

A FRESH LOOK TO THE YELLOW SYMBIOTIC STAR V471 PER

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

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

V471 Per (M1-2, VV 8, $\alpha = 01\ 58\ 50$, $\delta = +52\ 53\ 49$) 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 plate spanning the years 1898-1911 and 1951-1959. A binary nature was suspected by Adams (1975), who suggested that a $T_{\text{eff}} \geq 60,000$ K star as 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. Grauer and Bond (1981), and Yamasaki et al. (1984) were however 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. Noteworthy, a low amplitude and very long period $\Delta V=0.2$ and $\Delta B=0.3$ mag variability was reported by Arkhipova and Noskova (1988). Gromadzki et al. (2006) looked for flickering and found none.

Since 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 collected with the 1.82m and 1.22m telescopes operated in Asiago by INAF Astronomical Observatory of Padova and University of Padova, Department of Astronomy, respectively. CCD UBVRcIc 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 UBVRcIc comparison sequence published by Henden and Munari (2001). The lightcurve 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, Rc=12.290 and 12.349, Ic=11.900

and 11.902, respectively.

We have combined Arkhipova and Noskova (1988) yearly means with those from Munari and 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 band pass adopted by Arkhipova and Noskova (1988) differs from our CCD V band pass, and because of the emission-line dominated spectrum of V471 Per this means a different zero point of our and Arkhipova and Noskova (1988) V band magnitudes, thus preventing a meaningful search of the 21 yr periodicity in V band too.

The minimal photometric variability and absence of reports in literature about significant spectral variability, allowed us to combine a current optical, absolutely fluxed spectrum with IUE SWP 42152 archive spectrum (collected on 1991 Aug 01, cf Figure 3), to perform a nebular modelling with CLOUDY94 (Ferland 2003). Assuming $E(B-V) = 0.37$ (Feibelman 1983), a spherically symmetric nebulosity and optically thick Lyman lines (case B), we obtained for the hot component $R_{\text{HC}} = 0.57 R_{\odot}$, $T_{\text{eff,HC}} = 95,000$ K, and for the nebula $\log(N_e) = 7.7$, $R_{\text{neb}} = 85$ AU, $M_{\text{HI,neb}} = 3 \times 10^{-4} M_{\odot}$ (total mass of the ionized gas). We are collecting high resolution ($R = 20,000$ to $30,000$) ECHELLE spectra since 1987 (an example of emission line profiles is given in Figure 3) and we plan to measure the radial velocities on all 40 available spectra to the aim of testing if the 21 yr periodicity is actually the orbital period of the system.

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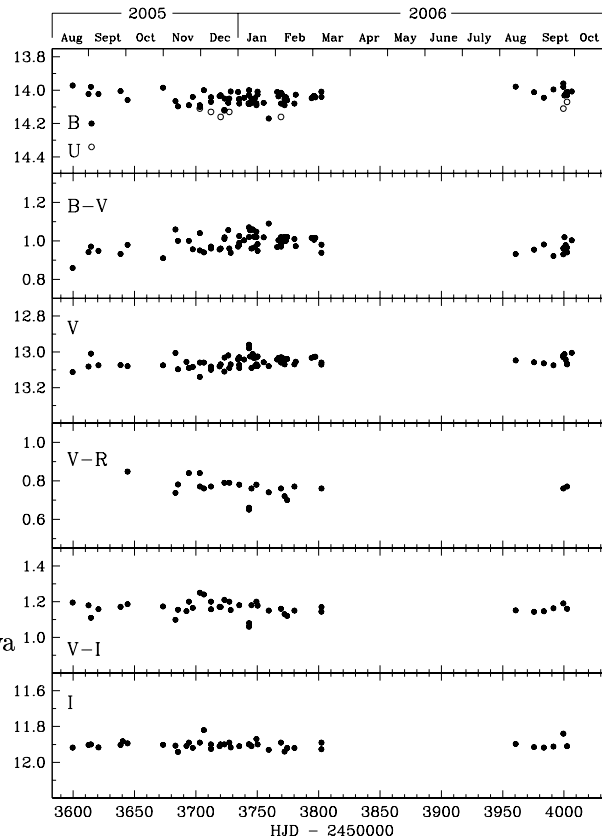


Fig. 1. Our photometric monitoring of V471 Per from 2005 Aug to 2006 October

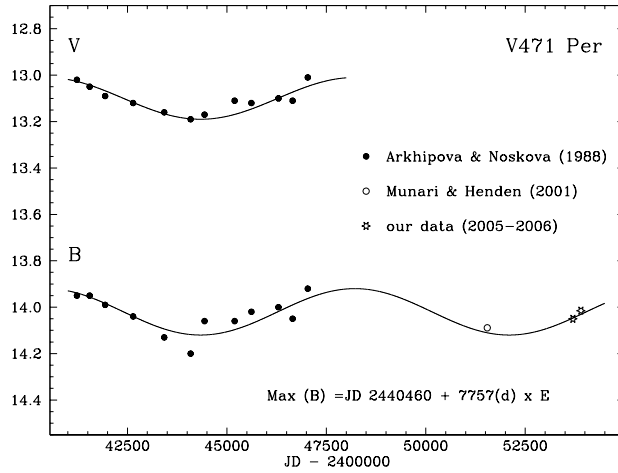


Fig. 2. The proposed 21 yr periodicity and the yearly means in B and V from Arkhipova and Noskova (1988), Munari & Henden (2001) and this study.

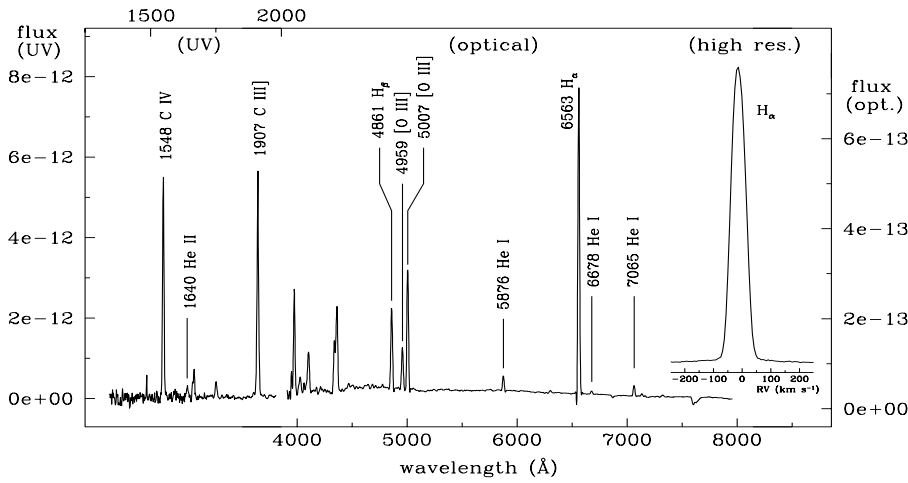


Fig. 2. IUE and optical spectral appearance of V471 Per.

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