Searching for RR Lyrae in The Dark Energy Survey

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Takeaway

In the near future our team led by Katelyn Stringer will be releasing the DES RRab catalog covering 5,000 square degrees containing ~5800 RRab stars of which ~30% are new and mainly in the distant outer halo of the Milky Way.
Outline

- Tracing (Sub)Structure with RR-Lyrae
- DES data
- Fitting Light Curves and Classifying Objects
- Preliminary Results
Tracing (Sub)Structure with RR-Lyrae

- Precise distances to known objects
- Properties of Galactic Halo
- Characterization of 3d geometry
- Identification of streams
- Identification of distant dwarfs

Hernitschek+2018
Tracing (Sub)Structure with RR-Lyrae

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Hernitschek+2017
Tracing (Sub)Structure with RR-Lyrae

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Mateu+2018
Recent wide field RR Lyrae Catalogs

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DES Data

- Using Y3 data over ~700,000 objects pass quality and variability cuts
- Co-add g depth is ~23
- Median number of observations per object is 18 (~4 in each band grizY)
Challenges in using DES

SDSS data

DES data

Magnitude vs. Phase for SDSS and DES data. The graphs show the magnitude of light at different phases, with colors indicating different filters: g, r, i, z, Y. The phase range is from 0 to 2.0.

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Challenges in using DES

Multi-band Lomb Scargle

SDSS data, Period=0.61431

DES data, Period=0.66554

Magnitude

Phase

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Template Fitting

Returns:

\( \mu \) - Distance modulus

\( A \) - Amplitude

\( P \) - Period

\( \phi \) - Phase offset

\( M_b \) - Magnitude

Sesar ID 1013184
Distance = 112651 pc
Example Fit

Unfolded DES Light Curve

Folded Light Curve with Template Fit

MJD - 56545.36

Phase

Magnitude

g
r
i
z
Y

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Random Forest Classification

Trained on DES measurements of RRab, variables, & standards from SDSS Stripe 82

Purity ~ 85%

Completeness ~ 75%

Purity/Completeness Curve, Stripe 82
Random Forest Classification

Synthetic light curves used to characterize behavior at fainter than $g \sim 21$

Distance Modulus error $\sim 0.12 \text{ mag}$

$\sim 5\%$ of dist

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Comparison to other surveys

Red-DES RRab

Blue-Previous RRab that are in DES DR1 catalog as objects

Orange- Previous RRab recovered in this analysis

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RRab candidates

OPTICS Clustering RRab candidates

Left: Color is distance
Blue = close, red = far

Right: color indicates group
All distances in kpc
Science with the catalog

- Identify RRab member stars of dwarfs and streams at large projected distances
- Already been used to augment CRTS and SOAR light curve observations of the Tuc III stream (Martínez-Vázquez in prep)
- Characterize 3D structure of classical dwarfs
- Use clustering algorithms to search for overdensities
- Characterize the Galactic halo profile at very large radii
- More!
Conclusions

- The RRab stars in the Dark Energy Survey probe an interesting parameter space in the outer halo to ~230 kpc over a wide field (5000 sq deg).

- Using template fitting and a random forest classifier we were able to identify sparsely sampled RRab light curves.

- In the near future we will be releasing a catalog containing ~5,000 RRab candidates (~1700 previously unidentified) that we hope will help in exploring (sub)structure in the Milky Way halo.