Derivation of the current cosmic microwave background temperature

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Abstract

Since the discovery of the cosmic microwave radiation background in 1965 (CMB) until today, various predictions have been made (before and after 1965) about the current value of 2.72548 K. It is worth highlighting the one carried out in 1948 by George Gamow, Ralph Alpher and Robert Herman whose reestimation predicted a temperature of 2.8 K. In this work we start from an inflationary model that resides in the fine structure constant and a fluctuation (anisotropy) based on information theory (Shanon entropy)

1 Introduction

Our work is based, as we have mentioned in the summary, on the fine structure constant, specifically on its inverse. This is because its inverse represents the unit probability (1) that an electron emits or absorbs a photon. Therefore, this inverse value also represents for the quantum vacuum the quantity of photons that decay into particle-antiparticle pairs. And this is precisely the phenomenon that is theorized to have occurred at the beginning of the universe before the decoupling of radiation. Other work that we find very interesting in the prediction of CMB temperature is[6]

The great isotropy of this background radiation is explained very well by inflationary models. Likewise, primordial fluctuations necessary for the creation of aggregates of matter and their subsequent conversion into galaxies, etc. are expected.In this article, the inverse of the fine structure constant will be used as the basis of the exponential inflation factor of the decrease in temperature, based on the Planck energy. An indeterminacy or fluctuation will be introduced using information theory and as an entropy of the inverse of the fine structure constant. Finally, an empirical, theoretical, and heuristic correction will give us a very approximate value of the current CMB temperature.

1.1 Inverse of the fine structure constant

Inverse Fine structure constant =137.035999084= $\alpha^{-1}(0)$

Now taking into account the creation of particle-antiparticle pairs, the inverse of this constant must be reduced by half as the basis of the exponential factor.

$$\frac{\alpha^{-1}(0)}{2} \tag{1.1}$$

1.2 Fluctuations: entropy of the inverse of the fine structure constant

We will adopt the entropy of equiprobable states based on the fact that at the beginning of the universe all particles could be "created" by photons in an equiprobable way (Unification Theories). In this way we obtain for this entropy:

$$\ln\left[\alpha^{-1}(0)\right] = 4.92024365834741 \tag{1.2}$$

Therefore, the previous entropy will be added to the value of equation 1.1 to obtain a first approximation to the final exponential inflation factor.

$$\frac{\alpha^{-1}(0)}{2} + \ln\left[\alpha^{-1}(0)\right]$$

In this way and with this theoretical approach and using Planck's energy and Boltzman's constant, the following temperature is obtained:

$$\frac{(m_{PK} \cdot c^2/k_B)}{\exp\left(\dfrac{\alpha^{-1}(0)}{2} + \ln\left[\alpha^{-1}(0)\right]\right)} = 1.8091722\ K \tag{1.3}$$

To obtain the correct value of 2.72548 K it is necessary to introduce a correction to the entropy due to the baryon density.

1.3 Entropy correction, dependent on baryon density.

As we have already shown in our other works, the baryon density is given by the following equation [8]:

$$\frac{2 \cdot \ln\left(m_{PK}/m_e\right) + \alpha^{-1}(0) - 240}{2} = \Omega_b = 0.045839537445 \tag{1.4}$$

After the decoupling of the radiation and taking the least energetic particles or those belonging to the limit of the Higgs vacuum (standard model), and since the universe had cooled enough to allow the formation of hydrogen nuclei. In this way, twenty state-particles could be counted, which would be: 6 leptons, 6 quarks, 1 gluon, 1 photon, 1 W boson, 1 Z boson, 1 Higgs boson, 1 graviton, 1 axion and the Higgs vacuum itself. (1).

Therefore the correction to the entropy (fluctuations) would be given by this equation:

$$20 \cdot \Omega_b \cdot \ln\left[\alpha^{-1}(0)\right] \tag{1.5}$$

With this correction we have the current final temperature derived from the following final equation:

$$\frac{\left(m_{PK} \cdot c^2/k_B\right)}{\exp\left(\dfrac{\alpha^{-1}(0)}{2} + 20 \cdot \Omega_b \cdot \ln\left[\alpha^{-1}(0)\right]\right)} = 2.724484\ K$$

As you can see, this temperature value is very close to the established one of 2.72548 K.

2 Conclusions

In a simple but powerful way we have been able to derive the current value of the CMB temperature from a theoretical point of view. Based on a purely informational treatment, since the inverse of the fine structure constant is a quantity, in this case of photons and with the use of their entropy and the introduction of a logical correction due to the density of baryons and the amount of different particles (20) when the universe was already cold enough.

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