arXiv:submit/3374394 [astro-ph.SR] 17 Sep 2020

Many faces of Blazhko modulation observed from space

Attila Bódi,[1,2] Emese Plachy,[1,2] Pál Szabó,[1,2] László Molnár,[1,2]
András Pál,[1,3,4] and Róbert Szabó[1,2]

[1] *Konkoly Observatory, Research Centre for Astronomy and Earth Sciences, Konkoly Thege Miklós út 15-17, H-1121 Budapest;* `bodi.attila@csfk.mta.hu`

[2] *MTA CSFK Lendület Near-Field Cosmology Research Group*

[3] *Eötvös Loránd University, H-1117 Pázmány Péter sétány 1/A, Budapest, Hungary*

[4] *MIT Kavli Institute for Astrophysics and Space Research, 70 Vassar Street, Cambridge, MA 02109, USA*

Abstract. The K2 and the TESS missions provide an unique opportunity to investigate the phenomenon of the Blazhko effect in great detail. Here we present the analysis of nearly two hundred Blazhko stars that represent the largest sample of modulated RR Lyrae stars investigated with space-based photometry so far. We focus on the relation between the modulation of the pulsation phase and the pulsation amplitude, as well as the coexistence of the Blazhko effect with the nonlinear phenomenon called period doubling. Given the limited length of observations, we were able to determine only relatively short modulation periods accurately. Nevertheless, we found that the pulsation amplitude and phase changes are not necessarily correlated and their relation can be rather complex.

1. Methods

The K2 light curves has been extracted using our own method, the Extended Aperture Photomerty (Plachy et al. 2019). The TESS light curves were produced by applying differential-image aperture photometry using the `fitsh` code (PÃąl 2012).

The frequency spectra, the average pulsation periods, amplitudes and phases were calculated by the standard methods of the software `Period04` (Lenz & Breger 2005). We used the first five harmonics to create a template light curve. To calculate the variation of the pulsation amplitude and phase along the Blazho modulation, we first splitted the light curves into 3-pulsation-period-long segments with 1-period-long overlaps. In case of each segment, we fitted the template by scaling the amplitudes and phases using Monte-Carlo based technique. The yielded O–C curves can be seen in Fig. 1.

In order to reveal the presence of subharmonics in the Fourier spectra, we prewhitened with the significant harmonics and divided the frequency values with the pulsation period. This way the sub-harmonics, if present, can be found at 0.5 and 1.5 in the spectra.

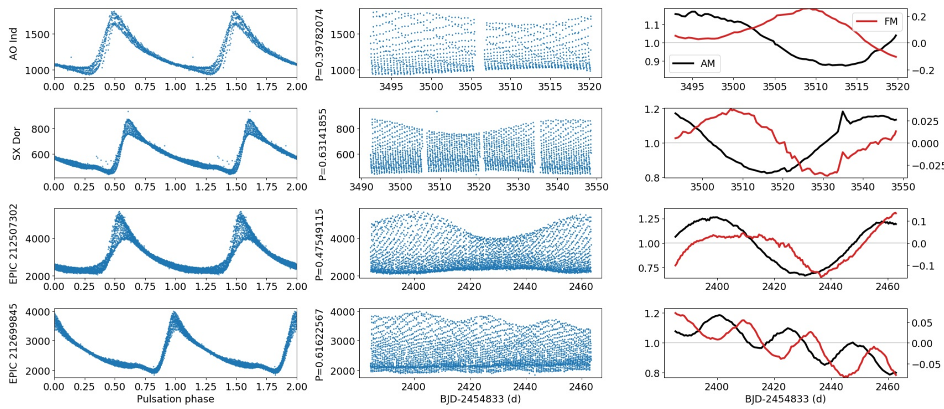

Figure 1. Gallery of phase curves (left), light curves (middle) and amplitude-phase modulations (right). The first two rows show TESS, while the last two ones show K2 light curves. In case of the right-hand side column, the red curves show the phase, while the black ones show the amplitude modulations.

2. Results

Our new findings can be summarised as follows:

- Out of 462 stars, 191 (41%) show Blazhko modulation.
- About 8% of modulated stars show subharmonics in their Fourier-spectra.
- There is a difference between period of amplitude and phase modulation above ~55 days modulation period.

Acknowledgments. Funding for the Kepler and K2 missions are provided by the NASA Science Mission directorate. Funding for the TESS mission is provided by the NASA Explorer Program. EP was supported by the Bolyai János Research Scholarship, LM by the Premium Postdoctoral Research Program of the Hungarian Academy of Sciences. This research received funding from the Hungarian National Research, Development and Innovation Office grants KH-18 (130405), 2018-2.1.7-UK GYAK-2019-00009, from the LendÃijlet LP2018-7/2019 and KEP-7/2018 grants of the Hungarian Academy of Sciences, and GINOP-2.3.2-15-2016-00033 by the Hungarian National Research, Development and Innovation Fund together with the European Union.

References

Lenz P., Breger M., 2005, CoAst, 146, 53
Pál A., 2012, MNRAS, 421, 1825
Plachy E., Molnár L., Bódi A., Skarka M., Szabó P., Szabó R., Klagyivik P., Sódor Á., Pope B. J. S., 2019, ApJS, 244, 32