Enriching the Symphony of Gravitational Waves from Binary Black Holes by Tuning Higher Harmonics

Roberto Cotesta, Alessandra Buonanno, Serguei Ossokine, Sylvain Marsat, Michael Pürrer, Katerina Chatziioannou

1 Abstract

Improving models of gravitational waves is crucial to take full advantage of the sensitivity's increase of LIGO and Virgo detectors. The gravitational waveform of binary black-hole coalescences is usually approximated by the dominant quadrupole mode. Several studies have shown that this approximation degrades with increasing total mass of the system, mass ratio, and binary-observer orientation. In these cases, neglecting higher-order modes in the waveform could lead to biases in the parameter estimation or, worst, to the loss of interesting detections. Higher modes are also important to test the Kerr nature of the remnant of a binary black-hole coalescence. I will present a new inspiral-merger-ringdown waveform model within the effective-one-body formalism for spinning binary black holes including higher-order modes. In the non-precessing case, I will also discuss its reduced–order-model fast version, which allows us to speed up the generation of a single waveform by orders of magnitude. I will use this new model to infer the astrophysical properties of GW170729, which so far has the highest total mass among the LIGO and Virgo detections, thus it is the most promising event to observe higher modes.