THE $^{12}C/^{13}C$ RATIO AS A TRACER OF THE EVOLUTION OF POST COMMON ENVELOPE SYSTEMS AND CATACLYSMIC VARIABLES

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To provide a direct test of common envelope (CE) evolution which can be easily confirmed by observations, we (Sarna et al. 1995) recently modelled the change in the abundance ratio of $^{12}C/^{13}C$ on the surface of the lower mass star of a binary during the CE phase. The model is based on the fact that it is probable that the dwarf star accretes material during the CE phase. Since, during the CE phase, the dwarf secondary effectively exists within the atmosphere/envelope of the giant or supergiant primary, the accreted material has the abundances/composition of a giant/supergiant star. The $^{12}C/^{13}C$ ratio is known to decrease from approximately 90 in dwarf stars (in which the ^{13}CO band at 2.3448 microns is barely visible) to approximately 10 in giants (in which the ^{13}CO band at 2.3448 microns is fairly prominent). Hence, by measuring the $^{12}C/^{13}C$ ratio in post common envelope binaries (PCEBs) and comparing it to our models we would be able not only to confirm the CE theory but also to determine the amount of mass accreted during the CE phase and hence the initial mass of the dwarf component prior to the CE phase. We also propose an evolutionary scenario in which PCEBs with secondary component mass near $1.0\,M_\odot$ start semi-detached evolution almost immediately after the CE phase. The progenitor system is a wide binary consisting of a $3\,M_\odot$ primary with a $1.0\,M_\odot$ secondary star. The primary evolves to fill its Roche lobe when it has a $0.6\,M_\odot$ C–O core, with two shell burning regions. Such a star has a thick convective envelope, mass transfer is dynamically unstable and a common envelope forms. After the CE phase we are left with a close detached binary consisting of the primary's core ($0.6\,M_\odot$) and the secondary ($1.0\,M_\odot$) main sequence star. Shortly afterwards the secondary fills its Roche lobe and mass transfer occurs (Sarna, Marks & Smith 1995). The system now evolves as a semi–detached binary (CV), transferring material to the white dwarf which undergoes nova outbursts. Figs. 1 and 2 show the isotopic ratios of $^{12}C/^{13}C$ and $^{16}O/^{17}O$ during the semi–detached evolution. In Fig. 1

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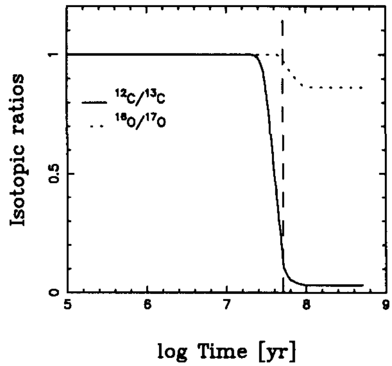

Figure 1. The isotopic ratios in the mass–losing secondary star are shown, as a function of time, for a secondary which accreted no material during the CE phase. The solid line represents the evolution of the carbon isotopic ratio. The dotted line represents the evolution of the oxygen isotopic ratio. In both cases the ratios are normalised to the cosmic value which we assume to be 91 and 2724 for carbon and oxygen ratios respectively. The vertical (dashed) line shows where the system detaches.

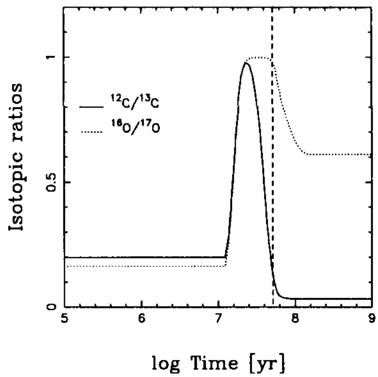

Figure 2. The isotopic ratios versus time are shown for a secondary which accreted $0.2\,M_{\odot}$ during the CE stage. All annotation is as in Fig. 1.

the secondary did not accrete any material during CE evolution whilst in Fig. 2 the secondary accreted $0.2\,M_{\odot}$ during the CE stage.

References

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