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**SHORT-PERIOD OSCILLATIONS IN THE ALGOL-TYPE SYSTEMS III:  
NEWLY DISCOVERED VARIABLE GSC 4588-0883**

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GSC 4588-0883 was discovered as a new eclipsing binary in our search for new variables in the NSVS database (Wozniak et al., 2004). According to the NSVS data the star was classified as Algol-type binary with period  $P \simeq 3.2582$  days, amplitude of primary minimum  $A_R > 0.65$  mag, and the magnitude in maximum  $R'_{\max} \simeq 11.67$  mag. The astrometric and photometric data for the star (Table 1) are taken from NOMAD catalogue (Zacharias et al., 2004).

The CCD photometry (in *BVR* bands) of GSC 4588-0883 was carried out with the 60cm Cassegrain telescope at NAO Rozhen, equipped with the CCD camera FLI PL09000 ( $3056 \times 3056$ ,  $12\mu$  pixel), and Bessell (1990) standard *UBVRI* filters. The standard IRAF procedures were used for the reduction of the photometric data. Using the method of Everett and Howell (2001) six stars with  $\sigma < 0.005$  mag in all *R* band observations (Table 1) were selected to create an ensemble standard star.

The NSVS and Rozhen's light curves of GSC 4588-0883 are shown on Fig. 2. The light curves for 6 nights, obtained in *R* band are shown in Fig. 4 and Fig. 5. Short-period oscillations with a peak-to-peak amplitude of up to 0.015 mag in *R* (Table 2) were detected. The oscillations are smaller than in the previous discovered stars GSC 4550-1408 and GSC 3889-0202 (Dimitrov et al., 2008a,b). The oscillations are present at the primary and the secondary minima also. A preliminary periodogram analysis (Fig. 6) of the data shows a main periodicity in the interval  $71 \div 78$  minutes.

Spectral observations of GSC 4588-0883 were obtained with the Coudé spectrograph (resolution of  $0.19 \text{ \AA}/\text{pixel}$ ) of the 2m RC telescope at NAO Rozhen (Table 3). The spectral domain covered three regions around  $H_\alpha$ ,  $H_\beta$ , and MgII 4481 lines (Fig. 3). The data reduction of the spectra was made with the standard IRAF procedures. The radial velocities were measured by the cross-correlation technique using synthetic spectrum, calculated with the programme SPECTRUM (Gray & Corbally, 1994) and a grid of LTE atmosphere models for a solar-type chemical composition (Castelli & Kurucz, 2003), as a template spectrum. The physical parameters of the primary component were estimated by comparing the synthetic and the observed spectra. The parameters of the secondary were computed with the PHOEBE software (Prša & Zwitter, 2005). The spectral types of the components were determined using Straižys & Kuriliene (1981) calibration (Table 4).

The new ephemeris were computed using both Rozhen and NSVS data:

$$HJD(\text{MinI}) = 2451274.021(\pm 0.005) + 3.25855(\pm 0.00009)E \quad (1)$$

**Acknowledgements** This study made use of the SIMBAD, ADS, and VSX databases, and GCVS catalogue.

Table 1. Data for the variable, and standard stars used in the CCD photometry

ID	Name	RA (J2000)	DEC (J2000)	$V$	$B - V$	$V - R$
VAR	GSC 4588-0883	19 <sup>h</sup> 27 <sup>m</sup> 53 <sup>s</sup> .70	+77° 17' 41".8	11.32	0.50	0.34
C1	GSC 4588-0579	19 <sup>h</sup> 25 <sup>m</sup> 59 <sup>s</sup> .69	+77° 25' 47".9	11.38	0.46	0.31
C2	GSC 4588-2368	19 <sup>h</sup> 26 <sup>m</sup> 12 <sup>s</sup> .00	+77° 27' 25".9	12.26	1.02	0.97
C3	GSC 4588-0521	19 <sup>h</sup> 28 <sup>m</sup> 07 <sup>s</sup> .31	+77° 20' 51".4	12.35	0.92	0.88
C4	GSC 4588-0164	19 <sup>h</sup> 30 <sup>m</sup> 24 <sup>s</sup> .86	+77° 17' 21".8	12.20	1.01	0.63
C5	GSC 4588-0781	19 <sup>h</sup> 27 <sup>m</sup> 30 <sup>s</sup> .51	+77° 26' 49".5	13.15	0.41	0.31
C6	GSC 4588-1313	19 <sup>h</sup> 26 <sup>m</sup> 32 <sup>s</sup> .13	+77° 25' 42".9	13.02	0.54	0.32

Table 2. Observational runs of GSC 4588-0883

Date	HJD(start)	Length	Filter	Exp. [s]	N	Phase	$A_R \text{max(osc.)}$
02.09.2008	2454712.24749	04 <sup>h</sup> 40 <sup>m</sup>	$R$	120	120	0.14 - 0.20	0.015
03.09.2008	2454713.42091	03 <sup>h</sup> 57 <sup>m</sup>	$R$	120	131	0.50 - 0.55	0.010
04.09.2008	2454714.40448	05 <sup>h</sup> 24 <sup>m</sup>	$R$	120	128	0.80 - 0.87	0.015
05.09.2008	2454715.53156	01 <sup>h</sup> 51 <sup>m</sup>	$R$	120	45	0.15 - 0.17	0.012
08.09.2008	2454718.25881	08 <sup>h</sup> 33 <sup>m</sup>	$R$	120	202	0.98 - 0.09	0.015
03.10.2008	2454743.45837	04 <sup>h</sup> 18 <sup>m</sup>	$BVR$	3×120	38,38,38	0.72 - 0.77	0.012
31.10.2008	2454771.18693	00 <sup>h</sup> 42 <sup>m</sup>	$R$	120	20	0.23 - 0.24	
01.11.2008	2454772.35613	03 <sup>h</sup> 18 <sup>m</sup>	$R$	120	89	0.59 - 0.63	0.015
02.11.2008	2454773.39219	01 <sup>h</sup> 25 <sup>m</sup>	$R$	120	38	0.59 - 0.63	
04.11.2008	2454775.20502	03 <sup>h</sup> 05 <sup>m</sup>	$BVR$	3×120	26,23,23	0.46 - 0.50	< 0.01

Table 3. Rozhen spectra of GSC 4588-0883

Date	HJD(mid)	S/N	Exp. [s]	RV [kms <sup>-1</sup> ]	Region [Å]	Phase
15.10.2008	2454755.4238	36	1800	-64.18±1.39	4400 - 4600	0.390
15.10.2008	2454755.4468	47	1800	-61.35±2.58	4800 - 5000	0.397
15.10.2008	2454755.4696	56	1800	-49.87±2.18	6500 - 6700	0.404
16.10.2008	2454756.2574	44	1800	-17.52±1.50	4400 - 4600	0.646
16.10.2008	2454756.2785	41	1800	-16.71±1.12	4400 - 4600	0.652
16.10.2008	2454756.3016	50	1800	-12.89±3.01	4800 - 5000	0.660
16.10.2008	2454756.3227	54	1800	-12.61±2.03	4800 - 5000	0.666
16.10.2008	2454756.3454	60	1800	-11.10±2.55	6500 - 6700	0.673
16.10.2008	2454756.3665	61	1800	-13.14±2.05	6500 - 6700	0.679

Table 4. Preliminary physical parameters of GSC 4588-0883 binary system

Parameter	Primary star	Secondary star
$T_{\text{eff}}$ [K]	7650	4100
$\log g$	3.9	3.2
Spectral type	A9 IV	K4 III
$M_S/M_P$		0.16
$K_P$ [kms <sup>-1</sup> ]		63.0
$\gamma$ [kms <sup>-1</sup> ]		-42.0
$i$ [deg]		78.5
$v \sin i$ [kms <sup>-1</sup> ]		~ 60

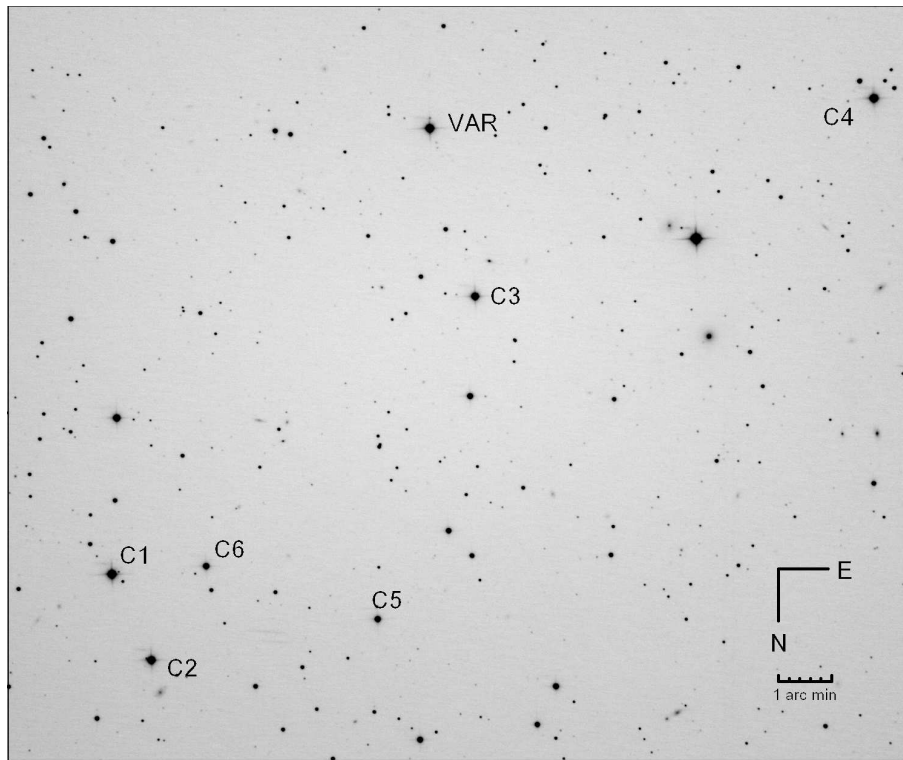


Figure 1. Field of the eclipsing binary GSC 4588-0883.

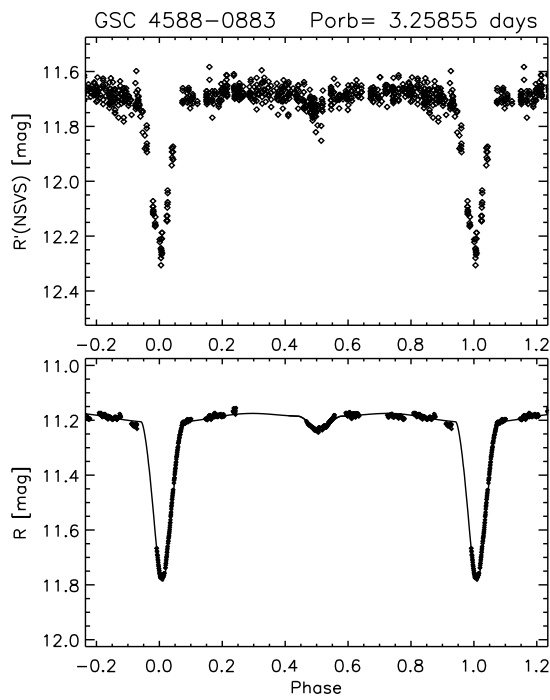


Figure 2. Light curves of GSC 4588-0883. Upper panel - NSVS data, lower panel - Rozhen R data (dots) and model (solid line).

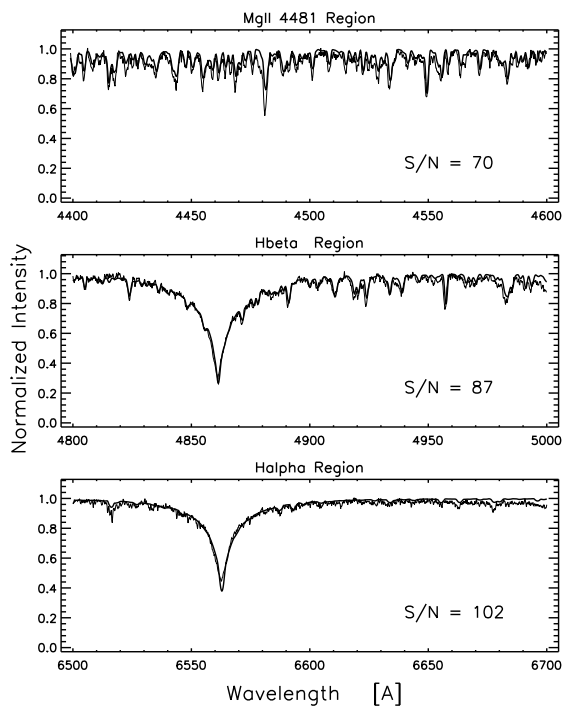
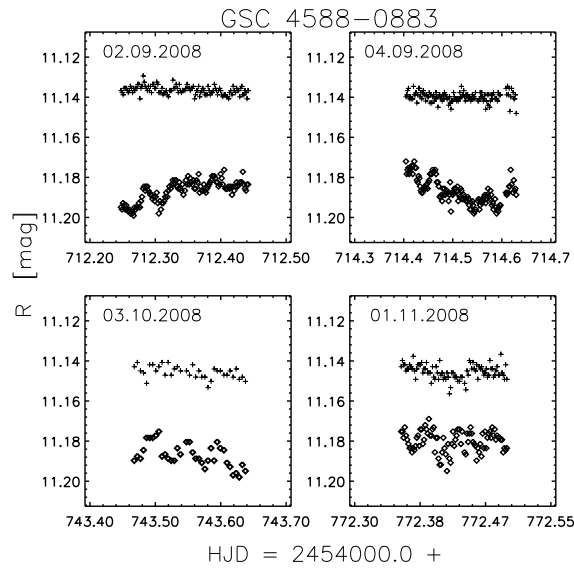
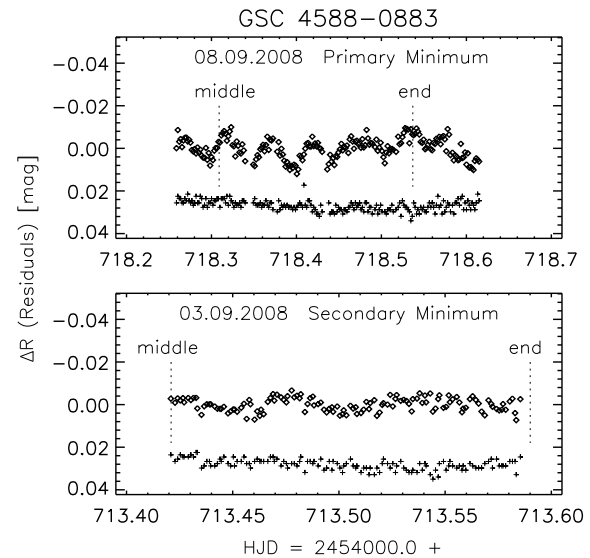


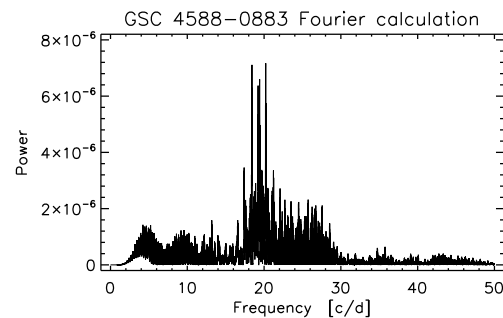
Figure 3. Rozhen combined spectra (thin line) of GSC 4588-0883 and the best synthetic spectra (thick line).



**Figure 4.** R light curves of GSC 4588-0883 (diamonds) and C1 standard star (crosses).



**Figure 5.** Residuals between observations and the model near the primary and secondary minima (diamonds) and shifted C1 standard (crosses). Dashed vertical lines indicate the middle and the end of the eclipses.



**Figure 6.** Power spectrum of GSC 4588-0883 Rozhen data after subtracting the synthetic light curve.

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