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Significance and Applications of the Strong Coupling Constant in the Light of Large Nuclear Gravity and Up and Down Quark Clusters

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

As a hypothetical approach, strong interaction without repulsive forces can be assumed to be equivalent to a large gravitational coupling. Based on this concept, strong coupling constant can be defined as a ratio of the electromagnetic force and the gravitational force associated with proton, neutron, up quark and down quark. With respect to the product of strong coupling constant and fine structure ratio, we review our recently proposed two semi empirical relations and coefficients 0.00189 and 0.00642 connected with nuclear stability and binding energy. We wish to emphasize that- by classifying nucleons as 'free nucleons' and 'active nucleons', nuclear binding energy can be fitted with a new class of 'three term' formula having one unique energy coefficient. Based on the geometry and quantum nature, currently believed harmonic oscillator and spin orbit magic numbers can be considered as the lower and upper "mass limits" of quark clusters.

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1. INTRODUCTION

With reference to nuclear stability and binding energy, relationship between nuclear force and strong force is still a grey area and is a challenging task for field experts and young scientists [1,2]. It is well established that,

1) Less than 0.8 femtometer (fm), strong force is mediated by gluons.
2) At a range of 1 to 3 fm, strong force is mediated by mesons.
3) Neutrons, protons, baryons and mesons are made up of quarks.
4) Gluons interact with quarks and other gluons and mesons interact with neutrons and protons.
5) Strong force that binds quarks into neutrons, and protons can be called as 'residual strong force' or simply 'nuclear force'.
6) Within the quark surroundings, force is strong and distance independent.
7) Nuclear force is weaker and rapidly decreases with increasing distance among nucleons (bound quarks).
8) Even though nuclear force is weaker than the strong force, still it is very energetic in producing gamma rays and holding nucleons with large binding energy.
9) Strength of strong interaction is parameterized by strong coupling constant, $\alpha_s \cong 0.1181$ [3].

By taking into account the published concept of large nuclear gravitational coupling [4,5,6,7,8] and our recent paper [9] and references therein, we make an attempt to understand the physical significance and applications of strong coupling constant with respect to nuclear stability and binding energy.

2. PHYSICAL SIGNIFICANCE OF STRONG COUPLING CONSTANT

Strong coupling constant (α_s) can be defined as a ratio of the electromagnetic force and the gravitational force associated with proton, neutron, up quark and down quark. Mathematically, it can be represented as

$$\alpha_s \cong \frac{e^2}{4\pi\varepsilon_0}\begin{bmatrix}\left[G_s m_p\left(2m_u+m_d\right)\right] \\ +\left[G_s m_n\left(m_u+2m_d\right)\right]\end{bmatrix}^{-1} \tag{1}$$

where $G_s =$ Large nuclear gravitational constant, $\left(m_p, m_n\right)$ = Proton and neutron masses and $\left(m_u, m_d\right)$ = Up and down quark masses.

In our earlier published papers, we proposed that [9], $G_s \cong 3.329561\times10^{28}\text{m}^3\text{kg}^{-1}\text{sec}^{-2}$. With reference to particle data group [3],

$$\left.\begin{matrix} m_u \cong 2.16^{+0.49}_{-0.26}\ \text{MeV} \\ m_d \cong 4.67^{+0.48}_{-0.17}\ \text{MeV}\end{matrix}\right\}$$

Based on these values, estimated $\alpha_s \cong 0.11333$ and its recommended world average $\alpha_s \cong 0.1181$. By refining the magnitudes of up and down quark masses and the large nuclear gravitational constant, absolute value of α_s can be fixed. Conceptually, it seems better to understand that,

$$\frac{e^2}{4\pi\varepsilon_0} \cong \alpha_s \begin{Bmatrix}\left[G_s m_p\left(2m_u+m_d\right)\right] \\ +\left[G_s m_n\left(m_u+2m_d\right)\right]\end{Bmatrix} \tag{2}$$

3. TWO NEW COEFFICIENTS AND THEIR APPLICATIONS

In our earlier publications, in a quantum gravitational approach [9], we have introduced two coefficients 0.00189 and 0.006423 pertaining to nuclear stability and binding energy.

A) Coefficient connected with Stability

We noticed that,

1) As proton number increases, at stability zone, neutron number increases with square of the proton number.
2) Proportionality coefficient seems to be close to a number 0.0064 [5,6,7]. Quantitatively it can be fitted with a relation of the form,

$$\begin{matrix} k \cong \alpha - \alpha\alpha_s \cong \left(1-\alpha_s\right)\alpha \cong 0.00644 \\ \text{where } \alpha_s \cong 0.1181 \end{matrix} \tag{3}$$

Based on the coefficient, $k \cong 0.00644$, neutron number close to stability zone can be expressed as,

$$\left.\begin{array}{l} N_s \cong Z + kZ^2 \\ N_s - Z \cong kZ^2 \end{array}\right\} \quad (4)$$

where, Z = Proton number

N_s = Neutron number close to stability

In terms of nucleon number,

$$\left.\begin{array}{l} A_s \cong 2Z + kZ^2 \\ A_s - 2Z \cong kZ^2 \end{array}\right\} \quad (5)$$

where

A_s = Nucleon number close to stability

$(N_s - Z) \cong (A_s - 2Z) \cong \Delta N_s$

= Excess Neutron number close to stability zone

With this kind of relation, by guessing the proton number, corresponding stable zone nucleon number can be estimated directly. With even-odd corrections and fine tuning the value of k, better understanding is possible. Considering $k \cong 0.00644$ and by considering a simple quadratic equation, relation (5) can be derived.

$$\left.\begin{array}{l} \text{Let, } X = \dfrac{Zk}{2} \\ C = \dfrac{Zk}{2} = \dfrac{Ak}{4}\left(\because \text{Initially}, Z = \dfrac{A}{2}\right) \\ \text{and} \quad X^2 + X - C \cong 0 \\ \left\{\begin{array}{l} X^2 \text{ coefficient} = 1 \\ X \text{ coefficient} = 1 \end{array}\right\} \\ \rightarrow \dfrac{Zk}{2} \cong \dfrac{-1 \pm \sqrt{kA+1}}{2} \end{array}\right\} \quad (6)$$

With reference to observational data, it seems reasonable to assign the proposed relation (5) with mean stable mass number (A_m).

$$(A_s)_{mean} \cong A_m \cong A\_mean \cong 2Z + kZ^2 \quad (7)$$

Best lower and upper limits for stable and relatively long living mass numbers can be approximated with the following relation.

$$\begin{array}{l} (A_s)_{lower}^{upper} \cong 2Z + (1 \pm \alpha_s)^2 kZ^2 \\ A_{lower} \cong 2Z + (1-\alpha_s)^2 kZ^2 \cong 2Z + \left(0.78kZ^2\right) \\ A_{upper} \cong 2Z + (1+\alpha_s)^2 kZ^2 \cong 2Z + \left(1.25kZ^2\right) \end{array} \quad (8)$$

Using these relations as guidelines, long living isotopes of super heavy elements can be estimated.

With reference to the famous stability relation pertaining to semi empirical mass formula [10,11,12],

$$Z \cong \frac{A}{\left(2.0 + (a_c/2a_a)A^{2/3}\right)} \cong \frac{A}{\left(2.0 + 0.0153A^{2/3}\right)} \quad (9)$$

where $a_c \cong 0.71$ MeV and $a_a \cong 23.2$ MeV

Based on the proposed quadratic relation (6) and relation(9), it is possible to show that,

$$Z \cong \frac{\sqrt{kA+1}-1}{k} \quad (10)$$

Comparing relations (9) and (10), solution seems to be a relation of the form,

$$0.0153A^{2/3} \approx \sqrt{kA+1}-1 \quad (11)$$

$$Z \cong \frac{A}{\left(2.0 + 0.0153A^{2/3}\right)} \quad (12A)$$

$$Z \cong \frac{A}{1+\sqrt{kA+1}} \quad (12B)$$

$\left[\sqrt{kA+1}-1\right]$ seems to be more appropriate than $\left[0.0153A^{2/3}\right]$ and it needs further study. With a curiosity, we noticed that,

$$\left(\alpha_s^2 + \alpha_s^3 + \alpha_s^4 + \alpha_s^5 + ...\right) \cong 0.0158 \approx \frac{a_c}{2a_a} \approx 0.0153 \quad (13)$$

where $a_c \cong 0.71$ MeV and $a_a \cong 23.2$ MeV

See Table 1 for a comparison for estimated proton number starting from A=340 to 4.

Based on the data presented in Table 1, workability of the proposed coefficient $k \cong 0.00644$, can be validated.

B) Coefficient connected with free nucleons

It is known that,

1) The nucleons not involving in nuclear binding energy scheme are called 'free nucleons'.
2) Number of free nucleons increases with increasing $A\sqrt{ZN}$.

3) Nucleons that involve in nuclear binding energy scheme can be called as 'active nucleons'.
4) In finding the free nucleon number, with trial–error solutions, we are able to come across a number close to 0.00189 [9]. Quantitatively it can be fitted with a relation of the form,

$$f \cong \left(\frac{m_d}{m_u}\right)\alpha\alpha_s \cong 0.001863 \quad (14)$$

where $\alpha_s \cong 0.1181$

Table 1. Proton number comparison estimated with relations (12A) and (12B)

Mass number	Proton number estimated with relation (12A)	Proton number estimated with relation (12B)	Difference in estimated proton number
340	124	122	2
332	121	120	1
324	119	118	1
316	117	115	2
308	114	113	1
300	112	111	1
292	109	108	1
284	107	106	1
276	104	104	1
268	102	101	1
260	99	99	0
252	97	96	1
244	94	94	0
236	91	91	0
228	89	89	0
220	86	86	0
212	83	84	-1
204	81	81	0
196	78	78	0
188	75	76	-1
180	72	73	-1
172	70	70	0
164	67	67	0
156	64	65	-1
148	61	62	-1
140	58	59	-1
132	55	56	-1
124	52	53	-1
116	49	50	-1
108	46	47	-1
100	43	44	-1
92	40	41	-1
84	37	37	0
76	33	34	-1
68	30	31	-1
60	27	28	-1
52	23	24	-1
44	20	21	-1
36	17	17	0
28	13	13	0
20	9	10	-1
12	6	6	0
4	2	2	0

5) To a very good approximation, free nucleon number can be expressed with a relation of the form,

$$A_f \cong f \times A\sqrt{ZN} \cong 0.001863A\sqrt{ZN} \quad (15)$$

6) Active nucleon number can be expressed with a relation of the form,

$$A_a \cong A - A_f \cong A\left(1 - 0.001863\sqrt{ZN}\right) \quad (16)$$

7) By considering the integer form of $A_a \cong \left(1 - 0.001863\sqrt{ZN}\right)A$ or $A_f \cong \left(0.001863A\sqrt{ZN}\right)$, to some extent, error can be minimized in the estimation of binding energy.

4. PROPOSED NUCLEAR BINDING ENERGY SCHEME

We propose that, nuclear binding energy [1,2,13,14,15]

1) Can be understood with single energy coefficient and three simple terms.
2) Decreases with increasing number of free nucleons.
3) Increases with increasing number of active nucleons.
4) Decreases with increasing radius.
5) Of stable and unstable isotopic mass numbers can be estimated with mean stable mass number as a reference line of stability.

Based on these points, for estimating nuclear binding energy (BE), we propose the following semi empirical relation for Z=3 to 118.

$$\left.\begin{array}{l} (BE)_{(z,A)} \cong \left\{A_a - A^{1/3} - \left(1 + \dfrac{(A_m - A)^2}{A_m}\right)\right\}B_0 \\ \cong \left\{\left(1 - 0.001863\sqrt{ZN}\right)A - A^{1/3} - \left(1 + \dfrac{(A_m - A)^2}{A_m}\right)\right\}10.1 \text{ MeV} \end{array}\right\} \quad (17)$$

$$\text{where } B_0 \cong \frac{G_s m_p (2m_u + m_d)}{R_0} + \frac{G_s m_n (m_u + 2m_d)}{R_0}$$

$$\cong \frac{3}{2}(m_u + m_d)c^2 \cong 10.245 \text{ MeV} \approx 10.1 \text{ MeV}$$

$$\text{and } R_0 \cong \frac{2G_s m_p}{c^2} \cong \frac{2G_s m_n}{c^2} \cong 1.24 \text{ fm.}$$

In this relation (17),

First term: $+\left(1 - 0.001863\sqrt{ZN}\right)A \times 10.1 \text{ MeV}$ (18)

Second term: $-A^{1/3} \times 10.1 \text{ MeV}$ (19)

Third term: $-\left(1 + \dfrac{(A_m - A)^2}{A_m}\right) \times 10.1 \text{ MeV}$ (20)

$\left(\dfrac{(A_m - A)^2}{A_m}\right)$ can be considered as a representation of 'asymmetry' about the mean line of stability.

We are still working on understanding the physical significance of the third term [16,17,18] and it needs in-depth study. Close to mean stable mass number,

$$(BE)_{(z,A_m)} \cong \left\{\left(1-f\sqrt{ZN_m}\right)A_m - A_m^{1/3} - 1\right\}10.1 \text{ MeV}$$
$$\text{where } \begin{cases} A_m \cong \left(2Z + kZ^2\right) \text{ and} \\ N_m \cong A_m - Z \cong \left(Z + kZ^2\right) \end{cases} \tag{21}$$

See Table 2 and Fig. 1 for the estimated BE of isotopes of Z=50 estimated with relations (7) and (17) compared with standard semi empirical mass formulae (SEMF).

Note: The numbers $(f \text{ and } k)$ can be considered as the characteristic outcomes of the combined effect of strong and electromagnetic coupling constants. With trial-error method, we noticed that, $(k, f) \cong \left(\frac{(1-\alpha_s)^n}{2n-1}\right)\alpha \cong (0.00644, 0.001892)$ where $n \cong 1, 2$; It needs further study.

$$\left.\begin{array}{l} \text{In Table 2, (Column-6)} - \textbf{SEMF} - \textbf{1 BE} \\ \text{(https://en.wikipedia.org/wiki/Semi-empirical\_mass\_formula)} \\ BE \cong (a_v * A) - \left(a_s * A^{2/3}\right) - \left(a_c * \frac{Z*(Z-1)}{A^{1/3}}\right) - \left(a_a * \frac{(A-2Z)^2}{A}\right) \pm \left(\frac{a_p}{\sqrt{A}}\right) \\ \text{where } \begin{cases} a_v \cong 15.8 \text{ MeV; } a_s \cong 18.3 \text{ MeV; } a_c \cong 0.714 \text{ MeV;} \\ a_a \cong 23.2 \text{ MeV; } a_p \cong 12.0 \text{ MeV;} \end{cases} \end{array}\right\} \tag{22}$$

$$\left.\begin{array}{l} \text{In Table 2, (Column-7)} - \textbf{SEMF} - 2\ \textbf{BE} \\ \text{(http://oregonstate.edu/instruct/ch374/ch418518/lecture3-1.pdf)(Slide-16)} \\ BE \cong (a_v * x * A) - \left(a_s * x * A^{2/3}\right) - \left(a_c * \frac{Z^2}{A^{1/3}}\right) + \left(a_{pr} * \frac{Z^2}{A}\right) \pm \left(\frac{a_p}{\sqrt{A}}\right) \\ \text{where } \begin{cases} x \cong \left[1 - 1.79\left(\frac{N-Z}{A}\right)^2\right] \\ a_v \cong 15.677 \text{ MeV; } a_s \cong 18.56 \text{ MeV; } a_c \cong 0.717 \text{ MeV;} \\ a_{pr} \cong 1.211 \text{ MeV; } a_p \cong 11.0 \text{ MeV;} \end{cases} \end{array}\right\} \tag{23}$$

Table 2. Estimated BE of isotopes of Z= 50

Z	A	N	Estimated A_mean	Estimated BE (MeV)	SEMF-1 BE (MeV)	SEMF-2 BE (MeV)
50	100	50	116	836.6	810.1	813.0
50	101	51	116	847.4	823.1	825.7
50	102	52	116	858.0	838.0	840.2
50	103	53	116	868.4	850.1	852.1
50	104	54	116	878.6	864.1	865.7
50	105	55	116	888.6	875.4	876.9
50	106	56	116	898.5	888.6	889.8
50	107	57	116	908.1	899.1	900.2
50	108	58	116	917.6	911.5	912.4

Z	A	N	Estimated A_mean	Estimated BE (MeV)	SEMF-1 BE (MeV)	SEMF-2 BE (MeV)
50	109	59	116	926.9	921.2	922.1
50	110	60	116	936.0	932.8	933.6
50	111	61	116	944.9	941.9	942.7
50	112	62	116	953.7	952.8	953.6
50	113	63	116	962.3	961.1	962.0
50	114	64	116	970.6	971.4	972.3
50	115	65	116	978.8	979.1	980.1
50	116	66	116	986.9	988.8	989.8
50	117	67	116	994.7	995.9	997.1
50	118	68	116	1002.4	1004.9	1006.1
50	119	69	116	1009.8	1011.4	1012.9
50	120	70	116	1017.1	1019.9	1021.4
50	121	71	116	1024.2	1025.9	1027.7
50	122	72	116	1031.1	1033.8	1035.7
50	123	73	116	1037.9	1039.3	1041.5
50	124	74	116	1044.4	1046.7	1049.0
50	125	75	116	1050.8	1051.6	1054.3
50	126	76	116	1057.0	1058.5	1061.3
50	127	77	116	1063.0	1063.1	1066.1
50	128	78	116	1068.9	1069.5	1072.7
50	129	79	116	1074.5	1073.5	1077.1
50	130	80	116	1080.0	1079.5	1083.3
50	131	81	116	1085.3	1083.2	1087.3
50	132	82	116	1090.4	1088.7	1093.0
50	133	83	116	1095.3	1091.9	1096.6
50	134	84	116	1100.0	1097.0	1101.9
50	135	85	116	1104.6	1099.9	1105.1
50	136	86	116	1108.9	1104.6	1110.0
50	137	87	116	1113.1	1107.1	1112.9
50	138	88	116	1117.1	1111.5	1117.4
50	139	89	116	1121.0	1113.6	1119.9
50	140	90	116	1124.6	1117.6	1124.1
50	141	91	116	1128.1	1119.4	1126.3
50	142	92	116	1131.3	1123.0	1130.1
50	143	93	116	1134.4	1124.5	1132.0
50	144	94	116	1137.3	1127.8	1135.5
50	145	95	116	1140.1	1129.0	1137.0
50	146	96	116	1142.6	1131.9	1140.2
50	147	97	116	1145.0	1132.8	1141.4
50	148	98	116	1147.2	1135.5	1144.3
50	149	99	116	1149.2	1136.1	1145.2
50	150	100	116	1151.0	1138.5	1147.8
50	151	101	116	1152.7	1138.8	1148.5
50	152	102	116	1154.1	1140.9	1150.8
50	153	103	116	1155.4	1140.9	1151.1
50	154	104	116	1156.5	1142.8	1153.2
50	155	105	116	1157.4	1142.5	1153.3
50	156	106	116	1158.1	1144.1	1155.0
50	157	107	116	1158.7	1143.7	1154.9
50	158	108	116	1159.0	1145.0	1156.4
50	159	109	116	1159.2	1144.3	1156.0
50	160	110	116	1159.2	1145.4	1157.2

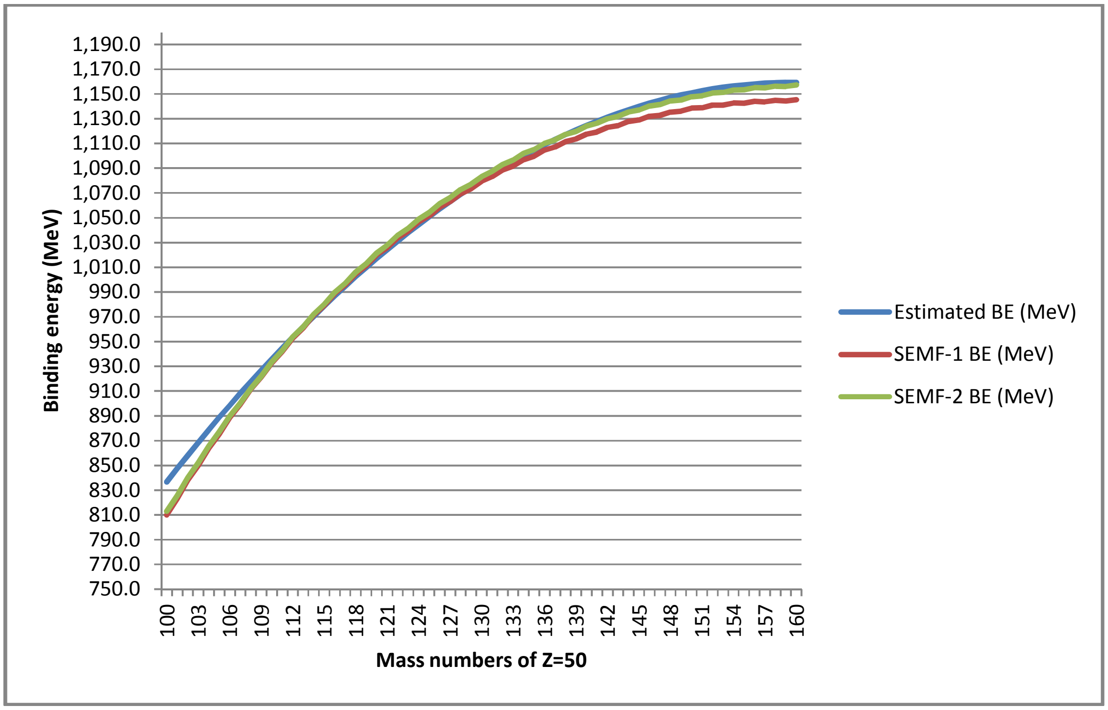

Fig. 1. BE of isotopes of Z=50

Table 3. Mean, lower and upper mass limits of quark clusters

Principal quantum number	Mean mass number	Lower mass number	Upper mass number
1	1 ±1	0	2
2	4 ±2	2	6
3	11 ±3	8	14
4	24 ±4	20	28
5	45 ±5	40	50
6	76 ±6	70	82
7	119 ±7	112	126
8	176 ±8	168	184
9	249 ±9	240	258
10	340 ±10	330	350

5. MAGIC NUMBERS AND QUARK CLUSTERS

Two observed series of magic numbers 2,8,20,… and 28,50,82,… can be understood with quarks in the following way. Based on the geometry [19] and quantum nature [20-28],

1) Nuclear volume constitutes systematically arranged quark clusters.
2) Currently believed harmonic oscillator and spin orbit magic numbers can be considered as the lower and upper "mass limits" of the assumed quark clusters.
3) Each quark shell is associated with a principal quantum number, $n = 1, 2, 3, ...$
4) As nucleon constitutes 3 quarks, number of quarks that can be accommodated in n^{th} cluster can be represented by,

$$\left.\begin{aligned} 3A_n &\cong \left[\left(n^3 + 2n\right) \pm 3n\right] \\ &\cong 3\left[n + \sum_{n=1}^{n} n(n-1)\right] \pm 3n \end{aligned}\right\} \quad (24)$$

5) Corresponding lower and upper limits of the nucleons can be represented by,

$$\left.\begin{aligned}(A_n)_{lower} &\cong \left[\frac{(n^3+2n)}{3}\right]-n \\ &\cong \sum_{n=1}^{n} n(n-1)\end{aligned}\right\} \quad (25)$$

$$\left.\begin{aligned}(A_n)_{upper} &\cong \left[\frac{(n^3+2n)}{3}\right]+n \\ &\cong 2n+\sum_{n=1}^{n} n(n-1)\end{aligned}\right\}$$

(26)

See Table 3 and Fig. 2 for the lower, mean and upper mass limits of quark clusters.

6) Gap between n^{th} cluster $(A_n)_{lower}$ and cluster $(A_n)_{upper}$ is $(n-1)(n-2)$.
7) Based on the beta stability relations (12A) and (12B) and on the capacity of the quark cluster and corresponding to the lower, average and upper limits of the nucleons in the quark cluster, even proton numbers (2 to 4) can be inferred. These inferred even protons seem to have more number of isotopes and magic nature. Inferred proton number corresponding to the average mass number of any quantum cluster seems to have more isotopes compared to minimum and maximum mass limits.
8) At $n=6$, quark cluster lower, average and upper mass limits are 70, 76 and 82 respectively and this mass range seems to be in-line with the whole isotopic mass range of Z=34. Corresponding even proton numbers seem to be 34 ± 2 . See references [24,27,28].
9) At $n=7$, quark cluster lower, average and upper mass limits are 112, 119 and 126 respectively and this mass range seems to be in-line with the whole isotopic mass range of Z=50. Corresponding even proton numbers seem to be 50 ± 2.
10) At $n=(8,9,10)$, inferred proton numbers are $Z \approx (70 \text{ to } 74),(92 \text{ to } 96) \text{and} (120 \text{ to } 124)$ respectively. It needs further investigation.
11) At $n=2$, quark cluster upper mass limit is 6 and at $n=3$, quark cluster upper mass limit is 14. See references [21, 26].

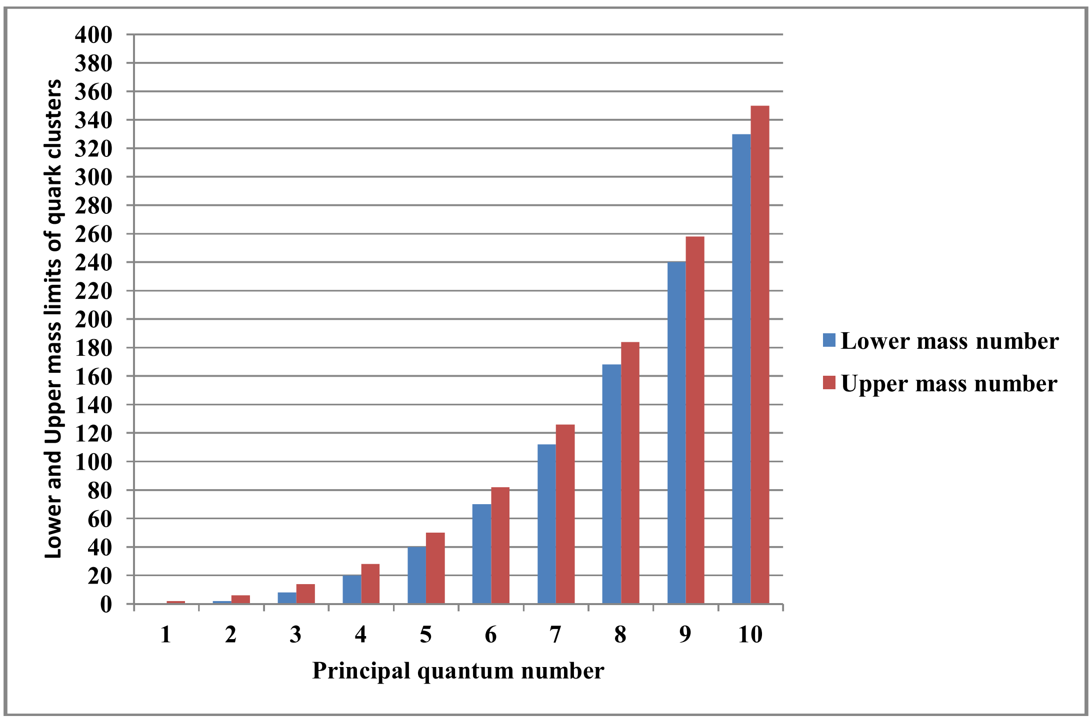

Fig. 2. Estimated lower and upper mass limits of quark clusters

6. DISCUSSION

1) Even though celestial objects that show gravity are confirmed to be made up of so many atoms, so far scientists could not find any relation in between gravity and the atomic interactions at quantum gravity level.
2) When microscopic space time is highly curved than macroscopic space time curvature, it is natural to assign a large value to microscopic gravitational constant. Compared to particles having a structure, for point particles, magnitude of gravitational constant can be much higher. Based on this logic, for each atomic interaction, one different gravitational constant can be assigned. Thinking in this way, in our earlier publication [9] and references therein, with respect to three different atomic gravitational constants assumed to be associated with strong, weak and electromagnetic interactions, we have proposed many interesting applications and finally we could able to estimate the Newtonian gravitational constant with the three atomic gravitational constant.
3) Different interactions were assumed starting from electron rest mass to Planck mass as follows,

$$G_X M_X^2 \approx \hbar c \tag{28}$$

where,

Interaction dependent gravitational constant= G_X
Interaction dependent massive fermion = M_X

To proceed further, we defined that,

a) For electroweak interaction,

$$G_w M_w^2 \equiv \hbar c \tag{29}$$

where,

Weak gravitational constant= G_w
Characteristic weak massive fermion = M_w

b) For strong interaction,

$$G_s m_p^2 \cong \left(\frac{e_s}{e}\right)\hbar c \cong \sqrt{\frac{1}{\alpha_s}} \times \hbar c \tag{30}$$

where,

Nuclear or strong gravitational constant= G_s
Mass of proton = m_p
Strong elementary charge = e_s
Ordinary elementary charge = e
Strong coupling constant= α_s

c) For electromagnetic interaction,

$$G_e m_e^2 \cong \left(\frac{M_w}{m_p}\right)\hbar c \tag{31}$$

where,

Electromagnetic gravitational constant= G_e
Mass of electron = m_e

Based on these relations, it is possible to arrive at,

$$\frac{G_e m_e^2}{\hbar c} \cong \frac{\hbar c}{G_s m_p m_e} \cong \left(\frac{M_w}{m_p}\right) \cong \sqrt{\frac{\hbar c}{G_w m_p^2}} \tag{32}$$

Out of the three (G_e, G_s, G_w), if anyone is known, other two can be estimated. With reference to their approximate magnitudes, we noticed that,

$$\left(\frac{m_p}{m_e}\right) \cong 2\pi\sqrt{\frac{4\pi\varepsilon_0 G_e m_e^2}{e^2}} \tag{33}$$

$$\sqrt{\frac{e_s^2}{4\pi\varepsilon_0 G_s m_p m_e}} \cong 2\pi \tag{34}$$

$$\frac{G_w}{G_N} \cong \left(\frac{m_p}{m_e}\right)^{10} \tag{35}$$

where,

Newtonian gravitational constant= G_N

4) In this context, readers are encouraged to see our recent paper [18]. Newtonian gravitational constant can be addressed with a relation of the form,

$$G_N \cong \frac{G_w^{21} G_e^{10}}{G_s^{30}} \cong 6.679855 \times 10^{-11}\ \text{m}^3\text{kg}^{-1}\text{sec}^{-2} \tag{36}$$

where,
$G_e \cong 2.374335 \times 10^{37}\ \text{m}^3\text{kg}^{-1}\text{sec}^{-2}$
$G_s \cong 3.329561 \times 10^{28}\text{m}^3\text{kg}^{-1}\text{sec}^{-2}$
$G_w \cong 2.909745 \times 10^{22}\ \text{m}^3\text{kg}^{-1}\text{sec}^{-2}$

Strong coupling constant can be addressed with a relation of the form,

$$\frac{1}{\alpha_s} \cong \left(\frac{G_s^{10}}{G_e^4 G_w^6}\right) \cong 0.1152 \quad (37)$$

Weakly interacting massive fermion can be expressed as,

$$M_w \cong \sqrt{\frac{\hbar c}{G_w}} \cong 584.725\ \text{GeV}/c^2 \quad (38)$$

5) Our proposed '4G model' of final unification is still under its budding stage and we are working on it.
6) We would like to emphasize the fact that, high energy physics is failing in explaining the basic mechanism of nuclear binding energy scheme and magic numbers. Scientists should consider this as a major shortcoming of the current quark model of particle physics.
7) When ordinary (low energy scale) nuclear material is used as an input for high energy nuclear experiments, it is important to review low energy and high nuclear physical concepts in a unified approach.
8) Without explaining the low energy scale structure of nucleus with quarks, focussing on high energy scale quark properties seems to be ambiguous and incomplete.
9) After establishing a harmony in between low and high energy nuclear physics with quarks and gravity, issues pertaining to other branches of physics like understanding the behaviour of stars, formation of compact objects, inferring baryon acoustic oscillations and origin of dark energy can be studied in a better way.
10) By extending our ideas to high energy physics, it may be possible to study low energy physics and high energy physics in a unified approach.
11) So far we could find three definitions for the strong coupling constant. Our basic idea is that, there exists a strong interaction elementary charge in such a way that, it's squared ratio with normal elementary charge is close to inverse of the strong coupling constant. Using this charge, proton magnetic moment and nuclear binding energy coefficient can be estimated. Another interesting application is that, based on strong charge conservation [29] and super symmetry [30], fractional charge quarks can be understood.
12) Asymptotic freedom [31,32] is a peculiar feature of quantum chromodynamics (QCD) at high energy scale. Clearly speaking,

a) Quarks interact strongly at low energies and weakly at high energies.
b) Strength of interaction decreases with increasing energy logarithmically.

Qualitatively, to some extent, this concept can be understood with relativistic speed of proton. With reference to velocity of proton and based relation (1), it is possible to have a similar idea of the form,

$$(\alpha_s)_v \propto \left(\frac{m_p}{\sqrt{1-(v^2/c^2)}}\right)^{-1} \quad (39)$$

where, $v =$ Velocity of proton.

With reference to velocity of proton, relativistic strong coupling constant can be expressed as,

$$(\alpha_s)_v \cong (\alpha_s)_{v=0} \times \sqrt{1-\left(\frac{v^2}{c^2}\right)} \quad (40)$$

where, $(\alpha_s)_{v=0} \cong (\alpha_s) \cong 0.1181$

Based on this relation and starting form $(v/c) \cong 0.9$ to $(v/c) \cong 0.999624$, we tried to estimate the magnitude of $(\alpha_s)_v$. See the following Fgure-3. This may not be the exact case as suggested by the field experts and Nobel laureates Wilczek, Politzer and Gross. We are working in this direction. By considering other characteristic physical parameters associated with strong interaction, it may be possible to understand the mystery of strong interaction strength at basic level.

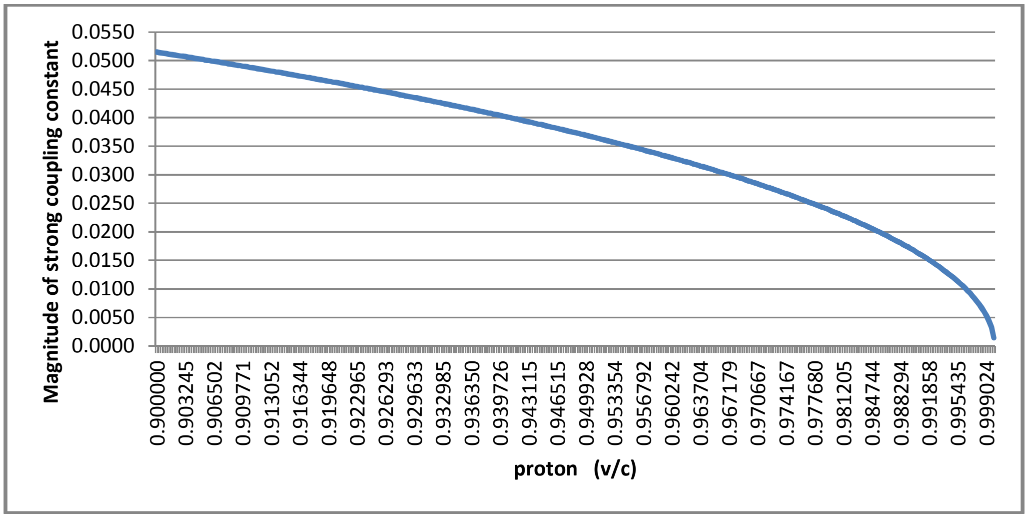

Fig. 3. Relativistic magnitude of strong coupling constant

7. CONCLUSION

With reference to the data presented in Tables 1, 2 and 3, our proposed concepts and relations can be recommended for further investigation. By refining the values of (G_s, m_u, m_d), magnitudes of (α_s, f, k, B_0) can be refined.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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