Stream Gap Analysis with Next Generation Surveys

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Image credit: ESA/Hubble and NASA, P. Dobbie et al.





image:Vasily Belokurov, Ana Bonaca

Stream gaps with LSST

Stellar streams are everywhere



Shipp et al. 2018

Stream gaps with LSST

The LSST primary survey will be excellent for stream science •Deep •Wide •Multi-epoch



The LSST primary survey will be excellent for stream science

One of the most exciting science cases is the search for stream gaps



Bonaca et al. 2018

The LSST primary survey will be excellent for stream science

One of the most exciting science cases is the search for subhalo encounters



$5 \times 10^6 \ M_{\odot}$ subhalo encounter

Bonaca et al. 2019

Stream gaps with LSST

Dark matter physics controls the subhalo's properties

WDM

Adhkari et al. 2016

Stream gaps with LSST

CDM

Dark matter physics controls the subhalo's properties



Adhkari et al. 2016 Bose et al. 2016 David Hendel

WDM has 50% fewer subhalos at $3\times 10^8~{\rm M}_{\odot}$

Stream gaps with LSST

CDM

Analytic models can capture single interactions



Position

Erkal & Belokurov 2015 David Hendel

Stream gaps with LSST

Stream density

Analytic models can capture single interactions



Position

Erkal & Belokurov 2015 David Hendel

Stream gaps with LSST

Stream density

Single gap sensitivity

Generative model for streams (galpy's streamdf)
Calibrated to Palomar 5 (CFHT/HST)
Sampled down the main sequence
Photometry and error models for

• SDSS

- CFHT (~DES)
- LSST
- CASTOR
- WFIRST
- Foregrounds from Galaxia



- Backgrounds from Hubble Legacy Fields
- Analytic gap density description

Single gap sensitivity



Might even be possible in Andromeda! related: Pearson et al. 2019

Stream gaps with LSST

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make

Smallest subhalo that can

Single gap sensitivity



LSST footprint is ~10x larger than the WFIRST HLS

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make

Smallest subhalo that can

Realistic, stochastic interactions are more complicated



Stream gaps with LSST

Realistic, stochastic interactions are more complicated



Details of subhalo interaction history -> qualitatively different density structure What is the subhalo mass function? Cutoff? Mass-radius distribution?

Stream gaps with LSST

LSST will provide a clean sample

~11%



Contamination ~50%

Stream gaps with LSST

~22%

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~3%

~13%

LSST will provide the many constraints



Length scale

Density-density powe

Can be used to infer the interaction rate and mass function slope/cutoff



Length scale

Stream gaps with LSST

- Conclusions
- LSST et al. will discover & characterize many new streams
- LSST provides a nice balance between detecting small single gaps in the many
 - streams
 - Sensitivity to 10⁶ M_☉ subhalos; interesting constraints on DM physics
- LSST will allow powerful inference of the subhalo mass function cutoff from statistical density fluctuations



Upcoming extensions

- More streams: GD-1, arbitrary streams
- Multi-stream joint inference of subhalo dN/dM
- Fore/background cleaning with PMs
 - More surveys for improved wavelength/sky coverage, e.g. Euclid, CFIS/UNIONS