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Non-conservative Hamiltonian perturbation methods for post-Newtonian binary dynamics at 2.5PN

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Non-conservative processes, such as gravitational radiation in compact binaries, are inherently challenging to describe within traditional action principles. To address this limitation, a useful strategy is to embed the system into a higher dimensional manifold, which allows the variational principle to be reframed via initial (causal) conditions. This approach has been explored both in quantum settings (the Schwinger-Keldysh formalism), and in classical settings: Galley's non-conservative principle of stationary action. Building upon Galley's principle, we present a novel extension of discrete Hamiltonian mechanics to non-conservative systems. We show that this framework can systematically recast any second-order system of ordinary differential equations as a Hamiltonian system, irrespective of prior canonical structure. In particular, we exploit our formalism by generalizing the Lie perturbation approach to dissipative systems, and then applying it to solving the equations of motion for post-Newtonian radiating binaries, departing from the point-mass ADM Hamiltonian at 2.5PN. This generalized Lie method allows for a systematic computation of both secular and oscillatory contributions to inspiral dynamics, holding promise for precision waveform modelling in next-generation gravitational wave detectors.

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