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RR Lyrae stars: The changing light curve shape during the Blazhko cycle

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Abstract

High-precision multisite photometry was used for a detailed investigation of the bump occurring before minimum light in the light curves of the two RRab Blazhko stars RR Lyr and SS For. For both stars, the phase of the bump was found to be variable with a period equal to the Blazhko period, with the bump occurring at an earlier phase around Blazhko minimum and at higher values during maximum.

Target Stars

For the analysis on the star SS For, we used mmag precision data from our campaigns in the years 2004 and 2005 as well as the best 311 data points from the All Sky Automated Survey, ASAS (Pojmanski 2002). Data from our campaign comprise a total of 1218 points gathered in 50 nights with a typical scatter of a few millimag per point, while the ASAS data show a typical scatter of 0.03 mag. For more details on the data set see Kolenberg et al. (2007). Using a Blazhko period of about 34.7 days we created 20 overlapping phase bins of 0.1 of the Blazhko period. For each of those the phase of the bump maximum was measured and plotted against the Blazhko phase. Both phase and amplitude of the bump were found to be variable.

The first question arising is whether this variability of bump phase is a common phenomenon among (Blazhko) RR Lyr stars. Therefore we performed the same test on a similar data set of RR Lyr (Kolenberg et al. 2006). 14702 data points gathered in 98 nights over a period of 421 days were used for the investigation. With a scatter of 0.01–0.02 mag the data were less accurate than in the case of SS For. The Blazhko period found from the data set was 39 days. The results concerning the bump turned out to be comparable.

Results

- For both stars the phase of the bump maximum is variable with a period identical to the Blazhko period
- For both stars the smallest value of the bump phase is reached near Blazhko minimum, while the largest value is reached near maximum pulsation amplitude.
- For SS For the phase of the bump varies between 0.65 and 0.85 (i.e. 20 per cent of the pulsation period!), for RR Lyr between 0.67 and 0.75 with the total light curve maximum set to zero phase.
- For SS For the phase variation is non-sinusoidal and is characterized by a slow progress to lower phases ('to the left') and a quicker motion to higher phases after the Blazhko minimum.

- The bump is stronger in the B filter than it is in V, as it is clearly visible in a (B-V) diagram.
- In SS For the bump is most distinct during Blazhko minimum and almost vanishes around Blazhko maximum. For RR Lyr we cannot find any noteworthy dependence of the bump strength on the Blazhko phase.

Conclusions

In both examined stars, the bump moves back and forth in the phase diagram during a Blazhko cycle. Models for Blazhko RR Lyrae stars should therefore allow the bump phase to be variable. To clarify the bump behaviour, high-resolution spectroscopic data covering the bump at different Blazhko phases are needed. It will be necessary to investigate a larger sample of Blazhko and non-Blazhko stars to find out whether a variable bump is a common phenomenon. Future studies will also focus on the relation between the Blazhko phase and the occurrence of the hump in the ascending branch of the light curve.

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