

O–C Investigations of RRab Stars from the SuperWASP Archive

Paul A. Greer¹ and Andrew J. Norton¹

1. The Open University, Walton Hall, Milton Keynes, UK

Early results are presented from O–C investigations into the phase modulation of RRab class RR Lyrae stars from the SuperWASP archive. These results show several objects with good parabolic fits which could be segments of longer sinusoidal period changes due to light travel time effects (LTTE). Visual inspection of O–C diagrams suggest some long period sinusoidal phase modulation, and some cases of phase modulation with periods too short to be LTTE, which could be previously unidentified cases of the Blazhko effect.

1 Introduction

SuperWASP is the Super Wide Angle Search for Planets (Pollacco et al., 2006). Its primary mission was to detect exoplanets but its archive of over 31 million objects includes many thousands of variable objects. These variable objects include nearly 5000 RRab class RR Lyrae and nearly 900 Blazhko effect stars. SuperWASP’s high cadence and long baseline make it ideal for investigating long term variations in the pulsations of RRab, such as the Blazhko effect, and searching for signs of binary systems via light travel time effects.

2 Producing O–C Diagrams

To create the O–C diagrams, templates were created using a 100-bin phase-folded average light curve for each object from the SWASP RRab catalogue by Greer et al. (2017). These templates were then fitted to nights with more than 50 data points, after the removal of outliers beyond 3σ , allowing for a vertical offset between nights.

3 LTTE

The O–C diagrams were then fitted using linear and quadratic fits, as demonstrated in Fig. 1, where the goodness of fit was quantified using a χ^2 value. In these tests, objects were automatically selected for LTTE visual inspection if the quadratic fit were below 70% of the linear fit’s χ^2 value. Parabolic curves could be caused by LTTE as part of a long orbital period binary system where only part of the period has been observed during SuperWASP observations.

During the initial visual inspection, several of the O–C diagrams appear to show a full sinusoidal period within the duration of SuperWASP observations, leading to the potential identification of binary systems with slightly shorter orbital periods than those with a parabolic trend. However, several objects that show sinusoidal

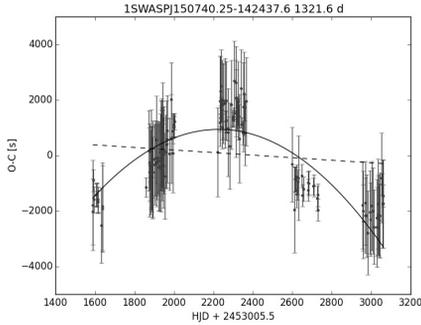


Fig. 1: The O–C residuals of object 1SWASPJ150740.25-142437.6 showing the linear and quadratic fits in dashed and solid lines respectively.

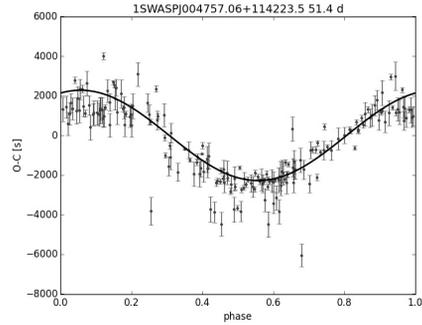


Fig. 2: The O–C residuals of object 1SWASPJ004757.06+114223.5 folded on a candidate Blazhko period of 51.4 d, with a sinusoidal fit shown by the solid line.

variability in their O–C residuals are known, or candidate, Blazhko effect objects. It is not possible to determine any LTTE in these cases as the periodic variation may be due to a long period component of a multi-periodic Blazhko effect. New Blazhko candidates may be identified using the process described below.

4 Identifying the Blazhko Effect Using PDM

The residuals from several O–C diagrams showing short-period variations were each phase-folded using a phase dispersion minimisation (PDM) technique (Stellingwerf, 1978) in order to find potential Blazhko periods, and thereby isolate the phase modulation aspect of the Blazhko effect. This PDM routine quantified the candidate Blazhko periods before a sinusoidal fit calculated the amplitude of the phase modulation.

Candidate Blazhko periods from the PDM process were compared to the candidate Blazhko periods in Greer et al. (2017). Fig. 2 shows the O–C residuals of a known Blazhko effect object, FR Psc (1SWASPJ004757.06+114223.5), folded by the candidate Blazhko period of 51.4 d, which is similar to the 50.9 ± 0.1 d period derived using Fourier analysis.

5 Future Work

Future work will consist of measuring the goodness of fit value for sinusoidal curves fitted to the unfolded O–C residuals in the case of LTTE candidates, and folded O–C residuals in the case of Blazhko candidates. This will hopefully lead to a new list of Blazhko candidates, and possibly several binary systems containing pulsators.

References

- Greer, P. A., et al., *A&A* **607**, A11 (2017), [arXiv: 1707.02045](https://arxiv.org/abs/1707.02045)
 Pollacco, D. L., et al., *Publications of the Astronomical Society of the Pacific* **118**, 848, 1407 (2006), URL <http://www.jstor.org/stable/10.1086/508556>

Stellingwerf, R. F., *ApJ* **224**, 953 (1978)



Conference dinner in the Wieliczka Salt Mine, Jan Haluszka Chamber. Going clockwise around the table: Karen Kinemuchi, Grzegorz Pietrzyński, Radek Smolec, Zbyszek Kołaczkowski, Natalia Żywucka-Hejzner, Igor Sożyński and Charles Kuehn.



Conference dinner, going clockwise around the table: Joonas Saario, Zdenek Prudil, Marek Skarka, Henryka Netzel, Krzysztof Kotysz and Paul Greer.