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IDENTIFICATION OF TWO ROTSE TRANSIENTS AS CATACLYSMIC VARIABLES IN OUTBURST

SOUTHWORTH, J.; REBASSA-MANSERGAS, A.

Department of Physics, University of Warwick, Coventry, CV4 7AL, UK, email: j.k.taylor@warwick.ac.uk

In 2007 November the ROTSE sky survey observed two optical transients, using the 0.45 m ROTSE-IIIb telescope at MacDonald Observatory (Yuan et al., 2007). The two transients were labeled ROTSE3 J031031.4+431115.0 and ROTSE3 J113709.0+513451.1 (hereafter ROTSE 0310 and ROTSE 1137, respectively). The brightness of ROTSE 0310 rose from below the detection limit to ROTSE (unfiltered) magnitude 16.4 (2007 November 8), before gradually fading over a period of one week. It had previously been observed twice at magnitude 17.0 (2007 September 7 and October 20). The brightness of ROTSE 1137 was observed to rise to magnitude 17.2 (2007 November 2) before decaying to magnitude 18.5 over the following week.

ROTSE 0310 has a counterpart in the USNO-B1.0 survey with magnitudes $B_2 = 18.32$ and $R_2 = 19.10$. ROTSE 1137 has a counterpart in the Sloan Digital Sky Survey (SDSS; York et al., 2000) with magnitudes $g = 20.64$ and $r = 20.10$. Based on the observed outbursts and the magnitudes of the counterparts in the USNO and SDSS surveys, Yuan et al. (2007) "tentatively" classified both objects as faint CVs which were observed by ROTSE-IIIb whilst in outburst.

It is becoming progressively more important to understand the characteristics of optical transients in monitoring surveys, as large-area deep variability studies become more common (e.g. OGLE, PanSTARRS and the LSST). We therefore obtained medium-resolution spectroscopy of ROTSE 0310 and ROTSE 1137 in order to determine their object types. The observations were obtained with the William Herschel Telescope and ISIS double-beam grating spectrograph, using a slit width of 1.0 arcsec and the standard 5300 Å dichroic. The blue arm was equipped with the R600B grating, giving a wavelength coverage of 3600–5100 Å and a resolution of 2 Å. In the red arm we used the R316R grating, obtaining a coverage of 6200–8800 Å with a resolution of 4 Å.

A spectrum of ROTSE 0310 was obtained on the night of 2007 December 31, with an exposure time of 900 s. Its brightness was roughly $V = 19.5$, indicating that it was in quiescence. ROTSE 1137 was observed on 2008 February 15 in poor conditions (seeing 2.5–3.5 arcsec), with a longer exposure time of 1800 s. Its brightness was consistent with its SDSS magnitudes, so it was also in quiescence. Data reduction was performed using optimal extraction (Marsh, 1989) and our usual procedures (see Southworth et al., 2007a, 2007b). Wavelength calibration was undertaken using copper-neon and copper-argon arc lamps. Flux calibration and corrections for telluric absorption was done using spectra of HD 84937).

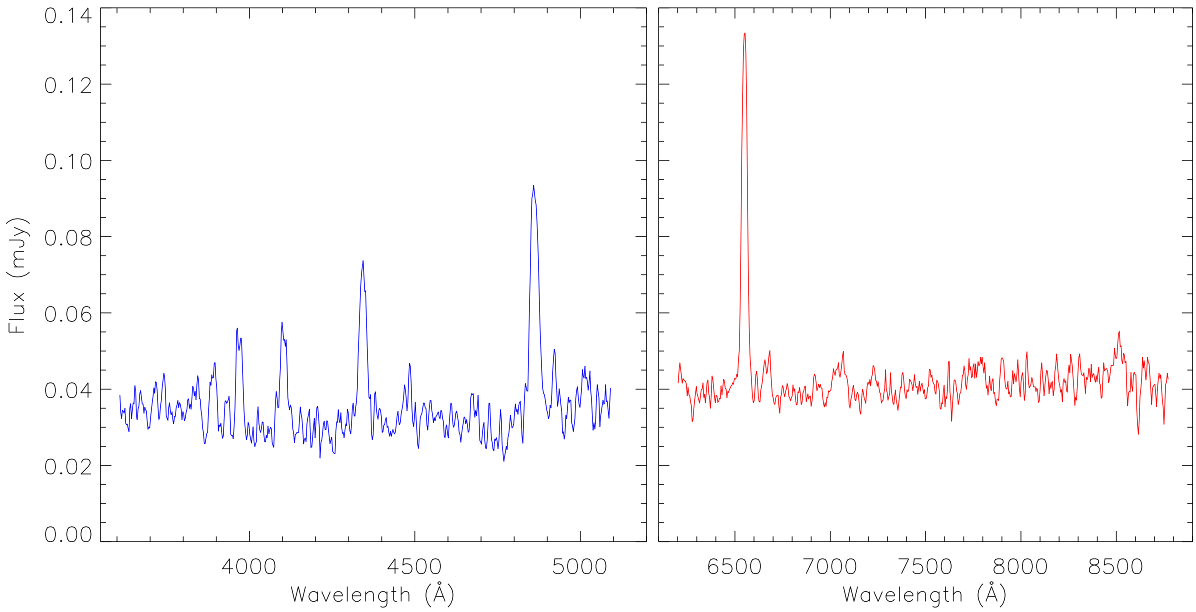

Figure 1. WHT/ISIS spectrum of ROTSE3 J031031.4+431115.0 whilst in quiescence. The spectrum from the blue arm is shown on the left and that from the red arm on the right. The data have been smoothed slightly for display purposes.

The spectrum of ROTSE 0310 is plotted in Fig. 1. Its flux calibration is only approximate as it does not take account of slit losses; the flux level is appropriate for an object at magnitude $V \sim 19.5$ at the time of observation. The spectrum shows strong single-peaked emission at the hydrogen Balmer line wavelengths. The emission is strongest at Hα and decreases to higher-order lines, which is the signature of an optically thin hydrogen-rich accretion disc (Williams, 1980). Emission is also seen at a number of He I lines, including λ4386, λ4471, λ4921, λ5015, λ6678 and λ7065. He II λ4686 emission is also detectable. The spectrum of ROTSE 0310 displays the classical signatures of a cataclysmic variable (CV) in quiescence (Warner, 1995), unambiguously confirming the tentative identification ascribed by Yuan et al. (2007). As it is known to show outbursts, ROTSE 0310 can be further categorised into the dwarf nova subclass of CVs (Warner, 1995).

Our observation of ROTSE 1137 was obtained during poor seeing conditions, and has a very low flux level. A portion of the red spectrum is shown in Fig. 2, and only Hα can clearly be identified. The rest of the spectrum is unusuable as slight inaccuracies in subtraction of the sky emission lines causes changes in flux at a similar level to the puny signal detected from the target. The ISIS blue spectrum has too low a continuum flux level to extract a spectrum, so we have taken the cosmologist's approach (A. Levan, priv. comm.) of measuring the positions of emission lines directly from the CCD image. By careful application of the correct wavelength calibration, we have been able to identify four emission lines with wavelengths λ4861 (Hβ), λ4341 (Hγ) and λ4100 (Hδ). We have therefore detected emission from four Balmer lines. The Balmer emission and the light curve obtained by ROTSE point to the identification of ROTSE 1137 as a faint CV of dwarf nova type.

To summarise, ROTSE 0310 and ROTSE 1137 were both detected as transient objects by the ROTSE-III sky survey. Their magnitudes peaked at 16.4 and 17.2, respectively, before decaying to below the detection limit over roughly one week. There are faint counterparts of both objects, one in USNO-B1.0 and one in the SDSS. We have obtained

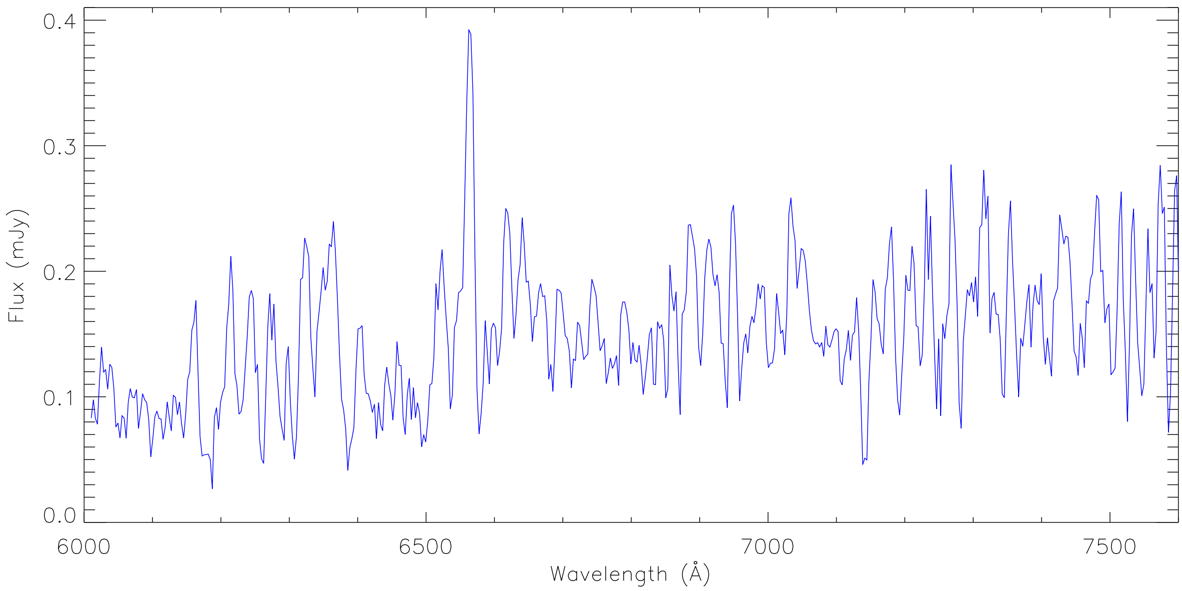

Figure 2. WHT/ISIS red spectrum of ROTSE3 J113709.0+513451.1 in quiescence. The data have been smoothed slightly for display purposes.

WHT medium-resolution spectroscopy of ROTSE 0310 and ROTSE 1137, and in both cases have detected the Balmer emission lines which are the dominant spectral characteristic of quiescent CVs. We therefore confirm the suggestion of Yuan et al. (2007) that the two objects are faint CVs which were caught in outburst by ROTSE. Neither system is mentioned in the CV catalogues of Downes et al. (2001) or Ritter & Kolb (2003; plus updates), so both are new discoveries.

This is not the first time that faint optical transients have turned out to be previously unknown CVs. Rau et al. (2007) followed up three faint optical transients and found that two of these were CVs, both of which were new discoveries. In the near future an increasing number of large-scale deep optical sky surveys will obtain observations of many thousands of transient objects. Becker (2008) discusses the various types of optical transients and predicts that the Large Synoptic Survey Telescope (LSST) may produce between 10^5 and 10^6 of these *per night*. A substantial proportion of these will be CVs, and follow-up observations similar to those presented here will likely lead to a huge increase in the known CV population.

References:

Becker, A. C., 2008, *AN*, in press (arXiv:0801.1503)
Downes, R. A., Webbink, R. F., Shara, M. M., Ritter, H., Kolb, U., Duerbeck, H. W., 2001, *PASP*, **113**, 764
Marsh, T. R., 1989, *PASP*, **101**, 1032
Rau, A., et al., 2007, *ApJ*, **664**, 474
Ritter, H., Kolb, U., 2003, *A&A*, **404**, 301
Southworth, J., et al., 2007a, *MNRAS*, **378**, 635
Southworth, J., et al., 2007b, *MNRAS*, **382**, 1145
Warner, B., 1995, *Cataclysmic Variable Stars* (Cambridge University Press, Cambridge, UK)
Williams, R. E., 1980, *ApJ*, **235**, 939
York, D. G., et al., 2000, *AJ*, **120**, 1579
Yuan, F., 2007, *The Astronomer's Telegram*, **1272**

ERRATA FOR IBVS 5583

The following corrections were communicated to IBVS by Petr Zasche and the author, Miloslav Zejda. The times of minima for HT Vir were erroneously given in the article, and should be replaced by those given below.

Star name	Corrected time of min.
HT Vir	52751.5845
HT Vir	52751.3807
HT Vir	52765.4468
HT Vir	53068.5504