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Measuring the gravitational recoil from binary black hole mergers
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Gravitational waves carry energy, angular momentum, and linear momentum. For generic binary black holes, the loss of linear momentum imparts a recoil velocity or a kick to the remnant black hole produced by the merger. We exploit recent advances in gravitational waveform and remnant black hole modeling to measure both the kick magnitude and direction from gravitational wave signals. We find that very little information can be gained about the kick velocity for existing gravitational wave events, but that interesting measurements will soon become possible as the detectors improve. We show that, once LIGO and Virgo reach their design sensitivities, we will reliably measure the kick velocity for generically precessing binaries, including the so-called superkicks reaching up to 5000 km/s. Kick measurements such as these are fundamentally interesting as probes of the ability of gravitational fields to carry linear momentum. They can also be used to place an independent constraint on the rate of second-generation binary mergers. Finally, we show that the kick must be factored into tests of general relativity with third-generation gravitational wave detectors to avoid Doppler-induced biases in the remnant mass as measured from the ringdown alone.

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