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Semi Empirical Derivations Pertaining to 4G Model of Final Unification

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Authors' contributions

This work was carried out in collaboration between both authors. Author UVSS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author SL managed the analyses of the study and literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

When 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. In this context, in earlier publications, three large atomic gravitational constants have been defined pertaining to electroweak, strong and electromagnetic interactions. In a semi empirical way, in this paper, an attempt has been made to derive the earlier proposed relations connected with the four gravitational constants. This model is first of its kind with a simultaneous existence of four gravitational constants pertaining to the four basic physical interactions and can be called as 4G model of final unification.

Keywords: Four gravitational constants; 4G model of final unification; microscopic quantum gravity.

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1. INTRODUCTION

With reference to three large gravitational constants assumed to be associated with weak, strong and electromagnetic interactions, many practical applications have been developed in earlier publications [1-7]. Including the Newtonian gravitational constant, as the subject under consideration deals with 4 different gravitational constants, this model can be called as 4G model of final unification or Microscopic Quantum Gravity. After developing many relations among 3+1 gravitational constants, it has been understood that, when 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. This idea can be quantified with a relation of the form, $G_x m_x^2 \approx \hbar c$. In this context, an attempt has been made to derive the earlier proposed relations in a semi empirical approach.

2. LIST OF SYMBOLS

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
15) Charge radius of nucleus= R_0
16) Proton number = Z
17) Neutron number = N
18) Charge radius of (Z, N) = R_c
19) Magnetic moment of proton = μ_p
20) Neutron life time= t_n

3. BASIC ASSUMPTIONS

The following assumptions are made [2-5].

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 reciprocal of the strong coupling constant.
3) Each atomic interaction is associated with a characteristic gravitational coupling constant.

4. SEMI EMPIRICAL DERIVATIONS

This section has been divided into 4 sub sections. Based on the proposed second and third assumptions, in section 4.1, relations (1), (3) and (4) have been defined.

In Section 4.2 important numerical fitting relations (10), (11), (12) and (13) have been proposed (pertaining to nuclear charge radius, Planck size and Fermi's weak coupling constant) and an attempt has been made to infer an expression for weak gravitational constant [8].

In Section 4.3, based on the results obtained from Section 4.1 and Section 4.2, an important inference i.e. relation (18), has been made.

Section 4.4 includes simplified relations pertaining to elementary mass ratios, Newtonian gravitational constant and strong coupling constant.

4.1 Defined Basic Relations and their Consequences

4.1.1 Ratio of Newtonian and electromagnetic gravitational constants

Considering the similarities in between gravitational and electromagnetic interactions, relation (1) has been defined to understand the role and to estimate the approximate magnitudes of the electromagnetic and Newtonian gravitational constants [1,2].

$$\left.\begin{array}{l} m_p \cong \left(\dfrac{G_N}{G_e}\right)^{\frac{1}{6}} \sqrt{M_{pl} \times m_e} \cong \left(\dfrac{G_N}{G_e}\right)^{\frac{1}{6}} \left(\dfrac{\hbar c m_e^2}{G_N}\right)^{\frac{1}{4}} \\ \text{where, } M_{pl} \cong \sqrt{\dfrac{\hbar c}{G_N}} \cong \text{Planck mass} \end{array}\right\} \quad (1)$$

On rearranging relation (1),

$$M_{pl} \cong \sqrt{\frac{\hbar c}{G_N}} \cong \left(\frac{G_e}{G_N}\right)^{\frac{2}{3}} \left(\frac{m_p^2}{m_e}\right) \tag{2}$$

4.1.2 Proton – electron mass ratio

Pertaining to proton-electron mass ratio, relations (3) and (4) have been defined [2] in the following way.

$$\frac{m_p}{m_e} \cong \left(\frac{G_e m_e^2}{\hbar c}\right)\left(\frac{G_s m_p^2}{\hbar c}\right) \tag{3}$$

$$\frac{m_p}{m_e} \cong \left(\frac{e_s^2}{4\pi\varepsilon_0 G_s m_p^2}\right) \div \left(\frac{e^2}{4\pi\varepsilon_0 G_e m_e^2}\right) \tag{4}$$

Based on the second assumption and relations (3) and (4),

$$\left(\frac{e_s}{e}\right)^2 \cong \frac{1}{\alpha_s} \cong \frac{G_s m_p^3}{G_e m_e^3} \cong \frac{G_s^2 m_p^4}{\hbar^2 c^2} \tag{5}$$

$$\left(\frac{e_s}{e}\right) \cong \sqrt{\frac{1}{\alpha_s}} \cong \sqrt{\frac{G_s m_p^3}{G_e m_e^3}} \cong \frac{G_s m_p^2}{\hbar c} \tag{6}$$

Based on relation (5), quantitatively, it can be inferred that,

$$\sqrt{\frac{e_s^2}{4\pi\varepsilon_0 G_s m_p m_e}} \cong 2\pi \tag{7}$$

Based on relation (5), substituting $e_s^2 \cong \left(\frac{G_s m_p^3}{G_e m_e^3}\right) e^2$ in relation (7),

$$\frac{m_p}{m_e} \cong 2\pi \sqrt{\frac{4\pi\varepsilon_0 G_e m_e^2}{e^2}} \tag{8}$$

Based on relation (1) and (3), on eliminating $\hbar c$,

$$\frac{m_p}{m_e} \cong \left(\frac{G_s}{G_e^{1/3} G_N^{2/3}}\right)^{1/7} \tag{9}$$

4.2 Numerical Fits and Their Consequences Pertaining to Nuclear Charge Radius, Planck Size and Fermi's Weak Coupling Constant

With reference to nuclear gravitational constant [9,10], nuclear charge radius can be fitted with,

$$R_0 \cong \left(\frac{2G_s m_p}{c^2}\right) \cong 1.2393 \text{ fm} \tag{10}$$

With reference to Planck size, it has been noticed that,

$$\left(\frac{G_s m_p}{c^2}\right) \div \sqrt{\frac{G_N \hbar}{c^3}} \cong \left(\frac{m_p}{m_e}\right)^6 \tag{11}$$

Based on relation (10), Fermi's weak coupling constant can be fitted with,

$$G_F \cong \left(\frac{m_e}{m_p}\right)^2 \hbar c R_0^2 \cong \frac{4\hbar G_s^2 m_e^2}{c^3} \cong 1.4402105 \times 10^{-62} \text{ J.m}^3 \tag{12}$$

Based on relations (10), (11) and (12),

$$G_F \cong \left(\frac{m_p}{m_e}\right)^{10} \frac{4\hbar^2 G_N}{c^2} \tag{13}$$

Based on the magnitude of weak gravitational constant proposed by Roberto Onofrio [8] and based on relation (13), it has been inferred that,

$$G_w \cong \left(\frac{m_p}{m_e}\right)^{10} G_N \tag{14}$$

Based on relations (13) and (14)

$$G_F \cong \frac{4\hbar^2 G_w}{c^2} \tag{15}$$

Based on relations (12) and (15),

$$\sqrt{\frac{G_F}{\hbar c}} \cong \frac{2G_s m_e}{c^2} \cong \sqrt{\frac{4G_w \hbar}{c^3}} \tag{16}$$

4.3 Important Inference and Its Implications Pertaining to First Assumption

Based on the above relations (1) to (16), on eliminating the three proposed atomic gravitational constants [5], one can get the following relation.

$$\alpha \cong 4\pi^2\left(\frac{m_e}{m_p}\right)^7\sqrt{\frac{\hbar c}{G_N m_p^2}} \tag{17}$$

Based on this complicated relation (17), it is possible to infer that,

$$\hbar c \cong G_w M_w^2 \tag{18}$$

Based on relations (16) and (18),

$$G_s m_e \cong G_w M_w \tag{19}$$

Based on relations (17), (18) and (19), the following relations can be obtained.

$$m_p \cong \left(\frac{4\pi^2}{\alpha}\right)^{\frac{1}{3}}\left(M_w m_e^2\right)^{\frac{1}{3}} \tag{20}$$

$$G_F \cong G_w M_w^2 R_w^2$$
$$\text{where, } R_w \cong \frac{2G_w M_w}{c^2} \tag{21}$$

$$m_e \cong \left(\frac{G_w}{G_s}\right) M_w \tag{22}$$

$$m_p \cong \left(\frac{G_s}{G_w}\right)\left(\frac{G_s}{G_e}\right) M_w \cong \left(\frac{G_s^2}{G_w G_e}\right) M_w \tag{23}$$

$$\frac{m_p}{m_e} \cong \frac{G_s^3}{G_w^2 G_e} \tag{24}$$

$$\hbar c \cong \left(\frac{G_e G_w}{G_s}\right) m_p m_e \cong G_s M_w m_e \tag{25}$$

4.4 Simplified Relations for Elementary Mass Ratios, Newtonian Gravitational Constant and Strong Coupling Constant

Based on relation (17) and considering other relations, it is possible to get the following simplified elementary mass ratios.

$$\frac{M_w}{m_e} \cong \frac{G_w^{5/2} G_e^{5/3}}{G_s^4 G_N^{1/6}} \tag{26}$$

$$\frac{M_w}{m_p} \cong \frac{G_s^{1/2} G_e^{1/6} G_N^{1/12}}{G_w^{3/4}} \tag{27}$$

$$\frac{m_p}{m_e} \cong \frac{G_w^{13/4} G_e^{3/2}}{G_s^{9/2} G_N^{1/4}} \tag{28}$$

On eliminating proton and electron rest masses, Newtonian gravitational constant and strong coupling constant take the following simplified forms.

$$G_N \cong \frac{G_w^{21} G_e^{10}}{G_s^{30}} \tag{29}$$

$$\frac{1}{\alpha_s} \cong \frac{G_s^{10}}{G_e^4 G_w^6} \tag{30}$$

Based on relations (29) and (30),

$$\alpha_s \cong \frac{G_N^{1/3} G_e^{2/3}}{G_w} \tag{31}$$

5. DISCUSSION

a) Relation (10) seems to play a key role in validating the existence of the proposed nuclear gravitational constant.
b) Reference [8] and relations (10), (11), (12) and (13) greatly helped in inferring an expression for weak gravitational constant.
c) Based on relations (3), (6) and (15), proton rest mass can be expressed with,

$$m_p \cong \left(\frac{e_s}{e}\right)\left(\frac{G_e m_e^2}{G_w M_w^2}\right)(m_e) \tag{32}$$

d) On re-arranging relation (14), it is possible to show that [11,12],

$$G_N \cong \frac{16\pi^4}{\alpha^2}\left(\frac{m_e}{m_p}\right)^{14}\left(\frac{\hbar c}{m_p^2}\right)$$
$$\cong 6.679855\times10^{-11}\ \text{m}^3\text{kg}^{-1}\text{sec}^{-2} \tag{33}$$

This relation can be given a chance in connecting gravity with microscopic physical constants.

e) Relation (31) appears to be simple and seems to emit new light on understanding the direct role of Newtonian gravitational constant in particle physics.

f) Based on relation (8), it is possible to work on developing procedures for estimating the magnitude of strong gravitational constant and weak gravitational constant independent of the reduced Planck's constant. Appropriate relations seem to be associated with experimental or recommended values of strong coupling constant [11,12], nuclear charge radii [13,14], magnetic moment of proton, neutron life time [15] and magnetic flux quantum [16,17]. See the following relations.

$$\alpha_s \cong \frac{G_e m_e^3}{G_s m_p^3} \cong 0.1152 \tag{34}$$

$$R_c \cong r_Z \left[1+0.015\left(\frac{N-(N/Z)}{Z}\right)\right] Z^{1/3} \tag{35}$$

where, $r_Z \cong 1.245 \text{ fm} \approx \frac{2G_s\sqrt{m_p m_n}}{c^2} \cong 1.24 \text{ fm.}$

$$\mu_p \cong \frac{e_s \hbar}{2m_p} \cong \frac{eG_s m_p}{2c} \tag{36}$$

$$\cong 1.487\times10^{-26} \text{ J.Tesla}^{-1}$$

$$t_n \cong \left(\frac{G_e^2 m_n^2}{G_w\left(m_n - m_p\right)c^3}\right) \cong 874.94 \text{ sec} \tag{37}$$

$$\left(\frac{h}{e}\right) \cong \sqrt{\left(\frac{\mu_0}{4\pi}\right)\left(\frac{G_s m_p^3}{m_e}\right)} \tag{38}$$

g) With further study, mystery of origin of the Reduced Planck's constant and Newtonian gravitational constant [11,12,18] can be understood.

h) Quantitatively, with the above relations,

$$\left.\begin{array}{l} G_e \cong 2.374335\times10^{37} \text{ m}^3\text{kg}^{-1}\text{sec}^{-2} \\ G_s \cong 3.329561\times10^{28} \text{m}^3\text{kg}^{-1}\text{sec}^{-2} \\ G_w \cong 2.909745\times10^{22} \text{ m}^3\text{kg}^{-1}\text{sec}^{-2} \\ G_N \cong 6.679855\times10^{-11} \text{ m}^3\text{kg}^{-1}\text{sec}^{-2} \\ G_F \cong 1.4402105\times10^{-62} \text{ J.m}^3 \\ \alpha_s \cong 0.1151937 \text{ and } e_s \cong 2.9463591e \end{array}\right\}$$

6. CONCLUSION

With current notion of unification of fundamental forces, it seems impossible to correlate microscopic physical constants with gravity. Clearly speaking, there is a grey area in the land of unified physics and needs a special focus. In this critical situation, considering three large atomic gravitational constants seems to be attractive and heuristic.

With three assumptions, 3 defined relations (1, 3 and 4) and four numerical fitting relations (10, 11, 12 and 13), a semi empirical procedure has been developed for deriving other useful relations.

By considering the number of applications projected in the fields of nuclear physics, particle physics and astrophysics [1-7], proposed semi empirical derivations can be given a chance in understanding and validating the three atomic gravitational constants. With further research, it seems possible to derive the above relations in a theoretical approach.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Seshavatharam UVS, Lakshminarayana S. Quantum gravitational applications of

nuclear, atomic and astrophysical phenomena. International Journal of Advanced Astronomy. 2016;4(1):20-26.
2. Seshavatharam UVS, Lakshminarayana S. Understanding the basics of final unification with three gravitational constants associated with nuclear, electromagnetic and gravitational interactions. Journal of Nuclear Physics, Material Sciences, Radiation and Applications. 2017;4(1):1-19.
3. Seshavatharam UVS, Lakshminarayana S. A play with four virtual gravitational constants associated with the four basic interactions. Asian Journal of Research and Reviews in Physics. 2019;2(2):1-7.
4. Seshavatharam UVS, Lakshminarayana S. On the role of four gravitational constants in nuclear structure. Mapana Journal of Sciences. 2019;18(1):21-45.
5. Seshavatharam UVS, Lakshminarayana S. Implications and applications of electroweak quantum gravity. International Astronomy and Astrophysics Research Journal. 2020;2(1):13-30.
6. Seshavatharam UVS, Lakshminarayana S. 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. 2020;2(1): 56-68.
7. Seshavatharam UVS, Lakshminarayana S. 4G model of fractional charge strong-weak super symmetry. International Astronomy and Astrophysics Research Journal. 2020;2(1):31-55.
8. Roberto Onofrio. On weak interactions as short-distance manifestations of gravity. Modern Physics Letters A. 2013;28: 1350022.
9. Tennakone K. Electron, muon, proton and strong gravity. Phys. Rev. D. 1974;10:1722.
10. Salam A, Sivaram C. Strong gravity approach to QCD and confinement. Mod. Phys. Lett. 1993;A8(4):321-326.
11. Tanabashi M, et al. Particle Data Group. Phys. Rev. 2018;D98:030001.
12. Mohr PJ, Newell DB, Taylor BN. CODATA recommended values of the fundamental constants. Rev. Mod. Phys. 2014;88: 035009.
13. Hofstadter R, Fechter HR, McIntyre JA. High-energy electron scattering and nuclear structure determinations. Phys. Rev. 1953;92:978.
14. Bayram Tuncay, Akkoyun Serkan, Kara Sibel, Sinan Alper. New parameters for nuclear charge radius formulas. Acta Phys. Polon. B. 2013;44(8):1791-1799.
15. Pattie RW Jr. et al. Measurement of the neutron lifetime using a magnetogravitational trap and *in situ* detection. Science. 2018;360(6389):627-632.
16. Loder Florian, Kampf Arno, Kopp Thilo, Mannhart Jochen, Schneider C, Barash Yuri. Magnetic flux periodicity of h/e in superconducting loops. Nature Physics. 2008;4:112-115.
17. Fagaly RL. Superconducting quantum interference device instruments and applications. Review of Scientific Instruments. 2006;77:101101.
18. Li Qing, et al. Measurements of the gravitational constant using two independent methods. Nature. 2018;560: 582-588.

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