Non-linear Superradiance of Charged Black Holes: Beyond Spherical Symmetry

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The presence of bosonic fields in the vicinity of a black hole can lead to many kinds of interesting dynamics. One of them is superradiance. For rotating black holes a free, massive, complex, bosonic field can extract rotational energy and angular momentum from the black hole, spinning it down and leading to a new equilibrium state: a black hole with synchronized bosonic hair. For charged black holes, it was recently discussed that a self-interacting, gauged scalar field can extract Coulomb energy and charge from the black hole, decreasing its charge, and leading to a new equilibrium state: a black hole with resonant bosonic hair. This latter work showed a type of non-linear superradiance. However, this analysis assumed spherical symmetry.

In this work, we move beyond those assumptions and perform numerical simulations using full 3+1 numerical relativity of a scalar field, that is minimally coupled to the electromagnetic sector, around a charged black hole.