Searching for RR Lyrae in The Dark Energy Survey

Presented by: Peter Ferguson
Work led by: Katelyn Stringer
with
Lucas Macri, Jennifer Marshall,
Zhenfeng Lin, James Long,

Takeaway

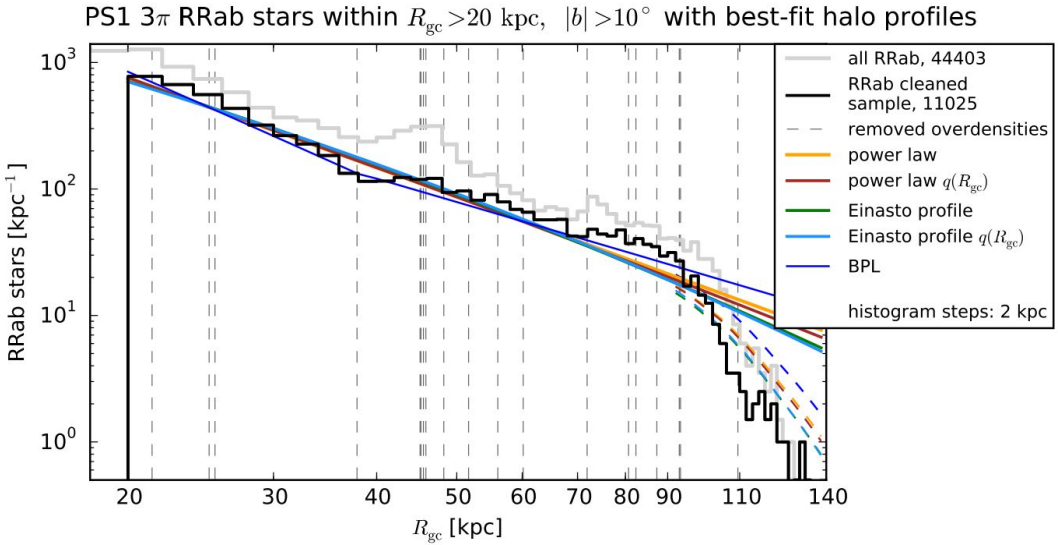
In the near future our team led by Katelyn Stringer will be releasing the DES RRab catalog covering 5,000 square degrees containing ~5800 RRab stars of which ~30% are new and mainly in the distant outer halo of the Milky Way.

Outline

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

Tracing (Sub)Structure with RR-Lyrae

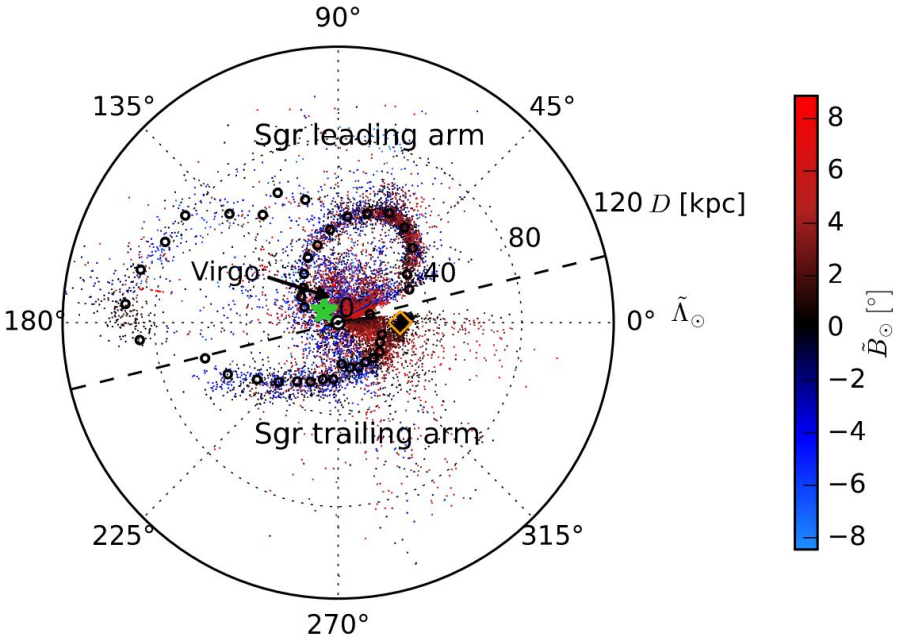
- Precise distances to known objects
- Properties of Galactic Halo
- Characterization of 3d geometry
- Identification of streams
- Identification of distant dwarfs



Hernitschek+2018

Tracing (Sub)Structure with RR-Lyrae

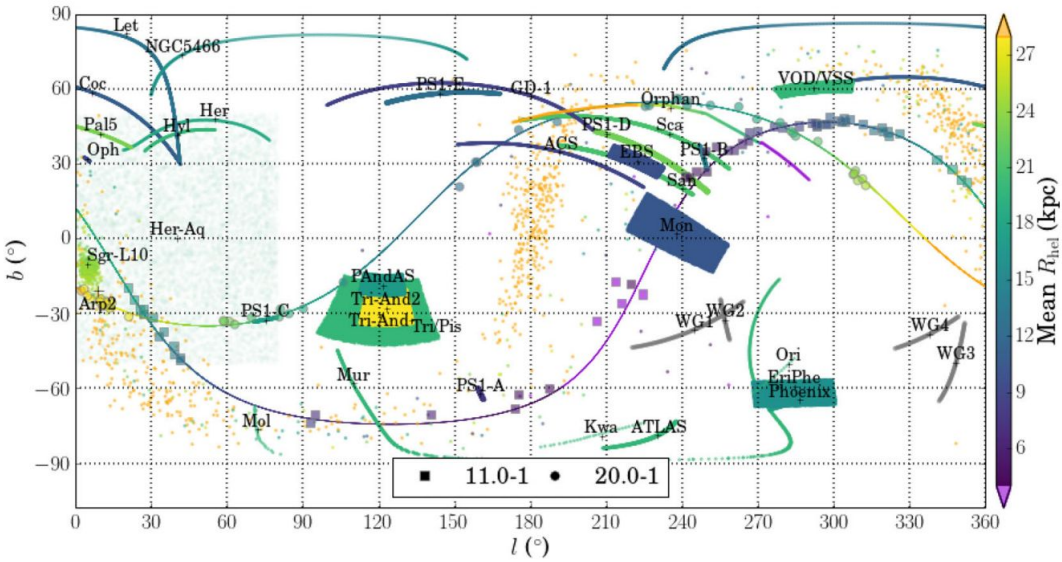
- Precise distances to known objects
- Properties of Galactic Halo
- Characterization of 3D geometry
- Identification of streams
- Identification of distant dwarfs



Hernitschek+2017

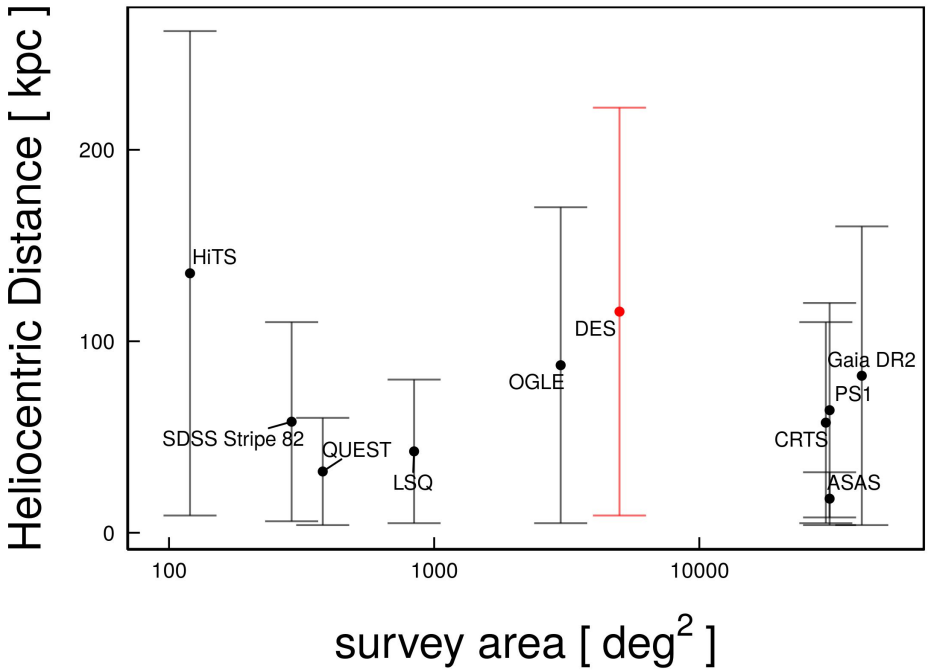
Tracing (Sub)Structure with RR-Lyrae

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



Mateu+2018

Recent wide field RR Lyrae Catalogs

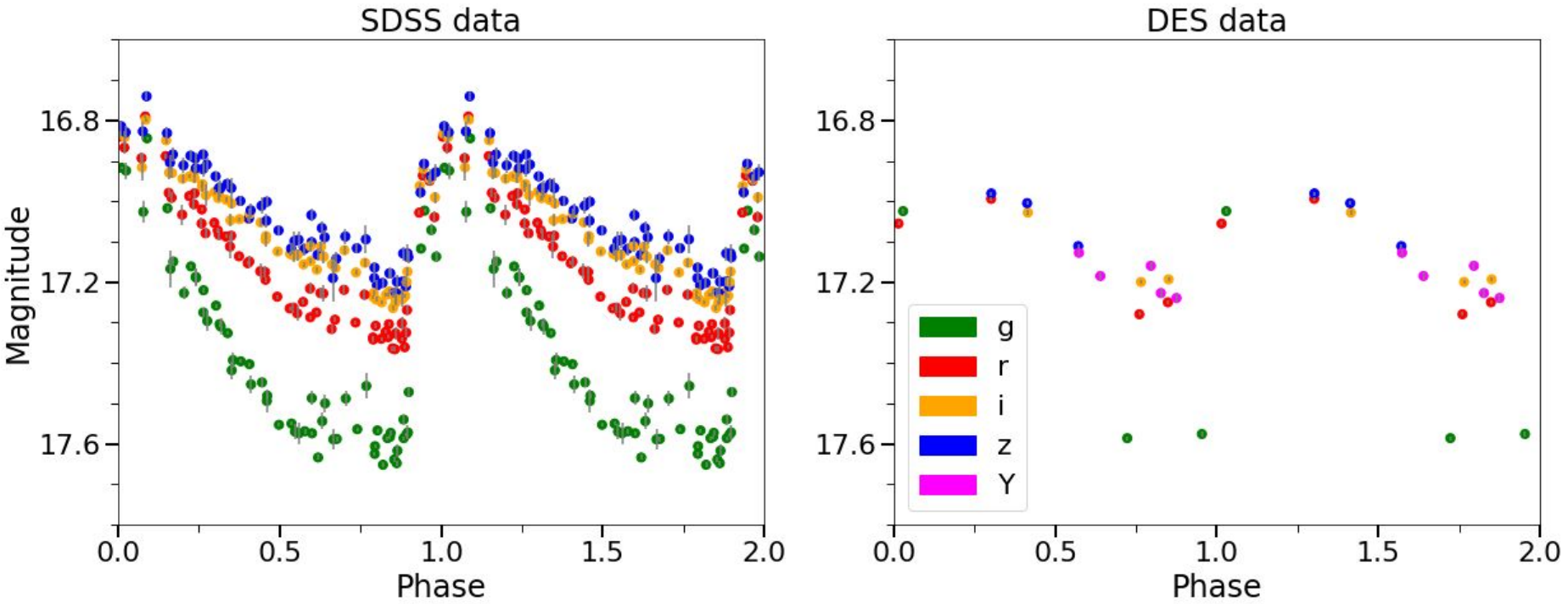


Gaia DR2	Gaia Data Release 2
PS1	PANSTARRS 1
CRTS	Catalina Real-Time Transient Survey
DES	Dark Energy Survey
LSQ	La Silla QUEST
QUEST	Quasar Equatorial Survey Team
SDSS Stripe 82	Sloan Digital Sky Survey Stripe 82
HiTS	High cadence Transient Survey
OGLE	Optical Gravitational Lensing Experiment
ASAS	All Sky Automated Survey

DES Data

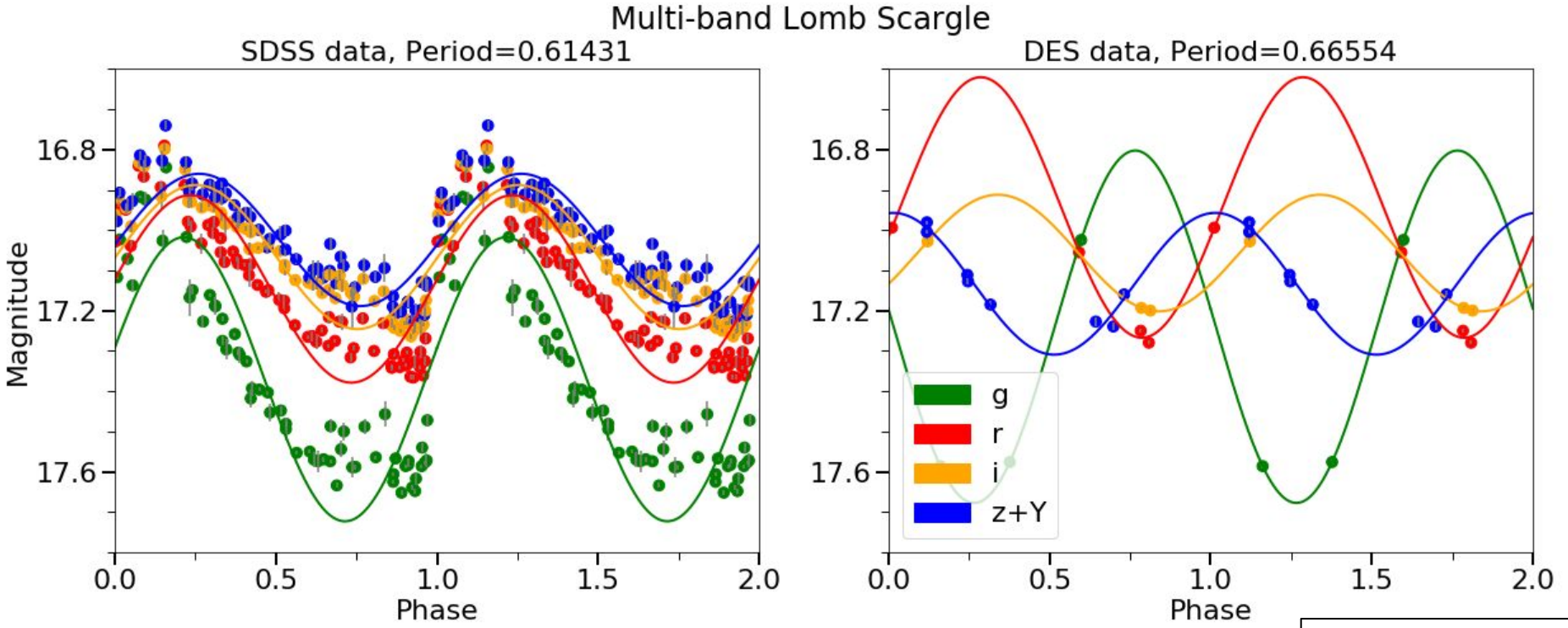
- Using Y3 data over ~700,000 objects pass quality and variability cuts
- Co-add g depth is ~ 23
- Median number of observations per object is 18 (~4 in each band *grizY*)

Challenges in using DES



Stringer + in prep

Challenges in using DES



Stringer + in prep

Template Fitting

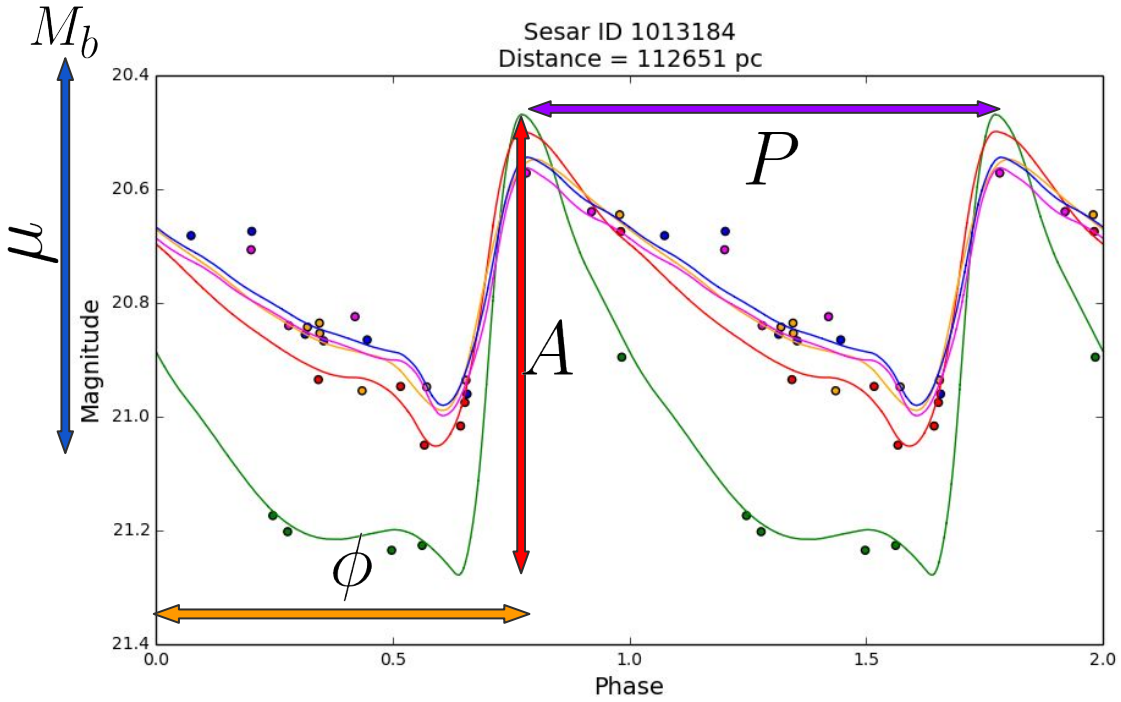
Returns:

μ - Distance modulus

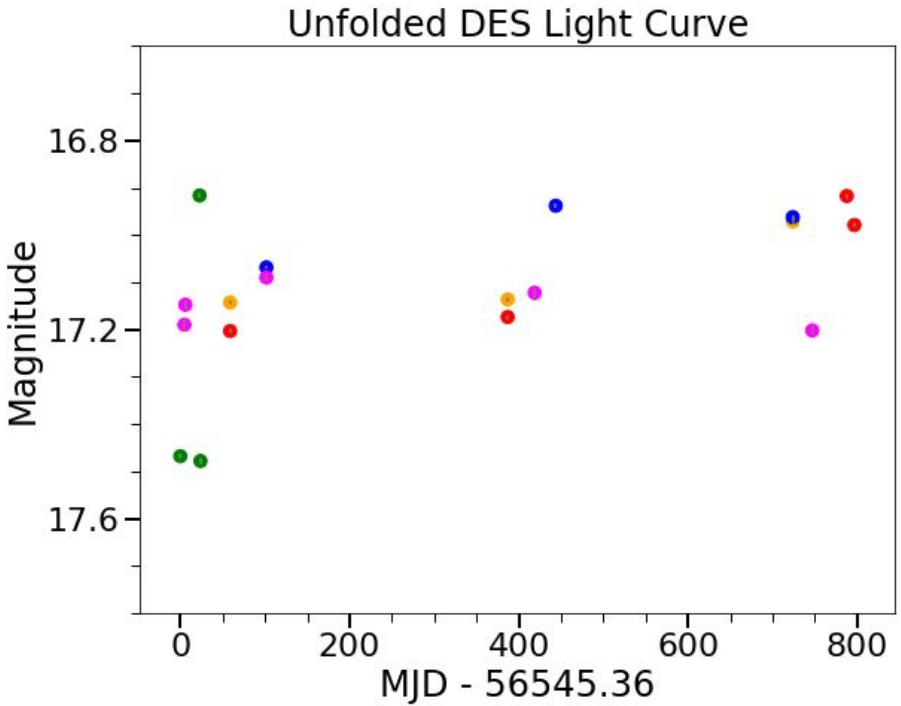
A - Amplitude

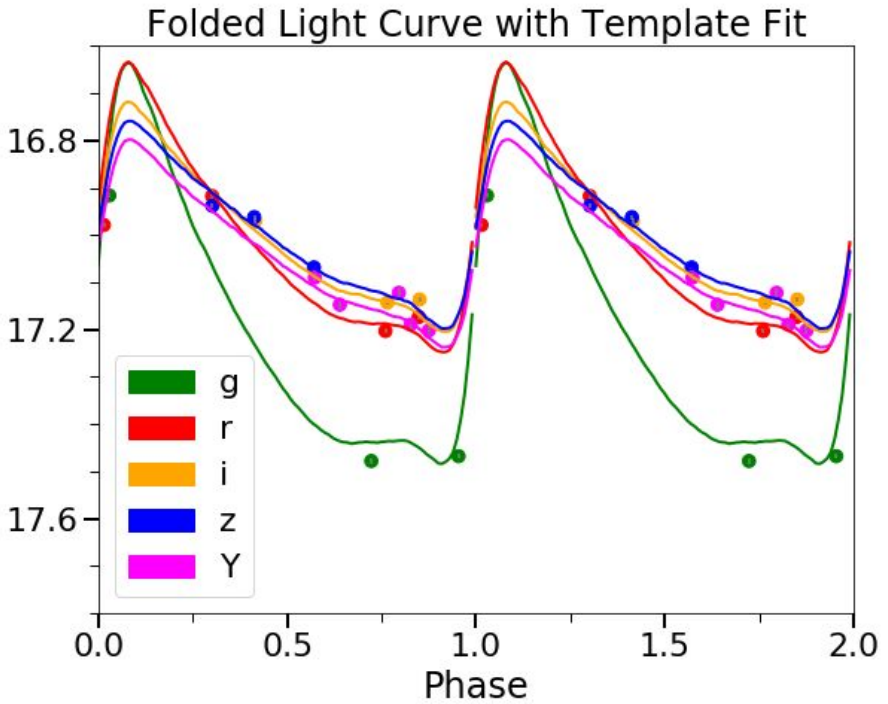
P - Period

ϕ - Phase offset



Example Fit





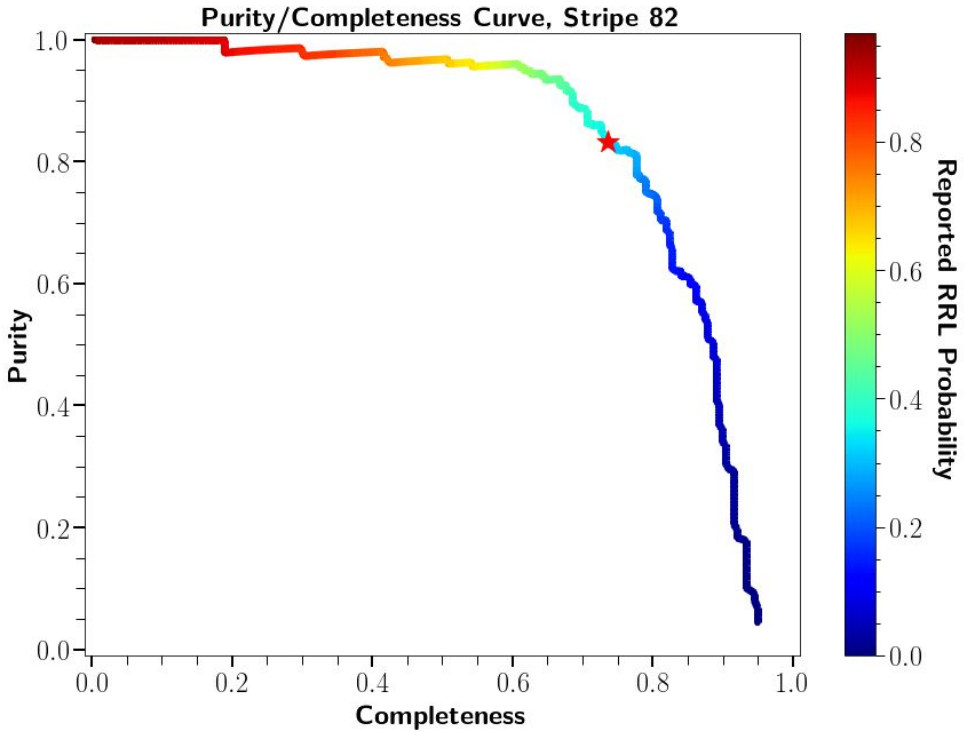
Stringer + in prep

Random Forest Classification

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

Purity ~ 85%

Completeness ~ 75%

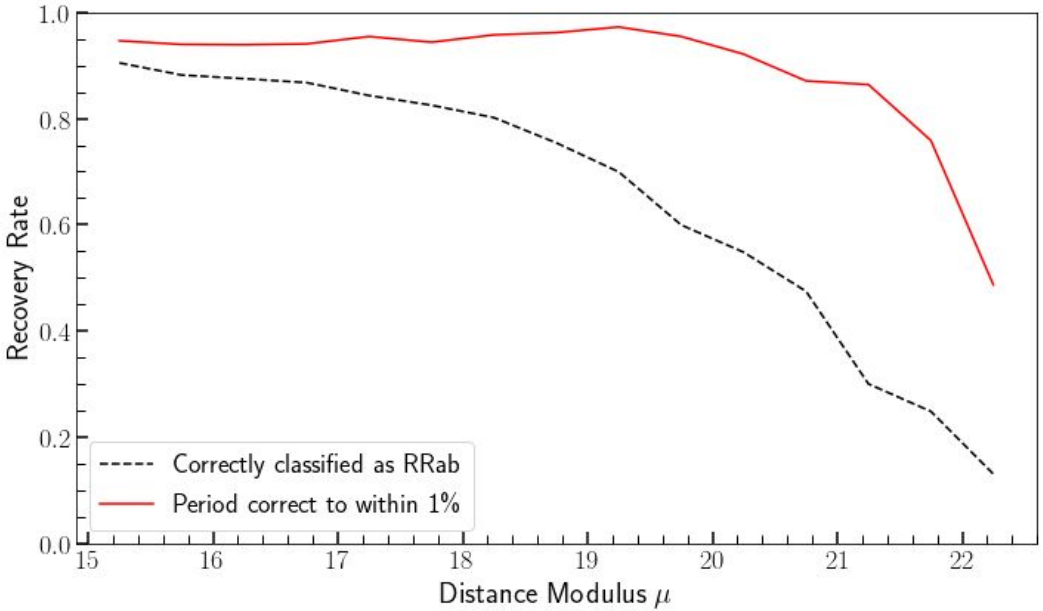


Stringer + in prep

Random Forest Classification

Synthetic light curves used to characterize behavior at fainter than g~21

Distance Modulus error ~ 0.12 mag
~ 5% of dist



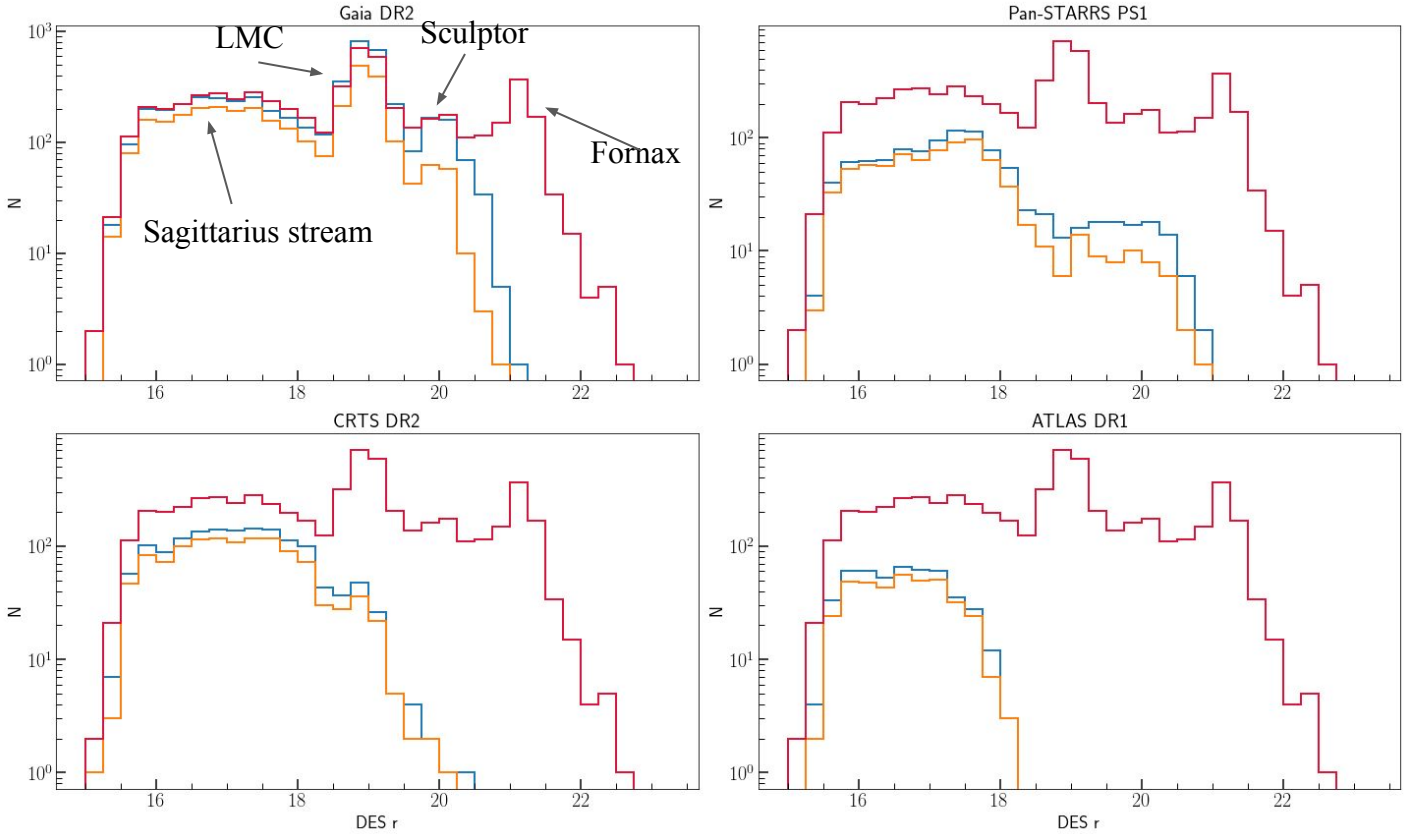
Stringer + in prep

Comparison to other surveys

Red-DES RRab

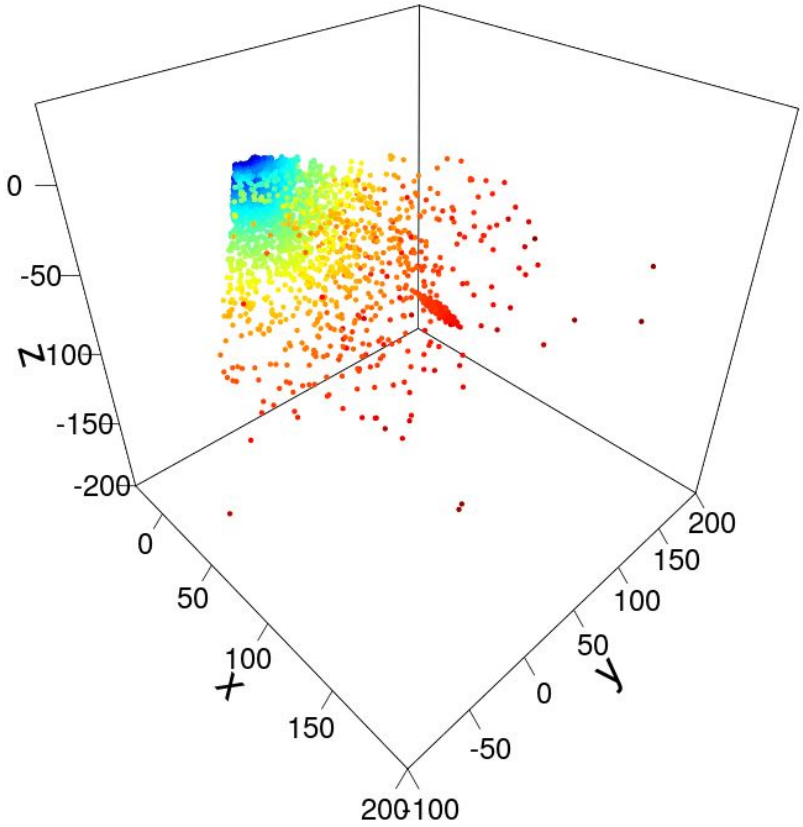
Blue-Previous RRab that are in DES DR1 catalog as objects

Orange- Previous RRab recovered in this analysis

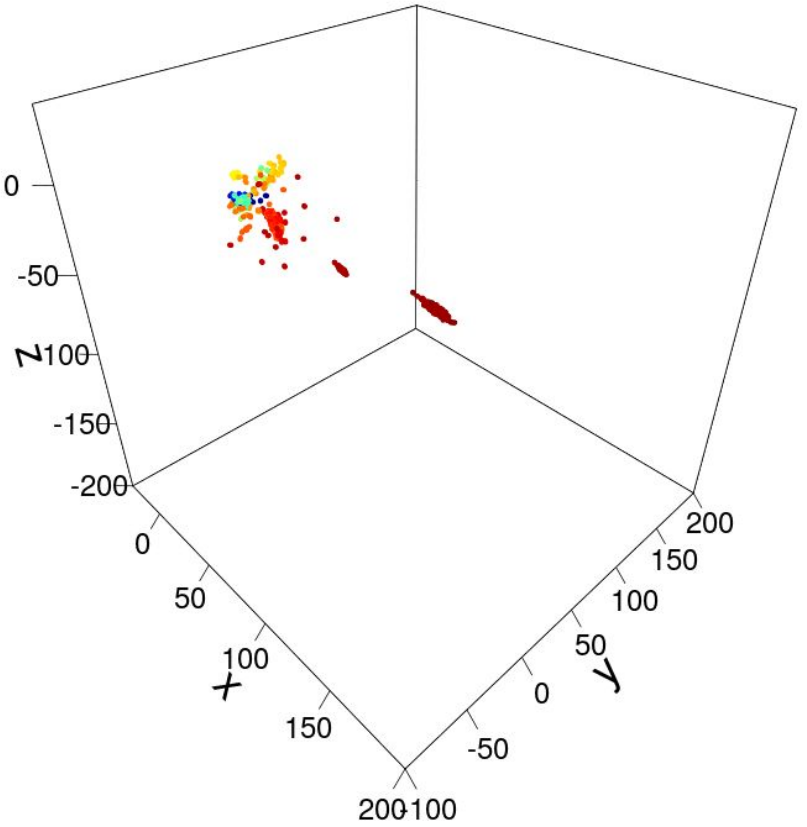


Stringer + in prep

RRab candidates



OPTICS Clustering RRab candidates



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

All distances in kpc

Right: color indicates group

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