The 133 e-Folds of Inflation and the CMB Spectral Index of 0.96666

Sylwester Kornowski

Abstract: Here, applying the Scale-Symmetric Theory (SST), we show that there were the 133.27 e-folds of the smooth SST inflation. On the other hand, SST leads to conclusion that the inflation of the Cosmos, which is about 4 orders of magnitude bigger than the present-day Universe, was separated in time from the expansion of the Universe. The CMB was produced when there dominated the electromagnetic and weak interactions - it leads to the SST CMB spectral index of 0.96666 which is consistent with the index that results from the Planck-satellite 2015 data (0.968 +- 0.006). But the SST CMB spectral index is 3 orders of magnitude more accurate so future more accurate observational data should show whether the SST cosmology is correct.

1. Introduction

The Scale-Symmetric Theory (SST) starts from the succeeding phase transitions of the Higgs field (HF) (composed of the non-gravitating tachyons) during the smooth inflation [1A], [1B]. The tachyons are the non-transparent, internally structureless balls i.e. they have the inertial mass only – they are not the principle-of-equivalence (PoE) particles. The transitions lead to the different mass/energy scales and size scales [1A]. At the end of the smooth inflation there were created two boundaries of our Cosmos which is about 4 orders of magnitude bigger than the present-day Universe [1B]. All objects in the inner Cosmos and the inner boundary itself are built of the tachyons – it is due to their dynamic viscosity [1A]. The phase transitions caused that there appeared the other interactions and the PoE particles [1A].

During the smooth inflation almost whole Higgs field transformed into the gravitating Einstein spacetime (ES) – the ground state of it is composed of the non-rotating-spin-1 neutrino-antineutrino pairs [1A]. It means that there is the two-component spacetime composed of the residual Higgs field associated with the gravitational fields and the Einstein spacetime (ES) associated with the Standard-Model fields [1A]. The initial inertial-only mass density of the inflation-field/Higgs-field was equal to the inertial-only mass density of a tachyon $\rho_{HF,initial} = \rho_t = 8.32192436 \cdot 10^{85}$ kg m^{-3} [1A]. At the end of the smooth inflation, the density of the residual Higgs field (due to the two boundaries of the Cosmos, this density is an invariant) was and still is $\rho_{HF} = 2.645834 \cdot 10^{-15}$ kg m^{-3} [1A]. At the end of the smooth inflation, the density of the Einstein spacetime was and still is ρ_{ES} =

$1.10220055 \cdot 10^{28}$ kg m^{-3} [1A]. Such 3 from the 7 initial parameters only lead to a thousand basic theoretical results consistent with experimental data [2].

Within SST, we showed that each coupling constant, α_i, is directly proportional to density of field, ρ_i, associated with α_i [1A]

$$\alpha_i \sim \rho_i \,. \tag{1}$$

It causes, for example, that the fine-structure constant, $\alpha_{em} = 1 / 137.036$, is about $4.2 \cdot 10^{42}$ times higher than the gravitational coupling constant for electron and positron, $\alpha_{g(electron\text{-}positron)}$, in an electron-positron pair

$$\alpha_{em} / \alpha_{g(electron\text{-}positron)} = \rho_{ES} / \rho_{HF} = 4.166 \cdot 10^{42} \,. \tag{2}$$

2. The 133 e-folds of inflation

The e-folding is defined as the time interval in which an exponentially increasing (decreasing) quantity increases (decreases) by a factor $e \approx 2.71828$. It leads to a definition of the n e-folding (n lifetimes) for decreasing during the smooth inflation density of the spacetime

$$n = ln\,(\rho_{spacetime,beginning} / \rho_{spacetime,end}). \tag{3}$$

For the SST inflation is: $\rho_{spacetime,beginning} = \rho_{HF,initial}$ and $\rho_{spacetime,end} = \rho_{ES} + \rho_{HF}$ so we obtain

$$n = ln\,[\rho_{HF,initial} / (\rho_{ES} + \rho_{HF})] = 133.27 \tag{4}$$

There was the smooth expansion of each region of the initial inflation field. Inflation of the inner Cosmos lasted about 10^{-67} s [1A], [1B] so there was no time for the three Standard-Model interactions. Below we calculated the spectral indices at the end of the SST inflation. It shows that we should not observe some gravitational or other density perturbations at the end of the SST inflation. It suggests that the origin of the scalar spectral index for CMB is different.

3. The scalar spectral indices of the density perturbations

Spectral index of a source, N, is a measure of the dependence of flux density, S, on frequency, ν

$$S \sim \nu^{\,N}, \tag{5}$$

The scalar spectral index, n_s, describes how density fluctuations vary with scale. The variations are the same on all scales for $n_s = 1$.

SST shows that the nuclear strong fields are the closed fields because of their finite range [1A]. Coupling constant for the strong interactions inside a strong field is $\alpha_{strong} = 1$ (we should not confuse this with the running coupling for the strong interactions) [1A]. On the other hand, such closed fields should not create density perturbations outside them i.e. the scalar spectral index should be zero. It leads to following formula for the scalar spectral index of a field

$$n_s = 1 - \Sigma_i \alpha_i \,, \qquad (6)$$

where α_i are the all coupling constants characteristic for the considered field/spacetime.

According to SST, the expansion of the Universe was separated in time from the inflation [1B]. The density fluctuations that we see in CMB were produced in the Einstein spacetime. For the ES are characteristic the electromagnetic interactions (there are produced the electron-positron pairs) and the weak interactions (there are produced the condensates from the ES components) [1A]. The involved coupling constants are as follows: the fine-structure constant, coupling constant for the weak interactions of protons: $\alpha_{w(proton)} = 0.0187229$, and coupling constant for the weak interactions of protons with electrons and positrons $\alpha'_{w(proton\text{-}electron)} = 1.11944 \cdot 10^{-5}$ [1A]. In the nuclear plasma there is produced one electron-positron pair per proton [1C] – applying formula (6) we obtain

$$n_s = 1 - \alpha_{w(proton)} - 2\,(\alpha_{em} + \alpha'_{w(proton\text{-}electron)}) = 0.96666 \,. \qquad (7)$$

The SST CMB scalar spectral index of 0.96666 is consistent with the index that results from the Planck-satellite 2015 data (0.968 ± 0.006) [3]. But the SST CMB spectral index is 3 orders of magnitude more accurate so future more accurate observational data should show whether the SST cosmology is correct.

We showed that the fine-structure constant, $\alpha_{em} = 1 / 137.036$, is about $4.2 \cdot 10^{42}$ times higher than the gravitational coupling constant for an electron-positron pair so from formula (6) results that we should not observe some gravitational density perturbations.

4. Summary

Within the SST cosmology we showed that we should not observe gravitational density perturbations and other density perturbations from the inflation.

The consistency of the SST CMB scalar spectral index and the index that results from the Planck-satellite 2015 data indeed suggests that the expansion of the Universe was separated in time from the inflation. Future more accurate observational data should show whether the SST cosmology is correct.

References

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