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Killing tensors in stationary and axially symmetric space-times

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Abstract

We discuss the existence of Killing tensors for certain (physically motivated) stationary and axially symmetric vacuum space-times. We show nonexistence of a nontrivial Killing tensor for a Tomimatsu-Sato metric (up to valence 7), for a C-metric (up to valence 9) and for a Zipoy-Voorhees metric (up to valence 11).

The results are obtained by mathematically completely rigorous, nontrivial computer algebra computations with a huge number of equations involved in the problem.

1 Introduction

Let (M, g) be a 4-dimensional manifold with Lorentzian metric g of signature (+,+,+,–). A *Killing tensor* of valence d on M is a symmetric tensor field K whose symmetrized covariant derivative vanishes,

$$\nabla_{(j} K_{i_1 \dots i_d)} = 0. \tag{1}$$

Here, ∇ denotes the Levi-Civita connection of g and the components $K_{i_1 \dots i_d}$ smoothly depend on the position coordinates.

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