The Beginnings and Ends of Double White Dwarfs

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# Energy budget and drag force in 3D global AMR simulations of common envelope evolution

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Common envelope evolution (CEE) is presently a poorly understood, yet critical, process in binary stellar evolution. I present results from a suite of high resolution global 3D hydrodynamical adaptive mesh refinement simulations of CEE involving a red giant branch or asymptotic giant branch primary and a white dwarf or main sequence secondary. The simulations are analyzed to understand how energy is transferred between various forms to unbind the envelope. I show that simulation results and theory based on the $\alpha_{\rm CE}$ energy formalism are mutually consistent, in spite of the fact that no CEE simulation to date has succeeded in completely ejecting the envelope without including extra energy sources. I argue for an alternative framing of the problem which more cleanly separates the energy of secondary and primary core particles from that of gas, thereby facilitating analysis. The forces resulting from the gravitational interaction between gas and core particles are also analyzed. It is found that the gas dynamical friction force on the secondary, which is responsible for loss of orbital energy, is much smaller than what is expected from Bondi-Hoyle-Lyttleton theory. This is a consequence of a strong non-axisymmetric perturbation on the gravitational potential caused by spiral tidal wakes emanating from the core particles.

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