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V2467 CYG — A NOVA WITH EXTREMELY STRONG O I 8446 Å EMISSION

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V2467 Cyg ≡ Nova Cyg 2007 was discovered by Tago (see Nakano et al., 2007) at $7\overset{m}{.}4$ on March 15.8 already declining from the maximum. The brightness maximum occurred somewhere between this date and Tago's last negative observation on March 12.8 (Nakano et al., 2007). The nova was confirmed spectroscopically on March 16.8 with an expansion velocity of ~ 1200 km s^{-1}, measured for the P Cyg absorption component of Hα (Nakano et al., 2007). Kubat & Niemczura (2007) reported a velocity of 968 km s^{-1} on March 17.1 and 900 km s^{-1} on March 17.2. Munari et al. (2007) presented a detailed quantitative description of the optical spectrum on March 18.2 and concluded that V2467 Cyg belongs to Williams's (1992) "Fe II" class. They reported the presence of two P Cyg absorption components in the Hα and Hβ profiles with velocities 913 km s^{-1} and 1900 km s^{-1}. Steeghs et al. (2007) identified the progenitor as an early A spectral type object with IPHAS magnitudes $r' = 18\overset{m}{.}46 \pm 0\overset{m}{.}01$ and $i' = 17\overset{m}{.}49 \pm 0\overset{m}{.}1$. They estimated the distance to V2467 Cyg in the range 1.5–4 kpc and an outburst amplitude $\sim 12^{\rm m}$ typical for "Fe II" type galactic novae.

Photometric and spectral observations of V2467 Cyg at the Toruń Observatory began on March 24, about ten days after the maximum brightness. Photometric data were recorded with the 60-cm Cassegrain and 60/90-cm Schmidt–Cassegrain telescopes and the SAVS equipment (Niedzielski et al., 2003), all of them equipped with CCD cameras. We used the Henden & Munari (2007) photometric sequence to reduce our observational data. Additionally, we carried out rapid brightness variation monitoring, mainly in V and $R_{\rm C}$. The photometric data are listed in Table 1, the monitoring data are available electronically.

Spectra with $R \sim 3000$, ~ 1500 and ~ 750 covering different regions in the spectral interval 4000 Å–8800 Å were recorded with the Canadian Copernicus Spectrograph (CCS) attached to the 60/90-cm Schmidt–Cassegrain telescope. Additionally, with the same telescope, we obtained prismatic spectra in the range 4300 Å–10500 Å with a resolution of about ~ 5 Å, ~ 20 Å and ~ 60 Å at Hγ, Hα and 9000 Å, respectively.

The nova light curve and the color indices after April 12, 2007 are shown in Fig. 1. The star is already $\sim 4^{\rm m}$ fainter than at maximum, one month earlier. During the following month the V2467 Cyg brightness in V decreased by about $0\overset{m}{.}9$. The most remarkable variation is a dip between JD 2454206 and JD 2454214. The colors $U - B$ and $B - V$

Table 1. Toruń $UBVR_CI_C$ photometric observations of V2467 Cyg

HJD	U	B	V	R_C	I_C	Telescope	Monitoring*
2454184.611			9.56			SAVS	
2454185.615			9.70			SAVS	
2454203.458		12.40	11.42			90-cm	$3.^{h}6$ (V)
2454203.595	12.87	12.45	11.37	8.92	7.84	60-cm	$0.^{h}3$ (B), $0.^{h}9$ (R_C)
2454204.508	12.95	12.47	11.42	8.93	7.87	60-cm	$2.^{h}3$ (B), $2.^{h}2$ (R_C)
2454206.483	13.09	12.64	11.60	9.10	8.07	60-cm	$2.^{h}8$ (B), $2.^{h}7$ (R_C)
2454207.481	13.43	12.82	11.84	9.34	8.37	60-cm	
2454207.549			11.79			SAVS	
2454209.551			12.11			SAVS	
2454211.598	13.23	12.80	11.81	9.39	8.46	60-cm	$3.^{h}4$ (V), $3.^{h}3$ (R_C)
2454212.544			11.71			SAVS	
2454216.503	13.09	12.73	11.71	9.37	8.52	60-cm	$1.^{h}6$ (V), $1.^{h}7$ (R_C)
2454217.475	13.18	12.72	11.71	9.34	8.48	60-cm	$2.^{h}6$ (V, R_C)
2454218.588	13.12	12.79	11.76	9.41	8.57	60-cm	$2.^{h}7$ (V, R_C)
2454221.455	13.25	12.89	11.84	9.53	8.75	60-cm	$3.^{h}0$ (R_C)
2454222.430	13.29	12.75	11.76	9.49	8.73	60-cm	$2.^{h}9$ (V), $3.^{h}5$ (R_C)
2454224.433	13.37	12.80	11.77	9.52	8.75	60-cm	$3.^{h}5$ (V, R_C)
2454226.457	13.45	12.91	11.88	9.65	8.91	60-cm	$1.^{h}0$ (R_C)
2454230.501		12.99	12.04	9.82	9.17	60-cm	
2454240.560			12.13	9.98	9.42	60-cm	
2454241.419	13.17	13.01	12.12	9.96	9.37	60-cm	$3.^{h}5$ (V, R_C)
2454244.554	13.06	12.96	11.99	9.92	9.30	60-cm	
2454245.397		13.05	12.04	9.94	9.34	60-cm	
2454246.392		13.12	12.21	10.06	9.54	60-cm	
2454249.421	13.80	13.19	12.32	10.19	9.66	60-cm	

* Available at the IBVS website for B, V, R_C filters as files 5779-t1.txt, 5779-t2.txt, 5779-t3.txt, respectively

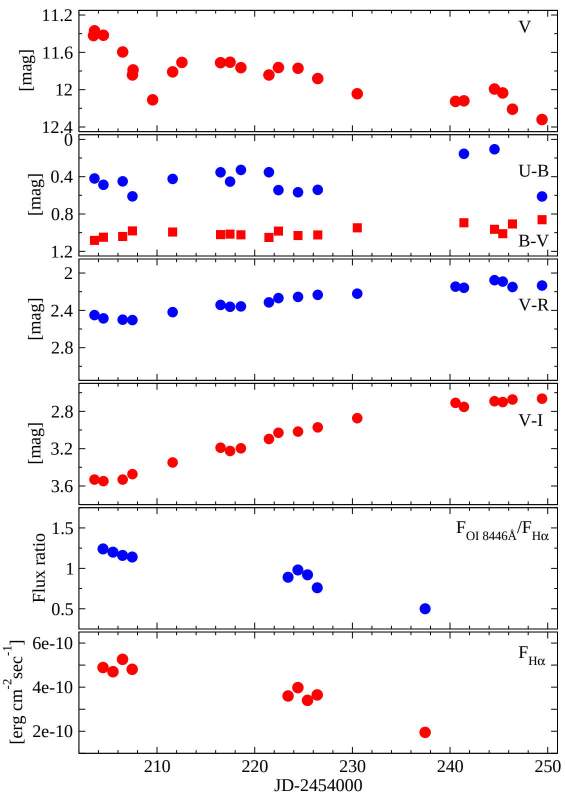

Figure 1. The V light curve and the color variations of V2467 Cyg. In the two bottom panels, the flux ratio O I 8446 Å/Hα and the Hα flux from our objective prism spectra are shown

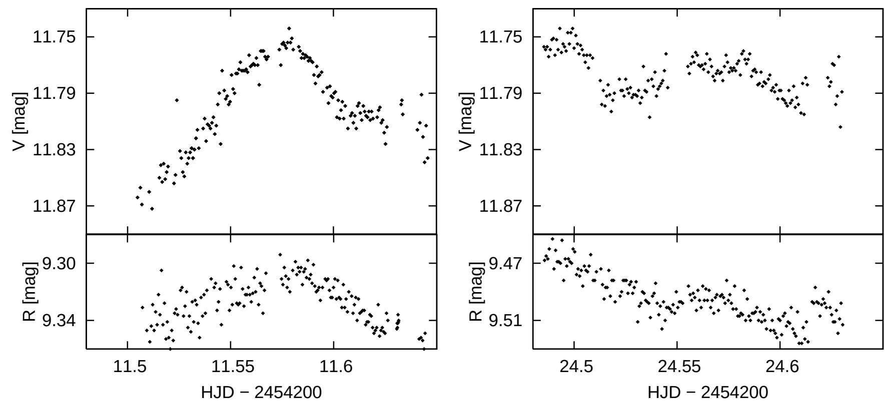

Figure 2. Examples of the rapid brightness variations of V2467 Cyg in V and $R_{\rm C}$ filters

vary around $0\overset{\rm m}{.}4$ and $1^{\rm m}$, respectively. Stronger variations are apparent in the $V-R$ and $V-I$ colors. $V-R$ became bluer by about $0\overset{\rm m}{.}40$ and $V-I$ changed from $3\overset{\rm m}{.}6$ to $2\overset{\rm m}{.}7$.

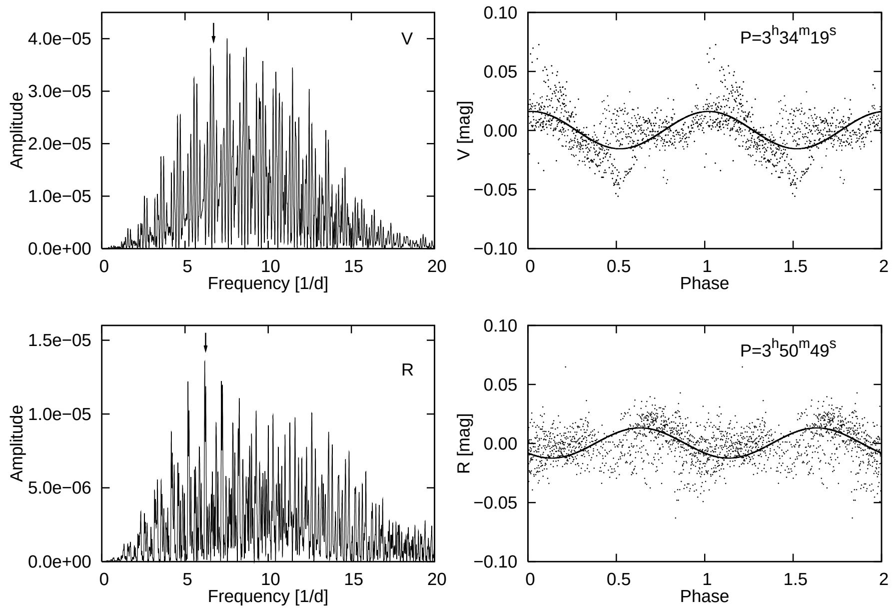

Figure 3. The power spectra and the light curves in V and $R_{\rm C}$, phased with the corresponding periods marked by arrows

In Fig. 2 examples of our V and $R_{\rm C}$ monitoring are shown. Similar short time variability is obvious in both filters with a significantly larger amplitude in V. Fourier analysis cannot distinguish a single coherent frequency in both V and $R_{\rm C}$ bands. We have analyzed residuals from each night's mean brightness for 18.4 hours and 1220 observational points in V, and 17.3 hours and 983 points in the $R_{\rm C}$ band, obtained during the period April 12–May 5. The resulting power spectra are shown in Fig. 3 and look like a superposition of two quasi periodic oscillations (QPO) $P_1 \geq 3^{\rm h}$ and $P_2 \leq 2^{\rm h}$, just above and below the period gap for cataclysmic variables. The most probable period lies between the peaks at 6.24 d^{-1} for $R_{\rm C}$ and at 6.72 d^{-1} for V, both marked in Fig. 3. The light curves corresponding to these frequencies are presented in the right panels of the same figure. The light curves for any other strong aliases look similar.

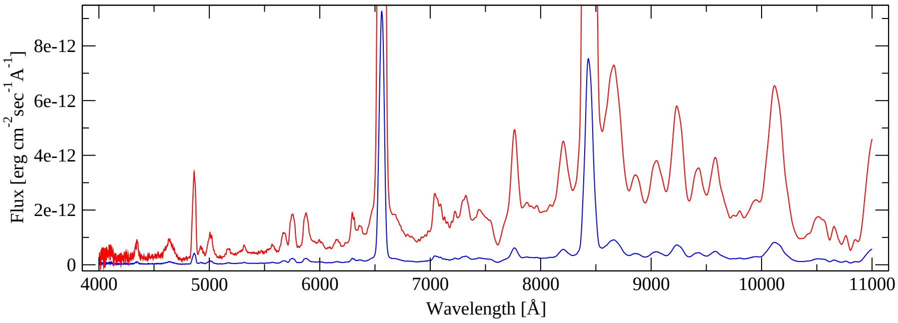

Figure 4. The lower curve shows the objective prism spectrum of V2467 Cyg obtained on April 13, 2007. The same spectrum multiplied by 8 is also plotted

Since the beginning of our observations, V2467 Cyg followed a normal "Fe II" nova spectral evolution. At the end of March, the spectrum was dominated by Balmer and Fe II emission lines. Two P Cyg absorption components were obvious in the Balmer lines and the slowest one was easily visible in the Fe II lines as well. Their velocities were about 2290 km s^{-1} and 1300 km s^{-1} on March 24 and increased to $\sim$ 2590 km s^{-1} and $\sim$ 1405 km s^{-1} on April 1.

Between April 1 and 13 the nova spectrum changed significantly. The [OI] lines 6300 Å and 6364 Å, visible as weak emissions since the beginning of our observations, increased significantly during this period. Many new emission lines appeared in the spectrum. The most intensive among them were [OIII] 5007 Å, [OI] 5577 Å, [NII] 5755 Å, He I 5876 Å, 6678 Å, 7065 Å, C II 7234 Å, [OII] 7325 Å. However, the strongest emission line was O I 8446 Å (Fig. 4). We started our objective prism observations covering this region on April 13 but the line was probably present in the spectrum during all the time of our observations. The reason why we think this relates to the other O I line at 7774 Å visible at the red edge of our CCS spectrum obtained on March 26. In the later spectra, both O I lines were visible together and the 8446 Å one was much stronger. In Fig. 1 the changes in the Hα flux as well as the flux ratio O I 8446 Å/Hα are shown. The Hα flux decreases from $\sim 4.9 \times 10^{-10}$ erg cm^{-2} sec^{-1} in mid April to $\sim 2.0 \times 10^{-10}$ erg cm^{-2} sec^{-1} in mid May. During the same time the flux ratio O I 8446 Å/Hα changes from $\sim$ 1.2 to $\sim$ 0.5. The O I 8446 Å flux larger than Hα is probably exceptional. However, this O I line is produced in a fluorescent cascade as a result of pumping by Lyβ H I photons (Kastner & Bhatia, 1995), so such a strong O I flux could indicate an extremely high oxygen overabundance.

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