



The Calar Alto Legacy Integral Field Area (CALIFA) Survey

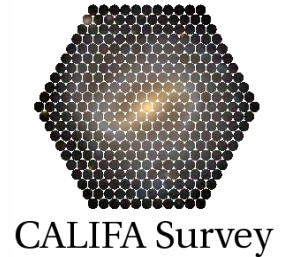
CALIFA collaboration

C. Jakob Walcher
Leibniz Institut für Astrophysik Potsdam (AIP)





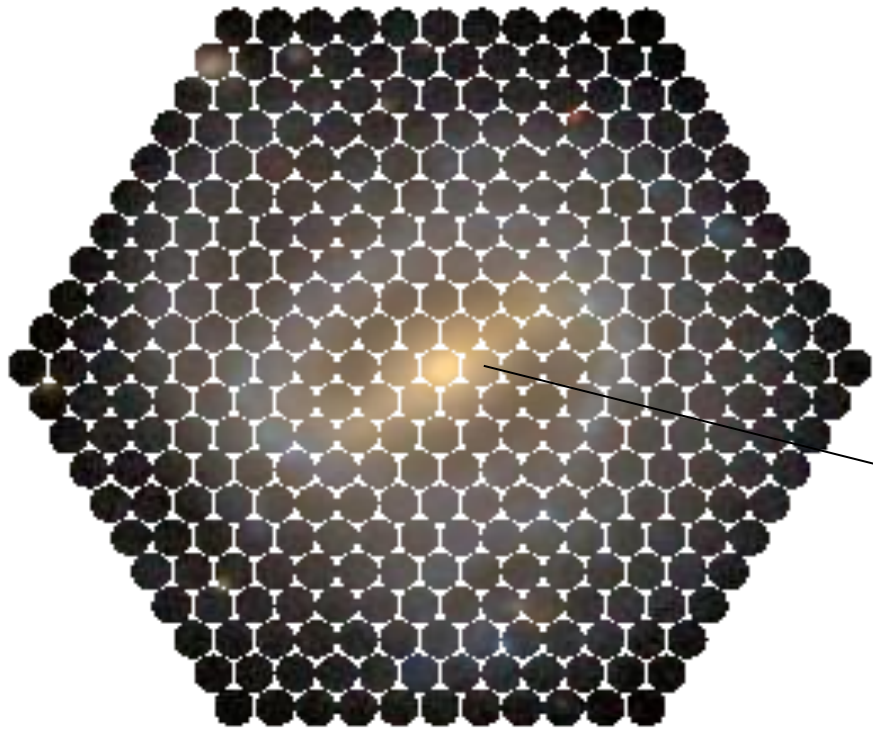
State-of-astronomy



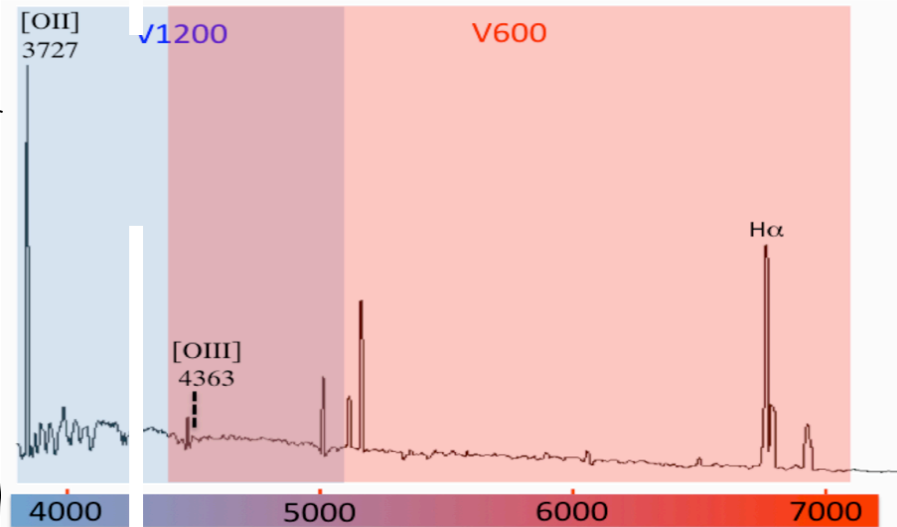
- Λ CDM is the paradigm for cosmology
 - There is no full paradigm for galaxy evolution, because baryonic physics is a complicated, multi-parameter affair
- Age-old questions remain:
- Where and when do the stars in galaxies form?
 - How is angular momentum lost and found?
 - Where and when are the heavy elements made?
 - How is the gas in galaxies processed?



Imaging Spectroscopy (IFS)



CALIFA Survey



Instrument used: PMAS (AIP) at CAHA3.5 (MPIA)



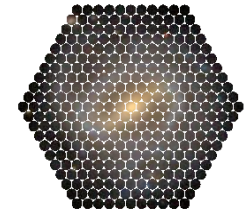
CALIFA: Design Drivers



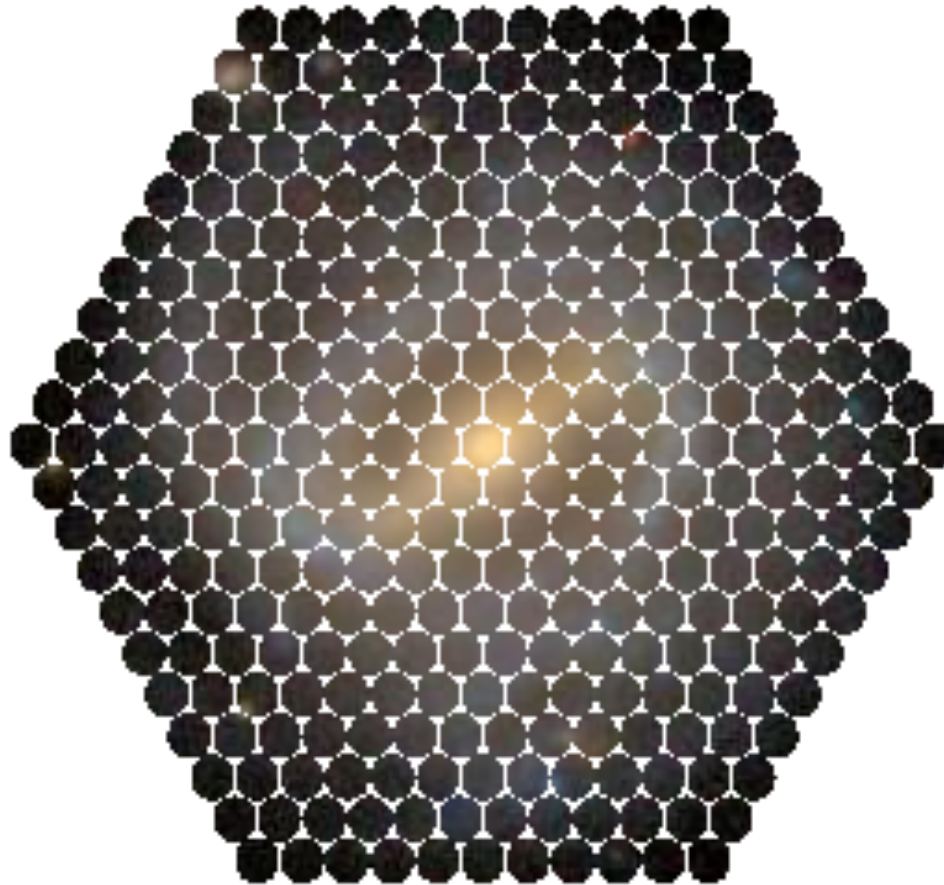
- Be a legacy survey exploiting the power of IFS!
- Large sample of galaxies covering all types.
- Measure the following properties:
 - Stellar populations, ages and metallicities
 - Ionized gas: distribution, excitation mechanism and chemical abundances
 - Kinematics: both from stellar and ionized gas components
- Probe targets over their whole optical extent



Spatial coverage



CALIFA Survey

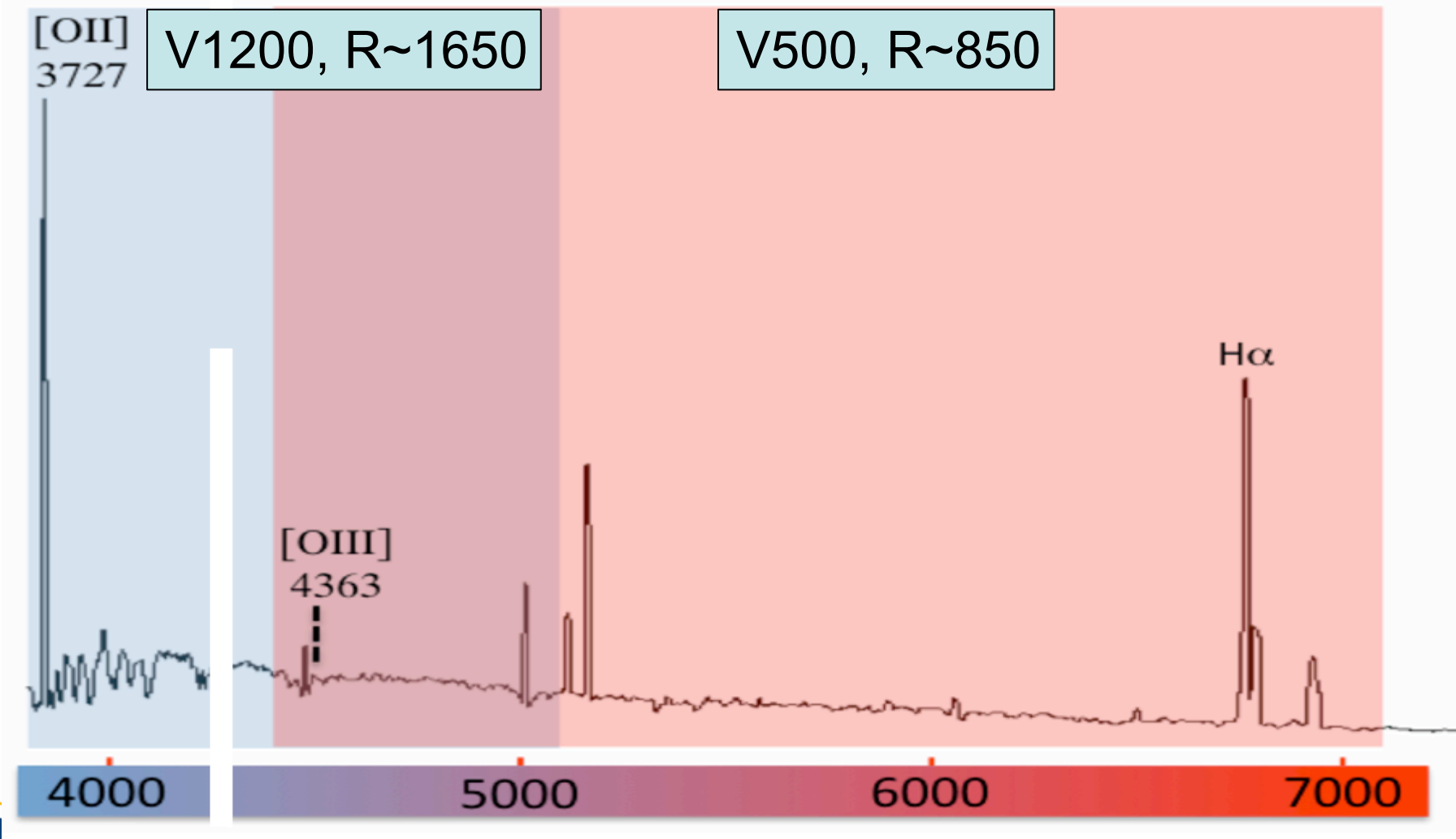
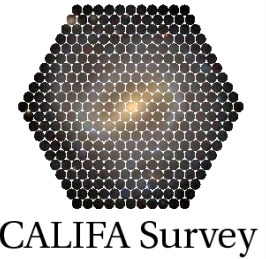


1 fiber \sim 0.5 kpc
1 FoV $>$ $3 \cdot r_e$

CALIFA Survey



Wavelength coverage

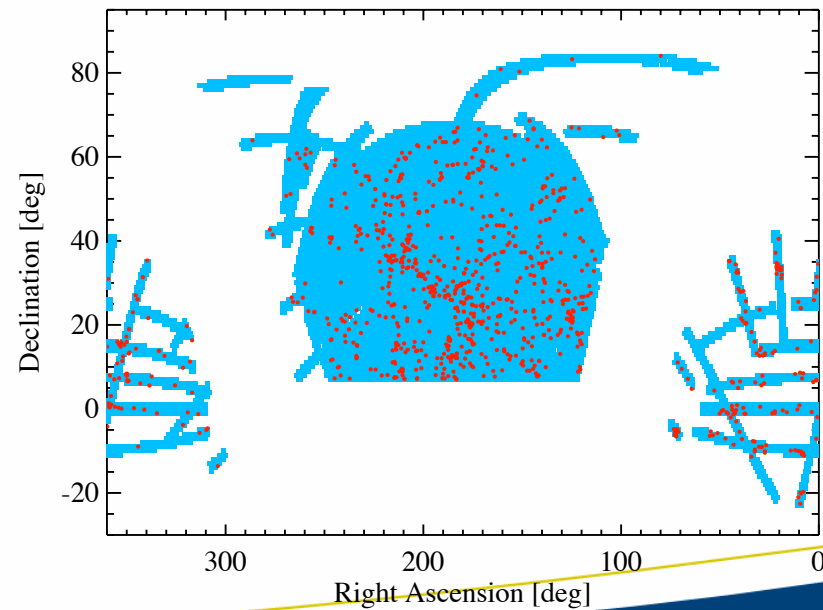
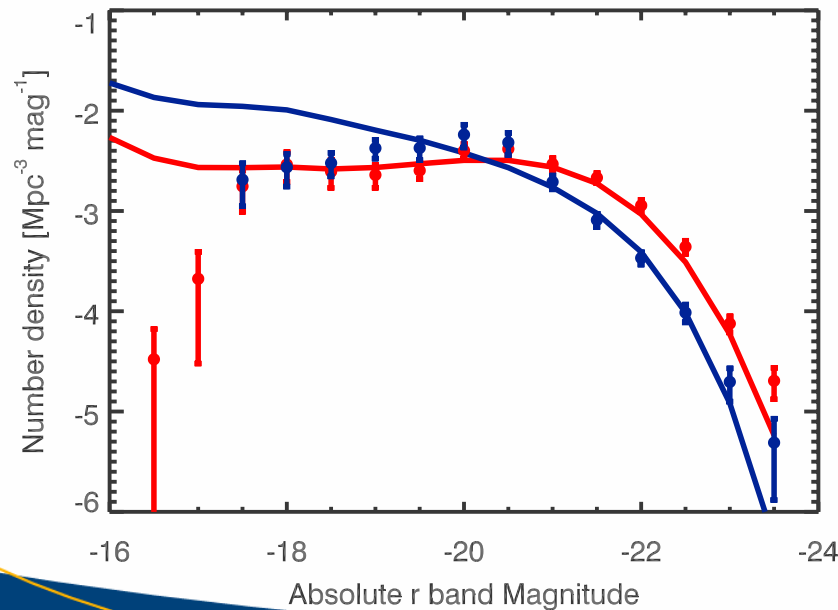




Sample



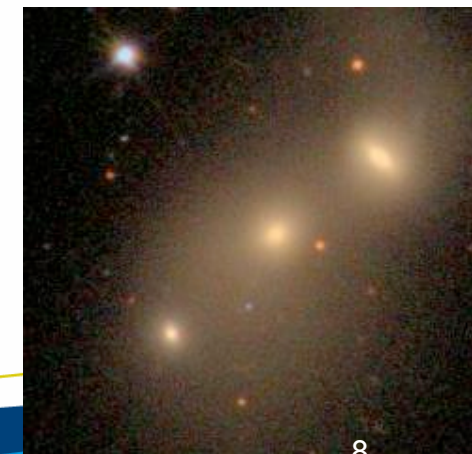
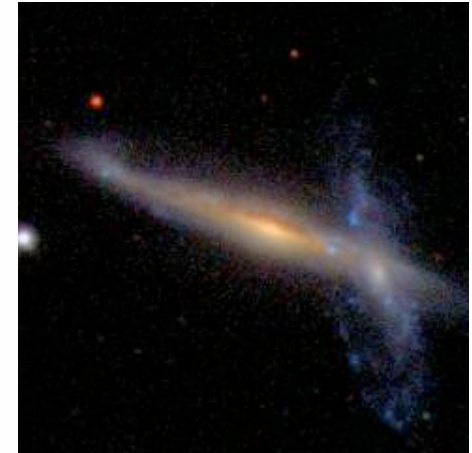
- 600 galaxies will be observed out of a
- mothersample of 937 galaxies.
- $45'' < D_{25} < 80''$ isophotal radius at 25 mag/arcsec²
- $0.005 < z < 0.03$ spatial sampling $2'' \approx 0.5\text{-}1$ kpc





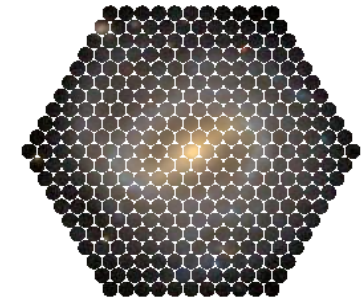
CALIFA Uniqueness

- Large wavelength coverage
 - full BPT, extended view on stelpops
- Large FoV
 - entire galaxies (>3 re)
 - good spatial resolution
- Large, homogeneous sample
 - statistics, classification
 - rare objects (e.g. 114 interacting)
 - comparison between different types
- Regular data releases!





CALIFA status



CALIFA Survey

- Granted 210 dark nights at CAHA over 3 years
- 80 scientists from 20 institutions in 7 countries
- PI: S. Sanchez, PS: C.J. Walcher
- >170 Objects observed in both setups (>250 V500)
- First articles being published
- Automatic data reduction pipeline working, vs 1.3

**Data Release 1: November 1st 2012!
100 objects with good quality**

<http://califa.caha.es/>

News Publications Contact Next Events

CALIFA 1st Data Release Searching Tool (for Mac users)

This searching tool is designed to select CALIFA data corresponding to particular targets, based on some of their properties. It includes all CALIFA galaxies comprised in the mother sample. Therefore, many of the listed objects may not have released data. If you are not sure of list of released objects please select "[Galaxies with both setups](#)" in the Object entry.

Object

RA (HH:MM:SS) ± DELTA_RA (MM)

DEC (±DD:MM:SS) ± DELTA_DEC (MM)

REDSHIFT -

g-band magnitude -

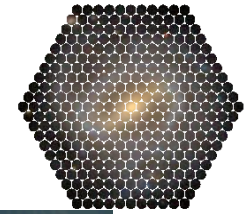
Hubble type

Barredness

Merging or isolated



DR1 tools



A Survey

ALIFA Red Book

ALIFA Collaboration

Members

Structure

Publications

News

Events

Text Events

ALIFA Sample

Observed Objects Up-to-Date

SDSS Poststamps: Obs. Sample

SDSS poststamps: Full sample

ALIFA Meetings

With Busy Week

Hard Busy Week

Mid Busy Week

Soft Busy Week

Click-Off Meeting

Internal WIKI

login

username:

password:

login

request new password

search

CALIFA EXPLORER V1.0

Tue, 11/22/2011 - 15:31

NAME (684)	RA	DEC	CALIFAID
NGC5406	14:00:20.11	+38:54:55.53	684

BASIC PARAMETERS	VALUE	REF.
Name	NGC5406	NED
Redshift	0.0180046	SDSS
Petrosian Mags (u,g,r,i,z)	(15.2046 ,13.1207 ,12.37 ,11.9409 ,)	SDSS
Galactic Extinctions (u,g,r,i,z)	(0.060522 ,0.0445315 ,0.032298 ,0.0244906 ,0.0173641)	SDSS

CALIFA OBSERVATIONS

V500

20120516

[V500 Cube](#)

V1200

20120621

[V1200 Cube](#)

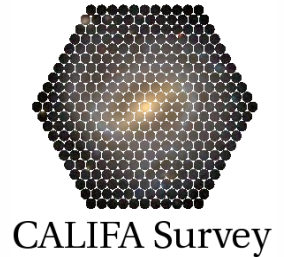
17.10.2012

ESO Surveys Meeting / Walcher

11



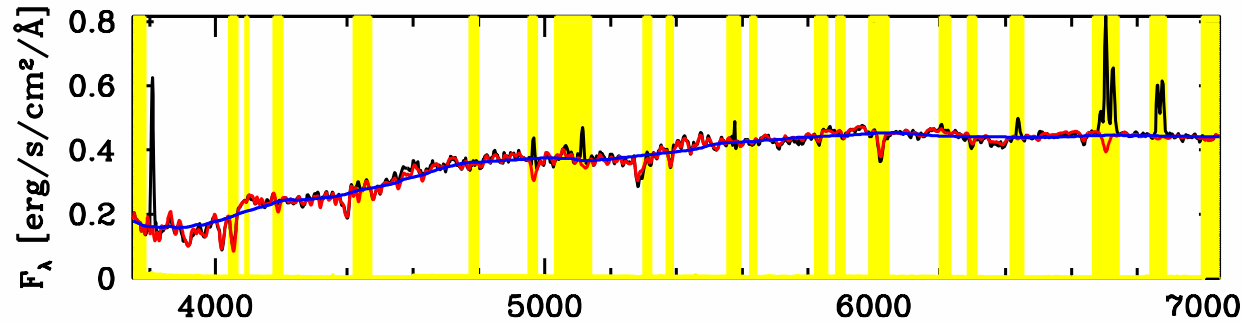
Data Quality



- Characteristic performance:
 - Surface brightness 3σ :
 - ~ 23.0 mag/arcsec² for V500
 - ~ 22.8 mag/arcsec² for V1200
 - Wavelength:
 - ~ 5 km s⁻¹ for V1200
 - ~ 10 km s⁻¹ for V500
 - Sky subtraction residual $\sim 6\%$
 - Flux calibration:
 - $\sim 3\%$ relative (blue-to-red)
 - $\sim 15\%$ absolute (tied to SDSS)
- Primary products:
 - Resampled data cubes with 1sq arcsec spaxels
 - Meaningful noise cubes!

Husemann et al., submitted

Data Analysis



Spectral fitting is a key tool

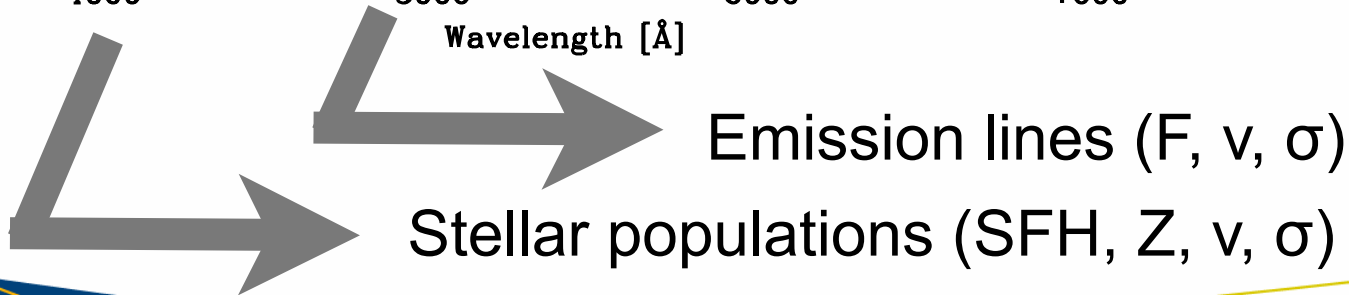
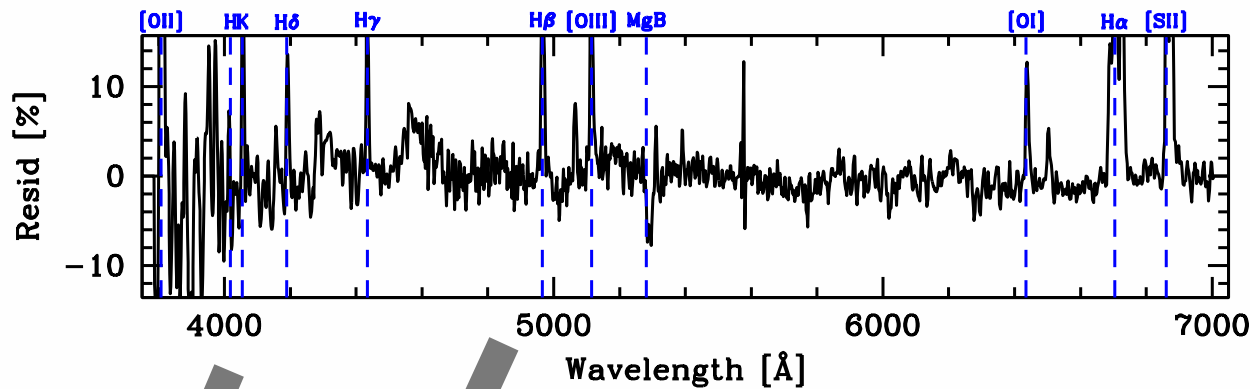
Challenges:

1 Million spectra

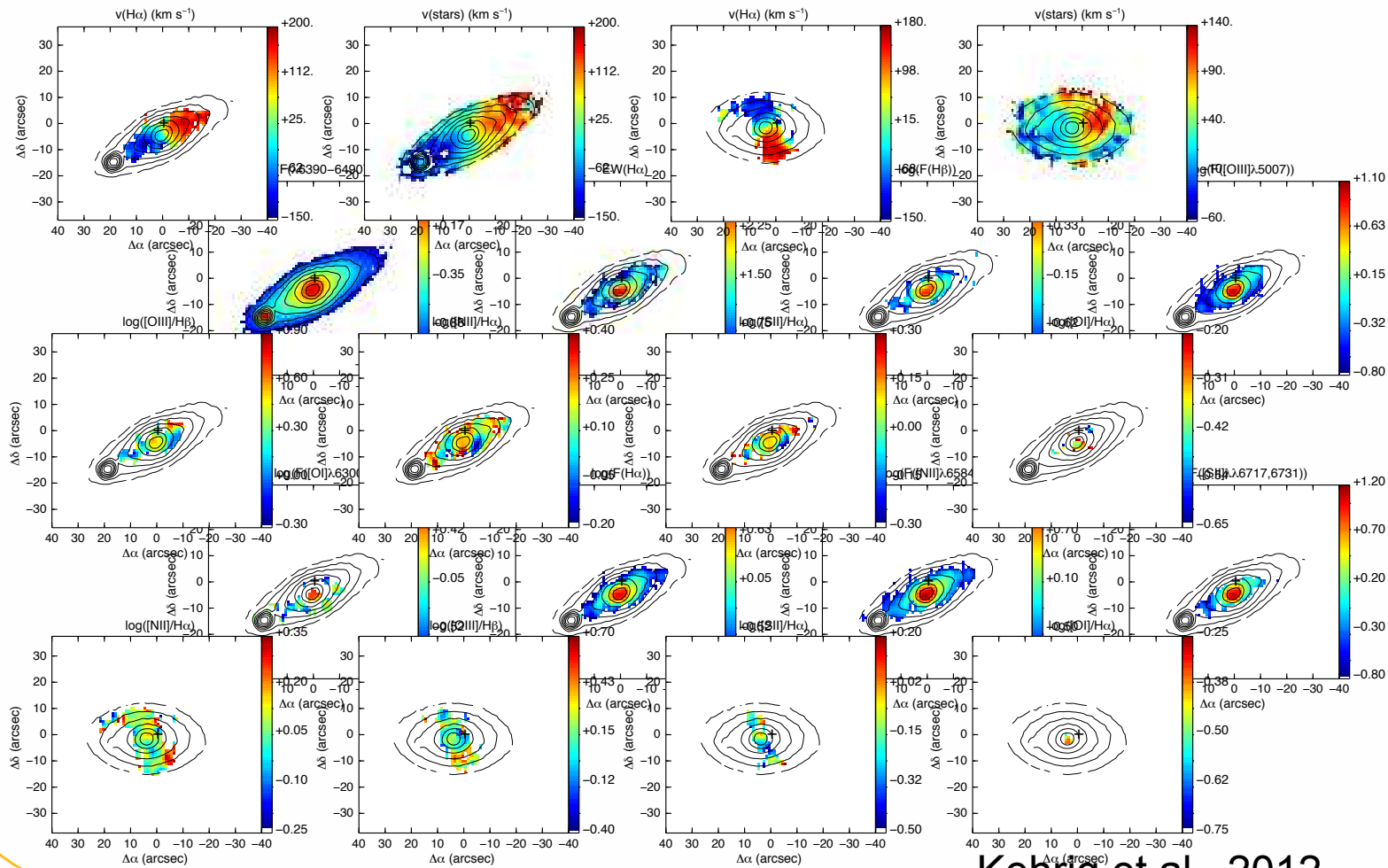
Data issues

Unusual physics

Data presentation

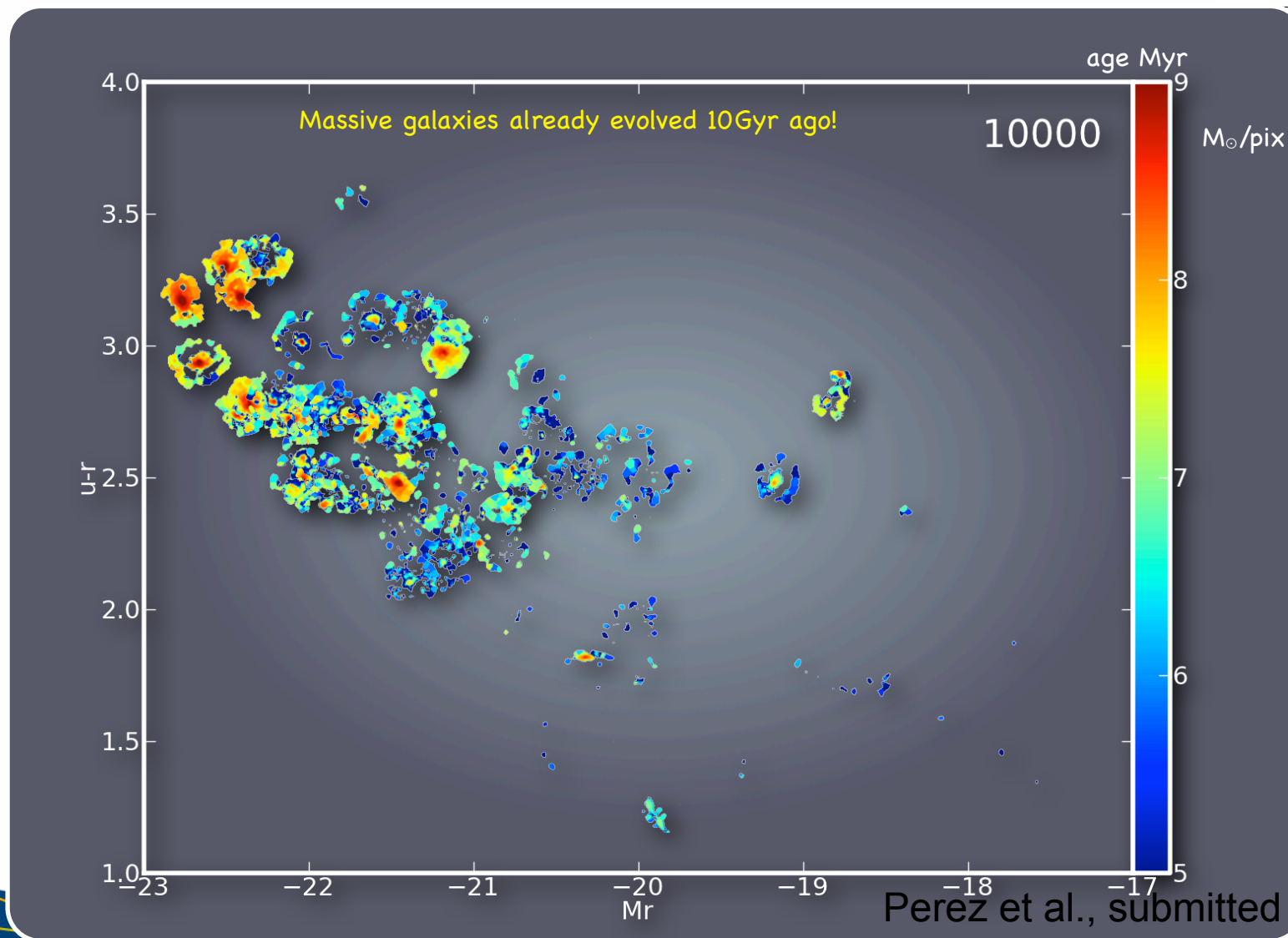
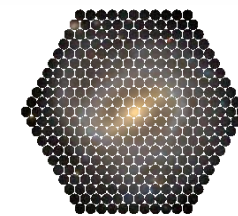


Data products: property maps

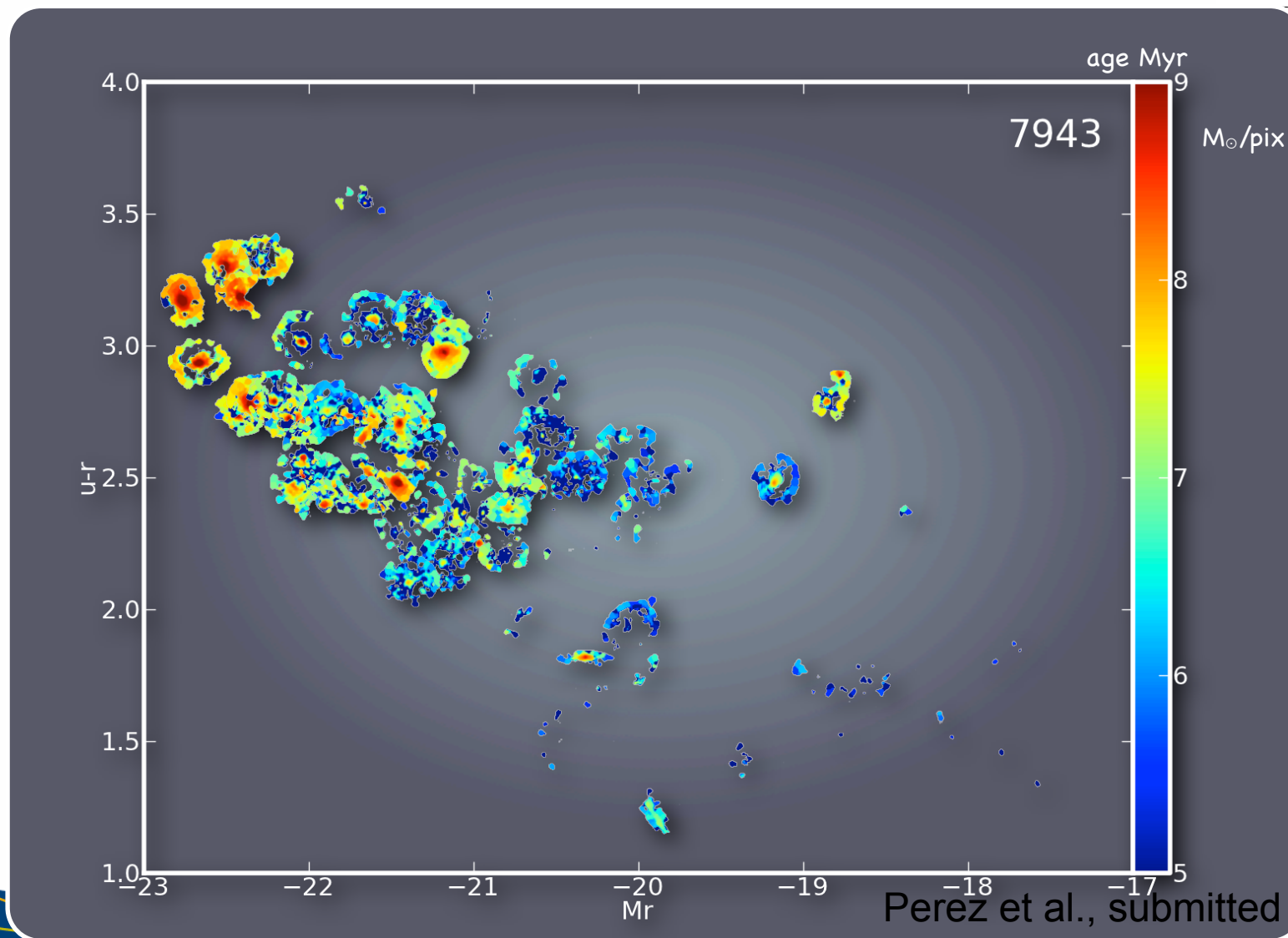
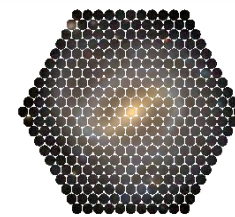


Kehrig et al., 2012

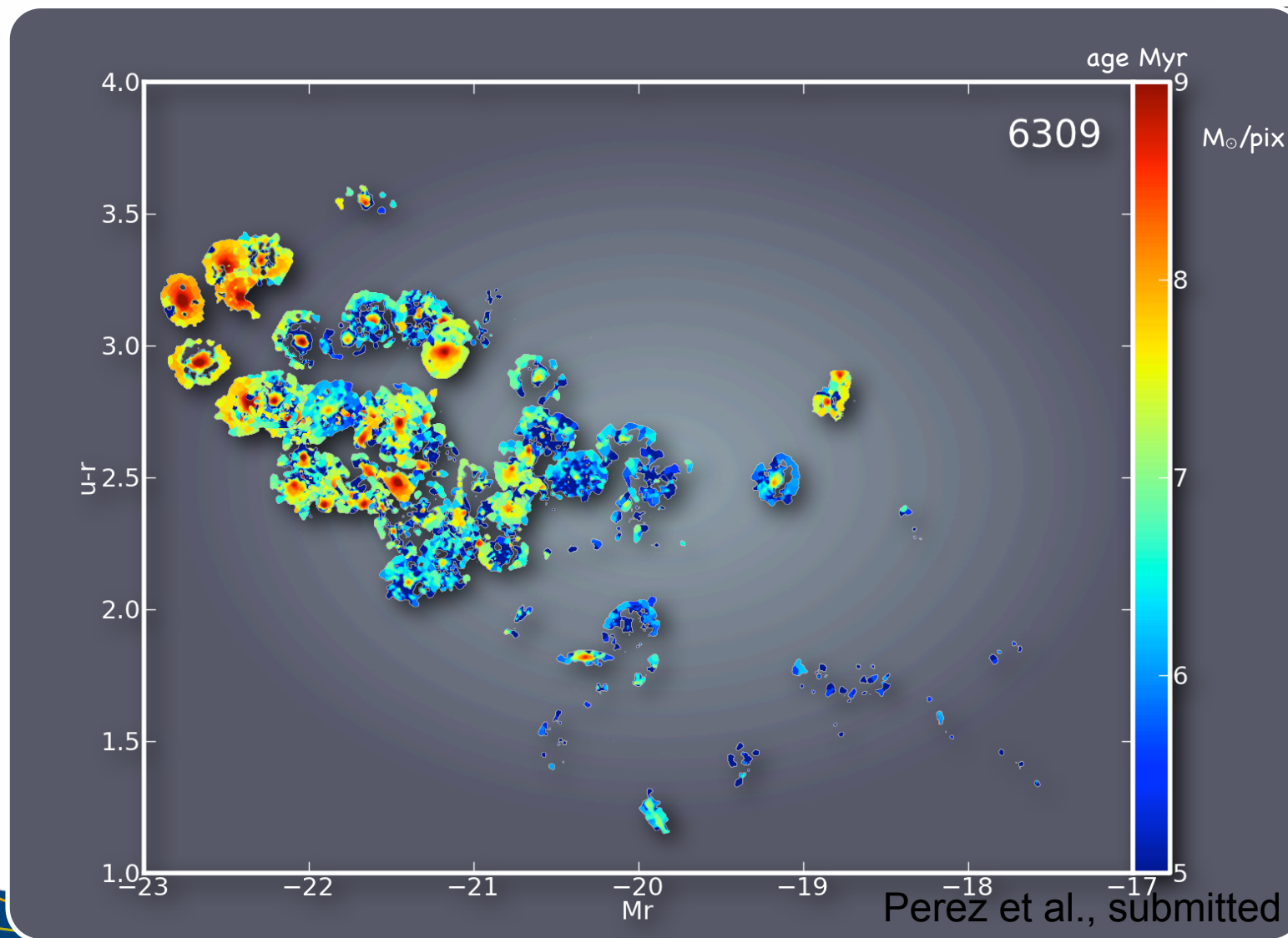
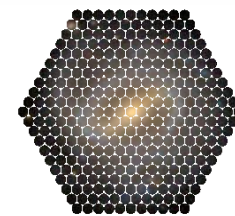
How stellar mass builds up



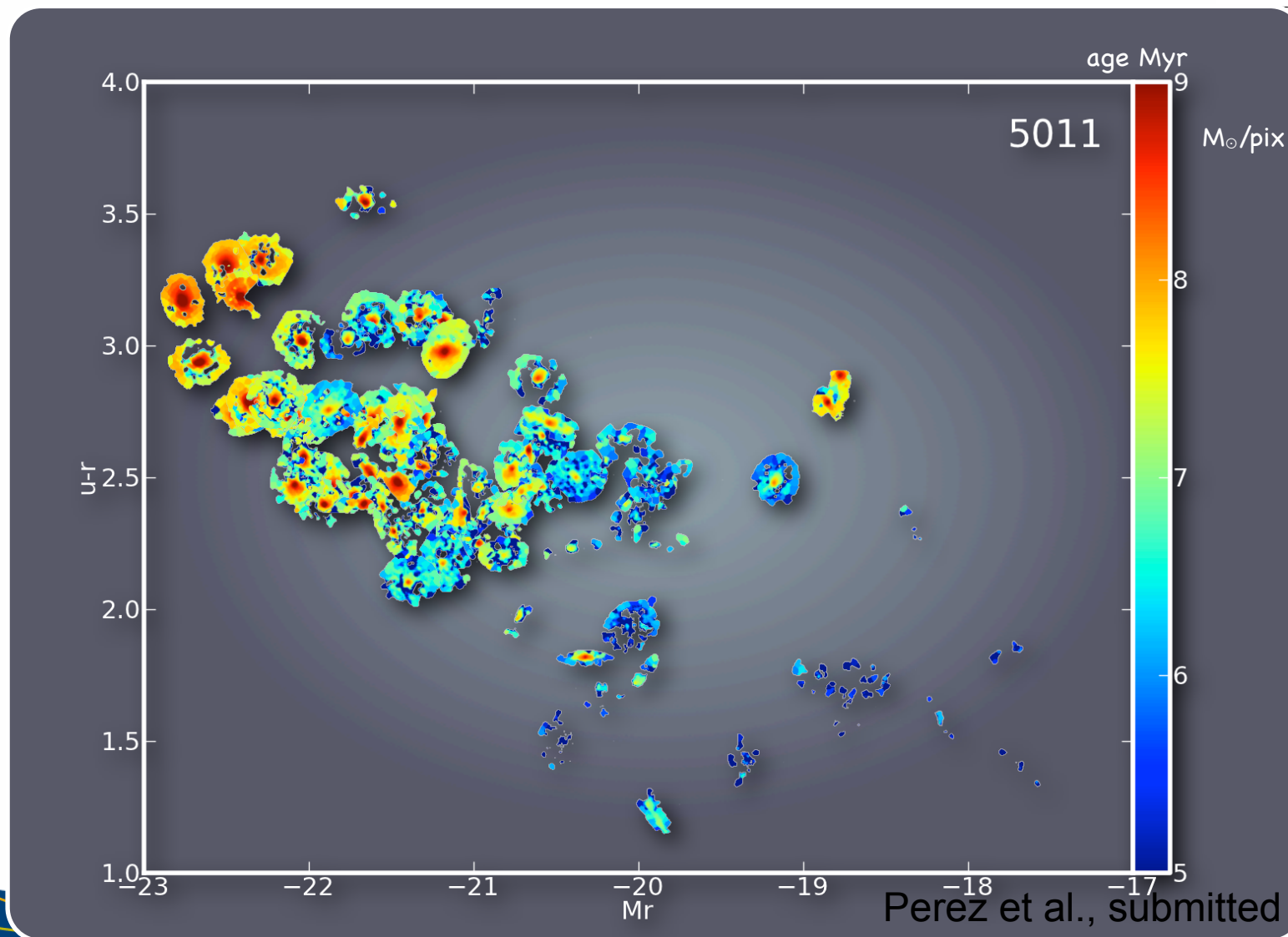
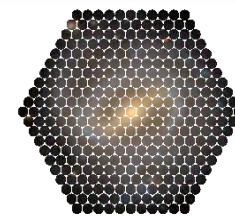
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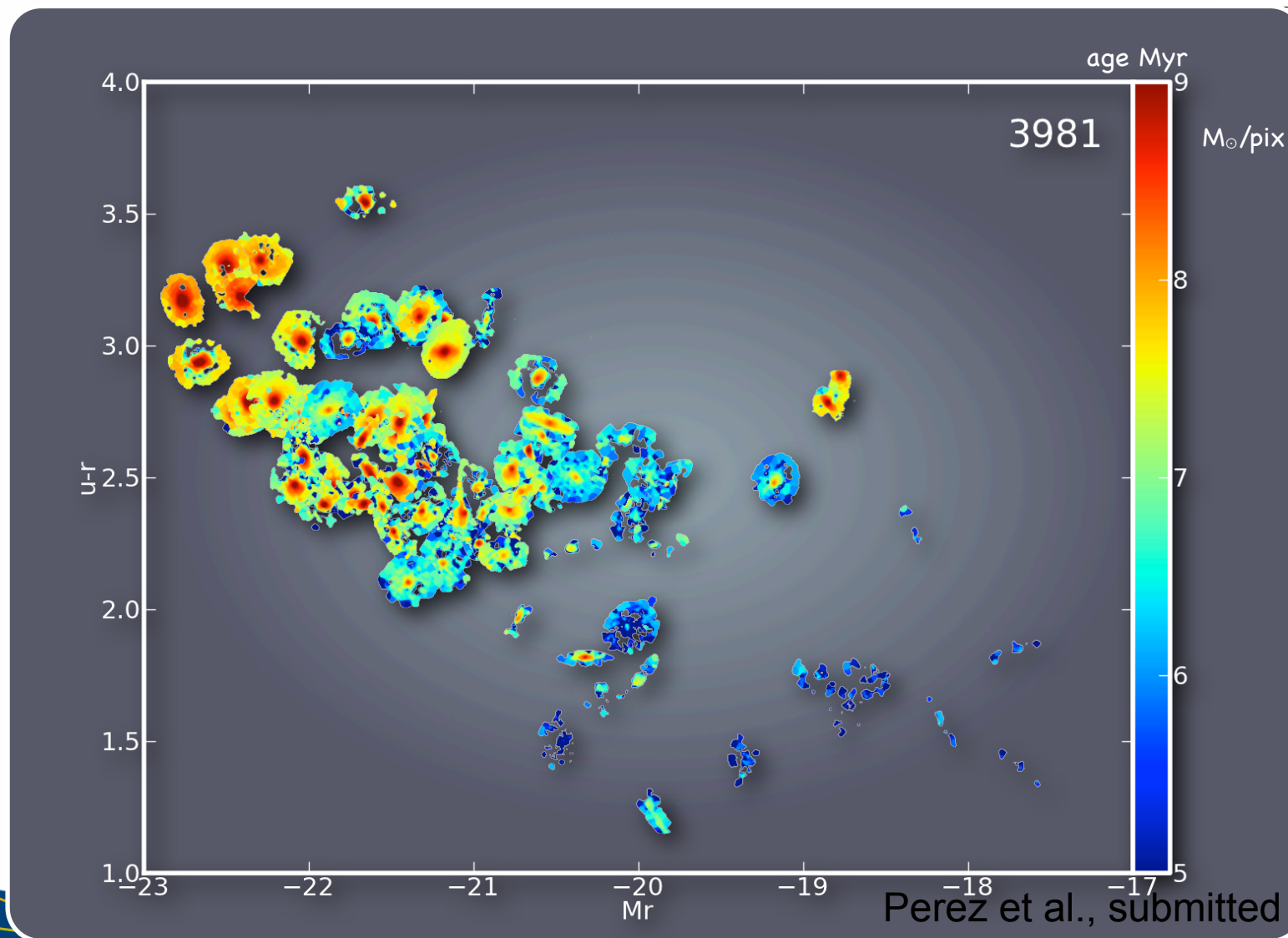
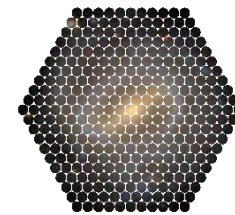
How stellar mass builds up



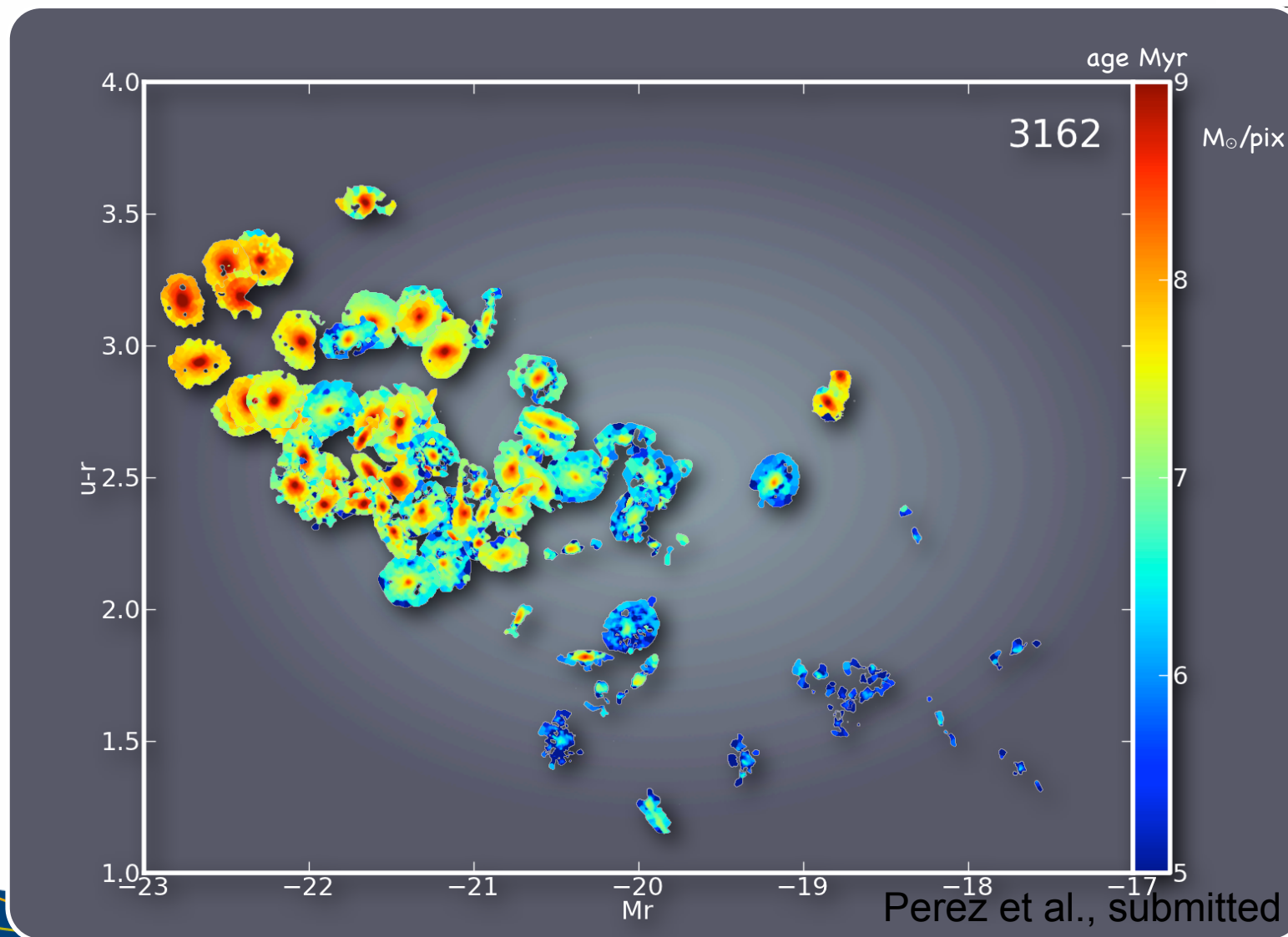
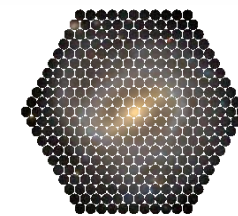
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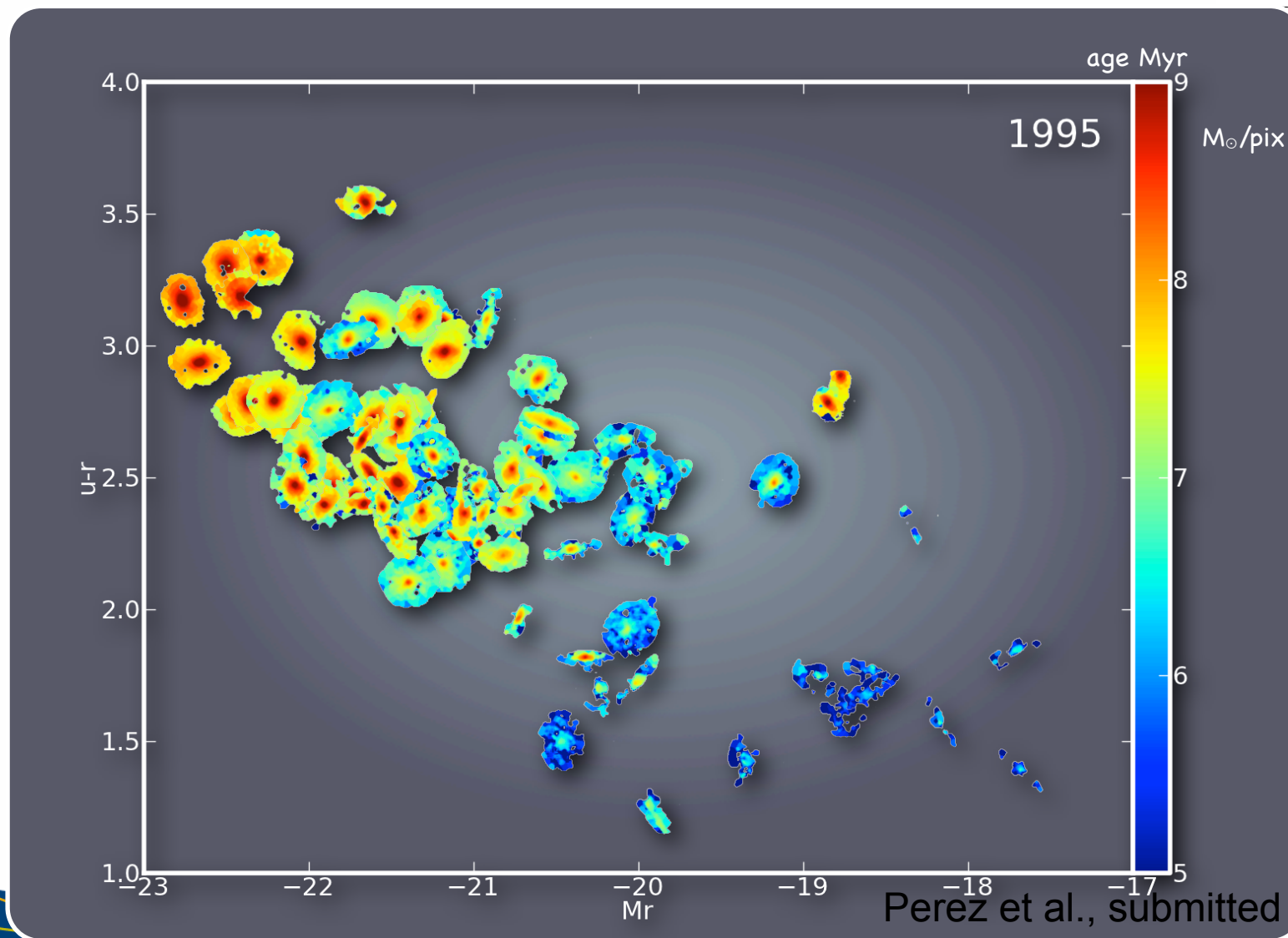
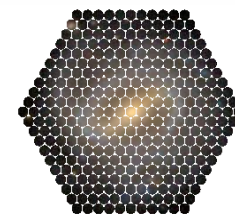
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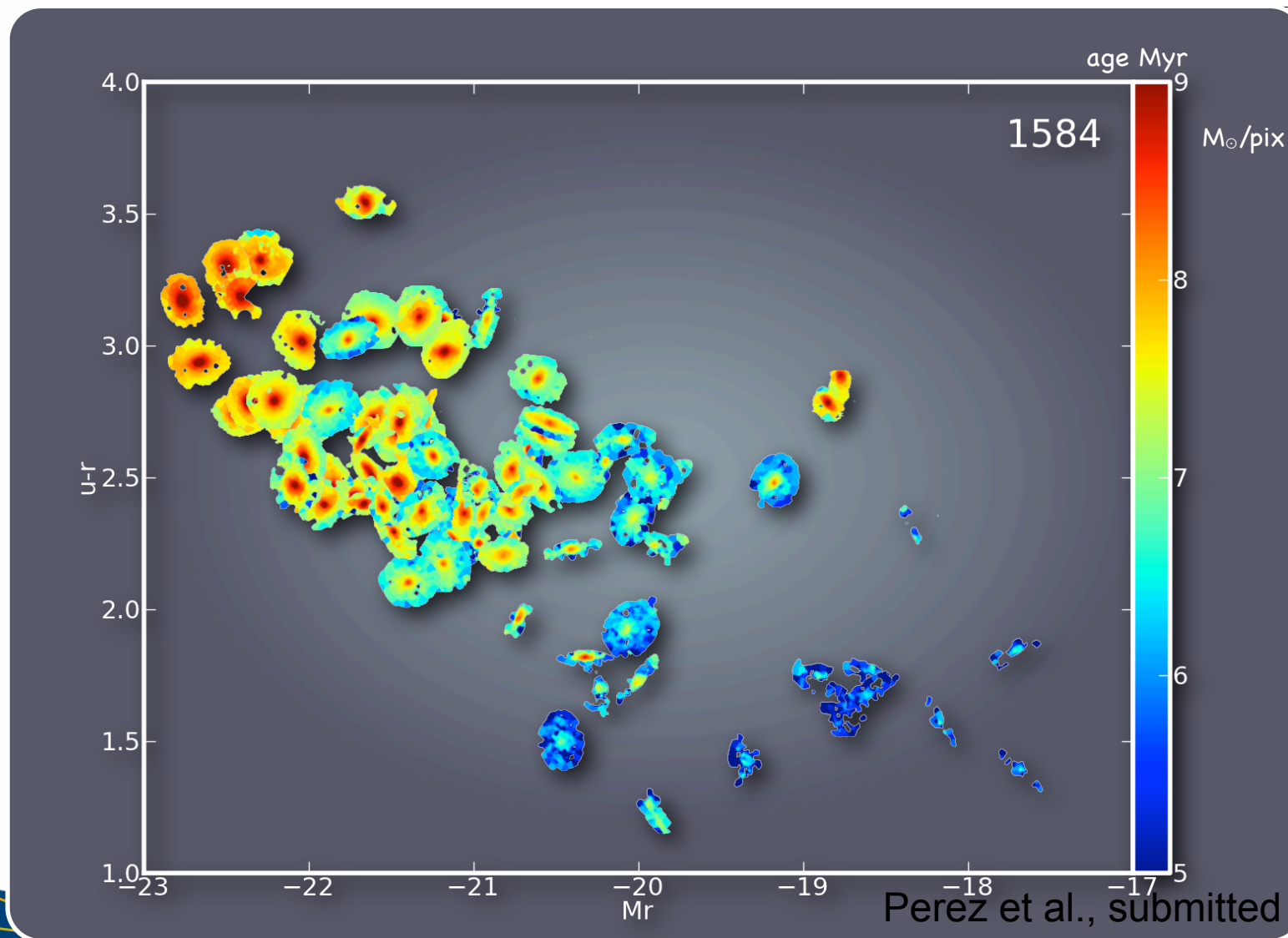
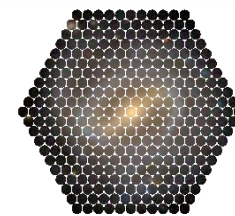
How stellar mass builds up



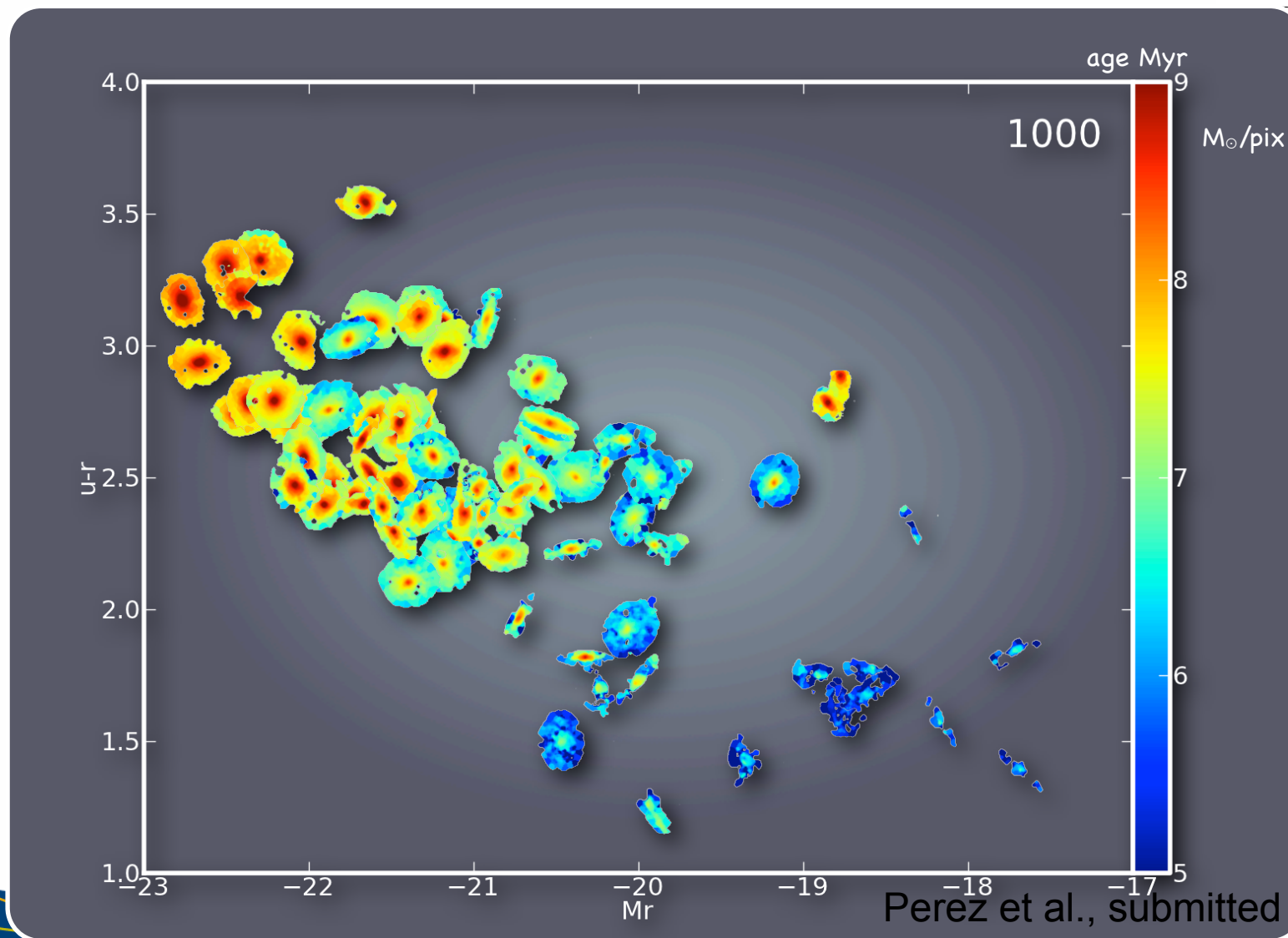
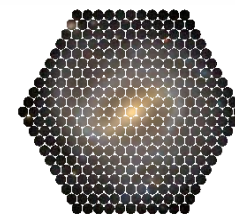
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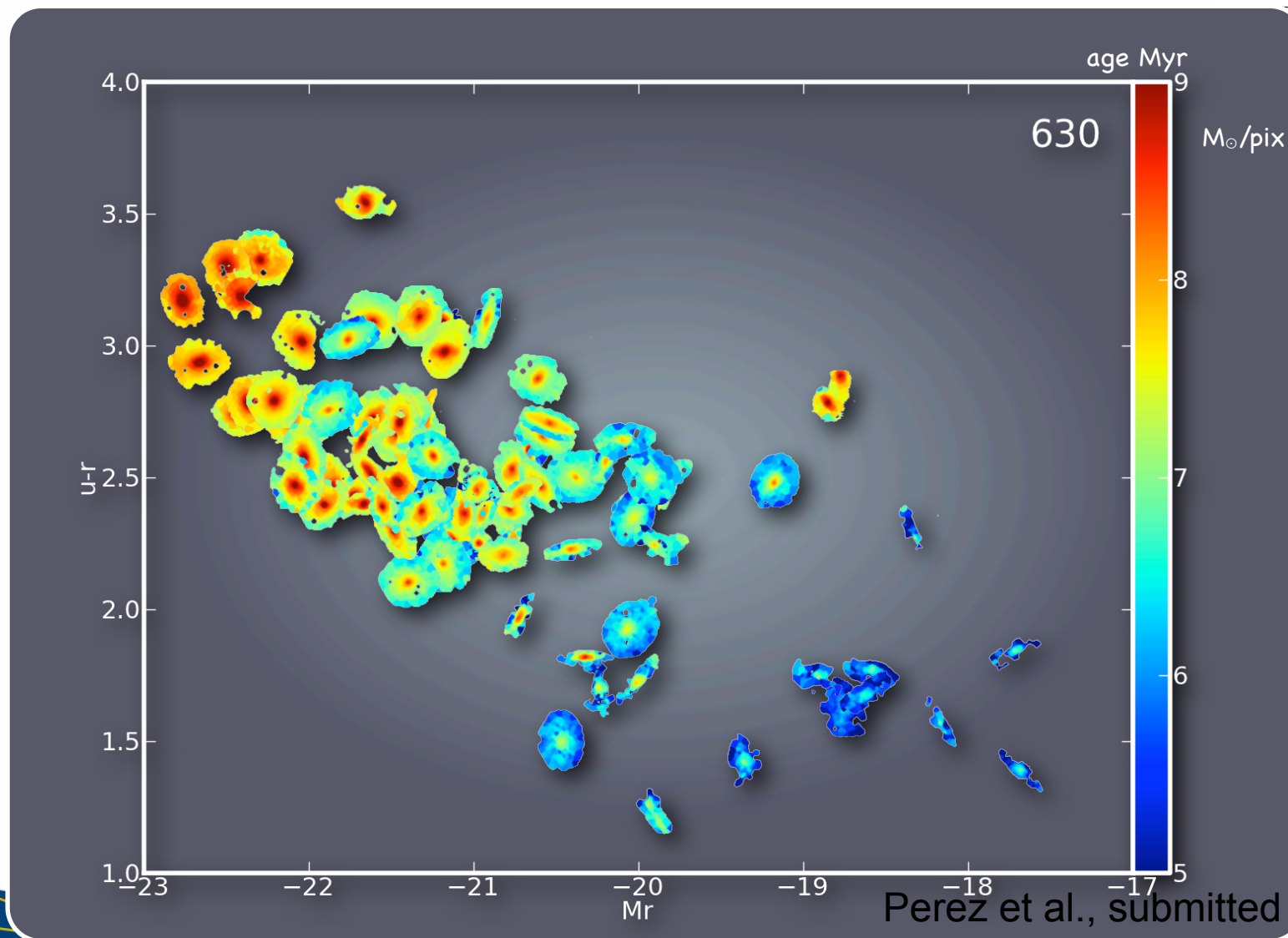
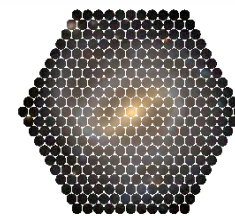
How stellar mass builds up



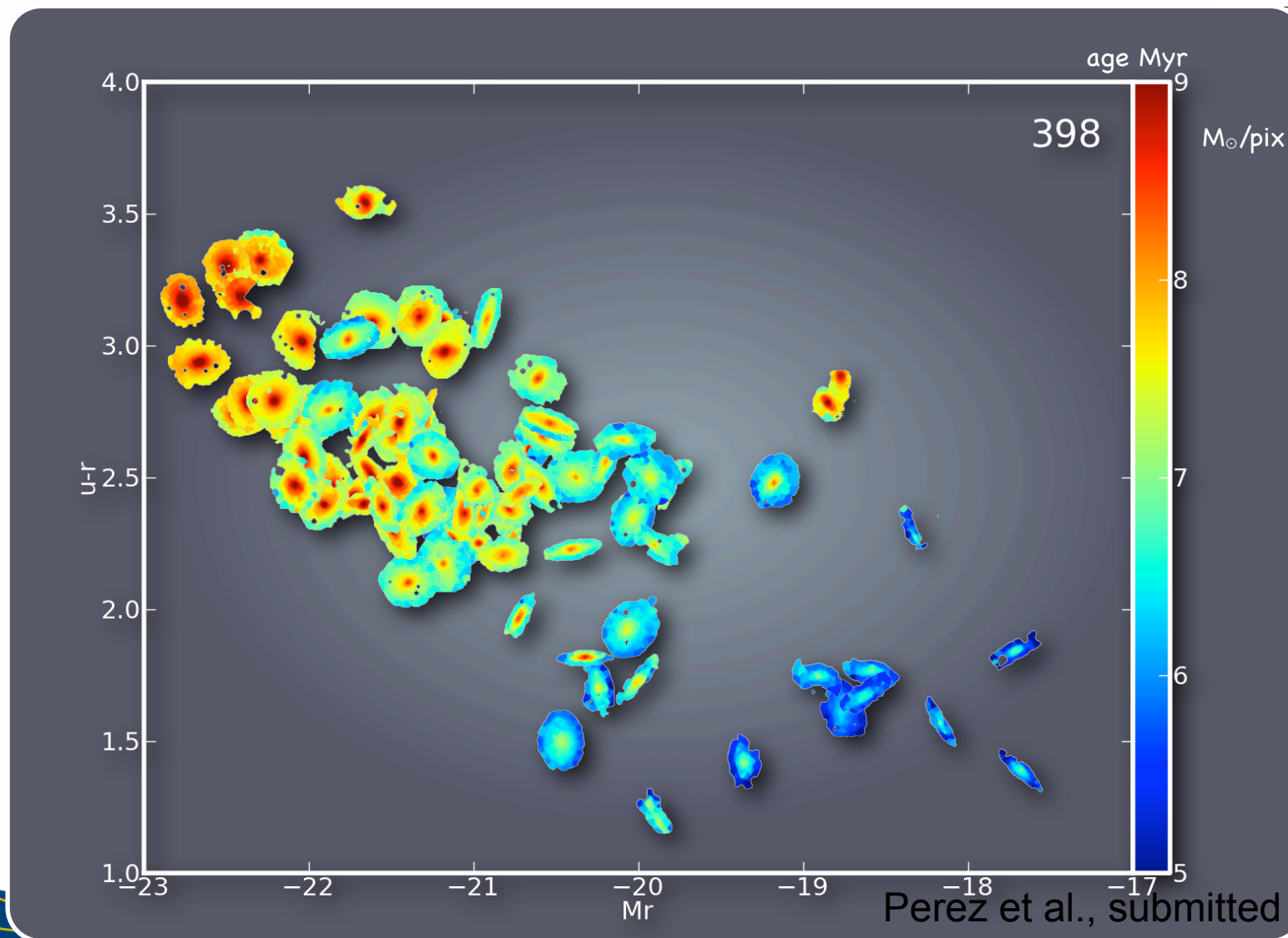
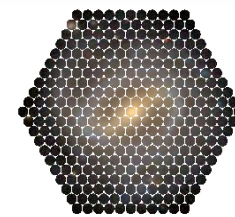
How stellar mass builds up



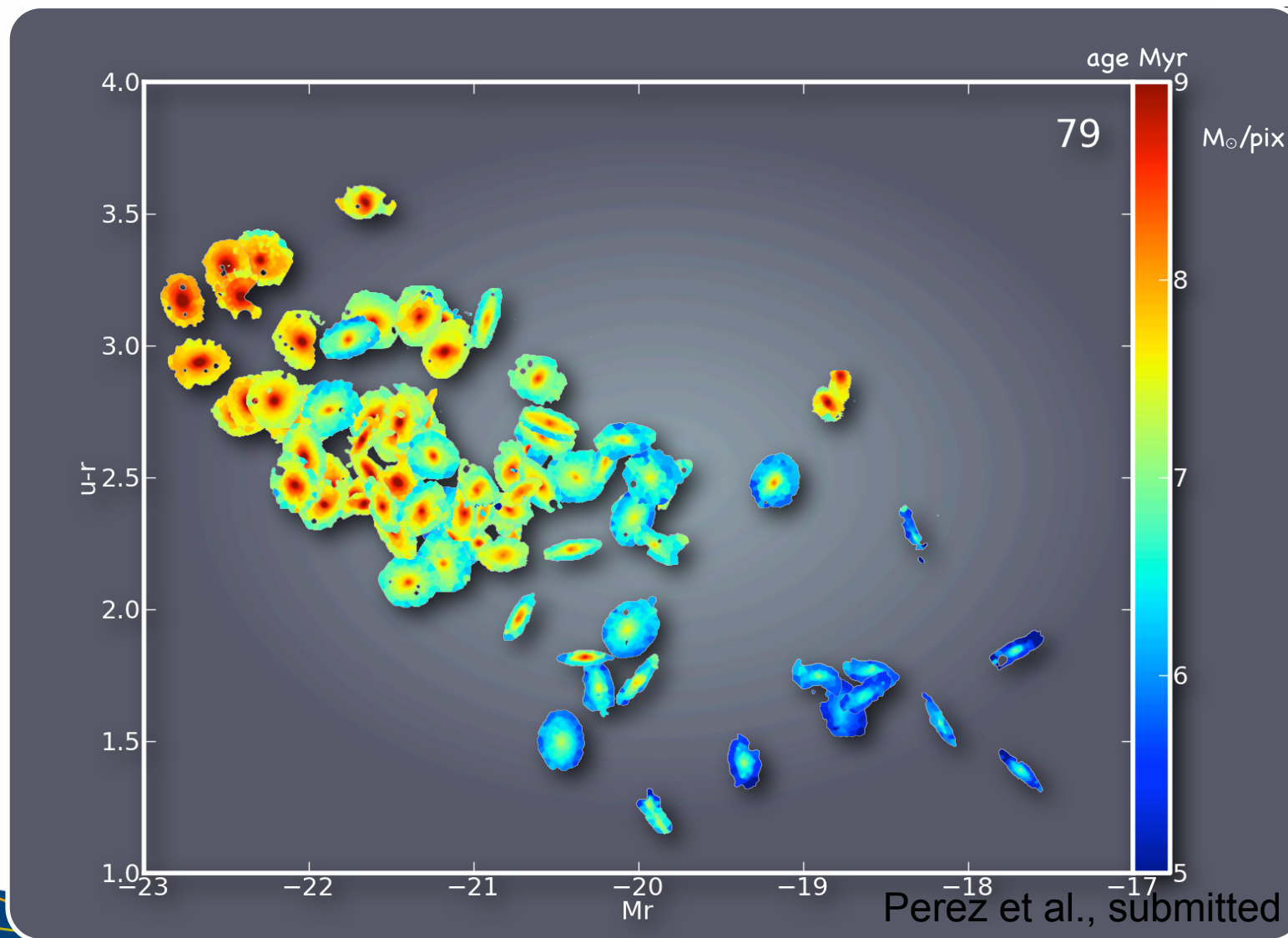
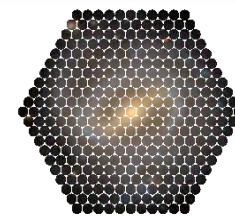
How stellar mass builds up



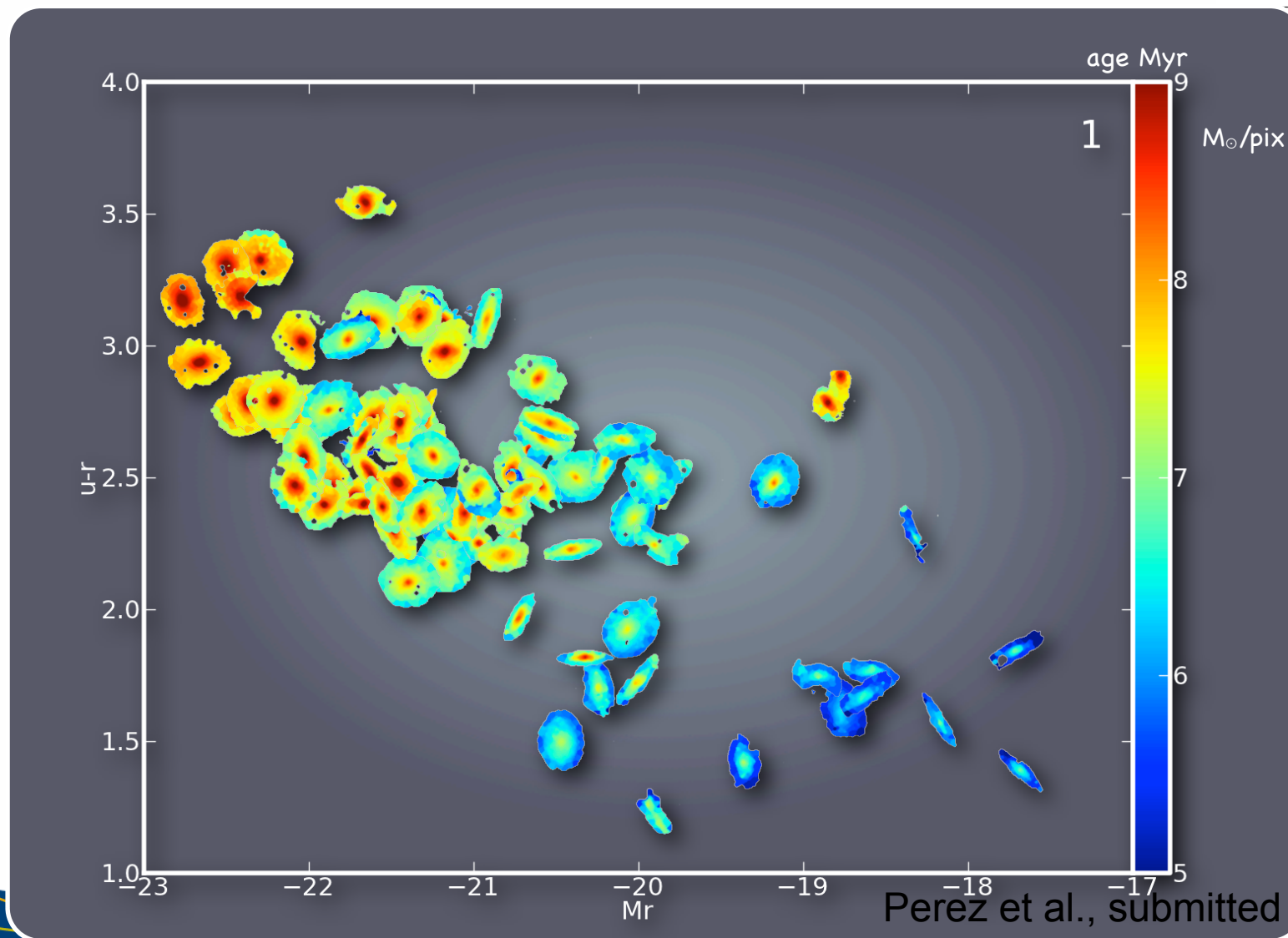
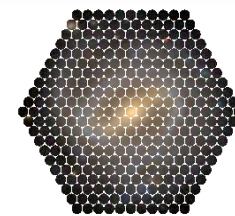
How stellar mass builds up



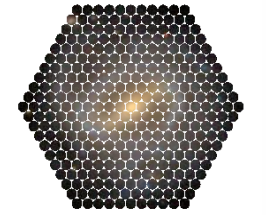
How stellar mass builds up



How stellar mass builds up



Stellar Kinematics

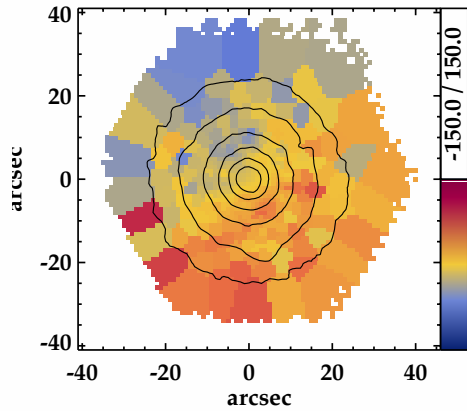


CALIFA Survey

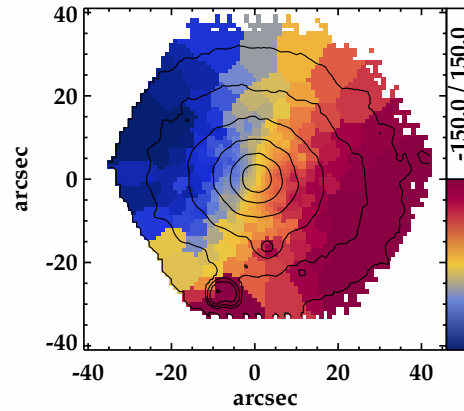
**Slow Rotator
(Low V , High σ)**

**Bulge+disk galaxy
(High V , High σ)**

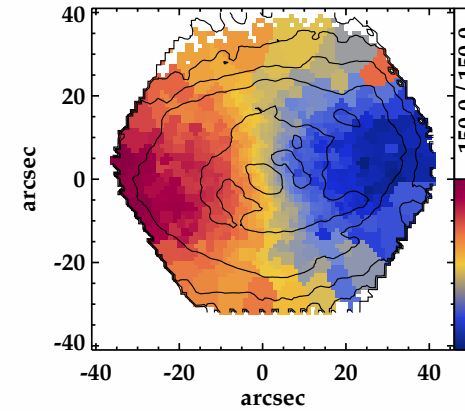
**Pure disk
(High V , Low σ)**



NGC6125

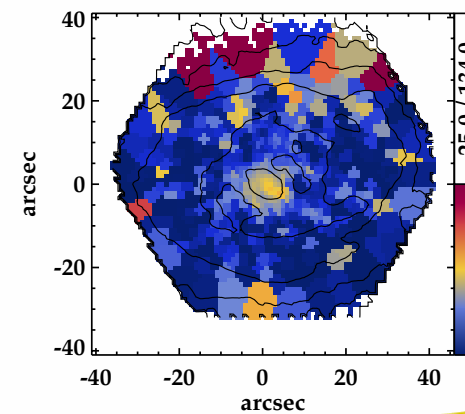
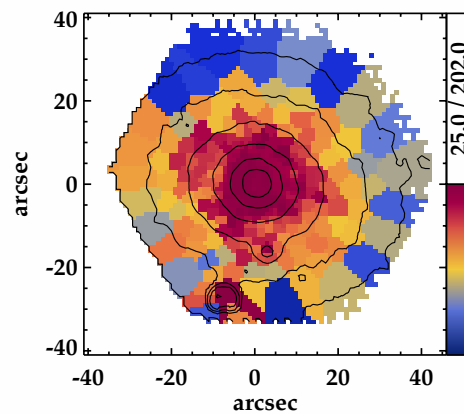
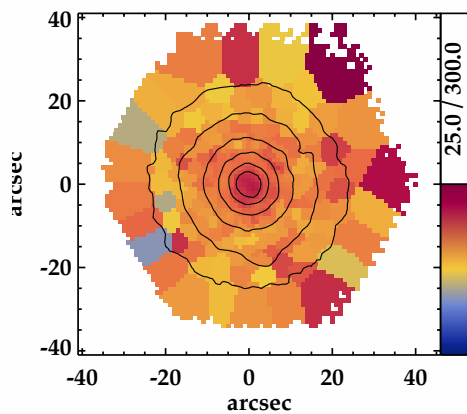


NGC4210



NGC1167

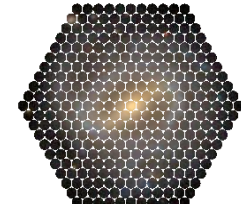
V



σ

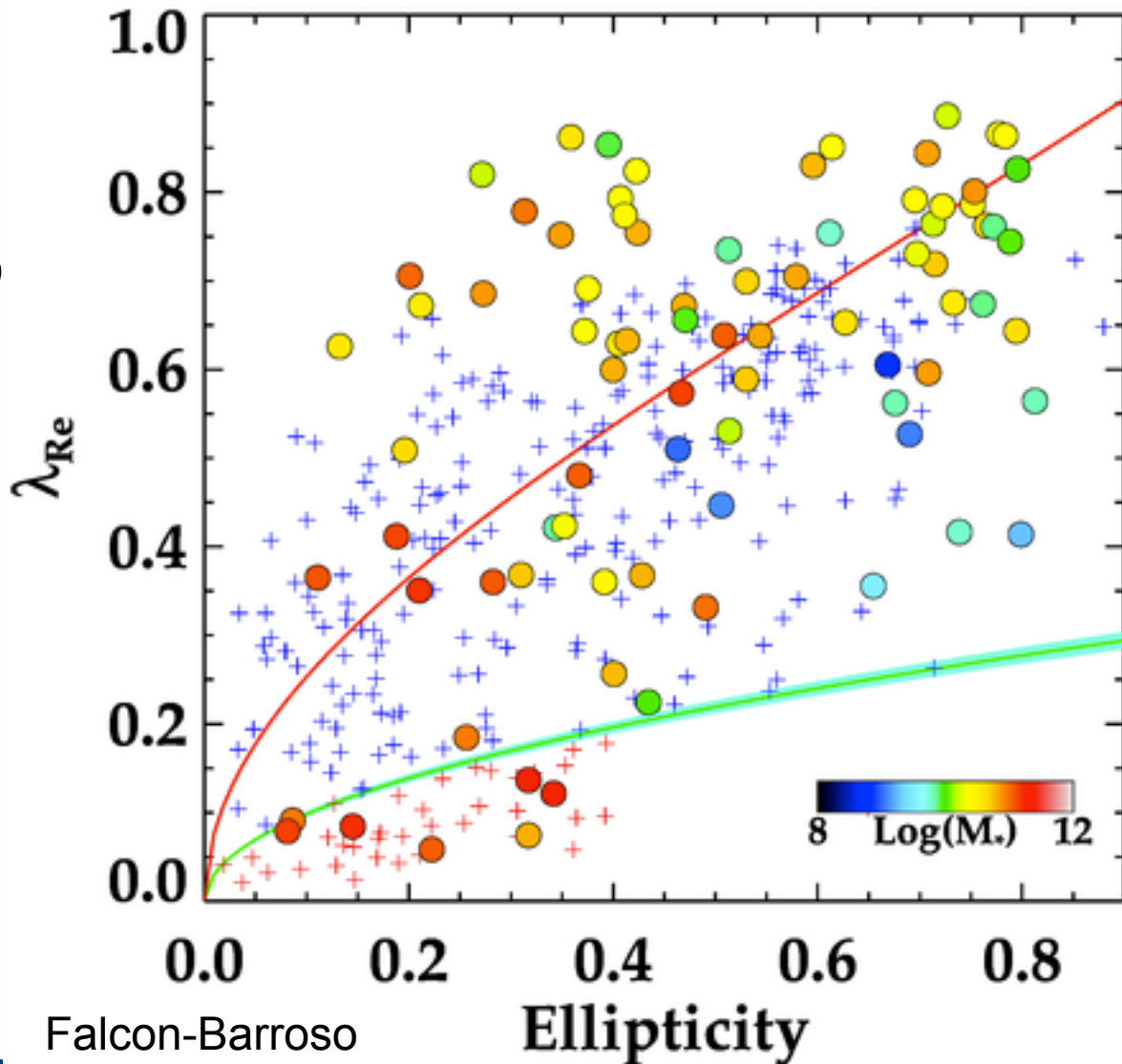
Falcon-Barroso et al., in prep.

Kinematic classification



CALIFA: extension to

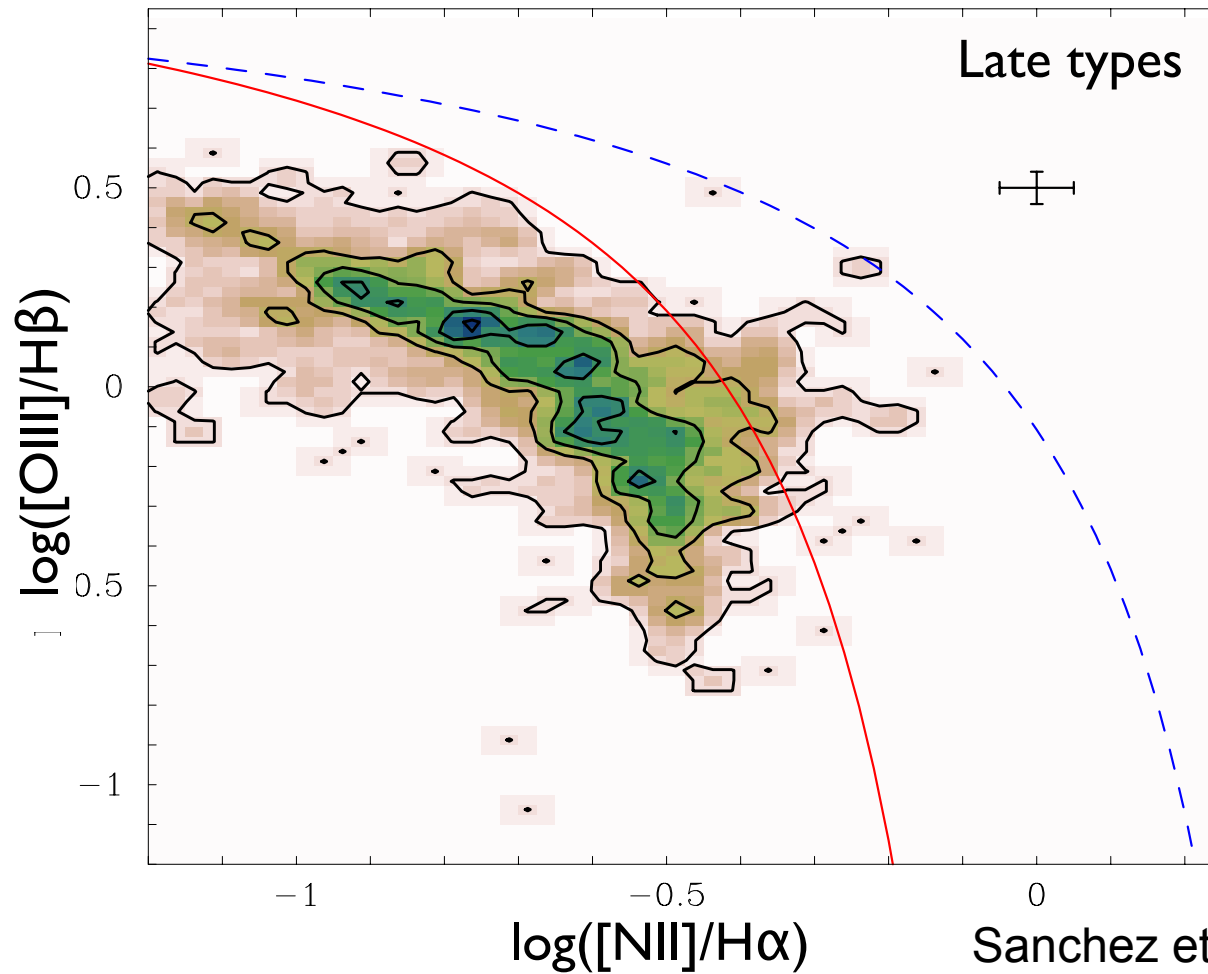
- Bulges
- Bars
- Disks!



Falcon-Barroso

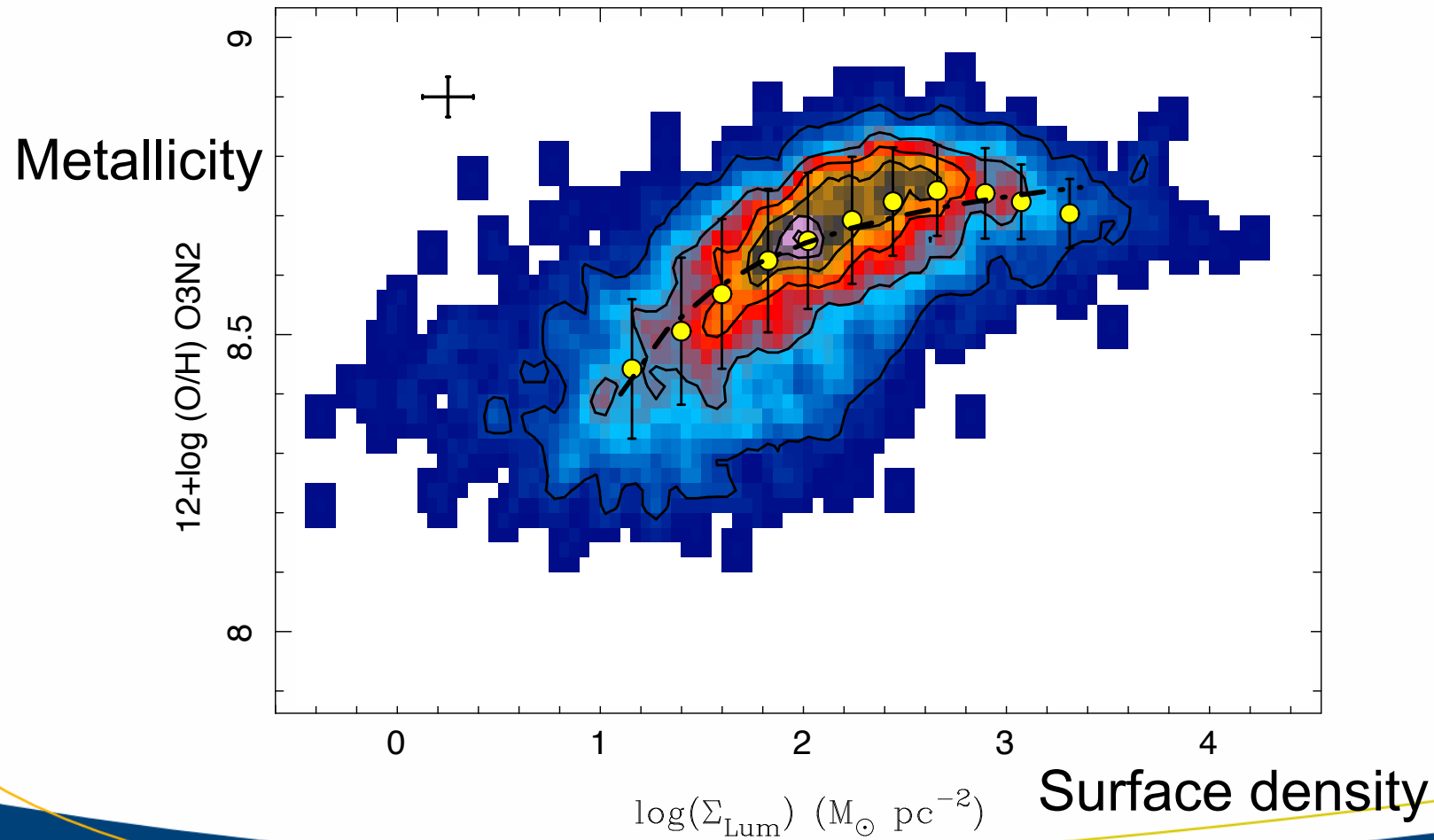
Ellipticity

ISM physics - excitation



Plotting
all the
fibers

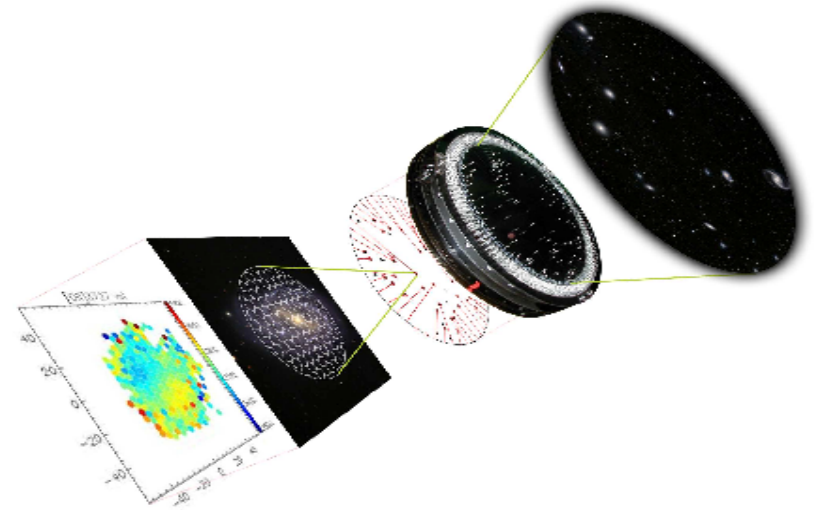
Global M-Z local Σ -Z





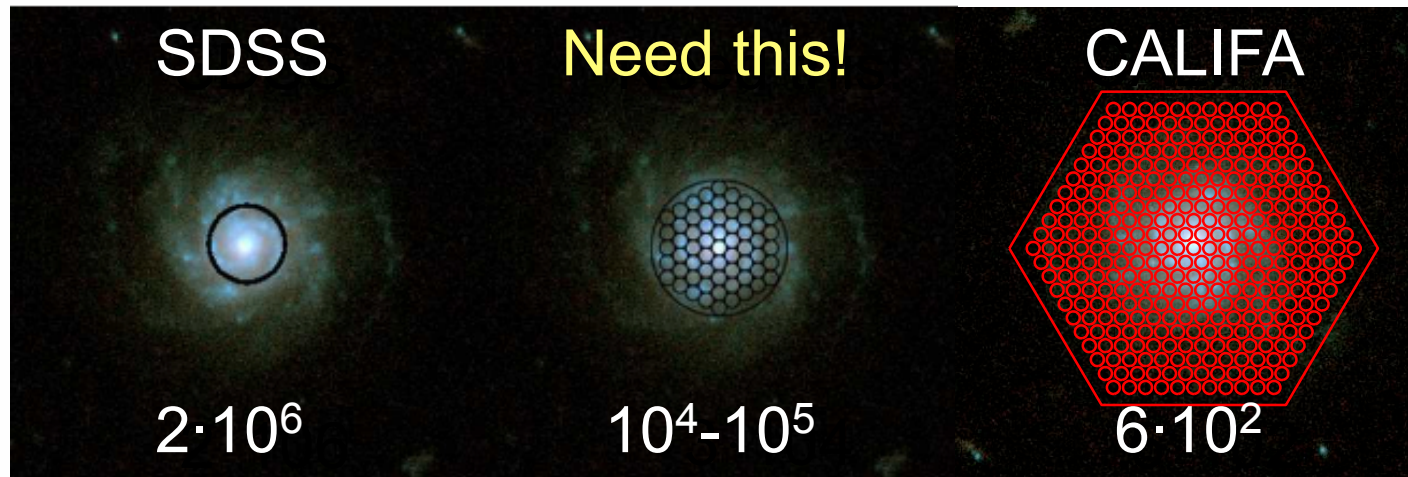
Future

THE next step after CALIFA is a larger sample



- Science questions CALIFA only touches
 - Angular momentum in galaxies (clusters, sheets, voids)
 - Major and minor merger rates from internal kinematics
 - AGN fueling as function of mass and environment
 - Systematic variation of gradients as function of mass, environment, morphology
 - and more
- All of these need statistics (>10k galaxies)

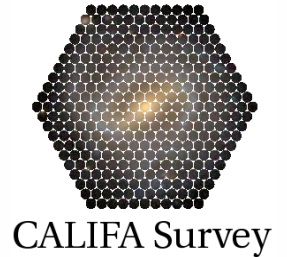
CALIFA “follow-up”



- Fireball (FLAMES upgrade, currently held up, ~30k galaxies)
- Manga (SDSS extension in AS3, hardware developments underway, ~10k galaxies)
- SAMI (AAT, observations starting, ~10k galaxies)



Conclusions



- CALIFA is a unique opportunity to understand the baryonic physics of galaxies using integral field spectroscopy.
- CALIFA is a legacy survey, data are being collected, quality is excellent, and all will be public!
- CALIFA is producing first, exciting science results right now.
- Next generation IFS surveys will be complementary to CALIFA.

<http://califa.caha.es/>