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A parametrized test of General Relativity applied to LISA Massive Black Hole Binaries

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LISA observations of Massive Black Hole Binaries (MBHBs) will provide high signal-to-noise ratio (SNR) data, ideal for testing General Relativity (GR) in the strong field regime. MBHBs with masses between 10^4 and $10^7 M_\odot$ produce inspiral signals in LISA's frequency band, well-modeled by the Post Newtonian (PN) approach, followed by loud merger-ringdown signals. We present a framework for parametrized inspiral GR tests with gravitational waves (GWs) from MBHBs, inspired by existing LIGO-Virgo-KAGRA (LVK) tools. This approach introduces generic deviations to the PN coefficients of the frequency-domain GW phase, effectively identifying potential GR violations by constraining deviations in the PN phasing formula.

Our results demonstrate that parameter constraints depend significantly on both mass and SNR, as LISA's sensitivity to different gravitational wave phases—inspiral, merger, and ringdown—varies across MBHB's parameter space. We also investigate the interplay between inspiral-only versus inspiral-merger-ringdown analyses in constraining deviation parameters.

Complementary analyses using Fisher matrix and full Bayesian approaches confirm that LISA observations could improve constraints on deviations from GR by at least two orders of magnitude compared to the most recent LVK measurements.

This work contributes to the development of robust tests of GR with LISA, enhancing our ability to probe the nature of gravity.

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