COMMISSIONS 27 AND 42 OF THE IAU
INFORMATION BULLETIN ON VARIABLE STARS
Number 4668

Konkoly Observatory
Budapest
29 January 1999
HU ISSN 0374 – 0676

V335 Vul = AS 356: A CARBON SYMBIOTIC BINARY?

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Merrill & Burwell (1950) were the first to notice the unusual nature of V335 Vul (= IRAS 19211+2421 = GSC 2128–00676). They reported an N or S continuum with the Hα in emission (MHα 215-33). As a carbon star (Case 452) the object appeared in the Nassau & Blanco (1957) catalog and later in the Stephenson (1973) General Catalogue of Cool Carbon Stars (C 2728). Collins (1991) reported a variability in the range 10.1–12.7 mag (unfiltered TP2415 sensitivity interval), and Kazarovets et al. (1993) classified V335 Vul as a semi-regular variability. Finally, Skiff & Williams (1997) identified the variable # 120 in the list by Dahlmark (1993) as V335 Vul. Little is known about the overall properties of V335 Vul, particularly about the spectroscopic ones.

We obtained low-resolution spectra of V335 Vul in 1993 and 1997, and a high resolution one in 1998 (cf. the journal of observations in Table 1). The low-resolution observations were secured with the Boller & Chivens+CCD spectrograph mounted on the 1.82 m telescope of the Padova & Asiago Astronomical Observatories. The high-resolution spectrum was obtained with the Echelle+CCD spectrograph on the same telescope. The spectra were extracted and calibrated in a standard fashion using the IRAF† software package. All observations were performed in non-perfect photometric conditions. Therefore the slope of the B&C spectra are indeed accurate, but the zero point in Figure 1 is arbitrary. The parts of the Echelle spectrum in Figures 2 and 3 are in relative fluxes.

Our spectra confirm the presence of a carbon giant in V335 Vul, with bands of carbon molecules dominating the continuum of B&C spectra. The Echelle spectrum is quite characteristic of carbon stars too: it appears extremely "spiky" in spite of the intrinsic high S/N ratio and the NaI doublet (at 5889.953 and 5895.923 Å) is in remarkably strong and wide absorption.

The two B&C spectra in Figure 1 document spectacular spectroscopic changes. The most remarkable one is the appearance in 1997 of Balmer lines in strong emission together with a hot continuum in the blue. Balmer lines were in emission at the time of the Merrill & Burwell (1950) discovery but not when we observed V335 Vul in 1993. This behavior suggests that V335 Vul is a binary star where the carbon giant is orbited by a hot companion whose temperature and/or luminosity varies remarkably in time.

The Hα profile in the expanded plot in Figure 2 is very similar to that shown by symbiotic binaries (Oliversen & Anderson 1982, Munari 1993), with marked blue asymmetry or

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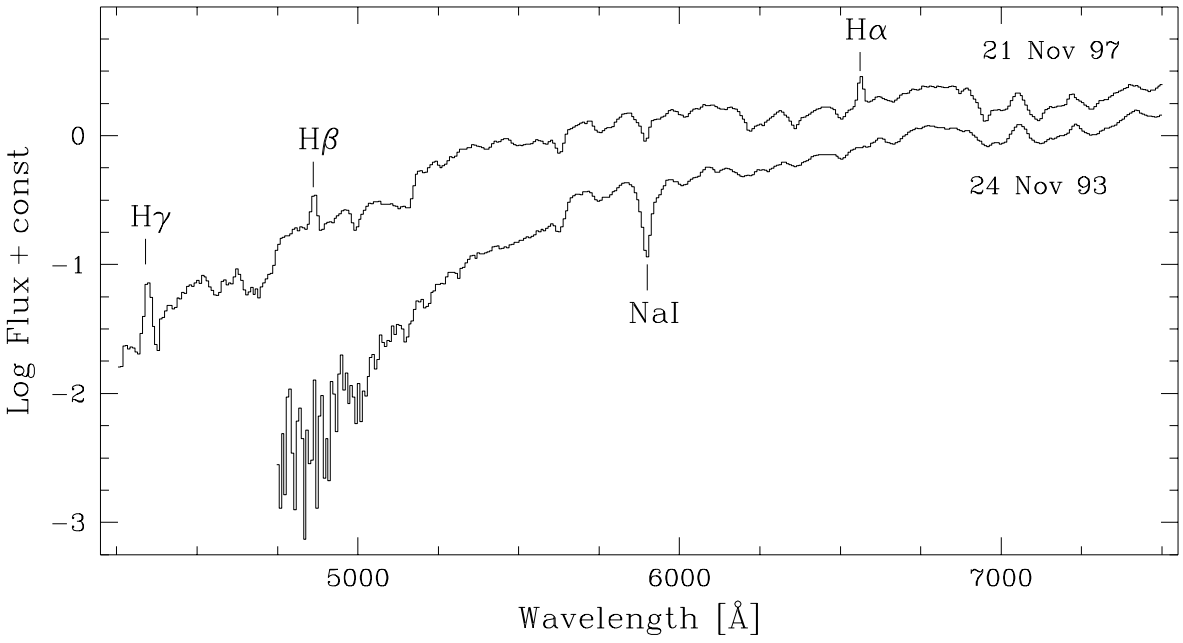

Figure 1. Boller & Chivens spectra of V335 Vul.

Table 1: Journal of observations

Date	JD 2400000+	Exp. time [sec]	Resolution [Å]	Instrument
24. Nov. 1993	49316.22	60+360	18	B&C + CCD
21. Nov. 1997	50774.22	30+300	16	B&C + CCD
08. Aug. 1998	51034.36	900	0.25	Echelle + CCD

with a blue shifted absorption component causing the Hα profile to appear double-peaked (again it is useful to remind the reader that the apparently noisy spectrum is indeed a manifestation of the carbon continuum, the S/N ratio of the continuum being around 95). It may be anticipated by analogy with symbiotic binaries that prolonged monitoring of V335 Vul should reveal changes in the emission line profiles, changes that should repeat in phase with the orbital motion (cf. Munari 1988, outburst-like activities aside).

The heliocentric radial velocities in the Echelle spectrum are -15 and -1 km s^{-1} ($\pm$7.0 km s^{-1}) for the Hα emission and the NaI D$_{1,2}$ absorption, respectively. Given the probable binary nature of V335 Vul, such radial velocities should vary in time and trace the orbital motion. The emission line flux ratio in the 1997 B&C spectrum is Hα/Hβ/Hγ = 1.0/0.18/0.37. The large Hα/Hβ/Hγ ratio is pretty similar to what normally observed in symbiotic stars, and reinforce the link of V335 Vul with this class of interacting binaries.

V335 Vul would be a fully flagged symbiotic star (according to the generally accepted definition by Allen 1984) if He II or higher ionization emission lines would be detected in the spectra. The absence of a *true* continuum in the high resolution spectra of carbon stars and the extreme crowding of absorption lines (which overlapping eventually mimics a forest of emission lines), make detection of moderate or weak emission lines very difficult (in Figure 2 a 3-times weaker Hα could have escape detection on a cursory inspection). Therefore specifically devoted observations are necessary to detect the He II, He I and

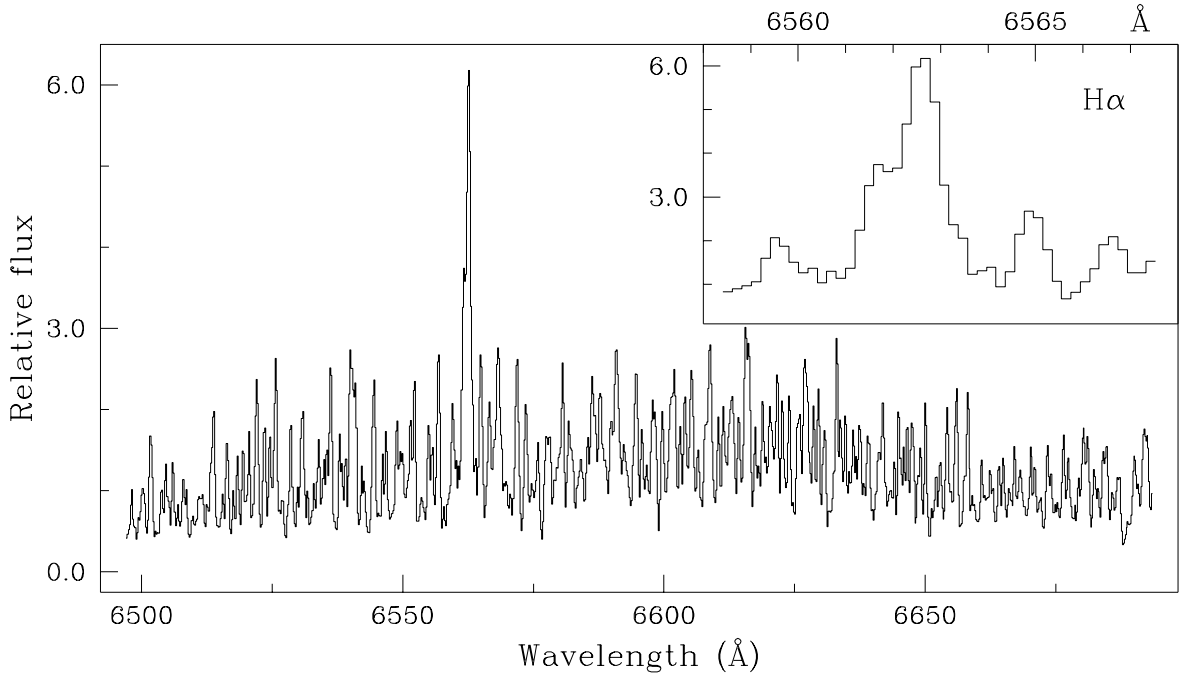

Figure 2. Hα order of the Echelle spectrum of V335 Vul. The enlarged Hα profile is shown in the inset.

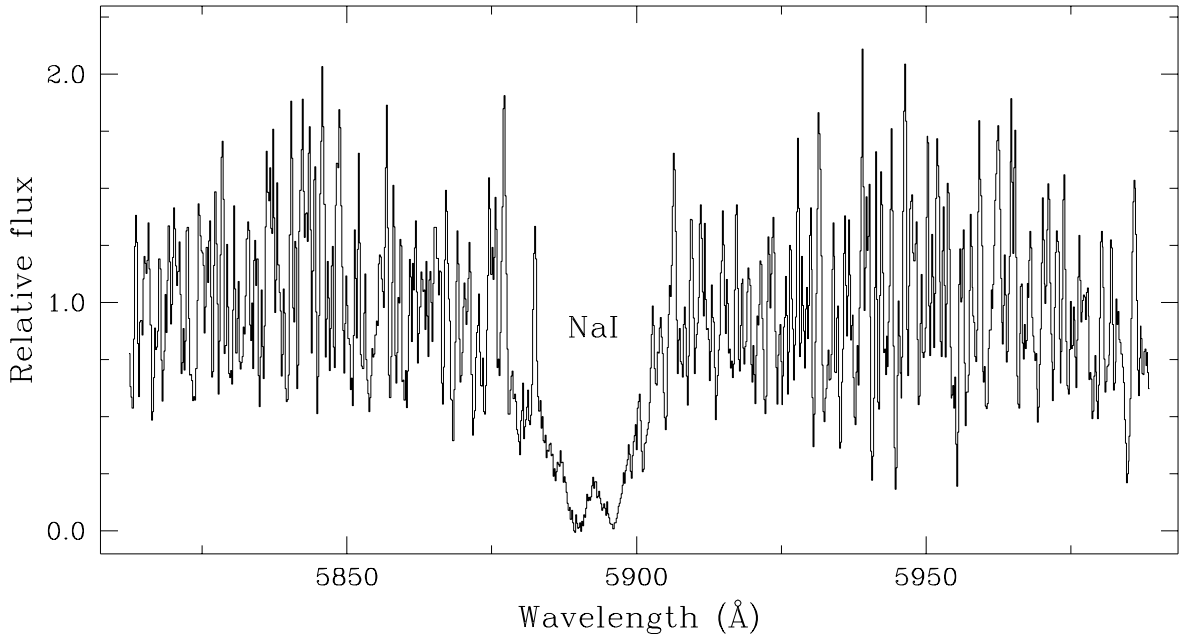

Figure 3. NaI order of the Echelle spectrum of V335 Vul.

[OIII] emission lines that are normally observed in symbiotic stars.

Devoted, repeated and high-resolution observations are clearly in order to document the binary nature, derive the orbital parameters and monitor the activity of the hot component. If V335 Vul should turn out to be a genuine symbiotic star this would be an interesting result because of the paucity of carbon symbiotic stars known in our Galaxy. In the latter only ∼1% of all known symbiotics harbor a carbon giant, whereas in the LMC, SMC and Draco satellite galaxies the vast majority of symbiotic stars are indeed carbon stars.

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