

Problem set IV

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Problem 1: Let φ_i be the scalar fields in the vector representation of the $SU(n)$ group.

- Write down the $SU(n)$ invariant potential (up to 4th order in the field)
- Work out explicitly the possible pattern for spontaneous symmetry breaking for φ_i . How many Goldstone Bosons are there in this case?
- Discuss the possible spontaneous symmetry breaking pattern for the case where there are two such scalar fields φ_{1i} and φ_{2i}

Problem 2: Show the standard model predicts trilinear $H^0 W^+ W^-$ and quadrilinear $H^0 H^0 W^+ W^-$ Higgs boson couplings with strengths:

$$igM_w \quad \text{and} \quad \frac{i}{4}g^2$$

respectively. Where M_w is the mass of the W and g is the coupling constant associated with the $SU(2)_L$ group.

Problem 3: Show that the Standard Model predicts that the Higgs couples to two photons only via heavy charged particle loops. Write down the relevant terms of the Standard Model Lagrangian and derive the Feynman rules. What is the strength of the couplings involved?

Problem 4: The Standard Model predicts that the Higgs has tri-linear and quadric-linear self-couplings. Indicate the part of the interaction-Lagrangian that those couplings come from, draw the relevant Feynman diagrams, and calculate their strength.