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A Brief Report on Scale Independent Quantum Cosmology

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ABSTRACT

In this paper an attempt is made to highlight and strengthen the inherent role of quantum gravity in cosmology. At any time, the product of cosmic 'critical density' and 'critical Hubble volume' can be called as the 'critical mass' of the evolving universe. By considering the Planck mass as the critical mass connected with big bang, Planck scale critical mass density and Hubble constant can be defined. Proceeding further, it can be suggested that, during evolution, cosmic thermal energy density may be directly proportional to critical mass-energy density. Observed redshift can be reinterpreted as a cosmological light emission phenomenon connected with cosmologically reinforcing hydrogen atom. 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.

Introduction

Photon can be considered as the best candidate of quantum gravitational object. It is true that, without the universe there is no independent existence to any photon. Now the fundamental question to be answered is: Is the universe a quantum gravitational object or something else? Physicists expressed several opinions with many possible solutions [1,2]. By correlating the basics of Quantum mechanics, Special and General theories of relativity and big bang - in this letter authors explore the possibility of developing a scale independent quantum cosmology.

Scale independent quantum cosmology

Some of the other modern cosmologists believe that, during the cosmic evolution, Planck scale quantum gravitational interactions might have an observable effect on the current observable cosmological phenomena. Clearly speaking, with respect to the current concepts of 'Quantum gravity' and Planck scale early universal laboratory, current universe can be considered as a low energy scale laboratory. If so, cosmological quantum gravity can be considered as the scale independent model. If one is willing to consider the current observable universe as a low energy scale operating laboratory, currently believed cosmic microwave back ground temperature can be considered as the low energy quantum gravitational effect. At any time in the past, i.e as the operating 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 [3], quantum gravity can be considered as a scale independent model and the universe can be considered as the best quantum gravitational object.

The unified Planck scale mass unit connected with big bang

With reference to the famous Planck's constant, the unified quantum mass unit connected with big bang can be expressed as follows. It can be obtained from equations (5,6 and 8).

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

Here, from quantum theory of light [4,5],
$x \cong 4.9651142317442...$ and $y \cong 2.82143937212...$

With 98% accuracy, its classical unified expression can be expressed as follows. In this context interested readers may go through the reference [5].

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

1. The unified quantum scale Hubble constant connected with big bang

With reference to the General theory of light and Friedmann cosmology, current and past critical mass densities can be expressed as follows.

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

With reference to the observable volume of the current and past universe, current and past critical volumes can be can be expressed as follows.

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

Characteristic critical masses of the current and past universe can be expressed as follows.

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

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Scientists proposed several characteristic constants connected with unification and cosmology. 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.

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

Using this characteristic big bang Hubble constant, in a cosmological approach, a suitable proportionality 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.

Different relations connected with Quantum cosmology and big bang

Based on the quantum cosmological concepts, the following semi empirical heuristic equations can be given a fundamental significance [5] in cosmology. Using these relations current cosmological parameters can be fitted accurately. Relation between thermal energy density and critical energy density

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

$$aT_t^4 \propto \frac{3H_t^2c^2}{8\pi G} \quad (7)$$

With reference to the Planck scale and by considering the proportionality factor as $\left[1+\ln\left(\frac{H_U}{H_t}\right)\right]^{-2}$,

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

For the current universe,

$$aT_0^4 \cong \left[1+\ln\left(\frac{H_U}{H_0}\right)\right]^{-2}\left(\frac{3H_0^2c^2}{8\pi G}\right) \quad (9)$$

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

Relation between cosmic thermal wave lengths and Hubble lengths

Let λ_f, λ_m represent the thermal wavelengths [4] related with frequency and wavelength domains respectively. From relations and with reference to the two forms of Wien's law, at any time in the past,

$$\left.\begin{aligned}(\lambda_f,\lambda_m)_t &\cong \left(\frac{x}{y}\right)^{\pm\frac{1}{2}}\cdot\sqrt{1+\ln\left(\frac{H_U}{H_t}\right)}\cdot\left(\frac{2\pi c}{\sqrt{H_UH_t}}\right)\\ \rightarrow (\lambda_f)_t &\cong \left(\frac{x}{y}\right)^{\frac{1}{2}}\cdot\sqrt{1+\ln\left(\frac{H_U}{H_t}\right)}\cdot\left(\frac{2\pi c}{\sqrt{H_UH_t}}\right)\\ (\lambda_m)_t &\cong \left(\frac{y}{x}\right)^{\frac{1}{2}}\cdot\sqrt{1+\ln\left(\frac{H_U}{H_t}\right)}\cdot\left(\frac{2\pi c}{\sqrt{H_UH_t}}\right)\end{aligned}\right\} \quad (10)$$

For the current universe,

$$(\lambda_f,\lambda_m)_0 \cong \left(\frac{x}{y}\right)^{\pm\frac{1}{2}}\cdot\sqrt{1+\ln\left(\frac{H_U}{H_0}\right)}\cdot\left(\frac{2\pi c}{\sqrt{H_UH_0}}\right) \quad (11)$$

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

Relation between matter energy density, thermal energy density and critical energy density

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

$$(\rho_m)_t \cong \frac{1}{c^2}\sqrt{\left(\frac{3H_t^2c^2}{8\pi G}\right)(aT_t^4)} \cong \sqrt{1+\ln\left(\frac{H_U}{H_t}\right)}\left(\frac{aT_t^4}{c^2}\right) \cong \left(\frac{3H_t^2}{8\pi G}\right)\Big/\sqrt{1+\ln\left(\frac{H_U}{H_t}\right)} \quad (12)$$

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

$$(\rho_m)_0 \cong \frac{1}{c^2}\sqrt{\left(\frac{3H_0^2c^2}{8\pi G}\right)(aT_0^4)} \cong \sqrt{1+\ln\left(\frac{H_U}{H_0}\right)}\left(\frac{aT_0^4}{c^2}\right) \cong \left(\frac{3H_0^2}{8\pi G}\right)\Big/\sqrt{1+\ln\left(\frac{H_U}{H_0}\right)} \quad (13)$$

If $H_0 \cong 71$ km/sec/Mpc, $(\rho_m)_0 \cong 6.62\times 10^{-32}$ gram.cm^{-3}

Relation between cosmic temperature and temperature fluctuations

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

$$(\delta T)_t \propto T_t \quad (14)$$

$$(\delta T)_t \cong \left(\frac{3H_t^2c^2}{8\pi GaT_t^4}\right)^{-1}T_t \cong \left[1+\ln\left(\frac{H_U}{H_t}\right)\right]^{-2}T_t \quad (15)$$

For the current universe,

$$(\delta T)_0 \cong \left(\frac{3H_t^2c^2}{8\pi GaT_0^4}\right)^{-1}T_0 \cong \left[1+\ln\left(\frac{H_U}{H_0}\right)\right]^{-2}T_0 \quad (16)$$

If $H_0 \cong 71$ km/sec/Mpc, $(\delta T)_0 \cong 135\ \mu$K

Reinterpreting cosmic red shift

During the cosmic evolution, right from the beginning of the formation of hydrogen atoms, as the baby hydrogen atom starts growing, cosmologically bonding strength increases in between proton and electron casing increasing electron excitation energy to emit increased quantum of energy. With reference to the current grown or strengthened or reinforced hydrogen atom, difference in 'emitted quantum of energy' can be considered seen as a cosmological redshift associated with galactic hydrogen atom and no way connected with the galaxy receding [6,7]. If cosmic time is running fast or if cosmic size/boundary is increasing fast or if cosmic temperature is decreasing fast then redshift seems to increase fast with reference to the current hydrogen atom. For a while guess that cosmological binding strength of proton and electron in the cosmologically evolving hydrogen atom is inversely proportional to the cosmic temperature, then with usual notation, observed cosmic red shift can be expressed as follows.

$$(E_{photon})_t \cong \left(\frac{T_0}{T_t}\right)\left\{\left(\frac{e^4m_e}{32\pi^2\varepsilon_0^2\hbar^2}\right)\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right]\right\} \cong \frac{hc}{\lambda_t} \quad (17)$$

where, T_0 represents the current CMBR temperature, represents T_t past cosmic temperature and λ_t is the wavelength of photon received from the galactic photon. At any time in the past, at any galaxy, emitted photon energy can be expressed as follows.

$$\left.\begin{array}{l} E_t \cong \dfrac{hc}{\lambda_t} \cong \left(\dfrac{T_0}{T_t}\right)\left(\dfrac{hc}{\lambda_0}\right) \cong \left(\dfrac{T_0}{T_t}\right)E_0 \\ \to z_0 \cong \dfrac{\lambda_t - \lambda_0}{\lambda_0} \cong \dfrac{E_0 - E_t}{E_t} \cong \dfrac{T_t - T_0}{T_0} \\ \text{and } \dfrac{E_0}{E_t} \cong \dfrac{\lambda_t}{\lambda_0} \cong \dfrac{T_t}{T_0} \cong (z_0 + 1) \end{array}\right\} \quad (18)$$

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_t is the wave length of emitted and received photon from the galactic hydrogen atom and λ_0 is the corresponding wave length in the laboratory. At any time in the past - in support of the proposed cosmological red shift interpretation, in hydrogen atom above relations can be expressed in the following form. From Bohr's theory of hydrogen atom, with usual notation, for the revolving electron,

$$\left(E_{\text{potential}}\right)_t \cong -\left(\frac{T_0}{T_t}\right)\frac{e^4 m_e}{16\pi^2\varepsilon_0^2\hbar^2} \quad (19)$$

$$\left(E_{\text{total}}\right)_t \cong -\left(\frac{T_0}{T_t}\right)\frac{e^4 m_e}{32\pi^2\varepsilon_0^2\hbar^2} \quad (20)$$

$$\left(E_{\text{photon}}\right)_0 \cong \left(\frac{T_0}{T_t}\right)\left\{\frac{e^4 m_e}{32\pi^2\varepsilon_0^2\hbar^2}\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right]\right\} \quad (21)$$

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

$$z_f \cong \frac{E_f - E_0}{E_0} \cong \frac{E_f}{E_0} - 1 \quad (22)$$

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 - $\left[d(z_f)/dt\right]$ can be considered as an index of the absolute rate of cosmic expansion. As cosmic time passes, within the scope of experimental accuracy of laboratory hydrogen atom's redshift, if magnitude of $\left[d(z_f)/dt\right]$ is gradually increasing, it is an indication of cosmic acceleration. If magnitude of $\left[d(z_f)/dt\right]$ is practically constant, it is an indication of uniform rate of cosmic expansion. If magnitude of $\left[d(z_f)/dt\right]$ is gradually decreasing, it is an indication of cosmic deceleration. If magnitude of $\left[d(z_f)/dt\right]$ is zero, it is an indication of cosmic halt.

Discussion and Conclusion

Quantum cosmology is a field attempting to study the effect of quantum mechanics on the formation of the universe, or its early evolution, especially just after the Big Bang. In this context, in this brief report, the authors introduced the words, 'cosmic critical volume' and 'cosmic critical mass'. Sincerely speaking, these two words seem to be connected with "Mach's principle". Accommodating Mach's principle in modern cosmology is a very challneging but 'inevitable' task. With reference to the proposed semi empirical relations and accurate data fitting, now it seems essential to revise the basics of modern cosmology with respect to Quantum gravity and Mach's principle [8,9]. Based on the Hubble's law and based on the Super novae dimming [10], currently it is believed that, universe is accelerating [11]. Modern cosmologists believe that rate of the change of the Hubble constant describes how fast/slow the Hubble constant changes over time and this rate does not tell if the Universe is currently expanding. This logic seems to be misleading. In authors' opinion, if magnitude of past Hubble's constant was higher than the current magnitude then magnitude of past $\left(c/H_t\right)$ will be smaller than the current Hubble length $\left(c/H_0\right)$. If so rate of decrease of the Hubble constant can be considered as a true index of rate of increase in Hubble length and thus with reference to Hubble length, rate of decrease of the Hubble constant can be considered as a true index of cosmic rate of expansion. Proceeding further - in future, certainly with reference to current Hubble's constant, $d\left(c/H_0\right)/dt$ gives the true cosmic rate of expansion. Same logic can be applied to cosmic back ground temperature also. Clearly speaking $d\left(T_0\right)/dt$ gives the true cosmic rate of expansion. To understand the ground reality, accuracy of current methods of estimating the magnitudes of $\left(H_0 \text{ and } T_0\right)$ must be improved [12]. Future science, engineering and technology may resolve all the related issues

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