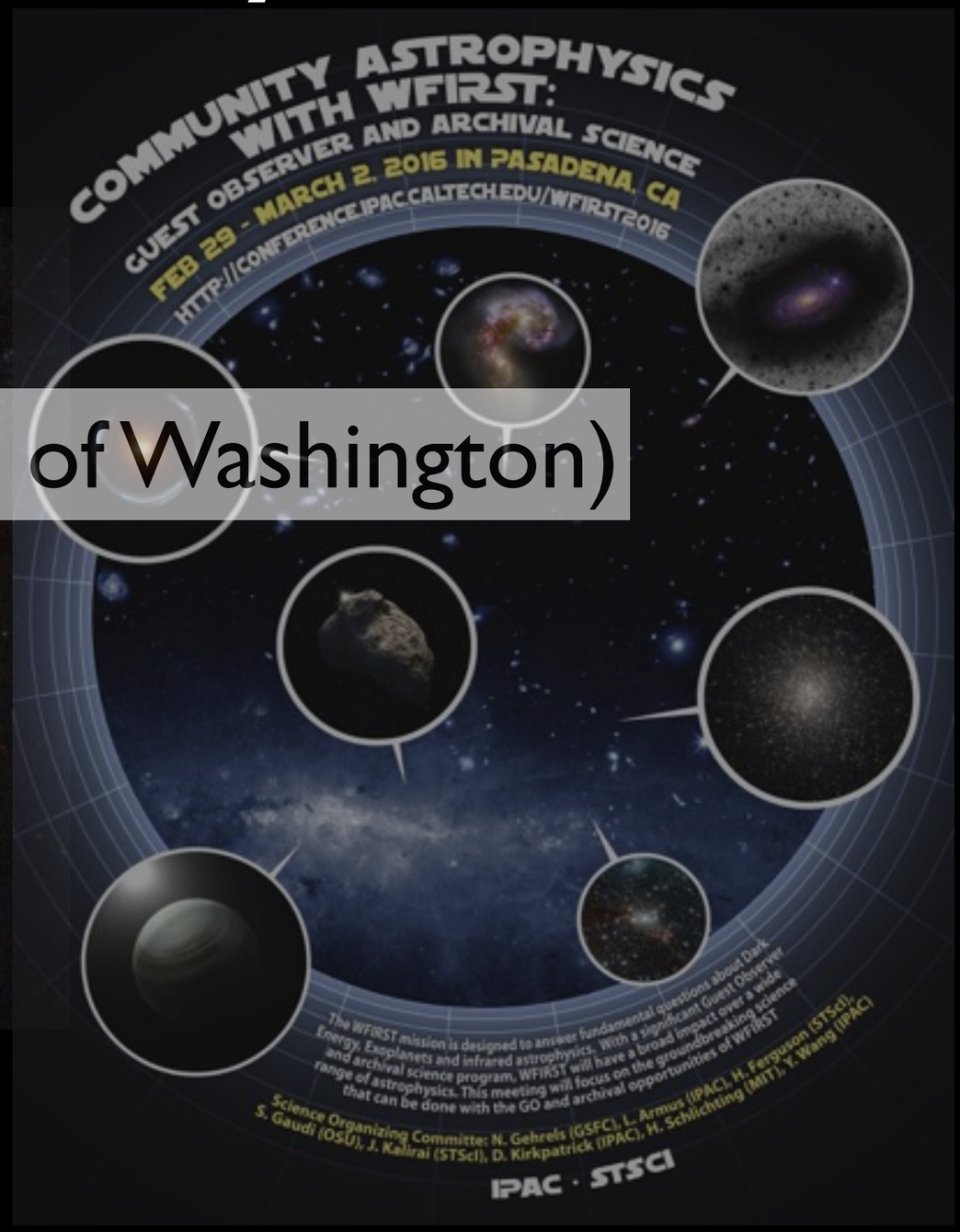
WFIRST Infrared Nearby Galaxy Survey

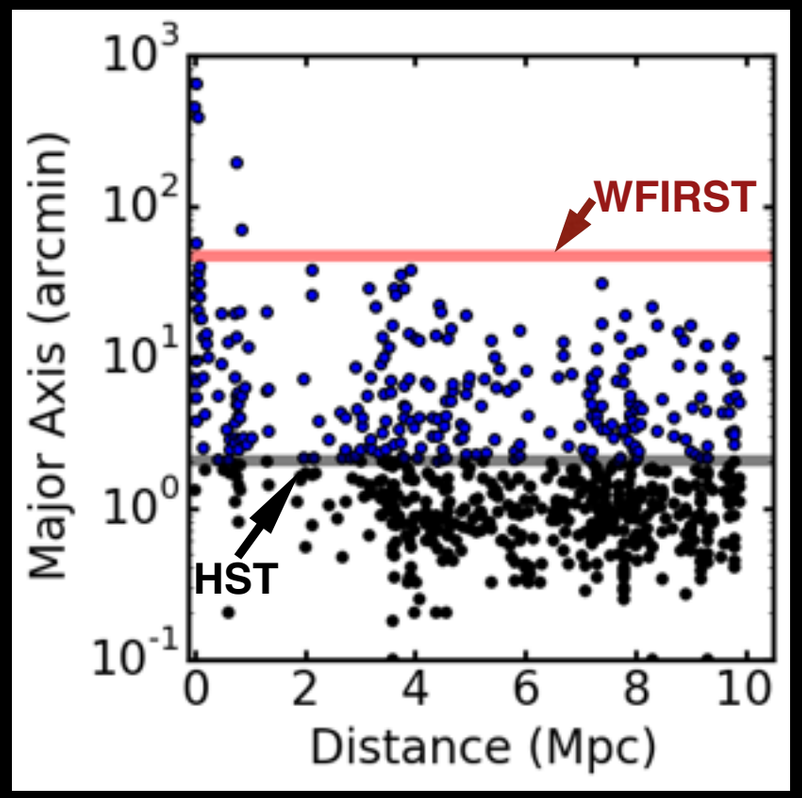
Ben Williams (University of Washington)

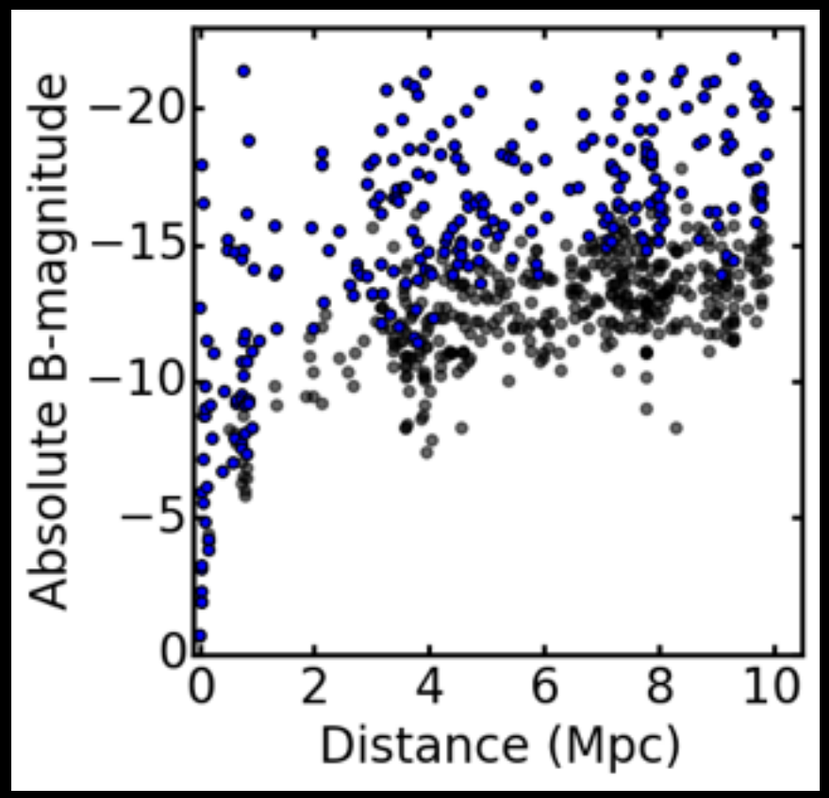


Nearby Galaxies Are Great for Astrophysics

- Detailed view and context simultaneously
- Sensitive to galaxy evolution and cosmology
- Anchor our knowledge for interpretation of more distant universe
- Large samples - Subdivide sample for specific goals
- Cover a wide range of galaxy properties

Huge Potential Data Set





$N_{galaxies}$	~500
Distances	<10 Mpc
Metallicities	-2<[Fe/H]<+0.2
Stellar Masses	10^5-10^{11} M_{sun}
Luminosities	-1>M_B>-21
Angular Sizes	0.05°<θ<10°
Point depth	+7>M_{F160W}>-3
Proper Motion	D_{Max}<100 kpc
FoV/Galaxy	1-100
$N_{satellites}$/Galaxy	<100
$N_{streams}$/Galaxy	<100
$N_{clusters}$/Galaxy	<500
# Resolved Stars	~1,000,000,000

Projects and Lead Co-Is

PI: Williams (U. Wash.) Deputy PI: Dalcanton (U. Wash.)

Photometry	Dolphin (Raytheon)
Stellar Halos	Bell (Mich.), Johnston (Columbia), Bullock (Irvine)
Dwarf Satellites	Sand (TTU), Bullock (Irvine)
Small Scale Dark Matter	Walker (CMU), Johnston (Columbia)
Globular Clusters	Seth (Utah)
Star Formation Histories	Weisz (Berkeley)
Dust & ISM	Gordon (STScI), Dalcanton (UW)
Stellar Evolution	Boyer (Maryland)

Collaborators

Raja Guhathakurta (UCSC)
Denija Crnojevic (TTU)
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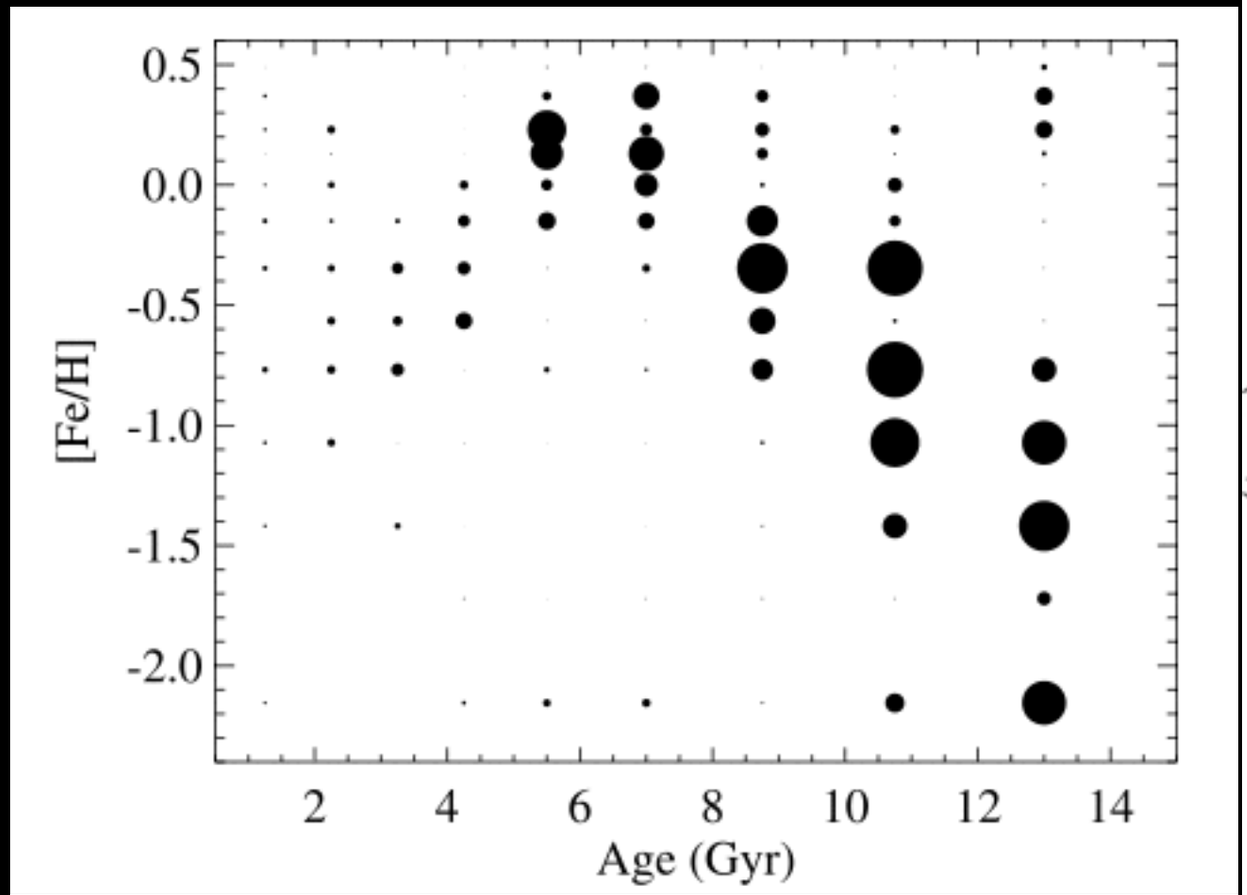
Karin Sandstrom (UCSD)
Julia Roman-Duval (STScI)
Alberto Bolatto (Maryland)
Josh Peek (STScI)
Jay Anderson (STScI)
David Hendel (Columbia)

Beth Willman (LSST)
Phil Rosenfield (CfA)
Margaret Meixner (STScI)
Leo Girardi (Padova)
Nicolas Martin (MPIA)
Cliff Johnson (UCSD)
Jay Strader (MSU)
Robyn Sanderson (Columbia)
Adrian Price-Whelan (Columbia)
Sergey Koposov (Cambridge)
Julio Chaname (Catolica)
Jorge Penarrubia (Edinburgh)
Coral Rose Wheeler (UCI)

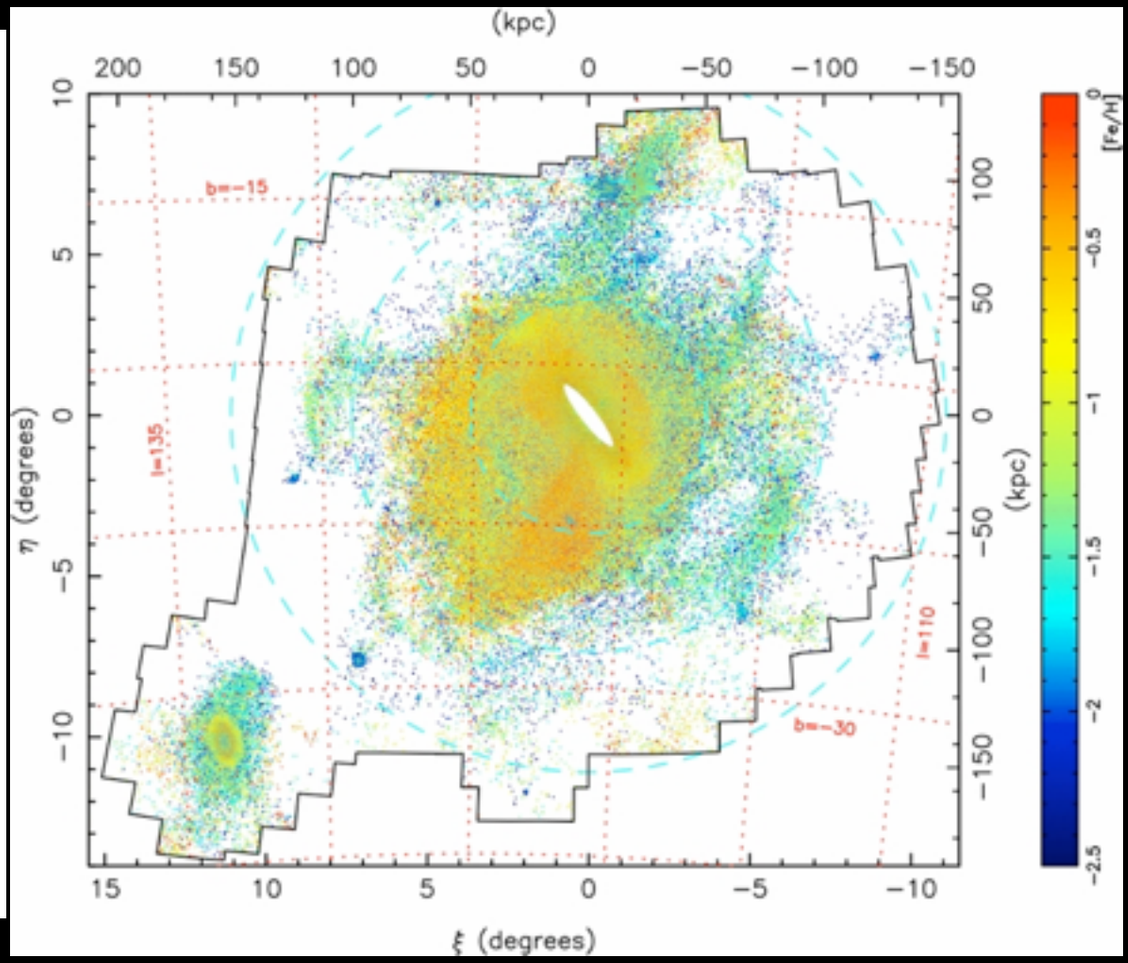
Stellar Halos

Details from HST



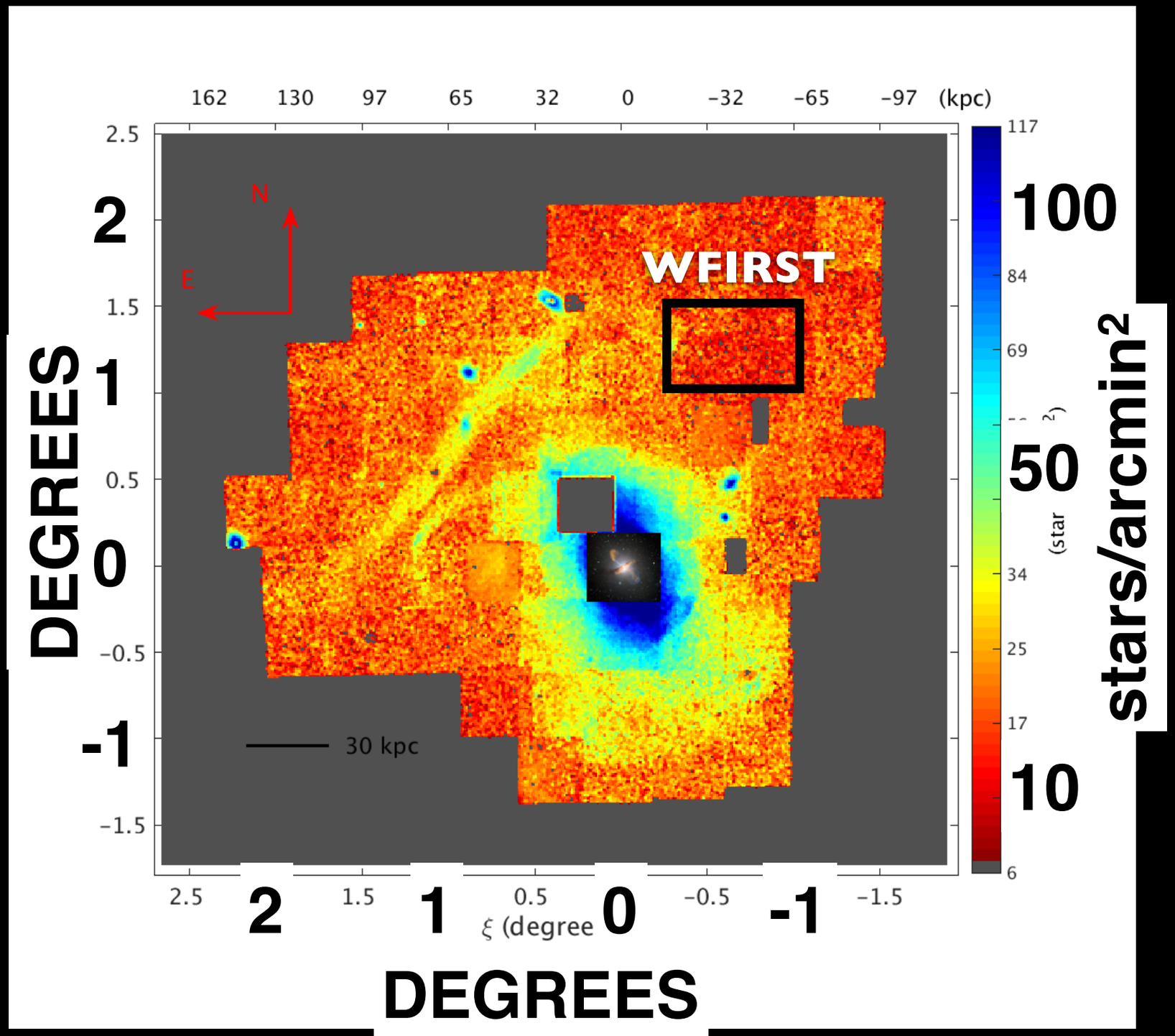
Brown et al. 2006

Context from ground



Ibata et al. 2014

Cen-A - Megacam



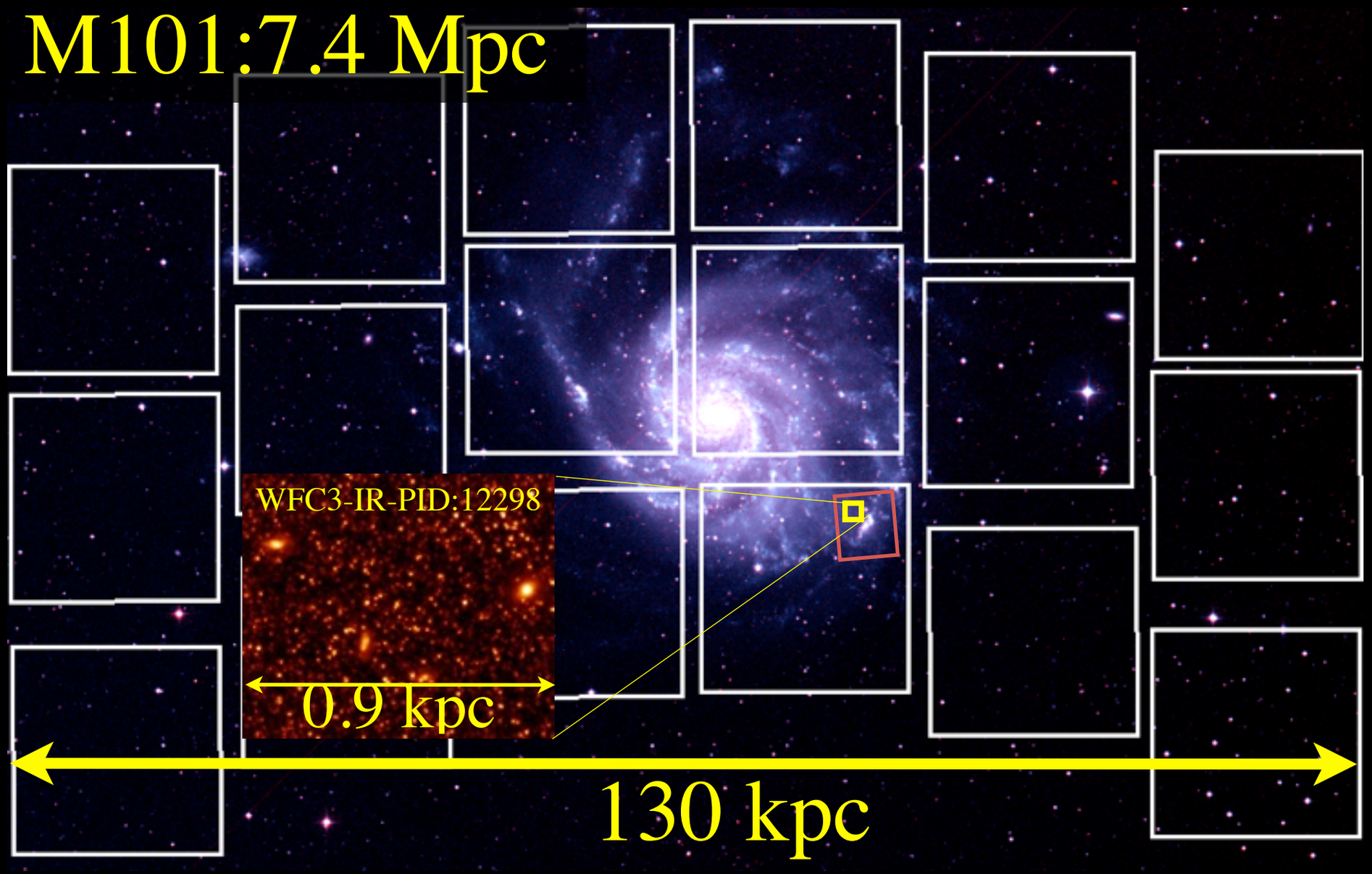
WFIRST should reach <1 star/arcmin²

Crnojevic et al. 2015

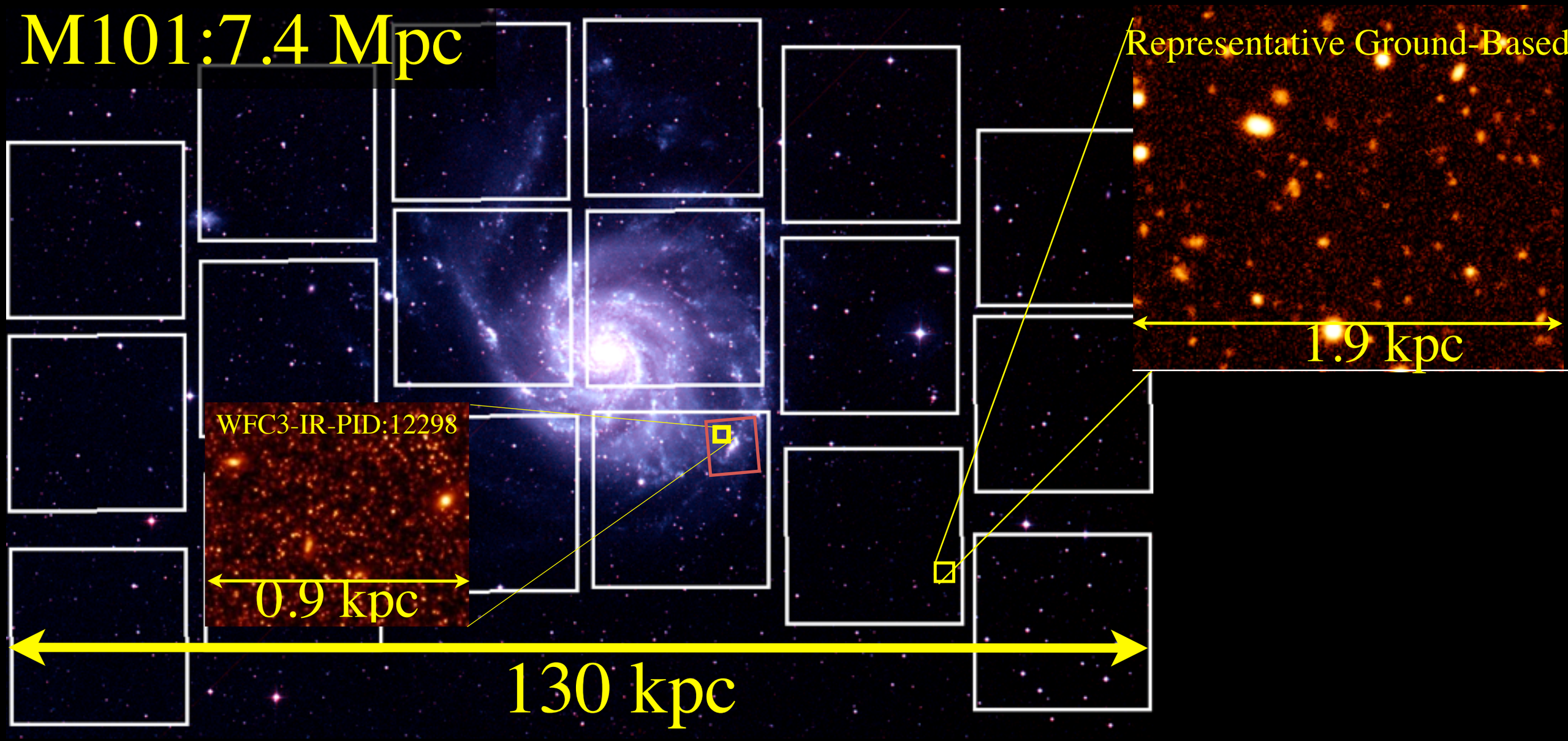
For HST, Even relatively far away coverage is sparse

M101:7.4 Mpc

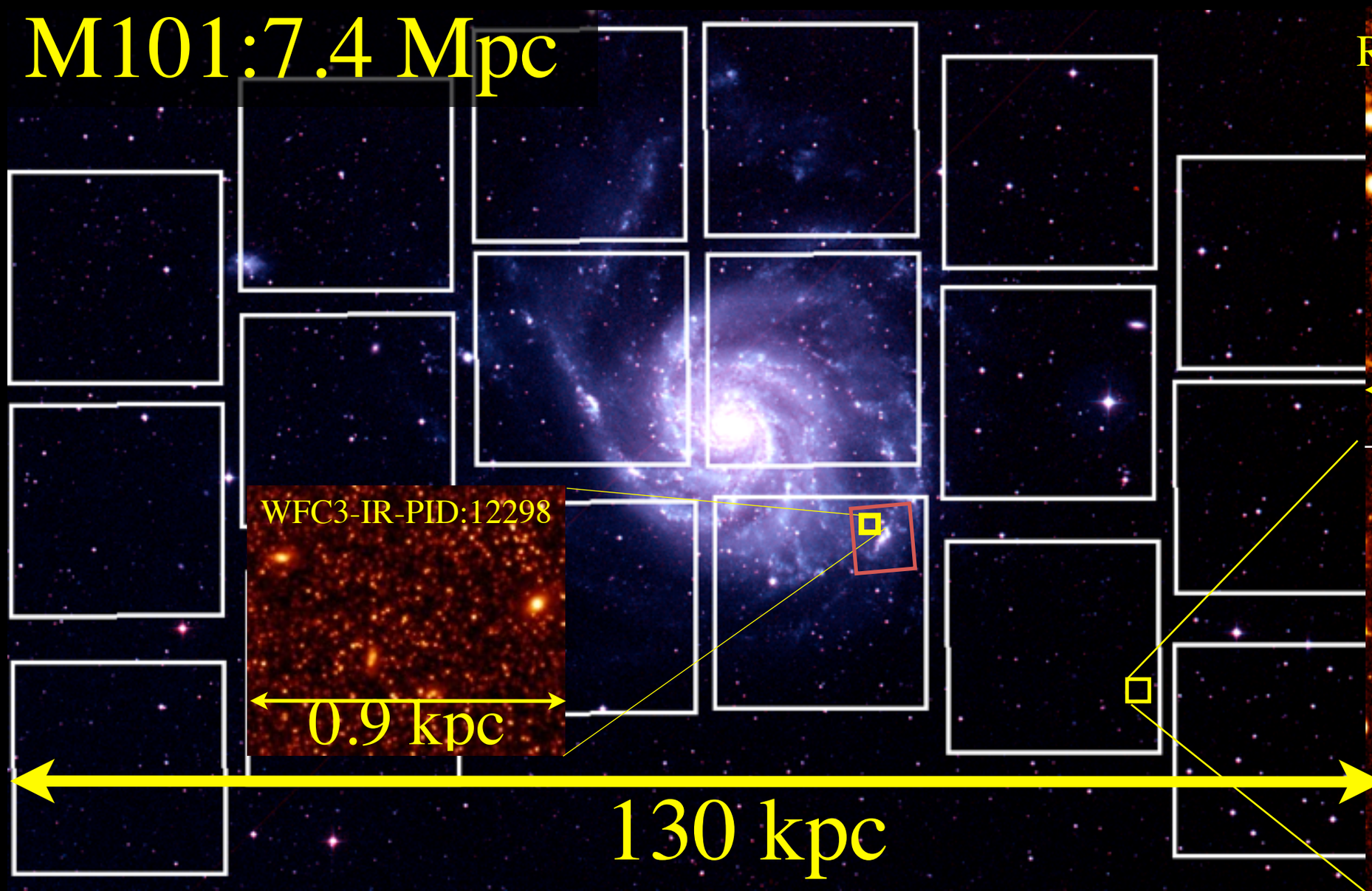
WFIRST gets full coverage

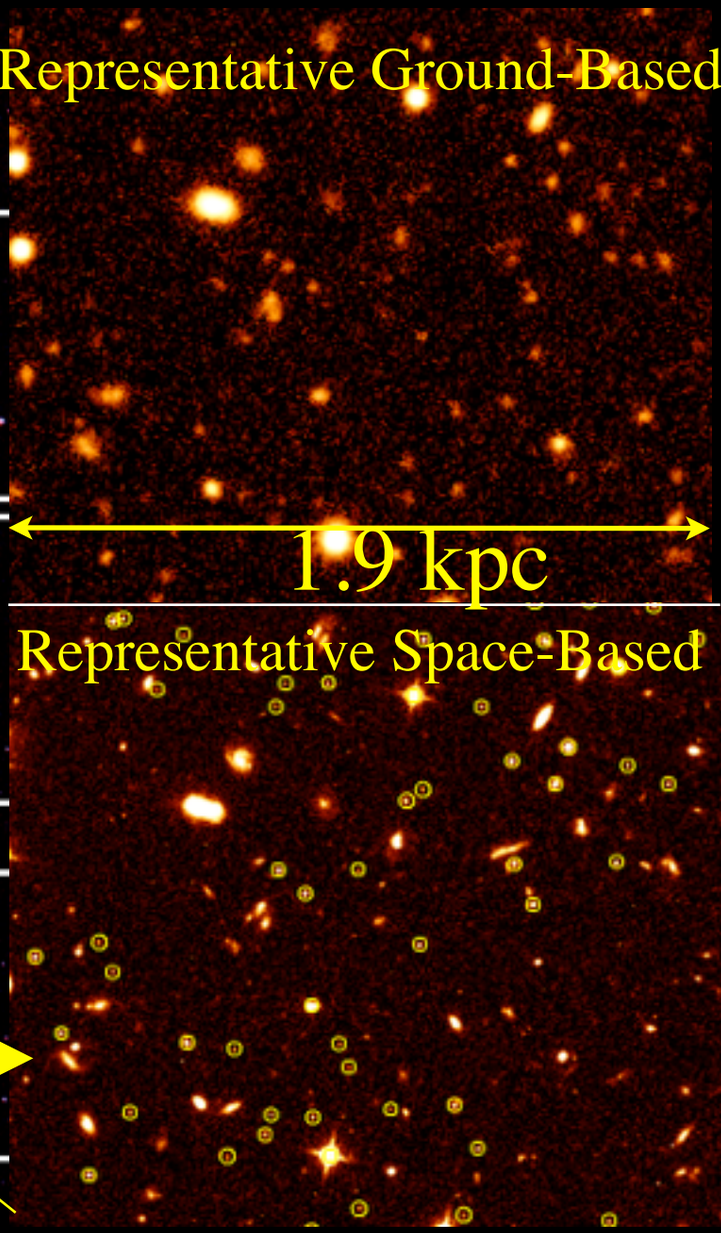


WFIRST gets full coverage

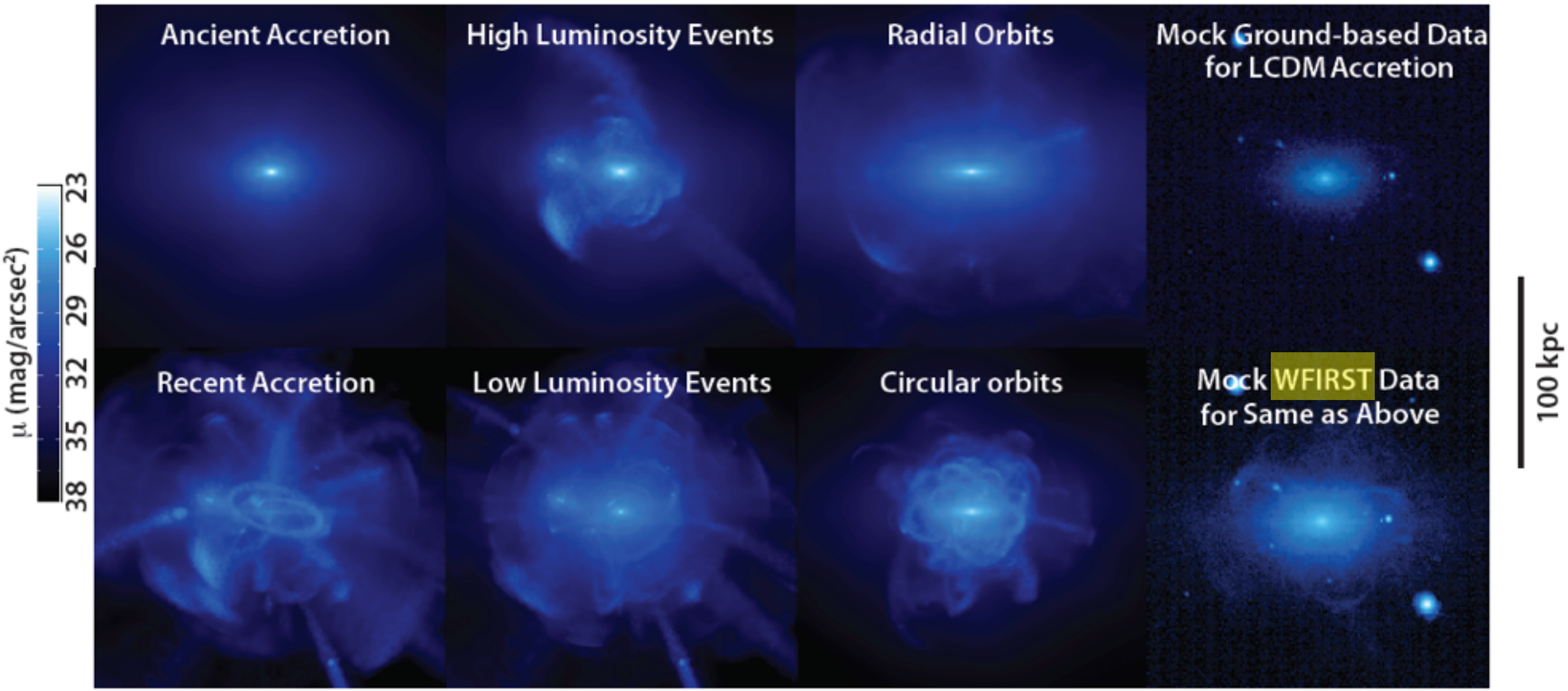


WFIRST gets full coverage





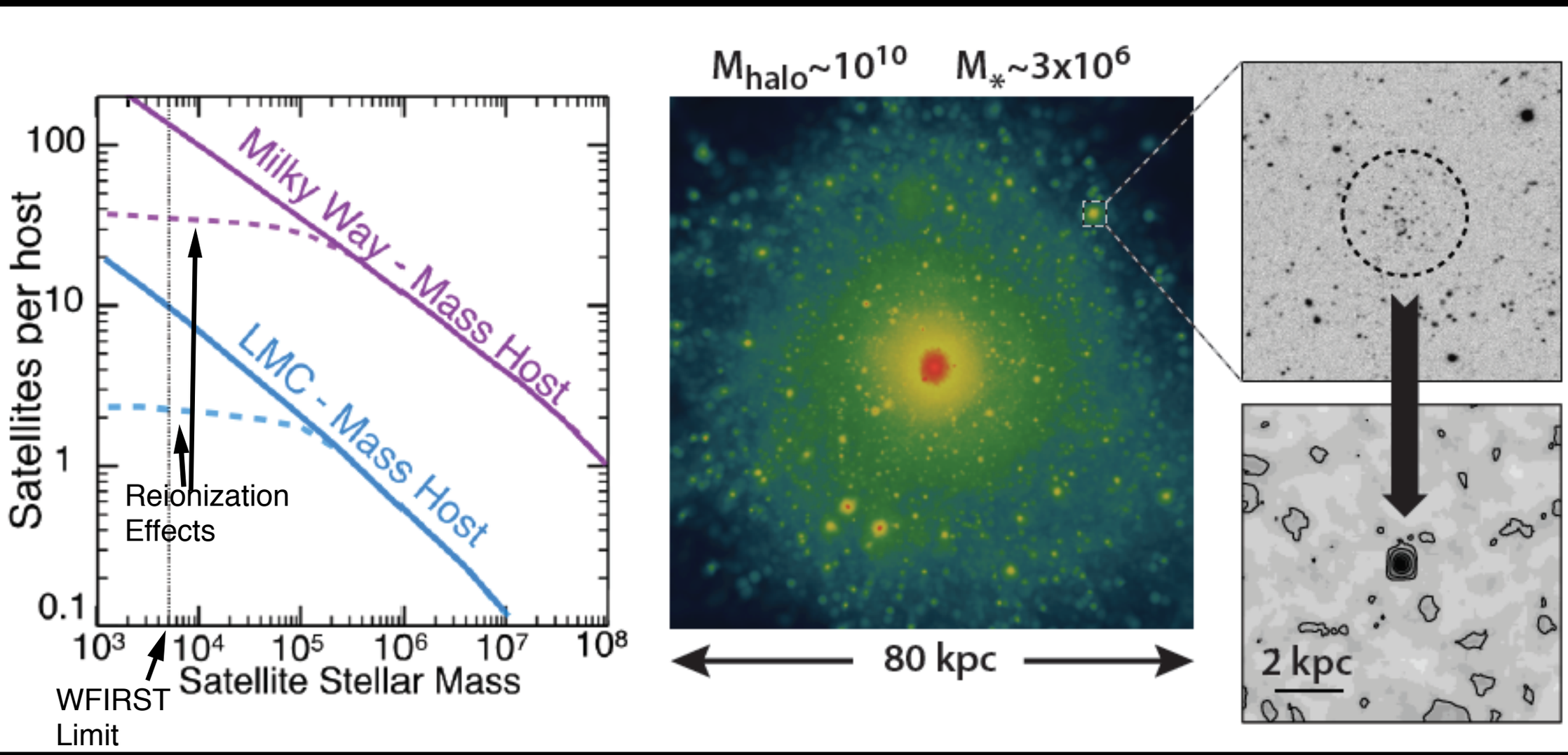
Stellar Halo Structures



Number, luminosity, shape of streams → Types, timing and orbits of galaxies accreted.
Disrupted streams → Small-scale dark matter halos.

Williams: WFIRST Infrared Nearby Galaxy Survey

Dwarf Satellites

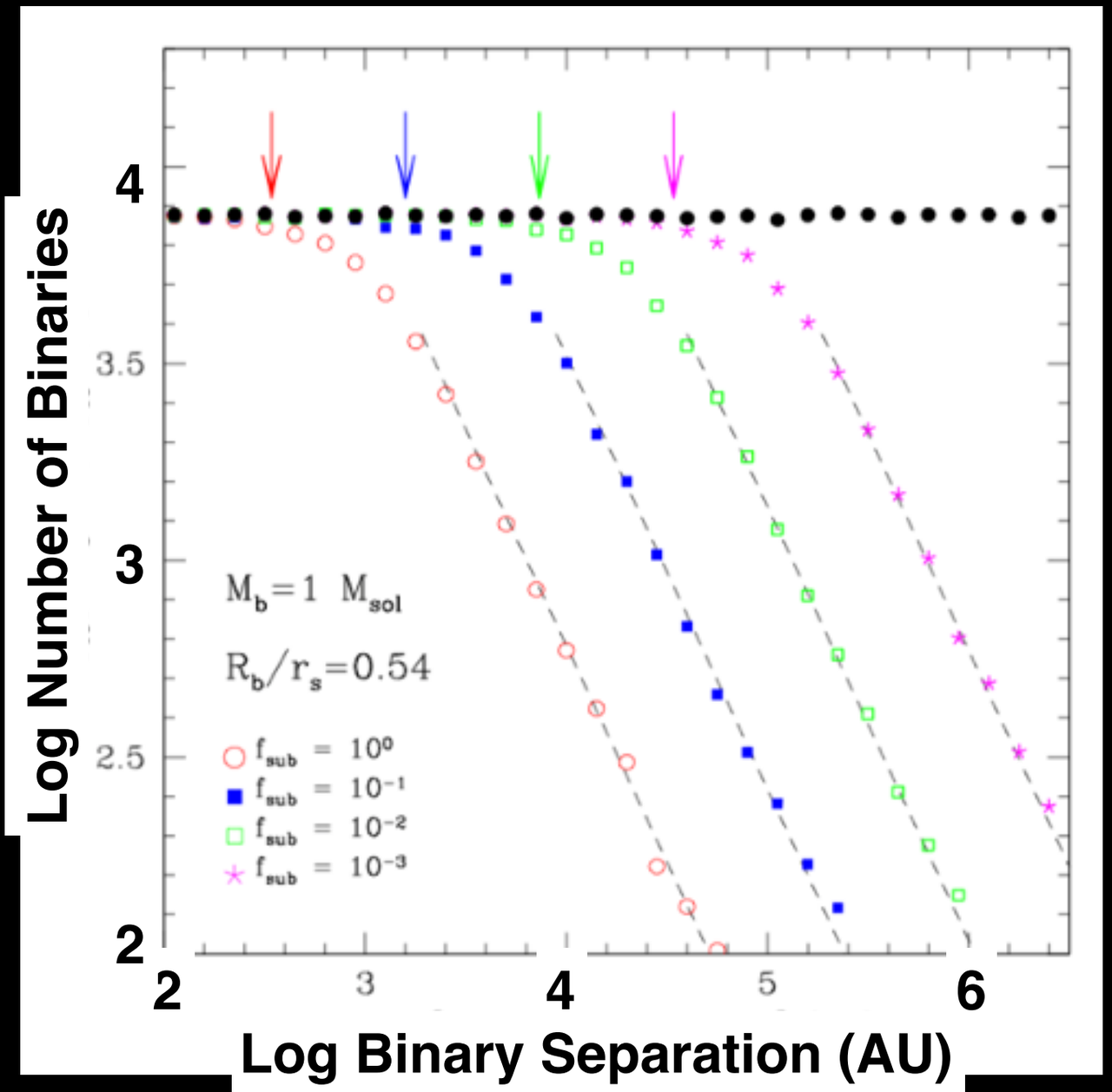


Lots of dark, sub-galactic halo satellites predicted

See Poster

Wide Binaries

Dark sub-halos disrupt wide binary systems. Their would put stress on Lambda-CDM.



Penarrubia et al. 2010

0.1% in bound subhalos

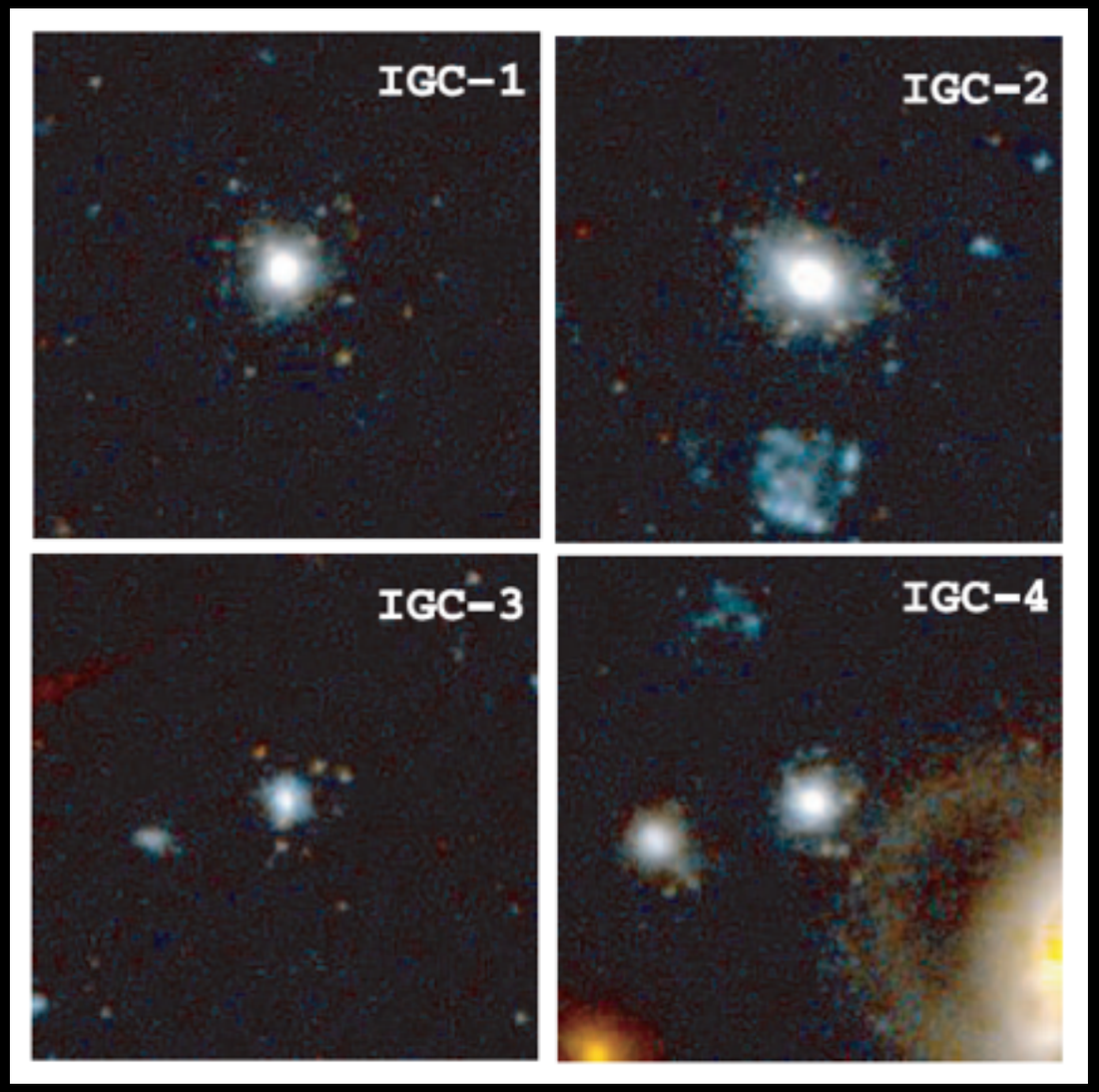
1% in bound subhalos

10% in bound subhalos

100% in bound subhalos

Faint → Nearby Galaxies
Avoid non-DM perturbs → Old Dwarfs
Allow disruption time → Old Dwarfs
~0.05" separation → High resolution
Changes across galaxy → Wide FoV

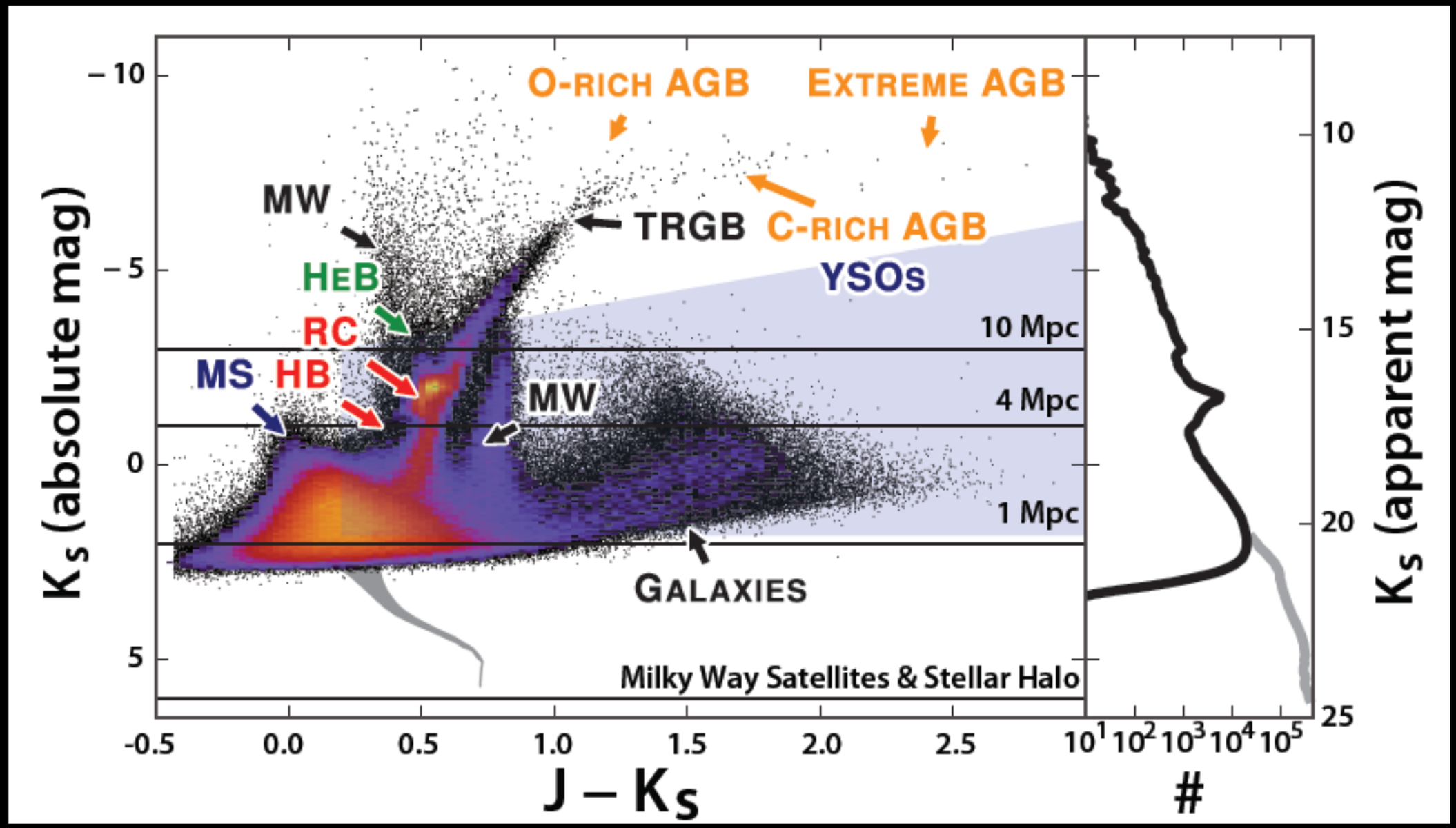
Globular Clusters



Virgo intracluster globulars
(Williams et al. 2007)

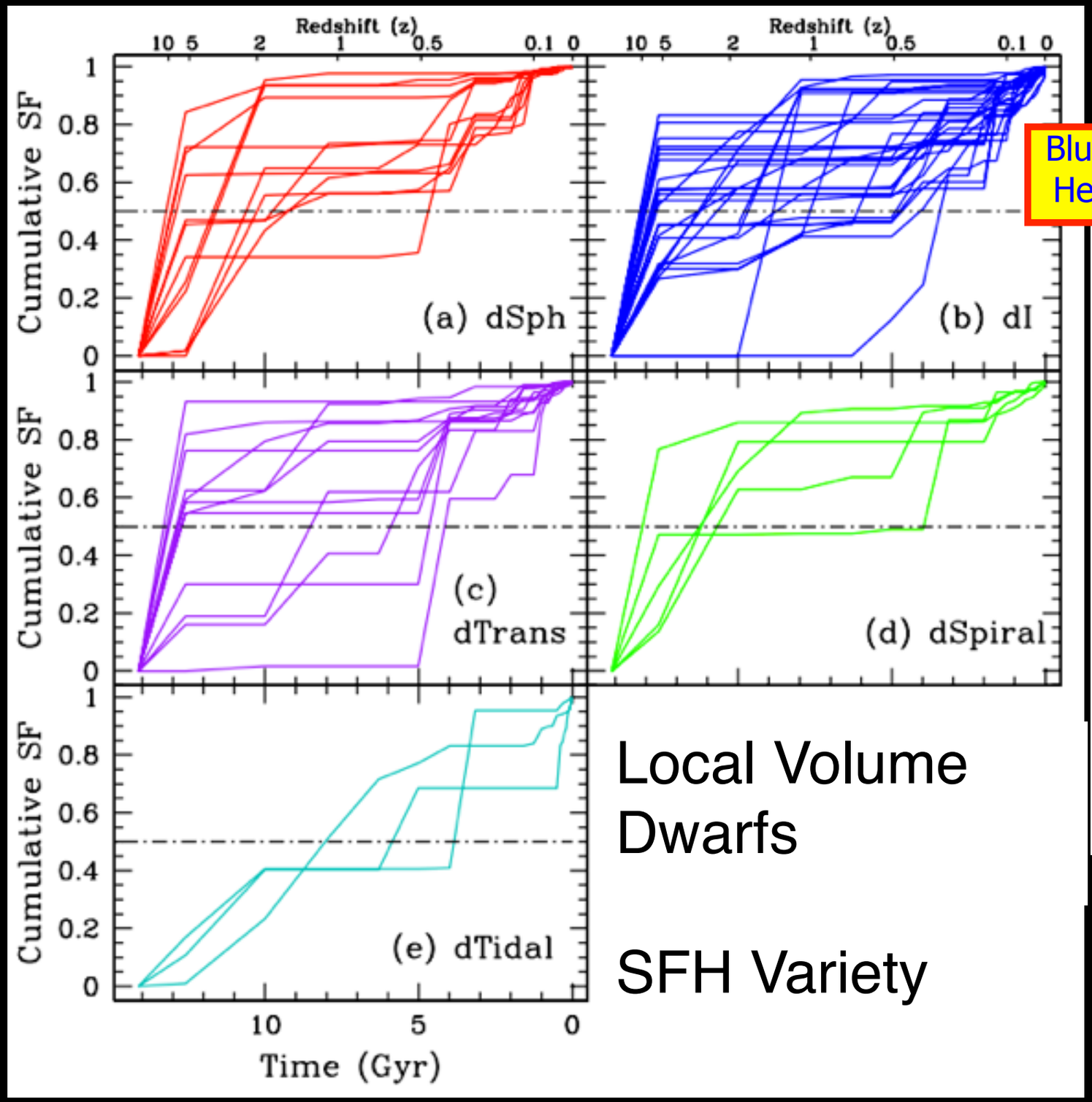
- Old: Probe early epochs of galaxy assembly and halo formation
- WFIRST partially resolves >90% of GCs in galaxies <10 Mpc
- Individual RGB stars can give information on metallicity
- Spectroscopy Targets

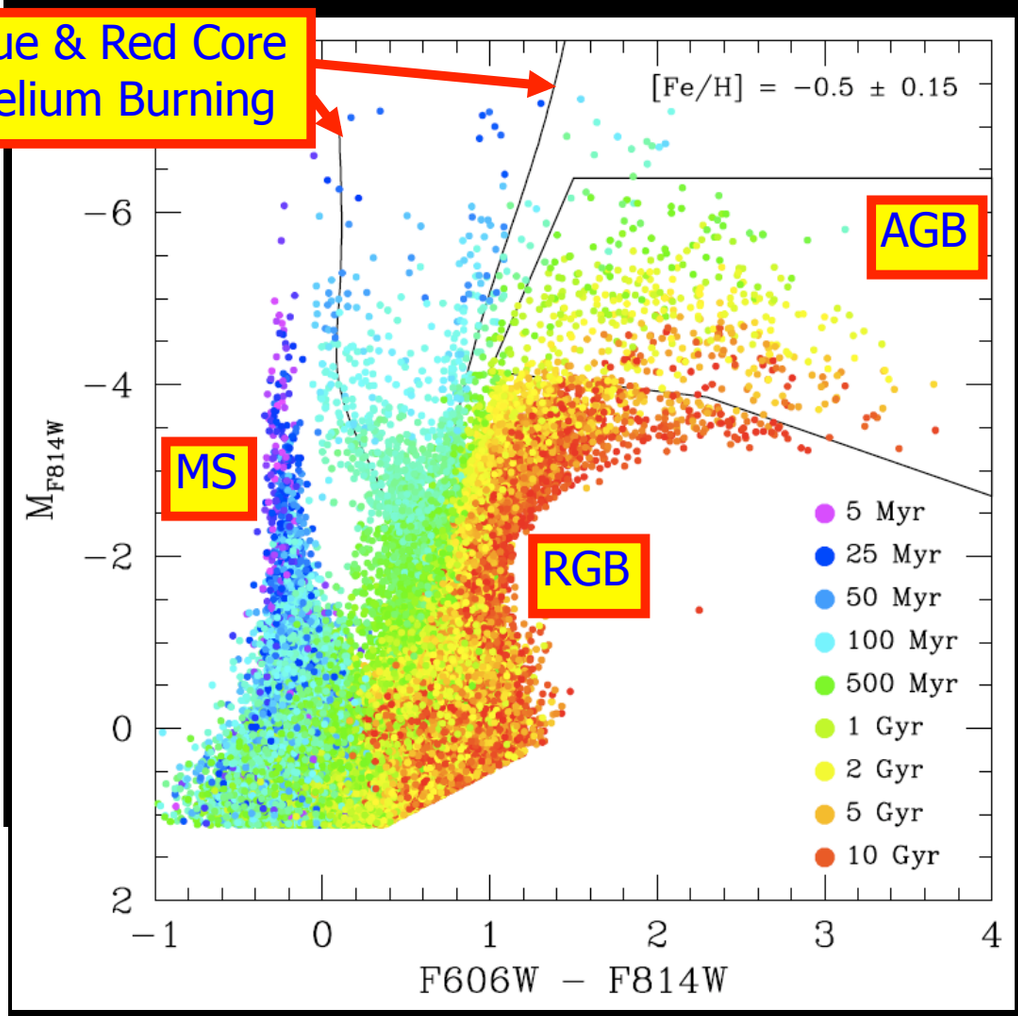
Stellar Populations



Huge increase in sampling of short-lived, high-luminosity phases

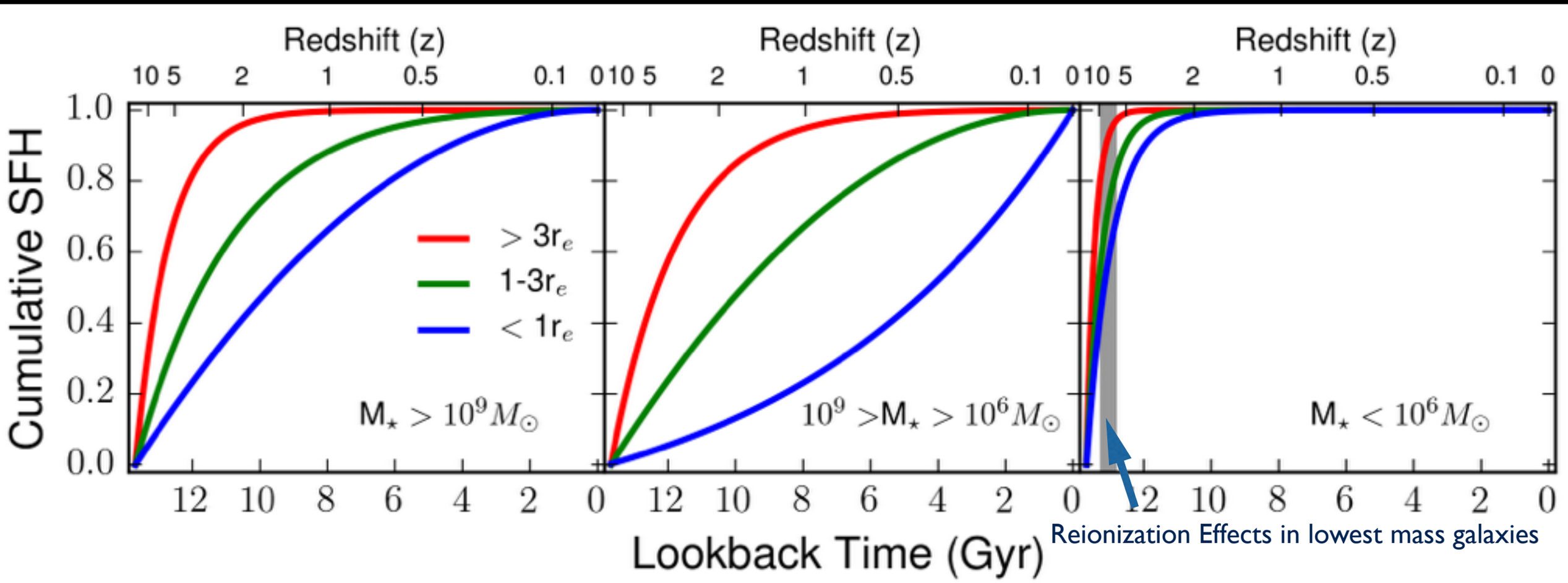
Star Formation Histories





Weisz et al. 2011

Star Formation Histories

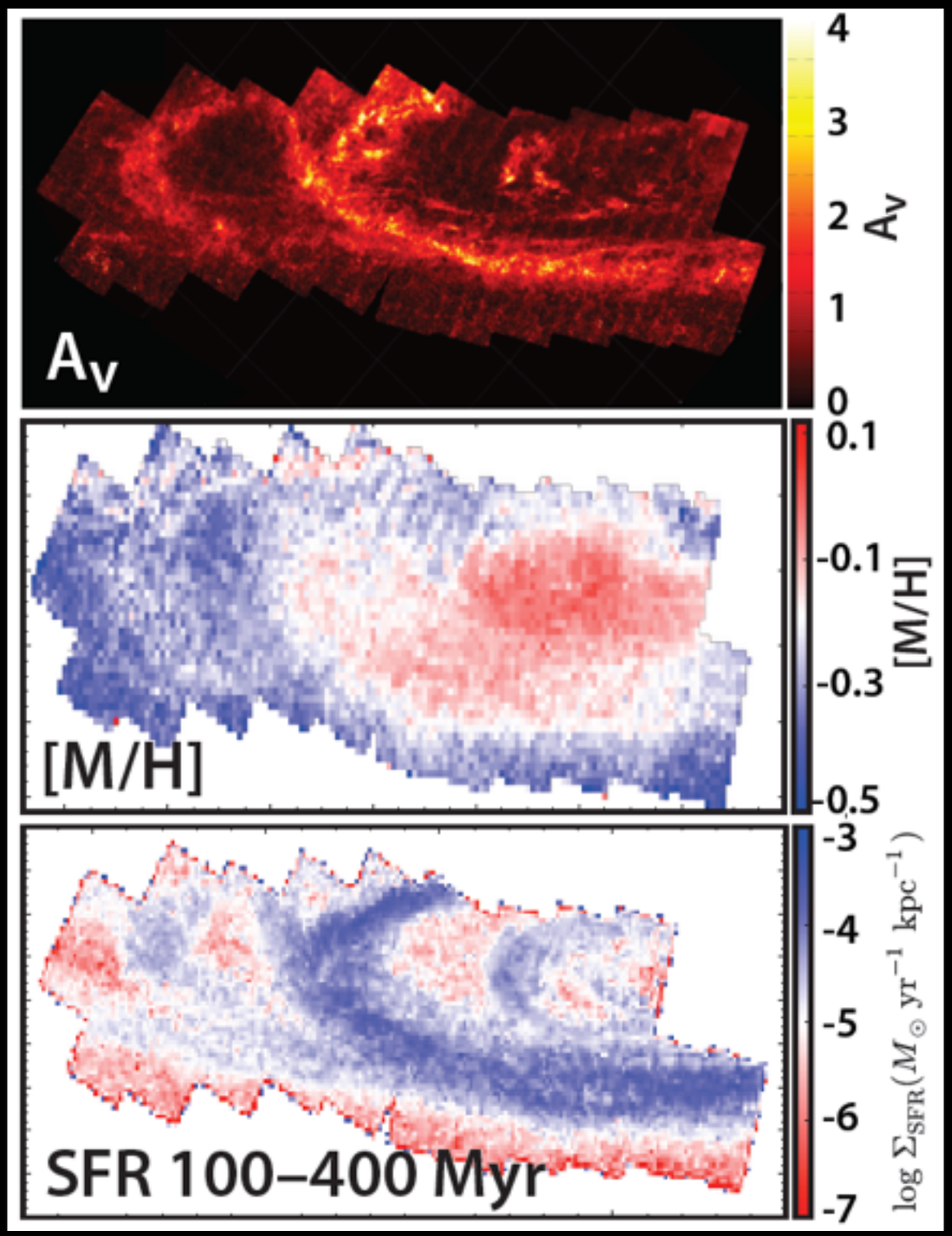


Wide Field Coverage Probes Trends with Radius

Large Sample Probes Trends with Galaxy Mass.

Lowest masses sensitive to reionization.

Dust and Population Maps



- RGB Width → Dust Absorption
- RC/RGB Color → Metallicity
- Main Sequence → Star Formation Rate

Conclusions

Maximizing the value of a WFIRST survey of nearby galaxies

Sample Selection: Number/properties we need for variety of projects

Distance Distribution: More tiling vs. longer exposures

Depth: What is optimal for various sub-projects?

Area: How far out in the halo does the science return decrease?

Filters: How many bands? Which bands?

Scheduling: Proper motion possibilities

Data Products: Crowded field photometry (including quality metrics)