8.251 – Homework 5

B. Zwiebach | Spring 2007

Due Tuesday, March 13.

1. (10 points) Problem 6.2 (restated here for your convenience with added notation).

   Examine the Nambu-Goto action (6.39) for a relativistic string with endpoints attached at $(0, \vec{0})$ and $(a, \vec{0})$. Consider the non-relativistic approximation where $|\vec{v}_\perp| \ll c$ and the oscillations are small (see (4.3), whose left-hand side should have an absolute value!).

   You may denote by $\vec{y}$ the collection of transverse coordinates $X^2, \ldots X^d$ and write $\vec{y}(t, x)$, where x is the coordinate corresponding to X^1.

   Work in the static gauge. Moreover, parameterize the strings using $X^1 = x = a\sigma/\sigma_1$. This parameterization is allowed for small oscillations. In fact, it is allowed for any motion in which X^1 is an increasing function along the string.

   Show that the action reduces, up to an additive constant, to the *action* for a non-relativistic string performing small transverse oscillations. What is the tension and the linear mass density of the resulting string? What is the additive constant?

2. (5 points) Consider a D1-brane in four-dimensional spacetime. The brane lies on the $x^3 = 0$ plane and it is rotated an angle θ with respect to the x^1 axis in the counterclockwise direction. Describe in full detail the boundary conditions that apply to open strings on this D-brane. Give your answers as a set of conditions on $X^\mu(\tau, \sigma_*)$ and $\mathcal{P}^\sigma_\mu(\tau, \sigma_*)$, where $\mu = 0, 1, 2, 3$.

3. (10 points) Problem 6.4.

4. (10 points) Problem 6.6.

5. (15 points) Problem 6.7.

6. (10 points) Problem 7.3.

7. (10 points) Problem 7.4.

I would recommend problem 7.2 for practice.