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Bayesian Inference of Gravitational-Wave Signals from Merging Massive Black Hole Binaries

Merging massive black hole binaries (MBHBs) are important gravitational wave (GW) sources for the future space-based observatory LISA. The GW signal from the merger will be detected throughout the entire Universe. Characterization of the GW signal allows us to infer masses and spins of MBHs, the position of the source in the sky and the distance. This information will allow us to understand the mechanism of MBHs formation and their evolution through cosmic history.
The binary could be surrounded by a gaseous disk accreting on each companion, which causes a variability in the X-ray emission correlated with the GW signal. Observation of this feature is a “smoking gun” of a binary system present in the active galactic nuclei. An accurate measure of the MBHB sky position will facilitate simultaneous multimessenger (GW and e/m) observation of merging MBHBs, provided that we already have an estimate of the coalescence time from the inspiral part of the signal.
In this project, we consider the detection of MBHB mergers in the LISA band. During Bayesian parameter estimation, the sky localization of the source in the sky could be improved if we detect higher modes of the GW signal, which we expect to be significant (breaking degeneracies in the parameter space). In addition, we show the prospect of implementing a heterodyned mode-by-mode likelihood scheme, in order to significantly reduce the computational time in Bayesian inference, specifically when including multiple radiation harmonics in the analysis.

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