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**GSC 2038.0293 IS A NEW SHORT-PERIOD  
 ECLIPSING RS CV<sub>n</sub> VARIABLE**

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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 the ROTSE1 database (Woźniak et al., 2004) it was found that the uncatalogued variable NSVS object ID 7869362 (= GSC 2038.0293) was coincident with the X-ray source 1RXS J160248.3+252031. Further details of the programme are presented in Bernhard et al. (2005). GSC 2038.0293 has  $V = 10.62$  and  $B - V = 0.83$  from the Tycho-2 catalogue (Høg et al., 2000), the 2MASS catalogue gives  $J - K = 0.612$  (Cutri et al., 2003).

Our observations were made using both a 20-cm Schmidt–Cassegrain telescope and a Starlight XPress SX CCD camera with  $BV$  filters (2005) and  $BVR$  filters (2006) in Linz, Austria and a Flatfield Camera 576/2.0 with a CCD camera OES-LcCCD12 and  $IR$ -cutting filter in Velden, Germany (2005 and 2006). The comparison stars used were GSC 2038.0565 and GSC 2038.0663, which were found to be constant within  $< 0.03$  mag.

The following primary minima were observed in 2005 and 2006 (Table 1):

Table 1: Times of primary minima of GSC 2038.0293 (HJD 245...)

minimum time	filter	observer	$O - C$ (d)
3566.433 (2)	$IR$ cutt.	Frank	-0.002
3569.405 (2)	$V$	Bernhard	-0.003
3846.348 (2)	$IR$ cutt.	Frank	+0.005
3877.555 (2)	$V$	Bernhard	+0.002

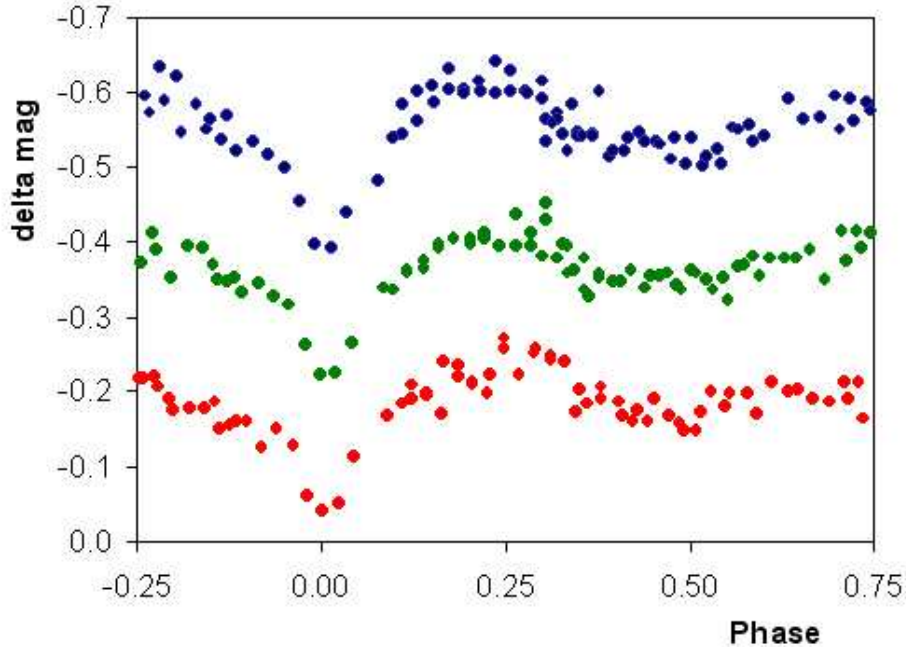
Figures in brackets denote rms errors in units of the last decimal,  $O - C$  values were calculated with the ephemeris given below.

A Fourier analysis of the available data including ASAS3 (Pojmanski, 2002) and ROTSE1 was performed to search for periodicity of the light variations. The following ephemeris can be derived from the analysis with the algorithm Period04 (Lenz and Breger, 2005):

$$\text{HJD}_{\text{MinI}} = 2453560.491 + 0^{\text{d}}495410 \times E.$$

$\pm 3$                        $\pm 1$

The folded (and in  $y$ -direction shifted) light curves of the  $BVR$  filtered observations in May and June 2006 are given in Figure 1 and show an amplitude of nearly 0.20 mag for the  $B$  observations and of nearly 0.18 mag for the  $V$  and  $R$  observations.



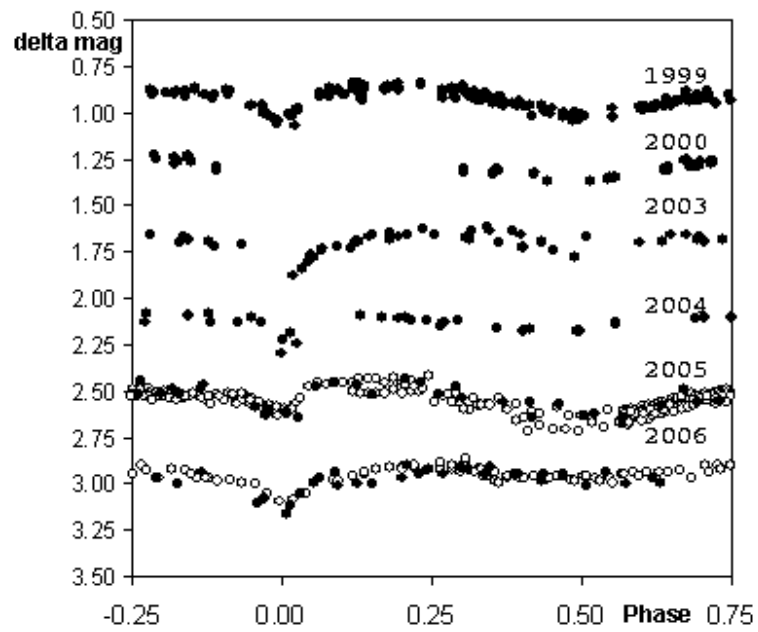
**Figure 1.** Folded  $BVR$  light curves of GSC 2038.0293 in the observing season 2006

The shape of the folded light curve with two minima of considerably different width clearly identifies GSC 2038.0293 with a very short period and heavily spotted RS CVn type star. This finding is also supported by the X-ray identification, and the values of the Tycho-2 and 2MASS colours, which point to a spectral type of late G or early K.  $B - V$  and  $V - R$  values of our observations in 2006 indicate a slight reddening of the star, when it enters the minimum of the spotted light curve. The peak to peak amplitude (i.e. the magnitude difference between the secondary and primary minima), determined by low order polynomial fitting, is for the  $B$  band about 0.09 mag, for the  $V$  and  $R$  band only 0.07 and 0.06 mag. This is in good agreement with data from literature, where a  $\Delta R/\Delta V$  value of 0.90 for active stars has been determined (Drake, 2006).

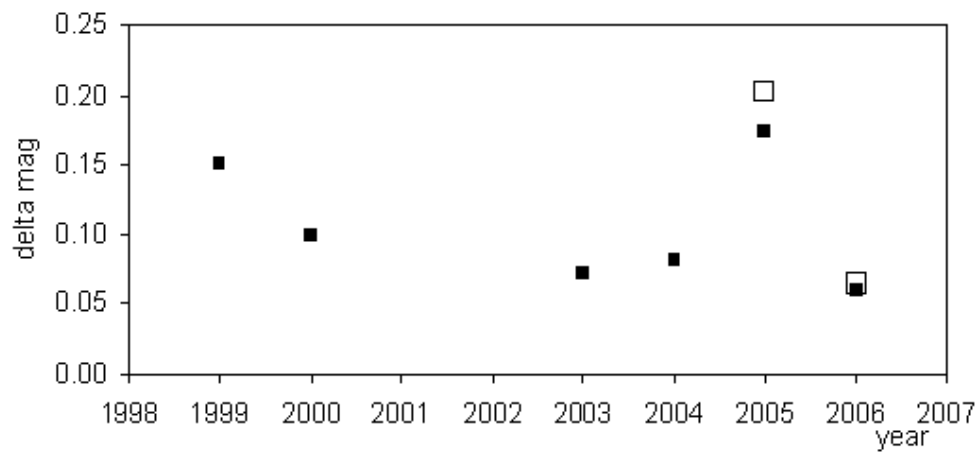
The period of 0.495410 days is very short for an RS CVn star. Only one of 206 binary systems of the second edition of the catalogue of chromospherically active binary stars has a shorter period (XY UMa, 0.4789944 days; Strassmeier et al., 1993).

The folded light curves of ROTSE1, ASAS3 and our  $V$ -band data, which are shifted for the different years, are given in Figure 2.

ROTSE1 data are available for 1999 and 2000, ASAS3  $V$  data for 2003, 2004, 2005 and 2006 (filled circles). Our  $V$ -band data for 2005 and 2006 are shown as open circles. The amplitudes of the  $V$  and  $R$  band are very similar (see Figure 1). Therefore it can be assumed, that also ASAS3 ( $V$ ) and ROTSE1 amplitudes (near  $R$  values) are roughly comparable.



**Figure 2.** Folded ASAS3 and ROTSE light curves (filled circles) and our *V* data (open circles) in 1999–2006



**Figure 3.** Peak to peak amplitude of the minimum of the spotted light curve in the ASAS3 and ROTSE data (filled squares) and in our *V*-band data (open squares) in 1999–2006

It can be clearly seen, that the primary minimum has fairly the same amplitude in 1999–2006, but the depth of the minimum of the spotted light curve is changing to a large extent. The long-term changes of the light curve are illustrated in more detail in Figure 3.

The amplitude of the spotted light curve shows a clear variation in 1999–2006 with two clear maxima in the years 1999 and 2005. In 2005, the year of the highest variation, the minimum of the spotted light curve was fainter than the primary (eclipsing) minimum. We noticed considerable changes in the shape of the lightcurve on timescales of a few weeks in our  $B$ ,  $V$  and unfiltered observations. This resulted in an increased scatter near the minimum of the spotted light curve in the ASAS and our data of that year (see Figure 2).

Though it is clear that more observations will be necessary to describe the long-term activity of GSC 2083.0293, (cyclic?) variations on timescales of 6–8 years seem to occur. Similar cycles have also been observed for other RS CVn stars (e.g. Berdyugina and Tuominen, 1998). We conclude that GSC 2038.0293 is a new RS CVn variable with one of the shortest known periods and a dramatically changing light curve. We hope that the present study will stimulate more observations of this interesting, high activity star.

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