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A BRIEF REPORT ON SCALE INDEPENDENT QUANTUM COSMOLOGY

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ABSTRACT

In the evolving universe, cosmic thermal energy density is always directly proportional to the critical mass-energy density. At any time, the product of cosmic 'critical density' and 'critical Hubble volume' can be called as the 'critical mass' of the evolving universe. With reference to Mach's principle, cosmic 'critical density', 'critical volume' and 'critical mass' can be considered as the quantified back ground dynamic properties of the evolving universe. With reference to Planck mass, Hubble constant connected with big bang and critical density connected with big bang- both can be defined. With 'cosmologically reinforcing hydrogen atom' concept, observed cosmic redshift and super novae dimming both can be reinterpreted in a new approach. To understand the ground reality of cosmic rate of expansion, accuracy of the current methods of estimating the magnitudes of current Hubble's constant and current CMBR temperature must be improved.

Keywords: Modern cosmology, Quantum gravity, Mach's principle, Product of critical volume and critical density, Cosmic repulsive force.

Contribution/Originality

This paper's primary contribution is finding the applications of quantum gravity connected with high energy as well as low energy in the domain of observable cosmology.

1. INTRODUCTION

One can find more than 16 major theoretical approaches of quantum gravity in the advanced and unified theoretical physics literature [1-6]. The most widely pursued possibilities for quantum gravity phenomenology include violations of Lorentz covariance or Lorentz invariance, imprints of quantum gravitational effects in the cosmic microwave background and de-coherence induced by fluctuations in the space-time foam. It is well established that, photons, elementary particles and atoms play a vital role quantum mechanics. 'Black holes' and 'gravitons' both seem

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to play a vital role in the unification of general theory of relativity and quantum mechanics and many observations and experiments are on the way confirm their existence. Most of the modern physicists believe that, 1) Quantum gravitational effects are extremely weak and cannot be tested in any ground based laboratory operating under low energy scales. 2) At higher laboratory energy scales, quantum gravitational effects become stronger and their results can be observed and measured. By correlating the basics of Quantum mechanics, Special and General theories of relativity and big bang - in this letter the authors explore the possibility of developing a scale independent quantum cosmology.

2. SCALE INDEPENDENT QUANTUM GRAVITY CONNECTED WTH COSMOLOGY

Some of the other modern physicists believe that, during the cosmic evolution, Planck scale quantum gravitational interactions might have an observable effect on the current observable cosmological phenomena. This proposal seems to have more impact on the observable universal laboratory. Clearly speaking, with respect to the Planck scale early universal laboratory, current universe can be considered as a low energy scale laboratory. If one is willing to consider the current observable universe as a low energy scale operating laboratory, currently believed cosmic microwave background temperature can be considered as the low energy quantum gravitational effect. As the operating (past) energy scale was assumed to be increasing; past high cosmic back ground temperature can be considered as the high energy quantum gravitational effect. Thinking in this way, starting from the Planck scale and with reference to the decreasing magnitude of cosmic back ground temperature [7], quantum gravity can be considered as a scale independent model and the universe can be considered as the best quantum gravitational object.

3. THE CHARACTERISTIC UNIFIED MASS UNIT CONNECTED WITH BIG BANG AND PLANCK SCALE

Characteristic and unified quantum mass unit connected with big bang and Planck scalecan be expressed as follows.

$$M_U \cong \left(\frac{\pi}{xy\sqrt{45}}\right)\sqrt{\frac{hc}{G}} \cong 1.82386\times10^{-9}\ \text{kg} \qquad (1)$$

Here, from quantum theory of light [8], $x \cong 4.96511423...$ and $y \cong 2.821439372...$ This relation ca n be obtained from equations (5,6,7,8 and 9). With 98% accuracy, its classical unified expression c an be expressed as follows. In this context interested readers may go through the references [6, 9].

$$M_U \cong \sqrt{\frac{e^2}{4\pi\varepsilon_0 G}} \cong 1.859272\times10^{-9}\ \text{kg} \qquad (2)$$

4. HUBBLE CONSTANT CONNECTEDWITH BIG BANG PLANCK SCALE

With reference to modern cosmology, current and past critical mass densities can be expressed as follows.

$$\rho_0 \cong \frac{3H_0^2}{8\pi G} \text{ and } \rho_t \cong \frac{3H_t^2}{8\pi G} \qquad (3)$$

Current and past critical Hubble volumes can be can be expressed as follows.

$$V_0 \cong \frac{4\pi}{3}\left(\frac{c}{H_0}\right)^3 \text{ and } V_t \cong \frac{4\pi}{3}\left(\frac{c}{H_t}\right)^3 \qquad (4)$$

Critical masses connected with currently believed and past universe can be expressed as follows.

$$\left.\begin{aligned} M_0 \cong \rho_0 V_0 \cong \left(\frac{3H_0^2}{8\pi G}\right)\left[\frac{4\pi}{3}\left(\frac{c}{H_0}\right)^3\right] \cong \frac{c^3}{2GH_0} \\ M_t \cong \rho_t V_t \cong \left(\frac{3H_t^2}{8\pi G}\right)\left[\frac{4\pi}{3}\left(\frac{c}{H_t}\right)^3\right] \cong \frac{c^3}{2GH_t} \\ \rightarrow H_0 \cong \frac{c^3}{2GM_0} \text{ and } H_t \cong \frac{c^3}{2GM_t} \end{aligned}\right\} (5)$$

Now with reference to the above proposed unified Planck scale quantum mass M_U, unified Hubble's constant (assumed to be connected with big bang) can be defined as follows.

$$\left.\begin{aligned} H_U \cong \frac{c^3}{2GM_U} \cong \frac{xy\sqrt{45}}{2\pi}\sqrt{\frac{c^5}{Gh}} \\ \cong 1.1067817\times 10^{44} \text{ sec}^{-1} \end{aligned}\right\} (6)$$

Using this characteristic big bang Hubble constant, in a cosmological approach, a suitable pro portionality coefficient of the following form $\left[1+\ln\left(\frac{H_U}{H_t}\right)\right]$ can be considered for further study as proposed in the following sections.

5. IMPORTANTRELATIONS CONNECTED WITH QUANTUMGRAVITYAND BIG BANG

Based on the quantum cosmological concepts, the following semi empirical heuristic equations can be given a fundamental significance [6] in cosmology. Current cosmological parameters can be also be fitted accurately.

5.1. Thermal Energy Density and Critical Energy Density of the Black Hole Universe

During cosmic evolution, at any time, thermal energy density is proportional to the critical mass energy density.

$$aT_t^4 \cong \gamma.\left(\frac{3H_t^2c^2}{8\pi G}\right) \qquad (7)$$

where γ is a model dependent proportionality coefficient. With reference to the Planck scale and current key cosmological physical parameters, the proportionality coefficient can possibly be fitted in the following way [6].

$$\gamma \cong \left[1+\ln\left(\frac{H_U}{H_t}\right)\right]^{-2} \quad (8)$$

It is for further study and critical analysis.

$$aT_t^4 \cong \left[1+\ln\left(\frac{H_U}{H_t}\right)\right]^{-2}\left(\frac{3H_t^2c^2}{8\pi G}\right) \quad (9)$$

For the current universe,

$$aT_0^4 \cong \left[1+\ln\left(\frac{H_U}{H_0}\right)\right]^{-2}\left(\frac{3H_0^2c^2}{8\pi G}\right) \quad (10)$$

If $H_0 \cong 71$ km/sec/Mpc, obtained $T_0 \cong 2.723$ K.

5.2. Thermal Wave Lengths and Hubble Lengths of the Black Hole Universe

Let λ_f, λ_m represent the thermal wavelengths [8] related with frequency and wavelength domains respectively. From relations (5) to (9) and with reference to the two forms of Wien's law, at any time in the past,

$$\left(\lambda_f, \lambda_m\right)_t \cong \left(\frac{x}{y}\right)^{\pm\frac{1}{2}} \sqrt{1+\ln\left(\frac{H_U}{H_t}\right)}\left(\frac{2\pi c}{\sqrt{H_U H_t}}\right) \quad (11)$$

For the current isotropic universe [10],

$$\left(\lambda_f, \lambda_m\right)_0 \cong \left(\frac{x}{y}\right)^{\pm\frac{1}{2}} \cdot \sqrt{1+\ln\left(\frac{H_U}{H_0}\right)} \cdot \left(\frac{2\pi c}{\sqrt{H_U H_0}}\right) \quad (12)$$

If $H_0 \cong 71$ km/sec/Mpc, obtained wavelengths are
$\left(\lambda_f\right)_0 \cong 1.872655$ mm and $\left(\lambda_m\right)_0 \cong 1.06414$ mm.

5.3. Thermal Wave Lengths and Repulsive Force of the Black Hole Universe

With usual notation, from General theory of relativity [11] ,

$$G_{\mu\nu} \equiv R_{\mu\nu} - \frac{1}{2}Rg_{\mu\nu} = \frac{8\pi G}{c^4}T_{\mu\nu} \quad (13)$$

In this historical relation, the most important point to be noted is that, the expression $\left(8\pi G/c^4\right)$ seems to be a proportionality constant. If one is willing to consider its 'inverse form', it becomes $\left(c^4/8\pi G\right)$ and seems to play a very crucial role in the evolving cosmology. It can be called as the 'repulsive force' of the evolving universe. From above relations it can be expressed as follows. At any time in the past,

$$\sqrt{1+\ln\left(\frac{M_t}{M_U}\right)} \cdot \frac{\sqrt{M_U M_t}c^2}{\sqrt{\left(\lambda_f\right)_t\left(\lambda_m\right)_t}} \cong \frac{c^4}{4\pi G} \quad (14)$$

For the current universe,

$$\sqrt{1+\ln\left(\frac{M_0}{M_U}\right)}\cdot\frac{\sqrt{M_U M_0}c^2}{\sqrt{\left(\lambda_f\right)_0\left(\lambda_m\right)_0}}\cong\frac{c^4}{4\pi G} \qquad (15)$$

5.4. Interconnection in between Matter Energy Density, Thermal Energy Density and Critical Energy Density of the Black Hole Universe

During cosmic evolution, at any time, matter energy density is the geometric mean of critical mass energy density and thermal energy density.

$$\left(\rho_m\right)_t \cong \frac{1}{c^2}\sqrt{\left(\frac{3H_t^2c^2}{8\pi G}\right)\left(aT_t^4\right)}\cong\left[1+\ln\left(\frac{H_U}{H_t}\right)\right]\left(\frac{aT_t^4}{c^2}\right)$$
$$\cong\left(\frac{3H_t^2}{8\pi G}\right)\Big/\left[1+\ln\left(\frac{H_U}{H_t}\right)\right] \qquad (16)$$

For the current universe and with reference to elliptical and spiral galaxies [11] whose mass-light ratio is close to 8 to 10,

$$\left(\rho_m\right)_0 \cong \frac{1}{c^2}\sqrt{\left(\frac{3H_0^2c^2}{8\pi G}\right)\left(aT_0^4\right)}\cong\left\{1+\ln\left(\frac{H_U}{H_0}\right)\right\}\left(\frac{aT_0^4}{c^2}\right)$$
$$\cong\left(\frac{3H_0^2}{8\pi G}\right)\Big/\left\{1+\ln\left(\frac{H_U}{H_0}\right)\right\} \qquad (17)$$

If $H_0\cong 71$ km/sec/Mpc, $\left(\rho_m\right)_0\cong 6.62\times10^{-32}$ gram.cm^{-3}

5.5. Temperature and Temperature Fluctuations of the Black Hole Universe

During cosmic evolution, at any time, temperature anisotropy is directly proportional to cosmic back ground temperature.

$$\left(\delta T\right)_t \propto T_t \qquad (18)$$

$$\left(\delta T\right)_t \cong \left(\frac{3H_t^2c^2}{8\pi GaT_t^4}\right)^{-1}T_t\cong\left[1+\ln\left(\frac{H_U}{H_t}\right)\right]^{-2}T_t \qquad (19)$$

With reference to the currently observed cosmic temperature anisotropy, it is possible to guess that,

$$\left(\delta T\right)_0 \cong \left(\frac{3H_t^2c^2}{8\pi GaT_0^4}\right)^{-1}T_0\cong\left[1+\ln\left(\frac{H_U}{H_0}\right)\right]^{-2}T_0 \qquad (20)$$

If $H_0\cong 71$ km/sec/Mpc, $\left(\delta T\right)_0\cong 135$ μK .

6. TO FIT THE MAGIC NUMBERS 5%, 27% AND 67% OF THE MODERN (ACCELERATING) COSMOLOGY

Currently believed critical mass density of the universe can be expressed as follows:

$$\rho_0 \cong M_0 \Big/ \frac{4\pi}{3}\left(\frac{c}{H_0}\right)^3 \cong \frac{3H_0^2}{8\pi G} \qquad (21)$$
$$\cong 9.469\times10^{-30}\,\text{gram.cm}^{-3}$$

Currently observed matter density of the universe can be expressed as follows:

$$\left(\rho_{\text{matter}}\right)_0 \cong \left(\frac{3H_0^2}{8\pi G}\right) \Big/ \left[1+\ln\left(\frac{H_U}{H_t}\right)\right] \qquad (22)$$
$$\cong 6.62\times10^{-32}\ \text{gram.cm}^{-3}$$

Hypothetically if one is willing to think that, critical mass density of the present universe suddenly drops to the magnitude of the present 'matter density'. Then present Hubble length hypothetically increases by a factor

$$\left\{\left[1+\ln\left(\frac{H_U}{H_t}\right)\right]\right\}^{\frac{1}{3}} \cong (143.028)^{\frac{1}{3}} \cong 5.23 \quad (23)$$

This can be compared with the currently believed 'matter density percentage' of the accelerating universe [10-13].

Currently believed critical mass-energy density of the universe can be expressed as:

$$\rho_0 c^2 \cong M_0 c^2 \Big/ \frac{4\pi}{3}\left(\frac{c}{H_0}\right)^3 \cong \frac{3H_0^2 c^2}{8\pi G} \qquad (24)$$
$$\cong 8.51\times10^{-10}\,\text{J.m}^{-3}$$

Currently observed thermal energy-energy density of the universe can be expressed as:

$$aT_0^4 \cong \frac{3H_0^2 c^2}{8\pi G} \Big/ \left[1+\ln\left(\frac{H_U}{H_0}\right)\right]^2 \qquad (25)$$
$$\cong 4.16\times10^{-14}\,\text{J.m}^{-3}$$

Hypothetically if one is willing to think that, critical mass-energy density of the current universe suddenly drops to the magnitude of the current thermal energy density. Then current Hubble length hypothetically increases by a factor:

$$\left\{\left[1+\ln\left(\frac{H_U}{H_t}\right)\right]\right\}^{\frac{2}{3}} \cong (143.028)^{\frac{2}{3}} \cong 27.35 \quad (26)$$

This can be compared with the currently believed 'dark matter density percentage' of the accelerating universe [10-13].

These two accurate coincidences cast doubt on the validity of the third well believed algebraic 'dark energy density percentage form' of [100-(5.23+27.35)]% =67.42%.

7. ALTERNATIVE APPROACH TO COSMIC RED SHIFT

In this paper the authors introduce the new compound word: "Cosmologically reinforced hydrogen atom". In the evolving universe, right from the beginning of formation of hydrogen atoms, as any baby hydrogen atom starts growing, cosmologically, bonding strength increases in between proton and electron. As a result energy required to excite electron increases with increasing cosmic time and thus emitted quantum of energy also increases and difference in 'emitted quantum of energy' can be considered as the current cosmological redshift associated with galactic hydrogen atom. Observed Super novae dimming can be understood in this way [12]. Based on this new proposal, 'galaxy receding' concept suggested by Hubble [14, 15] can be reviewed at fundamental level. With 'fast running cosmic time' or with 'fast expanding cosmic

size' or with 'fast decreasing cosmic temperature' - future redshift seems to increase fast with reference to the current hydrogen atom. If it is assumed that, cosmological binding strength of proton and electron is always inversely proportional to the cosmic back ground temperature, then with usual notation, observed cosmic red shift can be expressed as follows.

$$\left(E_{photon}\right)_t \cong \left(\frac{T_0}{T_t}\right)\left\{\left(\frac{e^4 m_e}{32\pi^2\varepsilon_0^2\hbar^2}\right)\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right]\right\} \cong \frac{hc}{\lambda_t} \qquad (27)$$

where, T_0 represents the current CMBR temperature, T_t represents past cosmic back ground temperature and λ_t is the wavelength of photon 'emitted as well as received' from the galactic hydrogen atom.

At any time in the past, at any galaxy, emitted photon energy can be expressed as follows.

$$\left.\begin{aligned} E_t \cong \frac{hc}{\lambda_t} \cong \left(\frac{T_0}{T_t}\right)\left(\frac{hc}{\lambda_0}\right) \cong \left(\frac{T_0}{T_t}\right)E_0 \\ \rightarrow z_0 \cong \frac{\lambda_t-\lambda_0}{\lambda_0} \cong \frac{E_0-E_t}{E_t} \cong \frac{T_t-T_0}{T_0} \\ \text{and} \quad \frac{E_0}{E_t} \cong \frac{\lambda_t}{\lambda_0} \cong \frac{T_t}{T_0} \cong \left(z_0+1\right) \end{aligned}\right\} \qquad (28)$$

Here, z_0 is the current redshift, E_t is the energy of emitted photon from the galactic hydrogen atom and E_0 is the corresponding energy in the laboratory. λ_0 is the λ_t's corresponding wave length in the laboratory.

From laboratory point of view, above concept can be understood in the following way. After some time in future,

$$z_f \cong \frac{E_f-E_0}{E_0} \cong \frac{E_f}{E_0}-1 \qquad (29)$$

Here, E_f is the energy of photon emitted from laboratory hydrogen atom after some time in future. E_0 is the energy of current photon emitted from laboratory hydrogen atom. z_f is the redshift of laboratory hydrogen atom after some time in future. From now onwards, as time passes, in future - $\left[d\left(z_f\right)/dt\right]$ can be considered as an index of the absolute rate of cosmic expansion. Within the scope of experimental accuracy of laboratory hydrogen atom's redshift, it can be suggested that,

$$\left.\begin{aligned} \left[d\left(z_f\right)/dt\right] \rightarrow \text{Increasing} \rightarrow \text{Cosmic Acceleration} \\ \left[d\left(z_f\right)/dt\right] \rightarrow \text{Constant} \rightarrow \text{Cosmic Uniform expansion} \\ \left[d\left(z_f\right)/dt\right] \rightarrow \text{Decreasing} \rightarrow \text{Cosmic Deceleration} \\ \left[d\left(z_f\right)/dt\right] \rightarrow \text{Zero} \rightarrow \text{Cosmic halt} \end{aligned}\right\} (30)$$

8. DISCUSSION

The authors request the science community to please look into the following points in a true scientific spirit.

1) As suggested by Hawking [16], there is no scientific evidence to Friedmann's second assumption [17].
2) If it is true that galaxy constitutes so many stars, each star constitutes so many hydrogen atoms and light is coming from any excited electron of any galactic star's any hydrogen atom, then considering redshift as an index of 'whole galaxy' receding may not be reasonable.
3) Merely by estimating 'galaxy distance' and without measuring any 'galaxy's actual receding speed', one cannot verify the cosmic acceleration. Note that, in 1947 Hubble himself thought for a new mechanism for understanding the observed red shift. In this context, interested readers may refer [15]. Even though it is very attractive, Einstein could not implement the Mach's principle [18] in Hubble-Friedmann-cosmology.
4) Until 1964, cosmologists could not believe in 'cosmic background temperature'.
5) Current 'quantum gravity' is in its advanced theoretical phase.

In this context, with relations starting from (7) to (26) the authors fitted the currently confirmed cosmological data very accurately. Starting from relations (27) to (30) the authors proposed a very interesting mechanism for understanding the observed cosmic redshift and true cosmic rate of expansion. Henceforth the proposed new concepts and relations can be considered for further research and analysis positively.

9. CONCLUSION

With reference to Mach's principle, cosmic 'critical density', 'critical volume' and 'critical mass' can be considered as the quantified dynamic back ground properties of the evolving universe**.** With reference the proposed semi empirical relations and accurate data fitting, now it seems inevitable to revise the basics of modern cosmology with respect to Quantum gravity and Mach's principle. Based on the Hubble's law and Super novae dimming, currently it is believed that, universe is accelerating [12, 13]. In the authors' opinion, if magnitude of past Hubble's constant was higher than the current magnitude then magnitude of past (c/H_t) will be smaller than the current Hubble length (c/H_0). Based on this logic, rate of decrease of the Hubble constant can be considered as a true index of rate of increase in Hubble length. Proceeding further - in future, with reference to the current Hubble's constant, $d(c/H_0)/dt$ certainly gives the true cosmic rate of expansion. Similarly, by considering $d(T_0)/dt$ -present 'true cosmic rate of expansion' can be understood. To understand the ground reality, accuracy of current methods of estimating the magnitudes of $(H_0 \text{ and } T_0)$ must be improved.

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