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# LIGHT SPEED EXPANSION AND ROTATION OF A VERY DARK MACHIAN UNIVERSE HAVING INTERNAL ACCELERATION

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**Abstract:** We present a Machian model of Quantum Cosmology with full dark matter and light speed expansion and rotation. During galaxy formation and evolution, fraction of dark matter transforms to visual matter with a relation of the form,  $m_{vis} = \text{constant} * (m_{dark})^{2/3}$ . Using this relation and replacing MOND's 'critical acceleration' with "current cosmic maximum angular acceleration", galactic flat rotation speed range of (50 to 500) km/sec can be fitted well. Estimated flat rotation speeds of DD168, Milky Way and UGC12591 are 49.96 km/sec, 199.66 km/sec and 521.75 km/sec respectively. Based on these striking coincidences, it is possible to say that, MOND's approach is implicitly connected with cosmological estimation of 95% invisible matter. Considering galactic total matter and current cosmic maximum angular acceleration, galactic working radii, angular velocity and visual matter density can be estimated. Even though, this model is free from 'big bang', 'inflation', 'dark energy', 'flatness' and 'red shift' issues, at  $T_0 \cong 2.722 K$ , estimated present Hubble parameter is  $H_0 \cong 66.24 \text{ km/Mpc/sec}$ , cosmic radius is 146.3 times the Hubble radius, angular velocity is 146.3 times lower than the Hubble parameter and cosmic age is 146.3 times the Hubble age. With future observations and advanced telescopes, it may be possible to see far distant galaxies and very old stars far beyond the current observable cosmic radius.

**Keywords:** Planck scale; Machian universe; Speed of light; Galactic dark matter; Galactic visible mass; Galactic visible mass density; Cosmic anisotropy; Galactic internal acceleration; Cosmic graviton wavelength;

## 1. Introduction

We would like to emphasize the fact that, the basic principles of cosmology were developed when the subject of cosmology was in its budding stage. Friedmann made two simple assumptions about the universe [1,2]. They can be stated in the following way.

- 1) When viewed at large enough scales, universe appears the same in every direction.
- 2) When viewed at large enough scales, universe appears the same from every location.

In this context, Hawking expressed that [2]: "There is no scientific evidence for the Friedmann's second assumption. We believe it only on the grounds of modesty: it would be most remarkable if the universe

looked the same in every direction around us, but not around other points in the universe".

In our earlier and recent published papers [3-20] we tried to highlight the basic drawbacks of big bang, inflation and galactic red shift in various possible ways. As of now, theoretically and observationally, with respect to inflation, isotropy, expansion speed, dark matter, dark energy and rotation, whole subject of cosmology is being driven into many controversies and dividing cosmologists into various groups with difference of opinions. On the other hand, very unfortunate thing is that, quantum cosmology point of view, 'as a whole', progress is very poor [21]. Instead of discussing the controversies, we would like to propose a new model which can pave a new way for understanding and correlating astrophysical and cosmological observations in terms of quantum

[20] Seshavatharam UVS and Lakshminarayana S. (2020) Light speed expansion and rotation of a primordial cosmic black hole universe having internal acceleration. *International Astronomy and Astrophysics Research Journal*. 2(2): 9-27.

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mechanics and general theory of relativity in a Machian view. It needs further study.

With reference to our very recent publication [20], in this version,

- 1) Implemented Mach's relation in place of Schwarzschild radius of black hole.
- 2) We tried to couple cosmic gravitational self energy density and cosmic thermal energy density.
- 3) Tried to define the Gamma parameter with the ratio of past and current temperatures [10,11]. It helps in estimating the Hubble parameter with a direct relation rather than trial-error approach.
- 4) Made an attempt to bring clarity in the estimation of galactic dark matter.
- 5) Tried to define a dark matter reference mass unit of  $3.523 \times 10^{38}$  kg in terms of current cosmic mass and Planck mass.
- 6) Tried to provide a clear procedure for understanding galactic dark matter via Inverse square law and cosmic angular acceleration.
- 7) Removed some topics pertaining to 'Cold dark matter' and 'Relativistic dark matter' of galaxies.
- 8) Removed Tables and Figures in view of compiling updated data on galactic visual masses and rotational curves extended to increasing galactic radii.

With three simplified assumptions, an attempt has been made to develop a practical model of the universe. As so many galaxies are rotating and all the cosmic observations are being carried out with photons, we consider a light speed expanding [22-26] and light speed rotating universe. As galaxies are the key building blocks of the evolving universe and as all galaxies constitute massive rotating dark holes at their centers, we consider a growing and rotating Machian universe model [27-34]. That is why we call it a practical model. Interesting point to be noted is that, our model is absolutely free from 'cosmic red shift' concept. Most important point to be noted is that, we

have developed a very tight quantum gravity relation for correlating cosmic temperature and Hubble parameter independent of galactic red shifts and galactic distances. It can be applied to different time periods of the past.

## 2. Holographic principle and Mach's relation

According to G't Hooft, the combination of quantum mechanics and gravity requires the three dimensional world to be an image of data that can be stored on a two dimensional projection much like a holographic image [35,36]. The 'holographic principle' is a property of string theory and a supposed property of quantum gravity that states that the description of a volume of space can be thought of as encoded on a lower-dimensional boundary. Based on this concept, for the four dimensional spacetime universe, its three dimensional increasing volume can be set by Mach's principle,  $(GM_t/c^2 R_t) \cong 1$ . Clearly speaking, information of the evolving universe, can be extracted from  $R_t \cong \frac{GM_t}{c^2}$ . With this proposal, at any stage of cosmic evolution, a closed and massive universe can be defined with its minimum possible radius. One can find interesting technical discussion on this relation by D.W.Sciama, R.H. Dicke, C. Brans and G. J. Whitrow [27-34].

## 3. Reasons for choosing light speed

Based on the following reasons, we consider light speed as a special feature of cosmic expansion and rotation.

- 1) All cosmic observations are being studied with photons.
- 2) It is well believed that gravity propagates with light speed.
- 3) It is well established that electromagnetic interaction propagates with light speed.
- 4) It is well proved that, light speed is the ultimate speed of material particles.

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- 5) So far, it has not yet been possible physically to measure the actual galactic receding speeds.
- 6) So far, it has not yet been possible to demonstrate and distinguish 'space without matter' and 'matter without space'. In this ambiguous situation, without knowing the origins of 'space' and 'matter', it is quite illogical to say that, space drags massive galaxies at super luminal speeds.
- 7) So far, either at microscopic level or at macroscopic level, it has not yet been possible to establish a common understanding among quantum mechanics and gravity.

### 4. Reasons for considering universe as a Machian Sphere

Based on the following reasons, we consider a Machian universe.

- 1) 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, to some extent, point of big bang can be considered as a possible centre of cosmic evolution. If so, thinking about a centre less universe is illogical.
- 2) Mass and size pertaining to pre and post big bang [35] are unclear.
- 3) Whether Planck scale is associated with big bang or big bang is associated with Planck scale is also unclear.
- 4) As there exist no clear reasons for understanding the occurrence of exponential expansion, cosmologists are having different opinions on cosmic inflation [36].
- 5) So far, it has not yet been possible to establish solid connection between Planck scale and cur-

rent physical parameters of the observable universe.

- 6) At any stage of cosmic expansion, if the universe wishes to maintain a closed boundary to have its size minimum, it is having an option to follow the "Mach's relation" at that time. It may be noted that, Machian radius is 2 times less than the Schwarzschild radius of a black hole. At any stage of cosmic evolution, if one is willing to consider the 'Machian radius' of the evolving universe as its minimum possible radius, corresponding other characteristic cosmic physical parameters can be estimated/predicted easily and can be compared with time to time cosmological observations.

### 5. List of symbols

At any stage of cosmic evolution,

- 1) Cosmic time =  $t$
- 2) Cosmic Hubble parameter =  $H_t$
- 3) Cosmic angular velocity =  $\omega_t$
- 4) Ratio of Hubble parameter to angular velocity =  $\Upsilon_t$
- 5) Cosmic radius =  $R_t$
- 6) Cosmic total dark mass =  $M_t$
- 7) Cosmic volume =  $\Phi_t$
- 8) Cosmic temperature =  $T_t$
- 9) Galactic distance from cosmic centre =  $(r_{Gdis})_t$
- 10) Galactic receding speed from cosmic centre =  $(v_{Gres})_t$
- 11) Increment in expansion distance =  $\Delta(d_{exp})_t$
- 12) Distance from cosmic centre =  $(r_d)_t$
- 13) Wavelength of cosmic graviton =  $(\lambda_{gw})_t$
- 14) Frequency of cosmic graviton =  $(\nu_{gw})_t$
- 15) Galactic star rotation speed =  $(V_{Grot})_t$
- 16) Galactic angular velocity =  $(\omega_{Grot})_t$
- 17) Estimated visible mass of galaxy =  $(M_{Gvis})_t$

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18) Estimated visible mass density of galaxy =  $(\rho_{Gvis})_t$

19) Estimated total mass of galaxy =  $(M_{Gtot})_t$

20) Estimated dark mass of galaxy =  $(M_{Gdark})_t$

21) Ratio of dark mass of galaxy to visible mass of galaxy = Dark mass factor =  $(X_{Gdark})_t$

22) %Dark mass of galaxy =  $\left( \frac{(X_{Gdark})_t}{1 + (X_{Gdark})_t} \right) \times 100$

**Note:** Planck scale symbols can be understood with a subscript 'pl' and current symbols can be understood with a subscript '0'.

### 6. Three simple assumptions

We propose the following three assumptions.

**Assumption-1:** By following Mach's principle, right from the beginning of Planck scale, universe is expanding with speed of light and rotating with speed of light from and about the cosmic centre. It can be expressed with,

$$GM_t \cong c^2 R_t \quad (1)$$

$$R_t \cong \frac{GM_t}{c^2} \cong \frac{c}{\omega_t} \quad (2)$$

$$\therefore M_t \cong \frac{c^3}{G\omega_t} \quad (3)$$

**Assumption-2:** At any stage of cosmic evolution, ratio of Hubble parameter to angular velocity can be expressed as,

$$\frac{H_t}{\omega_t} \cong \left\{ 1 + \ln \left( \frac{T_{pl}}{T_t} \right) \right\} \cong \Upsilon_t \quad (4)$$

where  $T_{pl} \cong$  Planck scale temperature.

**Assumption-3:** Right from the beginning of Planck scale, at any stage of cosmic expansion, gravitational

self energy density and thermal energy density are equal in magnitude and can be expressed as follows.

$$\text{Let, Cosmic volume} = \Phi_t \cong \left( \frac{4\pi}{3} R_t^3 \right) \quad (5)$$

Based on relations (3) and (5), gravitational self energy density can be expressed as,

$$\frac{(\rho_{gsc})_t c^2}{\Phi_t} \cong - \left( \frac{3GM_t^2}{5R_t} \right) \div \left( \frac{4\pi}{3} R_t^3 \right) \cong - \frac{9\omega_t^2 c^2}{20\pi G} \quad (6)$$

$$- \frac{9\omega_t^2 c^2}{20\pi G} + aT_t^4 \cong 0 \quad (7)$$

$$\frac{9\omega_t^2 c^2}{20\pi G} \cong aT_t^4 \quad (8)$$

### 7. Expressions for cosmic temperature and age

Rewriting relation (8) with respect to the radiation energy density constant,  $a \cong \frac{\pi^2 k_B^4}{15\hbar^3 c^3}$  and considering relation (3), cosmic temperature can be estimated in the following way.

Based on assumption (3) and relation (8),

$$\frac{\pi^2 k_B^4 T_t^4}{15\hbar^3 c^3} \cong \frac{9\omega_t^2 c^2}{20\pi G} \quad (9)$$

By proceeding in the following way, a very simple expression for cosmic temperature can be obtained.

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$$\left. \begin{aligned}
k_B^4 T_t^4 &\cong \left( \frac{135}{20\pi^3} \right) \frac{\omega_t^2 \hbar^3 c^5}{G} \\
&\cong \left( \frac{135}{20\pi^3} \right) \frac{\omega_t^2 \hbar^3 c^5}{G} \times \left( \frac{G\hbar c}{G\hbar c} \right) \\
&\cong \left( \frac{135}{20\pi^3} \right) \frac{\omega_t^2 \hbar^4 c^6}{G^2} \left( \frac{\hbar c}{G} \right)^{-1} \\
&\cong \left( \frac{135}{20\pi^3} \right) \frac{\omega_t^2 \hbar^4 c^6}{G^2} \left( \sqrt{\frac{\hbar c}{G}} \right)^{-2} \times \left( \frac{4G^2 c^6}{4G^2 c^6} \right) \\
&\cong \left( \frac{135}{20\pi^3} \right) \frac{\hbar^4 c^{12}}{G^4} \left( \sqrt{\frac{\hbar c}{G}} \right)^{-2} \times \left( \frac{c^3}{2G\omega_t} \right)^{-2} \\
&\cong \left( \frac{135}{20\pi^3} \right) \frac{\hbar^4 c^{12}}{G^4 M_{pl}^2 M_t^2}
\end{aligned} \right\} \quad (10)$$

Hence,

$$T_t \cong \left( \frac{135}{20\pi^3} \right)^{\frac{1}{4}} \frac{\hbar c^3}{k_B G \sqrt{M_t M_{pl}}} \cong \frac{0.6831 \hbar c^3}{k_B G \sqrt{M_t M_{pl}}} \quad (11)$$

As universe is always expanding with speed of light,

$R_t \cong ct$ . Hence,

$$t \cong \frac{R_t}{c} \cong \frac{1}{\omega_t} \cong \frac{Y_t}{H_t} \quad (12)$$

## 8. Current cosmic physical parameters at current cosmic temperature

Following the assumptions, the Planck scale Hubble parameter can be expressed as follows:

$$\begin{aligned}
\omega_{pl} &\cong \frac{c^3}{GM_{pl}} \cong \frac{c}{R_{pl}} \cong H_{pl} \\
&\cong 1.85492 \times 10^{43} \text{ sec}^{-1}
\end{aligned} \quad (13)$$

where  $R_{pl} \cong GM_{pl}/c^2 \cong \sqrt{G\hbar/c^3} \cong 1.6162 \times 10^{-35} \text{ m}$  is the Planck length and the assumed radius connected with the Planck mass.

Planck scale cosmic temperature can be expressed as

$$\begin{aligned}
T_{pl} &\cong \left( \frac{9H_{pl}^2 c^2}{20\pi G a} \right)^{1/4} \cong \left( \frac{9H_{pl}^2 c^2}{20\pi G a} \right)^{1/4} \\
&\cong 9.67791 \times 10^{31} \text{ K}
\end{aligned} \quad (14)$$

As per the 2015 Planck data (Planck Collaboration 2015) [37],

The current value of the Hubble parameter is reported to be:

$$\left. \begin{aligned}
\text{Planck TT+low P: } &(67.31 \pm 0.96) \text{ km/sec/Mpc} \\
\text{Planck TE+low P: } &(67.73 \pm 0.92) \text{ km/sec/Mpc} \\
\text{Planck TT,TE,EE+low P: } &(67.7 \pm 0.66) \text{ km/sec/Mpc}
\end{aligned} \right\}$$

The current value of CMBR temperature is reported to be:

$$\left. \begin{aligned}
\text{Planck TT + lowP + BAO: } &(2.722 \pm 0.027) \text{ K} \\
\text{Planck TT; TE; EE + low P + BAO: } &(2.718 \pm 0.021) \text{ K}
\end{aligned} \right\}$$

In this paper, for calculation purpose, we consider  $T_0 \cong 2.722 \text{ K}$ . Hence,

$$\Upsilon_0 \cong \left\{ 1 + \ln \left( \frac{T_{pl}}{T_0} \right) \right\} \cong 146.3 \quad (15)$$

$$\omega_0 \cong \sqrt{\frac{20\pi G a T_t^4}{9c^2}} \cong 1.4674 \times 10^{-20} \text{ rad.sec}^{-1} \quad (16)$$

$$\begin{aligned}
H_0 &\cong \Upsilon_0 \omega_0 \cong 2.14675 \times 10^{-18} \text{ sec}^{-1} \\
&\cong 66.24 \text{ km/Mpc/sec}
\end{aligned} \quad (17)$$

$$\begin{aligned}
R_0 &\cong \frac{c}{\omega_0} \cong \Upsilon_0 \left( \frac{c}{H_0} \right) \\
&\cong 2.043 \times 10^{28} \text{ m}
\end{aligned} \quad (18)$$

$$M_0 \cong \frac{c^3}{G\omega_0} \cong 2.751 \times 10^{55} \text{ kg} \quad (19)$$

$$t_0 \cong \frac{1}{\omega_0} \cong \frac{\Upsilon_0}{H_0} \cong 2159.5 \text{ Billion years} \quad (20)$$

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### 9. Cosmic rotation

As ‘spin’ is a basic property of quantum mechanics, from the subject point of quantum gravity, universe must have ‘rotation’. If it is assumed that, universe is a Machian sphere, it is quite natural to expect ‘cosmic rotation’.

Kurt Gödel put lot of efforts in developing a realistic universe model with rotation and expansion. His heuristic results were presented at International Congress of Mathematics held at Cambridge (Massachusetts) from 30th August to 5th September 1950 [38].

The first experimental evidence of the Universe rotation was done by Birch in 1982 evidently [39]. According to Birch, there appears to be strong evidence that the Universe is anisotropic on a large scale, producing position angle offsets in the polarization and brightness distributions of radio sources. These can probably be explained on the basis of a rotation of the Universe with an angular velocity of approximately  $10^{-13}$  rad/year. In our model, current cosmic angular velocity is  $4.631 \times 10^{-13}$  rad/year. Observational effects of current cosmic rotation can be understood with the works of Obukhov [40], Godlowski [41], Longo [42] and Chechin [43].

Yuri N. Obukhov says: “Whether our universe is rotating or not, it is of fundamental interest to understand the interrelation between rotation and other aspects of cosmological models as well as to understand the observational significance of an overall rotation”.

According to Michael Longo the universe has a net angular momentum and was born in a spin.

Whittaker says [44]: “however, that any of the mathematical-physical theories that have been put forward to explain spin (rotation) in the universe has yet won complete and universal acceptance; but progress has been so rapid in recent years that it is reasonable to hope for a not long-delayed solution of this fundamental problem of cosmology”.

According to T. Valery and S. V. Timkov, current universe is rotating with light speed and angular velocity equal to the current Hubble parameter [45].

Very recent and advanced studies of Lior Shamir suggest [46] that, the distribution of galaxy spin directions in SDSS and Pan-STARRS shows patterns in the asymmetry between galaxies with opposite spin directions and can be considered as an evidence for large-scale anisotropy and an indication for a rotating universe.

### 10. Understanding galactic dark matter and its estimation

As per modern cosmological observations, dark matter seems to have a major role in understanding galactic rotational curves, gravitational lensing, galactic evolution, galactic collisions, motion of galaxies within galaxy clusters and cosmic microwave fluctuations [47,48]. In this context we propose our views in the following way.

- 1) Right from the beginning of Planck scale, ‘universe’ is generating dark mass only.
- 2) Dark mass plays the complete role in the formation and evolution of galaxies.
- 3) During cosmic evolution, for any galaxy, part of dark mass slowly transforms to visual mass.
- 4) Current galactic visual mass can be understood with the following relation.

$$(M_{Gvis})_0 \cong \left[ (M_X)_0 (M_{Gdark})_0^2 \right]^{\frac{1}{3}} \quad (21)$$

where  $(M_{Gvis})_0$  = Current visual mass of galaxy.

$(M_{Gdark})_0$  = Dark mass of galaxy.

$$(M_X)_0 \cong \frac{(M_0^3 M_{pl})^{\frac{1}{4}}}{(1 + \sqrt{\Upsilon_0})} \cong 3.523 \times 10^{38} \text{ kg}$$

= Current semi empirical mass of reference [20].

- 5) By estimating the current galactic visual mass, current galactic dark mass can be understood with the following relations.



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$$(M_{Gdark})_0 \cong \frac{\sqrt[3]{(M_{Gvis})_0}}{\sqrt{(M_X)_0}} \quad (22)$$

$$(M_{Gdark})_0 \propto (M_{Gvis})_0^{3/2} \quad (23)$$

- 6) Current galactic dark mass factor can be understood with the following relation.

$$(X_{Gdark})_0 \cong \frac{(M_{Gdark})_0}{(M_{Gvis})_0} \cong \sqrt{\frac{(M_{Gvis})_0}{(M_X)_0}} \quad (24)$$

$(X_{Gdark})_0$  = Current total mass factor of galaxy.

$$(M_{Gdark})_0 \cong (X_{Gdark})_0 (M_{Gvis})_0 \quad (25)$$

- 7) Current galactic total mass can be understood with the following relation.

$$(M_{Gtot})_0 \cong (M_{Gdark})_0 + (M_{Gvis})_0 \quad (26)$$

$$\cong [1 + (X_{Gdark})_0] (M_{Gvis})_0$$

where,  $(M_{Gtot})_0$  = Current total mass of galaxy.

- 8) Current galactic dark mass percentage can be understood with the following relation.

$$\begin{aligned} \% (M_{Gdark})_0 &\cong \frac{(M_{Gdark})_0}{(M_{Gtot})_0} \times 100 \\ &\cong \frac{(X_{Gdark})_0}{[1 + (X_{Gdark})_0]} \times 100 \end{aligned} \quad (27)$$

# 11. To develop a MOND like relation for galactic flat orbiting speed with cosmic angular velocity and galactic total mass

Even though MOND approach [49,50,51] was aimed for understanding galactic rotation curves without dark matter, with reference to the proposed current cosmic angular velocity and relation (10), it is possible to fit the rotation curves and thereby galactic dark masses can be inferred.

Observed galactic flat rotation curves can be understood in the following way. At present, for any galaxy, let,

$$(V_{Grot})_0 \cong \sqrt{\frac{G(M_{G1})_0}{(r_{G1})_0}} \cong \sqrt{\frac{G(M_{G2})_0}{(r_{G2})_0}} \cong \sqrt{\frac{G(M_{G3})_0}{(r_{G3})_0}} \quad (28)$$

where,

$(V_{Grot})_0$  = Current observed flat orbiting velocity of galactic star.

$(r_{G1})_0, (r_{G2})_0, (r_{G3})_0$

$\cong$  Increasing galactic distances from galactic centre.

$(M_{G1})_0, (M_{G2})_0, (M_{G3})_0$

$\cong$  Increasing galactic masses at  $(r_{G1})_0, (r_{G2})_0, (r_{G3})_0$ .

$$\left( \frac{(M_{G1})_0}{(r_{G1})_0} \cong \frac{(M_{G2})_0}{(r_{G2})_0} \cong \frac{(M_{G3})_0}{(r_{G3})_0} \cong \text{Constant} \right)$$

Point to be noted is that, star's orbiting velocity changes with changing galactic dark mass distribution and it needs further study and observational data for a number of galaxies. Let,

$$(V_{Grot})_0 \cong \sqrt{\frac{G(M_{Gtot})_0}{(r_{Geffe})_0}} \quad (29)$$

where,

$(V_{Grot})_0$   $\cong$  Observed current flat orbiting speed of galactic star.

$(r_{Geffe})_0$   $\cong$  Current galactic effective radius.

Writing  $(r_{Geffe})_0 \cong \frac{G(M_{Gtot})_0}{(V_{Grot})_0^2}$  and eliminating

$(r_{Geffe})_0$ ,

$$\frac{G(M_{Gtot})_0}{(r_{Geffe})_0^2} \cong \frac{(V_{Grot})_0^4}{G(M_{Gtot})_0} \quad (30)$$

Now, based on MOND approach, assume that,

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$$\frac{(v_{Grot})_0^4}{G(M_{Gtot})_0} \cong c\omega_0 \quad (31)$$

where,

$c\omega_0 \cong$  Current possible maximum cosmic angular acceleration.

Thus,

$$\begin{aligned} (V_{Grot})_0 &\cong \sqrt[4]{G(M_{Gtot})_0 c\omega_0} \\ &\cong \sqrt[4]{G[1+(X_{Gdark})_0](M_{Gvis})_0 c\omega_0} \end{aligned} \quad (32)$$

*Based on this relation, estimated flat rotation speeds of DD168, Milky Way and UGC12591 are 49.96 km/sec, 199.66 km/sec and 521.75 are 52 km/sec, 202.6 km/sec and 500 km/sec respectively. As per the reference photometric data [49] and [52], their corresponding flat rotation speeds km/sec respectively. Within a range of (50 to 500) km/sec, these striking coincidences are strongly supporting our proposed concepts. We are working on collecting data for most of the galaxies and updating this draft with detailed Tables and Figures in our next revision.*

In this way,

- 1) Current galactic angular velocity can be understood with the following relations.

$$(\omega_{Grot})_0 \cong \frac{(V_{Grot})_0^3}{G(M_{Gtot})_0} \quad (33)$$

where,  $(\omega_{Grot})_0 =$  Current galactic angular velocity

$$(V_{Grot})_0 (\omega_{Grot})_0 \cong c\omega_0 \quad (34)$$

- 2) Based on relations (28), (31) and (32), effective radius of galaxy can be expressed as,

$$(r_{Geffe})_0 \cong \frac{G(M_{Gtot})_0}{\sqrt{G(M_{Gtot})_0 c\omega_0}} \cong \sqrt{\frac{G(M_{Gtot})_0}{c\omega_0}} \quad (35)$$

- 3) Based on relation (28), as a special case, radius of galaxy corresponding to its visual mass and

flat rotation speed, can be called as galactic 'visual radius' and can be expressed as,

$$(r_{Gvis})_0 \cong \frac{G(M_{Gvis})_0}{\sqrt{G(M_{Gtot})_0 c\omega_0}} \cong \sqrt{\frac{(M_{Gvis})_0}{[1+(X_{Gdark})_0] c\omega_0}} \quad (36)$$

- 4) Based on relations (28), (34) and (35), if dark matter distribution is 'as expected', galaxy should follow flat rotation speeds in between  $(r_{Gvis})_0$  and  $(r_{Geffe})_0$ . A least, close to the geo-

metric mean of  $(r_{Gvis})_0$  and  $(r_{Geffe})_0$  rotation speed should be flat. It can be expressed as,

$$(r_{Ggeom})_0 \cong \sqrt{(r_{Geffe})_0 (r_{Gvis})_0} \cong \sqrt{\frac{G(M_{Gvis})_0}{c\omega_0}} \quad (37)$$

- 5) Effective, geometric and visual radii can be expressed with a common relation of the form,

$$(r_{Gx})_0 \cong [1+(X_{Gdark})_0]^p \sqrt{\frac{G(M_{Gvis})_0}{c\omega_0}} \quad (38)$$

where,  $p = \left(+\frac{1}{2}, 0, -\frac{1}{2}\right)$

- 6) With reference to the observed ordinary matter density [37,53], we noticed that, for any galaxy,

$$\begin{aligned} (\rho_{Gvis})_0 &\approx \left[\frac{(V_{Grot})_0}{c}\right] \left[\frac{\sqrt{(M_{Gvis})_0 (M_{Gtot})_0}}{\frac{4\pi}{3} (r_{Geffe})_0^3}\right] \\ &\approx \sqrt{(X_{dark}+1)} \left[\frac{(V_{Grot})_0}{c}\right] \left[\frac{3(M_{Gvis})_0}{4\pi (r_{Geffe})_0^3}\right] \end{aligned} \quad (39)$$

It may also be noted that, based on the average mass-to-light ratio for any galaxy, present matter density can be expressed with the following relation [53].

$$(\rho_{Gvis})_0 \cong 1.5 \times 10^{-32} \eta h_0 \text{ gram/cm}^3 \quad (40)$$



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$$\text{Here, } \left\{ \begin{array}{l} \eta \cong \left\langle \frac{M}{L} \right\rangle_{\text{galaxy}} / \left\langle \frac{M}{L} \right\rangle_{\text{sun}} \text{ and} \\ h_0 \cong H_0 / 100 \text{ Km/sec/Mpc} \cong 0.68 \end{array} \right.$$

Note that elliptical galaxies probably comprise about 60% of the galaxies in the universe and spiral galaxies thought to make up about 20% percent of the galaxies in the universe. Almost 80% of the galaxies are in the form of elliptical and spiral galaxies. For spiral galaxies,  $\eta h_0^{-1} \cong 9 \pm 1$  and for elliptical galaxies,  $\eta h_0^{-1} \cong 10 \pm 2$ . For our galaxy inner part,  $\eta h_0^{-1} \cong 6 \pm 2$ . Thus the average  $\eta h_0^{-1}$  is very close to 8 to 9 and its corresponding matter density is close to  $(5.55 \text{ to } 6.24) \times 10^{-32} \text{ gram/cm}^3$  and can be compared with the above proposed magnitude of  $6.25 \times 10^{-32} \text{ gram/cm}^3$ .

*Note: Important point to be noted is that, in estimating the approximate visual mass of the universe, while multiplying the average galactic visual matter density with total cosmic volume, one must exclude the intergalactic volume or volume occupied by the free space. Clearly speaking, one must find the ratio of total galactic volume and total free space volume.*

- 7) With reference to MSTG and MOND approaches [49], approximate galactic core radius can be expressed as,

$$(r_{\text{Gcore}})_0 \approx \frac{(r_{\text{Gvis}})_0}{2\pi} \approx \left( \frac{1}{2\pi} \right) \sqrt{\frac{G(M_{\text{Gvis}})_0}{(X_{\text{dark}} + 1)c\omega_0}} \quad (41)$$

## 12. To understand cosmic redshift associated with cosmic current and past temperatures

With reference to the light emitted from first hydrogen atoms, we define the following two ad hoc relations.

$$\text{Let, } x_t \cong 1 + \ln \left( \frac{R_t}{R_{pl}} \right) \quad (42)$$

where  $R_{pl}$  is the Planck scale cosmic radius.

$$Z \cong \sqrt{\exp(x_0 - x_t)} - 1 \quad (43)$$

Based on these two ad hoc definitions, it is possible to show that,

$$\left. \begin{aligned} Z &\cong \sqrt{\exp \left\{ \left[ 1 + \ln \left( \frac{R_0}{R_{pl}} \right) \right] - \left[ 1 + \ln \left( \frac{R_t}{R_{pl}} \right) \right] \right\}} - 1 \\ &\cong \sqrt{\exp \left\{ \left( \ln \left( \frac{R_0}{R_{pl}} \right) - \ln \left( \frac{R_t}{R_{pl}} \right) \right) \right\}} - 1 \\ &\cong \sqrt{\exp \left\{ \ln \left( \frac{R_0}{R_t} \right) \right\}} - 1 \cong \sqrt{\frac{R_0}{R_t}} - 1 \end{aligned} \right\} \quad (44)$$

With respect to the proposed assumptions, it is clear that at any stage of cosmic expansion,

- 1) Cosmic radius is inversely proportional to cosmic angular velocity.
- 2) Cosmic angular velocity is directly proportional to squared cosmic temperature.

Hence,

$$Z \cong \sqrt{\frac{R_0}{R_t}} - 1 \cong \sqrt{\frac{\omega_t}{\omega_0}} - 1 \cong \sqrt{\frac{T_t^2}{T_0^2}} - 1 \cong \frac{T_t}{T_0} - 1 \quad (45)$$

where  $T_t$  is the past cosmic temperature and  $T_0$  is the current cosmic temperature.

$$\therefore Z + 1 \cong \frac{T_t}{T_0} \quad (46)$$

## 13. To understand Hubble's law and to locate the cosmic centre

Based on first assumption and special theory of relativity, from and about the cosmic centre, for any materialistic galaxy, its current receding speed can be understood in the following way.

**A review on Reference [20]**

$$\begin{aligned}
 (v_{Gres})_0 &\equiv \left( \frac{(r_{Gdis})_0}{R_0} \right) c \\
 &\equiv (r_{Gdis})_0 \omega_0 \equiv \left( \frac{1}{Y_0} \right) (r_{Gdis})_0 H_0
 \end{aligned} \quad (47)$$

In this way qualitatively Hubble's [54] law can be understood. Since  $\omega_0$  is known, by knowing the actual galactic receding speed, its distance from the cosmic centre can be estimated. By estimating the cosmic radial distances of galaxies along with their locations, it seems possible to locate the cosmic centre. If any galaxy's actual receding speed is found to be faster than speed of light, our model can be falsified.

**14. To estimate current cosmic gravitational wave length**

With reference to current cosmic mass and Planck mass, wavelength of current gravitational waves [55] can be obtained as follows.

Our idea is that, at any stage of cosmic evolution, 'evolving universe' is an 'internal accelerating' object and wavelength of cosmic graviton is equal to  $2\pi$  times the geometric mean of radius of universe at time  $t$  and Planck scale radius. It can be expressed as,

Based on this idea, at present,

$$\begin{aligned}
 (\lambda_{gw})_0 &\equiv 2\pi \sqrt{R_0 R_{pl}} \equiv 2\pi \left( \frac{G \sqrt{M_0 M_{pl}}}{c^2} \right) \\
 &\equiv \frac{2\pi G \sqrt{M_0 M_{pl}}}{c^2} \equiv 0.00361 \text{ m}
 \end{aligned} \quad (48)$$

Corresponding frequency and energy can be expressed as,

$$\begin{aligned}
 (v_{gw})_0 &\equiv \frac{c}{(\lambda_{gw})_0} \equiv \frac{c}{2\pi \sqrt{R_0 R_{pl}}} \\
 &\equiv \frac{c^3}{2\pi G \sqrt{M_0 M_{pl}}} \equiv 83.033 \text{ GHz}
 \end{aligned} \quad (49)$$

$$\begin{aligned}
 (E_{gw})_0 &\equiv \frac{\hbar c^3}{2G \sqrt{M_0 M_{pl}}} \equiv \frac{\hbar c}{\sqrt{R_0 R_{pl}}} \\
 &\equiv 0.0003434 \text{ eV}
 \end{aligned} \quad (50)$$

**15. Understanding cosmic anisotropy**

As universe is always expanding at speed of light, at any stage of expansion, cosmic boundary expands by  $3 \times 10^8$  m in one second. In between the cosmic centre and cosmic boundary, expansion distance covered in one second can be expressed as,

$$\Delta(d_{\text{exp}})_t \equiv \frac{(r_d)_t}{R_t} (3 \times 10^8) \text{ m} \quad (51)$$

where,

$\Delta(d_{\text{exp}})_t$  = Increment in expansion distance at time  $t$ .

$(r_d)_t$  = Distance from cosmic centre at time  $t$ .

$R_t$  = Cosmic radius at time  $t$ .

Clearly speaking,

- 1) Distance moved near to cosmic boundary is more compared to distance moved near to cosmic centre.
- 2) Rate of volume change near to cosmic boundary is higher than the rate of volume change near to cosmic centre.
- 3) Anisotropy [46,56] gradually increases from cosmic centre to cosmic boundary.

**16. Understanding (internal) cosmic acceleration**

According to Saul Perlmutter, Adam Riess and Brian Schmidt, observable universe is accelerating [57,58]. Clearly speaking, expansion of the universe is such that the velocity at which a distant galaxy is receding from the observer is continuously increasing with time. It can be understood in the following way.

## A review on Reference [20]

Based on relation (47) and with reference to two time periods ( $t_2 > t_1$ ), ratio of galactic receding speeds can be expressed as,

$$\frac{(v_{Gres})_{t_2}}{(v_{Gres})_{t_1}} \cong \left( \frac{(r_{Gdis})_{t_2}}{(r_{Gdis})_{t_1}} \right) \left( \frac{R_{t_1}}{R_{t_2}} \right) \quad (52)$$

where,

$(v_{Gres})_{t_1}$  and  $(v_{Gres})_{t_2}$  = Galactic receding speeds corresponding to  $t_1, t_2$  respectively where  $(v_{Gres})_{t_2} > (v_{Gres})_{t_1}$ .

$(r_{Gdis})_{t_1}$  and  $(r_{Gdis})_{t_2}$  = Galactic distances corresponding to  $t_1, t_2$  respectively where  $(r_{Gdis})_{t_2} > (r_{Gdis})_{t_1}$ .

$R_{t_1}$  and  $R_{t_2}$  = Theoretical cosmic radii corresponding to  $t_1, t_2$  respectively where  $(R_{t_2} > R_{t_1})$ .

Clearly speaking,

- 1) Within the cosmic horizon, second by second, galactic receding speeds are increasing and resemble a kind of internal cosmic acceleration.
- 2) Acceleration seems to be higher near to cosmic centre and gradually reaches to zero at horizon.
- 3) Hubble's law pertaining to two increasing time periods seems to be a natural consequence of internal cosmic acceleration.
- 4) Cosmic horizon is always expanding at speed of light.

### 17. To relinquish dark energy

If it is assumed that, universe is always expanding with speed of light, then, considering 'dark energy' like concepts need not be required [59,60]. If one is able to understand the reasons for light speed expansion, it may help in understanding the internal acceleration. Proceeding further, till today, no cosmo-

logical observation or no ground based experiment could shed light on the physical nature of dark energy.

### 18. Understanding cosmic age

Observable cosmic radius is just 2.2 times the Hubble radius and corresponding cosmic age is  $(1/H_0)$ . Our model result of cosmic radius is 146.3 times the Hubble radius and corresponding light speed cosmic age is 146.3 times  $(1/H_0)$ . In this way, our model result of cosmic age can be justified. We would like to emphasize that,

- 1) Modern cosmological observations are limited to 2.2 times the Hubble radius and needs further study.
- 2) Time is a dynamic and emerging cosmic parameter.
- 3) Cosmic age depends on the model under consideration.
- 4) One should not worry about the absolute value of cosmic age.

### 19. Understanding nucleosynthesis

Based on relations (1) to (20) and by assuming appropriate density range or temperature range that is required for formation of nucleons and atoms, cosmic physical parameters pertaining to nucleosynthesis can be understood [61]. For example, cosmic age corresponding to a temperature of  $10^{10}$  K is 5.05 sec. It needs further study. Estimated cosmic age corresponding to 3000 K is  $1.78 \times 10^6$  years. This estimation is 4.68 times higher than the current estimation of  $3.8 \times 10^5$  years. Clearly speaking, starting from the Planck scale, without considering 'inflation' like cooling pattern, our model follows a slow thermal cooling pattern throughout the cosmic evolution.

### 20. Inferences of growing Machian universe

Based on the proposed assumptions and with reference to the above relations, we would like to say that,

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- 1) Earth, Solar family, Milky way and all other galaxies are living inside the proposed Machian universe.
- 2) There is matter and space outside the proposed growing and rotating Machian universe.
- 3) The growing and rotating Machian universe always sucks matter inward and thus it grows on with increasing suction rate.
- 4) At poles, inward matter flow rate is maximum and at equator, inward matter flow rate is zero. Thus, starting from poles to equator, inward matter flow rate gradually decreases.

### 21. To develop practical methods for understanding growing Machian universe

We would like to propose the following points for understanding cosmic singularity.

- 1) To study cosmic anisotropy on very large cosmic distances.
- 2) To believe, to understand and to study the consequences of cosmic rotation.
- 3) To develop high precision cosmic gyroscopes.
- 4) To study galactic mean temperature and to estimate the galactic dark mass.
- 5) To correlate galactic rotations and cosmic rotation.
- 6) To find oldest galaxies like EGSY8p7 whose age is closer to or greater than 13.8 billion years.
- 7) To study very high energy cosmic gravitons.
- 8) To study cosmic dipole magnetic moment and its related properties.

### 22. Discussion on cosmic temperature, angular velocity, radius and age

Relation (11) is very similar to the famous Hawking's black hole temperature formula [62]. This is due to the similarities in between Mach's relation for increasing cosmic radii and Schwarzschild radius of a black hole. For the Planck scale, cosmic temperature can be expressed as,

$$T_{pl} \cong \frac{0.6831\hbar c^3}{k_B G M_{pl}} \quad (53)$$

Comparing this with Hawking's relation, it is differing by the factor numerical 0.6831. In may be noted that, in our earlier publications [3,12], we tried to develop models of black hole cosmology with modified Hawking's temperature relation as,

$$T_t \cong \frac{\hbar c^3}{8\pi k_B G \sqrt{M_t M_{pl}}} \quad (54)$$

$$\text{where } M_t \cong \left( c^3 / 2GH_t \right)$$

In those publications our aim was to couple Hubble parameter and cosmic temperature without cosmic rotation. In some situations, we were forced to assume the equality of Hubble parameter and angular velocity. By doing so, we could be able to match current Hubble radius and Hubble age. But, our idea of MOND's approach of dark matter analysis and advocated [39] Birch's cosmic angular velocity are not working for the case of  $H_0 \cong \omega_0$ . Hence, in this paper, we are forced to accommodate  $146.3(c/H_0)$  radius  $146.3(1/H_0)$ . With future observations and advanced telescopes, it may be possible to see far distant galaxies. For example, the oldest stars in the Milky Way are nearly as old as the current universe itself. Based on this observation, by considering very old galaxies compared to Milky Way, there is a possibility of observing very old stars beyond our current observable radius which may help in understanding the actual cosmic radius and age.

### 23. Discussion on galactic flat rotation curves and galactic dark matter estimation

- 1) With reference to maximum possible (current) cosmic angular acceleration, MOND relation can be rewritten as follows.

$$(V_{Grot})_0 \cong \sqrt[4]{G \left[ 27.28(M_{Gvis})_0 \right] c \omega_0} \quad (55)$$

where,  $\left( \frac{1.2 \times 10^{-10} \text{ m.sec}^{-2}}{c \omega_0} \right) \cong 27.28$

- 2) On comparison, percentage of dark mass in MOND model seems to be constant at

**A review on Reference [20]**

$(26.28/27.28) \times 100 = 96.33\%$  whereas in our approach, dark matter percentage increases with increasing (visible) mass and radius of galaxy. It is very interesting to note that, MOND's approach implicitly seems to support the cosmological estimation of 95% invisible matter and 5% visible matter. It needs further study.

- 3) *By minimizing the errors in estimating the visible mass of galaxy and by properly choosing the effective radius of galaxy, accuracy can be improved in estimating the dark mass of a galaxy. Point to be noted is that, there is no correlation between photometric mass estimations and parametric mass estimations. Similarly, in some cases, including Milky Way, there is no correlation between MSTG mass estimations and MOND mass estimations. It needs a careful analysis.*
- 4) Starting from the lowest massive galaxy, (DDO 154) to the highest massive galaxy (NGC 2841), dark mass seems to increase from 2.7 to 49.3 times respectively and needs further study. Applying this idea to Sun like stars, dark mass ratio is close to 0.0001.
- 5) As per the recent studies [63], Virial mass of Milky Way is  $1.28^{+0.97}_{-0.48} \times 10^{12} M_{\odot}$  and its corresponding upper limit is  $2.25 \times 10^{12} M_{\odot}$ . Based on proposed relations, for Milky Way [49], estimated flat rotation speed is 199.6 km/sec and its corresponding total mass is  $25.5 \times [10.6 \times 10^{10} M_{\odot}] \cong 2.7 \times 10^{12} M_{\odot}$ . This is a good fit and strong support for our proposal. Based on relation (34), estimated angular velocity of whole Milky Way is  $2.2 \times 10^{-17} \text{ rad. sec}^{-1}$ . It is for observational testing [39] and further study. Sun is located at 25 kpc from the Milky Way center and is having a rotational period of 240 million years. So, for the whole Milky Way of radius 290 kpc, our proposal can be given a chance [64].
- 6) For Milky Way, its corresponding 'visual' and 'effective' radii are 11.5 kpc and 293.66 kpc. Corresponding geometric radius is 58.1 km/sec.

As per the observational data [65], for Milky Way, starting from a radius of 60 kpc, rotation speed seems to decrease gradually [66,67]. Using the current dwarf galaxy population, very recently predicted [64] edge of the Milky Way halo is  $(292 \pm 61) \text{ kpc}$ . This is a very support.

- 8) In near future, by thoroughly studying the galactic dark mass distribution and corresponding deviations, variations in flat rotation speeds can be analyzed in a systematic approach. Very recent studies conducted on super spiral galaxies with Southern African Large Telescope (SALT) suggest high rotation speeds in the range of (240 to 570) km/sec indicating a dynamical mass range of  $(0.6 \text{ to } 4) \times 10^{12} M_{\odot}$  [68]. It may be noted that, with a visual galactic mass of  $(\sqrt{0.6 \times 4}) \times 10^{12} M_{\odot} \cong 1.55 \times 10^{12} M_{\odot}$ , estimated flat rotation speed is 539 km/sec. This is a good support for our proposal pertaining to most massive galaxies having fast rotation speeds. Considering a visual mass of  $(0.98 \pm 0.1)$  of  $\log(M_{\text{dark}})$  mentioned in Table-1 of Ref. [68], corresponding flat rotation speeds can be fitted well.
- 9) We are also working on developing alternative relations for estimating  $(X_{\text{Gdark}})_0$ . On lower side, by studying the ultra faint dwarf galaxies it seems possible to fine tune  $X_{\text{dark}}$ .
- 10) Interesting point to be noted is that, for small galaxies whose mass is less than  $3.5 \times 10^{38} \text{ kg}$ , their dark mass seems to be less than their visual mass. Whether it is - 'correct or not' - can be confirmed with their galactic rotational curves. For a galaxy of visual mass  $10^6 M_{\odot}$ , galactic flat rotation speed seems to be 5.0 km/sec. It needs further investigation with respect to least massive galaxy, Segue2. According to Evan N. Kirby et al [69]: "Either Segue 2 would be the first of a vast class of new galaxies to be discovered with very low luminosities and very low dark matter content, or it would have to represent a rare case of a dark matter halo that is typically too small to host a galaxy but, for

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some reason, managed to form a small number of stars over at least 100 Myr.”

- 10) Relation (34) seems to be very simple in representation, easy to follow and simple to visualize and analyze MOND in approach connected with galactic structures and cosmic structure.

### 24. Discussion on the nature of dark matter

We would like to appeal that, when 95% of total cosmic mass is believed to be in the form of dark nature having interactions only with gravitation, it may not be logical to attribute its nature to any known or known any elementary particle supposed to be originating from interactions involved with visible mass spectrum.

As current cosmic temperature is at 2.7 K, recently it has been suggested that, galactic cold hydrogen can be considered as dark matter [70,71]. Since hydrogen is the basic building block of visible matter, this proposal can be given a chance. If so, 95% of the cosmic mass must be explained with a suitable mechanism with respect to current sub zero temperatures, past high temperatures and dark matter needed for the formation and evolution of galaxies. For example, based on our approach, estimated dark mass of current Milky Way is 24.5 times of its visible mass. It needs a reasonable mechanism for generating the required dark matter distribution.

If dark matter is really having a different nature and if one is willing to study and understand the mechanism of transformation of dark mass to Hydrogen atoms, it may give some clue. Applying our idea to Sun and Proton, their current dark masses are  $1.5 \times 10^{26}$  kg and  $3.6 \times 10^{-60}$  kg respectively. With these magnitudes, it is possible to say that, at atomic level, at present, dark matter influence is negligible. Even for Sun like massive stars, dark matter is having a very little role. This can be confirmed with current gravitational observations. We are thinking in this direction.

### 25. Conclusion

Considering the points and relations proposed in sections (2) to (24), our model can be recommended for further research. We would like to emphasize the point that, ‘space’ and ‘matter’ are inseparable cos-

mic entities and like matter, space cannot travel faster than speed of light.

Flatness problem can be understood well with Machian radius of the current universe. Considering light speed expansion, inflation and dark energy concepts can be relinquished. Based on relations (4) and (8), Hubble parameter can be estimated independent of galactic distances and their red shifts.

Even though, cosmic horizon is assumed to be expanding at light speed, based on relations (47) and (52), it seems possible to have internal acceleration below the cosmic horizon and seems to be a consequence of Hubble’s law for increasing time periods. Even though, estimated cosmic radius is 146.3 times the Hubble radius, estimated angular velocity is 146.3 times less than the Hubble parameter and is directly helping in estimating galactic dark masses with relations (21) to (41).

Further study and advanced telescopes may help in thoroughly exploring the cosmic and galactic structures in a broad view based on the concepts of Quantum Cosmology. In this context, relation (8) can be given some consideration.

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