# On the topology of black holes

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**Abstract**

There is a widely held belief in physics that a true astrophysical black hole, formed from the gravitational collapse of some stellar object, can be described by a certain exact solution to the Einstein equations discovered by Kerr in the 60's. This belief is based largely on a powerful theorem which shows that the Kerr solution is the unique solution to the vacuum (source-free) Einstein equations with certain prescribed properties. A basic step in the proof is Hawking's theorem on the topology of black holes which asserts that, under physically natural conditions, the surface of a black hole (i.e., cross section of the event horizon) must be topologically a $2$-sphere.

Developments in string theory over the past ten years have generated considerable interest in gravitation and black holes in higher dimensions. The remarkable discovery of Emparan and Reall of a $4+1$ dimensional vacuum black hole solution to the Einstein equations with nonspherical horizon topology raised the question as to what horizon topologies are allowable in higher dimensions. In this talk we review Hawking's theorem on the topology of black holes in $3+1$ dimensions and discuss a generalization of it to higher dimensions obtained in joint work with Rick Schoen. As we shall discuss, this latter result, together with a more recent refinement of it, puts restrictions on the topology of black holes in higher dimensions.

This talk should be accessible to graduate students.