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Parameter estimation of gravitational waves from hyperbolic black hole encounters

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Binary black hole systems with unbound orbits can produce a diverse array of gravitational wave signals with rich morphology. This parameter space encompasses both hyperbolic orbit scattering events and dynamical captures, including zoom-whirl orbits with multiple flybys and direct plunge mergers. These signals challenge traditional parameter estimation infrastructure, which is largely optimized for quasicircular inspiral binaries. In this work we discuss the adaptation of the Rapid Iterative FiTting (RIFT) algorithm to this problem using the TEOBResumSDALI waveform model which can simulate generic orbits. We present results from a study of simulated signals emulating a scatter and plunge event, utilizing the design sensitivity of the forthcoming Cosmic Explorer interferometer. Our analysis demonstrates that RIFT accurately recovers the mass, spins, and hyperbolic orbit parameters: the system energy and angular momentum defined at a fiducial initial separation.

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