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Variable Stars in the Young Open Cluster NGC 663

by

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ABSTRACT

The discovery of two variable stars in the field of young open cluster NGC 663 is reported. Both stars are most probably eclipsing systems with relatively short periods.

Key words: *binaries: eclipsing – open clusters and associations: individual: NGC 663*

1. Introduction

The young open cluster NGC 663 ($\alpha = 01^{\rm h}43\overset{\rm m}{.}6$, $\delta = +61°01'$, 1960.0) is placed in the center of the association Cas OB8. The lack of field stars and CO observations (Leisawitz 1988) suggest that this cluster is in front of a molecular cloud (Phelps and Janes 1994).

NGC 663 has been the subject of numerous studies in the past. Tapia *et al.* (1991), from near-infrared *JHK*, Strömgren *uvby* and H_β photometry, determined a distance of 2.5 kpc, an age of 9 Myr, and the ratio of total to selective absorption towards NGC 663 of 2.73. Recently Phelps and Janes (1994) observed this cluster in *UBV* system, for the first time with CCD technique. They found a color excess in the range of $0.7 < E(B-V) < 1.0$ with strong maximum at 0.80. The procedure of fitting the theoretical isochrones to the observed color-magnitude diagram gives a distance of 2.8 kpc and an age between 12 and 25 Myr. The radial velocities for stars from the cluster field were determined by Liu *et al.* (1991). NGC 663 contains 24 H_α-emission-line stars (Sanduleak 1990). None of them are known to be variable.

In Kubiak and Pietrzyński (1995) and in Pietrzyński (1996) the first results of our program of searching for variable stars in the young open clusters were presented. In the present note the discovery of two variable stars in the field of NGC 663, another cluster included to our program is reported.

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2. Observations

All the observations were carried out with 0.6 m Zeiss reflector in the Ostrowik observing station of the Warsaw University Observatory. The detector was a Tektronix TK512CB backside illuminated thin CCD chip. The size of the chip is 512×512 pixels. The total field of view was 6.5×6.5 arcmin with a scale of $0\farcs74$/pixel. The description of the camera and of the acquisition system is given in Udalski and Pych (1992).

The present observations were collected on 6 nights. All observations were made through filter I with exposure times 10, 20, 500 and 600 s. Some of the observations were done through thin clouds. Flat-field exposures ranging from 2 to 12 s in I filter were made on twilight sky.

Preliminary processing of the raw CCD data (debiasing, dark signal subtraction, flat-fielding) was done with the IRAF package.[1] The profile photometry was derived using DAOphot II. Formal errors returned by DAOphot are smaller than 0.06 mag for stars brighter than 16 mag in V.

The map of the observed part of the NGC 663, generated from an I frame taken with 600 s exposure time is shown in Fig. 1.

As reference list served the list of 398 stars with I magnitude determined from the best frame. The faintest stars from our list have brightness of about 18 mag in V. Relative magnitudes of all stars from the observed field were obtained as differences star *minus* comparison. Photometric accuracy of the comparison star was in the range from about 0.005 mag for good nights and 0.008 mag for bad nights.

All light curves obtained in the present observations were visually examined and for suspected variables the power spectra (The CLEAN algorithm, Roberts, Lehár and Dreher 1987) and/or periodograms based on the method described in Schwarzenberg-Czerny (1989) were obtained. The present data allowed to find two variable stars presented in the next section. Their locations in the cluster are marked by arrows in Fig. 1.

3. Variables

Fig. 2 shows the light curve of variable designated tentatively as v1. Both kinds of minima are clearly visible. The depths of primary and secondary minima are 0.14 and 0.11 mag respectively. Relatively big scatter observed on the light curve is due to observational errors. The observed times of primary minimum are HJD 2450199.320, 171.415, 174.430. The secondary minimum occurred at HJD 2450179.545.

[1] IRAF is distributed by National Optical Astronomy Observatories, which is operated by the Association of Universities for Research in Astronomy, Inc., under cooperative agreement with National Science Foundation.

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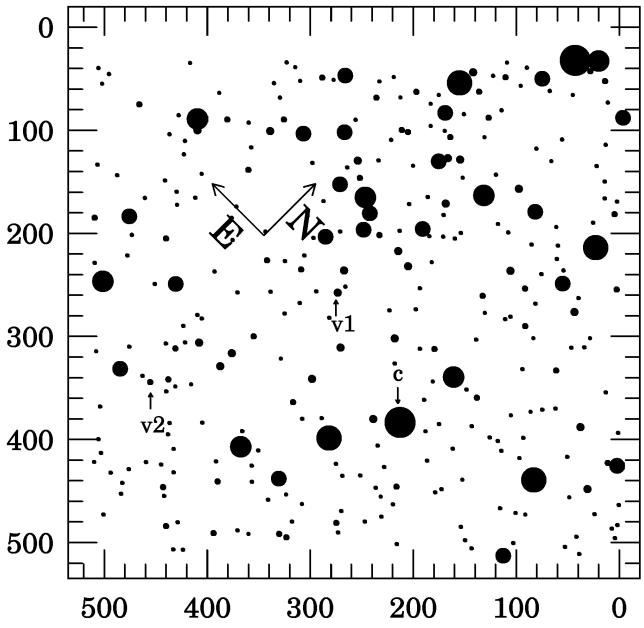

Fig. 1. Map of NGC 663, based on a I frame taken with 600 s exposure. One pixel corresponds to $0.''74$. v1 and v2 mark the discovered variable, c is a comparison star.

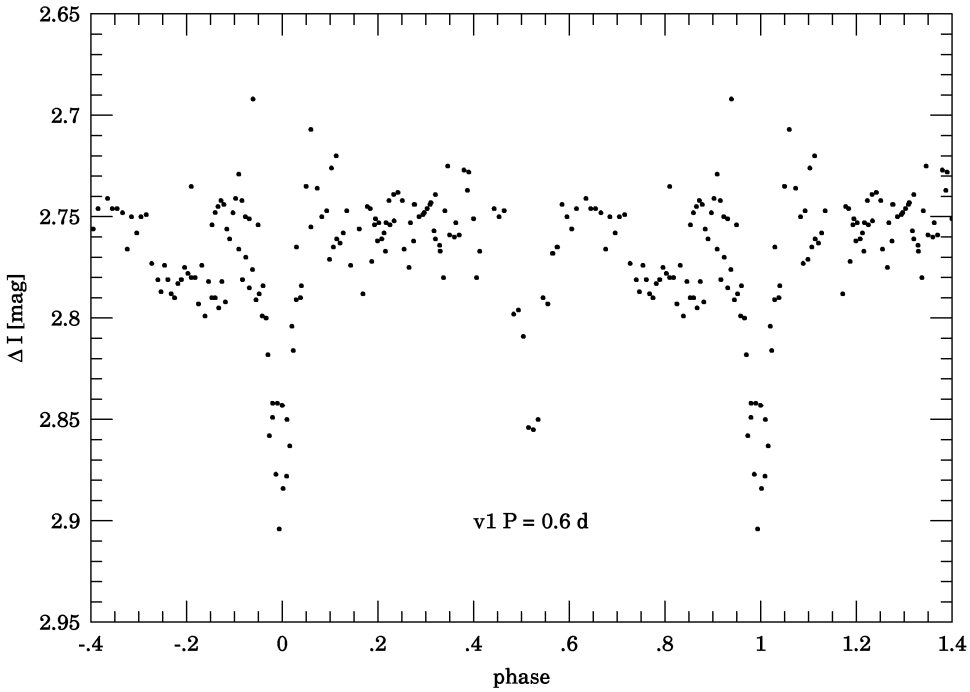

Fig. 2. Light curve of v1. ΔI is a difference variable minus comparison.

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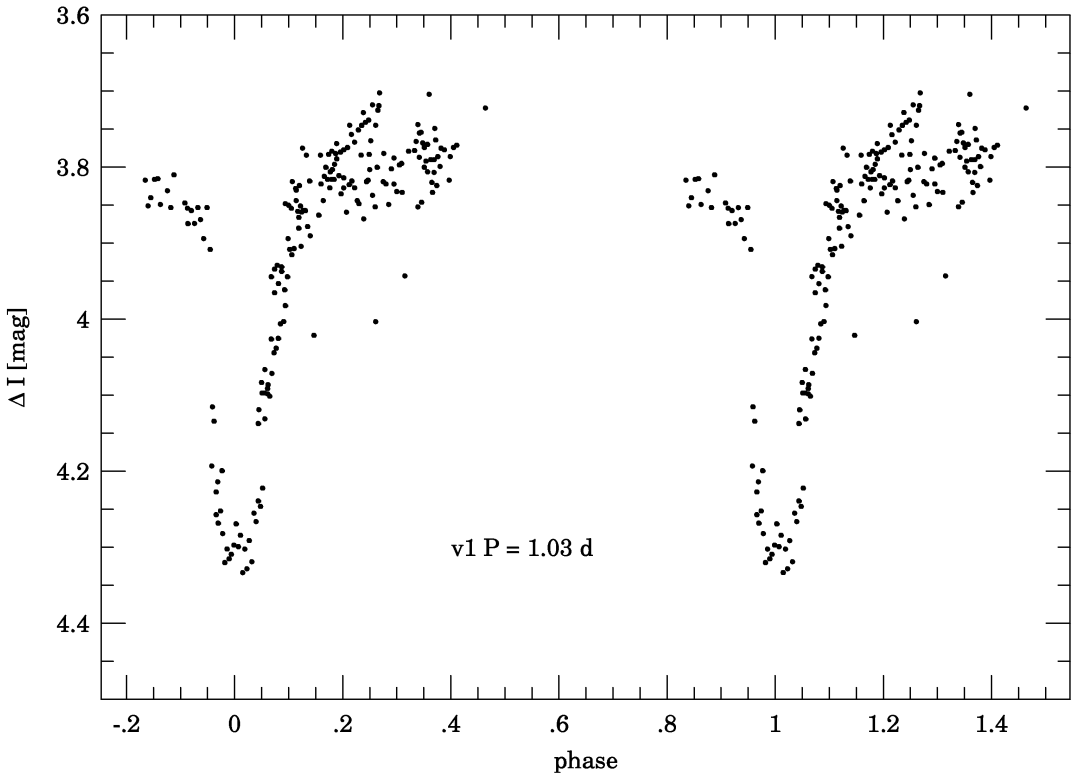

Fig. 3. Light curve of the variable v2. ΔI stands for the difference variable minus comparison.

The observations of variable v2 folded with the most probable period $P = 1\overset{\mathrm{d}}{.}03$ are presented in Fig. 3. The lack of observations at the expected secondary minimum does not allow to exclude period two times shorter. The asymmetry of observed minimum is visible in Fig. 3. More data are needed to say something definitive about this star.

Observations of the cluster are continued.

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