LOW ENERGY SCALE APPLICATIONS OF QUANTUM COSMOLOGY

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Motivating Concept-1

- **It may or may not be possible to see the internal structure of any astrophysical black hole, as a special case, if one is willing to consider the whole observable universe as an evolving black hole, it certainly paves a way to understand/verify the combined effects of quantum theory and gravity assumed to be associated with ‘*past*’ and ‘*current*’ situations of the universe.**

Motivating Concept-2

- **So far modern astrophysicists could not visualize the internal structure or internal constructional features of any astrophysical black hole. In addition, astrophysicists strongly guessing the existence of 'primordial black holes'. When it is believed that, universe constitutes so many galaxies with so many galactic central black holes, then one cannot rule out the possibility of considering the universe as a growing black hole.**

Motivating Concept-3

a) **Implementing Planck scale in current paradigm of cosmological observations and standard cosmology is very challenging and is inevitable.**

b) **If 'Planck mass' is the characteristic beginning 'mass scale' of the universe, then by substituting the geometric mean mass of the present Hubble mass and the Planck mass in the famous Hawking's black hole temperature formula, the observed 2.725 K can be obtained very easily.**

Motivating Concept-4

- **Recent cosmological observations strongly support the revision of 'cosmic acceleration' with 'constant speed of expansion'. If 'whole theoretical and observational physics' is believed to follow photon's characteristic speed limit- as a special case, 'constant rate of cosmic expansion' can suitably be synchronized with 'speed of light' and other cosmological observations.**

Motivating Concept-5

- **Until one finds solid applications of super luminal speeds and super luminal expansions in other areas of physics like astrophysics and nuclear astrophysics, currently believed 'cosmic inflation' cannot be considered as a real physical model and alternative proposals of inflation can be given a chance in exploring the evolving history of the universe.**

Back ground of the Assumptions

1. Assumptions are believed to be associated with Quantum gravity.
2. Assumptions seem to be practical and strictly follow Special theory of light
3. Number of assumptions can be limited to three.

First Assumption

- Right from the beginning of the Planck scale, the cosmic horizon is expanding at light speed.

Second Assumption

- Beginning with the Planck scale, the cosmic radius and Hubble parameter follow the relation,

$$R_t \cong \frac{2GM_t}{c^2} \cong \frac{c}{H_t}$$

where (R_t, M_t, H_t and c) represent the radius, mass, Hubble parameter and expansion speed at time t, respectively.

Third assumption

- At any stage of cosmic evolution, thermal energy density is directly proportional to the mass energy density and ratio of mass energy density and thermal energy density is equal to

$$\left[\frac{3H_t^2c^2}{8\pi G}\bigg/ aT_t^4\right] \cong \frac{3H_t^2c^2}{8\pi G} \cong \left[1+\ln\left(\frac{H_{pl}}{H_t}\right)^2\right]$$

Where, T_t is the cosmic temperature, $H_{pl} \cong (1/2)\sqrt{c^5/G\hbar}$ is the Planck scale Hubble parameter and

H_t is the cosmic Hubble parameter at time t.

Galactic redshift

- Observed galactic red shift is a secondary consequence of cosmic evolution and cannot be a considered as a deciding factor of current and future cosmic rate of expansion.
- Clearly speaking, galactic redshift cannot be considered as a major criterion of cosmic evolution.

$$Z \cong \sqrt{\frac{H_t}{H_0} - 1} \cong \sqrt{\frac{R_0}{R_t} - 1} \cong \sqrt{\frac{2GM_0}{c^2 R_t} - 1} \cong \sqrt{\frac{T_t^2}{T_0^2} - 1} \simeq \frac{T_t}{T_0}$$

where $R_t < R_0$, and $M_0 \cong c^3 / 2GH_0$.

Visual matter density

$$\left(\rho_{v.matter}\right)_t c^2 \cong \left[1+\ln\left(x_t\right)\right]\sqrt{\left(\frac{3H_t^2c^2}{8\pi G}\right)\left(aT_t^4\right)}$$

$$\text{where, } x_t \cong \sqrt{\frac{3H_t^2c^2}{8\pi GaT_t^4}} \cong 1+\ln\left(\frac{H_{pl}}{H_t}\right)$$

Dark matter density

$$\left(\rho_{d.matter}\right)_t c^2 \cong \left[1+\ln\left(x_t\right)\right]^2 \sqrt{\left(\frac{3H_t^2c^2}{8\pi G}\right)\left(aT_t^4\right)}$$

$$\text{where, } x_t \cong \sqrt{\frac{3H_t^2c^2}{8\pi G a T_t^4}} \cong 1+\ln\left(\frac{H_{pl}}{H_t}\right)$$

Dark matter and Visual matter Density ratio

- At any stage of cosmic expansion,

$$\frac{\left(\rho_{d.matter}\right)_t c^2}{\left(\rho_{v.matter}\right)_t c^2} \cong \left[1+\ln\sqrt{\frac{3H_t^2c^2}{8\pi GaT_t^4}}\right] \cong \left\{1+\ln\left[1+\ln\left(\frac{H_{pl}}{H_0}\right)\right]\right\}$$

$$\frac{\left(\rho_{d.matter}\right)_0 c^2}{\left(\rho_{v.matter}\right)_0 c^2} \cong 5.963$$

Cosmic Age

- At any stage of cosmic expansion,

$$\left.\begin{array}{l} t \cong \dfrac{\left(R_t - R_{pl}\right)}{c} \quad \text{and} \\ ct \cong \left(R_t - R_{pl}\right) \cong R_t \quad (\text{where } R_t \gg R_{pl}) \end{array}\right\}$$

$$t_0 \cong \frac{R_0}{c} \cong \frac{1}{H_0} \cong \text{ 14.02 Billion Years}$$

ADVANTAGES

- Planck scale can be successfully implemented in understanding past and current cosmological predictions and observations.
- Hubble parameter and cosmic temperature can be inter-linked at fundamental level.
- As the universe is always assumed to be expanding at 'speed of light', there is no scope for 'temperature isotropy' and cosmic temperature will always tends to decrease. Since the current observable universe is very large and as the observer is not in a position to reach all parts of the current universe, one may be forced to arrive at a misconception of 'CMBR isotropy'.
- Time to time, visible matter energy density and dark matter energy density can be predicted and thereby their creation rate can be understood .
- Attributed results of currently believed 'cosmic inflation' can be understood well.
- Cosmic horizon problem can be relinquished at fundamental level.
- Deep space galactic redshift can be understood as a consequence of cosmological gravitational effect and cannot be considered as a deciding factor of current and future cosmic rate of expansion.
- Special theory of relativity, General theory of relativity and Quantum mechanics can be studied in a unified manner and with further research, a unified model of quantum cosmology can be developed.

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Thank you for your kind attention