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PHOTOMETRY AND SPECTROSCOPY OF V841 Cen IN 1984/5

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During a programme of study of active-chromosphere stars in the 1980s we obtained photometric and spectroscopic data on the single-lined binary V841 Cen (HD 127535). Collier (1982) performed the first extensive observations of the system, finding a V range of 0.07 magnitude, and a radial velocity variation with a 6 day period. Udalski and Geyer (1984) obtained photometry in 1984 April, finding the V range had increased to 0.25 mag. Our initial data were presented in Innis et al. (1985). A more extensive discussion incorporating later results appeared only in the unpublished thesis of Innis (1986). The orbital period of just over 6 days derived in Innis et al. (1985) was revised to 5.988 days in Innis (1986), in agreement with the work of Collier (1982). Since then studies by e.g. Strassmeier et al., 1994; Cutispoto et al., 1996, and references therein, have added to the understanding of this object. As our data may be of interest when considering the long term behaviour of this star, we present our observations here.

Differential photometry of V841 Cen was obtained with the 0.4-m and 0.6-m telescope at Siding Spring Observatory (SSO). In 1984 UBVR_C data were obtained on six nights during August 03-09. In 1985 V data were collected on five nights during February 05-11, and on April 06, 07, 08, and 09. The comparison stars used were HD 128277 and HD 127724. Observations of E-region standard stars allowed us to transform the data to standard magnitudes. The magnitudes and colours of the comparison stars are in Table 1, along with representative maximum light values for V841 Cen. The mean V difference between the comparison stars was 1.913 ± 0.010 and 1.908 ± 0.013 in 1984 and 1985 respectively. Our photometry of V841 Cen is given in Table 2. Figure 1 shows the multi-colour photometry from 1984. Figure 2 (left panel) shows the 1985 V photometry. We use an epoch of HJD 2444653.737 and a period of 5.988 days for all the plots here.

Table 1 – Magnitudes and colours of target and comparison stars

Star	V	B–V	V–R
V841 Cen	8.6	1.06	0.61
HD 128277	8.30	1.05	0.54
HD 127724	6.39	1.26	0.63

Table 2 – Photometry of V841 Cen.

1984 Observations

1985 Observations

HJD-2440000	V	B-V	V-R _C	U-B	HJD-2440000	V	HJD-2440000	V
5916.044	8.652	1.064	0.610	0.897	6102.223	8.650	6108.236	8.660
5916.050	8.661	1.055	0.610	0.893	6102.244	8.660	6162.274	8.689
5917.000	8.721	1.059	0.619	0.877	6102.259	8.651	6162.278	8.694
5918.965	8.641	1.072	0.606	0.877	6103.185	8.774	6162.292	8.694
5919.000	8.662	1.103	0.612	0.914	6103.204	8.771	6163.054	8.836
5919.963	8.606	1.040	0.607	0.895	6103.223	8.782	6163.062	8.824
5919.976	8.603	1.056	0.599	0.867	6106.058	8.596	6164.169	8.790
5920.884	8.604	1.051	0.601	0.837	6106.069	8.589	6164.175	8.772
5920.902	8.608	1.045	0.601	0.850	6107.211	8.645	6164.183	8.765
5920.922	8.610	1.044	0.606	0.858	6107.225	8.625	6165.165	8.614
5920.943	8.607	1.053	0.597	0.846	6107.237	8.641	6165.171	8.609
5920.964	8.610	1.050	0.605	0.870	6108.203	8.673	6165.178	8.619
5920.984	8.616	1.052	0.603	0.851	6108.220	8.646	-	-
5921.979	8.659	1.061	0.610	0.867	-	-	-	-
5921.992	8.666	1.059	0.615	0.863	-	-	-	-

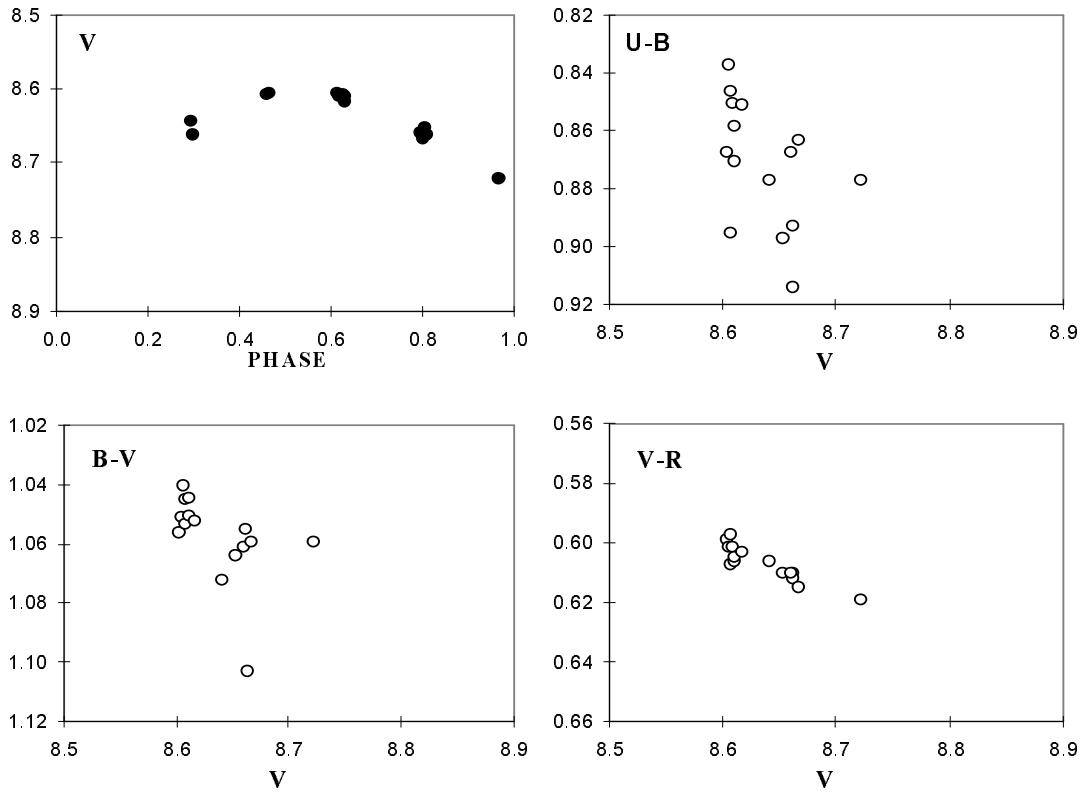


Figure 1. Photometry of V841 Cen in 1984

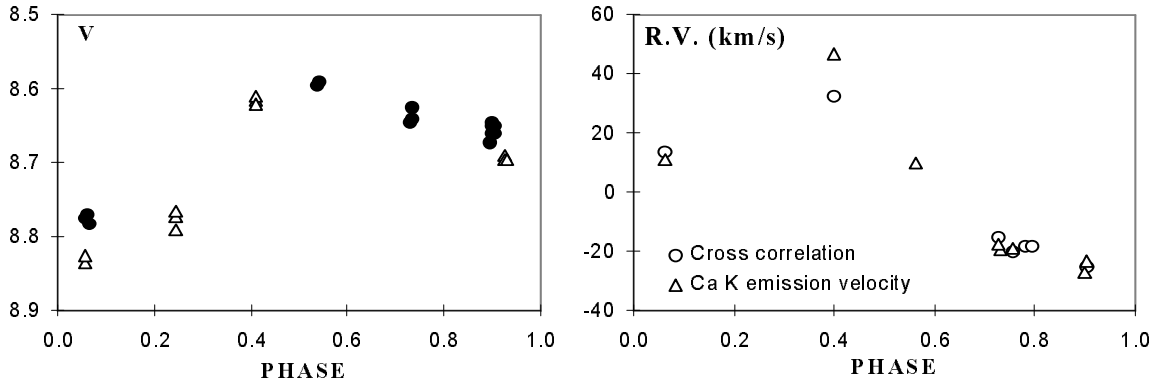


Figure 2. 1985 Photometry (left) and Radial velocity data (right) for V841 Cen

Digital spectra (resolution $\sim 0.2 \text{ \AA}$) were obtained with the 1.0-m SSO telescope in three runs: 1984 August (H-alpha), 1985 February, and 1985 August (Ca K). The two spectra from the first run showed H-alpha as a symmetric emission feature. Radial velocities were determined by cross correlation on absorption line features using template stars of known radial velocity. For the later data the radial velocity of the Ca K emission peak was determined, as was the Ca K emission peak equivalent width. See Innis et al. (1988) for more details of the procedures used. The results are given in Table 3. Radial velocities are heliocentric, and are in km s^{-1} , while Ca K equivalent widths are in Angstroms. Unfortunately the cross correlation velocity for HJD 2446101.228 and the Ca K equivalent width for HJD 2446304.969 appear not to have been calculated. The two asterisked values of radial velocity are for spectra that show low cross correlation maxima. We recommend that they not be included in any further analysis. Our radial velocity data are plotted in Figure 2 (right panel).

Table 3 – Spectroscopic observations for V841 Cen

HJD-2440000	RV (cross corr.)	RV (Ca K emiss)	Eq width Ca K (\AA)
5927.879	-18.1	-	-
5927.941	-18.3	-	-
6101.228	-	-19.6	2.42
6102.221	4.8 (\star)	-26.8	1.11
6103.221	13.6	11.2	1.74
6105.214	32.4	46.8	3.52
6106.211	19.8 (\star)	9.9	1.70
6107.183	-14.8	-17.3	6.46
6108.238	-24.9	-23.3	5.29
6304.969	-20.0	-19.0	-

The V light curve is of amplitude ~ 0.1 magnitude in the 1984 August data, about half that observed by Udalski and Geyer (1984) a few months earlier, but had increased to ~ 0.2 mag in 1985. The light curve in 1985 was not stable, data taken in February deviating from those obtained at similar phases in April (shown as open triangles in Figure 2). There is also a small colour change apparent in the 1984 data, the star being bluest when brightest.

There is generally good agreement between the radial velocities determined from cross correlations using the absorption line spectra and those determined from least-squares fits to the Ca K emission, usually to within the experimental error of a few km s^{-1} . The changes in the Ca K emission equivalent width are quite marked, and exceed the estimated error (of $\sim 0.5 \text{ \AA}$) by a considerable factor. There is no correlation with photometric phase (Figure 3). The spectra in question were carefully examined, and it was concluded that the variations were not due to either computational errors or poor signal-to-noise ratio spectra. Such emission strength changes, if real, are almost unprecedented. This star is a strong microwave flaring source (e.g. Innis et al., 1985; Slee et al., 1987). Hobbs et al. (1979) observed an increase of around a factor two in the Ca K emission of the very active binary V711 Tau (HR 1099) over four nights, during a microwave radio outburst. It may be that V841 Cen shows similar Ca K enhancement during radio flares, but further, simultaneous, data are required.

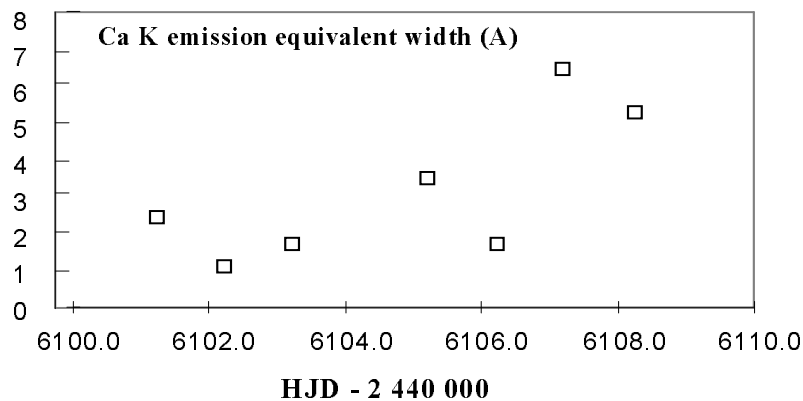


Figure 3. V841 Cen Calcium K emission strength, 1985 Feb

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