Exploration

Simplified & Unified Picture of Nuclear Binding Energy

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Abstract

In analogy with gravity and Schwarzschild interaction, the authors have suggested in their recent publications that: 1) There exists a strong elementary charge of magnitude, e_s= 4.720586603 x10^{-19} C; 2) Squared ratio of electromagnetic and strong interaction charges is equal to the strong coupling constant; 3) There exists a gravitational constant associated with strong interaction, G_s=3.329561213x10^{28} m^3 $kg^{-1}sec^{-2}$; and 4) There exists a gravitational constant associated with electromagnetic interaction, G_e=2.374335685 x$10^{37}$$m^3$ $kg^{-1}sec^{-2}$. As the magnitude of operating force is far less than the magnitude of c^4/G, protons and electrons cannot be considered as black holes. Based on these new concepts, in this paper an attempt is made to understand the mysterious nuclear binding energy in a unified and very simplified picture.

Keywords: Schwarzschild interaction, electromagnetic, gravitational constant, strong interaction, strong elementary charge, beta stability line, nuclear binding energy.

1. Introduction

With reference to Schwarzschild interaction, the authors have recently developed several characteristic unified relations including the proposals the existence of strong interaction elementary charge [1-5]. In this paper, the authors make the attempt to understand the nuclear binding energy.

It may be noted that, from gravity point of view, so far no model succeeded in understanding the link between strongly interacting massive fermions and massive celestial objects. The authors would like to stress the fact that strongly interacting massive fermions only are playing a major role in the formation of observable luminous and non-luminous massive celestial objects that follow gravitational interaction. In this paper, the authors review the basics of strong nuclear interaction in a unified picture by interconnecting the strong coupling constant and gravitational constant via the Schwarzschild interaction. Readers are encouraged to read the recently published papers [1-4].

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2. Understanding the Strength of Any Interaction

The authors first make the following observations:

1) If it is true that c and G are fundamental physical constants, then $\left(c^4/G\right)$ can be considered as a fundamental compound constant related to a characteristic limiting force.
2) Black holes are the most compact form of matter.
3) Magnitude of the operating force at the black hole surface is of the order of $\left(c^4/G\right)$.
4) Gravitational interaction taking place at black holes can be referred to 'Schwarzschild interaction'.
5) Strength of this 'Schwarzschild interaction' can be assumed to be unity.
6) Strength of any other interaction can be defined as the ratio of operating force magnitude and the classical or astrophysical force magnitude $\left(c^4/G\right)$.
7) If one is willing to represent the magnitude of the operating force as a fraction of $\left(c^4/G\right)$ i.e. X times of $\left(c^4/G\right)$, where $X \ll 1$, then

$$\frac{X \text{ times of } \left(c^4/G\right)}{\left(c^4/G\right)} \cong X \rightarrow \text{Effective } G \Rightarrow \frac{G}{X} \tag{1}$$

If X is very small, *1*/*X* becomes very large. In this way, X can be considered as the strength of interaction. Thus, the strength of any interaction is *1*/*X* times smaller than the 'Schwarzschild interaction' and effective G becomes *G*/*X*.

3. Three Basic Assumptions of Final Unification

At fundamental level, the following three assumptions can be considered in a final unification program [1-5]:

Assumption 1:The gravitational constant associated with the electromagnetic interaction , $G_e \cong 2.374335685 \times 10^{37}\ \text{m}^3\text{kg}^{-1}\text{sec}^{-2}$.

Assumption 2: The gravitational constant associated with the strong interaction, $G_s \cong 3.329561213 \times 10^{28}\ \text{m}^3\text{kg}^{-1}\text{sec}^{-2}$.

Assumption 3: There exists strong elementary charge, $e_s \cong \left(e_e/\sqrt{\alpha_s}\right)$ where e_s is the assumed strong interaction elementary charge, e_e is the currently believed electromagnetic elementary charge and α_s is the currently believed strong coupling constant.

With these three assumptions, the key features of nuclear and atomic structure can be understood. With reference to the Schwarzschild interaction, for electromagnetic interaction, $X \cong 2.8105 \times 10^{-48}$ and for strong interaction, $X \cong 2.004 \times 10^{-39}$. Here the authors would like to stress the fact that, as the magnitude of operating force is far less than the magnitude of $\left(c^4/G\right)$, protons and electrons cannot be considered as black holes. Within the nuclear medium, in analogy with gravity and Schwarzschild interaction, nuclear phenomena can be understood with large value of gravitational constant. With further research and analysis, massive origin of protons and electrons can be understood.

4. Important Results Connected With Strong Interaction and Final Unification

With reference to the recommended values [6-7] of fundamental physical constants, the authors assume that:

A) **Strong coupling constant** may be understood as follows:

$$\alpha_s \cong \left(\frac{e_e}{e_s}\right)^2 \cong \frac{G_e m_e^3}{G_s m_p^3} \tag{2}$$

B) **Fine structure ratio** may be understood as follows:

$$\alpha \cong \frac{e_s e_e}{4\pi\varepsilon_0 G_s m_p^2} \tag{3}$$

C) **Reduced Planck's constant** may be understood as follows:

$$\left.\begin{aligned} \hbar &\cong \left(\frac{e_e}{e_s}\right)\left(\frac{G_s m_p^2}{c}\right) \cong \sqrt{\alpha_s}\left(\frac{G_s m_p^2}{c}\right) \\ &\cong \sqrt{\frac{m_e}{m_p}}\sqrt{\left(\frac{G_s m_p^2}{c}\right)\left(\frac{G_e m_e^2}{c}\right)} \\ &\cong \frac{\sqrt{\left(G_s m_p\right)\left(G_e m_e\right)} * m_e}{c} \end{aligned}\right\} \tag{4}$$

$$G_s \cong \left(\frac{e_s}{e_e}\right)\left(\frac{\hbar c}{m_p^2}\right) \cong \left(\frac{1}{\sqrt{a_s}}\right)\left(\frac{\hbar c}{m_p^2}\right) \tag{5}$$

D) **Down and Up quark mass ratio** may be understood as follows:

$$\frac{m_d}{m_u} \cong 2\pi\left(\frac{e_e}{e_s}\right) \cong 2\pi\sqrt{\alpha_s} \tag{6}$$

E) **Magnetic moment of proton** may be understood as follows:

$$\mu_p \cong \frac{e_s \hbar}{2m_p} \cong \frac{G_s e_e m_p}{2c} \tag{7}$$

F)**Magnetic moment of neutron** may be understood as follows:

$$\mu_n \cong \frac{e_s \hbar}{2m_n} - \frac{e_e \hbar}{2m_n} \cong \frac{\hbar}{2m_n}\left(e_s - e_e\right) \tag{8}$$

G) **Magnetic moment of electron** may be understood as follows:

$$\mu_e \cong \left(\frac{e_s}{m_p}\right)\left(\frac{G_e m_e^2}{2c}\right) \tag{9}$$

H) **Magnetic moment of muon** may be understood as follows:

$$\mu_\mu \cong \left(\frac{e_s}{m_p}\right)\left\{\left(\frac{m_e}{m_\mu}\right)\left(\frac{G_e m_e^2}{2c}\right)\right\} \tag{10}$$

I) **Nuclear charge radius** may be understood as follows:

$$R_0 \cong \frac{2G_s m_p}{c^2} \tag{11}$$

J) **Root mean square radius of proton** may be understood as follows:

$$R_p \cong \frac{\sqrt{2}G_s m_p}{c^2} \tag{12}$$

K) **Ratio of rest mass of proton and electron** may be understood as follows:

$$\frac{G_s m_p m_e}{\hbar c} \cong \frac{\hbar c}{G_e m_p^2} \tag{13}$$

On simplification,

$$\left(\frac{m_p}{m_e}\right) \cong \left(\frac{4\pi\varepsilon_0 G_e m_e^2}{e_e^2}\right) \Big/ \left(\frac{4\pi\varepsilon_0 G_s m_p^2}{e_s^2}\right)$$
$$\Rightarrow \frac{m_p}{m_e} \cong \left(\frac{G_e e_s^2}{G_s e_e^2}\right)^{\frac{1}{3}} \tag{14}$$

$$G_e \cong \left(\frac{e_e^2}{e_s^2}\right)\left(\frac{m_p^3}{m_e^3}\right)G_s \cong \alpha_s\left(\frac{m_p^3}{m_e^3}\right)G_s \tag{15}$$

L) **Planck's constant** may be understood as follows:

$$h \cong \sqrt{\left(\frac{e_s^2}{4\pi\varepsilon_0 c}\right)\left(\frac{G_e m_e^2}{c}\right)} \tag{16}$$

Based on these relations, unified fundamental physical constants can be fitted as shown in the following Table 1.

Table 1: Fundamental physical constants

$G_s \cong 3.329561213\times10^{28}$ m^{3}kg^{-1}sec^{-2} $G_e \cong 2.374335685\times10^{37}$ m^{3}kg^{-1}sec^{-2}	$\alpha_s \cong 0.1151937072$ $e_s \cong 4.720586603\times10^{-19}$ C
$\frac{m_d}{m_u} \cong 2\pi\sqrt{\alpha_s} \cong 2.1325256$	$R_0 \cong 1.239290981\times10^{-15}$ m $R_p \cong 0.87631106\times10^{-15}$ m
$\mu_p \cong 1.488142\times10^{-26}$ J/Tesla $\mu_n \cong 9.817104\times10^{-27}$ J/Tesla	$\mu_e \cong 9.27009\times10^{-24}$ J/Tesla $\mu_\mu \cong 4.485159\times10^{-26}$ J/Tesla

The very interesting point to be noted here is that, Proton's magnetic moment is associated with its strong elementary charge. Neutron's magnetic moment seems to be the difference of magnetic moment associated with strong interaction and magnetic moment associated with electromagnetic interaction. Considering relations (2) to (16), the authors would like to say that:

A. Along with the strong elementary charge, within the atomic medium there exit two different gravitational constants and their existence is real, not virtual.
B. Whether quantum constants decide the existence of $(G_s \text{ and } G_e)$ or $(G_s \text{ and } G_e)$ will decide the existence of quantum constants - is for future study.
C. It may be noted that, in nature, one can see one proton, two protons, three protons etc. If nuclear mass is discrete, revolving electron can certainly have a discrete angular momentum. With reference to the concept of 'number of protons', discrete nature of $\hbar, 2\hbar, 3\hbar, ...$ or $\hbar, \sqrt{2}\hbar, \sqrt{3}\hbar, ...$ can be understood. Alternatively, by considering $(1/2n^2)$ as a probability factor of systematically arranged electrons, currently believed discrete nature of revolving electron's energy spectrum can be re-interpreted.
D. Strong elementary charge and strong gravitational constant play a combined role in understanding Beta stability line and nuclear binding. See the following sections.

5. Proton-Neutron Beta Stability Line

Inside an atomic nucleus, 'beta decay' is a type of radioactive decay in which a proton is transformed into a neutron, or vice versa. This process allows the atom to move closer to the optimal proton–neutron ratio. The important point here is that most naturally occurring isotopes on Earth are beta stable. Beta-decay stable isobars are the set of nuclides which cannot undergo beta decay. A subset of these nuclides are also stable with regards to double beta decay as they have the lowest energy of all nuclides with the same mass number. This set of nuclides is also known as the 'line of beta stability'. The line of beta stability can be defined mathematically by finding the nuclide with the greatest binding energy for a given mass number and can be estimated by the classical semi-empirical mass formula.

The naturally occurring stable mass number connected with the proton number can be expressed as follows [8-10].

$$A_s \cong 2Z + \left\{\left(\frac{G_s m_p m_e}{\hbar c}\right)\right\}(2Z)^2 \cong 2Z + \left\{\left(\frac{e_s}{m_p}\right)\Big/\left(\frac{e_e}{m_e}\right)\right\}(2Z)^2$$
$$\cong 2Z + \left[\left(\frac{4G_s m_p m_e}{\hbar c}\right)Z^2\right] \cong 2Z + \left(0.00642 * Z^2\right) \tag{17}$$

Note that,

$$\left(\frac{G_s m_p m_e}{\hbar c}\right) \cong \frac{G_s m_p m_e}{\sqrt{\alpha_s} G_s m_p^2} \cong \left(\frac{e_s}{m_p}\right)\Big/\left(\frac{e_e}{m_e}\right)$$
$$\cong \frac{\text{Specific charge of proton}}{\text{Specific charge of electron}} \cong \frac{1}{623.194} \cong 0.001605 \cong k....(\text{say}) \tag{18}$$

Using this proposed ratio k, nuclear stability and nuclear binding energy both can be understood at fundamental level. This is a very important point to be noted here. If $Z = 92$, obtained $A_s \cong 238.17$ and its actual stable mass number is 238. Considering even-odd corrections, naturally occurring stable atomic nuclides can also be fitted with this relation. In addition, super heavy stable atomic nuclides can also be predicted.

Using this proposed ratio k, based on the assumed stable mass number, stable atomic nuclide's proton number can also be fitted as follows.

$$Z_s \cong \frac{A_s}{2 + \left(\frac{3}{2}kA\right)} \cong \frac{A_s}{2 + \left(0.00241 A_s\right)}$$
$$\Rightarrow \left(A_s - 2Z_s\right) \cong 0.00241 A_s Z_s \tag{19}$$

Here, factor $(3/2)$ in the denominator needs special explanation. This relation is almost similar to the currently believed stability relation,

$$Z_s \cong \frac{A_s}{2 + \left(0.0157 A^{\frac{2}{3}}\right)} \tag{20}$$

where factor 0.0157 in the denominator is connected with coulombic and asymmetric energy coefficients of the semi empirical mass formula. Thus numerically it is possible to show that,

$$\left(0.0157 A^{\frac{2}{3}}\right) \approx \left(0.00241 A\right) \tag{21}$$

6. Understanding Nuclear Binding Energy

Step 1: The maximum binding energy per nucleon

Individual self potential energy of the strongly interacting proton can be fitted as follows.

$$E_{pot} \cong -\frac{3}{5}\left(\frac{e_s^2}{4\pi\varepsilon_0 R_p}\right) \cong -\frac{3}{5}\left(\frac{e_s^2}{4\pi\varepsilon_0\left(\sqrt{2}G_s m_p / c^2\right)}\right) \cong -(8.56 \text{ to } 8.92) \text{ MeV} \quad (22)$$

From muon experimental data, root mean square radius of proton is 0.841 fm and from electron scattering experimental data, root mean square radius of proton is 0.8775 fm. Based on these values, $E_{pot} \cong -(8.5 \text{ to } 8.9)$ MeV. The very interesting point to be noted here is that, with relation (22), considering the proposed strong elementary charge and root mean square radius of proton it is possible to directly fit and understand the maximum binding energy per nucleon.

Step 2: The Binding Energy and neutron-proton beta stability line

Choosing a value close to 8.85 MeV it is possible to show that, for stable mass numbers, $A_s \geq 56$,

$$\begin{aligned} B_{(A_s,Z_s)} &\cong (A_s * 8.85 \text{ MeV}) - \left(A_s^3 * k^2 * 8.85 \text{ MeV}\right) \\ &\cong A_s * 8.85 * \left(1 - A_s^2 k^2\right) \text{MeV} \end{aligned} \quad (23)$$

If assumed A_s is 209, its corresponding estimated stable proton number is $Z_s \approx 83.48 \approx 83$, and estimated binding energy is 1641.5 MeV and actual binding energy is 1640.23 MeV.

Similarly, if assumed A_s is 238, its corresponding estimated stable proton number is $Z_s \approx 92.48 \approx 92$, and estimated binding energy is 1799.0 MeV and actual binding energy is 1801.69 MeV.

Clearly speaking, **for medium and heavy stable atomic nuclides**, binding energy is proportional to $A_s * 8.85$ MeV and reduces by $A_s^3 * k * 8.85$ MeV. Very interesting point to be noted here is that, magnitude of $A_s^3 * k * 8.85$ MeV is close to the currently believed asymmetry energy term $\left[\frac{(A_s - 2Z_s)^2}{A_s}\right] 23.2$ MeV where 23.2 MeV is the currently believed asymmetry energy coefficient. In the following figure-1, Blue curve represents $A_s^3 * k * 8.85$ MeV and Green Curve represents $\left[\frac{(A_s - 2Z_s)^2}{A_s}\right] 23.2$ MeV.

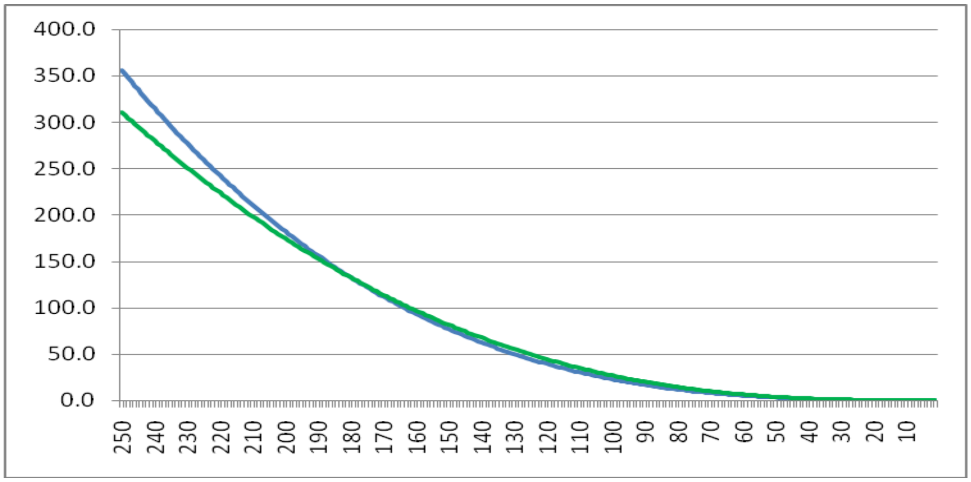

Figure 1: Proposed and current asymmetry energy terms at beta stability line

Based on this observation it is possible to show that,

$$\left.\begin{array}{l}\left[\dfrac{(A_s-2Z_s)^2}{A_s}\right]23.2\text{ MeV}\cong A_s^3*k^2*8.85\\ \to A_s-2Z_s\cong\sqrt{k^2A_s^4\left(\dfrac{8.85\text{ MeV}}{23.1\text{ MeV}}\right)}\cong\dfrac{3}{5}kA_s^2\\ \Rightarrow Z_s\cong\dfrac{1}{2}\left(A_s-\dfrac{3}{5}kA_s^2\right)\cong\dfrac{A_s}{2}\left(1-\dfrac{3}{5}kA_s\right)\end{array}\right\} \tag{24}$$

where $\sqrt{\dfrac{8.85\text{ MeV}}{23.1\text{ MeV}}}\cong 0.6175\cong\dfrac{3}{5}$. See the following figure-2 and table-2 for data. In figure-2, Blue curve represents $A_s*8.85\text{ MeV}$, Red curve represents $\dfrac{A_s^3*8.85\text{ MeV}}{(623.19)^2}\approx\left[\dfrac{(A_s-2Z_s)^2}{A_s}\right]23.2\text{ MeV}$ and Green curve represents $A_s*8.85\text{ MeV--}\left(\dfrac{A_s^3*8.85\text{ MeV}}{(623.19)^2}\right)$.

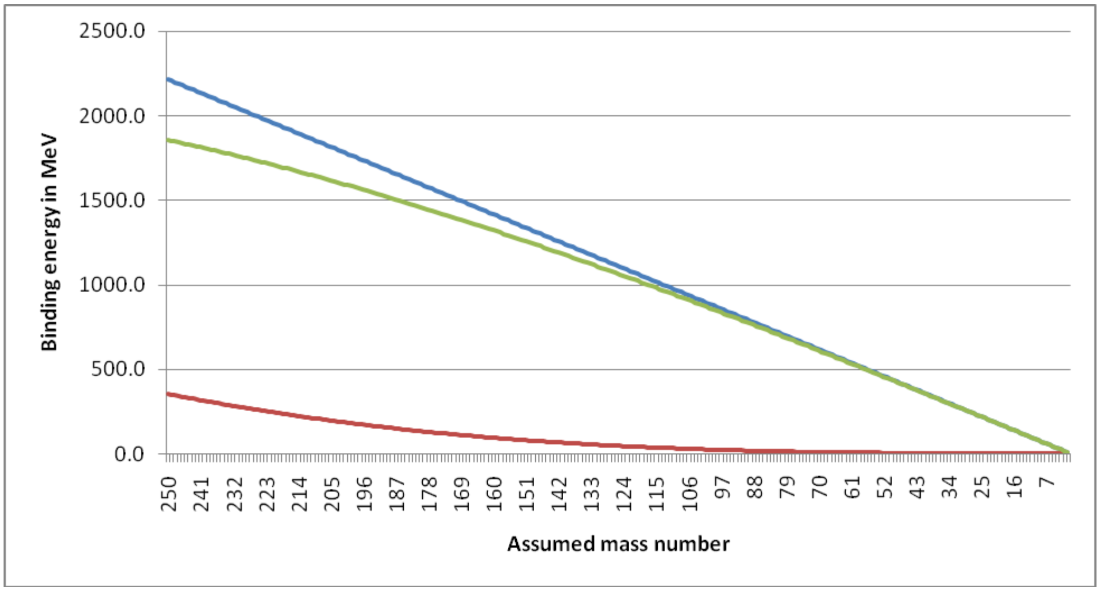

Figure 2: To understand the nuclear binding energy at beta stability line

Table 2: To understand the nuclear binding energy at beta stability line

Assumed stable mass number	Stable Proton number		Binding energy (MeV)		
	Estimated	Actual	Estimated	Actual [10]	%error
56	26.2	26	491.6	493.258	0.3
70	32.3	32	611.7	610.521	-0.2
84	38.1	38	729.9	728.906	-0.2
100	44.6	44	862.2	861.928	0.0
114	50.1	50	975.1	971.574	-0.4
130	56.2	56	1100.4	1092.722	-0.7
142	60.6	60	1191.4	1185.142	-0.5
160	67.1	66	1322.6	1309.455	-1.0
175	72.3	71	1426.6	1412.106	-1.0
190	77.3	76	1525.1	1512.799	-0.8
209	83.5	83	1641.5	1640.23	-0.1
238	92.5	92	1798.9	1801.69	0.2

Step 3: The Binding Energy of light atomic nuclides

For light atomic nuclides, $(56 \le A_s \ge 4)$, binding energy constant can be fitted as follows.

$$E_{pot} \cong \left(\frac{A_s}{56}\right)^{1/12} * 8.85 \text{ MeV} \quad \text{where } (56 \le A_s \ge 4) \tag{25}$$

$$B_{(A_s,Z_s)} \cong \left(\frac{A_s}{56}\right)^{\frac{1}{12}} * A_s * 8.85 * \left(1 - A_s^2 k^2\right) \text{MeV} \tag{26}$$

See the following table-3 for the estimated binding energy of light atomic nuclides.

Table 3: To understand the nuclear binding energy of $(56 \le A_s \ge 4)$

Assumed stable mass number	Stable Proton number		Binding energy (MeV)		
	Estimated	Actual	Estimated	Actual [10]	%error
4	1.99	2	28.41	28.296	-0.4
12	5.91	6	93.37	92.162	-1.3
16	7.85	8	127.48	127.619	0.1
20	9.76	10	162.28	160.645	-1.0
24	11.66	12	197.63	198.257	0.3
28	13.54	14	233.42	236.537	1.3
32	15.41	16	269.58	271.781	0.8
36	17.25	18	306.06	306.717	0.2
40	19.08	19	342.79	341.524	-0.4
44	20.89	20	379.75	380.96	0.3
48	21.79	22	416.89	418.7	0.4
52	23.58	24	454.18	456.349	0.5

Step 4: The Binding Energy of isobars

Considering isobars, if r is ratio of two proton numbers, it is possible to show that,

$$B_{(A_s,Z)} \cong r^{\frac{1}{3}} B_{(A_s,Z_s)} \quad where \begin{cases} r \cong \left(\frac{Z_{any}}{Z_s}\right) \le 1, \text{ if } Z_{any} < Z_s; \\ r \cong \left(\frac{Z_s}{Z_{any}}\right) \le 1, \text{ if } Z_s < Z_{any}; \end{cases} \tag{27}$$

This is a very rough estimation and needs further study at fundamental level. For the time being it can be understood as follows. Let, $A_s = 107$ be the assumed stable mass number. From relation (19), it's corresponding stable proton number can be estimated as $Z_s \cong 47.4 \approx 47.$ From relation

(23), binding energy of $B_{(107,47)}$ can be 919.0 MeV. From reference [9], binding energy of $B_{(107,47)}$ is 914.86 MeV.

Considering the isobars of $A_s = 107$, binding energy of $Z = 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52,..$etc approximately can be understood as follows. See the following table-4.

Table 4: To understand the nuclear binding energy of $Z = (42 \text{ to } 52)$ and $A_s = 107$

Binding energy of $A_s = 107$, $Z = 42, 43, 44, 45, 46$ in MeV		Binding energy of $A_s = 107$, $Z = 48, 49, 50, 51, 52$ in MeV	
Estimated	Reference[9]	Estimated	Reference[9]
$B_{(107,42)} \cong \left(\frac{42}{47}\right)^{1/3} 919.0 \cong 885.0$	892.0	$B_{(107,48)} \cong \left(\frac{47}{48}\right)^{1/3} 919.0 \cong 912.57$	912.84
$B_{(107,43)} \cong \left(\frac{43}{47}\right)^{1/3} 919.0 \cong 892.15$	908.59	$B_{(107,49)} \cong \left(\frac{47}{49}\right)^{1/3} 919.0 \cong 906.32$	909.05
$B_{(107,44)} \cong \left(\frac{44}{47}\right)^{1/3} 919.0 \cong 899.0$	912.62	$B_{(107,50)} \cong \left(\frac{47}{50}\right)^{1/3} 919.0 \cong 900.24$	903.51
$B_{(107,45)} \cong \left(\frac{45}{47}\right)^{1/3} 919.0 \cong 905.78$	914.69	$B_{(107,51)} \cong \left(\frac{47}{51}\right)^{1/3} 919.0 \cong 894.32$	894.19
$B_{(107,46)} \cong \left(\frac{46}{47}\right)^{1/3} 919.0 \cong 912.43$	915.70	$B_{(107,52)} \cong \left(\frac{47}{52}\right)^{1/3} 919.0 \cong 884.55$	883.42

Considering the isobars of $A_s = 160$, binding energy of $Z = 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72$ approximately can be understood as follows. See the following table -5.

Table 5: To understand the nuclear binding energy of $Z = (60 \text{ to } 72)$ and $A_s = 160$

Binding energy of $A_s = 160$, $Z = 60, 61, 62, 63, 64, 65$ in MeV		Binding energy of $A_s = 160$, $Z = 67, 68, 69, 70, 71, 72$ in MeV	
Estimated	Reference[9]	Estimated	Reference[9]
$B_{(160,60)} \cong \left(\frac{60}{66}\right)^{1/3} 1322.6 \cong 1281.24$	1292.24	$B_{(160,67)} \cong \left(\frac{66}{67}\right)^{1/3} 1322.6 \cong 1315.99$	1305.75
$B_{(160,61)} \cong \left(\frac{61}{66}\right)^{1/3} 1322.6 \cong 1288.32$	1297.01	$B_{(160,68)} \cong \left(\frac{66}{68}\right)^{1/3} 1322.6 \cong 1309.5$	1304.46
$B_{(160,62)} \cong \left(\frac{62}{66}\right)^{1/3} 1322.6 \cong 1295.32$	1303.79	$B_{(160,69)} \cong \left(\frac{66}{69}\right)^{1/3} 1322.6 \cong 1303.15$	1298.07

$B_{(160,63)} \cong \left(\frac{63}{66}\right)^{1/3} 1322.6 \cong 1302.25$	1305.49	$B_{(160,70)} \cong \left(\frac{66}{70}\right)^{1/3} 1322.6 \cong 1296.91$	1294.49
$B_{(160,64)} \cong \left(\frac{64}{66}\right)^{1/3} 1322.6 \cong 1309.1$	1309.30	$B_{(160,71)} \cong \left(\frac{66}{71}\right)^{1/3} 1322.6 \cong 1290.79$	1286.03
$B_{(160,65)} \cong \left(\frac{65}{66}\right)^{1/3} 1322.6 \cong 1315.89$	1308.21	$B_{(160,72)} \cong \left(\frac{66}{72}\right)^{1/3} 1322.6 \cong 1284.79$	1280.42

7. Conclusions

It may be noted that, the two theories upon which all modern physics rests are general relativity (GR) and quantum field theory (QFT). GR is a theoretical framework that only focuses on the force of gravity for understanding the universe in regions of both large-scale and high-mass: stars, galaxies, clusters of galaxies, etc. On the other hand, QFT is a theoretical framework that only focuses on three non-gravitational forces for understanding the universe in regions of both small scale and low mass: sub-atomic particles, atomic nuclei, atoms, molecules, etc. QFT successfully implemented the Standard Model and unified the three non-gravitational interactions. But, so far no model succeeded in coupling and understanding the unified concepts of gravitational interaction and electromagnetic and strong interactions.

In this context, the authors would like to suggest that:

A) Proposed applications strongly support the possible existence of a new elementary charge connected with strong interaction.
B) The results obtained from the above relations are very simple to understand and seem to be more physical with reference to unified models at fundamental level.
C) Proposed method of estimating the binding energy of medium and heavy stable atomic nuclides with unified physical principles is an interesting issue.
D) Considering relations (22) and (23), the first three terms of the semi empirical mass formula can be simplified into a single term and a unified model of nuclear binding energy can be developed at fundamental level.
E) Estimated binding energy of light atomic nuclides is roughly (10 to 20) MeV higher than the actual binding energy and can be understood with relations (25) and (26).
F) Qualitatively and quantitatively the proposed three assumptions collectively can be given some priority at fundamental level.

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