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Photometry Using *Kepler* "Superstamps" of Open Clusters NGC 6791 & NGC 6819

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Abstract. The *Kepler* space telescope has proven to be a gold mine for the study of variable stars. Usually, *Kepler* only reads out a handful of pixels around each pre-selected target star, omitting a large number of stars in the *Kepler* field. Fortunately, for the open clusters NGC 6791 and NGC 6819, *Kepler* also read out larger "superstamps" which contained complete images of the central region of each cluster. These cluster images can be used to study additional stars in the open clusters that were not originally on *Kepler*'s target list. We discuss our work on using two photometric techniques to analyze these superstamps and present sample results from this project to demonstrate the value of this technique for a wide variety of variable stars.

1 Introduction

While *Kepler*'s high photometric precision and virtually uninterrupted observing cadence made it a revolutionary instrument for the study of oscillating stars, the fact that only a small postage stamp of pixels were read out around pre-selected stars meant that no photometric information was obtained for the majority of stars in its field of view. The exception to this mode of operation was for the open clusters NGC 6791 and NGC 6819 where large 200×200 pixel (13.3 arc minutes on a side) superstamps covering the central regions of the clusters were obtained by *Kepler* in long cadence mode. These superstamps provide an opportunity to obtain photometric information on the non-target stars in these regions. The goal of this project is to use traditional photometric techniques to obtain light curves for as many stars as possible in the superstamps.

2 Photometry

Two photometric techniques were used on the cluster superstamps. Aperture photometry was performed on the relatively uncrowded stars in each superstamp. A custom-written program was used to create custom aperture masks for each star for each quarter; this was necessitated by the irregular PSF shapes on the CCD.

The crowded nature of the cluster centers and the large pixel scale (3.98 arc seconds per pixel) results in the majority of the stars in the clusters being at least partially blended, rendering them unsuitable for aperture photometry. This is also the region that contains the most promise for finding new variable stars in the clusters. In order to obtain photometry for these blended stars, we performed image subtraction using Wojtek Pych's DIAPL2 package[1]; DIAPL2 is an improved version of the DIAPL package [1].

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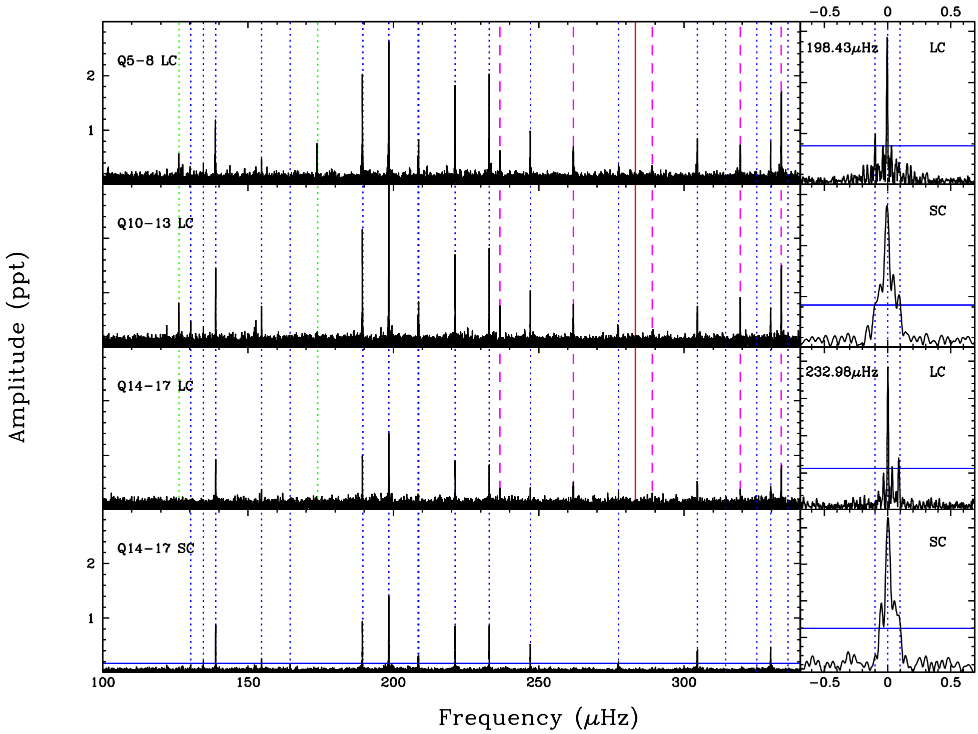

Fig. 1. Amplitude spectra for the sdB star KIC 2569576, located in NGC 6791. The left panels show different segments of long cadence (LC) data from the superstamps (top three panels) compared to the short cadence (SC) data obtained through GO observations (bottom panel). The green lines indicate frequencies that were not seen during the SC observing period but which are evident in the other quarters. The right panels show two multiplets in both SC and LC data; the full 17 quarters of LC data from the superstamps allow the multiplets to be resolved which was not possible with only the SC data from quarters 14-17 from GO observations.

3 Results

The biggest advantage of the cluster superstamps is that they allow us to obtain photometry of stars that were not selected as target stars, allowing for the identification of new variables. We are currently in the process of identifying and classifying new variables but one of the early results is the discovery of a new Cepheid variable, KIC 2569073, only the second star of this type found in the *Kepler* field[2].

Many of the stars observed by *Kepler* as part of the guest observer (GO) program were only targeted for a portion of the mission. Thanks to the superstamps, we can now obtain photometry of these stars for the entire duration of the mission. This additional data provides many benefits to the analysis of these variables; see Figure 1 for an example.

References

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