Fitting Newtonian gravitational constant with microscopic physical constants

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Abstract

- By considering two virtual gravitational constants assumed to be associated with electromagnetic and strong interactions, in a theoretical and verifiable approach, we make an attempt to estimate the Newtonian gravitational constant from microscopic elementary physical constants.
- With respect to weak coupling constant and root mean square radius of proton, estimated value of the Newtonian gravitational constant is 6.67454X10^(-11) m3/kg/sec2 and our estimated value is 6.679856X10^(-11) m3/kg/sec2.

Two new Gravitational constants

- Gravitational constant associated with electron:

$$G_e \cong 2.374335472 \times 10^{37}\ \text{m}^3\text{kg}^{-1}\text{sec}^{-2}$$

- Gravitational constant associated with proton:

$$G_s \cong 3.32956081 \times 10^{28}\ \text{m}^3\text{kg}^{-1}\text{sec}^{-2}$$

Assumption-1

In Hydrogen atom, ground state potential energy of electron can be given by,

$$\left.\begin{array}{l}\left(E_{pot}\right)_{ground} \cong -\left(\dfrac{e^2}{4\pi\varepsilon_0 G_e m_e^2}\right)\left(\dfrac{e^2}{4\pi\varepsilon_0\left(G_s m_p / c^2\right)}\right) \\ \to \text{Bohr radius, } a_0 \cong \left(\dfrac{4\pi\varepsilon_0 G_e m_e^2}{e^2}\right)\left(\dfrac{G_s m_p}{c^2}\right)\end{array}\right\}$$

where, we choose or define,

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

$$\left.\begin{array}{l}\hbar c \cong \sqrt{\left(G_s m_p m_e\right)\left(G_e m_e^2\right)} \\ hc \cong \sqrt{\left(\dfrac{m_p}{m_e}\right)\left(\dfrac{e^2}{4\pi\varepsilon_0}\right)\left(G_s m_p^2\right)}\end{array}\right\}$$

Assumption-2

- With reference to Planck scale,

$$\frac{G_s m_p}{c^2} \cong \left(\frac{m_p}{m_e}\right)^6 \sqrt{\frac{G_N \hbar}{c^3}}$$

Where $\sqrt{\frac{G_N \hbar}{c^3}} = \text{Planck length}$

Application-1

Rest mass of proton:

$$\left.\begin{array}{l}\left(\dfrac{m_p}{m_e}\right) \cong \left(\dfrac{G_s}{G_N^{2/3} G_e^{1/3}}\right)^{\frac{1}{7}} \\[2em] m_p \cong \left(\dfrac{G_N}{G_e}\right)^{\frac{1}{6}} \sqrt{m_e \sqrt{\dfrac{\hbar c}{G_N}}}\end{array}\right\}$$

Applications-2 and 3

➢ **Nuclear charge radius**:

$$R_0 \cong 2\left(\frac{G_s m_p}{c^2}\right) \cong 1.2393 \times 10^{-15}\ \text{m}$$

➢ **Root mean square radius of proton**:

$$R_p \cong \sqrt{2}\left(\frac{G_s m_p}{c^2}\right) \cong 0.87631 \times 10^{-15}\ \text{m}$$

Application-4

- **Characteristic atomic radius of Hydrogen atom (pertaining to covalent bond):**

$$R_{hydrogen} \cong \frac{2\sqrt{(G_s G_e)}\, m_{atom}}{c^2} \cong 33 \text{ picometers}$$

where m_{atom} **is the unified atomic mass,** 1.66054×10^{-27} kg

- **Atom as a '<u>whole</u>' seems to have an effective gravity of** $\sqrt{(G_s G_e)}$

Application-5

Mass and radius of neutron star:

$$\frac{G_N M_{NS} m_n}{\hbar c} \approx \sqrt{\frac{G_s}{G_N}} \rightarrow M_{NS} \approx 3.175 M_{\odot}$$

$$\frac{R_{NS}}{\left(\sqrt{G_s \hbar / c^3}\right)} \approx \sqrt{\frac{G_s}{G_N}} \rightarrow R_{NS} \approx 8.06 \text{ km}$$

Fermi's weak coupling constant and Newtonian gravitational constant

- **One simple relation:**

$$G_F \cong \left[\left(G_e m_p^2\right)^2 \left(G_N m_p^2\right)\right]^{\frac{1}{3}} \left(\frac{2G_s m_p}{c^2}\right)^2$$

$$\rightarrow G_N \cong \frac{G_F^3 c^{12}}{64 G_e^2 G_s^6 m_p^{12}}$$

$$\cong 6.619384 \times 10^{-11}\ \mathrm{m^3 kg^{-1} sec^{-2}}$$

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Newtonian gravitational constant

Our fitting relation :

$$G_N \cong \left(\frac{m_e}{m_p}\right)^9 \left(\frac{G_s}{G_e}\right)\left(\frac{\hbar c}{m_p^2}\right)$$

$$\cong 6.679856 \times 10^{-11}\ \mathrm{m^3kg^{-1}sec^{-2}}$$

Fermi's weak coupling constant and electron rest mass

- **Our fit for Fermi's weak coupling constant**:

$$G_F \cong \frac{4\hbar G_s^2 m_e^2}{c^3} \cong 1.44021 \times 10^{-62} \ \mathrm{J.m^3}$$

- **Electron rest mass can be fitted with:**

$$m_e c^2 \cong \sqrt{\frac{G_F c^7}{4\hbar G_s^2}} \cong \frac{1}{2}\left(\frac{c^4}{G_s}\right)\sqrt{\frac{G_F}{\hbar c}}$$

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Nuclear Planck mass and radius

- **Nuclear Planck mass**:

$$m_{npl} \cong \sqrt{\frac{\hbar c}{G_s}} \cong 546.62\ \mathrm{MeV}/c^2$$

- **Nuclear Planck radius**:

$$R_{npl} \cong \frac{2G_s m_{npl}}{c^2} \cong 2\sqrt{\frac{G_s \hbar}{c^3}} \cong 0.722\ \mathrm{fm}$$

$$\rightarrow m_e c^2 \cong \frac{1}{R_{npl}} \sqrt{G_F \left(\frac{c^4}{G_s}\right)}$$

Proton melting point

- **With reference to Hawking's formula**:

$$T_{proton} \cong \frac{\hbar c^3}{8\pi k_B G_s m_p} \cong 0.15\times10^{12}\ \mathrm{K}$$

- **Melting point of quarks:**

$$T_{quark} \cong \left(\frac{m_q}{m_{up}}\right)\frac{\hbar c^3}{8\pi k_B G_s m_{up}}$$

Neutron life time-an approximation

- An approximation:

$$t_n \cong \sqrt{\frac{G_e}{G_N}}\left(\frac{G_s m_n^2}{\left(m_n - m_p\right)c^3}\right)$$

$$\cong \sqrt{\frac{G_s}{G_N}}\left(\frac{\sqrt{G_e G_s}\, m_n^2}{\left(m_n - m_p\right)c^3}\right) \cong 896.8 \text{ sec}$$

Neutron life time - a fit

With accuracy :

$$t_n \cong \sqrt{\frac{G_s}{G_N}} \left(\frac{\sqrt{G_e G_s}\, m_{atom}^2}{\left(m_n - m_p\right) c^3} \right) \cong 881.5 \text{ sec}$$

Avogadro number

- Approximately:

$$\sqrt{\frac{G_e}{G_N}} \cong 5.9645176 \times 10^{23}$$

$$\approx \text{Avogadro number, } N_A$$

Proton-Neutron stability

- Let:

$$s \cong \left(\frac{G_s m_p m_e}{\hbar c}\right) \cong \left(\frac{\hbar c}{G_e m_e^2}\right) \cong 1.604637101 \times 10^{-3}$$

$$A_s \cong 2Z + s(2Z)^2 \cong 2Z + (4s)Z^2$$

$$\cong 2Z + 0.00641855Z^2$$

where we define

$$(4s) = k \cong 0.00641855$$

Nuclear binding energy potential-1

- Close to beta stability line:

$$B_0 \cong \left(\frac{1}{\alpha_s}\right)\left(\frac{e^2}{4\pi\varepsilon_0 R_0}\right)$$

$$\cong \left(\frac{1}{\alpha_s}\right)\left(\frac{e^2 c^2}{8\pi\varepsilon_0 G_s m_p}\right) \cong 10.09 \text{ MeV}$$

where α_s is the strong coupling constant

Nuclear binding energy factor

Close to beta stability line:

$$\left[\frac{N_s^2 - Z^2}{3Z}\right] \cong \frac{kZA_s}{3}$$

$$\text{where,} \ \left(A_s - Z\right) \cong N_s$$

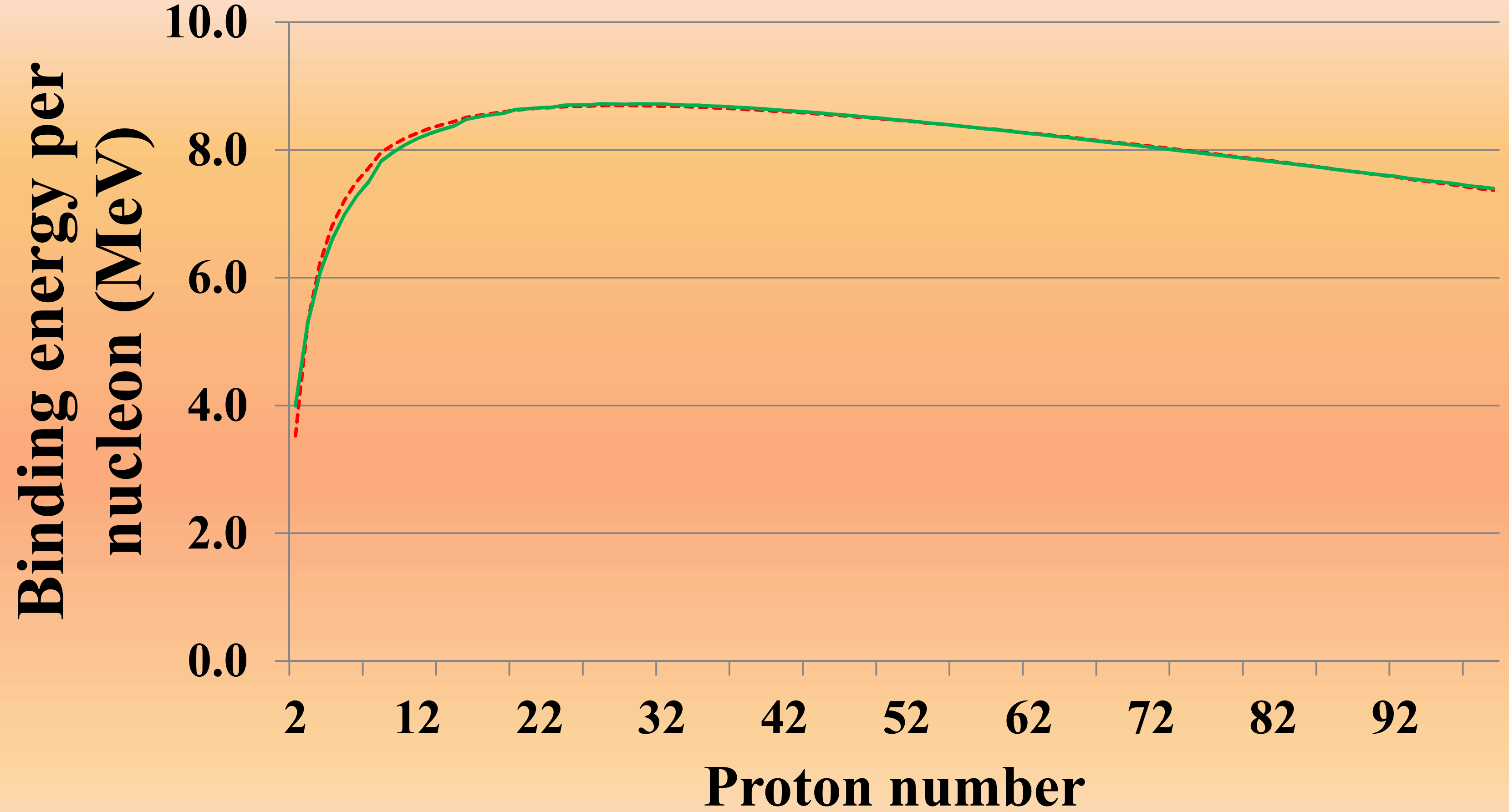
Reference: N.Ghahramany et al. New approach to nuclear binding energy in integrated nuclear model. Journal of Theoretical and Applied Physics 6:3 (2012).

Nuclear binding energy

- Close to beta stability line:

$$\left(B\right)_{A_s} \cong \left[A_s - A_s^{1/3} - \frac{kA_s\sqrt{N_s Z}}{3.40} - 1 \right] \times 10.09 \text{ MeV}$$

Comparison with first 4 terms of SEMF



Strong nuclear charge

- New elementary charge associated with nucleus can be expressed as:

$$e_s \cong \left(\frac{G_s m_p^2}{\hbar c} \right) e \cong 2.9464e$$

$$\cong 4.72 \times 10^{-19}\ \text{C}$$

Strong coupling constant

- With reference to strong nuclear charge,

$$\alpha_s \cong \left(\frac{e}{e_s}\right)^2 \cong \left(\frac{\hbar c}{G_s m_p^2}\right)^2$$

$$\cong 0.1152$$

Magnetic dipole moment of nucleons

- With reference to strong nuclear charge,

$$\mu_p \cong \frac{e_s \hbar}{2m_p} \cong 1.48 \times 10^{-26} \text{ J/tesla}$$

$$\mu_n \cong \frac{(e_s - e)\hbar}{2m_n} \cong 9.817 \times 10^{-27} \text{ J/tesla}$$

Nuclear binding energy potential-2

With reference to strong nuclear charge,

$$B_0 \cong \left(\frac{1}{\alpha_s}\right)\left(\frac{e^2}{4\pi\varepsilon_0 R_0}\right) \cong \left(\frac{e_s^2}{4\pi\varepsilon_0 R_0}\right)$$

$$\cong \left(\frac{e_s^2 c^2}{8\pi\varepsilon_0 G_s m_p}\right) \cong 10.09 \text{ MeV}$$

To proceed further…

For detailed information, interested scholars may go through our preprint: To Develop a Virtual Model of Microscopic Quantum Gravity. *Preprints* 2017,2017110119, 23 pages.

To conclude…

- It is inevitable to unite gravity and other three atomic interactions.
- If one is willing to explore the possibility of incorporating the proposed assumptions either in String theory models or in Quantum gravity models, certainly, background physics assumed to be connected with proposed semi empirical relations can be understood and in near future, a 'workable' or 'practical' model of "everything" can be developed.
- Fermi's weak coupling constant and the three gravitational constants can be fitted in a unified approach and finally, in a verifiable approach, Newtonian gravitational constant can be estimated accurately with microscopic physical constants.

Thank You

for your kind attention