Scientific Justification *Be sure to include overall significance to astronomy. For standard proposals limit text to one page with figures, captions and references on no more than two additional pages.*

Through a coordinated network of world-wide observatories, we propose to take advantage of recent advances in pulsation theory to empirically determine the physical properties of convection in a pulsating hydrogen atmosphere white dwarf star (DAV). Convection remains one of the largest sources of uncertainty in our understanding of the stellar physics, leading to significant age uncertainties in massive stars ($\sim 20\%$, Di Mauro 2003). Convection is also the single largest uncertainty in determining the temperatures of pulsating white dwarfs (e.g. Bergeron et al. 1995). This is compelling since we use our knowledge of white dwarf interiors to calibrate white dwarf cooling sequences, which in turn provide accurate estimates for the ages of individual white dwarfs (Ruiz & Bergeron 2001) and the age of the Galactic disk (Winget 1987). Applying a technique introduced by Montgomery (2005), we can use observed nonlinear pulse shapes of pulsating white dwarfs to directly probe the nature of their convection zones.

Montgomery (2005) bases his approach on important analytical (Goldreich & Wu 1999, Wu 2001) and numerical (Brickhill 1992) precursor calculations. The aspect of the convection zone which pulsations sample is the thermal response timescale, $\tau_{\rm C}$, which is directly related to the mass and therefore the depth of the convection zone. Simple mixing-length convection theories predict that this timescale should scale as $\tau_{\rm C} \approx \tau_0(\rm T_{eff}/T_{eff,0})^{-N}$, where $T_{\rm eff}$ is the instantaneous effective temperature, N$\approx$90 for DAVs, and τ_0 and $T_{\rm eff,0}$ are the time-averaged convective timescale and the mean effective temperature, respectively. It is the extreme temperature sensitivity (N $\sim$ 90) which gives rise to the non-sinusoidal light curves present even in modest amplitude pulsators (Brickhill 1992, Wu 2001, Montgomery 2005). Fits to these nonlinear shapes offer the first empirical determinations of stellar convection zone thicknesses/timescales in stars other than the Sun.

Fitting nonlinear, high S/N light curves allows us to observationally determine τ_0 and N. Combined with an independent $T_{\rm eff,0}$ determined from spectra, we derive the classical convective efficiency parameter (mixing length ratio), α. Essentially, for each star examined, we obtain a value for τ_0 and its slope as a function of $T_{\rm eff,0}$. We illustrate this in Figure 2, which shows the technique's potential to map the behavior of convection in the $\log \tau_0 - T_{\rm eff,0}$ plane. Empirical determinations of convection can be found for any pulsator with this technique, and the next logical step is to map a population spanning a range of temperatures and masses in both the DAV (11000–12000 K) and DBV (22000–29000 K) instability strips, enabling us to determine the depth and temperature dependence of their convection zones as a function of $\rm T_{eff}$ and $\log g$.

The convective fitting technique was first applied to two monoperiodic pulsators (Montgomery 2005). Most stars, including our target, contain many modes, making the light curves more difficult to fit. In 2006, the Whole Earth Telescope (WET) (Nather 1990) proved that we can measure the convective parameters in these complex pulsators (Provencal et al. 2007) through observations of GD358, see Figure 1. We now propose to do the same with EC14012-1446, which will add to our knowledge of convection across the DAV instability strip ($T_{\rm eff,0}$=11,294 K, Koester et al. 2001).

We have chosen early April for this WET run because it allows us to optimize coverage for both EC14012-1446 and our secondary star, PG1159-035. As the secondary is a very hot (T 140,000K) pulsating white dwarf star, it is cooling quickly, causing rapid changes in its observed period (between 0.1 and 40 ms/yr). PG1159 requires extended, continuous, coverage to resolve its multiplet structure with sufficient precision to detect the period change. Once combined with similar data sets taken in 1983, 1985, 1993 and 2002, our data set will be able to measure both the first and second derivative of the period as a function of time. This will directly measure the cooling rate as well as changes in the stellar rotation and contraction.

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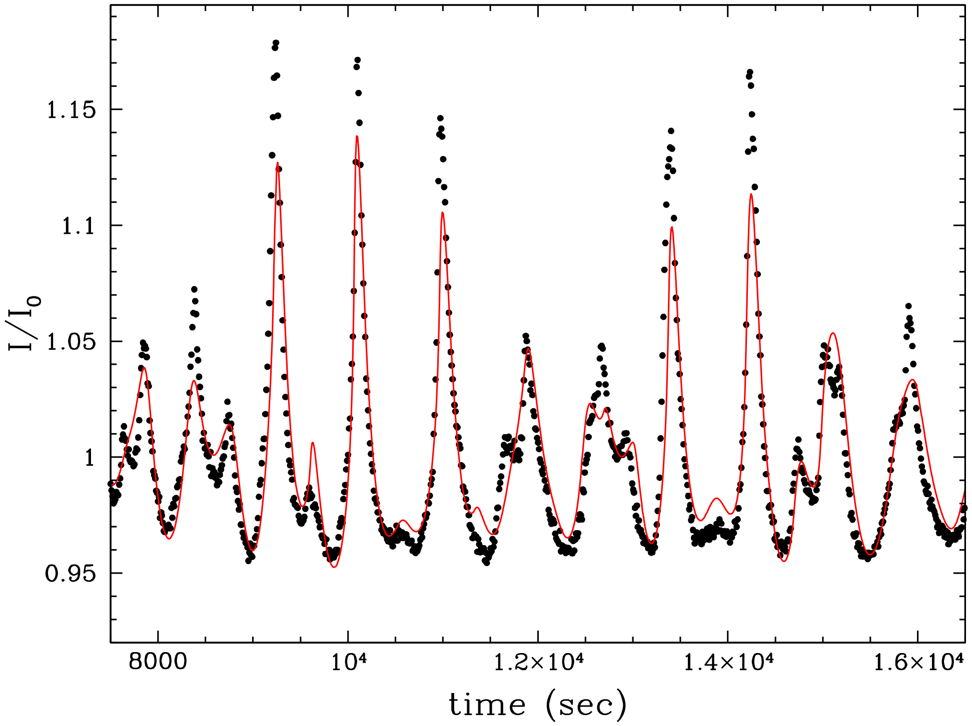

Figure 1: A fit (solid line) to data (filled circles) of the DBV GD 358. These data were taken by the Nordic Telescope (NOT) on La Palma in June 2007. The preliminary determination of the characteristic thermal response time for this star is $\tau_0 = 300$ s.

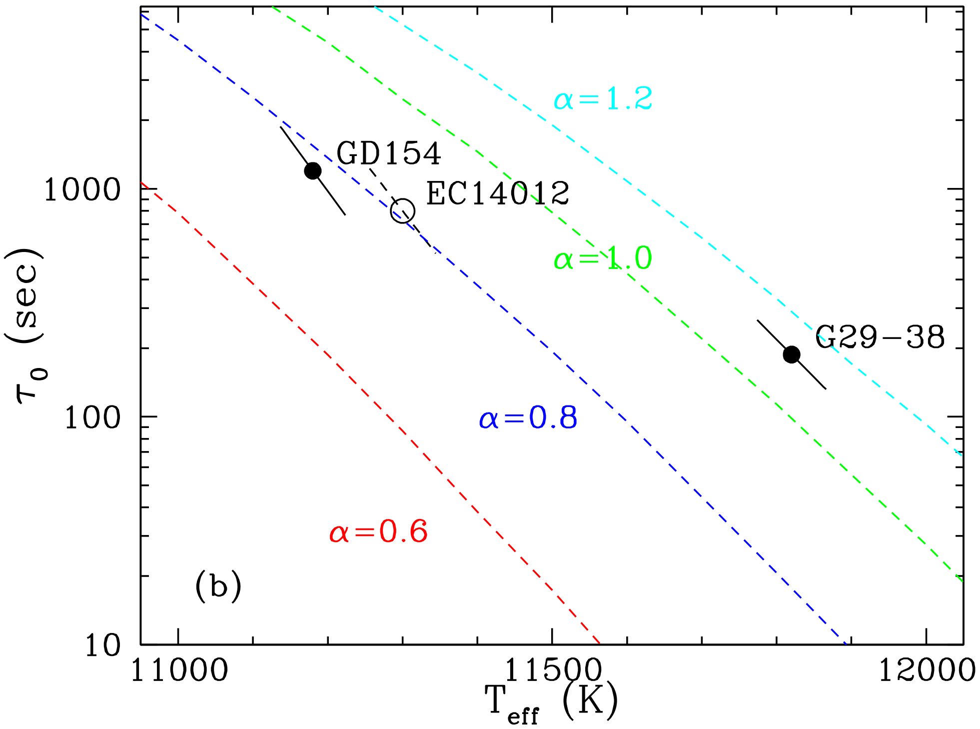

Figure 2: Plot of $\log \tau_0$ vs. $T_{\rm eff,0}$ for the DAV instability strip. The filled circles represent the two objects already observed and the open circle is an example of where EC14012-1446 could lie. The dashed lines represent theoretical models of different mixing length ratios (α).