Scale Independent Quantum Black Hole Cosmology

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Abstract: ***Considering the subject of black hole cosmology as a key branch of the quantum gravity, many fundamental issues of theoretical and observational cosmology can be understood.***

1. Introduction

Even though standard cosmology [1] indirectly confirmed the existence of dark energy and dark matter, so far no ground based laboratory confirmed their individual existence. If theoretical predictions are not in line with the observations, then either observations has to be interpreted in a different manner or theory has to be modified as per the observations. In this context, quantum gravity [2] can be a considered as a key tool. In the Wikipedia one can see a beautiful review on quantum gravity. One of the difficulties of quantum gravity is that quantum gravitational effects are only expected to become apparent near the Planck scale (a scale far smaller in distance and far larger in energy than what is currently accessible at high energy particle accelerators). As a result, quantum gravity seems to be mainly a theoretical enterprise, although there are speculations about how quantum gravity effects might be observed in existing experiments. Anyhow combining quantum mechanics and general theory of relativity is a must and needs conceptual fine tuning. It can be understood in the following way.

1) To consider the cosmic microwave back ground temperature as a quantum gravitational effect [3].
2) To consider the CMBR temperature as the characteristic temperature of the evolving primordial cosmic black hole [4-11].
3) To consider the primordial cosmic black hole as an evolving and light speed rotating black hole with angular velocity identical with the cosmological hubble constant.
4) As suggested by the hot big bang model [12], to consider the current black hole universe as decelerating. Modern cosmologists believe that the 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 the 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 the 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, sensitivity and accuracy of current methods of estimating the magnitudes of $\left(H_0 \text{ and } T_0\right)$ must be improved [13].

2. Important results

A. Physical measurements of the black hole universe

If it is assumed that, from the beginning of the Planck scale, universe always rotates at light speed with angular velocity identical to the corresponding hubble constant,

At the Planck scale**,**

$$R_{Pl} \cong \frac{2GM_{Pl}}{c^2} \text{ and } H_{Pl} \cong \frac{c}{R_{Pl}} \cong \frac{c^3}{2GM_{Pl}} \tag{1}$$

where, $\left(M_{Pl}, R_{Pl}, H_{Pl}\right)$ represent the Planck scale mass, radius and hubble constant respectively. At any time in the past,

$$R_t \cong \frac{2GM_t}{c^2} \text{ and } H_t \cong \frac{c}{R_t} \cong \frac{c^3}{2GM_t} \tag{2}$$

where, $\left(M_t, R_t, H_t\right)$ represent the past mass, radius and hubble constant respectively. At present,

$$R_0 \cong \frac{2GM_0}{c^2} \text{ and } H_0 \cong \frac{c}{R_0} \cong \frac{c^3}{2GM_0} \tag{3}$$

where, $\left(M_0, R_0, H_0\right)$ represent the past mass, radius and hubble constant respectively.

B. Temperature of the evolving black hole universe

At the Planck scale [14]**,**

$$T_{Pl} \cong \frac{\hbar c^3}{8\pi k_B G M_{Pl}} \tag{4}$$

where, T_{Pl} represents the Planck scale cosmic black hole's temperature. At any time in the past,

$$T_t \cong \frac{\hbar c^3}{8\pi k_B G\sqrt{M_t M_{Pl}}} \cong \frac{\hbar}{4\pi k_B}\left(\frac{c^3}{2G\sqrt{M_t M_{Pl}}}\right) \cong \frac{\hbar\sqrt{H_t H_{Pl}}}{4\pi k_B} \quad (5)$$

where, T_t represents the past cosmic black hole's temperature. At present,

$$T_0 \cong \frac{\hbar}{4\pi k_B}\left(\frac{c^3}{2G\sqrt{M_0 M_{Pl}}}\right) \cong \frac{\hbar\sqrt{H_0 H_{Pl}}}{4\pi k_B} \quad (6)$$

where, T_0 represents the current cosmic black hole's temperature. From this relation current Hubble's constant can be expressed and fitted in the following way.

$$H_0 \cong \left(\frac{4\pi k_B T_0}{\hbar}\right)^2 \frac{1}{H_{Pl}} \cong \left(\frac{4\pi k_B T_0}{\hbar}\right)^2 \left(\frac{2GM_{Pl}}{c^3}\right) \quad (7)$$

$$\cong 66.893 \text{ km/sec/Mpc.}$$

This is matching with the current estimations [13]: $\{(67.80 \pm 0.77), (68.1 \pm 1.2)\}$ km/sec/Mpc. Thus from now onwards, CMBR temperature can be called as 'Comic Black Hole's Thermal Radiation' temperature. If current rate of decrease in H_0 is small very and is beyond the scope of observational or experimental detection – for the whole cosmic black hole as H_0 practically remains constant, its corresponding thermal energy density will be the same throughout its volume. This may be the reason for the observed 'isotropic' nature of the current CMB radiation. At any time in the past,

$$\frac{T_t}{T_0} \cong \sqrt{\frac{H_t}{H_0}} \quad (8)$$

C. Matter density in the evolving black hole universe

At the Planck scale**,**

$$\rho_{Pl} \cong \left(\frac{aT_{Pl}^4}{c^2}\right) \quad (9)$$

where, ρ_{Pl} represents the Planck scale cosmic black hole's matter density. At any time in the past**,**

$$\rho_t \cong \left[1 + \ln\left(\frac{M_t}{M_{Pl}}\right)\right]\left(\frac{aT_t^4}{c^2}\right) \cong \left[1 + \ln\left(\frac{H_{Pl}}{H_t}\right)\right]\left(\frac{aT_t^4}{c^2}\right) \quad (10)$$

where, ρ_t represents the past cosmic black hole's matter density. At present**,**

$$\rho_0 \cong \left[1 + \ln\left(\frac{M_0}{M_{Pl}}\right)\right]\left(\frac{aT_0^4}{c^2}\right) \cong \left[1 + \ln\left(\frac{H_{Pl}}{H_0}\right)\right]\left(\frac{aT_0^4}{c^2}\right) \quad (11)$$

$$\cong 6.53 \times 10^{-32} \text{ gram / cm}^3$$

where, ρ_0 represents the current cosmic black hole's matter density. Note that almost (70 to 80)% of the galaxies are in the form of elliptical and spiral galaxies. For spiral galaxies, mass-to-light ratio is $\eta h_0^{-1} \cong 9 \pm 1$ 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 9. Based on the average mass-to-light ratio for elliptical and spiral galaxies present matter density can be expressed with the following relation.

$$(\rho_m)_0 \cong 1.5 \times 10^{-32} \eta h_0 \text{ gram/cm}^3 \quad (12)$$

Here, $\eta \cong \left\langle \frac{M}{L} \right\rangle_{\text{galaxy}} \Big/ \left\langle \frac{M}{L} \right\rangle_{\text{sun}}$ and $h_0 \cong 0.68$.

Corresponding matter density is close to 6.24 × 10^{-32} gram/cm^3 and can be compared with the above proposed magnitude of 6.5 × 10^{-32} gram/cm^3.

D. Galactic rotational curves in the current black hole universe

With reference to the MOND results [15], empirically rotational speed of a star is being represented as

$$v_s \cong \sqrt[4]{GMa_0} \quad (13)$$

where $a_0 \cong (1.2 \pm 0.3) \times 10^{-10}$ $m.\text{sec}^{-2} \approx cH_0/2\pi$, and M is the mass of galaxy. In the light speed rotating black hole universe,

1) The acceleration constant a_0 is not a constant but a variable and depends on the galactic revolving speed about the center of the light speed rotating black hole universe.
2) Its magnitude can be assumed to be proportional to the current hubble constant and can be called as the cosmological galactic acceleration.
3) By considering the galactic revolving speed V_g about the center of the cosmic black hole, magnitude of (cH_0) can be assumed to vary in the following way.

$$(V_g/c)(cH_0) \cong (V_g H_0) \cong a_g \,. \quad (14)$$

Thus authors replace the empirical acceleration constant a_0 with (a variable) cosmological galactic acceleration, $a_g \cong V_g H_0$. Now rotational speed of a star in any galaxy can be represented as follows.

$$v \cong \sqrt[4]{GM(V_g H_0)} \cong \sqrt[4]{GMr_g H_0^2} \quad (15)$$

Here if it is assumed that, galaxies under observation possesses a cosmological revolving speed in the range 0.1 to 0.25 times the speed of light currently observed all galactic rotational speeds can be fitted well. If current $H_0 \cong 68$ km/sec/Mpc, $0.1(cH_0) \cong 0.66\times10^{-10}\, m.\sec^{-2}$ and $0.25(cH_0) \cong 1.65\times10^{-10}\, m.\sec^{-2}$. Advantage of this proposal is that, by knowing the galactic mass and rotational speeds of its stars, galactic revolving speed and hence distance between galaxy and the cosmic black hole center can be estimated. This is for further study. It is true that this proposal is 1) Qualitatively suitable for understanding the galactic rotation curves in the light of light speed cosmic rotation. 2) By knowing the galactic rotational speeds quantitatively suitable for estimating the galactic cosmological revolution speed and distance from the cosmic center.

E. Galactic redshift in the evolving black hole universe

During cosmic evolution, at any time in the past , decreasing cosmic black hole's temperature forced hydrogen atom to emit increasing photon energy. Thus past light emitted from older galaxy's excited hydrogen atom will show redshift with reference to the current laboratory data. As cosmic time passes, in future, the absolute rate of cosmic expansion can be understood by observing the rate of increase in the magnitude of photon energy emitted from laboratory hydrogen atom. Aged super novae dimming may be due to the effect of high cosmic back ground temperature. Observed galactic redshift can be understood in the following way.

$$\left.\begin{aligned} \frac{E_0}{E_t} &\cong \frac{\lambda_t}{\lambda_0} \cong \frac{T_t}{T_0} \cong (z_0+1) \\ z_0 &\cong \frac{E_0-E_t}{E_t} \cong \frac{\lambda_t-\lambda_0}{\lambda_0} \cong \frac{T_t-T_0}{T_0} \end{aligned}\right\} \tag{16}$$

Here, 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. T_t is the cosmic temperature at the time when the photon was emitted and T_0 is the current cosmic temperature and z_0 is the current redshift.

At any time in the past - in support of the proposed cosmological red shift interpretation, in hydrogen atom, total energy of electron in n^{th} orbit can be expressed as follows.

$$\begin{aligned} (E_{\text{tot}})_t &\cong -\left(\frac{T_0}{T_t}\right)\frac{e^4 m_e}{32\pi^2\varepsilon_0^2\hbar^2 n^2} \\ &\cong -\sqrt{\frac{H_0}{H_t}}\cdot\frac{e^4 m_e}{32\pi^2\varepsilon_0^2\hbar^2 n^2} \end{aligned} \tag{17}$$

where $n = 1,2,3,..$ From laboratory point of view, above concept can be understood in the following way. After some time in future,

$$z_f \cong \frac{E_f - E_0}{E_0} \cong \frac{E_f}{E_0} - 1 \tag{18}$$

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. In future - within the scope of experimental accuracy of laboratory hydrogen atom's redshift - $\left[d(z_f)/dt\right]$ can be considered as a true index of absolute rate of cosmic expansion. It can be understood from table-1 in the following way.

Table-1: To understand the true nature of cosmic expansion

	Nature of change	Nature of cosmic expansion
$\frac{d(z_f)}{dt}$	Increasing	Acceleration
	Constant	Uniform rate
	Decreasing	Deceleration
	Zero	Zero

F. Strange microscopic quantum mechanical result

To a great surprise it is noticed that,

$$\sqrt{\left(\frac{2GM_0}{c^2}\right)\left(\frac{2G\sqrt{m_p m_e}}{c^2}\right)} \cong \frac{e^2}{4\pi\varepsilon_0 m_e c^2} \tag{19}$$

Here, m_e, m_p and represent the rest masses of electron and proton respectively and $M_0 \cong c^3/2GH_0$. If one is willing to consider that the current black hole universe is decelerating and reaching a point of no expansion, i.e. saturation of expansion, above relation can be expressed as follows.

$$\frac{2G\sqrt{M_S\sqrt{m_p m_e}}}{c^2} \Rightarrow \frac{e^2}{4\pi\varepsilon_0 m_e c^2} \tag{20}$$

where $M_S \cong c^3/2GH_S$ and H_S can be called as the saturated hubble constant. If so to a great accuracy, $H_S \cong 67.5$ km/sec/Mpc. Proceeding further, if one is willing to consider 'half the magnitude of classical radius of electron' as the Compton wavelength of charged Pion, then

$$\frac{G\sqrt{M_S\sqrt{m_p m_e}}}{c^2} \Rightarrow \frac{\hbar}{m_\pi c} \tag{21}$$

If so, $H_S \cong 67.0$ km/sec/Mpc. Clearly speaking, when the magnitude of hubble constant reaches 67 km/sec/Mpc, quantum mechanically rate of expansion of the black hole universe becomes zero and there is no further expansion! This is a best example of the combined study of cosmology and microscopic physics.

G. To understand the galactic revolution and receding

As the universe is growing and always rotating at light speed , at any time, any galaxy will have revolution speed as well as receding speed [16] simultaneously and both can be expressed in the following way.

$$\left(V_g\right)_{revolution} \cong \left(\frac{r_g}{R_t}\right)c \cong r_g H_t \tag{22}$$

r_g is the distance between galaxy and the cosmic center,

R_t is the cosmic radius at time t and $r_g \leq \left(R_t \cong \frac{c}{H_t}\right)$.

$$\left(v_g\right)_{receding} \cong \left(\frac{r_g}{R_t}\right)\frac{dR_t}{dt} \cong \left(\frac{r_g}{R_t}\right)\frac{d}{dt}\left(\frac{c}{H_t}\right) \tag{23}$$

At present,

$$\left(V_g\right)_{revolution} \cong \left(\frac{r_g}{R_0}\right)c \cong r_g H_0 \tag{24}$$

$$\left(v_g\right)_{receding} \cong \left(\frac{r_g}{R_0}\right)\frac{dR_0}{dt} \cong \left(\frac{r_g H_0}{c}\right)\frac{d}{dt}\left(\frac{c}{H_0}\right) \tag{25}$$

3. Conclusion

Based on the above concepts, results and data fitting procedure, it can be suggested that,

1) With reference to the current CMB radiation temperature, foundations of Quantum mechanics and General theory of relativity may be reviewed in a unified manner.
2) Until the confirmation of right cosmology, black hole cosmology [4-11] can be given equal priority along with the presently believed accelerating cosmology.

In a nut shell, considering the current cosmic microwave back ground temperature as a quantum gravitational effect of the evolving primordial cosmic black hole, general theory of relativity and quantum mechanics can be combined into a 'scale independent' true unified model of quantum gravity. Considering cosmic black hole's light speed rotation and galactic revolution, observed galactic rotational curves can be understood. In the past, decreasing high cosmic black hole temperature forced hydrogen atom to emit increasing photon energy resulting in the observed redshift. Aged super novae dimming may be due to the effect of past high cosmic black hole temperature. As cosmic time passes, decreasing current cosmic black hole temperature makes hydrogen atom to emit increased quanta of energy causing the future redshift. In future, with reference to laboratory hydrogen atom, decreasing current cosmic temperature and measured rate of increase in emitted photon energy - true rate of future cosmic expansion can be understood. With reference to the decreasing current Hubble constant and decreasing current cosmic black hole temperature, true rate of future cosmic expansion can also be understood. Studying microscopic physics and black hole cosmology in a unified manner, foundations of Quantum mechanics and General theory of relativity may be reviewed and the true cosmic rate of expansion can be understood.

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