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PHOTOMETRIC VARIABILITY IN THE STRONGLY INTERACTING BINARY DK CANUM VENATICORUM

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The variability of DK Canum Venaticorum ($\alpha = 12^{\rm h}33^{\rm m}09\overset{\rm s}{.}33$ and $\delta = +37^\circ58'20\overset{''}{.}3$ J2000, $V = 13.2$) was discovered by the Robotic Optical Transient Search Experiment (Akerlof et al., 2000) and Diethelm (2001) noted that the star showed a "pronounced reflection effect". Our initial observations in 2002 showed that the distortion in the light curve was not due to the reflection effect but looked rather like that in V361 Lyrae (Hilditch et al., 1997) wherein a mass transfer stream impacts the secondary component and creates a hot spot. Figure 1 shows $UBVR_cI_c$ data of DK CVn from 2002 with a pronounced distortion around phase 0.25 that is larger at shorter wavelengths, indicating a high temperature source, perhaps a hot spot.

Observations in 2003 showed dramatically different light curves from those of 2002. As seen in Figure 2, the amplitude of the light curve distortion had decreased noticeably. By 2004, the distortion had largely disappeared and the light curve of the system looked relatively clean and similar to the light curve of a short-period Algol. Figure 3 shows the 2004 R_c light curve compared to the one from 2003.

Given the large changes between observing seasons, we observed DK CVn more frequently in 2005 to see if noticeable changes occurred on shorter timescales. Figure 4 shows that significant changes occur on monthly timescales. We also observed several flare events, the largest of which occurred at HJD 2453395.0028, lasting about 30 minutes, and had an amplitude of about 0.5 magnitudes in B. This flare is shown in Figure 5.

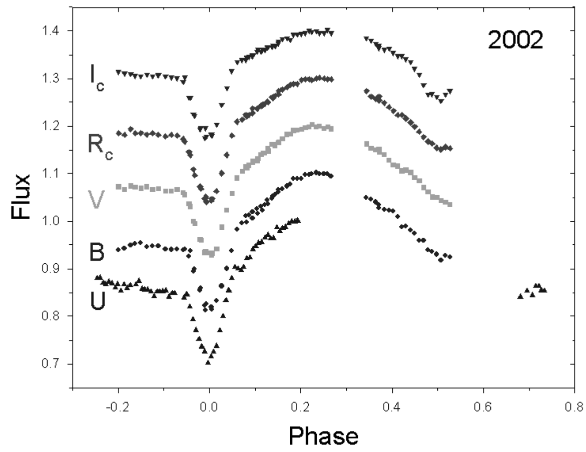

Figure 1. $UBVR_cI_c$ light curves of DK CVn from 2002.

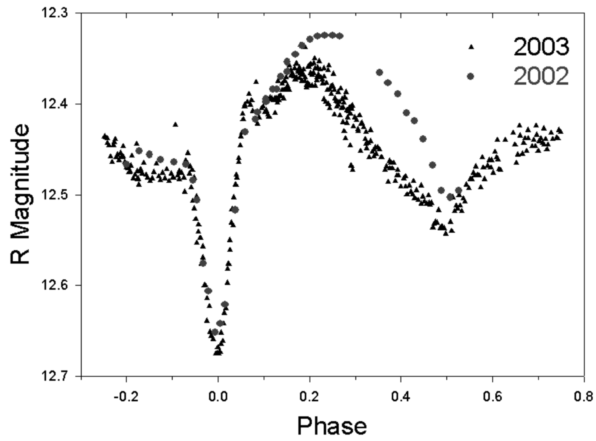

Figure 2. R_c light curve of DK CVn in 2003 compared with the 2002 light curve.

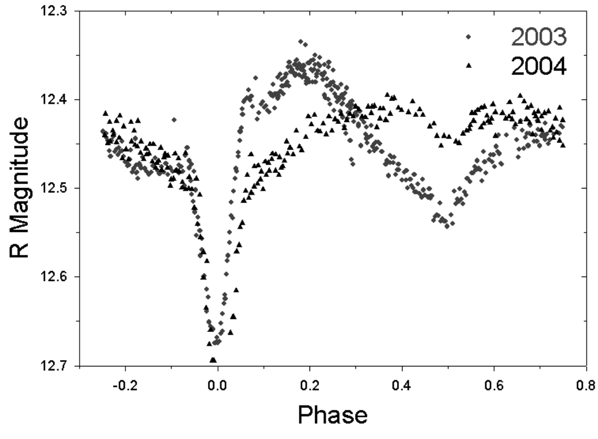

Figure 3. R_c light curve of DK CVn in 2004 compared with the 2003 light curve.

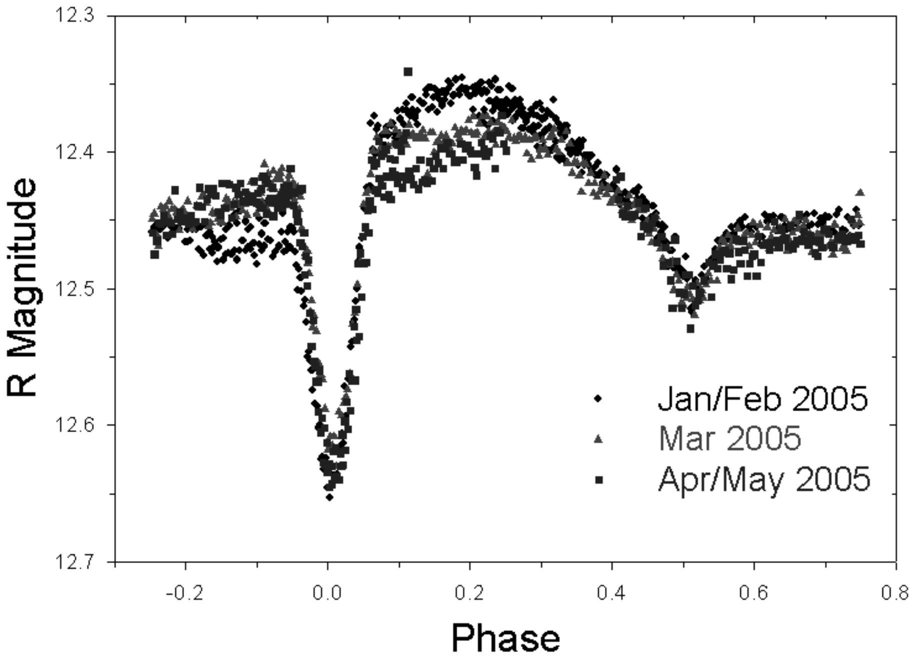

Figure 4. R_c light curve of DK CVn showing variability on monthly timescales in 2005.

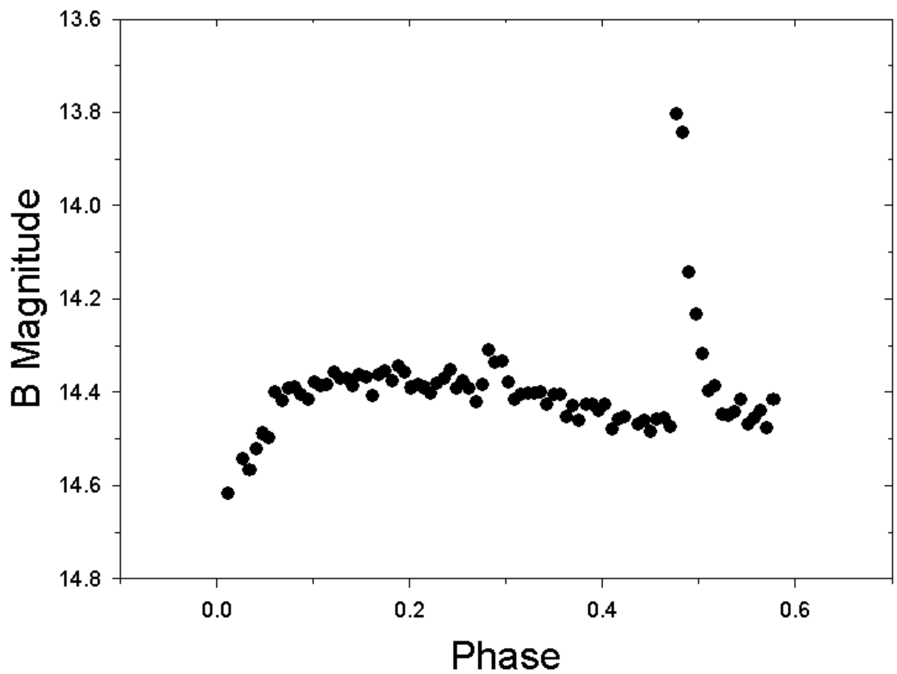

Figure 5. DK CVn flare event on HJD 2453395.

From the nearly 10,000 photometric observations we have obtained of DK CVn over four observing seasons, we have determined 38 times of primary minimum. We used the AVE[1] software which implements the Kwee-van Woerden method. The times of minimum are listed in Table 1 along with the standard errors. The errors are probably optimistic given the often quite distorted nature of the primary minimum but they do provide some estimate of the relative errors of the minima. A linear fit to the times of minimum yields the ephemeris for primary minima: 2453094.8234(2) + 0.4949631(2)×E where the numbers in parentheses are the standard errors in the last digits of the parameters. No evidence for period changes is seen in the time of minimum analysis.

Table 1. Times of primary minimum for DK CVn

HJD	Error (days)	Filter	HJD	Error (days)	Filter
2452361.7820	0.0008	R	2452363.7604	0.0006	I
2452363.7618	0.0008	R	2452363.7623	0.0019	V
2452408.8049	0.0001	U	2452712.7104	0.0003	R
2452713.7008	0.0002	R	2453083.9362	0.0007	R
2453085.9135	0.0005	V	2453094.8234	0.0002	V
2453108.6837	0.0008	I	2453109.6731	0.0005	B
2453383.8786	0.0002	V	2453383.8798	0.0003	R
2453383.8788	0.0004	V	2453385.8600	0.0005	V
2453388.8299	0.0002	R	2453389.8191	0.0004	R
2453390.8090	0.0004	R	2453420.0139	0.0009	B
2453421.9926	0.0013	B	2453422.9834	0.0058	B
2453426.9420	0.0013	B	2453427.9322	0.0007	B
2453430.9040	0.0002	V	2453430.9043	0.0005	B
2453432.8825	0.0005	B	2453432.8840	0.0005	V
2453433.8726	0.0004	B	2453443.7712	0.0005	V
2453445.7507	0.0005	B	2453448.7210	0.0008	B
2453451.6915	0.0004	V	2453456.6409	0.0002	R
2453457.6302	0.0003	B	2453478.9140	0.0002	R
2453479.9051	0.0010	B	2453496.7330	0.0001	R

We obtained a low resolution spectrum of DK CVn in March 2005 with the B&C+CCD spectrograph at the 1.22m telescope operated in Asiago by the Univ. of Padova, and we classify the primary component as a K7 V star. From the relative depths of the eclipses in the I_c light curve, we estimate that the secondary component is a late M-type star. Radial velocities will be necessary to estimate the physical parameters of the system and we plan to obtain high resolution spectra during the next observing season.

References:

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[1]AVE is written by Rafael Barbera and the software can be obtained from `http://www.astrogea.org/soft/ave/introave.htm`