Physics 250: Introduction to String Theory

Homework Assignment V

This assignment is worth 10 points, and is due in class on Thu, April 25. The main theme is BRST quantization of strings.

1. Using either the explicit expression for the BRST charge Q_B in terms of oscillators of the ghost-antighost sector and the matter Virasoro generators (as presented in Eqn. (4.3.7) of [Polchinski I], or using results of Exercise 4.3 of [Polchinski I], calculate the anticommutator $\{Q_B, Q_B\}$, for an arbitrary value of the matter central charge c_m, and demonstrate that Q_B is nilpotent only when $c_m = 26$. (This problem was mentioned in class, and a partial answer was given.)
2. (Exercise 4.5(a) of [Polchinski I]):
   Carry out the BRST quantization of the first two levels of the bosonic closed string in 26 flat uncompactified dimensions.
3. (Exercise 10.13 of [Polchinski II]):
   The BRST quantization of the superstring is equally easy to understand. The logic is exactly the same as in the bosonic string case, the only new step being that we are now dealing with a gauge superalgebra (super Virasoro) and not a bosonic algebra, therefore some of the corresponding ghost and antighost fields are bosonic instead of fermionic. Using the structure of BRST in the superstring as discussed on page 24 of [Polchinski II], verify the operator products (10.5.22) of [Polchinski II], and verify the nilpotence of the BRST operator of the superstring in the critical dimension.