

Physics 222. Quantum Field Theory 3. Professor Dine

Spring, 2011. Homework Set 1. Due Tues, April 12.

1. Fadeev-Popov Ghosts

- Derive the transformation law for the gauge field A_μ^a , under an infinitesimal gauge transformation ω^2 , and show that it can be elegantly expressed in terms of the covariant derivative of ω^a , thought of as a scalar field.
- Implement the Fadeev-Popov procedure; derive the ghost lagrangian (you don't have to write hundreds of pages for this; just give a brief summary).

2. Feynman rules: derive the three gauge boson coupling and the ghost propagator and interaction terms.

3. Higgs phenomenon: consider an $O(3)$ (equivalent to $SU(2)$) gauge theory with Higgs fields in the adjoint representation. If we call the fields $\vec{\phi}$, take

$$V(\vec{\phi}) = -\frac{1}{2}\mu^2|\vec{\phi}|^2 + \frac{\lambda}{4}|\vec{\phi}|^4. \quad (1)$$

Determine the pattern of symmetry breaking, and the mass of the gauge bosons (there is an unbroken gauge symmetry). Determine the charges of the gauge bosons under the remaining symmetry.