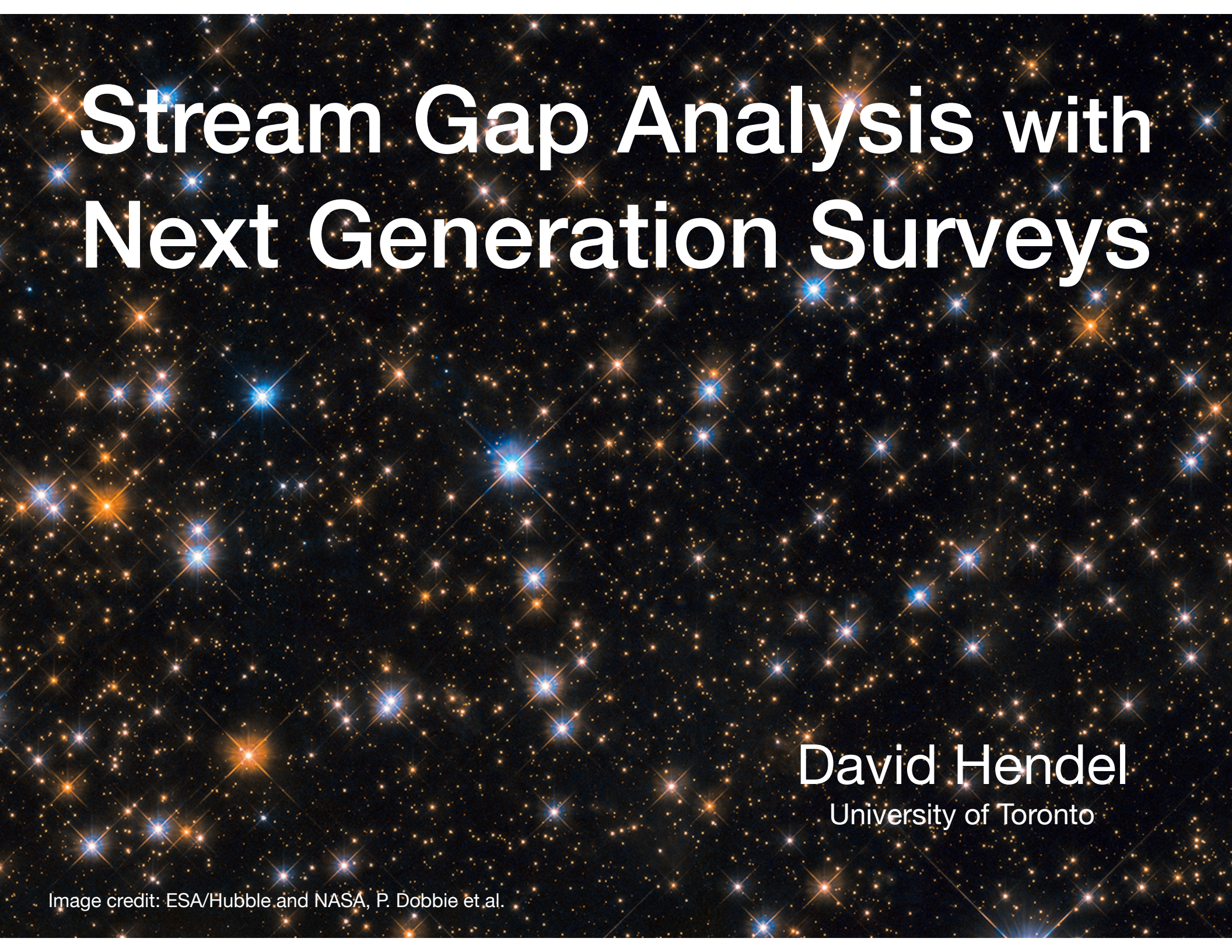
Stream Gap Analysis with Next Generation Surveys



David Hendel
University of Toronto

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

Stellar streams are everywhere

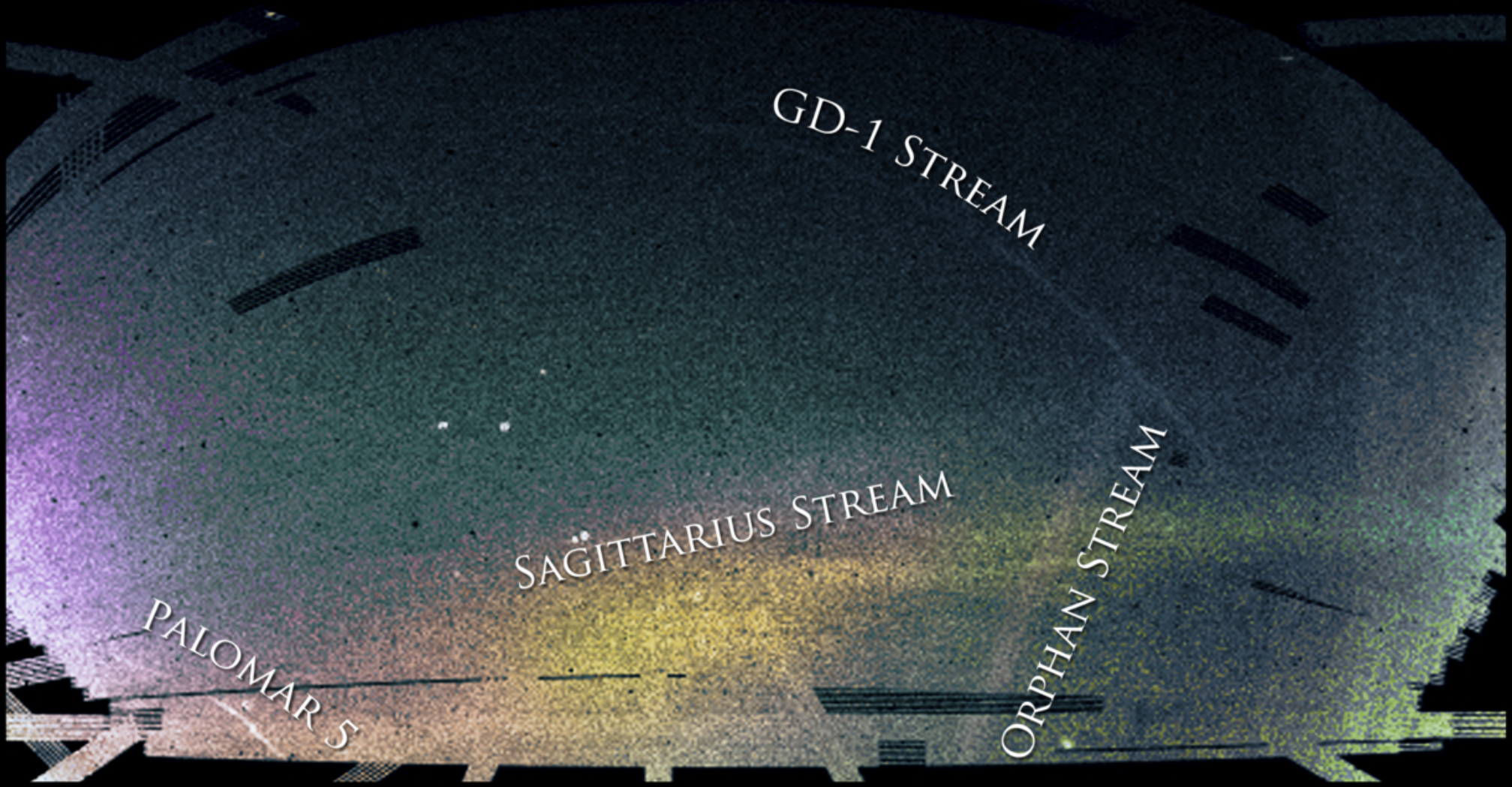
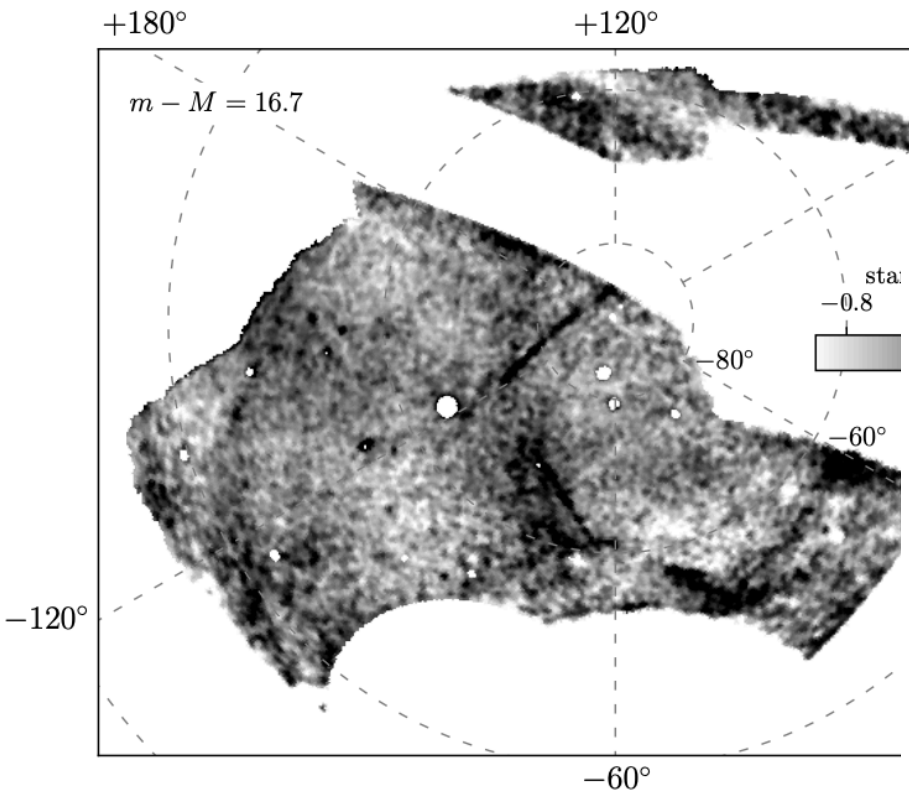
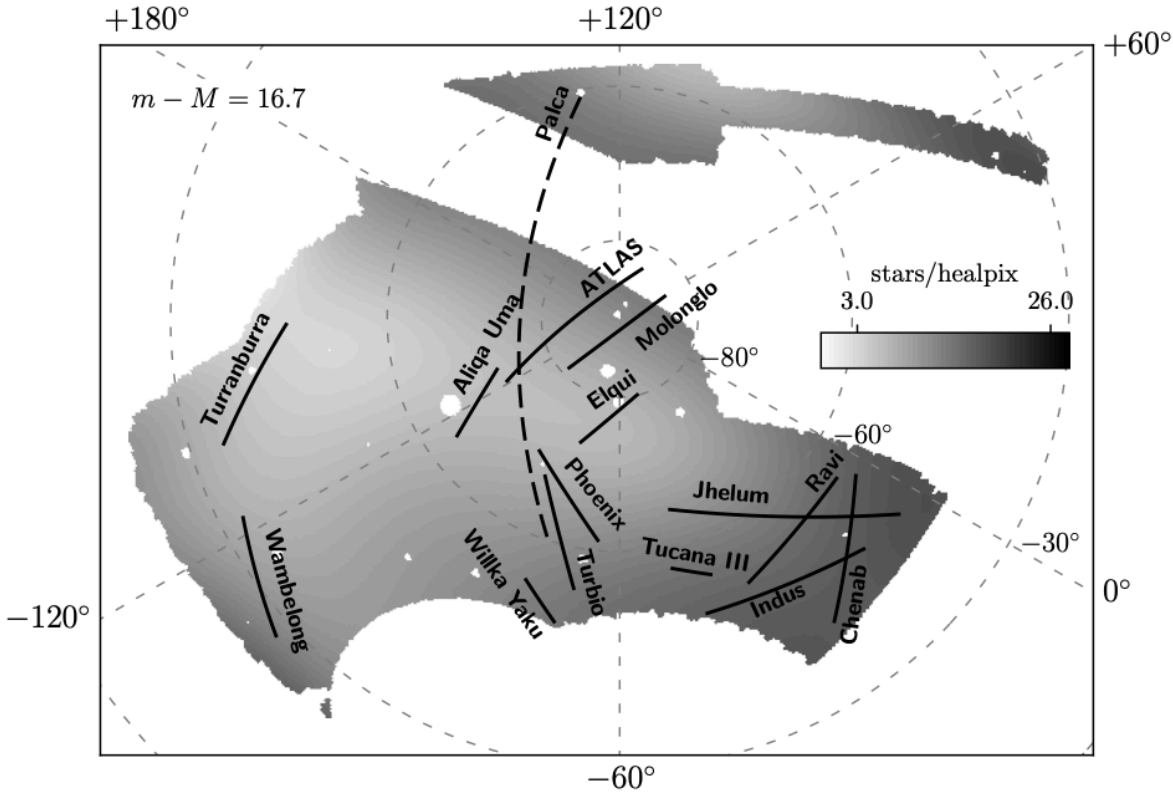


image:Vasily Belokurov, Ana Bonaca

Stellar streams are everywhere

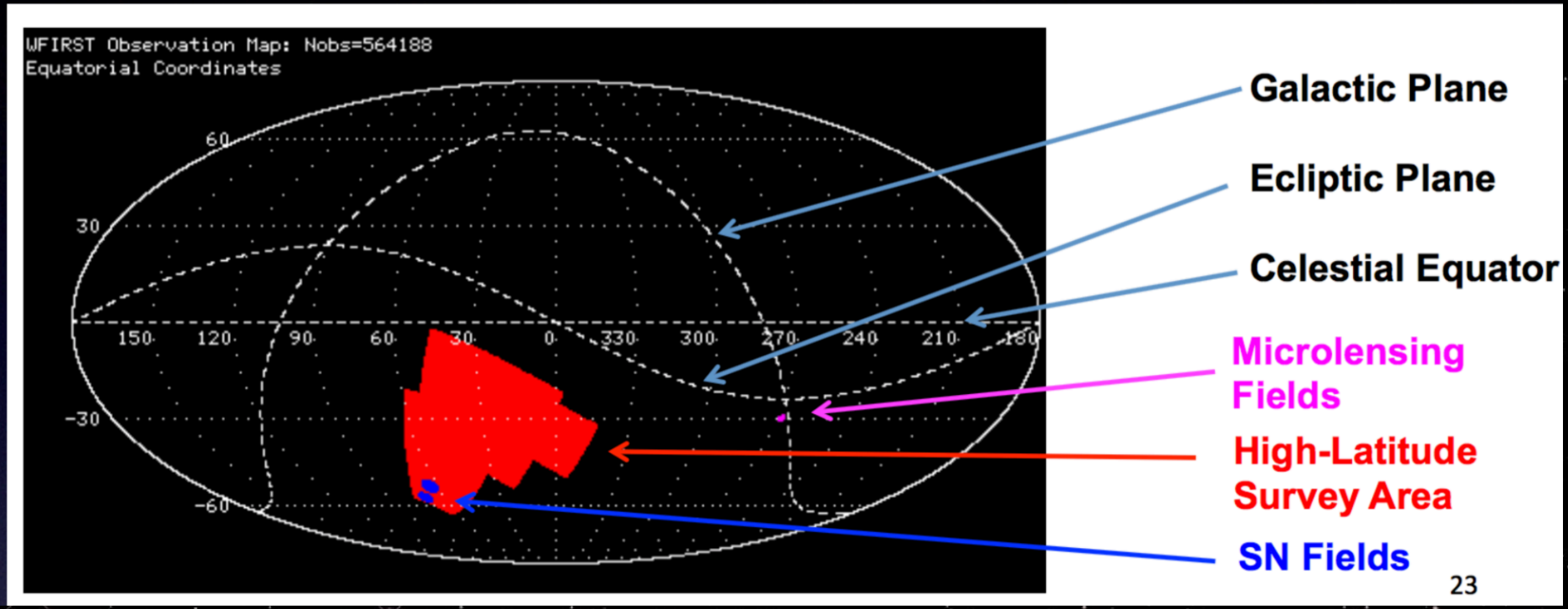




Shipp et al. 2018

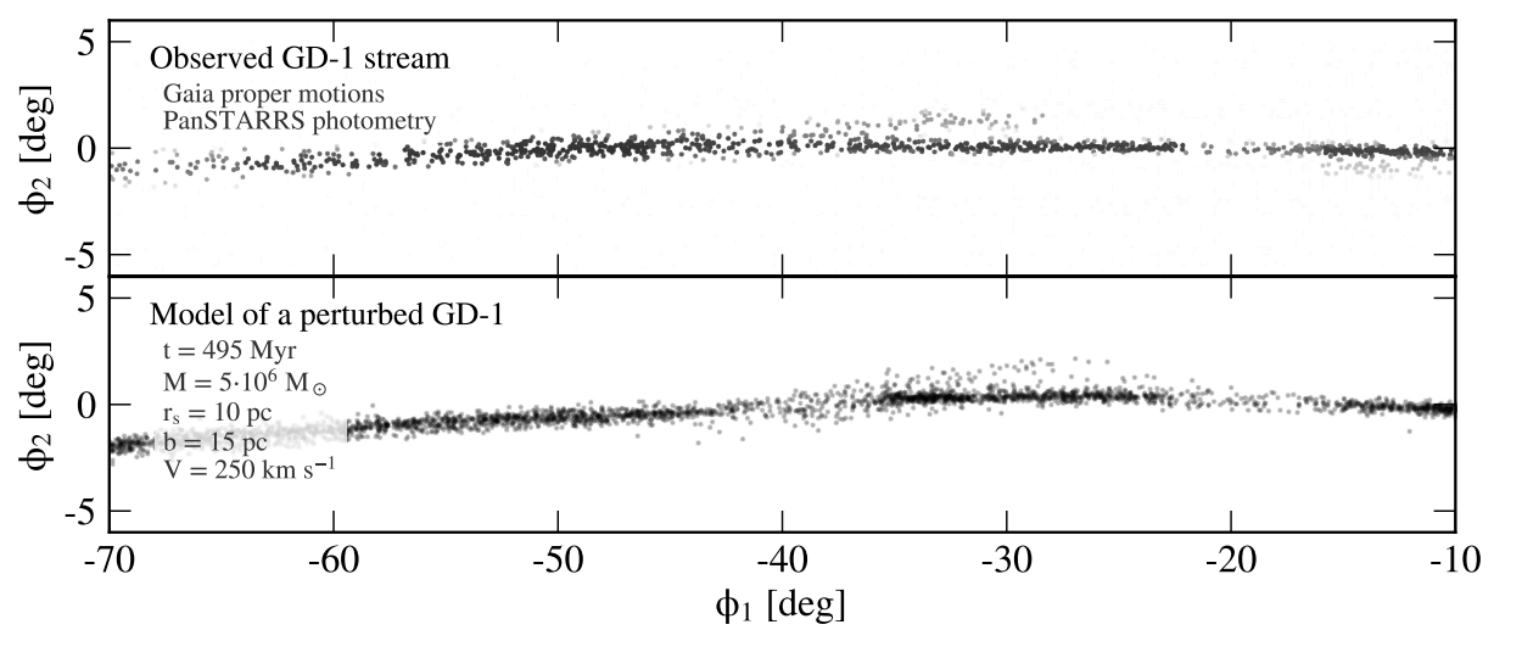
WFIRST primary science and GO programs are ideal for stream science

- Wide field
- Deep
- High resolution
- Multi-epoch
- Overlap with LSST



WFIRST primary science and GO programs are ideal for stream science

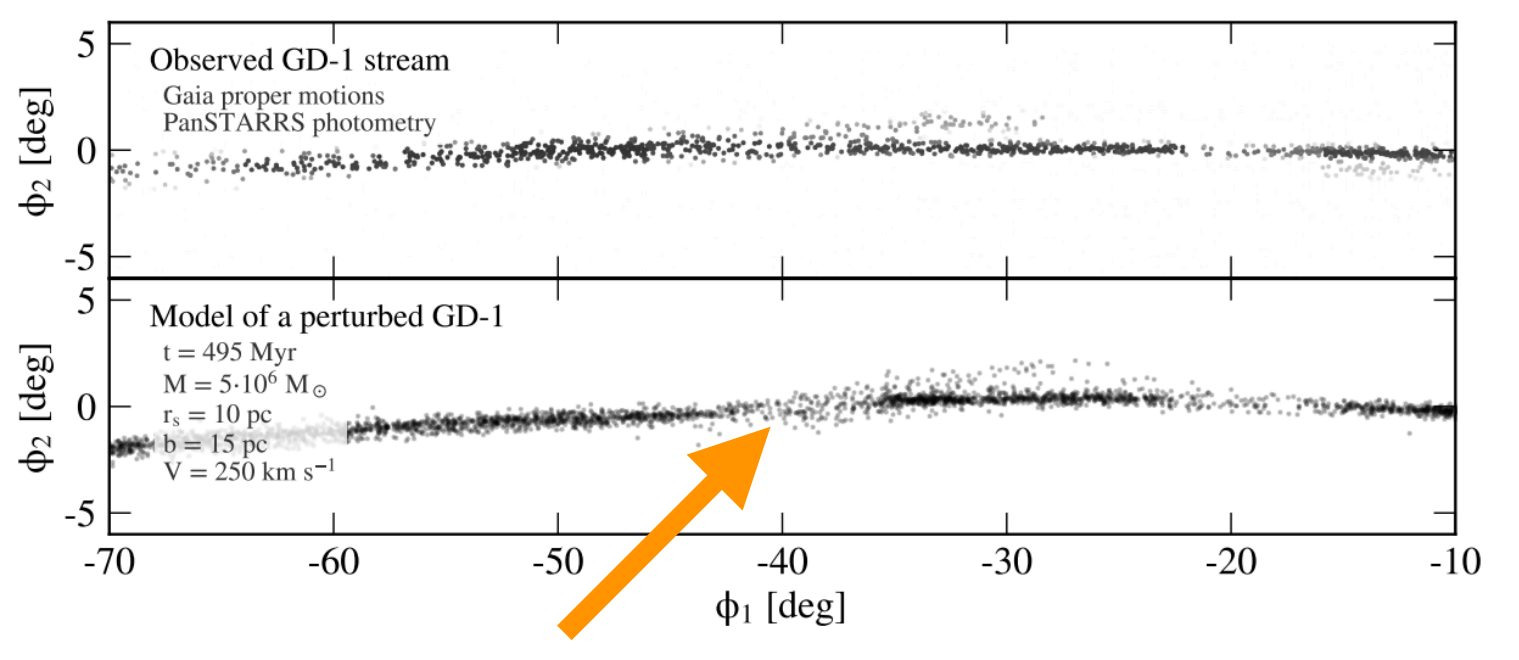
One of the most exciting science cases is the search for stream gaps



Bonaca et al. 2018

WFIRST primary science and GO programs are ideal for stream science

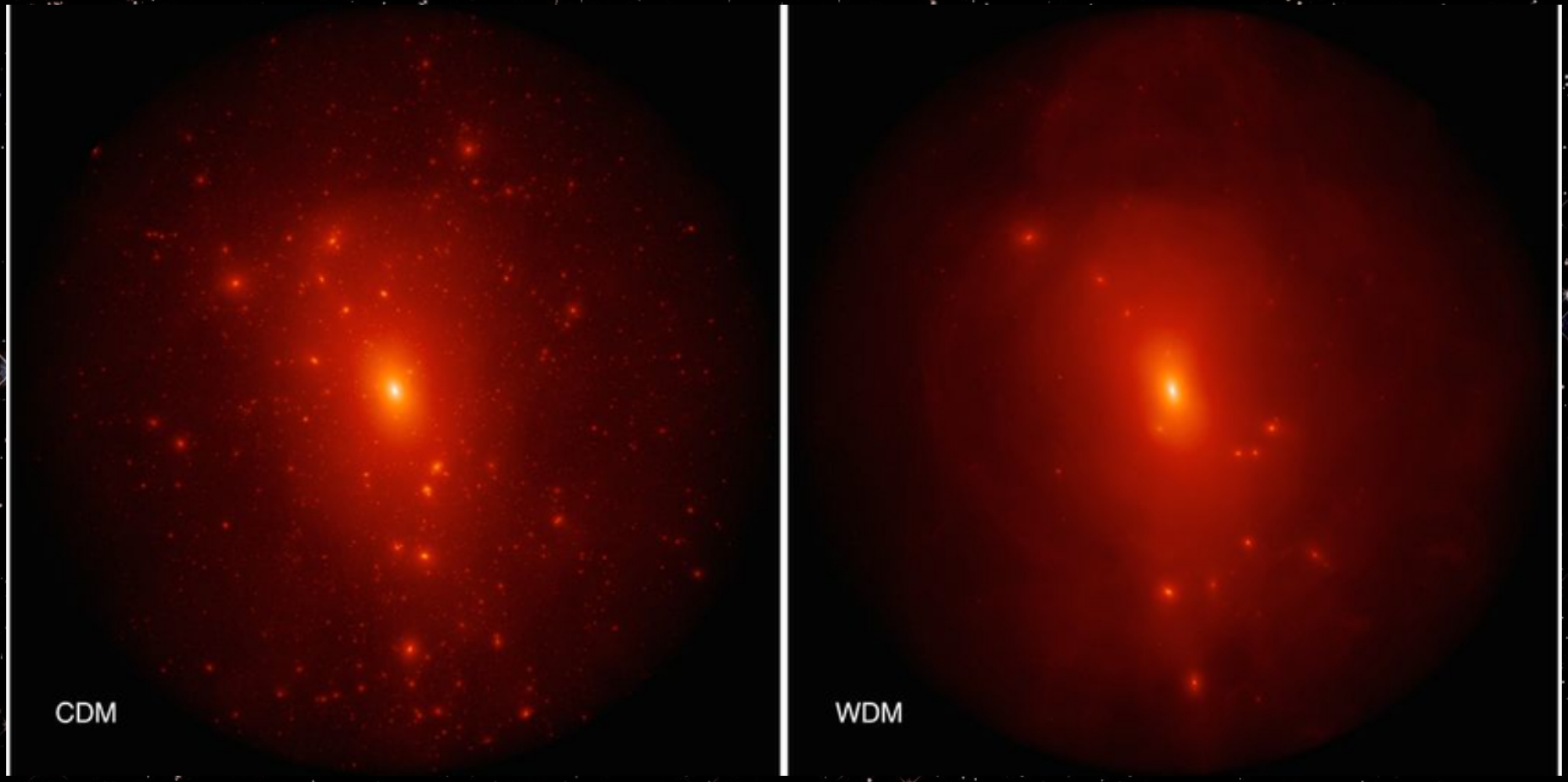
One of the most exciting science cases is the search for dark matter subhalos



5×10^6 $M_\odot$ subhalo encounter

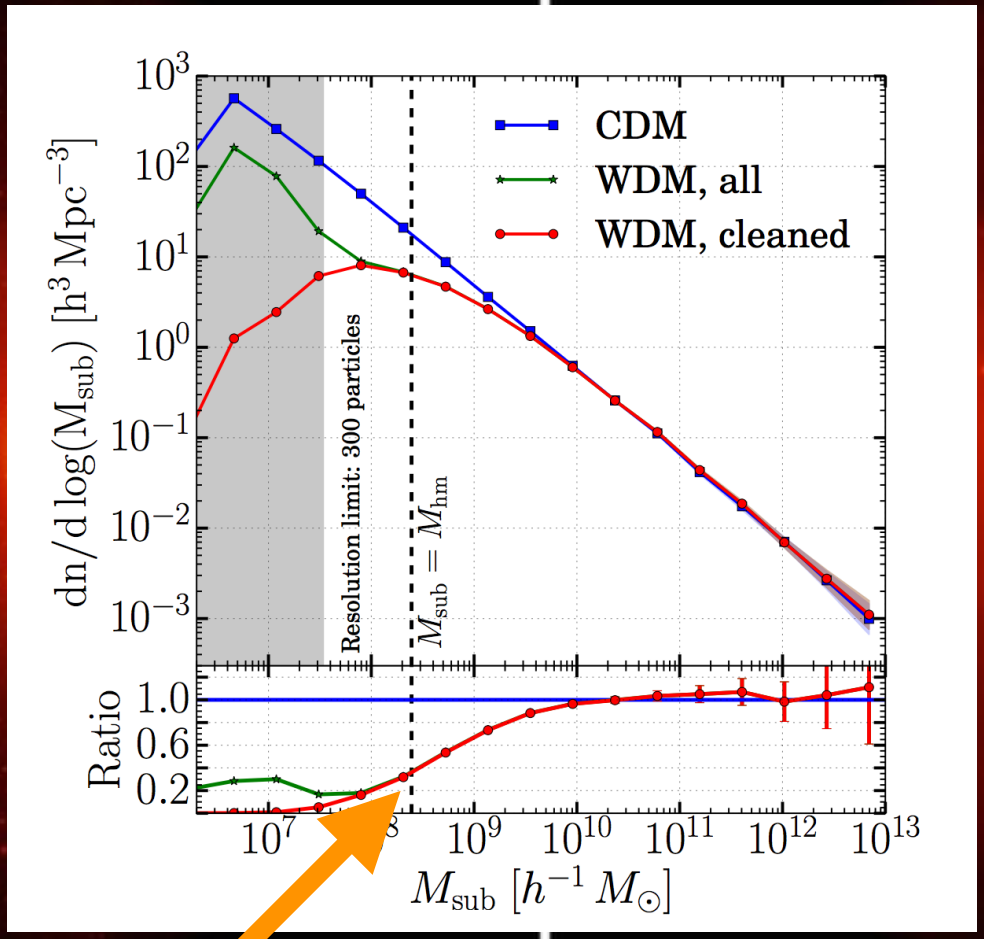
Bonaca et al. 2019

Dark matter physics controls the subhalo's properties



Adhkari et al. 2016

Dark matter physics controls the subhalo's properties

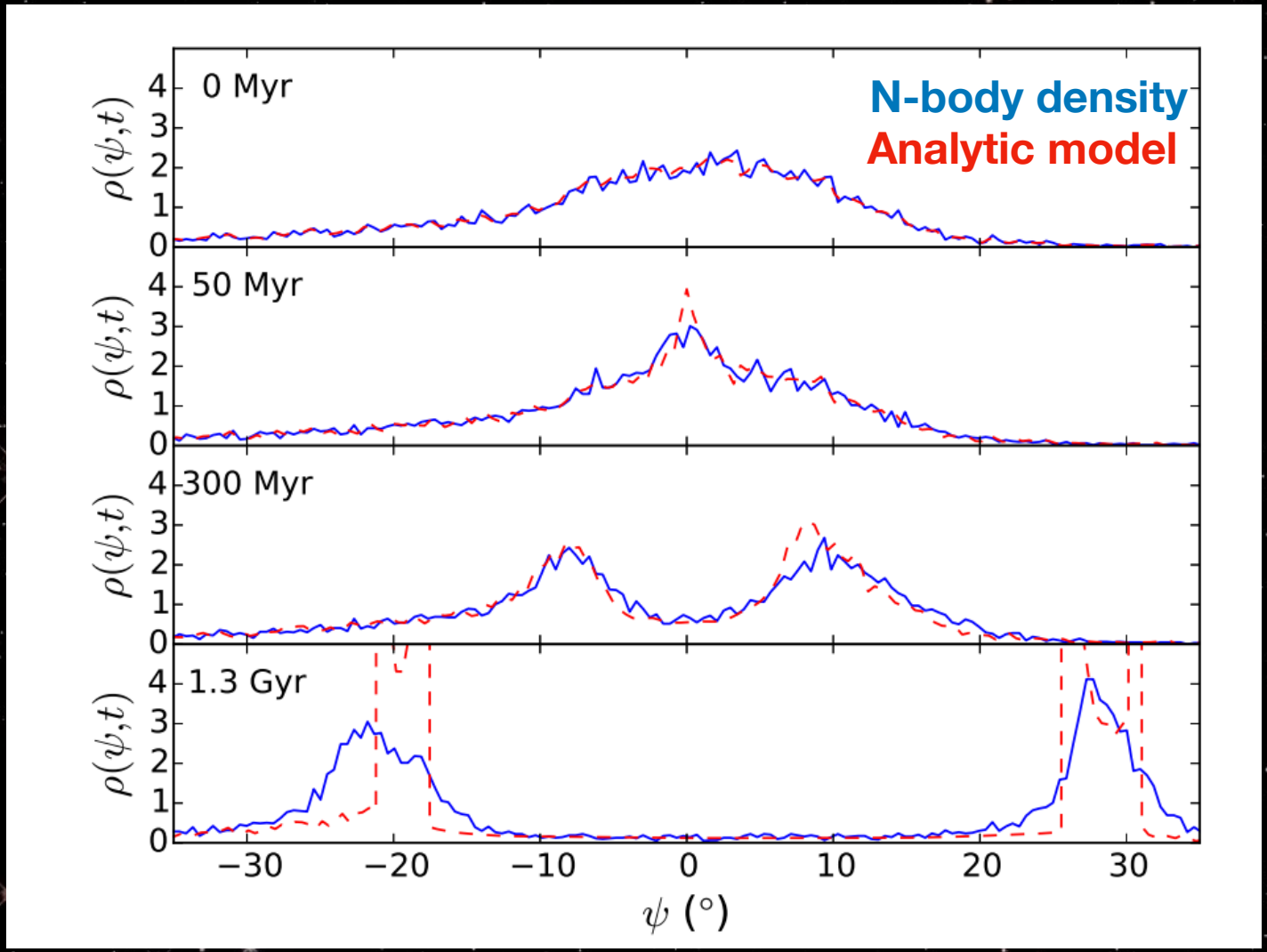


CDM

WDM has 50% fewer subhalos at 3×10^8 $M_\odot$

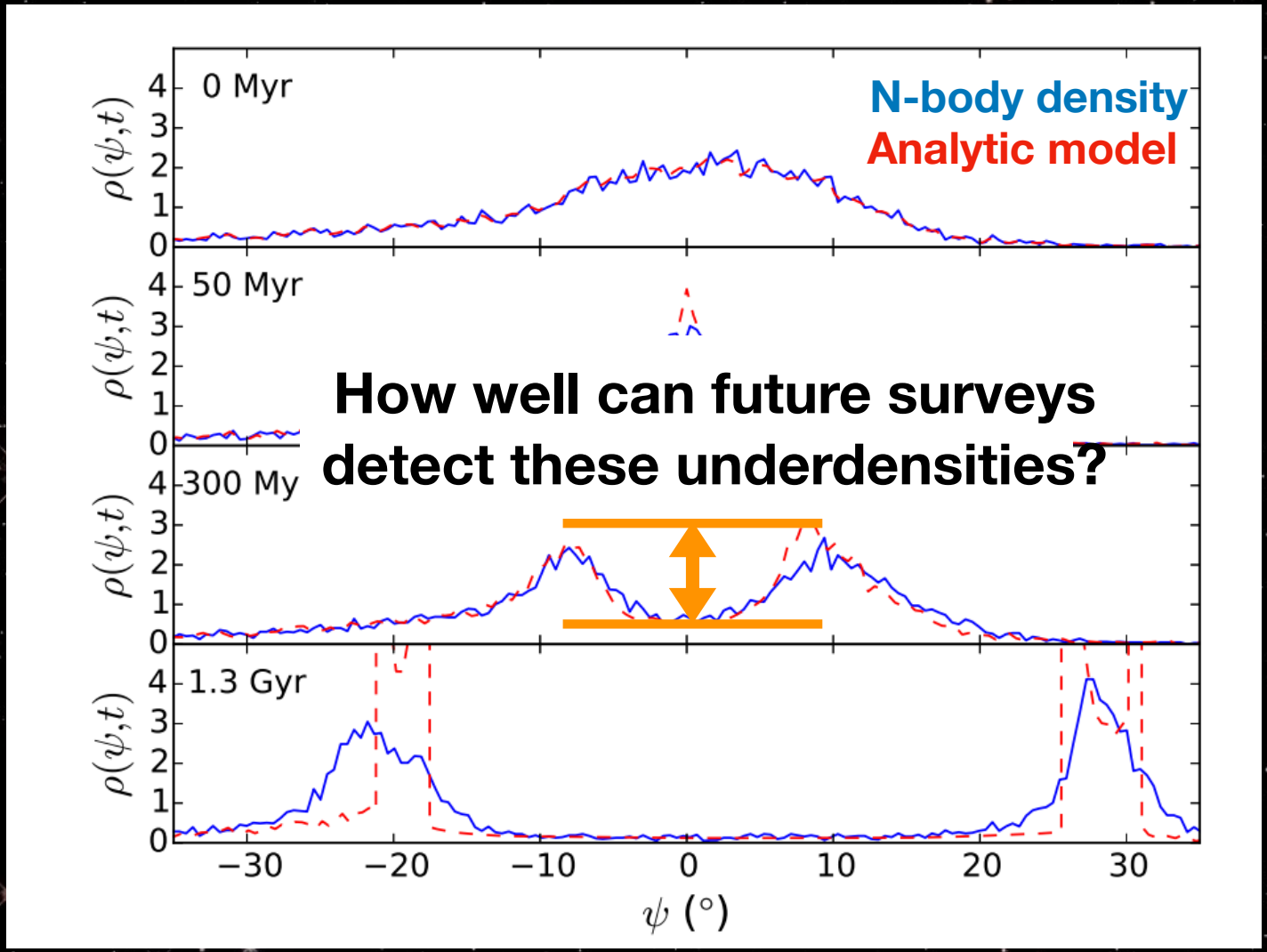
Adhkari et al. 2016
Bose et al. 2016

Analytic models can capture single interactions



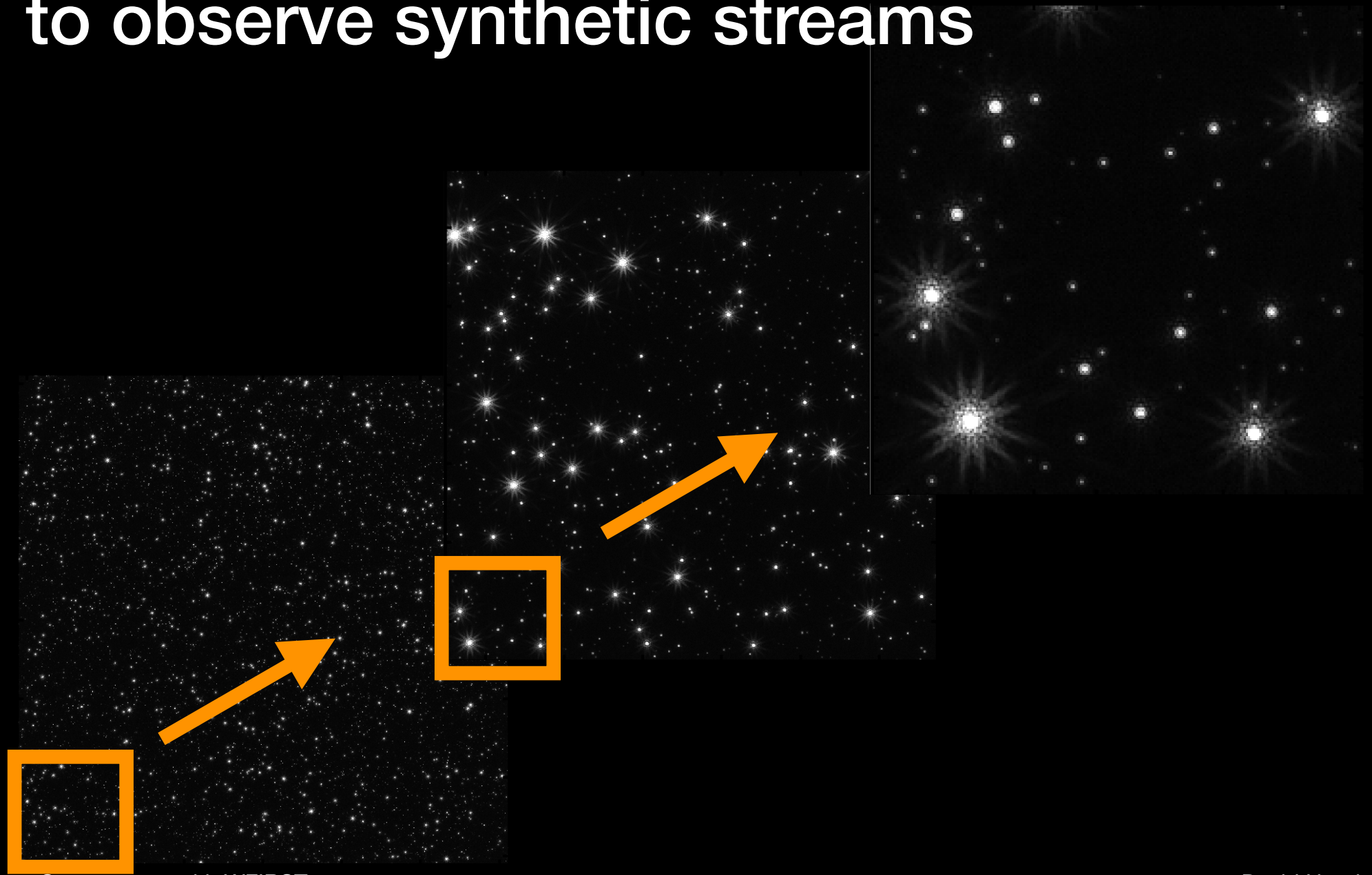
Erkal & Belokurov 2015

Analytic models can capture single interactions

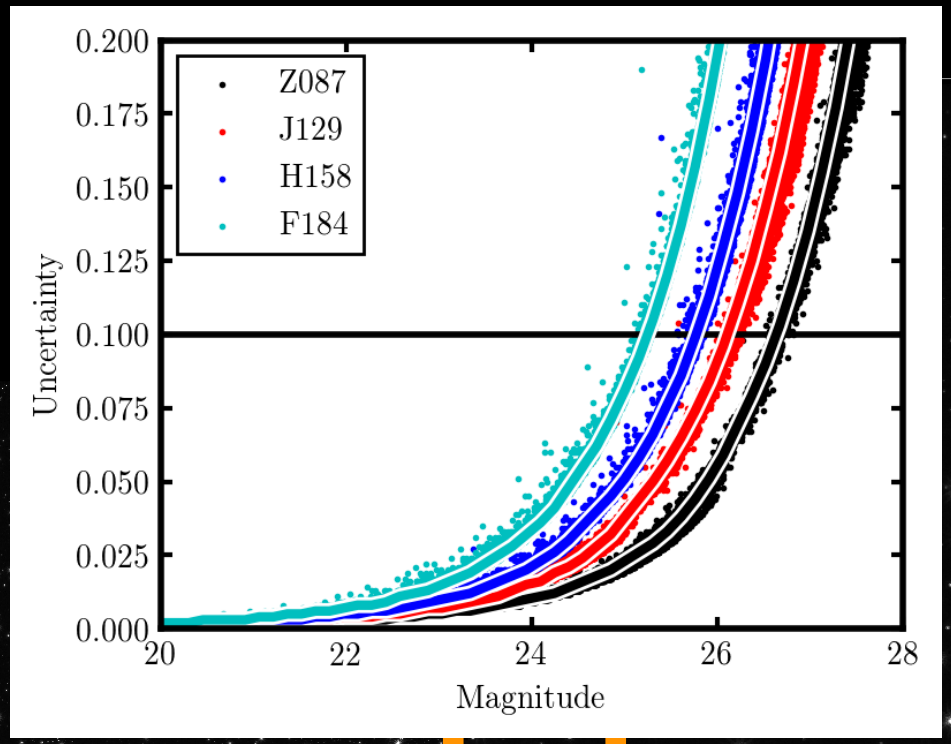


Erkal & Belokurov 2015

STIPS + DOLPHOT mock photometry to observe synthetic streams



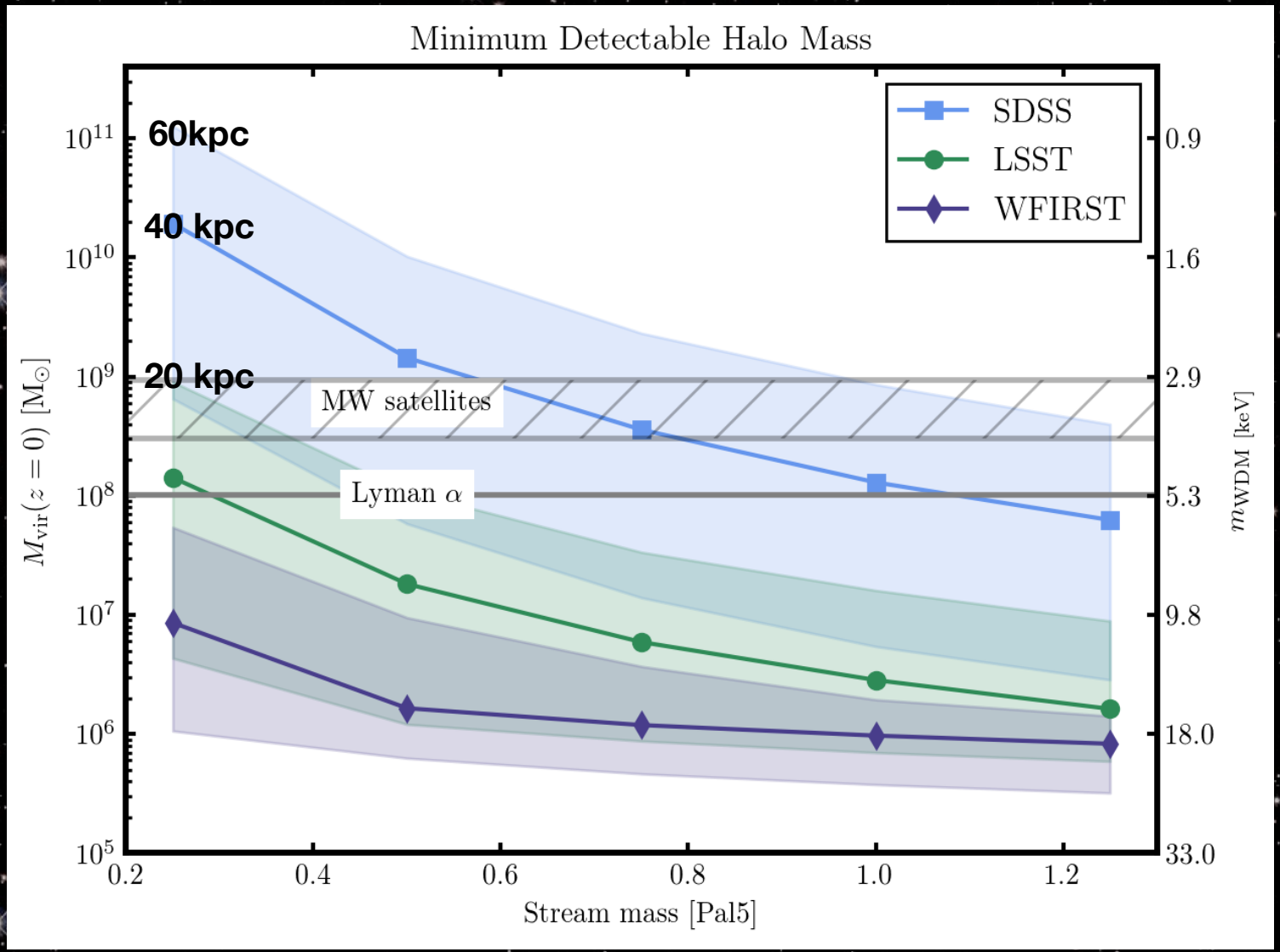
STIPS + DOLPHOT mock photometry to observe synthetic streams



Realistic foregrounds (Galaxia) & backgrounds (HLF GOODS-S)

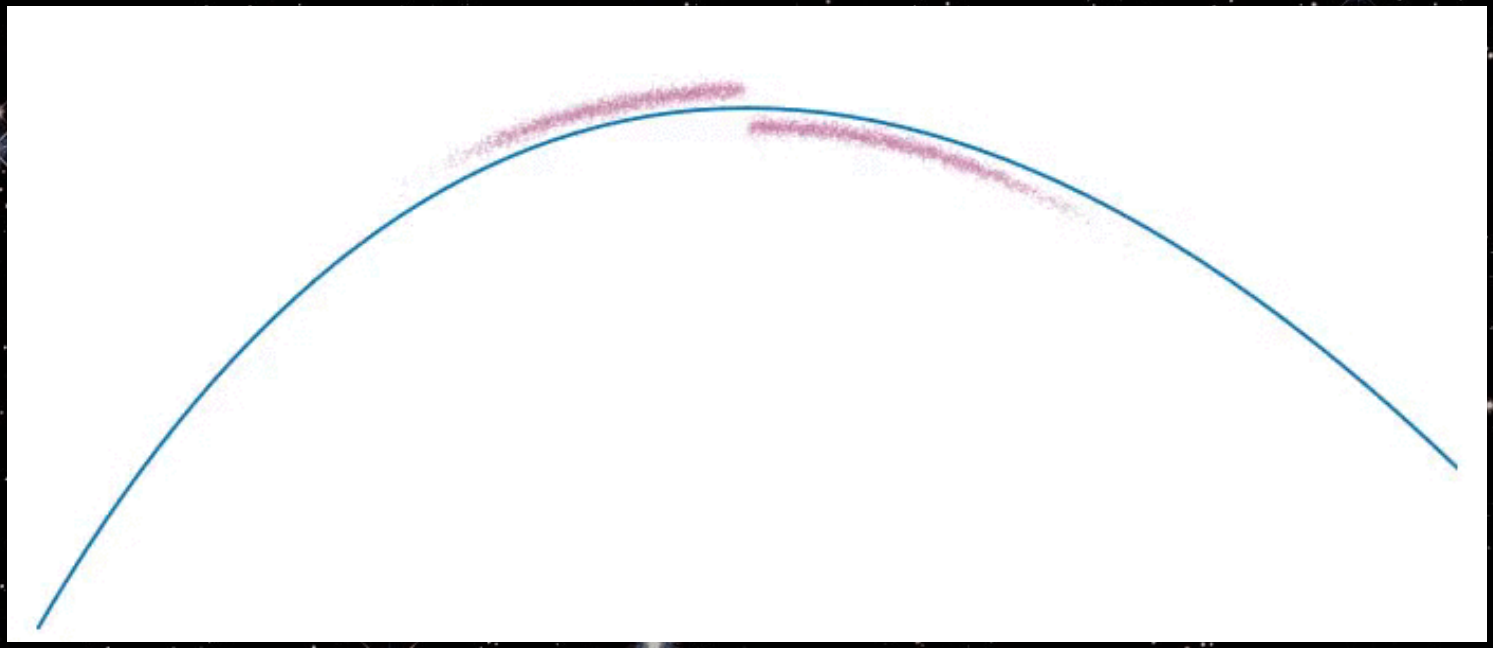
Single gap sensitivity

Smallest subhalo that can make a gap, detected at 5 sigma



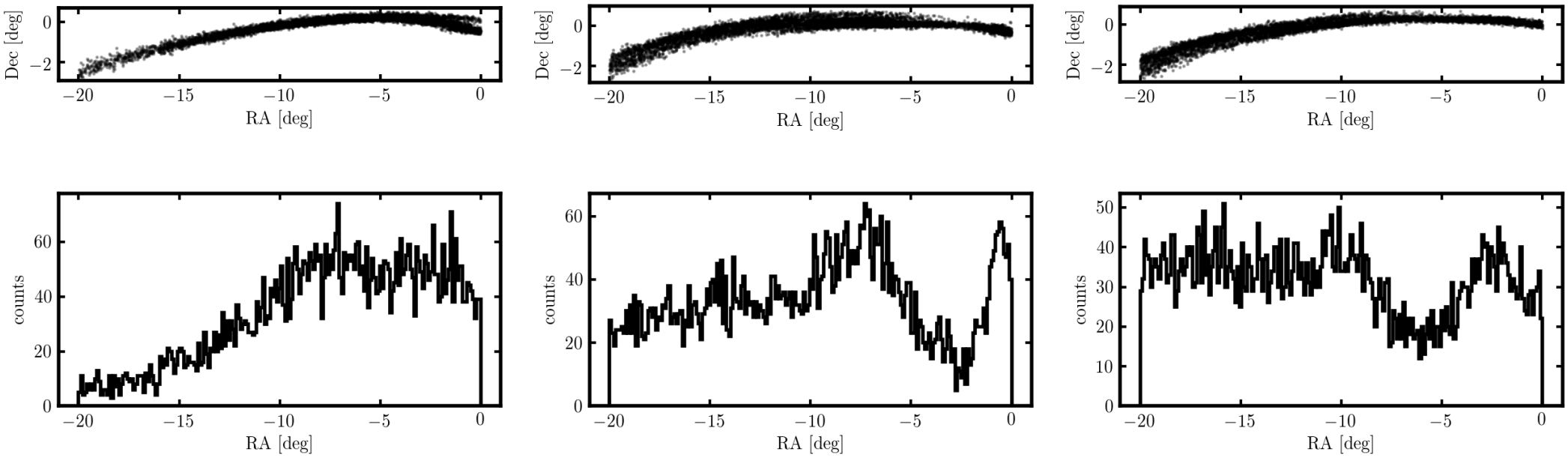
Might even be possible in Andromeda! related: Pearson et al. 2019

Realistic, stochastic interactions are more complicated



Bovy et al. 2016

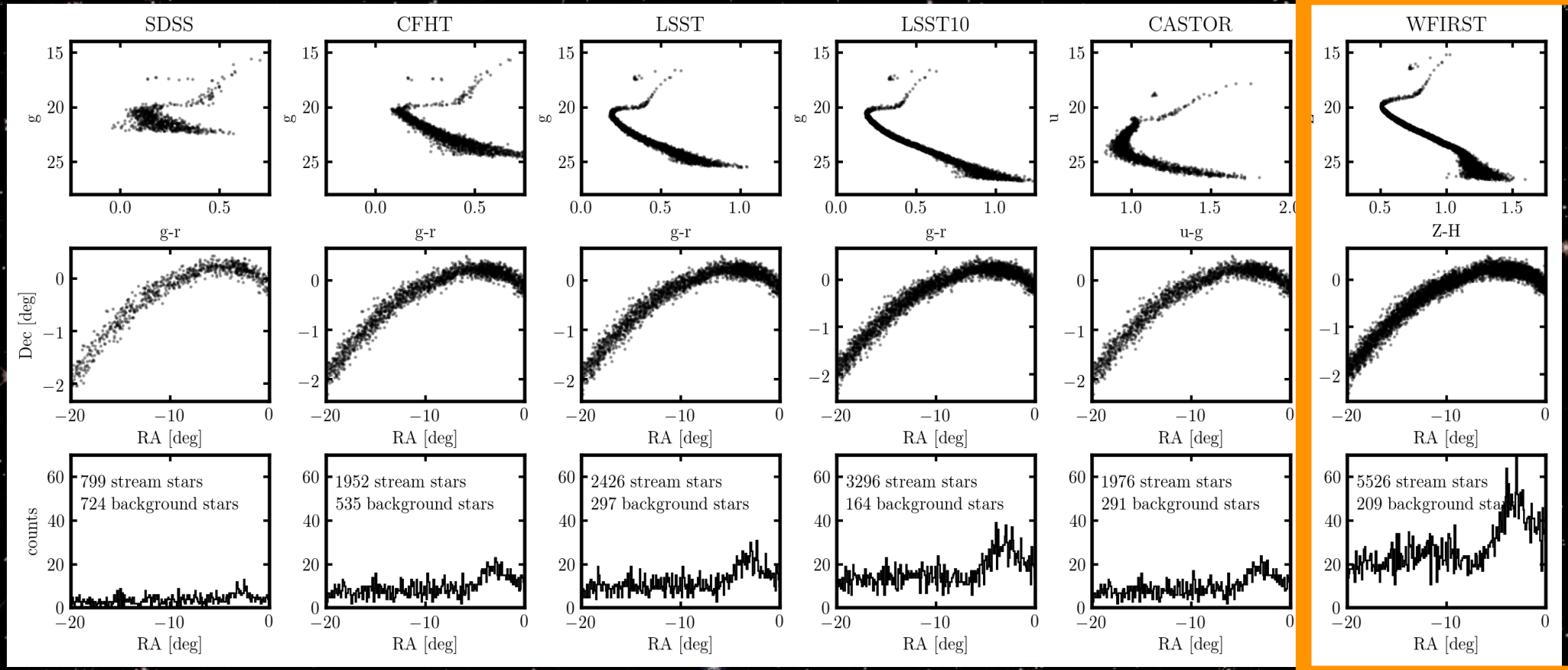
Realistic, stochastic interactions are more complicated



Details of subhalo interaction history -> qualitatively different density structure

What is the subhalo mass function? Cutoff? Mass-radius distribution?

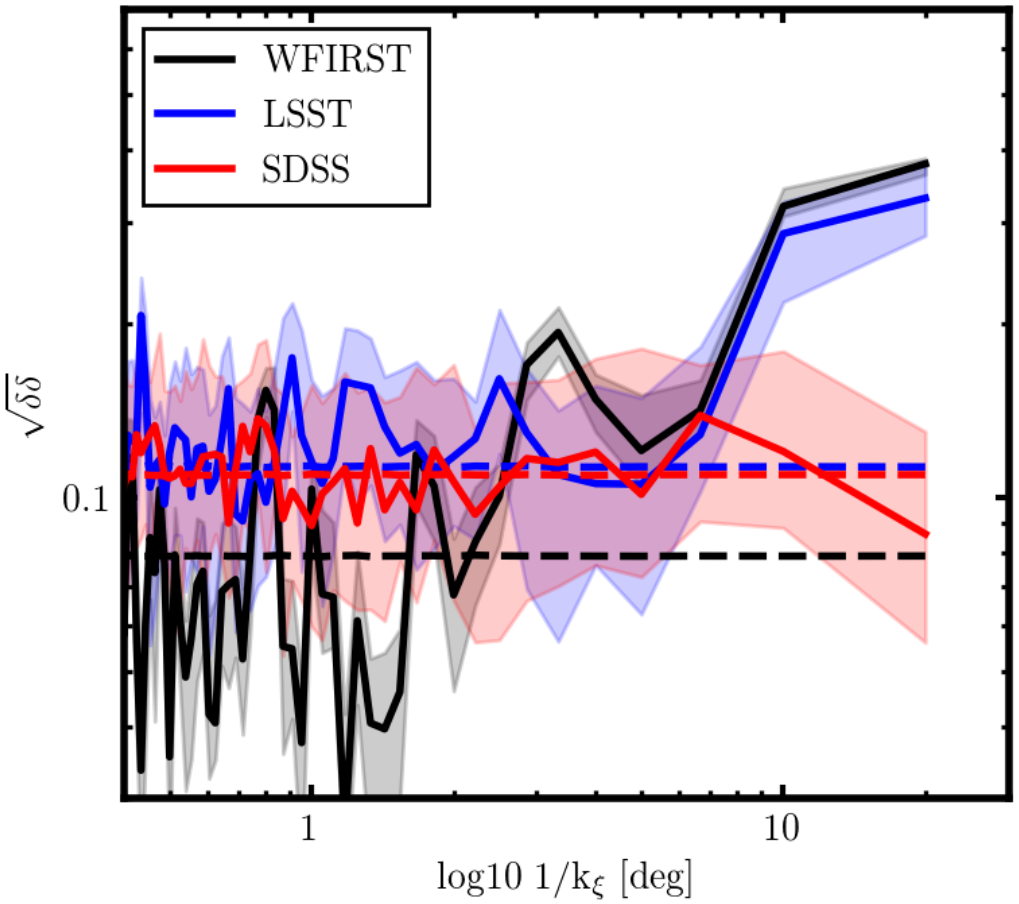
WFIRST will provide the cleanest sample

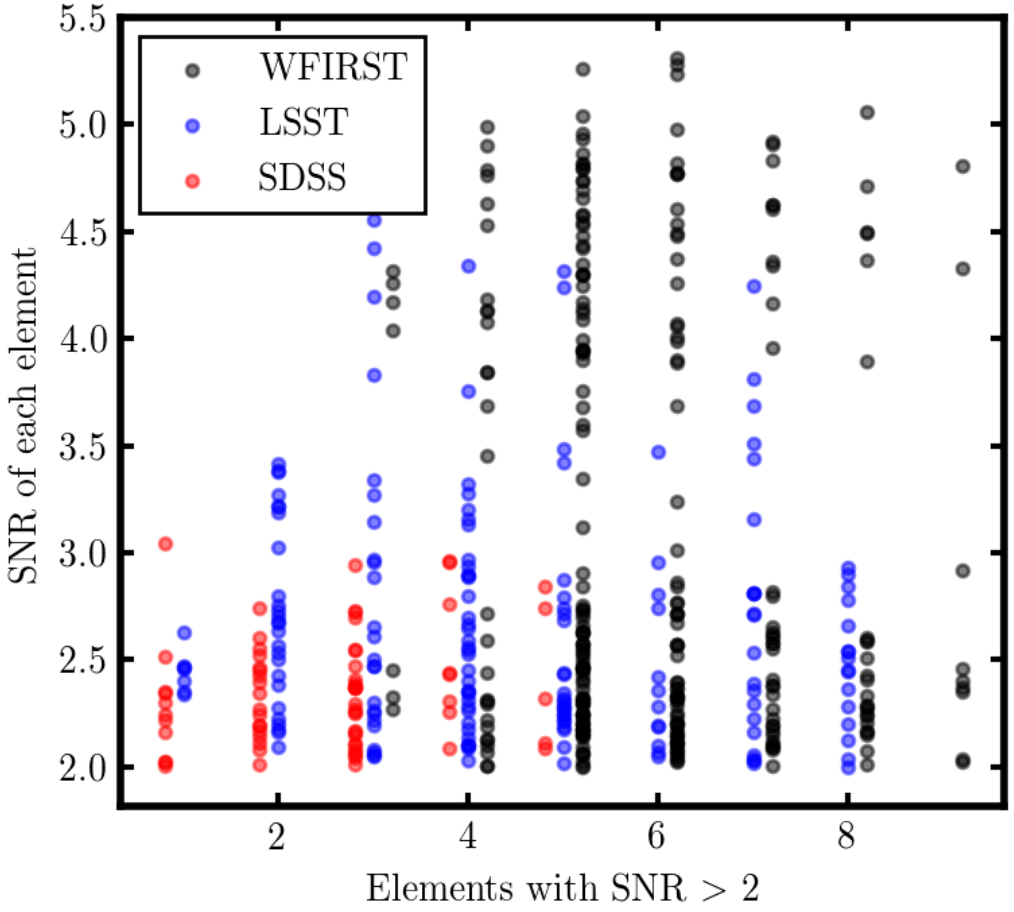


Contamination

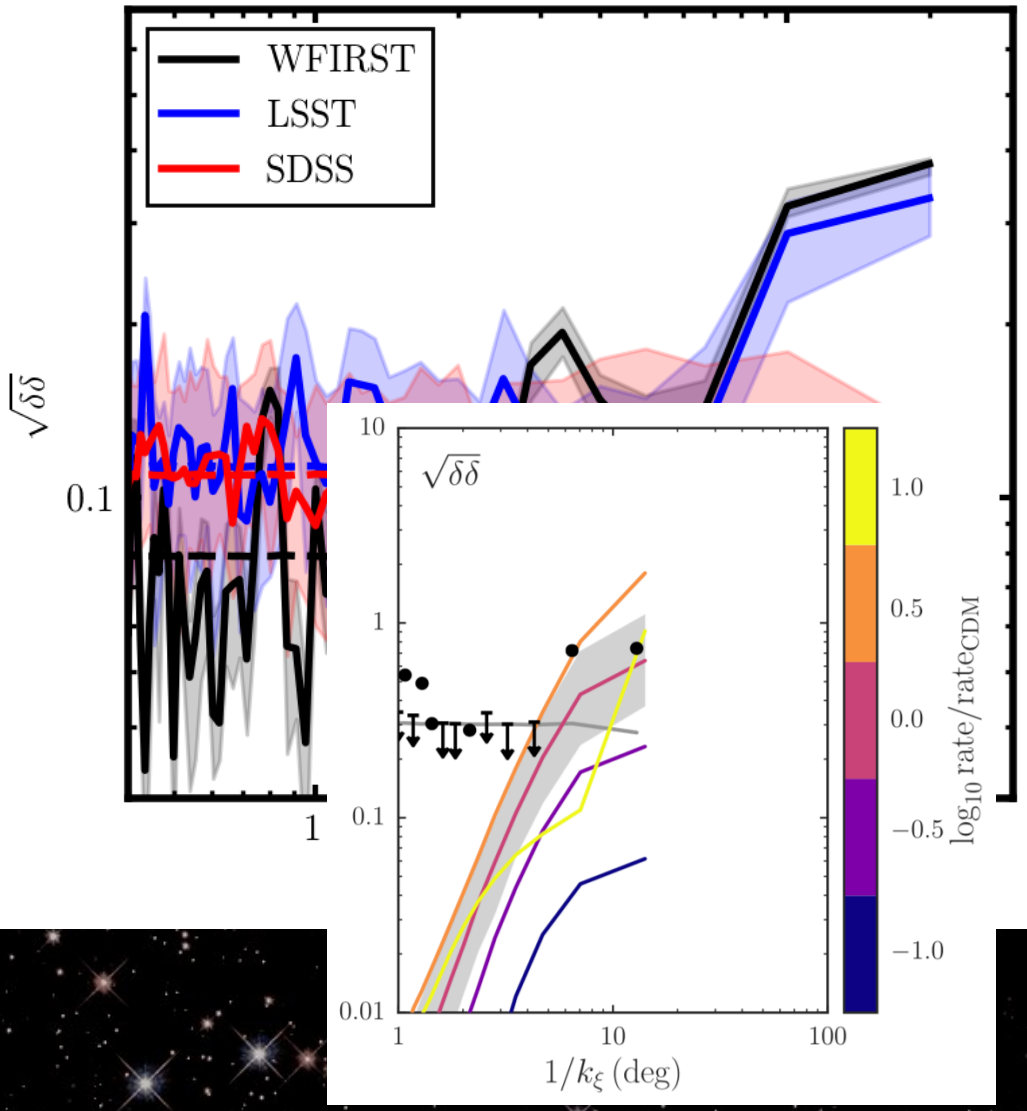
~50%	~22%	~11%	~5%	~13%	~3%

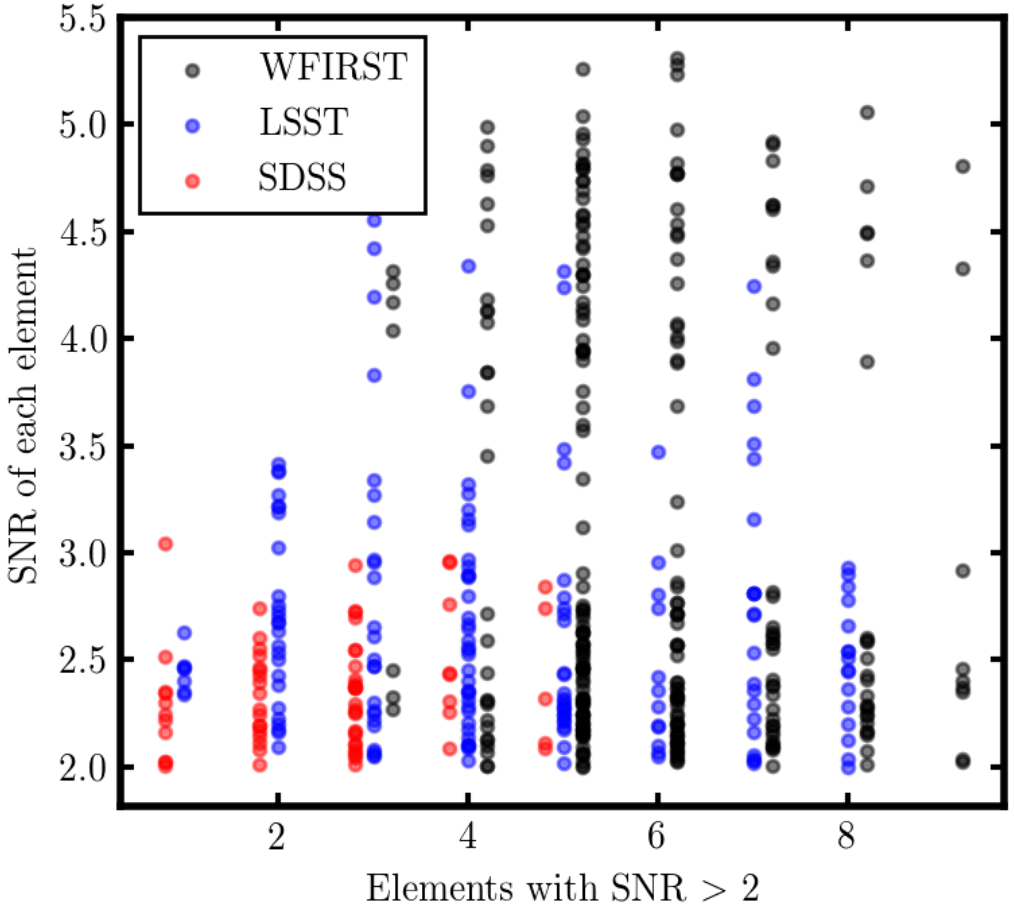
WFIRST will provide the most constraints





WFIRST will provide the most constraints





Bovy et al. 2017: 3 constraints with SNR <3

Conclusions

- **WFIRST et al. will discover & characterize many new streams**
- **WFIRST is our best bet for the smallest single gaps in the faintest streams**
  - **Sensitivity to 10^6 $M_\odot$ subhalos; strong constraints on DM physics**
- **WFIRST 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**