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Classical variables in the era of space photometric missions

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Abstract. The space photometric missions like CoRoT and *Kepler* transformed our view of pulsating stars, including the well-known RR Lyrae and Cepheid classes. The K2, TESS and PLATO missions will expand these investigations to larger sample sizes and to specific stellar populations.

1 Introduction

Results from the Kepler, CoRoT and MOST missions proved that continuous, high-precision photometry can reveal important new insights about two types of otherwise well-researched classical variables, Cepheids and RR Lyrae stars (see, e.g. [1–4]. However, Cepheids are rare beasts in the Galaxy and the sample so far is very small: only a handful of stars were ever measured from space. Similarly, out of the tens of thousands of RR Lyrae stars, only a few dozen were observed by photometric missions. In the near future, K2, TESS and PLATO may provide observations of thousands of RR Lyrae stars and hundreds of Cepheids. The temporal coverage of the individual missions range from 27 days to 2-3 years, therefore not all missions will be able to observe longer-term phenomena but successive missions may complement the measurements of each other.

2 K2: target selection and early results

During the K2 mission [5], *Kepler* will be able to measure several Type I and II Cepheids. It will also observe hundreds of RR Lyrae stars in several distinct stellar populations: field stars, globular cluster members and even stars in dwarf spheroidal galaxies around the Milky Way [6].

Even the very first observations during the 9-day K2 Two-Wheel Concept Engineering Test run provided interesting targets. These include two double-mode RR Lyrae stars and a rare, modulated first-overtone star (Figure 1), two types the original *Kepler* field lacked. In fact, this is the first Blazhko-RRc star observed from space. The analysis of the entire sample will be published elsewhere.

Apart from the field stars, we identified more specific targets as well. Field 2 contains the Messier 4 and 80 globular clusters, while Field 9 will survey the Galactic bulge. *Kepler* has the resolution to observe close-by extragalactic variables too. It already observed three RR Lyrae stars in the Leo IV dwarf spheroidal galaxy in Field 1 and will hopefully detect several Cepheids in IC 1613 which is located in Field 8.

3 Future missions: TESS and Plato

The two new photometric missions will have differing observing strategies. TESS will survey the entire sky, but it will be limited in terms of time span (27 days per scan except for overlapping regions),

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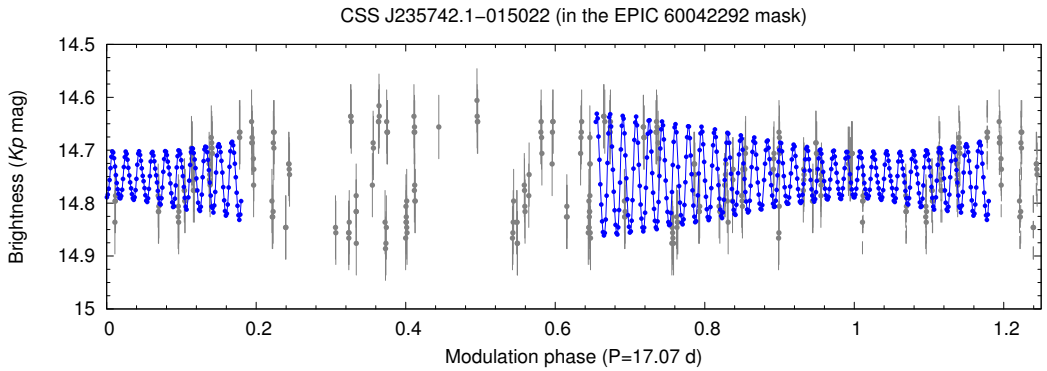

Fig. 1. Light curve of the modulated RRc star, folded with the modulation period. Blue: K2-E2 data, grey: Catalina Sky Survey data, shifted to the *Kepler* passband brightness.

brightness and resolution [7]. It will be able to detect several hundred Cepheids and the closest few hundred RR Lyrae stars. A huge advantage of TESS is that it will provide a snapshot of all variable stars brighter than 12 magnitudes in the entire sky. These include some very special targets, such as the modulated Cepheid star, V473 Lyrae [8] that was recently observed by the MOST space telescope as well. It will also revisit the CoRoT and *Kepler* fields, providing an excellent follow-up capability.

TESS will initially avoid the Ecliptic and therefore the K2 fields, but a natural extension of the mission could be an ecliptic survey by rotating the spacecraft by 90 degrees. This way TESS would be able to revisit all not-too-faint K2 targets with similar precision in 2019-20.

PLATO will reach down to 13-16th magnitudes per exposure, depending on the number of telescopes observing the target [9]. The mission will be more limited for fainter stars by the confusion arising from the low angular resolution than by the actual photometric performance. But it will still be able to observe hundreds of Cepheids and several thousand RR Lyrae stars. The two long-duration pointings will allow for very detailed studies, similar to the *Kepler* investigations, but with much larger sample size and better temporal resolution. The step-and-stare phase of the mission will employ 2-5-month long pointings which are comparable with the K2 campaign lengths.

These new surveys, complete with the distance and velocity data provided by GAIA, will usher a new era in the understanding of pulsating variable stars.

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