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SPECTROSCOPIC CLASSIFICATION OF A SUSPECTED SU UMa STAR IN LIBRA

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During the REU (Research Experiences for Undergraduates) observation campaign at CTIO (Cerro Tololo Inter-American Observatory) in February 2004, the VSNET alert 7982 by Pojmanski was received, indicating the outburst of a new eruptive star (with designation ASAS 153616-0839.1) in Libra. Light curves taken all over the world revealed that the object showed periodic variability with probably increasing period (Kiyota, 2004), which could thus been interpreted as growing superhumps with a final period of $P_{sh} = 0.06501(3)$ d (Kato, 2004).

We observed the object in low resolution with the R-C spectrograph at the 1.5 m telescope at CTIO, see Table 1 for the details. Standard data reduction was performed with IRAF including bias and flatfield correction and wavelength calibration. The standard star HR 3454 has been used to correct for the instrument curve. The spectra have a resolution of 1.5 nm and cover the range of 370–970 nm. Since we did not find variations in the spectra (apart from the increasing brightness), we averaged them to increase the S/N. All subsequent analysis of the data has been done using MIDAS.

In Fig. 1, the average spectrum of the two nights is plotted. Note that the flux values should be taken as relative values only, the absolute flux calibration is just a rough estimate. The spectrum is given as observed, without correction for interstellar reddening. It shows a very blue continuum, with the characteristic dwarf nova lines (hydrogen and

Table 1: Observational details of the individual spectra.

Date	UT start	Exp-time [s]
2004-02-09	08:25:57.5	900
2004-02-09	08:42:09.4	900
2004-02-10	07:40:11.9	900
2004-02-10	08:56:04.4	900

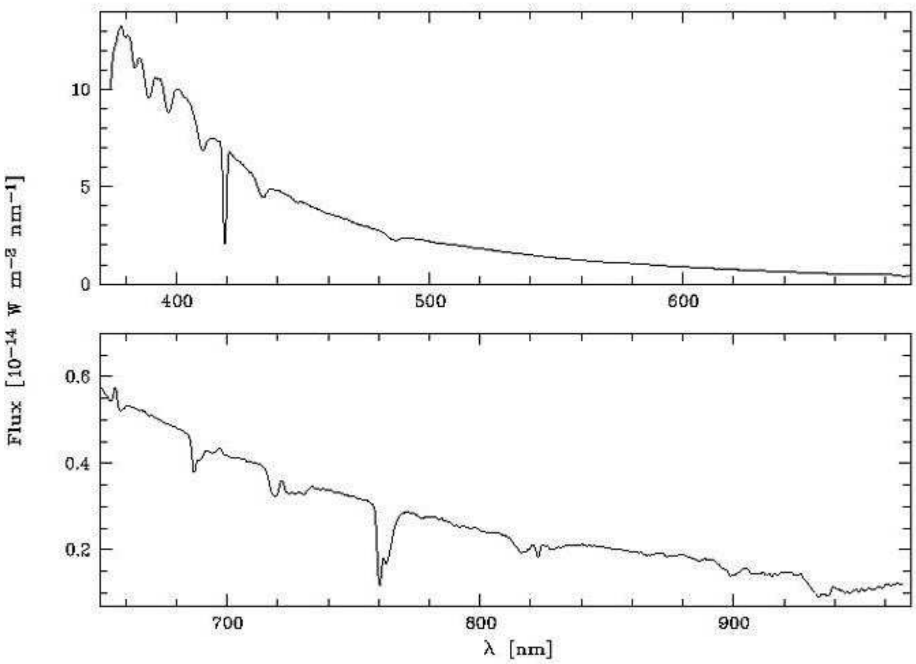

Figure 1. The spectrum is dominated by a very blue continuum and the hydrogen lines in absorption. The feature at $\lambda = 418\,\mathrm{nm}$ is due to a CCD artefact. The spectrum thus confirms the classification as a dwarf nova in outburst.

helium) present as broad absorption features, indicating an optically thick disc of high temperature.

We have tried to fit a λ^{α} power law to the blue part of the spectrum, leaving out the line features, and determined $\alpha = -4.5(2)$. The spectral energy distribution is thus much bluer than expected for a steady state disc; for comparison, Lynden–Bell (1969) calculates the maximum slope to be $\lambda^{-7/3}$. Furthermore, the fit showed clearly that a single power law is not sufficient to fit even the blue slope of the continuum. This is not surprising, if we assume the system to be of SU UMa type. The superhump during the outburst phase gives an additional blue contribution to the continuum, which is thus no longer disc dominated.

To check for other, weaker lines and in search for emission features, we normalised the spectrum using high order splines. A part of this normalised spectrum is plotted in Fig. 2. The emission core of Hα is clearly visible in the broad absorption trough, as is emission of He II at 468.6 nm blended with the Bowen emission feature at 464 nm. He I is present in absorption at $\lambda = 402.6\,\mathrm{nm}$ (outside plotted range), 447.1 nm, 492.1 nm (barely visible in the red flank of Hβ) and 667.8 nm. A broad emission feature centred on 584 nm is probably caused by C IV/N IV blended with He I and the nearby Na D line in absorption. The half width of this emission feature is about 3400 km/s indicating that the origin of these highly ionised lines either lies in the boundary layer between the accretion disc and the white dwarf surface or at least in the very inner region of the accretion disc. The FWHM and the equivalent width of the main absorption features are given in Table 2.

We have compared our spectrum to those of other dwarf novae in outburst. Mennickent et al. (2002) published an analysis of V592 Her during its outburst in August 1998 and their average spectrum looks very similar to ours. However, it shows a slightly less blue

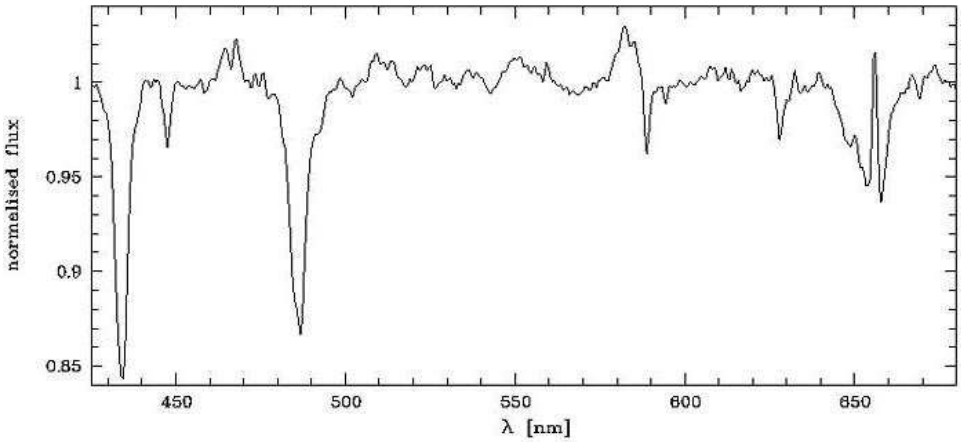

Figure 2. In the normalised spectrum, the weak lines like Hα, He I (447.1 nm), He II (468.6 nm) blended with Bowen-blend, or N IV/C IV(583 nm) blended with Na D in absorption become more apparent. The line at $\lambda = 628.3$ nm is of atmospheric origin.

continuum ($\alpha = 3.50(1)$), the absorption lines are narrower, and emission cores of He I are found in the absorption troughs. This behaviour can be explained with ASAS 153616-0839 having a higher temperature and thus a thicker disc.

Similar spectra have also been obtained of WZ Sge during the first days of its super-outburst in 2001 (Nogami & Iijima, 2004). Except for the double–peaked line–profile of He II and Hα, whose separation of 780 km/s would be below the detection limit of our resolution, and the absence of He II at 541.1 nm in our spectrum, their average spectrum from day 1–5 resembles the spectrum of ASAS 153616-0839. However, the spectra of WZ Sge evolved very rapidly during the outburst. After day 5, emission cores became visible for Hβ and later also for the other blue Balmer lines as well as for He I, while the emission features of He II and N IV/C IV disappeared. The similarity to the first spectra would thus indicate that our observations have been taken during the beginning of the super-outburst. This is consistent with the photometric observations, as the superhumps were still evolving in this epoch.

To summarise this investigation, we would like to state that the spectra of ASAS 153616-0839 confirm its photometric classification as a cataclysmic variable of SU UMa type. Although rather blue, they are consistent with spectra observed during early outburst phases of similar systems. The FWHM of the lines indicate that the system is seen at high inclination. As it has not been known before the outburst, but should be reasonably bright also in quiescence, it will present an interesting object for further studies.

Table 2: The full width of half maximum and the equivalent width (both in nm) are listed for the main absorption lines in the spectrum.

	H_9	H_8	Hϵ	Hδ	Hγ	Hβ	He I 402.6	He I 447.1	Na D
FWHM	2.38	2.92	3.03	4.06	4.13	5.75	1.03	2.45	2.18
W	0.22	0.40	0.47	0.99	0.72	0.79	0.015	0.088	0.071

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