Hidden symmetry of three dimensional rotating black hole

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Abstract

In this work, we study explicit and hidden symmetries of curved space-time. The explicit and hidden symmetries share the feature that their generators in the phase space of probe particle are constants of motion. Their difference is that the generator of hidden symmetry is given by the contraction of Killing tensor by two or more particle momenta while for the explicit symmetry, this generator is linear in particle momentum. Therefore, we can read the Killing tensors of a curved space-time using the constants of motions associated with its probe particle. The Killing tensors of four-dimensional and also higher-dimensional geometries have been studied. In this work, we answer the question about the existence of hidden symmetry in the three-dimensional rotating black hole. To this end, we independently analyze two types of probes: free particle and scalar field. Using the related constants of motion, we show that the Killing tensor of this three-dimensional black hole is trivial.

Keywords: curved space-time, Killing tensor, phase space, scalar field

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