Studying the Effects of Higher-Order Modes on the Parameter Estimation of Precessing Low-Mass Binary Black Holes

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Precessing low-mass binary black holes are promising detection candidates in Advanced LIGO's upcoming observation runs. The gravitational radiation emitted by these systems is distributed across various gravitational wave modes. While the waveforms of symmetric, non-precessing systems can be well described by lower-order modes alone, higher-order modes can carry a significant amount of energy, and thus information, which may be particularly relevant for precessing systems. During parameter estimation, model waveforms are compared against detected signals to recover the parameters of the observed systems. Often, these models only include a few dominant modes, potentially neglecting important information about the source that may be encoded in other modes of its gravitational waveform. This project aims to investigate whether the inclusion of higher-order modes in model waveforms has a significant effect on the accuracy of parameter estimation for precessing, low-mass binary black holes systems. The methods we employ include a Fisher matrix analysis, as well as parameter estimation using Bayesian inference. While our analysis is limited to inspiral waveforms due to a lack of availability of complete inspiral-merger-ringdown waveforms with higher-order modes for precessing systems, future research can extend this analysis to merger and ringdown waveforms, where higher-order modes are expected to be even more significant.