white dwarf studies. The main purpose of this study has been to perform a further test of the CM model in the context of DB white dwarfs as well as to describe the behavior of the evolving outer convective zone, which plays a crucial role in pulsating white dwarfs. In this context and using thermal time-scales, we found that the CM model leads to a good agreement with observations of pulsating DB white dwarfs. In particular, for the range of masses and metallicities assumed in this study, our theoretical blue edges for DB white dwarfs are located between 24,200 – 25,600 K (Althaus and Benvenuto 1996). Although the theoretical blue edges given by the CM model are quite similar to those given by the ML2 version of the mixing length theory, the structure of the evolving outer convection zones is, according to our calculations, substantially different in both theories. The aforementioned agreement with observations suggested by our results, indicates that the Canuto and Mazzittelli theory of convection is a very valuable tool in modelling convection also in the high-density, low-temperature regime that characterizes the outer layers of WD stars. For the sake of comparison with previous studies, we also included in our study the mixing length theory and its different versions.

Althaus, L. G. & Benvenuto, O. G., 1996, MNRAS (to be published)
Canuto, V. M. & Mazzitelli, I., 1991, ApJ 370, 295

WHITE DWARF COOLING AND CRYSTALLIZATION

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We performed evolutionary calculations of C-O white dwarf (WD) models of 0.4, 0.55, 0.8, 1.0, and 1.2 $M_\odot$ with helium surface layers (DB WD). These models were evolved from $\log L/L_\odot = 0$ to the phase corresponding to the fast Debye cooling ($\log L/L_\odot \approx -5.8$). The emphasis of this study has been placed on the behavior of the crystallization front. We employed a detailed evolutionary code in which neutrino emission processes, latent heat released during crystallization, convective transport of energy, and a complete equation of state have been taken into account. At a certain luminosity that depends primarily on the stellar mass of the model, WDs begin to develop a crystalline core as a result of the Coulomb interactions. We found the growth of the crystal phase to be quite similar for all the models here considered, which become completely solid in a narrow range of luminosity. In particular, the model with 1.2 $M_\odot$ begins to crystallize when its luminosity is about 100 times as high as the luminosity of crystallization onset for the 0.55 $M_\odot$ model. This fact causes the effect of the released latent heat on cooling times to be relatively more important for low mass objects.

We also study the crystallization process by means of an analytic model, which accounts for the numerical results. This treatment (based on the Mestel analytic model for WD cooling), considers an isothermal interior, a gaussian approximation for the density profile of the WD interior, and assumes a relation between luminosity and central temperature of the form $L \propto T_c^\alpha$, which is indeed verified by detailed numerical simulations (in particular, for the case of Kramers opacities, $\alpha = 3.5$). Under these assumptions we found that the theoretical crystal growth function is given by

$$\frac{M_{\rm cryst}}{M} = erf(\sqrt{\frac{3\psi}{\alpha}}) - 2\sqrt{\frac{3\psi}{\pi\alpha}} \exp{(-\frac{3\psi}{\alpha})}, \qquad (1)$$

where $erf(x)$ is the error function, $L = L_0 \exp{(-\psi)}$, and L_0 is the luminosity at the onset of crystallization. For more details, see Benvenuto & Althaus (1996)

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A THERMAL SPUR PROBABLY ASSOCIATED TO THE H II REGION S54: A MODEL TO EXPLAIN RADIO RECOMBINATION LINE OBSERVATIONS

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H159 alpha line (λ = 18 cm) observations of a thermal spur, supposed to be emerging from the H II region S54, are reported. The spur had been previously observed in the H110 alpha recombination line by Mueller et al. (1987, A&A, 183, 327). From our observations, physical parameters of the ionized gas, are derived. An inhomogeneous thermal model which accounts for the Radio Recombination Line and continuum observations suggests the gas of the spur should be ionized by at least 40 B1 stars of average mass of 10 solar masses. A physical mechanism that could have created the spur and ionized the material is not yet known.

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