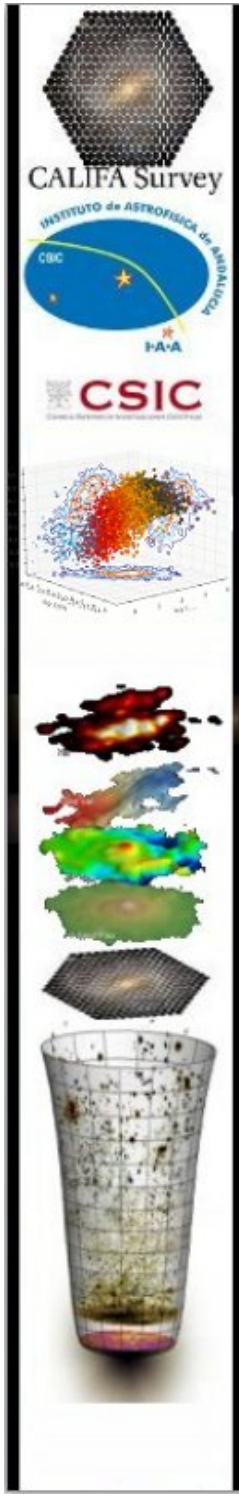
The CALIFA Survey: Properties of the HII regions

Sebastián F. Sánchez -IAA (CSIC), CAHA

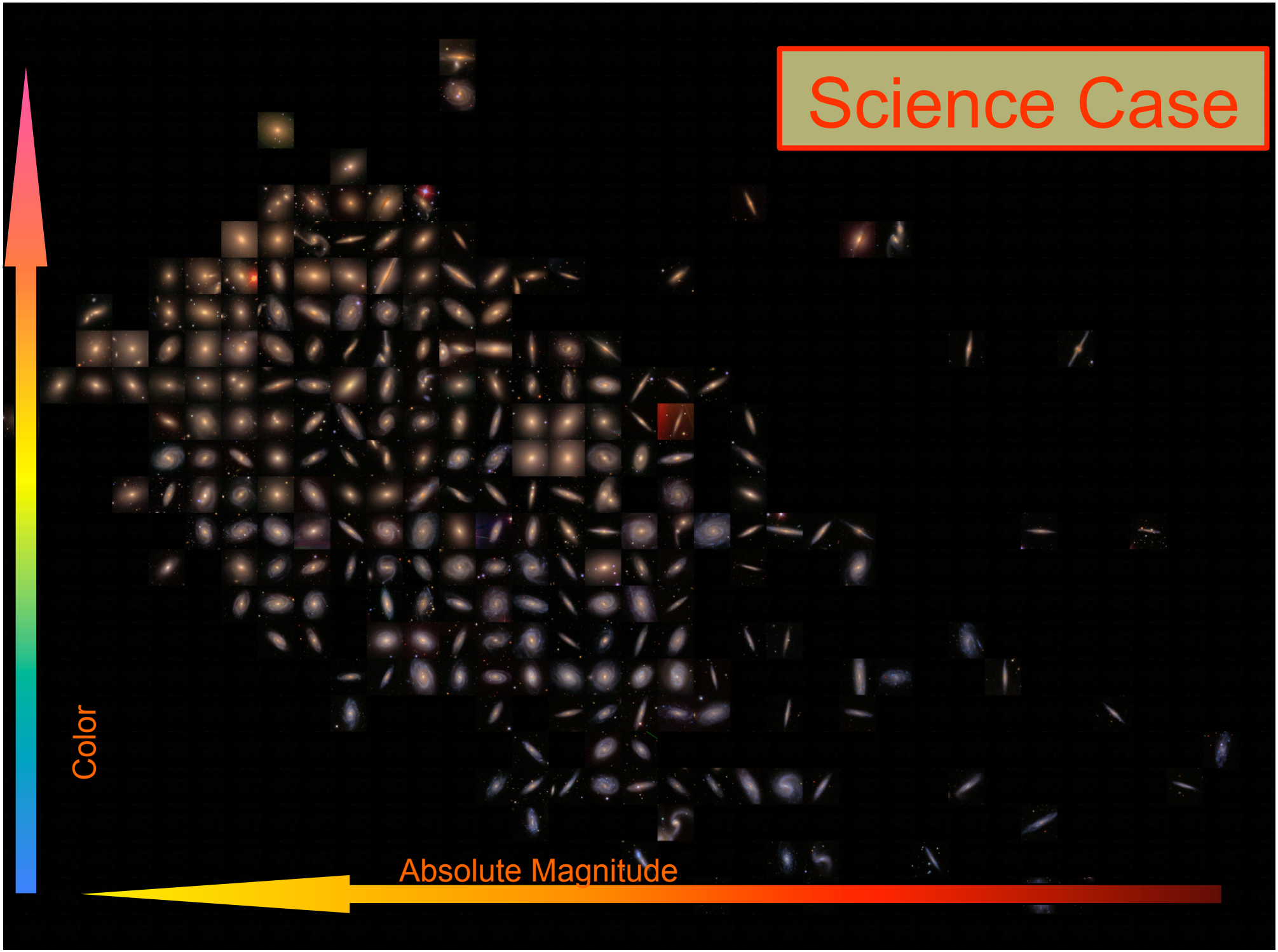
- Galaxies meets GRBs at Cabo de Gata-

- Las Negras, Almeria, 2013-

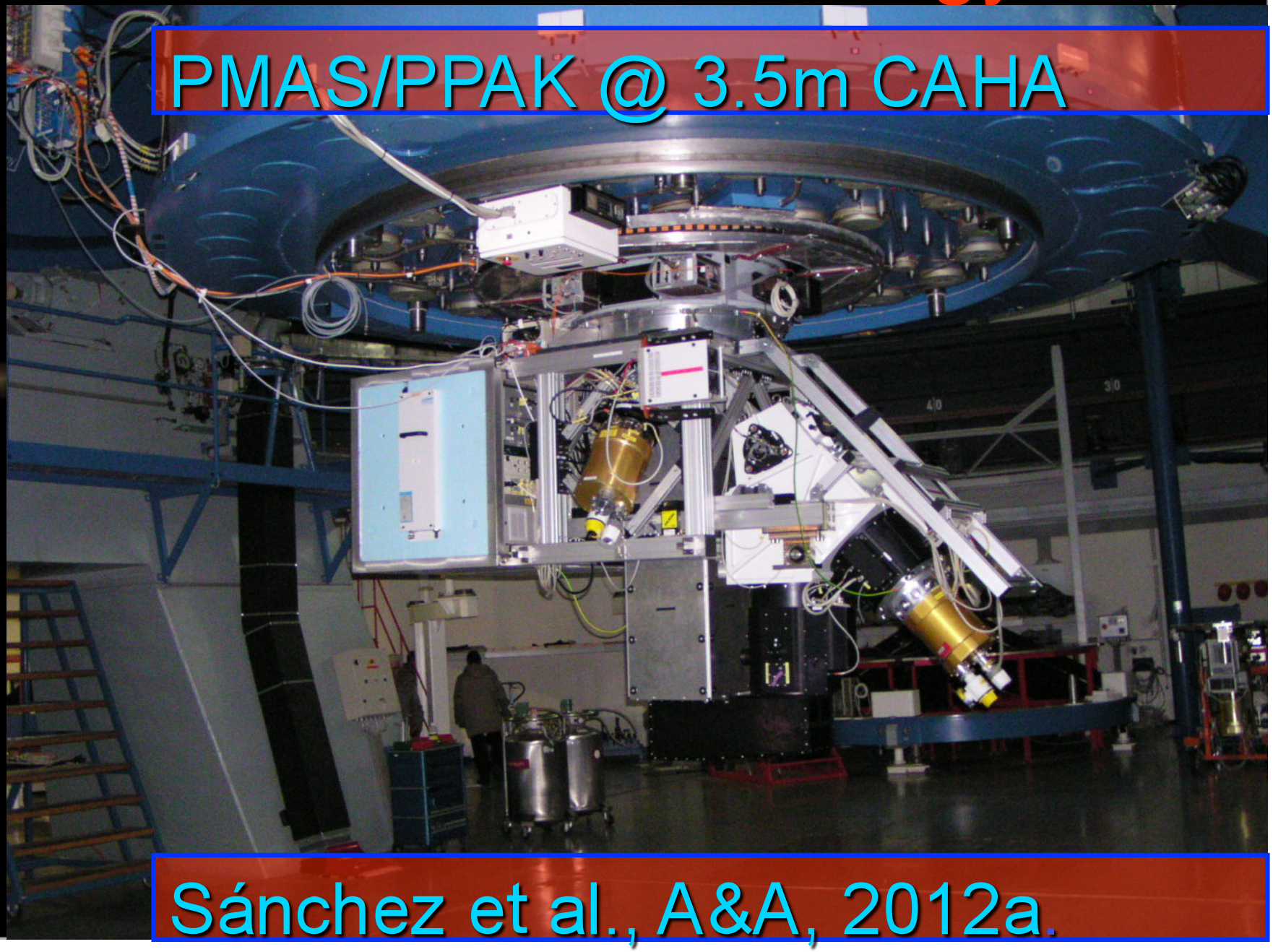


CALIFA: Summary

- Legacy Survey of Galaxies in the Local Universe, using Integral Field Spectroscopy (CAHA 3.5m telescope).
- 82 members of 13 countries (25 institutes)
- 250 dark nights in 3 years.
- Started on July 1st 2010.
- Main Goals:
  - Characterize the Spatially resolved spectroscopic properties of Galaxies in the Local Universe.
  - Uncover the fossil records of the evolution of galaxies.
- Predecesors: PINGS (PPak IFS Nearby Galaxy Survey, F.F. Rosales-Ortega)

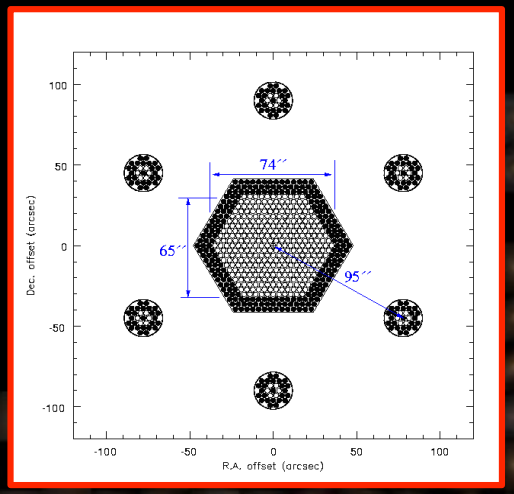

Science Case
Color
Absolute Magnitude

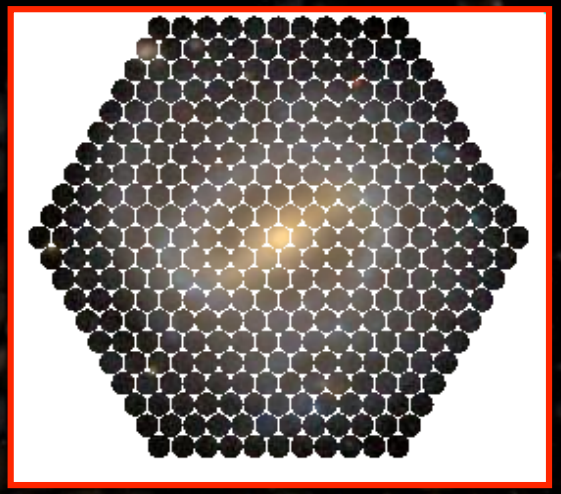
CALIFA: Metodology

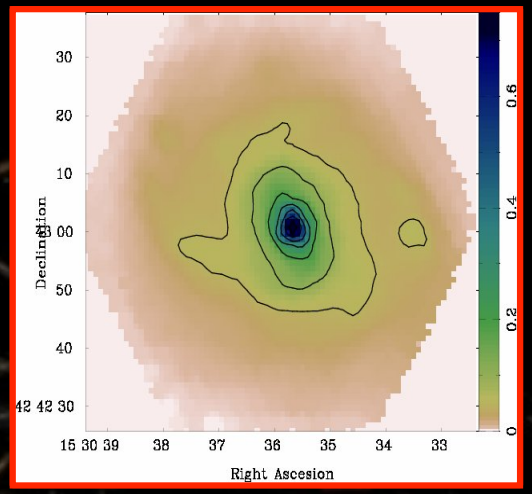


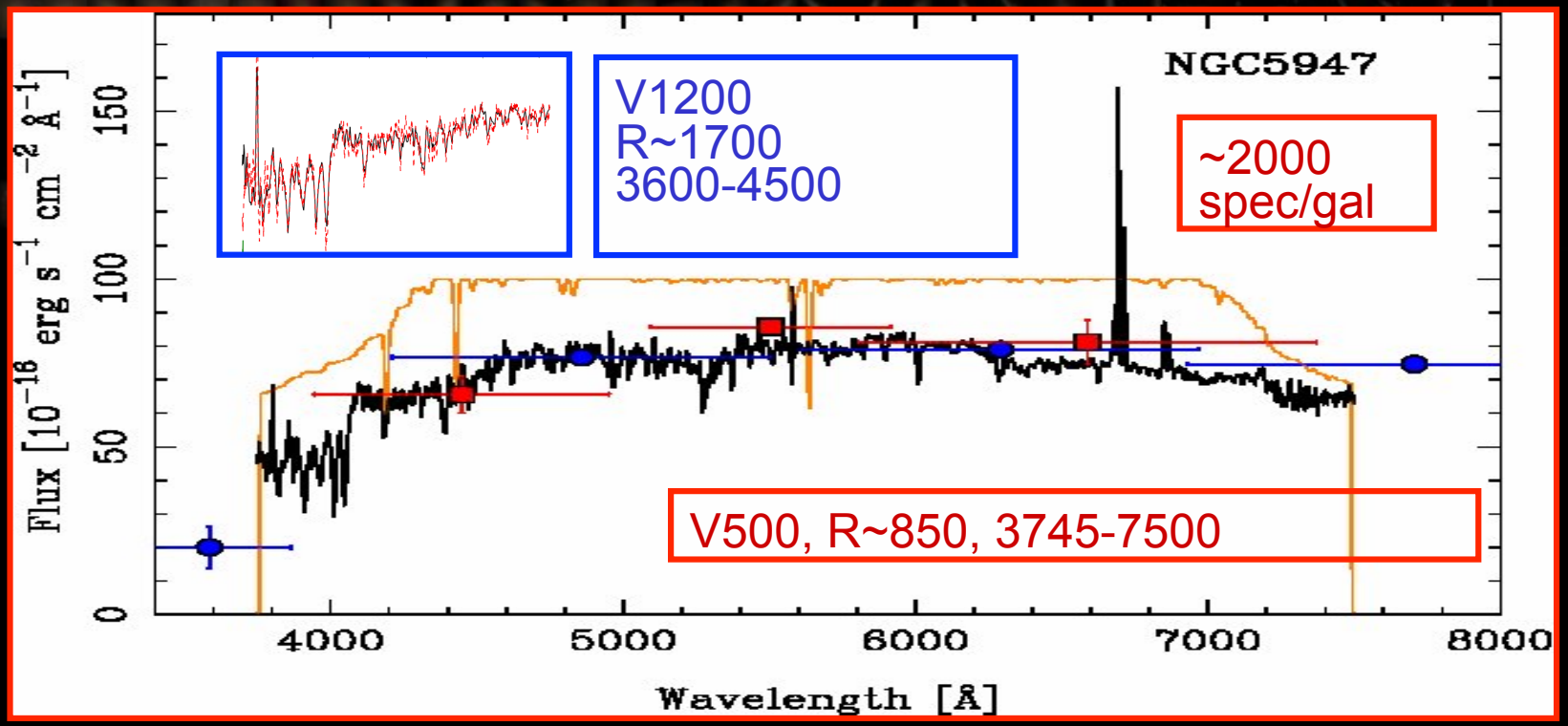
Sánchez et al., A&A, 2012a.

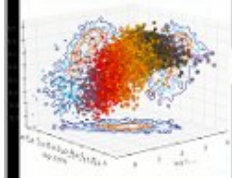
CALIFA: Metodology

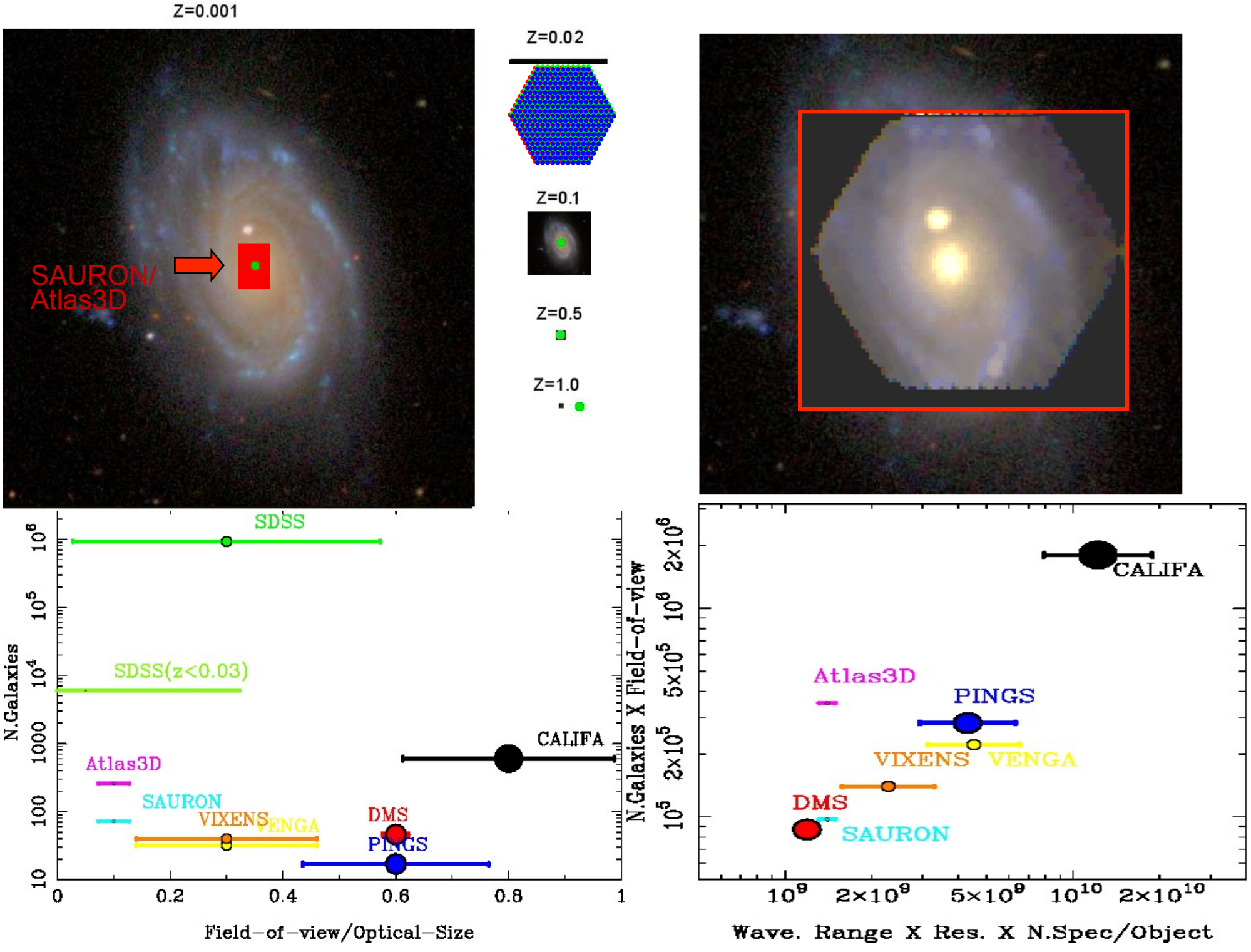


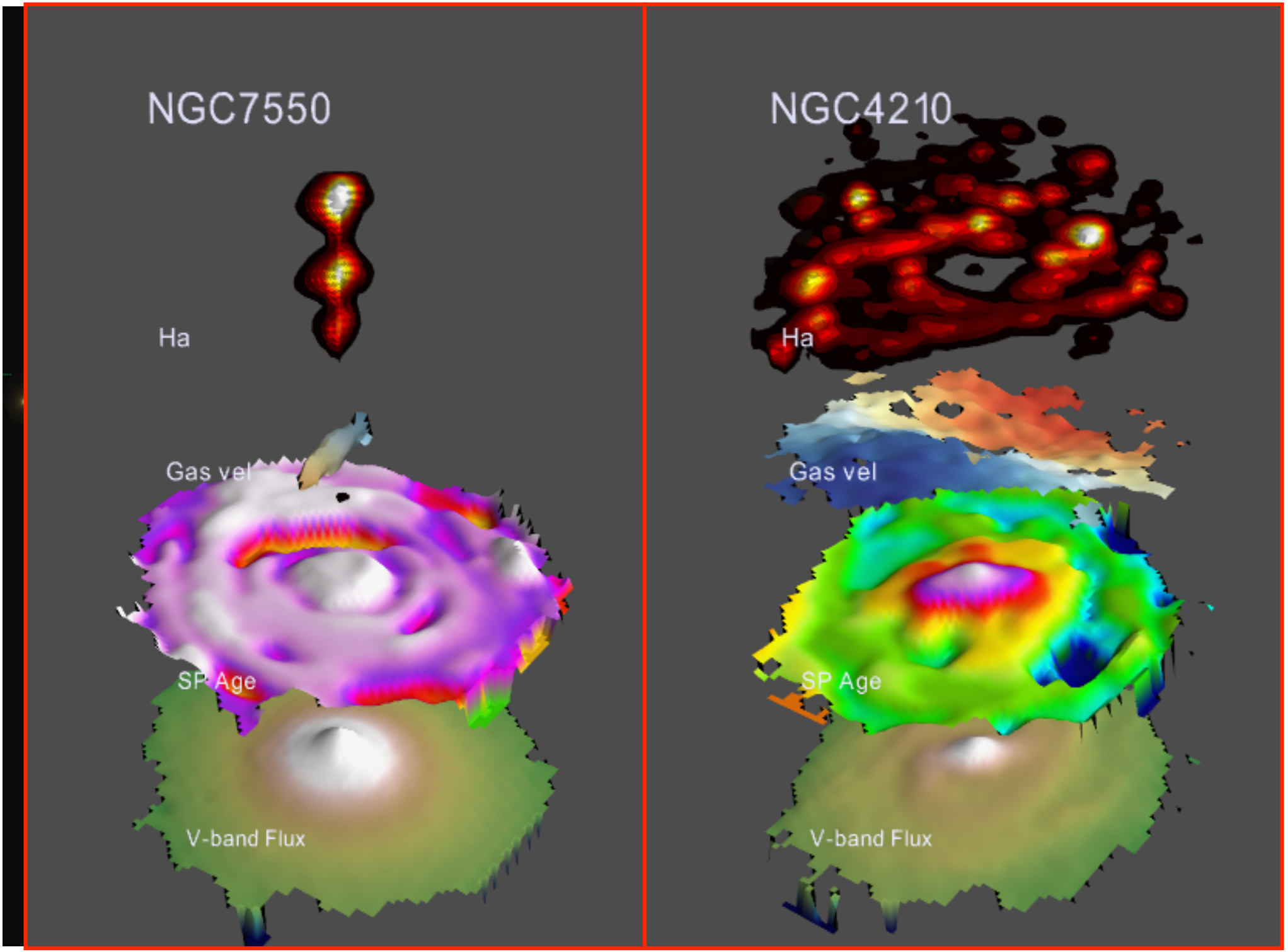


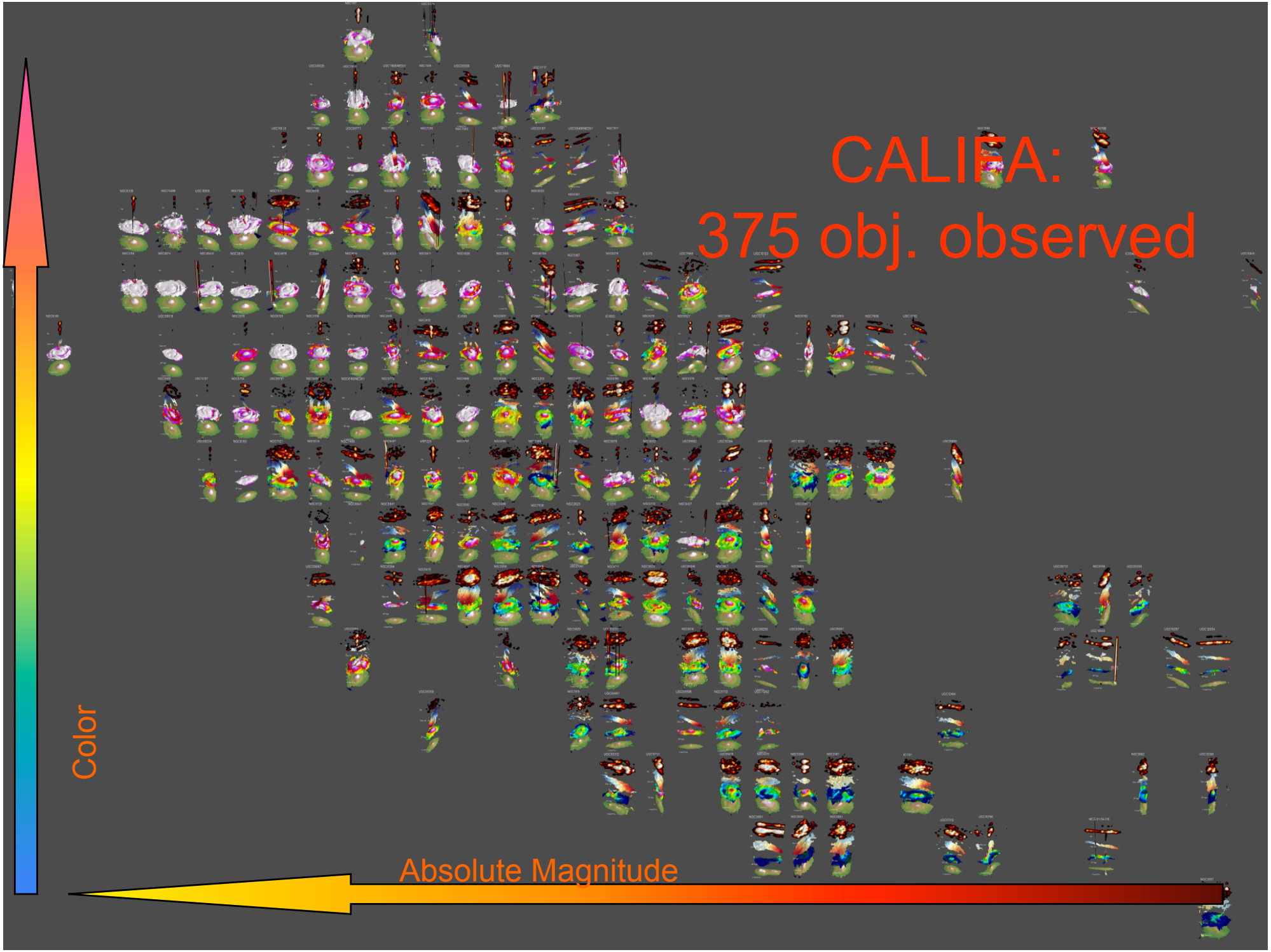


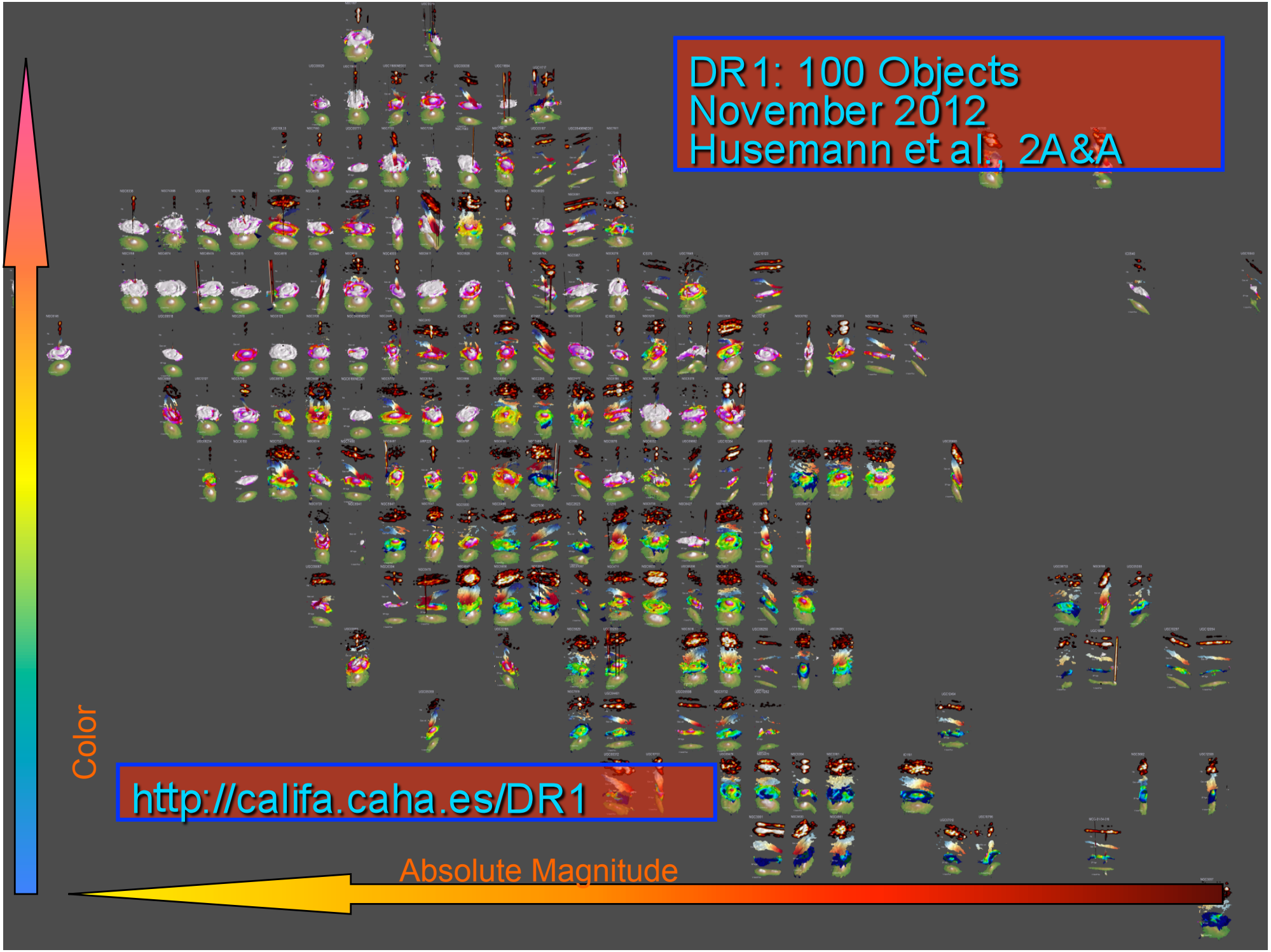


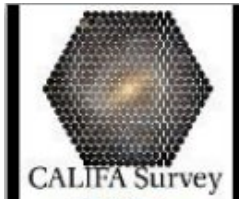


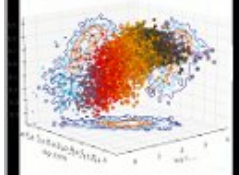

Z=0.001
SAURON/
Atlas3D
Z=0.02
Z=0.1
Z=0.5
Z=1.0
SDSS
SDSS(z<0.03)
CALIFA
Atlas3D
SAURON
VIXENS
VENGA
DMS
PINGS
N.Galaxies
Field−of−view/Optical−Size
N.Galaxies X Field−of−view
Wave. Range X Res. X N.Spec/Object


NGC7550
Ha
Gas vel
SP Age
V-band Flux
NGC4210
Ha
Gas vel
SP Age
V-band Flux


CALIFA:
375 obj. observed
Color
Absolute Magnitude

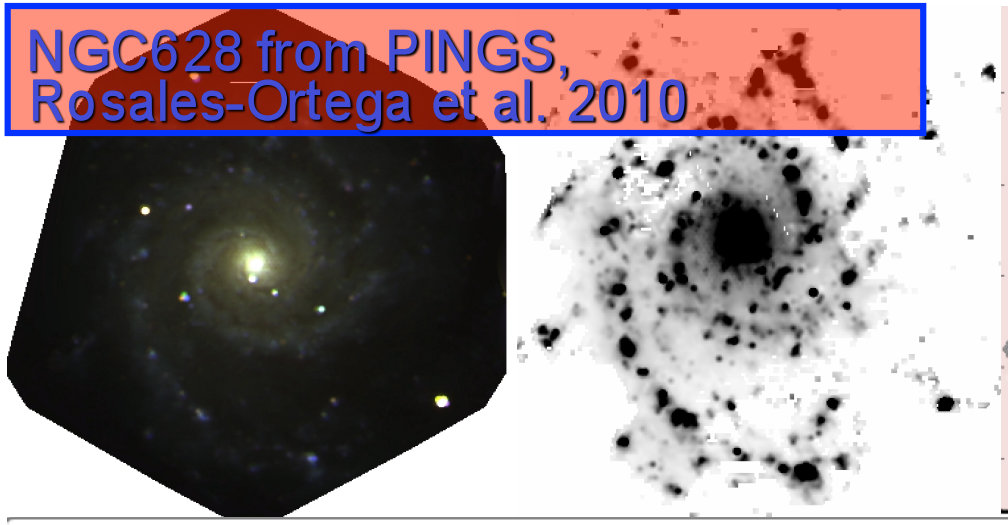

DR1: 100 Objects
November 2012
Husemann et al., 2A&A
Color
http://califa.caha.es/DR1
Absolute Magnitude

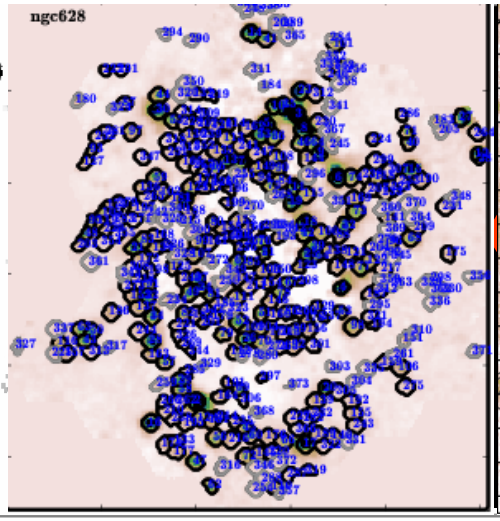


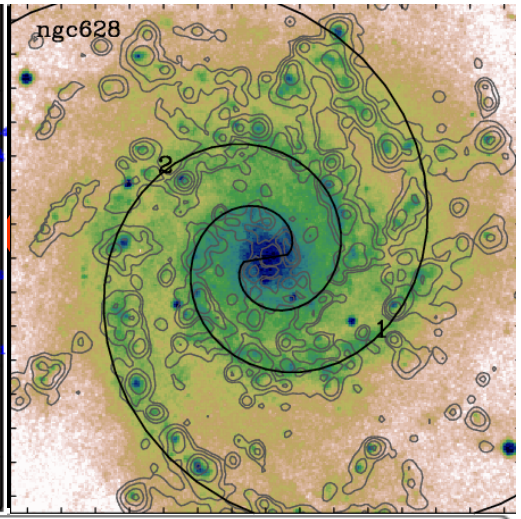


-CALIFA-
Properties of the HII regions

NGC628 from PINGS, Rosales-Ortega et al. 2010







HIIexplorer flow chart

Hα emission line map

Find peak emission pixel above absolute flux threshold

NO

YES

Pixel location stored as central coordinate of HII region

running index (ID) assigned

Criteria to grow the HII region

1. The distance to the central/peak pixel is below the considered limit
2. The flux at the pixel is above the relative threshold with respect to the peak emission
3. The flux at the pixel is above the absolute flux threshold

NO

Stops aggregating pixels

ID + 1
Aggregated pixels are masked-off

YES

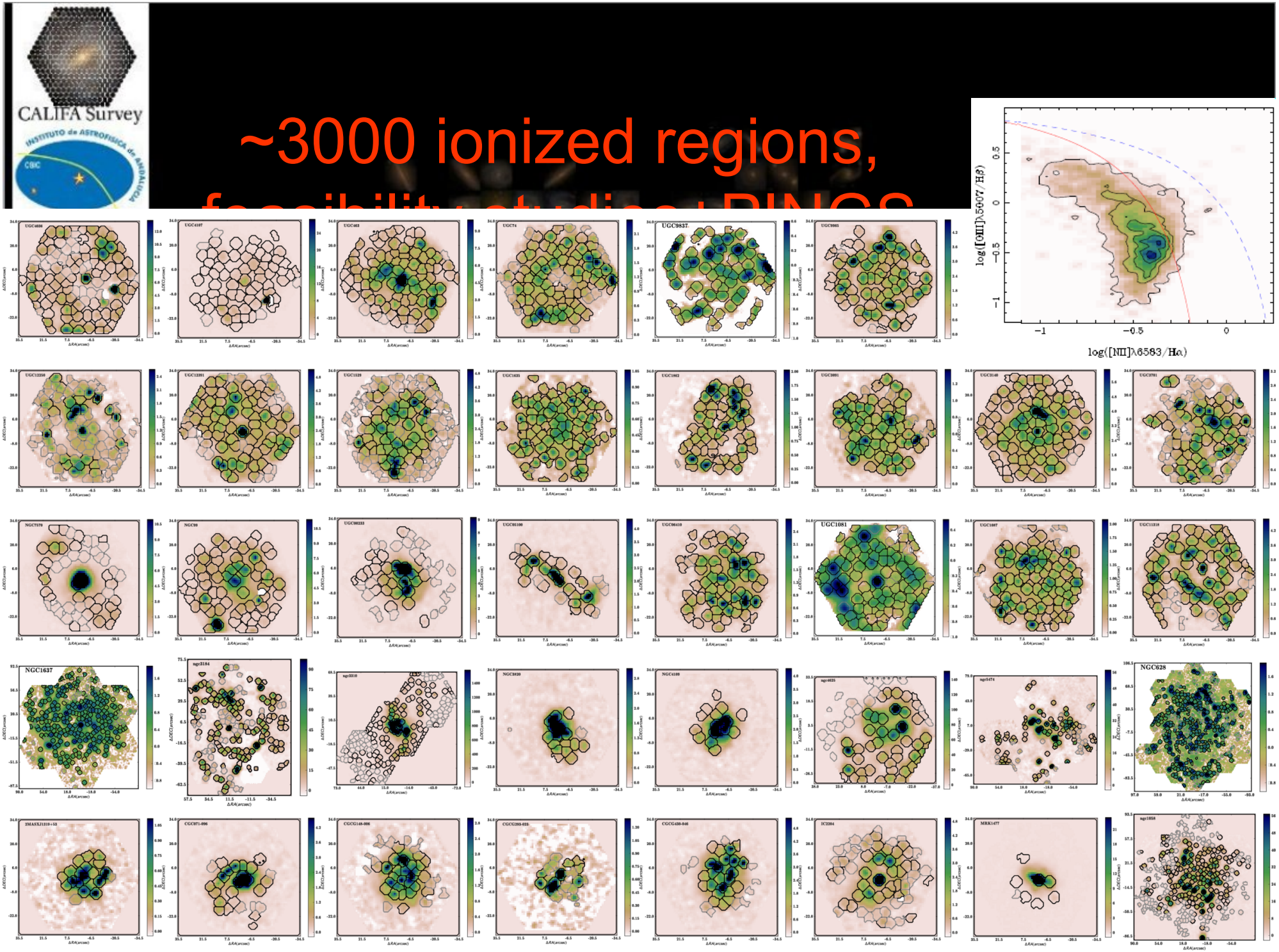
Keep aggregating surrounding pixels

HII region spectra

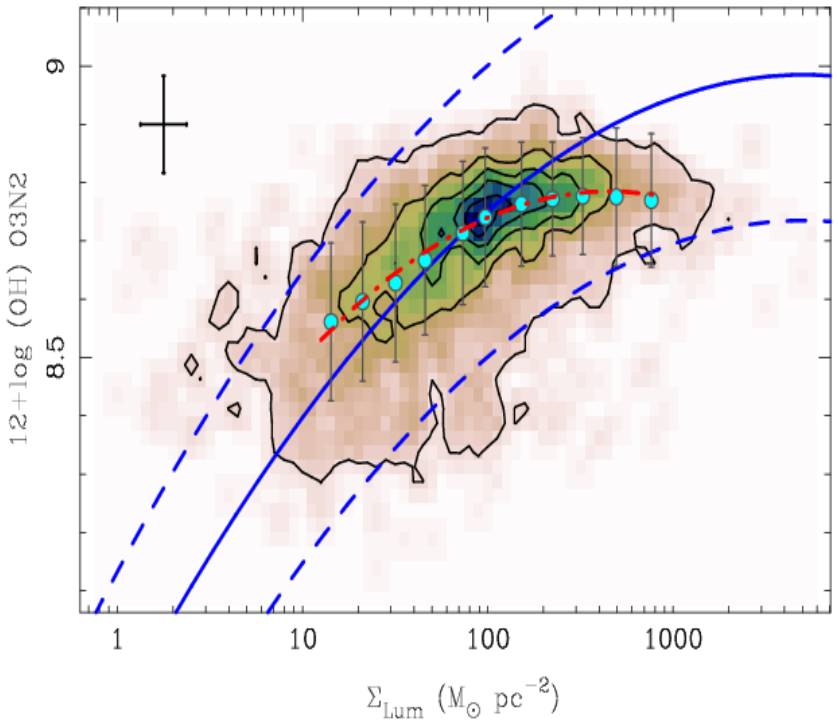
3D data cube

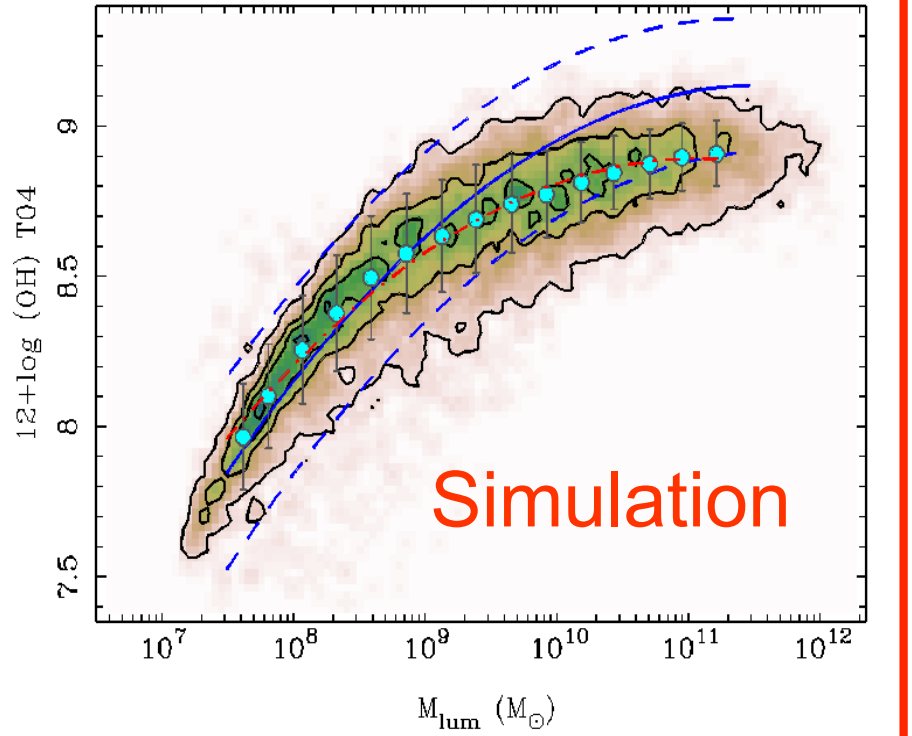
Segmentation mask created

Sánchez et al., A&A, 2012b


CALIFA Survey
~3000 ionized regions,
log([OIII]λ5007/Hβ)
log([NII]λ6583/Hα)
UGC4036
UGC4107
UGC463
UGC74
UGC9837
UGC9965
UGC12250
UGC12281
UGC1529
UGC1635
UGC1862
UGC2091
UGC3140
UGC3701
NGC7570
NGC39
UGC80233
UGC85100
UGC86410
UGC1081
UGC1807
UGC11318
NGC1637
ngc3184
ngc3310
NGC3920
NGC4100
ngc4625
ngc5474
NGC628
2MASXJ1319+53
CGCG71-096
CGCG148-006
CGCG293-023
CGCG438-046
IC2264
MRK1477
ngc1058

The resolved M-Z relation

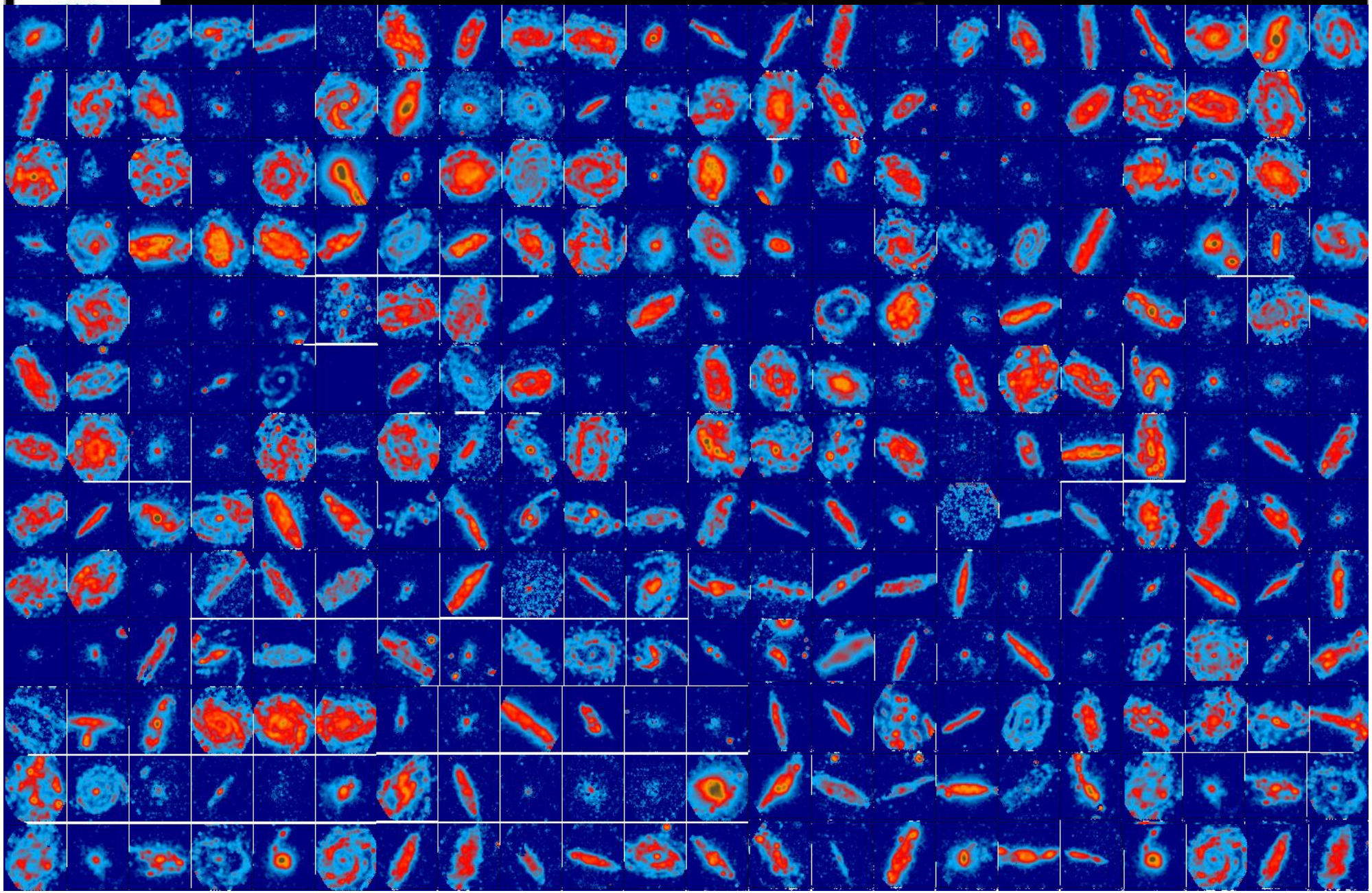




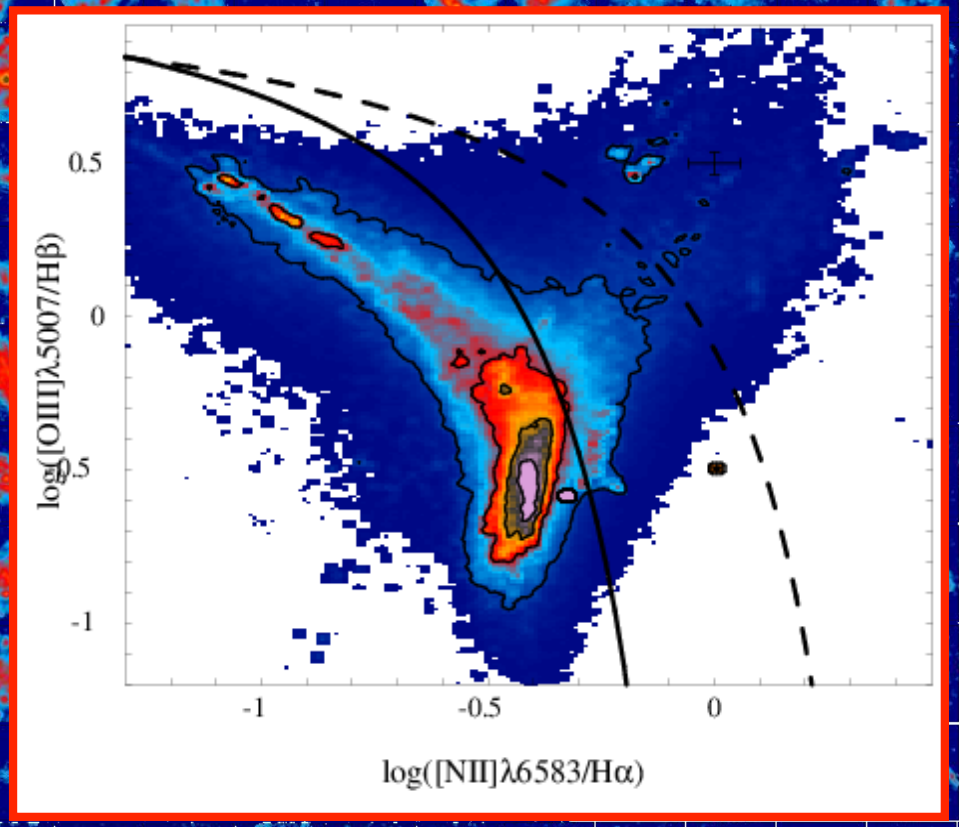
- There is tight correlation between the Mass Surface density and the metallicity.
- We can reproduce the global relation from the local one: Product of the evolution of SFR!

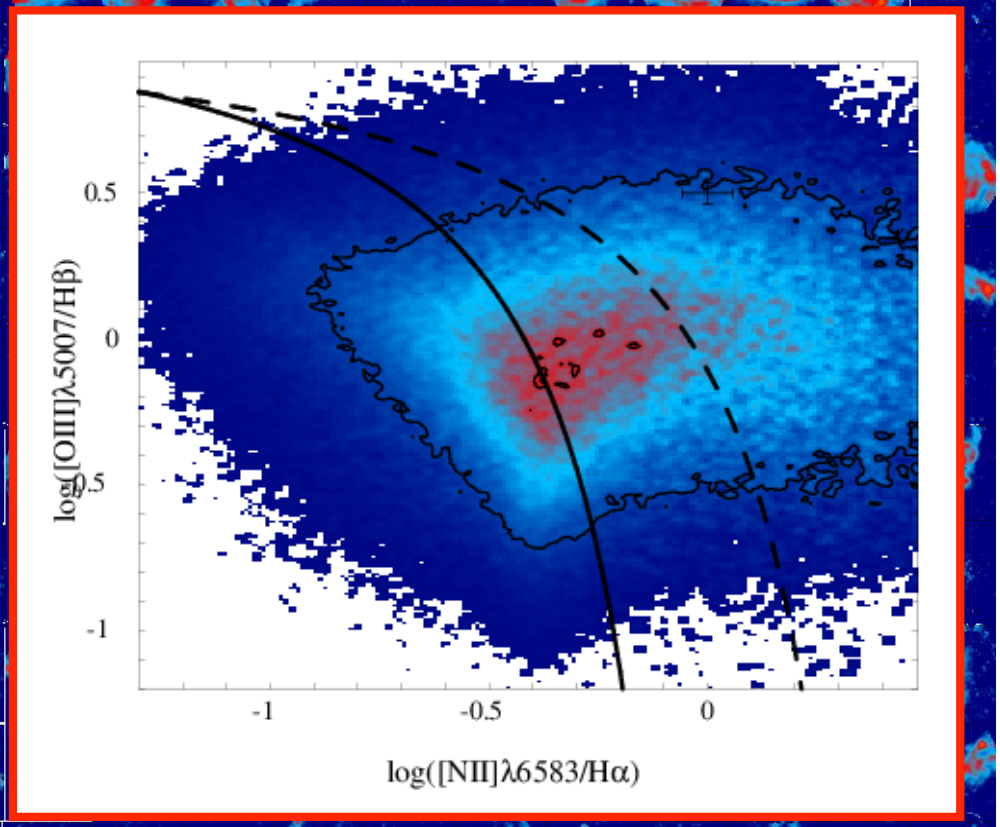
Rosales-Ortega et al., ApJL, 2012

Ionized gas detected in all galaxies?

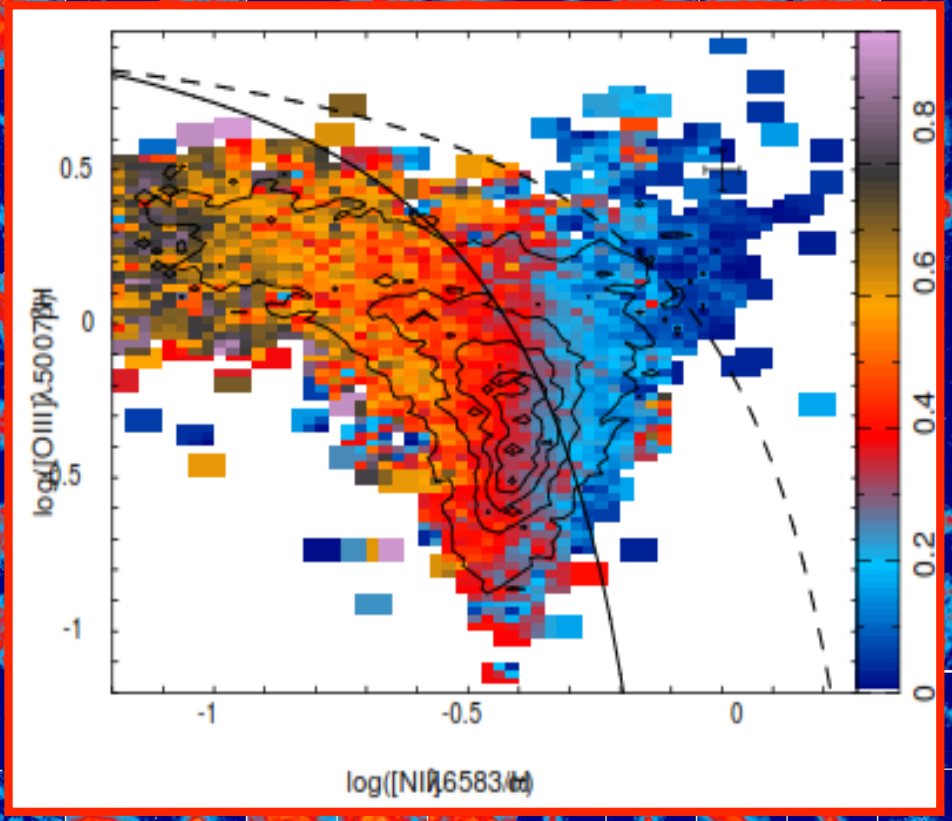


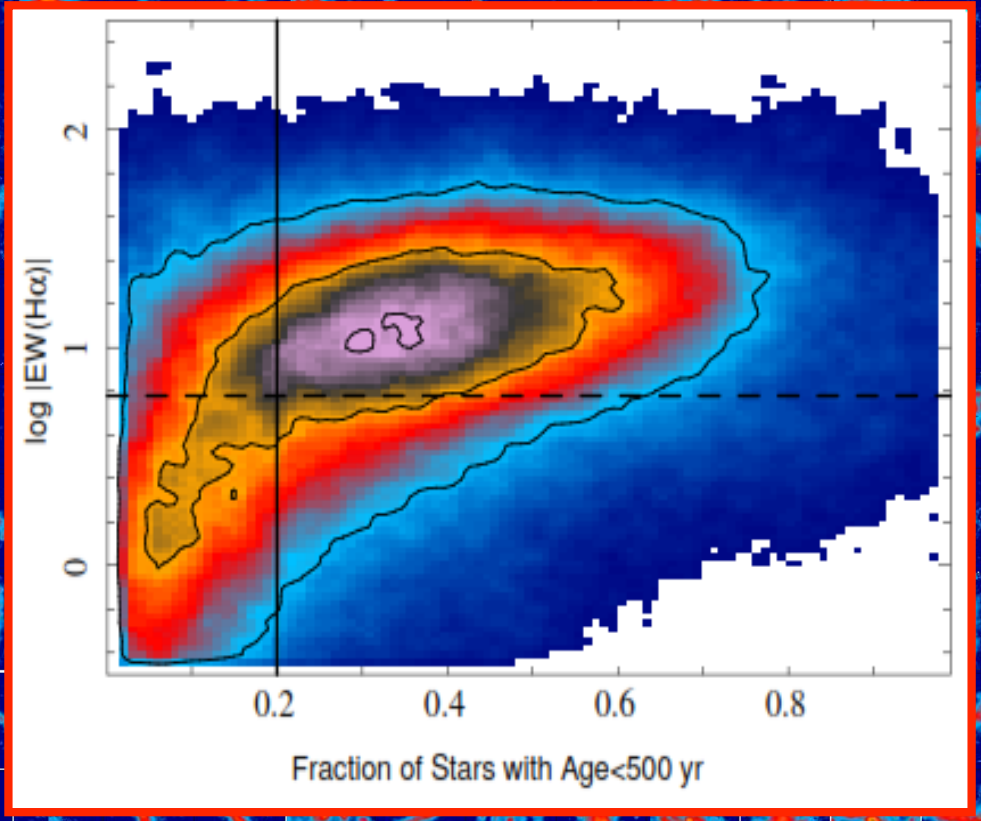
What ionize the gas?





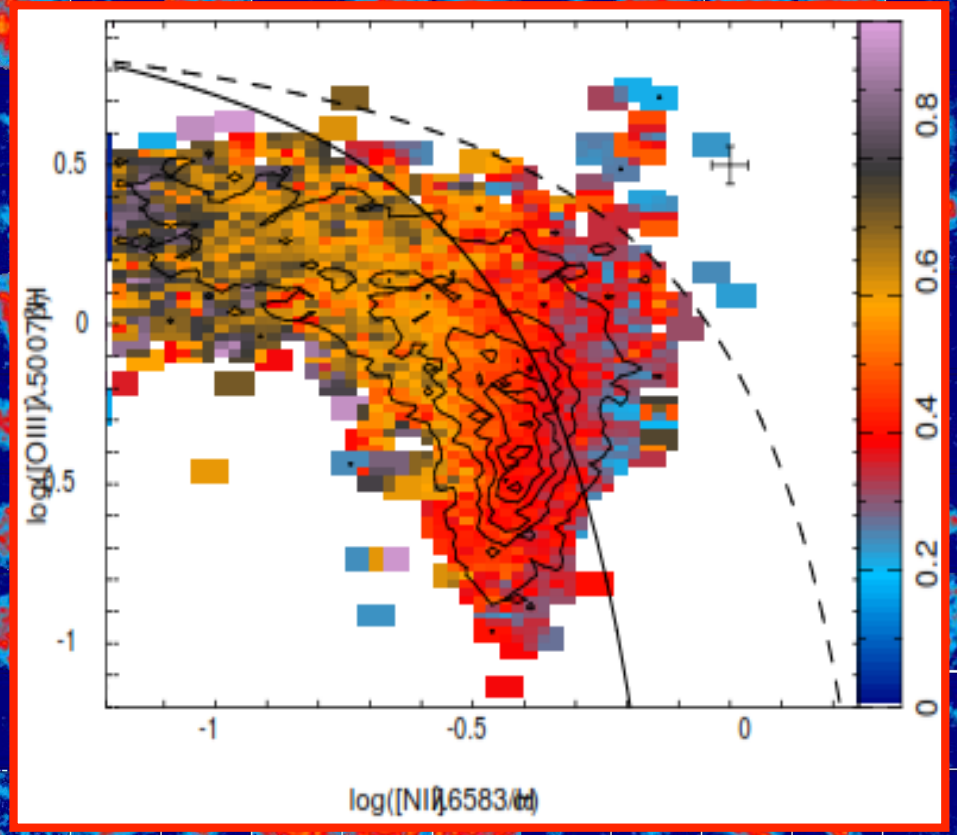
What ionize the gas?

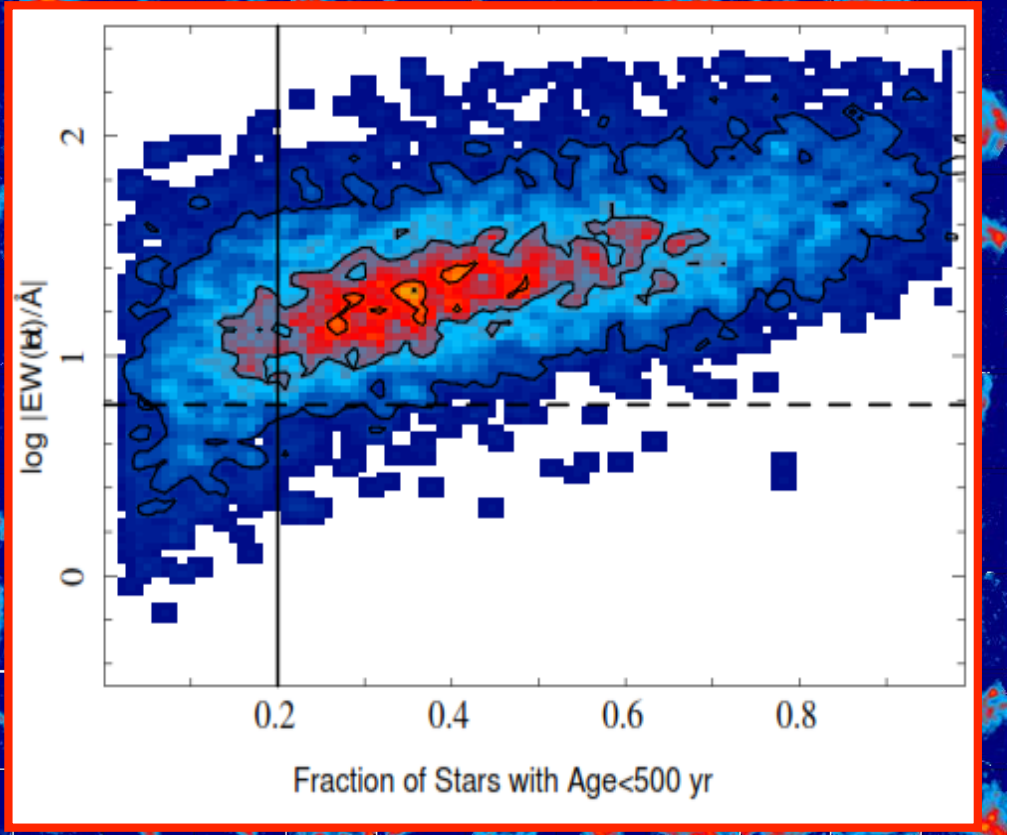




CALIFA Survey

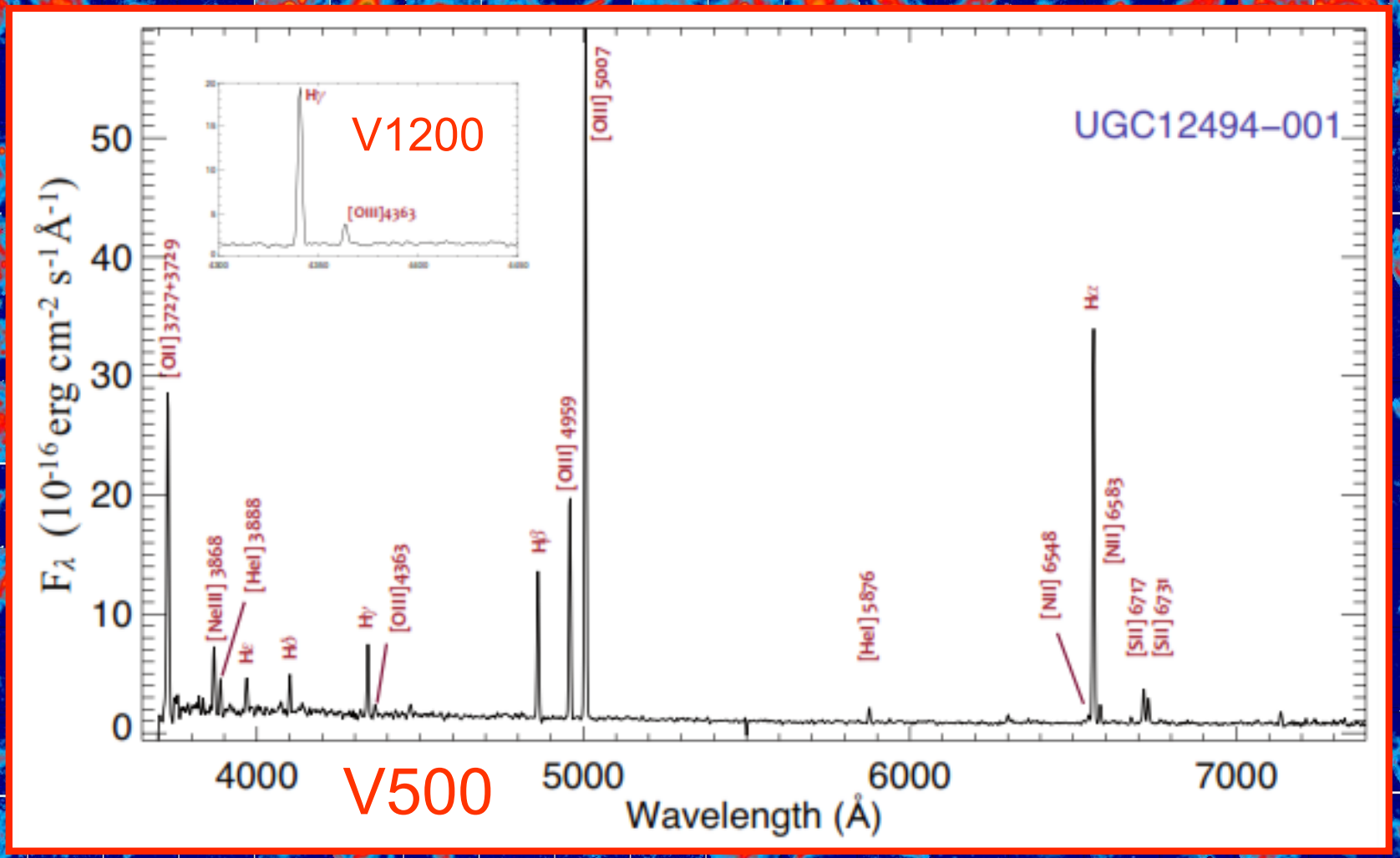
~6500 regions, with CALIFA





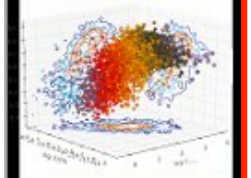
CALIFA Survey

~6500 regions, with CALIFA

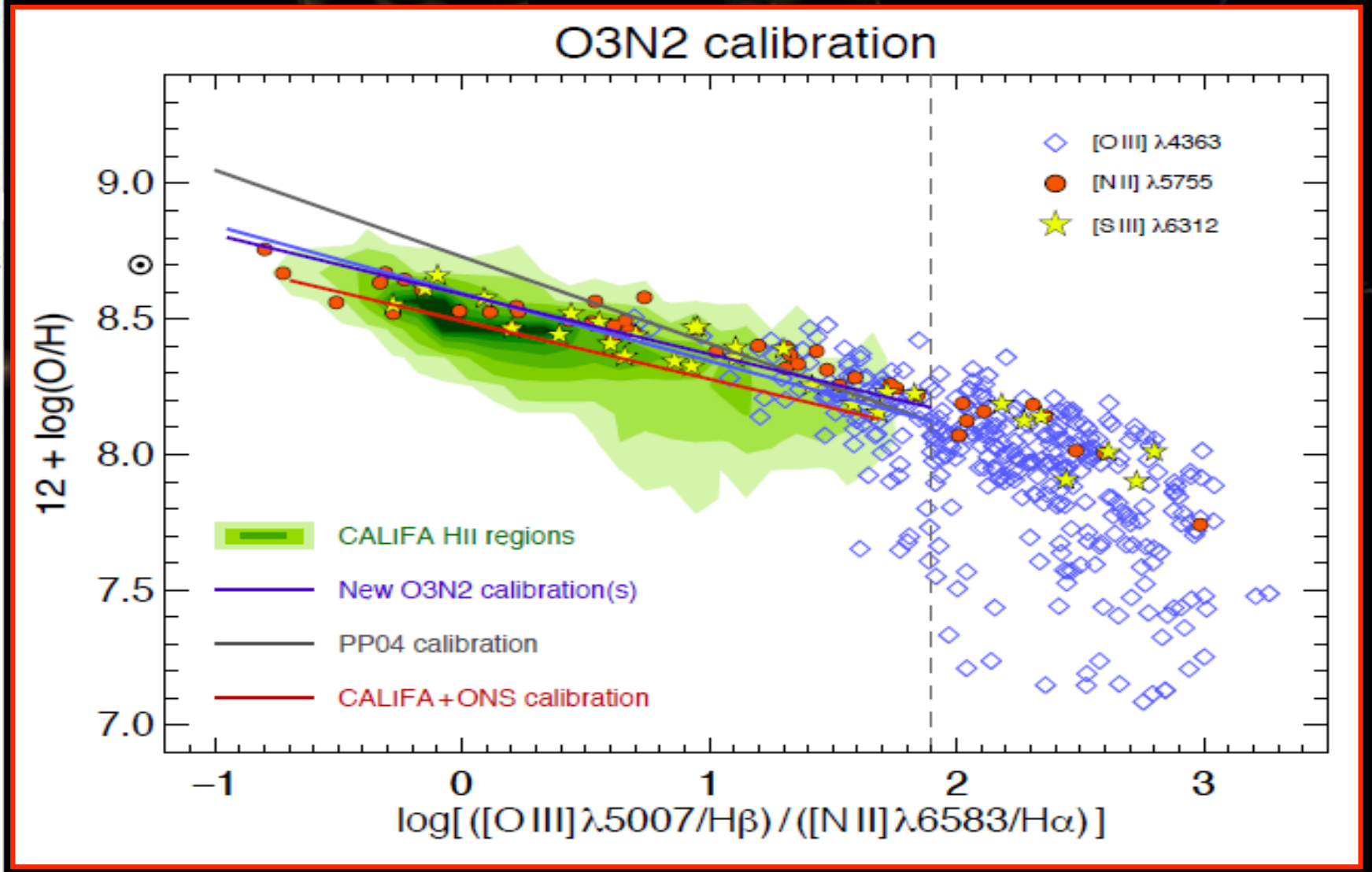


CALIFA Survey

CSIC

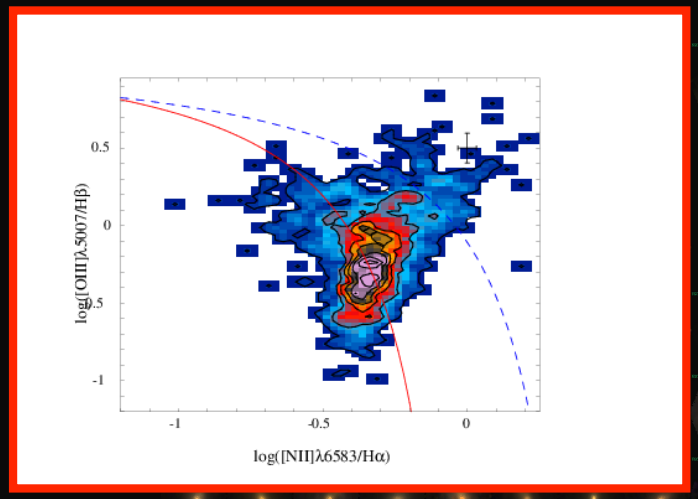


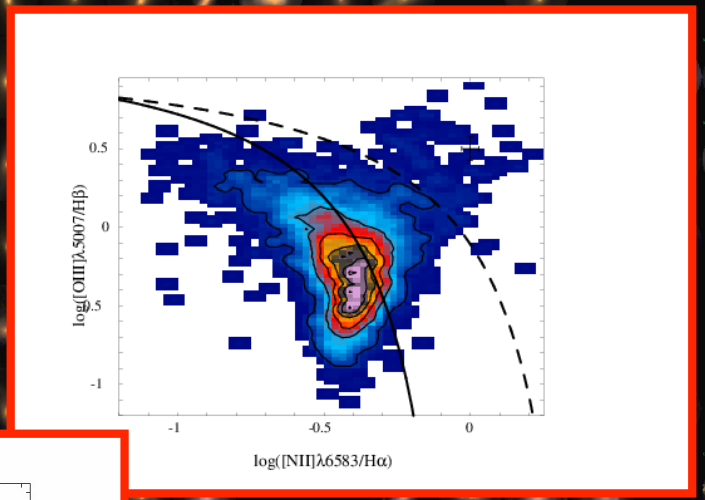
Improved O/H calibrators

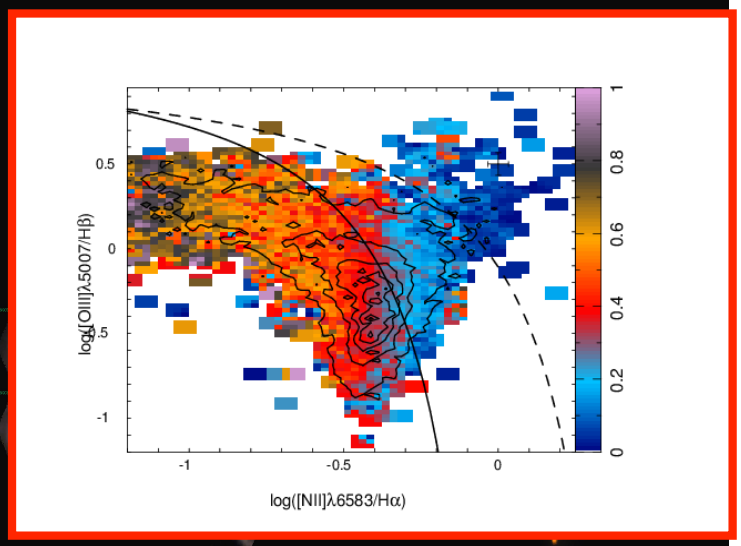


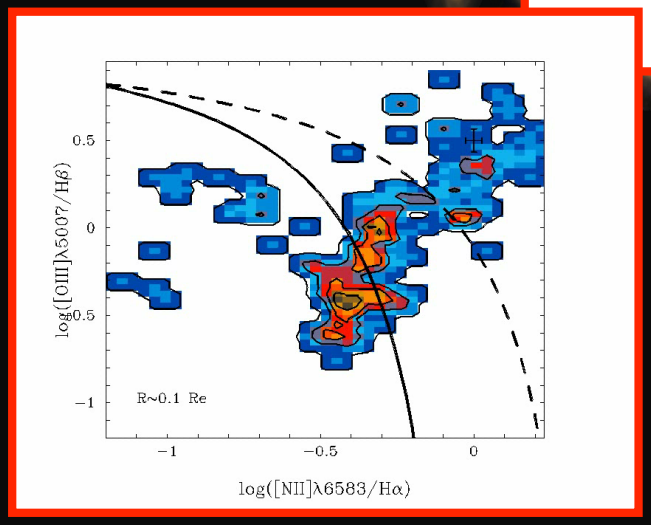
Marino et al., subm.

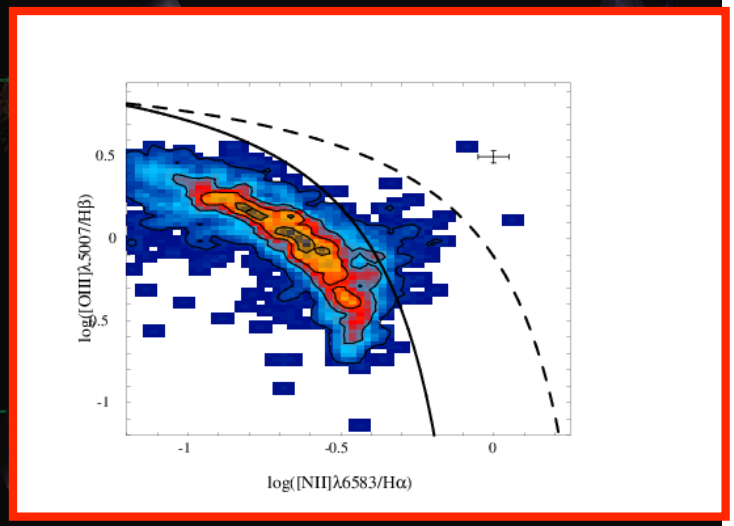
Ionized Gas: Global vs. Local?



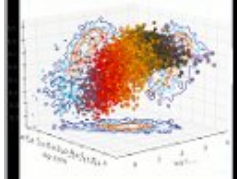


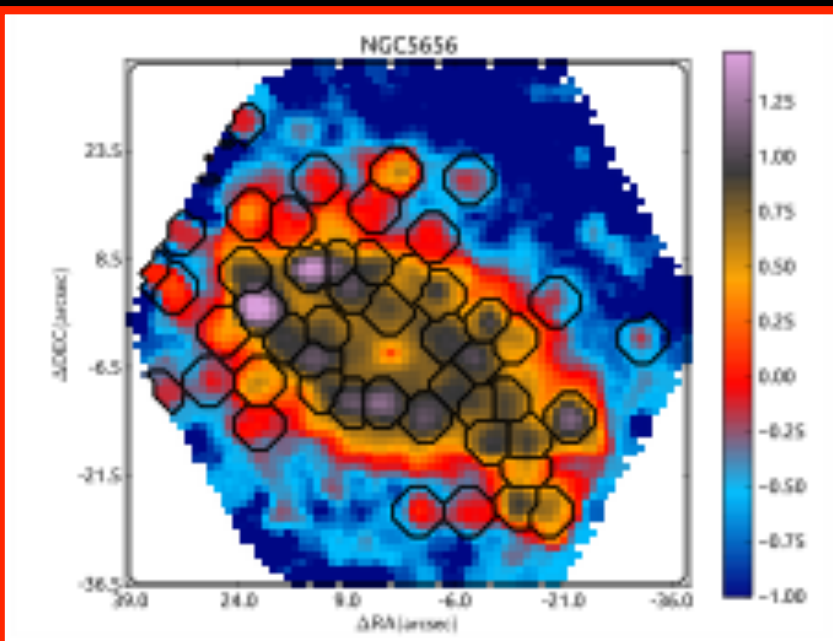


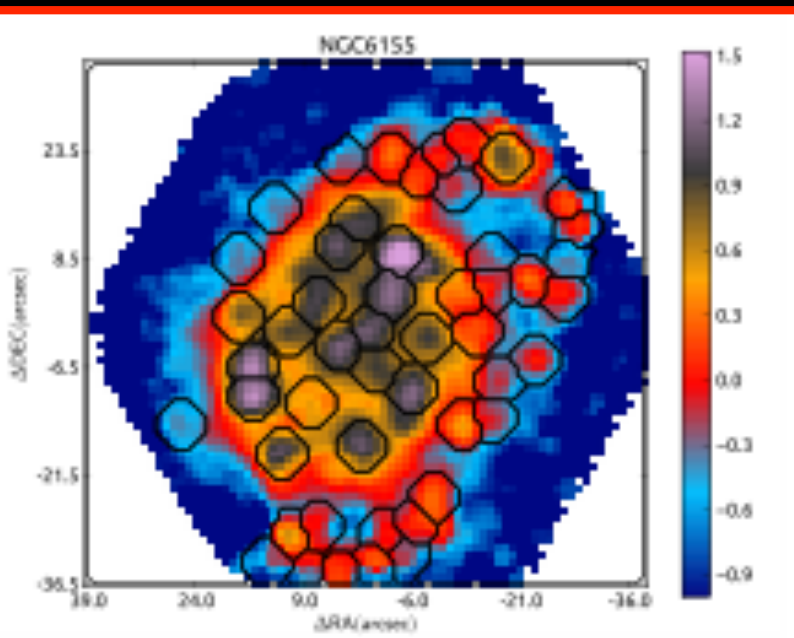


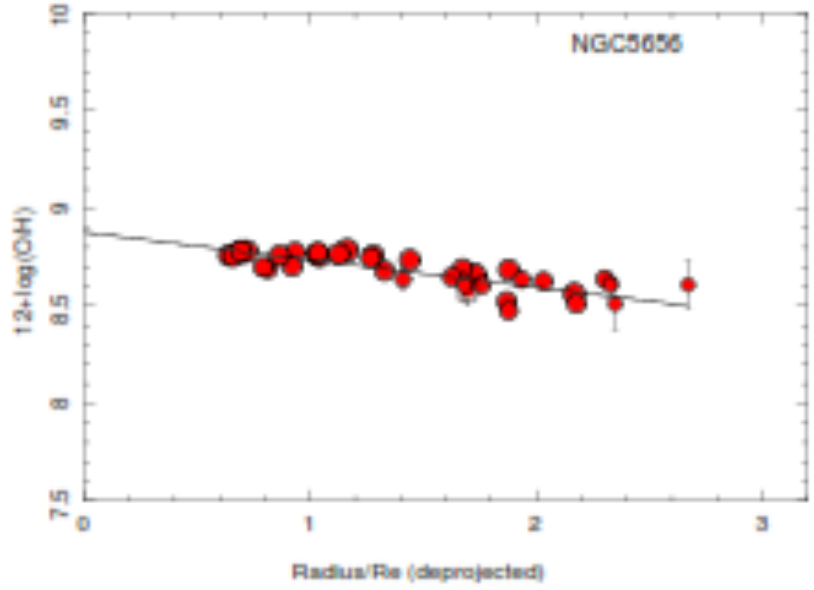


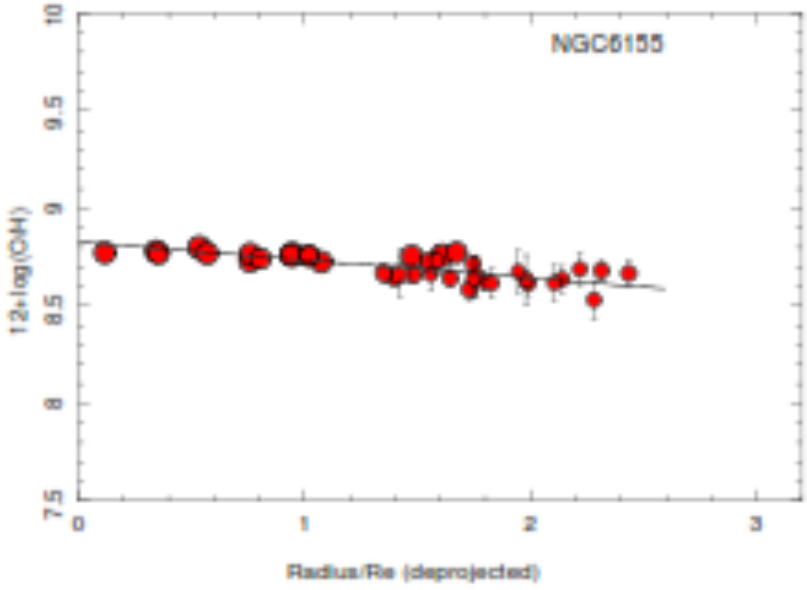
CALIFA Survey







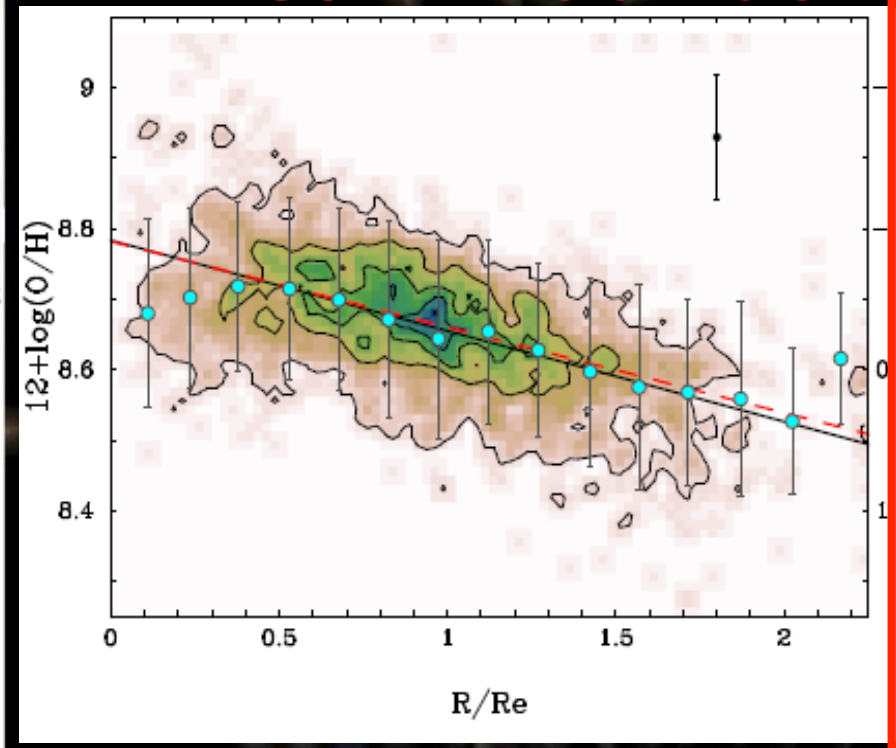


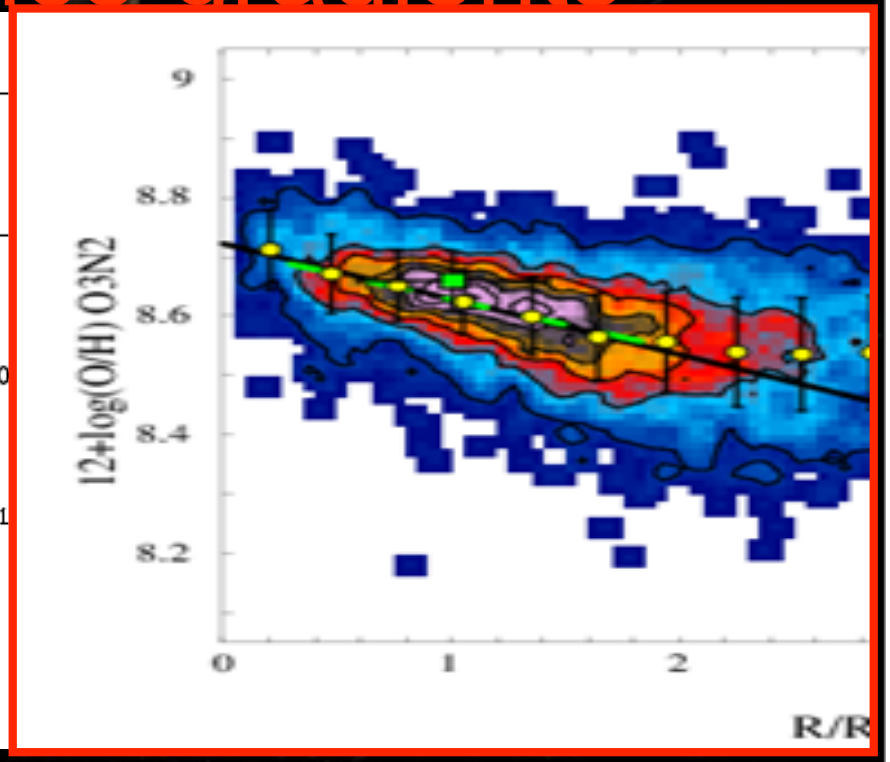


CALIFA Survey

Sánchez et al., A&A, 2012b

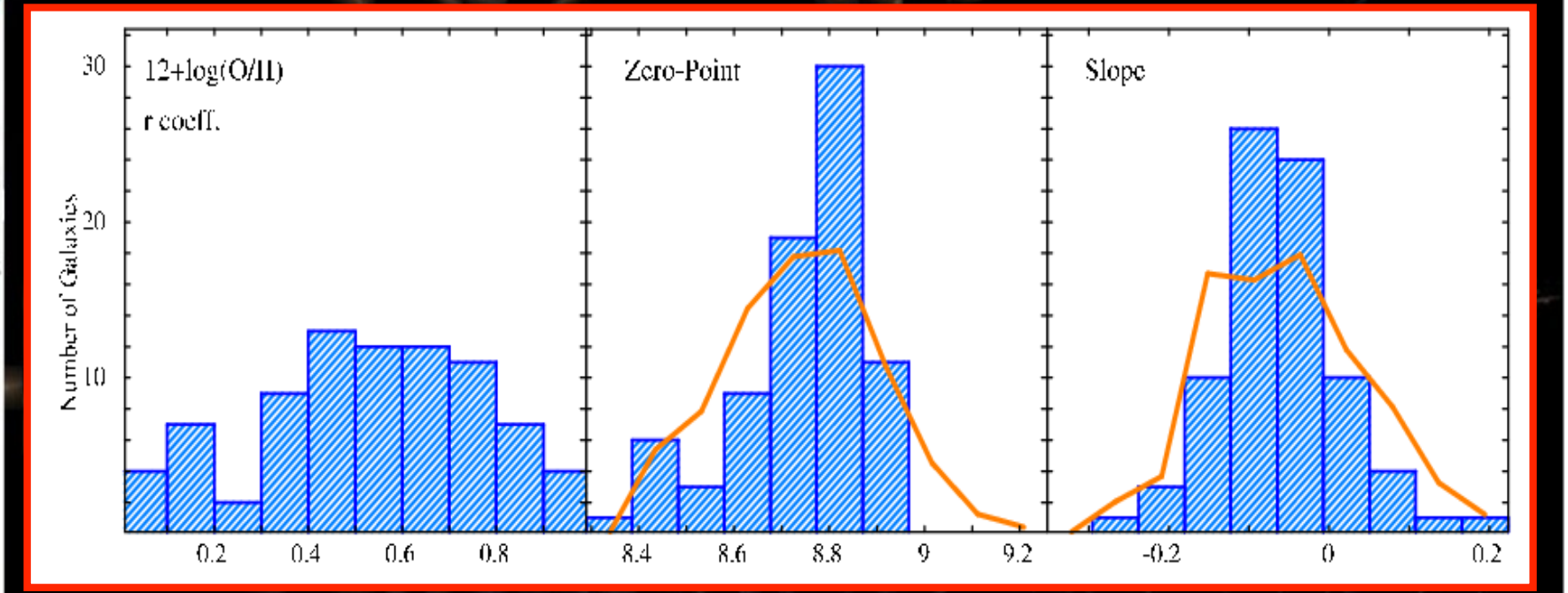
O/H Abundance gradients





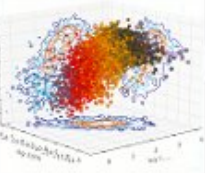
- All Abundance gradients are compatible with being a subsample of Gaussian distribution.
- Slope ~ -0.12+-0.10 dex/Reff.
- No significant difference found by galaxy types: Barred/unbarred, Grand-design/flocculent.

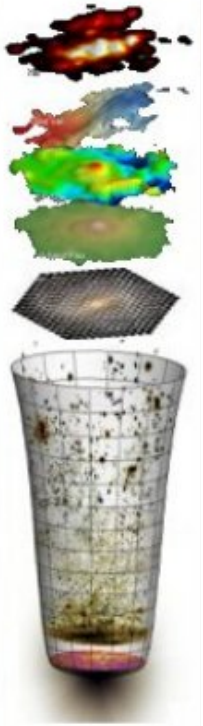
O/H Abundance gradients With CALIFA galaxies



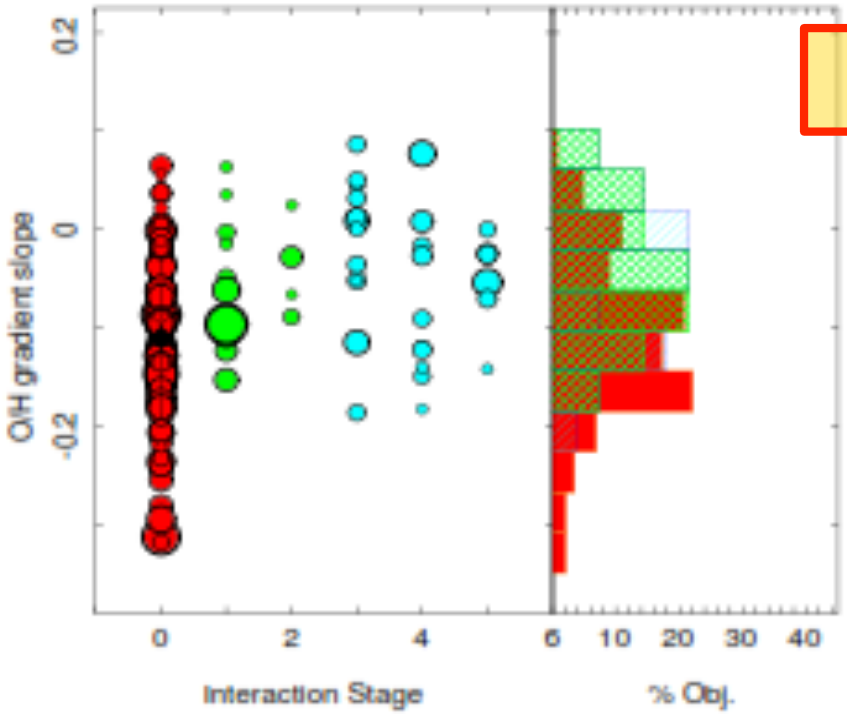
- Gradients determined at 0.3<R/Re<2.1.
- 207 galaxias, ~6500 regions.
- Gradients distribution compatibles with of single Gaussians.
- Slope ~ -0.11+-0.08 dex/Reff.

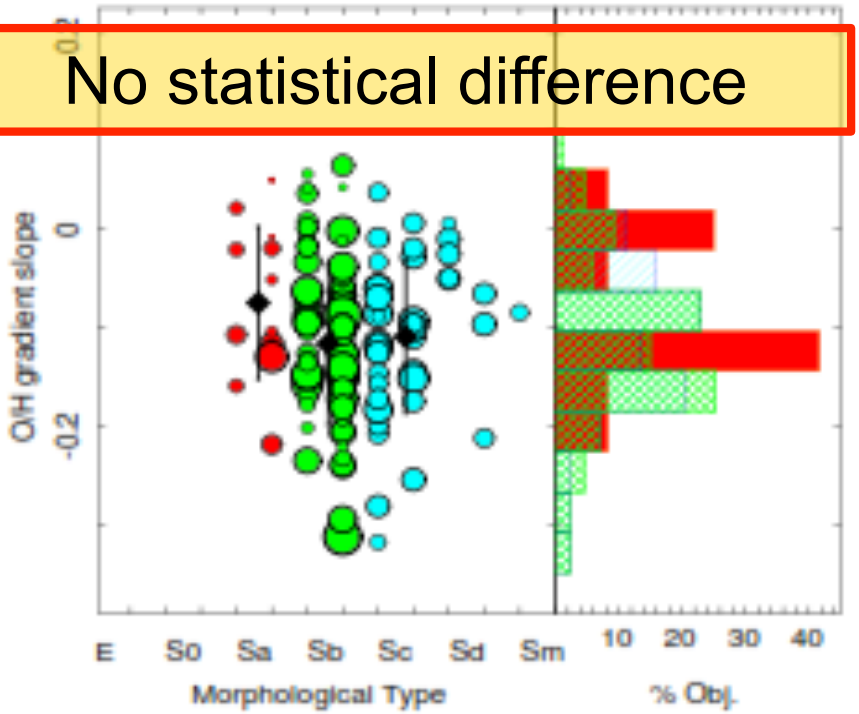
CALIFA Survey

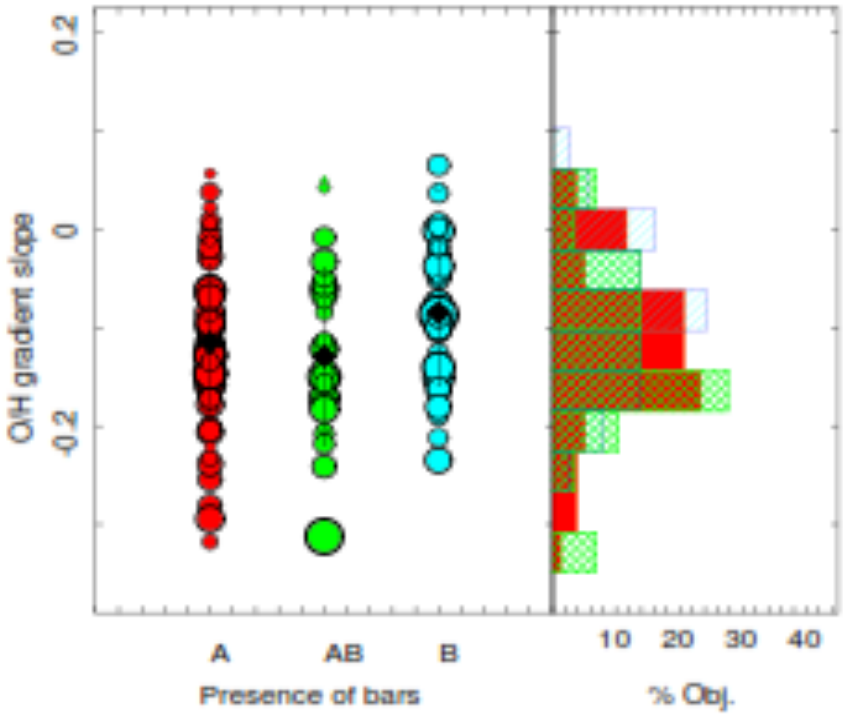


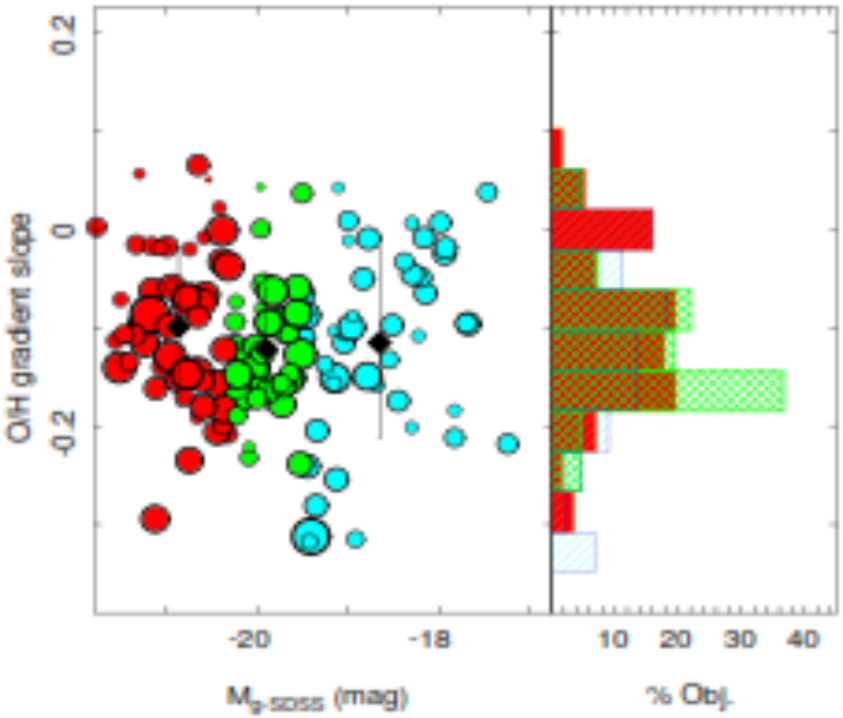


No statistical difference



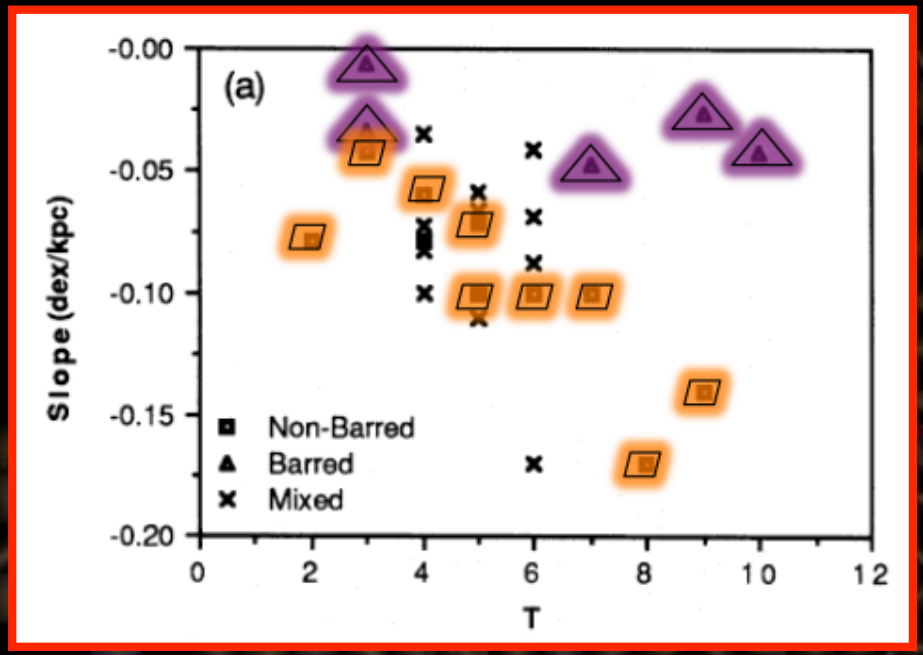


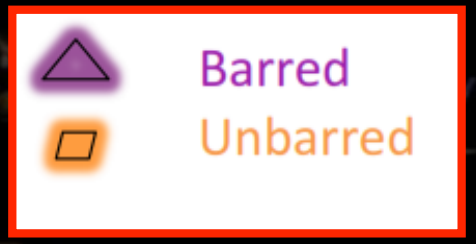




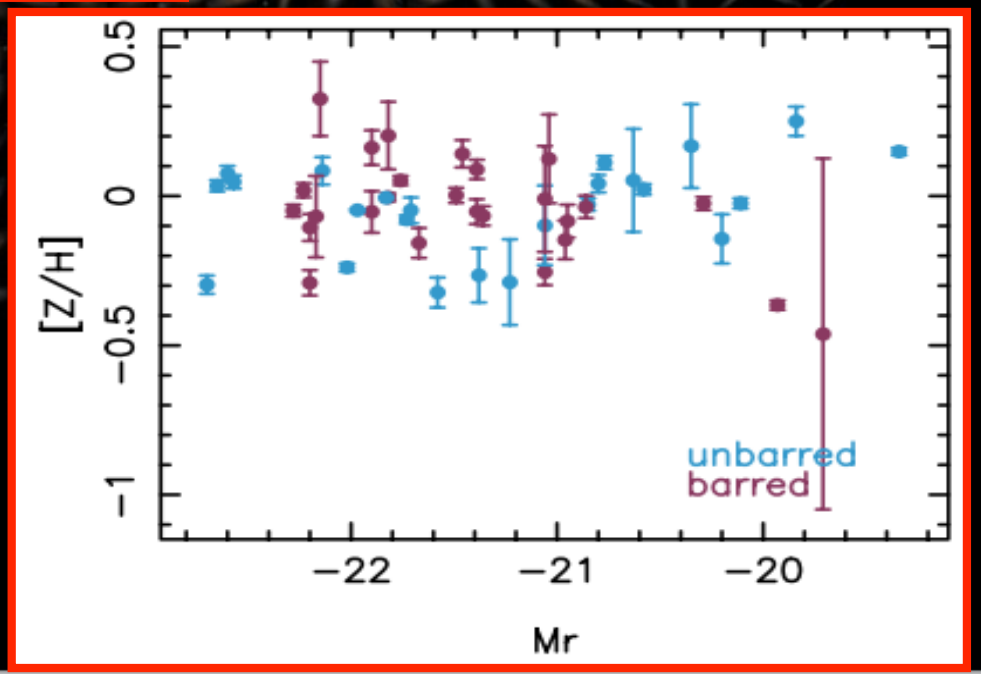
CALIFA Survey

Zaritsky, Kennicutt & Huchra 1994





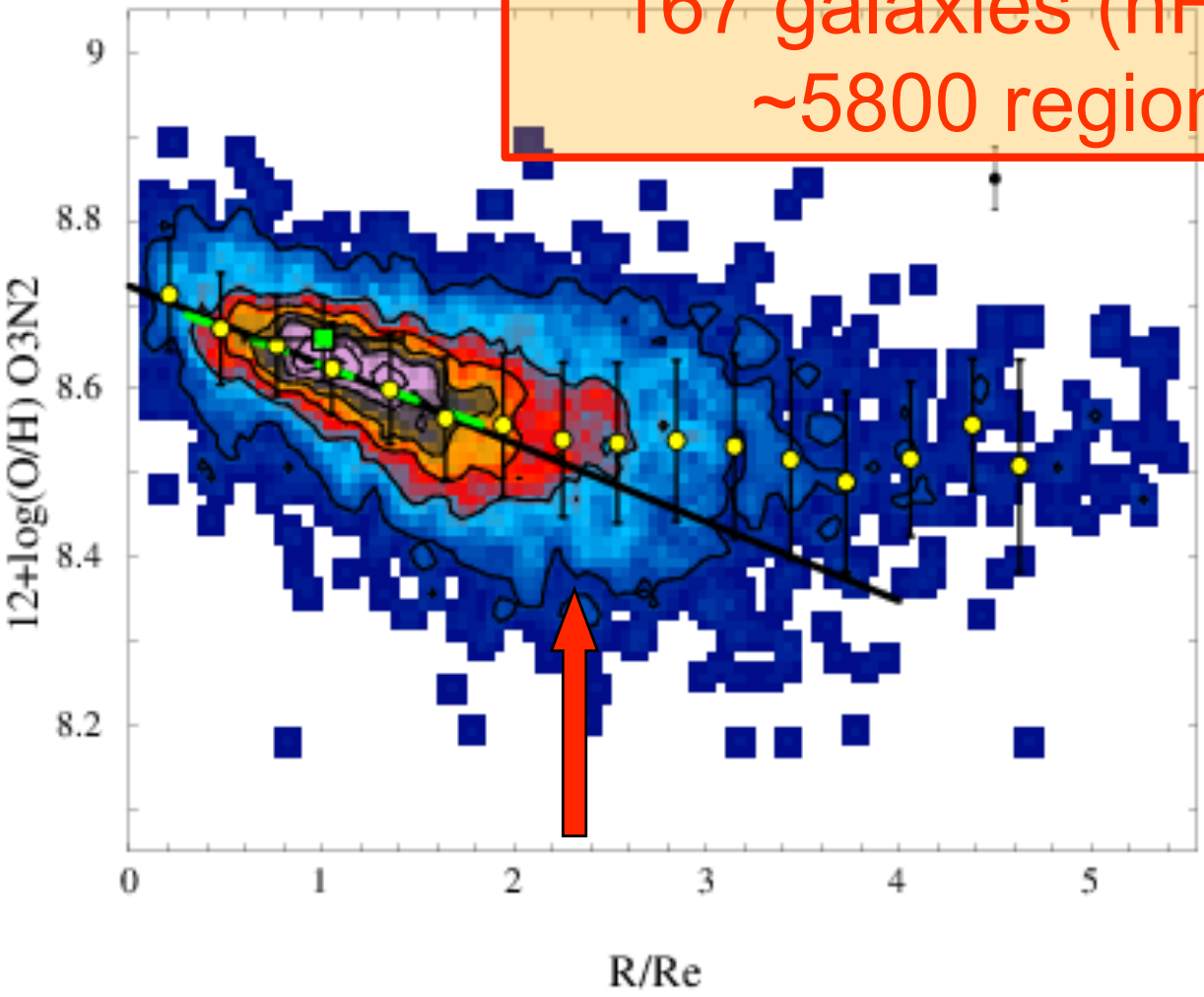
P. Sánchez-Blazquez et al., in prep.

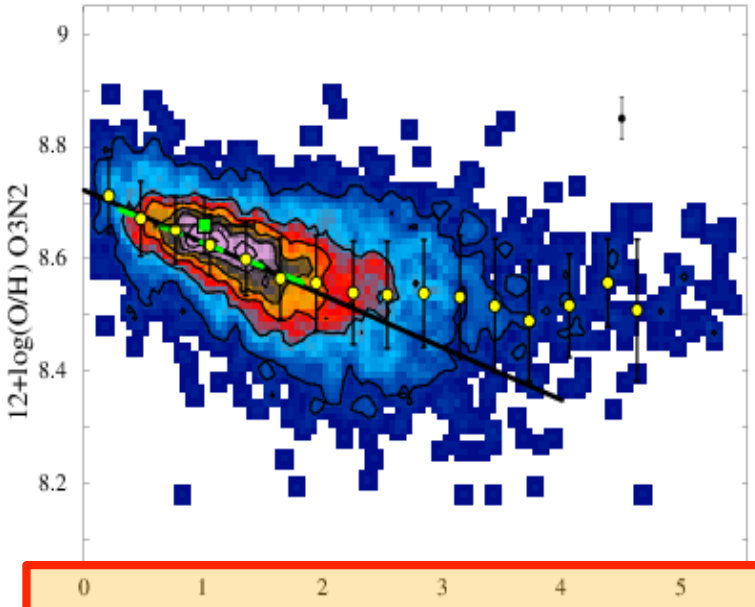


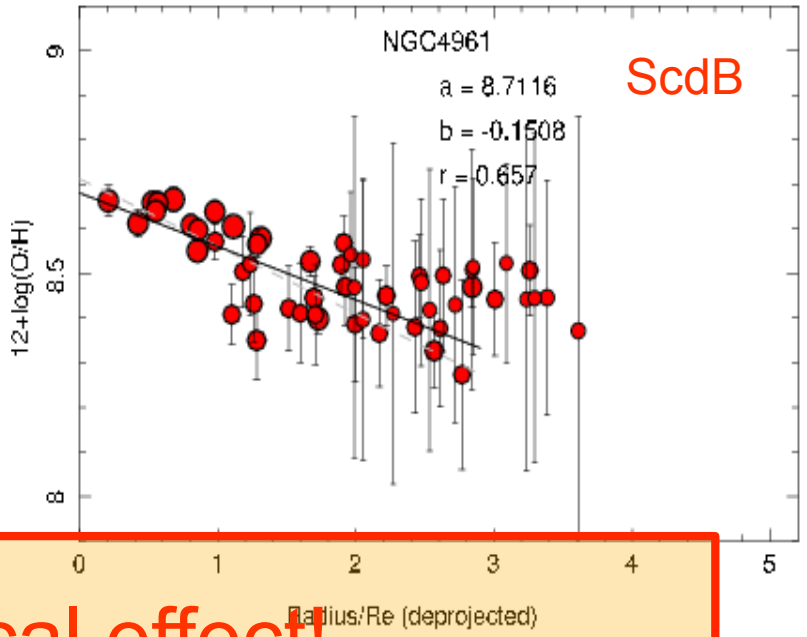
CALIFA Survey

O/H Abundance gradients

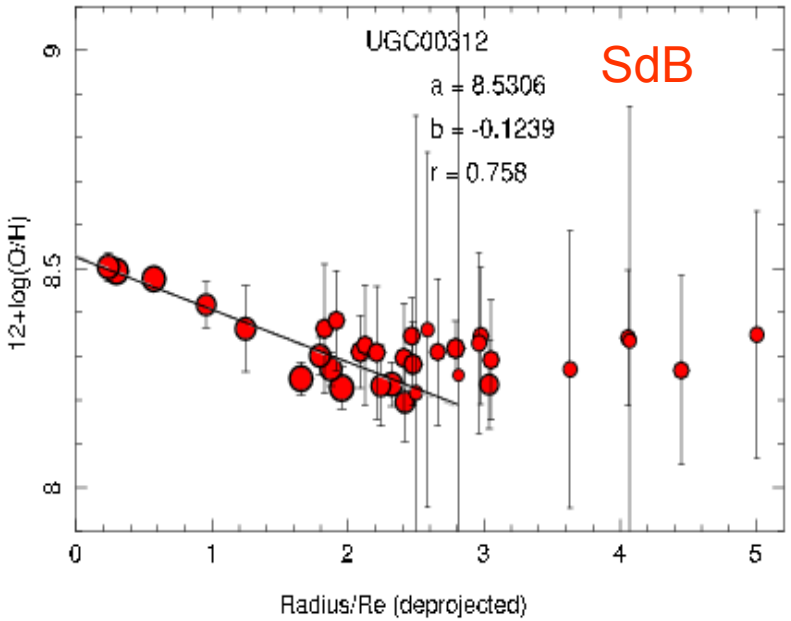
167 galaxies (nHii>4)
~5800 regions

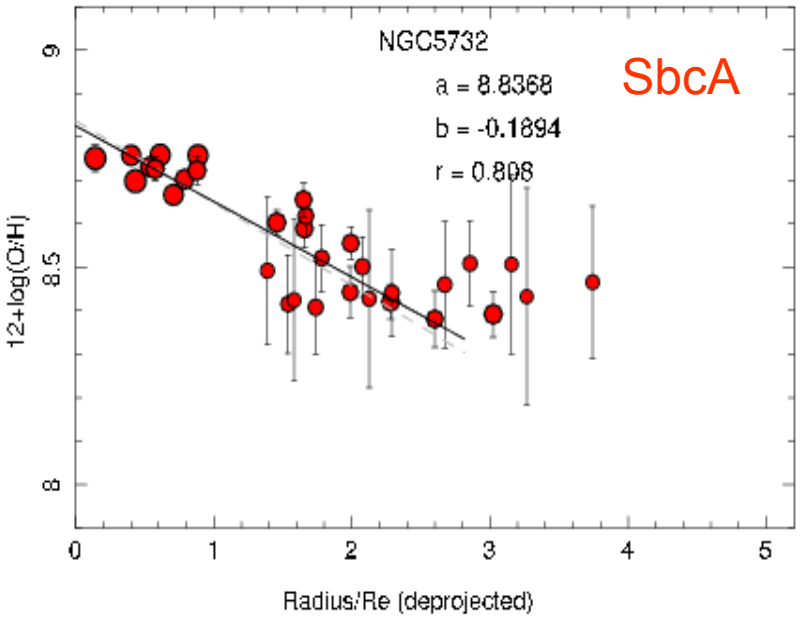


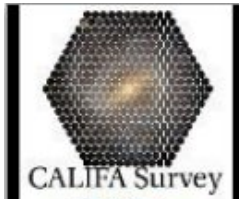


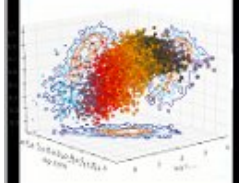


Not an statistical effect!



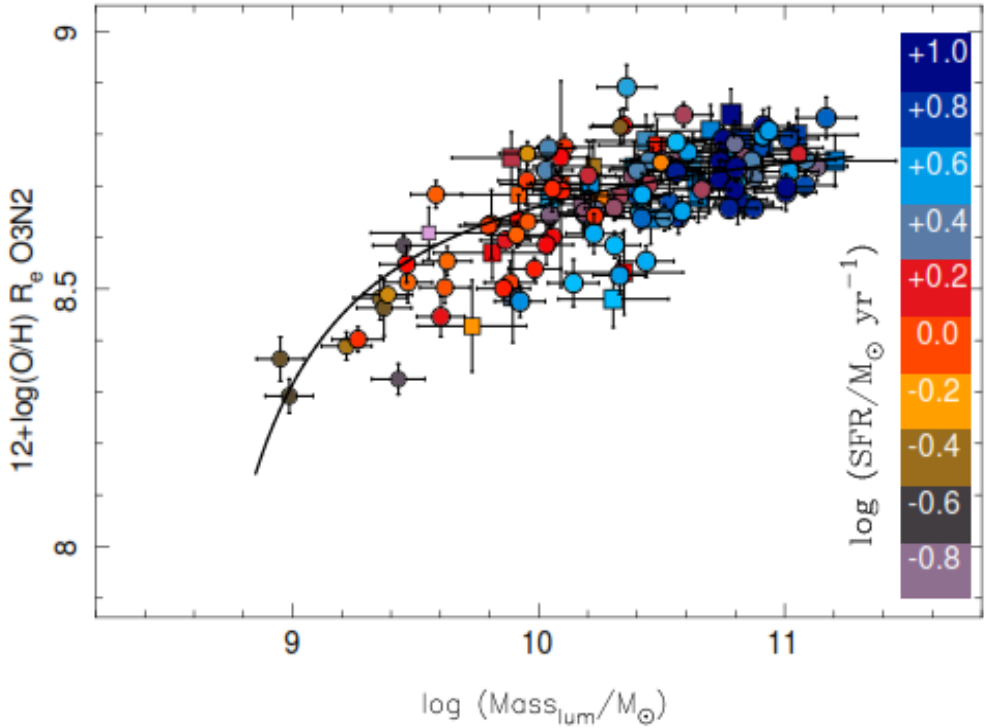


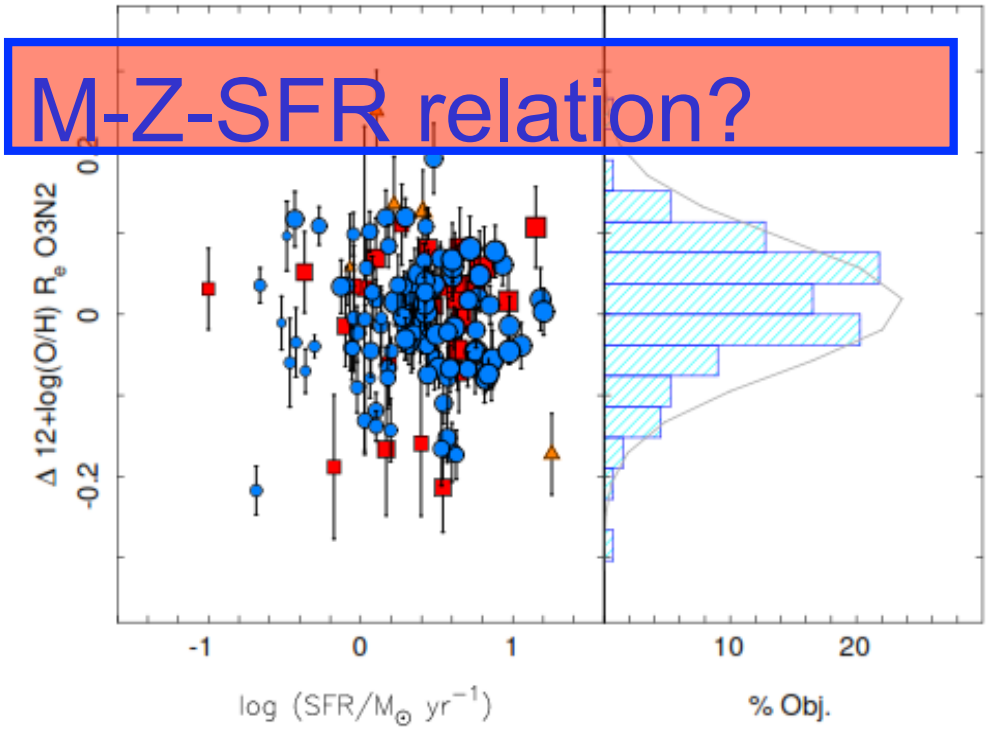


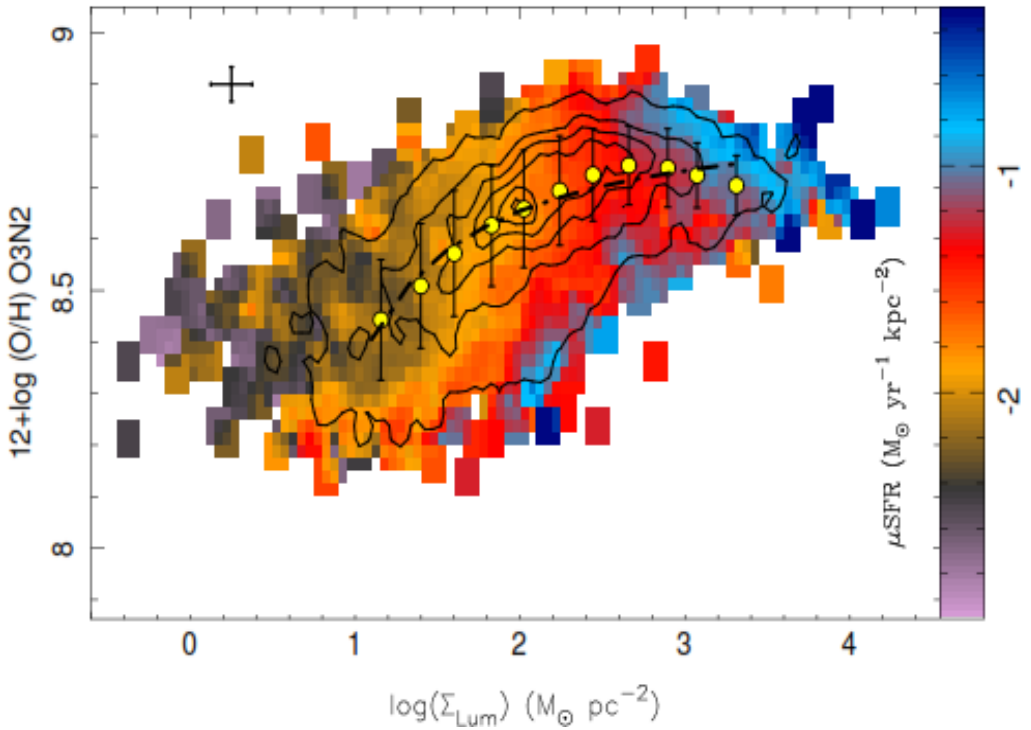


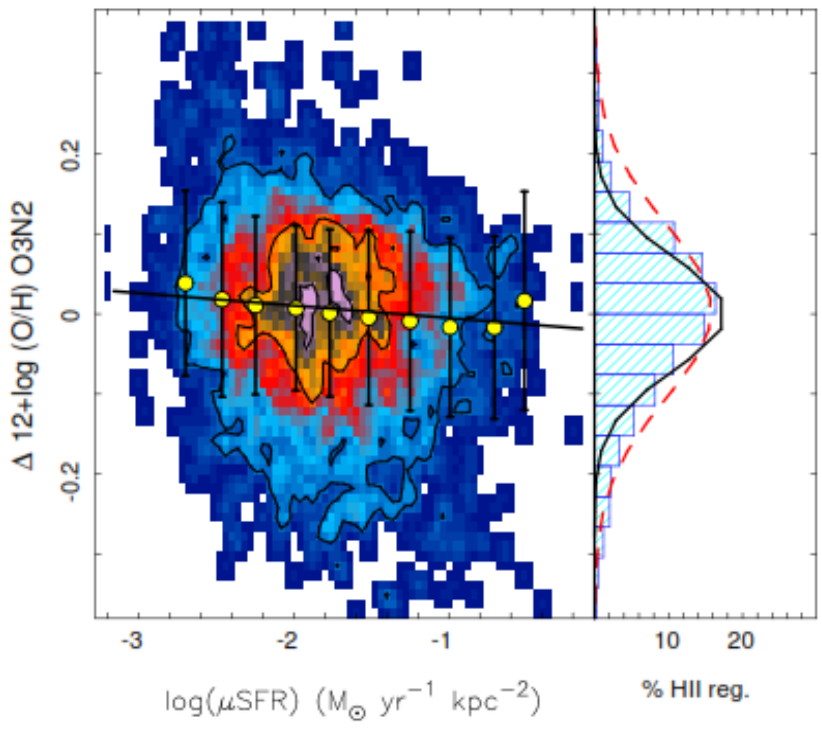
-CALIFA-
HII regions
Additional Results

M-Z-SFR relation?









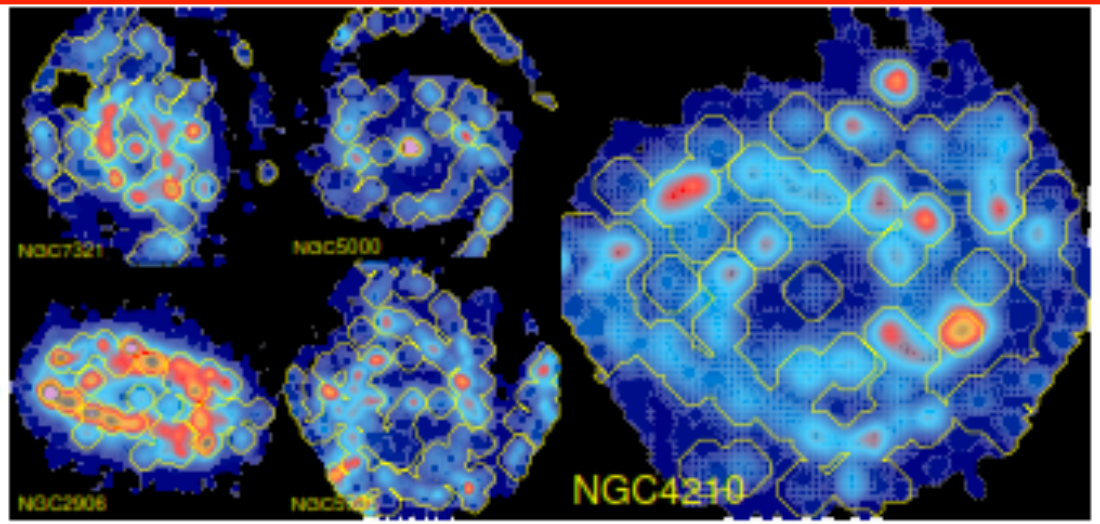
CALIFA Survey

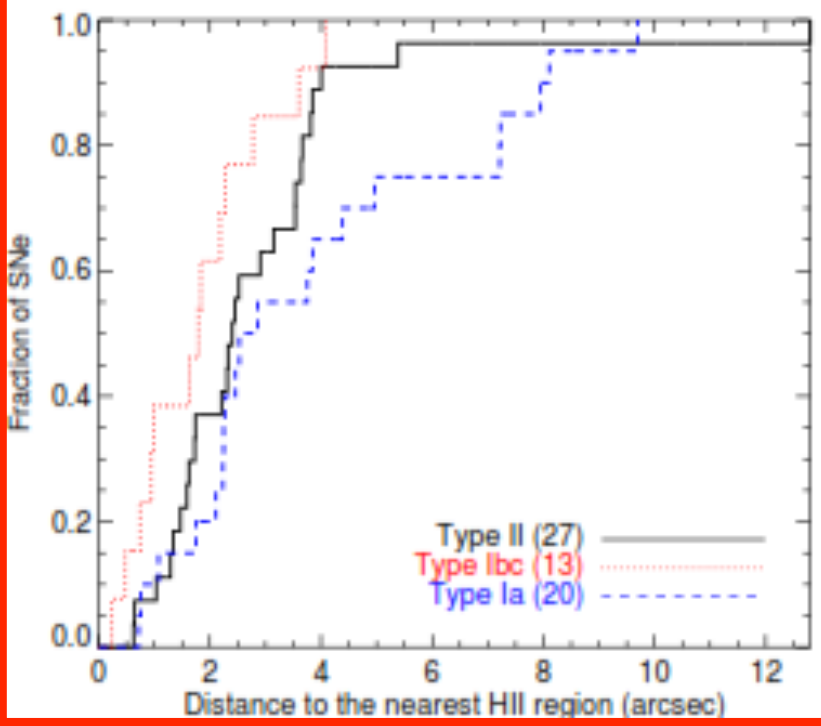
Which are the progenitors of SN?

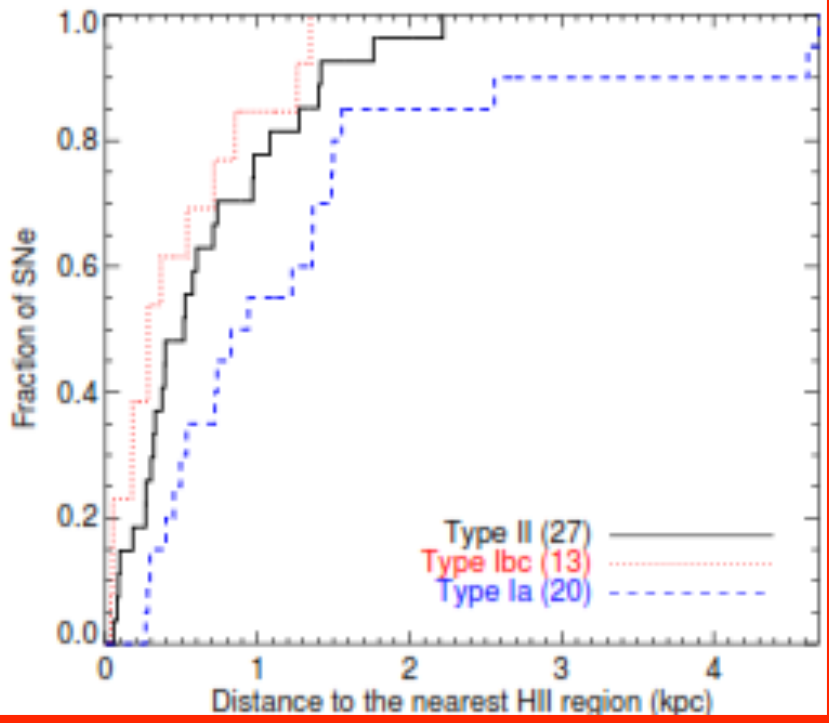
HII regions

60 Hosts Analyzed

HIIexplorer
Sánchez et al. 2012



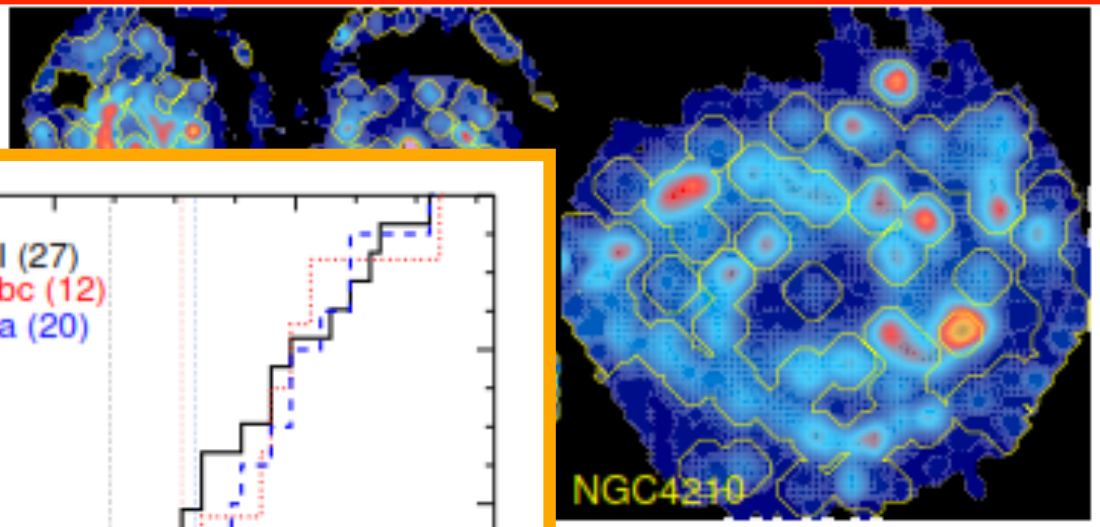


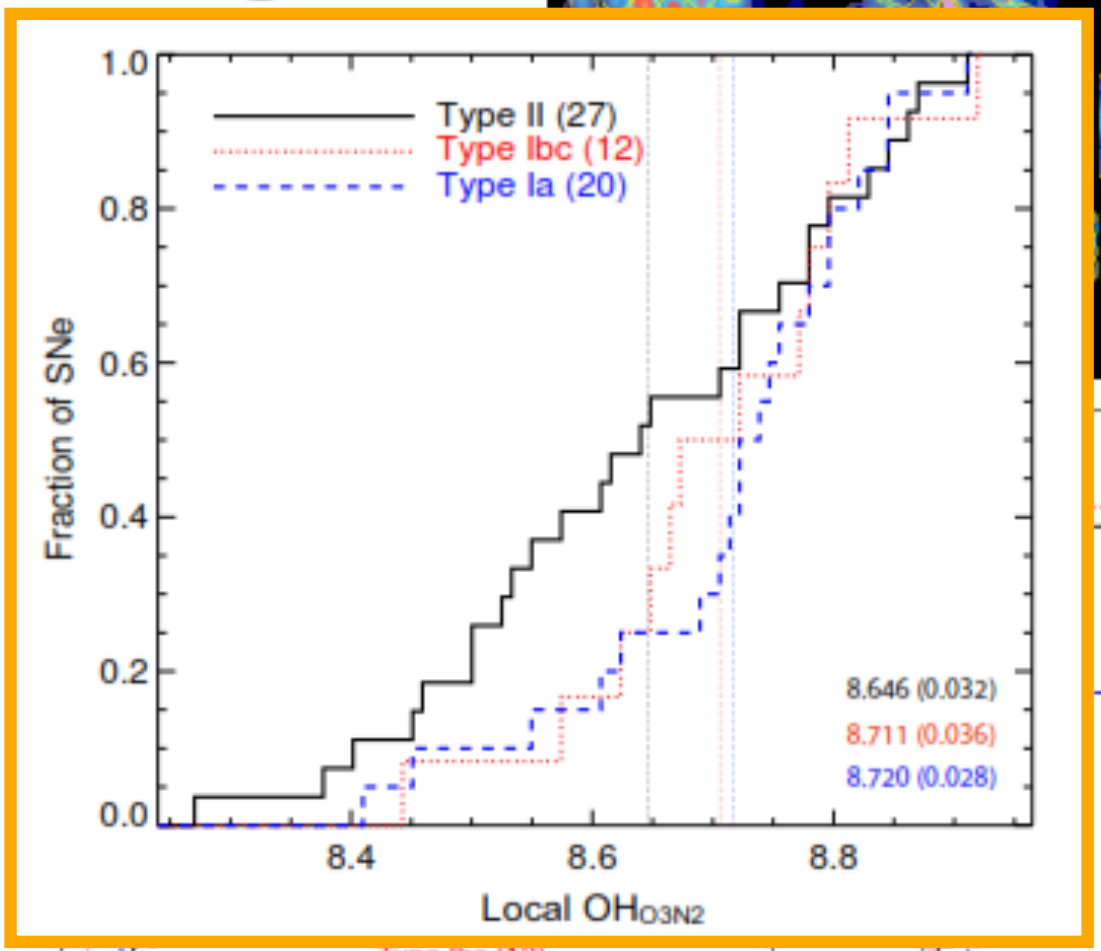


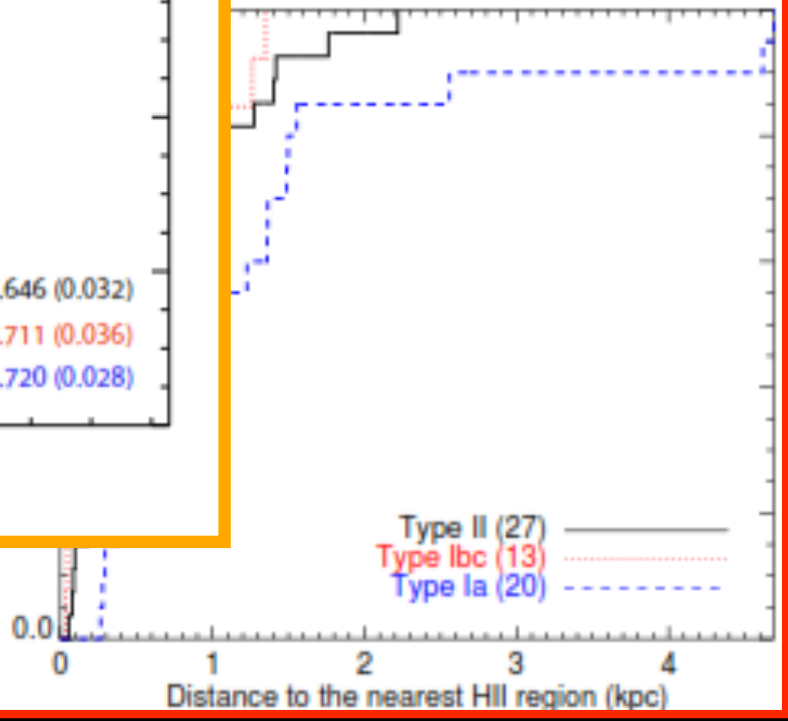
CALIFA Survey

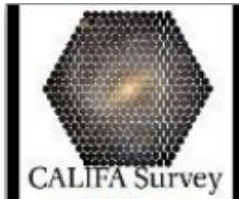
Which are the progenitors of SN?

HII regions









Summary

- CALIFA is an unique dataset for the understanding of galaxy evolution.
- The largest catalogue of HII regions (~10.000) so far.
- HII regions have memory of the SFH.
- A fundamental relation between the Mass-Density and the Abundance.
- Common gradient of the Abundance independent of galaxy morphology.
- M-Z relation: Second relation with the SFR?
- All results are consistent with an inside-out growth of disks.