Analytical estimation of the gravitational constant with atomic and nuclear physical constants

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Introduction

If N_A represents the Avogadro's number, gravitational constant associated with atomic electromagnetic interaction [1,2,3,4] can be expressed as $G_E \cong N_A^2 G.$ With G_E and with the assumed two new pseudo numbers $x \approx 38.725$ and $y \approx 47.415,$ value of G can be fixed for 10 digits in a verifiable approach [2]. (x, y) can be called as the 'back ground analytical numbers' using by which micro-macro physical constants can be interlinked qualitatively and quantitatively.

Application-1: **Rest masses of electron and proton**

Electron rest mass can be expressed in the following way.

$$m_e \cong x^{\frac{1}{2}} y \sqrt{\frac{e^2}{4\pi\varepsilon_0 G_E}} \tag{1}$$

With (x, y), proton rest mass can be expressed in the following way.

$$m_p \cong x^{\frac{3}{2}} y^2 \sqrt{\frac{e^2}{4\pi\varepsilon_0 G_E}} \tag{2}$$

$$\rightarrow \frac{m_p}{m_e} \cong xy \tag{3}$$

Application-2: Rest masses of muon and tau

$$\text{Let, } \beta \cong x^{\frac{1}{2}} y \tag{4}$$

where β can be called as the electron mass index. It can be estimated as:

$$\beta \cong x^{\frac{1}{2}} y \cong \sqrt{\frac{4\pi\varepsilon_0 G_E m_e^2}{e^2}} \cong 295.0509223 \tag{5}$$

With this number β, electron, muon and tau rest masses can be fitted with the semi empirical relation.

$$\left. \begin{aligned} \left(m_{lepton}\right)_n c^2 &\cong \left[\beta^3 + \left(n^2\beta\right)^n \sqrt{N_A}\right]^{\frac{1}{3}} \sqrt{\frac{e^2 c^4}{4\pi\varepsilon_0 G_E}} \\ &\cong \left[\beta^3 + \left(n^2\beta\right)^n \sqrt{N_A}\right]^{\frac{1}{3}} 0.001731 \text{ MeV} \end{aligned} \right\} \tag{6}$$

where $n = 0,1,2.$ Obtained rest energies are 0.511 MeV, 105.95 MeV and 1777.4 MeV respectively. New heavy charged lepton at $n = 3$ may be predicted close to 42262 MeV. This is for future experimental observations.

Application-3: The reduced Planck's constant

From above relations,

$$\left. \begin{aligned} x &\cong \left(\frac{1}{\beta}\frac{m_p}{m_e}\right)^2 \cong 38.72787108 \\ y &\cong \left(\frac{1}{x}\frac{m_p}{m_e}\right) \cong 47.41166036 \end{aligned} \right\} \tag{7}$$

If so, Reduced Planck's constant can be with fitted the following semi empirical relation.

$$\left(e^x\right)^{-\frac{1}{6}} \left(\frac{G_E m_e^2}{c}\right) \cong \hbar \tag{8}$$

Application-4: **To fit the nuclear unit charge radius**

With reference to the electron scattering experiments, it is also noticed that,

$$\left. \begin{aligned} &\left(\frac{\hbar c}{G_E m_e^2}\right)^2 \left(\frac{2G_E m_e}{c^2}\right) \cong R_0 \cong 1.215\times 10^{-15} \text{ m} \\ &\rightarrow \left(\frac{G_E m_e^2}{\hbar c}\right) \cong \sqrt{\frac{2G_E m_e}{c^2 R_0}} \cong \left(e^x\right)^{\frac{1}{6}} \end{aligned} \right\} \tag{9}$$

Application-5: To fit the characteristic nuclear binding energy constant

Note that, by considering the nuclear Fermi model, it is possible to show that- at stable mass numbers of $Z \geq 30$,

A) Ratio of nuclear binding energy and Fermi model of protons' kinetic energy is equal to unity.
B) Ratio of nuclear binding energy and proton number is close to 19.7 MeV.

Characteristic nuclear binding energy constant can be fitted as:

$$B_0 \cong \left(m_p c^2 / y\right) \cong 19.79 \text{ MeV} \qquad (10)$$

For details, readers are encouraged to see the authors recently published paper [5].

To fit and verify the gravitational constant

G. Rosi et al say [6]: "There is no definitive relationship between G and the other fundamental constants, and there is no theoretical prediction for its value, against which to test experimental results. Improving the precision with which we know G has not only a pure metrological interest, but is also important because of the key role that G has in theories of gravitation, cosmology, particle physics and astrophysics and in geophysical models".

In this context, from above relations and with the following set of three semi empirical relations, like other physical constants, magnitude of the gravitational constant can be fitted for 10 digits.

$$\left.\begin{array}{l} x \cong \ln\left(\dfrac{G_E m_e^2}{\hbar c}\right)^6 \quad ....(11) \\ y \cong \left(\dfrac{m_e}{m_p}\right)\dfrac{4\pi\varepsilon_0 G_E m_e^2}{e^2} .....(12) \\ xy - \left(\dfrac{m_p}{m_e}\right) \cong 0 \quad ......(13) \end{array}\right\}$$

By assuming the value of G and considering the value of N_A, value of x can be estimated. By considering the value of x, value of y can be estimated. By considering both the values of (x, y), best value of value of G can be taken when relation (13) seems to be satisfied. Thus relations (11,12 and 13) can be considered as the 3 characteristic semi empirical unified relations.

$$\left.\begin{array}{l} \text{By considering} \\ N_A \cong 6.022141293 \times 10^{23} \\ m_e \cong 9.109382914 \times 10^{-31} \text{ kg} \\ m_p \cong 1.672621777 \times 10^{-27} \text{ kg} \\ \hbar \cong 1.054571726 \times 10^{-34} \text{ J.sec} \\ c \cong 2.99792458 \times 10^{8} \text{ m/sec} \\ \text{e} \cong 1.602176565 \times 10^{-19} \text{ C} \\ \varepsilon_0 \cong 8.854187817 \times 10^{-12} \text{ J.m} \\ \text{and by assuming,} \\ \begin{cases} G \cong 6.674378868 \times 10^{-11} \text{ m}^3\text{kg}^{-1}\text{sec}^{-2} \\ x \cong 38.72479081 \text{ and } y \cong 47.41543166 \end{cases} \\ \text{relation (13) can be satisfied.} \end{array}\right\}$$

This estimated value of G may not be absolute but can be given some consideration in unification program for further analysis.

References

[1] U. V. S. Seshavatharam, S. Lakshminarayana. Nucleus in Strong nuclear gravity. Proceedings of the DAE Symp. on Nucl. Phys. 56, pp.302 (2011)

[2] U. V. S. Seshavatharam and S. Lakshminarayana, to confirm the existence of atomic gravitational constant. Hadronic journal, Vol-34, No 4, p379 (2011).

[3] U. V. S. Seshavatharam, S. Lakshminarayana . On fixing the magnitudes of gravitational constant and strong coupling constant. International Journal of Advanced Astronomy, 3 (1) 17-23. (2015)

[4] U. V. S. Seshavatharam, S. Lakshminarayana. Final unification with Schwarzschild's interaction. Journal of Applied Physical Science International. 3(1): 12-22, 2015.

[5] U. V. S. Seshavatharam, Lakshminarayana S. Understanding Nuclear Stability, Binding Energy and Magic Numbers with Fermi Gas Model. Journal of Applied Physical Science International, 4 (2) pp.51-59 (2015)

[6] G. Rosi, F. Sorrentino, L. Cacciapuoti, M. Prevedelli and G. M. Tinol. Precision measurement of the Newtonian gravitational constant using cold atoms. Nature 510, 518-521. (2014)