

Physics 744 - Field Theory
Homework Set 8

1. In the $\bar{\psi}\psi\phi$ theory, calculate the unpolarized rate for the decay $\phi \rightarrow \bar{\psi}\psi$ assuming $M > 2m$ for the case of (a) scalar coupling and (b) pseudoscalar coupling.
2. In the $\bar{\psi}\psi\phi$ theory with pseudoscalar coupling, consider the scattering of $\psi(\mathbf{p}_1)\bar{\psi}(\mathbf{p}_2) \rightarrow \psi(\mathbf{p}_3)\bar{\psi}(\mathbf{p}_4)$.
 - (a) Draw the two relevant Feynman diagrams and write the relevant Feynman amplitude.
 - (b) Sum and average the Feynman amplitude squared over outgoing and incoming spin states respectively. Simplify the result in the ultrarelativistic limit, so that we can neglect both m and M . The result should be quite simple.
 - (c) Calculate the differential and total cross-section.
3. In the $\bar{\psi}\psi\phi$ theory with pseudoscalar coupling, consider the annihilation process $\psi(\mathbf{p})\bar{\psi}(\mathbf{p}') \rightarrow \phi(\mathbf{k})\phi(\mathbf{k}')$
 - (a) Write the two Feynman amplitudes. I found it useful to always write the intermediate propagator in terms of the \mathbf{k} and avoid \mathbf{k}' . I also found it useful to combine the two terms, as much as possible, before proceeding.
 - (b) Square and average over incoming spins.
 - (c) Calculate the differential and total cross-section for this annihilation process. To simplify, ignore the mass M (treat the pseudoscalar as massless) but not the mass m .