Boletim da Sociedade Astronômica Brasileira, **30**, no. 1, 103-104


# Photometry and spectroscopy of A-type stars observed by the Kepler K2 Mission Campaign 8

J. M. Eidam[1], A. W. Pereira[1], M. Emilio[1], L. Andrade[1], M. C. Rabello-Soares[2], E. Janot-Pacheco[3] & J. Armstrong[4]

[1] Universidade Estadual de Ponta Grossa - e-mail: jessyeidam@gmail.com
[2] Universidade Federal de Minas Gerais
[3] IAG – Universidade de São Paulo
[4] Institute for Astronomy/University of Hawaii

**Abstract.** In this work we present the preliminary results of the analysis of eight A-type stars observed in the Galactic Pole by the Kepler K2 Mission during its Campaign 8. Frequency analysis of the eight light curves was made using the CLEANEST algorithm. In addition to the photometric data, ground spectroscopy was done at the OPD/LNA in October 2015 with the Zeiss Telescope (0.6m) and in August 2016 with the Perkin-Elmer Telescope (1.6m). Ground spectroscopic information enhances the data from the satellite's light curves, allowing for the characterization of the internal structure of the stars. Spectroscopy data were reduced using IRAF, and spectral characterization using Spectroscopy Made Easy (SME). In this work, we present preliminary results of this analysis. We show that a variable star, BD+10 102, has a period of 1.55 days (0.645 c/d) and can be classified as an A0/B9.5 star.

**Resumo.** Neste trabalho são apresentados resultados preliminares da análise de oito estrelas do tipo A observados no Pólo Galactico pela Missão Kepler K2 durante a campanha 8. A análise das frequencias das oito curvas de luz foi feita usando o algoritmo CLEANEST. Além dos dados fotométricos, espectroscopia de solo foi feita no OPD/LNA em outubro de 2015 com o telescópio Zeiss (0.6m) e em agosto de 2016 com o telescópio Perkin-Elmer (1.6m). Informações espectroscópicas de solo completam os dados das curvas de luz do satélite, permitindo a caracterização da estrutura interna das estrelas. Dados de espectroscopia foram reduzidos usando IRAF, e a caracterização espectral usando o Spectroscopy Made Easy (SME). Neste trabalho, apresentamos os resultados preliminares desta análise. Mostramos o estudo de uma estrela variável, BD+10 102, com um período de 1.55 dias (0.645 c/d) e que pôde ser classificada como uma estrela A0/B9.5.

**Keywords.** Stars: early-type – Stars: fundamental parameters – Techniques: photometric – Techniques: spectroscopic

## 1. Introduction

The primary objective of the Kepler Mission was monitoring more than 150 000 stars to transit-driven exoplanet detection in the Cygnus-Lyra region. After the loss of two reaction wheels, the spacecraft was refitted to observe the ecliptic plane, and renamed the K2 mission. Since then, it allows the scientific community to propose targets to be observed. Campaign 8 was observed between January and March 2016 and among the targets were eight A-type stars proposed by our group at the Galactic Pole. Pointing: RA: 16.3379975 degrees; Dec: 5.2623459 degrees; Roll: -157.3538761 degrees[1].

Figure 1 shows the distribution of our targets observed by Campaign 8, and figure 2 shows the light curve for one of our targets, BD+10 102 (or EPIC ID 220679442).

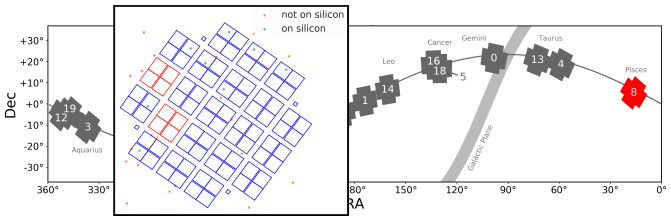


**Figure 1.** K2 campaign fields, with field 8 highlighted. Inset: Targets proposed for campaign 8. Green targets were observed, and red targets were discarded.

[1] https://keplerscience.arc.nasa.gov/

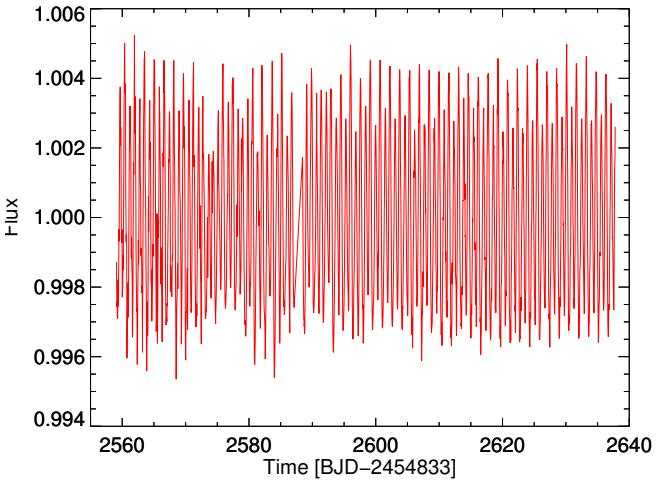


**Figure 2.** Corrected K2 light curve of target BD+10 102.

## 2. Methods

Frequency analysis of the eight light curves was made using the CLEANEST algorithm (Foster 1995).

In addition to photometric data, ground spectroscopy was obtained from the Observatório Pico dos Dias / Laboratório Nacional de Astrofísica (LNA) in October 2015 – before K2 observing – with the Zeiss Telescope (0.6m) and in August 2016 – after K2 observing – with the Perkin-Elmer Telescope (1.6m).

Spectroscopic data was reduced using IRAF, and spectral characterization was made using Spectroscopy Made Easy (SME) – an IDL software and a compiled external library that fits stellar spectra with synthetic ones (Valenti & Piskunov 1996; Piskunov & Valenti 2017).

Figures 3 and 4 show the spectra of one of the targets, BD+10 102, taken with the 1.6m telescope and centered respectively on 4400Åand 6300Å.

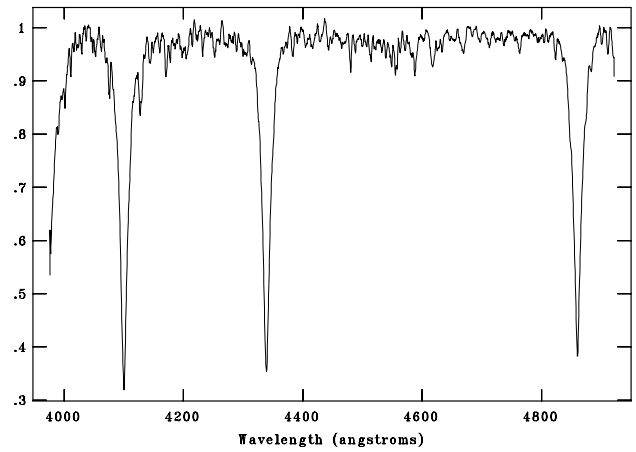


**Figure 3.** Spectrum in the blue region of C8 target BD+10 102 observed at the OPD/LNA in August 2016.

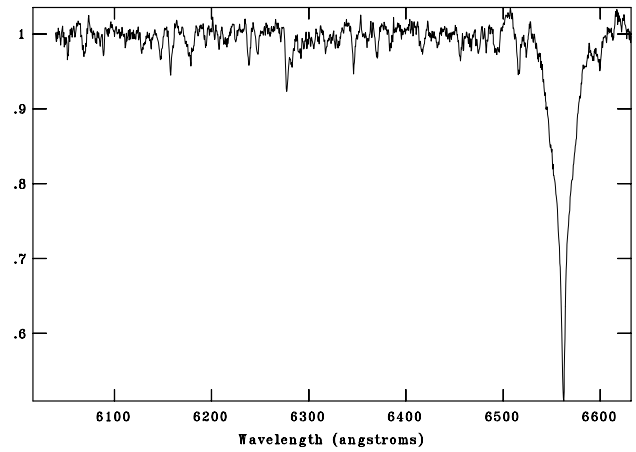


**Figure 4.** Spectrum in the red region of C8 target BD+10 102 observed at the OPD/LNA in August 2016.

The synthetic spectrum is calculated from the initial parameters provided by the user. For this, a list of input lines provided by the Vienna Atomic Line Database (VALD) is used, which is one of the requirements to operate spectral tuning in SME (Heiter et al. 2008). The global parameters are then varied internally and in different directions with the aid of interpolated atmospheric models for the parameter space to be determined.

We obtain from SME the following stellar parameters for each target: its effective temperature (Teff), surface gravity (logg), vsini, macro and micro velocity turbulence, radial velocity and metallicity. SME provides uncertainty values that are purely numerical and therefore do not properly represent the real uncertainties. Thus, we executed for each adjusted parameter 100 Monte Carlo simulations, randomly varying 5% of the best fit obtained with SME. We assume as uncertainty in the measures the value of $1\sigma$ in the dispersion of each parameter.

## 3. Results and conclusions

Performing the frequency analysis of the light curve for star BD+10 102, we determined its fundamental period as 1.55 days, or, in frequency, 0.645 cycles/day, as can be seen in figure 5.

From the values generated by SME, after passing through the Monte Carlo method, and based on the values for Teff and log g we could confirm BD+10 102 to be a A0/B9.5 star. We are currently finishing the analysis of the eight targets, and by finding their pulsation frequencies we hope to be able to classify any variabilities found.

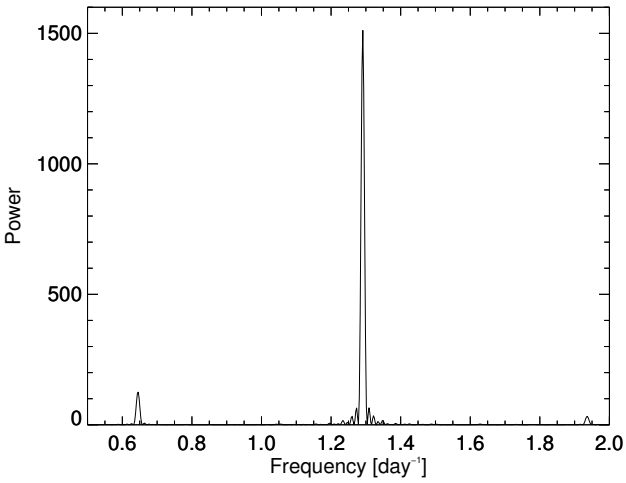


**Figure 5.** Frequency analysis of the light curve of star BD+10 102.

*Acknowledgements.* Based on observations made at the Observatório Pico dos Dias / LNA. This paper includes data collected by the Kepler mission.

## References

Foster, G. 1995, AJ, 109, 1889
Heiter, U. et al. 2008, J.Phys.Conf.Ser., 130, 012011
Piskunov, N. & Valenti, J. A. 2017, A&A, 597, A16
Valenti, J. A. & Piskunov, N. 1996,A&AS, 118, 595