The Strong and Weak Forces and their Relationship to the Dirac Particles and the Vacuum State

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This paper argues that the strong and weak forces arise from the proton and electron coupling to the Planck vacuum state. Thus they are not free space forces that act between free space particles, in contradistinction to the gravitational and electromagnetic forces. Results connect these four natural forces to the vacuum superforce.

1 Introduction

The Dirac particles (proton and electron) have been discussed in a number of previous papers [1] [2] [3] [4], where it is shown that they possess similar structures. Of interest here is the fact that they are both strongly coupled to the Planck vacuum (PV) state via a two-term coupling force that vanishes at their respective Compton radii. It is at these vanishing points where the strong and weak forces emerge. Consequently both forces are defined by the particle/PV coupling; i.e., they are not free space forces acting between free space particles.

What follows derives the strong and weak forces and calculates their relative strengths with respect to each other and with respect to the gravitational and electromagnetic forces. It is shown that these four forces are connected to the superforce associated with the PV (quasi-) continuum.

Strong Force

In its rest frame the proton core (e_*, m_p) exerts the following two-term coupling force (the Compton relations $r_e m_e c^2 = r_p m_p c^2 = r_* m_* c^2 = e_*^2$ are used throughout the calculations)

$$F_p(r) = \frac{(e_*)(-e_*)}{r^2} + \frac{m_p c^2}{r} = -F_s\left(\frac{r_p^2}{r^2} - \frac{r_p}{r}\right) \tag{1}$$

on the PV continuum, where the proton Compton radius r_p ($= e_*^2/m_p c^2$) is the radius at which the force vanishes. The mass of the proton is m_p [3] and the bare charge e_* is massless. The radius r begins at the proton core and ends on any particular Planck-particle charge $(-e_*)$ at a radius r within the PV.

The strong force

$$F_s \equiv \left|\frac{(e_*)(-e_*)}{r_p^2}\right| = \frac{m_p c^2}{r_p} \qquad \left(= \frac{m_p m_* G}{r_p r_*}\right) \tag{2}$$

is the magnitude of the two forces in the first sum of (1) where the sum vanishes. The (e_*) in (2) belongs to the free-space proton and the $(-e_*)$ to the separate Planck particles of the PV, where the first and second ratios in (2) are the vacuum polarization and curvature forces respectively. It follows that the strong force is a proton/PV force. The Planck particle mass m_* and Compton radius r_* are equal to the Planck Mass and Planck Length [5, p.1234].

Weak Force

The electron core $(-e_*, m_e)$ exerts the coupling force

$$F_e(r) = \frac{(-e_*)(-e_*)}{r^2} - \frac{m_e c^2}{r} = F_w\left(\frac{r_e^2}{r^2} - \frac{r_e}{r}\right) \tag{3}$$

on the vacuum state and leads to the Compton radius r_e ($= e_*^2/m_e c^2$), where the first $(-e_*)$ in (3) belongs to the electron and the second to the separate Planck particles in the negative energy vacuum.

The weak force

$$F_w \equiv \frac{(-e_*)(-e_*)}{r_e^2} = \frac{m_e c^2}{r_e} \qquad \left(= \frac{m_e m_* G}{r_e r_*}\right) \tag{4}$$

is the magnitude of the two forces in the first sum of (3) where the sum vanishes. Again, the first and second ratios in (4) are vacuum polarization and curvature forces. Thus the weak force is an electron/PV force.

2 Relative Strengths

The well known gravitational and electromagnetic forces of interest here are

$$F_g(r) = -\frac{m^2 G}{r^2} \qquad \text{and} \qquad F_{em}(r) = \pm\frac{e^2}{r^2} \tag{5}$$

where r is the free-space radius from one mass (or charge) to the other.

The relative strengths of the four forces follow immediately from equations (2), (4), and (5):

$$\frac{F_w}{F_s} = \frac{r_p^2}{r_e^2} = \frac{m_e^2}{m_p^2} = \frac{1}{1836^2} \approx 3\times 10^{-7} \tag{6}$$

$$\frac{|F_g(r_p)|}{F_s} = \frac{m_p^2 G/r_p^2}{e_*^2/r_p^2} = \frac{m_p^2(e_*^2/m_*^2)}{e_*^2} = \\ = \frac{m_p^2}{m_*^2} = \frac{r_*^2}{r_p^2} \approx 6\times 10^{-39} \tag{7}$$

where $G = e_*^2/m_*^2$ [1] is used in the calculation, and

$$\frac{|F_{em}(r_p)|}{F_s} = \frac{e^2/r_p^2}{e_*^2/r_p^2} = \frac{e^2}{e_*^2} = \alpha \approx \frac{1}{137} \tag{8}$$

where α is the fine structure constant.

3 Superforce

The relative strengths (6)–(8) agree with previous estimates and demonstrate that the free space forces

$$F_g(r_p) = -\frac{r_*^2}{r_p^2} F_s\,, \qquad F_g(r_e) = -\frac{r_*^2}{r_e^2} F_w \tag{9}$$

and

$$F_{em}(r_p) = \pm\alpha F_s\,, \qquad F_{em}(r_e) = \pm\alpha F_w \tag{10}$$

are related to the proton and electron coupling forces (1) and (3) through the strong and weak forces.

Equations (2) and (4) give precise definitions for the strong and weak forces, and are connected to the vacuum superforce via:

$$F_s = \left(\frac{r_*^2}{r_p^2}\right) \frac{e_*^2}{r_*^2} \qquad \text{and} \qquad F_w = \left(\frac{r_*^2}{r_e^2}\right) \frac{e_*^2}{r_*^2} \tag{11}$$

where

$$\text{superforce} \equiv \frac{e_*^2}{r_*^2} = \frac{m_* c^2}{r_*} \qquad \left(= \frac{m_*^2 G}{r_*^2}\right) \tag{12}$$

is the PV superforce to which Davies alludes [6, p.104]. The equality of the first and third ratios in (12) indicate that the degenerate vacuum state is held together by gravity-like forces.

The Newtonian force

$$-F_g(r) = \frac{m^2 G}{r^2} = \frac{(mc^2/r)^2}{c^4/G} =$$

$$= \frac{(mc^2/r)^2}{m_* c^2/r_*} = \left(\frac{mc^2/r}{m_* c^2/r_*}\right)^2 \frac{m_* c^2}{r_*} \tag{13}$$

is related to the superforce through the final expression, where $c^4/G\,(= m_* c^2/r_*)$ is the curvature superforce in the Einstein field equations [7]. The parenthetical ratio in the last expression is central to the Schwarzschild metrics [8] associated with the general theory.

Finally,

$$F_{em}(r) = \pm\frac{e^2}{r^2} = \pm\alpha \left(\frac{r_*^2}{r^2}\right) \frac{e_*^2}{r_*^2} \tag{14}$$

is the free space Coulomb force in terms of the vacuum polarization superforce.

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