Quantenfeldtheorie

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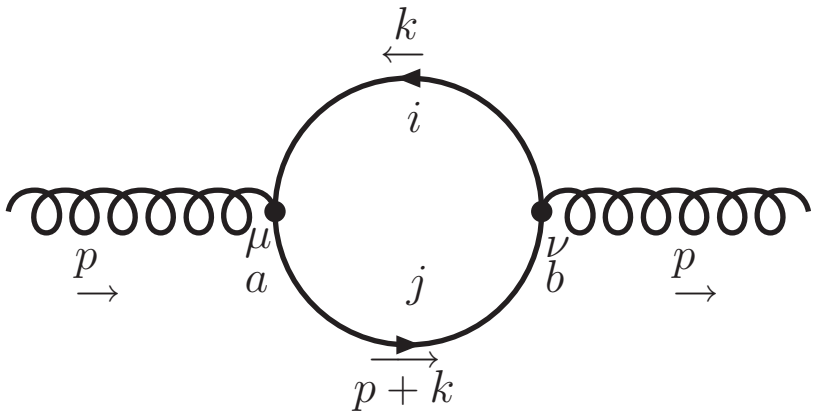
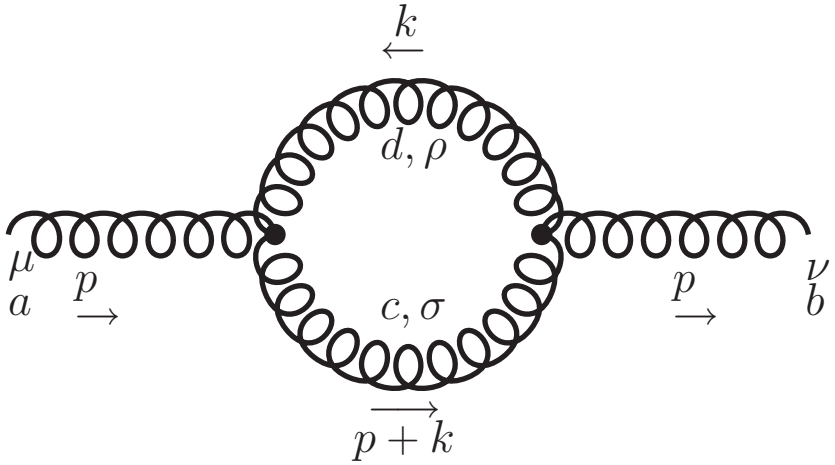
Aufgabe 16: *One-loop gluon self-energy*

The one-loop corrections for the gluon self-energy is given by the following Feynman diagrams:

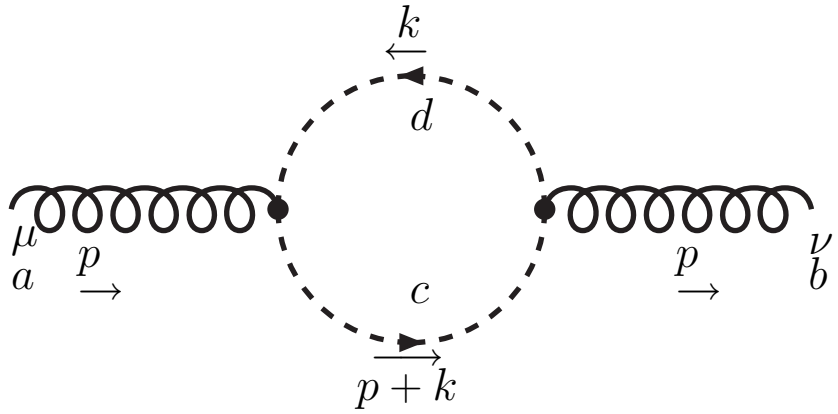
- The quark-loop, denoted by $i\Pi^{q,ab}_{\mu\nu}(p,m)$:



- The gluon loop (with 3-gluon vertices), denoted by $i\Pi^{3g,ab}_{\mu\nu}(p,m)$:



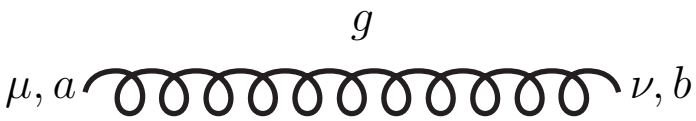
- The ghost loop, denoted by $i\Pi^{FP,ab}_{\mu\nu}(p,m)$:



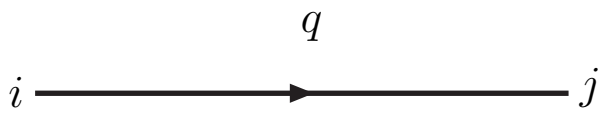
a) Show that the gluon loop with a 4-gluon vertex vanishes in dimensional regularization. To this end, use that (by definition)

$$\int d^D k (k^2)^n = 0 \qquad \text{for} \qquad n > -D/2\,.$$

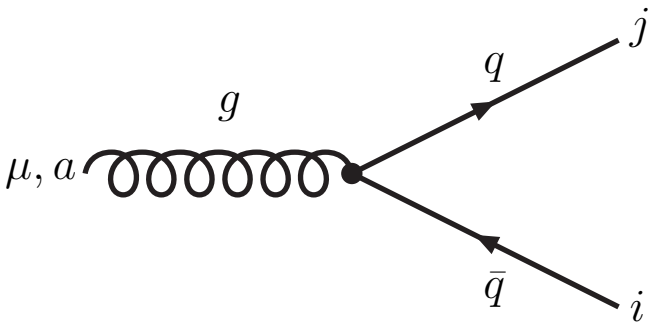
b) Use the following Feynman rules to calculate the one-loop gluon self-energy in dimensional regularization:



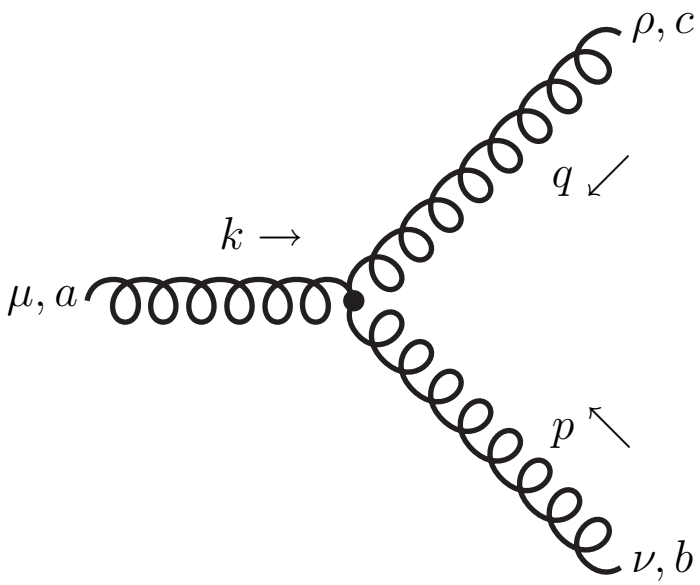
$$-i\delta^{ab}\frac{g_{\mu\nu}}{p^2}$$



$$i\delta^{ij}\frac{\not{p}+m}{p^2-m^2}$$

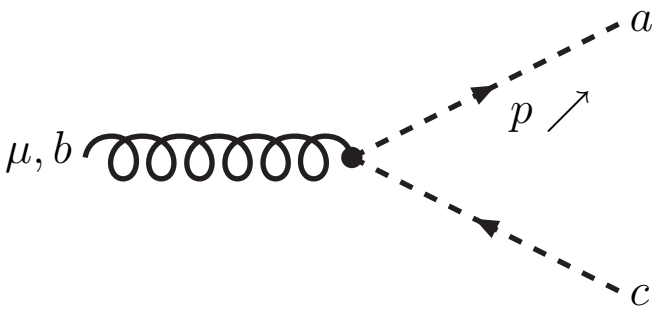


$$ig\gamma^\mu\left(T^a\right)_{ij}$$



$$gf^{abc}\left[g^{\mu\nu}(k-p)^{\rho}+g^{\nu\rho}(p-q)^{\mu}+g^{\rho\mu}(q-k)^{\nu}\right]$$

$$-i\delta^{ab}\frac{1}{p^2}$$



$$-gf^{abc}p^{\mu}$$