STELLAR HALOS WITH LSST

COLIN SLATER
UNIVERSITY OF WASHINGTON
LSST DEPUTY DM SCIENTIST
& DATABASE SCIENCE LEAD
RESOLVED STELLAR POPS

- We’ve heard about resolved halo pops in the 3-10 Mpc neighborhood

- Étendue is the key, enabled by large cameras on 8-m telescopes
Unresolved pops from Virgo to Coma

Requires careful attention to instrumental design, observing strategy, processing methods

A little effort goes a long way with a big survey

INTEGRATED LIGHT

Merritt+ 2016

Mihos 2015

Kado-Fong 2018
Gaia is changing our toolkit for studying the halo

In the halo it’s only measuring the tip of the iceberg

Getting at that signal requires going deeper than 20th mag with well-measured, long term baselines

MW DYNAMICS

Malhan+ 2018
Telescope movie!

https://gallery.lsst.org/bp/#/folder/2943691/76494733
LSST IS FULLY INTO INTEGRATION

- Telescope is being finished and shipped. Dome is in progress.
- Sensor delivery will be complete in ~months. Assembly of sensors into the camera is starting.
- LSST software is producing HSC data releases and distributing ZTF transient alerts.
- Deployments of the user-facing LSST Science Platform (image portal, databases, hosted Jupyter) already operational for in-house users.
LSST IS STILL A REALLY HARD PROBLEM

- Coadds and accurate measurement on numerous epochs is insidiously hard.
- Star-galaxy separation, blending, and measurements of semi-resolved dwarfs are all limiting factors for stellar halos and galactic structure.
- Optimizing the survey strategy is ongoing.
BACKGROUND-MATCHED COADDS

- 5 sq. deg g,r,i composite, 55 epochs
- Background matching uses image differencing to find and remove time-varying sky background, keep constant astrophysical light

Developed in Yusra AlSayyad's Thesis
Non-negative matrix factorization provides generalized fitting for a wide variety of objective constraints.

Currently implemented color-consistency requirement, expand in the future to star/galaxy priors, or cross-instrument information, etc.

**SCARLET:** Source separation in multi-band images by Constrained Matrix Factorization

*Peter Melchior*, *Fred Moolekamp*, *Maximilian Jerdee*, *Robert Armstrong*, *Ai-Lei Sun*, *James Bosch*, *Robert Lupton*

*Department of Astrophysical Sciences, Princeton University, Princeton, NJ 08544, USA*
*Department of Physics & Astronomy, Johns Hopkins University, Bloomberg Center, 3400 N. Charles St., Baltimore, MD 21218, USA*
STAR–GALAXY SEPARATION IS STILL HARD

- Experience with SDSS/PS1 tells us S/G separation gets hard \( \approx 21 \); galaxies begin to dominate.
- LSST single visit depth is \( \approx 24.5 \), coadds >27.
- Understanding why S/G is hard is critical to designing a survey & software to mitigate S/G problems.
By forward modeling the size measurements, including object populations and observing conditions, we can predict completeness/contamination.

Enables us to make smart decisions about survey strategy, target the science-limiting factors for optimization.

Slater & Ivezić, in prep.
S/G modeling disentangles seeing from depth.

Depth, a.k.a. signal-to-noise, is what enables size measurements!

Seeing helps, but also largely by improving SNR.
Better Seeing, same depth

\[
\text{FWHM} = 0.70''
\]

\[
1.00''
\]

\[
1.40''
\]
Better Seeing, same depth
Better Depth
SNR is the key quantity to optimize for Galactic/Stellar/Local Group science.

Seeing factors into that, but it’s less important as an independent goal.
FIDUCIAL SURVEY STRATEGY

Number of visits in all filters (baseline-2018a)

- North Ecliptic Spur
- Galactic Plane
- Deep Drilling Fields
- Wide Fast Deep
- South Celestial Pole

Number of visits

0 200 400 600 800 1000 1200
Call for cadence proposals is out now!

- Deep drilling, Galactic plane, LMC/SMC, your favorite survey topic are all valid proposals.
- Sky coverage and temporal sampling
- Proposals due November 30th

ls.st/c66
Stars, Milky Way, and Local Volume Collaboration

https://milkyway.science.lsst.org
Survey observing simulation movie!

https://www.youtube.com/watch?v=GW---5VehuE