Problem Set 1

Physics 485

Due May 10

Some abbreviations: Pol - Polchinski

Feel free to use any references you like for these exercises though try to do them without aid initially. You are meant to learn from the problems, not merely complete them.

1. The place where you are most likely to closely analyze supersymmetric field theory and use superspace is in four dimensions.

(i) Let's start by constructing all supermultiplets with N=1,2,4,8 supersymmetries in D=4. The only bound we will impose is that all spins ≤ 2.

(ii) We didn't study vector multiplets in lecture but you should have constructed an N=1 supermultiplet with a vector particle in part (i). Write the most general action in N=1 superspace that possesses N=2 supersymmetry without gravity i.e., vector multiplets and hypermultiplets.

(iii) Analyze the classical vacuum structure of this theory. What is the moduli space? At a given point on the moduli space, what are the massless excitations? What are the unbroken flavor and gauge symmetry groups?

(iv) Take the case of pure N=2 Yang-Mills with no hypermultiplets. Compute the supersymmetry algebra and exhibit the central charges.

(v) A rather famous solitonic solution of field theory is the magnetic monopole. This solution carries a unit of magnetic charge. In supersymmetric field theory (with more than minimal supersymmetry), this particle is BPS. Derive first order differential equations for the monopole solution using its BPS nature. Then find the 1-monopole solution and compute its mass. Note the dependence on the Yang-Mills coupling.

2. Pol. 13.2

3. Pol. 13.3

4. Pol. 13.4