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HD 87271: A PULSATING CLASSICAL λ BOOTIS STAR

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The λ Bootis stars are a chemically peculiar subgroup of the A-type stars, characterized by deficiencies of Fe-peak elements, but having approximately solar abundances of C, N, O and S (e.g. Paunzen 1999 and references therein). There are two main competing theories attempting to explain this abundance pattern: a mass loss/diffusion theory (Michaud & Charland 1986) and an accretion/diffusion theory (Venn & Lambert 1990). The first theory would generate λ Bootis stars only after about 10^9 yrs, whereas the second one can yield λ Bootis stars within a few $\times\, 10^6$ yrs (Charbonneau 1993), although older λ Bootis stars would be possible (cf. Gray & Corbally 1998). Age determinations for λ Bootis stars are therefore of interest. Pulsation information may thus help to discriminate between these two theories. As many λ Bootis stars are located within the δ Scuti instability strip (at a few $\times\, 10^9$ yrs) and do pulsate, this has been attempted by Paunzen et al. (1998). In this note we report the discovery of a new pulsating λ Bootis star.

Whilst searching HIPPARCOS photometry (ESA 1997) for new γ Doradus star candidates (Handler 1999a), several possible new δ Scuti stars were set aside. One of them was HD 87271, which is a $7^{\rm th}$ magnitude equatorial star with an HD spectral classification of A0; no other classification was found in the literature. The standard deviation of the HIPPARCOS measurements of HD 87271 exceeds the mean of its formal errors (usually a very good estimate of the real accuracy of the data) by more than a factor of 2 and the amplitude spectrum of these data (Fig. 1) is not consistent with noise, but it is inconclusive otherwise.

To shed more light on the nature of HD 87271, Strömgren photometry was obtained (Handler 1999b). This showed the star to be located in the δ Scuti instability strip, but it also revealed that HD 87271 is quite metal-poor. This prompted us to study the star in more detail.

Two classification spectra of the star were taken with the Gray/Miller spectrograph on the 0.8-m telescope of the Dark Sky Observatory (Appalachian State University) using a 1024×1024 Tektronics thinned, back-illuminated CCD. The spectra were reduced using standard methods under IRAF, and have S/N > 300. The first spectrum has a resolution of 3.6 Å/2 pixels and a spectral range from 3800–5600 Å. The second has a resolution

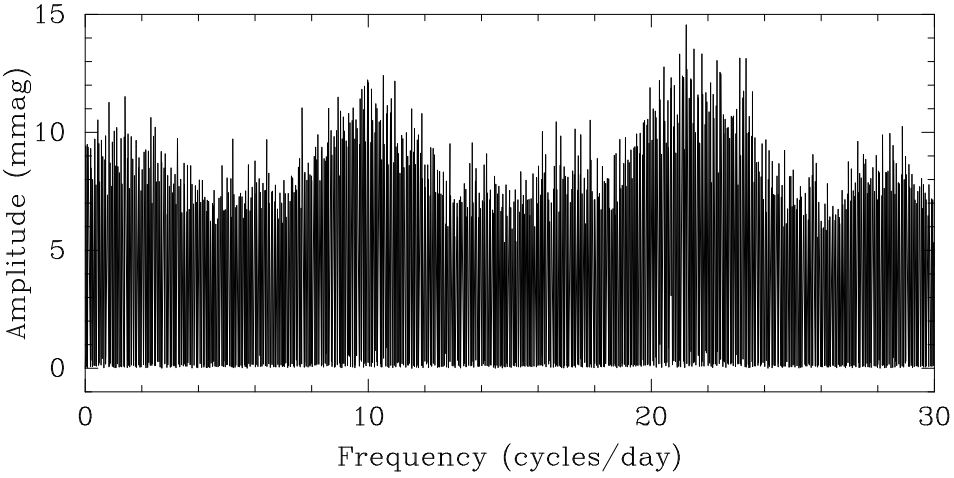

Figure 1. Amplitude spectrum of the HIPPARCOS photometry of HD 87271. δ Scuti-type variability can be suspected, but not proven.

of 1.8 Å/2 pixels and a spectral range from 3800–4600 Å. Both spectra yielded the same classification. HD 87271 appears to be a classical λ Bootis star, and may be one of the most extreme known. The hydrogen lines in HD 87271 are a good match to an A9 dwarf, and are the best indicators of the effective temperature of the star. However, the metallic-line spectrum, including the K-line and the Mg II λ 4481 line, is extremely weak, and roughly matches an A0 star in strength (although not in morphology — the zero-volt lines are more dominant in HD 87271 which is considerably cooler than the typical A0 star). Thus, the spectral type is A9 kA0mA0 V λ Boo (kA0 and mA0 would be the spectral types derived from the *K*-line and *m*etal lines only, respectively). The spectrum of HD 87271 is shown in Fig. 2, in comparison with HR 4881, another extreme λ Bootis star.

HD 87271 was tested for light variations. Differential photoelectric photometry was taken with a single-channel photometer (with a GaAs tube as the detector) attached the 0.6-m telescope at Siding Spring Observatory, Australia. Two comparison stars, HD 87178 (F6III) and HD 87423 (F5) were used in the observing sequence C1–V–C2–V–C1–V–C2... There is no evidence for variability of the two comparison stars, whose magnitude differences showed an rms scatter of 3.5 mmag for the *B* filter and 4.5 mmag for the *V* filter per single measurement after the reductions, which comprised dead time correction, subtraction of sky background and compensation for extinction and transparency changes. The reduced light curves of HD 87271 are shown in Fig. 3.

It is quite clear that HD 87271 is a multiperiodic pulsator; the mean period in our observations is about 80 minutes. This is in good agreement with the time scales and supposed complexity of the light variations anticipated from the HIPPARCOS photometry.

Turning to a discussion of the physical properties of HD 87271, one can estimate an effective temperature of 7650 ± 150 K from the Strömgren indices using the model atmosphere calibration by Kurucz (1991). This is consistent with the A9 hydrogen-line spectral type derived above. The HIPPARCOS parallax of the star yields an absolute magnitude of $M_v = 1.26$ mag, which is in agreement with the absolute magnitude estimated from calibrations of Strömgren photometry (Crawford 1979). We point out that the latter

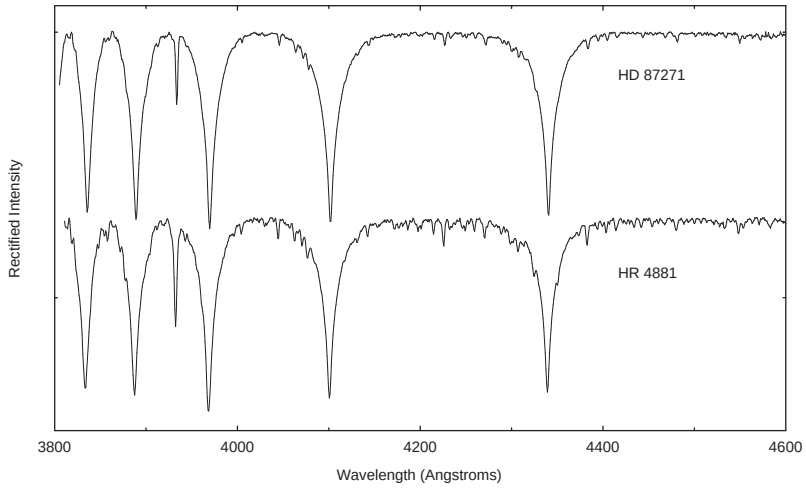

Figure 2. The classification spectrum of HD 87271 compared with that of another extreme λ Bootis star, HR 4881.

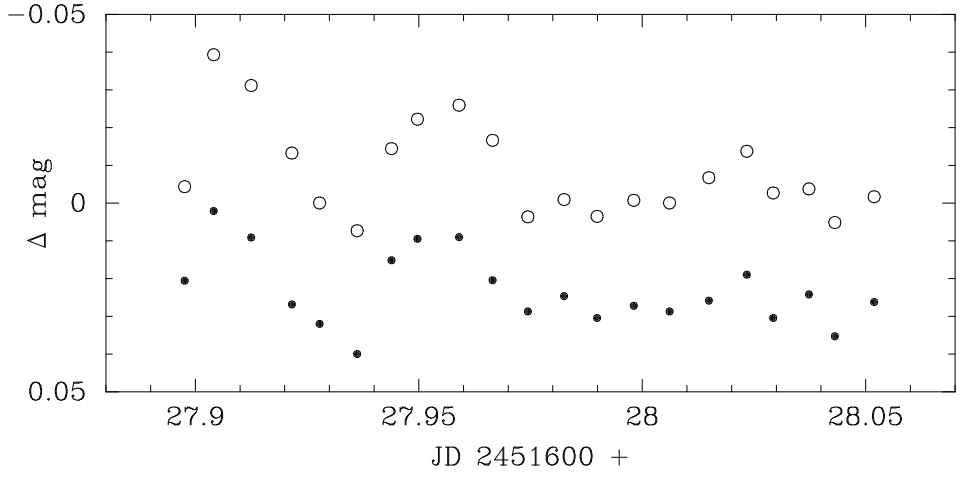

Figure 3. Differential B (open circles) and V (filled circles) filter light curves of HD 87271. The presence of multiperiodic pulsations is quite obvious.

and the effective temperature given above should be taken with caution, as the chemical peculiarity of the star surely affects the results. Still, they are sufficient for our purposes.

With this absolute magnitude and temperature, the evolutionary state of HD 87271 is ambiguous, as it is close to the TAMS. We cannot say whether it is still on the main sequence or already in the post-main sequence phase of evolution. By comparison with evolutionary tracks (e.g. those plotted by Handler et al. 1997) we estimate the mass of HD 87271 to be close to 2.05 $M_{\odot}$. This results in a pulsation "constant" $Q = 0.017$ d for an 80-minute period and indicates pulsation near the third radial overtone, which is quite typical for a pulsating λ Bootis star with physical parameters as inferred above (cf. Paunzen et al. 1998).

We conclude with the remark that HD 87271 is a highly interesting object for further study. High-resolution spectra to perform an abundance analysis would be desirable and the apparently rich pulsation spectrum coupled with rather high amplitudes would make a more detailed asteroseismological study worthwhile.

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References:

Charbonneau, P., 1993, *ApJ*, **405**, 720
Crawford D. L., 1979, *AJ*, **84**, 1858
ESA, 1997, The Hipparcos and Tycho catalogues, ESA SP-1200
Gray, R. O., Corbally, C. J., 1998, *AJ*, **116**, 2530
Handler G., Pikall H., O'Donoghue D., et al., 1997, *MNRAS*, **286**, 303
Handler G., 1999a, *MNRAS*, **309**, L19
Handler G., 1999b, *IBVS*, No. 4817
Kurucz, R. L., 1991, *Van Vleck Obs. Contr.*, **11**, 27
Michaud G., Charland Y., 1986, *ApJ*, **311**, 326
Paunzen E., Weiss W. W., Kuschnig R., et al., 1998, *A&A*, **335**, 533
Paunzen E., 1999, *Ap&SS*, **266**, 379
Venn K. A., Lambert D. L., 1990, *ApJ*, **363**, 234