

Characterizing Bias in Multi-Source Gravitational Wave Inference with LISA

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The Laser Interferometer Space Antenna (LISA) will be the first gravitational wave detector able to observe sources that emit in the millihertz regime such as Galactic Binaries (GBs), Massive Black Hole Binaries (MBHBs) or Extreme Mass Ratio Inspirals (EMRIs). Consequently, the data stream sent by LISA will be a superposition of an unknown number of various gravitational wave sources. In theory, up to 10,000 compact binaries, several hundred of EMRIs and about a hundred of MBHBs are expected to be sensed by the instrument. This overlap makes inferring source parameters extremely challenging.

This project aims to infer the parameters of EMRIs and MBHBs and investigate the intercorrelation between parameters of different sources and intracorrelation among the parameters of the same source. To study this, we compare two inference strategies: a local-fit approach, where individual signals are iteratively inferred and removed while treating other sources as noise, and a computationally intensive global-fit approach that jointly infers multiple sources using a combined likelihood. Our analysis focuses on quantifying biases introduced during parameter estimation. Results show that EMRI signals exhibit minimal overlap with GBs and MBHBs in the frequency domain, suggesting they can often be analysed independently. We also examine interparameter correlations across different source classes and intraparametric correlations within individual sources, finding negligible cross-source correlations but significant correlations among EMRI parameters. These findings highlight the importance of understanding and mitigating inference bias for accurate population studies in future LISA observations. Our simulations have shown promising results and paves the way for future work on multiple EMRIs characterization.

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