

# CCD VRI photometry of the old open cluster NGC 7142

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Photometry of 2194 stars in the field of the open cluster NGC 7142 in VRI filters was performed to search variable stars. Eleven probable variable stars were found using robust median statistics. We separated probable cluster members using proper motions from UCAC3 and our photometric diagrams. Also we used our VRI photometry and JHK photometry from 2MASS to improve the age and the reddening for the cluster assuming the distance 1683 pc from WEBDA database.

**Key words:** open clusters and associations: general, stars: variables: general, techniques: photometric

## INTRODUCTION

The old open cluster NGC 7142 (ra =  $21^h45^m09^s$ , dec =  $+65^\circ46'30''$  (2000),  $l = 105^\circ.347$ ,  $b = 9^{circ}.485$ ) is located in Cepheus, a star-rich region of the Milky Way. Few arcminutes aside one can find young open cluster NGC 7129 surrounded by a reflecting nebula as a background, which partially obscures some regions in NGC 7142, therefore absorption in the field is irregular. Trumpler [12] defined the cluster as II 1m. Subsequent work on the cluster was reported by Hoag [5] (first color-magnitude diagram (CMD) of the cluster), by Sharov [10] (interstellar absorption, star counts) and by van den Bergh [14], who paid attention to the similarities of the CMD of NGC 7142 to those of the old open clusters NGC 188 and M 67. Later van den Bergh & Heeringa [15] estimated the distance modulus as  $(m - M)_0 = 12.5$  and the age as lying between M 67 and NGC 188 ages. Crinklaw & Talbert [2] performed the first CCD photometry and derived new distance of  $(m - M)_0 = 11.4 \pm 0.9$  for the cluster, also they found one variable star (V375 Cep) and proposed that stars of WUMa type could be found in the cluster. Rose & Hintz [8] performed a search for low amplitude short-period variables up to  $15^m$  in a core region of NGC 7142. This paper presents the new CCD VRI photometry of the cluster.

## OBSERVATIONS AND DATA REDUCTION

All observations were performed between February 2 and March 21, 2010 at Kourovskaya Astronomical Observatory with Hamilton system telescope

MASTER II of MASTER Robotic Net [6]. The telescope has two identical tubes with focal length = 1000 mm, aperture = 400 mm, field of view  $2^\circ \times 2^\circ$ , CCD ALTA U16M cameras,  $4096 \times 4096$  px, and scale:  $1.8''/\text{px}$ . Number of frames and exposure time are presented in Table 1.

Astrometrical cross matching and aperture photometry of more than 500 frames were processed with IRAF software package [11]. For the following reduction and differential photometry of 2194 stars in the field of NGC 7142 covering  $30' \times 30'$  a special console program in C++ language was written. The program executes algorithms described by Everett & Howell [3]. Our photometrical errors for stars of  $11^m - 15^m$  are less than  $0.05^m$  in all bands. We transformed our instrumental magnitudes to the Johnson-Cousins VRI system using CCD photometry of our field from [2, 4, 7]. Our instrumental magnitudes system has a negligible dependence on magnitude (slope =  $-0.00013 \pm 0.00012$ ). The rms deviation from standard system is  $\pm 0.035^m$ .

Table 1: Observations

band	nuber of frames	exposure time, s
V	483	120
R	115	60
I	664	180

## CCD VRI PHOTOMETRY

JHK photometry from 2MASS Point Source Catalogue was used to estimate reddening and eliminate cluster members using CMD and Q-index diagram. For the last one the sequence of non-reddened stars

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Table 2: Variable stars.

ID	ra	dec	Type	max	min	System	Period, days	Sp
958	21 44 54.74	+65 43 55.3	EA	16.13,15.50	16.53,15.90	V, I	0.9720	K0
995	21 46 03.07	+65 43 59.7	SR:	13.55,12.30,11.06	13.61,12.36,11.10	V, R, I	14:	
1043	21 44 13.20	+65 45 01.3	EB/EW	15.75,15.15,15.05	16.20,15.60,15.50	V, R, I	0.4413	G3
1153	21 44 55.97	+65 45 49.9	SR:	15.51,14.33,13.75	15.71,14.53,13.86	V, R, I	>20	
1233	21 44 28.43	+65 46 36.5	EB/EW	17.75,16.70	18.75,17.70	V, I	0.3303	
1400	21 43 47.85	+65 48 22.5	SR:	13.43,12.16,11.14	13.47,12.19,11.17	V, R, I	20:	
1459	21 44 29.61	+65 48 43.8	EA	14.70,14.73	15.15,15.10	R, I	-	F5
1523	21 45 15.15	+65 49 24.2	RR:	15.27,14.77,14.83	15.37,14.87,14.95	V, R, I	0.2900	F0
1561	21 46 08.90	+65 49 31.8	SR:	13.30,12.09,11.30	13.35,12.13,11.33	V, R, I	13:	
1865	21 43 52.83	+65 54 27.7	SR:	14.23,12.80,11.68	14.35,12.90,11.73	V, R, I	20:	
1880	21 45 10.69	+65 54 22.6	SR:	13.09,11.78,10.81	13.14,11.83,10.84	V, R, I	>20	

## CONCLUSIONS

We performed VRI photometry of 2194 stars in the field of the open cluster NGC 7142. According to its CMD and color-color diagrams we determined the log age of 9.55 and reddening  $E(J-H) = 0.13 \pm 0.05$ . These results are in good agreement with the previous estimations. 11 variables were studied, 10 among them were detected for the first time, 4 variables appeared to be probable cluster members.

NGC 7142 obviously contains blue straggler stars (BSs). Our next task is to investigate high-resolution spectra of brightest BSs of the cluster. For our variable stars we intend to solve lightcurves of the eclipsing binaries we found and probably to search for low-amplitude variables with periodogram analysis.

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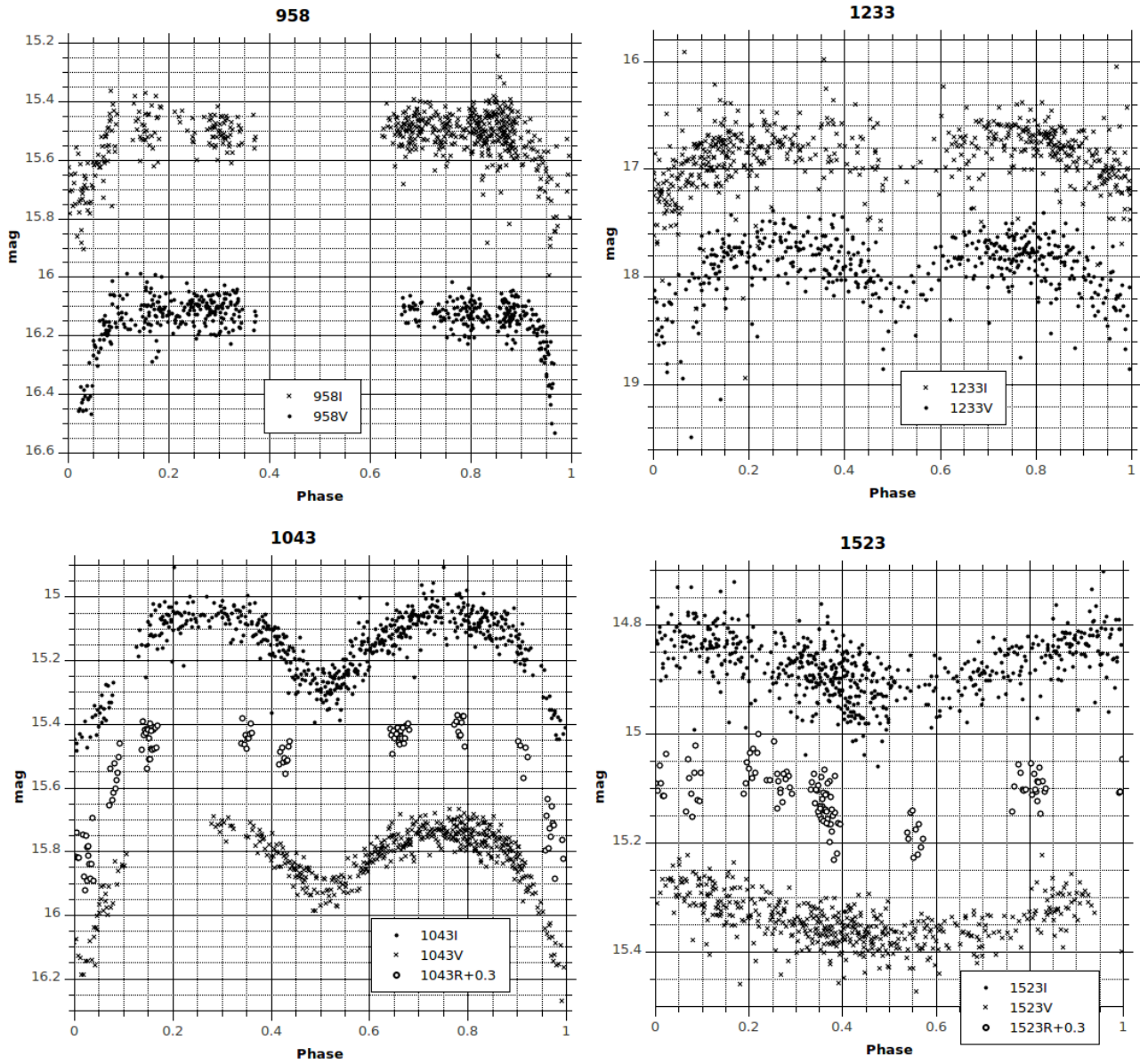


Fig. 3: Lightcurves of the short-period variable stars which periods were determined precisely.