Article

On the Possible Role of Continuous Light Speed Expansion in Black Hole & Gravastar Cosmology

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Abstract

In the article, the authors propose a unified model of quantum cosmology that connects currently observed Hubble parameter and cosmic microwave back ground temperature. In this model, (1) the relation, $\left(2GM_t/c^2\right) \cong R_t \cong \left(c/H_t\right)$, is used to unify the subjects of black holes and cosmology into evolving black hole cosmology in order to eliminate cosmic horizon problem; (2) continuous light speed expansion of the cosmic black hole horizon is implemented in special theory of relativity in order to eliminate cosmic inflation and cosmic acceleration at fundamental level; and (3) the relation, $\left[\left(3H_t^2c^2/8\pi G\right)/aT_t^4\right] \cong \left[1+\ln\left(H_{pl}/H_t\right)\right]^2$, is implemented in quantum gravity al low energy scale. In addition, the authors show that the currently believed dark matter energy density and visible matter energy density may be related through $\left[1+\ln\left(H_{pl}/H_t\right)\right]$. With further studies and advanced cosmological observations, 'light speed' or 'accelerating' or 'decelerating' 'Gravastar cosmology' models can be developed as advanced versions of black hole cosmology.

Keywords: Cosmology, Planck scale, light speed expansion, cosmic thermal energy density, dark matter density, visible matter density, quantum gravity, black hole, gravastar.

1. Introduction

Nielsen J.T, *et. al.* state [1] that:

> The 'standard' model of cosmology is founded on the basis that the expansion rate of the universe is accelerating at present --- as was inferred originally from the Hubble diagram of Type Ia supernovae there exists now a much bigger database of supernovae so we can perform rigorous statistical tests to check whether these 'standardisable candles' indeed indicate cosmic acceleration taking account of the empirical procedure by which corrections are made to their absolute magnitudes to allow for the varying shape of the light curve and extinction by dust, we find, rather surprisingly, that the data are still quite consistent with a constant rate of expansion.

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Most recently main stream cosmologists suggest that our universe appears to be expanding at a constant rate rather than accelerating [1-3]. This is really a very big shock to them. In 2013, Abhas Mitra suggested that the data purported to show cosmic acceleration could be an artifact of inhomogeneity [4, 5]. In 2011, Paul J. Steinhardt, one of the creators of the inflation theory, suggested that the theory might be deeply flawed [6]. These references seriously cast doubt on the current model of modern cosmology. From quantum gravity point of view, main stream scientists are seriously trying to implement quantum concepts in cosmology [7]. It is clear that either from quantum gravity point of view or from Planck scale implementation point of view currently believed modern cosmology is very weak in many aspects.

Even though physical evidence of ‘dark energy’ is absolutely poor and experimentally beyond the scope of current engineering and technology, possibility of the existence of dark energy, (conjectured to be responsible for the present accelerated expansion of the Universe), has opened up new possibilities in theoretical research. To maintain the assumed ‘theoretical existence’ and to counter the ‘singularity situation’ of the currently believed fascinating black holes, modern scientists proposed a new approach [8-11]. The central idea of this new approach is that, interior of a black hole is being governed by ‘dark energy’. In this context, the authors would like to stress the following two points. 1) Since the (well believed) basic nature of dark energy is to maintain the cosmic expansion/acceleration - if one is willing to consider ‘dark energy’ as a key constituent of the interior of a black hole, it is very reasonable to think about ‘growing black holes’. 2) The observed ‘evolving universe’ can also be treated as a kind of ‘evolving black hole’ having filled with ‘dark energy’ like fluid.

The key theme of the authors’ published papers [12-20] is to fit the present day Hubble parameter, dark matter density and visible (baryonic) matter density with the current cosmic microwave background temperature and the Planck scale Hubble parameter. It is currently believed that, in order to explain many observations such as Type Ia supernovae data and baryon acoustic oscillations, the cosmological constant and dark matter must be integrated into the cosmological model. It may also be noted that, in order to obtain the value of the Hubble parameter, cosmologists assume the existence of dark matter and dark energy. Sophisticated statistical methods are required to determine the present day Hubble parameter. This is the case with the recent Planck survey analysis [21]. Independent of this routine procedure and without considering galactic redshift data, a heuristic model of evolving black hole cosmology can be developed with three simple assumptions. This new approach to quantum cosmology connects special theory of relativity, general theory of relativity and the Planck scale [22] at utmost fundamental level.

Photons and black holes can be considered as the best candidates of quantum gravitational objects. It is true that, without the existence of universe, there is no independent existence to any photon or any black hole. Now the fundamental question to be answered is: Is our universe a quantum gravitational object or something else? Physicists expressed several opinions with many possible solutions. Astrophysicists believe that, universe constitutes so many galaxies and each galaxy constitutes a massive central black hole. Some of the black hole physicists believe in the existence of primordial black holes also. When the early universe was able to create a number of galactic black holes or primordial black holes, it may not be a big problem for the whole universe to behave like a big primordial evolving 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 [23,24]. By considering the current observable universe as an evolving primordial black hole, many fundamental issues of cosmology can be resolved. It may be noted that, when modern cosmology was in its development stage, black hole physics was in its budding stage.

1.1 Major short comings of standard cosmology

1) The standard Big Bang model tells us that the Universe exploded out of an infinitely dense point, or singularity. But nobody knows what would have triggered this outburst: the known laws of physics cannot tell us what happened at that moment.

2) Without a radial in-flow of matter in all directions towards one specific point, one cannot expect a big crunch and without a big crunch, one cannot expect a big bang. Really if there was a 'big bang' in the past, with reference to formation of big bang as predicted by GTR and with reference to the cosmic rate of expansion that might had been taken place simultaneously in all directions at a 'naturally selected rate' about the point of big bang - 'point' of big bang can be considered as the characteristic reference point of cosmic expansion in all directions. In this case, saying that there is no preferred direction in the expanding universe - may not be reasonable.

3) It may be noted that, increased redshifts and increased distances forced Edwin Hubble to propose the Hubble's law of receding galaxies. Even then, merely by estimating galaxy distance and without measuring actual galaxy receding speed, one cannot verify galaxy acceleration. Clearly speaking: two points can be raised here: i) Assumed galaxy receding speed is not being measured and not being confirmed; ii) Without measuring and confirming the increasing galaxy receding speed, one cannot confirm galaxy acceleration.

4) Without considering a closed 'curvature', one cannot expect inflation-like 'sudden expansions'. If so, in the beginning of cosmic evolution, one cannot rule out the 'possible role of closed curvature'. In addition, inflation-like 'sudden expansion' mechanisms can be accommodated, either in 'open cosmology models' or 'closed cosmology models'.

5) A key requirement of inflation is that, 'sudden expansion' must continue 'long enough' to produce the present observable universe from a single, small inflationary Hubble volume. However, this type of idea violates basic concepts of GTR. Assuming a rapid rate of cosmic expansion in conjunction with a steady rate of cosmic time flow may not be reasonable. As per the basic concepts of GTR, if 'space' and 'time' are interrelated as space-time, then 'space' and 'time' both should simultaneously follow the momentary rapid exponential expansion. For example if space expands by a factor 10^{26} within a very 'short span', cosmic time should run fast in the same proportion. Accordingly, current cosmic age could be much greater than the expected 14 billion years.

6) Either in the big bang or in the inflation, quantification of the initial assumed conditions seems to be 'model dependent', not 'absolute' and not 'linked with any known physical relations'. In addition, the earliest phases of the currently believed Big Bang are subject to much speculation.

7) In the standard model of cosmology, in contrast to 'neutrino like dark matter', there is no clear-cut information about the precise nature of 'dark energy'. If its identification is not unique in nature, then different cosmology models can be developed with different forms of 'dark energy'. If so, understanding the absolute cosmic expansion rate with 'different forms' of dark energy seems to be ad-hoc.

8) So far, no ground-based experiment has confirmed the existence of dark energy. There is no single clue or evidence as to any of the physical properties of dark energy.

9) If there actually is 'dark energy' accelerating universal expansion on the large scale, then 'dark energy' quantum properties must also be understood, in order to achieve a final unification model. Such properties, and how they could be incorporated within known laws of physics, remain a complete mystery.

10) If 'dark energy' is supposed to have a key role in near-past and current cosmic expansion, then it might also have played a key role in the beginning of cosmic evolution. In this regard, no information is available in standard cosmology. Even the current theory of 'inflation' does not address the origin, identity or role of 'dark energy' in the early universe.

11) To achieve final unification, it will be necessary to reconcile quantum mechanics and gravity on all scales. So far, quantum gravity models assumed to be associated with the Planck scale and the Big Bang cannot predict/fit the observed low energy scale of the cosmic microwave background (CMB) temperature.

12) Even though observational astronomy is completely based on a photon's characteristic speed limit, the majority of cosmologists choose to believe in superluminal galactic receding speeds without being able to provide any evidence of such.

1.2. Important points concerning black holes and recent observations

1) The subject of modern black hole physics is largely theoretical. To this point, modern astrophysicists have had no way to visualize the internal structure of an astrophysical black hole. It may or may not be possible to see the internal structure of a black hole, particularly if, as a special case, one is willing to consider the possibility that the entire observable universe is a black hole. The latter possibility might provide a way to understand/verify the combined effects of quantum theory and gravity assumed to be associated with past and current evolution of the universe.

2) Astrophysicists have guessed at the existence of 'primordial black holes' and particle physicists have guessed at the existence of microscopic black holes. It is only recently believed that super massive black holes may also be at the center of all or most galaxies. Given this amazingly broad possible size range of black holes, one should not be too quick to absolutely rule out the possibility of considering the universe as a growing black hole.

3) Very recently, on 14th Sep 2015, LIGO team announced the successful detection of 'gravitational waves,' in strong support of Einstein's general theory of relativity and the existence of black holes as proposed by Schwarzschild. For detailed information one can refer to [25] or see the web site:

   http://www.ligo.org/news/detection-press-release.pdf. Conclusions of the paper are: "The LIGO detectors have observed gravitational waves from the merger of two stellar-mass black holes. The detected waveform matches the predictions of general relativity for the in spiral and merger of a pair of black holes and the ring down of the resulting single black hole. These observations demonstrate the existence of binary stellar-mass black hole systems. This is the first direct detection of gravitational waves and the first observation of a binary black hole merger".

4) At any given cosmic time, the product of currently believed 'critical density' and 'Hubble volume' gives a characteristic cosmic mass, which one can consider as the 'Hubble mass'. Of interest, the Schwarzschild radius of this 'Hubble mass' appears to coincide with the currently believed 'Hubble length'. Most cosmologists believe that this is merely a coincidence. Here the authors wish to emphasize the possibility that this coincidence might imply a deep inter-connection between cosmic geometry and other cosmological physical phenomena.

5) If the '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. Standard cosmology is not throwing any light on this surprising coincidence.

6) If, in fact, the universe is an 'evolved growing black hole', then thinking about the existence of something 'beyond' its enclosed boundary would not seem logical or reasonable. If so, whatever may be the cosmic rate of expansion, the question of a 'horizon problem' would be irrelevant.

7) By similar logic, whatever may be its speed of expansion, if the current universe is assumed to be a (growing) gigantic black hole of a mass of around 10^{53} kg, it may not be reasonable to think about the existence of matter 'outside' the cosmic black hole's increasing boundary. Once again, a 'horizon problem' can be avoided.

8) Recent cosmological observations strongly support the revision of 'cosmic acceleration' with 'constant speed of expansion' [1,2,3]. If the rest of theoretical and

observational physics is believed to follow the photon's characteristic speed limit, then' light speed cosmic expansion' can suitably be synchronized with cosmological observations and the rest of physics.

9) At any stage of cosmic evolution, if one is willing to consider the 'Schwarzschild radius' of the expanding black hole universe as its effective or characteristic or critical radius, corresponding other characteristic cosmic physical parameters (like cosmic temperature, dark matter density, visual matter density, cosmic age, etc.) can be estimated/predicted easily and can be compared with cosmological observations.

10) If one is willing to believe in quantum cosmology, from the beginning of Planck scale, time to time, dark matter density and visible matter density both can be estimated.

11) As 'sudden expansions' are model independent, in quantum cosmology also, one can accommodate 'inflation' like models with minor changes.

12) Outline remaining as black hole cosmology, based on the positive observational evidences of 'cosmic rate of expansion', 'dark energy', 'inflation' and 'gravastars', future cosmology models can also be developed as 'light speed' or 'accelerating' or 'decelerating' Gravastar cosmologies' [9,10,11,26].

2. Three Simplified Assumptions Connected with Planck Scale

From the Planck scale to the scale of our observable universe, three workable and simple assumptions can be expressed as follows:

Assumption 1: Right from the beginning of the Planck scale, the cosmic horizon is expanding at light speed.

Comment 1: Even though this assumption is ad-hoc, it can be supported by the recently published paper [2] reporting a critical re-evaluation of the Type Ia supernovae data. It paves a way to understand cosmic flatness. In addition, if the very nature of universe is to expand with light speed, then there is no need to think about the existence of currently believed 'Lambda term'. It may be noted that, so far no theoretical model explained the reasons for the photon's light speed. Moreover, currently believed standard physical concepts and current cosmological observations, all are completely based on the 'light speed' concept only. Even though standard cosmology is well standing on 'inflation', there is no clear cut reasoning for its super luminal speed of expansion and super swelling. 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. As a compromising solution in between 'physics' and 'physical observations', general theory of relativity and special theory of relativity both can be firmly coupled with 'continuous light speed expansion'. Consequences of light speed expansion seem to be practical and fruitful

Assumption 2: Beginning with the Planck scale, the cosmic radius and Hubble parameter follow the relation:

$$R_t \cong \frac{2GM_t}{c^2} \cong \frac{c}{H_t} \tag{1}$$

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

Comment 2: At any stage of cosmic expansion, matter is confined within a radius limited by $\left[R_t \cong 2GM_t/c^2\right] \cong \left[c/H_t\right]$ and there is no scope to have matter outside of $\left[R_t \cong 2GM_t/c^2\right] \cong \left[c/H_t\right]$. At any stage of cosmic evolution, mass energy density can be expressed as, $\rho_t c^2 \cong \frac{M_t c^2}{V_t} \cong \left(\frac{3H_t^2 c^2}{8\pi G}\right)$. Note that, this approach is completely different from the current notion of 'critical energy density'. It is also possible to interlink the current notion of 'flat space' with the assumed 'light speed' expanding cosmic black hole horizon.

Assumption 3: 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 $\left[1+\ln\left(\frac{H_{pl}}{H_t}\right)\right]^2$ where H_{pl} is the Planck scale Hubble parameter and H_t is the cosmic Hubble parameter at time *t*.

$$\left.\begin{array}{l} \frac{3H_t^2 c^2}{8\pi G a T_t^4} \cong \left[1+\ln\left(\frac{H_{pl}}{H_t}\right)\right]^2 \\ \Rightarrow \sqrt{\frac{3H_t^2 c^2}{8\pi G a T_t^4}} \cong \left[1+\ln\left(\frac{H_{pl}}{H_t}\right)\right] \end{array}\right\} \tag{2}$$

Comment 3: At the Planck scale, cosmic mass-energy density and thermal energy density are equal in magnitude. During subsequent cosmic evolution, mass-energy density is always higher than the thermal energy density by the authors' proposed scaling factor, $\left[1+\ln\left(H_{pl}/H_t\right)\right]^2$. It may be noted that, even though the current universe is expanding at light speed,

1) Current universe is outsized;
2) Current Hubble parameter is very small;
3) Current rate of Hubble parameter decline is very small;
4) Assumed to follow the relation (2), i.e.

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

Based on these four points, the decline in current thermal energy density must be very minute and may reflect the "currently believed isotropic" behavior. In reality, 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'.

3. Planck Scale Cosmic Physical Parameters

About the Planck scale

The nature of reality at the Planck scale is the subject of much debate in the world of physics, as it relates to a surprisingly broad range of topics. It may, in fact, be a fundamental aspect of the universe. In terms of size, the Planck scale is extremely small and can be compared with the size of our universe connected with big bang. In terms of energy, it is extremely 'hot and energetic' and can be compared with cosmic temperature connected with big bang. Planck scale seems to be a fascinating realm for speculation by theoretical physicists from various schools of thought. Although it remains impossible to probe this realm directly, as those energies are well beyond the capability of any current or planned particle accelerator, there possibly was a time when the universe itself achieved Planck scale energies.

In an optimistic approach, some of the modern cosmologists believe that, during cosmic evolution, Planck scale quantum gravitational interactions might have an observable effect on the current observable cosmological phenomena. Clearly speaking, with respect to '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 scale independent. If one is willing to consider the current observable universe as a low energy scale 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, quantum cosmology can be considered as 'scale independent model' and the universe can be considered as the best quantum gravitational object. In this context, the authors would like to stress the fact that, by considering a scaling factor like $\sqrt{\frac{3H_t^2c^2}{8\pi GaT_t^4}} \cong \left[1+\ln\left(\frac{H_{pl}}{H_t}\right)\right]$ where H_{pl} is the Planck scale Hubble parameter and H_t is the time dependent cosmic Hubble parameter, theoretically it is possible to fit the current Hubble parameter and current cosmic microwave back ground temperature.

Planck scale mass unit can be expressed as follows.

$$M_s \cong \sqrt{\frac{\hbar c}{G}} \cong 2.17651\times10^{-8}\,\text{kg} \tag{4}$$

Planck scale Hubble parameter can be expressed as follows:

$$H_{pl} \cong \frac{c}{R_{pl}} \cong \frac{c^3}{2GM_{pl}} \cong \frac{1}{2}\sqrt{\frac{c^5}{G\hbar}} \cong 9.27461\times10^{42}\ \text{sec}^{-1} \quad (5)$$

where $R_{pl} \cong 2GM_{pl}/c^2 \cong 3.2324\times10^{-35}$ m is the Planck scale cosmic radius.

Planck scale cosmic temperature can be expressed as

$$T_s \cong \left(\frac{3H_{pl}^2 c^2}{8\pi Ga}\right)^{\frac{1}{4}} \cong 6.546\times10^{31}\ \text{K} \quad (6)$$

4. Relation between Thermal Energy Density & Mass Energy Density

Basic concept is that during cosmic evolution, at any time, thermal energy density is proportional to the 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 $\left[1+\ln\left(\frac{H_{pl}}{H_t}\right)\right]^{-2}$,

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

For the current evolving black hole universe,

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

With trial-error it is noticed that, if $H_0 \cong 69.75$ km/sec/Mpc, obtained $T_0 \cong 2.7226$ K.

As per the 2015 Planck data [21], the current value of the Hubble parameter is reported to be:

$$\left.\begin{array}{l}\text{Planck TT+low P: } (67.31\pm0.96)\ \text{km/sec/Mpc}\\ \text{Planck TE+low P: } (67.73\pm0.92)\ \text{km/sec/Mpc}\\ \text{Planck TT,TE,EE+low P: } (67.7\pm0.66)\ \text{km/sec/Mpc}\end{array}\right\}$$

As per the 2015 Planck data, the current value of CMBR temperature is:

$$\left.\begin{array}{l}\text{Planck TT + lowP + BAO: } (2.722\pm0.027)\ \text{K}\\ \text{Planck TT; TE; EE + low P + BAO: } (2.718\pm0.021)\ \text{K}\end{array}\right\}$$

5. Current mass, radius and mass density of evolving black hole universe

In this paper, for calculation purpose, the authors consider $H_0 \cong 69.75$ km/sec/Mpc.

Step 1: Current cosmic radius can be estimated as follows:

$$R_0 \cong \frac{c}{H_0} \cong 1.3263 \times 10^{26} \text{ m} \tag{10}$$

Step 2: Current cosmic mass can be estimated as,

$$M_0 \cong \frac{R_0 c^2}{2G} \cong \frac{c^3}{2GH_0} \cong 8.93 \times 10^{52} \text{ kg} \tag{11}$$

Step 3: Current cosmic mass energy density can be estimated as,

$$\begin{aligned} \rho_0 c^2 &\cong \frac{M_0 c^2}{V_0} \cong \left(\frac{c^5}{2GH_0}\right) \Big/ \left(\frac{4\pi}{3}\left(\frac{c}{H_0}\right)^3\right) \\ &\cong \frac{3H_0^2 c^2}{8\pi G} \cong 8.2135 \times 10^{-10} \text{ J.m}^{-3} \end{aligned} \tag{12}$$

Note: Total estimated mass of our current universe is approximately 1.46 x 10^{53} kg. This can be compared with proposed estimate of 8.93 x 10^{52} kg. Estimation of visible baryonic mass mainly depends on estimating the number of galaxies, estimating the number of stars per galaxy and estimating the average mass per star. This entire procedure is based on observation and requires many correction factors. A current best estimate of visible baryonic mass is approximately 2 x 10^{52} kg, correlating with approximately 2 x 10^{22} stars. This can only be considered as a rough estimate. The cosmic dark matter component of roughly 5 times this amount must be added to the visible mass estimate to arrive at a total estimated mass of cosmic matter.

6. Predicting & Fitting Dark Matter &Visible Matter Energy Densities

With reference to the currently observed data, visible matter energy density and dark matter energy density can be fitted in the following way:

Let $\left(\rho_{v.matter}\right)_t c^2$ is the visible matter energy density at time t.

$$\left.\begin{aligned} \left(\rho_{v.matter}\right)_t c^2 &\cong \left[1+\ln\left(x_t\right)\right]\sqrt{\left(\frac{3H_t^2 c^2}{8\pi G}\right)\left(aT_t^4\right)} \\ \text{where, } x_t &\cong \sqrt{\frac{3H_t^2 c^2}{8\pi G a T_t^4}} \cong 1+\ln\left(\frac{H_{pl}}{H_t}\right) \end{aligned}\right\} \tag{13}$$

Current visible matter energy density [21] can then be fitted as follows:

$$\left.\begin{aligned}&\left(\rho_{v.matter}\right)_0 c^2 \cong \left[1+\ln\left(x_0\right)\right]\sqrt{\left(\frac{3H_0^2c^2}{8\pi G}\right)\left(aT_0^4\right)}\\&\cong\left[\frac{\left[1+\ln\left(x_0\right)\right]}{x_0}\right]\left(\frac{3H_0^2c^2}{8\pi G}\right)\cong 0.0423*\left(\frac{3H_0^2c^2}{8\pi G}\right)\\&\text{where, } x_0\cong\sqrt{\frac{3H_0^2c^2}{8\pi GaT_0^4}}\cong 1+\ln\left(\frac{H_{pl}}{H_0}\right)\end{aligned}\right\}\quad(14)$$

Note that, this obtained value of the current visible matter density can be compared with the current galactic mean matter density which is being estimated by considering different galactic mass-to-light ratios and is having a very broad range [27]. The corresponding relation is,

$$\left(\rho_{galaxy}\right)_0 \cong 1.5\times10^{-32}\eta h_0 \text{ g.m}^{-3} \quad (15)$$

$$\text{where}\begin{cases}h_0\cong\dfrac{H_0}{100\text{ km/sec/Mpc}}\text{ and}\\ \eta\cong\left[\left(10\pm2\right)h_0 \text{ to } \left(500\pm200\right)h_0\right]\end{cases}$$

It may also be noted that, based on the big bang nucleosynthesis, [28], $\left(\rho_{baryon}\right)_0 \cong \left(1.7 \text{ to } 4.1\right)\times10^{-31}\text{g.m}^{-3}$.

Let $\left(\rho_{d.matter}\right)_t c^2$ is the dark matter energy density at time t.

$$\left.\begin{aligned}&\left(\rho_{d.matter}\right)_t c^2 \cong \left[1+\ln\left(x_t\right)\right]^2\sqrt{\left(\frac{3H_t^2c^2}{8\pi G}\right)\left(aT_t^4\right)}\\&\text{where, } x_t\cong\sqrt{\frac{3H_t^2c^2}{8\pi GaT_t^4}}\cong 1+\ln\left(\frac{H_{pl}}{H_t}\right)\end{aligned}\right\}\quad(16)$$

Current dark matter energy density [21] can be fitted as follows:

$$\left.\begin{aligned}&\left(\rho_{d.matter}\right)_0 c^2 \cong \left[1+\ln\left(x_0\right)\right]^2\sqrt{\left(\frac{3H_0^2c^2}{8\pi G}\right)\left(aT_0^4\right)}\\&\cong\left[\frac{\left[1+\ln\left(x_0\right)\right]^2}{x_0}\right]\left(\frac{3H_0^2c^2}{8\pi G}\right)\cong 0.2515*\left(\frac{3H_0^2c^2}{8\pi G}\right)\\&\text{where, } x_0\cong\sqrt{\frac{3H_0^2c^2}{8\pi GaT_0^4}}\cong 1+\ln\left(\frac{H_{pl}}{H_0}\right)\end{aligned}\right\}\quad(17)$$

Interesting observation is that, at present,

$$\frac{(\rho_{d.matter})_0 c^2}{(\rho_{v.matter})_0 c^2} \cong \left[1+\ln(x_0)\right] \cong 5.963 \tag{18}$$

At the Planck scale, magnitude of mass energy density, thermal energy density, visible matter energy density and dark matter energy density is same! Based on these relations (13) to (18), from the beginning of cosmic evolution, visible matter creation rate and dark matter creation rate can be understood and can be recommended for further analysis.

Note: With reference to current notion of standard cosmology, $\rho_0 c^2 - \left[(\rho_{v.matter})_0 c^2 + (\rho_{d.matter})_0 c^2\right]$ is the 'dark energy density' and it is the source of current cosmic acceleration. It may be noted that, at any stage of evolution, if universe is assumed to be a black hole, then it is very natural to think about cosmic rotation! For the current evolving black hole universe, if one is willing to consider $\rho_0 c^2 - \left[(\rho_{v.matter})_0 c^2 + (\rho_{d.matter})_0 c^2\right]$ as a source of current cosmic rotation, it is possible to show that, ratio of current cosmic angular velocity and current Hubble parameter is close to unity. It is for further study at fundamental level. It can be understood in the following way.

Let, $I_0\omega_0^2 \cong \left[\frac{2}{3}\left(M_0 R_0^2\right)\right]\omega_0^2$ be the current rotational energy of the evolving black hole universe having very low density. Then,

$$\left.\begin{aligned} I_0\omega_0^2 &\cong \left[\frac{2}{3}\left(M_0 R_0^2\right)\right]\omega_0^2 \\ &\cong \left[1-(0.0423+0.2515)\right]\left(\frac{3H_0^2 c^2}{8\pi G}\right)\left[\frac{4\pi}{3}\left(\frac{c}{H_0}\right)^3\right] \\ \Rightarrow \omega_0 &\cong \sqrt{0.7062\left(\frac{3c^5}{4GM_0 R_0^2 H_0}\right)} \cong \sqrt{0.7062\left(\frac{3c^3 H_0}{4GM_0}\right)} \\ &\cong \sqrt{0.7097\left(\frac{3H_0^2}{2}\right)} \cong 1.029 H_0 \end{aligned}\right\} \tag{19}$$

This strange theoretical observation casts doubt on the currently believed basic definition of 'cosmic flatness'. The authors request the science community to consider this issue for in-depth analysis at fundamental level.

7. Estimating the Current Cosmic Age

In general, cosmic age estimates are model-dependent and cosmic size-dependent. In this proposed model, cosmic age estimation is very simple and direct. As the cosmic model is always assumed to be expanding with light speed, from the beginning of Planck scale, cosmic age can be estimated as follows:

$$\left.\begin{array}{l} t \cong \dfrac{\left(R_t - R_{pl}\right)}{c} \text{ and} \\ ct \cong \left(R_t - R_{pl}\right) \cong R_t \text{ (where } R_t \gg R_{pl}) \end{array}\right\} \tag{20}$$

For the current case, since $\left(R_{pl}\right)$ is very small and $\left(R_0 - R_{pl}\right) \cong R_0$.

$$t_0 \cong \frac{R_0}{c} \cong \frac{1}{H_0} \cong \text{ 14.02 Billion Years} \tag{21}$$

8. Two Model Equations of Cosmic Non-Linear Redshift

During its evolution, as universe is assumed to be expanding at light speed, it is natural to think about 'formation of galaxies' and 'galactic receding' from and about the cosmic centre in all directions. The authors would like to stress the following two points.

A) Galactic redshift cannot be considered as a major criterion of cosmic evolution.
B) Clearly speaking, observed galactic red shift is a consequence of cosmic evolution and cannot be a considered as a deciding factor of current and future cosmic rate of expansion.

In this section, in a semi-empirical approach, the authors propose two model equations of non-linear galactic red shift. Considering the proposed relations (22) to (24), deep space redshift nonlinearity can be shown to be connected with cosmological gravitational effects.

$$\begin{array}{l} Z \cong \sqrt{\dfrac{H_t}{H_0} - 1} \cong \sqrt{\dfrac{R_0}{R_t} - 1} \cong \sqrt{\dfrac{2GM_0}{c^2 R_t} - 1} \\ \text{where } R_t < R_0, \text{ and } M_0 \cong c^3/2GH_0. \end{array} \tag{22}$$

Similarly R_0 and R_t represent current and past cosmic radii, respectively, pertaining to specific astronomical observations.

With respect to the proposed assumptions it is clear that at any stage of cosmic expansion, cosmic radius is approximately inversely proportional to the squared cosmic temperature. The above relation (22) can be expressed as follows.

$$Z \cong \sqrt{\frac{R_0}{R_t} - 1} \cong \sqrt{\frac{T_t^2}{T_0^2} - 1} \tag{23}$$

where T_t is the past cosmic temperature and T_0 is the current cosmic temperature and $T_t > T_0$ .For past higher cosmic temperatures, where $T_t >> T_0$

$$Z \cong \sqrt{\frac{T_t^2}{T_0^2} - 1} \cong \frac{T_t}{T_0} \tag{24}$$

This relation (24) can be compared with the currently believed relation connected with cosmic scale factor and CMB radiation.

$$Z+1 \cong \frac{T_t}{T_0} \tag{25}$$

Based on the approach of obtaining the relation (24), validity of the proposed relation (22) can be understood and can be recommended for further research.

9. Discussion

Progress towards final unification has proceeded by a series of 'successive approximations', allowing more and more accurate observations over a wider and wider range of phenomena. In modern cosmology, it is generally believed that it makes no sense to model our universe without assuming the existence of cosmic acceleration. But, recent research study on Super novae red shift data confirms [1] cosmic constant rate of expansion rather than acceleration. One must accept the fact that, with currently believed modern cosmological concepts and relations it is impossible to implement Planck scale in current cosmological observations. These two points strongly necessitate the need of revising the foundations of accelerating model of cosmology. With three simple assumptions and without considering cosmic acceleration or redshift concepts, proposed 'light speed evolving black hole cosmology' model succeeds in fitting the basic observed physical parameters of the current universe with surprising accuracy!

9.1 About Assumption 1

In this proposed model cosmic horizon is assumed to be expanding at light speed. This assumption seems to be strongly supported by recent papers [2,3] presenting a critical analysis of the Type Ian supernovae data which suggests that the evidence of cosmic acceleration is marginal at best, and that our universe may well be expanding at a constant speed. If the very nature of universe is to expand with light speed, then there is no need to think about the existence of currently believed 'Lambda term'. In addition, with continuous light speed expansion, the early and modern concepts of inflation [29] can be re-addressed at fundamental level.

9.2 About Assumptions 2 and 3

Here the authors would like to stress the following facts:

A) Considering assumption-2, the cosmic horizon problem can be relinquished. At any stage of cosmic expansion, no matter can exist beyond the cosmic radius, as defined by $\left[R_t \cong 2GM_t/c^2\right] \cong \left[c/H_t\right]$. If one is willing to consider this proposal, then there is no scope for thinking about the causal connection of matter lying outside of $\left[R_t \cong 2GM_t/c^2\right] \cong \left[c/H_t\right]$.

B) Considering assumptions 2 and 3 together, current CMBR temperature, Hubble parameter, dark matter energy density and visible matter density can be fitted accurately.

C) With reference to data-fitting, proposed method is completely new, simple and surprisingly accurate. At any stage of cosmic expansion, the characteristic expression $\left[1+\ln\left(H_{pl}/H_t\right)\right]$ can be considered as a useful index of dark matter percentage and visible matter percentage and can be recommended for further study.

10. Conclusions

The very important point to be noted is that, subject of cosmology is mostly subjected to very long range cosmological observations and are beyond the scope of confirmation. As universe is vast, time to time observations are indicating different set of results and are again subjected to future observations. By going through the history of observational cosmology one can understand this. One best example is the ‘cosmic back ground temperature’. Day by day, ‘accelerating model of cosmology’ is losing its basic identity with recent and advanced cosmological observations. In addition, ‘dark energy’ and ‘Lambda term’ both seem to remain as virtual objects of modern cosmology. Anyhow, from unification point of view, it is a must to implement Planck scale in early and current cosmological predictions and observations. In this context, the authors would like to stress the fact that, by considering ‘cosmic light speed expansion’ and ‘cosmic Schwarzschild radius’ concepts, a potentially useful ‘evolving black hole cosmology’ can be developed [30-32].

The basic advantages of this model are:

1. Planck scale can be successfully implemented in understanding past and current cosmological predictions and observations.

2. Hubble parameter and cosmic temperature can be inter-linked at fundamental level.

3. As the universe is always assumed to be expanding at ‘speed of light’, there is no ‘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’.

4. Visible matter energy density and dark matter energy desnity can be predicted and thereby their creation rate can be understood.

5. Attributed results of currently believed ‘cosmic inflation’ can be understood well.

6. Cosmic horizon problem can be relinquished at fundamental level.

7. 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.

8. 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.

9. With further studies and advanced cosmological observations, 'light speed' or 'accelerating' or 'decelerating' 'Gravastar cosmology' models can be developed as advanced versions of black hole cosmology.

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References

[1] Nielsen JT, et al. Marginal evidence for cosmic acceleration from Type Ia supernovae. arXiv:1506.01354v2; (2015).
[2] Jun-Jie Wei et al. A comparative analysis of the supernova legacy survey sample with ΛCDM and the Rh=ct Universe. The Astronomical Journal.149:102. (2015)
[3] Melia F, Maier RS. Cosmic chronometers in the Rh=ct Universe. Mon. Not. Roy. Astron. Soc.;432:2669. (2013)
[4] Mitra A. Energy of Einstein's static universe and its implications for the Λ CDM cosmology. JCAP.;03:007. (2013)
[5] Mitra S. Bhattacharyya, Bhatt N. LCDM cosmology through the lens of Einstein's Static Universe, The Mother of Λ. Int. J.Mod. Phys. D22.;2:1350012 (2013)
[6] Steinhardt PJ. The inflation debate: Is the theory at heart of modern cosmology deeply flawed? Scientific American.;304(4):18-25. (2011)
[7] Hawking, Stephen W. Quantum cosmology. In Hawking, Stephen W.; Israel, Werner. 300 Years of Gravitation. Cambridge University Press. 631–651. (1987)
[8] F.S.N. Lobo, Stable dark energy stars, Class. Quant. Grav., 23, 1525 (2006)
[9] M. Malaver and M.Esculpi, A theoretical model of stable dark energy stars, IJRRAS, 14(1), 26-39 (2013)
[10] G.Chapline, Dark Energy Stars, Proceedings of the Texas Conference on Relativistic Astrophysics, Stanford (2004).
[11] M. Visser and D. L. Wiltshire, Stable gravastars – an alternative to black holes? Class. Quant. Grav. 21 1135 (2004)
[12] U.V.S. Seshavatharam. Physics of Rotating and Expanding Black Hole Universe", Progress in Physics, vol. 2, pp7-14, (2010).
[13] Seshavatharam U.V.S, Lakshminarayana S. A brief report on scale independent quantum cosmology. Review of Advances in Physics Theories and Applications. ;2(1):1-9. (2015)

[14] Tatum, E.T., Seshavatharam, U.V.S. and Lakshminarayana, S. The Basics of Flat Space Cosmology. International Journal of Astronomy and Astrophysics, 5, 116-124 (2015)

[15] Tatum ET, Seshavatharam U.V.S, Lakshminarayana S. Flat space cosmology as a mathematical model of quantum gravity or quantum cosmology. International journal of astronomy and astrophysics. 5, 133-140. (2015).

[16] Tatum, E.T., Seshavatharam, U.V.S. and Lakshminarayana, S. Thermal Radiation Redshift in Flat Space Cosmology. Journal of Applied Physical Science International, 4, 18-26. (2015)

[17] Seshavatharam, U.V.S, Tatum, E.T and Lakshminarayana, S. On the role of gravitational self energy density in spherical flat space quantum cosmology. Journal of Applied Physical Science International. Vol.: 4, Issue.: 4, 228-236 (2015)

[18] Eugene Terry Tatum, U.V.S. Seshavatharam, and S. Lakshminarayana, Flat Space Cosmology as an Alternative to Lcdm Cosmology. Frontiers of Astronomy, Astrophysics and Cosmology, vol. 1, no. 2 (2015)

[19] Seshavatharam, U.V.S. and Lakshminarayana, S. Primordial Hot Evolving Black Holes and the Evolved Primordial Cold Black Hole Universe. Frontiers of Astronomy, Astrophysics and Cosmology, 1, 16-23. (2015)

[20] Seshavatharam, U.V.S. and Lakshminarayana, S. Friedmann Cosmology: Reconsideration and New Results. International Journal of Astronomy, Astrophysics and Space Science, 1, 16-26. (2014)

[21] Planck Collaboration: Planck 2015 Results. XIII. Cosmological Parameters.

[22] Luis J. Quantum gravity and minimum length. International Journal of Modern Physics A, vol 10, issue 2, pp. 145 (1995)

[23] Tatum, E.T. Could Our Universe Have Features of a Giant Black Hole? Journal of Cosmology, 25, 13061-13080.(2015)

[24] Tatum, E.T. How a Black Hole Universe Theory Might Resolve Some Cosmological Conundrums. Journal of Cosmology, 25, 13081-13111. (2015)

[25] B. P. Abbott et al .Observation of Gravitational Waves from a Binary Black Hole Merger. PRL 116, 061102 (2016)

[26] Rocha et al. Bounded excursion stable gravastars and black holes. JCAP 0806:025 (2008)

[27] J.V.Narlikar. An Introduction to Cosmology. 3rd edition. Cambridge University press. (2002)

[28] Copi C.J. Schramm DN and Turner MS.Big-bang nucleosynthesis and the baryon density of the universe. Science. Jan 13;267 (5195):192-9. (1995)

[29] Guth AH. Inflationary universe: A possible solution to the horizon and flatness problems. Phys. Rev.;D23:347.(1981).

[30] Applications of light speed expansion and gravitational self-energy density in black hole cosmology. International Journal of Advanced Astronomy, 3 (2) 123-128. (2015)

[31] Seshavatharam, U.V.S. and Lakshminarayana. Is Current CMBR Temperature: The Scale Independent Quantum Gravitational Result of Black Hole Cosmology? pp. 464-476, In: Unified Field Mechanics: Natural Science Beyond the Veil of Spacetime - Proceedings of the IX Symposium Honoring Noted French Mathematical Physicist Jean-Pierre Vigier. Edited by AMOROSO RICHARD L ET AL. Published by World Scientific Publishing Co. Pte. Ltd., 2016. ISBN #9789814719063.

[32] Seshavatharam, U. V. S. and S. Lakshminarayana. Basics of Black Hole Cosmology – First Critical Scientific Review. Physical Science International Journal, Vol.: 4, Issue.: 6, pp.842-879 (2014)