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Origin of Matter from Vacuum in Conformal Cosmology

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Abstract

We introduce the hypothesis that the matter content of the universe can be a product of the decay of primordial vector bosons. The effect of the intensive cosmological creation of these primordial vector W , Z bosons from the vacuum is studied in the framework of General Relativity and the Standard Model where the relative standard of measurement identifying conformal quantities with the measurable ones is accepted. The relative standard leads to the conformal cosmology with the z -history of masses with the constant temperature, instead of the conventional z -history of the temperature with constant masses in inflationary cosmology. In conformal cosmology both the latest supernova data and primordial nucleosynthesis are compatible with a stiff equation of state associated with one of the possible states of the infrared gravitation field.

The distribution function of the created bosons in the lowest order of perturbation theory exposes a cosmological singularity as a consequence of the theorem about the absence of the massless limit of massive vector fields in quantum theory. This singularity can be removed by taking into account the collision processes leading to a thermalization of the created particles.

The cosmic microwave background (CMB) temperature $T = (M_W^2 H_0)^{1/3} \sim 2.7K$ occurs as an integral of motion for the universe in the stiff state. We show that this temperature can be attained by the CMB radiation being the final product of the decay of primordial bosons.

The effect of anomalous nonconservation of baryon number due to the polarization of the Dirac sea vacuum by these primordial bosons is considered.

1. Introduction

In the inflationary models [1] it is proposed that from the very beginning the universe is a hot fireball of massless particles that undergo a sequence of phase transitions. However, the origin of particles is an open question as the isotropic evolution of the universe cannot create massless particles [2, 3, 4, 5, 6, 7]. Nowadays, it is evident that the problem of the cosmological creation of matter from the vacuum is beyond the scope of the inflationary model.

The problem of cosmological particle creation in strong gravitational fields, in particular in the vicinity of the cosmological singularity, has been topical for more than thirty years. For the first time this problem was described in [2, 3] and developed in [4, 5, 6, 7].

Until now the consideration of the cosmological creation of particles was restricted only to scalar and spinor fields (though the necessity of including into consideration vector

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Abstract

We list arguments in favour of that the visible matter can be a product of the decay of primordial vector bosons. The effect of the intensive cosmological creation of these primordial vector W , Z bosons from vacuum is studied in the framework of General Relativity and the Standard Model where the relative standard of measurement identifying conformal quantities with the measurable ones is accepted. The relative standard leads to the conformal cosmology with the z -history of masses with the constant temperature, instead of the z -history of the temperature with constant masses in the inflationary cosmology. In the conformal cosmology both the latest SN data and primordial nucleosynthesis are compatible with the stiff state associated with one of the possible states of the infrared gravitation field.

The distribution function of the created bosons in the lowest order of perturbation theory exposes cosmological singularity as a consequence of the theorem about the absence of the massless limit of massive vector fields in quantum theory. This singularity can be removed by taking into account the scattering processes associated with the introduction of the temperature.

The CMB temperature $T = (M_W^2 H_0)^{1/3} \sim 2.7K$ occurs as an integral of the motion in the stiff state. We show that this temperature can be inherited by the CMB radiation as the final product of the decay of primordial bosons.

The effect of anomalous nonconservation of the baryon number due to polarization of the Dirac sea vacuum by these primordial bosons is considered.

1. Introduction

In the inflationary models [1] it is proposed that from the very beginning the universe is a hot fireball of massless particles that undergo a set of phase transitions. However, the origin of particles is an open question as the isotropic evolution of the universe cannot create massless particles [2, 3, 4, 5, 6, 7]. Nowadays, it is evident that the problem of the cosmological creation of matter from vacuum is beyond the scope of the inflationary model.

The problem of cosmological particle creation in strong gravitational fields, in particular in the vicinity of the cosmological singularity, has been topical for more than thirty years. For the first time this problem was described in [2, 3] and developed in [4, 5, 6, 7].

Till now consideration of the cosmological creation of particles was restricted only to scalar and spinor fields (though the necessity of including into consideration vector fields was discussed [4]). It is considered that the number of created particles is obviously not sufficient for the description of primordial element abundance in the early universe [4]. The

problem of a possible origin of the matter in the universe as a result of the cosmological particle creation from vacuum is still under consideration.

The investigation of the cosmological creation of massive vector bosons from vacuum can introduce corrective amendments to the modern model of the isotropic evolution of the universe, since vector bosons detected at the CERN accelerator, are unique particles of the Standard Model (SM) which can exhibit a space singularity.

The matter is that the phenomenon of the cosmological creation in isotropic models is described by the diagonalization of equations of motion. This diagonalization includes a transformation into so-called conformal fields and coordinates. In terms of conformal quantities the metrics is plane, and the spatial scale factor is the scale of all masses, including the Planck mass and masses of particles in the field theories, in particular in SM. For massive particles the cosmological singularity, i.e., disappearance of the spatial scale means disappearance of masses. The massive vector bosons are unique particles of SM which have a mass singularity [8].

The absence of the massless limit of the massive Yang-Mills theory is a well-known fact [9]. It leads, as we shall show below, to an ultra-violet divergence of the number of created longitudinal bosons calculated in the lowest order of perturbation theory.

In the present paper, we consider the cosmological creation of massive vector bosons from vacuum in the conformal flat metrics, used for the description of the models of isotropic evolution of the universe. We investigate various possibilities to explain the origin of a visible matter as a finite product of decay of primary vector bosons, in agreement with the results of the primordial element abundance [10] and the latest Supernova data on the redshift - luminosity-distance relation [11].

We list theoretical and observational arguments in favour of the consideration of created vector bosons as primary particles whose decay products form all visible matter of the universe, including CMBR and galaxies with baryon asymmetry.

The present paper is an attempt to justify this statement, being grounded on the field theory, which unifies SM as the theory of fundamental particles in Riemannian space - time and general relativity (GR) with the relative measurement standard [12, 13]. According to this standard, the extension of the universe assumes the extension of all intervals, including the measurement standards of these intervals. The relative measurement standard means identification of observable quantities with conformal fields and coordinates, which leads to the conformal cosmology [14] of the evolution of masses of the type of Hoyle-Narlikar [15], instead of the standard cosmology of distance evolution. The conformal cosmology [14] describes the present-day stage of accelerated evolution (according to the latest data on Supernova) and the stage of primordial element abundance in the case of the stiff state which specifies the pure gravitational origin of dark energy [16, 17, 18, 19].

In the present paper, we used the holomorphic representation of quantized fields [20, 21] in terms of the creation and annihilation operators considered as field variables (instead of stationary value coefficients, as it was in the previous papers [2] - [7]).

The contents of the paper is the following. The second section is devoted to the description of vector bosons and their cosmological creation. In the third section, the possibilities for substantiation of the CMB temperature in SM are investigated. In the fourth section, the baryon asymmetry of matter in the universe is considered. In the conclusion, the arguments in favour of the Cold Scenario of the evolution of the universe, based on the relative standard of measurement in GR, are given.

2. Vector Bosons in the Isotropic Model of the Universe

2.1. Action

Consider "free" vector massive particles in the homogeneous approximation of GR described by the Friedmann-Robertson-Walker cosmological models. Equations of motion of fields and metrics in the homogeneous approximation can be derived by the variation of the action

$$S_{\text{tot}} = S_{\text{univ}} + S_{\text{v}}, \quad (1)$$

where

$$S_{\text{v}} = \int d^4x \sqrt{-g} \left[-\frac{1}{4} F_{\mu\nu} F^{\mu\nu} - \frac{1}{2} M_v^2 v_\mu v^\mu \right], \quad (2)$$

is the action of "free" vector W^\pm, Z^0 bosons $v_\mu = (\mathbf{v}_0, \mathbf{v}_i)$ with the tension $F_{\mu\nu} = (\partial_\mu v_\nu - \partial_\nu v_\mu)$ in the conformal-flat metric

$$ds^2 = g_{\mu\nu} dx^\mu dx^\nu = a(x^0)^2 \left[(\bar{N}_0(x^0) dx^0)^2 - (dx^i)^2 \right], \quad (3)$$

where $\bar{N}_0(x^0)$ is the lapse function defining the conformal time

$$d\eta = \bar{N}_0(x^0) dx^0; \quad (4)$$

$$S_{\text{univ}} = -V_0 \int_{x_1^0}^{x_2^0} dx^0 \left[\varphi_0^2 \frac{(\partial_0 a)^2}{\bar{N}_0} + \bar{N}_0 \rho_{\text{univ}}(a) \right], \quad (5)$$

is the action that gives the dynamics of the spatial scale factor under the supposition that the space is filled with the homogeneous "substance" with the conformal density $\rho_{\text{univ}}(a)$, to be defined below, V_0 is a constant size of the coordinate space, and

$$\varphi_0^2 = M_{\text{Planck}}^2 \frac{3}{8\pi}.$$

We reiterated calculations of [8] (where the action of vector fields is reduced into solutions of constraint equations, i.e., equations on the time component) for the considered conformal flat metrics (3), and rewrote the action (1) in terms of the physical transverse and longitudinal variables

$$S_{\text{tot}} = \int dx^0 \left\{ V_0 \varphi_0^2 \left[-\frac{(\partial_0 a(x^0))^2}{\bar{N}_0} - \bar{N}_0 \rho_{\text{univ}}(a) \right] + \bar{N}_0 \int_{V_0} d^3x \mathcal{L}_{\text{v}} \right\}, \quad (6)$$

where $\mathcal{L}_{\text{v}} = \mathcal{L}_{\text{v}}^\perp + \mathcal{L}_{\text{v}}^\parallel$,

$$\begin{aligned} \mathcal{L}_{\text{v}}^\perp &= \frac{1}{2} \left[\frac{(\partial_0 \mathbf{v}^\perp)^2}{N_0^2} + (\mathbf{v}^\perp, (\partial^2 - (M_v a(x^0))^2) \mathbf{v}^\perp) \right], \\ \mathcal{L}_{\text{v}}^\parallel &= -\frac{(M_v a(x^0))^2}{2} \left[\left(\frac{\partial_0 \mathbf{v}^\parallel}{N_0}, \frac{1}{\partial^2 - (M_v a(x^0))^2} \frac{\partial_0 \mathbf{v}^\parallel}{N_0} \right) + \mathbf{v}^\parallel{}^2 \right] \end{aligned} \quad (7)$$

are the Lagrangians of transverse and longitudinal bosons, and the brackets (\mathbf{v}, \mathbf{w}) designate a dot product of two vectors.

2.2. Hamiltonian

For definition of the law of evolution of all fields it is convenient to utilize the Hamiltonian form of action (6) in terms of the Fourier-components $\mathbf{v}_k^I = \int_{V_0} d^3x e^{i\mathbf{k}\cdot\mathbf{x}} \mathbf{v}^I(\mathbf{x})$

$$S_{\text{tot}} = \int_{x_1^0}^{x_2^0} dx^0 \left(\sum_k \left(\mathbf{p}_k^\perp \partial_0 \mathbf{v}_k^\perp + \mathbf{p}_k^\parallel \partial_0 \mathbf{v}_k^\parallel \right) - P_a \partial_0 a + \bar{N}_0 \left[\frac{P_a^2}{4V_0 \varphi_0^2} - V_0 \rho_{\text{tot}}(a) \right] \right), \quad (8)$$

where

$$\rho_{\text{tot}}(a) = \rho_{\text{univ}}(a) + \rho_{\text{v}}(a), \quad (9)$$

$$\rho_{\text{v}}(a) = V_0^{-1} (H^\perp + H^\parallel); \quad (10)$$

H^\perp and H^\parallel represent Hamiltonians of free fields for transverse and longitudinal components of vector bosons

$$H^\perp = \sum_{k,\sigma} \frac{1}{2} \left[\mathbf{p}_k^{\perp 2} + \omega^2 \mathbf{v}_k^{\perp 2} \right], \quad (11)$$

$$H^\parallel = \sum_{k,\sigma} \frac{1}{2} \left[\left(\frac{\omega(a,k)}{M_v a} \right)^2 \mathbf{p}_k^{\parallel 2} + (M_v a)^2 \mathbf{v}_k^{\parallel 2} \right],$$

with the dispersion relation in the form $\omega(a, k) = \sqrt{\mathbf{k}^2 + (M_v a)^2}$.

2.3. Evolution of the Universe

The basic equation of the FRW cosmology (i.e., the Einstein equation for the balance of energy densities) is gained by variation of the action (1) with respect to the function \bar{N}_0 .

The variation of the action (1) determines the equations for the scale factor

$$\varphi_0^2 [a'(\eta)]^2 = \rho_{\text{tot}}(a) = \rho_{\text{univ}}(a) + \rho_{\text{v}}(a) \quad (12)$$

and its solution

$$\eta(a_I | a_0) = \varphi_0 \int_{a_I}^{a_0} \frac{da}{\sqrt{\rho_{\text{tot}}(a)}} \quad (13)$$

in terms of the conformal time $d\eta = \bar{N}_0 dx^0$, where $f' = df/d\eta$.

Transition to physical values (time t_{FRW} , distance l_{FRW} , density ρ_{FRW}) of the FRW cosmology is carried out with the help of conformal transformations

$$t_{\text{FRW}} = \int_0^\eta d\bar{\eta} a(\bar{\eta}), \quad (14)$$

$$l_{\text{FRW}} = a(\eta) r, \quad r = \sqrt{x_1^2 + x_2^2 + x_3^2} \quad (15)$$

$$\rho_{\text{FRW}}(a) = \frac{\rho_{\text{tot}}(a)}{a^4} \quad (16)$$

$$T_{\text{FRW}} = \frac{T_{\text{CC}}}{a}. \quad (17)$$

In the terms of the FRW cosmology the equation of evolution takes the conventional form

$$\varphi_0^2 H_{\text{FRW}}^2(t) = \rho_{\text{FRW}}(a), \quad (18)$$

where $H_{FRW}(t) = a^{-1}(t)\dot{a}(t)$ is the Hubble parameter, and $\dot{f} = df/dt$.

Generally, the dependence of the conformal density of the universe ρ_{univ} , filled with the homogeneous substance, on the scale factor $a(\eta)$ in the considered class of models for plane space looks like

$$\rho_{\text{univ}}(a) = \rho_{\text{Stiff}}a^{-2} + \rho_{\text{Rad}} + \rho_{\text{M}}a + \rho_{\Lambda}a^4. \quad (19)$$

Here ρ_{Stiff} describes the isotropic contribution of the stiff state, for which the density is equal to pressure¹; ρ_{Rad} is utilized in the FRW cosmology for the description of the radiation epoch of primordial nucleosynthesis; ρ_{M} is the contribution of both visible and invisible baryon substance; ρ_{Λ} is the contribution vacuum of Higgs scalar fields ρ_{Λ} in the inflationary epoch.

Solution of the equation of evolution of the scale with the initial data $a(t_0) = 1$, $H_{FRW}(t_0) = H_0$ in terms of the world time t for each equation of state looks like

$$\begin{aligned} a_{\text{Stiff}}(t) &= \sqrt[3]{1 + 3H_0(t - t_0)}, \\ a_{\text{Rad}}(t) &= \sqrt{1 + 2H_0(t - t_0)}, \\ a_{\text{M}}(t) &= \left(1 + \frac{2}{3}H_0(t - t_0)\right)^{3/2}, \\ a_{\Lambda}(t) &= e^{H_0(t - t_0)}. \end{aligned} \quad (20)$$

Rewrite these solutions in terms of the conformal time η with the initial data $a(\eta_0) = 1$, $a'(\eta_0) = da/d\eta = H_0$

$$\begin{aligned} a_{\text{Stiff}}(\eta) &= \sqrt{1 + 2H_0(\eta - \eta_0)}, \\ a_{\text{Rad}}(\eta) &= 1 + H_0(\eta - \eta_0), \\ a_{\text{M}}(\eta) &= \left[1 + \frac{1}{2}H_0(\eta - \eta_0)\right]^2, \\ a_{\Lambda}(\eta) &= [1 - H_0(\eta - \eta_0)]^{-1}. \end{aligned} \quad (21)$$

The equations on evolution of the scale coincide with the equations on a collective motion of spatial volume derived in GR [18, 19].

The question arises: what is the reason of evolution of spatial volume (or the scale) of the universe? Till 1981 the predominant opinion was that such a reason is the matter of massive particles $\rho_{\text{M}}(a)$, visible (baryons) and invisible (such as a massive neutrino), which before the recombination epoch ($z+1 = 1100$) existed as radiation with the density $\rho_{\text{Rad}}(a)$. The modern data on primordial nucleosynthesis and the element abundance in the universe convincingly testify to that the baryon matter is $30 \div 20$ times smaller than it is necessary for explanation of the evolution of the scale of the universe.

The small contribution of the baryon matter to the evolution of the scale poses the problem on a source of this evolution in the long epoch of primordial nucleosynthesis (from 10^{-12} up to 10^{11} sec.). Its history testifies to the dependence of the scale on observable time as the square root. In the FRW cosmology this dependence (20) is explained by the dominance of "radiation" with density $\rho_{\text{Rad}}(a)$. If the baryon matter is insufficient for

¹Nonisotropic version of this state with subsequent isotropization [4, 7] was utilized for description of the early universe from 1921 [16] to 1981; see, for example, [4, 7, 17].

evolution of the scale, then all known "radiations" are also insufficient for explanations of the evolution of the scale in the epoch of primordial nucleosynthesis.

The newest data on the dependence of red shift on the distance up to Supernova [11], in the framework of the FRW cosmology, testifies to the dominance of the inflationary state of substance $\rho_\Lambda(a)$. If one explains such a dominance by the "tail" of the epoch of primordial inflation of the early universe, one should also elucidate why there is an epoch with the dominance of "radiation" between two inflationary epoches (the primordial and the present-day) and where one should take so much "radiation" for visible evolution of the scale in this epoch of primordial nucleosynthesis. To answer these questions, we consider a wider supposition [14] that the evolution of the scale of the universe can be determined not only by the theory and initial data, but also by the standard of measurement.

2.4. Standard of measurement

It is worth reminding that the concept of measurable quantities in the field theory is no less important than the equations of the theory².

Suppose that nature selects itself both the theory and standards of measurement, and the aim of observation is to reveal not only initial data, but also these measurement standards. In particular, one of the central concepts of the modern cosmology is the concept of the scale defined as a functional of spatial volume in GR [18, 19]. If expanding volume of the universe means the expansion of "all its lengths", we should specify whether the measurement standard of length expands. Here there are two possibilities: the first, the absolute measurement standard does not expand; and the second, the relative measurement standard expands together with the universe.

Until the present time the first possibility was mainly considered in cosmology. The second possibility means that we have no absolute instruments to measure absolute values in the universe. We can measure only a ratio of values which does not depend on the spatial scale factor. The relative measurement standard transforms the spatial scale of the intervals of lengths into the scale of masses which permanently grow. The spectrum of photons emitted by atoms on far stars two billion years ago remembers a size of an atom which is determined by its mass. This spectrum is compared with spectrum of similar atoms on the Earth whose mass, at the present time, becomes much larger. This change of the mass leads to red shift described by the relative (conformal) cosmology. This means that the observable time is identified with the conformal time, and the square root dependence of the scale factor on the observable (i.e., conformal) time (44) follows from the stiff state.

As it was shown in a recent paper [14], the stiff state in the framework of the conformal cosmology simultaneously describes the present-day stage of accelerated evolution according to the latest data on Supernova. These data together with the primordial nucleosynthesis can be treated as evidence of the relative standard of measurement of the intervals of time and space in GR.

In paper [19], the stiff state in the conformal cosmology was described as a free motion of metrics along a geodesic line in the "field space". The geometry of this "field space" in

²"The most important aspect of any phenomenon from mathematical point of view is that of a measurable quantity. I shall therefore consider electrical phenomena chiefly with a view to their measurement, describing the methods of measurement, and defining the standards on which they depend." (J.C. Maxwell) [23].

General Relativity was obtained by Borisov and Ogievetsky [24] in terms of the Cartan forms [25, 26] as a geometry of the coset of the affine group $A(4)$ over the Lorentz one L . The Cartan method of constructing the nonlinear realization of the affine symmetry [25, 26], in particular the operation of the group summation formulated in [27] - [30], allows us to introduce the concepts of "collective" and "relative" coordinates, and a class of "inertial motions" along "geodesic lines" into the coset $A(4)/L$ (i.e., motions with constant canonical momenta).

Therefore, considering the problem of creation of vector bosons and origin of the matter in the universe, we shall compare both the measurement standards of the evolution.

2.5. The evolution of vector bosons

In the literature [2]-[7], [21], the description of the cosmological creation of particles in the considered class of models includes transforming to conformal fields and coordinates

$$d\bar{s}^2 = \bar{g}_{\mu\nu} dx^\mu dx^\nu = (\bar{N}_0 dx^0)^2 - (dx^i)^2, \quad (22)$$

in terms of which the action for free vector W, Z bosons takes the form

$$S_v = \int d^4x \bar{N}_0 \left[-\frac{1}{4} (\partial_\mu v_\nu - \partial_\nu v_\mu) (\partial_{\mu'} v_{\nu'} - \partial_{\nu'} v_{\mu'}) \bar{g}^{\mu\mu'} \bar{g}^{\nu\nu'} - \frac{1}{2} a^2 M_v^2 v_\mu v_\mu \bar{g}^{\mu\nu} \right], \quad (23)$$

and the scale factor $a(x^0)$ becomes the scale of all masses, including the Planck mass and masses of particles (including vector boson with mass M_v) in field theory.

Further calculations are conveniently carried out in terms of "the running Planck mass" $\varphi(x^0) \equiv \varphi_0 a(x^0)$ with the scale factor

$$M_v a(x^0) = y_v \varphi(x^0), \quad y_v = \frac{M_v}{\varphi_0}. \quad (24)$$

In field theories "particles" are defined as holomorphic field variables

$$\begin{aligned} \mathbf{v}_k^\perp(x^0) &= \sum_\sigma \frac{1}{\sqrt{2V_0\omega(\varphi, k)}} (a_\sigma^{\perp+}(-k, x^0) \mathbf{e}_\sigma^\perp(-k) + a_\sigma^\perp(k, x^0) \mathbf{e}_\sigma^\perp(k)), \\ \mathbf{p}_k^\perp(x^0) &= -i \sum_\sigma \frac{\sqrt{\omega(\varphi, k)}}{\sqrt{2V_0}} (a_\sigma^{\perp+}(-k, x^0) \mathbf{e}_\sigma^\perp(-k) - a_\sigma^\perp(k, x^0) \mathbf{e}_\sigma^\perp(k)), \\ \mathbf{v}_k^\parallel(x^0) &= \frac{\sqrt{\omega(\varphi, k)}}{y_v \varphi \sqrt{2V_0}} (a^{\parallel+}(-k, x^0) + a^\parallel(k, x^0)), \\ \mathbf{p}_k^\parallel(x^0) &= -i \frac{y_v \varphi}{\sqrt{2V_0\omega(\varphi, k)}} (a^{\parallel+}(-k, x^0) - a^\parallel(k, x^0)). \end{aligned} \quad (25)$$

These variables are distinguished, since they diagonalize the field Hamiltonian

$$H^I = \sum_{k, \sigma, I} \omega(\varphi, k) (\hat{N}_{k, \sigma}^I + 1/2),$$

where $\omega(\varphi, k) = \sqrt{k^2 + y_v \varphi^2}$ is the one-particle energy, $\hat{N}^I = a_\sigma^{I+}(-k, x^0) a_\sigma^I(k, x^0)$ is the operator of the number of particles with the spin σ and $I = \parallel, \perp$. This definition of

particles, by virtue of the dependence of mass on time, leads to nongiaogonal terms in the canonical differential form, as sources of the cosmological creation of particles

$$\left[\sum_{\varsigma} p_{\varsigma}^I \partial_0 v_{\varsigma}^I \right] = \sum_{\sigma, k} \frac{\imath}{2} \left[a_{\sigma}^{I+}(k, x^0) \partial_0 a_{\sigma}^I(-k, x^0) - a_{\sigma}^I(k, x^0) \partial_0 a_{\sigma}^{I+} \right] - \sum_{\sigma, k} \frac{\imath}{2} \left[a_{\sigma}^{I+}(k, x^0) a_{\sigma}^{I+}(-k, x^0) - a_{\sigma}^I(k, x^0) a_{\sigma}^I(-k, x^0) \right] \partial_0 \Delta_k^I(\varphi),$$

where ς is the index including momentum k and spin σ of vector bosons,

$$\Delta_v^{\perp}(\varphi) = \frac{1}{2} \ln \left(\frac{\omega_v}{\omega_I} \right),$$

$$\Delta_v^{\parallel}(\varphi) = \ln \left(\frac{\varphi}{\varphi_I} \right) - \frac{1}{2} \ln \left(\frac{\omega_v}{\omega_I} \right),$$

and φ_I and ω_I are cosmic initial data. The classical equations in terms of "particles" can be written as

$$i \frac{d}{d\eta} \chi_{a_{\varsigma}} = -\hat{H}_{a_{\varsigma}} \chi_{a_{\varsigma}}. \quad (26)$$

where

$$\bar{\chi}_{a_{\varsigma}} = (a_{\varsigma}, -a_{\varsigma}^+); \quad \chi_{a_{\varsigma}} = \begin{pmatrix} a_{\varsigma}^+ \\ a_{\varsigma} \end{pmatrix}; \quad \hat{H}_{a_{\varsigma}} = \begin{vmatrix} \omega_{a_{\varsigma}} & , & -i\Delta_{\varsigma} \\ -i\Delta_{\varsigma} & , & -\omega_{a_{\varsigma}} \end{vmatrix}. \quad (27)$$

After the Bogoliubov transformations

$$\begin{aligned} b_{\varsigma}^+ &= \alpha_{\varsigma}^* a_{\varsigma}^+ + \beta_{\varsigma}^* a_{\varsigma} \\ b_{\varsigma} &= \alpha_{\varsigma} a_{\varsigma} + \beta_{\varsigma} a_{\varsigma}^+ \end{aligned} \quad (28)$$

written briefly as

$$\chi_b = \hat{O} \chi_a; \quad \hat{O} = \begin{pmatrix} \alpha^* & \beta^* \\ \beta & \alpha \end{pmatrix}; \quad \hat{O}^{-1} = \begin{pmatrix} \alpha & -\beta^* \\ -\beta & \alpha^* \end{pmatrix}; \quad (29)$$

this equation becomes

$$i \frac{d}{d\eta} \chi_b = [-i \hat{O}^{-1} \frac{d}{d\eta} \hat{O} - \hat{O}^{-1} \hat{H}_a \hat{O}] \chi_b \equiv -\hat{H}_b \chi_b. \quad (30)$$

Let us require \hat{H}_b to be diagonal

$$\hat{H}_b = \begin{pmatrix} \omega_b & , & 0 \\ 0 & , & -\omega_b \end{pmatrix}. \quad (31)$$

This means that α and β satisfy the equations

$$\omega_b = (|\alpha|^2 + |\beta|^2) \omega_a - i(\beta^* \alpha - \beta \alpha^*) \Delta - i(\beta^* \partial_T \beta - \alpha \partial_T \alpha^*), \quad (32)$$

$$0 = 2\beta \alpha \omega_a - i(\alpha^2 - \beta^2) \Delta - i(\alpha \partial_T \beta - \beta \partial_T \alpha). \quad (33)$$

For

$$\alpha = \cosh(r)e^{i\theta} ; \quad \beta = i \sinh(r)e^{-i\theta} \quad (34)$$

these equations convert into the equations for the coefficients of the Bogoliubov transformation as conditions of diagonalization [21]

$$\begin{aligned} [\omega_\zeta - \theta'_\zeta] \sinh(2r_\zeta) &= \Delta'_\zeta \cos(2\theta_\zeta) \cosh(2r_\zeta) , \\ r'_\zeta &= -\Delta'_\zeta \sin(2\theta_\zeta) . \end{aligned} \quad (35)$$

These coefficients determine the number of particles

$$\mathcal{N}'_\zeta(\eta) = {}_{\text{sq}}\langle 0 | \hat{N}'_\zeta | 0 \rangle_{\text{sq}} = \sinh^2 r_\zeta(\eta) \quad (36)$$

created during the time η from "squeezed" vacuum defined as

$$b_\zeta | 0 \rangle_{\text{sq}} = 0 .$$

The density of created particles is

$$\rho_v = \sum_\zeta \omega_\zeta(\varphi) {}_{\text{sq}}\langle (0 | \hat{N}'_\zeta | 0)_{\text{sq}} + 1/2 \rangle . \quad (37)$$

Further, we restrict ourselves to the cases when the back reaction of this density on the evolution of the universe can be neglected.

2.6. Initial data

To find initial data for the Bogoliubov equation (35), we make a change of variables $(r_\zeta, \theta_\zeta \rightarrow C_\zeta, \mathcal{N}'_\zeta)$

$$\begin{aligned} \cos(2\theta_\zeta) \sinh(2r_\zeta) &= C_\zeta , \\ \sinh(2r_\zeta) &= \sqrt{\mathcal{N}'_\zeta(\mathcal{N}'_\zeta + 1)} . \end{aligned} \quad (38)$$

Then, equations (35) become

$$\begin{aligned} \mathcal{N}'_\zeta &= \left(\frac{\Delta'_\zeta}{2\omega_\zeta} \right) C'_\zeta , \\ \mathcal{N}'_\zeta &= -\Delta'_\zeta \sqrt{4\mathcal{N}'_\zeta(\mathcal{N}'_\zeta + 1) - C'^2_\zeta} . \end{aligned} \quad (39)$$

From equations (39) it follows that *vacuum* initial states $\mathcal{N}'_\zeta(\eta = 0) = 0$ correspond to the value $C'_\zeta(\eta = 0) = 0$. This gives the following initial values of the coefficients r and θ

$$r_\zeta(\eta = 0) = 0, \quad \theta_\zeta(\eta = 0) = \frac{\pi}{4} . \quad (40)$$

2.7. The distribution function

Let us consider an example of the solution of the obtained set of equations for the stiff state $\rho = \rho_{\text{stiff}}$ neglecting the back reaction of the density of created bosons on the evolution of the universe.

In this case, the Bogoliubov equations (35), rewritten in the dimensionless variables

$$\tau = \eta 2H_I = \eta/\eta_I, \quad x = \frac{q}{M_I} \quad (41)$$

and initial data $M_I = M_v(\eta = 0)$, $H_I = H(\eta = 0)$ with taking into account the dispersion relation $\omega_v = H_I \gamma_v \sqrt{1 + \tau + x^2}$, where

$$\gamma_v = \frac{M_I}{H_I}, \quad (42)$$

take the form

$$\begin{aligned} \left[\frac{\gamma_v}{2} \sqrt{(1+\tau) + x^2} - \frac{d\theta_v^{\parallel}}{d\tau} \right] \tanh(2r_v^{\parallel}) &= \frac{1}{4} \left[\frac{2}{(1+\tau)} - \frac{1}{[(1+\tau) + x^2]} \right] \cos(2\theta_v^{\parallel}), \\ \frac{d}{d\tau} r_v^{\parallel} &= -\frac{1}{2} \left[\frac{1}{(1+\tau)} - \frac{1}{2[(1+\tau) + x^2]} \right] \sin(2\theta_v^{\parallel}), \\ \left[\frac{\gamma_v}{2} \sqrt{(1+\tau) + x^2} - \frac{d}{d\tau} \theta_v^{\perp} \right] \tanh(2r_v^{\perp}) &= \frac{1}{4} \left[\frac{1}{(1+\tau) + x^2} \right] \cos(2\theta_v^{\perp}), \\ \frac{d}{d\tau} r_v^{\perp} &= -\frac{1}{4} \left[\frac{1}{(1+\tau) + x^2} \right] \sin(2\theta_v^{\perp}). \end{aligned}$$

These equations were solved numerically at positive values of momentum $x = q/M_I$, by utilizing the asymptotics of the solutions $r(\tau) \rightarrow \text{const} \cdot \tau$, $\theta(\tau) = \pi/4 + O(\tau)$ from the neighborhood $\tau = 0$. The distribution functions of the longitudinal $\mathcal{N}^{\parallel}(x, \tau)$ and transverse $\mathcal{N}^{\perp}(x, \tau)$ vector bosons for the initial data $H_I = M_I$, $\gamma_v = 1$, are introduced in Fig. 1.

The choice of these initial data is determined by the lower boundary for a boson mass from the area of its initial values allowed by the uncertainty principle $\delta E \eta_I \geq \hbar$ for energy variations of energy $\delta E = 2M_I$ at creation of a pair of bosons in the universe with minimum lifetime for a considered case $\eta_I = 1/2H_I$.

From Fig. 1. one can see that a longitudinal component of the distribution function is essentially larger than the transverse one, which demonstrates a more intensive cosmological creation of longitudinal bosons in contrast with transverse ones. The sluggish decrease with momentum of longitudinal components is explained by mass singularity of a distribution function of longitudinal vector bosons [8, 9]. One of the consequences of such a decrease is the divergence of the density of created particles [3]

$$n_v(\eta) = \frac{1}{2\pi^2} \int_0^{\infty} dq q^2 \left[\mathcal{N}^{\parallel}(q, \eta) + 2\mathcal{N}^{\perp}(q, \eta) \right] \rightarrow \infty. \quad (43)$$

It is possible to test that the divergence takes place for any equation of state. That is the shortage of the lowest order of perturbation theory, where one neglects interactions of

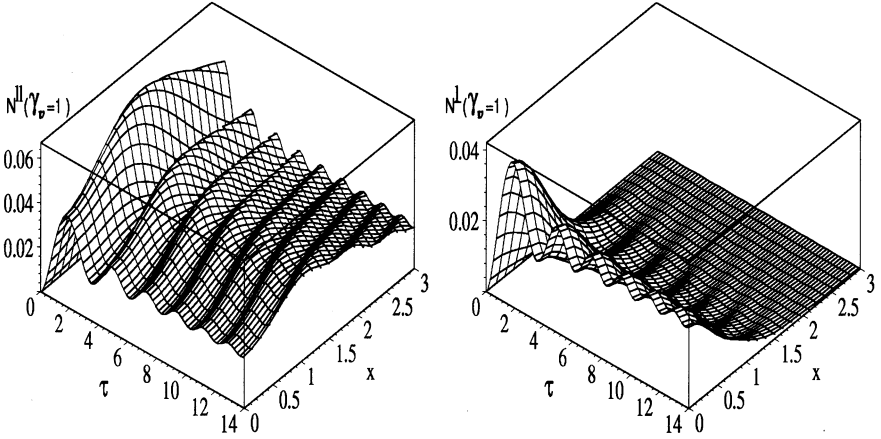


Figure 1: Dependence of longitudinal N^{\parallel} and transverse N^{\perp} components of the distribution function of vector bosons from dimensionless time $\tau = 2H_I\eta$ and dimensionless momentum $x = q/M_I$ at value of the initial data $M_I = H_I$ ($\gamma_v = 1$).

vector bosons, including the scattering processes forming an integral of collisions in the kinetic equation for distribution functions.

The divergence of the integral over momentum and the mass singularity give a possibility of explaining the genesis of the matter in the universe and its temperature by cosmological creation of particles from vacuum. Let us remind that the problem of genesis of the primordial particles is not considered in the inflationary model of the universe. This model is based on the conjectures

- 1) nonzero vacuum density of a scalar Higgs field ,
- 2) nonzero initial data for numbers of all particles considered as massless ones,
- 3) dependence of a homogeneous scalar field on temperature, the reason of forming of which is obscure,
- 4) the concept of temperature in a strongly nonequilibrium regime of the inflationary expansion.

According to the standard cosmological model of the expanding hot universe, the existence of the temperature of matter removes the divergence of the integral over momenta by the corresponding Boltzmann factor. In this case, at a value of temperature of about boson mass, the universe at the stage of the radiation dominance is capable of creating so many bosons with the density of about T^3 , that they can explain the very stage of radiation dominance, if the radiation is considered as the final product of decays of primordial bosons. Let us remind that the radiation dominance in the standard cosmological model is the condition for the element abundance and the chemical evolution of the matter. This result poses the following problems: What was in the expanding universe before creation of vector bosons? Is it possible to explain all observed matter (with CMB radiation and

baryon-asymmetric matter) by its cosmological creation from vacuum at the radiation dominance stage?

The latest data on the dependence of the redshift - distance-relation on distance to Supernova [11] testifying to the dominance in the universe of the unobservable dark energy (called Quintessence [22]) have posed the problem of explanation, in the Hot Universe Scenario, of the appearance of a pure radiation stage between two inflationary stages - rapid (primordial) and sluggish *Quintessence*, both have no a bearing on the observed matter? Why does the inflationary stage appear again after the radiation epoch as it follows from the latest Supernova data [11]? All these problems have not yet found a satisfactory explanation within the framework of the inflationary model and the Hot Universe Scenario.

3. The temperature of CMB Radiation

3.1. The relative standard of measurement of intervals

For solution of the problem of the genesis of the matter in the universe in the context of the obtained effect of intensive creation of vector bosons we consider the Cold Universe Scenario based on the relative measurement standard in GR.

The fixed fact of the primordial nucleosynthesis [10] testifies only to that the scale factor is proportional to the square root of the observed time

$$a^2(\eta) = a_I^2(1 + 2H_I\eta) = (1 + 2H_0(\eta - \eta_0)), \quad (44)$$

where a_I and H_I are primordial values of the cosmological scale and the Hubble parameter, and $a_0 = 1$, H_0 are their present-day values connected with the first by the integral of motion

$$a_I^2 H_I = a^2(\eta) H(\eta) = H_0. \quad (45)$$

If we identify the observed time with the conformal one, then the proportionality of the scale factor to the square root of the observed (i.e., conformal) time (44) follows from the stiff state where the density of energy is equal to that of pressure. As it has been shown in a recent paper [14], the stiff state is compatible with the latest Supernova data on the accelerating universe evolution [11]. Moreover, the conformal version of the stiff state reproduces the z-history of the chemical evolution of the element abundance in the FRW cosmology, since we have, in the conformal cosmology, the same square root dependence of the scale factor on the observable time in the stiff stage. Therefore, we can utilize the rigid equation of state for estimation of temperature of the CMB radiation as a final product of the decays of primordial vector bosons.

The primordial value H_I of the Hubble parameter sets a natural unit of time $\eta_I = 1/2H_I$ as a minimal lifetime of the universe. As it follows from the uncertainty principle for energy $\delta E \eta \geq \hbar$, a characteristic time of all physical processes with variation of energy δE is less than this lifetime $\eta_I = 1/2H_I$. We can speak about the cosmological creation of a pair of massive particles in the universe, when the particle mass $M_v(\eta = 0) = M_I$ is larger than the primordial Hubble parameter $M_I \geq H_I$. Therefore, it is worth introducing a ratio of the initial data $M_I/H_I = \gamma_v \geq 1$ (41).

3.2. The estimation of the temperature of the CMB Radiation

To remove the divergence in the integral (43) and estimate the temperature of the CMB radiation, we multiply the distribution function of the primordial bosons $\mathcal{N}^{\parallel}(q, \eta)$ and $\mathcal{N}^{\perp}(q, \eta)$ by the Bose-Einstein distribution function (with the Boltzmann constant $k_B = 1$)

$$\mathcal{F}(T, q, M_v(\eta), \eta) = \left\{ \exp \left[\frac{\omega_v(\eta) - M_v(\eta)}{T} \right] - 1 \right\}^{-1}, \quad (46)$$

where T represents the cutoff parameter. In this case, the expression for density (43) takes the form

$$n_v(T, \eta) = \frac{1}{2\pi^2} \int_0^{\infty} dq q^2 \mathcal{F}(T, q, M(\eta), \eta) \left[\mathcal{N}^{\parallel}(q, \eta) + 2\mathcal{N}^{\perp}(q, \eta) \right]. \quad (47)$$

Let us propose that a characteristic duration of all processes in the universe should not exceed the minimal lifetime of the universe, we can estimate values of integrals (47) under the condition that initial data for the temperature inherits the initial data for the Hubble parameter

$$T = M_I = H_I. \quad (48)$$

In this conjecture the temperature as a constant of the conformal cosmology is the single integral of the stiff state (45)

$$T = [M_I^2 H_I]^{1/3} = [M^2(0) H_0]^{1/3} = 2.76 \text{ K}, \quad (49)$$

where $M(0)$ coincides with the present-day value of the mass of the vector boson M_W .

Now we show that such a coincidence with the CMB temperature is not accidental. Calculations demonstrate rapid determination of the density of vector bosons (47) (during the time $\eta_I = 1/2H_I$) in an equilibrium state where the weak dependence of the density on time is observed.

The dominating contribution of large momenta to the integral (47) (see Fig.1.) means the relativistic dependence of the density on temperature

$$n_v = CT^3.$$

The numerical calculation of the integral (47) gives for the constant C the following value:

$$C = \frac{n_v}{T^3} = \frac{1}{2\pi^2} \left\{ [1.877]^{\parallel} + 2[0.277]^{\perp} = 2.432 \right\}, \quad (50)$$

where the contributions of longitudinal and transverse bosons are indicated by the subscripts (\parallel, \perp).

The thermal equilibrium is formed, if the relaxation time of the process of establishment of temperature of vector bosons

$$\eta_{\text{relax.}} = \frac{1}{n(T^3)\sigma_{\text{scat.}}} \leq \frac{1}{2H_I} \quad (51)$$

is less than the time for creating vector bosons. Fig. 1 shows us that the latter is the order of lifetime of the Universe $\eta_I = 1/2H_I$. The condition (51) is fulfilled for

$$\sigma_{\text{scat.}} = \gamma_{\text{scat.}}/M_I^2, \quad (52)$$

if $C\gamma_{\text{scat}} > 2$.

On the other hand, it is possible to estimate the lifetime of the created bosons in the early universe in dimensionless unities $\tau_L = \eta_L/\eta_I$, where $\eta_I = (2H_I)^{-1}$, by utilizing an equation of state $a^2(\eta) = a_I^2(1 + \tau_L)$ and define the lifetime of W -bosons in the Standard Model

$$1 + \tau_L = \frac{2H_I \sin^2 \theta_{\alpha_{\text{QED}}W}}{M_W(\eta_L)} = \frac{\sin^2 \theta_W}{\alpha_{\text{QED}}\gamma_v\sqrt{1 + \tau_L}}, \quad (53)$$

where θ_W is the Weinberg angle, $\alpha_{\text{QED}} = 1/137$.

The solution of equation (53)

$$\tau_L + 1 = \left(\frac{2 \sin^2 \theta_W}{\gamma_v \alpha_{\text{QED}}} \right)^{2/3} \simeq \frac{16}{\gamma_v^{2/3}} \quad (54)$$

gives an estimation of the lifetime of the created bosons for $\gamma_v = 1$

$$\tau_L = \frac{\eta_L}{\eta_I} \simeq \frac{16}{\gamma_v^{2/3}} - 1 = 15, \quad (55)$$

which is 15 times larger than the relaxation time.

Therefore, the relaxation time is much less than the lifetime of vector bosons, and we can introduce the concept of the temperature of vector bosons, which is inherited by final products of their decays, i.e. gamma-quanta, forming, according to the modern point of view, the CMB radiation in the universe. It is easy to show that the temperature of photons $n_\gamma \simeq n_v$ coincides with the constant temperature of the primordial bosons $T \simeq 2.76K$.

Really, if one photon goes from annihilation of products of the decay of W^\pm bosons, and another photon - of Z bosons, we get the density of photons with a constant temperature

$$\frac{n_\gamma}{T^3} = \frac{1}{\pi^2} \{2.432\}. \quad (56)$$

This temperature is of an order of the temperature of the CMB radiation $T = T_{\text{CMB}} = 2.73 K$.

The temperature of photon radiation, which appears after annihilation and decays of W^\pm and Z bosons in the conformal cosmology, is invariant and the simple estimation fulfilled above gives the value surprisingly close to the observed temperature of the CMB radiation which is determined in the conformal cosmology as a fundamental constant - the integral of the stiff state (49).

3.3. The back reaction of created particles on the evolution of the Universe

The equation of motion $\varphi'^2(\eta) = \rho_{\text{tot}}(\eta)$ with the Hubble parameter defined as $H = \varphi'/\varphi$ means that the energy density of the universe at any moment is equal to the so-called critical density

$$\rho_{\text{tot}}(\eta) = H^2(\eta)\varphi^2(\eta) \equiv \rho_{\text{cr.}}(\eta).$$

The permanent dominance of the matter with the stiff state means the existence of the integral of motion

$$H(\eta)\varphi^2(\eta) = H_0\varphi_0^2.$$

Now find a ratio of the density of the created matter $\rho_v(\eta_I) \sim T^4 \sim H_I^4 \sim M_I^4$ to the density of the primordial cosmological motion of the universe $\rho_{cr.}(\eta) = H_I^2 \varphi_I^2$. This ratio has an extremely small number

$$\frac{\rho_v(\eta_I)}{\rho_{cr.}(\eta_I)} = \frac{M_I^2}{\varphi_I^2} = \frac{M_W^2}{\varphi_0^2} = y_v^2 = 10^{-34}.$$

Therefore the back reaction of created particles on the evolution of the universe is a negligible quantity. For the lifetime of the universe the primordial density of the cosmological motion $\rho_{tot}(\eta) = H_I^2 \varphi_I^4 / \varphi^2(\eta) \equiv H_0^2 \varphi_0^4 / \varphi^2(\eta)$ decreases by 10^{29} times, and in the present-day epoch the critical density $\rho_{cr0} \equiv H_0^2 \varphi_0^2 = 10^{-29} \rho_{crI}$ is $20 \div 30$ times greater than the density of the observed baryon matter.

4. Baryon Asymmetry of Matter in the Universe

The baryon asymmetry of the matter in the universe can be formed by polarization of the Dirac sea vacuum by fundamental bosons during their life.

Interaction of the primordial W and Z bosons with the left-hand fermions leads to non-conservation of fermion quantum numbers. It is known that the gauge-invariant current of each doublet is saved only at a classic level [31].

At a quantum level, we have an abnormal current $j_L^{(i)} = \psi_L^{(i)} \gamma_\mu \psi_L^{(i)}$,

$$\partial_\mu j_L^{(i)} = -\frac{\text{Tr} F_{\mu\nu}^* F_{\mu\nu}}{16\pi^2}, \quad F_{\mu\nu} = -\frac{ig\tau_a}{2} F_{\mu\nu}^a \text{ (p.t.)}, \quad F_{\mu\nu}^a \text{ (p.t.)} = \partial_\mu v_\nu^a - \partial_\nu v_\mu^a.$$

During their lifetime, the vector bosons polarize the Dirac sea of the left-hand fermions with negative energy. The number of the left-hand fermions $N(\eta_L)$ is determined by the expectation value of the Chern-Simons functional from the Bogoliubov vacuum [31]

$$N(\eta_L) = -\int_0^{\eta_L} d\eta \int \frac{d^3x}{16\pi^2} \text{sq} \langle 0 | \text{Tr} F_{\mu\nu}^* F_{\mu\nu} | 0 \rangle_{\text{sq}},$$

where $\tau_L = \eta_L / \eta_I$ is the lifetime of bosons. During their lifetime, transverse vector bosons are evolving so that the Chern-Simons functional is changed. If we take the integral over four-dimensional conformal space-time confined between three-dimensional hyperplanes $\eta = 0$ and $\eta = \eta_L$, we find that the number of left fermions $N(\eta_L)$ is equal to the Chern-Simons functional

$$\Delta N_W = \frac{4\alpha_{\text{QED}}}{\sin^2 \theta_W} \int_0^{\eta_W} d\eta \int \frac{d^3x}{4\pi} \text{sq} \langle 0 | E_i^W B_i^W | 0 \rangle_{\text{sq}}, \quad (57)$$

where E_i and B_i are the electric and magnetic fields strengths. The squeezed vacuum and Bogoliubov transformations (28) give a nonzero value for these quantities

$$\int \frac{d^3x}{4\pi} \text{sq} \langle 0 | E_i^v B_i^v | 0 \rangle_{\text{sq}} = -\frac{V_0}{2} \int_0^\infty dk |k|^3 \cos(2\theta_C) \sinh(2r_C), \quad (58)$$

where θ_c and τ_c are given by equation (35) for transverse bosons. Using the relation

$$\Delta N_Z = \frac{\alpha_{\text{QED}}}{\sin^2 \theta_W \cos^2 \theta_W} \int_0^{\eta^z} d\eta \int \frac{d^3 x}{4\pi} \text{sq} \langle 0 | E_i^Z B_i^Z | 0 \rangle_{\text{sq}}, \quad (59)$$

we find the Chern-Simons functional for Z bosons in a similar way.

If we take into account the numerical evaluation of the integral (58), in the conjecture that the lifetime of bosons is $\tau_L^W = 15$, $\tau_L^Z = 30$, we estimate the magnitude of the nonconservation of the fermion number

$$\begin{aligned} \Delta F &= \frac{(\Delta N_W + \Delta N_Z)}{V_0} \\ &= \frac{\alpha_{\text{QED}}}{\sin^2 \theta_W} \left(\frac{T^3 2.402}{\pi^2} \right) \left(4 \times 1.44 + \frac{2.41}{\cos^2 \theta_W} \right) \left(\frac{\pi^2}{2.402} \right) = 1.2 n_\gamma, \end{aligned} \quad (60)$$

where n_γ is the density of the number of the CMB photons(56). The baryon asymmetry appears as a consequence of three Sakharov conditions [31]: the CP-nonconservation, the evolution of the universe $H_0 \neq 0$ and the violation of the baryon number

$$\Delta B = X_{\text{CP}} \frac{\Delta F}{3} = 0.4 X_{\text{CP}} n_\gamma,$$

where X_{CP} is a factor determined by a superweak interaction of d and s -quarks ($d + s \rightarrow s + d$) with the CP-violation experimentally observed in decays of K mesons [32]. From a ratio of the number of baryons to the number of photons it is possible to make an estimation of magnitudes of a constant of a weak coupling $X_{\text{CP}} \sim 10^{-8}$.

5. Conclusion

The main result of the paper is the description of the effect of the intensive creation of longitudinal vector bosons from vacuum with the divergent integral for the density of the number of created particles in the lowest order of perturbation theory. The divergence of the integral is a corollary that the massless limit of the massive vector theory does not exist (as it was revealed as far back as early papers by Ogievetsky, Polubarinov as well as Faddeev and Slavnov). The back reaction of created particles on the evolution of the universe is a negligible quantity.

We have considered this effect, comparing two possible measurement standards: the absolute (not extending together with the universe) and the relative (extending together with the universe), appropriate to the Friedmann-Robertson-Walker cosmology and the conformal cosmology. These standards are connected by the conformal transformations.

In the case of the Friedmann-Robertson-Walker cosmology of the expanding hot universe the primordial temperature cuts the divergent integral by the Boltzmann factor.

At the value of the temperature about the mass of bosons, the universe at the stage of the radiation dominance is able of creating many bosons with the density of the order of T^3 . The question arises: how many bosons are necessary for an explanation of the very stage of the radiation dominance, if one considers the radiation as the final product of the decay of primordial bosons.

This result poses problems which up till now have no answer in the FRW cosmology. What is the origin of the primordial temperature? Is it possible to introduce the concept of temperature into a strongly nonequilibrium stage of the inflationary expansion? What was in the universe before the creation of vector bosons? Is it possible to explain all visible matter (with relict radiation and baryon-asymmetry) by its cosmological creation from vacuum? Why should the radiation-dominant stage in the Hot Universe Scenario again transfer into the inflationary stage, as it follows from the latest Supernova data [11]? Is it possible, in principle, to explain the appearance of the stage of an only radiation matter between two inflationary stages in the Hot Universe Scenario: fast (relict) and sluggish (Quintessence), both having no relationship to the visible matter of the Universe?

We have tried here, within the framework of the Standard Model and General Relativity, to answer these questions using the relative measurement standard [12] and the conformal cosmology [14]. The stiff state in the framework of the conformal cosmology describes simultaneously all stages of the evolution of the universe: the present-day stage of the accelerating evolution (in the agreement with the latest data on Supernova), the stage of primordial element abundance in the universe, and the stage of creation from geometrical vacuum of primordial particles most singular in masses (in the Standard Model the only candidate for a role of such primary particles is longitudinal vector bosons W, Z). We have shown that the temperature of the CMB radiation arises as an integral of cosmic motion of the universe, which determines the initial data for the Hubble constant ($H_I \sim 2.7K$) and the running Planck mass ($\varphi_I \sim 10Tv$).

During their lifetime vector bosons polarize the Dirac sea of left fermions with negative energy. The baryon asymmetry arises owing to three Sakharov conditions: the CP - nonconservation, the evolution of the universe and the violation of the baryon number. From the ratio of the number of baryons to the number of photons it is possible to make an estimation of the value of the constant of a weak interaction.

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