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Ringdown and echoes as probes of strong-field dynamics of general relativity

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The detections of the presumed binary black hole coalescences in the first observing run of Advanced LIGO have allowed us to probe the genuinely strong-field dynamics of Einstein's general theory of relativity for the first time, and put tight constraints on the inspiral-merger-ringdown dynamics of the binary coalescence process. Subsequent detections are expected to be able to more directly probe the nature of the compact objects themselves in complementary ways.

Observation of the ringdown of the merger remnant will allow for a test of the black hole no-hair theorem. One can search for systematic departures in quasinormal mode frequencies and damping times from their values as predicted by general relativity. In the first part, we present a pipeline to carry out such a test of the no-hair theorem.

Exotic compact objects (e.g. boson stars, dark matter stars, gravastars), and even certain quantum modifications to black holes (e.g. firewalls) are speculated to have consequences in the form of gravitational wave echoes, or bursts of radiation that appear at regular time intervals after the ringdown has ended. In the concluding part, we discuss the prospects of a search for such post-merger signals.

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