Basics of Atomic Cosmology - Part-1

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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, $F_C \cong (c^4/G)$. Ratio of classical force limit and weak force magnitude is $(F_C/F_W) \cong N^2$. 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.

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

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).

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

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

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

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

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

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

Recommended value [24] of G $= 6.6742867 \times 10^{-11}$. m^{3}Kg^{-1}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

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

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 $(\hbar/m_e c)$ 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,

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

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

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

Application-5: Higgs fermion and the Z boson

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

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

From relation (14)

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

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

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

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

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

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

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.

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

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,

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

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

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

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

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

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

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

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 $\gamma \to \sqrt{\dfrac{4\pi\varepsilon_0 G_A m_e^2}{e^2}} \cong 295.0606339$, 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,

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

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

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

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

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

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

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

In a unified approach it is noticed that, the energy coefficients are having strong inter-relation with the above number $k \cong \left(\dfrac{G_A m_e^2}{\hbar c}\right) \cong 635.3132$. 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

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

3) Pairing energy constant be

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

4) Maximum nuclear binding energy per nucleon be

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

5) Coulombic energy constant be

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

6) Surface energy constant be

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

7) Volume energy constant be

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

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

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

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.

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

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.

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

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

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.

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

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

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

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

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

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

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

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^{3}LO $\alpha_s \cong 0.1139 \pm 0.0020$. It can be fitted or defined in the following way.

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

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

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

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

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

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

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

Discussion and Conclusions

6

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. $\left(\dfrac{G_A m_e^2}{\hbar c}\right)$ 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.

Acknowledgements

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Basics of Atomic Cosmology – Part-2

Abstract: Current cosmological changes may be reflected in any existing atom. Hubble length $\left(c/H_t\right)$ can be considered as the gravitational or electromagnetic interaction range. In this paper an attempt is made to verify the cosmic acceleration in a quantum mechanical approach. The four key assumptions are : 1) Reduced Planck's constant increases with cosmic time. 2) Being a primordial evolving black hole and angular velocity being H_t, universe is always rotating with light speed. 3) Atomic gravitational constant is squared Avogadro number times the classical gravitational constant and 4) Atomic gravitational constant shows discrete behavior. This may be the root cause of discrete nature of revolving electron's total energy. With reference to the present atomic and nuclear physical constants, obtained $H_0 \cong 69.642$ km/sec/Mpc and can be compared with the recent value $H_0 \cong 69.32 \pm 0.80$ km/sec/Mpc.

1. INTRODUCTION

If universe is really accelerating, based on the Hubble's law [1], for the observer - the receding or accelerating galaxy must show a continuous increase in its red shift! Some says: instantaneously red shift cannot increase due to the limited photon speed. If cosmic acceleration began 5 billion years ago, then during its accelerated receding journey, the galaxy must show a continuous increase in red shift - whether the change is due to past accelerated receding or present accelerated receding. There is no such evidence. In this connection - the appropriate idea can be stated as follows: 1) 'Redshift' is a measure of expansion and 2) 'Rate of increase in red shift' is a measure of cosmic 'rate of expansion'. This idea can be supported by another simple concept: 1) 'Drop in cosmic temperature' is a measure of cosmic expansion and 2) 'Rate of decrease in cosmic temperature' is a measure of cosmic 'rate of expansion'. In 1947 Hubble [2] suggested that

"The red shifts are more easily interpreted as evidence of motion in the line of sight away from the earth – as evidence that the nebulae in all directions are rushing away from us and that the farther away they are, the faster they are receding. This interpretation lends itself directly to theories of expanding universe. The interpretation is not universally accepted, but even the most cautious of us admit that red shifts are evidence of either an expanding universe or of some hitherto unknown principle of nature"

"Attempts have been made to attain the necessary precision with the 100 inch, and the results appear to be significant. If they are valid, it seems likely that the red-shifts may not be due to an expanding universe, and much of the current speculation on the structure of the universe may require re-examination. The significant data, however, were necessarily obtained at the very limit of a single instrument, and there were no possible means of checking the results by independent evidence. Therefore the results must be accepted for the present as suggestive rather than definitive".

"We may predict with confidence that the 200 inch will tell us whether the red shifts must be accepted as evidence of a rapidly expanding universe, or attributed to some new principle in nature. Whatever may be the answer, the result may be welcomed as another major contribution to the exploration of the universe."

In physics history, for any new idea or observation or new model - at the very beginning – their existence was very doubtful. The best examples were : 1) Existence of atom 2) Existence of quantum of energy 3) Existence of integral nature of angular momentum 4) Existence of wave mechanics 5) Six quarks having fractional charge 6) Confusion in confirming the existence of muon/pion 7) Existence of Black holes 8) Black hole radiation 9) Einstein's cosmological Lambda term 10) Cosmic red shift 11) Discovery of CMBR and 12) Accelerating universe [3-11] and so on.

"Hubble volume" can be considered as a key tool in cosmology and unification. Some cosmologists use the term 'Hubble volume' to refer to the volume of the observable universe. With reference to the Mach's principle [12] and the Hubble volume, at any cosmic time, if "Hubble mass" is the product of cosmic critical density and the Hubble volume, then it can be suggested that, "within the Hubble volume, each and every point in free space is influenced by the Hubble mass". In this paper an attempt is made to understand the basic unified concepts of the four fundamental cosmological interactions.

Note that, Einstein, more than any other physicist, untroubled by either quantum uncertainty or classical complexity, believed in the possibility of a complete, perhaps final, theory of everything. [13]. He also believed that the fundamental laws and principles that would embody such a theory would be simple, powerful and beautiful. Physicists are an ambitious lot, but Einstein was the most ambitious of all. His demands of a fundamental theory were extremely strong. If a theory contained any arbitrary features or undetermined parameters then it was deficient, and the deficiency pointed the way to a deeper and more profound and more predictive theory. There should be no free parameters – no arbitrariness. According to his philosophy, electromagnetism must be unified with general relativity, so that one could not simply imagine that it did not exist. Furthermore, the existence of matter, the mass and the charge of the electron and the proton (the only elementary particles recognized back in the 1920s), were arbitrary features. One of the main goals of a unified theory should be to explain the existence and calculate the properties of matter. . In this paper authors made an attempt to understand the basic concepts of unification via particle cosmology [14,15].

1.1 The cosmic 'critical density' and its dimensional analysis

Recent findings from the University of Michigan suggest that the shape of the Big Bang might be more complicated than previously thought, and that the early universe spun on an axis. A left-handed and right-handed imprint on the sky as reportedly revealed by galaxy rotation would imply the universe was rotating from the very beginning and retained an overwhelmingly strong angular momentum [16]. Galaxies spin, stars spin, and planets spin. So, why not the whole universe? The consequences of a spinning universe seems to be profound [17-29], natural and 'cosmic collapse' can be prevented. Thus 'cosmic (light speed) rotation' can be considered as an alternative to the famous 'repulsive gravity' concept.

With a simple derivation it is possible to show that,

Hubble's constant (H_t) represents cosmological angular

velocity. Assume that, a planet of mass (M) and size (R)

rotates with angular velocity (ω_e) and linear velocity (v_e) in such a way that, free or loosely bound particle of mass (m) lying on its equator gains a kinetic energy equal to potential energy as,

$$\frac{1}{2}mv_e^2 = \frac{GMm}{R} \qquad (1)$$

$$R\omega_e = v_e = \sqrt{\frac{2GM}{R}} \quad \text{and} \quad \omega_e = \frac{v_e}{R} = \sqrt{\frac{2GM}{R^3}} \qquad (2)$$

i.e Linear velocity of planet's rotation is equal to free particle's escape velocity. Without any external power or energy, test particle gains escape velocity by virtue of planet's rotation. Using this idea, 'Black hole radiation' and 'origin of cosmic rays' can be understood. Note that if Earth completes one rotation in one hour then free particles lying on the equator will get escape velocity. Now writing,

$$M = \frac{4\pi}{3}R^3\rho_e,$$

$$\omega_e = \frac{v_e}{R} = \sqrt{\frac{8\pi G\rho_e}{3}} \quad \text{Or} \quad \omega_e^2 = \frac{8\pi G\rho_e}{3} \qquad (3)$$

$$\text{Density, } \rho_e = \frac{3\omega_e^2}{8\pi G} \qquad (4)$$

In real time, this obtained density may or may not be equal to the actual density. But the ratio, $\frac{8\pi G\rho_{real}}{3\omega_{real}^2}$ may have some physical meaning. The most important point to be noted here, is that, as far as dimensions and units are considered, from equation (4), it is very clear that, proportionality constant being $\frac{3}{8\pi G}$,

$$\text{density} \propto (\text{angular velocity})^2 \qquad (5)$$

Equation (4) is similar to "flat model concept" of cosmic "critical density"

$$\rho_c = \frac{3H_t^2}{8\pi G} \qquad (6)$$

Comparing equations (4) and (6) dimensionally and conceptually, i.e.

$$\rho_e = \frac{3\omega_e^2}{8\pi G} \quad \text{with} \quad \rho_c = \frac{3H_t^2}{8\pi G} \qquad (7)$$

$$H_t^2 \to \omega_e^2 \quad \text{and} \quad H_t \to \omega_e \qquad (8)$$

It is very clear that, dimensions of 'Hubble's constant' must be 'radian/second'. In any physical system under study, for any one 'simple physical parameter' there will not be two different units and there will not be two different physical meanings. This is a simple clue and brings "cosmic rotation" into picture. This is possible in a closed universe only. Cosmic models that depends on this "critical density" may consider 'angular velocity of the universe' in the place of 'Hubble's constant'. In the sense, 'cosmic rotation' can be included in the existing models of cosmology. Then the term 'critical density' simply appears as the 'spherical volume density' of the closed and expanding universe.

2.0 POSSIBLE ASSUMPTIONS IN UNIFIED COSMIC PHYSICS

The possible assumptions in unified cosmic physics can be expressed in the following way [28-31],[32-47]:

A) Hubble length (c/H_t) can be considered as the gravitational or electromagnetic interaction range.

B) Being a primordial evolving black hole and angular velocity being H_t, universe is always rotating with light speed.

C) Atomic gravitational constant is squared Avogadro number times the classical gravitational constant. Thus,

$$G_A \cong N^2 G \qquad (9)$$

where (G_A) is the Atomic gravitational constant, (N) is the Avogadro number and (G) is the classical gravitational constant. Note that, (N^2) can be considered as the ratio of classical force limit (c^4/G) and weak force magnitude [38,42].

D) Atomic gravitational constant shows discrete behaviour as $n.G_A$ where $n = 1, 2, 3,..$

E) Reduced Planck's constant increases with cosmic time [30].

Thus at any given cosmic time t,

1) $\frac{d(\hbar)}{dt}$ is a measure of cosmic rate of expansion. It is possible to show that, potential energy of electron in hydrogen atom is directly proportional to $\hbar^2$. Bohr's

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second postulate which suggests that potential energy of electron in hydrogen atom is inversely proportional to $\hbar^2$ seems to be a coincidence [48,49].

2) Past light quanta emitted from aged galaxy will have less energy and show a red shift with reference to the receiving galaxy. During journey light quanta will not lose energy and there will be no change in light wavelength.

3) The basic definition of redshift (z) seems to be $z \cong \dfrac{\lambda_G - \lambda_0}{\lambda_G}$ but not $z \cong \dfrac{\lambda_G - \lambda_0}{\lambda_0}$. Here λ_G is the wave length of light received from observed galaxy and λ_0 is the wave length of light in laboratory. Note that, based on the increasing value of the Planck's constant, red shift (z) will be directly proportional to the age difference of our galaxy and the old galaxy (Δt). Thus $z \propto \Delta t$ and $z \cong H_t \Delta t$. Here H_t is the proportionality constant. In this way H_t can be incorporated directly. Our galaxy and observed galaxy age difference is, $\Delta t \cong \dfrac{z}{H_t}$. If $c\Delta t$ is a measure of galaxy distance, then

$$c\Delta t \cong z \cdot \frac{c}{H_t}. \qquad (10)$$

In this way, the basic and original definition of 'galaxy receding' and 'accelerating universe' concepts can be eliminated and a 'decelerating or expanded universe' concept can be continued without any difficulty.

4) The Schwarzschild radius of universe is

$$\frac{2GM_t}{c^2} \cong \frac{c}{H_t} \qquad (11)$$

where M_t is the cosmic mass at that time. The cosmic mass can be expressed as

$$M_t \cong \frac{c^3}{2GH_t}. \qquad (12)$$

It can be called as the 'Hubble mass'. Thus the cosmic volume density takes the following well known 'critical density' form,

$$(\rho_v)_t \cong \frac{c^3}{2GH_t} \div \frac{4\pi}{3}\left(\frac{c}{H_t}\right)^3 \cong \frac{3H_t^2}{8\pi G}. \qquad (13)$$

It can be caled as the cosmic Hubble density.

3.0 APPLICATIONS OF THE PROPOSED ASSUMPTIONS

3.1 Cosmic Matter Density

Approximately relation between cosmic volume density $(\rho_v)_t$ and matter density $(\rho_m)_t$ can be expressed as

$$(\rho_m)_t \cong \left[1 + \ln\sqrt{\frac{4\pi\varepsilon_0 GM_t^2}{e^2}}\right]^{-1}\left(\frac{3H_t^2}{8\pi G}\right) \qquad (14)$$

Note that, at present obtained matter density ρ_m can be compared with the elliptical and spiral galaxy matter density. Based on the average mass-to-light ratio for any galaxy [50]

$$(\rho_m)_0 \cong 1.5 \times 10^{-32} \eta h_0 \ \text{gram/cm}^3 \qquad (15)$$

where for any galaxy, $\langle M/L \rangle_{Galaxy} = \eta \langle M/L \rangle_{Sun}$ and the number: $h_0 \cong \dfrac{H_0}{100 \ \text{Km/sec/Mpc}} \cong \dfrac{70.75}{100} \cong 0.7075$. Note that elliptical galaxies probably comprise about 60% of the galaxies in the universe and spiral galaxies are thought to make up about 20% of the galaxies in the universe. Almost 80% of the galaxies are in the form of elliptical and spiral galaxies. For spiral galaxies, $\eta h_0^{-1} \cong 9 \pm 1$ and for elliptical galaxies, $\eta h_0^{-1} \cong 10 \pm 2$. For our galaxy inner part, $\eta h_0^{-1} \cong 6 \pm 2$. Thus the average ηh_0^{-1} is very close to 8 to 9 and its corresponding matter density is $(6.0 \text{ to } 6.67) \times 10^{-32}$ gram/cm^3.

3.2. Cosmic Thermal Energy Density

At any given cosmic time, if (a) is the radiation energy constant and (b) is the Wein's displacement constant, ratio of cosmic volume energy density and cosmic thermal energy can be expressed as

$$\left(\frac{\rho_v c^2}{aT^4}\right)_t \cong \left[1 + \ln\sqrt{\frac{4\pi\varepsilon_0 GM_t^2}{e^2}}\right]^2 \qquad (16)$$

Here, $a \cong \dfrac{8\pi^5}{15}\dfrac{k_B^4}{h^3 c^3} \cong \left(\dfrac{8\pi^5}{15 \times (4.96511423)^3}\right) \cdot \dfrac{k_B}{b^3}$

$\cong 1.3333991714 \cdot \dfrac{k_B}{b^3} \cong \dfrac{4}{3} \cdot \dfrac{k_B}{b^3}$. Thus in a classical approach, independent of the Planck's constant, radiation constant can be expressed as above. This is a very sensitive point to be discussed [51,52]. Wien's law is based on the classical approach. With reference to Wein's displacement law, it can be understood that, for any black body, most strongly emitted thermal wave length is inversely proportional to its absolute temperature. Even with reference to quantum mechanics also, 'Wein's constant' is a cosmological constant. With reference to the current magnitude of the Planck's constant, accurate value of the Wein's constant can be estimated and

that obtained magnitude can be considered as a constant throughout the cosmic time. If so, at any given cosmic time, thermal energy density can be expressed as

$$aT_t^4 \cong \left[1+\ln\sqrt{\frac{4\pi\varepsilon_0 GM_t^2}{e^2}}\right]^{-2}\left(\frac{3H_t^2 c^2}{8\pi G}\right) \qquad (17)$$

If H_0 is close to 70 km/sec/Mpc, obtained CMBR temperature [53] is 2.704 ^{0}K. Thus it can be suggested that, at any given cosmic time, matter energy density can be considered as the geometric mean of thermal-energy density and volume-energy density.

$$\left(\rho_m c^2\right)_t \cong \sqrt{\left(aT_t^4\right)\left(\frac{3H_t^2 c^2}{8\pi G}\right)} \cong \sqrt{\left(aT^4\right)_t\left(\rho_v c^2\right)_t} \qquad (18)$$

3.3. Wavelength of the CMB radiation

Authors noticed two approximate methods for estimating the CMB radiation. Geometric mean of the 2 methods is fitting with the observational data accurately.

Method-1: Let $\left(M_e\right)^{\pm}\cong\sqrt{\frac{e^2}{4\pi\varepsilon_0 G}}$ represents a characteristic fundamental unified charged mass unit. With reference to the Wein's displacement law, wave length of the most strongly emitted CMB radiation can be expressed as

$$\left(\lambda_m\right)_t \cong \left(\frac{\rho_v}{\rho_m}\right)_t\frac{G\sqrt{M_t M_e}}{c^2} \cong \left[1+\ln\left(\frac{M_t}{M_e}\right)\right]\frac{G\sqrt{M_t M_e}}{c^2} \quad (19)$$

Note that this expression is free from the 'radiation constants'. If H_0 is close to 70 km/sec/Mpc, obtained (most strongly emitted) wavelength of the CMB radiation is 1.37 mm.

Method-2: Pair particles creation and annihilation in 'free space'- is an interesting idea. In the expanding universe, by considering the proposed charged $\left(M_e\right)^{\pm}$ and its pair annihilation as a characteristic cosmic phenomena, origin of the isotropic CMB radiation can be addressed.. Thermal energy can be expressed as

$$k_B T_t \cong \sqrt{\frac{M_e}{M_t}}\cdot\left[\left(M_e\right)^+ + \left(M_e\right)^-\right]c^2 \cong \sqrt{\frac{M_e}{M_t}}\cdot 2M_e c^2 \quad (20)$$

Based on Wein's displacement law,

$$\left(\lambda_m\right)_t \cong \frac{b}{T_t} \cong \sqrt{\frac{M_t}{M_e}}\cdot\frac{bk_B}{2M_e c^2} \qquad (21)$$

If H_0 is close to 70 km/sec/Mpc, obtained (most strongly emitted) wavelength of the CMB radiation is 0.822 mm.

Method-3: Considering the geometric mean wave length of wave length obtained from methods-1 and 2, wave length of the most strongly emitted CMB radiation can be expressed as

$$\left(\lambda_m^2\right)_t \cong \left[1+\ln\left(\frac{M_t}{M_e}\right)\right]\cdot\left(\frac{M_t}{2M_e}\right)\cdot\left(\frac{bk_B G}{c^4}\right) \qquad (22)$$

$$\left(\lambda_m\right)_t \cong \sqrt{\left[1+\ln\left(\frac{M_t}{M_e}\right)\right]\cdot\left(\frac{M_t}{M_e}\right)\cdot\left(\frac{bk_B G}{2c^4}\right)} \qquad (23)$$

If H_0 is close to 70 km/sec/Mpc, obtained (most strongly emitted) wavelength of the CMB radiation is 1.064 mm. In this way, in a semi empirical approach, the observed CMB radiation temperature can be understood. Clearly speaking,

$$\left(\lambda_m\right)_t \propto \sqrt{\left(\frac{\rho_v}{\rho_m}\right)_t} \propto \sqrt{1+\ln\left(\frac{M_t}{M_e}\right)} \qquad (24)$$

$$\left(\lambda_m\right)_t \propto \sqrt{\frac{M_t}{M_e}} \qquad (25)$$

and $\sqrt{\frac{bk_B G}{2c^4}} \cong 1.2856\times10^{-35}$ m seems to be a classical constant and can be considered as a characteristic thermal wave length. The most important point is that, as the black hole universe is expanding, its expansion rate can be checked with $\frac{d}{dt}\left(\lambda_m\right)_t$. Present observations indicates that, CMB radiation is smooth and uniform. Thus it can be suggested that, at present there is no detectable cosmic expansion or cosmic acceleration.

3.4 . The Cosmological Fine Structure Ratio

In physics, the fine-structure ratio (α) is a fundamental physical constant, namely the coupling constant characterizing the strength of the electromagnetic interaction. Being a dimensionless quantity, it has constant numerical value in all systems of units. If $\left(\rho_v c^2\right)_0$ is the present cosmic volume energy density and aT_0^4 is the present cosmic thermal energy density, it is noticed that,

$$\ln\sqrt{\left(\frac{aT^4}{\rho_v c^2}\right)_0\cdot\frac{4\pi\varepsilon_0 GM_0^2}{e^2}} \cong \left(\frac{1}{\alpha}\right) \qquad (26)$$

Note that, from unification point of view, till today role of dark energy or dark matter is unclear and undecided. Their laboratory or physical existence is also not yet confirmed. In this critical situation this application can be considered as a key tool in particle cosmology. Note that large dimensionless constants and compound physical constants reflect an intrinsic property of nature. At present above relation takes the following form.

$$\ln \sqrt{\frac{2\pi}{3} \cdot \frac{4\pi\varepsilon_0 a T_0^4 c^4}{e^2 H_0^4}} \cong \frac{1}{\alpha} \qquad (27)$$

At present if observed CMBR temperature is $T_0 \cong 2.725 \ {}^0\text{K}$, obtained $H_0 \cong 71.415$ Km/sec/Mpc. After simplification, it can be interpreted as follows. Total thermal energy in the present Hubble volume can be expressed as,

$$(E_T)_0 \cong a T_0^4 \cdot \frac{4\pi}{3} \left(\frac{c}{H_0} \right)^3 \qquad (28)$$

If $\left(\dfrac{c}{H_0} \right)$ is the present electromagnetic interaction range, then the present electromagnetic potential can be expressed as

$$(E_e)_0 \cong \frac{e^2}{4\pi\varepsilon_0 (c/H_0)} \qquad (29)$$

Now inverse of the present fine structure ratio can be expressed as

$$\left(\frac{1}{\alpha} \right)_0 \cong \ln \sqrt{\frac{(E_T)_0}{2(E_e)_0}} \qquad (30)$$

Here, in RHS, denominator '2' may be a representation of total thermal energy in half of the cosmic sphere or thermal energy of any one pole of the cosmic sphere. Thus at any cosmic time,

$$\left(\frac{1}{\alpha} \right)_t \cong \ln \sqrt{\frac{(E_T)_t}{2(E_e)_t}} \qquad (31)$$

When, $M_t \to M_e$ and $\left(a T_t^4 \right) \to \dfrac{3H_t^2 c^2}{8\pi G}$, $\left(\dfrac{1}{\alpha} \right)_t \to 0$. In this way, in a unified manner, the present fine structure ratio can be fitted. From this relation it is possible to say that, cosmological rate of change in fine structure ratio, $\dfrac{d}{dt}\left(\dfrac{1}{\alpha} \right)$ may be considered as an index of the future cosmic acceleration. Many physicists think it's possible variation and experiments are in progress. Specifically, a varying α has been proposed as a way of solving problems in cosmology and astrophysics. More recently, theoretical interest in varying constants (not just α) has been motivated by string theory and other such proposals for going beyond the Standard Model of particle physics. In October 2011 Webb *et al.* reported a variation in α dependent on both redshift and spatial direction [54]. Till today from ground based laboratory experiments no variation was noticed in the magnitude of the fine structure ratio. Future experiments and observations may reveal the real picture. Semi empirically to a good approximation, it is noticed that,

$$\frac{1}{\alpha_t} \cong \ln \left(\frac{x}{1 + \ln(x)} \right) \qquad (32)$$

Here $x \cong \sqrt{\dfrac{4\pi\epsilon_0 G M_t^2}{e^2}}$. If $M_t \to \sqrt{\dfrac{e^2}{4\pi\epsilon_0 G}}$, $\left(\dfrac{1}{\alpha} \right)_t \to 0$. With this relation and with reference to the current magnitude of the fine structure ratio, obtained value of the present Hubble's constant is close to 71.75 km/sec/Mpc.

3.5. Characteristic Reduced Planck's Constant

From above relations (14,16,18,26) at any time $(1/\alpha)_t$ can be estimated and thus the reduced Planck's constant can be obtained with the following relation,

$$\hbar_t \cong \frac{1}{\alpha_t} \cdot \frac{e^2}{4\pi\varepsilon_0 c} \qquad (33)$$

With this idea, magnetic moments of electron, neutron and proton can be expressed as

$$\mu_m \cong \left(\frac{x}{\alpha_0} \right) \cdot e \cdot c \cdot \left(\frac{e^2}{4\pi\varepsilon_0 m c^2} \right) \qquad (34)$$

where x is a factor to be determined. In case of electron, $x \cong \dfrac{1}{2}$, for neutron, $x \cong 1$, and for proton, $x \cong \sqrt{2}$. It can be suggested that, there exists a strong interconnection in between universe and the Hydrogen atom. With many coincidences it is also noticed that,

$$\hbar_0 \cong \left(\frac{2Gm_p}{c^2 R_p} \right) \cdot \frac{m_e c^2}{H_0} \cong \frac{2Gm_p m_e}{R_p H_0} \qquad (35)$$

Please see the appendix. Note that here, $\left(R_p \right)$ is the 'rms' radius of proton [55-58]. If electron revolves round the proton, this expression can be given a chance. Now

$$\frac{1}{\alpha_0} \cong \left(\frac{2Gm_p}{c^2 R_p} \right) \cdot \left(\frac{e^2}{4\pi\varepsilon_0 m_e c^2} \right)^{-1} \left(\frac{c}{H_0} \right) \qquad (36)$$

Here $\left(\dfrac{e^2}{4\pi\varepsilon_0 m_e c^2} \right)$ is the classical radius of electron and $\left(c/H_0 \right)$ is the assumed present gravitational and electromagnetic interaction range. Now the fundamental question to be answered is- How $\left(\hbar_t \right)$ varies with time? Whether it follows a 'natural logarithmic relation' or a 'linear relation' – to be confirmed. Answer can be obtained from analysing the relations (33) and (35). It can also be verified from past and future 'galaxy age and redshift' data analysis.

3.6. Electron's Characteristic Potential Energy

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

$$\left(\frac{e^2}{4\pi\varepsilon_0 G_A m_e^2} \right) \sqrt{\frac{\sqrt{m_p m_e^3}}{2}} \cdot c^2 \cong \alpha_0^2 m_e c^2 \qquad (37)$$

This is an observation. Here, LHS = 27.356 eV and RHS = 27.21138 eV. Here error is 0.5315%. It can be expressed as

$$E_p \cong -\left[\left(\frac{e^2}{4\pi\varepsilon_0 G_A m_e^2} \right) \sqrt{\frac{\sqrt{m_p m_e^3}}{2}} \cdot c^2 \right]^2 \div \alpha_0^2 m_e c^2 \qquad (38)$$

On simplification, it takes the following simple form.

$$E_{p0} \cong -\left(\frac{\hbar_0 c}{G_A m_e^2} \right)^2 \cdot \frac{\sqrt{m_p m_e} \cdot c^2}{2} \qquad (39)$$

Here error is 0.3177%. With reference to the error bars [55] 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 [48,49] can be expressed as

$$E_{p0} \cong -\left(\frac{\hbar_0 c}{(n.G_A) m_e^2} \right)^2 \cdot \frac{\sqrt{m_p m_e} \cdot c^2}{2} \qquad (40)$$

where n =1,2,3,..Thus at any given cosmic time,

$$E_{pt} \cong -\left(\frac{\hbar_t c}{(n.G_A) m_e^2} \right)^2 \cdot \frac{\sqrt{m_p m_e} \cdot c^2}{2} \qquad (41)$$

Thus it can be suggested that, $E_{pt} \propto \hbar_t^2$. From above relations, at present Bohr radii in hydrogen atom can be expressed as

$$a_n \cong \left(\frac{(n.G_A) m_e^2}{\hbar_0 c} \right)^2 \cdot \frac{2e^2}{4\pi\varepsilon_0 \sqrt{m_p m_e} c^2} \qquad (42)$$

where n =1,2,3,..

4.0 ROLE OF (N^2) AND (H_0) IN ATOMIC AND NUCLEAR PHYSICS

4.1 Relation between electron and proton rest masses

By trial-error, it is noticed that,

$$\ln\sqrt{\frac{e^2}{4\pi\varepsilon_0 G m_p^2}} \cong \sqrt{\frac{m_p}{m_e} - \ln\left(N^2\right)} \qquad (43)$$

Here, LHS $\cong 41.55229152$ and RHS $\cong 41.55289244$.

$$\ln\sqrt{\frac{e^2}{4\pi\varepsilon_0 G m_p^2}} - \sqrt{\frac{m_p}{m_e} - \ln\left(N^2\right)} \cong 0 \qquad (44)$$

Interesting thing is that, this relation is free from $(\hbar)$. By trial- error method and by assuming the rest mass of proton, from this relation proton rest mass and proton-electron mass ratio can be estimated simultaneously. Alternatively with reference to electron rest mass, proton rest mass and Avogadro number, magnitude of the classical gravitational constant can be estimated with the following relation.

$$G \cong \left[\exp\sqrt{\frac{m_p}{m_e} - \ln\left(N^2\right)} \right]^{-2} \cdot \frac{e^2}{4\pi\varepsilon_0 m_p^2} \qquad (45)$$

$\cong 6.66627 \times 10^{-11}$ kg/m^{3}sec^2. This obtained value can be compared with the recommended value [55].

4.2 To fit the rms radius of proton

With reference to the 'rms' radius of proton [55-58], it is noticed that,

$$R_p \cong \left(\frac{4\pi\varepsilon_0 G m_p^2}{e^2} \right)^{\frac{1}{4}} \cdot \frac{2G_A m_p}{c^2} \cong 0.854531 \text{ fm} \qquad (46)$$

Note that, no arbitrary parameter is involved in this relation. But its interpretation seems to be very complicated. The two important observations are, 1) Schwarzschild radius of proton where the operating gravitational constant is $(N^2 G)$ and 2) Gravitational and electromagnetic force ratio of proton. The two best quoted values of the rms radius [55,58] of proton are 0.87680(690)fm and 0.84184(67) fm and their geometric mean is 0.8591485 fm. This is very close to the obtained radius of proton. This proposal may be given a chance. From relations (35) and (46)

$$\hbar_0 \cong \left(\frac{e^2}{4\pi\varepsilon_0 G m_p^2} \right)^{\frac{1}{4}} \cdot \frac{1}{N^2} \cdot \frac{m_e c^2}{H_0} \qquad (47)$$

$$\frac{1}{\alpha_0} \cong \left(\frac{e^2}{4\pi\varepsilon_0 G m_p^2} \right)^{\frac{1}{4}} \cdot \frac{1}{N^2} \cdot \left(\frac{e^2}{4\pi\varepsilon_0 m_e c^2} \right)^{-1} \left(\frac{c}{H_0} \right) \qquad (48)$$

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With reference to relation (47) present magnitude of Hubble's constant can be expressed as

$$H_0 \cong \left(\frac{e^2}{4\pi\varepsilon_0 G m_p^2}\right)^{\frac{1}{4}} \cdot \frac{1}{N^2} \cdot \frac{m_e c^2}{\hbar_0} \qquad (49)$$

$\cong 2.256928 \times 10^{-18}$ rad/sec $\cong 69.642$ km/sec/Mpc. This can be compared with the recent value (recommended by C. L. Bennett et al [53] on 20 December 2012) $H_0 \cong 69.32 \pm 0.80$ km/sec/Mpc. This is a remarkable coincidence and seems to play a vital role in future unified physics

4.3 The Semi empirical mass formula, the unified atomic mass unit and the Gram mole

The semi-empirical mass formula (SEMF) is used to approximate the mass and various other properties of an atomic nucleus [59-62]. As the name suggests, it is based partly on theory and partly on empirical measurements. 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

$$BE \cong A a_v - A^{\frac{2}{3}} a_s - \frac{Z(Z-1)}{A^{\frac{1}{3}}} a_c - \frac{(A-2Z)^2}{A} a_a \pm \frac{1}{\sqrt{A}} a_p \qquad (50)$$

Unified atomic mass unit can be estimated as

$$m_u c^2 \cong \left(\left(\frac{m_p + m_n - a_v}{2}\right) + m_e\right)c^2 \cong 931.53966 \text{ MeV} \qquad (51)$$

where a_v is taken as 15.78 MeV. It can be simplified as

$$m_u c^2 \cong \left(\left(\frac{m_p + m_n}{2}\right) - \left(\frac{a_v}{2}\right) + m_e\right)c^2 \quad \text{Or} \qquad (52)$$

$$m_u c^2 \cong \left(\left(\frac{m_p + m_n}{2}\right) - (B_{ave}) + m_e\right)c^2 \qquad (53)$$

where (B_{ave}) is the average mean binding energy per nucleon. Accuracy mainly depends upon (B_{ave}). Now 'gram mole' (M_x) can be estimated with the following relation.

$$G_A m_u^2 \cong G M_x^2 \qquad (54)$$

$$\text{Thus} \quad M_x \cong \sqrt{\frac{G_A}{G}} \cdot m_u \cong N \cdot m_u \qquad (55)$$

In this way, independent of the system of units 'gram mole' can be fitted.

4.4 To fit the SEMF nuclear binding energy constants

With reference to sections - 4.2 and 4.3, let,

$$E_x \cong \frac{e^2}{4\pi\varepsilon_0 R_p} \cong 1.6851 \text{ MeV} \qquad (56)$$

$$E_y \cong \ln\left(\frac{2G_A m_p}{R_p c^2}\right) E_x \cong 35.0 \text{ MeV} \qquad (57)$$

Maximum mean binding energy per nucleon can be expressed as

$$B_m \cong \frac{E_y}{4} \cong 8.75 \text{ MeV} \qquad (58)$$

Asymmetry energy constant can be expressed as

$$a_a \cong \frac{2}{3} E_y \cong 23.34 \text{ MeV} \qquad (59)$$

Pairing energy constant can be expressed as

$$a_p \cong \frac{a_a}{2} \cong \frac{1}{3} E_y \cong 11.67 \text{ MeV} \qquad (60)$$

It is noticed that,

$$\frac{a_c}{a_a} \cong \frac{2}{3} \cdot \frac{E_x}{E_y} \qquad (61)$$

Thus, $a_c \cong \left(\frac{2}{3}\right)^2 E_x \cong 0.7489 \text{ MeV} \qquad (62)$

Average binding energy per nucleon can be expressed as

$$B_{ave} \cong B_m - a_c \cong \frac{E_y}{4} - a_c \cong 8.0 \text{ MeV} \qquad (63)$$

Volume energy constant can be expressed as

$$a_v \cong \left(2 - \frac{1}{2\pi}\right)\frac{E_y}{4} \cong \left(2 - \frac{1}{2\pi}\right)B_m \cong 16.11 \text{ MeV} \qquad (64)$$

Surface energy constant can be expressed as

$$a_s \cong \left(2 + \frac{1}{2\pi}\right)\frac{E_y}{4} \cong \left(2 + \frac{1}{2\pi}\right)B_m \cong 18.90 \text{ MeV} \qquad (65)$$

Thus it can be suggested that,

$$a_v + a_s \cong a_a + a_p \cong \frac{3}{2} a_a \cong E_y \qquad (66)$$

In table-1 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 [62]. Column-3 represents the calculated binding energy and column-4 represents the measured binding energy. Reducing 0.02 MeV

in $\left(a_v\right)$ and increasing 0.02 MeV in $\left(a_s\right)$ error can be minimized.

Table 1. SEMF binding energy with the proposed energy coefficients

Z	A	$\left(BE\right)_{cal}$ in MeV	$\left(BE\right)_{meas}$ in MeV
26	56	493.17	492.254
28	62	547.63	545.259
34	84	729.0	727.341
50	118	1009.20	1004.950
60	142	1186.47	1185.145
79	197	1561.31	1559.40
82	208	1631.42	1636.44
92	238	1811.40	1801.693

DISCUSSION & CONCLUSIONS

With reference to the present concepts of cosmic acceleration and with laboratory experiments one may not decide whether universe is accelerating or decelerating. Many experiments are under progress to detect and confirm the existence of dark matter and dark energy. Along with these experiments if one is willing to think in this new direction, from atomic and nuclear inputs it may be possible to verify the future cosmic acceleration. With the proposed concepts and with the advancing science and technology, from the ground based laboratory experiments, from time to time the concept $d\left(\hbar_t\right)/dt$ can be put for experimental tests. There is no need to design a new experiment. Well established experiments are already available by which Planck's constant can be estimated.

Alternatively in a theoretical way, the proposed applications or semi empirical relations can be given a chance and the subject of elementary particle physics and cosmology can be studied in a unified manner [63,64]. It is true that the proposed relations are speculative and peculiar also. By using the proposed relations and applying them in fundamental physics, in due course their role or existence can be verified. With these relations, Hubble constant can be estimated from atomic and nuclear physical constants. If one is able to derive them with a suitable mathematical model, independent of the cosmic redshift and CMBR observations, the future cosmic acceleration can be verified from atomic and nuclear physical constants.

In understanding the basic concepts of unification or TOE, role of dark energy and dark matter is insignificant. Based on the proposed relations and applications, Hubble volume or Hubble mass, can be considered as a key tool in unification as well as cosmology. Considering the proposed relations and concepts it is possible to say that there exists a strong relation between cosmic Hubble mass, Avogadro number and unification. Now the new set of proposed relations are open to the science community. Whether to consider them or discard them depends on the physical interpretations, logics, experiments and observations. The mystery can be resolved only with further research, analysis, discussions and encouragement.

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