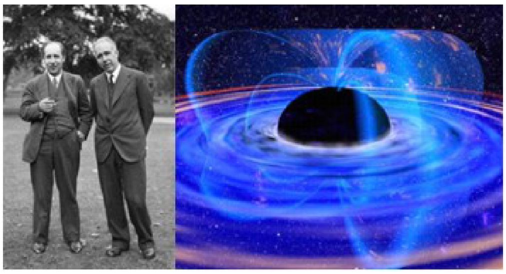
Mathematical Aspects of General Relativity



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Negative Point Mass Singularities (NPMS)

Friday 11 April 2008 16:20 (45 minutes)

In this talk we will discuss a geometric inequality which is in the same spirit as the Positive Mass Theorem and the Penrose Inequality for black holes. Whereas the cases of equality of these first two theorems are respectively Minkowski space (which can be thought of as Schwarzschild with zero mass) and the Schwarzschild spacetime with positive mass, the case of equality for the inequality we will discuss is the Schwarzschild spacetime with negative mass.

Physically speaking, when positive amounts of energy are concentrated as much as possible, black holes results. However, when negative amounts of energy are “concentrated” as much as possible, it is in fact possible to form point singularities in each spacelike slice (which form a timelike curve of singularities in the spacetime).

As usual we will focus on maximal, spacelike slices of spacetimes as a first step. The assumption of nonnegative energy density on these slices implies that these Riemannian 3-manifolds have nonnegative scalar curvature. However, we will allow these 3-manifolds to have singularities which contribute negatively to the total mass. The standard example is the negative Schwarzschild metric on R^3 minus a ball of radius m/2, (1 - m/2r)^4 \delta_{ij}. This metric (which has total mass -m) has zero scalar curvature everywhere but has a singularity at r = m/2. We will propose a definition for the mass of a singularity, and prove a sharp lower bound on the ADM mass in terms of the masses of the singularities in the 3-manifold, modulo an interesting geometric conjecture.

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