PHYS 528 Homework #5

Due: Mar.1, 2024, 12pm PST

1. Final project topics.

   Choose a topic for the final project. A list of potential topics can be found here:
   https://particletheory.triumf.ca/PHYS528/fproj.html

   Please check your topic with me before you begin on the project and fix it by March 1.
   I'll help you get started by suggesting some reading material.
   Did you fix your final project topic? (Y/N)

2. Reading week.

   Reread all the previous class notes and read ahead to `notes-05`.
   Did you do the reading? (Y/N)

3. $AA \to \psi\bar{\psi}$ in a general non-Abelian gauge theory with ψ transforming in the rep r.

   a) There are two Feynman diagrams for this process: one with the vector in the
   s-channel, and one with the fermion in the t-channel. Find the contribution to
   the amplitude for $A^a_\mu A^b_\nu \to \psi_i \bar{\psi}_j$ from the s-channel diagram alone.
   Hint: the three-point vector interaction is defined for ingoing momenta on all legs.
   For an outgoing momentum on a leg, just swap $p \to -p$ on that leg.

   b) Square this contribution and sum it over all final states and average over initial
   states (including spin and group), working in the centre-of-mass (CM) frame.
   Hint: in the CM frame with vector momenta p_1 and p_2, $(p_1 \cdot \epsilon_2) = 0 = (p_2 \cdot \epsilon_1)$.
   Also, $(p_1 - p_2) \cdot (p_1 + p_2) = 0$ for massless vectors. Use this to simplify the amplitude
   enormously before squaring.

   c) Write down the contribution to the amplitude $A^a_\mu A^b_\nu \to \psi_i \bar{\psi}_j$ from the t-channel
   diagram alone.

   d) Work out the group theory factor corresponding to the t-channel diagram when
   one squares this contribution and sums/averages it over all final/initial states.