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The rotational velocity of the rapidly oscillating Ap star HD 83368

Bruce W. Carney★ *Department of Physics and Astronomy, University of North Carolina, Chapel Hill, North Carolina 27514, USA*

Ruth C. Peterson *Lockheed Solar Observatory, Palo Alto, California 94301, USA*

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Summary. A rotational velocity $v_{rot} \sin i = 33 \pm 3 \text{ km s}^{-1}$ has been measured for the Ap star HD 83368, confirming the prediction of 32 km s^{-1} (Kurtz) from an 'oblique pulsator' model.

1 Introduction

HD 83368 (HR 3831) is an Ap star, classified by Houk (1978) as Ap SrEuCr. Renson & Manfroid (1978) and Renson *et al.* (1984) have found it to be a photometric variable, with an apparent period of 1.42602±0.00006 day, probably due to rotation.

Kurtz (1982) obtained very accurate photometry for the star, and from the slight asymmetry in the light curve, he inferred the correct rotation period to be twice that suggested above. Fitting the star's faint G dwarf companion (Hurly & Warner 1983) to the zero-age main sequence yielded a stellar radius for HD 83368 of $1.8 R_\odot$ from which it follows that $v_{rot} = 33 \text{ km s}^{-1}$.

Kurtz also found evidence for two short-period low-amplitude variability time-scales, which could be modelled by two pulsational modes, but with the oscillations occurring along the star's magnetic axis, which is inclined at an angle β with respect to the rotational axis. Analysis revealed each mode was split into frequency triplets, and with the aid of the dipole oblique pulsator model and pulsation theory, Kurtz concluded the probable values of i and β are 86° and 36°, respectively, but that a 36° and 86° combination is also possible.

Kurtz's (1982) model predicts the magnetic field should change sign and vary in phase with the rotation period. $v_{rot} \sin i$ values would be either 32 (19) km s^{-1} for $i = 86°$ (36°). Thompson (1983) obtained magnetic field strength data for HD 83368, finding the predicted strong, reversing field with a period of 2.86±0.07 day, ruling out the shorter rotation period. We report here our observation of $v_{rot} \sin i = 33 \pm 3 \text{ km s}^{-1}$, consistent with the $i = 86°$, $\beta = 36°$ case.

2 Observations and results

A single spectrogram of HD 83368 was obtained at the Cerro Tololo Interamerican Observatory on the night of 1983 April 29/30 with the echelle spectrograph and the 4-m reflector. We used the 31 lines mm^{-1} echelle grating, the 226-1 cross disperser grating, and a post-slit GG385 filter to

★Visiting astronomer, Cerro Tololo Interamerican Observatory, National Optical Astronomy Observatory, which is operated by Aura, Inc, under contract with the National Science Foundation.

Table 1. Spectral lines co-added to produce the mean profile shown in Fig. 1.

λ (Å)	Element	χ (eV)
5001.87	Fe I	3.88
5133.70	Fe I	4.18
5137.39	Fe I	4.18
5142.53	Fe I	4.28
5162.28	Fe I	4.18
5172.70	Mg I	2.71

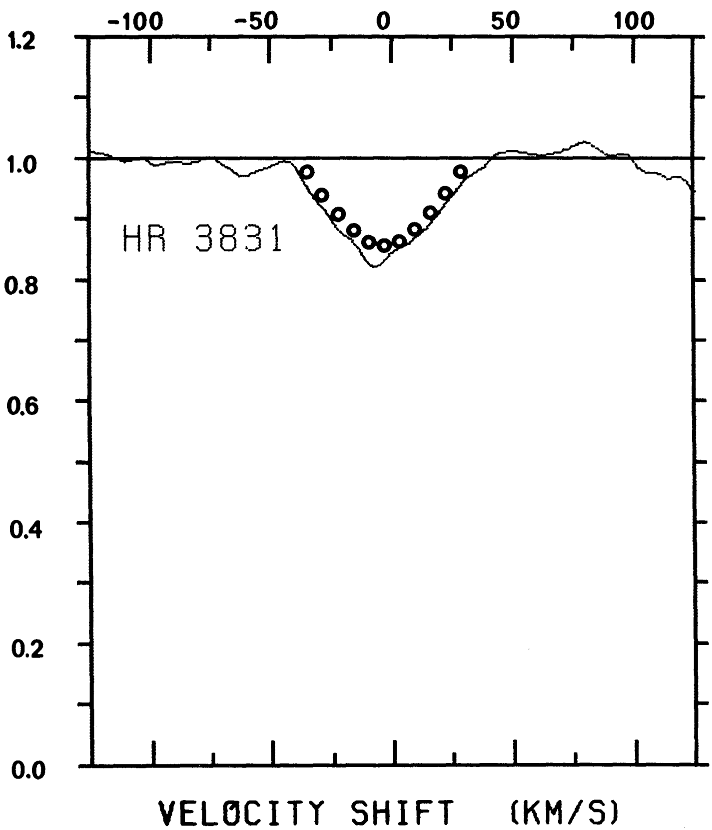

Figure 1. The resultant profile from the co-addition in velocity space of the six weak, unblended lines given in Table 1. Superposed is the synthetic line profile with a rotational broadening of 30 km s^{-1}.

eliminate the second-order violet spectrum. An uncooled C33063 ('Carnegie') two-stage image tube was used, and the spectrum was recorded on a baked IIIa-J plate, then developed simultaneously with a spot sensitometer plate taken during the exposure. The spectral coverage was λλ4800–6800, with a dispersion of 2.3 Å mm^{-1} at 5000 Å, and the resolution due to the image tube and the slit width (1.2 arcsec) was 10 km s^{-1}. The seeing was 1.5 arcsec, and, because of clouds, the exposure time was 8 min.

The spectrogram was traced at the Lockheed Solar Observatory with a PDS 1010G microdensitometer controlled by a PDP 11/45 computer (see Peterson & Title 1975 for a fuller description). A sample of six weak, unblended lines were identified (Table 1) and their profiles were added in velocity space to improve the signal-to-noise ratio. The resultant profile is shown in Fig. 1, where it is clear that HD 83368 experiences significant rotational broadening.

To determine the rotational velocity, we compared the observed profile with synthetic spectral lines computed using the program SYNTHE (Kurucz 1981), which allows for variable instrumental and rotational broadening. A synthetic profile with $v_{rot} \sin i = 30\,\mathrm{km\,s^{-1}}$ is plotted as circles in Fig. 1. It is taken directly from Peterson, Tarbell & Carney (1983), wherein the details regarding its construction may be found. This profile slightly underestimates the observed broadening, which we find by such methods to be $33 \pm 3\,\mathrm{km\,s^{-1}}$.

We must allow for two external effects on the observed profile. First, the faint companion could contaminate the observed spectrum. However, the companion is about three magnitudes fainter than HD 83368 at $\lambda 5100$ (Hurly & Warner 1983). Further, it lies 3.3 arcsec due south, and the spectrograph's 1.2-arcsec slit was oriented east–west. Contamination is thus expected to be insignificant. Secondly, the observed line profile has been smeared out by pulsation, for our exposure time was comparable to that of the two oscillation modes. However, following Balona & Stobie (1979), Kurtz has argued that for the $l=1$ mode and the observed maximum visual amplitude $A_V = 0.003$ mag, the expected radial velocity amplitude should be less than $2\,\mathrm{km\,s^{-1}}$. Again, this is an insignificant contribution to the observed profile.

Ap stars in general are slow rotators. Wolff's (1981) analysis of G. Preston's unpublished data for 61 SrEuCr stars revealed $\langle v_{rot} \sin i \rangle = 24\,\mathrm{km\,s^{-1}}$, or $\langle v_{rot} \rangle = 31\,\mathrm{km\,s^{-1}}$. HD 83368 is normal in this regard. However, since the observed $v_{rot} \sin i$ values range from 0 to $70\,\mathrm{km\,s^{-1}}$, the agreement of Kurtz's predicted value with that observed could not have been expected *a priori*.

Our result thus confirms the prediction made by Kurtz (1982) for the observed rotational velocity of HD 83368, and hence lends support to his model of an 'oblique pulsator'.

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