

246A take home final due Fri. June 9 at noon. Please slip under my door. You can use the course notes and the textbook, nothing else. Do not work together.

1. Construct the complete massless  $\mathcal{N} = 3$  SUSY multiplet with maximal helicity 2 (i.e. the graviton supermultiplet).
2. In the approximation where the  $SU(2)_L$  gaugino soft mass is much larger than the  $\mu$  term which is itself much larger than the  $W$  mass (i.e.  $M_2 \gg \mu \gg M_W$ ), estimate the lifetime in seconds of the decay of the heaviest chargino to neutral higgs and light chargino, neglecting the final state masses.
3. Using a renormalization group argument estimate the  $\mathcal{O}(y_t^2)$  splitting of the Higgs-wino-higgsino coupling and  $SU(2)$  gauge coupling due to the splitting of the top squark masses and the top quark mass. What is the deviation from unity in the ratio of the squared couplings?
4. Consider the superpotential which couples the three fields  $\phi_1$ ,  $\phi_2$ , and  $\phi_3$ :

$$W = \mu\phi_1\phi_2 + f\phi_3 + m\phi_2^2 + \frac{\lambda}{2}\phi_2^2\phi_3 . \quad (1)$$

What is the scalar potential for this theory? Is SUSY preserved in the vacuum? Assuming  $\mu^2 \gg f$ , is there a flat direction starting at the origin of the moduli space?