Variability survey in the young open cluster IC 1805

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We present preliminary results of the photometric variability survey in the very young open cluster IC 1805. We found more than 70 variable stars in the field, including pulsating stars and a large sample of most likely pre-main sequence stars.

1 Introduction

The variability survey in the young open cluster IC 1805 is a part of the ongoing program of searching for early-type variable stars in open clusters of the northern sky conducted in Wrocław (see Jerzykiewicz et al. 2011 and references therein). We are particularly interested in pulsating stars such as β Cephei and SPB. These stars are very promising targets for asteroseismology. In particular, open clusters rich in these variables can be used for so called ensemble asteroseismology (Saesen et al. 2010).

The open cluster IC 1805 is located in the Perseus spiral arm of our Galaxy in the centre of Cas OB6 association and the molecular cloud W4. The surrounding nebula, named also IC 1805, has a nickname Heart Nebula (Fig. 1). The cluster is very young; its age is estimated for only several Myr and distance, for about 2–2.4 kpc (Ishida 1968; Joshi & Sagar 1983; Guetter & Vrba 1989; Massey, Johnson & DeGioia-Eastwood 1995; Sung & Lee 1995). It is also heavily reddened and the reddening is not uniform across the cluster. There was no thorough variability survey in the cluster up to date. The NSV catalog (Samus et al. 2010) lists only eight suspected variables falling into the field of view of our observations.

2 Observations and reductions

All observations were carried out in Białków Observatory (University of Wrocław) between 2007 and 2010. We used a 60-cm Cassegrain telescope equipped with the Andor Tech. DW 432-BV CCD camera covering a 13′ × 12′ field of view. We have acquired almost ten thousands CCD frames during 44 observing nights. They were taken through three filters, B, V and I_C. The exposure times ranged from 10 to 100 s. The observed field of IC 1805 is shown in Fig. 1.

The observations were calibrated in a standard way which included bias and dark subtraction and correction for inhomogeneous sensitivity using flat-field frames. The aperture and profile magnitudes calculated by means of the DAOPHOT II package (Stetson 1987) were used to derive differential magnitudes that were subsequently used in the variability search.

The instrumental BV I_C photometry for all 1511 detected stars was transformed to the standard system using photometry published by Sung & Lee (1995). The resulting colour-magnitude diagram is shown in Fig. 2. As can be seen, the main sequence of the cluster is slightly smeared due to variable reddening.

Fig. 1 DSS image of the Heart Nebula IC 1805 and its central open cluster. The observed field is marked by the cyan square.
3 Analysis and results

The search for variable stars was based on the analysis of differential magnitudes by means of a Fourier amplitude spectrum and eye inspection of light curves and calculation of phase diagrams. The search has been done using the most numerous \(I_C\)-filter observations. The periodograms were calculated in the range between 0 and 80 \(d^{-1}\). In the first step, the identification of variable stars was made automatically. The light curves and Fourier spectra of variable candidates were then inspected by eye. In this way, some non-periodic variables were also identified. For multiperiodic stars, we also carried out a prewhitening procedure in order to derive frequencies and amplitudes of all significant signals.

The search resulted in the detection of 71 variables. Only four of them were suspected to be variable before our study, the remaining 67 are new discoveries. We found eight pulsating stars in the observed field: two \(\beta\) Cephei and six \(\delta\) Scuti type stars. The two \(\beta\) Cephei stars and one \(\delta\) Scuti star are likely members of IC 1805. If this is the case, the \(\delta\) Scuti star might be still in the pre-main sequence phase of evolution. The periodogram of one (low-amplitude) \(\beta\) Cephei star is shown in Fig. 3. In addition, we found 8 stars showing variability caused by eclipses or ellipsoidal effects, 24 irregular and 31 monoperiodic variables. The monoperiodic variables occupy mostly the region where pre-main sequence members of IC 1805 are expected (Fig. 2). Their variability is probably related to rotation. The light curves of some of the irregular variables resemble those of UX Orionis stars in which the variability is attributed to the changes in the circumstellar environment. An example light curve for one of IC 1805 stars is shown in Fig. 4.

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