Understanding the basics of nuclear physics and quantum physics with final unification

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Assumptions

1) Magnitude of the gravitational constant associated with electron is, $G_e \approx 2.375 \times 10^{37}\ \text{m}^3\text{kg}^{-1}\text{sec}^{-2}$.

2) Magnitude of the gravitational constant associated with proton is, $G_s \approx 3.328 \times 10^{28}\ \text{m}^3\text{kg}^{-1}\text{sec}^{-2}$.

3) In nuclear and sub nuclear physics, there exists a hidden elementary charge, $e_s \approx 4.72 \times 10^{-19}$ C

Note: It may be noted that, with reference to the operating force magnitudes, protons and electrons cannot be considered as 'black holes'. But electrons and protons can be assumed to follow the relations that black holes generally believed to follow. Clearly speaking, in the study of black holes, Newtonian gravitational constant G_N plays a major role, whereas in the study of elementary particles, G_s and G_e play the key role.

Applications

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Sub-nuclear physics (Elementary particle melting points, Quark masses, Charged lepton masses etc.)
Nuclear physics (Proton Size, Nuclear size, Nuclear binding energy, Proton-electron mass ratio, magnetic moments of proton & neutron)
Atomic and Quantum physics (Bohr radius and Quantum of angular momentum)
Astrophysics (Newtonian Gravitational constant, neutron star mass and radius, New 3.5 keV photons)

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Proton-electron mass ratio $\left(\frac{m_p}{m_e}\right) \cong \left(\frac{G_s m_p^2}{\hbar c}\right)\left(\frac{G_e m_e^2}{\hbar c}\right)$	**Proton-electron mass ratio** $\left(\frac{m_p}{m_e}\right) \cong \left(\frac{G_N}{G_e}\right)^{\frac{1}{3}}\left(\frac{M_{pl}}{m_p}\right)$ where, $M_{pl} \cong \sqrt{\hbar c/G_N} \cong$ Planck mass
Nuclear charge radius $R_0 \cong \frac{2G_s m_p}{c^2}$	**Newtonian gravitational constant** $G_N \cong \left(\frac{\hbar^3 c^3 m_e^6}{G_e^2 m_p^{12}}\right) \cong \left(\frac{G_s m_p^2}{\hbar c}\right)\left(\frac{m_e}{m_p}\right)^{12} G_s$
Root mean square radius of proton $R_p \cong \frac{\sqrt{2} G_s m_p}{c^2}$	**Gravitational constant associated with Electron** $G_e \cong \frac{\hbar^2 c^2}{G_s m_p m_e^3} \cong \left(\frac{\hbar c}{G_s m_p m_e}\right)\left(\frac{\hbar c}{m_e^2}\right)$
Bohr radius of electron in hydrogen atom $a_0 \cong \left(\frac{4\pi\varepsilon_0 G_e m_e^2}{e^2}\right)\left(\frac{G_s m_p}{c^2}\right)$	**Strong coupling constant** $\alpha_s \cong \left(\frac{e_e}{e_s}\right)^2 \cong \left(\frac{\hbar c}{G_s m_p^2}\right)^2 \cong \left\{\left(\frac{m_e}{m_p}\right)^{24}\left(\frac{G_s}{G_N}\right)^2\right\}$

Newtonian gravitational constant can be expressed in the following way.

$$G_N \cong \left(\frac{m_e}{m_p}\right)^{12}\left(\frac{c^3 R_p^2}{2\hbar}\right) \cong 8.698623312 \times 10^{19} R_p^2$$

where R_p is the root mean square radius of proton. In this proposed method, a change in 18th decimal place of the root mean square radius of proton seems to change the 14th decimal place of the Newtonian gravitational constant. Interesting observation is that,

$$\sqrt{\frac{G_e}{G_N}} \approx 5.96 \times 10^{23} \approx \text{Avogadro number}$$

Proton-electron mass ratio

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

Square root of force ratio

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

Fine structure constant

$$\alpha \cong \left(\frac{e_e e_s}{4\pi\varepsilon_0 G_s m_p^2}\right)$$

Magnetic moment of proton

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

Magnetic moment of neutron

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

Specific charge ratio of proton-electron

$$\left(\frac{e_s}{m_p}\right) \Big/ \left(\frac{e_e}{m_e}\right) \cong \left(\frac{G_s m_p m_e}{\hbar c}\right) \cong \left(\frac{\hbar c}{G_e m_e^2}\right)$$

Reduced Planck's constant

$$\hbar \cong \left(\frac{e_e}{e_s}\right)\left(\frac{G_s m_p^2}{c}\right) \cong \sqrt{\frac{m_e}{m_p}}\sqrt{\left(\frac{G_s m_p^2}{c}\right)\left(\frac{G_e m_e^2}{c}\right)}$$

Fermi's weak coupling constant

$$F_W \cong \left[\frac{m_e^2}{m_p^2}\right]\left(\hbar c R_0^2\right) \cong \left(\frac{e_e}{e_s}\right)\frac{\left(G_s m_e^2\right)\left(G_s m_e^2\right)}{\left(c^4/4G_s\right)}$$

Proton's characteristic nuclear potential

$$E_{proton} \cong -\frac{e_s^2}{4\pi\varepsilon_0\left(G_s m_p/c^2\right)} \approx -20.0 \text{ MeV}$$

Nuclear binding energy at stability zone of $Z \geq 30$)

$$B \approx -\frac{(Z-1)e_s^2}{4\pi\varepsilon_0\left(G_s m_p/c^2\right)} \approx -(Z-1)\times 20.0 \text{ MeV}$$

where, Stable mass number,

$$A_s \cong 2Z + \left\{\left(\frac{e_s}{m_p}\right)\Big/\left(\frac{e_e}{m_e}\right)\right\}(2Z)^2 \approx Z(2+0.00642Z)$$

Nuclear binding energy at stability zone of $Z \approx (3 \text{ to } 29)$

$$B \approx -\left(\frac{Z-1}{30}\right)^{\frac{1}{12}}(Z-1)\times 20.0 \text{ MeV}$$

where, Stable mass number,

$$A_s \cong 2Z + \left\{\left(\frac{e_s}{m_p}\right)\Big/\left(\frac{e_e}{m_e}\right)\right\}(2Z)^2 \approx Z(2+0.00642Z)$$

Experimentally observed Muon and Tau rest masses can be fitted with the following way.
For $n=1$, obtained $m_\mu c^2 \approx 106$ MeV and $n=2$, obtained $m_\tau c^2 \approx 1770$ MeV

$$m_{(\mu,\tau)}c^2 \cong \left[\gamma^3 + \left(n^2\gamma\right)^n \sqrt[4]{\frac{G_e}{G_N}}\right]^{\frac{1}{3}} 1.75 \text{ keV}$$

where, $\gamma \approx \sqrt{\frac{4\pi\varepsilon_0 G_e m_e^2}{e^2}} \approx 292.3$ and $n = 1$ and 2.

<u>Sub-Nuclear physics</u>: Proton melting temperature

$$T_p \cong \frac{\hbar c^3}{8\pi k_B G_s m_p} \approx 0.147 \text{ Trillion K}$$

Electron melting temperature

$$T_e \cong \frac{\hbar c^3}{8\pi k_B G_e m_e} \approx 5670 \text{ Trillion K}$$

As electron is a weakly interacting particle, its melting temperature seems to be 38580 times higher than melting temperature of proton.

Melting temperature of up quark

$$T_{up} \cong \frac{\hbar c^3}{8\pi k_B G_s m_{up}} \approx 64 \text{ Trillion K}$$

Melting temperature of down quark

$$T_{down} \cong \frac{\hbar c^3}{8\pi k_B G_s m_{down}} \approx 29 \text{ Trillion K}$$

Melting temperature of strange quark

$$T_{strange} \cong \frac{\hbar c^3}{8\pi k_B G_s m_{strange}} \approx 1.47 \text{ Trillion K}$$

Melting temperature of charm quark

$$T_{charm} \cong \frac{\hbar c^3}{8\pi k_B G_s m_{charm}} \approx 0.11 \text{ Trillion K}$$

Melting temperature of bottom quark

$$T_{bottom} \cong \frac{\hbar c^3}{8\pi k_B G_s m_{bottom}} \approx 0.33 \text{ Trillion K}$$

Melting temperature of top quark

$$T_{top} \cong \frac{\hbar c^3}{8\pi k_B G_s m_{top}} \approx 0.8 \text{ Billion K}$$

<u>Astrophysics</u>: To fit and understand the mass limit and radius of neutron star

If (M_n, m_n) represent the mass limit of neutron star and neutron mass respectively, it is noticed that,

$$\left(\frac{G_N M_n m_n}{\hbar c}\right) \cong \sqrt{\frac{G_s}{G_N}}$$
$$\Rightarrow M_n \cong \left(\frac{G_s}{G_N}\right)^{1/2}\left(\frac{\hbar c}{G_N m_n}\right) \cong 6.32\times10^{30} \text{ kg}$$

$$\frac{M_n}{m_n} \cong \left(\frac{e_e}{e_s}\right)\left(\frac{G_s}{G_N}\right)^{3/2} \cong 3.18 M_\odot$$

Neutron star radius R_n can be fitted with the following expression.

$$R_n \approx \sqrt{\frac{G_s}{G_N}}\left(\frac{G_s m_p}{c^2}\right) \approx 13.5 \text{ km}$$

It may be noted that, mass distribution point of view, white dwarf stars' characteristic mass is peaked at , $(M_{wd})_{peak} \approx (0.6)\mathrm{M}_\odot$. Based on this observation, it is noticed that,

$$\frac{M_n}{(M_{wd})_{peak}} \cong \frac{e_e^2}{4\pi\varepsilon_0 G_s m_p m_e} \cong 4.54$$

With reference to the Chandrasekhar mass limit, $M_C \approx (1.4 \text{ to } 1.5)\mathrm{M}_\odot$, it is noticed that,

$$\frac{M_n}{M_C} \cong \left(\frac{e_e^2}{4\pi\varepsilon_0 G_s m_p m_e}\right)^{\frac{1}{2}} \cong 2.13$$

Thus, the characteristic white dwarf peak mass limit, Chandrasekhar mass limit and neutron star mass limit can be inter-related in the following way.

$$M_C \cong \sqrt{M_n (M_{wd})_{peak}}$$

Important points:

1) If it is true that c and G_N are fundamental physical constants, then $\left(c^4/G_N\right)$ can be considered as a fundamental compound constant related to a characteristic limiting force.
2) Black holes are the ultimate state of matter's geometric structure.
3) Magnitude of the operating force at the black hole surface is the order of $\left(c^4/G_N\right)$.
4) Gravitational interaction taking place at black holes can be called as 'Schwarzschild interaction'.
5) Strength of '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 $\left(c^4/G_N\right)$.
7) If one is willing to represent the magnitude of the operating force as a fraction of $\left(c^4/G_N\right)$ i.e. X times of $\left(c^4/G_N\right)$, where $X \ll 1$, then

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

If X is very small, $\frac{1}{X}$ becomes very large. In this way, X can be called as the strength of interaction. Clearly speaking, strength of any interaction is $\frac{1}{X}$ times less than the 'Schwarzschild interaction' and effective G becomes $\frac{G}{X}$.

8) With reference to Schwarzschild interaction, for electromagnetic interaction, $X \approx 2.811\times10^{-48}$ and for strong interaction, $X \cong 2.0\times10^{-39}$.
9) Characteristic operating force corresponding to electromagnetic interaction is $\left(c^4/G_e\right) \approx 3.4\times10^{-4}$ N and characteristic operating force corresponding to strong interaction is $\left(c^4/G_s\right) \approx 242600$ N.
10) Characteristic operating power corresponding to electromagnetic interaction is $\left(c^5/G_e\right) \approx 10990$ J/sec and characteristic operating power corresponding to strong interaction is $\left(c^5/G_s\right) \approx 7.27\times10^{13}$ J/sec
11) Based on these concepts, it is possible to assume that,

$$\hbar c \cong \frac{\left(m_e c^2\right)^{\frac{3}{2}}\left(m_p c^2\right)^{\frac{1}{2}}}{\sqrt{\left(c^4/G_e\right)\left(c^4/G_s\right)}} \qquad \hbar \cong \frac{\left(m_e c^2\right)^{\frac{3}{2}}\left(m_p c^2\right)^{\frac{1}{2}}}{\sqrt{\left(c^5/G_e\right)\left(c^5/G_s\right)}}$$

12) As $\left[\left(c^4/G_e\right),\left(c^4/G_s\right)\right] \ll \left(c^4/G_N\right)$ and $\left[\left(c^5/G_e\right),\left(c^5/G_s\right)\right] \ll \left(c^5/G_N\right)$, protons and electrons can not be considered as 'black holes', but may be assumed to follow similar relations that black holes generally believed to follow.

Summary

According to Roberto Onofrio, weak interactions are peculiar manifestations of quantum gravity at the Fermi scale, and that the Fermi coupling constant is related to the Newtonian constant of gravitation. In his opinion, at atto-meter scale, Newtonian gravitational constant seems to reach a magnitude of $8.205\times10^{22}\text{m}^3\text{kg}^{-1}\text{sec}^{-2}$.In this context, one can see plenty of papers on 'strong gravity' in physics literature. It may be noted that, till date, 'strong gravity' is a non-mainstream theoretical approach to Color confinement/particle confinement having both a cosmological scale and a particle scale gravity. In between ~(1960 to 2000), it was taken up as an alternative to the then young QCD theory by several theorists, including Abdus Salam. Very interesting point to be noted is that, Abdus Salam showed that the 'particle level gravity approach' can produce confinement and asymptotic freedom while not requiring a force behavior differing from an inverse-square law, as does QCD.

Qualitatively and quantitatively, references strongly suggest the possible existence of 'Newtonian (like) gravitational constant with very large magnitude' in nuclear and particle physics. Based on this concept and in pursuit of bridging the gap in between 'General theory of relativity' and 'Quantum field theory', in the recent publications, the authors suggested the existence of two pseudo gravitational constants associated with strong and electromagnetic interactions. It may be noted that, even though 'String theory' and 'Quantum gravity' models are having a strong mathematical back ground and sound physical basis, both the models are failing in developing a 'workable' model of final unification. By considering the proposed concepts and relations, the authors would like to highlight the following points.

A) With further research, in near future, absolute value of the Newtonian gravitational constant can be estimated with atomic and nuclear physical constants.

B) The proposed two assumptions can be given some priority at fundamental level and with further research, their state of 'physical existence' (whether pseudo or real) can be assessed.

C) If one is willing to explore the possibility of incorporating the proposed assumptions either in 'String theory' models or in 'Quantum gravity' models or 'Strong gravity' models, certainly, back ground physics assumed to be connected with proposed semi empirical relations, can be understood and a 'practical' model of "everything" can be developed.

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