Resolving stellar halos with Roman

Simulating background, and predictions for stellar halos and satellites

Eric Bell, Ben Williams, Rubab Khan, Leo Girardi, and the RINGS SIT

Supported by
NSF-AST 2007065
NASA grant NNG16PJ28C (WINGS)

Stellar halos and satellites are the *only* way to understand the hierarchical growth history of individual galaxies.

NANCY GRACE ROMAN SPACE TELESCOPE

MW's main merger event 10 Gyr ago created the thick disk

Helmi et al. 2018; Belokurov et al. 2018; Gallart et al. 2019; Belokurov et al. 2020

M31 suffered a large merger 2Gyr ago; its disk survived, had a starburst, and satellites were delivered

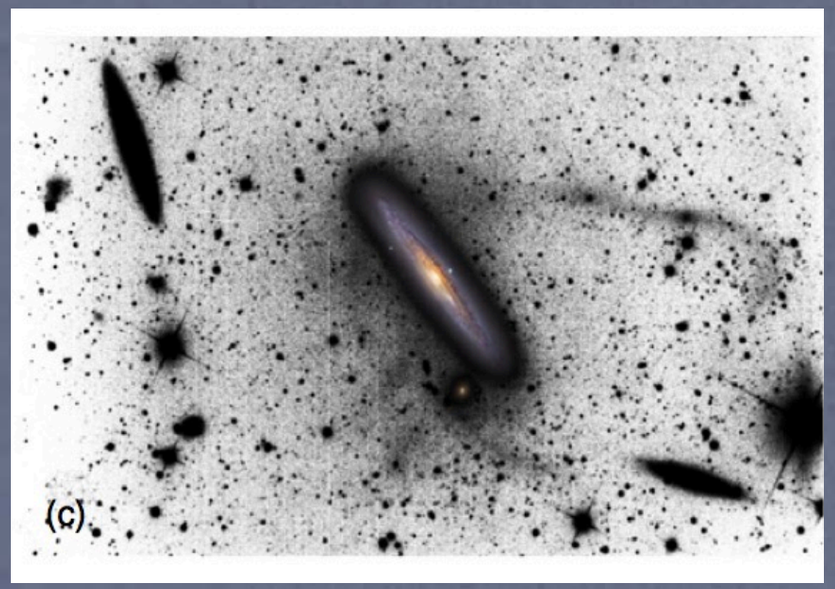
D'Souza & Bell 2018; Hammer et al. 2018; Dorman et al. 2015; Williams et al. 2017; Weisz et al. 2019; D'Souza & Bell 2021

While integrated light allows discovery of bright streams and satellites…

Build simple intuition using Bullock & Johnston 2005

Simulated 5 sq. degrees(!) at 3.5Mpc distance

Very best integrated-light depth (unrealistic, because no foreground star contamination)



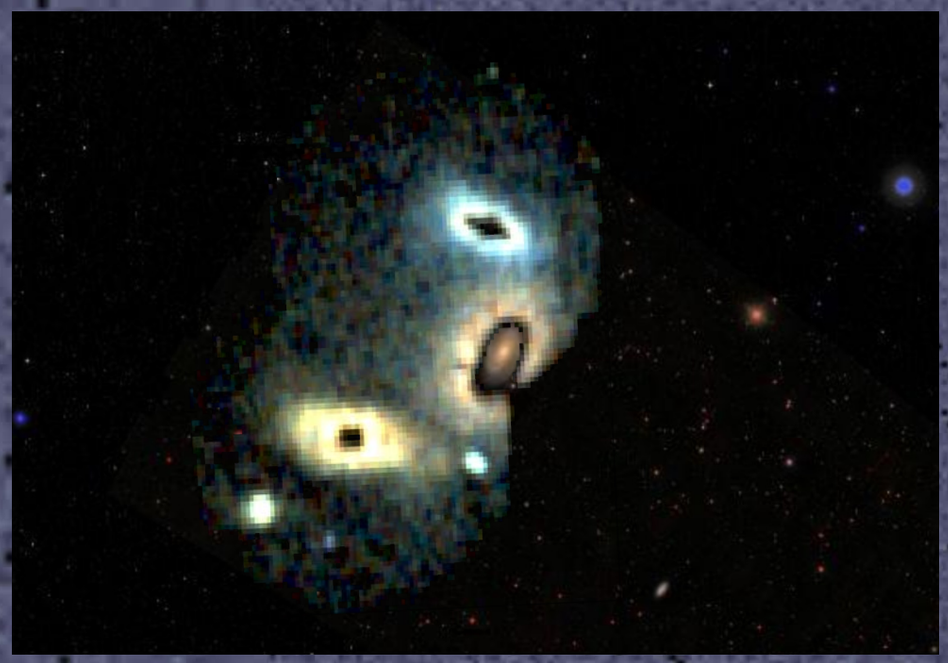
Martinez-Delgado et al. 2010
van Dokkum et al. 2014; Merritt et al. 2016

And ground-based resolved star work allows one to go 10x deeper in terms of halos, streams and satellites…

Bullock & Johnston 2005

Simulated 5 sq. degrees(!) at 3.5Mpc distance

Resolved star counts from Subaru or Rubin/LSST depth



Okamoto et al. 2015
Crnojevic et al. 2016
Smercina et al. 2020

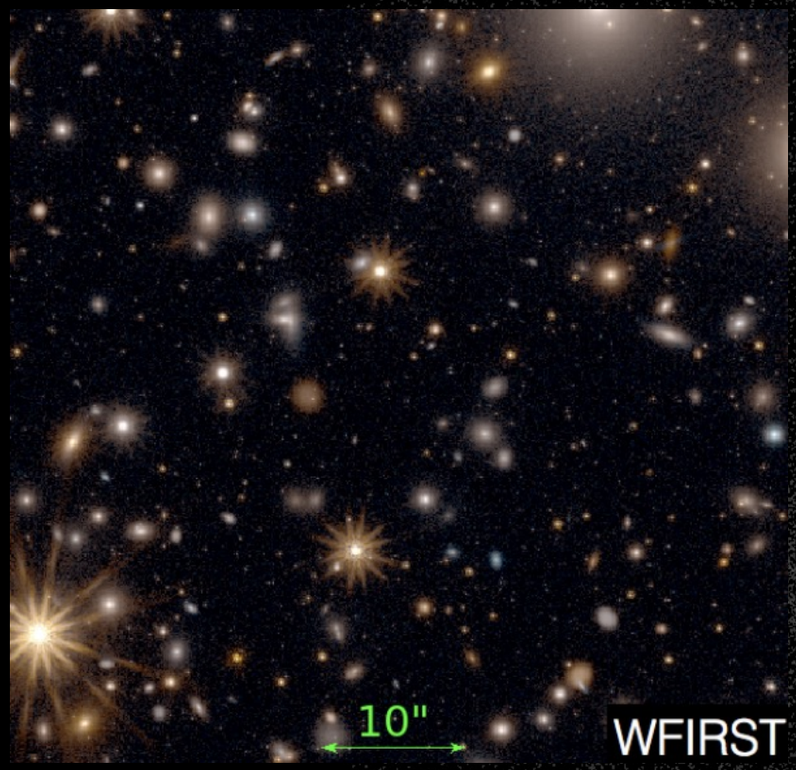
Roman Space Telescope's wide field, deep point-source detection and star-galaxy separation is 10x deeper still

Bullock & Johnston 2005

Simulated 5 sq. degrees(!) at 3.5Mpc distance (J/H ~20h total)

Background is CANDELS UDS unresolved sources x 540(!)

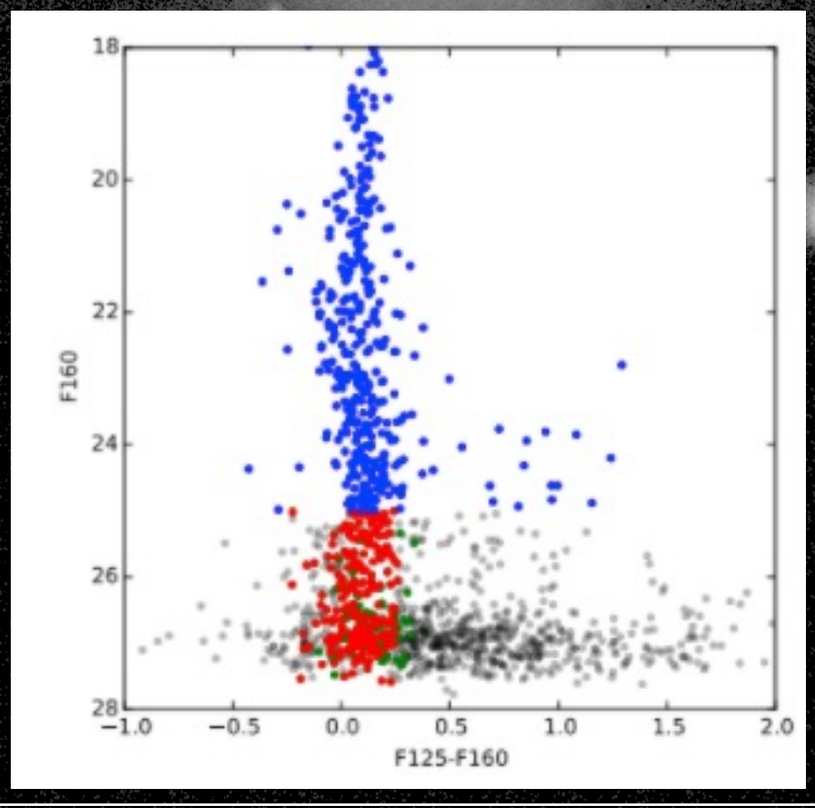
HST/CANDELS (Guo et al. 2013) can give realistic background, with realistic clustering



F125W and F160W CANDELS UDS WIDE Sersic catalog

Wide range of object sizes, colors + realistic clustering

Transformed to Roman filters and sampled with Roman PSF



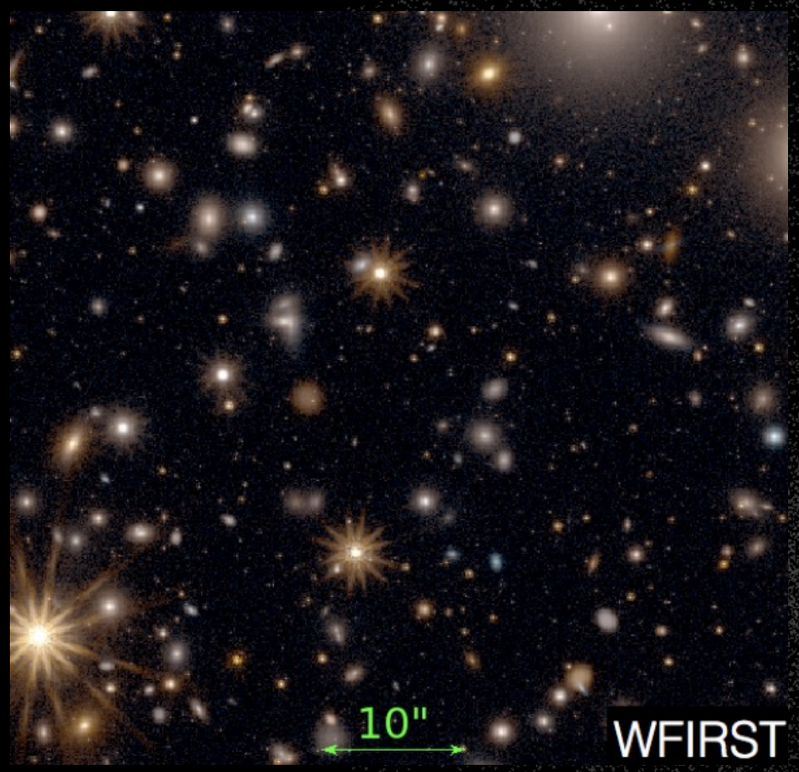
Bullock & Johnston 2005

Simulated 5 sq. degrees(!) at 3.5Mpc distance (J/H ~20h total)

Background is CANDELS UDS unresolved sources x 540(!)

Unresolved sources provide realistic background for Roman resolved star predictions

HST/CANDELS (Guo et al. 2013) can give realistic background, with realistic clustering



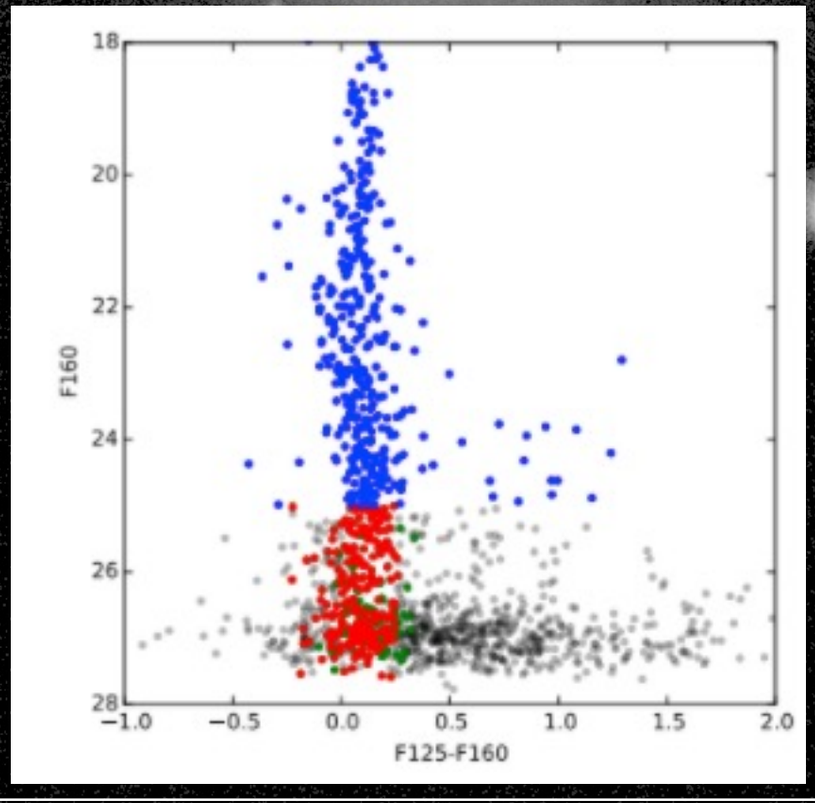
F125W and F160W CANDELS UDS WIDE Sersic catalog

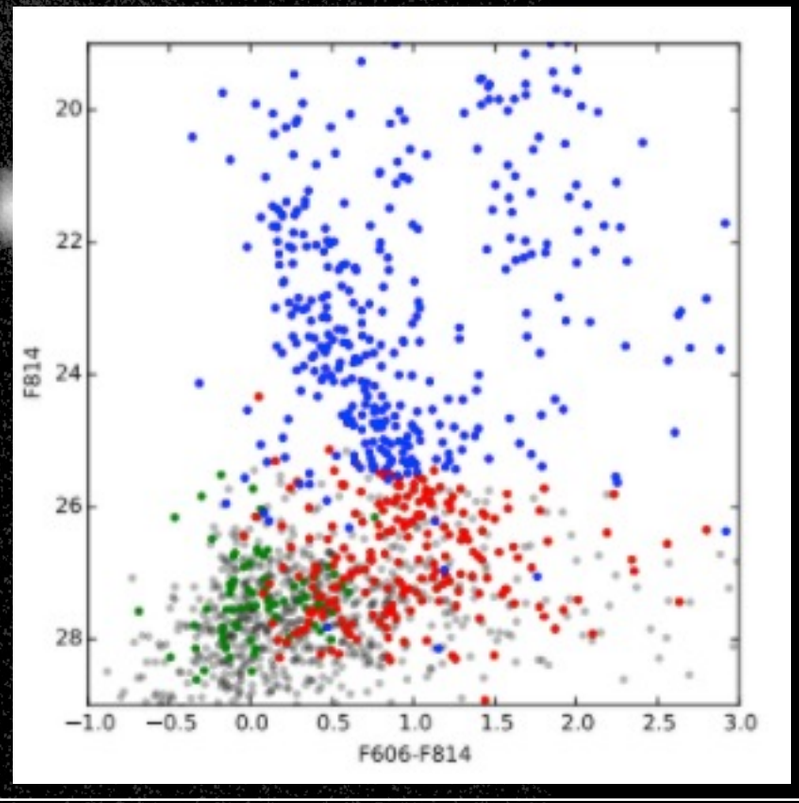
Wide range of object sizes, colors + realistic clustering

Transformed to Roman filters and sampled with Roman PSF

Unresolved sources provide realistic background for Roman resolved star predictions

Reveal that the F062 and F087 filters give age/metallicity information, *and* allow some elimination of background galaxies/quasars





Ultra-faint satellites can be detected in the Local Volume to M_V~-4 (M*~5000 $M_\odot$!)

NANCY GRACE ROMAN SPACE TELESCOPE

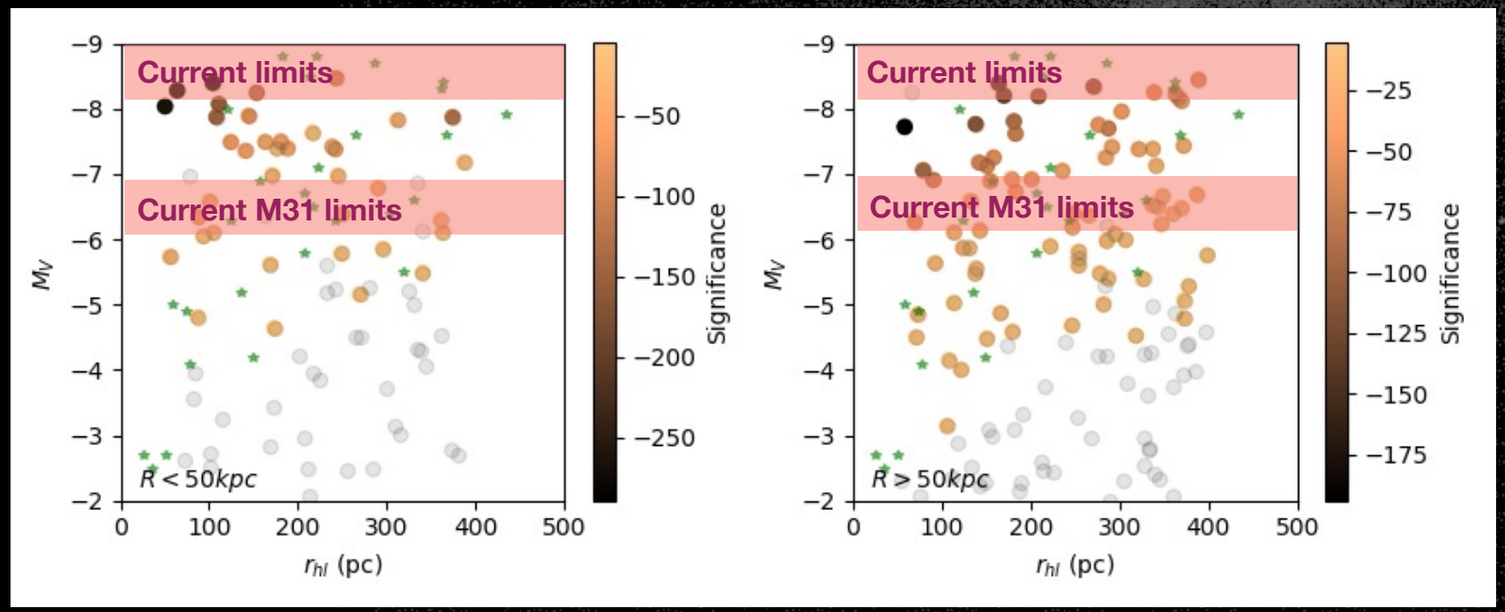
Bullock & Johnston 2005

Simulated 5 sq. degrees(!) at 3.5Mpc distance (J/H ~20h total)

Background is CANDELS UDS unresolved sources x 540(!)

+ ultra-faint satellites added by hand (Bullock & Johnston didn't go fainter than M_V~-9)

Roman resolved stars are so powerful that the stellar halo of the galaxy itself limits satellite detection(!)



Bullock & Johnston 2005

Simulated 5 sq. degrees(!) at 3.5Mpc distance (J/H ~20h total)

Background is CANDELS UDS unresolved sources x 540(!)

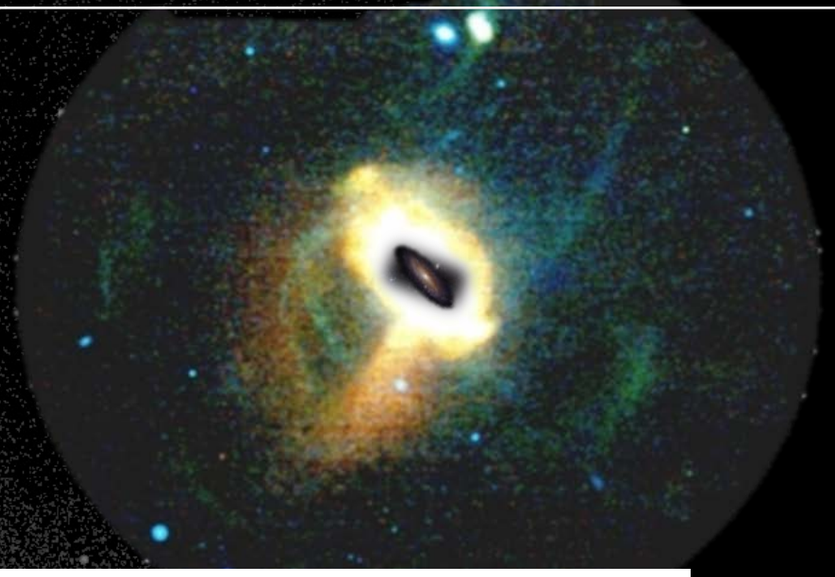
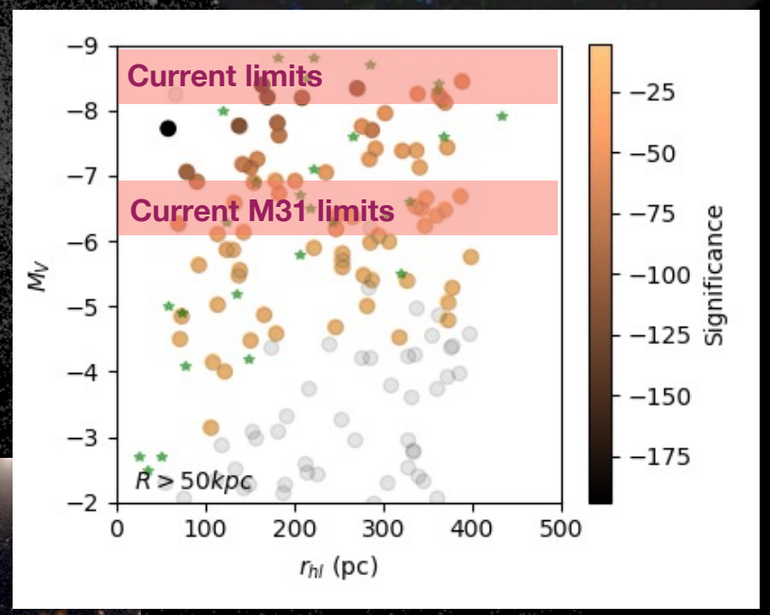
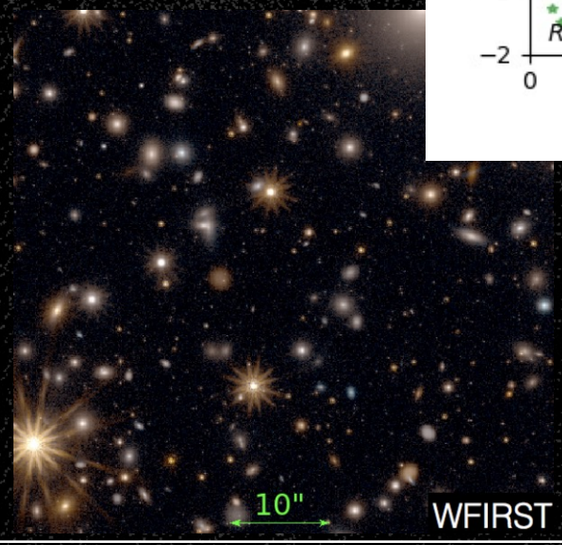
+ ultra-faint satellites added by hand (Bullock & Johnston didn't go fainter than M_V~-9)

Roman promises to revolutionize our understanding of stellar halos, mergers and satellites in the Local Volume

NANCY GRACE ROMAN SPACE TELESCOPE

Measuring stellar halos 10-100x deeper than currently possible (Sanderson, Mandel)

Will permit the understanding of mergers and their effects for dozens of galaxies

Deep census of satellites, 10-100x fainter than currently possible (Sand)

Simulated datasets use realistic HST backgrounds from CANDELS/UDS (Thob)