Black hole spectroscopy with overtones

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Gravitational waves promise to be an essential tool in furthering our understanding of fundamental physics, including testing general relativity and experimentally studying black holes. This can be achieved by analyzing the properties of remnants from compact-binary coalescences, so as to understand whether they are indeed the Kerr black holes predicted by Einstein's theory. Perhaps the most direct way to do this is to identify and characterize the quasinormal modes in the ringing of the remnant object, as imprinted on the final portion of the gravitational-wave signal. This program is known as "black-hole spectroscopy." In this talk, we will discuss the role that overtones, the quasinormal modes with the shortest durations, have to play in this program. In particular, we will show how overtones can enable tests of the no-hair theorem with existing gravitational wave detectors, and demonstrate this with LIGO data. This is unlike most other studies, which tend to focus on next-generation instruments (ground-based or spaceborne). Finally, we will present projections for future detectors and discuss implications for the study of the fundamental physics of black holes.