Stability of the positive mass theorem under isoperimetric and integral curvature bounds

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The positive mass theorem is perhaps the most well known and important member of a family of geometric inequalities which links the interior geometry of an asymptotically flat manifold to quantities defined “at infinity”. The Riemannian positive mass theorem states that an asymptotically flat Riemannian manifold with non-negative scalar curvature must have non-negative mass. Furthermore, if an asymptotically flat Riemannian manifold with non-negative scalar curvature has zero mass, then it must be isometric to Euclidean space.

In dimension three, H. Bray, D. Kazaras, M. Khuri, and D. Stern derive a formula for the mass of an asymptotically flat Riemannian manifold in terms of scalar curvature and harmonic functions. One result of this formula is a new and beautiful proof of the positive mass theorem. However, even more interestingly, such quantitative knowledge is likely crucial to answering the following question: if an asymptotically flat Riemannian manifold with non-negative scalar curvature has small mass, must it be close to Euclidean space?

In this talk I will outline some recent work on this problem carried out in collaboration with B. Allen and D. Kazaras.