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SPECTROSCOPY OF THE FAINT OLD NOVAE V Per AND V500 Aql

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Results of time-resolved spectroscopy of the faint old novae V Per and V500 Aql are reported for the first time. The observations were performed using the Low Resolution Spectrograph (LRS) at the 9.2-m Hobby-Eberly Telescope (HET) and the FORS1 instrument at the ESO Very Large Telescope (VLT) Unit No. 1. Table 1 lists the observing log for each object. All spectra were reduced with IRAF† standard tools. Radial velocities were measured applying the double-Gaussian convolution method (see e.g. Shafter et al., 1986). The corresponding code was written using the yorick language.

Table 1: Journal of observations. UT times refer to the start of the first and last exposure, respectively

Object	Date	First exp. (UT)	Last exp. (UT)	Indiv. exp. time (s)	No. exp.	Res. (Å/pix)	Tel.
V Per	2001 Oct. 14	04:21:34	05:48:42	500	8	2	HET
	2001 Oct. 14	09:13:47	10:01:15	500	5	2	HET
	2001 Nov. 25	06:30:38	07:38:39	500	8	2	HET
V500 Aql	1999 June 11	06:47:12	10:24:54	420/720	20	1.2	VLT

V Per (Nova Persei 1887) is a faint ($V \approx 18$) eclipsing ($\Delta V \approx 1.3$) classical nova. The orbital period of the system is 2.571 hr, thus placing it near the middle of the period gap of cataclysmic variables (Shafter & Abbott, 1989). In their recent eclipse analysis Shafter & Misselt (2006) investigated the structure of the accretion disk and estimated the masses of the components to be most likely $M_1 = 0.85\ M_\odot$ and $M_2 = 0.17\ M_\odot$. The only spectrum of the postnova known so far is that published by Shafter & Abbott (1989). The exposure time was around 1 hr thus covering nearly half an orbital cycle. Besides the Balmer emissions (H_α, H_β, H_γ) the spectrum shows the high excitation lines He II λ4686 and λ5411 which are characteristic for old novae. Moreover, the fact that He II λ4686 is stronger than H_β led the authors to suggest that V Per might be a magnetic system. But the object was not detected as an X-ray source in the ROSAT All Sky Survey (Verbunt et al., 1997) and shows no circular polarization (Stockman et al., 1992) which would have strengthened this interpretation.

†IRAF is distributed by the National Optical Astronomy Observatories, which are operated by the Association of Universities for Research in Astronomy, Inc., under cooperative agreement with the National Science Foundation.

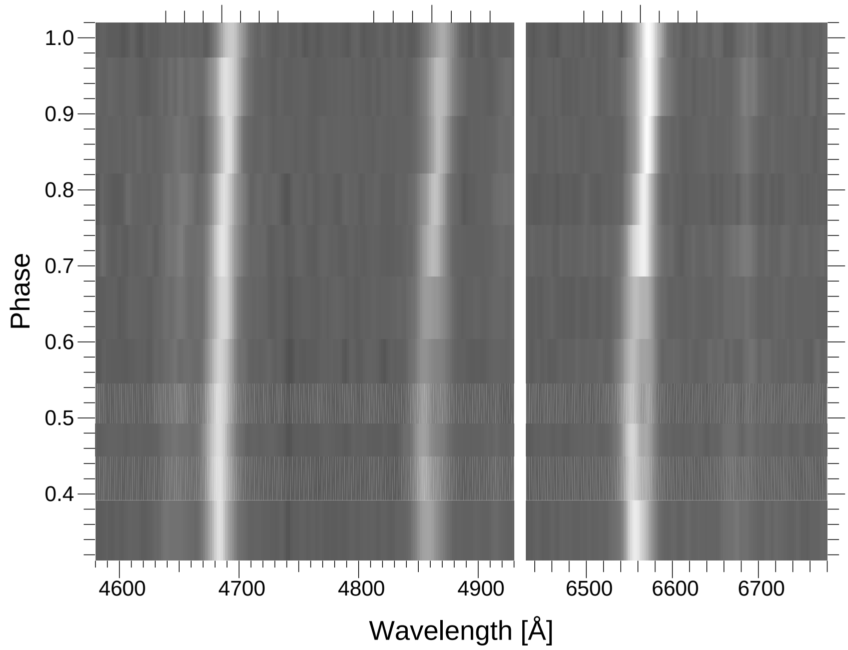

Figure 1. Grey-scale representation of the He II λ4686 and H_β lines (left) and the H_α line (right) of V Per. The spectra are folded on the orbital period and averaged into 11 phase bins. A velocity scale is given on top: the central large tick represents zero velocity for each line and the smaller ticks to the left and right follow in steps of $\pm$1000 km/s. The double-peaked structure of H_α and H_β around phase 0.5 is clearly recognisable whereas the He II line remains single-peaked

V500 Aql (Nova Aquilae 1943) is a faint ($\sim$ 18 mag) old nova which shows eclipses ($\sim$ 0.4 mag) repeating with a period of 3.485 hr (Haefner, 1999). No spectroscopic information on the postnova is known in the literature.

The phases for our 21 time-resolved spectra of V Per (wavelength range $\lambda\lambda$4500–7000 Å) were computed using the new ephemeris given by Shafter & Misselt (2006). The spectra cover the phase interval φ = 0.31–0.97 with respect to the eclipse time. Between φ = 0.39 and φ = 0.60 the H_α and H_β emissions exhibit a moderate double-peaked structure whereas the strong He II λ4686 line remains single-peaked at all times, a phenomenon shared with the SW Sex stars. Since the spectra are unevenly distributed over the phase, they were averaged into 11 almost evenly spaced phase bins for better presentation of the effect (Fig. 1). Because the high-velocity wings of all lines seemed to be undisturbed an attempt was made to determine radial velocities. The resulting radial velocity curve for H_α ($K_1 = 308 \pm 21$ km/s, $\gamma = 56 \pm 18$ km/s) is convincing (Fig. 2). However, the pronounced phase lag of $75° \pm 4°$ relative to the photometric ephemeris shows that H_α does not follow the motion of the white dwarf. The same holds true for the H_β and He II λ4686 lines. But, whereas a (full) Gaussian separation of 1400 km/s was essential to obtain the H_α radial velocity curve showing the least scatter, separations of 1800 km/s and 1960 km/s were required for an optimal solution in the case of H_β and He II, respectively. The corresponding radial velocity curves though being of suboptimal quality show lower semi-amplitudes ($K_1 \sim 235$ km/s) and phase lags on the order of some 60°. Therefore, there must be severe departures from symmetric line emission across the whole accretion disk or the system really harbours a magnetic white dwarf. Though the incomplete phase coverage might have some influence on the resulting radial velocity curves, their amplitudes constitute in any case no reliable quantity to derive e.g.

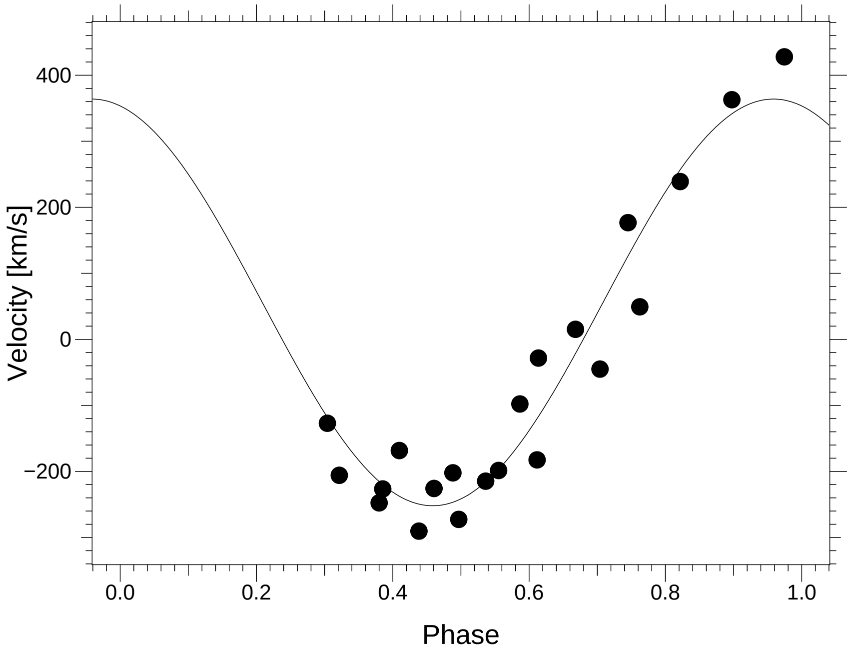

Figure 2. Radial velocity curve of the H_α line in V Per along with the best-fitting sinusoid. The velocities were measured using a (full) Gaussian separation of 1400 km/s. Note the large phase lag of 75°. A separation of e.g. 1960 km/s (He II) would reduce the phase lag only marginally by 3° but would increase the scatter of the radial velocity curve

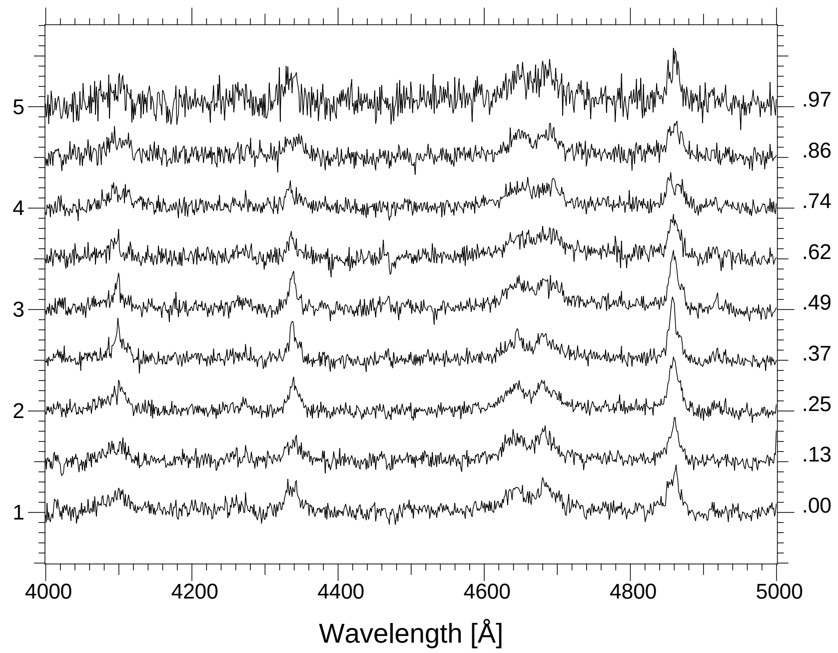

Figure 3. Orbital emission line variations of V500 Aql. The spectra are normalised to continuum level and separated vertically by constant offsets. Phase zero is arbitrarily assigned to the first spectrum of the series. The spectrum for phase 0.97 (actually an average of three) shows larger scatter since the data suffer from large air mass and a possible partial coverage of the shallow eclipse

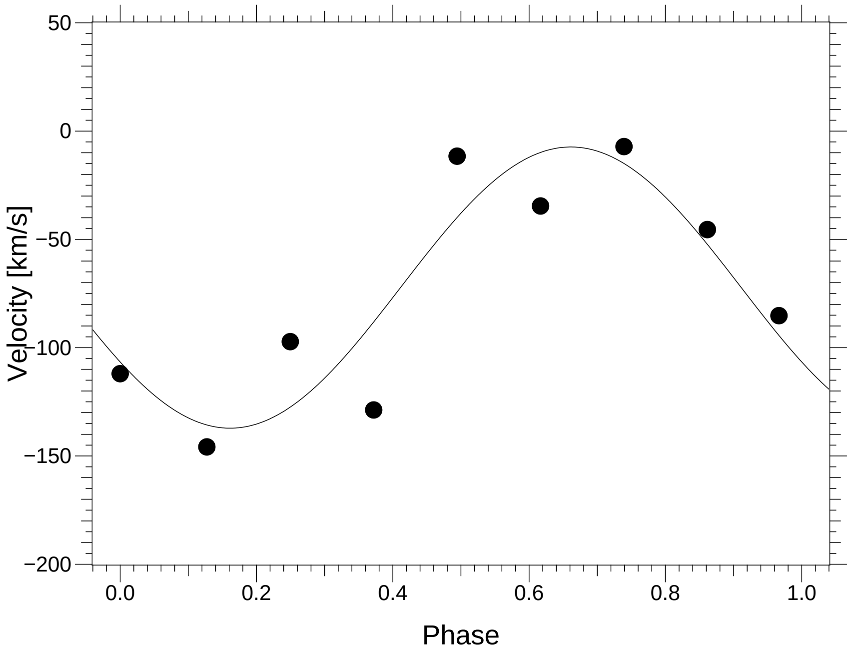

Figure 4. Radial velocity curve of the H_β line in V500 Aql along with the best-fitting sinusoid ($K_1 = 65 \pm 13$ km/s, $\gamma = -72 \pm 10$ km/s). The velocities were measured using a (full) Gaussian separation of 1890 km/s and folded on the orbital period (3.485 hr). Note that phase zero is arbitrary

the mass of the primary. In view of this it rather becomes redundant to mention that the measured large values of K_1 would result in an unrealistically small mass for the white dwarf ($M_1 \ll M_2$).

Our 20 time-resolved spectra of V500 Aql (wavelength range $\lambda\lambda$4000–5000 Å) cover one orbital revolution and show the typical emission line features of old novae. The Balmer lines, as compared with V Per, are quite weak with He II λ4686 being less prominent than H_β. The C III/N III λ4640–4650 complex, however, exhibits the same intensity as the He II line. Since the individual spectra are rather noisy (in particular the first three and last four of the series with individual exposure times of 420 s) the data were averaged resulting in nine spectra which are nearly equally spaced in phase. Complex changes especially in the Balmer line profiles can be recognized (Fig. 3). Nevertheless, at least the H_β line seemed to be suitable for radial velocity measurements. The resulting radial velocity curve (Fig. 4) exhibits a moderate amplitude, but disallows any reliability check since the photometric ephemeris is not known with the required precision to establish a possible phase lag.

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