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Spin-induced quadrupole moment test for eccentric compact binaries

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Testing the binary black hole nature of compact binaries relies on the “no-hair” conjecture, which posits that a Kerr black hole’s properties are fully characterized by its mass and spin. This conjecture underpins tests applied to circular compact binaries detected by gravitational wave (GW) detectors, where the quadrupole moment depends solely on mass and spin. In contrast, exotic compact objects may require additional parameters, such as the equation of state, encoded in spin-induced quadrupole moments. Extending previous tests to binaries on eccentric orbits, we use Fisher matrix analysis to quantify parameter uncertainties and assess eccentricity’s impact. Next-generation detectors like the Einstein Telescope and Cosmic Explorer, with their enhanced low-frequency sensitivity, will make these tests more powerful, allowing for tighter constraints on higher-order multipole moments.

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