Stars and their variability observed from space
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PRE-TESS OBSERVATIONS OF PULSATING WHITE DWARF STARS AT KONKOLY OBSERVATORY

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Abstract. The *TESS* (Transiting Exoplanet Survey Satellite) all-sky survey space mission provides a unique opportunity to study the pulsations of white dwarf variables with its 120-second cadence mode. We performed survey observations at the Piszkstető mountain station of Konkoly Observatory, Hungary, to find new bright white dwarf pulsators, which could be potentially interesting targets for *TESS* observations. We successfully identified two new ZZ Ceti pulsators, WD 1310+583 and PM J22299+3024. We also performed extended observations of other proposed *TESS* targets, LP 119-10 and HS 1625+1231, respectively. With the one-season long measurements of these stars, we determined a set of eigenmodes for all targets. We present here the results of our measurements on these four ZZ Ceti variables.

Keywords: techniques: photometric, stars: oscillations, white dwarfs

1 Introduction

The most populous group of the pulsating white dwarf stars is that of ZZ Ceti. ZZ Ceti (or DAV) stars are short-period (P ∼ 100–1500 s) and low-amplitude ($A \sim 0.1\%$) pulsators with 10 500–13 000 K effective temperatures. Pulsation modes detected in these objects are low spherical degree ($\ell = 1$ and 2), low-to-mid radial order g-modes.

The main goal of the almost all-sky survey *TESS* space mission (Ricker et al. 2015) is to detect exoplanets at nearby and bright stars with the transit method. However, with the time sampling of 120 s of the short-cadence mode available for selected targets, it is also possible to study the light variations of several different types of short-period pulsating variable stars, including white dwarf pulsators.

We performed observations with the 1-m Ritchey–Chrétien–Coudé telescope located at the Piszkéstető mountain station of Konkoly Observatory, Hungary. We obtained data with an FLI Proline 16803 CCD camera in white light. The exposure times were 30–60 s. Raw data frames were treated the standard way utilizing IRAF tasks, then we performed standard Fourier analysis of the reduced data sets with the photometry modules of the Frequency Analysis and Mode Identification for Asteroseismology (FAMIAS) software package (Zima 2008).

2 WD 1310+583

WD 1310+583 ($B = 13.9$ mag) was observed on eight nights during the 2017 March–July term, and we determined 17 significant frequencies in the complete data set (Bognár et al. 2018). Seven of them seem to be independent pulsation modes. The additional, closely spaced frequencies to these modes suggest the presence of amplitude and/or phase variations, frequently observed in ZZ Ceti stars in the middle of the instability strip or close to its red edge. This newly discovered relatively bright WD variable is an excellent target for 1-m-class telescopes.

3 HS 1625+1231

HS 1625+1231 ($B = 16.1$ mag) was reported as a new ZZ Ceti variable by Voss et al. (2006). They detected three pulsation periods at 385.2, 533.6, and 862.9 s. We observed this star on 14 nights in the 2019 observing season (March–July), and our frequency analysis resulted in the determination of six pulsation modes between 514 − 881 s.

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4 PM J22299+3024

We discovered the variability of PM J22299+3024 ($g = 15.9$ mag) in July 2018. At that time we considered it as a variable candidate, as only one night of observations was available on this target (Bognár et al. 2019). However, the subsequent observations proved that PM J22299+3024 is indeed a new, bright ZZ Ceti star, laying close to the red edge of the instability strip. Based on 14 nights of observations (2018 July–November), we accepted eight modes between $967 - 1335$ s, which can be inputs for asteroseismic fittings. However, its complex frequency structure suggests that further modes may be present in the data set. Additional observations will hopefully clear this situation up.

5 LP 119-10

LP 119-10 ($B = 15.3$ mag) was discovered to be a variable star by Green et al. (2015). They presented one frequency at 873.6 s in the discovery publication. We collected data on this star altogether on 20 nights between October 2018 and April 2019. Our data analysis revealed an even more complex frequency structure than in the case of PM J22299+3024, and we have determined ten pulsation modes between $768 - 1005$ s.

6 Ongoing observations and future plans

All four stars are amongst the targets proposed for *TESS* observations. However, because of the unexpected field shifts, the space telescope did not observe PM J22299+3024 in the planned cycle. Therefore, we decided to collect more data on this target from the ground until December, 2019. We also plan to analyse the *TESS* data on the remaining three targets, correct the periods if needed, complete the list of known eigenmodes with the ones detected by the space-based measurement (if any), and perform asteroseismic fits utilizing the modes derived this way.

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