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*APEs*

I will discuss asymptotically hyperbolic manifolds and sub-types, especially Asymptotically Poincaré-Einstein (APE) manifolds. These are manifolds whose metrics admit a Fefferman-Graham type expansion near conformal infinity, such that the first few leading terms are determined by the Einstein equations. APEs appear in physics, both as time slices of asymptotically Anti-de Sitter (AdS) spacetimes and as Wick rotations of static AdS spacetimes. Among the invariants that can (sometimes) be associated to APEs are mass and renormalized volume. For APEs that represent static AdS black holes in 4 dimensions, the renormalized volume and the mass of a static slice can be related. Remarkably, this relationship, which can be established purely on geometric grounds, is the Gibbs relation of black hole thermodynamics. A related result is that APEs which are time-symmetric slices of globally static AdS spacetimes cannot have positive mass. Examples are provided by Horowitz-Myers geons, which are complete APEs with scalar curvature $S = -n(n-1)$ and negative mass. They serve as time-symmetric slices of so-called AdS solitons, which are Einstein spacetimes with toroidal conformal infinity. The Horowitz-Myers "positive" energy conjecture proposes that Horowitz-Myers geons minimize the mass over all APEs with scalar curvature $S \geq -n(n-1)$ and the same toroidal conformal infinity. The conjecture is a major open problem in the field, but it is possible to show that if this conjecture is true then there is a rigidity theorem for Horowitz-Myers geons: the least-mass geon is the unique complete APE having that mass and obeying $S \geq -n(n-1)$.