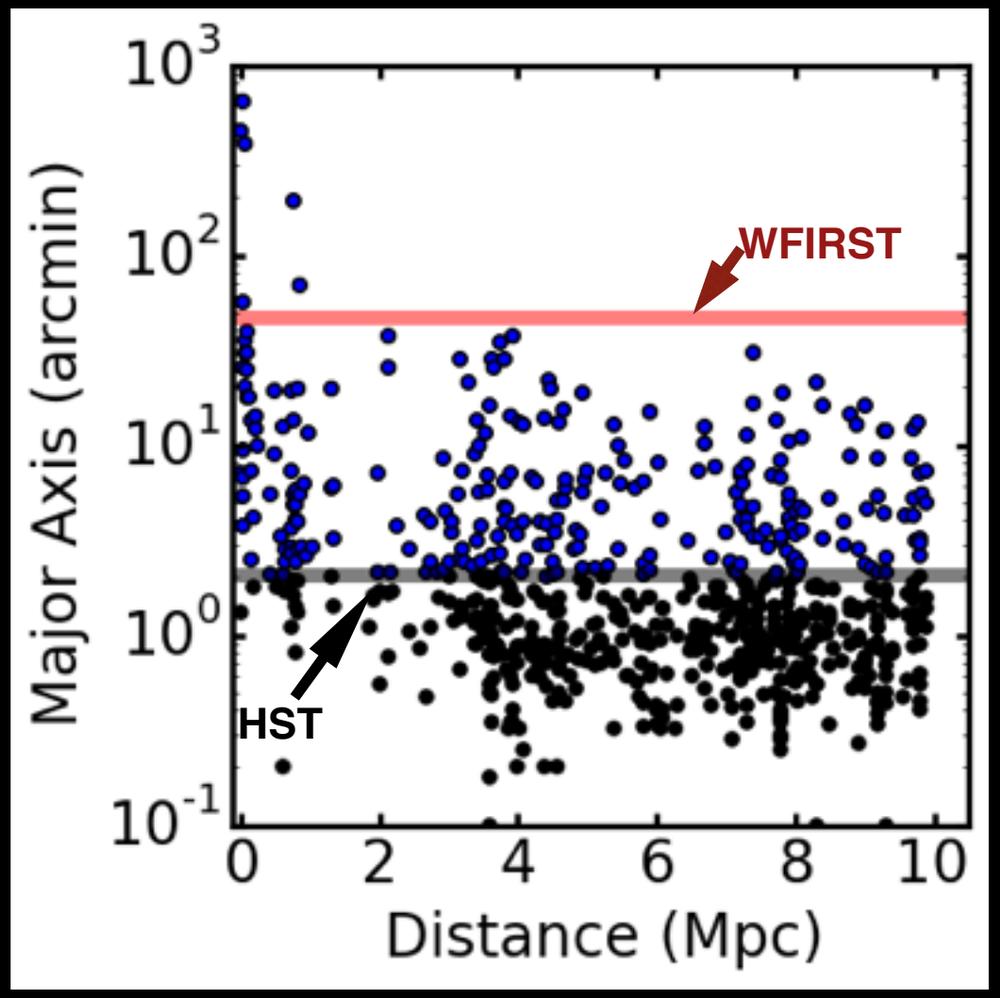
WFIRST Infrared Nearby Galaxy Survey

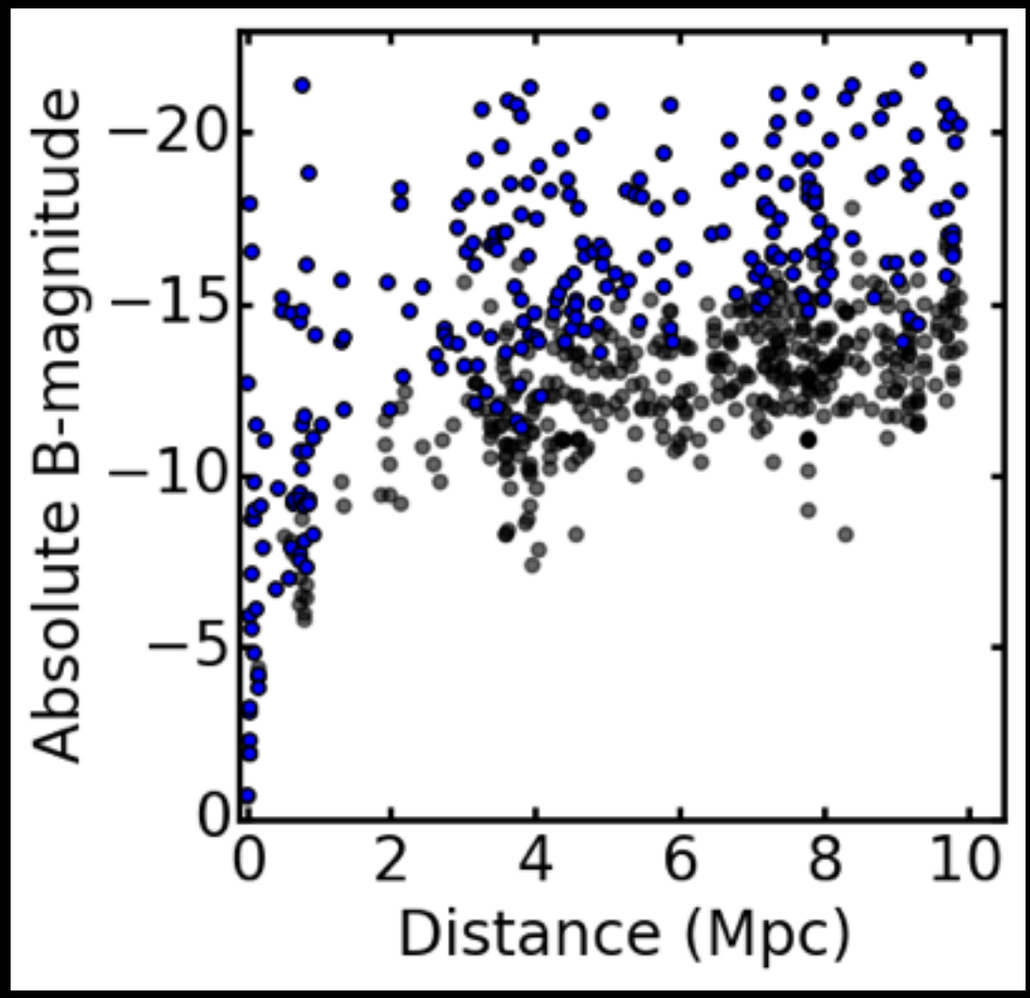
Ben Williams (University of Washington)

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





Projects and Lead Co-Is

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

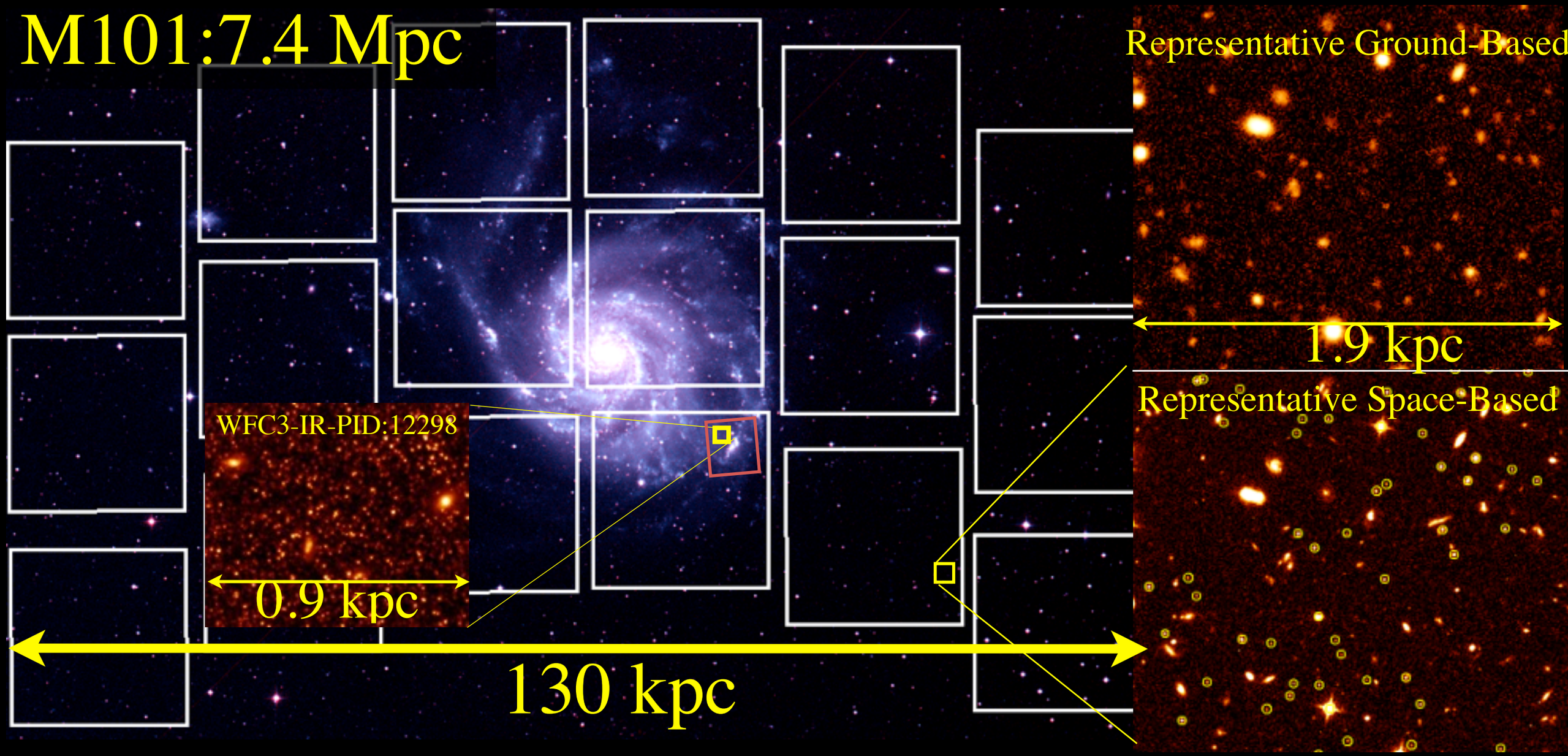
Postdoc: Khan (U.Wash.)

Photometry	Dolphin (Raytheon)
Stellar Halos	Bell (Mich.), *Johnston (Columbia)*, Bullock (Irvine)
Dwarf Satellites	Sand (UA), 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 (STScI)*

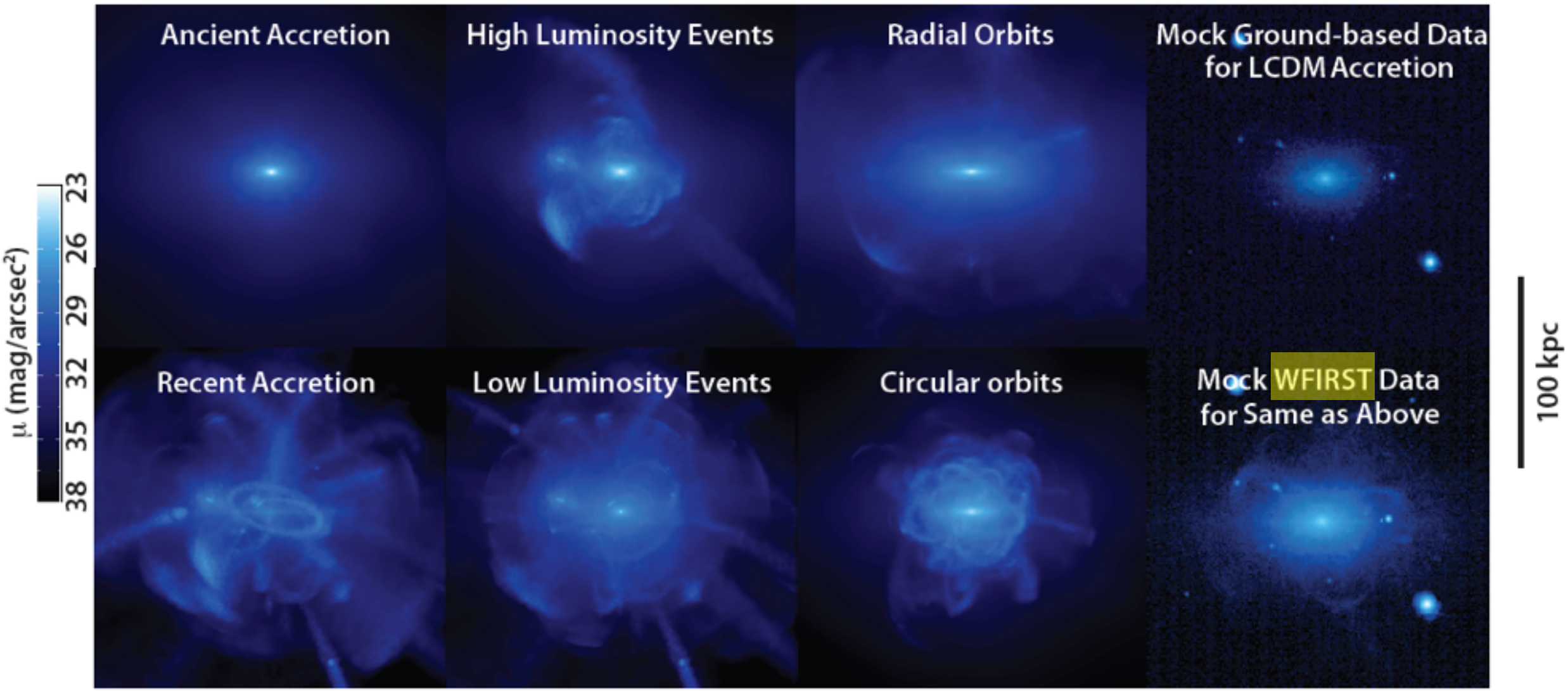
Collaborators

Raja Guhathakurta (UCSC)
Denija Crnojevic (TTU)
Marina Rejkuba (ESO)
Antonela Monachesi (MPA)
Alan McConnachie (HIA)
Laura Sales (UCR)
Karin Sandstrom (UCSD)
Julia Roman-Duval (STScI)
Alberto Bolatto (Maryland)
Josh Peek (STScI)
Jay Anderson (STScI)
David Hendel (Columbia)
Meredith Durbin (UW)
Andrew Graus (Irvine)
Tyler Kelley (Irvine)
Anna Yu (Irvine)
Sol Courtney (Columbia)
Amy Secunda (Columbia)
Beth Willman (LSST)
Phil Rosenfield (CfA)
Margaret Meixner (STScI)
Leo Girardi (Padova)
Nicolas Martin (MPIA)
Cliff Johnson (UCSD)
Jay Strader (MSU)
Robyn Sanderson (Caltech)
Adrian Price-Whelan (Columbia)
Sergey Koposov (Cambridge)
Julio Chaname (Catolica)
Jorge Penarrubia (Edinburgh)
Coral Rose Wheeler (Caltech)

Stellar Halos with WFIRST

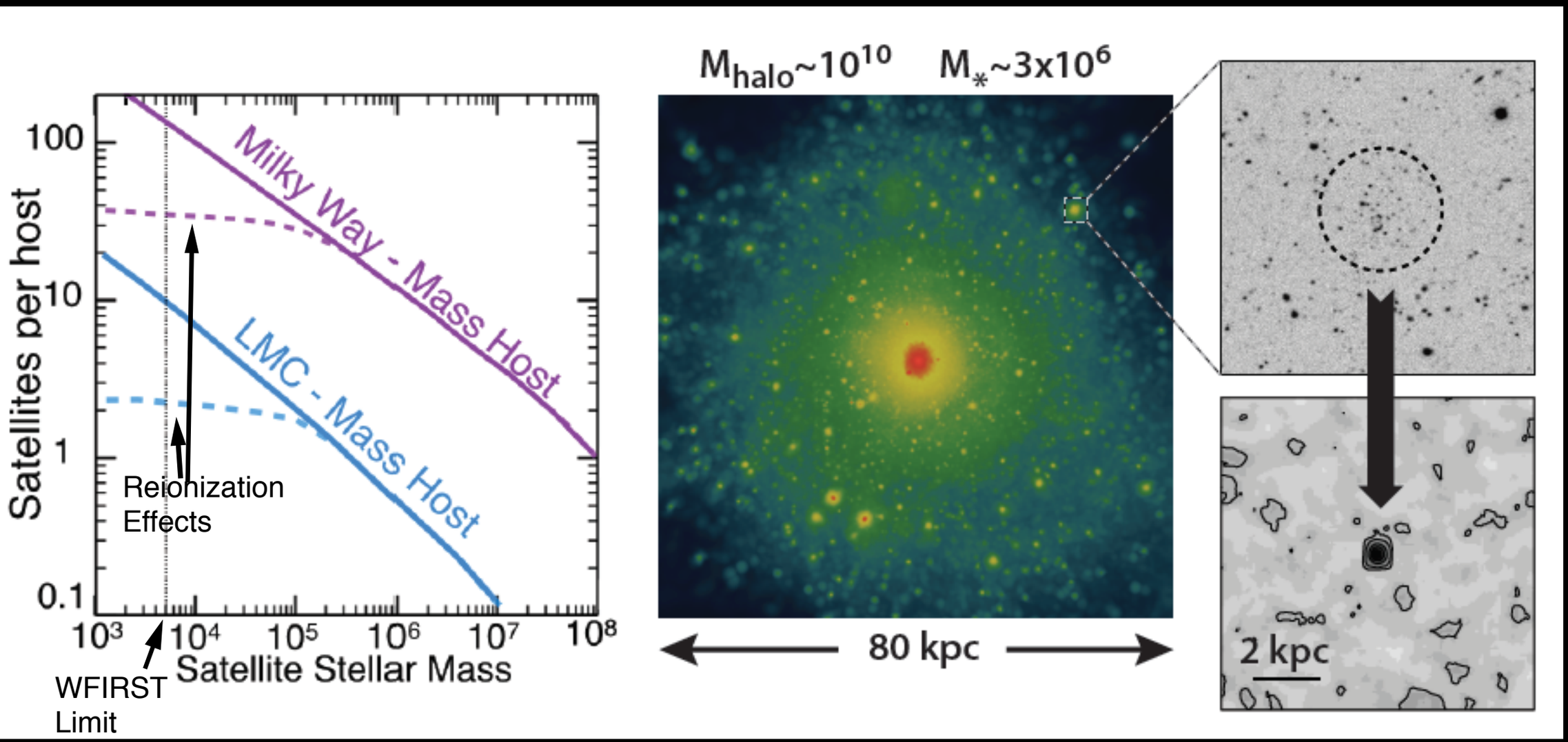


Stellar Halo Structures



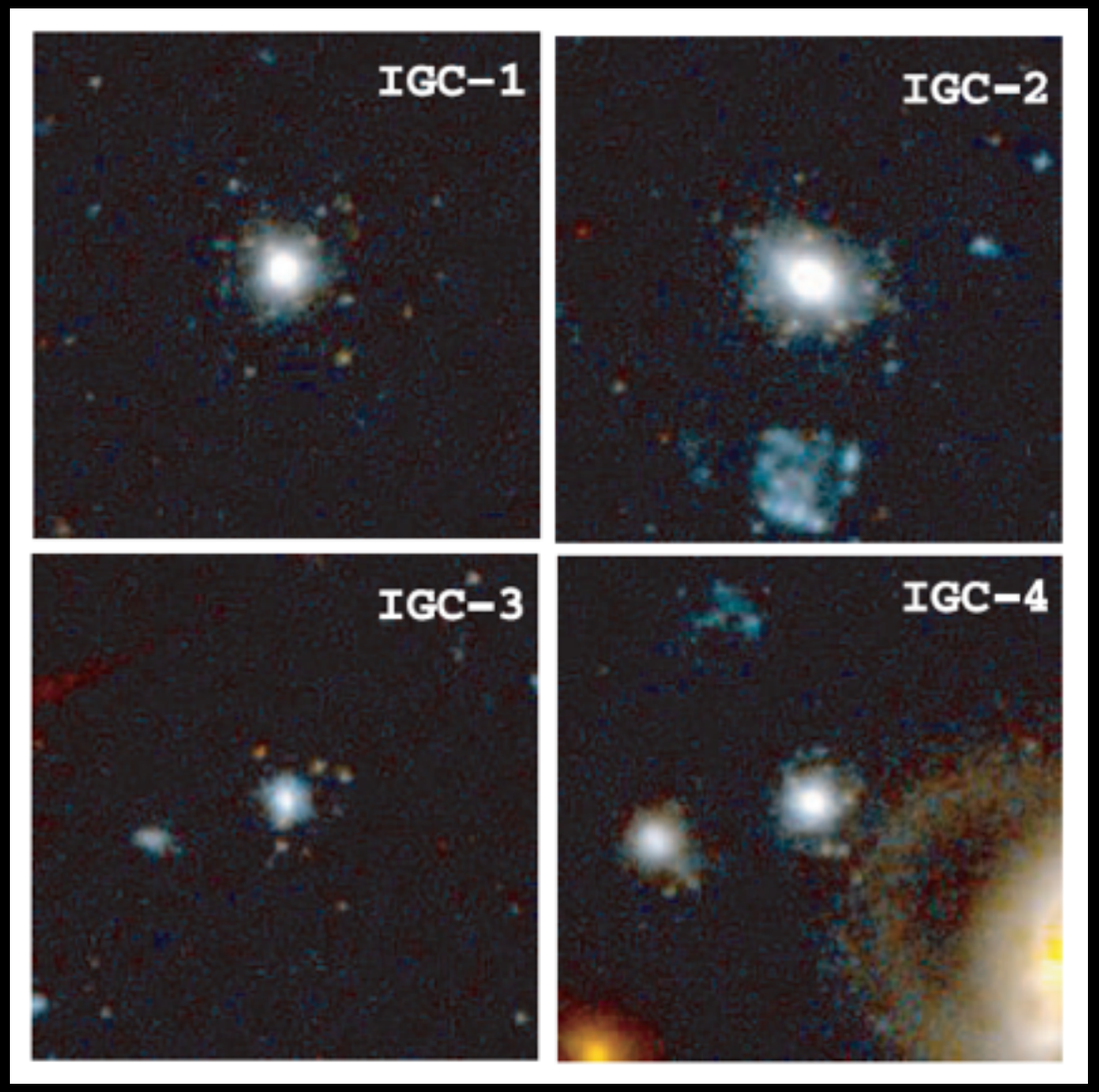
Number, luminosity, shape of streams → Types, timing and orbits of galaxies accreted.
Disrupted streams → Small-scale dark matter halos.

Dwarf Satellites



Lots of dark, sub-galactic halo satellites predicted

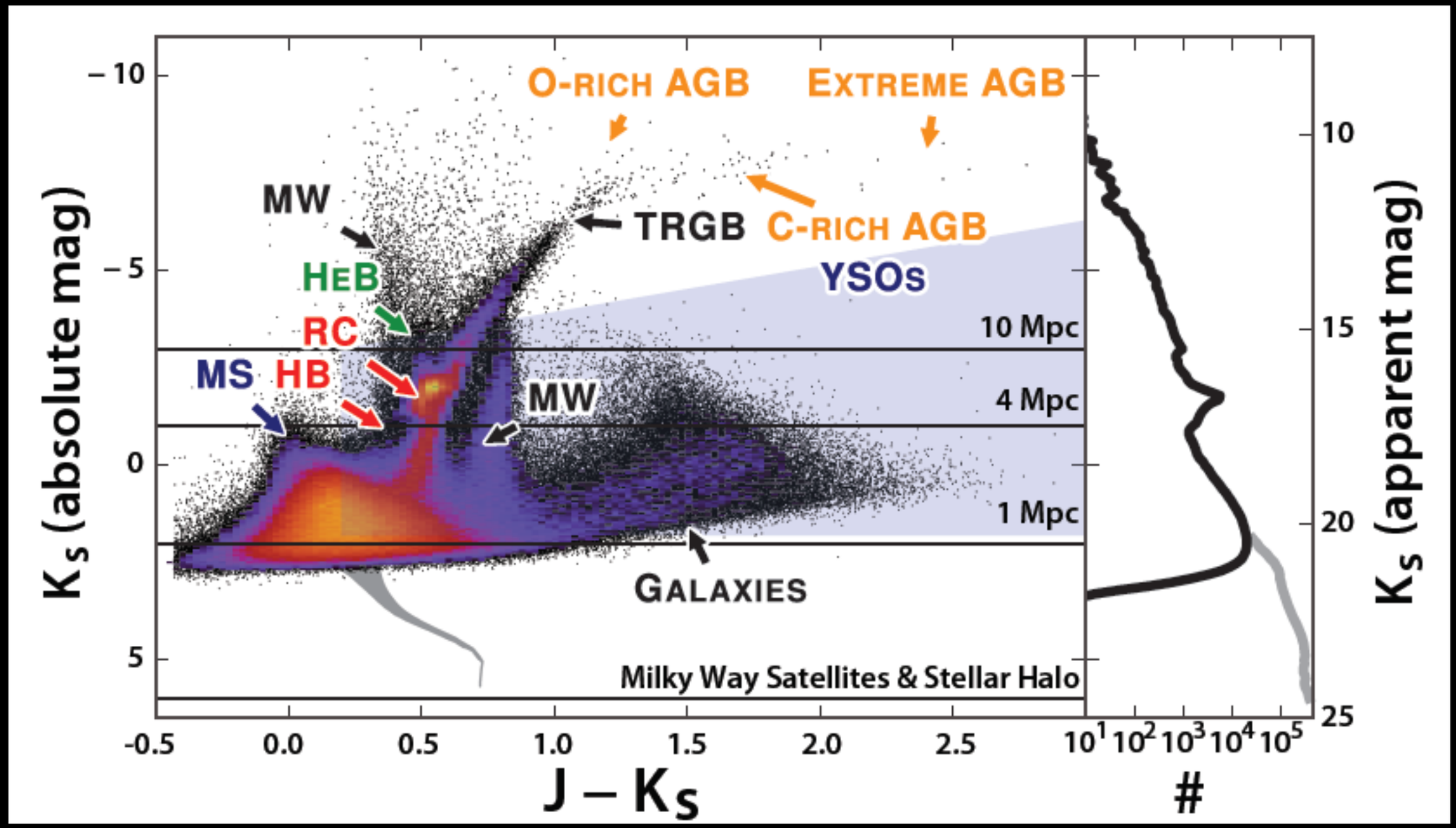
Globular Clusters



Virgo intracluster globulars
(Williams et al. 2007)

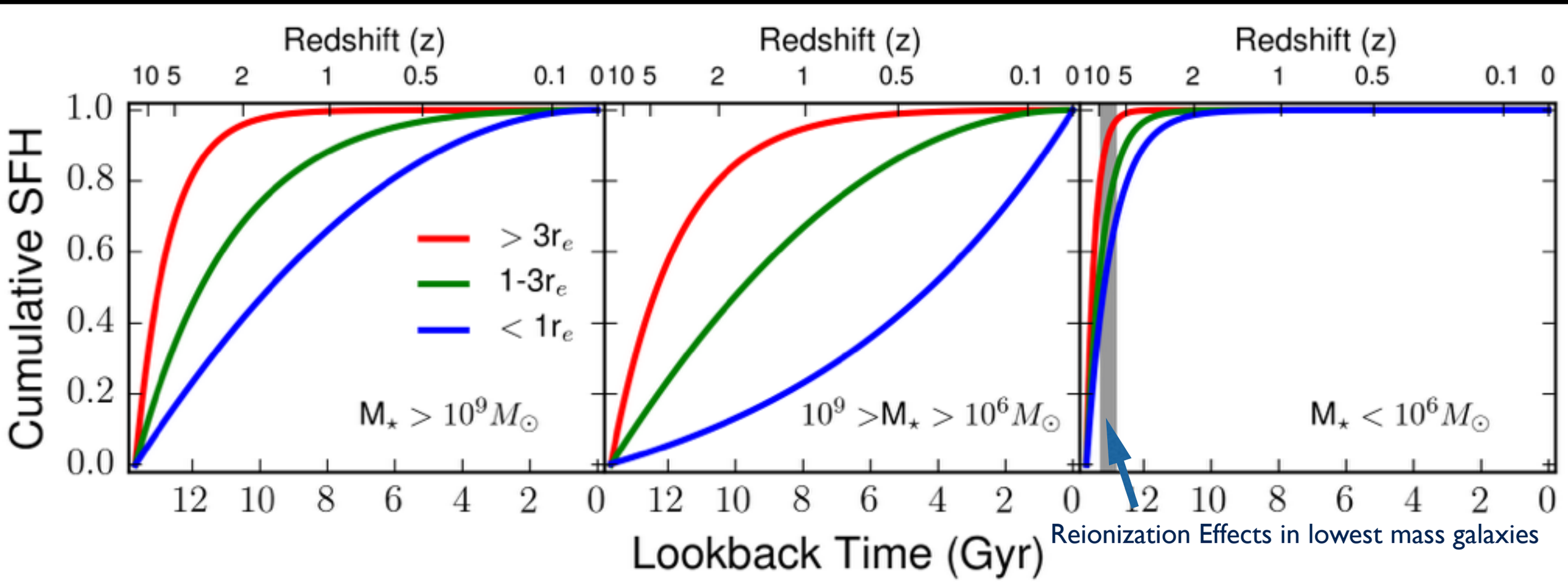
- Old: Probe early epochs of galaxy assembly and halo formation
- WFIRST partially resolves >90% of GCs in galaxies <10 Mpc
- Individual RGB stars can give information on metallicity
- Spectroscopy Targets

Stellar Populations with WFIRST



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

Star Formation Histories



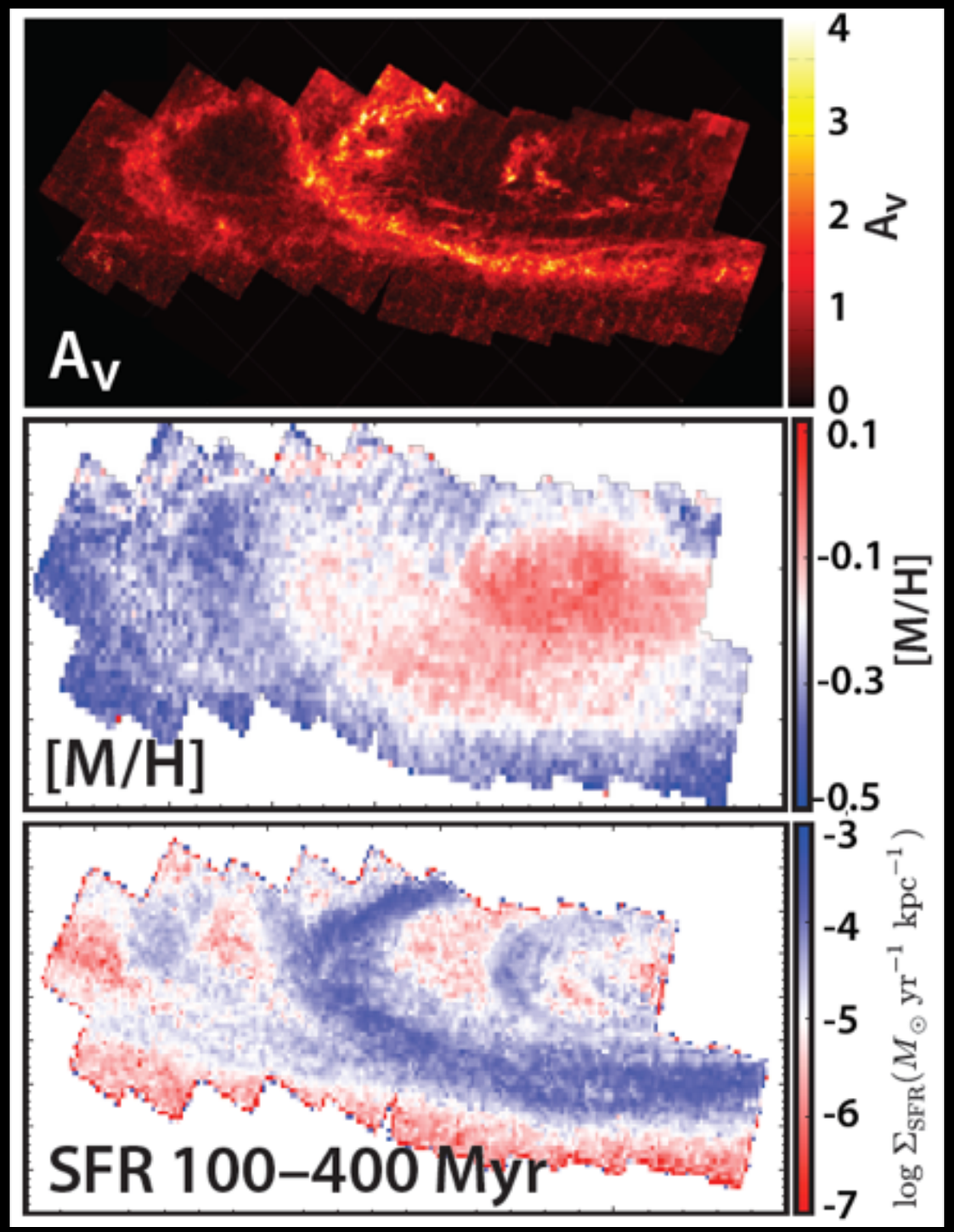
Wide Field Coverage Probes Trends with Radius

Large Sample Probes Trends with Galaxy Mass.

Lowest masses sensitive to reionization.

Andrew Graus, speaking later!

Dust and Population Maps

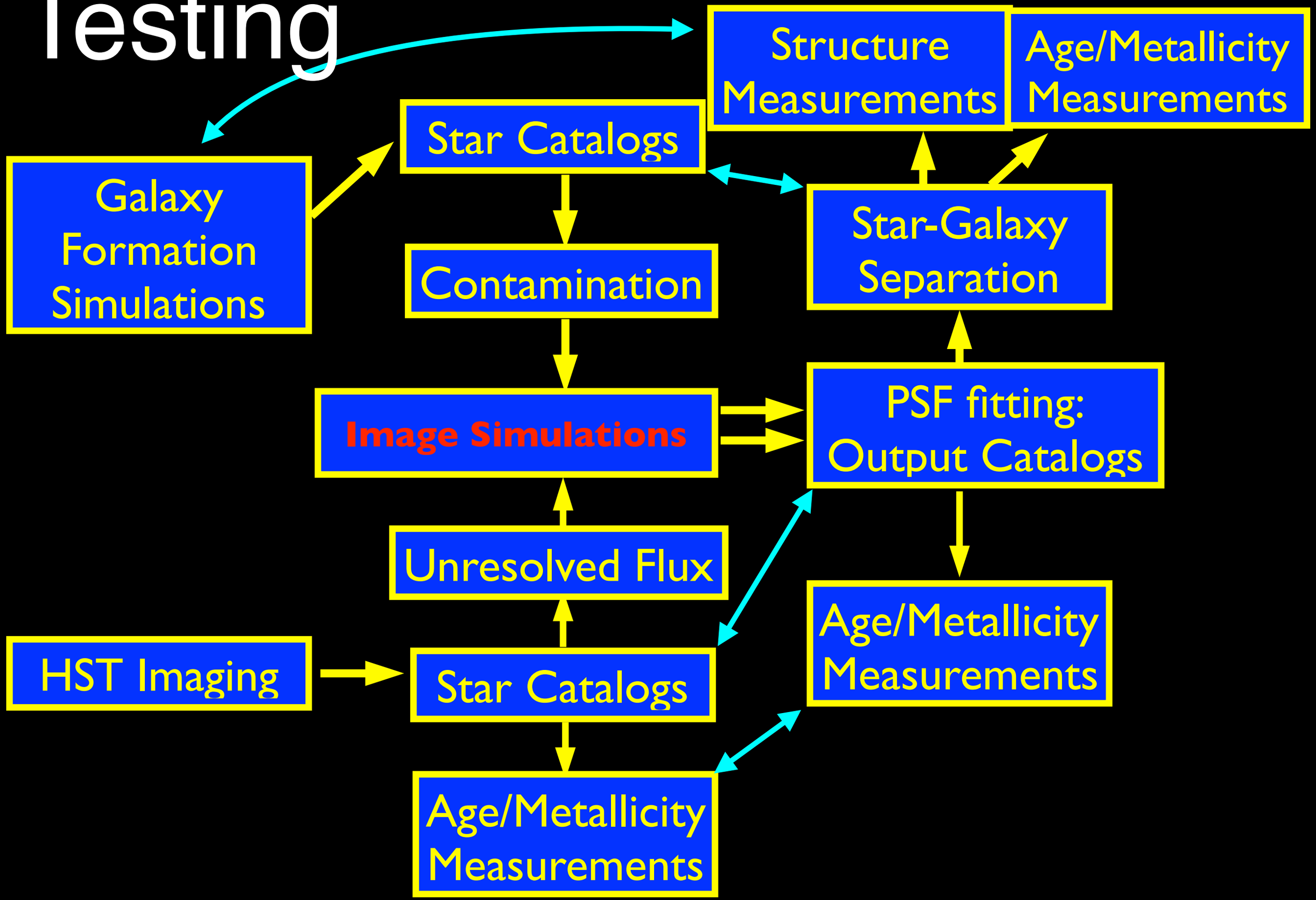


- RGB Width → Dust Absorption
- RC/RGB Color → Metallicity
- Main Sequence → Star Formation Rate

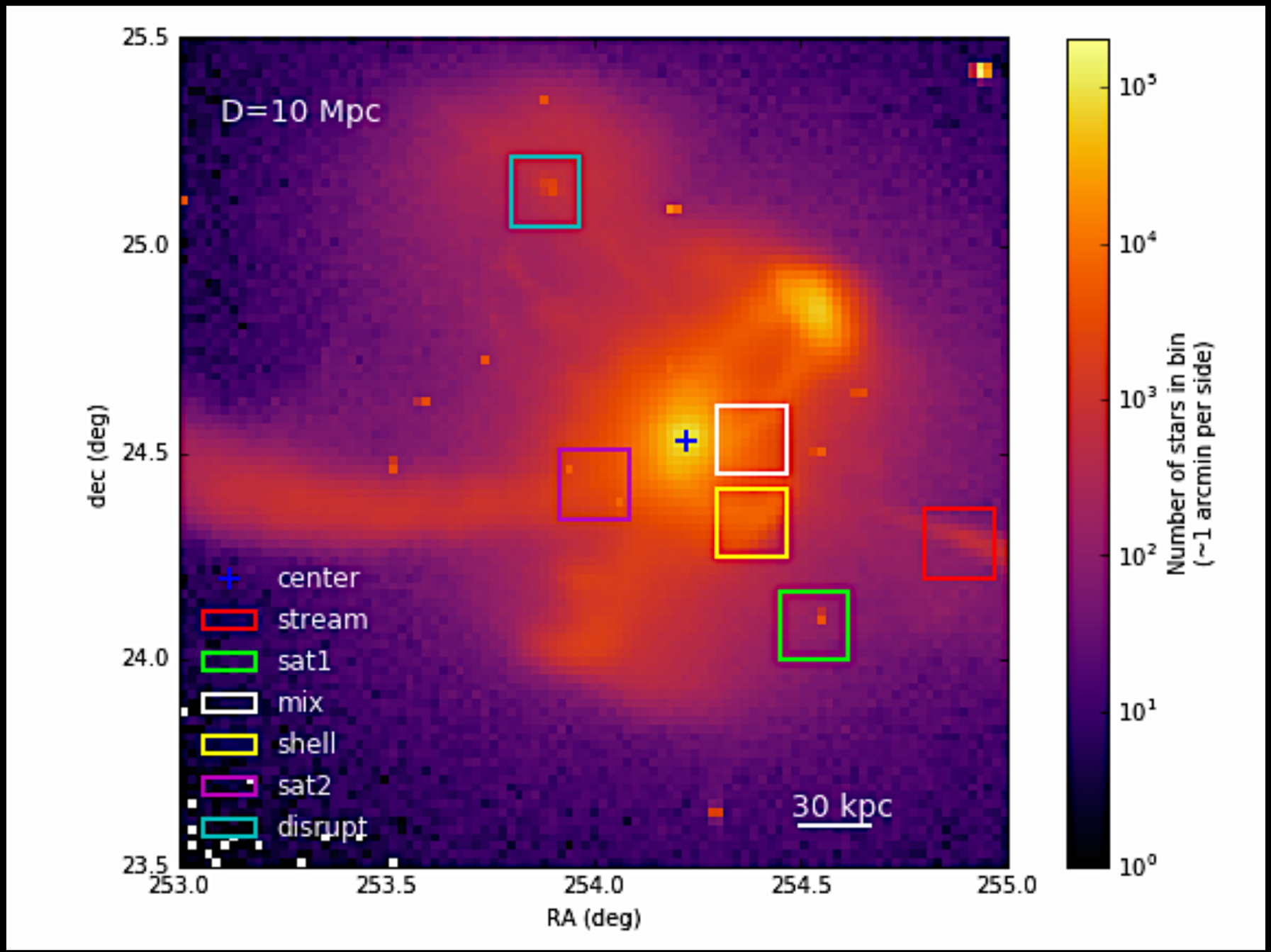
GO-program synergy: Resolved Population Needs

- Field of View (context and more stars)
- Wavelength coverage (colors)
- Resolution (depth and background removal)

Testing

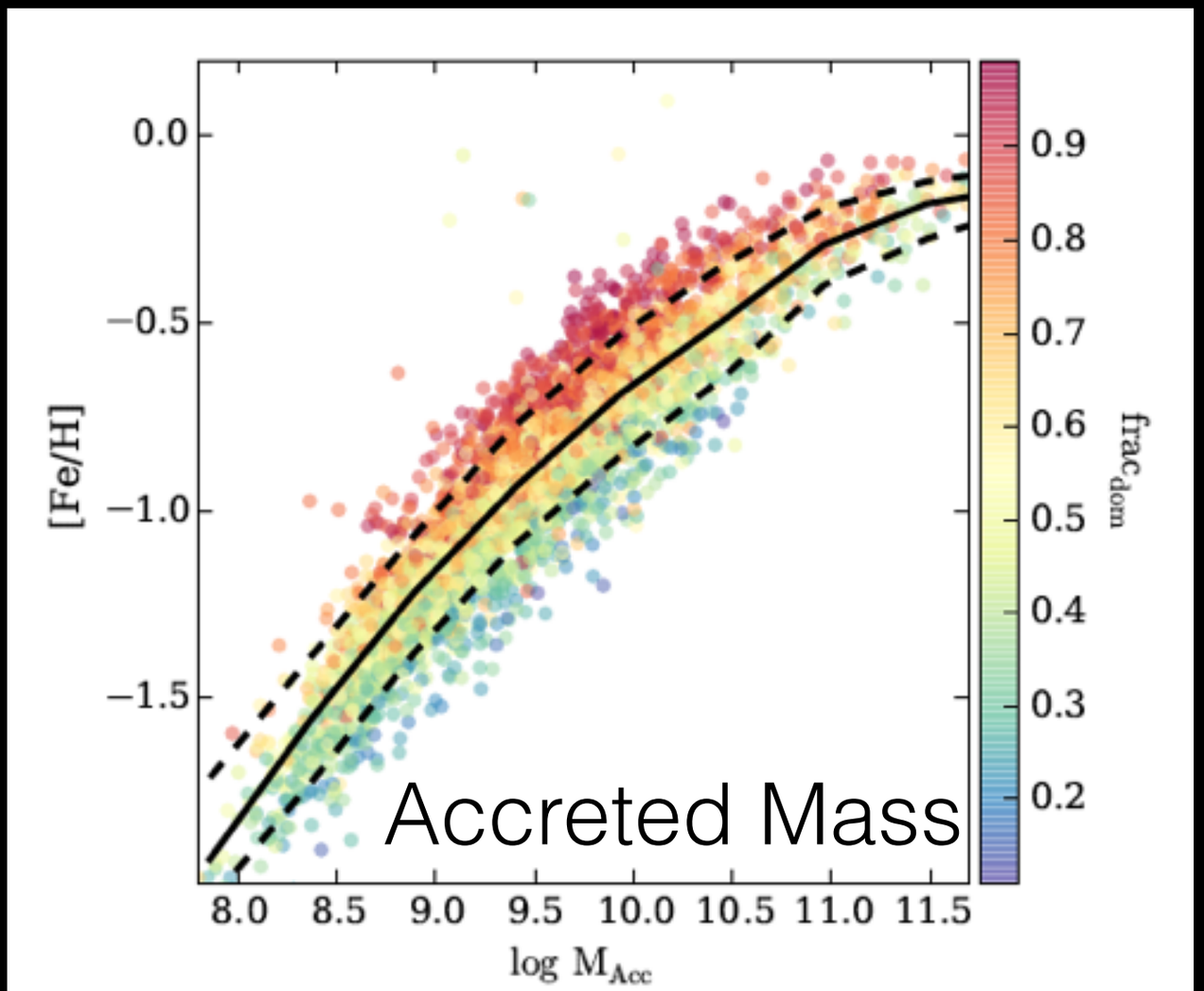

Structure Measurements
Age/Metallicity Measurements
Star Catalogs
Galaxy Formation Simulations
Contamination
Star-Galaxy Separation
Image Simulations
PSF fitting: Output Catalogs
Unresolved Flux
Age/Metallicity Measurements
HST Imaging
Star Catalogs
Age/Metallicity Measurements

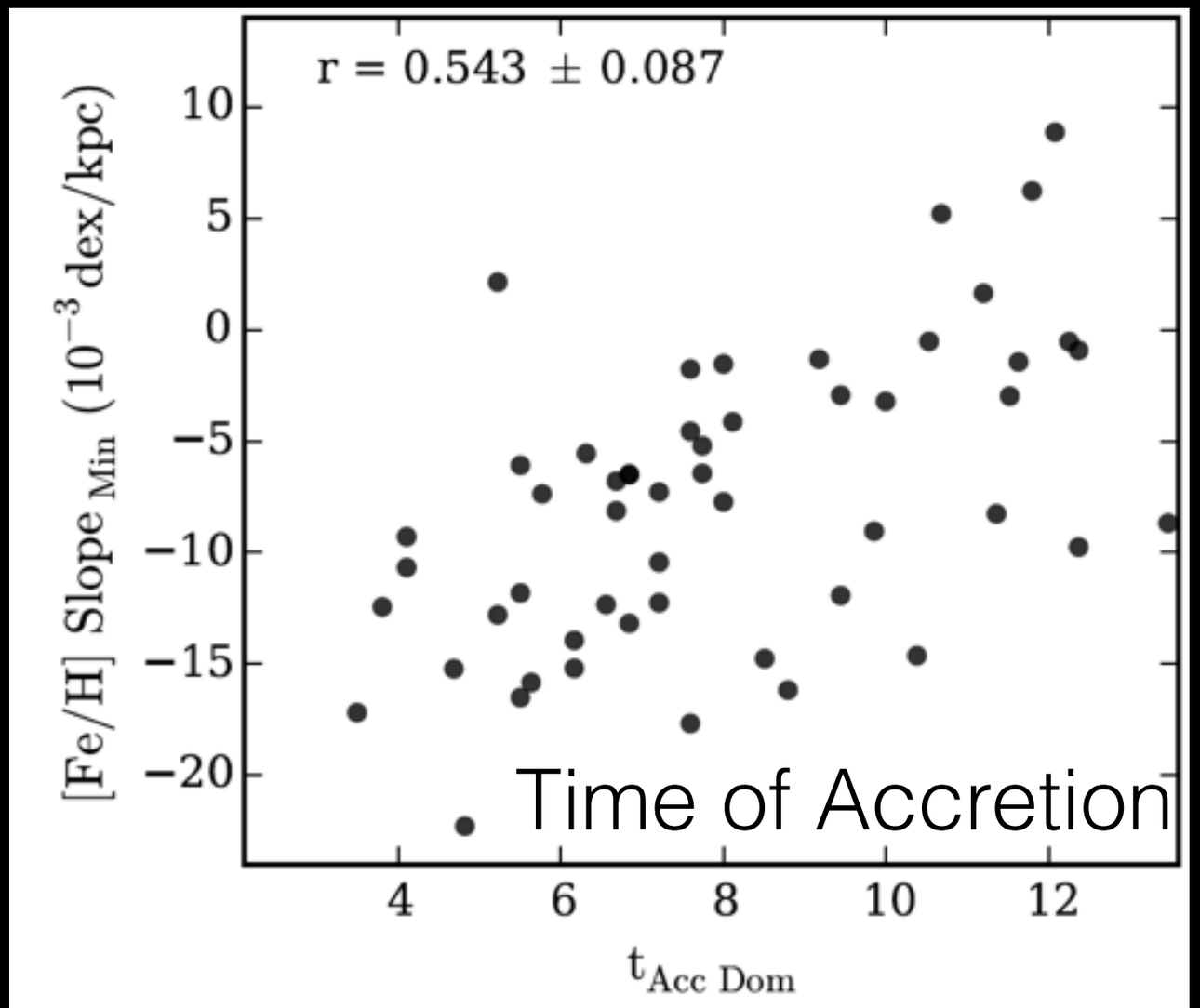
WFIRST Imaging of Bullock & Johnston Simulations



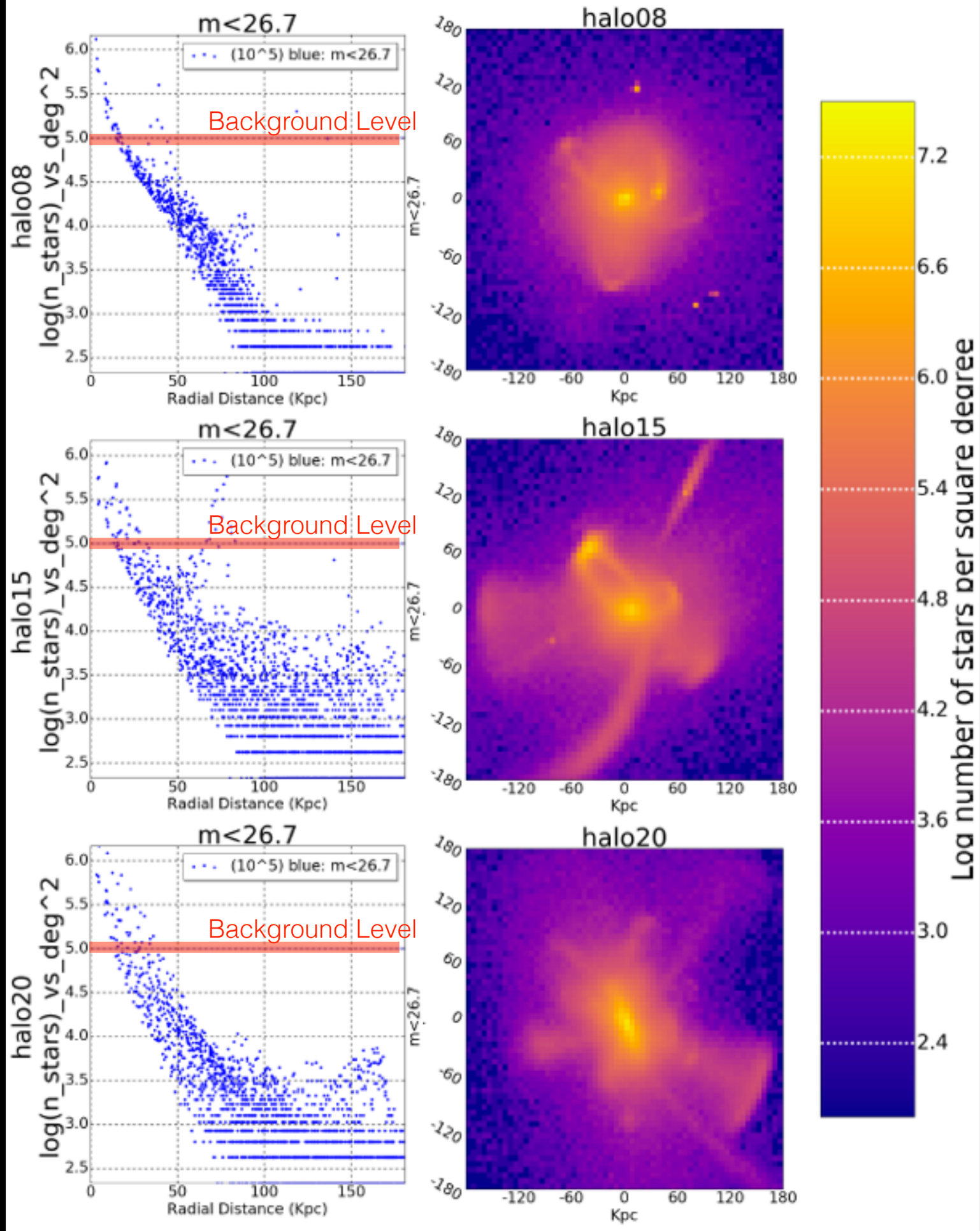
Halo populations by Robyn Sanderson

Accreted Halo Metallicity and Accretion History





D'Souza & Bell, 2017; from Illustris simulations



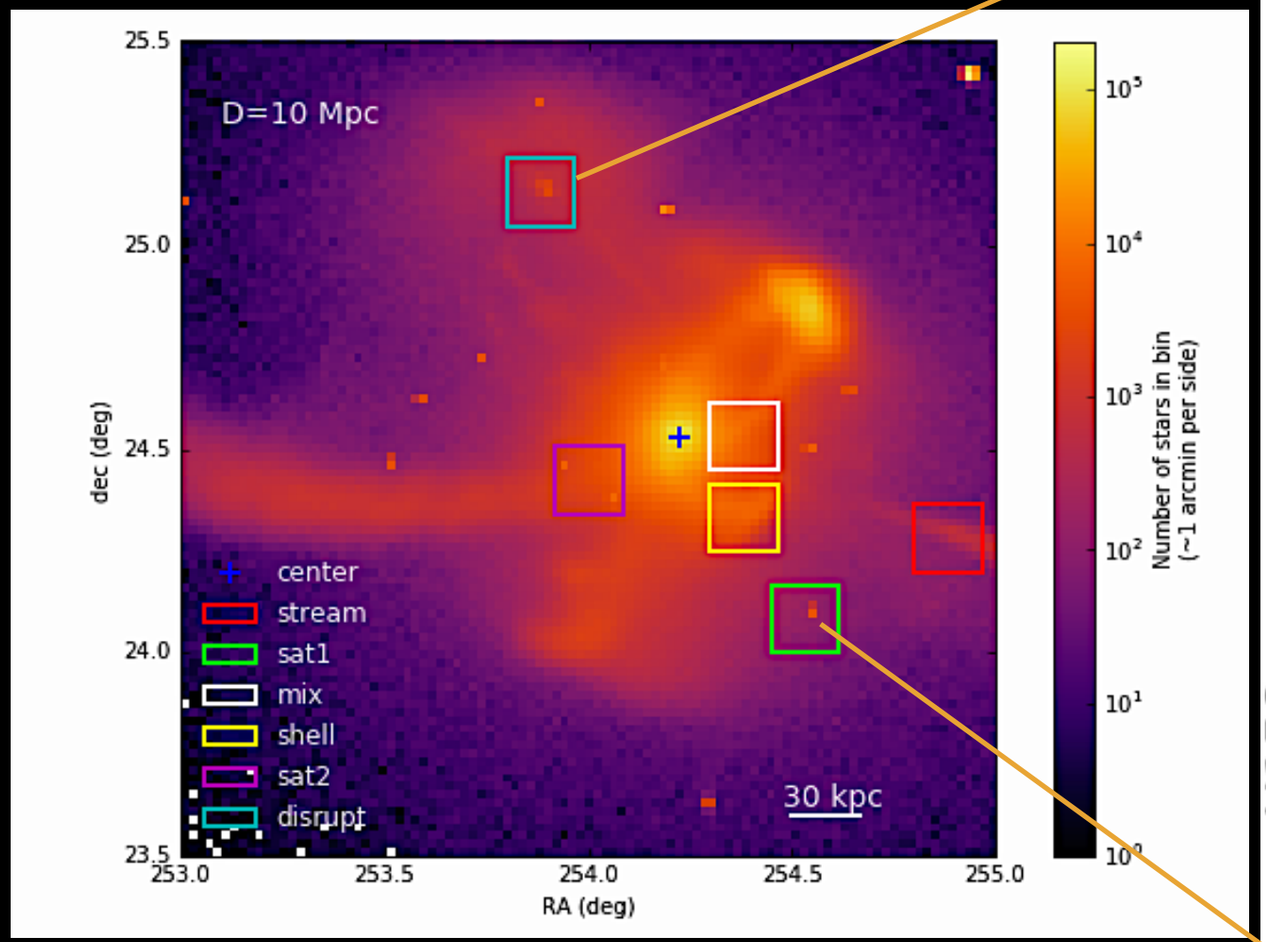
Production of simulated halos to test structure recovery

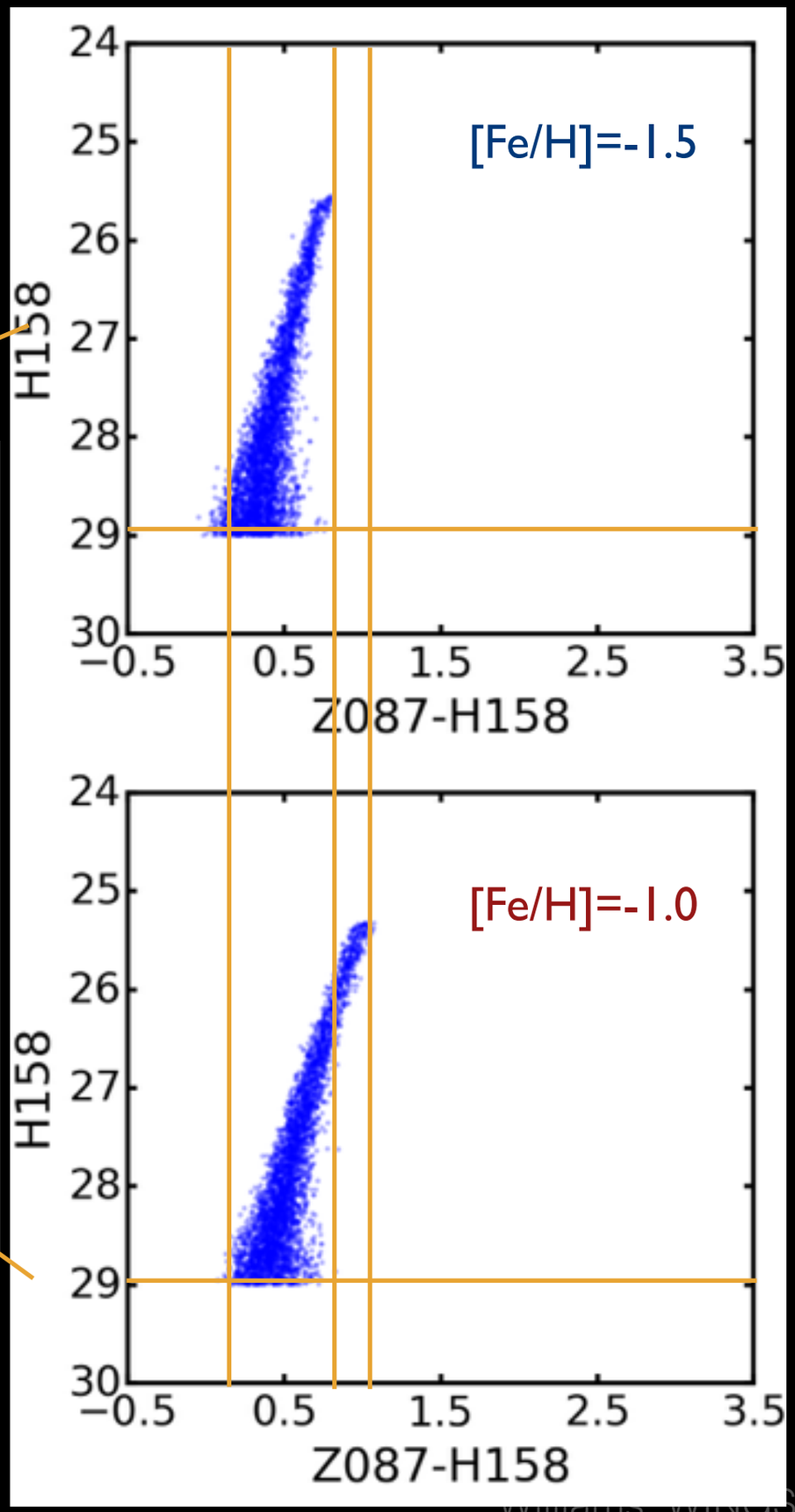
See poster by Sol Courtney

Also the Galactic halo

poster by Amy Secunda

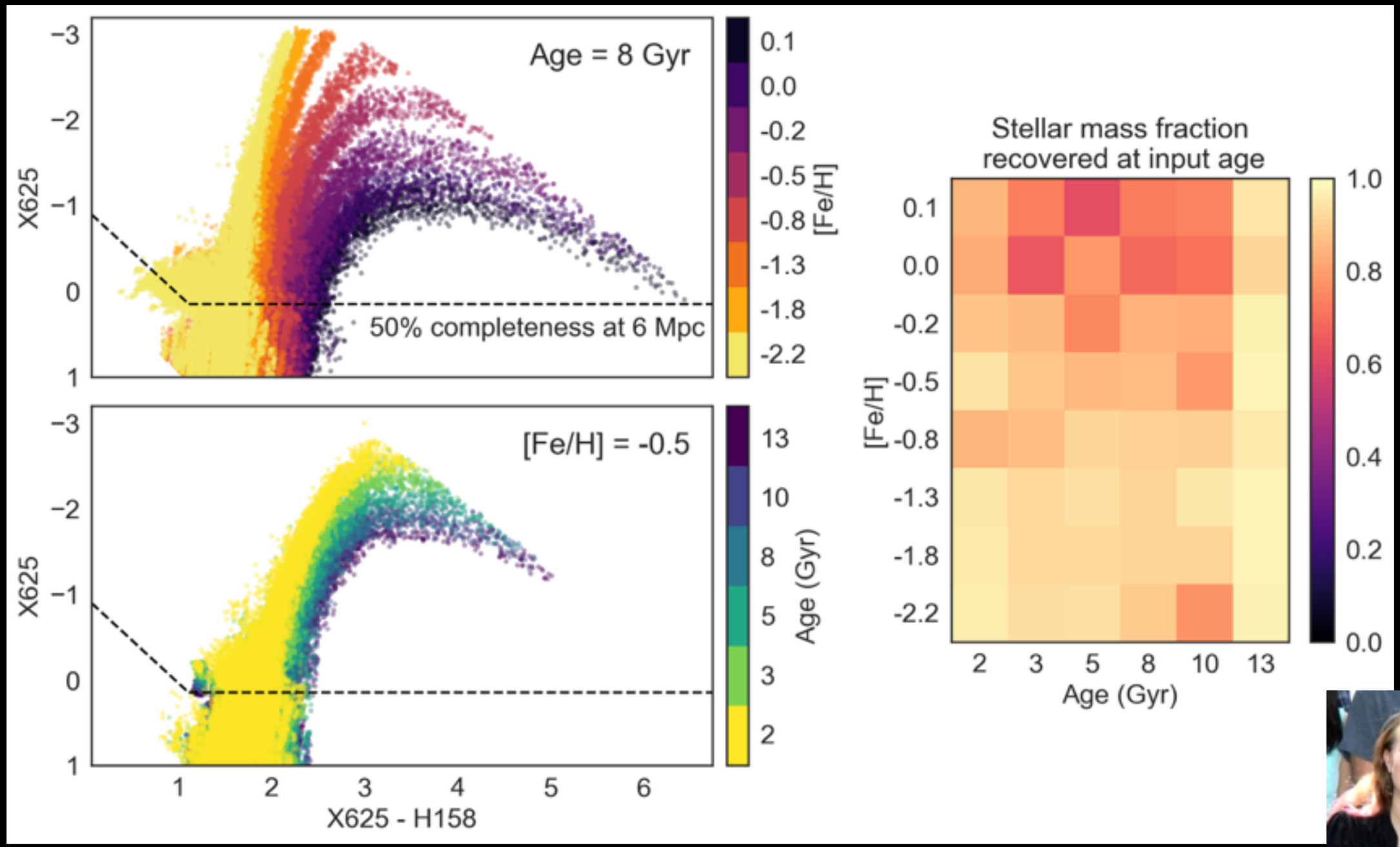
Recovering Populations Δ[Fe/H]=0.5 dex

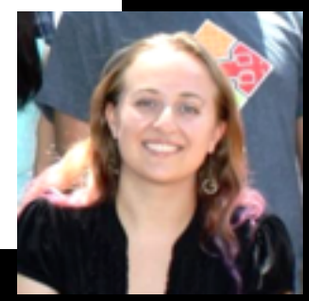




Z087 and H158 Colors

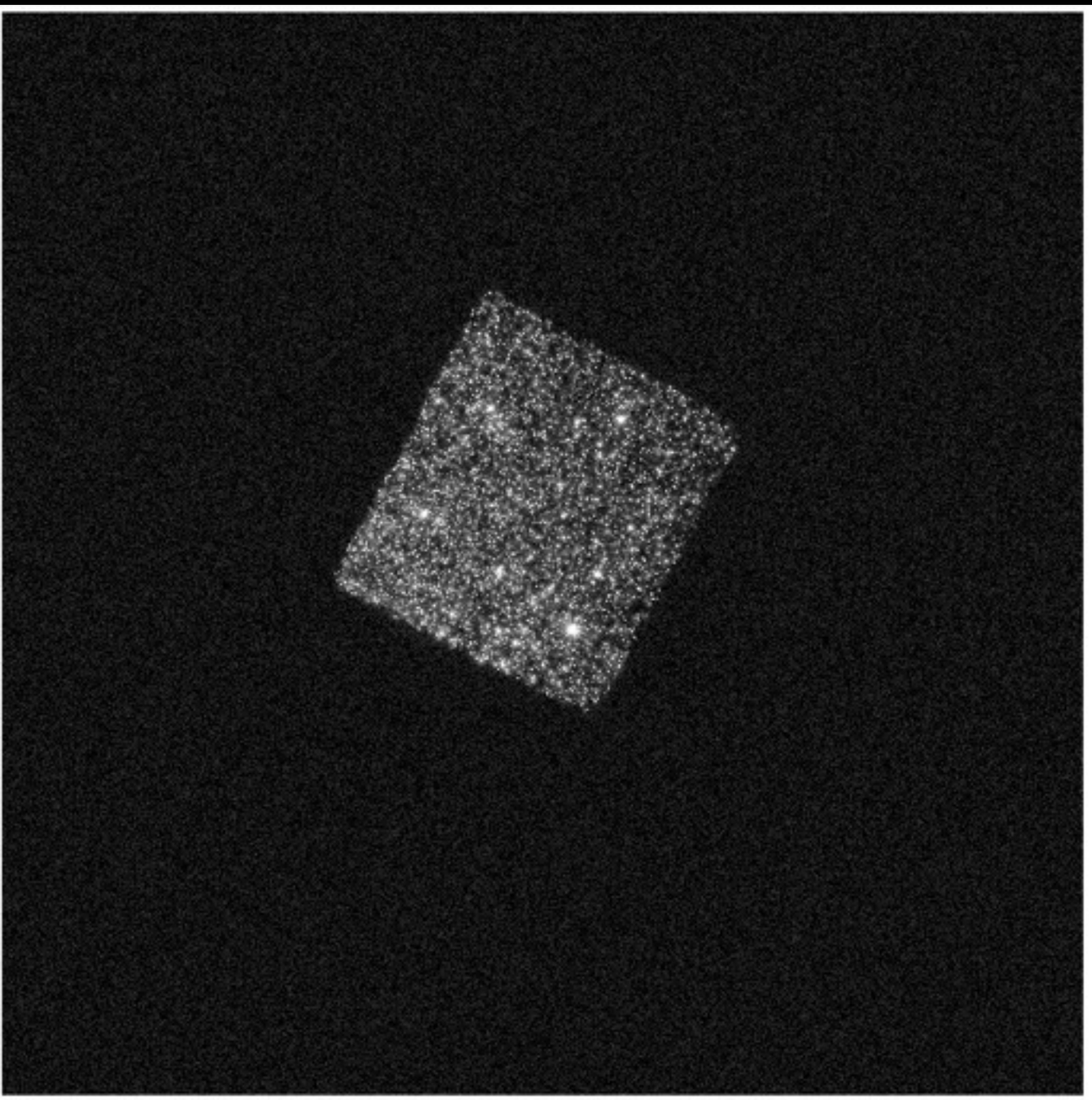
Age/Metallicity recovery

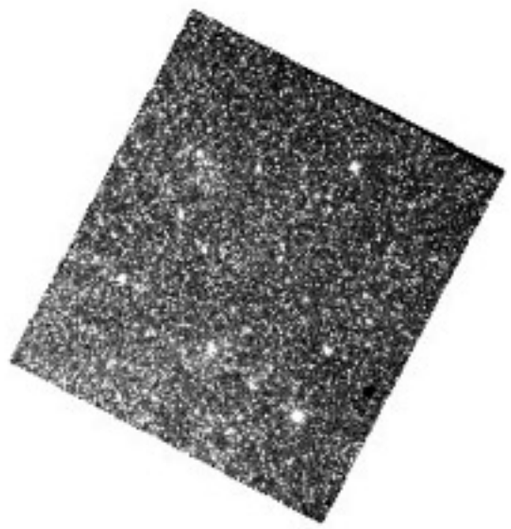




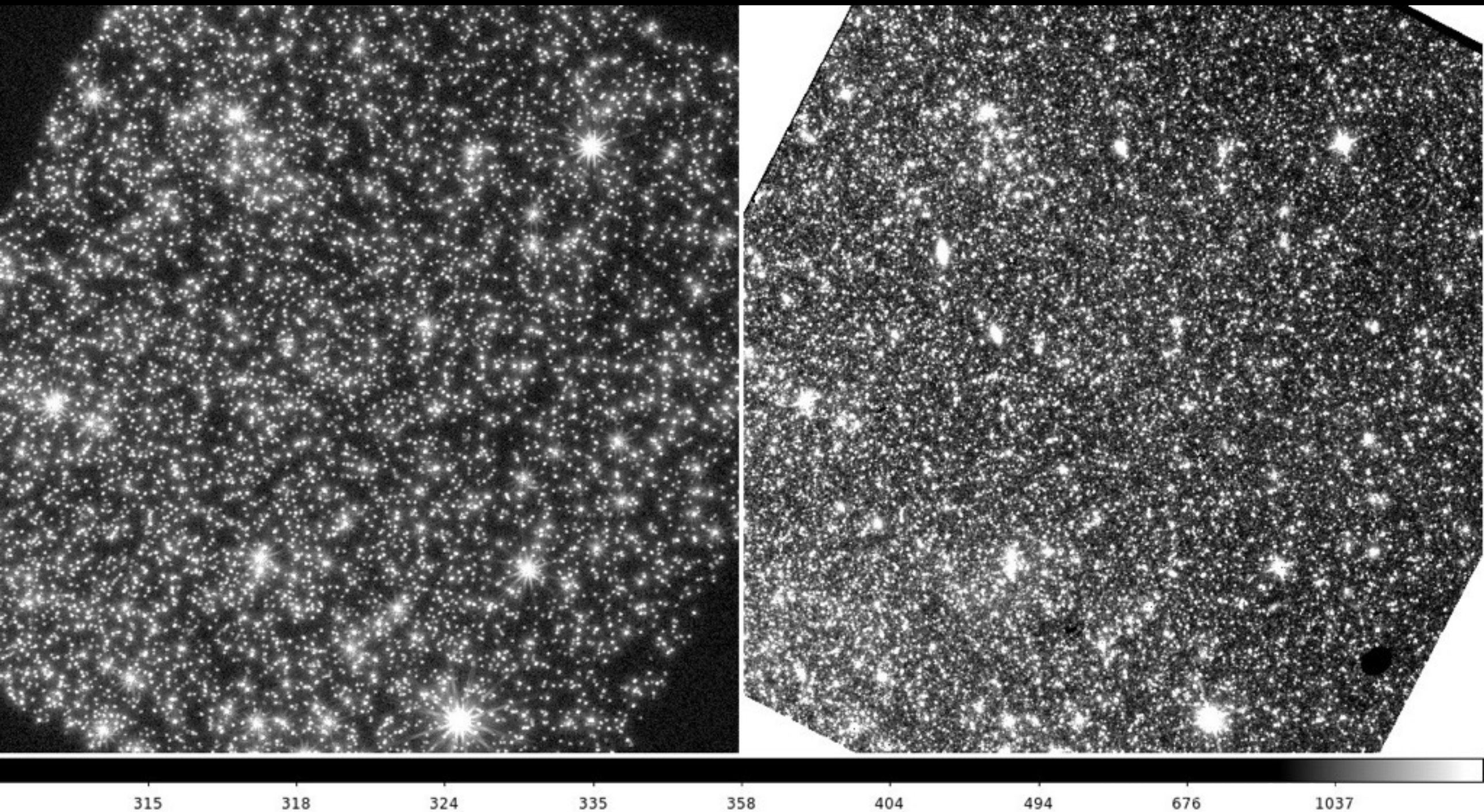
See poster by Meredith Durbin

Simulating Observations
Space Telescope Image Product Simulator (STIPS)

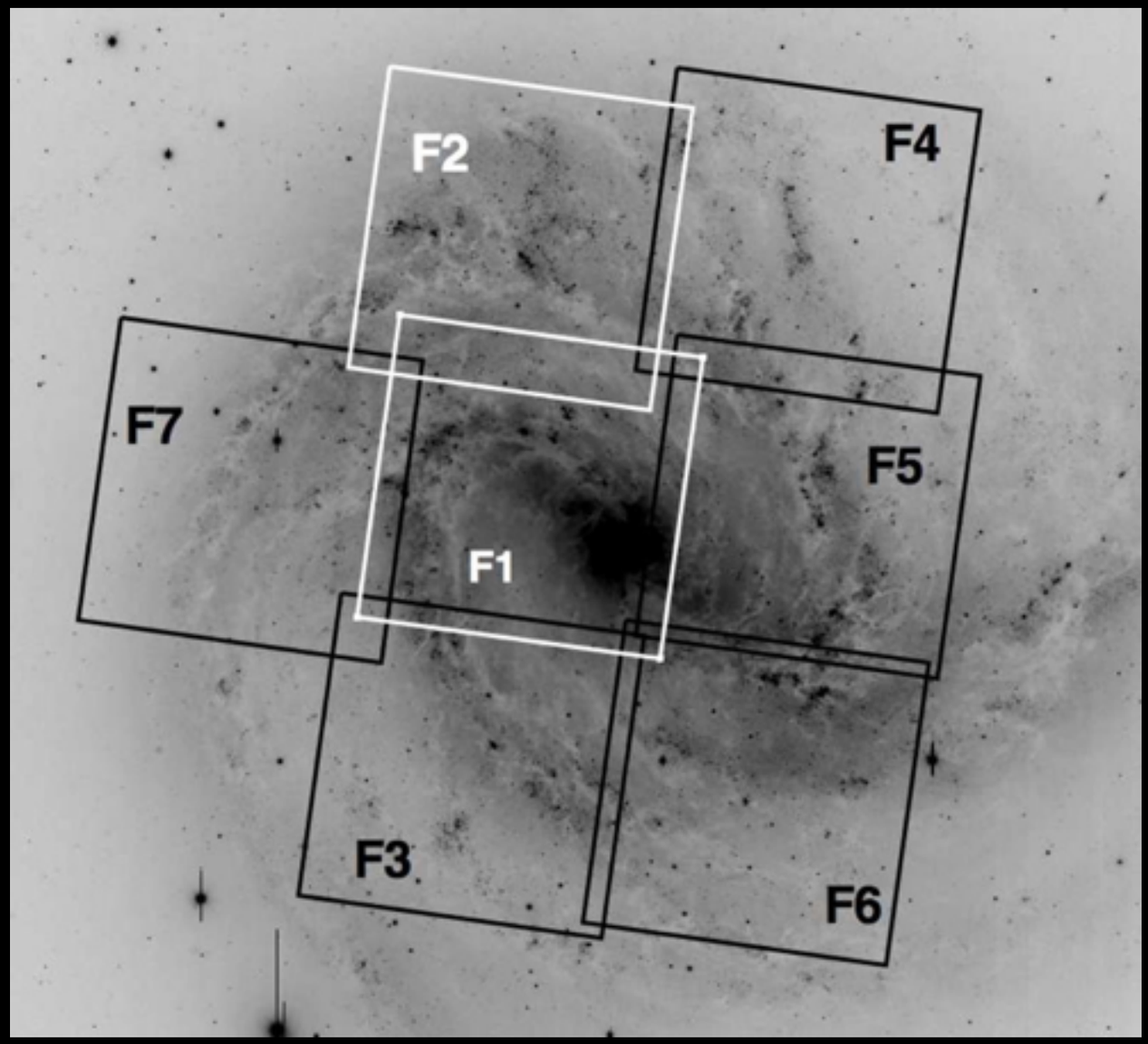




STIPS simulations



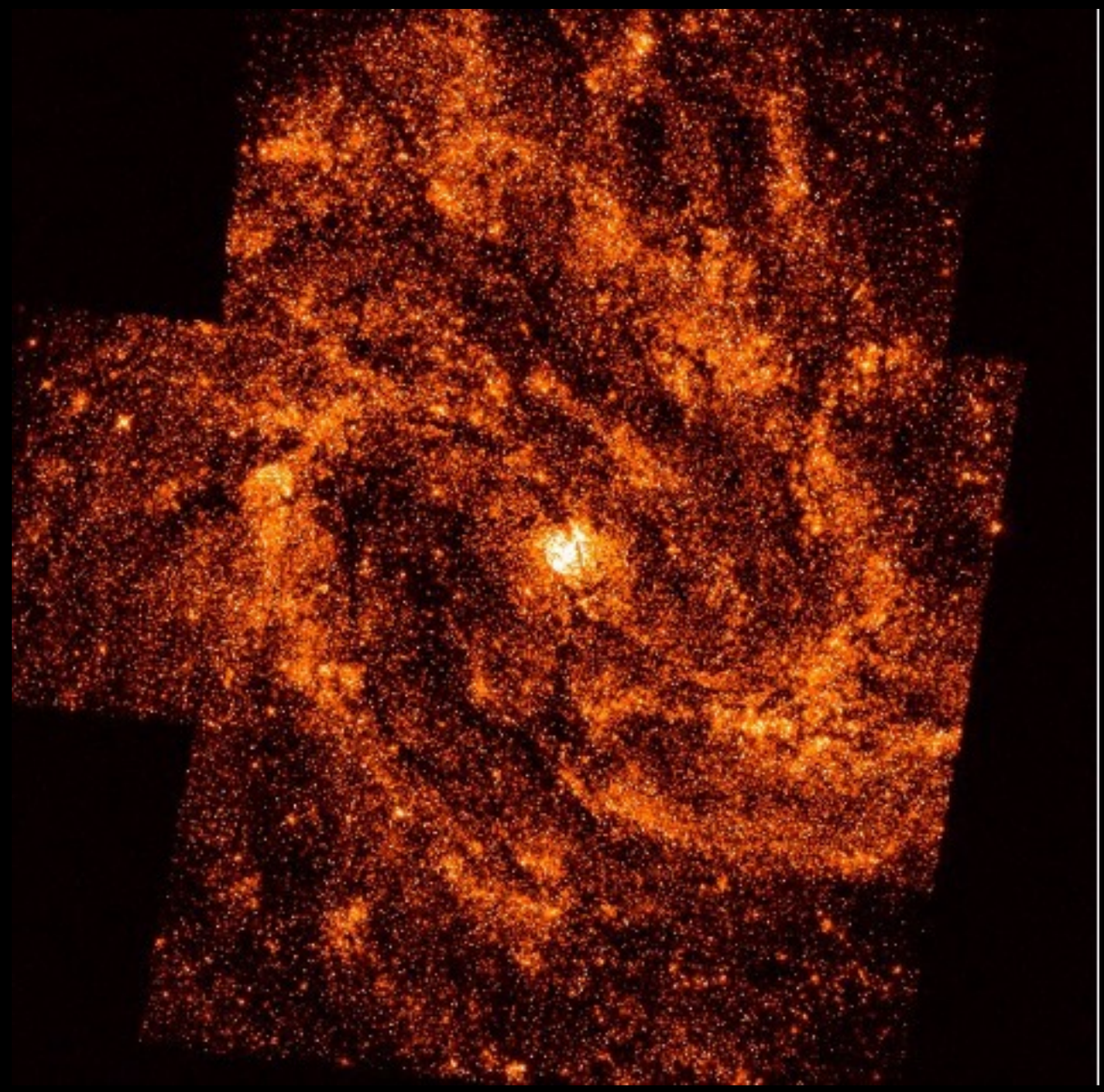
Simulating M83 (~4 Mpc)

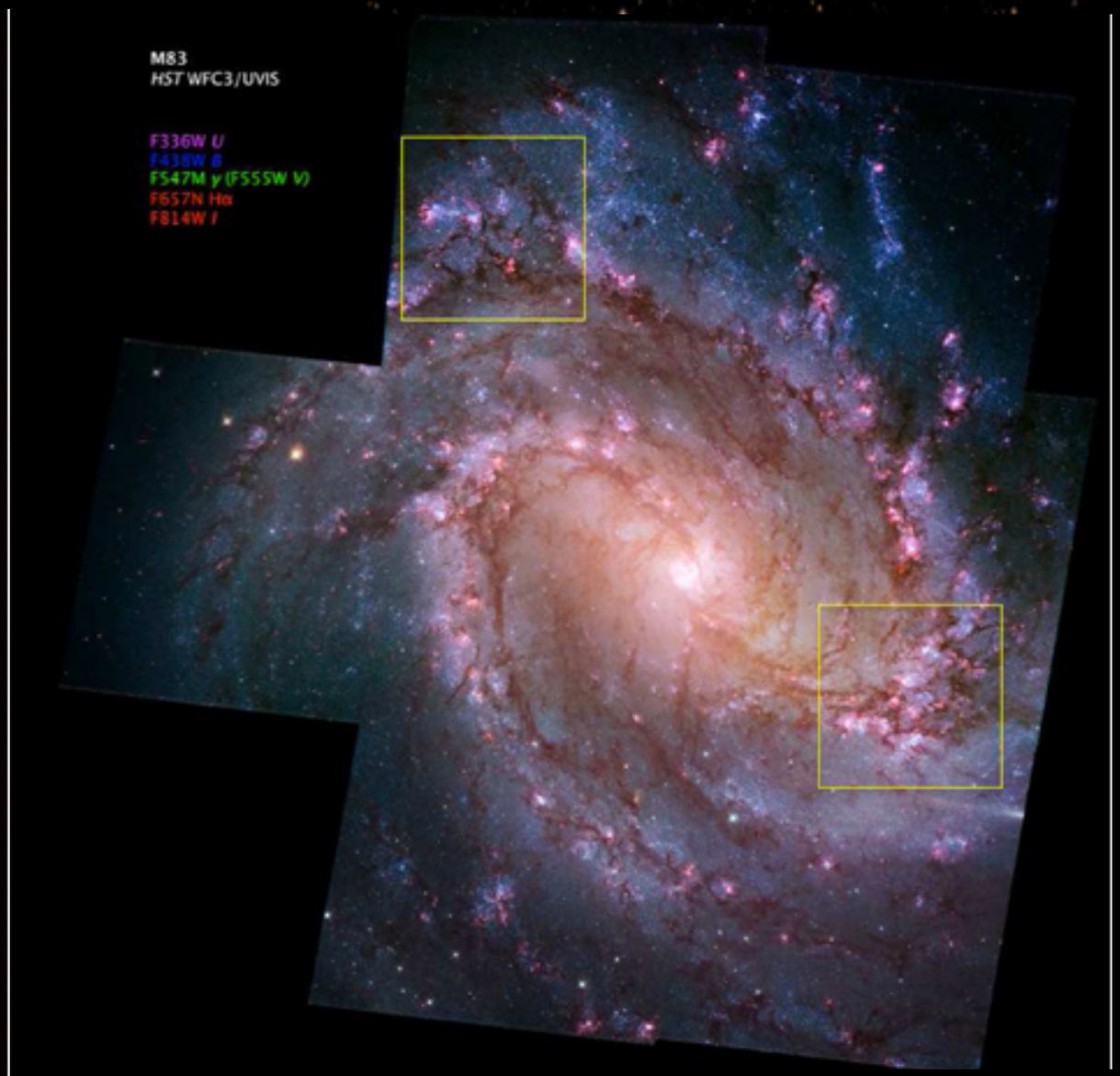


Blair et al. 2014

7 Field UVIS Mosaic —- One WFIRST 4k x 4k detector

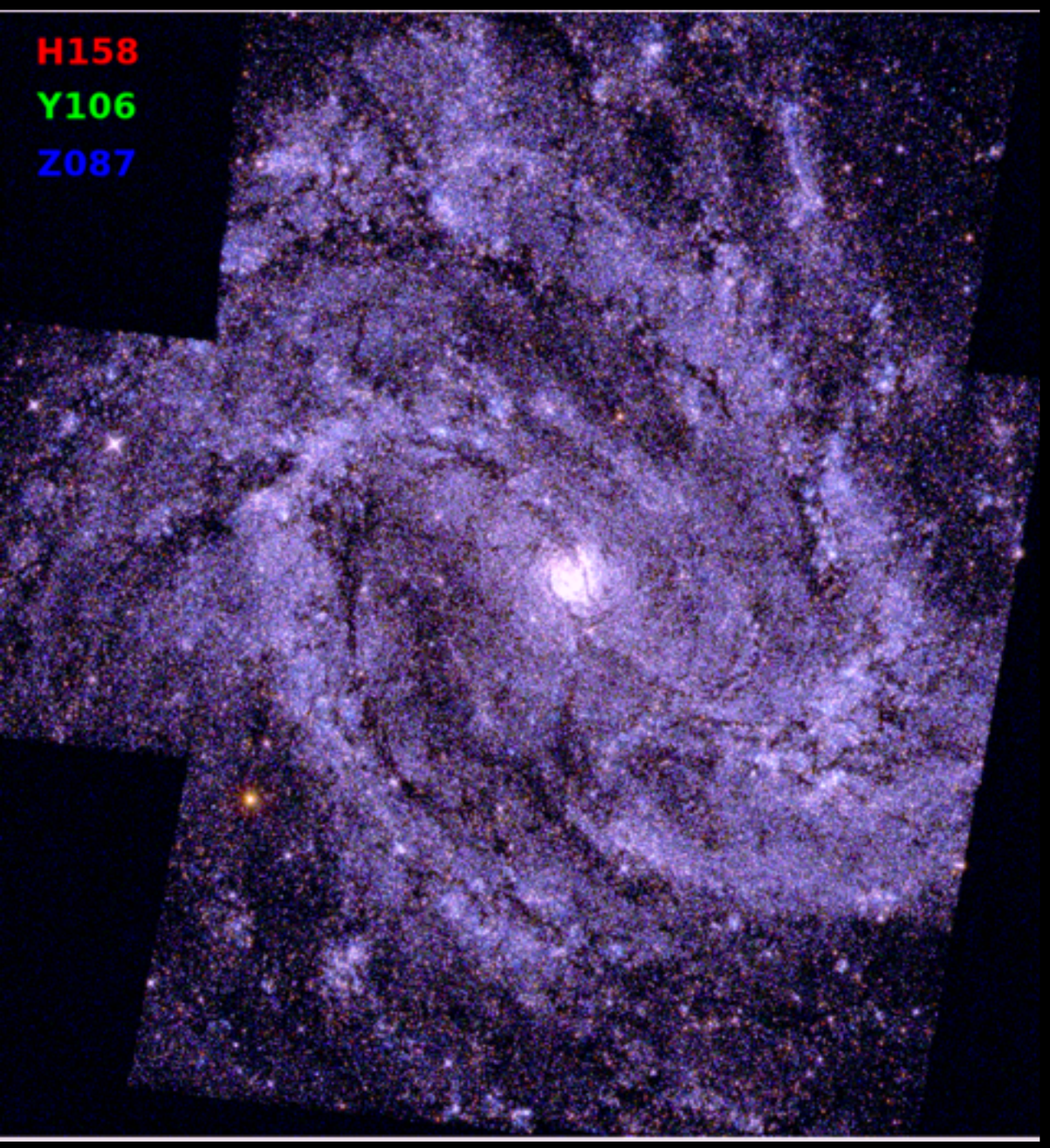
Simulating M83

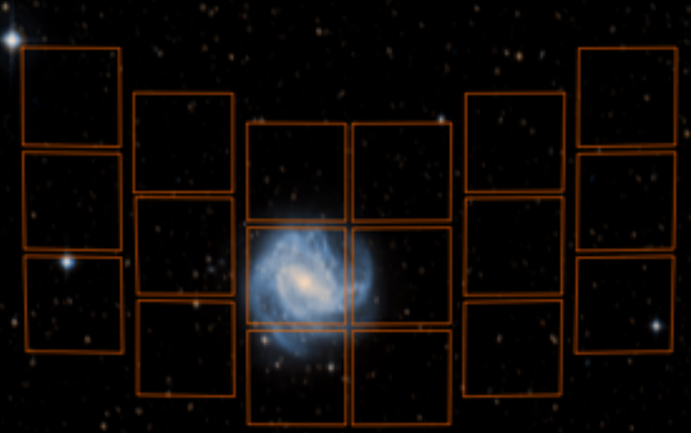


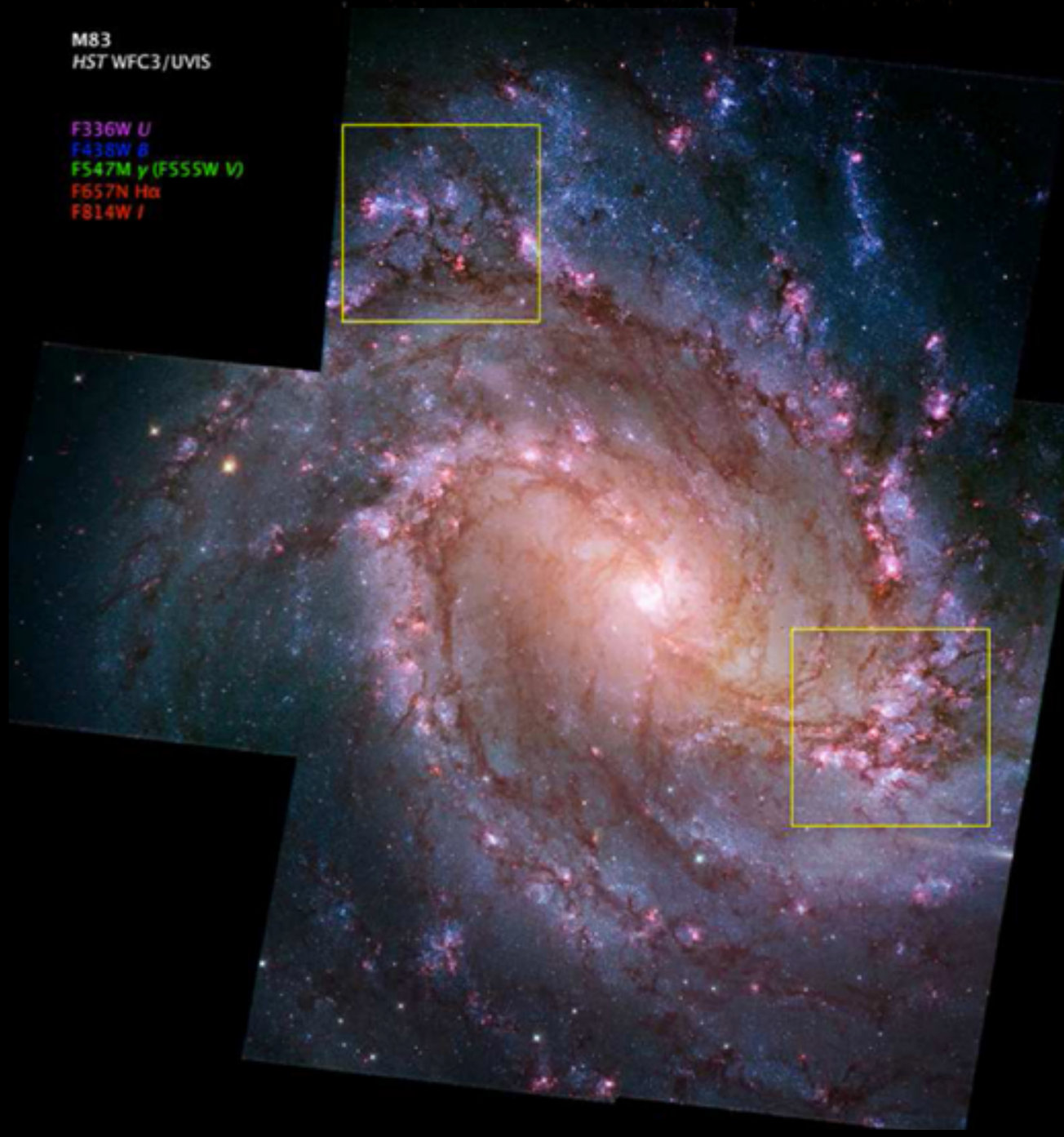


7 Field UVIS Mosaic —- One WFIRST 4k x 4k detector

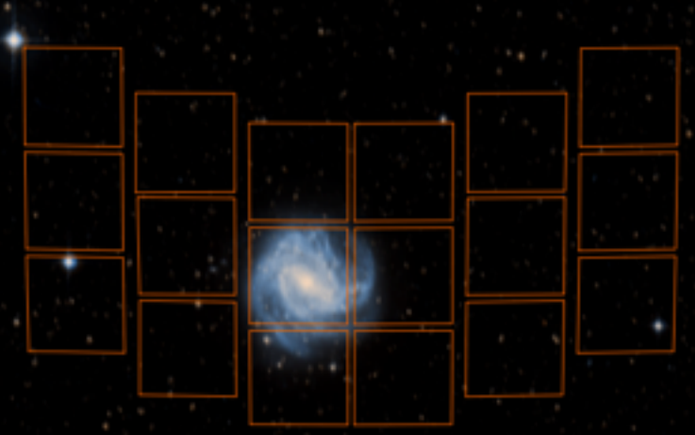
STIPS simulations

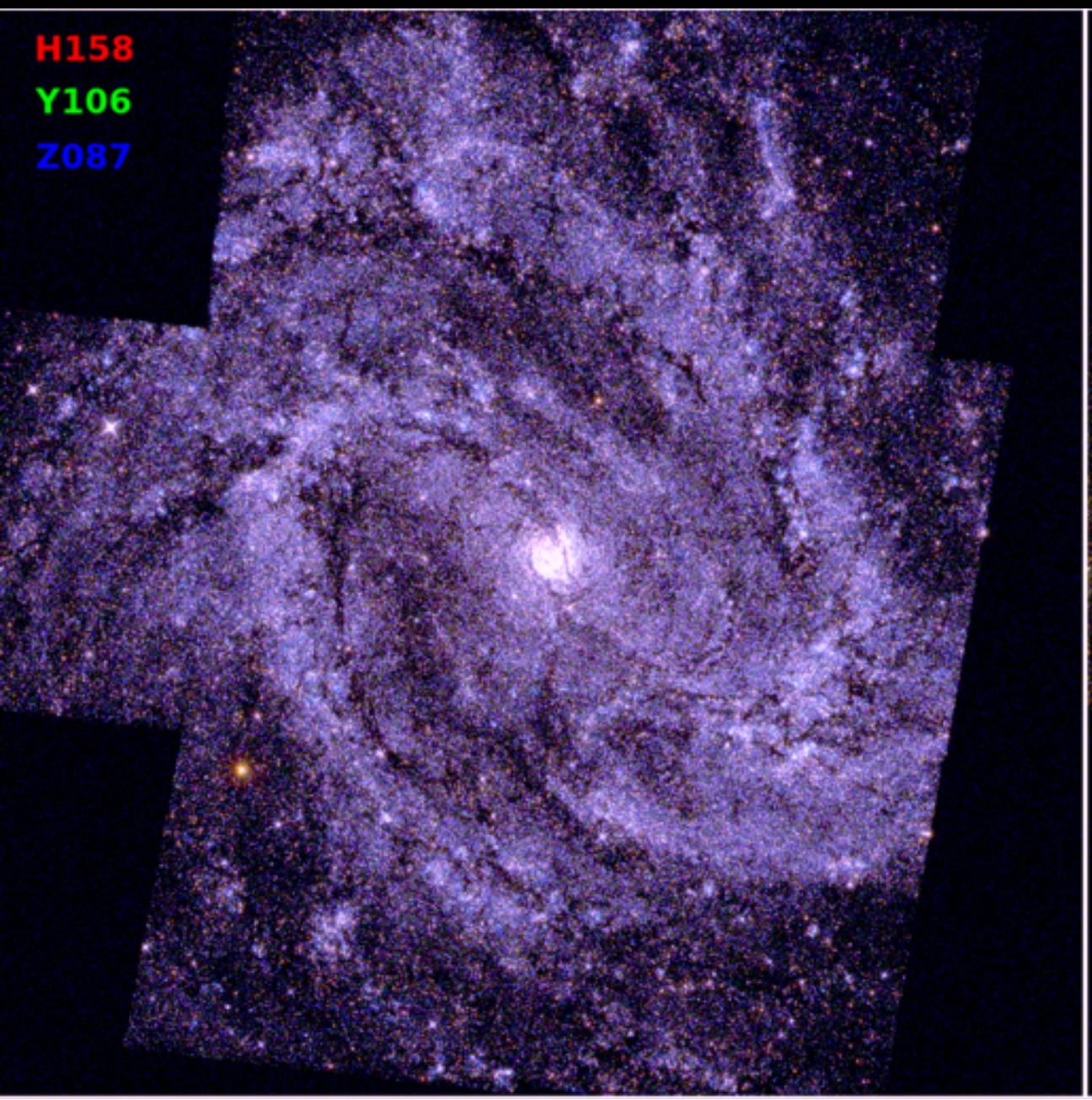


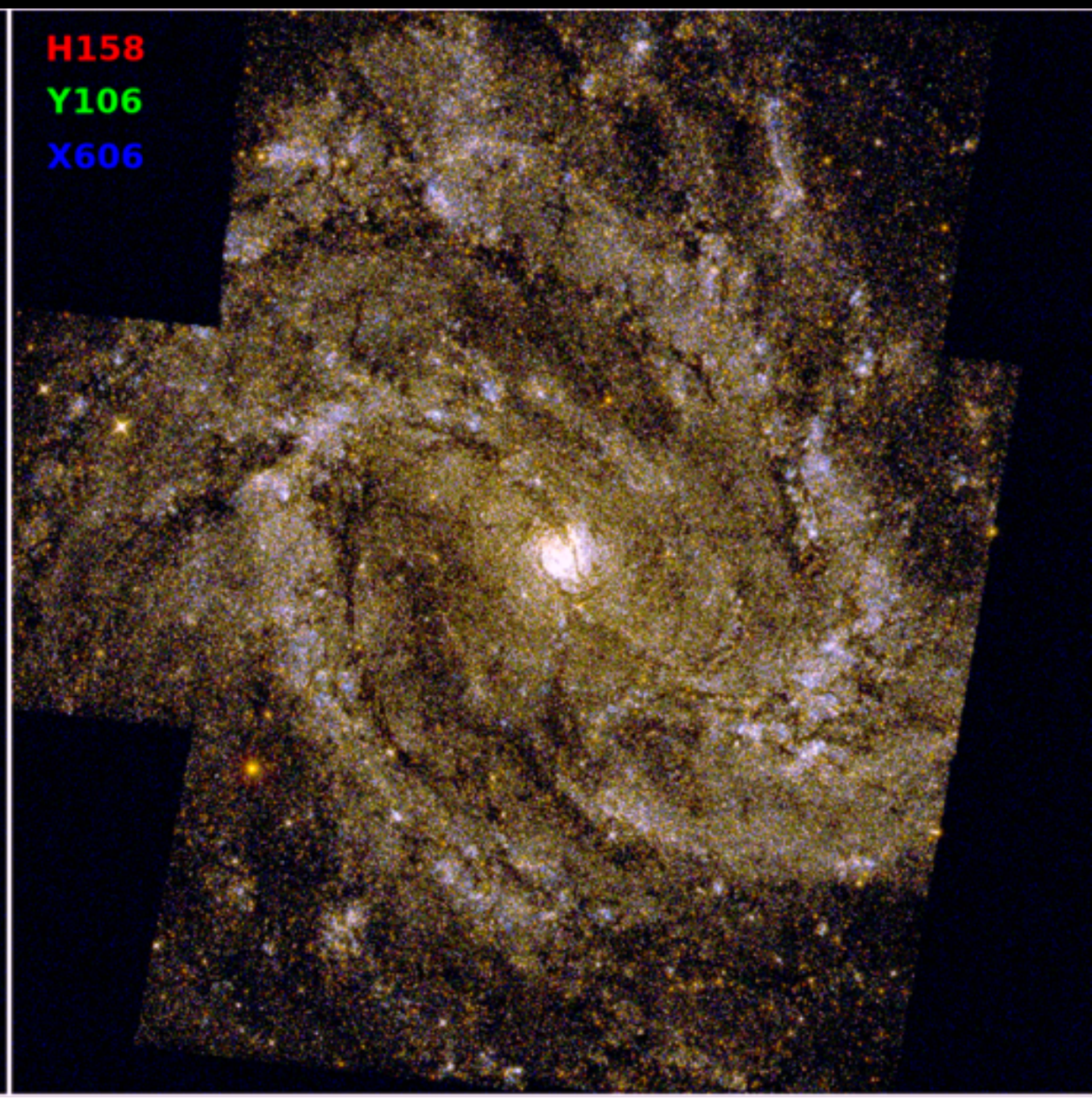




F606W as Blue Filter







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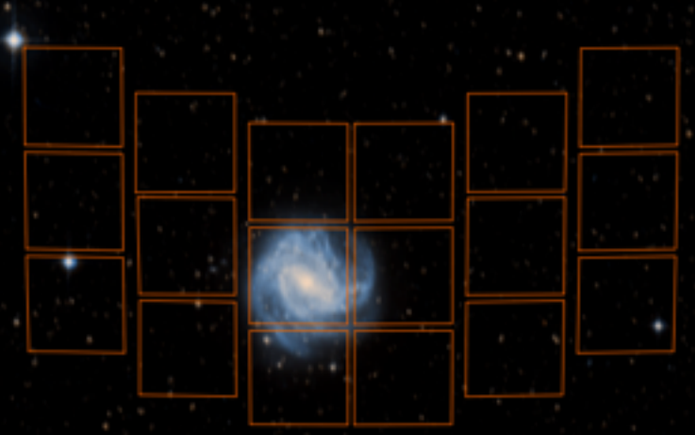

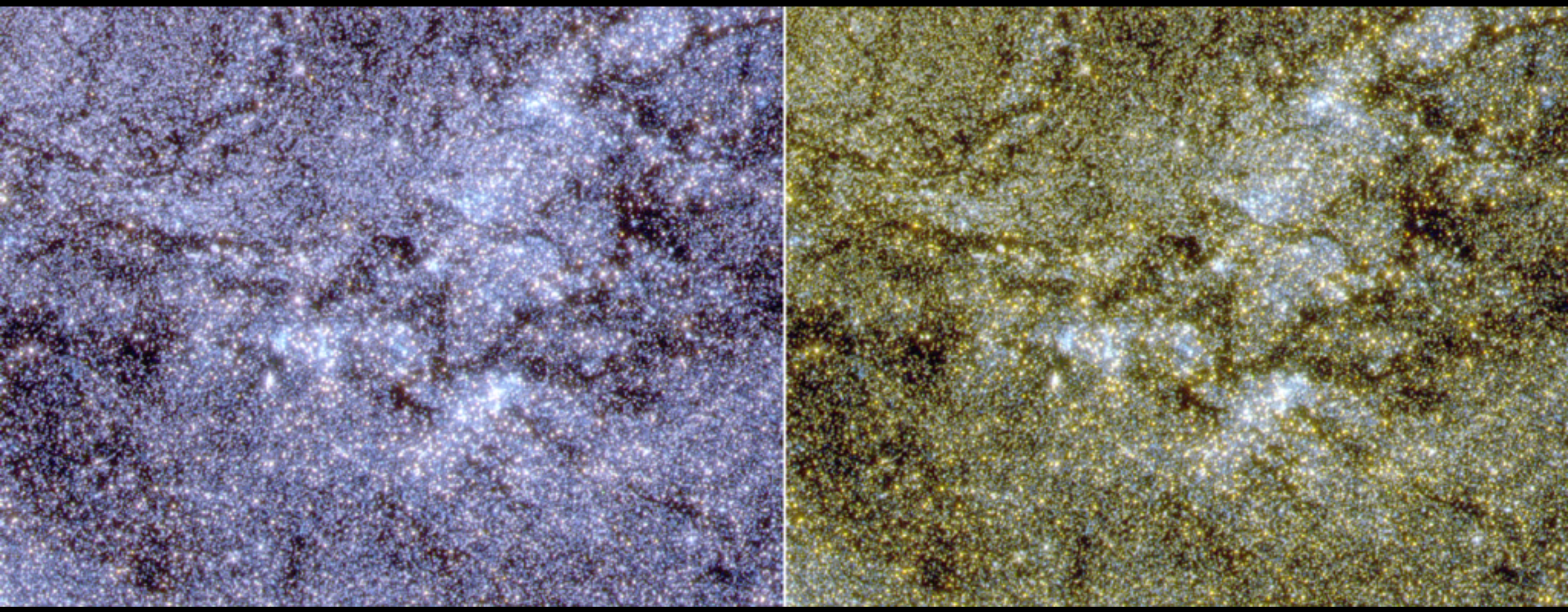

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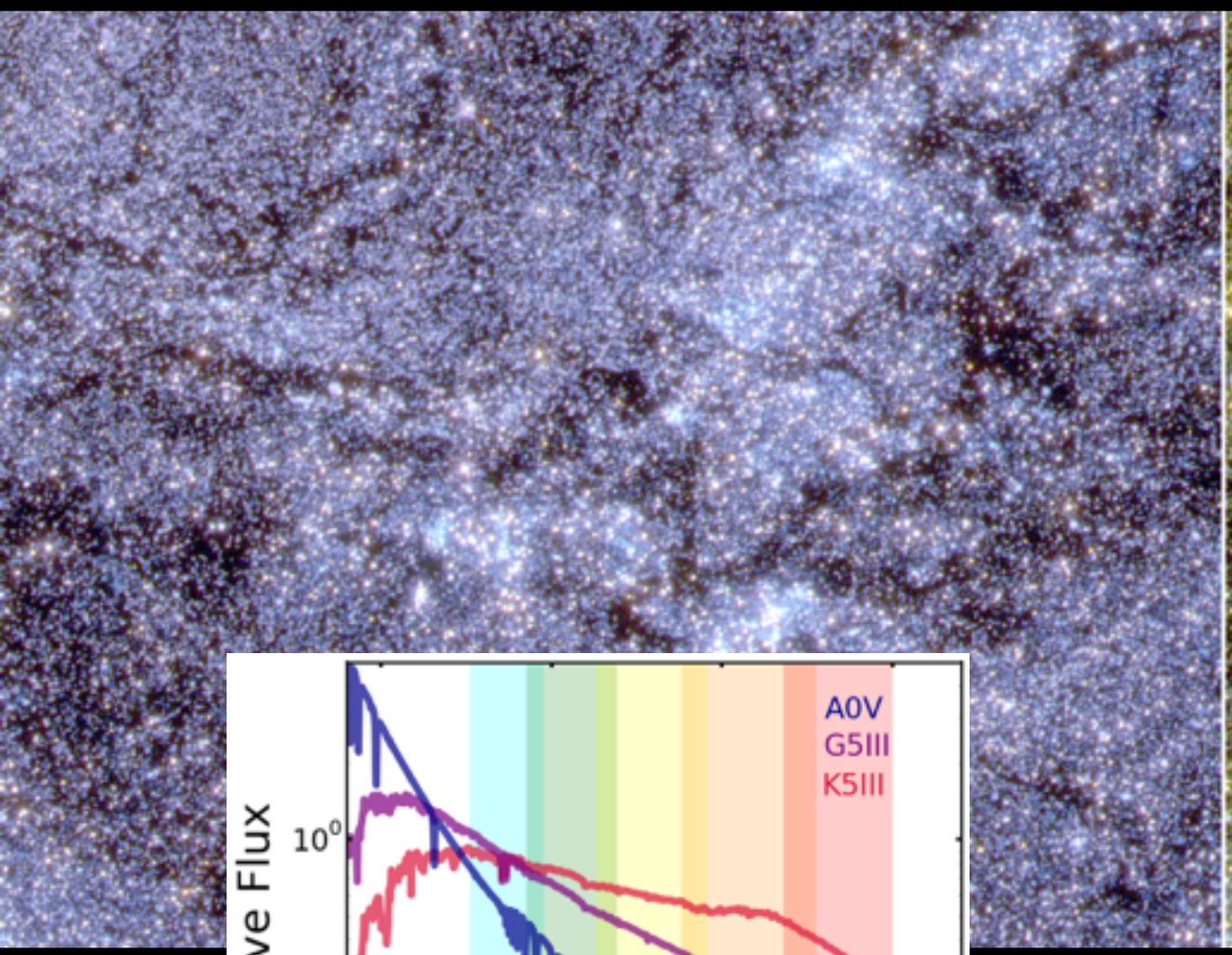

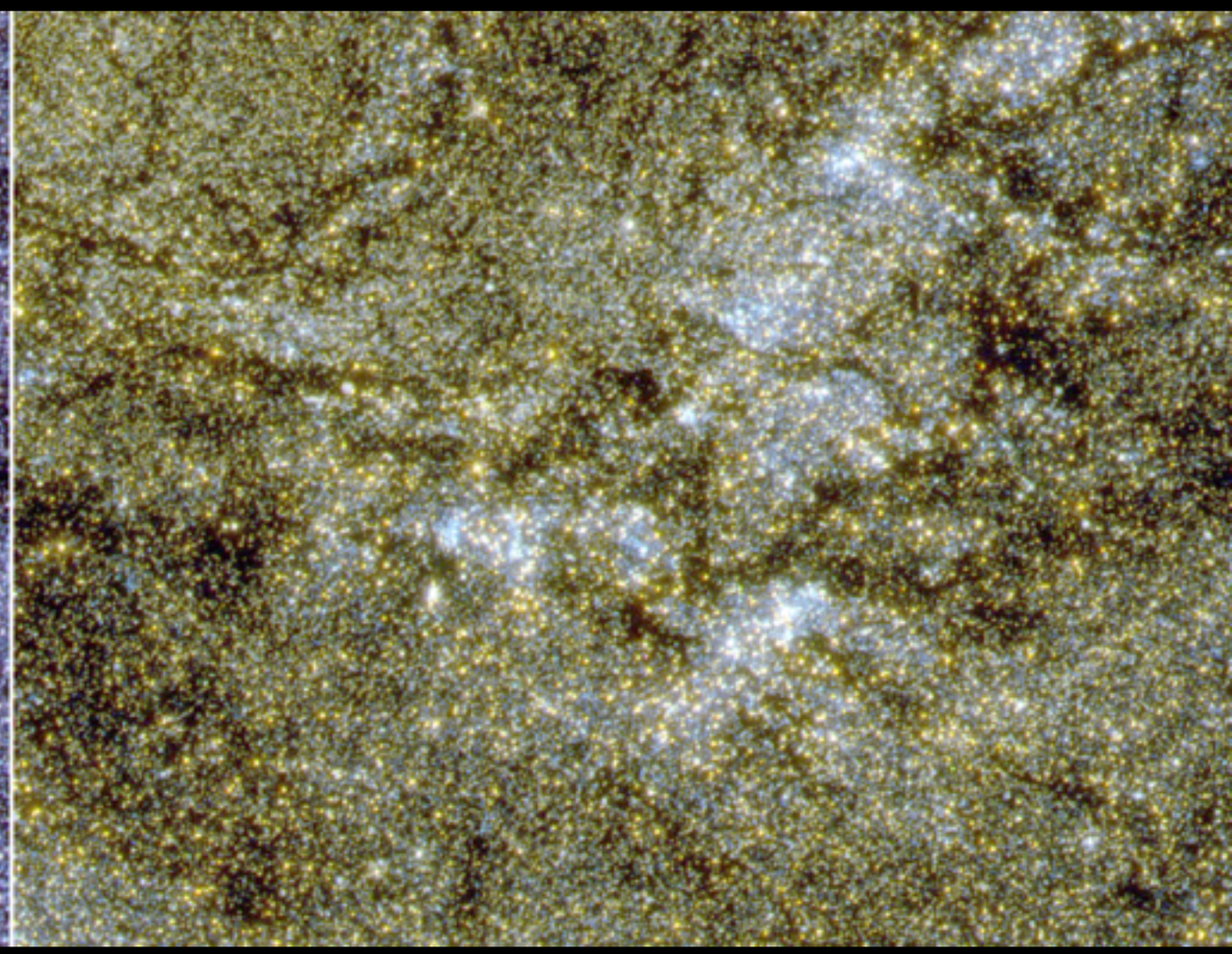

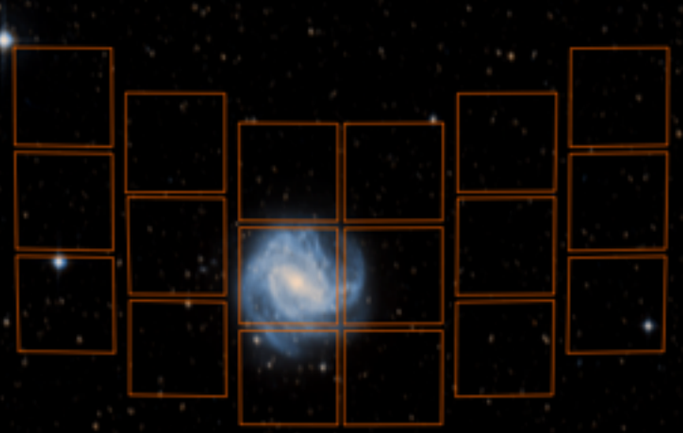

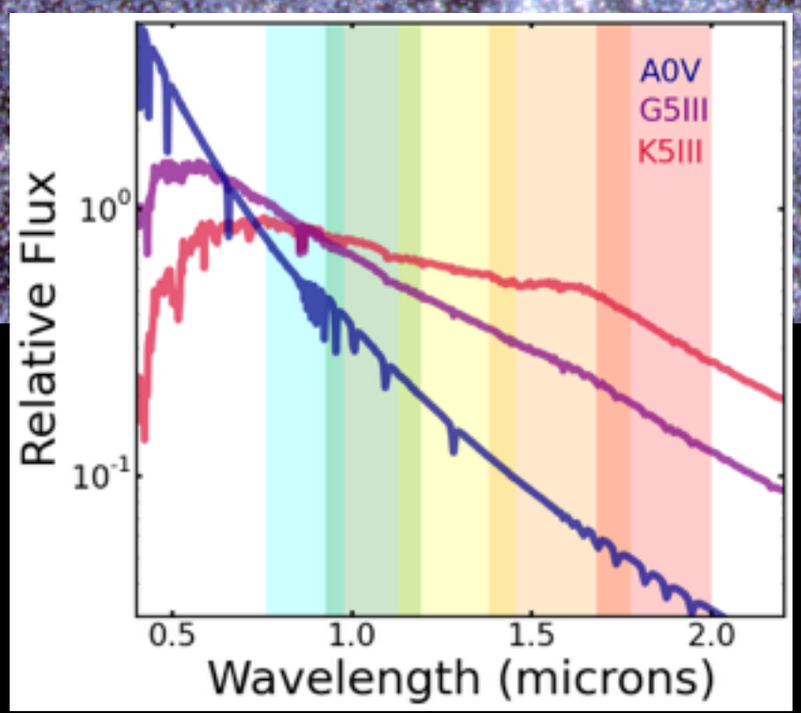

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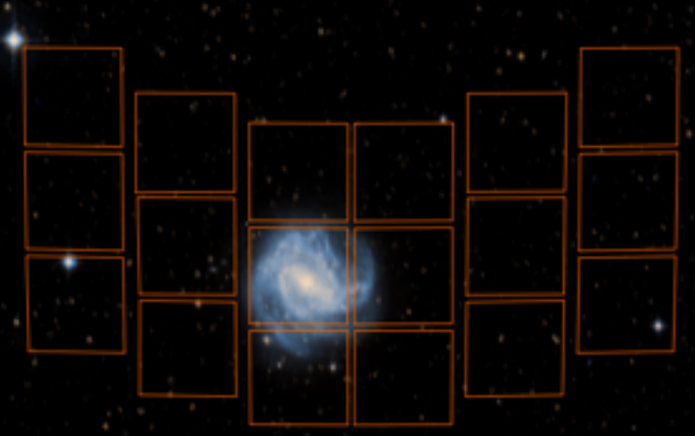
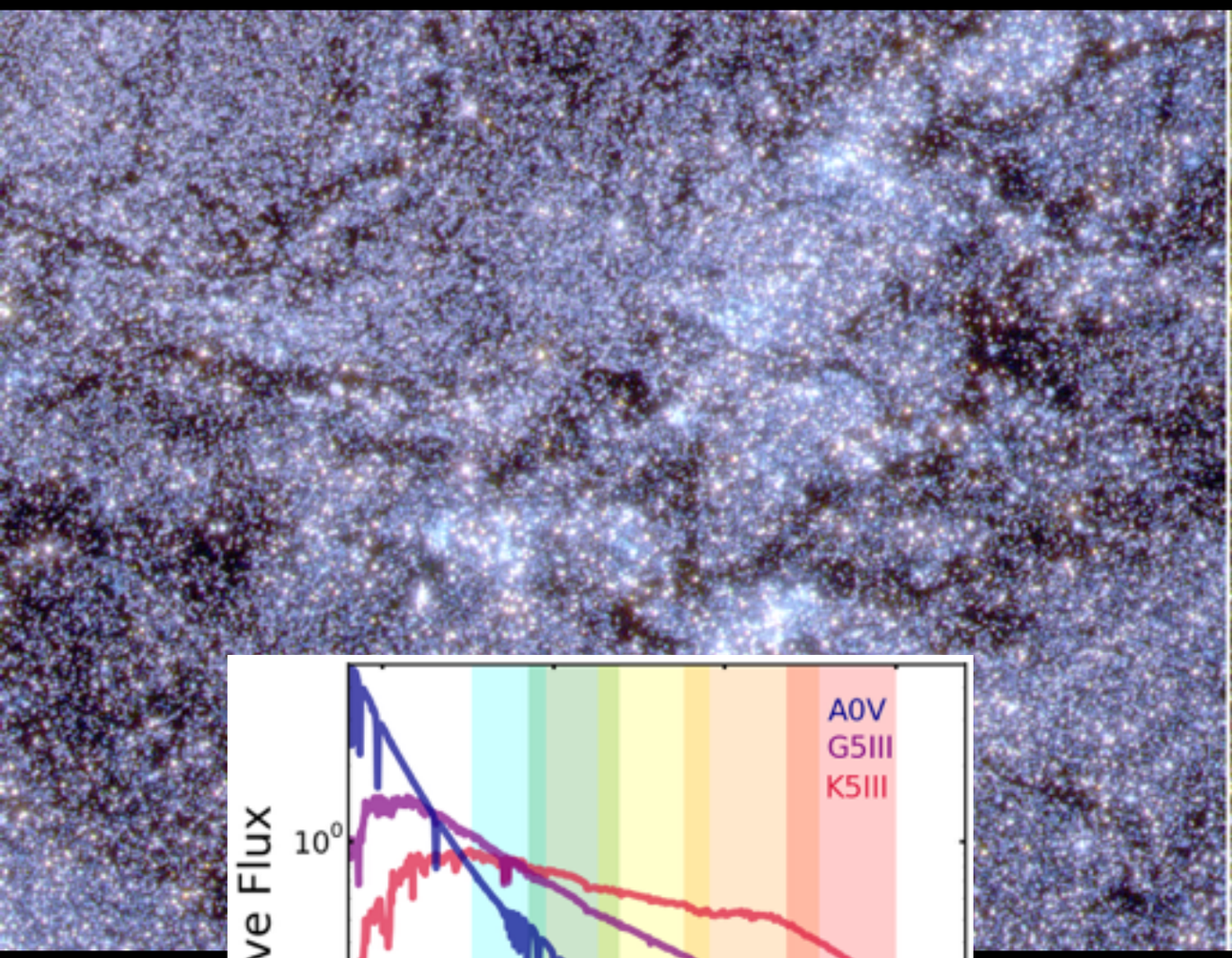
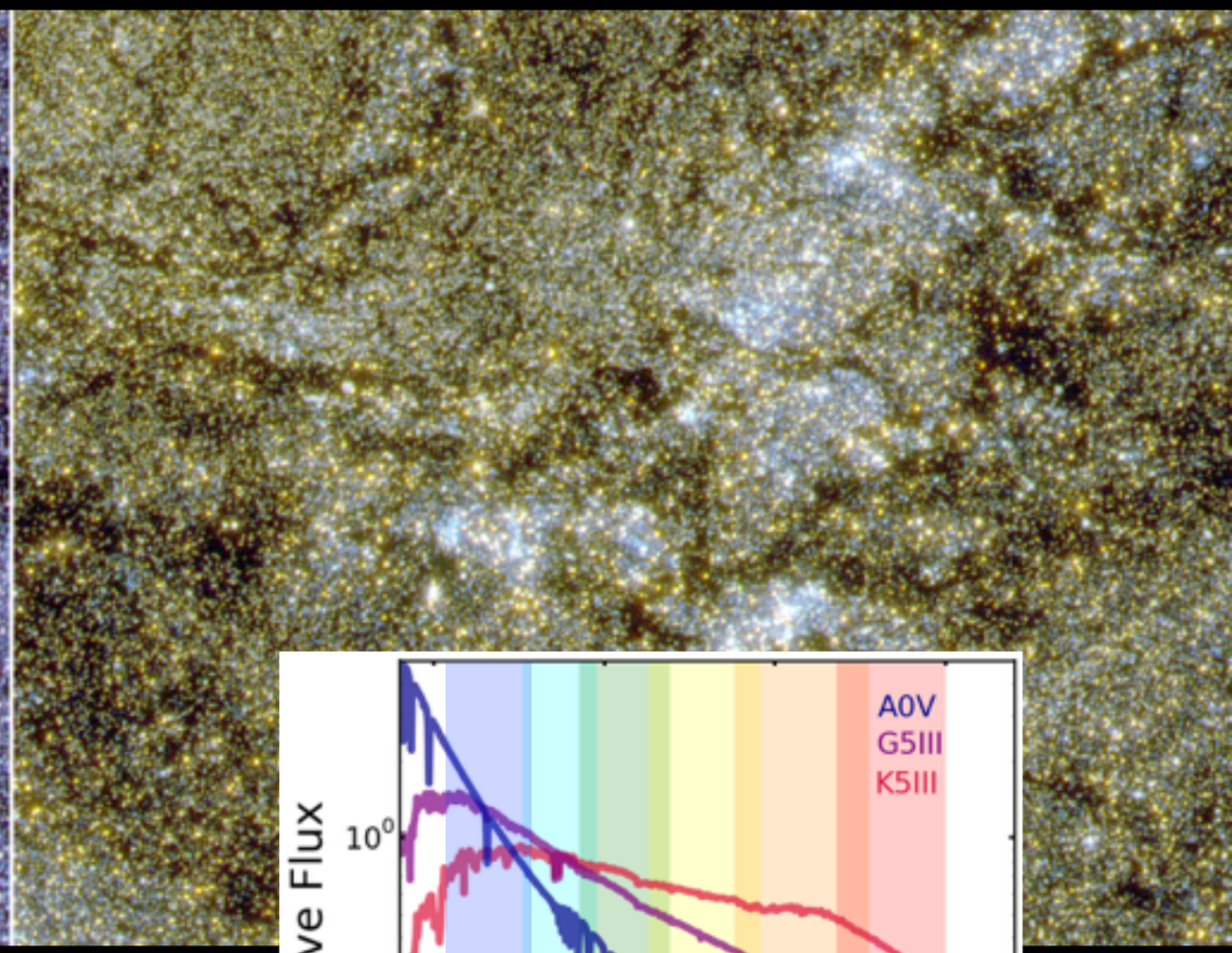
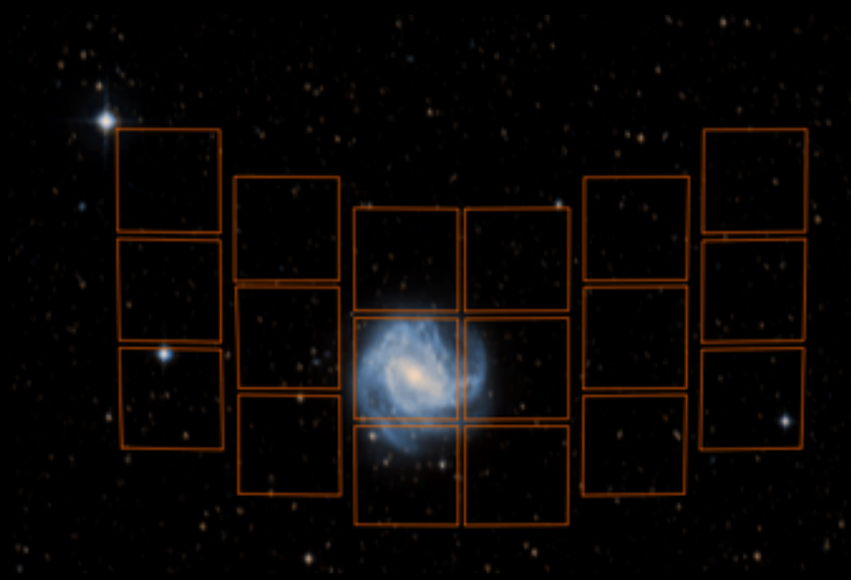




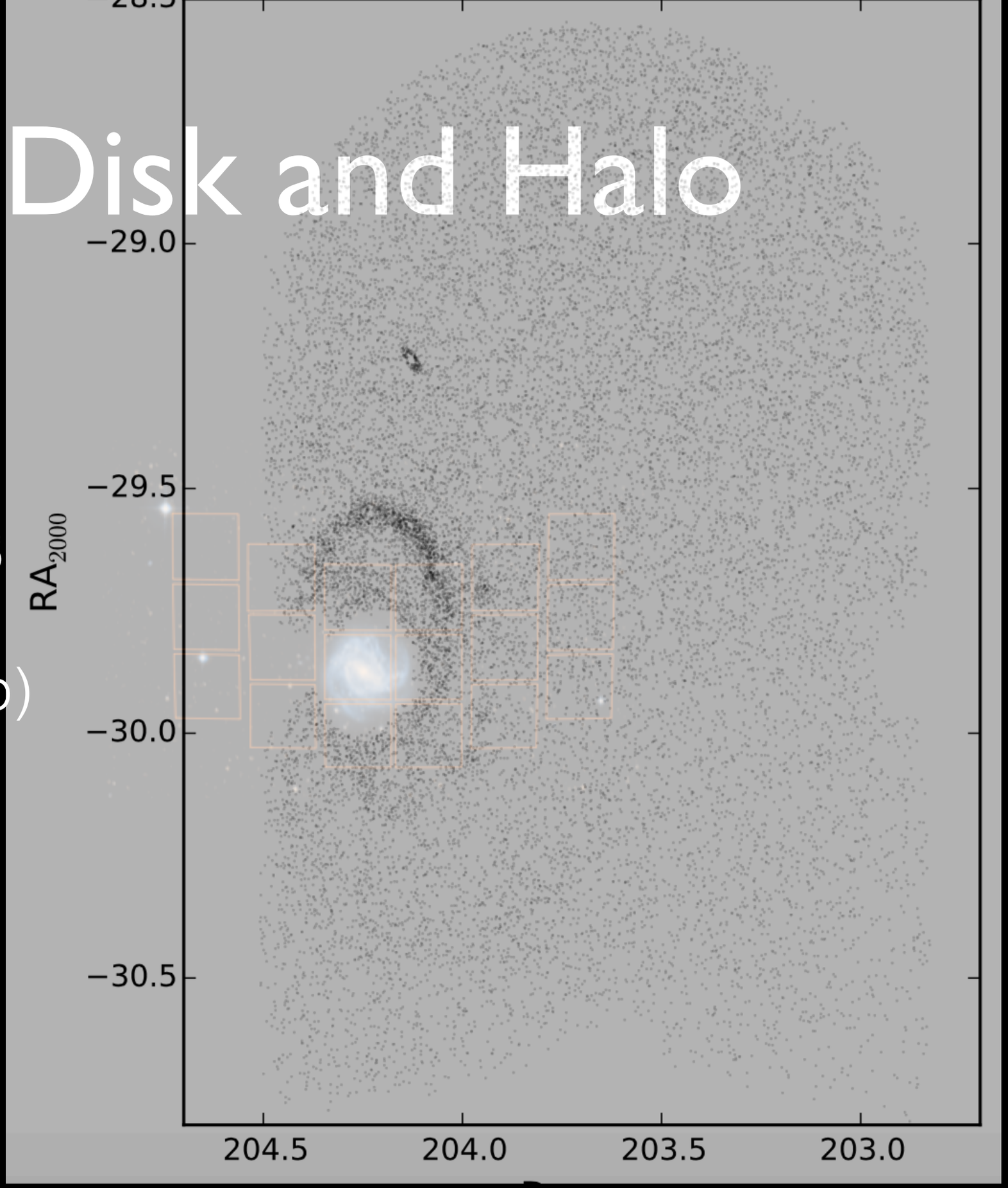


Disk and Halo

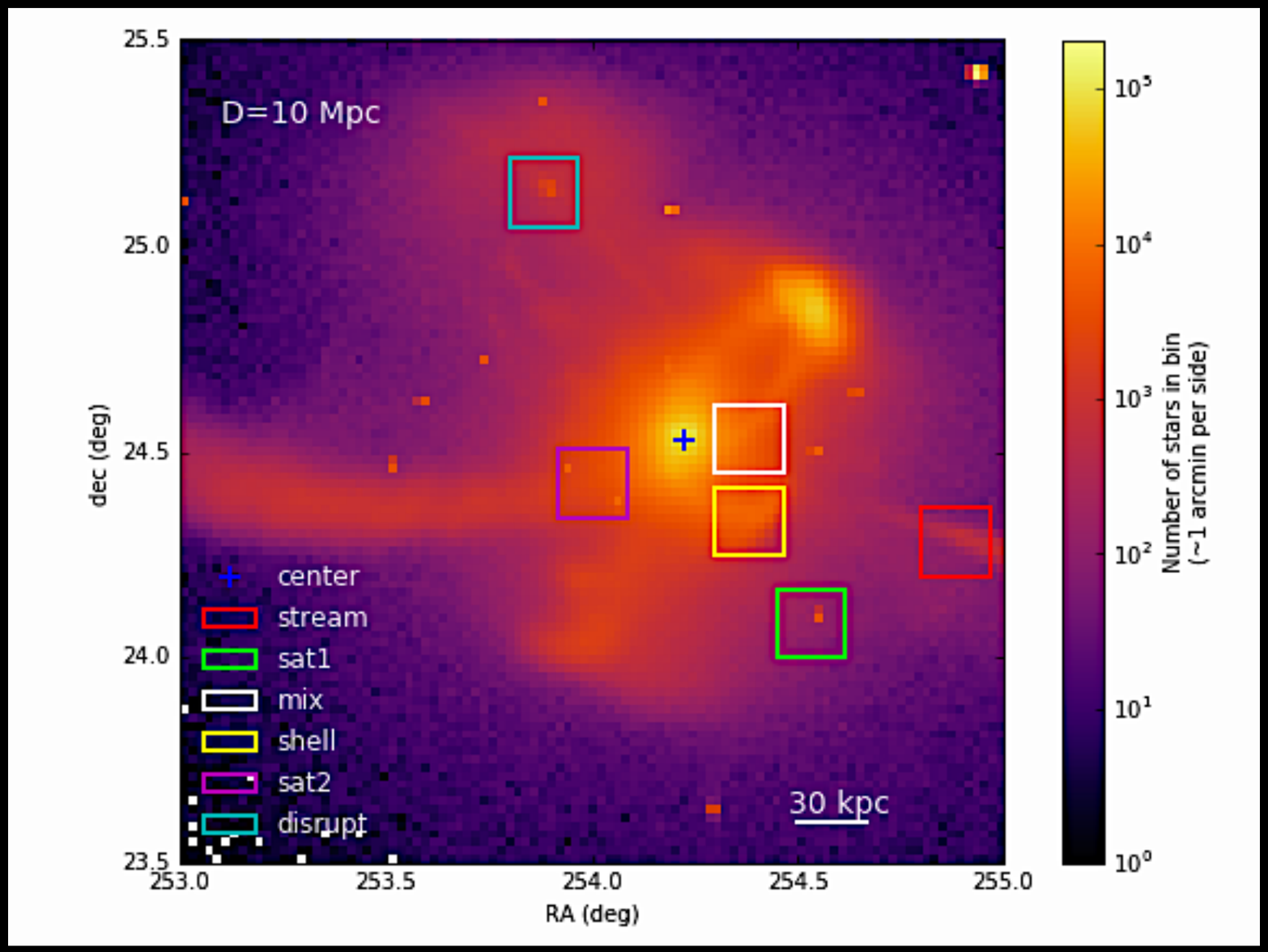


Disk and Halo

Metal-poor RGB
Subaru HSC
Bell et al. (in prep)



Simulating Halo Images

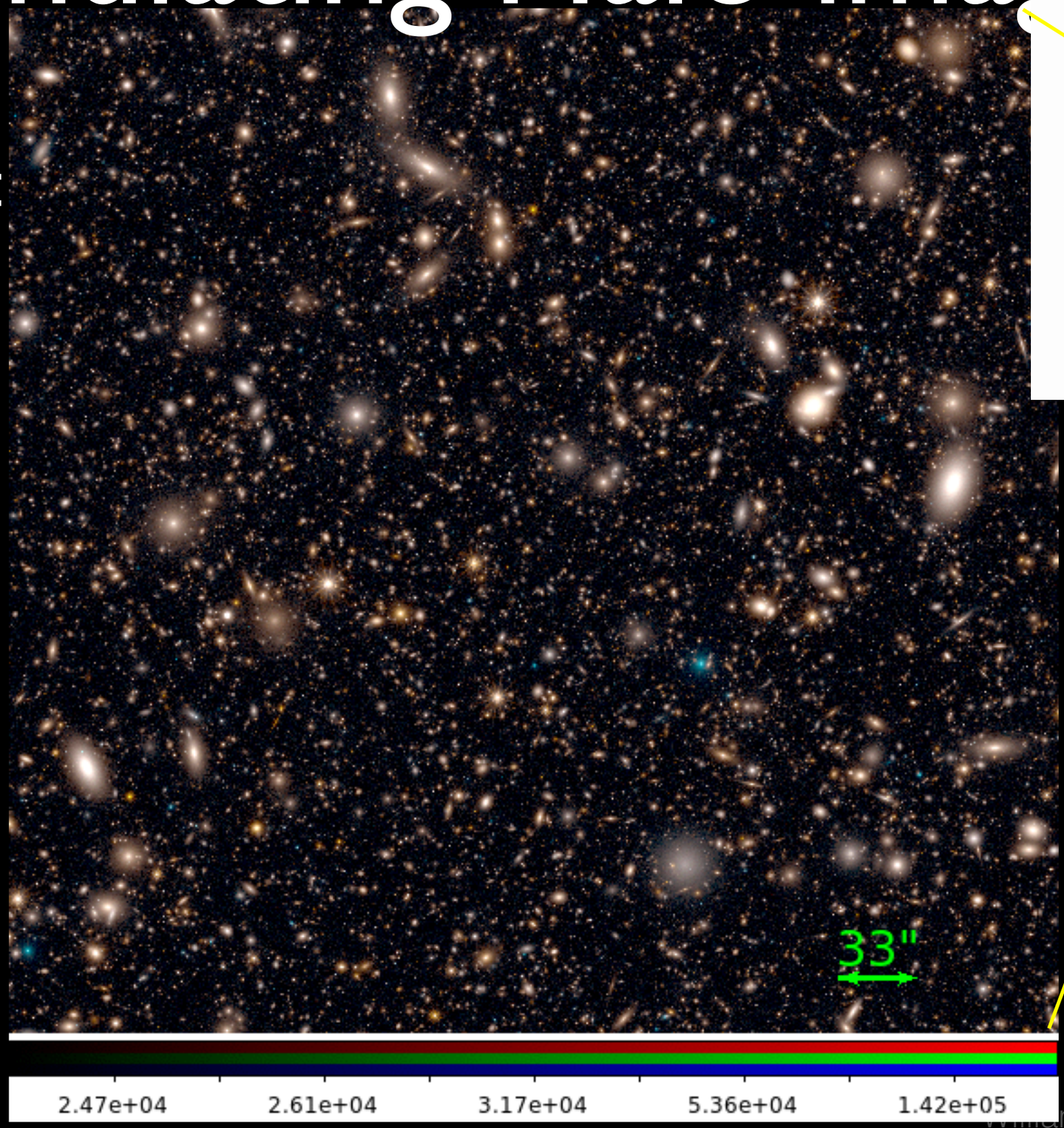


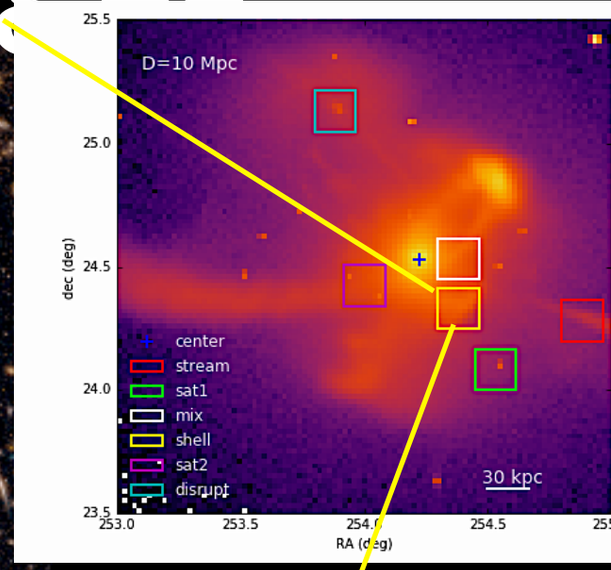
Simulating Halo images

Backgrouind: CANDELS-based catalogs

Stars: Galaxia catalogs of simulations

Blue = Z087
Red = H158





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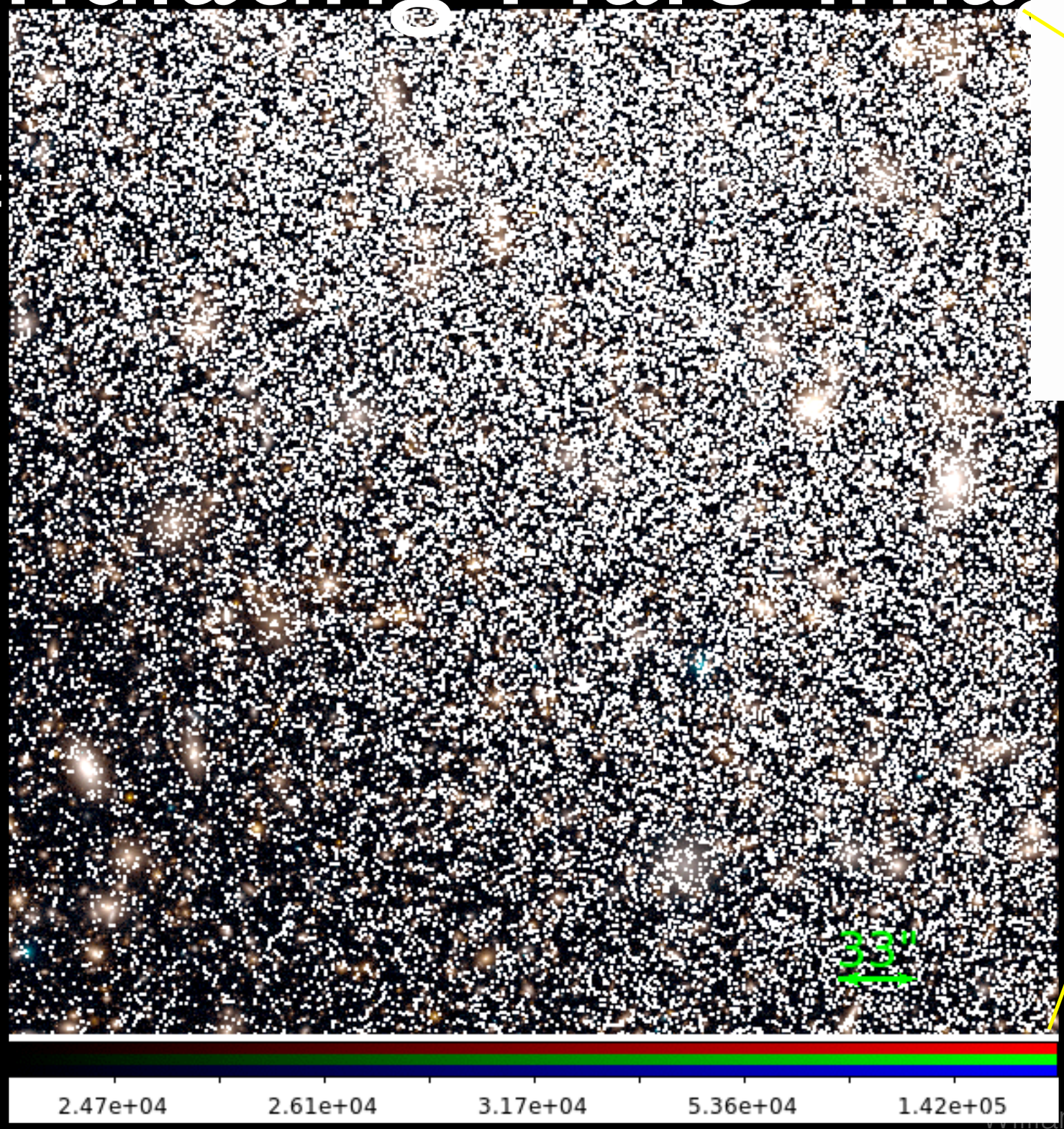

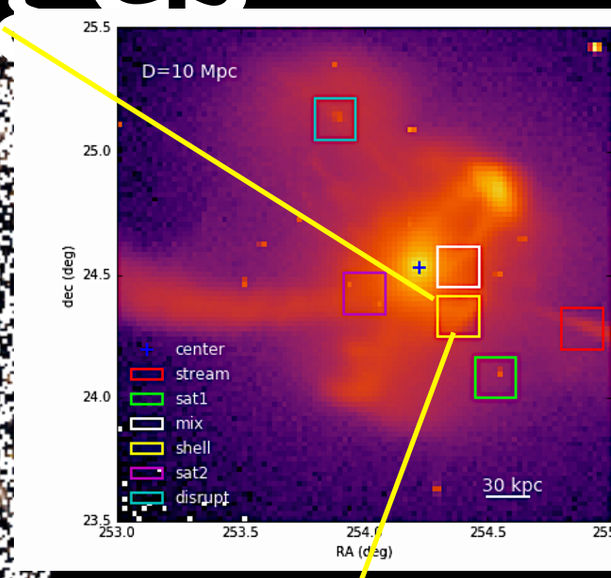

Stars in a Halo at 5 Mpc

Simulating Halo images

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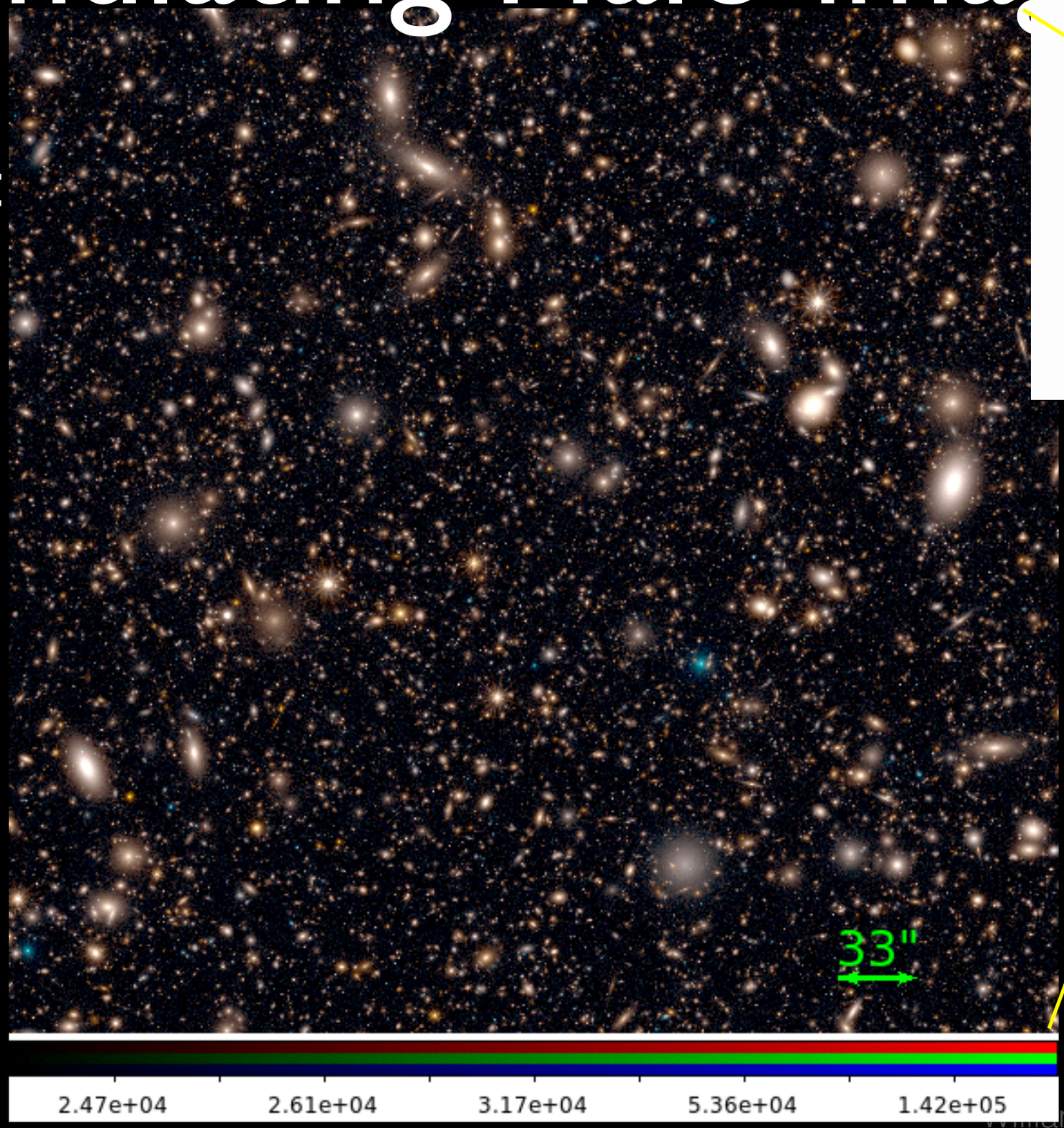

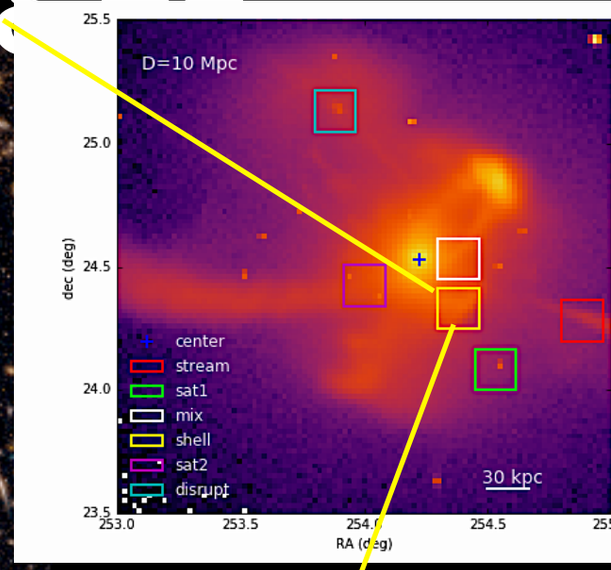

Simulating Halo images

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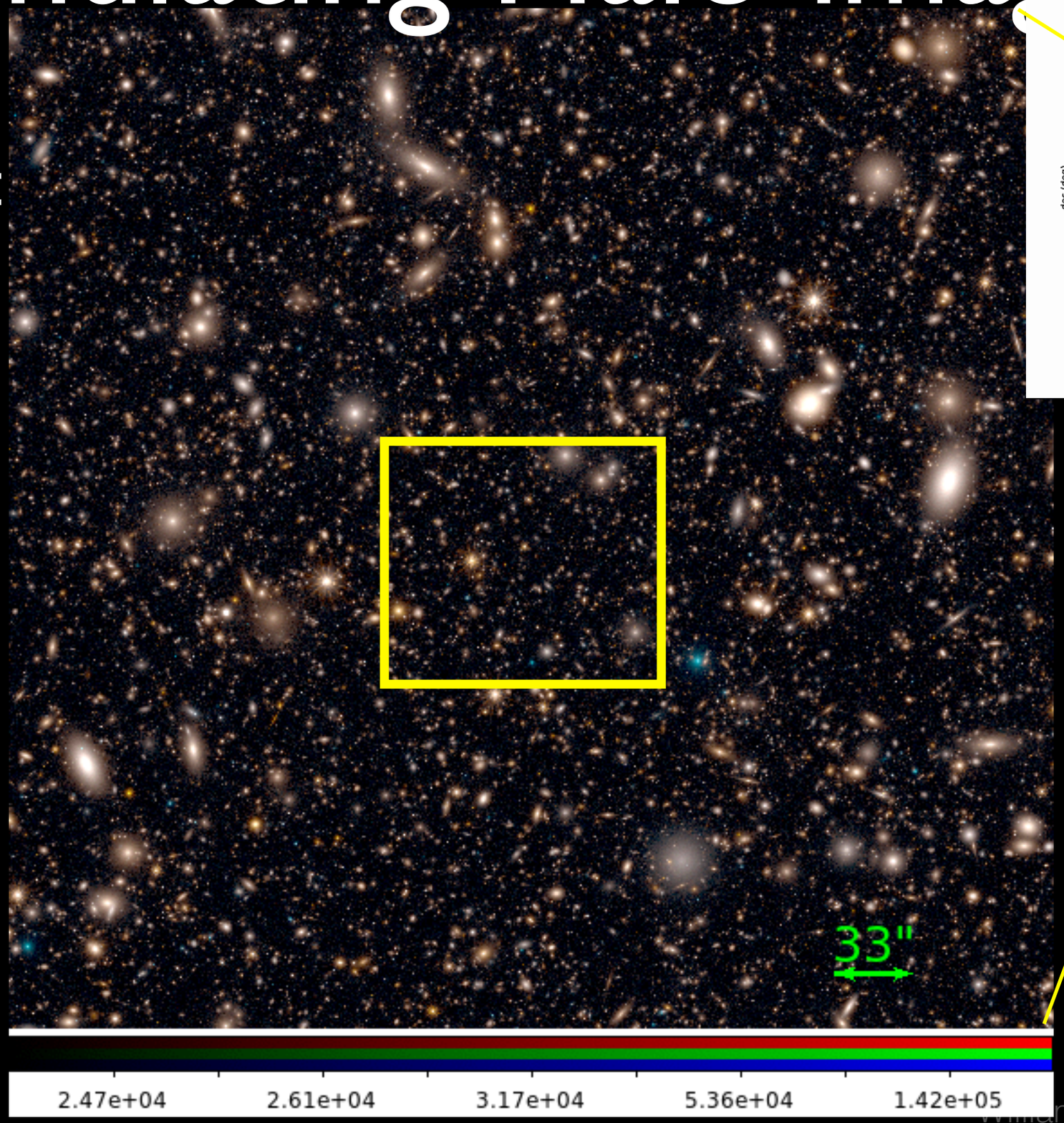

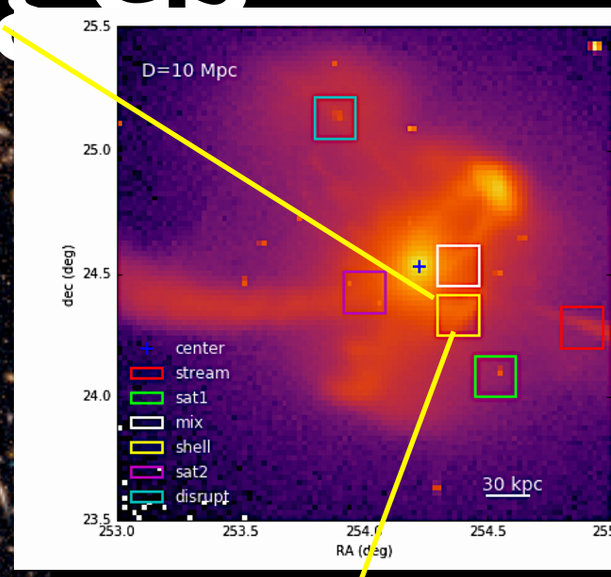

Simulating Halo Images

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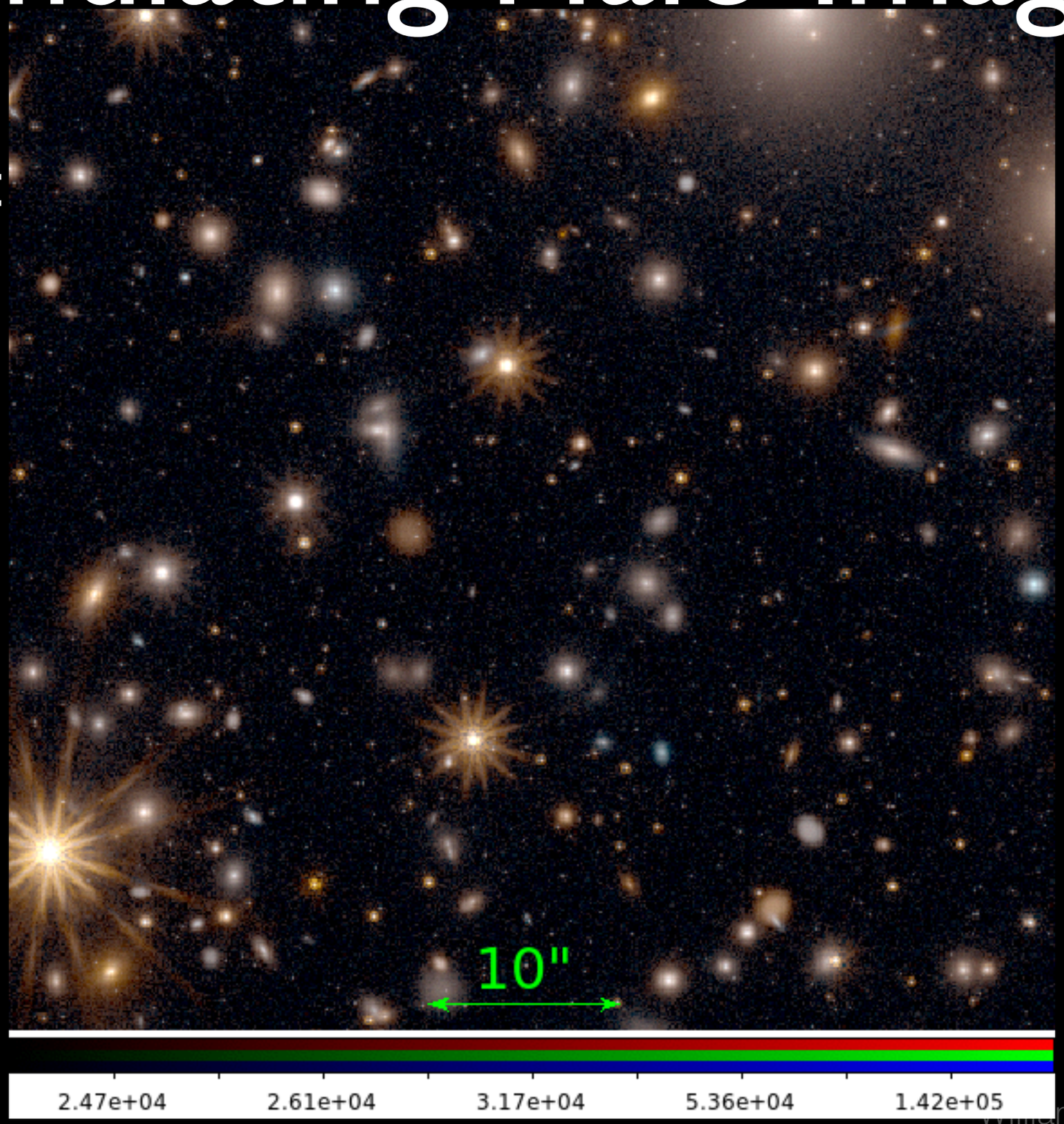

Simulating Halo Images

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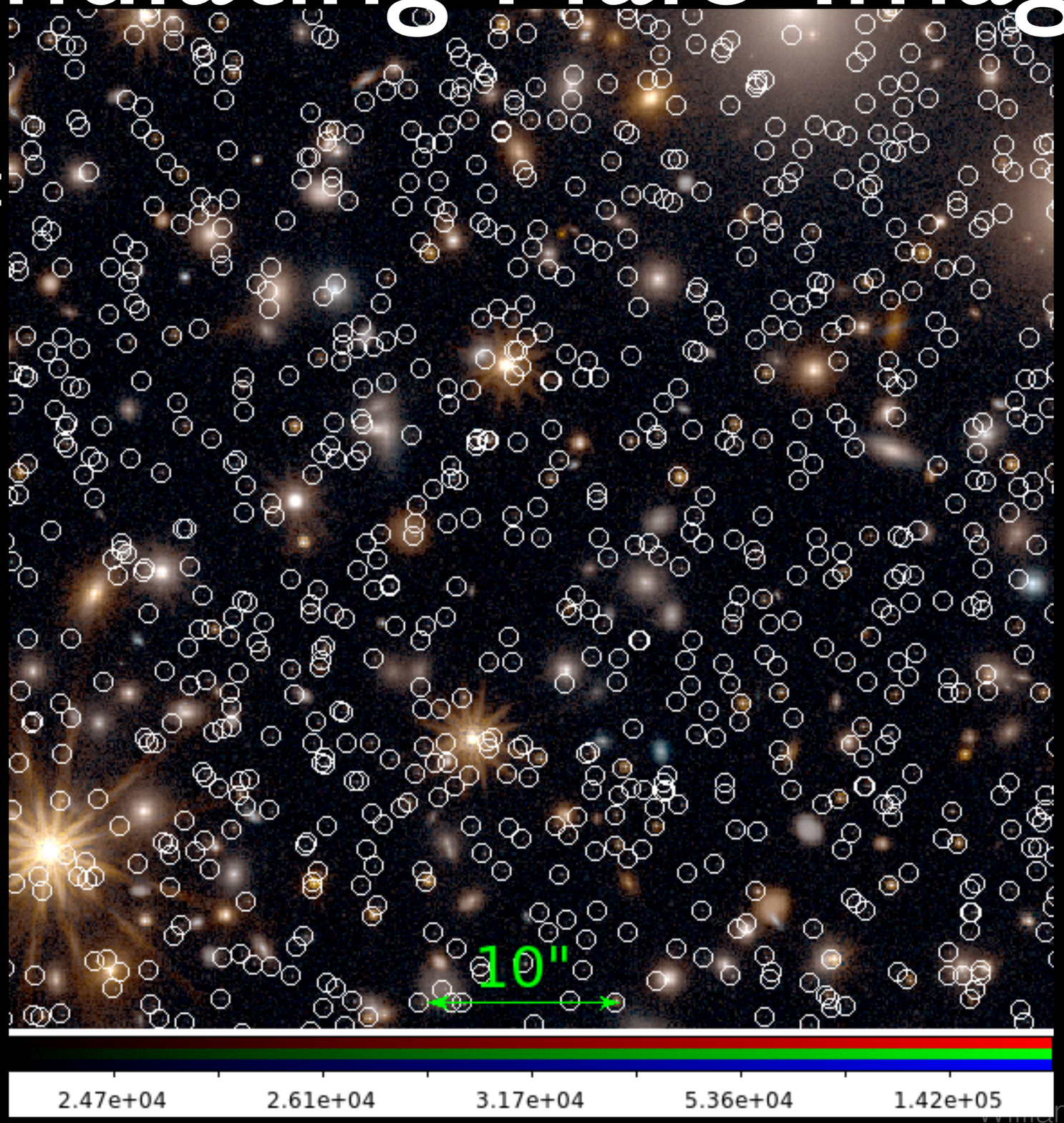

Simulating Halo Images

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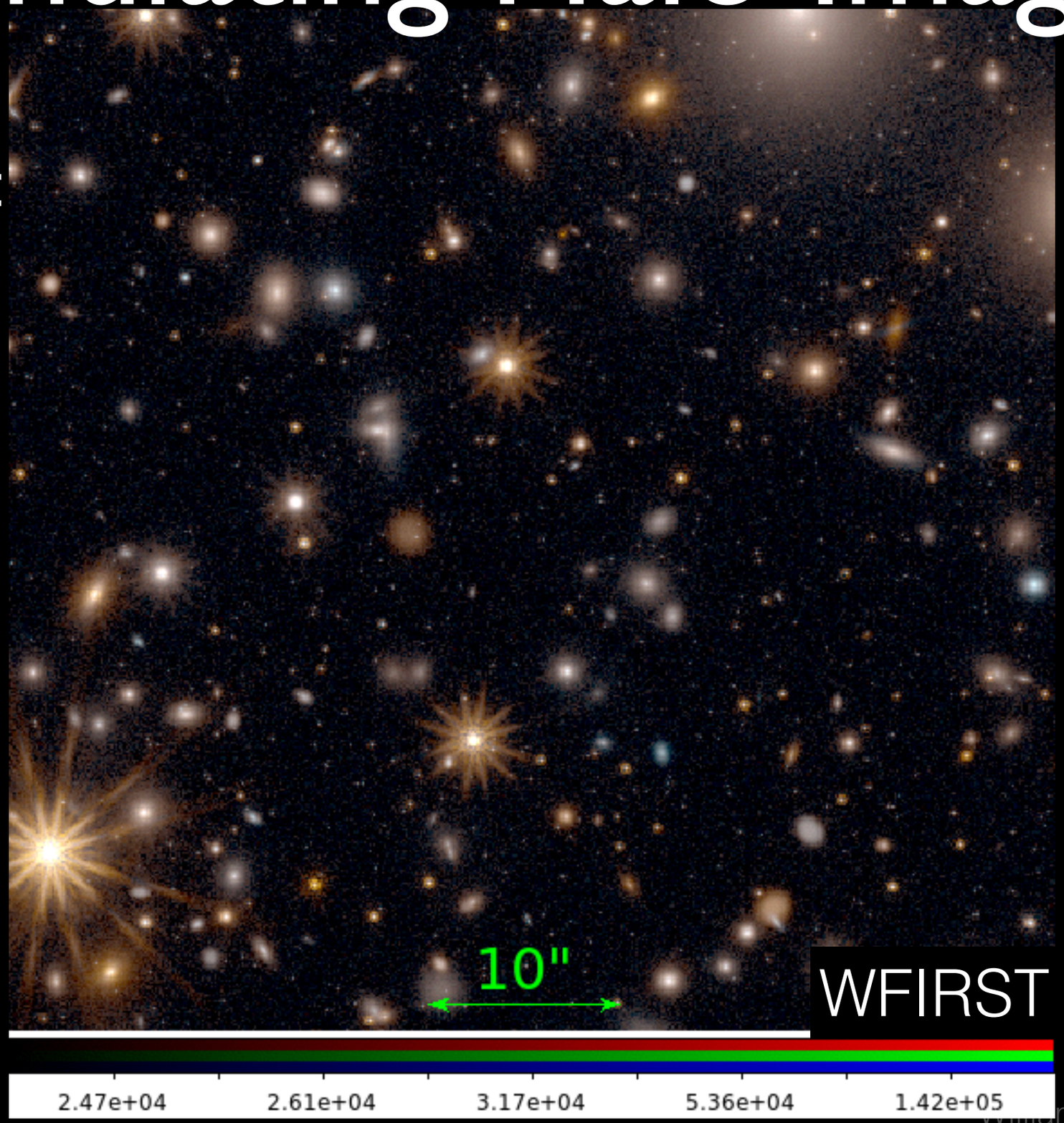

Simulating Halo Images

Backgrouind: CANDELS-based catalogs

Stars: Galaxia catalogs of simulations

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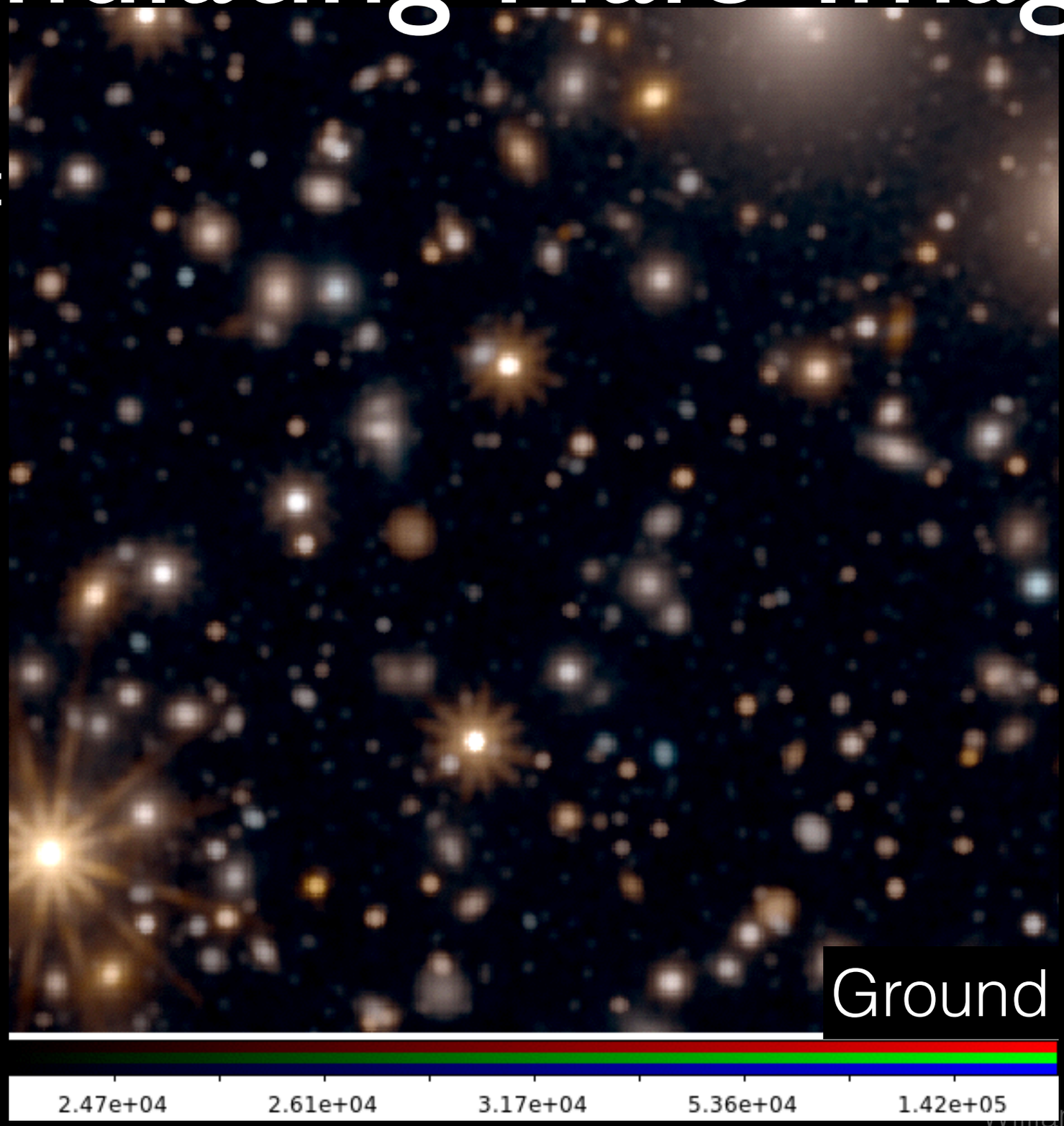
Red = H158



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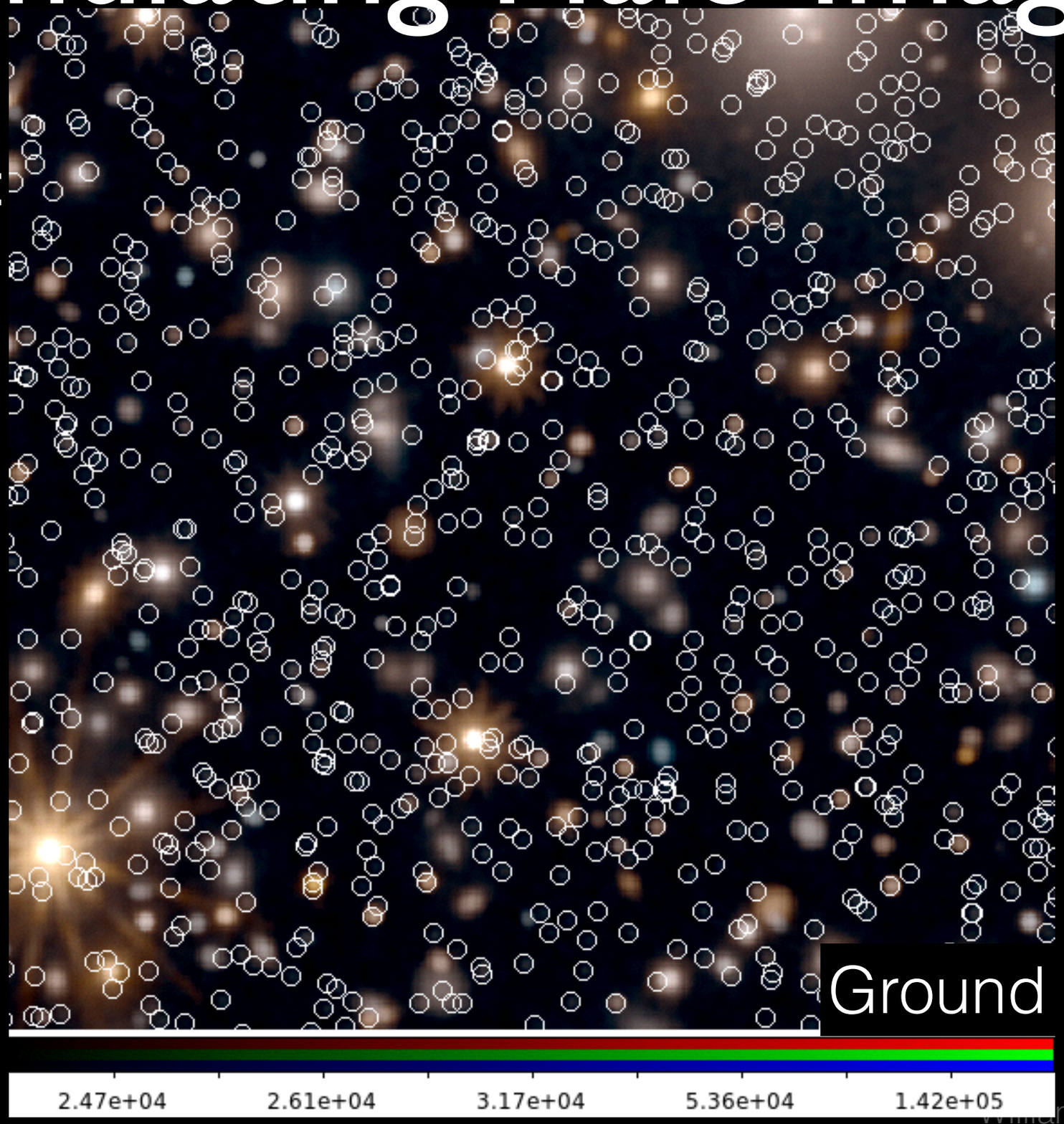

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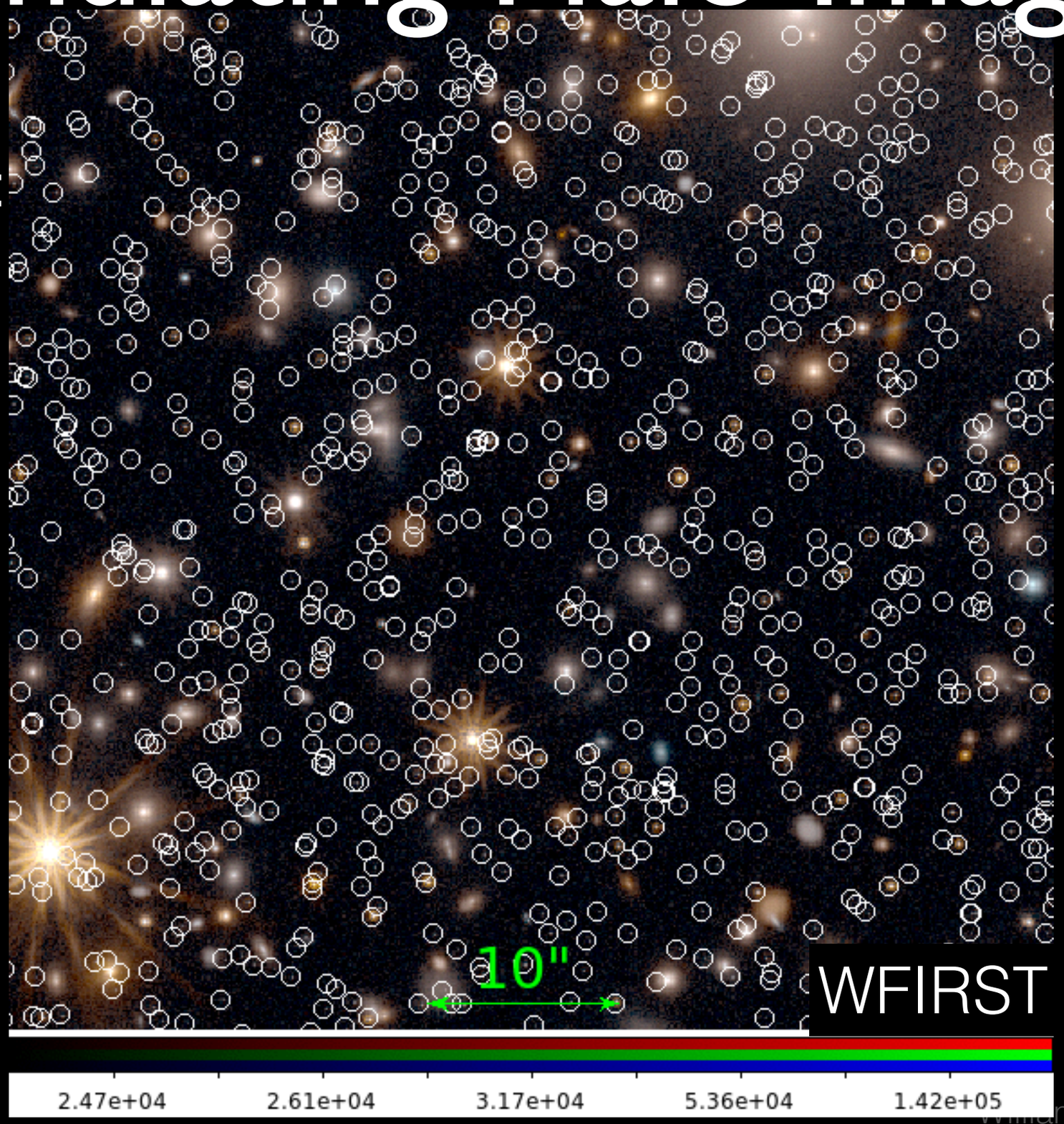

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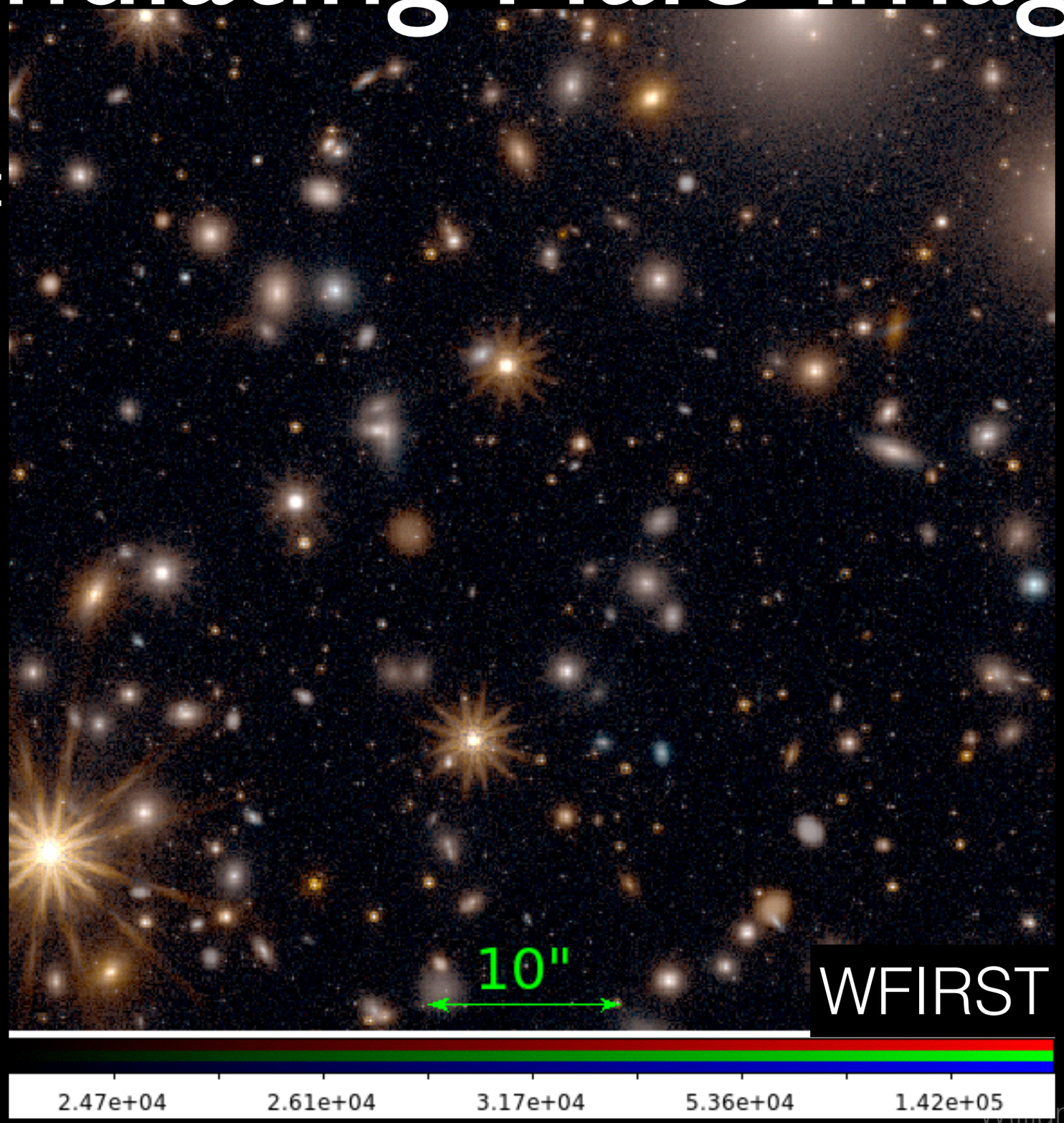
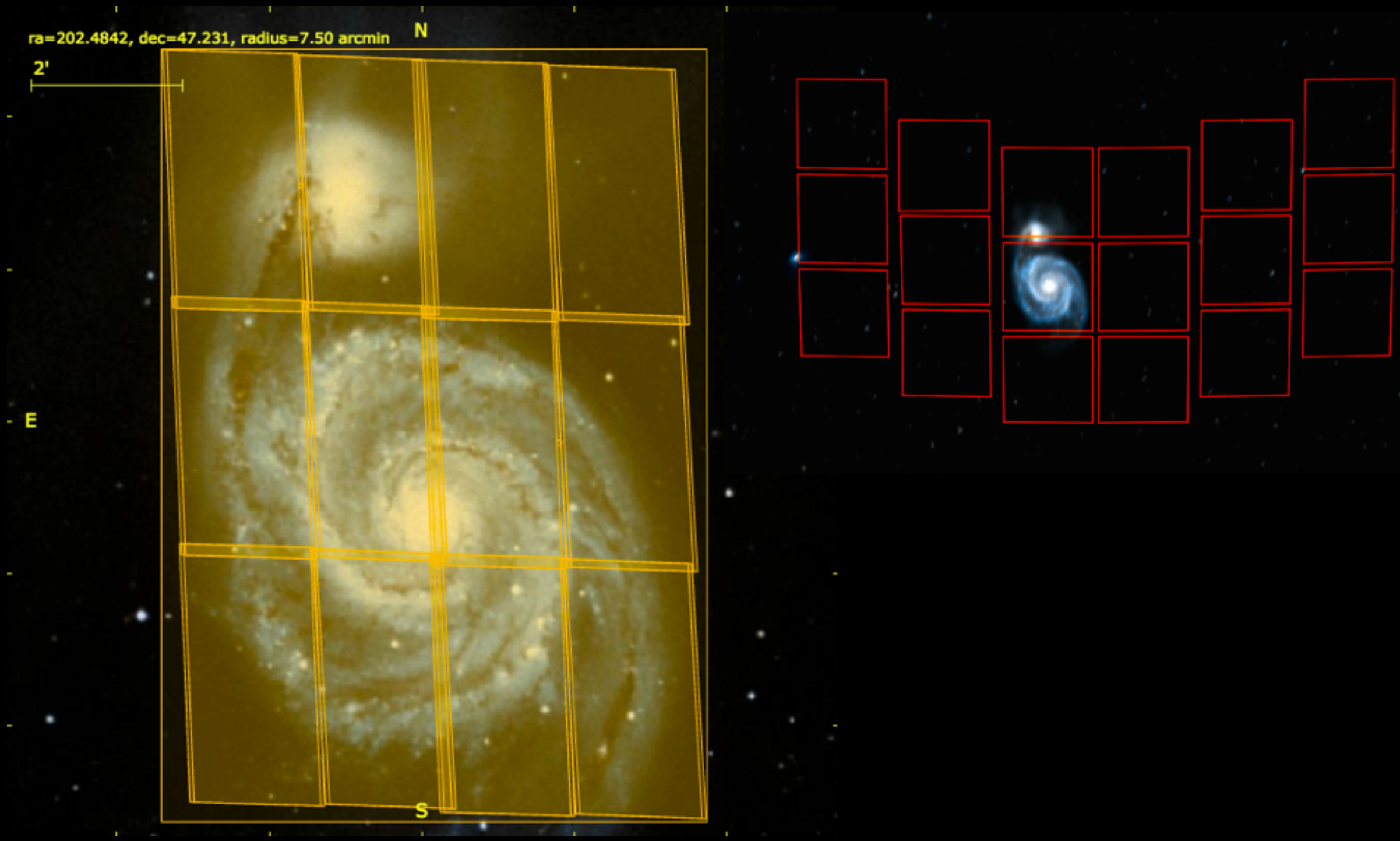


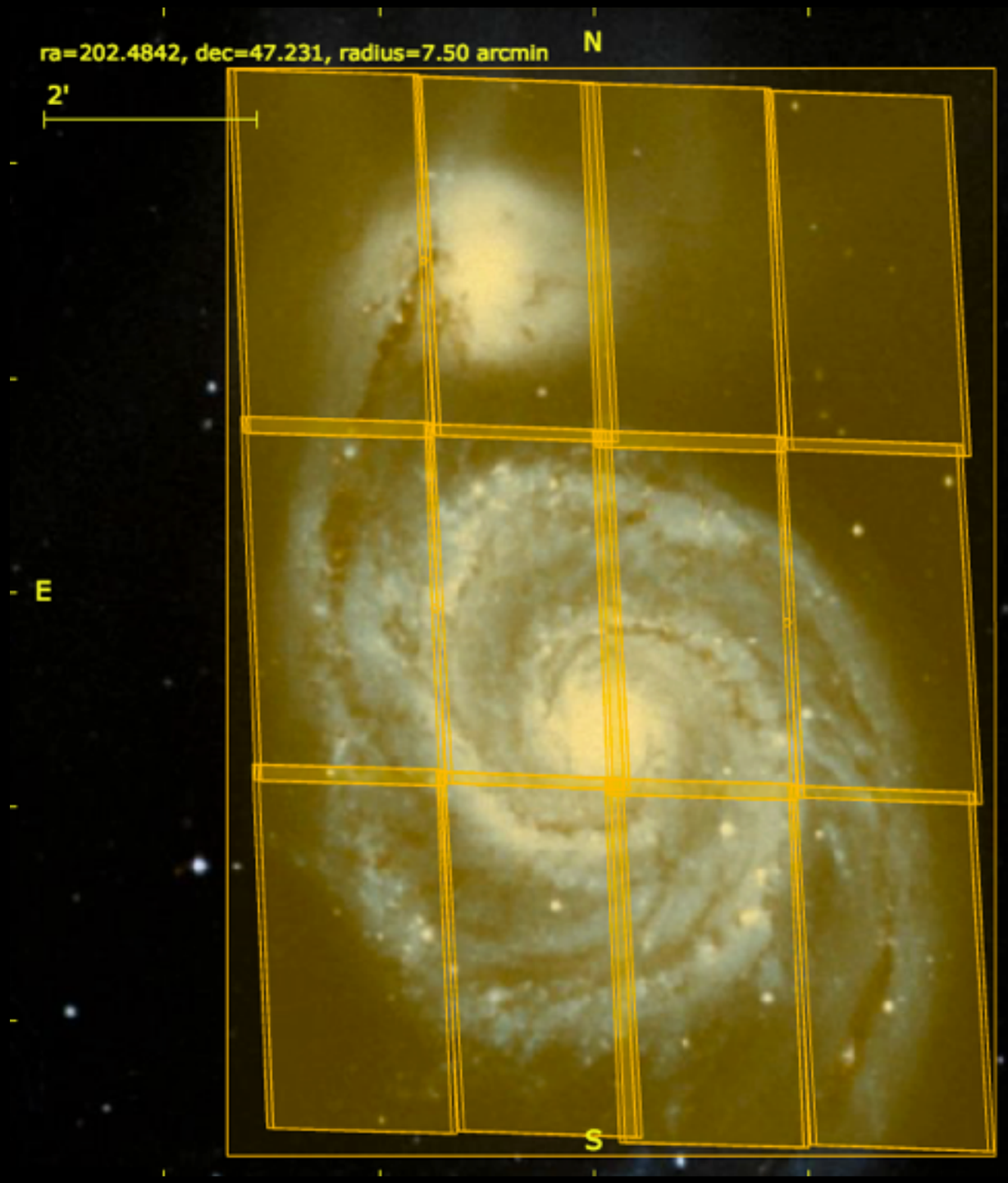
Testing WFIRST with Nearby Galaxies

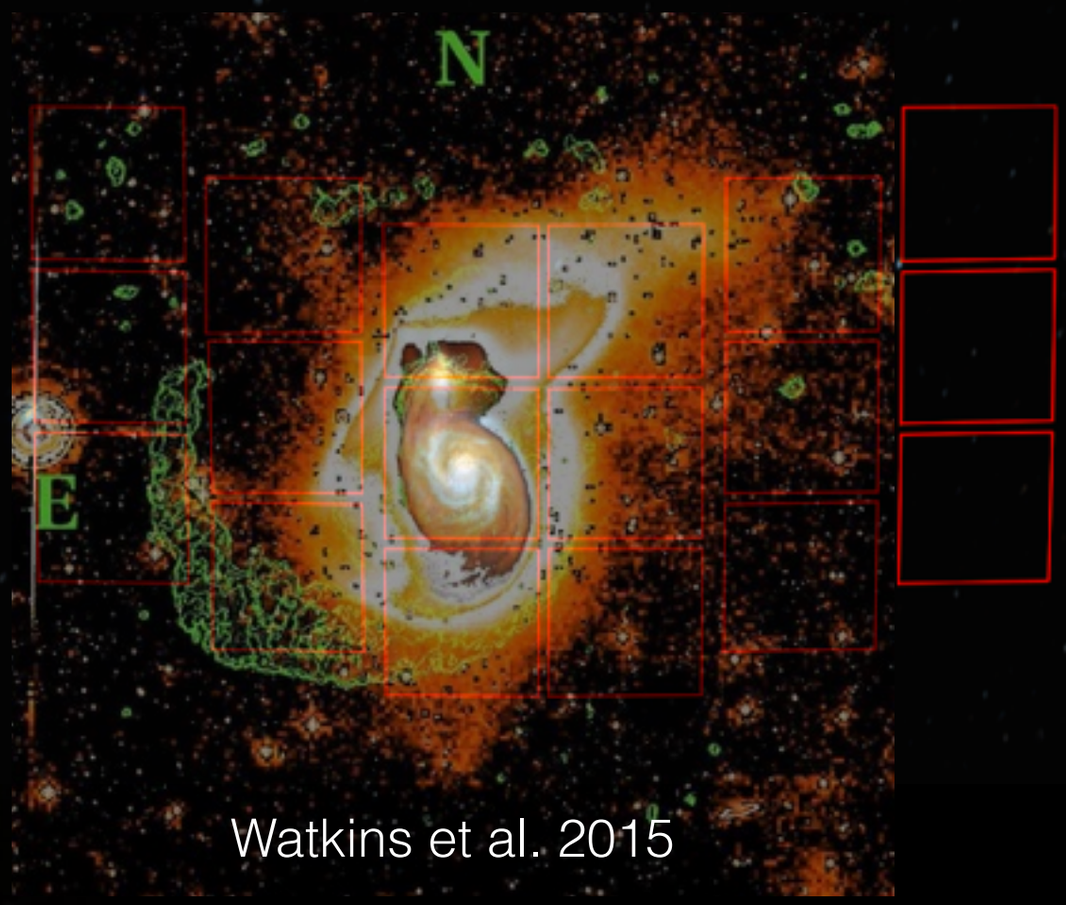
- Continue STIPS development. Complete end-to-end simulations
  - Simulate observation of real galaxies, simulated halos, simulated companions
    - Run photometry, S/G separation, and model fitting
- Try different filter, dither precision, and PSF possibilities
  - Optimize science (density feature recovery, population recovery) given the trades

Next up: M51 (~8 Mpc)



Next up: M51 (~8 Mpc)





Watkins et al. 2015