HAMILTONIAN GENERAL RELATIVITY IN CMB FRAME

B.M. Barbashov\textsuperscript{1}, Ł.A. Glinka\textsuperscript{1,2,*}, V.N. Pervushin\textsuperscript{1}, and A.F. Zakharov\textsuperscript{1,3,4}

\textsuperscript{1} Bogoliubov Laboratory of Theoretical Physics, Joint Institute for Nuclear Research, 6 Joliot–Curie Street, 141980, Dubna, Russia
\textsuperscript{2} College of Inter-faculty Individual Studies in Mathematics and Natural Sciences (MISMaP), Warsaw University, 93 Zwirki i Wigury Street, Room 156, 02-089, Warsaw, Poland
\textsuperscript{3} National Astronomical Observatories of Chinese Academy of Sciences, Beijing 100012, China
\textsuperscript{4} Institute of Theoretical and Experimental Physics, 25, 117259, Moscow, Russia

Abstract

A collection of requirements to the General Relativity that follow from the WMAP observations of the Cosmic Microwave Background radiation anisotropy as an inertial frame are discussed. These obligations include the separation of both the CMB frame from the diffeomorphisms and the diffeo-invariant cosmic evolution from the local scalar metric component in the manner compatible with the canonical Hamiltonian approach to the Einstein–Hilbert theory with the energy constraints. The solution of these constraints in classical and quantum theories and a fit of units of measurements are discussed in the light of the last Supernovae data.

\*Electronic addresses: glinka@theor.jinr.ru, lukaszglinka@wp.eu
1. Introduction

Measurement of the dipole component of Cosmic Microwave Background (CMB) radiation temperature $T_0(\theta) = T_0[1 + (\beta/c) \cos \theta]$, where $\beta = 390 \pm 30$ km/s, [1] testifies to motion of the Earth to the Leo with the velocity $|\vec{v}| = 390 \pm 30$ km/s with respect to CMB, where 30 km/s rejects the copernican annual motion of the Earth around the Sun, and 390 km/s to the Leo is treated as the parameter of the Lorentz transformation from the the Earth frame to the CMB frame. The CMB frame can be identified with the comoving inertial frame of the Early Universe created at zero moment of its proper time, if the CMB is considered as the evidence of such the creation.

This relativistic treatment of the observational data produces the definite questions to the General Theory of Relativity and the modern cosmological models destined for description of the processes of origin of the Universe and its evolution:

1. How can separate the CMB frame from the general coordinate transformations?
2. How can separate the cosmic evolution from a dynamics of the local scalar component in the CMB reference frame?
3. What are the requirements of the CMB data description to the canonical approach to the General Relativity and the Standard Model including the Vacuum Postulate?

In this paper, we try to get the possible responses to these issues that follow from the principles of General Theory of Relativity and Quantum Field Theory, in order to clear up restrictions of the cosmic motion of the Universe in both the Minkowski space of events and in the Wheeler-DeWitt field space of events [2].

We show how these responses can help to clear up the origin of CMB and to explain the energetical budget of our Universe.

2. Canonical General Relativity

2.1. The Fock separation of the frame transformations from diffeomorphisms

Recall that the Einstein–Hilbert theory of gravitation is given by two fundamental quantities, they are a geometric interval

$$ds^2 = g_{\mu\nu}dx^\mu dx^\nu$$ (1)
and the dynamic Hilbert action

\[ S[\varphi_0|F] = \int d^4x \sqrt{-g} \left[ -\frac{\varphi_0^2}{6} R(g) + L(M) \right] = \int d^4x \sqrt{-g} L, \]

(2)

where \( \varphi_0^2 = \frac{3}{8\pi} M_{\text{Pl}}^2 \), \( G \) is the Newton constant in the units \( \hbar = c = 1 \), \( L(M) \) is the Lagrangian of the matter fields. This action is clearly dependent on the collection of fields and metric \( F = [f, g] \). These fundamental quantities \((1)\) and \((2)\) are invariant with respect to action of general coordinate transformations, known widely as diffeomorphisms

\[ x^\mu \rightarrow \tilde{x}^\mu = \tilde{\varphi}(x^0, x^1, x^2, x^3), \]

(3)

Separation of the diffeomorphisms from the Lorentz transformations in GR is fulfilled by introduction of a square root of the interval \((4)\)

\[ ds^2 = \omega^i(\alpha) \omega^i(\alpha) = \omega^i(x) \omega^i(x) - \omega^i(1) \omega^i(1) - \omega^i(2) \omega^i(2) - \omega^i(3) \omega^i(3), \]

(4)

where \( \omega^i(\alpha) \) are linear differential forms invariant with respect to action of diffeomorphisms

\[ \omega^i(\alpha)(x^\mu) \rightarrow \omega^i(\alpha)(\tilde{x}^\mu) = \omega^i(\alpha)(x^\mu). \]

These forms are treated as components of an orthogonal simplex of reference with the following Lorentz transformations

\[ \omega^i(\alpha) \rightarrow \omega^i(\alpha) = \omega^i(\alpha) = L(\alpha)_{\beta} \omega^i(\beta). \]

(5)

There is an essential difference between diffeomorphisms \((4)\) and the Lorentz transformations \((5)\). Namely, parameters of the Lorentz transformations \((5)\) are measurable quantities, while parameters of diffeomorphisms \((4)\) are unmeasurable one. Especially, the simplex components \( \omega^i(\alpha) \) in the Earth frame moving with respect to Cosmic Microwave Background (CMB) radiation with the velocity \( |\vec{v}| = 390 \text{ km/s} \) to the Leo are connected with the simplex components in the CMB frame \( \omega^i \) by the following formulae

\[ \omega^i(0) = \frac{1}{\sqrt{1 - \vec{v}^2}} \left[ \omega^i(0) - \vec{v}^i \omega^i(0) \right], \]

\[ \omega^i(\beta) = \frac{1}{\sqrt{1 - \vec{v}^2}} \left[ \omega^i(\beta) - \vec{v}^i \omega^i(0) \right], \]

(6)

where the velocities \( \vec{v} \) are measured \([1]\) by the the modulus of the dipole component of CMB temperature \( T_0(\theta) = T_0[1 + (\beta/c) \cos \theta] \) and its direction at the space \([1]\).

### 2.2. The Dirac – ADM canonical General Theory of Relativity in the CMB frame

The problem of the choice of a specific frame destined for description of evolution of the Universe in GR was formulated by Dirac and Arnowitt, Deser and Misner \([4]\) as 3+1 foliated space-time (see also \([5]\)). This foliation can be rewritten in terms of the Fock simplex components as follows

\[ \omega^i(0) = \psi^0 N_4 dx^0, \quad \omega^i(\beta) = \psi^i e_{(b)i}(dx^i + N^i dx^0), \]

(7)

where triads \( e_{(a)i} \) form the spatial metrics with \( \det |e| = 1 \), \( N_4 \) is the Dirac lapse function, \( N^k \) is the shift vector and \( \psi \) is a determinant of the spatial metric.

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1. The invariance of the action with respect to frame transformations means that there are integrals of motion (the first Noether theorem \([3]\)); while the invariance of the action with respect to diffeomorphisms leads to the Gauss type constraints between the motion integrals (the second Noether theorem \([6]\)). These constraints are derived in a specific frame of reference to the initial data. The constraints mean that only a part of metric components becomes degrees of freedom with the initial data. Another part corresponds to the diffeo-invariant static potentials that do not have initial data because their equations contain the Beltrami-Laplace operator. And the third part of metric components after the resolution of constraints becomes diffeo-invariant non-dynamical variables that can be excluded by the gauge-constraints \([4]\) like the longitudinal fields in Quantum Electrodynamics \([2]\).
In this case, the accepted canonical Dirac – ADM approach \[4\] to GR is given by the action \[2\] in the Hamiltonian form

\[
S_{\text{canonical}}[\varphi_0|F] = \int dx^0 \int d^3x \left( \sum_F P_F \partial_0 F + C - N_d T_d \right),
\]

where \(P_F = (p_\psi, p_{(b)}, p_f)\) is the set of canonical momenta including the metric component ones

\[
p_\psi = \frac{\partial [\sqrt{-g} L]}{\partial (\partial_0 \ln \psi)} = -\frac{8\varphi_0^2}{N_d} \left[ (\partial_0 - N^i \partial_i) \log \psi - \frac{1}{6} \partial_1 N^1 \right],
\]

\[
p^{(b)} = \frac{\partial [\sqrt{-g} L]}{\partial (\partial_0 \epsilon_{(a)i})} = e_{(a)i} \frac{\varphi_0^2}{6} \left( \epsilon_{(a)i} v^{(b)}_{(b)} + \epsilon_{(b)} v_{(a)i} \right),
\]

where

\[
v_{(a)i} = \frac{1}{N_d} \left[ (\partial_0 - N^i \partial_i) \epsilon_{(a)i} + \frac{1}{3} \epsilon_{(a)i} \partial_1 N^1 - \epsilon_{(a)} \partial_i N^i \right],
\]

and

\[
C = N_{(b)} T^0_{(b)} + \lambda_0 p_\psi + \lambda_2 \partial_k \epsilon_{(a)}
\]

is a sum of the constraints with the Lagrangian multipliers, including three first class constraints

\[
- \epsilon_{(a)} \frac{\delta S}{\delta N^k} = T^0_{(a)} = -p_\psi \partial_0 \epsilon_{(a)} \psi + \frac{1}{6} \partial_0 (p_\psi \psi) + 2 p_{(b)c}\sigma_{(b)(c)} - \partial_0 p_{(ba)} + T^0_{(a)(m)},
\]

where \(p_{(ab)} = \frac{1}{2} \left( \epsilon_{(a)b} p_{(b)c} + \epsilon_{(b)p} p_{(a)c} \right), \sigma_{(a)(b)(c)} = \epsilon_{(c)} \nabla_i \epsilon_{(a)c} \epsilon_{(b)} - \frac{1}{2} \epsilon_{(a)c} \left[ \partial_0 \epsilon_{(b)} - \partial_0 \epsilon_{(c)} \right] \) are the coefficients of the spin-connection (see \[3\] Eq. (98.9)), and four the second class ones \[4\]

\[
\partial_0 \epsilon_{(a)} = 0, \quad p_\psi = 0.
\]

It is not difficult to check that the last constraints, i.e. the zero momentum of the spatial volume element

\[
p_\psi = -8\varphi_0^2 \psi = 0 \rightarrow \partial_0 (\psi^6) = \partial_1 (\psi^6 N^1),
\]

means the minimal hypersurface of imbedding of the three-dimensional manifold into four-dimensional space-time, and these constraints lead to the Hamiltonian density

\[
- \frac{\delta S}{\delta N_d} \equiv T_d = \frac{4\varphi_0^2}{3} \psi^7 \triangle_{BL} \psi + \sum_{I=0,4,6,8,12} \psi^I T_I = 0,
\]

where

\[
\triangle_{BL} \psi \equiv \frac{1}{\sqrt{g}} (\partial_0 \sqrt{g} \gamma^{(ab)} \partial_0) \psi = \partial_0 \partial_{(b)} \psi
\]

is the Beltrami–Laplace operator, \(\gamma^{(ab)}\) is a spatial metric, \(\partial_{(a)} = \epsilon_{(a)} \partial_k\), and \(T_I\) is partial Hamiltonian density marked by the index \(I\) running a collection of values \(I = 0\) (stiff), 4 (radiation), 6 (mass), 8 (curvature), 12 (\(\Lambda\)-term) in accordance with a type of matter field contributions, particularly for metric components these densities take the following form \[9\]

\[
T_{I=0} = \frac{6}{\varphi_0^2} p^2_{(ab)} - 16 \frac{\varphi_0}{\varphi_0^2} p_\psi, \quad T_{I=8} = \frac{\varphi_0}{6} (3) \mathcal{R}(\epsilon),
\]

where

\[
(3) \mathcal{R}(\epsilon) = -2 \partial_1 \left[ \epsilon_{(b)} \sigma_{(c)(b)} \right] - \sigma_{(c)(b)} \epsilon_{(a)(b)} + \sigma_{(c)(d)} \epsilon_{(f)(d)}
\]

is a spatial curvature.
2.3. The Lichnerowicz variables and relative units of the dilaton gravitation

The dependence on the energy momentum tensors (17) on the spatial determinant potential \( \psi \) is completely determined by the Lichnerowicz (L) transformation to the conformal variables

\[
\omega_{(\mu)} = \psi^2 \omega_{(\mu)}^{(L)},
\]
\[
\hat{g}_{\mu\nu} = \psi^4 \hat{g}_{\mu\nu}^{(L)},
\]
\[
F^{(n)} = \psi^{-2n} F^{(n)}_{(L)},
\]

where \( F^{(n)} \) is any field with the one of conformal weights \( n \):
- \( n_{\text{scalar}} = 1 \)
- \( n_{\text{spinor}} = 3/2 \)
- \( n_{\text{vector}} = 0 \).

One can say that the manifest dependence on the energy density \( T_d \) on the spacial determinant \( \psi \) in the expression (8) is equivalent to a choice the L-coordinates (22) \( \omega_{(\mu)}^{(L)} \) and L-variables (23), (24) as observable ones. The L-observables are physically equivalent with the case when the field with the mass \( m = m_0 \psi^2 \) is contained in space-time distinguished by the unit spatial metric determinant and the volume element

\[
dV^{(L)} = \omega_{(1)}^{(L)} \wedge \omega_{(2)}^{(L)} \wedge \omega_{(3)}^{(L)} = d^3x.
\]

In terms of the L-variables and L-coordinates \( \hat{\omega}_{0} \psi^2 = w \) the Hilbert action of classical theory of gravitation (2) is formally the same as the action of the dilaton gravitation (DG) [10]

\[
S_{DG}[\hat{g}^w] = -\int d^4x \frac{\sqrt{-\hat{g}^w}}{6} R(\hat{g}^w) \equiv -\int d^4x \left[ \frac{\sqrt{-\hat{g}^w}}{6} R(g) - w \partial_\mu \left( \sqrt{-\hat{g}} \partial_\nu \hat{g}^{\mu\nu} \right) \right],
\]

where \( \hat{g}^w = w^2 \hat{g} \) and \( w \) is the dilaton scalar field. This action is invariant with respect to the scale transformations

\[
F^{(n)\Omega} = \Omega^n F^{(n)}, \quad \hat{g}^{\Omega} = \Omega^2 \hat{g}, \quad w^{\Omega} = \Omega^{-1} w.
\]

One can see that there is a transformation

\[
\Omega = \frac{w}{\hat{\omega}_{0}}
\]

converting the dilaton action (26) into the Hilbert one (2). In this manner, the CMB frame reveals the possibility to choose the units of measurements in the canonical GR.

2.4. The Newton law

The \( \psi \)-independence of L-variables are compatible with the Newton law and the cosmological dependence of the energy density on the scale factor \( a \) in the homogeneous approximation \( \psi^2 \to \sigma \).

The Newton law is determined by the energy constraints (17) and the equation of motion of the spatial determinant that, in the case of the minimal surface constraints (16), take the potential form

\[
-\psi \frac{\delta S}{\delta \psi} \equiv T_\psi = \frac{4\psi_0^2}{3} \left\{ 7N_d \psi^2 \triangle_{BL} \psi + \psi \triangle_{BL} \left[ N_d \psi^2 \right] \right\} + N_d \sum_{l=0,8} I_l \psi^l T_I = 0.
\]

It is not embarrassing to check that in a region of the empty space, where two dynamic variables are absent \( e_{(a)k} = \delta_{(a)k} \) (i.e. \( T_I = 0 \)), one can get the Schwarzschild-type solution of equations (17) and (29) in the form

\[
\triangle_{BL} \psi = 0, \quad \triangle_{BL} [N_d \psi^2] = 0 \quad \rightarrow \quad \psi = 1 + \frac{r_g}{r}, \quad [N_d \psi^2] = 1 - \frac{r_g}{r}, \quad N^k = 0,
\]

where \( r_g \) is the constant of the integration given by the boundary conditions.

The question arises: Where is the Hubble evolution in the canonical GR?
2.5. Global energy constraint and dimension of diffeomorphisms \((3L + 1G \neq 4L)\)

The Dirac – ADM approach to the Einstein–Hilbert theory \([7]\) states that five components \(\psi, N_d, N^k\) are treated as potentials satisfying the Laplace type equations in curved space without the initial data, three components are excluded by the gauge constraints \(\phi \epsilon_k \alpha_I\), and only two rest transverse gravitons are considered as independent degrees of freedom satisfying the d’Alambert type equations with the initial data. This Dirac – ADM classification is not compatible with both the cosmological observations including the last CMB data and the group of general coordinate transformations that conserves a family of constant coordinate time hypersurfaces \(x_0^0 = \text{const.}\). The group of these transformations, known as kinemetic subgroup \([5]\), contains only homogeneous reparameterizations of the coordinate evolution parameter \((x^0)\) and three local transformations of the spatial coordinates:

\[
\begin{bmatrix}
  x^0 \\
  x^i
\end{bmatrix} \rightarrow \begin{bmatrix}
  \tilde{x}^0(x^0) \\
  \tilde{x}^i(x^0, x^i)
\end{bmatrix}
\]

This means that dimension of the kinemetic subgroup of diffeomorphisms (three local functions and one global one) does not coincide with the dimension of the constraints in the canonical approach to the classical theory of gravitation that remove four local variables (the law \(3L + 1G \neq 4L)\).

The kinemetic subgroup \([51]\) essentially simplifies the solution of the energy constraint \([17]\), if the homogeneous variable is extracted from the the determinant

\[
\varphi_0 \psi^2(x^0, x^k) = \varphi(x^0) \tilde{\psi}^2(x^0, x^k)
\]

with the additional constraints

\[
\int d^3x \log \tilde{\psi} = \int d^3x \left[\log \psi - \langle \log \psi \rangle \right] \equiv 0, \quad \langle \log \psi \rangle \equiv \frac{1}{V_0} \int d^3x \log \psi,
\]

where \(V_0 = \int d^3x < \infty\) is the finite Lichnerowicz volume.

According to the definition of all measurable quantities as diffeo-invariants \([11]\), in finite space-time the non diffeo-invariant quantity \((31)\) \((x^0)\) is not measurable. Wheeler and DeWitt \([2]\) draw attention that in this case evolution of a universe in GR lies in full analogy with a relativistic particle given by the action

\[
\tilde{S}_{\text{SR}}[X^0, X^k] = \frac{m}{2} \int d\tau \frac{1}{\epsilon_p} \left[ \left( \frac{dX^0}{d\tau} \right)^2 - \left( \frac{dX^k}{d\tau} \right)^2 + \epsilon_p^2 \right] = \int d\tau \left[ -P^\mu \frac{dX^\mu}{d\tau} + \epsilon_p \left( P^2 - m^2 \right) \right]
\]

in the Minkowski space of events \([X^0, X^k]\) and the interval \(ds = \epsilon_p d\tau\), because both the actions \((34)\) in SR and \([5]\) in GR are invariant with respect to reparametrizations of the coordinate evolution parameters \(\tau \rightarrow \tilde{\tau} = \tilde{\tau}(\tau)\) and \(x^0 \rightarrow \tilde{x}^0 = x^0(x^0)\), respectively. In any relativistic theory given by an action and a geometrical interval \([12]\) there are two diffeo-invariant time-like parameters: the diffeo-invariant geometrical proper time interval (g-time) \(\epsilon_p d\tau = ds\) and the one of dynamical variables \(X^0\) in the space of events \([X^0, X^k]\) (d-time).

Therefore, one should points out in the finite volume GR the homogeneous variable \(\varphi(x^0)\) as the evolution parameter (d-time) in the field space of events \([\varphi |\tilde{F}\]\) and diffeo-invariant time coordinate \(\epsilon_u d\tilde{x}^0 = d\zeta\) (g-time), where \(\epsilon_u [N_d]\) as functional of \(\tilde{N}_d\) can be defined as the spacial averaging

\[
\frac{1}{\epsilon_u [N_d]} = \frac{1}{V_0} \int \frac{d^3x}{N_d} \equiv \langle \tilde{N}_d^{-1} \rangle.
\]

This definition is consistent with action of GR obtained after the extraction of the d-time \((32)\) \([9, 13, 14]\)

\[
\tilde{S}[\varphi_0 |\tilde{F}] = \tilde{S}_u [\varphi |\tilde{F}] - V_0 \int dx^0 \frac{1}{\epsilon_u} \left( \frac{d\varphi}{dx^0} \right)^2 = \int dx^0 L;
\]

where \(\tilde{S}[\varphi |\tilde{F}]\) is the action \((2)\) in terms of metrics \(\tilde{g}\), where \(\varphi_0\) is replaced by the running scale \(\varphi(x^0) = \varphi_0 a(x^0)\) of all masses of the matter fields. The action \((36)\) leads to the energy constraints

\[
\frac{\delta \tilde{S}[\varphi_0]}{\delta N_d} = -T_d = \frac{\left( \partial_0 \varphi \right)^2}{N^2_d} - \tilde{T}_d = 0, \quad \tilde{T}_d \equiv -\frac{\delta \tilde{S}[\varphi]}{\delta N_d} \geq 0
\]
3. Canonical cosmic evolution in the field space of events

3.1. The Wheeler – DeWitt universe – particle correspondence

Table 1: The Universe-particle correspondence \[9\][14].

| № | concepts | universe | particle |
|---|----------|----------|----------|
| 1. | reparametrizations | \( x^0 \rightarrow x^0 = \hat{x}^0(x^0) \) | \( \tau \rightarrow \tau = \tau(\tau) \) |
| 2. | evolution parameter | \( \varphi(x^0) = \varphi_0a(x^0) \) | \( X_0(\tau) \) |
| 3. | space of events | \( \varphi \mid F \) | \( X_0 \mid X_k \) |
| 4. | geometric time | \( d\zeta = dx^idx^0e_u \) | \( ds = d\tau\varepsilon \) |
| 5. | the arrow of time | \( \zeta(\pm) = \pm \int_{\varphi}^{\varphi_0} d\varphi \left\langle (T_\theta)^{-1/2} \right\rangle \ge 0 \) | \( s_\pm = \pm \frac{\alpha^2}{2}[X_0^0 - X_0^1] \ge 0 \) |
| 6. | energy constraint | \( P_\varphi^2 - E_\varphi^2 = 0 \) | \( P_0^2 - E_0^2 = 0 \) |
| 7. | energy of events | \( P_\varphi = \pm E_\varphi = \pm 2 \int d^3x(T_\theta)^{1/2} \) | \( P_0 = \pm E_0 = \pm \sqrt{m^2c^4 + |\vec{p}|^2} \) |
| 8. | wave equation | \( [P_\varphi^2 - E_\varphi^2]\Psi_{WDW} = 0 \) | \( [P_0^2 - E_0^2]\Psi_{KG} = 0 \) |
| 9. | secondary quantization | \( \Psi_{WDW} = \frac{1}{\sqrt{2E_\varphi}}[A^+ + A^-] \) | \( \Psi_{KG} = \frac{1}{\sqrt{2E_0}}[a^+ + a^-] \) |
| 10. | Bogoliubov transformation | \( A^+ = \alpha B^+ + \beta^+B^- \) | \( a^+ = \alpha b^+ + \beta^**b^- \) |
| 11. | the stable vacuum state | \( B^- |0 \rangle = 0 \) | \( b^- |0 \rangle = 0 \) |
| 12. | creation from vacuum | \( N_\text{universe} = <0|A^+A^-|0 \rangle \neq 0 \) | \( N_\text{particle} = <0|a^+a^-|0 \rangle \neq 0 \) |

According to the Wheeler – DeWitt \[2\] there is the universe – particle correspondence given in the Table 1 \[9\][14]. This universe-particle correspondence rejects the Hilbert Foundations of relativistic physics of 1915 \[12\] that include also the geometric interval (Table 1.4) and the group of diffeomorphisms (Table 1.1), in contrast to the classical physics based only on an action and the group of the data transformations. The group of diffeomorphisms (Table 1.1) leads to the energy constraint (Table 1.6). Resolution of the energy constraint gives the Hubble type relation (Table 1.5) between d-time (Table 1.3) and g-time (Table 1.4) and determines the energy of events (Table 1.7) that can take positive and negative values. In aim to remove the negative value, one can use the rich experience of QFT, i.e. the primary quantization (Table 1.8) and the secondary one (Table 1.9). This quantization procedure leads immediately to creation from stable Bogoliubov vacuum state (Table 1.12) of both quasuniverses and quasiparticles (Table 1.11) obtained by the Bogoliubov transformation (Table 1.10) \[15\][16]. This QFT experience illustrates the possibility to solve the problems of the quantum origin of all matter fields in the Early Universe, its evolution, and the present-day energy budget \[9\][17][18]. In order to use this possibility, one should impose a set of requirements on the cosmic motion in the field space of events that follow from the general principles of QFT.

3.2. CMB requirements to the canonical cosmological perturbation theory

The QFT experience supposes that the action \[36\] can be represented in the canonical Hamiltonian form like \[8\]

\[
S_{\text{canonical}}[\varphi_0|F] = \int dx^0 \left\{ -P_\varphi \partial_0 \varphi + e_\mu [\hat{N}_d] \frac{P_\varphi^2}{4V_0} + \int d^3x \left[ \sum_F P_F \partial_0 \bar{F} + C - \hat{N}_d \bar{T}_0 \right] \right\}. \tag{38}
\]

However, the acceptable cosmological perturbation theory \[19\][20][13] is not compatible with the Hamiltonian formulation \[38\], because of after the separation of cosmological scale factor in the common accept cosmological perturbation theory the number of variables does not coincide with the number of variables in GR \[13\].

In this case, the energy constraint \[37\] takes the form of the Friedmann equation

\[
\left[ \frac{d\varphi}{d\zeta} \right]^2 = \varphi^2 = \left\langle (\bar{T}_\theta)^{1/2} \right\rangle^2, \tag{39}
\]

7
and the algebraic equation for the diffeo-invariant lapse function

\[ N_{inv} = \langle (\tilde{N}_d)^{-1} \rangle \tilde{N}_d = \langle (\tilde{T}_d)^{1/2} \rangle (\tilde{T}_d)^{-1/2}. \]

(40)

We see that the energy constraint (37) removes only one global momentum \( P_\phi \) in accord to the dimension of the kinematic diffeomorphisms (31) that is consistent with the second Noether theorem.

One can find the evolution of all field variables \( F(\varphi, x^i) \) with respect to \( \varphi \) by variation of the “reduced” action

\[
S[\varphi_0]_{e_\varphi = \pm \epsilon_\varphi} = \int_{\varphi_0}^{\varphi_1} d\varphi \left\{ \int d^3x \left[ \sum_i P_i \partial_\varphi F + \tilde{C} = -2 \sqrt{\tilde{T}_d(\varphi)} \right] \right\},
\]

(41)

obtained as values of the Hamiltonian form of the initial action (38) onto the energy constraints (39), where \( \tilde{C} = C/\partial_0 \tilde{\varphi} \) [21].

The energy constraints (37) and the Hamiltonian reduction (41) lead to the definite canonical rules of the Universe evolution in the field space of events \( [\varphi | F] \).

**Rule 1: Causality Principle in the WDW space**

\[ \frac{d\varphi_1}{d\varphi_0} = 0 \] follows from the Hamiltonian reduction (41) that gives us the solution of the Cauchy problem and means that initial data do not depend on the Planck value.

**Rule 2: Positive Energy Postulate**

follows from the energy constraint (37)

\[ \frac{(\partial_0 \varphi)^2}{N^2_d} = \tilde{T}_d \]

\[ \tilde{T}_d = -\frac{16}{\varphi^2} + \ldots \geq 0 \quad \rightarrow \quad p_\varphi = -\frac{4\varphi^2}{3\varphi^2 N_{inv}} \tilde{C} = -\frac{4\varphi^2}{3\varphi^2 N_{inv}} [\tilde{N}^i (\tilde{N}^j) - (\tilde{N}^j)^i] = 0, \] (42)

where \( \tilde{T}_d \) is given by equations of the type of (17) and (19) and \( (\tilde{N}^i) = \tilde{N}^i (\tilde{N}_d^{-1}) \neq 0 \).

**Rule 3: Vacuum Postulate**

\[ B^- | 0 \rangle = 0 \] restricts the Universe motion in the field space of events

\[ P_\varphi \geq 0 \quad \text{for} \quad \varphi_1 \leq \varphi_0 \]

\[ P_\varphi \leq 0 \quad \text{for} \quad \varphi_1 \geq \varphi_0. \] (43)

**Rule 4: Lapse Function**

\[ N_{inv} > 0 \] follows from the nonzero energy density \( \tilde{T}_d \neq 0 \).

The Rule 1 is not compatible with the Planck epoch in the beginning of the Universe \( \frac{d\varphi_1}{d\varphi_0} \neq 0 \).

The Rule 2 is not compatible with dynamic evolution of the local scalar component \( \tilde{\varphi}^2 = \varphi^2/a \).

The Rule 3 leads to the arrow of the geometric time.

The Rule 4 forbids any penetration into a internal region of black hole because this penetration is accompanied the change of a sign of the lapse function.

Thus, the explanation of the quantum origin of the Universe in GR (Table 2.1.) and its matter in the framework of the canonical GR is not compatible with the frame free cosmology (Table 2.2.), the Planck’s initial data at the Early Universe (Table 2.3.) and the scalar component dynamics (Table 2.8.) considered as the basis of the Inflationary model [22].

First of all one should check the correspondence of the canonical GR with both the QFT in the flat space-time and the classical Newton theory.

### 3.3. Test I. The QFT limits and SN data

The correspondence principle [21] as the low-energy expansion of the “reduced action” (41) over the field density \( T_s \)

\[
2d\varphi \sqrt{T_0} = 2d\varphi \sqrt{\rho_0(\varphi) + T_s} = d\varphi \left[ 2 \sqrt{\rho_0(\varphi) + \frac{T_s}{\sqrt{\rho_0(\varphi)}}} + \ldots \right]
\]

(44)
gives the following sum:

$$S^{(+)\text{constraint}} = S^{(+)\text{cosmic}} + S^{(+)\text{field}} + \ldots,$$

where

$$S^{(+)\text{cosmic}}[\phi | \phi_0] = -2V_0 \int_{\phi_i}^{\phi_0} d\phi \sqrt{\rho_0(\phi)}$$

is the reduced cosmological action (41), and

$$S^{(+)\text{field}} = \int_{\eta_1}^{\eta_0} \int_{V_0} d^3x \left[ \sum_F P_F \partial_\eta F + \mathcal{C} - T_s \right]$$

is the standard field action in terms of the conformal time: $d\eta = \frac{d\phi}{\sqrt{\rho_0(\phi)}}$, in the conformal flat space–time with running masses $m(\eta) = a(\eta)m_0$.

This expansion shows that the Hamiltonian approach to the General Theory of Relativity in terms of the Lichnerowicz scale-invariant variables (55) identifies the “conformal quantities” with the observable ones including the conformal time $d\eta$, instead of $dt = a(\eta)d\eta$, the coordinate distance $r$, instead of the Friedmann one $R = a(\eta)r$, and the conformal temperature $T_c = Ta(\eta)$, instead of the standard one $T$. Therefore, the scale-invariant variables distinguish the conformal cosmology (CC) [29, 30], instead of the standard cosmology (SC). In this case, the red shift of the wave lengths of the photons emitted at the time $\eta_0 - r$ by atoms on a cosmic object in the comparison with the Earth ones emitted at emitted at the time $\eta_0$, where $r$ is the distance between the Earth and the object:

$$\frac{\lambda_0}{\lambda_{\text{cosmic}}(\eta_0 - r)} = \frac{a(\eta_0 - r)}{a(\eta_0)} \equiv a(\eta_0 - r) = \frac{1}{1 + z}.$$  

(48)

This red shift can be explained by the running masses $m = a(\eta)m_0$ in action (47). In this case, the Schrödinger wave equation

$$\left[ \frac{\hat{p}_r^2}{2a(\eta)m_0} - \frac{a}{r} \right] \Psi_L(\eta, r) = \frac{d}{d\eta} \Psi_L(\eta, r)$$

(49)

can be converted by the substitution $r = \frac{R}{a(\eta)}$, $p_r = P_R a(\eta)$, $a(\eta)d\eta = dt$, $a(\eta)\Psi_L(\eta, r) = \Psi_0(t, R)$ into the standard Schrödinger wave equation with the constant mass

$$\left[ \frac{\hat{p}_R^2}{2m_0} - \frac{a}{R} \right] \Psi_0(t, R) = \frac{d}{dt} \Psi_0(t, R).$$

(50)

Table 2: The canonical cosmological perturbation theory [9, 14] versus the standard one [19, 20, 13].

| No. | concepts | Canonical Cos. P.Th. | Standard Cos. P.Th. |
|-----|----------|----------------------|---------------------|
| 1.  | Number of variables | It is equal to the GR one | It is not equal to the GR one |
| 2.  | frame | CMB frame | frame free |
| 3.  | Planck’s epoch | It is at present-day | It is at Early Universe |
| 4.  | geometric time | diffeo-invariant $d\zeta = dx^i\epsilon_{iu}$ | diffeo-invariant $\eta$ |
| 5.  | the arrow of time | $\zeta(\pm) = \pm \int_{\phi_1}^{\phi_0} d\phi \left( (T_d)^{-1/2} \right) \geq 0$ | Is not |
| 6.  | energy of events | $P_{\theta} = \pm E_\theta = \pm 2 \int d^3x (T_d)^{1/2}$ | It is not |
| 7.  | Kinetic perturbations | $p_{\psi} = 0$ | $p_{\phi} \neq 0$ |
| 8.  | Shift vector $N^z$ | $N^z \neq 0$ | $N^z = 0$ |
| 9.  | vacuum postulate | vacuum exist | vacuum not exist |
| 10. | Potential perturbations | $T_d(\psi) = T_d(\psi = a^{1/2}) + \Delta T_d$ | $T_d(\psi) = T_d(\psi = a^{1/2})$ |
Figure 1: The Hubble diagram in cases of the absolute units of standard cosmology (SC) and the relative units of conformal cosmology (CC) [23, 24, 25]. The points include 42 high-redshift Type Ia supernovae [26] and the reported farthest supernova SN1997ff [27]. The best fit to these data requires a cosmological constant $\Omega_\Lambda = 0.7$, $\Omega_{\text{CDM}} = 0.3$ in the case of SC, whereas in CC these data are consistent with the dominance of the rigid (stiff) state. The Hubble Scope Space Telescope team analyzed 186 SNe Ia [28] to test the CC [25].

Returning back to the Lichnerowicz variables $\eta, r$ we obtain the spectral decomposition of the wave function of an atom with the running mass

$$\Psi_L(\eta, r) = \frac{1}{a(\eta)} \sum_{k=1}^{\infty} e^{-i\varepsilon_0^{(k)} \int \eta^0 d\bar{a}(\bar{\eta})} \Psi_0^{(k)}(a(\eta)r) = \sum_{k=1}^{\infty} \Psi_L^{(k)}(\eta, r).$$  \hspace{1cm} (51)

Where $\varepsilon_0^{(k)} = \alpha^2 m_0 / k^2$ is a set of eigenvalues of the Schrödinger wave equation in the Coulomb potential. We got the equidistant spectrum $-i(d/d\eta)\Psi_L^{(k)}(\eta, r) = \varepsilon_0^{(k)} \Psi_L^{(k)}(\eta, r)$ for any wave lengths of cosmic photons remembering the size of the atom at the moment of their emission.

The conformal observable distance $r$ loses the factor $a$, in comparison with the nonconformal one $R = ar$. Therefore, in the case of CC, the redshift–coordinate-distance relation $d\bar{\eta} = \frac{d\varphi}{\sqrt{\rho_0(\varphi)}}$ corresponds to a different equation of state than in the case of SC [29]. The best fit to the data, including Type Ia supernovae [26, 27], requires a cosmological constant $\Omega_\Lambda = 0.7$, $\Omega_{\text{CDM}} = 0.3$ in the case of the “scale-variant quantities” of standard cosmology. In the case of “conformal quantities” in CC, the Supernova data [26, 27] are consistent with the dominance of the stiff (rigid) state, $\Omega_{\text{Rigid}} \simeq 0.85 \pm 0.15$, $\Omega_{\text{Matter}} = 0.15 \pm 0.15$ [29, 23, 24]. If $\Omega_{\text{Rigid}} = 1$, we have the square root dependence of the scale factor on conformal time $a(\eta) = \sqrt{1 + 2H_0(\eta - \eta_0)}$. Just this time dependence of the scale factor on the measurable time (here – conformal one) is used for description of the primordial nucleosynthesis [24, 31].
This stiff state is formed by a free scalar field when \( E_{\phi} = 2V_0 \sqrt{\rho_0} = \frac{Q}{\phi} \). In this case there is an exact solution of the Bogoliubov equations of the number of universes created from a vacuum with the initial data \( \phi(\eta = 0) = \phi_I, H(\eta = 0) = H_I \). 

3.4. Test II: Cosmological creation of CMB and matter

These initial data \( \phi_I \) and \( H_I \) are determined by the parameters of matter cosmologically created from the Bogoliubov vacuum at the beginning of a universe \( \eta \simeq 0 \).

\[
T_c \sim (M_I^2 H_I)^{1/3} = (M_0^2 H_0)^{1/3} \sim 3K
\]

as a conserved number of cosmic evolution compatible with the Supernova data \([29, 26, 27]\). We can see that this value is surprisingly close to the observed temperature of the CMB radiation \( T_c = T_{\text{CMB}} = 2.73 \, \text{K} \).

The primordial mesons before their decays polarize the Dirac fermion vacuum (as the origin of axial anomaly \([33, 34, 35, 36]\)) and give the baryon asymmetry frozen by the CP – violation. The value of the baryon–antibaryon asymmetry of the universe following from this axial anomaly was estimated in paper \([18]\) in terms of the coupling constant of the superweak-interaction

\[
n_b/n_{\gamma} \sim X_{CP} = 10^{-9}.
\]
The cosmological generalization of the static potential in terms of the Lichnerowicz variables is as fol-

All these results (52) – (54) testify to that all visible matter can be a product of decays of primordial bosons, and the observational data on CMB radiation can reflect parameters of the primordial bosons, but not the history of evolution of masses of elementary particles in the cold universe with the constant conformal temperature $T_c = a(y)T = 2.73$ K of the Cosmic Microwave Background radiation.

Equations of the vector bosons in SM are very close to the equations of the QED ones (17) and (29).

The temperature history of the expanding universe copied in the “conformal quantities” looks like

In the case of point mass distribution in a finite volume $V_0$ with the zero pressure and the density

...
Figure 3: The diffusion of a system of particles moving in the space $ds^2 = d\eta^2 - (dx^i + N^i d\eta)^2$ with periodic shift vector $N^i$ and zero momenta could be understood from analysis of O.D.E. $dx^i/d\eta = N^i$ considered in the two-dimensional case in the book [37], if we substitute $t = m(\ldots)\eta$ and $N^i \sim \frac{x^i}{r} \sin m(\ldots)r$ in the equations, where $m(\ldots)$ is defined by Eq. (61).

where $\gamma_1 = \frac{1 + 7\beta}{2}$, $\gamma_2 = \frac{14\beta - 1}{28\beta}$, $r_g = \frac{3M}{4\pi \varphi^2}$, $r = |x - y|$. These solutions have spatial oscillations and the nonzero shift of the coordinate origin that leads to the large scale distribution of the matter [9].

In the infinite volume limit $\langle T_{i\kappa} \rangle = 0$, $a = 1$ solutions (63) and (64) coincide with the isotropic version of the Schwarzschild solutions: $\bar{\psi} = 1 + \frac{r_g}{4r}$, $N_{i\kappa} \bar{\psi} = 1 - \frac{r_g}{4r}$, $N^k = 0$. However, the Black Hole generalization is forbidden by the energy constraint (40) $N_d \geq 0$.

In the contrast to standard cosmological perturbation theory [19, 20, 13] the diffeo-invariant version of the perturbation theory do not contain time derivatives that are responsible for the CMB “primordial power spectrum” in the inflationary model [13]. However, the diffeo-invariant version of the Dirac Hamiltonian approach to GR gives another possibility to explain the CMB radiation ‘spectrum’ and other topical problems of cosmology by cosmological creation of the vector bosons considered above. The equations describing the longitudinal vector bosons in SM, in this case, are close to the equations that follow from the Lifshits perturbation theory and are used, in the inflationary model, for description of the “power primordial spectrum” of the CMB radiation.

The next differences are a nonzero shift vector and spatial oscillations of the scalar potentials determined by $\hat{m}^2(\ldots)$ (see Fig. 3). In the scale-invariant version of cosmology, [29] the SN data dominance of stiff state $\Omega_{\text{Stiff}} \sim 1$ determines the parameter of spatial oscillations

$$\hat{m}^2(\ldots) = \frac{6}{7} H_0^2 (\Omega_R(z + 1)^2 + \frac{9}{2} \Omega_{\text{Mass}}(z + 1)).$$

(65)

The redshifts in the recombination epoch $z_r \sim 1100$ and the clustering parameter [37]

$$r_{\text{clustering}} = \frac{\pi}{\hat{m}(\ldots)} \sim \frac{\pi}{H_0\Omega R^{1/2}(1 + z_r)} \sim 130 \text{ Mpc}$$

(66)

recently discovered in the researches of a large scale periodicity in redshift distribution [38, 39] lead to a reasonable value of the radiation-type density $10^{-4} < \Omega_r \sim 3 \cdot 10^{-3} < 5 \cdot 10^{-2}$ at the time of this epoch.
4. Geometrization of the Higgs particles in the unified theory

We listed a set of arguments in favor that the cosmological problems and CMB anisotropy can be explained in the framework of the canonical GR, if we accept the relative units and dilaton GR, for which the Hilbert action (2) formally coincides with the action the dilaton gravitation (DG) [23]

\[
S_{DG}[w,g] = -\int d^4x \sqrt{-\hat{g}} \frac{1}{6} R(\hat{g}^w) \equiv -\int d^4x \left[ \sqrt{-\hat{g}} \frac{\sqrt{w^2}}{6} R(\hat{g}) - w \partial_{\mu} \left( \sqrt{-\hat{g}} \partial_{\nu} w g^{\mu\nu} \right) \right],
\]

where \( \hat{g}^w = w^2 g \) and \( w \) is the dilaton scalar field. This action is invariant with respect to the scale transformations (27).

The scale invariant kinetic action of the Higgs field modulus can be written in the similar form (67)

\[
S_{DG}[g^h] = \int d^4x \sqrt{-\hat{g}} R(\hat{g}^h), \quad \hat{g}^h = \frac{|\Phi|^2}{2} g,
\]

So that the effective inverse Newton coupling constant takes the form of the sum of squares of two the scalar fields – dilaton and modulus of the Higgs field

\[
(w^h)^2 = (w)^2 - \frac{|\Phi|^2}{2},
\]

After the transformation

\[
w = w^h \cosh Q, \quad \frac{|\Phi|}{\sqrt{2}} = w^h \sinh Q
\]

we get the action of the dilaton GR and SM

\[
S_{tot} = S_{DG}[w^h] + S_{SM} \left[ \frac{|\Phi|}{\sqrt{2}} = w^h \sinh Q \right] + \int d^4x (w^h)^2 \partial_\mu Q \partial_\nu Q g^{\mu\nu}.
\]

The Higgs potential \( S_{Higgs} \left[ \frac{|\Phi|}{\sqrt{2}} = w^h \sinh Q \right] \) becomes an superfluous ornamentation, if the field \( Q \) begins from the initial data \( Q_{iv} \). The spontaneous symmetry breaking by the initial data is possible due to the Gell-Mann-Oakes-Renner type mechanism of the vacuum ordering [40].

5. Discussion

The WMAP observations of the CMB anisotropy now is treated as distinguishing of one of relativistic inertial reference frames. The treatment of the velocity 390 km/c to the Leo as the parameters of the Lorentz transformations give some requirements to the fundamentals of the General Theory of Relativity.

The CMB frame is separated from the general coordinate transformations by the use of the Fock simplex components, where spatial determinant is separated.

The dependence of the energy – momentum tensor components on the determinant component is determined by the Lichnerowicz transformations of any field with the conformal weight \( (n) \) to the conformal-invariant (dilaton) version of GR [67], where the differential element of spatial volume coincides with the coordinate one and the absolute Newton coupling constant is converted into the present-day value of dilaton.

The CMB frame is invariant with respect to the kinematic subgroup of the general coordinate transformations, that includes only the reparametrizations of the coordinate evolution parameter. These reparametrizations means the existence of the homogeneous time-like dynamics of a whole system of fields that can be treated as the global motion of the universe in the field space of events subgroup of diffeomorphisms of the CMB frame can be considered the foundation of the canonical version of the cosmological perturbation theory that keeps the the Hamiltonian dynamics with the energy constraint.

The energy constraint and the Hamiltonian reduction lead to the definite canonical rules of the Universe evolution in the field space of events including positive energy of events, the vacuum postulate, arrow of geometric time, potential perturbation, which are omitted by the standard Lifshits theory.

It is interesting to apply this canonical approach to describe the fluctuations of CMB temperature.
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References

[1] D.N. Spergel, et al. “First Year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Determination of Cosmological Parameters”, *Astrophys. J. Suppl.* **148**, 175–203 (2003); astro-ph/0302209

[2] J.A. Wheeler, in *Batelle Rencontres: 1967, Lectures in Mathematics and Physics*, edited by C. DeWitt and J.A. Wheeler, New York, 1968, p. 242; B.C. DeWitt, *Phys. Rev.* **160**, 1113 (1967).

[3] V.A. Fock, *Zs. f. Phys.* **57**, 261 (1929).

[4] P.A.M. Dirac, *Proc. Roy. Soc.* **A 246**, 333 (1958); P.A.M. Dirac, *Phys. Rev.* **114**, 924 (1959); R. Arnowitt, S. Deser and C.W. Misner, *Phys. Rev.* **117**, 1595 (1960).

[5] A.L. Zelmanov, *Dokl. AN USSR*, **107**, 315 (1956); A.L. Zelmanov, *Dokl. AN USSR*, **209**, 822 (1973); Yu.S. Vladimirov, *Reference Frames in Theory of Gravitation*, Moscow, Energoizdat, 1982, [in Russian].

[6] E. Noether, *Göttinger Nachrichten, Math.-Phys. Kl.*, **2**, 235. (1918).

[7] P.A.M. Dirac, *Proc. Roy. Soc.*, **A 114**, 243–249 (1927); P.A.M. Dirac, *Can. J. Phys.*, **33**, 650–661 (1955).

[8] L.D. Landau, E.M. Lifshitz, *Classical Theory of Fields*, Pergamon, 1975.

[9] B.M. Barbashov, V.N. Pervushin, A.F. Zakharov, V.A. Zinchuk, *Physics of Atomic Nuclei*, (in press) astro-ph/0507368; B.M. Barbashov, V.N. Pervushin, A.F. Zakharov, V.A. Zinchuk, in *Nuclear Science and Safety in Europe*, T. Cechak et al. (eds.), Springer, 2006, p. 125; B.M. Barbashov, V.N. Pervushin, A.F. Zakharov, V.A. Zinchuk, in *Proceedings of the 8th International Workshop Relativistic Nuclear Physics: From Hundreds MeV TO TeV*, May 23 - 28, 2005 JINR, Dubna, Russia, p.11, 2006; B.M. Barbashov, V.N. Pervushin, A.F. Zakharov, V.A. Zinchuk, in *Proceedings of the XXVIII Spanish Relativity Meeting E.R.E. 2005 “A Century of Relativity Physics”, Oviedo (Asturias) Spain, September 6-10, 2005, American Institute of Physics, v. 841, p. 362 (2006); V.N. Pervushin, A.F. Zakharov, V.A. Zinchuk, in *Proceedings of the International INTAS Summer School and Conference “New Trends In High-Energy Physics (experiment, phenomenology, theory)”, Yalta, Crimea, Ukraine, Bogoliubov Institute for Theoretical Physics, NAS of Ukraine, JINR, Kiev 2005, p. 271; V.N. Pervushin, A.F. Zakharov, V.A. Zinchuk, in *Nuclear Science and Safety in Europe*, T. Cechak et al. (eds.), Springer, 2006, p. 201; B.M. Barbashov, V.N. Pervushin, A.F. Zakharov, V.A. Zinchuk, *International Journal of Geometric Methods in Modern Physics*, hep-th/0606054.

[10] R. Penrose, *Relativity, Groups and Topology*, Gordon and Breach, London 1964; N. Chernikov and E. Tagirov, Ann. Inst. Henri Poincarè 9, 109 (1968).

[11] Dirac P.A.M. “Generalized Hamiltonian Dynamics”, *Proc. Roy. Soc. (London)* **A 246**, 326–332 (1958); Dirac P.A.M. “Fixation of Coordinates in the Hamiltonian Theory of Gravitation”, *Phys. Rev.* **114**, 924–930 (1959).

[12] D. Hilbert, *Nachrichten von der Kön. Ges. der Wissenschaften zu Göttingen, Math.-Phys. Kl.*, **3**, 395 (1915).

[13] V.F. Mukhanov, H.A. Feldman and R.H. Brandenberger, *Phys. Rep.* **215**, 206 (1992).

[14] B.M. Barbashov, V.N. Pervushin, A.F. Zakharov, V.A. Zinchuk, *Phys. Lett B* **633**, 458 (2006); hep-th/0501242; B.M. Barbashov, V.N. Pervushin, A.F. Zakharov, V.A. Zinchuk, Hamiltonian a General Relativity in Finite Space and Cosmological Potential Perturbations, *Int. Jour. Mod. Phys.* **A 21**, 5957 (2006).
[15] S. Schweber, An Introduction to Relativistic Quantum Field Theory, Row, Peterson and Co, Evanston, Ill., Elmsford, N.Y, 1961.

[16] N. N. Bogoliubov, A. A. Logunov, and I. T. Todorov, General Principles of Quantum Field Theory, Nauka, Moscow, 1969.

[17] V.N. Pervushin, V.A. Zinchuk, Invited talk at the XXXIX PNPI Winter School on Nuclear Particle Physics and XI St. Petersburg School on Theoretical Physics (St. Petersburg, Repino, February 14 - 20, 2005), gr-qc/0504123; A.F. Zakharov, V.A. Zinchuk, and V.N. Pervushin, Physics of Particles and Nuclei, 37, 104 (2006).

[18] D.B. Blaschke, S.I. Vinitsky, A.A. Gusev, V.N. Pervushin, and D.V. Proskurin, *Physics of Atomic Nuclei*, 67, 1050 (2004); [hep-ph/0504225].

[19] E.M. Lifshits, ZhETF 16, 587 (1946).

[20] J.M. Bardeen, *Phys. Rev. D* 22, 1882 (1980); H. Kodama, M. Sasaki, Prog. Theor. Phys. Suppl. 78 1 (1984).

[21] M. Pawlowski, V.N. Pervushin, *Int. J. Mod. Phys. A* 16, 1715 (2001); [hep-th/0006116].

[22] Linde A.D. “Elementary Particle Physics and Inflation Cosmology”, Nauka, Moscow, 1990.

[23] D. Blaschke, D. Behnke, V. Pervushin, and D. Proskurin, in *Proc. of the XVIIIth IAP Colloquium “On the Nature of Dark Energy”*, Paris, July 1-5, 2002; Report-no: MPG-VT-UR 240/03; [astro-ph/0302001].

[24] D. Behnke, *Conformal Cosmology Approach to the Problem of Dark Matter*, PhD Thesis, Rostock Report MPG-VT-UR 248/04 (2004).

[25] A.F. Zakharov, A.A. Zakharova, V.N. Pervushin astro-ph/0611639

[26] A.G. Riess et al., *Astron. J.* 116, 1009 (1998); S. Perlmutter et al., *Astrophys. J.* 517, 565 (1999).

[27] A.G. Riess et al., *Astrophys. J.* 560, 49 (2001); A.G. Riess et al., *Astrophys. J.* 607, 665 (2001).

[28] A.D. Riess, et al., *Astrophys. J.*, 607 (2004) 665.

[29] D. Behnke, D.B. Blaschke, V.N. Pervushin, and D.V. Proskurin, *Phys. Lett. B* 530, 20 (2002); [gr-qc/0102039].

[30] J.V. Narlikar, *Introduction to Cosmology*, Jones and Bartlett, Boston, 1983.

[31] S. Weinberg, *First Three Minutes. A Modern View of the Origin of the Universe*, Basic Books, Inc., Publishers, New-York, 1977.

[32] A. Gusev et al. (2004) In *Problems of Gauge Theories*, JINR D2-2004-66, Dubna, 127-130.

[33] V.N. Pervushin, *Riv. Nuovo Cimento*, 8 N 10, 1 (1985).

[34] N. Ilieva, V.N. Pervushin, *Int. J. Mod. Phys. A* 6, 4687 (1991).

[35] S. Gogilidze, N. Ilieva, V.N. Pervushin, *Int. J. Mod. Phys. A* A 14, 3531 (1999).

[36] P.Z. Jordan, *Phys. 93*, 464 (1935).

[37] V.I. Klyatskin, *Stochastic Equations from Physicist Point of View*, Moscow, Fizmatlit, 2001 [in Russian].

[38] W.J. Cocke, W.G. Tifft, *Astrophys. J.*, 368, 383 (1991).

[39] K. Bajan, P. Flin, W. Godłowski, V. Pervushin, and A. Zorin, *Spacetime & Substance* 4, 225 (2003).

[40] B.M. Barbashov, L.A. Glinka, V.N. Pervushin, S.A. Shuvalov, and A.F. Zakharov, [hep-th/0611252]