Thermal Timescale Mass Transfer and the Evolution of White Dwarf Binaries
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abstract

The evolution of binaries consisting of evolved main sequence stars ($1 < M_d/ M_\odot < 3.5$) with white dwarf companions ($0.7 < M_{wd}/ M_\odot < 1.2$) is investigated through the thermal mass transfer phase. Taking into account the stabilizing effect of a strong, optically thick wind from the accreting white dwarf surface, we have explored the formation of several evolutionary groups of systems for progenitors with initial orbital periods of 1 and 2 days. The numerical results show that CO white dwarfs can accrete sufficient mass to evolve to a Type Ia supernova and ONeMg white dwarfs can be built up to undergo accretion induced collapse for donors more massive than about $2 M_\odot$. For donors less massive than $\sim 2 M_\odot$ the system can evolve to form a He and CO or ONeMg white dwarf pair. In addition, sufficient helium can be accumulated ($\sim 0.1 M_\odot$) in systems characterized by $1.6 \lesssim M_d/ M_\odot \lesssim 1.9$ and $0.8 \lesssim M_{wd}/ M_\odot \lesssim 1$ such that sub Chandrasekhar mass models for Type Ia supernovae, involving off center helium ignition, are possible for progenitor systems evolving via the Case A mass transfer phase. For systems characterized by mass ratios $\gtrsim 3$ the system likely merges as a result of the occurrence of a delayed dynamical mass transfer instability. A semi-analytical model is developed to delineate these phases which can be easily incorporated in population synthesis studies of these systems.