UNIVERSITY OF CALIFORNIA, SANTA BARBARA
Department of Physics

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

Gauge Theories

ASSIGNMENT #9

Due Thursday, March 15, 2007

1. Verify the cancellation of anomalies between the $\bar{5}$ and 10 representations of $SU(5)$.

2. Perform the calculation of coupling unification in the $SU(5)$ model, verifying that you have the correct formulas for the $SU(3), SU(2)$ and $U(1)$ beta functions. Start with the measured values of the $SU(2)$ and $U(1)$ couplings, being careful about the differing normalizations in the Standard Model and in $SU(5)$. Compute the value of the unification scale (the point where these two couplings are equal); then determine the value of α_3 at M_Z. Compare with the value given by the Particle Data Group. You need only study the equations to one-loop order. In practice, two-loop corrections, as well as threshold effects and higher-order corrections to the beta function, are often included.

3. In SUSY $SU(5)$, find the vacua of the superpotential

$$W(\Sigma) = m\ tr\ \Sigma^2 + \frac{\lambda}{3}\ tr\ \Sigma^3\ ,$$

and characterize their symmetry breaking patterns.

4. Beginning with the known beta-function coefficients for QCD, verify our formulas for the beta function coefficients above the SUSY breaking scale in the MSSM.