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Affiliation: Rochester Institute of Technology

Carlos Lousto

The Latest Results of Numerical Relativity Simulations of Binary Black Holes

Abstract

We explicitly demonstrate that current numerical relativity techniques are able to accurately evolve black hole binaries with mass ratios of the order of 1000:1. This proof of principle is relevant for future third generation gravitational wave detectors and space mission LISA, as by purely numerical methods we would be able to accurately compute gravitational waves from the last stages of black hole mergers, as directly predicted by general relativity. This work represents a first step towards the considerable challenge of applying numerical-relativity waveforms to interpreting gravitational-wave observations by LISA and next-generation ground-based gravitational-wave detectors.

We also performed a series of 1381 full numerical simulations of high energy collision of black holes to search for the maximum recoil velocity after their merger. We consider equal mass binaries with opposite spins pointing along their orbital plane and perform a search of spin orientations, impact parameters, and initial linear momenta to find the maximum recoil for a given spin magnitude s. This spin sequence for s=0.4, 0.7, 0.8, 0.85, 0.9 is then extrapolated to the extreme case, s=1, to obtain an estimated maximum recoil velocity of 28,562+/-342km/s, thus approximately bounded by 10% of the speed of light.