COMMISSION 27 OF THE I. A. U.
INFORMATION BULLETIN ON VARIABLE STARS
Number 2725

Konkoly Observatory
Budapest
21 May 1985

*HU ISSN 0374 - 0676*

# THE DETECTION OF RAPID VARIABILITY IN HR 5156

The F3Vp star HR 5156 (HD 119288, SAO 120075; V=5.88) was monitored photometrically for a total of 6.2 hours during four nights between 11/12 and 15/16 February 1985, as part of a search for rapid oscillations among peculiar stars with spectral types from late A to early F. Low-amplitude light variations with periods near 17 and 24 minutes were detected in this star.

The rapid photometry - a series of continuous 20-second integrations through a Johnson B filter - was performed by one of the authors (JMM) using the 0.9 m telescope and photometer of the Cerro Tololo Inter-American Observatory. Because the programme star was being monitored for periods as short as one minute, a comparison star could not be used for these observations. Although this means that there is no compensation for random changes in sky transparency in the data, such changes should be slow and random enough on nights of good quality that they will not interfere with the identification of rapid periodic variations in the star. This technique of rapid photometry has already been successful in the discovery and study of the rapidly oscillating Ap stars (e.g. Kurtz 1982, Weiss 1983).

On the first night that HR 5156 was observed, there were indications in the raw photometry of regular variations with a period near 16-18 minutes and an amplitude just above the noise level of the measurements. As a result, the star was reobserved on three more nights. A sample light curve, for the night of 14/15 February (JD 2446111), is shown in Figure 1. (The crosses represent three-point averages of the original data. The measurements have been corrected for mean extinction. Also, some power with periods greater than three hours - attributed to sky variations - has been removed.)

The photometric data were searched for periodicities by Fourier analysis, using an algorithm similar to the modified version of Deeming's (1975) code described by Kurtz (1985). Figure 2 is a periodogram (a representation of the amplitude spectrum) of the data presented in Figure 1. Peaks are observed to rise above the noise at frequencies of 0.710, 0.975, and 3.269 ($\pm$0.005)mHz; corresponding to periods of 23.5 $\pm$0.2, 17.1 $\pm$0.1, and 5.10 $\pm$0.01 minutes, respectively. This last peak was not seen on any of the other three nights.

If this peak does arise from variations in HR 5156, it would have to be either transient or modulated in amplitude.

A periodogram of the entire data set is displayed in Figure 3. Here, peaks occur at frequencies of 0.708 and 0.981 ($\pm$0.002)mHz. These values coincide with two of the peak frequencies in Figure 2, to within the uncertainties.

The 1.2 mmag peak near 0.22 mHz (period = 75 min) may be due entirely to sky transparency variations. However, we note that the beat frequency of 0.71 and 0.98 mHz (the two frequencies prominent in both Figures 2 and 3) is 0.27 mHz. It is possible that some of the power in this lower-frequency peak may result from such a beat. (Since each segment of data is only about 1 1/2 hours long, reliable frequency identification near this timescale using Fourier techniques are impractical.)

Based upon the periodogram of Figure 3, a sum of two sinusoids, with periods (amplitudes) of 17.1 min (0.8 mmag) and 23.5 min (0.7 mmag), has been superimposed upon the light curve of Figure 1. It is shown in that figure as the solid curve. The correspondence between the measurements and the fitted curve is reasonably good.

HR 5156 has been classified as a weak-lined F3Vp star by Cowley and Bidelman (1979). They point out that both the Balmer and CaI lines imply a late F type, whereas the metal lines are consistent with an F3 star. No G band is observed in the spectrum. Bidelman (private communication) describes the Balmer and CaII H and K lines as strong and sharp, and CaI 4226 as moderately strong.

The Strömgren indices from the Strömgren-Perry catalogue (1962) - (b-y)= 0.278, $[\Delta m_1]$ = 0.025, $[\Delta c_1]$ = 0.044 - are those of a normal (or only slightly metal-deficient) F dwarf. The star has a measured parallax, yielding a distance of 28 pc (Eggen 1972), and hence a reliable absolute magnitude ($M_V$=3.35). This value agrees with that derived from the Strömgren colours for a normal F dwarf.

To date, the only stars in this region of the HR diagram for which rapid oscillations (i.e. periods less than about 30 minutes) have been reported are Ap stars. The chemical peculiarities of HR 5156 as indicated by its spectrum - enhanced Ca and possibly slightly underabundant metallicity - are completely inconsistent with those expected for a magnetic Ap star. Polarization measurements of HR 5156 by Mathewson and Ford (1970) give a value of only 0.02 $\pm$0.05 percent; the presence of a strong magnetic field in this star seems unlikely.

All discussions of the variability mechanism(s) in the rapidly oscillating Ap stars have invoked either the strong magnetic fields present in those stars (e.g. Cox 1984) or $\delta$ Scuti-type pulsation in which only high overtones

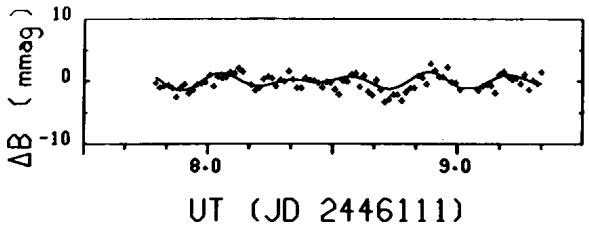
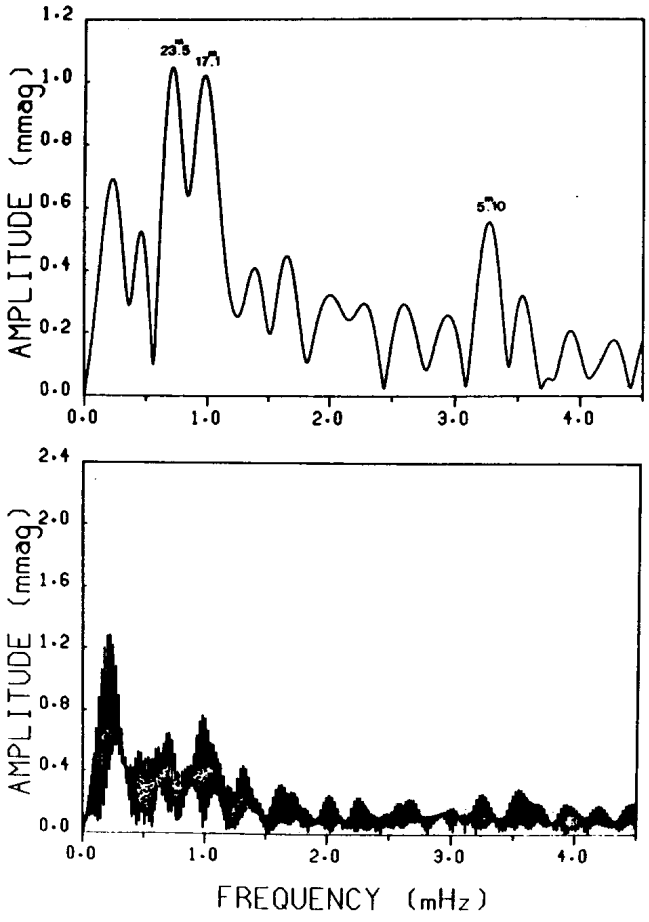



Figure 1




Figures 2 - 3

are allowed to persist by the magnetic field (e.g. Kurtz 1982). In the case of HR 5156, neither agency would appear to apply. This star is presumably non-magnetic, and its colour and absolute magnitude place it well outside the known $\delta$ Scuti instability strip.

Given the limited set of observations of HR 5156 and the small sample (10) of known rapidly oscillating Ap stars, it is premature to speculate on any link (or lack thereof) between their variations. Additional rapid photometry of HR 5156, to confirm the variability we have reported, is called for.

JAYMIE M. MATTHEWS
WILLIAM H. WEHLAU
Department of Astronomy
University of Western Ontario
London, Ontario, Canada
N6A 3K7

References:

Cowley, A.P. and Bidelman, W.P. 1979, P.A.S.P. 91, 83.
Cox, J.P. 1984, Ap. J. 280, 220.
Deeming, T.J. 1975, Ap. Space Sci. 36, 137.
Eggen, O.J. 1972, Ap. J. 175, 787.
Kurtz, D.W. 1982, M.N.R.A.S. 200, 807.
Kurtz, D.W. 1985, M.N.R.A.S. 213, 773.
Mathewson, D.S. and Ford, V.I. 1970, Mem. R.A.S. 74, 139.
Strömgren, B. and Perry, C. 1962, unpublished.
Weiss, W. 1983, Astron. Astrophys. 128, 152.