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Non-singular spacetimes with the NUT parameter

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The spacetimes with the NUT parameter are commonly associated with an unwanted defect in the form of a singular axis of symmetry. In the case of the Taub-NUT spacetime the most common remedy is the Misner's interpretation: by compactifying the orbits of the cyclic time symmetry one discovers that the spacetime has a structure of the Hopf fibration. Then Taub-NUT may be regarded as a smooth "regularizer" of the Schwarzschild solution curing the curvature singularity at $r = 0$.

I will discuss how the above results may be extended to black hole spacetimes including more parameters – Kerr rotation, cosmological constant and acceleration. Surprisingly, additional parameters do not necessarily lead to harsher conditions for non-singularity. The basic premise of the extension of Misner's interpretation to more general spacetimes is to find Killing vector fields generating the non-singular orbit space and subsequently impose the $U(1)$ -principle bundle structure onto the spacetime. This leads to spacetimes without singular axis for all admissible parameters, and even to completely singularity-free spacetime for a subfamily of accelerated Kerr-NUT-(anti-) de Sitter (i.e. general Plebański-Demiański, type D, black hole solution). The application of the non-singular interpretation to Killing horizons and cosmology will be presented.

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