SHORT-PERIOD OSCILLATIONS IN THE ALGOL-TYPE SYSTEMS IV:
NEWLY DISCOVERED VARIABLE GSC 4293-0432

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A new Algol-type system GSC 4293-0432 was extracted during our data-mining variability search in the NSVS database (Wozniak et al., 2004). The parameters of the system are as follows: period $P \simeq 4.3844$ days, amplitude of the primary minimum $A_R > 0.25$ mag, and magnitude in the maximum $R'_{\max} \simeq 10.72$ mag. $R'_{\max}$ stands for the maximum in the light curve in the instrumental system of NSVS, which is similar, but not identical to the R color (hence, R'). The astrometric and photometric data for the stars (Table 1) are taken from NOMAD catalogue (Zacharias et al., 2004).

The CCD photometry of GSC 4293-0432 in BVR bands was carried out with the 60cm Cassegrain telescope at Rozhen NAO, equipped with the CCD camera FLI PL09000 (3056×3056, 12μ pixel), and Bessell (1990) standard $UBVRI$ filters. The standard IDL procedures were used for the reduction of the photometric data. Five stars from the field (Fig. 1) with $\sigma < 0.005$ mag in V band observations were selected to create an ensemble standard star (Everett & Howell, 2001).

The NSVS and Rozhen light curves of GSC 4293-0432 are shown in Fig. 2. The six V light curves of the star are shown in Fig. 4. During the campaign short-period oscillations (also present at the secondary minimum) with a peak-to-peak amplitude of up to 0.04 mag in B, 0.04 mag in V, and 0.035 mag in R (Table 2) were detected. The frequency analysis of the residual light curve, performed with the `PERIOD-04` software based on the classical Fourier analysis (Lenz & Breger, 2005), revealed multi-periodic pulsation of the primary star. The main peaks in the power spectrum were observed at about 8 c/d and 22 c/d in V band (Fig. 5).

Spectral observations of GSC 4293-0432 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 two regions around H$_\beta$, and MgII 4481 lines (Fig. 3). The data reduction of the spectra was made with standard IRAF procedures. The corresponding radial velocities (Table 3) 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 (Prśa & Zwitter, 2005). The spectral types of the two components were determined using Straižys & Kuriliene (1981) calibration (Table 4).

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

$$HJD\ (\text{MinI}) = 2451271.7302(\pm 0.0013) + 4.38440(\pm 0.00019)E \qquad (1)$$

Table 1. Data for the variable and comparison stars
used in the CCD photometry from NOMAD

ID	Name	RA (J2000)	DEC (J2000)	V	$B-V$	$V-R$	Sp. type
V1	GSC 4293-0432	$23^{\rm h}45^{\rm m}41\overset{\rm s}{.}82$	$+66°05'06\overset{''}{.}5$	10.567	0.334	0.217	A2
C1	GSC 4293-0050	$23^{\rm h}45^{\rm m}46\overset{\rm s}{.}11$	$+65°59'45\overset{''}{.}7$	10.067	0.336	0.217	A0
C2	GSC 4293-0424	$23^{\rm h}46^{\rm m}15\overset{\rm s}{.}22$	$+66°09'30\overset{''}{.}8$	10.442	0.251	0.162	
C3	GSC 4293-0603	$23^{\rm h}45^{\rm m}11\overset{\rm s}{.}23$	$+65°59'00\overset{''}{.}4$	11.798	0.608	0.408	
C4	GSC 4293-0424	$23^{\rm h}46^{\rm m}15\overset{\rm s}{.}22$	$+66°09'30\overset{''}{.}8$	11.862	0.630	0.442	
C5	GSC 4293-0105	$23^{\rm h}46^{\rm m}16\overset{\rm s}{.}47$	$+66°05'27\overset{''}{.}5$	12.148	0.584	0.338	

Table 2. Observational runs of GSC 4293-0432

Date	HJD(start)	Length	Filter	Exp.[s]	N	Phase	$A_{osc}(\text{max})$
06.11.2008	2454777.20962	$07^{\rm h}06^{\rm m}$	V	30	429	0.54-0.60	0.025
12.11.2008	2454783.26564	$07^{\rm h}32^{\rm m}$	V	60	360	0.92-0.99	0.020
13.11.2008	2454784.32173	$05^{\rm h}42^{\rm m}$	V	60	300	0.16-0.21	0.040
01.12.2008	2454802.21245	$07^{\rm h}23^{\rm m}$	BVR	120,60,30	100	0.24-0.31	0.04,0.03,0.025
05.12.2008	2454806.29740	$04^{\rm h}19^{\rm m}$	BVR	120,60,60	50	0.17-0.21	0.03,0.03,0.035
07.12.2008	2454808.43581	$01^{\rm h}30^{\rm m}$	BVR	120,60,60	20	0.66-0.67	$\sim$0.02
09.12.2008	2454810.27001	$05^{\rm h}34^{\rm m}$	BVR	120,60,60	70	0.08-0.13	0.035,0.035,0.03

Table 3. Rozhen spectra of GSC 4293-0432

Date	HJD(mid)	S/N	Exp. [s]	RV [kms^{-1}]		Region [Å]	Phase
08.05.2009	2454960.55950	56	1800	-18.0	± 1.4	4400-4600	0.353
08.05.2009	2454960.58215	77	1800	-11.9	± 1.4	4800-4965	0.358
10.05.2009	2454962.56910	58	1200	18.9	± 1.5	4800-4965	0.812
10.05.2009	2454962.58534	61	1200	18.8	± 1.4	4400-4600	0.815

Table 4. Preliminary physical parameters of the GSC 4293-0432 components

Parameter		Primary star	Secondary star
$T_{\rm eff}$	[K]	7750	4300
$v\sin i$	[kms^{-1}]	40	
Spectral type		A7	K3

References:

Bessell, M., S., 1990, *PASP*, **102**, 1181
Castelli, F., Kurucz, R., 2003, *IAU Symp.*, **210**, 20
Everett, M., Howell, S., 2001, *PASP*, **113**, 1428
Gray, R., Corbally, C., 1994, *AJ*, **107**, 742
Lenz, P., Breger, M., 2005, *CoAst*, **146**, 53
Prśa, A., Zwitter, T., 2005, *ApJ*, **628**, 426
Straižys, V., Kuriliene, G., 1981, *ApSS*, **80**, 353
Wozniak, P., Vestrand, W., Akerlof, C. et al., 2004, *AJ*, **127**, 2436
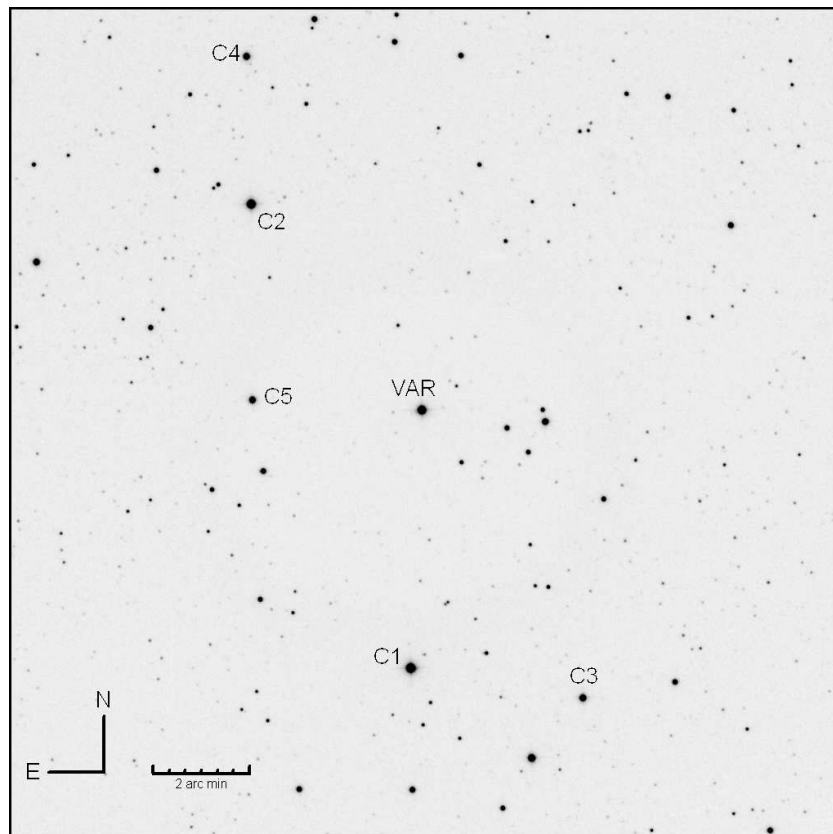Zacharias, N., Monet, D., Levine, S. et al., 2004, *AAS*, **205**, 4815

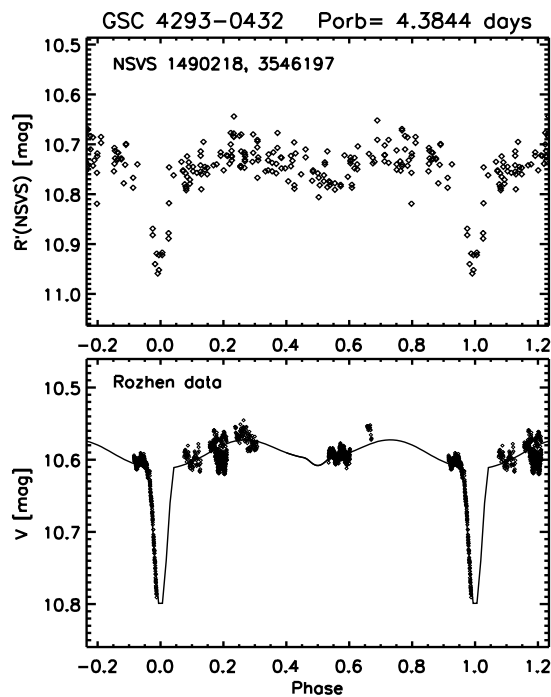**Figure 1.** Field of the eclipsing binary GSC 4293-0432.

Figure 2. Light curves of GSC 4293-0432. Upper panel - NSVS data, lower panel - Rozhen *V* data (dots) and model (solid line).
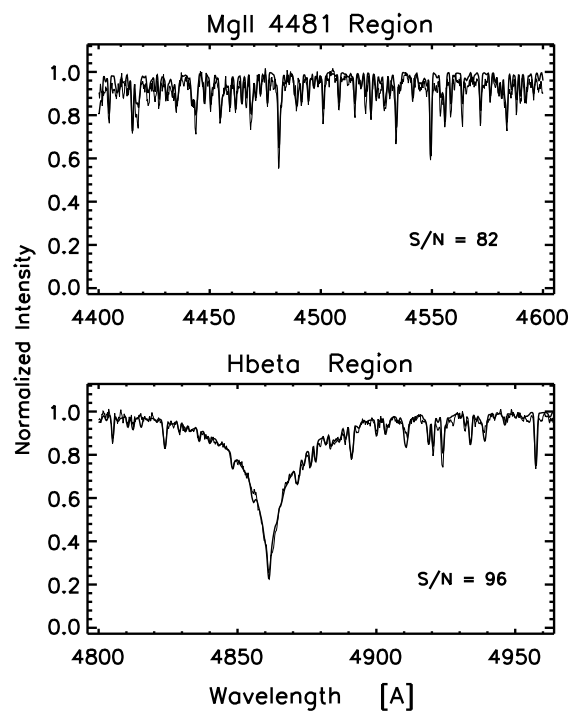

Figure 3. Rozhen combined spectra (thin line) of GSC 4293-0432 and the best synthetic spectra (thick line).
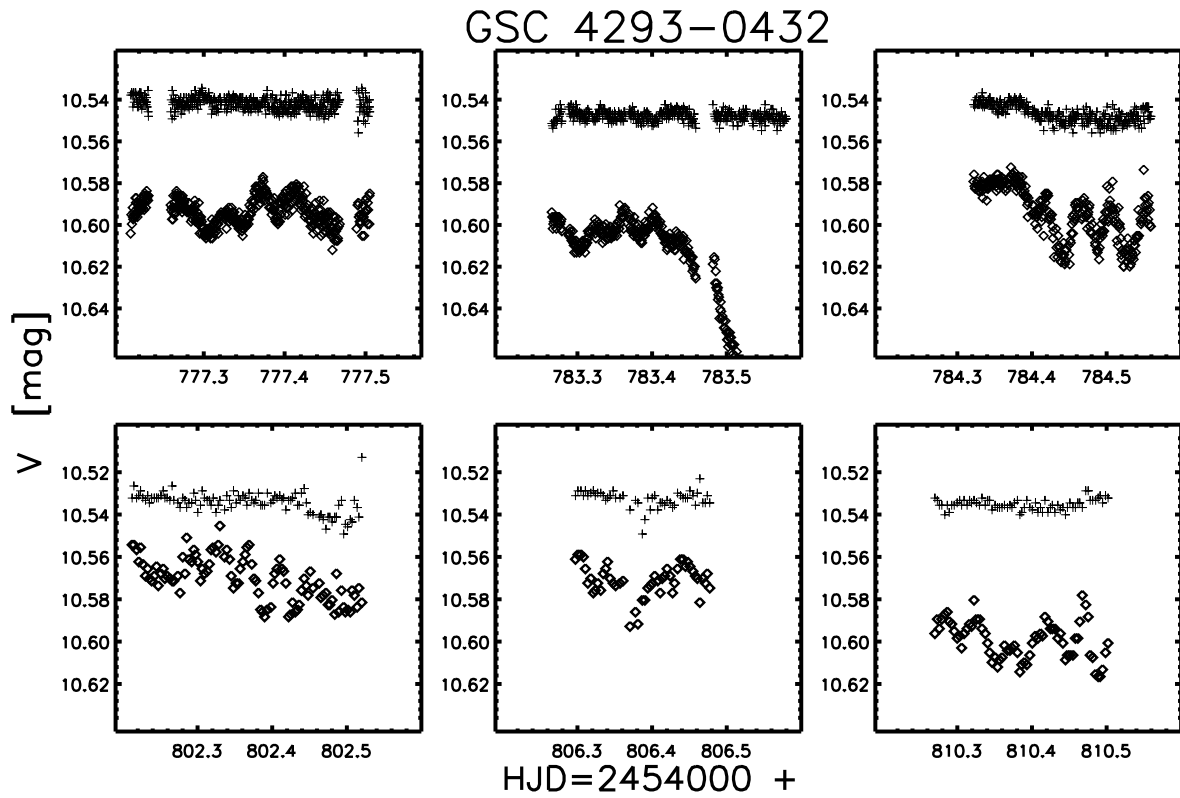
GSC 4293−0432

Figure 4. Sample *V* light curves of GSC 4293-0432 (diamonds), and shifted comparison star C2 (crosses).
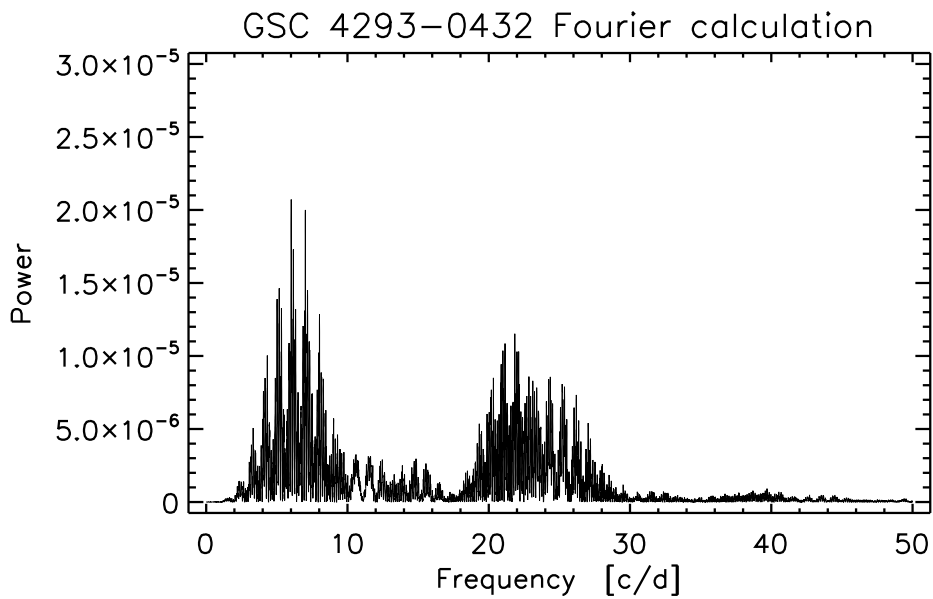

Figure 5. Power spectrum of GSC 4293-0432 Rozhen data after subtracting the synthetic light curve from the data.