Regular and Black Hole solutions with Non-Abelian Gauge Fields

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Abstract

We consider globally regular and black hole solutions in Einstein-Yang-Mills (EYM), Einstein-Yang-Mills-dilaton (EYMD) and Einstein-Yang-Mills-Higgs (EYMH) theory. The solutions are asymptotically flat. The black hole solutions carry non-trivial non-Abelian gauge fields outside their regular event horizon.

Static EYM(D) solutions are labeled by the node number and the winding number of their gauge fields. For higher winding numbers they possess only axial symmetry, giving rise to static black holes with deformed horizon.

EYMH theory allows for gravitationally bound multimonopoles, for not too large mass of the Higgs field. In the vacuum sector, monopole-antimonopole pair solutions exist, as well as black holes with dipole hair.

Rotating black holes emerge from the static EYM black holes for finite horizon angular velocity. Whereas the static black holes have vanishing electric fields, these EYM black holes carry a non-Abelian electric charge. In the presence of a dilaton, rotating black holes may carry non-trivial electric fields and no charge. No regular counterparts of these black holes could be found.

When a dilaton is coupled, a new mass formula - similar to the Smarr formula - is obtained for the EYMD black holes, where the

dilaton charge enters instead of the magnetic charge. A modified uniqueness conjecture for non-Abelian black holes includes the dilaton charge and a topological horizon charge.

For large node number, the non-Abelian black holes tend to embedded Abelian black holes. Recently, rotating Einstein-Maxwell-dilaton black holes with static and counterrotating horizon were found.