physical sciences forum

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Proceeding Paper

A Rotating Model of Light Speed Expanding Hubble-Hawking Universe †

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† Presented at the 2nd Electronic Conference on Universe, 16 February–2 March 2023; Available online: https://ecu2023.sciforum.net/.

Abstract: Based on Light speed expansion, modified red shift formula, scaled Hawking's black hole temperature formula, super gravity of galactic baryon matter and baby Planck ball – in our recent publications, we have clearly established a novel model of quantum cosmology. In this contribution, we appeal the need of reviewing the basics of Lambda cosmology in the context of cosmic quantum spin. We would like to emphasize the point that, spin is a basic property of quantum mechanics and one who is interested in developing quantum models of cosmology, must think about cosmic rotation. It may also be noted that, 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 have 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. Thinking in this way, either the point of big bang or baby Planck ball can be considered as a possible centre of cosmic evolution.

Keywords: Light speed expansion; Planck ball; Hubble-Hawking universe; Quantum cosmology; Cosmic rotation; Limiting magnitudes of current cosmic angular velocity and rotation speed;

Citation: Seshavatharam, U.V.S.; Lakshminarayana, S. A Rotating Model of Light Speed Expanding Hubble-Hawking Universe. *Phys. Sci. Forum* **2023**, *3*, x. https://doi.org/10.3390/xxxxx

Published: 18 February 2023

1. Introduction

Mainstream cosmologists are strongly believing that, current expanding universe is having no center and no rotation [1]. Scientists who are strongly believing in cosmic rotation suggest that, current magnitude of cosmic angular velocity is very small in magnitude and is beyond the scope of observations [2–4]. Unfortunately, applications of cosmic angular velocity are also lagging in acquiring a strong foundation in constructing workable models of rotating cosmologies. In this context, we emphasize the following facts.

1) Quantum cosmology [5] point of view, in a theoretical approach, Spin or Rotation can be given a chance in developing quantum models of cosmology.
2) Current model of Lambda cosmology [6] is badly failing in incorporating quantum gravity concepts.
3) Very few cosmologists are working on quantum cosmology models.
4) Clearly speaking, no cosmologist is having a clear vision of quantum models of cosmology.

Keeping these points in view, we can confidently say that, models of cosmology without cosmic rotation cannot be considered as standard models of cosmology. In support of this statement, we propose the following logical points.

1) Important point to be noted is that, to have rotation, universe should have a closed or positive curvature. Two most recent technical papers [7,8] published in two very high impact journals seem to support a closed universe. In this context, we would like to recall the views of Di Valentino, Melchiorri and Silk [7]. According their analysis and interpretation, observed enhanced lensing amplitude of cosmic microwave background radiation can be explained with a positive curvature of the universe at 99% confidence level. Proceeding further, according to Will Handley [8] - In light of the inconsistency between Planck, CMB lensing and BAO data in the context of curved universes, cosmologists can no longer conclude that observations support a flat universe.
2) Hubble's observations [9] can also be studied with rotating and expanding models of cosmology.
3) In a rotating frame, quantitatively Hubble's law resembles cosmic light speed rotation concept.
4) General theory of relativity is no way against to cosmic rotation [10].
5) 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 have 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. Thinking in this way, either the point of big bang or baby Planck ball can be considered as a possible centre of cosmic evolution.
6) If observed universe is assumed to be associated with only one big bang, then 'point of big bang' can certainly be considered as the characteristic reference point of cosmic evolution in all directions.
7) If currently believed cosmic big bang is really a 'singularity', it seems more logical to depend on Planck scale rather than big bang. It may be noted that, in general, gravitational singularities are not clear about "Where, When and How" like essential points that are believed to be the basics of developing any workable physical model.
8) Modern cosmological observations are providing strong evidences for the existence of mysterious rotational features of large cosmic filaments [11].
9) Current Hubble's constant can be considered as a limiting magnitude of current cosmic angular velocity. Similarly, light speed can be considered as a limiting magnitude of current cosmic rotation speed.
10) If it is really important to understand the radical nature of current cosmic acceleration [12], based on light speed expansion, it can be understood as follows. As time is passing, to sustain continuous light speed expansion, galaxies maintain higher acceleration near to cosmic center and lower acceleration near to cosmic boundary. Clearly speaking, being higher in magnitude near to cosmic center, galactic acceleration, gradually disappears at cosmic boundary. In a mathematical form, for the current case, it can be expressed as, $(a_r)_0 = \left[c - (v_r)_0\right] H_0$ where r, (v_r) and (a_r) represent galactic distance, receding speed and acceleration from the cosmic center respectively.

2. Light speed expanding Hubble-Hawking universe

Based on Light speed expansion, modified red shift formula, scaled Hawking's black hole temperature formula, super gravity of galactic baryon matter and baby Planck ball – in our recent publications, we have clearly established a novel model of quantum cosmology [13–22]. Here we would like to appeal that, a new model of cosmology, that follows

Hubble's notion of expansion and Hawking's notion of black hole structure having thermal radiation can be called as Hubble–Hawking model of cosmology. We continue this section with the need of considering light speed expansion and four astrophysical and cosmological coincidences.

2.1. Need of considering light speed expansion

Technical publications that are having very high impact on science community are raising many new ideas and doubts on dark energy and dark matter. Now it is very clear hat, there is a disagreement between main stream cosmologists and other researchers. Cosmological observations are not straight forward. For the same data, different interpretations are coming into picture with a great diversity. Right now it is not at all possible to prove the exact nature of cosmic expansion whether it is accelerating or decelerating. In this very ambiguous situation, it seems interesting to take the help of 'light speed' as a tool. There is a possibility for considering light speed radial expansion as well as light speed rotation. We would like to emphasize that,

1) All cosmological observations and physical studies & research are being accomplished with 'light speed' only.
2) As per the papers published in Astronomical Journal 2012 [23] and Nature-Scientific Reports 2016 [24], data pertaining to 580 to 740 super novae clearly reveal that, universe is expanding at an uniform rate. In 2018-2019, the same result has been obtained by a student Lisa Goh Wan Khee of National University of Singapore supervised by Cindy Ng [25]. This information can be considered as a base for light speed cosmic expansion.
3) So far no single experiment or no single observation confirmed super luminal physical results.
4) It is well confirmed that, gravitons are moving with speed of light.
5) In one sentence, 'without light', there is no cosmology and there is no physics.

2.2. Cosmic age and cosmic radius

Currently believed cosmic age is 13.8 billion years [26]. Distance travelled by a photon in 13.8 billion years is 1.3x10^{26} m and is almost equal to the currently believed Hubble radius $R_0 \cong (c/H_0)$. It clearly indicates something new about the cosmic expansion speed in terms of speed of photon. We interpret this relation as, from the beginning of Planck scale, universe expands with speed of light. In a mathematical form, $R_t - R_{pl} \cong ct$ where R_{pl}, R_t represent Planck scale cosmic radius and radius at any time t. Lambda model of cosmic age up to (1+ z) = 1100 can be fitted accurately with, $t \cong (1/1+z)^{\frac{3}{2}} (1/H_0) \cong \sqrt{1+z}/H_t$ where H_t is related with Hubble-Hawking model. It needs a review at fundamental level.

2.3. Cosmic critical density, volume and mass

Currently believed cosmic critical density is, $\rho_0 \cong \left(3H_0^2/8\pi G\right)$. Considering the product of currently believed cosmic critical density and Hubble volume, $V_0 \cong \left(\frac{4\pi}{3}\right)(c/H_0)^3$, it is possible to show that, $M_0 \cong \left(c^3/2GH_0\right)$. On re-arranging this mass expression, $2GM_0/c^2 \cong c/H_0 \cong R_0$. It clearly indicates something new about the current universe in terms of current cosmic black hole mass, radius and expansion speed. We interpret this relation as, from the beginning of Planck scale, $R_t \cong (c/H_t) \cong 2GM_t/c^2$.

2.4. Cosmic temperature

Currently believed cosmic temperature T_0 seems to be equal to the geometric mean of Hawking temperature [27] of Planck mass, $T_{M_{pl}} \cong \frac{\hbar c^3}{8\pi k_B G M_{pl}}$ and Hawking temperature of current cosmic Hubble mass, $T_{M_0} \cong \frac{\hbar c^3}{8\pi k_B G M_0}$. In a simplified form, it can be expressed as, $T_0 \cong \frac{\hbar c^3}{8\pi k_B G\sqrt{M_{pl} M_0}}$. It clearly indicates something new about the current cosmic temperature in terms of Hawking's Black hole physics. We interpret this relation as, from the beginning of Planck scale, $T_t \cong \frac{\hbar c^3}{8\pi k_B G\sqrt{M_{pl} M_t}} \cong \frac{\hbar\sqrt{H_t H_{pl}}}{4\pi k_B}$ where $M_t \cong \frac{c^3}{2GH_t}$, $M_{pl} \cong \sqrt{\frac{\hbar c}{G}}$ and $H_{pl} \cong \frac{1}{2}\sqrt{\frac{c^5}{G\hbar}}$.

For an observed value of $T_0 \cong 2.72548$ K, estimated $H_0 \cong 2.167867\times10^{-18}$ sec^{-1} $\cong$ 66.89 km/sec/Mpc. We would like to emphasize the point that, based on Hawking's black hole temperature formula, geometric mean of Planck mass and the so called Hubble mass, seems to play a crucial role in estimating the observed cosmic microwave back ground temperature, (CMBR) [26]. This kind of relation is missing in Lambda cosmology and to a great extent, currently observed discrepancy or tension in estimating the Hubble parameter can be eliminated. Proceeding further currently believed Baryon acoustic bubble radius [19,21] can be fitted with a simple relation of the form, $(R_{BAO})_0 \cong \sqrt{\frac{T_0}{T_{\text{Recombination}}}} * \left(\frac{c}{H_0}\right) \cong \sqrt{\frac{2.725\text{ K}}{3000\text{ K}}} * \left(\frac{c}{H_0}\right) \cong 135$ Mpc.

Considering both Planck mass and the Universe as 'point particles', cosmic temperature relation can be derived with three hypothetical conditions, $\frac{GM_t M_{pl}}{r_t^2} \cong \left(\frac{c^4}{8\pi G}\right)$; $r_t \cong \left(\frac{2.898\times10^{-3}}{2\pi T_t}\right)$ and $M_t \cong \left(\frac{c^3}{2GH_t}\right)$. Derived relation is, $T_t \cong \frac{\hbar c^3}{24.891 k_B G\sqrt{M_{pl} M_t}}$ and the denominator coefficient 24.891 is almost equal to $8\pi \cong 25.13274$.

2.5. Galactic light travel distances

It may be noted that, by the time of defining the definition of galactic red shift, maximum red shift value was around 0.003. We would like to emphasize the point that, definition of galactic red shift is ambiguous. It can also be defined as, $z_{new} \cong \frac{\lambda_{Observed} - \lambda_{Lab}}{\lambda_{Observed}} \cong 1 - \frac{\lambda_{Lab}}{\lambda_{Observed}} \cong \frac{z}{z+1}$. With reference to current definition, z value lies between 0 and infinity. By following our new definition, z value lies between 0 and 1. It may be noted that, with our given definition, it is very easy to implement 'light speed expansion' in cosmic evolution scheme. Fig. 1 compares galactic light travel distances according to our new definition, $d_G \cong (z_{new})(c/H_0)$ (Red curve) and the conventional formula connected with dark energy density and other density fractions (Green curve). For verification, readers are encouraged to visit the URLs, http://www.atlasoftheuniverse.com/cosmodis.c and https://cosmocalc.icrar.org/.

Above coincidences will certainly encourage any cosmologist to solve Einstein's field equations with a closed curvature spreading at speed of light. By considering $z_{new}c$ as the receding speed of galaxy, Hubble's law [9] can be expressed as, $v_G \cong H_0 d_G$. Conceptually this relation resembles cosmic light speed rotation. We are working in this direction.

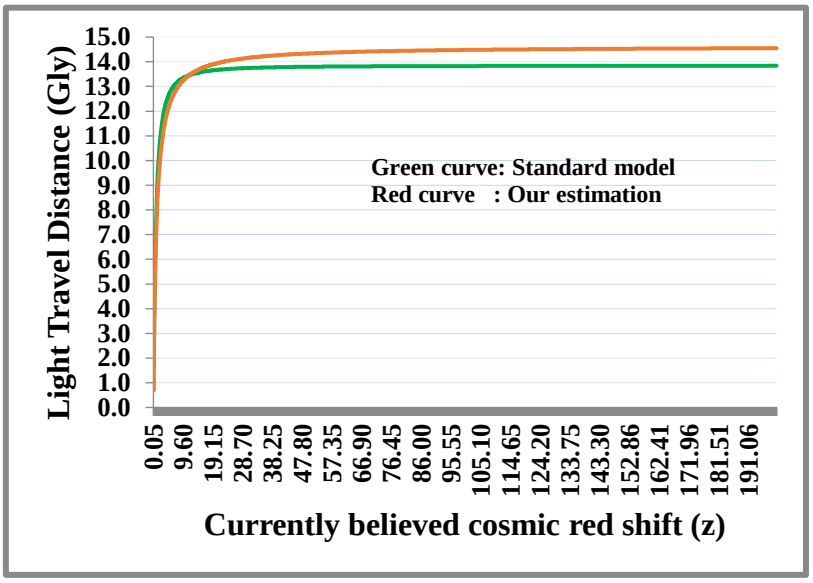

Figure 1. Comparison of standard and estimated light travel distances.

3. Our 4 basic assumptions

Based on the above points and logics proposed in sections (1) and (2),

1) We emphasize the point that, without a radial in-flow of matter in all directions towards any one specific point, it may not be possible to have a big crunch and discussing on center-less universe having a big bang or big bounce seems to be meaningless.
2) Considering the evolving universe as a growing black hole or simply a white hole [15,16], it seems natural to expect cosmic rotation.

In this section, considering the current Hubble's constant as an index of current cosmic angular velocity, we propose a simple model of light speed expanding and light speed rotating model of cosmology. It needs a review at fundamental level. It may be noted that, our first assumption helps in understanding cosmic curvature, expansion speed, rotation speed and cosmic mass. Second assumption helps in understanding the relation between cosmic mass, cosmic temperature, expansion speed and rotation speed. Third assumption helps in understanding the super gravity of galactic baryon mass. Fourth assumption helps in understanding the galactic flat rotation speeds.

From the beginning of Planck scale,

Assumption-1: Universe is growing like a black hole with light speed expansion and light speed rotation. Mathematically, it can be expressed as,

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

Assumption-2: Universe is growing like a black hole with a scaled Hawking's black hole temperature formula. Mathematically, it can be expressed as,

$$T_t \cong \frac{\hbar c^3}{8\pi k_B G\sqrt{M_{pl}M_t}} \cong \frac{\hbar\sqrt{H_t H_{pl}}}{4\pi k_B} \cong \frac{\hbar\sqrt{\omega_t \omega_{pl}}}{4\pi k_B} \tag{2}$$

where $M_t \cong \frac{c^3}{2GH_t} \cong \frac{c^3}{2G\omega_t}$, $M_{pl} \cong \sqrt{\frac{\hbar c}{G}}$ and $H_{pl} \cong \omega_{pl} \cong \frac{1}{2}\sqrt{\frac{c^5}{G\hbar}}$.

It may be noted that, this assumption certainly helps in eliminating the tension in estimating the magnitude of Hubble parameter.

Assumption-3: There exists no dark matter [28–31] and when baryon mass of any galaxy crosses (180 to 200) million solar masses, galaxy 'as a whole' experiences super gravity [17,21] in such a way that its effective or total mass can be expressed as,

$$\left(M_{Total}\right)_G \cong \left\{\left(M_{baryon}\right)_G + \left[\frac{\left(M_{baryon}\right)_G^{3/2}}{\sqrt{\left(M_{\text{limit}}\right)_0}}\right]\right\} \text{ kg} \tag{3}$$

where

$\left(M_{\text{limit}}\right)_0 \cong$ Current mass limit of ordinary gravity = 180 to 200 solar masses $\cong \left(3.6 \text{ to } 4.0\right)\times 10^{38}$ kg.

Starting from the recombination period, its current cosmological mass expression can be expressed as, $\frac{M_0}{\left(M_{\text{limit}}\right)_0} \cong \exp\left(\sqrt{\frac{T_{\text{Recomb}}}{T_0}}\right)$

where $M_0 \cong \frac{c^3}{2GH_0} \cong \frac{c^3}{2G\omega_0}$

and $\frac{T_{\text{Recomb}}}{T_0} \cong \frac{\text{Recombination temperature}}{\text{Current cosmic temperature}} \cong \frac{3000 \text{ K}}{2.725 \text{ K}}$.

Assumption-4: Current cosmic mass plays a vital role in understanding the observed galactic flat rotation speeds in such a way that [23],

$$\frac{V_G}{c} \cong \frac{1}{4}\left[\frac{\left(M_{Total}\right)_G}{M_0}\right]^{1/4} \tag{4}$$

$$\begin{aligned} V_G &\cong 0.2973\left[G\left(M_{Total}\right)_G\left(cH_0\right)\right]^{1/4} \\ &\cong 0.2973\left[G\left(M_{Total}\right)_G\left(c\omega_0\right)\right]^{1/4} \end{aligned} \tag{5}$$

It may be noted that, this relation is very similar to the famous MOND's formula [26]. Interesting point to be noted is that $\left(c\omega_0\right)$ can be considered as the upper limit of current cosmic acceleration. In addition to that, MOND's concept of weak gravity can be studied in terms of Mach's view on the universal role of cosmic distance back ground [32,33]. See Fig. 2 for the estimated galactic flat rotation speeds.

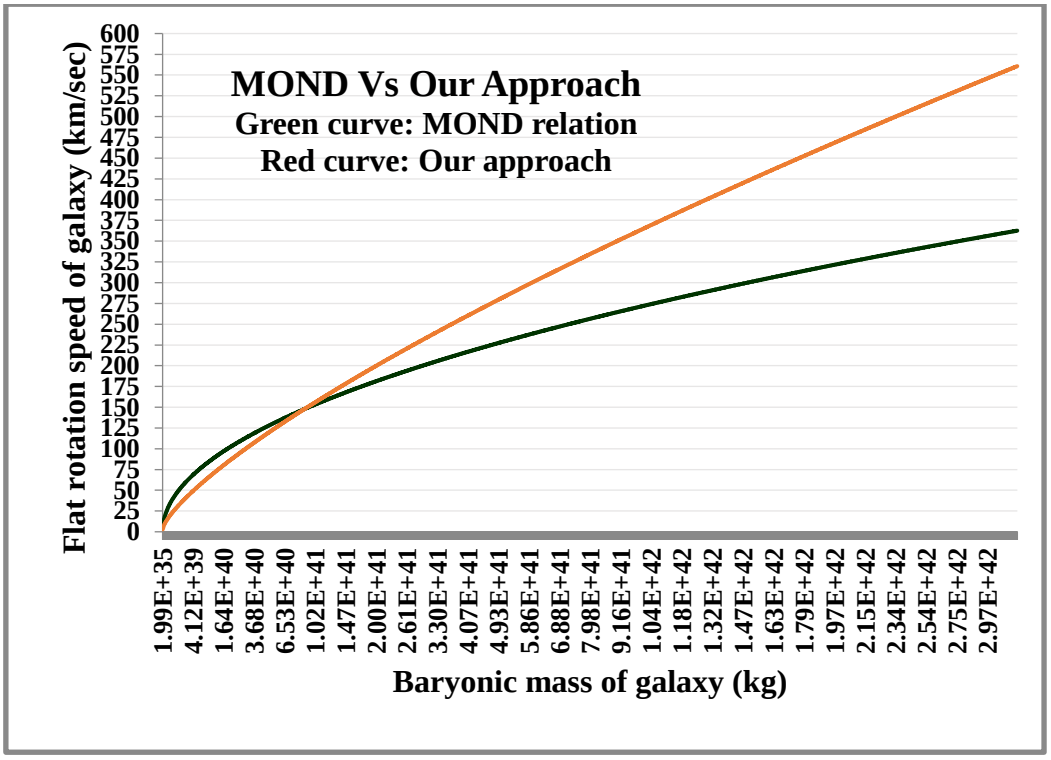

Figure 2. Galactic flat rotation speeds.

4. Discussion

Historically, Godel, Gamow, Whittakar, Hawking, Narlikar, Nodland, Ralston, Rubin, Birch, Korotky, Obukhov, Chechin, Sivaram, Magueijo and Longo like many cosmologists expressed their positive opinion on cosmic rotation [2–4,34–40]. Recent observations on cosmic anisotropy [41] and galactic spin directions seem to support the possible existence of cosmic rotation [2,42]. Most recent references [7,8] seem to shed light on the necessity of considering cosmic positive curvature which is a major prerequisite for cosmic rotation. Even though cosmological principle [43] is having 100 years of strong footing, at present, it is being suspected and examined in many directions seriously.

It may be noted that, by considering 'light speed rotation' and ignoring 'light speed expansion', Einstein's static universe can be made stable dynamically. There seems no need to introduce the 'Lambda term'. Against to the strongly believed current cosmic acceleration [12], if current universe is having a trend of deceleration as proposed by Paul J. Steinhardt et al and reviewed by Perlmutter S. [44] – by considering light speed rotation throughout the cosmic history- there is a scope for developing light speed rotating and decelerating models of cosmology [13]. We are working on understanding and validating the dual role of light speed in cosmic expansion and rotation. With ongoing observations, whether it is cosmic light speed expansion or light speed rotation - can be explored in all possible ways.

Quantum cosmology point of view, our views seem to have an interesting role. Clearly speaking, our assumptions are very clear and seem to incorporate Planck scale in current cosmic observations. Our assumptions (1) and (2) are giving a very nice explanation for the origin of current cosmic temperature. It is well believed that, Hawking's findings about black holes and the universe [45] are the most important contributions to physics in recent decades. Proposed Hawking's scaled black hole temperature formula can be given a chance in understanding and refining the views of Hawking's multi universal paradigm. Hence, we appeal the science community to recommend our rotating model of Hubble-Hawking universe for further research and study. Based on assumptions (1) and (2), both cosmic thermal expansion and physical expansion can be studied in a unified

manner. Based on assumptions (1) and (3), dark energy and dark matter concepts can be relinquished. Based on assumptions (1) and (4), role of cosmic angular velocity and angular acceleration in galactic structures can be understood.

Based on relation (5), if one is willing to consider the current cosmic angular velocity as,

$$\omega_0 \cong (0.2973)^4 H_0 \cong 1.694\times10^{-20} \text{ rad/sec} \cong 5.345\times10^{-13} \text{ rad/year}. \tag{6}$$

This value is nicely fitting with the observational data associated with galactic rotation [37]. Another interesting theoretical coincidence is that,

$$\left(\frac{3\omega_0^2c^2}{8\pi G}\right)\div\left(aT_0^4\right) \cong \frac{3\omega_0^2c^2}{8\pi G\left(aT_0^4\right)} \cong \frac{4.613\times10^{-14} \text{ J/m}^3}{4.169\times10^{-14} \text{ J/m}^3} \cong 1.1065 \tag{7}$$

Based on this coincidence, qualitatively and quantitatively, it is possible to guess that,

$$\left.\begin{aligned} &\frac{3\omega_0^2c^2}{8\pi G\left(aT_0^4\right)} \cong 1 \cong \frac{3\omega_t^2c^2}{8\pi G\left(aT_t^4\right)} \\ &\frac{\omega_0}{H_0} \cong \frac{\omega_t}{H_t} \cong \sqrt{\frac{1}{5760\pi}} \cong 0.0074338505 \end{aligned}\right\} \tag{8}$$

This number 0.0074338505 resembles the Fine structure ratio $\alpha \cong 0.007297353$ which is equal to the ratio of speed of electron in Bohr radius to speed of light. Very interesting observation is, $\ln\sqrt{\frac{M_0V_0R_0}{\hbar}} \cong 137.5 \cong \frac{1}{\alpha}$

where

$M_0 \cong \frac{c^3}{2GH_0} \cong 9.311252\times10^{52}$ kg,

$R_0 \cong \frac{c}{H_0} \cong 1.3828914\times10^{26}$ m,

$V_0 \cong c\sqrt{\frac{1}{5760\pi}} \cong 2.2286\times10^{6}$ m.sec^{-1}.

Now assumption (1) can be modified as,

$$R_t \cong \frac{2GM_t}{c^2} \cong \frac{c}{H_t} \cong \frac{V_t}{\omega_t} \tag{9}$$

where V_t = Cosmic rotation speed and ω_t = Cosmic angular velocity.

$$V_t \cong R_t\omega_t \cong \left(\frac{\omega_t}{H_t}\right)c \cong 0.0074339c \tag{10}$$

For the current case, based on relation (10), galactic flat rotation speed can be expressed as,

$$\left.\begin{aligned} &V_G \cong \left[G\left(M_{Total}\right)_G\left(c\omega_0\right)\right]^{1/4} \cong \left[G\left(M_{Total}\right)_G\left(V_0H_0\right)\right]^{1/4} \\ &\text{where } V_0 \cong 0.0074339c \end{aligned}\right. \tag{11}$$

Now based on assumptions (3) and (4) and following the generally believed gravitational law, $GM = v^2r$, radius of any galaxy can be expressed as [17],

$$R_G \cong \frac{G\left(M_{Total}\right)_G}{V_G^2} \cong \sqrt{\frac{G\left(M_{Total}\right)_G}{V_0H_0}} \cong \sqrt{\frac{G\left(M_{Total}\right)_G}{c\omega_0}} \tag{12}$$

For Milky way, based on its accepted flat rotation speed of $V_{MW} \cong 200$ km/sec, its obtained total mass is $(M_{total})_{MW} \cong 4.962\times10^{42}$ kg $\cong 2.5\times10^{12} M_{\odot}$ and its corresponding radius is $R_{MW} \cong 8.28\times10^{21}$ m $\cong 268.4$ kpc. These values can be compared with recent estimates [46].

Considering relations (11) and (12) and by knowing the galactic flat rotation speeds, galactic total masses and galactic radii can be estimated without the need of currently believed 'dark matter halo' concepts and their complicated analytical procedures [47].

Based on relations (8) to (12), one can understand the potential applications of current cosmic angular velocity or rotation speed in exploring the constructional secrets of galaxies. It needs further study.

It may be noted that, considering a rotating and expanding model of cosmology, it seems possible to say that,

1) Galaxies seem to follow an outward spiral path.
2) Galaxies can be seemed to be arranged in a systematic order.
3) Even though present universe is believed to be accelerating, as current expansion rate is very small, increase in separation distance between neighboring galaxies seems to be negligible. Hence, distance between neighboring galaxies seems to be approximately fixed.

5. Conclusion

In this paper, considering current Hubble constant as a limiting case of current angular velocity and considering speed of light as a limiting case of current cosmic rotation speed, we have developed a simple model of rotating cosmology. Qualitatively and quantitatively, in a theoretical approach, compared to the historical arguments on cosmic rotation, our views seem to be more coherent, strongly connected with quantum gravity and are closer to observational findings. Hence, we sincerely appeal the science community to recommend our rotating model of the universe for further research.

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