SIMULTANEOUS PHOTOMETRIC AND SPECTRAL ANALYSIS OF A NEW OUTBURST OF V1686 CYG

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3 HAeBe stars



V1686 Cyg: short history

The photometric variability of $LkH\alpha$ 224 was detected by Wenzel (1980); as the variable this star received V1686 Cyg designation.

The star fluctuates near the mean brightness level, sometimes (usually one time per year) demonstrating **irregular Algol-like minima, which last one-two months**.

Its mean level of brightness itself varies from V=12.5 down to V=15 (Hillenbrand et al. 1995; Herbst & Shevchenko 1999; Oudmaijer et al. 2001).

A typical minimum of V1686 Cyg (Herbst & Shevchenko 1999)



Very large dispersion in spectral types from B2 to F9 (Hernandez et al, 2004). Emission lines in V1686 Cyg spectrum also demonstrate significant variability (Mora et al. 2001). The profile of H α emission is broad and asymmetric with several superposed narrow absorption-like features, suggesting the existence of expanding envelopes (Magakyan & Movsesyan, 1997)

Photometry

New observations were carried out on 2.6-m telescope in Byurakan Observatory, with multi-mode SCORPIO spectral camera. Both direct images and long-slit spectra were obtained.

Observations were implemented from Sept. 2015 to July 2017. Spectral observations were from Sept. 2015 to Dec. 2016, with different spectral resolutions: 0.50, 0.80, 1.50 and 2.65 Å/pix.

In 2015 during our observations of this field, a new outburst of V1318 Cyg S was detected and studied in detail afterwards (Magakian et al. 2019).

In parallel to this, star V1686 Cyg also was observed. The data from other surveys, combined with our measurements, show that the more or less persistent brightness level of V1686 Cyg lowered in last 15 years by 1.5 magnitude, and during our observations it became even lower at least 2.5 magnitudes below the 1999 level. **But an unexpected short outburst of this star was found in 2016 Aug**.

The new outburst of V1686 Cyg



18.11.2015

23.08.2016

				Ι	11 -
22.09.2015	17.22	15.88	14.68	13.27	12 -
18.11.2015	17.18	15.96	14.87	13.56	
31.03.2016	17.03	15.61	14.48	13.07	se 14 -
10.06.2016	17.42	16.05	14.76	13.00	
23.08.2016	14.82	13.50	12.48	11.58	
20.12.2016	16.34	14.98	13.62	12.49	
20.07.2017	16.99	15.66	14.63	13.53	JD (+2450000)

After data reduction we found that the full rise and decline of V1686 Cyg brightness had almost 3 magnitudes amplitude and lasted about 2 months.

The spectrum of V1686 Cyg in quiescent

Spectra, taken before the outburst, are quite typical for this star, being similar to the previous results (Hillenbrand et al. 1995; Magakyan Movsesyan, 1997). The most conspicuous line is a broad and strong $H\alpha$ emission with superposed weak blue-shifted absorption feature. Forbidden emissions of [OI] also are present as well as faint emission lines of FeII (40) and CaI (18), not described before. In all spectra we detected DIB 6284 Å with intensity, similar to nearby V1318 Cyg

Spectral type of V1686 Cyg can be assumed as an early Ae.



Spectrum of V1686 Cyg in maximum

During the outburst V1686 Cyg spectrum is quite different and shows remarkable changes especially in the profile of H α line. The strength of iron emissions decreases, forbidden lines of [OI] nearly disappear.



Spectrum of V1686 Cyg in maximum

Low-resolution spectra including blue range



Episodic appearance of FeII absorptions

Development of the spectrum

In 06.11.2016 all absorption lines, including NaD and H α line absorption component, are disappeared. All emission lines became stronger than before. Emission line spectrum is very similar to the spectra of PV Cep and V350 Cep (Magakian et al. 2019).

As it seems, outer envelope virtually dissipated for several weeks.



Equivalent widths and radial velocities

The strength of emission lines relative to continuum significantly lowered during the maximal brightness period. EW of H α changed from -35Å to -12Å in the end of Aug. 2016; then high values again were restored.

- EW of NaD absorption in the period of the outburst reached 5Å, while this line was actually invisible before.
- Especially high values of EW of emission lines were observed in the end of 2016.
- Radial velocities show a pattern, very typical for young stellar objects. All measurable absorption lines demonstrated negative velocity: the mean velocity of the absorption component of H α is -97 ± 47 km s⁻¹, both lines of NaD have velocity near -57 km s⁻¹, similar negative velocity has also $\lambda 6300$ Å [OI] emission. The peak of H α emission has positive radial velocity: +95±29 km s⁻¹.

Variations in Ha profile





Pronounced changes in the strength of some absorption lines (NaD), explain the large range of the spectral types, assigned to this object. Actually, **V1686 Cyg is one of the most variable photometrically and spectrally HAeBe stars.**

Spectral changes can be interpreted as the formation of **dense expanding envelope around the star, with its subsequent dissipation** during several months. The envelope covers up lower layers of the stellar chromosphere, making invisible and diminishing emission lines.

The existence of the blue-shifted absorption components in the H α allows to conclude, that the similar expanding envelopes nearly always are present around V1686 Cyg star, and the described outburst differs only by its extremity.

Several authors make analogies between V1686 Cyg short-time light drops and UX Ori type variability. However, this question remains to be investigated by spectral observations. In fact, this star may be **an object, which combines two types of PMS variability**, like V2492 Cyg, V350 Cep or V582 Aur.

THANK YOU FOR YOUR ATTENTION!

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