DIFFERENTIAL GEOMETRY/PDE SEMINAR
(JOINT WITH MATH-PHYSICS STRING THEORY SEMINAR)

Tuesday, December 2, 2003
Padelford C-401
1:30 pm

The analysis and geometry of black holes, Price's law, and the cosmic censorship conjectures

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The central physical problem in classical general relativity is the study of the collapse of isolated self-gravitating systems. Mathematically, the problem is expressed as the global study of the evolution of asymptotically flat data for appropriate Einstein-matter systems. Gravitational collapse is associated with spectacular predictions: the formation of black holes, naked singularities, and Cauchy horizons. These phenomena raise fundamental questions, such as the validity of the principle of determinism in the context of classical physics. These questions find a definite mathematical formulation in the celebrated weak and strong cosmic censorship conjectures of Roger Penrose.

In this talk, I will present rigorous results pertaining to a well-known model for gravitational collapse, which has been heuristically and numerically studied for many years now in the physics literature. In particular, under a definite formulation, strong cosmic censorship is found to be false, and Cauchy horizons are shown to be stable, albeit in a weak sense. (The results confirm a scenario, known as "mass inflation", first postulated in 1990 by Israel and Poisson.)

Mathematically, the results described in this talk depend on the qualitative study of the large time behavior to large-data solutions of a system of non-linear hyperbolic p.d.e.'s in 2 dimensions. The techniques depend heavily on the interplay of the global conformal geometry of the black hole that forms, the celebrated red-shift and blue-shift effects, and local energy conservation.

An important component of the results I will describe is the proof of the so-called "Price's law". (This part is joint work with Igor Rodnianksi.) This "law", dating back to 1972, postulates inverse-power decay rates for the gravitational radiation flux on the event horizon and null infinity, with respect to appropriately normalized advanced and retarded null coordinates. Besides relating to strong cosmic censorship and the fate of observers who dare cross the event horizon, this law has independent interest, as it can be interpreted in terms of observations in the astrophysical regime. The methods employed may be relevant for understanding the general problem of stability of black hole solutions in the absence of symmetry.

For more information about this seminar, visit the DG/PDE Seminar Web page (from the Math Department home page, `www.math.washington.edu`, follow the link **Seminars, Colloquia, and Conferences**).

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