

Strömgren photometry and medium-resolution spectroscopy of some δ Scuti and γ Doradus stars in the *Kepler* field

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Abstract. We have obtained CCD photometry and medium-resolution spectroscopy of a number of δ Scuti and γ Doradus stars in the *Kepler* field-of-view as part of the ground-based observational efforts to support the *Kepler* space mission. In this work we present the preliminary results of these observations.

Keywords. stars: variables: δ Sct, stars: variables: γ Dor

1. Introduction

The *Kepler* space mission (Borucki *et al.* 2010) was successfully launched in March 2009 and since then it has been monitoring a huge number of stars in a region of 105 square degrees located between the constellations of Cygnus and Lyra. Although the main scientific goal of the mission is to discover Earth-sized planets, the high precision photometry provided by the *Kepler* satellite gives a unique opportunity to study the pulsational variability of thousands of stars across the H-R diagram in details by means of asteroseismic methods (Aerts *et al.* 2010). As is well known, asteroseismic studies require accurate and precise atmospheric parameters of the stars to produce reliable results. Since the precision of the physical parameters like effective temperature, gravity and metallicity available in the *Kepler Input Catalog* (KIC, Latham *et al.* 2005) is generally too low for asteroseismic modelling, to best exploit the *Kepler* data additional multi-colour and spectroscopic information is needed. In the framework of the *Kepler* Asteroseismic Science Consortium (KASC, <http://astro.phys.au.dk/KASC/>) several ground-based observational efforts have been undertaken to derive physical parameters of the *Kepler* stars with high precision (e.g. Uytterhoeven *et al.* 2011, Molenda-Żakowicz *et al.* 2011). This paper describes our observational efforts at the Observatorio Astronómico Nacional at San Pedro Mártir (OAN-SPM) in Baja California, Mexico to derive the physical parameters of several δ Scuti and γ Doradus stars in the *Kepler* field.

2. Observations, data reduction and conclusion

The CCD observations of 74 δ Scuti and γ Doradus stars in the *Kepler* field have been made with the 0.84-m f/15 Ritchey-Chrétien telescope at OAN-SPM, during six consecutive nights, from 2012 June 21 to June 26. The telescope hosted the filter-wheel ‘Mexman’ with the ESOPO (E2V) CCD camera, which has a 2048×4608 pixel array, with a pixel size of $15 \times 15 \mu\text{m}^2$. The typical field-of-view with this configuration is $8' \times 8'$. The observations were taken with Strömgren *uvby* and $H\beta$ filters to take advantage of the Strömgren-Crawford photometric system in deriving physical parameters of the

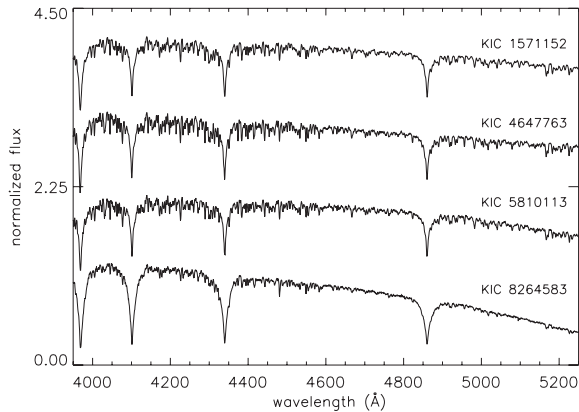


Figure 1. Reduced spectra of some *Kepler* targets.

stars. A set of standard stars from well observed open clusters (e.g. Peña *et al.* 2011) was also observed each night to transform instrumental observations onto the standard system and to correct for atmospheric extinction. The usual calibration procedures for CCD photometry have been carried out during our observing run. Sky flat fields, bias and dark exposures were taken every night. The data reduction of this CCD photometry has been carried out with the usual techniques and IRAF packages. The instrumental magnitudes and colours, once corrected for atmospheric extinction were transformed to the standard system. In this way, we have obtained the standard Strömgen indices not only of the δ Scuti and γ Doradus target stars, but also of all the stars brighter than $V \sim 15$ mag located within each observed field.

The spectroscopic observations were conducted at the 2.12-m telescope of the OAN-SPM observatory during several short runs between 2010 and 2012. We used the same equipment as explained in Fox Machado *et al.* (2010). In particular, we used the Boller & Chivens spectrograph installed in the Cassegrain focus of the telescope. The 1200 lines/mm grating with a blaze angle of 13° was used. The grating angle was set to 19° to cover a wavelength range from 3950 Å to 5250 Å. A 2048×2048 E2V CCD camera was used for the observations. The typical resolution of the spectra is 2.2 Å and the dispersion 2.6 Å per pixel. The reduction procedure was performed with the standard routines of the IRAF package. Examples of the reduced spectra are shown in Fig. 1. The final results of these observations will be published elsewhere (Fox Machado *et al.*, in preparation).

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