Article

Superluminal Expansion & Rotation in Redshift Independent Accelerating Quantum Cosmology

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Abstract

In this article, we consider superluminal expansion & rotation in redshift independent accelerating quantum cosmology. With our proposed assumptions, it is possible to show that, at H_0 =70 km/sec/Mpc, current cosmic temperature is 2.721 K, current cosmic radius is 90 billion light years and current cosmic mass is 1.14654x10^{54} kg. Current cosmic mass density is 0.0482 times the current critical density and current cosmic rotational kinetic energy density is 0.6667 times the current critical energy density. Based on the estimated mass density and rotational kinetic energy density, we show that the current cosmic dark matter density is 0.2851 times the current critical density. These estimated density coincidences cast doubts on the existence of dark energy.

Keywords: Big Bang, Planck scale, Hubble parameter, quantum cosmology, Mach's principle, observational cosmology, superluminal expansion, superluminal rotation, Dark Energy, scale factor.

1. Introduction

Photons and black holes can be considered as the best candidates of quantum gravitational objects. It is true that, without the existence of universe, there is no independent existence to any photon or any black hole. Now the fundamental question to be answered is: Is our universe a quantum gravitational object or something else? Physicists expressed several opinions with many possible solutions [1-5]. We have also expressed different views on this subject [6-8].

Some cosmologists believe that, Planck scale quantum gravitational interactions during cosmic evolution might have an observable effect on the current observable cosmological phenomena. With respect to quantum gravity and early universe at Planck scale, current universe can be considered as a low energy scale laboratory. If one is willing to consider the current observable universe as a low energy scale laboratory, currently believed cosmic microwave back ground tem-

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perature can be considered as 'low energy quantum gravitational effect'. At any time in the past, i.e., as energy scale was assumed to be increasing, past high cosmic back ground temperature can be considered as 'high energy quantum gravitational effect'. Thinking in this way, starting from the Planck scale, quantum cosmology may be considered as scale independent and the universe can be considered as the best quantum gravitational object.

In this context, we have chosen the following two quantitative relations:

1) We define the Planck scale Hubble parameter, $H_{pl} \cong \sqrt{c^5/G\hbar} \cong 1.8549215 \times 10^{43}$ sec^{-1} and apply it to cosmological data fitting in the form of $\left[1+\ln\left(\frac{H_{pl}}{H_t}\right)\right]^n$ where H_t is the running Hubble parameter and n is a suitable power index.

2) To have a closed and evolving massive universe, we choose 'Mach's principle'. In this context, one of our assumption, $\left(GM_0/R_0c^2\right) \cong 1$ can be given some consideration at fundamantal level. One can find interesting technical discussion on this assumption by D.W.Sciama, R.H. Dicke, C. Brans and G. J. Whitrow [9-16].

Based on these quantitative relations, we re-view the assumed effects of 'inflation' [17,18,19] 'acceleration' and 'dark energy' [20-23] with increasing super luminal expansion speeds and increasing super luminal rotational speeds.

2. Workable assumptions connected with Planck scale

With the following simple and logical assumptions, most of the currently believed cosmological observations can be reviewed and refined at fundamental level; (A major controversy arises with respect to the currently believed 'dark energy' and proposed cosmic 'rotational kinetic energy' and needs further investigation).

1) With reference to big bang and Planck scale, Hubble parameter associated with Planck scale can be defined as $H_{pl} \cong \sqrt{c^5/G\hbar} \cong 1.8549215 \times 10^{43}$ sec^{-1}

2) Speed of light can be considered as the initial cosmic expansion speed.

3) At any stage of cosmic evolution, from and about the point of big bang,

a) H_t^{-1} can be considered as the cosmic age.

b) $\frac{GM_t}{R_t c^2} \cong 1$ where M_t is the cosmic mass and R_t is the cosmic radius or distance travelled.

c) Magnitude of cosmic angular velocity is equal to H_t.

d) $V_t \cong \sqrt{1+\ln\left(\frac{H_{pl}}{H_t}\right)} \times c$ can be considered as the cosmic expansion speed.

e) Ratio of critical energy density and thermal energy density is equal to $\left[1+\ln\left(\frac{H_{pl}}{H_t}\right)\right]^2$.

Mainstream cosmologists believe that the superluminal expansion period of the universe (called "cosmic inflation") ended by 10^{-32} seconds (a tiny fraction of a second) after the Big Bang [17-19]. Since that time, they believe, expansion initially decelerated (from gravity) and then, after about 6 billion years, began very slowly to accelerate (from dark energy). Many cosmologists proposed different starting mechanisms for initiating and fine tuning the believed 'inflation'. In this context, we would like to stress the fact that, starting from 'speed of light', our model assumes a continuous increase in expansion speed attains a current radius of 90 billion light years which is just twice of the modern estimate! Clearly speaking, considering assumptions 2,3b,3c and 3d, currently believed cosmic inflation, acceleration, dark energy, cosmic homogeneity and cosmic horizon problems can be reviewed and re-addressed in a very simplified approach. In addition, problems connected with 'fine tuning' of beginning of 'inflation' can be ignored.

3. Various applications of $\left[1+\ln\left(H_{pl}/H_t\right)\right]$ in cosmology

Application 1: Relation between cosmic thermal energy density and critical energy density

Let us assume that, during cosmic evolution, at any time, thermal energy density is proportional to the critical energy density.

$$aT_t^4 \propto \frac{3H_t^2c^2}{8\pi G} \tag{1}$$

With reference to the Planck scale and by considering the proportionality factor as $\left[1+\ln\left(\frac{H_{pl}}{H_t}\right)\right]^{-2}$, it is possible to define that,

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

where V_t is the cosmic expansion speed and c is the initial cosmic expansion speed.

$$\sqrt{\frac{3H_t^2c^2}{8\pi GaT_t^4}} \cong \left[1+\ln\left(\frac{H_{pl}}{H_t}\right)\right] \cong \left(\frac{V_t}{c}\right)^2 \tag{3}$$

For the current case,

$$aT_0^4 \cong \left[1+\ln\left(\frac{H_{pl}}{H_0}\right)\right]^{-2}\left(\frac{3H_0^2c^2}{8\pi G}\right) \cong \left(\frac{c}{V_0}\right)^4\left(\frac{3H_0^2c^2}{8\pi G}\right) \tag{4}$$

where V_0 is the current cosmic expansion speed.

$$\sqrt{\frac{3H_0^2c^2}{8\pi GaT_0^4}} \cong \left[1+\ln\left(\frac{H_{pl}}{H_0}\right)\right] \cong \left(\frac{V_0}{c}\right)^2 \tag{5}$$

With trial-error, if it is assumed that, $H_0 \cong 70.0$ km/sec/Mpc,

obtained $T_0 \cong 2.7208$ K and $\sqrt{1+\ln\left(\frac{H_{pl}}{H_0}\right)} \cong \left(\frac{V_0}{c}\right) \cong 11.8851$

As per the 2015 Planck data [21], the current value of CMBR temperature is:

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

This fitted value of $H_0 \cong 70.0$ km/sec/Mpc can be compared with the very recent reference [22]. Its full title is : A 2.4% Determination of the Local Value of the Hubble Constant by Adam G. Riess et al.[Astrophys.J. 826 no.1.(2016)]. As per reference [22], best value of $H_0 \cong (73.24 \pm 1.74)$ km/sec/Mpc

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

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

Clearly speaking, our fit of H_0 seems to lie in between the values recommended in reference [21] and reference [22] respectively. See section 4 for further discussion on relation (2).

Note: As the universe is always assumed to be expanding at 'increasing super luminal speeds', there is no scope for 'temperature isotropy' and cosmic temperature will decrease continuously. Since the current observable universe is very large and as the observer is not in a position to reach all parts of the current universe, one may be forced to arrive at a misconception of 'CMBR isotropy'.

Application 2: Estimating the current cosmic acceleration

From the beginning of Planck scalewhich is assumed to be associated with big bang, cosmic acceleration can be estimated as follows:

$$a_t \cong \frac{V_t - V_i}{t} \cong \left(V_t - c\right) H_t \tag{6}$$

where V_t and a_t are the cosmic expansion speed and acceleration respectively at time t

and $V_i = c$ is the initial cosmic expansion speed.

For the current case, if $V_0 \cong 11.8851 \times c$ and $t_0 \cong H_0^{-1}$,

$$a_0 \cong \frac{V_0 - c}{t_0} \cong \left(V_0 - c\right) H_0 \cong 7.403 \times 10^{-9} \text{ m.sec}^{-2} \tag{7}$$

Application 3: Estimating the current radius or distance travelled by the universe

According to modern cosmological observations, the commoving distance from Earth to the edge of the observable universe is about 14.26 Gpc (46.5 Gly = 4.40×10^{26} meters) in any direction. The observable universe is thus a sphere with a diameter of about28.5 Gpc = 93 Gly = 8.8×10^{26} m). Readers are encouraged to see the valuable scientific information available in Wikipedia web site on 'Observational cosmology'.

According to Mihran Vardanyan et al [23], "Bayesian model averaging is a procedure to obtain parameter constraints that account for the uncertainty about the correct cosmological model. We use recent cosmological observations and Bayesian model averaging to derive tight limits on the curvature parameter, as well as robust lower bounds on the curvature radius of the Universe and its minimum size, while allowing for the possibility of an evolving dark energy component. Because flat models are favored by Bayesian model selection, we find that model-averaged constraints on the curvature and size of the Universe can be considerably stronger than non model-averaged ones. For the most conservative prior choice (based on inflationary considerations), our procedure improves on non model- averaged constraints on the curvature by a factor of 2. The curvature scale of the Universe is conservatively constrained to be R_c> 42 Gpc (99%), corresponding to a lower limit to the number of Hubble spheres in the Universe NU > 251 (99%)".

With reference to our proposed assumptions, current cosmic radius (including observable and non-observable) can be estimated in the following way. From the beginning of Planck scale which is assumed to be associated with big bang, cosmic distancetravelled can be estimated as follows:

$$S_t \cong R_t \cong \frac{V_t^2 - V_i^2}{2a_t} \cong \frac{V_t^2 - c^2}{2(V_t - c)H_t} \cong \frac{V_t + c}{2H_t} \cong \left(\frac{c}{2H_t}\right)\left[1 + \sqrt{1 + \ln\left(\frac{H_{pl}}{H_t}\right)}\right] \tag{8}$$

For the current case,

$$S_0 \cong R_0 \cong \frac{V_0^2 - c^2}{2a_0} \cong \frac{V_0^2 - c^2}{2(V_0 - c)H_0} \cong \frac{V_0 + c}{2H_0} \cong \left(\frac{c}{2H_0}\right)\left[1 + \sqrt{1 + \ln\left(\frac{H_{pl}}{H_0}\right)}\right] \cong 6.4425\left(\frac{c}{H_0}\right) \cong 8.514 \times 10^{26}\ \text{m} \tag{9}$$

From our estimate, current distance (observable and non-observable) about the point of big bang is 90 Gly= 27.6 Gpc. See the following table-1. Clearly speaking, current universe seems to constitute 267 Hubble spheres [23].This is really a very interesting coincidence and needs further study at fundamental level.

Table 1: Fitting the current cosmic distance

Estimating method	**Cosmic distance**	**Reference point**
Modern estimate (only observable)	46.5Gly 14.26Gpc	About earth
Our estimate (Observable + non-observable)	90.0Gly 27.6Gpc	About the point of big bang
Note: Gly = Giga or billion light years Gpc = Giga or billion parsec		

From table1, our estimate seems to be approximately 1.935 times higher than modern estimation. With further research and analysis and by understanding the galactic red shifts, discrepancy can be reviewed and resolved. From our estimate, diameter of current (observable and non-observable) cosmic sphere about the point of big bang is 180 Gly=55.2 Gpc. See the following table-2.

Table 2: Fitting the current cosmic diameter

Estimating method	**Cosmic diameter**	**Reference point**
Modern estimate (only observable)	93 Gly 28.5 Gpc	About earth
Our estimate	180Gly	About the point

(Observable + non-observable)	55.2Gpc	of big bang

Application 4: Estimating the galactic receding speeds and galactic distances in th e current accelerating universe

Based on relations (8) and (9), within the current radius of 90 Gly=27.6Gpc, from and about the point of big bang, galactic receding speeds can be approximated with the following relation.

$$v_g \cong \left(\frac{d_g}{S_0}\right)V_0 \cong \left(\frac{d_g}{S_0}\right)11.8851c \cong \left\{\frac{2\sqrt{1+\ln\left(H_{pl}/H_0\right)}}{\left[1+\sqrt{1+\ln\left(H_{pl}/H_0\right)}\right]}\right\}\left(d_g H_0\right) \tag{10}$$

where d_g is the (assumed current) galactic distance from the point of big bang and v_g is the (current) galactic receding speed.

Based on this relation (10), within the current boundary of 90 Gly=27.6 Gpc, galactic distances corresponding to assumed galactic receding speeds can be expressed in the following way.

$$d_g \cong \left(\frac{v_g}{V_0}\right)S_0 \cong \left(\frac{v_g}{11.8851c}\right)*8.514\times10^{26}\text{ m} \tag{11}$$

See the following table-3.

Table 3: To understand galactic receding speeds and distances from and about the point of big bang

Galactic receding speed	Estimated distance from and about the point of big bang		
	meters	Gly	Gpc
0.1*c*	7.164E+24	0.76	0.23
0.2 *c*	1.433E+25	1.51	0.46
0.3 *c*	2.149E+25	2.27	0.70
0.4 *c*	2.865E+25	3.03	0.93
0.5 *c*	3.582E+25	3.79	1.16
0.6 *c*	4.298E+25	4.54	1.39
0.7 *c*	5.015E+25	5.30	1.63
0.8 *c*	5.731E+25	6.06	1.86
0.9 *c*	6.447E+25	6.81	2.09
c	7.164E+25	7.57	2.32
1.1 *c*	7.880E+25	8.33	2.55
1.2 *c*	8.596E+25	9.09	2.79

1.3 *c*	9.313E+25	9.84	3.02
1.4 *c*	1.003E+26	10.60	3.25
1.5 *c*	1.075E+26	11.36	3.48
1.6 *c*	1.146E+26	12.12	3.72
1.7 *c*	1.218E+26	12.87	3.95
1.8 *c*	1.289E+26	13.63	4.18
1.9 *c*	1.361E+26	14.39	4.41
2 *c*	1.433E+26	15.14	4.65

By co-relating the estimated galactic distances and 'actual receding speeds' with observed galactic red shifts, further research can be carried out.

Application 5: Estimating the current mass and mass density of the universe

It may be noted that, many scientists are thinking on 'understanding the mass of universe' in terms of 'Mach's principle' i.e "relation between inertia and gravity"[9-16]. We have chosen assumption 3b to fit the current visible mass density and tried for estimating the current cosmic rotational kinetic energy. With further research, our proposed set of assumptions can be recommended for a serious investigation.

From applications 2 and 3, current visual and non-visual cosmic radius is around 90 Gly = 27.6 Gpc. With reference to assumption 3b, current mass of our (visible and invisibl e parts) universe can be estimated with the following relation.

$$M_0 \cong \frac{c^2 R_0}{G} \cong 1.14654\times 10^{54}\ \text{kg} \tag{12}$$

where, $R_0 \cong \frac{V_0 + c}{2H_0} \cong \left(\frac{c}{2H_0}\right)\left[1+\sqrt{1+\ln\left(\frac{H_{pl}}{H_0}\right)}\right]$. It may be noted that, with this mass, current mass density can be expressed with the following relation.

$$\begin{aligned}(\rho_{mass})_0 &\cong \frac{M_0}{(4\pi/3)R_0^3} \cong \frac{3c^2}{4\pi G R_0^2} \\ &\cong \left[1+\sqrt{1+\ln\left(\frac{H_{pl}}{H_0}\right)}\right]^{-2}\frac{3H_0^2}{\pi G} \cong 4.43505\times 10^{-28}\ \text{kg.m}^{-3}\end{aligned} \tag{13}$$

Mass-energy density can be expressed with the following relation.

$$\left(\rho_{mass}c^2\right)_0 \cong \frac{M_0 c^2}{(4\pi/3)R_0^3} \cong \frac{3c^4}{4\pi G R_0^2}$$
$$\cong \left[1+\sqrt{1+\ln\left(\frac{H_{pl}}{H_0}\right)}\right]^{-2} \frac{3H_0^2 c^2}{\pi G} \cong 3.9865\times 10^{-11} \text{ J.m}^{-3} \tag{14}$$

Now ratio of mass energy density and critical energy density [21] can be expressed with the following relation.

$$\left(\frac{\rho_{mass}c^2}{\rho_{critical}c^2}\right)_0 \cong 8\left[1+\sqrt{1+\ln\left(\frac{H_{pl}}{H_0}\right)}\right]^{-2} \cong 0.048185 \tag{15}$$

Based on this strange and interesting coincidence, proposed method of estimating the current cosmic mass can be given some consideration. Clearly speaking, Mach's principle and its quantitative relation, $GM_0 \cong c^2 R_0$ seems to play a vital role in understanding the large scale structure of the evolving universe.

Application 6: Estimating the current cosmic rotational kinetic energy

Based on the proposed assumptions, current cosmic rotational energy can be estimated in the following way.

From classical mechanics, rotational kinetic energy of any spherical body is given by,

$$K_{rot} \cong \frac{1}{2} I \omega^2 \tag{16}$$

where, I is the moment of inertia of the rotating body and ω is the angular velocity. Based on this relation, current cosmic rotational kinetic energy can be expressed with the following relation.

$$\left(K_{rot}\right)_0 \cong \frac{1}{2} I_0 \omega_0^2 \cong \frac{1}{2} I_0 H_0^2 \tag{17}$$

As current 'mass density' is very small in magnitude, current observable universe can be considered as a thin spherical shell and hence its corresponding current moment of inertia can be expressed with the following relation.

$$I_0 \cong \frac{2}{3} M_0 R_0^2 \tag{18}$$

From the above two relations, current cosmic rotational kinetic energy can be expressed with the following simple relation.

$$\left(K_{rot}\right)_0 \cong \frac{1}{3}M_0 R_0^2 \omega_0^2 \cong \frac{1}{3}M_0 R_0^2 H_0^2 \cong 1.4257\times 10^{72} \text{ J} \tag{19}$$

Surprisingly it is noticed that, ratio of proposed current cosmic rotational energy density and currently believed dark energy density is very close to unity. It can be expressed in the following way.

$$\left[\frac{\left(K_{rot}\right)_0}{\left(4\pi/3\right)R_0^3}\right]\Bigg/\left[0.68\times\left(\frac{3H_0^2c^2}{8\pi G}\right)\right] \cong 0.98 \tag{20}$$

where $0.68\times\left(\frac{3H_0^2c^2}{8\pi G}\right)$ is the currently believed dark energy density [21].

With reference to critical energy density, current rotational kinetic energy density can be expressed with the following relation.

$$\frac{\left(K_{rot}\right)_0}{\left(4\pi/3\right)R_0^3} \cong \frac{M_0\omega_0^2}{4\pi R_0} \cong \frac{M_0H_0^2}{4\pi R_0} \tag{21}$$

With respect to cosmic mass,

$$\frac{\left(K_{rot}\right)_0}{\left(4\pi/3\right)R_0^3} \cong \frac{\omega_0^2}{4\pi R_0}\left(\frac{c^2R_0}{G}\right) \cong \frac{H_0^2}{4\pi R_0}\left(\frac{c^2R_0}{G}\right) \cong \frac{H_0^2c^2}{4\pi G} \tag{22}$$

Point to be noted here is that, ratio of current cosmic rotational kinetic energy density and critical energy density is equal to $\frac{2}{3} \cong 0.666667$. It can be expressed in the following way.

$$\left[\frac{\left(K_{rot}\right)_0}{\left(4\pi/3\right)R_0^3}\right]\Bigg/\left[\frac{3H_0^2c^2}{8\pi G}\right] \cong \left[\frac{H_0^2c^2}{4\pi G}\right]\Bigg/\left[\frac{3H_0^2c^2}{8\pi G}\right] \cong \frac{2}{3} \tag{23}$$

If one is willing to consider this coincidence as a 'heuristic coincidence', it is possible to say that, currently believed 'dark energy' is nothing but the current cosmic rotational kinetic energy. It is for further study.

Application 7: Estimating the current 'dark matter' energy density

Based on the currently believed 'flat' model concept and current observations, 'dark matter' energy density can be fitted in the following way.

$$\left(\rho_{d.matter}c^2\right)_0 \cong 1-\left[\frac{\left(K_{rot}\right)_0}{\left(4\pi/3\right)R_0^3}+\frac{M_0c^2}{\left(4\pi/3\right)R_0^3}\right] \cong 1-\left[\frac{2}{3}+0.048185\right] \cong 0.28515 \tag{24}$$

Quantitatively this can be compared with the currently believed 'dark matter' energy density [21] and needs further study.

Application 8: Fitting & understanding the cosmic scale factor

From above relations, we prepared the following table-4 pertaining to various cosmological physical parameters.

Table 4: Estimated cosmological physical parameters

Assumed Hubble parameter (1/sec)	Estimated Cosmic age (sec)	Estimated factor $\sqrt{1+\ln\left(\frac{H_{pl}}{H_t}\right)}$	Estimated expansion speed (m/sec)	Estimated cosmic acceleration (m/sec^2)	Estimated cosmic radius (m)	Estimated cosmic mass (kg)	Estimated cosmic temperature (K)
2.26853E+42	4.41E-43	1.76105	5.28E+08	5.18E+50	1.82E-34	2.46E-07	1.84E+31
2.26853E+41	4.41E-42	2.32462	6.97E+08	9.01E+49	2.20E-33	2.96E-06	4.40E+30
2.26853E+40	4.41E-41	2.77605	8.32E+08	1.21E+49	2.50E-32	3.36E-05	1.16E+30
2.26853E+39	4.41E-40	3.16371	9.48E+08	1.47E+48	2.75E-31	0.000371	3.23E+29
2.26853E+38	4.41E-39	3.50879	1.05E+09	1.71E+47	2.98E-30	0.004012	9.22E+28
2.26853E+37	4.41E-38	3.82286	1.15E+09	1.92E+46	3.19E-29	0.042916	2.67E+28
2.26853E+36	4.41E-37	4.113	1.23E+09	2.12E+45	3.38E-28	0.454975	7.86E+27
2.26853E+35	4.41E-36	4.38399	1.31E+09	2.30E+44	3.56E-27	4.79089	2.33E+27
2.26853E+34	4.41E-35	4.63918	1.39E+09	2.47E+43	3.73E-26	50.1796	6.97E+26
2.26853E+33	4.41E-34	4.88104	1.46E+09	2.64E+42	3.89E-25	523.318	2.10E+26
2.26853E+32	4.41E-33	5.11147	1.53E+09	2.80E+41	4.04E-24	5438.23	6.33E+25
2.26853E+31	4.41E-32	5.33195	1.60E+09	2.95E+40	4.18E-23	56344.2	1.92E+25
2.26853E+30	4.41E-31	5.54367	1.66E+09	3.09E+39	4.32E-22	582282	5.83E+24
2.26853E+29	4.41E-30	5.7476	1.72E+09	3.23E+38	4.46E-21	6.00E+06	1.78E+24
2.26853E+28	4.41E-29	5.94453	1.78E+09	3.36E+37	4.59E-20	6.18E+07	5.44E+23
2.26853E+27	4.41E-28	6.13515	1.84E+09	3.49E+36	4.71E-19	6.35E+08	1.67E+23
2.26853E+26	4.41E-27	6.32002	1.89E+09	3.62E+35	4.84E-18	6.51E+09	5.12E+22
2.26853E+25	4.41E-26	6.49963	1.95E+09	3.74E+34	4.96E-17	6.67E+10	1.57E+22
2.26853E+24	4.41E-25	6.67442	2.00E+09	3.86E+33	5.07E-16	6.83E+11	4.84E+21
2.26853E+23	4.41E-24	6.84474	2.05E+09	3.97E+32	5.18E-15	6.98E+12	1.49E+21
2.26853E+22	4.41E-23	7.01092	2.10E+09	4.09E+31	5.29E-14	7.13E+13	4.61E+20

2.26853E+21	4.41E-22	7.17325	2.15E+09	4.20E+30	5.40E-13	7.27E+14	1.43E+20
2.26853E+20	4.41E-21	7.332	2.20E+09	4.31E+29	5.51E-12	7.41E+15	4.41E+19
2.26853E+19	4.41E-20	7.48737	2.24E+09	4.41E+28	5.61E-11	7.55E+16	1.37E+19
2.26853E+18	4.41E-19	7.63959	2.29E+09	4.52E+27	5.71E-10	7.69E+17	4.23E+18
2.26853E+17	4.41E-18	7.78883	2.34E+09	4.62E+26	5.81E-09	7.82E+18	1.31E+18
2.26853E+16	4.41E-17	7.93527	2.38E+09	4.72E+25	5.90E-08	7.95E+19	4.08E+17
2.26853E+15	4.41E-16	8.07905	2.42E+09	4.81E+24	6.00E-07	8.08E+20	1.27E+17
2.26853E+14	4.41E-15	8.22032	2.46E+09	4.91E+23	6.09E-06	8.20E+21	3.93E+16
2.26853E+13	4.41E-14	8.3592	2.51E+09	5.00E+22	6.18E-05	8.33E+22	1.22E+16
2.26853E+12	4.41E-13	8.49581	2.55E+09	5.10E+21	0.000627	8.45E+23	3.81E+15
2.26853E+11	4.41E-12	8.63026	2.59E+09	5.19E+20	0.006363	8.57E+24	1.18E+15
2.26853E+10	4.41E-11	8.76265	2.63E+09	5.28E+19	0.064508	8.69E+25	3.69E+14
2.26853E+09	4.41E-10	8.89306	2.67E+09	5.37E+18	0.653698	8.80E+26	1.15E+14
2.26853E+08	4.41E-09	9.0216	2.70E+09	5.46E+17	6.62191	8.92E+27	3.58E+13
2.26853E+07	4.41E-08	9.14832	2.74E+09	5.54E+16	67.0564	9.03E+28	1.12E+13
2.26853E+06	4.41E-07	9.27331	2.78E+09	5.63E+15	678.824	9.14E+29	3.49E+12
2.26853E+05	4.41E-06	9.39665	2.82E+09	5.71E+14	6869.73	9.25E+30	1.09E+12
2.26853E+04	4.41E-05	9.51838	2.85E+09	5.79E+13	69501.7	9.36E+31	3.40E+11
2.26853E+03	0.000441	9.63857	2.89E+09	5.87E+12	702959	9.47E+32	1.06E+11
2.26853E+02	0.004408	9.75729	2.93E+09	5.96E+11	7.11E+06	9.57E+33	3.31E+10
2.26853E+01	0.044081	9.87458	2.96E+09	6.04E+10	7.19E+07	9.68E+34	1.04E+10
2.26853E+00	0.440814	9.99049	3.00E+09	6.11E+09	7.26E+08	9.78E+35	3.24E+09
2.26853E-01	4.40814	10.1051	3.03E+09	6.19E+08	7.34E+09	9.88E+36	1.01E+09
2.26853E-02	44.0814	10.2184	3.06E+09	6.27E+07	7.41E+10	9.98E+37	3.16E+08
2.26853E-03	440.814	10.3304	3.10E+09	6.35E+06	7.49E+11	1.01E+39	9.90E+07
2.26853E-04	4408.14	10.4413	3.13E+09	642090	7.56E+12	1.02E+40	3.10E+07
2.26853E-05	44081.4	10.551	3.16E+09	64954.9	7.63E+13	1.03E+41	9.69E+06
2.26853E-06	440814	10.6595	3.20E+09	6569.32	7.70E+14	1.04E+42	3.03E+06
2.26853E-07	4.41E+06	10.767	3.23E+09	664.241	7.78E+15	1.05E+43	949733
2.26853E-08	4.41E+07	10.8734	3.26E+09	67.1477	7.85E+16	1.06E+44	297393
2.26853E-09	4.41E+08	10.9788	3.29E+09	6.78643	7.92E+17	1.07E+45	93141.3
2.26853E-10	4.41E+09	11.0831	3.32E+09	0.685741	7.98E+18	1.08E+46	29176.5
2.26853E-11	4.41E+10	11.1865	3.35E+09	0.069277	8.05E+19	1.08E+47	9141.14
2.26853E-12	4.41E+11	11.289	3.38E+09	0.006997	8.12E+20	1.09E+48	2864.45
2.26853E-13	4.41E+12	11.3905	3.41E+09	0.000707	8.19E+21	1.10E+49	897.745
2.26853E-14	4.41E+13	11.4911	3.44E+09	7.13E-05	8.25E+22	1.11E+50	281.406
2.26853E-15	4.41E+14	11.5909	3.47E+09	7.20E-06	8.32E+23	1.12E+51	88.2224
2.26853E-16	4.41E+15	11.6898	3.50E+09	7.27E-07	8.38E+24	1.13E+52	27.6623
2.26853E-17	4.41E+16	11.7879	3.53E+09	7.34E-08	8.45E+25	1.14E+53	8.67482

2.26853E-18	4.41E+17	11.8851	3.56E+09	7.40E-09	8.51E+26	1.15E+54	2.72077

It may be noted that,

1) Based on modern concepts of cosmic scale factor ,
2) With reference to CMBR redshift of ~1100 and temperature 3000 K and
3) With reference to the data presented in table-4,

It is possible to show that,

$$\left((z+1) \cong \frac{T_t}{T_0}\right) \approx \sqrt{\left(\frac{V_0}{V_t}\right)\left(\frac{R_0}{R_t}\right)} \tag{25}$$

Important point to be noted here is that, the expression $\sqrt{\frac{V_0 R_0}{V_t R_t}}$ seems to play an interesting role in understanding the cosmic scale factor and needs further study. For example, for $H_t \cong 2.4569 \times 10^{-12}$ sec^{-1} and $T_t \cong 2981.91$ K,

$$(z+1) \cong \sqrt{\frac{V_0 R_0}{V_t R_t}} \cong \sqrt{\frac{3.5631\times10^9 * 8.514\times10^{26}}{3.3833\times10^9 * 7.4955\times10^{20}}} \cong 1093.73$$
$$\text{and} \quad z \cong \sqrt{\frac{V_0 R_0}{V_t R_t}} - 1 \cong 1093.73 - 1 \cong 1092.73$$

Proceeding further,

$$\frac{T_0^2 V_0 R_0}{T_t^2 V_t R_t} \approx 1 \tag{26}$$

From relation (2),

$$\left.\begin{aligned} T_0^2 &\cong \frac{c^2}{V_0^2}\left(\frac{3c^2 H_0^2}{8\pi G a}\right)^{\frac{1}{2}} \cong \left[1+\ln\left(\frac{H_{pl}}{H_0}\right)\right]^{-1}\left(\frac{3c^2 H_0^2}{8\pi G a}\right)^{\frac{1}{2}} \\ T_t^2 &\cong \frac{c^2}{V_t^2}\left(\frac{3c^2 H_t^2}{8\pi G a}\right)^{\frac{1}{2}} \cong \left[1+\ln\left(\frac{H_{pl}}{H_t}\right)\right]^{-1}\left(\frac{3c^2 H_t^2}{8\pi G a}\right)^{\frac{1}{2}} \end{aligned}\right\} \tag{27}$$
$$\rightarrow \frac{T_0^2}{T_t^2} \cong \frac{V_t^2 H_0}{V_0^2 H_t} \Rightarrow \frac{V_0}{V_t} \approx \frac{H_0 R_0}{H_t R_t}$$

On simplification,

$$(z+1) \approx \sqrt{\frac{V_0 R_0}{V_t R_t}} \cong \frac{T_t}{T_0} \approx \frac{R_0}{R_t}\sqrt{\frac{H_0}{H_t}} \approx \sqrt{\frac{\left[1+\sqrt{1+\ln\left(\frac{H_{pl}}{H_0}\right)}\right]H_t}{\left[1+\sqrt{1+\ln\left(\frac{H_{pl}}{H_t}\right)}\right]H_0}} \quad (28)$$

This relation indicates that, $(z+1)$ is a function of $\left(H_0, H_t \text{ and } H_{pl}\right)$. Based on this relation, for each value of assumed z, corresponding value of H_t can be estimated. Proceeding further, by knowing the current cosmic temperature, current and past Hubble parameters, past cosmic temperature can be estimated with the following relation.

$$T_t \approx T_0 (z+1) \approx T_0 \sqrt{\frac{\left[1+\sqrt{1+\ln\left(\frac{H_{pl}}{H_0}\right)}\right]H_t}{\left[1+\sqrt{1+\ln\left(\frac{H_{pl}}{H_t}\right)}\right]H_0}} \quad (29)$$

Past cosmic temperature data estimated by this relation is very close to the temperature data estimated from relation (2).

Alternatively, if it is assumed that,

$$(z+1) \cong \sqrt{\frac{V_0 R_0}{V_t R_t}} \quad (30)$$

From our assumptions and relations, it is possible to show that,

$$(z+1) \cong \sqrt{\frac{V_0 R_0}{V_t R_t}} \cong \sqrt{\frac{\left[\sqrt{1+\ln\left(\frac{H_{pl}}{H_0}\right)}\right]\left[1+\sqrt{1+\ln\left(\frac{H_{pl}}{H_0}\right)}\right]H_t}{\left[\sqrt{1+\ln\left(\frac{H_{pl}}{H_t}\right)}\right]\left[1+\sqrt{1+\ln\left(\frac{H_{pl}}{H_t}\right)}\right]H_0}} \quad (31)$$

Based on this relation also, for each value of assumed z, corresponding value of H_t can be estimated. From relation (2),

$$\left.\begin{array}{l} H_0 \cong \dfrac{V_0^2}{c^2}\left(\dfrac{8\pi Ga}{3c^2}\right)^{\frac{1}{2}} T_0^2 \cong \left[1+\ln\left(\dfrac{H_{pl}}{H_0}\right)\right]\left(\dfrac{8\pi Ga}{3c^2}\right)^{\frac{1}{2}} T_0^2 \\ H_t \cong \dfrac{V_t^2}{c^2}\left(\dfrac{8\pi Ga}{3c^2}\right)^{\frac{1}{2}} T_t^2 \cong \left[1+\ln\left(\dfrac{H_{pl}}{H_t}\right)\right]\left(\dfrac{8\pi Ga}{3c^2}\right)^{\frac{1}{2}} T_t^2 \\ \rightarrow \dfrac{H_t}{H_0} \cong \left(\dfrac{V_t^2}{V_0^2}\right)\left(\dfrac{T_t^2}{T_0^2}\right) \cong \left(\left[1+\ln\left(\dfrac{H_{pl}}{H_t}\right)\right] \Big/ \left[1+\ln\left(\dfrac{H_{pl}}{H_0}\right)\right]\right)\left(\dfrac{T_t^2}{T_0^2}\right) \end{array}\right\} \tag{32}$$

From above relations,

$$\begin{array}{l} (z+1) \cong \sqrt{\dfrac{V_0 R_0}{V_t R_t}} \cong \left(\dfrac{T_t}{T_0}\right)\sqrt{\dfrac{V_t(V_0+c)}{V_0(V_t+c)}} \\ \cong \left(\dfrac{T_t}{T_0}\right)\sqrt{\dfrac{\left[\sqrt{1+\ln\left(\dfrac{H_{pl}}{H_t}\right)}\right]\left[1+\sqrt{1+\ln\left(\dfrac{H_{pl}}{H_0}\right)}\right]}{\left[\sqrt{1+\ln\left(\dfrac{H_{pl}}{H_0}\right)}\right]\left[1+\sqrt{1+\ln\left(\dfrac{H_{pl}}{H_t}\right)}\right]}} \end{array} \tag{33}$$

This relation indicates that, $(z+1)$ is a function of $\left(T_0, T_t, H_0, H_t \text{ and } H_{pl}\right)$.

Still we are working in this new direction and these proposed relations can be recommended for further research and analysis.

4. Discussion on Quantum cosmology, the Planck scale Hubble parameter and the cosmic temperature

It may be noted that, in a quantum gravitational approach, relation (2) can be expressed in the following general form.

$$\begin{array}{l} T_t \cong \left[0.46148\left(\dfrac{\sqrt{1+\sqrt{y}}}{\sqrt{y}}\right)\right]\dfrac{\hbar c^3}{k_B G\sqrt{M_t M_{pl}}} \\ \text{where, } y \cong \left[1+\ln\left(\dfrac{H_{pl}}{H_t}\right)\right], M_t \cong \dfrac{c^3}{2GH_t}\left[1+\sqrt{1+\ln\left(\dfrac{H_{pl}}{H_t}\right)}\right] \text{ and } M_{pl} \cong \sqrt{\dfrac{\hbar c}{G}} \end{array} \tag{34}$$

Here in this relation, we try to highlight the expression, $\left[\dfrac{\hbar c^3}{k_B G\sqrt{M_t M_{pl}}}\right]$. Qualitatively this expression is similar to Hawking's black hole temperature formula [24] and needs further study.

In our earlier publications,{author Seshavatharam U.V.S [25,26] and along with S. Lakshminarayana and E. Terry Tatum[27-31]}, we proposed that,

$$T_t \cong \frac{\hbar c^3}{8\pi k_B G\sqrt{M_t M_{pl}}} \tag{35}$$

where M_t is the mass of universe and is equal to $\left(\frac{c^3}{2GH_t}\right)$.

In modern physics literature, one can find many articles on 'quantum cosmology'. One best review article is by Martin Bozowald [1]. In his opinion,

1) "*Quantum cosmology is based on the idea that quantum physics should apply to anything in nature, including the whole universe. Quantum descriptions of all kinds of matter fields and their interactions are well known and can easily be combined into one theory — leaving aside the more complicated question of unification, which asks for a unique combination of all fields based on some fundamental principles or symmetries. Nevertheless, quantizing the whole universe is far from being straightforward because, according to general relativity, not just matter but also space and time are physical objects. They are subject to dynamical laws and have excitations (gravitational waves) that interact with each other and with matter. Quantum cosmology is therefore closely related to quantum gravity, the quantum theory of the gravitational force and space-time. Since quantum gravity remains unfinished, the theoretical basis of quantum cosmology is unclear. And to make things worse, there are several difficult conceptual problems to be overcome*".

2) "*We remain far from a proper understanding of quantum cosmology, especially when physics at the Planck scale is involved. At the same time, research on quantum cosmology has led to progress in our understanding of generally covariant quantum systems and often showed unexpected effects of quantum space-time*".

These points clearly indicate the poor status of 'current quantum cosmology'. In this context, proposed Planck scale Hubble parameter $H_{pl} \cong \sqrt{c^5/G\hbar} \cong 1.8549215\times10^{43}\ \text{sec}^{-1}$ can be recommended for in depth analysis at fundamental level.

5. Discussion on the proposed assumptions and their consequences or results

We would like to highlight the following points:

1) Modern cosmologists strongly believe that current universe is accelerating. But they are

silent in quantifying the past and current cosmic expansion speeds. In general, 'cosmic acceleration' means, 'rate of increase' in cosmic expansion speed. Based on assumptuion 3d, we treied our level best in quantifying the past and current cosmic expansion speeds.

2) Even though, modern cosmology is strongly believing in current cosmic acceleration, it is silent in quantifying the current cosmic acceleraton. Along with the assumed cosmic age, we assume the current and initial cosmic expansion speeds and thereby estimating the current cosmic acceleration by implementing the utmost basic kinematic relation! In addition, based on the estimated current cosmic acceleration, we estiamted the current cosmic radius.

3) With reference to the proposed assumptions, current universe seems to constitute 267 Hubble spheres. According to Mihran Vardanyan *et al* [23], the curvature scale of the Universe is conservatively constrained to be R_c> 42 Gpc (99%), corresponding to a lower limit to the number of Hubble spheres in the Universe NU > 251 (99%). This coincidence clearly indicates the workability of our proposed assumptions.

4) We consider continuous superluminal expansions and hence it is possible to understand the currently observed large scale cosmic homogeniety or isotropy. Important point to be noted is that, modern estimate of cosmic radius is strictly assumed to obey 'inflation' whereas our estimate of cosmic radius (that is twice of modern estiamte) is independent of 'inflation'. From Table 4, it is clear that, at around 4.4×10^{-32} seconds, cosmic expansion speed was around *5.3c* and at around 1 second, cosmic expansion speed was around *10c*. Based on these points, 'inflation' concept can be relinqushed [18]. In addition, concepts associated with 'fine tuning' of 'beginning of inflation' can also be ignored.

5) As the observed universe is very large and observers cannot reach outer parts of the univese, one may be forced to believe in 'temperature isotropy'.In reality, as universe is continuously assumed to be expanding at increasing super luminal speeds, expecting 'temperature isotropy' may not be reasonable.

6) Since it is assumed that, universe is always expanding with increasing super luminal speeds, generally believed 'Lambda term ' can be ignored in our proposed model.

7) Without a radial in-flow of matter in all directions towards one specific point, one cannot expect a big crunch and without a big crunch, one cannot expect a big bang. Really if there was a 'big bang' in the past, with reference to formation of big bang as predicted by GTR and with reference to the cosmic rate of expansion that might had 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 center of cosmic expansion.

8) It may be noted that, many cosmologists are working on 'cosmic rotation' [32-64].In this context, one can see the following important points quoted by eminent scientists:

A) According to Fani Dosopoulou et al [34]: "Current observations are consistent with small amounts of universal rotation, which means that, if the universe rotates, it does so very slowly. This is also in agreement with the inflationary scenario, where the exponential expansion is expected to essentially eliminate any traces of primordial vorticity. Nevertheless, most (if not all) astrophysical structures rotate, which raises the question whether their rotation is of cosmological origin, or a relatively recent addition due to local physical processes. Magnetic fields have long been known to act as sources of rotational distortions and the agent responsible for their generation is the field's tension. Consequently, one could argue that the origin of cosmic magnetism and that of universal rotation are closely (if not directly) related. Put another way, magnetized universes should also rotate."

B) According to L.M.Chechin [35]: "From these estimations it result that Universe angular velocity must be in the following range $10^{-21}\text{sce}^{-1} \leq \omega_0 \leq 10^{-17}\text{sce}^{-1}$. Our previous estimate of the Universe rotation 10^{-19}sce^{-1}, as it seems, is in good correlation with specified interval. At the same time the peculiarity of quoted articles is the Universe rotation searching in the determination by a baryonic substrate. In contrary, i.e the Universe rotation determines by Newtonian's mechanics and is the consequence of vacuum presence. That is why the ratio of Universe angular velocity to the Hubble parameter is about unit, i.e. $(\omega/H)_0 \sim 1$. From this follows the correctness of Gamov's remark [64] that the unique reason for Universe expansion and its rotation must be. If take into account that vacuum creates all baryonic substance, it is the moving force of the total Universe evolution, hence."

C) According to C.Sivaram et al [37]: "The origin of rotation or spin of objects, from stars to galaxies, is still an unanswered question. Even though there are models which try to explain this, none of them can account for the initial impulse that gave rise to this spin. In this paper we present that a cosmological model that contains a term involving the primordial spin of the universe can explain how these objects acquired the property of spin. This model also gives a natural explanation for the quadratic scaling of angular momentum with mass. Again, from this model, the background torsion due to a universal spin density not only give rise to angular momenta for all structures but also provide a background "centrifugal term" acting as a repulsive gravity accelerating the universe, with spin density acting as effective cosmological constant."

D) According to Serkan Zorba [38,39]: "The universe is rigidly rotating with an angular frequency equal to the Hubble's constant, and with a centrifugal force that is linearly proportional to distance. It implies that dark energy is not the "vacuum energy," but rather the rotational energy of the universe. My model thus has significant implications for the cosmological principle and the standard model of cosmology. Our universe appears to possess mysterious dark energy and dark matter because it is part of a rotating space-time of a disk-shaped universe, and the centrifugal and Coriolis forces due to rotation are perceived by us as dark energy and dark matter."

E) According to Wlodzimierz Godlowski [40]: "The presented observational situation is that the galaxies, their pairs and compact groups have a non-vanishing angular momentum. In the structures of mass corresponding to groups of galaxies, this feature has not been found, while in the clusters and super clusters alignment of galaxy orientation has been actually found. Also we know that galaxies have net angular momentum due to the fact that we actually measure the rotation curves of galaxies. These facts lead to the conclusion that theories which connect galaxy angular momentum with its surrounding structure are at some extend favored by data. We show that in the light of scenarios of galaxy formations this result could be interpreted as an effect of tidal forces mechanism, but it is also consistent with Li's model, in which galaxies form in the rotating universe."

F) According to Michael J. Longo [41]:"A preference for spiral galaxies in one sector of the sky to be left-handed or right-handed spirals would indicate a parity violating asymmetry in the overall Universe and a preferred axis. This study uses 15158 spiral galaxies with redshifts $z < 0.085$ from the Sloan Digital Sky Survey. An unbinned analysis for a dipole component that made no prior assumptions for the dipole axis gives a dipole asymmetry of -0.0408 ± 0.011 with a probability of occurring by chance of 7.9×10^{-4}. A similar asymmetry is seen in the Southern Galaxy spin catalog of Iye and Sugai. The axis of the dipole asymmetry lies at approx. $(l,b) = (52.0^\circ, 68.5^\circ)$, roughly along that of our Galaxy and close to alignments observed in the WMAP cosmic microwave background distributions. The observed spin correlation extends out to separations ~ 210 Mpc/h, while spirals with separations < 20 Mpc/h have smaller spin correlations."

G) According to Korotky V.A. and Obukhov [51]:"We believe that the cosmic rotation is an important physical effect which should find its final place in cosmology. In this paper we outlined one of the possible theoretical frameworks which can underlie our understanding of this phenomenon."

9) From modern estimates, cosmic radius about earth is 46.5 billion light years and from our estimate, cosmic radius about the point of big bang is 90 billion light years and ratio of these two radii is very close to ½. Estimated radii point of view, factor ½ is not a big issue. As earth is far away from the observable cosmic boundary, even though, if current universe is really rotating with very small magnitude of angular velocity, one may not be able to observe the effects of cosmic rotation from and about earth.

10) Considering all the proposed assumptions collectively, it is certainly possible to show that, ratio of currently believed 'dark enery density' and proposed 'rotational kinetic energy density' is equal to unity. This coincidence casts doubt on the existence of 'dark energy' at fundamanetal level and needs further study.

11) Even though our proposed model is independent of galactic redshifts, galactic distances and galactic receding speeds, with proposed assumptions, outline of the currently believed evolving cosmic structure can be understood very easily. By measuring the actual galactic receding speeds, assumption 3d can be investigated further.

12) In any model of cosmology, fundamental questions to be solved are: 1) Why do 'dark matter' and 'visible matter' have their measured values of ~33% of critical energy? 2) Why do 'dark energy' has its measured values of ~68% of critical energy? 3) How to estimate their past and future magnitudes? These are the puzzling questions raised by the Royal Swedish Academy of Sciences [20] in 2011. In the conclusion part, Royal Swedish Academy of Sciences say:"The study of distant supernovae constitutes a crucial contribution to cosmology. Together with galaxy clustering and the CMB anisotropy measurements, it allows precise determination of cosmological parameters. The observations present us with a challenge, however: What is the source of the dark energy that drives the accelerating expansion of the Universe? Or is our understanding of gravity as described by general relativity insufficient? Or was Einstein's "mistake" of introducing the cosmological constant one more stroke of his genius? Many new experimental efforts are underway to help shed light on these questions". In this context, in applications 5, 6 and 7, we tried our level best in answering these basic questions with assumption 3b which is having a long history in General relativity and Cosmology. To have more clarity, readers are strongly encouraged to refer Serkan Zorba's papers [37,38] that strongly suggest that, dark energy and dark matter are inertial effects.

6. Conclusions

By following the proposed assumptions, we tried in this paper our best to estimate and co-relate Hubble parameter, temperature, age, expansion speed, acceleration, radius, mass, mass-energy density, rotational kinetic energy, dark matter energy density and galactic receding speeds of the current accelerating universe. The advantages of the proposed assumptions are:

1) Inherently connected with the Planck scale.
2) Successful implementaion of Mach's principle.
3) Logically very simple to implement and understand.
4) Resolutions of the key issues connected with currently believed 'inflation','cosmic horizon' and 'dark energy'.

5) Perfect connection of the current Hubble parameter and current cosmic temperature.
6) In all the cases, easy exptrapolation to past and future.
7) With further research, possible development of a unified model of quantum cosmology.

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