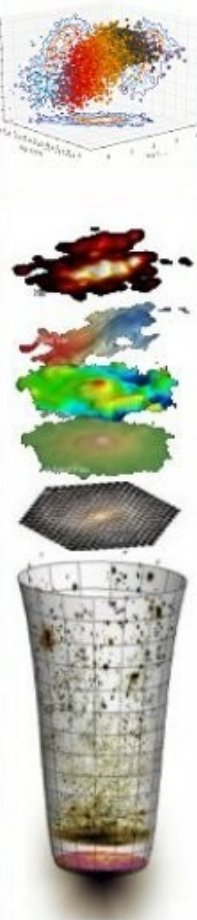
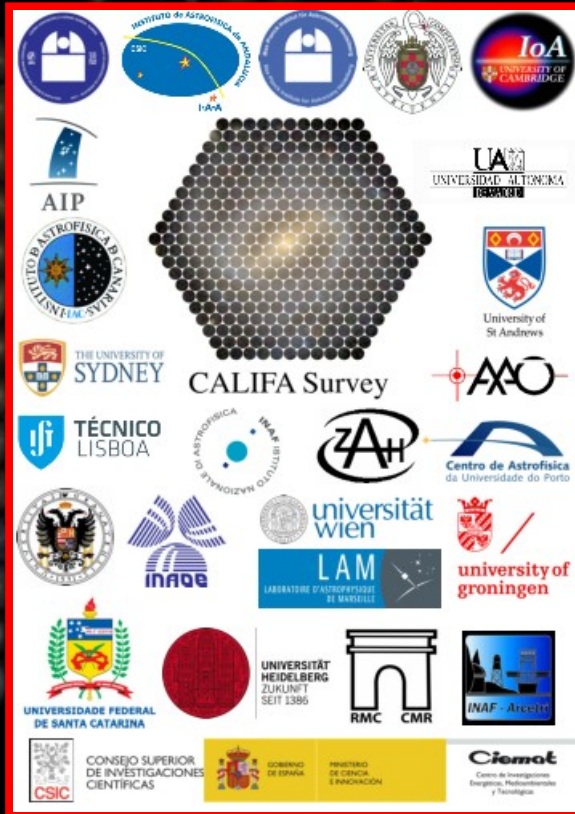
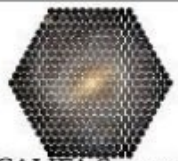


Effects of AGNs in the SFH of galaxies: The CALIFA view.



Sebastián F. Sánchez -IA/UNAM
- Guillermo Haro School, July 2015 -

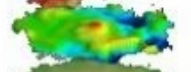
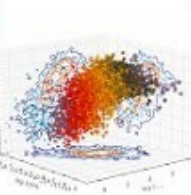


CALIFA Survey



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CALIFA Survey

6900 Å 5250 Å 4100 Å

IFU FoV/2 ~ 2.5 Re
Diameter Selection
All galaxy types.
Good sampling of CM

H α velocities
max
min

H α flux
max
min

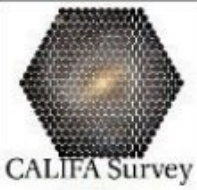
log (μ_* [$M_\odot \text{ pc}^{-2}$])
3.4
1.2

log (Age [yr])
9.9
8.3

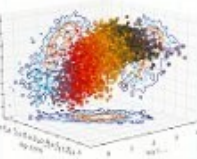
DR2: 200 galaxies.
1st Oct. 2014.
<http://califa.caha.es/DR2>

529 cal. obj. obs.
+109 ext. obj. obs.
>600 -the final goal-

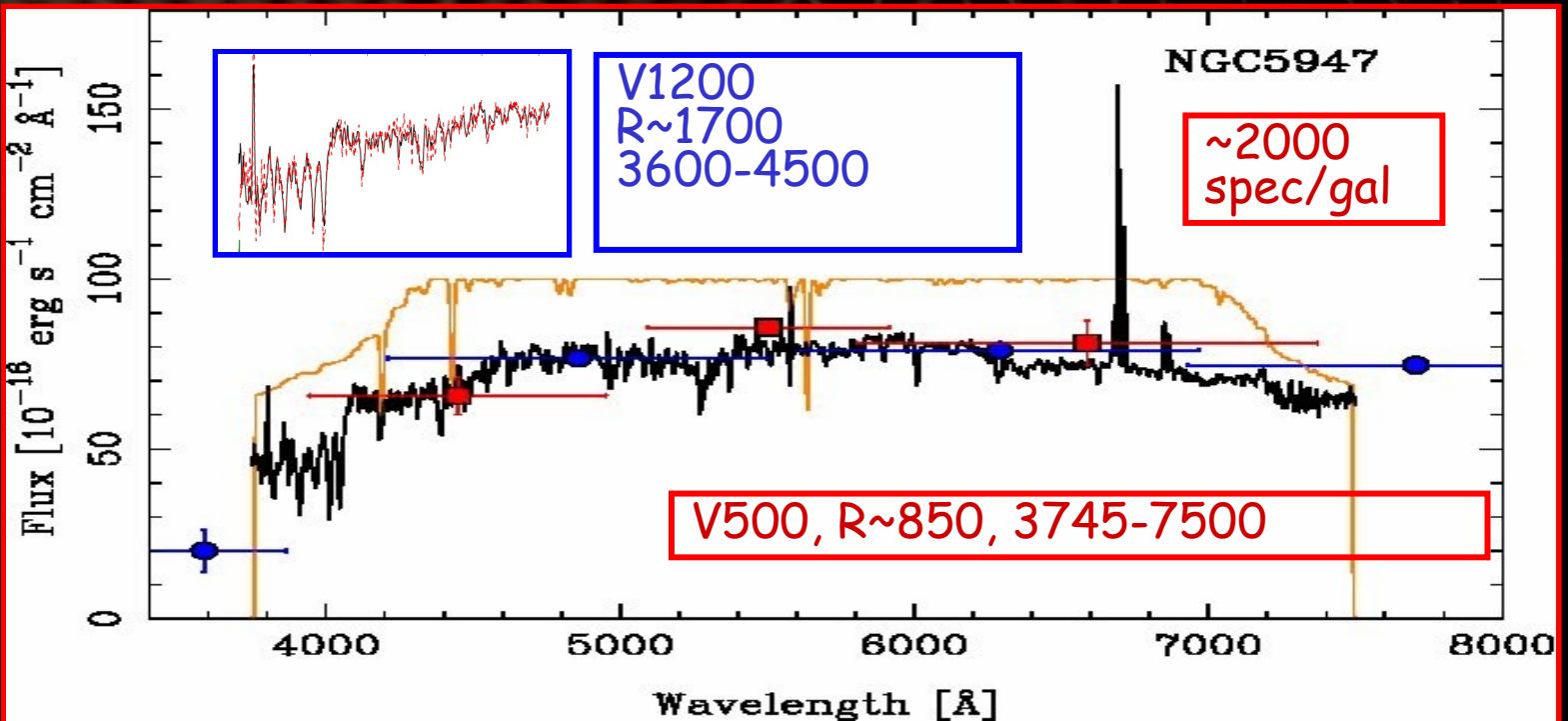
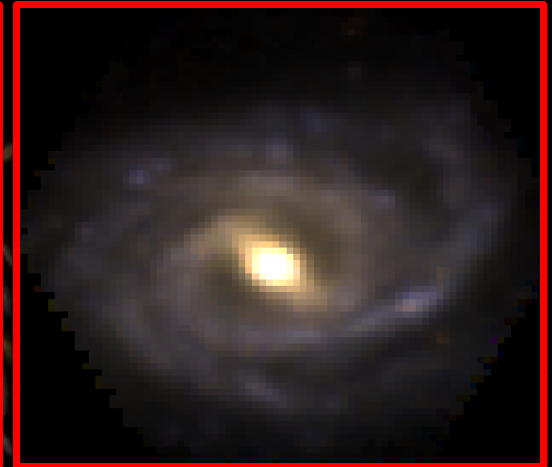
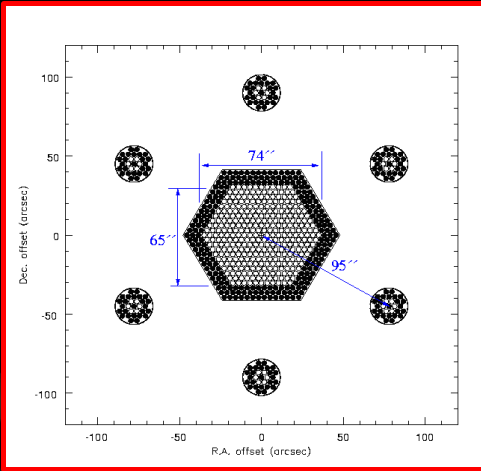
H α [NII] 6584 Å [OIII] 5007 Å

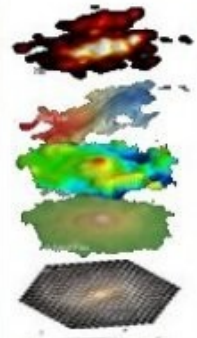
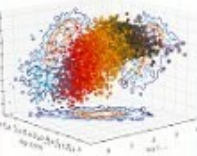


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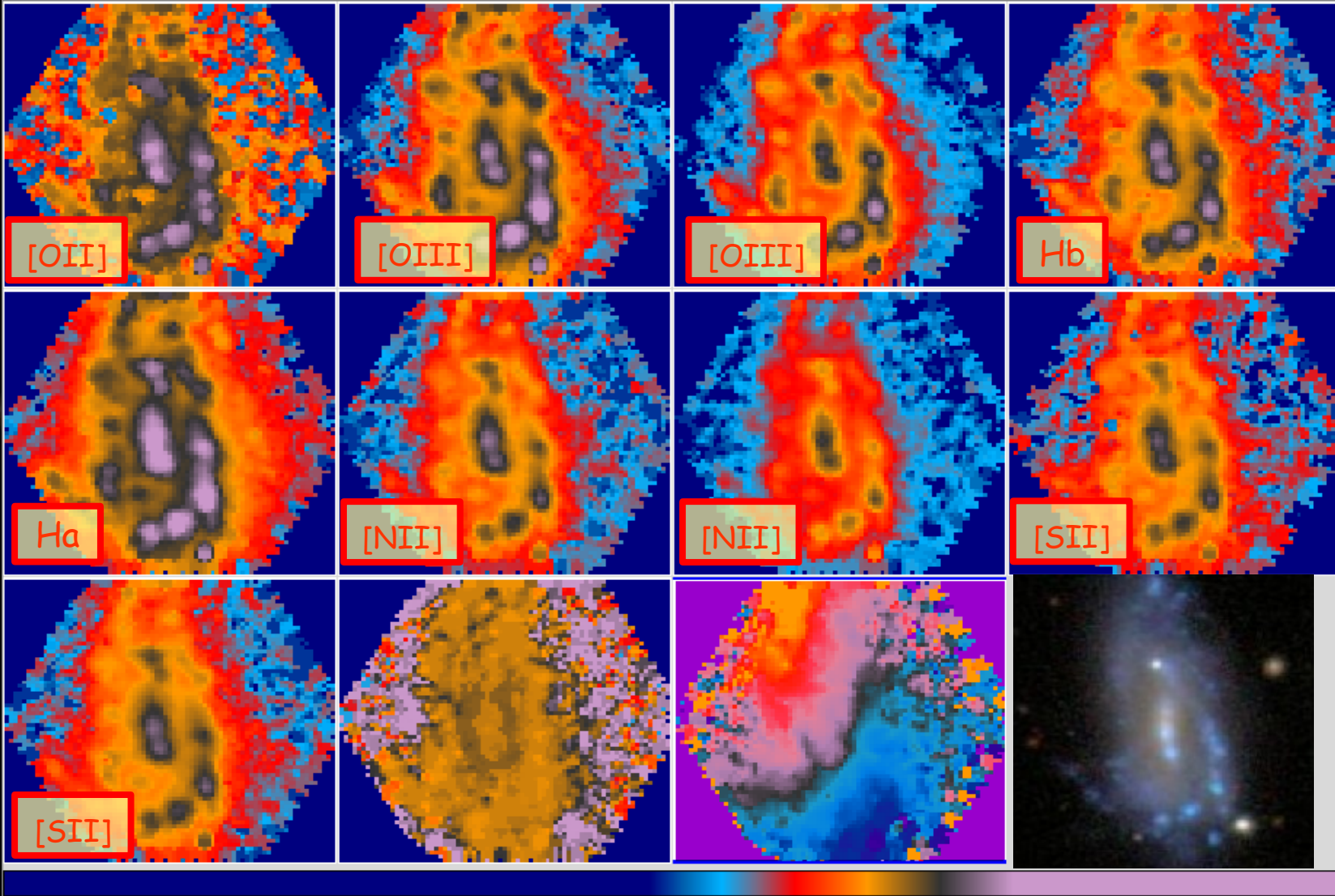


CALIFA: Metodology



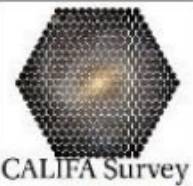


CALIFA: A panoramic view



Ionized Gas: Multiple emission lines intensity maps, velocity and velocity dispersion.

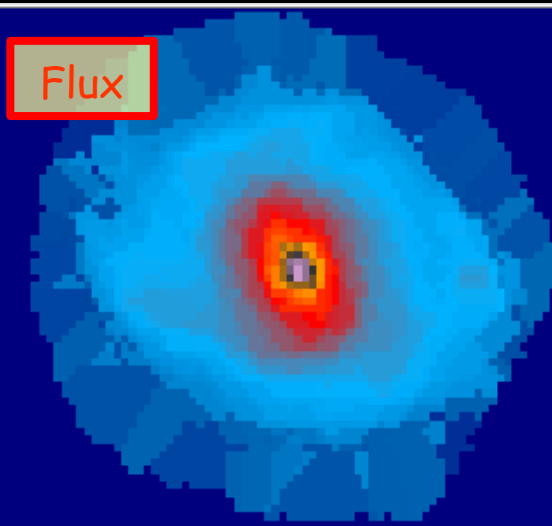
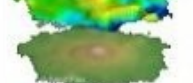
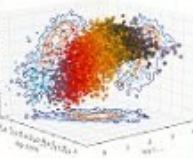
CALIFA: A panoramic view



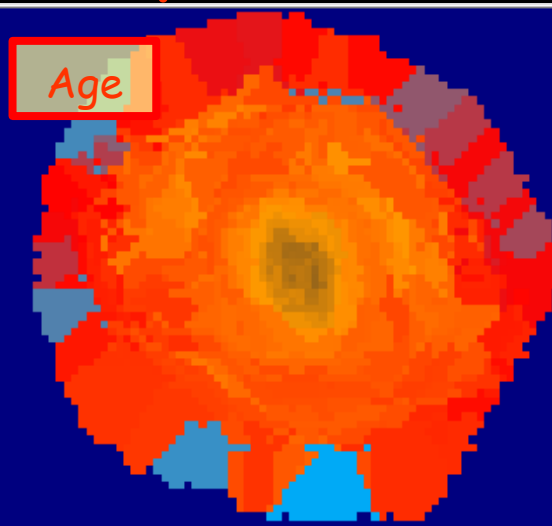
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Flux



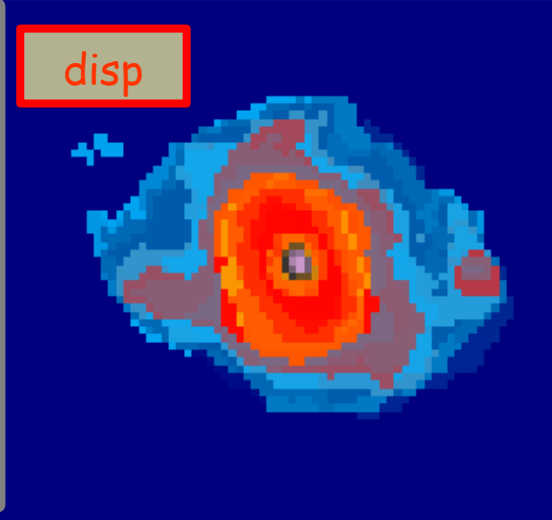
Age



[Z/H]



SDSS



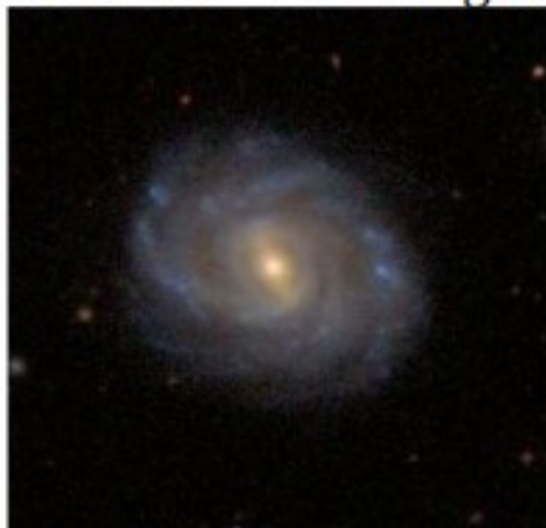
disp



vel

Stellar Populations: Average Properties.

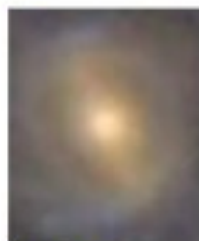
SDSS 90"x90" image



Atlas3D



Z~Z califa



Z~Z Atlas3D

MaNGA largest FoV

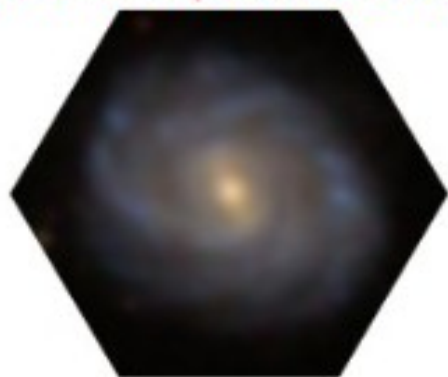


FoV~1.5Re



~2.5Re

CALIFA (V500/V1200)



SAMI



Z~Z califa



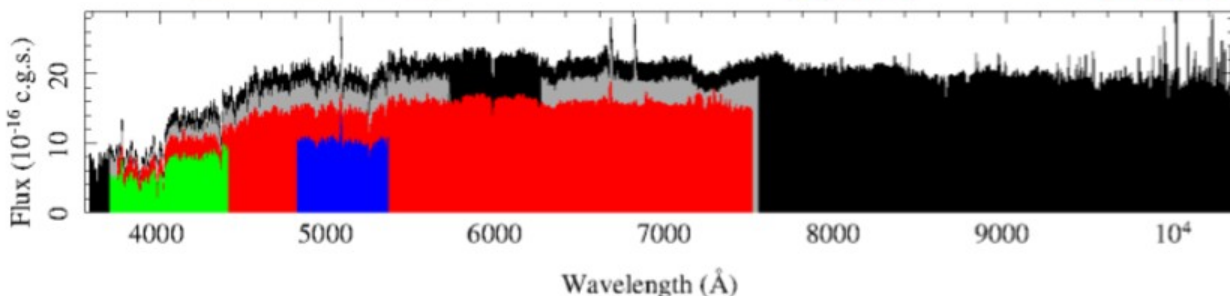
Z~Z SAMI

CALIFA
 2x3x331 spaxels; 2.7"/spaxel
 600 galaxies of any type
 ~1.200.000 spec.; 3700-7500 Å

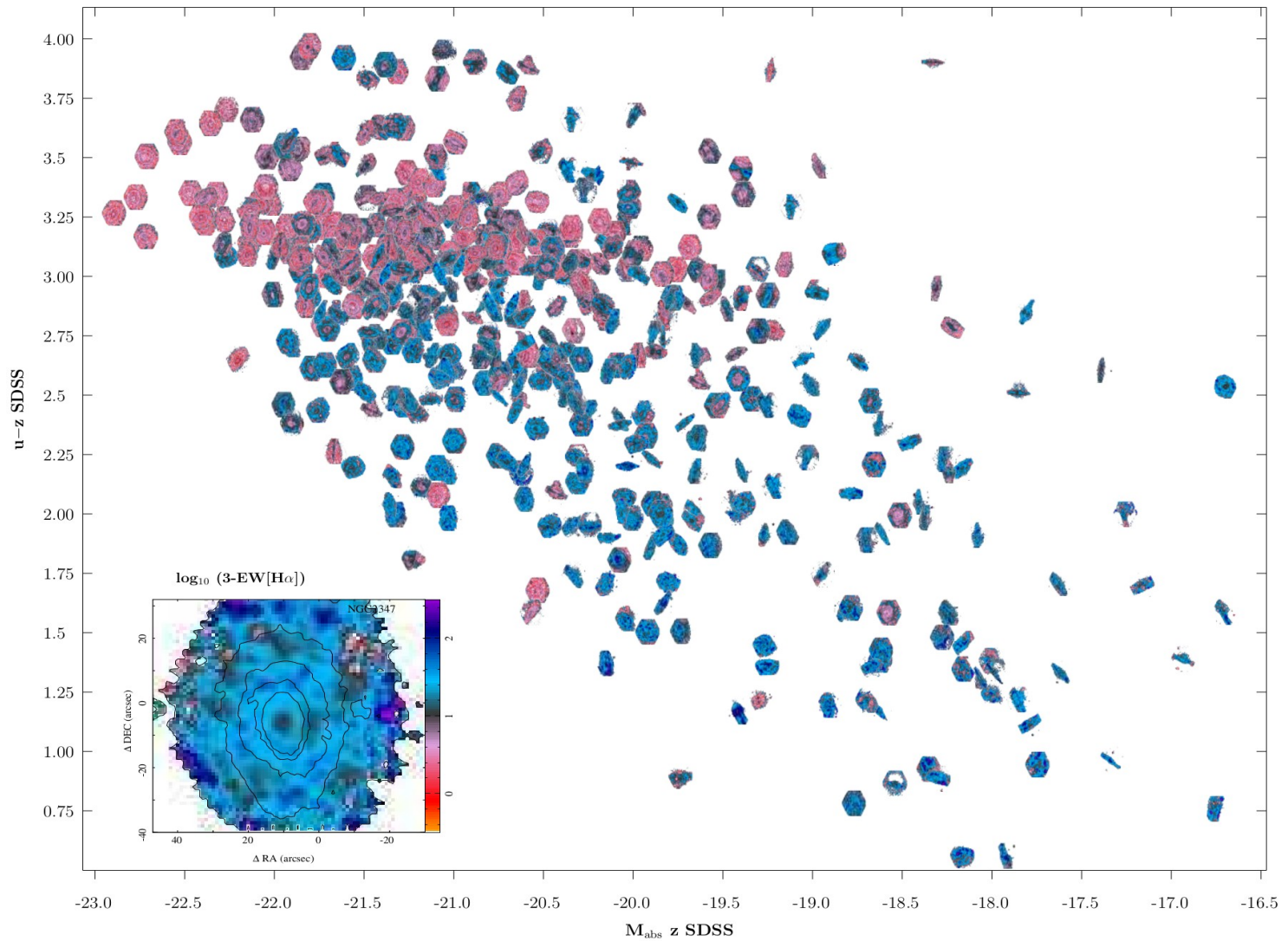
Atlas3D
 1577 spaxels; 0.94"/spaxel
 260 ETGs
 ~400.000 spectra; 4810-5350 Å

MaNGA
 3x(19-127) spaxels; 2"/spaxel
 7000 gal. of any type (~1.5Re)
 2000 gal. of any type (~2.5Re)
 1000 gal. of any type (any Re)
 ~800.000 spec.; 3550-10000 Å

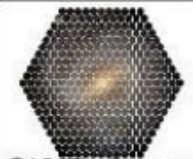
SAMI
 9x61 spaxels; 1.6"/spaxel
 3400 galaxies of any type
 ~1.900.000 spec.; 3700-9500 Å



Bimodal properties of galaxies...



Bimodal properties of galaxies...

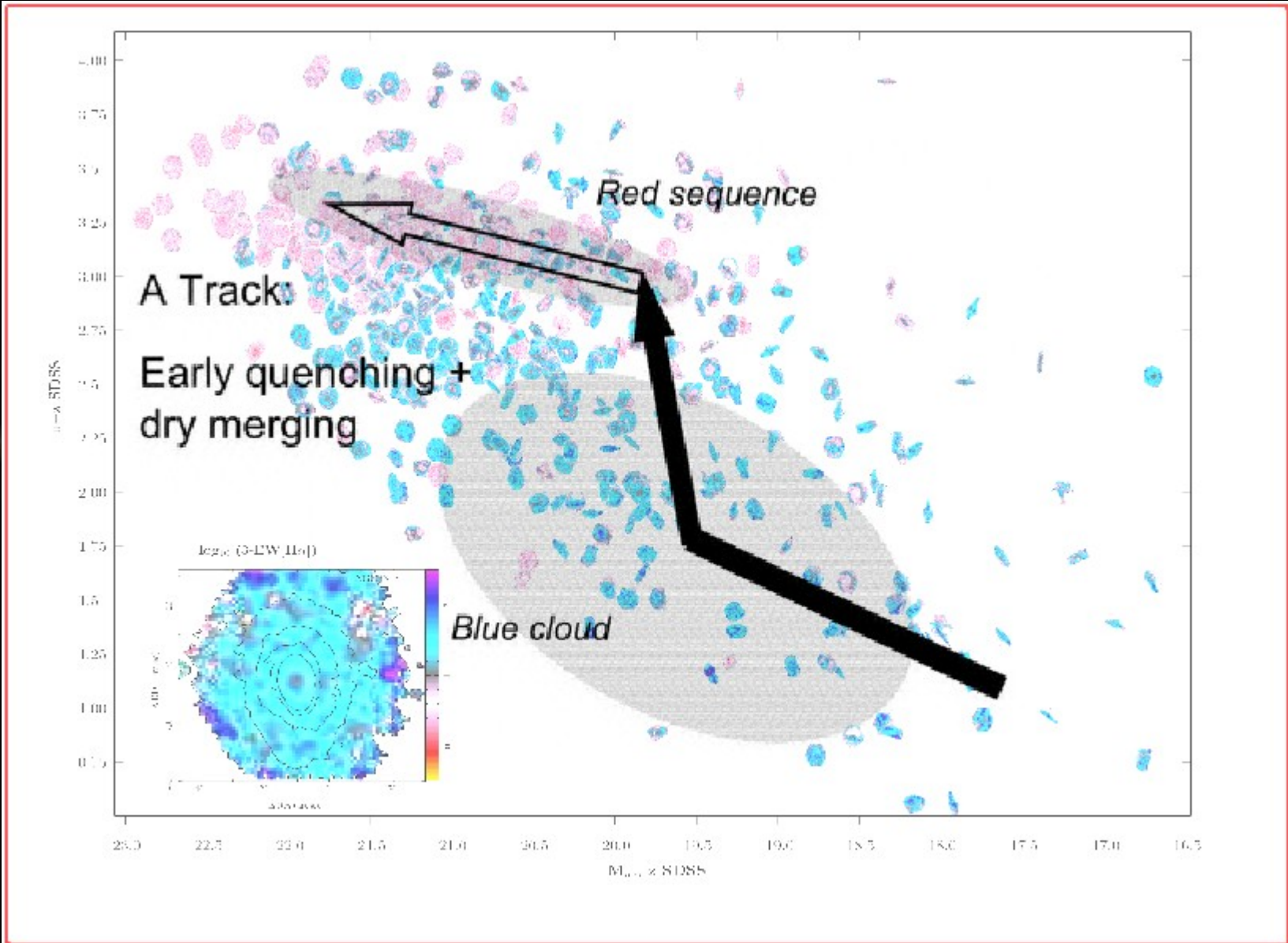
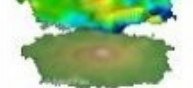
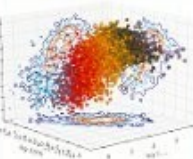


CALIFA Survey

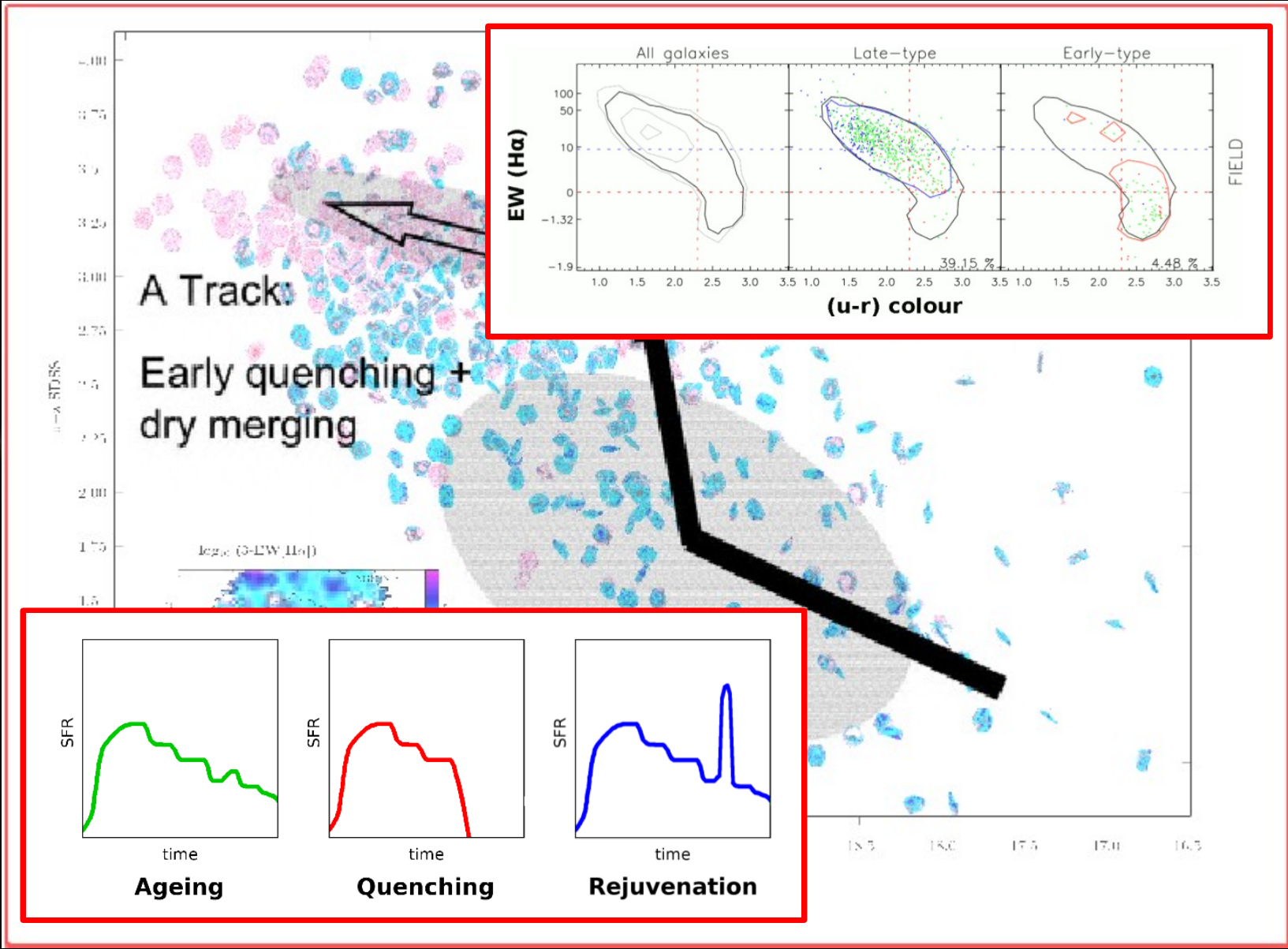


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Bimodal properties of galaxies...

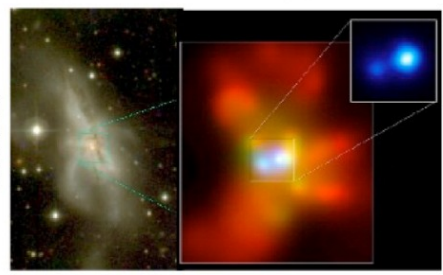


(c) Interaction/"Merger"



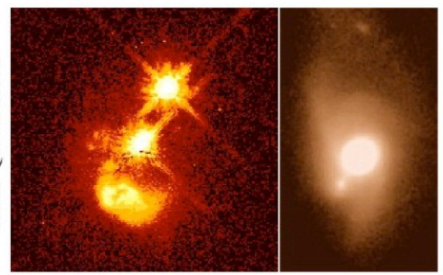
- now within one halo, galaxies interact & lose angular momentum
- SFR starts to increase
- stellar winds dominate feedback
- rarely excite QSOs (only special orbits)

(d) Coalescence/(U)LIRG



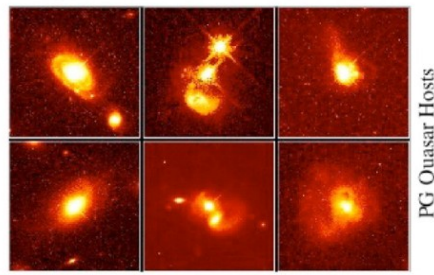
- galaxies coalesce: violent relaxation in core
- gas inflows to center: starburst & buried (X-ray) AGN
- starburst dominates luminosity/feedback, but, total stellar mass formed is small

(e) "Blowout"



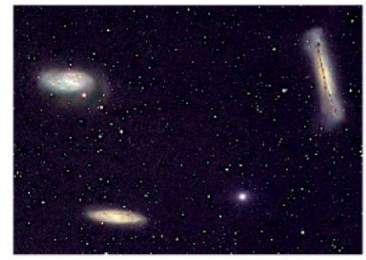
- BH grows rapidly: briefly dominates luminosity/feedback
- remaining dust/gas expelled
- get reddened (but not Type II) QSO: recent/ongoing SF in host
- high Eddington ratios
- merger signatures still visible

(f) Quasar



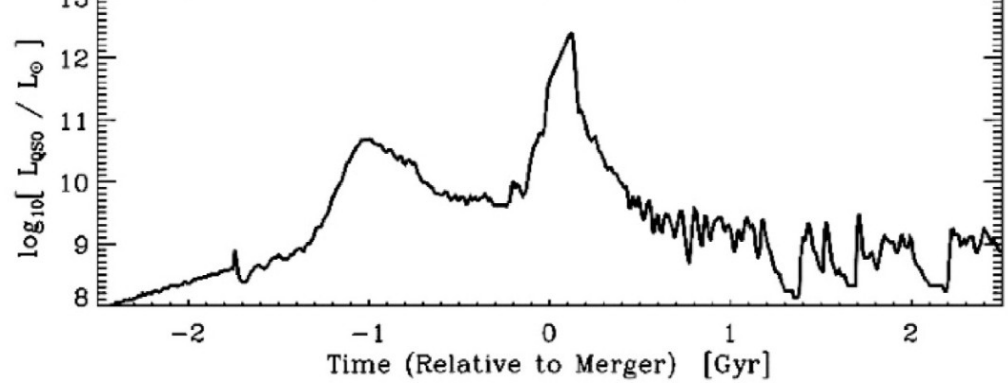
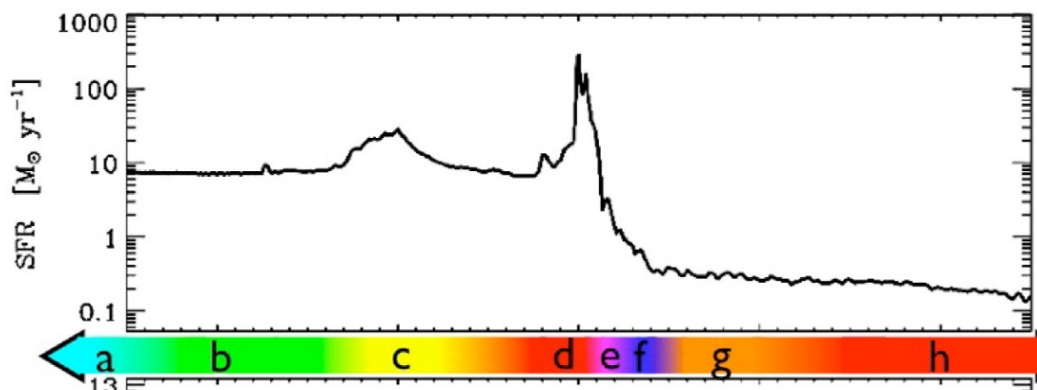
- dust removed: now a "traditional" QSO
- host morphology difficult to observe: tidal features fade rapidly
- characteristically blue/young spheroid

(b) "Small Group"



- halo accretes similar-mass companion(s)
- can occur over a wide mass range
- M_{halo} still similar to before: dynamical friction merges the subhalos efficiently

... a consequence of AGN ...

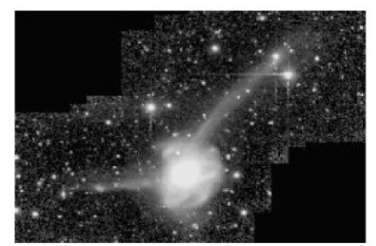


(a) Isolated Disk



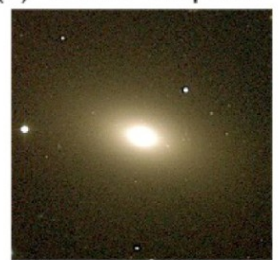
- halo & disk grow, most stars formed
- secular growth builds bars & pseudobulges
- "Seyfert" fueling (AGN with $M_B > -23$)
- cannot redden to the red sequence

(g) Decay/K+A



- QSO luminosity fades rapidly
- tidal features visible only with very deep observations
- remnant reddens rapidly (E+A/K+A)
- "hot halo" from feedback
- sets up quasi-static cooling

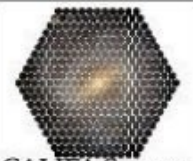
(h) "Dead" Elliptical



- star formation terminated
- large BH/spheroid - efficient feedback
- halo grows to "large group" scale: the gas become inefficient growth by "dry" mergers

Hopkins et al., ApJ, 2008, but said before: Lipari, Sanders

Do AGN hosts fit the picture (type II)?

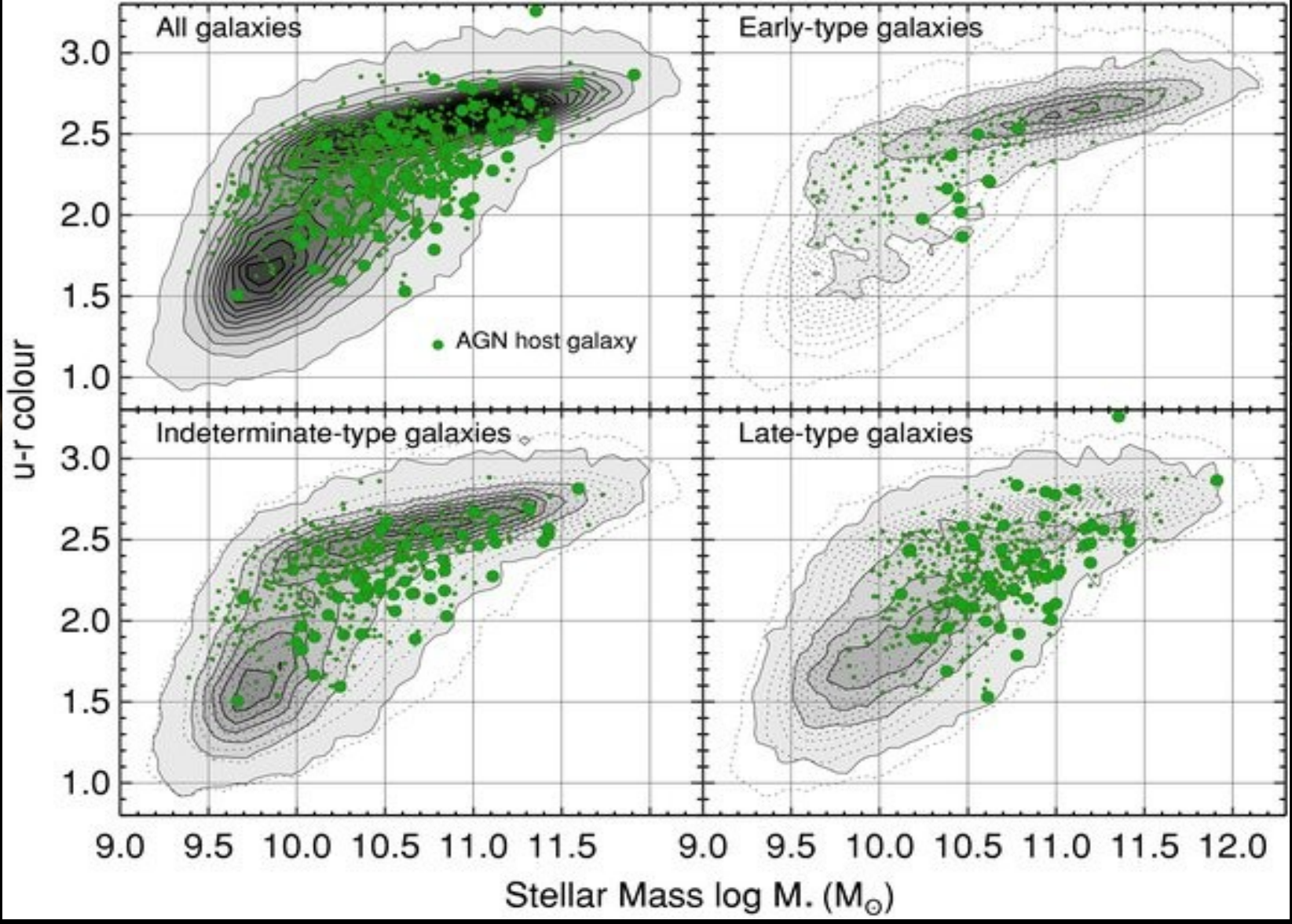
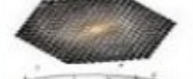
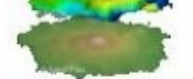
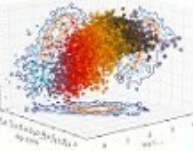


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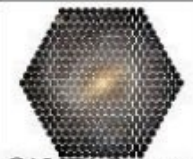
UNAM



Schawinski et al., ApJ, 2010

+ Kauffmann et al. 2003 and others...

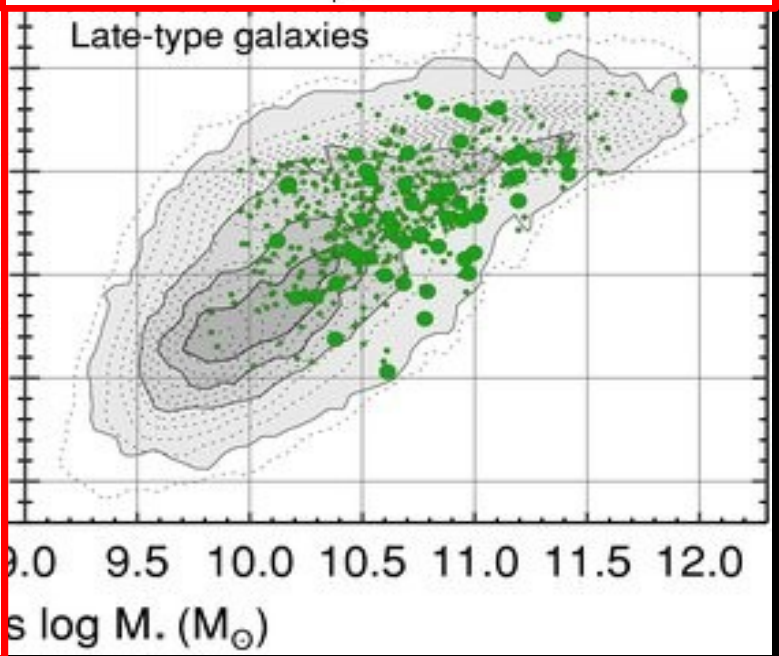
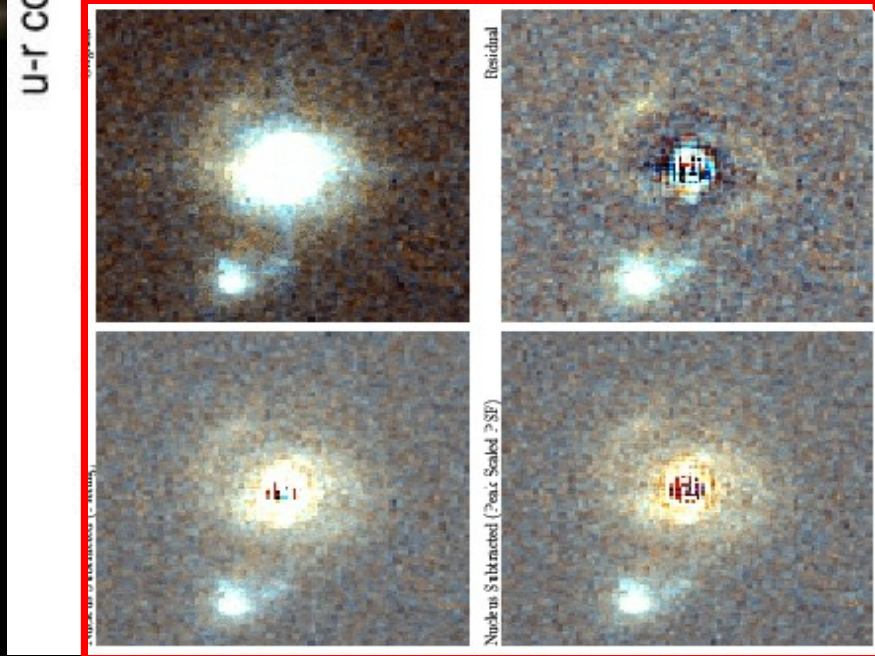
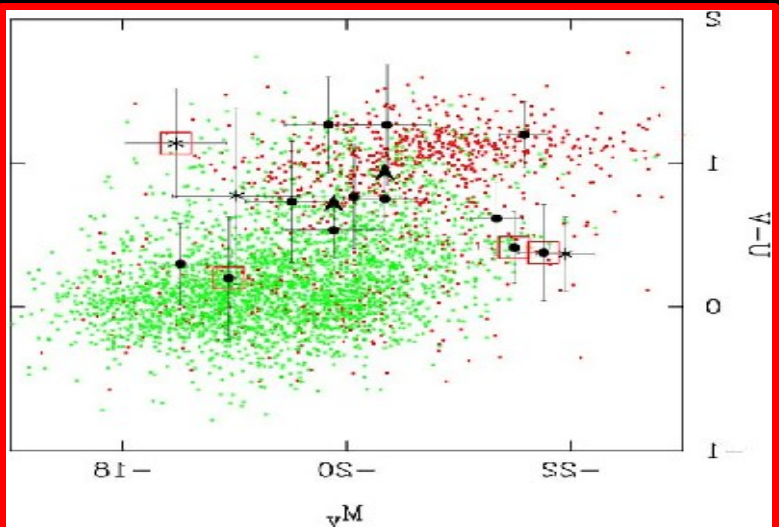
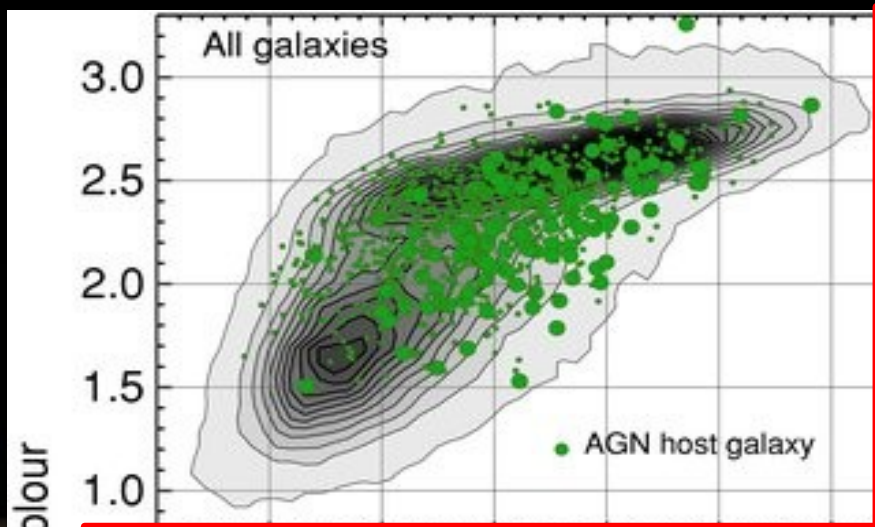
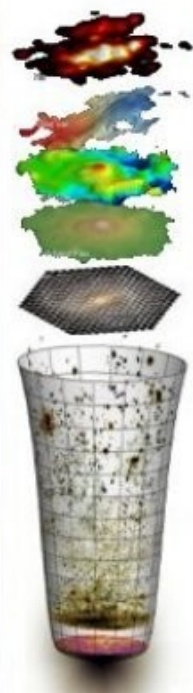
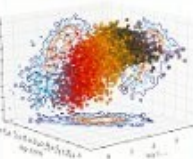
Do AGN hosts fit the picture (type I)?



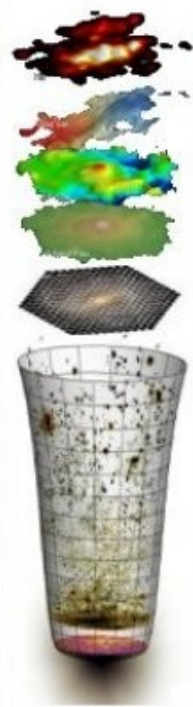
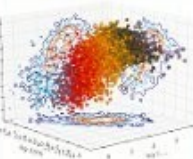
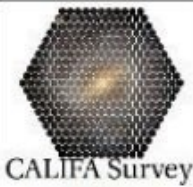
CALIFA Survey



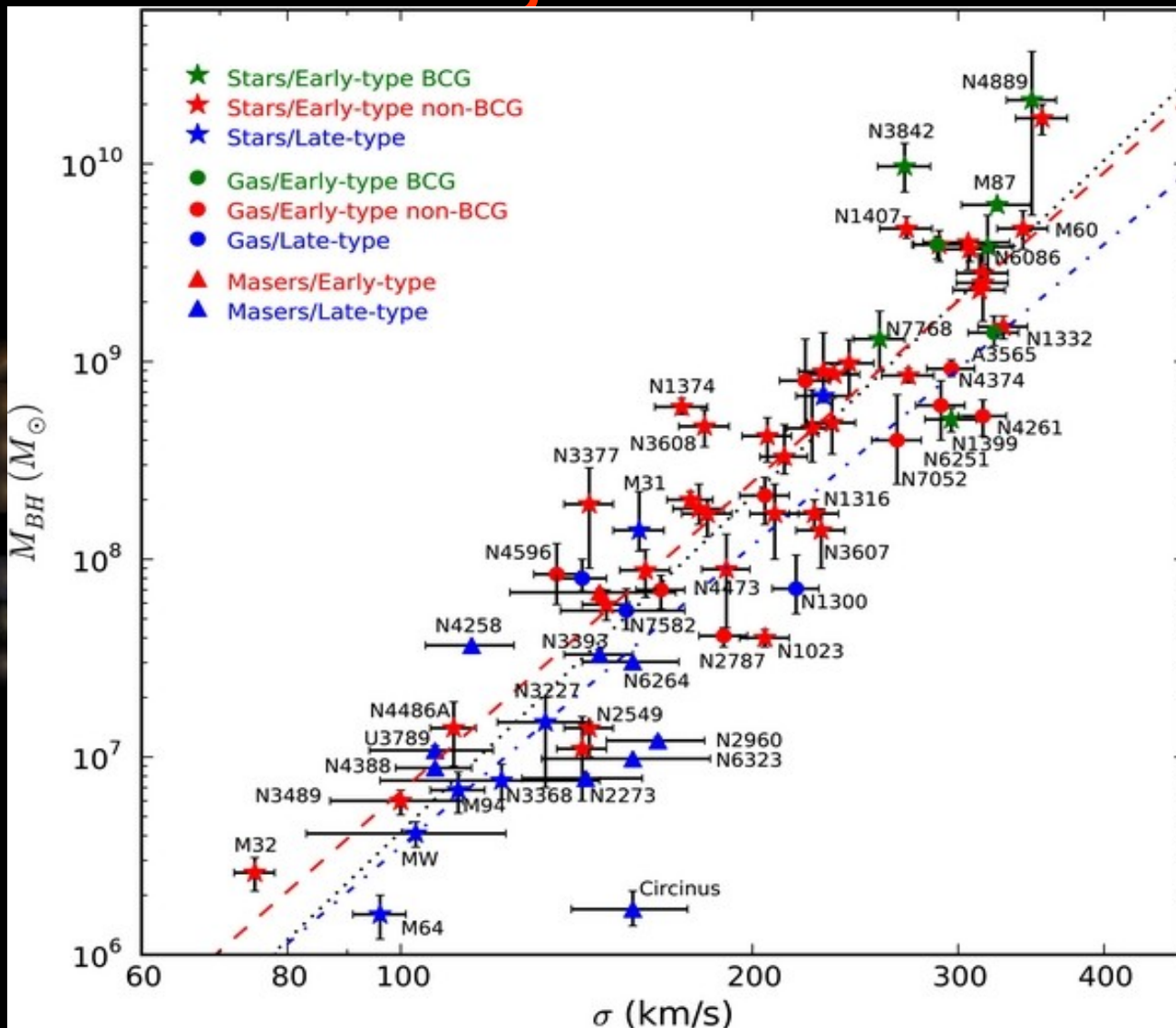
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Sánchez et al., ApJ, 2004

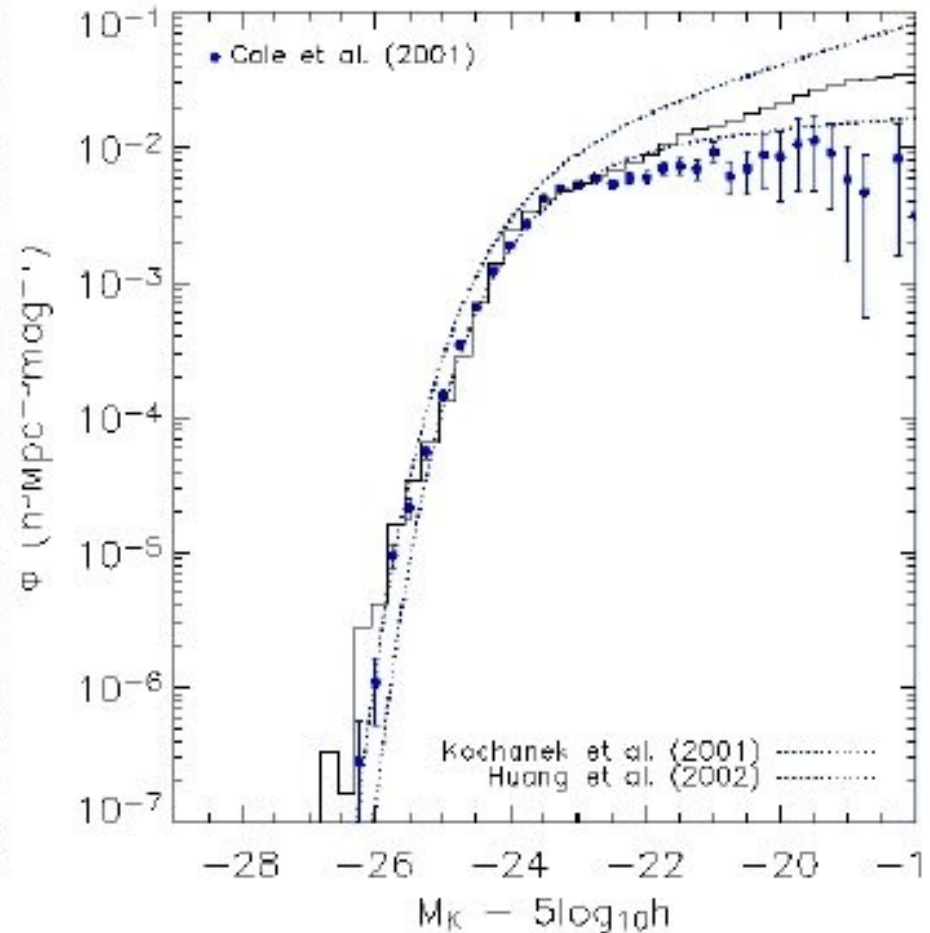
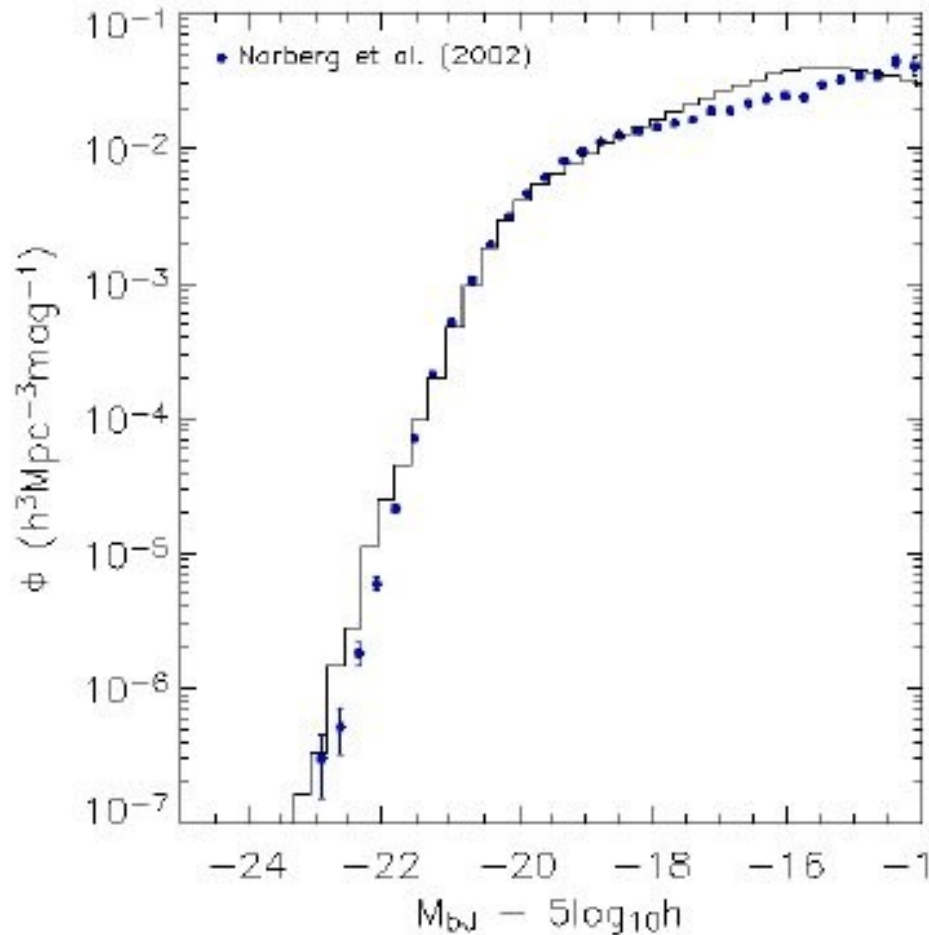


BH vs. Bulge co-evolution



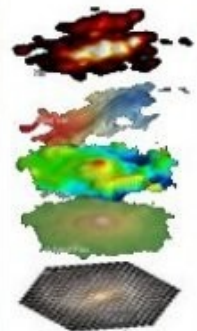
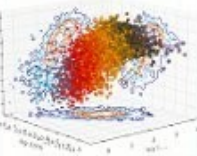
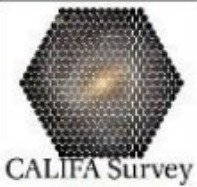
Magorrian/Gebhart/Kormendy & Ho, ARAA 2013

Required to reproduce the LM of galaxies



Full model with reionisation, AGN and SN feedback

Croton et al 2006



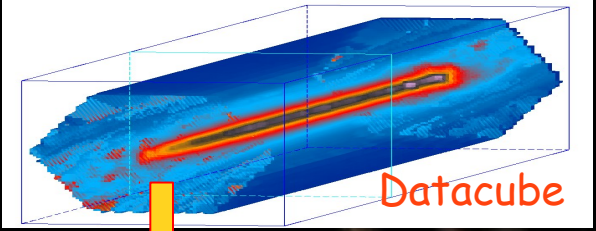
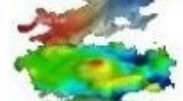
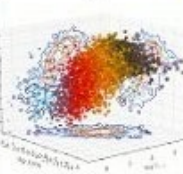
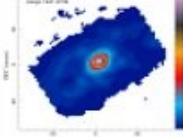
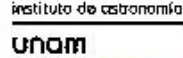
What have we found with CALIFA?

...

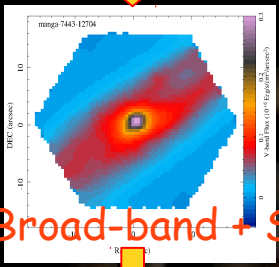
And other IFU surveys

...

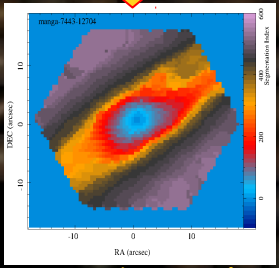
... a bit of technical details ...



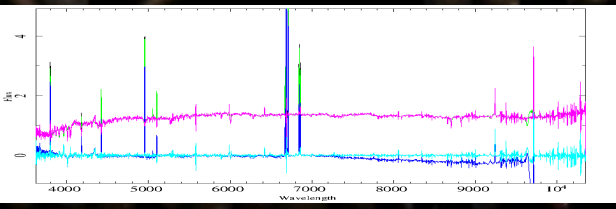
Datacube



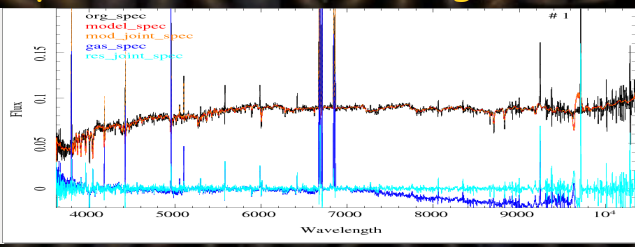
Broad-band + S/N



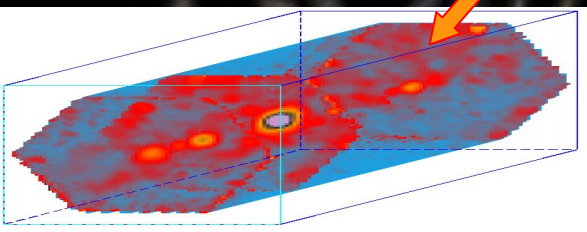
Seg./Voxel map.
Not based in Voronoi!



Central Aperture+FIT3D+small SSP template (6 SSPs)+Strong Em. lines



RSS+FIT3D+small SSP template (12 miuscat SSPs 3600-9500 AA) +Strong Em. Lines



Gas pure Datacube →
Analysis of the strong and weak emission lines

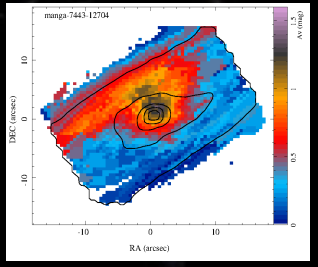
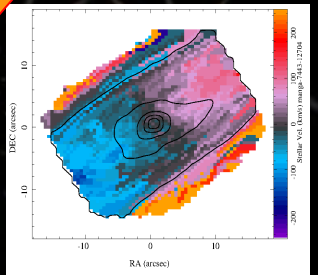
Gas "cleaned" datacube
RSS-segmented
FIT3D+large SSP template (156 SSPs 3600-7200 AA)
SFH, Age, [Z/H], St. Mass

Pipe3D: Basic Steps

How to twist the arm to the data!!!

- Sys. Vel.
- σ_{cen}
- Range of param.

- St. Vel. map.
- St. σ map.
- St. Av map. (Cardelli et al. 1998, curve)



PIPE3D, A PIPELINE TO ANALYZE INTEGRAL FIELD SPECTROSCOPY DATA: I. NEW FITTING PHILOSOPHY OF FIT3D.

S. F. Sánchez¹, E. Pérez², P. Sánchez-Blázquez³, J.J. González¹, F.F. Rosález-Ortega⁴, M. Cano-Díaz¹, C. Cobá¹

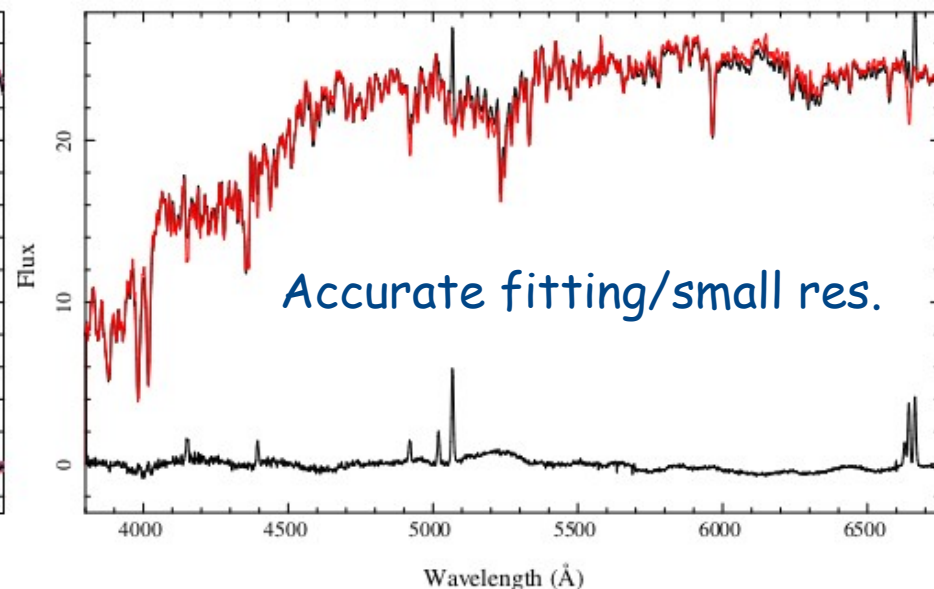
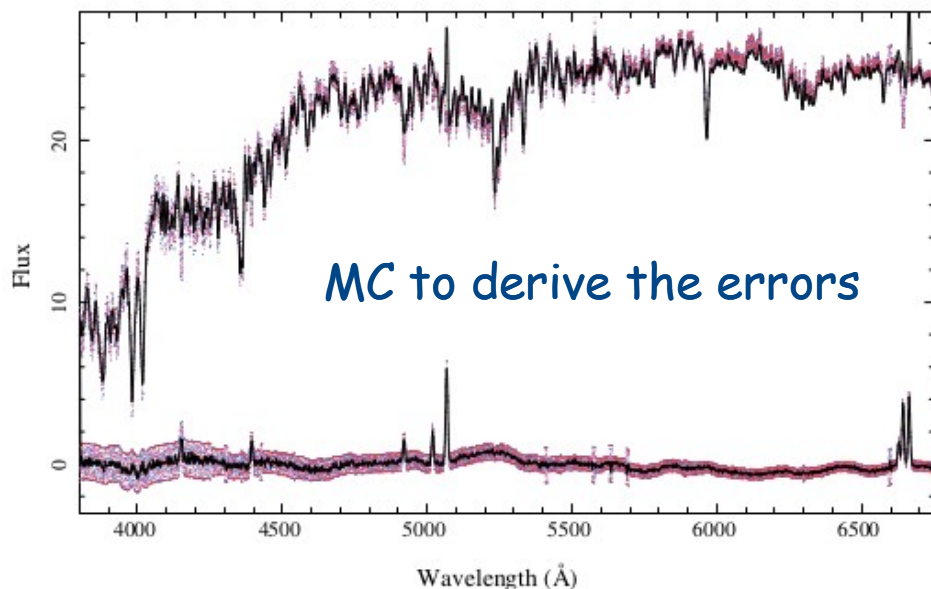
Received ; accepted

RESUMEN

TBW

ABSTRACT

We present an improved version of FIT3D, a fitting tool for the the analysis of the spectroscopic properties of both the stellar populations and ionized gas emission derived from moderate resolution spectra of galaxies. FIT3D is a tool developed to analyze Integral Field Spectroscopy data and it is the basis of PIPE3D, the pipeline already used in the analysis of datasets like CALIFA, MaNGA and SAMI.



PIPE3D, A PIPELINE TO ANALYZE INTEGRAL FIELD SPECTROSCOPY DATA: I. NEW FITTING PHILOSOPHY OF FIT3D.

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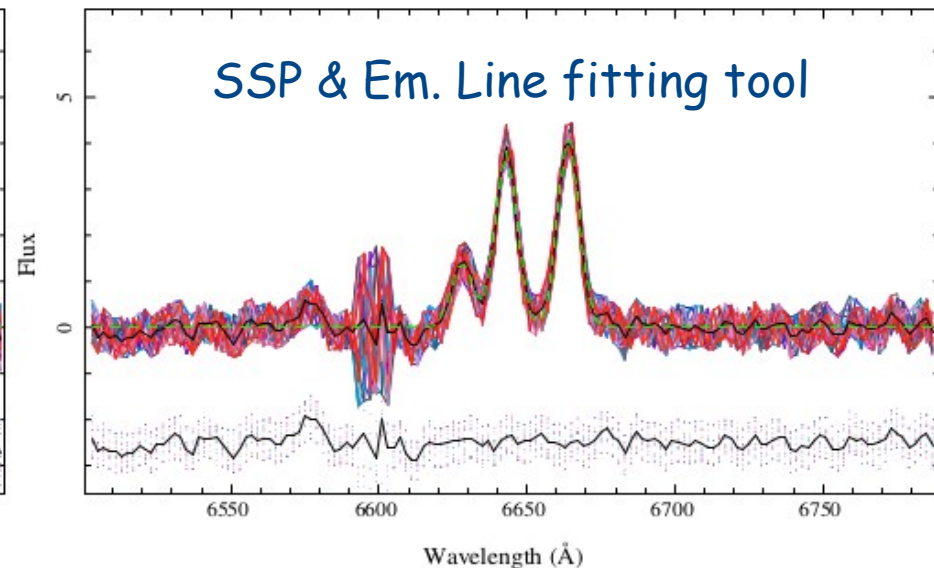
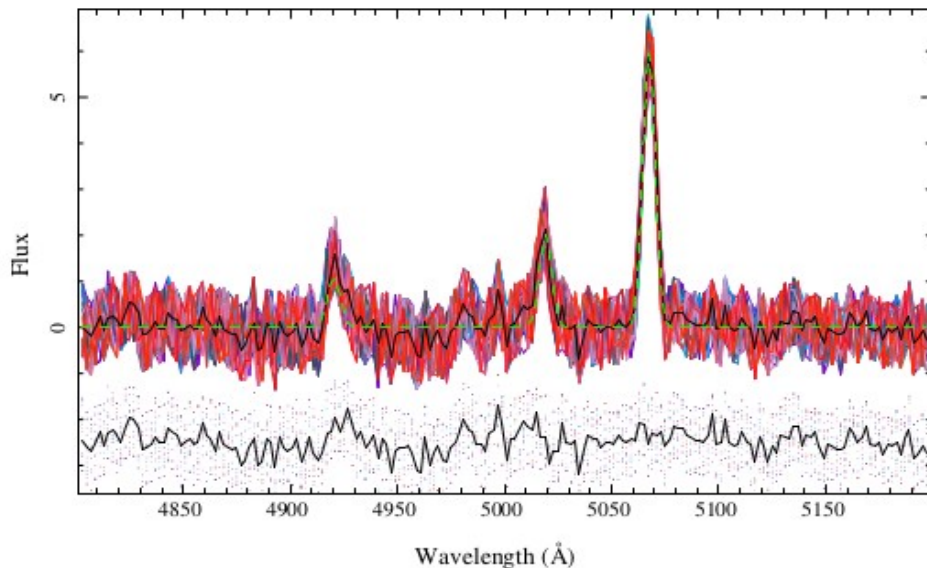
Received ; accepted

RESUMEN

TBW

ABSTRACT

We present an improved version of FIT3D, a fitting tool for the the analysis of the spectroscopic properties of both the stellar populations and ionized gas emission derived from moderate resolution spectra of galaxies. FIT3D is a tool developed to analyze Integral Field Spectroscopy data and it is the basis of PIPE3D, the pipeline already used in the analysis of datasets like CALIFA, MaNGA and SAMI.



PIPE3D, A PIPELINE TO ANALYZE INTEGRAL FIELD SPECTROSCOPY DATA: I. NEW FITTING PHILOSOPHY OF FIT3D.

Blázquez³, J.J. González¹, F.F. Rosález-Ortega⁴, M. Cano-Díaz¹, C. Cobá¹

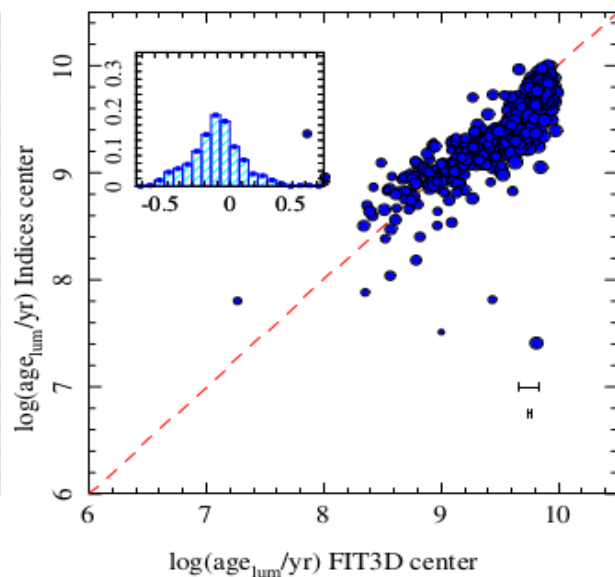
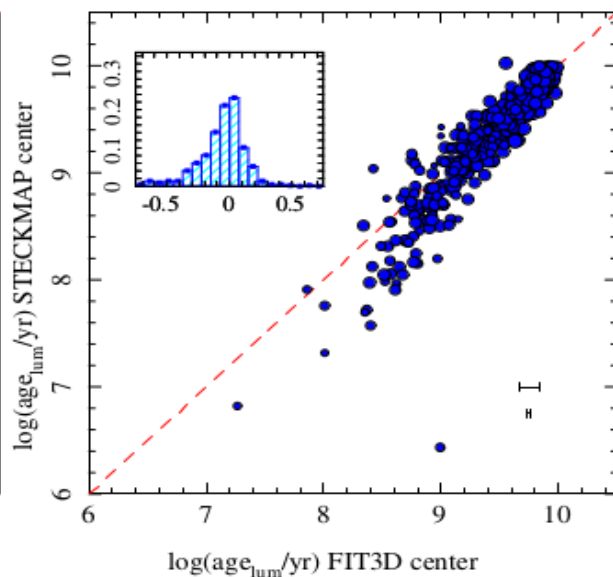
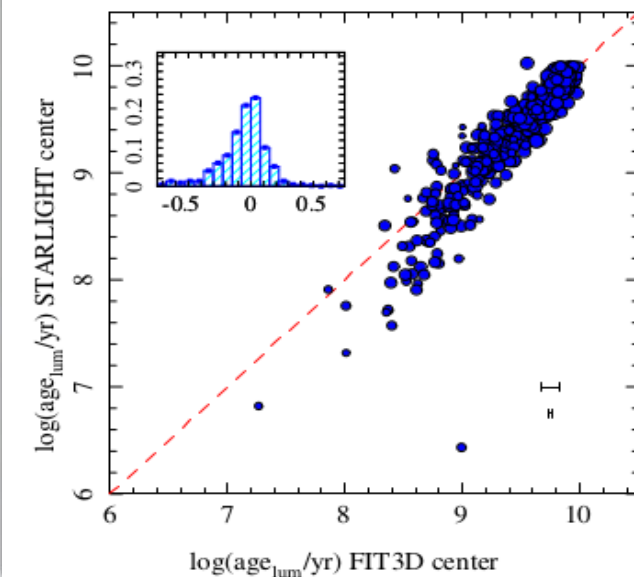
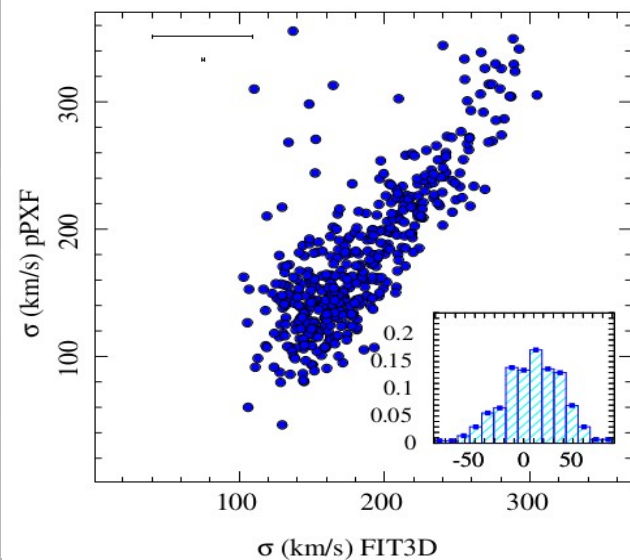
Received ; accepted

RESUMEN

Compared with other tools

ABSTRACT

Improved version of FIT3D, a fitting tool for the analysis of the spectra of galaxies. FIT3D is a tool developed to analyze Integral Field Spectroscopy (IFS) data and it is the basis of PIPE3D, the pipeline already used in the ALFA, MaNGA and SAMI.



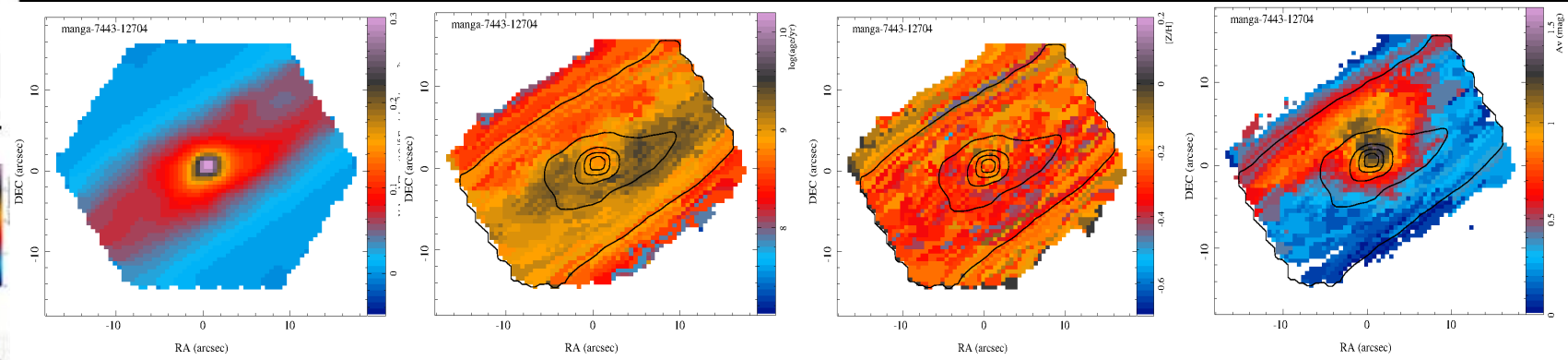
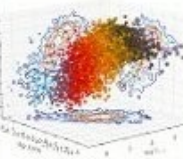
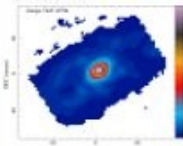


Pipe3D: Stellar Data products

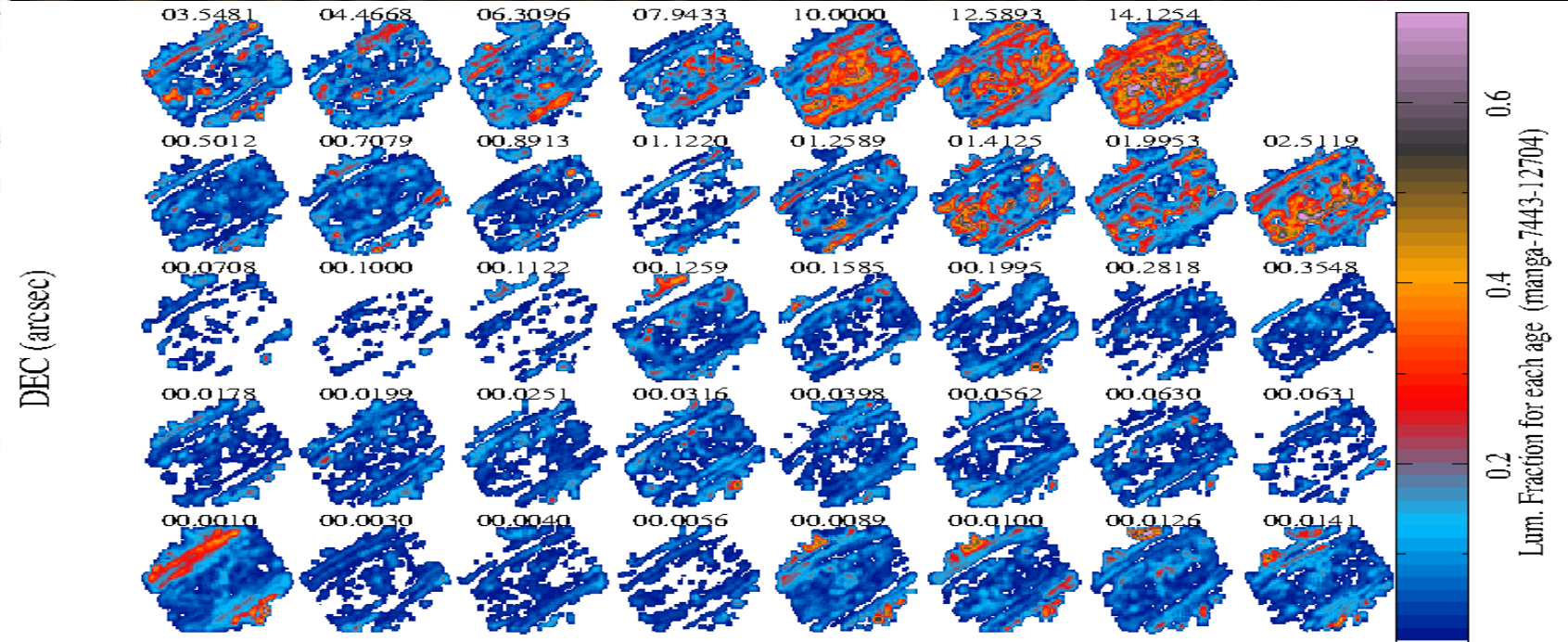


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V-band age_{lum} [Z/H]_{lum} Av (mag)



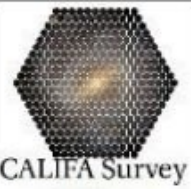
DEC (arcsec)

RA (arcsec)

Weight in Light of each SSP

Lum. Fraction for each age (manga-7443-12704)

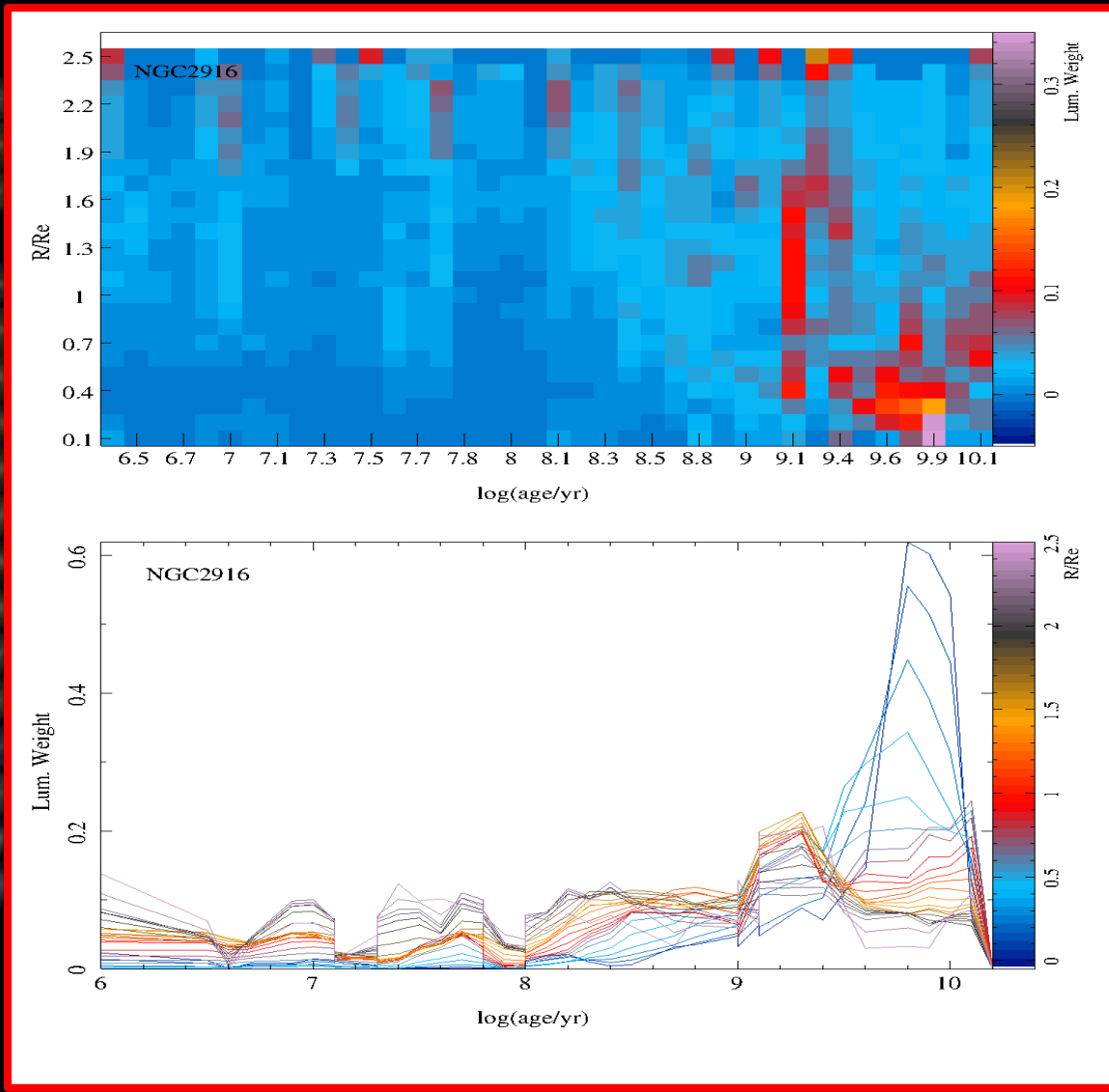
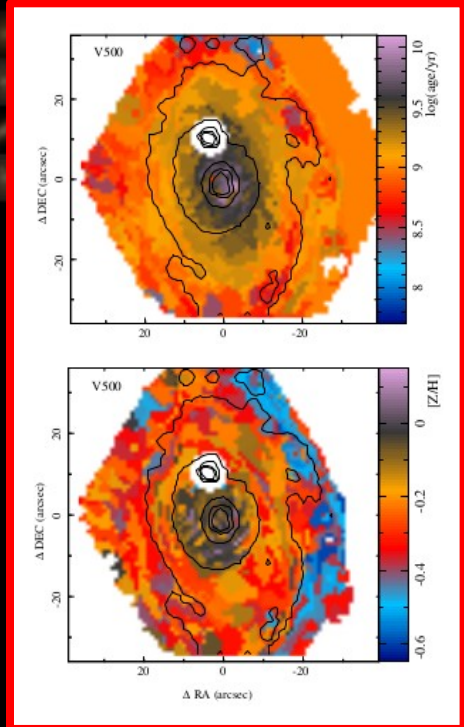
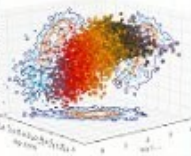
Radial distribution of the SSP-decomposition



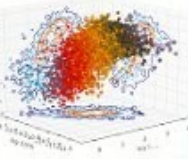
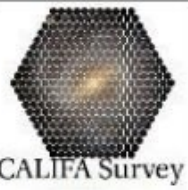
CALIFA Survey



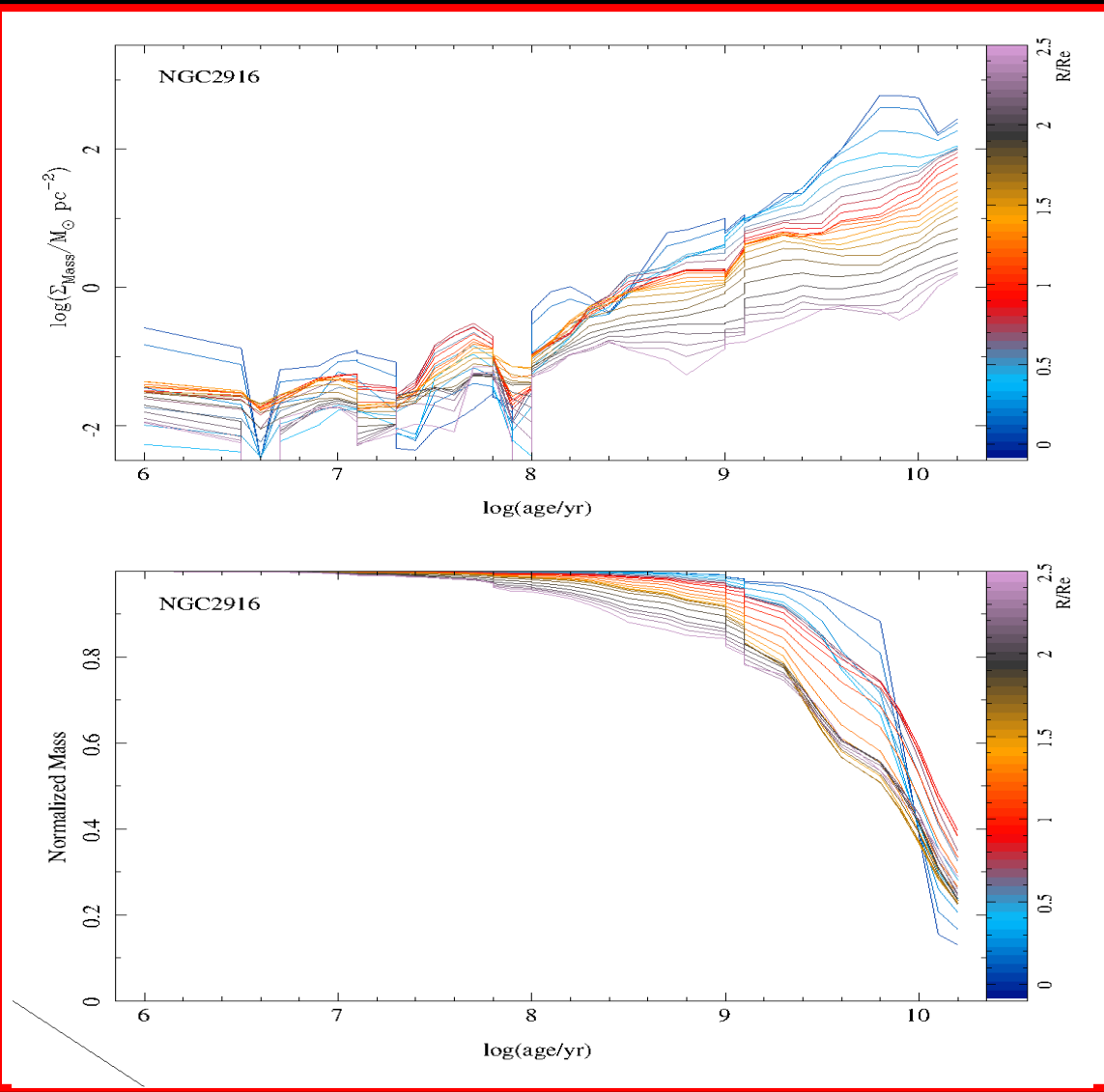
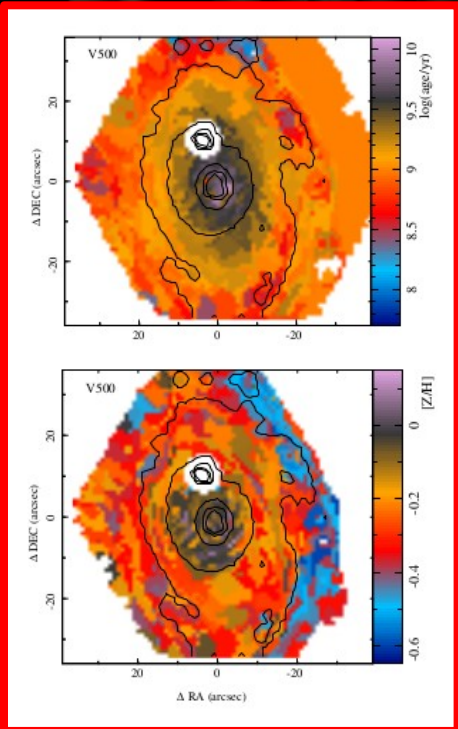
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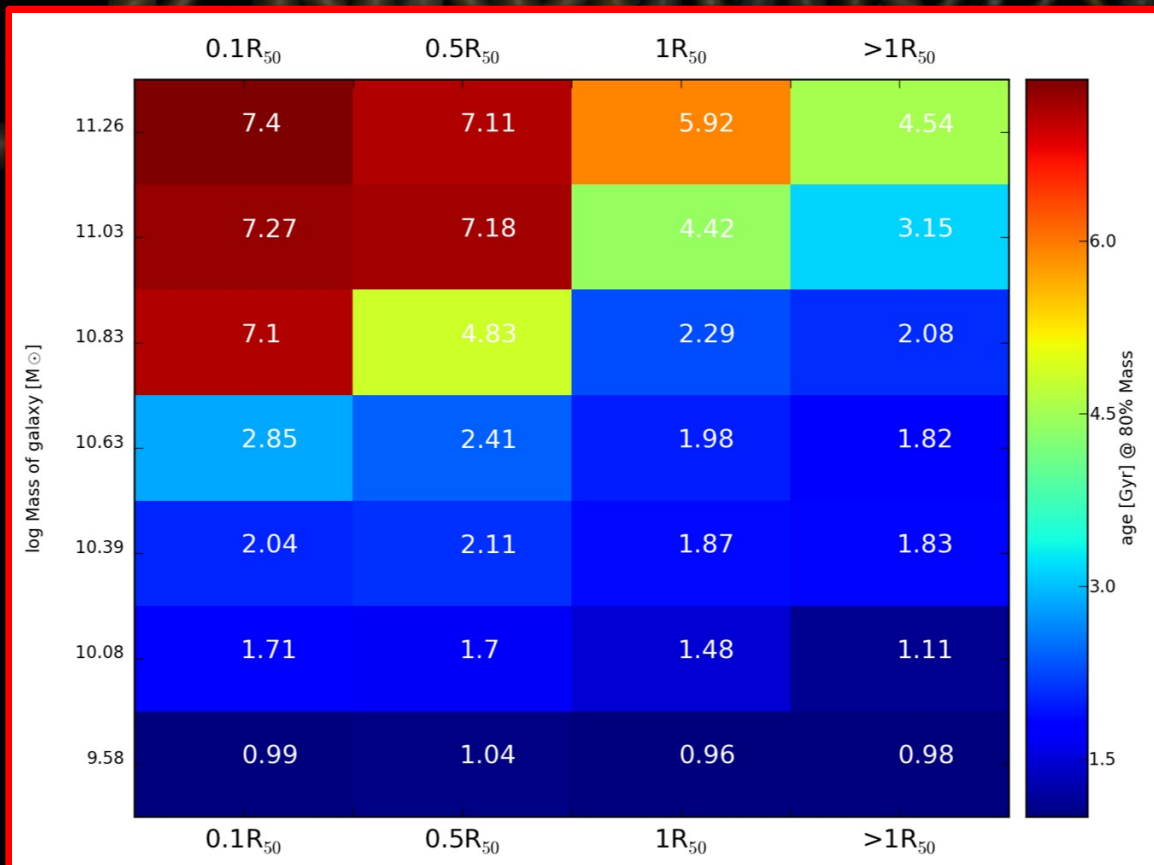
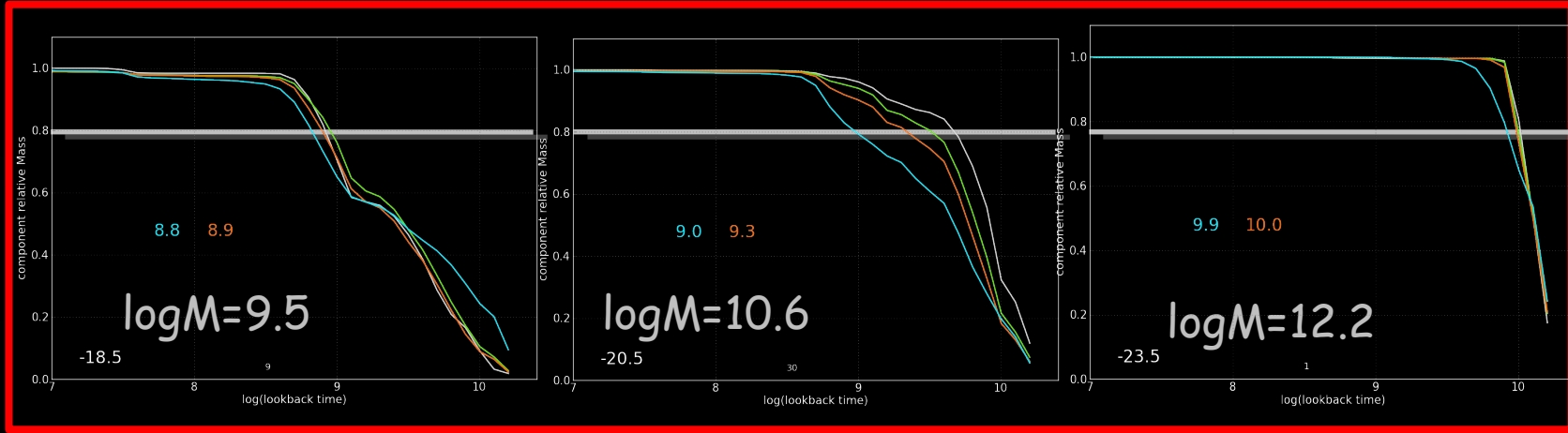
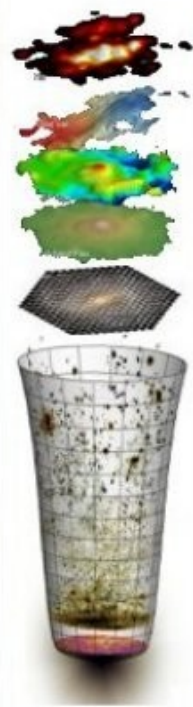
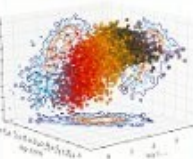
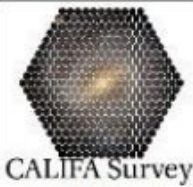
... In general: sequence of burst following an exp. decay



Radial distribution of the Σ_{mas} @ cosm-time



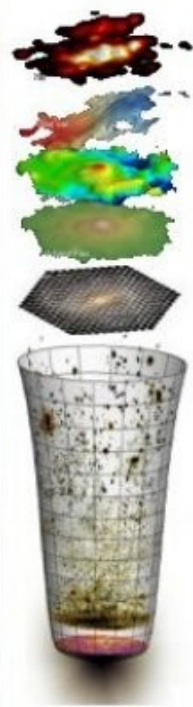
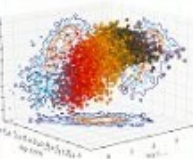
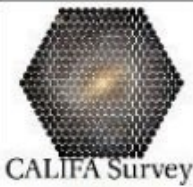
... Inside-out growth in the last 8-9 Gyrs (before?)



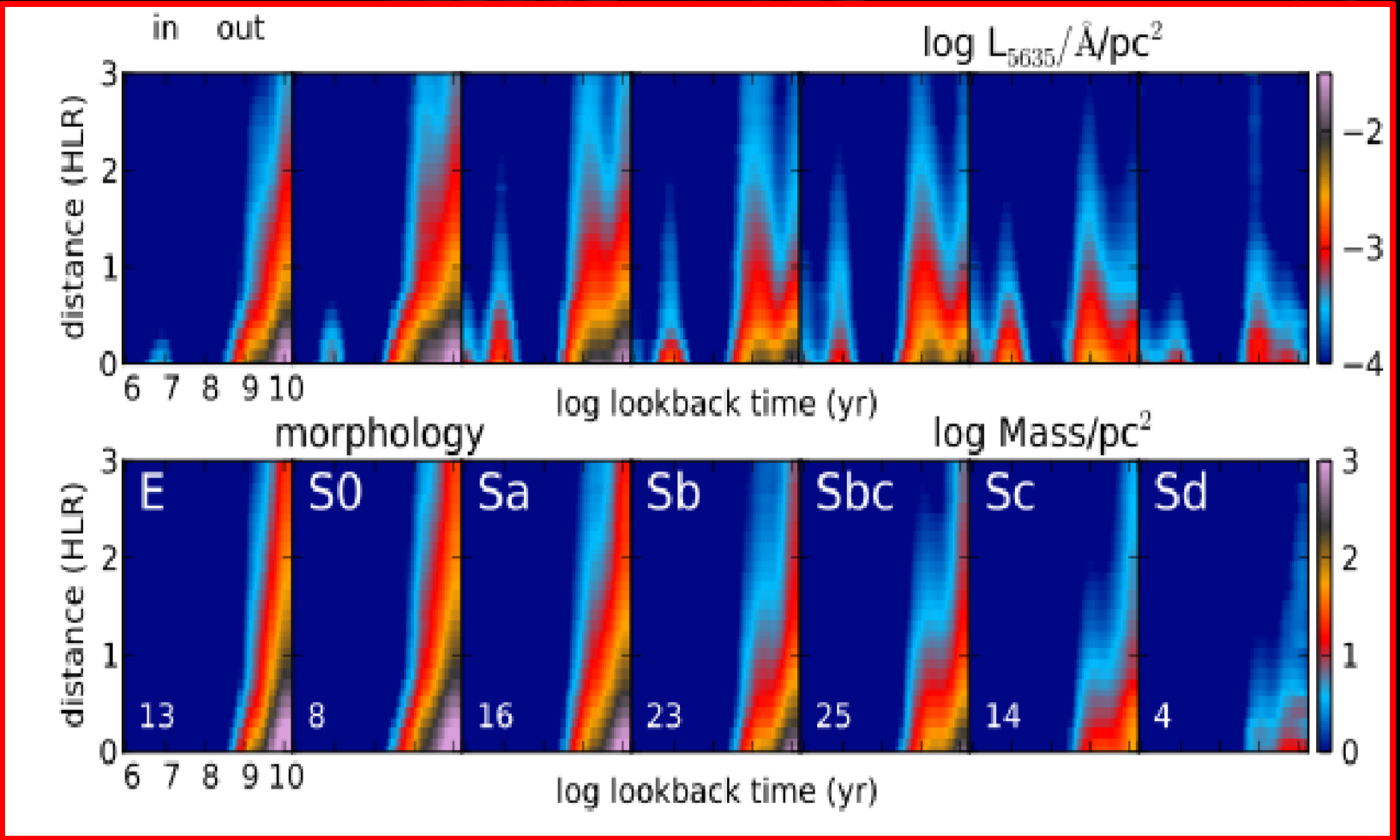
Mass Growth:

1) Inside-Out
2) Local Downsizing

Perez et al., ApJL, 2013

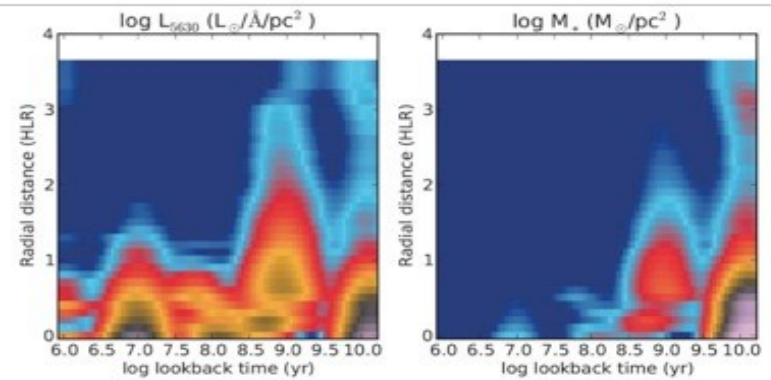
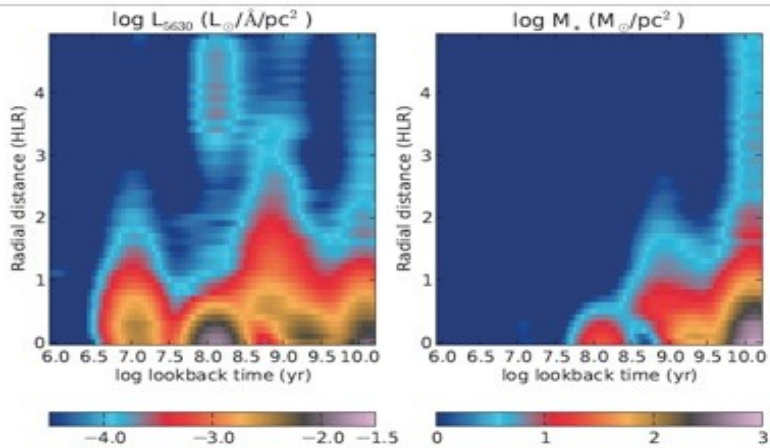
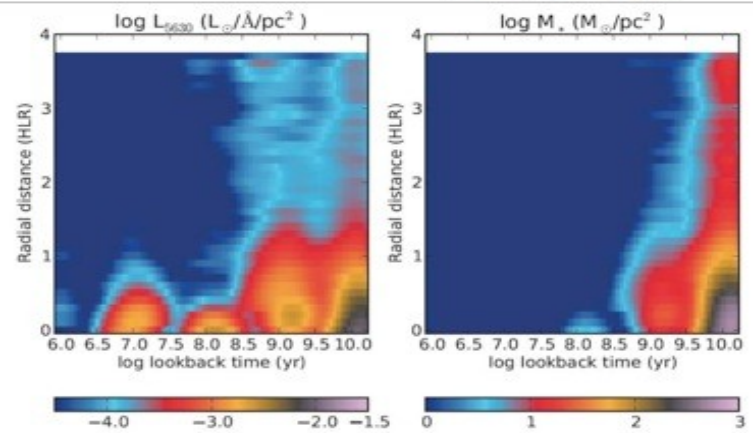
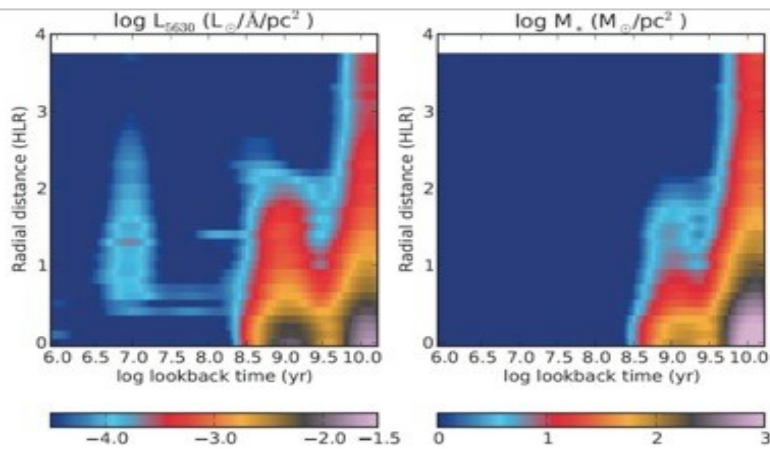
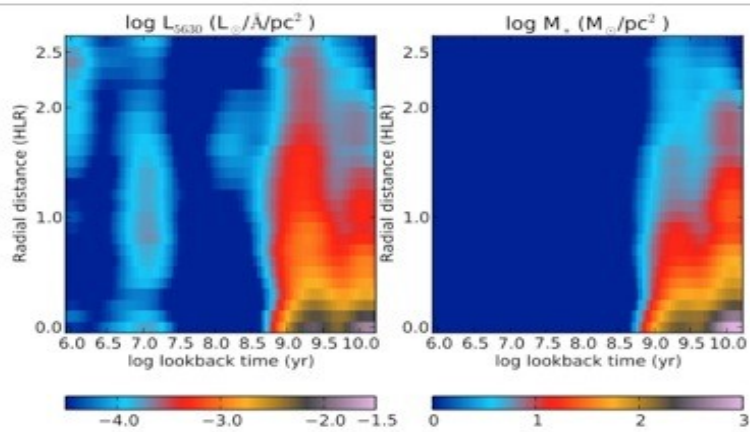


Spatial Resolved SFH Differences by morphology

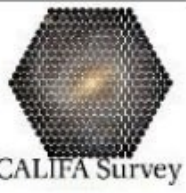


Cid Fernandes, et al.,
A&A 2013, 2014

Gonzalez Delgado, et al., IAU Symp. 295,
2012 (arXiv:1301.1685)

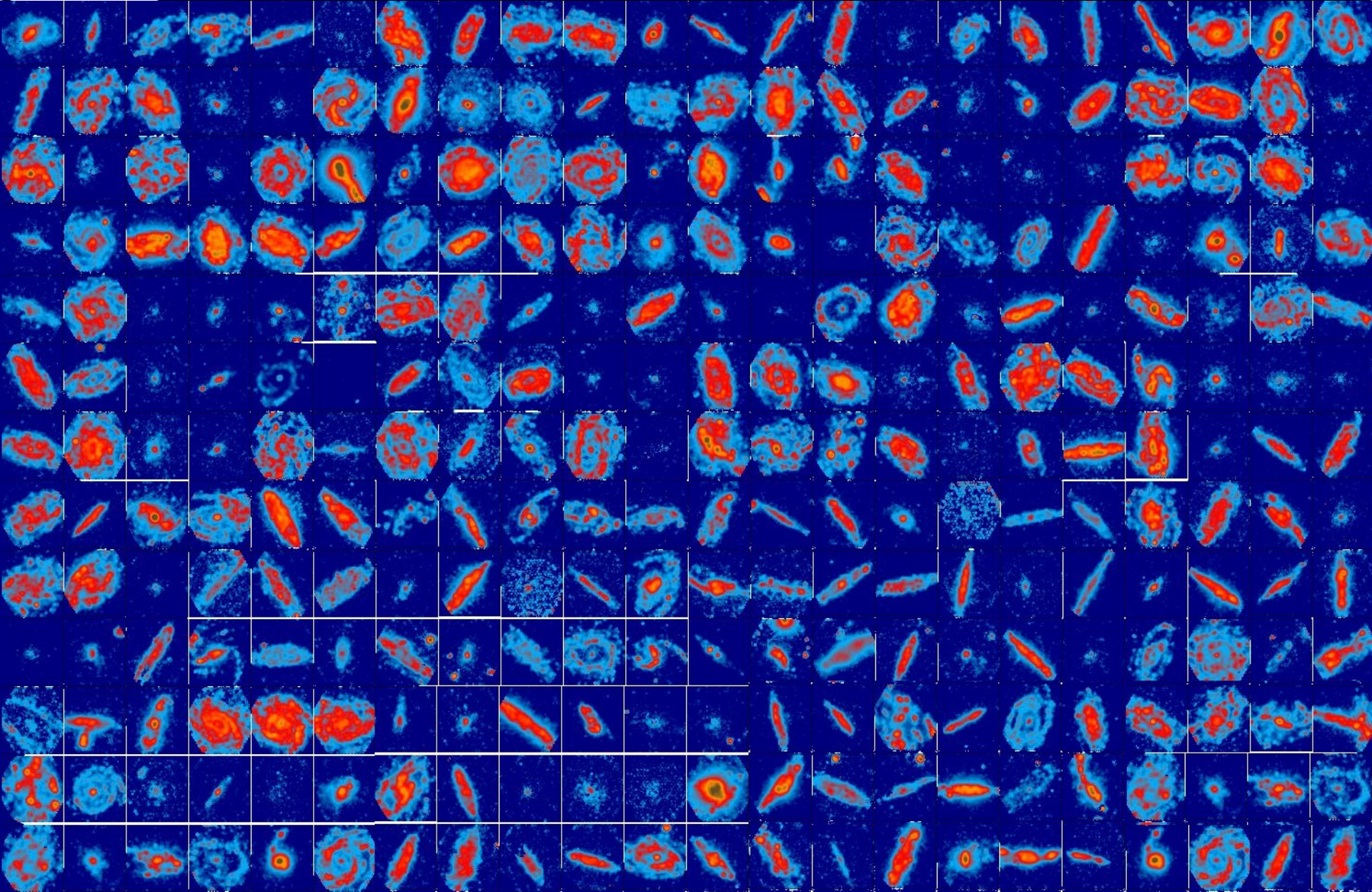


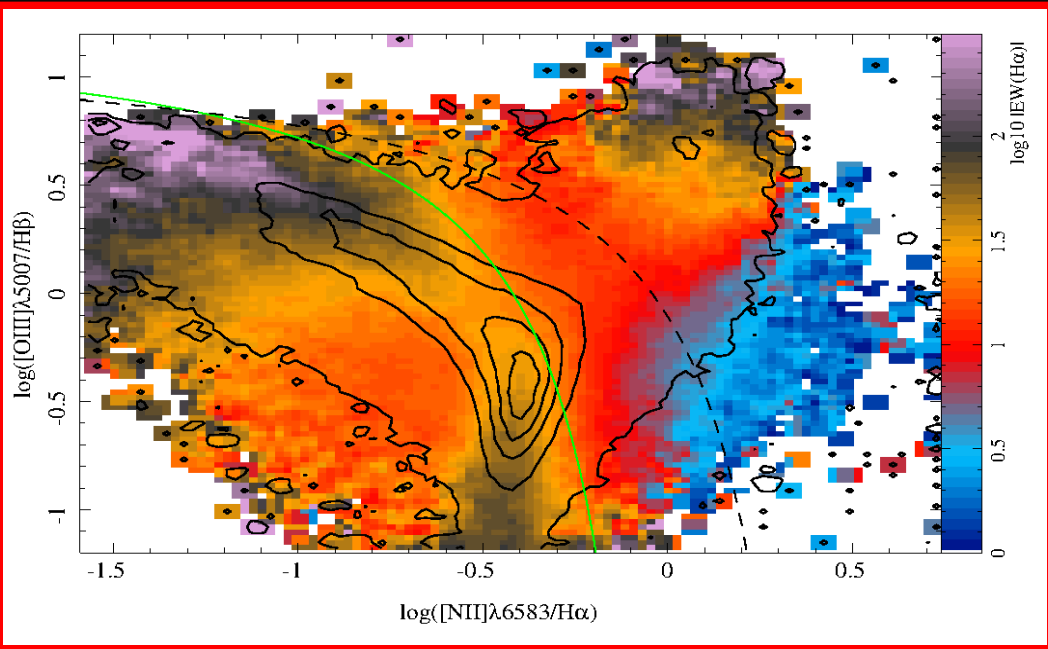
Gonzalez Delgado, et al., AIP, 2013



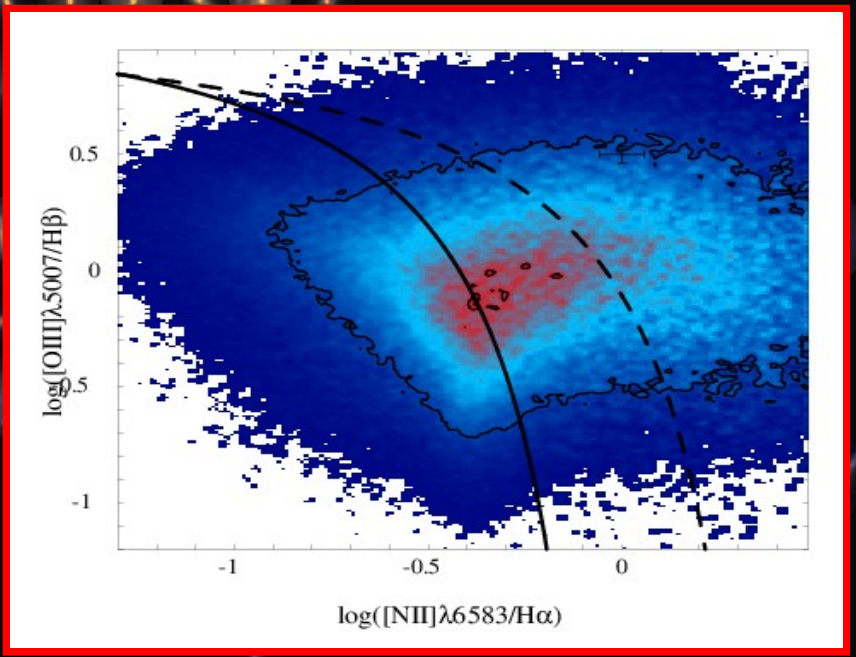
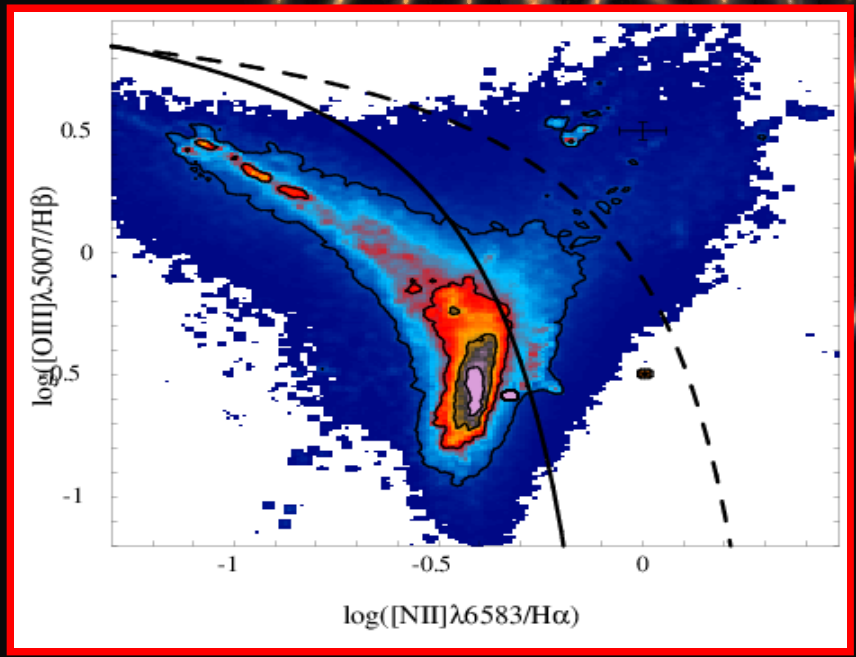
CALIFA Survey

Ionized gas detected in all galaxies?

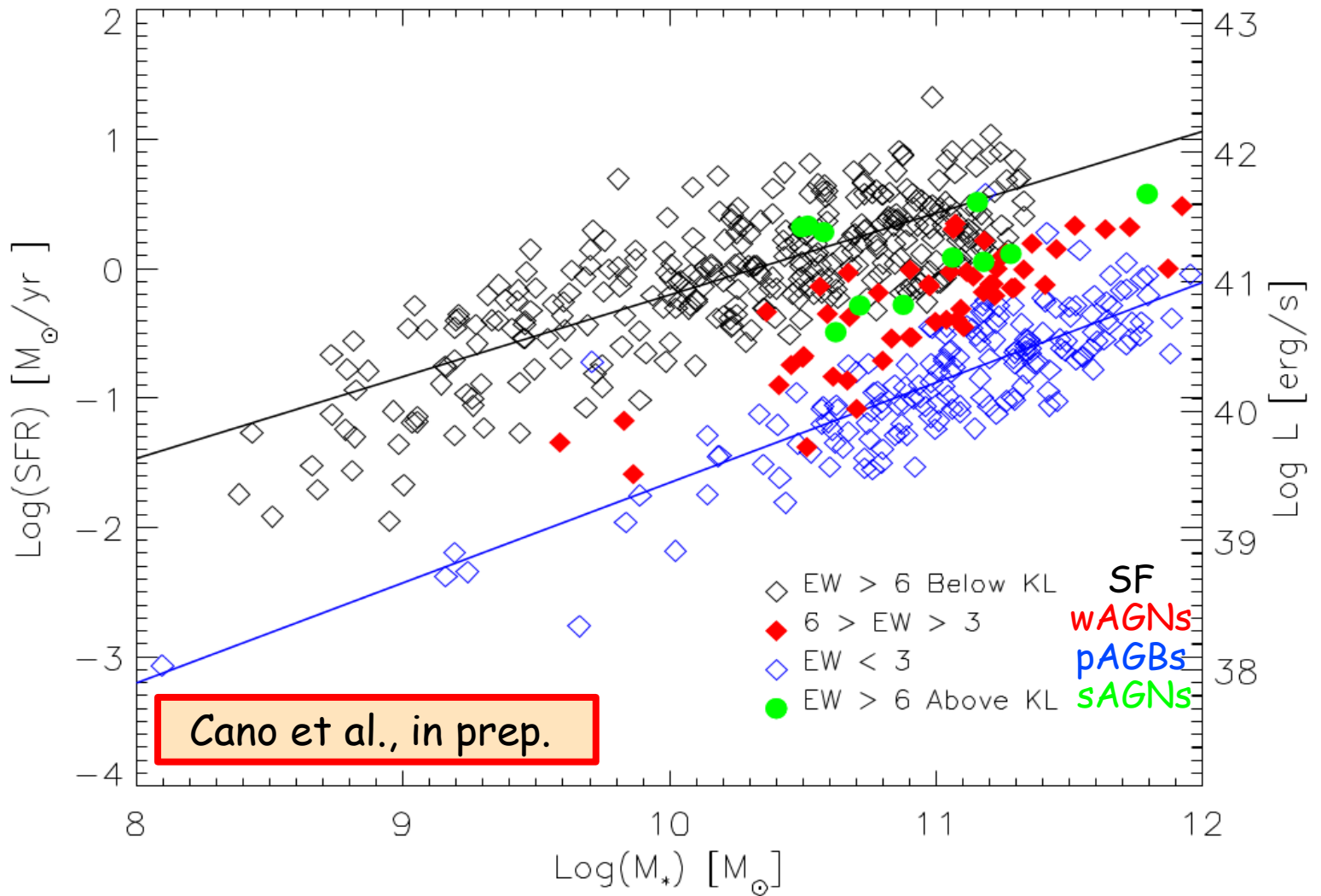




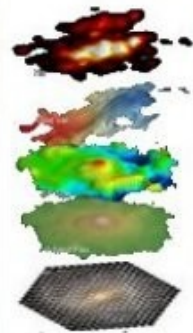
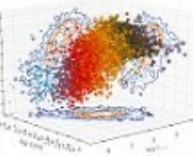
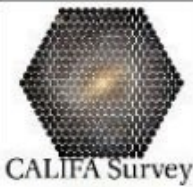
What ionize the gas?
 SF vs. pAGBs vs. AGNs
 How to classify them?



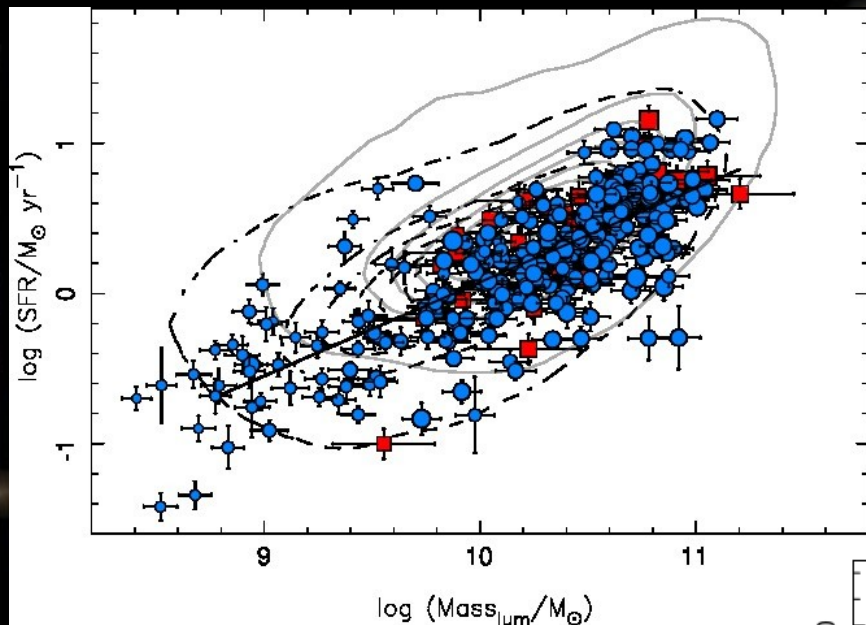
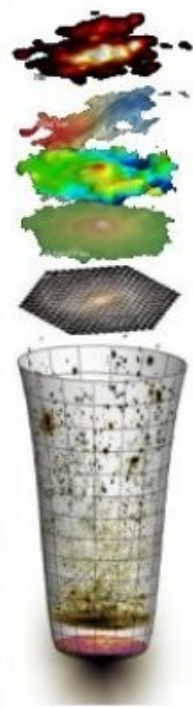
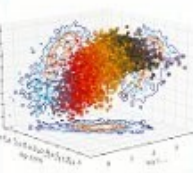
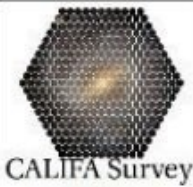
Main Sequence of Star-forming galaxies



AGNs @ SF-MS green valley \rightarrow Quenching?



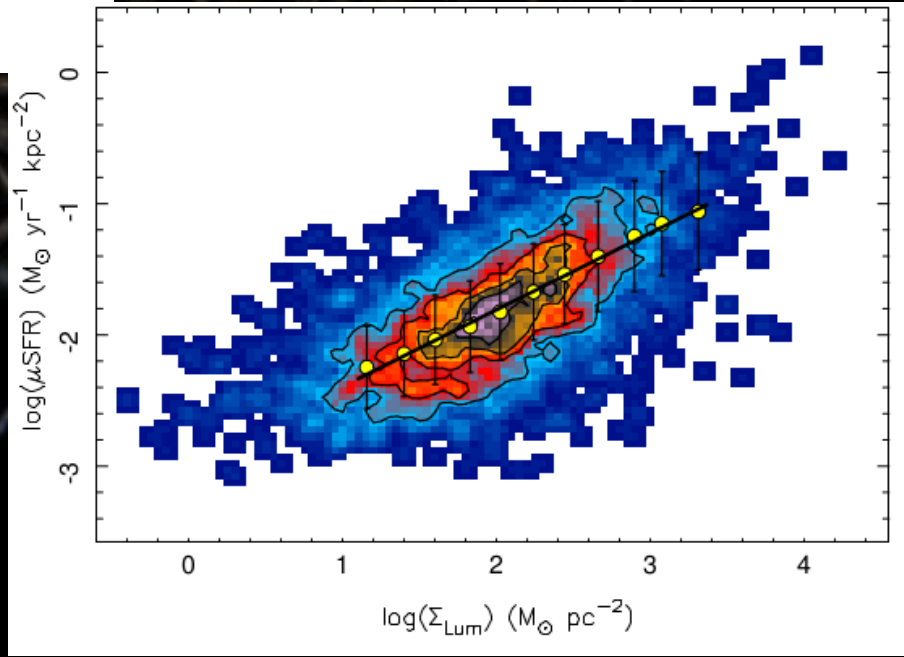
Local vs. Global Relations



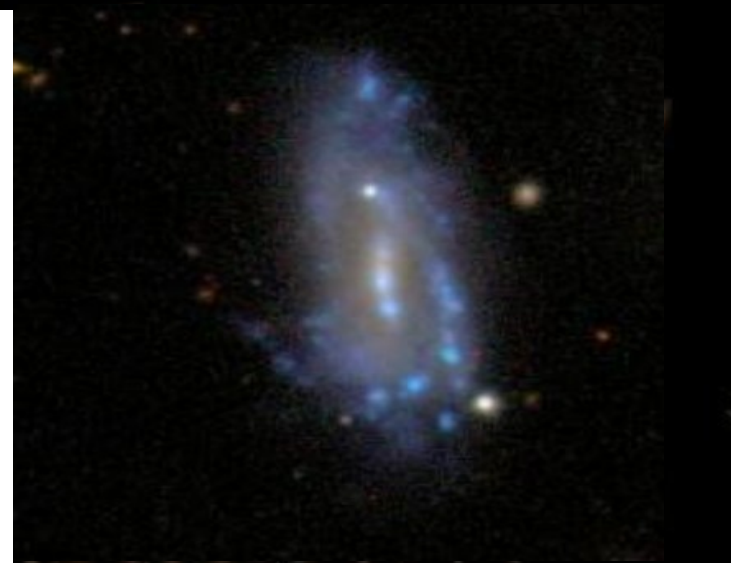
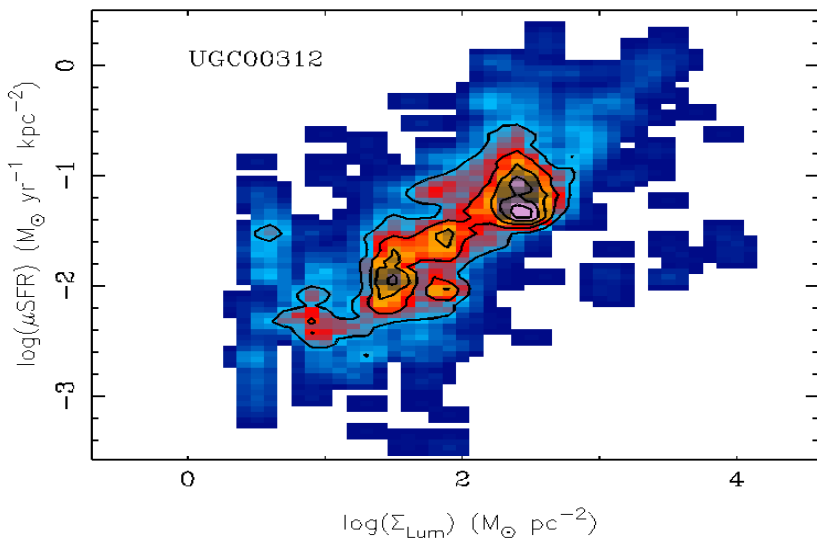
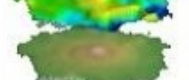
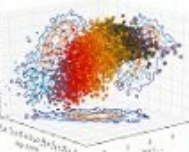
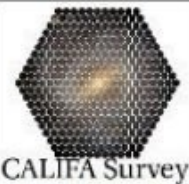
Main Sequence of Star-forming galaxies

Main Sequence of Star-forming regions?

Sánchez et al. A&A 2013

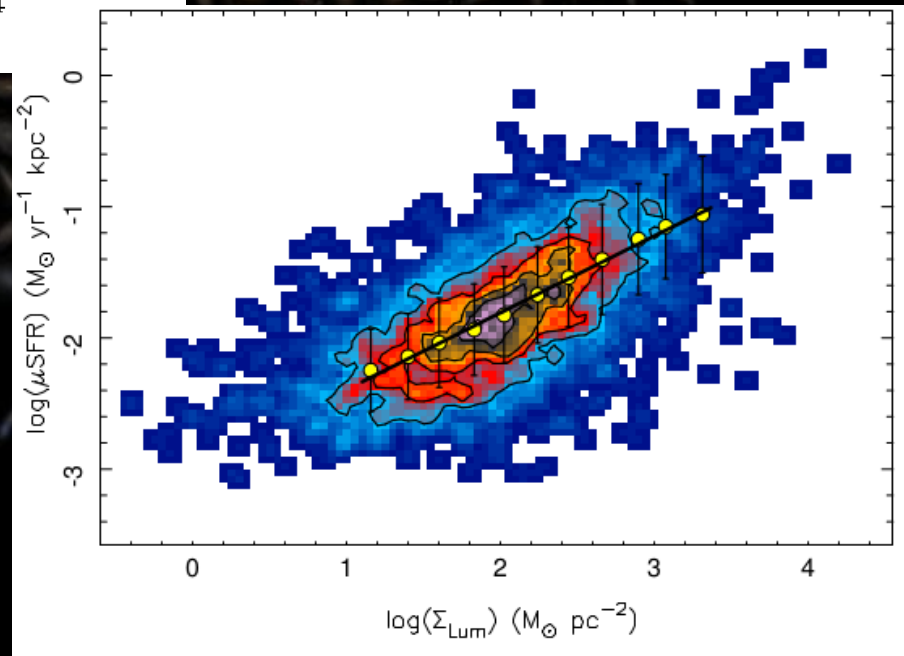


Local vs. Global Relations

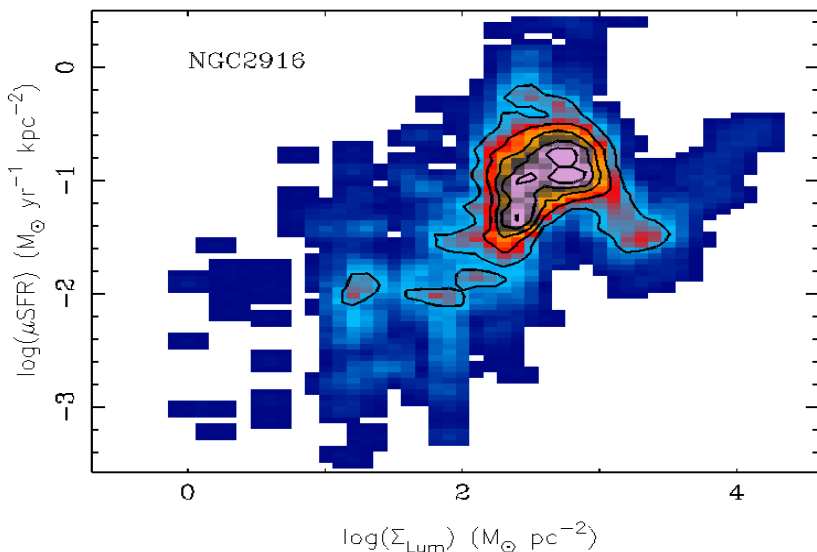
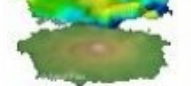
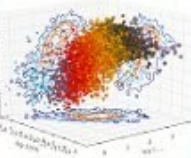
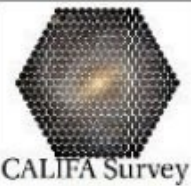


Main Sequence of Star-forming regions?

Cano et al., in prep.

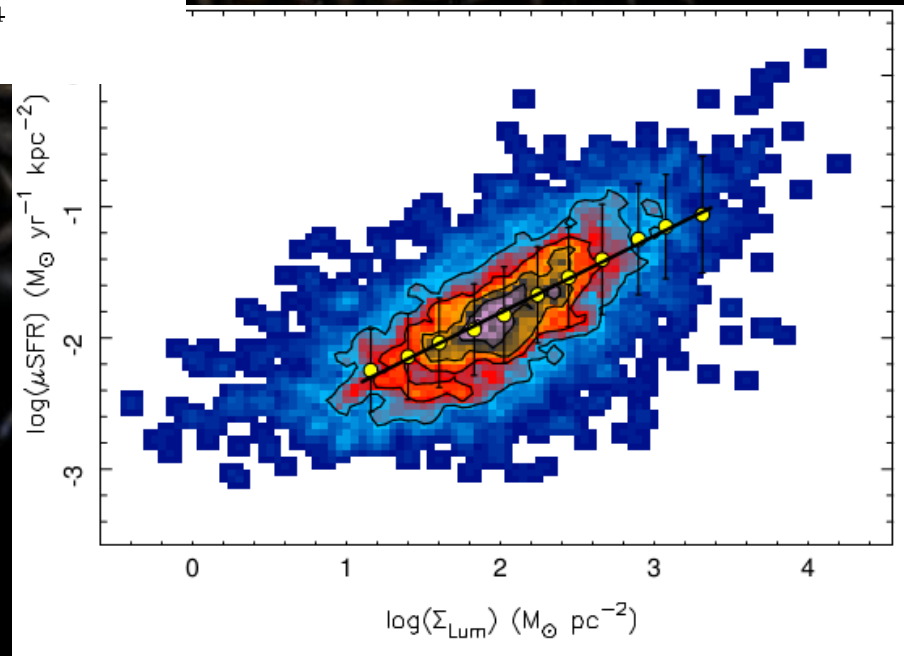


Local vs. Global Relations

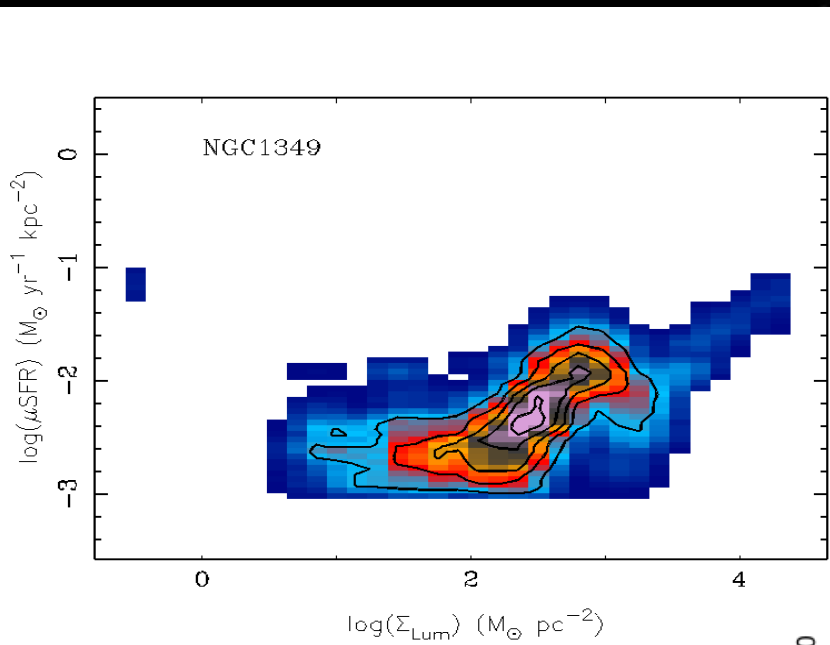
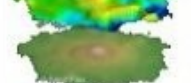
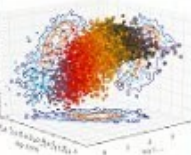
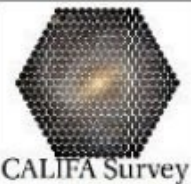


Main Sequence of Star-forming regions?

Cano et al., in prep.

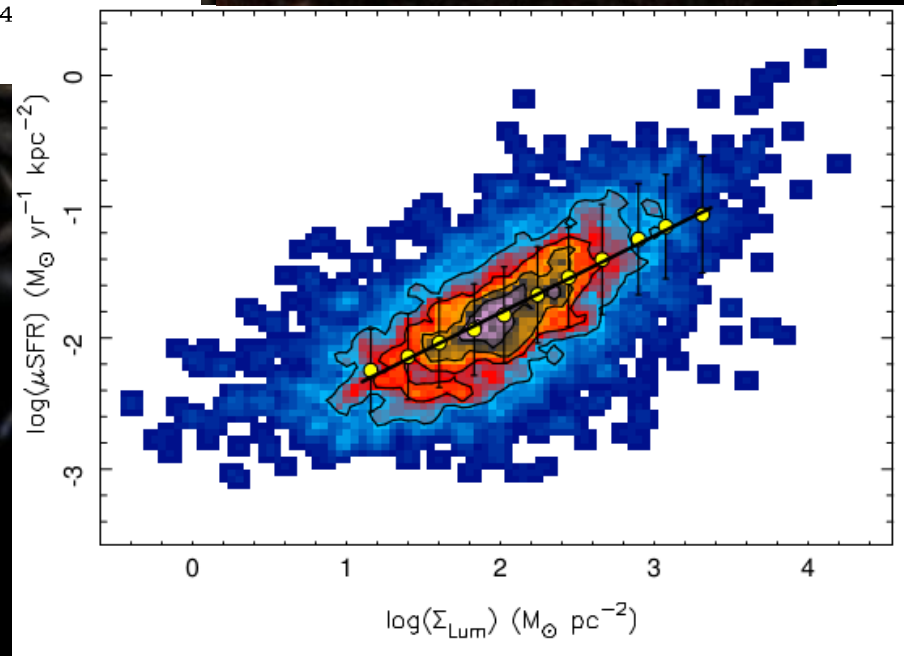


Local vs. Global Relations

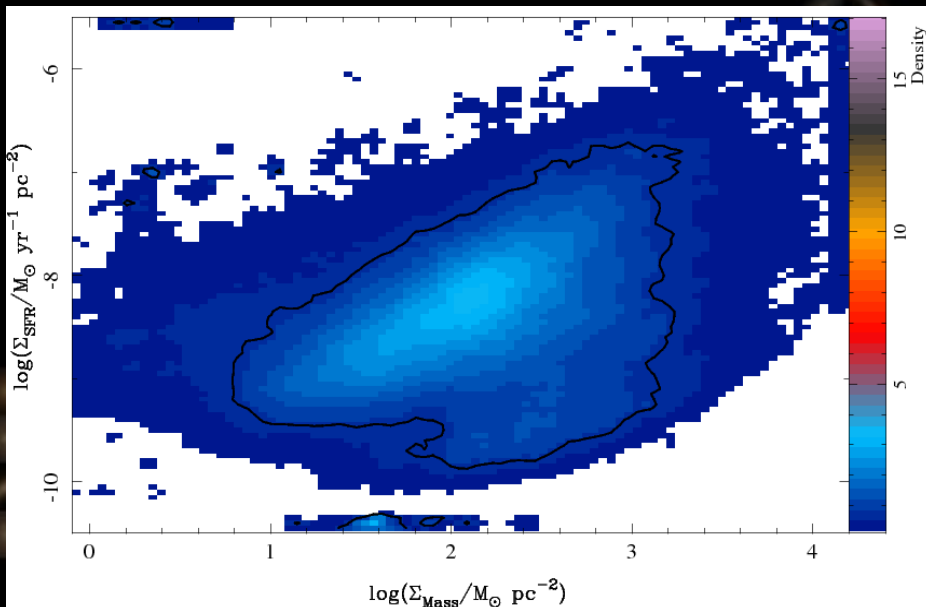
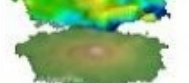
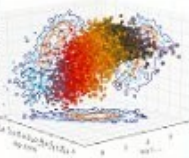
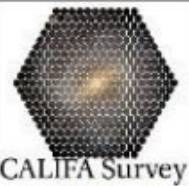


Main Sequence of Star-forming regions?

Cano et al., in prep.



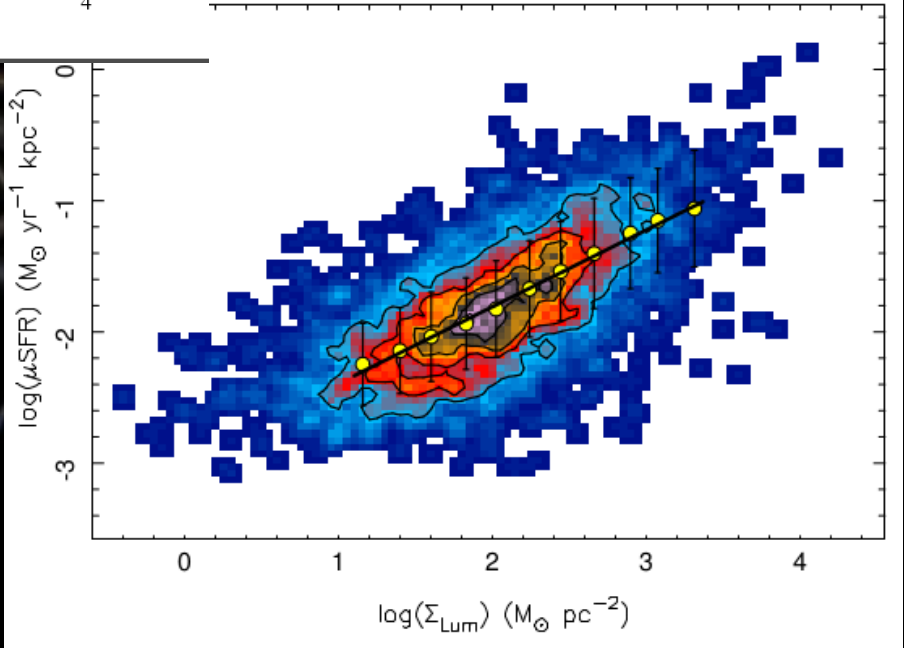
Local vs. Global Relations



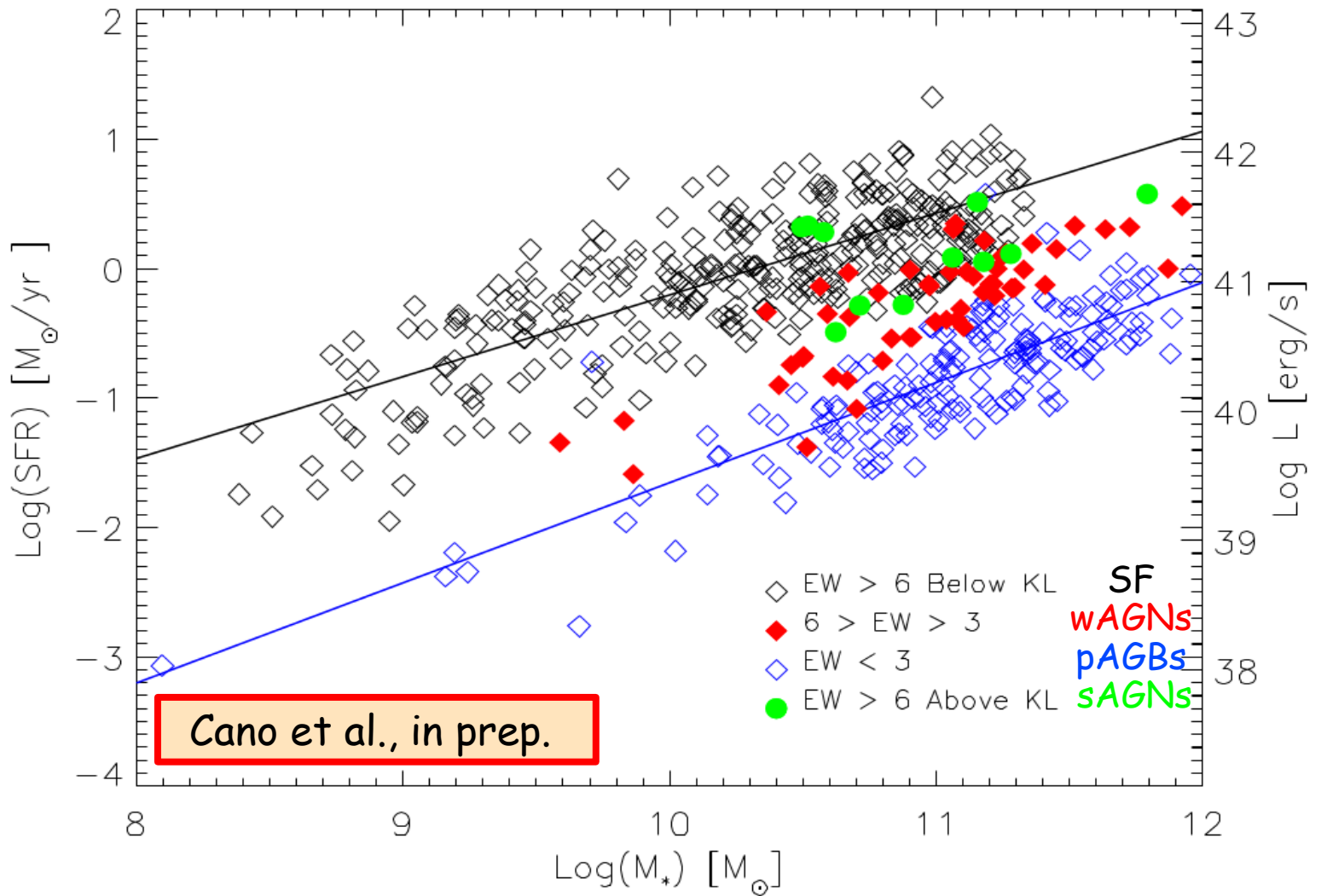
Spaxel-Wise:
~1 Million spectra
analyzed

Main Sequence of
Star-forming regions?

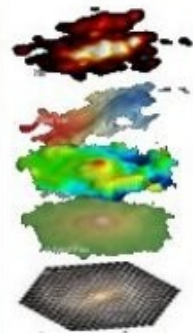
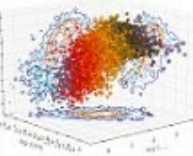
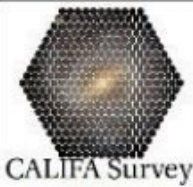
Cano et al., in prep.

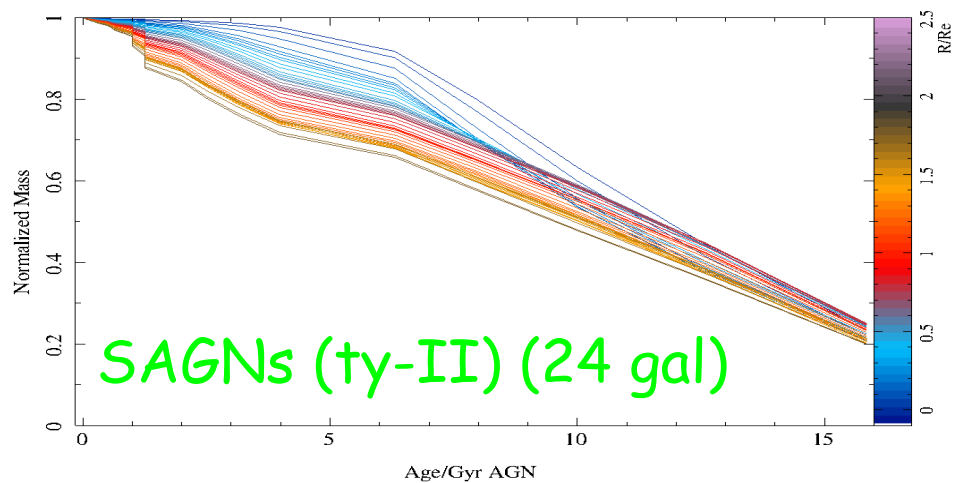
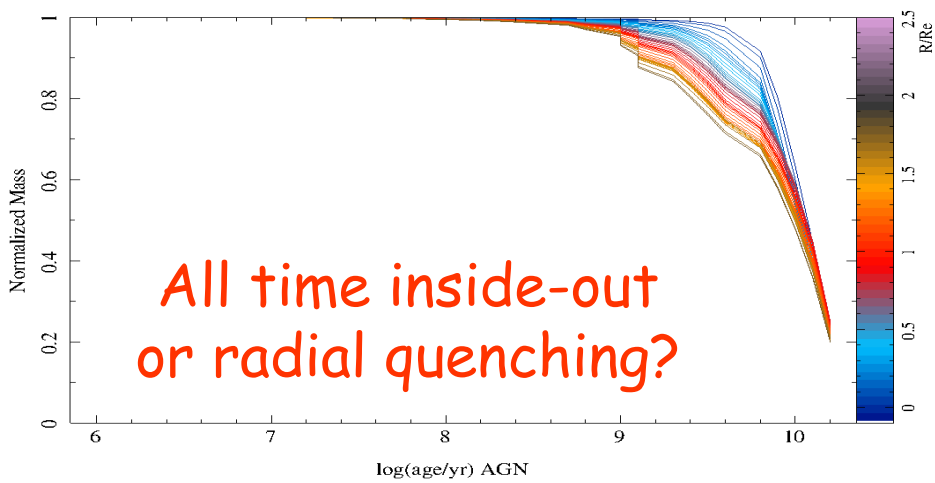
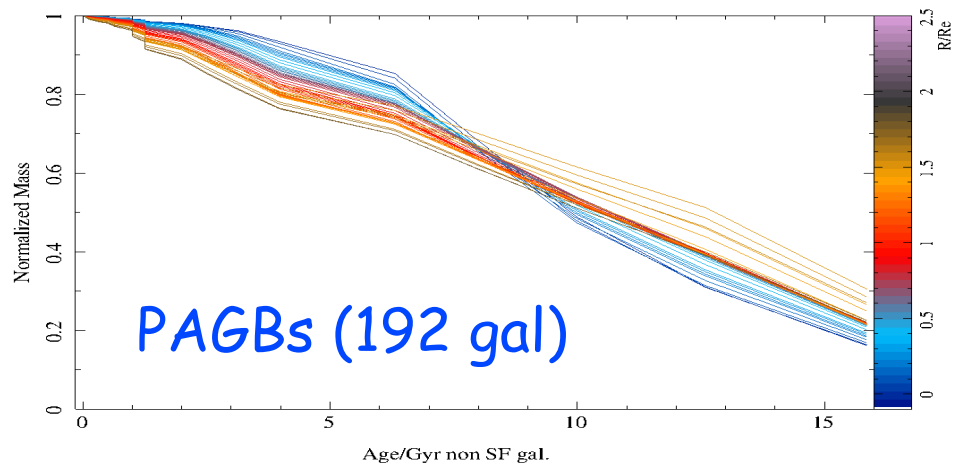
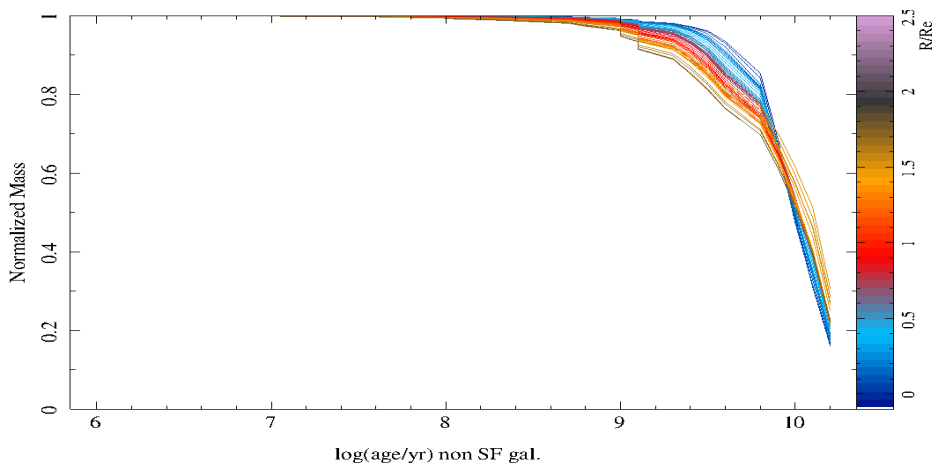
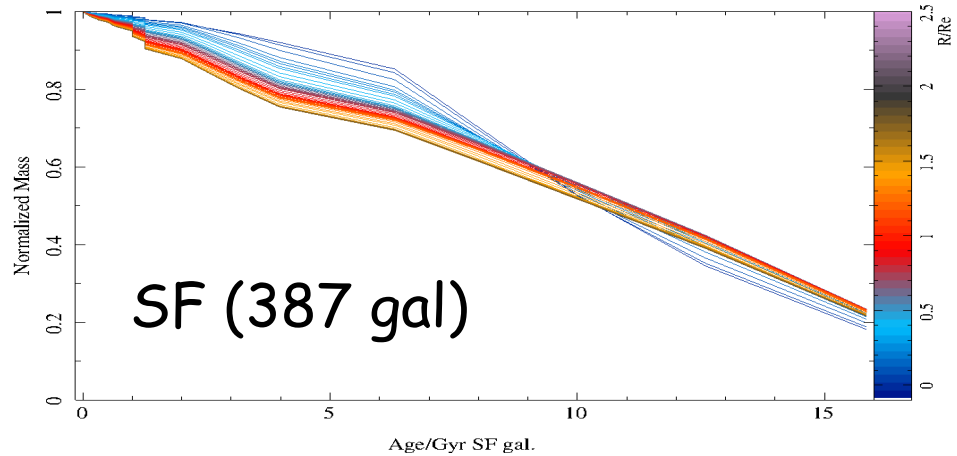
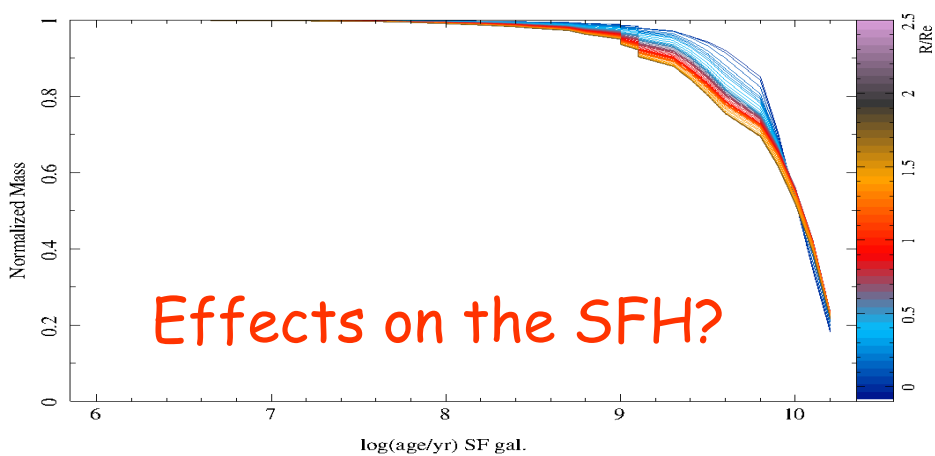


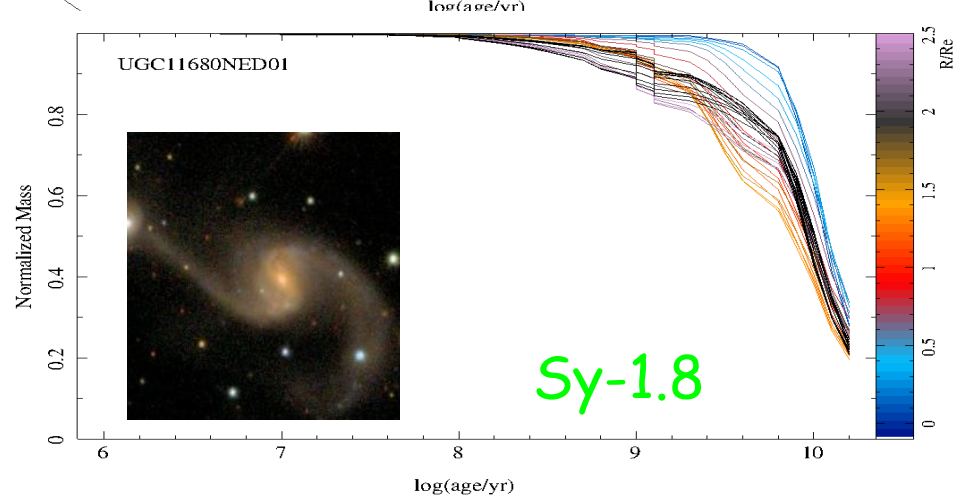
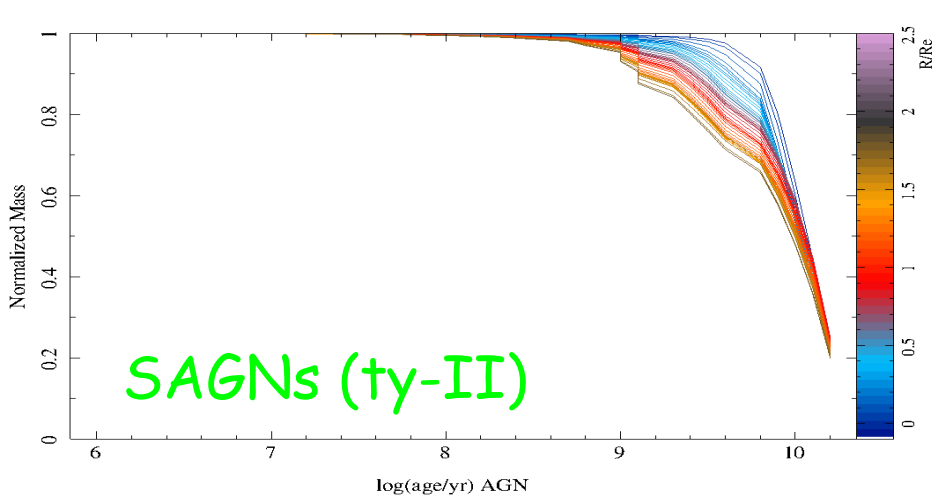
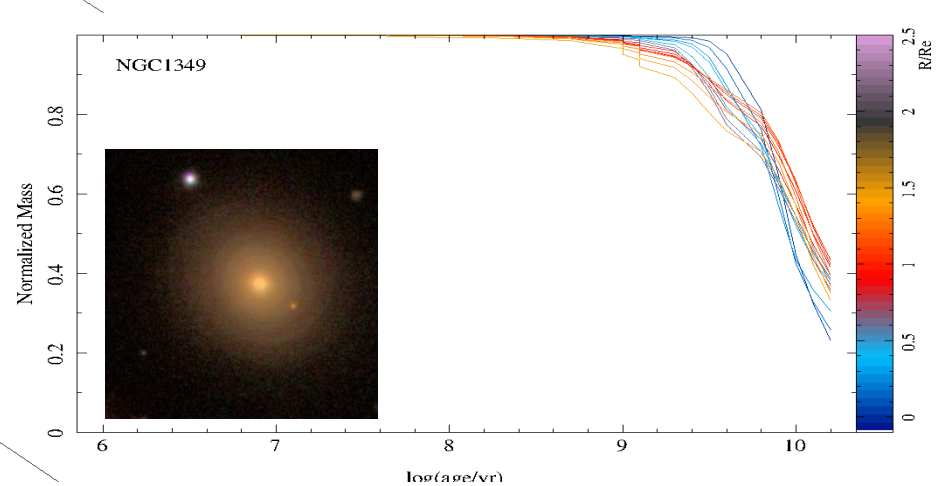
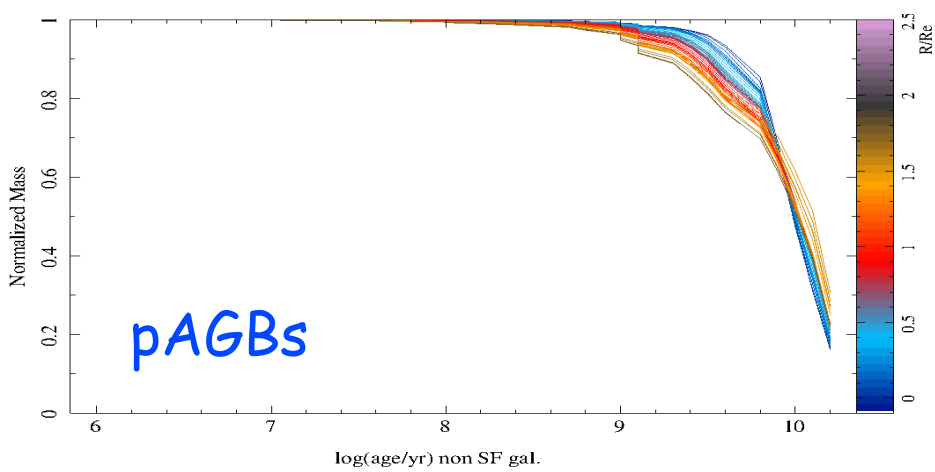
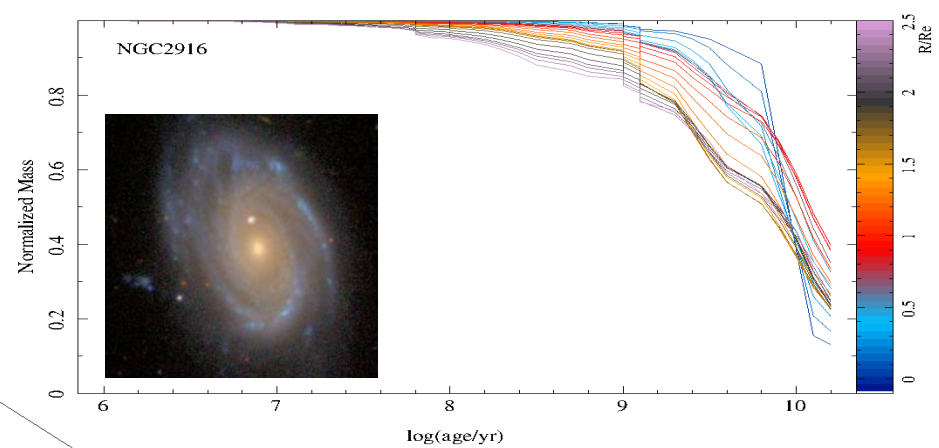
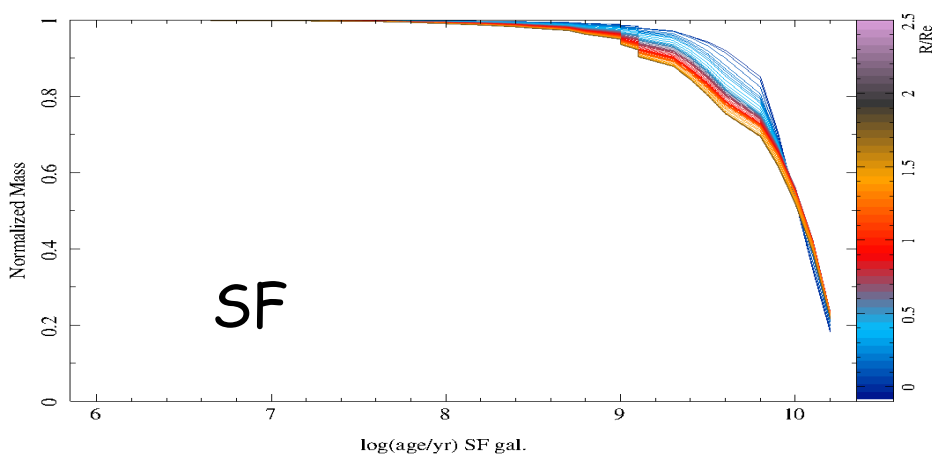
Main Sequence of Star-forming galaxies

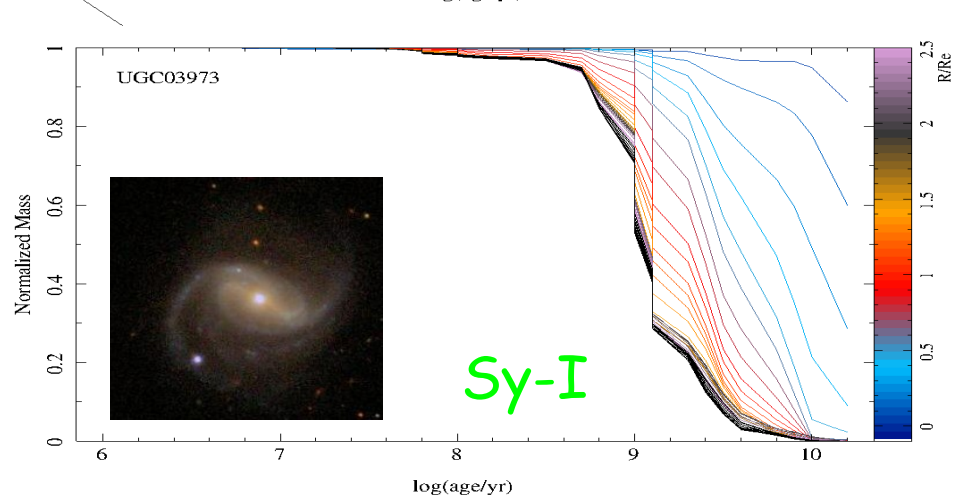
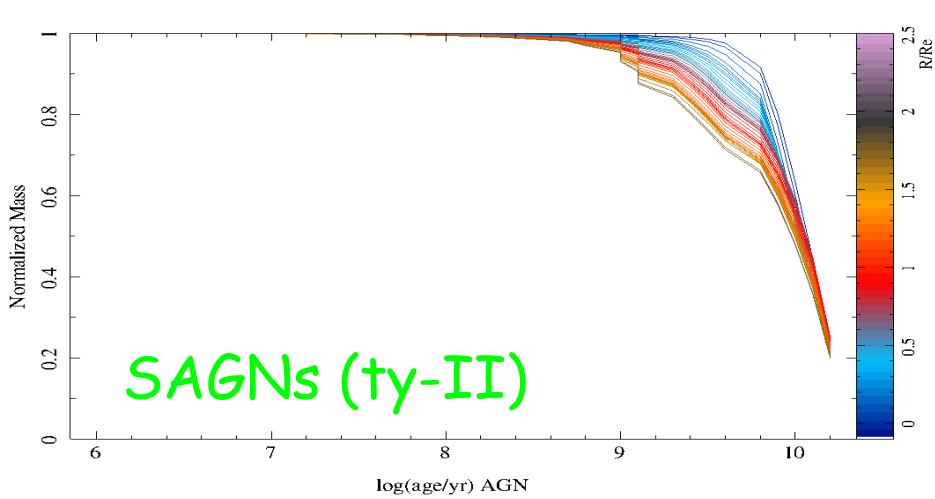
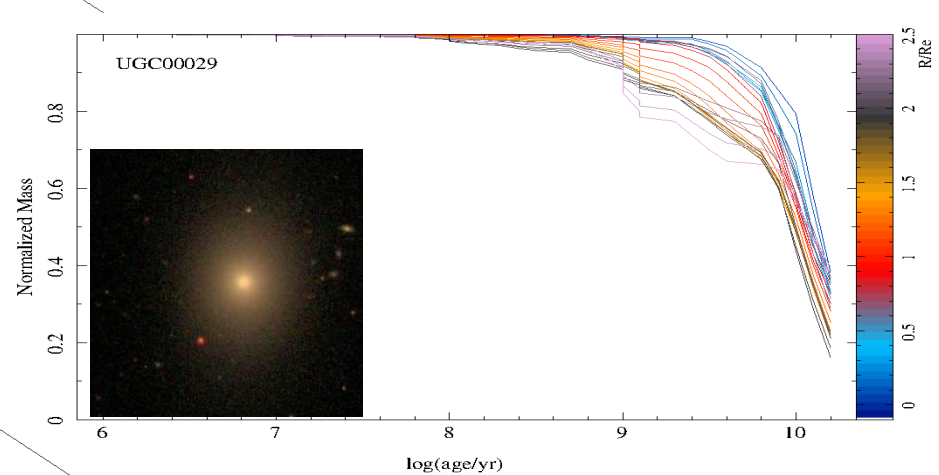
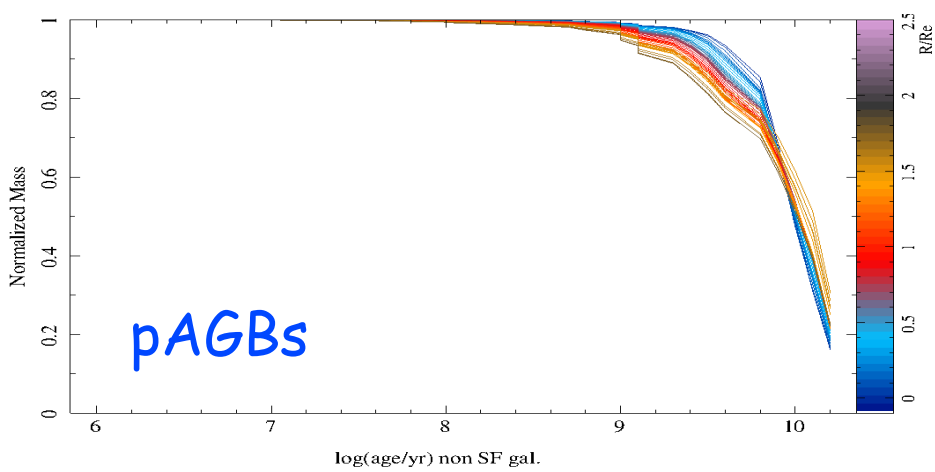
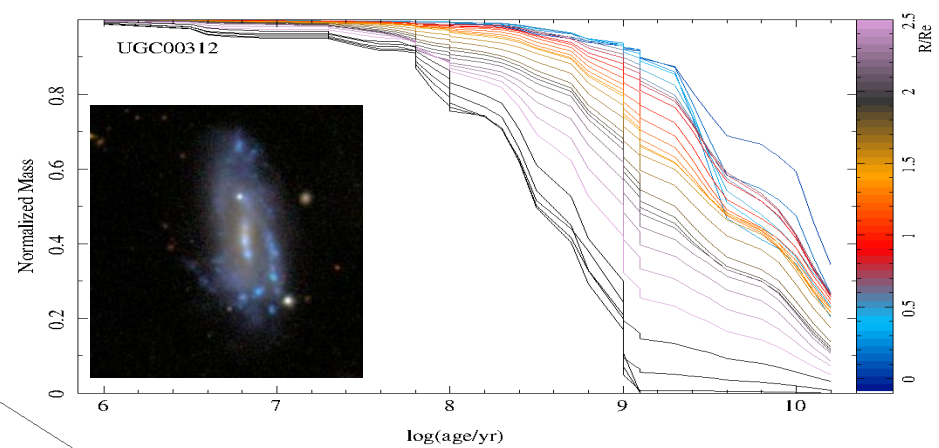
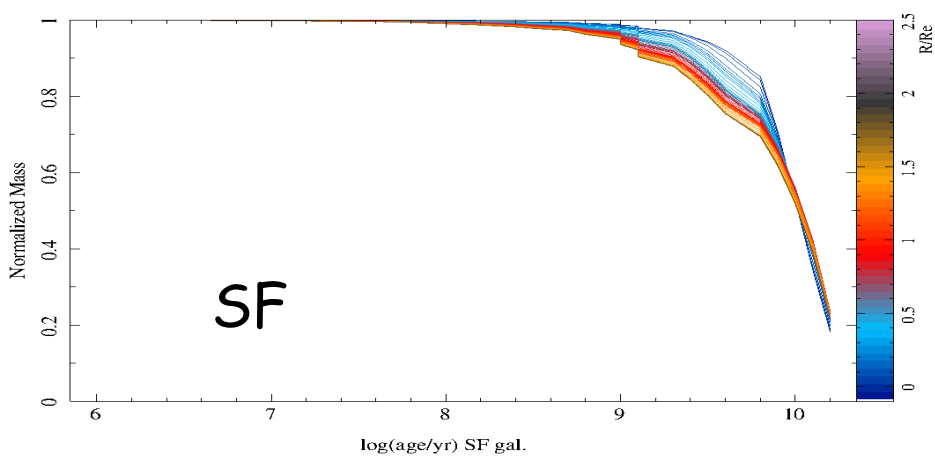


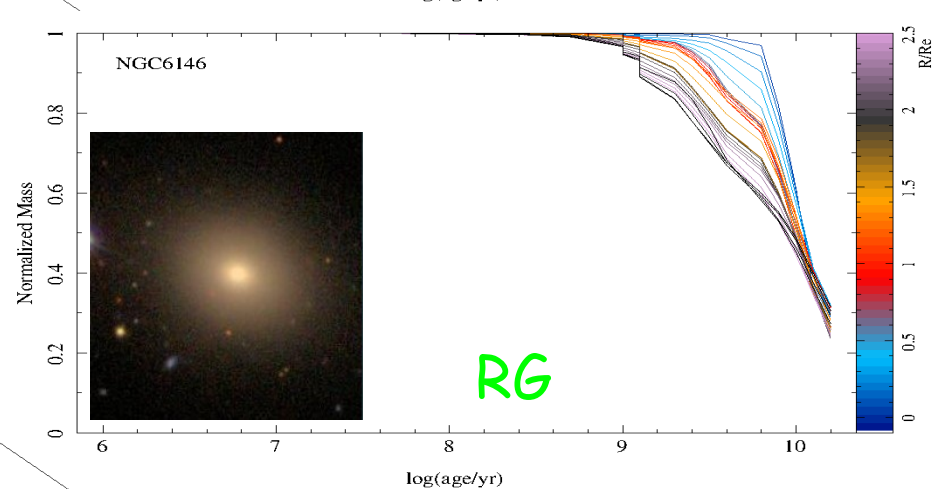
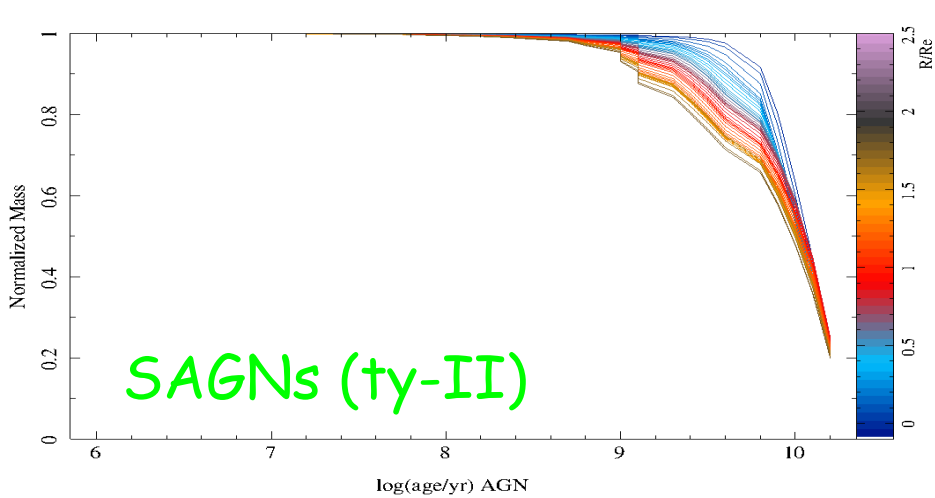
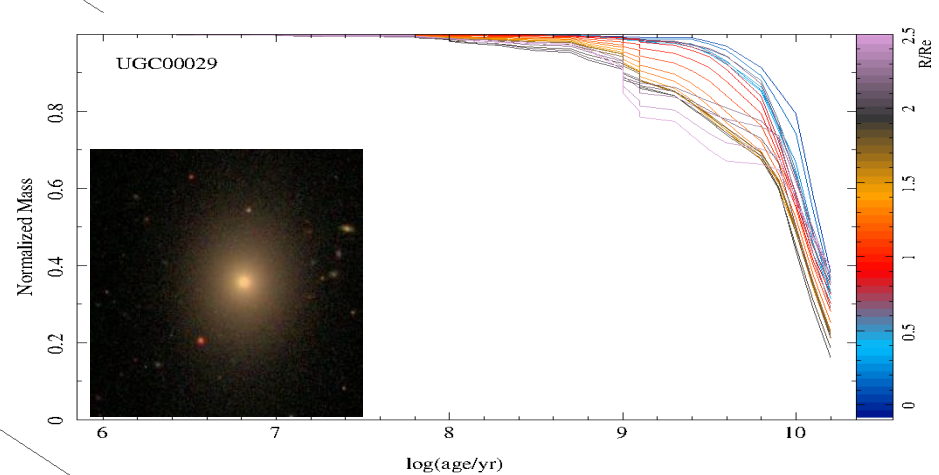
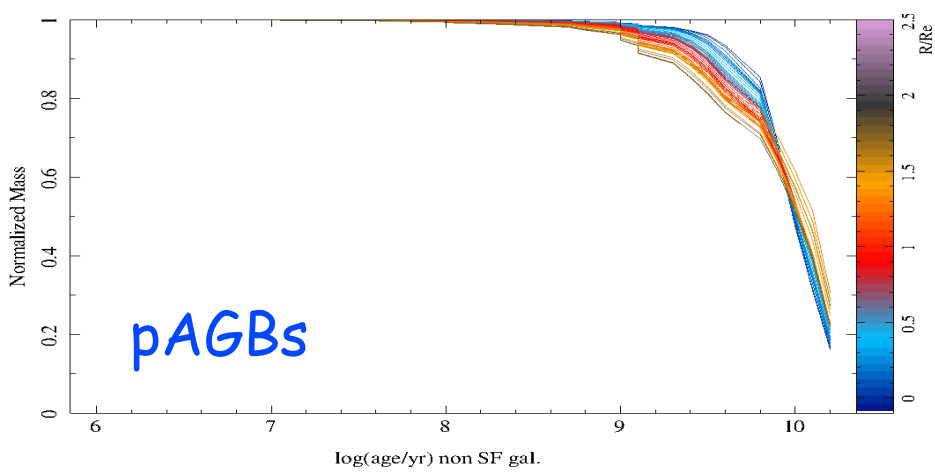
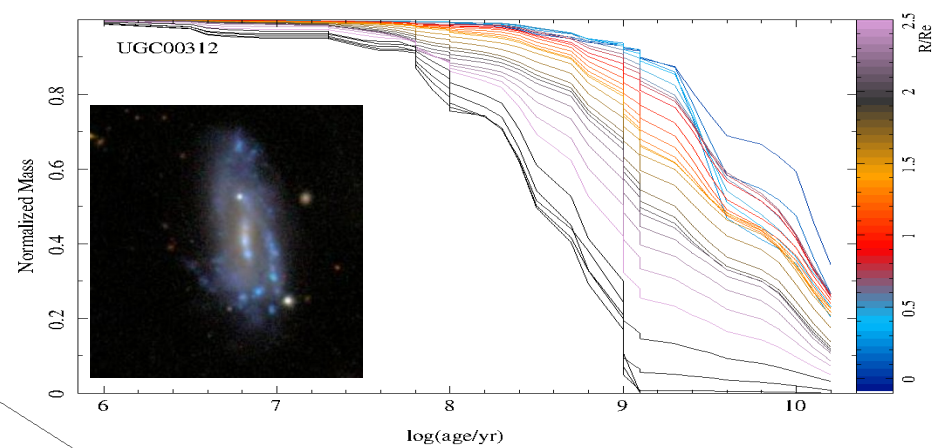
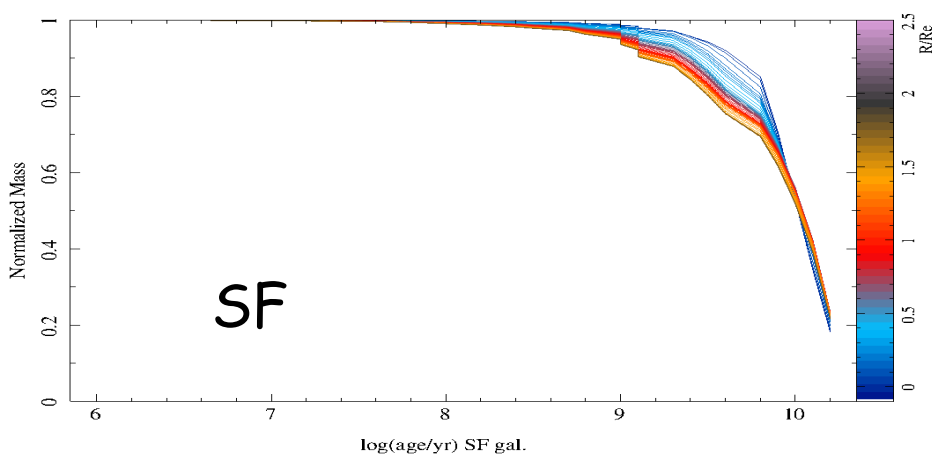
AGNs @ SF-MS green valley \rightarrow Quenching?

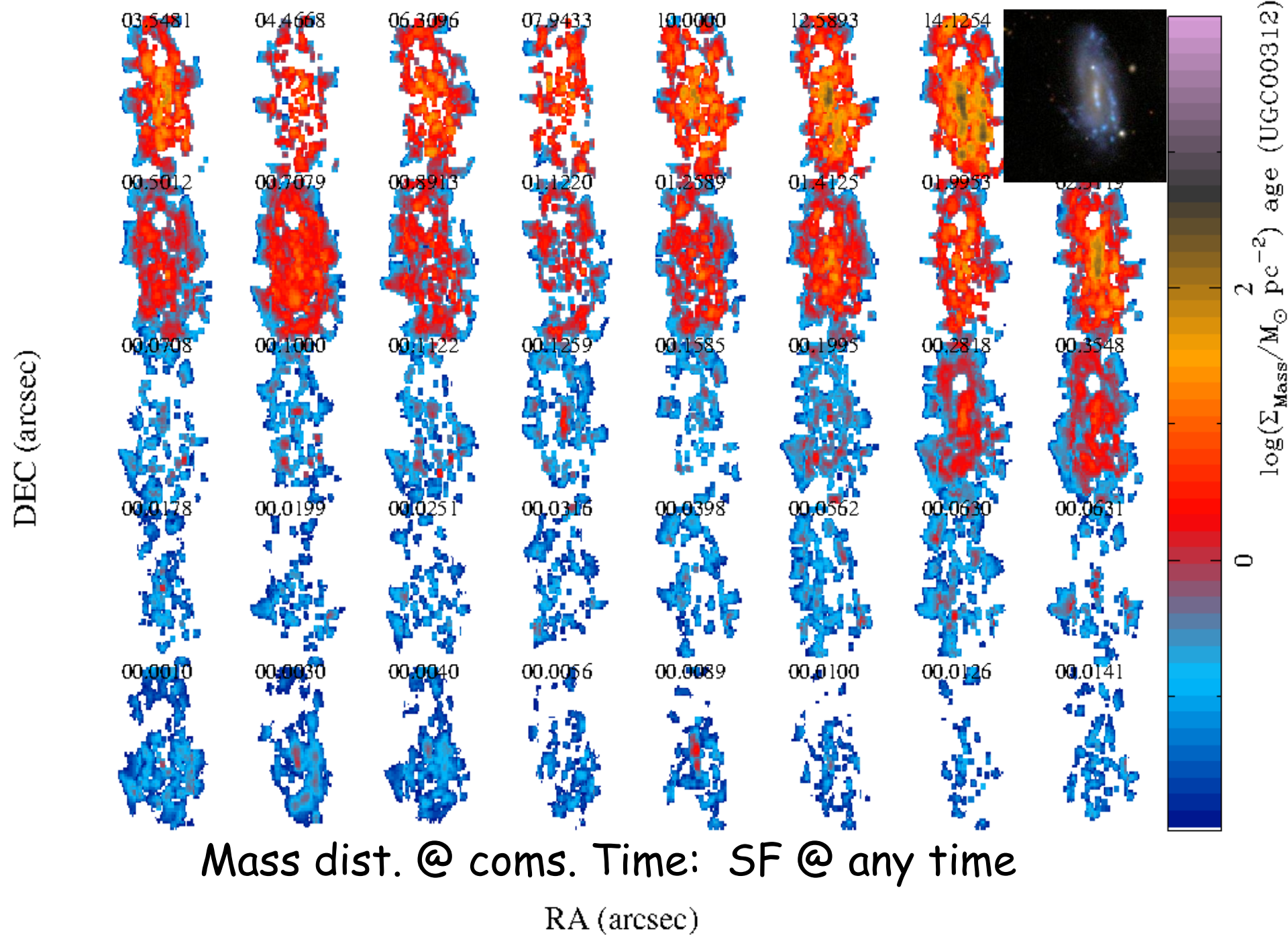


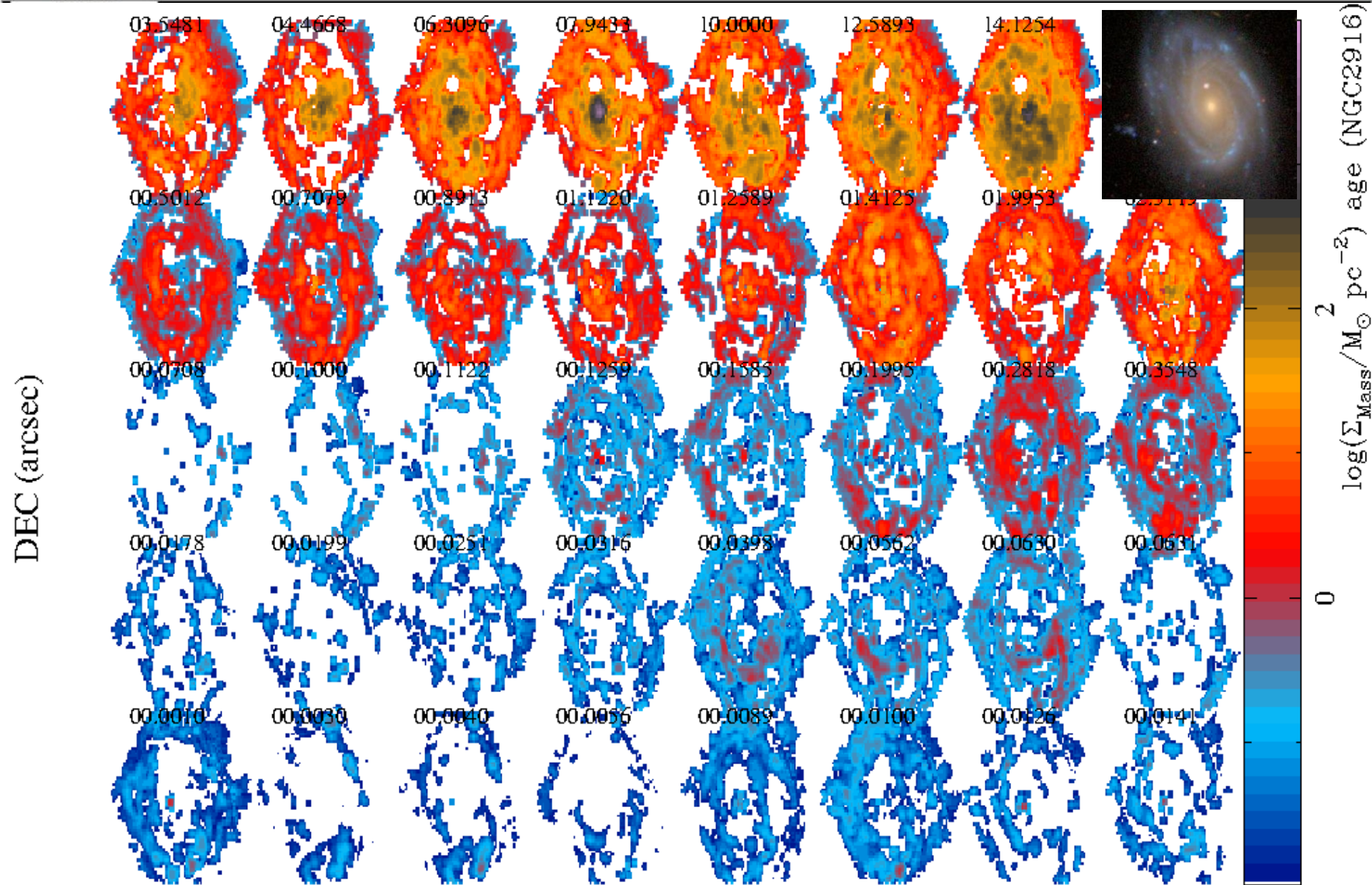




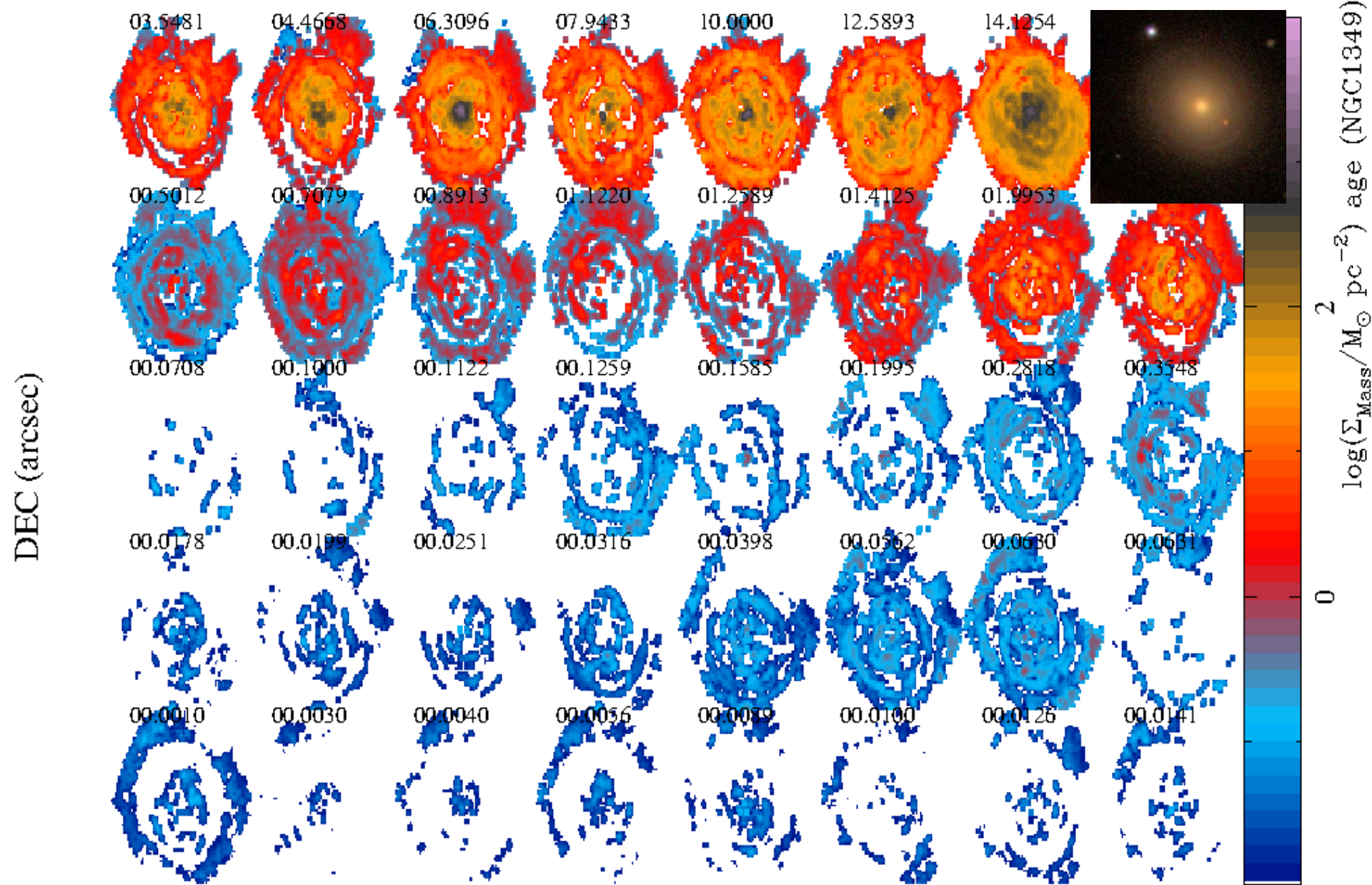




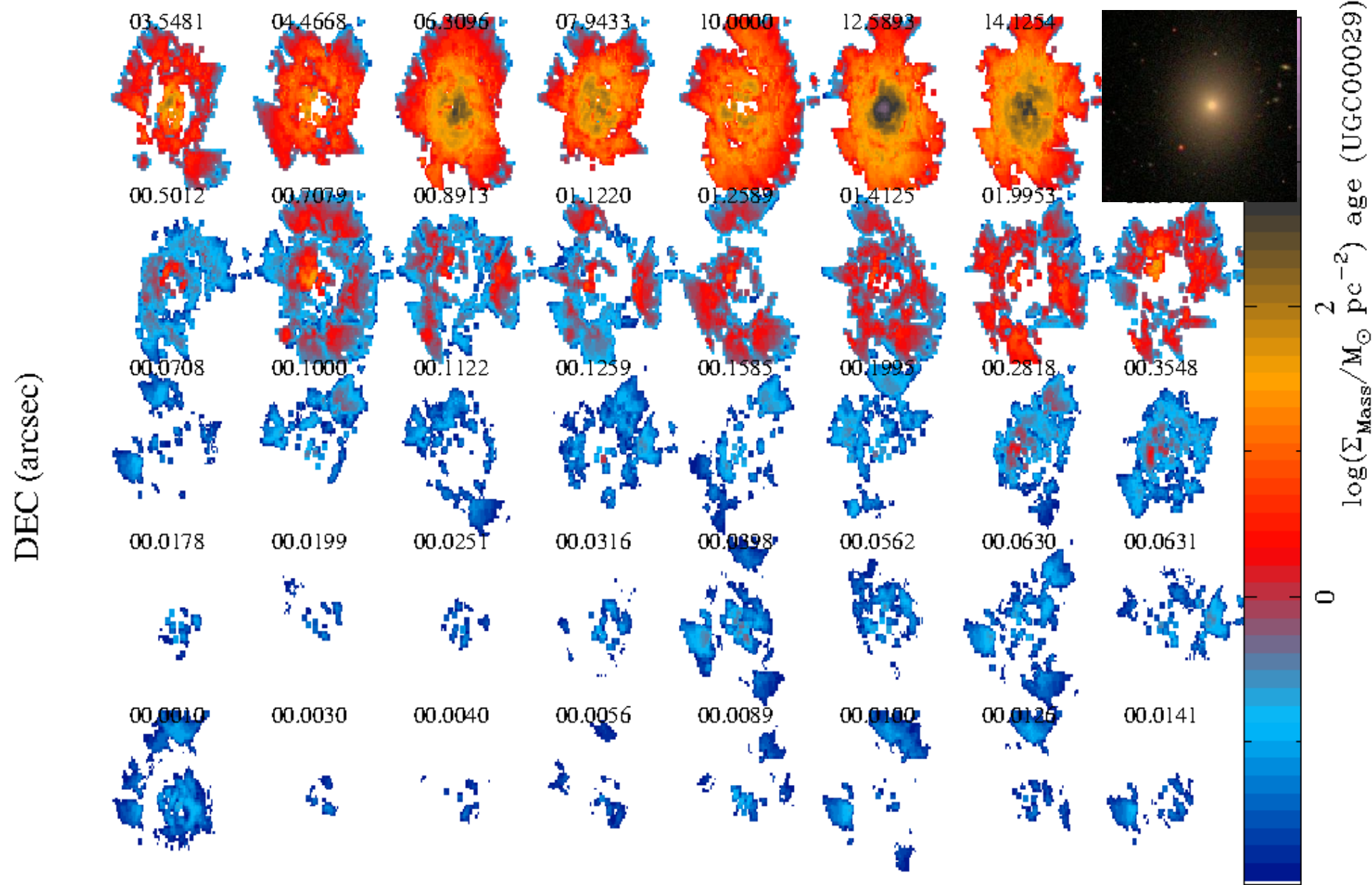




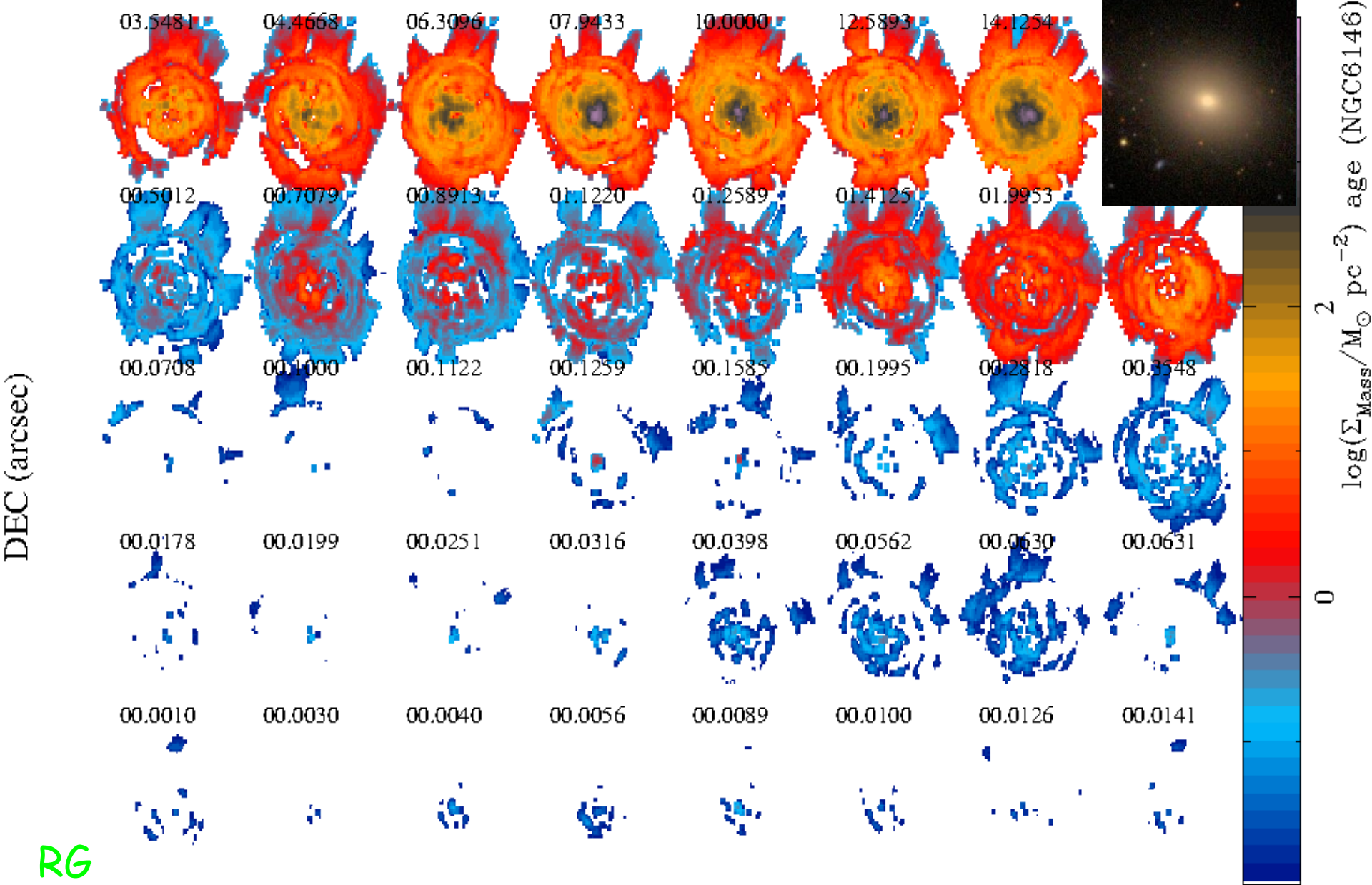
Mass dist. @ coms. Time: SF ceased in the center
RA (arcsec)



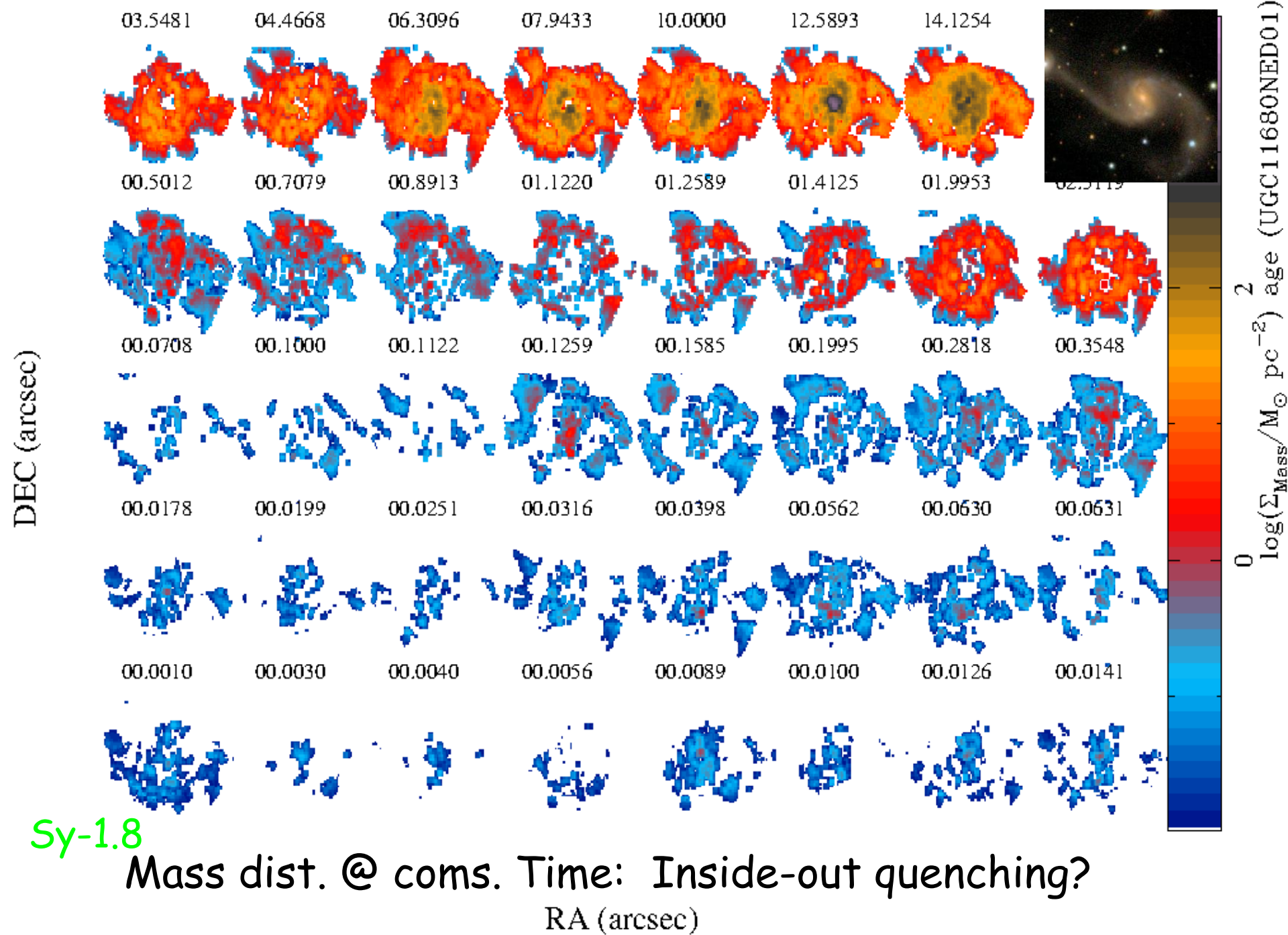
Mass dist. @ coms. Time: SF almost ceased \rightarrow Aging?

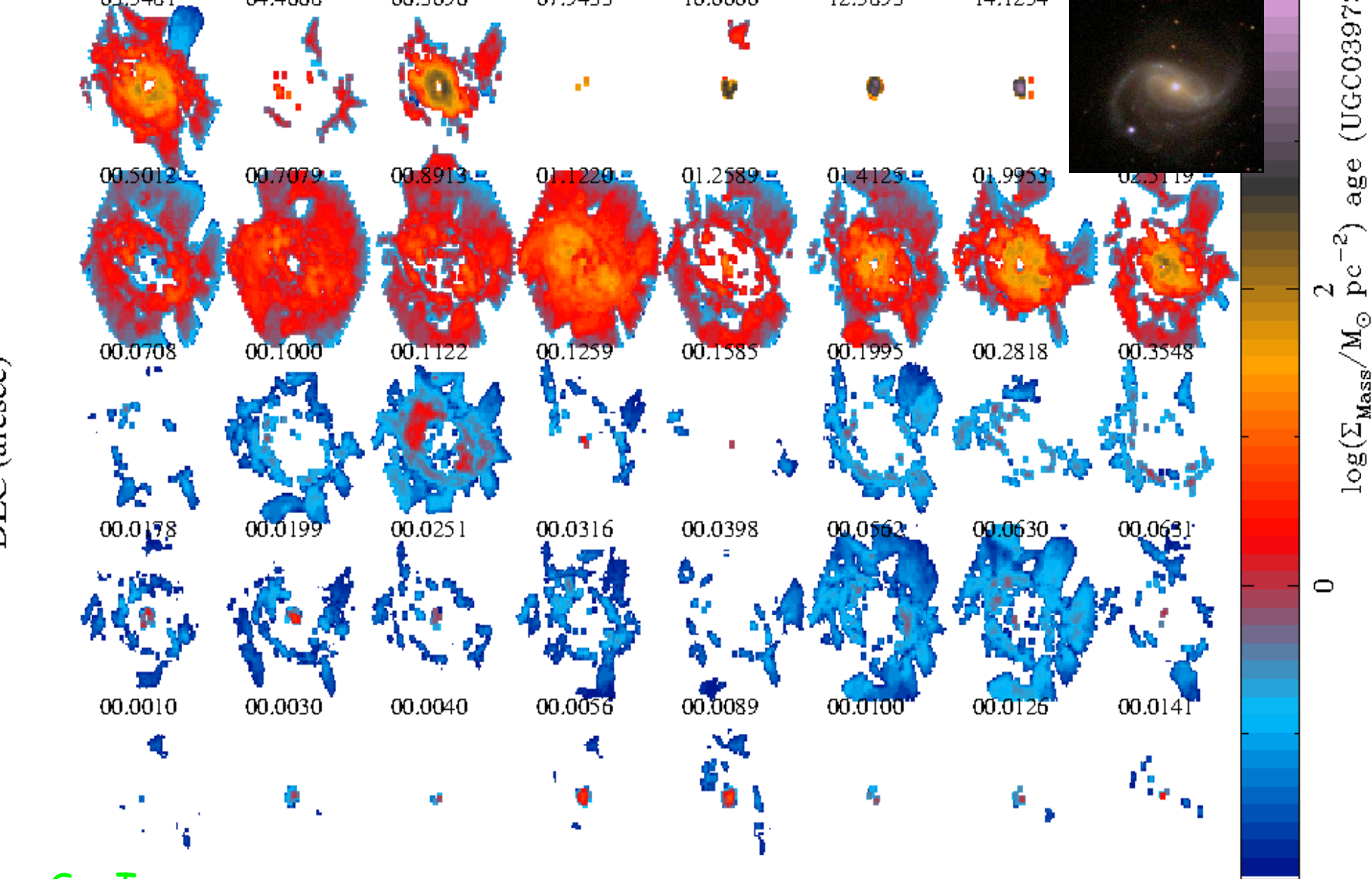


Mass dist. @ coms. Time: SF almost ceased \rightarrow Aging?
 RA (arcsec)



Mass dist. @ coms. Time: SF totally ceased → Quenchiq?
RA (arcsec)



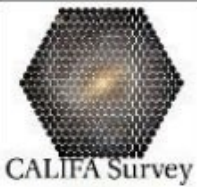


Sy-I

Mass dist. @ coms. Time: clear quenching & BH dating!

Summary

- We explored the influence of AGNs in the evolution of galaxies, based on the CALIFA dataset.
- There is a clear distinction between SF, retired and AGN-hosts in their location along the main sequence, with AGNs located in the "green valley".
- The SFH of SF and retired galaxies present two epochs: outside-in ($t > 9 \text{ Gyr}$) and inside-out ($t < 9 \text{ Gyr}$).
- The Mass-Assembly in the retired galaxies is faster and more concentrated in the center (aging?).
- AGN-hosts present an inside-out mass growth in all his cosmological evolution.
- Most AGN hosts present "hole" in the SF that grow from the inside-out.
- In the case of the explored type-I AGN there is a clear evidence of abrupt quenching.

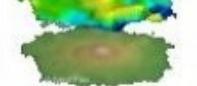
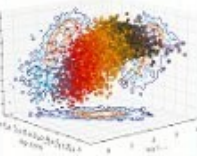


CALIFA Survey



Instituto de astronomía

UNAM



THE INTERPLAY BETWEEN LOCAL AND GLOBAL PROCESSES IN GALAXIES

COZUMEL, MÉXICO, 11TH-15TH APRIL, 2016



<http://www.astroscu.unam.mx/galaxies2016/>

→ THE INTERPLAY BETWEEN LOCAL AND GLOBAL PROCESSES IN GALAXIES

Cozumel, México, 11th-15th April, 2016

Ⓟ RATIONALE

Galaxy evolution is complex, with multiple processes acting on galaxies to shape them into the entities we see today. Many of these processes play out on scales much smaller than the entire galaxy. They also work with varying effectiveness at different places in the galaxies, making it imperative to study galaxies over their full extent. Studying galaxies on different spatial scales is thus one way to make significant progress in the quest to understand galaxy evolution.

In the last decade, improvements in technical observing capabilities have progressed galaxy evolution science into the area of spatially resolved spectroscopic surveys. It is thus possible to study the emergence of global galaxy properties from the local, kpc-scale distribution of these properties within the galaxies at essentially any wavelength, for large samples of galaxies and over a significant fraction of each galaxies total mass. Only a few relevant instruments and projects can be named here as particular prototypes: Atlas3D, CALIFA, SAMI, MaNGA for the optical, Spitzer and Herschel for the infrared, (e-)VLA and ALMA for the radio, Galex for the UV, Chandra and XMM in the X-ray, and near-infrared IFS and MUSE at higher redshifts. At the same time, progress in our theoretical understanding of galaxy evolution has not only produced a background framework to interpret the new data. Even more directly, cosmological hydrodynamic simulations are yielding large samples of galaxies that could be studied in the same way