Introduction to Theoretical Particle Physics: WS 2022/2023: Exercise sheet 4

02.12.2022

Exercise 1: Gluon self-energy (100+25 points)

(0)(0 points) How much time did you spend in solving this exercise sheet?

(a)(100 points) Consider an arbitrary $SU(N)$-invariant theory in Lorenz gauge with massless fermions:

$$\mathcal{L} = -\frac{1}{4}F_{a;\mu}F_a^{\mu\nu} - \frac{1}{2}(\partial A)^2 + (\partial^\mu \bar{c}_a)(\delta_{ac}\partial_\mu + g f_{abc}A_{b;\mu})\, c_c + \\ + \bar{\psi}_i \left[\delta_{ij}(i\partial\gamma) + g(A_a\gamma)(T_a)_{ij}\right]\psi_j$$

Calculate the one loop-correction to the self-energy of the gauge boson in the dimensional regularization and find the divergent part.

(b*)(Bonus - 25 points) Prove that the scalar field theory with ϕ^4 interaction has no diagrams with an odd number of external legs at any order of perturbation theory.

Literature

1. Quantum Field Theory and the Standard Model, Schwartz M.D. - chapters 25 and 26.