

The Ongoing Search for Variables in Young Clusters: Up-to-Date Results and Perspectives

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Abstract. The goals, results and perspectives of the ongoing search for variables in open clusters and associations of the northern hemisphere, carried out at the Białków Observatory of the Wrocław University, are presented.

Since 1994 we have observed seven open clusters and one OB association and have discovered about 130 variables. The observations were carried out with a 60-cm Cassegrain telescope equipped with a $6' \times 4'$ field-of-view CCD camera, an autoguider, and two sets of filters: $BV(RI)_C$ and $H\alpha$. A typical run consisted of about 20 observing nights and, depending on the cluster, covered one or several fields.

1. The goals

The main goals of our search were the following: (1) To map the observational instability regions of the β Cephei, SPB and other pulsators of the upper part of the H-R diagram and to find the incidence of variability within them. (2) To find the characteristics of variable stars in young clusters at different evolutionary stages, including the pre-main sequence stage. (3) To select variables suitable for asteroseismology and/or distance determination. (4) To find the Be star content in clusters and OB associations. (5) To derive the cluster parameters such as distance, age, and reddening. (6) To derive reddening maps (in cases of substantial differential reddening).

2. Results

The most interesting results we obtained during the search can be summarized as follows:

- Observations of two young objects, the Cygnus OB2 association (Pigulski & Kołaczkowski 1998) and the open cluster NGC 6823 (Pigulski et al. 2000), show that, in comparison with the predictions of the linear pulsation theory, there is a deficiency of β Cephei-type pulsators among stars earlier than B0.
- Although ten β Cephei stars were observed in the clusters we monitored, it seems that they constitute only a small fraction of B-type stars falling into

the instability strip. The fraction is much larger in some southern clusters and could be the consequence of metallicity differences among clusters.

- Only 1–2% of all mid and late B-type stars show variability of the SPB type. All the stars we discovered of this type appear to be monoprotic. It seems, therefore, that multiproticity is not a common feature of these stars as was initially thought.
- Two pre-main sequence δ Scuti stars were found in NGC 6823. Both are biprotic and can be used to test the evolutionary period changes predicted by the theory.
- About 30 Be stars in six clusters and the Cygnus OB2 association were discovered by means of our H α photometry. In this context, the most interesting is finding that NGC 7419 contains at least 31 Be stars, that is, about 36% of all early B-type stars in the cluster (Pigulski & Kopacki 2000). Apart from NGC 663, this is the only known cluster in the Galaxy with such a large fraction of Be stars. About 80% of all Be stars show some kind of photometric variability with ranges up to 0.5 mag in the I_C filter.
- We discovered about ten eclipsing binaries that have components of O or B spectral type. Some are bright enough to be studied spectroscopically with a large telescope. This would yield cluster distances.

3. Perspectives

There are at least 200 open clusters in the Northern hemisphere young enough to contain B-type pulsators. In addition, 29 OB associations are known in this part of the sky. All are potential targets for our investigation. The considered area ($30^\circ < l < 210^\circ$, $-10^\circ < b < 10^\circ$) covers about 3500 square degrees.

The most serious limitation of our search is the small field of view of our camera and the fact that only 15–20% of the nights are clear at our site. This enables us to acquire observations for at most two open clusters per year. The improvements we plan are the following:

1. To install a CCD camera with a larger field of view. At present, the camera's field-of-view covers only about 8% of the telescope's field-of-view. Attaching a new camera would increase the observed area several times. Still, some interesting objects (especially OB associations) will not be covered because of their large angular extent.
2. Since the regions around the galactic plane are heavily crowded and reddened, all-sky automated surveys similar to ASAS (Pojmański 1997) would reach only relatively near early B-type stars. In order to also observe these types of stars at larger distances, we plan to set up an inexpensive robotic telescope (or telescopes) at a good site, equipped with a large-format CCD camera and the optics with a spatial resolution on the order of 1" per pixel. Observations would be then restricted to selected areas containing some interesting clusters, OB associations and dense stellar fields in the galactic plane.

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References

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