

ELEMENTARY PARTICLE PHYSICS

WS 2016/2017: Exercise sheet 13

38. Verify the gauge invariance of the electromagnetic field strength tensor under local U(1) gauge transformations and show, that the field strength tensor of QCD

$$G_{\mu\nu} = \partial_\mu G_\nu - \partial_\nu G_\mu + ig[G_\mu, G_\nu]$$

transforms as $SG_{\mu\nu}S^{-1}$ under local SU(3) gauge transformations $S(x)$, i.e. is not gauge invariant.

39. The free Lagrange density for a complex scalar field is

$$\mathcal{L} = (\partial_\mu \phi)^* (\partial^\mu \phi) - m^2 \phi^* \phi.$$

How do you have to change the Lagrange density in order to obtain invariance under local gauge transformations $\phi(x) \rightarrow e^{-ie\alpha(x)}\phi(x)$, and what type of vertices do you get then ?

40. a) Draw all Feynman diagrams which contribute to the reaction $qG \rightarrow qG$ in order g^2 and compare with Compton scattering $e\gamma \rightarrow e\gamma$.
b) Draw all diagrams which contribute to GG scattering in order g^2 .
c) Draw all Feynman diagrams which, in lowest order g , contribute to the reaction $e^+e^- \rightarrow 4$ jets.
d) Find a reaction with which the 4-gluon vertex can be investigated experimentally. Also draw all competing diagrams which from the same initial state lead to the same final state. Note that quarks and gluons are confined.