Detection of variable stars in DES ultra-faint dwarf galaxies

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Motivations

Detection and classification of variable stars, specifically RR Lyrae stars (RRLs), lay the groundwork for characterizing their host galaxies:

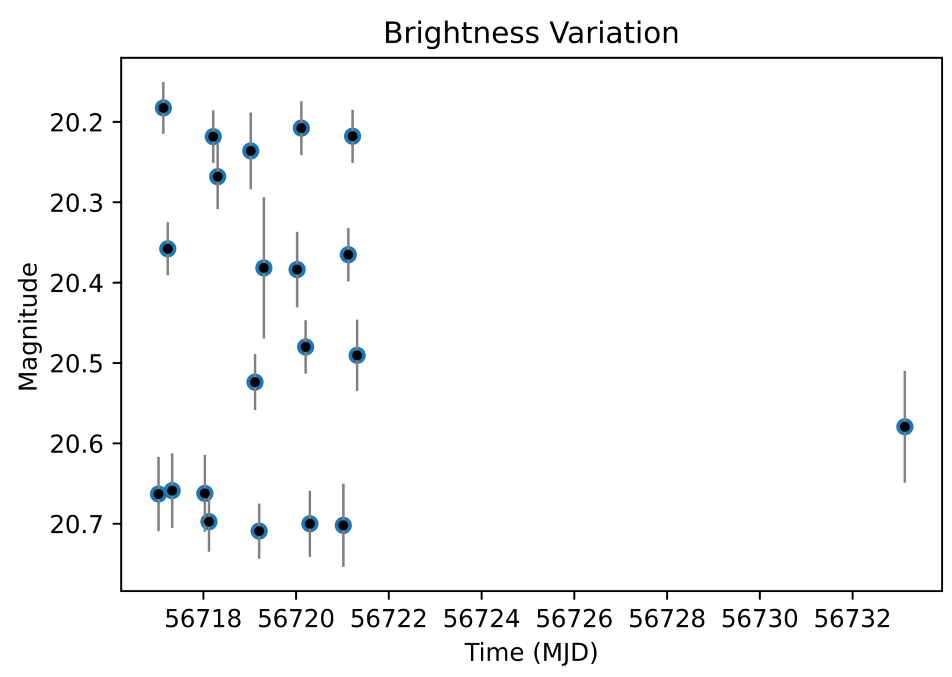
- RRLs are precise distance indicators due to the period-luminosity-metallicity
- RRLs can be used to study the density profiles of the galaxies they belong to
- Studying the density profiles of ultra-faint dwarfs gives insight on the nature of dark matter, as these galaxies are dark matter dominated

As such, identifying and classifying RRLs from a selection set of ultra-faint dwarfs (mostly discovered by the Dark Energy Survey) is the focus of this project.

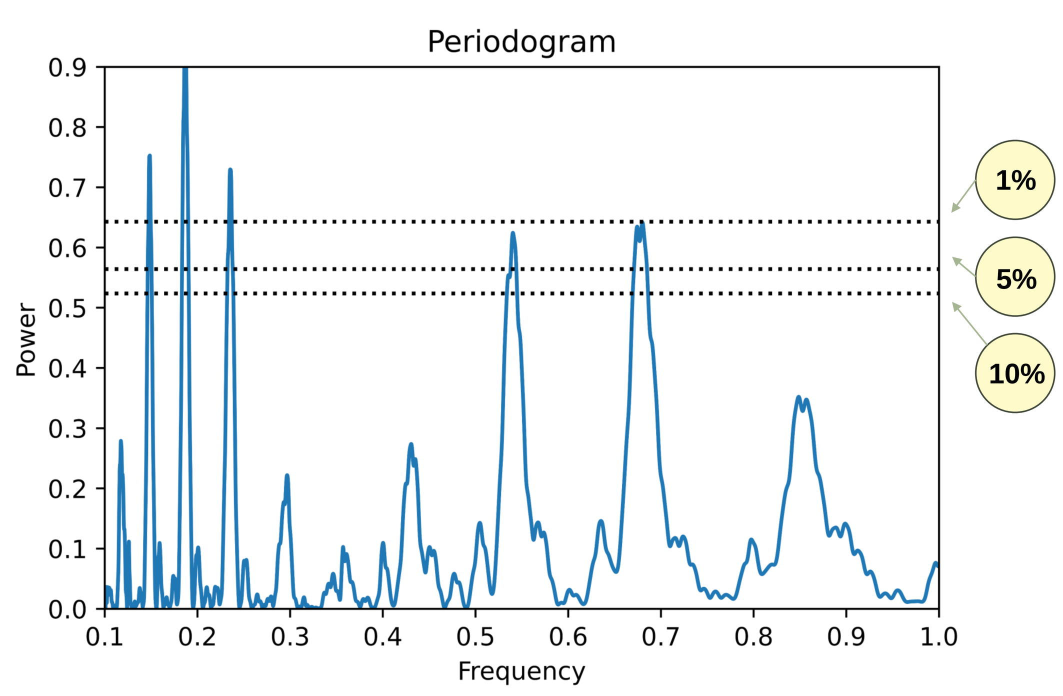
Methods – Frequency Analysis

An important step in determining properties of an RR Lyrae star is through Frequency Analysis:

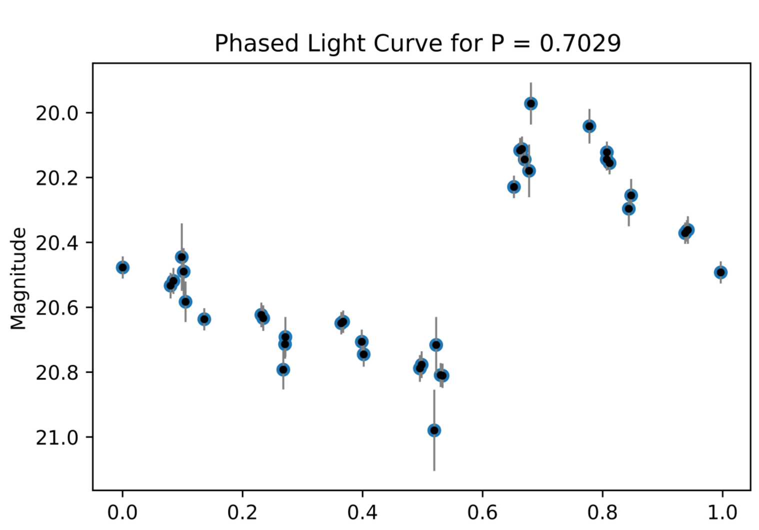
The time series of a star is plotted, this is the first step in finding the pulsation period. The amplitude is found by taking the maximum value of magnitude and subtracting by its minimum value, this information will later help classify the RRL.



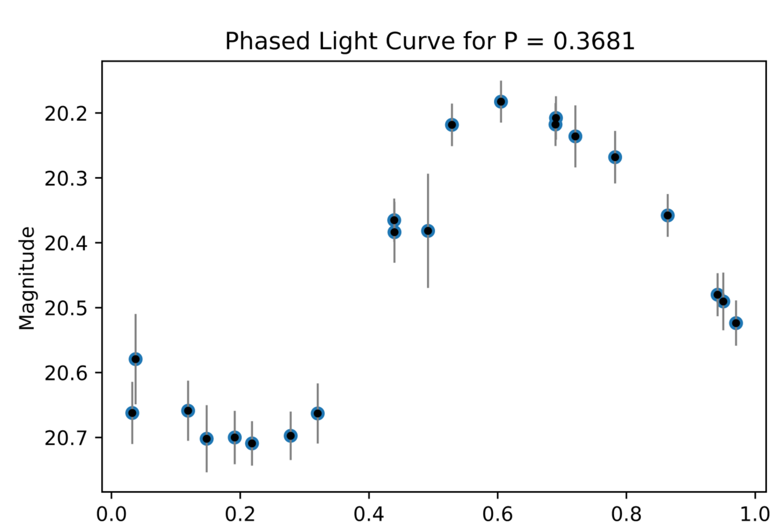
Using Astropy Lomb-Scargle tool, a periodogram is constructed, each peak corresponding with a detected frequency/potential pulsation period. All peaks below the 10% significance lines are considered noise, and periods detected outside of the 0.2-1.0 range are not considered as they fall outside of the expected values. Due to aliasing, period values such as 1.0, 0.5, 0.33 may also be omitted from consideration.



Phased light curves are then constructed from the set of potential pulsation periods being considered. Finally, the star can be classified as RRab or RRc based off the values of its amplitude, period, and the shape of light curve.



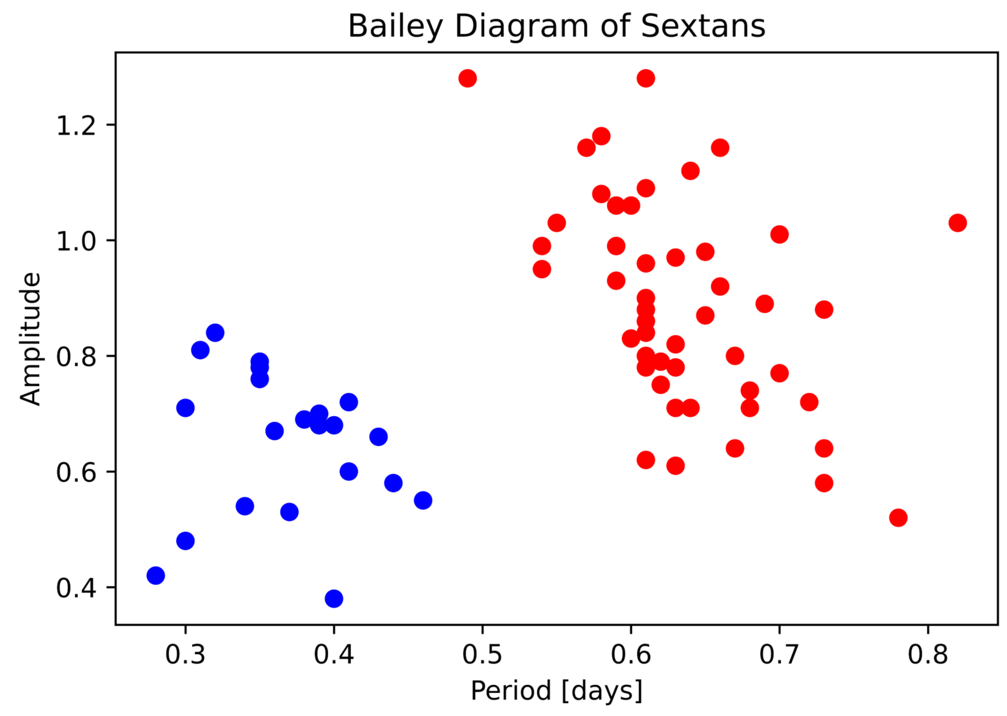
RRab



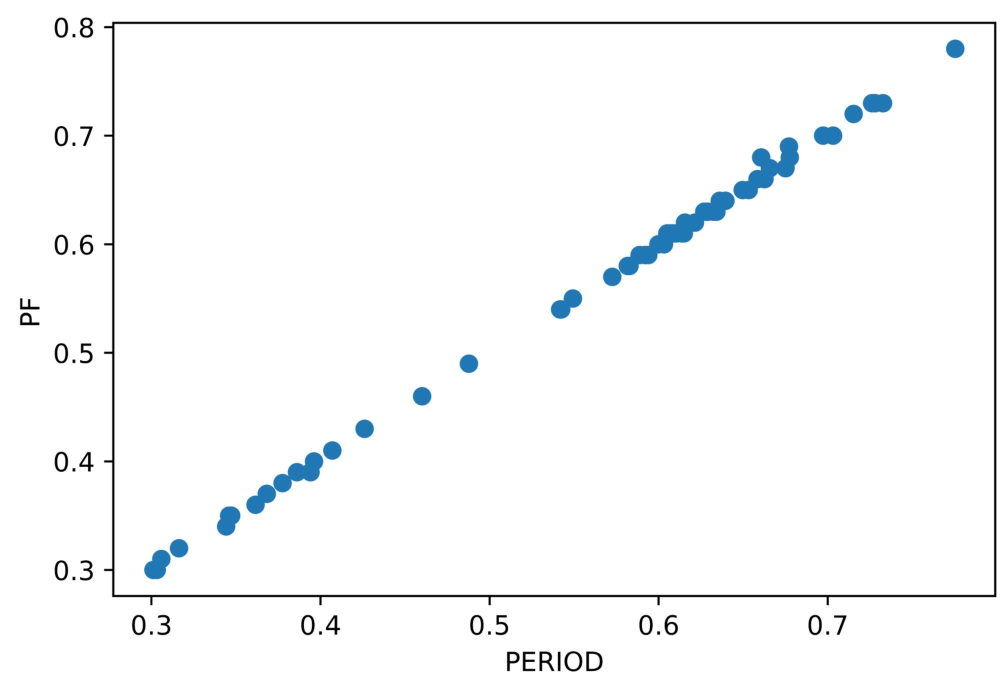
RRc

Results – Sextans Dwarf Galaxy

By conducting Frequency Analysis over a catalogue of 173 stars from the Sextans dwarf, 70 RR Lyrae stars were identified. Of the 70, 49 were classified as type RRab, and 21 were classified as type RRc . In the Bailey Diagram below, red indicates type RRab and blue indicates type RRc.



65 of these RRL crossmatched with a previous catalogue. Comparing the value of the respective pulsation periods, we get the following graph.



Measuring the strength of the linear relationship, the value of its correlation coefficient is 0.9995.

Future Steps

Analyzing the RRLs of Aquarius II [1] is an immediate next step, as photometric data in the g-, z-, & i- bands are available, with g band containing 19 epochs, and therefore allowing for the building of time series. With this information, in addition to the color information, robust identification of RRLs in this galaxy will be possible.

Subsequent iterations of this project would include conducting the frequency analysis detailed in Methods over a catalogue of stars from a set of ultra-faint dwarf galaxies:

- Tucana IV [2]
- Cetus II [3]
- Reticulum II [4]
- Horologium II [5]
- Eridanus III [6]

References

[1]Torrealba G., et al. 2016, MNRAS, 459, 2370. doi:10.1093/mnras/stw733
[2] Drlica-Wagner A., et al. 2015, ApJ, 813, 109. doi:10.1088/0004-637X/813/2/109
[3] Drlica-Wagner A., et al., 2015, ApJL, 809, L4. doi:10.1088/2041-8205/809/1/L4
[4] Koposov S. E., et al., 2015, ApJ, 811, 62. doi:10.1088/0004-637X/811/1/62
[5] Koposov S. E., et al. 2015, ApJ, 805, 130. doi:10.1088/0004-637X/805/2/130
[6] Kim D., Jerjen H., 2015, ApJL, 808, L39. doi:10.1088/2041-8205/808/2/L39

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