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SPECTROSCOPIC IDENTIFICATION OF STARS MISCLASSIFIED AS CATACLYSMIC VARIABLES

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In a recent paper, Bennert et al. (1999, hereafter B99) presented lightcurves of four systems which were classified as possible cataclysmic variables (CVs) in the catalogue of Downes et al. (1997). The authors found no evidence for a variability and thus argued that these systems are misclassified. They also called for a spectroscopic confirmation of their conclusion. While for one of these systems, FBS 1614+711, this proof was already provided by Liu et al. (1999), we here present spectroscopy of the other three systems, HM Aur, NSV 7956, and FBS 0827+738, and additionally of PG 1316+678.

The history of the first three systems was already presented comprehensively by B99, and we therefore refer the reader to their paper. PG 1316+678 is a little studied object found in the Palomar-Green sky survey and was classified as a possible CV by Green et al. (1986). However, Misselt & Shafter (1995) found no variability in a $1\overset{\mathrm{h}}{.}5$ lightcurve, and consequently suggested a misclassification.

The spectra presented here were taken on February 2, 2000, at the 1.82-m telescope at Mt. Ekar, Asiago Observatory, using the AFOSC[1] system. The objects were observed both with grism 7 (λ4444–6677 Å, $\Delta\lambda_{\mathrm{FWHM}} = 9.2$ Å) and with grism 8 (λ6333–8431 Å, $\Delta\lambda_{\mathrm{FWHM}} = 8.4$ Å) to cover the blue and the red part of the spectrum, respectively. As an exception, NSV 7956 was observed with grism 7 only, due to technical problems following that exposure. For wavelength calibration purposes, comparison spectra were taken with a He-lamp for grism 7 and with a Ne-lamp for grism 8. The slit aperture was chosen to $2\overset{''}{.}1$, accounting for the seeing conditions. Additionally, CCD images were taken with a Bessel V filter to allow for a comparison with the differential magnitudes provided by B99. Standard reduction concerning BIAS, domeflats, optimal extraction (Horne 1986), and wavelength calibration, was performed with IRAF[2] packages. No flux calibration was attempted. Details of the observations are given in Table 1.

Differential photometry was performed with respect to the comparison stars used in B99. We find only minor differences in the range of -0.04 to -0.09 magnitudes for the

[1] Asiago Faint Object Spectroscopic Camera

[2] IRAF is distributed by the National Optical Astronomy Observatories.

Table 1: Characteristics of the spectra. Columns 2–5 give the exposure time in seconds and the average airmass for bot grisms. Columns 6 and 7 contain the spectral type which gave the best fit for the metal and Balmer lines, respectively (uncertain types are included in brackets), while the last column (8) gives the concluded type.

Object	Grism 7		Grism 8		Spectral Type		
	$t_{\rm exp}$	$M(z)$	$t_{\rm exp}$	$M(z)$	metal	Balmer	result
HM Aur	300	1.0	30	1.0			M7– III
NSV 7956	300	1.3	—	—	G8 III	K1– III–IV	G9+ III
FBS 0827+738	1800	1.1	1800	1.2	G5+ III	(G4+ V–IV)	G5+ III
PG 1316+678	600	1.1	720	1.1	(F7+ II–III)	(M0+ II–III)	F?

resulting differential magnitudes. These values are also found for common comparison stars, and we therefore ascribe them to instrumental differences (i.e. Bessel vs. Johnson filters). We thus conclude that the objects have been at the same brightness level both in the B99 and in our data set.

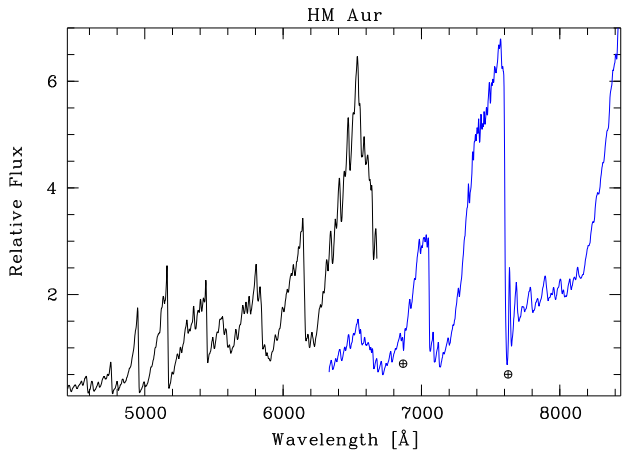

Figure 1. Spectroscopic data: HM Aur. The blue and red spectra have been scaled in order to fit into one plot. Atmospheric features are indicated by ⊕.

The resulting spectra are shown in Figs. 1 and 2. They contain both the blue and the red spectrum, which have been scaled accordingly. NSV 7956 is shown at the same wavelength scale to allow for a direct comparison with the other objects. Although in the case of FBS 0827+738 and PG 1316+678, the S/N is rather modest, the presence of emission lines can be definitely excluded for all systems, thus speaking against a CV nature of these objects.

For a more precise analysis, the catalogues of Jacoby et al. (1984), Kiehling (1987), and Silva & Cornell (1992) were used for comparison. After adjusting the spectral resolution of the catalogue and the observed spectra a pseudocontinuum has been determined in the following way. To avoid an overestimation introduced by noise, first the spectra have been smoothed by convolving them with a gaussian function with $\sigma = 3$ Å. Then the blue and red spectra have been fitted iteratively with polynomials of degree 6 and 3, respectively. After each step the points situated under the polynomial have been replaced by the regression curve itself. After 20 steps the iteration converged sufficiently. Now

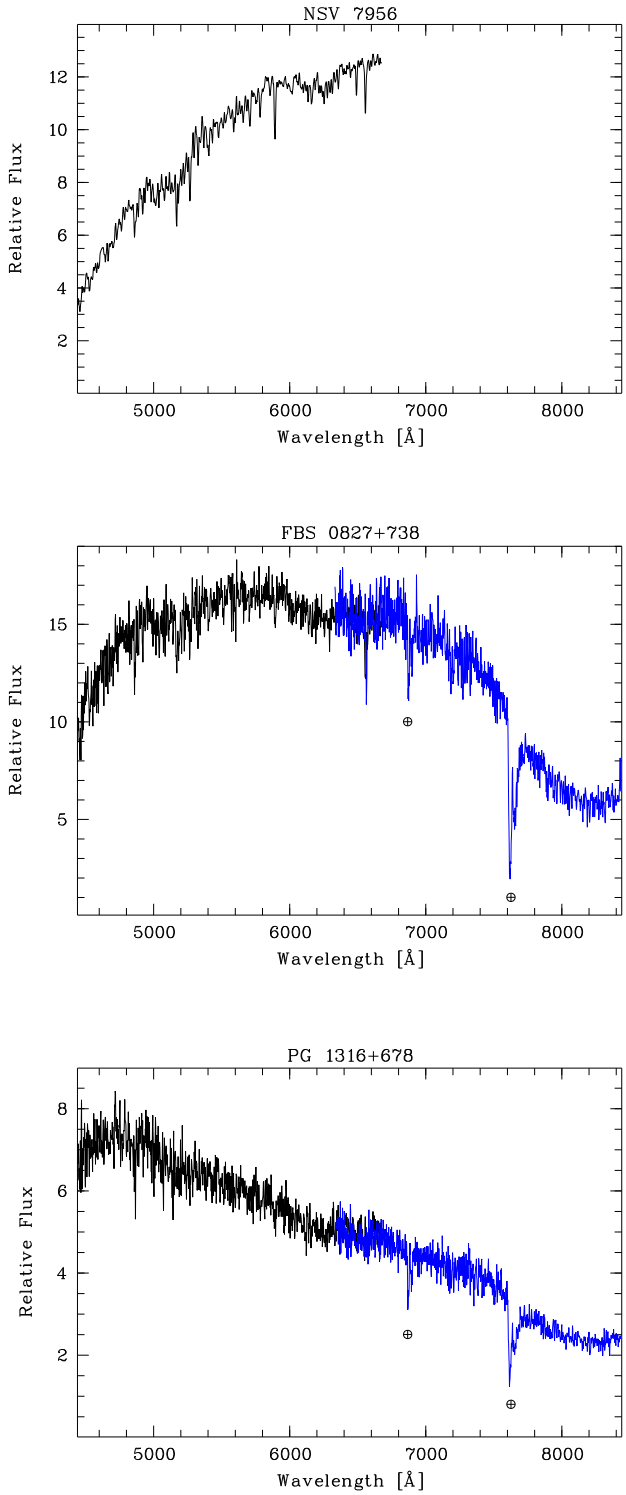

Figure 2. Spectroscopic data for NSV 7956 (top), FBS 0827+738 (middle), and PG 1316+678 (bottom). The blue and red spectra for the latter two have been scaled to match the overlapping region (λ6330–6680 Å). Atmospheric features are indicated by ⊕.

the line profiles were fitted with the catalogue spectra, applying the smallest euclidean distance technique.

Apart from HM Aur, where the whole spectrum could be fitted, we concentrated on strong lines only, i.e. the metal lines at 5153–5197 (Mgb), 5240–5286 (blend), 5874–5909 (NaD), and 6471–6507 (blend), and the Balmer lines at 4846–4877 (Hβ) and 6532–6584 (Hα). Both line types were examined separately to account for a possible binary character, which, however, was not detected for any of the stars within the uncertainties. The results are given in Table 1.

Unambiguous conclusions could be drawn especially in the cases of HM Aur (almost perfect fit) and NSV 7956 (average of two well-defined results). For FBS 0827+738, we based our result on the metal type, which, however, matches also the more uncertain Balmer one. In the case of PG 1316+678, the metal type is very uncertain, nevertheless the deviation from the better defined Balmer type is significant. The absence of molecular absorption bands, however, does not favour the suggested late Balmer type, which is mimicked by the almost complete absence of the Hα line, which is very surprising within the rather early metal type. The poor quality of the spectrum and its peculiarity makes a definite classification impossible. This object thus represents an interesting target for further spectroscopic studies.

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