

Short cadence RR Lyrae targets - K2/C1 proposal

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Introduction. RR Lyrae stars are horizontal-branch, large-amplitude pulsators that are used as cosmic distance indicators and tracers of galactic history and dynamics. After the many groundbreaking findings on this class of pulsators that sprouted from the *Kepler* mission, *K2* allows us to magnificently increase the number of studied RR Lyrae targets with “*Keplerian*” accuracy. In addition, our investigations are taken to a next level of scrutiny by looking at a few selected RR Lyrae stars in 1-minute cadence.

K2's Field 1 contains 133 Galactic RR Lyrae stars, and, for the first time, the target list contains the three prevalent types of RR Lyrae stars: the fundamental-mode pulsators (RRab), the first-overtone pulsators (RRc) and also one star exhibiting both these modes simultaneously – a double-mode pulsator (RRd). RRd stars are unique tools because the two radial modes provide insight in both RRab and RRc stars, and their period ratio provides strong constraints on the stellar parameters such as mass and metallicity.

Aims. Short-cadence data with *K2* provide us with a 0.1-0.2% time resolution of a typical RR Lyrae light curve, essential to: **(a)** capture the sharp, localized features of the light curves, the shock waves and the maxima. Their variations may signal various mode interactions [1], and covering the shock phases with the necessary resolution provides us with new insights into the intricate dynamics of RR Lyrae stars; **(b)** get a detailed picture of additional frequencies, e.g., those with 0.60-0.64 period ratio that are observed in RRc and RRd stars [2,3], and the supposedly higher-order overtones and/or nonradial modes; **(c)** unveil transient events. All of these are likely to be missed with long-cadence observations.

For these reasons, we request short-cadence observations for the following targets:

- **RRd star** (1) LIN2122319: pulsating in both the first-overtone and the fundamental radial modes (and several other – yet unrevealed - modes). This is only the third RRd to be observed from space [4,5], and never before have short-cadence data of an RRd been obtained. *The short-cadence data of this RRd star will provide a key to several long-standing riddles concerning all prevalent types of RR Lyrae stars (RRab stars, RRc stars and RRd stars):* various mode interactions, the nature of the additional frequencies (with particular yet unexplained frequency ratios to the first-overtone radial mode [2,3]) that were seen in the other RRc stars and studied RRd stars [4,5].
- **RRc stars** (2) LIN1915212 and LIN1748058: both of them show hints of modulation. No RRc with Blazhko effect has been found from satellite data, this is a unique opportunity to find such an object. Moreover, the additional modes that were found in many non-Blazhko RRc stars [2,3] can be studied with short-cadence observations.
- **RRab stars** (3) AN Leo, KW Leo and CSS-J1133552: The former two show the Blazhko effect. KW Leo and CSS-J1133552 are long-period (resp. $P=0.7d$ and $0.8d$) RRab stars, yet show clear hints of modulation. For unknown reasons, the Blazhko effect is very rare for RR Lyraes with periods $P > 0.66d$. This seems to hold in our Galaxy and beyond. For the LMC the Blazhko effect incidence rate is $\sim 17\%$ for $P < 0.6d$ but drops to only $\sim 4\%$ for $P > 0.7d$ [6]. Short-cadence data will allow us to check whether this observation is only an amplitude selection effect. Moreover, we expect seeing hints of higher-order radial (and possibly nonradial) modes from the short cadence data [1].

Targets. Our list of six RR Lyrae targets is ordered by ranking (RRd, RRc, RRab). Ground-based follow-up observations will put the detected variations into context.

References

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