General Relativity and Quantum Cosmology

The Non-Autonomous Chiral Model and the Ernst Equation of General Relativity in the Bidifferential Calculus Framework

Aristophanes Dimakis, Nils Kanning, Folkert Müller-Hoissen

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The non-autonomous chiral model equation for an $m \times m$ matrix function on a two-dimensional space appears in particular in general relativity, where for $m=2$ a certain reduction of it determines stationary, axially symmetric solutions of Einstein's vacuum equations, and for $m=3$ solutions of the Einstein-Maxwell equations. Using a very simple and general result of the bidifferential calculus approach to integrable partial differential and difference equations, we generate a large class of exact solutions of this chiral model. The solutions are parametrized by a set of matrices, the size of which can be arbitrarily large. The matrices are subject to a Sylvester equation that has to be solved and generically admits a unique solution. By imposing the aforementioned reductions on the matrix data, we recover the Ernst potentials of multi-Kerr-NUT and multi-Demianski-Newman metrics.

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