The universal unit of time, the age of the Universe and the exact calculation of the gravitational constant G

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Introduction

It is hypothesised that the Universe is not only expanding in space, but also in time (i.e. time slows down as the Universe ages). A new universal unit of time, acting as a scaling factor for the Universe, is proposed. An equation to calculate the age of the Universe and an equation to calculate the exact value of the gravitational constant G from the other fundamental constants are introduced.

The universal unit of time (T_{factor})

Using the 2014 CODATA recommended values [1], the proposed equation for the universal unit of time is:

$$T_{factor} = \frac{\alpha}{\nu_e \times \alpha_G} = \frac{\alpha \times \lambda_e^3 \times c^2}{2\pi \times \mu^2 \times G \times h} = 1.000001 \times 10^{16} \text{ sec} \quad (1)$$

T_{factor} = Universal unit of time (and scaling factor)
α = Fine structure constant
ν_e = Electron Compton frequency
α_G = Gravitational coupling constant (proton/proton)
λ_e = Electron Compton wavelength
c = Speed of light
μ = Proton to electron mass ratio
G = Gravitational constant
h = Planck constant

Taking into account the relative standard uncertainty (4.7×10^{-5}) on the gravitational constant G [1], it is proposed that the value of the T_{factor} is exactly 1×10^{16} sec.

The above equation is derived from the hypothesis that the electron Compton frequency and the ratio between the electromagnetic force and the gravitational force are linked as follows:

$$T_{factor} = \frac{F_{electromagnetic}}{\nu_e \times F_{gravity}} \quad (2)$$

The standard equation for the ratio between the electromagnetic force and the gravitational force between two protons is:

$$\frac{F_{electromagnetic}}{F_{gravity}} = \frac{k_e \times e^2}{G \times m_{pr}^2} = \frac{\alpha \times h \times c}{2\pi \times G \times m_{pr}^2} = \frac{\alpha \times \lambda_e^2 \times c^3}{2\pi \times \mu^2 \times G \times h} = \frac{\alpha}{\alpha_G} \quad (3)$$

k_e = Coulomb's constant
e = Elementary charge
m_{pr} = Proton mass

Combining (2) and (3):

$$T_{factor} = \frac{\alpha}{\nu_e \times \alpha_G} = \frac{\alpha \times \lambda_e^3 \times c^2}{2\pi \times \mu^2 \times G \times h} = 1.\ 000001 \text{ x } 10^{16} \text{ sec} \quad (1)$$

The age of the Universe and the T_{factor}

It is proposed that the age of the Universe and the T_{factor} have the following relationship:

$$A_u = \frac{T_{factor}}{\alpha \times \pi} = \frac{1}{\pi \times \nu_e \times \alpha_G}$$

A_u = Age of the Universe
T_{factor} = Universal Unit of Time (and scaling factor)
α = Fine structure constant
ν_e = Electron Compton frequency
α_G = Gravitational coupling constant (proton/proton)

The above equation can be verified in two ways:

Taking the universal unit of time T_{factor} to be exactly 1 x 10^{16} sec and using the 2014 CODATA recommended value for the fine structure constant α [1]:

$$A_u = \frac{1}{\alpha \times \pi} \times 10^{16} \text{ sec} = 4.361991 \text{ x } 10^{17} \text{ sec (13.8223 x } 10^9 \text{ years)} \quad (4)$$

Using the 2014 CODATA recommended values for ν_e and α_G [1]:

$$A_u = \frac{1}{\pi \times \nu_e \times \alpha_G} = 4.361999 \text{ x } 10^{17} \text{ sec (13.8223 x } 10^9 \text{ years)} \quad (5)$$

These values are in agreement with the 2015 Planck estimate for the age of the Universe of 13.813 ± 0.038 billion years [2].

The gravitational constant G and the T_{factor}

From equation (1) and taking the universal unit of time T_{factor} to be exactly 1 x 10^{16} sec, the exact value for the gravitational constant G can be calculated:

$$G = \frac{\alpha \times \lambda_e^3 \times c^2}{2\pi \times \mu^2 \times h \times T_{factor}} = 6.674093051 \text{ x } 10^{-11} \text{ m}^3 \text{ Kg}^{-1} \text{ sec}^{-2} \quad (6)$$

The 2014 CODATA recommended value is 6.67408 (31) x 10^{-11} m^3 Kg^{-1} sec^{-2} [1].

From equation (1), the following relationship between the gravitational constant G and the Coulomb constant k_e is revealed:

$$G = k_e \times \frac{e^2}{m_e^2 \times \mu^2 \times \nu_e \times T_{factor}} \quad (7)$$

Combining equations (4) and (6):

$$G = \frac{\lambda_e^3 \times c^2}{2\pi^2 \times \mu^2 \times h \times A_u} = \frac{h^2}{2\pi^2 \times c \times \mu^2 \times m_e^3 \times A_u} \quad (8)$$

Extracting the electron mass m_e and using the value of A_u from equation (5):

$$m_e = \sqrt[3]{\frac{h^2}{2\pi^2 \times c \times \mu^2 \times G \times A_u}} = 9.10938356 \times 10^{-31} \text{ Kg} \quad (9)$$

The 2014 CODATA recommended value [1] is 9.10938356 (11) x 10^{-31} Kg.

The similarities with the Weinberg's empirical formula for the mass of a typical elementary particle [3] are noted.

$$m \approx \sqrt[3]{\frac{h^2 \times H_0}{4\pi^2 \times c \times G}} \quad \text{(Weinberg formula)} \quad (10)$$

H_0 = Hubble constant

Conclusion

The equations presented above set the foundations for a new model of the Universe. The implications of this new model are far reaching and may include the following:

- As well as space, time also expands (i.e. time slows down as the Universe ages)
- Particles also expand/change scale
- Time and space are quantized and are geometrically linked
- Constants such as G, h, c and v_e vary over cosmic time scales, but this change is unnoticed as they all vary together; this possibility is discussed in several publications [4],[5],[6]
- The small and large scale structures of the Universe are inextricably linked
- At the start of the Universe, electromagnetic and gravitational forces were of the same magnitude
- "Fine-tuning" is a continuing process from the very start of the Universe

References

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