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HD 74425: A NEW ELLIPSOIDAL VARIABLE STAR

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We find the SB2 star HD 74425 ($V = 7.8$, F8) to be a new ellipsoidal variable star, based on one year of photometric observations with a 0.4 m automatic photoelectric telescope (APT). The observations also suggest additional small-amplitude variations that may be due to star spots. The star was on our observing program as a photometric comparison star.

Nordström et al. (1997) found HD 74425 to be a double-lined spectroscopic binary with a period of 1.585232 ± 0.000008 days and a mass ratio of 1.17. They did not determine spectral types for the individual components due to their limited spectral coverage; the combined HD spectral type of F8 remains the only classification. The star is listed as a photometrically constant, single star in the *HIPPARCOS* catalogue (Perryman et al. 1997) with $V = 7.82$, $B - V = 0.47$, and $\pi = 9.26$ mas. The *HIPPARCOS* results and the mass ratio are consistent with both components being main-sequence F stars.

From 23 September 1997 through 1 June 1998, the 0.4 m APT acquired nearly 400 measurements of HD 74425 in the Johnson B and V bands. The observations were reduced differentially with respect to the constant comparison star HD 70312 ($V = 7.7$, F5), corrected for extinction with nightly extinction coefficients, and transformed to the Johnson system with long-term mean transformation coefficients. Further details of the observing and data reduction procedures can be found in Henry (1995).

Our periodogram analysis finds the strongest periodicity at $0^{\rm d}\!.79267 \pm 0^{\rm d}\!.00006$ and $0^{\rm d}\!.79266 \pm 0^{\rm d}\!.00005$ in the V and B observations, respectively (Figure 1). This period is exactly half of the orbital period found by Nordström et al. (1997) to within the formal 1-σ errors, which suggests that variability is due to tidal distortion in one or both stars. Therefore, we present our V-band observations in Figure 2 phased with the orbital ephemeris

$$\mathrm{JD_{conj}} = 2\,447\,799.138 + 1^{\rm d}\!.585232 \times E, \qquad (1)$$

where the time of conjunction corresponds to the less massive star in front (Andersen 1999) and the period is the orbital period from Nordström et al. (1997). The fact that the minima in the phase curve occur at the spectroscopic times of conjunction confirms that photometric variability is due to the ellipticity effect.

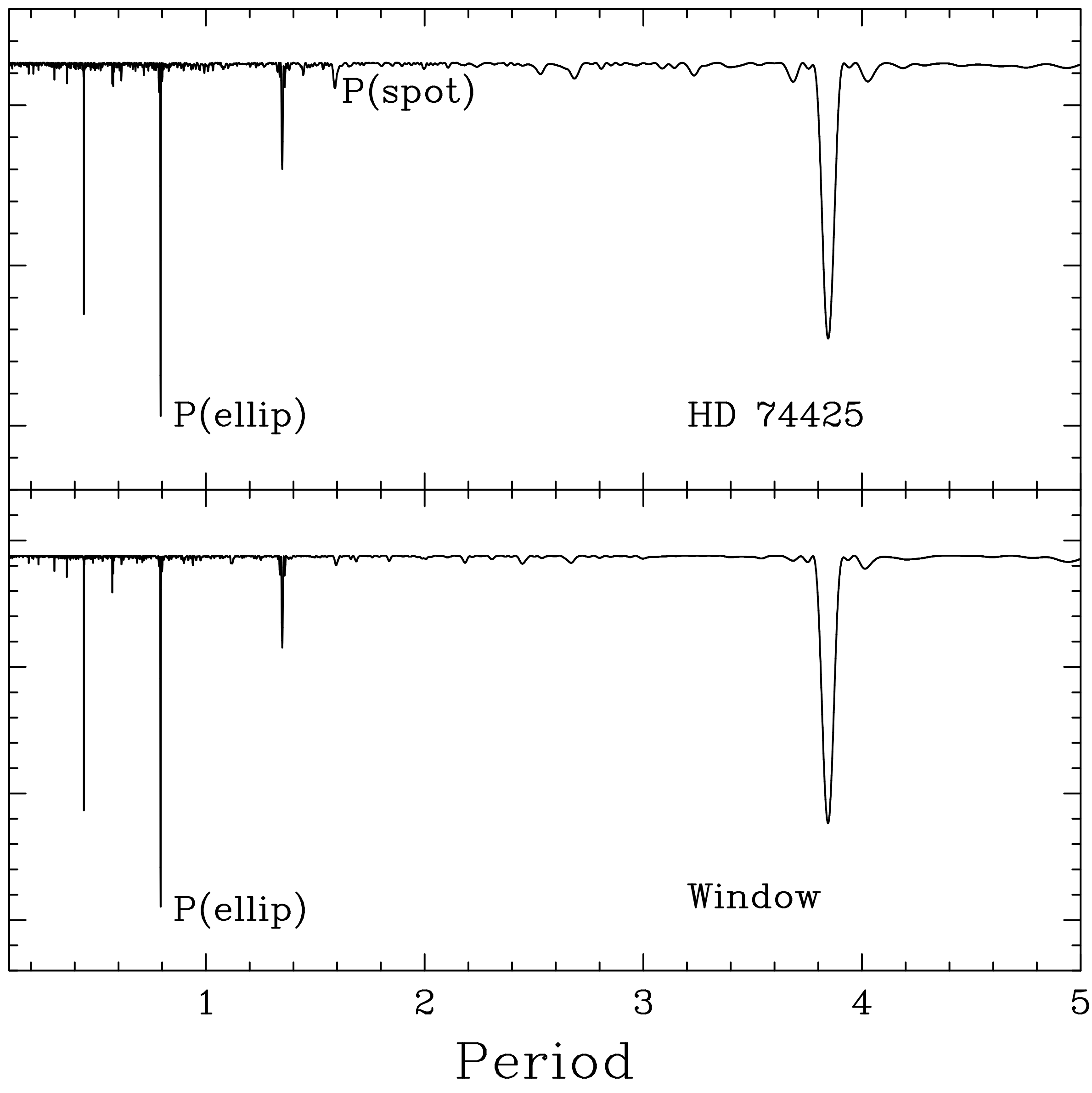

Figure 1. Periodogram analysis of HD 74425. The upper panel shows the periodogram of the V data with labels for the $0\overset{d}{.}79267$ ellipticity period and a much weaker $1\overset{d}{.}590$ period, probably arising from spot modulation. All other significant dips are aliases of the $0\overset{d}{.}79267$ period, as shown by the window function on that period in the lower panel.

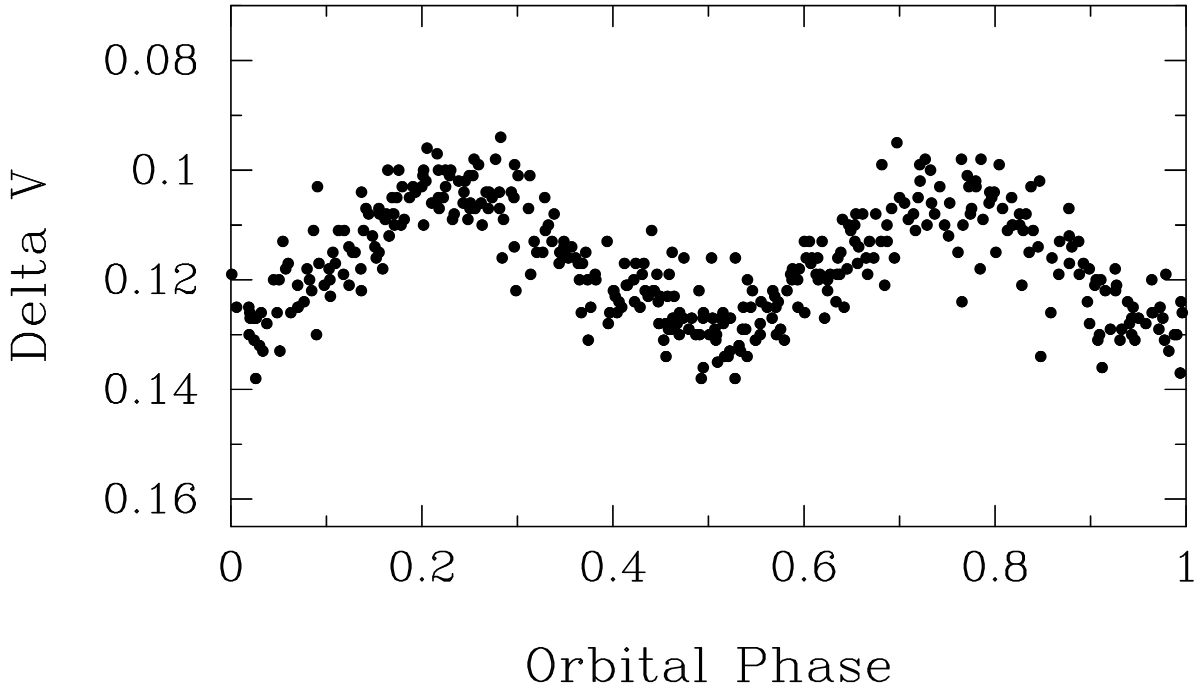

Figure 2. V-band observations of HD 74425 phased with the orbital ephemeris in equation 1. The minima occur at the times of conjunction, confirming that the majority of the variability is due to the ellipticity effect. There is no evidence for eclipses.

We used least squares to fit the truncated Fourier series

$$m = A_1 \cos(\theta) + B_1 \sin(\theta) + A_2 \cos(2\theta) + m_0 \tag{2}$$

to the phased V and B data sets. The $\cos(2\theta)$ term gives the amplitude of the ellipticity effect, while the $\cos(\theta)$ and $\sin(\theta)$ terms give the amplitude and phase of any light variation on the orbital period. The results of this analysis are given in Table 1. Column 1 gives the photometric band, column 2 the date range, and column 3 the number of observations. Column 4 lists the peak-to-peak amplitude of the ellipticity effect. Columns 5 and 6 show that slight photometric variability does exist on the orbital period. This is probably due to small star spots on the cooler secondary star, which would be expected to rotate synchronously with the orbital period. The spot amplitudes and phases in Columns 5 and 6 agree within their respective errors. The spot-rotation period is also evident in our V and B periodograms at a period of $1\overset{d}{.}590 \pm 0\overset{d}{.}002$ (see Figure 1), which suggests nearly perfect synchronization.

Table 1: Photometric Analysis of HD 74425

Filter	Date Range $HJD - 2400000$	n	Ellipticity Amp (mag)	Spot Amp (mag)	Spot Phase
V	50718–50963	398	0.0233 ± 0.0008	0.0027 ± 0.0008	0.66 ± 0.05
B	50714–50959	387	0.0277 ± 0.0008	0.0025 ± 0.0008	0.59 ± 0.05

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