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A NEW BRIGHT U Gem VARIABLE IDENTIFIED WITH THE X-RAY SOURCE 1RXS J053234.9+624755

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During a programme of optical identification of X-ray sources from the ROSAT all-sky survey bright source catalogue (Voges et al., 1999) with variable stars in the ROTSE1 database (Woźniak et al., 2004) it was found that the uncatalogued variable at $05^{\rm h}32^{\rm m}32\overset{\rm s}{.}68$ $+62°47'54\overset{''}{.}7$ was coincident the X-ray source 1RXS J053234.9+624755. The ROTSE1 light curve is available from the Northern Sky Variability Survey (NSVS) website (see reference Woźniak et al., 2004) and is shown in Figure 1. ROTSE1 magnitudes are broadly equivalent to R. The data show two, or including the poor quality points, three large outbursts from magnitude $R \sim 16.0$ to 12.9. The last outburst is particularly well covered by the ROTSE1 data and is shown in more detail in Figure 2. This, and the rapid rise time of the second outburst argues against any other type of large variation suggesting that this star is a cataclysmic variable (CV) of the U Gem type with a recurrence time scale of ~ 133 days. The duration of the outbursts is very short, about 4 days in total, and the initial decline rate, $T_1 = 1.0$ days.

The ROTSE1 position lies almost exactly between two stars in the GSC 2.2, USNO and 2MASS catalogues, so its identification is not immediately obvious. The two stars are separated by $17''$ and the preceding (west) component is the brighter, by approximately

Table 1: Photometry of the two sources close to the ROTSE1 position

	East						West					
Source	B	R	I	J	H	K	B	R	I	J	H	K
GSC 2.2	16.0	15.8					16.0	15.1				
USNO A2.0	16.3	16.4					15.8	15.1				
USNO B1.0	16.8	16.3	15.7				16.4	15.4	14.8			
	16.5	16.0					16.2	15.5				
2MASS				15.18	15.02	14.30				14.15	14.06	13.83

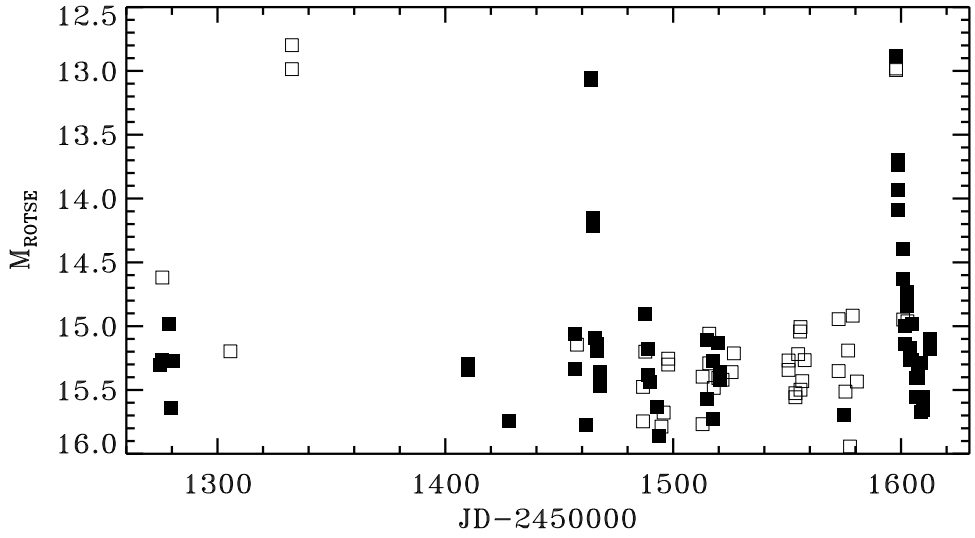

Figure 1. The ROTSE1 data showing the combined light of the two stars as discussed in the text. At quiescence the CV is below the detection threshold. The flagged data are shown as open squares.

one magnitude. The resolution element of the ROTSE1 survey is $\sim 14''$ so these stars are on the resolution limit.

The available photometry of these two stars has been collected in Table 1 and suggests that the brighter component is always above the ROTSE1 threshold of $R \sim 15.5$ while the fainter component is (usually) below it. The ROTSE1 position is derived from a combination of the two sources, the western component during CV quiescence, and the CV dominated position during outburst. All the photometric and astrometric evidence strongly suggests that the CV is the eastern component of this pair at $05^{\rm h}32^{\rm m}33\overset{\rm s}{.}87$ $+62^\circ47'52\overset{''}{.}1$ and this is confirmed by recent observations.

In Figure 1 there are several measurements apparently showing the CV at quiescence but these are probably entirely due to the brighter companion. Even the brighter measurements will still have a significant contribution from the companion, and the CV will only begin to dominate at magnitudes above $R \sim 14.5$.

The colours of the CV are not well determined in the optical, but yield an average $B - R = 0.3$ which is consistent with this type of object. However, the 2MASS colours (Cutri et al., 2003), $J-H = 0.15$ and $H-K = 0.72$ suggest a very red object at the longest wavelengths, which contrasts with the blue object seen in the optical. This combination of colours has been seen before in CVs (Hoard et al., 2002). The 2MASS colours do not suggest any particular type of CV; most have colours similar to main-sequence stars and all types have objects with anomalous colours. It is obviously a recurrent object with a relatively short cycle and the statistics suggest weakly that it is a U Gem star rather than a magnetic CV.

The X-ray source 1RXS J053234.9+624755 from the ROSAT all-sky survey bright source catalogue (Voges et al., 1999) lies close by at $05^{\rm h}32^{\rm m}34\overset{\rm s}{.}90$ $+62^\circ47'55\overset{''}{.}5$ with a nominal uncertainty of $8''$. The X-ray source lies $8''$ from the CV, within the error ellipse, and $24''$ (3σ) from the companion. The source was observed by the ROSAT PSPC with a count rate of $0.260 \pm 0.0270/s$ so assuming an optical magnitude, $V = 16.3$ this leads to

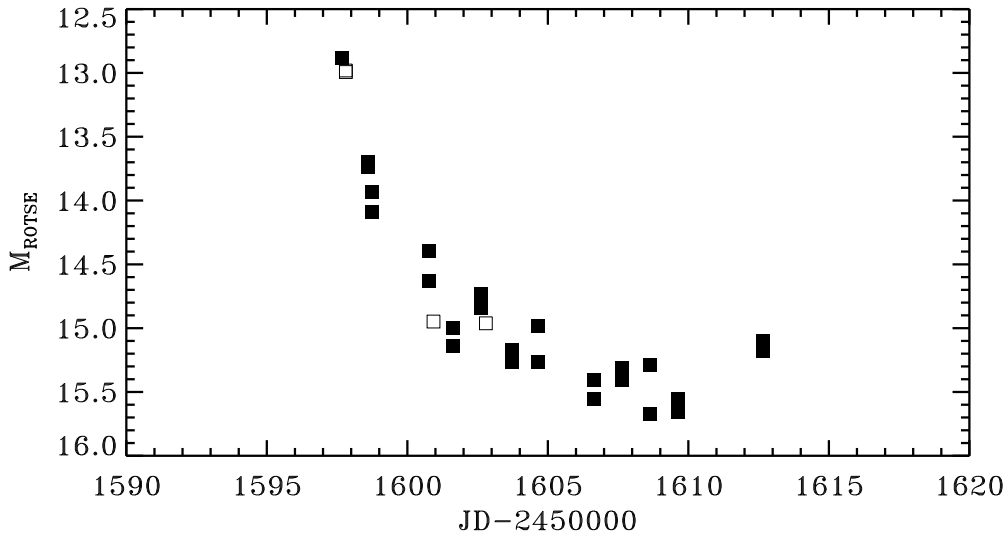

Figure 2. The detail of the last outburst from the ROTSE1 data.

$F_x/F_{opt} = 0.30$. For CVs in general F_x/F_{opt} is notoriously variable but this value is in the middle of the range. When combined with the hardness ratios, $HR1 = 0.15 \pm 0.10$ and $HR2 = 0.16 \pm 0.14$ this object lies on the lower edge of the group with higher F_x/F_{opt} ratios. In the hardness ratio plane this object lies in the central, more neutral group of CVs, as opposed to the 'hard' group or with the small number of very soft sources (see Motch et al., 1998).

In an effort to identify previous outbursts the Sonneberg Plate Archive was searched and estimates were made on 123 pg plates taken during JD 2448220 – 2451601 and 111 pv plates taken during JD 2447803 – 2451927. As a result four further outbursts were identified and together with the ROTSE1 data an outburst ephemeris was derived. Following a call for observations, which was kindly provided by the CVNET (`http://home.mindspring.com/ mikesimonsen/cvnet/index.html`) another outburst was detected on 16 March 2005 independently by four observers. These were by W. Kriebel (JD 2453446.309, mag 12.0), P. Schmeer (JD 2453446.319, mag 11.9) and W. Renz

Table 2: Outbursts of 1RXSJ053234.9+624755

HJD	mag	Cycle	$O-C$(d)	Source & remarks
2447975.312	11.6	0	−5.8	Sonneberg plate pv
2448650.344	12.4	5	+1.2	Sonneberg plate pv
2449058.306	13.7	8	+8.4	Sonneberg plate pg
2450097.427	13.6	16	−21.3	Sonneberg plate pg
2451332.672	12.79	25	+11.5	ROTSE *flag 8192
2451463.772	13.06	26	+9.0	ROTSE
2451597.676	12.89	27	+9.3	ROTSE
2453446.309	12.5	41	−12.4	Pietz, Kriebel, Schmeer & Renz

* flag 8192: High scatter of the corrections across the map larger than 0.1 mag

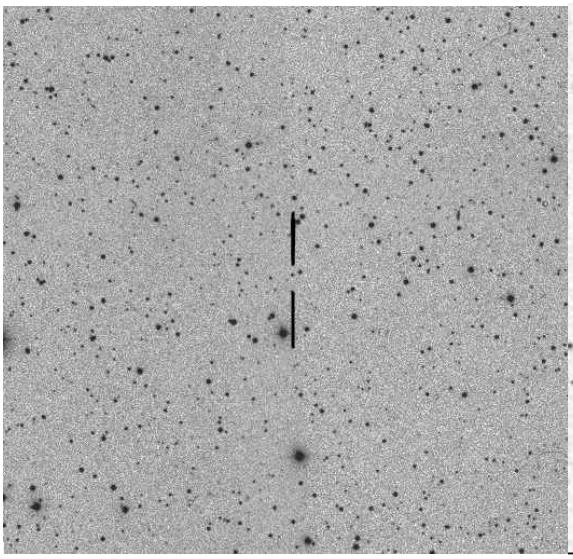

Figure 3. Finding chart from a POSS O plate showing a $20' \times 20'$ field around the CV. North is up and east to the left.

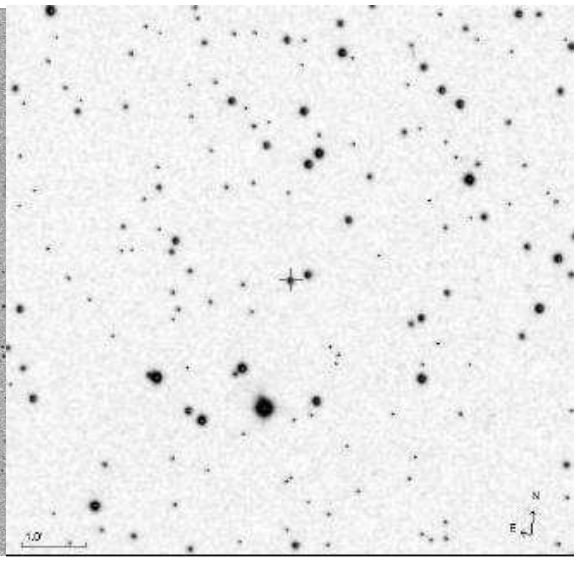

Figure 4. Finding chart from a POSS E plate showing a $10' \times 10'$ field around the CV. The bar is 1 arc minute long.

(JD 2453446.323, mag 12.0) observing visually and J. Pietz with an unfiltered CCD SBIG ST-6 (JD 2453446.309, mag 12.5). All the times of outburst are collected in Table 2 and were fitted by least squares to derive an outburst ephemeris of,

$$\begin{array}{c} \mathrm{HJD_{Max}} = 2447981.1 + 133\overset{\mathrm{d}}{.}6 \times \mathrm{E} \\ \qquad\qquad\quad \pm 8.0 \qquad \pm 0.4 \end{array}$$

The most recent observations suggest that this star is currently undergoing a super-outburst which is brighter and longer than seen in the ROTSE1 data. The only previous occasion when the star was observed this bright was on the first of the Sonneberg outbursts 5471 days earlier. There are several, as yet, unpublished reports of superhumps with a short period, so this star is a new short-period UGSU-type dwarf nova and will obviously receive considerable attention in the future.

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