Appendix

Feynman rules

A.1 R_ξ and BFM gauges

The Feynman rules for QCD in R_ξ gauges are given in Figure A.1. In the case of the background field gauge, because the gauge-fixing term is quadratic in the quantum fields, apart from vertices involving ghost fields, only vertices containing exactly two quantum fields might differ from the conventional ones. Thus, the vertices $\Gamma_{\widehat{A}\psi\bar{\psi}}$ and $\Gamma_{\widehat{A}AAA}$ have, to lowest order, the same expression as the corresponding R_ξ vertices $\Gamma_{A\psi\bar{\psi}}$ and Γ_{AAAA} (to higher order, their relation is described by the corresponding BQIs). Feynman rules for background fields are shown in Figure A.2.

A.2 Antifields

The couplings of the antifields Φ^* with fields is entirely encoded in the BRST Lagrangian of Eq. (4.4). When choosing the BFM gauge, the additional coupling $g f^{amn} A^{*m}_\mu \widehat{A}^n_\nu c^a$ will arise in the BRST Lagrangian $\mathcal{L}_{\text{BRST}}$ as a consequence of the background field method splitting $A \to \widehat{A} + A$. One then gets the Feynman rules given in Figure A.3.

A.3 BFM sources

Feynman rules involving the background field source Ω^m_μ can be easily derived by the one involving the (gluon) antifield A^{*m}_μ through the replacements $A^{*m}_\mu \to \Omega^m_\mu$ and $c^m \to \bar{c}^m$.

https://doi.org/10.1017/9781009402415.013 Published online by Cambridge University Press

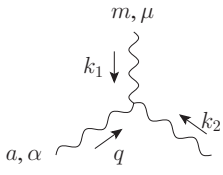
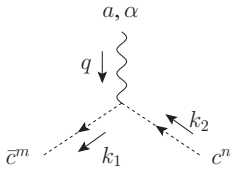
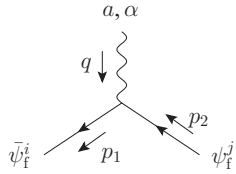
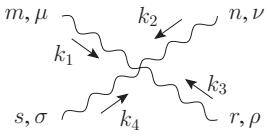
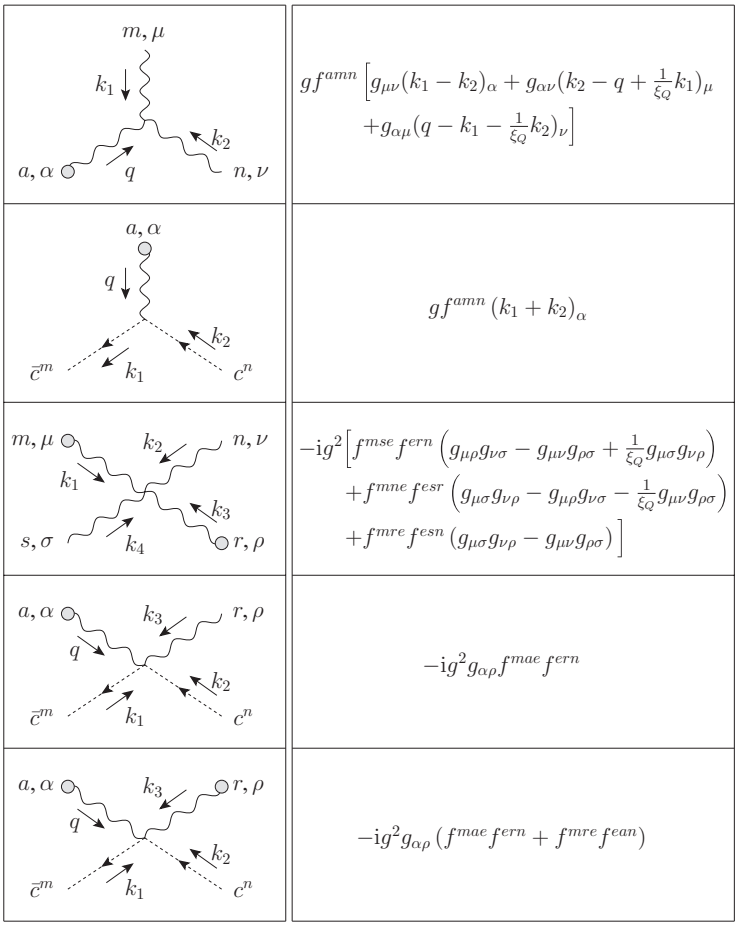
m,μ ~~~ n,ν	$-\mathrm{i}\delta^{mn}\frac{1}{q^2}\left[g_{\mu\nu}-(1-\xi)\frac{q_\mu q_\nu}{q^2}\right]$
m ----------> n	$\mathrm{i}\delta^{mn}\frac{1}{k^2}$
i,f ——————> j,f'	$\mathrm{i}\delta^{ij}\delta^{\mathrm{ff}'}\frac{1}{k^\mu\gamma_\mu-m_\mathrm{f}}$
	$gf^{amn}\left[g_{\mu\nu}(k_1-k_2)_\alpha+g_{\alpha\nu}(k_2-q)_\mu+g_{\alpha\mu}(q-k_1)_\nu\right]$
	$gf^{amn}k_{1\alpha}$
	$\mathrm{i}g\gamma^\alpha t^a_{ij}$
	$-\mathrm{i}g^2\left[f^{mse}f^{ern}\left(g_{\mu\rho}g_{\nu\sigma}-g_{\mu\nu}g_{\rho\sigma}\right)+f^{mne}f^{esr}\left(g_{\mu\sigma}g_{\nu\rho}-g_{\mu\rho}g_{\nu\sigma}\right)+f^{mre}f^{esn}\left(g_{\mu\sigma}g_{\nu\rho}-g_{\mu\nu}g_{\rho\sigma}\right)\right]$

Figure A.1. Feynman rules for QCD in the R_ξ gauges.

https://doi.org/10.1017/9781009402415.013 Published online by Cambridge University Press



$$gf^{amn}\Big[g_{\mu\nu}(k_1-k_2)_\alpha + g_{\alpha\nu}(k_2-q+\tfrac{1}{\xi_Q}k_1)_\mu + g_{\alpha\mu}(q-k_1-\tfrac{1}{\xi_Q}k_2)_\nu\Big]$$

$$gf^{amn}\,(k_1+k_2)_\alpha$$

$$-\mathrm{i}g^2\Big[f^{mse}f^{ern}\left(g_{\mu\rho}g_{\nu\sigma}-g_{\mu\nu}g_{\rho\sigma}+\tfrac{1}{\xi_Q}g_{\mu\sigma}g_{\nu\rho}\right) + f^{mne}f^{esr}\left(g_{\mu\sigma}g_{\nu\rho}-g_{\mu\rho}g_{\nu\sigma}-\tfrac{1}{\xi_Q}g_{\mu\nu}g_{\rho\sigma}\right) + f^{mre}f^{esn}\left(g_{\mu\sigma}g_{\nu\rho}-g_{\mu\nu}g_{\rho\sigma}\right)\Big]$$

$$-\mathrm{i}g^2 g_{\alpha\rho}f^{mae}f^{ern}$$

$$-\mathrm{i}g^2 g_{\alpha\rho}\left(f^{mae}f^{ern}+f^{mre}f^{ean}\right)$$

Figure A.2. Feynman rules for QCD in the background field gauge. We include only those rules that are different from the R_ξ rules to lowest order. As usual, a shaded circle on a gluon line indicates a background field.

https://doi.org/10.1017/9781009402415.013 Published online by Cambridge University Press

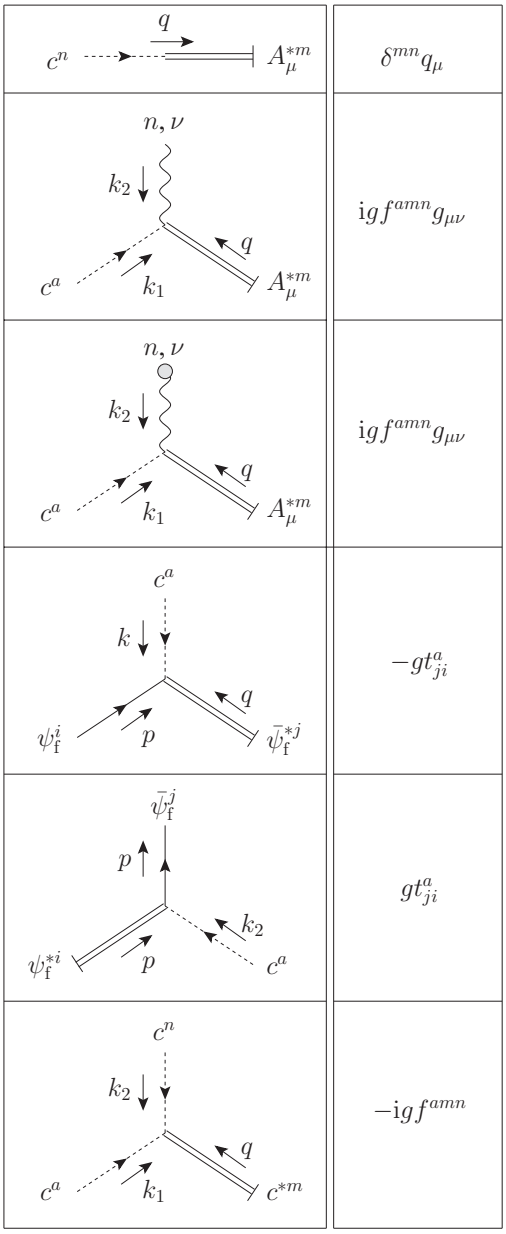


Figure A.3. Feynman rules for QCD antifields.

https://doi.org/10.1017/9781009402415.013 Published online by Cambridge University Press