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3 Title

A time domain phenomenological model for gravitational waves from binary black hole coalescence

4 Abstract

Accurate and fast models for gravitational wave signals are required for confident extraction of physical information about the sources of gravitational wave observations, with more stringent requirements needed as the sensitivity of gravitational wave observatories becomes better [1]. Phenomenological waveform models in the frequency domain have become a standard tool of gravitational wave data analysis [2, 3], providing a number of valuable features: fast and closed-form implementations that provide insight about waveform phenomenology, modularity to treat independently different aspects of the morphology of compact binary coalescence (CBC) signals: unequal spins effects [4], higher order modes [5, 6], precession [7], or eccentricity [8]. However, the frequency domain nature of current phenomenological models can obscure and mix effects that otherwise could be cleaner in time domain, e.g. they make it difficult to cleanly separate the merger and ringdown, which complicates applications to tests of general relativity [9].

Here we present a highly accurate and computationally efficient phenomenological model in the time domain for the dominant mode of spin-aligned systems and the details of its construction and validation. By working in the time domain, the model allows for a cleaner separation of merger and ringdown part of the waveform, and gives rise to new parameterisations of deviations from general relativity, and we discuss how these features benefit tests of general relativity. In addition we discuss how this new approach will benefit the construction of phenomenological models for precessing or eccentric signals, and subdominant spherical harmonics.

5 References

1) The LIGO Scientific Collaboration, the Virgo Collaboration. Class. Quantum Grav. 34 (2017) 104002. *Effects of waveform model systematics on the interpretation of GW150914.*

2) Sebastian Khan et al. Phys. Rev. D 93, 044007 (2016). *Frequency-domain gravitational waves from non-precessing black-hole binaries. II. A phenomenological model for the advanced detector era.*

3) Mark Hannam et al. Phys Rev Lett. 113.151101 (2014). *A simple model of complete precessing black-hole-binary gravitational waveforms.*

4) Geraint Pratten et al. In preparation.

5) Lionel London et al. Phys. Rev. Lett. 120, 161102 (2018). *First higher-multipole model of gravitational waves from spinning and coalescing black-hole binaries.*

6) Cecilio García et al. In preparation.

7) Sebastian Khan et al. arXiv:1809.10113 (2018). *Phenomenological model for the gravitational-wave signal from precessing binary black holes with two-spin effects.*

8) Antoni Ramos et al. In preparation.

9) Abhirup Ghosh et al. Classical and Quantum Gravity 35 (1), 014002, 2017. *Testing general relativity using gravitational wave signals from the inspiral, merger and ringdown of binary black holes.*