Testing the multipole structure of compact binaries using gravitational wave observations: The spinning case

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We propose a model-independent method to test general relativity by parametrizing the gravitational waveform in terms of the multipole moments within the Post-Newtonian (PN) framework. We derive the parametrized multipolar gravitational-wave phase evolution for compact binaries in quasi-circular orbit, including spin effects in the inspiral dynamics at 3.5PN order and deviations to the PN coefficients in the conserved energy. We assume that the companion spins are either aligned or anti-aligned with respect to the orbital angular momentum and compute spin-orbit corrections that are accurate up to the next-to-next-to-leading order (3.5PN order) and the quadratic-in-spin effects up to 3PN order in the gravitational-wave flux and the PN phase, parametrized in terms of multipole moments. We find that LISA can measure the first 4 leading order multipole coefficients with reasonable accuracies for an observation time of one year. Our waveforms could be used to investigate any deviations of the multipole coefficients from GR using data from current and future observing runs and to assess theability of next generation of detectors to constrain GR.

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