Symmetries in the universe , a quanton origin

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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 , in addition , he had a firm belief that such recurrences were not pure coincidence but rather the result of symmetries on the micro scale which found their manifestations on a macro scale [1]

here, we will discuss some of the 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

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 [2] ,[3] , and even more recent work proposed that dark

matter is an exotic form of electromagnetic waves [4]

“The quanton based model of field interactions” [5], introduced the concept of energy constraining , how space and time varying energy fields can be contained inside the quanton, which is a quantum entity

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

1.Physical basis of this model

a-at any time , vacuum energy density is the summation of quanton energy densities which have statistically distributed frequencies

b- the quanton frequencies can be replaced by a single equivalent frequency which represents the statistical mean of all 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/m3) (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)

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

universe- excluding normal matter and radiation)

$\varrho_v = E_q\, v_c$ (7-2)

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

quanton , v_c : constant depends on the geometry of the quanton)

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

$V_u = \frac{V_q N q}{v_c}$ (V_u : universe volume) **(9-2)**

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

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)**

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

and the quanton energy density is in the form

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

to assess the entire energy stored in both fields ,the quanton packet energy be equal to the volumetric integration

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

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

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

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

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

Which has the value of 1.576 x 10^{-62} $\mathrm{j.sec^4/m^3}$,

to relate the average energy density E_q to it maximum value

$\mathrm{E_{qo}}$, we use the quanton/ anti quanton expansion model

$\mathrm{E_q}$=$[\frac{1}{2}(\mathrm{E_{qf}} + \mathrm{cE_{qc}})]$ $[\frac{1}{2}(\frac{\mathrm{E_{qf}}}{\mathrm{c}} + \mathrm{E_{qc}})]$,

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

$\mathrm{E_q}$=$\mathrm{E_{qfo}}$ cos ($\frac{\pi r}{2r_q}$-ωt) $\mathrm{E_{qco}}$ cos ($\frac{\pi r}{2r_q}$-ωt) = $\mathrm{E_{qo}}$ $\cos^2(\frac{\pi r}{2r_q}$-ωt) (15-2)

The average value of a periodic function is defined as

$\mathrm{E_q}$ = $\frac{1}{T}\int_0^T \mathrm{E_{qo}}\ (t)$

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

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

$\mathrm{E_{qo}}$ = 2 $\mathrm{E_q}$ = $\frac{h\,\omega^4}{8\pi^4\ c^3}$ (16-2)

the quanton volume is represented by an equivalent volume that

equals 8 $r_q{}^3$,

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})

$\varrho_v = \sum_i^{N_q} \varrho_{vi}$, 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

$$\varrho_v = E_q \tag{17-2}$$

When dealing with the approximative method to determine the energy density constant ,given that the quanton packet energy is defined as

$E_p = \frac{hc}{2r_q}$ and , assuming the uniformity of the field across the length of the radius , the packet energy becomes $E_p(a) = \frac{hc}{2r_q}(\frac{a}{r_q})$

this uniformity of the fields inside the quanton allows for integration

of the form $\mathbf{E_p} = \int_{V_q} \mathbf{E_q}\ \mathbf{d\,V} = \mathbf{E_q} \int_{V_q} \mathbf{d\,V}$ **(18-2)**

this uniformity would lead to a highly symmetric quanton shape as

well (a sphere) , now quanton energy density becomes

$\mathbf{E_q} = \frac{\mathbf{E_p}}{\int_{V_q} \mathbf{d\,V}} = \frac{\mathbf{h\omega}}{(2\pi)(\frac{4\pi}{3}\mathbf{r_q}^3)}$ $\left(\mathbf{r_q} = \frac{\pi c}{\omega} \right)$ **, substituting for** $r_q{}^3$

$$\mathbf{E_q} = \left(\frac{3h\omega}{(2\pi)(4\pi)} \right)\left(\frac{\omega^3}{\pi^3 c^3} \right) = \frac{3h\,\omega^4}{8\pi^5 c^3} = \mathbf{h_q}\omega^4 \qquad \textbf{(19-2)}$$

which is the linear energy density / degree of freedom relationship

here ,energy density constant $\mathbf{h_q} = \frac{3\,h}{8\,\pi^5 c^3}$ **, the ratio between the this**

value and that obtained through the analytical method is ($\frac{\pi}{6}$**) , the link**

between the two methods can be shown to be the result to total

energy of the universe (excluding normal matter and radiation) and

its volume are related to those of the quanton

$$\varrho_v = \frac{E_u}{V_u} = \frac{v_c\, E_p\, N_q}{V_q\ N_q} = \frac{v_c\, E_p}{V_q}$$

Table 1. shows why the vacuum energy density is uniform throughout Space as both the analytical and the approximative method give the same results

parameter	Analytical method	Approximative method
Integration volume	Universe volume	n/a
Quanton equivalent volume	$\frac{\text{Universe volume}}{\text{number of quantons}}$	$\frac{4\pi}{3}\, r_q{}^3$
Quanton shape	cubic	spherical
Quanton dimensions	Each side = 2 r_q	Radius = r_q
Density constant h_q	$\frac{h}{16\pi^4 c^3}$	$\frac{3\,h}{8\pi^5 c^3}$
Energy density inside the quanton	E_q (=$\frac{E_{qo}}{2}$)	$(\frac{6}{\pi})E_q$
Free and constrained field	Inside and outside quanton (Propagate throughout space)	Inside quanton only
Volumetric constant v_c	One	$\frac{\pi}{6}$
Vacuum energy density	E_q	E_q

Table 1.differences between the analytical and approximative method of determining the quanton energy density constant h_q

the density constant derived through the analytical method will be

used from here on so as to generate the quanton parameters ,

given the vacuum energy density at any instant in time is known

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} gm /cm^3 or the equivalent to 8.65 x 10^{-10} j /m^3 [6]

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

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

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

Quanton volume V_{qo} = 1.86 x 10^{-12} m^3

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

Number of quantons per cubic meter = $\frac{V_c}{V_q}$ **=5.36 x**10^{11}

the total mass in the universe is estimated to be close to 10^{53} **kgs**

(**based on hoyle formula** $M_u = \frac{c^3}{2GH}$ **) which corresponds to**

10^{70} **joules [7] , the equivalent number of quantons is**

$N_{qo} = \frac{E_u}{E_{po}}$ **= 5.9 x**10^{90} **quantons**

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 defined as $\frac{E_{pp}}{{L_p}^3}$ = 4.63 x10^{113} j/m^3 this theoretically derived value 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 hence vacuum energy density the Planck energy density has to be divided by a

factor of (2^3) to obtain a value of $\varrho_{vp} = 5.79 \times 10^{112}$ j /m^3

same result can be obtained for the vacuum energy density ,using the

simplified method when dividing by a factor of $(\frac{4\pi}{3})$ x$(\frac{6}{\pi})$ = 8

The angular frequency that corresponds to that energy density

$$\omega_p = \left(\frac{E_{qp}}{h_q}\right)^{.25} = 4.37 \times 10^{+43} \text{ rad /sec}$$

and the corresponding quanton radius $r_{qp} = \frac{\pi c}{\omega_p} = 2.15 \times 10^{-35}$ m ,

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

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

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}

universe volume $V_{up} = \frac{\text{qunaton volume} * \text{number of quantons}}{\text{volumetric constant}} = \frac{V_{qp}N_{qp}}{v_c} =$

1.73 x $10^{-43} m^3$

universe radius r_{up}= $\sqrt[3]{\frac{3 \text{ x } V_{up}}{4\pi}}$ = 3.4 x 10^{-15} m

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 2

Relative ratio	description	symbol	value	Degrees of freedom	remarks
Qunton number	$\frac{\text{number of quntons now}}{\text{Planck era nuner of quantons}}$	$\frac{N_{qo}}{N_{qp}}$	2.73×10^{30}	one	
Quanton radius	$\frac{\text{qunton radius now}}{\text{Plank era qunton radius}}$	$\frac{r_{qo}}{r_{qp}}$	2.86×10^{30}	one	
Quanton volume	$\frac{\text{qunton volume now}}{\text{Plank era qunton volume}}$	$\frac{V_{qo}}{V_{qp}}$	$2.33 \times 10^{91} = (2.83 \times 10^{30})^3$	three	
Angular frequency	$\frac{\text{qunton ang. frequency now}}{\text{Plank era ang. frequency}}$	$\frac{\omega_o}{\omega_p}$	2.86×10^{30}	one	
Energy density ratio	$\frac{\text{energy density now}}{\text{Plank era energy density}}$	$\frac{\varrho_{vo}}{\varrho_{vp}}$	$1.49\ X\ 10^{-122} = (\frac{1}{2.86 \times 10^{30}})^4$	four	
Universe radius ratio	$\frac{\text{universe radius now}}{\text{Plank era universe radius}}$	$\frac{r_{uo}}{r_{up}}$	$4.46 \times 10^{+40}$ $(= 3.07 \times 10^{30})^{\frac{4}{3}}$	$\frac{4}{3}$	Shell shaped
Universe radius ratio	$\frac{\text{universe(equivalent) radius now}}{\text{Plank era universe radius}}$	$\frac{r_{ueo}}{r_{up}}$	$4.0 \times 10^{+40}$ $(= 2.83 \times 10^{30})^{\frac{4}{3}}$	$\frac{4}{3}$	* (1) (equivalent sphere shaped)
Universe volume ratio	$\frac{\text{universe volume now}}{\text{Plank era universe volume}}$	$\frac{V_{uo}}{V_{up}}$	$6.37 \times 10^{121} = (2.82 \times 10^{30})^4$	Four*	
Universe to quanton radii ratio (now)	$\frac{\text{universe radius now}}{\text{quanton radius now}}$	$\frac{r_{uo}}{r_{qo}}$	2.50×10^{30}		**(2)
Universe to quanton radii ratio (Planck)	$\frac{\text{planck era universe radius}}{\text{Plank era quanton radius}}$	$\frac{r_{up}}{r_{qp}}$	$1.61 \times 10^{+20}$ $(= 2.03 \times 10^{30})^{\frac{2}{3}}$		
Time ratio	$\frac{\text{time now}}{\text{Planck era time}}$	$\frac{t_o}{t_p}$	$8.08 \times 10^{60} = (2.84 \times 10^{30})^2$		***(3)

Table 2. Various ratios and their relationship to energy degrees of freedom

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

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

= $(4.46 \text{ x}10^{40})$ $(1.61 \text{ x } 10^{20})$ $\frac{1}{(2.86 \text{ x}10^{30})}$

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

to note that

1-by comparing values for the universe volume ratio $\frac{V_{uo}}{V_{up}}$ =

6.37 $\text{x } 10^{121} = (2.82 \text{ x } 10^{30})^4$ with the quanton volume ratio

$\frac{V_{qo}}{V_{qp}}$ = 2.33 $\text{x } 10^{91} = (2.83 \text{ x}10^{30})^3$, and that of the quanton number

ratio $(2.73 \text{ x}10^{30})$, one can draw the conclusion that the process of

four dimensional energy density expansion (inside the quanton)

into three dimensional space can be achieved through the quanton

splitting mechanism

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 $E_u = \frac{hc}{2\ r_{qs}}$

and since there is no data about the energy density at the era the starting point would be the use of the single quanton radius

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 ,

$\omega_s = \frac{\pi c}{r_{qs}}$**= 9.93 x 10^{+103} rad /sec**

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

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

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

those values lead to the development of another set of ratios this time relating them to Planck era as is shown in table.3

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	$\frac{\text{Plank era universe radius}}{\text{single quanton radius}}$	$\frac{r_{up}}{r_{qs}}$	$2.80 \times 10^{+80}$ $= (2.16 \times 10^{60})^{\frac{4}{3}}$	$\frac{4}{3}$	*(1) , **(2)
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 3. Various ratios (Planck era parameters to that of single quanton) and their relationship to energy degrees of freedom

***(1) for the particular case of single quanton**

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

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

****(2) 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): $\frac{r_{us}}{r_{qs}} = \sqrt[3]{\frac{6}{\pi}}$,

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

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

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

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

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

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} $(= (2.17 \text{ x } 10^{60})^2$ **) ,**

$t_s = 1.15 \text{ x } 10^{-164} \text{ sec}$ **(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 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

$(\mathbf{10^{-15}\ m})$

b- and the very fast rate of quanton splittings ($= \mathbf{2.17\ x\ 10^{60}}$)

in a time span less than Planck time (which is equivalent to double

order of magnitude of the splittings that occurred throughout the

remaining life span of the universe),

these figures might be helpful in understanding , for now , where the

source of the primordial of radiation came from

6.<u>energy density as an independent parameter</u>

it can be argued that there exists an infinite number of possible

combinations for the values of $\mathbf{r_q}$, $\boldsymbol{\omega}$ and $\mathbf{h_q}$ that would result in

similarities between quanton and universe relative ratios ,

when plotting energy density against both the quanton radius ($\frac{1}{{r_q}^4}$)

and angular frequency (ω^4) the intersection of both curves defines

the unique quanton radius and angular frequency that corresponds to a specific energy density

in other words, every energy density defines a specific quanton radius and angular frequency and this is due to the fact that the density constant (h_q) is defined in terms of physics as well as geometry, once both r_q , ω are known , the quanton packet energy E_p is also known , not only this , the quanton radius defines a specific number of quantons per cubic meter ,

this dependence on the energy density does not stop there , the total number of quantons and subsequently the volume of the universe itself can be determined , all this in terms of a single independent parameter

7. Time variation -energy degree of freedom relationship

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

$$\mathbf{r_q = K_r \sqrt[2]{t}} \quad \textbf{(1-7)}$$

and the angular frequency $\omega=\frac{K_\omega}{\sqrt{t}}$ **(2-7)**

$\mathbf{K_r}$, $\mathbf{K_\omega}$ **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

asymmetric 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

$$\mathrm{Dof}_{r_q} = 1 = \mathrm{Dof}_{\omega} = \frac{1}{2}\,\mathrm{Dof}_t \quad \text{or} \quad \mathrm{Dof}_t = \mathrm{Dof}_{r_q} + \mathrm{Dof}_{\omega} = 2 \qquad (3,4\text{-}7)$$

$$\mathrm{Dof}_{V_q} \text{ (quanton volume)} = 3\,\mathrm{Dof}_{r_q} = \frac{3}{2}\,\mathrm{Dof}_t \ , \qquad (5\text{-}7)$$

$$\mathrm{Dof}_{N_q} \text{ (number of quantons)} = 1 = \frac{1}{2}\,\mathrm{Dof}_t \qquad (6\text{-}7)$$

$$\mathrm{Dof}_{V_u} = 4 = 4\,\mathrm{Dof}_{r_q} = 2\,\mathrm{Dof}_t \ , \qquad (7\text{-}7)$$

$$\mathrm{Dof}_{r_u}\text{(universe radius)} = \frac{1}{3}\,\mathrm{Dof}_{V_u} = \frac{4}{3} = \frac{2}{3}\,\mathrm{Dof}_t \qquad (8\text{-}7)$$

$$\mathrm{Dof}_{\varrho_v} \text{ (energy density)} = 4\,\mathrm{Dof}_{r_q} = 4 = 2\,\mathrm{Dof}_t \qquad (9\text{-}7)$$

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

$$x(t) = K_x\, t^{+/-\left(\frac{\mathrm{Dof}_x}{2}\right)} \qquad (10\text{-}7)$$

to preserve the wave behavior the constan*ts* K_r **,** K_{ω} **must be related such that** $r_q = \frac{\pi c}{\omega}$ **hence** $K_r\ K_{\omega} = \pi c$

other wave relations still apply ,

wave period : $T(t) = K_T\sqrt{t}$, wave number $k = \frac{K_k}{\sqrt{t}}$, (11-7)

$\frac{2\pi K_r}{K_T} = c \; (= \frac{\lambda}{T})$, $\frac{K_\omega}{K_k} = c \; (= \frac{\omega}{k})$ (12,13-7)

$K_T K_\omega = 2\pi \; (= \omega T)$, $K_k K_r = 1 \; (= \frac{k\lambda}{2\pi})$ (14,15-7)

8.quanton and cosmological parameter variation with time

1-Number of quantons: N_q , with a ratio $(2.73 \text{ x } 10^{30})$ should be

ideally related to time variation by the relationship

$$N_q(t) = K_n \; t^{\frac{1}{2}} , \tag{1-8}$$

$N_q(t)$: 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 (2-8)

2-quanton radius $r_q(t) = k_{rq} \; t^{\frac{1}{2}}$ (3-8)

$$\frac{dr_q}{dt} = \frac{1}{2} K_r \ t^{\frac{-1}{2}} \quad (4\text{-}8)$$

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

$$\frac{d\omega}{dt} = \frac{-1}{2} K_\omega \ t^{\frac{-3}{2}} \quad (5\text{-}8)$$

alternatively $\omega(t) = \frac{\pi c}{r_q} = \frac{\pi c}{K_r \ t^{\frac{1}{2}}}$ $\quad (K_\omega = \frac{\pi c}{K_r}) \quad$ **(6-8)**

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

4- quanton packet energy $E_p(t) = \frac{h\omega}{2\pi} = \frac{1}{2\pi} K_\omega h \ t^{\frac{-1}{2}}$ **(8-8)**

$$\frac{dE_p}{dt} = \frac{-K_\omega h \ t^{\frac{-3}{2}}}{4\pi} = \frac{-hc}{4\pi \ K_r} t^{\frac{-3}{2}} \quad (9\text{-}8)$$

5-quanton volume $V_q(t) = K_{vq} \ t^{\frac{3}{2}}$ **(10-8)**

$$\frac{dV_q(t)}{dt} = \frac{3}{2} K_{vq} \ t^{\frac{1}{2}} \quad (11\text{-}8)$$

6- energy density $\varrho_v(t) = K_\varrho \ t^{\frac{-4}{2}} = K_\varrho \ t^{-2}$ **(12-8)**

$$\frac{d\varrho_v}{dt} = -2\ K_\varrho\ t^{-3} \qquad \textbf{(13-8)}$$

9.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) = $(\frac{N_q(t)\ V_q\ (t)}{v_c})$

$$=(\frac{1}{v_c})\ (\ K_n\ \ t^{\frac{1}{2}}\ )(\ \ K_{vq}\ \ t^{\frac{3}{2}}\ ) =(\frac{1}{v_c})\ \ K_n\ \ K_{vq}\ \ t^2 = K_{vu}\ \ t^2 \quad (1\text{-}9)$$

where $K_{vu} = \frac{K_{vq}K_n}{v_c}$ **(2-9)**

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

$$\frac{dV_u}{dt} =(\frac{1}{v_c})\ (N_q\ \frac{dV_q}{dt}+\frac{dN_q}{dt}V_q\ \ ) \quad (3\text{-}9)$$

$$=(\frac{1}{v_c})\ [(\ K_n\ \ t^{\frac{1}{2}}\ )(\ \frac{3}{2}\ K_{vq}\ \ t^{\frac{1}{2}}\ )+ (\ \frac{1}{2}\ K_n\ \ t^{-\frac{1}{2}}\ )(\ K_{vq}\ \ t^{\frac{3}{2}}\ )] \quad (4\text{-}9)$$

$$\frac{dV_u}{dt} = \left(\frac{K_n K_v}{v_c}\right)\left(\frac{3}{2}t + \frac{1}{2}t\right) = \frac{2K_n K_v t}{v_c} = 2\,K_{vu}\,t \qquad (5\text{-}9)$$

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

$$r_u = \sqrt[3]{\frac{3}{4\pi}V_u} = r_q\,\sqrt[3]{\frac{3V_q N_q}{4\pi v_c}} = r_q\,\sqrt[3]{\frac{6}{\pi}N_q} \qquad (6\text{-}9)$$

$$r_u(t) = \left(K_{rq}\,t^{0.5}\right)\left(\sqrt[3]{\frac{6K_n}{\pi}}\;t^{\frac{1}{2*3}}\right) = K_{rq}\sqrt[3]{\frac{6K_n}{\pi}}\;t^{\frac{2}{3}} \qquad (7\text{-}9)$$

$$= K_{ru}\,t^{\frac{2}{3}} \qquad (8\text{-}9)$$

$$\frac{dr_u}{dt} = \frac{2}{3}\,K_{ru}\,t^{\frac{-1}{3}} \qquad (9\text{-}9)$$

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, and to illustrate this symmetry of parameter variation is maintained throughout the history of the universe and not just to those particular instances which we have selected previously another

set of relative ratios for two further points at $t_x = 400000$ y ,

9 G years are provided with respect to present day parameter which

are presented in table.4

ratio	ratio	symbol	Relative ratio at (t_x)= 9 G years	Relative ratio at (t_x)= 400,000 y	remarks
Number of quantons	$\frac{\text{no of qunton now}}{\text{no of quantons at (x) years}}$	$\frac{N_{qo}}{N_{qx}}$	1.24	186	
Quanton radius	$\frac{\text{quanton radius}}{\text{qunton radius at (x) years}}$	$\frac{r_{qo}}{r_{qx}}$	1.24	186	
Quanton volume	$\frac{\text{qunton volume now}}{\text{qunton volume at (x)years}}$	$\frac{V_{qo}}{V_{qx}}$	1.89 $(1.236)^3$	6.3942 X 10^6 $(186)^3$	
Quanton frequency	$\frac{\text{quanton frequency now}}{\text{frequency at (x) years}}$	$\frac{E_{po}}{E_{px}}$	0.808 $(\frac{1}{1.24})$	0.00539 $(= \frac{1}{186})$	
Energy density ratio	$\frac{\text{Plank era energy density}}{\text{energy density at (x)years}}$	$\frac{E_{qo}}{E_{qx}}$	0.42657 $(\frac{1}{1.238})^4$	$8.42\ X10^{-10}$ $(\frac{1}{186})^4$	
Universe radius ratio	$\frac{\text{universe radius now}}{\text{universe radius at (x)years}}$	$\frac{r_{uo}}{r_{ux}}$	1.32 $(1.236)^{\frac{4}{3}}$	1059 $(186)^{\frac{4}{3}}$	spherical shaped)
Universe volume ratio	$\frac{\text{universe volume now}}{\text{volume at (x)years}}$	$\frac{V_{uo}}{V_{ux}}$	2.34 $(1.238)^4$	1.19 x 10^9 $(186)^4$	
Time ratio	$\frac{\text{time now}}{\text{time at (x)years}}$	$\frac{t_o}{t_x}$	0.42657 $(\frac{1}{1.238})^2$	$8.42 \text{ x } 10^{-10}$ $(\frac{1}{186})^2$	

Table 4. **quanton and cosmological parameter ratios at 400000 years, 9 G years**

10. 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

$$\mathbf{r_{qs} = quanton\ radius = K_{rq}\ \sqrt{t_s} = \frac{hc}{2\ E_u}}$$

$$\mathbf{K_{rq} = \frac{hc}{2\ E_u\sqrt{t_s}}} \qquad \textbf{(1-10)}$$

($\mathbf{t_s}$: time to single quanton , $\mathbf{E_u}$: universe's total energy

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

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

$$K_w = \frac{2\pi\sqrt{t_s}E_u}{h} \quad (2\text{-}10)$$

$$V_{qs} \text{ (quanton volume at S. Q)} = 8\ r_{qs}{}^3 = K_{vq}\ t_s^{\frac{3}{2}} \quad (3\text{-}10)$$

$$K_{vq} = 8\ K_{rq}{}^3 \quad (4\text{-}10)$$

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

$$K_{\varrho v} = \frac{v_c\, h\, K_w{}^4}{16\ \pi^4\ c^3} \quad (4\text{-}10)$$

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

$$K_n = \frac{1}{\sqrt{t_s}} \quad (5\text{-}10)$$

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**

$K_w = \frac{2\pi E_u}{h\, K_n}$ **and** $K_{rq} = \frac{hc\, K_n}{2\, E_u}$ **(6-10)**

Those two relations lead to the following definitions of the

quanton radius and angular frequency

$$r_q = \frac{hc}{2\pi E_u}\sqrt{\frac{t}{t_s}} \quad , \quad \omega = \frac{2\pi E_u}{h}\sqrt{\frac{t_s}{t}} \qquad (7,8\text{-}10)$$

and as to the cosmological parameters

$V_u = \frac{V_q N_q}{v_c}$ **which leads to** $K_{vu} = \frac{K_{vq} K_n}{v_c}$

while expanding into a sphere , the radius of the universe

$$r_u = \sqrt[3]{\frac{3}{4\pi} V_u} = \sqrt[3]{\frac{V_q N_q}{v_c}}$$

$$K_{ru} = \sqrt[3]{\frac{K_{vq} K_n}{v_c}} = K_{rq} \sqrt[3]{\frac{K_n}{v_c}} \qquad (9\text{-}10)$$

And $\frac{r_u}{r_q} = \sqrt[3]{\frac{N_q}{v_c}}$ **as before** **(10-10)**

11.Inflationary history of he universe

Dimensional energy symmetry or the equipartition 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

The expanding fields in space which are interacting with one another through the mechanism of energy degree of freedom, this ensures the homogeneity and uniformity of space fabric , this mechanism predisposes this 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 of shell shaped

The inflationary history of the universe comprises two phases

11.a-Inflation in a spherical shaped universe

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

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

is defined as $r_u = \sqrt[3]{\frac{3}{4\pi} V_u} = \sqrt[3]{\frac{3}{4\pi} K_{vu}} \; t^{\frac{2}{3}} = K_{ru} \; t^{\frac{2}{3}}$ (1-11)

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

$$\frac{dr_u}{dt} = \frac{d}{dt} (K_{ru} t^{\frac{2}{3}}) = \frac{2}{3} K_{ru} t^{-\frac{1}{3}} \qquad (2\text{-}11)$$

For earlier period of the universe's inflationary history (and especially for very values of t < 1 second) the rate comoving 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

$$\frac{dr_u}{dt} = c = \frac{2}{3} K_{ru}\ t_r^{\frac{-1}{3}} \quad , t_r = (\frac{2K_{ru}}{3c})^3 \qquad (3, 4\text{-}11)$$

transition time t_r= about 5 billion years ,

beyond that the universe no longer follows the spherical shaped

pattern

for that era (spherically shaped) the universe radius , volume and

their rates of change with time are

$$1 - \frac{dV_u}{dt} = \frac{dV_u}{dr_u}\frac{dr_u}{dt} = 2K_{vu}t = (4\pi\ r_u^{\ 2})(\frac{2}{3}\ K_{ru}t^{-\frac{1}{3}}) = \frac{8\pi}{3} K_{ru}^{\ 3}t \qquad (4\text{-}11)$$

and the Hubble parameter of that era would be equivalent to

$$H(t) = \frac{\frac{dr_u}{dt}}{r_u} = \frac{\frac{2}{3}K_{ru}t^{-\frac{1}{3}}}{K_{ru}\ t^{\frac{2}{3}}} = \frac{2}{3\ t} \qquad (5\text{-}11)$$

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

Parameter (a) or $\frac{\frac{dr_u}{dt}}{r_u} = \left(\frac{\dot{a}}{a}\right)$ **since no inter galactical distances are**

involved here)

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

<u>11.b- inflation in a spherical shell like</u>

as the comoving rate of $\left(\frac{dr_u}{dt}\right)$ **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 =

c) , and from that instant on the universe expands at a constant velocity

$\frac{dr_u}{dt}$ **= c , as this happens the shape of the universe no longer follows**

the spherical model , as it became a spherical shell like

space fabric literally migrates gradually across a hypothetical

spherical and progressively decelerating radius defined by $K_{ru}\, t^{\frac{2}{3}}$

so as to create a shell like shape with an outer radius (r_o**) and inner**

radius (r_i) **, this happens since 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-**$t_r$**) +**$K_{ru}\;\; {t_r}^{\frac{2}{3}}$ **(6-11)**

2- $V_u = K_{vu}t^2 = \frac{4\pi}{3}(r_o{}^3 - r_i{}^3)$ **(7-11)**

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

$= 4\pi\,(c\,r_o{}^2 - c\,r_i{}^2\frac{dr_i}{dr_o}) = 4\pi c\,(r_o{}^2 - r_i{}^2\frac{dr_i}{dr_o})$ **(8-11)**

Those three equations have three unknowns r_o, r_i , $\frac{dr_i}{dr_o}$ (given that we already postulated that $\frac{dr_o}{dt}$ = c),when solving for present day values

r_o= 1.54 x 10^{26} m , r_i= 1.01 x 10^{26} m , $\frac{dr_i}{dr_o}$=1.01

While the value of $\frac{dr_i}{dr_o}$ is always greater than zero in magnitude and assumes positive values, (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 – case of progressively thinning shell

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

$$\frac{dV_{uo}}{dt} = \frac{d}{dt}\left(\frac{4\pi}{3} r_o{}^3\right) = 4\pi \; r_o{}^2 \frac{d\,r_o}{dt} , \qquad (9\text{-}11)$$

$$\frac{d\,r_o}{dt} = \frac{d}{dt}\left[c\,(t-t_r) + K_{ru}\;t_r^{\frac{2}{3}}\right] = c \qquad (10\text{-}11)$$

$$\frac{dV_{uo}}{dt} = 4\pi\, c\,\left[c\,(t - t_r) + K_{ru}\;t_r^{\frac{2}{3}}\right]^2 \text{ which is proportional to } (t^2) \qquad (11\text{-}11)$$

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 $\frac{dV_{uo}}{dt} = 8.94 \times 10^{61}\, m^3$/sec and for $\frac{dV_u}{dt} = 5.05 \times 10^{61}\, m^3$/sec which indicates a lower rate of space fabric expansion that that of the outer sphere expansion , and this gap between the two expansion rates is widening with time

an upper, mean , and a lower value of the Hubble parameter can then

be established given that $r_m = \frac{1}{2}(r_0 + r_i)$, $\frac{dr_m}{dt} = \frac{c}{2}(1 + \frac{dr_i}{dr_o})$ (12,13-11)

lower limit : $H_L(t) = \frac{\frac{dr_o}{dt}}{r_0} = 1.94 \times 10^{-18}$ m.sec^{-1}/m which corresponds to

a value of 59 km/sec/mega parsec

mean value $H_m(t) = \frac{\frac{dr_m}{dt}}{r_m} = \frac{\frac{dr_m}{dr_o}\frac{dr_o}{dt}}{r_m} = 2.36 \times 10^{-18}$ m/sec/m which

corresponds to a value of 71 km/sec/mega parsec

while the upper limit $H_u(t) = \frac{\frac{dr_i}{dt}}{r_i} = \frac{\frac{dr_i}{dr_o}\frac{dr_o}{dt}}{r_i} = 2.99 \times 10^{-18}$ m/sec/meter

=91 km/sec/ mega parsec which is physically meaningless as it

relates to the expansion of the inner void

The direct result one can draw from these results 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 accessing the inflation of the universe where

$$\mathbf{H_o\ (CMB)} = \frac{\mathbf{c}}{\mathbf{r_{ueo}}}$$

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

For the current values $\mathrm{H_o\ (CMB)}$ =2.17x 10^{-18} m/sec/meter which is equivalent to 66.1 km/sec/mega parsec

<u>11.c observational findings</u>

recent research works indicate that

1- the universe is closed in contract to the long held view of a flat universe [8]

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 [9]

12. 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 symmetry of the quanton / cosmological relative ratios with time relative ratio ,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** $\mathbf{Dof_{r_q}}$ **=** $\mathbf{\frac{9}{4}}$ $\mathbf{Dof_t}$ **,**

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

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

Which requires Planck time to be

$\mathbf{t_p = \frac{t_o}{(8.08 \text{ x } 10^{60})^{\frac{2}{3}}}}$ **=1.08 x** $\mathbf{10^{-23}sec}$ **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 $\mathbf{t_p = t_o(8.08 \text{ x } 10^{60})^{\frac{1}{3}}}$ **=.00217 sec**

The very close match between quanton , cosmological parameter

ratios to that of time ($\mathbf{\sqrt[2]{8.08 \text{ x } 10^{60}}}$ **per Degree of freedom)**

suggests a uniform inflationary history of the nature $\mathbf{r_u = K_{ru}\, t^{\frac{2}{3}}}$

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 $\frac{V_{ur2}}{V_{ur1}} = \left(\frac{{t_{r2}}^2}{{t_{r1}}^2} \right)$

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 an older Planck time as illustrated previously

13.inflationary theory and standard cosmology versus quanton model

as the quanton model differs significantly from existing inflationary theory and standard cosmology , it would be beneficial to highlight the major differences between both of them

table.5 illustrates main timeline differences between the inflationary theory / standard cosmology and the quanton model

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 ($1.15x10^{-164}$ 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 -(a) α $t^{\frac{2}{3}}$ throughout
Matter dominated era t<9 G years inflation	decelerating inflation (a)α $t^{\frac{2}{3}}$	Inflation under a comoving rate $\frac{dr_u}{dt}$ > c , the universe is spherical in shape $\frac{dr_u}{dt}$ α $t^{\frac{-1}{3}}$
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

table 5. 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 , following tables 6 , 7 illustrate major differences between standard cosmology and the quanton model are illustrated

parameter	Standard cosmology	Quanton based model
radiation	Dominant energy at 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)

table 6. Major differences between standard cosmology and quanton model (a)

parameter	Standard cosmology	Quanton model
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 $\alpha\ (t^{\frac{-1}{3}})$
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 7. Major differences between standard cosmology and quanton model (b)

(14) ethical statement

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

(15) Data vailability

The data that support the findings of this study are available from the corresponding author, upon request.

(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 parameters (and subsequently the universe's) takes place as the time variation is split anti symmetrically between space varying (quanton radius) degree of freedom and time varying (angular frequency) degree of freedom

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