Quantum Field Theory II

Problem Set 12

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Exercise 39: Feynman rules in non-Abelian gauge theories

The "gauge-fixed" Yang-Mills Lagrangian is

$$\mathcal{L}_{\text{mod}} = -\frac{1}{4} F_{\mu\nu}{}^{\alpha} F^{\mu\nu}{}_{\alpha} - \frac{1}{2\xi} \partial_\mu A^{\mu\alpha} \partial_\nu A^{\nu}{}_{\alpha} + \cdots, \tag{1}$$

where

$$F_{\mu\nu}{}^{\alpha} = \partial_\mu A_\nu{}^{\alpha} - \partial_\nu A_\mu{}^{\alpha} + g\, C_{\alpha\beta\gamma} A_\mu{}^{\beta} A_\nu{}^{\gamma}. \tag{2}$$

Find the gauge boson propagator and the gauge boson cubic vertex.

Exercise 40: BRST Symmetry (Reading)

Read about BRST symmetry in your favorite textbook, and try to answer:

1. Is the "gauge-fixed" Yang-Mills action gauge invariant? Is it BRST invariant?
2. How does the BRST transformation act on matter and gauge fields? How is this related to a gauge transformation?
3. What is the basic property of a BRST transformation?
4. How is the cohomology of a nilpotent operator defined?
5. What are the physical states in a general BRST invariant theory?
6. Enumerate the actual physical states in non-Abelian gauge theories.