Energy Based True Definition of Cosmic red Shift and Quantum Halt of the Current Universe Having Light Speed Rotation

U.V.S. Seshavatharam [1,*] and S. Lakshminarayana [2]

[1]   Honorary faculty, I-SERVE, Survey no-42, Hitech city, Hyderabad-84,Telangana, India
[2]   Dept. of Nuclear Physics, Andhra University, Visakhapatnam-03, A.P, India; Lnsrirama@gmail.com
*   Correspondence: Seshavatharam.uvs@gmail.com

Abstract: We appeal the science community to review the basic definition of wavelength dependent cosmic red shift. We would like to emphasize the point that, the true cosmic red shift must be defined as the ratio of loss in energy of photon to the energy of photon at galaxy. In terms of wavelength, photon red shift must be defined as the ratio of change in wavelength to the observed wavelength of photon. Considering the recent paper pertaining to cosmic halt authored by Cosmin Andrei, Anna Ijjas, and Paul J. Steinhardt and reviewed by Saul Perlmutter, in this paper we propose a very simple model of the universe having early stage light speed expansion and current stage quantum halt accompanied by continuous light speed rotation. In this context, representing early cosmic expansion and rotation as an outward spiral, it seems possible to consider Hubble's law as a representation of current cosmic light speed rotation having no further expansion. To understand the current cosmic halt, we are proposing very simple and very strange atomic and nuclear relations that constitute Hubble parameter and gravitational constant. Qualitatively and quantitatively, gravitational potential energy of proton and electron separated by a distance of root mean square radius of proton seems to be equal to half the product of reduced Planck's constant and current Hubble parameter. Based on uncertainty condition, it needs further study, observations and analysis.

Keywords: true definition of cosmic red shift; Hubble-Hawking universe; light speed expansion; light speed rotation; cosmic halt with quantum physics

1. Introduction

One of the key pillars of Lambda model of cosmology is 'cosmic red shift'. Since from the beginning, physicists and cosmologists strongly believe that, cosmic red shift is a measure of galactic distances and receding speeds (Bahcall 2015). It may be noted that, by the time of defining galactic red shift, maximum red shift was around 0.003. In terms of energy of photon, we would like to emphasize the point that, traditional definition of cosmic red shift is absolutely wrong. True cosmic red shift must be defined as the ratio of loss in energy of photon to the energy of photon at galaxy. As a consequence, in terms of wavelength, photon red shift must be defined as the ratio of change in wavelength to the observed wavelength of photon. Following this energy dependent true definition of cosmic red shift, we appeal the science community to review the basics and advanced concepts of Lambda model of accelerating cosmology (Perlmutter et al. 1999).

Recent observations pertaining to 740 supernovae clearly suggest that current universe is expanding at constant rate of expansion (Melia 2012; Nielsen et al. 2016) .Very recent paper on Lambda cosmology is turning towards a big crunch based on dark energy dependent cosmic deceleration and halt (Andreia et al. 2022). Very surprising point to be noted is that, this new paper has been authored by Cosmin Andrei, Anna Ijjas and Paul J. Steinhardt and reviewed by Saul Perlmutter. Based this very recent reference and considering our new definition of cosmic red shift, in this paper, we propose a very simple model of rotating model of universe having no further expansion. Considering atomic and nuclear constants, in section-6 we are making a bold attempt to understand the quantum mechanical halting mechanism of the current universe.

2. On the Role of True Definition of Cosmic Red Shift in Fitting Galactic Distances

In a mathematical form, true definition of cosmic red shift can be expressed as (Seshavatharam and Lakshminarayana 2021,2022),

$$z_{new} \cong \frac{E_{Galaxy} - E_{Observed}}{E_{Galaxy}} \cong \frac{\lambda_{Observed} - \lambda_{Galaxy}}{\lambda_{Observed}} \cong 1 - \frac{\lambda_{Galaxy}}{\lambda_{Observed}} \tag{1}$$

If it is believed that, known physical laws of atomic and nuclear physics are applicable to other galaxies, then one can assume that, energy of photon at any galaxy is same as energy of photon coming from a laboratory resting in Milky Way. Then,

$$z_{new} \cong \frac{E_{Lab} - E_{Observed}}{E_{Lab}} \cong \frac{\lambda_{Observed} - \lambda_{Lab}}{\lambda_{Observed}} \cong 1 - \frac{\lambda_{Lab}}{\lambda_{Observed}} \cong \frac{z}{1+z}$$

$$\text{where, } z \cong \frac{\lambda_{Observed} - \lambda_{Lab}}{\lambda_{Lab}} \cong \frac{\lambda_{Observed}}{\lambda_{Lab}} - 1 \cong \frac{E_{Lab} - E_{Observed}}{E_{Observed}} \cong \frac{E_{Lab}}{E_{Observed}} - 1 .... \text{(illogical)} \tag{2}$$

This definition seems to be completely different from the currently believed definition of cosmic red shift and needs a review at fundamental level. With reference to current definition, $0 > z <$ Infinity. Based on our definition, $0 > z_{new} < 1$. Following relation (2), observed farthest galactic distances can be estimated very easily with $d_G \cong (z_{new})(c/H_0)$. See Table 1.

Table 1. To estimate and fit the distances of farthest galaxies.

Galaxy	Red shift	Standard Light travel distance (Gly)	Estimated Light travel distance (Gly)	%Error
GN-z11	11.09	13.39	13.41	-0.15
MACS1149-JD1	9.11	13.26	13.17	0.65
EGSY8p7	8.68	13.23	13.11	0.91
A2744 YD4	8.38	13.2	13.06	1.05
EGS-zs8-1	7.73	13.13	12.95	1.41
z7 GSD 3811	7.66	13.11	12.93	1.36
z8_GND_5296	7.51	13.1	12.9	1.51
SXDF-NB1006-2	7.215	13.17	12.84	2.5
GN-108036	7.213	13.07	12.84	2.5
BDF-3299	7.109	13.05	12.84	2.5
A1703 zD6	7.014	13.04	12.84	2.5
BDF-521	7.008	13.04	12.84	2.5
G2-1408	6.972	13.03	12.84	2.5
IOK-1	6.964	13.03	12.84	2.5

For further analysis and verification, readers are encouraged to visit the URLs, https://cosmocalc.icrar.org/. and http://www.atlasoftheuniverse.com/cosmodis.c. Most important point to be noted is that, based on the data presented in Table 1, cosmic acceleration and dark energy concepts can be relinquished logically.

3. Continuous Light Speed Rotation, Initial Light Speed Expansion and Final Zero Expansion Speed

Considering continuous cosmic light speed rotation and based on the above new and true definition of cosmic red shift, let us define decreasing cosmic expansion speed as,

$$\left(V_{\exp}\right)_t \cong \left[1 - (z_{new})_t\right] c \tag{3}$$

As universe is expanding/growing, cosmic mass is increasing and trying to halt the universe. At the ending stage of expansion, about the cosmic center, universe will have a maximum galactic red shift of 1. i.e. $(z_{new}) \to 1$. Thinking in this way, for the current case or may be in very near future,

$$
\left(\frac{(V_{\exp})_0}{c} \right) \cong 1 - (z_{new})_0 = 1 - 1 = 0
$$
$$
\to (V_{\exp})_0 = 0
$$

(4)

In this way, there is a scope for continuous light speed rotation with no further expansion.

4. Hubble's Law and Its Possible Applicability to Cosmic Rotation

Many cosmologists strongly believe that, there exists a link between cosmic structure and cosmic rotation (Whittaker 1945; Gamow 1946; Godel 1950; Hawking 1969; Birch 1982; Seshavatharam 2010; Godlowski 2011; Sivaram and Arun 2012; Magueijo et al 2013; Michael 2013; Korotky et al 20202;). In this context, in our recent publication (Seshavatharam and Lakshminarayana 2023a) titled "A Rotating Model of a Light Speed Expanding Hubble-Hawking Universe" published in Physical Science Forum, we have made many logical and supporting arguments in favor of cosmic rotation and positive curvature. Readers are encouraged to go through. We would like to emphasize that, in a quantum mechanical and quantum gravitational (Calcagni et al 2022) picture,

a) Without Spin there is no existence to quantum mechanics.
b) Without rotation there is no independent existence to cosmic structure as a whole.
c) Big bang can be replaced with a growing and rotating Planck ball.
d) Cosmic red shift can be considered as a measure of distance about the cosmic center and no way associated with galactic receding speeds.
e) Light speed rotation and cosmic red shift jointly resembles the observed Hubble's law.

Cosmic isotropy and flatness (no curvature) are the rival factors that make cosmologists to ignore the idea of cosmic rotation. Isotropy point of view, many cosmologists (Pavan Kumar et al. 2022; Shamir 2022) are analyzing the true nature of the assumed cosmic isotropy in all possible ways. Future observations may definitely shed light on the validity of Perfect Cosmological Principle i.e. At any location and in any direction, universe is homogeneous and isotropic. Most recent observations on cosmic microwave background radiation pertaining temperature and polarization anisotropy strongly suggest the possibility of considering a positively curved universe (Di Valentino et al. 2020; Ellis et al. 2020; Handley 2021; Weiqiang et al. 2023).

We would like to emphasize the point that, conceptually, we are neither against to big bang nor against to cosmic expansion. Starting from the Planck scale, by representing early light speed cosmic expansion and rotation as an outward spiral, it seems possible to consider Hubble's law as a representation of current cosmic light speed rotation having no further expansion. It needs strong theoretical and observational support. Here it is important to note that – whether current/future universe is expanding or not can be understood with,

a) Rate of decrease in cosmic temperature.
b) Rate of decrease in Hubble parameter.
c) Analyzing distant galactic surface brightness (Lerner 2014, 2018; Crawford 2014; Lovyagin et al. 2022;).

Hence, Hubble's law for cosmic rotation applicable to whole Hubble volume can be expressed as,

$$
d_G H_0 \cong \left(\frac{z}{z+1} \right) c \cong (z_{new}) c
$$

(5)

By this time, if universe is not really expanding,

1) It seems illogical to consider H_0 as a representation of current cosmic expansion rate.
2) It seems meaningful to consider H_0 as a representation of current cosmic angular velocity.

New and recent observations are indicating strange things in cosmology - They are cosmic filaments (very long tube like structures) that constitute galaxies and assumed dark matter. Here point of interest is that the large cosmic filaments are found to have spin. Cosmologists are working on understanding the mystery of filament spin (Wang 2021). We hope that, with future observations and cosmic rotation, it seems possible to understand the mysterious spin of cosmic filaments.

5. Understanding the Cosmic Scale Factor

As per the basics of Lambda cosmology, cosmic scale factor is defined as,

$$\frac{a_{then}}{a_{now}} \cong \frac{a_t}{a_0} \cong \frac{1}{1+z} \cong a_t \tag{6}$$

where, $z \cong \dfrac{\lambda_{Observed} - \lambda_{Lab}}{\lambda_{Lab}}$; $\dfrac{a_{then}}{a_{now}} \cong a_{then} \cong a_t$ if $a_{now} \cong a_0 \cong 1$

Based on our definition, $z_{new} \leq 1$ and $1+(z_{new}) \leq 2$. Hence it seems quite complicated to follow the above relation (6). To resolve the problem, we appeal that,

$$\text{(Either)} \quad a_t \cong \left(\frac{T_0}{T_t}\right) \quad \text{.....................(7A)}$$

$$\text{(Or)} \quad a_t \cong \frac{1}{1+(z_{new})} \text{.................(7B)} \tag{7}$$

For further study, we appeal the science community to choose either (7A) or (7B). Choosing relation (7A) and following our Hubble-Hawking model related with Planck mass, $M_{pl} \cong \sqrt{\dfrac{\hbar c}{G}}$, currently believed cosmic time scale up to the formation of first hydrogen atom can be fitted with,

$$t \cong \left(\frac{1}{1+z}\right)^{3/2}\left(\frac{1}{H_0}\right) \cong \sqrt{\frac{T_t}{T_0}}\left(\frac{1}{H_t}\right)\text{........(8A)}$$

$$\cong \left(\frac{1}{T_0}\right)^{1/2}\left(\frac{1}{T_t}\right)^{3/2} 3.42646 \times 10^{18} \text{ sec} \tag{8}$$

$$tH_t \cong \sqrt{\frac{1}{a_t}} \cong \sqrt{\frac{T_t}{T_0}} \text{................. ....(8B)}$$

where,

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

provided, $M_t \cong \dfrac{c^3}{2GH_t}$ and $H_{pl} \cong \dfrac{c^3}{2GM_{pl}} \cong \dfrac{1}{2}\sqrt{\dfrac{c^5}{G\hbar}}$.

$$H_t \cong \left(\frac{1}{H_{pl}}\right)\left(\frac{4\pi k_B T_t}{\hbar}\right)^2 \cong 2.91846 \times 10^{-19}\left(T_t\right)^2$$

Note: For, $T_0 \cong 2.72548$ K, obtained $H_0 \cong 66.89$ km/sec/Mpc.

Relation (8A) is a very nice fit for the currently believed cosmic time scale and it is very essential to work on it for clarity and better understanding based on Hubble-Hawking cosmology. If so, interesting observation to be noted is that,

$$\frac{H_t}{H_0} \cong \left(\frac{T_t}{T_0}\right)^2 \cong \frac{1}{a_t^2} \tag{9}$$

6. Relation between Various Cosmological Distances

Based on the new red shift definition as discussed in section (2), various distances associated with galactic light can be understood in the following way.

Light Travel Distance can be approximated with,

$$LTD \cong z_{new}\left(\frac{c}{H_0}\right) \tag{10}$$

Comoving Distance can be approximated with,

$$CD \cong \exp(z_{new}) * LTD \cong z_{new}\exp\left(z_{new}\right)\left(\frac{c}{H_0}\right) \tag{11}$$

Luminosity Distance can be approximated with,

$$LD \cong \frac{CD}{1-z_{new}} \cong \left[\frac{z_{new}\exp\left(z_{new}\right)}{1-z_{new}}\right]\left(\frac{c}{H_0}\right) \tag{12}$$

For data comparison, readers are encouraged to refer Table 2 of our recent publication (Seshavatharam and Lakshminarayana 2023b).

Based on relation (9), Hubble's law for galactic comoving distances can be expressed as,

$$CD_{gal} \cong z_{new}\exp(z_{new})\left(\frac{c}{H_0}\right) \tag{13}$$

For, $z_{new} = 1,$ $CD_{gal} \cong \exp(1)\left(\frac{c}{H_0}\right) \cong 2.7183\left(\frac{c}{H_0}\right) \cong 39.74$ Gly.

7. Discussion on Present Cosmic Halt

Based on ref. (Andreia 2022), it seems very clear to say that, dark energy is taking a new turn and making the universe to decelerate and within 100 million years, universe is coming to a halt. Here it is very important to note that, so far no single observation or no single experiment has shown a signal for the existence of dark energy. Cosmologists are somehow making attempts to understand the expanding nature of current universe in terms of dark energy for acceleration as well as deceleration. If it is really true that, in near future, universe is going to a halt, it can be understood in terms of unification of atomic and cosmic physical constants (Seshavatharam and Lakshminarayana 2013a, 2013b, 2013c; Seshavatharam et al. 2013; Seshavatharam and Lakshminarayana 2016;) with the following strange relations.

$$\frac{Gm_pm_e}{R_pH_0} \equiv \frac{\hbar}{2} \quad \text{Or} \quad \frac{Gm_pm_e}{R_p} \equiv \frac{1}{2}\hbar H_0 \dots\dots\dots\dots\dots(14A)$$

$$\frac{2Gm_pm_e}{\hbar R_p} \equiv H_0 \cong \left(67.88 \text{ to } 70.69\right) \text{km/sec/Mpc}\dots\dots(14B) \tag{14}$$

where $R_p \cong \left(0.84184 \text{ to } 0.87680\right)$ fm

Here in this expression (14A), LHS is a representation of gravitational potential energy of proton and electron separated by a distance equal to the root mean square radius of proton. RHS seems to be a representation of ground state quantum of energy associated with current Hubble parameter and characteristic quantum constant. Following relation (14), quantum of orbiting electron's areal velocity can be expressed as,

$$\frac{dA}{dt} \cong \frac{1}{2}vr \cong \frac{Gm_p}{R_pH_0} \tag{15}$$

Based on our 4G model of final unification (Seshavatharam and Lakshminarayana 2020, 2022), we noticed that (Zyla et al 2021),

$$R_p \cong \sqrt{\frac{\alpha_s}{\alpha}} \left(\frac{\hbar}{m_p c} \right) \cong \sqrt{\frac{0.115 \text{ to } 0.12}{0.0073}} \left(\frac{\hbar}{m_p c} \right) \cong \left(4 \mp 0.05 \right) \left(\frac{\hbar}{m_p c} \right) \cong 4 \left(\frac{\hbar}{m_p c} \right) \qquad (16)$$

where, α_s is the strong coupling constant and

α is the fine structure ratio.

Hence, it is also possible to write two more relations in the following way.

$$\sqrt{\frac{G m_p^2 m_e c}{2 H_0}} \cong \hbar ....(17A)$$

$$\frac{G m_p^2 m_e c}{2 \hbar^2} \cong H_0 \cong 70.75 \text{ km/sec/Mpc}......(17B) \qquad (17)$$

Another very interesting relation is associated with fine structure ratio. For $H_0 \cong 76.266$ km/sec/Mpc,

$$\frac{1}{\alpha} \cong \ln \sqrt{\frac{(E_T)_0 / 2}{(E_{em})_0}} \cong \ln \sqrt{\frac{4 \pi \varepsilon_0 c^6}{23040 \pi G H_0^2 e^2}} \cong 137.036 \qquad (18)$$

where,

$$(E_T)_0 \cong a T_0^4 \left(\frac{4\pi}{3} \left(\frac{c}{H_0} \right)^3 \right)$$

$\cong$ Current thermal energy within the current Hubble volume.

$$(E_T)_0 / 2 \cong \text{Half of } a T_0^4 \left(\frac{4\pi}{3} \left(\frac{c}{H_0} \right)^3 \right)$$

$\cong$ Current thermal energy within the current hemi spherical or dipole Hubble volume.

$$(E_{em})_0 \cong \frac{e^2}{4 \pi \varepsilon_0 (c/H_0)} \cong \text{Electromagnetic potential assocaited with current Hubble radius.}$$

Readers are encouraged to refer the URL: "https://en.wikipedia.org/wiki/Hubble%27s_law" for various values of the current Hubble parameter estimated with various methods. From the data it is clear that, $H_0 \cong (67.6 \text{ to } 76.2)$ km/sec/Mpc. Relation (18) seems to give a nice picture of the current cosmic closed or positive curvature and it needs a very special study at fundamental level.

8. Relation between True Cosmic Red Shift, Expansion Speed and Age

To fit and understand the comic age, radius, expansion speed and angular velocity, we proceed in the following way. These relations starting from (19) to (22) can be called as approximate mapping relations and can be modified as per the observations and for a better understanding.

Concept-1: Throughout the cosmic expansion, numerically, cosmic expansion rate and angular velocity are equal in magnitude.

$$\omega_t \cong H_t \qquad (19)$$

Concept-2: For a continuous light speed rotation, throughout the cosmic expansion, cosmic radius can be expressed as.

$$R_t \cong \frac{c}{H_t} \cong \frac{c}{\omega_t} \qquad (20)$$

Concept-3: Throughout the cosmic expansion, cosmic red shift can be expressed as.

$$\left(z_{new}\right)_t \cong \left(1 - \frac{\left(V_{\exp}\right)_t}{c}\right) \cong \ln\left(\frac{H_{pl}}{H_t}\right) \Big/ \ln\left(\frac{H_{pl}}{H_0}\right)$$

(21)

where, $H_t \cong \left(9.275 \times 10^{42} \quad \text{to} \quad 2.167 \times 10^{-18}\right) \sec^{-1}$

See the following Figure 1 for a rough relation between true cosmic red shift and Hubble parameter.
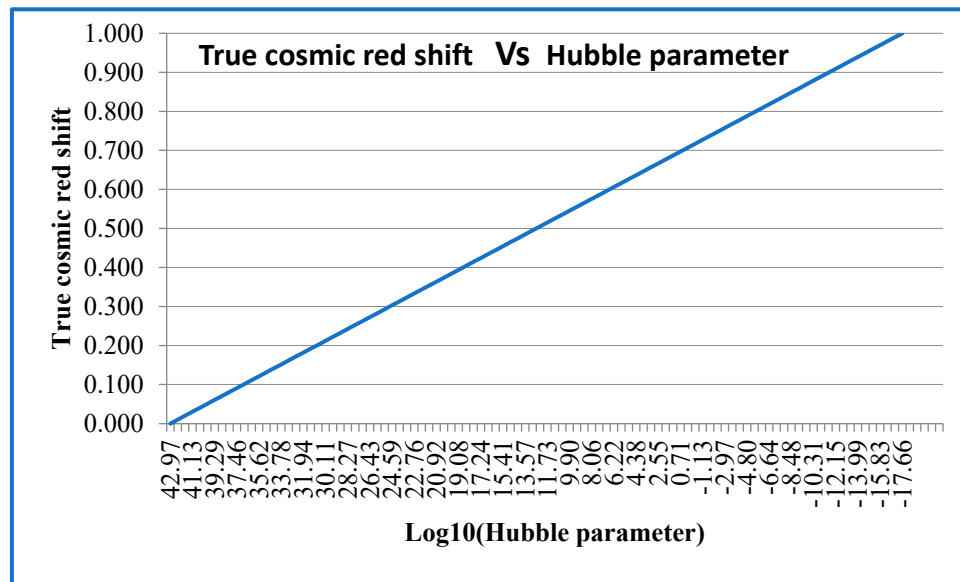
Figure 1. Approximate relation between true cosmic red shift and Hubble parameter.

Concept-4: Throughout the cosmic expansion, cosmic age can be expressed as.

$$\left(\frac{c + \left(V_{\exp}\right)_t}{2}\right) * t \cong \frac{c}{H_t}$$

$$\rightarrow t \cong \left(\frac{2}{2 - \left(z_{new}\right)_t}\right)\left(\frac{1}{H_t}\right)$$

(22)

Clearly speaking, starting from the Planck scale, Average expansion speed×Cosmic age = Cosmic radius.

For, the current case, $t_0 \cong \frac{2}{H_0}$ and for the Planck scale, $t_{pl} \cong \frac{1}{H_{pl}}$. Studying relations (8) and (22) in a systematic approach, actual cosmic time scale can be can be developed by means of considering or ignoring the cosmic scale factor.

9. Conclusion

We would like to emphasize the point that current definition of cosmic red shift is absolutely wrong and considering our given energy based true definition of cosmic red shift, there is a scope for understanding the true nature of cosmic expansion. In this context, current universe can be supposed to be rotating at light speed with no further expansion by virtue of an unknown quantum mechanical halting mechanism. Based on relations (14) to (18), new research seems to be essential in interpreting and understanding the actual physics associated with current cosmic expansion rate and electron moment in atom.

Acknowledgements: In preparing this paper, author Seshavatharam is greatly inspired by Dr. Mohsen Lutephy and Dr. Dimitar Todorov Valev for their thought provoking concepts on quantum cosmology having no further

expansion.

References

Andreia Cosmin, Anna Ijjasb and Paul J. 2022. Steinhardt. Rapidly descending dark energy and the end of cosmic expansion. Proceedings of the National Academy of Sciences, 119(15) e2200539119.

Bahcall, N. Hubble's Law and the expanding universe. 2015. Proceedings of the National Academy of Sciences of the United States of America. 112: 3173-5.

Birch P. 1982. Is the Universe rotating? Nature. 298: 451-454.

Calcagni Gianluca et al. Lectures on classical and quantum cosmology. PoS (CORFU2021) 317, 2022.

Crawford David F. Observational evidence favors a static universe. arXiv:1009.0953v5 [physics.gen-ph] for this version) 2014.

Di Valentino, E., Melchiorri, A. & Silk, J. Planck. 2020. Planck evidence for a closed Universe and a possible crisis for cosmology. Nat. Astron. 4:196–203.

Ellis George, Julien Larena. 2020. The case for a closed universe, *Astronomy & Geophysics.* 61(1): 1.38–1.40.

Eric J. Lerner, Renato Falomo, Riccardo Scarpa. 2014. UV surface brightness of galaxies from the local Universe to z ~ 5. Int. J. Mod. Phys. D . 23(6): 1450058.

Gamow G. 1946. Rotating Universe? Nature. 158: 549.

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

Godlowski, W. Global and Local Effects of Rotation: Observational Aspects. 2011. International Journal of Modern Physics D. 20:1643.

Handley Will. 2021. Curvature tension: evidence for a closed universe. Phys. Rev. D 103: 041301.

Hawking S. 1969. On the rotation of the Universe. Mon. Not. R. Astron. Soc., 142:129-141.

Korotky Vladimir A, Eduard Masár Yuri N Obukhov. 2020. In the Quest for Cosmic Rotation. Universe, 6:14.

Lerner, Eric. 2018. Observations contradict galaxy size and surface brightness predictions that are based on the expanding universe hypothesis. Mon. Not. R. Astron. Soc. 477(3):3185–3196.

Lovyagin Nikita, Alexander Raikov, Vladimir Yershov and Yuri Lovyagin. 2022. Cosmological model tests with JWST. Galaxies, 10(6):108.

Magueijo Jo˜ao et al. 2103. Cosmology with a spin. Phys. Rev. D 87: 063504.

Melia Fulvio (Arizona U. and Arizona U., Astron. Dept. - Steward Observ.). 2012. Fitting the Union2.1 SN Sample with the R_h=ct Universe. Astron.J. 144:110.

Michael Buser,, Endre Kajari, and Wolfgang P. Schleich. 2013. Visualization of the Gödel universe. New Journal of Physics 15.1: 013063.

Nielsen J.T, Guffanti A, Sarkar S. 2016. Marginal Evidence for Cosmic Acceleration from Type Ia Supernovae. Nature, Scientific Reports. 6(Oct): 35596.

Pavan Kumar Aluri et al. Is the Observable Universe Consistent with the Cosmological Principle? arXiv:2207.05765 [astro-ph.CO] 2022. To be appeared in Class. Quant. Grav - "Focus issue on the Hubble constant tension".

Perlmutter S et al. Measurements of Ω and Λ from 42 High-Redshift Supernovae. 1999. The Astrophysical Journal. 517(2): 565.

Seshavatharam U.V.S, Lakshminarayana S. 2013a. Applications of Hubble Volume in Atomic Physics, Nuclear Physics, Particle Physics, Quantum Physics and Cosmic Physics. J. Nucl. Phy. Mat. Sci. Rad. A. 1(1): 45-60.

Seshavatharam U.V.S and Lakshminarayana S. 2013b. Is Planck's constant a cosmological variable? International Journal of Astronomy, 2(1): 11-15.

Seshavatharam U.V.S, Lakshminarayana S. 2013c. Black hole Cosmos and the Micro Cosmos. International Journal of Advanced Astronomy. 1(2): 37-59.

Seshavatharam U.V.S, Lakshminarayana, S, Sai B.V.S.T. 2013. Is red shift an index of galactic 'atomic light emission' mechanism? International Journal of Physics, 1(3), 49-64.

Seshavatharam U.V.S and Lakshminarayana S. 2016. Cosmologically Strengthening Hydrogen Atom in Black Hole Universe. J. Nucl. Phy. Mat. Sci. Rad. A. 3(2):265–278.

Seshavatharam U.V.S, Lakshminarayana S. 2012. Light speed expanding white hole universe having a red shift of [z/(1+z)]. World Scientific News, 162: 87-101.

Seshavatharam U.V.S and Lakshminarayana S. 2012. Is reduced Planck's constant - an outcome of electroweak

gravity? Mapana Journal of Sciences. 19(1):1-13

Seshavatharam U.V.S, Lakshminarayana S. 2022. Concepts and results of a Practical Model of Quantum Cosmology: Light Speed Expanding Black Hole Cosmology. Mapana Journal of Sciences. 21(2):13-22.

Seshavatharam U.V.S. 2010. Physics of Rotating and Expanding Black Hole Universe. Progress in Physics. 2 (April): 7-14.

Seshavatharam, U.V.S, Lakshminarayana S. 4G model of fitting RMS radius of proton. Nucleus 2022: Fundamental problems and applications. Moscow July 11–16, 2022. Book of abstracts, 88-89,2022. https://events.sinp.msu.ru/event/8/contributions/613/attachments/594/1212/ID_25_24_uvssa_sln_14 July2022.pdf

Seshavatharam, U.V.S, Lakshminarayana S. 2023a. A Rotating Model of a Light Speed Expanding Hubble-Hawking Universe. Phys. Sci. Forum. 7:43.

Seshavatharam U.V.S, Lakshminarayana S.   2023b. An open review on light speed expanding Hubble-Hawking universe. Journal of physics and astronomy. 11(2): 322.

Seshavatharam, U.V.S,   Lakshminarayana, S. 2019. Role of Four Gravitational Constants in Nuclear Structure. Mapana-Journal of Sciences.18:,1-21.

Shamir L. 2022. Asymmetry in Galaxy Spin Directions-Analysis of Data from DES and Comparison to Four Other Sky Surveys. Universe, 8:397.

Sivaram C., Kenath Arun. 2012. Primordial Rotation of the Universe, Hydrodynamics, Vortices and Angular Momenta of Celestial Objects. The Open Astronomy Journal. 5:7-11.

Wang, P. et al. 2021. Possible observational evidence for cosmic filament spin. Nat. Astron. 5:839–845.

Weiqiang Yang et al. 2023. Revealing the effects of curvature on the cosmological models. Phys. Rev. D 107: 063509.

Whittaker E.T. 1945. Spin in the universe, Yearbook of Roy. Soc. Edinburgh, 5.

Zyla P.A. et al. 20121. (Particle Data Group), Prog. Theor. Exp. Phys. 2020, 083C01 (2021) and 2021 update.