

## Problem Set 2

Physics 485

Due May 26

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. Pol. 13.6

2. Pol. 13.7

3. Pol. 13.12

4. Pol. 14.2

5. We described the duality relation between M-theory, IIA and IIB string theory. We also showed how the M5-brane of M-theory reduces to either an NS5-brane or a D4-brane of type IIA. Complete this “brane-scan.” Describe the BPS branes in each theory and how they map from one theory to another. Compute the tensions of each brane in each theory. The descriptions can be quite different depending on the frame of reference.

6. Type IIA on a two-torus maps back to itself under T-duality along both legs of the torus. For a particular self-dual torus, the theory maps back to itself. Derive the BFSS Matrix model description of this background and explain how this T-duality symmetry appears.

7. Extra credit: the equations describing bound state wavefunction for a single D0-brane and a single D4-brane simplify in an unexpected way via deprolongation (this is much simpler than it sounds). You can find this described in hep-th/0002131.

Can you solve the resulting 2-D Laplace equation either numerically or analytically to find the shape of the bound state? The key constraint is normalizability of the original bound state wavefunction prior to deprolongation.

Can you show that any other related theories deprolong? For example, increasing either the number of D0-branes or D4-branes, or considering the D0-D0 system. I suspect this to be the case but a more conceptual rather than computational argument is required.