

This is a review article on recent developments in systematic construction of black hole solutions by use of the inverse scattering method (ISM) [1]. The ISM turns out to be a powerful tool to generate “black ring” solutions in five-dimensional gravity theories; the “black rings” were first discovered in [2]. In an introductory section the authors provide a nice review for the black ring solutions in relation to the applications of the ISM. A detailed description of the ISM is then given, followed by an illustration of its use to generate, in particular, electrically charged black ring solutions of five-dimensional Einstein-Maxwell dilaton (EMd) theory.

What is behind the success of the ISM in generating such black ring solutions seems to be the integrability of Einstein equations in a higher dimension. As succinctly illustrated in this review, the five-dimensional EMd theory can be obtained by dimensional reduction of the six-dimensional pure gravity theory. Applying the ISM to the latter theory defined in $\mathbb{R}^5 \times S^1$ then leads to a variety of solutions in the former theory after Kaluza-Klein reduction (of the pure gravity theory). This suggests that other tools for the analysis of integrable models are also useful as a solution-generating method for five-dimensional black hole solutions; for a related review, see [3].

The main purpose of these studies is to find new higher-dimensional black hole solutions, in a sense, descended from the spirit of Kerr who discovered the famous Kerr black holes. From a perspective of gauge/gravity duality or string theory, however, these solutions may provide an unexpected insight into gauge theories.

References

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