Quanton based model of field interactions

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Abstract

The mechanism of the universe’s inflation is variation of energy in space and in time, the relationship between space and time varying energy fields is governed by energy constraining inside a quantum entity: the quanton.

As energy varies in space or in time, it creates associated fields and through their interactions, inflationary momentum and the fundamental forces are generated.

This model comes in three parts: energy constraining, where the evolution of the quanton and its different transitions are discussed; the second part, electromagnetic waves in terms of space and time varying energy fields and role of Maxwell equations in the evolution of the quanton.
the third part, energy fields and their interactions, while using basic physics concepts, this model shows that the origin many of the physical phenomena can be traced back to the quanton based world.

**Key words**

space and time varying fields, energy degrees of freedom
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1. The physical basis of this model

This model is based on the following two concepts:

a- the relationship between energy density inside the quanton and its parameters (defined in terms of parameters: \( k, \omega, \) or \( r_q \) (quanton radius)) is an energy degree of freedom relationship

b- the complex nature of the energy expansion in the form of space varying and time varying fields

The following points will be discussed throughout the model:

1- as energy expands from a packet state (energy non varying in space or time), it creates associated fields that vary in space and in time

2- the symmetric nature of this variation in space and in time

3- as a result of this symmetry, the relationship between those space and time varying fields is governed by energy degrees of freedom
2-Definition of the model

2.a Quantons

1-quantons are an accumulation of space and time varying energy fields, as those fields vary at periodic rate, they possess wave-like behaviour, (it will be later discussed why those fields do not interact directly with electromagnetic waves, and when and how such waves leave the quanton).

Each quanton is composed of two different types of energy fields (free and constrained) which interact to form a binding relationship.

2-they exist in lattice form which constitutes the space fabric.

3-quantons are spherical in shape due to equi-partition of energy (here it will be called: dimensional energy symmetry) but may vary in their energy content (packet or total energy) and in volume with time as they expand and split.

4-quantons are held in a quasi equilibrium state under the effect
of Internal and external interactions of energy fields

5-due to the imbalance of these interactions the quantons expand, then split up, the resulting pair share up the original energy content, fig.1. provides a summary of various states which quanton goes through

2.b.Anti quantons

anti quantons are similar to quantons but the dominant nature of their energy differs from that of the quanton
2.b.1 Anti quanton generation

anti quntons are generated from quantons, quantons and anti quantons exist in pairs as they become a quantum entity of the form Q+AQ

3. Mathematical brief

1-The following formulations for various energy fields inside or outside the quanton (anti quanton),

\[ E_{sf} = \frac{\partial E}{\partial s} : \text{free space varying field} \] (1-3)

\[ E_{tf} = \frac{\partial E}{\partial t} : \text{free time varying field} \] (2-3)

\[ E_{sc} = \int E \, ds \quad \text{space varying constrained field} \] (3-3)

\[ E_{tc} = \int E \, dt \quad \text{time varying constrained field} \] (4-3)

\[ E_s = E_{sf} \quad E_{sc}, \quad E_t = E_{tf} \quad E_{tc} \] (5,6-3)

2-quanton and anti quanton energy density equation is in the form of

\[ E_q = E_{sf} \quad E_{sc} \quad E_{tf} \quad E_{tc} \quad \text{and neither in the form} \] (7-3)
3-energy fields are vector quantities which have direction as well as magnitude.

4-an energy field like free space varying energy can be defined as

\[ E_{sf} = K_{sf} D_{sf} \psi_{sf} \quad (8-3) \]

where \( D_{sf} \) : energy field strength (degree of freedom parameter – in exponential terms of the constant c),

\( K_{sf} \) : field intensity parameter which is defined in terms of the quanton total energy divided by four degrees of freedom

and \( \psi_{sf} \) is reserved for variation parameter of space varying energy field

5-the two types of quanton energy fields are the free energy dominated \( E_{qf} = E_{sf} E_{tc} \quad (9-3) \)

and the constrained energy dominated \( E_{qc} = E_{sc} E_{tf} \) and can be
expressed by the one-dimensional PDE

\[(E_{qf})_{tt} = c^2 (E_{qf})_{xx} \quad \text{or} \quad (E_{qc})_{tt} = c^2 (E_{qc})_{xx}\]  \hspace{1cm} (10-3)

6- \(E = E_s E_t \) (an energy packet state – energy not varying in space or time, no associated fields)

which is generated by energy constraining

4. variation parameters of energy fields

quanton (or anti quanton) energy density defined as the multiplication of field strengths and intensities of four types of energy fields which takes the form

\[E_q = (E_{sf} E_{tc}) (E_{sc} E_{tf}) = E_{qf} E_{qc}\]  \hspace{1cm} (1-4)

Each of those four functions expresses the change of either space or time as follows,

\[1 - \psi_{sf} = e^{\frac{-jr}{2r_q}} \text{ which defines change of free energy field in space}

, \(r = (x, y, z)\) ,  \hspace{1cm} (2-4)\]
2 - \( \psi_{sc} = e^{-j \frac{fr}{2\hbar}} \) defines change of constrained energy field in space  

\[(3-4)\]

3 - \( \psi_{tf} = e^{+j\omega t} \) : that expresses variation of free energy field in time

4 - \( \psi_{tf} = e^{-j\omega t} \) : variation parameter of constrained energy field in time

5. Energy constraining

1-Energy constraining describes evolution, interaction of energy fields which is summarized as

a-the act of containment free energy fields \((E_{sf}, E_{tf})\) inside quantons (this will be discussed in the section : Maxwell equations role in the evolution of quantons)

b-the appearance of constrained energy fields \((E_{sc}, E_{sc})\)

c- evolution of the quanton fields’ degrees of freedom

d-energy field expansion inside the quanton and its subsequent
splitting

1. The release of radiation energy as a result of the quanton expansion.

2. As energy expands in space in the form of space and time-varying fields, it’s said to have free degrees of freedom, and it must express these degrees of freedom in a symmetric way with respect to all spatial dimensions, and this is only possible inside a spherical structure, a quanton, so dimensional energy symmetry (DES) is behind the evolution of the quantons as a spatially symmetric shape.

3. As energy is released, it must expand, not only by variation in space but by variation in time as well, hence the appearance of energy fields $E_{sf}, E_{tf}$ (free energy that varies in space and free energy that varies in time), such expansion takes the form...
\[ \frac{\partial}{\partial s}(E) = \frac{\partial}{\partial s}(E_s E_t) = \frac{\partial E}{\partial s} \frac{\partial E}{\partial t} = E_{sf} E_{tf} \]

4-energy fields cannot vary in space and time simultaneously

, so no energy field is in the form \( E_{sf,tf} = fn(s, t) \)

, but rather \( E = E_{sf}(x, y, z) E_{tf}(t) \)

and this is because the relationship between the expansion of space varying and time varying fields is diametric, as the time varying field (curls) the free expansion of space varying field hence the appearance of the quanton (this point will be further discussed in the section Maxwell equations of energy fields)

5-Energy fields can either be free in space varying

\( (E_{sf} = \frac{\partial E}{\partial s}) \) or free in time varying field \( (E_{tf} = \frac{\partial E}{\partial t}) \)

or space constrained \( (E_{sc} = \int E_s ds) \) or time constrained

\( (E_{tc} = \int E dt) \), while non space or time varying energy

in the form \( (E = E_s E_t) \) can be defined as an energy packet state
energy that does not change in space or in time

6-the appearance of constrained energy fields inside the quanton (anti quanton), is due to the fact that free energy fields \((E_{sf} \, E_{tf})\) seek to form a more stable binding interactions with these newly appeared constrained fields \((E_{sc} \, E_{tc})\) under inflationary conditions rather than the less stable repulsive self interactions (discussed in detail in the section: space fabric field interactions and why space fabric generates binding interactions).

7-as space varying field \((E_{sf})\) expands, it must have a constrained time varying field \((E_{tc})\) such that \(E_{qf} = E_{sf}E_{tc}\), so the field \(E_{qf}\) is a predominantly free type due to space varying energy field \((E_{sf})\).

8-as time varying energy expands \((E_{tf})\), it must be expand in part by variation in space as well, hence the appearance of space varying constrained energy field \((E_{sc})\) such that \(E_{qc} = E_{sc}E_{tf}\), so \((E_{qc})\) is a predominantly constrained type due to the field \((E_{sc})\).
9-as energy expands from a packet state \( E = E_s E_t \), it possesses

Four degrees of freedom, and for the quanton ( or anti quanton ) to
exist as an independent energy entity, it must possess all of those
Four degrees of freedom ( needless to say one of them varies in
time)

10- based on the previous point, inside the quanton ( anti quanton )
energy fields cannot expand by free variation in space and in time
in the form \( E_q = E_{sf} E_{tc} \) or of the form \( E_{aq} = E_{sc} E_{tf} \) alone
the emerging fields for the quanton now become

\[
E_q = (E_{sf}E_{tc})(E_{sc} E_{tf}) = E_{qf} E_{qc}\quad (1-5)
\]

and for anti quanton

\[
E_{aq} = \left(\frac{E_{sf}E_{tc}}{c}\right)(c E_{sc} E_{tf}) = \left(\frac{E_{qf}}{c}\right) (cE_{qc})\quad (2-5)
\]

This quanton energy density equation represents two fields

( discussed in the section: wave model inside the quanton )
one of them is free energy dominated or  \( E_{qf} = (E_{sf}E_{tc}) \), and the other is constrained energy dominated  \( E_{qc} = (E_{sc}E_{tf}) \).

The anti quanton’s energy density equation is the same as the energy density equation of quanton’s, but degrees of freedom of various fields are different from those of the quanton (this will be discussed later in the sections: quanton and anti quanton evolution and their energy degrees of freedom).

11- the fields  \( E_{qf}, E_{qc} \) are orthogonal (will be discussed further in the section: Maxwell’s equations of energy fields).

12- for free energy fields  \( E_{sf}, E_{tf} \), differentiation is the mathematical expression of free energy expansion by variation in space or time, while integration is the corresponding mathematical expression of constraining of free fields varying in space or time.

A-for space varying field, full expansion in space:

\[
\frac{\partial}{\partial x} \frac{\partial y}{\partial z} (E_s) = \frac{\partial E}{\partial s} = E_{sf} \quad (\text{energy expands from a packet state to }
\]

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become a space varying field )

b-constraining of free energy fields takes the form

\[ \iiint E_{sf} \, dx \, dy \, dz = E_s \]  
\[ \text{ ( free space varying field is packetized-} \]
\[ \text{ reduced into a non varying state ) , } \]  
(3-5)

\[ \text{c- for free time varying field } \]
\[ \frac{\partial}{\partial t} (E_t) = \frac{\partial E}{\partial t} = E_{tf} , \text{ and constraining } \int E_{tf} = E_t \]  
(4-5)

13- for constrained energy fields \( E_{sc} , E_{tc} \), integration is the

mathematical expression of free energy expansion by variation in

space or time, and differentiation is the corresponding

mathematical expression of energy constraining in space or time

a- for constrained space varying field, expansion in space is

defined as \[ \iiint E_s \, dx \, dy \, dz = E_{sc} \]  
\[ \text{ ( expansion of constrained space} \]
\[ \text{ varying field ) } \]

b- while constraining takes the form
\[ \frac{\partial}{\partial x} \frac{\partial y}{\partial y} \frac{\partial}{\partial z} (E_{sc}) = \frac{\partial}{\partial s} (E_{sc}) = E_s \text{ (reduction of constrained space varying field into a packet state-non varying in space or time)}, \]

(5-5)

c- for time varying field

expansion in time \[ \int E_t \, dt = E_{tc} \], and when being constrained

\[ \frac{\partial}{\partial t} (E_{tc}) = E_t \]  

(6-5)

14- energy field (free-constrained) expansion inside the quanton is more or less a process of differentiating two variables

15- expansion of (free-constrained) energy fields by variation in space or time follows differentiation of two variables rule

\[ \frac{\partial}{\partial x} (f(x) \, g(x)) = \frac{\partial f}{\partial x} \, g(x) + \frac{\partial g}{\partial x} \, f(x) \]

results of an energy expansion process inside the quanton = expansion of the (free-constrained fields) + constraining of (free-constrained fields)

let’s consider the case of expansion of free space varying field \( E_{sf} \)
inside the quanton or \[
\frac{\partial}{\partial s} \left( \frac{\partial E}{\partial s} \right) = \frac{\partial E}{\partial s} \int E \ dt = E_{sf} E_{tc}
\] (7-5)

(this step will be further elaborated in the chapters: quanton degrees of freedom and the role of Maxwell equations in the evolution of the quanton)

16- similarly for the case of free time varying field

\[
\frac{\partial}{\partial t} \left( \frac{\partial E}{\partial t} \right) = \frac{\partial E}{\partial t} \int E \ ds = E_{sc} E_{tf}
\] (8-5)

Now the quanton energy density equation

\[
E_q = \left( \frac{\partial E}{\partial s} \right) \left( \int E \ ds \frac{\partial E}{\partial t} \right) = (E_{sf} E_{tc})(E_{sc} E_{tf})
\] (9-5)

Table 1. provides a summary for expansion / constraining and the corresponding mathematical operations

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<th>Constrained energy field</th>
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<td>integration</td>
</tr>
<tr>
<td>constraining</td>
<td>integration</td>
<td>differentiation</td>
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Table 1. Mathematical expression of energy expansion /constraining inside the quanton

17- the quanton’s four degrees freedom are the sum of free
energy fields’ degrees of freedom plus the constrained energy fields’ degrees of freedom or

\[ \text{Dof}_q = \text{Dof}_{sf} + \text{Dof}_{sc} + \text{Dof}_{tf} + \text{Dof}_{tc} = 4 \quad (10-5) \]

18- it is understood that the space varying energy fields (free and constrained) have three degrees of freedom or

\[ \text{Dof}_{sf} + \text{Dof}_{sc} = 3 \quad (11-5) \]

while time varying energy fields (free and constrained) have one degree of freedom or \( \text{Dof}_{tf} + \text{Dof}_{tc} = \text{one} \quad (12-5) \)

19–energy fields \( E_{sf}, E_{tf}, E_{sc}, E_{tc} \) do not have the dimensions of energy, but their product \( (E_q) \) does have the dimensions of energy density which is defined as energy divided by three dimensional volume \( [E_q] = \frac{\text{energy}}{\text{volume}} = M L^{-1} T^{-2} \)

( later, it will be shown that this energy density is in fact four dimensional that expands in 3D space )

20- as free energy fields expand, constraining of the expanding
fields takes place

\[ \frac{\partial}{\partial s} \left( \frac{\partial E}{\partial s} \right) = \frac{\partial E}{\partial s} + \int \left( \frac{\partial E}{\partial s} \right) \, ds \text{ or} \]

\[ \frac{\partial}{\partial s} (E_{sf}) = \frac{\partial}{\partial s} \left( \frac{\partial E}{\partial s} \right) = \frac{\partial E}{\partial s} + \text{constraining term} \]

and \[ \frac{\partial}{\partial t} (E_{tf}) = \frac{\partial}{\partial t} \left( \frac{\partial E}{\partial t} \right) = \frac{\partial E}{\partial t} + \int \left( \frac{\partial E}{\partial t} \right) \, dt \text{ or} \]

\[ \frac{\partial}{\partial t} (E_{tf}) = \frac{\partial}{\partial t} \left( \frac{\partial E}{\partial t} \right) = \frac{\partial E}{\partial t} + \text{constraining term} \]

and so on for higher order derivatives, and this process represents the expansion of the free energy by variation in space or time which must be accompanied by constraining while inside the quanton

21- as constrained energy fields expand, constraining of the expanding fields takes place

\[ \int (\int E \, ds) \, ds = \int E \, ds + \frac{\partial}{\partial s} \left( \int E \, ds \right) \text{ or} \]

\[ \int (\int E \, ds) \, ds = (\int E_{sc} \, ds) \, ds = \int E \, ds + \text{constraining term} \text{, and} \]
\[ \int (\int E \ dt) \ dt = (\int E_{tc} \ dt) \ dt = \int E \ dt + \frac{d}{dt} (\int E \ dt) \quad \text{or} \]

\[ \int (\int E \ dt) \ dt = (\int E_{tc} \ dt) \ dt = \int E \ dt + \text{constraining term} , \]

this means that expansion of constrained energy fields must also be accompanied by constraining of those constrained energy fields.

22- when energy is released from a field constraining process For free or constrained energy field as in (20) or (21), it is released in the packet state \( E = E_s E_t \) (energy non-varying in space or time) in other words, released energy cannot take the form of \( E_s \) or \( E_t \) as either of those forms of energy do not exist independently.

23- a cycle of expansion and constraining is not a reversible process due to losses and effect of entropy (irreversible process) (will be further clarified in the section energy constraining and the Release of radiative energy)
24- energy degree of freedom must be identical in spatial dimensions for \( (E_{sx}, E_{sy}, E_{sz}) \) for each field otherwise energy field is deemed to be unstable.

25- an energy field expansion process results in an expanding field plus energy constraining, so it is expected that the total energy content of the quanton (or anti quanton) to decrease during the process of expansion.

26- since the quanton is a quantum entity, its packet energy – total energy content of the quanton – is governed solely by the Planck–Einstein relationship so, quanton energy is determined by its wave parameters \( (k, \omega, \sigma_{q}) \), while an energy degree of freedom - which is defined in terms of the constant \( (c) \), is just a mechanism of division of energy between the various space and time varying fields.
27- recalling point (7), fields of the following forms do not exist independently

\[ a - \frac{\partial E}{\partial s} \frac{\partial E}{\partial t} \] (energy field cannot expand in space and in time simultaneously without having a constrained part)

\[ b - (\int E \, ds \int E \, dt) \] (constrained energy field expand in space and in time simultaneously without having an free expansion part)

28- though quanton includes both field of both types (free and constrained), but there is a dominant type of energy field, this is based on which type of field has the majority of Dof’s

29- for the quanton, the free energy field is the dominant while for anti quanton, the constrained type of field is the dominant type

30- the packet in this model assumes two roles

a-the packet energy: total energy of the quanton which is defined
as \( E_p = \frac{h}{2\pi} \omega = \int E_q \, dV \) \hspace{1cm} (13-5)

b- packet state which is the result from constraining process

and defined as \( E = E_s E_t \)

( energy nonvarying in space or in time)

6. Bridging the gap between mathematics physics of energy constraining

1-while differentiation of two functions involves differentiating only one at a time and maintaining the other as constant, in real world this is not possible since an expanding energy fields must vary either in space or in time

2-when dealing with expansion of constrained energy fields integration is the physical equivalent to mathematically maintaining one function as a constant

3-expansion of two energy fields of the form

\[
\frac{\partial}{\partial s} \left( \frac{\partial E}{\partial s} \frac{\partial E}{\partial t} \right) = \left( \frac{\partial E}{\partial s} \frac{\partial E}{\partial t} \right) \left( \int E \, ds \int E \, dt \right)
\]
Could not be in the form \( \left( \frac{\partial E}{\partial s} - \frac{\partial E}{\partial t} \right) + \left( \int E \, ds \int E \, dt \right) \)

Since the energy fields \( \left( \frac{\partial E}{\partial s} - \frac{\partial E}{\partial t} \right) \) or \( \left( \int E \, ds \int E \, dt \right) \) are unstable in this form as the quanton is in the process of formation and free or constrained energy fields could not exist independently.

4-The quanton energy density equation

\[
E_q = \left( \frac{\partial E}{\partial s} - \frac{\partial E}{\partial t} \right) \left( \int E \, ds \int E \, dt \right)
\]

expresses two physical entities (free energy fields: \( \left( \frac{\partial E}{\partial s} - \frac{\partial E}{\partial t} \right) \) and constrained energy fields \( \left( \int E \, ds \int E \, dt \right) \)) and each of those types of fields behave as single physical entity (ie single variable), so the four different energy fields, are in fact, representing only two variables instead of four (energy field interactions will be based on this particular point).

5-recalling points (13), (14) from previous section, for complex Energy fields (free / constrained)
\( E_q = E_{sf} E_{sc} E_{tf} E_{tc} \) energy constraining which happens through

**Quanton expansion** in space is defined as

\[
\frac{\partial}{\partial s} (E_q) = \frac{\partial}{\partial s} ((E_{sf} E_{tc})(E_{sc} E_{tf}) )
\]

\[
(\frac{\partial E_{sf}}{\partial s} \int E_{tc} \, dt)(\int E_{sc} \, ds \frac{\partial E_{tf}}{\partial t}) + (\int E_{sf} \, ds \frac{\partial E_{tc}}{\partial t})(\frac{\partial E_{sc}}{\partial s} \int E_{tf} \, dt )
\]

\[
= (E_{sf} E_{tc} E_{sc} E_{tf}) + E_s E_t \quad (1-6)
\]

6- when dealing with Energy field expansion inside the quanton there would be two terms as a result of the expansion

**a-expansion term** : differentiating free energy fields *integration of constrained energy fields

**b-constraining term** : integrating free energy fields * differentiating constrained fields

7- energy expansion process inside the quanton , involves both free and constrained energy fields , and to avoid confusion while using the gradient operator (\( \nabla \)) for both types of field
expansion, the use of the differential / integral operators will be maintained as \((\frac{\partial}{\partial s})\) for expansion of free energy fields and \((\oint)\) for the expansion of constrained energy fields inside the quanton.

8- when dealing with energy expansion we will use the wave like form 

\[ E_q = (E_{sf} E_{tc})(E_{sc} E_{tf}) \]

while when dealing with fields and energy interactions

the form 

\[ E_q = (E_{sf} E_{tf})(E_{sc} E_{tc}) \]

will be used.

7. Energy Degrees of freedom

1-as energy is allowed to vary in space or in time, it is said to have an energy degree of freedom

2- the quanton energy density is defined in terms of the degrees of freedom of its wave parameters \((\omega, k, r_q)\)

3- \(E_q\) (quantum energy density) will be shown to be directly proportional to \(\omega^4, k^4\) or \(\frac{1}{r_q^4}\)
4- while the energy density of the quanton is defined in terms of
\[ \omega^4, \ k^4 \text{ or } \frac{1}{r_q^4}, \] however the energy fields are defined in terms of

Field strength or in terms of the constant (c) in the form of

\[ D_{sf} = c^{Dof_{sf}}, \ \text{Dof}_{sf}: \text{degrees of freedom of free space varying} \]
field (transformation from degrees of freedom from formulation in
terms of wave parameters, to degrees of freedom in terms of (c))

5-for space varying and time varying energy fields, where the
resultant energy density is in the form

\[ E_q = (E_{sf}E_{tc})(E_{sc}E_{tf}) \text{ and not in the square root form} \]

\[ E_q = \sqrt{E_{sf}^2 + E_{sc}^2 + E_{tf}^2 + E_{tc}^2} \]

this multiplier form allows (c) to become an energy degree of
freedom in an exponential form, where energy is divided up
symmetrically, between the space and time varying fields, hence
the uniform and symmetric expansion of energy across all
6-the constant (c) plays a bigger role than being the velocity of light or the velocity of transmission of the fundamental forces, as it plays the role of ratio between space and time varying fields, this is based on the following

a- the constant (c) represents the relationship between energy field expansion by variation in space and in time, for the wave parameters of the fields $E_{tc}$, $E_{sf}$

$$\psi_{tc}, \, \psi_{sf} \text{ where } \psi_{tc} = e^{-j\omega t}, \, \psi_{sf} = e^{+jk(x+y+z)}$$

$$\psi = \psi_{tc} \, \psi_{sf}$$

$$\frac{\partial \psi_{tc}}{\partial t} = -j\omega \, \psi_{tc}, \quad \frac{\partial \psi_{sf}}{\partial x} = jk \, \psi_{sf}$$

$$\left(\frac{\partial \psi}{\partial t}\right) = \frac{\partial}{\partial t} (\psi_{sf} \, \psi_{tc}) = \psi_{sf} \frac{\partial \psi_{tc}}{\partial t} = -j\omega \, \psi_{sf} \psi_{tc}$$

$$\left(\frac{\partial \psi}{\partial x}\right) = \frac{\partial}{\partial x} (\psi_{sf} \, \psi_{tc}) = \frac{\partial \psi_{sf}}{\partial x} \, \psi_{tc} = jk \, \psi_{sf} \psi_{tc}$$

$$-\frac{\left(\frac{\partial \psi}{\partial t}\right)}{\left(\frac{\partial \psi}{\partial x}\right)} = \frac{j\omega}{jk} \frac{\psi_{sf} \psi_{tc}}{\psi_{sf} \psi_{tc}} = \frac{\omega}{k} = c \quad (1-7)$$
which is the relationship between rate of field variation in space and in time

b- recalling the Lagrangian (L) of an action as
\[ \frac{d}{dt} \frac{\partial L}{\partial \dot{x}} - \frac{\partial L}{\partial x} = 0 \]
given that momentum \( P = \frac{\partial L}{\partial \dot{x}} \)

we get \( \frac{\partial P}{\partial t} = \frac{\partial L}{\partial x} \) or alternatively \( \frac{\partial L}{\partial P} = \frac{\partial x}{\partial t} = c \)

an energy degree of freedom: the rate of change of the total energy of the system with respect to its momentum

c-the same result can be obtained directly from the energy-momentum relationship
\[ E^2 = P^2 c^2 + m_0^2 c^4 \]

differentiating both sides \( 2 E \frac{dE}{dt} = 2 P \frac{dP}{dt} \)

\[ \frac{dE}{dP} = \left( \frac{Pc}{E} \right) c \quad \text{and} \quad \frac{dE}{dP} = c \]

where for space fabric case ( \( m_0 = \text{zero} \) ), \( E = P \ c \)

which is an alternative definition of the energy degree of freedom

6-both results of (a ) and (c) are equivalent , given that
\[ \psi = \psi_{sf} \psi_{tc} \]

using the Schrödinger equation, for time and space derivatives

\[ -\frac{\partial \psi}{\partial t} = \frac{jE}{2\pi \hbar} \psi \]

\[ \nabla \psi = \frac{j\mathbf{p}}{2\pi \hbar} \psi \]

\[ \frac{\partial \psi}{\partial t} \cdot \nabla \psi = \frac{E}{p} = c \quad (2-7) \]

based on the above points, the division of energy density between space and time-varying fields can be done where strength of space and time-varying energy fields (Dof) is expressed in terms of the constant (c) that defines the relationship between their rate of variation. It is worth noting that

1-energy field degrees of freedom (field strength) is not related to the total energy of the quanton, as it is only a mechanism for the division of the quanton energy density between the various space and time-varying energy fields, and what differs the total energy
content of any quanton from another is only the rate of variation of fields with time and space according to Planck - Einstein relationship:

\[ E_p = \frac{h}{2\pi} \omega \]

2- the energy degrees of freedom can be classified as follows:

a- active (actual degrees of freedom) that belong to the energy fields inside or outside the quanton

b- kinetic degree of freedom which expresses the propagation of energy fields (outside the quanton in the form of electromagnetic waves) in one direction, this kinetic degree of freedom is subtracted from the existing four degrees of energy freedom for space and time varying fields (discussed in the section: electromagnetic waves out of quanton), where Dof’s = (2)+1 instead of (3)+(1)

c- scalarized degrees of freedom: when a degree of freedom of an
energy field becomes part of its intensity parameter instead of its
strength parameter (discussed in the section: normal mater
quantons)

8. The superposition principle inside the quanton

1. The linear superposition of energy fields still applies inside and
outside the quanton with a resultant field which equals to the
addition of the individual field intensities on condition that
a-those fields must be of the same type (free / constrained) and
b- have the same degree of freedom

\[ E_{si} + E_{sj} = K_{sfi}D_{sf} + K_{sfj}D_{sf} \]
\[ = (K_{sfi} + K_{sfj})D_{sf} \quad (1-8) \]

\[ (E_{sfi}E_{tci}) + (E_{sfj}E_{tcj}) = (K_{sfi}D_{sf})(K_{tci}D_{tc}) + (K_{sfj}D_{sf})(K_{tcj}D_{tc}) \]
\[ = (K_{sfi}K_{tci})(D_{sf}D_{tc}) + (K_{sfj}K_{tcj})(D_{sf}D_{tc}) \]
\[ = (K_{sfi} + K_{sfj})(K_{tci} + K_{tcj})(D_{sf}D_{tc}) \quad (2-8) \]
while the superposition of fields of different nature (free / constrained) or fields that do have different energy Dof’s

the superposition is done by adding their field strength (ie exponential degree of freedom) and multiplying their intensities

2- the exponential form of superposition applies, as energy fields are defined in terms of energy degree of freedom (Dof), which is expressed as the exponent of \(c^{Dof}\)

the resulting superposition inside the quanton will not be a linear one instead, it is an exponential superposition where

\[
E_{si} E_{sj} = (K_{sfi}D_{sf})(K_{scj}D_{sc}) = (K_{sfi} K_{scj})(D_{sf} D_{sc}) \quad (3-8)
\]

\[
E_{sf} E_{tc} = (K_{sf}D_{sf})(K_{tc}D_{tc}) = (K_{sf} K_{tc})(D_{sf} D_{tc}) \quad (4-8)
\]

and for the quanton as a whole

\[
E_q = (E_{sf} E_{tc})(E_{sc} E_{tf}) = (K_{sf}D_{sf})(K_{tc}D_{tc})(K_{sc}D_{sc})(K_{tf}D_{tf})
\]
\[ (K_{sf} K_{tc} K_{sc} K_{tf}) c^{Dof_{sf}+Dof_{tc}+Dof_{sc}+Dof_{tf}} = (K_{sf} K_{tc} K_{sc} K_{tf}) c^4 \] (5-8)

3- inside the quanton, instead of the addition of the same type of energy, the exponential addition can be between two different types of energy fields (space and time varying fields) and of two different natures (free / constrained) to give a complex energy field.

The main reason behind this is that free and constrained fields cannot be considered as an independent energy entity individually, since neither of them does possess four degrees of freedom, and hence their individual Dof’s must be added exponentially to obtain either a complex field equivalent to the total energy density of the quanton if the addition is for all four energy fields.

9. Definition of directional field directional components

For free space varying fields
\[ E_{sf} = \sqrt{E_{sfx}^2 + E_{sfy}^2 + E_{sfz}^2} \]  
(1-9)

and space varying constrained field

\[ E_{sc} = \sqrt{E_{scx}^2 + E_{scy}^2 + E_{scz}^2} \]  
(2-9)

for spatially varying fields

\[ E_{sx} = E_{sfx} E_{scx}, \quad E_{sy} = E_{sfy} E_{scy} \]  
(3-9)

\[ E_{sz} = E_{sfz} E_{scz} \]  
(4-9)

And for time varying fields,

\[ E_t = E_{tf} E_{tc} \]  
(5-9)

Those are 8 components, 6 that vary in space and 2 that vary in time. 3 are constrained space varying and one is constrained time varying, and 3 are free space varying and one is free in time.

It is worth noting that 1-spatial and time varying energy fields cannot exist independently of each other, as discussed previously.
2- the quanton fields $E_{sf}, E_{sc}, E_{tf}, E_{tc}$ neither have the dimensions of energy nor the energy density but their product has the dimension of energy divided by three dimensional volume.

10. Dimensional energy symmetry (DES)

Dimensional energy symmetry is the mechanism which ensures the uniformity and homogeneity of energy under inflationary conditions, it expresses the uniform energy density expansion in 3 dimensional space or the equipartition of energy

given that $E_q = (E_{sf}E_{tc})(E_{sc}E_{tf})$ energy as it expands in along the x-axis $\frac{\partial}{\partial x} (E_q)$ will not only give as the result of the expansion

$$\left( \frac{\partial E_{sf}}{\partial x} \int E_{tc} \ dt \right) \left( \int E_{sc} \ dx \ \frac{\partial E_{tf}}{\partial t} \right) +$$

$$\left( \int E_{sf} \ dx \ \frac{\partial E_{tc}}{\partial t} \right) \left( \frac{\partial E_{sc}}{\partial x} \ \int E_{tf} \ dt \right), \text{ but it will be of the form}$$

$$\frac{\partial}{\partial x} (E_q) = \frac{\partial}{\partial x} (E_{sf}E_{tc}E_{sc}E_{tf}) =$$
\[
\frac{\partial}{\partial x} (E_{sf} E_{scx}) + \frac{1}{\partial x} \frac{\partial y}{\partial t} \frac{\partial y}{\partial x} (E_{sfy} E_{scy}) + \frac{1}{\partial x} \frac{\partial z}{\partial t} \frac{\partial z}{\partial x} (E_{sfz} E_{scz}) + \frac{1}{\partial x} \frac{\partial}{\partial t} (E_{tf} E_{tc})
\]

\[
= ( \frac{\partial}{\partial x} (\frac{1}{\partial x} \frac{\partial y}{\partial t} \frac{\partial y}{\partial x}) (E_{sf}) \int (E_{tc}) \, dt )^* +
\]

\[
\int \int \int (E_{sc}) \, dx \, dy \left( \frac{1}{\partial y} \frac{\partial z}{\partial x} \right) (\frac{1}{\partial y} \frac{\partial z}{\partial x}) (E_{tf}) +
\]

\[
\int \int \int (E_{sf}) \, dx \, dy \left( \frac{1}{\partial y} \frac{\partial z}{\partial x} \right) (\frac{1}{\partial y} \frac{\partial z}{\partial x}) (E_{tc})^*
\]

\[
( \frac{\partial}{\partial x} (\frac{1}{\partial x} \frac{\partial y}{\partial t} \frac{\partial y}{\partial x}) (\frac{1}{\partial x} \frac{\partial z}{\partial t} \frac{\partial z}{\partial x}) (E_{sc}) \int (E_{tf}) \, dt ) \left( \frac{\partial y}{\partial t} \right)
\]

given that \( \frac{\partial x}{\partial t} = \frac{\partial y}{\partial t} = \frac{\partial z}{\partial t} = c \)

\[
\frac{\partial}{\partial x} (E_{q}) = \left( \frac{\partial E_{sf}}{\partial s} \int E_{tc} \, dt \right) \left( \int E_{sc} \, ds \frac{\partial E_{tf}}{\partial t} \right) +
\]

\[
\left( \int E_{sf} \, ds \frac{\partial E_{tc}}{\partial t} \right) \left( \frac{\partial E_{sc}}{\partial s} \int E_{tc} \, dt \right) = \frac{\partial}{\partial s} (E_{q}) \quad (1-10)
\]

**Note:** we applied the chain rule for differentiation and integration by change of variables.

We can clearly see that as energy expands along one axis, it must not only expand along other spatial and temporal axes but be
constrained along the spatial and temporal axes as well,

we conclude that

1-events in one direction are immediately reflected in the other
spatial and temporal directions, and by the same magnitude

2-the uniformity and the homogeneity of space fabric is ensured
through the role time plays as the link between all the three spatial
axis (and via the constant \( c \))

3-to satisfy dimensional energy symmetry for quanton, the degrees
of freedom must be symmetric with respect space and time

varying energy fields

define the \( \text{Dof}_q, D_q \) (in terms of \( c \))

where the degree of freedom parameter

\[
\text{Dof}_q = \text{Dof}_{sf} + \text{Dof}_{tf} + \text{Dof}_{sc} + \text{Dof}_{tc} = 4 \tag{2-10}
\]

Energy field strength parameter \( D_q = D_{sf}D_{tf}D_{sc}D_{tc} = c^4 \tag{3-10} \)
\[ D_s = c^3, \quad D_{sf} = c^{\text{Dof}_{sf}}, \quad D_{sc} = c^{\text{Dof}_{sc}} = c^{3-\text{Dof}_{sf}} \quad (4,5,6,7-10) \]

\[ D_t = c, \quad D_{tf} = c^{\text{Dof}_{tf}}, \quad D_{tc} = c^{\text{Dof}_{tc}} = c^{1-\text{Dof}_{tf}} \quad (8,9,10-10) \]

\[ \text{Dof}_{sfx} = \text{Dof}_{sfy} = \text{Dof}_{sfz} \quad (11-10) \]

4-the degree of freedom of constrained space varying field must be identical for spatial time varying components

\[ \text{Dof}_{sx} = \text{Dof}_{sy} = \text{Dof}_{sz} \quad (12-10) \]

in other words for free and constrained fields the degree of freedom must be expressed in a symmetric way across all spatial and time varying fields, fig.2. shows energy density expands uniformly inside the quanton as it's defined in terms of (c) instead of the quanton wave parameters.
Fig. 2. role of dimensional energy symmetry in ensuring the uniformity of energy distribution inside the quanton

11. Energy density / Degree of freedom relationship

when assessing the relationship between the quanton energy density $E_q$ and its wave parameters, two methods will be used,

and as it turned out, the two are equivalent, first is the simplified method which is discussed here, and secondly, the analytical,

which is dealt with in the section: energy field parameters
a-simplified method

based on two basic assumptions

1-high symmetry, the quanton volume can be represented by a highly symmetric 3 dimensionally symmetric shape (a sphere) given that \(2r_q = \lambda\),

2- the uniformity of the field inside the quanton

the total energy at any radius \(a\) can be defined as

\[
E(a) = \frac{hc}{2r_q} \left( \frac{a}{r_q} \right), \quad (a < r_q)
\]

under such assumptions, the following relations would be used as an approximation

\[
E_p = \int_{V_q} E_q \, dV = E_q \, V_q = \frac{h}{2\pi} \, \omega \quad (1-11)
\]

where \(E_q\) is the average energy density inside the quanton,

\(E_p\) : packet energy,

based on assumption of uniform energy density inside the
quanton, \( V_q = \frac{4}{3} \pi r_q^3 \)

given that \( \omega = kc = \frac{\pi c}{r_q}, \ k = \frac{2\pi}{\lambda} = \frac{\pi}{r_q}, \ r_q = \frac{\lambda}{2} \)

\[
V_q = \frac{4}{3} \pi r_q^3 = \frac{4}{3} \pi \left( \frac{\pi^3}{k^3} \right) = \frac{4}{3} \frac{\pi^4 c^3}{\omega^3}
\]

This shows that the quanton volume can be defined in terms of the parameters \( k, \omega \), this indicates that the relationship

\[
E_p = \int_{V_q} E_q \, dV = E_q \, V_q \quad \text{is not only a volumetric relationship but an energy degree of freedom as well, now the energy density can be written as}
\]

\[
E_q = \frac{E_p}{\int_{V_q} dV} = \frac{\hbar \omega}{(2\pi)(\frac{4\pi}{3} r_q^3)} \quad \text{(} r_q = \frac{\pi c}{\omega} \text{)}, \text{ substituting for } r_q^3
\]

\[
E_q = \frac{3\hbar \omega}{(2\pi c^3)} \left( \frac{\omega^3}{c^3} \right) = \frac{3\hbar \omega^4}{8\pi^5 c^3}
\]

and this is a very important relationship since the term

\[
\frac{3\hbar}{8\pi^5 c^3} = \text{constant, in other words,}
\]

Field energy density inside the quanton is linearly proportional to
the four degrees of freedom as expressed by either \( \omega^4, k^4 \) or \( \frac{1}{r^4} \),

\[
define \ h_q = \frac{3h}{8 \pi^5 c^3} \tag{6-11}
\]

\[
E_q = h_q \omega^4 = h_q k^4 c^4 = h_q \frac{\pi^4 c^4}{r^4} \tag{7-11}
\]

substituting \( E_p = E_q V_q = h_q V_q \omega^4 \)

from (2-11) and given that \( \omega = kc = \frac{\pi c}{r_q} \)

\[
\frac{V_q^2}{V_{q1}} = \left( \frac{r_{q2}}{r_{q1}} \right)^3 = \frac{\omega_1^2}{\omega_2^3} \quad \text{and} \quad \frac{r_{q2}}{r_{q1}} = \frac{\omega_1}{\omega_2} \tag{8-11}
\]

12 - Energy constraining and the release of thermal energy

1-as the quantons expand, field constraining takes place

( transformation into a packet state – energy non varying in space or time)

2-Energy constraining during quanton inflation as follows

a-Expansion of free energy fields \( \left( \frac{\partial E_{sf}}{\partial s} \frac{\partial E_{sf}}{\partial t} \right) \) must be accompanied by constraining of part - of the expanding free energy fields in the
form ( \( \int E_{sf} \ ds \int E_{tf} \ dt \) )

b-expansion of constrained fields ( \( \int E_{sc} \ ds \int E_{tc} \ dt \) ) must be accompanied by an constraining of part of the expanding field in the form ( \( \frac{\partial E_{sc}}{\partial s} \frac{\partial E_{tc}}{\partial t} \) )

c-In both cases, the result will be the release of energy in a packet state (non varying in space or time) of the form \( E = E_s \ E_t \) for the free type of energy as it expands

\[
\frac{\partial}{\partial s} [(E_{sf} E_{tc})(E_{sc} E_{tf})] = \left( \frac{\partial E_{sf}}{\partial s} \int E_{tc} \ dt \right) \left( \int E_{sc} \ ds \ \frac{\partial E_{tf}}{\partial t} \right)
\]

\[
+ \left( \int E_{sf} \ ds \ \frac{\partial E_{tc}}{\partial t} \right) \left( \frac{\partial E_{sc}}{\partial s} \int E_{tf} \ dt \right)
\]

given that \( \frac{\partial E_{sf}}{\partial s} = E_{sf}, \int E_{tc} \ dt = E_{tc}, \ \int E_{sc} \ ds = E_{sc}, \ \frac{\partial E_{tf}}{\partial t} = E_{tf} \)

and ( \( \int E_{sf} \ ds \ \frac{\partial E_{tc}}{\partial t} \) = E_s \ E_t, \ \left( \frac{\partial E_{sc}}{\partial s} \int E_{tf} \ dt \right) = E_s \ E_t \)

the results of field expansion inside the quanton can be defined as a-expansion term:
\[
\left( \frac{\partial \Delta E_{sf}}{\partial s} \int E_{tc} \, dt \right) \left( \int E_{sc} \, ds \, \frac{\partial \Delta E_{tf}}{\partial t} \right) = (E_{sf} E_{tc})(E_{sc} E_{tf})
\]

Corresponds to the expanding fields which expand through variation of energy in space and in time, the nature of expanding fields is the same as the original type of fields (though with lesser energy content).

b- The constraining term \( (\int E_{sf} \, ds \, \frac{\partial E_{tc}}{\partial t})(\frac{\partial E_{sc}}{\partial s} \int E_{tf} \, dt) = E_s \, E_t \)

represents the release of energy in a packet state which is due to the constraining of part of the free and constrained fields this nonvarying energy expands and is released from the quanton in the form of radiative energy, fig. 3. Shows the expansion of the quanton and the subsequent release of radiative energy.
Fig. 3. Quanton energy density expansion process

13. energy constraining - a possible origin of cosmic microwave background (CMB)

Inflation of the universe (expansion of space fabric) is a free expansion process and is accompanied by the release of thermal energy, the idea that a free expansion process gives off heat is rather odd, since expansion is closely related to reduction in temperature, in fact any release of thermal energy is more than offset by the effects of inflation, so the net result would be a reduction in temperature (observed as thermal degradation of
CMB photons

This free expansion process of the universe, which according to the second law of thermodynamics, is an irreversible process, this irreversibility is due to losses in the form of space fabric giving off heat during expansion

the origin of this release of thermal energy: is energy constraining based on the previous results, we can conclude that the CMB origin is due to release of thermal energy during free expansion of the space fabric itself

the extraordinarily high degree of CMB homogeneity with variation of the order of (10^{-5}), reflects the high degree of homogeneity of space fabric itself as it releases radiation during the free expansion process, and, in fact energy constraining inside the quantons is behind that release of this radiation energy
14. why do quantons split?

the question how the quantons split is discussed in the following section, but why this happens resides in the fact that the quanton energy density is four dimensional.

1- as the quanton expands from a volume \( V_{q1} \) to \( V_{q2} \)

the quanton radius \( r_q \) and its volume \( V_q \) should change in the following manner

\[
\frac{V_{q2}}{V_{q1}} = \left( \frac{r_{q2}}{r_{q1}} \right)^3
\]

which is expected in case of an expansion in three dimensional space.

2- quanton energy fields change periodically with time,

this variation at the rate of \( \omega \) rad/sec, and vary in space at the rate of \( k = \frac{\pi}{r_q} \), the total energy of the quanton (as a quantum entity) is governed by Planck Einstein relationship (function only in its wave parameters), namely

\[
E_p = hf = \frac{hc}{2\pi} = \frac{hc}{2r_q}
\]

the relationship between quantons of different energy content can
be put in the form \[ \frac{E_p^2}{E_p^1} = \frac{\omega_2}{\omega_1} = \frac{k_2}{k_1} = \frac{\lambda_1}{\lambda_2} = \frac{r_{q1}}{r_{q2}} \]

which means that the quanton radius (and the wave length of its characteristic wave behaviour are inversely proportional to its total (packet) energy content

3-recalling here the first concept upon which this model is based namely the DoF relationship between energy density inside the quanton and its wave parameters

energy density inside the quanton can be assessed as

\[ E_p = E_q \ V_q \quad \text{or} \quad E_q = \frac{E_p}{V_q} , \text{ then} \]

\[ \frac{E_{q2}}{E_{q1}} = \left( \frac{E_{p2}}{E_{p1}} \right) \left( \frac{V_{q1}}{V_{q2}} \right) \]

substituting for \( \left( \frac{E_{p2}}{E_{p1}} \right) = \left( \frac{r_{q1}}{r_{q2}} \right) \), and \( \left( \frac{V_{q1}}{V_{q2}} \right) = \left( \frac{r_{q1}}{r_{q2}} \right)^3 \)

we get \[ \frac{E_{q2}}{E_{q1}} = \left( \frac{r_{q1}}{r_{q2}} \right)^4 \] (1-14)

which deviates from what we would expect in a classical
volume / density relationship of the form
\[ \frac{q_2}{q_1} = \frac{V_1}{V_2} = \left( \frac{r_1}{r_2} \right)^3 \]

and this is due to the fact that energy density inside the quanton is

inversely proportional to \( r_q^4 \) and not to \( r_q^3 \)

this previous relationship can be obtained directly from the equation (6-11), namely

\[ E_q = \pi^4 h q \frac{c^4}{r_q^4} \text{ or} \]

\[ E_q = \left( \text{constant} \right) \frac{1}{r_q^4} \]

so as quantons expand into a three dimensional space,

they have to release energy, in the form of radiation

but, energy release from such a process would be excessive

instead, the quantons, as they expand, do split, to allow for

subsequent expansion, put this time with minimal release

of thermal energy

15. Mechanism of quanton splitting

this model for quanton splitting serves as preliminary
and introductory one since the CMB radiation has a statistically
distributed frequencies indicating that the quanton
frequencies are also statistically distributed and the splitting
occurs non symmetrically
there are two mechanisms that can cause the quantons to
expand, namely
a-splitting action of the quantons due dimensional energy
asymmetry
b-the sole release of energy from the quantons
as for the first mechanism
stage(1-2) expansion under the effect of self interacting repulsive field
1-the two types of fields inside the quanton (free Dominated $E_{qf}$
and constrained dominated $E_{qc}$) interact, creating a binding
relationship but since the energy Dof's (i.e field strength) of both
fields are not the same, the field of the dominant type of energy

self-interact creating a repulsive interaction that causes the
quantons to expand, the self-interacting (unbound) field is

( $E_{sfu} E_{tfu}$ ) for quantons and ( $E_{scu} E_{tcu}$ ) for anti quantons -
discussed in the section: quanton field interactions)

2-the unbound field is at the origin of the quanton inflationary
energy, which has a greater potential (in terms of the quanton
total energy) than the quanton binding energy, as a result, it
overcomes this binding and causes the quanton to expand

3-as the quanton expands its wave parameters ( $\omega, k$ ) are altered
while its energy content remains the same since there’s no energy
release from the quantons at this stage, as a result the quanton

has either to

a- to release thermal energy to maintain the relationship $E_p = \frac{\hbar \omega}{2\pi}$ or

b- to split thereby reducing its overall energy content and allowing
for further expansion

stage (2-3) dimensional energy asymmetry occurs and quanton splits

since the quanton parameters \((\omega, k)\) do not reflect its energy content, \(\frac{E_{p2}}{E_{p1}}\) must be equal to \(\frac{r_{q1}}{r_{q2}} = \frac{\omega_2}{\omega_1} = \frac{k_2}{k_1}\), while \(E_{p2}\) still equals \(E_{p1}\), this conflict causes quanton to split as a mechanism to restore the relationship

\((r_{q3}) = \frac{(r_{q2})}{2} = r_{q1}\), \(E_{p3} = \frac{E_{p2}}{2} = \frac{E_{p1}}{2}\)

, the splitting corresponds to a quanton radius \(r_{q2} = x \cdot r_{q1}\), \(x > 1\)

stage(3) quanton expands further

following quanton splitting its packet (total energy) becomes

\(E_{p3} = \frac{E_{p2}}{2}\), while wave parameters \((\omega, k)\) must expand further to satisfy the relationship \(\frac{E_{p4}}{E_{p2}} = \frac{\omega_4}{\omega_1} = \frac{k_4}{k_1} = \frac{r_{q1}}{r_{q4}} = \frac{1}{2}\)

as the quantons expand, they release thermal energy in the form
of CMB photons, and to arrive at the final pseudo stable state.

Fig. 4. Provides an illustration of the quanton expansion, splitting cycle while Table 2. provides a summary of those stages and the corresponding quanton parameters.

Fig. 4. Cycle of quanton splitting and subsequent inflation.
stage | (1) | (2) | (3, 4)  
--- | --- | --- | ---  
Total quanton energy : \( E_p \) | \( E_{p1} \) | \( E_{p1} \) | \(< \frac{E_{p1}}{2}\)  
Wave parameter \( \omega \) | \( \omega_1 \) | \( \frac{\omega_1}{x} \) | \(< \frac{\omega_1}{2}\)  
Quanton energy density : \( E_q \) | \( E_{q1} \) | \( \frac{E_{q1}}{x^3} \) | \(< \frac{E_{q1}}{16}\)  
Quanton radius \( r_q \) | \( r_{q1} \) | \( x r_{q1} \) | \( > 2 r_{q1}\)  
Quanton volume \( V_q \) | \( V_{q1} \) | \( x^3 V_{q1} \) | \( > 8 V_{q1}\)  
Number of quantons | one | one | two  

Table 2. Summary of the stages of the quanton splitting and expansion \( x > 1 \)

the second method is the pure release of thermal energy

followed up by a subsequent quanton expansion

this mechanism is such an inefficient one in comparison to the

fore described method of quanton splitting and subsequent

expansion, given the high efficiency of the splitting process as a

mechanism to manage the expansion of the quanton through both

inflation and multiplication while on the other hand minimizing the

thermal energy release, it is clear that quanton splitting and
subsequent expansion is the actual mechanism of space fabric expansion.

The release of the radiative energy during the process of expansion of the quanton is not related to the re-establishment of the wave parameter relationship with the quanton energy.

A simple explanation lies in the fact that all the quanton energy fields are involved in different interactions, mainly binding ones, while energy in a packet state is not involved in any of those binding interactions, and already possesses four degrees of freedom, as a result, small part of this energy escapes in the form of radiative energy.

16. Mathematics behind constraining

1- As the quanton forms, the nature of the energy field changes (from free to constrained).

2- To perform such an operation, energy fields must transit through
a packet state (energy that does not vary in space or in time)

3-and as energy field strength is in terms of Dof’s, its operator (integration/differentiation) has to be applied at an exponential level, thus the exponent of field variation parameter which is operated upon

a—for evolution of constrained space varying field

\[
\frac{\partial}{\partial s} \left( \frac{\partial E}{\partial s} \right) = \frac{\partial}{\partial s} \left( K_{sf} D_{sf} \psi_{sf} \right) = K_{sf} D_{sf} \frac{\partial}{\partial s} (\psi_{sf}) \\
= K_{sf} D_{sf} \left[ (e^{ik_s}) \left( e^{\frac{\partial}{\partial s}(jk_s)} \right) \right] \\
= [K_{sf} D_{sf} (e^{ik})][K_s D_s e^{(jk)}] \\
= (\frac{\partial E}{\partial s})(K_s D_s e^{(jk)}) = (\frac{\partial E}{\partial s})(E_s)
\]

\[
\int (E_s) \, ds = (K_s D_s e^{-\int (jk) \, ds}) \\
= [K_{tc} D_{tc} (e^{-jk_s})] = \int E \, ds
\] (2-16)

b—for the evolution of the constrained time varying field

\[
\frac{\partial}{\partial t} \left( \frac{\partial E}{\partial t} \right) = \frac{\partial}{\partial t} \left( K_{tf} D_{tf} \psi_{tf} \right) = K_{tf} D_{tf} \frac{\partial}{\partial t} (\psi_{tf})
\]
\[= K_{tf} D_{tf} \left[ (e^{j\omega t}) \left( \frac{\partial}{\partial t} (e^{-j\omega t}) \right) \right] \tag{4-16}\]

\[= [K_{tf} D_{tf} (e^{j\omega t})][K_t D_t (e^{j\omega})] \]

\[= \left( \frac{\partial E}{\partial t} \right) (E_t) \]

\[\int (E_t) \, dt = [K_t D_t (e^{-j\omega t})] \tag{5-16}\]

\[=[(K_{tc} D_{tc} (e^{-\omega t}))] = \int E \, dt \tag{6-16}\]

while evolution of the type \( \frac{\partial}{\partial s} \left( \frac{\partial E}{\partial s} \right) = \frac{\partial E}{\partial s} \int E \, dt \) and

\[\frac{\partial}{\partial t} \left( \frac{\partial E}{\partial t} \right) = \frac{\partial E}{\partial s} \int E \, ds \] a more plausible, such a case will not

result in a quanton field arrangement where the inflationary and

the binding Dof's would not correspond to the existing values for

dark energy and dark matter

and for the quanton expansion and constraining terms

**a-Expansion part**

as mentioned earlier, the expansion of constrained fields is

handled by integration process
\[ \frac{\partial}{\partial s} (E_q) = \frac{\partial}{\partial s} ((E_{sf} \ E_{tc})(E_{sc} \ E_{tf})) \]

\[ = K_{sf}K_{tc} D_{sf} D_{tc} \frac{\partial}{\partial x} \psi_{sf} \int \psi_{tc} \ dt) (K_{sc} K_{tf} D_{sc} D_{tf} \int \psi_{sc} dx \frac{\partial}{\partial t} \psi_{tf}) \]  

\[ = K_{sf} K_{tc} D_{sf} D_{tc} (\frac{jk}{-j\omega} \psi_{sf} \psi_{tc}) (K_{sc} K_{tf} D_{sc} D_{tf}) (\frac{j\omega}{jk} \psi_{sc} \psi_{tf}) \]

\[ = K_{sf} \psi_{sf} D_{sf}(K_{tc} \ D_{tc} \ \psi_{tc}) ((K_{sc} D_{sc} \ \psi_{sc}) (K_{tf} \ D_{tf} \ \psi_{tf})) \]

\[ = (E_{sf} \ E_{tc})(E_{sc} \ E_{tf}) = E_q \]

**b- constraining term**

\[ (\int E_{sf} \ ds \ \frac{\partial E_{tc}}{\partial t})(\frac{\partial E_{sc}}{\partial s} \int E_{tf} \ dt) \]

\[ = [(K_{sf} D_{sf} \ e^{\frac{\partial}{\partial s}(jk)}) (K_{tc} D_{tc} e^{\frac{\partial}{\partial t}(-j\omega t)})][(K_{tf} D_{tf} e^{\frac{\partial}{\partial s}(-jk)}) (K_{sc} D_{sc} D_{tf} e^{\frac{\partial}{\partial t}(j\omega t)})] \]

\[ = (K_{sf} K_{tc} D_{sf} D_{tc} e^{jk} e^{(-j\omega)}) (K_{sc} K_{tf} D_{sc} D_{tf} e^{(-jk)} e^{(j\omega)}) \]

\[ = K_s D_s K_t = E_s E_t \]

To summarize, the exponential differentiation / integration would be applied in either of the following cases

1-change of the nature of the energy field (free / constrained)
or (space varying / time varying) and vice versa

2- change in the degrees of freedom of any energy field (Dof rearrangement of Dof's between fields)

17. Wave-like properties of space fabric

Energy which varies in time and varies in space has wave-like properties as it changes at periodic rate that equals $\omega \text{ rad/sec}$

\((= 2 \pi f)\) and the space varying field, where $r_q (= \frac{\pi}{k})$, such that

$\omega r_q = \text{constant} = \pi c$, in fact the quanton (or anti quanton) is represented by two (wave like) equations, to show how the wave equations would look like for the free and constrained energy fields, first remembering

that $\psi_{sf} = e^{ikx}$, $\psi_{tc} = e^{-j\omega t}$, $\psi_{sc} = e^{-jklx}$, $\psi_{tf} = e^{i\omega t}$

the free energy dominated wave parameters

$\psi_{qf} = (\psi_{sf} \psi_{tc})$ differentiating both sides w.r.t time
\[
\frac{\partial \psi_{qf}}{\partial t} = \frac{\partial \psi_{tc}}{\partial t} \psi_{sf} = -j \omega \psi_{sf} \psi_{tc}
\]

\[
\frac{\partial^2 \psi_{qf}}{\partial t^2} = \frac{\partial^2 \psi_{tc}}{\partial t^2} \psi_{sf} = -\omega^2 \psi_{sf} \psi_{tc}
\]

while differentiating w.r.t \((x)\)

\[
\frac{\partial \psi_{qf}}{\partial x} = \frac{\partial \psi_{sf}}{\partial x} \psi_{tc}
\]

\[
\frac{\partial^2 \psi_{qf}}{\partial x^2} = \frac{\partial^2 \psi_{sf}}{\partial x^2} \psi_{tc} = -k^2 \psi_{sf} \psi_{tc}
\]

For a wave equation \( \frac{\partial^2 \psi_{qf}}{\partial t^2} = c^2 \frac{\partial^2 \psi_{qf}}{\partial x^2} \) to be satisfied

\[
\frac{\partial^2 \psi_{tc}}{\partial t^2} = c^2 \left( \frac{\partial^2 \psi_{sf}}{\partial x^2} \psi_{tc} \right) \quad \text{or} \quad (E_{qf})_{tt} = c^2 \left( E_{qf} \right)_{xx} \quad \text{as before} \quad (1-17)
\]

which is the PDE forth free energy dominated field

similarly, for the constrained energy dominated wave

\(\psi_{qc} = (\psi_{sc} \psi_{tf})\) differentiating both sides w.r.t time

\[
\frac{\partial \psi_{qc}}{\partial t} = \frac{\partial \psi_{tf}}{\partial t} \psi_{sc}
\]

\[
\frac{\partial^2 \psi_{qc}}{\partial t^2} = \frac{\partial^2 \psi_{tf}}{\partial t^2} \psi_{sc} \quad , \text{while differentiating w.r.t} \ x
\]

\[
\frac{\partial \psi_{qc}}{\partial x} = \frac{\partial \psi_{sc}}{\partial x} \psi_{tf}
\]

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\[
\frac{\partial^2 \psi_{qc}}{\partial x^2} = \frac{\partial^2 \psi_{sc}}{\partial x^2} \psi_{tf},
\]

for a wave equation \( \frac{\partial^2 \psi_{qc}}{\partial t^2} = c^2 \frac{\partial^2 \psi_{qc}}{\partial x^2} \) to be satisfied

\[
\frac{\partial^2 \psi_{tf}}{\partial t^2} = c^2 \left( \frac{\partial^2 \psi_{sc}}{\partial x^2} \frac{\psi_{tf}}{\psi_{sc}} \right) \quad \text{or} \quad (E_{qc})_{tt} = c^2 (E_{qc})_{xx} \quad (2-17)
\]

this PDE for the constrained energy dominated field,

which shows also how a wave equation of space and time varying fields would look like, but does the quanton energy density equation in its differential / integral form really represent two wave equations?

a-For the free energy dominated term \( (\frac{\partial E}{\partial s} \int E \, dt) \)

Differentiating with respect to time \( \frac{\partial}{\partial t} \left( \frac{\partial E}{\partial s} \int E \, dt \right) = \)

\[
\left[ \left( \frac{\partial x}{\partial t} \right) \frac{\partial}{\partial x} \left( \frac{\partial E}{\partial s} \right) \int E \, dt \right] + \left[ \frac{\partial E}{\partial s} \frac{\partial}{\partial t} (\int E \, dt) \right]
\]

\[
= \left[ c \frac{\partial}{\partial x} \left( \frac{\partial E}{\partial s} \right) \int E \, dt \right] + \left[ \frac{\partial E}{\partial s} \frac{\partial}{\partial t} (\int E \, dt) \right]
\]

differentiating again with respect to time
\[ \frac{\partial}{\partial t} \left[ c \frac{\partial}{\partial x} \left( \frac{\partial E}{\partial s} \right) \int E \, dt \right] + \frac{\partial}{\partial t} \left[ \frac{\partial E}{\partial s} \frac{\partial}{\partial t} (\int E \, dt) \right] \]

\[ = \left[ c \left( \frac{\partial x}{\partial t} \right) - \frac{\partial^2}{\partial x^2} \left( \frac{\partial E}{\partial s} \right) \int E \, dt \right] + \left[ c \frac{\partial}{\partial x} \left( \frac{\partial E}{\partial s} \right) \frac{\partial}{\partial t} (\int E \, dt) \right] \]

\[ + \left[ \left( \frac{\partial x}{\partial t} \right) \frac{\partial^2}{\partial s^2} \left( \frac{\partial E}{\partial s} \right) \int E \, dt \right] + \left[ \frac{\partial E}{\partial s} \frac{\partial^2}{\partial t^2} (\int E \, dt) \right] \]

\[ [ c^2 \frac{\partial^2}{\partial x^2} \left( \frac{\partial E}{\partial s} \right) \int E \, dt ] + 2c \left[ \frac{\partial}{\partial x} \left( \frac{\partial E}{\partial s} \right) \frac{\partial}{\partial t} (\int E \, dt) \right] + \left[ \frac{\partial E}{\partial s} \frac{\partial^2}{\partial t^2} (\int E \, dt) \right] \]

for the same energy type differentiating with respect to \( x \)

\[ \frac{\partial}{\partial x} \left( \frac{\partial E}{\partial s} \int E \, dt \right) = \left[ \frac{\partial}{\partial x} \left( \frac{\partial E}{\partial s} \right) \int E \, dt \right] + \left[ \frac{\partial E}{\partial s} \frac{1}{c} \right] \frac{\partial}{\partial t} (\int E \, dt) \]

\[ = \left[ \frac{\partial}{\partial x} \left( \frac{\partial E}{\partial s} \right) \int E \, dt \right] + \left[ \frac{\partial E}{\partial s} \frac{1}{c} \right] \frac{\partial}{\partial t} (\int E \, dt) \]

differentiating again with respect to \( x \)

\[ \frac{\partial}{\partial x} \left[ \frac{\partial}{\partial x} \left( \frac{\partial E}{\partial s} \right) \int E \, dt \right] + \frac{\partial}{\partial x} \left[ \frac{\partial E}{\partial s} \frac{1}{c} \frac{\partial}{\partial t} (\int E \, dt) \right] \]

\[ = \left[ \frac{\partial^2}{\partial x^2} \left( \frac{\partial E}{\partial s} \right) \int E \, dt \right] + \left[ \frac{\partial}{\partial x} \left( \frac{\partial E}{\partial s} \right) \frac{1}{c} \frac{\partial}{\partial t} (\int E \, dt) \right] \]

\[ + \left[ \frac{1}{c} \frac{\partial}{\partial x} \left( \frac{\partial E}{\partial s} \right) \frac{\partial}{\partial t} (\int E \, dt) \right] \frac{\partial^2}{\partial t^2} (\int E \, dt) \]

\[ = \left[ \frac{\partial^2}{\partial x^2} \left( \frac{\partial E}{\partial s} \right) \int E \, dt \right] + 2 \frac{1}{c} \left[ \frac{\partial}{\partial x} \left( \frac{\partial E}{\partial s} \right) \frac{\partial}{\partial t} (\int E \, dt) \right] + \left( \frac{1}{c} \right)^2 \left[ \frac{\partial E}{\partial s} \frac{\partial^2}{\partial t^2} (\int E \, dt) \right] \]
by comparing the results of both double differentiation

\[ \frac{\partial^2}{\partial t^2} \left( \frac{\partial E}{\partial s} \int E \, dt \right) = c^2 \frac{\partial^2}{\partial x^2} \left( \frac{\partial E}{\partial s} \int E \, dt \right) \]

which is customary form of for a wave relation

b- For the constrained energy dominated wave

\[ E_{qc} = \int E \, ds \ \frac{\partial E}{\partial t} \text{, expanding in } x \text{ direction} \]

\[ \frac{\partial}{\partial x} \left( \int E \, ds \ \frac{\partial E}{\partial t} \right) = \left[ \frac{\partial}{\partial x} \left( \int E \, ds \right) \frac{\partial E}{\partial t} \right] + \left[ \int E \, ds \ \frac{1}{\partial x} \frac{\partial}{\partial t} \left( \frac{\partial E}{\partial t} \right) \right] \]

\[ = \left[ \frac{\partial}{\partial x} \left( \int E \, ds \right) \frac{\partial E}{\partial t} \right] + \left[ \int E \, ds \ \frac{1}{\partial x} \frac{\partial}{\partial t} \left( \frac{\partial E}{\partial t} \right) \right] \]

\[ = \left[ \frac{\partial}{\partial x} \left( \int E \, ds \right) \frac{\partial E}{\partial t} \right] + \left[ \int E \, ds \ \frac{1}{\partial t} \left( \frac{\partial E}{\partial t} \right) \right] \]

differentiating again with respect to \( x \)-axis

\[ \frac{\partial}{\partial x} \left[ \frac{\partial}{\partial x} \left( \int E \, ds \right) \frac{\partial E}{\partial t} \right] + \frac{\partial}{\partial x} \left[ \frac{1}{c} \ \int E \, ds \ \frac{\partial}{\partial t} \left( \frac{\partial E}{\partial t} \right) \right] \]

\[ = \frac{\partial^2}{\partial x^2} \left( \int E \, ds \right) \frac{\partial E}{\partial t} + \left[ \frac{\partial}{\partial x} \left( \int E \, ds \right) \frac{1}{\partial x} \frac{\partial}{\partial t} \left( \frac{\partial E}{\partial t} \right) \right] + \]

\[ \left[ \frac{1}{c} \ \frac{\partial}{\partial x} \left( \int E \, ds \right) \ \frac{\partial E}{\partial t} \right] \left( \frac{\partial E}{\partial t} \right) \left( \frac{\partial E}{\partial t} \right) \right] = \]

\[ = \frac{\partial^2}{\partial x^2} \left( \int E \, ds \right) \frac{\partial E}{\partial t} + 2 \left( \frac{1}{c} \ \frac{\partial}{\partial x} \left( \int E \, ds \right) \ \frac{\partial E}{\partial t} \ \frac{\partial E}{\partial t} \right) \left( \frac{\partial E}{\partial t} \right) \left( \frac{\partial E}{\partial t} \right) \left( \frac{\partial E}{\partial t} \right) \right] \]
when differentiating with respect to time

\[
\frac{\partial}{\partial t}\left( \int E \, ds \frac{\partial E}{\partial t} \right) = [ \left( \frac{\partial}{\partial t} \right) \left( \int E \, ds \frac{\partial E}{\partial t} \right) ] + [ \int E \, ds \frac{\partial}{\partial t} \left( \frac{\partial E}{\partial t} \right) ]
\]

\[
= \left[ c \frac{\partial}{\partial x} \left( \int E \, ds \right) \frac{\partial E}{\partial t} \right] + \left[ \int E \, ds \frac{\partial}{\partial t} \left( \frac{\partial E}{\partial t} \right) \right]
\]
differentiating again with respect to time

\[
\frac{\partial^2}{\partial t^2}\left( \int E \, ds \frac{\partial E}{\partial t} \right) = \frac{\partial}{\partial t} \left[ \left( \frac{\partial}{\partial t} \right) \left( \int E \, ds \frac{\partial E}{\partial t} \right) \right] + \frac{\partial}{\partial t} \left[ \int E \, ds \frac{\partial}{\partial t} \left( \frac{\partial E}{\partial t} \right) \right]
\]

\[
= \left[ c \frac{\partial}{\partial x} \left( \frac{\partial^2}{\partial x^2} \left( \int E \, ds \right) \frac{\partial E}{\partial t} \right) \right] + \left[ \int E \, ds \, \frac{\partial^2}{\partial t^2} \left( \frac{\partial E}{\partial t} \right) \right] + \left[ \frac{\partial}{\partial t} \left( \int E \, ds \right) \frac{\partial^2}{\partial t^2} \left( \frac{\partial E}{\partial t} \right) \right]
\]

by comparing the results of both double differentiations

\[
\frac{\partial^2}{\partial t^2}\left( \int E \, ds \frac{\partial E}{\partial t} \right) = c^2 \frac{\partial^2}{\partial x^2} \left( \int E \, ds \frac{\partial E}{\partial t} \right)
\]

which is the usual form of the wave equation
18. quanton evolution and degrees of freedom

Evolution of the quanton takes place as both free fields \( E_{sf} \) and \( E_{tf} \) coexist.

1-as free energy field expands by variation in space it must vary in time, so, a constrained time varying field appears

\[
\frac{\partial}{\partial s} \left( \frac{\partial E}{\partial s} \right) = \left[ \frac{\partial}{\partial s} \left( \frac{\partial E}{\partial s} \right) \right] \left[ \int \left( \frac{\partial E}{\partial s} \right) \, ds \right] = \left( \frac{\partial E}{\partial s} \right) \left( \int E \, dt \right) \quad (1-18)
\]

2-as the time varying field \( E_{tf} \) expands, a part of it must vary in space in the form of constrained space varying energy field

\[
a - \frac{\partial}{\partial t} \left( \frac{\partial E}{\partial t} \right) = \frac{\partial}{\partial t} \left( \frac{\partial E}{\partial t} \right) \left( \int \frac{\partial E}{\partial t} \, dt \right) = \left( \frac{\partial E}{\partial t} \right) \left( \int E \, ds \right) \quad (2-18)
\]

And since none of the fields possesses all four Dof’s neither field can exist independently, now the quanton energy density equation becomes

\[
E_q = \left( \frac{\partial E}{\partial s} \int E \, dt \right) \left( \int E \, ds \frac{\partial E}{\partial t} \right) = (E_{sf}E_{tc})(E_{sc}E_{tf}) = E_qE_{qc} \quad (3-18)
\]
which expresses two apparently separate (but otherwise linked) fields

3-for time constrained energy field \((E_{tc})\), its energy Dof equals one third of the corresponding free energy field \((E_{sf})\)

4-for free time varying energy field \((E_{tf})\), its energy degree of freedom equals one third of the corresponding space constrained energy field \((E_{sc})\), the previous discussion can be summarized in the following 4 equations by solving them the quanton Dof’s for the four energy fields can be obtained

\[
Dof_{sf} = 3 \, Dof_{sc} \quad , \quad Dof_{tf} = 3 \, Dof_{tc} \\
Dof_{sf} + Dof_{sc} = 3 \quad , \quad Dof_{tf} + Dof_{tc} = 1
\]

which gives the following results

\[
Dof_{sf} = 2.25 \quad , \quad Dof_{sc} = 0.75 \\
Dof_{tf} = 0.75 \quad , \quad Dof_{tc} = 0.25
\]
Fig. 5. Shows the evolution of DOF’s of various fields of the quanton as it forms

\[ E = E_t E_s \]

Fig. 5. Tree diagram for the evolution of the degrees of freedom of quanton’s energy fields

5-for the quanton system despite having a constrained energy fields, it is dominated by the free energy field of the form \( \left( \frac{\partial E}{\partial s} \frac{\partial E}{\partial t} \right) \)

since this energy term represents 3.0 degrees of freedom while the constrained type \( (\int E \, ds \int E \, dt) \) constitutes 1.0 Dof out of four
6-the number of (unbound) degrees of freedom of free energy fields is equivalent to the number of free energy degrees of freedom (space plus time varying) minus the energy constrained degrees of freedom (space and time varying).

7- (unbound) free field is manifested in the form of quanton inflation

\[ D_{sfu} D_{tfu} \text{ (unbound field strength)} = \left( \frac{D_{sf} D_{tf}}{D_{sc} D_{tc}} \right) = \frac{e^{2.25c^{0.25}}}{e^{0.75c^{0.25}}} = c^{2.0} \tag{6-18} \]

unbound free Dof = ( \( \sum \) (free Dof) \( \) \( - \) (constrained Dof) )

= [ (Dof_{sf}) + (Dof_{tf}) ] - [ (Dof_{sc}) + (Dof_{tc}) ] = (3.0 - 1.0) = +2

19. Variation of quanton energy fields with time

not only the unbound energy fields \( E_{sfu} E_{sfu} \) of the quanton

(or \( E_{scu} E_{scu} \) for anti quanton) which change with time as the quanton (or anti quanton) expands, but rather all the other energy fields, and this is so, to ensure the uniformity of energy
density inside the quanton

19. a- Variation of space varying energy with time

\[
\frac{\partial E_{sf}}{\partial t} - \frac{\partial E_{sf}}{\partial x} \frac{\partial x}{\partial t} = c \frac{\partial E_{sf}}{\partial x} \tag{1-19}
\]

\[
\frac{\partial E_{sf}}{\partial x} = j k E_{sf} \tag{2-19}
\]

\[
\frac{\partial E_{sf}}{\partial t} = j k c E_{sf} \tag{3-19}
\]

b- time varying energy field variation

\[
\frac{\partial E_{tf}}{\partial t} = j \omega E_{tf} \tag{4-19}
\]

c- Relative rate of Variation between different energy fields

\[
\frac{\partial E_{sf}}{\partial E_{tf}} \frac{\partial E_{sf}}{\partial x} \left( \frac{\partial x}{\partial t} \right) \frac{1}{\partial E_{tf}} = \left( j k c E_{sf} \right) \left( \frac{1}{j \omega E_{tf}} \right) = \frac{E_{sf}}{E_{tf}} = D_{sf} \frac{D_{sf}}{D_{tf}} \tag{5-19}
\]

the same results can be reached when considering the wave parameters of energy fields

\[
\frac{\partial \psi_{tf}}{\partial \psi_{sf}} = \left( \frac{\partial \psi_{tf}}{\partial t} \right) \left( \frac{1}{\partial x} \right) \left( \frac{1}{\partial \psi_{sf}} \right) \tag{6-19}
\]

given that \( \psi_{tf} = e^{+j \omega t} \), \( \frac{\partial \psi_{tf}}{\partial t} = j \omega \psi_{tf} \)
\[ \psi_{sf} = e^{+jk(x+y+z)}, \quad \frac{\partial \psi_{sf}}{\partial x} = jk \psi_{sf} \]

\[ \frac{\partial \psi_{sf}}{\partial \psi_{sf}} = \frac{1}{c \ k} = 1 = \text{constant} \quad , \quad (7-19) \]

while from before \[ \frac{\partial E_{tf}}{\partial \psi_{sf}} = j \omega \quad E_{tf} \quad , \quad \frac{\partial E_{sf}}{\partial x} = jk \quad E_{sf} \]

\[ \frac{\partial E_{tf}}{\partial E_{sf}} = \frac{1}{c \ k} \quad \frac{E_{tf}}{E_{sf}} = \frac{E_{tf}}{E_{sf}} = D_{tf} \quad , \quad \text{which means that} \quad (8-19) \]

1-the rate of variation of energy fields wave parameters with respect to each other is constant (=1) (same rate of variation for all energy fields)

2-relative rate of variation in time of all energy fields is equal to the ratio between their degrees of freedom and this is due to the uniformity of their variation parameters

20. Energy field parameters while the energy degrees of freedom of the quanton total energy (packet energy \( E_p \)) are in terms of the wave parameters (\( k, \omega, r_q \)) , the energy degrees of freedom for the energy fields are in terms of
the constant \( c \) as pointed out earlier, this is because the constant \( c \) is what determines the relationship between the rate of variation of space and time varying fields, previously, the energy density constant \( h_q \) was determined while using an approximative method, now the analytical method shall be used to assess it

Recalling first that the quanton fields are infinite in range, and The definition of the variation parameters of \( E_{qf}, E_{qc} \) fields which corresponds to an exponentially decaying field away from the quanton, the free and constrained fields can be put as

\[
E_{qf}(x) = E_{qf} e^{-j \frac{x}{2q}} \quad \text{(free energy dominated field)}
\]

\[
E_{qc}(x) = E_{qc} e^{-j \frac{x}{2q}} \quad \text{(constrained energy dominated field)}
\]

and the quanton energy density is in the form

\[
E_q = (E_{sf} E_{te})(E_{sc} E_{tr}) = E_{qf} E_{qc} = E_q e^{-j \frac{x}{q}}
\] (1-20)
\( E_q \) : represents the average energy density over time

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

\[
E_p = \frac{\hbar \omega}{2\pi} = \iiint_{-\infty}^{\infty} E_q \ e^{-i\frac{\lambda x + y + z}{\lambda r}} \ dx \ dy \ dz = (2-20)
\]

\[
= (2)^3 \iiint_{0}^{\infty} E_q \ e^{-i\frac{\lambda x + y + z}{\lambda r}} \ dx \ dy \ dz \quad \text{(symmetric integration)}
\]

\[
x, y, z = \infty
\]

\[
= 8 \ (r_q)^3 \ E_q \ e^{-i\frac{\lambda x + y + z}{\lambda r}} \bigg|_{x, y, z = 0} = 8 \ (r_q)^3 \ E_q
\]

\[
E_q = \frac{\hbar \omega}{16\pi r_q^3} = \frac{\hbar \omega^4}{16 \pi^4 c^3}, \quad (3-20)
\]

where \( \frac{\hbar}{16\pi^4 c^3} = h_q \) (energy density constant) \quad (4-20)

to relate the average energy density \( E_q \) to its maximum value

\( E_{q0} \) over time, we use the quanton /anti quanton wave model

\[
E_q = \frac{1}{2} (E_{qf} + cE_{qc}) \ast \frac{1}{2} \left(\frac{E_{qf}}{c} + E_{qc}\right)
\]

and since \( E_{qfo} = cE_{qco} \)
\[ E_q = E_{q0} \cos \left( \frac{\pi r}{2r_q} \right) E_{qco} \cos \left( \frac{\pi r}{2r_q} \omega t \right) = E_{q0} \cos^2 \left( \frac{\pi r}{2r_q} \omega t \right) \]  (5-20)

the average value of a periodic function is defined as

\[ E_q = \frac{1}{T} \int_0^T E_{q0} \, dt \]  (6-20)

\[ E_q = \frac{E_{q0}}{T} \int_0^T \cos^2 \left( \frac{\pi r}{2r_q} \omega t \right) \, dt \]  (7-20)

the value of this integration equals to \( \left( \frac{1}{2} \right) \)

\[ E_{q0} = 2E_q = \frac{h \omega^4}{8\pi^4 c^3} , \]  (8-20)

here, the quanton is represented by an equivalent volume \( = 8r_q^3 \)

the same result can be reached alternatively, when calculating the vacuum energy density \( q_v \) at any point in space as the summation of individual energy density contributions of \( N_q \) quantons

\[ q_v = \sum_{i=1}^{N_q} q_{vi} , \] 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

\[ q_v = E_q \]  (8-20)
while in terms of the wave parameter \( k \), or the quanton radius

the quanton energy density takes the form

\[
E_q = \left( \frac{\hbar}{16 \pi^4 c^3} \right) k^4 c^4 = \frac{hc}{16 r_q^4}
\]  

(9-20)

energy as it expands by variation in space and time, it has four degrees of freedom, this can be used to define the various space and time varying fields

\[
E_q = \frac{\hbar}{16 \pi^4 c^3} k^4 c^4 = \text{constant} \times \left( \frac{2\pi}{\lambda} \right)^4 c^4 = \frac{\text{constant}}{4 \text{D volume}} \times c^4
\]  

(10-20)

this relationship does not only expresses a volumetric relationship of energy density as it expands into a 4 D volume, but it expresses an energy density – degree of freedom relationship as it can be put in terms of the wave parameters \( (k , \omega , \frac{1}{r_q}) \)

table 3. shows the main differences between the analytical and the approximative method, and shows that both methods are equivalent and this is mainly due to the homogeneity and
uniformity of space fabric

<table>
<thead>
<tr>
<th>parameter</th>
<th>Analytical method</th>
<th>Approximative method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integration volume</td>
<td>Universe volume</td>
<td>N/A</td>
</tr>
<tr>
<td>Equivalent volume</td>
<td>$\frac{\text{Universe volume}}{\text{number of quantons}}$</td>
<td>$\frac{4\pi}{3} r_q^3$</td>
</tr>
<tr>
<td>Quanton shape</td>
<td>cubic</td>
<td>spherical</td>
</tr>
<tr>
<td>Quanton dimensions</td>
<td>Each side = $2 r_q$</td>
<td>Radius = $r_q$</td>
</tr>
<tr>
<td>Density constant $h_q$</td>
<td>$\frac{h}{16 \pi^4 c^3}$</td>
<td>$\frac{3 h}{8 \pi^5 c^3}$</td>
</tr>
<tr>
<td>Energy density inside</td>
<td>$E_q \left(=\frac{E_{q0}}{2}\right)$</td>
<td>$\frac{6}{\pi} E_q$</td>
</tr>
<tr>
<td>the quanton</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free and constrained</td>
<td>Inside and outside quanton (both</td>
<td>Inside quanton only</td>
</tr>
<tr>
<td>field</td>
<td>Propagate throughout space)</td>
<td></td>
</tr>
<tr>
<td>Vacuum energy density</td>
<td>$E_q$</td>
<td>$E_q$</td>
</tr>
</tbody>
</table>

Table 3. difference between the analytical and approximative method of determining the quanton energy density constant $h_q$

the energy degrees of freedom which can be put as

$$D_q = c^4 = D_{sf} D_{sc} D_{tf} D_{tc} = \text{the field strength parameter of energy fields}$$

where

$$D_{sf} = c^{D_{of_{sf}}}, \quad D_{sc} = c^{D_{of_{sc}}}$$

$$D_{tf} = c^{D_{of_{tf}}}, \quad D_{tc} = c^{D_{of_{tc}}}$$

$$E_q = \frac{h}{16 \pi^4 c^3} k^4 c^4 = K_q^4 c^4$$

(11, 12-20)

(13, 14-20)
the quantity \( K_q^4 = \left( \frac{h}{16 \pi^4 c^3} \right) k^4 \) can be put as

\[
K_q^4 = h_q k^4 = K_{sf} K_{sc} K_{tf} K_{tc} \quad (= \text{energy field intensity parameter})
\]

(16-20)

where \( K_{sf} = K_q = 4 \sqrt{\frac{h}{16 \pi^4 c^3}} k \)

(17-20)

\[
K_{sc} = K_q = 4 \sqrt{\frac{h}{16 \pi^4 c^3}} k \quad , \quad K_{tf} = K_{tc} = K_q = \frac{4}{\sqrt{\left( \frac{h}{16 \pi^4 c^3} \right)} \frac{\omega}{c}}
\]

(18-20)

it must be noted that while \( \frac{E_q}{\omega^4} = \left( \frac{h}{16 \pi^4 c^3} \right) = h_q = \text{constant} \),

its fourth root is not a constant, \( 4 \sqrt[4]{\frac{E_q}{\omega^4}} \) or \( 4 \sqrt[4]{\frac{E_q}{k^4}} \) \( \neq \) constant

the division of the field intensity parameter does not follow the energy degree of freedom but follows the division of field types (free / constrained and space or time varying fields) otherwise

energy fields \( E_{sf} \), \( E_{tc} \) or \( E_{sc} \), \( E_{tf} \) could exist independently

one can be drawn to think that the division of \( (K_q^4) \) between various energy fields such that \( K_{sf} = K_q^{Dof_{sf}} = K_q^2 \), or
\[ K_{tf} = K_q^{Dof_{tf}} \], but since there are no wave parameters in nature of \[ k^2 \] or \[ \omega^{0.5} \] due to the symmetry of the wave behavior between various fields which is previously defined as \[ \frac{\partial \psi_f}{\partial \psi_f} = \frac{1}{c} \frac{\omega}{k} = \text{constant} \]

and \[ \frac{\partial E_{sf}}{\partial E_{sf}} = \frac{1}{c} \frac{\omega}{k} \frac{E_{sf}}{E_{sf}} = \frac{E_{sf}}{D_{sf}} \]

this leads to the following result: \[ K_{sf} = K_{sc} = K_{tf} = K_{tc} = K_q \] (19-20)

Finally, we can write the energy fields themselves as

\[ E_{sf} = E_{sf0} \psi_{sf} = K_q D_q^{Dof_{sf}} \psi_{sf} = 4 \sqrt{\frac{h}{16 \pi^4 c^3}} k c^{2.25} \psi_{sf} = 4 \sqrt{\frac{h}{16 c^3}} c^{2.25} r_q \psi_{sf} \] (20-20)

\[ E_{sc} = E_{sc0} \psi_{sc} = K_q D_q^{Dof_{sc}} \psi_{sc} = 4 \sqrt{\frac{h}{16 \pi^4 c^3}} k c^{0.75} \psi_{sc} = 4 \sqrt{\frac{h}{16 c^3}} c^{0.75} r_q \psi_{sc} \] (21-20)

\[ E_{tc} = E_{tc0} \psi_{tc} = K_q D_q^{Dof_{tc}} \psi_{tc} = 4 \sqrt{\frac{h}{16 \pi^4 c^3}} \frac{\omega}{c} c^{0.25} \psi_{tc} = 4 \sqrt{\frac{h}{16 c^3}} c^{0.25} r_q \psi_{tc} \] (22-20)

\[ E_{tf} = E_{tf0} \psi_{tf} = K_q D_q^{Dof_{tf}} \psi_{tf} = 4 \sqrt{\frac{h}{16 \pi^4 c^3}} \frac{\omega}{c} c^{0.75} \psi_{tf} = 4 \sqrt{\frac{h}{16 c^3}} c^{0.75} r_q \psi_{tf} \] (23-20)

\[ \frac{E_{sf}}{E_{tc}} = K_q D_q^{Dof_{sf}} \frac{\psi_{sf}}{D_q^{Dof_{tc}} \psi_{tc}} = \frac{K_q D_q^{Dof_{sf}}}{D_q^{Dof_{tc}}} \psi_{sf} = c^{2.0} \frac{\psi_{sf}}{\psi_{tc}} \] (24-20)

a unified value of \( K_q \) for all energy fields ensures that the
relationship between the different fields depends only on their degrees of freedom and not on the intensity of such fields. In general, a field energy can be seen as the product of two terms:

\[ \text{field energy} = \text{field intensity} \times \text{field strength} \]

where field intensity is defined in terms of the quanton's energy degrees of freedom, and field strength is defined in terms of energy degrees of freedom.

**21. Dimensions of vector energy fields**

While being a scalar quantity, energy as it expands in the form of space and time-varying fields, which are vector quantities, does not exist individually. This is due to the fact that quanton energy fields are inexorably linked to the quanton volume in a dependence relationship. This makes it impossible to determine the total energy of each individual field.

The energy fields must be defined in terms of the quanton.
dimensions, in addition to energy dimensions and degrees of freedom for each energy field.

The quanton radius \( r_q \) and its volume \( V_q \) are not constant but rather inversely proportional to its packet energy content, and consequently its energy fields while \( V_q = fn( r_q^3 ) = fn( \lambda^3 ) = fn( \frac{1}{\omega^3} ) \)

and \( E_q = E_{sf} E_{sc} E_{tf} E_{tc} = \left( \frac{\hbar}{16 \pi^4 c^3} \right) \omega^4 = \text{constant} \times \omega^4 \)

hence \( V_q = fn \left( \frac{\omega}{E_{sf} E_{sc} E_{tf} E_{tc}} \right) \) ie quanton volume is dependent on the product of all four energy field densities.

Dimensions of individual energy fields are expected to be as follows:

\[
(E_{sf}) = \left[ \sqrt[4]{\left( \frac{\hbar}{16 \pi^4 c^3} \right)} \right] k c^{2.25} \psi_{sf}
\]

\[
[E_{sf}] = \mathcal{M}^{0.25} \mathcal{L}^{0.5-0.75-1+2.25} \mathcal{T}^{-0.25+0.75-2.25} = \mathcal{M}^{0.25} \mathcal{L}^{1.00} \mathcal{T}^{-1.75} \quad (1-21)
\]

\[
[E_{sc}] = \left[ \sqrt[4]{\left( \frac{\hbar}{16 \pi^4 c^3} \right)} \right] k c^{0.75} \psi_{sc} = \mathcal{M}^{0.25} \mathcal{L}^{-0.50} \mathcal{T}^{-0.25}, \quad (2-21)
\]
\[ [E_{fr}] = \left[ 4 \left( \frac{h}{16 \pi^4 c^3} \right)^\frac{w}{c} c^{0.75} \psi_{fr} \right] = M^{0.25} L^{-0.50} T^{-0.25} \] (3-21)

\[ [E_{tc}] = \left[ 4 \left( \frac{h}{16 \pi^4 c^3} \right)^\frac{w}{c} c^{0.25} \psi_{tc} \right] = M^{0.25} L^{-1.00} T^{0.25} \] (4-21)

21 b. effect of fixed relative ratio between space and time varying fields

as it had been mentioned previously, exponential degrees of freedom while in terms of the constant \( c \), provide a mechanism for the division of energy density between the space and time varying energy fields so as to maintain a constant ratio between them, for space varying fields value (in magnitude):

\[ E_s = E_{sf} E_{sc} = (K_q c^{2.25}) (K_q c^{0.75}) = K_q^2 c^3 = \sqrt[2]{\left( \frac{h c^3}{16 \pi^4} \right)} k^2 \]

for time varying energy fields:

\[ E_t = E_{tf} E_{tc} = (K_q c^{0.25}) (K_q c^{0.75}) = K_q^2 c = \sqrt[2]{\left( \frac{h}{16 \pi^4 c} \right)} k^2 \]

the relative ratio between space and time varying energy fields:

\[ \frac{E_{sf} E_{sc}}{E_{tf} E_{tc}} = \text{constant} = c^2 \], the ratio of the space and time varying
energy fields does vary as the wave parameters change very high values of \((k, \omega)\) corresponding to relatively high percentage for the share of the time varying fields, as the universe expands, this percentage drops while the percentage of the space varying energy fields increases comparatively

22. field representation inside the quanton

While free and constrained fields extend beyond the quanton radius, yet an expression for those fields inside the quanton can be provided

2- under condition of equipartition of energy in spatial axes quanton energy fields must be at any instant symmetrically expressed in all three dimensional space, based on this, each of the quanton fields is represented by concentric toroidal solenoid
while in the proper (own) frame of reference the free dominated field components can be defined as

\[ E_{qf\text{-}x}^\text{\*,} = 0 \]  
\[ E_{qf\text{-}y}^\text{\*,} = E_{qf\text{-}x} \sin (\omega t) \]  
\[ E_{qf\text{-}z}^\text{\*,} = E_{qf\text{-}x} \cos (\omega t) \]

and the constrained energy dominated field components

\[ E_{qc\text{-}x}^\text{\*,} = E_{qc\text{-}x} \cos (\omega t) \]  
\[ E_{qc\text{-}y}^\text{\*,} = E_{qc\text{-}x} \sin (\omega t) \]  
\[ E_{qf\text{-}z}^\text{\*,} = 0 \]

the proper frame of reference \((x^*, y^*, z^*)\) is related to the observer frame of reference \((x, y, z)\) via 3 dimensional transformation matrix \((T)\)
The matrix (T) which has the angles $\theta$, $\varphi$, $\psi$ (Euler's angles) as its elements

and the resultant fields are

$E_{qfx} = \sum_i^n E_{qfxi}$  \hspace{1cm} (9-22)

$E_{qfy} = \sum_i^n E_{qfyi}$ , $E_{qfz} = \sum_i^n E_{qfzi}$  \hspace{1cm} (10, 11-22)

$E_{qcx} = \sum_i^n E_{qcxi}$ , $E_{qcy} = \sum_i^n E_{qcyi}$ , $E_{qczi} = \sum_i^n E_{qczi}$  \hspace{1cm} (12,13,14-22)

23. what maintains the integrity of the quanton?

1-Free and constrained energy dominated fields $E_{qf}$ and $E_{qc}$ are interacting through free / constrained energy field interaction

this interaction creates a binding relationship that maintains

the integrity of the quanton
2- any radiative energy that leaves the quanton must have four degrees of freedom (transmission of energy through space can only take place while fields varying in space and time have those four Dof’s)

under such a condition, no individual field (E_qr or E_qc) can leave the quanton completely and independently, instead, both fields can leave the quanton conjointly in the form of electromagnetic waves

24. quanton wave form: (Q+AQ) pair

This model illustrates that the quanton-anti quanton pair would create a form of quanton waves, later this concept would be used to develop a model for electromagnetic waves in terms of space and time varying fields quantons and anti quantons exist in pairs in the form (Q+AQ)
this linear superposition form is due to the fact that either quanton
or anti quanton is a separate but not independent energy system
as the pair is considered to be a single quantum entity.

to fulfil the wave behaviour (linear supposition of fields), the Dof
symmetry condition must be satisfied

a-For the higher degree of freedom field pair (2.5 Dof’s)

\[
(E_{qc})_{aq} = (E_{qf})_{q} \quad \text{or} \quad (\text{Dof}_{qc})_{aq} = (\text{Dof}_{qf})_{q}
\]  

(1-24)

b-for the lower degree of freedom pair (1.5 Dof’s)

\[
(E_{qf})_{aq} = (E_{qc})_{q} \quad \text{or} \quad (\text{Dof}_{qf})_{aq} = (\text{Dof}_{qc})_{q}
\]  

(2-24)

a model for the energy fields given that

\[
E_q = E_{sf}E_{tc}E_{sc}E_{tf} = E_{qf}E_{qc}
\]

and

\[
E_{aq} = \left( \frac{E_{sf}E_{tc}}{c} \right) \left( cE_{sc}E_{tf} \right)
\]

wave form is as follows

higher Dof \quad E_{wf} = \frac{1}{2} \left[ (E_{qf})_{q} + (E_{qc})_{aq} \right]

(3-24)

lower Dof \quad E_{wc} = \frac{1}{2} \left[ (E_{qc})_{q} + (E_{qf})_{aq} \right]

(4-24)

\[
E_{wh} = \frac{1}{2} K_q \left( D_{sf}D_{tc} \psi_{sf} \psi_{tc} + c D_{sc}D_{tf} \psi_{sc} \psi_{tf} \right)
\]
\[
\frac{1}{2} K_q^2 c^{2.5} \cos\left(\frac{\pi x}{2r_q} - \omega t\right)
\]

(5-24)

\[
E_{wl} = \frac{1}{2} K_q^2 (D_{sc} D_{tf} \psi_{sc} \psi_{tf} + \frac{1}{c} D_{sf} D_{tc} \psi_{sf} \psi_{tc}) = \frac{1}{2} K_q^2 c^{1.5} \cos\left(\frac{\pi x}{2r_q} - \omega t\right)
\]

(6-24)

the symmetry between free and constrained fields DoF's

does not mean that (Q-AQ) would not expand or there would not be radiative energy release from the pair as the Q/AQ pair expands

while the energy density of such a pair

\[
E_q = \frac{1}{2} \left[ (E_{qt})_q + (E_{qc})_{aq}\right] \times \frac{1}{2} \left[ (E_{qc})_q + (E_{qt})_{aq}\right]
\]

and due to the symmetry of interaction where \((E_{qt})_q = (E_{qc})_{aq}\)

\[
[E_{qc}]_q = (E_{qt})_{aq}
\]

\[
E_q = \frac{1}{4c} E_{qt}^2 + 2 \times \frac{c}{4} E_{qt} E_{qc} + \frac{c}{4} E_{qc}^2
\]

\[
= \frac{1}{4} \left( \frac{E_{qt}^2}{c} + 2 E_{qt} E_{qc} + c E_{qc}^2 \right) = E_{qt} E_{qc}
\]
25. Electromagnetic waves as space and time varying fields

The difference between quanton – anti quanton pair and electromagnetic waves lie in the fact that electromagnetic waves propagate in linear directions, and consequently, one degree of freedom is subtracted from space varying fields (free and constrained), as it becomes a kinetic degree of freedom, this relativistic effect is split equally between free and constrained fields or each of the free and the constrained waves have one half of Dof less than the corresponding quaton fields, radiative (electromagnetic) energy is released from the quanton in the following one dimensional form

Propagation of electromagnetic energy long the x-direction

The formulation of electromagnetic waves in terms of energy fields depends on the system of units

under the (Esu) system \( U \) (volumetric electromagnetic energy)
density ) = E^2 = c^2 B^2

(\varepsilon)= 1 , \mu = \frac{1}{c^2} , \text{ under such system}

electric and the magnetic fields are defined as follows

\[ E_f(x) = \frac{E_{qf}(x)}{\sqrt{c}} = \frac{E_{sf}(x)}{\sqrt{c}} E_{tc} , \quad B_c (x) = \frac{E_{qc}(x)}{\sqrt{c}} = \frac{E_{sc}(x)}{\sqrt{c}} E_{tf} \quad (1-25) \]

where \( E_f(x) \) is the electric field due to the free energy dominated field, \( B_c(x) \) is the magnetic field due to the constrained field propagating along x- axis

given that \( \cos(kx-\omega t) = \frac{1}{2} (e^{i(kx-\omega t)} + e^{-i(kx-\omega t)}) \)

define the electromagnetic ( sinusoidal waves ) \( E (x) , B (x) \)

\[ E (x) = \frac{1}{2} (E_f(x) + c B_c(x)) = \frac{1}{2} \left[ \frac{(E_{qf})_q}{\sqrt{c}} + \frac{(E_{qc})_q}{\sqrt{c}} \right] \quad (2-25) \]

\[ = \frac{1}{2} \left( \frac{E_{sf}(x)}{\sqrt{c}} E_{tc} + \sqrt{c} E_{sc}(x) E_{tf} \right) \quad (3-25) \]

\[ B (x) = \frac{1}{2} (B_c(x) + \frac{1}{c} E_f(x)) = \frac{1}{2} \left[ \frac{(E_{qc})_q}{\sqrt{c}} + \frac{(E_{qf})_q}{\sqrt{c}} \right] \quad (4-25) \]
\[ U = \varepsilon_0 E^2 = \frac{1}{\mu_0} B^2 \]

\[ E_f(x) = \frac{E_{qf}(x)}{\sqrt{c}} = \frac{E_{sf}(x) E_{tc}}{\sqrt{c}} \quad , \quad B_c(x) = \frac{E_{qc}(x)}{\sqrt{c}} = \frac{E_{sc}(x) E_{tf}}{\sqrt{c}} \quad (6-25) \]

define the electromagnetic (sinusoidal waves) as \( E(x), B(x) \)

\[ E(x) = \frac{1}{2} \frac{1}{\sqrt{\varepsilon_0}} \left[ (E_f(x) + c B_c(x)) = \frac{1}{2} \frac{1}{\sqrt{\varepsilon_0}} \left[ \left( \frac{E_{qf}}{\sqrt{c}} \right) + \left( \frac{E_{qc}}{\sqrt{c}} \right) \right] \right. \]

\[ = \frac{1}{2} \frac{1}{\sqrt{\varepsilon_0}} \left( E_{sf}(x) E_{tc} + \sqrt{c} E_{sc}(x) E_{tf} \right) \quad (7-25) \]

\[ B(x) = \frac{1}{2} \frac{1}{\sqrt{\varepsilon_0}} \left( B_c(x) + \frac{1}{c} E_f(x) \right) = \frac{1}{2} \frac{1}{\sqrt{\varepsilon_0}} \left[ \left( \frac{E_{qc}}{\sqrt{c}} \right) + \left( \frac{E_{qf}}{\sqrt{c}} \right) \right] \quad (8-25) \]

\[ = \frac{1}{2} \frac{1}{\sqrt{\varepsilon_0}} \left( E_{sc}(x) E_{tf} + \frac{1}{c} E_{sf}(x) E_{tc} \right) \quad (10-25) \]

\[ B(x) = \frac{1}{2} \left( \frac{E_{qc}(x)}{\sqrt{\varepsilon_0} \sqrt{c}} + \sqrt{\mu_0} \frac{E_{qf}(x)}{\sqrt{c}} \right) \quad (11-25) \]

and as a magnitude, \( E_0(x) = \left( \frac{1}{\sqrt{\varepsilon_0}} \sqrt{\frac{h}{16 \pi^4 c^3}} \right) (k^2 c^2) \quad (Dof = 2) \quad (12-25) \]

\[ B_0(x) = \left( \frac{1}{\sqrt{\varepsilon_0}} \sqrt{\frac{h}{16 \pi \ c^3}} \right) (k^2 c) \quad (Dof = one) \quad (13-25) \]
To note that

1-space and time varying energy fields leave the quanton in the form of electromagnetic waves, where there is no field component along the direction of the wave propagation, this absence of fields in the wave propagation direction is translated into a kinetic degree of freedom which is subtracted from the free and constrained dominated fields Dof’s, in other words

\[
D_{\text{electric field}} + D_{\text{magnetic field}} + D_{\text{kinetic}} = 3+1 = 4 \quad (14-25)
\]

2-energy leaves the quanton in the form of an energy packet

\[E = E_s E_t,\] and the expansion of this energy packet in space is different from that inside the quanton

energy expansion inside the quanton is in the form

\[
\frac{\partial}{\partial s} (E_s E_t) = E_q = E_{sf} E_{tf} E_{sc} E_{tc}, \quad \text{while outside the quanton}
\]

it takes the form

\[E_q = \frac{3}{\partial s} (E_s E_t) = c\varepsilon_0 \left( \frac{E_{sf} E_{tc}}{\sqrt{e_o \sqrt{c}}} \right) \left( \frac{E_{sc} E_{tf}}{\sqrt{e_o \sqrt{c}}} \right) = c\varepsilon_0 E \quad B\]
and as energy has to be ejected from the quanton, one degree of energy freedom became a kinetic degree of freedom, and so the quanton instead of being stationary becomes relativistic quanton anti quanton pair

3- the difference between the two cases of energy expansion, is due to the absence of the field component in the relativistic (Q+AQ) pair propagation direction which means that this quanton pair is a two dimensional one and must substitute this lost Dof with a relativistic Dof to maintain dimensional energy symmetry

4-electromagnetic waves leave quanton under two constraints

a-Integrity of the energy is maintained (no dispersion)

b-free and constrained fields (E_qf, E_qc) cannot leave the quanton independently, as the electromagnetic waves are the mechanism of transmission of energy through 3D space, they must have energy fields which are varying in space and time
whose energy $Dof = 4$ (one of them a kinetic $Dof$)

this is achieved by cross linking free and constrained fields in the

form for sinusoidal waves

$$
E(x) = \frac{1}{2} \frac{1}{\sqrt{\varepsilon_0}} \left[ \frac{(E_{qt})_q}{\sqrt{c}} + \frac{(E_{qc})_{aq}}{\sqrt{c}} \right], \quad B(x) = \frac{1}{2} \frac{1}{\sqrt{\varepsilon_0}} \left[ \frac{(E_{qc})_q}{\sqrt{c}} + \frac{(E_{qt})_{aq}}{\sqrt{c}} \right]
$$

5- electromagnetic waves in the previous form can be seen as a

relativistic two dimensional quanton anti quanton pairs, where

one energy degree of freedom is replaced by a kinetic energy

degree of freedom as the waves are formed,

dimensional analysis,

based on free and constrained energy field dimensions, the

dimensions of electromagnetic field can be determined

the electric field $[E] = \left[ \frac{E_{sf}E_{te}}{c\sqrt{c}} \right] = M^{+0.5} L^{-0.5} T^{-1}$ (15-25)

and the magnetic field $[B] = \left[ \frac{E_{sf}E_{te}}{c\sqrt{c}} \right] = M^{+0.5} L^{-1.5} T^{0.0}$ (16-25)

$[U] = \text{electromagnetic energy density} = \left[ \frac{E}{V} \right] = [\varepsilon E^2] = M L^{-1} T^{-2}$
(ε : can be chosen according to a system of units to be = 1)

\[ U = (E_f + c B_c)^2 = \frac{1}{4} \left( \frac{E_{sf} E_{tc}}{\sqrt{c}} + \sqrt{c} E_{sc} E_{tf} \right)^2 \]

\[ [U] = \frac{1}{4} * 4 \left( \frac{\hbar}{\sqrt{16 \pi^4 c^3}} \right)^2 (k^2 c^2)^2 = \left( \frac{\hbar c}{16 r_q^4} \right) = \frac{hc}{\lambda^4} \quad (17-25) \]

=\[ \frac{E}{v} \] = M L^{-1} T^{-2}, this is the generic non statistical form of

Electromagnetic energy density while in terms of the magnetic field

\[ [U] = [ \frac{B^2}{\mu} ] = c^2 \left( B_c + \frac{1}{c} E_f \right)^2 = c^2 \left( \frac{E_{sc} E_{tf}}{\sqrt{c}} + \frac{1}{c} \frac{E_{sf} E_{tc}}{\sqrt{c}} \right)^2 = M L^{-1} T^{-2} \]

(μ : chosen according to a system of units to be = \( \frac{1}{c^2} \))

\[ U = \left( \frac{\hbar}{\sqrt{16 \pi^4 c^3}} \right)^2 (k^2 c)^2 = \frac{hc}{16 \pi^4} k^4 = \left[ \frac{E}{v} \right] = M L^{-1} T^{-2} \]

Table.4 provides details of the Dof’s for various space and time varying fields of the electromagnetic waves
QUANTON BASED MODEL OF FIELD INTERACTIONS

25.b. Differences between quanton and electromagnetic waves

The following table 5. Illustrates the major differences between quanton and electromagnetic fields.

<table>
<thead>
<tr>
<th>parameter</th>
<th>Quanton waves</th>
<th>electromagnetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kinetic degrees of freedom</td>
<td>none</td>
<td>one</td>
</tr>
<tr>
<td>Nature of fields</td>
<td>three dimensional</td>
<td>Two dimensional</td>
</tr>
<tr>
<td>$D_{sf}$, $D_{sc}$</td>
<td>2.25, 0.75</td>
<td>1.75, 0.25</td>
</tr>
<tr>
<td>Field energy density</td>
<td>4-Dimensional</td>
<td>3D+relativistic Dof</td>
</tr>
<tr>
<td>Wave vector (pointing vector)</td>
<td>static</td>
<td>one directional translation</td>
</tr>
<tr>
<td>Viewed as</td>
<td>Static three dimensional (Q+AQ) pair</td>
<td>Relativistic two dimensional (Q+AQ) pair</td>
</tr>
</tbody>
</table>

Table 5. Comparison between quanton (free /constrained ) waves and electromagnetic waves

26. Maxwell equations of energy fields

as energy variation in space and time creates dynamic fields, so we can relate the four Maxwell equations for electromagnetism to
their original form for energy fields

we have defined the electromagnetic waves as the relativistic expansion of quantons / anti quantons pair that is travelling through space at velocity (c) in the form

\[
E = \frac{1}{2} \left( \left( \frac{E_{sf} E_{tc}}{\sqrt{\varepsilon_0 c}} \right) q + \left( \frac{E_{sc} E_{tf}}{\sqrt{\varepsilon_0 c}} \right) aq \right)
\]

\[
B = \frac{1}{2} \left( \left( \frac{E_{sc} E_{tf}}{\sqrt{\varepsilon_0 c}} \right) q + \left( \frac{E_{sf} E_{tc}}{\sqrt{\varepsilon_0 c}} \right) aq \right)
\]

substituting in the four Maxwell equations with the constituent energy fields corresponding to the electric and magnetic fields

1-Gauss law of electric field

\[
\nabla \cdot E = \frac{\rho_c}{\varepsilon_0}
\]

\( \rho_c \): charge density

\[
\nabla \cdot E = \nabla \cdot \left[ \left( \frac{E_{sf} E_{tc}}{\sqrt{\varepsilon_0 c}} \right) q + \left( \frac{E_{sc} E_{tf}}{\sqrt{\varepsilon_0 c}} \right) aq \right] = 2 \left( \frac{\rho_c}{\varepsilon_0} \right)
\]

\( (E_{tc} \nabla \cdot E_{sf}) q + (E_{tf} \nabla \cdot E_{sc}) aq \) = 0 (for electromagnetic waves and
space fabric case )

where $\nabla \cdot E_{tf} = 0$, $\nabla \cdot E_{tc} = 0$ ($E_{tf}$, $E_{tc}$ are function of time only)

$$0 = (E_{tc} \nabla \cdot E_{sf})_q - (E_{tf} \nabla \cdot E_{sc})_{aq}$$ (2-26)

### 2-Gauss law of magnetic field

$$\nabla \cdot B = 0$$

$$\left(\frac{E_{tf}}{\sqrt{\varepsilon_0 c}} \nabla \cdot E_{sc}\right)_q + \left(\frac{E_{tc}}{\sqrt{\varepsilon_0 c}} \nabla \cdot E_{sf}\right)_{aq} = 0$$ (3-26)

$$\left( E_{tc} \nabla \cdot E_{sf}\right)_{aq} = -\left( E_{tf} \nabla \cdot E_{sc}\right)_q$$ (4-26)

### 3-faraday’s law for electric field

$$\nabla \times E = -\frac{\partial B}{\partial t}$$

$$\nabla \times E = \left(\frac{E_{tc}}{\sqrt{\varepsilon_0 c}} \nabla \times E_{sf}\right)_q + \left(\frac{E_{tf}}{\sqrt{\varepsilon_0 c}} \nabla \times E_{sc}\right)_{aq}$$ (5-26)

$$\left(\frac{E_{tc}}{\sqrt{\varepsilon_0 c}} \nabla \times E_{sf}\right)_q + \left(\frac{E_{tf}}{\sqrt{\varepsilon_0 c}} \nabla \times E_{sc}\right)_{aq}$$ (6-26)

$$-\frac{\partial B}{\partial t} = -\frac{\partial}{\partial t} \left( E_{sc} \frac{E_{tf}}{\sqrt{\varepsilon_0 c}}\right)_q - \left( E_{sf} \frac{E_{tc}}{\sqrt{\varepsilon_0 c}}\right)_{aq}$$ (7-26)

$$\left(\frac{E_{sc}}{\sqrt{\varepsilon_0 c}} \frac{\partial E_{tf}}{\partial t}\right)_q - \left(\frac{E_{sf}}{\sqrt{\varepsilon_0 c}} \frac{\partial E_{tc}}{\partial t}\right)_{aq}$$
by comparing eq 6, 7 We get

\[ (\nabla \times E_{sf})_q = \left( \frac{E_{sc}}{\sqrt{\varepsilon_0 c}} \frac{\partial E_{tf}}{\partial t} \right)_q \]

or

\[ (E_{tc} \nabla \times E_{sf})_q = - \left( \frac{E_{sc}}{\sqrt{\varepsilon_0 c}} \frac{\partial E_{tf}}{\partial t} \right)_q \]

and

(8-26)

\[ \left( \frac{E_{tf}}{\sqrt{c/v_0}} \nabla \times E_{sc} \right)_{aq} = - \left( \frac{E_{sf}}{\sqrt{c/v_0}} \frac{\partial E_{tc}}{\partial t} \right)_{aq} \]

or

(9-26)

where \( \frac{\partial}{\partial t} (E_{sf}) = 0, \frac{\partial}{\partial t} (E_{sc}) = 0 \)

\( (E_{sf}, E_{sc} \) are function of space only)

4-ampere’s law for magnetic field

\[ \nabla \times B = \mu_0 (j + \varepsilon_0 \frac{\partial E}{\partial t}) \]

where \( \mu_0 \varepsilon_0 = \frac{1}{c^2} \)

\[ \nabla \times B = \nabla \left( \frac{E_{sc}}{\sqrt{\varepsilon_0 c}} E_{tf} \right)_q + \nabla \left( \frac{E_{sf}}{\sqrt{\varepsilon_0 c}} E_{tc} \right)_{aq} \]

\[ = \left( \frac{E_{tf}}{\sqrt{\varepsilon_0 c}} \nabla \times E_{sc} \right)_q + \left( \frac{E_{tc}}{\sqrt{\varepsilon_0 c}} \nabla \times E_{sf} \right)_{aq} \]
\[
\frac{1}{c^2} \frac{\partial E}{\partial t} = \frac{1}{c^2} \frac{\partial}{\partial t} \left[ \left( \frac{E_{sf}}{\sqrt{\varepsilon_0 c}} E_{tc} \right)_q + \left( \frac{E_{sc}}{\sqrt{\varepsilon_0 c}} E_{tf} \right)_{aq} \right]
\] 

\[
= \frac{1}{c^2} \left[ \left( \frac{E_{sf}}{\sqrt{\varepsilon_0 c}} \frac{\partial E_{tc}}{\partial t} \right)_q + \left( \frac{E_{sc}}{\sqrt{\varepsilon_0 c}} \frac{\partial E_{tf}}{\partial t} \right)_{aq} \right]
\] 

(11-26)

by comparing eq 10, 11 we get

\[
(E_{tf} \nabla x E_{sc})_q = \frac{1}{c^2} \left( E_{sf} \frac{\partial E_{tc}}{\partial t} \right)_q \quad \text{and}
\]

\[
(E_{tc} \nabla x E_{sf})_{aq} = \frac{1}{c^2} \left( E_{sc} \frac{\partial E_{tf}}{\partial t} \right)_{aq}
\]

(12-26)

It is worth noting that

1- the equations (2, 3) can be put in the following form

For quantons: \[
\frac{\nabla x E_{sf}}{\frac{\partial}{\partial t} E_{tf}} = - \frac{E_{sc}}{E_{tc}}
\]

(13-26)

For anti quantons: \[
\frac{\nabla x E_{sc}}{\frac{\partial}{\partial t} E_{tc}} = - \frac{E_{sf}}{E_{tf}}
\]

(14-26)

2- Maxwell equations remain invariant under relativistic effects

as this effect is split equally between two fields

27. Role of Maxwell equations in the evolution of the quanton

Based on the previous results of Maxwell’s equations which link the
Free and constrained fields of both the quanton and the anti quanton together, the quanton 's own form of Maxwell equations can be deduced

1-the basic fields during the primordial time were in the form

\[ E_{sf}, E_{tf} \] (free energy field that varies in space and free energy field that varies in time) as the formation of the quanton took the path of the coexistence of both fields

2-as energy expands by varying in time \( (E_{tf}) \), its rate of variation induces a curl in the space varying field such that

\[ \nabla \times E_{sf} = - \frac{E_{sc}}{E_{tc}} \frac{\partial E_{tf}}{\partial t} \] in other words, the rate of variation of \( E_{tf} \) causes \( E_{sf} \) to curl into the quanton as it is formed hence, the energy fields \( E_{sf}, E_{tc} \) are contained into a quanton formation

5- the rate of variation of the time varying field \( E_{tc} \) induces a formation of a curl in the constrained space varying field \( E_{sc} \),
such that \( \nabla x E_{sc} = \frac{1}{c^2} \frac{E_{sf}}{E_{tf}} \frac{\partial E_{tc}}{\partial t} \), such that fields \( E_{sc} \), \( E_{tf} \)

are also contained in the quanton as it formed

28. Anti quanton evolution and its degrees of freedom

Initially, this model proposed anti quanton to have evolved from free time varying energy (\( E_{tf} \)), however, through later work, many changes had to be made to match a more refined version of space fabric evolution from a single quanton, the existence of anti quanton as a stable part of space fabric may seem to be problematic, however, other evidence still weighs in its favour, namely

1-its role in the electromagnetic wave generation

( already discussed in electromagnetic section )

2-its role in the formation of the negatively charged particles

( electrons, down quarks )

3-anti quanton is stable under expansion conditions
(no degeneration)

4-the interactions generated by anti quanton energy fields are symmetric to those of the quanton, hence, it can not affect the space fabric homogeneity and integrity.

Fig. 6. hypothetical tree diagram for the evolution and the degrees of freedom of anti quanton energy fields, and why the independent evolution of the anti quanton seems to be problematic in an inflationary scenario.
From the above degree of freedom evolution diagram, the anti quanton would have evolved from energy fields $E_{sc}$, $E_{tc}$ such space and time varying fields could not evolve independently under inflationary conditions, an alternative scenario is offered, which is the evolution of the anti quanton from the quanton itself and through the pathways of Maxwell’s equations, which are in its generalized form, links the variation of both space and time $a$-free dominated field splits, reduced into a packet state

$$\int E_{qf} \, ds = \int E_{sf} \, ds \frac{\delta E_{tc}}{\delta t} = E_s \, E_t$$  \hspace{1cm} (1-28)

then expands as a constrained space-$a$-free time varying field

$$\int (E_s) \, ds \frac{\partial}{\partial t} (E_t) = \int E_s \, ds \frac{\partial E_{tf}}{\partial t} = (E_{qc})_{aq}$$  \hspace{1cm} (2-28)

b-for the quanton’s constrained space dominated field

$$\int E_{qc} \, ds = \frac{\partial}{\partial s} (E_{sc}) \int (E_{tf}) \, dt = E_s \, E_t$$  \hspace{1cm} (3-28)

then expands as a free space-$a$-constrained time varying field
\[
\frac{\partial}{\partial s}(E_s) \int (E_t) \, dt = \frac{\partial E_s}{\partial t} \int E_t \, dt = (E_{qt})_{aq} \tag{4-28}
\]

anti quanton is the mirror image of the quanton’s DoF’s

5-For the energy degrees of freedom inside anti quanton,

they are governed by the Maxwell’s equations

rate of variation of \(E_{tc}\) curls \(E_{sc}\) such that

\[
(E_{tf} \nabla \times E_{sc})_{aq} = -(E_{sf} \frac{\partial E_{tc}}{\partial t})_{aq}
\]

rate of variation of \(E_{tf}\) curls \(E_{sf}\) such that

\[
(E_{tc} \nabla \times E_{sf})_{aq} = \frac{1}{c^2} \left( E_{sc} \frac{\partial E_{tf}}{\partial t} \right)_{aq}
\]

the relationship between Q/AQ pair is governed by

\[
(E_{tf} \nabla \cdot E_{sc})_{aq} = -(E_{tc} \nabla \cdot E_{sf})_{q}
\]

\[
(E_{tc} \nabla \cdot E_{sf})_{aq} = -(E_{tf} \nabla \cdot E_{sc})_{q}
\]

6-the dominant energy of the anti quanton system is constrained

\[
D_{net} (\text{unbound}) = \frac{\text{constrained fields DoF}}{\text{free fields DoF}}
\]

\[
D_{scu} \quad D_{tcu} (\text{unbound}) = \frac{(D_{tc} D_{sc})}{(D_{sf} D_{tf})} = \frac{c^{2.25}c^{0.75}}{c^{0.75}c^{0.25}} = c^2 \tag{5-28}
\]
(unbound) constrained Dof = (Σ(constrained Dof) - Σ(free Dof) = [(Dof_{sc}) + (Dof_{tc})] - [(Dof_{sf}) + (Dof_{tf})] = 2.0

29. Lorentz transformation of energy fields

In the previous chapters we have discussed the concept of a relativistic quanton and how it is represented electromagnetic waves in the form of space and time varying fields.

Here, the Lorentz transformation will be discussed, for the electromagnetic waves also in terms of the quanton energy fields considering the case when energy fields are seen by an observer traveling at relativistic velocity along x axis.

For Lorentz transformation of electromagnetic waves, and while denoting (‘) for the case of a moving frame of reference, the transformation takes the form:

\[ E'_x = E_x, \quad E'_y = \gamma(E_y + \beta c B_z) \]
In this case the electric field is represented by the field $E_y(x)$ and the magnetic field is represented by the field $B_z(x)$ using the same transformation for the case of free and constrained energy dominated system, where

$$E = \frac{1}{2} \frac{1}{\varepsilon_0} \left( E_I + c B_c \right) = \frac{1}{2} \frac{1}{\varepsilon_0} \left( \frac{E_{sf}}{\sqrt{c}} + \frac{E_{tc}}{\sqrt{c}} \right)$$

$$B = \frac{1}{2} \frac{1}{\varepsilon_0} \left( B_c + \frac{1}{c} E_I \right) = \frac{1}{2} \frac{1}{\varepsilon_0} \left( \frac{E_{sc}}{\sqrt{c}} + \frac{1}{c} \frac{E_{tf}}{\sqrt{c}} \right)$$

after substitution, we get for $E$ and $B$

$$E_x' = \gamma \left( E_z + \beta c B_y \right), \quad B_x' = B_x$$

$$B_y' = \gamma \left( B_y - \frac{v E_z}{c^2} \right), \quad B_z' = \gamma \left( B_z - \frac{v E_y}{c^2} \right)$$

$$E_y' = \frac{\gamma}{2} \frac{1}{\varepsilon_0} \left( \left( \frac{E_{sf}}{\sqrt{c}} \right) + c \left( \frac{E_{sc}}{\sqrt{c}} \right) \right) + v \left( \frac{E_{sc}}{\sqrt{c}} \right) + \frac{v}{c} \left( \frac{E_{tf}}{\sqrt{c}} \right) \left( 1 + \frac{v}{c} \right) \left( 1 + \frac{v}{c} \right)$$

$$E_y' = \frac{\gamma}{2} \frac{1}{\varepsilon_0} \left( \left( \frac{E_{sf}}{\sqrt{c}} \right) \left( 1 + \frac{v}{c} \right) + c \left( \frac{E_{sc}}{\sqrt{c}} \right) \left( 1 + \frac{v}{c} \right) \right) \left( 1 + \frac{v}{c} \right) = \sqrt{\frac{1 + \frac{v}{c}}{1 - \frac{v}{c}}} E_y$$
Where \( \gamma \left( 1 + \frac{v}{c} \right) = \sqrt{\frac{1 + \frac{v}{c}}{1 - \frac{v}{c}}} = \sqrt{\frac{1 + \frac{v}{c}}{1 - \frac{v}{c}}} \) (4-29)

\[ B_z' = \frac{v}{2} \frac{1}{\varepsilon_0} \left( \frac{E_{sc} E_{tf}}{\sqrt{c}} \right) + \frac{1}{c} \left( \frac{E_{sf} E_{tc}}{\sqrt{c}} \right) + \frac{\gamma}{c^2} \left( \frac{E_{sc} E_{tf}}{\sqrt{c}} \right) + c \left( \frac{E_{sc} E_{tf}}{\sqrt{c}} \right) \] (5-29)

\[ B_z' = \frac{\gamma}{2} \frac{1}{\varepsilon_0} \left( \frac{E_{sc} E_{tf}}{\sqrt{c}} \right) (1 + \frac{v}{c}) + \frac{1}{c} \left( \frac{E_{sf} E_{tc}}{\sqrt{c}} \right) (1 + \frac{v}{c}) = \sqrt{\frac{1 - \frac{v}{c}}{1 + \frac{v}{c}}} B_z \] (6-29)

where \( \gamma \left( 1 - \frac{v}{c} \right) = \sqrt{\frac{1 - \frac{v}{c}}{1 + \frac{v}{c}}} \) (7-29)

For a comoving frame of reference at \( v \) where \( \beta = \frac{v}{c} \) and \( \gamma = \frac{1}{\sqrt{1 - \beta^2}} \)

The electromagnetic fields as viewed by moving observer

are \( E' = \frac{1}{2} \frac{1}{\varepsilon_0} \left( \frac{E_{sf} E_{tc}'}{\sqrt{c}} \right) + c \frac{E_{sc} E_{tf}'}{\sqrt{c}} = \frac{1}{\sqrt{\varepsilon_0}} \sqrt{\frac{1 + \beta}{1 - \beta}} K_q \frac{c^2}{1 + \beta} \cos(k' r' - \omega t') \) (8-29)

\[ B' = \frac{1}{2} \frac{1}{\varepsilon_0} \left( \frac{E_{sc} E_{tf}'}{\sqrt{c}} + \frac{1}{c} \left( \frac{E_{sf} E_{tc}'}{\sqrt{c}} \right) = \frac{1}{\sqrt{\varepsilon_0}} \sqrt{\frac{1 - \beta}{1 + \beta}} K_q \frac{c}{1 + \beta} \cos(k' r' - \omega t') \] (9-29)

where \( k' = \frac{1 - \beta}{1 + \beta} k \), \( r' = \frac{1 - \beta}{1 + \beta} r \)

\( \omega' = \frac{1 - \beta}{\sqrt{1 + \beta}} \omega \), \( t' = \frac{1 - \beta}{\sqrt{1 + \beta}} t \)
to note that the product \( E'_y \cdot B'_z = \sqrt{\frac{1 + \frac{v}{c}}{1 - \frac{v}{c}}} E_y \sqrt{\frac{1 + \frac{v}{c}}{1 + \frac{v}{c}}} B_z \)

\[ = E_y B_z = \text{constant, irrespective of the frame of reference} \]

30. some concepts behind space fabric

1-equipartition of energy or dimensional energy symmetry (with respect to time and space variation of energy) which is manifested in the form of uniform energy density throughout space

2- all fields are interacting, no silent energy field, energy fields of different types (free/constrained) interact with other energy fields of different or similar nature to create a binding or repulsive interaction

3-Preservation of space fabric integrity (in the form of space fabric Binding and retaining interactions)

4-energy field interactions are expressed at all the scales (energy fields are infinite in range)
31. Interactions of energy fields

1-as energy varies in space or time it creates associated dynamic fields that exist inside as well as outside the quantons

2-the nature of the field interactions depends on the type of the energy field (free or constrained energy dominated)

3- energy field interaction is according to following manner

a-Interaction of energy fields of similar type (free or constrained) is repulsive in nature

b-interaction energy fields of different type creates a binding interaction

4-an energy field can interact with another energy field only if they have the same field strength (they both have the same Dof’s) (necessity condition)

5- same energy field can self-interact to generate a repulsive reaction
6-though energy fields are infinite in their range of action but this range can still be divided into 3 main zones

a-inside quantons        b- outside quantons : short range

32. Bound and unbound fields

1-inside the quanton, interaction between energy fields of different nature (free- constrained) generates a binding interaction and those energy fields which are involved in such an interaction are said to be bound fields, while energy fields that do not generate such interactions are said to be unbound fields

2-for quantons free energy fields are split into two parts: bound and unbound part  $E_{sf} = K_{sf} \left( D_{sf} D_{sfu} \right)$,  $E_{tf} = K_{tf} \left( D_{tf} D_{tfu} \right)$

3-fields generated by free energy ($E_{sf}$ $E_{tf}$) fully interact with fields generated by constrained energy ($E_{sc}$ $E_{tc}$) in a binding interaction, while for anti quanton $E_{sc} = K_{sc} \left( D_{sc} D_{scu} \right)$.
\( E_{tc} = K_{tc} \left( D_{tc} D_{tcu} \right), \) and the binding interaction is between fields \( (E_{scb} E_{tcb}) \) and \( (E_{sf} E_{tf}) \)

4- unbound energy fields are repulsive in nature due to their self-interaction

5- for the space fabric case, binding interaction expresses a state of equilibrium due to the symmetry interacting energy fields (equal in strength and intensity)

6- for an energy system to be under equilibrium, all its energy fields must be tied in a binding relationships (with other energy fields) at all the scales (absence of unbound fields)

7-bound energy fields create binding interactions necessary for the integrity of the space fabric (later they will be called quanton binding \( (E_b) \) and retaining \( (E_t) \) interactions)

9-all remaining unbound energy fields and through the self
interaction give rise to quanton inflation, splitting and on larger scale inflationary momentum.

33. types of field interactions
33.a. single interactions

1-single Interactions of the type $E_{\text{binding } ij} = \frac{(E_{sfi})(E_{scj})}{(\Delta r_{ij})}$ do no exist in nature since space varying fields cannot exist independently of time varying fields.

2-simple interactions between different energy fields inside and around the quanton do not generate four dimensional potential energies, so we use the term interaction ($E_{\text{binding } ij}$) to describe the simple binding between energy fields of the type $(E_{sfbi}E_{tfbi}), (E_{scj}E_{tcj})$.

3-the dimensions of any interaction depend on its degrees of freedom

the interactions between energy fields ($E_{sfbi}E_{tfbi}$) and ($E_{scj}E_{tcj}$) can
be assessed as follows:

the binding interaction \( E_{\text{binding-ij}} \) between fields \( (E_{\text{sfb}i}, E_{\text{fbi}}) \)

and \( (E_{\text{scj}}, E_{\text{tcj}}) \) (for visualization here, this can be represented by shared flux lines) is proportional to the generated flux \( \varphi_{ij} \) between the two energy fields, the flux itself is proportional to the product of the Dof’s and intensities of those two fields, and follows the same guidelines outlined in the section:

- superposition principle inside the qunton, namely

1-the generated interaction Dof’s equal to the summation of energy degrees of freedom of both fields (proportional to the product of field strength of both fields) -for example

\[
D_{\text{binding-ij}} = (D_{\text{sfb}i} D_{\text{fbi}})(D_{\text{scj}} D_{\text{tcj}}) = c^{D_{\text{sfb}} + D_{\text{fbi}} + D_{\text{sc}} + D_{\text{tc}}} \quad (1-33)
\]

2-the interaction intensity must be proportional to the product of intensity of both fields as defined by the parameter \( K_q \)
(for example \(K_{sfbi}K_{tfbi}(K_{scj}K_{tcj}) = K_q^4\))

3- the interaction must be related to true energy, so dimensions of the energy fields intensities must always represent the real binding energy, in other words interactions must be always in terms of

\[K_q^4 \quad (K_{ij\text{\scriptsize binding}} = (K_{sf}K_{tf})(K_{sc}K_{tc}) = K_q^4)\]

as the term \(K_q^4\) represents an energy density divided by \(c^4\)

4 – the binding relationship for the case of two fields

\[E_{\text{binding}ij} = \frac{\varphi_{ij}^2}{\Delta r_{ij}} = \frac{(E_{sfbi}E_{tfbi})(E_{scj}E_{tcj})}{(\Delta r_{ij})} \quad (2-33)\]

\[= \frac{(K_{sfbi}K_{scj})(D_{sfbi}D_{scj})(K_{tfbi}K_{tcj})(D_{tfbi}D_{tcj})}{(\Delta r_{ij})} \quad (2-33)\]

\[= \frac{(K_{sfbi}K_{tfbi})(K_{scj}K_{tcj})(D_{sfbi}D_{tfbi})(D_{scj}D_{tcj})}{(\Delta r_{ij})} \quad (3-33)\]

\[= \frac{(K_q^4)(D_{sf}D_{tf})(D_{sf}D_{sc})}{(\Delta r_{ij})} \quad (3-33)\]

\[= \sqrt{\alpha_b} \frac{h}{2r_qv_q} c^{D_{of\text{\scriptsize sfb}}+D_{of\text{\scriptsize tfb}}+D_{of\text{\scriptsize sc}}+D_{of\text{\scriptsize tc}}} \quad (4-33)\]

\(\alpha_b\) : parameter of interaction, \(\Delta r_{ij}\) : effective distance between
two fields, while $E_{sfbi}$ is defined as being equal to $K_{sfbi} D_{tbi}$

(which expresses the energy field as the product of its strength (Dof) and intensity),

the dimensions of such an interaction would be $\frac{\text{Energy}}{c^{4-(Dof_{total})}}$ (3D volume)

where $Dof_{total} = Dof_{free} + Dof_{constrained}$

so only interactions which have four degrees of freedom are able of generating a binding that has the true dimensions of energy density

33.b multiple fields interactions

1-Energy fields tend to form higher order interactions whenever possible (multiple field interactions) (this is true up to Dof = 4)

1- hyper interactions (summation of Dof of constituent fields greater than 4) are inhibited inside and outside quanton.

for real interactions, Dofs must be equal or less than (4) whether it is a single or multiple interaction
(in real spaces only real interactions can be generated)

2- simpler interactions can combine to form a multiple interaction with higher degrees of freedom (up to 4)

so, multiple complex field interactions are generated as a result of two simple binding interactions of the type \((E_{sfbi} E_{tfbi})(E_{scj} E_{tcj})\)

that can combine with another simple interaction \((E_{sfbj} E_{tfbj})(E_{sci} E_{tcil})\) to form a complex one of the type

\[
E_{binding \ ij} = \frac{(E_{sfbi} E_{tfbi})(E_{scj} E_{tcj})(E_{sfbj} E_{tfbj})(E_{sci} E_{tcil})}{(\Delta r_{ij})} \tag{5-33}
\]

which is the case of gravitation

33.d. nonbinding (repulsive) interactions

while inside the quanton, the unbound field \(E_{sfu} E_{tfu}\) (or \(E_{scu} E_{tcu}\) for the case of anti quanton) generates self-interaction that gives rise only to simple repulsive interactions inside the quanton, while outside the quanton (anti quanton) the generated
self-interacting field can be involved in a repulsive interaction as well with another energy field of the same nature (free or constrained) and the generated interaction would always be a repulsive one, as this energy field cannot create a binding interaction with another field with opposing type due to this repulsive self interacting nature even if they share the same Dof's

$$E_{rij} = \left( E_{sfi}E_{tui} \right) \left( E_{sfj}E_{tuj} \right) \frac{1}{(\Delta r_{ij})}$$

$$= \left( K_{qi}^2 D_{sfi}D_{tui} \right) \left( K_{qj}^2 D_{sfj}D_{tuj} \right) \frac{1}{(\Delta r_{ij})} \quad (6-33)$$

$$= K_q^4 \left( D_{sfi}D_{tui} \right)^2 \frac{1}{(\Delta r_{ij})}$$

$$= \sqrt{\alpha_r} \frac{h}{2r_q v_q} c^{D_{sfu} + D_{tfu}} \quad (7-33)$$

and once outside the quanton, the fields behave as complex ones so, they must interact with another field (simple or complex) of
the same energy nature to generate a nonbinding (repulsive) interaction in both cases.

34. quanton field interactions
34.a-inside quantons
34.a.1The quanton retaining interaction \( (E_t) \)

the free and constrained energy fields interact with the energy of an opposite nature inside the quanton to create the quanton retaining interaction \( (E_t) \)

This is interaction is between (the bound part) of the free energy field \( (E_{sf} E_{tfb}) \) and constrained energy field \( (E_{sc} E_{tc}) \) for the case of quanton and the bound part of the constrained energy field \( (E_{scb} E_{tcb}) \) and free energy field \( (E_{sf} E_{tf}) \) for the bound part of the free energy field that participates in this interaction has to have the same degrees of freedom as constrained field (due to the symmetry of Dof’s of the interaction)

and is expressed as
\[ E_{sf}E_{tf} = (K_{sf}K_{tf})(D_{sf}D_{tf}) (D_{sfu}D_{tfu}) \]

\[ (D_{sf}D_{tf})_{\text{binding}} = (D_{sf}D_{tf}) = D_{sc}D_{tc} \quad \text{or} \quad (1-34) \]

\[ (D_{sf}D_{tf}) = c^{1.0} \quad (2-34) \]

\[ (D_{sfu}D_{tfu}) = \frac{E_{sf}E_{tf}}{E_{sc}E_{tc}} = \frac{K_q^2 D_{sf}D_{tf}}{2 D_{sc}D_{tc}} = \frac{D_{sf}D_{tf}}{D_{sc}D_{tc}} = \frac{c^3}{c^{1.0}} = c^{2.0} \quad (3-34) \]

the generated retaining interaction \( (E_t) \) that maintains the quanton’s integrity and prevents it from disintegration, the retaining interaction \( (E_t) \) is binding energy type since it is developed between two fields of different nature.

this interaction takes the following form for a single quanton

\[ (E_t)_q = (E_{sf}E_{tf})_{\text{binding}} (E_{sc}E_{tc}) \quad (4-34) \]

\[ = [K_q^2(D_{sf}D_{tf})] [K_q^2(D_{sc}D_{tc})] \]

\[ (E_t)_q = K_q^4 c^2 = \frac{\sqrt{\alpha_h k^4}}{16\pi^4} = \frac{\sqrt{\alpha_h}}{16 c r_q^4} \quad (5-34) \]

where the term \( (E_{sf}E_{tf})_{\text{binding}} \) represents the binding part of the
free energy fields \((E_{sf}E_{tf})\) that interacts with constrained fields
\((E_{sc}E_{tc})\), \((r_q)\) is the quanton radius, \(\alpha_t\) : retaining interaction parameter

while for anti quanton case the retaining interaction would be

\[
(E_t)_{aq} = (E_{sc}E_{tc})_{bound} (E_{sf}E_{tf})
\]

\[
= [K_q^2 \begin{array}{c} D_{scb} D_{tcb} \end{array}] [K_q^2 (D_{sf}D_{tf})]
\]

\[
(E_t)_{aq} = K_q^4 c^2 = \frac{\sqrt{\alpha_t h}}{16 c r_q^4}
\]

as for the dimensions of such interaction, which has two Dof’s,

while its dimension is \([\frac{\text{energy}}{\text{volume} \cdot c^2}] = M L^{-3} T^{-0}0\)

34.a.2. quanton inflationary interaction \((E_i)\)

Type : simple nonbinding (repulsive)

Inflationary interaction can be thought of as the result of the

self-interaction of the unbound part of free energy field which is

not involved in the retaining interaction \((E_t)\)

the consequence of this self-interaction is the appearance of a
repulsive interaction \((E_i)\) that causes quanton to expand,

the generated quanton inflationary interaction would be in the form

\[
(E_i)_q = (\sqrt{(E_{sf} E_{tr})_{unbound}})^2
\]  

\[
= (K_q \sqrt{(D_{sfu} D_{tru})}) (K_q \sqrt{(D_{sfu} D_{tru})})
\]  

\[
(E_i)_q = K_q^2 c^2 = \frac{2\alpha_i h c}{\sqrt{16 \frac{r_q}{4}}}
\]  

\(\alpha_i\) : inflationary interaction parameter

the inflationary interaction is at the origin of the quanton’s inflation and subsequent division, which is a synonym with space fabric expansion, this self-interaction can be thought of as energy field

of a strength \(\sqrt{D_{sfu} D_{tru}}\) that is interacting with another energy field of similar magnitude creating this repulsive interaction

the dimensions of such a energy-like interaction, which has two Dof’s, it should be \([\sqrt{\text{energy} \over \text{volume}}] = M_{0.5} L^{-0.5} T^{-1.0}\)
While for the case of anti quanton, the inflationary energy

\[(E_{i})_{aq} = (K_q \sqrt{(D_{scu} D_{tcu})})^2 K_q \sqrt{(D_{scu} D_{tcu})})\]

\[(E_{i})_{aq} = K_q^2 c^2 = \frac{2 \alpha Q h c}{16 \pi r_q^4} (10-34)\]

34.b-outside quanton

34.b.1-Space fabric binding interaction \((E_b)\)

Type: multiple binding

as energy fields are not limited in range to inside the quanton,

the fields of the free energy outside the quanton interact with the

fields of the constrained fields of other quantons to generate

the binding interaction \((E_b)\) and vice versa

the generated binding interaction \((E_b)\) is responsible for

maintaining the space fabric integrity, it is represented by two

contributions due to quantons and anti quantons,

where \((E_{bi})_q\) is the binding interaction developed between the quanton \((q_i)\) and other quantons \((q_j)\) or anti quatons \((aq_j)\),
For the case of quantons

\[ E_{bfi} = E_b( E_{sfb}E_{tfbi} )_q = \left[ (E_{sfb}E_{tfbi})_q \sum_j^n (E_{scj}E_{tcj})_q \right] \left( \frac{r_{qi}^2}{(r_i - r_j)} \right) \]

\[ + \left[ (E_{sfb}E_{tfbi})_q \sum_j^n (E_{scbj}E_{tcbj})_{aq} \right] \left( \frac{r_{qi}^2}{(r_i - r_j)} \right) \]

\[ = \left[ K_{qi}^2 (D_{sfb}D_{tfbi})_q \sum_j^n K_{qj}^2 (D_{scj}D_{tcj})_q \right] \left( \frac{r_{qi}^2}{(r_i - r_j)} \right) + \]

\[ [K_{qi}^2 (D_{sfb}D_{tfbi})_q \sum_j^n K_{qj}^2 (D_{scbj}D_{tcbj})_{aq}] \left( \frac{r_{qi}^2}{(r_i - r_j)} \right) \]

\[ E_{bfi} = K_q^2 c^2 \left( \sum_j^n \left( \frac{r_q}{(r_i - r_j)} q_q \right) \right) + \left( \sum_j^n \frac{r_q}{(r_i - r_j)} q_{aq} \right) \]

\[ = \frac{\sqrt{\alpha_b} \hbar}{2c} \frac{1}{r^3 q} \left( \sum_j^n \left( \frac{1}{(r_i - r_j)} q_q \right) \right) + \left( \sum_j^n \frac{1}{(r_i - r_j)} q_{aq} \right) \]  \hspace{1cm} (12-34)

where the term \((E_{sfb}E_{tfbi})_q\) represents the bound part of the free energy fields \((E_{st}E_{tf})\) that interacts with constrained energy fields \((E_{sc}E_{tc})\),

\((r_i - r_j)\) : the distance between quantons \((q_i)\) and \((q_j)\) or anti quantons \((aq_j)\), \((i\neq j)\), \(\sqrt{\alpha_b}\) : binding interaction parameter
while the binding interaction due to the constrained field $E_{sc} E_{tc}$

will be in the form

$$E_{bci} = E_{bi} (E_{sci} E_{tci})_q = \left\{ (E_{sci} E_{tci})_q \sum_j^n (E_{sfbj} E_{tfbj})_q \right\} \left( \frac{r_{q_i} r_{q_j}}{(r_i-r_j)} \right)$$

+ \left\{ (E_{sci} E_{tci})_q (E_{sfj} E_{tfj})_{aq} \right\} \left( \frac{r_{q_i} r_{q_j}}{(r_i-r_j)} \right) \} \} \ (13-34)$$

$$= \left\{ K^4_q (D_{sci} D_{tci})_q \sum_j^n (D_{sfbj} D_{tfbj})_q \right\} \left( \frac{r_{q_i} r_{q_j}}{(r_i-r_j)} \right)$$

$$= \sum_j^n \left( \frac{r_{q_i}}{(r_i-r_j)} \right)_{q-q} + \sum_j^n \left( \frac{r_{q_j}}{(r_i-r_j)} \right)_{q-aq}$$

$$E_{bci} = \left[ \sum_j^n \left( \frac{1}{(r_i-r_j)} \right)_{q-q} + \sum_j^n \left( \frac{1}{(r_i-r_j)} \right)_{q-aq} \right] \ (14-34)$$

which is the same expression as before or

$$E_{bf} (E_{sfj} E_{tfj}) =$$

$$E_{bc} (E_{sci} E_{tci})_q$$ and this is due to the symmetry of interactions

later a single expression for both interactions will be developed

which will be of a multiple binding type ,

of course there would be no counting of any quantons , as the
summation can be handled by assessing energy density over an integration volume

as for the factor \( \frac{\sqrt{r_{q1}r_{qj}}}{(r_i-r_j)} \), while for a single quanton of a radius \( r_q \) it has a total binding energy between bound free energy fields

\((E_{sfb} E_{tfb})\) and constrained energy fields \((E_{sc} E_{tc})\) that is

equivalent To \( E_{tp} = \int_{V_q} E_t \, dV = \int_{V_q} (E_{sfb} E_{tfb}) \, (E_{sc} E_{tc}) \, dV \)

\[
= \frac{h}{16(\pi)^4} k^4 \, V_q
\]

\[
= \frac{\sqrt{\alpha_t} h}{2} \frac{1}{8 r_q^3} \, c \, \frac{1}{r_q} \, V_q = \sqrt{\alpha_t} \, h \, c \, V_q = \sqrt{\alpha_t} \, h \, c
\]

which says that the binding energy is directly proportional to \(( \frac{1}{r_q} )\),

now for the case of a virtual quanton whose radius now becomes \((r_i-r_j)\) instead of \( r_q \), the binding energy between the two energy fields inside two separate quantons \( q_i, q_j \) becomes

\[
E_{bp} = \left( \int_{V_{q_i}} (E_{sfbi} E_{tfbi}) \, dV \right) \left( \int_{V_{q_j}} (E_{scj} E_{tcj}) \, dV \right) \frac{\sqrt{r_{q1}r_{qj}}}{(r_i-r_j)}
\]
\[ \begin{align*}
&= K_{qi}^2 (D_{sfi} D_{tbf}) K_{qj}^2 (D_{scj} D_{tcq}) V_q \frac{\sqrt{r_{qi} r_{qj}}}{(r_i - r_j)} \\
&= \sqrt{\alpha_b} c^2 \sqrt{2} \frac{h}{2 c^3 V_{qi} r_{qi}} \sqrt{2} \frac{h}{2 c^3 V_{qj} r_{qj}} V_q \frac{\sqrt{r_{qi} r_{qj}}}{(r_i - r_j)} \\
&= \frac{\sqrt{\alpha_b} h}{2(r_i - r_j) c}
\end{align*} \]

this factor \( (\frac{\sqrt{r_{qi} r_{qj}}}{(r_i - r_j)}) \) acts as a conversion factor for the calculation of the binding between any energy fields regardless whether they belong to the same quanton or not.

34.b.2-Quanton repulsive interaction \( (E_r) \)

Type: repulsive

outside the quanton, the unbound free energy field \( (E_{sfui}E_{tfui})_q \) generates a repulsive interaction with other quantons’ unbound free energy \( (E_{sfij}E_{tfui})_q \)

for quanton \( (q_i) \)

\[ E_r((E_{sfui}E_{tfui})_q) = [(E_{sfui}E_{tfui})_q \sum_j^n (E_{sfuj}E_{tfui})_q \left(\frac{\sqrt{r_{qi} r_{qj}}}{(r_i - r_j)}\right)] \quad (16-34) \]
\[ = [K_{ql}^2 D_{sfl}D_{tfl} \ ]_q \sum_j^n (K_{qj}^2 D_{sfj}D_{tfj} \ )_q \left( \frac{1}{\sqrt{r_{ql}r_{qj}}(r_{l} - r_{j})} \right) \]

\[ = 2\sqrt{\alpha_r} c^4 \ \sqrt{\frac{h}{16 c^3 r_{ql}^4}} \sum_j^n 2 \ \sqrt{\frac{h}{16 c^3 r_{qj}^4}} \ \left( \frac{1}{\sqrt{r_{ql}r_{qj}}(r_{l} - r_{j})_{q-q}} \right) \]

\[ E_{r} = \sqrt{\frac{\alpha_r h c}{16 r_{q}^3}} \sum_j^n \left( \frac{1}{\sqrt{r_{l} - r_{j}}_{q-q}} \right) \]  \hspace{1cm} (17-34)

\[ \alpha_r : \text{repulsive interaction parameter} \]

The dimensions of such a energy density interaction, which has four Dof’s, it should be \( \frac{\text{energy}}{\text{volume}} \) \( ( = \text{M} \ L^{-1} \ T^{-2}) \)

**For anti quanton (aqi)**

generated interaction due to unbound field \( E_{sfl}E_{tfl} \)\( _{aq} \) outside
the anti quanton is also a repulsive in nature in nature since this field interacts with the surrounding anti quantons’ unbound constrained energy field \( E_{sfl}E_{tfl} \)\( _{aq} \) to generate a repulsive interaction \( E_{r}((E_{sfl}E_{tfl})_{aq}) = \)

\[ [E_{sfl}E_{tfl}]_{aq} \sum_j^n (E_{sfl}E_{tfl})_{aq} \left( \frac{1}{\sqrt{r_{ql}r_{qj}}(r_{l} - r_{j})} \right) \]  \hspace{1cm} (18-34)
\[ = [K_{qi}^2 D_{s_{qi}D_{tf_{ui}}} \)_{aq} \sum_j^n (K_{qj}^2 D_{s_{qj}D_{tf_{uj}}} \)_{aq} ] \left( \frac{\sqrt{r_{qi}r_{qj}}}{(r_i-r_j)} \right) \]

\[ = K_q^4 c^4 \sum_j^n \frac{\sqrt{r_{qi}r_{qj}}}{(r_i-r_j)_{aq-aq}} \]

\[ = 2\sqrt{\alpha_c} c^4 \left( \frac{h}{\sqrt{16 c^3 r_{qi}}} \right)^2 \sum_j^n \left( \frac{h}{16 c^3 r_{qj}^4} \right)^2 \left( \frac{\sqrt{r_{qi}r_{qj}}}{(r_i-r_j)_{aq-aq}} \right) \]

\[ E_{ri} = \frac{2\sqrt{\alpha_c} h c}{16 r_q^3} \sum_j^n \left( \frac{1}{(r_i-r_j)_{aq-aq}} \right) \quad (19-34) \]

35. generation of space fabric binding interaction (Eₙ)

1- energy fields out of the quanton, which generate the quanton binding interaction are also at the origin of dark matter gravitation like effect as well as at the origin of gravitation for the case of normal matter, if inter-quanton binding were not present, there would have been no gravitational like effect of dark matter, nor gravitation for normal matter

2-The generated free energy fields out of the quanton are not in the form \( E_{sf} \ E_{tf} \), instead the free energy field
out of the quanton is divided into two parts:

first part which is the binding part which forms the retaining interaction \( (E_t) \) or \((E_{sfb}E_{t fb})_q = K_q^2 (D_{sfb}D_{t fb})_q \) and has

\((1.0 \text{ Dof's})\), and the second part which generates the quanton inflationary interaction \((E_i)\) namely the unbound part

\(((E_{sfu}E_{t fu})_q = K_q^2 (D_{sfu}D_{t fu})_q \) which has two degrees of freedom,

so we can summarize the energy fields as they leave the quanton as follows

\(a - E_{sc}E_{tc}\) \((1.0 \text{ Dof's})\) (bound constrained fields)

\(b - (E_{sfb}E_{t fb})\) \((1.0 \text{ Dof's})\) (bound free fields)

\(c - (E_{sfu}E_{t fu})\) \((1.0 +1.0 \text{ Dof's})\) (unbound self-interacting free field), and for anti quanton case

\(a - E_{sr}E_{tf}\) \((1.0 \text{ Dof's})\) (bound free field)

\(b - (E_{scb}E_{t cb})\) \((1.0 \text{ Dof's})\) (bound constrained field)
\( c = (E_{scu}E_{tcu}) \) (1.0+1.0 Dof’s) (unbound constrained field)

3-each energy field can only interact with an energy field which has the similar degrees of freedom

4-the free energy fields \((E_{st}E_{tf})_{\text{bound}}\) of the quanton or \((E_{st}E_{tf})\) of the anti quantons create in an interaction with the constrained energy field \((E_{sc}E_{tc})\) of the other quantons or \((E_{sc}E_{tc})_{\text{bound}}\) of the anti quantons which generates a more stable binding energy rather than the less stable repulsive interaction with an energy field of the same nature

5-binding energy fields out of the quanton are symmetric to those out of the anti quanton (1.0 Dof’s of each type of field), and they all the generate a binding interaction \((E_b)\)

Fig. 7. Illustrates how the quanton packet (total) energy is transformed through field interactions into different inflationary
and binding potentials which form the basis of dark energy and dark matter

![Diagram of quanton packet energy and interactions]

Fig. 7. the relationship between quanton packet energy and the Energy of various interactions

36. Dimensions of energy field interactions

While interactions that generate real energy density have 4 Dof’s, interactions that involve space fabric, have different dimensions generally, the number of energy Dof’s involved in an interaction is what determines its dimensions
From the previous discussion, we can deduce some rules regarding the dimensionality of an interaction \( (E_i) \) that involves \( (\text{Dof}_i = x) \) degrees of freedom.

dimensions of interaction \([E_i] = \left( \frac{\text{energy}}{\text{volume}} \right) \left( \frac{1}{c^{4-x}} \right) = \)

\[
= ML^{2-3+4+x} T^{-2+4-x} = ML^{x-5} T^{2-x} = [\frac{ML^{x-2} T^{2-x}}{\text{volume}}]
\]

For the special case of \( x = 4 \), \([E_{\text{D}_4}] = ML^{-1} T^{-2} = (\frac{\text{energy}}{\text{volume}})\]

37-dark energy and dark matter in terms of quanton interaction potentials

Previously the quanton interactions were discussed in terms of energy density, alternatively, those interactions can be assessed in terms of the quanton packet energy via volumetric integration

\[ E_{tp} = \left( \int_V (E_{st} E_{tf})_{\text{bound}} (E_{sc} E_{tc}) \right) dV \]

\[
= [(K_q^2 (D_{sfb} D_{tfb} ) (K_q^2 (D_{sc} D_{tc} ))] V_q \]

(1-37)
\[ = K_q^4 c^2 V_q = \alpha_t \frac{\hbar k^4}{16 \pi^4 c} = \frac{\sqrt{\alpha_i \hbar}}{2} \frac{1}{(8 r_q^3) r_q c} V_q \]

\[ E_{ip} = \sqrt{\alpha_t} \frac{\hbar}{2r_q c} \quad (2-37) \]

for the inflationary interaction

\[ E_{ip} = \int_{V_q} K_q \left( \sqrt{D_{sfu} D_{tfu}} \right) \left( K_q \sqrt{D_{sfu} D_{tfu}} \right) dV \]

\[ = \left[ (K_q^2 (D_{sfu} D_{tfu})) \right] \sqrt{V_q} \]

\[ = 2 \sqrt{\frac{\alpha_i \hbar c}{2V_q r_q}} \sqrt{V_q} = 2 \sqrt{\frac{\alpha_i \hbar c}{2r_q}} \quad (3-37) \]

for the repulsive interaction

\[ E_{rp} = \int_{V_q} K_{qi}^2 (D_{sfui} D_{tfui}) \left( K_{qj}^2 D_{sfuj} D_{tfuj} \right) dV \]

\[ = \left[ (K_q^4 (D_{sfu} D_{tfu})^2) \right] V_q \]

\[ = \frac{2\sqrt{\alpha_r} \hbar}{2V_q r_q c} V_q = \frac{2\sqrt{\alpha_r} \hbar}{2V_q r_q c} \quad (4-37) \]

37b. multiple form of quanton interactions

When possessing a wave behaviour the quanton anti quanton pair
Behave in the form Q+AQ to obtain an energy density as a result of this superposition, however as quanton/anti quanton develop field interaction, the manner quanton anti quanton behaviour does not follow a linear superposition rule, instead it follows a Dof superposition of the form Q.AQ to obtain the total energy of the quanton as a result of this superposition, this means the when interacting, the quanton or the anti quanton possesses only two Dof's in comparison to four Dof's when having a wave behaviour. It must be stressed here that both images of the quanton anti quanton pair (Q+AQ and Q.AQ) are simultaneous and not interchangeable, the interactions of the Q+AQ pair combine to form higher order interactions (Dof = four). This particular point addresses the question why the quanton evolved to become a pair of the form Q.AQ. Now for the quanton, the interaction terms become...
\[ E_{sfu} E_{tfu} + E_{sfb} E_{tfb} E_{sc} E_{tc} \]  \hspace{1cm} (4-37)

and for anti quanton

\[ E_{scu} E_{tcu} + E_{sf} E_{tf} E_{scb} E_{tcb} \]  \hspace{1cm} (5-37)

We notice here the plus sign (+) between the binding and inflationary fields which replaces the multiplication for the case of wave behaviour, later it will be shown how both fields of the quanton anti quanton pair would interact as Q.AQ pair interaction would lead to development of real four dimensional potential in the form

\[ E_p \ (\text{total energy of the quanton}) = \]

\[ E_{tp} \ (\text{total retaining energy}) + E_{ip} \ (\text{total inflationary energy}) \]

\[ + E_{bp} \ (\text{total binding energy}) + E_{rp} \ (\text{total repulsive energy}) \]

fig. 8. shows how the Q.AQ multiple interactions are evolved
Fig. 8. Evolution of Q.AQ field interactions

37b.1. binding interaction

for a multiple interaction which combines both binding of

1- field $(E_{sfb_i}E_{tfbi})_q$ of the quanton (i) with the constrained fields

$(E_{scj}E_{tcj})_q$ of the quanton (j) (or $(E_{scbj}E_{tcbj})_q$ anti quanton (j))

2- the constrained fields $(E_{sci}E_{tcii})_q$ quanton (i) with free fields

$(E_{sfbj}E_{tfbj})_q$ of the quanton (j) ( $(E_{sfj}E_{tfj})_q$ or anti quanton(j))

$$E_{btij} = \frac{c^4E_{bp}^2}{E_{ref}} = \frac{c^4}{E_{ref}}$$

$$[\int_{V_{qi}} (E_{sfbi}E_{tfbi})_q (E_{sci}E_{tcii})_q dV \sum_j^n \int_{V_{qj}} (E_{sfbj}E_{tfbj})_q (E_{scj}E_{tcj})_q dV \sqrt{r_{qi}r_{qj}} (r_i - r_j)]$$

$$+ \int_{V_{qi}} (E_{sfbi}E_{tfbi}E_{sci}E_{tcii})_q dV \sum_j^n \int_{V_{qj}} (E_{sfj}E_{tfj}E_{scbj}E_{tcbj})_aq dV \sqrt{r_{qi}r_{qj}} (r_i - r_j)]$$

$$= \frac{2r_{ref} c^4}{\hbar c} [(K_{qi}^4(D_{sfbi}D_{tfbi}D_{sci}D_{tcii})_q V_{qi} \sum_j^n K_{qj}^4 (D_{sfbj}D_{tfbj}D_{scj}D_{tcj})_q V_{qj} \sqrt{r_{qi}r_{qj}} (r_i - r_j))$$

$$+ K_{qi}^4 (D_{sfbi}D_{tfbi}D_{sci}D_{tcii})_q V_{qi} \sum_j^n K_{qj}^4 (D_{sfj}D_{tfj}D_{scbj}D_{tcbj})_aq V_{qj} \sqrt{r_{qi}r_{qj}} (r_i - r_j))]$$

(7-37)
\[ E_{btij} = \frac{2\alpha_b c^3}{\hbar} \frac{h}{2V_{qi} c^3 r_{qi}} c^2 V_{qi} \left[ \left[ \sum_j^n \frac{h}{2V_{qj} c^3 r_{qj}} c^2 V_{qj} \frac{r_{qi} r_{qj}}{(r_i - r_j)_{q-q}} \right] + \left[ \sum_j^n \frac{1}{(r_i - r_j)_{q-aq}} \right] \right] \]  

\[ (8-37) \]

\[ \left[ \sum_j^n \frac{h}{2V_{qi} c^3 r_{qi}} c^2 V_{qi} \frac{r_{qi} r_{qj}}{(r_i - r_j)_{q-aq}} \right] \]  

\[ (8-37) \]

\[ = \frac{\alpha_b \hbar c}{2} \left( \sum_j^n \left( \frac{1}{(r_i - r_j)_{q-q}} \right) + \left( \sum_j^n \frac{1}{(r_i - r_j)_{q-aq}} \right) \right) \]  

\[ (9-37) \]

\[ E_{ref} = \frac{\hbar c}{2 r_{ref}} , \quad r_{ref} = \sqrt{r_{qi} r_{qj}} \]  

\[ (10-37) \]

\[ E_{bt} = \text{total binding potential of quanton / anti quanton pair} \quad (= \frac{c^4 E_{bb}^2}{E_{ref}}) \]

37.b.2. retaining interaction

for the retaining interaction that combines both bindings of Q .AQ pair , given that \( E_t = (E_{sb} E_{tfb})(E_{sc} E_{tc}) \)

\[ \frac{c^4 E_{bb}^2}{E_{ref}} = \frac{c^4}{E_{ref}} \int_{V_q} (E_{sb} E_{tfb})_q (E_{sb} E_{tc})_q dV \int_{V_{aq}} (E_{sf} E_{tf})_{aq} (E_{sf} E_{tc})_{aq} dV \]  

\[ (11-37) \]

\[ = \frac{2 r_{ref} c^4}{\hbar c} \left( K_q^4 (D_{sf} D_{tfb} D_{sc} D_{tc})_q V_q (D_{sf} D_{tf} D_{scb} D_{tcb})_{aq} V_{aq} \right) \]  

\[ (12-37) \]

\[ = \frac{2\alpha_t r_{ref} c^4}{\hbar c} \left( \frac{h}{16 c^3 r_{q}^4} c^2 V_q \right) \left( \frac{h}{16 c^3 r_{q}^4} c^2 V_{aq} \right) \]

\[ \text{total retaining interaction potential} \quad \frac{c^4 E_{bb}^2}{E_{ref}} = \frac{\alpha_t \hbar c}{2 r_{q}} \]  

\[ (13-37) \]
the summation of both the binding and retaining interactions

For the total number of quantons \( N_q \) represents the dark matter

with its largely gravitational effects

\[
E_u * f_{DM} = \left[ N_q \frac{r_q c^4 E_{ip \nu}^2}{h} + \frac{1}{2} \sum_i^m \sum_j^n \frac{r_q c^4 E_{thij}^2}{h} \right]
\] (14-37)

\[
= \left[ N_q \frac{\alpha_h}{2r_q} + \frac{\alpha_h}{2} \sum_i^m \sum_j^n \frac{1}{r_{i-j}} \right]
\]

Where \( f_{DM} \) represents the dark matter fraction of the total energy

of the universe, \( E_u \) : total energy in the universe

and the summation for \( n = N_q, m = N_q - 1, i \neq j \)

37b.3. inflationary and repulsive interactions in multiple form

for the combined inflationary interaction due to unbound fields

of both the Q.Q pair

\[
E_{ip} = \int_{V_q} (E_{sfu} E_{tfu})_q (E_{scu} E_{tcu})_aq dV
\] (15-37)

\[
= [K_q^2 (D_{sfu} D_{tfu})_q (K_q^2 (D_{scu} D_{tcu})_aq] V_q
\] (16-37)

\[
= \alpha_i \left( \sqrt{\frac{h}{16c^3}} - \frac{c^2}{r_q^2} \right) \left( \sqrt{\frac{h}{16c^3}} - \frac{c^2}{r_q^2} V_q \right)
\]
the combined repulsive interaction of the Q.AQ pair

\[ E_{riq} = \frac{1}{E_{ref}} \left[ \sum_j \left( E_{sfui} E_{tfui} \right)_q \left( E_{scui} E_{tcui} \right) \frac{dV}{\sqrt{r_{qi} r_{qj}}} \right] \]

\[ \sum_j \int_{V_q} (E_{sfui} E_{tfui})_q (E_{scui} E_{tcui})_q dV \frac{\sqrt{r_{qi} r_{qj}}}{(r_i - r_j)} \]

\[ = \frac{\sqrt{r_{qi} r_{qj}}}{hc} \left[ (K_{qi}^4 \left( D_{sfui} D_{tfui} \right)_q \left( D_{scui} D_{tcui} \right)_q \frac{\sqrt{r_{qi} r_{qj}}}{(r_i - r_j)} \right] \]

\[ \sum_j^{\infty} K_{qi}^4 \left( D_{sfuj} D_{tfuj} \right)_q \left( D_{scuj} D_{tcuj} \right)_q V_q \frac{\sqrt{r_{qi} r_{qj}}}{(r_i - r_j)} \]

\[ = \alpha_r \frac{hc}{16 c^3} \sum_j \frac{c^4}{r_{qi}^4} V_q \left[ \sum_j^{\infty} \frac{h}{16 c^3} \frac{c^4}{r_{qi}^4} V_q \left( \frac{\sqrt{r_{qi} r_{qj}}}{(r_i - r_j)} \right) \right] \]

\[ = \alpha_r \frac{hc}{2} \left( \sum_j^{\infty} \frac{1}{(r_i - r_j)} \right) \]

\[ (20-37) \]

the summation of both the inflationary and the repulsive

Interactions for the total number of quantons \( N_q \) in the universe

represents the dark energy with its largely inflationary effects
\[ E_u * f_{DE} = [ N_q E_{ip} + \frac{1}{2} \sum_i^m \sum_j^n E_{rij} ] \]  
\[ = [ N_q \frac{\alpha_i h}{2r_q} + \frac{\alpha_r h}{2} \sum_i^m \sum_j^n \frac{1}{(r_i-r_j)} ] \]

Where \( f_{DE} \) represents the dark energy fraction of the total energy of the universe.

38. Why quanton does not achieve equilibrium

Energy fields inside the quanton try to achieve stability in the form of binding interaction which has the maximum of binding potential. The rearrangement, the quanton Dof's to satisfy the condition would be as follows: \( Dof_{tf} = Dof_{tc} = 0.5 \)

\( Dof_{sf} = Dof_{sc} = 1.5 \), \( Dof_{sf} Dof_{tf} = Dof_{sc} Dof_{tc} = 2 \)

His binding interaction here has all four Dof's. Under such conditions, the quanton is in equilibrium, no unbound fields exist to cause quanton inflation or splitting.

But this will not happen as such a condition would entail that there
would be no inflation of the universe beyond the single quanton, which would remain in this state indefinitely.

this scenario is not possible as energy has to expand, by variation in space and variation in time since the repulsive self interaction (represented by the dark energy) is always present in addition to the binding potential (represented by the dark matter).

39. The inverse relationship between wave length / energy – a possible explanation

The quanton retaining (binding) interaction took the form:

\[ E_t = (E_{sfb}E_{tfb})(E_{sc}E_{tc}) \], unlike any other potentials like:

\[ U_g = G \frac{Mm}{r} \quad \text{or} \quad U_e = K \frac{Q_1 Q_2}{r} \], term \( \left( \frac{1}{\Delta r} \right) \) does not appear in this binding potential.

In fact, the quanton, like any other quantum system has its energy which is defined as \( E_p = \frac{\hbar c}{2\pi} \), and can be put alternatively as:

\[ E_p \ (\text{packet energy}) = \frac{\hbar c}{2\pi} \cdot \frac{hc}{2r_q} \quad (\text{where} \quad k = \frac{\pi}{r_q}) \]
While \( E_{tp} = \int_{V_q} E_t \, dv = E_t \, V_q = \frac{\sqrt{\alpha_t h}}{2 \, r_q} \)

(\( E_{tp} \) : total retaining energy inside quanton)

this shows that the quanton radius is inversely proportional to retaining energy (a binding type interaction), which already satisfies the inverse proportionality law as the quanton energy \( E_p \) decreases, its retaining energy decreases and consequently quanon radius and its wave length increases, this shows that the term \( \left( \frac{1}{r_q} \right) \) is inherently present in the retaining interaction as well as all forms of quanton interactions and for the particular case of electromagnetic waves, the inverse relationship between the wavelength and the energy of the wave is an expression of an increased binding energy which leads to a corresponding change in the relativistic quanton dimensions or its wave length.
both table 8. and fig. 9. summarize the quanton interactions at all
the scales (inside, outside short and long range), while table 9.
Lists all the developed quanton / anti quanton interactions outside
the quanton

40. Role of individual energy fields in the formation of space
fabric interactions

<table>
<thead>
<tr>
<th>Energy field</th>
<th>role inside quanton</th>
<th>role outside quanton (short range)</th>
<th>interaction at cosmological scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>$E_{sfb}$ $E_{tfb}$ (bound)</td>
<td>Quanton retaining interaction $E_t$</td>
<td>Quanton binding interaction $E_b$</td>
<td>Dark matter gravitational like effect</td>
</tr>
<tr>
<td>$E_{sc}$ $E_{tc}$ (bound)</td>
<td>quanton retaining interaction $E_t$</td>
<td>Quanton binding interaction $E_b$</td>
<td>Dark matter gravitational like effect</td>
</tr>
<tr>
<td>$E_{sfu}$ $E_{tfu}$ (unbound)</td>
<td>Quanton inflationary interaction $E_i$</td>
<td>Quanton repulsive interaction $E_r$</td>
<td>Matter distortion of space fabric</td>
</tr>
</tbody>
</table>

Table 8. Summary of the role of individual energy fields and their interactions at Planck and cosmological scale for the quontons of space fabric
Fig. 9. Summary of the quanton energy fields and the generated interactions
<table>
<thead>
<tr>
<th>structure</th>
<th>quanton</th>
<th>Anti quanton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy field</td>
<td>$(E_{sfbi}E_{tfbi})$ (bound)</td>
<td>$(E_{scbj}E_{tcbj})$ (bound)</td>
</tr>
<tr>
<td>quanton</td>
<td>$E_b$</td>
<td>$E_b$</td>
</tr>
<tr>
<td>$E_{sci}E_{tci}$ (bound)</td>
<td>$E_b$</td>
<td>$E_b$</td>
</tr>
<tr>
<td>$(E_{sfui}E_{tfui})$ unbound</td>
<td>$E_r$</td>
<td>$N/A$</td>
</tr>
<tr>
<td>Anti quanton</td>
<td>$(E_{scbi}E_{tcbi})$ (bound)</td>
<td>$(E_{sfj}E_{tfj})$ (bound)</td>
</tr>
<tr>
<td>$E_{sfj}E_{tfj}$ (bound)</td>
<td>$E_b$</td>
<td>$E_b$</td>
</tr>
<tr>
<td>$(E_{scui}E_{tcui})$ (unbound)</td>
<td>$E_r$</td>
<td>$E_r$</td>
</tr>
</tbody>
</table>

Table 9. Summary of the generated interactions outside quanton / anti quanton due to different energy fields outside of the quanton.

41. energy fields’ role in the generation of the fundamental forces

1-ordinary matter evolved from quanton / anti quanton pair as they split in a process that led to the rearrangement of their degrees of freedom which became different compared space fabric case

2-normal matter quantons are quantized, but not a quantum entity and can be regarded as at the origin of bound mass

in addition to bound mass, normal matter is composed of
associated fields

3-normal matter quantons are comprise only two degrees of freedom as the remaining two become scalarized (transformed from being part of the field strength to being part of its intensity).

4-for the case of space fabric, the qunaton is not under equilibrium of interactions (equilibrium: absence of the repulsive self interacting fields), as it expands and splits, while for the case of normal matter quntons, they are under an actual equilibrium of interactions due to the complete symmetry between free and constrained fields, where no inflation or splitting.

5-under such conditions, normal matter quantons and anti quantons became identical.

6-for space fabric, unbound fields inside the qunaton, give rise to qunaton inflation, for the normal matter, the unbound energy fields (associated fields) gave rise to fundamental forces.
through their interactions with other fields (except gravitation
where it is originated from bound energy fields inside the quanton)
a model for this rearrangement in the structure of the normal matter
quanton is as follows
1- bound fields: normal matter quantons are formed from space
and time fields (E_{sfb}, E_{tfb}, E_{scb}, E_{tcb}) (now quantons and for anti
quantons are identical due to fact that bound free and constrained
fields both have the same Dof’s)
2-unbound fields (E_{sfu}, E_{tfu}), or (E_{sfu}, E_{tfu}) have the following
roles,
a-for the gluons: they gave rise to part of the strong nuclear
force
b-for the electrically charged particles: they are at the origin of
the atomic electric field
42. Degrees of freedom of quantons of normal matter

* a-gravitational mass

we recall that the normal matter quantons have only two Dof’s

and for normal matter both quantons and anti quantons are identical

1-since normal matter quantons are under equilibrium of interactions the bound fields now can reflect the space time symmetry such that

\[
\begin{align*}
\text{Dof}_{sfb} &= \text{Dof}_{scb} = 0.75, \quad \text{Dof}_{tfb} = \text{Dof}_{tcb} = 0.25 \\
(\text{Dof}_{sfb} + \text{Dof}_{scb}) &= 1.5, \quad \sum \text{Dof}_p = 2
\end{align*}
\]

(1-42)

Energy of the bound mass take the non-relativistic form

\[
E_m = \sum_i \int V_p E_{sfb} E_{tfb} E_{scb} E_{tcb} \, dV,
\]

(3-42)

The volumetric integration represents bound fields that are involved in formation of bound mass
**b-charged atomic fields**

a-space unbound fields \((E_{sfu}, E_{scu})\) have the same Dof

\[
(Dof_{sfu} = Dof_{scu} = 1.5 \text{ Dof's })
\]

b-time unbound fields \((E_{tfu}, E_{tcu})\) also have the same Dof

\[
(Dof_{tfu} = Dof_{tcu} = 0.5)
\]

3-for positively charged particles: the atomic field is represented by the unbound fields \((E_{sfu}, E_{tfu})\)

while for the negatively charged particles, the associated atomic Field is represented by the unbound fields \((E_{scu}, E_{tcu})\)

4-for normal matter, the active degrees of freedom are four: two for the normal matter quanton, and two for the associated fields

3- Due to absence of the curl (point source), the atomic electric Field becomes invariant (but its denotation is maintained)

Table 10 illustrates main differences between quantons of space
fabric and those of normal matter

<table>
<thead>
<tr>
<th>parameter</th>
<th>Space fabric quantons</th>
<th>Normal matter quantons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature of the quanton</td>
<td>Quantum entity of the form Q+AQ</td>
<td>Not a quantum entity Q and AQ are identical</td>
</tr>
<tr>
<td>Bound fields</td>
<td>Q: ($E_{sfb} E_{tfb}$) ($E_{sc} E_{tc}$)</td>
<td>Q or AQ: $E_{sfb} E_{tfb} E_{scb} E_{tcb}$</td>
</tr>
<tr>
<td>AQ: ($E_{sf} E_{tf}$) ($E_{scb} E_{tcb}$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>unbound fields</td>
<td><strong>unbound fields</strong></td>
<td><strong>unbound fields</strong></td>
</tr>
<tr>
<td>Q: ($E_{sfu} E_{tfu}$)</td>
<td></td>
<td>Gluons</td>
</tr>
<tr>
<td>AQ: ($E_{scu} E_{tcu}$)</td>
<td></td>
<td>Q: $E_{sfu} E_{tfu}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AQ: $E_{scu} E_{tcu}$</td>
</tr>
<tr>
<td>Wave behaviour</td>
<td>Q+AQ pair has wave properties</td>
<td>Inside quantons: No wave behaviour, only binding energy fields</td>
</tr>
<tr>
<td>Degrees of freedom</td>
<td>Four</td>
<td>Dof_p: two</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Associated unbound fields: two</td>
</tr>
<tr>
<td>Nature of fields</td>
<td>orthogonal</td>
<td>parallel</td>
</tr>
<tr>
<td>$E_{qf}, E_{qc}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quanton Expansion, splitting</td>
<td>Quantons Expand, and split</td>
<td>No expansion or splitting (quantons are under actual equilibrium)</td>
</tr>
<tr>
<td>$r_q, \omega$</td>
<td>Varying</td>
<td>invariant</td>
</tr>
<tr>
<td>Variation (under static conditions)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 10. Summary of the differences between space fabric and normal matter quantons
43. bound mass and its relativistic effect

The reduced quanton of the normal matter is composed of a pair of coplanar fields (free/constrained) namely

\[ E_{qf} = E_{sfb} E_{tcb}, \quad E_{qc} = E_{scb} E_{tfb} \]  \hspace{1cm} (1-43)

\[ E_m = \sum_j \int_{Vp} E_{qfbj} E_{qcbj} \quad dV = \sum_j E_{qfj} E_{qcj} V_{pj} \]  \hspace{1cm} (2-43)

unlike the case of quanton fields or electromagnetic waves (where the free dominated field \( E_{qf} \) and the constrained dominated \( E_{qc} \) are orthogonal to each other) for the normal matter the free and the constrained energy dominated fields are coplanar (exist in one plane), the magnitude of the energy density is represented by dot product of both fields, this would lead to the development of field equations of gravitational mass

\[ E_{qf} \times E_{qc} = 0 \]  \hspace{1cm} (3-43)
43.b For the relativistic effects of the bound matter

as the inertial body moves along a certain direction (x), the two
dimensional fields \( E_{qf}, E_{qc} \) undergo a gradual limitation of
variation, from 3 dimensional, to becoming two dimensional (y, z)
which is orthogonal to the movement direction
the main driving force behind this change is to maintain the
integrity of the matter, under such conditions, we would expect
there would be no energy fields along the direction of motion
the relativistic mass under Lorentz transform of transverse
energy fields now becomes \( E_{mo}' = (E_{qf}', E_{qc}', V_p) \) \( (5-43) \)
\[ E_{mo}' = \frac{(E_{qf} E_{qc} V_p)}{\sqrt{1 - \left(\frac{V}{c}\right)^2}} = \frac{E_{mo}}{\sqrt{1 - \beta^2}} \] \( (6-43) \)
and the same results can be obtained via the energy momentum
relationship where \( P_c = \frac{E}{c} v = \frac{(E_{qf} E_{qc} V_p)}{c} v \) \( (7-43) \)
\[ E_m^2 = m^2 c^4 = p^2 c^2 + m_0^2 c^4 \]

\[
\left( \frac{E_{qf} E_{qc} V_p}{c^2} \right)^2 = \left( \frac{E_{qf} E_{qc} V_p}{c^2} \right)^2 + \left( E_{qf} E_{qc} V_p \right)^2 \quad (8-43)
\]

\[
\left( \frac{E_{qf} E_{qc} V_p}{c^2} \right)^2 (1 - \frac{v^2}{c^2}) = \left( E_{qf} E_{qc} V_p \right)^2 \quad (9-43)
\]

\[
\frac{E_{qf} E_{qc} V_p}{c^2} = E_m = \frac{E_{qf} E_{qc} V_p}{\sqrt{1 - \beta^2}} = \frac{E_{mo}}{\sqrt{1 - \beta^2}} \quad (10-43)
\]

**44. Energy field parameters for normal matter**

Normal matter quanton which is composed of bound energy fields

\((E_{slb} E_{tfb}) (E_{scb} E_{scb})\) is not a quantum entity (as it possesses only two degrees of freedom), no splitting or expansion, yet it can be quantized form using the relationship

\[ E_p = \frac{\alpha_m c}{2 r_p} \]

where \( r_p \) (particle radius) = fixed

\[ E_m = M c^2 = \sum_n \frac{m_j}{c^4} c^4 = \sum n \frac{\alpha_m h}{2 c^3 r_{pj}} c^4 \]

\[ = n \frac{\alpha_m h}{2 c^3 r_p} c^4 \quad (1-44) \]

where \( \frac{\alpha_m h}{2 c^3 r_p} \) = constant \quad (2-44)
this is quantized energy relationships and not a quantum relationship since the Planck Einstein relationship is not applicable namely \( E_m \neq f_n \left( \frac{1}{r_p} \right) \), \( r_p \) represents the radius of normal matter’s quanton, normal matter energy is presented in this quantized form as it will serve two main purposes

1-to define field interactions in terms of the constant \((c)\)

2-to facilitate studying interactions with quantum based fields.

the parameters \(\omega\), \(k\), and \(r_q\) for the quanton are now replaced by the alternative characteristic length \((r_p)\)

the energy of the bound mass

\[
E_m = \sum_j^n \int_{V_p} E_{sfbj} E_{sbj} E_{tbfj} E_{tcbj} \ dV
\]

\[
= \sum_j^n (E_{sfbj} E_{sbj} E_{tbfj} E_{tcbj}) V_{pj}
\]

(3-44)
given that \(V_p = \text{constant}\), \(\sum_j^n V_{pj} = n \ V_p\)

\[
E_m = V_p \left( \sum_j^n E_{sfbj} E_{tbfj} \right) \left( E_{sbj} E_{tcbj} \right)
\]
\[ E_m = n E_{sfb} E_{sch} E_{tfb} E_{tcb} V_p = n \frac{\alpha_m \hbar c}{2 r_p} \]  

(4-44)

and as an energy density

\[ E_{pm} = \frac{n \alpha_m \hbar c}{2 r_p (V_p)} = n \frac{\alpha_m \hbar c}{2 r_q (8 r_p^3)} = n \frac{\alpha_m \hbar c}{16 r_p^4} \]  

(5-44)

where the dimensions of the bound fields \( E_{sfb} E_{tfb} E_{sch} E_{tcb} \) are

\[
\left[ \frac{\hbar c}{c^2 r_p^4} \right] = M^1 L^{-3} T^{00} = \frac{\text{energy}}{\text{volume} \cdot c^2} = \frac{\text{mass}}{\text{volume}}
\]

44.a-NM Bound energy fields

these degrees of freedom here become part of the intensity parameter as the NM quanton has two Dof's only

(scalarized degrees of freedom)

\[ E_{sfb} = \sqrt[4]{\frac{\alpha_m h c^2}{16 c^3 r_p}} = K_p \frac{c^{0.75}}{r_p} = K_{sfb} D_{sfb} \]  

(6-44)

\[ K_{sfb} = K_p = \sqrt[4]{\frac{\alpha_m h c^2}{16 c^3 r_p}} \quad , \quad D_{sfb} = c^{0.75} \]  

(7-44)

\[ E_{tfb} = \sqrt[4]{\frac{\alpha_m h c^2}{16 c^3 r_p}} = K_p c^{0.25} = K_{tfb} D_{tfb} \]  

(8-44)

\[ E_{sch} = K_{sch} D_{sch} = \sqrt[4]{\frac{\alpha_m h c^2}{16 c^3 r_p^2}} = K_p c^{0.75} = K_{sch} D_{sch} \]  

(9-44)
where $K_{sfb} = K_{tb} = K_{scb} = K_{tcb} = K_p$

44.b- unbound energy fields

44.b.1-positively charged particles

$$E_{sfu} = \sqrt[4]{\frac{\alpha e h \sqrt{c^2}}{16 c^3}} \frac{c^{0.25}}{r_p} = K_{sfu} D_{sfu} = K_p c^{1.5} \quad (11-44)$$

$$E_{tfu} = \sqrt[4]{\frac{\alpha e h \sqrt{c^2}}{16 c^3}} \frac{c^{0.5}}{r_p} = K_{tfu} D_{tfu} = K_p c^{0.5} \quad (12-44)$$

$$K_{sfu} K_{tfu} = K_p^2, \quad \alpha_e = \frac{1}{137} \quad (13-44)$$

44.b.2-negatively charged particles

$$E_{scu} = \sqrt[4]{\frac{\alpha e h \sqrt{c^2}}{16 c^3}} \frac{c^{1.5}}{r_p} = K_{scu} D_{scu} = K_p c^{1.5} \quad (14-44)$$

$$E_{tcu} = K_{tcu} D_{tcu} = K_p c^{0.5}, \quad K_{scu} K_{tcu} = K_p^2 \quad (15-44)$$

45. scalarized degrees of freedom, a possible origin of bound mass,

bound mass density is represented by the product of the normal matter field intensities which are
\[ K_{sfb} K_{tfb} K_{scb} K_{tcb} = K_p^4 = \left( \sqrt[4]{\frac{\alpha_m h}{16 c^3}} \right)^4 \left( \frac{1}{r_p^4} \right) \]

\[ \frac{\alpha_m h}{16 c r_p^4} = \frac{\text{mass}}{\text{volume}} \]

the normal matter, the intensity parameter became

\[ K_{sfb} = K_{tfb} = K_{scb} = K_{tcb} = \sqrt[4]{\frac{h c^2}{16 c^3}} \frac{1}{r_p} = \sqrt[4]{\frac{h}{16 c}} \frac{1}{r_p} \text{ instead of} \]

\[ 4 \sqrt[4]{\frac{h}{16 c^3}} \frac{1}{r_p} \text{ for the space fabric quantons} \]

while energy density equation of normal matter quanton is in the form

\[ E_q = E_{sfb} E_{scb} E_{tfb} E_{tcb}, \text{ with a reduction of overall degrees} \]

of freedom from four to two due to the fact that two degrees of freedom now transformed from belonging to the field strength parameter to become a part of the field intensity as a result of this reduction of degrees of freedom the normal matter, Dof’s of quantons representing the bound mass become of the form \(1.5+0.5\) instead of \(3+1\)
gauge theory prevents the gauge particles from acquiring mass, however, under low dimensions conditions, photons, gluons can acquire a dynamic mass under Schwinger model of reduced dimensions, here, a generalization which proposes that reduction in the energy degree of freedom is possibly at the origin of mass generation (rest/dynamic) is suggested.

46. field interactions of normal matter

46.a-Quanton retaining interaction (Type: single binding)

\[
(E_t) = (E_{sfb} E_{tfb}) (E_{scb} E_{tcb})
\]

\[
= (K_p^2 D_{sfb} D_{tfb}) (K_p^2 D_{scb} D_{tcb})
\]

\[
= \int V_p (K_p^2 \frac{c}{r_p^2}) (K_p^2 \frac{c}{r_p^2}) \ dV
\]

\[
E_t = \alpha_t \left( \frac{h c^2}{16 c^3} \right) \frac{c^2}{r_p^4} (8 r_p^3) = \alpha_t \frac{h c}{2 r_p}
\]

(2-46)

where \( K_p = \sqrt{\frac{h}{16 c}} \), this interaction has two degrees of freedom, and the dimensions of energy = \( M^1 L^2 T^{-2} \)
46.b-quanton’s gravitational binding of the bound mass

type : multiple binding

the normal matter particles develop a gravitational type of binding

as energy fields tend to form higher order interactions up to four

degrees of freedom

bound energy fields of each quanton form a gravitational binding interaction with bound energy fields of other quantons

of the form \((E_{s_f i} E_{t_f i}) (E_{s_c b} E_{t_c b})\) and \((E_{s_c b} E_{t_c b}) (E_{s_f b} E_{t_f b})\)

to generate the gravitational binding energy \(E_{gb}\) between particle \(p_i\) and other particles \(p_j\)

formulation of the gravitational binding energy of the normal matter differs from all other normal matter interactions due to the following reason

1-for normal matter space and time fields \((E_{s_f b} E_{t_f b})(E_{s_c b} E_{t_c b})\)

The intensity parameter is of nature \((K_p^4)\)
2-the gravitational binding interaction is based on two binding

interactions for fields for particles $p_i, p_j$, which are

a-between $(E_{sfbi} E_{tfbi})$ and $(E_{scbj} E_{tcbj})$

b-between $(E_{sfbj} E_{tfbj})$ and $(E_{scbi} E_{tcbi})$

those two simple interactions combine to form gravitational

binding since each one of those interactions has only two degrees

of freedom (complex interactions allowed up to 4 DoF’s)

3-the resulting interaction has would be in the form

$$E_g = K_g (K_{pi}^4 c^2) (K_{pj}^4 c^2) \frac{r_{pi} r_{pj}}{(r_{i} - r_{j})}$$

(3-46)

intensity term is becomes $(K_p^4)^2$ instead of $(K_p^4)$ which is

required for true energy generated by the interaction

and since $E_g$ has the dimensions of energy $M^1 L^{+2} T^{-2}$, the

constant $K_g$ appears as a dimensional correction since each of the

parameters\[
\left[ K_{pi}^4 \right] \left[ V_{pi} \right] \left[ K_{pj}^4 \right] \left[ V_{pj} \right] = \left( \frac{h}{2 c r_p} \right)^2 = \left[ \frac{\text{energy}}{c^2} \right] \left[ \frac{\text{energy}}{c^2} \right]
\]
to obtain a truly binding interaction $E_g$ (in terms of energy

with dimensions $M^1L^{+2}T^{-2}$)

the constant $K_g$ should be equivalent to $\frac{c^4}{E_{\text{ref}}}$ where for normal

matter $E_{\text{ref}} = \frac{\hbar c}{2r_p}$

(quanton gravitational binding is between fields which have the

dimension of energy, while gravitation in its classical form is

between two masses so each of the interaction terms is divided by

($c^2$) and then multiplying ($\frac{1}{E_{\text{ref}}}$) by ($c^4$)

$$E_{gbi} = \frac{c^4}{E_{\text{ref}}} \left[ \left( \int_{V_{pi}} E_{sfbi} E_{tfbi} E_{scbi} E_{tcbi} \frac{dV}{c^2} \right) \sum_j \int_{V_{pj}} E_{sfbj} E_{tfbj} E_{scbj} E_{tcbj} \frac{dV}{c^2} \right] \left( \frac{\sqrt{r_{pi} r_{pj}}}{(r_i - r_j)} \right)$$

$$= \frac{c^4}{E_{\text{ref}}} \left[ \left( \frac{D_{sfbi}}{K_{pi}} \frac{D_{tfbi}}{c^2} \frac{D_{scbi}}{D_{tcbi}} V_{qi} \right) \left( \sum_j^n \frac{K_{pj}}{c^2} \frac{D_{sfbj}}{D_{tfbj} D_{scbj}} \frac{D_{tcbj}}{V_{qj}} \left( \frac{\sqrt{r_{pi} r_{pj}}}{(r_i - r_j)} \right) \right) \right]$$

$$= \frac{c^4 r_p^2}{E_{\text{ref}}} \left[ \left( K_{pi}^4 V_{pi} \right) \left( \sum_j^n K_{pj}^4 V_{pj} \right) \left( \frac{1}{(r_i - r_j)} \right) \right]$$

which is a summation for particles (j)
given that $r_{pi} = r_{pj} = r_p$, for normal matter $K_{pi} = K_{pj} = K_p = \sqrt{\frac{\hbar}{16 c r_p}}$

$$\int V_p E_{sfb} E_{tfb} E_{scb} E_{tcb} dV = E_{sfb} E_{tfb} E_{scb} E_{tcb} V_p$$

$V_{pi} = V_{pj} = V_p = 8 r_p^3$

$$K_p^4 = \frac{\hbar}{16 c} \left( \frac{1}{r_p} \right)^4 = \frac{\hbar}{2 c \cdot r_p} \frac{1}{V_p}$$

$$E_{gbi} = \frac{2\alpha_g c^4 r_p^2}{\hbar c} \left[ \left( \frac{\hbar}{2 c \cdot V_{pi}} \frac{1}{r_p} V_{pi} \right) \sum_j \left( \frac{\hbar}{2 c \cdot V_{pj}} \frac{1}{r_p} V_{pj} \right) \left( \frac{1}{(r_i - r_j)} \right) \right]$$

$$= \left( \frac{\alpha_g c^4}{\hbar c} \right) \left( \frac{\hbar}{c} \right) \sum_j \left( \frac{\hbar}{2 c} \right) \left( \frac{1}{(r_i - r_j)} \right)$$

$$= \left( \alpha_g c^2 \right) \sum_j \left( \frac{\hbar}{2 c} \right) \left( \frac{1}{(r_i - r_j)} \right)$$

$$= \frac{\alpha_g h c}{2} \sum_j \left( \frac{1}{(r_i - r_j)} \right)$$

(6-46)

(7-46)

$G$ can be defined in terms of $\left( \frac{2\alpha_g c^2 r_p^2}{h} \right)$

(8-46)

And $r_p = \sqrt{\frac{G h}{2\alpha_g c^3}}$,

(9-46)

$r = \sqrt{\frac{G h}{2\pi c^3}}$ is nothing other than the Planck length

it is worth noting that while the gravitational constant $G$ remains
invariant with time as the normal matter particle radius \( r_p = \) constant, the binding parameter for space fabric

\[ K_g = \frac{2\alpha g c^2 r_q^2}{\hbar} \] is a variable with time as the quanton radius \( r_q \) varies with time

fig. 10. and table 12. Show the roles of the bound and unbound fields for the positively charged particles of the normal matter

Fig. 10. summary of developed interactions due to bound and unbound fields for positively charged particles
Table 12. Summary of the interactions developed by each energy fields at different scales for positively charged particles

<table>
<thead>
<tr>
<th>Energy field</th>
<th>Role at short range (inside quanton)</th>
<th>interactions outside quanton</th>
<th>Long range interactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>$E_{sb}E_{fb}$ (bound)</td>
<td>quanton retaining interaction $E_t$</td>
<td>quanton binding interaction $E_b$ (gravitational binding)</td>
<td>1-gravitation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2-dark matter gravitational attraction</td>
</tr>
<tr>
<td>$E_{scb}E_{tcb}$ (bound)</td>
<td>quanton retaining interaction $E_t$</td>
<td>quanton binding interaction $E_b$ (gravitational binding)</td>
<td>1-gravitation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2-dark matter gravitational attraction</td>
</tr>
<tr>
<td>$E_{sfb}E_{tfb}$ (unbound)</td>
<td>Atomic electric field</td>
<td>Atomic Electric field</td>
<td>Atomic Electric field</td>
</tr>
<tr>
<td>$E_{scu}E_{tcu}$ (unbound)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

47. Gravitational interaction of bound mass

Type: multiple binding

outside quantons, bound energy field interactions are involved in maintaining normal matter integrity via the gravitational binding interaction, but as pointed out earlier that energy fields are infinite in range, so there is a residual amount that is left untied in any
binding interaction, which gives rise to gravitation, defined as the summation of interactions due to this residual bound free and constrained fields outside of the quanton between two bodies (i, j)

\[ E_g : \text{gravitational binding energy} \]

while the gravitational interaction takes place between bound fields

\[ (E_{sfb} E_{tfb} E_{scb} E_{tcb} V_q) \] of bodies (i, j) the gravitation in its universal form \( E = G \frac{m_1 m_2}{R} \) is defined in terms of mass interaction

so we have to divide the gravitational field interaction by \((c^2 \times c^2)\) and then multiply the compensation term \( K_g \) by \( c^4 \) to obtain a gravitational interaction which represents the two masses \( m = \frac{E_m}{c^2} \)

\[ E_g = G \left( \frac{E_{mi}}{c^2} \right) \left( \frac{E_{mj}}{c^2} \right) \frac{1}{(r_i - r_j)} = G \frac{m_i m_j}{(r_i - r_j)} \] \[ (G = \frac{2a r_p^2}{E_{ref}} = \frac{2a c^4 r_p^2}{hc}) \]

\[ = \frac{2 c^4}{hc} \left[ \sum_i \int_{V_{pi}} \frac{E_{sfbj} E_{tfbj} E_{scbj} E_{tcbj}}{c^2} dV \right] \left[ \sum_j \int_{V_{pj}} \frac{E_{sfbj} E_{tfbj} E_{scbj} E_{tcbj}}{c^2} dV \right] \frac{1}{(r_i - r_j)} \] (1-47)

\[ = \frac{2 c^4 r_p^2}{hc} \left( \sum_i K_{pi} \frac{4 D_{sfbj} D_{tfbj} D_{scbj} D_{tcbj}}{c^2} V_{pi} \right) \left( \sum_j K_{pj} \frac{4 D_{sfbj} D_{tfbj} D_{scbj} D_{tcbj}}{c^2} V_{pj} \right) \frac{1}{(r_i - r_j)} \]
to note that the gravitation is the only force due to residual of fields between two bound energy fields \((E_{sfb}, E_{tfb})\) \((E_{scb}, E_{tcb})\) those energy fields form the retaining interaction \((E_t)\) first, then the gravitational like binding interaction \((E_{gb})\) and gravitation at last and this is one of the reasons behind the weakness of gravitation in comparison to other forces

48. atomic electric charge and field

unbound fields for the case of charged particles are expressed in the form of atomic electric field and ensuing electric charge,
those unbound energy fields must now be defined in terms of dimensions the new particle structure rather than the quanton dimensions.

energy stored in the positive atomic electric field is in the form

\[ E_e = \int_{V_p} (E_{sfu}E_{tfu})^2 \, dV = \sum_i^n (E_{sfu}E_{tfu})^2 \, V_{pi} \]  

(1-48)

Or \[ \alpha_e \frac{hc}{2 r_p} = \frac{Q^2}{4\pi \varepsilon_0 r_p} \]  

(2-48)

\( \alpha_e = \) coupling constant for atomic electric field, \( V_p : \) particle

Volume, for the case of positively charged particles (free energy dominated), the atomic charge can be assessed using Gauss law, where \[ \int E_{sfu} E_{tfu} \, dA = \frac{q}{\varepsilon_0} \]

\( q = \) charge density, \( E_{sfu}E_{tfu} \) are the unbound now invariant atomic (static) electric field

\[ E(+) = E_{sfu}E_{tfu} = \frac{Q}{4\pi \varepsilon_0 r_p^2}, \quad r_p: \) estimated radius of the particle

\[ Q(+) = 4\pi \varepsilon_0 r_p^2 (E_{sfu}E_{tfu}) \]
which has the dimensions of \([Q] = M^{0.5} \ L^{+1.5} \ T^{-1}\]

the accompanying electric field at any point \(r_0\) becomes

\[
E(+) = \frac{Q}{4\pi \varepsilon_0 \Delta r_0^2} = \frac{r_p^2 E_{sfu} E_{tfu}}{(\Delta r_0)^2} = \frac{\alpha_e h c}{2 V_p r_p} \frac{r_p^2}{(\Delta r_0)^2}
\]

which has the dimensions of \([E]= M^{0.5} \ L^{-0.5} \ T^{-1}\]

for negatively charged particles (constrained fields dominated)

\[
\begin{align*}
Q(-) &= 4\pi \varepsilon_0 r_p^2 \ E_{scu} \ E_{tcu} \\
\end{align*}
\]

where \(E_{scu} \ E_{tcu}\) are the unbound invariant constrained fields

\textbf{48.b. Electric binding energy}

\[
E_e = K_e \left( \frac{Q_i Q_j}{\Delta r_{ij}} \right)
\]

\[
= K_e \left( 4\pi \varepsilon_0 r_p^2 \ (E_{sfui} E_{tfui}) \right) \left( 4\pi \varepsilon_0 r_p^2 \ (E_{scuj} E_{tcuj}) \right) \frac{\sqrt{F_i F_j}}{(r_i - r_j)}
\]

\[
E_e = \frac{4\pi \varepsilon_0 \alpha_e h c}{(r_i - r_j)}
\]

\(K_e: \text{Coulomb Constant (} = 4\pi \varepsilon_0, \)
49. Strong nuclear binding / repulsive interaction

1- It is represented by self-interaction of the unbound free and constrained energy fields.

2- Real energies (which have the dimension of $ML^{+2}T^{-2}$) must be generated by interactions which have four degrees of freedom (terms of $c^4$), so we should expect the strong self-interaction also to be to have four degrees of freedom.

3- Gluons are based equitably on both free and constrained fields so as to provide for the symmetry of the self-interaction.

Free energy field based flux tube $V_{fi}$ of the form $(E_{sfu}E_{tfu})$

This field which has two Dof's is complex in nature.

$$E_{sfu}E_{tfu} = K_p^2 (D_{sfu}D_{tfu}) \quad (1-49)$$

where $D_{sfu} = c^{1.5}$, $D_{tfu} = c^{0.5}$

Constrained energy field based flux tube $V_{fj}$ in the form $(E_{scu}E_{tcu})$, which has also two Dof's.
\[ E_{scu} E_{tcu} = K_p^2 \left( D_{scu} D_{tcu} \right) \quad (2-49) \]

where \( D_{scu} = c^{1.5} \), \( D_{tcu} = c^{0.5} \)

4-energy stored in the flux tubes

\[ E_s = \int_{V_f} \left( E_{sfu} E_{tfu} \right)^2 \, dV \quad \text{and} \quad (3-49) \]

\[ E_s = \int_{V_f} \left( E_{scu} E_{tcu} \right)^2 \, dV \quad (4-49) \]

\( V_f \): flux tube volume

**a-Repulsive part (self interaction) type: simple nonbinding**

the repulsive part of strong nuclear force is a self interaction based gluon flux tubes with free energy fields \( (E_{sfu} E_{tfu}) \) in addition to self-interaction of the constrained energy field based flux tubes or \( (E_{scu} E_{tcu}) \) and generating the repulsive part of the strong binding energy, the interaction takes the form

\[ E_{sr} = \left( \int_{V_f} K_p^4 \left[ D_{sfu} D_{tfu} \right]^2 \, dV + \int_{V_f} K_p^4 \left[ D_{scu} D_{tcu} \right]^2 \, dV \right) \left( \frac{r_p}{\Delta r_p} \right) \quad (5-49) \]
Δr_p : characteristic length : distance between two quarks ,

the first term describes the contribution of free fields , while the
second term describes the contribution of constrained fields

\[
E_{sr} = K_p^4 \left( \sum_i^m [D_{sfui}D_{tfui}]^2 \right) V_{fi} + \sum_i^m [D_{scui}D_{tcui}]^2 \ V_{fi} \left( \frac{r_p}{\Delta r_p} \right) \tag{6-49}
\]

\[
= \alpha_s \left( \sqrt{\frac{\hbar}{2 \ c^3 V_p r_p}} \right)^2 (c^2)^2 \sum_i^n V_{fi} \left( \frac{r_p}{\Delta r_p} \right)
\]

\[
E_{sr} = \alpha_s \frac{\hbar c}{2 \Delta r_p} \sum_i^n \left( \frac{V_{fi}}{V_p} \right) \tag{7-49}
\]

\[\alpha_s : \text{ strong coupling constant}\]

49.b- the binding part type : simple binding

the attraction part is generated by the interaction between free
field dominated flux tubes and constrained field dominated gluon
flux tubes

\[
E_{sb} = \left( \int_{V_f} (E_{sfu}E_{tfu})(E_{scu}E_{tcu}dV) \left( \frac{r_p}{\Delta r_f} \right) \right)
\]

\[
E_{sb} = K_p^4 \left( \int_{V_f} (D_{sfu}D_{tfu})(D_{scu}E_{tcu}dV) \left( \frac{r_p}{\Delta r_f} \right) \right) \tag{8-49}\]
\[ K_p^4 \sum_i^m (D_{sfi}D_{tfi}) (D_{scui}D_{tcui}) V_{fi} \left( \frac{r_p}{\Delta r_f} \right) \]

\[ = \alpha_s \left( \frac{2}{\sqrt{2c^3v_p r_p}} \right)^2 (c^2)^2 \sum_i^m V_{fi} \left( \frac{r_p}{\Delta r_f} \right) \]

\[ = \alpha_s \frac{hc}{2v_p r_p} V_f \left( \frac{r_p}{\Delta r_f} \right) = \alpha_s \frac{hc}{2 \Delta r_f} \sum_i^n V_{fi} \frac{V_f}{V_p} \quad \text{(9-49)} \]

\( \Delta r_f \) = average distance between the flux tubes

it is noted that the distance \( (\Delta r_f) \) between flux tubes = constant

as the distance between quarks increases, \( V_f \) increases linearly

as more energy is being added to the flux tubes, so the potential

for the attraction energy increases linearly with the distance,

unlike the case of repulsive interaction where \( (\Delta r_p) \) (distance

between quarks) changes and the value of the interaction

changes accordingly, while energy content of the flux tubes

remains the same

fig. 11. and table 13. detail the role of energy fields inside and

outside the quanton for the gluons
Fig. 11. Summary of the interactions of bound and unbound fields for gluons

<table>
<thead>
<tr>
<th>Energy field</th>
<th>Role at short range (inside quanton)</th>
<th>Role outside quanton (short range)</th>
<th>interactions at long range</th>
</tr>
</thead>
<tbody>
<tr>
<td>$E_{sfb} E_{tfb}$ (bound)</td>
<td>1-Quanton retaining interaction $E_t$</td>
<td>Quanton binding $E_b$ (gravitational binding)</td>
<td>1-gravitation</td>
</tr>
<tr>
<td>$E_{scb} E_{tcb}$ (bound)</td>
<td>1-Quanton retaining interaction $E_t$</td>
<td>Quanton binding $E_b$ (gravitational binding)</td>
<td>1-gravitation</td>
</tr>
<tr>
<td>$E_{sfu} E_{tfu}$ (unbound)</td>
<td>Strong nuclear force (attraction and repulsion part)</td>
<td>Matter distortion of space fabric</td>
<td></td>
</tr>
<tr>
<td>$E_{scu} E_{tcu}$ (unbound)</td>
<td>Strong nuclear force (attraction and repulsion part)</td>
<td>Matter distortion of space fabric</td>
<td></td>
</tr>
</tbody>
</table>
table 13. Summary of the role of the interactions developed by each energy field at Planck and cosmological scales for gluons

50.Gravitational like attraction of dark matter
Type : multiple binding

1-The interaction that generates the gravitational like attraction of the dark matter is between fields of the bound fields

\[(E_{sfb} E_{t fb} E_{sc} E_{tc})_s\] of space fabric's quantons or

\[(E_{sf} E_{tf} E_{scb} E_{tcb})_s\] for ani-quantons and the bound fields

\[(E_{sfb} E_{t fb} E_{scb} E_{tcb})_m\] of the normal matter's quantons

2-space fabric bound fields have 2.0 DoF's each which create a gravitational binding interaction with the galactic normal matter quantons’ bound fields ( also have two DoF’s ) , those same energy fields which generate the gravitation binding

50.b.Gravitational like effect on normal matter free energy field

while in its density interaction form \(E_{gs} = \)
while in its complex form

\[
E_{gs} = \frac{c^4}{E_{ref}} \sum_i K_{pi} 4 \left( \frac{D_{sfi} D_{tfi} D_{scbi} D_{tcbi}}{c^2} \right)_m \ V_p \ \left[ \left( \sum_j K_{qj} 4 \left( D_{sfbj} D_{tfbj} D_{scbj} D_{tcbj} \right)_{qs} V_{qj} \right) \right] \\
+ \left[ \sum_j \int_{V_{aq}} \left( E_{sfb} E_{tfb} E_{scb} E_{tcb} \right)_{aq} \ dV \right] \cdot \left( \frac{\sqrt{r_{pi} r_{qj}}}{(r_i - r_j)} \right) \\
= \frac{c^4}{E_{ref}} \sum_i K_{pi} 4 \left( \frac{D_{sfi} D_{tfi} D_{scbi} D_{tcbi}}{c^2} \right)_m \ V_p \ \left[ \left( \sum_j K_{qj} 4 \left( D_{sfbj} D_{tfbj} D_{scbj} D_{tcbj} \right)_{qs} V_{qj} \right) \right] \\
+ \left[ \sum_j \int_{V_{aq}} \left( E_{sfb} E_{tfb} E_{scb} E_{tcb} \right)_{aq} \ dV \right] \cdot \left( \frac{\sqrt{r_{pi} r_{qj}}}{(r_i - r_j)} \right) \\
= \frac{2\sqrt{\alpha_g \alpha_b} r_{ref} c^4}{\hbar c} \left[ \left( \frac{\hbar}{2c V_{pi} r_{pi}} \right) V_p \ \sum_j \left( \frac{1}{c^2} \right) \ V_j \ \left( \frac{\sqrt{r_{pi} r_{qj}}}{(r_i - r_j)} \right) \right] \\
E_{gs} = \frac{\sqrt{\alpha_g \alpha_b} \hbar c}{2} \ \sum_j \left( \frac{1}{(r_i - r_j)} \right)_{m-qs} \\
\]

this binding interaction is between bound free and constrained energy fields of normal matter quantons \((i)\) and bound free and constrained energy fields of the space fabric’s quantons or anti
quantons (j), \( E_{\text{ref}} = \frac{hc}{2 \sqrt{r_p r_q}} \), and since the quanton radius of space fabric is varying with time, it is expected that the gravitational parameter of this interaction to be varying also with time as well.

50.c. Why normal matter generates space fabric distortion

It had been proposed that bound energy fields \((E_{\text{sf}b} E_{\text{tf}b} E_{\text{sc}} E_{\text{tc}b})_q\)

or \((E_{\text{sc}b} E_{\text{tc}b} E_{\text{sf}b} E_{\text{tc}f})_{aq}\) of space fabric which generate the space fabric binding interaction \(E_b\), would also generate the gravitational attraction between the dark matter and the normal matter \(E_{\text{gs}}\), since the binding interaction is more stable than the repulsive alternative, now for normal matter why this is not the case, which, based on the fore-mentioned discussion, there should have been no normal matter distortion of space fabric as unbound fields \((E_{\text{sf}u} E_{\text{tf}u}), (E_{\text{sc}u} E_{\text{tc}u})\) of both normal matter’s gluons and space fabric would have created more stable binding.
interaction rather than the less stable repulsive interaction

the main reason behind this is that the unbound fields of space

fabric \((E_{sfu} E_{tfu})_q\) of quanton and \((E_{scu} E_{tcu})_{aq}\) of anti quanton

generate self-interacting fields

those fields, which are at the origin of the quanton expansion,

splitting and the inflationary momentum in general, are repulsive

in nature, this means that they are complex repulsive fields

(have combined Dof that is equal 1.0 +1.0), those repulsive fields
do not completely merge to generate a resultant field of Dof

strength = 2.0) as those fields are of the form:

\[
(K_q \sqrt{(D_{sfu} D_{tfu})_q}) (K_q \sqrt{(D_{sfu} D_{tfu})_q}) \text{ or }
\]

\[
(K_q \sqrt{(D_{scu} D_{tcu})_{aq}}) (K_q \sqrt{(D_{scu} D_{tcu})_{aq}}) \text{ and not of the form }
\]

\[
K_q^2(D_{sfu} D_{tfu})_q \text{ or } K_q^2(D_{scu} D_{tcu})_{aq}, \text{ which causes them to be}
\]

involved in repulsive interaction with unbound fields of normal
matter’s gluons \((E_{sfu} E_{tfu})_m\), \((E_{scu} E_{tcu})_m\) (which are generating strong nuclear force), and this repulsive interaction is at the origin of normal matter distortion of space fabric.

51. Evidence of space fabric distortion: case of abnormal galactic rotational curves

1-the contribution of the dark matter to the rotation curves of galaxies is increasing away from the galactic bulge. This is suggestive of a presence of a repulsive effect of normal galactic mass near the bulge which causes a-reduced space fabric quanton energy density near the bulge (which leads to near Keplerian pattern of rotational velocities)

b-an increased space fabric quanton energy density away from the galactic bulge and consequently an increased gravitational effect of dark matter and increased rotation curve velocities away from the galactic bulge
2- a localized drop in the rotational curve of spiral galaxies was observed, this localized drop coincides with the spiral arms of the spiral galaxies, an interpretation of such phenomena can be put as follows, an accumulation of galactic mass in the spiral arms causes a distortion in the nearby region of the space fabric, and as a result of this distortion a drop in the gravitational like effect of the dark matter takes place, and thus causing this characteristic localized drop of rotational curves of spiral galaxies

examples: rotational curve of the milky way, localized bottoming coincides with and scutum–Centaurus and Orion - Cygnus arms for other spiral galaxies: NGC 2590, NGC 1620, NGC 7674, NGC 7217, NGC 2998, NGC 801, fig. 12, 13, 14. Show the same localized rotation curve bottoming characteristic of spiral galaxies
Fig. 12. Rotational velocity of the milky display characteristic localized bottoming which coincides with spiral arms

Fig. 13. Source: http://hyperphysics.phy-astr.gsu.edu/hbase/Astro/darmat.html
Source: http://ircamera.as.arizona.edu/Astr2016/lectures/darkmatter.htm

Fig. 14. rotational curves of various spiral galaxies display characteristic localized bottoming which coincides with spiral arms: an evidence of mass distortion space fabric and gravitational pattern.

51.b. mass distortion of space fabric

\[ E_{di} = \frac{1}{E_{ref}} \{ \int_{V_{qs}} [(E_{sful} E_{tfui})_{qs} (E_{scui} E_{tcui})_{aq} dV] \}

\[ \sum_{j} \int_{V_{f}} (E_{sful} E_{tfui})_{m} (E_{scui} E_{tcui})_{m} dV) \} \sqrt{\frac{r_{qj} r_{pj}}{(r_{i} - r_{j})}} \] (1-51)

\[ = \frac{2}{h c} \{ \frac{K_{pq}^{4} (D_{sful} D_{tfui})_{qs} (D_{scui} D_{tcui})_{aq} V_{qi}}{\sum_{j} K_{qj}^{4} (D_{sful} D_{tfui})_{m} (D_{scui} D_{tcui})_{m} V_{pj} \left( \frac{v_{ij}}{v_{pj}} \right)} \} \sqrt{\frac{r_{qj} r_{pj}}{(r_{i} - r_{j})}} \] (3-51)
\[ E_{di} = \alpha_r \left( \frac{\hbar}{2} \right) \sum_{j}^n \left( \frac{V_{ij}}{V_{pj}} \right) \left( \frac{1}{|r_i - r_j|} \right) \]  

(4-51)

the summation for quanton and anti quanton pair (i) of space fabric for 1 to n and for j quantons of the stellar matter unbound gluon fields.

52. Electromagnetic field interactions

the relativistic degree of freedom affected the space varying fields and led to the rearrangement of energy degree of freedom as follows

\[ Dof_{sf} Dof_{tc} = 2.5 - 0.5 = 2.00 \quad , \quad Dof_{sc} Dof_{tf} = 1.5 - 0.5 = 1.0 \]

\[ (Dof_{sf} Dof_{tf})_{\text{bound}} = (Dof_{sc} Dof_{tc})_{\text{bound}} 0.5 \]

\[ (Dof_{sf} Dof_{tf})_{\text{unbound}} = 2.0 \quad , \]

52.a-Retaining energy interaction

the photon retaining interaction is has two degrees of freedom as
the relativistic Dof is added to the binding Dof to generate a four dimensional interaction

\[ E_{tp} = \int_{V_q} (E_{sfb}E_{t fb}) \ (E_{sc}E_{tc}) \ c \ dV \]  \hspace{1cm} (1-52)

\[ = [K_{qs}^2 (D_{sfb} D_{t fb})] [K_{qs}^2 (D_{sc} D_{tc})] \ c \ V_q \]

\[ E_{tp} = K_{qs}^4 c^2 V_q = \sqrt{\alpha_t} \ \frac{\hbar k^4}{16 \pi^4} \ c \ V_q = \sqrt{\alpha_t} \ \frac{\hbar}{16 \ c \ r_q^4} \ c \ V_q \]  \hspace{1cm} (2-52)

\[ E_{tp} = \sqrt{\alpha_t} \ \frac{\hbar}{2 \ c \ r_q} \]  \hspace{1cm} (3-52)

and the total retaining energy for the photon Q+AQ pair

\[ = \frac{c^4}{E_{rel}} E_{tp} \^2 = \alpha_t \ \frac{\hbar c}{r_q} \]

52.b inflationary and repulsive interactions

Same as space fabric

52.c-Gravitational binding interaction of electromagnetic waves

recalling the mass-energy equivalency principle, which for the case of the photon takes the form \[ E = \frac{m}{c^2} \]

the two degrees of freedom here belong to the unbound fields
which is the opposite to bound mass case

the binding interaction for electromagnetic wave has one degree of freedom in addition to the relativistic Dof

the binding interaction takes the form

\[ E_{gbi} = \frac{c^4}{E_{ref}} \left\{ \frac{1}{2} \int_{V_q} (E_{sfbi} E_{tfbi} E_{sci} E_{tcbi}) q \ c \ dV \right\} + \]

\[ \left[ \frac{1}{2} \int_{V_q} (E_{sf} E_{tf} E_{sci} E_{tc}) aq c \ dV \right] \sum_j^n \int_{V_p} \left( \frac{E_{sfj} E_{tfbj} E_{schj} E_{tcbj}}{c^2} \right) m dV \left( \frac{\sqrt{r_{qj} r_{pj}}}{(r_i - r_j)} \right) \] (4-52)

\[ = \frac{c^4 r_{qj} r_{pj}}{hc} \left\{ \left[ \frac{1}{2} K_{qi}^4 \left( D_{sfbi} D_{tfbi} D_{sci} D_{tcbi} \right) q c V_{qi} \right] \right\} + \]

\[ \left[ \frac{1}{2} K_{qi}^4 \left( D_{sf} D_{tf} D_{sci} D_{tc} \right) aq c V_{aqi} \right] \sum_j^n K_{pj}^4 \frac{D_{sfj} D_{tfbj} D_{schj} D_{tcbj}}{c^2} V_{pj} \frac{1}{(r_i - r_j)} \]

\[ = \frac{2 c^3 r_{qj} r_{pj}}{h} \left( K_{qi}^4 c^2 V_{qi} \right) \left( \sum_j^n K_{pj}^4 c^2 V_{pj} \right) \left( \frac{1}{r_i - r_j} \right) \] (5-52)

\[ = \frac{2 c^3 r_{qj} r_{pj}}{h} \left( \frac{h c^2}{2 c^3 V_{qi} r_{qi}} \right) V_{qi} \sum_j^n \left( \frac{h c^2}{2 c V_{pj} r_{pj}} \right) V_{pj} \left( \frac{1}{r_i - r_j} \right) \]

\[ E_{gbi} = \frac{h c^{\sqrt{a_b a_g}}}{2} \sum_j^n \left( \frac{1}{r_i - r_j} \right) \] (6-52)
noting that this gravitational like binding can exist between two
different electromagnetic waves

\[ K_g = \frac{c^4}{E_{\text{ref}}} \times \frac{2 \sqrt{r_{qj} r_{pj}} c^3}{h} \]  (previously, it was defined as

\[ K_g = \frac{2 r_p c^3}{h} \text{ for the case of normal matter gravitation} \]

52 d. dark matter distortion of electromagnetic waves

both unbound fields of space fabric and electromagnetic waves

interact in a mutually repulsive interaction to create the dark

matter distortion of electromagnetic waves, keeping in mind that

those unbound fields can only create a repulsive interaction

\[ E_{\text{rei}} = \frac{1}{E_{\text{ref}}} \left\{ \left[ \int V_{q} (E_{\text{sui}} E_{\text{tfui}})_{q} (E_{\text{sui}} E_{\text{tcui}})_{aq} \, dV \right] \right\} \]

\[ \left[ \sum_{j} \int V_{q} (E_{\text{sui}} E_{\text{tfui}})_{q} (E_{\text{sui}} E_{\text{tcui}})_{aq} \, dV \right] \left( \frac{\sqrt{r_{qj} r_{pj}}}{(r_i-r_j)} \right) \]  \[ (6-52) \]

\[ = \frac{r_{\text{ref}}}{h c} \left\{ [K_{qi}^4 (D_{\text{sui}} D_{\text{tfui}})_{q} (D_{\text{sui}} D_{\text{tcui}})_{aq} \, V_{qi}] \right\} \]

\[ \left[ \sum_{j} K_{pj}^4 (D_{\text{sui}} D_{\text{tfui}})_{q} (D_{\text{sui}} D_{\text{tcui}})_{aq} \, V_{qj} \right] \left( \frac{\sqrt{r_{qj} r_{pj}}}{(r_i-r_j)} \right) \]  \[ (7-52) \]
\[
-\frac{2\sqrt{r_{qi} r_{pj}}}{\hbar c} (K_{qi} c^4 V_{qi}) (\sum_{j}^{n} K_{pj} c^4 V_{qj})(\frac{1}{(r_{i}-r_{j})})
\]

\[
= \alpha_r \left( \frac{\hbar}{2c^3 V_{qi} r_{qi}} V_{qi} \right) c^4 \sum_{j}^{n} \frac{\hbar}{2c^3 V_{qj} r_{qj}} c^4 V_{qj} \left(\frac{\sqrt{r_{qi} r_{pj}}}{(r_{i}-r_{j})}\right)
\]

\[
E_{ref} = \frac{\alpha_r \hbar c}{2} \sum_{j}^{n} \frac{1}{(r_{i}-r_{j})} e^{-s} \tag{8-52}
\]

this interaction which has four Dof’s and between unbound free and constrained fields of photon (i) and unbound free and constrained fields of quanton and anti quanton pair (j)

where \( E_{ref} = \frac{\hbar c}{2 \sqrt{r_{qi} r_{pj}}} \)

Table 14. provides a summary of interactions, their source fields and their types.
<table>
<thead>
<tr>
<th>Interaction Type</th>
<th>Interaction</th>
<th>Free Energy Field</th>
<th>Constrained Energy Field</th>
<th>Interaction Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-$E_i$ : quanton retaining</td>
<td>$E_{sf} E_{bf} E_{tf}$</td>
<td>$E_{scb} E_{tcb}$</td>
<td>multiple binding</td>
<td></td>
</tr>
<tr>
<td>2-$E_b$ : quanton binding</td>
<td>$E_{sf} E_{bf} E_{tf}$</td>
<td>$E_{scb} E_{tcb}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>For normal matter</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$E_i$ : quanton retaining</td>
<td>$E_{sfu} E_{tfu}$</td>
<td>$E_{scu} E_{tcu}$</td>
<td>Single binding</td>
<td></td>
</tr>
<tr>
<td>1-$E_i$ : quanton inflationary</td>
<td>$E_{sfu} E_{tfu}$</td>
<td>$E_{scu} E_{tcu}$</td>
<td>repulsive</td>
<td></td>
</tr>
<tr>
<td>2-$E_r$ : quanton repulsive</td>
<td>$E_{sf} E_{bf} E_{tf}$</td>
<td>$E_{scb} E_{tcb}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-gravitation binding</td>
<td>$E_{sf} E_{bf} E_{tf}$</td>
<td>$E_{scb} E_{tcb}$</td>
<td>Multiple binding</td>
<td></td>
</tr>
<tr>
<td>2- Gravitation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electric force</td>
<td>$E_{sfu} E_{tfu}$</td>
<td>$E_{scu} E_{tcu}$</td>
<td>a-single binding or b-repulsive</td>
<td></td>
</tr>
<tr>
<td>Strong nuclear</td>
<td>$E_{sfu} E_{tfu}$</td>
<td>$E_{scu} E_{tcu}$</td>
<td>a-single binding or b-repulsive</td>
<td></td>
</tr>
<tr>
<td>Dark matter gravitation like effect</td>
<td>$(E_{sf} E_{bf} E_{tf})_{qs}$</td>
<td>$(E_{sc} E_{tc})_{qs}$</td>
<td>Multiple binding</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$(E_{sf} E_{bf} E_{tf})_{aq}$</td>
<td>$(E_{sc} E_{tc})_{aq}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$(E_{sf} E_{bf} E_{tf})_{m}$</td>
<td>$(E_{scb} E_{tcb})_{m}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Matter distortion of space fabric</td>
<td>$(E_{sf} E_{bf} E_{tf})_m$</td>
<td>$(E_{sc} E_{tc})_m$</td>
<td>repulsive</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$(E_{sf} E_{bf} E_{tf})_s$</td>
<td>$(E_{sc} E_{tc})_s$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>gravitation like binding of EM waves</td>
<td>$(E_{sf} E_{bf} E_{tf})_{qe}$</td>
<td>$(E_{sc} E_{tc})_{qe}$</td>
<td>multiple binding</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$(E_{sf} E_{bf} E_{tf})_{aqe}$</td>
<td>$(E_{sc} E_{tc})_{aqe}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$(E_{sf} E_{bf} E_{tf})_m$</td>
<td>$(E_{scb} E_{tcb})_m$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dark matter distortion of electromagnetic waves</td>
<td>$(E_{sf} E_{bf} E_{tf})_e$</td>
<td>$(E_{sc} E_{tc})_e$</td>
<td>repulsive</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$(E_{sf} E_{bf} E_{tf})_s$</td>
<td>$(E_{sc} E_{tc})_s$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 14. Summary of interactions, their types and their energy field source
CPT symmetry has its origins at the quanton level, as it reflects symmetries created due to energy constraining, as the degrees of freedom of anti quanton’s free and constrained fields are mirror symmetric to those of the quanton’s.

Tables 15, 16. provide an illustration of this symmetry at the level of the quanton fields and their Dof’s.

<table>
<thead>
<tr>
<th>field</th>
<th>quanton</th>
<th>anti quanton</th>
<th>Dof</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature of dominant energy</td>
<td>free</td>
<td>constrained</td>
<td></td>
</tr>
<tr>
<td>Main-space field</td>
<td>$E_{sf}$</td>
<td>$E_{sc}$</td>
<td>2.25</td>
</tr>
<tr>
<td>Auxiliary-space field</td>
<td>$E_{sc}$</td>
<td>$E_{sf}$</td>
<td>0.75</td>
</tr>
<tr>
<td>Main time field</td>
<td>$E_{tf}$</td>
<td>$E_{tc}$</td>
<td>0.75</td>
</tr>
<tr>
<td>Auxiliary time field</td>
<td>$E_{tc}$</td>
<td>$E_{tf}$</td>
<td>0.25</td>
</tr>
</tbody>
</table>

Table 15. Mirror symmetry between quanton and anti quanton
<table>
<thead>
<tr>
<th>CPT</th>
<th>free</th>
<th>constrained</th>
</tr>
</thead>
<tbody>
<tr>
<td>time</td>
<td>Positive configuration for the free time field ($E_{tf}$)</td>
<td>negative configuration for the constrained time field ($E_{tc}$)</td>
</tr>
<tr>
<td>parity</td>
<td>Positive position vector configuration for the free space fields ($E_{sf}$)</td>
<td>negative position vector configuration for the constrained space field ($E_{sc}$)</td>
</tr>
<tr>
<td>charge</td>
<td>positive atomic fields and charges due to unbound fields ($E_{sfu}E_{tfu}$)</td>
<td>negative atomic fields and charges due to unbound fields ($E_{scu}E_{tcu}$)</td>
</tr>
</tbody>
</table>

Table 16. CPT symmetry and its link to quanton / anti quanton mirror symmetry

54. Conclusions

Uniformity and homogeneity of CMB testifies to its origin which is the release of radiation from the space fabric as a direct result of the process of free expansion of the universe (second law of Thermodynamics), this gives a gate way for further understanding of the quanton interactions.
55. References

Basic physics.