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Theory: Constructing accelerating NUT black holes

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We employ Ehlers transformations, Lie point symmetries of the Einstein field equations, to efficiently endorse accelerating metrics with a nontrivial NUT charge. Under this context, we begin by re-deriving the known C-metric NUT spacetime described by Chng, Mann, and Stelea in a straightforward manner, and in the new form of the solution introduced by Podolský and Vrátný. Next, we construct for the first time an accelerating NUT black hole dressed with a conformally coupled scalar field. These solutions belong to the general class of type I spacetimes, therefore cannot be obtained from any limit of the Plebański-Demiański family whatsoever and their integration needs to be carried out independently. Including Maxwell fields is certainly permitted, however, the use of Ehlers transformations is subtle and requires further modifications. Ehlers transformations do not only partially rotate the mass parameter such that its magnetic component appears, but also rotate the corresponding gauge fields. We present a Reissner-Nordström-C-metric NUT-like black hole that correctly reproduces the Reissner-Nordström-C-metric and Reissner-Nordström-NUT line elements in the corresponding limiting cases but with a misaligned electromagnetic potential.

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