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Unraveling the Connection: Eccentric Binary Black Holes and Microlensed Signals

Microlensing and eccentricity are two distinct physical effects that have not yet been observed in real gravitational wave events. While the rate of microlensed signals remains uncertain, the impact of non-zero eccentricity becomes increasingly significant as we explore the early stages of binary evolution or improve the sensitivity of detectors. Therefore, it is crucial to investigate whether microlensing modulations can mimic the effects of eccentricity, potentially affecting microlensing searches. In this study, we examine the degeneracy between eccentricity and microlensing by analyzing both eccentric numerical relativity (NR) data and TEOBResumS injections. Our findings indicate that the preference for the microlensing hypothesis over the usual unlensed hypothesis strengthens with: (i) higher eccentricities, (ii) longer waveforms, and (iii) high signal-to-noise ratios (SNRs). Population studies demonstrate that microlensing templates are consistently favored over unlensed templates when eccentricities exceed approximately 0.2. Based on these results, our study strongly suggests that any identified microlensed signal should also be confirmed using an eccentric waveform model to resolve the degeneracy. We further demonstrate this by recovering signals with eccentric templates and comparing them with the microlensed ones.

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