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On the Geometry and Topology of Initial Data Sets in General Relativity

An initial data set in a spacetime (M, g) consists of a spacelike hypersurface V, together with its induced (Riemannian) metric h and second fundamental form K. A solution to the Einstein equations for physically relevant sources influences the geometry of V via the Gauss–Codazzi equations. In this talk we present some results concerning the geometry and topology of asymptotocally flat initial data sets in spacetime. In particular, we will consider the topology of black holes in higher dimensional gravity, inspired by certain developments in string theory and issues related to black hole uniqueness. We will also discuss recent work on the geometry and topology of the region of space exterior to all black holes, which is closely connected to the notion of topological censorship. The results to be discussed rely on the recently developed theory of marginally outer trapped surfaces, which are natural spacetime analogues of minimal surfaces in Riemannian geometry. This talk is based on works with a number of collaborators: Lars Andersson, Mattias Dahl, Michael Eichmair, Dan Pollack and Rick Schoen.