Quantum Field Theory I

Problem Set 8

Due: 26 November 2007

1. Calculate the differential cross-section for electron scattering in the field of a magnetic dipole when the initial and final momenta are both perpendicular to the dipole axis, to lowest order in perturbation theory (Born approximation). [The vector potential of a dipole $\vec{M}$ is $\nabla \times \left(\vec{M}/r\right)$ so you can find its Fourier transform from that of $1/r$.]

2. S, Problem 48.2

3. S, Problem 48.5

4. We shall soon find, when we complete the quantization of the electromagnetic field, that the photon propagator can be taken to be

$$\langle A_\mu(x) A_\nu(y) \rangle = \int \frac{d^4p}{(2\pi)^4} \frac{-i\eta_{\mu\nu} e^{i(x-y)\cdot p}}{p^2 - i\epsilon}.$$

Anticipatiing this result, calculate, to lowest order, the differential cross-section for (a) e^+e^- scattering (Bhabha scattering) and (b) e^-e^- scattering (Moller scattering) for the case that both particles in the initial state are unpolarized and the final spins are unobserved. Notice that the expressions for the squares of the amplitudes summed over spins for these two processes are simply related to each other by changing the signs and interchanging some of the 4-momenta. Thus the traces need to be calculated for only one of the two processes. Give the differential cross section for both processes in the Center of Mass frame. Discuss the limiting cases of low and high energy for both processes.