Multicolor photometric behavior of the young stellar object V1704 Cygni

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Abstract. Results from *BVRI* photometric observations of the pre-main sequence star V1704 Cyg collected during the time period from August 2010 to December 2017 are presented. The star is located in the star-forming HII region IC 5070 and it exhibits photometric variability in all optical passbands. After analyzing the obtained data, V1704 Cyg is classified as a classical T Tauri star.
Key words: stars: pre-main sequence, stars: variables: T Tauri, star: individual: (V1704 Cyg)

1. Introduction

One of the most frequent types of pre-main sequence (PMS) stars are the low-mass ($M \leq 2M_{\odot}$) T Tauri stars (TTSs). The first study of the TTSs as a separate class of variables with the prototype star T Tau was made by Joy (1945). These stars show irregular photometric variability and emission spectra.

TTSs are divided into two sub-classes: classical T Tauri stars (CTTSs) still actively accreting from their massive circumstellar disks and the weak-line T Tauri stars (WTTSs) without evidence of disk accretion (Ménard & Bertout 1999).

According to the classification scheme for the light curves of the CTTSs proposed by Ismailov (2005) we can clearly distinguish five principal types based on the light curve shape: (Type I): constant mean brightness without changes in the amplitude of the rapid brightness variability; (Type II): constant mean brightness with changes in the amplitude of the rapid variability; (Type III): varying mean brightness without changes in the amplitude of the rapid variability; (Type IV): variations of both the mean brightness and the amplitude of the rapid variability; and (Type V): the variable is often bright, and rare brightness decreases are observed. The possible physical mechanisms responsible for the different light curve shapes are given in Ismailov (2005).

The long-term multicolor observations are of particular importance to the finding and the classification of PMS stars. The number of the studied PMS stars is not large. Each individual study in this direction is important and contributes to the overall shaping of the scientific ideas about the star formation process.

V1704 Cygni (also known as LkH$_{\alpha}$ 155 and [KW97] 50-45) was included in the list of H$_{\alpha}$ emission-line stars published by Herbig (1958). The spectrum of the star taken by Mendoza et al. (1990) shows spectral type K3 and strong hydrogen ($W_\lambda(H_\alpha)$=98.8 Å and $W_\lambda(H_\beta)$=36.7 Å) and forbidden emission lines. He I (λ 5876 Å and λ 7065 Å), [O II] (λ 3727-9 Å) and [S II] (λ 6717 plus λ 6731 Å) emission lines are present. Guieu et al. (2009) included V1704 Cyg in their list of young stellar object candidates.

Section 2 in the present paper gives information about the telescopes and cameras used to collect the photometric observations. Section 3 describes the derived results and their interpretation.

2. Observations and Data reduction

The *BVRI* photometric observations of V1704 Cyg were performed from August 2010 to December 2017 with the 2-m Ritchey-Chrétien-Coudé (RCC), the 50/70-cm Schmidt and the 60-cm Cassegrain telescopes administered by the Rozhen National Astronomical Observatory in Bulgaria and the 1.3-m Ritchey-Chrétien (RC) telescope administered by the Skinakas Observatory[1] of the University of Crete in Greece. The total number of the nights used for observations is 212.

The observations were performed with four different types of CCD cameras: VersArray 1300B at the 2-m RCC telescope, ANDOR DZ436-BV at the 1.3-m RC telescope, FLI PL16803 at the 50/70-cm Schmidt telescope, and FLI PL09000 at the 60-cm Cassegrain telescope. The technical parameters and specifications for the cameras used are given in Ibryamov et al. (2015). All frames were taken through a standard Johnson−Cousins *BVRI* set of filters. The frames are dark (bias) frame subtracted and flat field corrected. The photometric data were reduced using IDL based DAOPHOT subroutine. As a reference, the *BVRI* comparison sequence of eleven stars in the field around V2492 Cyg reported in Ibryamov et al. (2018) was used. All data were analyzed using the same aperture, which was chosen to have a 4″ radius, while the background annulus was taken from 9 to 14″. The average value of the errors in the reported magnitudes is 0.01−0.02 mag for the *I*- and *R*-band data and 0.01−0.03 mag for the *V*- and *B*-band data.

3. Results and Discussion

V1704 Cyg is located in the field of the Pelican Nebula (IC 5070) at 1′ from the well-studied young star V2492 Cyg. The results from our long-term *BVRI* photometric monitoring of V1704 Cyg are summarized in Tab. 1[2]. The available photometric data of the star are plotted on Fig. 1.

Table 1: Photometric CCD observations of V1704 Cyg.

Date	J.D. (24...)	*I* [mag]	*R* [mag]	*V* [mag]	*B* [mag]	Telescope	CCD
26.08.2010	55435.339	14.66	16.24	17.61	19.24	1.3-m	AND

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

[2] The table is available also via CDS Vizier Online Data Catalog.

Table 1: Continued.

Date	J.D. (24...)	I [mag]	R [mag]	V [mag]	B [mag]	Telescope	CCD
07.09.2010	55447.457	14.60	16.11	17.20	-	Sch	FLI
08.09.2010	55448.298	14.57	16.07	17.25	-	Sch	FLI
09.09.2010	55449.378	14.62	16.14	17.32	-	Sch	FLI
11.10.2010	55481.316	14.24	15.69	16.92	18.27	1.3-m	AND
29.10.2010	55499.210	14.51	15.98	17.20	18.71	2-m	VA
30.10.2010	55500.184	14.50	15.98	17.20	18.69	2-m	VA
31.10.2010	55501.178	14.46	15.98	-	-	Sch	FLI
31.10.2010	55501.253	14.47	15.97	17.19	18.67	2-m	VA
01.11.2010	55502.178	14.48	15.97	17.15	18.57	2-m	VA
02.11.2010	55503.188	14.39	15.82	-	-	Sch	FLI
03.11.2010	55504.219	14.41	15.92	-	-	Sch	FLI
04.11.2010	55505.175	14.44	15.98	-	-	Sch	FLI
05.11.2010	55506.206	14.47	15.98	17.18	-	Sch	FLI
06.11.2010	55507.207	14.50	15.99	-	-	Sch	FLI
01.01.2011	55563.188	14.49	16.04	-	-	Sch	FLI
06.01.2011	55568.169	14.31	15.67	16.62	17.85	2-m	VA
08.01.2011	55570.171	14.49	15.93	17.09	18.52	2-m	VA
09.01.2011	55571.173	14.34	15.85	16.95	18.30	2-m	VA
11.01.2011	55573.215	14.62	16.02	17.18	-	2-m	VA
12.01.2011	55574.240	14.59	16.10	17.28	-	2-m	VA
07.02.2011	55599.675	14.58	16.12	17.52	-	Sch	FLI
04.04.2011	55656.484	14.56	16.00	-	-	Sch	FLI
08.04.2011	55659.502	14.37	15.80	-	-	2-m	VA
21.05.2011	55703.401	14.66	-	-	-	Sch	FLI
23.05.2011	55705.398	14.54	-	-	-	Sch	FLI
25.05.2011	55707.379	14.63	-	-	-	Sch	FLI
08.06.2011	55721.357	14.61	16.07	-	-	2-m	VA
21.06.2011	55734.405	14.66	-	-	-	Sch	FLI
23.06.2011	55736.468	14.72	-	-	-	Sch	FLI
16.08.2011	55790.302	14.62	-	-	-	1.3-m	AND
17.08.2011	55791.306	14.68	16.29	17.61	19.14	1.3-m	AND
23.08.2011	55797.310	14.64	-	-	-	Sch	FLI
10.09.2011	55815.428	14.72	16.33	17.66	19.14	1.3-m	AND
11.09.2011	55816.415	14.66	16.22	17.53	-	1.3-m	AND
19.09.2011	55824.258	14.55	16.06	17.29	18.69	1.3-m	AND
23.09.2011	55828.268	14.57	-	-	-	Sch	FLI
07.10.2011	55842.288	14.46	15.88	-	-	1.3-m	AND
13.10.2011	55848.252	14.67	16.28	17.62	18.94	1.3-m	AND
29.10.2011	55864.210	14.70	16.17	17.43	-	2-m	VA
31.10.2011	55866.256	14.47	15.93	17.02	18.36	2-m	VA
26.11.2011	55892.192	14.35	15.77	16.91	-	2-m	VA
29.11.2011	55895.188	14.49	15.92	-	-	Sch	FLI
30.11.2011	55896.201	14.53	15.99	-	-	Sch	FLI
29.12.2011	55925.190	14.52	-	-	-	Sch	FLI
01.01.2012	55928.172	14.53	-	-	-	Sch	FLI
17.03.2012	56003.552	14.52	-	-	-	Sch	FLI
29.03.2012	56015.527	14.57	-	-	-	2-m	VA
15.06.2012	56094.409	14.58	16.07	17.27	-	2-m	VA
17.06.2012	56096.374	14.57	16.00	-	-	Sch	FLI
11.07.2012	56120.350	14.62	16.10	17.32	-	Sch	FLI
12.07.2012	56121.313	14.64	16.17	17.36	-	Sch	FLI
13.07.2012	56122.375	14.57	16.13	17.25	-	Sch	FLI
14.07.2012	56123.347	14.56	16.08	17.28	18.64	Sch	FLI
01.08.2012	56141.399	14.54	16.02	17.23	-	1.3-m	AND
02.08.2012	56142.285	14.53	16.02	17.22	-	1.3-m	AND
03.08.2012	56143.269	14.59	16.10	17.23	-	1.3-m	AND
12.08.2012	56151.614	14.55	16.05	17.25	-	1.3-m	AND

Table 1: Continued.

Date	J.D. (24...)	I [mag]	R [mag]	V [mag]	B [mag]	Telescope	CCD
19.08.2012	56159.326	14.64	16.20	17.39	-	Sch	FLI
20.08.2012	56160.303	14.69	16.32	17.58	-	Sch	FLI
21.08.2012	56160.540	14.66	16.26	17.56	-	1.3-m	AND
21.08.2012	56161.323	14.70	16.32	17.54	-	Sch	FLI
22.08.2012	56162.315	14.66	16.23	17.48	-	Sch	FLI
02.09.2012	56173.310	14.64	16.23	17.52	19.08	1.3-m	AND
03.09.2012	56174.274	14.64	16.27	17.51	19.07	1.3-m	AND
07.09.2012	56178.280	14.63	16.18	17.35	18.74	1.3-m	AND
08.09.2012	56179.449	14.55	16.10	17.28	-	1.3-m	AND
09.09.2012	56180.281	14.50	15.96	17.07	18.40	1.3-m	AND
10.09.2012	56181.267	14.52	16.02	17.16	18.52	1.3-m	AND
11.09.2012	56182.222	14.50	16.00	17.13	18.51	1.3-m	AND
12.09.2012	56183.346	14.59	16.15	17.34	18.78	1.3-m	AND
22.09.2012	56193.254	14.59	16.13	17.27	18.68	1.3-m	AND
22.09.2012	56193.317	14.60	16.16	17.36	18.77	Sch	FLI
23.09.2012	56194.301	14.50	15.93	17.22	18.48	Sch	FLI
07.10.2012	56208.229	14.69	16.27	17.42	-	Sch	FLI
08.10.2012	56209.232	14.65	16.21	17.42	-	Sch	FLI
09.10.2012	56210.214	14.65	16.20	17.42	-	Sch	FLI
11.10.2012	56212.241	14.59	16.11	17.29	-	60-cm	FLI
13.10.2012	56214.223	14.60	16.14	17.37	18.88	2-m	VA
25.10.2012	56226.298	14.61	16.19	17.37	-	Sch	FLI
26.10.2012	56227.406	14.61	16.17	17.40	-	Sch	FLI
17.11.2012	56249.191	14.69	16.32	17.56	-	Sch	FLI
18.11.2012	56250.201	14.63	16.18	17.38	18.76	Sch	FLI
12.12.2012	56274.189	14.62	16.12	17.37	-	2-m	VA
14.12.2012	56276.191	14.62	16.08	17.29	18.81	2-m	VA
31.12.2012	56293.225	14.57	16.12	17.35	-	Sch	FLI
01.01.2013	56294.205	14.49	15.96	17.15	-	60-cm	FLI
03.01.2013	56296.253	14.63	16.13	-	-	60-cm	FLI
19.01.2013	56312.197	14.52	16.04	17.23	-	2-m	VA
05.02.2013	56329.182	14.78	16.33	-	-	Sch	FLI
06.03.2013	56357.621	14.51	16.00	17.22	-	60-cm	FLI
12.04.2013	56394.505	14.52	15.92	17.05	18.48	Sch	FLI
18.03.2013	56396.585	14.55	16.06	17.31	19.05	2-m	VA
04.05.2013	56417.438	14.64	16.14	17.41	19.11	2-m	VA
15.05.2013	56428.423	14.64	16.15	-	-	60-cm	FLI
17.05.2013	56430.426	14.67	16.26	-	-	60-cm	FLI
30.05.2013	56443.403	14.52	16.06	17.19	18.70	Sch	FLI
31.05.2013	56444.375	14.58	16.12	17.31	18.73	Sch	FLI
04.07.2013	56478.389	14.68	16.20	17.46	19.01	2-m	VA
01.08.2013	56506.376	14.68	16.21	17.48	19.05	2-m	VA
02.08.2013	56507.386	14.66	16.23	17.54	19.20	2-m	VA
03.08.2013	56508.395	14.63	16.18	17.47	19.06	2-m	VA
04.08.2013	56509.310	14.61	16.18	17.37	-	Sch	FLI
05.08.2013	56510.365	14.62	16.19	17.49	-	Sch	FLI
05.08.2013	56510.392	14.60	16.14	17.40	-	60-cm	FLI
06.08.2013	56511.432	14.65	16.23	17.42	-	60-cm	FLI
07.08.2013	56512.379	14.60	16.12	17.32	-	Sch	FLI
07.08.2013	56512.423	14.56	16.11	17.32	-	60-cm	FLI
08.08.2013	56513.401	14.62	16.20	17.33	-	60-cm	FLI
09.08.2013	56514.369	14.57	16.09	17.30	-	60-cm	FLI
04.09.2013	56540.298	14.58	16.08	17.32	18.63	Sch	FLI
05.09.2013	56541.292	14.59	16.10	17.27	18.60	Sch	FLI
07.09.2013	56543.426	14.71	16.23	17.52	19.12	2-m	VA
08.09.2013	56544.280	14.72	16.26	17.50	-	2-m	VA
11.09.2013	56547.408	14.64	16.16	17.36	-	60-cm	FLI

Table 1: Continued.

Date	J.D. (24...)	I [mag]	R [mag]	V [mag]	B [mag]	Telescope	CCD
17.09.2013	56553.262	14.61	16.20	17.43	-	1.3-m	AND
11.10.2013	56577.327	14.57	16.15	17.32	-	60-cm	FLI
12.10.2013	56578.352	14.59	16.18	17.42	-	60-cm	FLI
07.11.2013	56604.286	14.58	16.09	17.22	-	60-cm	FLI
09.12.2013	56636.209	14.55	16.05	-	-	2-m	VA
29.12.2013	56656.202	14.66	16.19	-	-	Sch	FLI
23.01.2014	56681.208	14.61	16.16	-	-	Sch	FLI
06.02.2014	56694.641	14.49	15.93	17.08	-	2-m	VA
22.03.2014	56738.568	14.63	16.21	17.43	-	Sch	FLI
21.05.2014	56799.450	14.51	16.01	-	-	Sch	FLI
23.05.2014	56801.411	14.60	16.13	17.40	-	2-m	VA
23.06.2014	56832.439	14.54	16.00	17.24	-	2-m	VA
25.06.2014	56834.400	14.55	16.01	17.19	-	2-m	VA
25.07.2014	56864.345	14.66	-	-	-	Sch	FLI
03.08.2014	56873.383	14.67	-	-	-	2-m	VA
29.08.2014	56899.292	14.58	16.13	-	-	1.3-m	AND
26.11.2014	56988.172	14.58	-	-	-	Sch	FLI
13.12.2014	57005.216	14.54	16.01	-	-	Sch	FLI
14.12.2014	57006.246	14.48	15.91	-	-	Sch	FLI
24.12.2014	57016.190	14.52	16.03	-	-	2-m	VA
21.02.2015	57074.619	14.40	15.83	-	-	Sch	FLI
23.04.2015	57136.465	14.42	15.88	17.02	18.50	Sch	FLI
25.04.2015	57138.472	14.52	16.05	17.24	18.79	Sch	FLI
18.05.2015	57161.391	14.32	15.62	16.63	-	Sch	FLI
21.05.2015	57164.440	14.23	15.48	16.47	-	Sch	FLI
24.05.2015	57167.386	14.41	15.90	17.11	18.50	2-m	VA
13.06.2015	57187.356	14.37	15.87	16.91	18.14	2-m	VA
16.07.2015	57220.341	14.53	16.01	17.13	-	Sch	FLI
17.07.2015	57221.393	14.61	16.16	17.40	-	Sch	FLI
19.07.2015	57223.366	14.43	15.88	16.99	18.35	2-m	VA
20.07.2015	57224.394	14.25	15.54	16.57	17.77	2-m	VA
11.08.2015	57246.372	14.44	15.92	17.08	18.41	1.3-m	AND
12.08.2015	57247.299	14.43	15.91	17.03	18.33	1.3-m	AND
17.08.2015	57252.305	14.36	15.77	16.98	18.30	2-m	VA
24.08.2015	57259.466	14.38	15.74	-	-	Sch	FLI
25.08.2015	57260.364	14.29	15.68	-	-	Sch	FLI
03.09.2015	57269.350	14.38	15.77	16.90	17.96	Sch	FLI
04.09.2015	57270.433	14.38	15.85	16.86	18.18	2-m	VA
05.09.2015	57271.411	14.42	15.83	16.96	18.29	2-m	VA
06.09.2015	57272.406	14.25	15.60	16.62	17.83	2-m	VA
03.11.2015	57330.215	14.35	15.75	16.82	-	Sch	FLI
04.11.2015	57331.201	14.44	15.87	16.96	-	Sch	FLI
05.11.2015	57332.204	14.59	16.17	17.51	-	Sch	FLI
06.11.2015	57333.202	14.51	16.02	17.23	-	Sch	FLI
07.11.2015	57334.199	14.42	15.84	16.94	-	Sch	FLI
12.12.2015	57369.186	14.48	15.93	17.16	18.56	2-m	VA
13.12.2015	57370.163	14.51	16.04	17.32	18.89	2-m	VA
14.12.2015	57371.177	14.49	16.01	17.19	-	2-m	VA
15.12.2015	57372.193	14.41	15.85	16.92	18.35	Sch	FLI
02.01.2016	57390.173	14.41	15.83	16.97	-	Sch	FLI
07.02.2016	57426.188	14.40	15.78	16.67	-	Sch	FLI
04.04.2016	57483.498	14.43	15.87	17.02	18.46	2-m	VA
06.04.2016	57484.539	14.49	16.00	17.25	18.69	2-m	VA
06.04.2016	57485.499	14.51	15.95	17.18	18.60	Sch	FLI
27.04.2016	57506.420	14.31	15.63	16.74	18.10	Sch	FLI
13.05.2016	57522.406	14.40	15.75	16.84	-	Sch	FLI
14.05.2016	57523.408	14.44	15.87	17.04	-	Sch	FLI

Table 1: Continued.

Date	J.D. (24...)	I [mag]	R [mag]	V [mag]	B [mag]	Telescope	CCD
31.05.2016	57540.384	14.43	15.90	-	-	2-m	VA
25.06.2016	57565.442	14.44	15.85	17.06	-	Sch	FLI
11.07.2016	57581.363	14.38	15.80	17.00	-	Sch	FLI
12.07.2016	57582.391	14.46	15.93	17.18	18.56	Sch	FLI
13.07.2016	57583.377	14.31	15.70	16.76	-	Sch	FLI
01.08.2016	57602.356	14.37	15.87	16.94	18.33	2-m	VA
04.08.2016	57605.360	14.60	16.15	17.38	18.95	Sch	FLI
05.08.2016	57606.353	14.62	16.17	17.46	-	Sch	FLI
11.09.2016	57643.261	14.23	15.50	16.56	18.00	Sch	FLI
02.10.2016	57664.230	-	15.81	16.91	-	Sch	FLI
05.11.2016	57698.260	14.35	15.68	16.77	18.05	Sch	FLI
21.11.2016	57714.222	14.38	15.86	16.97	18.46	2-m	VA
22.11.2016	57715.204	14.38	15.78	16.86	18.16	2-m	VA
23.11.2016	57716.215	14.31	15.83	16.89	18.31	2-m	VA
02.01.2017	57756.202	14.46	15.92	17.06	18.60	Sch	FLI
17.02.2017	57801.603	14.42	15.89	17.09	-	Sch	FLI
05.03.2017	57817.549	14.45	15.83	-	-	Sch	FLI
02.04.2017	57845.538	14.45	15.94	17.10	18.59	Sch	FLI
03.04.2017	57846.567	14.53	16.05	17.18	18.61	Sch	FLI
01.05.2017	57875.483	14.18	15.55	16.54	17.79	2-m	VA
18.05.2017	57892.420	14.33	15.68	16.72	18.08	Sch	FLI
19.05.2017	57893.422	14.33	15.78	16.85	18.06	2-m	VA
01.08.2017	57967.382	14.49	15.98	17.13	-	Sch	FLI
02.08.2017	57968.322	14.42	15.81	16.89	-	Sch	FLI
03.08.2017	57969.336	14.32	15.63	16.72	-	Sch	FLI
12.08.2017	57978.495	14.43	15.79	16.90	18.26	Sch	FLI
14.09.2017	58011.268	14.48	15.92	17.12	18.57	Sch	FLI
15.09.2017	58012.286	14.50	15.94	17.15	18.61	Sch	FLI
16.09.2017	58013.269	14.51	15.97	17.18	18.81	Sch	FLI
12.10.2017	58039.223	14.38	15.82	17.00	18.43	Sch	FLI
14.10.2017	58041.398	14.36	15.80	16.94	18.28	2-m	VA
16.10.2017	58043.234	14.37	15.81	16.95	18.36	Sch	FLI
16.10.2017	58043.272	14.38	15.85	16.99	18.33	2-m	VA
17.10.2017	58044.295	14.39	15.79	16.99	18.42	Sch	FLI
18.10.2017	58045.385	14.31	15.71	16.83	18.07	Sch	FLI
22.11.2017	58080.245	14.45	15.92	17.06	-	Sch	FLI
23.11.2017	58081.257	14.38	15.81	16.96	-	Sch	FLI
21.12.2017	58109.266	14.35	15.81	16.89	18.39	Sch	FLI
25.12.2017	58113.189	14.51	16.01	17.27	18.80	Sch	FLI
26.12.2017	58114.223	14.46	15.90	17.13	18.57	Sch	FLI

The data indicate that V1704 Cyg shows both active states with high amplitudes and quiet states with lower amplitudes, at the same brightness level. The registered amplitudes of the irregular brightness variations of the star during the whole time of observations are 1.47 mag for the B-band, 1.19 mag for the V-band, 0.85 mag for the R-band and 0.60 mag for the I-band. Such variability is typical of a CTTS and it could be due to the variations in the mass accretion rate and the modulation of the star's brightness in the presence of hot spots on the stellar surface (see Herbst et al. 1994). Also, the shape of the light curves of V1704 Cyg is typical of the CTTSs of Type II in the classification scheme of Ismailov (2005).

According to Herbst et al. (1994) the hot spots on the CTTSs are small; in most cases they cover a few percent of the stellar surface area. The

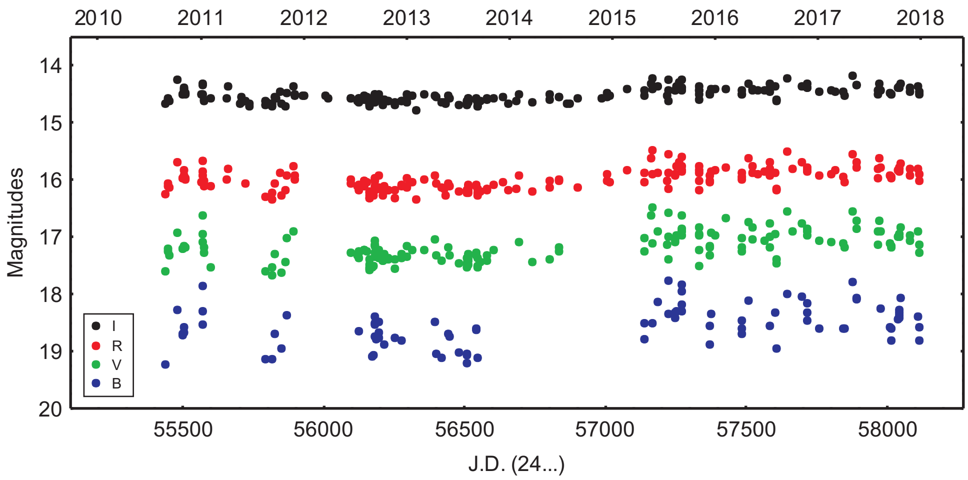

Fig. 1. *BVRI* light curves of V1704 Cyg for the time period August 2010−December 2017.

temperatures of the hot spots are typically 10 000 K. Such temperature is significantly higher than that of the stellar photosphere. Therefore, even hot spots with small sizes cause a significant modulation in the star's brightness. The hot spots are interpreted as accretion spots or zones, heated by the infall of a column of matter. Whereas cool spots may last for hundreds or thousands of rotations, hot spots appear to come and go on a much shorter time scale (Herbst et al. 1994). Probably during the quiet states of V1704 Cyg with lower amplitudes, the hot spots disappear (or change their sizes). Another possible cause is the decrease of the mass accretion rate. It is possible that both events occur simultaneously.

2MASS JHK_s magnitudes of V1704 Cyg were used to construct a color-color ($J-H$ versus $H-K_s$) diagram to check whether the star has infrared excess, which is a sure indication for the presence of a circumstellar disk. Fig. 2(left) shows the location of the main sequence (the black line) and the giant stars (the blue line) from Bessell & Brett (1988), and the location of the CTTSs (the red line) from Meyer et al. (1997). A correction to the 2MASS photometric system was performed following the procedure in Carpenter (2001). It can be seen from the figure that V1704 Cyg lies on the line of the CTTSs, i.e. the star has infrared excess indicating the presence of disk around it.

An important result from the photometric study of V1704 Cyg is the variation of the color indices with the star's brightness. The measured color indices ($V-I$, $V-R$ and $B-V$) versus the stellar V-magnitude during the photometric monitoring of the star are plotted on Fig. 2(right). A clear dependence can be seen from the figure: the star becomes redder as it fades. Such color variations are typical for the TTSs, whose variability is produced by the rotational modulation of spot(s) on the stellar surface.

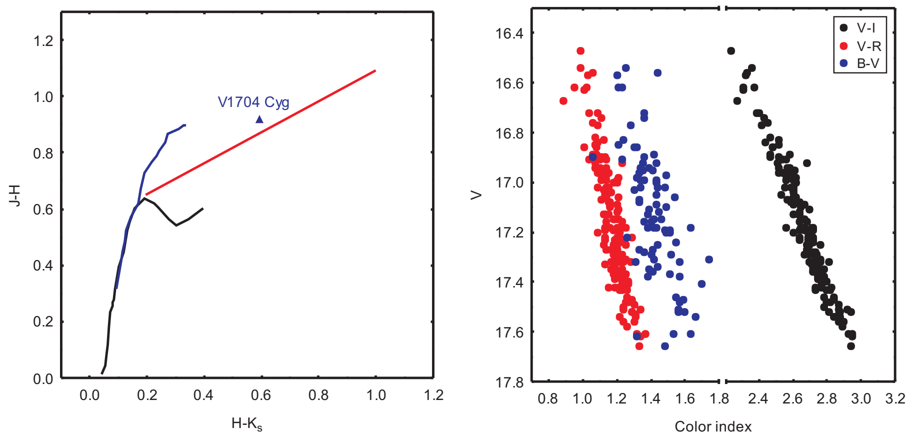

Fig. 2. (left): Color−color diagram for V1704 Cyg detected in the JHK_s-bands in the 2MASS catalogue; (right): Color indices versus the stellar V-magnitude of V1704 Cyg.

The PERIOD04 (Lenz & Breger 2005) software was used to search for periodicity in the light curves of V1704 Cyg. In Fig. 3 the obtained periodogram using the data in R-band is shown. We found a significant peak in the periodogram corresponding to 1 day period. This is parasite frequency, an artifact produced by the fact that we observe nightly or at close time-intervals. The other found peaks correspond to 1/2, 1/3 and 1/4 days overtones of the 1 day alias. The shapes of the phase-folded light curves according to periods of 1, 1/2, 1/3 and 1/4 days are identical. Apart from all data obtained during the whole time of observations we used data points from different time periods of observations for time-series analysis. During these analyzes, we did not find any reliable periodicity in the brightness variations of V1704 Cyg. The reason is probably the short life of the hot spots or that the variability of the star is not only due to hot spots but also to the variations in the mass accretion rate.

4. Conclusion

The long-term $BVRI$ light curves, the color−magnitude and 2MASS two−color diagrams of V1704 Cyg were presented and discussed. We found that the variability of the star is typical of a CTTS. The shape of the light curves, the location on the two−color diagram, the spectrum of the star (reported by Mendoza et al. 1990) and the observed amplitudes in the brightness variations confirmed that conclusion. Evidence of reliable periodicity in the photometric behavior of V1704 Cyg is not detected. This study adds a new CTTS to the PMS stars family. We are continuing to collect photometric observations of the Pelican Nebula. In the future, we plan to study several dozen PMS stars located in this star-forming region.

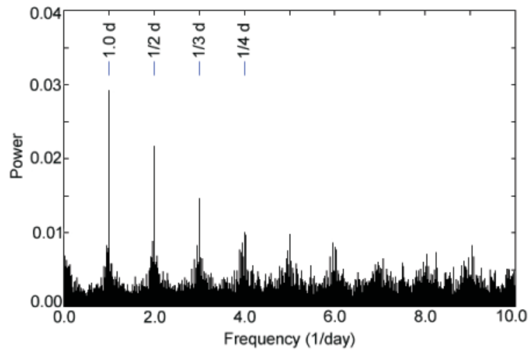

Fig. 3. Periodogram analysis of timescales inferred from the photometric time-series of V1704 Cyg.

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