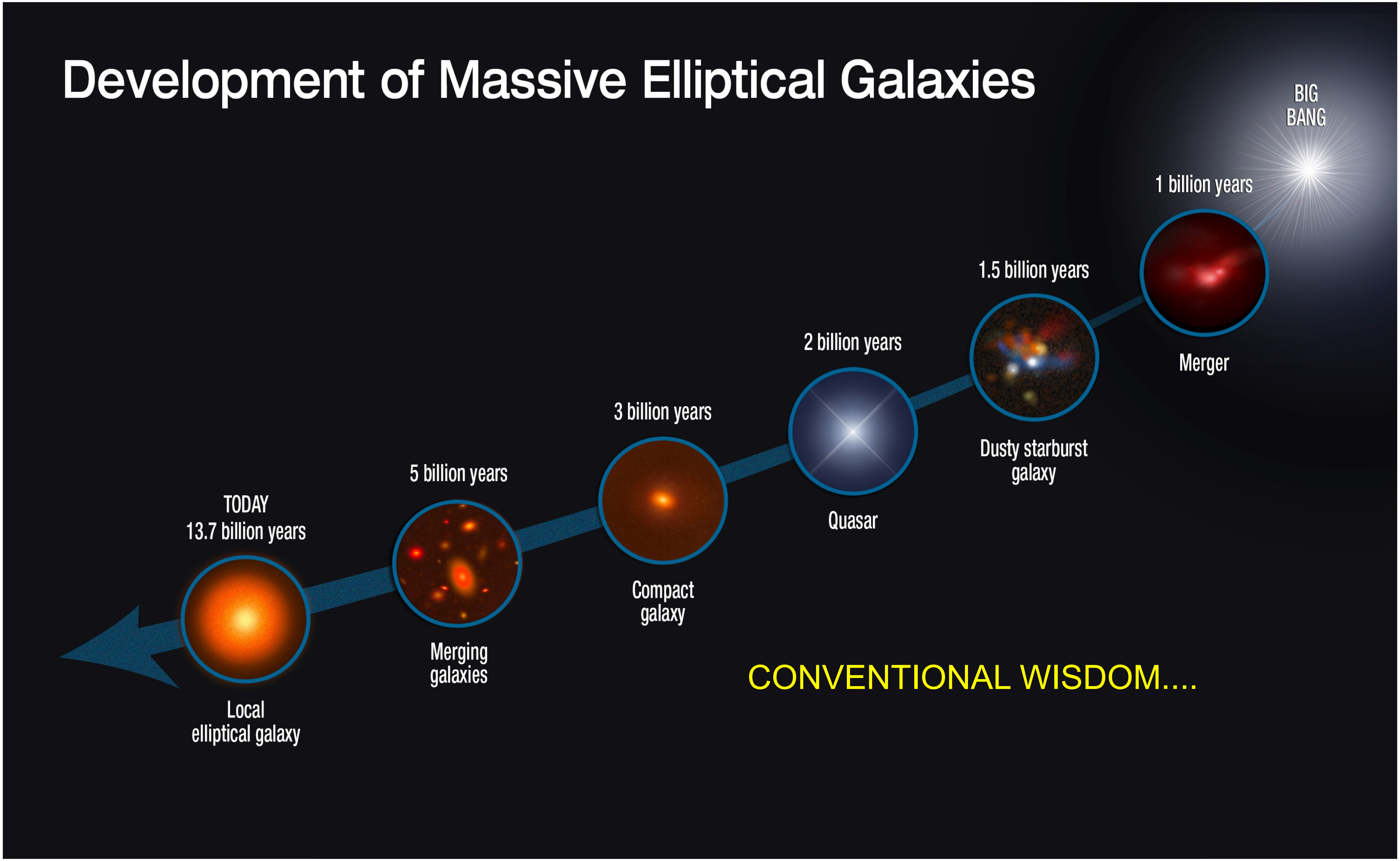
SOME TOPICS IN GALAXY FORMATION I AM CURRENTLY ENTHUSIASTIC ABOUT



The life-cycle of radio AGN in massive galaxies

Compact (young?) radio galaxy

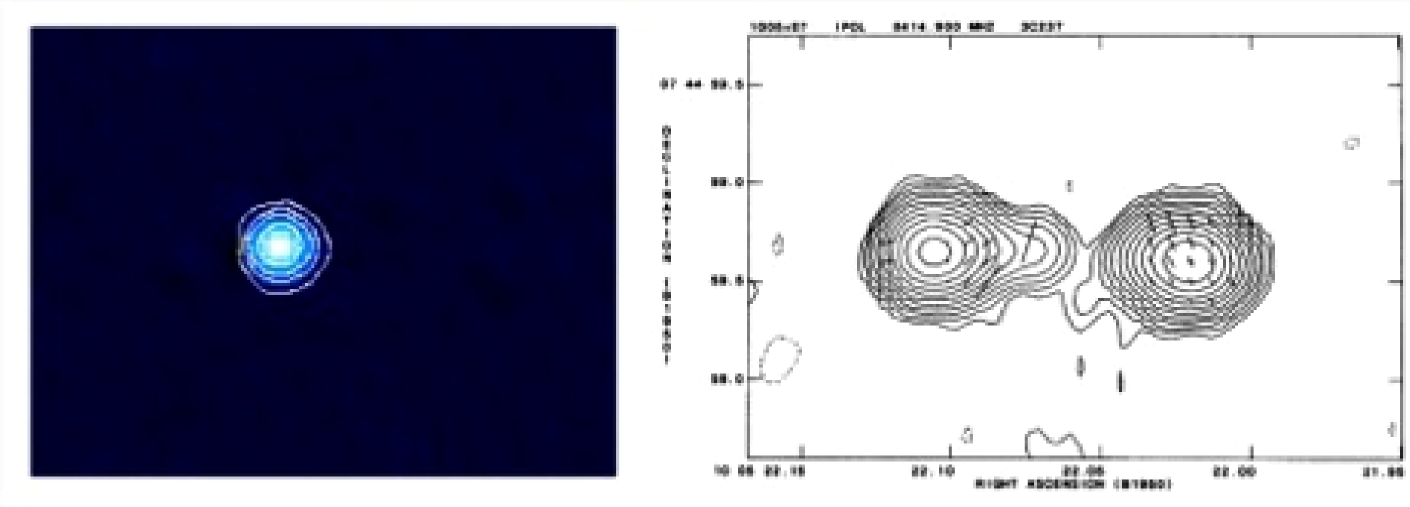
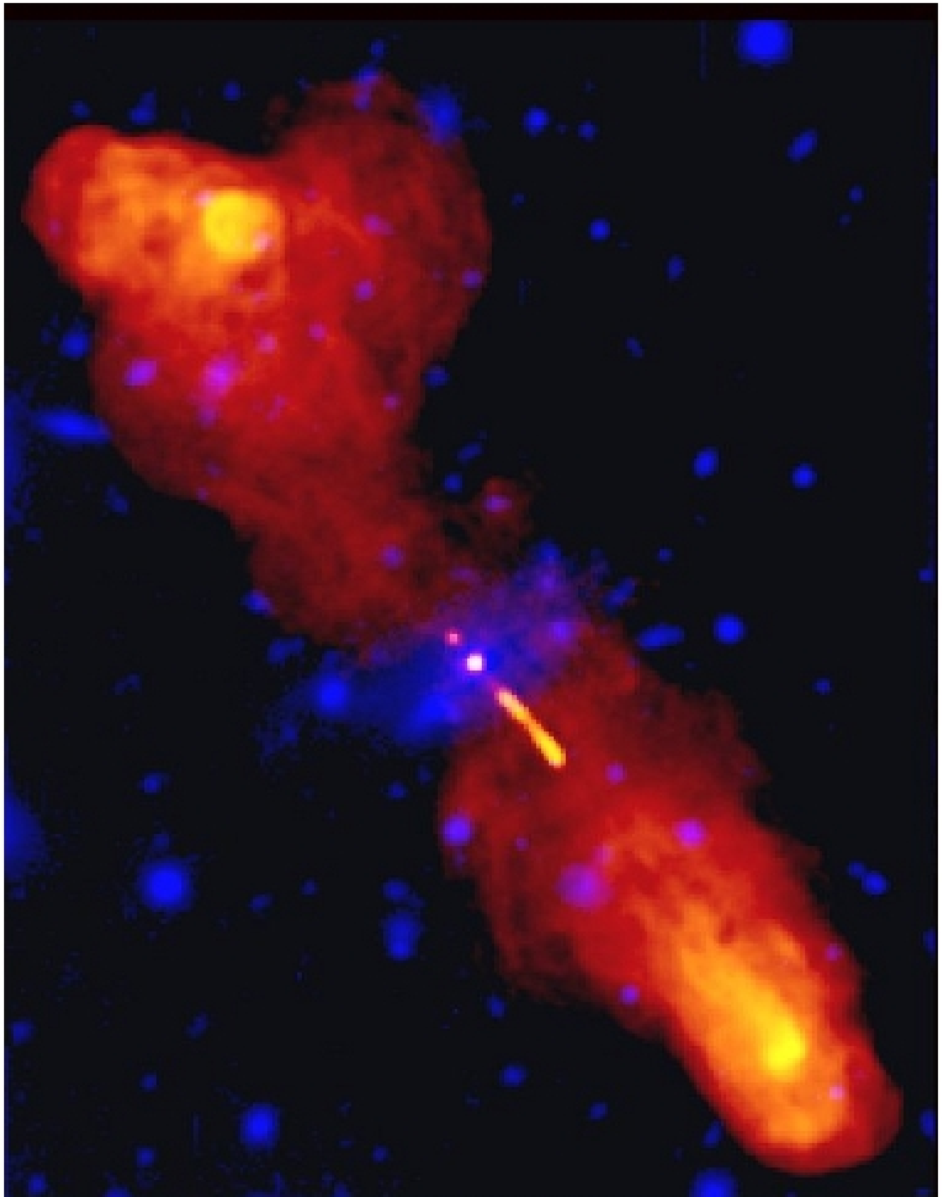


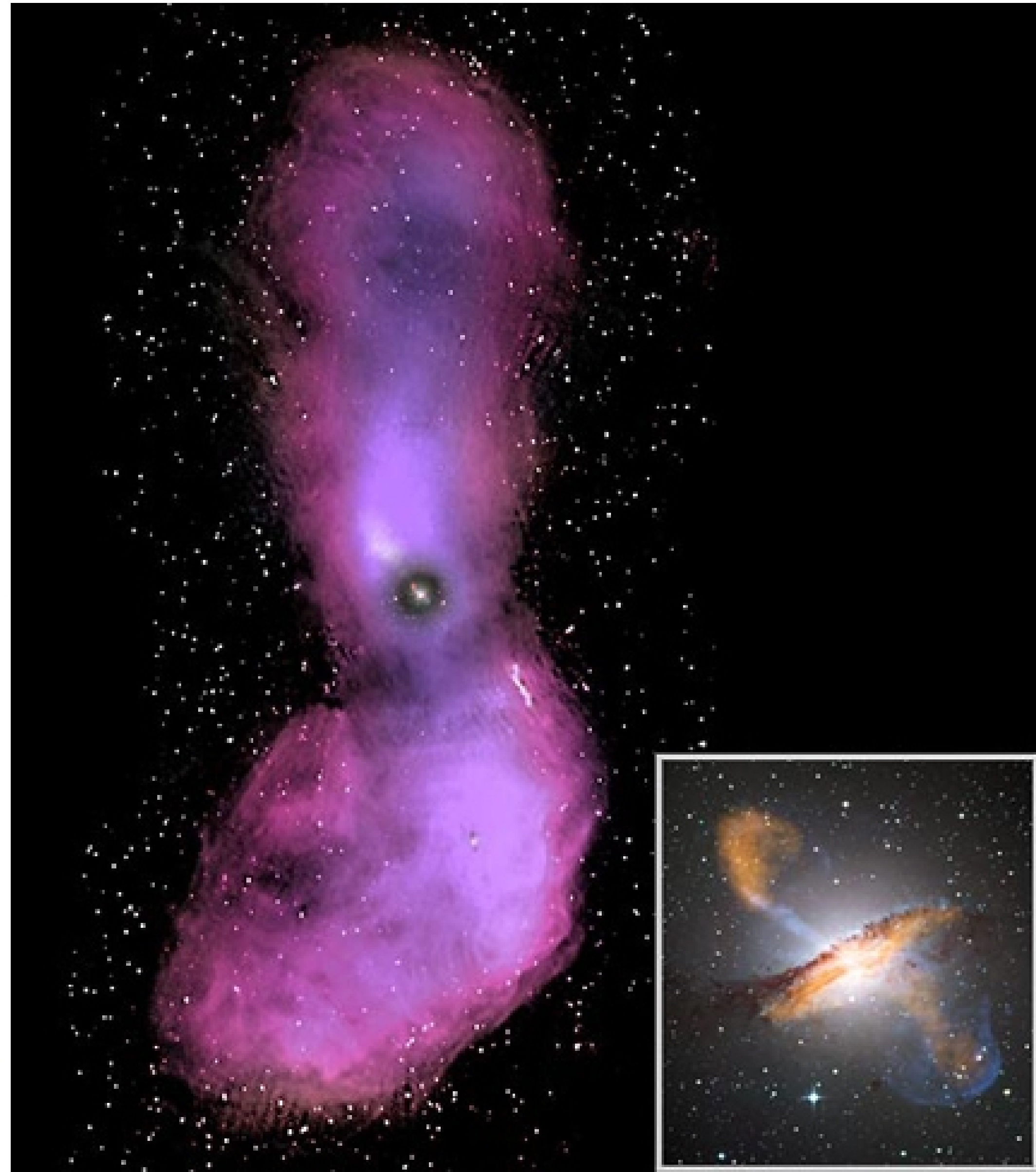
Figure 3: A typical CSS radio source, 3C 237, as seen with the FIRST survey (left) and with 20 times higher resolution VLA observations (right). This small radio galaxy lies at a redshift z = 0.877 and is only 9 kilo-parsecs (30 thousand light years) in size. *Credits: FIRST, Akujor & Garrington 1995.*

Typical evolved state at high redshifts
(FR II radio source)



This state very poorly studied

Typical evolved state at low redshift
(FR I radio source)



Star-Forming Radio Galaxies

Finding Targets

An object whose ANCILLARY_TARGET1 value includes one or more of the bitmasks in the following table was targeted for spectroscopy as part of this ancillary target program. See SDSS-III bitmasks to learn how to use these values to identify objects in this ancillary target program.

Primary Program	Sub-program (bit name)	Bit Number	Target density (deg^{-2})	Survey Area (deg^2)
Star Forming Radio Galaxies	BLUE_RADIO	56	0.4	10,000

Description

Joint analysis of SDSS, FIRST, and the NRAO VLA Sky Survey (NVSS; Condon et al. 1998) has shown that low redshift radio AGNs play an essential role in regulating the growth of massive galaxies (e.g. Best et al. 2005, 2007). However, much less is known about the detailed interplay of gas cooling and radio feedback in more luminous radio galaxies at higher redshifts. Current samples are incomplete, in particular for radio galaxies with significant on-going star formation.

Overview
Bitmasks
Survey coordinates
Target Selection
APOGEE
BOSS
MARVELS
SEGUE
Legacy Survey
Imaging Data
Quality Flags
Astrometric Calibration
Sky Measurements
Image Masks
DR7 Photometry QA

Target Selection Details

This ancillary program selects radio galaxies with blue colors at z > 0.3 that would otherwise be missed from the LOWZ and CMASS samples. Galaxy targets were selected from DR7 according to the following criteria:

- extended morphology in SDSS photometry;
- clean *ugriz* model photometry and $17 < i < 19.9$;
- $i_{fib2} < 21.7$;
- $[(g - r) > 1.45]$ OR $[(u - g) < 1.14 * (g - r)]$, where photometry is determined from model magnitudes.

The last criterion is designed to color-select objects at z > 0.3. We cross-matched this sample with the FIRST catalog (July 2008 version) and selected all objects within 3″ of FIRST sources with fluxes > 3.5 mJy. Most targets were within 1.5″. Finally, we rejected objects spectroscopically observed by SDSS-I/II, and objects meeting the target selection criterion for the galaxy samples. In total there were 4610 targets; we randomly sampled these to produce a final list of 4170 ancillary targets.

Primary contact

Guinevere Kauffmann
MPA-Garching
gkauffmann -at- mpa-garching.mpg.de

DR7 Photometry QA description

Optical Spectra

Wavelength Calibration

Seeing During Spectroscopic Observations

Redshifts, Classifications and Velocity Dispersions

Spectrophotometry

Stellar Parameters (SSPP)

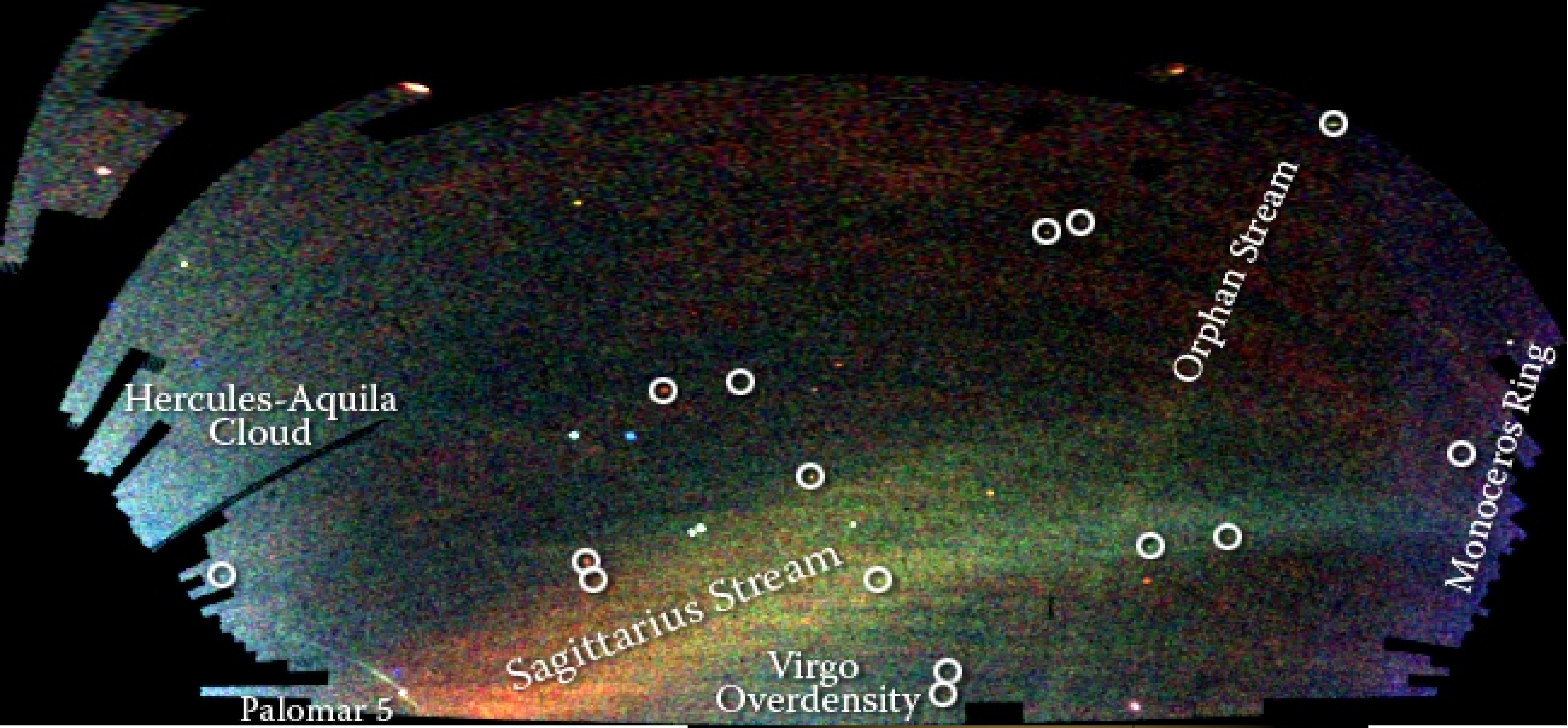
Matching photometry and spectra

Galaxy Properties

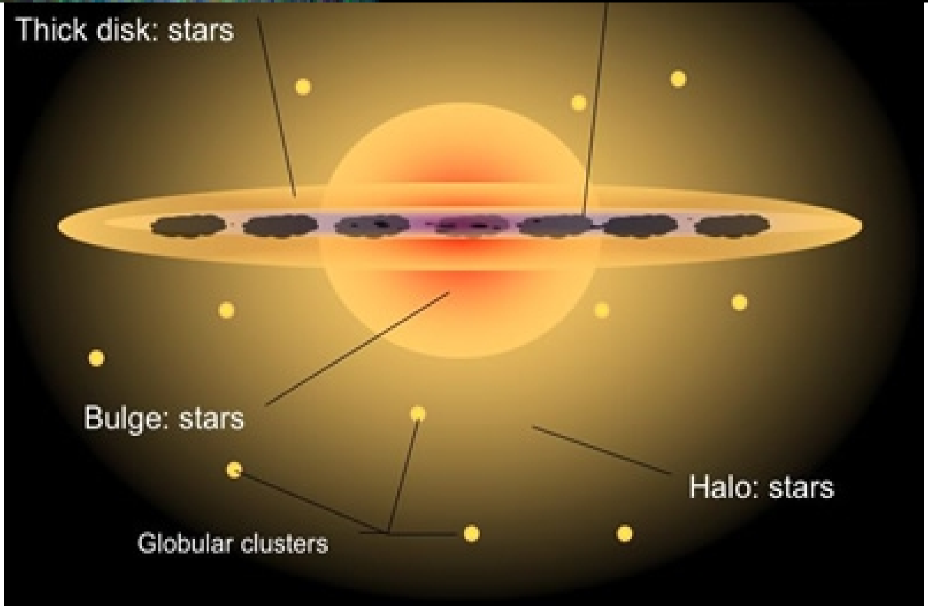
Stellar Populations Models

PROJECT TO STUDY THESE SOURCES AVAILABLE!

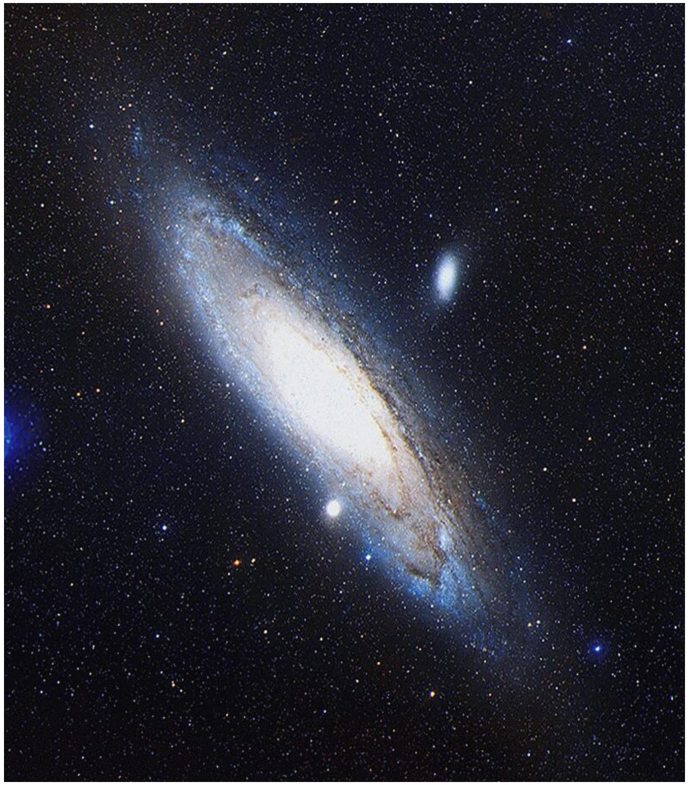
You will learn about SDSS and what can be learned from imaging/spectra

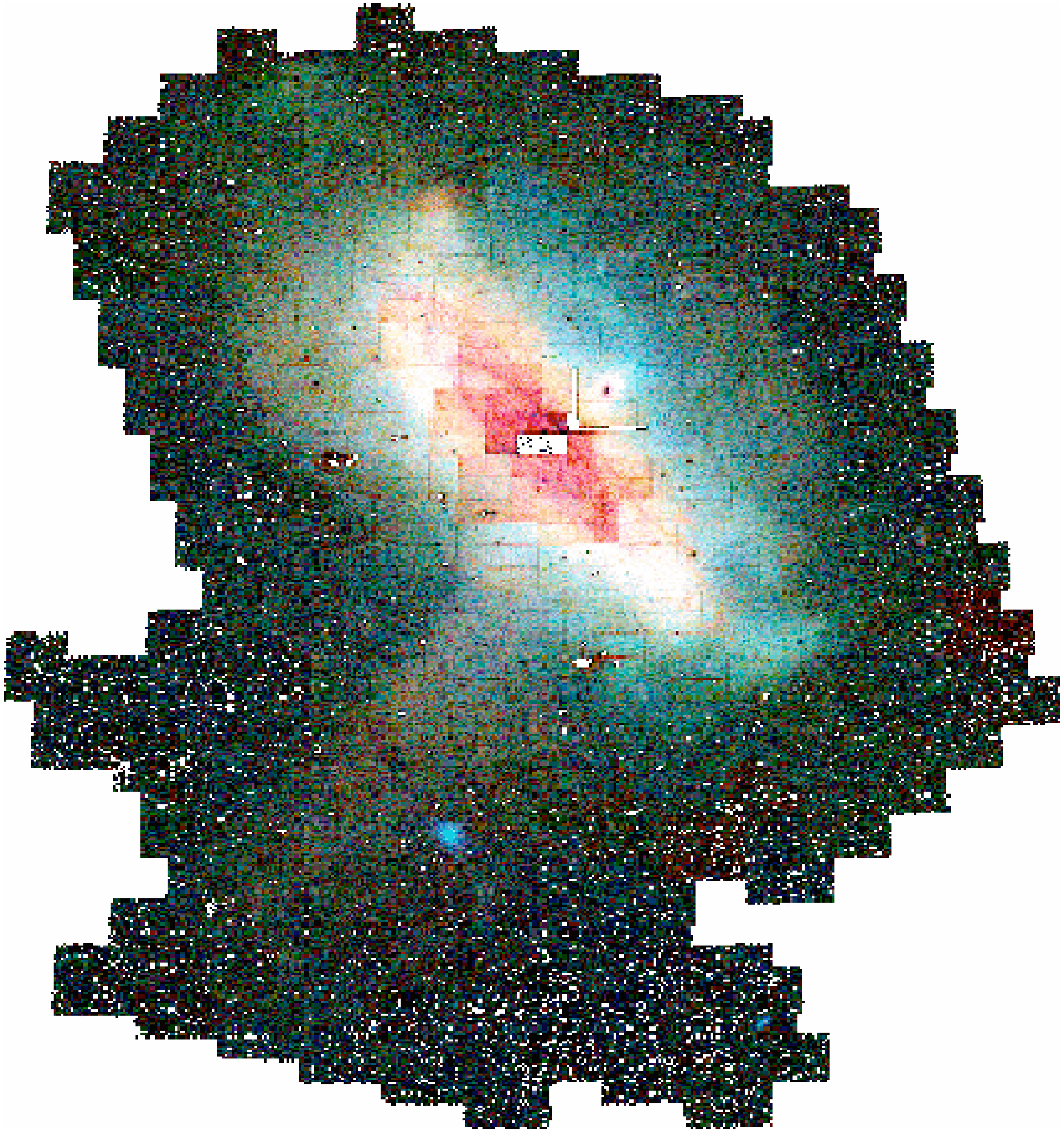


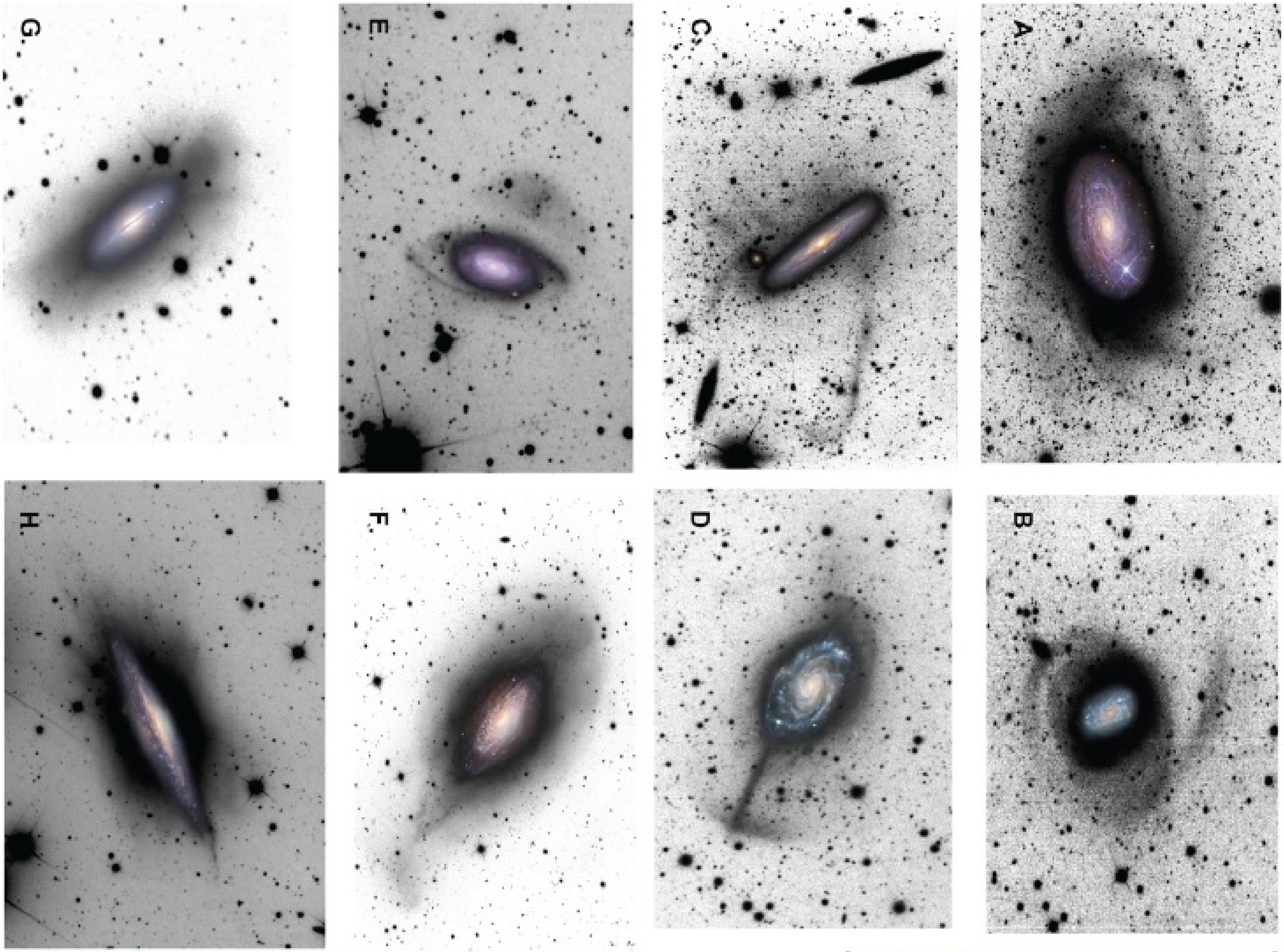
Stellar Halo of the Milky Way



The Andromeda Galaxy

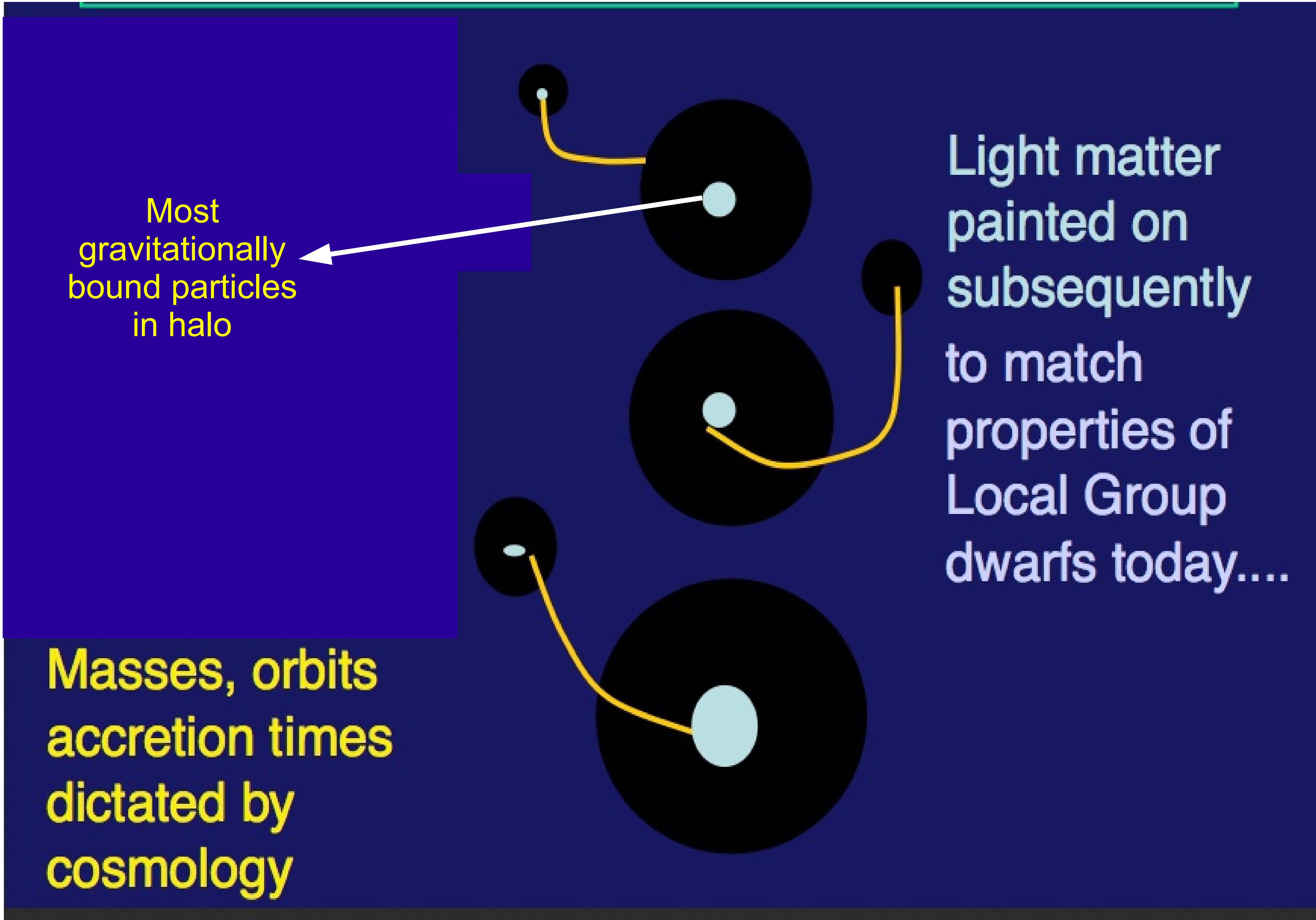


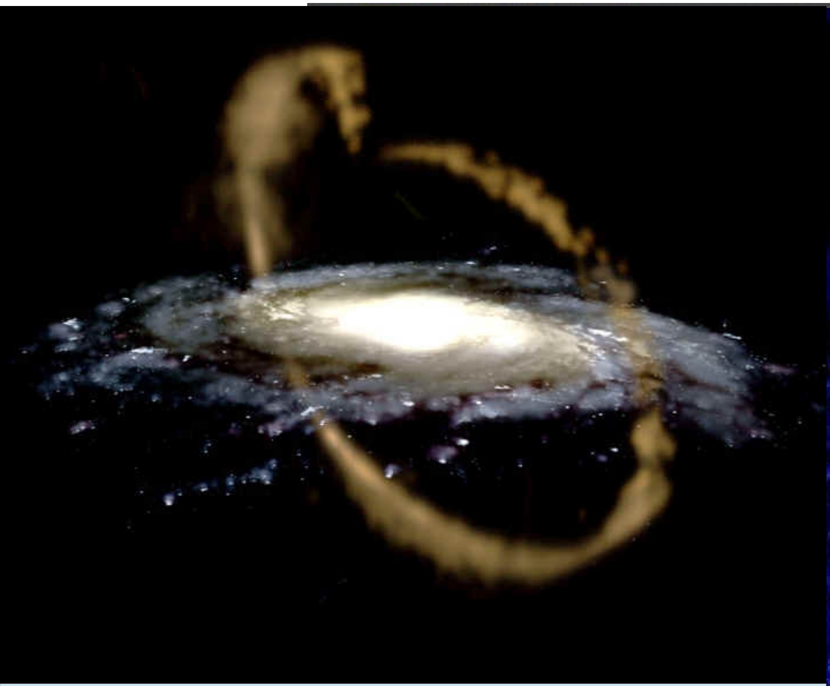


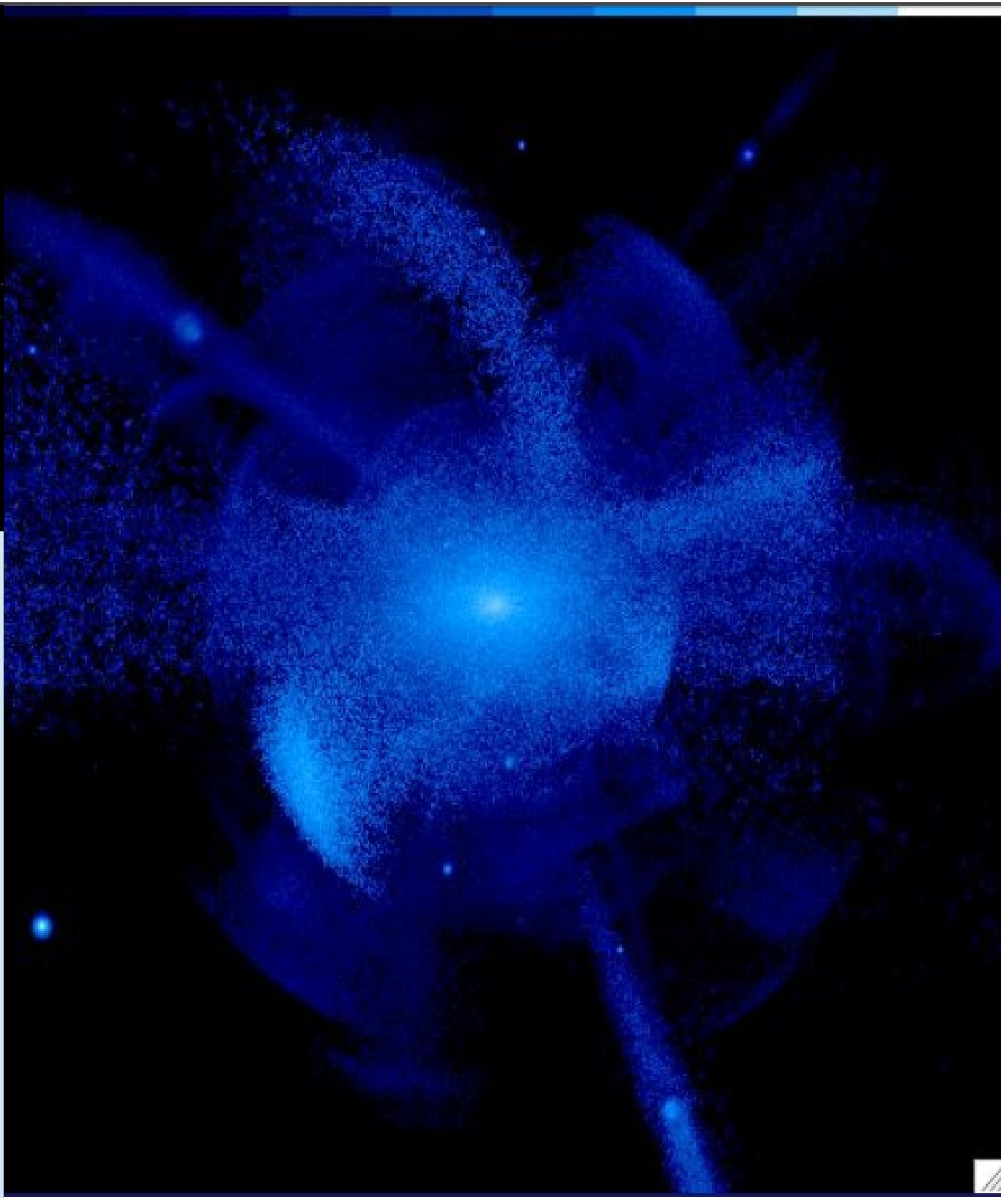


Martinez-Delgado et al. 2010

Institute for Computational Cosmology


Most gravitationally bound particles in halo
Light matter painted on subsequently to match properties of Local Group dwarfs today....
Masses, orbits accretion times dictated by cosmology

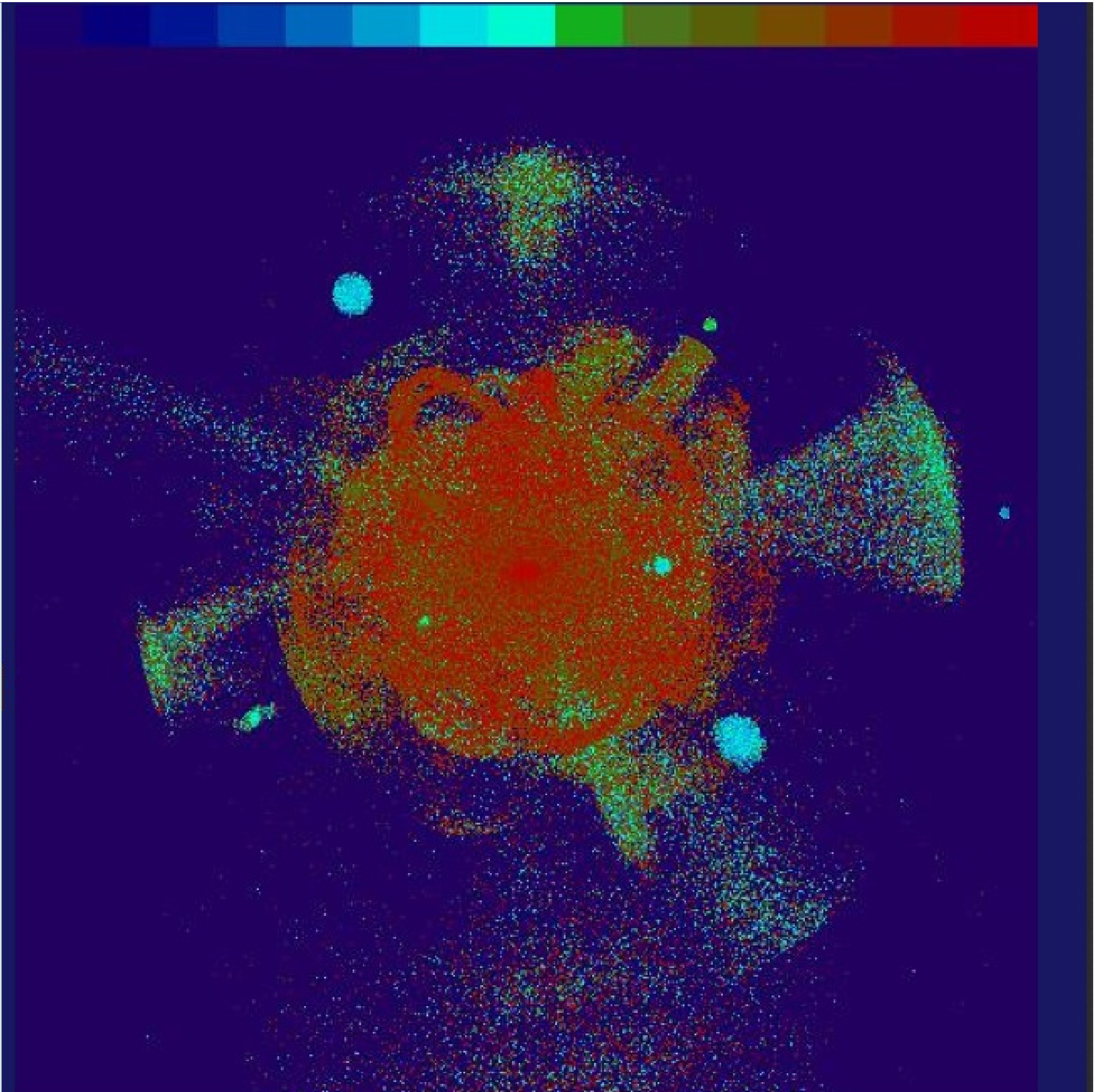


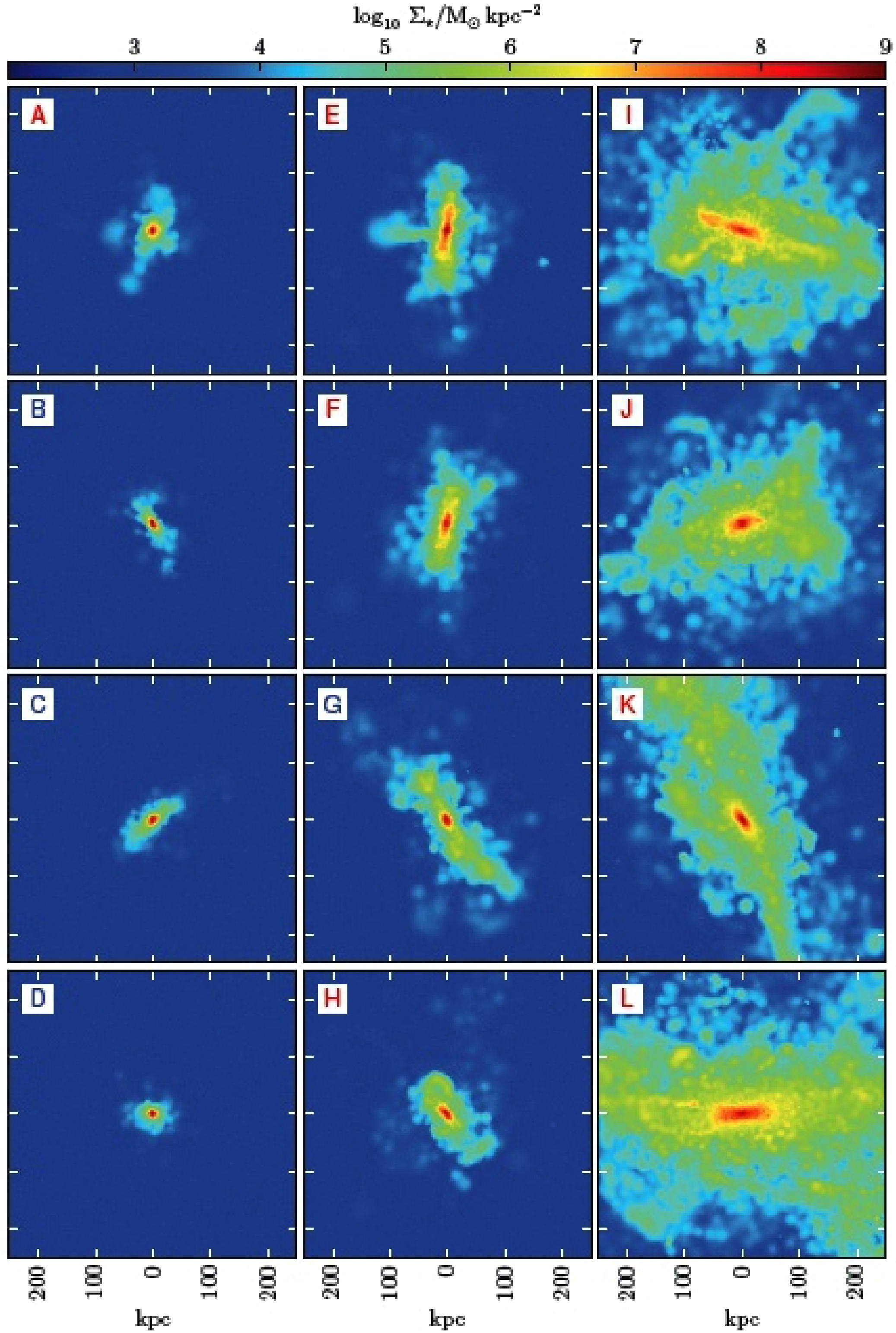


Tidal disruption of multiple accreting satellites forms the halo. Brightest features are from larger, more recent accretion events.

Include chemical evolution models in particle-tagging scheme,

Here, star particles are colour-coded by metallicity. (Red being high metallicity)

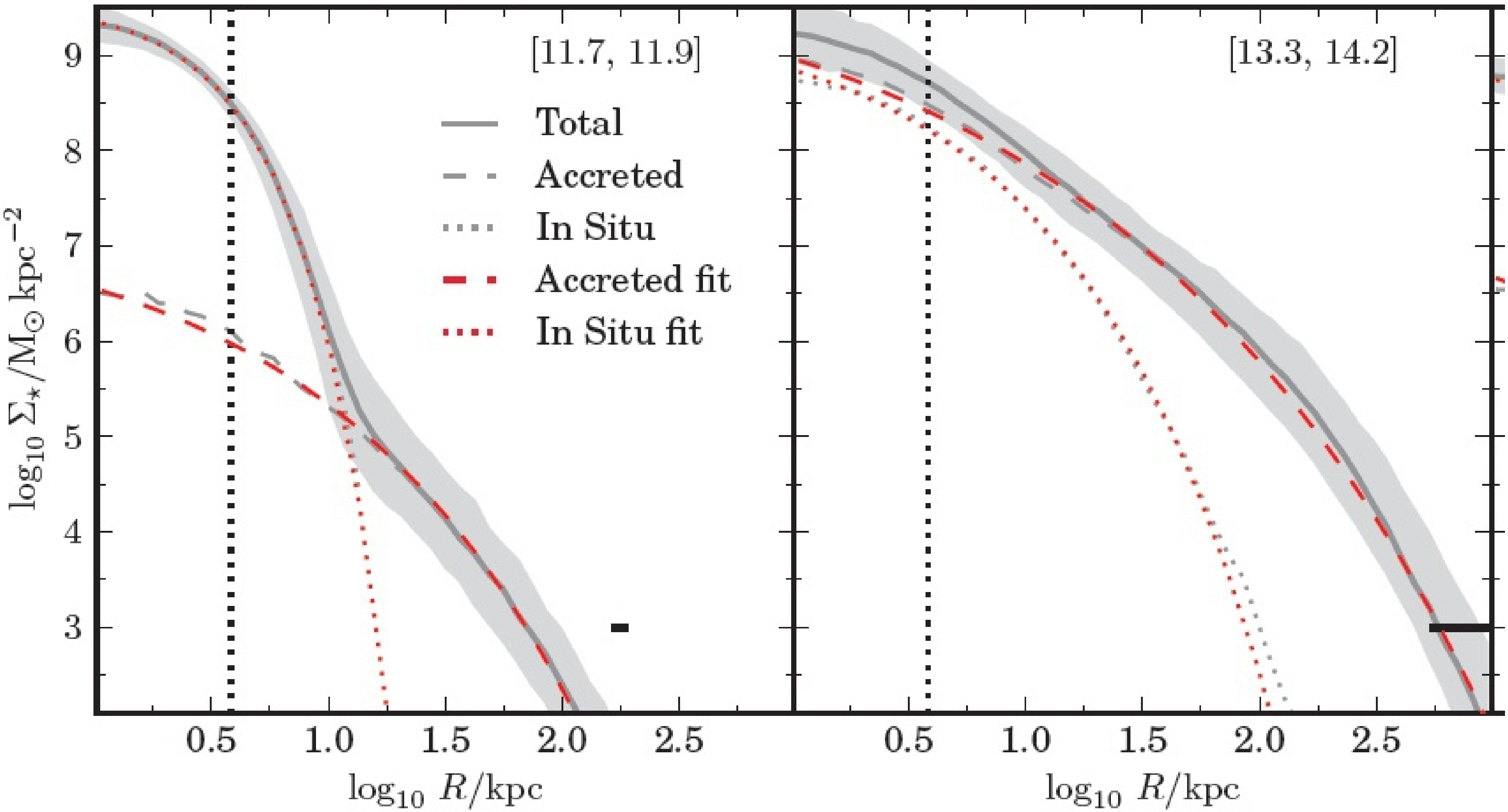




Stellar halos for galaxies of increasing mass

(particle tagging implemented on Millennium II simulation)

STELLAR MASS DENSITY PROFILES



LOW MASS **HIGH MASS**

Stacking SDSS images to detect outer halo light

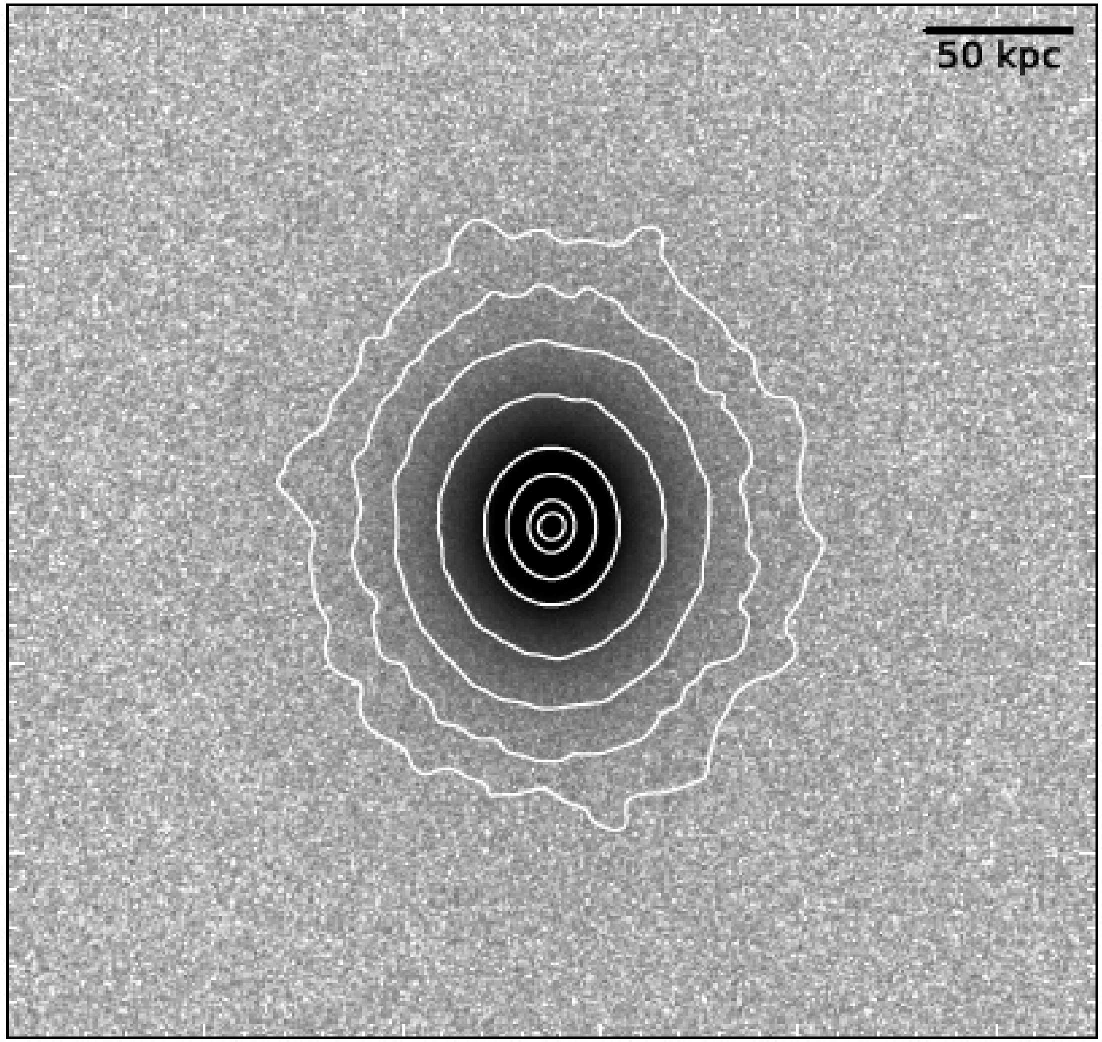
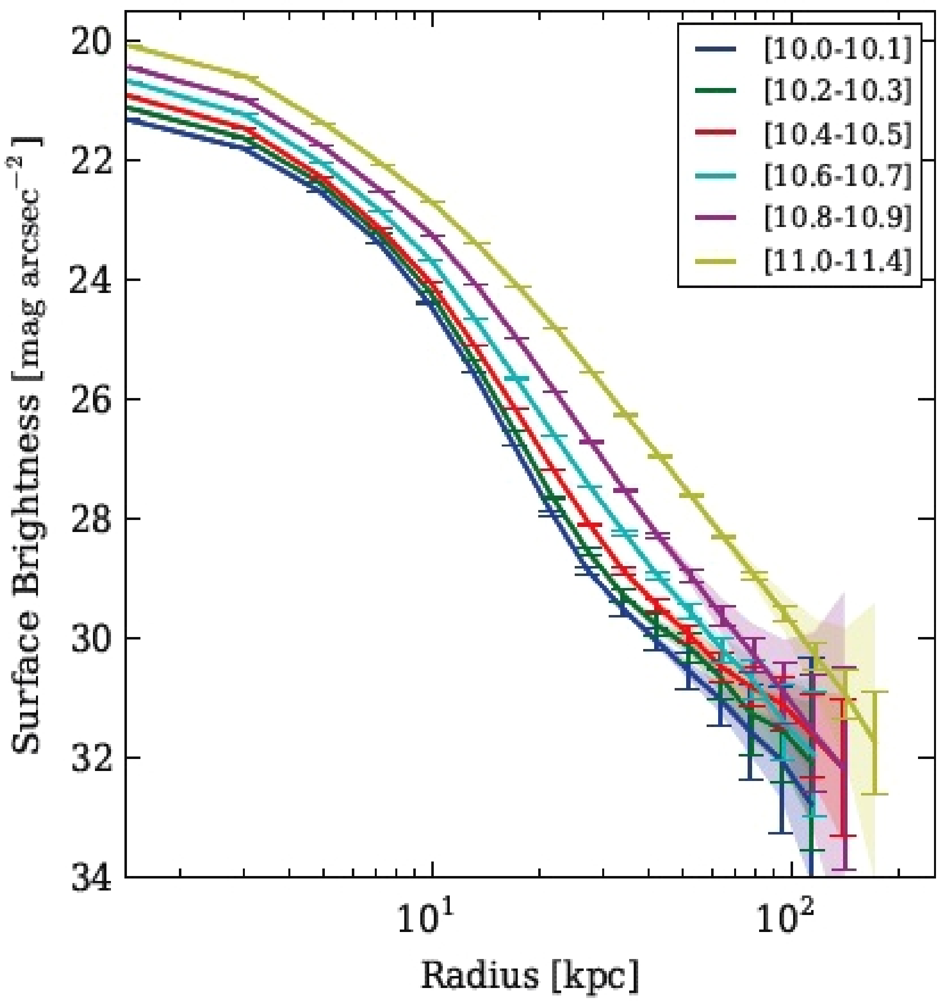
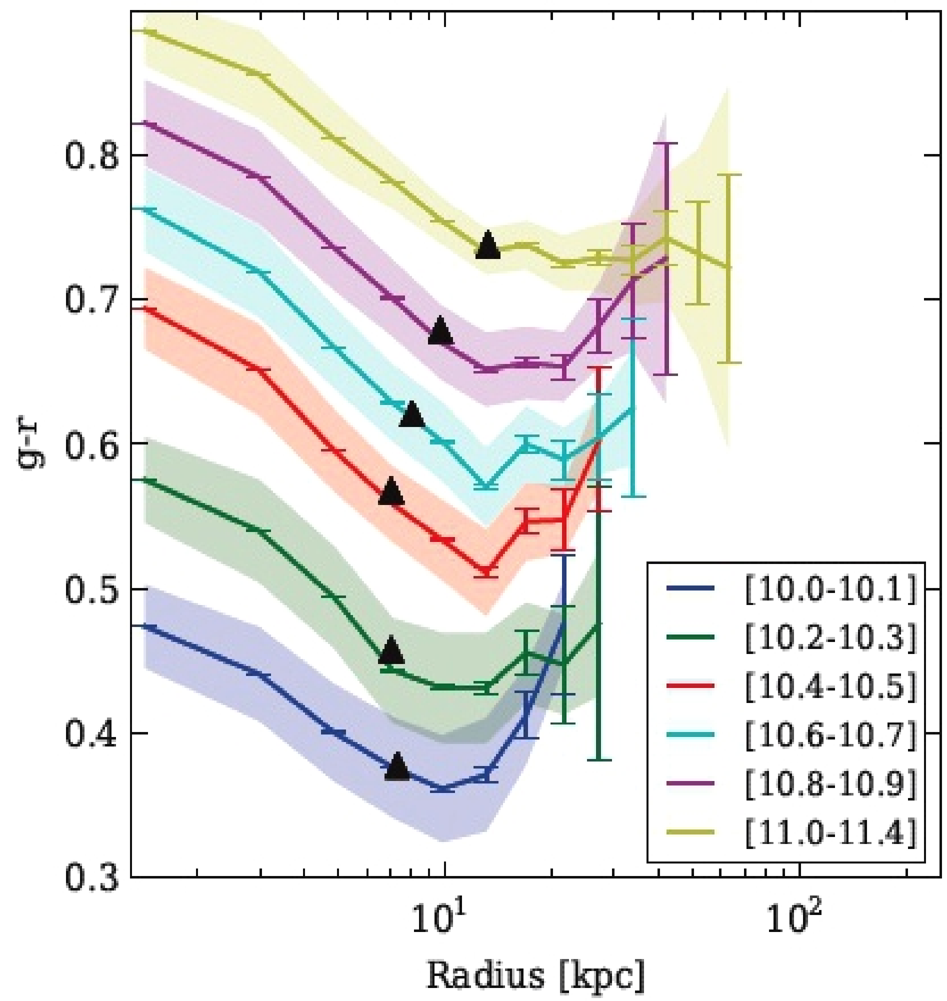


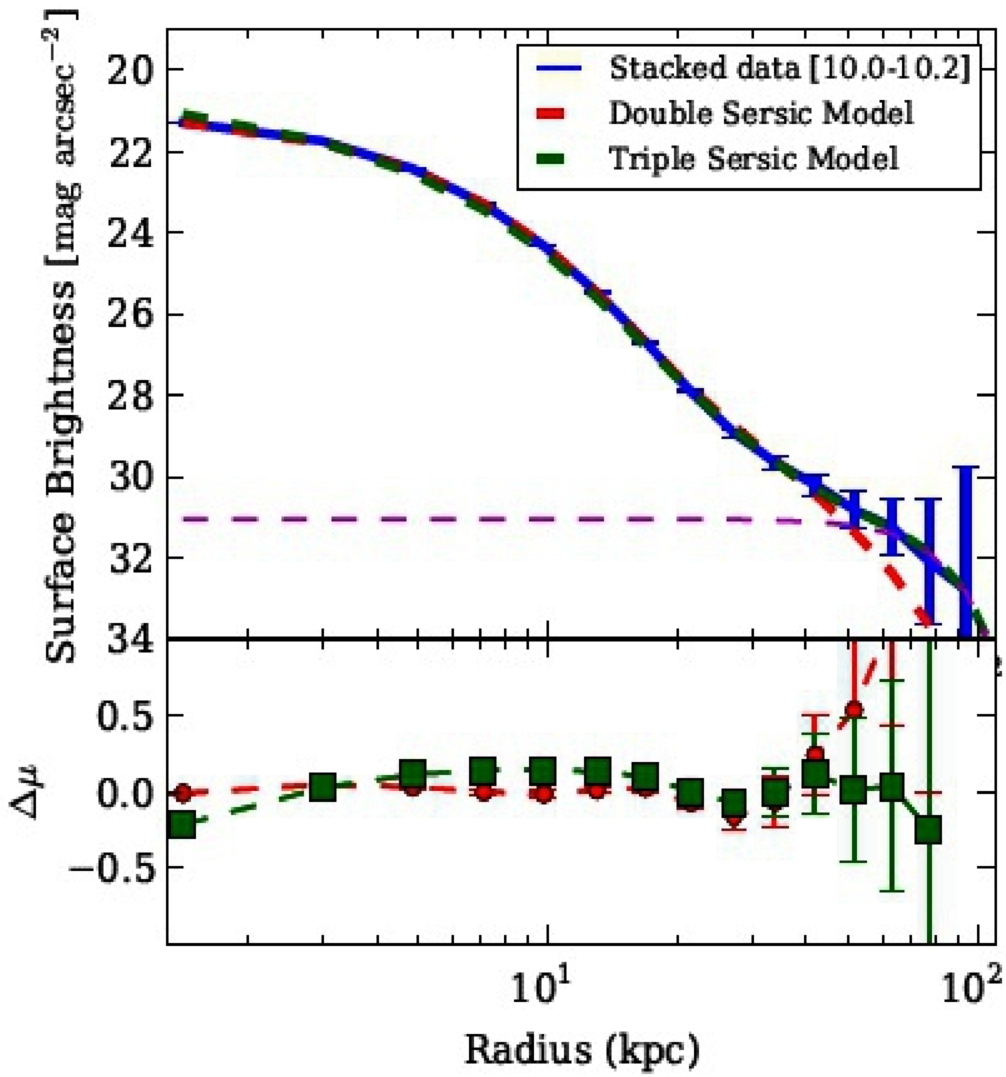
Figure 4. The stacked image consisting of 4040 images in the mass range $10^{11.0}M_{\odot} < M_{*} < 10^{11.4}M_{\odot}$ and $C > 2.6$. Elliptical contours are drawn at 5, 10, 20, 30, 50, 70, 90 and 110 kpc.

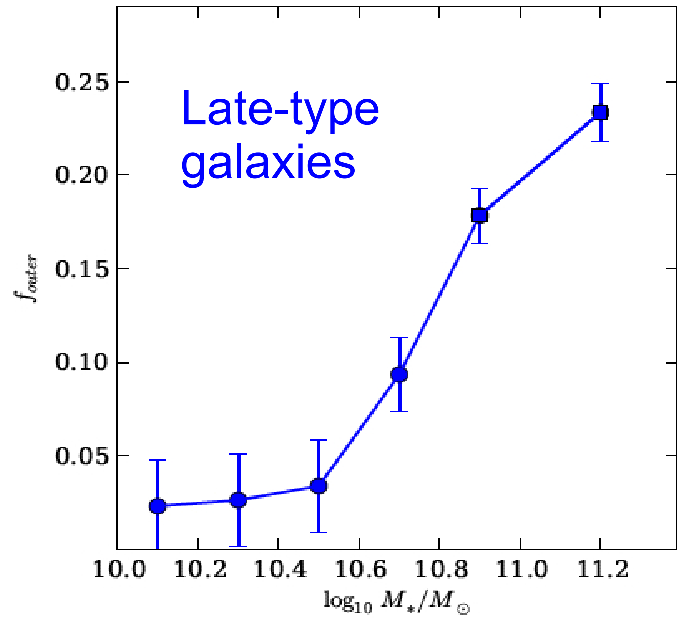
Stellar mass surface density and colour profiles of stellar halos : trends as function of mass

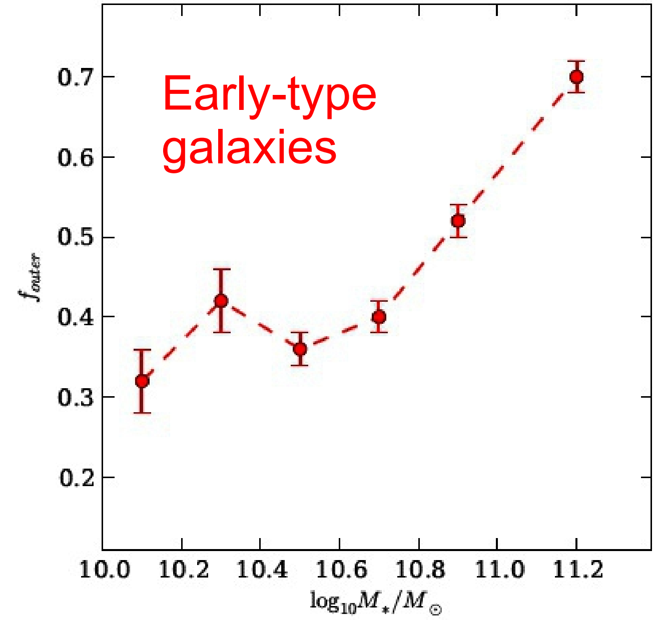




Double or Triple Sersic models required to fit the light profiles.
Fraction of light/mass in the outer component







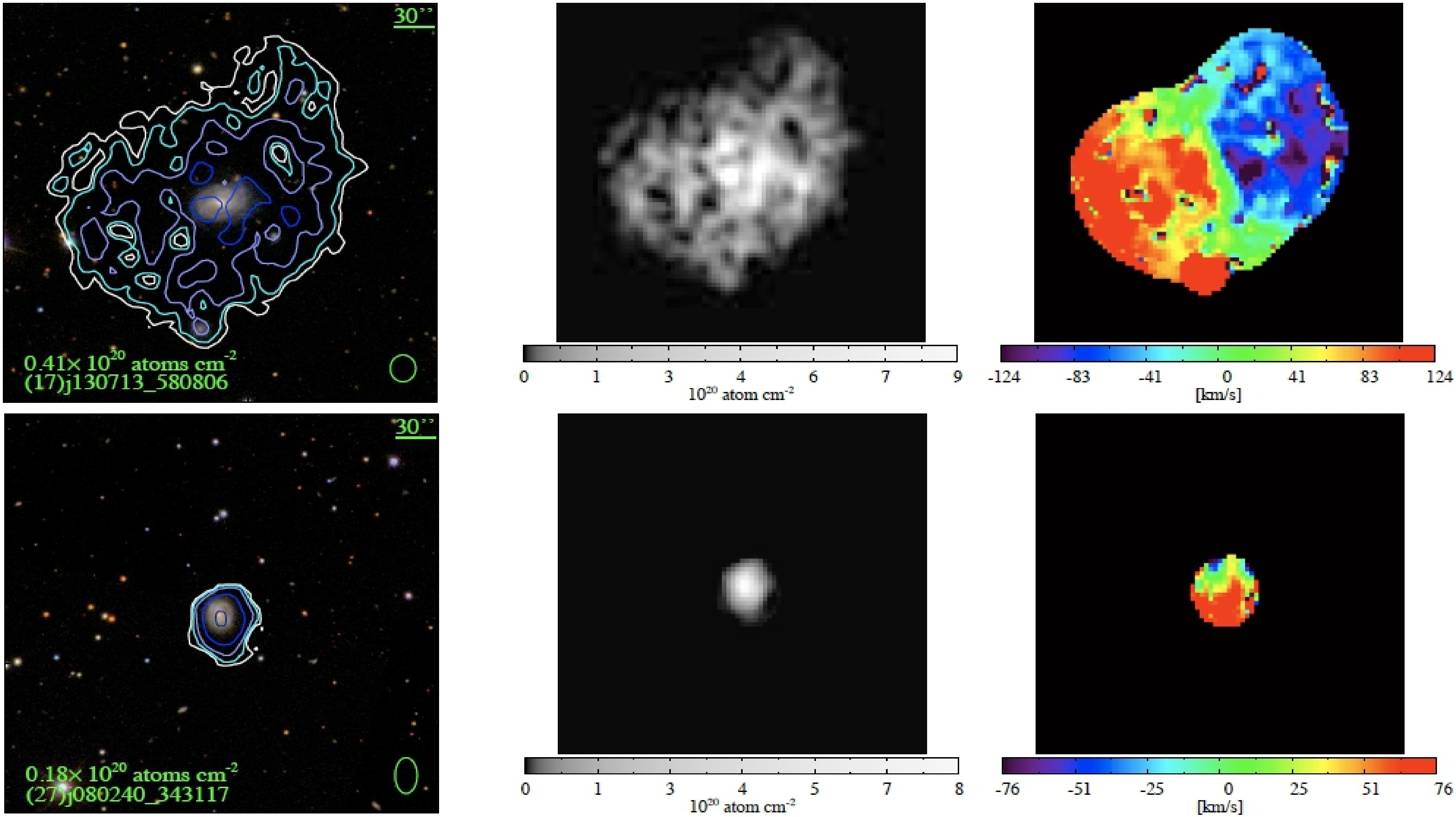
NEXT STEPS:

1) Comparison with simulation predictions

2) Analysis of IFU spectroscopy of outer halos

3) Deeper imaging – detect accreted features in Individual galaxy images

STUDYING THE ATOMIC AND MOLECULAR GAS PROPERTIES OF REPRESENTATIVE SAMPLES OF NEARBY GALAXIES



GASS: The cold gas content of massive galaxies

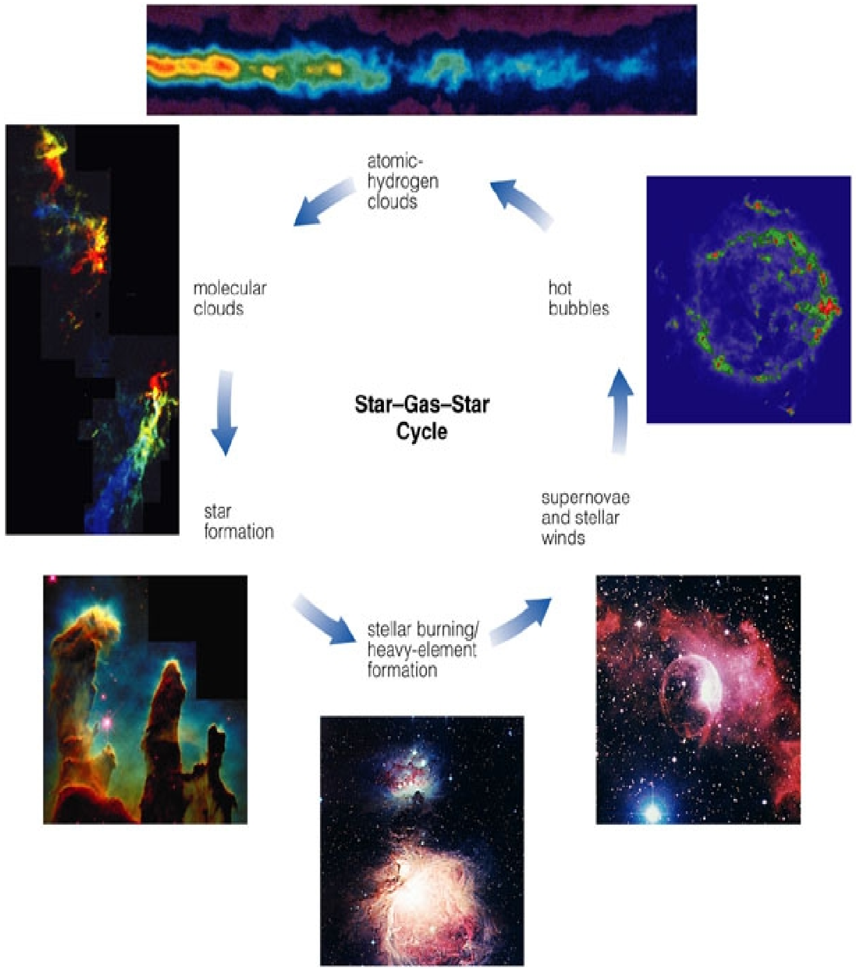
$\log M_\star \geq 10$

- HI survey of ~1000 galaxies selected from SDSS main galaxy sample
- Redshift range: 0.025<z<0.05 (110-220 Mpc)
- Footprint: Overlap of ALFALFA HI survey, SDSS (sp), and GALEX
- Depth: *HI mass fraction limit* — $f_{gas}>0.02$ (typ. log $M_{HI}>8.5$-9)
- Arecibo large program (~1000 hours), initial observations in 2008.

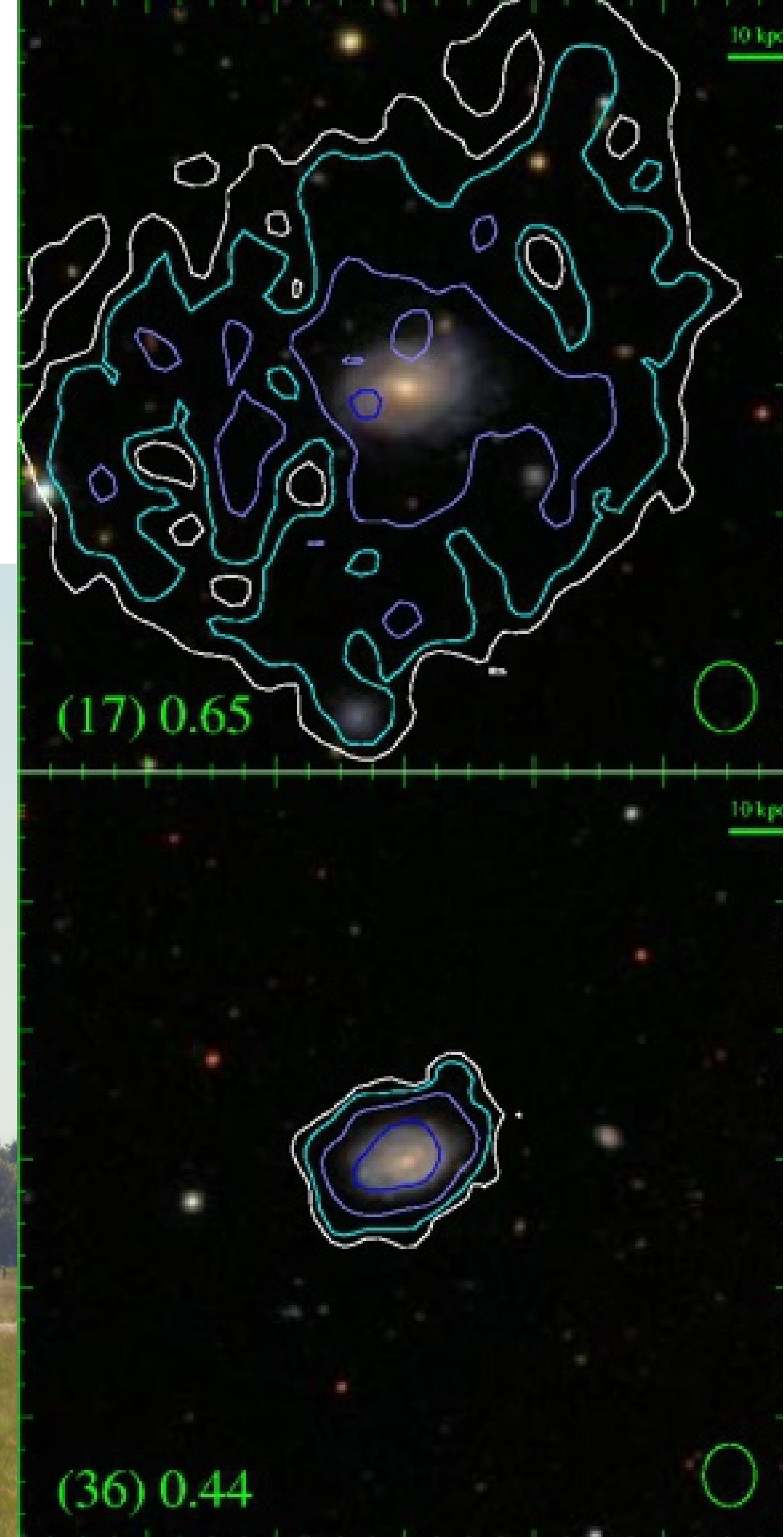


Using the IRAM 30m telescope, we have obtained accurate and homogeneous molecular gas masses for a subset of 350 galaxies from the GASS sample. The data will allow us to understand the balance between atomic and molecular gas in nearby galaxies, and how these gas properties scale with other global galaxy properties such as stellar masses and star formation rates.

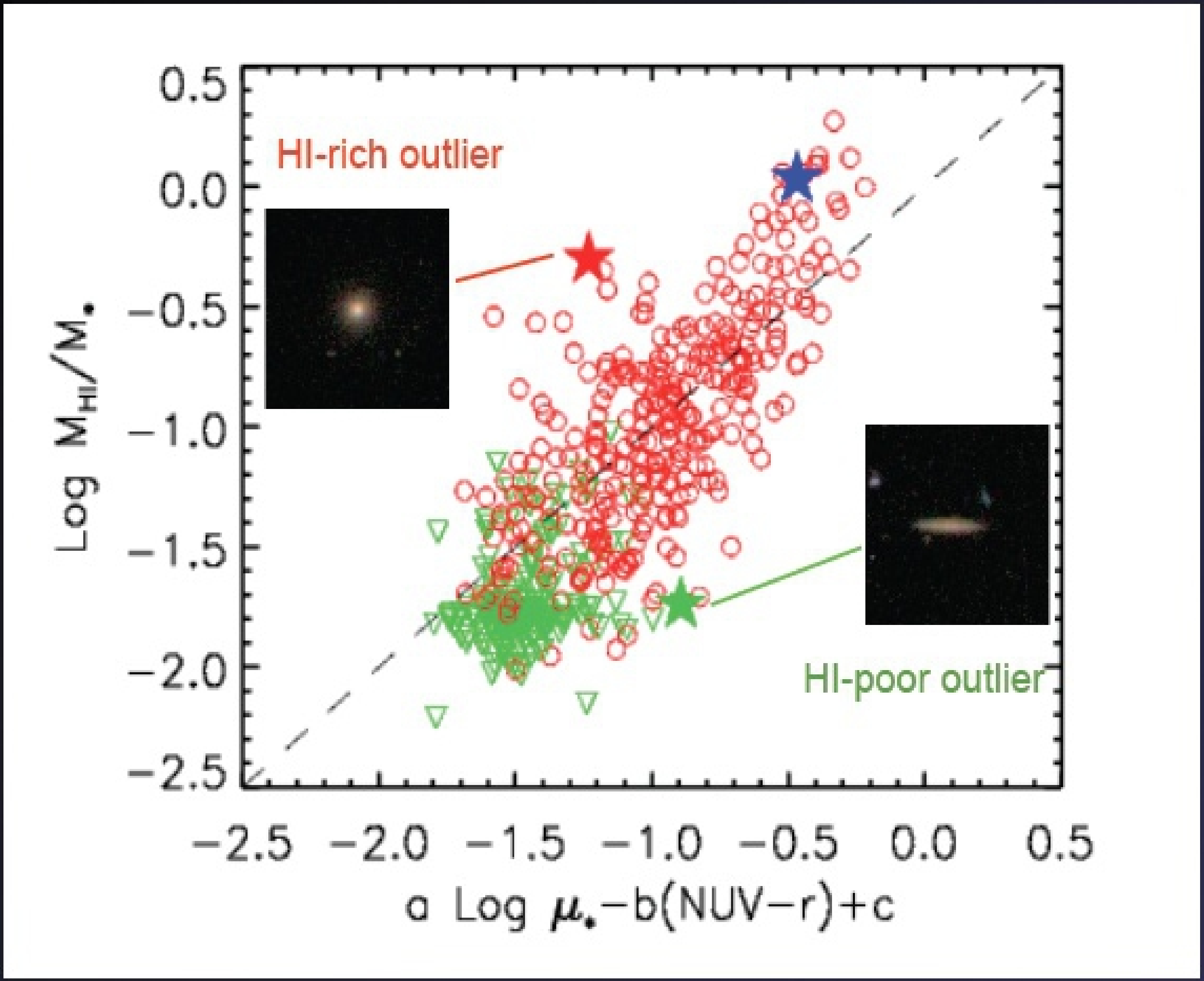
The telescope and the IRAM offices/guest house to its left.



The Bluedisk project, is a large programme at the Westerbork Synthesis Radio Telescope that has mapped the HI in a sample of 25 nearby galaxies with unusually high HI mass fractions, along with a similar-sized sample of control galaxies. The aim is to investigate the link between cold gas accretion and galactic disk formation in the local universe.



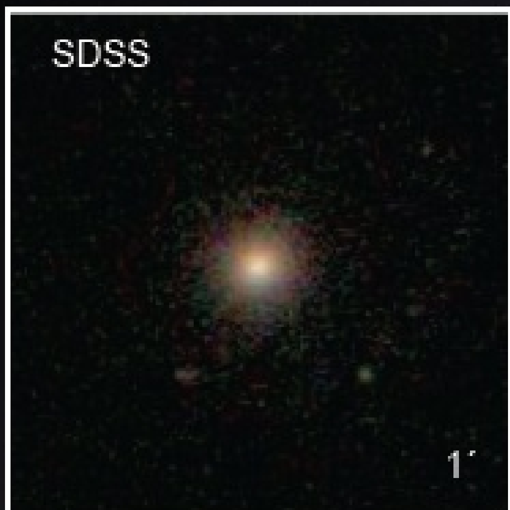
DR2 HI gas fraction plane

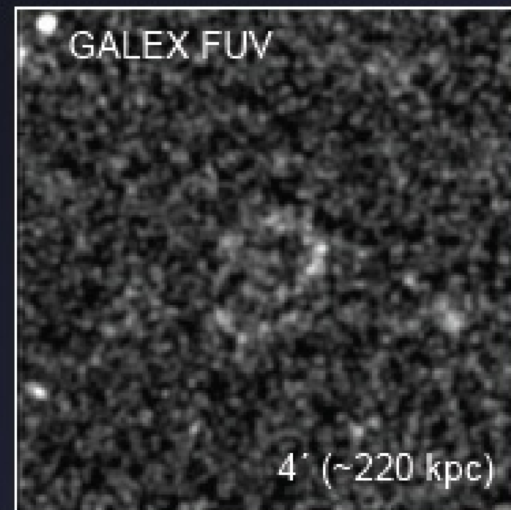


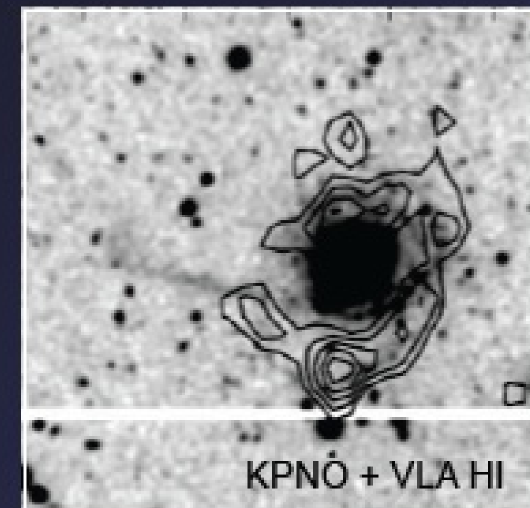
Transition galaxies: anomalous gas content given their optical/NUV colors and μ_*

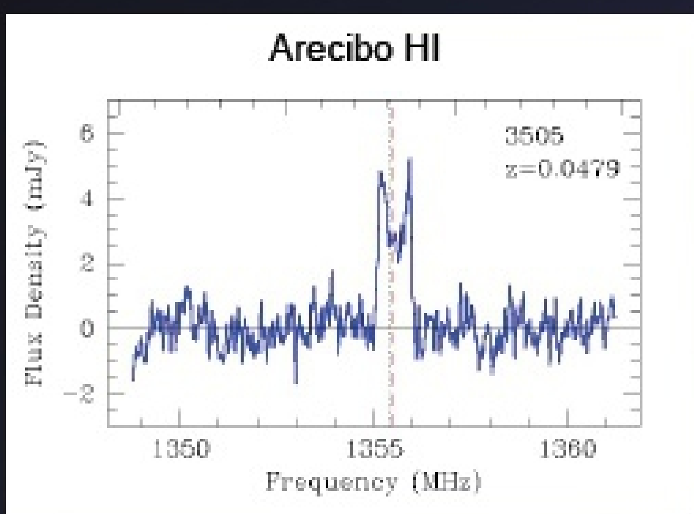
Catinella et al 2010;2012

GASS 3505: a gas-rich, "red and dead" galaxy

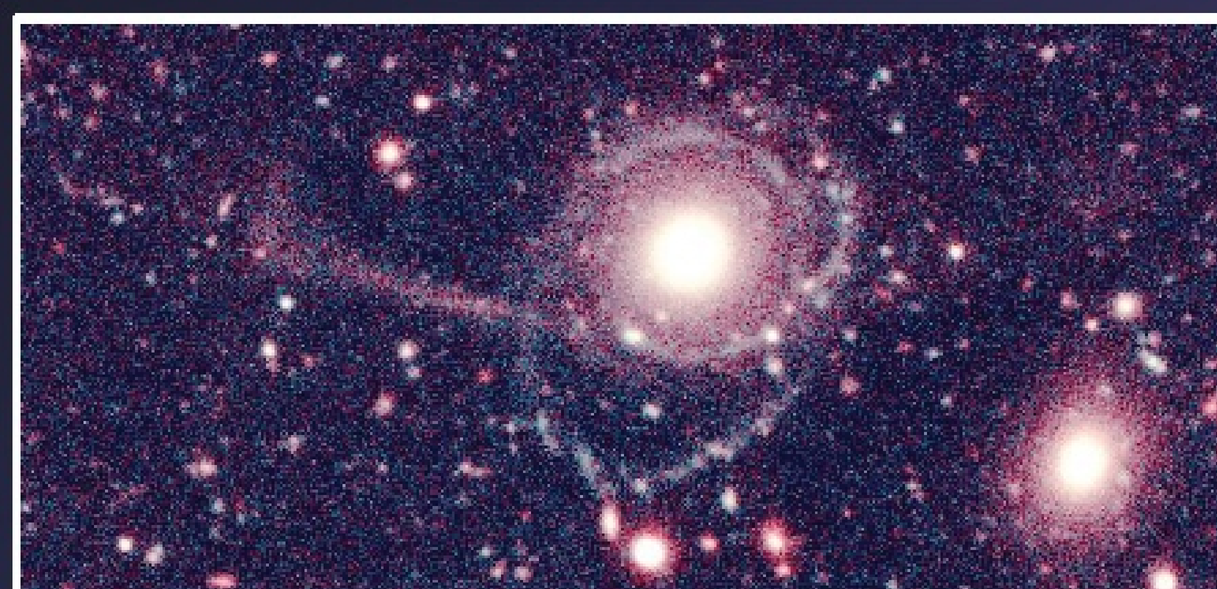




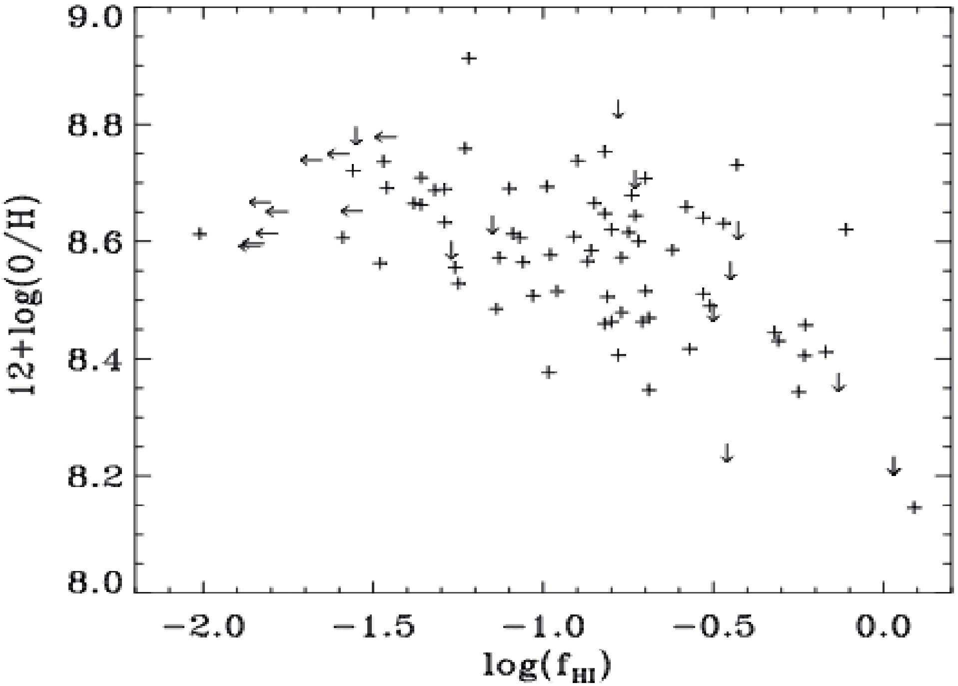




$\log M_{HI}/M_{\odot}=9.91$ $M_{HI}/M_{\star}=50\%$



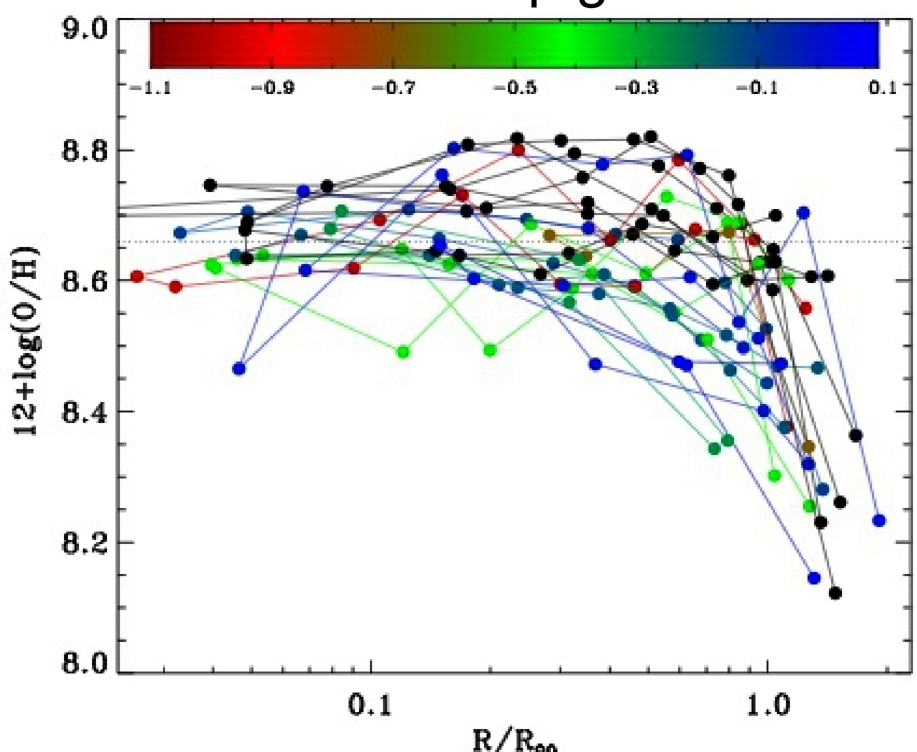
MMT g and r-band imaging (S. Moran)



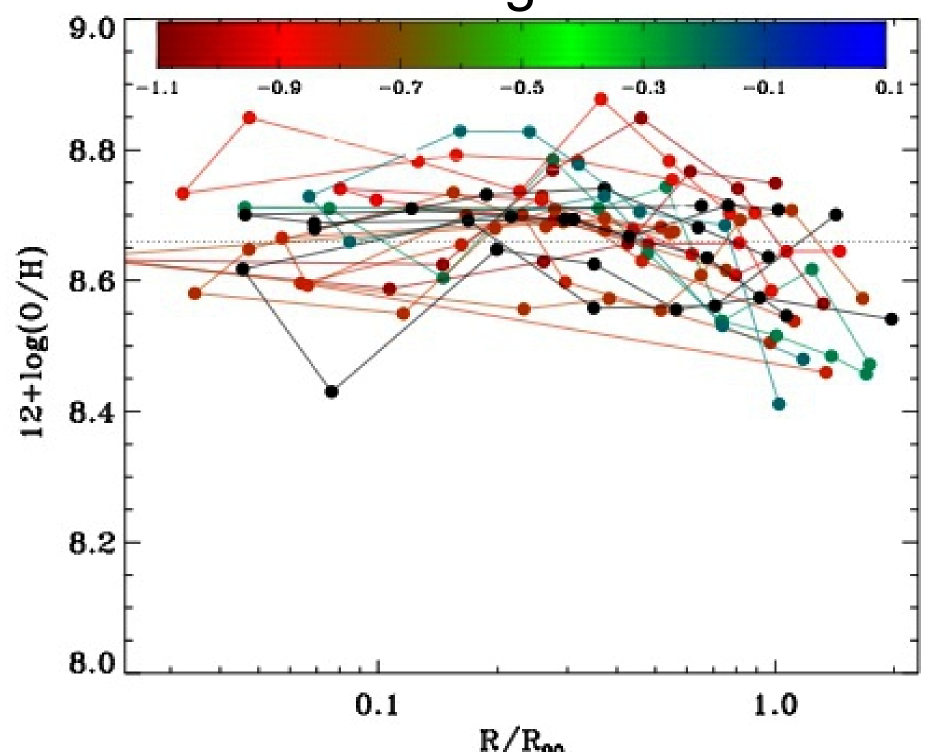
Outer gas-phase metallicity correlates with HI mass fraction.

Moran et al. 2012

Metal-drop galaxies

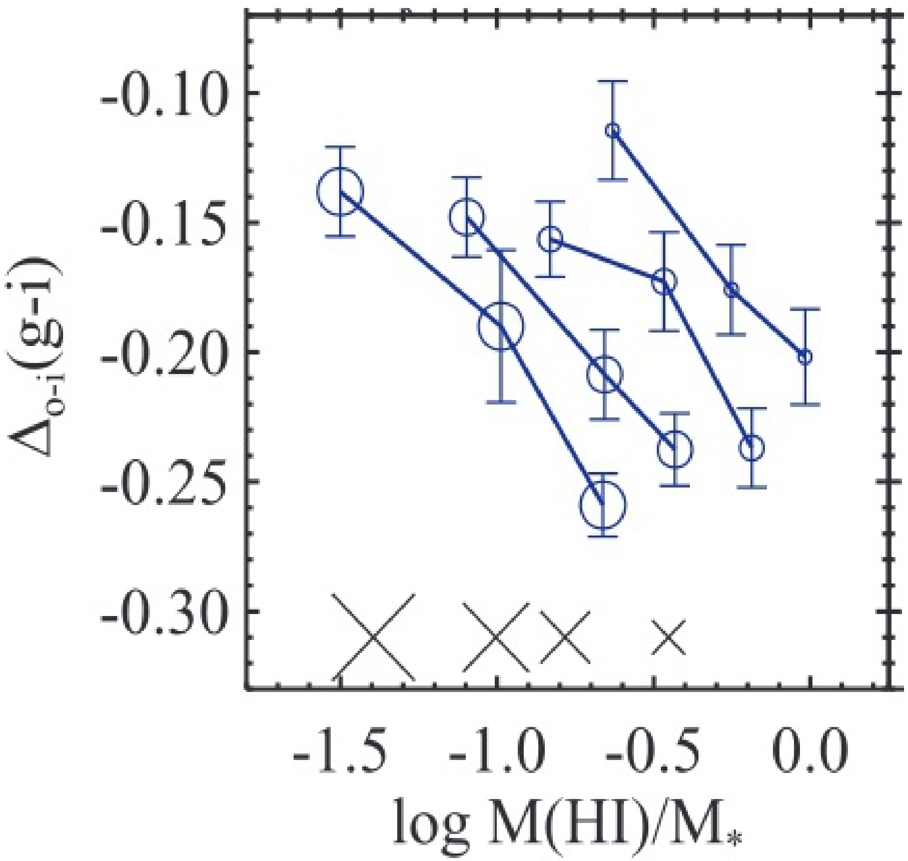


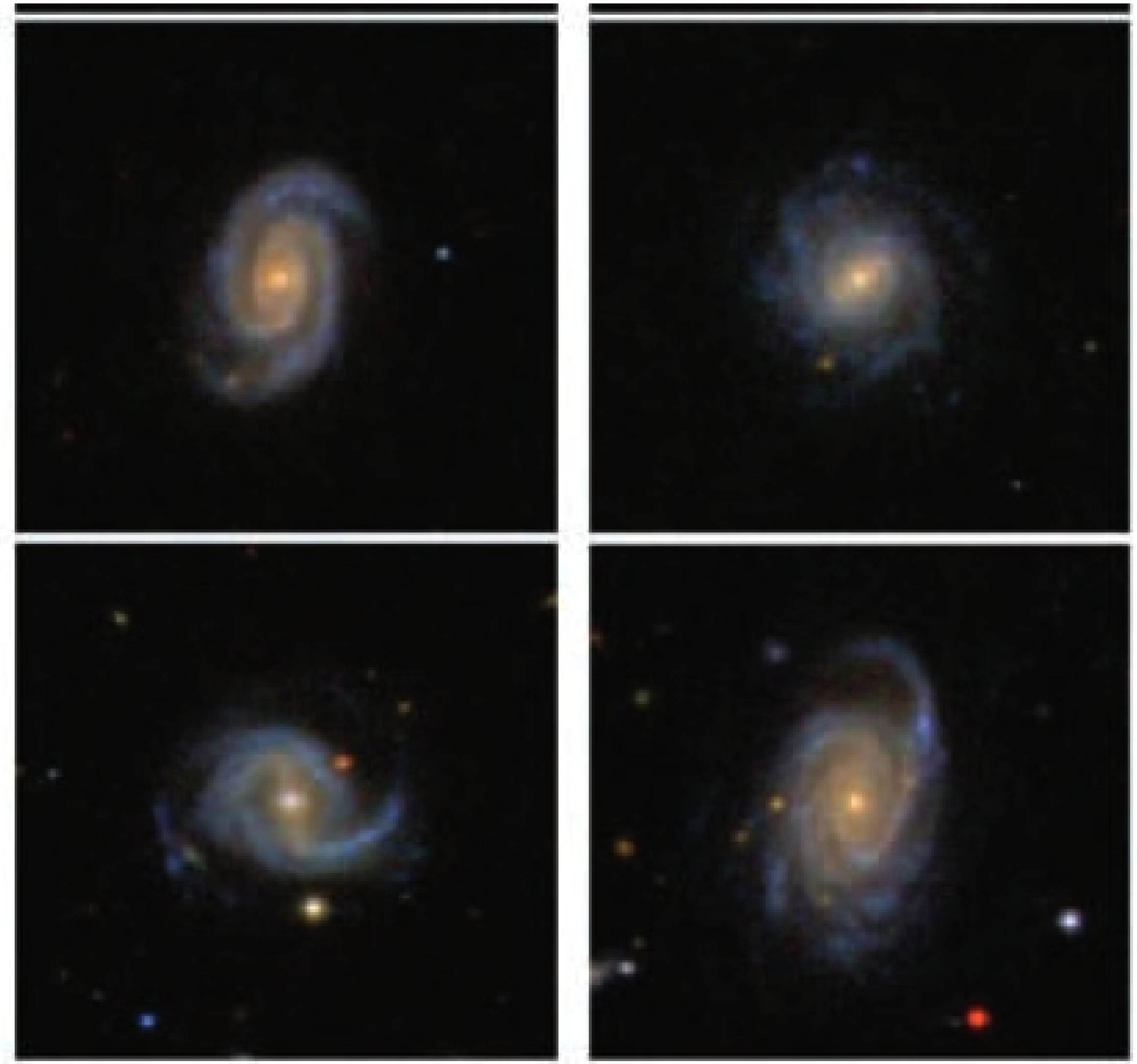
Flat metal gradients



Galaxies with blue outer disks tend to be unusually rich in atomic gas

Wang et al 2010

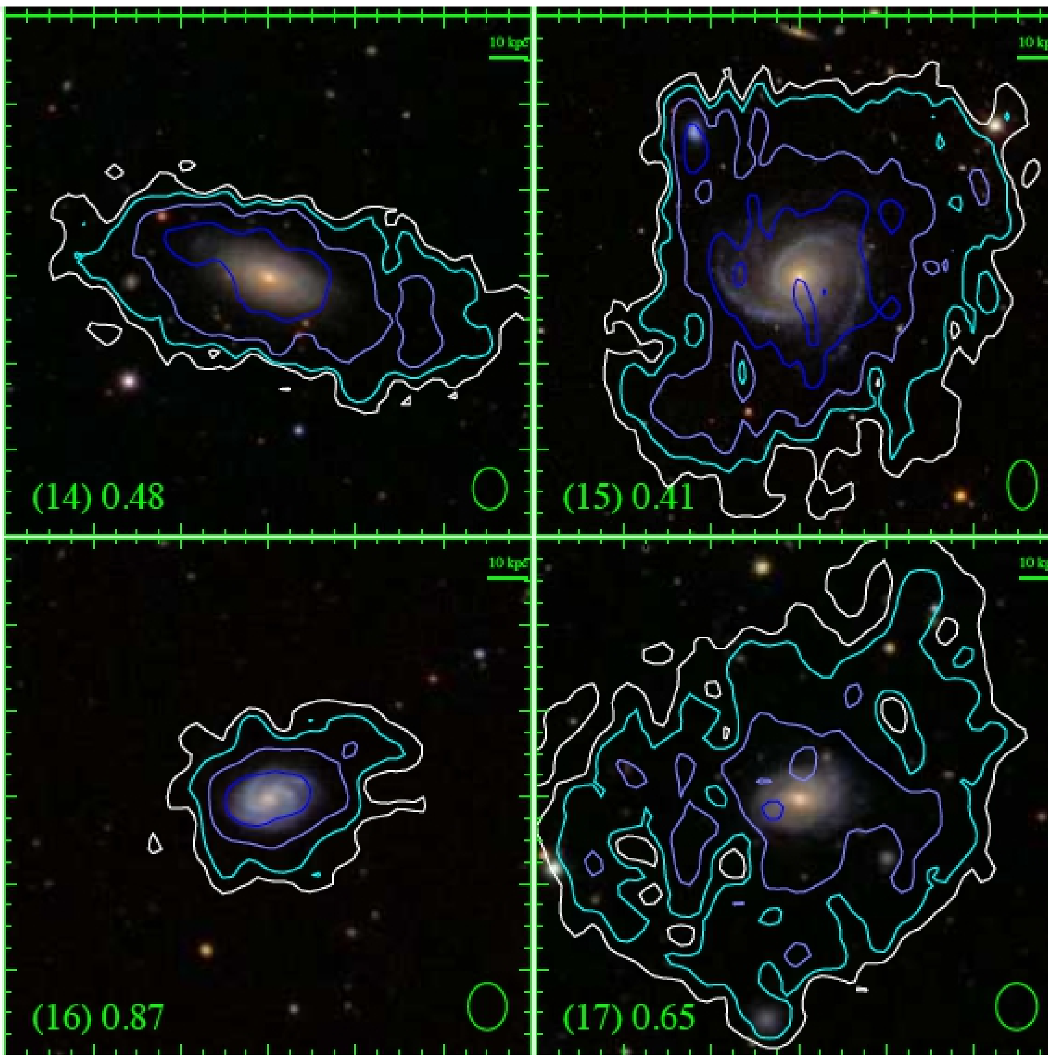




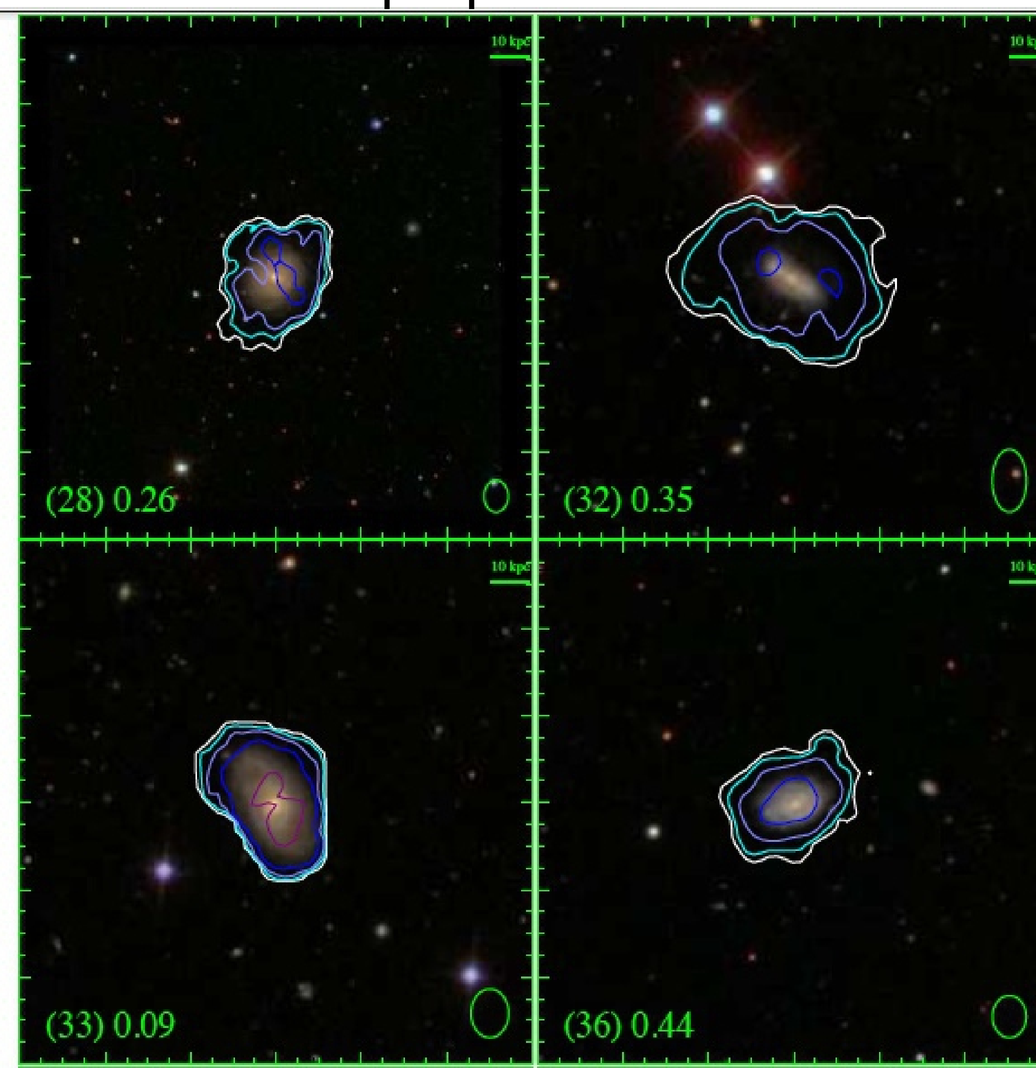
Wang et al 2011

The BlueDisk Project

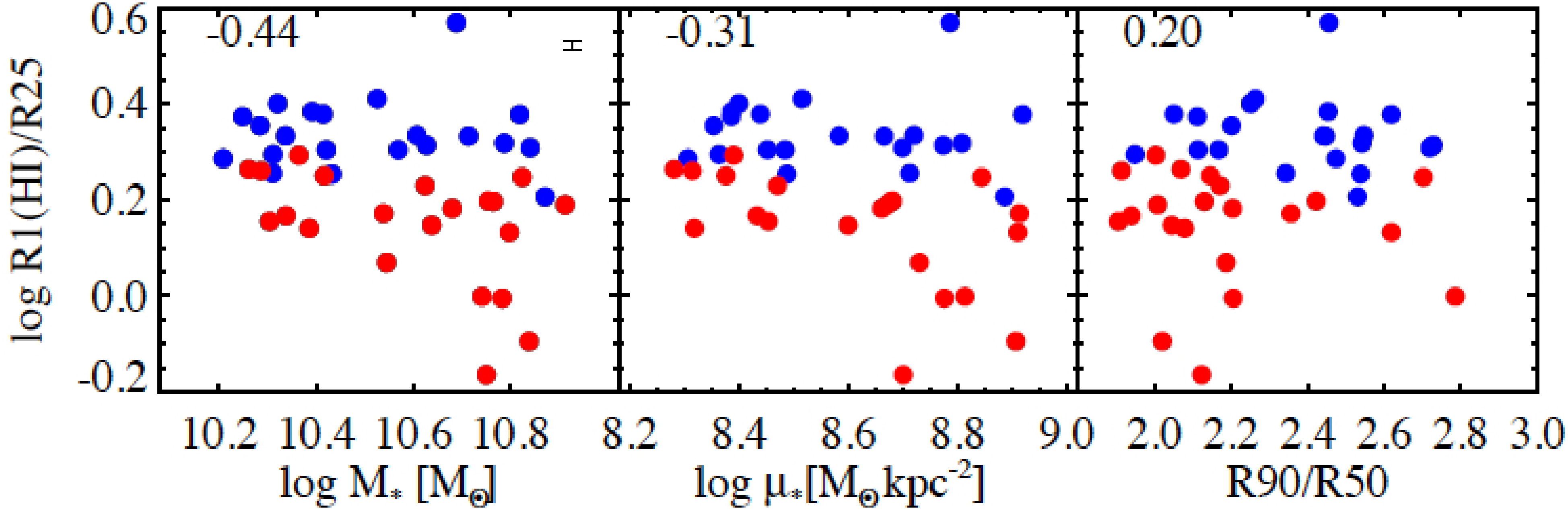
Galaxies with unusually blue outer disks



Control sample matched in optical properties

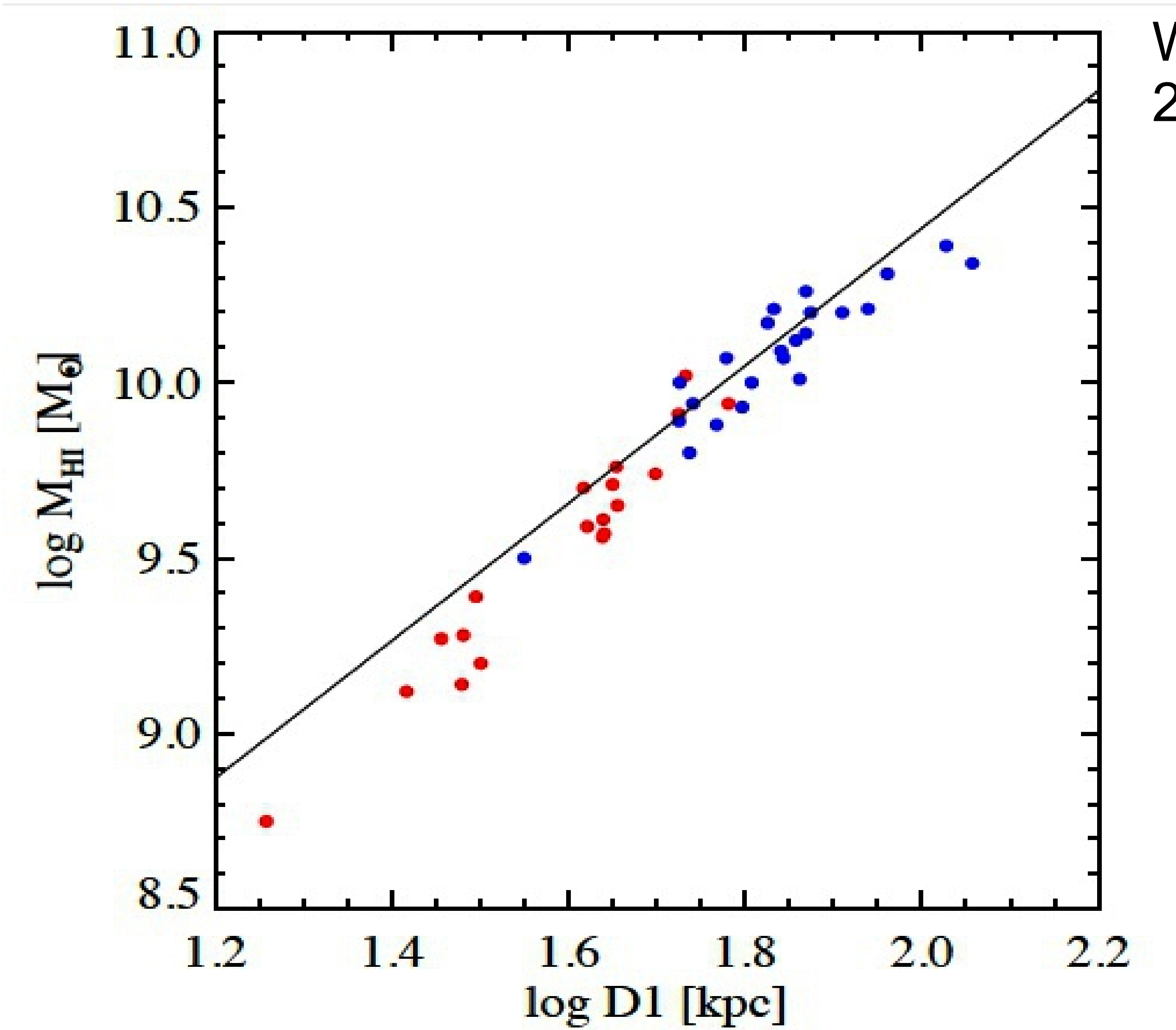


The BlueDisk galaxies have larger HI/optical disk size ratios

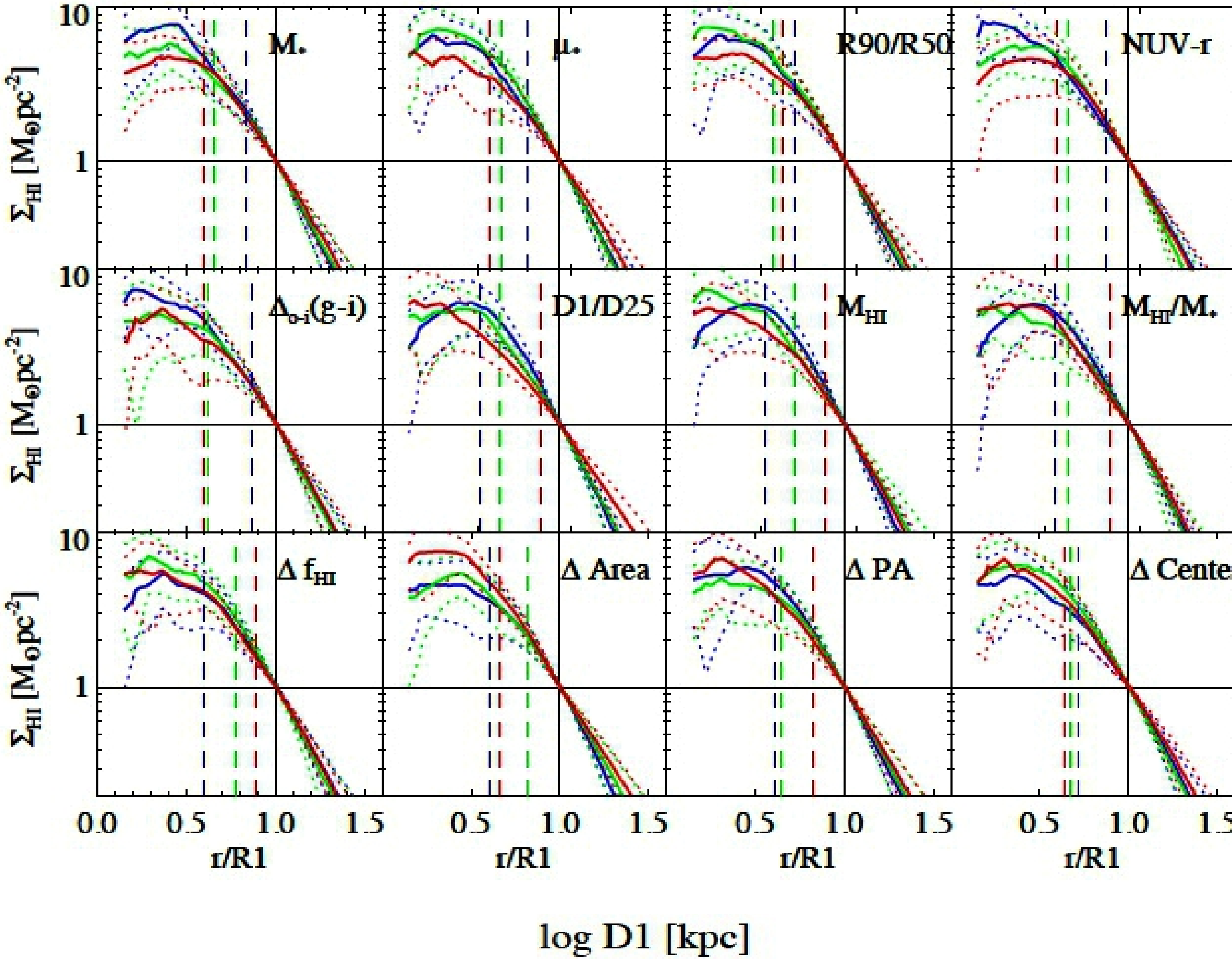


Wang et al 2013

The BlueDisk galaxies extend the HI size-mass relation to HI diameters of 100 kpc and HI masses of 2 x 10^{10} M_{sun}



Wang et al 2013


M*
μ*
R90/R50
NUV-r
Δo-i(g-i)
D1/D25
MHI
MHI/M*
Δ fHI
Δ Area
Δ PA
Δ Center
ΣHI [M⊙pc-2]
r/R1
log D1 [kpc]

PROFILE FITTING

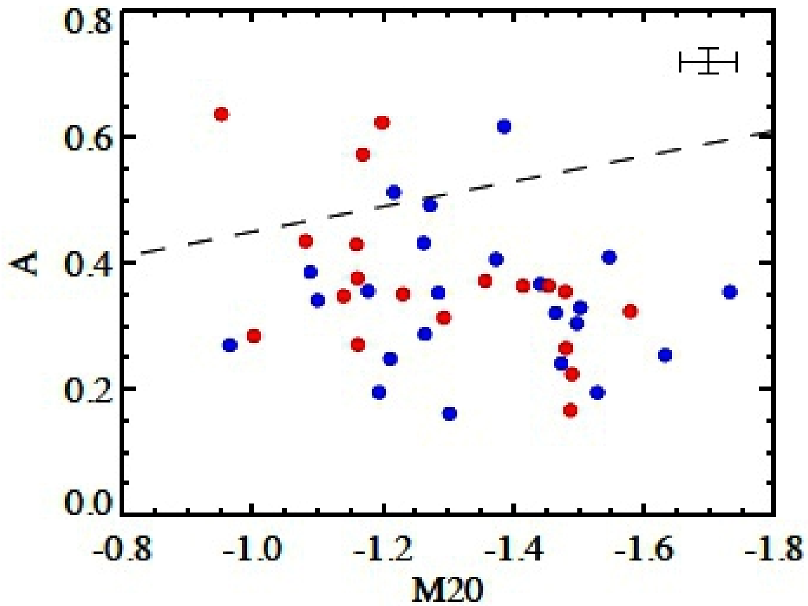
Wang et al 2014

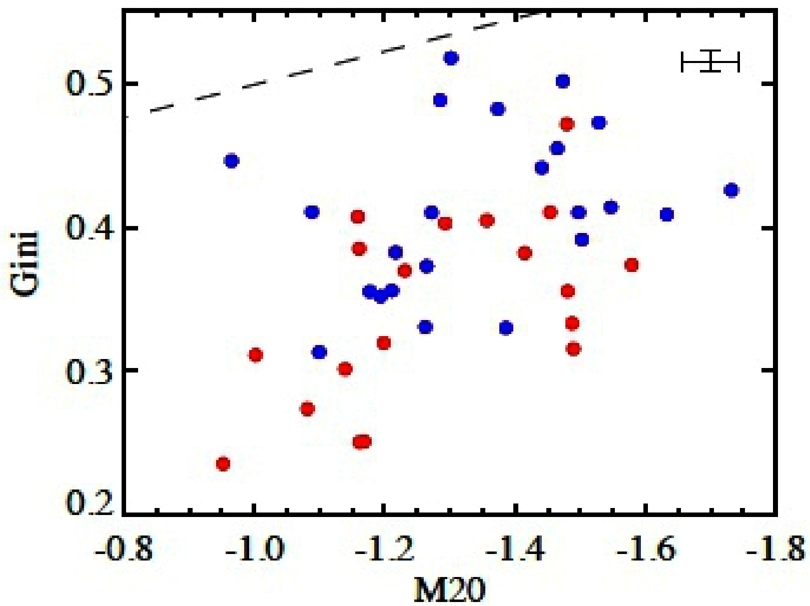
To describe the shape of a two-component HI radial profile and to obtain the de-convolved shape of it, we choose a simple analytic expression of the form

$$\Sigma_{\rm HI,model}(r) = \frac{I_1 \exp(-r/r_{\rm s})}{1 + I_2 * \exp(-r/r_{\rm c})}, \qquad (1)$$

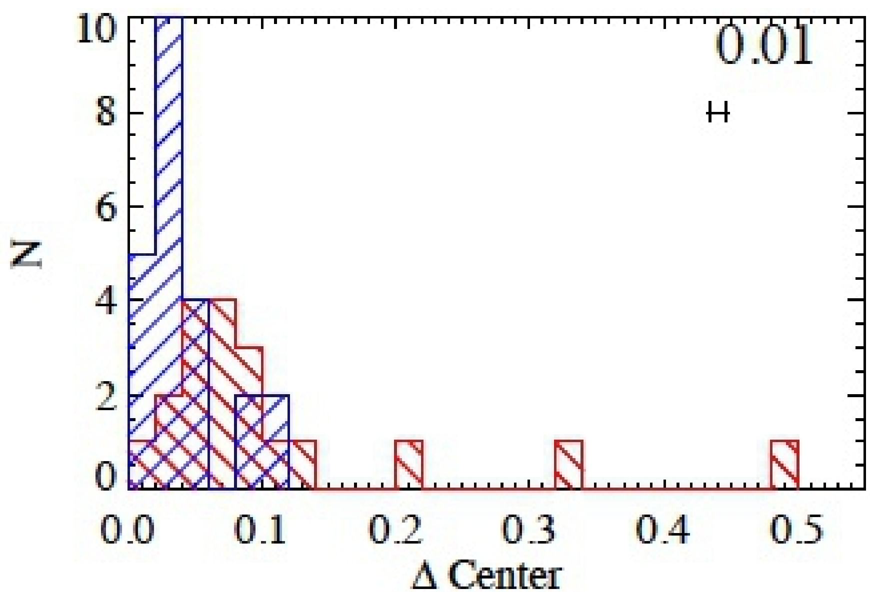
and fit our data to it, where I_1, I_2, $r_{\rm s}$ and $r_{\rm c}$ are free parameters. When the radius is large, the denominator is equal to one and the function reduces to an exponential with scale radius $r_{\rm s}$. $r_{\rm c}$ is the inner radius where the profile flattens.

The BlueDisk galaxies display no signs of disturbances due to interactions and have CAS parameters similar to the controls.

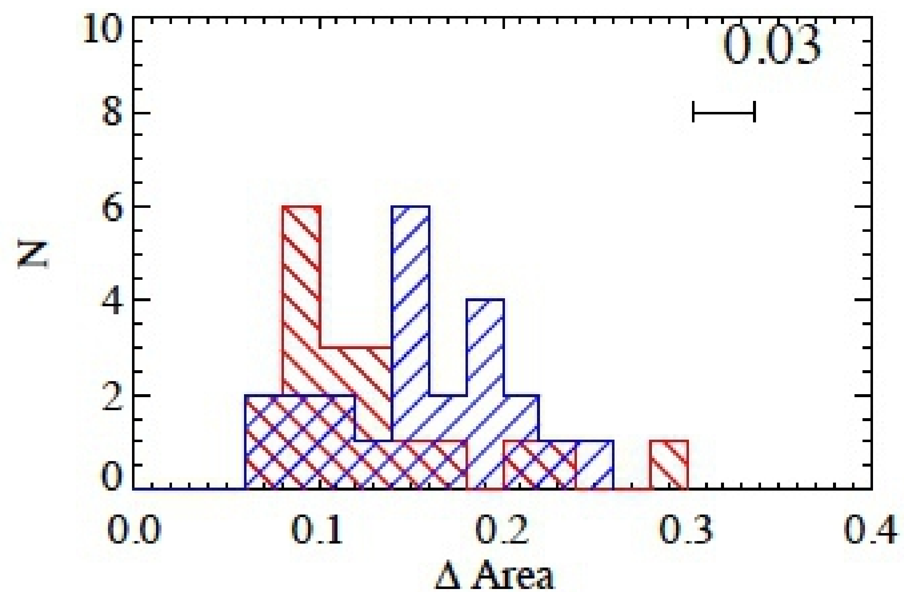




Their optical and HI centers are MORE aligned

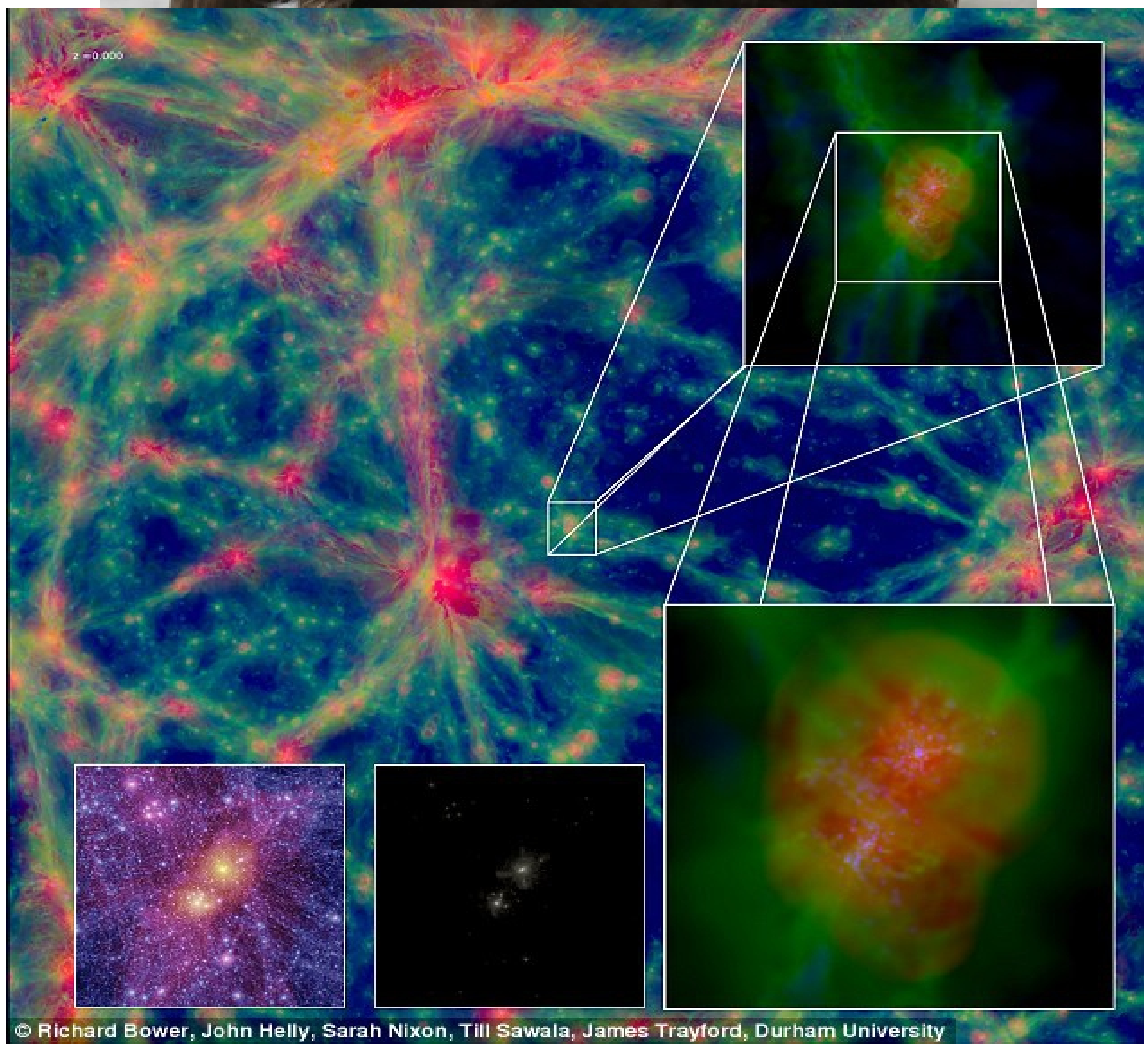


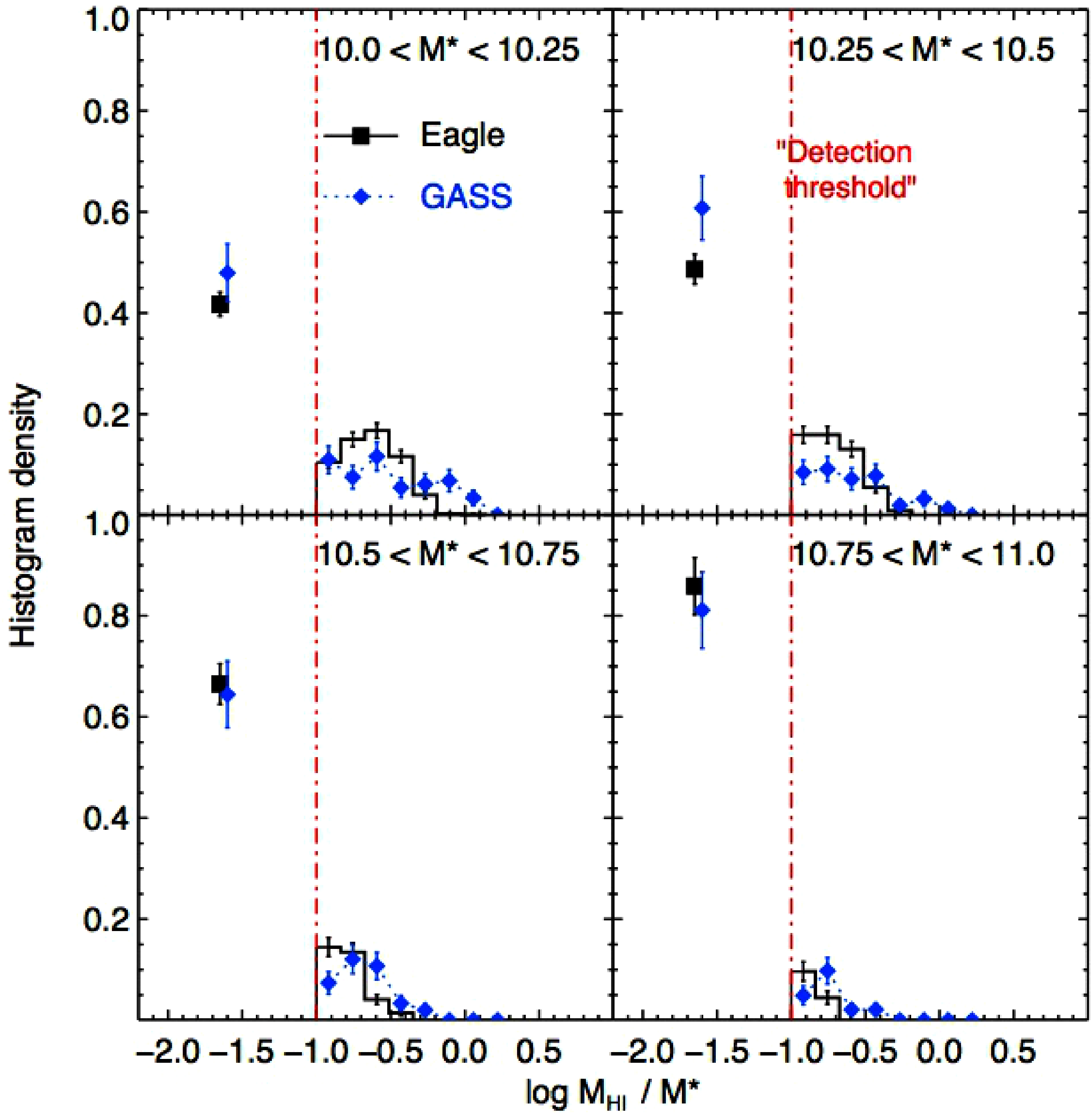
Outer HI contours more irregular



Bahé et al, 2014,
in preparation

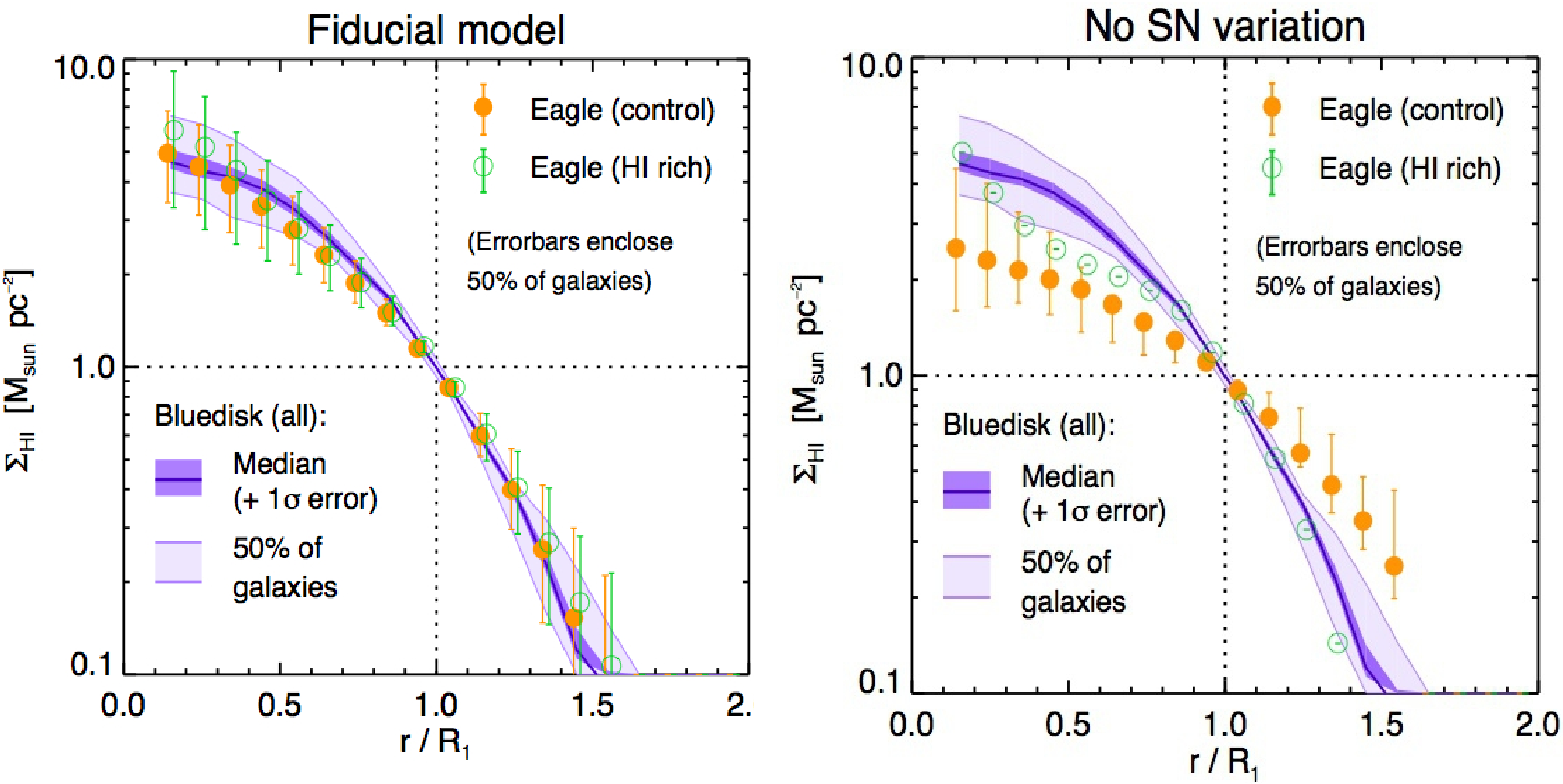
EAGLE
simulation
comparison
with results from
GASS
and COLD GASS



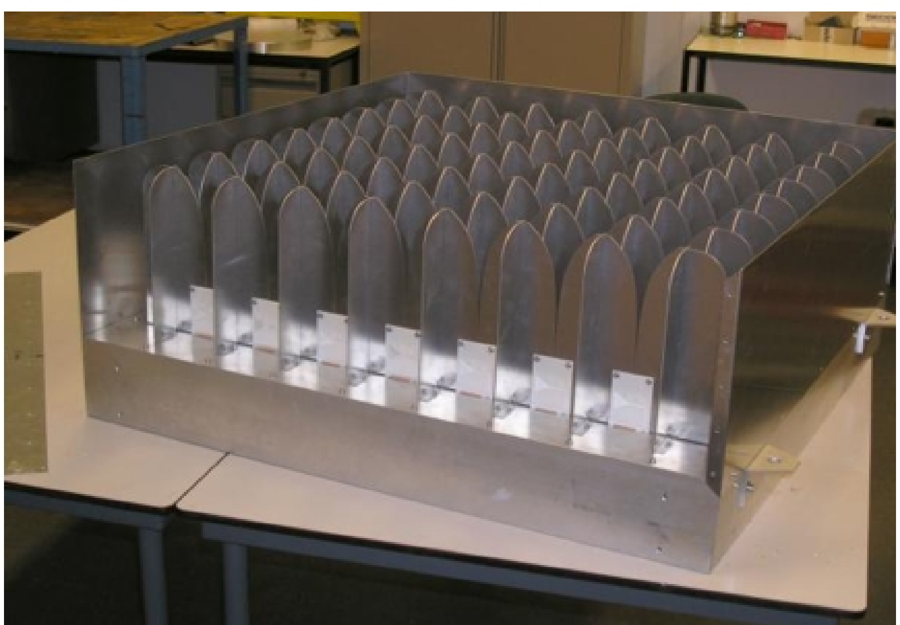


10.0 < M* < 10.25
Eagle
GASS
10.25 < M* < 10.5
"Detection threshold"
10.5 < M* < 10.75
10.75 < M* < 11.0
Histogram density
1.0
0.8
0.6
0.4
0.2
−2.0 −1.5 −1.0 −0.5 0.0 0.5
log M_{HI} / M*

Gas profile shapes, and differences between HI rich and control galaxies ARE SENSITIVE to the implementation of feedback!

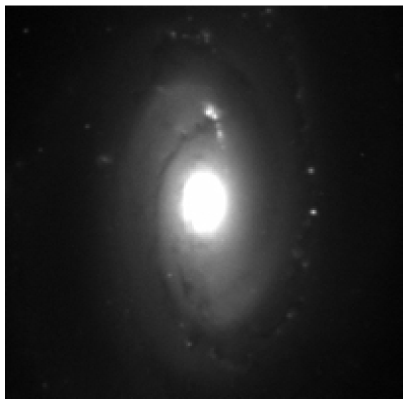


Large HI Surveys with Apertif on Westerbork

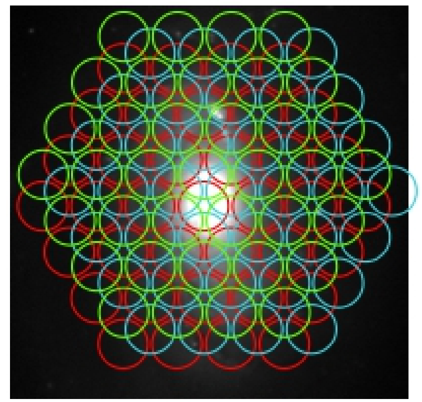


Mapping Nearby Galaxies at APO (MaNGA): one survey in SDSS-IV?

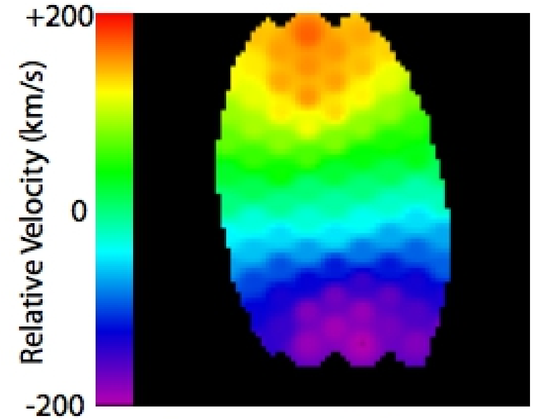
A spatially-resolved survey of 10,000 galaxies



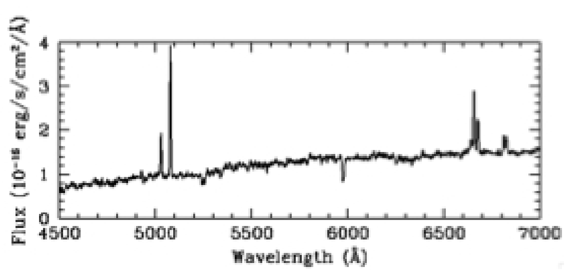
Hα image of NGC 4450



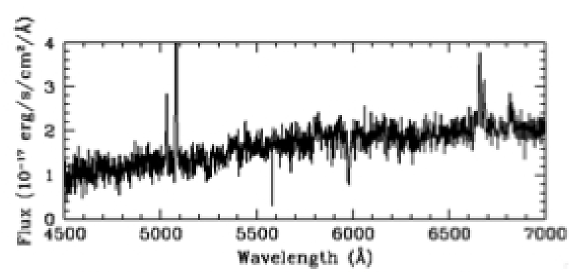
MaNGA fiber bundle
(with 3 dither positions)



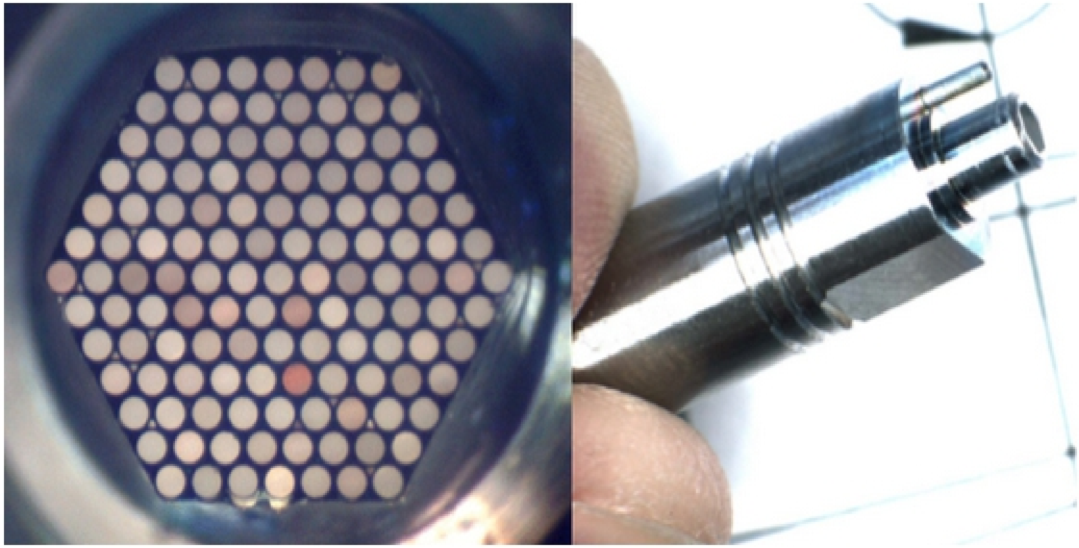
Recovered velocity map



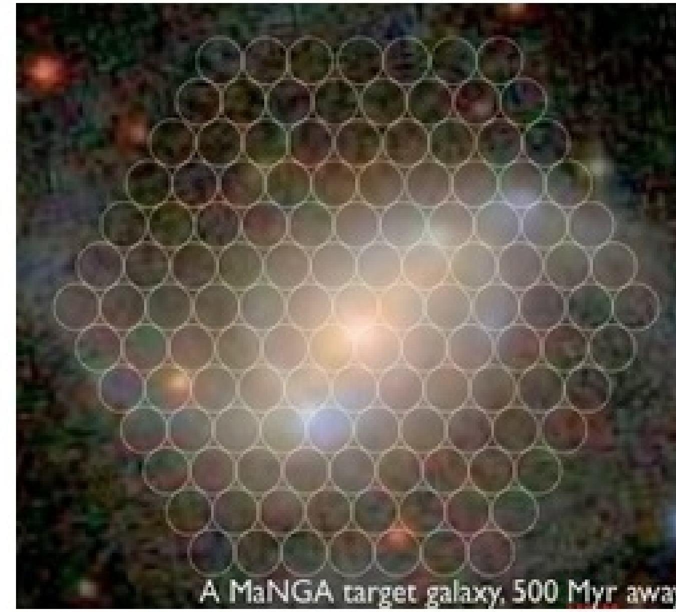
Simulated spectrum (central fiber)



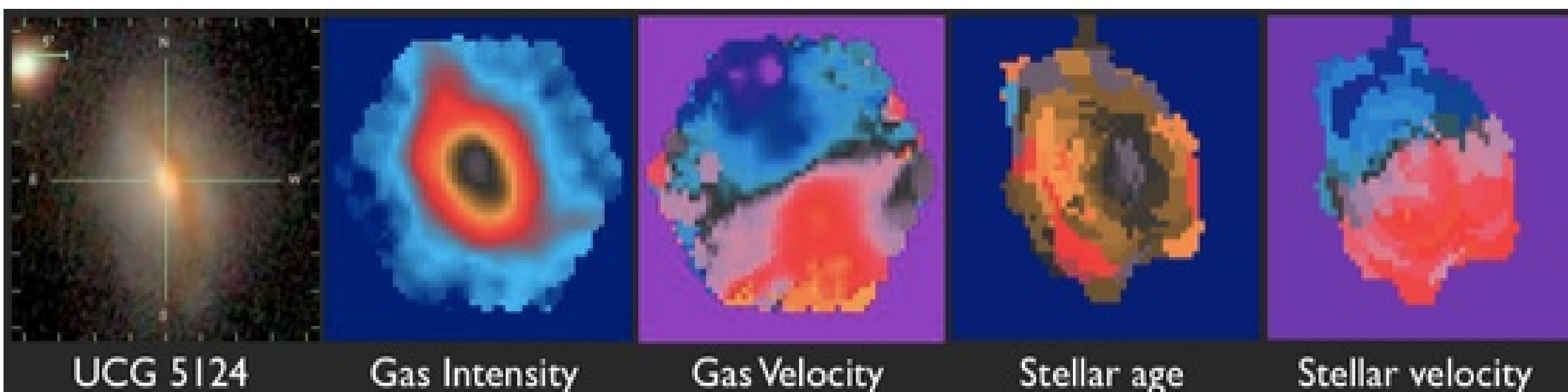
Simulated spectrum (edge fiber)



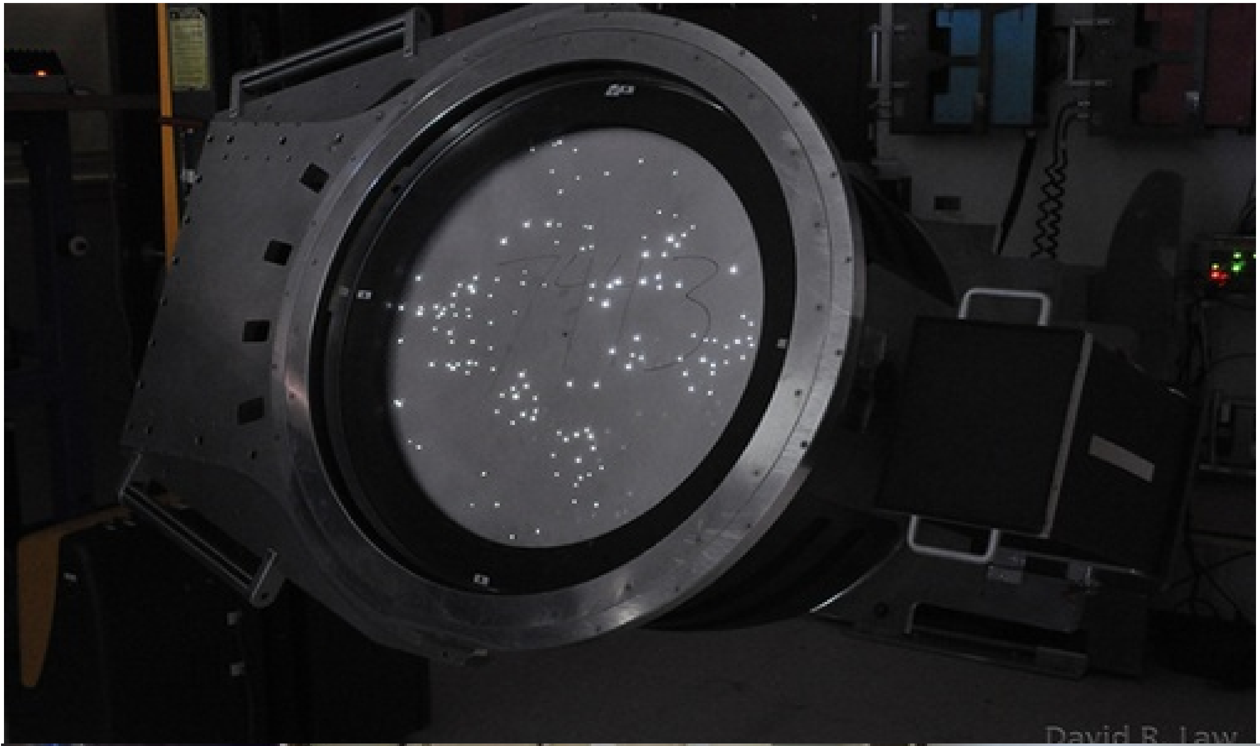
On the left, an image of the face of a 127 fiber IFU. Its ferrule housing which holds the IFU and allows it to be plugged into the SDSS plate is shown on the right.



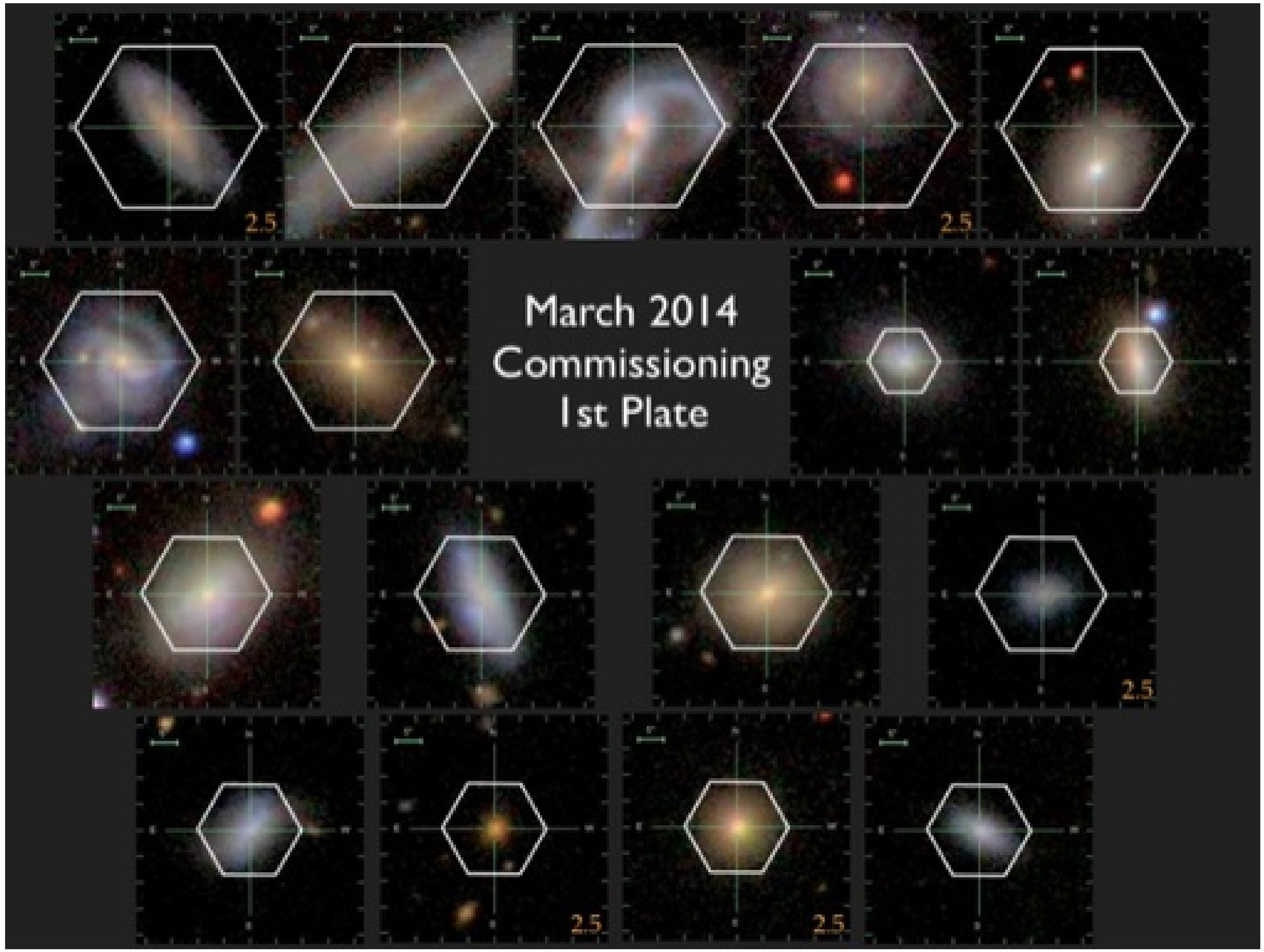
A MaNGA target galaxy, 500 Myr away



Example MaNGA maps from the Jan 2013 test run. Credit: Sebastian Sanchez.



Only 9,966 more to go!



One plate full of galaxies. These galaxies are the very first ones observed by the final MaNGA instrument. Some galaxies have been off-set from the centre of the IFU to allow inclusion of foreground stars, to test our measurement precisions. (credit: K. Bundy).