Strong and Weak Force Proposed Equations

Matthew Cepkauskas, *Member, IAENG*

***Abstract*— The search for grand unification, the understanding and identifying the relations of forces of physics, has been the interest of many particle physicist for many decades. The present paper investigates the validity of a previous paper that proposed two possible equations for both the strong force and the weak force. It investigates the magnitude of these equations for the Hydrogen atom. Also, the coupling constant are determined and compared with known values. Both the forces and coupling constants show good agreement with existing known results. Other elements on the periodic table are used to further evaluate the validity of the equations. It is also shown that the four forces of strong, weak, gravitational and Coulomb converge to the expected energy and corresponding length identified by the Standard model and Super Symmetry models. It is believed that these equations represent the dominate terms in a perturbation series solution.**

***Index Terms*—Strong Force, Weak Force, Grand Unification, Electro Magnetic Force, Gravitational Force.**

I. INTRODUCTION

The search for grand unification, the understanding and identifying the relations of forces of physics, has been the interest of many particle physicist for many decades [1]. The present investigation is a continuation of a previous paper found in [2] to determine the validity of proposed potential weak force and strong force equations.

In grand unification, two of the four forces are well known namely Newton's gravity and Coulomb's electric charge, the second two forces, weak and strong, do not have known force equations associated with them, thus the four equations can be written as:

$$F_{Gravity} = G\frac{m^2}{L^2} \quad \text{(1-a)} \qquad F_{Coulomb} = K_e\frac{Q_0^2}{L^2} \quad \text{(1-b)}$$

$$F_{Weak} = ?? \quad \text{(1-c)} \qquad F_{Strong} = ?? \quad \text{(1-d)}$$

In [2], using the pi theorem for dimensional analysis, the following five forces (gravity, Coulomb, thermodynamic, quantum and relativity) were identified. These equations are well known, and the dimensions can simply be confirmed as correct without using the pi theorem.

$$F_{Gravity} = G\frac{m^2}{L^2} \quad \text{(2-a)} \qquad F_{Coulomb} = K_e\frac{Q_0^2}{L^2} \quad \text{(2-b)}$$

$$F_{Thermo} = K_b\frac{T}{L} \quad \text{(2-c)} \qquad F_{Quantuum} = \bar{h}\frac{1}{tL} \quad \text{(2-d)}$$

$$F_{\mathrm{Re}lativity} = c\frac{m}{t} \quad \text{(2-e)}$$

Comparison of these two sets of equations begs the question: Is the weak and strong force a combination of the five forces? This question was the basis for [2].

II. PROPOSED EQUATIONS

A. Background

As reported in [2], today it is understood that the approximate ratio of forces when normalized to the force of gravity is as follows:

Gravity	1.0
Weak	1.0E25
Electromagnetic	1.0E36
Strong	1.0E38

In [2], 45 cases of permutation of possible products of the five equations were investigated using the parameters of interest [mass, length, temperature, time and charge, along with gravitational, Coulomb, Boltzmann, Planck and relativity constants] for the Hydrogen atom. This resulted in the identity of two potential weak equations and two potential strong force equations that when normalized to gravity agreed with the known weak and strong values, above. An error was made in [2], the size of the hydrogen atom was incorrectly taken as 1.0 E-15 meters. When the size is corrected to 1.0 E-10 meters, the following equations were found:

Potential Weak Force Equation with Coupling Constants:

$$F_{weak\_1} = \frac{F_{Thermodynamic}F_{Quantum}}{F_{\mathrm{Re}lativity}} = \frac{\bar{h}K_b}{c}\frac{T}{L^2 m} \quad \text{(3-a)}$$

$$\alpha_{weak\_1} = \frac{K_b}{c^2}\frac{T}{m} \quad \text{(3-b)}$$

$$F_{weak\_2} = \frac{F_{Coulomb}F_{Quantum}}{F_{\mathrm{Re}lativity}} = \frac{\bar{h}K_e}{c}\frac{Q_0^2}{L^3 m} \quad \text{(4-a)}$$

$$\alpha_{weak\_2} = \frac{K_e}{c^2 L}\frac{Q_0^2}{m} \quad \text{(4-b)}$$

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Matthew Cepkauskas is with Baker Hughes, a GE Company, Jacksonville, Florida, USA (e-mail: Matt.Cepkauskas@BHGE.com).

Potential Strong Force Equation with Coupling Constants:

$$F_{strong\_1} = \frac{F_{Relativity} F_{Coulomb}}{F_{Quantum}} = \frac{cmK_e}{\bar{h}} \frac{Q_0^2}{L} \tag{5-a}$$

$$\alpha_{strong\_1} = \frac{mLK_e Q_0^2}{\bar{h}^2} \tag{5-b}$$

$$F_{strong\_2} = \frac{F_{Thermodynamic} F_{Relativitty}}{F_{Quantum}} = \frac{cmK_b}{\bar{h}} T \tag{6-a}$$

$$\alpha_{strong\_2} = \frac{K_b TmL^2}{\bar{h}^2} \tag{6-b}$$

The incorrect diameter used in reference [2] was fortuitous in that it showed that these equations can either be weak or strong force equations. Note that not only are 3 of the 4 equations dependent on the length dimension, but also since they are normalized to the gravitational force (also dependent on the length) all four equations are influenced by the choice of length. It is well known that both the weak and strong force are dependent on distance, thus strong_2 equation, 6-a & 6-b is eliminated from consideration. This identified the need to examine these forces further from the size of the hydrogen atom to much smaller dimensions up to 10 E-23 meters. This effort identified the best choice of the possible equations to be:

B. Potential Weak Force Equation with Coupling Constants

$$F_{Weak} = \frac{F_{Relativity} F_{Coulomb}}{F_{Quantum}} = \frac{cmK_e}{\bar{h}} \frac{Q_0^2}{L} \tag{7-a}$$

$$\alpha_{Weak} = \frac{mLK_e Q_0^2}{\bar{h}^2} \tag{7-b}$$

C. Potential Strong Force Equation with Coupling Constants

$$F_{Strong} = \frac{F_{Coulomb} F_{Quantum}}{F_{Relativity}} = \frac{\bar{h} K_e}{c} \frac{Q_0^2}{L^3 m} \tag{8-a}$$

$$\alpha_{Strong} = \frac{K_e}{c^2 L} \frac{Q_0^2}{m} \tag{8-b}$$

III. Results

Rohlf [5] provides a plot of relative strength of the four forces in his Figure 1-19. Plotting equations 2-a, 2-b, 7-a and 8-a and taking the same liberty as found in [5] where the strong force is negligible for a dimension greater than 10 E-15 m and the weak force is negligible for a dimension greater than 10-18 m results in figure 1. Figure 1 shows the gravity force for electron- electron, electron-proton and proton- proton for clarity. The resemblance to the results found in [5] is remarkable.

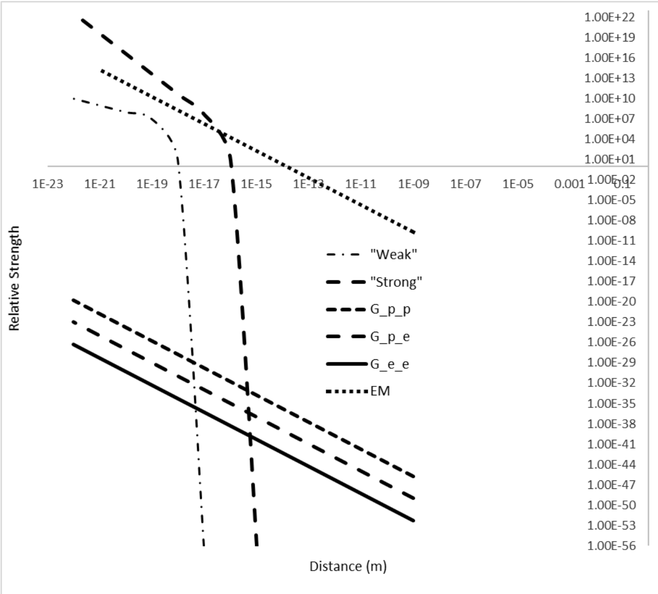

Fig. 1 Relative strength of weak, Electromagnetic, Strong and Gravitational forces. Gravity shown for proton-proton, proton-electron and electron-electron combinations

Per Reference [5], the coupling constants are given with numerical values of:

Strong coupling constant = 1.0
Electro Magnetic coupling constant = 1/137
Weak Coupling constant = 10-6 to 10-7
Gravity Coupling constant = 10-39

The proposed equations have the coupling constants for strong and weak force as being a function of dimensions resulting in the weak force ranging from 3.5 E-5 at 10 E-18 m to 3.5 E-9 at 10 E-22 m and the strong force starting at 0.0015 at 10 E-15 m to 1.5 E+4 at 10 E-22 m for Hydrogen. This is in agreement with the expected coupling constants found in [5].

The coupling constant equations for the Coulomb, Weak and Strong force are plotted versus electron volts by converting length to electron volts, by use of dimensional analysis. It should also be noted that mass and charge can be converted to electron volts. Figure 2 and 3 give results using Planck's dimensions as defined in [2] with the proposed strong and weak force. This represents a check on the dimensional conversion as the forces in Figure 2 converge to Planck's force of 1.21xE+44 Newtons at Planck's length of 1.616x10-35meters. Figure 3 shows the convergence to exist at Planck's energy of 1.22x1019 GeV.

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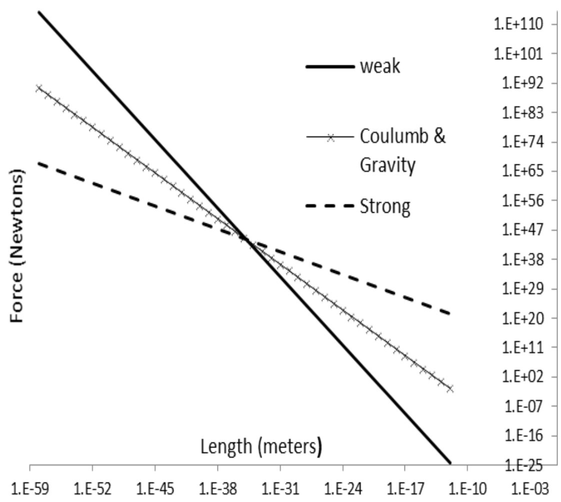

Fig. 2 Planck's Force Versus Length

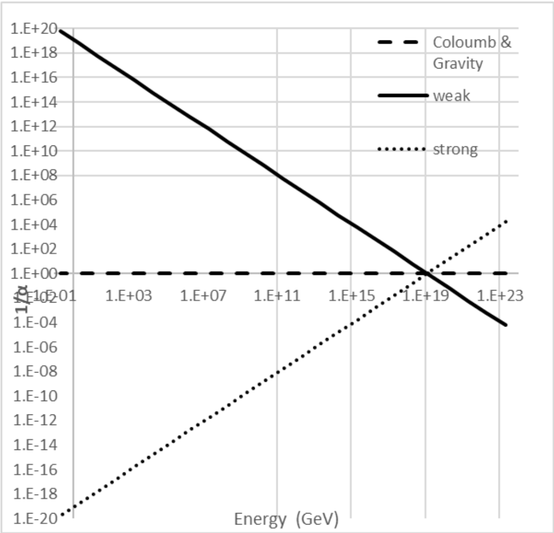

Fig. 3 Planck's Inverse Coupling Constants versus Energy

By maintaining the hydrogen charge and increasing the hydrogen mass to 15 orders of magnitude to a mass of 1.67 E-12 Kg, results in behavior at high energy levels, known as the Grand Unified Theory (GUT). Figure 4 shows, using the proposed equations with gravity and Coulomb for the inverse of the coupling constants, convergence of three of the four forces occurs at 10E+16 GeV (10E-32 meters). By increasing the mass to 1.67 E-9 Kg results in convergence of all four forces at an energy level of ~10E18 GeV, the energy level of the Theory of Everything (TOE), as found in physics texts [3,4,5] based on the standard model and supper symmetry.

In addition, the weak and strong force are shown in Figure 5 and Figure 6 for other elements on the periodic table with break in continuity going from one row of the periodic table to the next. Figure 6 shows an increase in strong force with increasing number of protons as expected. Figure 5 also shows an increase in weak force. It is not clear that Figure 5 supports the proposed weak equation, a force that would bring an unstable element to equilibrium but is presented here for completeness.

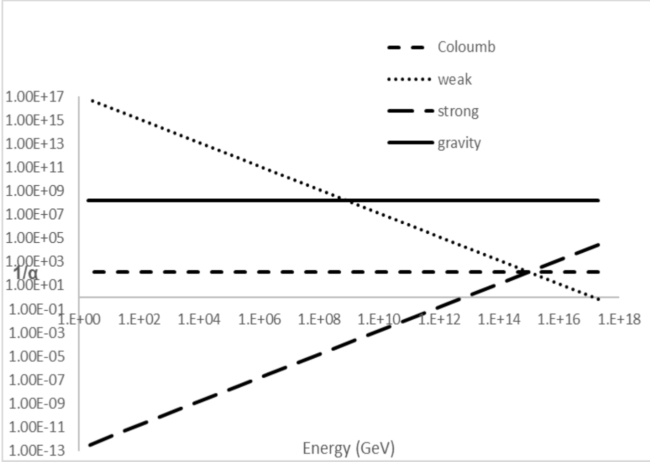

Fig. 4 Inverse Coupling Constants versus Energy for Large Mass

Figure 5 & 6 need a word of caution. It appears that the strong force is smaller than the weak force. The reason for this is the diameter was taken as twice the atomic radius, which is on the order of 10 E-10 m, but the weak and strong force only exhibit significance in distances less than 10 E-15. As the dimensions get smaller the order of magnitude of the strong and weak equations reverse. Thus figure 5 & 6 should be individually looked at as relative behavior within the periodic table and not compared to each other.

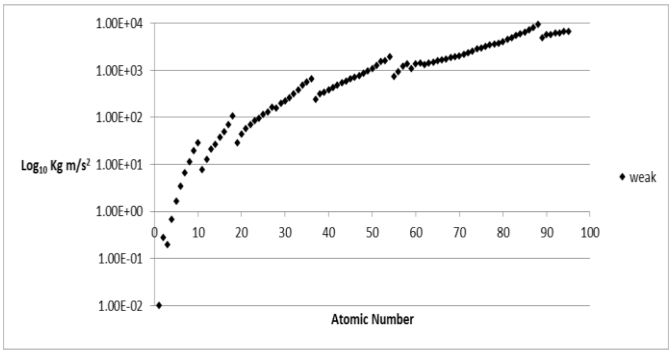

Fig. 5 Weak Force for Elements on the Periodic Table

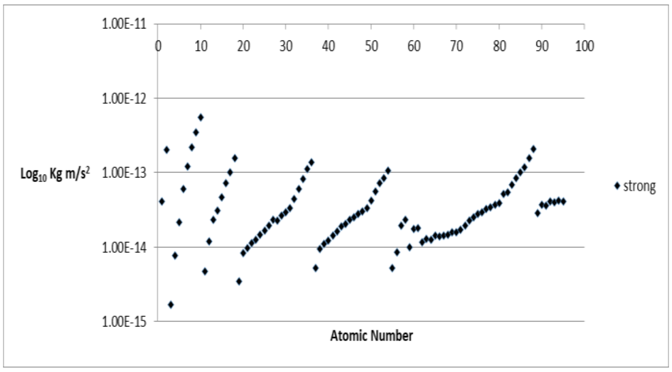

Fig. 6 Strong Force for Elements on the Periodic Table.

IV. DISCUSSION

The simple equations proposed for the strong force and weak force leaves the author in a quandary. Can it be so simple? Are these equations a valid approximation or at least a possible teaching tool? Does one not report the results for fear of errors in the logic? A critical review of the approach by the Physics community is appreciated.

Note that equating the coupling constants result in an equation at which GUT converges. That is $mL=\hbar/c$. This same identity results are obtained by equating the Coulomb coupling constant with the Strong coupling constant and then to the weak coupling constant. A similar expression for TOE would be to equate the gravity coupling constant with the Coulomb resulting in $m_1m_2/Q^2 = Ke/G$. This convergence is not surprising as indicated in [4], two non-parallel lines will converge.

The logic utilized in [2] to obtain the proposed equations consisted of:

1. Treat the available relative strength information as experimental test results.
2. As in many test, use dimensional analysis to reduce the number of parameters.
3. Speculate if the strong and weak force can be a product of the five fundamental forces (denote them as subscripts 1,2,3,4,5 in lieu of thermal, quantum, relativity, Coulomb and gravity).
4. Look for products such as F1*F2/F3 or F1*F2*F3/F4*F5 (45 cases in total) that when normalized to gravity match the available relative strength data.
5. One possible flaw maybe in the choice of exponents for the forces. It was noted that in Planck's units the force exponent would all need to be one since all forces are equal as shown in [2]. However, the data that was being used was based on today's relative strength. Thus, it was assumed that today similar distribution, i.e. exponent of one is correct.

Although the two equations, 3 and 6, that are a function of Thermodynamic, Quantum and Relativity forces were not investigated in detail, two observations are made:

1. Both the identified strong force equations (5-a and 6-a) and weak force equations (3-a and 4-a) when equated yield: $TL=q^2K_e/K_b$ which identifies a relationship between temperature and charge, such an identity does exist in Planck units. Proof: Consider $L_P*T_P=SQRT(\hbar c^5/G)*SQRT(G\hbar/c^3)/K_b=c\hbar/K_b=q_P{}^2K_e/K_b$, therefore $L_P*T_P = q_P{}^2K_e/K_b$.
2. Since for example, equation 5-a and equation 6-a are on the same order of magnitude, their sum is of a similar order of magnitude and also qualifies for a possible combination to make up the strong force

V. Conclusion

The present paper has identified a possible force equation for the weak and strong force with supporting data for the hydrogen atom and convergence of forces. One would not expect these equations to be exact but may represent the dominant term in a series solution. It also shows the behavior of these equations for elements of the periodic table.

On one hand the results appear too simple to be correct, yet on the other hand these simple equations appear to have some of the required ingredients and behave in a manner suggested by more sophisticated models.

Acknowledgment

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