Quasinormal mode orthogonality II: Application to Kerr

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Abstract

For stationary, (t, ϕ)–symmetric spacetimes we have shown the existence of a bilinear form with respect to which quasinormal modes are orthogonal. This is used to analyze nonlinear mode coupling by expanding Einstein's equations into quasinormal modes and projecting the leading nonlinearities onto these modes. Though the modes are not complete, we expect the analysis to provide a qualitative nonlinear description of the long-lived perturbations near highly spinning black holes. Our aim is to understand these (transient) phenomena within the context of wave turbulence and Kolmogorov scaling, as valid in a time window set by how far the black hole is from the extremal state.

In fact, for very nearly extremal black holes, the corresponding mode solutions take simple analytic forms in a matched asymptotic expansion. We evaluate the bilinear form on these modes, and show that it depends only on the near-horizon region where the mode functions form representations of the near-horizon symmetry group. This should enable a group theoretic interpretation of the nonlinear physics.