A new prolonged decrease event in the brightness of the young stellar object V2492 Cygni

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Abstract. Results from the $BV(RI)_c$ photometric observations of the young stellar object V2492 Cyg collected in the period from April 2018 to September 2020 are presented. These observations are part of our monitoring of the star which started in 2010 and are continuing to date. V2492 Cyg is located in the Pelican Nebula and its variability has been explained by both accretion and extinction events. The new photometric data show that the star continues to exhibit rapid irregular variability in all bands. In the period from March 2019 to May 2020, we registered a prolonged decrease event in the light curve of V2492 Cyg.
Key words: stars: pre-main sequence — techniques: photometric — methods: observational — stars: individual: V2492 Cyg

1. Introduction

Studies of the photometric variability of pre-main-sequence (PMS) stars are important for the understanding of the early stages of stellar evolution. A special kind of variability can be seen in the PMS stars, which undergo outbursts or obscurations. The outbursts of the PMS stars with amplitude reaching up to 5 mag are grouped in two types: FUors with prototype FU Orionis (Reipurth & Aspin 2010), and EXors with prototype EX Lupi (Herbig 2007). The outbursts of FUors and EXors are generally attributed to a sizable increase in the accretion rate from the circumstellar disk onto the stellar surface. The deep minima, with amplitudes reaching up to 3 mag, are mostly seen in the early types of PMS stars, which are called UXors with prototype UX Orionis (Natta et al. 1997). It is generally accepted that the observed minima result from the obscuration of the star from circumstellar clouds of dust. During the deep minima, the color indices of UXors often become bluer. This phenomenon is known as the "blueing effect" or "color reverse" (see Bibo & Thé 1990).

V2492 Cyg (also know as PTF 10nvg and IRAS 20496+4354) lies in the field of the Pelican Nebula (IC 5070). The star was discovered by Itagaki & Yamaoka (2010) during a CCD survey on 23 August 2010 when its unfiltered magnitude was about 13.8. The authors reported that V2492 Cyg was not detected at its position on a survey reference image taken on 7 August 2008 (limiting magnitude about 17.5).

V2492 Cyg shows the characteristics inherent to EXor- and UXor-type variables. Detailed studies of the star were made by Covey et al. (2011), Kóspál et al. (2011), Aspin (2011), Kóspál et al. (2013), Hillenbrand et al. (2013), Scholz et al. (2013), Fehér et al. (2017), Giannini et al. (2018), Ibryamov et al. (2018). The star was also subject of several Astronomer's Telegrams (see Semkov & Peneva 2012, Arkharov et al. 2015, Ibryamov & Semkov 2017, Munari et al. 2017, Froebrich et al. 2017, Ibryamov & Semkov 2019).

In our first paper (Ibryamov, Semkov & Peneva 2018, hereafter ISP18), we presented the results from $BV(RI)_c$ observations of V2492 Cyg obtained in the period from 2010 to 2017. In this study, we present new photometric data of the star and discuss its photometric behavior.

2. Observations

The observations of V2492 Cyg were obtained as part of our continuous monitoring of the star (ISP18). They were collected in the period from April 2018 to September 2020 with the 2-m Ritchey-Chrétien-Coudé (RCC) and the 50/70-cm Schmidt telescopes administered by the Rozhen National Astronomical Observatory in Bulgaria. Two types of CCD cameras were used to perform of the observations: Andor iKon-L (2048 × 2048 pixels, 13.5 × 13.5 μm pixel^{-1} size and 0.17$''$ pixel^{-1}) on the 2-m RCC telescope, and FLI PL16803 (4096 × 4096 pixels, 9 × 9 μm pixel^{-1} size and 1.08$''$ pixel^{-1}) on the 50/70-cm Schmidt telescope. The observational procedure and data reduction process were described in ISP18.

All frames were taken through a standard Johnson-Cousins (BVR_cI_c) set of filters. As a reference, the comparison sequence reported in ISP18 was used. In very low light, the brightness of V2492 Cyg was under the detection limit of the telescopes used (usually about 20.5 mag for the 2-m RCC telescope, and about 19.5 mag for the 50/70-cm Schmidt telescope).

3. Results and discussion

The results of the photometric observations of V2492 Cyg are summarized in Table 1. The columns contain the Julian date of the observations, the measured magnitudes of the star, and the telescope used.

The $BV(RI)_c$ light curves of V2492 Cyg are shown in Fig. 1. The available data suggest that during our observations, the star shows strong irregular variability in all bands. It can be seen from Fig. 1 that from April 2018 to January 2019 the star's brightness varies in wide ranges: 12.24-14.00 mag in the I_c band, 13.67-15.44 mag in the R_c band, 14.94-16.78 mag in the V band, and 16.79-18.88 mag in the B band. In early March 2019, a deep minimum (I_c=17.41 mag) in the light curve of V2492 Cyg was observed. In April 2019 the brightness of the star began to increase gradually, and at the end of July 2019 it reached I_c=15.73 mag.

At the beginning of August 2019 the brightness of V2492 Cyg began to decline again, and in mid-January 2020 was registered the deepest drop (ΔI_c=6.83 mag). It is important to mention that during the observations on 15 and 16 January 2020 with the 50/70-cm Schmidt telescope, the star is not visible at its position (Fig. 2). As can be seen from Fig. 1, at the end of July 2020 V2492 Cyg returned to maximum light.

Table 1: Photometric observations of V2492 Cyg in the period April 2018−September 2020.

J.D. (24...)	I_c [mag]	R_c [mag]	V [mag]	B [mag]	Tel	J.D. (24...)	I_c [mag]	R_c [mag]	V [mag]	B [mag]	Tel
58217.573	13.13	14.72	16.07	17.97	Sch	58705.349	16.90	-	-	-	Sch
58218.560	13.11	14.71	16.04	17.96	Sch	58706.348	16.96	19.46	-	-	Sch
58220.517	13.11	14.71	16.07	18.01	Sch	58707.438	17.06	-	-	-	Sch
58278.385	13.41	15.03	16.41	18.31	Sch	58726.272	17.97	19.89	-	-	2-m
58281.419	13.77	15.16	16.78	18.88	2-m	58727.333	17.92	-	-	-	2-m
58312.385	13.46	15.28	16.76	18.66	Sch	58728.345	17.91	19.62	-	-	2-m
58316.386	12.75	14.37	15.73	17.61	Sch	58729.296	17.96	19.74	-	-	2-m
58340.327	13.71	15.42	16.72	18.55	Sch	58729.516	18.09	-	-	-	Sch
58342.329	13.71	15.28	16.50	18.22	Sch	58730.301	17.90	19.57	-	-	2-m
58343.339	13.89	15.38	16.56	18.21	Sch	58730.412	17.97	-	-	-	Sch
58344.321	13.96	15.44	16.61	18.26	Sch	58757.344	18.73	-	-	-	Sch
58346.273	14.00	15.27	16.50	18.15	2-m	58758.312	18.79	-	-	-	Sch
58363.297	13.49	15.01	16.29	17.98	Sch	58759.299	18.69	-	-	-	Sch
58364.275	13.40	14.94	16.18	17.86	Sch	58864.233	-	-	-	-	Sch
58365.498	13.31	14.63	16.04	17.79	2-m	58865.213	-	-	-	-	Sch
58409.286	12.24	13.67	14.94	16.79	Sch	58867.200	19.07	-	-	-	2-m
58428.234	13.35	14.88	16.17	18.00	Sch	58993.397	18.12	20.05	-	-	2-m
58435.215	12.71	14.11	15.36	17.14	Sch	58993.421	18.44	-	-	-	Sch
58492.176	13.42	14.77	15.97	17.67	Sch	59040.340	14.54	16.50	18.41	-	Sch
58547.594	17.41	-	-	-	Sch	59041.372	14.46	16.38	18.20	-	Sch
58603.449	17.13	-	-	-	Sch	59042.358	14.47	16.41	18.25	-	Sch
58604.474	16.96	19.29	-	-	Sch	59059.347	12.98	14.61	16.11	18.30	Sch
58606.408	16.72	-	-	-	2-m	59060.342	13.02	14.64	16.14	18.43	Sch
58606.483	16.76	19.29	-	-	Sch	59075.302	13.02	14.34	15.82	17.81	2-m
58665.358	16.64	19.24	-	-	Sch	59085.259	12.78	14.20	15.50	17.45	Sch
58666.363	16.36	18.97	-	-	Sch	59101.381	12.38	13.73	14.98	16.83	Sch
58667.366	16.51	19.02	-	-	Sch	59102.320	12.40	13.57	14.75	16.70	2-m
58690.282	15.82	17.59	19.66	-	2-m	59103.306	12.58	13.78	14.99	16.92	2-m
58691.386	15.98	17.74	20.02	-	2-m	59104.355	12.31	13.64	14.85	16.67	Sch
58692.337	15.73	17.46	19.83	-	2-m	59105.283	12.36	13.68	14.91	16.74	Sch
58704.317	16.91	-	-	-	Sch						

We constructed two color−magnitude diagrams of V2492 Cyg, which are displayed in Fig. 3. The diagrams indicate that the star becomes redder when fainter in a manner consistent with changing extinction. Such colour variations are typical for PMS stars whose light is obscured by dust grains or filaments in the line of sight. In the color indices, there is no blue shift during the low states of the star. In this case, it can be assumed that extinction is not the predominant mechanism for the brightness variation of V2492 Cyg.

The long-term I_c light curve of V2492 Cyg, constructed from all available observations, is shown in Fig. 4. It can be seen that the star shows large-amplitude variations in the brightness. Several clearly expressed deep minima in the light curve can be distinguished, with different amplitudes and duration. The variability of the star may result from the superposition of both variable accretion rate and variable extinction, although their mutual proportion has not been clarified yet. It is very difficult to distinguish the two phenomena using only photometric data. We carried out a periodicity search of the deep minima in the brightness of V2492 Cyg, but we did not find any.

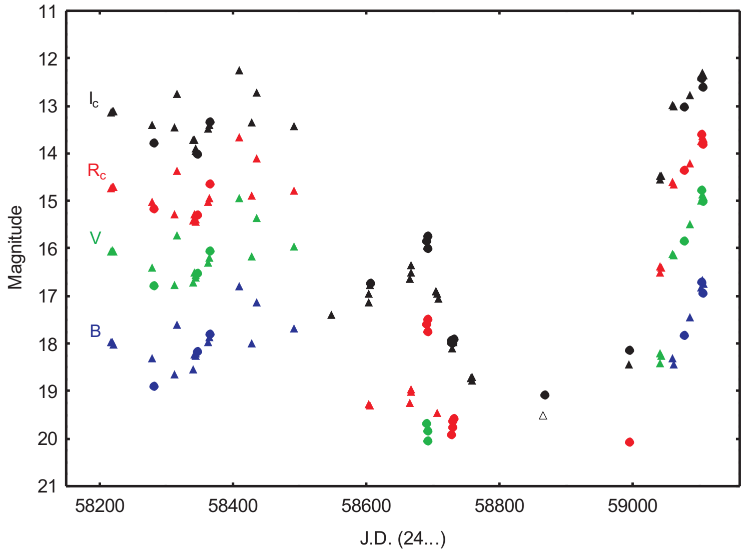

Fig. 1. $BV(RI)_c$ light curves of V2492 Cyg for the period April 2018−September 2020. The circles denote the data from the 2-m RCC telescope, the triangles represent the data from the 50/70-cm Schmidt telescope, and the empty triangles mark the brightness limit in the I_c band for two nights (15 and 16 January 2020) where the star was not visible.

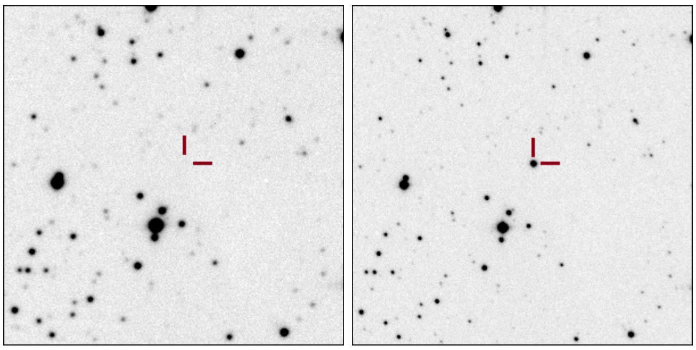

Fig. 2. I_c frames of the field of V2492 Cyg during the deepest observed drop (16.01.2020, left image, exp. 300 s) and when the star returned to maximum light (28.07.2020, right image, exp. 120 s). The position of V2492 Cyg is marked. North is up, east is left. The frames were taken with the 50/70-cm Schmidt telescope. The field of view is 5.5′.

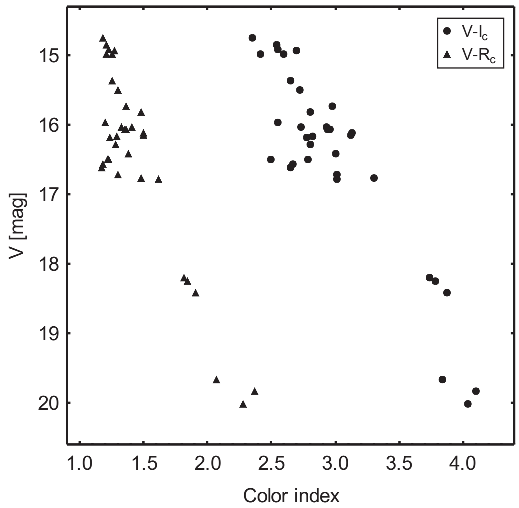

Fig. 3. Color indices $V - I_c$ and $V - R_c$ versus the stellar V magnitude of V2492 Cyg for the period April 2018−September 2020.

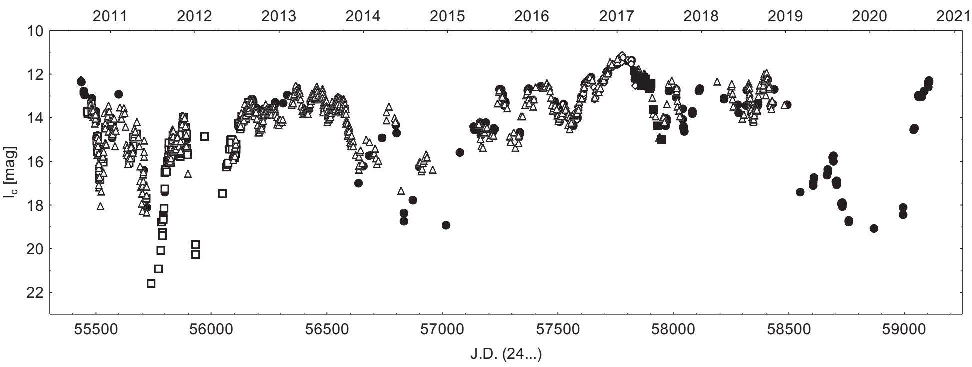

Fig. 4. Long-term I_c light curve of V2492 Cyg for the period August 2010−September 2020. The meaning of the different symbols is as in Fig. 2 of ISP18.

4. Conclusion

We presented and discussed the results from the photometric observations of V2492 Cyg during the new decrease event in its brightness. The star shows strong irregular variability in all bands. This variability can likely be explained by a superposition of both variable accretion rate and variable extinction, although their mutual proportion has not been clarified yet. It is difficult to distinguish the two phenomena using only photometric data. V2492 Cyg retains its complicated light curve, and further observations (photometric and spectroscopic) are very important for clarifying its exact nature.

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