

215a Homework exercises 7, due Dec. 7

1. Compute $d\sigma/d\Omega$ in the center of momentum frame, to lowest nontrivial order in perturbation theory, averaged over initial spins and summed over final spins, for **nucleon-antinucleon** scattering in the theory discussed in class, taking $\mathcal{L}_I = -g\phi\bar{\psi}\Gamma\psi$, with $\Gamma = i\gamma_5$. Please simplify your answer to the point where there are no longer any things like u_p^r , nor gamma matrices. It should just involve the Mandelstam variables s and t , the masses μ (mass of ϕ) and m (mass of ψ), and g .
2. In the same theory, what is the condition needed for a ϕ quanta (meson) to be kinematically able to decay to a nucleon-antinucleon pair? (b) Assuming that this condition is satisfied, compute the meson decay rate, and total lifetime. Again, your answer should not involve any u s or γ matrices.
3. A massive vector meson is minimally coupled to a charged Dirac particle. Compute, to lowest non-trivial order in perturbation theory, the amplitudes for fermion-fermion and fermion-antifermion scattering. You do not have to sum over spins or compute cross sections, just write down the amplitudes. Explicitly verify that the contribution of the term in the vector meson propagator proportional to $k_\mu k_\nu/\mu^2$ vanishes.