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KIC2569073, A second Cepheid in the Kepler FOV

Jason A. Drury[1,2], Charles A. Kuehn[1,2], Beau R. Bellamy[1,2], Dennis Stello[1,2], and Timothy R. Bedding[1,2]

[1] Sydney Institute for Astronomy (SIfA) - School of Physics, The University of Sydney
[2] Stellar Astrophysics Center (SAC) - Aarhus University, Denmark

Abstract. One particularly interesting new variable discovered via *Kepler*'s 200x200 pixel superstamp images is KIC2569073. With a period of 14.66 days and 0.04mag variability it is only the second Cepheid in the *Kepler* field, or a rotationally modulated variable. We discuss its classification as a Type II W Virginis Class Cepheid, and present the cycle-to-cycle period variations of this star, as well as the first direct observations of granulation noise within a Cepheid.

1 Introduction

Cepheids are intrinsic variable stars with periods ranging from 1 to 50 days, which have long been held as stable pulsators. [1] discovered that there are cycle to cycle variations in the pulsational period of V1154 Cyg, the first Cepheid in the *Kepler* field of view (FOV), and similar period variations have been discovered in two other Cepheids by [2] using MOST data. Convective hotspots on the stellar surface, combined with stellar rotation is the currently proposed explanation for this variation [3].

2 Data Extraction and Processing

We extracted data of KIC2569073 from the 200x200 pixel 'superstamps' [4] of NGC 6791 by applying a custom aperture mask to the source for each 'quarter' data set and running our custom aperture photometry script. We removed non-linear trends and outliers from each quarter, and stitched the resulting quarter data sets together using our simple stitching algorithm.

3 Results

KIC2569073 has a $B-V$ colour of 0.54 mag and an apparent magnitude (V) of 14.219 mag. We determined the amplitude of variability to be approximately 0.04 magnitudes, with an average period of 14.66 days. We classified KIC2569073 as belonging to the W Viriginis class of Type II Cepheids based on this variability and the long period, making this star only the second Cepheid discovered in the Kepler FOV. The period-luminosity relation for Type II Cepheids [5] allowed us to determine the distance to this Cepheid to be 13.8 kpc, much further than the ~4kpc to NGC 6791, making it a background star.

We conducted an observed-calculated (O-C) analysis of the lightcurve similar to those by [1] and [2] for both the maxima and minima points. Due to data gaps we discarded quarters one and two and divided the lightcurve into single cycle segments centered on the minima or maxima. We fitted a polynomial of 4th order to the maxima and 6th order to the minima and recorded the times of maxima or minima. From the resulting O-C diagrams (Figure 1) we found random variations from the mean

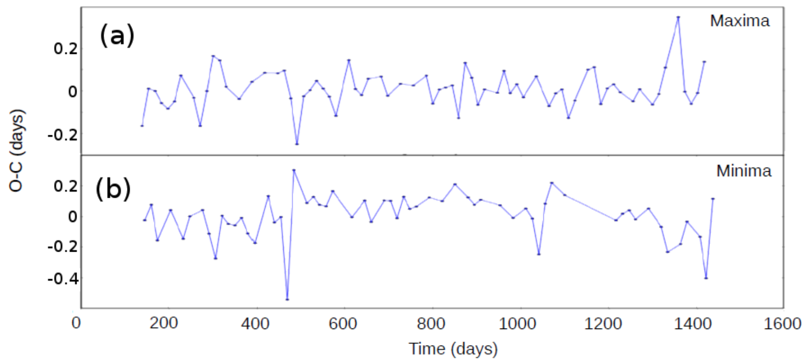

Fig. 1. O-C Diagram of KIC2569073 based on (a) maxima of lightcurve (b) minima of lightcurve.

period of 14.664 days between approximately 0.2 and -0.2 days for the maxima peak times and between 0.4 and -0.4 days for the minima peak times. This corresponds to a period variation in peak times of approximately $\Delta P/P \leq 1.5\%$ and $\Delta P/P \leq 3\%$ for the maxima and the minima, respectively. This is slightly larger than the $\Delta P/P \leq 0.5\%$ value obtained for V1154 Cyg by [1] but is smaller than the period variations of approximately $\Delta P/P \leq 5\%$ and 10% for the two Cepheids investigated by [2].

Convection has been difficult to observe in Cepheids in the past but data from the Kepler mission has now enabled us to make direct observations of the granulation noise within a Cepheid for the first time. We conducted a Fourier analysis of this light curve and subtracted off the frequency of maximum amplitude and the first five harmonics (Figure 2). This power spectrum will allow for further investigation and understanding of the role convection plays in Cepheid pulsations.

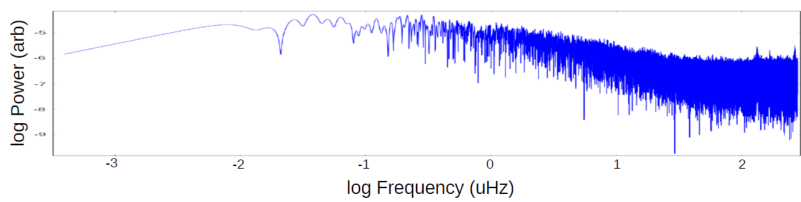

Fig. 2. Power Spectrum of Granulation Noise for KIC2569073.

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