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FIVE BRIGHT NEW VARIABLE STARS

We report UBV photometry obtained during the first quarter of 1984 with the 10-inch automatic photoelectric telescope at Fairborn Observatory West in Phoenix, Arizona, which shows five bright stars to be variable: HR 4430, HD 25893, HD 28591, HD 116204, and HD 136901.

We suspected variability because all five have characteristics which marked them as possible RS CVn binaries. HR 4430 is a known SB1 (Northcott 1947) containing a late-type giant. The other four, though not known binaries, were of late spectral type and Bidelman (1983) reported Ca II H and K in emission. Heard (1956) did, however, report "variable velocity" for HD 136901 on the basis of nine radial velocity measures. HD 116204 was included in the list of 20 suspected variables published by Hall (1983).

Table I lists the approximate V magnitude of each variable, the comparison star we used, the spectral type, and the source of the spectral type.

Table I

Star	V	Comparison	Sp. Tp.	Source
HR 4430	$6^m.4$	HD 101133	K2 III	Y.B.S.C.
HD 25893	7.1	HD 25975	G5	HD
HD 28591	6.7	HD 28620	G5	HD
HD 116204	7.2	HD 116010	K2	HD
HD 136901	7.4	HD 136643	K1 III	Heard (1956)

Our photometry is described by Boyd, Hall, and Genet (1984) and the data have been sent to the I.A.U. Commission 27 Archive for Unpublished Data on Variable Stars (Breger 1982) where they are available as file no. 136 . HD 25893 is ADS 2995 but, since the two visual components are separated by only about 1.5 arcseconds, both components were included in the diaphragm during photometry.

We determined photometric periods by estimating times of well-defined minima and maxima and using least squares to fit those times with a linear ephemeris. If maxima did not occur midway between successive minima, we shifted their times accordingly by a constant amount. For HD 28591 we added $4\overset{d}{.}0$ to times of maxima; for HD 116204 we subtracted $3\overset{d}{.}0$. The resulting ephemerides are given in Table II, where integer values of n refer to minimum light and half-integer values of n refer to maximum light.

Table II

Star	Ephemeris	V
HR 4430	2445704.1 + $39\overset{d}{.}0$ n ±2.2 ±1.3	$0\overset{m}{.}13$
HD 25893	2445701.0 + 7.37 n ± .4 ± .06	0.03
HD 28591	2445698.9 + 21.3 n ±1.0 ± .4	0.07
HD 116204	2445700.3 + 21.7 n ± .5 ± .2	0.06
HD 136901	2445705.9 + 9.63 n ± .2 ± .05	0.16

Light curves are plotted in Figures 1 through 5. Each point is a mean of three individual observations of the variable, each of these three flanked by comparison star measures; each mean corresponds to one line in

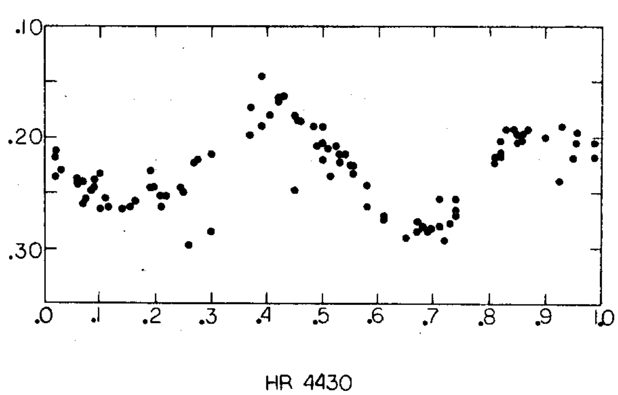

Figure 1

Light curve of HR 4430 .

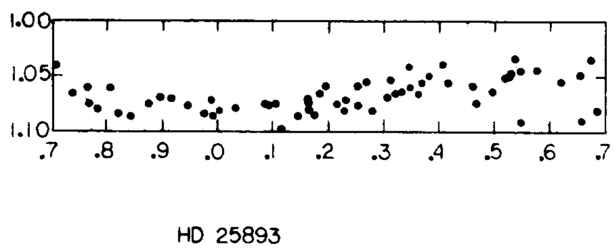

Figure 2
Light curve of HD 25893.

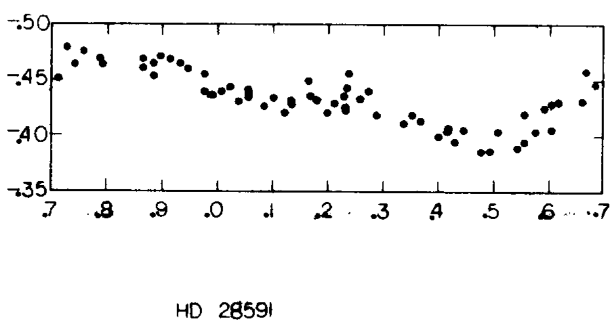

Figure 3
Light curve of HD 28591.

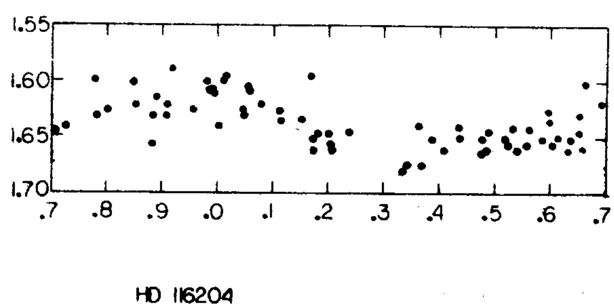

Figure 4
Light curve of HD 116204.

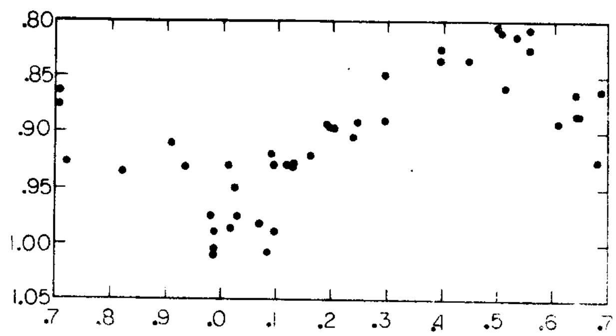

Figure 5
Light curve of HD 136901.

file no. 136 . Except for one case, phases are computed with the ephemerides in Table II. For HR 4430 the photometric period is very nearly half the spectroscopically determined orbital period of Northcott (1947), so we used her ephemeris

$$JD(hel.) = 2430852.014 + 74\overset{d}{.}861\ n\ ,$$

where the initial epoch is a time of periastron. The approximate total range of the brightness variation in V is given in the last column of Table II. The corresponding ranges in B and U are similar.

Because Lucy and Sweeney (1971) judged the orbit of HR 4430 circular, we ignored the eccentricity and estimated a time of conjunction (the K1 III star behind) to be JD 2430826.0 ± $1\overset{d}{.}0$. Extrapolating this forward to the epoch of our photometry, we concluded that the two minima seen in Figure 1 coincide with the two conjunctions and the two maxima coincide with the two quadratures, all to within the cumulative uncertainty of about ± $0\overset{P}{.}05$. Such a light curve could be a result of ellipticity and/or shallow eclipses, similar to that of the giant eclipsing binary 5 Ceti (Lines and Hall 1981). On the other hand, we note that the two maxima are not equally bright and the two minima are not equally faint, suggesting similarity to the double - humped light curve of the RS CVn binary HD 185151 (Bopp et al. 1982), although the absence of Ca II H and K emission (Lloyd-Evans 1977) suggests HR 4430 is not an RS CVn binary.

The other four stars, because of the Ca II H and K emission, probably are RS CVn binaries. Therefore the photometric periods in Table II are probably rotational periods for the brighter star in each, which we presume are unevenly darkened with starspots. Moreover, since rotation in virtually all known RS CVn binaries is synchronous to within a very few percent, these photometric periods provide useful estimates of what future spectroscopic observations may prove the orbital period to be.

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