

## PRECISION ASTEROSEISMOLOGY OF PRE-WHITE DWARFS AND PN CENTRAL STARS

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The nonradially pulsating GW Vir (a.k.a. DOV, or pulsating PG1159) stars and the K1-16 type variable stars provide an unparalleled opportunity to probe the internal structure of planetary nebula central stars and their immediate descendants, hot pre-white dwarfs. Recent global photometry campaigns have provided data of sufficient quality to severely constrain evolutionary models of these stars.

This paper reports on a sequence of new structural models of pre-white dwarfs to explore their seismological properties. In the asymptotic limit, the periods of  $g$ -modes with consecutive radial overtone number are spaced equally in period. The value of this period spacing is a property of the equilibrium structure of the star (Kawaler 1991 and references therein). We explored how the period spacings of models in our grid depend on the stellar mass, luminosity, and helium layer thickness. The mean spacing depends principally on mass, with much weaker dependence on luminosity and surface helium layer thickness. We also explored how mode trapping at the He/C-O composition transition zone causes regular departures from uniform period spacing.

Observations of the pulsation spectrum of PG 1159 -035 with the Whole Earth Telescope (Winget *et al.* 1991) provide rich detail on the  $g$ -modes in this hot pre-white dwarf star. Using our models, the best fit to all the periods seen in PG1159 is for a model mass of  $0.58 \pm 0.01 M_{\odot}$ ,  $L = 200 L_{\odot}$ ,  $T_{eff} = 143,000 K$ ,  $M_{helium} = 0.003 M_{*}$ , and  $Y_{surf} = 0.30$ . Analysis is currently in progress on W.E.T. data on the DOV stars PG 1707 and PG 2131, and on the CCD network data on NGC1501 and Sand 3 (Bond and Ciardullo, these proceedings). A paper in preparation (Kawaler & Bradley 1993) extends this work considerably using truly evolutionary models, and discusses more fully the implications for the formation and future evolution of pre-white dwarf stars.

### References

- Kawaler, S.D. (1991), C. Cacciari and G. Clementini (eds.), *Confrontation Between Stellar Evolution and Pulsation*, (PASP Conference Series: Provo) pp. 494-512.
- Kawaler, S.D. and Bradley, P.A. (1993), in preparation.
- Winget, D., *et al.* (1991), *Ap. J.*, **378**, 326.