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Well-posedness of characteristic formulations of GR

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Characteristic formulations of General Relativity (GR) have advantages over more standard spacelike foliations in a number of situations. For instance, the Bondi-Sachs formalism is at the base of codes that aim to produce gravitational waveforms of high accuracy, exploiting the fact that null hypersurfaces reach future null infinity and hence avoid systematic errors of extrapolation techniques. Furthermore, characteristic formulations in asymptotically anti-de Sitter spacetimes are widely used in the field of numerical holography, which can provide insights for the behavior of strongly coupled matter. Well-posedness of the resulting PDE systems, however, remains an open question. The answer to this question affects the accuracy of the results and the reliability of the conclusions drawn from numerical studies based on such formulations. A numerical solution can converge to the continuous one only for well-posed PDE systems. The well-posedness of the initial value problem of such systems is characterized by strong hyperbolicity. We find that the PDE systems arising from the aforementioned formulations are only weakly hyperbolic, due to a shared pathological structure in both the asymptotically flat and anti de-Sitter cases. We present numerical tests that demonstrate this problem at the practical level.

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