AR PER showing the Blazhko effect?

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Abstract

In October and November 2011 light curve measurements were performed on AR Per, a variable star classified as a RR Lyrae type.

These measurements were combined with ESA OMC satellite data because of ESA's Explore the High-Energy universe competition.

Measurements in the visual part of the spectrum were performed by students of the Emmauscollege in Rotterdam together with their physics teacher using a Celestron C11 with SXV-H9 CCD camera.

These measurements show, with the combined datasets, that the period of AR Per is 0.425548 +/- 0.000010 days.

Also in our measurements signs of the Blazhko effect can be found.

Introduction

AR Per is classified as a RR Lyrae type of star in the constellation of Perseus. More specifically, AR Per is a RRab type (with magnitude changes over 0.9th of a magnitude). This star was chosen to observe because of it's relatively short period and it's relatively high change in magnitude, making it a star that could be observed in a limited amount of time. It was also perfectly visible in the European skies at the time of the observations (November).

RR Lyrae stars usually show a typical light curve, starting with a slight drop in the magnitude, then a (relatively) steep rise, before dropping gradually again, with a hold in the middle of the drop (see figure 1).

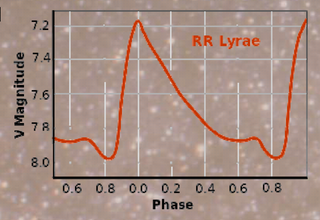

Figure 1: A typical RR Lyrae lightcurve. [1]

Also a commonly seen effect in RR Lyrae stars is the Blazhko effect [2], which means that the amplitude or the period of the star changes over time. Question is if the above described phenomenons also occurs in AR Per and if the Blazhko effect is detectable in our data.

Figure 2: Overview of the field of view used during imaging (images obtained during measurements)

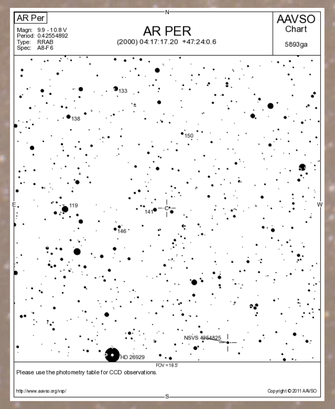

Figure 3: AAVSO reference map for AR Per

Equipment and data overview

Data of AR Per has been obtained during several nights in November 2011 using a Celestron C11 in combination with an SXV-H9 CCD camera and a Baader V-filter.

During the sessions the setup was running in automatic guiding mode obtaining images at 30s intervals.

During the observations darks, flats and darkflats were made directly after the measurements.

Flat frames were made using a LED-panel directly after stopping the imaging procedure.

Date	Number of images	Exposure	Conditions
9/11/11	533	30s/30s interval	Very good seeing, dry, clear night. Temperature just above freezing, and a full moon.
11/11/11	408	30s/30s interval	Clear weather and good seeing
14/11/11	161	30s/30s interval	Good weather and good seeing
16/11/2011	204	30s/30s interval	Good seeing and weather at the beginning of the night, after 23:30h the fog came in.
27/11/2011	393	30s/30s interval	Clear night, good seeing,

Table 1: Overview of obtained data

Processing

Image capturing was performed using Nebulosity 2.0. The data was saved as raw fits files. Together with every set of raw lights also 10 darks, 20 flats and 10 darkflats were captured.

The image processing was performed using Maxim DL5. Also the necessary corrections were made with this program. The images were batched into batches of 5 minutes to reduce signal noise and strengthen the measurements. After stacking the images were analysed using the photometry module of Maxim DL 5.

Fixed magnitude stars were used as reference stars that were kindly provided by the AAVSO. AR Per was measured relative to these reference stars. The program created a file containing Julian dates and magnitude estimates as well as the possible error.

These dates were converted to heliocentric time using the website listed in the competition introduction. Thereafter ESA's OMC data was converted from barytime to heliocentric Julian date.

The obtained dataset was combined with the ESA OMC dataset. Peranso 2.0 was used to perform period analysis on AR Per and to produce light curves of this star.

In Peranso the ANOVA procedure was used to perform this period analysis.

This method employs periodic orthogonal polynomials to fit observations, and the analysis of variance (ANOVA) statistic to evaluate the quality of the fit. This method was proposed by Schwarzenberg-Czerny [3]. It strongly improves peak detection sensitivity and damps alias periods.

Results

By using Peranso 2.0 the shown light curves were obtained. Peranso also gave estimates of the period of AR PER, shown in table 2.

Figure 3 shows an interesting clue that the Blazhko effect could be present in our dataset. The top of the curve is changing during the measurements, clearly giving an indication that the amplitude of this star is AR PER has variations that can be attributed to the Blazhko effect.

Period analysis of AR Per

	Period (days)	
OMC Data	0.425550	+/- 0,000010
Own data	0,425501	+/- 0,000070
OMC + Own	0,425548	+/- 0,000005

Table 2: Estimated periods of AR Per

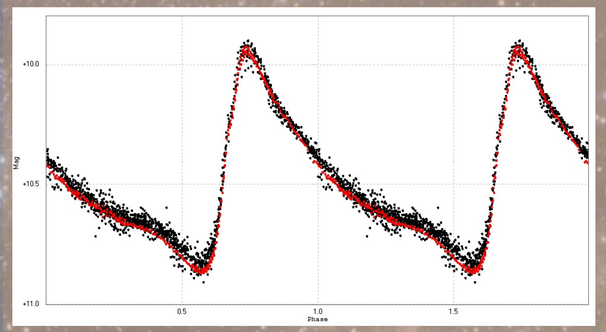

Figure 4: Lightcurve of AR Per with the OMC data (black) included.

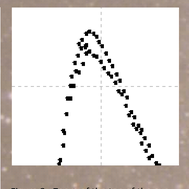

Figure 3: Zoom of the top of the curve showing changing amplitudes between measurements.

Conclusion/discussion

The light curve of AR Per shows a typical behaviour for a RR Lyrae star. The magnitude slightly drops, then rises steeply before dropping gradually again, with a hold in the middle of the drop, almost identical to figure 1.

Variations of the amplitude of the star give indications of the presence of the Blazhko effect in the measurements, though it can't be said with certainty the effect is there. Therefore we would recommend further investigation of this star.

References/Acknowledgements

[1] Smith, Horace A., *RR Lyrae Stars*, Cambridge (2004)

[2] The Blazhko Project, http://www.univie.ac.at/tops/blazhko/Project.html

[3] Schwarzenberg-Czerny, A., ApJ, 460, L107-110, 1996

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