Spectroscopy and Physical Properties of RR Lyrae Variable Stars

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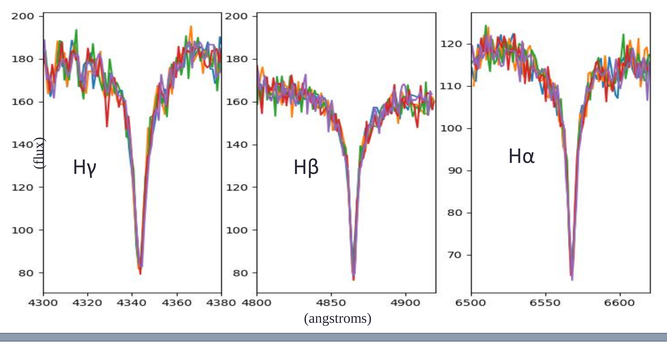
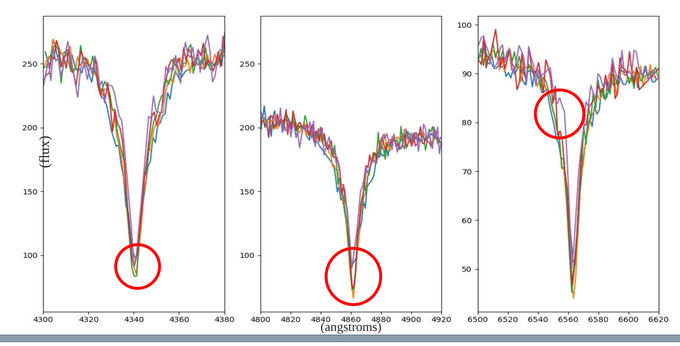
ABSTRACT

The Large sky Area Multi-Object fiber Spectroscopic Telescope (LAMOST), Sloan Digital Sky Survey (SDSS), and the General Catalog of Variable Stars are surveys which collect data on stars within the Milky Way Galaxy. Spectra observed by LAMOST, as well as spectra observed by SDSS, were cross matched with known RR Lyrae type stars in GCVS. This provided spectral data for these variable stars. The hydrogen Balmer series is particularly important in these stars. Two different methods were used in order to link spectral properties to variability: determination of wavelength shifts due to radial velocity, and chi-square differences for changes in flux. Results showed that these methods have notable correlations to variability.

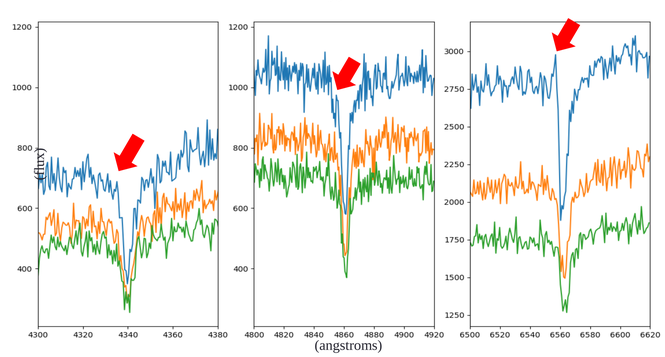
Regular Star



Variable Star



Variable Star with Hypersonic Shockwave



INTRODUCTION

What is an RR Lyrae?

- Type of variable star
- Short periods (<1 day)
- Commonly found in globular clusters

What are Balmer lines?

- Caused by changes in electron energy levels in hydrogen atoms
- Different lines occur at different wavelengths
- Always end in the n = 2 quantum state

Chi-square equation

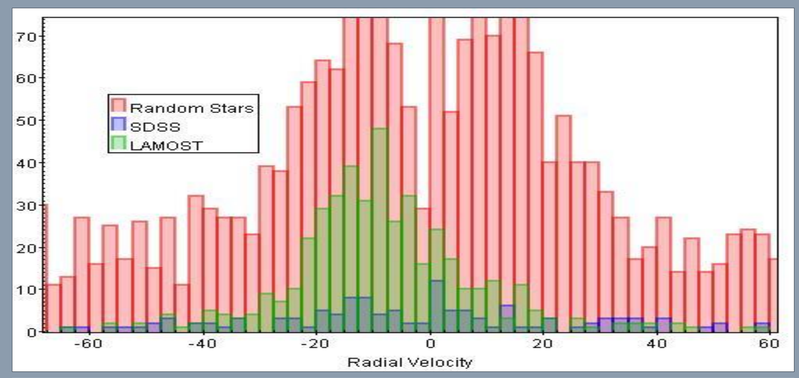
$$\chi^2 = \frac{1}{N}\sum_i \frac{(f_1 - f_2)^2}{\sigma_1 \sigma_2}$$

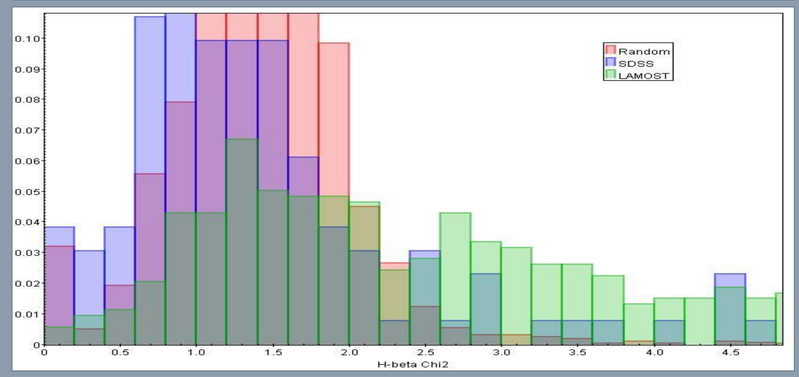
METHODS

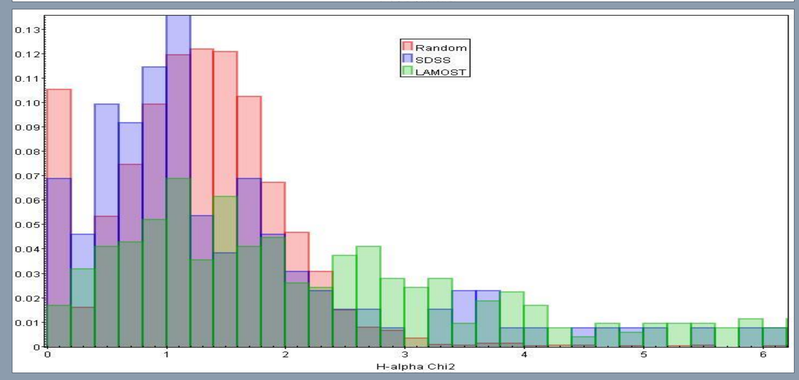
- Cross-matched SDSS/LAMOST with GCVS using positions on the sky
- Plotted resulting spectra
  - Visually examined hydrogen Balmer series, specifically Hα, Hβ, and Hγ
- Searched for spectroscopic indicators of variability using two methods:
  - Radial Velocity - Changes in wavelength (x-axis)
  - Chi-square - Changes in flux (y-axis)
- Determined cuts on chi-square for Hα and Hβ to select the variable stars
- Cross-matched 3998 random SDSS stars with SIMBAD[1]
  - Tested accuracy of cuts

RESULTS

- 43% of hypersonic SDSS candidates were recovered with our cuts
  - 14 stars were visually selected, 6 of which matched the cuts
- 1.2% of stars matched with SIMBAD were recovered
  - SIMBAD listed 311 of 1675 stars to be RR Lyrae
  - 20 RR Lyrae stars satisfied our cuts for Hα & Hβ
- 24% of variable SDSS candidates were recovered
  - 49 stars were visually selected, 12 of which passed the cuts
- In our random selection of 3998 stars, there are 5 RR Lyrae candidates not already in SIMBAD
- If we were to expand this fraction to the entire SDSS database of 115,965 stars with similar characteristics, we would expect to find 145 new RR Lyrae star candidates







FUTURE WORK

- Analyze Radial Velocity trend lines and their correlation to variability
- Create python script which optimizes Hα and Hβ cuts based on recovery rate
- Use analysis method on LAMOST database to find potential RR Lyrae candidates
- Follow up observations on candidates to verify their variability

REFERENCES

1. SIMBAD Astronomical Database – CDS (Strasbourg) http://simbad.u-strasbg.fr/simbad/