Science Justification for PG1159-035

PG1159-035 is a hot ($T_{\rm eff}$=140,000 K), pulsating pre-white dwarf star (DOV), with pulsation periods between 300 and 1000 seconds. Such stars represent descendants of post-asymptotic giant branch progenitors, and are evolving very rapidly along the white dwarf cooling track. The observations we propose here will directly measure this evolution, which includes the cooling and contraction of the star and the change of its rotation period. Such a direct probe of these quantities in a post-AGB star has never before been made.

The defining analysis of PG1159-035 is Winget et al. (1991), where 264 hrs of observations resulted in the identification of 101 specific pulsation modes. This number has improved with the addition of 4 data sets (from 1983, 1985, 1993 and 2002). Analysis of this combined data increases the identified modes to 198, allowing us to refine our determination of the star's rotation period ($P_{\rm rot} = 1.3920 \pm 0.0008$ days), as well as constraining the location and structure of its chemical profiles (Costa & Kepler 2007, Córsico & Althaus 2006, Bradley & Kawaler 1994).

PG1159-035's high temperature, coupled with the fact that it is no longer supported by thermonuclear reactions, means that its structure is changing relatively rapidly. This manifests itself as a change in pulsation period, and PG1159-035's pulsation periods are changing with rates between $0.1 < \dot{P} < 40$ ms/year, large enough to be directly measured (Costa et al. 2007). By comparison, DAV white dwarfs cool *much* more slowly, with $\dot{P} \sim 10^{-15}$s s^{-1} (Kepler et al. 2005). We propose to utilize this large rate of period change to measure two fundamental aspects of pre-white dwarf evolution: (1) the rate of change of the rotation period, and (2) the rate of cooling/evolution of the star. When coupled to evolutionary models of the star, we can probe whether the cooling rate matches that of the models (testing the neutrino rates, among other things) and whether the change in rotation rate is consistent with angular momentum conservation in a contracting star, which in turn is a diagnostic of whether PG1159-035 is still undergoing mass loss.

With the observations from this WET run, we hope to measure $\dot{P}$ for at least 5 different modes, and with the long time baseline we have spanning 2 decades, we may be able to detect $\ddot{P}$ for the largest amplitude doublet in this star. These measurements will give us direct clues not only to PG1159-035's place in the cooling track, but also its *direction of motion* in the H-R diagram. This will help shed light on a brief but important phase of stellar evolution of stars who have just shed mass and are in the process of becoming white dwarfs.

An international WET run is required to resolve known multiplets (which have frequency splittings on the order of 1 d^{-1}) and to provide the high signal to noise required to detect low amplitude modes. These new observations will turn the current limits on $\ddot{P}$ to a detection and will accurately measure $\dot{P}$ and $\ddot{P}$ for many additional modes in PG1159-035. *XX* telescope will provide important longitudinal coverage during this run.

References

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