FINE STRUCTURE CONSTANT AT COSMOLOGICAL SCALE

Alberto Coe . Independent researcher
albamv8@gmail.com

Abstract

Will describe the ratio between two energies. The energy of photons associated to the cosmic microwave background and the gravitational potential energy of a system of particles (protons and electrons). The value of this ratio is equivalent to the current value of the fine structure constant.

Keywords . Fine structure constant, cosmic microwave background, gravitational potential energy.

Method and results

Energy of one photon of the cosmic microwave background.

applying the formula Einstein-Planck

\[ E = \gamma \ h \ \nu_0 \]  \hspace{1cm} (1)

\( \gamma \sim 10^{89} \) assumed number of photons in the observable universe

\( h = 1.054572 \times 10^{-34} \text{ Js} \) refers to the reduced Planck constant

\( \nu_0 = 1.602 \times 10^{11} \text{ s}^{-1} \)

\( E = 1.6894 \times 10^{66} \text{ J} \)

Gravitational potential energy in a system constituted by protons and electrons

Apply the equation of gravitational potential energy of a system of particles, equivalent to the gravitational potential energy for a constant density sphere of mass \( M \) and radius \( d \),

\[ U = -\frac{3}{5} G_N \frac{M^2 N^2}{d} \]  \hspace{1cm} (2)
Let’s neglect the term \((-\frac{3}{5})\) 
and write the equivalence \(M^2 = (p_m \times e_m)\)

\[ G_N = 6.674 \times 10^{-11} m^3 kg^{-1} s^{-2} \]  
the Newtonian gravitational constant

\[ p_m = 1.673 \times 10^{-27} kg \]  
proton mass

\[ e_m = 9.10938 \times 10^{-31} kg \]  
electron mass

\(N \sim 10^{81}\) defines the assumed number of protons and electrons in the observable universe

\[ d = e f l_p = 4.393 \times 10^{26} m. \]

\(e = 2.71828...\) Euler constant

\(f \sim 10^{61}\) orders of magnitude between the radius of the observable universe and Planck length

Radius of the observable universe \(\sim 10^{26} m\)

\(l_p = 1.6162 \times 10^{-35} m\), Planck’s length

Therefore the resulting gravitational potential energy

\[ U = 2.315 \times 10^{68} j \]

Divide both energies

\[ \frac{E}{U} = \frac{1.6894 \times 10^{66} j}{2.315 \times 10^{68} j} = 0.0072973 ... = \alpha, \text{ the fine structure constant}. \]

Note that the more the distance \(d\) in equation (2) increases, the lower the value of \(E\) in equation (1).