COMMISSIONS 27 AND 42 OF THE IAU
INFORMATION BULLETIN ON VARIABLE STARS
Number 4251

Konkoly Observatory
Budapest
26 September 1995
HU ISSN 0374 – 0676

PU Vul DURING THE BRIGHTNESS WEAKENING OF 1993-1994

We recently (Andrillat and Houziaux, 1994, hereafter referred as AH94) reviewed spectral features of the symbiotic nova PU Vulpeculae during its nebular phase between 1989 June and 1992 October. Observations of this object have been resumed in 1993 July, 1994 June and 1995 June with the same instrumentation as in AH94. We report here on these spectra.

Monochromatic magnitudes at wavelengths where the continuum may be easily located between 375 and 900 nm show a significant drop (about 1.2 mag.) from the violet limit up to 700 nm between 1993 July and 1994 June. Figure 1 shows the composite aspect of the continuum corrected for an E(B−V)=0.4 interstellar extinction. Above 700 nm the continuum is due to the M6 III component, deeply cut by strong TiO bands, while at shorter wavelengths the photon flux originates in a hotter source, presumably the hot wind ejected from the compact object. The drop in the blue continuum can be explained by the eclipse already mentioned by Nussbaumer and Vogel (1994) from the IUE observations and confirmed by Garnavich (1994), who also notes in early 1994 April that the increase in equivalent width of Hβ may be due to a drop in the continuum around 480 nm.

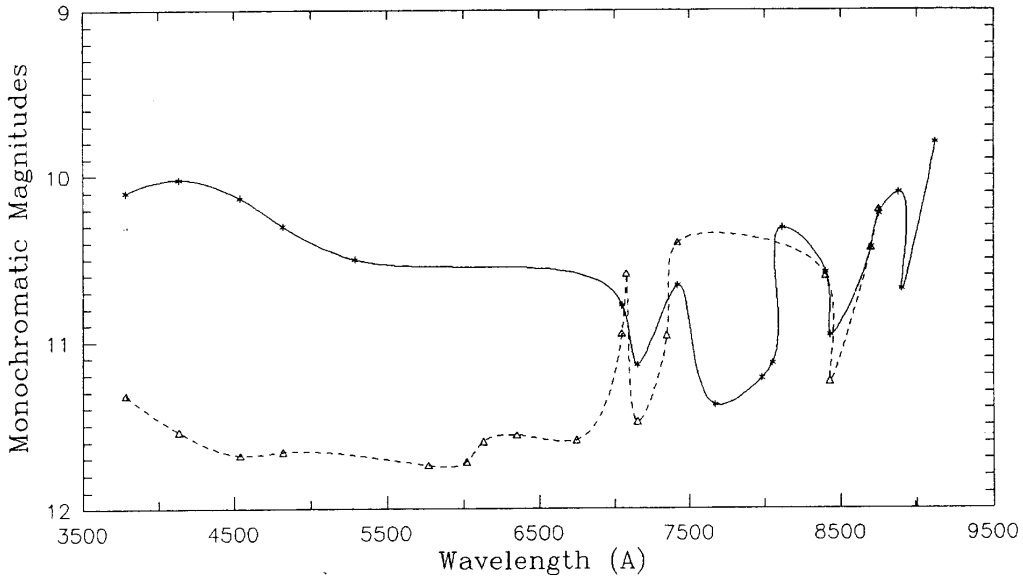

Figure 1. Continuous spectrum in 1993 July (solid line) and during the eclipse in 1994 June (dashes)

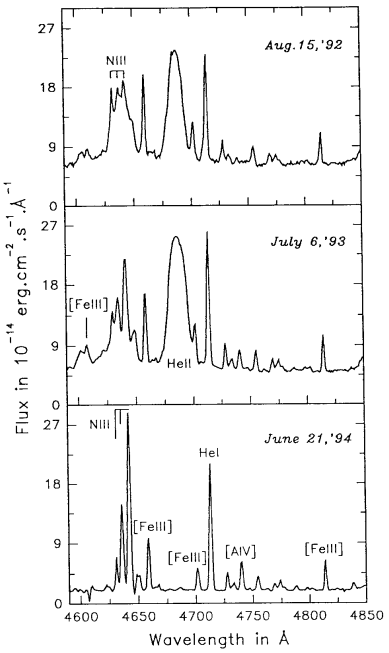

Figure 2. Variations of the absolute fluxes around 4700Å from August 15, 1992 to June 2, 1994. Note the collapse of HeII during the eclipse and the stability of the HeI line in spite of the drop of the continuum at the time of the eclipse.

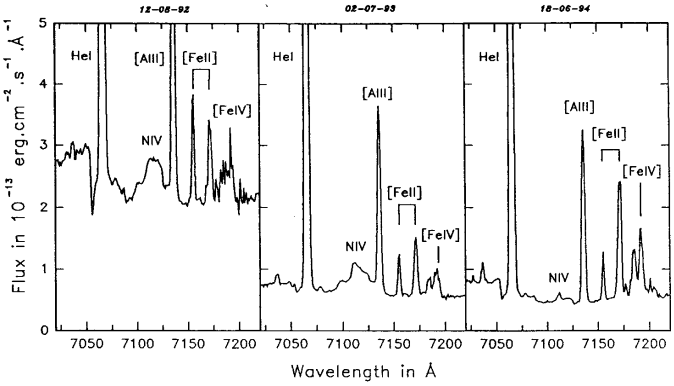

Figure 3. Variations of the absolute fluxes in the 7000Å region between August 12, 1992, and July 2, 1993 and during the eclipse phase on June 18, 1994. The continuum level drops by a factor of about 3 between August 1992 and July 1993 but remains unaltered by the eclipse. Remark that the drop of NIV at 7120Å is similar to the behavior of the HeII line in Figure 2.

The nebular spectrum has been observed between 375 and 900 nm. As in 1992, (see AH94), a large proportion of the lines belong to the Fe^{+} and Fe^{++} ions. Fluxes determined in 1994 June are in good agreement with the values given by Kolotikov et al. (1995). Discordances are observed mostly in the cases of blends, as our resolution permits to separate components unresolved on the low resolution Asiago B&C + CCD spectra. In general, [Fe III] lines slowly drop in intensity, while the [AIV] line at 474 nm increases, as it is apparent in Figure 2. On the spectrum secured during the brightness drop of 1993-1994, we observe the disappearence of the wind features, as already mentioned by Garnavich and Trummel (1994).

Table 1

Date	flux in HeII 468.6 in 10^{-12} erg.s^{-1}	FWHM in km, s^{-1}
91 Oct 25	1.09	820
92 Aug 15	2.52	833
92 Sept 9	2.71	953
93 July 6	3.30	1150
93 July 24	4.18	1200
94 June 17	< 0.1	–
95 June 17	7.33	1535

These "WR" features which have disappeared include He II at 454.2 and 468.6 nm, C II at 711.7 nm, C IV at 580.1-581.2 and 722.6 nm, N III at 420.0, 451.5, 452.3, 464.0 and 489.7 nm, and finally N IV lines at 405.0, 579.4, 638.3, 710.9-712.3 nm. Let us remark that during the 1992-1995 interval the He I 471.4 and 706.5 nm remain quite stable in flux. On the contrary, the [A IV] line at 474.0 nm, absent in 1992 (Figure 2), is stronger than the [Fe II] neighbouring lines. On the other side, we note that, except for the 1993-1994 luminosity drop, the He II λ 468.6 nm line increases both in flux and in FWHM, as reported in Table 1.

The parabolic shape of the He II line remains all trough the observed period of time, however its red wing is altered by the [Fe III] line at 470.1 nm: well separated on the 1991 October spectrum, this line is just visible as a shoulder on the 1995 June spectrum. Morever, it seems that between 1994 June and 1995 June, a narrow "spike" has developed on top of the wind component. Such a feature was observed, although ill-defined on a 1992 September 11 spectrum, although it could not be seen on August 15, 1992 (see Figure 2). This spike shows in 1995 June a -150 km.s^{-1} shift with respect to the wind component. A similar behavior is also observed in the N III line at 464 nm. In 1991 October, a strong and wide complex (2.12 10^{-12} ergs s^{-1}) is dominated by a wide 464nm line. In 1992 August, its intensity has increased to 2.75 10^{-12} ergs s^{-1} but three narrow spikes develop on top of the broad emission, corresponding to the 3^2P°- 3^2D°multiplet components. During the eclipse phase, the broad feature drops (as it is the case for the N IV line at 712 nm, see Figure 3), while the narrow components increase in strength (Figure 2). In 1995 June, when the broad line moderately reappears, the strongest N III components reach over 7 times the local continuum.

It is clear that the "hot" nebular spectrum of PU Vul has not yet reached its full development, while the wind features steadily reinforce their strength, indicating an increase of the wind density. The development of nebular components in the N III 464.0 nm and in the He II 468.6 nm lines shows that the nebular temperature is also increasing between 1992 and 1995.

Yvette ANDRILLAT
Université de Montpellier II
Laboratoire d'Astronomie
F 34095 Montpellier CEDEX 5
France

Léo HOUZIAUX
Département d'Astrophysique
Université de Mons-Hainaut
B 7000 Mons
Belgium

References:

Andrillat, Y. and Houziaux, L., 1994, *M.N.R.A.S.*, **271**, 875
Garnavich, P., 1994, *IAU Circ.*, No. 5969
Garnavich, P. and Trummel, S.R., 1994, *IAU Circ.*, No. 6089
Kolotikov, E.A., Munari, U., Yudin, B.F., 1995, *M.N.R.A.S.*, **275**, 185
Nussbaumer, H., Vogel, M., 1994, *IAU Circ.*, No. 5960