UNIVERSITY OF CALIFORNIA, SANTA BARBARA
Department of Physics

Prof. S.B. Giddings **Physics 229A** Winter 2007

Gauge Theories

ASSIGNMENT #2

Due Thursday, January 25, 2007

1. Write the general Lorentz-invariant quadratic action with no more than two derivatives for a charged vector field W_μ. Find the corresponding momentum-space propagator. What is the mass of the propagating state(s)? Compare the sign of the propagator for the different states. Can you explain the reason for our choice of the Proca lagrangian? (Hint: study the propagator of the so-called R_ξ gauges – see e.g. Srednicki.)

2. Find the linear combination of the charges Q_{em} and Q^3 defined in class that commutes with Q^+ and Q^-.

3. Calculate the μ decay rate assuming $M_W >> m_\mu >> m_e$. Note that in this limit it depends on G_F and m_μ.

4. A general $n \times n$ unitary matrix has n^2 parameters, (check this). Show that $2n-1$ phases may be removed from the Kobayashi-Mashawa matrix U by choice of phases of the quark fields, leaving $(n-1)^2$ parameters. By subtracting the number of mixing angles needed to specify an $n \times n$ orthogonal matrix show that there are $\frac{1}{2}(n_g - 1)(n_g - 2)$ phases in the standard model with n_g generations. For 2 generations there is only one angle, the Cabbibo angle θ_1 or θ_c. How is this result modified in a theory with right-handed charged currents?