Antiparticles and Charge Conjugation in the Planck Vacuum Theory

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This short paper defines charge conjugation in terms of the Planck vacuum substructure rather than the particle equation of motion. As such, the corresponding operator applies to the proton as well as the electron. Results show that, like their electron and proton counterparts, the positron is structureless while the antiproton possesses a structure consisting of a small vacuum "collar" surrounding its charged core.

1 Introduction

At present the Planck vacuum (PV) theory includes a model for both the electron and proton and the PV state to which these two particles are coupled [1]. But there is a problem: while the theory suggests a source for the negative bare charge ($-e_*$) of the electron (the current PV state itself), it is mute when it comes to the positive bare charge (e_*) of the proton. What follows assumes a bifurcated vacuum state that includes both negative and positive bare charges ($\mp e_*$). This bifurcated state is understood to mean that at each point in free space there exists a PV subspace consisting of a charge doublet ($\mp e_*$), to either branch of which a free particle charge can be coupled.

The charge conjugation operator C from the quantum theory is an operator that changes particles into antiparticles, and visa versa [2, p. 118]. An analogous operator is defined below to expand the PV model to include the particle-antiparticle symmetries and a source for the proton charge (e_*).

2 Charge conjugation

The electron and proton cores, $(-e_*, m_e)$ and (e_*, m_p) respectively, exert the two particle/PV coupling forces

$$\pm\left(\frac{e_*^2}{r^2} - \frac{mc^2}{r}\right) \tag{1}$$

on the PV state, where the plus and minus signs in (1) refer to the electron and proton respectively. At their respective Compton radii these forces reduce to

$$F_e = \frac{(-e_*)(-e_*)}{r_e^2} - \frac{m_e c^2}{r_e} = \frac{e_*^2}{r_e^2} - \frac{m_e c^2}{r_e} = 0 \tag{2}$$

and

$$F_p = \frac{(e_*)(-e_*)}{r_p^2} + \frac{m_p c^2}{r_p} = -\left(\frac{e_*^2}{r_p^2} - \frac{m_p c^2}{r_p}\right) = 0 \tag{3}$$

where $r_e\,(= e_*^2/m_e c^2)$ and $r_p\,(= e_*^2/m_p c^2)$ are the electron and proton Compton radii. The first ($-e_*$) and second ($-e_*$) in (2) belong to the electron core and PV charges respectively. The charge (e_*) in (3) belongs to the proton core. The vanishing forces F_e and F_p are Lorentz invariant constants; and the two forces on the right side of (2) are the "weak" forces, while the two on the right side of (3) are the "strong" forces.

If it is assumed that the charge conjugation operator C' applies only to free-particle charges, then from (2) and (3)

$$C'F_e = \frac{(e_*)(-e_*)}{r_e^2} - \frac{m_e c^2}{r_e} = -\left(\frac{e_*^2}{r_e^2} + \frac{m_e c^2}{r_e}\right) \neq 0 \tag{4}$$

and

$$C'F_p = \frac{(-e_*)(-e_*)}{r_p^2} + \frac{m_p c^2}{r_p} = \frac{e_*^2}{r_p^2} + \frac{m_p c^2}{r_p} \neq 0 \tag{5}$$

both of which destroy the electron and proton Compton radii because the equations are nonvanishing. Since the corresponding antiparticles should possess a Compton radius like their particle counterparts, the C' operator is not a valid charge conjugation operator.

If it is assumed, however, that the charge conjugation operator C applies to both the free-space particle charge and the PV charge doublet, then (2) and (3) yield

$$CF_e = \frac{(e_*)(e_*)}{r_e^2} - \frac{m_e c^2}{r_e} = \frac{e_*^2}{r_e^2} - \frac{m_e c^2}{r_e} = 0 \tag{6}$$

and

$$CF_p = \frac{(-e_*)(e_*)}{r_p^2} + \frac{m_p c^2}{r_p} = -\left(\frac{e_*^2}{r_p^2} - \frac{m_p c^2}{r_p}\right) = 0 \tag{7}$$

where both the electron and proton Compton radii are preserved in their antiparticles. Equations (6) and (7) imply that the equations in (1) are also the antiparticle/PV coupling forces. It is clear from the first charges in (6) and (7), (e_*) and ($-e_*$), that the positron is positively charged and that the antiproton carries a negative charge.

3 Comments

The second charges ($-e_*$) in the first terms of (2) and (3), and the second charges (e_*) in the first terms of (6) and (7), suggest that free particles and their antiparticles exist in two separate spaces, corresponding respectively to the negative and positive branches of the PV charge doublet.

In addition to the C operator preserving electron and proton Compton radii, the form of the first terms in (6) and (7) imply that the positron is structureless and that the antiproton has structure [1, App. A]. This mirrors those same qualities in the electron and proton, the first terms in (2) and (3).

As an aside, it is interesting to apply C to the electron equation of motion. The Dirac equation for the electron can be expressed as [2, p. 74]

$$ic\hbar\left(\frac{\partial}{c\partial t}+\boldsymbol{\alpha}\cdot\nabla\right)\psi = m_e c^2 \beta\psi \tag{8}$$

or, using $c\hbar = e_*^2$,

$$\left[i(-e_*)(-e_*)\left(\frac{\partial}{c\partial t}+\boldsymbol{\alpha}\cdot\nabla\right) - m_e c^2\beta\right]\psi = 0 \tag{9}$$

where the first $(-e_*)$ belongs to the electron and the second to the negative branch of the PV charge doublet. The corresponding positron equation of motion is then obtained from the charge conjugation of (9)

$$C\left[i(-e_*)(-e_*)\left(\frac{\partial}{c\partial t}+\boldsymbol{\alpha}\cdot\nabla\right) - m_e c^2\beta\right]\psi$$

$$= \left[i(e_*)(e_*)\left(\frac{\partial}{c\partial t}+\boldsymbol{\alpha}\cdot\nabla\right) - m_e c^2\beta\right]\psi_c = 0 \tag{10}$$

where ψ_c is the positron spinor that obeys the same equation (9) as the electron spinor ψ. Due to the second (e_*) in (10), it is clear that the positron belongs in the positive branch of the PV doublet.

The same calculations in (8)–(10) are not applicable to the proton particle because, due to the vacuum "collar" (of radius $r_p/3.15$) surrounding the proton core (e_*, m_p), the proton does not obey a Dirac equation of motion. In effect, the proton cannot be modeled as a point charge because of this "collar", even though its core (e_*, m_p) is orders-of-magnitude smaller than its Compton radius r_p.

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References

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