the general science journal

Possibility of considering the universe as a primordial cosmic black hole

U. V. S. Seshavatharam
Honorary faculty, I-SERVE
Alakapuri, Hyderabad-35, India
e-mail: seshavatharam.uvs@gmail.com

November 7, 2011

Abstract: The concept of 'dark energy' is still facing and raising a number of fundamental unresolved problems. 'Cosmic acceleration','dark energy' and 'inflation', are the results of Edwin Hubble's incomplete conclusions. If there is a misinterpretation in Hubble's law - flat model of cosmology can not be considered as a correct model of cosmology. **If the *primordial universe* is a natural setting for the creation of black holes and other nonperturbative gravitational entities, it is also possible to assume that throughout its journey, the whole universe is a *primordial cosmic black hole.*** Planck particle can be considered as the baby universe. Key assumption is that, "at any time, cosmic black hole rotates with light speed". Cosmic temperature is inversely proportional to the geometric mean of cosmic mass and planck mass. For this growing cosmic sphere as a whole, while in light speed rotation, 'rate of decrease' in temperature is a "primary" measure of cosmic 'rate of expansion'. It can be suggested that, 'rate of increase in galaxy red shift' from and about the cosmic center is a "secondary" measure of cosmic 'rate of expansion'. Present 'cosmic mass density' and 'cosmic time' are fitted with the natural logarithm of ratio of cosmic volume and planck particle's volume.

Since 1992, measured CMBR temperature data (2.725 ^{0}Kelvin) indicates that, at present there is no continuous decrease in cosmic temperature. This directly indicates that, at present "rate of decrease" in temperature is practically 'zero' and 'rate of expansion' is practically 'zero'. Hence present universe is isotropic and hence practically static and is rotating as a rigid sphere with light speed. At present, galaxies are revolving with speeds proportional to their distances from the cosmic axis of rotation. If present CMBR temperature is 2.725 ^{0}Kelvin, present angular velocity is 2.17 x 10^{-18} rad/sec = 67 Km/sec/Mpc.

Keywords: Black hole, planck particle, baby universe, primordial cosmic black hole, Unruh effect, light speed rotation, rate of decrease in CMBR temperature and rate of increase in cosmic redshift.

Contents

1 Disclosure

Part of information included in this article has been previously published in the paper "Physics of Rotating and Expanding Black Hole Universe", Progress in Physics, vol. 2, April, 2010, p. 7-14. In that paper author suggested that-through out its journey, universe is an expanding and (light speed) rotating black hole. This article is a compilation of similar ideas on black hole cosmology. Compilation is the base of unification. Author requests the world science community to kindly look into this article. Finally in this article it is suggested that universe can be considered as the primordial cosmic black hole.

Existence of dark matter, dark energy, inflation and the accelerating universe - these four concepts are having only indirect support and can be considered as 'enigmatic concepts'. Their root was originated in 1929 from Edwin Hubble's incomplete interpretations. For the same observations it is also possible to reinterpret as: 'rate of increase in redshift' is a measure of cosmic rate of expansion. With this idea, automatically a closed expanding and rotating model of universe comes into picture.

With the above four enigmatic concepts (directly and indirectly) GTR is loosing its original identity from the rest of the physics world. But this is the time to think about the unification of GTR and quantum mechanics. In this critical situation, one very interesting theoretical idea is - now a days to understand the origin of dark matter and galaxy growth, physicists are focussing their concentration on primordial cosmic black holes. One interesting observation is : central galactic black holes are spinning close to speed of light. Even though these two are also enigmatic concepts, GTR and quantum mechanics can be studied in a unified manner.

2 Dark matter & dark energy - body & soul of modern cosmology

The existence of dark energy, in whatever form, is needed to reconcile the measured geometry of space with the total amount of matter in the universe. Measurements of cosmic microwave background (CMB) anisotropies, most recently by the WMAP spacecraft, indicate that the universe is close to flat. For the shape of the universe to be flat, the mass/energy density of the universe must be equal to a certain critical density. The total amount of matter in the universe (including baryons and dark matter), as measured by the CMB, accounts for only about 30% of the critical density. This implies the existence of an additional form of energy to account for the remaining 70%.The WMAP five-year analysis estimate a universe made up of 74% dark energy, 22% dark matter, and 4% ordinary matter. More recently, the WMAP seven-year analysis gave an estimate of 72.8% dark energy, 22.7% dark matter and 4.6% ordinary matter.

2.1 Dark matter - the first enigma in modern physics

The discovery of dark matter is of fundamental importance to the present-day particle physics and cosmology. The origin and the nature of dark matter, however, remains largely unknown, which is a great challenge to the particle physics. From particle physics point of view, it definitely requires new physics beyond the current standard model of particle physics. The vast majority of dark matter in the universe is believed to be nonbaryonic, and thus not formed out of atoms. It is also believed that it does not interact with ordinary matter via electromagnetic forces; in particular, dark matter particles do not carry any electric charge. The nonbaryonic dark matter includes neutrinos, and possibly hypothetical entities such as axions, or super symmetric particles. Unlike baryonic dark matter, nonbaryonic dark matter does not contribute to the formation of the elements in the early universe ("Big Bang nucleosynthesis") and so its presence is revealed only via its gravitational attraction. In addition, if the particles of which it is composed are super symmetric, they can undergo annihilation interactions with themselves resulting in observable by-products such as photons and neutrinos ("indirect detection"). Much of the evidence for dark matter comes from the study of the motions of galaxies. As important as dark matter is believed to be in the cosmos, direct evidence of its existence and a concrete understanding of its nature have remained elusive. Though the theory of dark matter remains the most widely accepted theory to explain the anomalies in observed galactic rotation, some alternative theoretical approaches have been developed which broadly fall into the categories of modified gravitational laws, and quantum gravitational laws. The most surprising thing is that, today modern physicists assume that primordial black holes are responsible for the origin of dark matter.

2.2 Dark energy - the second enigma in modern physics

The nature of dark energy is a matter of mystery. The evidence for dark energy is only indirect coming from distance measurements and their relation to redshift. It is thought to be very homogeneous, not very dense and is not known to interact through any of the fundamental forces other than gravity. Since it is not very dense- roughly 10^{-29} grams per cubic centimeter - it is hard to imagine experiments to detect it in the laboratory.

From particle physics point of view, these two concepts are very interesting. But there is no solid mechanism or no physical phenomena for detecting or producing or understanding their physical identity. It is very surprising that most of the modern cosmologists and particle physicists are believing in these two speculative concepts. Now the situation is that, 'dark matter and dark energy' both seems to be the "body and soul" of the modern cosmology. For detecting dark matter and dark energy many exciting experiments are set up and are in progress.

2.3 The accelerating universe - great mystery of modern physics

This is the press release information on 2011 Nobel prize in physics from the official web site of the Nobel prize (nobelprize.org). *In 1998, cosmology was shaken at its foundations as two research teams presented their findings. Headed by Saul Perlmutter, one of the teams had set to work in 1988. Brian Schmidt headed another team, launched at the end of 1994, where Adam Riess was to play a crucial role. The research teams raced to map the Universe by locating the most distant supernovae. More sophisticated telescopes on the ground and in space, as well as more powerful computers and new digital imaging sensors (CCD, Nobel Prize in Physics in 2009), opened the possibility in the 1990s to* *add more pieces to the cosmological puzzle. The teams used a particular kind of supernova, called type Ia supernova. It is an explosion of an old compact star that is as heavy as the Sun but as small as the Earth. A single such supernova can emit as much light as a whole galaxy. All in all, the two research teams found over 50 distant supernovae whose light was weaker than expected - this was a sign that the expansion of the Universe was accelerating. The potential pitfalls had been numerous, and the scientists found reassurance in the fact that both groups had reached the same astonishing conclusion. For almost a century, the Universe has been known to be expanding as a consequence of the Big Bang about 14 billion years ago.* ***However, the discovery that this expansion is accelerating is astounding. If the expansion will continue to speed up the Universe will end in ice. The acceleration is thought to be driven by dark energy, but what that dark energy is remains an enigma - perhaps the greatest in physics today. What is known is that dark energy constitutes about three quarters of the Universe****. Therefore the findings of the 2011 Nobel Laureates in Physics have helped to unveil a Universe that to a large extent is unknown to science. And everything is possible again.*

2.4 Black Hole - the most perfect object in the universe

This is a quotation from : S. Chandrasekhar, Truth and Beauty: Aesthetics and Motivations in Science, University of Chicago Press, 1987, pages 153-154. *Black holes are macroscopic objects with masses varying from a few solar masses to millions of solar masses. To the extent they may be considered as stationary and isolated, to that extent, they are all, every single one of them, described exactly by the Kerr solution. This is the only instance we have of an exact description of a macroscopic object. Macroscopic objects, as we see them all around us, are governed by a variety of forces, derived from a variety of approximations to a variety of physical theories. In contrast, the only elements in the construction of black holes are our basic concepts of space and time. They are, thus, almost by definition, the most perfect macroscopic objects there are in the universe. And since the general theory of relativity provides a single unique two-parameter family of solutions for their description, they are the simplest objects as well.*

2.5 Light speed rotation - an unified enigmatic concept

All these enigmatic concepts can be unified into one enigmatic concept. That is - light speed rotation. Its important and immediate applications are

1. Classical limits of force and power can be generated.
2. GTR and quantum mechanics can be studied in a unified manner.
3. Origin of the planck scale can be understood.
4. A closed rotating and expanding model of the universe can be developed.

5. The two experimental numbers CMBR temperature and cosmic expansion rate can be interrelated in a unified way.

6. Finally a unified black hole model of cosmology can be developed.

3 The primordial black holes

A primordial black hole [1-3] 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. One way to detect primordial black holes is by their Hawking radiation. Stephen Hawking theorized in 1974 that large numbers of such smaller primordial black holes might exist in the Milky Way in our galaxy's Halo region. All black holes are believed by many theorists to emit Hawking radiation at a rate inversely proportional to their mass. Since this emission further decreases their mass, black holes with very small mass would experience runaway evaporation, creating a massive burst of radiation at the final phase, equivalent to millions of one-megaton hydrogen bombs exploding. This explanation is, however, considered unlikely. Other problems for which primordial black holes have been suggested as a solution include the dark matter problem, the cosmological domain wall problem and the cosmological monopole problem. Primordial black holes in the mass range 10^{14} kg to 10^{23} kg may also have contributed to the later formation of galaxies. This is due to the possibility that at this low mass they would behave as expected of other particle candidates for dark matter. As of today there is no solid evidence for the existence of PBHs, but their presence would be very difficult to detect even if they constitute the bulk of the dark matter. A black hole with a mass of about 10^{11} kg would have a lifetime about equal to the age of the universe. Based on the present theoretical works, expected mass of the nonevaporating PBHs ranges from $M \geq \left(0.1 \text{ to } 10^5\right) \times M_\odot$. PBHs with masses $M \cong M_\odot$ may form during the QCD (quark-hadron) phase transition at $t \cong 10^{-5}$ seconds, or PBHs with mass $10^5 \times M_\odot$ may form during the e^+, e^- annihilation era. **If the *primordial universe* is a natural setting for the creation of black holes and other non-perturbative gravitational entities, what is wrong in assuming the whole universe as the *primordial cosmic black hole*?**

3.1 The four remarkable published abstracts

Abstract-1: *Recent developments in the study of primordial black holes (PBHs) are reviewed, with particular emphasis on their formation and evaporation. It is still not clear whether PBHs formed but, if they did, they could provide a unique probe of the early Universe, gravitational collapse, high energy physics and quantum gravity. Indeed their study may place interesting constraints on the physics relevant to these areas even if they never existed.* It's author is B.J. Carr [1]. This abstract can be downloaded from http://arxiv.org/abs/astro-ph/0511743v1. In this paper it is suggested that: *Roughly 30 % of the total density of the Universe is now thought to be in the form of "cold dark matter". Recently there has* *been a lot of interest in whether PBHs could provide this, since those larger than* 10^{15} *gram would not have evaporated yet and would certainly be massive enough to be dynamically "cold". It is also possible that the Planck relics of evaporated PBHs could provide the dark matter.* Regarding the large-scale structure and super massive black holes formation he says: *PBHs might also play a role in the formation of large-scale structure. For example, it has been realized for some time that Poisson fluctuations in the number density of PBHs can generate appreciable density perturbations on large scales if the PBHs are big enough. This idea has recently been invoked to explain voids and Lyman-alpha clouds. In such scenarios, it is important to know how much a PBH can grow through accretion and it has been argued that this could be significant even in the period after matter-radiation equality. Several people have suggested that the* 10^6 to $10^8 \times \mathrm{M}_\odot$ *super massive black holes thought to reside in galactic nuclei could be of primordial origin. For example, a 1st order phase transition could produce clusters of PBHs, around which a single super massive black hole might then condense. Alternatively, it has been proposed that inflation could produce closed domain walls, which then collapse to form* $10^8 \times M_\odot$ *PBHs. Another scheme invokes more modest mass PBHs of* $10^3 \times M_\odot$*, resulting from a feature in the inflation potential, which then grow to* $10^8 \times M_\odot$ *by accretion.*

Abstract-2: *Production of high-energy gravitational objects is a common feature of gravitational theories. The primordial universe is a natural setting for the creation of black holes and other nonperturbative gravitational entities. Cosmic black holes can be used to probe physical properties of the very early universe which would usually require the knowledge of the theory of quantum gravity. They may be the only tool to explore thermalization of the early universe. Whereas the creation of cosmic black holes was active in the past, it seems to be negligible at the present epoch.* This abstract is published in International journal of modern physics D, Volume: 12, Issue: 9(2003) pp. 1699-1704. It's authors are Eun-Joo Ahn and Marco Cavagli. This is a remarkable paper and is selected for 2003 Gravity Research Foundation, honourable mention Awards[4].

Abstract-3: *We consider the radial geodesic motion of a massive particle into a black hole in isotropic coordinates, which represents the exterior region of an Einstein-Rosen bridge (wormhole). The particle enters the interior region, which is regular and physically equivalent to the asymptotically flat exterior of a white hole, and the particle's proper time extends to infinity. Since the radial motion into a wormhole after passing the event horizon is physically different from the motion into a Schwarzschild black hole, Einstein-Rosen and Schwarzschild black holes are different, physical realizations of general relativity. Yet for distant observers, both solutions are indistinguishable. We show that timelike geodesics in the field of a wormhole are complete because the expansion scalar in the Raychaudhuri equation has a discontinuity at the horizon, and because the Einstein-Rosen bridge is represented by the Kruskal diagram with Rindler's elliptic identification of the two antipodal future event horizons. These results suggest that observed astrophysical black holes may be Einstein-*

Rosen bridges, each with a new universe inside that formed simultaneously with the black hole. Accordingly, our own Universe may be the interior of a black hole existing inside another universe. This abstract is published in Physics letters B, Volume 687, Issues 2-3, 12 April 2010, Pages 110-113. It's author is Nikodem J. Popawski [5].

Abstract-4: *A new cosmological model called black hole universe is proposed. According to this model, the universe originated from a hot star-like black hole with several solar masses, and gradually grew up through a super massive black hole with billion solar masses to the present state with hundred billion-trillion solar masses by accreting ambient materials and merging with other black holes. The entire space is structured with infinite layers hierarchically. The innermost three layers are the universe that we are living, the outside called mother universe, and the inside star-like and super massive black holes called child universes. The outermost layer is infinite in radius and limits to zero for both the mass density and absolute temperature. The relationships among all layers or universes can be connected by the universe family tree. Mathematically, the entire space can be represented as a set of all universes. A black hole universe is a subset of the entire space or a subspace. The child universes are null sets or empty spaces. All layers or universes are governed by the same physics - the Einstein general theory of relativity with the Robertson-walker metric of spacetime - and tend to expand outward physically. The evolution of the space structure is iterative. When one universe expands out, a new similar universe grows up from its inside. The entire life of a universe begins from the birth as a hot star-like or super massive black hole, passes through the growth and cools down, and expands to the death with infinite large and zero mass density and absolute temperature. The black hole universe model is consistent with the Mach principle, the observations of the universe, and the Einstein general theory of relativity. Its various aspects can be understood with the well-developed physics without any difficulty. The dark energy is not required for the universe to accelerate its expansion. The inflation is not necessary because the black hole universe does not exist the horizon problem.* This abstract is published in Progress in Physics, Volume 3, July 2009. It's author is Tianxi Zhang[6].

3.2 Force and power limits in black hole cosmology

Published abstracts 1, 2, 3 and 4 clearly indicates that, current cosmological observations can be understood with the black hole concepts and the possibility of a model of black hole cosmology is not far away from reality. Interesting research work on black hole cosmology can be seen in physics literature [7-14]. In a unified approach it is noticed that $\frac{c^4}{G}$ is the classical limit of force and $\frac{c^5}{G}$ is the classical limit of power. With these two limits, mathematical complexity involved in GTR can be simplified. Planck mass can be derived very easily. Light speed rotating black hole's formation can be understood. GTR and quantum mechanics can be coupled in a unified manner. Rotating black hole temperature formula can be derived very easily. Interesting thing is: force $\frac{c^4}{G}$ keeps the light speed rotating black hole stable. Finally a rotating model of 'black hole cosmology' can be developed [11,12]. Very interesting observation is that, any elementary particle can escape from the light speed rotating black hole's equator. This idea may be given a chance in understanding the mystery of origin of cosmic rays.

3.3 Need of the existence of primordial cosmic black hole

From above discussion, to understand the cosmological observations and black hole physics in a unified manner, it can be assumed that, right from the beginning to the present state, universe can be considered as the primordial black hole. To proceed further, it is a must to show that,

1. There is a fundamental flaw in the basics of modern flat cosmology. It goes back to 1929 Hubble's interpretation of galactic redshift data [13]. It's correct interpretation is: 'rate of increase' in red shift is a measure of cosmic rate of expansion.
2. Rate of decrease in CMBR temperature is a measure of cosmic rate of expansion. 'Cosmic isotropy' and 'cosmic acceleration' both are inversely proportional to each other.
3. Dimensions of Hubble's constant are 'radian/sec' but not '1/sec'. This is very simple and brings cosmic rotation into picture [14-17].
4. Universe follows a closed expanding boundary. Best example is :'Apple grows like an apple' with closed expanding/growing boundary. Rotation will make the closed expanding universe stable.
5. At any time, strong gravity plays an interesting role in minimizing the (expanding) cosmic size.
6. Large cosmic time and smooth cosmic expansion play an interesting role in the evolution of fundamental particles.

4 The cosmic critical density and its dimensional analysis

Assume that, a planet of mass (M) and size (R) rotates with angular velocity (ω_e) and linear velocity (v_e) in such a way that, free or loosely bound particle of mass (m) lying on its equator gains a kinetic energy equal to potential energy as,

$$\frac{1}{2}mv_e^2 = \frac{GMm}{R} \tag{1}$$

$$R\omega_e = v_e = \sqrt{\frac{2GM}{R}} \text{ and } \omega_e = \frac{v_e}{R} = \sqrt{\frac{2GM}{R^3}} \tag{2}$$

i.e Linear velocity of planet's rotation is equal to free particle's escape velocity. Without any external power or energy, test particle gains escape velocity by virtue of planet's rotation. Using this idea, 'Black hole radiation' and 'origin of cosmic rays' can be understood. Note that if Earth completes one rotation in one hour then free particles lying on the equator will get escape velocity. Now writing,

$$M = \frac{4\pi}{3} R^3 \rho_e, \quad \omega_e = \frac{v_e}{R} = \sqrt{\frac{8\pi G\rho_e}{3}} \text{ Or } \omega_e^2 = \frac{8\pi G\rho_e}{3} \tag{3}$$

$$\text{Density, } \rho_{\mathrm{e}} = \frac{3\omega_{\mathrm{e}}^2}{8\pi \mathrm{G}} \tag{4}$$

In real time, this obtained density may or may not be equal to the actual density. But the ratio, $\frac{8\pi G\rho_{real}}{3\omega_{real}^2}$ may have some physical meaning. The most important point to be noted here, is that, as far as dimensions and units are considered, from equation (4), it is very clear that, proportionality constant being $\frac{3}{8\pi G}$,

$$\text{density} \propto (\text{angular velocity})^2 \tag{5}$$

Equation (4) is similar to "flat model concept" of cosmic "critical density"

$$\rho_c = \frac{3H_0^2}{8\pi G} \tag{6}$$

Comparing equations (4) and (6) dimensionally and conceptually,

$$\rho_e = \frac{3\omega_e^2}{8\pi G} \text{ and } \rho_{\mathrm{c}} = \frac{3\mathrm{H}_0^2}{8\pi \mathrm{G}} \Rightarrow \mathrm{H}_0^2 \to \omega_{\mathrm{e}}^2 \text{ and } \mathrm{H}_0 \to \omega_{\mathrm{e}} \tag{7}$$

In any physical system under study, for any one 'simple physical parameter' there will not be two different units and there will not be two different physical meanings. This is a simple clue and brings "cosmic rotation" into picture. This is possible in a closed universe only. It is very clear that, dimensions of 'Hubble's constant' must be 'radian/second'. Cosmic models that depends on this "critical density" must accept 'angular velocity of the universe' in the place of 'Hubble's constant'. In the sense, 'cosmic rotation' must be included in the existing models of cosmology. Then the term 'critical density' simply appears as the 'spherical geometric density' of the closed and expanding universe. One should not deny this dimensional analysis.

5 Was Hubble's interpretation 100% complete?

Edwin Hubble and Milton Humason extended V. M. Slipher's list of cosmic observations (1912 to 1925) to more number of brightest galaxies and noticed that 'redshift' plays a key role in galaxy distance measurement. In 1929 Hubble announced his famous and exhilarating linear cosmic expansion law as- 'redshift' is a measure of galaxy distance and galaxy 'receding speed' is directly proportional to its 'redshift' [13]. This was the incomplete interpretation that changed the destiny of the modern cosmology. Based on this interpretation modern cosmologists arrived at the conclusion that – at present, universe is flat and is accelerating [18, 19]. **In this connection, author humbly says – there was something wrong and missing in Hubble's interpretation**.

For the same observations it can also be possible to state that, in a closed and expanding universe, from and about the cosmic center, rate of increase in galaxy redshift is a measure of cosmic rate of expansion. This statement includes 3 points. First point is – light from the galaxy travels opposite to the direction of cosmic expansion and shows redshift and thus redshift is a measure of galaxy distance from the cosmic center. Second point is- in the expanding universe, increase in redshift is instantaneous due to instantaneous increase in galaxy distance (which is due to instantaneous increase in cosmic volume) and the third point is – rate of increase in redshift indicates the cosmic rate of expansion. Here in both of these interpretations the unknown or mysterious thing is- why and how universe is expanding?

6 Cosmic closed model and rotation

In our daily life generally it is observed that, any animal or fruit or human beings (from birth to death) grows with closed boundaries (irregular shapes also can have a closed boundary). An apple grows like an apple. An elephant grows like an elephant. A plant grows like a plant. A Human grows like a human. Throughout their life time, they won't change their respective identities. These are observed facts. From these observed facts it can be suggested that, "growth" or "expansion" can be possible with a closed boundary. By any reason, if the closed boundary is opened it leads to 'destruction' rather than 'growth or expansion'. Thinking that nature loves symmetry, in a heuristic approach in this paper author assumes that, throughout its life time, universe is a black hole. Even though it is growing, at any time it is having an event horizon with a closed boundary and thus it retains her identity as a black hole forever. The subject of black hole cosmology is not new. Note that universe is an independent body. It may have its own set of laws. At any time, if universe maintains a closed boundary, to have its size minimum at that time, it must follow 'strong gravity' at that time. If universe is having 'no black hole structure', any massive body (which is bound to the universe) may not show a 'black hole structure'. i.e 'Black hole structure' may be a sub set of 'cosmic structure'.

Rotation is an universal phenomenon; the earth and all the other members of the solar system rotate on their axes, the satellites revolve round the planets, the planets revolve round the Sun, and the Sun himself is a member of the galaxy or Milky Way system which revolves in a very remarkable way. How did all these rotary motions come into being? What secures their permanence or brings about their modifications? And what part do they play in the system of the world? Recent observations indicates that, black holes are spinning close to speed of light [20].

Clearly and strictly speaking there was no big bang at all. Highly dense, hot and tiny planck particle (the baby universe) was rotating with light speed and high angular velocity. Why, how and when the planck particle was born? is a trillion dollar question to be answered. As time is passing, forever rotating at light speed [21] the baby universe starts growing with decreasing temperature, decreasing angular velocity, increasing size and increasing mass. At what rate the changes are occurring? is a fundamental question to be answered. By observations and suitable analysis it is possible. The utmost fundamental question to be answered is – is planck particle a black hole? If it is a really a black hole certainly it possess an intrinsic or a characteristic (high) temperature [22]. Keeping this idea in mind if one proceeds further concepts of isotropy, homogeneity can be answered very easily. Inflation hypothesis can be eliminated. A unified model of black hole cosmology can be developed. But the subject of black holes is still under development. So many doubts and conflicts are there about the formation and growth of galactic central black holes and galaxy as a whole [23].

7 The cosmological principle and the closed expanding universe

It may be a flat universe or closed universe, why universe is/was filled with thermal bath? is a million dollar question. If it is a black hole this question can be answered partially. The cosmological principle states that at any given cosmic time universe is homogeneous and isotropic. Compared to a flat model, isotropy is more natural in a closed expanding universe. Considering the closed expanding universe this can be very easily understood. In a closed expanding universe the utmost important and interesting point is that as the closed universe is expanding its thermal waves are stretched by the closed cosmic working or active boundary in opposite directions simultaneously. As long as the closed universe is expanding instantaneously thermal waves undergo continuous stretching and results in instantaneous isotropy or thermal equilibrium. This is just like stretching of a rubber band with both the hands in opposite directions.

In a flat universe there exists no working or active cosmic boundary and hence stretching of the thermal waves in opposite directions may not be possible instantaneously. Hence isotropy or thermal equilibrium cannot be maintained instantaneously in a flat model. Even the possibility of a proper physical coupling or contact in between the thermal bath and the flat cosmic volume is doubtful. Inflation may be required in a flat model but not required for the closed expanding model. Even in particle physics also there is no clear and solid mechanism for the initiation of inflation. More over inflation or exponential expansion of cosmic space violates the constancy of speed of light. Please note that at present there is no fundamental theory for the inflationary universe. With this discussion any one can confidently say that - the notion of 'flat accelerating universe' is incorrect. Note that present 'accelerating model' and 'dark matter' both are the consequences of 'flat model'. Hence their survival seems to be ad-hoc and uncertain.

The new SNe distance determinations [24, 25] do not state that the expansion of the universe is accelerating, nor that there is some kind of "antigravity" effect, nor that there is some new substance. The data only forces the conclusion that there is a problem in the purely Hubble conception of the cosmos or at least in the Hubble-based method of determining the distance to distant objects. If age of the universe is long, by this time, early born 'aged' galaxies might be moved far away from the cosmic center and close to the cosmic boundary. Various factors like cosmic age, galaxy age or non availability of nuclear fuel etc may be playing a key role in dimming of the supernovae. Big bang model assumes that at the beginning cosmic temperature was very high and at present due to its expansion, its temperature is very small. From this one can say that- rate of decrease in temperature is a measure of cosmic rate of expansion. Present observational or experimental data indicates that cosmic microwave back ground radiation temperature is 2.725 ^{0}kelvin. It is very uniform up to several mega parsecs from Earth and so smooth to one part in 100000. If universe is really accelerating one must find a continuous drop in CMBR temperature but not the temperature fluctuations. Note that cosmic anisotropy indicates the temperature fluctuations in the different galactic volumes.

8 GTR, Planck mass and CMBR temperature

Let us assume that present universe is a point particle having mass M_0. Assume that gravitational force of attraction between the point universe mass and the planck mass (the baby universe mass) is equal to $\left(c^4/8\pi G\right)$. Author humbly say- this simple assumption unifies GTR, quantum mechanics, planck scale, big bang cosmology and Hubble's observations.

$$\frac{GM_0 M_P}{r_0^2} \cong \frac{c^4}{8\pi G} \tag{8}$$

From big bang model at any time expanding universe possess some temperature and its present CMBR temperature is $T_0 = 2.725^o$ Kelvin. Surprisingly it is noticed that, above assumption is satisfied at the following 2 conditions.

$$r_0 = \left(\frac{\lambda_m T}{2\pi T_0}\right) = \frac{2.898 \times 10^{-3}}{2\pi T_0} = \frac{hc}{2\pi \times 4.965 k_B T_0} \text{ meter} \tag{9}$$

$$M_0 = \frac{c^3}{2GH_0} \tag{10}$$

where H_0 is the present cosmic expansion rate index. Above expression can be expressed as

$$T_0 = \frac{1}{\sqrt{8\pi * 4.965^2}} \frac{\hbar c^3}{Gk_B\sqrt{M_0 M_P}} \cong \frac{\hbar c^3}{8\pi G k_B \sqrt{M_0 M_P}} \tag{11}$$

Note that, $\sqrt{8\pi * 4.965^2} \cong 24.891 \cong 8\pi = 25.13274123$. Hence

$$T_0 \cong \frac{\hbar}{4\pi k_B} \sqrt{\frac{c^3}{2GM_P} \times \frac{c^3}{2GM_0}} \tag{12}$$

There is no working boundary in the flat model cosmology. It is an usual and widespread practice to say that $\left({}^{c}/_{H_0}\right)$ is the characteristic length of the universe and is called as the Hubble radius. Not only that Hubble volume $\frac{4\pi}{3}\left(\frac{c}{H_0}\right)^3$ represents the characteristic and observable volume of the universe .

It is defined and accepted that H_0 value changes with time. Cosmic temperature also changes with time. By any chance if one is able to consider $\frac{c^3}{2GM_0}$ as the present angular velocity, $\frac{c^3}{2GM_P}$ as the planck mass angular velocity then above relation can be expressed as

$$4\pi k_B T_0 \cong \hbar\sqrt{\omega_P \omega_0} \tag{13}$$

This is definitely possible only if universe follows strong gravity and light speed rotation. During the cosmic evolution, at any time above equation can be re-expressed as

$$4\pi k_B T_t \cong \hbar\sqrt{\omega_P \omega_t} \tag{14}$$

The surprising and interesting idea is for the baby universe or for the planck mass $\omega_t = \omega_P$. Hence

$$4\pi k_B T_t \cong \hbar\omega_P \tag{15}$$

This procedure may be ad-hoc. But beauty of this procedure is that it couples

1. Newton's law of gravitation,
2. Einstein's cosmic force constant,
3. Wein's displacement law and
4. Special theory of relativity (for constancy of light speed).

9 Derivation for light speed rotating black hole temperature

Stephen Hawking says- "*The main difficulty in finding a theory that unifies gravity with the other forces is that general relativity is a "classical" theory;*

that is, it does not incorporate the uncertainty principle of quantum mechanics. On the other hand, the other partial theories depend on quantum mechanics in an essential way. A necessary first step, therefore, is to combine general relativity with the uncertainty principle. As we have seen, this can produce some remarkable consequences, such as black holes not being black, and the universe not having any singularities but being completely self-contained and without a boundary

Einstein's general theory of relativity seems to govern the large-scale structure of the universe. It is what is called a classical theory; that is, it does not take account of the uncertainty principle of quantum mechanics, as it should for consistency with other theories. The reason that this does not lead to any discrepancy with observation is that all the gravitational fields that we normally experience are very weak. However, the singularity theorems discussed earlier indicate that the gravitational field should get very strong in at least two situations, black holes and the big bang. In such strong fields the effects of quantum mechanics should be important. Thus, in a sense, classical general relativity, by predicting points of infinite density, predicts its own downfall, just as classical (that is, non quantum) mechanics predicted its downfall by suggesting that atoms should collapse to infinite density. We do not yet have a complete consistent theory that unifies general relativity and quantum mechanics, but we do know a number of the features it should have. The consequences that these would have for black holes and the big bang will be described in later chapters. For the moment, however, we shall turn to the recent attempts to bring together our understanding of the other forces of nature into a single, unified quantum theory.

A black hole of mass (M) having size, $R = \frac{2GM}{c^2}$ rotates with an angular velocity(ω) and rotational speed (v $= R\omega$). Assume that, its temperature (T) is inversely proportional to its rotational time period(t). Keeping '**Law of uncertainty'** in view, assume that,

$$(k_B T) * t = \frac{h}{4\pi} = \frac{\hbar}{2} \tag{16}$$

$$\text{(Or)} \quad T * t = \frac{h}{4\pi k_B} = \frac{\hbar}{2k_B} \tag{17}$$

Here, t = rotational time period and T = Temperature, k_B = Boltzmann's radiation constant, h = Planck's constant and $\left[\left(\frac{k_B T}{2}\right) + \left(\frac{k_B T}{2}\right)\right] = k_B T$ is the sum of kinetic and potential energies of a particle in any one direction. We know that,

$$t = \frac{2\pi}{\omega} = \frac{2\pi R}{v} = \frac{4\pi GM}{c^2 v} \tag{18}$$

Hence,

$$T = \frac{\hbar c^2 v}{8\pi GM k_B} \tag{19}$$

It is very surprising to say that – a small physical constant is influencing a big massive body. If the black hole rotational speed v approaches light speed c, then temperature reaches to maximum. Here author's humble appeal is : force limit $\left(c^4/G\right)$ keeps the black hole 'stable or rigid' even at light speed rotation.

$$v \to v_{\max} \to c, \quad T = \frac{\hbar c^3}{8\pi G M k_B} \cong T_{\max} \tag{20}$$

Please note that, this idea or assumption couples GTR and quantum mechanics successfully. Hawking's black hole temperature formula can be obtained easily. And its meaning is simple and there is no need to consider the pair particle creation for understanding 'hawking radiation'. This is the main advantage of this simple derivation. Conceptually this can be compared with the **Unruh effect** [26].

9.1 Fulling-Davies-Unruh effect

The 'Unruh effect' or 'Fulling-Davies-Unruh effect', was first described by Stephen Fulling in 1973, Paul Davies in 1975 and Bill Unruh in 1976. It is the prediction that an accelerating observer will observe black-body radiation where an inertial observer would observe none. In other words, the background appears to be warm from an accelerating reference frame. The ground state for an inertial observer is seen as in thermodynamic equilibrium with a non-zero temperature by the uniformly accelerated observer. It is currently not clear whether the Unruh effect has actually been observed, since the claimed observations are under dispute. There is also some doubt about whether the Unruh effect implies the existence of 'Unruh radiation'. The Unruh temperature, derived by William Unruh in 1976, is the effective temperature experienced by a uniformly accelerating detector in a vacuum field. Its mathematical expression is

$$T = \frac{\hbar a}{2\pi c k_B} \tag{21}$$

where a is the local acceleration. If one is willing to replace the 'local acceleration' with the 'angular acceleration' of the rotating black hole, then 'black hole temperature' comes into picture. If the black hole rotates with an angular acceleration of magnitude equal to $a \cong \frac{GM}{R^2} \cong \frac{c^4}{4GM}$, then Unruh formula changes to Hawking's expression

$$T = \frac{\hbar a}{2\pi c k_B} \cong \frac{\hbar c^3}{8\pi G M k_B} \tag{22}$$

Under experimentally achievable conditions for gravitational systems this effect is too small and its observation is very difficult. Unruh demonstrated theoretically that the notion of vacuum depends on the path of the observer through spacetime. From the viewpoint of the accelerating observer, the vacuum of the inertial observer will look like a state containing many particles in thermal equilibrium-a warm gas. Although the Unruh effect would initially be perceived as counter-intuitive, it makes sense if the word 'vacuum' is interpreted as simply the lowest 'possible' quantum energy state.

9.2 Hawking's Black hole temperature demands (light speed) rotation

From the above discussion it is very clear that, origin of Hawking radiation is possible in another way also. But it has to be understood more clearly. Information can be extracted from a black hole, if it rotates with "light speed". If a black hole rotates at 'light speed', photons or elementary particles can escape from its 'equator only' with light speed and in the direction of black hole rotation and this seems to be a signal of "Black hole radiation" around the black hole equator. *With this idea origin of cosmic rays can also be understood.* Please note that, not only at the black hole equator, Hawking radiation can take place at the event horizon of the black hole having a surface area.

This equation (20) is identical to the famous expression derived by Hawking. From the assumptions and from the obtained expressions, it is clear that, "black hole temperature is directly proportional to the rotational speed of the black hole". Temperature of a stationary black hole is always 'zero' and increases with increasing rotational speed and reaches to maximum at 'light speed rotation'. In this way also GTR and quantum mechanics can be coupled. But this concept is not the output from Hawking's black hole temperature formula. In any physical system, for any physical expression there exists only one true physical meaning. Either Hawking's concept is true or the proposed concept is true. Since the black hole temperature formula is accepted by the whole science community, author humbly requests the modern scientists to kindly look into this major conceptual clash at utmost fundamental level.

Temperature of any black hole is very small and may not be found experimentally. But this idea can successfully be applied to the Universe! By any reason if it is assumed that, Universe is a black hole, then it seems to be surprising that, temperature of a stationary cosmic black hole is "zero". Its temperature increases with increase in its rotational speed and reaches to maximum if the rotational speed of the cosmic black hole approaches 'light speed". This is the essence of cosmic black hole rotation. CMBR temperature demands the existence of "cosmic rotation". This is the most important point to be noted here.

10 Proposed five assumptions

To implement the planck scale successfully in cosmology, to develop a unified model of cosmology and to obtain the value of present Hubble's constant (without considering the cosmic redshift), starting from the planck scale, it is assumed that, at any time (t),

1. the universe can be treated as a rotating and growing black hole.
2. with increasing mass and decreasing angular velocity, the universe is always rotating with speed of light.

3. without 'cosmic rotation' there is no 'cosmic temperature'. Cosmic temperature follows Hawking black hole temperature formula where mass is equal to the geometric mean of planck mass and cosmic mass.

4. 'rate of decrease' in CMBR temperature is a measure of cosmic 'rate of expansion'.

5. space, time and matter are the immediate and parallel results of cosmic expansion.

11 Results in black hole cosmology

1. Based on the increasing cosmic time, 'cosmic isotropy' and 'cosmic acceleration' both are inversely proportional to each other. It can be suggested that, from cosmology point of view 'dark matter' and 'dark energy' are 'ad-hoc & misleading' concepts.

2. (H_0) is the present angular velocity (ω_t) of the slowly expanding light speed rotating black hole universe. Presently believed critical density, $\rho_0 \cong \frac{H_0^2}{8\pi G}$ is a space-time geometric density and is a variable parameter and in any way it is not connected with the cosmic expansion.

3. At any time, $4\pi * k_B T_t \cong \hbar * \sqrt{\omega_t \omega_P} \cong \hbar * \left(\frac{c^3}{2G\sqrt{M_t M_P}}\right)$ where M_t is the cosmic mass, T_t is the cosmic temperature, ω_t is the cosmic angular velocity and M_P is the planck mass, T_P is the planck temperature, ω_P is the planck angular velocity respectively. If present CMBR temperature is 2.725 ^{0}Kelvin, present angular velocity is 2.17 x 10^{-18} rad/sec = 67 Km/sec/Mpc.

4. Mass density = $\rho_m \cong 3\ln\left(\frac{R_t}{R_P}\right) * \frac{aT_t^4}{c^2} \cong 6\ln\left(\frac{T_P}{T_t}\right) * \frac{aT_t^4}{c^2}$ where R_P, T_P are size and temperature of plank particle and R_t, T_t are size and temperature of the light speed rotating black hole universe at time 't' [27]. Its present value is 1.95×10^{-31} gram/cm^3.

5. If $m_n c^2$ is the rest energy of nucleon, baryon-photon number density ratio can be expressed as $\left(\frac{N_B}{N_\gamma}\right) \cong 3\ln\left(\frac{R_t}{R_P}\right) * \left(\frac{2.7 k_B T_t}{m_n c^2}\right)$.

6. Basically cosmic redshift is a measure of galactic distances. At any time 't', Cosmic red shift, $z_t = \left(\frac{\lambda_{measured} - \lambda_{emitted}}{\lambda_{measured}}\right)$ but not $z_t = \left(\frac{\lambda_{measured} - \lambda_{emitted}}{\lambda_{emitted}}\right)$.

7. At any time, galaxies are rotating about the cosmic center about an axis at some distance and proportionately show some redshift. Since the total cosmic sphere is rotating and expanding, galaxies will have some receding. This receding is directly proportional to the rate of expansion of the rotating cosmic sphere as a whole. In this scenario, for any galaxy, continuous

increase in red shift is a measure of rapid expansion and (practically) constant red shift is a measure of no expansion i.e change in galaxy distance from cosmic axis is practically zero. In this scenario, for any galaxy, from and about the cosmic center,

(a) If rate of increase in red shift is increasing - it means universe is expanding with acceleration.

(b) If rate of increase in red shift is decreasing - it means universe is expanding with deceleration.

(c) If rate of increase in red shift is same- it means universe is expanding with uniform velocity.

(d) If rate of increase in red shift is zero- it means universe is not expanding.

When the universe was young i.e in the past, Hubbles law was true, in the sense,“increasing red shift was a measure of galaxy receding (if born)” and now also Hubbles law is true, in the sense, “red shift is a measure of galaxy revolution”. As time is passing, galaxy receding is gradually stopped and galaxy revolution is gradually accomplished. Galaxies lying on the equator will revolve with light speed and galaxies lying on the cosmic axis will have zero speed. Hence it is reasonable to put the red shit boundary as ‘0 to 1’. Then their distances will be proportional to their red shifts from the cosmic axis of rotation.

8. Now and then universe is rotating with ‘light speed’, big bang concepts of ‘nucleosynthesis’ can be combined with the proposed ideas.

9. $(1/H_0) \cong (1/\omega_t)$ indicates the time required to complete one radian and $(2\pi/H_0) \cong (2\pi/\omega_t)$ indicates the time required to complete one rotation.

10. Time required to expand from planck volume to existing volume can be called as the present cosmic time. Its proposed expression is $t \cong 3\ln\left(\frac{R_t}{R_P}\right)*\left(\frac{8\pi}{\omega_t}\right) \cong 24\pi\ln\left(\frac{R_t}{R_P}\right)*\left(\frac{1}{\omega_t}\right)$. At present, $t \cong 4.85\times10^{\,21}$ seconds. With this large time ‘smooth cosmic expansion’ can be possible [11, 12].

11. Inflation, magnetic monopoles problem and supernovae dimming etc can be understood by a ‘larger cosmic time and smooth cosmic expansion’. It indicates that, unlike the planck time, here in this model cosmic time starts from zero seconds. This idea is very similar to the birth of a living creature. How and why, the living creature was born? - this is a fundamental question to be investigated by the present and future mankind. In the similar way, how and why, the ‘planck particle’ was born? has to be investigated by the present and future cosmologists.

12. If assumed $T_t \cong 2.73 \times 10^{11}\ {}^0\mathrm{kelvin}$, $\mathrm{t} \cong 0.31$ sec, $\mathrm{R_t} \cong 13833.6$ m, $\omega_\mathrm{t} \cong 21671$ rad/sec, $\mathrm{M_t} \cong 9.31 \times 10^{30}$ Kg. If $T_t \cong 2.73 \times 10^{10}\ {}^0\mathrm{kelvin}$, $\mathrm{t} \cong 32.55$ sec, $\mathrm{R_t} \cong 1.38 \times 10^6$ m, $\omega_\mathrm{t} \cong 216.71$ rad/sec, $\mathrm{M_t} \cong 9.31 \times 10^{32}$ Kg.

If $T_t \cong 2.73 \times 10^9\ {}^0$kelvin, t $\cong$ 3415.24 sec, $\mathrm{R_t} \cong 1.38 \times 10^8$ m, $\omega_\mathrm{t} \cong$ 2.167 rad/sec, $\mathrm{M_t} \cong 9.31 \times 10^{34}$ Kg. One second after the birth of planck particle, $R_t \cong 4.23 \times 10^4$ m. This is less than one light second, 3×10^8 m . From this data it can be suggested that, the cosmic expansion is smooth.

13. To a great surprise, this obtained time is matching with 96.84% of the present age of lord Brahma of Hindu or Indian vedic cosmology = 158.7 trillion years = 5×10^{21} seconds [28]. Really this is a miracle. This may be a coincidence also. The interesting question is – why and how the ancient Indians obtained that number? If so the interesting thing is that 1.7 days of lord Brahma is roughly matching with the current estimations of cosmic age!

12 Conclusion

The concept of 'dark energy' is still facing and raising a number of fundamental unresolved problems. Note that 'cosmic acceleration','dark energy' and 'inflation', are the results of Edwin Hubble's incomplete conclusions. If there is a misinterpretation in Hubble's law - flat model of cosmology can not be considered as a correct model of cosmology. Now a days many scientists are thinking in favour of the existence of primordial black holes. Their assumed role in galaxy formation is very interesting. Surprising and interesting idea is that primordial black holes are also assumed for solving the dark matter problem. Even though the detection of primordial cosmic black holes is very difficult, their direct effects are best seen in the form of old and new galaxies and their fast spinning galactic centers. Recent observations reveals that galactic central black holes are spinning close to speed of light. Compared to dark matter and dark energy, primordial cosmic black holes connects GTR, quantum mechanics and comology in a unified manner. Hence from its birth to its present state, universe can be considered as a growing and rotating primordial black hole. Constant speed of rotation maintains its stability and rate of decrease in temperature indicates its growth rate. Rate of increase in galaxy red shift from and about the cosmic center is an alternative measure of its growth rate.

Acknowledgements

Author is indebted to Prof. K. V. Krishna Murthy, Chairman, Institute of Scientific Research on Vedas (I-SERVE), Hyderabad, India, Shri K. V. R. S. Murthy, former scientist IICT (CSIR) Govt. of India and Director (R D), (I-SERVE), Hyderabad, India, professor S. Lakshminarayana, Dept. of Nuclear physics, Andhra university, India and Dr. Sankar Hazra, PIRT-CMS, Kolkata, for their valuable guidance and great support in developing this subject.

References

1. B. J. Carr. Primordial Black Holes: Do They Exist and Are They Useful? Proceedings of "Inflating Horizon of Particle Astrophysics and Cosmology", Universal Academy Press Inc and Yamada Science Foundation (2005).

2. P Kanti. Black holes in theories with large extra dimensions: A review. Int. J. Mod. Phys. A 19 (2004) 4899. http://arxiv.org/abs/hep-ph/0402168v2

3. Massimo Ricottiet al, Effect of primordial black holes on the cosmic microwave background and cosmological parameter estimates.The Astrophysical Journal, 680:829-845, 2008 June 20

4. Eun-Joo Ahn and Marco Cavaglia. Cosmic black holes, Int. J. Mod. Phys. D, Volume: 12, Issue: 9(2003) pp. 1699-1704.

5. Nikodem J. Popawski, Radial motion into an Einstein-Rosen bridge. Physics Letters B. Volume 687, Issues 2-3, 12 April 2010, p 110-113

6. Tianxi Zhang. A New Cosmological Model: Black Hole Universe. Volume 3, July 2009 Progress in Physics.

7. Hawking S.W. Black Holes and Baby Universes and Other Essays, (Bantam Books 1993) ISBN 0553374117

8. Emanuele Berti and Marta Volonteri, Cosmological Black Hole Spin Evolution by Mergers and Accretion, The Astrophysical Journal, 684:822-828, 2008 September 10.

9. R. K. Pathria, The Universe as a Black Hole, Nature 240, 298-299 (1 December 1972).

10. Thorne. Kip, Black Holes and Time Warps: Einstein's Outrageous Legacy, W. W. Norton & Company; Reprint edition, January 1, 1995.

11. U. V. S. Seshavatharam. Physics of Rotating and Expanding Black Hole Universe. Progress in Physics, vol. 2, April, 2010, p. 7-14.

12. U. V. S. Seshavatharam and S. Lakshminarayana. Unified model of universe and the atom. Book. ISBN: 9783843393966, LAP LAMBERT Academic Publishing GmbH & Co. KG, Germany, 2011 March.

13. Hubble E. P. A relation between distance and radial velocity among extragalactic nebulae. PNAS, 1929, v. 15, 168-173.

14. Kurt Godel, Rotating Universes in General Relativity Theory. Proceedings of the international Congress of Mathematicians in Cambridge, 1: 175-81, 1950.

15. Robert V Gentry. New Cosmic Center Universe Model Matches Eight of Big Bang's Major Predictions Without The F-L Paradigm. CERN preprint, EXT-2003-022, 14 Apr 2003.
http:// www.robertvgentry.com/reports/ext-2003-022.pdf.

16. Shi Chun et al, Is the universe rotating? http://arxiv.org/abs/0902.4575v3

17. G. Chapline. Blueprint for a Rotating Universe. http://arxiv.org/ftp/astro-ph/papers/0608/0608389.pdf

18. Joshua A. Fireman et al. Dark Energy and the Accelerating Universe. http://www.arxiv.org/abs/0803.0982v1

19. Arman Shafieloo et al. Is cosmic acceleration slowing down? Phys. Rev. D 80, 101301 (Rapid Communication). http://arxiv.org/abs/0903.5141v4. 8 Oct 2009.

20. Black Holes spinning near the Speed of Light.
http://www.space.com/scienceastronomy080115-st-massive-black-hole.html

21. Dmitri Rabounski. On the Speed of Rotation of Isotropic Space: Insight into the Redshift Problem. The Abraham Zelmanov Journal, Vol. 2, 2009, 208-223.

22. Hawking S.W. Particle Creation by Black Holes. Commun. Math. Phys. 43, 199-220

23. John Kormendy et al, Supermassive black holes do not correlate with dark matter halos of galaxies. Nature Letter, 20 January 2011.
http://arxiv.org/abs/1101.4650v1

24. Saul Perlmutter. Supernovae, Dark Energy and the Accelerating Universe. 2003 American Institute of Physics, S-0031-9228-0304-030-4, April 2003 Physics Today.

25. Narlikar, J. V, Vishwakarma R. G, Burbidge G. (2002). Interpretations of the Accelerating Universe.
arXiv:astro-ph/0205064.

26. W.G. Unruh. Physics meets Philosophy at the Planck Scale. Cambridge University Press. 2001.

27. Craig J. Copi et al. Big bang nucleosynthesis and the baryon density of the universe. Fermilab. astro-ph/9407006. Submitted to Science. http://arxiv.org/abs/astro-ph/9407006v2.

28. Ebenezer Burgess. 'Translation of the Surya-Siddhanta, a text-book of Hindu Astronomy', Journal of the American Oriental Society 6 (1860): 141- 498.