Fermi scale applications of strong (nuclear) gravity-1

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Introduction

With reference to the picture of 'Strong (nuclear) gravity' [1], if $G_f \approx G_s \approx 10^{38} G_N$ and with reference to our recent symposium proceedings, we review reference [2] with the following three assumptions for a better understanding on nuclear stability and binding energy. For calculation purpose, we consider $G_s \cong \frac{4\pi\varepsilon_0 \hbar^2 c^2 m_e}{e^2 m_p^3} \cong 3.329560807 \times 10^{28}$ m^{3}kg^{-1}sec^{-2}.

Three simple assumptions

1) Nuclear charge radius can be addressed with, $R_0 \cong \frac{2G_s m_p}{c^2} \cong 1.23929083$ fm
2) Strong coupling constant can be expressed with, $\alpha_s \cong \left(\frac{\hbar c}{G_s m_p^2}\right)^2 \cong 0.1151937353$
3) There exists a strong elementary charge in such a way that, $e_s \cong \left(e/\sqrt{\alpha_s}\right) \cong 4.720586027 \times 10^{-19}$ C

Semi empirical relations and applications

1) Proton magnetic moment can be addressed with $\mu_p \cong \frac{e_s \hbar}{2m_p} \cong 1.488142 \times 10^{-26}$ J.T^{-1}
2) Neutron magnetic moment can be addressed with $\mu_n \cong \frac{(e_s - e)\hbar}{2m_n} \cong 9.817102 \times 10^{-27}$ J.T^{-1}.
3) Nuclear unit radius can be expressed as, $R_0 \cong \frac{2G_s m_p}{c^2} \cong \left(\frac{e_s}{e}\right)\left\{\frac{\hbar}{m_p c} + \frac{\hbar}{m_n c}\right\}$
4) Root mean square nuclear charge radii can be addressed with
$$R_{(Z,A)} \cong \left\{Z^{1/3} + \left(\sqrt{Z(A-Z)}\right)^{1/3}\right\}\left(\frac{G_s m_p}{c^2}\right)$$
5) Nuclear potential energy can be understood with, $\frac{e^2 G_s m_p^3}{4\pi\varepsilon_0 \hbar^2} \cong \frac{e_s e}{4\pi\varepsilon_0 (\hbar/m_p c)}$
$\cong \frac{e_s^2}{4\pi\varepsilon_0 (G_s m_p/c^2)} \cong 20.1734$ MeV
6) Nuclear binding energy can be understood with, $\frac{e^2 G_s m_p^3}{8\pi\varepsilon_0 \hbar^2} \cong \frac{e_s e}{8\pi\varepsilon_0 (\hbar/m_p c)}$
$\cong \frac{e_s^2}{8\pi\varepsilon_0 (G_s m_p/c^2)} \cong 10.0867$ MeV
7) With reference to $(\hbar/2)$, a useful quantum energy constant can be expressed with, $E_{(\hbar/2)} \cong \left(\frac{e^2 G_s m_p^3}{4\pi\varepsilon_0 (\hbar/2)^2}\right) \cong 80.6934$ MeV
8) Characteristic melting temperature associated with proton can be expressed with, $T_{proton} \cong \frac{\hbar c^3}{8\pi k_B G_s m_p} \cong 0.15 \times 10^{12}$ K

To fit neutron-proton mass difference

Neutron-proton mass difference can be understood with:

$$\left(\frac{m_n c^2 - m_p c^2}{m_e c^2}\right) \cong \ln\sqrt{\frac{E_{(\hbar/2)}}{m_e c^2}} \cong \ln\sqrt{\frac{4e^2 G_s m_p^3}{4\pi\varepsilon_0 \hbar^2 m_e c^2}} \quad (4)$$

To fit neutron life time

Neutron life time t_n can be understood with the following relation:

$$t_n \cong \exp\left(\frac{E_{(\hbar/2)}}{(m_n - m_p)c^2}\right) \times \left(\frac{\hbar}{m_n c^2}\right) \cong 874.8\,\text{ec} \quad (5)$$

This value can be compared with recommended value of (878.5 ± 0.8) sec.

Understanding proton-neutron stability relation

Let, $\left(\frac{m_e c^2}{E_{(\hbar/2)}}\right) \cong \left(\frac{4\pi\varepsilon_0 \hbar^2 m_e c^2}{4e^2 G_s m_p^3}\right) \cong k \cong 0.0063326$ (6)

Stable mass number A_s of Z can be estimated with [2],

$$A_s \cong (N_s + Z) \cong 2Z + kZ^2 \cong 0.0063326(Z)^2 \quad (7)$$

Nuclear binding energy close to stable mass numbers

Under the influence of strong interaction, energy coefficient being 10.09 MeV, ***close to the stable mass numbers of Z***, nuclear binding energy seems to:

1) Increase with increasing number of nucleons.
2) Decrease with increasing radius.
3) Decrease with excess number of neutrons.

Thus,

$$\left.\begin{aligned}(BE)_{A_s} &\approx \left[A_s - A_s^{1/3} - (A_s - 2Z)\right] \times 10.09 \text{ MeV} \\ &\approx \left[2Z - A_s^{1/3}\right] \times 10.09 \text{ MeV}\end{aligned}\right\} \quad (8)$$

With reference to the new integrated model proposed by Ghahramany et al [3,4], binding energy seems to be reduced by a term $\left[(N^2 - Z^2)/3Z\right]$ due to asymmetry and coulomb effects. With reference to the new number $k \cong 0.0063326$, close to stable mass numbers of Z, we noticed that,

$$\left(\frac{N_s^2 - Z^2}{3Z}\right) \cong \frac{kA_s Z}{3} \quad (9)$$

With reference to relations (8) and (9), replacing $(A - 2Z)$ by an expression of the form $\left(kA\sqrt{NZ}/3.4\right)$, close to stable mass numbers of $(Z \geq 24)$,

$$(BE)_A \cong \left[A - A^{1/3} - \frac{kA\sqrt{NZ}}{3.4}\right] \times 10.0 \text{ MeV} \quad (10)$$

Note-1: To fit the data, in place of coefficient 3 of relation (9), we choose a number $\sqrt{\sqrt{(1/k)} - 1} \cong 3.4$.

Note-2: If $(A - 2Z) \to \left(kA\sqrt{NZ}/3.4\right)$, one can find the starting stable A of even Z. For $(Z = 50, A = 112)$, $(A - 2Z) \cong 12$, $\left(kA\sqrt{NZ}/3.4\right) \cong 11.6$

Starting from $Z = 3$, relation (10) can be expressed as,

$$(BE)_A \cong \left[A - A^{1/3} - \frac{kA\sqrt{NZ}}{3.40} - 1\right] \times 10.1 \text{ MeV} \quad (11)$$

See picture 1 for binding energy per nucleon close to stable mass numbers of Z= (3 to 100) estimated with relations (7) and (11). Dashed red curve can be compared with the SEMF green curve. See table-1 for the isotopic binding energy of Z=50.

Figure-1: Binding energy per nucleon close to beta stability line of (Z=3 to 100)

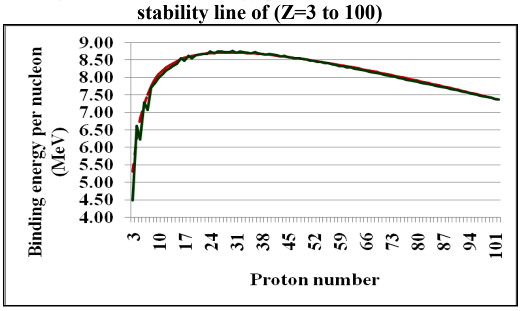

Table-1: Isotopic binding energy of Z=50

Proton number	Mass number	Estimated BE (MeV	Actual BE (MeV)	Error (MeV)
50	112	955.1	953.532	-1.6
50	114	971.0	971.574	0.6
50	115	979.0	979.121	0.2
50	116	986.9	988.684	1.8
50	117	994.8	995.627	0.8
50	118	1002.7	1004.955	2.2
50	119	1010.6	1011.438	0.8
50	120	1018.5	1020.546	2.0
50	122	1034.3	1035.53	1.2
50	124	1050.0	1049.963	-0.1

References

[1] O. F. Akinto, Farida Tahir. (2017) Strong Gravity Approach to QCD and General Relativity. arXiv:1606.06963v3

[2] Seshavatharam U. V. S, Lakshminarayana, S., A new approach to understand nuclear stability and binding energy. Proceedings of the DAE-BRNS Symp. onNucl. Phys. 62, 106-107 (2017)

[3] Ghahramany et al. New scheme of nuclide and nuclear binding energy from quark-like model. IJST (2011) A3: 201-208.

[4] Ghahramany et al. New approach to nuclear binding energy in integrated nuclear model. Physics of Particles and Nuclei Letters, 2011, Vol. 8, No. 2, pp. 97–106.