Electron Recoil in the Compton Effect as Viewed in the Planck Vacuum Theory

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***Abstract*—This paper calculates the recoil equation for an electron after being struck by an x-ray photon in a Compton scattering event as seen in the Planck vacuum (PV) theory.**

***Index Terms*—Compton Effect, Electron Recoil, Planck Vacuum State.**

I. Introduction

THE theoretical foundation [1] [2] [3] [4] of the PV theory rests upon the unification of the Einstein, Newton, and Coulomb superforces:

$$\frac{c^4}{G_d}\left(=\frac{m_*c^2}{r_*}\right)=\frac{m_*^2G}{r_*^2}=\frac{e_*^2}{r_*^2}\to r_*m_*c=\frac{e_*^2}{c}\quad(=\hbar)\quad(1)$$

where the ratio c^4/G_d is the curvature superforce that appears in the Einstein field equations. G is Newton's gravitational constant, c is the speed of light, m_* and r_* are the Planck mass and length respectively [5, p.1234], and e_* is the massless bare (or coupling) charge. The Planck time is $t_*=r_*/c$ [5, p.1233]. The fine structure constant is given by the ratio $\alpha\equiv e^2/e_*^2$, where e is the observed electronic charge magnitude. The ratio e_*^2/c to the right of the arrow is the spin coefficient for the Planck particle (PP), the proton, and the electron cores, where $\hbar$ is the reduced Planck constant. The gravitational constants can be obtained from the three superforces above and are [6]

$$G_d=\frac{r_*c^2}{m_*}\qquad\text{and}\qquad G=\frac{e_*^2}{m_*^2}.\quad(2)$$

This highly energetic PV state is a universal state.

The coupling of the electron to the PV state is via the electron and PP spins:

$$r_em_ec=\frac{e_*^2}{c}=r_*m_*c.\quad(3)$$

II. Conclusions and Comments

Assume that a quantum of energy $h\nu$ moves along the positive x-axis and strikes a free electron at rest; and then departs at an angle θ to the axis, with a longer wavelength. Then the equation for the increase in wavelength of the photon can be expressed as [6]

$$\Delta\lambda=\lambda'-\lambda=2\pi r_e\left(1-\cos\theta\right)\quad(4)$$

where

$$r_e=\frac{e_*^2/c}{m_ec}\quad(5)$$

is the electron Compton radius. The following calculates the resulting electron recoil equation.

From (a) and (b) in Appendix A

$$h\nu-cP_e\cos\psi=h\nu'\cos\theta\quad(6)$$

and

$$cP_e\sin\psi=h\nu'\sin\theta.\quad(7)$$

From $(6)^2$ and $(7)^2$

$$(h\nu)^2-2(h\nu)cP_e\cos\psi+c^2P_e^2\cos^2\psi=(h\nu')^2\cos^2\theta\quad(8)$$

and

$$c^2P_e^2\sin^2\psi=(h\nu')^2\sin^2\theta.\quad(9)$$

The sum $(8)^2+(9)^2$ then leads to

$$c^2P_e^2=h^2(\nu'^2-\nu^2)+2(h\nu)cP_e\cos\psi.\quad(10)$$

The conservation of energy equation (c) gives

$$W_e^2=h^2(\nu-\nu')^2+2m_ec^2h(\nu-\nu')+m_e^2c^4.\quad(11)$$

But the relativistic energy equation requires that

$$W_e^2-c^2P_e^2=m_e^2c^4,\quad(12)$$

providing a means to eliminate W_e^2, $c^2P_e^2$, and $m_e^2c^4$ from the calculations. Thus subtracting (10) from (11) and using (12) leads to

$$-cP_e\cos\psi=\frac{\nu'-\nu}{\nu}(h\nu+m_ec^2).\quad(13)$$

Then using the photon velocity $\lambda\nu=c$ in the ratio of (13) leads to

$$\frac{\Delta\lambda}{\lambda}=-\frac{\nu'-\nu}{\nu}\quad(14)$$

with the resulting electron recoil equation

$$\frac{\Delta\lambda}{\lambda}=\frac{cP_e}{h\nu+m_ec^2}\cos\psi.\quad(15)$$

Appendix A
Compton-Effect Conservation Equations

From reference [7, pp.432-433] the Compton-effect conservation equations are

$$(a)\qquad\frac{h\nu}{c}=\frac{h\nu'}{c}\cos\theta+P_e\cos\psi\quad(\text{A1})$$

$$(b)\qquad 0=\frac{h\nu'}{c}\sin\theta-P_e\sin\psi\quad(\text{A2})$$

$$(c)\qquad h\nu+m_ec^2=h\nu'+W_e.\quad(\text{A3})$$

Equation (a) is the x-component of the total momentum, and (b) is its y-component. Equation (c) is the total energy.

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