - \frac{\partial h_{\mu 0}}{\partial x_\nu})\}$; before the first Big Bang it is the only field system in Universe) and we may close it adding to the Lagrangian $L_\varphi + L_i$ the Lagrangian $L_h$ of gravitational field $h_{\mu\nu}$. Hence total Lagrangian is *L*= $L_\varphi + L_i + L_h$. In the case of small and slowly changed functions $h_{\mu\nu}$ we can write Lagrangian $L_h$ in the form of gauge invariant quadratic form $L_h = \frac{c^3}{8\pi\gamma}h^2_{\mu[\nu\rho]}$ and action as an integral $A = \int L\, d^4x$. Here

$$\gamma = \nu^2 \frac{c^3}{hk^2} \tag{14}$$

is the Newtonian constant of gravitational interaction [2,3].

In the theory there are three fundamental dimensional constants: *c* (light velocity), *h* (Planck constant) and *k* (universal wave number with dimension $cm^{-1}$). They are proper characteristics of ether. In (14) dimensionless normalization constant $\nu^{-1} = 9^{20}$ is the number of mapping of the set from *20* elements $h_{\mu[\nu\rho]}$ into the set from *9* elements $h_{\mu\nu}$ [2,3]. This statement follows from the set theoretical analog of the Stocks formula (9), which gives the connection between $h_{\mu\nu}$ and $h_{\mu[\nu\rho]}$ (strictly speaking in fiber there is neither space-time nor measure and integral on it, only the set theory methods may be used there). As $\nu/k = l_{Pl} \approx 10^{-33}cm$ is the Planck length, so we have $k \approx 10^{14}cm^{-1}$.

Further varying total Lagrangian over $h_{\mu\nu}$ we get the equations

$$\Box h_{\mu\nu} = 4\pi\gamma T^{(\varphi)}_{\mu\nu} \tag{15}$$

describing creation process of gravity.

We think, the physical meaning of new theory is, first of all, in possibility to determine numerical value of the Newtonian constant $\gamma$.

Now we can construct the energy-momentum tensor $T^{(h)}_{\mu\nu}$ for gravitational field $h_{\mu[\nu\rho]}$ writing the formula

$$T^{(h)}_{\mu\nu} = \frac{1}{8\pi\gamma}(h_{\rho[\sigma\mu]}h_{\rho[\sigma\nu]} - \frac{1}{4}\delta_{\mu\nu}h^2_{\rho[\sigma\tau]}) \tag{16}$$

It satisfies the condition $T^{(h)}_{\mu\mu} = 0$. It is not difficult to get using the equations (12),(15) that the conservation law is fulfilled:

$$\frac{\partial}{\partial x_\nu}(T^{(h)}_{\mu\nu} + T^{(\varphi)}_{\mu\nu}) = 0. \tag{17}$$

It is very important to emphasize that as quanta *f* and their coherent states $\varphi$ are *c*-number fields (see [1]) so gravitation $h_{\mu\nu}$ is a *c*-number field, too. So at the ether level gravity is a pure classical phenomenon.

3. After irreversible quantum transition $f \to \dot{f}$, taking place in the bi-Hamiltonian system, Lagrangian fields $\psi(X,Y)$ of fundamental particles arises, see [1] (here $\dot{f}$ is the second component of the bi-Hamiltonian system).

Of course, ether deformation (1) is transferred from field $f(x)$ onto transition matrix elements

$\langle \dot{f}(\dot{x}), f(x) \rangle$ (definition see in [1]) and particle fields $\psi(X,Y), (X = \frac{1}{2}(x+\dot{x}), Y = \frac{1}{2}(x-\dot{x}))$. Not difficult to obtain equations for these fields $\psi$

$$(\Gamma_\mu \partial_\mu + M)\psi = h_{\mu\nu}\Gamma_{(\mu}\partial_{\nu)}\psi \tag{18}$$

(here $\partial_\mu = \partial / \partial X_\mu$ ) following from the explicit form of matrix elements, and to construct the energy-momentum tensor for these fields

$$T^{(\psi)}_{\mu\nu} = \frac{i}{2}[\bar{\psi}\Gamma_{(\mu}\partial_{\nu)}\psi - (\partial_{(\nu}\bar{\psi})\Gamma_{\mu)}\psi], \tag{19}$$

which creates the gravity field $h_{\mu\nu}$ by means of equation (compare with (15))

$$\Box h_{\mu\nu} = 4\pi\gamma T^{(\psi)}_{\mu\nu}. \tag{20}$$

As Lagrangian (elementary particle) fields $\psi$ are *q*-number quantities so $h_{\mu\nu}$ in (20) must be *q*-number quantity too. Hence at the elementary particle level gravity is quantized. We see that the gravitation interaction of observed matter is caused by gravity of ether.

It is seen also that for description of gravity at the ether level the theory of deformation (see for example [6]) applied to the ether medium is used. Note, that this theory deals with linear differential forms only. Hence our approach is principally distinguished from Einsteinian one, using bilinear (quadratic) differential forms and Riemannian geometry.

Now, proceeding from the equations (18) and using the standard «averaging technique» we may obtain gravity equations at the macro level. Important question is: what is connection of these equations with equations of GR?

First of all, it should be emphasized that in the suggested theory the case of strong (non-linear) gravitational fields $h_{\mu\nu}$ is connected with consideration of arbitrary Lagrangians $L_h$, but not Hilbert-Einstein Lagrangian - scalar curvature $R$. In the given form new theory is the linear approximation of Einsteinian one.

4. It turns out, besides the elementary particles and their interactions ether is responsible also for creation of space-time continuum. Individual quanta *f is* responsible for particles arising. But ether in whole (as an ensemble of quanta *f)* is else a source of space-time continuum.

*First* this continuum arose before the first Big Bang (which is the total irreversible quantum transitions $f \to \dot{f}$ because the theory of the bi-Hamiltonian system is non-unitary; from here time arrow originates). It is remarkable, that ensemble of quanta $f$ is characterized by the macroscopic energy-momentum tensor $\bar{T}^{(f)}_{\mu\nu}(\bar{X})$ (definition see in [2]; it is hydro-dynamical tensor), principally distinguished from microscopic one $T^{(f)}_{\mu\nu}(x)$ (4) or $T^{(\varphi)}_{\mu\nu}$ (13). This tensor generates absolute Newtonian space-time continuum (space-time filling by ether; $\bar{X}_\mu$ are measurable coordinates of this space [2]). Remarkable, that its metric $g_{\mu\nu}(\bar{X})$ and curvature $R_{\mu\nu\rho\sigma}(\bar{X})$ are determined exactly by the Hilbert-Einstein equations. In the theory space-time continuum is appeared in the form of compact closed Friedmann manifold $S^3 \otimes R_1$ (or $S^4$ ). It is atlas of our Universe which is originated in the process of sticking together of local maps (see [2]) which are Poincare-Minkovski space-time $A_{3,1}$ with coordinates $x_\mu$ (the set of non-measurable maps is a differential system in the sense of [7], the infinite small (indivisible) part of which is a speceuscula- carrier space of the field $f(x)$ ). Spaceuscula is identified with the mini-map $A_{3,1}$ (maximal size of which is $\approx 10^{-8}cm$, [2]).

In the framework of new theory the question about unification of gravitational field $h_{\mu\nu}(x)$ with metric field $g_{\mu\nu}(\bar{X})$ raised by Einstein will probably have negative answer because it is obviously that $h_{\mu\nu}(x) \neq g_{\mu\nu}(\bar{X})$ and ether $\neq$ space-time.

In spite of this in the suggested theory all three famous phenomena (they are: motion of the Mercury perigee and deviation of light rays - they are gravity effects, and also red shift - it is metric effect)) are of course the same.

So, at the ether level two problems of fundamental importance are solved: switching on gravitational interaction (and also other kinds of interactions) at micro level and creation of the space-time continuum at macro level. They are quite different things although gravity plays an important role in the forming of space-time continuum: it pastes together various maps $A_{3,1}$.

In connection with this we can say that the Einsteinian GR is the theory of physical space-time originating (but not gravity). Hereby the GR is the main part of cosmological theory of our Universe.

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