Abstract

Spiky strings introduced in String Theory by Kruczenski have been extensively studied in the last decade and a half by numerous authors, in the context of gauge-gravity duality. In this thesis, we primarily focus on studying the perturbations of such strings using the well–known Jacobi equations for small deformations about extremal configurations, with the goal of studying their stability.

We first review the context and background of our work and discuss several well-known string solutions. Thereafter, we briefly summarise the perturbation (Jacobi) equations for embedded timelike surfaces in generic curved background spacetimes.

Moving on towards studying perturbations, we first consider spiky strings and their duals in the $2+1$ dimensional, flat, Minkowski spacetime. We show how the problem of perturbations eventually reduces to analysing the well-known Poschl–Teller equation, often studied in elementary quantum mechanics. We explicitly demonstrate the stability and the perturbed profiles of the spiky string and its dual in 2+1 dimensional Minkowski spacetime using the solutions of the perturbation equation. Such perturbations lead to a rounding off of the spikes, which, in a way, demonstrates the stable nature of the unperturbed worldsheet. We also extend our work to similar spiky strings in 3+1 dimensional Minkowski spacetime.

Next we consider spiky strings in three dimensional Anti-de Sitter (AdS) spacetime. We show that the equation for the perturbation scalar, which governs the behaviour of such small deformations, is a special case of the well-known Darboux-Treibich-Verdier (DTV) equation. We obtain the eigenvalues and eigensolutions of the DTV equation for our case by solving certain continued fractions numerically. These solutions are then used to further demonstrate that there do exist finite perturbations of the AdS spiky strings, thereby confirming their stability.

Finally, we consider giant magnons in the $2+1$ dimensional curved $\mathbb{R} \times S^2$ background spacetime. We rewrite the giant magnon solution in a conformal gauge and work out the equation for normal perturbations. The equation for the perturbation scalar reduces to the wave equation in Minkowski spacetime. The solutions are straightforward and can be written in terms of elementary functions. Thus, we find that the giant magnons are also stable against such normal perturbations. We conclude with comments on the perturbations for the single spike solution and other generalities.

The thesis ends with a summary of the work done and brief comments on future scope of work along similar directions.

Keywords: AdS/CFT duality, spiky strings, giant magnons, perturbations.