A Further Step towards the Fundamental Unit of Mass

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Abstract:

The search towards the fundamental natural units of mass, distance and time began with Weyl [1,2], Eddington [3] and Dirac [4]. Max Planck derived fundamental units purely from fundamental physical constants *h*, *c* and *G* [5]. Weinberg proposed a formula for obtaining a unit of mass using the constants: *h* , *c* , *G* and H_0 , where H_0 is Hubble's constant [6]. Tank showed [7] that Planck's unit of length is a geometric-mean of two un-equal lengths; namely Compton-wavelength and Gravitational-radius of every particle, so the units, obtained by taking square-root of a set of fundamental physical constants, may not be truly fundamental units. Weinberg obtained a unit of mass by taking cube-root of a set of fundamental-constants, so we are not sure whether the multiplication of three masses in Weinberg's formula are of the same masses or of different masses. Therefore, here we shall derive a unit of mass without taking any square-root or cube-root. There is a possibility of physical existence of a particle with this mass, $h\, H_0 / c^2$; and it seems that a photon decays into a lighter photon plus this new particle of mass : $h\, H_0 / c^2$.

Introduction:

Weyl, Eddington and P.A.M. Dirac independently worked on an idea, that: We measure physical quantities in arbitrarily chosen units like: meter, kilogram and seconds. We should use some standard physical length, like the 'classical radius of an electron' (r_e), to measure lengths. As soon as they expressed the 'radius of the universe' R_0 in terms of 'radius of an electron', to their pleasant surprise the ratio: (R_0 / r_e) turned out to be equal to the ratio ($e^2/ G\, m_e\, m_p$) = 10^{40}. And the ratio (M_0 / m_p) = ($e^2/ G\, m_e\, m_p)^2$ = 10^{80} ; here M_0 is 'total mass of the universe' and m_p is mass of a proton. Though Dirac's 'Large Number Hypothesis', predicting reduction of 'strength of gravity' with age of the universe, did not match with observations, the numerology of the above 'Large Number Coincidence' has been striking. Later in 1997 this writer while explaining the 'large-number-coincidence' [8], showed that this coincidence implies that: Mass of the universe is equal to gravitational potential-energy of the universe; and electro-static potential-energy stored in an electron is equal to energy of mass of it.

Similarly Max Planck tried to derive natural units, of mass, length and time, purely from the fundamental physical constants; but Planck's unit of mass did not match with mass of any physically observed particle; and his unit of length did not match with Compton wavelength of any particle. Later this writer showed [7] that Planck's unit of mass is 'geometric mean value' of two different masses, namely 'total mass of the universe' M_0 and smallest conceivable mass ($h\, H_0\, /\, c^2$); and similarly, Planck's length is geometric-mean of Compton-wavelength and Gravitational-radius of every particle. So the mass and length obtained by taking square-root of a set of fundamental-constants may not be truly fundamental. To remind the readers, Planck's units of mass and length are:

$m_{\mathrm{P}} = \sqrt{\frac{\hbar c}{G}}$, and $l_{\mathrm{P}} = \sqrt{\frac{\hbar G}{c^3}}$

Following the line of thinking of Planck, Steven Weinberg tried to derive a fundamental unit of mass by taking four different fundamental constants, including H_0 [6].

Weinberg's mass: $m_W^3 = h^2 H_0 / c\,G$ ……………………………………..(1)

Here H_0 is Hubble's constant. But, in the LHS of expression-1 we are not sure, whether the product of three masses is of the same masses, or of different ones. So let us divide both the sides of expression-1 by a well-known set of fundamental-constants, $h\,c / G$, so that we do not have to take square-root or cube-root:

i.e. $(m_W^3) / (h\,c / G) = (h^2 H_0 / c\,G) / (h\,c / G)$

i. e. $m_T = h H_0 / c^2$ ………………………………………………………....(2)

Where: m_T is a fundamental unit of 'mass' proposed by this writer.

It may be interesting to see that: just as the 'fine-structure-constant' $(e^2/ h\,c) = (m_e / m_{pion})$, so exactly the product: $(e^2/ h\,c)\,[(G\,m_e\,m_{proton})/ (e^2)] = [(h\,H_0 /c^2) / m_e)]$. So the mass $(h\ H_0\ /\ c^2)$ seems to be of physical significance, not just a mathematical quantity.

The gravitational radius of this mass would be:

$[\,G\,(h\,H_0 / c^2) / c^2\,]$

The Compton wavelength of this particle would be:

Compton wavelength: $[\,h / (h\,H_0 / c^2)\,c\,]$.

And the product of its gravitational-radius and Compton wavelength:

$[\,G\,(h\,H_0 / c^2) / c^2\,]\,[\,h / (h\,H_0 / c^2)\,c\,] = [\,h\,G / c^3\,]$, which is the square of Planck's length. As was mentioned earlier, Planck's length has been the geometric-mean of two un-equal lengths. Therefore we derived here the unit of mass without taking any square-root or cube-root.

The linear part of the 'cosmological red-shift' is expressed as:

$(h\,f_0 - h\,f) / (h\,f) = H_0 D / c$

i.e. $(h\,f_0 - h\,f) = [\,(h\,f)\,H_0 D / c\,] = [\,(h\,H)\,(D / \lambda)\,]$ …………………….(3)

The expression-3 implies that the cosmologically red-shifting photon continuously splits into a lighter photon and the 'particle of fundamental mass $h\,H / c$, while traveling every distance of its wavelength.

Similarly, there seems to a fundamental unit of acceleration, a_0 :

Where: $a_0 = G\,(h\,H / c^2) / (\,h\,G / c^3\,) = H\,c$ ………………………………….(4)

The cosmologically red-shifting photon can be viewed as decelerating at this rate, as follows:

$(\,h\,f_0 - h\,f\,) / (\,h\,f\,) = H_0\,D / c$

i.e. $(\,h\,f_0 - h\,f\,) = [\,(\,h\,f / c^2\,)\,(\,H_0\,\,c\,)\,D$ …………………………………….(5)

Even the four space-probes Pioneer-10, Pioneer-11, Galileo and Ulysses too are observed to decelerate at this rate, $H_0\,\,c$, as Anderson J. D. et al have reported.

References:

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