General Relativity and Quantum Cosmology

Extending the effective-one-body Hamiltonian of black-hole binaries to include next-to-next-to-leading spin-orbit couplings

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In the effective-one-body (EOB) approach the dynamics of two compact objects of masses m1 and m2 and spins S1 and S2 is mapped into the dynamics of one test particle of mass mu = m1 m2/(m1+m2) and spin S* moving in a deformed Kerr metric with mass M = m1+m2 and spin Skerr. In a previous paper we computed an EOB Hamiltonian for spinning black-hole binaries that (i) when expanded in post-Newtonian orders, reproduces the leading order spin-spin coupling and the leading and next-to-leading order spin-orbit couplings for any mass ratio, and (iii) reproduces all spin-orbit couplings in the test-particle limit. Here we extend this EOB Hamiltonian to include next-to-next-to-leading spin-orbit couplings for any mass ratio. We discuss two classes of EOB Hamiltonians that differ by the way the spin variables are mapped between the effective and real descriptions. We also investigate the main features of the dynamics when the motion is equatorial, such as the existence of the innermost stable circular orbit and of a peak in the orbital frequency during the plunge subsequent to the inspiral.

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