Appendix: Feynman rules for QCD

Propagators:

Gluon propagator (Feynman gauge):

$-i\delta_{ab}g_{\mu\nu}/(k^2 + i\epsilon)$

(Massless) fermion propagator:

$i\delta_{ij}(\gamma \cdot k)_{\alpha\beta}/(k^2 + i\epsilon)$

(Massless) scalar propagator:
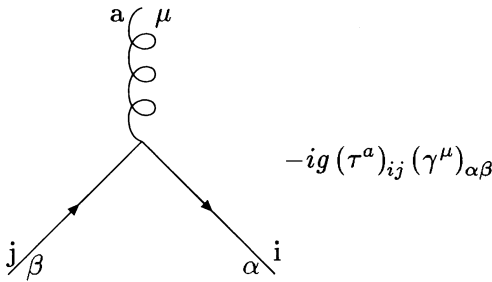

$i\delta_{ij}/(k^2 + i\epsilon)$

Vertices: (momenta are always outgoing)

Scalar–gluon interactions:

$-ig\,(\tau^a)_{ij}\,(q - p)^\mu$

$ig^2 g^{\mu\nu}\left(\tau^a\tau^b + \tau^b\tau^a\right)_{ij}$

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Fermion–gluon interaction:

$$-ig\,(\tau^a)_{ij}\,(\gamma^\mu)_{\alpha\beta}$$

Gluon self-interactions:

$$ig\,(T^a)_{bc}\,[g^{\nu\rho}(q-p)^\mu +$$
$$g^{\rho\mu}(2p+q)^\nu - g^{\mu\nu}(p+2q)^\rho]$$

$$ig^2\,(T^e)_{ab}\,(T^e)_{cd}\,(g^{\mu\rho}g^{\nu\sigma} - g^{\mu\sigma}g^{\nu\rho})$$
$$+ \nu \overset{b\leftrightarrow c}{\leftrightarrow} \rho + \nu \overset{b\leftrightarrow d}{\leftrightarrow} \sigma$$
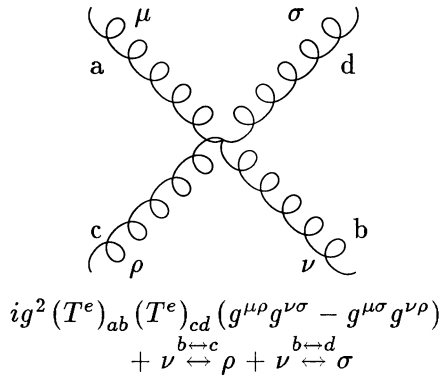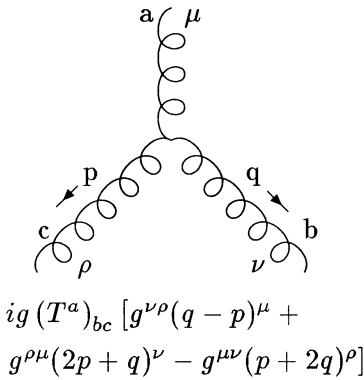
The gauge coupling constant is g $(\alpha_s = g^2/4\pi)$.

The matrices $(\tau^a)_{ij}$ are the matrices of the colour group in the representation of the quarks or colour scalar particles.

The matrices $(T^a)_{bc} = -if_{abc}$ are the colour matrices in the adjoint representation and f_{abc} are the structure constants of the colour group.

In addition there is a further factor of $-i$ accompanying each amplitude so that it is an element of the T-matrix rather than the S-matrix $(S = \mathbb{1} + iT)$.