

Problems II

Due date: 22.11.05

Up-to-date information and pdf-files of the tutorials also at

http://theorie3.physik.uni-erlangen.de/lectures/ws2005_2006/griesshammer/QFTII.html.

1. GAUGE TRANSFORMATIONS: Let $A_\mu(x) = A_\mu^a(x)t^a$ the non-Abelian gauge field, $D_\mu(x) = \partial_\mu - ig A_\mu(x)$ the gauge-covariant derivative, $U(x)$ an arbitrary gauge transformation, and $\Psi(x)$ a state vector on which a gauge transformation acts as $U\Psi(x) = U(x)\Psi(x)$.
 - a) Derive the transformation law for A_μ under a gauge transformation by requiring that the gauge-covariant derivative transforms as: $U[D_\mu(x)\Psi(x)] = U(x)D_\mu(x)\Psi(x)$.
 - b) Derive the infinitesimal versions of the gauge transformation $U(x) = \exp ig\beta(x) = \exp ig\beta^a(x)t^a$, $g\beta^a \ll 1\forall a$, of A_μ , A_μ^a and the field-strength tensor $F_{\mu\nu}$ and its components $F_{\mu\nu}^a$.

2. INTERACTIONS AND EQUATIONS OF MOTION OF THE YANG-MILLS FIELD:
 - a) Derive the classical equations of motion of a Yang-Mills field coupled to fermions from the Lagrangean given in the lecture. Interpretation. Derive the continuity equation for fields and charges. What are the classically conserved charges?
 - b) List diagrammatically the interactions of A_μ with itself and with fermions. Derive the Feynman rules in your conventions.