ACCRETION ON CO WHITE DWARFS. INFLUENCE OF THE EXTERNAL BURNING SHELLS ON THE EVOLUTION

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ABSTRACT

The influence of accretion in the evolution of CO white dwarfs is calculated, up to the thermonuclear runaway, with a previous analysis of the H-He burning shell. For this later study, a two-zone model is developed, consisting of two thin shells in plane-parallel approximation. The influence in the inner core evolution is discussed.

RESULTS AND DISCUSSION

The evolution of Carbon-Oxygen white dwarfs accreting mass in close binary systems can explain important astrophysical phenomena as the explosion of Supernovae of Type I (SNI) and the non-explosive collapse of white dwarfs to form neutron stars. But there are important uncertainties : restrictions relative to the mass accretion rates and the possible influence of the external burning shells in the inner core evolution.

We have performed the following calculations : precollapse evolution ignoring the burning shells (see the main results in Hernanz et al, 1988), evolution of the H-He external burning shell and precollapse evolution with a first approximation to take into account the external burning shells. The two-zone model developed is based on the one-zone model of Paczynski (1983). The main assumptions are : the hydrogen and helium zones are plane-parallel shells with a fixed gravity g, there is no evolution of the inner core during the flashes and only radiative transfer is considered. For the nuclear reaction rates, pp-chains and CNO cycle are considered for H and for He the contribution of the non-resso-

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nant reaction rate is included (Nomoto et al 1985). The interaction between H and He shells is considered : burned H increases the mass and the pressure of the He shell, and heat flux crosses the boundary between them.

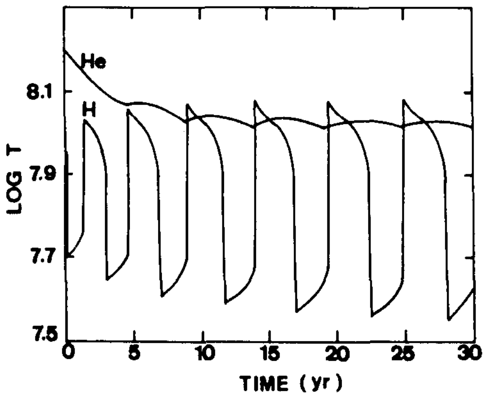

Figure 1 : H and He shell temperatures for H-flashes ($\dot{M}=3x10^{-7}$)

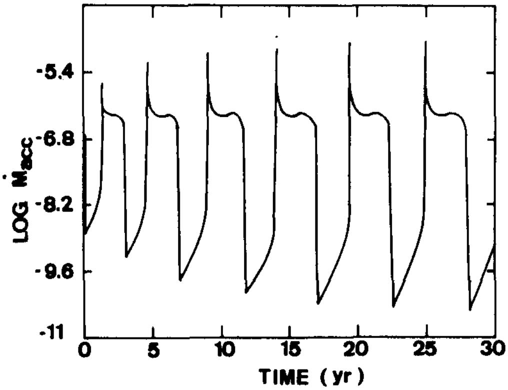

Figure 2 : He mass accretion rate generated by H-burning(same case)

The calculations done are of two types : H-shell flashes and He-shell flashes. The mass of the white dwarf is $1.2M_{\odot}$ and the accretion rates are : $\dot{M}=3x10^{-7}M_{\odot}.yr^{-1}$ (lower limit for H-static burning) and $\dot{M}$ = $2x10^{-10}M_{\odot}.yr^{-1}$ (upper limit for nova outbursts). In the case of helium flashes, we have considered the first accretion rate. The results are summarized in figures 1 and 2. A first approximation to take into account the influence of the external burning shells on the evolution of the inner core is made by adopting a mean temperature at the top of the core. There are small changes in the precollapse evolution : the ignition conditions remain almost unchanged.

The two-zone model is a tool to study the behaviour of the external burning shells of accreting white dwarfs. Some properties are analyzed and some correlations are obtained. Although our preliminary calculations seem to indicate that the influence of these shells is not very important for the evolution of the inner core, a more careful analysis of the external boundary conditions for the core is needed.

REFERENCES

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