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Quanton Based Model of Field Interactions,

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Abstract;

The search for a unification of the physical phenomena was the preoccupation of many physicists for long time. Starting from the seventeenth century with the unification of celestial mechanics and gravitation, then the unification of the electromagnetism in the nineteenth century.

The early twentieth century brought about the unification of space and time and the unification of energy and mass while the advent of gauge theory enabled the unification of the weak interaction with the electromagnetism in the middle of the twentieth century.

More recent theories are proposed as the answer to the unification question in physics include quantum gravity which unifies quantum mechanics and gravitation, and string theory.

Unification effort should not only address the known fundamental forces but the space fabric interactions which till now remain unknown but their manifestations are described as the dark energy and dark matter.

Here the concept of interacting space and time fields which constitute space time is discussed using classic method which has a certain advantage of bringing the physical meaning into visualization.

Keywords: Unification physics. Energy degree of freedom, space and time varying fields, bound and unbound fields

Introduction

Previously, a quantized model was introduced **[1]** where energy density expanded out of singularity This expansion takes the form of space and time fields which are of different natures (free and constrained), and those fields constitute the basic building blocks of a quantum entity : the quanton where the relationship between those fields is governed by the energy degree of freedom. This model has cosmological implications which were discussed in separate works **[2], [3]**

This work comes in two parts the first provides a model for the interactions of the quanton fields such gravitational and repulsive (inflationary) interactions which are at the origin of dark energy and dark matter

The second part deals with normal matter quantons and its fundamental interactions .

Throughout this model it will be shown how space and time fields can be used as a unified effective method to describe all types of interactions.

<u>Contents</u>

1. Mathematical brief

$E_{sf} = \frac{\partial E}{\partial s}$: free space field (1-1)

$E_{tf} = \frac{\partial E}{\partial t}$: free time field (2-1)

$E_{sc} = \int E\, ds$: constrained space field (3-1)

$E_{tc} = \int E\, dt$: constrained time field (4-1)

$E_s = E_{sf} E_{sc}$, $E_t = E_{tf} E_{tc}$ (5,6-1)

Energy fields are vector quantities which have direction as well as magnitude and can be defined as

(for the case of space varying free field)

$E_{sf} = K_{sf} D_{sf}\, \psi_{sf}$ (7-1)

where D_{sf} : energy field strength (degree of freedom parameter – in exponential terms of the constant (c) or $D_{sf} = c^{Dof_{sf}}$ (Dof : degree of freedom) (8-1)

K_{sf} : field intensity parameter which is defined in terms of the energy density divided by four degrees of freedom.

ψ_{sf} is reserved for variation parameter of space varying energy field.

$K_{sf} = \sqrt[4]{\frac{h}{16\,\pi\, c^3}}\; k$, $k = \frac{c}{\omega} = \frac{1}{r_q} = \frac{2\pi}{\lambda}$ (9,10-1)

$K_{sf} = K_{sc} = K_{tf} = K_{tc} = K_q$ (11-1)

The two types of quanton energy fields are the free field dominated $E_{qf} = E_{sf} E_{tc}$ (12-1)

and the constrained field $E_{qc} = E_{sc} E_{tf}$ (13-1)

Energy density ϱ_q represents the product of E_{qf} , E_{qc} or $\varrho_q = E_{qf} E_{qc}$ (14-1)

Each of the quanton fields is defined as a multiplication of field strength, field intensity and the field parameter variation .

The relationship between quanton and anti quanton field degree of freedom is mirror symmetric

$(\mathrm{Dof}_{sf})_q = (\mathrm{Dof}_{sc})_{aq} = 2.25$, $(\mathrm{Dof}_{sc})_q = (\mathrm{Dof}_{sf})_{aq} = 0.75$ (15-1), (16-1)

$(\mathrm{Dof}_{tf})_q = (\mathrm{Dof}_{tc})_{aq} = 0.75$, $(\mathrm{Dof}_{tc})_q = (\mathrm{Dof}_{tf})_{aq} = 0.25$ (17-1), (18-1)

$(\mathrm{Dof}_{free})_q = 3$ $(\mathrm{Dof}_{constrained})_q = 1$ (19-1), (20-1)

$(\mathrm{Dof}_{free})_{aq} = 1$ $(\mathrm{Dof}_{constrained})_q = 3$ (21-1), (22-1)

Previously it had been postulated that quanton frequencies are statistically distributed **[2]** versus energy density and this statistical distribution can be replaced by a single mean frequency, hence we can arrive at a relationship between energy density and the mean quanton parameters (ω , r_q)

This relationship takes the form

$$\varrho_q = \left(\frac{h}{16\,\pi\ c^3}\right) k^4\, c^4 = \frac{h\,c}{16\,\pi\ r_q{}^4} = \left(\frac{h}{16\,\pi\ c^3}\right) \omega^4 \quad (23\text{-}1)$$

$$r_q = \frac{1}{k} = \frac{c}{\omega} \quad (24\text{-}1)$$

$$\varrho_q = \frac{h}{16\,\pi\ c^3} k^4\, c^{\,4} = K_q{}^{4}\, c^{\,4} \quad (25\text{-}1)$$

The quantity $\left(\frac{h}{16\ \pi\ c^3}\right)$ can be put as equal to h_q

$$K_q{}^{4} = h_q\, k^4 = K_{sf}\, K_{sc}\, K_{tf}\, K_{tc} \quad (\,K_{xx} = \text{energy field intensity parameter}) \quad (26\text{-}1)$$

$$\text{Where } K_{sf} = K_q = \sqrt[4]{\frac{h}{16\,\pi\ c^3}}\ k \ \ ,\ (\ k = \frac{2\pi}{\lambda}\ ) \quad (27\text{-}1)$$

$$K_{sc} = K_q = \sqrt[4]{\frac{h}{16\,\pi\ c^3}}\ k\ ,\ K_{tf} = K_{tc} = K_q = \sqrt[4]{\left(\frac{h}{16\,\pi\ c^3}\right)\left(\frac{1}{r_q}\right)} \quad (28\text{-}1)$$

2.Quanton origin of CPT symmetry

Any new concept must not be in violation with existing laws of physics and this model is based on two of the fundamental principles in physics namely the second law of thermodynamics **[1]** and charge parity time - CPT symmetry

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 **[4],[5],[6]**

Tables 1. ,2. provide an illustration of this symmetry at the level of the quanton fields and their Dof's

field	quanton	anti quanton	Dof
Nature of dominant energy	free	constrained	
Main-space field	E_{sf}	E_{sc}	2.25
Auxiliary-space field	E_{sc}	E_{sf}	*0.75*
Main time field	E_{tf}	E_{tc}	0.75
Auxiliary time field	E_{tc}	E_{tf}	0.25

Table 1. Mirror symmetry between quanton and anti quanton

CPT	Free field	Constrained field
time	Positive configuration for the free time field (E_{tf})	negative configuration for the constrained time field (E_{tc})
parity	Positive position vector configuration for the free space fields (E_{sf})	negative position vector configuration for the constrained space field (E)
charge	positive atomic fields and charges due to unbound fields ($E_{sfu} E_{tfu}$)	negative atomic fields and charges due to unbound fields ($E_{scu} E_{tcu}$)

Table 2. CPT symmetry and its link to quanton / anti quanton mirror symmetry

3. Some concepts behind space fabric

1-Equipartition of energy density or (with respect to time and space) which is manifested in the form of uniform energy density expansion throughout space as the quantons are

a- Synchronized in their variation with respect to space and time **[2]**
b- statistically distributed

2- All fields are interacting, no silent energy field , energy fields of different natures (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 gravitational interactions)

4-Energy field interactions are expressed at all the scales (as energy fields are infinite in range)

4.Bound and unbound fields

As energy varies in space or time it creates associated dynamic fields that exist at all the scales and the nature of the field interactions depends on the type of the energy field free or constrained) 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 of energy fields of different types creates binding interaction. 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) While same energy field can self-interact to generate a repulsive reaction Although energy fields are infinite in their range of action but this range can still be divided into two main zones:

a-Intra quanton interactions **b**- inter quanton interactions

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 For quantons free energy fields are split into two parts: unbound part

$E_{sf} = K_{sf}(D_{sfu}D_{sfb}) = E_{sfu}\,E_{sfb}$ (1-4)

$E_{tf} = K_{tf}(D_{tfu}D_{tfb}) = E_{tfu}\,E_{tfb}$ (2-4)

$E_{sc} = K_{sc}D_{sc}$ (un-split) (3-4)

$E_{tc} = K_{tc}D_{tc}$ (un-split) (4-4)

And for anti quantons

$E_{scu} = K_{sc}(D_{scu}D_{scb}) = E_{scu}\,E_{scb}$ (5-4)

$E_{tcu} = K_{tc}(D_{tcu}D_{tcb}) = E_{tcu}\,E_{tcb}$ (6-4)

$E_{sf} = K_{sf}D_{scb} = E_{sfb}$ (un-split) (7-4)

$E_{tf} = K_{tf}D_{tfb} = E_{tfb}$ (un-split) (8-4)

Bound part $E_{sfb}E_{tfb}=K_{sf}\,K_{tf}(D_{tfb}\,D_{tfb})$ interacts with interact with constrained fields ($E_{sc}\,E_{tc}$) in a binging interaction, while for anti quanton

$E_{scb}E_{tcb} = K_{sc}\,K_{tc}(D_{tcb}D_{tcb})$, interacts with free fields ($E_{sf}E_{tf}$) also in a binding interaction.

<u>For the quantons</u>

$E_{sf}E_{tf} = [K_{sf}\,(D_{sfb}D_{tfb})\,][\,K_{tf}(D_{sfu}D_{tfu})\,]$ (9-4)

$(D_{sf}D_{tf})_{\ binding} = (D_{sfb}D_{tfb}) = D_{sc}D_{tc}$ or (10-4)

$(D_{sfb}\,D_{tfb}\,) = c^{1.0} = D_{sc}D_{tc}$ (11-4)

$(D_{sfu}D_{tfu}) = \frac{D_{sf\ \ tf}}{D_{sc}D_{tc}} = \frac{c^{3.0}}{c^{1.0}} = c^{2.0}$ (12-4)

<u>For the anti quantons</u>

$E_{sc}E_{tc} = (K_{sc}K_{tc})(D_{scb}D_{tcb})\ (D_{scu}D_{tcu})$ (13-4)

$(D_{sc}D_{tc})_{\ binding} = (D_{sf}D_{tf}) = D_{scb}D_{tcb}$ or (14-4)

$(D_{scb}\,D_{tcb}\,) = c^{1.0} = (D_{sf}D_{tf})$ (15-4)

$(D_{scu}D_{tcu}) = \frac{D_{scb\ \ tcb}}{D_{sf}D_{tf}} = \frac{c^{3.0}}{c^{1.0}} = c^{2.0}$ (16-4)

Unbound energy fields for the case of space fabric are repulsive in nature due to their self-interaction

To be under equilibrium (no variation of fields and no inflation) , all fields must be tied in a binding relationships (with other energy fields) at all the scales. (absence of unbound fields)

Bound energy fields create binding interactions necessary for the integrity of the space fabric (later they will be called quanton binding ($\boldsymbol{R_b}$) and retaining ($\mathbf{R_t}$) interactions.) All remaining unbound energy fields and through the self-interaction give rise to quanton inflation splitting and on larger scale inflationary momentum .

<u>5. Types of field interactions</u>

<u>5.a.Single interactions</u>

The term simple interaction is used to describe the binding between energy fields of the type ($E_{sfbi}E_{tfbi}$)and ($E_{scj}E_{tcj}$).

To assess the potential of interaction between energy fields ($E_{sfb}E_{tfb}$) and ($E_{sc}E_{tc}$) the binding interaction($R_{binding}$) between fields ($E_{sfb}\,E_{tfb}$) and ($E_{sc}\,E_{tc}$) (which can be represented by shared flux lines) is proportional to the generated flux(φ_{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 : the qunton superposition principle **[1]** , 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

$$D_{binding} = (D_{sfb}D_{tfb})(D_{sc}D_{tc}) = c^{Dof_{sfb}+Dof_{tfb}+Dof_{sc}+Dof_{tc}} \quad (1\text{-}5)$$

2- The interaction intensity must be proportional to the product of intensity of both fields as defined by the parameter K_q where $(K_{sf}K_{tf})(K_{sc}K_{tc}) = K_q^{\ 4}$ (2-5)

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 $K_q^{\ 4}$ ($K_{binding} = (K_{sf}\,K_{tf})(K_{sc}K_{tc}) = K_q^{\ 4}$) ,as the term $K_q^{\ 4}$ represents an energy density divided by c^4

4 – The binding relationship between two free/ constrained fields

$$\mathbf{R_{binding}} = \frac{\varphi_{ij}}{(\Delta r_{ij})} = \frac{(\sqrt[4]{\alpha_b}E_{sfb}E_{tfb})(\sqrt[4]{\alpha_b}E_{sc}E_{tc})}{(\Delta r\,)} \quad (3\text{-}5)$$

$$= \frac{[\sqrt[4]{\alpha_b}(K_{sf}\,K_{tf})\,(\,D_{sfb}D_{tfb})][\sqrt[4]{\alpha_b}(K_{tc}\,K_{tc})(\,D_{sc}D_{tc})]}{(\Delta r\,)} \quad (4\text{-}5)$$

$$= \frac{\sqrt[2]{\alpha_b}(K_{sf}\,K_{tf})\,(K_{sc}K_{tc})(D_{sfb}\,D_{tfb})\,(\,D_{sc}D_{tc})}{(\Delta r\,)} \quad (5\text{-}5)$$

$$= \frac{\sqrt[2]{\alpha_b}(\,K_q^{\ 4})(D_{sbfb}\,D_{tfb})\,(\,D_{sfb}D_{scb})}{(\Delta r\,)} \quad (6\text{-}5)$$

$$= \sqrt[2]{\alpha_b}\,\frac{h}{2\pi r_q\,v_q}\,c^{Dof_{sfb}+Dof_{tfb}+Dof_{sc}+Dof_{tc}} \quad (7\text{-}5)$$

α_b : parameter of interaction , Δr : effective distance between two fields ,

The dimensions of such an interaction would be $\frac{\text{Energy}}{c^{4-(Dof_{total})}\,(\,3D\ \text{volume}\,)}$ (8-5)

Where $Dof_{total} = Dof_{free} + Dof_{constrained}$ (9-5)

Interactions which have four degrees of freedom are able of generating a binding that has the true dimensions of energy density.

5.b. Multiple interactions

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

Hyper interactions (summation of Dof's of constituent fields greater than (*4*) are inhibited as for real interaction, Dof's must be equal to (4) whether it is a single or multiple interaction.

(in real spaces only real interactions can be generated.)

Simpler interactions (of less than 4 Dof's) 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 $[(\,E_{sfbi}\,E_{tfbi})(E_{scj}\ \ E_{tcj})[(E_{sfbj}\ \ E_{tfbj})(E_{sci}\ \ E_{tci})]$ that can combine to form a complex interaction of a gravitational nature

$$R_{binding\ ij} = \frac{[(E_{sfbi}\,E_{tfbi})(E_{sci}\ E_{tci})[(E_{sfbj}\,E_{tfbj})(E_{scj}\ E_{tfj})]}{(\Delta r_{ij})} \qquad (10\text{-}5)$$

5.c. Nonbinding (repulsive) interactions

Quanton's unbound fields $E_{sfu}\,E_{tfu}$ (or $E_{scu}\,E_{tcu}$ for the case of anti quanton) self-interact

The generated self-interaction that gives rise only to simple repulsive interactions, while when involving other quantons (anti quanton) the generated interaction would always be a repulsive one , since this self-interacting (unbound) field cannot create a binding interaction with another field with opposing type even if they have the same Dof's and as a result unbound fields interact with another fields of the same nature to generate a nonbinding (repulsive) interaction

$$\mathbf{R_{rij}} = (\sqrt[2]{\alpha_r}\ E_{sfui}E_{tfui})(\sqrt[2]{\alpha_r}\ E_{sfuj}E_{tfuj})\frac{1}{(\Delta r_{ij})} \qquad (11\text{-}5)$$

$$=[\sqrt[2]{\alpha_r}\,(K_{qi}{}^{2}\,D_{sfui}D_{tfui}\ )][\sqrt[2]{\alpha}\left(K_{qj}{}^{2}\,D_{sfuj}D_{tfuj}\right)]\frac{1}{(\Delta r_{ij})} \qquad (12\text{-}5)$$

$$=\alpha_r K_q{}^{4}(D_{sfu}D_{tfu})^{2}\frac{1}{(\Delta r_{ij})} = \alpha_r\frac{h}{2\pi r_q\,v_q}c^{2Dof_{sfu}+2Dof_{tfu}} \qquad (13\text{-}5)$$

6. Space fabric field interactions

6.a. Retaining interaction ($\mathbf{R_t}$)

Free and constrained energy fields interact in the same quanton to create the quanton retaining interaction ($\mathbf{R_t}$) which is binding in nature.

This is interaction is between the bound part of the free energy field ($E_{sfb}E_{tfb}$) 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 case of anti quanton.

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 which is a necessity condition)

The generated retaining interaction ($\mathbf{R_t}$) that maintains the quanton's integrity and prevents it from disintegration, the retaining interaction ($\boldsymbol{R_t}$) is binding potential type since it is developed between two fields of different nature and this interaction takes the following form .

$$(\mathbf{R_t})_\mathbf{q} = (\sqrt[4]{\alpha_t}E_{sf}E_{tf})_{bound}(\sqrt[4]{\alpha_t}E_{sc}E_{tc}) \qquad (1\text{-}6)$$

$$= [\sqrt[4]{\alpha_t}K_q{}^{2}(D_{sfb}\,D_{tfb})\ ]\,[\sqrt[4]{\alpha_t}K_q{}^{2}(D_{sc}D_{tc})] \qquad (2\text{-}6)$$

$$(\mathbf{R_t})_\mathbf{q} = \sqrt[2]{\alpha_t}\ K_q{}^{4}\ c^{2} = \frac{\sqrt[2]{\alpha_t}h\,k^{4}}{16\pi} = \frac{\sqrt[2]{\alpha_t}h}{16\,\pi\,c\,r_q{}^{4}} \qquad (3\text{-}6)$$

Where the term $(E_{sf}E_{tf})_{binding}$ represents the bound part of the free energy fields ($E_{sf}E_{tf}$) that interacts with constrained fields ($E_{scb}E_{tcb}$) , (r_q) is the quanton radius , α_t : retaining interaction parameter, while for anti quanton case the retaining interaction would be

$$(\mathbf{R_t})_\mathbf{aq} = \left(\sqrt[4]{\alpha_t}E_{sc}\,E_{tc}\right)_{bound}(\sqrt[4]{\alpha_t}E_{sf}E_{tf}) \qquad (4\text{-}6)$$

$$= [\sqrt[4]{\alpha_t}K_q{}^{2}\ (D_{scb}\,D_{tcb}\ )]\ \ [\sqrt[4]{\alpha_t}K_q{}^{2}(D_{sf}\,D_{tf}\ )]$$

$$(\mathbf{R_t})_\mathbf{aq} = \sqrt[2]{\alpha_t}\ K_q{}^{4}\ c^{2} = \frac{\sqrt[2]{\alpha_t}h}{16\pi\,c\,r_q{}^{4}} \qquad (5\text{-}6)$$

The dimension of such interaction which has two Dof's , while its dimension is $[\frac{energy}{volume*c^2}] = ML^{-3}T^{-00}$

6.b. Inflationary interaction ($\mathbf{R_i}$)

Type : Simple nonbinding(repulsive)

Inflationary interaction can be thought of as the result of the of the self-interaction of unbound part of free energy fields which are not involved in the retaining interaction ($\mathbf{R_t}$)

The consequence of this a repulsive interaction (R_i) is the quanton splitting and subsequent expansion which is a synonym with the universe inflation.

Self-interaction can be thought of as energy field of a strength $\sqrt{D_{sfu} D_{tfu}}$ (half of degrees of Freedom or a degree of freedom of the unbound field $E_{sfu} E_{tfu}$) which is interacting with the reminder of the unbound field of similar strength creating this repulsive interaction. and the generated quanton repulsive interaction would be in the form

$$(\mathbf{R_i})_\mathbf{q} = (\sqrt[4]{\alpha_i}\sqrt{(E_{sf}\, E_{tf})_{\text{unbound}}})^2 \tag{6-6}$$

$$= [\sqrt[4]{\alpha_i}\, K_q^{\,2} \sqrt{(D_{sfu}\, D_{tfu})}\,]\ [\sqrt[4]{\alpha_i}\ (K_q^{\,2} \sqrt{(D_{sfu}\, D_{tfu})}\ ] \tag{7-6}$$

$$(\mathbf{R_i})_\mathbf{q} = \sqrt[2]{\alpha_i} K_q^{\,4}\ c^2 = \frac{\alpha_i\, h}{16\,\pi\ \ c\ r_q^{\,4}} \tag{8-6}$$

α_i : inflationary interaction parameter and the dimensions of such a energy-like interaction , which has two Dof's , it should be $[\frac{\text{energy}}{\text{volume}*c^2}] = M^{+1}\,L^{-3}T^{-00}$, while for the case of anti quanton , the inflationary energy

$$(\mathbf{R_i})_\mathbf{aq} = [\sqrt[4]{\alpha_i} K_q \sqrt{(D_{scu}\, D_{tcu})}^{\,2}\,][\sqrt[4]{\alpha_i} K_q \sqrt{(D_{scu}\, D_{tcu})}\ )\ ] \tag{9-6}$$

$$(\mathbf{R_i})_\mathbf{aq} = \sqrt[2]{\alpha_i}\ \ K_q^{\,2}\ c^2 = \frac{\sqrt[2]{\alpha_i} h}{16\,\pi\, c\, r_q^{\,4}} \tag{10-6}$$

6.c. Intra quanton binding($\mathbf{R_{ti}}$)$_\mathbf{q-aq}$

Type : multiple interaction

This binding interaction maintains the quanton- anti quanton bond fields

The developed binding interaction between quanton and anti quanton takes the form

$$(\mathbf{R_{bi}})_\mathbf{q-aq} = [(\sqrt[4]{\alpha_{bi}} E_{sf}E_{tf})_{\text{binding}}(\sqrt[4]{\alpha_{bi}} E_{sc}E_{tc})\,]_{\boldsymbol{q}}[\,(\sqrt[2]{\alpha_{bi}} E_{sc}E_{tc})_{\text{binding}}(\sqrt[2]{\alpha_{bi}} E_{sf}E_{tf}\,)]_{\boldsymbol{aq}} \tag{11-6}$$

$$= [\sqrt[2]{\alpha_{bi}} K_q^{\,4}(D_{sfb}\, D_{tfb} D_{sc} D_{tc})\,]_{\boldsymbol{q}}[\sqrt[2]{\alpha_{bi}} K_q^{\,4}(D_{sf}\, D_{tf} D_{scb} D_{tcb})]_{\boldsymbol{aq}} \tag{12-6}$$

$$(\mathbf{R_{bi}})_\mathbf{q-aq} = \alpha_{bi}\, K_q^{\,4}\ \ c^{\,2} = \frac{\alpha_{bi} h\, k^4}{16\pi} = \frac{\alpha_{bi} h}{16\,\pi c\ \ r_q} \tag{13-6}$$

which has four degrees of freedom and the dimensions of $[\frac{\text{energy}}{\text{volume}}] = M^{+1}\,L^{-1}T^{-2}$

6.d-Inter-quanton interactions

6.d.1-Space fabric binding interaction ($\mathbf{R_b}$)

Type : Multiple binding

Energy fields which generate the quanton binding and retaining interactions are also at the origin of dark matter gravitation like effect as well.

If inter-quanton binding were not present , there would have been no gravitational like effect of dark matter, nor gravitation for normal matter .

The generated free energy fields are not in the form $E_{sf}\ E_{tf}$, instead the free energy field is divided into two parts : first part which is the binding part which forms the retaining interaction ($\mathbf{R_t}$) or $(E_{sfb}E_{tfb})_q = K_q^2(D_{sfb}D_{tfb})_q$ and has (1.0 Dof's) , and the second part which generates the quanton inflationary interaction (R_i) namely the unbound part $(E_{sfu}\ E_{tfu})_q = K_q^2(D_{sfu}D_{tfu})_q$ which has two degrees of freedom, so we can summarize the energy fields as as follows

a- $E_{sc}E_{tc}$ (1.0 Dof's) (bound constrained fields) (14-6)

b- $(E_{sfb}E_{tfb})$ (1.0 Dof's) (bound free fields) (15-6)

c- $(E_{sfu}E_{tfu})$ (2.0 Dof's) (unbound self-interacting free field) (16-6)

and for anti quanton case

a-$E_{sf}E_{tf}$ (1.0 Dof's) (bound free field) (17-6)

b- $(E_{scb}E_{tcb})$ (1.0 Dof's) (bound constrained field) (18-6)

c-$(E_{scu}E_{tcu})$ (2.0 Dof's) (unbound constrained field) (19-6)

Each energy field can only interact with an energy field which has the similar degrees of freedom.

The free energy fields $(E_{sf}E_{tf})_{bound}$ of the quanton or $(E_{sf}E_{tf})$ of the anti quantons create in an interaction with the constrained energy field $(E_{sc}E_{tc})$ of the other quantons or $(E_{sc}E_{tc})_{bound}$ of the anti quantons which generates a more stable binding potential energy rather than the less stable repulsive interaction with an energy field of the same nature.

Binding energy fields 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 ($\mathbf{R_b}$)

Interactions energy fields are not limited to same quanton interactions but extend to other quantons.

Free energy fields quanton (i) interact with the constrained fields of (j) quanton to generate the binding interaction ($\mathbf{R_b}$) and vice versa , the generated binding interaction ($\mathbf{R_b}$) which is responsible for maintaining the space fabric integrity, is represented by two anti symmetric contributions due to mirror symmetry between quanton and anti quanton field Dof's , ($\mathbf{R_{bi}}$)$_\mathbf{q}$ is the binding interaction developed between the quanton (q_i) and other quantons (q_j) or anti quatons (aq_j) ,

$$(\mathbf{R_{bfi}})_\mathbf{q} = (\sqrt[4]{\alpha_b}E_{sfbi}E_{tfbi})_q \{[\Sigma_j^n(\sqrt[4]{\alpha_b}E_{scj}E_{tcj})_\mathbf{q}\left(\frac{\sqrt{r_{qi}\,r_{qj}}}{(r_i-r_j)}\right)] + [\Sigma_j^n(\sqrt[4]{\alpha_b}E_{scbj}E_{tcbj})_\mathbf{aq}\left(\frac{\sqrt{r_{qi}\,r_{aqj}}}{(r_i-r_j)}\right)]\} \quad (20\text{-}6)$$

$$= \sqrt[4]{\alpha_b}K_{qi}^{\ 2}(D_{sfbi}D_{tfbi})_\mathbf{q}\ \{[\Sigma_j^n\sqrt[4]{\alpha_b}K_{qj}^{\ 2}(D_{scj}D_{tcj})_q\left(\frac{\sqrt{r_{qi}\,r_{qj}}}{(r_i-r_j)}\right)] + [\Sigma_j^n\sqrt[4]{\alpha_b}K_{aqj}^{\ 2}(D_{scbj}D_{tcbj})_{aq}\left(\frac{\sqrt{r_{qi}\,r_{qj}}}{(r_i-r_j)}\right)]\} \quad (21\text{-}6)$$

$$(\mathbf{R_{bfi}})_\mathbf{q} = \sqrt[2]{\alpha_b}\ K_q^{\ 4}c^2\left\{\left[\Sigma_j^n\left(\frac{r_q}{(r_i-r_j)}_{q-q}\right)\right] + \left[\Sigma_j^n\ \frac{r_q}{(r_i-r_j)}_{q-aq}\right]\right\}$$

$$(\mathbf{R_{bfi}})_\mathbf{q} = \frac{\sqrt[2]{\alpha_b}h}{2\pi}\frac{1}{8\,c\,r_q^{\ 3}}[\Sigma_j^n\left(\frac{1}{(r_i-r_j)}_{q-q}\right) + \left(\Sigma_j^n\ \frac{1}{(r_i-r_j)}_{q-aq}\right)] \quad (22\text{-}6)$$

Where the term $(E_{sfb}E_{tfb})_q$ represents the bound part of the free energy fields $(E_{sf}E_{tf})$ 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

The binding interaction due to the constrained field $E_{sc}\, E_{tc}$ will be in the form

$$(\mathbf{R_{bci}})_{\mathbf{q}} = (\sqrt[4]{\alpha_b}E_{sci}E_{tci})_q \{[\Sigma_j^n (\sqrt[4]{\alpha_b}E_{sfbj}E_{tfbj})_q \left(\frac{\sqrt{r_{qi}\, r_{qj}}}{(r_i-r_j)}\right)] + [\Sigma_j^n(\sqrt[4]{\alpha_b}E_{sfj}E_{tfj})_{aq} \left(\frac{\sqrt{r_{qi}\, r_{aqj}}}{(r_i-r_j)}\right)]\}$$

$$= \{ \sqrt[4]{\alpha_b}K_q^{\ 4} (D_{sci}D_{tci})_q \{ [\Sigma_j^n \sqrt[4]{\alpha_b} (D_{sfbj}D_{tfbj})_q] \left(\frac{\sqrt{r_{qi}\, r_{qj}}}{(r_i-r_j)}\right) + \Sigma_j^n [\sqrt[4]{\alpha_b} (D_{sfj}D_{tfj})_{aq}] \left(\frac{\sqrt{r_{qi}\, r_{aqj}}}{(r_i-r_j)}\right)\} \quad (23\text{-}6)$$

$$= \sqrt[2]{\alpha_b}\, K_q^{\ 4}c^2 [\Sigma_j^n \left(\frac{r_q}{(r_i-r_j)_{\ q-q}}\right) + \left(\Sigma_j^n \ (\frac{r_q}{(r_i-r_j)_{\ q-aq}}\right)]$$

$$(\mathbf{R_{bci}})_{\mathbf{q}} = \frac{\sqrt[2]{\alpha_b}h}{2\pi}\frac{1}{8\,c\, r_q^{\ 3}} [\Sigma_j^n \left(\frac{1}{(r_i-r_j)_{\ q-q}}\right) + (\Sigma_j^n \ \frac{1}{(r_i-r_j)_{\ q-aq}})] \quad (24\text{-}6)$$

Which is the same expression as before or $R_{bf}\,(E_{sfi}E_{tfi}) = R_{bc}\,(E_{sci}E_{tci})_q$ and this is due to the symmetry of interactions.

Similarly, expressions for anti quanton binding interaction $(\mathbf{R_{bfi}})_{\mathbf{aq}}$ and $(\mathbf{R_{bci}})_{\mathbf{aq}}$ with other quantons and anti quantons can be obtained.

Later a single expression for both interactions will be developed which will be of a multiple binding nature , of course there would be no counting of any quantons , as the summation can be handled by assessing energy density over an integration volume.

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

$$\mathbf{R_{tp}} = \int_{V_q} E_t\, dV = \int_{V_q}(E_{sfb}\, E_{tfb})\ (E_{sc}\, E_{tc})\, dv = \sqrt{\alpha_t}\frac{h}{16(\pi)} k^{\,4}V_q \quad (19\text{-}6)$$

$$= \frac{\sqrt{\alpha_t}h}{2\pi}\frac{1}{8\, r_q^{\ 3}c}\frac{1}{r_q}\ V_q = \sqrt{\alpha_t}\frac{h}{2\pi\, r_q c}\frac{1}{V_q}V_q = \sqrt{\alpha_t}\frac{h}{2\pi\, r_q c} \quad (20\text{-}6)$$

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 belonging to two separate quantons q_i , q_j becomes

$$R_{bp} = (\int_{V_{qi}}(\sqrt[4]{\alpha_b}E_{sfbi}\ E_{tfbi})dV \int_{V_{qj}}(\sqrt[4]{\alpha_b}E_{scj}\ E_{tcj})\ dV)\ \frac{\sqrt{r_{qi}\, r_{qj}}}{(r_i-r_j)} \quad (21\text{-}6)$$

$$= [\sqrt[4]{\alpha_b}\, K_{qi}^{\ 2} (D_{sfbi}\, D_{tfbi})][\sqrt[4]{\alpha_b}\, K_{qj}^{\ 2} (D_{scj}\, D_{tcj})]V_q \ \frac{\sqrt{r_{qi}\, r_{qj}}}{(r_i-r_j)} \quad (22\text{-}6)$$

$$= \sqrt[2]{\alpha_b}\ c^2 \sqrt[2]{\frac{h}{2\,\pi\, c^3\, V_{qi}\, r_{qi}}}\sqrt[2]{\frac{h}{2\,\pi\, c^3\, V_{qj}\, r_{qj}}}\ V_q\ \frac{\sqrt{r_{qi}\, r_{qj}}}{(r_i-r_j)} = \frac{\sqrt{\alpha_b}\ h}{2\pi(r_i-r_j)\, c} \quad (23\text{-}6)$$

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

6.d.2-Quanton repulsive interaction $(\mathbf{R_r})$ Type : repulsive

The unbound free energy field $(E_{sfui}E_{tfui})_q$ generates a repulsive interaction with unbound free energy fields $(E_{sfuj}E_{tfuj})_q$ of other quantons

<u>for quanton</u> (q_i)

$$R_r(E_{sfui}\,E_{tfui})_q = [(\sqrt[2]{\alpha_r}E_{sfui}E_{tfui})_q\ \Sigma_j^n(\sqrt[2]{\alpha_r}E_{sfuj}E_{tfuj})_q\left(\frac{\sqrt{r_{qi}\,r_{qj}}}{(r_i-r_j)}\right)] \quad (24\text{-}6)$$

$$= [\sqrt[2]{\alpha_r}K_{qi}^{\ 2}\,(D_{sfui}D_{tfui})_q\,\Sigma_j^n\,\sqrt[2]{\alpha_r}(K_{qj}^{\ 2}\,(D_{sfuj}D_{tfuj})_q\ )(\left(\frac{\sqrt{r_{qi}\,r_{qj}}}{(r_i-r_j)}\right)] \quad (25\text{-}6)$$

$$= \sqrt[2]{\alpha_r}\,c^4\ \sqrt[2]{\frac{h}{16\,\pi\ c^3 r_{qi}^{\ 4}}}\Sigma_j^n\ \sqrt[2]{\frac{h}{16\,\pi\ c^3 r_{qj}^{\ 4}}}\left(\frac{\sqrt{r_{qi}\,r_{qj}}}{(r_i-r_j)_{\ q-q}}\right) \quad (26\text{-}6)$$

$$R_r = \frac{\sqrt[2]{\alpha_r}h\,c}{16\ \pi\ \ r_q^{\ 3}}\ \Sigma_j^n\ \left(\frac{1}{(r_i-r_j)_{\ q-q}}\right) \quad (27\text{-}6)$$

α_r : repulsive interaction parameter

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

<u>For anti quanton</u> (aq_i) generated interaction due to unbound field $(\sqrt[2]{\alpha_r}E_{scui}E_{tcui})_{aq}$ with unbound fields of other anti quantons

This interaction is also a repulsive in nature in nature since this field interacts with the unbound constrained energy fields $(\sqrt[2]{\alpha_r}\ E_{scuj}E_{tcuj})_{\ aq}$ of other anti quantons to generate a repulsive interaction

$$R_r(E_{scui}E_{tcui})_{aq} = [(\sqrt[2]{\alpha_r}E_{scui}E_{tcui})_{aq}\ \ \Sigma_j^n\ \ (\sqrt[2]{\alpha_r}E_{scui}E_{tcui})_{aq}\ \ ]\ \frac{\sqrt{r_{aqi}\,r_{aqj}}}{(r_i-r_j)} \quad (28\text{-}6)$$

$$= [\sqrt[2]{\alpha_r}K_{qi}^{\ 2}D_{scui}D_{tfui}\ \ )_{aq}\ \ \Sigma_j^n\,\sqrt[2]{\alpha_r}\ \ (K_{qj}^{\ 2}D_{scuj}D_{tfuj}\ \ )_{aq}\ \ ]\left(\frac{\sqrt{r_{aqi}\,r_{aqj}}}{(r_i-r_j)}\right) \quad (29\text{-}6)$$

$$= \alpha_r\ K_q^{\ 4}\ \ c^4\,\Sigma_j^n\ \ \frac{\sqrt{r_{aqi}\,r_{aqj}}}{(r_i-r_j)_{\ aq-aq}}) \quad (30\text{-}6)$$

$$=\alpha_r\ \ c^4\ \ \sqrt[2]{\frac{h}{16\,\pi\ \ c^3 r_{aqi}^{\ 4}}}\Sigma_j^n\ \ \sqrt[2]{\frac{h}{16\,\pi\ \ c^3 r_{qj}^{\ 4}}}\left(\frac{\sqrt{r_{aqi}\,r_{aqj}}}{(r_i-r_j)_{\ aq-aq}}\right) \quad (31\text{-}6)$$

$$R_{ri} = \frac{\alpha_r\ \ h\,c}{16\,\pi\ \ r_{aq}^{\ 3}}\ \Sigma_j^n\ \ \left(\frac{1}{(r_i-r_j)_{\ aq-aq}}\right) \quad (32\ \text{-}6)$$

Fig. 1. Illustrates how the quanton total energy is transformed through field interactions into different inflationary and binding potentials which form the basis of dark energy and dark matter

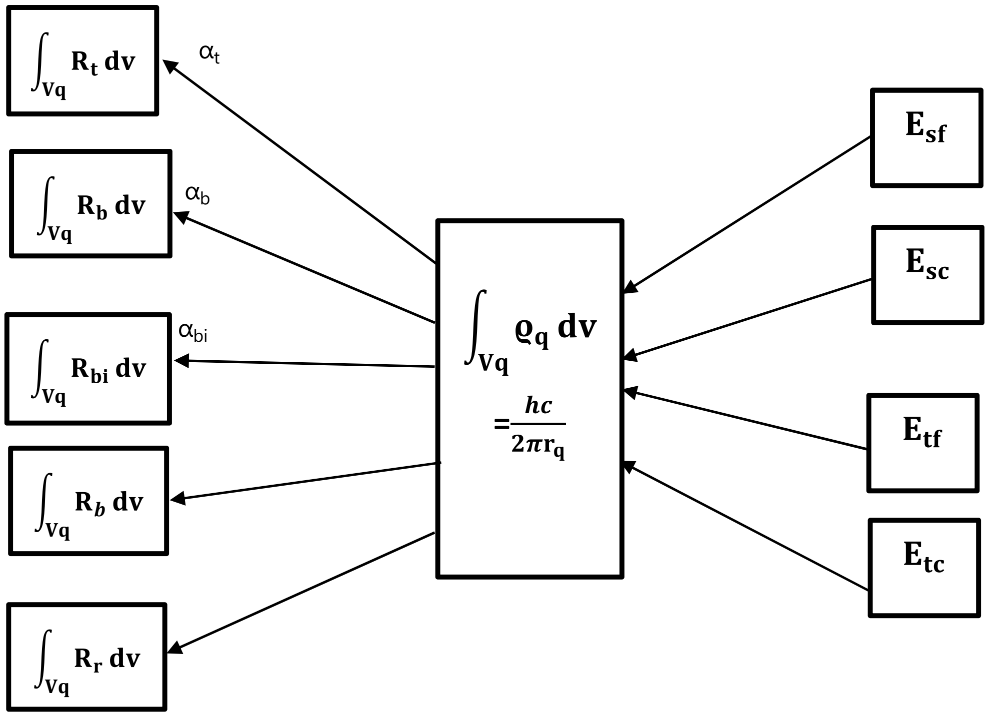

Fig. 1.the relationship between quanton total energy and the potential of various interactions

6.e Dmensions 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 ($Dof_i = x$) degrees of freedom .

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

$$= ML^{2-3-4+x}\,T^{-2+4-x} = ML^{x-5}\,T^{2-x} = \left[\frac{M\,L^{x-2}\,T^{2-x}}{volume}\right] = \frac{energy}{volume}\left(\frac{T^x}{L^x}\right) \quad (33\text{-}6)$$

For the special case of x= 4 , $[E_{D_4}] = ML^{-1}\,T^{-2} = \left(\frac{energy}{volume}\right)$

7-Dark energy and dark matter in terms of quanton interaction potentials

7.a-interaction potentials

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

Frist the retaining potential

$$\mathbf{R_{tp}} = \int_{V_q}[(\sqrt[4]{\alpha_t}E_{sf}E_{tf})_{\,bound}\left(\sqrt[4]{\alpha_t}\,E_{sc}E_{tc}\right)]dv \quad (1\text{-}7)$$

$$= [\sqrt[4]{\alpha_t}K_q^{\,2}(D_{sfb}\,D_{tfb}\,)][\,(\sqrt[4]{\alpha_t}K_q^{\,2}(D_{sc}D_{tc})]V_q \quad (2\text{-}7)$$

$$= \sqrt[2]{\alpha_t}\,K_q^{\,4}\;c^2\,V_q = \sqrt[2]{\alpha_t}\,\frac{h\,k^4}{16\,\pi\,c} = \frac{\sqrt[2]{\alpha_t}h}{2\,\pi}\,\frac{1}{(8\,r_q^{\,3})\,r_q\,c}\,V_q \quad (3\text{-}7)$$

$$\mathbf{R_{tp}} = \sqrt[2]{\alpha_t}\ \frac{h}{2\pi r_q c} \tag{4-7}$$

For the inflationary interaction potential

$$\mathbf{R_{ip}} = \int_{V_q} [\sqrt[4]{\alpha_i}\, K_q^{\ 2}\ (D_{sfu} D_{tfu})][(\sqrt[4]{\alpha_i} K_q^{\ 2} D_{sfu} D_{tfu})]dV \tag{5-7}$$

$$=[\sqrt[2]{\alpha_i}\,(K_q^{\ 4}\ (D_{sfu}D_{tfu})]\ V_q$$

$$= \frac{\sqrt[2]{\alpha_i} h}{2\pi} \frac{1}{(8\, r_q^{\ 3})\, r_q\, c}\ V_q = \sqrt[2]{\alpha_i}\ \frac{h}{2\pi\, r_q\, c} \tag{6-7}$$

For the repulsive interaction potential

$$\mathbf{R_{rp}} = \int_{V_q} [\sqrt[2]{\alpha_i} K_{qi}^{\ 2}\ (D_{sfui} D_{tfui})][\Sigma_j^n\ \sqrt[2]{\alpha_i}(K_{qj}^{\ 2}\ D_{sfuj} D_{tfuj})]dV\ \frac{\sqrt{r_{qi}\, r_{qj}}}{(r_i - r_j)} \tag{7-7}$$

$$= [\alpha_i\,(K_q^{\ 4}(D_{sfu}D_{tfu})^2]\ \Sigma_j^n\ V_q \frac{\sqrt{r_{aqi}\, r_{aqj}}}{(r_i - r_j)} \tag{8-7}$$

$$\mathbf{R_{rp}} = \frac{\alpha_i\ \ h}{2\pi V_q r_q c}\ V_q \Sigma_j^n \frac{\sqrt{r_{qi}\, r_{qj}}}{(r_i - r_j)} = \frac{\alpha_i\ \ h}{2\,\pi\, c} \Sigma_j^n \frac{1}{(r_i - r_j)} \tag{9-7}$$

7.b.Multiple form of quanton interactions

When possessing a wave behavior 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 behavior it must be stressed here that both images of the quanton anti quanton pair (Q+AQ and Q.AQ) are simultaneous and not alternatives,

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

$\mathbf{E_p}$ (total energy of the quanton/anti quanton)= $\mathbf{R_{tp}}$ (retaining potential) + $\mathbf{R_{ip}}$ (inflationary potential) + $\mathbf{R_{bp}}$ (binding potential)+$\mathbf{R_{rp}}$ (total repulsive energy) + $\mathbf{R_{bpi}}$ (intra quantonbinding potential) (10-7)

7.c.1.retaining potential

For the retaining interaction that combines both bindings of Q .AQ pair , given that

$\mathbf{R_{tq}} = \sqrt[2]{\alpha_t}(E_{sfb}E_{tfb})(E_{sc}E_{tc})$, $R_{taq} = \sqrt[2]{\alpha_t}(E_{scb}E_{tcb})(E_{sf}E_{tf})$

$$\frac{c^4 R_{tp}^{\ 2}}{E_{ref}} = \frac{\alpha_t\, c^4}{E_{ref}} [\int_{V_q} (\sqrt[2]{\alpha_t} E_{sfb} E_{tfb}\ E_{sc} E_{tc})_q\, dv \int_{V_{aq}} (\sqrt[2]{\alpha_t}\ E_{sf}E_{tf}E_{scb}\, E_{tcb})_{aq}\ dv] \tag{11-7}$$

$$= \frac{2\pi\, \alpha_t\, r_{ref} c^4}{hc} [K_q^{\ 4}(D_{sfb}D_{tfb}D_{sc}D_{tc})_q V_q\ (D_{sf}D_{tf}D_{scb}\, D_{tcb})_{aq} V_{aq}] \tag{12-7}$$

$$= \frac{2\pi\alpha_t\, r_{ref} c^4}{hc} [(\frac{h}{16\pi\, c^3 r_q^{\ 4}} c^2 V_q)\ (\frac{h}{16\,\pi\, c^3 r_q^{\ 4}}\ c^2 V_{aq})]$$

Retaining interaction potential $\frac{c^2 R_{tp}^{\ 4}}{E_{ref}} = \frac{\alpha_t hc}{2\pi r_q}$ (13-7)

7.c.2.Intra quanton binding potential ($\mathbf{R_{bpi}}$)

For the Intra quanton binding potential can be assessed as follows

$$\mathbf{R_{bpi}} = \frac{\alpha_{bi}\, c^4}{E_{ref}} \left[\int_{V_q} (\sqrt[2]{\alpha_{bi}}\, E_{sfb} E_{tfb}\ E_{sc} E_{tc})_q\, dv \int_{V_{aq}} (\sqrt[2]{\alpha_{bi}}\, E_{sf} E_{tf} E_{scb}\, E_{tcb})_{aq}\ dv \right] \tag{14-7}$$

$$= \frac{2\pi\, \alpha_{bi}\, r_{ref} c^4}{hc} \left[K_q{}^4 (D_{sfb} D_{tfb} D_{sc} D_{tc})_q\, V_q\, (D_{sf} D_{tf} D_{scb}\, D_{tcb})_{aq}\, V_{aq} \right] \tag{15-7}$$

$$= \frac{2\,\pi\alpha_{bi}\, r_{ref} c^4}{hc} \left[\left(\frac{h}{16\pi\, c^3 r_q{}^4}\, c^2 V_q\right) \left(\frac{h}{16\pi\, c^3 r_q{}^4}\ c^2 V_{aq}\right) \right]$$

Inter quanton binding potential $R_{bpi} = \frac{\alpha_{bi}\, hc}{2\,\pi\, r_q}$ (16-7)

$$E_{ref} = \frac{hc}{2\,\pi\, r_{ref}}\ ,\quad r_{ref} = r_q \tag{17-7}$$

7.c.3.Binding potential ($\mathbf{R_{bt}}$)

For a multiple interaction which combines both binding of

1- field $(E_{sfbi}E_{tfbi})_q$ of the quanton (i) with the constrained fields $(E_{scj}E_{tcj})_q$ of the quanton (j) (or $(E_{scbj}E_{tcbj})_{aq}$ of the anti quanton (j))
2- -the constrained fields $(E_{sci}E_{tci})_q$ quanton (i) with free fields $(E_{sfbj}E_{tfbj})_q$ of the quanton (j) ($(E_{sfj}E_{tfj})_q$ of the anti quanton(j))

$$\mathbf{R_{btij}} = \frac{c^4 R_{bp}{}^2}{E_{ref}} = \frac{c^4}{E_{ref}} \{ [\int_{V_{qi}} (\sqrt[2]{\alpha_b} E_{sfbi} E_{tfbi}\, E_{sci} E_{tci})_q dV \textstyle\sum_j^n \int_{V_{qj}} (\sqrt[2]{\alpha_b} E_{sfbj} E_{tfbj} E_{scj} E_{tcj})_q\, dV\ \frac{\sqrt{r_{qi}\, r_{qj}}}{(r_i - r_j)}]$$

$$+ [\int_{V_{qi}} (\sqrt[2]{\alpha_b}\ E_{sfbi} E_{tfbi} E_{sci} E_{tci})_q\, dV \textstyle\sum_j^n \int_{V_{aqj}} (\sqrt[2]{\alpha_b}\ E_{sfj} E_{tfj} E_{scbj} E_{tcbj})_{aq}\ \ dv\ \frac{\sqrt{r_{qi}\, r_{aqj}}}{(r_i - r_j)}] \} \tag{18-7}$$

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

$$+ K_{qi}{}^4 (D_{sfbi} D_{tfbi} D_{sci} D_{tci})_q\, V_{qi}\, \textstyle\sum_j^n K_{qj}{}^4 (D_{sfj} D_{tfj} D_{scbj} D_{tcbj})_{aq})\ \ V_{aqj}\, \frac{\sqrt{r_{qi}\, r_{aqj}}}{(r_i - r_j)})] \tag{19-7}$$

$$R_{btij} = \frac{2\pi\alpha_b\, c^3}{h}\, \frac{h}{2\pi V_{qi}\, c^3\, r_{qi}}\, c^2\, V_{qi} \{ [\textstyle\sum_j^n \frac{h}{2\pi V_{qj}\, c^3\, r_{qj}}\ c^2\, V_{qj}\, \frac{r_{qi}\, r_{qj}}{(r_i - r_j)_{\ q-q}}] + [\textstyle\sum_j^n \frac{h}{2\pi V_{qj}\, c^3\, r_{qj}}\ c^2\, V_{qj}\, \frac{r_{qi}\, r_{qj}}{(r_i - r_j)_{\ q-aq}})] \} \tag{20-7}$$

$$R_{btij} = \frac{\alpha_b\, hc}{2\pi} \left[\textstyle\sum_j^n \left(\frac{1}{(r_i - r_j)_{\ q-q}} \right) + \left(\textstyle\sum_j^n\ \frac{1}{(r_i - r_j)_{\ q-aq}} \right) \right] \tag{21-7}$$

$$E_{ref} = \frac{hc}{2\pi\, r_{ref}}\ ,\quad r_{ref} = \sqrt{r_{qi}\, r_{qj}} \tag{22-7}$$

$\mathbf{R_{bt}}$ = total binding potential of quanton/anti quanton = $\left(\frac{c^4 R_{bp}{}^2}{E_{ref}}\right)$ (23-7)

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**[7] , [8] , [9]**.

$$E_u\ *\ f_{DM} = \left[N_q \left(\frac{r_q c^4 R_{tp}{}^2}{h} + \frac{\alpha_{bi}\, hc}{2\pi r_q} \right) + \frac{1}{2}\ \textstyle\sum_i^m \sum_j^n \frac{r_q c^4 R_{tbij}{}^2}{h} \right] = [N_q \left(\frac{\alpha_t h}{2\pi r_q} + \frac{\alpha_{bi}\, hc}{2\pi r_q} \right) + \frac{\alpha_b h}{2\pi}\ \textstyle\sum_i^m \sum_j^n \frac{1}{(r_i - r_j)} \tag{24-7}$$

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 $n = N_q$, $m = N_q - 1$, $i \neq j$

7.d. Inflationary and repulsive interactions in multiple form

For the combined inflationary interaction due to unbound fields of both the Q.Q pair

$$R_{ip} = \int_{V_q} [(\sqrt[4]{\alpha_i} E_{sfu}\, E_{tfu}\,)_q\quad (\sqrt[4]{\alpha_i}\, E_{scu}\, E_{tcu}\,)_{aq}] dv \tag{24-7}$$

$$= \sqrt[2]{\alpha_i}[K_q^{\,2}\,(D_{sfu}\,D_{tfu})_q \quad (K_q^{\,2}\,(D_{scu}\,D_{tcu})_{aq} \;]\; V_q \tag{25-7}$$

$$= \sqrt[2]{\alpha_i}\,(\sqrt[2]{\frac{h}{16\pi\,c^3}}\,\frac{c^2}{r_q^{\,2}})\,(\sqrt[2]{\frac{h}{16\pi\,c^3}}\,\frac{c^2}{r_q^{\,2}}V_q)$$

$$\mathbf{R_{ip}} = \sqrt[2]{\alpha_i}\;\frac{hc}{2\pi V_q r_q}V_q = \alpha_i\;\frac{hc}{2\pi\,r_q} \tag{26-7}$$

the combined repulsive potential of the Q.AQ

$$\mathbf{R_{rpij}} = \frac{1}{E_{ref}}\{\left[\int_{V_{qi}}(\sqrt[2]{\alpha_r}E_{sfui}E_{tfui})_q \sum_j^n \sqrt[2]{\alpha_r}\,(E_{sfuj}E_{tfuj})_q\,Dv\,\right]\frac{\sqrt{r_{qi}\,r_{qj}}}{(r_i-r_j)}\right] +$$

$$[\int_{V_{qi}}(\sqrt[2]{\alpha_r}E_{scui}E_{tcui})_{aq}\sum_j^n \sqrt[2]{\alpha_r}\,(\,E_{scuj}E_{tcuj})_{aq}dv]\,\frac{\sqrt{r_{aqi}\,r_{aqj}}}{(r_i-r_j)}]\} \tag{27-7}$$

$$= \frac{2\,\pi\,\alpha_r\,\sqrt{r_{qi}\,r_{qj}}}{hc}\{[\,(K_{qi}^{\;4}(D_{sfui}D_{tfui}\,)_q\sum_j^n(D_{sfuj}D_{tfuj}\,)_q \quad \frac{\sqrt{r_{qi}\,r_{qj}}}{(r_i-r_j)} +$$

$$K_{qj}^{\;4}(D_{scui}D_{tcui}\;)_{aq}\;\sum_j^n(D_{scuj}D_{tcuj}\;)_{aq}\,V_{aq}\,\frac{\sqrt{r_{aqi}\,r_{aqj}}}{(r_i-r_j)}\;\} \tag{28-7}$$

$$\mathbf{R_{rpij}} = \alpha_r\,\frac{2\pi\sqrt{r_{qi}\,r_{qj}}}{hc}[\,\frac{h}{16\pi\,c^3}\,\frac{c^4}{r_{qi}^{\;4}}\,V_{qi}][\sum_j^n\frac{h}{16\pi\,c^3}\,\frac{c^4}{r_{qj}^{\;4}}V_q\,(\frac{\sqrt{r_{qi}\,r_{qj}}}{(r_i-r_j)}_{q-q})] \tag{29-7}$$

$$\mathbf{R_{rpij}} = \frac{\alpha_r\,hc}{2\,\pi}\,(\sum_j^n\,(\frac{1}{(r_i-r_j)}_{q-q})) \tag{30-7}$$

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 **[10] , [11] , [12]**

$$E_u \,*\, f_{DE} = [\,N_q\,R_{ip} + \;\sum_i^m\sum_j^n R_{rpij}\,] = [N_q\frac{\alpha_i h}{2\pi r_q} + \frac{\alpha_r h}{2\pi}\,\sum_i^m\sum_j^n\frac{1}{(r_i-r_j)}] \tag{30-7}$$

Where f_{DE} represents the dark energy fraction of the total energy of the universe

$$E_{ref} = \frac{hc}{2\,\pi\;\sqrt{r_{qi}\,r_{qj}}} \tag{31-7}$$

7.e.Why quanton does not achieve equilibrium

Quanton energy fields 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 : $Dof_{tf} = Dof_{tc} = 0.5$ $Dof_{sf} = Dof_{sc} = 1.5$, $Dof_{sf}\,Dof_{tf} = Dof_{sc}\,Dof_{tc} = 2$ This binding interaction has all four Dof's under such conditions the quanton is in equilibrium ,no unbound fields exist to cause quanton's 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 evolution of the constrained fields through energy constraining allows the degrees of freedom of those fields only to be one third of the corresponding free fields.

8. Qunton retaining (binding) potential : the inverse law

The quanton retaining (binding) interaction took the form $E_t = (E_{sfb}E_{tfb})(E_{sc}E_{tc})$, unlike any other potentials like that of gravitation or the electric force $U_g = G\frac{M\,m}{r}$ or $U_e = K\,\frac{Q_i\,Q_j}{r}$, term ($\frac{1}{\Delta r}$) does not appear in this binding potential In fact , the quanton energy which is defined as $E_p = \frac{hkc}{2\pi}$, and can be put alternatively as E_p(packet energy) $= \frac{hkc}{2\pi} = \frac{hc}{2\pi r_q}$ (where $k = \frac{1}{r_q}$) While $R_{tp} = \int_{V_q} E_t \, dv = E_t V_q = \frac{\sqrt{\alpha_t} h}{2\pi r_q}$ (R_{tp} : total retaining (potential) energy of 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 $(\frac{1}{r_q})$ 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 .

Table 3. summarizes the quanton interactions at all the scales (inter and intra quanton short and long range

Energy field	Intra quanton role	Inter quanton role (short range)	interaction at cosmological scale
$E_{sfb}E_{tfb}$ (bound)	1-retaining interaction $\mathbf{R_t}$ 2-Intra quanton binding $\mathbf{R_{bi}}$	Quanton binding interaction $\mathbf{R_b}$	Dark matter gravitational like effect
E_{sc} E_{tc} (bound)	1-retaining interaction $\mathbf{R_t}$ 2-Intra quanton binding $\mathbf{R_{bi}}$	Quanton binding interaction $\mathbf{R_b}$	Dark matter gravitational like effect
E_{sfu} E_{tfu} (unbound)	Quanton inflationary interaction $\boldsymbol{R_i}$	Quanton repulsive interaction $\mathbf{R_r}$	Inflationary momentum , Matter distortion of space fabric

Table 3 . summary of the role of individual energy fields and their interactions at Planck and cosmological scale for the quantons of space fabric

9. Role of energy fields in the generation of the fundamental forces

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.

Normal matter quantons can be regarded as at the origin of rest mass.

In addition to rest mass, normal matter is composed of associated fields.

Normal matter quantons comprise only two degrees of freedom as the remaining two belong to the associated fields.

For the case of space fabric, the qunatons are not under equilibrium of interactions (equilibrium: absence of the repulsive self-interacting fields) ,as they expand and split ,while for the case of normal matter quntons , quantons are under an actual equilibrium of interactions due to the absence of self-interaction, where no expansion or splitting occurs.

Under such conditions, normal matter quantons and anti quantons became identical

For space fabric, unbound fields , give rise to quanton 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 of 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 both bound free and constrained fields have the same Dof's)

2-unbound fields (E_{sfu} , E_{tfu}), or (E_{scu} , E_{tcu}) 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.

10.Degrees of freedom of normal matter space time fields

10.a-Rest mass

We recall that the normal matter quantons have only two Dof's and for normal matter both quantons and anti quantons are identical since normal matter quantons are under equilibrium of interactions

Bound fields now can reflect the space time symmetry such that

$$Dof_{sfb} = Dof_{scb} = 0.75 \quad , \quad Dof_{tfb} = Dof_{tcb} = 0.25 \qquad (1,2\text{-}10)$$

$$(Dof_{sfb} + Dof_{scb}) = 1.5 \quad , \sum Dof_p = 2.0 \qquad (3,4\text{-}10)$$

Energy of the rest mass take the non-relativistic form

$$E_m = \sum_i^m \int_{V_p} E_{sfb} E_{tfb} \, E_{scb} E_{tcb} \, dV \quad , \qquad (5\text{-}10)$$

The volumetric integration represents bound fields that are involved in formation of rest mass

10.b-charged atomic fields

a-Space unbound fields (E_{sfu} , E_{scu}) have the same Dof

$$(Dof_{sfu} = Dof_{scu} = 1.5 \text{ Dof's}) \qquad (6\text{-}10)$$

b-Time unbound fields (E_{tfu} , E_{tcu}) also have the same Dof

$$(Dof_{tfu} = Dof_{tcu} = 0.5) \qquad (7\text{-}10)$$

For positively charged particles : the atomic field is represented by the unbound fields ($\frac{E_{sfu} E_{tfu}}{\sqrt{\varepsilon_o}}$) ,

while for the negatively charged particles, the associated atomic field is represented by the unbound fields ($\frac{E_{scu} E_{tcu}}{\sqrt{\varepsilon_o}}$) For normal matter, the active degrees of freedom are four : two for the normal matter quanton , and two for the associated fields.

Table 4. illustrates main differences between quantons of space fabric and those of normal matter

parameter	Space fabric quantons	Normal matter quantons
nature	Two pairs of two orthogonal fields (Q+AQ) : $\varrho_q = (\mathrm{E_{sf}}\,\mathrm{E}_{tc})\frac{(\mathrm{E_{sc}}\,\mathrm{E}_{tf})}{c}$ & $\varrho_{aq} = (\mathrm{E_{sc}}\,\mathrm{E}_{tf})\frac{(\mathrm{E_{sf}}\,\mathrm{E}_{tc})}{c}$	Two orthogonal fields $\varrho_p = (\mathrm{E_{sfb}}\,\mathrm{E}_{tcb})(\mathrm{E_{scb}}\,\mathrm{E}_{tfb})$
Bound fields	Q: $(E_{sfb}E_{tfb})(E_{sc}\,E_{tc})$ AQ:$(E_{sf}E_{tf})(E_{scb}\,E_{tcb})$	Q or AQ: $E_{sfb}\,E_{tfb}\,E_{scb}\,E_{tcb}$
unbound fields	unbound fields : Q: $(E_{sfu}\,E_{tfu})$ AQ: $(E_{scu}\,E_{tcu})$	unbound fields Gluons Q: $E_{sfu}E_{tfu}$ AQ: $E_{scu}E_{tcu}$ Positive particles $E_{sfu}\,E_{tfu}$ negative particles $E_{scu}\,E_{tcu}$
Degrees of freedom	Four	Dof_p: two Associated unbound fields : two
Quanton Expansion , splitting	Quantons Expand , and split	No expansion or splitting (quantons are under actual equilibrium)
r_q , ω Variation	Varying	invariant
Scalarized degrees of freedom	Not present	present

Table 4. Summary of the differences between space fabric and normal matter quantons

11. Rest mass

The reduced quanton of the normal matter is composed of two pairs of orthogonal fields (free /constrained) namely

$$E_{qf} = E_{sfb}\,E_{tcb}\ ,\quad E_{qc} = E_{scb}\,E_{tfb} \tag{1-11}$$

$$E_m = \sum_j^n \int_{V_p} E_{qfbj}\,E_{qcbj}\,dv = \sum_j^n E_{qfj}\,E_{qcj}\,V_{pj} \tag{2-11}$$

$$E_m = \sum_j^n (E_{sfbj}\,E_{tcbj})(E_{scbj}\,E_{tfbj})\,V_{pj} \tag{3-11}$$

11.a Relativistic effects of the rest mass

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 .

The relativistic mass under Lorentz transform of transverse energy fields now becomes

$$E_{mo}' = (E_{qf}' E_{qc}' V_p) \quad (4\text{-}11)$$

$$E_{mo}' = \frac{(E_{qf}\ E_{qc}\ V_p)}{\sqrt{1-(\frac{v}{c})^2}}\ \frac{E_{mo}}{\sqrt{1-\beta^2}} \quad (5\text{-}11)$$

and the same results can be obtained via the energy momentum relationship where

$$Pc = \frac{E}{c}\ v = \frac{(E_{qf}E_{qc}V_p)}{c}\ v \quad (6\text{-}11)$$

$$E_m^2 = m^2c^4 = P^2c^2 + m_o^2c^4$$

$$(E_{qf}' E_{qc}' V_p)^2 = (E_{qf}' E_{qc}' V_p)^2\ \frac{v^2}{c^2} + (E_{qf}\ E_{qc}\ V_p)^2 \quad (7\text{-}11)$$

$$\left(E_{qf}' E_{qc}' V_p\right)^2 \left(1 - \frac{v^2}{c^2}\right) = (E_{qf}\ E_{qc}\ V_p)^2 \quad (8\text{-}11)$$

$$(E_{qf}' E_{qc}' V_p) = E_m = \frac{E_{qf}\ E_{qc}V_p}{\sqrt{1-\beta^2}} = \frac{E_{mo}}{\sqrt{1-\beta^2}} \quad (9\text{-}11)$$

12. Field parameters for normal matter

Normal matter quanton which is composed of bound energy fields $(E_{sfb}\ E_{tfb})\ (E_{scb}E_{scb})$ possess only two degrees of freedom ,as there is no splitting or expansion , yet it can be quantized form using the relationship

$E_p = \frac{h\,c}{2\pi\, r_p}$ where r_p (particle radius) = fixed

$$E_m = M\,c^2 = \sum_j^n \frac{m_j}{c^2}\ c^4 = \sum_j^n \frac{h}{2\,\pi c^3\ r_{pj}}\ c^4 = n\,\frac{h}{2\pi c^3\ r_p}\ c^4 \quad (1\text{-}12)$$

$$\text{where } \frac{h}{2\pi\, c^3\ r_p} = \text{ constant} \quad (2\text{-}12)$$

This is quantized energy relationship where r_p represents the radius of normal matter's quanton .

The parameters ω , k , and r_q for the quanton are now replaced by the alternative characteristic length (r_p) the energy of the bound mass

$$E_m = \sum_j^n \int_{V_p} (E_{sfbj}\ E_{scbj})(E_{tfbj}\ E_{tcbj})\ dv \quad (3\text{-}12)$$

$$= \sum_j^n (E_{sfbj}\ E_{scbj}\ \ E_{tfbj}\ E_{tcbj})\, V_{pj} \quad (4\text{-}12)$$

Given that V_p = constant , $\sum_j^n V_{pj} = n\, V_p$ (5-12)

$$E_m = V_p\ (\sum_j^n E_{sfbj}\ E_{tfbj})\ (E_{scbj}\ E_{tcbj}) \quad (6\text{-}12)$$

$$E_m = nE_{sfb}\ E_{scb}\ E_{tfb}\ E_{tcb}\ V_p = n\ \frac{hc}{2\,\pi\, r_p} \quad (7\text{-}12)$$

And as an energy density (ϱ_p)

$$\varrho_p = \frac{n\ \ hc}{2\,\pi\, r_p\ (V_p\ \ )} = \frac{n\ hc}{2\pi\, r_q\ (8\ r_p^3)} = n\,\frac{hc}{16\,\pi\ \ r_p^4} \quad (8\text{-}12)$$

Where the dimensions of the bound fields [$E_{sfb}E_{tfb}E_{scb}E_{tcb}$] are [$\frac{hc}{r_p{}^4}$] $= M^{+1}L^{-1}T^{-2} = (\frac{\text{energy}}{\text{volume}})$

Now the intensity parameter of the normal matter fields can be determined

(2 scalarized degrees of freedom)

$$E_{sfb} = \sqrt[4]{\frac{h\,c^2}{16\,\pi\,c^3}}\,\frac{c^{0.75}}{r_p} = \sqrt[4]{\frac{h}{16\pi\,c}}\,\frac{c^{0.75}}{r_p} = K_p\,c^{0.75} = K_{sfb}\,D_{sfb} \qquad (9\text{-}12)$$

$$K_{sfb} = K_p = \sqrt[4]{\frac{h}{16\pi\,c}}\,\frac{1}{r_p}\quad,\ D_{sfb} = c^{0.75} \qquad (10\text{-}12)$$

$$E_{tfb} = \sqrt[4]{\frac{h\,c^2}{16\,\pi\,c^3}}\,\frac{c^{0.25}}{r_p} = K_p\,c^{0.25} = K_{tfb}\,D_{tfb} \qquad (11\text{-}12)$$

$$E_{scb} = K_{scb}\,D_{scb} = \sqrt[4]{\frac{h\,c^2}{16\,\pi\,c^3}}\,\frac{c^{0.75}}{r_p{}^2} = K_p c^{0.75} = K_{scb}\,D_{scb} \qquad (12\text{-}12)$$

$$E_{tcb} = \sqrt[4]{\frac{h\,c^2}{16\,\pi\,c^3}}\,\frac{c^{0.25}}{r_p} = K_p\,c^{0.25} = K_{tcb}\,D_{sfb} \qquad (13\text{-}12)$$

Where $K_{sfb} = K_{tfb} = K_{scb} = K_{tcb} = K_p = \sqrt[4]{\frac{h}{16\,\pi\,c}}\,\frac{1}{r_p}$ (14-12)

The two scalarized degrees of freedom become part of the intensity parameter as the NM quanton has two active Dof's only

12.a- Unbound energy fields

12.a.1-Positively charged particles

The electric part of the electromagnetic field was defined previously **[1]** as

$$E\,(x) = \frac{1}{2}\,\frac{1}{\sqrt{\varepsilon_o}}\left[\left(\frac{E_{qf}}{\sqrt{c}}\right)_q + \left(\frac{E_{qc}}{\sqrt{c}}\right)_{aq}\right] \qquad (15\text{-}12)$$

The positive atomic field is now defined as $E(+) = \frac{E_{sfu}E_{tfu}}{\sqrt{\varepsilon_o}}$ (16-12)

and the negative atomic field is now defined as $E(-) = \frac{E_{scu}E_{tcu}}{\sqrt{\varepsilon_o}}$ (17-12)

$$E_{sfu} = \sqrt[4]{\frac{\alpha_e\,h}{16\,\pi\,c^3}}\,\frac{c^{1.5}}{r_p} = \sqrt[4]{\alpha_e}K_{sfu}\,D_{sfu} = \sqrt[4]{\alpha_e}K_p\,c^{1.5} \qquad (18\text{-}12)$$

$$E_{tfu} = \sqrt[4]{\frac{\alpha_e\,h}{16\,\pi\,c^3}}\,\frac{c^{0.5}}{r_p} = \sqrt[4]{\alpha_e}K_{tfu}\,D_{tfu} = \sqrt[4]{\alpha_e}\,K_p c^{0.5} \qquad (19\text{-}12)$$

$$K_{sfu}K_{tfu} = K_p{}^2 \quad,\ \alpha_e = \frac{1}{137} \qquad (20\text{-}12)$$

12.a.2-negatively charged particles

$$E_{scu} = \sqrt[4]{\frac{\alpha_e h}{16\,\pi\,c^3}}\,\frac{c^{1.5}}{r_p} = \sqrt[4]{\alpha_e}K_{scu}\,D_{scu} = \sqrt[4]{\alpha_e}\,K_p\,c^{1.5} \qquad (21\text{-}12)$$

$$E_{tcu} = \sqrt[4]{\alpha_e}K_{tcu}\,D_{tcu} = \sqrt[4]{\alpha_e}K_p\,c^{0.5},\ K_{scu}\,K_{tcu} = K_p{}^2 \qquad (22\text{-}12)$$

13. Scalarized degrees of freedom, a possible origin of rest mass,

The normal matter the intensity parameter is defined as

$$K_{sfb} = K_{tfb} = K_{scb} = K_{tcb} = \sqrt[4]{\frac{h\,c^2}{16\ c^3}}\frac{1}{r_p} = \sqrt[4]{\frac{h}{16\ \ c}}\frac{1}{r_p} \text{ instead of} \quad (1\text{-}13)$$

$\sqrt[4]{\frac{h}{16\ \pi\ c^3}}\ \frac{1}{r_p}$ for the space fabric quantons

Rest mass density is represented by the product of the normal matter field intensities which are

$$K_{sfb}K_{tfb}\ K_{scb}\ K_{tcb} = K_p{}^4 = \left(\sqrt[4]{\frac{h}{16\pi\ c}}\right)^4\left(\frac{1}{r_p{}^4}\right) = \frac{h}{16\,\pi\ \ c\,r_p{}^4} = [\frac{mass}{volume}] \quad (2\text{-}13)$$

This is due to the fact that energy density equation of normal matter quanton is in the form

$$\varrho_p = E_{sfb}\ E_{scb}E_{tfb}\ E_{tcb} \quad (3\text{-}13)$$

with a reduction of overall degrees of freedom from four to two where two degrees of freedom are now transformed from belonging to the field strength parameter to become a part of the field intensity and as a result of this reduction , the Dof's of quantons representing the rest 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 dimension conditions, photons, gluons can acquire a dynamic mass under Schwinger model **[13], [14]** 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

14. Field interactions of normal matter

14.a-Quanton retaining interaction (Type : single binding)

$$(R_t) = (\sqrt[2]{\alpha_t}E_{sfb}\ E_{tfb})\ (\sqrt[2]{\alpha_t}E_{scb}E_{tcb}\ ) \quad (1\text{-}14)$$

$$= \alpha_t\ (\sqrt[2]{\alpha_t}K_p{}^2D_{sfb}D_{tfb}\ )\ (\sqrt[2]{\alpha_t}K_p{}^2D_{scb}D_{tcb}\ ) \quad (2\text{-}14)$$

$$= \alpha_t\ \int_{V_p}(K_p{}^2\ \frac{c}{r_p{}^2})(\ K_p{}^2\ \frac{c}{r_p{}^2})\ dv \quad (3\text{-}14)$$

$$R_t = \alpha_t\left(\frac{h\ c^2}{16\,\pi\ c^3}\right)\frac{c^2}{r_p{}^4}\left(8\ r_p{}^3\right) = \alpha_t\frac{h\,c}{2\,\pi\,r_p} \quad (4\text{-}14)$$

Where $K_p = \sqrt[4]{\frac{h}{16\,\pi\ \ c}}$, this interaction has two degrees of freedom , and the dimensions of energy=$M^1L^2T^{-2}$

14.b-Gravitational binding of the rest mass (R_{gb})

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 ($E_{sfbi}\ E_{tfbi}$) ($E_{scbj}\ E_{tcbj}$) and ($E_{scbi}\ E_{tcbi}$) ($E_{sfbj}\ E_{tfbj}$)

Formulation of the gravitational binding energy E_{gb} between normal matter particles p_i and p_j differs from all other interactions as normal matter space and time fields ($E_{sfb}\ E_{tfb}$)($E_{scb}\ E_{tcb}$) have an intensity parameter that equals ($K_p{}^4$) 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) and the resulting interaction has would be in the form

$$\mathbf{R_{gb}} = K_g (K_{pi}{}^4 c^2)(K_{pj}{}^4 c^2) \frac{r_{pi} r_{pj}}{(r_i - r_j)} \quad (5\text{-}14)$$

Intensity term becomes $(K_p{}^4)^2$ instead of $(K_p{}^4)$ which is required for true energy generated by the interaction and since R_g has the dimensions of energy $M^1L^{+2}T^{-2}$, the constant K_g appears as a dimensional correction since each of the parameters$[K_{pi}{}^4 V_{pi}][K_{pj}{}^4 V_{pj}] = (\frac{h}{2 c r_p})^2 = \left[\frac{energy}{c^2}\right][\frac{energy}{c^2}]$

finally to obtain a truly binding interaction R_g (in terms of energy with dimensions $M^1L^{+2}T^{-2}$)

The constant K_g should be equivalent to $\frac{c^4}{E_{ref}}$ where for normal matter $E_{ref} = \frac{hc}{2\pi r_p}$ (6-14)

(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 $(\frac{1}{E_{ref}})$ by (c^4) .

$$\mathbf{R_{gbi}} = \frac{c^4}{E_{ref}}[(\sum_j^n \int_{V_{pi}} \frac{\sqrt[2]{\alpha_g} E_{sfbi}\ E_{tfbi} E_{scbi}\ E_{tcbi}}{c^2} dV) \sum_j^n \int_{V_{pj}} \frac{\sqrt[2]{\alpha_g} E_{sfbj}\ E_{tfbj} E_{scbj}\ E_{tcbj}}{c^2} dV] \left(\frac{\sqrt{r_{pi} r_{pj}}}{(r_i - r_j)}\right) \quad (7\text{-}14)$$

$$= \frac{c^4}{E_{ref}} [(\sum_j^n \sqrt[2]{\alpha_g} K_{pi}{}^4 \frac{D_{sfbi}\ D_{tfbi} D_{scbi}\ D_{tcbi}}{c^2} V_{qi})(\sum_j^n \sqrt[2]{\alpha_g} K_{pj}{}^4 \frac{D_{sfbj}\ D_{tfbj} D_{scbj}\ D_{tcbj}}{c^2} V_{qj}) \left(\frac{\sqrt{r_{pi} r_{pj}}}{(r_i - r_j)}\right)] \quad (8\text{-}14)$$

$$(\mathbf{R_{gbi}}) = \frac{c^4 r_p{}^2}{E_{ref}} [(K_{pi}{}^4 V_{pi})(\sum_j^n K_{pj}{}^4 V_{pj})(\frac{1}{(r_i - r_j)})] \quad (9\text{-}14)$$

which is a summation for particles (j)

for the special case where $r_{pi} = r_{pj} = r_p$, for normal matter $K_{pi} = K_{pj} = K_p = \sqrt[4]{\frac{h}{16\pi c}\frac{1}{r_p}}$

$$\int_{V_p} E_{sfb}\, E_{tfb}\, E_{scb}\, E_{tcb} dV = E_{sfb}\, E_{tfb}\, E_{scb}\, E_{tcb}\, V_p \quad (10\text{-}14)$$

$V_{pi} = V_{pj} = V_p = 8\, r_p{}^3$ (quanton equivalent volume) **[2]** (11-14)

$$K_p{}^4 = \frac{h}{16\pi\ c} (\frac{1}{r_p})^4 = \frac{h}{2\pi c\ r_p} \frac{1}{V_p} \quad (12\text{-}14)$$

$$\mathbf{R_{gbi}} = \frac{2\pi \alpha_g c^4 r_p{}^2}{hc} [\sum_i^m (\frac{h}{2\pi c\ V_{pi}} \frac{1}{r_p} V_{pi}) \sum_j^n (\frac{h}{2\pi c\ V_{pj}} \frac{1}{r_p} V_{qj})(\frac{1}{(r_i - r_j)})] \quad (13\text{-}14)$$

$$= (\frac{2\pi\ \alpha_g c^4}{hc})(\frac{h}{2\pi c}) \sum_i^m \sum_j^n (\frac{h}{2\pi c}) (\frac{1}{(r_i - r_j)}) \quad (14\text{-}14)$$

$$= (\alpha_g c^2) \sum_i^m \sum_j^n (\frac{h}{2\pi c}) (\frac{1}{(r_i - r_j)}) \quad (15\text{-}14)$$

$$\mathbf{R_{gbi}} = \frac{\alpha_g h\, c}{2\pi} \sum_i^m \sum_j^n (\frac{1}{(r_i - r_j)}) \quad (16\text{-}14)$$

G can be defined in terms of $(\frac{2\pi\alpha_g c^3 r_p{}^2}{h})$ (17-14)

And $r_p = \sqrt{\frac{Gh}{2\pi\alpha_g c^3}}$, (18-14)

$r = \sqrt{\frac{Gh}{2\pi\ c^3}}$ 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 $K_g = \frac{2\alpha_g c^2 r_q^2}{h}$ is a variable with time as the quanton radius r_q varies also with time .

Table 5. Show the roles of the bound and unbound fields for the positively charged particles of the normal matter

energy field	Role at short range	Interactions with other quantons (short range)	Long range interactions
$E_{sfb}E_{tfb}$ (bound)	quanton retaining interaction $\mathbf{R_t}$	Quanton binding interaction $\mathbf{R_b}$ (gravitational binding)	1-gravitation 2-dark matter gravitational attraction
$E_{scb}E_{tcb}$ (bound)	quanton retaining interaction $\mathbf{R_t}$	quanton binding interaction $\mathbf{R_b}$ (gravitational binding)	1-gravitation 2-dark matter gravitational attraction
E_{sfu} E_{tfu} (unbound)	Atomic electric field	Atomic Electric field	Atomic Electric field
$E_{scu}E_{tcu}$ (unbound)	N/A	N/A	N/A

Table 5. Summary of the interactions developed by each energy fields at different scales for positively charged particles

15.Gravitational interaction of rest mass ($\mathbf{R_g}$)

Type : multiple binding

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 of the quantons of the two bodies (i ,j) , R_g : gravitational binding energy.

While the gravitational interaction takes place between bound fields (E_{sfb} E_{tfb} E_{scb} E_{tcb}) 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 ($c^2 x\, c^2$) and then multiply the compensation term K_g by c^4 to obtain a gravitational interaction which represents the two masses ($m= \frac{E_m}{c^2}$)

$$\mathbf{R_g} = G\left(\frac{E_{mi}}{c^2}\right)\left(\frac{E_{mj}}{c^2}\right)\frac{1}{(r_i - r_j)} = G\frac{m_i m_j}{(r_i - r_j)} = \frac{2\alpha_g r_p{}^2{}_g}{E_{ref}} = \left(\frac{2\pi\alpha_g c^4 r_p{}^2}{hc}\right) \quad (1\text{-}15)$$

$$= \frac{2\pi c^4}{hc}\left[\sum_i^m \int_{V_{pi}} \left(\frac{\sqrt[2]{\alpha_g} E_{sfbi} E_{tfbi} E_{scbi} E_{tcbi}}{c^2}\right) dV\right]\left[\sum_j^n \int_{V_{pj}} \left(\frac{\sqrt[2]{\alpha_g} E_{sfbj} E_{tfbj} E_{scbj} E_{tcbj}}{c^2}\right) dV\right]\frac{r_{pi}\, r_{pj}}{(r_i - r_j)} \quad (2\text{-}15)$$

$$=\frac{2\pi\alpha_g c^4 r_p^2}{hc}[\Sigma_i^m K_{pi}^4 (\frac{D_{sfbi}D_{tfbi}D_{scbi}D_{tcbi}}{c^2}) V_{pi}][\Sigma_j^n K_{pj}^4 (\frac{D_{sfbj}D_{tfbj}D_{scbj}D_{tcbj}}{c^2})V_{pj}]\ \frac{1}{(r_i - r_j)} \quad (3\text{-}15)$$

$$=\frac{2\pi\alpha_g c^3 r_p^2}{h}\left[\Sigma_i^m \left(\frac{h}{16\pi\ c\ r_{pi}^3}\right)\frac{1}{r_{pi}}V_{pi}\right][\Sigma_j^n \left(\frac{h}{16\pi\ c\ r_{pj}^3}\right)\frac{1}{r_{pj}}V_{qj}]\ \frac{1}{(r_i - r_j)} \quad (4\text{-}15)$$

$$=\frac{2\pi\alpha_g c\, r_p^2}{hc}[\Sigma_i^m (\frac{h}{2\pi(8 r_{pi}^3)})\ \frac{V_{pi}}{r_{pi}}][\Sigma_j^n (\frac{h}{2\pi\ (8 r_{pj}^3)})\ \frac{V_{pj}}{r_{pj}}]\ \frac{1}{(r_i - r_j)} \quad (5\text{-}15)$$

$$= \alpha_g c\, r_p^2 (\ \Sigma_i^m (\frac{h}{2\pi r_{pi}})\Sigma_j^n\ \frac{1}{r_{pj}}\ \frac{1}{(r_i - r_j)})$$

$$\mathbf{R_g} = \frac{\alpha_g hc}{2\pi}(\Sigma_i^m\ \Sigma_j^n\ \frac{1}{(r_i - r_j)}) \quad (6\text{-}15)$$

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 ($\mathbf{R_t}$) first, then the Intra quanton binding ($\mathbf{R_{bi}}$) gravitational like binding interaction($\mathbf{R_{gb}}$) and gravitation at last and , and this is one of the reasons behind the weakness of gravitation in comparison to other forces.

16.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 of the particle structure rather than the quanton dimensions .

Potential energy stored in the positive atomic electric field is in the form

$$\boldsymbol{R_{ep}} = \int_{V_p} (\frac{E_{sfu}E_{tfu}}{\sqrt{\varepsilon_o}})^2 dV = (\frac{E_{sfu}E_{tfu}}{\sqrt{\varepsilon_o}})^2 V_p \quad (1\text{-}16)$$

$$\boldsymbol{R_{ep}} = [\ (\frac{1}{\sqrt{\varepsilon_o}})\left(\sqrt[4]{\frac{\alpha_e h}{16\ \pi\ \ c^3}\frac{c^{1.5}}{r_p}}\right)\left(\sqrt[4]{\frac{\alpha_e h}{16\ \pi\ \ c^3}\frac{c^{0.5}}{r_p}}\right)]^2 (8\, r_p^3) = \alpha_e \frac{hc}{2\pi\, r_p} \quad (2\text{-}16)$$

Given that $E_e = \frac{Q^2}{4\pi\varepsilon_o r_p}$

$$\alpha_e \frac{hc}{2\pi\, r_p} = \frac{Q^2}{4\pi\varepsilon_o r_p} \quad (3\text{-}16)$$

$$Q = \sqrt[2]{2\alpha_e \varepsilon_o hc} \quad (4\text{-}16)$$

α_e = coupling constant for atomic electric field , V_p : particle Volume , for the case of positively

charged particles (free field dominated), the atomic charge can be assessed using Gauss law

$$\text{where } \int \frac{E_{sfu}E_{tfu}}{\sqrt{\varepsilon_o}}\ dA = \frac{Q}{\varepsilon_o} \quad (5\text{-}16)$$

ϱ = charge density , E_{sfu} E_{tfu} are the unbound now invariant atomic (static) electric field

$$E(+) = \frac{E_{sfu}E_{tfu}}{\sqrt{\varepsilon_o}} = \frac{Q}{4\pi\ \varepsilon_o r_p^2}\ ,\quad r_p \text{ : estimated radius of the particle} \quad (6\text{-}16)$$

$$Q(+) = 4\,\pi\ \varepsilon_o r_p^2 (\frac{E_{sfu}E_{tfu}}{\sqrt{\varepsilon_o}}) \quad (7\text{-}16)$$

$$= 4\,\pi\ \varepsilon_o r_p^2\, K_p^2\, D_{sfu}\, D_{tfu} \quad (8\text{-}16)$$

Which has the dimensions of $[Q] = M^{0.5} L^{+1.5} T^{-1}$

the accompanying electric field at any point (r_0) becomes

$$E\,(+) = \frac{Q}{4\,\pi\ \varepsilon_o (\Delta\, r_0)^2} = \frac{r_p^2\, E_{sfu}\ E_{tfu}}{(\Delta\, r_0)^2 \sqrt{\varepsilon_o}} = \sqrt{\frac{\alpha_e h\ c}{2\pi\, V_p r_p}}\frac{r_p^2}{(\Delta\, r_0)^2} \quad (9\text{-}16)$$

Which has the dimensions of $[E]= M^{0.5} \; L^{-0.5} \; T^{-1}$

For negatively charged particles (constrained fields dominated)

$$Q(-) = 4\pi \sqrt{\varepsilon_o} r_p^2 \; E_{scu} \; E_{tcu} \qquad (10\text{-}16)$$

Where E_{scu} E_{tcu} are the unbound invariant constrained fields

16.b.Electric binding potential ($\mathbf{R_e}$)

$$\mathbf{R_e} = K_e \frac{Q_i \; Q_j}{(\Delta \, r_{ij})} \qquad (11\text{-}16)$$

$$= K_e(4\pi \varepsilon_o r_p^2)(\frac{E_{sfui}E_{tfui}}{\sqrt{\varepsilon_o}})(4\pi \; \varepsilon_o r_p^2)(\frac{E_{scuj}E_{tcuj}}{\sqrt{\varepsilon_o}}) \frac{\sqrt{r_{pi} r_{pj}}}{(r_i - r_j)}) \qquad (12\text{-}16)$$

$$\mathbf{R_e} = \frac{\alpha_e hc}{2\pi \, (r_i - r_j)} \qquad (13\text{-}16)$$

K_e : Coulomb Constant $(= \frac{1}{4\pi \; \varepsilon_o})$,

17.Strong nuclear binding / repulsive interaction

It is represented by self-interaction of the unbound free and constrained energy fields Real potentials (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 .

Gluons are based equitably on both free and constrained fields so as to provide for the symmetry of the self-interaction

Flux tube V_{fi} of free energy field (E_{sfu} E_{tfu}) has two Dof's

$$E_{sfu} \; E_{tfu} = K_p^2 (D_{sfu} \; D_{tfu}) \qquad (1\text{-}17)$$

where $D_{sfu} = c^{1.5}$, $D_{tfu} = c^{0.5}$ (2,3-17)

Constrained energy field based flux tube V_{fj} in the form (E_{scu} E_{tcu}) , which has also two Dof's

$$E_{scu} \; E_{tcu} = K_p^2 (D_{scu} \; D_{tcu}) \qquad (4\text{-}17)$$

where $D_{scu} = c^{1.5}$, $D_{tcu} = c^{0.5}$ (5,6-17)

Energy stored in the flux tubes

$$E_{stf} = \int_{V_f} (E_{sfu} \; E_{tfu})^2 \; dV \quad \text{and} \qquad (7\text{-}17)$$

$$E_{stc} = \int_{V_f} (E_{scu} \; E_{tcu})^2 \; dV \qquad (8\text{-}17)$$

, V_f : flux tube volume

17.a-Repulsive part (self interaction) $\mathbf{R_{sr}}$: simple nonbinding type

The repulsive part of strong nuclear force is represented by two self-interactions of gluon flux tubes

First between free energy fields ($E_{sfu}E_{tfu}$) in addition to another self-interaction of the constrained energy field based flux tubes ($E_{scu}E_{tcu}$)

The generated repulsive part of the strong interaction takes the form

$$\mathbf{R_{sr}} = [\int_{V_f} \alpha_s \, K_p^4 (D_{sfu} D_{tfu})^2 \, dv + \int_{V_f} \alpha_s K_p^4 (D_{scu} D_{tcu})^2 \; dV \,](\frac{r_p}{\Delta r_p}) \qquad (8\text{-}17)$$

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

$$\mathbf{R_{sr}} = K_p^4 [\sum_i^m \alpha_s(D_{sfui}D_{tfui})^2 \ V_{fi} + \sum_i^m \alpha_s (D_{scui}D_{tcui})^2 \ V_{fi}](\frac{r_p}{\Delta r_p}) \tag{9-17}$$

$$= \alpha_s(\sqrt[2]{\left(\frac{h}{2\pi c^3 V_p r_p}\right)})^2 (c^2)^2 \sum_i^m V_{fi} (\frac{r_p}{\Delta r_p})$$

$$\mathbf{R_{sr}} = \alpha_s \frac{hc}{2\pi \Delta r_p} \sum_i^m (\frac{V_{fi}}{V_p}) = \alpha_s \frac{m \ hc}{2\pi \Delta r_p} \tag{10-17}$$

α_s : strong coupling constant , valid for the case of $V_p = \sum_i^m V_{fi}$

17.b- the binding part type($\mathbf{R_{sb}}$) : simple binding

The attraction part is generated by the interaction between free field flux tubes and constrained field gluon flux tubes.

$$\mathbf{R_{sb}} = [\int_{V_f} (E_{sfu}E_{tfu})(E_{scu}E_{tcu})dV](\frac{r_p}{\Delta r_f}) \tag{11-17}$$

$$\mathbf{R_{sb}} = [\alpha_s K_p^4 \left(\int_{V_f} (D_{sfu}D_{tfu})(D_{scu}E_{tcu}\right) dV] (\frac{r_p}{\Delta r_f}) \tag{12-17}$$

$$= \alpha_s \ K_p^4 \ \sum_i^m (D_{sfui}D_{tfui}) (D_{scui}D_{tcui}) V_{fj}(\frac{r_p}{\Delta r_f}) \tag{13-17}$$

$$= \alpha_s(\sqrt[2]{\left(\frac{h}{2\pi c^3 V_p r_p}\right)})^2 (c^2)^2 \sum_i^m V_{fi} \ (\frac{r_p}{\Delta r_f}) \tag{14-17}$$

$$\mathbf{R_{sb}} = \alpha_s \frac{h c}{2\pi V_p \ r_p} V_f \left(\frac{r_p}{\Delta r_f}\right) = \alpha_s \frac{h c}{2\pi \Delta r_f} \sum_i^m \frac{V_{fj}}{V_p} = \alpha_s \frac{m \, h c}{2\pi \ \Delta r_f} \quad \textbf{[15]} \tag{15-17}$$

Δr_f = average distance between the flux tubes

It is noted that the distance (Δr_f) between flux tubes = constant and 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 (Δr_p) ((distance between quarks) changes and the value of the interaction changes accordingly, while energy content of the flux tubes remains the same

Table 6. details the role of energy fields for the gluons

Energy field	Role at short range(intra quanton)	Inter-quanton quanton (short range)	interactions at long range
$E_{sfb}E_{tfb}$ (bound)	1-Quanton retaining interaction $\mathbf{R_t}$ 2-intra quanton binding interaction $\mathbf{R_{bi}}$	Quanton binding $\mathbf{R_b}$ (gravitational binding)	1-gravitation 2-Dark matter gravitation of normal matter
$E_{scb}\ E_{tcb}$ (bound)	1-Quanton retaining interaction $\mathbf{R_t}$ 2-intra quanton binding interaction $\mathbf{R_{bi}}$	Quanton binding $\mathbf{R_b}$ (gravitational binding)	1-gravitation 2-Dark matter gravitation of normal matter
$E_{sfu}E_{tfu}$ (unbound)	Strong nuclear force (attraction and repulsion part)		Matter distortion of space fabric
$E_{scu}E_{tcu}$ (unbound)	Strong nuclear force (attraction and repulsion part)		Matter distortion of space fabric

Table 6. Summary of the role of the interactions developed by each energy field at Planck and cosmological scales for gluons

18. Gravitational like attraction of dark matter($\mathbf{R_{gs}}$)
Type : multiple binding

The interaction that generates the gravitational like attraction of the dark matter is between bound fields $(E_{sfb}\ E_{tfb}\ E_{sc}\ E_{tc})_s$ of space fabric's quantons or $(E_{sf}\ E_{tf}\ E_{scb}\ E_{tcb})_s$ for ani-quantons and the bound fields $(E_{sfb}\ E_{tfb}\ E_{scb}\ E_{tcb})_m$ of the normal matter's quantons.
Space fabric bound fields have 2.0 Dof's each which create a gravitational binding interaction with the galactic normal matter 's bound fields (also have two Dof's) , those same energy fields which generate the gravitation binding .

$$\mathbf{R_{gs}} = \frac{c^4}{E_{ref}}\left[\sum_i^m \int_V \left(\frac{\sqrt[2]{\alpha_g}\, E_{sfbi}E_{tfbi}E_{scbi}E_{tcbi}}{c^2}\right)_m dv\right]\left\{\left[\sum_j^n \int_{V_{qs}} \left(\sqrt[2]{\alpha_b} E_{sfbj}E_{tfbj}E_{scj}E_{tcj}\right)_{qs} dV\left(\frac{\sqrt{r_{pi}r_{qj}}}{(r_i-r_j)}\right)\right]\right.$$

$$\left.+\left[\sum_j^n \int_{V_{aqs}} \left(\sqrt[2]{\alpha_b} E_{sfj}E_{tfj}E_{scbj}E_{tcbj}\right)_{aqs} dV\left(\frac{\sqrt{r_{pi}r_{aqj}}}{(r_i-r_j)}\right)\right]\right\} \quad (1\text{-}18)$$

$$= \frac{c^4}{E_{ref}}\left[\sum_i^m \sqrt[2]{\alpha_g} K_{pi}^{\ 4}\left(\frac{D_{sfbi}D_{tfbi}D_{scbi}D_{tcbi}}{c^2}\right)_m V_{pi}\right]\left\{\left[\sum_j^n \sqrt[2]{\alpha_b} K_{qj}^{\ 4}\left(D_{sfbj}D_{tfbj}D_{scj}D_{tcj}\right)_{qs} V_{qj}\left(\frac{\sqrt{r_{pi}r_{qj}}}{(r_i-r_j)}\right)\right]\right.$$

$$\left.+\left[\sum_j^n \sqrt[2]{\alpha_b} K_{aqj}^{\ 4}\left(D_{sfj}D_{tfj}D_{scbj}D_{tcbj}\right)_{aqs} V_{aqj}\left(\frac{\sqrt{r_{pi}r_{aqj}}}{(r_i-r_j)}\right)\right]\right\} \quad (2\text{-}18)$$

$$= \frac{2\pi\sqrt{\alpha_g\alpha_b}\, r_{ref}\, c^4}{hc}\left[\sum_i^m \left(\frac{h}{2\pi\, c\, V_{pi} r_{pi}}\right) V_{pi} \sum_j^n c^2 \left(\frac{h}{2\pi\, c^3 V_{qj}\, r_{qj}}\right) V_{qj} \left(\frac{\sqrt{r_{pi}r_{qj}}}{(r_i-r_j)}\right)_{m-s}\right]$$

$$\mathbf{R_{gs}} = \frac{\sqrt{\alpha_g \alpha_b} h c}{2\pi} \sum_i^m \sum_j^n \left(\frac{1}{(r_i - r_j)}\right)_{m-qs} \quad (3\text{-}18)$$

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 quatons or anti quantons (j) , $E_{ref} = \frac{hc}{2\sqrt{r_p r_q}}$

19. Space fabric distortion of normal matter

It had been proposed that bound energy fields $(E_{sfb}\ E_{tfb}\ E_{sc}\ E_{tc})_q$ or $(E_{scb}\ E_{tcb}\ E_{sf} E_{tf})_{aq}$ of space fabric which generate the space fabric binding interaction $\mathbf{R_b}$, would also generate the gravitational attraction between the dark matter and the normal matter $\mathbf{R_{gs}}$, 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 $(E_{sfu}\ E_{tfu})$, $(E_{scu}\ E_{tcu})$ 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 which are at the origin of the quanton expansion, splitting and the inflationary momentum in general, are repulsive in nature as they are

complex 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 : $(K_q \sqrt{(D_{sfu}\ D_{tfu})_q})(K_q \sqrt{(D_{sfu}\ D_{tfu})_q})$ or $(K_q \sqrt{(D_{scu} D_{tcu})_{aq}})(K_q \sqrt{(D_{scu} D_{tcu})_{aq}})$ and not of the form $K_q^2 (D_{sfu}\ D_{tfu})_q$ or $K_q^2 (D_{scu} D_{tcu})_{aq}$,

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.

19.a. Evidence of space fabric distortion : case of abnormal galactic rotational curves

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 energy density near the bulge (which leads to near Keplerian pattern of rotational velocities)

b-An increased space fabric 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 **[16]** , **[17]** , **[18]** .

A localized drop in the rotational curve of spiral galaxies was observed, this localized drop coincides with the spiral arms of the spiral galaxies**,[19], [20] ,[21]**

An interpretation of such phenomena can be put as follows,

1-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

19.c. Matter distortion of space fabric($\mathbf{R_{di}}$)

$$\mathbf{R_{di}} = \frac{1}{E_{ref}}\Big\{\sum_i^m \int_{V_{qs}}[(E_{sfui}\,E_{tfui})_{qs}\,(E_{scui}\,E_{tcui})_{aqs}\,dV\Big]\,[\sum_j^n \int_V (E_{sfuj}\,E_{tfuj}\,)_m\,(E_{scuj}\,E_{tcuj}\,)_m\quad dV)]\,\}\,\frac{\sqrt{r_{qi}r_{pj}}}{(r_i-r_j)} \quad (1\text{-}19)$$

$$= \frac{2\pi\, r_{ref}}{hc}\{\sum_i^m[\alpha_r\, K_{pi}{}^4\,(D_{sfui}D_{tfui}\,)_{qs}(D_{scui}D_{tcui}\,)_{aqs}V_{qi}\,][\,\sum_j^n\,\alpha_s\,K_{qj}{}^4\,(D_{sfuj}\,D_{tfuj})_m\,(D_{scuj}D_{tcuj}\,)_m V_{pj}\,]\}\,\frac{\sqrt{r_{qi}r_{pj}}}{(r_i-r_j)} \quad (2\text{-}19)$$

$$=\sum_i^m\sum_j^n\frac{2\pi\alpha_r\alpha_s\sqrt{r_{qi}r_{pj}}}{hc}\quad(\frac{h\ \ c^4}{2\pi c^3 V_{qi}\ r_{qi}})V_{qi}\,(\frac{h\ \ c^4}{2\pi c^3 V_{pj}\ r_{pj}})V_{pj}\ (\frac{\sqrt{r_{qi}r_{pj}}}{(r_i-r_j)}) \quad (3\text{-}19)$$

$$\mathbf{R_{di}} = \alpha_s\,\alpha_r(\frac{h}{2\pi})\ \sum_i^m\sum_j^n(\frac{1}{(r_i-r_j)}) \quad (4\text{-}19)$$

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.

20. Electromagnetic field interactions

For space fabric quantons, two degrees of freedom belong to binding interactions between free and constrained fields and the remaining two degrees of freedom are due to repulsive self-interaction (between free fields for the quanton or constrained fields for anti quantons)

While for electromagnetic wave relativistic quantons, they have the same type of interactions but the binding interactions are one degree of freedom less due to the relativistic effect while the repulsive self-interaction remains unchanged as the nature of expansion and splitting of the electromagnetic fields is identical to that of space fabric quantons.

The relativistic degree of freedom affected the space varying fields and led to the rearrangement of energy degree of freedom as follows

$$Dof_{sf}\ Dof_{tc} = 2.5\text{-}0.5 = 2.00\quad ,\ Dof_{sc}\ Dof_{tf} = 1.5\text{-}0.5 = 1.0 \quad (1, 2\ \text{-}20)$$

$$(Dof_{sfb}\ Dof_{tfb}) = (Dof_{scb}\ Dof_{tcb}) = 0.5 \quad (3\text{-}20)$$

$$(Dof_{sfu}\ Dof_{tfu}) = 2.0\quad , \quad (4\text{-}20)$$

20.a-Retaining energy interaction

The photon retaining interaction has two degrees of freedom as the relativistic Dof is added to the

binding Dof to generate a four dimensional interaction for the quanton or anti quanton

$$\mathbf{R_{tp}} = [\sqrt[4]{\alpha_t}\int_{V_q}(E_{sfb}E_{tfb})\,][\ \sqrt[4]{\alpha_t}\ (E_{sc}E_{tc}\,)]\ c\ dv \quad (5\text{-}20)$$

$$= [\sqrt[4]{\alpha_t}K_{qs}{}^2(D_{sfb}\,D_{tfb}\,)][\sqrt[4]{\alpha_t}K_{qs}{}^2\,(D_{sc}\,D_{tc}\,)\,]\ c\,V_q \quad (6\text{-}20)$$

$$R_{tp} = \sqrt{\alpha_t}\,K_{qs}{}^4\,c^2\,V_q = \sqrt{\alpha_t}\,\frac{hk^4}{16\pi\ c}V_q = \sqrt{\alpha_t}\,\frac{h}{16\pi\ c\ \ r_q{}^4}V_q \quad (7\text{-}20)$$

$$R_{tp} = \sqrt{\alpha_t}\,\frac{h}{2\ \pi c\ r_q} \quad (8\text{-}20)$$

And the total retaining energy for the photon Q+AQ pair

$$= \frac{c^4}{E_{ref}}\,R_{tp}{}^2 = \alpha_t\,\frac{h\,c}{2\pi\ r_q} \quad (9\text{-}20)$$

20.b Inflationary ,and repulsive interactions

Same as space fabric

20.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

Binding interaction for electromagnetic wave has one degree of freedom in addition to the relativistic Dof

Binding interaction takes the form

$$\mathbf{R_{gbi}} = \frac{c^4}{E_{ref}}\{[\tfrac{1}{2}\int_{V_{qe}}(\sqrt{\alpha_b}\,E_{sfbi}E_{tfbi}E_{sci}E_{tci})_q\, c\, dV]+ \left[\tfrac{1}{2}\int_{V_{qe}}(\sqrt{\alpha_b}E_{sfi}E_{tfi}E_{scbi}E_{tcbi})_{aq} c\, dV\right]\Sigma_j^n\int_{V_p}\,[\sqrt{\alpha_g}(\frac{E_{sfbj}E_{tfbj}E_{scbj}E_{tcbj}}{c^2})_m dV]\left(\frac{\sqrt{r_{qi}r_{pj}}}{(r_i-r_j)}\right) \quad (10\text{-}20)$$

$$=\frac{2\pi c^4\, r_{qi}r_{pj}}{hc}\{[(\,K_{qi}{}^4(\sqrt{\alpha_b}D_{sfbi}D_{tfbi}D_{sci}D_{tci})_q cV_{qi})]+ [\,K_{qi}{}^4(\sqrt{\alpha_b}D_{sfi}D_{tfi}D_{scbi}D_{tcbi})_{aq}cV_{aqi})]\}\,\Sigma_j^n K_{pj}{}^4\sqrt{\alpha_g}\,\frac{D_{sfbj}D_{tfbj}D_{scbj}D_{tcbj}}{c^2}\; V_{pj}\frac{1}{(r_i-r_j)}$$

$$=\frac{2\pi c^3\sqrt{\alpha_b\alpha_g}r_q r_p}{h}\;(K_{qi}{}^4\, c^2\, V_{qi}\,)\;(\Sigma_j^n K_{pj}{}^4\, c^2\;\; V_{pj}\,)(\frac{1}{(r_i-r_j)}) \quad (11\text{-}20)$$

$$=\frac{2\pi c^3\, r_q r_p\sqrt{\alpha_b\alpha_g}}{h}\left(\frac{h\;c^2}{2\pi c^3 V_{qi}\;r_{qi}}\right)V_{qi}\;\;\Sigma_j^n\left(\frac{h}{2\pi\, c\;V_{pj}\,r_{pj}}\right)V_{pj}\;(\frac{1}{(r_i-r_j)}$$

$$\mathbf{R_{gbi}} = \frac{h\,c\sqrt{\alpha_b\alpha_g}}{2\,\pi}\;\Sigma_j^n(\frac{1}{(r_i-r_j)}) \quad (12\text{-}20)$$

Noting that this gravitational like binding can also exist between two different electromagnetic waves

The parameter $K_g = \frac{c^4}{E_{ref}} = \frac{2\pi\sqrt{r_{qi}r_{pj}}c^3}{h}$ (previously, it was defined as $K_g = \frac{2\pi\, r_p\, c^3}{h}$ for the case of normal matter's gravitation)

20.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

$$\mathbf{R_{rei}} = \frac{1}{E_{ref}}\{[\,\Sigma_i^m\int_{V_{qe}}(\sqrt[4]{\alpha_r}\,E_{sfui}E_{tfui})_{\mathbf{qe}}\,(\sqrt[4]{\alpha_r}\,E_{scui}E_{tcui})_{\boldsymbol{aqe}}\;\;dV]] [\Sigma_j^n\;\int_{V_{qs}}(\sqrt[4]{\alpha_r}\,E_{sfuj}E_{tfuj})_{\mathbf{qs}}\,(\sqrt[4]{\alpha_r}E_{scuj}E_{tcuj})_{\mathbf{aqs}}dV]\}(\frac{\sqrt{r_{qi}r_{pj}}}{(r_i-r_j)}) \quad (13\text{-}20)$$

$$=\frac{2\pi r_{ref}}{hc}\,[\sqrt[2]{\alpha_r}\;\Sigma_i^m\;\;K_{qi}{}^4(D_{sfui}D_{tfui})_{\mathbf{qe}}\;\;(D_{scui}D_{tcui})_{\mathbf{aqe}}\;\;V_{qi}] [\;\Sigma_j^n\sqrt[2]{\alpha_r}K_{pj}{}^4\left(D_{sfuj}D_{tfuj}\right)_{\mathbf{qs}}\left(D_{scuj}D_{tcuj}\right)_{\mathbf{aqs}}\;\;V_{qj}\;]\;\;\;(\frac{\sqrt{r_{qi}r_{pj}}}{(r_i-r_j)}) \quad (14\text{-}20)$$

$$=\Sigma_i^m\,\Sigma_j^n\,\frac{2\pi\,\alpha_r\sqrt{r_{qi}r_{pj}}}{hc}\;\;(K_{qi}{}^4\,c^4\,V_{qi})(\,\Sigma_j^n K_{pj}{}^4\,c^4\;V_{qj}\;\;)(\frac{1}{(r_i-r_j)}) \quad (15\text{-}20)$$

$$=\Sigma_i^m\,\Sigma_j^n\;2\pi\alpha_r\,(\frac{h}{2\pi c^3 V_{qi}\;r_{qi}}\;\;V_{qi}\,)c^4\frac{h}{2\pi c^3 V_{qj}\;r_{qj}}\;\;c^4\,V_{qj}\;\;(\frac{\sqrt{r_{qi}r_{pj}}}{(r_i-r_j)} \quad (16\text{-}20)$$

$$\mathbf{R_{rei}} = \frac{\alpha_r h c}{2\pi} \sum_i^m \sum_j^n \frac{1}{(r_i - r_j)}_{e-s} \quad (17\text{-}20)$$

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)

Table 7. provides a summary of interactions, their source fields and their types

interaction	free energy field	constrained energy field	Interaction type
1-$\mathbf{R_t}$: quanton retaining 2-$\mathbf{R_b}$: quanton binding 3-$\mathbf{R_b}$: intra-quanton binding	$(E_{sfb}E_{tfb})_q$ $(E_{sf}E_{tf})_{aq}$	$(E_{scb}E_{tcb})_{aq}$ $(E_{sc}E_{tc})_q$	Multiple binding
1-$\mathbf{R_i}$: quanton inflationary 2-$\mathbf{R_r}$: quanton repulsive	$(E_{sfu}E_{tfu})_q$	$(E_{scu}E_{tcu})_{aq}$	repulsive
1-gravitation binding $\mathbf{R_{bg}}$ 2- Gravitation $\mathbf{R_g}$	$(E_{sfb}E_{tfb})$	$(E_{scb}E_{tcb})$	Multiple binding
Electric force	$E_{sfu}\ E_{tfu}$	$E_{scu}E_{tcu}$	a-single binding or b-repulsive
Strong nuclear $\mathbf{R_s}$	$E_{sfu}E_{tfu}$	$E_{scu}\ E_{tcu}$	a-single binding or b-repulsive
Dark matter gravitation like effect	$(E_{sfb}E_{tfb})_{qs}$ $(E_{sf}\ E_{tf})_{aqs}$ $(E_{sfb}E_{tfb})_m$	$(E_{sc}E_{tc})_{qs}$ $(E_{scb}\ E_{tcb})_{aqs}$ $(E_{scb}E_{tcb})_m$	Multiple binding
Matter distortion of space fabric	$(E_{sfu}\ E_{tfu})_m$, $(E_{sfu}\ E_{tfu})_s$	$(E_{scu}\ E_{tcu})_m$, $(E_{scu}\ E_{tcu})_s$	repulsive
gravitation like binding of EM waves	$(E_{sfb}\ E_{tfb})_{qe}$ $(E_{sf}\ E_{tf})_{aqe}$ $(E_{sfb}\ E_{tfb})_m$	$(E_{sc}\ E_{tc})_{qe}$ $(E_{scb}\ E_{tcb})_{aqe}$ $(E_{scb}\ E_{tcb})_m$	multiple binding
Dark matter distortion of electromagnetic waves	$(E_{sfu}\ E_{tfu})_e$ $(E_{sfu}\ E_{tfu})_s$	$(E_{scu}\ E_{tcu})_e$ $(E_{scu}\ E_{tcu})_s$	repulsive

Table.7interactions, their types and their energy field source

21. Ethical statement

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

22.Conclusions

Fundamental as well as inflationary and gravitational space fabric interactions can be formulated in terms of bound and unbound space and time fields with energy degree of freedom as the unification origin.

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24. data availability

Author declares that there are no data involved in this research

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