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Pulsating stars and EBs in clusters: NGC 2506

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Abstract. Studying pulsating stars in clusters offers the advantage that constraints based on cluster membership can be imposed on the stellar models. This is a huge advantage in an asteroseismic analysis. The constraints become even stronger if the cluster contains detached eclipsing binaries (dEBs) for which precise masses and radii can be derived, pinpointing the isochrones. We present new time-series photometry, and VLT spectroscopy, of the open cluster NGC 2506, which contains a population of δ Scuti stars as well as two detached eclipsing binary systems. Three δ Scuti stars were known prior to our observations, but our preliminary data analysis reveals the presence of at least three more such variables. This makes NGC 2506 a key target for asteroseismology of $\sim 2 M_{\odot}$ stars.

Key words. Stars: Pulsating – Stars: Eclipsing Binaries – Stars: Open Clusters

1. The target cluster – NGC 2506

NGC 2506 is a ~2 Gyr old galactic open cluster, situated at a distance of about 2 kpc. This makes it an easy target for CCD photometry as the star field is dense, without being crowded, and the stars are sufficiently bright for spectroscopic observations with a large telescope. It is furthermore located in the sky near the celestial equator, making it observable from both the northern and the southern hemispheres.

Kim et al. (2001) found 3 δ Sct stars (V1–V3) and one dEB (V4) in NGC 2506. Later, we found an additional dEB (V5). As we are interested in combining studies of dEBs and pulsating stars within the same open cluster, NGC 2506 constitutes a very interesting target. We therefore obtained two-site, high-precision time-series photometry followed by spectroscopic observations with the VLT, using UVES and Giraffe/FLAMES.

The photometric observations were obtained at the Danish 1.54-m telescope at ESO, La Silla, during 23 nights in January 2005, and during 20 nights at the Flemish Mercator telescope on La Palma, in January–April 2005. Overlapping data were obtained on some of the January nights. In total, 2300 *BI*-images were obtained at La Silla, and 1100 at La Palma.

On the basis of the results of the January photometry, we applied for and obtained VLT time in service mode; 7 epochs with UVES fibre-spectra of 5 stars, including V4, and Giraffe/FLAMES spectra of 120 stars. The analysis of the spectra is ongoing and will not be discussed here, except from mentioning that

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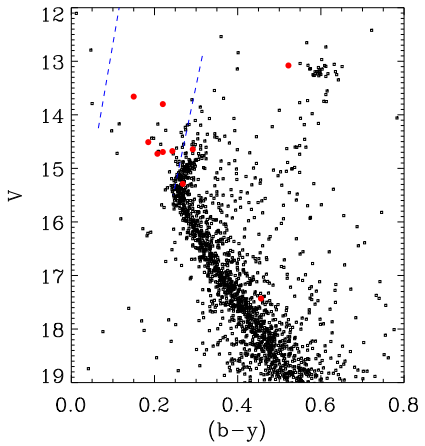

Fig. 1. The CMD: variables (dots) and the δ Sct instability strip (Breger 2000) are shown.

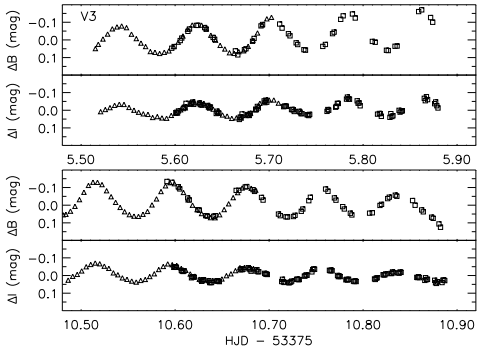

Fig. 2. *B* and *I* light curves of the δ Scuti star V3. Triangles are data from Mercator, squares are from the Danish 1.54-m.

they reveal the presence of at least 3 double-lined binaries (including V4). Four other stars show obvious radial velocity variations, while two stars show possible variations.

The Colour–Magnitude Diagram (CMD) of NGC 2506 is shown in Fig. 1 and light curves of the δ Sct star V3 are shown in Fig. 2. From the photometry we detect a number of new variable stars, of which 3 are δ Scuti stars, positioned in the CMD inside the instability strip. These variables are among the marked stars (dots) in Fig. 1. The data also allowed us, for the first time, to determine the orbital periods of V4 and V5, which were found to be 2.867 and 10.077 days, respectively. In Fig. 3 we show the positions of V4 and V5 in the CMD and discuss the constraints that can be imposed on the isochrones through the dEBs.

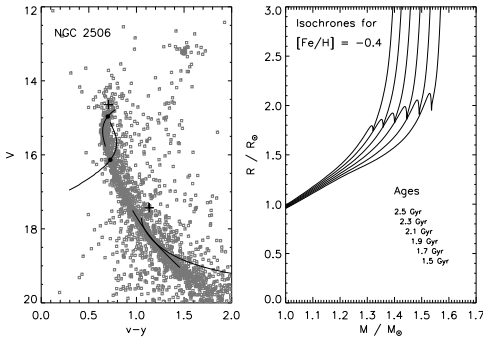

Fig. 3. Left: The Strömgren CMD with the observed locations of V4 and V5 marked as plus signs. The curves show possible locations of the individual component stars of the EBs. The crossings of the curves mark the probable locations of the components, assuming that the binaries are cluster members. Right: mass-radius plot showing isochrones for a metallicity appropriate to NGC 2506 and ages between 1.5–2.5 Gyr. The components of V4 and V5 are expected to span a factor of two in radius and mass, allowing us to tightly constrain the required position of the isochrone in the mass-radius diagram; at the same time this isochrone must also match the observed CMD.

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