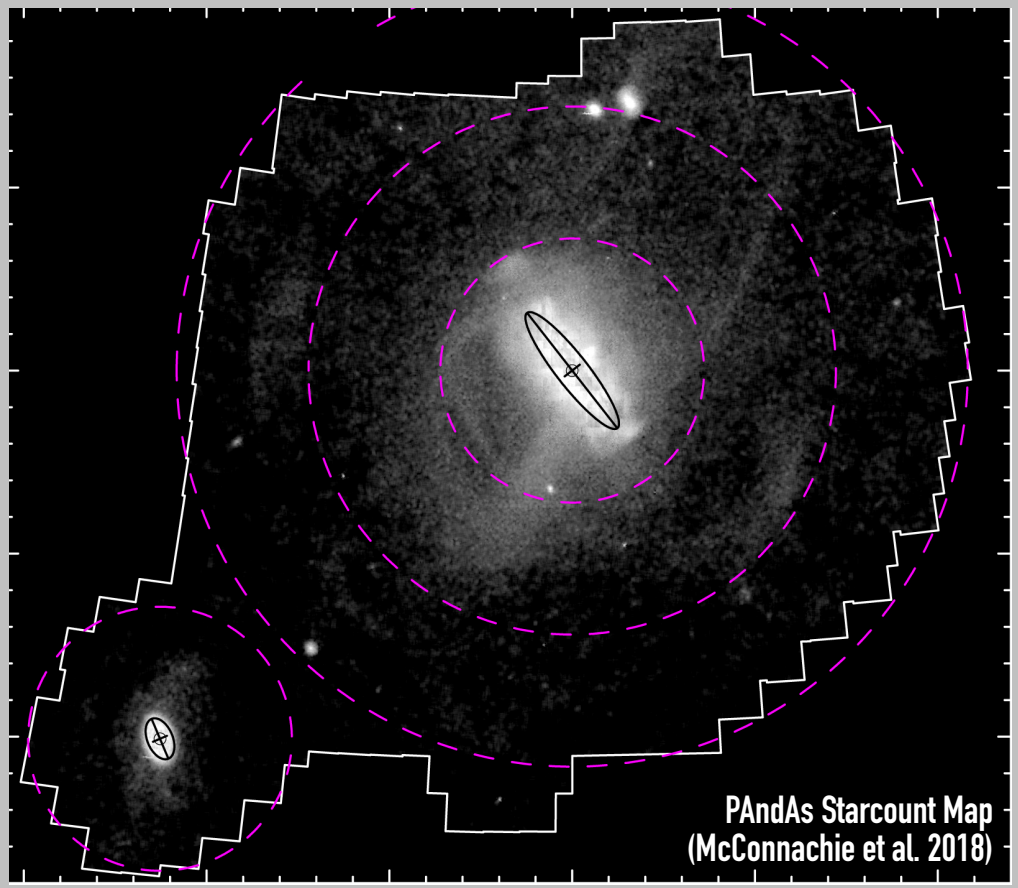
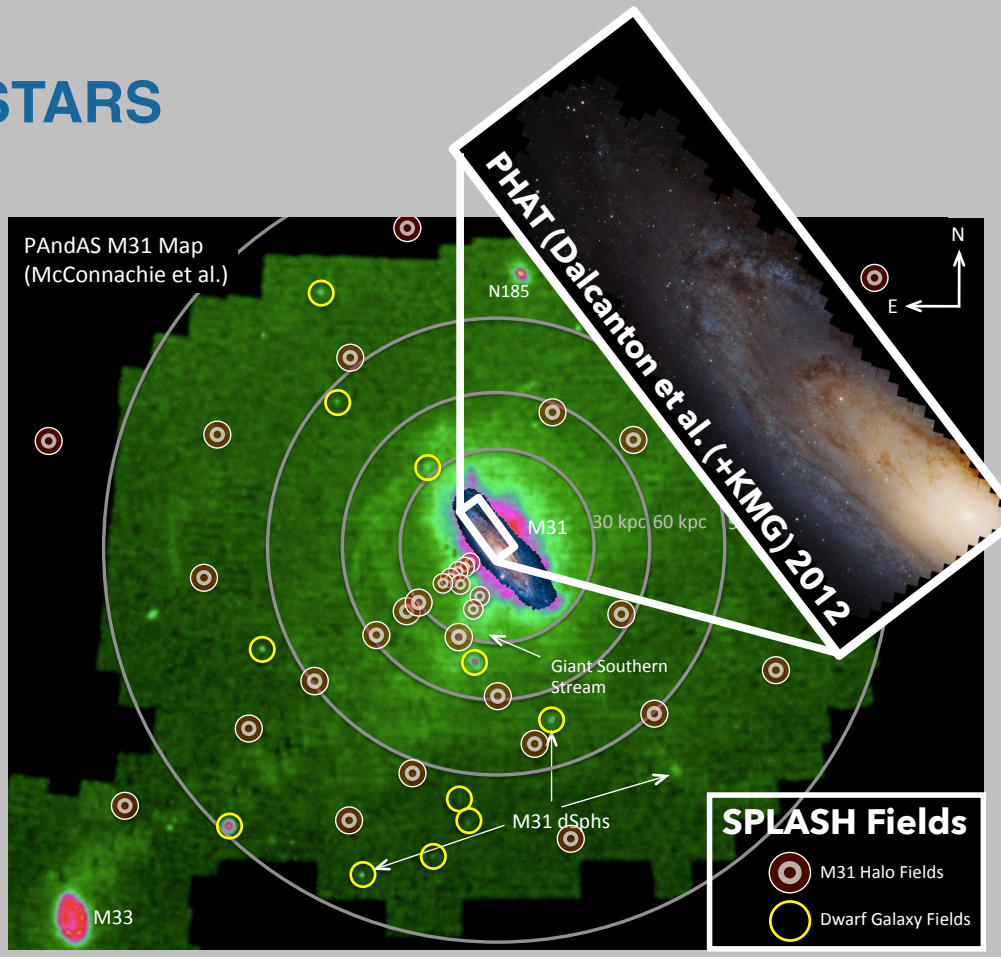
KAROLINE M. GILBERT
SPACE TELESCOPE SCIENCE INSTITUTE

THE POWER OF WIDE FIELDS
FOR REVEALING THE MERGER HISTORY OF THE ANDROMEDA GALAXY

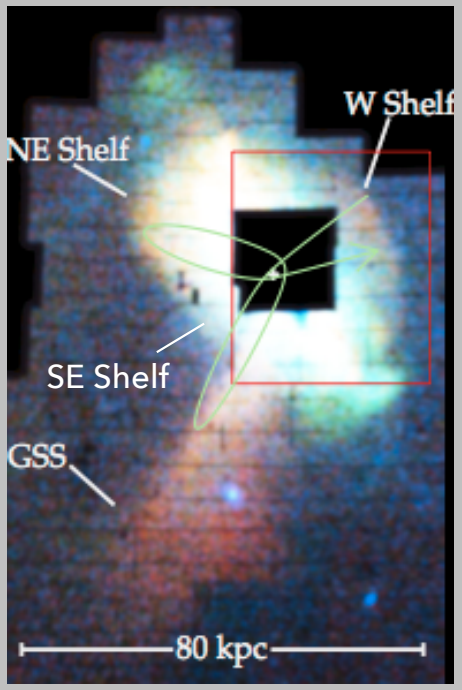
Image credit: Robert Gendler

CURRENT SURVEYS OF RESOLVED STARS





SPECTROSCOPY ENABLES DETAILED MODELING OF TIDAL STREAMS

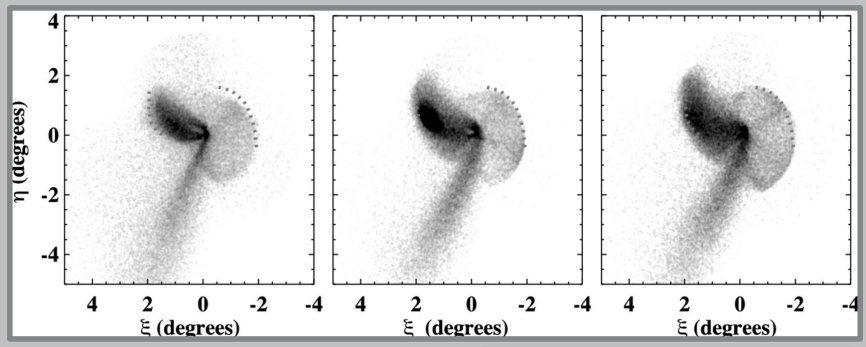


Fardal et al. (+KMG) 2012

Key Observables

- Line of sight velocities in W Shelf, SE Shelf, GSS
- Stellar density distribution
- Line of sight distance along the GSS

Fardal et al. (+KMG) 2013



Progenitor stellar mass:
~ LMC to M33

Disruption: ~ 750 Myr

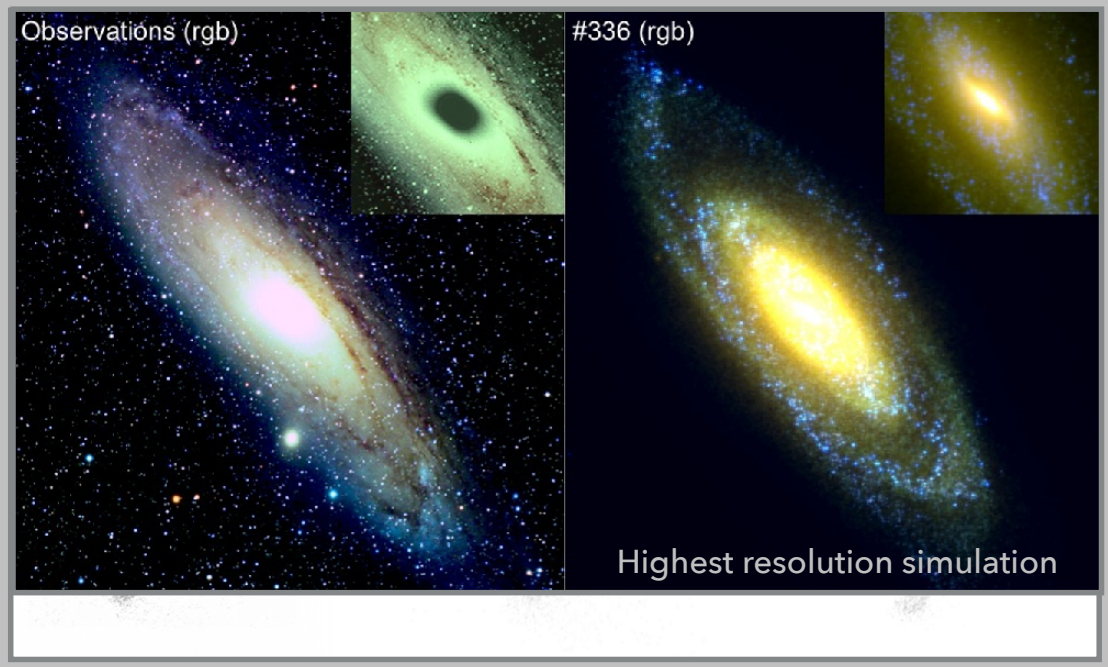
M31's mass:
M_{200} ~ 2 x 10^{12} Msun

See also: Fardal et al. 2006, 2007, 2008, 2012, 2013; Mori & Rich 2008; Sadoun et al. 2014; Kirihara et al. 2014, 2017

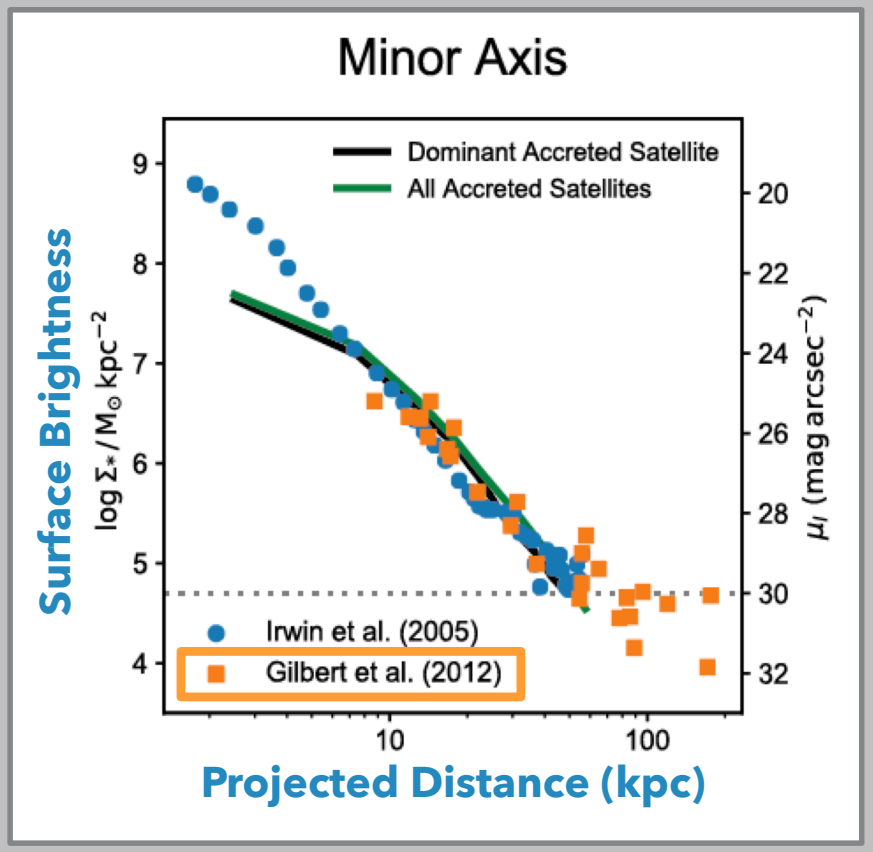
MAJOR MERGERS SIMULATED IN M31 ANALOGUES

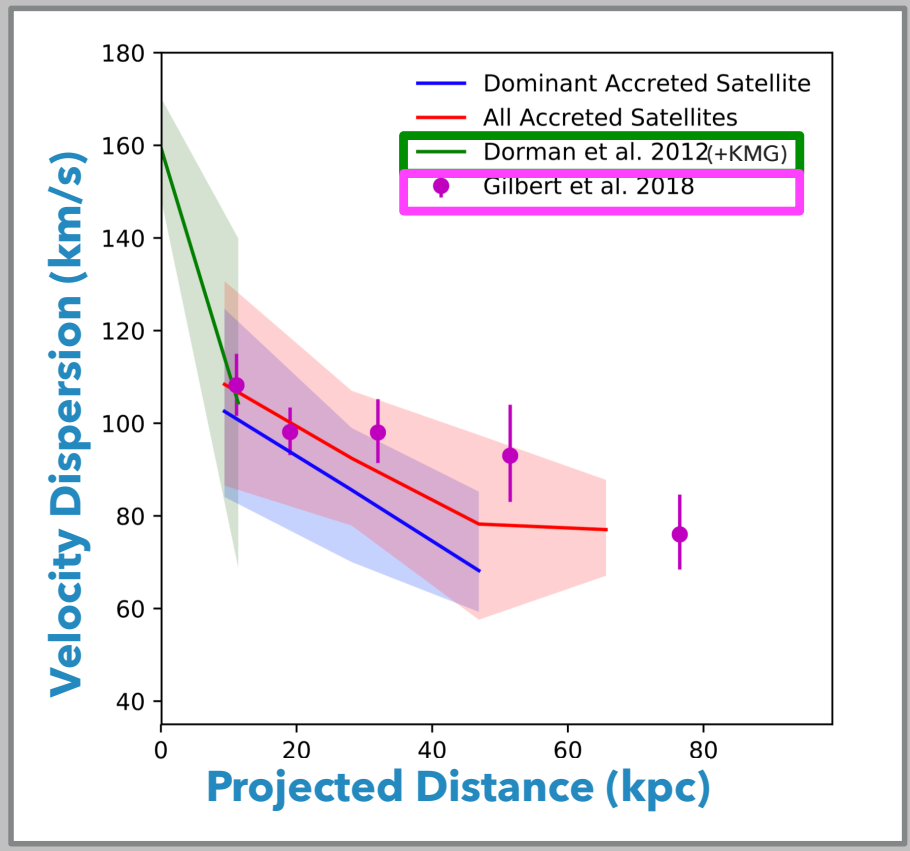
- A recent major merger can reproduce multiple observed properties of M31's stellar halo and disk
- Observations best matched by simulations of a ~4:1 merger
  - first passage 7-10 Gyr ago, coalescence ~2-3 Gyr ago

Hammer et al. 2018



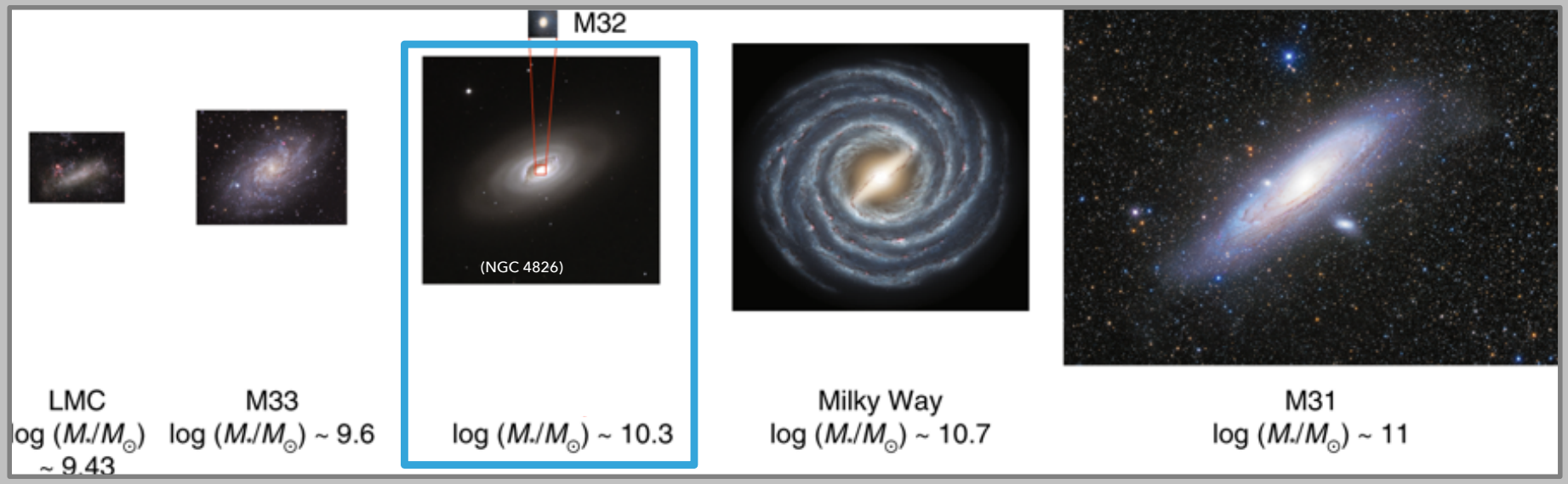
A MAJOR MERGER SCENARIO CAN MATCH GLOBAL PROPERTIES





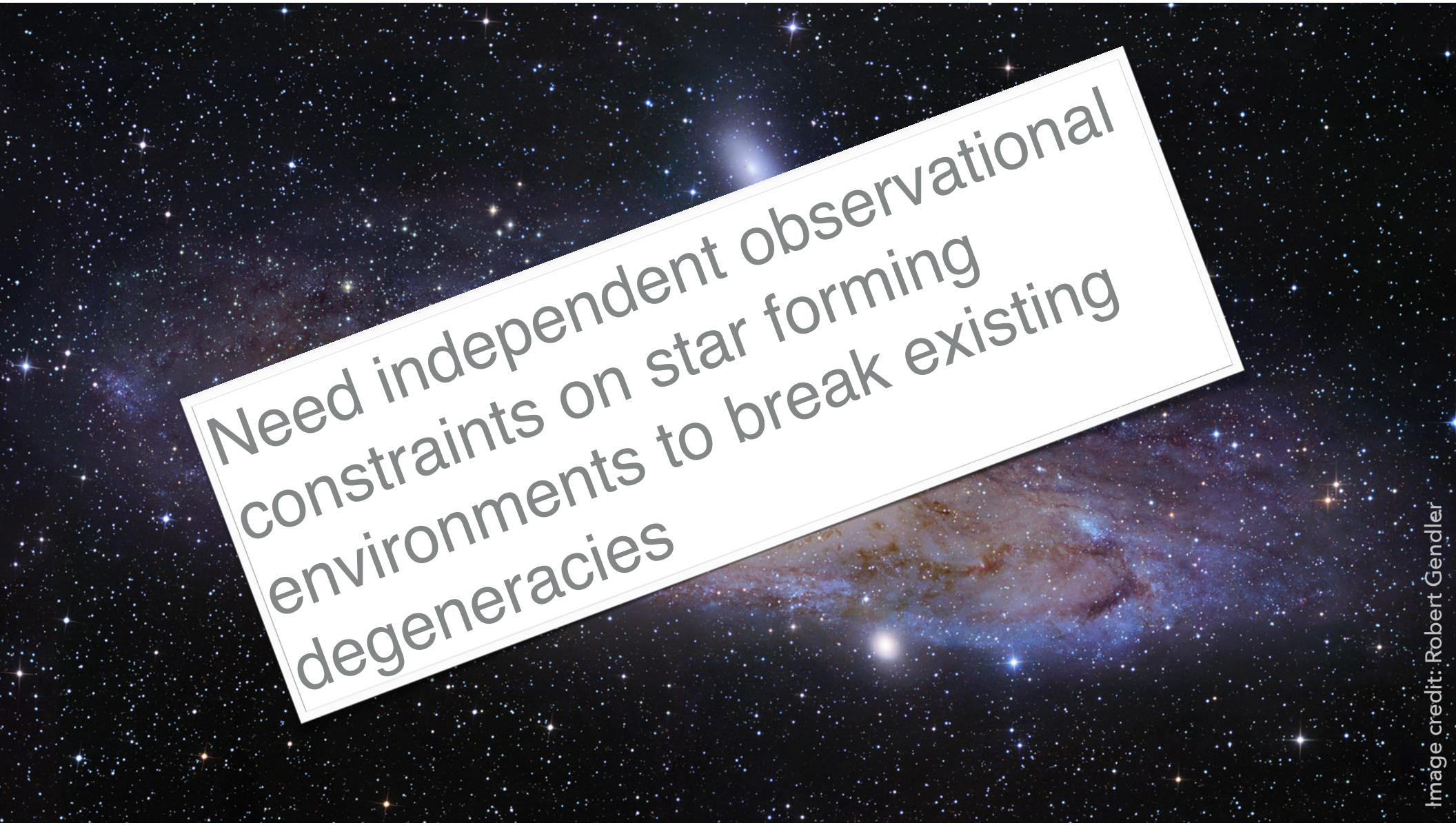
D'Souza and Bell 2018b

PLACING A MASSIVE PROGENITOR IN CONTEXT



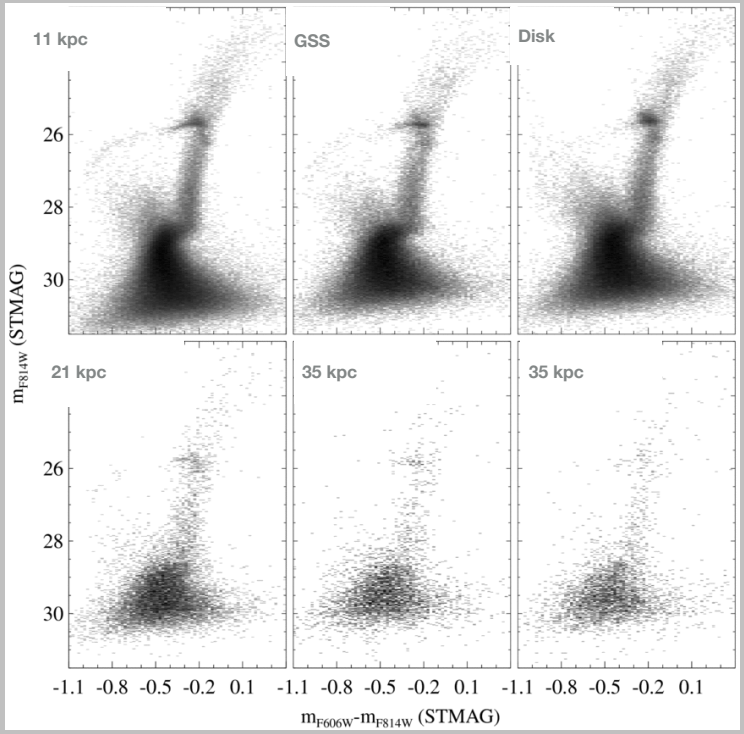
D'Souza and Bell 2018b

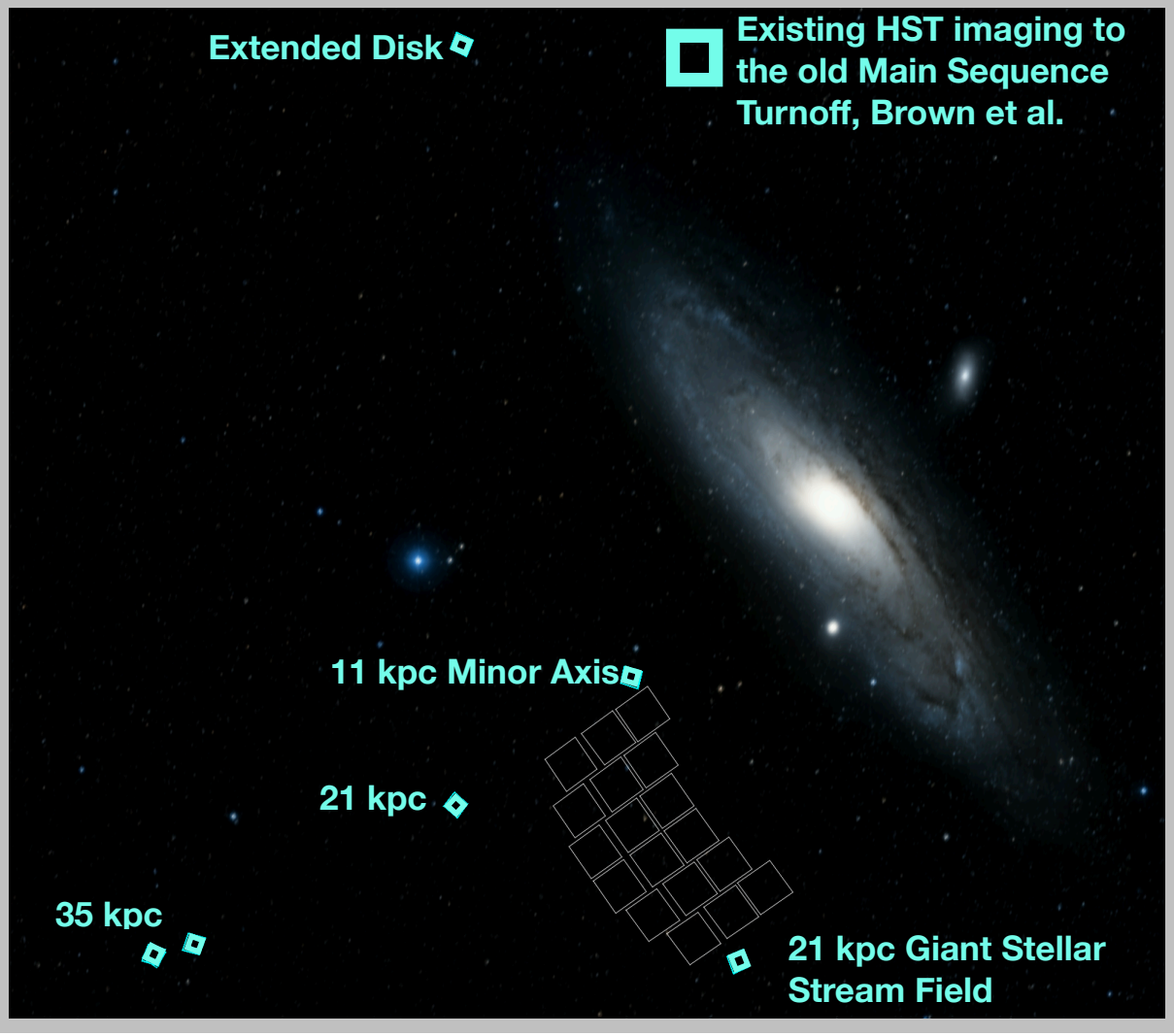
Hammer et al. 2018


Need independent observational constraints on star forming environments to break existing degeneracies
Image credit: Robert Gendler

DEEP HIGH RESOLUTION IMAGING IN M31

Brown et al. 2008, 2009





CHEMICAL ABUNDANCES

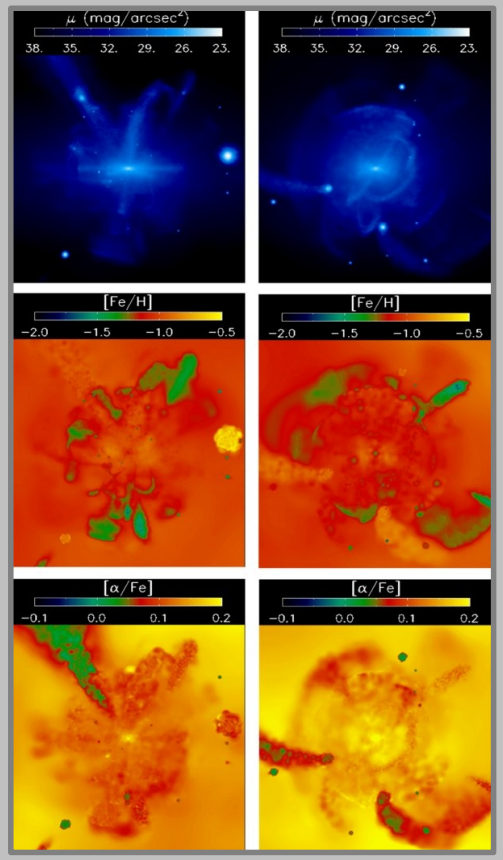


Image Credit Sanjib Sharma

Stellar Surface Density

Stellar luminosity plus time since disruption

Metallicity [Fe/H]

Stellar luminosity

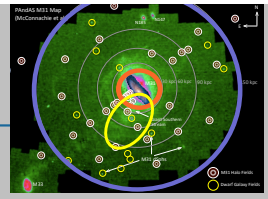
Alpha Element Abundances [α/Fe]

Time of infall

LUMINOSITY FUNCTION OF ACCRETED SATELLITES

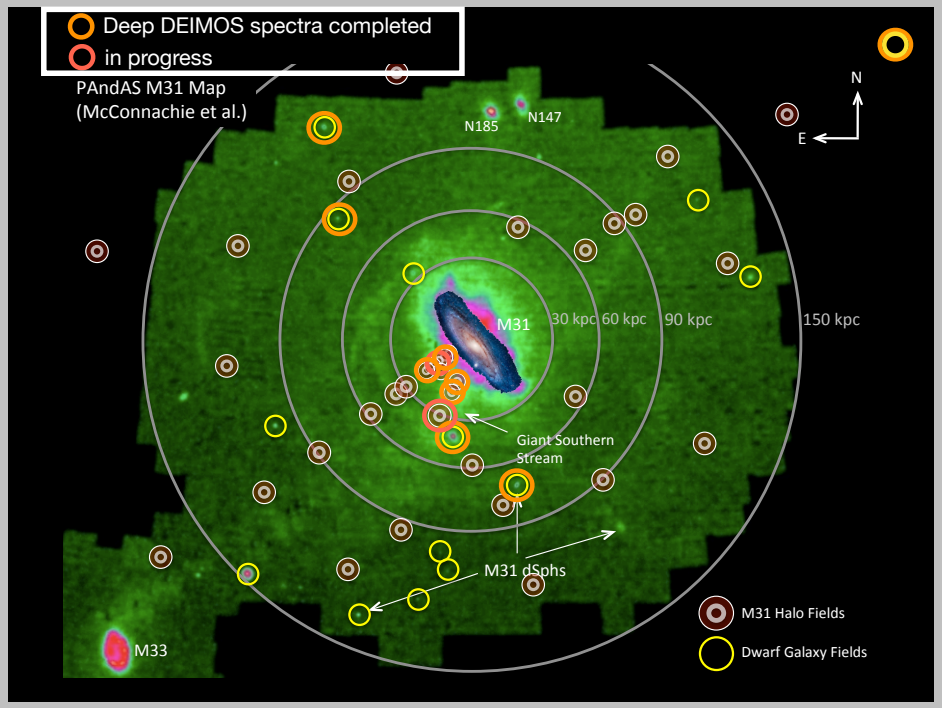
TIME OF ACCRETION

e.g., K. M. Gilbert et al. 2009a, Lee et al. 2015

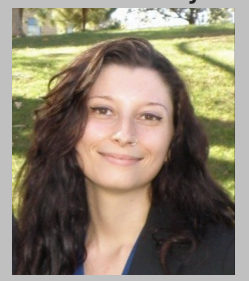


BUILDING A STATISTICAL CENSUS OF CHEMICAL ABUNDANCES

- Existing SPLASH data
  - Coadd low SNR spectra
  - Mean [Fe/H], [α/Fe] abundances
- New Spectroscopic Campaign
  - Obtain deep data in strategic dSph and halo fields
  - Distributions of [Fe/H], [α/Fe] abundances
- Extension of spectral synthesis method to lower resolution (R~3000) Escala, Kirby, K. M. Gilbert et al. 2019

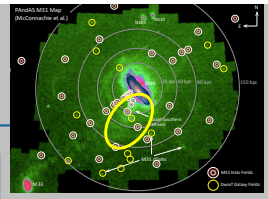



Jennifer Wojno


Ivanna Escala

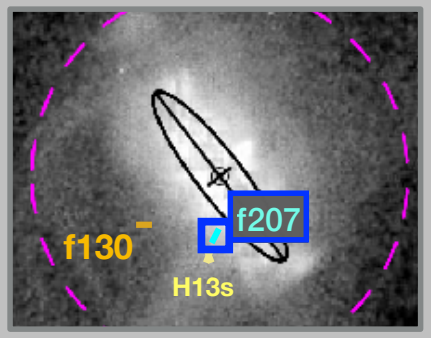

Evan Kirby

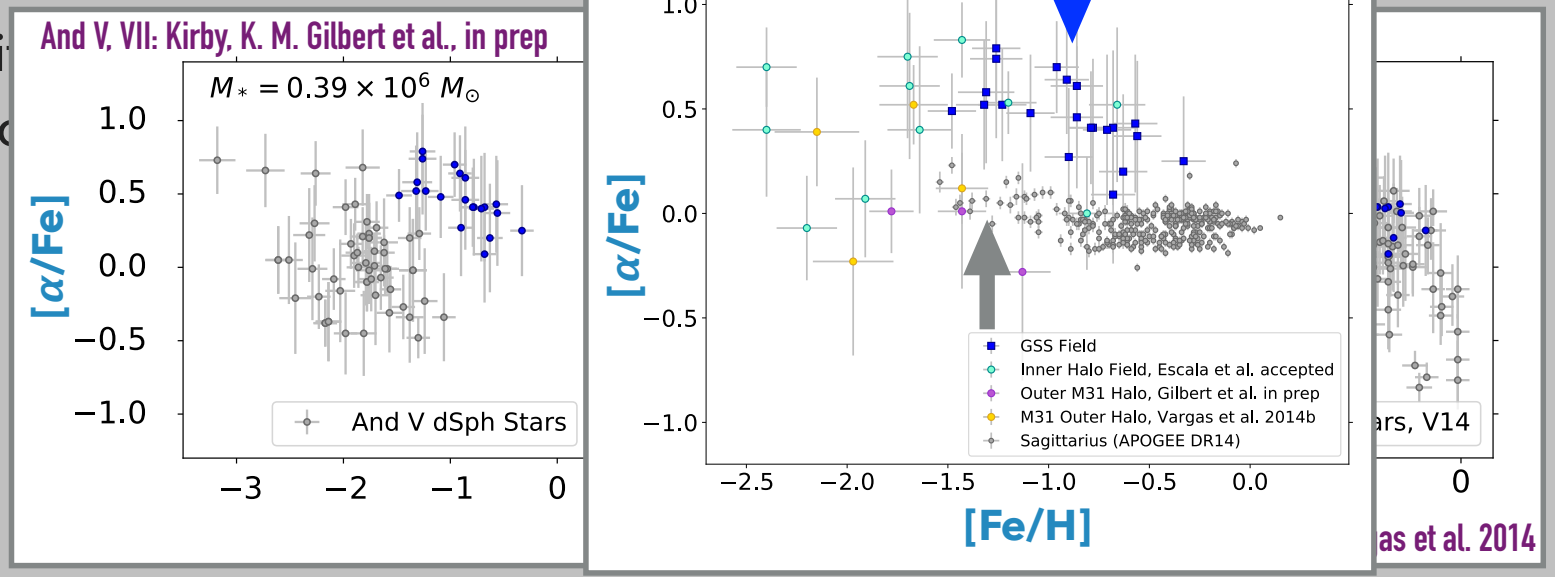
NSF AST-1614569 (PI K. M. Gilbert) and AST-1614081 (PI Kirby)



FIRST ALPHA ABUNDANCES IN GSS

- GSS experienced higher efficiency of star formation than surviving M31 dwarf satellites
- And than Sagi
  Magellanic Clo





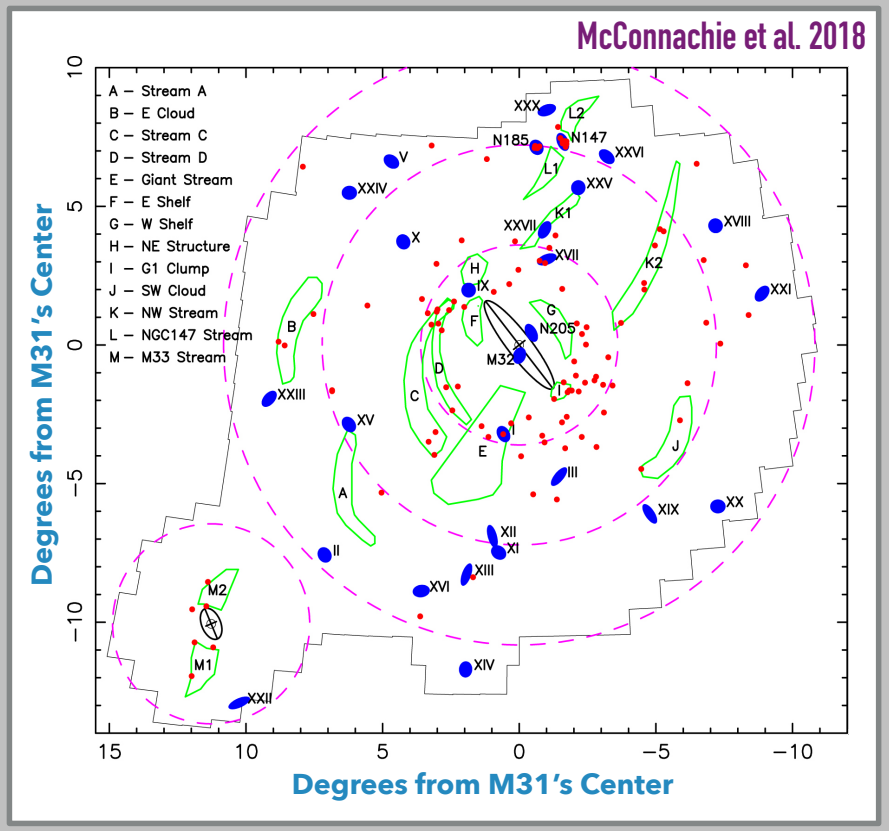
K. M. Gilbert et al., subm.

WIDE FIELDS AND EXPANDED SURVEY VOLUMES

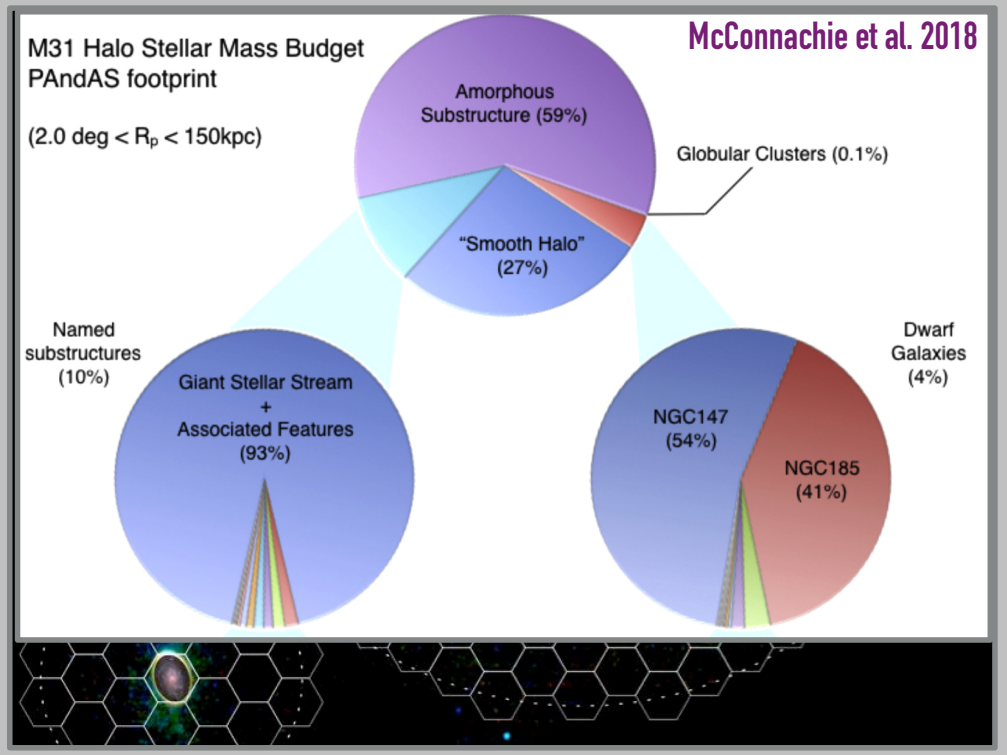
THE FUTURE OF STELLAR HALO STUDIES

WIDE FIELD SPECTROSCOPY IN ANDROMEDA

K. M. Gilbert & E. Tollerud, Astro2020 white paper



CURRENT SPECTROSCOPIC COVERAGE



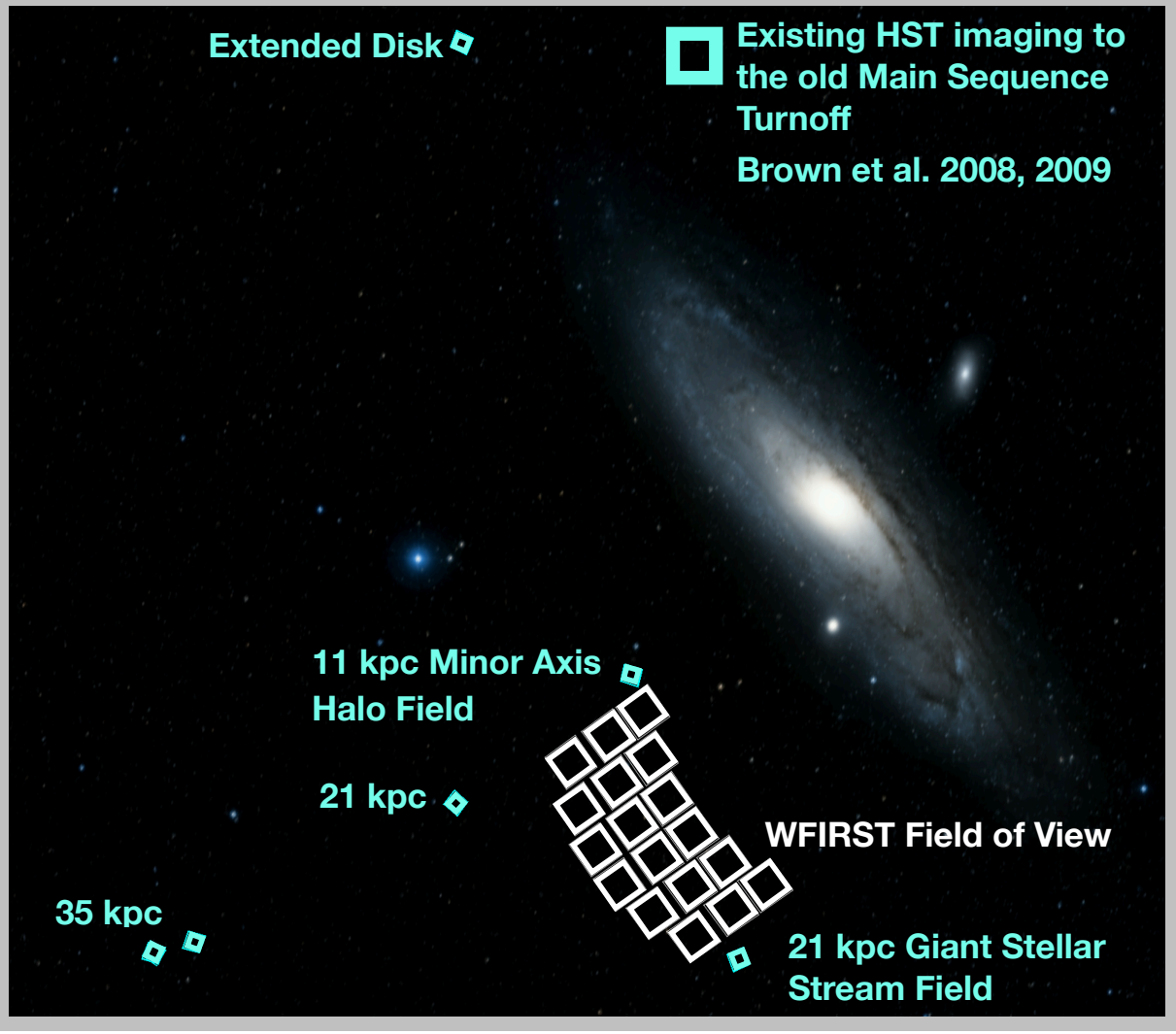
POTENTIAL WIDE FIELD MOS SURVEY COVERAGE

THE FUTURE OF STELLAR HALO STUDIES: WIDE FIELDS

K. M. Gilbert & E. Tollerud, Astro2020 white paper

WIDE FIELD HIGH RESOLUTION IMAGING IN ANDROMEDA

- Contiguous deep imaging to ancient Main Sequence turnoff will be enabled over significant areas of halo with WFIRST

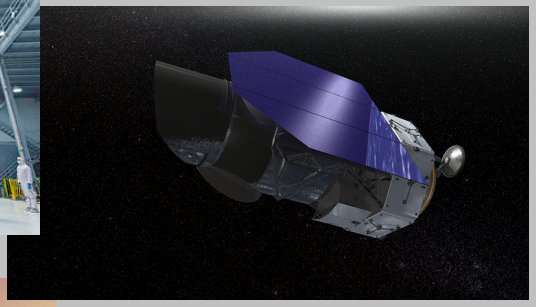


STELLAR HALOS IN THE LOCAL VOLUME

- Combination of JWST, 30-m telescopes, WFIRST, and LUVOIR will:
  - Extend current day M31-like studies to galaxies throughout the Local Volume
  - Wide field studies of M31 will be crucial for correctly interpreting the stellar halo observations

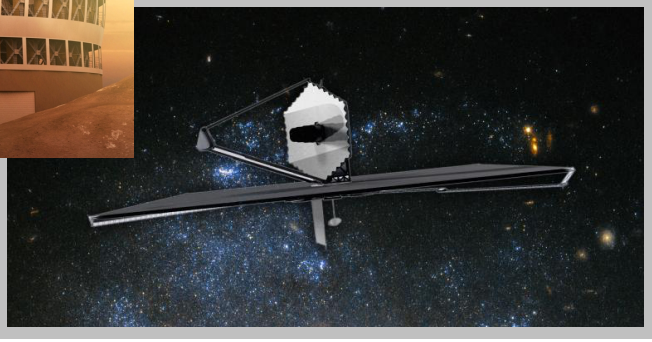
JWST

WFIRST



TMT

LUVOIR

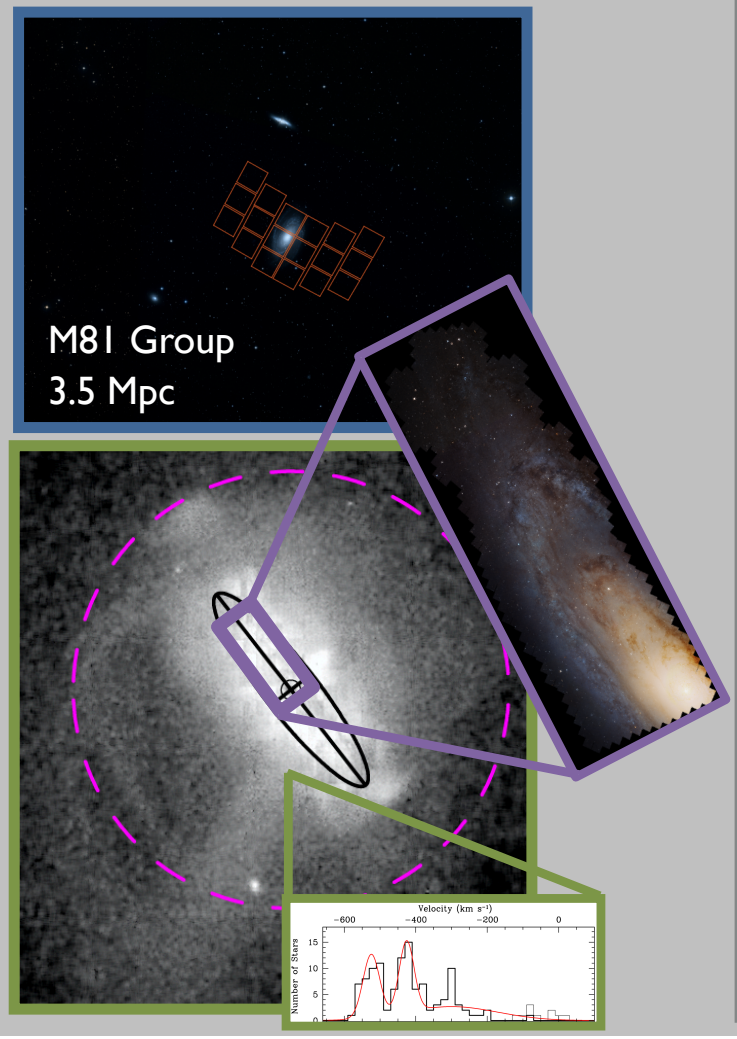


Mergers have played a significant role – at all radii – in crafting Andromeda's present-day morphology.

Observations of resolved stars enable reconstruction of the build-up of individual stellar halos - and chemical abundances and deep star formation histories provide key observational constraints.

Future wide field spectroscopy and deep imaging will revolutionize our understanding of Andromeda's halo and greatly increase the N_{halos} we can characterize.

THE FUTURE OF STELLAR HALO STUDIES: EXPANDED SURVEY VOLUMES



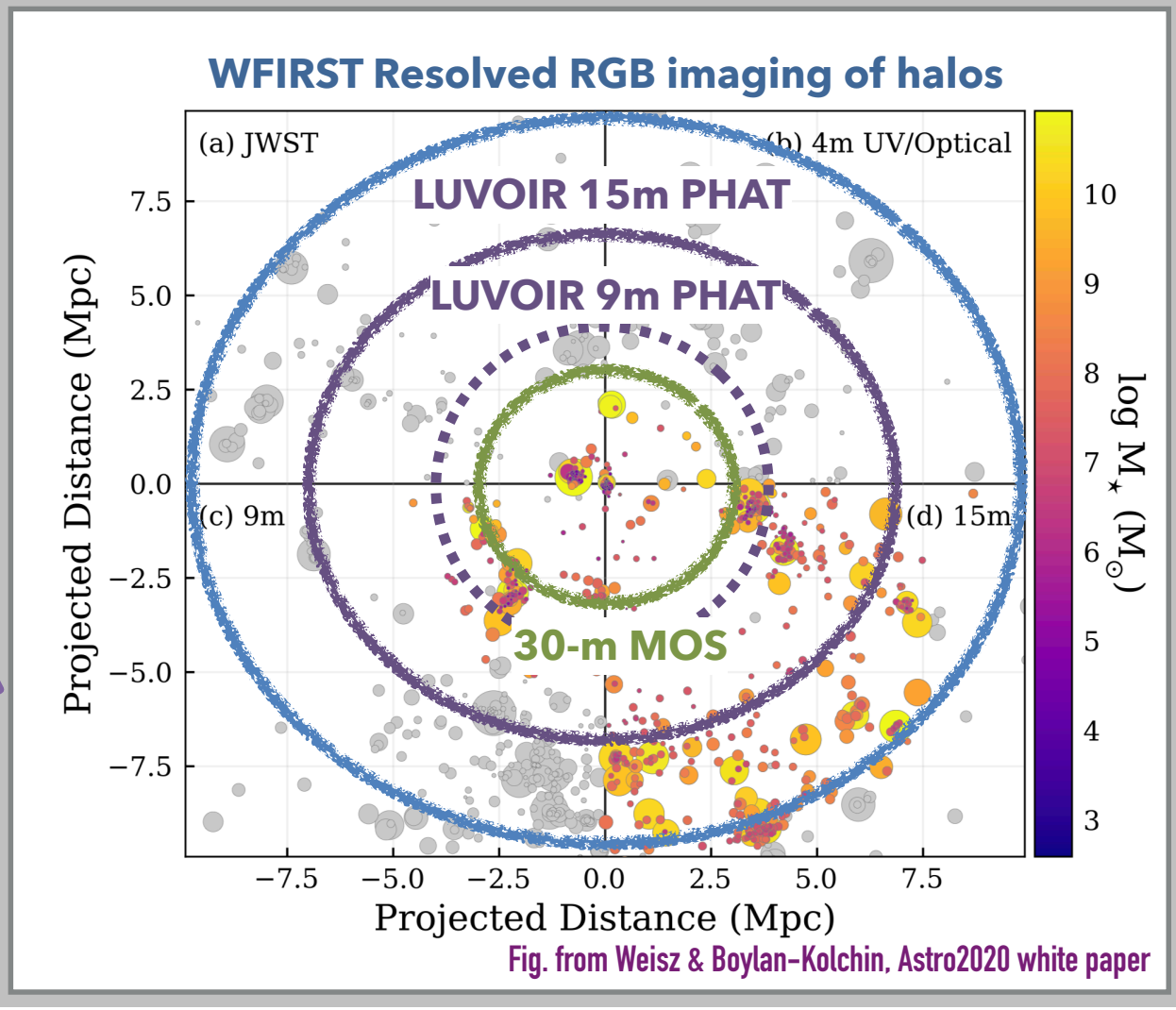


Fig. from Weisz & Boylan-Kolchin, Astro2020 white paper