

## CCD PHOTOMETRY OF THE SHORT-PERIOD ECLIPSING RS CVn VARIABLE GSC 2038.0293

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**Abstract:** GSC 2038.0293 is an eclipsing RS CVn variable, which has been discovered in the ROTSE1 database. BVR and unfiltered observations showed a further decline of starspot activity in 2007, which is in good agreement with a suggested cyclic variation of 6-8 years. Despite the low mean starspot activity we noticed considerable changes of starspot activity on timescales of a few weeks.

GSC 2038.0293 (RA: 16h02m48.1s, DEC: +25°20'38", J2000) is a short-period eclipsing and heavily spotted RS CVn variable, which was found 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 (Wozniak et al., 2004).

The period of about 0.495 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 following ephemeris was derived by using the ROTSE1, ASAS3 (Pojmanski, 2005) and unfiltered and BVR observations in 2005 and 2006 (Bernhard&Frank, 2006):

$$\text{HJD\_MinI} = 2453560.491 (+-3) + 0.495410 (+-1) \times E$$

Our observations in 2007 were made using both a 20-cm Schmidt-Cassegrain telescope and a Starlight XPress SX CCD camera with BVR filters in Linz, Austria, and a Flatfield Camera 576/2.0 with a CCD camera OES-LcCCD12 and IR-cutting filter in Velden, Germany. The comparison stars used were GSC 2038.0565 and GSC 2038.0663, which were found to be constant within <0.03 mag. Observations were performed on 10 nights between July and August 2007 (K. Bernhard) and on 8 nights between April and August 2007 (P. Frank).

The following primary minima were observed in 2007. The times of minima were calculated using the method of Kwee and van Woerden, the O-C values are calculated with the ephemeris given above (Table 1):

primary minimum (HJD)	filter	observer	O-C (d)
2454192.635(2)	IR cut	Frank	+0.001
2454213.445(2)	IR cut	Frank	+0.003
2454271.408(2)	IR cut	Frank	+0.004
2454318.471(2)	IR cut	Frank	+0.002
2454325.408(2)	IR cut	Frank	+0.004
2454327.389(3)	V	Bernhard	+0.003

The folded (and shifted in y-direction) light curves of the BVR filtered observations in July and August 2007 are given in Figure 1.

Figure 1 shows the primary minimum at phase 0.0 and an increased scatter between phases  $\sim 0.4$  and  $\sim 0.7$ . This increased scatter in the folded light curve can be explained by considerable changes of starspot activity between JD 2454288 and JD 2454307. ASAS3 data and our observations confirm similar changes on short timescales in the years 2003 and 2005 (Figure 2).

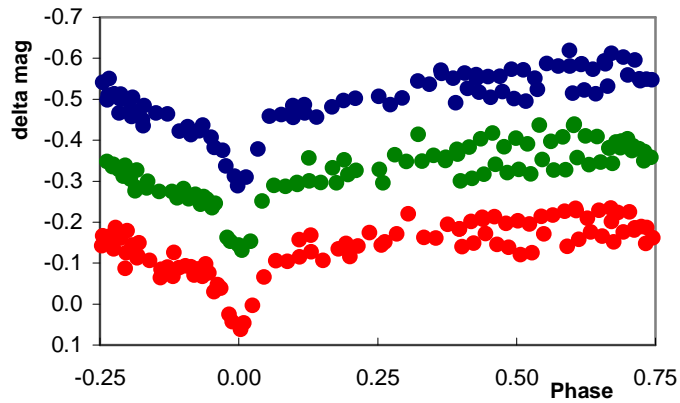


Figure 1: Folded B (blue circles), V (green circles) and R (red circles) light curves in the observing season 2007

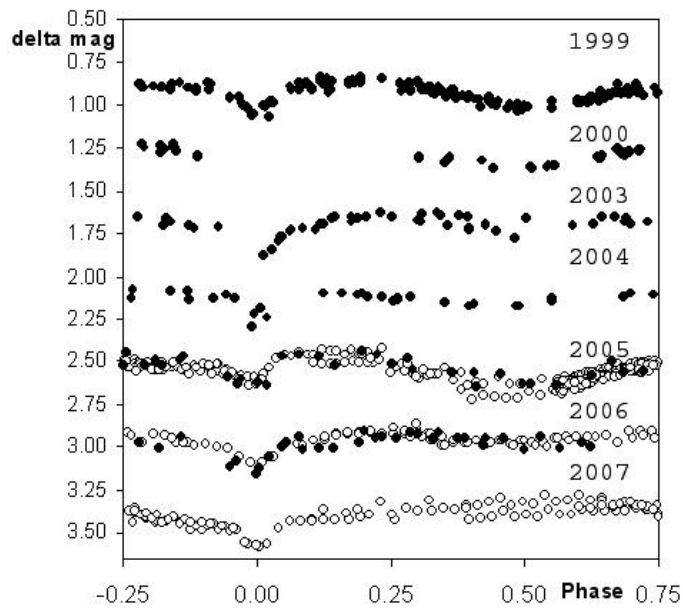


Figure 2: ROTSE1 (1999-2000, filled circles) and ASAS3 (2003-2006, filled circles) and our V data (open circles) in 1999-2007, the data of different years are shifted in y-direction

It can be clearly seen, that the primary minimum has fairly the same amplitude in 1999-2007, but the depth of the spotted light curve is changing to a large extent. In contrast to the years 1999-2006 a minimum of the spotted light curve (at phase  $\sim 0.5$ ) could not be detected in 2007.

The long term changes of the light curve are illustrated in more detail in Figure 3. Error bars estimate the uncertainties, which are mainly due to variations of starspot activity on short timescales (described below).

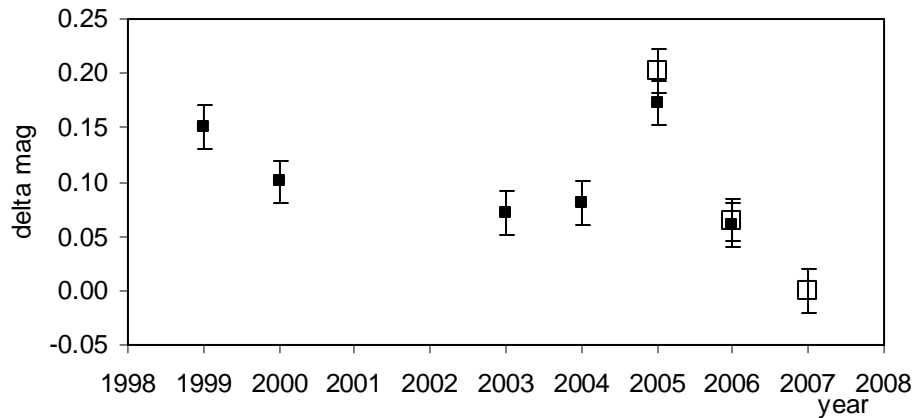


Figure 3: Peak to peak amplitude of the minimum of the spotted light curve (=amplitude of the “secondary” minimum) in the ASAS and ROTSE1 data (filled squares) and in our V-band data (open squares) in 1999-2007.

The amplitude of the spotted light curve shows two clear maxima in 1999 and 2005 and minima in ~2001-2002 and 2007, which was the year of the lowest starspot-activity so far. The observations of 2007 are in good agreement with suggested variations on timescales of 6-8 years (**Bernhard&Frank, 2006**).

Despite the low mean starspot activity considerable changes of the shape of the folded light curve occurred on timescales of a few weeks in 2007. The period of 0.495410 days is very near 0.5 days and therefore the binary system can be observed at almost the same phase in consecutive nights, which could be favorable for further detailed studies of this high activity star.

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