Hot Subdwarf Stars in Binary Systems

A brief overview of some topical problems

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Hot SDW stars dominate in UV spectra of many elliptical galaxies, Galactic halo and globular clusters.

High proportion of SDWs belong to binary systems:

Problems: SDW progenitors pass through a common envelope stage (CE).

Observationally: CE objects have no distinct reliable diagnostics - how to distinguish a giant (case B) or supergiant (case C) in common envelope from a single star ?

Theoretically: CE objects cover a large area of H-R diagram and the duration may be ~ 10^8 y (see Iben and Tutukov 1993).

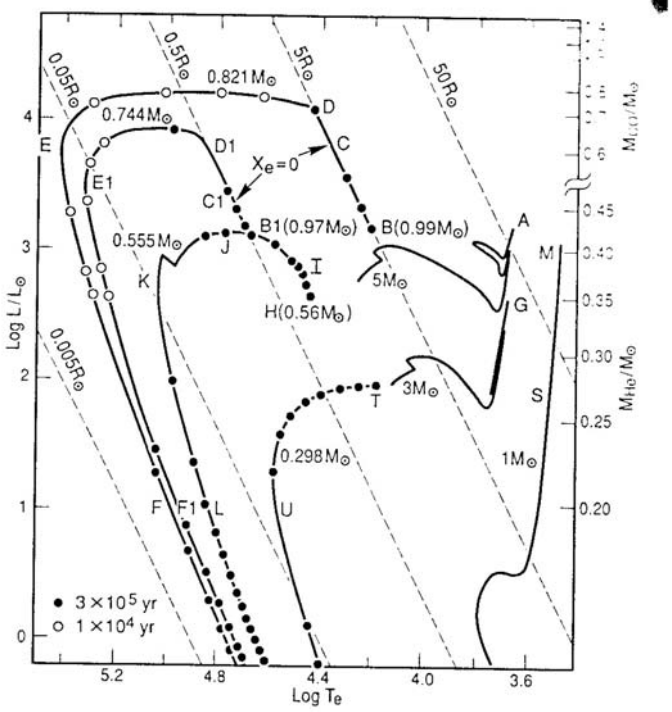

FIG. 6—Evolutionary tracks of models of initial mass 3 $M_\odot$ and 5 $M_\odot$ which are assumed to fill their Roche lobes during the EAGB phase at points G and A, respectively, and which are then subjected to mass loss on a time scale slightly smaller than the thermal time scale of the envelope. The model of lower initial mass is assumed to emerge from a CE phase when its radius is reduced to 1 $R_\odot$. Between points H and I, mass loss at a rate $\sim 10^{-8}\ M_\odot\ \mathrm{yr}^{-1}$ is required to maintain model radius at the fixed value of 1 $R_\odot$. For the model of larger initial mass, the radius of the final Roche lobe is chosen to be either 5 $R_\odot$ or 0.5 $R_\odot$. To prevent expansion beyond the Roche lobe, mass loss at the rates shown in Fig. 7 are required. For comparison, the evolutionary track of a low-mass model which experiences a CE event after it has established an electron-degenerate helium core of mass 0.3 $M_\odot$ is repeated from Fig. 2. An approximate relationship between electron-degenerate core mass and luminosity for single stars is indicated along the right-hand scale. From Iben and Tutukov (1993).

An essential ingredient of a CE scenario is a spin-orbit coupling ensuring synchronization between axial rotation and orbital revolution. Due to effective angular momentum loss an originally wide pair can be transformed into a close binary.

Enigma: Thus, observed spin periods for sdws in binaries must be much shorter than for single sdws (Iben and Livio 1993).However, practically all sdws are very slow rotators (typically Vr ~ 10 km/s) (Koester 1998, Karl et al 2005).

A probable solution: in many CE objects long before merging the low mass unevolved companion may be tidally disrupted and angular momentum acquired by debris (protoplanetary discs ?)

Some ongoing projects in search of giant planets around WDs

a) NICMOS direct imaging search for giant planets around WDs (see Friedrich et all 2005)

b) timing of pulsations of WDS with stable periods as intrinsic clocks (see Burleigh, Clarke and Hodgkin 2005)

A survey of nearby clusters (like Hyades – d=45 pc, age ~625 Myr) in far IR and submillimeter wave-length ranges is highly desirable.

Why WD are prospective ?

Cooling time scale is short.
Stellar magnitude contrast between WD and planetary discs is much lower than for normal stars, the probability of positive discovery is higher.
Time critical observations (eclipses).