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CCD BVRI photometry of the open clusters NGC 7142 and NGC 2281

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Abstract. Photometry of stars up to 17 mag in the field of the open clusters NGC 7142 and NGC 2281 in BVRI filters was performed to search for new short-term variable stars. Seventeen variable stars were found using robust median statistics and 18 were suspected to be variable. We separated probable cluster members using proper motions from UCAC3 and our photometric diagrams. Also we used our BVRI photometry and JHK photometry from 2MASS to improve age and reddening for the clusters.

Key words. open clusters and associations: general – stars: variables: general – techniques: photometric

1. Introduction

Photometric observations were performed in February and March 2010, in October 2011, in January and April 2012 at Kourovskaya astronomical observatory (57° N, 60° E) with Hamilton catadioptric telescope of MASTER Robotic Net (Lipunov et al. 2010). The observations were performed simultaneously in two filters (Johnson-Cousins BVRI system). Flat fields for each used filter were obtained from morning twilight sky automatically after every observational night. Dark frames were obtained automatically in the evening before starting the observing run.

Base data reduction (dark substraction and flat fielding), astrometrical cross matching and aperture photometry of all frames were processed with IRAF package (Tody 1993). For the following reduction and differential photometry of stars in the fields of NGC 7142 and NGC 2281 a console program Astrokit using C++ has been written. The program executes algorithms of correction of brightness variations associated with the variability of the atmospheric transparency, described by Everett & Howell (2001) and differential photometry for every star (using local ensemble of stars). Our photometrical errors for stars of 11—15 mag are less than 0.05 mag in all bands. We transformed our instrumental magnitudes to the Johnson-Cousins BVRI system using CCD photometry of our fields from Crinclaw & Talbert (1991); Magakian et al. (2004); Hartigan & Lada (1985); Droege et al. (2007); Mermilliod et al. (1997); Bucciarelli et al. (2001). Our instrumental magnitudes system has a negligible dependence on magnitude.

2. Search for variable stars

Our long- and short-term time series photometry was used for search for variable stars in the cluster fields. The search was first performed automatically with Astrokit which realize robust median statistics (RoMS), described by Rose & Hintz (2007). RoMS criterion estimates the brightness variations of the object. The use of robust median statistics is explained due to it's greater resistance to random fluctuations unlike of standard deviation (see fig. 1). However, this does not give an absolute assurance of the absence of false variables. A lot of the stars suspected to be variable turned out to be constant within the accuracy of our photometry.

Differential photometry was proceed for every star. Using a close ensemble of many (5—20) stars reduces the influence of variations of atmospheric transparency and the contribution of stellar scintillation in the budget of error values.

The periods were determined using the WinEfK software package developed by Dr. V. P. Goranskij for Windows environment using Lafler-Kinman method. All the spectral types were roughly determined from Q-index diagram which was plotted using JHK photometry from 2MASS.

We determined morphological light curves types using light curve shape, period, amplitude, spectral type according to classification in the 4th edition of GCVS (Samus et al. 2009).

As a result, 40 variable objects were found, 18 of them are new variable stars, seven previously known variables and 15 were suspected to be variable.We classified light curves of 13 stars: four as EA, seven as EB/EW and two as DSCT type.

3. CCD BVRI photometry of the cluster

JHK photometry from 2MASS Point Source Catalogue was used to estimate reddening and eliminate cluster members using CMD and Q-index diagram. For the latter the sequence of non-reddened stars was calculated from the data from the table 1 in Turner (2011). We also used stars' proper motions from UCAC3 to exclude foreground stars. The most part of stars in the core region of NGC 7142 has $\mu_\alpha = (-3 \pm 6)\ mas/yr$, $\mu_\delta = (1 \pm 6)\ mas/yr$, NGC 2281 — $\mu_\alpha = (-4 \pm 6)\ mas/yr$, $\mu_\delta = (-7 \pm 6)\ mas/yr$. Stars of core region (diameter=10') inside 3σ interval of the proper motions having the identical reddening were determined as probable cluster members.

Distance modulus and age estimation were performed using theoretical isochrones from Bertelli et al. (1994). We made no attempts to estimate distance modulus of NGC 7142 due to short portion of cluster main sequence we had in our disposition.

Our estimations of age, distance modulus and reddening appeared to be in good agreement with previous ones.

The study of the cluster NGC 7142 is presented in Punanova et al. (2011, 2012).

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