# Neutrino Mass Replaces Planck Mass as Fundamental Particle

Bhatt, Ankur S. Becker, F.M.

October 30, 2019

**Abstract**

The following derivation shows that the neutrino mass effectively replaces the Planck mass as a fundamental particle associated to Newton's Gravity Law. The neutrino mass is deduced from the cosmic microwave background and matches a previous obtained experimental value. Using a ratio of forces between two Planck mass pairs in comparison to two neutrino pairs, a proportion to the dimension of the Planck length and a Rindler horizon is formed. The work done on the two pairs are equivalent using this proportion. Additionally, it has been concluded that the cosmic diameter, as a particle horizon, can be written in terms of fundamental constants using Wien's displacement law and the Cosmic Microwave Background temperature.

## 1 Introduction

The Planck mass has been utilized as the fundamental mass also related to Newton's Gravity Law for over a century. This law, which includes the definition of the gravitational constant G, can be defined as the gravitational potential energy between two Planck masses at a certain distance. However, it is well known that many particle masses exist that are much smaller than the Planck mass. Some common examples include the proton, neutron and electron. Therefore, it can be surmised that the Planck mass might not be the fundamental mass that can be affected by a gravitational force. Currently, the smallest mass known to date looks to be the neutrino. It's mass has been narrowed down to a relatively small range. However, only the sum of the masses could be determined until recently. Here it is suggested that the neutrino mass could be a fundamental quantity that can be correlated to the photon energy of the Cosmic Microwave Background (CMB) [8]. Furthermore, an interesting coupling constant relation can be made between the gravitational force of two CMB masses and the Planck mass. Finally, the cosmic diameter can be theoretically derived only using fundamental constants and the CMB temperature.

## 2 Method

### 2.1 Neutrino CMB

Begin with the currently measured CMB temperature which is $T = 2.72548$ K. From Planck's law and Wien's displacement law the peak energy from the observed temperature can be computed. Using $E = BkT$ where $B = 4.965114$ is Wien's constant and $k$ is Boltzmann's constant [7].

$$E_{cmb} = \frac{hc}{\lambda} = BkT \tag{1}$$

Next use Einstein's mass energy relation $m_{cmb} = E/c^2$ to find the equivalent CMB mass at this particular energy.

$$m_{cmb} = \frac{BkT}{c^2} \tag{2}$$

Now, consider Newton's Gravity Law.

$$F_G = \frac{GM_1M_2}{r^2} \tag{3}$$

Rewrite the gravitational constant using the following $G = \frac{\hbar c}{m_p^2}$.

$$F_G = \left(\frac{\hbar c}{m_p^2}\right)\frac{M_1M_2}{r^2} \tag{4}$$

Now begin a thought experiment. Suppose two CMB masses are derived from an energy coordinate in space time equivalence. They are each located at the center of the observable universe and at the edge of the information horizon $R$ [12] [13] [2]. The observer can be seen as located at the center. Here, it is assumed that some non- local mass is located on the horizon or beyond. The Rindler horizon will be, $R = \frac{\Theta}{\beta\pi^2}$ as defined in quantized inertia [6] where $\beta = 1/B$. The Rindler horizon maximum distance is approximately equal to the particle horizon radius, $R \approx \Theta/2$. Interesting to note, it was determined both theoretically and experimentally that the energy of a right handed sterile neutrino could be $E_{\nu exp} = 0.00117$ eV [10] [4] [1] [3]. This matches the computed derivation of the CMB photon energy temperature above. This right handed sterile neutrino is assumed to be only affected by gravity. It could be located just beyond the information horizon. More will be discussed in Section 2.3. For now one can introduce a new factor called the gravitational CMB coupling constant $\alpha_G$. Assume for now that $m_{cmb}$ is the fundamental mass and can be treated physically.

$$F_G = \left(\frac{\hbar c}{m_{cmb}^2}\right)\frac{M_1 M_2}{r^2}\alpha_G \tag{5}$$

To find this new coupling constant, compute the gravitational force for the two separate scenarios. By continuing the thought experiment, locate two half Planck masses that have a distance of $R$ between them. One located at the center of the observable universe and the other right before CMB horizon at a distance of $R$. One particle is considered at the observer reference frame with a co-moving information horizon boundary. The Rindler horizon is defined as $R = \frac{\Theta}{\beta\pi^2}$. From this perspective it is necessary that the nodes fit exactly with the observer [6] and from the emitting CMB. The other are two CMB masses at with a separation distance of $R$ as well. The mass of the CMB is deduced from the emitted CMB photon at $R$ as seen in (2). Additionally, the forces of the two half Planck masses can be situated with same methodology.

$$F_{m_p/2} = \frac{G(m_p/2)^2}{R^2} \tag{6}$$

$$F_{cmb} = \frac{G m_{cmb}^2}{R^2} \tag{7}$$

Now, equate the energy of both gravitational force equations. Multiply $R$ to the CMB force equation to yield the dimension of physical work. This could represent the maximum distance of the two non-local CMB masses at a given coordinate of $R$. It could also be speculated that the CMB mass, acting as an energy localized coordinate, will lie past the information boundary of the cosmic horizon. For the Planck mass force equation, it was deduced that multiplication of the Planck length, $l_p$, finds the equivalent work done on the two half Planck masses.

$$RF_{cmb} = l_p F_{m_p/2} \tag{8}$$

Finally take the ratio of the two forces and that will be equivalent to the gravitational CMB coupling constant, $\alpha_G = \frac{F_{cmb}}{F_{m_p/2}}$. Notice this uses a similar concept to the See-saw principle [10] [11].

$$\alpha_G = \frac{m_{cmb}^2}{m_p^2} = \frac{l_p}{4R} \tag{9}$$

Replace $R = \frac{\Theta}{\beta\pi^2}$ in (9) to obtain the following.

$$\boldsymbol{\alpha_G = \frac{m_{cmb}^2}{m_p^2} = \frac{\beta\pi^2 l_p}{4\Theta}} \tag{10}$$

$$\boldsymbol{\alpha_G = \frac{(2m_{cmb})^2}{m_p^2} = \frac{\beta\pi^2 l_p}{\Theta}} \tag{11}$$

Recall that $\alpha_G = \frac{F_{cmb}}{F_{m_p/2}}$ which is the ratio of forces. It can be computed that $1/\alpha_G = \frac{4\Theta}{\beta\pi^2 l_p}$ with an error of only $4.79 \cdot 10^{-4}$. Interesting to note that if the decoupling photon temperature $T_p = 2.726$ K is used the error goes down to $9.8 \cdot 10^{-5}$. Plug in $\alpha_G = \frac{\beta\pi^2 l_p}{4\Theta}$ into (7)

$$F_G = \left(\frac{\hbar c M_1 M_2}{m_{cmb}^2 r^2}\right) \frac{\beta\pi^2 l_p}{4\Theta} \tag{12}$$

Finally, identify the new composite gravitational CMB constant.

$$\boldsymbol{G_{cmb} = \frac{\hbar c}{m_{cmb}^2} \cdot \frac{\beta\pi^2 l_p}{4\Theta}} \tag{13}$$

Where,

$$F_G = \frac{G_{cmb} M_1 M_2}{r^2} \tag{14}$$

Therefore, (14) is simply Newton's Gravity Law using only fundamental constants and the CMB as the fundamental mass.

## 2.2 Cosmic Diameter in terms of CMB parameters and Fundamental Constants

Next, use the known gravitational constant $G_H = \frac{c^3 l_p^2}{\hbar}$ and equate it to the new gravitational constant, $G_{cmb}$ [5] [9].

$$\frac{c^3 l_p^2}{\hbar} = \frac{\hbar c}{m_{cmb}^2} \cdot \frac{\beta\pi^2 l_p}{4\Theta} \tag{15}$$

Solve for the cosmic horizon diameter, $\Theta$.

$$\Theta = \frac{\beta\pi^2 \hbar^2}{4 m_{cmb}^2 c^2 l_p} \tag{16}$$

Finally replace $m_{cmb} = \frac{kT}{\beta c^2}$ to solve for for the cosmic diameter.

$$\Theta = \frac{\pi^2 \beta^3 c^2 \hbar^2}{4k^2 T^2 l_p} \tag{17}$$

This results in the following value.

$$\Theta = 8.8042 \cdot 10^{26} \quad [\mathrm{m}] \tag{18}$$

### 2.3 Determination of Neutrino Coupling Constant and Cosmic Diameter

As noted in section 2.1 the theoretical and experimental neutrino energy computed was $E_\nu = 0.00117$ eV. This coincidences with the equivalent CMB energy found in Section 2.1. Using this value, find the neutrino energy and compute the neutrino mass using $E = mc^2$.

$$m_\nu = \frac{E_\nu}{c^2} \tag{19}$$

Next utilize (9) but replace $R$ with $\Theta/2$. This corresponds to the exact nodes that will be on the information horizon. Also, replace $m_{cmb}$ with $m_\nu$.

$$\boldsymbol{\alpha_{G,\nu} = \frac{m_\nu^2}{m_p^2} = \frac{l_p}{2\Theta}} \tag{20}$$

This ratio of forces will have an error of $3.3 \cdot 10^{-5}$. Using the same procedure, the new experimental gravitational constant will be the following.

$$\boldsymbol{G_\nu = \frac{\hbar c}{m_\nu^2} \frac{l_p}{2\Theta}} \tag{21}$$

Next, use the known gravitational constant $G_H = \frac{c^3 l_p^2}{\hbar}$ and set it equal to the new neutrino gravitational constant, $G_\nu$ as in section 2.1.

$$\frac{c^3 l_p^2}{\hbar} = \frac{\hbar c}{m_\nu^2} \cdot \frac{l_p}{2\Theta} \tag{22}$$

Denote this as $\Theta_\nu$ and solve in terms of the fundamental constants.

$$\Theta_\nu = \frac{\hbar^2}{2c^2 l_p m_\nu^2} \tag{23}$$

Inserting numerical values for the fundamental constants results in the following.

$$\Theta_\nu = 8.7997 \cdot 10^{26} \quad [\mathrm{m}] \tag{24}$$

# 3 Discussion

It could be speculated that the CMB acts as an emitter and the energy transmitted could be linked to the property of mass. These results may suggest that the cosmic particle horizon might be interlinked to the phenomenon of gravity, other fundamental forces and composite physical constants. The errors using the CMB mass and neutrino mass seem to be of low numerical value. It seems both have almost full convergence.

Table 1: Error Table

| **Equation** | **Mass Type** | **Error %** |
|---|---|---|
| $\frac{m_{cmb}^2}{m_p^2} = \frac{\beta\pi^2 l_p}{4\Theta}$ | $m_{cmb}$ | 0.0479 |
| $\frac{m_\nu^2}{m_p^2} = \frac{l_p}{2\Theta}$ | $m_N$ | 0.0033 |

# 4 Conclusion

The above derivations suggest that the fundamental mass corresponds to the certain properties of a cosmic neutrino saturation or attributes of the CMB. The measured CMB photons provide a direct numerical link to the neutrino mass, and henceforth; to gravity. Additionally, a new composite version of the gravitational constant is found. From this, the cosmic diameter (particle horizon) can be computed with close convergence to the measured/estimated value. This can be done using only fundamental constants and the CMB temperature. The CMB, as anticipated, is likely a fundamental mechanism that provides a potential connection between neutrinos and their non-local states at the horizon. Here a correlation to a holographic principle could be speculated. Similar to an electrostatic approach, it could be speculated that charges might behave in a similar fashion. Further research is suggested to potentially discover more links to the CMB. This also could provide more insight about the importance of neutrinos and perhaps might lead to a future methodology explaining more about the nature of all four fundamental forces.

## 5 Acknowledgments

We would like to express gratitude to Marco Parigi for his discussions on the theory on neutrinos. We also would like to thank Dr. Mike McCulloch on his work with horizons to help facilitate this idea. Finally, we would like to sincerely thank Dr. Marni Sheppeard and Graham Dungworth for their inspiring work that led us to this conclusion.

## References

[1] P. Adamson, C. Andreopoulos, D. J. Auty, D. S. Ayres, C. Backhouse, P. D. Barnes, G. Barr, W. L. Barrett, M. Bishai, A. Blake, G. J. Bock, D. J. Boehnlein, D. Bogert, C. Bower, S. Cavanaugh, J. D. Chapman, D. Cherdack, S. Childress, B. C. Choudhary, J. A. B. Coelho, J. H. Cobb, S. J. Coleman, J. P. Cravens, D. Cronin-Hennessy, A. J. Culling, I. Z. Danko, J. K. de Jong, N. E. Devenish, M. V. Diwan, M. Dorman, A. R. Erwin, C. O. Escobar, J. J. Evans, E. Falk, G. J. Feldman, M. V. Frohne, H. R. Gallagher, A. Godley, M. C. Goodman, P. Gouffon, R. Gran, E. W. Grashorn, K. Grzelak, A. Habig, D. Harris, P. G. Harris, J. Hartnell, R. Hatcher, K. Heller, A. Himmel, A. Holin, X. Huang, J. Hylen, G. M. Irwin, Z. Isvan, D. E. Jaffe, C. James, D. Jensen, T. Kafka, S. M. S. Kasahara, G. Koizumi, S. Kopp, M. Kordosky, D. J. Koskinen, Z. Krahn, A. Kreymer, K. Lang, J. Ling, P. J. Litchfield, R. P. Litchfield, L. Loiacono, P. Lucas, J. Ma, W. A. Mann, A. Marchionni, M. L. Marshak, J. S. Marshall, N. Mayer, A. M. McGowan, R. Mehdiyev, J. R. Meier, M. D. Messier, C. J. Metelko, D. G. Michael, W. H. Miller, S. R. Mishra, J. Mitchell, C. D. Moore, J. Morfín, L. Mualem, S. Mufson, J. Musser, D. Naples, J. K. Nelson, H. B. Newman, R. J. Nichol, T. C. Nicholls, J. P. Ochoa-Ricoux, W. P. Oliver, M. Orchanian, T. Osiecki, R. Ospanov, J. Paley, V. Paolone, R. B. Patterson, i. c. v. Pavlović, G. Pawloski, G. F. Pearce, R. Pittam, R. K. Plunkett, A. Rahaman, R. A. Rameika, T. M. Raufer, B. Rebel, P. A. Rodrigues, C. Rosenfeld, H. A. Rubin, V. A. Ryabov, M. C. Sanchez, N. Saoulidou, J. Schneps, P. Schreiner, P. Shanahan, W. Smart, C. Smith, A. Sousa, P. Stamoulis, M. Strait, N. Tagg, R. L. Talaga, J. Thomas, M. A. Thomson, G. Tinti, R. Toner, G. Tzanakos, J. Urheim, P. Vahle, B. Viren, M. Watabe, A. Weber, R. C. Webb, N. West, C. White, L. Whitehead, S. G. Wojcicki, D. M. Wright, T. Yang, K. Zhang, and R. Zwaska. Search for sterile neutrino mixing in the minos long-baseline experiment. *Phys. Rev. D*, 81:052004, Mar 2010.

[2] R. Bousso and S. W. Hawking. Pair creation of black holes during inflation. *Phys. Rev. D*, 54:6312–6322, Nov 1996.

[3] P. collaboration, M. G. Betti, M. Biasotti, A. Boscá, F. Calle, G. Cavoto, C. Chang, A. G. Cocco, A. P. Colijn, J. Conrad, N. D'Ambrosio, N. D. Groot, P. F. de Salas, M. Faverzani, A. Ferella, E. Ferri, P. Garcia-Abia,

I. García-Cortés, G. G. Gomez-Tejedor, S. Gariazzo, F. Gatti, C. Gentile, A. Giachero, J. E. Gudmundsson, Y. Hochberg, Y. Kahn, A. Kievsky, M. Lisanti, C. Mancini-Terracciano, G. Mangano, L. E. Marcucci, C. Mariani, J. Martínez, M. Messina, A. Molinero-Vela, E. Monticone, A. Moroño, A. Nucciotti, F. Pandolfi, S. Parlati, S. Pastor, J. Pedrós, C. P. de los Heros, O. Pisanti, A. D. Polosa, A. Puiu, I. Rago, Y. Raitses, M. Rajteri, N. Rossi, I. Rucandio, R. Santorelli, K. Schaeffner, C. G. Tully, M. Viviani, F. Zhao, and K. M. Zurek. Neutrino physics with the ptolemy project, 2019.

[4] G. Dungworth and M. Sheppeard. Non local mirror neutrinos with r=ct. 11 2017.

[5] E. Haug. The gravitational constant and the planck units. a simplification of the quantum realm. *Physics Essays*, 29:558–561, 12 2016.

[6] M. E. McCulloch. Minimum accelerations from quantised inertia. *EPL (Europhysics Letters)*, 90(2):29001, 2010.

[7] P. J. Mohr, D. B. Newell, and B. N. Taylor. Codata recommended values of the fundamental physical constants: 2014. *Rev. Mod. Phys.*, 88:035009, Sep 2016.

[8] A. A. Penzias and R. W. Wilson. A Measurement of Excess Antenna Temperature at 4080 Mc/s. *apj*, 142:419–421, July 1965.

[9] M. Planck. Naturlische masseinheiten. *Der Koniglich Preussischen Akademie Der Wissenschaften*, page 479, 1899.

[10] M. Sheppeard. The algebra of non local neutrino gravity. 01 2018.

[11] M. D. Sheppeard. Constraining the standard model in motivic quantum gravity. *Journal of Physics: Conference Series*, 1194:012097, apr 2019.

[12] W. Unruh. Acceleration radiation for orbiting electrons. 307:163–171, 04 1998.

[13] W. G. Unruh. Notes on black-hole evaporation. *Phys. Rev. D*, 14:870–892, Aug 1976.