Using Kepler Data to Classify the Evolutionary State of Red Giant Stars

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Abstract

Utilizing Kepler long cadence data from quarters 4 through 11, a blind study was performed of the long period (>1 day) variability of 200 giant stars previously identified as hydrogen shell burning (Red Giant Branch – RGB) giants or helium core burning (Red Clump) giants by the Bedding et al. (2011) asteroseismology study. By focusing on periods between 1 and 30 days, a relationship was found between the amplitude of the strongest period and the Red Giant evolutionary state. A second blind test using this diagnostic was able to correctly predict the evolutionary state of the Red Giants -RGB or Red Clump - with 82% accuracy.

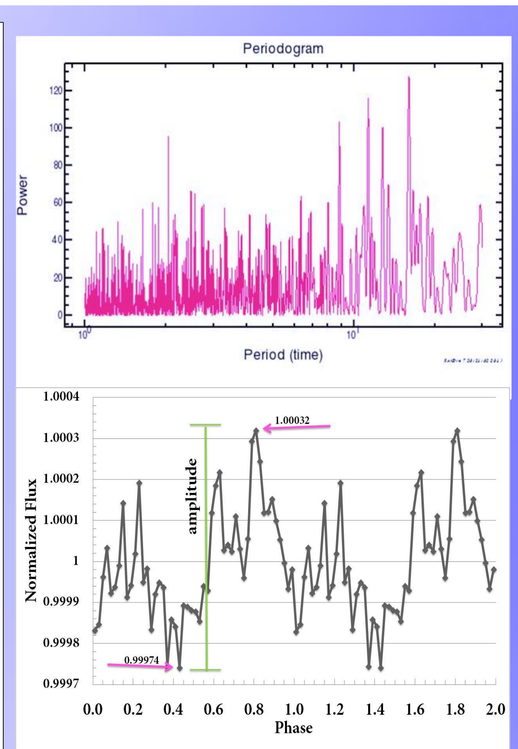
The goal was to find a diagnostic that would allow for ground based differentiation, but the typical amplitudes were less than 0.5 mmag. Understanding this difference may lead to a better understanding of the Red Giant evolutionary process. This research made use of the NASA Exoplanet Archive and was made possible through the NASA/IPAC Teacher Archive Research Program (NITARP), funded by NASA Astrophysics Data Program and Archive Outreach funds.

Method

1. Chose 200 stars with previously identified evolutionary states from Bedding, T. R., et al., 2011, Nature, 471, 608 study.
2. Used Exoplanet Archive periodogram function to identify strongest period for each star (figure 1).

http://exoplanetarchive.ipac.caltech.edu/

3. If phase bin period was sinusoidal, determined amplitude. If not, removed star from sample (figure 1).
4. Identified amplitude as diagnostic that split stars into groups.
5. Used amplitude diagnostic to complete a blind test by classifying 40 additional stars.



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- Strongest period: 15 days
- Amplitude: 0.00058
- Red Clump

Figure 1

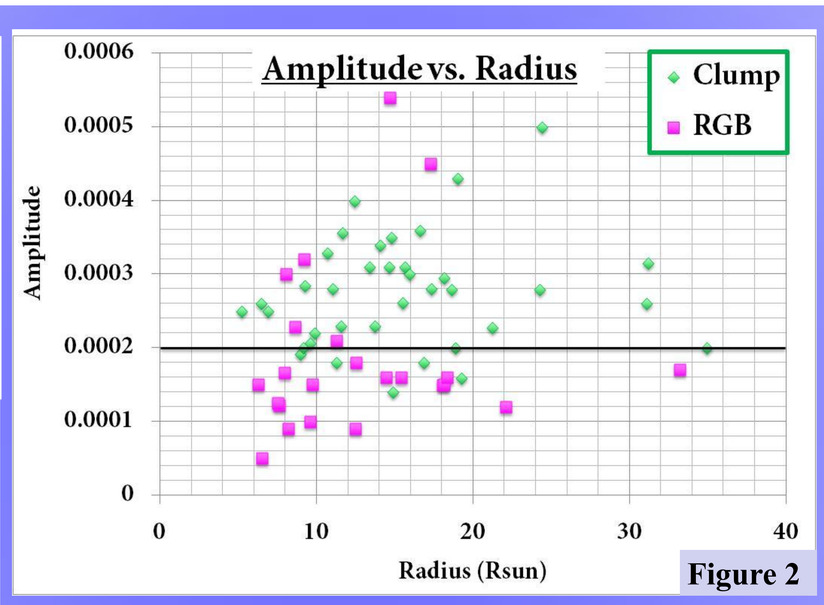

Figure 2

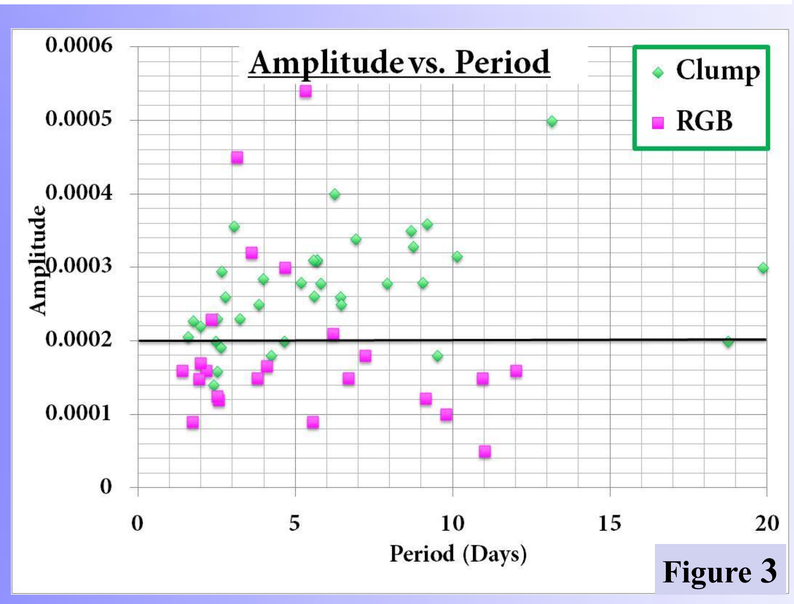

Figure 3

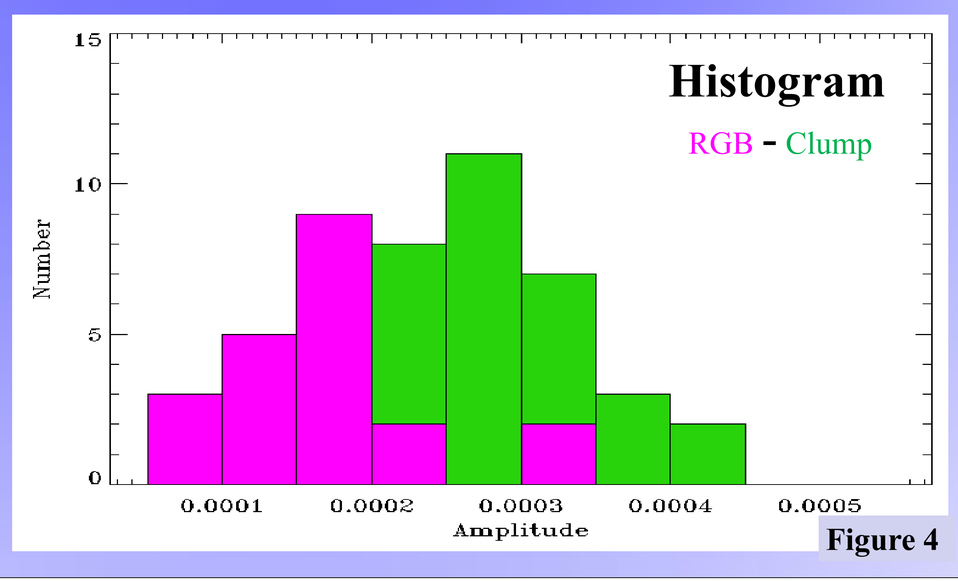

Figure 4

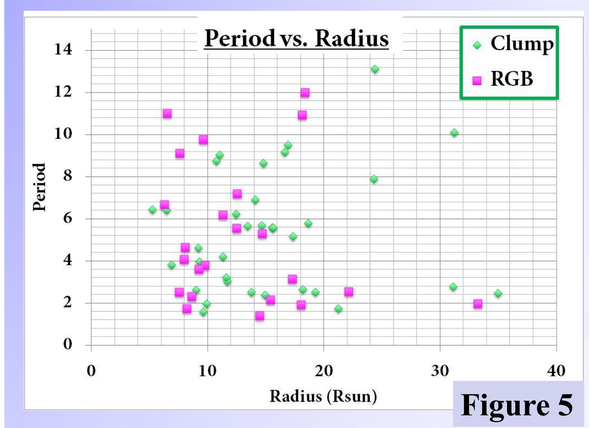

Figure 5

Results

- When examining stellar periods between 1 and 30 days, we found a relationship between amplitude of the strongest period and the evolutionary state of Red Giant stars (figure 2 and 3). Amplitude is independent of radius and period, therefore there is no correlation between period and radius (figure 5).
- Amplitude < 0.00020 magnitudes RGB – Hydrogen shell
- Amplitude > 0.00020 magnitudes Red Clump – Helium core (figure 4)
- A second blind test using this diagnostic yielded evolutionary state identification of 40 stars with 82% accuracy, as there is some overlap between Hydrogen shell and Helium core amplitudes.

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