

831 Homework set 9 (due Nov.10)

(1). Yukawa interaction:

Consider an interacting Lagrangian,

$$\mathcal{L}_I = H(x) \bar{\psi}(x)(a + ib\gamma_5)\psi(x),$$

where a, b are real coupling constants, $\psi(x)$ is a Dirac fermion field operator.

(a). What constraint on the field $H(x)$ can the Hermiticity condition impose?

(b). Show the transformation properties for the Lagrangian terms under C , P , T and CP , CPT .

(2). Non-renormalizable operators:

(a). Based on the field operators (and their derivatives) of a complex scalar ϕ (and ϕ^*), a vector A_μ (and $F_{\mu\nu}$) and a spinor ψ (and the bilinears), construct all dimension five locally Lorentz invariant, Hermitian operators that could be used as interacting Lagrangian density terms in a field theory (forget about γ^5 for the moment).

(b). Are all terms in your list invariant under a local gauge transformation? If not, what original gauge invariant forms could they have come from (recall the gauge invariant ingredients $F_{\mu\nu}$ and D_μ)?