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Curvature invariants for accelerating, rotating and charged black holes in (anti-)de Sitter spacetime

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The curvature scalar invariants of the Riemann tensor are important in General Relativity because they allow a manifestly coordinate invariant characterisation of certain geometrical properties of spacetimes such as, among others, curvature singularities, gravitomagnetism. We calculate explicit analytic expressions for the set of Zakhary-McIntosh curvature invariants for accelerating Kerr-Newman black holes in (anti-)de Sitter spacetime as well as for the Kerr-Newman-(anti-)de Sitter black hole.
These black hole metrics belong to the most general type D solution of the Einstein-Maxwell equations with a cosmological constant.
Explicit analytic expressions for the Euler-Poincare density invariant, which is relevant for the computation of the Euler-Poincare characteristic $\chi(M)$, and the Kretschmann scalar are also provided for both cases.
We perform a detailed plotting of the curvature invariants that reveal a rich structure of the spacetime geometry surrounding the singularity of a rotating, electrically charged and accelerating black hole . These graphs also help us in an exact mathematical way to explore the interior of these black holes.
Our explicit closed form expressions show that the above gravitational backgrounds possess a non-trivial Hirzebruch signature density. Possible physical applications of this property for the electromagnetic duality anomaly in curved spacetimes that can spoil helicity conservation are briefly discussed.

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