The Origin of the Space Roar

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Abstract: The space roar is the unsolved problem in cosmology and particle physics. Here, applying the Scale-Symmetric Theory, we showed that the ARCADE 2 and other literature the space roar for frequencies from 22 MHz to 10 GHz follows from the motion of the very early Universe in relation to the ground state of the luminal Einstein spacetime, follows also from the expansion of the Universe, and from the decays of the quadrupoles of charged pions and of the bottom quark-antiquark pairs into photons. Derived here the excess power-law spectrum in addition to a CMB temperature of 2.725 +- 0.001 K is consistent with observational data. Here as well we calculated the precise mass of the bottom quark: 4167.58 MeV. We showed also that production of the Higgs bosons during the period of time the CMB was produced cannot be neglected in a theory of the early Universe.

1. Introduction

Equations always are the physically incomplete mathematical objects. An equation always describes only very selected phenomena so to obtain a reasonable theoretical result we must apply approximations, mathematical tricks and, especially, free parameters. To change this uncomfortable situation, we must find the lacking part of ultimate theory. Just we must find the cosmological initial conditions and theory that leads to internal structure of the bare particles. And it is done within the Scale-Symmetric Theory (SST) [1].

When we neglect the SST, then there appear many fundamental paradoxes such as, for example, the exit from the black-hole state or the information paradox. Incompleteness of the mainstream theories causes that there is many unsolved basic problems as, for example, the origin of the space roar or the origin of the dark matter and dark energy.

The standard big bang model and SST lead to the cosmic microwave background (CMB) with blackbody spectrum. But there is the excess power-law spectrum from about 22 MHz to 10 GHz [2]. It is called "the space roar". The origin of the excess temperature to a CMB temperature of 2.725 ± 0.001 K for these frequencies is unknown. The radio background from ARCADE 2 and radio surveys is a factor of ~6 brighter than the estimated contribution of radio point sources [2].

Here we will show that the space roar is the result of the motion of the centre of mass of the very early Universe in relation to the ground state of the luminal Einstein spacetime ($v \approx 355$

m/s [3]) and is the result of the expansion of the Universe and follows from the decays of the quadrupoles of the charged pions and of the bottom quark-antiquark pairs into photons.

According to the SST, the expanding Universe is the result of evolution of the cosmic structure (the Protoworld) that appeared after the SST inflation [1B]. Initially, the Universe was the double loop of matter with a radius of $R_{U,initial} = 0.1911$ Gyr (i.e. 191.1 million light-years). Calculated within the SST the present-day radius of the sphere filled with baryonic matter is $R_{U,present\text{-}day} = 13.866 \pm 0.096$ Gyr so size of the Universe increased about F times [1B]:

$$F = R_{U,present\text{-}day} / R_{U,initial} = 72.56, \tag{1}$$

and the same concerns the wavelengths that appeared at the beginning of the expansion of the Universe i.e. when the CMB was produced.

2. Calculations

SST shows that there is obligatory the four-particle/object symmetry [1A]. This symmetry concerns as well pairs of fermions. According to this symmetry, the quadrupole of entangled 4 pairs of Λ hyperons is the excited lowest-energy state of nuclear matter so probability of creation of such quadrupoles is highest in collisions of atomic nuclei. The mass of such quadrupole is sufficient for creation of the bottom quark-antiquark pair

$$4\ (\Lambda\ \Lambda_{anti}) \rightarrow b\ b_{anti} \rightarrow \gamma_{maximum}\ \gamma_{maximum}. \tag{2}$$

The calculated within SST mass of the b quark is about 4190 MeV [1A], [1D]. Here we will calculate this mass in a different way.

There appear as well the quadrupoles of entangled charged pions so in following decay mode

$$\pi^+\pi^-\pi^+\pi^- \rightarrow 4\ \pi^o + (e^+e^-e^+e^-)^* + (\nu_e\nu_{e,anti}\nu_e\nu_{e,anti} \rightarrow \gamma_{minimum}\gamma_{minimum})$$

$$\rightarrow 4\ \pi^o + \ \gamma_{minimum}\gamma_{minimum} \tag{3}$$

there appear photons with energy about $\gamma_{minimum} = 9.2$ MeV (the expression (…)* means “virtual quadrupole”). The neutrino-antineutrino pairs are the carriers of gluons and photons [1A]. The relativistic quadrupoles of charged pions can produce photons carrying energies higher than 9.2 MeV but such energies cannot be higher than about 4190 MeV because then there are produced the bottom quark-antiquark pairs which decay into two photons.

The condensates created in the high-energy collisions of atomic nuclei are the hedgehog-like condensates [4]. It follows from the fact that the shortest-distance quantum entanglement is for neutrino-antineutrino pairs (i.e. for the Einstein-spacetime components) that directions of spins overlap [1A]. Mass of the hedgehog-like condensates is directly proportional to their size i.e. to the wavelengths of emitted photons

$$m_{hedgehog} \sim \lambda_{photon}\ . \tag{4}$$

From formula $mc^2 = h\nu$ follows that frequency, ν, is directly proportional to mass, m, whereas from the Wien’s law ($\lambda T = const.$) follows that temperature, T, is inversely proportional to wavelength, λ. It leads to conclusion that for hedgehog-like condensates an excess temperature, ΔT, is inversely proportional to frequency

$$\Delta T \sim 1 / \nu. \tag{5}$$

But the electromagnetic and nuclear weak interactions change the mass so the frequency and the excess temperature as well.

Here, the maximum involved energy is about $b + b_{anti} \approx 8380$ MeV. On the other hand, the neutral pions consist of four neutrinos, [1A], so energy carried by one neutrino is $E_{neutrino} \approx 33.744$ MeV and it is the involved lowest initial energy. Notice that there is satisfied following formula

$$E_{neutrino}{}^{\beta} = b + b_{anti} , \tag{6}$$

where the index is $\beta_{approx.} = 2.5672$. This index is very close to the ratio of the coupling constant of the nuclear weak interactions of proton, $\alpha_{W(proton)} = 0.01872286$ [1A], and the fine structure constant $\alpha_{em} = 1/137.036001$ [1A] i.e. $\beta = 2.56571$.

Why the electromagnetic interactions of photons (via the weak interactions of the hedgehog-like condensates) increase frequency from ν to ν^{β}?

There is obligatory the four-object symmetry. In the energetic collisions of ions, the neutral pions (i.e. the groups of entangled four neutrinos) transform (via the associations of the Lambda hyperons) into four pairs of the bottom quarks i.e. there take place following transformations

$$E_{neutral\text{-}pion} = 4\, E_{neutrino} \rightarrow 4\, E_{bb} , \tag{7a}$$

i.e.

$$4 \cdot 33.744 \text{ MeV} \rightarrow 4\,(2 \cdot 4190) \text{ MeV} , \tag{7b}$$

i.e.

$$E_{neutrino}{}^{\beta} = E_{bb} , \tag{7c}$$

where $\beta_{approx.} = 2.5672$ and it is close to

$$\beta = \alpha_{W(proton)} / \alpha_{em} = 2.56571 . \tag{8}$$

Knowing β and the experimental mass of neutral pion [5], we can calculate the precise mass of the bottom quark

$$m_{bottom\text{-}quark} = (m_{neutral\text{-}pion} / 4)^{\beta} / 2 = 4167.58 \text{ MeV} . \tag{9}$$

According to PDG [5], applying the minimal subtraction scheme to absorb the infinities that arise in perturbative calculations beyond leading order, introduced independently by Gerard ‘t Hooft (1973) and Steven Weinberg (1973), the mass of the bottom quark is $m_{bottom\text{-}quark} =$

4.18 ± 0.03 GeV so both theoretical results, i.e. 4190 MeV and 4167.58 MeV, are consistent with the PDG result.

We can rewrite formula (5) as follows

$$\Delta T\,[\mathrm{K}] = T_o\,(\nu / \nu_o)^{-ß}, \tag{10}$$

where T_o is a constant temperature whereas ν_o is a characteristic frequency for described here phenomena. We can assume that this frequency concerns the neutral pions which are responsible for the nuclear strong interactions.

Calculate the excess energy, ΔE, which follows from the motion of the very early Universe in relation to the ground state of the luminal Einstein spacetime. The velocity of the Protoworld and of the very early Universe and, next, of the starting to expand the very early Universe, i.e. during the period of time when the CMB was produced, was $\mathrm{v} = 354.89$ m/s [3]. This value follows from following formula $\mathrm{v} = c\,(\rho_{nuclear} / \rho_E)^{1/2}$, where c is the speed of light in "vacuum", $\rho_{nuclear}$ is the mass density of neutron (the range of strong interactions of nucleons calculated within SST is 2.95821 fm; $R_{Strong} = 2A(1 + 4\pi^2)^{1/2} / 3$, where $A = 0.6974425$ fm is the radius of the core of baryons [1A]), and $\rho_E = 1.10220055 \cdot 10^{28}$ kg/m^3 is the mass density of the luminal Einstein spacetime [1A]. In Paragraph 3, we calculated the modified value of the velocity v that additionally follows from production of the condensates responsible for the nuclear weak interactions.

The excess mass of particles in addition to their rest mass was

$$\Delta E = m_o\,[1 / (1 - \mathrm{v}^2 / c^2)^{1/2} - 1]. \tag{11a}$$

Since $\mathrm{v} << c$ so the approximate formula is

$$1 / (1 - \mathrm{v}^2 / c^2)^{1/2} \approx 1 + \mathrm{v}^2 / (2\,c^2). \tag{11b}$$

Then

$$\Delta E = m_o\,\mathrm{v}^2 / (2\,c^2) = f\,m_o\,, \tag{11c}$$

where $f = 0.70067 \cdot 10^{-12}$.

Calculate the characteristic frequency, ν_o, concerning the present-day excess energy of a hedgehog-like condensate with a mass equal to the rest mass of neutral pion created parallel with CMB ($m_o = m_{pion(o)}$)

$$\nu_o = m_o\,f\,c^2 / (h\,F) = C\,m_o = 1.310 \cdot 10^{36}\,m_o = 315.2\ \mathrm{MHz}\,. \tag{12}$$

The initial temperature of the baryonic plasma at the beginning of the expansion of the Universe (about 10^{12} K) is defined by the internal structure of the electric charge of proton [1D]. The present-day temperature of CMB, i.e. $T_P = 2.725 \pm 0.001$ K, should be equal to the present-day excess temperature of the electric charge of proton. Its mass is $X = 318.2955$ MeV [1A]. Applying formula (12) we obtain $\nu_X = 743.2$ MHz. Applying formula (10) we obtain

$$T_P = \Delta T = T_o\,(\nu_X / \nu_o)^{-ß}. \qquad (13)$$

For $T_P = 2.725$ K, $\nu_X = 743.2$ MHz, $\nu_o = 315.2$ MHz, and $\beta = 2.56571$, is $T_o = 24.62$ K.

Derived here the excess power-law spectrum of

$$\Delta T\,[\mathrm{K}] = T_o\,(\nu / \nu_o)^{-ß}, \qquad (14)$$

where $T_o = 24.62$ K, $\nu_o = 315.2$ MHz, and $\beta = 2.56571$, is consistent with the ARCADE 2 and other literature the excess power-law spectrum in addition to a CMB temperature of 2.725 ± 0.001 K [2].

3. The very-high-accuracy excess power-law spectrum for the space roar

The index $\beta = 2.56571$ is calculated with very high accuracy because the coupling constant for the nuclear weak interactions is used in many different calculations that lead to theoretical results consistent with experimental data, whereas the SST fine structure constant, i.e. 1/137.036001 [1A], is very, very close to experimental value but, of course, we can use the experimental value as well.

Here, accuracy of the parameter $T_o = 24.62$ K is limited by accuracy of the present-day temperature of the Universe (2.725 ± 0.001 K). It follows from the fact that instead the ratio of the frequencies we can use the ratio of masses i.e. the ratio $\nu / \nu_o = 318.2955 / 134.9766 = 2.35815$ must lead to the present-day temperature so we obtain $T_o = 24.62 \pm 0.01$ K.

The real problem concerns the accuracy of the characteristic frequency ν_o or, more precisely, the range of the strong interactions that lead to the linear velocity of the very early Universe in relation to the luminal Einstein spacetime. There are not only baryons but there as well were the condensates responsible for the nuclear weak interactions which radius is $r_{p(proton)} = 0.8710945 \cdot 10^{-17}$ m [1A]. This radius leads to the coupling constant for the nuclear weak interactions. Condensates that surfaces are tangent to surfaces of the strong fields of nucleons increase the range of the strong interactions. The condensates produce the standing waves in such a way that the distance between the standing-wave nodes is equal to the size of the condensates i.e. $\lambda = 4\,r_{p(proton)}$. Such method we applied as well to solve other problems [6]. We can assume that the modified range of the strong interactions is

$$R_{Strong}{}^{*} = R_{Strong} + 4\,r_{p(proton)} = 2.993054\ \mathrm{fm}. \qquad (15)$$

Such range leads to the linear velocity of the very early Universe in relation to the ground state of the luminal Einstein spacetime equal to v = 348.71 m/s. It means that we can rewrite formula (12) as follows

$$\nu_o = C\,m_o = 1.2646 \cdot 10^{36}\,m_o = 304.3\ \mathrm{MHz}, \qquad (16)$$

whereas formula (14) looks as follows

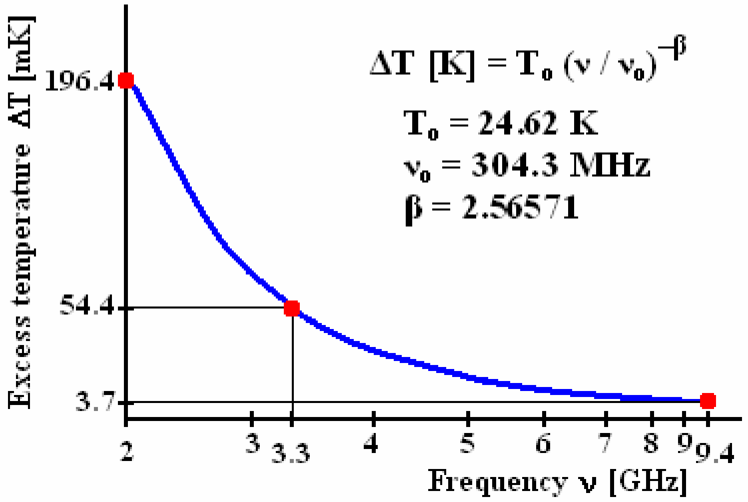
$$\Delta T\,[\mathrm{K}] = T_o\,(\nu / \nu_o)^{-ß}, \qquad (17)$$

where T_o = 24.62 ± 0.01 K, ν_o = 304.3 MHz, and β = 2.56571. This formula is consistent with the ARCADE 2 and other literature data concerning the excess temperature (in addition to a CMB temperature of 2.725 ± 0.001 K) as a function of frequencies [2].

Table 1 *Frequency and excess temperature*

Initial energy	Present-day frequency ν, formula (16)	Excess temperature ΔT, formula (17)
$\gamma_{minimum}$ = 9.2 MeV	20.74 MHz	24,220 K
$E_{neutrino}$ = 33.744 MeV	76.07 MHz	863 K
$m_{pion(o)}$ = 134.9766(6) MeV	ν_o = 304.3 MHz	T_o = 24.62 K
X = 318.2955 MeV	717.6 MHz	2.725 K
	2.0 GHz	196.4 mK
---------	3.3 GHz (ARCADE 2)	54.35 mK (ARCADE 2: 54 ± 6 mK)
$\gamma_{maximum}$ = b = 4167.58 MeV	9.396 GHz	3.71 mK
H = 125.0 GeV	281.8 GHz → → 1.0638 mm	

$\beta = \alpha_{W(proton)} / \alpha_{em} = 2.56571$



The excess radio spectrum to a CMB temperature of 2.725 +- 0.001 K for frequencies from 20.7 MHz to 9.4 GHz.

Can we verify formula (16)? Notice that the present-day wavelength that follows from the initial excess mass of the Higgs boson (125.0 GeV (formula (16)) → 281.8 GHz → 1.0638 mm), i.e. when the CMB was produced, is consistent with the wavelength that follows from both the present-day temperature of the Universe (2.725 ± 0.001 K) and the Wien's law ($\lambda_T T = 2.8977729(17) \cdot 10^{-3}$ m K) – we obtain λ_T = 1.0634 ± 0.0004 mm.

This result is very important because it shows that production of the Higgs bosons during the period of time the CMB was produced cannot be neglected in a theory of the early Universe.

4. Summary

Here we showed that the space roar for frequencies from 20.74 MHz to 9.40 GHz follows from the motion of the very early Universe (i.e. in the period of time the CMB was produced) in relation to the ground state of the luminal Einstein spacetime (i.e. in the period of time after the SST inflation; the velocity was 348.71 m/s), follows also from the expansion of the Universe (the wavelengths increased 72.56 times), and from the decays of the quadrupoles of the charged pions and of the bottom quark-antiquark pairs into photons.

Derived here the excess power-law spectrum of $\Delta T\,[\mathrm{K}] = T_o\,(\nu / \nu_o)^{-\beta}$, where $T_o = 24.62 \pm 0.01$ K, $\nu_o = 304.3$ MHz and $\beta = 2.56571$, in addition to a CMB temperature of 2.725 ± 0.001 K, is consistent with observational data.

Here as well we calculated the precise mass of the bottom quark: 4167.58 MeV. The earlier result calculated within the reformulated QCD is 4190 MeV. Both results are consistent with the PDG result 4.18 ± 0.03 GeV.

Emphasize also that according to the Scale-Symmetric Theory, even rotating modified neutron black holes (MNBHs) all other black holes consist of, are in the rest in relation to the luminal Einstein spacetime because its local angular momentum is the same as the MNBHs [7]. Since the very early Universe consisted of the MNBHs, [1B], so in the period of time the CMB was produced there dominated the blackbody radiation, the decay energy, and the excess energy.

Here we showed also that production of the Higgs bosons during the period of time the CMB was produced cannot be neglected in a theory of the early Universe.

References

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