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Symmetries of Cosmological Cauchy Horizons*

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Abstract. We consider analytic vacuum and electrovacuum spacetimes which contain a compact null hypersurface ruled by *closed* null generators. We prove that each such spacetime has a non-trivial Killing symmetry. We distinguish two classes of null surfaces, degenerate and non-degenerate ones, characterized by the zero or non-zero value of a constant analogous to the "surface gravity" of stationary black holes. We show that the non-degenerate null surfaces are always Cauchy horizons across which the Killing fields change from spacelike (in the globally hyperbolic regions) to timelike (in the acausal, analytic extensions).

For the special case of a null surface diffeomorphic to $\mathbf{T}^3$ we characterize the degenerate vacuum solutions completely. These consist of an infinite dimensional family of "plane wave" spacetimes which are entirely foliated by compact null surfaces. Previous work by one of us has shown that, when one dimensional Killing symmetries are allowed, then infinite dimensional families of non-degenerate, vacuum solutions exist. We recall these results for the case of Cauchy horizons diffeomorphic to $\mathbf{T}^3$ and prove the generality of the previously constructed non-degenerate solutions.

We briefly discuss the possibility of removing the assumptions of closed generators and analyticity and proving an appropriate generalization of our main results. Such a generalization would provide strong support for the cosmic censorship conjecture by showing that causality violating, cosmological solutions of Einstein's equations are essentially an artefact of symmetry.

I. Introduction

As is well known, there exist vacuum solutions of Einstein's equations such as the Taub-NUT solutions which contain smooth, compact Cauchy horizons. These horizons separate globally hyperbolic regions (e.g., Taub space) from causality

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