Symmetries in the universe , a quanton origin

Ayman Kassem (a) , (b)

(a) Aeronautical engineer, Cairo , Egypt

(b) Contact address : ayman_kassem@egyptair.com

abstract

The recurrence of high order dimensionless ratios of the physical and cosmological parameters had for long fascinated scientists, Paul Dirac was one of the first to notice this, and after him this phenomena was named (Dirac large number hypothesis) , where he tried to explain such a recurrence in terms of varying gravitational constant .

here, we will discuss some of the physical cosmological parameters and their ensuing large number ratios and relate them to each other using concepts developed in the (quanton based model of field interactions)

Key words

Uniformity and homogeneity of space fabric , large number hypothesis, energy degree of freedom

1. Introduction

Apart from normal matter and radiation energy, the bulk of energy in the universe is in the form of dark energy and dark matter, this division is based on difference in properties between largely inflationary dark energy and dark matter with mainly gravitational properties, previous research work had suggested that those two entities are nothing but one entity which possesses both the properties [1] ,[2] ,[3] , [4] and even more recent work proposed that dark matter is an exotic form of electromagnetic waves [5]

"The quanton based model of field interactions" [6], introduced the concept of

energy constraining , how space and time varying energy fields can evolve in the form of a quatum entity : the quanton.

The two types of fields are free dominated (E_{qf}) and constrained dominated (E_{qc}) , they interact inside and outside the quanton , the main mechanism which governs their interaction is energy degree of freedom .

To further illustrate these interactions , three points of interest were chosen (present day , Planck era , single quanton era) , so as to derive large number relative ratios for the quanton and cosmological parameters between these different points , the main variable used when deriving those relationships was the energy density , which is proposed to have a degree of freedom relationship with quanton wave parameters , in doing so it will be shown that the recurrence of high order ratios is not pure coincidence but rather the result of symmetries on the micro scale which found their manifestations on a macro scale [7] , [8]

2.Physical basis of this model

a-At any time , quanton frequencies have an energy density which is statistically distributed , and the vacuum energy density equals the summation of those statistically distributed densities .

b- The quanton frequencies can be replaced by a single equivalent frequency which represents the statistical mean of all quanton frequencies .

2.a.Equations used to develop this model

$r_q = \frac{\lambda}{2}$ **(quanton radius)** **(1-2)**

$\omega = kc = \frac{\pi c}{r_q}$, $k = \frac{2\pi}{\lambda} = \frac{\pi}{r_q}$, **(2-2)**

$E_q = h_q\ \omega^4$ **(E_q = energy density inside quanton joule/m^3)** **(*)** **(3-2)**

$h_q = \frac{h}{16\pi^4\ c^3}$ **(h_q : energy density constant)** **(*)** **(4-2)**

$E_p = \frac{hc}{2\,r_q}$ (E_p : packet energy, total energy of the quanton in joules) (5-2)

$N_q = \frac{E_u}{E_p}$ (N_q : total number of quantons , E_u : total energy in (6-2)

universe- excluding normal matter and radiation)

$\varrho_v = E_q$ (7-2)

(ϱ_v : vacuum energy density , E_q : average energy density inside the quanton)

$V_q = 8\ r_q^{\ 3}$ (V_q : quanton equivalent volume) (*) (8-2)

$V_u = V_q\ N_q$ (V_u : universe volume) (9-2)

$\varrho_v = \frac{E_u}{V_u}$ (10-2)

(*) more details are offered in the following section

2.b.The energy density constant

Our goal here is to define the quanton wave parameters (ω , r_q) and consequently the cosmological parameters in terms of the quanton energy density based on the relationship $E_q = h_q\ \omega^4$,to do so , the value of the energy density constant (h_q) must be established first

Recalling first that the quanton fields are infinite in range ,this corresponds to an exponentially decaying field away from the quanton , and the quanton free and constrained fields can be put as

$E_{qf}\ (x) = E_{qf}\ e^{-j(\frac{x}{2r_q})}$ (free energy dominated field) (11-2)

$E_{qc}\ (x) = E_{qc}\ e^{-j(\frac{x}{2r_q})}$ (constrained energy dominated field) (12-2)

and the quanton energy density is in the form

$E_q = E_{sf}E_{tc}E_{sc}E_{tf} = E_{qf}\ E_{qc}$, $E_{qf} = E_{sf}E_{tc}$, $E_{qc} = E_{sc}E_{tf}$ (13-2)

Where E_{sf}, E_{sc} are the free and constrained space varying fields , and E_{sf}, E_{sc} Are the free and constrained time varying fields [6] to assess the entire energy stored in both fields ,the quanton packet energy be equal to the volumetric integration

$$E_p = \frac{h\omega}{2\pi} = \iiint_{-\infty}^{\infty} E_q \; e^{-j(\frac{x+y+z}{r_q})} \, dx\, dy\, dz = \qquad (14\text{-}2)$$

$$= (2)^3 \iiint_{0}^{\infty} E_q \; e^{-j(\frac{x+y+z}{r_q})} \, dx\, dy\, dz \qquad (\text{ symmetric integration})$$

$$= 8\,(r_q)^3\, E_q \; e^{-j(\frac{x+y+z}{r_q})}\Big|_{x,\,y,\,z=0}^{x,\,y,\,z=\infty} \qquad = 8\,(r_q)^3\, E_q \qquad (15\text{-}2)$$

and given $r_q = \frac{\pi c}{\omega}$

$$E_q = \frac{h\,\omega^4}{16\pi^4\, c^3} = h_q\, \omega^4 \quad , \quad \frac{h}{16\,\pi^4\, c^3} = h_q \text{ (energy density constant)} \qquad (16\text{-}2)$$

Which has the value of 1.576 x $10^{-62}\,\mathrm{j.sec^4}/\mathrm{m^3}$, to relate the average energy density E_q to it maximum value E_{qo} , we use the quanton/ anti quanton

expansion model $E_q = \frac{1}{2}(E_{qf} + cE_{qc})$* $\frac{1}{2}(\frac{E_{qf}}{c} + E_{qc})$, (17-2)

And since $E_{qf} = cE_{qc}$

$$E_q = E_{qfo} \cos(\frac{\pi r}{2r_q} - \omega t) \; E_{qco} \cos(\frac{\pi r}{2r_q} - \omega t) = E_{qo} \cos^2(\frac{\pi r}{2r_q} - \omega t) \qquad (18\text{-}2)$$

The average value of a periodic function is defined as

$$E_q = \frac{1}{T}\int_0^T E_{qo}\,(t) \qquad (19\text{-}2)$$

$$E_q = E_{qo} \int_0^T \cos^2(\frac{\pi r}{2r_q} - \omega t)\, dt \qquad (20\text{-}2)$$

The value of this integration equals to $(\frac{1}{2})$

$$E_{qo} = 2\, E_q = \frac{h\,\omega^4}{8\pi^4\, c^3} \qquad (21\text{-}2)$$

The quanton is represented by an equivalent volume that equals 8 $r_q{}^3$ and the same result can be reached alternatively, when calculating the vacuum energy density ϱ_v at any point in space as the summation of individual energy density contributions (ϱ_{vi}) quantons (N_{qi})

$\varrho_v = \sum_i^{N_q} \varrho_{vi}$ **(22-2)**

Which leads to the same integration and the same energy density constant , and in general the vacuum energy density is equivalent to the quanton average energy density $\varrho_v = E_q$ **(23-2)**

3. Present day parameters

Present day parameters are suffixed (o)

The methodology followed here is to assess the quanton parameters (ω_o, r_{qo}) **while using the energy density / degree of freedom relationship namely** $E_{qo} = h_q\, \omega_o{}^4$ **, the energy density of space** ϱ_{vo} **is found to be closer to** $10^{-29}\,\mathrm{gm}/\mathrm{cm}^3$ **or the equivalent to 8.65 x** 10^{-10} j/m^3 **[9]**

Quanton energy density = $E_q = \varrho_{vo}$ **= 8.65 x** 10^{-10} j/m^3 **(1-3)**

Quanton radial frequency $\omega_o = \left(\frac{E_{qo}}{h_q}\right)^{.25}$ **= 1.53 x** 10^{+13} **rad /sec** **(2-3)**

Quanton radius = $r_{qo} = \frac{\pi c}{\omega_o}$ **= 6.15 x** 10^{-5} **m** **(3-3)**

Quanton volume V_{qo} **= 1.86 x** $10^{-12}\,\mathrm{m}^3$ **(4-3)**

And its packet (total) energy $E_{po} = \frac{h\, \omega_o}{2\,\pi}$ **= 1.61x** 10^{-21} **j** **(5-3)**

Number of quantons per cubic meter = $\frac{v_c}{V_q}$ **=5.36 x**10^{11} **(6-3)**

the total mass in the universe is estimated to be close to 10^{53} **kgs (based on Hoyle formula** $M_u = \frac{c^3}{2GH}$ **[10]** **(7-3)**

which corresponds to 10^{70} **joules , the equivalent number of quantons is**

$N_{qo} = \frac{E_u}{E_{po}}$ **= 5.9 x**10^{90} **quantons** **(8-3)**

The corresponding universe's volume = $N_{qo}\ V_{qo}$ **= 1.1 x**10^{79} m^3

4.Planck era parameters

Planck era parameters are suffixed (p) , We note the following

1- The Planck length does not reflect the true dimensions of that era's universe , since it requires an energy density to be of the order of $\frac{E_u}{V_{up}} = (\frac{1.x10^{70}}{(1.62x10^{-35})^3})$ **or approximately 2.35x**10^{174} **joules/** m^3 **which far exceeds the Planck energy density This leads to the only other alternative , namely the Planck units (length , angular frequency ,..) either belong to primordial radiation or the quanton parameters of that era.**

2- The relationship between Planck length and Planck angular frequency does not reflect the wave relationship ω=kc= $\frac{2\pi c}{\lambda}$ **, instead it defines a relationship** $\omega_p L_p$ **=c**

3-The Planck energy density which is theoretically derived and defined as $\frac{E_{pp}}{{L_p}^3}$ **= 4.63 x**10^{113} **j/**m^3 **does not take into account the geometry of the quanton which has a volume that equals 8** ${L_p}^3$ **, so to obtain the average quanton energy density and subsequently vacuum energy density the Planck energy density has to be divided by a factor of** (2^3) **, the resulting vacuum density would be**

$\varrho_{vp} =$ **5.79 x** 10^{112} $j\ /m^3$ **(1-4)**

The angular frequency that corresponds to that energy density

ω_p **=** $\left(\frac{E_{qp}}{h_q}\right)^{.25}$ **= 4.37 x** 10^{+43} **rad /sec (2-4)**

And the corresponding quanton radius r_{qp} **=**$\frac{\pi c}{\omega_p}$ **= 2.15x** 10^{-35} **m (3-4)**

Based on these values , the parameters at the Planck era would become

$V_{qp=}$ **quanton volume = 8** ${r_{qp}}^3$ **= 7.97 x** 10^{-104} m^3 **(4-4)**

$E_{\ pp} =$ **quanton packet (total) energy** $E_{\ pp} = \frac{h\ \omega_p}{2\pi}$ **= 4.61 x** 10^{+9} **joules (5-4)**

Total number of quantons = $\frac{\text{Energy content in the universe}}{\text{Planck era quanton packet energy}}$**=**$\frac{E_u}{E_{pp}}$**=2.17 x** 10^{+60} **(6-4)**

Universe volume V_{up}**=** $\frac{\text{qunaton volume} * \text{number of quantons}}{\text{volumetric constant}}$**=**$V_{qp}N_{qp} =$ **1.73 x** $10^{-43}m^3$ **(7-4)**

Universe radius r_{up}**=** $\sqrt[3]{\frac{3\ x\ V_{up}}{4\pi}}$ **= 3.4 x** 10^{-15} **m (8-4)**

Now the relative ratios between present day and Planck era parameters for the quanton and the cosmological parameters can be calculated as shown in table 1.

Relative ratio	description	symbol	value	Degrees of freedom	remarks
Qunton number	$\frac{\text{number of quntons now}}{\text{Planck era nuner of quantons}}$	$\frac{N_{qo}}{N_{qp}}$	$2.73\ x10^{30}$	one	
Quanton radius	$\frac{\text{qunton radius now}}{\text{Plank era qunton radius}}$	$\frac{r_{qo}}{r_{qp}}$	$2.86\ x10^{30}$	one	
Quanton volume	$\frac{\text{qunton volume now}}{\text{Plank era qunton volume}}$	$\frac{V_{qo}}{V_{qp}}$	$2.33\ x\ 10^{91} = (2.83\ x10^{30})^3$	three	
Angular frequency	$\frac{\text{qunton ang. frequency now}}{\text{Plank era ang. frequency}}$	$\frac{\omega_o}{\omega_p}$	$2.86\ x\ 10^{30}$	one	
Energy density ratio	$\frac{\text{energy density now}}{\text{Plank era energy density}}$	$\frac{\varrho_{vo}}{\varrho_{vp}}$	$1.49\ X\ 10^{-122} = (\frac{1}{2.86x10^{30}})^4$	four	
Universe radius ratio	$\frac{\text{universe radius now}}{\text{Plank era universe radius}}$	$\frac{r_{uo}}{r_{up}}$	$4.46\ x10^{+40}$ $(= 3.07\ x\ 10^{30})^{\frac{4}{3}}$	$\frac{4}{3}$	Shell shaped
Universe radius ratio	$\frac{\text{universe(equivalent) radius no}}{\text{Plank era universe radius}}$	$\frac{r_{ueo}}{r_{up}}$	$4.0\ x10^{+40}$ $(= 2.83\ x\ 10^{30})^{\frac{4}{3}}$	$\frac{4}{3}$	(*)equi-valent sphere shaped)
Universe volume ratio	$\frac{\text{universe volume now}}{\text{Plank era universe volume}}$	$\frac{V_{uo}}{V_{up}}$	$6.37\ x\ 10^{121} = (2.82x10^{30})^4$	Four*	
Universe to quanton radii ratio (now)	$\frac{\text{universe radius now}}{\text{quanton radius now}}$	$\frac{r_{uo}}{r_{qo}}$	$2.50\ x\ 10^{30}$		(**)
Universe to quanton radii ratio (Planck)	$\frac{\text{planck era universe radius}}{\text{Plank era quanton radius}}$	$\frac{r_{up}}{r_{qp}}$	$1.61\ x10^{+20}$ $(= 2.03\ x\ 10^{30})^{\frac{2}{3}}$		
Time ratio	$\frac{\text{time now}}{\text{Planck era time}}$	$\frac{t_o}{t_p}$	$8.08x10^{60} = (2.84x10^{30})^2$		(***)

Table 1. Various ratios and their relationship to energy degrees of freedom

(*) Equivalent spherical shaped universe whose radius = $\sqrt[3]{\frac{3}{4\pi V_u}}$

(**) $\frac{\text{universe radius now}}{\text{quanton radius now}}$ ($\frac{r_{uo}}{r_{qo}}$) can be viewed as equal to ($\frac{r_{uo}}{r_{up}}$)x($\frac{r_{up}}{r_{qp}}$)x($\frac{r_{qp}}{r_{qo}}$)

$$= (4.46\ x10^{40})\ (1.61\ x\ 10^{20})\ \frac{1}{(2.86\ x10^{30})} \quad (9\text{-}4)$$

(***) to be discussed in section : parameter variation with time.

It should be noted that

1-By comparing values for the universe volume ratio $\frac{V_{uo}}{V_{up}}$ = 6.37 $x\ 10^{121} =$ $(2.82\ x\ 10^{30})^4$ with the quanton volume ratio $\frac{V_{qo}}{V_{qp}}$ = 2.33 $x\ 10^{91} = (2.83\ x10^{30})^3$, and that of the quanton number ratio $(2.73\ x10^{30})$, one can draw the conclusion that the process of four dimensional quanton energy density expansion into three dimensional space can be achieved through the quanton splitting mechanism [6]

2-When calculating these ratios for present day to Planck era , the normal matter and radiation interactions with space fabric were not taken into account , as a result we can expect the true values to deviate by small percentage from these ideal values .

3-The energy conversion into normal matter affected the relative ratio of the number of quantons more than any other parameter (while disregarding the results of different interactions for now)

5. Single quanton Era

Single quanton era parameters are suffixed (s)

Single quanton describes the expansion of the universe starting from a single quanton which is still governed by Planck Einstein relationship , namely

$E_u = \frac{hc}{2\ r_{qs}}$ and since there is no data about the energy density at the era

the starting point would be to obtain the value of single quanton radius r_{qs} .

Under such conditions various parameters of quanton can then be obtained

r_{qs} (quanton radius)= $\frac{hc}{2\ E_u}$ = 9.92 X 10^{-96} m (1-5)

$\omega_s = \frac{\pi c}{r_{qs}}$= 9.93 $x\ 10^{+103}$ rad /sec (2-5)

quanton volume V_{qs} =8 $r_{qs}{}^3$ = 7.81 x10^{-285} m^3 (3-5)

(same as the volume of universe of that era V_{us})

ϱ_{vs} (energy density)= $E_{qs} = \frac{E_u}{V_{qs}}$ = 1.279 x 10^{+354} j / m^3 (4-5)

Those values lead to the development of another set of ratios this time relating

them to Planck era as is shown in table.2

Relative ratio	description	symbol	value	Degrees of freedom	remarks
Number of Quntons	= planck era qunton number	$\frac{N_{qp}}{N_{qs}} = N_{qp}$	2.16×10^{60}	one	
Quanton radius	$\frac{\text{Plank era quanton radius}}{\text{single qunton radius}}$	$\frac{r_{qp}}{r_{qs}}$	2.16×10^{60}	one	
Quanton volume	$\frac{\text{Plank era qunton volume}}{\text{single qunton volume}}$	$\frac{V_{qp}}{V_{qs}}$	1.01×10^{181} $= (2.16 \times 10^{60})^{3}$	three	
Angular frequency	$\frac{\text{single qunton ang. frequency}}{\text{Planck era ang. frequency}}$	$\frac{\omega_s}{\omega_p}$	2.16×10^{60}	one	
Energy density ratio	$\frac{\text{single quanton energy density}}{\text{Planck energy density}}$	$\frac{\varrho_{vs}}{\varrho_{vp}}$	2.21×10^{241} $=(\frac{1}{2.16 \times 10^{60}})^4$	four	
Universe radius ratio	$\frac{\text{Plank era universe radius}}{\text{single quanton radius}}$	$\frac{r_{up}}{r_{qs}}$	$2.80 \times 10^{+80}$ $= (2.16 \times 10^{60})^{\frac{4}{3}}$	$\frac{4}{3}$	(*), (**)
Universe volume ratio	$\frac{\text{Plank era universe volume}}{\text{single quanton volume}}$	$\frac{V_{up}}{V_{us}}$	2.21×10^{241} $(2.16 \times 10^{60})^4$	Four*	

Table 2. Various ratios (Planck era parameters to that of single quanton) and their relationship to energy degrees of freedom

(*) For the particular case of single quanton

the universe's radius is defined as $r_{us} = r_{qs} \sqrt[3]{\frac{6}{\pi}}$ $(N_{qs} = 1)$ **(5-5)**

and the volume of the universe = $\frac{4\pi}{3} r_{us}^3 = 8\, r_{qs}^3$ **= quanton volume**

(**) It is interesting here to note that the ratio of the radii of the universe to quanton $(\frac{r_u}{r_q})$ **changes as follows**

Single quanton : $\frac{r_{us}}{r_{qs}} = \sqrt[3]{\frac{6}{\pi}}$ **(6-5)**

Planck era $\frac{r_{up}}{r_{qp}} = (2.03 \times 10^{30})^{\frac{2}{3}} = \sqrt[3]{\left(\frac{6}{\pi} \times 2.17 \times 10^{60}\right)} = \sqrt[3]{\left(\frac{6}{\pi} N_{qp}\right)}$ **(7-5)**

Present day , equivalent sphere radius defined as $r_{ueo} = \sqrt[3]{\frac{3V_u}{4\pi}}$ **)** **(8-5)**

$\frac{r_{ueo}}{r_{qo}} = 2.24 \text{ x } 10^{30}$ = $\sqrt[3]{\left(\frac{6}{\pi} \text{ x}5.9\text{x}10^{90}\right)}$ = $\sqrt[3]{\left(\frac{6}{\pi} \text{ x}N_{qo}\right)}$ **(9-5)**

at any instance in time ,the radii ratio $\frac{r_u}{r_q}$ = $\sqrt[3]{\frac{V_v}{V_q}}$ = $\sqrt[3]{\frac{N_q V_q}{V_q}}$ **(10-5)**

= $\sqrt[3]{\frac{N_q(8\ r_q^3)}{\frac{4\pi}{3} r_q^3}}$ = $\sqrt[3]{\frac{6\ N_q}{\pi}}$ **which corresponds to one-third Dof** **(11-5)**

The universe radius (viewed as an equivalent sphere) is proportional to the cubic root of the number of quantons multiplied by quanton radius , in other words the universe volume which is represented by four degrees of freedom is the result of quanton volumetric expansion (represented by three degrees of freedom) and quanton splitting (represented by one Dof)

We can add to those ratios another one that relates to time ratio based on symmetry of behavior of energy expansion between

$\frac{t_p}{t_s}$ **(calculated) =**$\frac{\text{planck time}}{\text{single quanton time}}$ **= 4.7 x** $10^{120} = (2.17 \text{ x } 10^{60})^2$ **(12-5)**

$t_s = 1.15\ \text{x}\ 10^{-164}\ \text{sec}$ **(Time needed for quanton to evolve from an packet state (energy not varying in space or time) which is defined as** E_p**=** $E_s\ E_t$ **to become a single quanton in the form** E_q**=(** $E_{sf}\ E_{tc}$**)(** $E_{sc}\ E_{tf}$**) .**

Another important remark here that's the energy content of the universe (and consequently energy density) alters the quanton parameters (and consequently the cosmological parameters), but it does not alter quanton or cosmological symmetries as this energy content of the universe acts only as a scale-up or scale -down factor, in other words symmetries are preserved irrespective of the energy content or the energy density of vacuum.

The first question the single quanton model arises is where did the radiative energy required for nucleosynthesis come from ?

It would be too cold for normal matter to evolve under such model.

The quanton based model's main conclusion was that the CMB radiation was a direct result of the free expansion of the space fabric .

while the thermodynamics of quanton inflation and splitting remains unstudied subject till now , the attention must be drawn to the two facts:

a- The minuscule dimensions of the Planck era's universe (10^{-15} m)

b-And the very fast ratio of quanton splittings ($= 2.17 \text{ x } 10^{60}$)

Although quantons split asymmetrically , an ideal case whereby the quanton splits symmetrically can be discussed here quanton splitting cycle corresponds to the time needed (Δt) for every quanton to undergo a single splitting event , in other words , if the number of quantons N_q can be put in the form

$$N_q = 2^m \quad (13\text{-}5)$$

this corresponds to (m) splitting cycles , based on the obtained results for total number of quantons N_q (t_o)= 1.06 x10^{91} = 2^m (14-5)

Solving for m , result in m = 302 cycles (15-5)

For the number of Planck era splittings

N_q (t_{Plank})= 2.17 x10^{60} = 2^m (16-5)

Again solving for m , result in m = 200 cycles (16-5)

Out of those 300 splitting cycles about 200 cycles occurred in a time equal to Planck time (which is equivalent to double order of magnitude of the splittings that occurred throughout the remaining life span of the universe till now),

These figures might be helpful in understanding , for now , where the source of the primordial of radiation came from

6.<u>Time variation -energy degree of freedom relationship</u>

The time variation ratio ($\frac{t_o}{t_p}$) = $8.08 \text{ x} 10^{60}$ = $(2.84 \text{ x } 10^{30})^2$, is not a coincidence , quanton physical parameter ratios and consequently cosmological physical parameter ratios are strictly tied to time ratio and due to this fact , we can relate all the quanton parameters and consequently the cosmological parameter variations to time variation to obtain a profile of the parameter variation with time. At the origin of this symmetry is the relationship between the quanton wave

parameters ω , r_q and time variation .

Variation of time is split anti symmetrically and equally between the time and space varying quanton wave parameters, and as we are dealing with energy degrees of freedom which take an exponential form , this division of time variation takes the form ($\sqrt[2]{t}$) square root proportionality, the quanton radius can be put as $r_q = K_r \sqrt[2]{t}$ (1-6)

and the angular frequency $\omega = \frac{K_\omega}{\sqrt{t}}$ (2-6)

K_r , K_ω are time constants of the quanton radius and angular frequency and this antisymmetric division allowed for the wave behavior of the quanton to be preserved .

As the quanton wave parameters are linked together by an antisymmetric variation of time, all the other quanton parameters (quanton packet energy , energy density , and volume) are interconnected by the energy degree of freedom relationship which is related to the quanton parameters .

To define the various quanton and cosmological parameters' variation with time , it must be done in terms of their respective energy degrees of freedom as follows

$Dof_{r_q} = 1 = Dof_\omega = \frac{1}{2} Dof_t$ **or** $Dof_t = Dof_{r_q} + Dof_\omega = 2$ **(3,4-6)**

Dof_{V_q} **(quanton volume)=** $3\ Dof_{r_q} = \frac{3}{2}\ Dof_t$, **(5-6)**

Dof_{N_q} **(number of quantons)=1 =** $\frac{1}{2}\ Dof_t$ **(6-6)**

$Dof_{V_u} = 4 = 4\ Dof_{r_q} = 2\ Dof_t$, **(7-6)**

Dof_{r_u}**(universe radius) =** $\frac{1}{3} Dof_{V_u} = \frac{4}{3} = \frac{2}{3}\ Dof_t$ **(8-6)**

Dof_{ϱ_v} **(energy density) =** $4\ Dof_{r_q} = 4 = 2\ Dof_t$ **(9-6)**

In general a parameter (x) varies in time according to

$x(t) = K_x\ t^{+/-(\frac{Dof_x}{2})}$ **(10-6)**

To preserve the wave behavior the constan*ts* K_r , K_ω must be related such that

$r_q = \frac{\pi c}{\omega}$ **hence** $K_r\ K_\omega = \pi c$ **(11-6)**

Other wave relations still apply Wave period : $T(t) = K_T\sqrt{t}$ (12-6)

wave number $k = \frac{K_k}{\sqrt{t}}$, (13-6)

$\frac{2\pi K_r}{K_T} = c \ (= \frac{\lambda}{T})$, $\frac{K_\omega}{K_k} = c \ (= \frac{\omega}{k})$ (14,15-6)

$K_T K_\omega = 2\pi \ (= \omega T)$, $K_k K_r = 1 \ (= \frac{k\lambda}{2\pi})$ (16,17-6)

7.Quanton and cosmological parameter variation with time

1-Number of quantons: N_q , with a ratio (2.73×10^{30}) should be ideally related to time variation by the relationship $N_q(t) = K_n \ t^{\frac{1}{2}}$ (1-7)

$N_q(t)$: number of quantons at any time (t)

$\frac{N_q}{dt} = \frac{1}{2} K_n \ t^{\frac{-1}{2}}$, K_n : constant of proportionality (2-7)

2-Quanton radius $r_q(t) = k_{rq} \ t^{\frac{1}{2}}$ (3-7)

$\frac{dr_q}{dt} = \frac{1}{2} K_r \ t^{\frac{-1}{2}}$ (4-7)

3- Quanton angular frequency $\omega(t) = K_\omega \ t^{\frac{-1}{2}}$ (5-7)

$\frac{d\omega}{dt} = \frac{-1}{2} K_\omega \ t^{\frac{-3}{2}}$ (6-7)

Alternatively $\omega(t) = \frac{\pi c}{r_q} = \frac{\pi c}{K_r \ t^{\frac{1}{2}}}$ $\left(K_\omega = \frac{\pi c}{K_r} \right)$ (7-7)

$\frac{d\omega}{dt} = \frac{d\omega}{dr_q}\frac{dr_q}{dt} = \left(\frac{-\pi c}{r_q^2}\right)\left(\frac{1}{2} K_r \ t^{\frac{-1}{2}}\right) = \left(\frac{-\pi c}{K_r^2 t}\right)\left(\frac{1}{2} K_r \ t^{\frac{-1}{2}}\right) = \frac{-\pi c}{2 K_r t^{\frac{3}{2}}}$ (8-7)

4- Quanton packet energy $E_p(t) = \frac{h\omega}{2\pi} = \frac{1}{2\pi} K_\omega h \ t^{\frac{-1}{2}}$ (9-7)

$\frac{dE_p}{dt} = \frac{-K_\omega h \ t^{\frac{-3}{2}}}{4\pi} = \frac{-hc}{4 K_r} t^{\frac{-3}{2}}$ (10-7)

5-Quanton volume $V_q(t) = K_{vq} \ t^{\frac{3}{2}}$ (11-7)

$\frac{dV_q(t)}{dt} = \frac{3}{2} K_{vq} \ t^{\frac{1}{2}}$ (12-7)

6- Energy density $\varrho_v(t) = K_\varrho \ t^{\frac{-4}{2}} = K_\varrho \ t^{-2}$ (13-7)

$\frac{d\varrho_v}{dt} = -2 K_\varrho \ t^{-3}$ (14-7)

8.Relationship between quanton and cosmological parameter variation

The universe volume , its radius and the prevailing energy density are all related to the quanton parameters , the microscopic process that involves expansion and splitting of quantons leads to the macro scale in the form of the universe's inflation and progressive energy density reduction .

Those cosmological parameters are also governed by time / degree of freedom relationship .

Each one of these parameters has its own time variation as shown before, these relationships are defined as

V_u(t) = universe volume at any time (t) = $N_q(t)\, V_q\,(t)$

$$= (\ K_n\ t^{\frac{1}{2}})(\ K_{vq}\ t^{\frac{3}{2}}) = K_n\ K_{vq}\ t^2 = K_{vu}\ t^2 \qquad (1\text{-}8)$$

Where $K_{vu} = K_{vq}K_n$ (2-8)

This is a second order variation of the volume of universe with time which corresponds to expansion of energy density with four degrees of freedom .

This relationship between the universe's volume and that of the quanton parameters is the product of a quanton expansion which corresponds to three degrees of freedom and splitting of the quantons which corresponds to one degree of freedom .

the rate of the volumetric expansion of the universe

$$\frac{dV_u}{dt} = (N_q\frac{dV_q}{dt} + \frac{dN_q}{dt}V_q\ ) \qquad (3\text{-}8)$$

$$= [(\ K_n\ t^{\frac{1}{2}})(\frac{3}{2}\ K_{vq}\ t^{\frac{1}{2}}) + (\frac{1}{2}\ K_n\ t^{-\frac{1}{2}})(\ K_{vq}\ t^{\frac{3}{2}})] \qquad (4\text{-}8)$$

$$\frac{dV_u}{dt} = (K_nK_v)(\frac{3}{2}t + \frac{1}{2}t) = 2K_nK_vt = 2\ K_{vu}\ t \qquad (5\text{-}8)$$

and for the radius of the universe r_u while expanding as a sphere

$$r_u = \sqrt[3]{\frac{3}{4\pi}V_u} = \sqrt[3]{\frac{3V_qN_q}{4\pi}} = r_q\sqrt[3]{\frac{6}{\pi}N_q} \qquad (6\text{-}8)$$

$$r_u(t) = (\ K_{rq}\ t^{0.5})(\sqrt[3]{\frac{6K_n}{\pi}}\ t^{\frac{1}{2*3}}) = K_{rq}\sqrt[3]{\frac{6K_n}{\pi}}\ t^{\frac{2}{3}} \qquad (7\text{-}8)$$

$r_u(t) = K_{ru}\, t^{\frac{2}{3}}$ (8-8)

$K_{ru} = K_{rq}\sqrt[3]{\frac{6K_n}{\pi}}$ (9-8)

$\frac{dr_u}{dt} = \frac{2}{3} K_{ru}\, t^{\frac{-1}{3}}$ (10-8)

As all the quanton and cosmological parameters are synchronized via the degree of freedom – time relationship , the developed time constants (K's) can be used to chart the history of the parameter variation

9. Analytical determination of the time constants

The estimation of the value of time constants (K's) is not a curve fitting process , given that we have a reliable data about one point in time we can estimate those constants in terms of other physical and geometric constants

For the period (single quanton to Planck era), the various constants can be defined as $r_{qs} = \text{quanton radius} = K_{rq}\sqrt{t_s} = \frac{hc}{2\,E_u}$

$K_{rq} = \frac{hc}{2\,E_u\sqrt{t_s}}$ (1-9)

(t_s : time to single quanton , E_u : universe's total energy)

$\omega_s = \frac{K_w}{\sqrt{t_s}}$ = angular frequency at single quanton era $= \frac{2\pi E_{ps}}{h}$

E_{ps}= quanton packet energy (at single quanton era) = E_u ,

$K_w = \frac{2\pi\sqrt{t_s}E_u}{h}$ (2-9)

V_{qs} (quanton volume at S.Q)= 8 $r_{qs}{}^3 = K_{vq}\, t_s{}^{\frac{3}{2}}$ (3-9)

$K_{vq} = 8\, K_{rq}{}^3$ (4-9)

$\varrho_{vs} = E_{qs}$= vacuum energy density at single quanton era = $\frac{K_{\varrho v}}{t_s{}^2} = \frac{E_{ps}}{V_{qs}}$

$K_{\varrho v} = \frac{h\, K_w{}^4}{16\ \pi^4\ c^3}$ (4-9)

$N_{qs} = \text{number quantons} = K_n\sqrt{t_s}$ = one

$$K_n = \frac{1}{\sqrt{t_s}} \quad (5\text{-}9)$$

While the quanton packet energy can be alternatively defined as

$E_p = \frac{E_u}{N_q} = \frac{E_u}{K_n \sqrt{t}} = \frac{hK_w}{2\pi\sqrt{t}}$, which yields

$$K_w = \frac{2\pi E_u}{h K_n} \quad \text{and} \quad K_{rq} = \frac{hc\, K_n}{2\, E_u} \quad (6\text{-}9)$$

Those two relations lead to the following definitions of the quanton radius and angular frequency $r_q = \frac{hc}{2\pi\, E_u}\sqrt{\frac{t}{t_s}}$, $\omega = \frac{2\pi E_u}{h}\sqrt{\frac{t_s}{t}}$ (7,8-9)

and as to the cosmological parameters

$V_u = V_q N_q$ which leads to $K_{vu} = K_{vq} K_n$ (9-9)

While expanding into a sphere , the radius of the universe

$$r_u = \sqrt[3]{\frac{3}{4\pi} V_u} = \sqrt[3]{\frac{3}{4\pi} V_q N_q} \quad (10\text{-}9)$$

$$K_{ru} = \sqrt[3]{\frac{3}{4\pi} K_{vq} K_n} = K_{rq} \sqrt[3]{\frac{6}{\pi} K_n} \quad (11\text{-}9)$$

And $\frac{r_u}{r_q} = \sqrt[3]{\frac{6}{\pi} N_q}$ as before (12-9)

10.Inflationary history of he universe

Degree of freedom expansion of energy density in space is not restricted to micro scale as it is inside the quanton , but rather is extended to the macro scale or the cosmological level

This mechanism predisposes the expansion of space fabric to be in a spatially symmetrically shape , which restricts the inflation of the universe to be either in the form of sphere or shell .

The inflationary history of the universe comprises two phases

10.a-Inflation in a spherically shaped universe

Under which the rate of change of its comoving radius is $\frac{dr_u}{dt} > c$

the radius of the spherically shaped universe (where $V_u = K_{vu}t^2$)

is defined as $r_u = \sqrt[3]{\frac{3}{4\pi}V_u} = \sqrt[3]{\frac{3}{4\pi}K_{vu}}\ t^{\frac{2}{3}} = K_{ru}\ t^{\frac{2}{3}}$ **(1-10)**

and the rate of change of the universe radius is defined as

$\frac{dr_u}{dt} = \frac{d}{dt}(K_{ru}t^{\frac{2}{3}}) = \frac{2}{3}K_{ru}t^{-\frac{1}{3}}$ **(2-10)**

For earlier period of the universe's inflationary history (and especially for very small values of t < 1 second) the rate of change of the universe radius ($\frac{dr_u}{dt}$) was much greater than the constant (c).

Under primordial conditions, the universe radius grew from the dimensions of single quanton to that of the Planck era world by a 10^{80} fold and then by a further 10^{30} fold in just one second

As time passed, the rate of change of the universe radius dropped dramatically, which was viewed as a decelerating universe, until this rate of change of the universe's radius($\frac{dr_u}{dt}$) reached value equal to (c) , this instant corresponds to the transition time (t_r) defined as

$\frac{dr_u}{dt} = c = \frac{2}{3}K_{ru}\ t_r^{\frac{-1}{3}}$, $t_r = (\frac{2K_{ru}}{3c})^3$ **(3, 4-10)**

Transition time t_r= about 5 billion years ,

Beyond that the universe no longer follows the spherically shaped pattern.

For that era (spherically shaped) the universe radius , volume and their rates of change with time are

$1 - \frac{dV_u}{dt} = \frac{dV_u}{dr_u}\frac{dr_u}{dt} = 2K_{vu}t = (4\pi\ r_u^2)(\frac{2}{3}K_{ru}t^{-\frac{1}{3}}) = \frac{8\pi}{3}K_{ru}^3t$ **(4-10)**

And the Hubble parameter of that era would be equivalent to

$H(t) = \frac{\frac{dr_u}{dt}}{r_u} = \frac{\frac{2}{3}K_{ru}t^{-\frac{1}{3}}}{K_{ru}\ t^{\frac{2}{3}}} = \frac{2}{3\,t}$ **for** $t < t_r$ **(5-10)**

(Here the universe radius will be taken as a representative of the scalar

Parameter (a)) or $\frac{\frac{dr_u}{dt}}{r_u} = (\frac{\dot{a}}{a})$ (6-10)

This is the same solution of Friedmann's equations for matter dominated and decelerating universe (Einstein-Desitter model)

it's worth noting that the transition time is dependent on the energy content of the universe.

10.b- Inflation as a shell shaped

As the comoving rate of $(\frac{dr_u}{dt})$ for a spherically shaped universe decelerates to velocities < c beyond t= t_r , the inflationary momentum of the space fabric takes over as the driving force behind inflation (keeping in mind that quanton fields must expand at a fixed velocity that equals to c) , and from that instant on ,the universe expands at a constant velocity $\frac{dr_{uo}}{dt}$ = c , as this happened the shape of the universe no longer followed the spherical model , but rather it became a shell shaped.

Space fabric volume is defined by a hypothetical equivalent sphere whose radius

$r_{rue} = K_{ru}\, t^{\frac{2}{3}}$, $t > t_r$ (7-10)

shell shaped universe has an outer radius (r_o) and inner radius (r_i)

This happens as the volume created by the outer radius (r_o) (that expands at fixed velocity =c) which equals to $V_{uo}(= \frac{4\pi}{3} r_o{}^3)$ becomes greater than the volume space fabric itself (defined as $V_u = K_{vu}\ t^2$)

The universe volume , and its radius are related by the following equations

1- $r_o(t)(\text{ outer radius}) = c\,(t-t_r) + K_{ru}\ t_r{}^{\frac{2}{3}}$ (8-10)

2- V_u (volume of the shell shaped universe)

$= K_{vu} t^2 = \frac{4\pi}{3}(r_o{}^3 - r_i{}^3)$ (9-10)

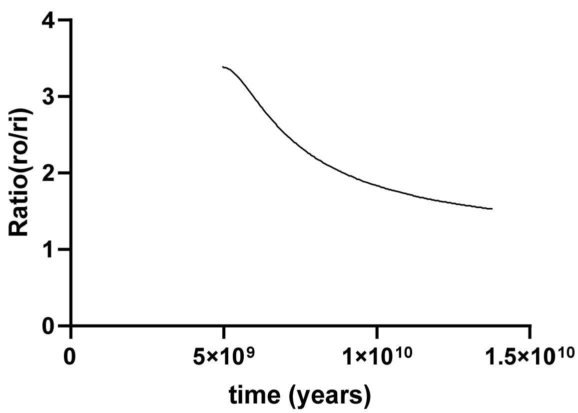
3- $\frac{dV_u}{dt} = \frac{dV_u}{dr_u}\ \frac{dr_u}{dt} = 2K_{vu}t = (\frac{dV_u}{dr_o}\ \frac{dr_o}{dt} - \frac{dV_u}{dr_i}\ \frac{dr_i}{dr_o}\ \frac{dr_o}{dt})$

$$= 4\pi\,(c\,r_o^{\,2} - c\,r_i^{\,2}\frac{dr_i}{dr_o}) = 4\pi c\,(r_o^{\,2} - r_i^{\,2}\frac{dr_i}{dr_o}) \qquad \textbf{(10-10)}$$

Those three equations have three unknowns r_o, r_i, $\frac{dr_i}{dr_o}$ (given that we have already postulated that $\frac{dr_o}{dt}$ = c),when solving for present day values the following results are obtained r_o= 1.54 x 10^{26} m , r_i= 1.01 x 10^{26} m , $\frac{dr_i}{dr_o}$=1.01 (11-10)

While the value of $\frac{dr_i}{dr_o}$ is always greater than zero in magnitude and assumes positive values, as negative values indicate narrowing inner void , positive values lesser than one indicate an outer radius growing at a higher rate than the inner radius , while values greater than one indicate a void inner radius which is growing at a rate greater than that of the outer radius

Ratios of outer and inner radii and their relative rate can be plotted versus time as shown in Fig.1 , Fig.2.



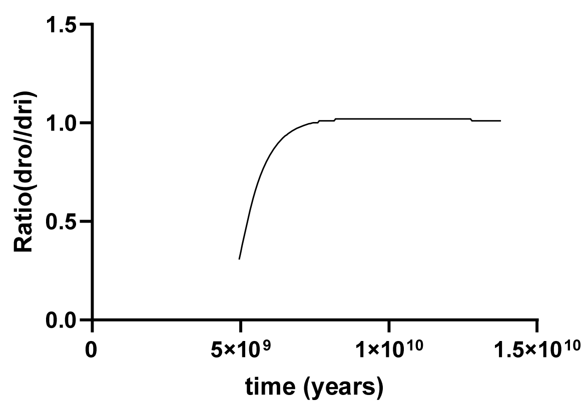


Fig.1 , Fig.2. Relative ratio between the universe outer and inner radii and their rates of change versus time

Alternatively , it can be shown that the volume enclosed by the outer radius increases at a rate that equals

$$\frac{dV_{uo}}{dt} = \frac{d}{dt}\left(\frac{4\pi}{3}\, r_o{}^3\right) = 4\pi\ \ r_o{}^2\, \frac{d\,r_o}{dt}\,, \qquad (12\text{-}10)$$

$$\frac{d\,r_o}{dt} = \frac{d}{dt}\left[c\ (t\text{-}t_r) + K_{ru}\ \ t_r{}^{\frac{2}{3}}\right] = c \qquad (13\text{-}10)$$

$$\frac{dV_{uo}}{dt} = 4\pi\ c\ \left[c\ (t - t_r) + K_{ru}\ \ t_r{}^{\frac{2}{3}}\right]^2 \quad \text{which is proportional to } (t^2) \qquad (14\text{-}10)$$

While space fabric expands at the rate of $\frac{dV_u}{dt} = 2\ \ K_{vu}\ \ t$ which is proportional to (t) The current values are $\frac{dV_{uo}}{dt} = 8.94\text{x}10^{61}\ m^3$/sec and for $\frac{dV_u}{dt} = 5.05\ \text{x}10^{61}\ m^3$/sec which indicates a lower rate of space fabric volumetric expansion than that of the outer sphere expansion , and this gap between the two expansion rates is widening with time

the relative ratios between outer sphere vs universe volume and their rates of change can be plotted against time as shown in Fig.3, fig.4.

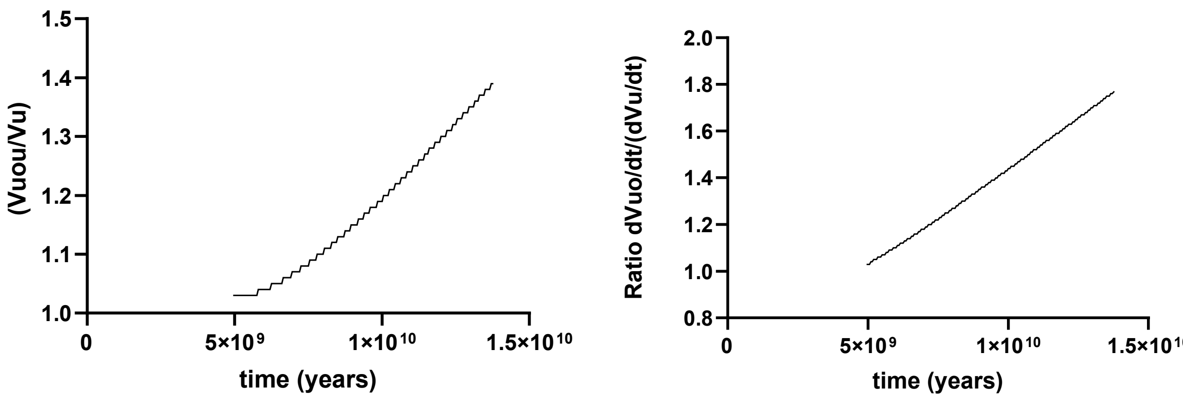


Fig.3, fig.4. Ratio between volumes of outer sphere and space fabric and consequently their rates which are increasing with time

An upper, mean , and a lower value of the Hubble parameter can then be established given that $r_m = \frac{1}{2}(r_0 + r_i)$, $\frac{dr_m}{dt} = \frac{c}{2}\left(1 + \frac{dr_i}{dr_o}\right)$ (15,16-10)

Lower limit : $H_L(t) = \frac{\frac{dr_0}{dt}}{r_0} = 1.94\ \text{x}10^{-18}$ m.sec^{-1}/m which corresponds to a value of 60.1 km/sec/mega parsec

Mean value $H_m(t) = \frac{\frac{dr_m}{dt}}{r_m} = \frac{\frac{dr_m}{dr_o}\frac{dr_o}{dt}}{r_m}$ =2.36x10^{-18} m/sec/m (17-10)

which corresponds to a value of 72.8 km/sec/mega parsec

While the upper limit $H_u(t) = \frac{\frac{dr_i}{dt}}{r_i} = \frac{\frac{dr_i}{dr_o}\frac{dr_o}{dt}}{r_i}$ = 2.99 x10^{-18} m/sec/meter

=92.8 km/sec/ mega parsec (18-10)

This value is physically meaningless as it relates to the expansion of the inner void The direct result one can draw from these values is the relative nature of the Hubble parameter since the uniformity and homogeneity of space fabric does not translate into uniformity of inflation, but it reflects uniformity of volumetric expansion of space fabric , as the relative values of the Hubble parameter reflect the progressive thinning of the shell .

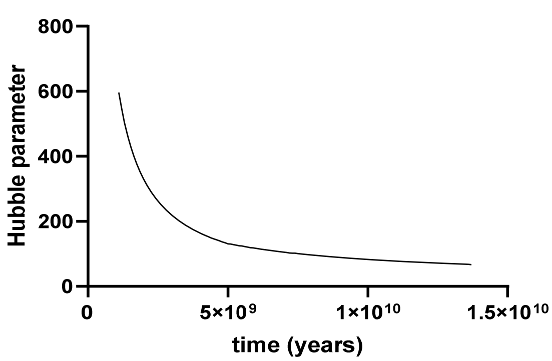
Instead , the CMB red shift can be used as an alternative means of assessing the inflation of the universe where

$H_o\ (CMB) = \frac{c}{r_{ueo}}$ (19-10)

r_{ueo} : radius of the equivalent sphere at present day = 1.38X10^{26} m

For the current values $H_o\ (CMB)$ =2.17x 10^{-18} m/sec/meter which is equivalent to 67.3 km/sec/mega parsec .

The following figures show variation of the Hubble parameter for the CMB case (Fig.5.) and for inner and outer radii of the universe (Fig.6.)



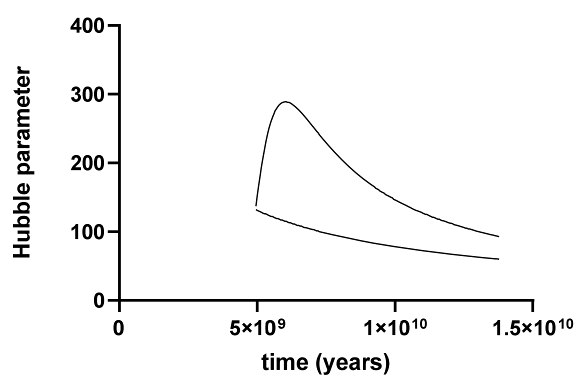


Fig.5. Hubble parameter for cosmic microwave background H(CMB) versus time , while Fig.6. shows Hubble parameter for both the inner and outer radii versus time

10.c observational findings

recent research work indicate that

1- the universe is closed in contrast to the long held view of a flat universe [11] ,[12]

2.a- expansion rate of the universe is not the same everywhere

2.b-and more importantly , there is a directional dependence of the expansion rate [13] ,[14]

11. Possible complex inflationary models

We have discussed only a single inflationary model of the form

(a) α $t^{\frac{2}{3}}$, to allow for a complex model , with different inflationary modes , while preserving the symmetries of the quanton / cosmological relative ratios with time relative ratio ,the Planck time must be altered , not only this but the smooth parameter transition between different phases must be ensured.

For inflation of the form (a) α $t^{\frac{1}{2}}$,the variation the parameter/ degree of freedom / time relationship takes the form

$\mathbf{Dof_{r_q}} = \frac{3}{8} = \mathbf{Dof_{\omega}} = \frac{1}{2}\,\mathbf{Dof_t}$ **or** $\mathbf{Dof_t} = \mathbf{Dof_{r_q}} + \mathbf{Dof_{\omega}} = \frac{3}{4}$

$\mathbf{Dof_{V_q}}$ **(quanton volume)= 3** $\mathbf{Dof_{r_q}} = \frac{9}{4}\,\mathbf{Dof_t}$ **,**

$\mathbf{Dof_{V_u}}$ **= 4** $\mathbf{Dof_{r_q}} = \frac{3}{2}\,\mathbf{Dof_t}$ **,**

$\mathbf{Dof_{r_u}}$**(universe radius) =** $\frac{1}{3}\,\mathbf{Dof_{V_u}} = \frac{1}{2}\,\mathbf{Dof_t}$

Which requires Planck time to be

$t_p = \frac{t_o}{(8.08 \times 10^{60})^{\frac{2}{3}}}$ **=1.08 x** 10^{-23}**sec so as to preserve the symmetry between parameter relative ratios and that of time.**

While inflation of the form (a) α t (constant inflation at v= c) requires

Planck time to become $t_p = t_o(8.08 \text{ x } 10^{60})^{\frac{1}{3}}$ =.00217 sec

The very close match between quanton , cosmological parameter ratios to that of time ($\sqrt[2]{8.08 \text{ x } 10^{60}}$ per Degree of freedom) suggests a uniform inflationary history of the nature $r_u = K_{ru}\, t^{\frac{2}{3}}$ as discussed before

Should there be any deviation from this model , the deviation would have been manifested directly in the form of significant variation between the quanton / cosmological relative ratios and that of time , as an example of this is the radiation dominated era (up to 380 k years)

which is defined as a α $t^{\frac{1}{2}}$ under such conditions $r_u = K_{ru}\, t^{\frac{1}{2}}$, $V_u = K_{ru}\, t^{\frac{3}{2}}$

and the cumulative ratio of present day to Planck era's volume of the universe $(\frac{V_{uo}}{V_{up}}) = (\frac{V_{uo}}{V_{ur2}})(\frac{V_{ur2}}{V_{ur1}})(\frac{V_{ur1}}{V_{up}})$ where V_{ur1} , V_{ur2} the volume at the start and end of radiation dominated era – V_{ur1} maybe taken to be identical to Planck era volume) , the value of the ratio $\frac{V_{ur2}}{V_{ur1}} = (\frac{t_{r2}^{\frac{3}{2}}}{t_{r1}^{\frac{3}{2}}})$ is smaller than the that of the uniform model $\frac{V_{ur2}}{V_{ur1}} = (\frac{t_{r2}^{2}}{t_{r1}^{2}})$, any ratio that deviates from the second order variation is going to impact the overall ratio of the universe's volume and deviates substantially from the closely matched value of the time ratio .

This is particularly true for the case of primordial time where for small values of (t) , the deviations become considerably high

The other alternative to preserve the symmetry of ratios is to allow for the use of Another value of Planck time as illustrated previously

12.inflationary theory and standard cosmology versus quanton model

as the quanton model differs in some aspects from existing inflationary theory and

standard cosmology , it would be beneficial to highlight the major differences

Time /event	Inflationary theory	Single quanton model
t=0	Singularity event	packet state (energy nonvarying in space or time) $E_p = E_s\ E_t$
t<t_s ($1.15\text{x}10^{-164}$ sec)	No data	Free energy dominated $E_q = E_{sf}\ E_{tf}$
t=t_s	No data	Evolution of single quanton E_q=$(E_{sf}E_{tc})(E_{sc}E_{tf})$
t_s<t <t_p (5.39x10^{-44} sec)	No data	-Quanton splitting and inflation , subsequent release of radiation energy -rapid but otherwise uniform inflation
t= t_p	Radiation dominated , the threshold of laws of physics	
10^{-32}>t >10^{-36}	Hyper Inflationary period	
t >10^{-32}	Start of nucleosynthesis	
Radiation dominated era	Slow inflation (a) α $t^{\frac{1}{2}}$	Inflation under a comoving rate $\frac{dr_u}{dt}$ > c , the universe is spherical in shape -r_u α $t^{\frac{2}{3}}$, $\frac{dr_u}{dt}$ α $t^{\frac{-1}{3}}$
Matter dominated era t<9 G years inflation	decelerating inflation (a)α $t^{\frac{2}{3}}$	
Dark energy dominated inflation	Accelerated inflation (a) α $e^{H_o t}$	Inflation under a constant rate $\frac{dr_u}{dt}$ = c , the universe moves to a shell like shape

between both of them

table.3 illustrates main timeline differences between the inflationary theory / standard cosmology and the quanton model

table 3. time line differences between inflationary theory /standard cosmology and quanton based model

It must be noted that when talking about energy density as a primary parameter its uniform expansion corresponds to a uniform volumetric expansion of space fabric as a quantum gas model

The following table 4 illustrates major differences between standard cosmology and the quanton model

parameter	Standard cosmology	Quanton based model
radiation	Dominant energy in and immediately after Planck era	Radiation is a by-product of quanton expansion
Origin of the universe inflation	No consensus : quantum fluctuations /dark energy /radiative pressure	Self interaction of space and time varying energy fields which lead to quanton expansion and splitting
Nature of inflation	uniform spatial inflation throughout (Hubble parameter is an absolute measure of the universe's inflation)	uniform volumetric inflation (Hubble parameter allowed to have relative values)
Representative Measurement of the universe's inflation	Supernova type Ia red shift	CMB red shift
Shape of the curvature	Determined by density parameter	always satisfies spatial symmetry which implies being either a sphere of shell in shape
Role of energy density	Determines the inflationary model	Can only control the rate of inflation The quanton model evolved to expand (up till now)
Decelerating inflation era	Due Matter dominated era	While expanding as a sphere : rate of increase of universe volume α (t) , while the rate of change of its radius α ($t^{\frac{-1}{3}}$)
Accelerating expansion of the universe	Dominance of dark energy	refer to section : inflationary history of the universe
Inflationary fate determinant factor (perpetual expansion / eventual contraction)	Perpetual expansion when density less than critical density	Interactions inside and outside the quanton determine the fate of the inflation

table 4. Major differences between standard cosmology and quanton model (b)

(13) ethical statement

The author declares that this work fully complies with the ethical guidelines as had been stated by the journal

(14) Data availability

The data that support the findings of this study are available from the corresponding author, upon request or alternatively it can be downloaded via one of the following links

https://drive.google.com/file/d/1RSdswcJLUnYOTmc4__GxVomr_556D7Ri/view?usp=sharing

or

https://archive.org/details/calculations-24

(15) Discussion

This model had provided a profile for quanton and cosmological parameter variation with time through the degree of freedom approach and one of the most significant consequences is the development of (Einstein –De sitter) inflationary model using this method as an alternative to Friedmann equations in a *closed universe cosmology*

Through fixed parameter time constants a truly nonaccelerating universe had been proposed , furthermore an answer to the (cosmological horizon problem) was provided in the form of synchronized quanton and consequently cosmological parameters

(16) conclusions

a-Qunton splitting is the mechanism of allowing four dimensional energy density to expand in three dimensional space with minimal losses .

b-Relative ratios of quanton and cosmological parameters like quanton number , its radius , angular frequency, universe volume , and its density are remarkably related due to the energy density- degree of freedom relationship .

c-Synchronization of the quanton's parameters (and subsequently the universe's) happens as the time variation is split anti symmetrically between space varying (quanton radius) degree of freedom and time varying (angular frequency) degree of freedom .

(17) References

[1] Benisty D , Guendelman E I . unified dark energy and dark matter from dynamical spacetime , Phys. Rev. D 98, 023506

URL https://doi.org/10.1103/PhysRevD.98.023506

[2] W. Wang , Y. Gui , S. Zhang , G. Guo , Y. Shao , the Unified Equation of State for Dark Matter and Dark Energy ,

Modern Physics Letters A Vol. 20, No. 19, pp. 1443-1449 (2005)

URL https://doi.org/10.1142/S0217732305016877

[3] Farnes J S. A unifying theory of dark energy and dark matter: negative masses and matter creation within a modified ΛCDM framework .

Astronomy & Astrophysics 620 , A 92 (2018)

URL https://doi.org/10.1051/0004-6361/201832898

[4] Bartolo N , Matarrese S. Unified Dark Matter Scalar Field Models

Advances in Astronomy / 2010/ 904379

URL https://doi.org/10.1155/2010/904379

[5] Man Ho C , Scherrer R J. anapole dark matter.

Physics Letters B , vol 722, Issue 4–5, 24 May 2013, P 341-346

URL https://doi.org/10.1016/j.physletb.2013.04.039

[6] Kassem A. quanton based model of field interactions

URL http://vixra.org/abs/1912.0314

[7] Ray S, Mukhopadhyay U, Ghosh P P . Large Number Hypothesis : a review

URL https://arxiv.org/abs/0705.1836

[8] Shemi-zadeh V E . Coincidence of large numbers, exact value of cosmological parameters and their analytical representation

URL https://arxiv.org/pdf/gr-qc/0405002.pdf

[9] Oldershaw R L. 1989a, Towards A Resolution Of The Vacuum energy Density Crisis.

URL https://arxiv.org/abs/0901.3381

[10] Valev D. Estimations of total mass and energy of the universe

Physics International 5 (1): 15-20, 2014

URL doi:10.3844/pisp.2014.15.20

[11] Valentino E Di , Melchiorri A , Silk J. Planck evidence for a closed Universe and a possible crisis for cosmology , Nat Astron 4, 196–203 (2020)

URL https://doi.org/10.1038/s41550-019-0906-9

[12] Handley W. Curvature tension: evidence for a closed universe

URL https://arxiv.org/pdf/1908.09139.pdf

[13] Qi J , Cao S , Zhang S , Biesiada M , Wu Y , Zhu Z.

The distance sum rule from strong lensing systems and quasars – test of cosmic curvature and beyond,

Monthly Notices of the Royal Astronomical Society, Volume 483,

Issue 1, February 2019, Pages 1104–1113

URL https://doi.org/10.1093/mnras/sty3175

[14] Migkas K , Schellenberger G , Reiprich T H , Pacaud F ,
Ramos-Ceja M E , Lovisari L . Probing cosmic isotropy with a new X-ray
galaxy cluster sample through the LX-T scaling relation

Astronomy &Aastrophysics , vol 636 (2020) A15

U R L https://doi.org/10.1051/0004-6361/201936602