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Mapping Convection using Pulsating White Dwarf Stars

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Parametrization of Convection Zone

As shown by Montgomery (2005), the non-sinusoidal shape of the light curves of pulsating white dwarf stars can be used to constrain models of convection in these objects. In particular, τ, the timescale on which the convection zone responds to a change in input flux at its base, can be parametrized as

$$\tau = \tau_0 \left(\frac{T_{\rm eff}}{T_{\rm eff0}} \right)^{-N},$$

where τ_0 and $T_{\rm eff0}$ are the equilibrium values of τ and the effective temperature, respectively, $T_{\rm eff}$ is the *instantaneous* effective temperature, and N is an exponent which determines how rapidly the depth of the convection zone changes with $T_{\rm eff}$.

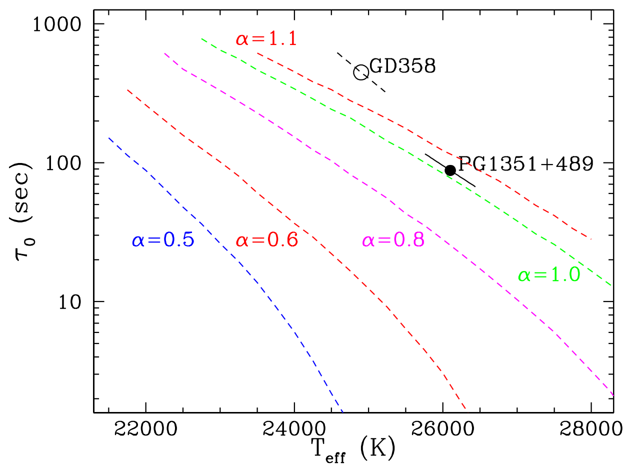

Figure 1: τ_0 versus $T_{\rm eff}$ assuming the pure He (no H) $T_{\rm eff}$ values from Table 1.

Table 1: Derived convective parameters for two DBVs

star	$\theta_{\rm i}$ (deg)	τ_0 (sec)	N	$T_{\rm eff}$ (no H)	$T_{\rm eff}$ (with H)
GD 358	62	450	25	24 900 K	24 700 K
PG1351+489	58	87	21	26 100 K	22 600 K

Mapping the DBV Instability Strip

We currently have examined two stars in the DBV instability strip: PG 1351+489 and GD 358. In Table 1, we list the convective parameters of the fits to these stars, as well as the derived inclination angles, θ_i. In addition, we list the effective temperatures determined from spectroscopic fits (Beauchamp et al. 1999), both for the case of pure He atmospheres and for the case of H contamination.

In Fig. 1, we show the location and slopes of these stars in the $\log \tau_0 - T_{\rm eff}$ plane, and we show the predictions of the Böhm & Cassinelli (1971) mixing length theory (ML2) for various values of α (dashed curves). ML2/$\alpha = 1.1$ provides a reasonable fit to the τ_0 of these stars. We note that if the effective temperatures assuming H contamination are used, we obtain the nonsensical result that the cooler star has the *thinner* convection zone (i.e., smaller value of τ_0), something which is not possible based on very general arguments.

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References

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