Baltic Astronomy, vol. 16, 52–54, 2007.

A FRESH LOOK TO THE YELLOW SYMBIOTIC STAR V471 PER

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Received: 2007 January 15

Abstract. The recent behavior of the yellow, low excitation symbiotic star V471 Per is investigated on the basis of absolute spectrophotometry, high resolution Echelle spectroscopy and $UBVR_CI_C$ CCD photometry. A photoionized modeling of the circumstellar nebula is presented.

Key words: stars: binaries: symbiotic – stars: individual (V471 Per)

V471 Per (M1-2, VV 8, α = 01 58 50, δ = +52 53 49, J2000) was discovered by Minkowski (1946) as an emission line star. O'Dell (1966) was the first to link it to symbiotic stars: strong Balmer and [O III] emission lines associated to a G2 supergiant absorption continuum. No photometric variability was detected by Arkhipova et al. (1974) on photographic plates spanning the years 1898–1911 and 1951–1959. A binary nature was suspected by Adams (1975), who suggested that a $T_{\rm eff} \geq 60\,000$ K star is responsible for the excitation of the nebula. Eclipses of 0.06 mag depth were announced by Drummond (1980) who argued that the object is an eclipsing system with a 4 hour orbital period. However, Grauer & Bond (1981) and Yamasaki et al. (1984) were unable to confirm the presence of corresponding photometric eclipses and orbital motion from radial velocities. A physical analysis of the system was performed by Feibelman (1983) on the basis of IUE spectra. A low amplitude and very long period for $\Delta V = 0.2$ and $\Delta B = 0.3$ mag variability was reported by Arkhipova & Noskova (1988). Gromadzki et al. (2006) looked for the flickering but found none.

Since the summer of 2005 we are carrying out an intensive photometric and spectroscopic monitoring of V471 Per as part of the ANS (Asiago Novae and Symbiotic stars) Collaboration. Spectra are being collected with the 1.82 m and 1.22 m telescopes operated in Asiago by the INAF Astronomical Observatory of Padova and the Department of Astronomy, University of Padova, respectively. CCD $UBVR_CI_C$ photometry is obtained with various telescopes belonging to ARAR (Bastia, RA), GAPC (Zugna, UD), AAVC (Cembra, TN) and a private observatory in Trieste. All photometric observations are accurately placed on the $UBVR_CI_C$ comparison sequence published by Henden & Munari (2001). The light curve based on our observations is shown in Figure 1. Mean values for 2005 and 2006 are: U = 14.130 and 14.115, B = 14.059 and 14.030, V = 13.071 and 13.055, R_C = 12.290 and 12.349, I_C = 11.900 and 11.902, respectively.

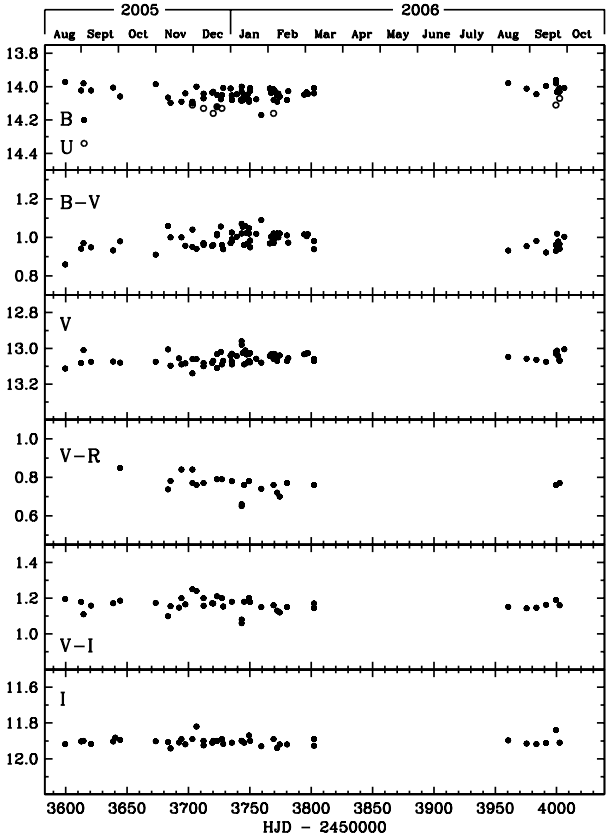

Fig. 1. Our photometric monitoring of V471 Per from 2005 August to 2006 October.

We have combined Arkhipova & Noskova (1988) yearly means with those from Munari & Henden (2001) and our ones for 2005 and 2006, and found that they are well fitted by a sinusoid of 21 yr period, with the ephemeris given in Figure 1. The photographic V passband adopted by Arkhipova & Noskova (1988) differs from our CCD V passband, and because of the emission-line dominated spectrum of V471 Per this gives a different zero point of our and Arkhipova & Noskova (1988) V magnitudes, thus preventing a meaningful search for the 21 yr periodicity in the V passband, too.

The minimal photometric variability and the absence of reports in the literature about a significant spectral variability allowed us to combine the current optical, absolutely fluxed spectrum with the IUE SWP 42152 archive spectrum (collected on 1991 August 1, cf. Figure 3) and to perform a nebular modeling with CLOUDY94 (Ferland 2003). Assuming $E_{B-V} = 0.37$ (Feibelman 1983), a spherically symmetrical nebulosity and optically thick Lyman lines (case B), we obtained for the hot component $R_{\rm HC} = 0.57\ R_\odot$, $T_{\rm eff,\,HC} = 95\,000$ K, and for the nebula $\log\,(N_{\rm e}) = 7.7$, $R_{\rm neb} = 85$ AU, $M_{\rm HI,\,neb} = 3 \times 10^{-4} M_\odot$ (total mass of the ionized gas). Since 1987 we are collecting high resolution ($R = 20\,000$ to $30\,000$) Echelle spectra (an example of emission line profiles is given in Figure 3) with the intention to measure radial velocities from all 40 available spectra and to verify whether the 21 yr periodicity is actually the orbital period of the system.

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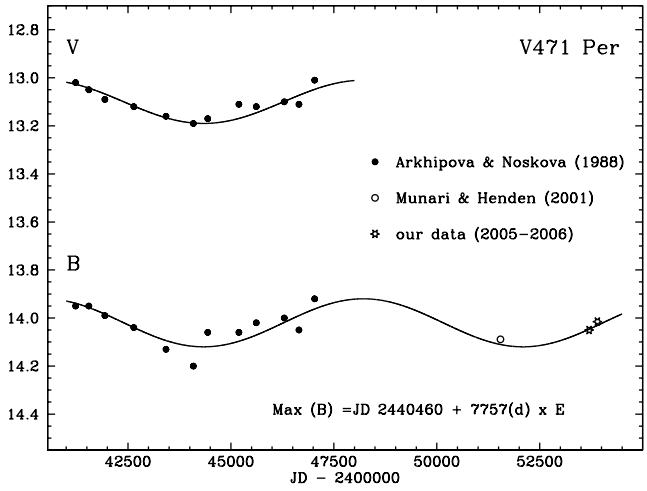

Fig. 2. The proposed 21 yr periodicity and the yearly means in the B and V passbands from Arkhipova & Noskova (1988), Munari & Henden (2001) and this study.

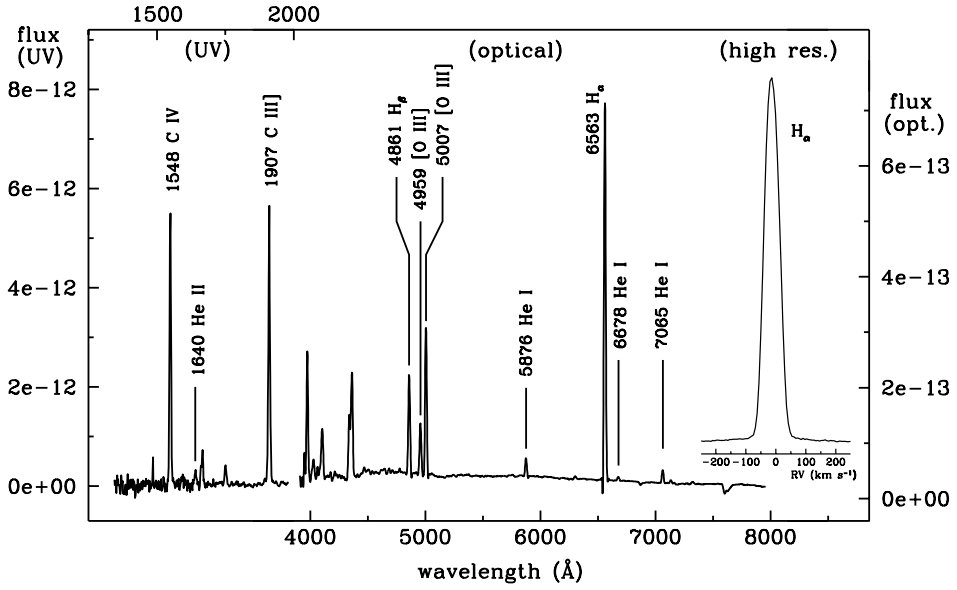

Fig. 3. The appearance of IUE and optical spectra of V471 Per.

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