Primordial Hot Evolving Black Holes and the Evolved Primordial Cold Black Hole Universe

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Abstract In a quantum gravitational approach, from the beginning of cosmic evolution, the authors assumed the existence of hot primordial evolving black holes. During the evolution of primordial black holes, decreasing thermal energy density is supposed to be directly proportional to their decreasing mass-energy density. When mass of the assumed evolving black hole approaches $\sin^{-2}(\theta_W)$ times the Chandrasekhar's mass limit, density of the evolving black hole seems to approach the order of nuclear mass density. If primordial universe is responsible for generating large number of primordial evolving black holes, then the whole universe can certainly be assumed to be a big primordial evolving black hole. By considering the current universe as an 'evolved' primordial black hole of isotropic temperature equal to the 2.725 K, in a quantum gravitational approach its current Hubble constant can be fitted very easily. In reality one may or may not be able to reach a black hole. By considering the whole "observable universe" as a huge primordial evolved black hole, many interesting solutions (including magnetic monopole problem) will come into visualization.

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1. Introduction

One can find more than 16 major theoretical approaches of quantum gravity in the advanced and unified theoretical physics literature [1-7]. Observed photons, elementary particles and atoms play a vital role in the well understood (theoretical and experimental) quantum mechanics. Black holes seem to play a major role in the advanced 'theoretical' quantum gravitational physics [8]. In an experimental approach, scientists went further in generating micro black holes in the Large Hadron Collider [9]. But researchers now reveal that they have not yet detected any sign of quantum black holes being created by the LHC. Finally the well assumed 'graviton' seems to play a vital role in the unification of general theory of relativity and quantum mechanics and many experiments are on the way to spot the great event of its detection [10]. Anyhow, 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. Anyhow, now a days quantum gravity approach seems to be successful in understanding the mystery of cosmic evolution [11] and cosmic back ground temperature [12].

In this context, in an optimistic approach, some of the 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, quantum gravity can be considered as a scale independent model and the universe can be considered as the best quantum gravitational (observational) object. In this paper the authors made an attempt to interrelate the current Hubble's constant and current CMB temperature in a quantum gravitational approach connected with primordial black holes [13].

2. Black holes – (theoretical) Quantum Gravitational Objects

Black holes have progressed from a curiosity of mathematical physics to a tool for building or studying models in other branches of physics. Examples range from feedback mechanisms that may control the formation and evolution of galaxies and the formation of the whole universe [14,15,16]. However, black holes remain fascinating objects in their own right and may yet reveal deep clues to further revolutions in fundamental physics. Very recently S.W. Hawking after 40 years of a great effort, modified his Black hole theory [17] with 'Apparent horizons'. This brought a serious confusion among the black hole physicists and whole science community. Basic idea seems to be: "There is no escape from a black hole in classical theory. Quantum theory, however, enables energy and information to escape from a black hole". A full explanation of the 'Apparent horizons' demands a new theory that successfully merges gravity with the other fundamental forces of nature. Abhas Mitra [18] showed that true black holes can never form. In his opinion the so-called black holes observed by astronomers are actually radiation pressure supported Eternally Collapsing Objects (ECOs). These balls of fire are so hot that even neutrons and protons melt there and their outward radiation pressure balances the inward pull of gravity to arrest a catastrophic collapse before any Black Hole or 'singularity' would actually form.

The three fundamental questions to be answered are: 1) **Are black holes really black?** 2) **Are black holes really cool?** and 3) **Are black holes really 'primordial' or 'gravitationally collapsed objects'?. In this context, the authors strongly emphasize that, by considering 'primordial evolving black holes', many basic issues of black hole physics, galaxy formation and cosmology can be resolved. In reality one may see or may not see a black hole. But by considering the whole "observable universe" as a huge primordial (quantum gravitational) evolved black hole, many interesting things will come into visualization [16]**. Leaving the 'gravitational collapsing phenomenon', in this paper the authors focused their attention only on the 'primordial evolving black holes'. The authors stress the fact that, they help a lot in understanding the actual growth rate of galactic halos, stability of galaxies and actual growth rate of the current observable universe.

3. Apparent Horizons and Natural Escaping of Photon

According to S.W. Hawking, black hole event horizons are 'Apparent' and "energy and information" can escape from the black hole. This concept can be understood in the following way. Being a quantum mechanical object, even though surface gravity is high, photon will escape from the massive black hole's event horizon. Clearly speaking during its escape from the massive black hole's event horizon, photon may lose energy due to massive black hole's surface gravity and show gravitational redshift but it will not lose its speed. Thus with increasing redshift photon will continue its journey until its energy becomes

zero and redshift reaches infinity. For a photon moving towards the massive black hole's horizon, its speed remaining constant it experiences gravitational blue shift and again speed remaining constant it leaves the massive black hole's horizon by losing its acquired (blue shift) energy by gravitational redshift. Compared to the photon that originates from the black hole, photon that enters and leaves the black hole will make a long journey. In this view, with respect to photons, 'event horizons' can be considered as 'Apparent horizons' or 'Quantum horizons'.

4. Thermal Energy Density and Quantum Gravitational Repulsive Force in Evolving Primordial Black Holes

A primordial black hole is a hypothetical type of black hole that is formed not by the gravitational collapse of a large star but by the extreme density of matter present during the universe's early expansion. According to the Big Bang Big Bang Model, during the first few moments after the Big Bang, pressure and temperature were extremely high. Under these conditions, simple fluctuations in the density of matter might have resulted in local regions dense enough to create black holes. Although most regions of high density would be quickly dispersed by the expansion of the universe, a primordial black hole would be stable, persisting to the present. Stephen Hawking theorized in 1974 that large numbers of such smaller primordial black holes might exist in the Milky Way in our galaxy's Galactic halo region. Now a days most of the astrophysicists believe that, every galaxy constitutes a central black hole. Moreover, existence of primordial black holes have been suggested as a solution for resolving the 'dark matter problem' [19], the 'cosmological Domain wall problem' [20] and the cosmological 'magnetic monopole problem' [21].

One way to detect primordial black holes is by their Hawking radiation. All black holes are theorized to emit Hawking radiation at a rate inversely proportional to their mass. **In this connection, the authors assume that: for any evolving black hole, at any time, its thermal energy density is directly proportional to its mass-energy density.**

4.1. First Central Idea of this Paper

$$a\left(T_B^4\right)_t \propto \left[\left(M_B\right)_t c^2 \left(\frac{4\pi}{3}\left(R_B^3\right)_t\right)^{-1}\right]$$
$$\cong x\left[\left(M_B\right)_t c^2 \left(\frac{4\pi}{3}\left(R_B^3\right)_t\right)^{-1}\right] \tag{1}$$

where x is a model dependent proportionality factor or coefficient. $\left(T_B\right)_t$, $\left(M_B\right)_t$ and $\left(R_B\right)_t \cong 2G\left(M_B\right)_t / c^2$ represent the evolving black hole's temperature, mass and radius respectively.

4.2. Second Central Idea of this Paper

With reference to the authors' critically reviewed and published paper on black hole cosmology [22] and with reference to the 'Planck mass', if one is willing to

consider the factor $x \cong \left[1 + \ln\left(\frac{(M_B)_t}{M_P}\right)\right]^{-2}$ as a characteristic and heuristic scaling factor, then

$$a\left(T_B^4\right)_t \cong \left[1 + \ln\left(\frac{(M_B)_t}{M_P}\right)\right]^{-2} \left[(M_B)_t \, c^2 \left(\frac{4\pi}{3}\left(R_B^3\right)_t\right)^{-1}\right] \quad (2)$$

Here $M_P \cong \sqrt{\hbar c / G}$ represents the Planck mass.

With reference to the compound radiation constant, $a \cong \frac{\pi^2}{15}\frac{k_B^4}{\hbar^3 c^3}$ and the Planck mass, above relation can be simplified into the following form.

$$\left(T_B\right)_t \cong \left(\frac{45}{32\pi^3}\right)^{\frac{1}{4}} \left\{\frac{\left[1 + \ln\left(\frac{(M_B)_t}{M_P}\right)\right]^{-\frac{1}{2}}}{\sqrt{\frac{(M_B)_t}{M_P}}}\right\}\left(\frac{\hbar c^3}{Gk_B (M_B)_t}\right) \quad (3)$$

$$\cong 0.4615 \left\{\left[1 + \ln\left(\frac{(M_B)_t}{M_P}\right)\right]^{-\frac{1}{2}} \sqrt{\frac{(M_B)_t}{M_P}}\right\}\left(\frac{\hbar c^3}{Gk_B (M_B)_t}\right)$$

This is similar to the Hawking's black hole temperature formula [23]. According Hawking, temperature of a black hole is given by the following famous relation.

$$T_B = \frac{\hbar c^3}{8\pi k_B G M_B} \quad (4)$$

Here, (M_B, T_B) represent the mass and temperature of the black hole respectively. Note that, so far Hawking's proposal is not verified and not confirmed by any of the advanced astrophysical observations or Large Hadron Collider experiments [24,25]. It is being believed only on the advanced quantum mechanical theoretical and mathematical formulations and modesty. Similar to the Hawking's black hole temperature formula, now above relation (3) can be re-expressed as follows.

$$\left(T_B\right)_t \cong \left\{0.4615 \Big/ \sqrt{1 + \ln\left(\frac{(M_B)_t}{M_P}\right)}\right\}$$
$$\left(\frac{\hbar c^3}{k_B G \sqrt{(M_B)_t \, M_P}}\right) \quad (5)$$

In coming future, relations (4) and (5) can be studied in a unified manner for understanding the ground reality of evolving primordial black holes decreasing temperature. As a special case, Planck scale temperature connected with Planck mass can be expressed as follows.

$$T_P \cong 0.4615\left(\frac{\hbar c^3}{k_B G M_P}\right) \quad (6)$$

Clearly speaking, at the Planck scale, i.e. when $(M_B)_t \to M_P$, relation (5) reduces to the Hawking relation with a change only in the coefficient. This is one important point that can be given some priority in confirming the proposed relations (1,2 and 5).

Under experimentally achievable conditions for gravitational systems Hawking radiation effect is too small to be observed directly. Advanced laboratory experiments are on the way to detect Hawking radiation [26,27]. As per the news cited in the web site, http://kpfu.ru/news-33/hawking-radiation-mimicked-in-the-lab-96960.html,

1) "The black hole analogue, reported in Nature Physics [27], was created by trapping sound waves using an ultra cold fluid. Such objects could one day help resolve the so-called black hole 'information paradox' - the question of whether information that falls into a black hole disappears forever".

2) "Hawking radiation relies on a basic tenet of quantum theory - large fluctuations in energy can occur for brief moments of time. That means the vacuum of space is not empty but seethes with particles and their antimatter equivalents. Particle-antiparticle pairs continually pop into existence only to then annihilate each other. But something special occurs when pairs of particles emerge near the event horizon - the boundary between a black hole, whose gravity is so strong that it warps space-time, and the rest of the Universe. The particle-antiparticle pair separates, and the member of the pair closest to the event horizon falls into the black hole while the other one escapes".

3) "Hawking radiation, the result of attempts to combine quantum theory with general relativity, comprises these escaping particles, but physicists have yet to detect it being emitted from an astrophysical black hole. Another way to test Hawking's theory would be to simulate an event horizon in the laboratory".

Here the authors stress the fact that, instead of simulating the black hole 'event horizons', to understand the ground reality, 'artificial micro black holes' must be created and by increasing the mass of the artificial micro black hole (confirmed to be generated in any laboratory experimental set up), its radiation effects (like temperature and stability) as well as other gravitational effects (like surface gravity) must be studied with respect to both the relations (3) and (5). It should be noted that, from both the relations (3) and (5) temperature of a micro black hole seems to be very high. It is really hard to believe that at such very high temperatures the whole laboratory equipment will not melt. Without creating any experimental micro black hole, thinking about its 'event horizon' seems to be 'odd' and 'ad-hoc'. The authors request the science community to look into the issue seriously.

Note that, when the mass of the assumed evolving black hole approaches roughly 5 times the Chandrasekhar's mass limit for the observed compact objects [28] $\approx 5 \times \left[1.44 \times \left(1.99 \times 10^{30}\right)\right] \approx 1.43 \times 10^{31} \text{kg}$, temperature and density of the evolving black hole reaches 2.68×10^{11} K and 3.55×10^{17} kg.m^{-3} respectively. This estimated density is very close to the observed nuclear density. With this new mass unit $M_X \cong 1.43 \times 10^{31}$ kg, with usual notation, it is noticed that,

$$\ln\left(\frac{M_X}{m_n}\right) \cong \ln\left(\frac{1.43\times10^{31}}{1.673\times10^{-27}}\right) \cong 133.39$$

$$\ln\left(\frac{M_X}{m_e}\right) \cong \ln\left(\frac{1.43\times10^{31}}{9.109\times10^{-31}}\right) \cong 140.91$$

$$\text{and} \quad \sqrt{133.39*140.91} \cong 137.10 \cong (137.036) \qquad (7)$$

$$\text{Let,} \quad \ln\left(\frac{M_X}{\sqrt{m_e m_n}}\right) \cong \frac{1}{\alpha}$$

$$\Rightarrow M_X \cong 1.274741\times10^{31} \text{ kg}$$

If so, with reference to the Chandrasekhar's mass limit M_{Ch} it is noticed that,

$$\frac{M_{Ch}}{M_X} \cong \frac{2.8656\times10^{30}}{1.274741\times10^{31}} \cong 0.2248 \cong \sin^2\theta_W$$

$$\sqrt{\frac{M_{Ch}}{M_X}} \cong \sqrt{\frac{2.8656\times10^{30}}{1.274741\times10^{31}}} \cong 0.47413 \cong \sin\theta_W \qquad (8)$$

where $\sin\theta_W$ is the currently believed weak coupling angle [29]. Qualitatively and quantitatively these coincidences can be given some priority in confirming the proposed relations (1, 2, 3 and 5).

In terms of the ultimate force [16] or the classical force limit or the astrophysical force limit $\left(c^4/G\right)$, the quantum gravitational repulsive force that prevents the collapsing of the evolving black hole can be expressed as follows.

$$\left\{\sqrt{1+\ln\left(\frac{(M_B)_t}{M_P}\right)}\bigg/0.4615\right\}$$
$$\left[\frac{\hbar}{c\sqrt{(M_B)_t M_P}}\right]^{-1} k_B(T_B)_t \cong \left(\frac{c^4}{G}\right) \qquad (9)$$

Here the authors wish to compare RHS of this relation (9) with the famous and standard Einstein's gravitational field equation coefficient. With usual notation,

$$G_{\mu\nu} \equiv R_{\mu\nu} - \frac{1}{2}Rg_{\mu\nu} = \frac{8\pi G}{c^4}T_{\mu\nu} \qquad (10)$$

In this historical relation, the most important point to be noted is that, the expression $\left(\frac{8\pi G}{c^4}\right)$ seems to be a proportionality constant. If one is willing to consider its 'inverse form', it becomes $\left(\frac{c^4}{8\pi G}\right)$ and takes a very crucial role as expressed in the above relations (13,14). Interested readers may go through the reference [22] for further details on the role and applications of $\left(\frac{c^4}{G}\right)$. With this force constant, Planck mass can be obtained easily and Schwarzschild radius can be understood in a simplified picture.

$$\left\{\sqrt{1+\ln\left(\frac{(M_B)_t}{M_P}\right)}\bigg/0.4615\right\}\frac{Gk_B(T_B)_t}{c^4} \cong \frac{\hbar}{c\sqrt{(M_B)_t M_P}} \qquad (11)$$

In this way, classical and quantum quantities can be studied in a unified manner with quantum gravity.

5. Universe – the Primordial Quantum Gravitational Observational Object

Photons and black holes can be considered as the best candidates of quantum gravitational objects [30-33]. It is true that, without the universe there is no independent existence to any photon or any black hole. 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. Most of the black hole physicists and cosmologists believe in the existence of primordial black holes. When the early universe was able to create a number of primordial black holes, it may not be a big problem for the whole universe to behave like a big primordial black hole. With reference to the current concepts of modern cosmology, probability of "this" to happen may be zero, but its possibility cannot be ruled out. By considering the current observable universe as an evolved primordial black hole, may fundamental issues of cosmology like 'magnetic monopole problem', cosmic boundary problem', and 'cosmic rate of expansion' can be resolved.

6. Understanding Evolving Cosmic Black Hole'S Temperature

For the assumed evolving primordial cosmic holes' current and past radii and masses be:

$$R_0 \equiv \frac{2GM_0}{c^2} \equiv \frac{c}{H_0} \quad \text{and} \quad M_0 \equiv \frac{c^3}{2GH_0}$$

$$R_t \equiv \frac{2GM_t}{c^2} \equiv \frac{c}{H_t} \quad \text{and} \quad M_t \equiv \frac{c^3}{2GH_t} \qquad (12)$$

$$R_P \equiv \frac{2GM_P}{c^2} \equiv \frac{c}{H_P} \quad \text{and} \quad H_P \equiv \frac{c^3}{2GM_P}$$

where M_0 and H_0 represent the current observable mass and Hubble constant of the evolved black hole universe respectively. Similarly M_t and H_t represent any past mass and Hubble constant of the evolving black hole universe respectively. As a peculiar case, M_P and H_P represent the Planck mass and Hubble constant connected with the beginning of the evolving universe respectively.

General back ground reasons for the above assumed heuristic and exploratory relations:
1) To probe the applications and importance of primordial evolving black holes.
2) To develop a unified and simplified model of quantum gravity connected with evolving cosmology.
3) To fit the measured and observed data of cosmology accurately.

4) To understand the ground reality of current and future cosmic rate of expansion in a quantum gravitational approach.

Technical reasons for the above assumed heuristic and exploratory relations:

1) As suggested by S.W. Hawking [34], there is no scientific proof or evidence to Friedmann's second assumption [35].

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 hydrogen atom, then considering redshift as an index of 'whole galaxy' receding may not be reasonable [36].

3) Even though no one could measure the actual galactic receding speed, most of the cosmologists were attracted by the Hubble's redshift interpretation.

4) Merely by estimating galaxy distance and without measuring galaxy receding speed, one cannot verify the cosmic acceleration.

5) Even though it is very attractive, Einstein could not implement the Mach's principle in Hubble-Friedmann- cosmology [37].

6) Until 1964, cosmologists could not believe in 'cosmic back ground temperature' [38].

7) Black hole physics and quantum gravity were in their beginning stage.

8) Note that, in 1947 Hubble himself thought for a new mechanism for understanding the observed red shift [39]. In his words: "We may predict with confidence that the 200 inch will tell us whether the red shifts must be accepted as evidence of a rapidly expanding universe, or attributed to some new principle in nature. Whatever may be the answer, the result may be welcomed as another major contribution to the exploration of the universe".

If, $H_0 \cong 70$ km/sec/Mpc $\cong 2.268 \times 10^{-18}$ sec^{-1},

$$M_0 \cong \frac{c^3}{2GH_0} \cong 8.9 \times 10^{52} \text{ kg.}$$

From relation (5) current cosmic temperature [40] can be fitted as follows.

$$T_0 \cong \left(\frac{45}{32\pi^3}\right)^{\frac{1}{4}} \left\{ \sqrt{\frac{M_0}{M_P}} \middle/ \sqrt{1 + \ln\left(\frac{M_0}{M_P}\right)} \right\} \left(\frac{\hbar c^3}{k_B G M_0}\right)$$

$$\cong \left\{ 0.4615 \middle/ \sqrt{1 + \ln\left(\frac{M_0}{M_P}\right)} \right\} \left(\frac{\hbar c^3}{k_B G \sqrt{M_0 M_P}}\right) \cong 2.728 \text{ K} \quad (13)$$

In the earlier published paper [16], the authors proposed that,

$$T_0 \cong \frac{\hbar c^3}{8\pi k_B G \sqrt{M_0 M_P}} \quad (14)$$

It is very interesting to note that, for the current situation,

$$\left\{ 0.4615 \middle/ \sqrt{1 + \ln\left(\frac{M_0}{M_P}\right)} \right\} \cong \frac{1}{25.69} \cong \frac{1}{8\pi} \quad (15)$$

In terms of the ultimate force [16,22] or the classical force limit or the astrophysical force limit $\left(c^4/G\right)$, the quantum gravitational repulsive force that prevents the collapsing of the evolving cosmic black hole can be expressed as follows.

$$\left\{ \sqrt{1 + \ln\left(\frac{M_0}{M_P}\right)} \middle/ 0.4615 \right\} \left[\frac{\hbar}{c\sqrt{M_0 M_P}}\right]^{-1} k_B T_0 \cong \left(\frac{c^4}{G}\right) (16)$$

$$\left\{ \sqrt{1 + \ln\left(\frac{M_0}{M_P}\right)} \middle/ 0.4615 \right\} \frac{G k_B T_0}{c^4} \cong \frac{\hbar}{c\sqrt{M_0 M_P}} \quad (17)$$

7. Understanding Evolving Cosmic Black Hole'S Matter Density

Past mass density of evolving black hole universe can be expressed as :

$$(\rho_{\text{mass}})_t \cong M_t \middle/ \left[\frac{4\pi}{3} R_t^3\right]$$

$$\cong \left(\frac{c^3}{2GH_0}\right) \left[\frac{4\pi}{3}\left(\frac{c}{H_t}\right)^3\right]^{-1} \cong \frac{3H_t^2}{8\pi G} \quad (18)$$

It exactly looks like the cosmological 'critical density' of modern Hubble-Friedmann cosmology. Here the authors would like to emphasize that, while Hubble-Friedmann cosmology was taking its full shape, black hole physics and quantum gravity were in their beginning stage. Based on the general and technical points proposed in section 6, the authors request the science community to visualize the currently believed 'critical mass density' as the 'mass density' of the evolving primordial black hole universe.

If so, past mass-energy density of the evolving primordial black hole universe can be expressed as:

$$(\rho_{\text{mass}})_t c^2 \cong M_t \middle/ \left[\frac{4\pi}{3} R_t^3\right]$$

$$\cong \left(\frac{c^5}{2GH_0}\right) \left[\frac{4\pi}{3}\left(\frac{c}{H_t}\right)^3\right]^{-1} \cong \frac{3H_t^2 c^2}{8\pi G} \quad (19)$$

At any time, matter-energy density can be considered as the geometric mean of mass-energy density and the thermal energy density and it can be expressed in the following way.

$$(\rho_{\text{matter}})_t \cong \frac{1}{c^2} \sqrt{\left(\frac{3H_t^2 c^2}{8\pi G}\right)\left(a T_t^4\right)}$$

$$\cong \left[1 + \ln\left(\frac{M_t}{M_P}\right)\right]^{-1} \left(\frac{3H_t^2}{8\pi G}\right) \cong \left[1 + \ln\left(\frac{M_t}{M_P}\right)\right]\left(\frac{a T_t^4}{c^2}\right) \quad (20)$$

At present,

$$\left(\rho_{\text{matter}}\right)_0 \cong \frac{1}{c^2}\sqrt{\left(\frac{3H_0^2 c^2}{8\pi G}\right)}\left(aT_0^4\right)$$

$$\cong \left[1+\ln\left(\frac{M_0}{M_P}\right)\right]^{-1}\left(\frac{3H_0^2}{8\pi G}\right) \tag{21}$$

$$\cong \left[1+\ln\left(\frac{M_0}{M_P}\right)\right]\left(\frac{aT_0^4}{c^2}\right) \cong 6.55\times10^{-32}\,\text{gram}/\text{cm}^3$$

Based on the average mass-to-light ratio for any galaxy, present matter density can be expressed with the following relation [41].

$$\left(\rho_m\right)_0 \cong 1.5\times10^{-32}\,\eta h_0 \quad \text{gram/cm}^3 \tag{22}$$

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

$h_0 \cong H_0/100\,\text{Km/sec/Mpc} \cong 0.70.$

Note that elliptical galaxies probably comprise about 60% of the galaxies in the universe and spiral galaxies thought to make up about 20% of the galaxies in the universe. Almost 80% of the galaxies are in the form of elliptical and spiral galaxies. For spiral galaxies, $\eta h_0^{-1} \cong 9\pm1$ and for elliptical galaxies $\eta h_0^{-1} \cong 10\pm2$. For our galaxy inner part, $\eta h_0^{-1} \cong 6\pm2$. Thus the average ηh_0^{-1} is very close to 9 and its corresponding matter density is very close to 6.6×10^{-32} gram/cm^3 and can be compared with the proposed magnitude of 6.55×10^{-32} gram/cm^3.

8. Understanding Primordial Evolving Black Hole'S Growth Rate

During the evolution of any primordial black hole,

1) If one assumes that, black hole's growth rate is directly proportional to its 'mass', then as mass of the evolving black hole increases, its growth rate increases. If such a black hole is governing any galaxy, then very soon, whole galaxy will be swallowed by the fast evolving black hole within a short span. If so stable galaxies cannot exist.

2) Alternatively if one assumes that, black hole's growth rate is inversely proportional to its 'mass', then as mass of the evolving black hole increases its growth rate decreases. If such a black hole is governing any galaxy, in a long run, whole galaxy will get stability and can exist for ever with a huge central governing mass.

With reference to the proposed black hole's temperature relation (5), above two points can be expressed as follows.

3) If one assumes that, black hole's growth rate is inversely proportional to its 'temperature', then as temperature of the evolving black hole decreases, its growth rate increases. If such a black hole is governing any galaxy, then very soon, whole galaxy will be swallowed by the fast evolving black hole within a short span. If so stable galaxies cannot exist.

4) Alternatively if one assumes that, black hole's growth rate is directly proportional to its 'temperature', then as temperature of the evolving black hole decreases its growth rate decreases. If such a black hole is governing any galaxy, in a long run, whole galaxy will get stability and can exist for ever with a huge central governing mass.

9. Understanding Evolving Cosmic Black Hole'S Growth Rate

With reference to the observed stable galaxies, by considering the points (2 and 4) of the above section 8, by considering the confirmed current isotropic temperature of the observed universe and by assuming the observed universe as an evolving black hole universe, it can be suggested that, at present universe is expanding at a very slow rate. Even though this suggestion is dead against the current notion of 'accelerating universe', based on the above proposed concepts and relations, the authors request the science community to review the basics of Hubble-Friedmann cosmology [42] in a quantum gravitational approach.

Modern cosmologists believe that the rate of change of 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 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 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. Need of new mathematical methods and techniques, computer simulations, advanced engineering skills seem to be essential in this direction.

10. Understanding and Re-Interpreting The Observed Cosmic Red Shift

During the cosmic evolution, right from the beginning of the formation of hydrogen atoms, as any baby hydrogen atom starts growing, cosmologically, bonding strength increases in between proton and electron causing 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 seen as a cosmological redshift associated with galactic hydrogen

atom and nowhere connected with the galaxy receding. 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 any cosmologically evolving hydrogen atom is inversely proportional to the cosmic temperature. Then, as cosmic time passes, decreasing back ground cosmic black hole temperature makes cosmologically evolving hydrogen atom to emit increased quanta of energy causing the observed redshift. Here in this context, the authors emphasize that fact that, during journey light quanta will not lose energy and there will be no change in light wavelength. If one is willing to think in this direction, it certainly paves a way for reviewing the basics of modern cosmology in a quantum gravitational approach as proposed herein section 8 with relations starting from (23) to (28).

$$\frac{E_0}{E_t} \cong \frac{\lambda_t}{\lambda_0} \cong \frac{T_t}{T_0} \cong (z_0 + 1) \qquad (23)$$

$$z_0 \cong \frac{E_0 - E_t}{E_t} \cong \frac{\lambda_t - \lambda_0}{\lambda_0} \cong \frac{T_t - T_0}{T_0} \qquad (24)$$

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 as well as 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 above relations can be expressed in the following form. From Bohr's theory of hydrogen atom, with usual notation, for the revolving electron,

$$\left(E_{\text{potential}}\right)_t \cong -\left(\frac{T_0}{T_t}\right)\frac{e^4 m_e}{16\pi^2 \varepsilon_0^2 \hbar^2} \qquad (25)$$

$$\left(E_{\text{total}}\right)_t \cong -\left(\frac{T_0}{T_t}\right)\frac{e^4 m_e}{32\pi^2 \varepsilon_0^2 \hbar^2} \qquad (26)$$

$$\left(E_{\text{photon}}\right)_0 \cong \left(\frac{T_0}{T_t}\right)\left\{\frac{e^4 m_e}{32\pi^2 \varepsilon_0^2 \hbar^2}\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]\right\} \qquad (27)$$

In future, with reference to the current laboratory hydrogen atom, decreasing current cosmic temperature and measured rate of increase in emitted photon energy - true rate of (current and future) cosmic expansion can be understood. From laboratory point of view, above concept can be understood in the following way. After some time in future,

$$z_f \cong \frac{E_f - E_0}{E_0} \cong \frac{E_f}{E_0} - 1 \qquad (28)$$

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 absolute rate of cosmic expansion. As cosmic time passes, within the scope of experimental accuracy of laboratory hydrogen atom's redshift, if magnitude of $\left[d\left(z_f\right)/dt\right]$ is gradually increasing, it is an indication of cosmic acceleration. If magnitude of $\left[d\left(z_f\right)/dt\right]$ is practically constant, it is an indication of uniform rate of cosmic expansion. If magnitude of $\left[d\left(z_f\right)/dt\right]$ is gradually decreasing, it is an indication of cosmic deceleration. If magnitude of $\left[d\left(z_f\right)/dt\right]$ is zero, it is an indication of cosmic halt. In support of this idea, rate of decrease in 'current Hubble's constant' and rate of decrease in 'current CMBR temperature' can be considered as true measures of current cosmic 'rate of expansion'.

11. Discussion

By assuming the existence of primordial evolving black holes with relations starting from (1 to 11), in this paper the authors proposed a new approach for understanding the quantum gravitational concepts. By considering the current universe as a primordial evolved black hole having an isotropic temperature equal to 2.725 K with relations (11 to 22) the authors proposed a new approach for verifying the quantum gravitational concepts. The very fortunate thing is that, so far no theoretical model or no experimental result disproved the model of quantum gravitational black hole cosmology. But, at this juncture, attracting/guiding/motivating the main stream science community towards a black hole cosmology is a very challenge issue. The main difficulty is with understating and interpreting the cosmic redshift. If one is willing to consider the new red shift interpretation, as proposed herein section 10 with relations starting from (23) to (28), it certainly paves a way for reviewing the basics of modern cosmology in a quantum gravitational approach.

Note that, from unification of point of view, somehow one must implement quantum gravity in fundamental cosmology. But understanding/visualizing 'quantum gravity' or 'quantum cosmology' is really a very big task. Unless a 'satellite' reaches any 'friendly' black hole or one creates a 'safe laboratory' micro black hole, critical issues of black hole physics cannot be resolved. Now a days scientists strongly believe that each and every galaxy of the universe constitutes a huge central black hole. Whether the assumed galactic central black holes are by the nature, "primordial" or "gravitationally collapsed" - is still not yet clear. Many of the issues related with black holes and cosmology can be resolved with the following three logics: **1) Galactic halos are basically "primordial and evolving" black holes'. 2) Growth rate of any primordial evolving black hole is directly proportional to its temperature. 3) The whole universe is a big primordial evolving black hole.**

12. Conclusion

In a quantum gravitational approach, considering 'evolving primordial black holes' and considering the 'evolving universe' as a 'primordial evolving black hole', magnetic monopole problem, formation of galaxies, growth rate of galaxies, growth rate of galactic halos, can be understood very easily and key observable physical parameters of the current universe can be fitted accurately. Finally, it can be suggested that, cosmic black hole's current and future 'rate of expansion' can be determined with rate of decrease in the current and future back ground temperature or rate of decrease in the current and future Hubble's constant. By considering the proposed "cosmologically strengthening or reinforcing hydrogen atom", 'galaxy receding' concept can be reviewed and possibly can also be relinquished. With further study, analysis and research in this direction, may resolve all the related issues.

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