Semi Empirical Derivations Pertaining to 4G Model of Final Unification

U. V. S. Seshavatharam* and S. Lakshminarayana

1Honorary Faculty, I-SERVE, Survey no-42, Hitech City, Hyderabad-84, Telangana, India. 2Department of Nuclear Physics, Andhra University, Visakhapatnam-03, AP, India.

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.

Article Information

Editor(s):
(1) Dr. Swarniv Chandra, Techno India University, India.  (2) Dr. Hadia Hassan Selim, National Research Institute of Astronomy and Geophysics, Egypt.

Reviewers:
(1) Ricardo Luís Lima Vitória, Universidade Federal do Pará, Brazil.  (2) Michael Ugwu Onuu, Alex Ekwueme Federal University, Nigeria.  (3) Sie Long Kek, Universiti Tun Hussein Onn Malaysia, Malaysia.  (4) Pasupuleti Venkata Siva Kumar, VNR VJIET, India.

Complete Peer review History: http://www.sdiarticle4.com/review-history/56893

Received 26 March 2020  Accepted 04 June 2020  Published 17 June 2020

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.
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, \( G_s m_e^2 \approx \hbar c \). 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 \( = \alpha_s \)
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 = \( R_s \)
16) Proton number \( = Z \)
17) Neutron number \( = N \)
18) Charge radius of \( (Z, N) \) = \( R_s \)
19) Magnetic moment of proton = \( \mu_p \)
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, \( M_w c^2 \approx 584.725 \text{ GeV} \).
   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].

\[
m_p \equiv \left( \frac{G_N}{G_e} \right) \sqrt{M_p \times m_e} \equiv \left( \frac{G_N}{G_e} \right) \left( \frac{\hbar c m_e^2}{G_N} \right)^{1/3} \quad (1)
\]

where, \( M_p \equiv \frac{\hbar c}{G_N} \) Planck mass
On rearranging relation (1),

\[ M_{pl} \approx \frac{\hbar c}{G_N} \approx \left( \frac{G_e}{G_N} \right)^2 \left( \frac{m_p}{m_e} \right) \]  \hspace{1cm} (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.

\[ \frac{m_p}{m_e} \approx \left( \frac{G_e m_e^2}{\hbar c} \right) \left( \frac{G_N m_p^2}{\hbar c} \right) \]  \hspace{1cm} (3)

\[ \frac{m_p}{m_e} \approx \left( \frac{e^2}{4\pi\varepsilon_0 G_e m_p^2} \right) + \left( \frac{e^2}{4\pi\varepsilon_0 G_e m_e^2} \right) \]  \hspace{1cm} (4)

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

\[ \left( \frac{e^2}{e} \right) \approx \frac{1}{\alpha_s} \approx \frac{G_e m_p^3}{G_N m_e^3} \approx \frac{G_e^2 m_p^4}{h^2 c^2} \]  \hspace{1cm} (5)

\[ \left( \frac{e^2}{e} \right) \approx \frac{1}{\alpha_s} \approx \frac{G_e m_p^3}{G_N m_e^3} \approx \frac{G_e m_p^2}{h c} \]  \hspace{1cm} (6)

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

\[ \sqrt{4\pi\varepsilon_0 G_e m_p m_e} \approx 2\pi \]  \hspace{1cm} (7)

Based on relation (5), substituting \( e^2 \equiv \left( \frac{G_e m_p^3}{G_N m_e^3} \right) e^2 \)

\[ G_e \equiv \left( \frac{m_p}{m_e} \right)^{10} \frac{4\hbar^2 G_N}{c^2} \]  \hspace{1cm} (13)

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

\[ \frac{G_e}{\hbar c} \equiv \left( \frac{2G_e m_e}{c^2} \right) \approx 1.4402105 \times 10^{-62} \text{ J.m}^3 \]  \hspace{1cm} (14)

Based on relations (13) and (14)

\[ G_e \equiv \left( \frac{m_p}{m_e} \right)^{10} \frac{4\hbar^2 G_N}{c^2} \]  \hspace{1cm} (15)

Based on relations (12) and (15),

\[ \frac{G_e}{\hbar c} \equiv \left( \frac{2G_e m_e}{c^2} \right) \approx \sqrt{4G_N \hbar} \]  \hspace{1cm} (16)

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,

\[ R_0 \equiv \left( \frac{2G_e m_p}{c^2} \right) \approx 1.2393 \text{ fm} \]  \hspace{1cm} (10)

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

\[ \frac{G_e m_p}{c^2} \approx \sqrt{\frac{G_N \hbar}{c^3}} \approx \left( \frac{m_p}{m_e} \right)^6 \]  \hspace{1cm} (11)

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

\[ G_F \equiv \left( \frac{m_e}{m_p} \right)^2 \hbar c R_0 \approx 4\hbar^2 G_e^2 m_e^2 \]  \hspace{1cm} (12)

\[ \approx 1.4402105 \times 10^{-62} \text{ J.m}^3 \]

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

\[ G_F \equiv \left( \frac{m_p}{m_e} \right)^{10} \frac{4\hbar^2 G_N}{c^2} \]  \hspace{1cm} (13)

Based on relations (13) and (14)
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.

\[ \alpha \approx 4\pi^2 \left( \frac{m_e}{m_p} \right) \frac{\hbar c}{G_N m_p^3} \]  

(17)

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

\[ \hbar c \approx G_N M_w^2 \]  

(18)

Based on relations (16) and (18),

\[ G_N m_e \approx G_N M_w \]  

(19)

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

\[ \frac{m_p}{m_e} \approx \left( \frac{4\pi^2}{\alpha} \right) \left( \frac{M_w m_p^2}{m_e} \right) \]  

(20)

\[ G_F \approx G_N M_w R_w^2 \]  

where,

\[ R_w \approx \frac{2 G_N M_w}{c^2} \]  

(21)

\[ m_e \approx \left( \frac{G_N}{G_s} \right) M_w \]  

(22)

\[ m_p \approx \left( \frac{G_N}{G_s} \right) \left( \frac{G_s}{G_N} \right) M_e \approx \left( \frac{G_s}{G_N G_s} \right) M_e \]  

(23)

\[ \frac{m_e}{m_p} \approx \frac{G_s}{G_N G_s} \]  

(24)

\[ \hbar c \approx \left( \frac{G_N G_s}{G_s} \right) m_p m_e \approx G_N M_w m_e \]  

(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.

\[ \frac{M_w}{m_e} \approx \frac{G_N^{14} G_s^{10}}{G_s^{6} G_s^{10}} \]  

(26)

\[ \frac{M_p}{m_p} \approx \frac{G_N^{14} G_s^{10} G_s^{12}}{G_s^{14}} \]  

(27)

\[ \frac{m_e}{m_p} \approx \frac{G_N^{14} G_s^{12}}{G_s^{6} G_s^{14}} \]  

(28)

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

\[ G_N \approx \frac{G_N^{14} G_s^{10}}{G_s^{6} G_s^{10}} \]  

(29)

\[ \frac{1}{\alpha} \approx \frac{G_s}{G_s G_s} \]  

(30)

Based on relations (29) and (30),

\[ \alpha \approx \frac{G_N^{10} G_s^{21}}{G_s} \]  

(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,

\[ \frac{m_p}{m_e} \approx \left( \frac{e}{e} \right) \left( \frac{G_N m^2}{G_N M_w^2} \right) (m_e) \]  

(32)

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

\[ G_N \approx \frac{16\pi^4 \left( \frac{m_e}{m_p} \right)^4 \left( \frac{\hbar c}{m_p} \right)}{\alpha^2} \]  

\[ \approx 6.679855 \times 10^{-11} \text{ m}^3 \text{kg}^{-1} \text{sec}^{-2} \]  

(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.

\[
\alpha_s \equiv \frac{G \frac{m^3}{F_s}}{G \frac{m^3}{F_p}} \approx 0.1152
\]  

(34)

\[
R_c \equiv r_z \left[ 1 + 0.015 \left\{ \frac{N - (N/Z)}{Z} \right\} \right] Z^{1/3}
\]

where, \( r_z \approx 1.245 \text{ fm} \approx \frac{2G \sqrt{m_s m_n}}{c^2} \approx 1.24 \text{ fm} \).

\[
\mu_p \equiv \frac{e \hbar}{2m_p} \approx \frac{eG \frac{m_p}{F_p}}{2c} \approx 1.487 \times 10^{-26} \text{ J.Tesla}^{-1}
\]

(36)

\[
t_o \approx \left( \frac{G^2 m_e^2}{G_o \left( m_n - m_p \right) c^3} \right) \approx 874.94 \text{ sec}
\]

(37)

\[
\left( \frac{\hbar}{c} \right) \approx \left( \frac{\hbar_o}{4\pi} \right) \left( \frac{G \frac{m_p^3}{F_p}}{m_e} \right)
\]

(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,

- \( G_s \approx 3.229561 \times 10^{28} \text{ m}^3 \text{kg}^{-1} \text{sec}^{-2} \)
- \( G_s \approx 3.237435 \times 10^{37} \text{ m}^3 \text{kg}^{-1} \text{sec}^{-2} \)
- \( G_s \approx 3.209745 \times 10^{27} \text{ m}^3 \text{kg}^{-1} \text{sec}^{-2} \)
- \( G_s \approx 8.6679855 \times 10^{11} \text{ m}^3 \text{kg}^{-1} \text{sec}^{-2} \)
- \( G_s \approx 1.4402105 \times 10^{42} \text{ J.m}^3 \)
- \( \alpha_s \approx 0.1151937 \) and \( e_s \approx 2.9463591 \text{e} \)

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.

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 great support in developing this subject. Both the authors are very much thankful to the anonymous reviewers for their valuable guidelines and suggestions in improving the quality and presentation of the paper.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

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


