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Improved gravitational waveform surrogate modelling through lower error and model extension

In the domain of gravitational wave exploration, the swift prediction of waveforms holds immense importance for real-time and computational scenarios. Our research revolves around the development of efficient surrogate models, encompassing a three-step process to engineer accurate representations of true waveforms. This endeavour brings about transformative enhancements in waveform prediction, parameter estimation, and comprehensive studies [1].

Our primary focus is on refining surrogate models within gravitational wave astronomy. We achieve this by expanding a surrogate model built using Effective One Body (EOB) waveform training data, i.e. 1D_EOBNRv2, with the objective of addressing inherent errors. The scope of our work extends to pushing the mass ratio (q) to 100 and investigating the (2, 2) mode, drawing inspiration from [2]. This exploration is facilitated using the BHPTNR-Sur1dq1e4 model. By embarking on this innovative expedition, we unveil the concealed harmonies within gravitational interactions, resonating throughout the cosmic expanse.

Our approach not only introduces efficiency in waveform prediction, enabling real-time applications and computational ease, but also significantly bolsters the precision of representing gravitational wave signals within predefined parameters. Consequently, our contributions advance the accuracy of parameter estimation and fortify the capabilities of future detectors. Our work stands out as a pioneering effort in refining surrogate models and expanding their potential in the field of gravitational wave astronomy.

References

[1] Scott E Field et al. "Fast prediction and evaluation of gravitational wave- forms using surrogate models". In: Physical Review X 4.3 (2014), p. 031006.

[2] Tousif Islam et al. "Surrogate model for gravitational wave signals from nonspinning, comparable-to large-mass-ratio black hole binaries built on black hole perturbation theory waveforms calibrated to numerical relativity". In: Physical Review D 106.10 (2022), p. 104025

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