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Effective-One-Body Numerical-Relativity waveform model for Eccentric spin-precessing binary black hole coalescence

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Waveform models are important to gravitational wave data analysis. People recently pay much attention to the waveform model construction for eccentric binary black hole coalescence. Several Effective-One-Body Numerical-Relativity waveform models of eccentric binary black hole coalescence have been constructed. But none of them can treat orbit eccentricity and spin-precessing simultaneously. The current paper focuses on this problem. The authors previously have constructed waveform model for spin-aligned eccentric binary black hole coalescence `SEOBNRE`. Here we extend such waveform model to describe eccentric spin-precessing binary black hole coalescence. We calculate the 2PN orbital radiation-reaction forces and the instantaneous part of the decomposed waveform for a general spinning precessing binary black hole system in effective-one-body (EOB) coordinates.
We implement these results based on our previous `SEOBNRE` waveform model. We have also compared our model waveforms to both SXS and RIT numerical relativity waveforms. We find good consistency between our model and numerical relativity. Based on our new waveform model, we analyze the impact of the non-perpendicular spin contributions on waveform accuracy. We find that the non-perpendicular spin contributions primarily affect the phase of the gravitational waveforms. For the current gravitational wave detectors, this contribution is not significant. The future detectors may be affected by such non-perpendicular spin contributions. More importantly our `SEOBNRE` waveform model, as the first theoretical waveform model to describe eccentric spin-precessing binary black hole coalescence, can help people to analyze orbit eccentricity and spin precession simultaneously for gravitational wave detection data.

Primary author: CAO, Zhoujian (Beijing Normal University)

Presenter: CAO, Zhoujian (Beijing Normal University)

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