Physics 615 Fall, 2013
Homework #9 Due: Nov. 12 at 4:00

1 [10 pts] Find the spin-averaged cross section for an electron scattering off a very heavy Dirac particle of charge e. Do not assume $m_e \approx 0$, but do take the limit that the other mass M goes to infinity. You can use the expression just above 5.60 with the cross section formula 4.84, working in the center of mass, which is the same as the lab frame in the $M \to \infty$ limit. The answer should be

$$\left(\frac{d\sigma}{d\Omega}\right)_{\rm CM} = \frac{\alpha^2}{4\vec{p}^2\beta^2\sin^4\frac{\theta}{2}}\left(1-\beta^2\sin^2\frac{\theta}{2}\right).$$

2 [5 pts] Write the amplitude for Compton scattering

$$e^-_{\vec{p},s} + \gamma_{\vec{k},\lambda} \longrightarrow e^-_{\vec{p}',s'} + \gamma_{\vec{k}',\lambda'}$$

for an electron of spin s and photon of polarization λ, as

$$i\mathcal{M} = i\epsilon^{\lambda'}_{\mu}{}^*(k')\epsilon^{\lambda}_{\nu}(k)\mathcal{M}^{\mu\nu},$$

where

$$i\mathcal{M}^{\mu\nu} = -ie^2\bar{u}(p')\left[\frac{\gamma^\mu \not{k}\gamma^\nu + 2\gamma^\mu p^\nu}{2p\cdot k} + \frac{-\gamma^\nu \not{k}'\gamma^\mu + 2\gamma^\nu p^\mu}{-2p\cdot k'}\right]u(p),$$

as given in 5.74. Show explicitly what the Ward identity claims must be true, namely that $k_\nu\mathcal{M}^{\mu\nu} = 0$.