The Beginnings and Ends of Double White Dwarfs

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The structure of the common envelope in the CEW model for Type Ia supernova

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Context. Although Type Ia supernovae (SNe Ia) are so important in many astrophysical fields, their progenitor nature is still unclear. Recently, Meng&Podsiadlowski (MP17) developed a new version of the single-degenerate model, i.e. the common-envelope wind (CEW) model. However, this model is still under development and some problems are still open, e.g. what is the exact appearance of a system during the CE phase?
Aims. In this paper, we try to investigate these problems for a system with a massive CE.
Methods. We used a thermally pulsing asymptotic giant branch (TPAGB) star with a CO core of 0.976M_sun and an envelope of 0.6M_sun to represent the binary system approximately, where the effects of the companion gravity and the rotation of common envelope are imitated by modifying the gravity constant, and the energy from friction between the binary and the common envelope is simulated by an extra heating.
Results. For a thick envelope, the modified TPAGB star still looks like a canonical TPAGB star, but with a smaller radius and a higher effective temperature, and then a higher surface luminosity, which is derived from the fact that among the three effects, the companion gravity dominates the evolution of the system. We found that the mixing length at the position of the companion is higher than the local radius, which could imply a turbulence and a breakdown of mixing length theory around this region. We also noticed that the modified TPAGB star is more stable than the canonical TPAGB star and the CE density around the companion is significantly higher than that used in MP17, which could not be real and be derived from a spherical symmetry hypothesis on the structure and an assumption of hydrostatic equilibrium.
Conclusions. A more detailed hydrodynamic simulation is needed to give the exact appearance of the system during the CE phase in the future.

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