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Analytic black-hole binary mergers: waveforms and kicks from first principles SEAN MCWILLIAMS, West Virginia University — We present a highly accurate, fully analytical model for the late inspiral, merger, and ringdown of black-hole binaries with arbitrary mass ratios and spin vectors, including the contributions of harmonics beyond the fundamental mode. This model assumes only that nonlinear effects remain small throughout the entire coalescence, and is developed based on a physical understanding of the dynamics of late stage binary evolution, in particular on the tendency of the dynamical binary spacetime to behave like a linear perturbation of the stationary merger-remnant spacetime, even at times before the merger has occurred. We demonstrate that the waveforms predicted by our model agree with the most accurate numerical relativity results to within their own uncertainties throughout the merger-ringdown phase, and do so for example cases spanning the full range of binary parameter space that is currently testable with numerical relativity. In addition, we combine the waveform model with an improved physical understanding of spinning binary mergers to fully explain the origin of "superkicks", and compare our predictions to numerical relativity. Finally, we highlight some novel predictions from our model that have not yet been observed in numerical relativity simulations.

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