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SHORT-PERIOD OSCILLATIONS IN THE ALGOL-TYPE SYSTEMS II: NEWLY DISCOVERED VARIABLE GSC 3889-0202

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GSC 3889-0202 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 $P \simeq 2.71$ days, amplitude of primary minimum $A_R > 0.35$ mag, and the magnitude in maximum $R'\mathrm{max} \simeq 10.6$ mag.

The CCD photometry (in BVR bands) of GSC 3889-0202 was carried out with the 60cm Cassegrain telescope at NAO Rozhen, equipped with the CCD camera FLI PL09000 (3056x3056, 12μ pixel), and Bessell (1990) standard $UBVRI$ filters. The standard IRAF procedures were used for the reduction of the photometric data. There are no suitable standards in the field (Fig. 1) and we apply the photometry method of Everett and Howell (2001). An ensemble standard star (COMP) was created using four stars (Table 1) with $\sigma < 0.013$ mag in all R band observations.

The phased light curves, based on the NSVS data and Rozhen observations, are shown on Fig. 2. The light curves for several nights, acquired in the BVR passbands are shown in Fig. 4 and Fig. 5. Short-period oscillations with a peak-to-peak amplitude of up to 0.045 mag in R (Table 2), 0.05 mag in V, and 0.07 mag in B (also present at the primary and the secondary minima) were detected. A preliminary periodogram analysis (Fig. 6) of the data shows a main periodicity of about 22.69 c/d ($\sim$ 63.47 minutes).

Spectral observations of GSC 3889-0202 were obtained with the Coudé spectrograph (resolution of 0.19 Å/pixel) of the 2m RC telescope at NAO Rozhen (Table 3). The spectral domain covered three regions around H_α, H_β, and MgII 4481 lines (Fig. 3). The data reduction of the spectra was made with the standard IRAF procedures. The corresponding 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 two components were determined using Gray & Corbally (1994) calibration (Table 4). The amplitude of the RV curve was estimated to be $A_{RV} \geq 60$ kms^{-1}, and the γ velocity is -16.2 kms^{-1} (Fig. 2).

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

$$HJD(\mathrm{MinI}) = 2454620.151(\pm 0.004) + 2.71066(\pm 0.00008)E \quad (1)$$

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

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

ID	Name	RA (J2000)	DEC (J2000)	$B_T - V_T$
VAR	GSC 3889-0202	$17^h\ 46^m\ 30.43^s$	$+53^\circ\ 11'\ 57.8''$	0.244
C1	GSC 3902-0709	$17^h\ 46^m\ 50.63^s$	$+53^\circ\ 12'\ 32.8''$	1.158
C2	GSC 3889-0120	$17^h\ 46^m\ 24.77^s$	$+53^\circ\ 12'\ 07.7''$	
C3	GSC 3889-0906	$17^h\ 46^m\ 38.61^s$	$+53^\circ\ 12'\ 27.6''$	
C4	GSC 3889-0216	$17^h\ 46^m\ 28.79^s$	$+53^\circ\ 09'\ 16.5''$	

Table 2. Observational runs of GSC 3889-0202

Date	HJD(start)	Length	Filter	Exp. [s]	N	Phase	$A_R$max(osc.)
05.06.2008	2454623.50080	$01^h\ 44^m$	R	60	83	0.24-0.27	0.02
27.06.2008	2454645.48054	$02^h\ 18^m$	BVR	120,60,30	35	0.35-0.38	-
29.06.2008	2454647.45583	$01^h\ 45^m$	R	60	99	0.08-0.10	0.045
30.06.2008	2454648.47006	$02^h\ 38^m$	R	60	135	0.45-0.49	0.03
01.07.2008	2454649.45747	$01^h\ 45^m$	R	60	98	0.81-0.84	0.02
03.07.2008	2454651.46105	$02^h\ 10^m$	R	60	119	0.55-0.59	0.03
06.07.2008	2454654.40236	$02^h\ 21^m$	R	30	239	0.64-0.67	0.015
17.07.2008	2454665.48791	$01^h\ 33^m$	R	60	79	0.73-0.75	0.015
18.07.2008	2454666.44853	$01^h\ 46^m$	R	60	99	0.08-0.11	0.035
25.07.2008	2454673.32356	$00^h\ 20^m$	R	60	19	0.61-0.62	-
02.08.2008	2454681.40295	$03^h\ 18^m$	BVR	120,60,30	49	0.60-0.65	0.02
03.08.2008	2454682.52403	$00^h\ 54^m$	BVR	120,60,30	14	0.01-0.03	-
04.08.2008	2454683.51846	$01^h\ 19^m$	BVR	120,60,30	19	0.38-0.40	0.03
05.08.2008	2454684.51287	$01^h\ 15^m$	BVR	120,60,30	19	0.75-0.77	0.04
06.08.2008	2454685.26067	$05^h\ 31^m$	R	60	252	0.02-0.11	0.02
07.08.2008	2454686.31423	$05^h\ 42^m$	BVR	120,60,30	89	0.41-0.50	0.025
11.08.2008	2454690.29035	$07^h\ 42^m$	BVR	120,50,20	127	0.88-1.00	0.035
06.09.2008	2454716.28481	$04^h\ 31^m$	BVR	120,60,30	57	0.47-0.54	0.04

Table 3. Rozhen spectra of GSC 3889-0202

Date	HJD(mid)	S/N	Exp. [s]	RV [kms^{-1}]		Region [Å]	Phase
10.06.2008	2454628.5088	39	1800	-40.8	±1.7	4400-4600	0.094
10.06.2008	2454628.4841	51	1800	-35.4	±6.5	4800-5000	0.084
10.06.2008	2454628.4612	63	1800	-36.0	±4.3	6500-6700	0.076
11.06.2008	2454629.4740	38	1800	-32.7	±1.6	4400-4600	0.450
11.06.2008	2454629.4968	52	1800	-25.9	±6.8	4800-5000	0.458
11.06 2008	2454629.5197	63	1800	-24.3	±2.3	6500-6700	0.467
12.06.2008	2454630.5328	35	1800	+17.2	±1.8	4400-4600	0.840
12.06.2008	2454630.5096	48	1800	+22.4	±5.7	4800-5000	0.832
12.06 2008	2454630.4864	58	1800	+24.6	±2.6	6500-6700	0.823

Table 4. Physical parameters of the primary and secondary components of GSC 3889-0202

Parameter		Primary star	Secondary star
T_{eff}	[K]	7750	4500
$\log g$		3.9	3.2
$v \sin i$	[kms^{-1}]	~ 60	
Spectral type		A7 V-IV	K III

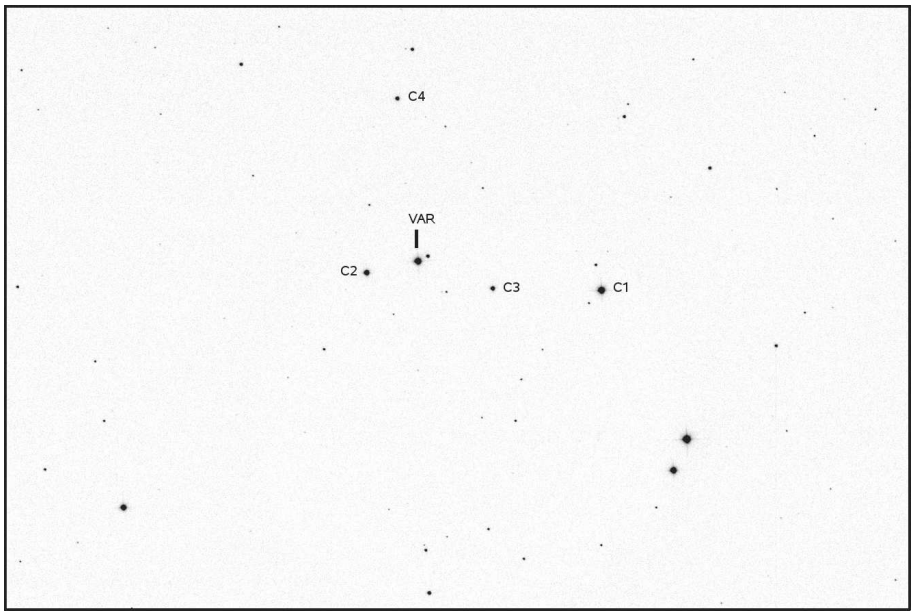

Figure 1. Field of the eclipsing binary GSC 3889-0202 (size $15' \times 10'$). North is down and East is to the right.

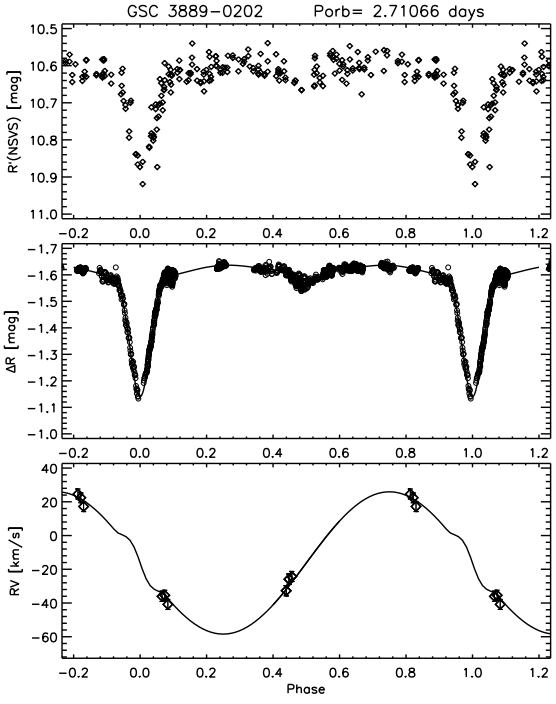

Figure 2. Light and radial velocity curves of GSC 3889-0202. Upper panel - NSVS data, midlie panel - Rozhen R data (dots) and model (solid line), and lower panel - Rozhen RV data (diamonds) and model (solid line).

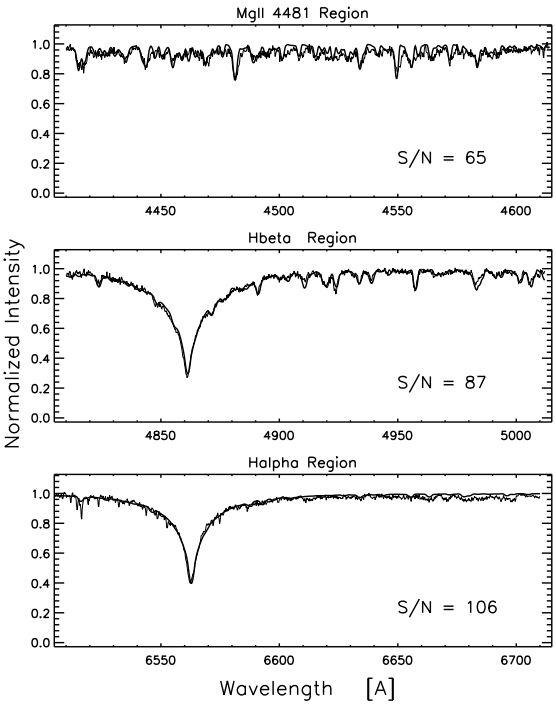

Figure 3. Rozhen combined spectra (thin line) of GSC 3889-0202 and the best synthetic spectra (thick line).

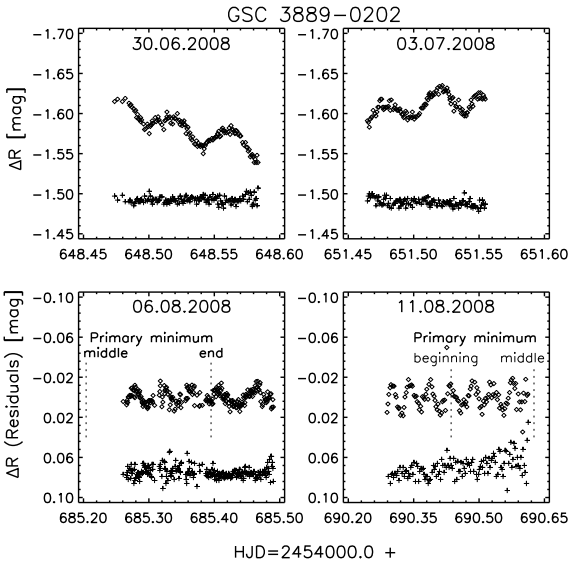

Figure 4. Sample ΔR light curves of GSC 3889-0202 (VAR–COMP, diamonds) and properly shifted C3 star (C3–COMP, crosses). Residuals between observations and the model near the primary minimum are presented on the lower panel. Dashed vertical lines indicate the beginning, middle, and the end of the eclipse.

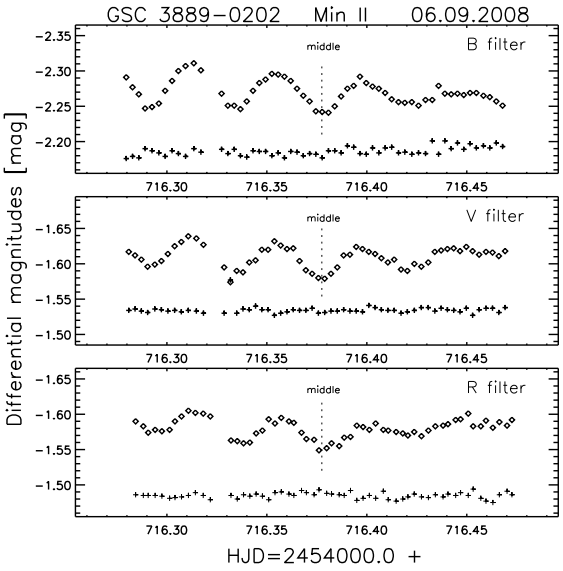

Figure 5. Differential BVR light curves of GSC 3889-0202 (VAR–COMP, diamonds) around secondary minimum and shifted C3 star (C3–COMP, crosses). Dashed vertical lines indicate the middle of the secondary eclipse.

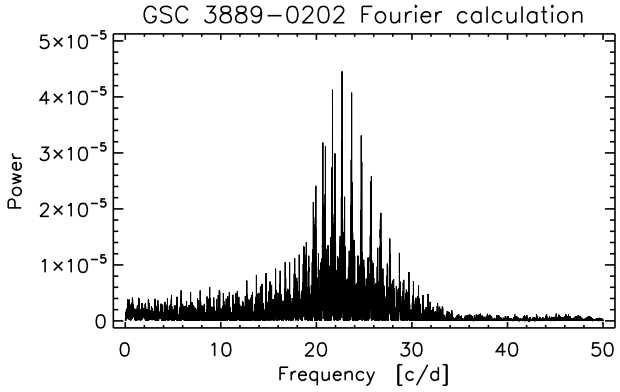

Figure 6. Power spectrum of GSC 3889-0202 Rozhen data after subtracting the synthetic light curve from the data.

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