Detection and characterization of eccentric compact binary coalescence at the interface of numerical relativity, analytical relativity and machine learning

ELIU HUERTA, DANIEL GEORGE, ROLAND HAAS, DANIEL JOHNSON, DEREK GLENNON, ADAM REBEI, A. MIGUEL HOLGADO, NCSA/University of Illinois at Urbana-Champaign, C. J. MOORE, ISTCENTRA, PRAYUSH KUMAR, Cornell University, ALVIN CHUA, JPL/Caltech, ERIK WESSEL, University of Arizona, JONATHAN GAIR, University of Edinburgh, HARALD PFEIFFER, CITA/AEI — We present ENIGMA, a time domain, inspiral-merger-ringdown waveform model that describes nonspinning binary black holes systems that evolve on moderately eccentric orbits (https://arxiv.org/abs/1711.06276). The inspiral evolution is described using a consistent combination of post-Newtonian theory, self-force and black hole perturbation theory. Assuming moderately eccentric binaries that circularize prior to coalescence, we smoothly match the eccentric inspiral with a stand-alone, quasi-circular merger, which is constructed using machine learning algorithms that are trained with quasi-circular numerical relativity waveforms. We show that ENIGMA reproduces with excellent accuracy the dynamics of quasi-circular compact binaries, and numerical relativity waveforms that describe eccentric binary black hole mergers with mass-ratios $1 < q < 5.5$, and eccentricities $e < 0.2$ ten orbits before merger. We use ENIGMA to show that if the gravitational wave events GW150914, GW151226, GW170104 and GW170814 have eccentricities $e \sim 0.1$ at 10 Hz, they can be misclassified as quasi-circular binaries due to parameter space degeneracies between eccentricity and spin corrections.

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