

The HST Treasury Survey of the M31 Satellite System

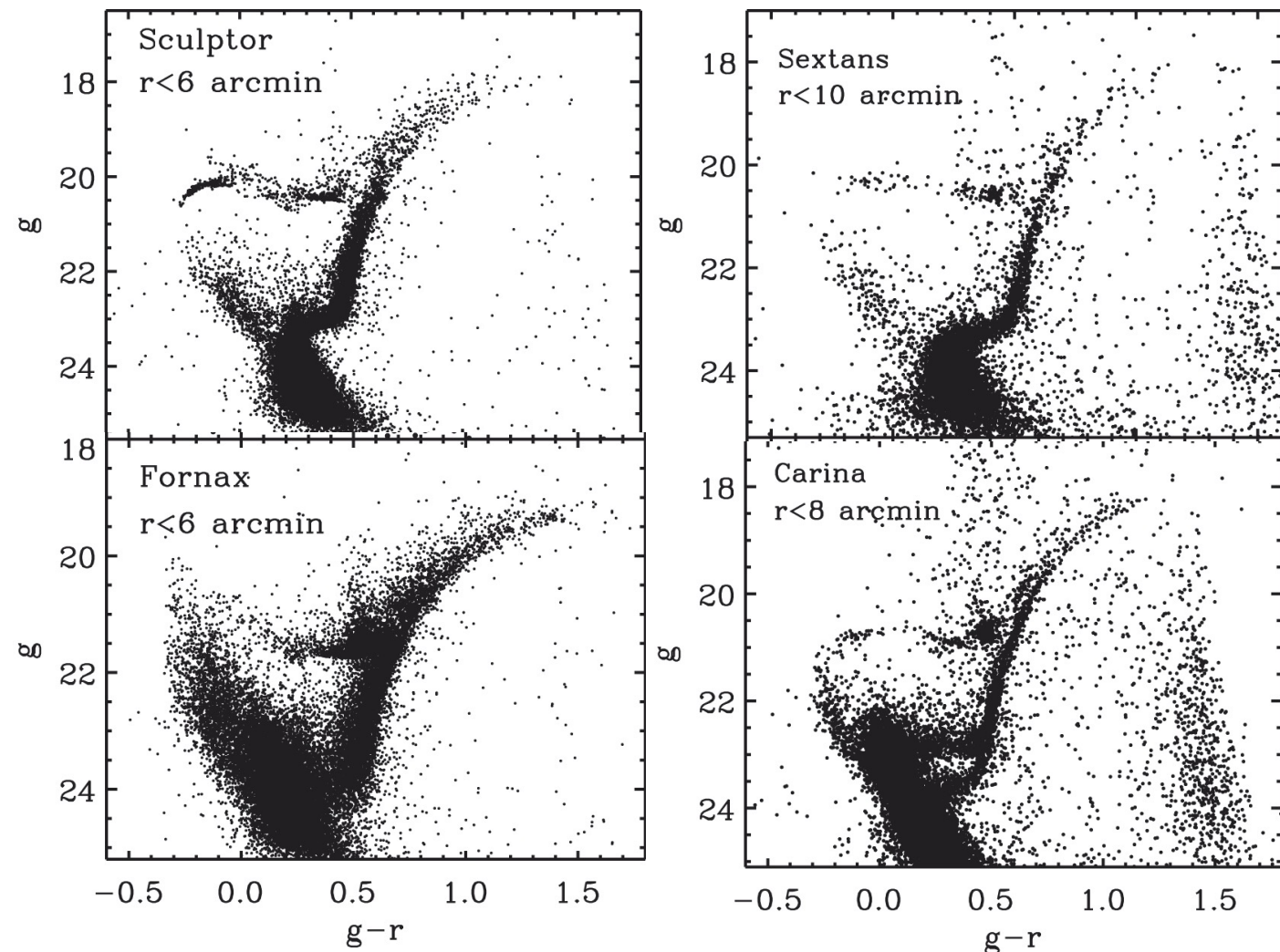
Alessandro Savino

Chicago – 8 July 2024

Collaborators: Dan Weisz, Andrew Dolphin, Meredith Durbin, Nityia Kallivayalil, Andrew Wetzel, Jay Anderson, Gurtina Besla, Mike Boylan-Kolchin, James Bullock, Andrew Cole, Michelle Collins, Michael Cooper, Alis Deason, Aaron Dotter, Mark Fardal, Annette Ferguson, Tobias Fritz, Marla Geha, Karoline Gilbert, Raja Guhathakurta, Rodrigo Ibata, Mike Irwin, Myongwon Jeon, Evan Kirby, Geraint Lewis, Dougal Mackey, Steve Majewski, Nicolas Martin, Alan McConnachie, Ekta Patel, Mike Rich, Josh Simon, Evan Skillman, Tony Sohn, Erik Tollerud, Roeland van der Marel

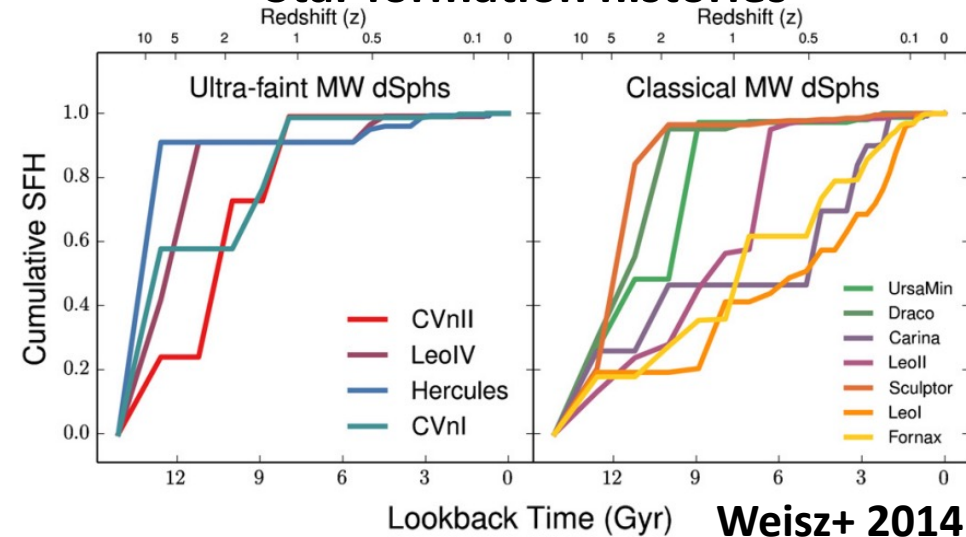
The Milky Way: a treasure trove for low-mass galaxy studies

Deep Color-Magnitude Diagrams



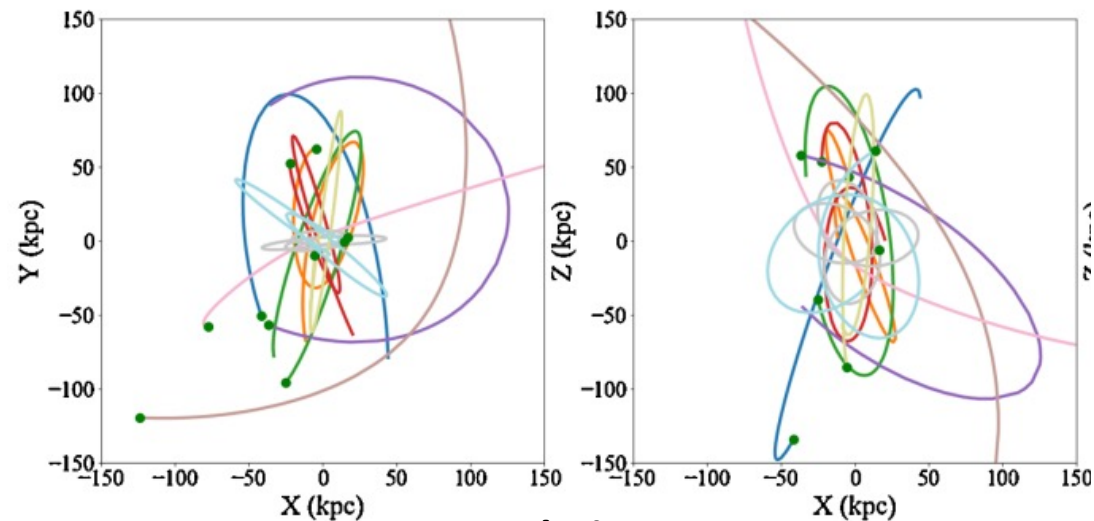
Muñoz+ 2018

Star formation histories



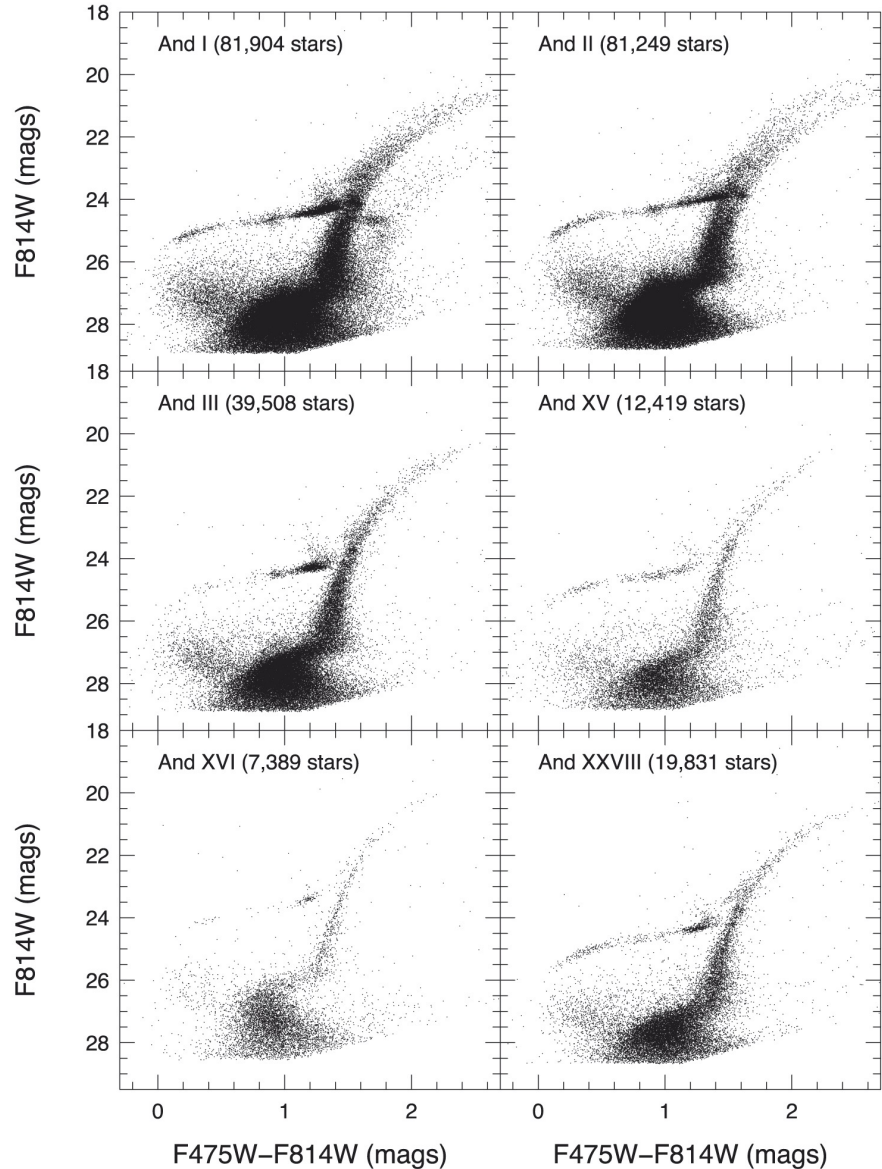
Weisz+ 2014

Orbital histories

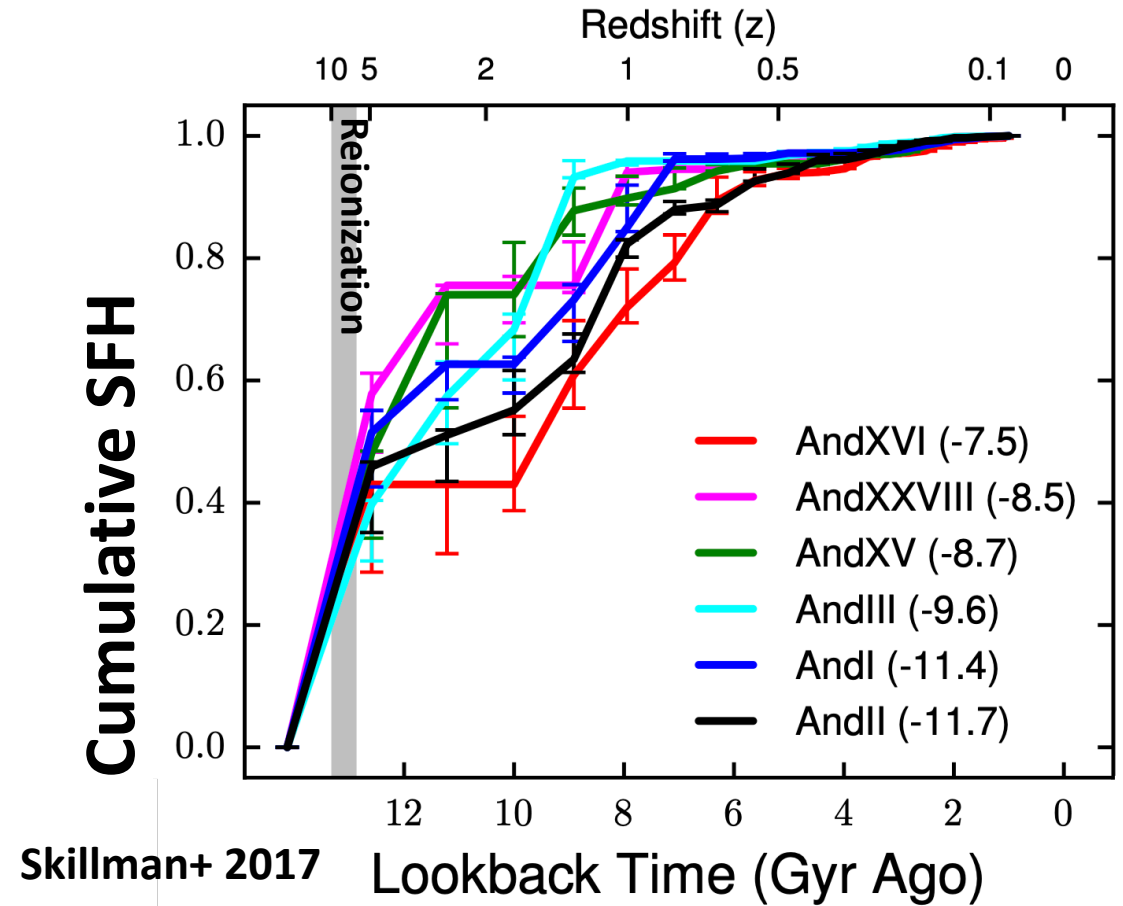


Helmi+ 2018

ISLAndS



SFHs in the M31 satellite system



+ Other individual SFH studies: e.g., Geha+ 2015; Monachesi+ 2011, Collins+ 2022, McQuinn+ 2023

The HST Treasury Survey of M31 Satellites

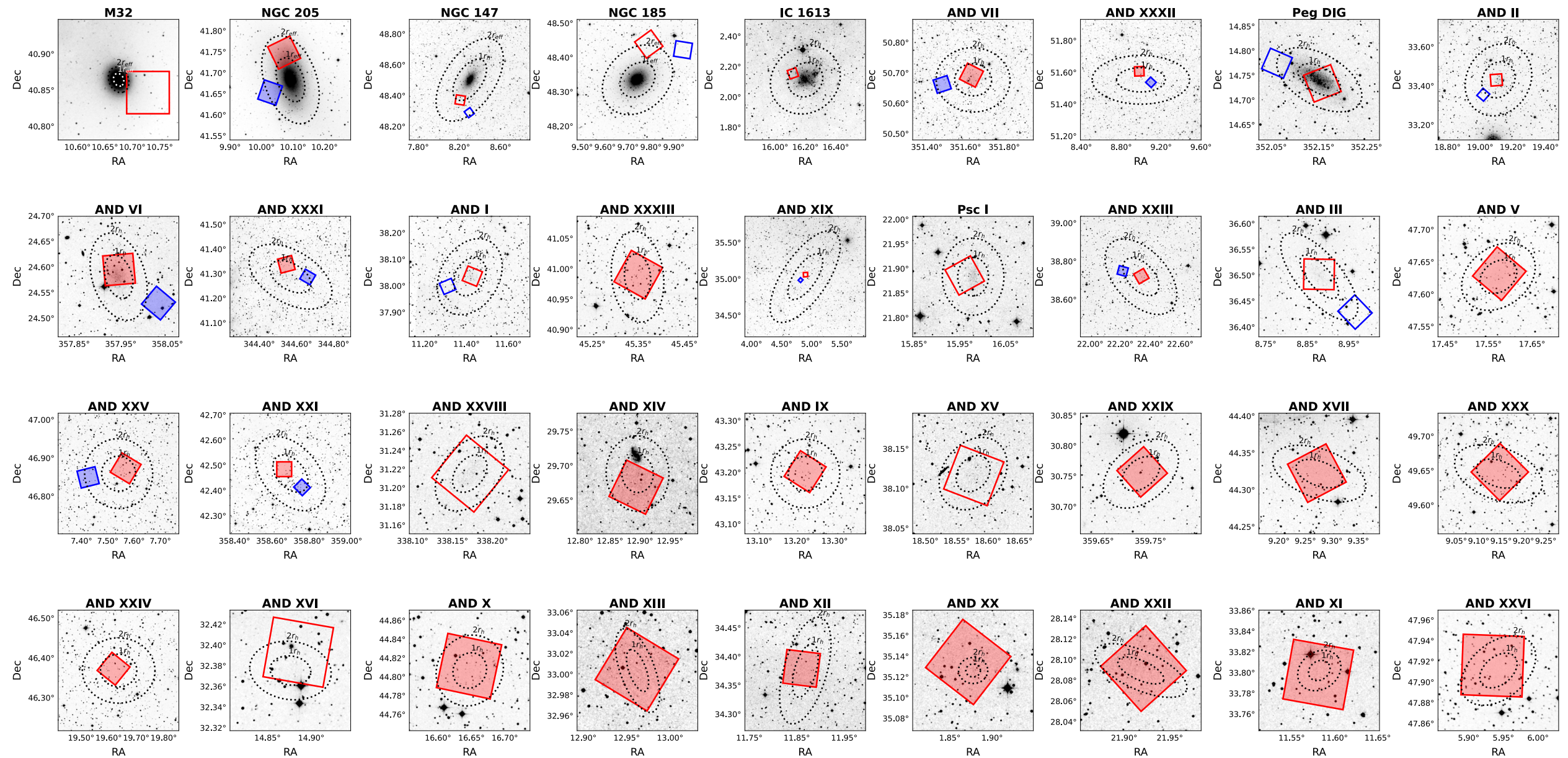
GO-15902

- **23 M31 satellites (+ 13 galaxies from the archive)**
- **244 prime HST orbits + parallels (and >500 archival orbits)**
- **ACS and UVIS imaging in F475W/F606W and F814W**
- **Depth: oldest MSTO**
- **Measure Star Formation Histories**
- **Precise Distances from RR Lyrae**
- **First Epoch for Proper Motions = Baseline for Orbital Histories**

PI: Dan Weisz

co-PIs: Nitya Kallivayalil, Andrew Wetzel

co-Is: Jay Anderson, Gurtina Besla, Mike Boylan-Kolchin, Tom Brown, James Bullock, Andrew Cole, Michelle Collins, Michael Cooper, Alis Deason, Andrew Dolphin, Aaron Dotter, Mark Fardal, Annette Ferguson, Tobias Fritz, Marla Geha, Karoline Gilbert, Raja Guhathakurta, Rodrigo Ibata, Mike Irwin, Myongwon Jeon, Evan Kirby, Geraint Lewis, Dougal Mackey, Steve Majewski, Nicolas Martin, Alan McConnachie, Ekta Patel, Mike Rich, Alessandro Savino, Josh Simon, Evan Skillman, Tony Sohn, Erik Tollerud, Roeland van der Marel



+

10 auxilliary fields in M31 halo, M33 and the GSS

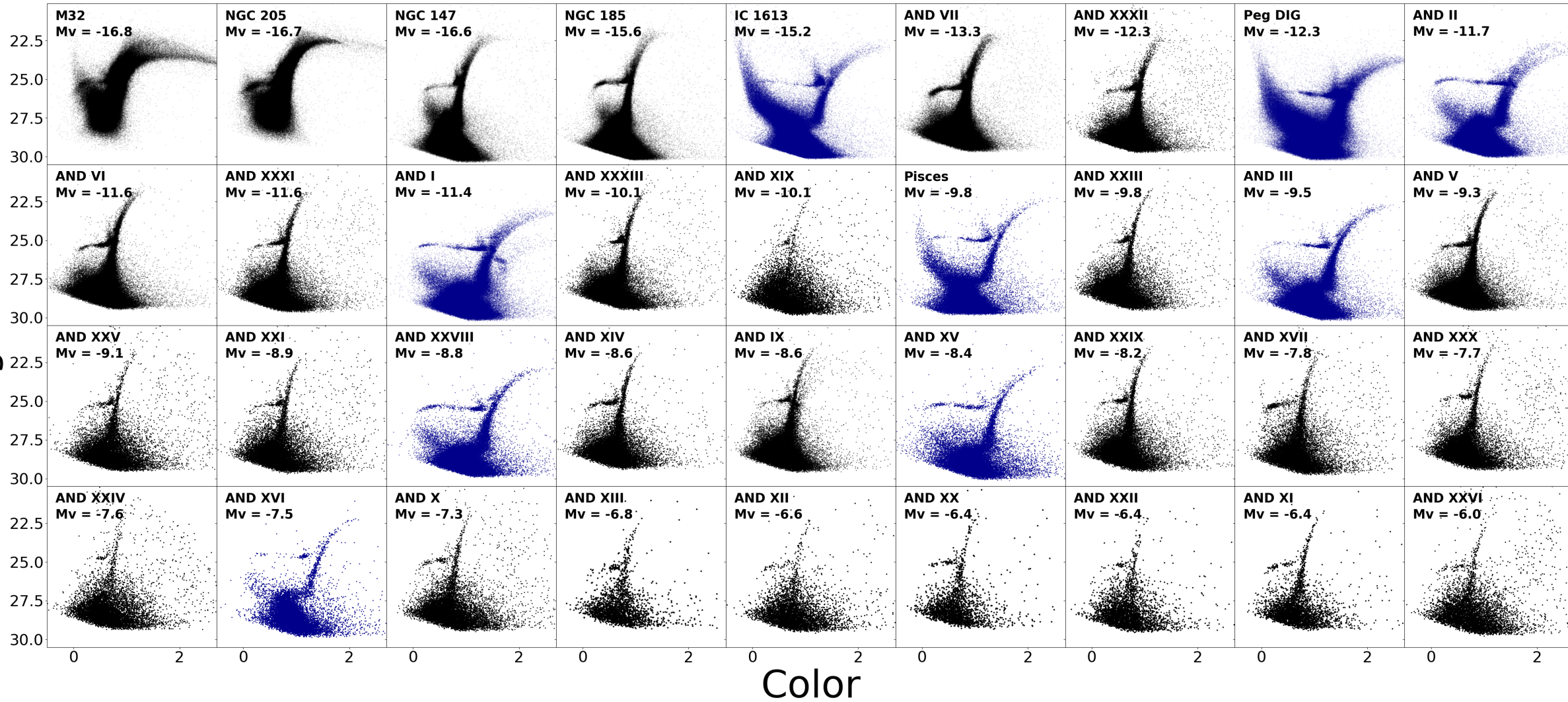
Savino+ in prep.

An HST view of the M31 satellite ecosystem

Bright



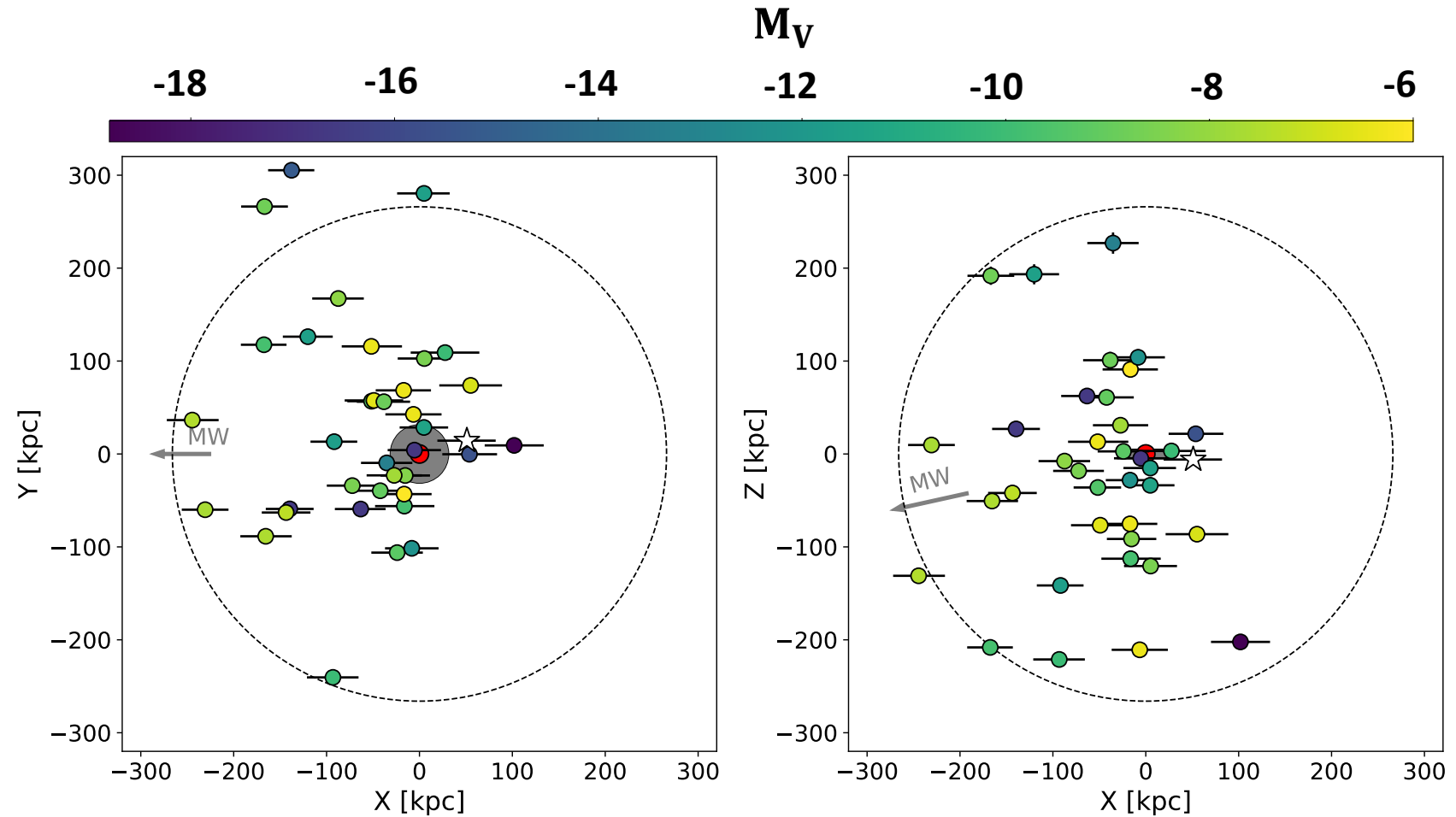
Magnitude



Color

Faint

- **4700 RR Lyrae in 39 stellar systems**
- **Homogenous distances based on Gaia calibrations**
- **A detailed 3D reconstruction of the satellite system**

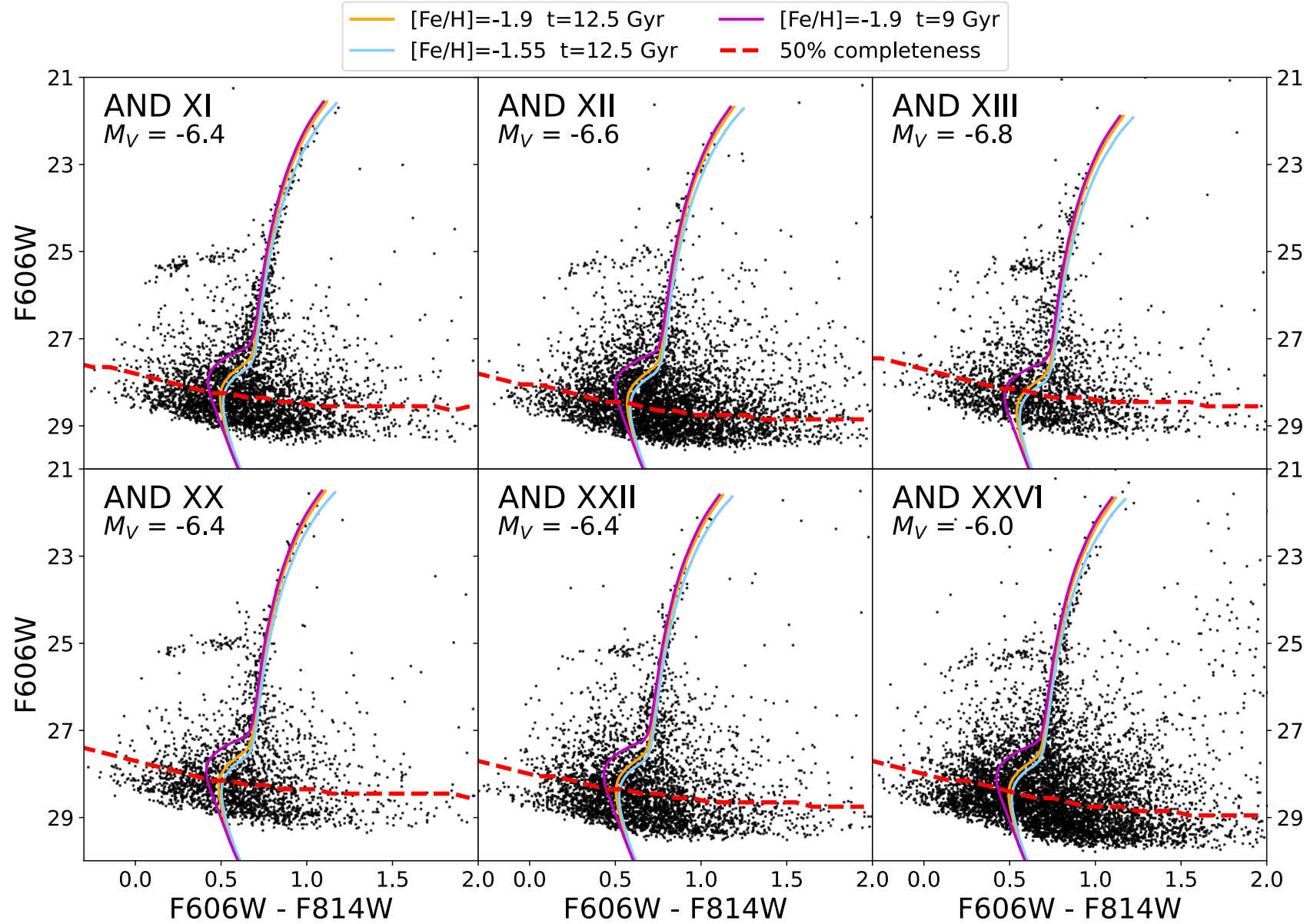


- **Strong spatial anisotropy: appears to be real...and puzzling**

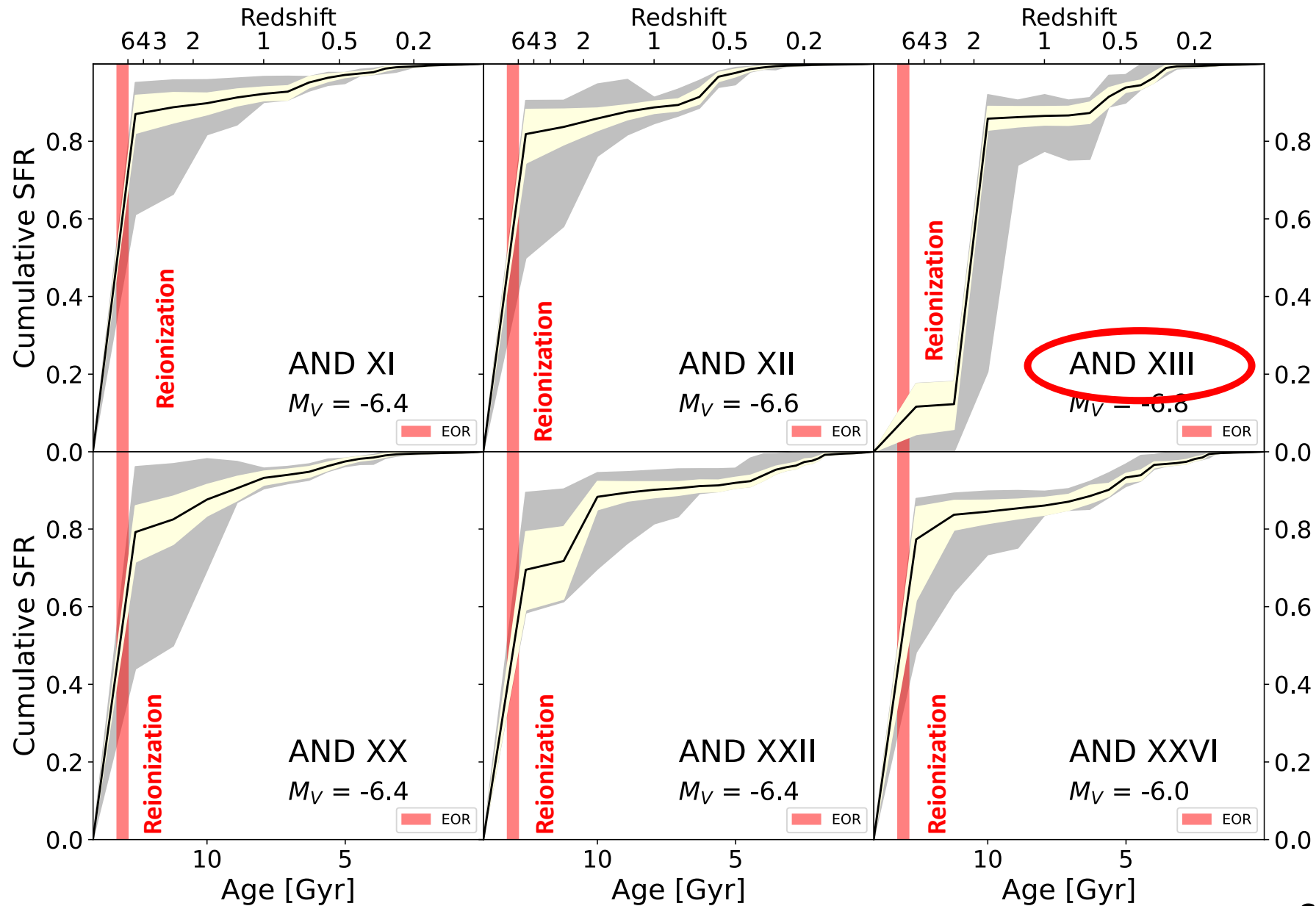
Savino+ 2022

- Consistently emerges using independent distance indicators (e.g., McConnachie 2006, Conn+2013)
- Selection effects ruled out by Doliva-Dolinsky+ 2022
- Indication of a recent dynamical perturbation?

Ultra-faint dwarfs in the M31 system



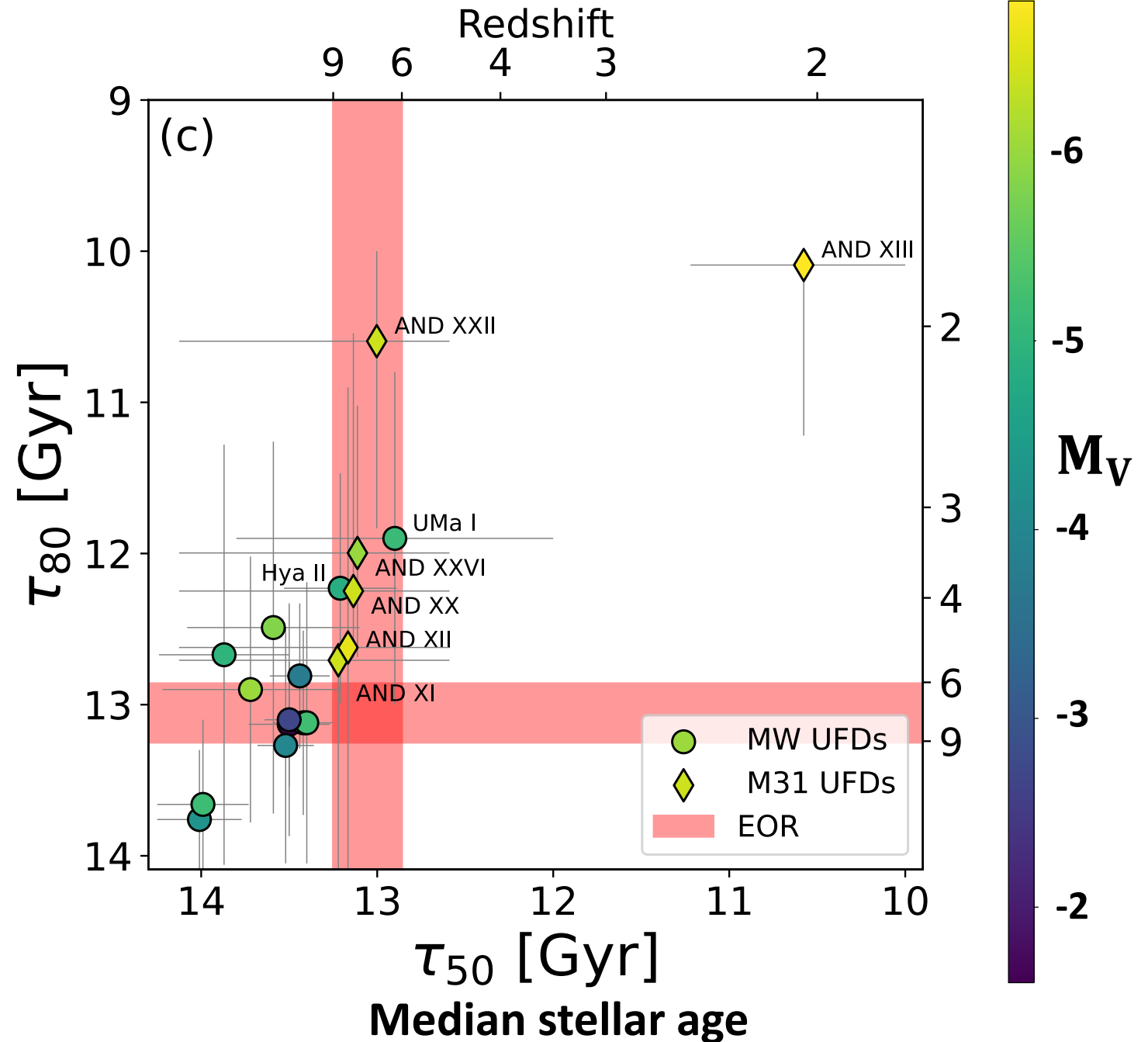
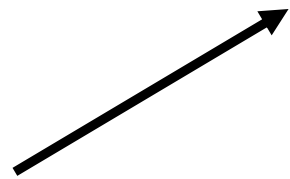
Lifetime Star Formation Histories



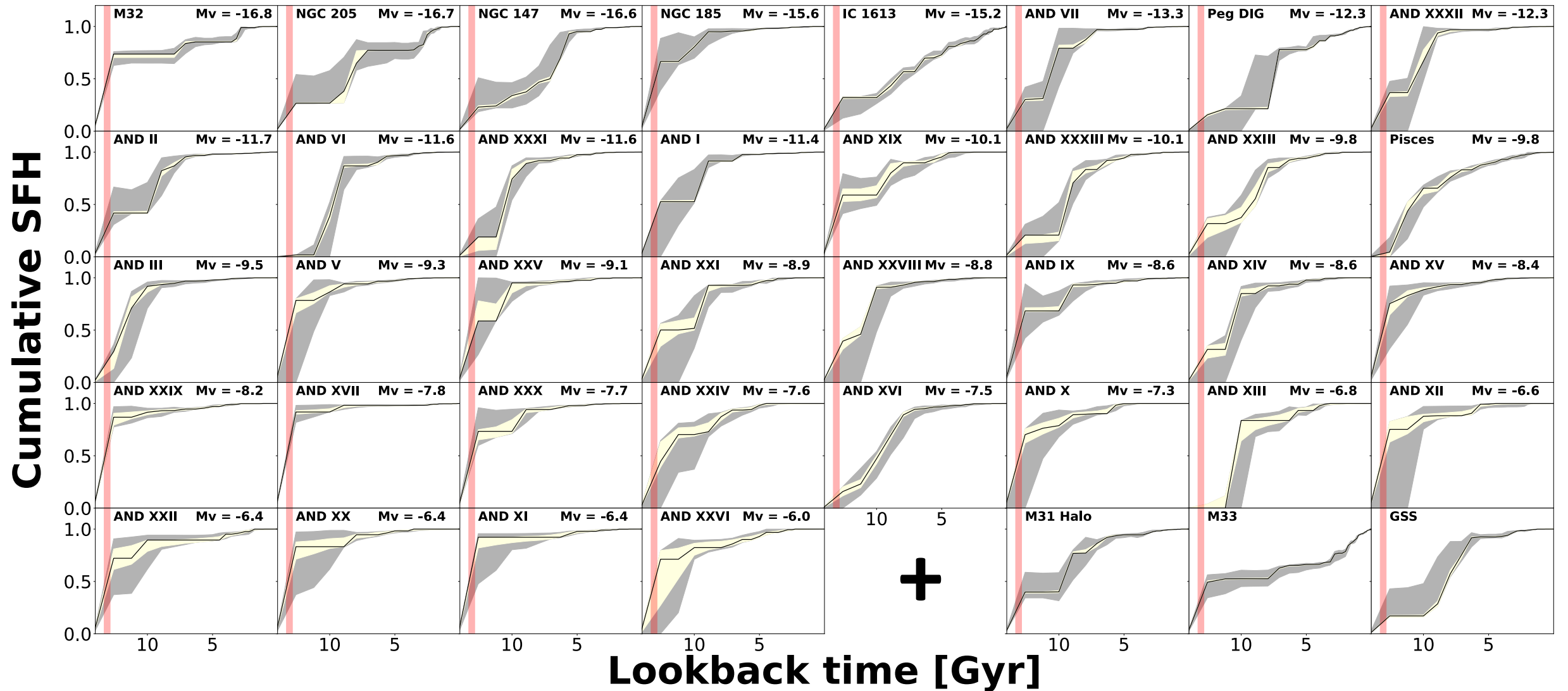
Ultra-faint dwarfs in M31:

- Diversity of SFHs
- Later quenching compared to MW
- Mass or Environment?

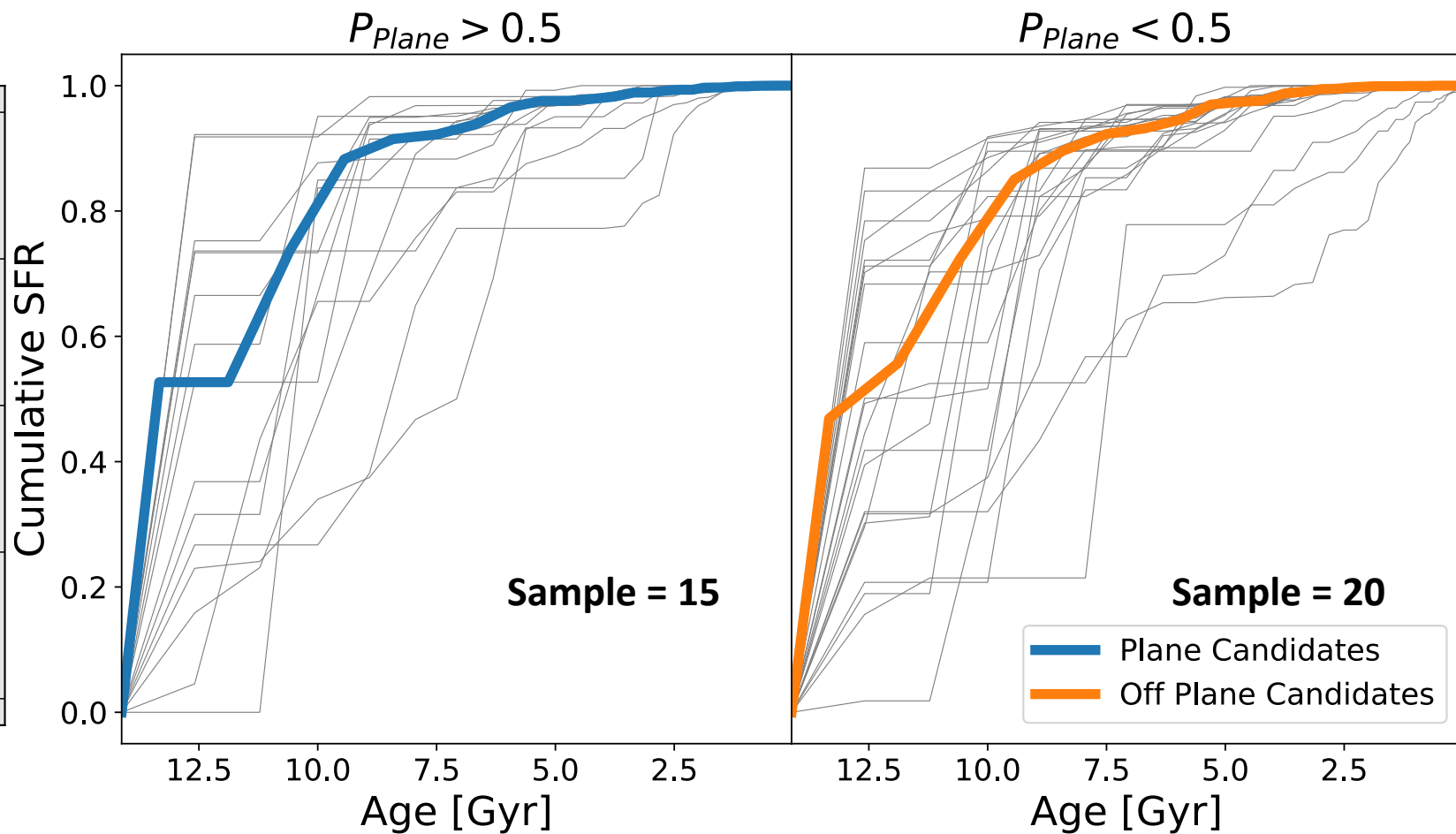
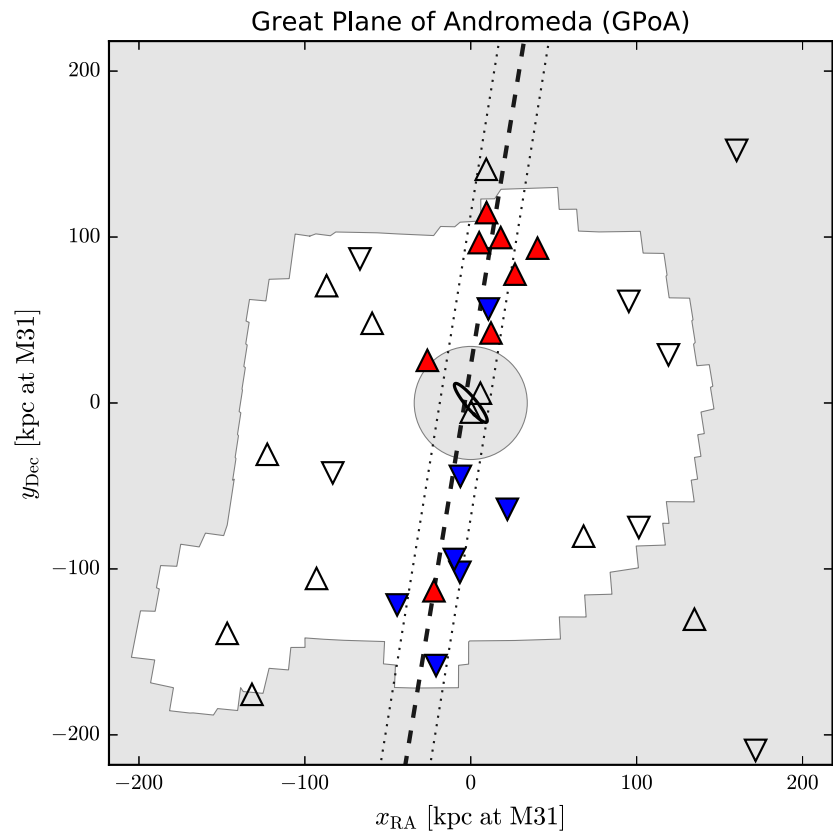
80% stellar mass formed
 \approx
Quenching epoch



Lifetime star formation histories of M31 satellites



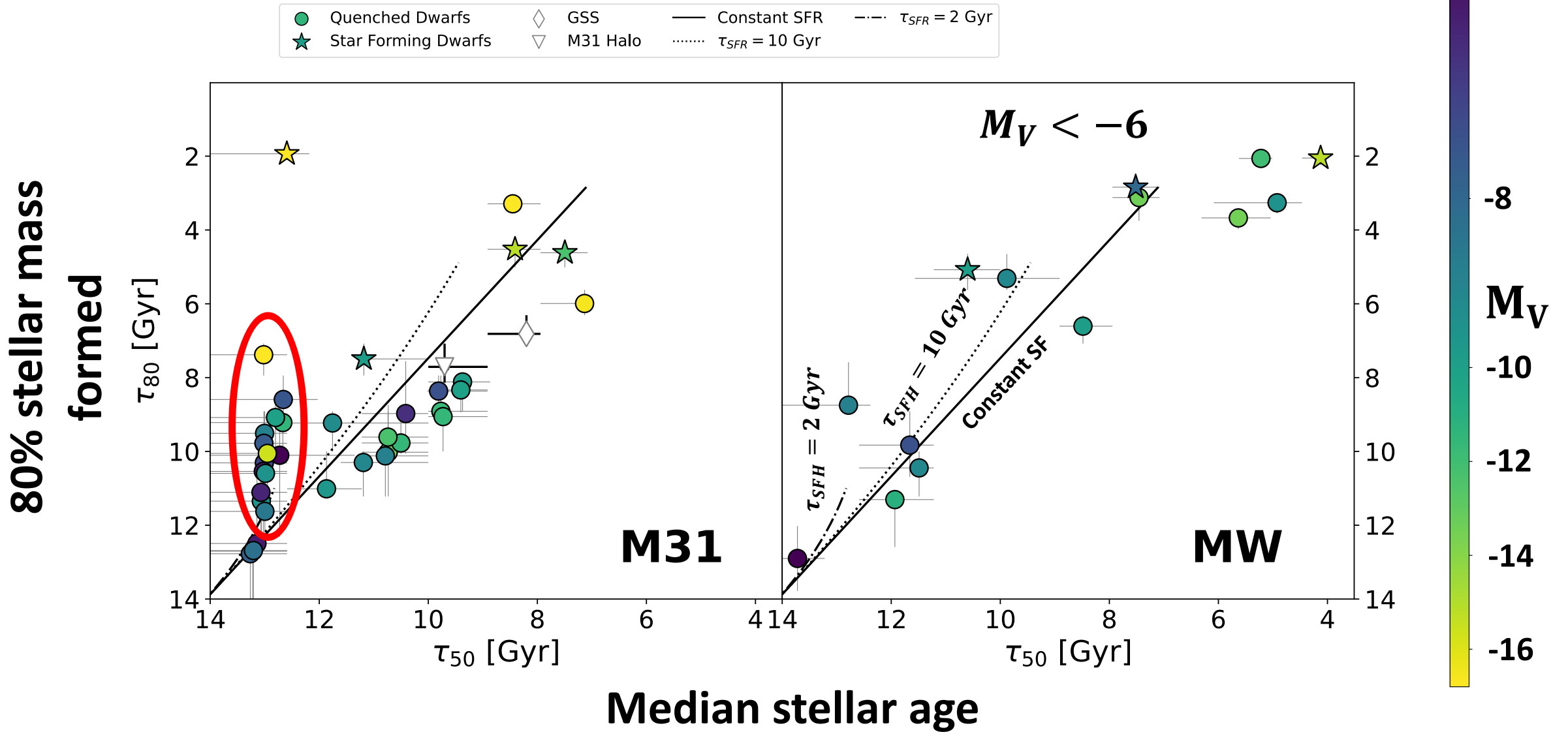
The Great Plane of Andromeda



Ibata+ in 2014

Savino+ in prep.

Andromeda vs Milky Way



Summary

- **The HST M31 satellite treasury survey has assembled a homogeneous photometric dataset of the dwarf galaxies around M31, enabling star formation histories, precise distances, and laying the foundations for orbital reconstructions**
- **Updated 3D map confirms the strong asymmetry of the M31 satellite distribution**
- **The UFDs around M31 show meaningful levels of late star formation, potentially being at the mass threshold of reionization quenching. And XIII is the first instance of a late bursting galaxy in this luminosity class**
- **The mean SFHs of satellites within and outside of the great plane of Andromeda are virtually indistinguishable**
- **M31 hosts a population of satellites characterized by rapid mass build-up and late quenching, which is unseen in the MW**

Opportunities for LSST:

- **What is the spatial distribution of faint satellites around other L^* hosts?**
- **Discovery and characterization of the faint UFD population around M31**
- **Discovery and characterization of isolated UFDs close to the reionization quenching threshold**