

Ph634: Advanced Quantum Mechanics / Quantum Field Theory

Problem Set 4: QED

(1) Consider $e^+\mu^- \rightarrow e^+\mu^-$ scattering. Let the momentum of the electron before and after the collision be k and k' , and that of the muon p and p' .

(a) Draw the leading Feynman graph for this process. Also, give some examples of higher order graphs that need not be considered for the computation of the scattering matrix \mathcal{M} because they are either vacuum or un-amputated graphs.

(b) Compute \mathcal{M} and the spin averaged $|\mathcal{M}|^2$. Express your result for the latter in terms of the Mandelstam variables $s = (k + p)^2$, $t = (k - k')^2$, $u = (k - p')^2$.

(2) Consider Compton scattering: $\gamma e \rightarrow \gamma e$. Use k, k' for the photon momenta and p, p' for the electron momenta.

(a) Draw the lowest order Feynman graphs for this process. (i.e. the order e^2 graphs that contribute to the scattering matrix)

(b) Calculate the scattering matrix \mathcal{M} and its spin averaged square. Specifically, average over incident electron and photon spins and sum over outgoing electron and photon spins. Express the final result in terms of s, t and u .

(c) Discuss the relation between your results and the process $e^+e^- \rightarrow \gamma\gamma$.

(3) Peskin problem 5.5(a)