The CMB Energy Equivalence Principle : A Correlation to Planck and Cosmic Horizon Energy

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Abstract

According to the Cosmic Microwave Background (CMB) temperature and Wien's displacement law, the CMB's energy value is equivalent to that of the measured and determined neutrino energy. The resulting CMB/neutrino mass is used to determine a ratio by correlating the accelerative work of two forces which corresponds to the cosmic particle horizon and Planck length. Planck's constant is shown to be proportional to the cosmic particle horizon and the CMB mass/energy and the speed of light in vacuum. Planck's constant, the cosmic horizon, the CMB energy and speed of light all appear to be interconnected and their correlations provide an amending perspective on the concepts of the fundamental laws and theories of the cosmos. Specifically, the squared energy of a CMB/neutrino is equal to the product of the energy of the maximum cosmic Rindler horizon, cosmic diameter, and the Schwarzschild radius for a Planck mass.

1 Introduction

Both Unruh and Hawking's concepts of information horizons are associated to radiation emission (separation of virtual particles) [5] [12] [11]. Therefore, it can be assumed that a Rindler horizon could create particle energy fields within accelerative information boundaries. This has been amended by McCulloch to predict Casimir effects on a cosmic scale which assumes an allowed discrete radiation spectrum with wave nodes located at an information horizon coordinate [6]. By associating the forces of the maximum and minimum allowed wavelength in the realm of virtual particles to the CMB/neutrino mass, a minimum quantized cosmic acceleration can be derived which is equivalent to the minimum acceleration method stipulated by McCulloch where $R = c^2/a$ and R is the Rindler horizon [7] . Correlating the fundamental constants also yields a simple formula connecting the size of the cosmic particle horizon to the neutrino mass and also to energy and momentum ratios that are unity. Required are the allowed minimum/maximum boundary Compton wavelengths using information horizons and the associated CMB energy. Furthermore, energy ratios are obtained which link the CMB background (photon energy squared) with the cosmic boundary wavelengths where the lower limit is the Schwarzschild radius for a fundamental Planck length energy. This approach is done without adding any additional parameters and is solely performed using scientifically defined/determined constants.

2 Method

2.1 CMB/Neutrino energy, Rindler horizon and Planck length

Consider the current CMB temperature measured value which is $T = 2.72548$ K and the cosmic diameter $\Theta = 8.8 \cdot 10^{26}$ m. Now use Wien's displacement law in order to compute the total energy from the observed temperature using $E = kT/\beta$ where k is Boltzmann's constant and $1/\beta = 4.965114$ is Wien's constant [9]. Recall the ratio of forces and its result which is equivalent to the gravitational CMB coupling constant, $\alpha_G = \frac{F_{cmb}}{F_{m_p}}$ and CMB mass is $m_{cmb} = \frac{kT}{\beta c^2}$ [3]. Note: Planck mass and Planck length are denoted by m_p and l_p, respectively.

$$\alpha_G = \frac{m_{cmb}^2}{m_p^2} = \frac{l_p}{2R} \tag{1}$$

The gravitational constant can be rewritten where the Rindler horizon is $R = \frac{2\Theta}{\beta\pi^2}$ [3].

$$G_{cmb} = \frac{\hbar c}{m_{cmb}^2} \cdot \frac{\beta\pi^2 l_p}{4\Theta} \tag{2}$$

After equating $G_{cmb} = \frac{\hbar c}{m_p^2}$ one can solve for the cosmic horizon diameter [3].

$$\Theta = \frac{\beta\pi^2\hbar^2}{4m_{cmb}^2 c^2 l_p} \tag{3}$$

Rewrite the equation in order to better identify certain terms.

$$\Theta = \frac{\beta\pi^2}{2}\frac{\hbar^2}{m_{cmb}^2 c^2 2l_p} \tag{4}$$

Now use the substitution for the Compton wavelength $\lambda = \frac{\hbar c}{m_{cmb}}$.

$$\frac{2}{\beta\pi^2}\Theta 2l_p = \lambda_{cmb}^2 \tag{5}$$

Momentum can be extracted from (4) defined as the following.

$$p_{2l_p} = \frac{\hbar}{2l_p} \tag{6}$$

$$p_R = \frac{\hbar}{(\frac{2}{\beta\pi^2})\Theta} \tag{7}$$

$$p_{cmb} = m_{cmb}c \tag{8}$$

The momentum equation can be written from (4) using (6) (7) and (8).

$$p_{cmb}^2 = p_R p_{2l_p} \tag{9}$$

$$\frac{p_{cmb}^2}{p_R p_{2l_p}} = 1 \tag{10}$$

Energy can also be written using $E = pc$ from (10). This can be interpreted as a geometric mean. The geometric mean of the energy of the Planck scale Schwarzschild radius and the Rindler horizon is equivalent to the squared energy of the CMB.

$$E_{cmb}^2 = E_R E_{2l_p} \tag{11}$$

Finally establish the CMB energy equivalence principle.

$$\boldsymbol{\frac{E_{cmb}^2}{E_R E_{2l_p}} = 1} \tag{12}$$

It was determined by measurements and by Sheppeard's approach that the equivalence of the CMB energy can be correlated to neutrino properties. The experimental neutrino energy computed was $E_N = 0.00117$ eV [10] [4] [1]. This principle can be considered an alternative perspective. Therefore, replace E_{cmb} with E_N and the same equation holds true.

$$\boldsymbol{\frac{E_N^2}{E_R E_{2l_p}} = 1} \tag{13}$$

2.2 CMB/Neutrino energy, Theta and Planck length

The subtle step here is to replace Wien's constant beta with the equivalent quantized cosmic acceleration scenario where β is substituted using the Rindler horizon coordinate by the using the present size of the cosmic particle horizon. The ratio of $\frac{2}{\beta\pi^2}$ goes to unity therefore $R = \Theta$ from (1). Also this makes physical sense since the maximum wavelength needs a node to be present at the CMB emitter. This is done to show the physical nature of the CMB energy equivalence principle.

$$\alpha_G = \frac{m_{cmb}^2}{m_p^2} = \frac{l_p}{2\Theta} \tag{14}$$

The gravitational constant and cosmic diameter equations will be the following.

$$G_{cmb} = \frac{\hbar c}{m_{cmb}^2} \cdot \frac{l_p}{2\Theta} \tag{15}$$

$$\Theta = \frac{\hbar^2}{2c^2 l_p m_{cmb}^2} \tag{16}$$

Rewrite the equation using the Compton wavelength.

$$2\Theta l_p = \lambda_{cmb}^2 \tag{17}$$

Rewrite (16).

$$m_{cmb}^2 c^2 = \frac{\hbar^2}{2\Theta l_p} \tag{18}$$

Momentum can be extracted from (18) and defined as the following.

$$p_{2l_p} = \frac{\hbar}{2l_p} \tag{19}$$

$$p_\Theta = \frac{\hbar}{\Theta} \tag{20}$$

$$p_{cmb} = m_{cmb} c \tag{21}$$

Substitute to write the equation in terms of the momentum relations.

$$p_{cmb}^2 = p_\Theta p_{2l_p} \tag{22}$$

$$\frac{p_{cmb}^2}{p_\Theta p_{2l_p}} = 1 \tag{23}$$

Next the energy can be written using $E = pc$ from (22).

$$E_{cmb}^2 = E_\Theta E_{2l_p} \tag{24}$$

Finally the CMB energy equivalence principle is obtained.

$$\boldsymbol{\frac{E_{cmb}^2}{E_\Theta E_{2l_p}} = 1} \tag{25}$$

Now replace E_{cmb} with E_N and the same equation holds true.

$$\boldsymbol{\frac{E_N^2}{E_\Theta E_{2l_p}} = 1} \tag{26}$$

The following table shows the convergence using the neutrino energy and the CMB energy.

Table 1: Error Table

Equation Number	Energy Type	Error %
12	E_{cmb}	0.311
13	E_N	0.00163
25	E_{cmb}	0.00486
26	E_N	0.308

2.3 Forces over CMB

Additionally, the CMB energy equivalence principle can also be extended to a general accelerative force. A minimum cosmic acceleration can be established by computing the radiation forces over the cosmic particle horizon. The forces can be computed using $F = E/d$ where $d = R, \Theta$.

$$\frac{F_{cmb,N}^2}{F_{R,\Theta} F_{2l_p}} = 1 \tag{27}$$

Additionally, the minimum acceleration can also be defined by the following.

$$a_{min} = \frac{\sqrt{F_{R,\Theta} F_{2l_p}}}{m_{cmb,N}} = \frac{F_{cmb,N}}{m_{cmb,N}} \tag{28}$$

3 Discussions

This equivalence principle may be considered a dot product of eigenvectors, by action principles of Quantum Mechanics, and may correspond to a pre-Hilbert space scenario. For further research it is suggested to apply the Dirac notation of $\langle E_\Theta | E_{2l_p} \rangle$ to the denominator of this formula and investigate the cosmic superposition relation of energy field eigenstates. Additionally, the numerator also suggests the application of a Dirac notation considering the square power of the neutrino/CMB energy relation. Finally, it could interpreted that this principle is a type of UV/IR mixing [8].

4 Conclusion

It was demonstrated that the numerical convergence for the (vacuum) speed of light and the cosmic particle horizon can be computed by using composite parameters inherently linked to the CMB. Taking this into account, the various fundamental constants become computationally interchangeable. The cosmic particle horizon, the Planck length, the Planck constant and the CMB (corresponding Neutrino energy/mass) formally interact with each other and a novel equivalence principle has been established. This formalism is an algebraic approach that considers the composite associated equations which can also replace the electric and magnetic constants [2].

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