PROBLEMS IN COMMON ENVELOPE EVOLUTION AS A PRE-STAGE OF CATACLYSMIC VARIABLES

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We follow the evolution of an originally widely separated red-giant in orbit with a low mass main sequence star to a cataclysmic binary system. Angular momentum transport via differential rotation leads to a common envelope around the red giant core and the main sequence star. The internal binary separation shrinks by frictional transfer of angular momentum to the extended red giant envelope. This shrinkage continues at nearly constant luminosity until after several hundred years the binary "Roche lobe" cuts into the dense layers of the main sequence star. The envelope will then be lost by a thermal instability. Method and computations for a 5 $M_\odot$ + 1 $M_\odot$ binary are presented elsewhere (Astron. Astrophys. 1979, in press).

We investigate how a variation in core mass and envelope mass affects the evolution. Both a smaller envelope mass and a higher core mass yield longer shrinking time, but of the same order of magnitude as before. Total luminosities are slightly changed (see Table).

$\log L/L_\odot$ τ	envelope mass 2 $M_\odot$	 4 $M_\odot$
core mass		
2 $M_\odot$	4.84 320 yr	4.96 250 yr
4 $M_\odot$		5.20 450 yr

Table - Luminosity L and shrinking time τ at binary separation $\log(r/cm) = 11$ for different binary core and envelope masses

In these cases the outer convection zone reaches less deep into the interior, requiring an angular momentum transfer through radiative zones. The star accomplishes this by steepening of the rotational profile until centrifugally driven convection arises. We determine the angular momentum transport in terms of the unstable angular velocity gradient in analogy to the Böhm-Vitense theory for thermal convection. This allows us to derive the efficiency in reducing the inner binary separation.

This common envelope evolution is relevant to the formation of planetary nebulae with central close binary systems like UU Sge.

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