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Spinning black holes with Skyrme hair

Abstract

We study a new family of stationary rotating axially symmetric hairy black holes which represent solutions of the non-linear O(3)sigma model in the Kerr spacetime. Here the scalar hairs represent topologically trivial clouds surrounding rotating black hole, they are counterparts of the "cloudy" black holes in the Einstein-Klein-Gordon theory, that trivialise both in the absence of a black hole and in the at flat space limit. We found that the spinning axially symmetric cloudy solutions of the O(3) sigma model also exist in the regular asymptotically flat space-time without the event horizon. These congurations are similar to the usual rotating boson stars, which, in the at flat space limit are linked to the axially symmetric Q-balls, in both cases the solutions exist for some restricted range of values of the angular frequency and possess a quantized angular momentum. However, unlike boson stars in the model with sextic potential, the O(3) scalar clouds do not posses a at space limit. We show that, depending on the values of the parameters of the model and the Hawking temperature, the branch structure of the cloudy solutions varies from the usual inspirraling pattern, which is typical for the boson stars, to the two branch structure, similar to that of the black holes with Skyrme hairs