**Physics 722, Spring 2007** Josh Erlich
**Problem Set 1: Discrete Symmetries**
due Thursday, Feb 8

1. *P,C and T*

a) Determine the action of P, C and T on the fermion bilinears $\overline{\psi}\psi$, $i\overline{\psi}\gamma^5\psi$, $\overline{\psi}\gamma^\mu\psi$, $\overline{\psi}\gamma^\mu\gamma^5\psi$, and $i\overline{\psi}[\gamma^\mu,\gamma^\nu]\psi$.

b) Convince yourself that any Lorentz invariant formed by fermion bilinears and/or space-time derivatives is invariant under the combined transformation CPT.

c) Convince yourself that QED is invariant under C, P, and T independently. How does the electromagnetic field $A_\mu$ transform?

d) What are the discrete symmetries of the following Lagrangians? (Write the transformations of the fields which leave the action invariant.)

$$\mathcal{L} = \overline{\psi}(i\partial\!\!\!/ - m)\psi + \frac{1}{2}(\partial_\mu\phi)^2 + g\overline{\psi}\psi\phi$$

$$\mathcal{L} = \overline{\psi}(i\partial\!\!\!/ - m)\psi + \frac{1}{2}(\partial_\mu\phi)^2 + ig\overline{\psi}\gamma^5\psi\phi$$

$$\mathcal{L} = \overline{\psi}(i\partial\!\!\!/ - m - eA\!\!\!/)\psi - \frac{1}{4}F_{\mu\nu}F^{\mu\nu} + ig\overline{\psi}[\gamma^\mu,\gamma^\nu]\psi F_{\mu\nu}$$