

Dynamically viable asymptotically flat black holes with scalar hair: superradiant growth *vs.* scalarisation

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Abstract

John Wheeler coined the mantra “Black Holes have no hair”, meaning there are no macroscopic degrees of freedom other than the ones associated to Gauss laws. Yet, there are many known hairy BH solutions. Then, the real question is, can a hairy black hole form dynamically and be sufficiently stable? I will describe two different models wherein asymptotically flat black holes with scalar hair form dynamically from instabilities of electro-vacuum black holes. In the first model, Kerr black holes are unstable, via superradiance, against the formation of hair when in the presence of a sufficiently light, massive scalar field. If the scalar field is, moreover, complex, then an entropically favoured stationary hairy black hole solution exists, which has been shown to form dynamically, via fully non-linear numerical simulations. This is not the end point of the process but can be very long lived. In the second model, Reissner-Nordström black holes are unstable, via a tachyonic instability, against the formation of hair when in the presence of a real massless scalar field non-minimally coupled to the electromagnetic field (but minimally coupled to gravity). There are also entropically favoured hairy black holes which have been shown to form dynamically, via fully non-linear numerical simulations. In these case these appear to be the endpoint of the instability. I will comment on the phenomenology and implications of these dynamically viable hairy black holes.