Stars and their variability observed from space
C. Neiner, W. W. Weiss, D. Baade, R. E. Griffin, C. C. Lovekin, A. F. J. Moffat (eds)

ECLIPSING BINARIES WITH POSSIBLE β CEPHEI VARIABLES

F. Kahraman Aliçavuş[1,2] and G. Handler[1]

Abstract. In this study, we present the result of our candidate β Cephei stars search in eclipsing binary systems. Candidate eclipsing binary systems were selected from the catalog given by Avvakumova et al. (2013). Using the available public data of 29 systems, the binarity effects from the light curves were removed after a light-curve analysis and to disclose possible pulsations, a frequency analysis was carried out on the residuals. As regards to pulsation, some candidate slowly pulsating B (SPB) variables were revealed, but no convincing detection of new β Cephei stars was achieved.

Keywords: stars: general – stars: binaries: eclipsing – stars: fundamental parameters – stars: β Cephei

1 Introduction

The existence of pulsating stars in eclipsing binary systems has been known for decades. These systems are astrophysically valuable because their pulsation and binary characteristics allow us to obtain accurate fundamental stellar parameters (mass, radius) and to probe their interior structures. B type pulsating variables, in particularly β Cephei stars, in eclipsing binaries are useful objects to understand the evolution from the main-sequence to supergiants via their binary nature as well as pressure and gravity modes. However, the known number of these variables is small. Therefore in this study, we present a search for β Cephei variables in eclipsing binaries (BCEB) to reveal new candidates and to understand the pulsational behaviour in these eclipsing binary member pulsators. We selected the candidates considering the following conditions. First, stars having spectral type B5 and earlier were selected as candidate BCEB stars from the most recent eclipsing binary catalog of Avvakumova et al. (2013). Second, $T_{\rm eff}$ values of the candidates were estimated using the relation between spectral type and $T_{\rm eff}$ (Gray & Corbally 2009). Third, luminosity values were calculated using mostly the Gaia (Gaia Collaboration et al. 2016, 2018), but also the *Hipparcos* (van Leeuwen 2007) parallaxes. As a final step, we plotted the candidate stars on the Hertzsprung-Russell (H-R) diagram (Fig. 1). The stars inside the β Cephei instability strip were selected as target objects.

2 Light Curve and Frequency Analysis

The photometric data of the selected candidate BCEB stars were retrieved from the SuperWASP and ASAS archives. Only 29 candidate β Cephei stars have available photometric data. These data were used for the light curve and frequency analyses. First, binary light curve analysis was performed by using the Wilson-Devinney code (Wilson & Devinney 1971). Second, the data of individual stars were cleaned from the binarity effects by using our binary light curve models. Third, a frequency analysis was carried out to the residuals using the Period04 (Lenz & Breger 2005) program to detect β Cephei type pulsators. As a result, we classified some candidate SPB variables. No convincing β Cephei candidate was found.

3 Conclusions

In this study, the result of our research for candidate BCEB stars is presented. We discovered a few SPB candidates, while no β Cephei candidates were found. To confirm the SPB type variability of the candidate stars and to find new β Cephei stars in eclipsing binaries, we plan to examine high-quality TESS data with the same methods as well. Some of the candidate BCEB and SPB systems have been already observed by TESS and most of the remaining systems will be observed during the mission. The high-quality TESS data will allow

[1] Nicolaus Copernicus Astronomical Center, Bartycka 18, PL-00-716 Warsaw, Poland
[2] Çanakkale Onsekiz Mart University, Faculty of Sciences and Arts, Physics Department, 17100, Çanakkale, Turkey

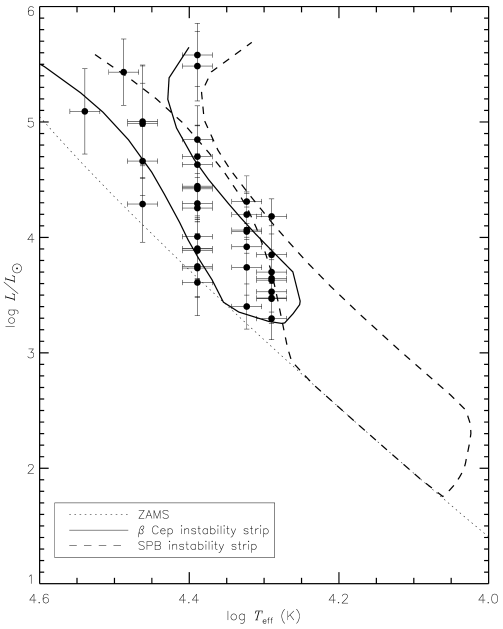

Fig. 1. The position of candidate β Cephei stars in eclipsing binary systems in the H-R diagram. The theoretical instability strips of β Cephei and slowly pulsating B (SPB) stars are from Pamyatnykh (1999).

us to confirm the pulsational variability in the candidate stars. There is one system in our sample, δ Pic, which was defined as a BCEB star using BRITE data (Pigulski et al. in preparation). This system was also observed by TESS and the pulsations were detected clearly. In further work, we will analyse available TESS data of the systems to reveal their oscillations, if they exist. As a result of this study, we aim to understand the pulsational behavior of β Cephei and SPB stars in eclipsing binary systems. Additionally, the fundamental parameters (mass, radius) of BCEB and SPB stars can be derived precisely and be used as input parameters in theoretical studies.

We thank the Polish National Center for Science (NCN) for supporting the study through grant 2015/18/A/ST9/00578. This study makes use of data from the first public release of the WASP data (Butters et al. 2010) as provided by the WASP consortium and services at the NASA Exoplanet Archive, which is operated by the California Institute of Technology, under contract with the National Aeronautics and Space Administration under the Exoplanet Exploration Program. This work has made use of data from the European Space Agency (ESA) mission Gaia (http://www.cosmos.esa.int/gaia), processed by the Gaia Data Processing and Analysis Consortium (DPAC, http://www.cosmos.esa.int/web/gaia/dpac/consortium). Funding for the DPAC has been provided by national institutions, in particular the institutions participating in the Gaia Multilateral Agreement. This research has made use of the SIMBAD data base, operated at CDS, Strasbourq, France.

References

Avvakumova, E. A., Malkov, O. Y., & Kniazev, A. Y. 2013, AN, 334, 860

Butters, O. W., West, R. G., Anderson, D. R., et al. 2010, A&A, 520, L10

Gaia Collaboration, Brown, A. G. A., Vallenari, A., et al. 2018, A&A, 616, A1

Gaia Collaboration, Brown, A. G. A., Vallenari, A., et al. 2016, A&A, 595, A2

Gray, R. O. & Corbally, Christopher, J. 2009, Stellar Spectral Classification (Princeton University Press)

Lenz, P. & Breger, M. 2005, Communications in Asteroseismology, 146, 53

Pamyatnykh, A. A. 1999, Acta Astron., 49, 119

van Leeuwen, F. 2007, A&A, 474, 653

Wilson, R. E. & Devinney, E. J. 1971, ApJ, 166, 605