ELEMENTARY PARTICLE PHYSICS

WS 2016/2017: Exercise sheet 14

41. Compute the color factor for gluon bremsstrahlung relative to photon bremsstrahlung of a quark in, say, $e^+e^- \to q\bar{q}G$ and $q\bar{q}\gamma$ resp.. The vertices are

$$g\bar{q}^i\gamma_\mu \left(\frac{\lambda^a}{2}\right)_{ij} q^j\epsilon_a^\mu \quad \text{and} \quad e_q\bar{q}\gamma_\mu q\epsilon^\mu$$

with $i,j = 1,2,3$ for the quark color, $a = 1,...,8$ for the gluon color, g the strong coupling constant, e_q for the electric charge of the quark and ϵ_a^μ and ϵ^μ for the outgoing gluon and photon resp..
Hint: You don't have to compute the complete squared transition amplitude but just the relative factor in the quark sector. Use $q^i\bar{q}^j \sim \delta_{ij}$, and $\epsilon_a^\mu\epsilon_b^{*\nu} \sim g^{\mu\nu}\delta_{ab}$ and $\epsilon^\mu\epsilon^{*\nu} \sim g^{\mu\nu}$ resp..

42. Compute the behavior of $(\bar{\psi}\psi)(\vec{x},t)$, $(\bar{\psi}\gamma_5\psi)(\vec{x},t)$, $(\bar{\psi}\gamma_\mu\psi)(\vec{x},t)$ and $(\bar{\psi}\gamma_\mu\gamma_5\psi)(\vec{x},t)$ under the parity transformation.

43. Assume that the field strength tensor for W ($W = \sum_{i=1}^3 \tau^i W^i$, $\tau^i = \sigma^i$, the Pauli matrices) and B bosons is given as

$$\begin{aligned} W_{\mu\nu} &= \partial_\mu W_\nu - \partial_\nu W_\mu + ig[W_\mu, W_\nu] \quad \text{and} \\ B_{\mu\nu} &= \partial_\mu B_\nu - \partial_\nu B_\mu \end{aligned}$$

(indeed that is the field strength tensor of GSW). Derive from it (qualitatively) all vertices which involve $W^\pm, Z^0$ und A only. Here

$$\begin{aligned} W^\pm &= (W^1 \pm iW^2)/\sqrt{2} \\ W^3 &= Z^0\cos\Theta_W + A\sin\Theta_W \\ B &= A\cos\Theta_W - Z^0\sin\Theta_W. \end{aligned}$$