Astrophysical Data and Conformal Unified Theory

V.N. Pervushin
Bogoliubov Laboratory of Theoretical Physics,
Joint Institute for Nuclear Research, 141980 Dubna, Russia
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Abstract

Astrophysical data reformulated in the units of the relative Paris meter and running Planck mass are used for restoration of a conformal version of the unified theory where the absolute Planck mass belongs to ordinary initial data (like the absolute Ptolemaeus position of the earth belongs to the initial data of Newton’s mechanics). In the conformal unified theory, both the latest data on the Supernova luminosity-distance – redshift relation and primordial nucleosynthesis are described by a free primordial motion of the scalar homogeneous field (Scalar Quintessence). This primordial cosmic evolution leads to intensive cosmological creation of vector bosons forming the baryon asymmetry of the universe (during their lifetime) and the CMB radiation as a final product of their decays. There are values of the initial data that give the CMB temperature (as an integral of the primordial motion) and the energy density budget in agreement with observational data.

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1 Introduction

The latest astrophysical data on the Supernova redshift – distance relation\cite{1, 2}, primordial nucleosynthesis, Cosmic Microwave Background radiation \cite{3}, and baryon asymmetry are treated by some specialists as a revolution in physical cosmology \cite{4}.

We try to show how these new and old facts of observational cosmology help us to restore the unified theory and to describe creation of the universe, time, and matter in agreement with these facts.

2 Astrophysical Data and Scenarios

2.1 Facts

We restrict ourselves to the following facts of these observations and measurements.

1. The data on the so-called distance – redshift relationship testifying to that the farther cosmic objects, the more redshift \cite{1, 2, 5}

\[
  z_{\text{cosmic}}(\text{coordinate}_c) + 1 = \frac{E_0}{E_{\text{cosmic}}(\text{coordinate}_c)}
\]

(1)

of spectral lines \(E_{\text{cosmic}}(\text{coordinate}_c)\) of atoms on these cosmic objects at the coordinate distance \((r_c = \text{coordinate}_c)\) in comparison with the present-day spectral \(E_0\) lines of the Earth atoms.

2. The data including primordial nucleosynthesis (PN) and the chemical evolution of the matter in the universe (described in the nice book by Weinberg \cite{6}) testifying to the definite dynamics of redshift in terms of measurable time

\[
  [z_{\text{cosmic}} + 1]^{-1}|_{(\text{PN})} \simeq \sqrt{(\text{measurable time})}
\]

(2)

that corresponds to a definite equation of state of matter in the universe. This equation helps us to determine a kind of matter taking part in the cosmic evolution of the redshift.

3. The data on the visible number of particles (baryons, photons, neutrinos, etc.) testifying to that visible baryon matter gives only the 0.03 part

\[
  \Omega_b = \frac{\rho_b}{\rho_{cr}} = 0.03
\]

(3)

of the critical density \(\rho_{cr}\) of the observational cosmic evolution \cite{7}.

4. The data on the Cosmic Microwave Background radiation with the temperature 2.7K and its fluctuations \cite{3}.

5. The data on the baryon asymmetry testifying to that the number of baryons is \(10^{-9}\) times less than the number of photons \cite{8}.

2.2 Scenarios of the Friedmann-Robertson-Walker Cosmology

The first scenario (1920-1980) describing observational data was based on Einstein’s general relativity (GR)

\[
  \text{GR}[\varphi_0|g] = - \int d^4x \sqrt{-g} \frac{\varphi_0^2}{6} R(g)
\]

(4)

with the Newton constant \(\varphi_0^2/6 = 1/G\) and the measurable interval

\[
  (ds^2) = g_{\mu\nu} dx^\mu dx^\nu.
\]

(5)
The standard cosmological model [5] appeared in the homogeneous approximation of the metrics
\[
    ds^2 = (dt)^2 - a^2(t)(dx^i)^2
\]
and began with the anisotropic rigid Casner state [9]. Then radiation appeared in the form of relativistic massive particles. When temperature became lower, these particles converted into the massive dust matter.

After 1980, this scenario (anisotropic rigid – radiation – dust matter) was changed by the scenario of Inflationary Cosmology [10] (inflation – radiation – dust matter) where the first state of evolution of the universe is considered in the form of the law of inflation with a constant \( C_I \)
\[
    [z_{\text{cosmic}} + 1]^{-1}(\text{Beginning}) \simeq \exp[C_I \times t]
\]
to solve some theoretical problems of the old scenario in the way compatible with the Standard Model (SM) of elementary particles [11] identified with excitations of a set of fields \( f \):
\[
    \text{SM} \ [M_{\text{Higgs}}]f \equiv \text{SM} \ [y_h \varphi_0]f.
\]
All masses of elementary particles are scaled by the Higgs mass expressed in the units of the Planck mass as the absolute parameter of general relativity (4) in the quantum relativistic region
\[
    M_{\text{Planck}} = \varphi_0 \sqrt{8\pi \hbar c/3} = 2.177 \times 10^{-8}\text{kg},
\]
as \( M_{\text{Higgs}} = y_h \varphi_0, \ y_h \sim 10^{-17} \).

Beginning in 1998, the new data were firstly obtained [1, 2] which made all these scenarios change. To describe these data in the framework of the Inflationary Cosmology with the absolute Paris meter and Planck mass, one needs to suppose that the 0.7 part of the energy density of the universe is in the inflationary state with another very small constant \( C_0 << C_I \) and 0.3 part is in the state of a dust matter (called the Cold Dark Matter). The problem appears: how to explain the origin of all these states (the primordial inflationary one, radiation, and the present-day inflationary state mixing with the Cold Dark Matter) and their interchanges, and to calculate their energy densities including the baryon density (3) using the parameters of the the unified theory (UT) of all interactions in the Riemannian space-time
\[
    UT[\varphi_0|F] = \text{GR}[\varphi_0|g] + \text{SM}[y_h \varphi_0|F = g, f]
\]
and the initial data.

2.3 Scenarios of the Conformal Cosmology

To solve this problem, we consider a wider supposition [12, 13, 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.

It is worth reminding that the concept of measurable quantities in the field theory is no less important than the equations of the theory.\(^1\)

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

\(^1\)"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) [15].
as the spatial volume in GR [16]. 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

\[
\text{Absolute Paris Meter} = 1 \text{m.} \quad (11)
\]

does not expand; and the second, the relative measurement standard

\[
\text{Relative Paris Meter} = 1 \text{m} \times a(t). \quad (12)
\]

expands together with the universe and means that the observable time is identified with the conformal time

\[
d\eta = \frac{dt}{a(t)}. \quad (13)
\]

Until the present time the first possibility was mainly considered in physical 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 all masses

\[
m_c(\eta) = m_f \times a(t) \quad (14)
\]

including the Planck one

\[
\varphi(\eta) = \varphi_0 \times a(t) \quad (15)
\]

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 conformal cosmology defined as the standard cosmology expressed in terms of the conformal quantities [12, 13, 14, 17]. The common point for two cosmologies is the identification of the evolution of the universe with the evolution of the same cosmic factor. In the standard cosmology the cosmic factor scales all distances besides the Paris meter (11). In the conformal cosmology the cosmic factor scales all masses (14) including the Planck mass (15). As it was shown in a recent paper [13], the recent experimental data for distant supernovae [1, 2], in the case of the relative Paris meridian (12) correspond to the cosmic evolution (see Fig.1)

\[
[z_{\text{cosmic}} + 1]^{-1}|_{(\text{Supernova})}(\eta) = \frac{\varphi_I}{\varphi_0} \sqrt{1 + 2H_I \eta} = \sqrt{1 + 2H_0(\eta - \eta_0)}. \quad (16)
\]

defined by the initial data: the primordial Planck scale \(\varphi_I\) and primordial Hubble parameter \(H_I\) related by \(\varphi_I^2 H_I = \varphi_0^2 H_0\) with the present-day values of the Planck scale \(\varphi_0\), and the Hubble parameter \(H_0\) forming the critical density \(\rho_c = \varphi_0^2 H_0^2\) at the present-day time \(\eta_0\).

We see, that, in the case of the relative Paris meter (12), both the present-day era and the era of the chemical evolution (2) can be described by only one isotropic rigid state (16). Thus, for the relative Paris meter (12) the problem of theoretical explanation is simplified, as we have a unique permanent state of the cosmic evolution (2) with the primordial density

\[
\rho_Q(\eta = 0) = \frac{\varphi_0^2}{\varphi_I^2} \rho_c. \quad (17)
\]

The problem is to calculate the densities of the CMB radiation \(\rho_{\text{CMB}}\) with temperature 2.7K (that is a constant in the conformal cosmology) and visible baryon matter (3) from the first principles of the unified theory (10) in the relative units (12).
Figure 1: The figure taken from [13] shows the Hubble diagram for a flat universe model in the standard cosmology (SC) with the absolute Paris meter (11) and conformal cosmology (CC) with the relative Paris meter (12). The points include 42 high-redshift Type Ia supernovae [1] and the reported farthest supernova SN1997ff [2]. The best fit to these data requires a cosmological constant $\Omega_\Lambda = 0.7$ in the case of the absolute Paris meter, whereas in the case of the relative Paris meter these data are consistent with the dominance of the rigid state (16).

3 Conformal-invariant Unified Theory

3.1 Frame symmetry

The simplification of the cosmic evolution in the conformal cosmology [12, 13, 14] can be considered as an argument in favor of that a group of transformations of all possible frames of reference (i.e., initial data) is the group of conformal transformations (instead of the Poincare group).

Historically, frame symmetries appeared as the Galilean group of transformations rearranging positions and velocities of initial data of particles in the Newton mechanics, where the Ptolemaeus absolute position of the earth belongs to the ordinary initial data.

The frame symmetry of the modern unified theory (10) is the Poincare group of transformations rearranging the initial data of relativistic fields.

The frame symmetry of Maxwell’s equations is the group of conformal transformations, as it was shown by Bateman and Cuninmg in 1909 [19]. The conformal group was discovered by Möbius in the 19th century [18]. The conformal transformations keep invariant the angle between two vectors in space-time.

The conformal symmetry of the laws of nature is not compatible with absolutes of the kind of the Planck mass as an absolute parameter of length, time, and mass in the unified theory (10). The conformal symmetry requires converting the unified theory (10) into a mathematically equivalent conformal-invariant unified theory (CUT) [12, 13, 14], where the absolute Planck mass $\varphi_0$ belongs to the initial data of a new dynamic variable (the dilaton scalar field $w$), like
the Ptolemaeus absolute position of the Earth belongs to ordinary initial data of the dynamic coordinate in Newton’s theory.

This, mathematically equivalent to general relativity (4), conformal-invariant theory of the scalar field \( w \) playing the role of the absolute measure was revealed by Penrose, Chernikov, and Tagirov (PCT) [20]. This theory is nothing but the Einstein theory (4) for metric multiplied by the square of the scalar field \( w \)

\[
-PCT[w|g] = GR \ [1|g \times w^2].
\] (18)

In the conformal-invariant unified theory (CUT)

\[
\text{CUT}[w|g] = -PCT[w|g] + \text{SM}[y_h \ w|F]
\] (19)

the PCT action takes the place of the Hilbert one (4), and the scalar field \( (y_h \ w) \), the Higgs mass in SM \( (M_{\text{Higgs}} = y_h \varphi_0) \).

The rigid state (4) of the Supernova cosmic evolution can be explained by the free homogeneous motion of the Scalar Quintessence (SQ) [14]. Both the running Planck mass \( w \) and Quintessence \( Q \) are described by the difference of two Penrose-Chernikov-Tagirov actions (18) \( PCT[w_+|g] - PCT[w_-|g] \), where \( w_+ = w \cosh Q \), \( w_- = w \sinh Q \) [14]. Finally, the conformal-invariant unified theory of all interaction takes the form

\[
\text{CUT}[w|g] = -PCT[w|g] + \text{SQ}[w|g] + \text{SM}[y_h \ w|F],
\] (20)

where

\[
\text{SQ}[w|g] = \int d^4x \sqrt{-g} \ w^2 \ \partial_\mu Q \partial^\mu Q.
\] (21)

3.2 Frame-fixing formulation

The old unified theory (10) (supplemented by the Quintessence) with an absolute Planck scale of mass appears as the Ptolemaeus choice of a frame of reference

\[
w_f = \varphi_0 = \text{constant},
\] (22)

with the absolute measurement standard (11). One of the main cosmological consequences of the absolute choice is expanding the spatial volume of the universe \( V_f = V_f(t) \) and all lengths in the universe with respect to the absolute Paris meter (11). Paris is a nice place in the universe. But why is the meter defined in 1791 as a 1/40,000,000 part of Paris meridian so distinguished? In any case, we can include into all lengths the measurement standard itself and use the relative Paris meter (12). Then our measurements of all lengths as ratios are not expanding. The measurable spatial volume of the universe is a constant \( V_c \). While, the measurable Planck mass in the same theory becomes a dynamic variable (15) with all measurable masses of elementary particles (14).

The relative Paris meter (12) means the Copernicus choice of a frame of reference in the field space

\[
w_c = \varphi(\eta), \quad V_c = \text{constant}
\] (23)

instead of the Ptolemaeus (22) with the running volume \( V(t) \).

Thus, the relative Paris meter (12) converted the Planck absolute mass into ordinary initial data, like Copernicus and Newton converted the Ptolemaeus absolute position of the Earth into ordinary initial data.

In 1974, Barbashov and Chernikov [21] applied the same frame-fixing formulation to the relativistic string theory and proved that this theory coincided with the Born-Infeld theory that
strongly differs from the abstract frame-free formulation of a string with the so-called Virasoro algebra [22]. Reiman and Faddeev [23] reproduced and generalized this result in 1975 (for details see [16]). Both the first Dirac quantization of electrodynamics [24] and the Schwinger quantization of modern gauge theory [25, 26] were fulfilled in a concrete frame. As it was shown by Schwinger [25, 26], this description does not contradict the general theory of irreducible and unitary representations of the relativistic group constructed by I.M. Gel’fand and M.I. Graev, and V. Bargmann, E.P. Wigner, and A.S. Wightman (see the monographs [27, 28]).

In the frame-fixing formulation, the problem of energy and time of the universe is solved by the identification of the measureable energy of the universe $E$ with respect to the evolution parameter $\varphi$ with the canonical momentum of this parameter $P_\varphi = \pm E$. This energy of the universe is similar to the frame-dependent definition of energy for a relativistic particle in special relativity by Poincare and Einstein [30], and for a relativistic string, by Barbashov and Chernikov [21, 23, 16], who got the Born-Infeld model instead of the Virasoro algebra.

### 3.3 Geometrization of the energy constraint

To explain the world by solving the Newton equation Laplace required initial data for the position and velocity of all particles in the absolute space-time. To obtain these data Laplace had to fix a frame of reference. If modern Laplace tries to explain a relativistic world fixing a frame like Poincare and Einstein [30], he will lose the dynamics of the particle in the world Minkowski space $[X_0|X_i]$ with respect to the geometric (i.e., proper) time-interval $\eta$, together with the pure relativistic effects of the type of relativistic time dilatation. This dilatation means that an unstable particle in the rest frame of an observer has greater lifetime than its geometric lifetime in its comoving frame. If Laplace tries to reduce a relativistic system to the Newton one, he loses pure relativistic effects.

The loss of the geometric time interval after fixation of a frame is the common problem of all relativistic theories including relativistic cosmology of the universe. Fixing a concrete frame Poincare and Einstein lost the proper time-interval in Special Relativity (where the role of the time-like evolution parameter is played by the definite variable $X_0$ in the world space $[X_0|X_i]$) and Wheeler and DeWitt [31] lost the time-interval in General Relativity (where the role of the time-like evolution parameter is played by the scale factor, i.e., the running Planck mass $\varphi$ in the world space $[\varphi|F]$).

In the gauge constrained relativistic theory one could obtain only the dependence of fields $[F]$ on this field evolution parameter $\varphi$: $[F(\varphi)]$ with the initial data at $\varphi = \varphi_I$. These initial data $[\varphi_I|F(\varphi_I)]$ at the world field space are treated as the field coordinates of a point of the greatest event - the creation of the universe in this world field space out of the time. Having these initial data one can describe the wavefunction of the universe $\Psi[F|\varphi \geq \varphi_I|F, F_I]$ as the amplitude of the probability to find the universe at the point $[\varphi|F]$, if it was created at the point $[\varphi_I|F_I]$, in the world field space out of the time. The geometric time is a superfluous element in both special relativity with the initial data in the Minkowski space-time and general relativity with the initial data in the field space.

In the case of a relativistic particle, there are two methods to obtain its dynamics with respect to the geometric time-interval: to change the frame, or to introduce one more reality (called geometric) of a particle in the same frame with the time-interval constructed by straightening the gauge constraint [16, 29]. The second method belongs to the Italian mathematician Levi-Civita who supposed to straighten a constraint in the theory of differential equations as far back as 1906 [32]. The Levi-Civita method of geometrization of the Minkowski world space means a transition to the geometric variables

$$[X_0|X_i] \Rightarrow [Q_0|Q_i], \quad (24)$$
where one of the variables coincides with the time-interval: \( Q_0 = \eta \). A relativistic particle can be completely described by two Newton-like realities in two world spaces: X-space and Q-space (24) supplemented by their relationship in the form of the geometricization (24)

\[
X_0(\eta, Q_i), \quad X_i(\eta, Q_i).
\]  

(25)

In this case, one should require two sets of the initial data in each reality. Then we obtain two wavefunctions \( \Psi_X[X_0 \geq X_0|I; X_i, X_i] \) and \( \Psi_Q[\eta \geq 0|Q_i, Q_i] \). The relationship (25) is treated as a new, in principle, element of the scientific explanation of the pure relativistic effects.

This geometricization [32] of the energy constraint is the universal method of a consistent description of all relativistic systems including a string [16] and a universe [29]. In the conformal-invariant unified theory (19), (23) this method converts the field space

\[ [\varphi \mid F = \text{Field variables}] \]  

(26)

with the field evolution parameter \( \varphi \) into the geometric world space

\[ [\eta \mid G = \text{Geometric variables}] \]  

(27)

with the time evolution parameter [29]. The geometricization as a rigorous mathematical construction of the geometric time \( \eta \) includes the transformations of the initial fields \( F \) into the geometric fields \( G \) (known as the Bogoliubov transformations) and introduces into the theory the cosmic initial data \( G_I \) at the beginning of the universe \( \eta = 0 \) (including a number of particles of geometric fields) [16, 29, 33].

The universe like a relativistic particle has two realities: field and geometric. Each of them has its world space of variables (26 or 27), its evolution parameter (the cosmic scale factor \( \varphi \) or geometric time \( \eta \)), and its wavefunction (the field \( \Psi_F[\varphi \geq \varphi_I|F, F_I] \) or geometric \( \Psi_G[\eta \geq 0|G, G_0] \)). The evolution of cosmic scale factor with respect to time

\[ \varphi(\eta) \]  

(28)

is considered as a pure relativistic effect of the geometricization of the energy constraint that is beyond the scope of the Newton-like mechanics.

Thus, the absolute-free conformal symmetry of the unified theory, its concrete frame-fixing fundamental formulation, and the geometricization of the energy constraint with two realities of the universe in the field space and the geometric one make up a new framework of explanation of all physical facts including physical cosmology. And this explanation should be considered on equal footing with the old scheme keeping the Newton absolutes of the type of the absolute Paris meter (11) and the absolute Planck era.

### 4 “Big Bang” as creation of the universe

#### 4.1 Creation of the universe and time

The wavefunction of the universe in the field reality

\[ \Psi_{\text{field}}[\varphi, \varphi_I|Q, Q_I; F, F_I] = \]

\[ A_E^+\Psi_{\text{universe}}[\varphi \geq \varphi_I|Q, Q_I; F, F_I] + A_E^+\Psi_{\text{anti-universe}}[\varphi \leq \varphi_I|Q, Q_I; F, F_I] \]

(29)

describes the greatest events — the creation of the universe with positive energy without the cosmic singularity \( \varphi \geq \varphi_I \), or the annihilation of the anti-universe also with positive energy.
and the cosmic singularity $\varphi \leq \varphi_I$. To make this creation stable, one should to construct the wavefunction of the quantum universe in the field reality excluding the negative value of the energy $P_\varphi = -E$ from the wave function. To do so one needed to treat the creation of the universe with negative energy as annihilation of the anti-universe with positive energy. This construction is known in quantum field theory as causal quantization with the operators of creation $A^+$ and annihilation $A^-$ of the universe [27, 28]. Consequences of the causal quantization are the positive arrow of the geometric time and its beginning $[16, 29] \eta \geq 0$.

The wavefunction of the universe in the geometric reality (including the Quintessence $Q_g$)

$$\Psi_{\text{geometric}}[\eta \geq 0|Q_g, G]$$

(30)

describes the quantum evolution of the universe in the geometric world space $[\eta|Q_g, G]$ with initial data for matter fields. The primordial Hubble parameter $H_I$ sets a natural unit of time $\eta_I = 1/2H_I$. We can choose the zero initial data for matter fields, as a stable state with the lowest energy, i.e., the quantum field vacuum.

### 4.2 Creation of matter

In the inflationary models [10] 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 [34]. Nowadays, it is evident that the problem of the cosmological creation of matter from vacuum is beyond the scope of the inflationary model.

Here we list arguments in favor of that the cosmological particle creation from vacuum in the conformal-invariant unified theory can describe the cosmic energy density budget of observational cosmology.

At the first moment $\eta_I = 1/2H_I$ of the lifetime of the universe, the fundamental frame-fixing quantization [25, 26] of the modern version of the unified theory shows us an effect of the intensive cosmological creation [34] from the geometric Bogoliubov vacuum of relativistic massive vector bosons [13, 14, 35]. The distribution functions of the longitudinal $N^\parallel$ and transverse $N^\perp$ vector bosons calculated in [13, 14, 35] for the initial data $H_I = M_I$ are introduced in Fig. 2.

The choice of the initial data $M_v(\eta = 0) = M_I$ 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 the case considered $\eta_I = 1/2H_I$. 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 $M_I \geq H_I$.

The distribution functions of the longitudinal $N^\parallel(x, \tau)$ vector bosons introduced in Fig. 2 show the large contribution of relativistic momenta. This means the relativistic dependence of the particle density on the temperature in the form $\rho(T) \sim T^3$. These distribution functions show also that the time of establishment of the density and temperature is the order of the inverse primordial Hubble parameter. In this case, one can estimate the temperature $T$ from the equation in the kinetic theory [36] for the time of establishment of the temperature

$$\eta_{\text{relaxation}}^{-1} \sim \rho(T) \times \sigma \sim H,$$

where $\sigma \sim 1/M^2$ is the cross-section.

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$^2$The effect of intensive creation of bosons is a pure relativistic consequence of the fundamental operator quantization [25, 26], as a change of the field variables removing this effect violates relativistic covariance, i.e., violates the Poincare algebra of observables constructed from these variables.
This kinetic equation and values of the initial data $M_I = H_I$ give the temperature of relativistic bosons \[12, 13, 14, 35\]

\[T \sim (M_I^2 H_I)^{1/3} = (M_0^2 H_0)^{1/3} = 2.7K\]

as a conserved number of cosmic evolution compatible with the Supernova data \[1, 2\] and the primordial chemical evolution \[6\]. We see that this calculation gives the value surprisingly close to the observed temperature of the CMB radiation $T = T_{\text{CMB}} = 2.73$ K.

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

\[\frac{\rho_v(\eta_I)}{\rho_{\text{Q}}(\eta_I)} \sim M_I^2 \varphi_I^2 = M_W^2 \varphi_0^2 \sim 10^{-34}. \tag{31}\]

On the other hand, it is possible to estimate the lifetime of the created bosons in the early universe in dimensionless units $\tau_L = \eta_L/\eta_I$, where $\eta_I = (2H_I)^{-1}$, by utilizing an equation of state $\varphi^2(\eta_L) = \varphi_0^2(1 + \tau_L)$ and define the lifetime of W-bosons in the Standard Model

\[1 + \tau_L = \frac{2H_I \sin^2 \theta_W}{\alpha_{\text{QED}} M_W(\eta_I)} = \frac{2\sin^2 \theta_W}{\alpha_{\text{QED}} \sqrt{1 + \tau_L}}, \tag{32}\]

where $\theta_W$ is the Weinberg angle, $\alpha_{\text{QED}} = 1/137$. The solution of equation (33) gives the value for $M_{\nu I} \simeq H_I$

\[\tau_L + 1 = \left(\frac{2\sin^2 \theta_W}{\alpha_{\text{QED}}}ight)^{2/3} \simeq 16. \tag{33}\]
The transverse bosons during their lifetime form the baryon symmetry of the universe as a consequence of the “polarization” of the Dirac sea vacuum of left fermions by these bosons, according to the selection rules of the Standard Model [37] with left current interaction in SM $j_{L\mu}^{(i)} = \psi_L^{(i)\gamma_\mu}\bar{\psi}_L^{(i)}$ for each left doublet $\psi_L^{(i)}$ marked by an index $(i)$. At a quantum level, we have an abnormal current

$$\partial_\mu j_{L\mu}^{(i)} = -\frac{\text{Tr}\hat{F}_{\mu\nu}^* \hat{F}_{\mu\nu}}{16\pi^2},$$

where in the lowest order of perturbation theory (p.t.) $\hat{F}_{\mu\nu} = -(ig_{a}/2)(\partial_\mu v_a^\nu - \partial_\nu v_a^\mu)$.

Integration of the equation (34) gives the number of left fermions $N = \int d^4x \sqrt{-g} \partial_\mu j_{L\mu}^{(i)}$ created during the lifetime $\eta_L = \tau_L \times \eta_I$ of vector bosons

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

where

$$N_W = \frac{4\alpha_{\text{QED}}}{\sin^2 \theta_W} \int_0^{\eta_L^W} d\eta \int \frac{d^3x}{4\pi} \text{sq} \langle 0 | E_j^W B_j^W | 0 \rangle_{\text{sq}},$$

$$N_Z = \frac{\alpha_{\text{QED}}}{\sin^2 \theta_W \cos^2 \theta_W} \int_0^{\eta_L^Z} d\eta \int \frac{d^3x}{4\pi} \text{sq} \langle 0 | E_j^Z B_j^Z | 0 \rangle_{\text{sq}},$$

$$\int \frac{d^3x}{4\pi} \text{sq} \langle 0 | E_j^W B_j^W | 0 \rangle_{\text{sq}} = -\frac{V_0}{2} \int_0^\infty dk |k|^3 \cos(2\theta_v) \sinh(2r_v),$$

$\theta_v$ and $r_v$ are given by the Bogoliubov equations [14, 35]. The lifetime of bosons $\tau_L^W = 15$, $\tau_L^Z = 30$, leads to an estimation of the magnitude of the nonconservation of fermion number

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

where $n_\gamma = (2.402/\pi^2)T^3$ is the density of number of the CMB photons. The baryon asymmetry appears as a consequence of three Sakharov conditions: CP-nonconservation, evolution of the universe $H_0 \neq 0$ and the violation of the baryon number [35]

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

where $X_{\text{CP}}$ 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 with a constant of a weak coupling $X_{\text{CP}} \sim 10^{-9}$ [38].

After the decay of bosons, their temperature is inherited by the Cosmic Microwave Background radiation. All the subsequent evolution of matter with varying masses in the constant Universe replicates the well-known scenario of the hot universe [6], as this evolution is determined by the conformal-invariant ratios of masses and temperature $m/T$.

As the baryon density increases as a mass and the Quintessence density decreases as the inverse square mass, the present-day value of the baryon density can be estimated by the relation

$$\Omega_b(\eta_0) = \left[ \frac{\varphi_0}{\varphi_L} \right]^3 \frac{\rho_b(\eta_L)}{\rho_Q(\eta_L)} = \left[ \frac{\eta_L}{\eta_I} \right]^{3/2} \sim \left[ \frac{\alpha_{\text{QED}}}{\sin^2 \theta_W} \right] \sim 0.03,$$

(35)
if the baryon asymmetry with the density

\[ \rho_b(\eta = \eta_L) \approx 10^{-9} 10^{-34} \rho_Q(\eta = \eta_L) \]

was frozen by the superweak interaction. This estimation gives the value surprisingly close to the observational density (3) in the agreement with the observational data. There are arguments [39] in favor of that cosmological creation of particles shown on Fig. 2 can also describe the primordial fluctuations of temperature of CMB [3]. Generally speaking, all these present and future results can only be treated as a set of arguments in favor of the considered unified theory.

5 Conclusion

Thus, we have shown that the conformal-invariant unified theory (20) with geometrization of constraint and frame-fixing with the primordial initial data \( \varphi_I = 10^4 \text{GeV}, H_I = 2.7 \text{ K} = 10^{29} H_0 \) (determined by a free homogeneous motion of the Scalar Quintessence, i.e., its electric tension) can describe the following events:

\[
\begin{align*}
\eta &= 0 & \text{creation of the “empty” universe from “nothing”} \\
\eta &\sim 10^{-12} s & \text{creation of vector bosons from “nothing”} \\
10^{-12} s < \eta < 10^{-11} &\div 10^{-10} s & \text{formation of baryon asymmetry} \\
\eta &\sim 10^{-10} s & \text{decays of vector bosons} \\
10^{-10} s < \eta < 10^{11} s & & \text{primordial chemical evolution of matter} \\
\eta &\sim 10^{11} s & \text{recombination, or separation of CMB} \\
\eta &\sim 10^{15} s & \text{formation of galaxies} \\
10^{17} s < \eta & & \text{hep experiments and Supernova evolution.}
\end{align*}
\]

In this case, coordinates of the point of creation of the universe in the world field space \( \varphi_I = \varphi_0/(z_I + 1) \) are considered as ordinary initial data. The absolute Planck mass (9) is determined by the present-day values of these field coordinates, like the absolute Ptolemaeus position of the earth is determined by the present-day values of its spatial coordinates in the Newton theory.

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