Mapana Journal of Sciences
2020, Vol. 19, No. 1, 1-13
ISSN 0975-3303 | https://doi.org/10.12723/mjs.52.1

Is Reduced Planck's Constant- An Outcome of Electroweak Gravity?

U V S Seshavatharam* and Srirama Lakshminarayana †

Abstract

When the mass of any elementary particle is extremely small/negligible compared to macroscopic bodies, highly curved microscopic space-time can be addressed with large gravitational constants and magnitude of elementary gravitational constant seems to increase with decreasing mass and increasing interaction range. Following the notion of string theory, compactification of six un-observable spatial dimensions might be playing a key role in hiding the large magnitudes of the three atomic gravitational constants. The existence of three large atomic gravitational constants are assumed to be associated with electroweak, strong and electromagnetic interactions is well established. Proceeding further, it is found that 1) Electroweak field seems to be operated by a primordial massive fermion of rest energy 585 GeV and can be considered as the zygote of all elementary particles and galactic dark matter; 2) H-bar seems to be a compactified outcome of unified electroweak gravity.

Keywords: Four gravitational constants; Electro weak Fermion; Reduced Planck's constant;

Orcid numbers: 0000-0002-1695-6037 (and) 0000-0002-8923-772X

---

* Honorary faculty, I-SERVE, Hyderabad-84, Telangana, India; seshavatharam.uvs@gmail.com
† Dept. of Nuclear Physics, Andhra University, Visakhapatnam, Andhra Pradesh, India; lnsrirama@gmail.com

Nomenclature

1. Newtonian gravitational constant = G_N
2. Electromagnetic gravitational constant= G_e
3. Nuclear gravitational constant = G_s
4. Weak gravitational constant = G_W
5. Fermi's weak coupling constant = G_F
6. Strong coupling constant = α_s
7. Electroweak fermion = M_w
8. Reduced Planck's constant = $\hbar$
9. Speed of light = c
10. Elementary charge = e
11. Strong nuclear charge = e_s
12. Mass of proton = m_p
13. Mass of neutron = m_n
14. Mass of electron = m_e

1. Charge radius of nucleus= R_0
2. Magnetic moment of proton = μ_p
3. Neutron life time= t_n
4. Weak interaction string tension= F_w
5. Strong interaction string tension= F_s
6. Electromagnetic interaction string tension= F_e
7. Gravitational interaction string tension= F_g
8. Weak interaction string potential= E_w
9. Strong interaction string potential = E_s
10. Electromagnetic interaction string potential = E_e
11. Gravitational interaction string potential = E_g
12. Fine structure ratio = α
13. Nuclear fine structure ratio = α_n

1. Introduction

The subject of final unification is very interesting and challenging. Unifying gravity and quantum mechanics is complicated and scientists are trying in different ways [1-9]. Considering the four gravitational constants assumed to be associated with the four basic interactions, we have developed many practical applications [10-13]. In this paper we present important relations pertaining to weak [14-17], strong [18, 19], electromagnetic [20] and gravitational constants [21-23]. Finally, in analogy with the string theory 'tension concept' and 'compactification of extra dimensions', we show evidences of the possible existence of three large atomic gravitational constants and make an attempt to understand the mystery of origin of the reduced Planck's constant.

2. Basic assumptions

1) There exists a characteristic electroweak fermion of rest energy, $M_w c^2 \cong 584.725$ GeV. It can be considered as the zygote of all elementary particles.

2) There exists a strong interaction elementary charge (e_s) in such a way that, it's squared ratio with normal elementary charge is close to the reciprocal of the strong coupling constant.

3) Each atomic interaction is associated with a characteristic gravitational coupling constant.

3. Semi empirical derivations

With reference to our three assumptions,

1) Our earlier proposed complicated relations can be simplified.

2) Mystery of the reduced Planck's constant can be understood.

3) One can understand the direct role of the Newtonian gravitational constant in elementary particle physics.

A) Defined basic relations and their consequences

$$m_p \cong \left(\frac{G_N}{G_e}\right)^{\frac{1}{6}} \sqrt{M_{pl} \times m_e}$$

$$\cong \left(\frac{G_N}{G_e}\right)^{\frac{1}{6}} \left(\frac{\hbar c m_e^2}{G_N}\right)^{\frac{1}{4}}$$

$$\text{where, } M_{pl} \cong \sqrt{\frac{\hbar c}{G_N}} \cong \text{Planck mass} \tag{1}$$

$$\left.\begin{array}{l} \text{A)}\ \dfrac{m_p}{m_e} \cong \left(\dfrac{G_e m_e^2}{\hbar c}\right)\left(\dfrac{G_s m_p^2}{\hbar c}\right) \\ \text{B)}\ \dfrac{m_p}{m_e} \cong \left(\dfrac{e_s^2}{4\pi\varepsilon_0 G_s m_p^2}\right) \div \left(\dfrac{e^2}{4\pi\varepsilon_0 G_e m_e^2}\right) \end{array}\right\}$$

where, Strong nuclear charge $= e_s$ (2)

As a result,

$$\rightarrow \left(\frac{e_s}{e}\right)^2 \cong \frac{1}{\alpha_s} \cong \frac{G_s m_p^3}{G_e m_e^3} \cong \frac{G_s^2 m_p^4}{\hbar^2 c^2}$$

$$\Rightarrow \left(\frac{e_s}{e}\right) \cong \sqrt{\frac{1}{\alpha_s}} \cong \sqrt{\frac{G_s m_p^3}{G_e m_e^3}} \cong \frac{G_s m_p^2}{\hbar c}$$

where, Strong coupling constant $= \alpha_s$ (3)

$$\left.\begin{array}{l} \text{A)}\ \sqrt{\dfrac{e_s^2}{4\pi\varepsilon_0 G_s m_p m_e}} \cong 2\pi \\ \text{B)}\ \dfrac{m_p}{m_e} \cong 2\pi\sqrt{\dfrac{4\pi\varepsilon_0 G_e m_e^2}{e^2}} \\ \text{C)}\ \dfrac{m_p}{m_e} \cong \left(\dfrac{G_s}{G_e^{1/3} G_N^{2/3}}\right)^{1/7} \end{array}\right\} \quad (4)$$

B) Observational fits and their consequences

$$G_F \cong \left(\frac{m_e}{m_p}\right)^2 \hbar c R_0^2 \cong \frac{4\hbar G_s^2 m_e^2}{c^3}$$

where $R_0 \cong \dfrac{2G_s m_p}{c^2} \cong 1.24\ \text{fm}$ (5)

$$\left.\begin{array}{l} G_F \cong \left(\dfrac{m_p}{m_e}\right)^{10} \dfrac{4\hbar^2 G_N}{c^2} \\ \text{where} \left\{\begin{array}{l} \dfrac{G_s m_p}{c^2} \cong \left(\dfrac{m_p}{m_e}\right)^6 \sqrt{\dfrac{G_N \hbar}{c^3}} \\ \text{and} \quad \dfrac{G_s^2 m_p^2}{G_N \hbar c} \cong \left(\dfrac{m_p}{m_e}\right)^{12} \end{array}\right\} \end{array}\right\} \tag{6}$$

$$\begin{array}{l} G_F \cong \dfrac{4\hbar^2 G_w}{c^2} \\ \text{where } G_w \cong \left(\dfrac{m_p}{m_e}\right)^{10} G_N \end{array} \tag{7}$$

C) Inferences and consequences of A and B

Readers are encouraged to see section (9) of ref. [13].

$$\alpha \cong 4\pi^2 \left(\frac{m_e}{m_p}\right)^7 \sqrt{\frac{\hbar c}{G_N m_p^2}} \tag{8}$$

$$\text{where,} \left\{\begin{array}{l} G_s \cong \left(\dfrac{m_p^5}{m_e^6}\right)\sqrt{G_N \hbar c} \\ G_e \cong \left(\dfrac{m_e}{m_p}\right)^{21} \dfrac{G_s^3}{G_N^2} \end{array}\right\}$$

$$\hbar c \cong G_w M_w^2 \tag{9}$$

$$\begin{array}{l} G_F \cong \dfrac{4 G_w^3 M_w^4}{c^4} \cong G_w M_w^2 R_w^2 \\ \text{where, } R_w \cong \dfrac{2 G_w M_w}{c^2} \end{array} \tag{10}$$

$$G_s m_p \cong \frac{G_w^2 M_w^4}{G_e m_e^3} \tag{11}$$

$$m_e \cong \left(\frac{G_w}{G_s}\right) M_w \tag{12}$$

$$m_p \cong \left(\frac{G_s^2}{G_w G_e}\right) M_w \tag{13}$$

$$\frac{m_p}{m_e} \cong \frac{G_s^3}{G_w^2 G_e} \tag{14}$$

$$\hbar c \cong \left(\frac{G_e G_w}{G_s}\right) m_p m_e \cong G_s M_w m_e \tag{15}$$

$$\left(\frac{e_s}{e}\right) \cong \frac{G_s m_p^2}{G_w M_w^2} \tag{16}$$

D) Consequences of A, B and C

$$\frac{M_w}{m_e} \cong \frac{G_w^{5/2} G_e^{5/3}}{G_s^4 G_N^{1/6}} \tag{17}$$

$$\frac{M_w}{m_p} \cong \frac{G_s^{1/2} G_e^{1/6} G_N^{1/12}}{G_w^{3/4}} \tag{18}$$

$$\frac{m_p}{m_e} \cong \frac{G_w^{13/4} G_e^{3/2}}{G_s^{9/2} G_N^{1/4}} \tag{19}$$

$$G_N \cong \frac{G_w^{21} G_e^{10}}{G_s^{30}} \tag{20}$$

$$\frac{1}{\alpha_s} \cong \frac{G_s^{10}}{G_e^4 G_w^6} \tag{21}$$

4. Characteristic unified relations pertaining to estimation of $\left(G_e, G_s, G_w, G_N\right)$

a) With the following relation, magnitude of G_e can be estimated.

$$G_e \cong \frac{e^2 m_p^2}{16\pi^3 \varepsilon_0 m_e^4} \tag{22}$$

b) After finding the value of G_e ,with the following relation, magnitude of G_s can be estimated.

$$G_s \cong \frac{G_w^2 M_w^4}{G_e m_p m_e^3} \cong \frac{\hbar^2 c^2}{G_e m_p m_e^3} \tag{23}$$

c) After finding the value of G_s , weak gravitational constant can be estimated with a relation of the form,

$$G_w \cong \sqrt{\left(\frac{m_e}{m_p}\right)\frac{G_s^3}{G_e}} \tag{24}$$

d) Thus, quantitatively,

$$\left.\begin{array}{l} G_e \cong 2.374335\times 10^{37}\ \text{m}^3\text{kg}^{-1}\text{sec}^{-2} \\ G_s \cong 3.329561\times 10^{28}\text{m}^3\text{kg}^{-1}\text{sec}^{-2} \\ G_w \cong 2.909745\times 10^{22}\ \text{m}^3\text{kg}^{-1}\text{sec}^{-2} \\ G_N \cong 6.679855\times 10^{-11}\ \text{m}^3\text{kg}^{-1}\text{sec}^{-2} \\ G_F \cong 1.4402105\times 10^{-62}\ \text{J.m}^3 \\ \alpha_s \cong 0.1151937 \text{ and } e_s \cong 2.9463591e \end{array}\right\}$$

e) Based on relation (22), the developing procedures for estimating the magnitude of strong gravitational constant and weak gravitational constant independent of the reduced Planck's constant is being worked on. Appropriate relations seem to be associated with the experimental values of strong coupling constant [19], nuclear charge radius [18,20], magnetic moment of proton and neutron life time [13,24].

$$\alpha_s \cong \frac{G_e m_e^3}{G_s m_p^3} \approx 0.1152 \tag{25}$$

$$R_0 \cong \frac{2G_s m_p}{c^2} \approx 1.24 \text{ fm.} \tag{26}$$

$$\mu_p \cong \frac{eG_s m_p}{2c} \approx 1.487\times10^{-26} \text{ J.Tesla}^{-1} \tag{27}$$

$$t_n \cong \left(\frac{G_e^2 m_n^2}{G_w \left(m_n - m_p\right)c^3} \right) \approx 874.94 \text{ sec} \tag{28}$$

5. Discussion

We would like to emphasise the following points:

1) Even though quantum mechanics is successful in understanding the quantum effects of microscopic systems, origin of the reduced Planck's constant is still a mystery at the microscopic level.
2) String theory is silent on the universal applicability of the reduced Planck's constant.
3) During cosmic evolution, if one is willing to give equal importance to Higgs Boson and Planck mass in understanding the massive origin of elementary particles, it seems quite logical to expect a common relation between Planck scale and Electroweak scale.
4) When microscopic space time is more curved than the macroscopic space time curvature, it is natural to assign a large value to microscopic gravitational constant.
5) Compared to particles having a structure, for point particles the magnitude of gravitational constant can be much higher.
6) Magnitude of the elementary gravitational constant seems to increase with the decreasing mass of the elementary particle under consideration.
7) According to the String theory, the real world is a compact manifold and out of 10 dimensions, 6 spatial dimensions get compressed and will not allow any observer to identify their existence. Applying this idea to our proposal, compactification

of 6 unobservable space dimensions might be playing a key role in hiding the large magnitudes of the three atomic gravitational constants.

8) Using the strong nuclear charge, proton magnetic moment $\left(e_s\hbar/2m_p\right)$, nuclear fine structure ratio $\alpha_n \cong \left(e_s^2/4\pi\varepsilon_0\hbar c\right)$, root mean square radius of proton [25,26] $R_p \cong \left(\sqrt{2}G_s m_p/c^2\right) \cong \left(e_s/e\right)\left(\sqrt{2}\hbar/m_p c\right)$, unified nuclear binding energy coefficient [27] $B_0 \cong \frac{1}{2}\sqrt{\alpha \times \alpha_n}\left(m_p c^2\right)$ and Fermi gas model of nuclear potential $E_F \cong \sqrt{\alpha \times \alpha_n}\left(m_p c^2 + m_n c^2\right)$ can be fitted. Another interesting application is that, based on strong charge conservation, electromagnetic charge conservation and supersymmetry, fractional charge quarks can be understood with generation of quark fermions and quark bosons [28,29,30].

9) 'String Tension' is a practical aspect of String Theory [31, 32]. Considering the proposed three atomic gravitational constants and following the universal applicability of 'speed of light', approximate tensions associated with weak, strong, electromagnetic and gravitational interactions can be represented by,

$$\left\{\begin{array}{l} F_w \cong \left(\dfrac{c^4}{4G_w}\right) \cong 6.94 \times 10^{10}\,\mathrm{N} \\ F_s \cong \left(\dfrac{c^4}{4G_s}\right) \cong 6.065 \times 10^{4}\,\mathrm{N} \\ F_e \cong \left(\dfrac{c^4}{4G_e}\right) \cong 8.505 \times 10^{-5}\,\mathrm{N} \\ F_g \cong \left(\dfrac{c^4}{4G_N}\right) \cong 3.026 \times 10^{43}\,\mathrm{N} \end{array}\right\} \tag{29}$$

10) Following the universal applicability of 'elementary charge', approximate (operating) energy potentials associated with the above string tensions can be represented by,

$$\left\{\begin{array}{l} E_w \cong \sqrt{\dfrac{e^2}{4\pi\varepsilon_0}\left(\dfrac{c^4}{4G_w}\right)} \cong 25.0\text{ GeV} \\ E_s \cong \sqrt{\dfrac{e^2}{4\pi\varepsilon_0}\left(\dfrac{c^4}{4G_s}\right)} \cong 23.3\text{ MeV} \\ E_e \cong \sqrt{\dfrac{e^2}{4\pi\varepsilon_0}\left(\dfrac{c^4}{4G_e}\right)} \cong 874\text{ eV} \\ E_g \cong \sqrt{\dfrac{e^2}{4\pi\varepsilon_0}\left(\dfrac{c^4}{4G_N}\right)} \cong 8.355\times 10^7\text{ J} \end{array}\right\} \quad (30)$$

11) These estimated weak, strong and electromagnetic energy potentials seem to be close to experimental values.
12) Relation (15) needs in depth discussion at fundamental level.
13) With reference to the current experimental values of root mean square radius of proton, (0.833 ± 0.01) fm [26] and $(0.831 \pm 0.007_{stat} \pm 0.012_{syst})$ fm [27], we noticed one interesting relation. It can be expressed as,

$$\left.\begin{array}{l} R_p \cong \sqrt{\left(\dfrac{4\pi\varepsilon_0\hbar^2}{e_s^2 m_p}\right)\left(\dfrac{\hbar}{m_p c}\right)} \\ \cong \sqrt{\dfrac{4\pi\varepsilon_0\hbar^3}{e_s^2 m_p^2 c}} \cong 0.835\text{ fm} \end{array}\right\} \quad (31)$$

In this relation,

a) $\left(\dfrac{4\pi\varepsilon_0\hbar^2}{e_s^2 m_p}\right) \cong 3.32$ fm can be inferred as the Bohr's model of probable distance of finding proton in the nuclear well where the operating charge is $e_s \cong 2.946e$.

b) $\left(\dfrac{\hbar}{m_p c}\right) \cong 0.21$ fm can be considered as the reduced Compton wavelength of proton.

Based on relation (31),

$$\left[\left(\frac{e_s^2}{4\pi\varepsilon_0 c}\right)\left(m_p R_p c\right)^2\right]^{\frac{1}{3}} \cong \hbar \tag{32}$$

6. Conclusion

With further study, research and confirming the existence of $M_w c^2 \cong 584.725$ GeV, the actual essence of final unification and the mystery of the reduced Planck's constant can also be understood.

Acknowledgements

Author Seshavatharam is indebted to professors Shri M. Nagaphani Sarma, Chairman; Shri K.V. Krishna Murthy, founder Chairman, Institute of Scientific Research in Vedas (I-SERVE), Hyderabad, India; and Shri K.V.R.S. Murthy, former scientist IICT (CSIR), Govt. of India, Director, Research and Development, I-SERVE, for their valuable guidance and support in developing this subject.

References

[1] Wadia, S. R. (2008). String theory: a framework for quantum gravity and various applications. *Current Science (00113891)*, *95*(9).

[2] Wilczek, F. (2000). QCD made simple. *Phys. Today*, *53*(8), 22-28.

[3] Bojowald, M. (2015). Quantum cosmology: a review. *Reports on Progress in Physics*, *78*(2), 023901.

[4] Hawking, S. W. (1975). Particle creation by black holes. *Communications in mathematical physics*, *43*(3), 199-220.

[5] Tennakone, K. (1974). Electron, muon, proton, and strong gravity. *Physical Review D*, *10*(6), 1722.

[6] Sivaram, C., & Sinha, K. P. (1977). Strong gravity, black holes, and hadrons. *Physical Review D*, *16*(6), 1975-1978.

[7] De Sabbata, V., & Gasperini, M. (1979). Strong gravity and weak interactions. *General Relativity and Gravitation*, *10*(9), 731-741.

[8] Salam, A., & Sivaram, C. (1993). Strong gravity approach to QCD and confinement. *Modern Physics Letters A*, *8*(04), 321-326.

[9] Onofrio, R. (2013). On weak interactions as short-distance manifestations of gravity. *Modern Physics Letters A*, *28*(07), 1350022.

[10] Seshavatharam, U. V. S., & Lakshminarayana, S. (2017). Understanding the basics of final unification with three gravitational constants associated with nuclear, electromagnetic and gravitational interactions. *Journal of Nuclear Physics, Material Sciences, Radiation,4*(1), 1-19.

[11] Seshavatharam, U. V. S., & Lakshminarayana, S. (2019). On the role of squared neutron number in reducing nuclear binding energy in the light of electromagnetic, weak and nuclear gravitational constants–A Review. *Asian Journal of Research and Reviews in Physics, 2*(3), 1-22.

[12] Seshavatharam, U. V. S., & Lakshminarayana, S. (2019). Role of Four Gravitational Constants in Nuclear Structure. *Mapana-Journal of Sciences,18*(1), 21-46.

[13] Seshavatharam, U. V. S., & Lakshminarayana, S. (2020). Implications and Applications of Electroweak Quantum Gravity. *International Astronomy and Astrophysics Research Journal*, 13-30.

[14] Fermi, E. (1933). Tentativo di una teoria dell'emissione dei Raggi Beta. *Ric. Sci*., 4, 491-495.

[15] Englert, F., & Brout, R. (1964). Broken symmetry and the mass of gauge vector mesons. *Physical Review Letters, 13*(9), 321.

[16] Higgs, P. W. (1964). Broken symmetries and the masses of gauge bosons. *Physical Review Letters, 13*(16), 508-509.

[17] Aad, G., Abajyan, T., Abbott, B., Abdallah, J., Khalek, S. A., Abdelalim, A. A., & AbouZeid, O. S. (2012). Observation of a new particle in the search for the Standard Model Higgs boson with the ATLAS detector at the LHC. *Physics Letters B, 716*(1), 1-29.

[18] Rutherford, E. (1911). LXXIX. The scattering of α and β particles by matter and the structure of the atom. *The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science, 21*(125), 669-688.

[19] Tanabashi, M., Hagiwara, K., Hikasa, K., Nakamura, K., Sumino, Y., Takahashi, F., & Antonelli, M. (2018). Review of particle physics. *Physical Review D, 98*(3), 030001.

[20] Hofstadter, R., Fechter, H. R., & McIntyre, J. A. (1953). High-energy electron scattering and nuclear structure determinations. *Physical Review, 92*(4), 978.

[21] Mohr, P. J. , Newell, D. B., & Taylor, B. N. (2014).CODATA recommended values of the fundamental constants: 2014. *American Physical Society, 88*(3), 73.

[22] Canuel, B., Bertoldi, A., Amand, L., Di Borgo, E. P., Chantrait, T., Danquigny, C., & Gillot, J. (2018). Exploring gravity with the MIGA large scale atom interferometer. *Scientific Reports, 8*(1), 1-23.

[23] Li, Q., Xue, C., Liu, J. P., Wu, J. F., Yang, S. Q., Shao, C. G., & Xu, H. (2018). Measurements of the gravitational constant using two

independent methods. *Nature, 560*(7720), 582-588.

[24] Pattie, R. W., Callahan, N. B., Cude-Woods, C., Adamek, E. R., Broussard, L. J., Clayton, S. M., & Fellers, D. E. (2018). Measurement of the neutron lifetime using a magneto-gravitational trap and in situ detection. *Science, 360*(6389), 627-632.

[25] Bezginov, N., Valdez, T., Horbatsch, M., Marsman, A., Vutha, A. C., & Hessels, E. A. (2019). A measurement of the atomic hydrogen Lamb shift and the proton charge radius. *Science, 365*(6457), 1007-1012.

[26] Xiong, W., Gasparian, A., Gao, H., Dutta, D., Khandaker, M., Liyanage, N., & Gnanvo, K. (2019). A small proton charge radius from an electron–proton scattering experiment. *Nature, 575*(7781), 147-150.

[27] Seshavatharam, U. V. S., & Lakshminarayana, S. (2020). Significance and Applications of the Strong Coupling Constant in the Light of Large Nuclear Gravity and Up and Down Quark Clusters. *International Astronomy and Astrophysics Research Journal. 2*(1), 55-68.

[28] Seshavatharam, U. V. S., & Lakshminarayana, S. (2010). Super symmetry in strong and weak interactions. *International Journal of Modern Physics E, 19*(02), 263-280.

[29] Seshavatharam, U. V., & Lakshminarayana, S. (2011). SUSY & STRONG NUCLEAR GRAVITY IN (120-160) GeV MASS RANGE. *Hadronic journal, 34*(3), 277.

[30] Seshavatharam, U. V. S., & Lakshminarayana, S. (2020). 4G Model of Fractional Charge Strong-Weak Super Symmetry. *International Astronomy and Astrophysics Research Journal, 2*(1), 31-55.

[31] Gibbons, G. W. (2002). The maximum tension principle in general relativity. *Foundations of Physics, 32*(12), 1891-1901.

[32] Mukhi, S. (2011). String theory: a perspective over the last 25 years. *Classical and Quantum Gravity, 28*(15), 153001.