PhD Thesis Abstract

BLACK HOLES AND SOLITONS IN STRING THEORY AND M-THEORY

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Abstract This thesis explores the effects of supersymmetry and higher-curvature corrections from superstring theory on black hole and soliton physics in different dimensions. The first-order $\alpha'-$corrections derived from heterotic string theory, up to a field redefinition, lead to Einstein-dilaton-Gauss-Bonnet theory. We construct the first-order correction of Schwarzschild black holes in arbitrary dimensions. In four dimensions, we show that the corrected backgrounds satisfy the first law of thermodynamics and allow the construction of slowly rotating black holes and accelerating black hole solutions in a perturbative approach. In five dimensions, we consider the α'-corrections to the black string background and the boosted black string. We construct the scalar perturbation of the metric field in the perturbative approach to assess the effect of α' on the Gregory-Laflamme instability. We found that in the regime of validity of our approach, the instability window enlarges and grows with α'.

In the context of the $D = 5$, $\mathcal{N} = 2$ gauged STU model, we construct supersymmetric solitons, establishing new asymptotically locally AdS_5 solutions with nontrivial boundary conditions for the gauge fields and their uplifts to type IIB supergravity. There exists a BPS limit for a specific relation between the boundary values of the gauge fields, leading to 1/8-BPS configurations. We study the phase diagram of this sector of the theory and found that, generally, there are two solitons for a given value of the boundary values of the gauge fields. Finally, we identify the states in supergravity that are dual to certain vacua in the dual field theory in the weak coupling and large N limit, labeled by the boundary conditions on the fields. This is done by computing the Casimir energy in the field theory in the weakly coupled limit and comparing it with the energy of the supergravity solution.

The four-dimensional STU model in maximal gauged supergravity is studied for static electric and magnetic black holes with general horizon geometries. Thermodynamic stability analysis reveals unstable electric black holes for temperatures below certain value, including Reissner-Nordström. While magnetic BPS black holes demonstrate quasi-stability. We find extremal non-BPS black holes, which are thermodynamically unstable.

These results deepen the understanding of the interplay between string-inspired corrections, black hole physics, and supersymmetric stability criteria in different dimensions.