COMMISSIONS 27 AND 42 OF THE IAU
INFORMATION BULLETIN ON VARIABLE STARS

Number 5647

Konkoly Observatory
Budapest
2 September 2005

HU ISSN 0374 – 0676

NEW PHOTOMETRY OF THE roAp STAR 33 Lib

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While photometry has been successful for discovering roAp stars and studying their frequency spectra, it is now clear that high resolution spectroscopy is a superior tool for these purposes, and for other purposes out of the reach of photometry. In a high-resolution spectroscopic survey of roAp stars, Kurtz, Elkin & Mathys (2005a) have shown that radial velocity variations of lines of the Rare Earth ion Pr III show amplitude modulation on time scales shorter than 2 hr. In the amplitude spectra this appears as new frequencies that are not known from previous photometric studies.

The first star showing such a new frequency was 33 Lib. The principal frequency at $\nu_1 = 2.015$ mHz and its harmonic are well-known in this star from both photometric studies (e.g., Kurtz 1991) and spectroscopic studies (Mkrtichian et al. 2003). Kurtz Elkin & Mathys (2005b) discovered the presence of another frequency at $\nu_2 = 1.769$ mHz with an amplitude 60% of the amplitude of the principal frequency ν_1, yet this frequency is clearly and definitely not visible in the earlier photometry, as shown in Figure 2 of Kurtz (1991).

The photometric observations of Kurtz (1991) and the spectroscopic observations of Kurtz, Elkin & Mathys (2005b) are separated by 17 yr, and roAp stars are known to have mode lifetimes shorter than this in some cases. For example, Kreidl et al. (1991) found a significant new pulsation frequency for the roAp star HD 217522, in data obtained in 1989, that was definitely not present at high precision in data obtained in 1982. This possibility is low for 33 Lib because we have two decades of data for the star with no evidence of ν_2. However, to check this more carefully we obtained a new light curve 75 d after the spectroscopic data were obtained. While this is not simultaneous, it is close in time, given the lack of changes to its frequency spectrum over the two decades of photometric observations that we already had, and it brings the photometric observations up to date.

33 Lib was observed with the South African Astronomical Observatory 0.75-m telescope and University of Cape Town Photometer on 2004 May 5 for a total of 5.1 hr through a Johnson B filter using 10-s integrations. The data were corrected for dead time losses, sky was subtracted and extinction corrections were made. Fig. 1 shows the amplitude spectrum for this light curve. There is no evidence of $\nu_2 = 1.769$ mHz.

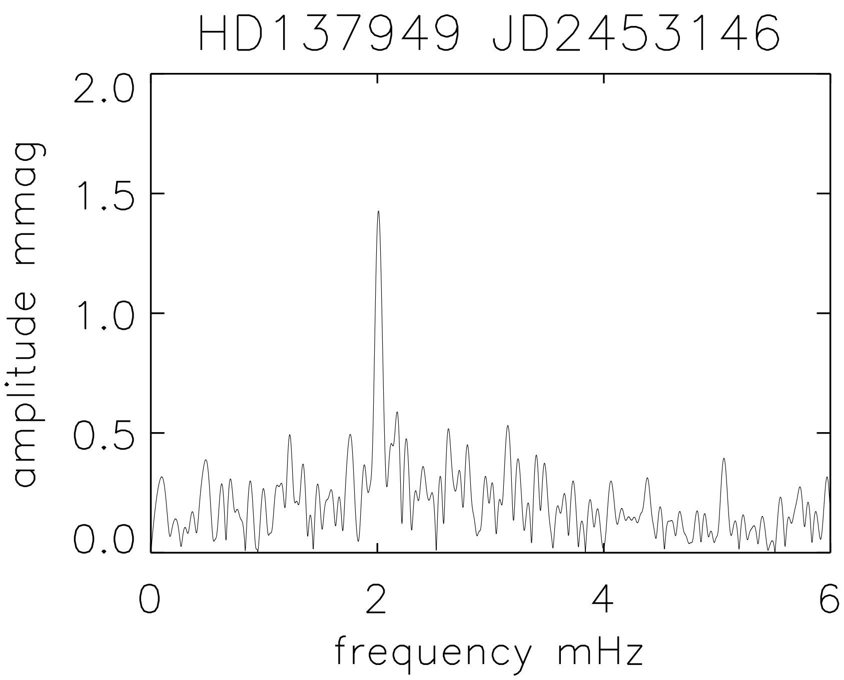

Figure 1. The amplitude spectrum of the B photometric variations for a 5.1-hr light curve obtained on 2004 May 20/21. If $\nu_2 = 1.769$ mHz were present at the same relative amplitude that is seen in the photometry, it would have an amplitude here of 0.9 mmag.

We conclude that the photometry is not sensitive to ν_2, whereas it can be seen in the amplitude spectra of radial velocity variation in the Rare Earth element lines. Kurtz, Elkin & Mathys (2005b) discuss two possible explanations for this: One is that there are modes that have detectable amplitude high in the atmosphere where the Rare Earth element lines form, but not lower in the atmosphere where continuum variations give rise to the broad-band photometric variations. The other is that there is short time-scale growth and decay of pulsation amplitude high in the atmosphere that gives rise to amplitude modulation of the radial velocity curves of the Rare Earth element lines, but that the amplitudes are more stable lower in the atmosphere where the photometric observations are sampling.

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