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Test of General Relativity Using Gravitational Waves from a Population of Binary Black Holes

Abstract

The quasi-normal modes (QNMs) in the gravitational waves of a binary black hole (BBH) merger are uniquely determined by their frequencies and damping parameters, which depend on the mass and spin of the remnant black hole. The measurement of these frequencies and damping parameters can be used as a test of General Relativity (GR). It is difficult to measure the QNMs for individual BBH events because of their low signal to noise ratio (SNR). We propose a method to add (stack) signals coherently from multiple BBH detections to increase the QNM's SNR. We determine the frequency and damping parameter of the dominant (l=2,m=2) mode for the stacked signal. This frequency and damping parameter are then used to find the spin of the remanent black hole, which is compared with GR predictions. We have used a population of BBH mergers detected in the O3 run for the stacking procedure and found the spin parameter to agree with GR predictions.