COMMISSIONS 27 AND 42 OF THE IAU
INFORMATION BULLETIN ON VARIABLE STARS
Number 5556

Konkoly Observatory
Budapest
6 August 2004

HU ISSN 0374 – 0676

UBVRI OBSERVATIONS OF V350 Cep IN THE PERIOD 2002-2004

SEMKOV, E.H.

Institute of Astronomy, Bulgarian Academy of Sciences, 72, Tsarigradsko Shose blvd., BG-1784 Sofia, Bulgaria, e-mail: evgeni@skyarchive.org

The pre-main sequence (PMS) star V350 Cep lies in the region of active star formation NGC 7129. The historical light curve of V350 Cep resembles the FU Orionis (FUOR) type stars (Semkov et al. 1999) but its spectrum is similar to the Classical T Tauri stars (Magakian et al. 1999). Since 1970 a gradual increasing of star brightness has begun and the R magnitude of V350 Cep increased with $\sim5^{\rm m}$ until 1977. Since 1977 the stellar brightness varies around the maximal value with an amplitude of about $1\overset{\rm m}{.}5$ (B).

The present data are a continuation of our investigation of V350 Cep (Semkov 1993; Semkov 1996; Semkov et al. 1999; Semkov 2002). Our photometric data were performed in two observatories with three telescopes: the 2-m Ritchey-Cretien-Coude and 50/70/172 cm Schmidt telescopes of the National Astronomical Observatory Rozhen (Bulgaria) and the 1.3-m Ritchey-Cretien telescope of the Skinakas Observatory[1] of the Institute of Astronomy, University of Crete (Greece). All frames ware taken through a standard Johnson-Cousins set of filters. The technical parameters for the CCD cameras used, observational procedure and data reduction process are described in Semkov (2002). As a reference the $UBVRI$ comparison sequence reported in Semkov (2002) was used. The results of our photometric observations of V350 Cep are summarized in Table 1. The table contains the date of observation, the Julian Date, the V magnitude, $U-B$, $B-V$, $V-R$ and $V-I$ indices and the used telescope.

Herbst et al. (1994) defined three basic types of brightness variation concerning PMS stars. Type I of variability is typical for Weak line T Tauri Stars (WTTSs). The variability is due to rotation of large cool surface spots. Periods of variability on time scales of days and amplitudes up to $0\overset{\rm m}{.}8$ in V are observed in WTTSs. Type II of variability occurs predominantly on Classical T Tauri Stars (CTTS) and it is caused by superposition of cool and hot surface spots. Non-periodic variations with amplitudes up to $3^{\rm m}$ in V are often observed on CTTSs. Type III is a more complicated variability observed on Herbig Ae/Be stars (HAEBESs) and some early F-G type CTTSs. The brightness variations are supposed to be produced by obscuration from circumstellar dust. The variability is either irregular or periodic on time scales of days or weeks and the observed amplitudes exceed up to $2\overset{\rm m}{.}8$ in extreme cases.

[1]Skinakas Observatory is a collaborative project of the University of Crete, the Foundation for Research and Technology - Hellas, and the Max-Planck-Institut für extraterrestrische Physik.

Table 1. Photometric observations of V350 Cep in the period February 2002 - May 2004

Date	J.D.(24...)	V	$U-B$	$B-V$	$V-R_C$	$V-I_C$	Tel.
5.02.2002	52311.226	16.08	–	0.97	0.84	2.04	Scm
6.02.2002	52312.219	16.22	–	–	0.92	2.12	Scm
7.02.2002	52313.213	16.09	–	1.18	0.82	2.04	Scm
8.06.2002	52433.502	16.344	–	1.054	1.012	2.160	1.3m
24.06.2002	52449.552	16.168	–	1.014	–	2.060	1.3m
2.07.2002	52457.533	16.105	−0.31	1.040	0.914	–	1.3m
3.07.2002	52458.546	16.193	–	1.015	0.962	2.076	1.3m
15.07.2002	52471.496	16.093	–	1.103	–	2.016	1.3m
22.08.2002	52508.543	16.199	–	1.071	0.953	2.055	1.3m
23.08.2002	52509.557	16.321	–	1.037	–	2.137	1.3m
24.08.2002	52510.549	16.374	–	–	–	2.150	1.3m
25.08.2002	52511.562	16.315	−0.15	0.978	0.985	2.134	1.3m
3.10.2002	52551.424	16.25	–	1.19	1.07	2.14	Scm
4.10.2002	52552.435	16.25	–	1.20	0.92	2.14	Scm
5.10.2002	52553.448	16.16	–	–	0.86	2.07	Scm
29.10.2002	52577.376	16.14	–	1.05	0.91	2.06	Scm
30.10.2002	52578.327	16.05	−0.36	1.00	0.89	1.98	Scm
31.10.2002	52579.214	16.07	−0.38	1.04	0.94	2.02	Scm
1.11.2002	52580.230	16.10	–	1.04	0.89	2.05	Scm
26.11.2002	52605.196	16.19	–	–	0.81	2.06	Scm
28.11.2002	52607.258	16.46	−0.45	1.10	1.01	2.27	Scm
29.11.2002	52608.220	16.38	–	1.23	0.97	2.22	Scm
28.02.2003	52698.592	16.391	−0.29	1.047	1.069	2.101	2m
2.03.2003	52700.581	16.398	−0.42	1.072	1.069	2.084	2m
3.03.2003	52701.568	16.247	−0.27	1.060	1.018	1.982	2m
3.04.2003	52732.587	16.32	–	1.04	0.97	2.17	Scm
1.05.2003	52761.461	16.29	–	–	0.97	2.15	Scm
2.05.2003	52762.440	16.24	–	1.01	0.90	2.14	Scm
5.05.2003	52765.448	16.21	–	0.93	0.96	2.11	Scm
11.06.2003	52801.544	16.273	–	–	–	2.136	1.3m
12.06.2003	52802.565	16.301	−0.34	1.039	–	2.136	1.3m
15.06.2003	52805.578	16.224	–	–	–	2.110	1.3m
16.06.2003	52806.570	16.108	–	1.006	–	2.057	1.3m
17.06.2003	52807.570	16.088	–	1.022	–	2.014	1.3m
18.06.2003	52808.569	16.221	–	1.043	–	2.028	1.3m
19.06.2003	52809.566	16.269	−0.24	1.069	–	2.080	1.3m
21.06.2003	52812.465	16.127	–	–	–	2.048	1.3m
23.06.2003	52813.573	16.173	–	–	–	2.077	1.3m
24.06.2003	52814.553	16.235	–	–	0.990	2.125	1.3m
25.06.2003	52815.563	16.326	–	–	0.993	2.171	1.3m
26.06.2003	52816.576	16.241	–	–	–	2.123	1.3m
27.06.2003	52817.561	16.111	–	–	–	–	1.3m
10.07.2003	52831.386	16.149	–	1.071	–	2.075	1.3m
12.07.2003	52832.565	16.134	–	1.040	–	2.057	1.3m
12.07.2003	52833.408	16.129	–	1.025	–	2.054	1.3m
13.07.2003	52834.424	16.044	–	1.031	–	2.026	1.3m
25.07.2003	52845.547	16.151	–	1.030	–	2.088	1.3m
26.07.2003	52846.581	16.065	–	1.021	–	2.070	1.3m
30.07.2003	52850.575	15.889	–	1.001	0.887	1.926	1.3m
9.08.2003	52860.539	15.990	–	–	–	1.981	1.3m
9.08.2003	52861.355	16.148	–	1.048	–	2.090	1.3m
10.08.2003	52862.416	16.179	–	1.076	–	2.101	1.3m
27.09.2003	52910.283	16.21	–	1.01	0.93	2.18	Scm
28.09.2003	52911.263	16.38	–	–	–	2.24	Scm
29.09.2003	52912.249	16.28	–	1.16	0.93	2.19	Scm
1.10.2003	52914.480	16.27	–	1.12	1.00	2.22	Scm
2.10.2003	52915.321	16.28	–	1.03	0.99	2.24	Scm
3.10.2003	52916.285	16.16	−0.25	1.04	0.97	2.16	Scm

Table 1. (continuation)

Date	J.D.(24...)	V	$U-B$	$B-V$	$V-R_C$	$V-I_C$	Tel.
24.10.2003	52968.410	15.88	–	–	–	1.96	2m
25.11.2003	52969.241	15.94	–	0.95	0.91	2.01	Scm
19.12.2003	52993.185	15.83	–	0.97	0.95	1.97	Scm
10.02.2003	53046.210	15.70	–	–	0.84	1.88	Scm
20.03.2003	53084.553	15.770	–	–	0.863	1.908	2m
21.03.2003	53085.578	15.963	–	–	0.923	2.046	2m
22.03.2003	53086.522	15.884	–	–	0.884	1.932	2m
13.05.2003	53138.513	15.97	–	0.99	0.90	2.03	Scm
13.06.2004	53170.440	15.87	–	–	0.91	1.96	Scm
15.07.2004	53201.407	15.89	–	–	0.85	1.98	Scm
16.07.2004	53202.433	16.03	–	1.05	0.93	2.05	Scm

The V-light curve of V350 Cep from all our CCD observations (Semkov 1996; Semkov et al. 1999; Semkov 2002 and this paper) is shown in Fig. 1. It is seen from the figure that for the ten years period of observations the star shows a long-term brightness variations on a time-scale of about one thousand days. Such long-term variability is also seen and from our photographic observations made in the period 1985-1994 (Semkov 1993; Semkov 1996). The long-term brightness variations are typical of HAEBE stars or related objects called UXors (Herbst and Shevchenko, 1999). The cause of variability of UXors can be obscuration from orbiting circumstellar matter or variable accretion from a circumstellar disk. In contrast to HAEBE stars and UXors V350 Cep is a low-mass star of M2 spectral type. The observed amplitude in V-light in the period 1994-2004 is only $0\overset{m}{.}8$.

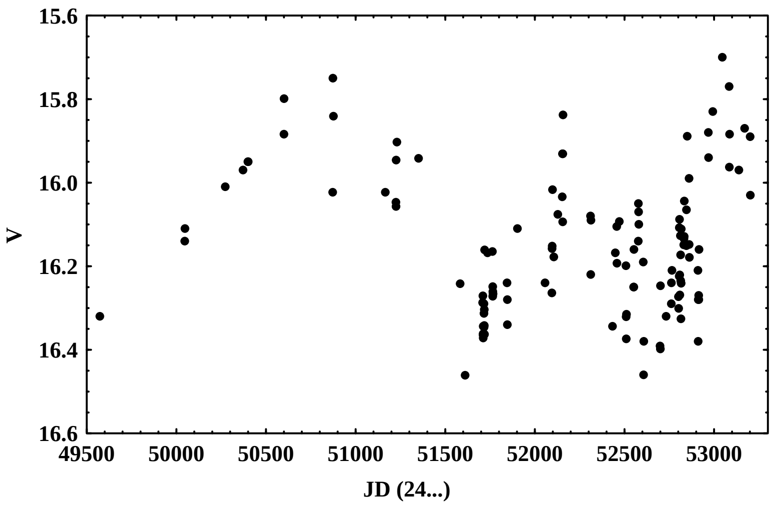

Figure 1. V-light curve of V350 Cep in the period August 1994 - July 2004

Another important result from our photometric study is the variation of color indices with stellar brightness. The measured color indices $V-I$ and $B-V$ versus stellar magnitude V during the period of our CCD observations are plotted in Fig. 2 and Fig. 3 respectively. A clear dependence can be seen from the figures: the star becomes redder as it fades. Such color variations are typical of stars with large cool spots whose variability is produced by rotation of the spotted surface (WTTs). Consequently, V350 Cep shows photometric characteristics of FUORs (5 magnitudes outburst), UXors (long-term brightness variations) and WTTs (variability with small amplitude in time scale of days). On the other hand, the observed spectra of V350 Cep can be classified as a CTTs spectrum (Magakian et al. 1999). As is seen from Table 1 V350 Cep shows a very strong ultraviolet excess a characteristic also typical of CTTs. These discrepancies make V350 Cep a unique object very difficult for exact classification.

The author thanks the Director of Skinakas Observatory Prof. I. Papamastorakis and Dr. I. Papadakis for the telescope time.

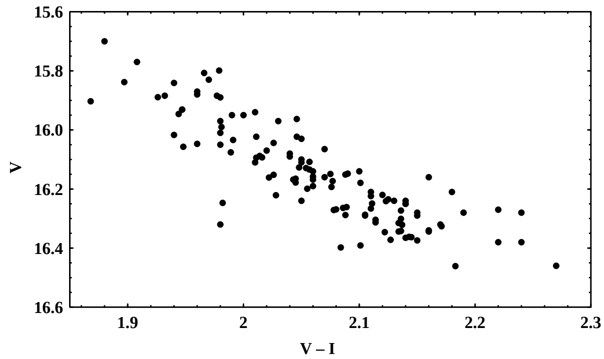

Figure 2. Relationship between V magnitude and V-I color index in the period of observations

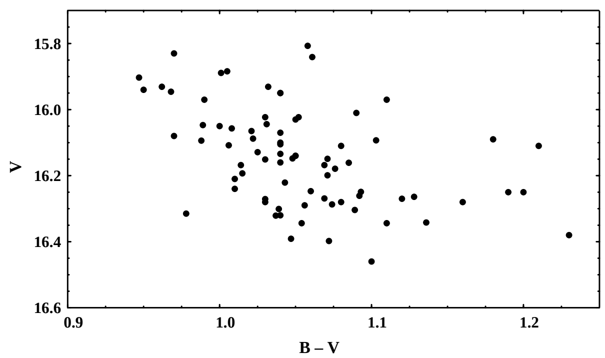

Figure 3. Relationship between V magnitude and B-V color index in the period of observations

References:

Herbst, W., Shevchenko, V.S., 1999, *AJ*, **118**, 1043
Herbst, W., Herbst, D. K., Grossman, E. J., Weinstein, D. 1994, *AJ*, **108**, 1906
Magakian, T.Y., Movsesian, T.A., Hovhannesian, E.R., 1999, *Astrofizika*, **42**, 121
Semkov, E.H., 1993, *IBVS*, No. 3825
Semkov, E.H., 1996, *IBVS*, No. 4339
Semkov, E.H., Mutafov, A.S., Munari, U., Rejkuba, M., 1999, *AN*, **320**, 57
Semkov, E.H., 2002, *IBVS*, No. 5214