Python Reduced Order Quadrature Builder PyROQ and Fast Inference on GWs from Eccentric Compact Binaries

Hong Qi[1] and Vivien Raymond[1]

[1] *School of Physics and Astronomy, Cardiff University, Cardiff, CF24 3AA, United Kingdom*

The low frequency sensitivity on the order of a few Hz in later generation GW detectors will use signals of longer and longer durations. However, the high computational costs of parameter estimation with longer waveforms make it almost impossible with existing Bayesian inference pipelines. Reduced order modelling (ROM) and reduced order quadrature (ROQ) integration rules have recently been exploited as promising techniques [1–3] that can greatly reduce parameter estimation computational costs. We describe a Python-based ROQ building code, PyROQ, to calculate the ROQ data required for the use of the ROQ rule in parameter estimation pipelines. The parameter estimation runs with the ROQ data built by PyROQ have been tested against the state-of-the-art algorithms [4, 5] with waveforms `TaylorF2` and `IMRPhenomPv2` [6] on all the real detections and a set of "zero-noise" injections. We then construct the first ROMs of gravitational waves that include the effects of eccentricity in compact binaries using the waveform known as `TaylorF2Ecc` and use PyROQ to calculate the ROQ data as part of the ROQ library to support parameter estimation ROQ runs such as in LIGO-Virgo observations.

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