

The Color Confinement Mathematical Mechanism

Yazzed T.Alharbi, KSA

1.Introduction :

There are a lots of mysterious data about the hadrons. The recent determination of the proton radius using the measurement of the lamb shift in muonic hydrogen atom experiment startled the physics world. The obtained value of 0.84087(39) fm is 4% smaller than the value of the CODATA which is 0.8775(51) fm. And actually that's called " the proton radius puzzle" [1]. In this paper, we will consider an idea that makes the obtained high-precision measured values as a dependent variables of the Planck length in a function.

And we just modeling the idea by mathematics to **reach the abstract proof step by step**

2.Basic Idea :

As we know that all the baryons [a type of the hadrons] are consist of an odd number of fundamental particles called quarks, like a proton consist of three quarks, or maybe more than three [2], and all the quarks have a quantization spin state with $1/2\hbar$. And now let's imagine the spacetime is a vacuum and the Higgs field is everywhere, Higgs bosons are attracting with the quarks (2 ups and 1 down), since this attracting is the mechanism of the mass source, and the particle reaches its maximum mass by reaching the equilibrium state of the attracting, the quarks have an Intrinsic property (the spin) that's quantitative property consuming energy to establish a differentiation in the spacetime vacuum, and since we know that quarks have an "excited versions", or kinetic energy by its movement and the probability density, it's very hard to calculate [3]. furthermore, we don't know how effective this on the Higgs field with the intrinsic property (the spin) and according to the Higgs field energy, it's energy is unknown. this maybe causes a difference in the equilibrium state of .the attracting with higgs field. And as we say, this difference can't be calculated.

While imagining this case, we find that the quarks spin with its kinetic energy causes a difference in the Higgs field, the Higgs boson those around the sphere surface area of the quark, by giving them an amount of energy in all the directions (we will consider the kinetic energy and the spin energy as a vectors, and since the spin causes a case in all the direction it's resultants with KE vectors will be in all the directions).

$$[\sum_0^{2\pi} S_E^2 + KE_q^2 - 2|S_E||KE_q|\cos\theta] \quad \text{Eq[1]}$$

In order to understand this equation and the whole amount of energy by Eq(1),

the spin KE is exactly in all the directions. we found that the energy resultant will be in all .the directions with a difference in the magnitude ; because the angle of the direction

Furthermore, we know that in each circumstance of a circle that it's center has a vertical distance from the sphere center, there are two energy resultant vectors with the same .magnitude. Now, we need to know how many circumstances are in the quark sphere

First we will calculate a ratio between the surface areas of two spheres, the sphere [S] with .a radius (R) and the Sphere [D] with a radius of (R+n) , which are $R, n \in \mathbb{Z}^+$

$$\frac{4\pi(R+n)^2}{4\pi R^2} = \frac{4\pi R^2 + 8\pi Rn + 4\pi n^2}{4\pi R^2} = 1 + \frac{2n}{R} + \frac{n^2}{R^2} \quad \text{Eq[2]}$$

So, we can calculate the surface area of any sphere according to another sphere. Lets suppose that a sphere with a radius of a Planck length ℓ_P and it's the origin sphere.

$$A_n = A_{\ell_P} \left[1 + \frac{2n}{\ell_P} + \frac{n^2}{(\ell_P)^2} \right] \quad \text{Eq[3]}$$

Now we can find the radius (n) to find the number of the circumferences in the sphere (n) by the same radius (n) of *the sphere (n)* :

$$R_n = \sqrt{\frac{A_{\ell_P} \left[1 + \frac{2n}{\ell_P} + \frac{n^2}{(\ell_P)^2} \right]}{4\pi}} \quad \text{Eq[4]}$$

$$C_n = \pi \sqrt{\frac{A_{\ell_P} \left[1 + \frac{2n}{\ell_P} + \frac{n^2}{(\ell_P)^2} \right]}{\pi}} \quad \text{Eq[5]}$$

$$\sum_{n=1, k=0}^{n_{\infty}, k_{\infty}} C_n = \sum_{n=1, k=0}^{n_{\infty}, k_{\infty}} \pi \sqrt{\frac{A_{\ell_P} \left[1 + \frac{2(n+kn)}{\ell_P} + \frac{(n+kn)^2}{(\ell_P)^2} \right]}{\pi}} \quad \text{Eq[6]}$$

Since the term (n+kn) is identical to $(\ell_P + k\ell_P)$:

$$(n + kn) \equiv (\ell_P + k\ell_P)$$

We can rewrite the above equation to:

$$\sum_{k=0}^{k_{\infty}} C_k = \sum_{k=0}^{k_{\infty}} \pi \sqrt{\frac{A_{\ell P} \left[1 + \frac{2(\ell P + k\ell P)}{\ell P} + \frac{(\ell P + k\ell P)^2}{(\ell P)^2} \right]}{\pi}}$$

Eq(7)

And now lets suppose and imagine that the difference that happens from the spin kinetic energy and the KE of the quark result vector [that "push" the higgs bosons on the surface area of the quark to collision with the others higgs bosons and lose their energy to return in the ground state of energy on the surface of the quark] in other words, as we suppose and imagine that the higgs bosons are like bouncing around the quark, they pushed away and return again to the surface of the quark, and these are the only bosons on the surface of the quark, or like I would to call this " the Ground state of higgs bosons energy" .

The higgs bosons and the higgs field are everywhere in the universe [3]. In order to determine the ground state approximately density we need to suppose that at every point of the Planck Length there is a higgs boson, If it's incorrect its will be relative; because as we said we can't calculate the resultant vector and the higgs bosons are everywhere. And we just modeling the idea by mathematics to reach the abstract proof step by step. Now if we consider the Planck length as length unit, the higgs field as an energy unit, then the ground state higgs bosons density will be as we said :

$$\varphi_{k_0} = \frac{V_q \frac{\left(\frac{Z_H}{\ell P}\right)^3}{4\pi R_q}}{H_m}$$

And ZH is higgs field energy, Vq is the volume of the quark, Hm is the higgs boson mass.

Eq(8)

Where k note here indicates to the ground energy density state.

If we continue imagining we will find that the energy which transfer from the bouncing ground state higgs bosons- will reach the next energy density state, and then transfer with a lower magnitude; because its collision with next energy density state higgs bosons { in a spherical coordinate system}- in the same directions.

And we figure out in Eq(2) that the surface area of a sphere with a radius (n) formula, now we need an equation to the whole action:

Eq(9)

$$\begin{aligned}
 & \{E_{K^0 \rightarrow (K+1)}\} \\
 = & \left[\sum_0^{2\pi} S_E^2 + KE_q^2 - 2|S_E||KE_q|\cos\theta \right] \left[\sum_{k=0}^{k_2} \pi \sqrt{\frac{A_{\ell P} \left[1 + \frac{2(\ell P + k\ell P)}{\ell P} + \frac{(\ell P + k\ell P)^2}{(\ell P)^2} \right]}{\pi}} \right] [\varphi_{k^0}] \\
 - & V_q \frac{\left(\frac{Z_H}{\ell P}\right)^3}{A_{\ell P} \left[1 + \frac{2(\ell P + k\ell P)}{\ell P} + \frac{(\ell P + k\ell P)^2}{(\ell P)^2} \right]} - Z_E^H
 \end{aligned}$$

The above equation is for the transformation from $K^0 \rightarrow (K + 1)$ Z is the higgs field energy,

To write the equations for the whole action :

$$\begin{aligned}
 & \{E_{K^0 \rightarrow (Kn)}\} \\
 = & \left[\sum_0^{2\pi} S_E^2 + KE_q^2 - 2|S_E||KE_q|\cos\theta \right] \left[\sum_{k=0}^{k_2} \pi \sqrt{\frac{A_{\ell P} \left[1 + \frac{2(\ell P + k\ell P)}{\ell P} + \frac{(\ell P + k\ell P)^2}{(\ell P)^2} \right]}{\pi}} \right] [\varphi_{k^0}] \\
 - & \sum_{(k=0)}^{k_n} V_q \frac{\left(\frac{Z_H}{\ell P}\right)^3}{A_{\ell P} \left[1 + \frac{2(\ell P + k\ell P)}{\ell P} + \frac{(\ell P + k\ell P)^2}{(\ell P)^2} \right]} - Z_E^H
 \end{aligned}$$

Eq[10]

We know that the bouncing higgs bosons will reach the maximum energy state and lost all their kinetic energy. And that takes a sphere shape. Also we know that all the quarks have the same spin magnitude, and its not really necessary to determine the direction of the spin; because the bouncing higgs boson are moving in all the directions. The direction of the spin actually doesn't make any difference.

Now that's leaves us with two cases; because the quarks properties are the same and the difference of them doesn't matter:

Case 1:

The kinetic energy of the quarks are the same.

Case 2:

The kinetic energy of the quarks are not the same.

Now lets take the first case, we know that the bouncing takes a spherical shape: because its movement is in the all the directions and all the quarks properties that makes a difference in this case is the same. That's mean that all the bouncing higgs bosons reach the same energy density state in the same time. And furthermore, their spherical bouncing is in a hadron, let's take an example, the proton is made of three quarks; two up quarks and one down quark. If we want to put three identical spheres in one sphere and simulate it by the geometry we find that the radiuses of the three spheres are equal to half the radius of the proton.

Now after all the hypothesizes, here is the abstract proof of all the above, by returning to the eq[3] we find that :

$$R_k = \sqrt{\frac{A_{\ell P} \left[1 + \frac{2(\ell P + k\ell P)}{\ell P} + \frac{(\ell P + k\ell P)^2}{(\ell P)^2} \right]}{4\pi}} \quad \text{Eq[11]}$$

$$R_k = \ell P \sqrt{\left[1 + \frac{2(\ell P + k\ell P)}{\ell P} + \frac{(\ell P + k\ell P)^2}{(\ell P)^2} \right]} \quad \text{Eq[12]}$$

And actually R_k is the distance between the original sphere center $A_{\ell P}$ to any sphere with the radius of R_k .

$$(n + kn) \equiv (\ell P + k\ell P) \equiv R_k \quad \text{Eq[13]}$$

And we can actually rearrange the equations from eq[2] to eq[5] by the formula :

$$A_K = A_{\ell P} \left[1 + \frac{2\ell P \sqrt{\left[1 + \frac{2(\ell P + k\ell P)}{\ell P} + \frac{(\ell P + k\ell P)^2}{(\ell P)^2} \right]}}{\ell P} + \frac{\ell P \sqrt{\left[1 + \frac{2(\ell P + k\ell P)}{\ell P} + \frac{(\ell P + k\ell P)^2}{(\ell P)^2} \right]^2}}{(\ell P)^2} \right] \quad \text{Eq[14]}$$

And now, the most exciting part; finding the value of the proton's radius by using the functions above about the circumferences or the surface areas of the spheres sequences [the bouncing transform the energy between the supposed states in a spherical shape] . As we said the bouncing bosons reaches the highest energy density states when its spherical shape got a radius that is half the radius of the proton, so :

$$R_p = \ell P \sqrt{\left[1 + \frac{2\ell P \sqrt{\left[1 + \frac{2(\ell P + k\ell P)}{\ell P} + \frac{(\ell P + k\ell P)^2}{(\ell P)^2} \right]}}{\ell P} + \frac{\ell P^2 \left[1 + \frac{2(\ell P + k\ell P)}{\ell P} + \frac{(\ell P + k\ell P)^2}{(\ell P)^2} \right]}{(\ell P)^2} \right]} \quad \text{Eq [15]}$$

$$R_p = \ell P \sqrt{\left[2 + 2 \sqrt{\left[1 + \frac{2(\ell P + k\ell P)}{\ell P} + \frac{(\ell P + k\ell P)^2}{(\ell P)^2} \right]} + \frac{2(\ell P + k\ell P)}{\ell P} + \frac{(\ell P + k\ell P)^2}{(\ell P)^2} \right]}$$

When we graph this function we find that when $k = 5.430458 \cdot 10^{19}$

$$R_p = 8.77562 \cdot 10^{-16}$$

And $8.77562 \cdot 10^{-16} / 1.616 \cdot 10^{-35} = 5.43007 \cdot 10^{19}$

That's mean the equation above is a function describes the distance that the bouncing higgs bosons moving in the spacetime and attracting with the others higgs boson, this function prove that the proton is just a continuous higgs field spherical waves that emitted by the spinning of its structure particles; which are the quarks. Since the gluons doesn't attract with the higgs field. And this idea is also explain the proton's mass and spin because these spherical waves duo to the spinning of the quarks so its got a rotation, furthermore, it might be crazy idea but its also describes the radius of the proton and its not invariant but change according the function above. I think this is the best physical explanation for the function which matching the reality.

Now, we should continue to model the whole idea by the mathematics. As we say, the spherical shape of the bouncing is identical of all the three quarks when its radius reach half the radius of the proton, we don't actually know the position of the three quarks exactly, we just sure about their bouncing higgs bosons spherical shapes. The three identical spheres are actually doesn't full the protons volume. Approximately the three empty volumes in the proton faces the quarter of the surface areas of two spheres. . Since the bosons are keep bouncing, two bosons will confluence and they will push by their resultant energy in all the directions to the empty volume of the proton *sphere and fill it.*

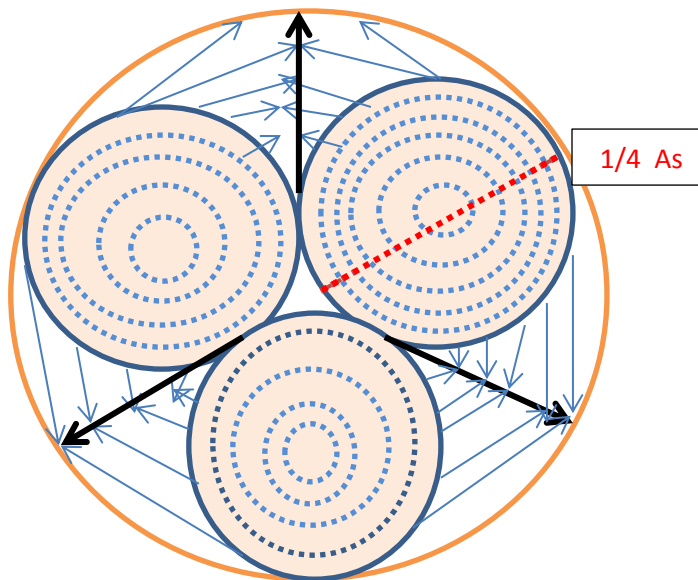


Fig.1

The black vector is equals to the total energy resultant and it's the sum of all the energy resultants of the bouncing higgs bosons in the empty volume space in the proton. All the three vectors can be described mathematically as:

$$\sum_{k_2=0}^{k_2=\pi-\theta} \prod_{\Delta E_{max}}^{\Delta E_0} \Delta E_0 |E|_{\frac{n}{n^0}} \frac{\cos[\theta + k_2]}{\cos\theta} \sum_{k=0}^{k_\infty} 6\pi \sqrt{\frac{A_{\ell P} \left[1 + \frac{2(\ell P + k\ell P)}{\ell P} + \frac{(\ell P + k\ell P)^2}{(\ell P)^2} \right]}{\pi}} \quad \text{Eq[16]}$$

The term $\prod_{\Delta E_{max}}^{\Delta E_0} \Delta E_0 |E|_{\frac{n}{n^0}}$ is actually sequence of the different transformer energies between the energy density state using a ratio between every two continuous states until the last one.

Now, we are finally got the formula of the proton total energy (mass) using the equations [9] and [15]:

$$\begin{aligned} P_m &= \left[\sum_0^{2\pi} S_E^2 + KE_q^2 - 2|S_E| |KE_q| \cos\theta \right] \left[\sum_{k=0}^{k_2} \pi \sqrt{\frac{A_{\ell P} \left[1 + \frac{2(\ell P + k\ell P)}{\ell P} + \frac{(\ell P + k\ell P)^2}{(\ell P)^2} \right]}{\pi}} \right] [\varphi_{k_0}] \\ &- \sum_{(k=0)}^{k_n} V_q \frac{\left(\frac{Z_H}{\ell P}\right)^3}{A_{\ell P} \left[1 + \frac{2(\ell P + k\ell P)}{\ell P} + \frac{(\ell P + k\ell P)^2}{(\ell P)^2} \right]} - Z_E^H \\ &+ \sum_{k_2=0}^{k_2=\pi-\theta} \prod_{\Delta E_{max}}^{\Delta E_0} \Delta E_0 |E|_{\frac{n}{n^0}} \frac{\cos[\theta + k_2]}{\cos\theta} \sum_{k=0}^{k_\infty} 6\pi \sqrt{\frac{A_{\ell P} \left[1 + \frac{2(\ell P + k\ell P)}{\ell P} + \frac{(\ell P + k\ell P)^2}{(\ell P)^2} \right]}{\pi}} \end{aligned} \quad \text{Eq[17]}$$

We can write the rest energy of the three spheres of the spherical waves no matter what the distance between any two spheres at any time even when its identical and mathematically the formula of the volume by using a ratio between the spherical waves distance :

$$V_p = 3 \left[2 \left[\sum_0^{\frac{\pi}{2}} \frac{2R_q^3 - 2R_q^3 \cos(\pi - 2\theta)}{d} + Rq \right] \left[1 + \frac{3(Rq + kRq)}{Rq} + \frac{3(Rq + kRq)^2}{R_q^2} + \frac{(Rq + kRq)^3}{R_q^3} \right] \right] \quad \text{Eq(18)}$$

QCD:

In quantum chromodynamics, when a quark emits a colorless gluon, in this case the colorless gluon can convert to another colorless gluon according to the super-position property. and separate into two gluons which absorbed by the quarks, and we can write the probabilities of this action as.

$$S_{action} = \frac{1}{\sqrt{2}} [\phi_{g\check{g}_2} + \phi_{g\check{g}_3}] + \frac{1}{\sqrt{2}} [|\phi_{g\check{g}_2}| \frac{1}{\sqrt{6}} [gg_2 + \check{g}\check{g}_2] + |\phi_{g\check{g}_3}| \frac{1}{\sqrt{6}} [gg_3 + \check{g}\check{g}_3]] \quad \text{Eq(19)}$$

Lately we considered that the energy (mass) of the proton is just an energy spherical waves fluctuations duo to the quarks spinning . Now, let's consider something which show us the subject associated and better for understanding. Let's imagine and consider that the color charge as a quantity, the gluons field is a spherical wave that collision with other gluon spherical wave by the color charged spinning quark. for imaging the action that we already talked about, the colorless gluon by the spherical waves concept we find that the model is actually explains the emitting of the pion (meson) to keep the nucleons valence and that because the model consider the the gluon field is actually carried by the bouncing Higgs bosons (making spherical waves) as we show mathematically. the quark-antiquark in the meson are emoted by the bouncing carrying charge Higgs boson after the action in rest of hadron mass when the bouncing spherical waves of the spinning quarks reaches its maximum limit by the case of the colorless gluon eq () :

$$M_q = \sum_{k_2=0}^{k_2=\pi-\theta} \prod_{\Delta E_{max}}^{\Delta E_0} \Delta E_0 |E|_{\frac{n}{n^0}} \frac{\cos[\theta + k_2]}{\cos\theta} \sum_{k=0}^{k_{\infty}} 4\pi \sqrt{\frac{A_{\ell P} \left[1 + \frac{2(\ell P + k\ell P)}{\ell P} + \frac{(\ell P + k\ell P)^2}{(\ell P)^2} \right]}{\pi}} \frac{1}{\sqrt{2}} [\phi_{g\check{g}_2} + \phi_{g\check{g}_3}] + \frac{1}{\sqrt{2}} [|\phi_{g\check{g}_2}| \frac{1}{\sqrt{6}} [gg_2 + \check{g}\check{g}_2] + |\phi_{g\check{g}_3}| \frac{1}{\sqrt{6}} [gg_3 + \check{g}\check{g}_3]] \quad \text{Eq(20)}$$

And since the Higgs bosons carried the charge while bouncing in SW (spherical waves) we found

$$S_{action} \equiv \sum_{k_2=0}^{k_2=\pi-\theta} \prod_{\Delta E_{max}}^{\Delta E_0} \Delta E_0 |E|_{\frac{n}{n^0}} \frac{\cos[\theta + k_2]}{\cos\theta} \sum_{k=0.5}^{k_{max}} 4\pi \sqrt{\frac{A_{\ell P} \left[1 + \frac{2(\ell P + k\ell P)}{\ell P} + \frac{(\ell P + k\ell P)^2}{(\ell P)^2} \right]}{\pi}} \quad \text{Eq(21)}$$

$$\sum_{k_2=0}^{k_2=\pi-\theta} \prod_{\Delta E_{max}}^{\Delta E_0} \Delta E_0 |E| \frac{n}{n^0} \frac{\cos[\theta + k_2]}{\cos\theta} [S_{action}] \sum_{k=0.5}^{k_{max}} k_{Rp} 4\pi \sqrt{\frac{A_{\ell P} \left[1 + \frac{2(\ell P + k\ell P)}{\ell P} + \frac{(\ell P + k\ell P)^2}{(\ell P)^2} \right]}{\pi}}$$

$$= 4.8_{-0.3}^{+0.5} MeV$$

And that's actually the down quark mass.

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