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Are Analytic Compact Cauchy Horizons Necessarily Killing Horizons?

Related Open Questions

1. In the *ergodic* case, the Cauchy horizon in question is (by definition) densely filled by its null generators. Examples of these are provided by flat Kazner spacetimes which are compactified to $\mathbf{T}^3 \times \mathbf{R}$ with appropriate 'irrational shifts' in the coordinates so as to achieve densely filling generators. One would like to prove that these and their finite quotients are the only possible ergodic solutions or, if this is not the case, to characterize the complete set of analytic ergodic, compact (electro-vacuum) Cauchy horizons.

2. Examples of degenerate *event* horizons are provided by extreme, stationary black hole solutions. But when these are compactified they yield spacetimes which are acausal on both sides of the 'horizon'. It seems to still be an open question whether examples admitting actual degenerate, compact Cauchy horizons exist at all. One would like to prove either that they don't exist or else to characterize them completely. A complication is that some of the basic methods developed for dealing with generators of finite affine length break down in the degenerate case.

3. Many of the existing arguments make special use of the 4-dimensional nature of spacetime. It is at least of mathematical interest to ask whether they can be generalized to spacetimes of higher dimensions. In related work Jim and I showed that rotating, higher dimensional stationary black holes always admit additional Killing fields but this argument makes a priori use of the stationarity assumption, the analogue of which is missing in the cosmological problem.

4. In some early work proving the existence of large families of *analytic* vacuum spacetimes having compact Cauchy horizons I exploited a *generalization* of the standard Cauchy-Kovalevskaya theorem. This was needed to handle the Fuchsian singularities in the field equations that appeared when the metric was written in coordinates adapted to the horizon. Can recent progress on the study of Fuchsian singular field equations be exploited to extend such results to deal with non-analytic solutions?