

Hubble Volume and the Fundamental Interactions

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Abstract In modern cosmology, the shape of the universe is flat. In between the closed space and flat space, there is one compromise. That is 'Hubble volume'. Even though Hubble volume is virtual in the flat universe, by considering the product of critical mass density and the Hubble volume, one can estimate the Hubble mass. By coupling the Hubble mass with the Mach's principle, one can understand the origin of cosmic, atomic and nuclear physical parameters. Thus the four fundamental interactions can be studied in a unified manner.

Keywords Hubble Radius, Hubble Volume, Hubble Mass, Mach's Principle, Planck Mass, Coulomb Mass, Fine Structure Ratio, the 4 Fundamental Interactions, SUSY and CMBR Temperature

1. Introduction

In 1998, published observations of Type Ia supernovae by the High-z Supernova Search Team followed in 1999 by the Supernova Cosmology Project suggested that the expansion of the universe is accelerating. 2011 Nobel Prize in Physics was awarded for this work. According to the WMAP seven-year analysis, universe constitutes 72.8% dark energy, 22.7% dark matter and 4.6% ordinary matter. Authors would like to ask the questions: What are the important applications of the 72.8% dark energy or 22.7% matter in the other important fundamental areas of physics (like unification of the fundamental interactions)? What is the role of dark matter or dark energy in Hydrogen atom or the atomic nucleus? To find a way to answer such questions, in this paper authors made an attempt to combine and study the concepts of 'cosmic critical density', 'Hubble volume' and the 'Mach's principle' in a unified semi empirical approach.

Please note that, when it was proposed in 1948, the CMBR idea was never accepted by the science community. But, in 1965, this concept was realized serendipitously. The very surprising thing was that the experimentalists were not aware of what they discovered! Up to 1998, people believed in cosmic deceleration. By 2000, it was a shocking news to many cosmologists that, the universe is accelerating. Please note that, still some scientists argue that, the only indication for the existence of dark energy is observations of distance measurements and associated redshifts. Cosmic microwave background anisotropies and baryon acoustic oscillations are only observations that redshifts are larger than expected from a "dusty" Friedmann-Lemaitre universe and the local

measured Hubble constant.

Here it is very important to note that, in reality no one measured the galaxy's receding speed! But it is the required primary measurement. Based on the Hubble's law, as a secondary or indirect measurement, receding galaxy's redshift is being measured. This is the normal practice and in support of that, galaxy's estimated distance is compared with other secondary methods! If the universe is really accelerating, based on the same Hubble's law, for the observer - the receding and 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: 'rate of increase in red shift is a measure of cosmic rate of expansion'. This idea can be supported by another interesting concept: 'rate of decrease in CMBR temperature is a measure of cosmic rate of expansion'.

1.1. Current Status of Mach's Principle - Hubble Volume

In theoretical physics, particularly in discussions of gravitation theories, Mach's principle [1-6] is the name given by Einstein to an interesting hypothesis often credited to the physicist and philosopher Ernst Mach. The idea is that the local motion of a rotating reference frame is determined by the large scale distribution of matter. There are a number of rival formulations of the principle. A very general statement of Mach's principle is 'local physical laws are determined by the large-scale structure of the universe'. This concept was a guiding factor in Einstein's development of the general theory of relativity. Einstein realized that the overall distribution of matter would determine the metric tensor,

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which tells the observer which frame is rotationally stationary.

One of the main motivations behind formulating the general theory of relativity was to provide a mathematical description to the Mach's principle. However, soon after its formulation, it was realized that the theory does not follow Mach's principle. As the theoretical predictions were matching with the observations, Einstein believed that the theory was correct and did not make any farther attempt to reformulate the theory to explain Mach's principle. Later on, several attempts were made by different researchers to formulate the theory of gravity based on Mach's principle. However most of these theories remain unsuccessful to explain different physical phenomena.

In the standard cosmology, "Hubble volume" or "Hubble sphere" is a spherical region of the Universe surrounding an observer beyond which objects recede from that observer at a rate greater than the speed of light due to the expansion of the Universe. The commoving radius of a Hubble sphere (known as the Hubble radius or the Hubble length) is, (c/H_0) , where (c) is the speed of light and (H_0) is the Hubble constant. More generally, the term "Hubble volume" can be applied to any region of space with a volume of the order of $4\pi/3(c/H_0)^3$.

1.2. Proposed New Concepts on the Mach's Principle, Hubble Volume and Hubble Mass

Note that till today quantitatively Mach's principle was not implemented successfully in cosmic and nuclear physics. If we do not yet know whether the universe is spatially closed or open, then the idea of Hubble volume can be used as a tool in cosmology and unification. Considering the particle and event horizon concepts, where ever we go in the flat universe, for the observer, Hubble volume is the only observable/workable volume. Hence where ever we go in the universe, Hubble volume plays the same role. It seems to be a quantitative description to the Mach's principle. In the universe, if the critical density is $\rho_c \cong (3H_0^2/8\pi G)$ and the characteristic Hubble radius is $R_0 \cong (c/H_0)$, mass of the cosmic Hubble volume is $M_0 \cong \frac{c^3}{2GH_0}$. For the time being let us call this mass as "Hubble mass". With this definition, apart from cosmology, Mach's principle can be given a fundamental unified significance in atomic, nuclear and particle physics! Here, as a point of curiosity, if one is willing to consider this mass as a characteristic mass of the universe, very easily, planck scale, cosmology and particle physics can be studied in a unified manner. It depends only on our choice of scientific interest. If m_p is the rest mass of proton and m_e is the rest mass of electron, it is noticed that,

$$R_s \cong \frac{G\sqrt{M_0}\sqrt{m_p m_e}}{c^2} \cong (1.37 \text{ to } 1.39) \times 10^{-15} \text{ m} \quad (\text{A})$$

This observed length can be compared with Yukawa's

strong interaction range or the characteristic nuclear unit radius.

$$2R_s \cong \frac{2G\sqrt{M_0}\sqrt{m_p m_e}}{c^2} \cong (2.74 \text{ to } 2.78) \times 10^{-15} \text{ m} \quad (\text{B})$$

This is close to the classical radius of electron! If M_p is the Planck mass and $R_0 \cong (c/H_0)$ is the gravitational and electro magnetic interaction range, it is noticed that,

$$\ln\left(\frac{m_e R_0^2}{M_p R_s^2}\right) \cong \frac{1}{137.2} \cong \frac{1}{\alpha}. \quad (\text{C})$$

This is another interesting coincidence! How to interpret these relations? Here, the utmost fundamental observation is: all the believed atomic and nuclear constants are joining with the growing cosmic Hubble size or Hubble volume or the Hubble mass. In the accelerating universe, how is it possible? From these relations it is possible to say that: 1) In the Hubble volume, each and every point in the free space is influenced by the Hubble mass, 2) Within the Hubble volume, the Hubble mass (distribution) plays a vital role in understanding the properties of electro magnetic and nuclear interactions and 3) Hubble mass plays a key role in understanding the geometry of the universe.

Including the CMB radiation energy density & the observed matter- energy density, in this connection, authors observed so many interesting relations. Whether this is the beginning of a controversy or the beginning of unification, for the time being authors propose the following (interesting) observations and concepts related to Mach's principle, Hubble volume and the fundamental interactions. Also please see appendix 1 and 2. Appendix-1 is: 'The characteristic nuclear radii in Cosmology' and appendix-2 is: 'Cosmic critical density, matter density and thermal energy density'.

2. Avogadro Number, Atom and the Universe

The subject of unification is very interesting and very complicated[7-18]. By implementing the Avogadro number N as a scaling factor in unification program, one can probe the constructional secrets of elementary particles. The Planck's quantum theory of light, thermodynamics of stars, black holes and cosmology totally depends upon the famous Boltzmann constant k_B which in turn depends on the Avogadro number[19]. 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. In this connection it is noticed that, 'molar electron mass' plays a very interesting role in nuclear and particle physics. Even if Avogadro number is a man-made number, authors humble opinion is - first let us find the various applications of the Avogadro number in unification. At any one nice relation, its meaning can be understood. The ratio of Planck mass and electron rest mass is close to Avogadro number/ 8π . This is a

very interesting and surprising result.

2.1. Key Concepts in Unification

Concept-1: In the expanding cosmic Hubble volume, characteristic cosmic Hubble mass is the product of the cosmic critical density and the Hubble volume. If the critical density is $\rho_c \cong (3H_0^2/8\pi G)$ and characteristic Hubble radius is $R_0 \cong (c/H_0)$, mass of the cosmic Hubble volume is

$$M_0 \cong \frac{c^3}{2GH_0} \quad (1)$$

Concept-2: There exists a charged heavy massive elementary particle M_X in such a way that, inverse of the fine structure ratio is equal to the natural logarithm of the sum of number of positively and negatively charged M_X in the Hubble volume. If the number of positively charged $(M_X)^+$ is $\left(\frac{M_0}{M_X}\right)$ and the number of negatively charged $(M_X)^-$ is also $\left(\frac{M_0}{M_X}\right)$ then

$$\frac{1}{\alpha} \cong \ln\left(\frac{M_0}{M_X} + \frac{M_0}{M_X}\right) \cong \ln\left(\frac{2M_0}{M_X}\right) \quad (2)$$

From experiments $1/\alpha \cong 137.0359997$ and from the current observations[20,21,22], magnitude of the Hubble constant is, $H_0 \cong 70.4_{-1.4}^{+1.3}$ Km/sec/Mpc. Thus

$$\begin{aligned} M_X &\cong e^{-\frac{1}{\alpha}} \left(\frac{c^3}{GH_0}\right) \cong e^{-\frac{1}{\alpha}} \cdot 2M_0 \\ &\cong (5.32 \text{ to } 5.53) \times 10^{-7} \text{ Kg} \end{aligned} \quad (3)$$

If $N \cong 6.022141793 \times 10^{23}$ is the Avogadro number and m_e is the rest mass of electron, surprisingly it is noticed that, $N \cdot m_e \cong 5.485799098 \times 10^{-7}$ Kg and this is close to the above estimation of M_X . Thus it can be suggested that,

$$\frac{M_X}{m_e} \cong N \quad (4)$$

In this way, Avogadro number can be coupled with the cosmic, atomic and particle physics. Then with reference to $(N \cdot m_e)$, the obtained cosmic Hubble mass is $M_0 \cong 8.957532458 \times 10^{52}$ Kg and thus the obtained Hubble's constant is $H_0 \cong \frac{c^3}{2GM_0} \cong 69.54$ Km/sec/Mpc.

Note that large dimensionless constants and compound physical constants reflects an intrinsic property of nature[23,24]. Whether to consider them or discard them depends on the physical interpretations, logics, experiments, observations and our choice of scientific interest. In most of the critical cases, 'time' only will decide the issue. The mystery can be resolved only with further research, analysis, discussions and encouragement.

Concept-3: For any observable charged particle, there exists 2 kinds of masses and their mass ratio is 295.0606339. Let this number be represented by X_E . First kind of mass seems to be the 'gravitational or observed' mass and the second kind of mass seems to be the 'electromagnetic' mass. This idea can be applied to proton and electron.

This number is obtained in the following way. In the Planck scale, similar to the Planck mass, with reference to the elementary charge, a new mass unit can be constructed in the following way.

$$M_C \cong \sqrt{\frac{e^2}{4\pi\epsilon_0 G}} \cong 1.859210775 \times 10^{-9} \text{ Kg} \quad (5)$$

$$M_C c^2 \cong \sqrt{\frac{e^2 c^4}{4\pi\epsilon_0 G}} \cong 1.042941 \times 10^{18} \text{ GeV} \quad (6)$$

Here e is the elementary charge. How to interpret this mass unit? Is it a primordial massive charged particle? If 2 such oppositely charged particles annihilates, a large amount of energy can be released. Considering so many such pairs annihilation hot big bang or inflation can be understood. This may be the root cause of cosmic energy reservoir. Such pairs may be the chief constituents of black holes. In certain time interval with a well defined quantum rules they annihilate and release a large amount of energy in the form of γ photons. In the Hubble volume, with its pair annihilation, origin of the CMBR can be understood. Clearly speaking, gravitational and electromagnetic force ratio of M_X is X_E^2 .

$$\frac{M_X}{M_C} \cong \sqrt{\frac{4\pi\epsilon_0 GM_X^2}{e^2}} \cong 295.0606338 \quad (7)$$

It can be interpreted that, if 5.486×10^{-7} Kg is the observable or gravitational mass of M_X , then M_C is the electromagnetic mass of M_X .

With reference to the electron rest mass,

$$\left(\frac{M_X}{m_e}\right)^2 \cong X_E^2 \cdot \frac{e^2}{4\pi\epsilon_0 G m_e^2} \cong N^2 \quad (8)$$

Concept-4: If \hbar is the quantum of the gravitational angular momentum, then the electromagnetic quantum can

be expressed as $\left(\frac{\hbar}{X_E}\right)$. Thus the ratio,

$$\left(\frac{\hbar}{X_E}\right) \div \left(\frac{e^2}{4\pi\epsilon_0 c}\right) \cong (X_E \alpha)^{-1} \cong 0.464433353 \cong \sin \theta_W \quad (9)$$

where $\sin \theta_W$ is very close to the weak mixing angle

Concept-5: In modified quark SUSY[25], if Q_f is the mass of quark fermion and Q_b is the mass of quark boson, then

$$\frac{m_f}{m_b} \cong \Psi \cong 2.2627062 \quad (10)$$

and $\left(1 - \frac{1}{\Psi}\right) Q_f$ represents the effective fermion mass. The number Ψ can be fitted with the following empirical

relation

$$\Psi^2 \ln(1 + \sin^2 \theta_W) \cong 1 \quad (11)$$

With this idea super symmetry can be observed in the strong interactions[25] and can also be observed in the electroweak interactions[26-28].

Concept-6: For electron, starting from infinity, its characteristic interaction ending range can be expressed as

$$r_{ee} \cong \frac{e^2}{4\pi\epsilon_0 (m_e / X_E) c^2} \cong X_E \frac{e^2}{4\pi\epsilon_0 m_e c^2} \cong 8.315 \times 10^{-13} \text{ m} \quad (12)$$

Similarly, for proton, its characteristic interaction starting range can be expressed as

$$r_{ss} \cong \frac{e^2}{4\pi\epsilon_0 (m_p / X_E) c^2} \cong X_E \frac{e^2}{4\pi\epsilon_0 m_p c^2} \cong 4.53 \times 10^{-16} \text{ m} \quad (13)$$

Concept-7: Ratio of electromagnetic ending interaction range and strong interaction ending range[29] can be expressed as

$$\frac{r_{ee}}{r_{se}} \cong \frac{GM_X^2}{\hbar c} \cong 635.3131866 \quad (14)$$

Thus if $r_{ee} \cong 8.315 \times 10^{-13} \text{ m}$, $r_{se} \cong 1.309 \times 10^{-15} \text{ m}$,

$$\left(\frac{r_{ee}}{r_{se}} \right)^2 \cong \left(\frac{GM_X^2}{\hbar c} \right)^2 \quad (15)$$

Interesting observation is

$$\frac{r_{ss} + r_{se}}{2} \cong 0.881 \times 10^{-15} \text{ m} \quad (16)$$

This can be considered as the mean strong interaction range and is close to the proton rms radius[30]!

Concept-8: For any elementary particle of charge e , electromagnetic mass (m / X_E) and characteristic radius R , it can be assumed as

$$\frac{e^2}{4\pi\epsilon_0 R} \cong \frac{1}{2} \left(\frac{m}{X_E} \right) c^2 \quad (17)$$

This idea can be applied to proton as well as electron. Electron's characteristic radius is

$$R_e \cong 2X_E \frac{e^2}{4\pi\epsilon_0 m_e c^2} \cong 1.663 \times 10^{-12} \text{ m} \quad (18)$$

Similarly proton's characteristic radius is

$$R_p \cong 2X_E \frac{e^2}{4\pi\epsilon_0 m_p c^2} \cong 0.906 \times 10^{-15} \text{ m} \quad (19)$$

This obtained magnitude can be compared with the rms charge radius of the proton[30]. With different experimental methods its magnitude varies from 0.84184(67) fm to 0.895(18) fm.

2.2. Potential Energy of Electron In Hydrogen Atom

Let E_p be the potential energy of electron in the Hydrogen atom. It is noticed that,

$$E_p \cong \frac{e^2}{4\pi\epsilon_0 a_0} \cong \left(\frac{\hbar c}{GM_X^2} \right) \frac{(\hbar / X_E) c}{\sqrt{R_e R_p}} \cong 27.12493044 \text{ eV} \quad (20)$$

where a_0 is the Bohr radius[31,32]. With 99.6822% this is matching with $\alpha^2 m_e c^2 \cong 27.21138388 \text{ eV}$. After simplification it takes the following form.

$$E_p \cong \left(\frac{\hbar c}{GM_X^2} \right)^2 \frac{\sqrt{m_p m_e} c^2}{2} \cong \alpha^2 m_e c^2 \quad (21)$$

Thus the Bohr radius can be expressed as

$$a_0 \cong \left(\frac{GM_X^2}{\hbar c} \right)^2 \frac{2e^2}{4\pi\epsilon_0 \sqrt{m_p m_e} c^2} \quad (22)$$

Without considering the integral nature of angular momentum, here by considering the integral nature of the elementary charge e , Bohr radius in n^{th} orbit can be expressed as

$$a_n \cong \left(\frac{GM_X^2}{\hbar c} \right)^2 \frac{2(ne)^2}{4\pi\epsilon_0 \sqrt{m_p m_e} c^2} \cong n^2 \cdot a_0 \quad (23)$$

where a_n is the radius of n^{th} orbit and $n = 1, 2, 3, \dots$. Thus in Hydrogen atom, potential energy of electron in n^{th} orbit can be expressed as

$$\frac{e^2}{4\pi\epsilon_0 a_n} \cong \left(\frac{\hbar c}{GM_X^2} \right)^2 \frac{\sqrt{m_p m_e} c^2}{2n^2} \quad (24)$$

Note that, from the atomic theory it is well established that, total number of electrons in a shell of principal quantum number n is $2n^2$. Thus on comparison, it can suggested

that, $\left(\frac{\hbar c}{GM_X^2} \right)^2 \sqrt{m_p m_e} c^2$ is the potential energy of $2n^2$

electrons and potential energy of one electron is equal to

$$\left(\frac{\hbar c}{GM_X^2} \right)^2 \frac{\sqrt{m_p m_e} c^2}{2n^2}.$$

2.3. Magnetic Moments of the Nucleon

If $(\alpha X_E)^{-1} \cong \sin \theta_W$, magnetic moment of electron can be expressed as[33]

$$\mu_e \cong \frac{1}{2} \sin \theta_W \cdot ec \cdot r_{ee} \cong 9.274 \times 10^{-24} \text{ J/tesla} \quad (25)$$

It can be suggested that electron's magnetic moment is due to the electromagnetic interaction range. Similarly magnetic moment of proton is due to the strong interaction ending range.

$$\mu_p \cong \frac{1}{2} \sin \theta_W \cdot ec \cdot r_{se} \cong 1.46 \times 10^{-26} \text{ J/tesla} \quad (26)$$

If proton and neutron are the two quantum states of the nucleon, by considering the mean strong interaction range

$$\left(\frac{r_{ss} + r_{se}}{2}\right), \text{ magnetic moment of neutron can be fitted as}$$

$$\mu_n \cong \frac{1}{2} \sin \theta_W \cdot ec \cdot \left(\frac{r_{ss} + r_{se}}{2}\right) \cong 9.82 \times 10^{-27} \text{ J/tesla} \quad (27)$$

3. Basic Ideas in 'Modified' Quark Super Symmetry

Till today there is no reason for the question: why there exists 6 individual quarks? Till today no experiment reported a free fractional charge quark. Authors humble opinion is nuclear charge (either positive or negative) constitutes 6 different flavors and each flavor holds certain mass. Charged flavor can be called as a quark. It is neither a fermion nor a boson. A fermion is a container for different charges, a charge is a container for different flavors and each flavor is a container for certain matter. If charged matter rests in a fermionic container it is a fermion and if charged matter rests in a bosonic container it is a boson. The fundamental questions to be answered are : what is a charge? why and how opposite charges attracts each other? why and how there exists a fermion? and why and how there exists a boson? Here interesting thing is that if 6 flavors are existing with 6 different masses then a single charge can have one or two or more flavors simultaneously. Since charge is a common property, mass of the multiple flavor charge seems to be the geometric mean of the mass of each flavor. If charge with flavor is called as a quark then charge with multi flavors can be called as a hybrid quark. Hybrid quark generates a multi flavor baryon. It is a property of the strong interaction space-time - charge. This is just like different tastes or different smells of matter. Important consequence of this idea is that-for generating a baryon there is no need to couple 3 fractional charge quarks[26].

1. There exist nature friendly integral charge quark fermions.

2. For every integral charge quark fermion there exists a corresponding integral charge quark boson. Quark fermion and quark boson mass ratio is close to 2.2627.

3. There exists integral charged massive quark fermi-gluons and integral charged massive quark boson-gluons. (Fermi-gluon means massive gluons having fermion behavior and boson-gluon means massive gluons having boson behavior. Quark fermi-gluon can be called as the 'quark baryon' and quark boson-gluon can be called as 'quark meson').

4. Quark fermi-gluon or quark baryon masses can be expressed as $Q_F c^2 \cong 0.2314 \left[M_{Hf}^2 \times Q_f \right]^{\frac{1}{3}} c^2$ and Quark boson-gluon or quark meson masses can be expressed as $Q_M c^2 \cong 0.2314 \left[M_{Hb}^2 \times Q_b \right]^{\frac{1}{3}} c^2$ where Q_f and Q_b are the rest masses of quark fermion and quark boson respectively and M_{Hf} and M_{Hb} are the Higgs charged fermion and

Higgs charged boson respectively.

5. $Q_{ef} \cong Q_f - Q_b \cong \left(1 - \frac{1}{\Psi}\right) Q_f$ acts as the effective quark fermion. Effective quark baryon mass can be expressed as $Q_E c^2 \cong 0.2314 \left[M_{Hf}^2 \times Q_{ef} \right]^{\frac{1}{3}} c^2$. These effective quark baryons play a vital role in fitting the unstable baryon masses. Quark meson masses play a vital role in fitting the unstable meson masses.

6. Characteristic nuclear fermion is 938.272 MeV and its corresponding nuclear boson is $\frac{938.272}{\Psi} \cong 414.67 \text{ MeV}$.

This boson couples with the light quark bosons or light quark mesons and generates neutral ground states. Thus it is the mother of presently believed strange mesons like 493, 548, 1020 MeV and 783, 890 MeV etc.

7. Charged ground state baryon rest energy is $(Q_{E1} Q_{E2})^{\frac{1}{2}} c^2$ or $(Q_{E1} Q_{E2})^{\frac{1}{3}} c^2$ or $(Q_{E1} Q_{E2} Q_{E3})^{\frac{1}{3}} c^2$ where Q_{E1}, Q_{E2} , and Q_{E3} represents any three effective quark baryons. Integral charge light quark bosons in one or two numbers couples with the ground or excited effective quark baryons and generates doublets and triplets. This is just like 'absorption of photons by the electron'.

8. Rest energy of nucleon is close to $\left(\frac{2U_F D_F}{U_F + D_F}\right) c^2 \cong 940.02 \text{ MeV}$ and nucleon rest energy difference is close to

$$\{m_n - m_p\} c^2 \cong \sin^2 \theta_W \cdot \left(\frac{2U_f D_f}{U_f + D_f}\right) c^2 \cong 1.29623 \text{ MeV}$$

9. Only oppositely charged quark mesons couples together to form a neutral meson. No two quark fermions couples together to form a meson. Neutral ground state meson rest energy is close to $(Q_{M1} + Q_{M2}) c^2$ where Q_{M1} and Q_{M2} represents any two quark mesons.

10. Fine rotational levels of any ground state energy $m_x c^2$ can be expressed as, if $n = 1, 2, 3, \dots$, and

$$I = n(n+1), (mc^2)_I \cong [I]^{\frac{1}{4}} m_x c^2 \text{ and } (mc^2)_{I/2} \cong \left[\frac{I}{2}\right]^{\frac{1}{4}} m_x c^2.$$

Super fine rotational levels can be obtained as

$$(mc^2)_I \cong [I]^{\frac{1}{12}} m_x c^2 \text{ and } (mc^2)_{I/2} \cong \left[\frac{I}{2}\right]^{\frac{1}{12}} m_x c^2.$$

3.1. To Fit the Muon and Tau Rest Masses

Using X_E charged muon and tau masses[34] were fitted in the following way.

$$m_l c^2 \approx \frac{2}{3} \left[a_c^3 + (n^2 X_E)^n a_a^3 \right]^{\frac{1}{3}} \quad (28)$$

where a_c and a_a are the coulombic and asymmetric energy

coefficients of the semi empirical mass formula and $n = 0, 1, 2$. This is an approximate relation. Qualitatively this expression is connected with β decay. Accuracy can be improved with the following relation.

$$\text{If } E_W \cong \frac{m_e c^2}{X_E} \cong 1.731843735 \times 10^{-3} \text{ MeV} \quad (29)$$

$$m_l c^2 \cong \left[X_E^3 + (n^2 X_E)^n \sqrt{N} \right]^{\frac{1}{3}} E_W \quad (30)$$

where $n = 0, 1, 2$. Please refer the published papers for the mystery of electro weak bosons and the Higgs boson[25,26]. Please see table-1.

Table 1. To fit the muon and tau rest masses

n	Obt. Lep. energy (MeV)	Exp. Lep. energy (MeV)
0	Defined	0.51098910(13)
1	105.951	105.6583668(38)
2	1777.384	1776.99(29)

3.2. To Correlate the Electron, Muon, Proton and the Charged Pion Rest Masses

From the above table-1, if $m_\mu c^2 \cong 105.95 \text{ MeV}$, surprisingly it is noticed that,

$$m_p c^2 \cong \frac{1}{\alpha} \cdot \left\{ \sqrt{m_\mu m_e} - m_e \right\} \cong 938.29 \text{ MeV} \quad (31)$$

Based on the proposed SUSY, it is also noticed that

$$\left\{ m_\mu c^2 \right\}^\pm \cong \frac{1}{\sqrt{2}} \cdot \sqrt{m_\mu m_p} \cong 139.34 \text{ MeV} \quad (32)$$

These two obtained mass units can be compared with the proton and the charged pion rest masses respectively. In a unified scheme these interesting observations cannot be ignored.

3.3. Nucleons, up & down Quarks and the Strong Coupling Constant

In our earlier published papers[25,26] it was also defined that

$$\frac{m_u c^2}{m_e c^2} \cong e^{X_E \alpha} \quad (33)$$

where m_u is the up quark rest mass and m_d is the down quark rest mass respectively. In our earlier papers, suggested up quark mass is 4.4 MeV and down quark mass is 9.476 MeV. With these magnitudes it is noticed that,

$$(m_n - m_p) c^2 \cong \ln \left(\frac{\sqrt{m_u m_d}}{m_e} \right) \bar{m}_e c^2 \quad (34)$$

Here lhs = 1.2933 MeV and rhs = 1.2963 MeV. It is also noticed that

$$\left(\frac{\sqrt{m_u m_d}}{m_e} \right) \cong \frac{1}{2} \sqrt{\frac{GM_X^2}{\hbar c}} \cong 12.60271 \quad (35)$$

With reference to the strong coupling constant α_s - it is also noticed that[19],

$$\left(\frac{1}{\alpha} + \frac{1}{\alpha_s} \right) \sqrt{m_u m_d} c^2 \cong 940 \text{ MeV} \quad (36)$$

$$\frac{\sqrt{m_u m_d} c^2}{(m_n - m_p) c^2} \cong \ln \left(\frac{1}{\alpha} + \frac{1}{\alpha_s} \right) \quad (37)$$

3.4. To Fit the Strong Coupling Constant

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[35] at is N³LO $\alpha_s \cong 0.1139 \pm 0.0020$. At lower side $\alpha_s \cong 0.1139 - 0.002 = 0.1119$ and at higher side $\alpha_s \cong 0.1139 + 0.002 = 0.1159$. It can be fitted or defined in the following way.

$$X_S \cong \frac{1}{\alpha_s} \cong \ln \sqrt{\frac{1}{\alpha} \left(\frac{r_{ee}}{r_{se}} \right)^2} \cong \ln \sqrt{\frac{1}{\alpha} \left(\frac{GM_X^2}{\hbar c} \right)^2} \cong 8.914239916 \quad (38)$$

$$\alpha_s \cong \frac{1}{X_S} \cong \frac{1}{\ln \left(X_E^2 \sqrt{\alpha} \right)} \cong 0.112180063 \quad (39)$$

This proposed value numerically can be compared with the current estimates of the α_s . Here note that the proposed definition considers the electromagnetic and strong interaction ranges in a unified manner. This proposal can be given a chance[25]. With this magnitude it is noticed that

$$m_n c^2 \cong \left(\frac{1}{\alpha} + \frac{1}{\alpha_s} \right) \sqrt{m_u m_d} c^2 - \frac{m_u}{m_d} \left(\frac{2m_u m_d}{m_u + m_d} \right) c^2 \cong 939.6 \text{ MeV} \quad (40)$$

$$m_p c^2 \cong \left(\frac{1}{\alpha} + \frac{1}{\alpha_s} \right) \sqrt{m_u m_d} c^2 - \sqrt{\frac{m_u}{m_d}} \left(\frac{2m_u m_d}{m_u + m_d} \right) c^2 \cong 938.30 \text{ MeV} \quad (41)$$

$$\text{where } \left(\frac{1}{\alpha} + \frac{1}{\alpha_s} \right) \sqrt{m_u m_d} c^2 \cong 942.393 \text{ MeV.}$$

4. Integral Charge Quark Fermions and Their SUSY Bosons

In the previous papers[25] authors suggested that up, strange and bottom quarks are in geometric series. Similarly down, charm and top quarks are in another geometric series. Obtained quark fermion masses can be compared with the current estimates. Up and down fermion masses can be given as

$$U_f c^2 \cong e^{\alpha X_E} \times m_e c^2 \cong 4.4 \text{ MeV} \quad (42)$$

$$D_f c^2 \cong \alpha X_E \times U_f c^2 \cong 9.4755 \text{ MeV} \quad (43)$$

It is very interesting to note that

$$\frac{\text{Down fermion mass}}{\text{Up fermion mass}} \cong \frac{D_f}{U_f} \cong \alpha X_E \cong \frac{1}{\sin \theta_W} \quad (44)$$

In this way $\sin \theta_W$ can be related with up and down quark mass ratio. Proposed USB geometric ratio is

$$g_U \cong \left[\alpha X_E \frac{\alpha X_E + 1}{\alpha X_E - 1} \right]^2 \cong 34.66294 \quad (45)$$

If DCT series is the second generation series, its geometric ratio is

$$g_D \cong \left[2\alpha X_E \frac{\alpha X_E + 1}{\alpha X_E - 1} \right]^2 \cong 138.651754 \quad (46)$$

$$\frac{g_D}{g_U} \cong \frac{\text{DCT geometric ratio}}{\text{USB geometric ratio}} \cong 4. \quad (47)$$

$$\text{Quark boson mass} = Q_b \cong \frac{\text{Quark fermion mass}}{\Psi} \cong \frac{Q_f}{\Psi} \quad (48)$$

Table 2. Fitting of quark fermion and quark boson masses

Quark	$Q_f c^2$ in MeV	$Q_b c^2$ in MeV
Up	4.401	1.945
Down	9.4755	4.188
Strange	152.5427	67.416
Charm	1313.796	580.63
Bottom	5287.579	2336.839
Top	182160.18	80505.46

Please see table-2 for the obtained quark ‘fermion’ and ‘boson’ masses. The observed baryon and meson charge-mass spectrum can be generated from these mass units. Strange quark boson pair generates the neutral pion of rest energy 134.83 MeV. Obtained top quark boson rest energy is 80505 MeV and is very close to the observed W boson rest energy $80.450 \pm 0.058 \text{ GeV}$ and $80.392 \pm 0.039 \text{ GeV}$. Please refer M. Yao et al[34] recommended PDG data. Really this is a great coincidence and support for the proposed new idea of “fermion-boson” unification scheme. This strongly supports super symmetry with small modifications.

4.1. Beta Decay, Higg’s Charged Fermion and its Boson

Table 3. Fitting of quark baryon and quark effective baryon rest energies

Quark	$Q_f c^2$ in MeV	$Q_F c^2$ in MeV	$Q_{ef} c^2$ in MeV	$Q_E c^2$ in MeV
Up	4.401	834.04	2.456	686.66
Down	9.4755	1076.97	5.2878	886.67
Strange	152.5427	2719.35	85.127	2238.84
Charm	1313.796	5574.13	733.165	4589.18
Bottom	5287.579	8866.53	2950.74	7299.81
Top	182160.18	28850.43	101654.72	23752.56

It is well established that in Beta decay electron is instantaneously created from neutron and this nuclear weak force is mediated by W and Z bosons. If W boson is really the SUSY partner of top quark then the role of W boson in weak decay seems to be nothing. Its role is taken up by the newly proposed Higgs charged boson of rest energy close to 45.6 GeV. Mass of ΨM_{Hb} or M_{Hf} can be expressed with the following relations.

$$M_{Hf} c^2 \cong \frac{1}{2} \cdot \left(\frac{GM_X^2}{\hbar c} \right)^2 \cdot \frac{m_e c^2}{\Psi} \cong 25.417 \text{ MeV} \quad (49)$$

$$M_{Hb} c^2 \cong \frac{M_{Hf} c^2}{\Psi} \cong \frac{1}{2} \cdot \left(\frac{GM_X^2}{\hbar c} \right)^2 \cdot \frac{m_e c^2}{\Psi} \cong 467 \text{ MeV} \quad (50)$$

4.2. Rest Energy of the Neutral Z Boson

From above estimation, neutral Z boson rest energy can be given as

$$m_Z c^2 \cong (M_{Hb} c^2)^\pm + (M_{Hb} c^2)^\mp \cong 2M_{Hb} c^2 \cong 91152.293 \text{ MeV} \quad (51)$$

$$m_Z c^2 \cong \left(\frac{GM_X^2}{\hbar c} \right)^2 \cdot \frac{m_e c^2}{\Psi} \cong 91152.293 \text{ MeV} \quad (52)$$

This obtained value can be compared with the experimental rest energy of Z boson = 91187.621 MeV. Please refer M. Yao et al recommended PDG data[34].

4.3. Recently Discovered Boson of Rest Energy 126 GeV

Close to the predicted rest energy of Higgs boson, recently a new boson of rest energy 124 to 160 GeV was reported. Surprising thing is that its existence is not matching with the current theoretical predictions. In this critical situation, with the help of strong nuclear gravity and modified super symmetry concepts, authors made an attempt to understand the origin of this new boson[26]. In our previous paper[25] it was suggested that: W boson is the super symmetric boson of the top quark fermion and the charged Higgs boson pair generates the neutralized Z boson. It is noticed that Higgs charged boson and top quark boson couples together to form a new neutral boson of rest energy 126.0 GeV. This is a very interesting observation. Like Z boson it can decay into 2 charged particles.

$$(M_{Hb} c^2)^\pm + (m_W c^2)^\mp \cong 126.0 \text{ GeV}. \quad (53)$$

4.4. Quark Baryon and Quark Meson Masses with SUSY Higg's Charged Particle

In our earlier published paper it was assumed that[25], if Q_F is the quark baryon rest mass

$$Q_F c^2 \cong [M_{Gf}^2 \cdot Q_f]^{\frac{1}{3}} c^2 \quad (54)$$

If Q_E is the quark effective baryon rest mass,

$$Q_E c^2 \cong [M_{Gf}^2 \cdot Q_{ef}]^{\frac{1}{3}} c^2 \quad (55)$$

If Q_M is the quark meson rest mass,

$$Q_M c^2 \cong [M_{Gb}^2 \cdot Q_b]^{\frac{1}{3}} c^2 \quad (56)$$

where $M_{Gf} c^2 \cong 11460$ MeV and its bosonic form $M_{Gb} c^2 \cong \frac{M_{Gf} c^2}{\Psi} \cong 5066$ MeV. With reference to the newly proposed Higgs charged fermion and boson, above relations can be expressed as

$$Q_F c^2 \cong x [M_{Hf}^2 \cdot Q_f]^{\frac{1}{3}} c^2 \quad (57)$$

$$Q_E c^2 \cong x [M_{Hf}^2 \cdot Q_{ef}]^{\frac{1}{3}} c^2 \quad (58)$$

$$Q_M c^2 \cong x [M_{Hb}^2 \cdot Q_b]^{\frac{1}{3}} c^2 \quad (59)$$

$$\text{where } x \cong \frac{1}{2\alpha(X_E + 1)} \cong 0.23143232 \quad (60)$$

Please see table-3 for the quark baryon rest energies and see table-4 for the quark meson rest energies.

Table 4. Fitting of quark boson and quark meson rest energies

Quark	$Q_b c^2$ in MeV	$Q_M c^2$ in MeV
Up	1.945	368.6
Down	4.188	475.98
Strange	67.416	1201.81
Charm	580.63	2463.48
Bottom	2336.839	3918.55
Top	80505.46	12750.41

4.5. Rest Energy of the Nucleon

From table-3 it is noticed that, nucleon mass is very close to the harmonic mean of the up baryon and down baryon masses.

$$\frac{2(U_F c^2)(D_F c^2)}{(U_F + D_F) c^2} \cong 940.06 \text{ MeV} \quad (61)$$

where $U_F c^2 \cong 834.04$ MeV and $D_F c^2 \cong 1076.97$ MeV. It is also noticed that,

$$(m_n - m_p) c^2 \cong \sin^2 \theta_W \left[\frac{2(U_f c^2)(D_f c^2)}{(U_f + D_f) c^2} \right] \cong 1.2964 \text{ MeV} \quad (62)$$

where m_p and m_n are the rest masses of proton and neutron respectively.

5. To Fit the Semi Empirical Mass Formula Energy Coefficients

The semi-empirical mass formula (SEMF) is used to approximate the mass and various other properties of an atomic nucleus[36,37]. 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

$$BE \cong A a_v - A^{\frac{2}{3}} a_s - \frac{Z(Z-1)}{A^{\frac{1}{3}}} a_c - \frac{(A-2Z)^2}{A} a_a \pm \frac{1}{\sqrt{A}} a_p \quad (63)$$

In a unified approach it is noticed that, the energy coefficients are having strong inter-relation with the proton rest mass and the 'mole electron mass'. The interesting observations can be expressed in the following way.

5.1. The Coulombic Energy Coefficient

It can be defined as[38],

$$a_c \cong \alpha \cdot \alpha_s \cdot m_p c^2 \cong 0.7681 \text{ MeV} \quad (64)$$

Ratio of the coulombic energy coefficient and the proton rest energy is close to the product of the fine structure ratio and the strong coupling constant.

5.2. The Surface and Volume Energy Coefficients

Surface energy coefficient can be defined as

$$a_s \cong \sqrt{\frac{GM_X^2}{\hbar c}} a_c \cong 9.36 \text{ MeV} \quad (65)$$

Volume energy coefficient can be defined as

$$a_v \cong \sqrt{\frac{GM_X^2}{\sqrt{2}\hbar c}} a_c \cong 6.28 \text{ MeV} \quad (66)$$

$$\text{Thus, } \frac{a_s}{a_v} \cong 2^{\frac{1}{4}} \quad (67)$$

5.3. The Asymmetry and Pairing Energy Coefficients

Asymmetry energy coefficient can be defined as

$$a_a \cong \frac{2}{3}(a_v + a_s) \cong 23.76 \text{ MeV} \quad (68)$$

Pairing energy coefficient is close to

$$a_p \cong \frac{1}{3}(a_v + a_s) \cong 11.88 \text{ MeV} \quad (69)$$

Thus, $a_v + a_s \cong a_a + a_p \cong 35.64 \text{ MeV}$ (70)

Table 5. SEMF binding energy with the proposed energy coefficients

Z	A	(BE) _{cal} in MeV	(BE) _{mes} in MeV
26	56	492.60	492.254
28	62	547.08	545.259
34	84	728.29	727.341
50	118	1007.46	1004.950
60	142	1183.64	1185.145
79	197	1554.82	1559.40
82	208	1625.22	1636.44
92	238	1803.12	1801.693

In table-5 considering the magic numbers, 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[39]. Column-3 represents the calculated binding energy and column-4 represents the measured binding energy. If this procedure is found to be true and valid then with a suitable fitting procedure qualitatively and quantitatively magnitudes of the proposed SEMF binding energy coefficients can be refined.

5.4. Proton-Nucleon Stability

It is noticed that

$$\frac{A_s}{2Z} \cong 1 + 2Z \left(\frac{a_c}{a_s} \right)^2 \cong 1 + 2Z \left(\frac{\hbar c}{GM_X^2} \right)$$
 (71)

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[33].

$$A_s \cong 2Z \left[1 + 2Z \left(\frac{a_c}{a_s} \right)^2 \right] \cong 2Z + Z^2 * 0.0063$$
 (72)

if Z = 21, $A_s \cong 44.78$; if Z = 29, $A_s \cong 63.29$; if Z = 47, $A_s \cong 107.91$; if Z = 53, $A_s \cong 123.68$; if Z = 60, $A_s \cong 142.66$; if Z = 79, $A_s \cong 197.29$; if Z = 83, $A_s \cong 209.37$; if Z = 92, $A_s \cong 237.29$;

Stable super heavy elements can be predicted with this relation. 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 upto Z ≈ 56 can be fitted with the following relation.

$$A_s \cong 2Z \left[1 + 2Z \left(\left(\frac{a_c}{a_s} \right)^2 + \left(\frac{a_c}{a_a + a_p} \right)^2 \right) \right] \cong 2Z + Z^2 * 0.0082$$
 (73)

From this relation for Z = 56, obtained upper $A_s \cong 137.7$. Note that, for Z = 56, actual stable

$A_s \cong 137 \cong \frac{1}{\alpha}$ where α is the fine structure ratio. This seems to be a nice and interesting coincidence. In between 0.0063 and 0.0082, for light and medium atoms up to Z ≈ 56 or $A_s \cong 137$, mean stability can be fitted with the following relation.

$$A_s \cong 2Z + Z^2 * 0.0072$$
 (74)

Surprisingly it is noticed that, in this relation, $0.0072 \approx \alpha \cong 0.0073$. Thus up to Z ≈ 56 or $A_s \cong 137$, mean stability can be expressed as

$$A_s \approx 2Z + (Z^2 \alpha)$$
 (75)

5.5. Nuclear Binding Energy with 2 Terms and Only One Energy Constant

Nuclear binding energy can be fitted with 2 terms or 4 factors with $a_c \cong 0.7681 \text{ MeV}$ as the single energy constant[33,40]. First term can be expressed as

$$T_1 \cong (f)(A+1) \ln[(A+1)X_S] a_c$$
 (76)

where $f \cong 1 + \frac{2Z}{A_s} \leq 2.0$ and $X_S \cong 8.91424$ is the strong coupling constant.

Second term can be expressed as

$$T_2 \cong \left[\frac{A^2 + (fZ^2)}{X_S^2} \right] a_c$$
 (77)

Close to the stable mass number A_s ,

$$B.E = T_1 - T_2$$
 (78)

Please see the following data.

- Z = 2 & A = 4, B.E ≅ 28.93 MeV;
- Z = 10 & A = 20, B.E ≅ 160.44 MeV;
- Z = 26 & A = 56, B.E ≅ 482.06 MeV;
- Z = 50 & A = 118, B.E ≅ 1007.35 MeV;
- Z = 79 & A = 197, B.E ≅ 1563.72 MeV;
- Z = 82 & A = 208, B.E ≅ 1634.76 MeV;
- Z = 92 & A = 238, B.E ≅ 1805.15 MeV.

Above 2 terms can be put into 4 factors as

$$B.E \cong \left[2 - \frac{A}{2Z} \right] (f)(A+1) \ln[(A+1)X_S] a_c$$
 (79)

With this relation,

- Z = 2 & A = 4, B.E ≅ 29.07 MeV;
- Z = 10 & A = 20, B.E ≅ 160.98 MeV;
- Z = 26 & A = 56, B.E ≅ 484.56 MeV;
- Z = 50 & A = 118, B.E ≅ 973.32 MeV;
- Z = 79 & A = 197, B.E ≅ 1542.1 MeV;
- Z = 82 & A = 208, B.E ≅ 1587.52 MeV;
- Z = 92 & A = 238, B.E ≅ 1764.8 MeV;

These relations can be considered for further research and analysis positively.

6. The Characteristic Nuclear Radii in Cosmology

Please recall that, the characteristic cosmic Hubble mass is $M_0 \cong \frac{c^3}{2GH_0} \cong 8.95 \times 10^{52}$ Kg and the electromagnetic mass of the proposed M_X is $M_C \cong \sqrt{\frac{e^2}{4\pi\epsilon_0 G}} \cong 1.859210775 \times 10^{-9}$ Kg.

6.1. The Characteristic Nuclear Charge Radius

If $H_0 \cong 69.54$ Km/sec/Mpc, R_S is the characteristic radius of nucleus, it is noticed that,

$$R_S \cong \left(\frac{m_p}{M_X} \right)^2 \frac{c}{H_0} \cong 1.2368 \times 10^{-15} \text{ m} \quad (80)$$

where m_p is the proton rest mass. This can be compared with the characteristic radius of the nucleus and the strong interaction range[29].

6.2. Scattering Distance between Electron and the Nucleus

If $R_S \cong 1.21$ to 1.22 fm is the minimum scattering distance between electron and the nucleus, it is noticed that,

$$R_S \cong \left(\frac{\hbar c}{GM_X^2} \right) \cdot \left(\frac{\hbar c}{Gm_e^2} \right) \cdot \frac{2Gm_e}{c^2} \cong 1.21565 \times 10^{-15} \text{ m} \quad (81)$$

Here M_X is the molar electron mass. Here it is very interesting to consider the role of the Schwarzschild radius of the 'electron mass'. Thus the two macroscopic physical constants N and G can be expressed in the following way.

$$N \cong \sqrt{\frac{2\hbar^2}{Gm_e^3 R_S}} \quad (82)$$

$$G \cong \frac{2\hbar^2}{(M_X)^2 m_e R_S} \quad (83)$$

In this way, either the Avogadro number or the gravitational constant can be obtained. Combining the relations (80) and (81) and if $H_0 \cong 69.54$ Km/sec/Mpc, it is noticed that,

$$\frac{\hbar c}{Gm_p \sqrt{M_0 m_e}} \cong 0.991415 \quad (84)$$

Surprisingly this ratio is close to unity! How to interpret this ratio? From this relation it can be suggested that, along with the cosmic variable, H_0 , in the atomic and nuclear physics, there exists one variable. In the physics history, it was suggested that, gravitational constant and the speed of light were cosmic variables. In our published paper[41] and accepted paper[42] it was assumed that, the reduced Planck's constant, the Bohr radius, the fine structure ratio were cosmic variables. In our another accepted paper[43] it was

assumed that, proton mass and the proton radius were cosmic variables. Any how this is a very sensitive case and has to be discussed in depth. But it is clear that, on the cosmological time scale, there exists one variable physical quantity in the presently believed atomic and nuclear physical constants. 'Rate of change' in its magnitude may be a measure of the present cosmic acceleration. Thus independent of the cosmic red shift and CMBR observations, from the atomic and nuclear physics, cosmic acceleration can be verified. Based on the above coincidence, magnitude of the present Hubble's constant can be expressed as

$$H_0 \cong \frac{Gm_p^2 m_e c}{2\hbar^2} \cong 70.75 \text{ Km/sec/Mpc} \quad (85)$$

6.3. To Fit the Radius of Proton

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

$$R_p \cong \frac{M_X}{m_p} \cdot \frac{2GM_C}{c^2} \cong 9.0566 \times 10^{-16} \text{ m} \quad (86)$$

This obtained magnitude can be compared with the rms charge radius of the proton[30]. With different experimental methods its magnitude varies from 0.84184(67) fm to 0.895(18) fm. Here also it is very interesting to consider the role of the Schwarzschild radius of M_C . This type of coincidence cannot be ignored in the unification scheme.

Here the strange observation is: the ratio $\frac{M_X}{m_p}$. Please note

that mass nature in both of the cases is the assumed 'gravitational mass' only. But the very strange observation is $\frac{2GM_C}{c^2}$. Here in this expression, M_C is playing a key role

instead of M_X . But M_C is the assumed electromagnetic mass of M_X . If this logic is having any sense, then similar to M_C , 'electromagnetic mass of the proton' must play a strong role in nuclear physics. In this direction, in the following subsection, an attempt is made.

6.4. Strong Interaction Range in Cosmology

Considering the above coincidences it can be suggested that, there exists a strong connection in between modern cosmology and the nucleus. It is noticed that,

$$R_S \cong \frac{2G\sqrt{M_0(m_p/X_E)}}{c^2} \cong 1.0493 \times 10^{-15} \text{ m} \quad (87)$$

where $H_0 \cong 70.75$ Km/sec/Mpc and $M_0 \cong 8.80434 \times 10^{52}$ Kg. Here R_S represents the represents the Schwarzschild radius of $\sqrt{M_0(m_p/X_E)}$. How to understand this radius!

Here the very peculiar and careful observation is

$$R_S \cong \frac{2G\sqrt{M_0(m_p/X_E)}}{c^2} \cong \sqrt{\left(\frac{2GM_0}{c^2} \right) \left(\frac{2G(m_p/X_E)}{c^2} \right)} \cong 1.0493 \times 10^{-15} \text{ m} \quad (88)$$

In this relation, $\frac{2GM_0}{c^2}$ is the Schwarzschild radius of the Hubble mass! It means, from unification point of view[10,11], if the above relation (88) receives any significance, then it can be suggested that, in the flat universe, for any observer - cosmic observations and events seems to be confined to the Hubble volume[44]. Some scientists may say: this is a play with numbers. Some scientists may say: it is very interesting. Some scientists say: nobody understands Mach's principle this way. Here, the fundamental question to be answered is - if the atom (and therefore all material rulers) expands, in what relation should the cosmic expansion then be measured? Answer is very simple. If the universe is really accelerating, based on the galactic red shift, for the observer - the receding and accelerating galaxy must show a continuous increase in its red shift[44]. There is no such evidence. If we do not yet know whether the universe is spatially closed or open, then the idea of Hubble mass can be used as a tool in cosmology and unification. Considering the particle and event horizon concepts, where ever we go in the flat universe, for the observer, Hubble volume is the only observable/workable volume. Hence where ever we go in the universe, Hubble mass plays the role. It is very close to the Mach's idea of distance cosmic back ground. It seems to be a quantitative description to the Mach's principle. Anyhow whatever may be their physical meaning, it is sure that these relations will help in understanding the characteristic properties of strong interaction, unification, cosmic acceleration and Mach's principle.

7. Cosmic Critical Density, Matter Density and Thermal Energy Density

It is noticed that, there exists a very simple relation in between the cosmic critical density, matter density and the thermal energy density. It can be expressed in the following way. At any time t ,

$$\left(\frac{\rho_c}{\rho_m}\right)_t \cong \left(\frac{\rho_m}{\rho_T}\right)_t \cong 1 + \ln\left(\frac{M_t}{M_C}\right) \tag{89}$$

where $\rho_c \cong M_t \left[\frac{4\pi}{3} \left(\frac{c}{H_t}\right)^3\right]^{-1} \cong \frac{3H_t^2}{8\pi G}$, ρ_m is the matter density and ρ_T is the thermal energy density expressed in gram/cm^3 or Kg/m^3 . Considering the Planck - Coulomb scale, at the beginning if $M_t \cong M_C$

$$\left(\frac{\rho_c}{\rho_m}\right)_C \cong \left(\frac{\rho_m}{\rho_T}\right)_C \cong 1 \tag{90}$$

$$(\rho_c)_C \cong (\rho_m)_C \cong (\rho_T)_C \tag{91}$$

Thus at any time t ,

$$\rho_m \cong \sqrt{\rho_c \cdot \rho_T} \tag{92}$$

$$\rho_m \cong \left[1 + \ln\left(\frac{M_t}{M_C}\right)\right]^{-1} \rho_c \tag{93}$$

$$\rho_T \cong \left[1 + \ln\left(\frac{M_t}{M_C}\right)\right]^{-2} \rho_c \cong \left[1 + \ln\left(\frac{M_t}{M_C}\right)\right]^{-1} \rho_m \tag{94}$$

In this way, observed matter density and the thermal energy density can be studied in a unified manner. The observed CMB anisotropy can be related with the inter galactic matter density fluctuations.

7.4. Present Matter Density of the Universe

At present if $H_0 \cong 70.75 \text{ Km/sec/Mpc}$,

$$(\rho_m)_0 \cong \left[1 + \ln\left(\frac{M_0}{M_C}\right)\right]^{-1} (\rho_c)_0 \tag{95}$$

$\cong 6.573 \times 10^{-32} \text{ gram/cm}^3$
 where $(\rho_c)_0 \cong 9.4 \times 10^{-30} \text{ gram/cm}^3$ and

$\left[1 + \ln\left(\frac{M_0}{M_C}\right)\right] \cong 143.013$. Based on the average

mass-to-light ratio for any galaxy[6]

$$(\rho_m)_0 \cong 1.5 \times 10^{-32} \eta h_0 \text{ gram/cm}^3 \tag{96}$$

where for any galaxy, $\left\langle \frac{M_G}{L_G} \right\rangle \cong \eta \left(\frac{M_\odot}{L_\odot}\right)$ and the number

$$h_0 \cong \frac{H_0}{100 \text{ Km/sec/Mpc}} \cong \frac{70.75}{100} \cong 0.7075.$$

Note that elliptical galaxies probably comprise about 60% of the galaxies in the universe and spiral galaxies thought to make up about 20% percent 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 close to $(6.0 \text{ to } 6.76) \times 10^{-32} \text{ gram/cm}^3$ and can be compared with the above proposed magnitude of $6.573 \times 10^{-32} \text{ gram/cm}^3$.

7.5. Present thermal Energy Density of the Universe

At present if $H_0 \cong 70.75 \text{ Km/sec/Mpc}$,

$$(\rho_T)_0 \cong \left[1 + \ln\left(\frac{M_0}{M_C}\right)\right]^{-2} (\rho_c)_0 \cong 4.6 \times 10^{-34} \text{ gram/cm}^3 \tag{97}$$

and thus

$$(\rho_T c^2)_0 \cong \left[1 + \ln\left(\frac{M_0}{M_C}\right)\right]^{-2} (\rho_c c^2)_0 \cong 4.131 \times 10^{-14} \text{ J/m}^3 \tag{98}$$

At present if

$$(\rho_T c^2)_0 \cong a T_0^4 \tag{99}$$

where $a \cong 7.56576 \times 10^{-16} \text{ J/m}^3\text{K}^4$ is the radiation energy density constant, then the obtained temperature is, $T_0 \cong 2.718 \text{ }^0\text{Kelvin}$. This is accurately fitting with the observed CMBR temperature[22] , $T_0 \cong 2.725 \text{ }^0\text{Kelvin}$. Thus in this way, the present value of the Hubble's constant and the present CMBR temperature can be co-related with the following trial-error relation.

$$\left[1 + \ln \left(\frac{c^3}{2GH_0M_C} \right) \right]^{-1} H_0 \cong \sqrt{\frac{8\pi GaT_0^4}{3c^2}} \quad (100)$$

8. Present Cosmic Age

Cosmic age can be assumed as

$$t \cong \left(\frac{\rho_c c^2}{\rho_T c^2} \right)_t \left(\frac{1}{H_t} \right) \cong \left[1 + \ln \left(\frac{c^3}{2GH_t M_C} \right) \right]^2 \left(\frac{1}{H_t} \right) \quad (101)$$

Here note that, cosmic age is directly proportional to the ratio of critical energy density and the thermal energy density. In this way, this proposed method differs from the current or standard model of cosmology by the ratio $\left(\frac{\rho_c c^2}{\rho_T c^2} \right)_0$.

Thus at any time t ,

$$t \cdot H_t \cong \left(\frac{\rho_c c^2}{\rho_T c^2} \right)_t \cong \left[1 + \ln \left(\frac{c^3}{2GH_t M_C} \right) \right]^2 \quad (102)$$

At present if $H_0 \cong 70.75 \text{ Km/sec/Mpc}$, present cosmic age can be expressed as

$$t_0 \cong \left[1 + \ln \left(\frac{c^3}{2GH_0 M_C} \right) \right]^2 \left(\frac{1}{H_0} \right) \quad (103)$$

i.e The present cosmic age is $8.92 \times 10^{21} \text{ sec} \cong 282.7$ trillion years. With this large time - smooth cosmic expansion, cosmic isotropy, super novae dimming and magnetic monopole vanishing etc can be understood. In Indian vedic cosmology, total age of the universe is 311 trillion years[43,45]. This is a striking and surprising coincidence. It can be suggested that, modern cosmology and Indian vedic cosmology can be studied in a unified manner.

9. Discussion & Conclusions

Professor Recami says[11]: Let us recall that Riemann, as well as Clifford and later Einstein, believed that the fundamental particles of matter were the perceptible evidence of a strong local space curvature. A theory which stresses the role of space (or, rather, space-time) curvature already does exist for our whole cosmos: General Relativity, based on Einstein gravitational field equations; which are probably the most important equations of classical physical theories, together with Maxwell's electromagnetic field equations. Whilst much effort has already been made to

generalize Maxwell equations, passing for example from the electromagnetic field to Yang-Mills fields (so that almost all modern gauge theories are modelled on Maxwell equations), on the contrary Einstein equations have never been applied to domains different from the gravitational one. Even if they, as any differential equations, do not contain any inbuilt fundamental length: so that they can be used a priori to describe cosmoses of any size. Our first purpose is now to explore how far it is possible to apply successfully the methods of general relativity (GR), besides to the world of gravitational interactions, also to the domain of the so-called nuclear, or strong, interactions: namely, to the world of the elementary particles called hadrons. A second purpose is linked to the fact that the standard theory (QCD) of strong interactions has not yet fully explained why the hadron constituents (quarks) seem to be permanently confined in the interior of those particles; in the sense that nobody has seen up to now an isolated "free" quark, outside a hadron. So that, to explain that confinement, it has been necessary to invoke phenomenological models, such as the so-called "bag" models, in their MIT and SLAC versions for instance. The "confinement" could be explained, on the contrary, in a natural way and on the basis of a well-grounded theory like GR, if we associated with each hadron (proton, neutron, pion,...) a particular "cosmological model".

String theory or QCD is not in a position to address the basics of cosmic structure. In understanding the basic concepts of unification or TOE, role of dark energy and dark matter is insignificant. Even though string theory was introduced for understanding the basics of strong interaction, its success seems to be a dilemma because of its higher dimensions and the non-coupling of the nuclear & planck scale. 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. From relations (80-88), if it is possible to identify the atomic cosmological physical variable, then by observing the rate of change in its magnitude (on the cosmological time scale), the cosmic acceleration can be verified and thus the cosmic geometry can be confirmed from atomic and nuclear physics! Without the advancement of nano-technology or fermi-technology this may not be possible. Not only that, independent of the cosmic red shift and CMBR observations cosmic acceleration can be checked in this new direction.

In this connection, it is noticed that, proton mass is a cosmic variable and not a fundamental physical constant. Molar electron mass seems to be the planck scale mass of the proton. By this time if the observed proton is the present cosmological characteristic nuclear mass unit, then abundance of the first proton products like Hydrogen and Helium may be high. In other words, compared to the heavy atoms, light atoms generation/abundance may be high. Thus in a very simple way, the basic and main observation of the big bang cosmology can be understood. In appendix-2, authors proposed the relation between CMBR energy density and the presently believed critical density in a growing Hubble volume.

Giving a fundamental importance to the 3 dimensional geometry rather than the existence of matter, it is possible to combine and study the “growing Hubble mass” and the “growing and light speed rotating primordial cosmic black hole[44]” concepts in a unified manner. Then automatically presently believed critical density comes into picture. Please recall the present concept of Hubble volume - after crossing the Hubble size, galaxies recedes with super luminal speeds. That means at the Hubble length, speed is luminal! Here the major conceptual clash is : whether the galaxy is receding or revolving (with luminal speed)? At this junction, this is a very sensitive and critical issue to confirm and authors are working on this in different angles like basics of primordial black holes formation, basics of space-time geometry, cosmic axis of evil[44], unification and super symmetry.

Considering the proposed semi empirical relations and concepts it is possible to say that there exists a strong relation between cosmic Hubble mass and unification. Authors request the science community to kindly look into this new approach.

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