Strong Nuclear Gravitational Constant and the Origin of Nuclear Planck Scale

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Whether it may be real or an equivalent, existence of strong nuclear gravitational constant G_S is assumed. Its value is obtained from Fermi's weak coupling constant as $G_S = 6.9427284\times10^{31}$ m^3/kg sec^2 and thus "nuclear planck scale" is defined. For strong interaction existence of a new integral charged "confined fermion" of mass 105.383 MeV is assumed. Strong coupling constant is the ratio of nuclear planck energy = 11.97 MeV and assumed 105.383 MeV. $\frac{1}{\alpha_s} = X_s$ is defined as the strong interaction mass generator. With 105.383 MeV fermion various nuclear unit radii are fitted. Fermi's weak coupling constant, strong interaction upper limit and Bohr radius are fitted at fundamental level. Considering Fermi's weak coupling constant and nuclear planck length a new number $X_e = 294.8183$ is defined for fitting the electron, muon and tau rest masses. Using X_s, X_e and α 105.32 = 0.769 MeV as the Coulombic energy constant = E_c, energy coefficients of the semi-empirical mass formula are estimated as $E_v = 16.32$ MeV, $E_s = 19.37$ MeV, $E_a = 23.86$ MeV and $E_p = 11.97$ MeV where Coulombic energy term contains $[Z]^2$. Starting from $Z = 2$ nuclear binding energy is fitted with two terms along with only one energy constant = 0.769 MeV. Finally nucleon mass and its excited levels are fitted.

1 Introduction

It can be supposed that elementary particles construction is much more fundamental than the black hole's construction. If one wishes to unify electroweak, strong and gravitational interactions it is a must to implement the classical gravitational constant G in the sub atomic physics. By any reason if one implements the planck scale in elementary particle physics and nuclear physics automatically G comes into subatomic physics. Then a large arbitrary number has to be considered as a proportionality constant. After that its physical significance has to be analyzed. Alternatively its equivalent "strong nuclear gravitational constant G_S can also be assumed. Some attempts have been done in physics history [1–5]. Whether it may be real or an equivalent if it is existing as a "single constant" its physical significance can be understood. "Nuclear size" can be fitted with "nuclear Schwarzschild radius". "Nucleus" can be considered as "strong nuclear black hole". This idea requires a basic nuclear fermion! Nuclear binding energy constants can be generated directly. Proton-neutron stability can be studied. Origin of "strong coupling constant" and "Fermi's weak coupling constant" can be understood. Charged lepton masses can be fitted. Authors feel that these applications can be considered favorable for the proposed assumptions and further analysis can be carried out positively for understanding and developing this proposed "nuclear planck scale"

2 Proposed assumptions

1. Strong nuclear gravitational constant can be given as $G_S = 6.94273\times10^{31}$ m^3/kg sec^2;
2. There exists a strongly interacting "confined" Fermionic mass unit $M_{Sf}\,c^2 = 105.383$ MeV. With this assumption in particle physics "super symmetry in strong and weak interactions" can be understood very easily [6];
3. Strong interaction mass generator $X_S = 8.8034856$ and Lepton mass generator $X_E = 294.8183$;
4. In the semi-empirical mass formula ratio of "Coulombic energy coefficient" and the proposed 105.383 MeV is equal to α. The Coulombic energy constant $E_C = 0.769$ MeV.

2.1 Planck scale Coulombic energy and the unified force

Let

$$M_P c^2 = \text{planck energy} = \sqrt{\frac{\hbar c^5}{G}} = \sqrt{\hbar c\,\frac{c^4}{G}}\,. \tag{1}$$

Multiplying this energy unit with $\sqrt{\alpha}$, we get

$$\sqrt{\alpha}M_P c^2 = \sqrt{\frac{e^2}{4\pi\epsilon_0}\frac{c^4}{G}}\,, \tag{2}$$

where $\sqrt{\alpha}M_P c^2$ can be termed as "Coulombic energy", $\frac{c^4}{G}$ is having the dimensions of force and can be considered as the classical limit of any force. This classical force limit $\frac{c^4}{G}$ and the classical power limit $\frac{c^5}{G}$ plays a very vital role in black hole formation and planck scale generation [7]. These are two very important observations to be noted here: $\frac{c^5}{G}$ plays a very crucial role in "gravitational radiation"; using $\frac{c^4}{G}$ minimum distance r_{min} between any two charged particles is given as

$$\frac{e^2}{4\pi\epsilon_0 r_{min}^2} \leqslant \frac{c^4}{G}\,, \tag{3}$$

$$r_{min} \geqslant \sqrt{\frac{e^2}{4\pi\epsilon_0}\frac{G}{c^4}}\,, \tag{4}$$

planck mass can be generated if it is assumed that

$$\frac{GM_P c^2}{r_{min}^2} \leqslant \frac{c^4}{G}\,, \tag{5}$$

$$2\pi r_{min} = \lambda_P = \text{planck wave length}, \tag{6}$$

where, M_P= planck mass and r_{min}= minimum distance between two planck particles. With these two conditions, planck mass can be obtained as

$$M_P = \text{planck mass} = \frac{h}{c\lambda_P} = \sqrt{\frac{\hbar c}{G}}\,. \tag{7}$$

Aim of equations (3, 4, 5, 6 and 7) is to show that there exists a fundamental force of the form $k\frac{c^4}{G} \cong 1.21027{\times}10^{44}$ Newton, where k is a proportionality ratio and is close to unity. This can be considered as the "unified force" of "true grand unification". In the foregoing sections authors show how it changes into the "strong nuclear force".

2.2 Strong nuclear gravitational constant G_S and strong nuclear force

Let the classical gravitational constant be represented by G_C and the assumed strong nuclear gravitational constant be represented by G_S. The most important definition is that

$$\frac{c^4}{G_S} = 116.3463 \text{ Newton} \tag{8}$$

can be called as the "nuclear strong force". This is the beginning of this "nuclear planck scale". Authors request the science community to analyze this equation positively. Magnitude of force of attraction or repulsion in between two nucleons when their distance of separation is close to 1.4 Fermi is

$$\frac{e^2}{4\pi\epsilon_0 R_0^2} \cong \frac{c^4}{G_S}\,, \tag{9}$$

$$R_0 \cong \sqrt{\frac{e^2}{4\pi\epsilon_0}\frac{G_S}{c^4}}\,. \tag{10}$$

If a nucleon of mass m_n revolves at a radius of R_0,

$$\text{potential energy} = E_P = -\frac{e^2}{4\pi\epsilon_0 R_0}\,, \tag{11}$$

$$\text{kinetic energy} = E_K = \frac{m_n v^2}{2} = \frac{e^2}{8\pi\epsilon_0 R_0}\,, \tag{12}$$

$$\text{total energy} = E_T = E_P + E_K = \frac{m_n v^2}{2} = -\frac{e^2}{8\pi\epsilon_0 R_0}\,. \tag{13}$$

We know that the characteristic size of nucleus is 1.3 to 1.4 Fermi. For $R_0 = 1.4$ Fermi total energy of revolving nucleon is close to the rest "energy of electron". This is still a mystery. Hence

$$\frac{e^2}{8\pi\epsilon_0 R_0} \cong \frac{1}{2}\sqrt{\frac{e^2}{4\pi\epsilon_0}\frac{c^4}{G_S}} \cong m_e c^2. \tag{14}$$

Here $m_e c^2$ is the rest energy of electron. Half the classical radius of electron can also be considered as the unit size of nucleus. If so with the assumed strong nuclear gravitational constant G_S it is noticed that

$$R_0 \cong \sqrt{\frac{e^2}{4\pi\epsilon_0}\frac{G_S}{c^4}} \cong \frac{e^2}{8\pi\epsilon_0 m_e c^2} \cong \frac{2G_S m_e}{c^2}\,. \tag{15}$$

This equation (15) clearly suggests that nucleus that we are observing or studying is not a simple object. It is a strange object and can be considered as an "electronic black hole" and works at strong nuclear gravitational constant G_S. Experimentally knowing the (exact) characteristic size of nucleus one can easily estimate the value of proposed G_S. Alternatively its value can be estimated form the famous Fermi weak coupling constant F_W. Considering "planck mass" and "electron mass" in view in a unified manner value of G_S can be obtained from the following 3 semi-empirical relations

$$F_W \cong \frac{1}{3}\left[\ln\left(\frac{\hbar c}{G_C m_e^2}\right)\right]^{-2}\left(\frac{e^2}{4\pi\epsilon_0}\right)^2\left(\frac{G_S}{c^4}\right). \tag{16}$$

This can be obtained from eq. (42, 31, 36, 43, 44 and 28)

$$G_S \cong 3\left[\ln\left(\frac{\hbar c}{G_C m_e^2}\right)\right]^2\left(\frac{4\pi\epsilon_0}{e^2}\right)^2 F_W c^4. \tag{17}$$

Its obtained value is $6.9427284{\times}10^{31}$ m^3/kg sec^2. This value is considered in this paper

$$F_W \cong \frac{16\alpha^2}{27}\left(\frac{e^2}{4\pi\epsilon_0}\right)^2\left(\frac{G_S}{c^4}\right). \tag{18}$$

This can be obtained from eq. (42, 31, 36, 43, 44, and 10)

$$G_S \cong \left(\frac{27}{16\alpha^2}\right)\left(\frac{4\pi\epsilon_0}{e^2}\right)^2 F_W c^4. \tag{19}$$

Its obtained value is $6.9052{\times}10^{31}$ m^3/kg sec^2. This method is independent of the classical gravitational constant G_C. Another interesting idea is

$$\frac{e^2}{4\pi\epsilon_0 G_S m_e^2} \cong 4, \tag{20}$$

$$G_S \cong \frac{1}{4}\left(\frac{e^2}{4\pi\epsilon_0 m_e^2}\right) \cong 6.9506{\times}10^{31}\ \text{m}^3/\text{kg sec}^2. \tag{21}$$

Here m_e = rest mass of electron. If this is having any physical meaning without considering the classical gravitational constant G_C value of G_S can be calculated from electron mass directly. Not only that in quark physics in our paper [6] it is assumed that

$$\frac{\text{DCT geometric ratio}}{\text{USB geometric ratio}} \cong 4. \tag{22}$$

2.3 "Strong nuclear force" and "nuclear planck scale"

Similar to the planck scale in unified nuclear physics nuclear scale planck energy can be given as

$$M_n c^2 = \sqrt{\frac{\hbar c^5}{G_S}} = \sqrt{\hbar c \frac{c^4}{G_S}} \cong 11.9705568 \text{ MeV}. \quad (23)$$

These 4 energy coefficients of the semi-empirical mass formula lies in between 11.97 MeV and 2×11.97 = 23.94 MeV. Not only that using this expression in particle physics [6] it can be shown that strongly interacting particles follows energy levels as $[n(n+1)]^{\frac{1}{4}}$ and $\left[\frac{n(n+1)}{2}\right]^{\frac{1}{4}}$ where, n =1, 2, 3... We know that

$$\text{planck length} = \sqrt{\frac{\hbar G_C}{c^3}} = 1.616244\times10^{-35} \text{ meter}. \quad (24)$$

Nuclear planck length can be given as

$$L_n = \sqrt{\frac{\hbar G_S}{c^3}} = 1.664844\times10^{-14} \text{ meter}. \quad (25)$$

Nuclear scale Coulombic energy can be given as

$$M_e c^2 = \sqrt{\frac{e^2}{4\pi\epsilon_0}\frac{c^4}{G_S}} \cong 1.02258 \text{ MeV}. \quad (26)$$

These energy units directly can be implemented in nuclear physics for understanding nuclear structure. Nuclear planck energy $M_n c^2$ or nuclear planck length L_n plays an interesting role in understanding the origin of strong coupling constant [8] and energy coefficients of the semi-empirical mass formula. Lepton masses can also be fitted. It is also noticed that

$$M_{Sf} c^2 E_P^2 \cong \left(M_n c^2\right)^2 E_C. \quad (27)$$

where $M_{sf} c^2$ = proposed new strongly interacting 105.383 MeV, E_P = nucleon's potential energy close to 1.4 Fermi = 2×0.511 MeV, $M_n c^2$ = proposed nuclear scale planck energy = 11.97 MeV, E_C = assumed Coulombic energy coefficient of the semi-empirical mass formula $\alpha M_{Sf} c^2 = \alpha 105.383$ = 0.769 MeV.

3 New strongly interacting fermion (105.38 MeV) and Fermi's weak coupling constant (F_W)

It is assumed that 105.383 MeV is a strongly interacting particle. Authors request that this should not be confused with weakly interacting muon. This particle can be called as sion. Its charge is $\pm e$. Just like quarks it is a confined fermion. It plays a crucial part in understanding the nuclear size, nuclear binding energy, magnetic moments of nucleons and weak interaction. Along with the strong coupling constant it plays a heuristic role in understanding "super symmetry" in strong and weak interactions [6]. Considering "planck mass" and "electron mass" in a unified manner it is empirically defined as

$$\ln\left(\frac{M_P c^2}{m_e c^2}\right)^2 \sqrt{\frac{e^2}{4\pi\epsilon_0}\frac{c^4}{G_S}} \cong 105.3826 \text{ MeV}. \quad (28)$$

Here $M_P c^2$ = planck energy and $m_e c^2$ = rest energy of electron. Classical radius of $M_{Sf} c^2$ can be given as

$$\frac{e^2}{4\pi\epsilon_0 M_{Sf} c^2} = 1.3664\times10^{-17} \text{ meter}. \quad (29)$$

Compton length of $M_{Sf} c^2$ can be given as

$$\frac{\hbar}{M_{Sf} c} = 1.87245\times10^{-15} \text{ meter}. \quad (30)$$

This length can be considered as the strong interaction upper limit.

3.1 Various nuclear unit sizes and the mystery of 1.4 Fermi

Let

$$\frac{\hbar}{M_{Sf} c} = 1.87245\times10^{-15} \text{ meter} = a\,, \quad (31)$$

$$\frac{\hbar}{2M_{Sf} c} = 0.93624\times10^{-15} \text{ meter} = b\,. \quad (32)$$

Here a can be considered as the upper limit of strong interaction range and b can be considered as lower limit of strong interaction. Considering these two lengths as the semi-major axis and semi-minor axis of the nucleus it is noticed that

$$\text{arthematic mean of } (a,b) = \left[\frac{a+b}{2}\right] \cong 1.404 \text{ Fermi}, \quad (33)$$

$$\text{geometric mean of } (a,b) = \left[\sqrt{ab}\right] \cong 1.324 \text{ Fermi}, \quad (34)$$

$$\text{harmonic mean of } (a,b) = \left[\frac{2ab}{a+b}\right] \cong 1.248 \text{ Fermi}. \quad (35)$$

These sizes can be compared with the experimental values of various nuclear unit or characteristic sizes. From equation (33) it is noticed that arithmetic mean of semi-major and semi-minor axis of the assumed nuclear size = 1.404 Fermi. From this coincidence "existence of the strongly interacting 105.383 MeV" can be justified

$$R_0 \cong \frac{3}{4}\frac{\hbar}{M_{Sf} c} \cong 1.40436 \text{ Fermi}, \quad (36)$$

$$E_T = \frac{e^2}{8\pi\epsilon_0 R_0} \cong \frac{2}{3}\left(\alpha M_{Sf} c^2\right) \cong 0.512676 \text{ MeV}. \quad (37)$$

This idea suggests that a nucleon revolving at 1.404 Fermi having a total energy of 0.51267 MeV which is close to the electron rest energy 0.511 MeV. This small energy difference 0.51267−0.511= 0.00167 MeV may be related with origin of massive neutrino. It is assumed that

$$\alpha M_{Sf} c^2 = 0.769 \text{ MeV}, \quad (38)$$

$$\frac{E_T}{E_C} \cong \frac{0.511 \text{ MeV}}{0.769 \text{ MeV}} \cong 0.66445 \cong \frac{2}{3}. \tag{39}$$

Considering $E_T = m_e c^2$ and rearranging this equation we get

$$\frac{M_{Sf} c^2}{E_T} \cong \frac{M_{Sf} c^2}{m_e c^2} \cong \frac{3}{2\alpha}, \tag{40}$$

and from literature [9] it is noticed that

$$\frac{\text{muon mass}}{\text{electron mass}} \cong \left(\frac{3}{2\alpha} + 2\right). \tag{41}$$

Authors here suggest that in equation (41) it is not the muon mass but it is the strongly interacting proposed 105.383 MeV particle.

3.2 Fermi's weak coupling constant and estimation of 105.383 MeV

Empirically Fermi's weak coupling constant F_W [10] can be fitted as

$$F_W \cong \left(\frac{\alpha^2}{2}\right)\left(\frac{e^2}{8\pi\epsilon_0 R_0}\right) a^3. \tag{42}$$

Authors request the science community to consider this equation positively. It has interesting applications. Electron's "total energy" in hydrogen atom can be related with the strong interaction range! From equations (31 and 36)

$$F_W \cong \left(\frac{\alpha^3}{3}\right)\left(M_{Sf} c^2\right) a^3 \cong \frac{1}{3}\left(M_{Sf} c^2\right)\left(\frac{e^2}{4\pi\epsilon_0 M_{Sf} c^2}\right)^3. \tag{43}$$

Experimentally $F_W = 1.435841179 \times 10^{-62}$ J×meter^3

$$\therefore M_{Sf} c^2 \cong \left(\frac{e^2}{4\pi\epsilon_0}\right)\left(\frac{e^2}{12\pi\epsilon_0 F_W}\right)^{\frac{1}{2}} \cong 105.38 \text{ MeV}. \tag{44}$$

3.3 Strong interaction mass generator X_S

Based on nuclear planck scale it is assumed that strong interaction mass generator is

$$X_S \cong \frac{M_{Sf} c^2}{M_n c^2} \cong 8.803486 \cong \frac{L_n}{a}, \tag{45}$$

$$X_S \cong \sqrt{\frac{G_S M_{Sf}^2}{\hbar c}} \cong 8.803486, \tag{46}$$

$$\alpha_s(M_Z) \cong \sqrt{\frac{\hbar c}{G_S M_{Sf}^2}} \cong 0.11359. \tag{47}$$

It is noticed that $X_S = 8.803486 = \frac{1}{0.11359}$ seems to be the "inverse" of the strong coupling constant [8] $\alpha_s(M_Z) = 0.1186 \pm 0.0011\,(\text{exper}) \pm 0.0050\,(\text{theor})$. Considering the lower limits of this value we get $0.1186 - 0.0050\,(\text{theor}) = 0.1136$. We know the importance of the "strong coupling constant" in particle physics. If the proposed definition is found to be true and meaningful one has to accept the existence of proposed "nuclear planck scale". In the sense one must accept the existence of "strong nuclear gravitational constant G_S and existence of 105.383 MeV". This number X_S plays a very interesting role in correlating the energy coefficients of the semi-empirical mass formula and proton-neutron stability. This number plays a crucial role in understanding super symmetry in strong and weak interactions [8].

Based on X_S it is noticed that, $X_S M_{Sf} c^2 = 927.737$ MeV. This is roughly close to proton mass. $X_S M_{Sf} c^2 + M_n c^2 = 939.7$ MeV. This is close to the neutron mass = 939.57 MeV. Some how 105.383 MeV and X_S plays a vital role in "weighing" of the nucleon mass. See Section 5 for "nucleon mass fitting" and nucleon's basic excited levels.

3.4 Fermi's weak coupling constant and the Bohr radius

By any reason for the nucleus if

$$\frac{e^2}{8\pi\epsilon_0 R_0} \cong m_e c^2, \tag{48}$$

$$\frac{e^2}{4\pi\epsilon_0 R_0} \cong 2 m_e c^2. \tag{49}$$

Equation(42) takes the following interesting form as

$$F_W \cong \left(\frac{\alpha^2}{2}\right)\left(\frac{e^2}{8\pi\epsilon_0 R_0}\right) a^3 \cong \left(\frac{\alpha^2}{2}\right)\left(m_e c^2\right) a^3. \tag{50}$$

At a glance equation (50) suggests that

$$\left(\frac{\alpha^2}{2}\right)\left(m_e c^2\right) \cong \frac{F_W}{a^3} \cong \left(\frac{\alpha^3}{3}\right) M_{Sf} c^2 \cong 13.65 \text{ eV}. \tag{51}$$

In this equation (51) "left hand side" is nothing but the "total energy of electron" in hydrogen atom. This is a very simple and strange relation! Based on the unification of strong and weak interactions "Bohr radius" of hydrogen atom can be given as

$$a_0 \cong \left(\frac{e^2}{8\pi\epsilon_0}\right)\left(\frac{a^3}{F_W}\right) \cong 5.27745 \times 10^{-11} \text{ meter}. \tag{52}$$

This is matching with $a_0 = 5.29177 \times 10^{-11}$ meter. This idea suggests that existence of the proposed nuclear strong interaction upper limit a=1.8725 Fermi and strongly interacting $M_{Sf} c^2 = 105.383$ MeV seems to be true and can be considered for further analysis. Their direct existence strongly supports the hidden existence of the proposed strong nuclear gravitational constant G_S.

3.5 Lepton mass generator X_E and electron, muon and tau rest mass fitting

A new number (X_E) is empirically defined [1] as

$$X_E \cong \left[\frac{e^2}{8\pi\epsilon_0 R_0} \frac{L_n^3}{F_W}\right]^{\frac{1}{3}} \cong X_S \left[\frac{e^2}{8\pi\epsilon_0 R_0} \frac{a^3}{F_W}\right]^{\frac{1}{3}}. \tag{53}$$

n	Obtained lepton mass, MeV	Exp. lepton mass, MeV
0	0.5127	0.510998922
1	105.86	105.658369
2	1775.506	1776.9
3	42206.19	Not discovered

Table 1: Fitting of charged lepton rest masses.

Its obtained value is 294.8183. Here L_n = proposed nuclear planck length, a = strong interaction upper limit and F_W = Fermi's weak coupling constant.

This number can be called as "lepton mass generator". It has wide applications in nuclear and particle physics. It is noticed that $(\alpha X_E) = 2.1514$ plays a very interesting role in estimating the quark masses [6]. The weak coupling angle can be considered as $(\alpha X_E)^{-1} = \sin(\theta_W) = 0.4648$. It plays a crucial role in estimating the charged lepton rest masses. It plays a very interesting role in fitting energy coefficients of the semi-empirical mass formula. It can be used for fitting the nuclear size with "Compton wavelength of nucleon". It is noticed that ratio of "nuclear volume" and "A nucleons Compton volume" is X_E. It can be called as the nuclear "volume ratio" factor.

Till now no mechanism is established for the generation of the charged lepton rest masses [11]. Considering equation (39) an interesting empirical relation is given for fitting electron, muon and tau particle rest masses as

$$m_l c^2 \cong \frac{2}{3}\left[E_C^3 + \left(n^2 X_E\right)^n E_A^3\right]^{\frac{1}{3}}, \tag{54}$$

where E_C = Coulombic energy coefficient of the semi-empirical mass formula, E_A = asymmetry energy coefficient of the semi-empirical mass formula and X_E = proposed lepton mass generator = 294.8183 and n = 0, 1, 2.

If E_C = 0.769 MeV and E_A= 23.86 MeV obtained charged lepton masses are shown in the following Table 1. It is known that these two coefficients plays a vital role in nuclear stability. It is well known that in weak decay for getting stability neutron in an unstable nuclide emits electron. If our study is focused on why and how a charged lepton is coming out from the nucleus this idea can be adapted. For any model data fitting is the first successful step in its implementation in the actual field.

3.6 Role of X_E in estimating the nuclear size R_0

Compton wave length of nucleon is

$$\frac{\hbar}{m_n c} = 2.1016{\times}10^{-16} \text{ meter}, \tag{55}$$

where m_n is the average mass of nucleon = 938.92 MeV. It is noticed that

$$R_0 \cong (X_E)^{\frac{1}{3}} \frac{\hbar}{m_n c} = 1.399{\times}10^{-15} \text{ meter}. \tag{56}$$

This is very close to the estimated nuclear characteristic size. With reference to Rutherford's alpha scattering experiments size of a nucleus that contains A nucleons can be given as

$$R_A \cong (A X_E)^{\frac{1}{3}} \frac{\hbar}{m_n c}. \tag{57}$$

Hence ratio of "nuclear volume" and "A nucleons Compton volume" = X_E.

4 Relations between energy coefficients of the semi-empirical mass formula

We know that the best energy coefficients of the semi-empirical mass formula [12–14] are, Coulombic energy coefficient E_C = 0.71 MeV, volume energy coefficient E_V = 15.78 MeV, surface energy coefficient E_S = 18.34 MeV, asymmetry energy coefficient E_A = 23.21 MeV and pairing energy coefficient E_{EO} = 12.0 MeV. The 4 major energy coefficients of the semi-empirical mass formula lies in between 11.97 MeV and 2×11.97 = 23.94 MeV. Really this is a very interesting case. If one proceeds further for analyzing this strange observation possibly role of "strong coupling constant" or "strong interaction mass generator" can be understood in the "nuclear mass generation". Thus unification of "gravitation" with "nuclear physics" may be possible. Authors proposal may be given a chance. See the following Table 2. In this context it is assumed that

$$\frac{M_{Sf} c^2}{E_C} \cong \frac{1}{\alpha} \quad \text{and} \quad E_C \cong \alpha M_{Sf} c^2 = 0.769 \text{ MeV}. \tag{58}$$

From equations (23, 46, 53 and 58) empirically it is noticed that

$$E_V \cong M_n c^2 + \left(X_E^{\frac{1}{3}} - 1\right) E_C \cong 16.32 \text{ MeV}, \tag{59}$$

$$E_S \cong M_n c^2 + \left(X_E^{\frac{1}{3}} + \sqrt{X_S}\right) E_C \cong 19.37 \text{ MeV}, \tag{60}$$

$$E_A \cong M_n c^2 + \left(X_E^{\frac{1}{3}} + X_S\right) E_C \cong 23.86 \text{ MeV} \cong 2 M_n c^2, \tag{61}$$

$$E_A - E_S \cong \left(X_S - \sqrt{X_S}\right) E_C, \tag{62}$$

$$E_{EO} \cong M_n c^2 \cong 11.97 \text{ MeV}. \tag{63}$$

It is also noticed that

$$X_E \cong \frac{E_S}{E_C}\sqrt{\frac{M_{Sf} c^2}{E_C}} \cong \frac{E_S}{E_C}\sqrt{\frac{1}{\alpha}}. \tag{64}$$

This is another interesting guess. This successfully implements the new number X_E. It is observed that proposed E_V-existing E_V = 16.32−15.78 = 0.54 MeV ≈ E_T = 0.511 MeV. Proposed E_S — existing E_S = 19.37 − 18.34 = 1.03 MeV ≈ $2E_T$ = 2×0.511 MeV. Proposed E_A-existing E_A = 23.86 − 23.21 = 0.65 MeV ≈ E_T = 0.511 MeV.

Please note that asymmetry energy coefficient is matching with twice of $M_n c^2$ = 23.94 MeV. This is very interesting. If proposed ideas has no significance here why and how it is happening like this? This data coincidence indicates that proposed scheme of energy coefficients can be applied in the

Z	A	Obtained Be, MeV	Be, MeV [13, 14]
8	16	121.6	118.13, 128.57
20	44	382.7	377.66, 382.78
28	62	543.7	538.85, 544.41
50	118	1003.4	1000.22, 1004.74
82	208	1620.6	1618.41, 1635.36
108	292	2089.6	2082.53, 2089.48

Table 2: Fitting of nuclear binding energy with proposed coefficients.

semi-empirical formula for understanding the significance of proposed 105.383 MeV and $X_S = 8.803486$ in the context of strong interaction. The semi-empirical mass formula is

$$Be = AE_V - A^{\frac{2}{3}} E_S - \frac{Z^2}{A^{\frac{1}{3}}} E_C - \frac{(A-2Z)^2}{A} E_A \pm \sqrt{\frac{1}{A}}\, E_{EO}. \quad (65)$$

Here $E_V = 16.32$ MeV, $E_S = 19.37$ MeV, $E_C = 0.769$ MeV, $E_A = 23.86$ MeV and $E_{EO} = 11.97$ MeV can be considered as the unified energy coefficients of the semi-empirical formula [13, 14] where Coulombic energy term contains $[Z]^2$.

If one wants to retain $[Z(Z-1)]$ energy coefficients can be fine tuned in the following way

$$E_{EO} \cong M_n c^2 \cong 11.97 \text{ MeV}, \quad (66)$$

$$E_A \cong 2M_n c^2 \cong 23.94 \text{ MeV}, \quad (67)$$

$$\frac{E_A}{E_V} \cong \sqrt{\alpha X_E} \text{ and } E_V \cong 16.322 \text{ MeV}, \quad (68)$$

$$E_V + E_S \cong E_A + E_{EO} \cong 3E_{EO}, \quad (69)$$

$$E_S \cong 3E_{EO} - E_V \cong 35.91 - 16.322 \cong 19.59 \text{ MeV}. \quad (70)$$

Alternatively

$$E_V \cong \left(\frac{3E_{EO}}{2}\right) - (\alpha X_E)\, E_C \cong 16.30 \text{ MeV}, \quad (71)$$

$$E_S \cong \left(\frac{3E_{EO}}{2}\right) + (\alpha X_E)\, E_C \cong 19.61 \text{ MeV}, \quad (72)$$

with $E_V = 16.30$ MeV, $E_S = 19.61$ MeV and with $E_V = 16.32$ MeV, $E_S = 19.59$ MeV,

- for $Z = 26$ and $A = 56$, $Be = 489.87$ MeV and 491.40 MeV,
- for $Z = 50$ and $A = 118$, $Be = 1002.88$ MeV and 1005.96 MeV,
- for $Z = 79$ and $A = 197$, $Be = 1547.96$ MeV and 1552.97 MeV,
- for $Z = 92$ and $A = 238$, $Be = 1794.87$ MeV and 1800.87 MeV.

Taking mean values of E_V and E_S, energy coefficients can be given as $E_V = 16.31$ MeV, $E_S = 19.60$ MeV, $E_C = 0.769$ MeV, $E_A = 23.94$ MeV and $E_{EO} = 11.97$ MeV.

4.1 Nuclear binding energy with two terms and one energy constant 0.769 MeV

An empirical method is proposed here for fitting the nuclear binding energy. This method contains two terms. For these two terms, Coulombic energy constant $E_C = 0.769$ MeV is applied. In this method the important point is at first for any Z its stable mass number A_S has to be estimated. Strong interaction mass generator X_S plays a crucial role in this method. For any Z error in binding energy is very small near the stable isotope A_S and increasing above and below A_S. Unifying 5 terms having 5 energy constants into two terms with one energy constant which are related with strong interaction mass generator is not a simple task. Authors proposal can be given a chance.

This method is applicable for light atoms also. For light atoms, when $A = 2Z$, obtained binding energy is very close to the actual value. For $Z = 2$ and $A = 4$ is 28.86 MeV, $Z = 4$, $A = 8$ is 59.57 MeV, $Z = 6$, $A = 12$ is 92.63 MeV $Z = 7$, $A = 14$ is 114.0 MeV, $Z = 8$ $A = 16$ is 127.14 MeV, $Z = 9$, $A = 19$ is 149.72 MeV and $Z = 10$, $A = 20$ is 155.06 MeV. For very light odd elements error is due to estimation of their stable mass numbers

$$T_1 = \left[(A+1)\left(1 + \frac{2Z}{A_S}\right)\right] \ln\left[(A+1)\, X_S\right] E_C\,. \quad (73)$$

Stable isotope of any Z can be estimated as

$$A_S \cong 2Z + \frac{Z^2}{S_f} \cong 2Z + \frac{Z^2}{155.72}\,. \quad (74)$$

Here S_f can be called as the nuclear stability factor. It can be given as

$$S_f \cong \frac{E_A}{E_C}\sqrt{\frac{E_S}{E_C}} \cong 155.72 \cong 2X_S^2 \cong 155.00. \quad (75)$$

After rounding off for even Z values, if obtained A_S is odd consider $A_S + 1$, for odd Z values if obtained A_S is even, consider $A_S - 1$. For very light odd elements this seems to be not fitting.

Term T_1 indicates the factors for increase in binding energy. Another observation is $[(A+1)\, X_S]$. This factor plays a key role in the saturation of the binding energy. It is observed that for any Z at its stable isotope A_S

$$T_1 \cong [A_S + 2Z + (1 \text{ or } 2)] \ln\left[(A_S+1)\, X_S\right] E_C. \quad (76)$$

The basic question is that how to extrapolate from the stable isotope A_S of any Z to above and below its stable and unstable isotopes? Authors are working in this direction also

$$T_2 \cong \left[\frac{A^2 + \left(fZ^2\right)}{X_S^2}\right] E_C\,, \quad (77)$$

where

$$f \cong 1 + \frac{2Z}{A_S} \cong \text{ a factor} \leqslant 2. \quad (78)$$

Z	A_S	Obtained Be, MeV
2	4	28.9
8	16	127.1
20	44	368.4
26	56	481.6
44	100	856.2
68	166	1347.1
83	209	1623.5
92	238	1775.5

Table 3: Fitting of nuclear binding energy with two terms and one energy constant.

Term T_2 indicates the factors for decrease in binding energy. Both of these terms has to be analyzed at fundamental level. T_1 and T_2 indicates the importance of the number $X_S = 8.8034856$ in strong interaction mass generation

$$Be = T_1 - T_2. \quad (79)$$

Whether this is the total binding energy that includes shell effects or liquid drop energy has to be decided with observations and analysis. This method has to be analyzed and extended for isotopes above and below the stable mass number A_S of any Z value. With reference to A_S and by considering shell effects error in finding the first term can be eliminated. In the second term by selecting a suitable expression for f error can be minimized. The advantage of this method is that number of energy constants can be minimized. See the following Table 3.

5 Rest mass of nucleon

Let m_nc^2 = rest mass of nucleon. Semi-empirically it is observed that

$$m_nc^2 \cong \ln\left(M_nc^2 \frac{8\pi\epsilon_0 R_0}{e^2}\right)^2 \sqrt{\frac{R_S}{a}}\, M_nc^2. \quad (80)$$

Here a is the Compton length of M_{Sf} and R_S is the black hole radius of M_{Sf} and is given by

$$R_S = \frac{2G_S M_{Sf}}{c^2} = 2.9023{\times}10^{-13} \text{ meter}, \quad (81)$$

$$m_nc^2 \cong \ln\left(\frac{8\pi\epsilon_0 R_0 M_nc^2}{e^2}\right)^2 \sqrt{\frac{2G_S M_{Sf}^2}{\hbar c}}\, M_nc^2. \quad (82)$$

From equation (48)

$$m_nc^2 \cong \ln\left(\frac{M_nc^2}{m_ec^2}\right)^2 \sqrt{\frac{2G_S M_{Sf}^2}{\hbar c}}\, M_nc^2. \quad (83)$$

5.1 Nucleon stability relation

If it is assumed that

$$A_S \cong 2Z + \frac{Z^2}{155.00} \cong 2Z + \frac{Z^2}{2X_S^2}\,, \quad (84)$$

significance of $2X_S^2$ can be given as

$$2X_S^2 \cong \frac{2G_S M_{Sf}^2}{\hbar c} \cong \frac{R_S}{a} \cong 155.00 \quad (85)$$

Hence

$$A_S \cong 2Z + \frac{Z^2}{S_f} \cong 2Z + \left(\frac{a}{R_S}\right) Z^2. \quad (86)$$

For example, if $Z = 47$, $A_S = 108.25$, $Z = 82$, $A_S = 207.38$ and $Z = 92$, $A_S = 238.6$. This clearly indicates the beautiful role of $2X_S^2$ in nuclear stability.

5.2 Excited levels of nucleon

From quantum mechanics quantized angular momentum is given by $\sqrt{n(n+1)}.\hbar$ where $n = 0, 1, 2\ldots$ Some how if $\hbar$ goes under a "square root" like the planck energy, $M_Pc^2 = \sqrt{\frac{\hbar c^5}{G_C}}$ as a ground state energy level in a heuristic way its massive excited levels are given by [6]

$$\left(M_Pc^2\right)_I = [n(n+1)]^{\frac{1}{4}} \sqrt{\frac{\hbar c^5}{G_C}}. \quad (87)$$

Here $n = 0, 1, 2, 3\ldots$ and $I = n(n+1)$. Keeping this idea in view it is assumed that "if m_0c^2 is the rest energy of a particle then its massive excited levels are given by

$$mc^2 = [n(n+1)]^{\frac{1}{4}}\, m_0c^2 \quad (88)$$

and each excited state can be seen as a new massive particle". The surprising observation is that in particle physics excited massive states are following two types of discrete levels. They are

$$[n(n+1)]^{\frac{1}{4}}\, m_0c^2 \;\text{ and }\; \left[\frac{n(n+1)}{2}\right]^{\frac{1}{4}} m_0c^2. \quad (89)$$

Presently understood "Regge trajectory" of some of the baryons and mesons are fitted in this way. These levels can be called as Fine rotational levels. If the proposed idea is correct nucleon must show excited levels as

$$\left(m_nc^2\right)_I = [I]^{\frac{1}{4}}\, 939 \;\text{ and }\; \left(m_nc^2\right)_{\frac{I}{2}} = \left[\frac{I}{2}\right]^{\frac{1}{4}} 939, \quad (90)$$

where $I = n(n+1)$ and $n = 1, 2, 3, \ldots$

At $I = 2$, 1117 MeV, $\frac{I}{2} = 3$, 1236 MeV, at $I = \frac{I}{2} = 6$, 1470 MeV, at $\frac{I}{2} = 10$, 1670 MeV, $I = 12$, 1748 MeV levels are obtained. This is a great coincidence and is a true reflection of the correctness of the proposed assumptions. Hence the proposed ideas can be given a chance in "final grand unified physics".

Conclusions

Nucleus has strong nuclear gravitational mechanism. Some how electron plays a crucial role in its structural formation. Just like quark masses $M_{Sf}c^2$ can be considered as a strongly interacting "confined" fermion. Whether G_S is really existing or an equivalent value it plays a heuristic role in understanding the experimental things and can be considered for further analysis. Based on the proposed data fitting results existence of the proposed strong interaction fermion $M_{Sf}c^2$ and the strong interaction mass generator $X_S = 8.8034856$ can be confirmed. 0.769 MeV can be considered as the unified Coulombic energy coefficient.

Two most important and interesting observations are as follows

$$\alpha X_E \cong \sqrt{\ln \sqrt{\frac{4\pi\epsilon_0 G_S M_{Sf}^2}{e^2}}} \cong 2.153. \tag{91}$$

This expression clearly demonstrates the hidden existence of $M_{Sf}c^2$ and G_S in nuclear and particle physics. In our paper [6] it is assumed that there exists a strongly interacting fermion 11450 MeV which plays a crucial role in estimating quark-gluon masses. Empirically it is noticed that

$$(11450)^{\frac{14}{30}} (105.38)^{\frac{16}{30}} \cong 939.54 \text{ MeV}. \tag{92}$$

This is very close to the neutron mass. Since both are integral charged particles and giving importance to the charged proton mass it can be written as

$$\left(\frac{11450}{105.38}\right)^{\frac{14}{30}} (105.38) \cong 939.54 \text{ MeV}, \tag{93}$$

where

$$\left(\frac{11450}{105.38}\right)^{\frac{14}{30}} \cong 8.9157 \cong X_S. \tag{94}$$

This number is very close to the proposed strong interaction mass generator X_S. It is noticed that $\frac{14}{30} \cong 0.4666$ and $\frac{16}{30} \cong 0.5333$. Comparing $\left(\frac{14}{30}\right)$ with $\left(\frac{1}{\alpha X_E}\right)$ one can see the significance of (αX_E) in deciding the mass of proton.

Even though this is an unconventional paper number of inputs are only two and they are assumed $M_{Sf}c^2$ and strong nuclear gravitational constant G_S. The main advantage of this paper is that there is no need to go beyond 4 dimensions. Authors humbly request the world science community to kindly look into these new and heuristic ideas for further analysis and development.

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