Solution to the Mysterious Weinberg Formula

Claude Mercier eng., April 2nd, 2013 claude.mercier@cima.ca
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In 1972, Weinberg formulated an empirical equation giving the mass of an object that appears to be a typical mass of a particle [1,10]*. His equation is not derived from any known equation. However, according to his words, ″… it should be noted that the particular combination of ħ, H_0, G and c appearing (in the formula) is much closer to a typical elementary particle mass than other random combinations of these quantities… ″.*

Following our researches on the acceleration of light over time [2]*, on the Dirac hypothesis on great numbers* [3]*, and on the theoretical calculation of the universal gravitational constant G* [4]*, we are now able to modify slightly the mysterious Weinberg formula, by adding a proportionality constant, to show that it should be equal to the mass of the electron. Changes would not be possible if we did not take into account the fact that the universe is expanding.*

Indeed, these calculations would be impossible to achieve without the use of the constant β that we discovered when we did work on the acceleration of light over time [2]. The equation gives the precise value of the mass of the electron presented in CODATA 2010 [5]: $m_e \approx 9.10938291 \pm 0.00000040 \times 10^{-31}$ kg. Although current measures of G and H_0 do not achieve this precision, this equation highlights the interrelationship between these constants.

KEY WORDS: Weinberg, Dirac, theory of great numbers, Hubble, H_0, G

1. INTRODUCTION

The universe is expanding [6]. It is expanding at the speed of light [7], at least for the luminous part of it. However, it cannot be the same for the material universe [2].

According to the principles of Einstein's relativity, a mass that moves at a velocity v is affected by the Lorentz factor [8,9]. The higher the speed, the greater is the mass. Ultimately, if the speed v tends to be the speed of light in vacuum c, the mass of the object approaches infinity. As an infinite mass is inconceivable, we come to the conclusion that the velocity of an object must necessarily be less than that of light.

According to a model of the universe that we have presented in the past [2], we found that the material universe must be expanding at a rate of $\beta \cdot c \approx 0.76 \cdot c$.

According to our conception of the universe, the inter-particle interactions taking place in the microscopic world have a direct effect on the macroscopic world and vice versa. Everything is intimately interrelated.

In this paper, we will show that the “mysterious Weinberg formula,” according to the words used by B. G. Sidharth [10], is in fact an empirical equation giving a mass similar to that of a typical elementary particle. It does not correspond to any known particle.

We will show that the Weinberg formula can be deduced from one of our equations that we found in the past [3,4] that gave the theoretical value of the Hubble constant H_0. By deducing it from our equation, we will find, at the same time, the constant of the missing proportionality to connect it to the real world, that is to say, to one of the known particles (in this case, the electron).

We will begin by presenting the Weinberg formula and some equations that have already been found in previous studies. From these equations we will deduce the Weinberg formula and we will relate it specifically to the mass of the electron.

2. DEVELOPMENT

2.1. Weinberg formula

Weinberg found an empirical formula which seems to give a value for a typical mass for a particle:

$$m \approx \left(\frac{H_0 \cdot \hbar^2}{G \cdot c} \right)^{\frac{1}{3}} \approx 1 \times 10^{-28} \text{kg} \tag{1}$$

Due to the fact that this equation is empirical, this equation is incomplete. We will show in this paper that by introducing the fine structure constant α and the constant β (described later), we will obtain exactly the mass of the electron:

$$m_e = \left(\frac{H_0 \cdot \hbar^2}{G \cdot c} \right)^{\frac{1}{3}} \cdot \frac{\alpha}{\sqrt{\beta}} \tag{2}$$

The value of β is an irrational number. It expresses the ratio between the rate of the expansion of the material universe and the speed of light in vacuum c [2]:

$$\beta = 3 - \sqrt{5} \approx 0.764 \qquad \textbf{(3)}$$

2.2. Theoretical Hubble Constant from Previous Works

In previous works [3] that we made public on Internet, we were showing that the value of the Hubble constant H_0 could be expressed by an equation whose accuracy depended mainly on the universal gravitational constant G.

$$H_0 = \frac{G \cdot m_e \cdot \beta^{3/2}}{c \cdot \alpha \cdot r_e^2} \qquad \textbf{(4)}$$

In more recent works [4], we obtained an equation that was used to calculate the universal gravitational constant G with a precision which depended mainly on the fine structure constant α, of the classical radius of an electron r_e, its mass m_e, and the speed of light in vacuum c:

$$G = \frac{c^2 \cdot r_e \cdot \alpha^{20}}{m_e \cdot \beta} \approx 6.67323036 \pm 0.00000030 \times 10^{-11}\ \mathrm{m}^3 / \left(kg \cdot s^2\right) \qquad \textbf{(5)}$$

According to the CODATA 2010 [5]:

- The actual speed of light in vacuum is $c \approx 299792458$ m/s
- The universal gravitational constant is $G \approx 6.67384\times10^{-11}$ m^3/(kg·s^2)
- The fine structure constant $\alpha \approx 7.2973525698\times10^{-3}$
- The classical radius of the electron is $r_e \approx 2.8179403267\times10^{-15}$ m
- The mass of the electron at rest is $m_e \approx 9.10938291\times10^{-31}$ kg

Using the equations **(4)** and **(5)**, we can obtain the following equation:

$$H_0 = \frac{c \cdot \alpha^{19} \cdot \beta^{1/2}}{r_e} \qquad \textbf{(6)}$$

$$H_0 \approx 72.09548632 \pm 0.00000046 \mathrm{km} / \left(s \cdot MPar\mathrm{sec}\right) \qquad \textbf{(7)}$$

Several research teams around the world have developed their own way of measuring the Hubble constant and get results that they expect to be the most accurate possible. With hindsight, we also find that some results are probably presented with margins of error which do not overlap. Since we do not know all the details that led to these results, it becomes difficult to give more credit to one or the other measurement method.

Our method to get H_0 does not come from direct measurements [2]. It involves, among other things, that there is a theoretical link between this parameter and the universal gravitational constant *G*. If the theoretical link that we found is good, then the margin of error is almost entirely based on the constant *G* since its margin of error is much greater than that of other used fundamental constants.

Since the assumptions of this paper are based on the recognition among some numbers dependent on H_0, the accuracy of this parameter seems crucial. If all the assumptions we have made in the past are true, it is logical that we should use the results of our calculations… until we find ourselves confronted with a phenomenon which invalidates what we found.

Since we still care about showing values that match independent researches, let's note that the value of H_0 obtained in **(7)** is in accordance with the one measured by the Xiaofeng Wang's team [11] that obtained the following value: $H_0 \approx 72.1 \pm 0.9$ km/(s·MParsec).

In previous works [3], we obtained an equation that enabled us to calculate the universal gravitational constant G , which had an accuracy depending mainly on the fine constant α , on the classical radius of electron r_e , on its mass m_e and on the speed of light in vacuum c:

$$G = \frac{c^2 \cdot r_e \cdot \alpha^{20}}{m_e \cdot \beta} \approx 6.6732309 \pm 0.0000003 \times 10^{-11}\ \mathrm{m}^3 / \left(kg \cdot s^2\right) \qquad \textbf{(8)}$$

Let's note that the value of the universal gravitational constant G obtained by equation **(8)** is in agreement with the one mentioned in the CODATA 2010 [5] which is $G \approx 6.67384 \pm 0.00080 \times 10^{-11}$ $\mathrm{m}^3/(\mathrm{kg} \cdot \mathrm{s}^2)$. Because we claim that the value of equation **(8)** is more accurate than the CODATA, we will use this value advantageously for the rest of this paper. Indeed, it allows us to conclude at the end that we are able to calculate the exact value of the mass of the electron, which would have been impossible to do with the value of *G* found in the CODATA [5].

2.3. Weinberg Formula

Let's show that equation **(2)** comes in fact from one of the equations that we have found and which expresses the theoretical value of the Hubble constant H_0 [3]. Let's start form the following equation (already cited in equation **(4)**):

$$H_0 = \frac{G \cdot m_e \cdot \beta^{3/2}}{c \cdot \alpha \cdot r_e^2} \qquad \textbf{(9)}$$

Isolating m_e , we get:

$$m_e = \frac{c \cdot H_0 \cdot \alpha \cdot r_e^2}{G \cdot \beta^{3/2}} \tag{10}$$

Given that the energy contained in the mass of the electron at rest is equal to the energy of the wave having a wavelength equal to the Compton wavelength associated with an electron, we have:

$$m_e \cdot c^2 = \frac{h \cdot c}{\lambda_c} \tag{11}$$

The Compton wavelength associated to an electron is equal to:

$$\lambda_c = \frac{2 \cdot \pi \cdot r_e}{\alpha} \tag{12}$$

So, we have:

$$m_e \cdot c^2 = \frac{h \cdot c \cdot \alpha}{2 \cdot \pi \cdot r_e} \tag{13}$$

Knowing that $\hbar = h/(2\pi)$, we find that:

$$r_e^2 = \frac{\hbar^2 \cdot \alpha^2}{m_e^2 \cdot c^2} \tag{14}$$

Equation **(10)** becomes:

$$m_e^3 = \frac{H_0 \cdot \hbar^2 \cdot \alpha^3}{G \cdot c \cdot \beta^{3/2}} \tag{15}$$

Isolating m_e, this equation becomes:

$$m_e = \left(\frac{H_0 \cdot \hbar^2}{G \cdot c}\right)^{\frac{1}{3}} \cdot \frac{\alpha}{\sqrt{\beta}} \approx 9.10938291 \pm 0.00000031 \times 10^{-31} \text{kg} \tag{16}$$

According to the CODATA 2010 [5], the mass of an electron is $m_e \approx 9.10938291 \times 10^{-31}$ kg with a precision of $\pm 0.00000040 \times 10^{-31}$ kg. The fact that the uncertainty of the result of equation **(16)** is slightly smaller than the CODATA 2010 is not significant. In fact, the two should be equal. However, the fact that everything fits means that the equation **(16)** well describes the interrelationship between these physical constants (G, H_0, c, $\hbar$, α and β) and the mass of the electron m_e.

We note the similarity between equation **(16)** and the mysterious Weinberg empirical formula [1,10] shown in equation **(1)**. We note that there is a

$\alpha / \sqrt{\beta}$ coefficient of difference.

We also note that without the factor β that we deduced from our model of the expanding universe [2], we would never have obtained the equality with the mass of the electron m_e in equation **(16)**.

3. CONCLUSION

The mysterious Weinberg formula giving a typical mass of a particle is the result of an empirical equation based on the layout of fundamental constants of physics in order to obtain a result with a unit of mass. At the same time, this result was close enough to the true values of masses of the main known particles (electron, proton, and neutron). It seemed to miss a simple proportionality constant to obtain the value of an existing mass.

In this paper, we show that the Weinberg equation can be obtained from an equation that we have established for the Hubble constant [3]. This allowed us to find the constant of proportionality that was missing to get exactly the mass of an electron. At the same time, it comforts us in our equations **(4)** to **(8)**. Indeed, the theoretical equations that we found for H_0 and G appear to be correct and accurate, as we have just shown that it is possible to calculate, thanks to them, the mass of electron. Remember that without the use of our factor β, the link between the Weinberg formula and the mass of an electron m_e would never have been found. It seems that this value, obtained from our model of the universe [1], can also be used in the microscopic world. We believe that this constant can be useful to make the link between several fundamental constants in physics.

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