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Biases in tests of GR due to microlensed GW signals

Gravitational waves (GW) from chirping binary black holes (BBHs) provide unique opportunities to test general relativity (GR) in the strong-field regime. However, testing GR can be challenging when incomplete physical modeling of the expected signal gives rise to systematic biases. In this talk, we discuss the potential influence of wave effects in gravitational lensing (also known as microlensing) on tests of GR using GWs. We present the results for an isolated point-lens model for microlensing with the lens mass ranging from $10-10^5$ $M_\odot$ and base our conclusions on an astrophysically motivated population of BBHs in the LIGO-Virgo detector network. Our analysis centers on two theory-agnostic tests of gravity: the inspiral-merger-ringdown consistency test (IMRCT) and the parameterized tests, providing insights into deviations from GR across different evolutionary phases of GW signals: inspiral, intermediate, and merger-ringdown. Our findings reveal two key insights: First, microlensing can significantly bias GR tests, with a confidence level exceeding 5σ. Second, deviations from GR correlate with pronounced interference effects, which appear when the GW frequency (f_{GW}) aligns with the inverse time delay between microlens-induced images (t_{d}). These false deviations peak in the wave-dominated region and fade where $f_{\mathrm{GW}} \cdot t_{\mathrm{d}}$ significantly deviates from unity. Our findings apply broadly to any microlensing scenario, extending beyond specific models and parameter spaces, as we relate the observed biases to the fundamental characteristics of lensing.

Primary author: GANGULY, Apratim (Inter-University Centre for Astronomy and Astrophysics)

Co-authors: Dr MISHRA, Anuj (ICTS-TIFR); Dr KRISHNENDU, N. V. (ICTS-TIFR)

Presenter: GANGULY, Apratim (Inter-University Centre for Astronomy and Astrophysics)

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