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Non-local Quantum theory is Fourier-transformed classical mechanics. Planck's constant as adiabatic invariant characterized by Hubble's and cosmological constants.

Lipovka Anton
aal@cifus.uson.mx
Departamento de Investigación en Física
Apdo. Postal 5-88
83000 Hermosillo, Sonora, México

El saber de mis hijos hará mi grandeza
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Centro de Investigacion en Fisica, Universidad de Sonora; Hermosillo, Sonora, Mexico.

e-mail: aal@cifus.uson.mx

ABSTRACT

In the present work we suggest a non-local generalization of quantum theory which include quantum theory as a particular case. On the basis of this idea we calculate the value of Plank constant from first principles, namely from the geometry of our Universe. The basic nature of the quantum theory is discussed. The nature of the dark energy is revealed.

Keywords: Cosmology, Quantum Theory, Unified theory.

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INTRODUCTION

Quantum Theory (In accordance with the historical terminology, we shall call "Quantum Theory" (QT) the theory, based on the concept of wave functions, or probability amplitudes), that recently celebrated its 100-year anniversary, allowed at the time to overcome a crisis that happened in atomic physics, giving researchers a necessary tool for the calculation of atomic and subatomic phenomena with an accuracy which is in striking agreement with experiment. However, since its foundation, more than hundred years ago, physicists and mathematicians are still attempting to understand what is behind this unusual and strange QT formalism.

Quantum Mechanics (QM) from the beginning (and then Quantum Field Theory as its successor) was built on the axiomatic approach, which cannot be considered as satisfactory. So, the concept of the wave function was postulated for all describable entities. On the other hand, the evolution operator for a system is linear with the wave function, whereas its square appears as the result of the measurement process. If we add to the above the presence of divergences and unrenormalizability in general theories, the complexity encountered in trying to combine QT with general relativity (GR), and the inability to obtain the mass and charge out of first principles, the incompleteness of QT becomes apparent, and thus there is need to find a complete theory describing the atomic and nuclear systems.

Since the moment of discovery, QT did not please its creators, giving rise to numerous discussions about the place for probability in physics, the wave-particle duality, discussion of thought experiments and paradoxes. We shall not discuss here again the well-known history of QT, for that the reader should refer to the monograph by M. Jammer (1985). With such an "unusual" physics, researchers put up nearly a century, excusing its numerous defects, because QT allowed calculate physically interesting phenomena in excellent agreement with the experiment. The situation began to change in the last decade of the 20th century, when the crisis that hit theoretical physics became obvious to many physicists and people started talking loudly about the problems that arise when trying to unify QT and GR.

Among the most serious problems of the Standard Model are the following:

1. The problem of the collapse of the wave function (the problem of the observer, or Einstein – Podolsky – Rosen paradox).

2. The presence of unrenormalizable (in general) divergences.

3. The huge discrepancy between the calculated with QFT methods and observed cosmological constant.

4. QT conflict with general relativity at the horizon of black holes.

5. Recent experimental data obtained with the Planck satellite, which disfavors all the best-motivated inflationary scenarios (A. Ljjas, P.J. Steinhardt, A. Loeb 2013).

6. Inability of a reasonable harmonization or unification of the standard model with gravity.

This incomplete list of problems indicates very serious gaps in our understanding of Nature. For the most part, the problems are directly or indirectly appears from a misunderstanding of the basis of the quantum theory, and the nature of her main concepts and axioms.

The present paper is urged to fill the above mentioned gap and to specify a way free from the difficulties listed above. We begin with a generalization of the quantum theory because in its present form it cannot be unified with General relativity.

QUANTIZATION

It is well known that quantum mechanics arose from the need to explain the experimentally observed blackbody emission spectrum and atomic spectra. Planck was the first to propose an analytical formula to describe the spectral energy distribution which was consistent with the experiment. However, as it was noted by Einstein (Einstein, 1906), the way in which Planck obtained his result, was not quite correct, though it did lead to the correct result. The problem was that Planck included in his formula not only the electromagnetic field, but also oscillators associated with the matter. As a result, in the electrodynamic part, based on Maxwell's equations, the energy of the oscillators is a continuously varying value, while in the statistical part the same energy is considered as a discrete value (quantized).

In 1905 Einstein published the work (Einstein, 1905) in which he showed that the emission field (without any assumptions on matter) behaves so as if consists of separate quanta (photons), characterized by energy $h\nu$. Later, in 1910 Debye (Debye, 1910) showed that Planck's formula can be deduced for the pure radiation field, absolutely without any assumptions on the oscillator's properties of the substance. Thus Planck's law and all its consequences, follows from the fact that the energy of freely propagating electromagnetic field is divided by parts proportional to $h\nu$.

It is known that the Bohr-Sommerfeld theory (so-called old quantum theory), based on the adiabatic hypothesis, is founded on two quantum axioms, which when added to the axioms of classical mechanics allows us to build a quantum theory. These two axioms are written as:

$$\oint p_k dq_k = n_k h \tag{1.1}$$

$$E_1 - E_2 = h\nu \tag{1.2}$$

The hypothesis expressed by Sommerfeld served as the basis for the writing of these relations. It states that in each elementary process, the action of the atom changes by an amount equal to the Planck constant. However, if we take into account the results obtained by Einstein and Debye, we easily receive these postulates, as a consequence of classical mechanics, i.e. we can construct the reasonable classical theory of emission / absorption in lines, and the classical atomic theory without recurring to the concept (axiom) of the wave function and the problems provoked by last one. It should be stressed here, that so-called “new quantum theory” also is based on the axiom, and this axiom (of the wave functions) cannot be explained or reduced to real physics, whereas the Bohr-Sommerfeld axioms can be reduced to (or obtained from) classical physics, which provide us with a fundamental view to the basic concept and understanding the nature of the quantum theory.

To achieve the above, it should be noted, that there are only two fields which are carrying out interactions at big distances ($r > 10^{-11} cm$). These are the electromagnetic and the gravitational fields. Considering that the interaction constant for a gravitational field is negligible in comparison with an electromagnetic one, we can surely approve the following:

Everything that we see, feel, hear, measure, we register with detectors, and this is an electromagnetic field and nothing else. That is we perceive the real world in the form of this picture, by means of electromagnetic waves registered by us. It is important to understand, that the electromagnetic field acts as intermediary between the observer and the real (micro) world, hiding from us reality (the so-called idea of existence of the "hidden parameters in QM"). In our case these hidden parameters lose the mystical meaning, becoming usual classical variables - coordinates and momenta of particles, but which can be measured only by the electromagnetic field means.

Thus as a starting point we propose the following:

1) The electromagnetic field is the only field responsible for interaction between objects and observer in Quantum mechanics.

2) The free electromagnetic field is quantized without the need of any assumptions about the properties of oscillators. That is the Planck's relation of $E = h\nu$, $P = \hbar k$ is satisfied, irrespective of the oscillators properties (see papers of Einstein (1905) and Debye (1910)).

The last thesis means that there exists (and therefore can be emitted) only the photon possessing the period 2π. In other words, emission / absorption of a photon can occur only for the whole period of movement of a charge (in system of coordinates in which proceed the emission / absorption).

Let's consider the closed system in which charge moves cyclically and with constant acceleration. In this case the Hamilton function of the electron does not depend explicitly on time. Let's write down it as:

$$H = K + U = E = const \tag{1.3}$$

here K, U are kinetic and potential energy and E is a total energy of system.

Then function of Lagrange is:

$$L = K - U = 2K - E \tag{1.4}$$

Let's write down action for the bounded electron:

$$S = \int_0^t L d\tau = 2\int_0^t K d\tau - Et = S_0 - Et \tag{1.5}$$

but

$$\Delta S = \int_0^{T_1} L_1 d\tau - \int_0^{T_2} L_2 d\tau = 0 \ ,$$

where T_1 and T_2 are the periods of movement of the electron in system on the first and second orbit respectively.

Then, considering the equation of Hamilton-Jacobi, for two different orbits 1 and 2 we have

$$\Delta S = S_2 - S_1 = 2\int_0^{T_2} K_2 d\tau - 2\int_0^{T_1} K_1 d\tau - (E_2T_2 - E_1T_1) = 0$$

However (see statements 1 and 2, mentioned above)

$$(E_2T_2 - E_1T_1) = h\upsilon T_{ph} = h \tag{1.6}$$

is action for a emitted / absorbed photon. Thus

$$2\int_0^{T_2} K_2 dt - 2\int_0^{T_1} K_1 dt = h \tag{1.7}$$

For example for an electron in the central field in the nonrelativistic limit we have: $K = \frac{1}{2}p\dot{q}$ and $dt = \left(\frac{dq}{\dot{q}}\right)$, where $p = -\left(\frac{\partial H}{\partial \dot{q}}\right)$.

Then expression (1.7) gives

$$\oint p_2 dq_2 - \oint p_1 dq_1 = h \tag{1.8}$$

which for s-state of atom of hydrogen gives a known ratio

$$mr_2^2\dot{\varphi}_2 - mr_1^2\dot{\varphi}_1 = \hbar$$

Or, the same

$$M_2 - M_1 = \hbar \tag{1.9}$$

where M_2 and M_1 are the angular momenta.

To write down the expression (1.9) we used that the obtained values $mr^2\dot{\varphi}$ formally coincides with the angular momenta in the central field.

Let's put $M_0 = 0$ (that corresponds to $r_0 = 0$).

In this case we have $M_1 = M_0 + \Delta M$, but $\Delta M = \hbar$, and obtain

$$M_1 = M_0 + \hbar = \hbar\,,\;\; M_2 = M_1 + \hbar = 2\hbar\ldots, \qquad M_n = n\hbar \tag{1.10}$$

From expression (1.10) and a principle of mechanical similarity for the central potentials of $U \sim r^k$, we have

$$\frac{M'}{M} = \left(\frac{r'}{r}\right)^{1+\frac{\kappa}{2}};\; \frac{E'}{E} = \left(\frac{r'}{r}\right)^k$$

from where we obtain:

$$r_n = r_1(n)^{\frac{1}{1+\frac{\kappa}{2}}} \;\;\text{and}\;\; E_n = E_1(n)^{\frac{k}{1+\frac{\kappa}{2}}} \tag{1.11}$$

Then for a classical harmonic oscillator ($k = 2$) from (1.11) we get:

$$r_n = r_1\sqrt{n}\,;\; E_n = E_1 n \tag{1.12}$$

and for atom of hydrogen

$$r_n = r_1 n^2\,; \quad E_n = \frac{E_1}{n^2} \tag{1.13}$$

The value E_1 in the last expression can be finding easily from expression (1.6) $(E_2T_2 - E_1T_1) = h$

Accepting classical value of the period

$$T = \pi e^2 \sqrt{\frac{m}{2|E|^3}} \tag{1.14}$$

and taking into account (1.13) $E_2 = \frac{1}{4}E_1$ we have:

$$E_1 = \frac{me^4}{2\hbar^2} \tag{1.15}$$

Thus we showed that so-called quantization of system arises in absolutely classical way from the intrinsic properties of the electromagnetic field and cannot be treated as quantum property of space or matter.

HARMONIC OSCILLATOR

There is a common misconception that the addition term of 1/2, which appears in the energy of the harmonic oscillator, is a quantum effect and is associated with the so-called zero - oscillations. Due to the methodological importance of this question, we discuss it here in a little more detail in the non-relativistic limit, and show that it is a purely classical effect.

Accordingly to classical mechanics, the energy of the harmonic oscillator is:

$$E = \frac{m}{2}(\dot{r}^2 + \omega^2 r^2) \tag{2.1}$$

where $\omega = \sqrt{\frac{k}{m}}$.

Then, considering that for the harmonic oscillator $\bar{T} = \bar{U}$, we obtain for the average energy for the period:

$$E_n = m{r_n}^2\omega^2 \tag{2.2}$$

To carry out transition from an initial state of system to the final one $E_n \to E_k$, we should "take away" energy from our oscillator by electromagnetic field.

It is known that emission of an electromagnetic field by a moving charge differ from zero only at integration for the full period T of movement in the course of which the emission or absorption appears. It corresponds to the fact that the full photon instead of a part is emitted / absorbed, that is the generated field satisfying to a periodicity condition.

The factor of proportionality between energy and frequency for a free electromagnetic field is $\hbar$:

$$\Delta E = E_n - E_k = \hbar\omega_{nk} \tag{2.3}$$

(Once again we emphasize here that as it follows from Einstein's and Debye works, the constant $\hbar$ concerns only to the electromagnetic field and do not appears in any way from matter properties, or the size of our system).

Expression (1.12) gives a ratio between energy levels, however considering (2.3) it is clear that the residual energy $E_0 = U(r_1)$ cannot be emitted by an photon $\hbar\omega$, because

$$\Delta E = E_1 - E_0 = mr_1^2\omega^2 - \frac{1}{2}mr_1^2\omega^2 = \frac{1}{2}E_1 < \hbar\omega \tag{2.4}$$

Therefore this additive constant should be simply added to the expression (1.12):

$$E_n = nE_1 + \frac{1}{2}E_1 = \hbar\omega(n + \frac{1}{2}) \tag{2.5}$$

Thus, the additive constant 1/2 appears naturally from classical consideration.

QUANTUM MECHANICS IS THE FOURIER - TRANSFORMED CLASSICAL MECHANICS

In standard textbooks of quantum mechanics problems arise and are solved for isolated systems, when the electromagnetic field is not included in the Hamiltonian of the system. For example a harmonic oscillator, the hydrogen atom, etc. Thus on the one hand any changes in the system (transitions between levels) associate with the electromagnetic field, but on the other hand, the field in such Hamiltonian does not appear. Reasonable questions arise: where the field is and why it is not appears in the Hamiltonian *H*? How is the electromagnetic field taken into account for the emission / absorption?

At the beginning of the 20-th century, the equations describing the quantum system have been intuitively guessed and accepted for the calculations (despite the emerging issues), because their predicted results were consistent with the experiments at the time. However, the meaning of the wave equations and the wave function itself is still not completely understood. In this section we will show sense of the formalism of quantum mechanics making a start from bases of classical mechanics

For simplicity, consider the one-dimensional motion. The generalization to three dimensions is obvious. Suppose we have the classical equations for energy:

$$H = E \tag{3.1}$$

Here H - classical Hamilton function of the system and E - total energy of the system.

Let's consider a particle in the field of $U(x)$. For a total energy of system we have two possibilities:

1) $E < 0$, the system is bounded, we have periodic movement,
2) $E > 0$, the system is unbounded, we have free movement.

As it is known, any function (and the Hamilton one in particular) can be expanded in a row $(E < 0)$ or in integral $(E > 0)$ Fourier on the complete system of functions. Photons can be described by harmonic waves which form complete set of functions for expansion :

$$\varphi = \exp(-ik_\alpha x^\alpha) \tag{3.2}$$

where k_α and x_α are 4 -vectors.

Let's consider $E < 0$, which corresponds to a discrete spectrum in quantum mechanics. The case of continuous spectrum, when $E > 0$, differs only by replacement of sums by integrals, but the entire derivation of the equations is done similarly.

Let's apply to (3.1) the opposite Fourier - transformation on coordinate x:

$$\int H(k,x)\varphi(k,x)dx = \int E\varphi(k,x)dx \tag{3.3}$$

or

$$\int \frac{p^2}{2m} e^{-\frac{i}{\hbar}(px-Et)}dx + \int U(x)e^{-\frac{i}{\hbar}(px-Et)}dx = \int E\, e^{-\frac{i}{\hbar}(px-Et)}dx \tag{3.4}$$

from where obtain:

$$\int dx[-\frac{\hbar^2}{2m}\frac{d^2}{dx^2} + U(x) = -i\hbar\frac{d}{dt}]e^{-\frac{i}{\hbar}(px-Et)} \tag{3.5}$$

or

$$\int dx[(\hat{H} - E)\varphi = 0] \tag{3.6}$$

We note here that the replacement of an electron for a positron (formally changes the sign in the exponent for the opposite), leads to the replacement of t by $-t$ in equation (3.5).

In equation (3.6) in the brackets is the Hamilton operator $\hat{H}$, which is the Liouville operator, so it has a complete set of orthogonal eigenfunctions.

Let $\Psi_k\ (x)$ is a complete set of eigenfunctions of the operator $\widehat{H}$, then we can write down

$$\varphi(p,x) = \sum_m a_m(p)\Psi_m(x) \tag{3.7}$$

and the equation (3.6) will become

$$\int dx \sum_m a_m(p)\ [(\widehat{H} - E)\Psi_m = 0] \tag{3.8}$$

or (taking into account that Ψ_m is eigenfunction of operator Liouville $\widehat{H}$)

$$\widehat{H}\Psi_m(x) = E_m\Psi_m(x) \tag{3.9}$$

This is the equation of Schroedinger in Schroedinger representation.

It is clear that if in (3.3) we integrate on p instead of coordinate, in the same way we will obtain the Schroedinger equation, but now in p - representation.

$$\widehat{H}\Psi_m(p) = E_m\Psi_m(p) \tag{3.10}$$

Let's make now inverse transformation of expression (3.8). We have:

$$\iint dx \sum_m \varphi^*(k,x)a_m[\widehat{H}\Psi_m - E\Psi_m]dp = 0 \tag{3.11}$$

considering that

$$\varphi^*(k,x) = \sum_m a_n^*(p)\Psi_n^*(x) \tag{3.12}$$

one can obtain

$$\iint dxdp \sum_m \sum_n a_m a_n^* \Psi_n^*(x)[\widehat{H} - E]\Psi_m(x) = 0 \tag{3.13}$$

or in another form:

$$\int dp \sum_m \sum_n a_m a_n^* \langle \Psi_n^* \mid [\widehat{H} - E] \mid \Psi_m \rangle = 0 \tag{3.14}$$

Which immediately implies matrix notation of quantum mechanics.

Thus we have showed that :

1) The quantum mechanics is the Fourier - transformed classical mechanics, and transformation goes on the function of a free electromagnetic field which cannot enter obviously into the Shroedinger equations, remaining out of consideration framework.
2) The quantum theory is an incomplete (local) theory because it is based on an incomplete (local) equation (3.9) (of Shroedinger) instead of the complete (non-local) equation (3.8) where the free electromagnetic field appears as coefficients $a_m(p)$ under summation and integration.

Thus so-called wave functions are not "probability density" but are eigenfunctions of the operator Liouville on which we make decomposition of the emitted / absorbed electromagnetic field.

To conclude, the uncertainty principle $\Delta p\Delta x \sim \hbar$ should be mentioned briefly.

As it was mentioned above, any measurement occurs with the assistance of a photon.

In this way, we can measure the coordinates of the object with the precision of up to $\Delta x = \lambda/cos\varphi$ where λ is wavelength of a photon. However in the course of coordinate measurement the photon transfers a part of their impulse to measured object so we can write $\Delta p = \hbar k cos\varphi$. Combining the first with the second we have $\Delta p\Delta x \sim \hbar$.

On the other hand, in view of that the phase is an invariant, we can conclude that symmetric expression also take place $\Delta E\Delta t \sim \hbar$.

ADIABATIC INVARIANT

From astronomical observations it is well established that we live in the non-stationary Universe, in which all parameters change over time. By taking into account this fact, let's consider a restricted mechanical system making finite movement. Without loss of a generality we consider only one coordinate q, characterizing movement of system. Suppose also that movement of system is characterized by a certain parameter r . Here we can take $r = r_u$- radius of the Universe or $r = R$ - scalar curvature of space. The final result will not depend on our choice.

Let the parameter *r* adiabatically changes over time, i.e.

$$T \ll \frac{r}{\dot{r}} \ , \qquad (4.1)$$

where T - is the characteristic time, or period of motion of our system . From (1.1) one can obtain an estimation of the natural frequency of the system satisfying the adiabatic condition:

$$\nu \gg 10^{-18}\,[s^{-1}]$$

which actually corresponds to the always fulfilled relation $\lambda_{ph} \ll r_u$ (the wavelength of a photon is much less than the size of the Universe).

It is clear that the system in question (photon) in this case is not isolated, and for the system energy we have the linear relationship $\dot{E}{\sim}\dot{r}$. The Hamiltonian of the system in this case depends on parameter r, therefore

$$\dot{E} = \frac{\partial H}{\partial t} = \frac{\partial H}{\partial r}\frac{\partial r}{\partial t} \qquad (4.2)$$

Averaging this expression on the period, we obtain

$$\oint \left(\frac{\partial p}{\partial E}\overline{\frac{\partial E}{\partial t}} + \frac{\partial p}{\partial r}\frac{\partial r}{\partial t}\right) dq = 0 \tag{4.3}$$

or designating our adiabatic invariant as h, get from (4.3)

$$\overline{\frac{\partial h}{\partial t}} = 0 \tag{4.4}$$

where

$$h = \frac{1}{2\pi}\oint pdq \tag{4.5}$$

is the Planck's constant on their sense. Considering that

$$2\pi\frac{\partial h}{\partial E} = \oint \frac{\partial p}{\partial E} dq = T \tag{4.6}$$

we can write down the energy of a photon

$$E = h\nu + E_0 \tag{4.7}$$

RELATION BETWEEN GEOMETRY OF THE UNIVERSE AND THE VALUE OF PLANCK CONSTANT

Earlier we have shown how the quantum mechanical picture of surrounding reality appears. In the present section we obtain the important quantitative characteristic of the quantum theory - value of the Planck constant, from observable geometry of the Universe.

It is well known that General Relativity formulated on Riemann manifold has some difficulties. Among the most significant the following should be mentioned:

1. The presence of singularities.
2. Inability to take into account the "large numbers" of Eddington-Dirac which formally suggest a relation between cosmological and the quantum values.
3. The cosmological constant which has no explanation within the framework of GR.

To search for a solution of these problems we must consider more general extensions of the Riemann geometry. One of its possible natural extension is the geometry of Riemann - Cartan in which the theory of Einstein - Cartan with asymmetrical connections can be developed. There is a variety of reasons on which such choice is valid:

1) The theory of Einstein - Cartan satisfies the principle of relativity and also the equivalence principle and does not contradict the observational data.

2) It follows necessarily from gauge theory of gravitation.

3) It is free from the problem of singularities.

4) It suggests the most natural way to explain the cosmological constant as a non-Riemannian part of the scalar curvature of space caused by torsion.

Within Riemann's geometry, as it is known, for the tensor of electromagnetic field we have:

$$A_{\nu;\mu} - A_{\mu;\nu} = A_{\nu,\mu} - A_{\mu,\nu} \tag{5.1}$$

But in the case of Einstein – Cartan theory with asymmetrical connections, the ratio (5.1) is not more fulfilled and an additional term in the tensor of electromagnetic field appears.

To construct a theory we need the Lagrangian, which includes a natural linear invariant - the scalar curvature obtained by reduction of the Riemann - Cartan tensor of curvature. Let's accept from the beginning that curvature of space is small (that conforms to experiment) and, therefore, in approach interesting for us we can neglect by quadratic invariants in Lagrangian, having written down action for a gravitational field and a matter in Riemann-Cartan geometry this manner:

$$S = S_g + S_m = \frac{c^3}{16\pi G}\int_\Omega \tilde{R}\,\sqrt{-g}\,d\Omega + \frac{1}{c}\int_\Omega \tilde{\mathcal{L}}_m\,\sqrt{-g}\,d\Omega \tag{5.2}$$

Here $\tilde{R}$ is scalar curvature and $\tilde{L}$ are Lagrangians of the matter which have been written down for Riemann-Cartan manifold, $d\Omega = d^4x$. Varying it obtain

$$\delta S_g = -\frac{c^3}{16\pi G}\int_\Omega \left(\tilde{R}_{\alpha\beta} - \frac{1}{2}g_{\alpha\beta}\,\tilde{R}\right)\delta g^{\alpha\beta}\sqrt{-g}d\Omega \tag{5.3}$$

and

$$\delta S_m = \frac{1}{2c}\int_\Omega \tilde{T}_{\alpha\beta}\,\delta g^{\alpha\beta}\sqrt{-g}d\Omega \tag{5.4}$$

or

$$-\frac{c^3}{16\pi G}\int_\Omega \left(\tilde{R}_{\alpha\beta} - \frac{1}{2}g_{\alpha\beta}\,\tilde{R} - \frac{8\pi G}{c^4}\tilde{T}_{\alpha\beta}\right)\delta g^{\alpha\beta}\sqrt{-g}d\Omega = 0$$

and finally

$$\tilde{R}_{\alpha\beta} - \frac{1}{2}g_{\alpha\beta}\,\tilde{R} = \frac{8\pi G}{c^4}\tilde{T}_{\alpha\beta} \tag{5.5}$$

Here $\tilde{T}_{\alpha\beta}$ is a tensor of density of energy - momentum of a matter in space with geometry of R-C. Simplifying on indexes we have:

$$\tilde{R} = -\frac{8\pi G}{c^4}\tilde{T}$$

or in other form

$$(R - 4\Lambda) = -\frac{8\pi G}{c^4}\tilde{T} \tag{5.6}$$

where R - is the scalar formed of the Riemann's tensor, $\Lambda = \left(R - \tilde{R}\right)/4$ and $\tilde{T}$ - trace of tensor $\tilde{T}_{\alpha\beta}$ of electromagnetic field in R-C geometry.

In the right side of (5.6) we have the value associated with the difference of geometry from the Riemann one (the trace of a tensor $T_{\alpha\beta}$ for the electromagnetic field is equal to zero in Riemann geometry because of symmetry of connections) that we want to evaluate. The problem in the direct estimate of the value of $\widetilde{T}$ is that we do not know the true metric of the Universe in which we live. We also do not know the real connection coefficients of our space. For this reason, we cannot directly calculate the value that we are interested in. Accordingly, we cannot just write out a corresponding amendment to the energy of electromagnetic field. However we can estimate this value indirectly, considering that the left part of expression (5.6) contains observable values.

As it follows from the section "adiabatic invariant" for action of electromagnetic field we have:

$$S = S_0 - h \tag{5.7}$$

where S_0 is action for electromagnetic field in Riemann-Cartan Universe and h - is the adiabatic invariant caused by slowly changing curvature of space. Then, considering that the trace of a tensor $T_{\alpha\beta}$ for the electromagnetic field is equal to zero in Riemann's geometry, we can write at once from (5.6)

$$(R - 4\Lambda)\frac{c^4}{8\pi G} \approx 2\frac{h}{\Delta t_0} = 2h\nu_0 \tag{5.8}$$

We emphasize here that at the left side of this expression, we have the observed quantities which characterize the Universe geometry, while on the right side, appears the Planck constant, which in turn, characterize a microcosm. The value Δt_0 is minimum possible interval of time corresponding to action h. To find it we notice that energy of free electromagnetic field can change only by the value $h\nu$. (see first part of paper).

Let's consider as an example atom of hydrogen (for our purposes we could consider any system in the lowest bounded state). The first Bohr orbit is characterized by value $M_1 = m_e\, a_0\, V_0 = h$. The state with $M_0 = 0$ is not achievable for our system. As radius reduce from

a_0 to $\lambda_c\ /\ 2\pi$ the value $M_1\ = \hbar$ cannot be changed, for the photon cannot be emitted. So we can write $\lambda_c\, c = 2\pi a_0 V_0$, or $\nu_0 = 1/\Delta t_0 = c/a_0 = 2\pi V_0\,/\lambda_c = 5.6652 \times 10^{18}\, [s^{-1}]$. Here we need to emphasize especially that time, as well as space, are continuous, i.e. they do not quantized. The interval $\Delta t_0\ = 1.7651 \times 10^{-19}\, [s]$ is the minimum interval of time, corresponding to value h. From expression (5.8), we can write down

$$(R - 4\Lambda)\frac{c^3\, a_0}{16\pi G} \approx h \tag{5.9}$$

where

$$R = 4\pi^2\frac{H_0^2}{c^2} \tag{5.10}$$

Let's estimate the Planck constant. The measured values of a constant of Hubble were presented in works (Riess et al. 2009) $H_0 = 74.2 \pm 3.6$ and (Riess et al. 2011) $H_0 = 73.8 \pm 2.4$. Let's take for our assessment average value $H_0 = 74$. Cosmological constant Λ we adopt according to measurements $\Omega_\Lambda = 0.7$ and we accept critical density $\rho_c = 1.88 \times 10^{-29}\, [g\ \ cm^{-3}]$. Then, from expression (5.9) we obtain value for the Planck's constant $h = 6.6 \times 10^{-27}\, [erg\ \ s]$, that coincides to within the second sign with experimental value.

Recently, the issue of a possible change in the fine structure constant α with time is widely debated, so for convenience, we put here another interesting relationship, which follows from (5.9)

$$(R - 4\Lambda)\frac{c^4}{16\pi G} \approx 2\pi m_e c^2 \alpha \tag{5.11}$$

OTHER OBSERVATIONAL EFFECTS

The results suggested in present work can be proved by independent experiments. The most basic of them is of course the double slit experiment. Recently it was accurately carried out by Demjanov (2010), which clearly argued for our model of non-local quantum theory. Another possible experiment could be a measurement of the blackbody spectrum in far Reyleigh-Jeans region. As it was shown earlier, , if the geometry of Riemann-Cartan has non-zero scalar curvature, in expression for energy of electromagnetic field appears the additional term $h\nu$. The energy of one photon in this case is:

$$E_\nu = E_\nu^0 + h\nu \tag{6.1}$$

Where ν is a frequency of a photon, and small parameter

$$E_\nu^0 = \frac{1}{16\pi}\int (E^2 + H^2)dV \tag{6.2}$$

Integration here is carried out on volume of one photon. Intensity of emission in this case one can write as

$$B_\nu = (E_\nu^0 + h\nu)\frac{2\nu^2}{c^2}\frac{1}{\exp\left\{\frac{E_\nu^0 + h\nu}{\kappa T}\right\} - 1} \tag{6.3}$$

As one can see, in Wien and in close Reyleigh-Jeans regions the spectrum is almost coincide with Planck one because of small value of E_ν^0. However it is clear that the small additive energy E_ν^0 can lead to measurable deviations from Planck spectrum in far Reyleigh-Jeans region and, probably, such deviation could be measured experimentally.

It is necessary to emphasize that such experiment has independent huge significance as will allow to state an assessment to the value E_ν^0 and to throw light on the geometrical nature of electromagnetic field.

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BIBLIOGRAPHY

P. Debye, Annalen der Physik, Bd 33 (1910) 1427.

V.V. Demjanov, arXiv (2010) 1002.3880

A. Einstein, Annalen der Physik, Bd. 17 (1905) 132, // American Journal of Physics, 33 (1965) 367.

A. Einstein, Annales der Physik, Bd 20 (1906) 199.

M. Jammer, The conceptual development of quantum mechanics. (Mc Graw Hill. New York, 1967)

A. Ljjas, P.J. Steinhardt, A. Loeb, 2013. Inflationary paradigm in trouble after Planck2013. / http://xxx.lanl.gov/abs/1304.2785.

A.G. Riess et al. Ap.J. 699 (2009) 539. // ArXiv 0905.0695

A.G. Riess et al. Ap.J. 730 (2011) 119. // ArXiv 1103.2976