New results on the RBGs/GR correspondence

Orazi E. *
ECT&IIP UFRN

Delhom A.**
IFIC-CSIC Universidade de Valencia

Olmo G.*
IFIC-CSIC Universidade de Valencia

Kerr black holes are known to support massive bosonic test fields whose phase angular velocity fulfills the synchronization condition, i.e. the threshold of superradiance. The presence of these real-frequency bound states at the linear level, commonly dubbed stationary clouds, is intimately linked to existence of Kerr black holes with bosonic hair at the non-linear level. These configurations are very similar to the atomic orbitals of the electron in a hydrogen atom. In fact, they are finite on and outside the black hole's event horizon, decay exponentially at spatial infinity and can be labeled by four quantum numbers: n, the number of nodes of the radial function; l, the orbital angular momentum; j, the total angular momentum; and m, the projection of the total angular momentum along the black hole's axis of rotation. The existence of stationary test-field configurations is only allowed for specific values of the black hole's mass M and angular momentum per unit mass a. Such quantization follows from the regularity of the bound states and results in an existence line in the two-dimensional Kerr parameter space defined by (M, a).
While the phenomenology of stationary scalar clouds has been widely addressed in the literature over the last years, little is known about the physical properties of their vector counterparts. Following the recent demonstration of the separability of the Proca equation in Kerr spacetime, we compute the existence lines of such stationary vector clouds in a (M, a) diagram for Kerr black holes and compare them with those of stationary scalar clouds, discussing the role played by the intrinsic angular momentum.

Keywords: Kerr black holes, stationary clouds, Proca equation