Week 8 (due May 25)

Reading: Terning chapter 10.

1. (a) Compute all 't Hooft anomalies for SUSY QCD for general values of N_f and N_c. Verify that for $N_f = N_c + 1$ the anomalies of the theory of mesons and baryons at the origin of the moduli space match with the anomalies of SUSY QCD.

(b) Show that for $N_f = N_c$ the anomalies of mesons and baryons regarded as fundamental fields do not match the 't Hooft anomalies of SUSY QCD, even though the theory is confining everywhere on the moduli space. Explain why this is OK.

2. Consider $N = 1$ SUSY gauge theory with gauge group $USp(2N_c)$ and $2N_f$ chiral multiplets in the fundamental $2N_c$-dimensional representation.

(a) For a fixed N_c, determine the range of N_f for which the theory flows to an interacting IR fixed point.

(b) Show that for $N_f = 2N_c + 1$ the theory has a moduli space of supersymmetric vacua which is a deformation of the classical one (analogous to the case $N_f = N_c$ in SUSY QCD).

(c) Show that for $N_f = 2N_c + 2$ the classical moduli space can be parameterized by the expectation value of a chiral superfield M_{ij}, anti-symmetric in the flavor indices i, j. Show that M_{ij} satisfies constraints on the classical level, and that these constraints can be deduced from the superpotential

$$W_{eff}(M) \sim Pf(M),$$

where Pf denotes Pfaffian. Show that this superpotential remains undeformed in the quantum theory.

3. Consider $N = 1$ SUSY gauge theory with the exceptional gauge group E_6 and N_f flavors of chiral superfields, where each flavor consists of a pair of superfields in representations **27** and $\overline{\mathbf{27}}$ of E_6. For group theory facts about E_6, see the review of R. Slansky, "Group theory for model building", esp. Table 47.

(a) Determine the range of N_f for which the theory is asymptotically free and the range of N_f for which it flows to an interacting IR fixed point.

(b) For $N_f = 0$, the theory is confining and undergoes gaugino condensation and spontaneous breaking of discrete R-symmetry . Determine the discrete R-symmetry and the number of vacua in this theory.

(c) For $N_f > 1$, determine the dimension of the classical moduli space as a function of N_f, assuming the gauge group is completely broken at a generic

point in the moduli space. (Hint: the dimension of the adjoint representation of E_6 is 78).