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Article

Nuclear Evidences for Confirming the Physical Existence of 585 GeV Weak Fermion and Galactic Observations of TeV Radiation

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Abstract: Background: In our recent publications pertaining to 4G model of final unification and based on strong and electroweak interactions, we have proposed the existence of a weak fermion of rest energy 585 GeV. **Objective**: To confirm the physical existence of the proposed 585 GeV weak fermion by analyzing weak and strong interactions in a unified approach via 4G model of final unification, super symmetry and string theory. **Method**: Considering the proposed nuclear charge of 2.95*e*, proton, electron mass ratio, specific charge ratios of proton and electron, Fermi's weak coupling constant, Reduced Planck's constant, nucleon magnetic moments, nuclear stability, nuclear binding energy, nuclear mass and neutron lifetime, it is planned to confirm the physical existence of the proposed 585 GeV weak fermion. **Results**: All proposed logics and formulae clearly establish the physical existence of 585 GeV weak fermion directly and indirectly. **Conclusion**: Believing in the physical existence of the proposed 585 GeV weak fermion, there is a scope for observing galactic TeV radiation coming by virtue of annihilation of 585 GeV fermions and radiation associated with various astrophysical acceleration mechanisms of 585 GeV fermions. **Appeal**: As we are beginners of astrophysics domain, we appeal the science community to see the possibility of considering the proposed 585 GeV weak fermion with a charge of $(\pm e)$ in place of electron and proton.

Keywords: 4G model of final unification; electroweak fermion; weak interactions; strong interactions; nuclear structure; super symmetry; string theory; detection of galactic TeV radiation;

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1. Introduction

Considering our 4G model of Final unification and its 3 assumptions [1-14], in our early and recent publications we have developed many relations in nuclear and particle physics. In this paper, we review the key nuclear relations that help in understanding and confirming the physical existence of our proposed 585 GeV electroweak fermion. Proceeding further, we show the possibility of confirming the physical existence of 585 GeV weak fermion with reference to the observed tera electron volt (TeV) photon radiation coming from astrophysical objects.

2. Three Assumptions of 4G Model of Final Unification

Following our 4G model of final unification, we proposed the following assumptions.

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

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(2) There exists a nuclear elementary charge in such a way that, $\left(\frac{e}{e_n}\right)^2 \cong \alpha_s \cong 0.1151935$ = Strong coupling constant [15,16] and $e_n \cong 2.946362e$.

(3) Each atomic interaction is associated with a characteristic large gravitational coupling constant. Their fitted magnitudes are,

$$G_e \cong \text{Electromgnetic gravitational constant} \cong 2.374335\times10^{37}\ \text{m}^3\text{kg}^{-1}\text{sec}^{-2}$$

$$G_n \cong \text{Nuclear gravitational constant} \cong 3.329561\times10^{28}\ \text{m}^3\ \text{kg}^{-1}\text{sec}^{-2}$$

$$G_w \cong \text{Electroweak gravitational constant} \cong 2.909745\times10^{22}\ \text{m}^3\text{kg}^{-1}\text{sec}^{-2}$$

Based on these fits,

(a) Considering the ratio of Planck scale to the nuclear scale, Newtonian gravitational constant [17,18] can be fitted with, $G_N \cong \frac{G_w^{21}G_e^{10}}{G_n^{30}} \cong 6.679851\times10^{-11}\ \text{m}^3\text{kg}^{-1}\text{sec}^{-2}$.

(b) On interpreting or eliminating the large numbers, neutriono rest mass [5] can be inferred as, $m_{xf} \cong \left(\frac{\sqrt{G_w G_N}}{G_n}\right)M_{wf} \cong \left(\frac{m_e^6}{m_p^5}\right)$. Thus, $m_{xf} \cong 4.365\times10^{-47}\ \text{kg} \cong 2.45\times10^{-11}\ \text{eV}/c^2$.

(c) Strong coupling constant [16] can be fitted with, $\alpha_s \cong \frac{G_w^6 G_e^4}{G_n^{10}} \cong 0.115193455$.

(d) Independent of system of units, Avogadro like large number [19,20] can be fitted with a relation of the form, $\frac{\text{Product of short range gravitational constants}}{\text{Product of long range gravitational constants}} \cong \frac{G_n G_w}{G_N G_e} \cong \frac{G_n^{31}}{G_w^{20}G_e^{11}} \cong 6.1088144\times10^{23}$.

(e) Neutron lifetime [5] can be fitted with, $t_n \cong \frac{G_e^2 m_n^2}{G_w\left(m_n - m_p\right)c^3} \cong 874.94$ sec. It seems that, outside the nucleus, neutron experiences electromagnetic interaction and weak interaction helps neutron to decay into proton, electron and neutrino.

(f) Characteristic atomic radii [5] can be addressed with $R_{atom} \cong A^{1/3}\left(\frac{2\sqrt{G_n G_e}M_U}{c^2}\right) \cong A^{1/3}\times 32.86$ pm where A represents the mass number and $M_U \cong 931.5\ \text{MeV}/c^2$ represents the unified atomic mass unit. Starting from the 3rd period, $R_{atom} \cong \left\{\left[4-\left(\frac{A}{Z}\right)\right]\left(\frac{Z_{fp}}{Z}\right)^2\right\}\left[A^{1/3}\left(\frac{2\sqrt{G_n G_e}M_U}{c^2}\right)\right]$ where Z represents the atomic number and Z_{fp} represents the atomic number of the first element of the period.

(g) Bohr radius of hydrogen atom can be addressed with, $a_0 \cong \left(\frac{4\pi\varepsilon_0 G_n m_p}{e^2 c^2}\right)\left(G_e m_e^2\right)$.

3. Scope and Possibility for the Physical Existence of the Proposed 585 GeV Weak Fermion

It is generally believed that, electrons and nucleons are fermions and are responsible for the observed spectrum of electromagnetic radiation that propagates in the form of photons. At sub nuclear level, it is well established that, quarks are fermions and play a vital role in generating baryons and mesons. Gluons are believed to be the force carriers in between quarks and hadrons. Here we would like to emphasize the point that, whether it is electromagnetic interaction or strong interaction, fermions are supposed to be the 'field generators' and photons and gluons are believed to be the 'force carriers'. It is very clear to say that, 'field generators' and 'force carriers' both are essential elements in understanding their respective interactions and both can be considered as a representation of 'head' and 'tail' of a coin. Coin 'without head' or 'without tail' – is practically an ambiguous physical issue. In this context, with reference to the well believed and well understood 'weak' interaction [21, 22] – we sincerely appeal that,

(1) There is a scope for understanding weak interaction with its 'weak field generating fermion'.
(2) There exists a 'weak field fermion' corresponding to the currently believed three weak bosons.

In this context, in our recently proposed '4G model of final unification' associated with three large atomic gravitational constants pertaining to the three atomic interactions, we have proposed the existence of a weak fermion of rest energy 585 GeV. In the following sections we are showing different possible nuclear evidences for the physical existence of 585 GeV weak fermion. Considering the basic concepts of super symmetry [23,24,25], it seems possible for the existence of weak fermion.

4. Interaction Ranges Associated with the 3 Atomic Interactions and the Scope for 4G Model of String Theory

By following the above assumptions, it is possible to estimate the three atomic interaction ranges in the following way.

Electroweak interaction range can be expressed as,

$$R_w \cong \frac{2G_w M_{wf}}{c^2} \cong 6.7494 \times 10^{-19} \text{ m} \tag{1}$$

Nuclear interaction range can be expressed as,

$$R_n \cong \frac{2G_n m_p}{c^2} \cong 1.2393 \times 10^{-15} \text{ m} \tag{2}$$

Electromagnetic interaction range can be expressed as,

$$R_e \cong \frac{2G_e m_e}{c^2} \cong 4.813 \times 10^{-10} \text{ m} \tag{3}$$

Here, we would like to highlight the following two points.

(1) Proposed weak interaction range, $\frac{2G_w M_{wf}}{c^2} \cong \sqrt{\frac{G_F}{\hbar c}}$ where G_F is the Fermi's weak coupling constant.
(2) String theory [26-30] can be made practical with reference to the three atomic gravitational constants associated with weak, strong and electromagnetic interaction gravitational constants. See Table 1. and Table 2. for sample string tensions and energies without any coupling constants.

Table 1. Charge dependent string tensions and energies.

S.No	Interaction	String Tension	String energy
1	Weak	$\frac{c^4}{4G_w} \cong 6.94 \times 10^{10}$ N	$\sqrt{\frac{e^2}{4\pi\varepsilon_0}\left(\frac{c^4}{4G_w}\right)} \cong 24.975$ GeV
2	Strong	$\frac{c^4}{4G_n} \cong 6.065 \times 10^4$ N	$\sqrt{\frac{e_n^2}{4\pi\varepsilon_0}\left(\frac{c^4}{4G_n}\right)} \cong 68.79$ MeV
3	Electromagnetic	$\frac{c^4}{4G_e} \cong 8.505 \times 10^{-5}$ N	$\sqrt{\frac{e^2}{4\pi\varepsilon_0}\left(\frac{c^4}{4G_e}\right)} \cong 874.3$ eV

Table 2. Quantum string tensions and energies.

S.No	Interaction	String Tension	String energy
1	Weak	$\frac{c^4}{4G_w} \cong 6.94\times10^{10}$ N	$\sqrt{\hbar c\left(\frac{c^4}{4G_w}\right)} \cong 292.36$ GeV
2	Strong	$\frac{c^4}{4G_n} \cong 6.065\times10^{4}$ N	$\sqrt{\hbar c\left(\frac{c^4}{4G_n}\right)} \cong 273.3$ MeV
3	Electromagnetic	$\frac{c^4}{4G_e} \cong 8.505\times10^{-5}$ N	$\sqrt{\hbar c\left(\frac{c^4}{4G_e}\right)} \cong 10234.77$ eV

5. Our 5 Definitions Related to Final Unification

In a unified approach, we have defined 5 relations in the following way.
Electron rest mass is defined as,

$$m_e \equiv \left(\frac{G_w}{G_n}\right) M_{wf} \quad (4)$$

Proton rest mass is defined as,

$$m_p \equiv \left(\frac{G_n^2}{G_e G_w}\right) M_{wf} \quad (5)$$

Nuclear and electromagnetic charge ratio is defined as

$$\left(\frac{e}{e_n}\right) \equiv \frac{\hbar c}{G_n m_p^2} \quad (6)$$

Product of Reduced Planck's constant and speed of light is defined as

$$\hbar c \equiv G_w M_{wf}^2 \quad (7)$$

Ratio of forces related to proton and electron is defined as

$$\frac{e_n^2}{4\pi\varepsilon_0 G_n m_p m_e} \equiv 4\pi^2 \quad (8)$$

6. Understanding the Reduced Planck's Constant and Its Integral Nature

Based on relation (7), the well believed quantum constant $\hbar c$ seems to have a deep inner meaning with reference to electroweak interaction. Following relation (7), there is a possibility to understand the integral nature of quantum mechanics with a relation of the form, $n^2\hbar \equiv \frac{G_w\left(nM_{wf}\right)^2}{c}$ where $n = 1,2,3,..$ It needs further study with reference to EPR argument and other physical logics [10,31,32,33,34]. Compared to large massive structures, -like living creatures- as elementary particles are having discrete nature, we would like to emphasize the point that, discreteness may be the root cause of quantum behavior at microscopic level. With reference to proton and electron rest masses, it seems possible to have different relations like, $\hbar \cong \left(\frac{e}{e_n}\right)\left(\frac{G_n m_p^2}{c}\right) \cong \left(\frac{G_w G_e}{G_n}\right)\frac{m_p m_e}{c} \cong \frac{m_e\sqrt{\left(G_n m_p\right)\left(G_e m_e\right)}}{c}$. We are working in this new direction and it needs further study.

7. Understanding Proton-Electron Mass Ratio

Considering weak, nuclear and electromagnetic interactions,

$$\frac{m_p}{m_e} \cong \frac{G_n^3}{G_w^2 G_e} \tag{9}$$

Strong coupling constant [16] can be expressed as,

$$\alpha_s \cong \left(\frac{e}{e_n}\right)^2 \cong \left(\frac{\hbar c}{G_n m_p^2}\right)^2 \cong \frac{G_e m_e^3}{G_n m_p^3} \cong \frac{G_w^6 G_e^4}{G_n^{10}} \tag{10}$$

Hence, proton and electron mass ratio can be expressed as,

$$\frac{m_p}{m_e} \cong \frac{e_n^2 G_e m_e^2}{e^2 G_n m_p^2} \cong \left(\frac{e_n^2}{4\pi\varepsilon_0 G_n m_p^2}\right) \div \left(\frac{e^2}{4\pi\varepsilon_0 G_e m_e^2}\right)$$
$$\cong \left(\frac{e_n^2 G_e}{e^2 G_n}\right)^{1/3} \cong \left[\left(\frac{e_n^2}{4\pi\varepsilon_0 G_n}\right) \div \left(\frac{e^2}{4\pi\varepsilon_0 G_e}\right)\right]^{1/3} \tag{11}$$

In terms of specific charge ratios,

$$\left(\frac{e}{m_e}\right) \div \left(\frac{e_n}{m_p}\right) \cong \frac{e m_p}{e_n m_e} \cong \frac{\hbar c}{G_n m_p m_e} \cong \frac{G_e m_e^2}{\hbar c} \cong \sqrt{\frac{R_e}{R_n}} \cong \frac{G_w G_e}{G_n^2} \cong \frac{M_{wf}}{m_p} \tag{12}$$

$$\left(\frac{e_n}{m_p}\right) \div \left(\frac{e}{m_e}\right) \cong \frac{e_n m_e}{e m_p} \cong \frac{G_n m_p m_e}{\hbar c} \cong \frac{\hbar c}{G_e m_e^2} \cong \sqrt{\frac{R_n}{R_e}} \cong \frac{G_n^2}{G_w G_e} \cong \frac{m_p}{M_{wf}} \cong 0.001605 \tag{13}$$

Here it is very interesting to note that,

$$\frac{m_p}{M_{wf}} \cong \left(\frac{\sqrt{(m_\pi c^2)^0 (m_\pi c^2)^\pm}}{\sqrt{(m_w c^2)^\pm (m_z c^2)^0}}\right) \cong \left(\frac{\sqrt{134.98\times 139.57}\ \text{MeV}}{\sqrt{80379.0\times 91187.6}\ \text{MeV}}\right) \cong 0.0016032 \tag{14}$$

Here ratio of rest mass of proton to the assumed electroweak fermion is equal to the ratio of mean mass of pions to the mean mass of electroweak bosons. Based on this unique and concrete observation, we are very confident to say that, strong and weak interactions play a vital role exploring the secrets of nuclear structure.

8. Understanding the Nucleon Magnetic Moments

Characteristic nucleon magnetic moment having a nuclear charge of e_n and electromagnetic charge of e can be expressed as,

$$\mu_X \cong \frac{\hbar\sqrt{e_n e}}{2m_p} \cong \frac{e\hbar}{2\sqrt{m_e M_{wf}}} \cong 8.6696\times 10^{-27}\ \text{J.Tesla}^{-1}$$
$$\text{where } M_{wf} \cong 1.042367\times 10^{-24}\ \text{kg} \tag{15}$$

Neutron magnetic moment [20] can be fitted with,

$$\mu_n \cong (1+\alpha_s)\frac{\hbar\sqrt{e_n e}}{2m_p} \cong (1+\alpha_s)\frac{e\hbar}{2\sqrt{m_e M_{wf}}} \cong 9.6684\times 10^{-27}\ \text{J.Tesla}^{-1} \tag{16}$$

Proton magnetic moment [20] can be fitted with,

$$\mu_p \cong (1.5+\alpha_s)\frac{\hbar\sqrt{e_n e}}{2m_p} \cong \frac{e\hbar}{2\sqrt{m_e M_{wf}}} \cong 1.40\times 10^{-26}\ \text{J.Tesla}^{-1} \tag{17}$$

Ratio of neutron and proton magnetic moments can be expressed as,

$$\frac{\mu_p}{\mu_p} \cong \frac{(1.0+\alpha_s)}{(1.5+\alpha_s)} \cong 0.69 \tag{18}$$

9. Understanding the Fermi's Weak Coupling Constant

Fermi's weak coupling constant can be fitted with the following relations [20,21,22].

$$G_F \cong \left(\frac{m_e}{m_p}\right)^2 \hbar c R_n^2 \cong \hbar c R_w^2 \qquad (19)$$
$$\cong G_w M_{wf}^2 R_w^2 \cong 1.440206 \times 10^{-62} \text{ J.m}^3$$

It's a very simple relation and demonstrates the confirmation of the physical existence of the proposed 585 GeV weak fermion. Obtained value is matching with the recommended value by 99.7%. It needs further study.

10. Understanding Nuclear Stability Associated with Beta Decay

Nuclear stability means, finding stable atomic nuclides having long living time compared to other living atomic nuclides having short living time. By beta decay, mostly short living atomic nuclides emit electrons and positrons transforms to stable atomic nuclides. In general, Beta decay process is believed to be associated with weak interaction. In this context, we noticed that, starting from Z=2 to 92,

$$A_s \cong 2Z + \beta(2Z)^2 \cong 2Z + 4\beta Z^2 \cong 2Z + 0.00642Z^2$$

where,

$A_s \cong$ Light house like stable mass number

Z $\cong$ Proton number (20)

$\beta \cong$ Specific charge ratios of proton and electron

$$\cong \left(\frac{e_n}{m_p}\right) \div \left(\frac{e}{m_e}\right) \cong \frac{e_n m_e}{e m_p} \cong \sqrt{\frac{R_n}{R_e}} \cong \frac{m_p}{M_{wf}} \cong 0.001605$$

$$4\beta \cong 4 \times 0.001605 \cong 0.00642$$

Here we wish to call β as the electroweak coefficient. Thus,

$$\frac{A_S - 2Z}{4Z^2} \cong \beta \qquad (21)$$

One can find a similar relation in the literature [35]. This relation can be well tested for Z=21 to 92. For example,

$$\frac{45-(2\times 21)}{4(21)^2} \cong 0.00170; \quad \frac{63-(2\times 29)}{4(29)^2} \cong 0.00149;$$
$$\frac{89-(2\times 39)}{4(39)^2} \cong 0.00181; \quad \frac{109-(2\times 47)}{4(47)^2} \cong 0.0017;$$
$$\frac{169-(2\times 69)}{4(69)^2} \cong 0.00163; \quad \frac{238-(2\times 92)}{4(92)^2} \cong 0.001595;$$

This is one best practical and quantitative application of our proposed electroweak fermion and bosons. Following this relation and based on various semi empirical mass formulae, by knowing any stable mass number, its corresponding proton number can be estimated with,

$$Z \cong \frac{A_S}{1+\sqrt{1+4\beta A_S}} \cong \frac{A_S}{1+\sqrt{1+0.00642 A_S}} \cong \frac{A_S}{2+0.0153 A_S^{2/3}}$$

(22)

$$\text{where } \frac{a_c}{2a_{asy}} \cong \frac{0.71 \text{ MeV}}{2\times 23.21 \text{ MeV}} \cong \frac{0.6615 \text{ MeV}}{2\times 21.6091 \text{ MeV}} \cong 0.0153$$

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With even-odd corrections and further study, super heavy atomic nuclides can be estimated easily. In this context, we have developed the following relation.

$$A_s \cong \text{RoundOff}\left\{\left(Z+\left(\frac{e_n}{e}\right)\right)^{1.2} - \sqrt{\frac{e_n}{e}}\right\} \cong \text{RoundOff}\left\{(Z+2.9464)^{1.2} - 1.7165\right\}$$

(23)

$$\text{where } \left(\frac{e_n}{e}\right)^{\frac{1}{6}} \cong \left(\frac{1}{\alpha_s}\right)^{\frac{1}{12}} \cong 1.19733 \cong 1.2$$

With even odd corrections,

$$A_s \cong \left[\text{RoundOff}\left\{(Z+2.9464)^{1.2} - 1.7165\right\} + [0,1]\right]$$

(24)

Here,

(1) If Z is even and obtained A_s is odd, then, $A_s \cong A_s + 1$.

(2) If Z is even and obtained A_s is even, then, $A_s \cong A_s$.

(3) If Z is odd and obtained A_s is odd, then, $A_s \cong A_s$.

(4) If Z is odd and obtained A_s is even, then, $A_s \cong A_s + 1$.

11. Understanding Nuclear Binding Energy

In our recent publications pertaining to 4G model of final unification and based on strong and electroweak interactions, we have developed a completely new formula for estimating nuclear binding energy [36-40]. With reference to currently believed Semi Empirical Mass Formula (SEMF), we call our formula as 'Strong and Electroweak Mass Formula' (SEWMF). Our formula constitutes 4 simple terms and only one energy coefficient of magnitude 10.1 MeV. First term is a volume term, second term seems to be a representation of free nucleons associated with electroweak interaction, third term is a radial term and fourth one is an asymmetry term about the mean stable mass number. Considering this kind of approach, nuclear structure can be understood in terms of strong and weak interactions in a theoretical approach positively [1-14]. For Z=6 to 118, improved binding energy relation can be expressed as,

$$BE \cong \left(A - A_{free} - A_{radial} - A_{asym}\right)\left(B_0 \cong 10.1 \text{ MeV}\right) \quad (25)$$

where $A \times 10.1$ MeV represents the volume term

$A_{free} \times 10.1$ MeV represents the modified electroweak term

$A_{radial} \times 10.1$ MeV represents the radial term

$A_{asym} \times 10.1$ MeV represents the modified asymmetry term

$$B_0 \cong -\frac{e_n^2}{8\pi\varepsilon_0\left(G_n m_p / c^2\right)} \cong -10.1 \text{ MeV}$$

$$\cong \frac{1}{2}\left[\left(2m_u c^2 + m_d c^2\right) + \left(m_u c^2 + 2m_d c^2\right)\right] \cong 10.1 \text{ MeV}$$

where (m_u, m_d) reprsent Up and Down quark masses.

$$BE \cong \left\{A - \left\{\left(\frac{1}{2}\right) + \beta\left[\left(Z^2 + N^2 + \left(\frac{Z^2}{N}\right)^2\right) - N^2\left(\frac{N-Z}{N+Z}\right)^2\right]\right\} - A^{1/3} - \frac{(A_s - A)^2}{A_s}\right\} 10.1 \text{ MeV}$$

where, $\beta \cong 0.001605$

(26)

Extrapolation point of view, there is a considerable error for very low and very high mass numbers of any Z and we are working in all possible ways. Close to the light house like stable mass numbers of Z=6 to 118,

$$BE \cong \left\{ A_s - \left\{ \left(\frac{1}{2}\right) + 0.001605\left[\sqrt{\left(Z^2+N^2+\left(\frac{Z^2}{N}\right)^2\right) - N^2\left(\frac{N-Z}{N+Z}\right)^2}\right] \right\} - A_s^{1/3} \right\} 10.1 \text{ MeV} \quad (27)$$

We are working on understanding the electroweak term in various possible ways. Based on Liquid drop model, close to beta stability line, number of free nucleons associated with nuclear volume and surface area, can be addressed with an approximate relation of the form,

$$\begin{aligned} A_{free} &\cong \frac{1}{2} + \left[0.000634\left(\sqrt{A + Z^{2/3} + N^{2/3}}\right)^2\right] \\ &\cong \frac{1}{2} + \left[0.000634\left(\sqrt{\left(Z+Z^{2/3}\right)} + \sqrt{\left(N+N^{2/3}\right)}\right)^2\right] \end{aligned} \quad (28)$$

$$\text{where} \quad \beta\left(\frac{m_e}{m_n - m_p}\right) \cong \frac{m_p m_e}{M_{wf}\left(m_n - m_p\right)} \cong 0.000634$$

12. Understanding the Mean Lifetime of Neutron

Ratio of neutron-proton mass difference to electron rest mass can be expressed as,

$$\left.\begin{aligned} &\left(\frac{m_n - m_p}{m_e}\right) \cong \ln(4\pi) \cong 2.531024247 \text{ and} \\ &\frac{(939.5654205 - 938.27208816)\text{ MeV}}{0.51099895\text{ MeV}} \\ &\cong \frac{1.2933324\text{ MeV}}{0.51099895\text{ MeV}} \cong 2.530988371 \end{aligned}\right\} \quad (29)$$

Relation (29) can be understood with the following relation.

$$\left.\begin{aligned} &\text{Let,}\left(\frac{m_n - m_p}{m_e}\right) \cong \ln\sqrt{\left(\frac{e^2 G_n m_p^3}{4\pi\varepsilon_0 (\hbar/2)^2}\right) \div \left(m_e c^2\right)} \\ &\cong \ln\sqrt{\frac{4e^2 m_p}{4\pi\varepsilon_0 \hbar m_e c}\left(\frac{G_n m_p^2}{\hbar c}\right)} \cong \ln\sqrt{\frac{4e_n^2 m_p}{4\pi\varepsilon_0 \hbar m_e c}\left(\frac{\hbar c}{G_n m_p^2}\right)} \\ &\cong \ln\sqrt{\left(\frac{4e_n^2}{4\pi\varepsilon_0 G_n m_p m_e}\right)} \cong \ln\sqrt{4\left(\frac{e_n^2}{4\pi\varepsilon_0 G_n m_p m_e}\right)} \\ &\cong \ln\sqrt{4\left(4\pi^2\right)} \cong \ln\sqrt{16\pi^2} \cong \ln\sqrt{4\pi} \end{aligned}\right\} \quad (30)$$

It may be noted that, $\frac{e^2 G_n m_p^3}{4\pi\varepsilon_0 (\hbar/2)^2} \cong \frac{4e^2 G_n m_p^3}{4\pi\varepsilon_0 \hbar^2} \cong 80.693732$ MeV. With a marginal error, it is matching with twice of potential depth of nucleon (40 MeV) associated with Fermi gas model [41,42] of the nucleus. Considering $\hbar$ in place of $(\hbar/2)$, $\frac{e^2 G_n m_p^3}{4\pi\varepsilon_0 \hbar^2} \cong 20.173433$ MeV. If $\frac{e^2 G_n m_p^3}{4\pi\varepsilon_0 \hbar^2} \cong \frac{e_n^2}{4\pi\varepsilon_0 \left(G_n m_p / c^2\right)} \cong 20.173433$ MeV is a kind potential energy, its total energy form is,

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$-\frac{e^2 G_n m_p^3}{8\pi\varepsilon_0 \hbar^2} \cong -\frac{e_n^2}{8\pi\varepsilon_0 \left(G_n m_p / c^2\right)} \cong -10.08672$ MeV. Based on these coincidences, bottle method of neutron lifetime [43-46] can be expressed as,

$$\left.\begin{aligned} t_n &\cong \exp\left[\frac{2\times \text{Nucleon potential well}(\approx 40\text{ MeV})}{(\text{Neutron, Proton})\text{ rest energy difference}}\right]\left(\frac{\hbar}{m_n c^2}\right) \\ &\cong \exp\left[\frac{e^2 G_n m_p^3}{4\pi\varepsilon_0 (\hbar/2)^2 (m_n - m_n)c^2}\right]\left(\frac{\hbar}{m_n c^2}\right) \\ &\cong \exp\left[4\left(\frac{e_n^2}{4\pi\varepsilon_0 \left(G_n m_p/c^2\right)}\right)\left(\frac{1}{(m_n - m_n)c^2}\right)\right]\left(\frac{\hbar}{m_n c^2}\right) \\ &\text{where factor '4' needs a review for its physical interpretation} \end{aligned}\right\}. \quad (31)$$

Thus, it is possible to show that,

$$\begin{aligned} t_n &\cong \exp\left[\left(\frac{m_e}{m_n - m_p}\right)\left(\exp\left(\frac{m_n - m_p}{m_e}\right)\right)^2\right]\left(\frac{\hbar}{m_n c^2}\right) \cong 871.04 \text{ sec} \\ &\cong \exp\left[\frac{16\pi^2}{\ln(4\pi)}\right]\left(\frac{\hbar}{m_n c^2}\right) \cong 874.174 \text{ sec.} \end{aligned} \quad (32)$$

Now coming back to our nuclear stability and binding energy relations, we noticed that,

$$\left(1+\frac{e_n}{e}\right)\left(\frac{m_p}{M_{wf}}\right) \cong 0.0063340 \cong \left(\frac{1}{4\pi}\right)^2 \cong 0.0063326 \quad (33)$$

If one is willing to replace the factor 4 with $\left(1+\frac{e_n}{e}\right) \cong 3.9464$ in relation (20), nuclear beta stability relation can be expressed as,

$$A_s \cong 2Z + \left(\frac{Z}{4\pi}\right)^2 \quad (34)$$

Root mean square radius of proton [47,48] can be understood with

$$\begin{aligned} R_p &\cong \left(1+\frac{e_n}{e}\right)\left(\frac{\hbar}{m_p c}\right) \cong \left(\frac{\hbar}{m_p c}\right) + \left(\frac{G_n m_p}{c^2}\right) \\ &\cong \left(1+\frac{e}{e_n}\right)\left(\frac{G_n m_p}{c^2}\right) \cong 8.3\times 10^{-16} \text{ m} \end{aligned} \quad (35)$$

Considering higher powers of $\left(\frac{e}{e_n}\right)$,

$$R_p \cong \exp\left(\frac{e}{e_n}\right)\left(\frac{G_n m_p}{c^2}\right) \cong 1.4041\left(\frac{G_n m_p}{c^2}\right) \quad (36)$$

Thus,

$$R_p \cong (1.3394 \text{ to } 1.4041)\left(\frac{G_n m_p}{c^2}\right) \cong (8.3 \text{ to } 8.7)\times 10^{-16} \text{ m} \quad (37)$$

For medium and heavy atomic nuclides, nuclear charge radii [49,50] can be expressed as,

$$\begin{aligned} R_{(Z,N)} &\cong \left[Z^{1/3} + \left(\sqrt{ZN}\right)^{1/3}\right]\left(\frac{G_n m_p}{c^2}\right) \\ &\cong \left[Z^{1/3} + \left(\sqrt{ZN}\right)^{1/3}\right]\times 0.6197\times 10^{-15} \text{ m} \end{aligned} \quad (38)$$

Believing in these simple and workable relations, Planck's constant and corresponding magnetic flux quantum [3,20] can be expressed as follows.

$$h \cong \sqrt{\left(\frac{e_n^2}{4\pi\varepsilon_0 c}\right)\left(\frac{G_e m_e^2}{c}\right)} \quad (39)$$

$$\left(\frac{h}{e}\right) \cong \left(\frac{e_n}{e}\right)\sqrt{\left(\frac{\mu_0}{4\pi}\right)G_e m_e^2} \quad (40)$$

With reference to experimental magnetic flux quantum $\left(\frac{h}{2e}\right)$, factor $\left(\frac{1}{2}\right)$ is missing in this relation. It can be understood as follows.

Total magnetic flux generated for one electron can be,

$$\Phi_{Total} \cong \left(\frac{e_n}{e}\right)\sqrt{\left(\frac{\mu_0}{4\pi}\right)G_e m_e^2} \cong \frac{h}{e} \quad (41)$$

For a simple two-pole system, quantum of magnetic flux per pole can be,

$$\Phi_{per/pole} \cong \frac{\Phi_{Total}}{2} \cong \frac{1}{2}\left(\frac{e_n}{e}\right)\sqrt{\left(\frac{\mu_0}{4\pi}\right)G_e m_e^2} \cong \frac{h}{2e} \quad (42)$$

We are working in this direction.

13. Discussion on Our 3 Assumptions, 5 Definitions and Many Applications

In our 4G model of final unification, there exists 3 assumptions, 5 definitions and many inferences. It may be noted that,

(1) The first 2 definitions are related to electron and proton rest masses.
(2) 3rd definition is related to nuclear charge and strong coupling constant.
(3) 4th definition is related to the product of Reduced Planck's constant and speed of light.
(4) 5th definition is related to $4\pi^2$
(5) 1st application is related to different meanings of proton-electron mass ratio.
(6) 2nd application is related to ratio of specific charge ratios of proton and electron.
(7) 3rd application is related to neutron and proton magnetic moments.
(8) 4th application is related to Fermi's weak coupling constant.
(9) 5th application is related to Neutron lifetime.
(10) 6th application is related to Planck's constant.
(11) 7th application is related to quantum of magnetic flux.
(12) 8th application is related to Root mean square radius of proton.
(13) 9th application is related to charge radii of medium and heavy atomic nuclides.
(14) 10th application is related to nuclear stability and binding energy.
(15) 11th application is related to neutrino rest mass.
(16) 12th application is related to quarks' fractional charges.
(17) 13th application is related to Unified atomic mass unit and Avogadro constant.
(18) 14th application is related to the Newtonian gravitational constant.
(19) 15th application is related to atomic radii.
(20) 16th application is related to advancement of string theory with 4 different gravitational constants applicable for the observed four interactions.

14. Tera Electron Volt Photon Radiation Coming from Galaxies

In near future, by increasing the operating capacity of particle accelerators, it seems possible to confirm the existence of 585 GeV. It can be understood by observing Tera electron volt (TeV) photons coming by annihilation of 585 GeV fermions within the core of the particle accelerator or surroundings of astrophysical objects. At the vicinity of compact stars or exploding stars, TeV radiation can be understood with three theoretical methods [51-54]. As we are beginners of astrophysics domain, we appeal the science community to see the possibility of considering the proposed 585 GeV weak fermion with a charge of $(\pm e)$ in place of electron and proton. As it is assumed that, 585 GeV weak fermion is the mother of all elementary particles, at very high energies, it can be assumed as relatively stable for the possible occurrence of the following accelerating mechanisms.

Method-1: Generation and annihilation of 585 GeV weak fermions

(a) 585 GeV fermions are generated by decay of high energy elementary particles available within the core of the hot astrophysical objects.
(b) 585 GeV weak fermions emit high energy radiation via annihilation mechanism.

Method-2: Annihilation of accelerated of 585 GeV weak fermions

(a) 585 GeV fermions are forced to accelerate by the surrounding shock ways.
(b) Accelerated 585 GeV weak fermions emit high energy photons via synchrotron mechanism or annihilation.

Method-3: Accelerated 585 GeV weak fermions sharing energy to low TeV photons

(a) 585 GeV fermions are forced to accelerate by the surrounding shock ways.
(b) By following Inverse Compton Effect (ICE), low TeV photons gain energy from high energy 585 GeV weak fermions resulting in much higher TeV photons.

15. Conclusion

In a microscopic approach, considering relations (1) to (42), it seems possible to understand and confirm the physical existence of the proposed 585 GeV weak fermion directly and indirectly. In a macroscopic approach, by considering TeV photons coming from astrophysical objects, there is a scope and possibility for confirming the physical existence of 585 GeV weak fermion. It needs further study.

References

1. Seshavatharam U. V. S., Gunavardhana Naidu T and Lakshminarayana S. To confirm the existence of heavy weak fermion of rest energy 585 GeV. AIP Conf. Proc. 2451, 020003, 2022.
2. Seshavatharam U. V. S. and Lakshminarayana S. 4G model of final unification – A brief report. Journal of Physics: Conference Series 2197 p 012029, 2022.
3. Seshavatharam U.V.S. and Lakshminarayana S. Understanding the Origins of Quark Charges, Quantum of Magnetic Flux, Planck's Radiation Constant and Celestial Magnetic Moments with the 4G Model of Nuclear Charge. Current Physics, 1, e090524229812, 122-147, 2024.
4. Seshavatharam U.V.S. and Lakshminarayana S. Exploring condensed matter physics with refined electroweak term of the strong and electroweak mass formula. World Scientific News.193(2) 105-13, 2024.
5. Seshavatharam U.V.S. and Lakshminarayana S. Inferring and confirming the rest mass of electron neutrino with neutron lifetime and strong coupling constant via 4G model of final unification. World Scientific News 191, 127-156, 2024.
6. Seshavatharam U.V.S. and Lakshminarayana. Understanding nuclear stability range with 4G model of nuclear charge. World Scientific News. 177, 118-136, 2023.
7. Seshavatharam U. V. S. and Lakshminarayana S., H. K. Cherop and K. M. Khanna, Three Unified Nuclear Binding Energy Formulae. World Scientific News, 163, 30-77, 2022.
8. Seshavatharam U.V.S. and Lakshminarayana, S., On the Combined Role of Strong and Electroweak Interactions in Understanding Nuclear Binding Energy Scheme. Mapana Journal of Sciences, 20(1), 1-18, 2021.
9. Seshavatharam U.V.S. and Lakshminarayana S., Strong and Weak Interactions in Ghahramany's Integrated Nuclear Binding Energy Formula. World Scientific News, 161, 111-129, 2021.
10. Seshavatharam U.V.S. and Lakshminarayana S. Is reduced Planck's constant - an outcome of electroweak gravity? Mapana Journal of Sciences. 19,1,1, 2020.
11. Seshavatharam U.V.S. and Lakshminarayana S.A very brief review on strong and electroweak mass formula pertaining to 4G model of final unification. Proceedings of the DAE Symp. on Nucl. Phys. 67,1173, 2023.

12. Seshavatharam U.V.S. and Lakshminarayana S. Understanding Super Heavy Mass Numbers and Maximum Binding Energy of Any Mass Number with Revised Strong and Electroweak Mass Formula. Preprints 2024, 2024051928
13. Seshavatharam U.V.S. and Lakshminarayana S. EPR argument and mystery of the reduced Planck's constant. Algebras, Groups, and Geometries. 36(4), 801-822, 2020.
14. Seshavatharam U.V.S. and Lakshminarayana S. Computing Unified Atomic Mass Unit and Avogadro Number with Various Nuclear Binding Energy Formulae Coded in Python. Preprints 2024, 2024081881
15. Camarda, S., Ferrera, G. & Schott, M. Determination of the strong-coupling constant from the Z-boson transverse-momentum distribution. Eur. Phys. J. C 84, 39, 2024.
16. Andreev, V., Baghdasaryan, A., Begzsuren, K. et al. Determination of the strong coupling constant in next-to-next-to-leading order QCD using H1 jet cross section measurements. Eur. Phys. J. C 77, 791, 2017.
17. Quinn Terry and Speake Clive 2014The Newtonian constant of gravitation—a constant too difficult to measure? An introductionPhil. Trans. R. Soc. A.37220140253.
18. S. Schlamminger et al. Measurement of the Gravitational Constant at NIST. American Physical Society meeting, Minneapolis, April 15, 2023.
19. David B. Newell and Eite Tiesinga (2019): The International System of Units (SI). NIST Special Publication 330, National Institute of Standards and Technology.
20. Peter Mohr, David Newell, Barry Taylor, Eite Tiesinga. CODATA Recommended Values of the Fundamental Physical Constants: 2022. arXiv:2409.03787 [hep-ph]
21. Wilson, Fred L. Fermi's theory of beta decay. American Journal of Physics. 36 (12): 1150–1160,1968.
22. Rajasekaran, G. Fermi and the theory of weak interactions. Reson 19, 18–44, 2014.
23. Salam, A.; Strathdee, J. A. Supersymmetry and Nonabelian Gauges. Physics Letters B. 51 (4): 353–355,1974.
24. Farrar, G.R., Mackeprang, R., Milstead, D. et al. Limit on the mass of a long-lived or stable gluino. J. High Energ. Phys. 2011, 18, 2011.
25. Baer, H.; Barger, V.; Serce, H.; Sinha, K. Higgs and superparticle mass predictions from the landscape. Journal of High Energy Physics. 1803 (3): 002,2017.
26. Sunil Mukhi.String theory: a perspective over the last 25 years. Class. Quantum Grav. 28 153001, 2011.
27. Sachdev, Subir. Strange and stringy. Scientific American. 308 (44): 44–51,2013.
28. Blumenhagen R., Lüst D., Theisen S. Basic Concepts of String Theory. Theoretical and Mathematical Physics Springer Heidelberg, Germany, 2013.
29. Seshavatharam U.V.S. and Lakshminarayana S. On the compactification and reformation of string theory with three large atomic gravitational constants. International Journal of Physical Research, 9(1), 42-48, 2021.
30. Arnab Priya Saha and Aninda Sinha Phys. Field Theory Expansions of String Theory Amplitudes.Rev. Lett. 132, 221601,2024.
31. A Einstein, B Podolsky and N Rosen. Can Quantum-Mechanical Description of Physical Reality Be Considered Complete?, Physical Review. 47, 777, 1935.
32. N Bohr, Can QuantumMechanical Description of Physical Reality be Considered Complete?, Physical Review, 48, 696,1935.
33. Arvind. The EPR paradox: Einstein scrutinizes quantum mechanics. Reson. 5, 28–36, 2000.
34. Fine, Arthur The Einstein-podolsky-Rosen argument in quantum theory. Stanford Encyclopedia of Philosophy.2008.
35. D.N. Basu. Neutron and proton drip lines using the modified Bethe-Weizsacker mass formula.nt.J.Mod.Phys. E13, 747-758, 2004.
36. Bethe H. A. Thomas-Fermi Theory of Nuclei. Phys. Rev., 167(4), 879-907, 1968.
37. Myers W. D. and Swiatecki W. J. Nuclear Properties According to the Thomas-Fermi Model.LBL-36557 Rev. UC-413, 1995.
38. Cht Mavrodiev S, Deliyergiyev MA. Modification of the nuclear landscape in the inverse problem framework using the generalized Bethe-Weizsäcker mass formula. J. Mod. Phys. E 27: 1850015, 2018.
39. Gao Z. P, Wang YJ, Lü HL et al., Machine learning the nuclear mass. Sci. Tech. 32, 109, 2021.
40. X.W. Xia, Y. Lim, P.W. Zhao et al. The limits of the nuclear landscape explored by the relativistic continuum Hartree–Bogoliubov theory. Atomic Data and Nuclear Data Tables. 121–122, 1-215, 2018.
41. Zelevinsky, Vladimir & Volya, Alexander. (2017). Fermi Gas Model. 10.1002/9783527693610.ch7.
42. Hassanabadi, H., Armat, A. & Naderi, L. Relativistic Fermi-Gas Model for Nucleus. Found Phys 44, 1188–1194, 2014.
43. UCNτ Collaboration, F. M. Gonzalez, E. M. Fries, C. Cude-Woods, T. Bailey, M. Blatnik, L. J. Broussard, N. B. Callahan, J. H. Choi, S. M. Clayton, and others, Improved Neutron Lifetime Measurement with UCN τ. Rev. Lett. 127, 162501, 2021
44. Anirban, A. Precise measurement of neutron lifetime. Rev. Phys. 4, 9, 2022.
45. Zhang, J., Zhang, S., Zhang, ZR. et al. MFV approach to robust estimate of neutron lifetime. ur. J. C 82, 1106, 2022.

46. Tsung-Han Yeh, Keith A. Olive, Brian D. Fields.The Neutron Mean Life and Big Bang Nucleosynthesis.arXiv:2303.04140 [astro-ph.CO], UMN--TH--4210/23, FTPI--MINN--23/04
47. Gao, H.; Vanderhaeghen, M. The proton charge radius. Rev. Mod. Phys. 2022, 94, 015002
48. Thomas Walcher. The Lamb shift in muonic hydrogen and the electric rms radius of the proton. arXiv:2304.07035 [physics.atom-ph]
49. Tuncay Bayram, Serkan Akkoyun, S. Okan Kara, Alper Sinan. New Parameters for Nuclear Charge Radius Formulas. Acta Phys. Polon. B 44, 8, 1791-1799, 2013.
50. Angeli, K.P. Marinova, Table of experimental nuclear ground state charge radii: An update. Atomic Data and Nuclear Data Tables, 99(1), 69-95, 2013.
51. Sarira Sahu et al, Deciphering the 18 TeV Photons from GRB 221009A.ApJL 942 L30,2023.
52. Giorgio Galanti, Lara Nava, Marco Roncadelli, Fabrizio Tavecchio, and Giacomo Bonnoli. Multi-TeV photons from GRB 221009A: uncertainty of optical depth considered.Phys. Rev. Lett. 131, 251001,2023.
53. Chuyuan Yang, Houdun Zeng, Biwen Bao and Li Zhang. Possible hadronic origin of TeV photon emission from SNR G106.3+2.7.A&A 658, A60, 2022.
54. Jirong Mao, Jiancheng Wang, Jitter radiation: towards TeV-photons of gamma-ray bursts, Monthly Notices of the Royal Astronomical Society, 505(3),4608–4615, 2021.