On the estimation of nuclear force and theoretical mass of proton

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Abstract:

We proposed a new expression for force to estimate the numerical amount of nuclear force, this is the most fundamental forces of nature and its gives us the theoretical mass of proton and electron, followed by the proton-to-electron mass ratio. Through it, we also determined the size of nucleus, we believe, this work be helpful to understand the evolution of first atom after the Big-Bang.

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1. Introduction:

Electrons and protons are building block of atoms. Experiment suggested that, protons are confined within the nucleus[1] due to influences of strong nuclear force yet we don't have any mathematical expression to estimate this force theoretically. Furthermore, proton's mass is determined by experimental measurements[2] and understand it as constant quantities, up to now there is none theory to deduce its mass from any theory.

In this letter we discussed these two fundamental issues and we proposed a new expression for force which is quantized and a quantum form of classical inverse square law of force and shown that nuclear force is a form of it. If we assume this as fundamental form of nature's force and we take it as unit, it gives the theoretical mass of proton and electron. Apart to it, we find the proton-to-mass ratio theoretically and finally we derived mathematical expressions to determine the nuclear radius and atomic electronic orbitals. This letter is divided in three parts; the first part is all about the proposal of new form of force and followed by the deduction of an equation to calculate the mass of proton and electron. The last part is devoted to the theoretical determination of size of nucleus.

2. Proposed expression of force:

Here we are in search of a new mathematical expression for force which must be quantized and compatible with the basic assumption of quantum theory. This is a fundamental force such as gravity and electrostatic[3]. Since, these classical forces were derived empirically[4], thus in same vain here we propose a new relation for force in term of quanta. On analogy to above mentioned classical force, let us assume that two photons are placed in *R* distance apart to each other thus the force *(F)* between these two photons will be,

$$F \propto \frac{1}{R^{2.}} \tag{1}$$

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To eliminate the proportionality we use some constants, here we empirically use a universal constant to remove proportionality that is $\hbar c$ where $\hbar$ is reduced Planck constant and c is speed of light, therefore

$$F = \frac{\hbar c}{R^2} \tag{2}$$

this is the desired expression for force, hereafter we call it "quantum space force" reason is straightforward it is quantized and only function of space or distance. This relation is very interesting since it is quantum form of inverse square law of force which validates this law in quantum world. We will come to this point later when we will discuss about the nuclear force.

If we substitute $R = \frac{2\pi\hbar}{mc}$, we will get another expression for force in term of mass, therefore,

$$F = \frac{m^2 c^3}{4\pi^2 \hbar} \tag{3}$$

this force is only function of square of mass and it is quantized as well but its gives the absolute value of force since force is vector quantity but here this expression is indeed a scalar quantity. We will discuss its role and significance later.

3. Quantum space force for nucleus and electronic orbits:

It may be possible that, the two photon placed in certain distance apart to each other in space, may have certain type of interaction, if there any kind of interaction exist, then the numerical amount of interacting force can be determined through eq. (2) and it will be only function of distance as that expression suggests, this is very similar to classical inverse square law of force. To test this proposal, we apply it to calculate the theoretical amount of quantum space force for nucleus of hydrogen like atom which has single proton and neutron.

To calculate the quantum space force for the nucleus, we substitute $R = 1.75 \times 10^{-15} m$, the nucleus radius, in eq. (2), and we got $F = 1.03 \times 10^4$, while for the same range the gravitational force for proton ($m = 1.67 \times 10^{-27} kg$), will be $6.0 \times 10^{-35} N$, thus by comparing both numerical values we will get the relative strengths of gravity[5] which is about the order of 10^{-39}, this is similar to previously calculated value of gravitational coupling constant[6].

From this result one can say that, the numerical amount of nuclear force can be theoretically estimated though the proposed equation however this forced us to conclude that, in fact, the nuclear force is quantum space force itself or equivalent to it. This force can also be estimated through eq. (3) and one can get nuclear force $F \sim 1.81 \times 10^4\ N$, this is in similar range as we calculated previously. In fact, this expression can be used to determined the force carried by mesons, as we know that the mass of meson[7] is equal to $\frac{m_p}{2\pi}$, thus it represent the numerical value of Yukawa force.

As it shown, the quantum space force is only function of distance or space thus if one know the radius of atomic orbitals one can calculate the quantum space force for each atomic orbitals

through eq. (2). Since, atomic orbital[8] is dominated by electrostatic force therefore we can find the coupling constant for electrostatic force to quantum space force, if we compare the eq. (2) with classical electrostatic force i.e. $\alpha\frac{\hbar c}{R^2} = \frac{e^2}{4\pi\varepsilon_0 r^2}$ where all constants holds their usual meanings, it gives $\alpha = \frac{e^2}{2\varepsilon_0 hc}$ and this is fine structure constant[9] itself and this is here as electrostatic coupling constants[10].

This result is very interesting because of it changed the perspective and definition of electrostatic coupling constant; it was believed that fine structure constant show the relative strength of electrostatic force to nuclear force but now it is clear, this is the relative strengths for electrostatic force to quantum space force.

4. Theoretical mass of proton and electron:

Now we come to the crucial point, it has been a crucial issue, how to determine theoretically the mass of proton and electron? If we have any equation to equate its theoretical value we can know, what factors are responsible for its origin. The atomic model can successfully predict many atomic phenomena but it assumed itself the mass of proton and electrons are constants thus the physics behind the origin of these particles is hidden. We believe the proposed force may give some hints.

To estimate theoretically the mass of proton and electron along with the radius of nucleus, we made an assumption that, quantum space force is a fundamental force of nature, on base of this force, rest other forces comes in existence and emerged, however, if we set it equal to unit, the eq. (3) will gives the theoretical mass *m* which is equal to the quadratic mean of m_p the mass of proton and m_e the mass of electron, therefore,

$$m^2 = m_p m_e = \frac{\hbar}{c^3} F_c \tag{4}$$

where $F_c = 1$(as per our assumption) is constant force and rest other constants holds its usual meanings and has its accepted values, if one will substitute all values of constants in this equation one can calculate the mass of electron and proton.

On order to find the m_p and m_e separately, we need some kind of other expressions to relate these entities each other and the most promising candidate is proton-to-electron mass ratio μ and this can be derived if we take, electrostatic force equal to gravitational force by using coupling constants, so that,

$$\alpha\frac{e^2}{4\pi\varepsilon_0} = \frac{Gm_e^2}{\alpha_G} \tag{5}$$

where all constant holding its usual meanings and α_G is gravitational coupling constants and it will be equal to $\alpha_G = \frac{Gm_p^2}{\hbar c}$ therefore this equation will turn into followings,

$$m_e^2 = \alpha^2 m_p^2 \tag{6}$$

If one take in account following relation,

$$r_p \frac{m_p}{2\pi} = \frac{\hbar}{c} = r_e m_e \alpha \tag{7}$$

One can observe that the quantity m_p which is actually $\frac{m_p}{2\pi}$, therefore eq. (6) will be corresponding to the following expressions,

$$\mu = \frac{m_p}{m_e} = \frac{2\pi}{\alpha} \tag{8}$$

we got here $\mu = 860$, the more precise values can be obtained by inserting some numerical constants, prima facie one can observe that the force calculated through eq. (2) and (3) are not equal and later is larger than by order of *2* to former, however, if we multiply this numerical factor in eq. (8) therefore, $\mu = 1720$ and this is comparable to its factual values.

Now, by combining eq. (8) and (4) one can get, theoretical mass of proton and electron by following mathematical expressions,

$$m_e = \sqrt{\frac{\alpha}{2\pi}} \sqrt{\frac{\hbar}{c^3} F_c} \tag{9}$$

$$m_p = \sqrt{\frac{2\pi}{\alpha}} \sqrt{\frac{\hbar}{c^3} F_c} \tag{10}$$

by substituting the values we get the respective value of mass of electron and protons and it has been found that the calculated values are comparable to its experimental values. Thus we conclude that, our proposal is in good agreement with experimental findings. This may help to understand the cosmological origin of mass of proton and electron.

5. Theoretical size of nucleus and electronic orbital:

Similarly, the radius of nucleus and first atomic orbital can be deduced through eq. (2) and one can get following expressions,

$$r^2 = r_p r_e = \frac{\hbar c}{F_c} \tag{11}$$

where r_p is radius of nucleus and r_e is radius of first atomic orbitals. Using eq. (7) and (8), the radius of nucleus and orbits can be related each other through following mathematical expressions, so that,

$$\frac{r_p}{r_e} = \alpha^2 \tag{12}$$

by this in eq. (11) we can get the theoretical value of radius of nucleus and atomic orbitals by following expressions,

$$r_p = \alpha \sqrt{\frac{\hbar c}{F_c}} \tag{13}$$

$$r_e = \frac{1}{\alpha}\sqrt{\frac{\hbar c}{F_c}} \tag{14}$$

if we substitute the values of all constants we will get the radius of nucleus and radius of first atomic electronic orbitals and equated values are comparable to its previously reported values this show the compatibility of our hypothesis with the existing theories.

One very interesting aspect of these equations is that size of nucleus and electronic orbit is independent of mass and only function of universal constants while Bohr's electronic orbital are depends on mass of electrons. This sheds light on the formation of atom after the big bang.

6. Conclusions:

The proposed quantum space force, which is a quantum form of classical inverse square law of force and it has been shown that nuclear force also follows this law as other classical fundamental forces does. This force can also be calculated for electronic orbitals and found that if we compare it with classical electrostatic force it gives the electrostatic coupling constants; this shows its compatibility with the other existing theories. It also gives the theoretical proton to electron mass ratio and calculated value is comparable to experimental values, thus we conclude that there is certain relation between the mass of proton and electron and these are interrelated in some ways.

Furthermore, we theoretically estimated the size of nucleus and electronic orbitals, this result is interesting since Bohr calculated the size of electronic orbital in term of mass and charge of electrons but our equation is free from mass and function of fundamental constants. Nevertheless, we didn't find the precise values yet it sheds light on formation of atom from Big-Bang.

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