Logic Behind the Squared Avogadro Number

U. V. S. Seshavatharam[1] and S. Lakshminarayana[2]

[1]Honorary faculty, I-SERVE, Alakapuri, Hyderabad-35, AP, India. Email: seshavatharam.uvs@gmail.com
[2]Dept. of Nuclear Physics, Andhra University, Visakhapatnam-03, AP, India. Email:lnsrirama@yahoo.com

Abstract: The definition of Avogadro number (N) and the current experiments to estimate it, however, both rely on the precise definition of "one gram". Hence most of the scientists consider it as an ad-hoc number. But in reality it is not the case. In atomic and nuclear physics, atomic gravitational constant (G_A) is squared Avogadro number times the Newton's gravitational constant and is discrete as $(n.G_A)$ where n =1,2,3. Key conceptual link that connects the gravitational force and non-gravitational forces is - the classical force limit, $F_C \cong \left(c^4/G\right)$. Ratio of classical force limit and weak force magnitude is $\left(F_C/F_W\right) \cong N^2$. Thus in this paper authors proposed unified methods for estimating the Avogadro number.

Keywords: Avogadro number; Gravitational constant; classical force limit; weak force magnitude; weak coupling angle; proton rest mass; proton rms radius; nuclear binding energy constants; nucleon magnetic moments; strong coupling constant;

1 Introduction

Considering strong gravity, Erasmo Recami says [1]: *A consequence of what stated above is that inside a hadron (i.e., when we want to describe strong interactions among hadron constituents) it must be possible to adopt the same Einstein equations which are used for the description of gravitational interactions inside our cosmos; with the only warning of scaling them down, that is, of suitably scaling, together with space distances and time durations, also the gravitational constant G (or the masses) and the cosmological constant Λ.*

In 3+1 dimensions, experiments and observations reveals that, if strength of strong interaction is unity, with reference to the strong interaction, strength of gravitation is 10^{-39}. If this is true, any model or theory must explain this astounding fact. At least in 10 dimensions also, till today no model including String theory [2-4] or Super gravity [5,6] has succeeded in explaining this fact. Note that in the atomic or nuclear physics, till today no experiment reported or estimated the value of the gravitational constant. Note that G is quite difficult to measure, as gravity is much weaker than the other fundamental forces, and an experimental apparatus cannot be separated from the gravitational influence of other bodies. Furthermore, till today gravity has no established relation to other fundamental forces, so it does not appear possible to calculate it indirectly from other constants that can be measured more accurately, as is done in other areas of physics. It is sure that something is missing in the current understanding of unification. This clearly indicates the need of revision of our existing physics foundations. In this sensitive and critical situation, considering Avogadro number as an absolute proportionality ratio in 3+1 dimensions, in this paper an attempt is made to understand the basics of gravitational and non-gravitational interactions in a unified manner [7-12],[13-19].

2 About the Avogadro number

Avogadro's number, N is the fundamental physical constant that links the macroscopic physical world of objects that we can see and feel with the submicroscopic, invisible world of atoms. In theory, N specifies the exact number of atoms in a palm-sized specimen of a physical element such as carbon or silicon. The name honors the famous Italian mathematical physicist Amedeo Avogadro (1776-1856), who proposed that equal volumes of all gases at the same temperature and pressure contain the same number of molecules [20]. Long after Avogadro's death, the concept of the mole was introduced, and it was experimentally observed that one mole (the molecular weight in grams) of any substance contains the same number of molecules[21-24].

Today, Avogadro's number is formally defined to be the number of carbon-12 atoms in 12 grams of unbound carbon-12 in its rest-energy electronic state. The current state of the art estimates the value of N, not based on experiments using carbon-12, but by using X-ray diffraction in crystal silicon lattices in the shape of a sphere or by a watt-balance method. According to the National Institute of Standards and Technology (NIST), the current accepted value for $N \cong (6.0221415 \pm 0.0000010) \times 10^{23}$. The CODATA recommended value is $N \cong 6.02214179(30) \times 10^{23}$. This definition of N and the current experiments to estimate it, however, both rely on the precise definition of "one gram"! Hence most of the scientists consider it as an ad-hoc number. But in reality it is not the case. Please see the following sections.

2.1 The Boltzmann constant: Bridge from macroscopic to microscopic physics

In statistical mechanics that makes theoretical predictions about the behavior of macroscopic systems on the basis of statistical laws governing its component particles, the relation of energy and absolute temperature T is usually given by the inverse thermal energy $\frac{1}{k_B T}$. The constant k_B, called the Boltzmann constant is equal [25] to the ratio of the molar gas constant R_U and the Avogadro number N.

$$k_B = \frac{R_U}{N} \cong 1.38065(4) \times 10^{-23} \text{ J/}^0\text{K} \quad (1)$$

where $R_U \cong 8.314504(70)$ J/mol.^{0}K and N is the Avogadro number. k_B has the same units as entropy. k_B plays a crucial role in this equality. It defines, in particular, the relation between absolute temperature and the kinetic energy of molecules of an ideal gas. The product $k_B T$ is used in physics as a scaling factor for energy values in molecular scale (sometimes it is used as a pseudo-unit of energy), as many processes and phenomena depends not on the energy alone, but on the ratio of energy and $k_B T$. Given a thermodynamic system at an absolute temperature T, the thermal energy carried by each microscopic "degree of freedom" in the system is of the order of $(k_B T/2)$.

As Planck wrote in his Nobel Prize lecture in 1920, [26]: *This constant is often referred to as Boltzmann's constant, although, to my knowledge, Boltzmann himself never introduced it - a peculiar state of affairs, which can be explained by the fact that Boltzmann, as appears from his occasional utterances, never gave thought to the possibility of carrying out an exact measurement of the constant.* The Planck's quantum theory of light, thermodynamics of stars, black holes and cosmology totally depend upon the famous Boltzmann constant which in turn depends on the Avogadro number. From this it can be suggested that, Avogadro number is more fundamental and characteristic than the Boltzmann constant and indirectly plays a crucial role in the formulation of the quantum theory of radiation.

2.2. Current status of the Avogadro number

The situation is very strange and sensitive. Now this is the time to think about the significance of 'Avogadro number' in a unified approach. It couples the gravitational and non-gravitational interactions. It is observed that, either in SI system of units or in CGS system of units, value of the order of magnitude of Avogadro number $\cong N \approx 6 \times 10^{23}$ but not 6×10^{26}. But the most surprising thing is that, without implementing the gravitational constant in atomic or nuclear physics this fact cannot understood. It is also true that till today no unified model successfully implemented the gravitational constant in the atomic or nuclear physics. Really this is a challenge to the modern nuclear physics and astrophysics.

3 Four assumptions in unification

Assumption-1: In atomic and nuclear physics [27-33], atomic gravitational constant (G_A) is squared Avogadro number times the classical gravitational constant (G_C).

$$G_A \cong N^2 G_C \quad (2)$$

and it is discrete as $(n.G_A)$ where n =1,2,3…

Assumption-2: The key conceptual link that connects the gravitational and non-gravitational forces is - the classical force limit

$$F_C \cong \left(\frac{c^4}{G_C}\right) \cong 1.21026 \times 10^{44} \text{ newton} \quad (3)$$

It can be considered as the upper limit of the string tension. In its inverse form it appears in Einstein's theory of gravitation [1] as $\frac{8\pi G_C}{c^4}$. It has multiple applications in Black hole physics and Planck scale physics [34,35]. It has to be estimated either from the experiments or from the cosmic and astronomical observations.

Assumption-3: Ratio of 'classical force limit (F_C)' and ' weak force magnitude (F_W)' is N^2 where N is a large number close to the Avogadro number.

$$\frac{F_C}{F_W} \cong N^2 \cong \frac{\text{Upper limit of classical force}}{\text{Nuclear weak force magnitude}} \quad (4)$$

Assumption-4: Ratio of fermion and its corresponding boson mass is not unity but a value close to $\Psi \approx 2.2627$. This idea can be applied to quarks, leptons, proton and the Higgs fermion. One can see "super symmetry" in low energies as well as high energies. This is a fact and cannot be ignored. Authors explained these facts in detail [27,28]. For the time being its value can be fitted with the relation, $\Psi^2 \ln\left(1+\sin^2\theta_W\right) \cong 1$ where $\sin\theta_W$ can be considered as the weak coupling angle. Please see application-3.

Application-1: To fit the rest mass of proton or the gravitational constant or the Avogadro number

Semi empirically it is also noticed that

$$\ln\sqrt{\frac{e^2}{4\pi\epsilon_0 G_C m_p^2}} \cong \sqrt{\frac{m_p}{m_e} - \ln\left(N^2\right)} \quad (5)$$

where m_p is the proton rest mass and m_e is the electron rest mass. Here, LHS $\cong 41.55229152$ and RHS $\cong 41.55289244$.

$$\ln\sqrt{\frac{e^2}{4\pi\epsilon_0 G m_p^2}} - \sqrt{\frac{m_p}{m_e} - \ln\left(N^2\right)} \cong 0 \quad (6)$$

Considering this as a characteristic relation, and by considering the electron rest mass as a fundamental input, proton rest mass and proton-electron mass ratio can be estimated simultaneously in the following way.

$$e^{\sqrt{\frac{m_p}{m_e} - \ln\left(N^2\right)}} \cdot m_p \cong \sqrt{\frac{e^2}{4\pi\varepsilon_0 G_C}} \quad (7)$$

Interesting thing is that, this relation is free from $(\hbar)$. Gravitational constant can be expressed as

$$G_C \cong \left(e^{\sqrt{\frac{m_p}{m_e} - \ln\left(N^2\right)}}\right)^{-2} \cdot \frac{e^2}{4\pi\epsilon_0 m_p^2} \quad (8)$$

$\cong 6.666270179 \times 10^{-11}$ $\text{m}^3\text{Kg}^{-1}\text{sec}^{-2}$.

Recommended value [24] of G = $6.6742867 \times 10^{-11}$. $\text{m}^3\text{Kg}^{-1}\text{sec}^{-2}$. Fitting the gravitational constant with the atomic and nuclear physical constants is a challenging task. Avogadro number can be expressed as

$$N \cong \sqrt{exp\left[\frac{m_p}{m_e} - \left(\ln\sqrt{\frac{e^2}{4\pi\epsilon_0 G_C m_p^2}}\right)^2\right]} \quad (9)$$

$\cong 6.174407621 \times 10^{23}$.

Application-2: To fit the gram mole and the unified atomic mass unit

Unified atomic mass-energy unit $m_u c^2$ can be expressed as [24]

$$m_u c^2 \cong \left(\frac{m_p c^2 + m_n c^2}{2} - B_A\right) + m_e c^2 \quad (10)$$

where B_A is the mean binding energy per nucleon. Accuracy depends on $B_A \approx 8.0$ MeV. The characteristic relation that connects gram mole and the unified atomic mass unit can be expressed in the following way.

$$G_A m_u^2 \cong G_C M_x^2. \quad (11)$$

where $M_x \cong 0.001$ kg $\cong 1$ gram and is the 'gram mole'. Thus 'gram mole' [22] can be expressed as

$$M_x \cong \sqrt{\frac{G_A}{G_C}}. m_u \cong N.m_u \quad (12)$$

Application–3: The weak mixing angle and its applications

The weak mixing angle can be expressed as

$$\sin\theta_W \cong \left(\frac{\hbar}{m_e c}\right) \div \sqrt{\frac{e^2}{4\pi\epsilon_0 F_W}} \cong 0.464433353 \quad (13)$$

Here $\left(\hbar/m_e c\right)$ is the Compton wave length of electron and $\sqrt{\frac{e^2}{4\pi\varepsilon_0 F_W}}$ seems to be a characteristic length of weak interaction. Considering this F_W, Higgs fermion and boson masses can be fitted.

Application-4 Scattering distance between electron and the nucleus

If $R_0 \cong 1.21$ to 1.22 fm is the scattering distance between electron and nucleus [36,37] it is noticed that,

$$R_0 \cong \left(\frac{\hbar c}{G_A m_e^2}\right)^2 \cdot \frac{2G_A m_e}{c^2} \cong 1.21565 \text{ fm} \quad (14)$$

$$N \cong \sqrt{\frac{2\hbar^2}{G_C m_e^3 R_0}} \quad (15)$$

$$G_C \cong \frac{2\hbar^2}{N^2 m_e{}^3 R_0} \quad (16)$$

Application-5: Higgs fermion and the Z boson

Let M_{hf} be the ferminoic form of the charged Higgs fermion [27,28].

$$\frac{M_{hf}}{m_e} \cong \frac{m_e c^2}{F_W R_0} \quad (17)$$

From relation (14)

$$M_{hf}c^2 \cong \left(\frac{m_e c^2}{F_W R_0}\right) m_e c^2$$

$$\cong \frac{1}{2}\left(\frac{G_A m_e^2}{\hbar c}\right)^2 m_e c^2 \cong 103125.64 \text{ MeV} \quad (18)$$

Based on the proposed SUSY fermion boson mass ratio, its corresponding charged Higgs boson is

$$M_{hb}c^2 \cong \frac{M_{hf}c^2}{\Psi} \cong 45576.36 \text{ MeV} \quad (19)$$

The neutral (Z) boson rest energy can be expressed as

$$\left(M_Z c^2\right)^0 \cong \left(M_{hb}c^2\right)^+ + \left(M_{hb}c^2\right)^- \cong 2M_{hb}c^2 \quad (20)$$
$$\cong 91152.73 \text{ MeV}$$

This can be compared with the PDG recommended value [38]. Based on 'integral charge quark SUSY' [27,28] authors suggested that W boson may be considered as the SUSY boson of the top quark. Close to the predicted rest energy of Higgs boson, recently a new boson of rest energy 124 to 160 GeV was reported [38]. It can be suggested that, proposed charged Higgs boson and the charged W boson joins together to form a neutral boson of rest energy 126 GeV.

$$\left(M_{Hb}c^2\right)^{\pm} + \left(m_W c^2\right)^{\mp} \cong 126.0 \text{ GeV}. \quad (21)$$

W boson pair generates a neutral boson of rest energy 161 GeV. This is an accurate and interesting fit and can be a given chance in understanding the electroweak physics.

Application-6 To fit the rms radius of proton

Let R_p be the 'rms' radius of proton. It is noticed that,

$$R_p \propto \left(\frac{4\pi\epsilon_0 G m_p^2}{e^2}\right)^{\frac{1}{4}} \quad (22)$$

$$R_p \propto \frac{2G_A m_p}{c^2} \quad (23)$$

$$R_p \cong \left(\frac{4\pi\epsilon_0 G_C m_p^2}{e^2}\right)^{\frac{1}{4}} \cdot \frac{2G_A m_p}{c^2} \cong 0.854531 \text{ fm}. \quad (24)$$

This can be compared with the 2010 CODATA recommended rms radius of proton $0.8775(51)$ fm. Recent work on the spectrum of muonic hydrogen indicates a significantly lower value for the proton charge radius, $R_p \cong 0.84184(67)$ fm and the reason for this discrepancy is not clear [39-40]. Geometric mean of these two radii is 0.859513 fm and is very close to the proposed value.

Application-7: To fit the rest masses of muon and tau

Muon and tau rest masses can be fitted in the following way [24,38]. Considering the ratio of the volumes $\frac{4\pi}{3}R_0^3$ and $\frac{4\pi}{3}\left(\frac{2G_C m_e}{c^2}\right)^3$, let

$$\ln\left(\frac{R_0 c^2}{2G_C m_e}\right)^3 \cong \gamma \cong 289.805 \quad (25)$$

Now muon and tau masses can be fitted with the following relation.

$$\left(m_l c^2\right)_x \cong \left[\gamma^3 + \left(x^2\gamma\right)^x \sqrt{N}\right]^{\frac{1}{3}} \cdot \frac{m_e c^2}{\gamma} \quad (26)$$

where x = 0,1 and 2. At x = 0, $\left(m_l c^2\right)_0 \cong m_e c^2$. At x = 1, $\left(m_l c^2\right)_1 \cong 107.23$ MeV and can be compared with the rest mass of muon (105.66 MeV). At x = 2, $\left(m_l c^2\right)_2 \cong 1788.07$ MeV and can be compared with the rest mass of tau (1777.0 MeV).

Table 1: To fit the muon and tau rest masses

n	Obtained Lepton rest energy (MeV)	Experimental Lepton rest energy (MeV)
0	Defined	0.510998910(13)
1	105.951	105.6583668(38)
2	1777.384	1776.99(29)
3	(42262)	To be discovered

When $\gamma \to \sqrt{\frac{4\pi\varepsilon_0 G_A m_e^2}{e^2}} \cong 295.0606339$, accuracy can be improved. Please see table-1.

Application-8: Electron's Characteristic Potential Energy in hydrogen atom

In Hydrogen atom, by trial-error, it is noticed that,

$$\alpha^2 m_e c^2 \cong -\left(\frac{\hbar_0 c}{G_A m_e^2}\right)^2 \cdot \frac{\sqrt{m_p m_e} \cdot c^2}{2} \quad (27)$$

Here error is 0.3177%. With reference to the error bars [24] in the magnitudes of (N, G), this relation can be given a chance. From unification point of view, at present, in hydrogen atom, electron's characteristic discrete potential energy can be expressed as

$$E_p \cong -\left(\frac{\hbar c}{(n.G_A) m_e^2}\right)^2 \cdot \frac{\sqrt{m_p m_e} \cdot c^2}{2} \quad (28)$$

where n =1,2,3,.. Bohr radii in hydrogen atom can be expressed as

$$a_n \cong \left(\frac{(n.G_A) m_e^2}{\hbar c}\right)^2 \cdot \frac{2e^2}{4\pi\epsilon_0 \sqrt{m_p m_e} c^2} \quad (29)$$

where n =1,2,3,..

Application-9: Nuclear binding energy constants

The semi-empirical mass formula (SEMF) is used to approximate the mass and various other properties of an atomic nucleus [41,42]. As the name suggests, it is based partly on theory and partly on empirical measurements. The theory is based on the liquid drop model proposed by George Gamow and was first formulated in 1935 by German physicist Carl Friedrich von Weizsäcker. Based on the 'least squares fit', volume energy coefficient is $a_v = 15.78$ MeV, surface energy coefficient is $a_s = 18.34$ MeV, coulombic energy coefficient is $a_c = 0.71$ MeV, asymmetric energy coefficient is a_a = 23.21 MeV and pairing energy coefficient is $a_p = 12$ MeV. The semi empirical mass formula is

$$BE \cong A a_v - A^{\frac{2}{3}} a_s - \frac{Z(Z-1)}{A^{\frac{1}{3}}} a_c - \frac{(A-2Z)^2}{A} a_a \pm \frac{1}{\sqrt{A}} a_p \quad (30)$$

In a unified approach it is noticed that, the energy coefficients are having strong inter-relation with the above number $k \cong \left(\frac{G_A m_e^2}{\hbar c}\right) \cong 635.3132$. The interesting semi empirical observations can be expressed in the following way.

1) Neutron and proton mass difference can be expressed as

$$(m_n - m_p)c^2 \cong \sqrt{\ln\left(\frac{G_A m_e^2}{\hbar c}\right)} \cdot m_e c^2 \cong 1.2982 \text{ MeV} \quad (31)$$

$$a_v + a_s \cong a_a + a_p \cong \frac{3}{2} a_a \cong \frac{m_p c^2}{1+\sqrt{k}} \cong 35.8045 \text{ MeV} \quad (32)$$

2) Asymmetric energy constant be

$$a_a \cong \frac{2}{3} \cdot \left(\frac{m_p c^2}{1+\sqrt{k}}\right) \cong 23.870 \text{ MeV} \quad (33)$$

3) Pairing energy constant be

$$a_p \cong \frac{a_a}{2} \cong \frac{1}{3} \cdot \left(\frac{m_p c^2}{1+\sqrt{k}}\right) \cong 11.935 \text{ MeV} \quad (34)$$

4) Maximum nuclear binding energy per nucleon be

$$B_m \cong \frac{1}{4} \cdot \left(\frac{m_p c^2}{1+\sqrt{k}}\right) \cong 8.9511 \text{ MeV} \quad (35)$$

5) Coulombic energy constant be

$$a_c \cong \sqrt{\alpha} . B_m \cong 0.7647 \text{ MeV} \quad (36)$$

6) Surface energy constant be

$$a_s \cong 2B_m \left(1 + \sqrt{\frac{a_c}{a_a}}\right) \cong 19.504 \text{ MeV} \quad (37)$$

7) Volume energy constant be

$$a_v \cong 2B_m \left(1 - \sqrt{\frac{a_c}{a_a}}\right) \cong 16.30 \text{ MeV} \quad (38)$$

Table 2. SEMF binding energy with the proposed energy coefficients

Z	A	$(BE)_{cal}$ in MeV	$(BE)_{meas}$ in MeV
26	56	492.17	492.254
28	62	546.66	545.259
34	84	727.75	727.341
50	118	1007.76	1004.950
60	142	1184.50	1185.145
79	197	1556.66	1559.40
82	208	1627.11	1636.44
92	238	1805.60	1801.693

In table-2 within the range of $(Z=26; A=56)$ to $(Z=92; A=238)$ nuclear binding energy is calculated and compared with the measured binding energy [43]. Column-3 represents the calculated binding energy and column-4 represents the measured binding energy.

Proton-nucleon stability relation can be expressed as

$$\frac{A_s}{2Z} \cong 1 + 2Z\left(\frac{a_c}{a_s}\right)^2 \quad (39)$$

where A_s is the stable mass number of Z. This is a direct relation. Assuming the proton number Z, in general, for all atoms, lower stability can be fitted directly with the following relation [41]. Stable super heavy elements can also be predicted with this relation.

$$A_s \cong 2Z\left[1 + 2Z\left(\frac{a_c}{a_s}\right)^2\right] \cong 2Z + Z^2 * 0.00615 \quad (40)$$

if $Z = 21$, $A_s \cong 44.71$; if $Z = 29$, $A_s \cong 63.17$;
if $Z = 47$, $A_s \cong 107.58$; if $Z = 53$, $A_s \cong 123.27$
if $Z = 60$, $A_s \cong 142.13$; if $Z = 79$, $A_s \cong 196.37$;
if $Z = 83$, $A_s \cong 208.36$; if $Z = 92$, $A_s \cong 236.04$;

In between $Z = 30$ to $Z = 60$ obtained A_s is lower compared to the actual A_s. It is noticed that, upper stability in light and medium atoms up to $Z \approx 56$ can be fitted with the following relation.

$$A_s \cong 2Z\left[1 + 2Z\left(\left(\frac{a_c}{a_s}\right)^2 + \left(\frac{a_c}{4B_m}\right)^2\right)\right] \quad (41)$$

$$\cong 2Z + Z^2 * 0.0080$$

From this relation for $Z = 56$, obtained upper $A_s \cong 137.1$. Note that, for $Z = 56$, actual stable $A_s \cong 137 \cong \frac{1}{\alpha_0}$ where α_0 is the fine structure ratio. This seems to be a nice and interesting coincidence. In between 0.00615 and 0.0080, for light and medium atoms up to $Z \approx 56$ or $A_s \approx 137$, mean stability can be fitted with the following relation.

$$A_s \cong 2Z + Z^2 * 0.00706 \quad (42)$$

Surprisingly it is noticed that, in this relation, $0.0071 \approx \alpha$. Thus up to $Z \cong 56$ or $A_s \approx 137$, mean stability can be expressed as

$$A_s \approx 2Z + \left(Z^2 \alpha_0\right) \quad (43)$$

Application-10: Magnetic moments of nucleons

In the earlier published papers [44] authors suggested that, magnetic moment of electron is due to weak force magnitude [45] and similarly nucleon's magnetic moment is due to the strong force magnitude or strong interaction range. Based on the proposed concepts and representing $\hbar$ in terms of Avogadro number and $\sin\theta_W$, magnetic moment of proton can be expressed as

$$\mu_p \cong \frac{1}{2}\sin\theta_W \cdot ec \cdot R_0 \cong 1.356 \times 10^{-26} \text{ J/tesla} \quad (44)$$

where $R_0 \cong 1.21565 \times 10^{-15}$ m. If proton and neutron are the two quantum states of the nucleon, by considering the "rms" radius of proton as the radius of neutron, magnetic moment of neutron can be fitted as

$$\mu_n \cong \frac{1}{2}\sin\theta_W \cdot ec \cdot R_P \cong 9.59 \times 10^{-27} \text{ J/tesla} \quad (45)$$

where $R_P \cong 0.86 \times 10^{-15}$ m is the radius of proton. This seems to be a very nice and interesting fitting.

Application-11: The strong coupling constant and the weak coupling angle

The strong coupling constant α_s is a fundamental parameter of the Standard Model. It plays a more central role in the QCD analysis of parton densities in the moment space. Considering perturbative QCD calculations from threshold corrections, its recent obtained value [46] at is N^3LO $\alpha_s \cong 0.1139 \pm 0.0020$. It can be fitted or defined in the following way.

$$\left(\frac{1}{\alpha_s}\right) \cong \left(\frac{G_A m_e^2}{\hbar c}\right)^{\frac{1}{3}} \cong 8.596651 \quad (46)$$

and $\alpha_s \cong 0.1163244$. This can be compared with the PDG and NIST recommended values [38] $\alpha_s\left(M_Z^2\right) \cong 0.1172 \pm 0.0037$ and (0.1184 ± 0.0007). The weak coupling angle can be expressed as

$$\frac{1}{\sin\theta_W} \cong \ln\left(\frac{1}{\alpha_s}\right) \cong \frac{1}{3}\ln\left(\frac{G_A m_e^2}{\hbar c}\right) \quad (47)$$

Down and Up quark mass ratio can be expressed as [27]

$$\frac{m_d}{m_u} \cong \ln\left(\frac{1}{\alpha_s}\right) \cong \frac{1}{\sin\theta_W} \cong 2.1513727 \quad (48)$$

Up quark and electron mass ratio can be expressed as [27]

$$\frac{m_u}{m_e} \cong \left(\frac{1}{\alpha_s}\right) \cong 8.596651 \quad (49)$$

Discussion and Conclusions

Initially string theory was originated in an attempt to describe the strong interactions. It is having many attractive features. Then it must explain the ratio of (3+1) dimensional strong interaction strength and the gravitational interaction strength. Till date no single hint is available in this direction. This clearly indicates the basic drawback of the current state of the art unified models. Proposed semi empirical relations clearly show the applications in different ways. $\left(\frac{G_A m_e^2}{\hbar c}\right)$ seems to play a very interesting role in unification program.

Now this is the time to decide, whether Avogadro number is an arbitrary number or a characteristic unified physical number. Developing a true unified theory at 'one go' is not an easy task [12]. Qualitatively and quantitatively proposed new concepts and semi empirical relations can be given a chance in understanding and developing the unified concepts [47]. If one is able to fine tune the "String theory" or "Super gravity" with the proposed assumptions (within the observed 3+1 dimensions), automatically planck scale, nuclear scale and atomic scales can be interlinked into a theory of 'strong gravity' [1,13,14]. But this requires further observations, analysis, discussions and encouragement.

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