Radial and Nonradial Pulsations as Probes of Stellar Physics
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Radial Velocities for the Pulsating Subdwarf B Star PG 1605+072

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Abstract. We have performed high-speed spectroscopy of the pulsating subdwarf B star PG 1605+072. Its radial velocity variations have frequencies similar to those reported from photometric observations. Peak amplitude ratios are different, probably as a result of power shifting between modes over time. Line-shape variations have also been detected.

It is now several years since the discovery that some subdwarf B stars pulsate (Kilkenny et al. 1997). Their variations, based on photometry, generally have periods of 100–200 s and appear to be due to low-order stellar pulsations.

PG 1605+072 has the largest photometric pulsation amplitudes and the richest frequency spectrum of all sdBVs studied. As such, it is ideal for study to determine whether asteroseismology can be used to determine the physical properties of sdBVs.

We obtained high-speed spectroscopy of PG 1605+072 using 4-m class telescopes: the AAT and the WHT. Our data covered 16.3 hours of a 32.1 hour period. They included the Hδ and Hγ Balmer lines. The spectra were obtained every 13 s (WHT) or every 22 s (AAT), a faster repetition rate than used in earlier spectroscopic studies of the star (O'Toole et al. 2000). Our data reduction and analysis followed the method outlined by Jeffery & Pollacco (2000) and is discussed in Woolf et al. (2002).

The periodogram for our data is compared in Fig. 1 with the frequencies and relative strengths of peaks found in the photometry periodogram by Kilkenny et al. (1999). Peaks occur in similar positions in both periodograms. The difference in peak amplitudes indicates a shift of power between modes over the ~ 3 year period between measurements. The frequencies of some peaks also differ slightly from those found using photometry. For example, the strong peaks in our velocity periodogram at 2.731 and 2.753 mHz do not correspond well with the peaks in that frequency region in the photometric periodogram of Kilkenny et al. (1999), where there is one strong peak at 2.743 mHz and several much weaker peaks, none of which are at the velocity peak frequencies.

A possible method to identify pulsation modes, as needed for use in asteroseismology, is the moment method (Balona, 1986). To test whether variability of the moments can be measured in PG 1605+072, we used the cross correla-

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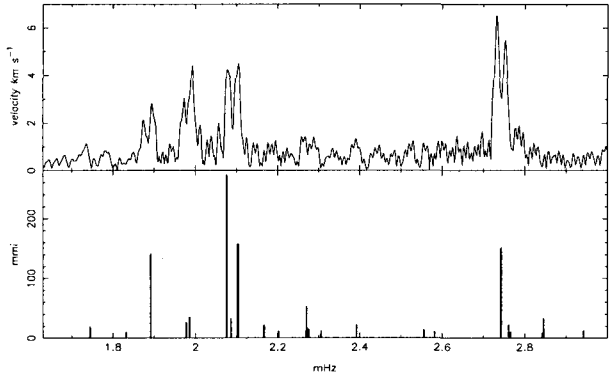

Figure 1. Periodogram of velocity data (top panel). Kilkenny et al. (1999) peak frequencies and strengths (bottom panel).

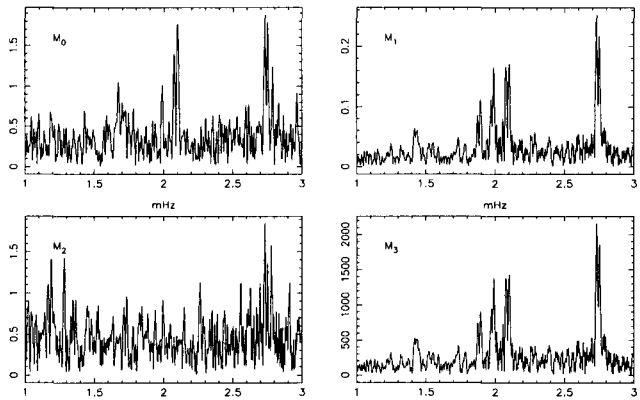

Figure 2. Moments of the cross correlation function.

tion function to approximate the average line profile and measured its moments. Peaks are present in the moments' periodograms, as seen in Fig. 2.

A multi-site campaign of simultaneous high-speed spectroscopy and photometry will provide the best chance of successful mode identification for PG 1605+072.

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