215a Homework exercises 8, Fall 2019, does not need to be turned in

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 last week, taking $\mathcal{L}_I = -g\phi\bar{\psi}\Gamma\psi$, with $\Gamma = i\gamma_5$. Please simply 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 us or γ matrices.

3. Tong exercise sheet 4, question 7 (Compton scattering). This was discussed quickly in lecture, so the exercise here is to just write out the amplitude yourself using the Feynman rules, and verify that the amplitude vanishes if the external photon polarization vectors are gauge transformed as $\epsilon^\mu(p) \to \epsilon^\mu(p) + p^\mu f(p)$.

4. Tong exercise sheet question 8 $(e^+e^- \to \mu^+\mu^-)$. Use the photon propagator with the ξ term, and verify that the ξ term drops out. Again, this was discussed in lecture, and the exercise here is to just work it out yourself from the Feynman rules.