CASE : M33 - 3D

Dark matter profile

Stellar populations

Interstellar medium

Structure and evolution

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NMSU - New Mexico
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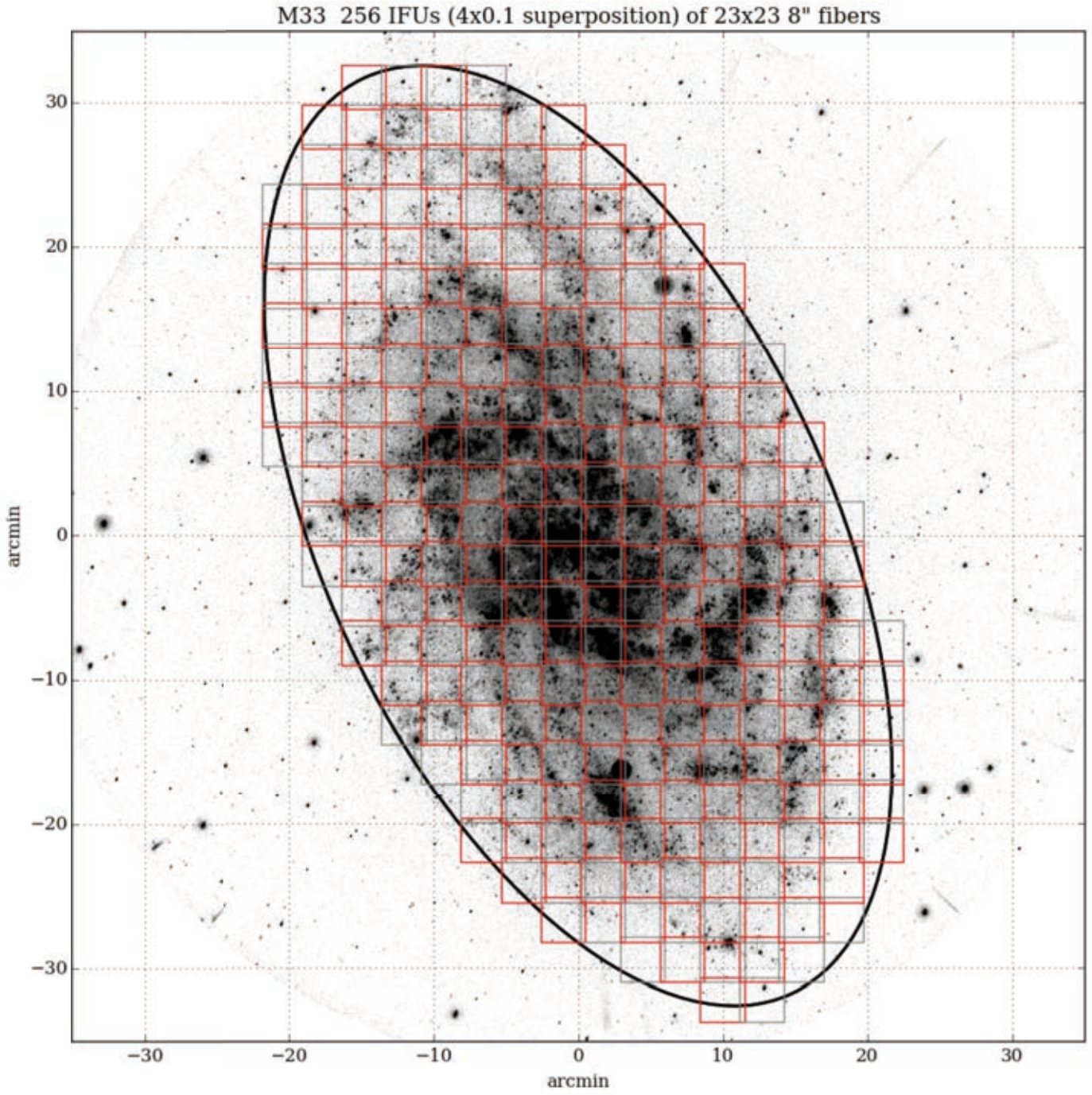
What is it?



What can we study?

Dark matter profile

Stellar populations

Interstellar medium

Structure and evolution

The (fossil record) method

Decomposing galaxy spectra

$$L_{gal}(\lambda) = \sum_{t,Z} M_{SSP}(t,Z) \times SSP(\lambda;t,Z) \times e^{-\tau(\lambda)}$$

Observables:
Full spectrum

SFH:
Mass or light fractions

Spectral Base

Dust

The method

Decomposing galaxy spectra

M_{ion} = 0.00% | 0.00% (10Ma|20Ma) 5377x.nuc.txt.DR.sc4.C11.gm.CAL

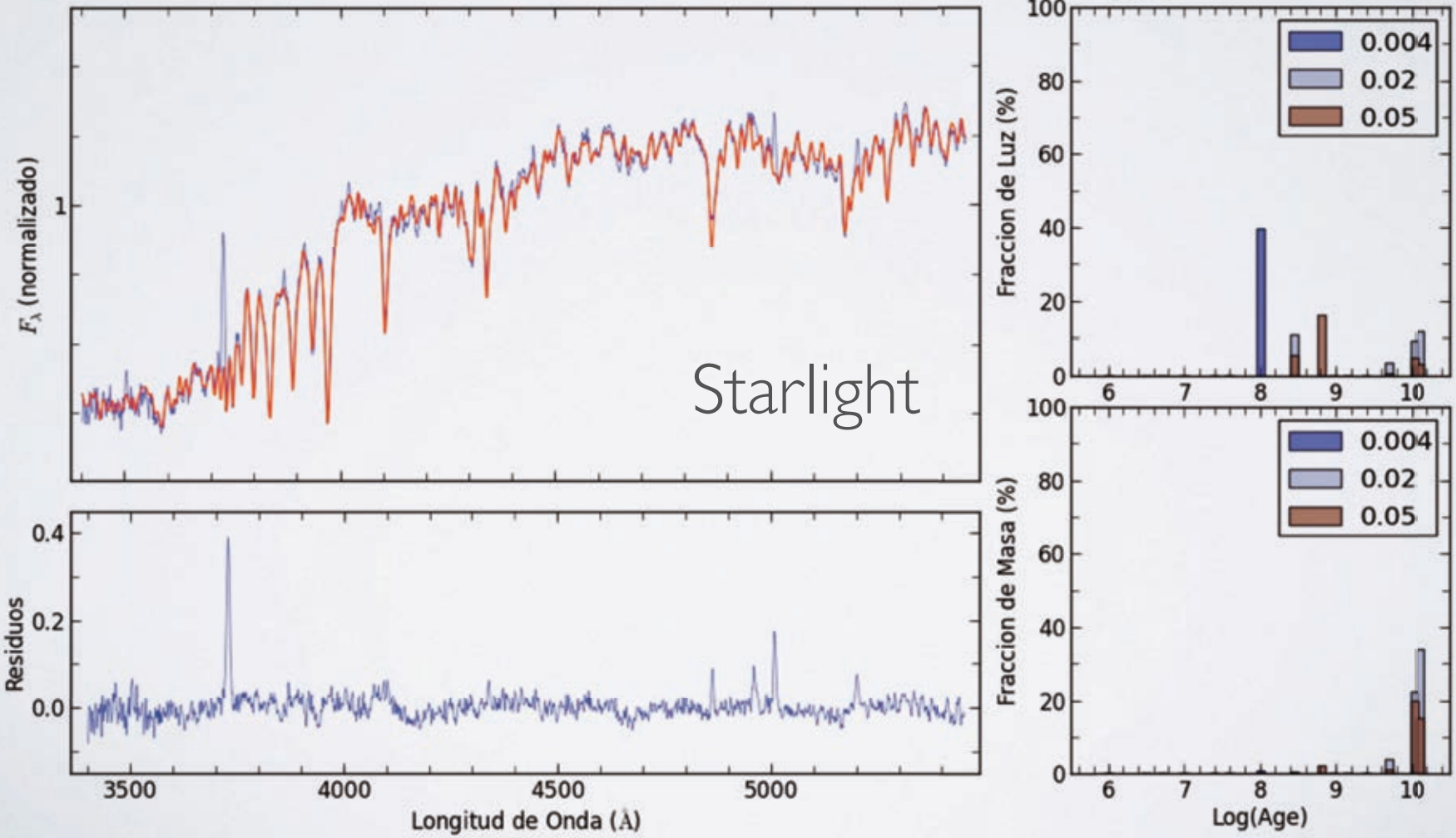
EW(Hβ) = 0.000 | 0.000 $\frac{Cont_{ion}}{Cont_{tot}}$ χ^2 = 0.499

$M_* = 1.169e+06 \times D^2\ M_\odot$ Z = 0.004 ⊕ 0.02 ⊕ 0.05

V0 = -46.27 km/s

Vd = 191.58 km/s

AV = 0.5656 mag

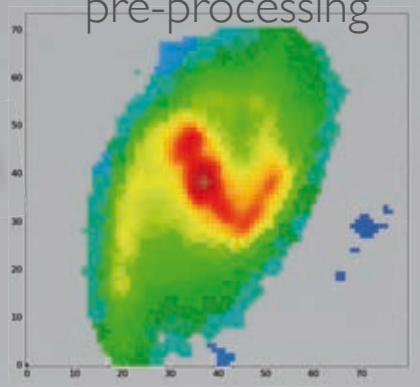


de-construct

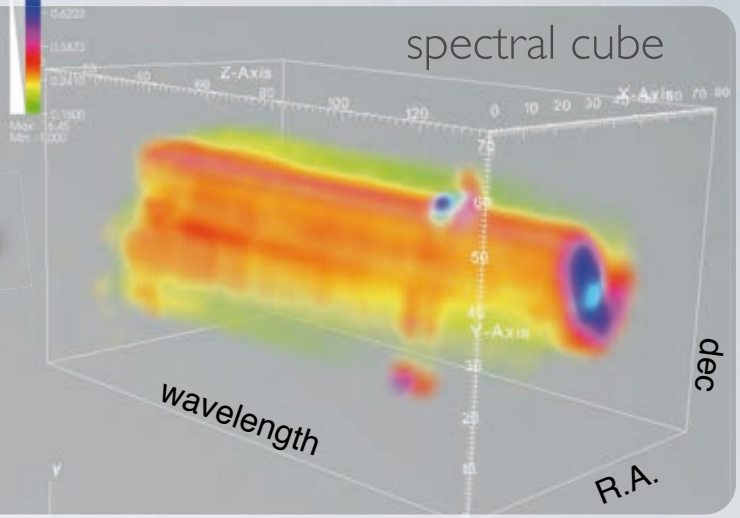
STARLIGHT
Cid Fernandes

re-construct

spatial binning, mask, etc
pre-processing



spectral cube



READ
Starlight
output

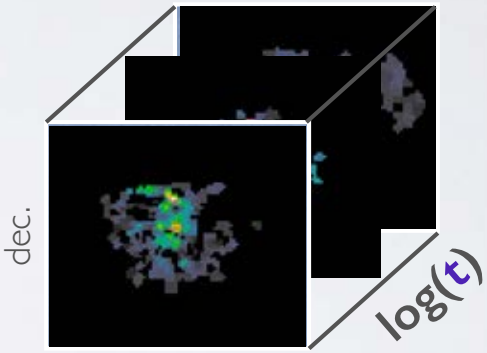
MagesDict
[Z,t]

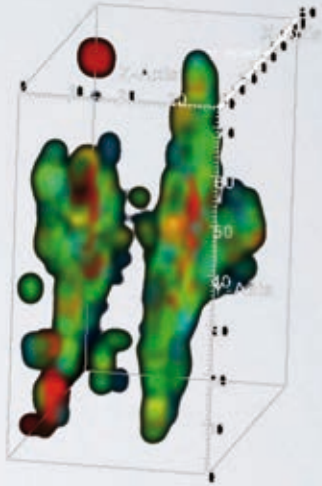
Σ_Z

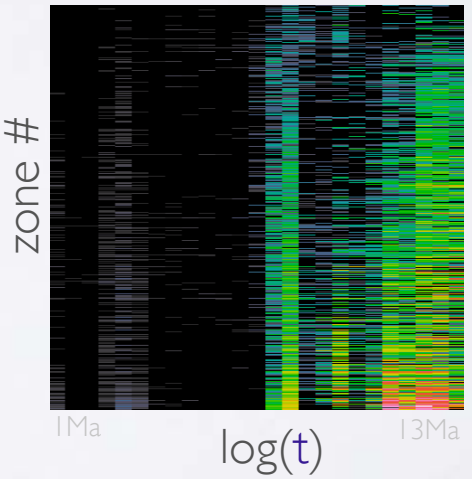
Magebins
[t]

Mages_cube[t,y,x] =
zone(y,x) x
Magebins[t] / area(zone)

Mcen[zone,t] =
zone(y,x) x
Magebins[t] / area(zone)





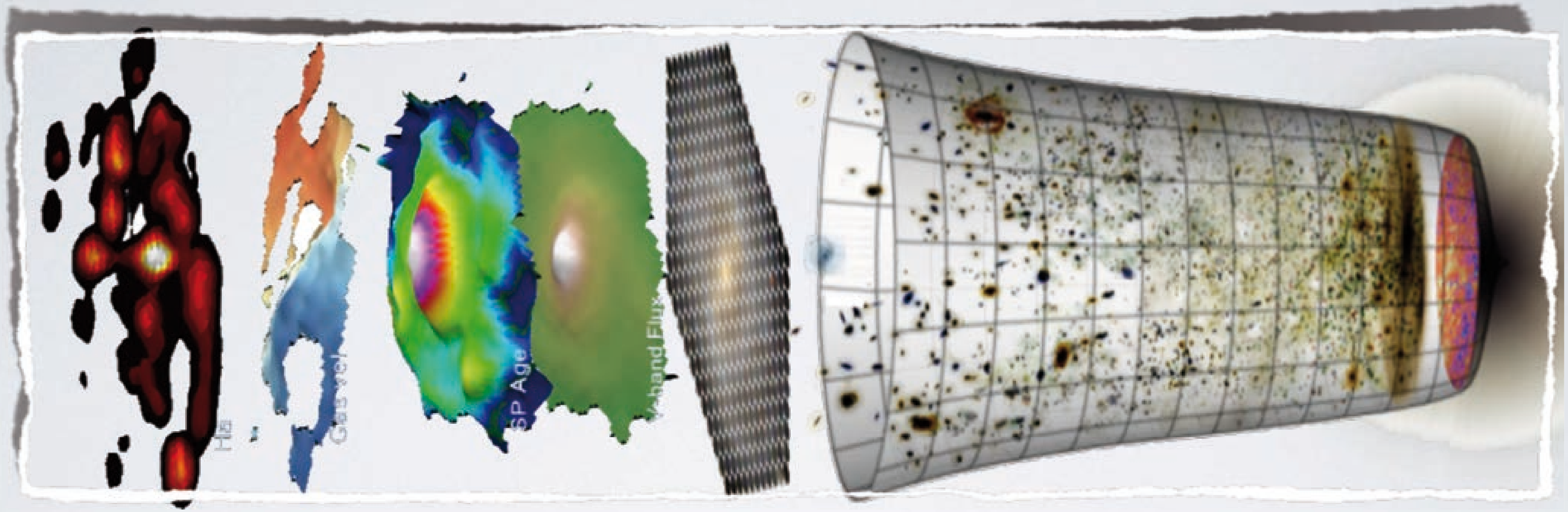


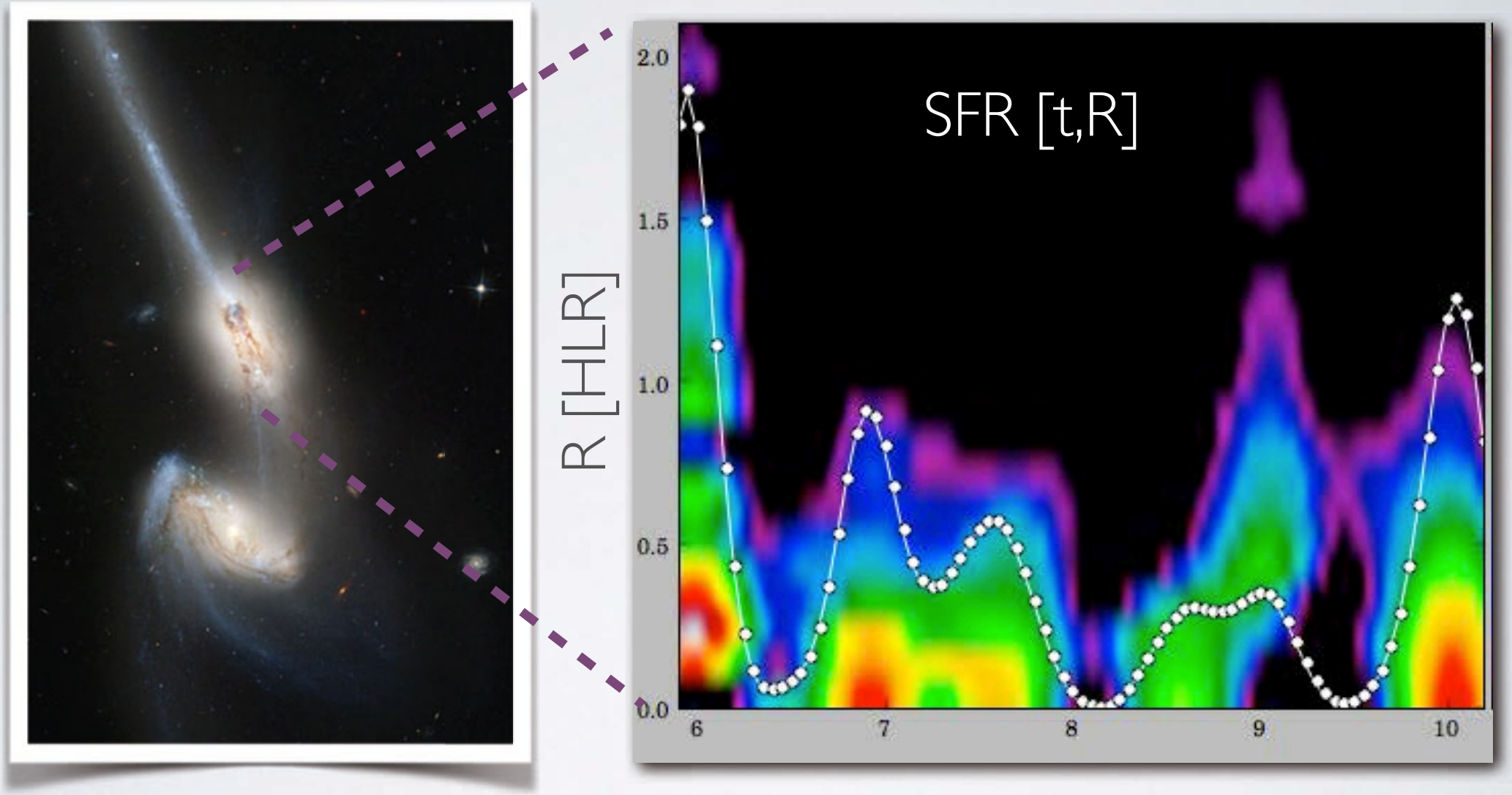
L(x,y,t)
M(x,y,t)
Z(x,y,t)

Av, v, vd : (x,y)

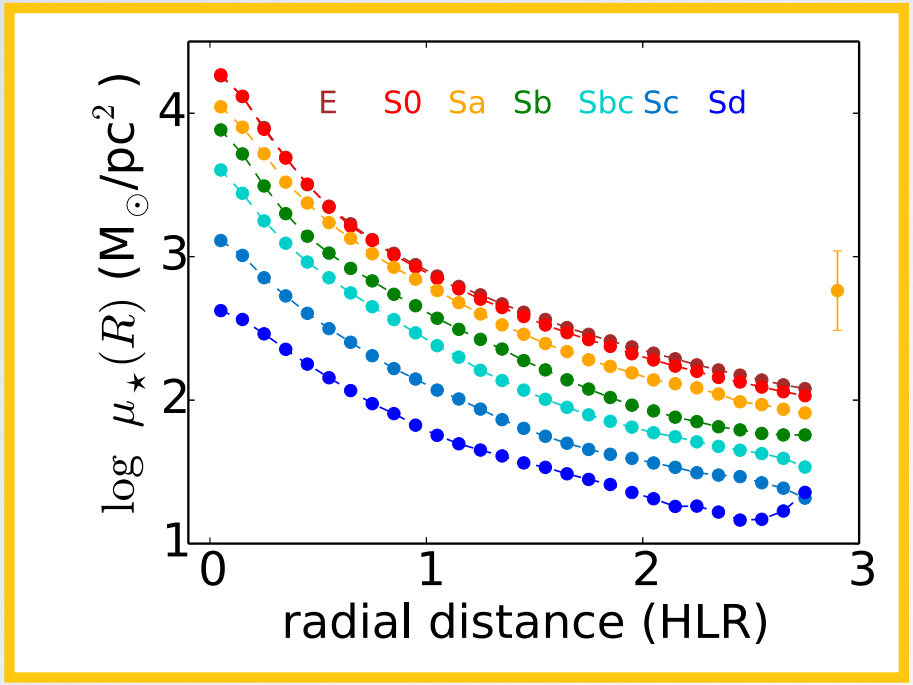
Processing & Analysis pipelines

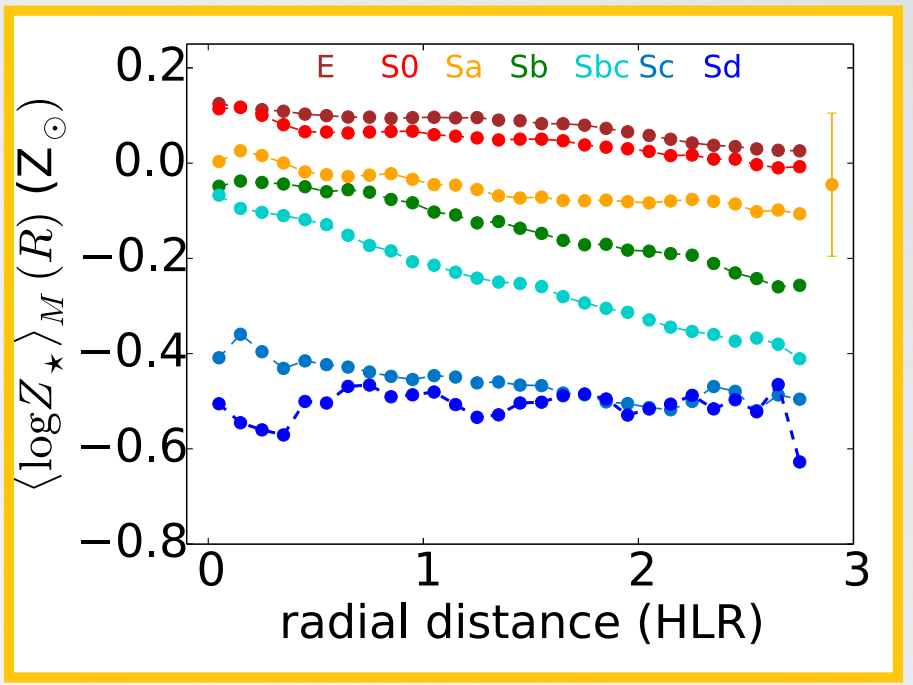
look back in time vs. fossil record

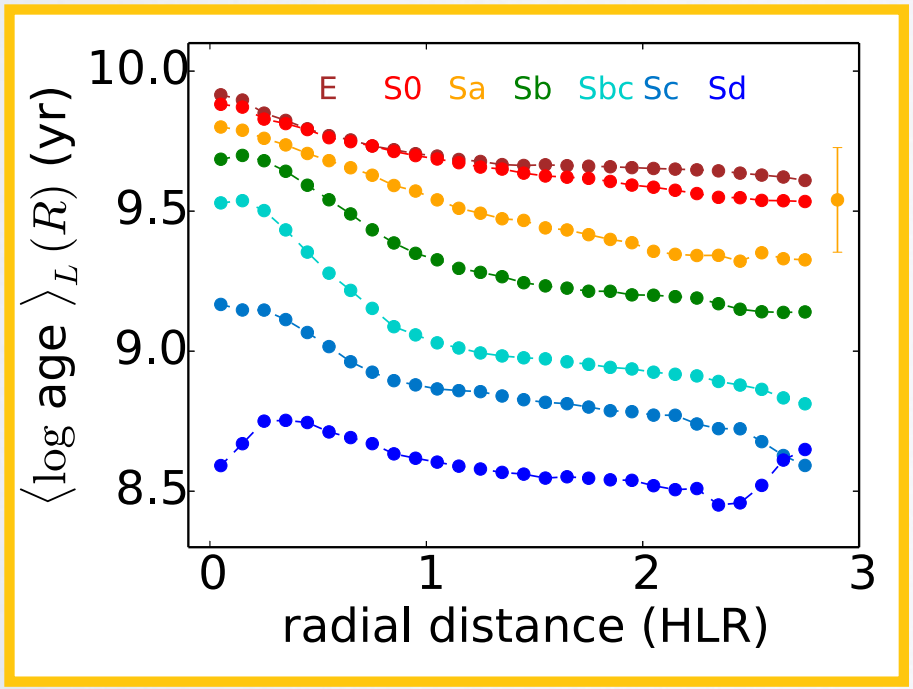


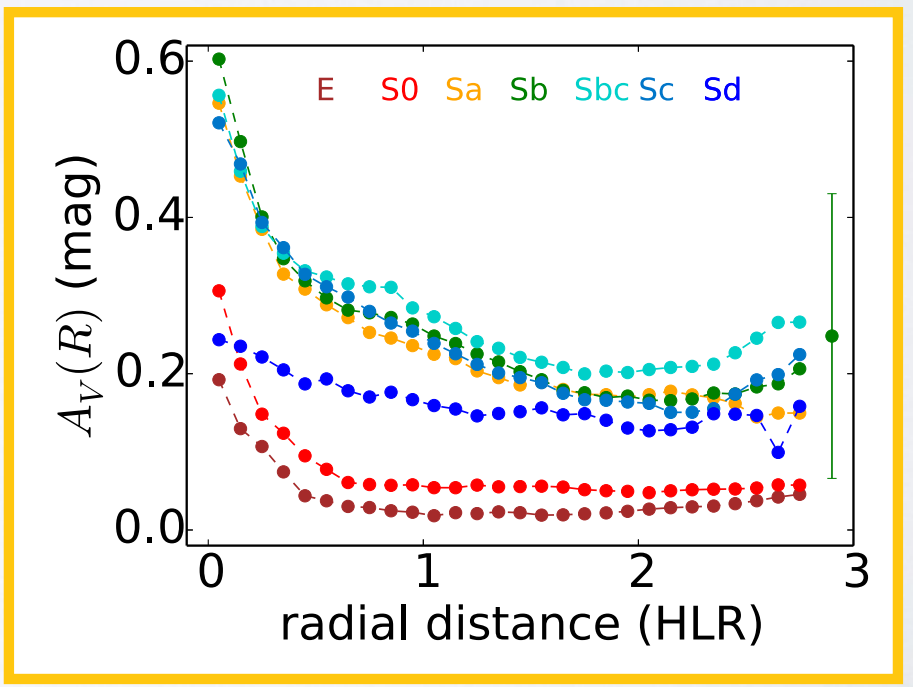

SFR [t,R]
R [HLR]
2.0
1.5
1.0
0.5
0.0
6
7
8
9
10
log time [yr]

Radial structure of the stellar stellar population properties







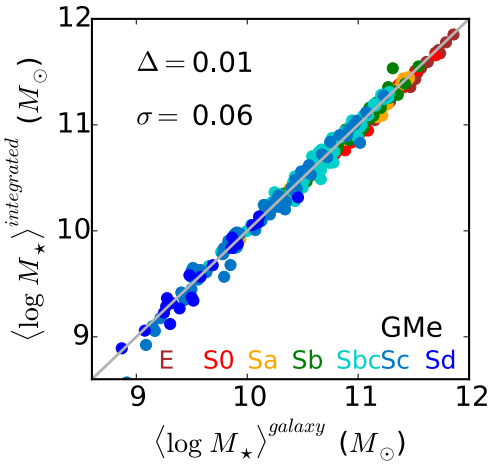


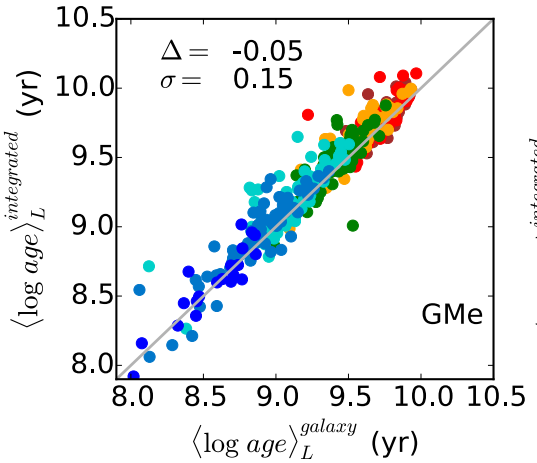
✳González Delgado et al. 2015, A&A, 581, 103 (analysis for 300 CALIFA galaxies)

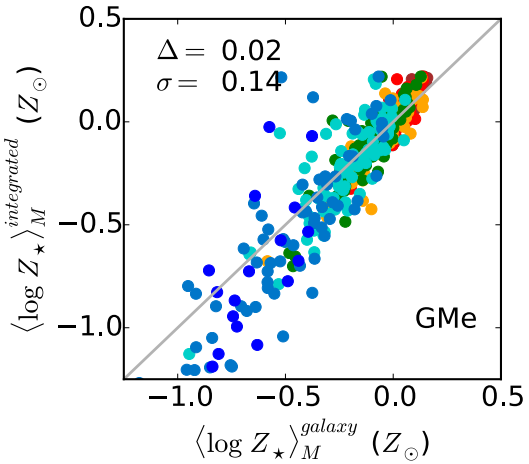
stellar properties: radial dependence

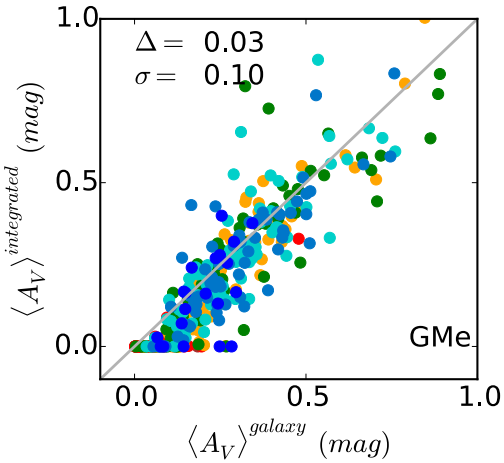
400 CALIFA galaxies

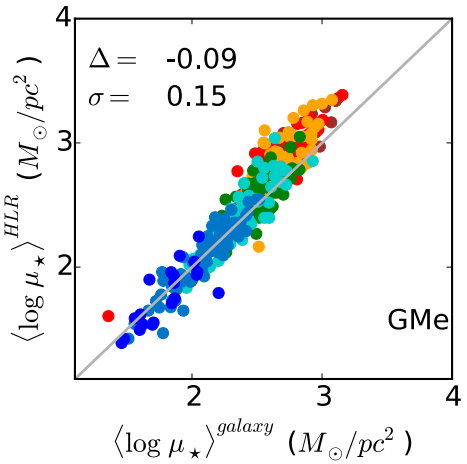
Integrated vs. ⟨resolved⟩

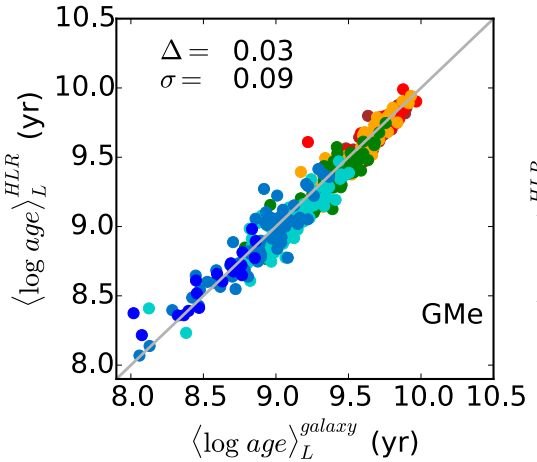


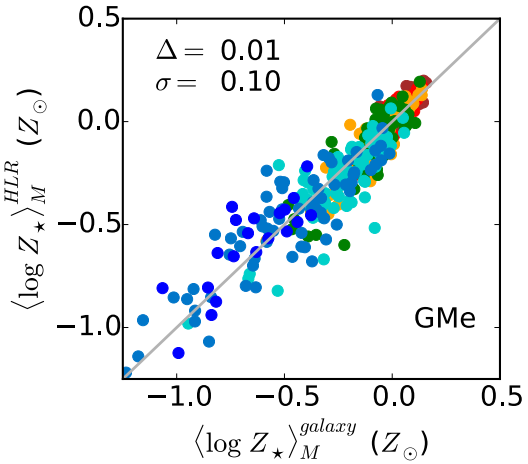


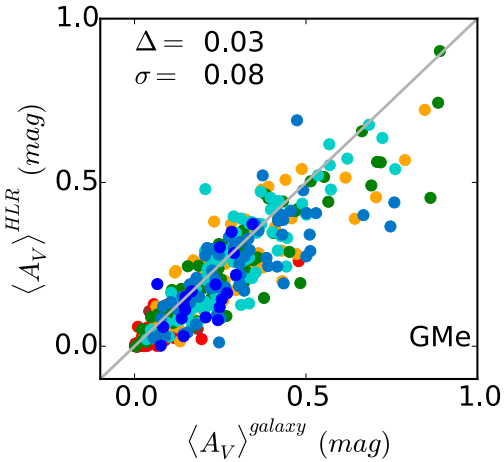










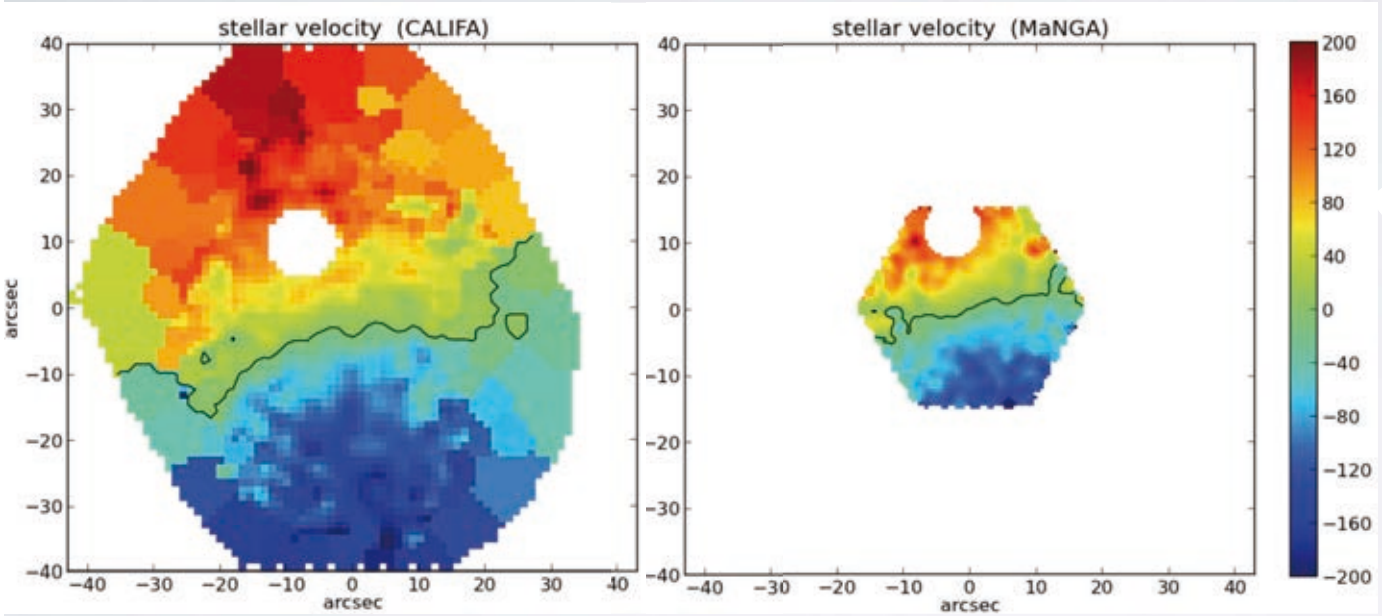


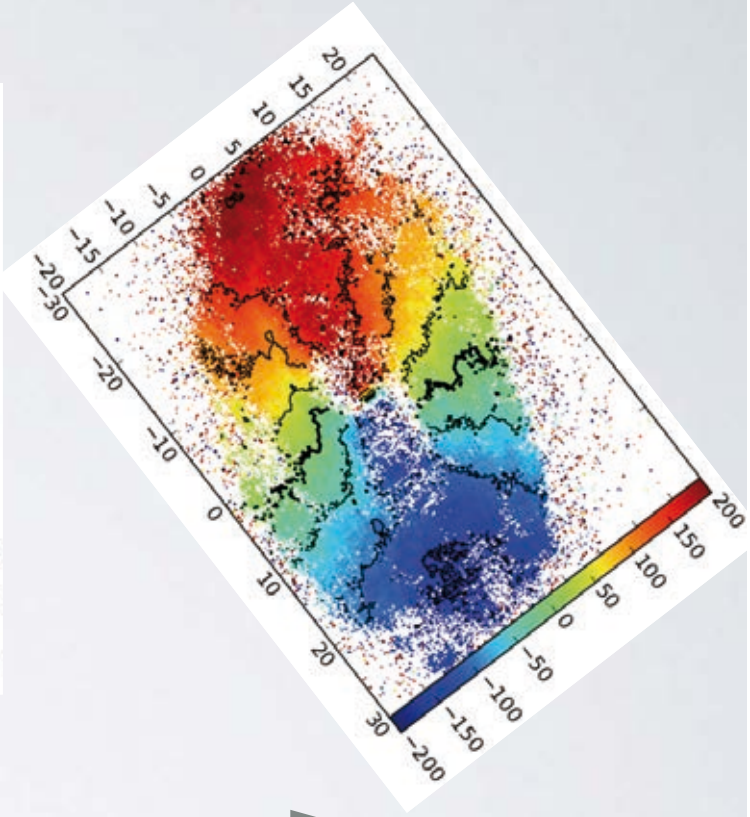
@1HLR vs. ⟨resolved⟩

3.5@CAHA
CALIFA
1.000

2.5@APO
MaNGA
150

8@VLT
MUSE
90.000





NGC2906

CASE : M33-3D ~135.000 spectra

Numerical simulations of an M33 type galaxy:

How well can we recover the parameters? A simulated case

CLUES simulation
(Constrained Local UniversE Simulations, Yepes et al. 2014)

- Cosmology: LCDM (WMAP3 params)
- Box total volume: 64 h^{-1} Mpc (h^{-1}=0.73)
- Zoomed-in region is resimulated at high resolution (including barions and hydro): 1h^{-1} Mpc
Total # particles in resimulation: 4096^3

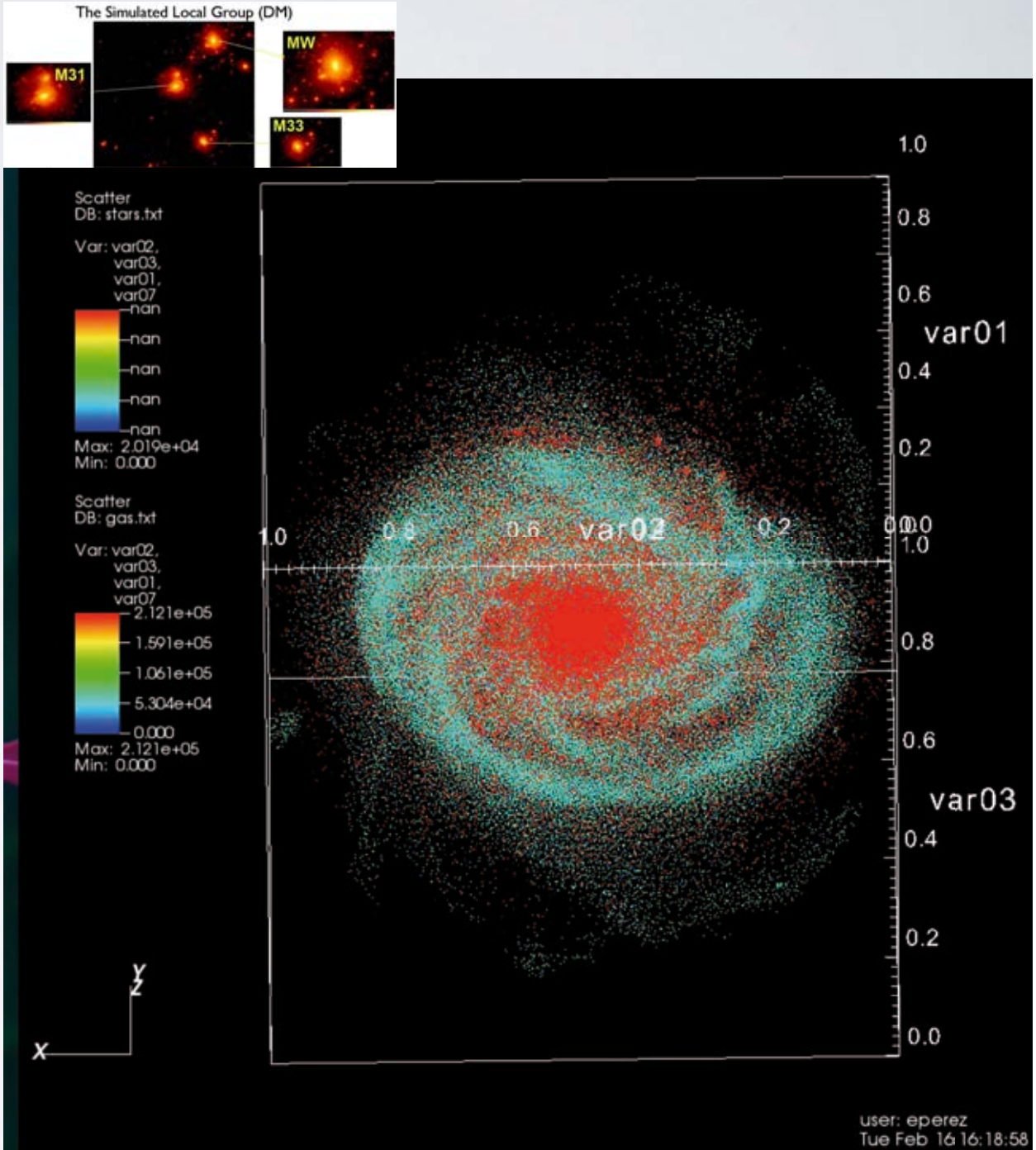
- Mass resolution of particles:
  m_{gas} = 1.8 10^4 M_{sol}
  m_{star} = 1.3 10^4 M_{sol}
  m_{DM} = 2.9 10^5 M_{sol}

- Gravitational softening lengths:
  $\varepsilon_{barions}$ = 223 pc
  ε_{DM} = 486 pc

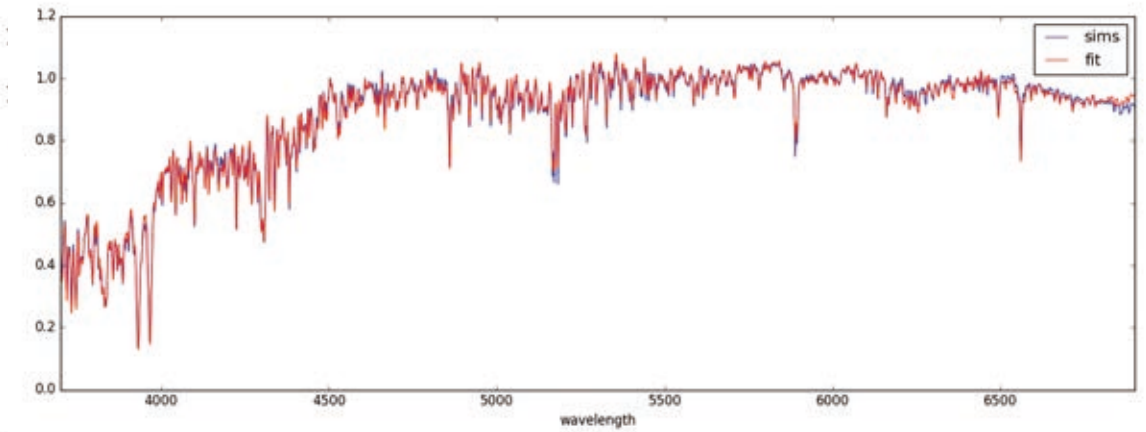
Evolved with GASOLINE (SF, radiative cooling, hydro, feedback, metal evolution, etc).

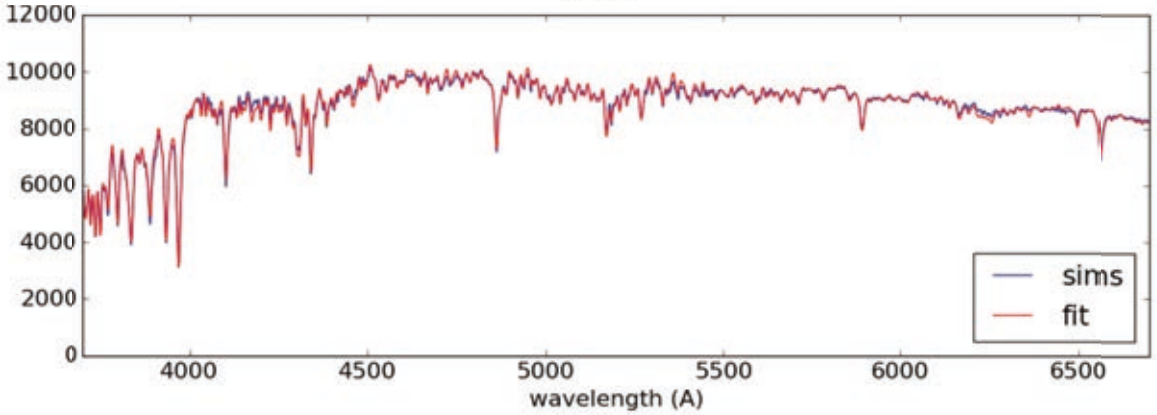
Galaxy C3 in Santos-Santos et al. (2016)
  M_{star} = 5.1 10^9 Msol
  M_{gas} = 2.2 10^{10} Msol
  M_{DM} = 2.4 10^{11} Msol
  M_{total} = 2.7 10^{11} Msol

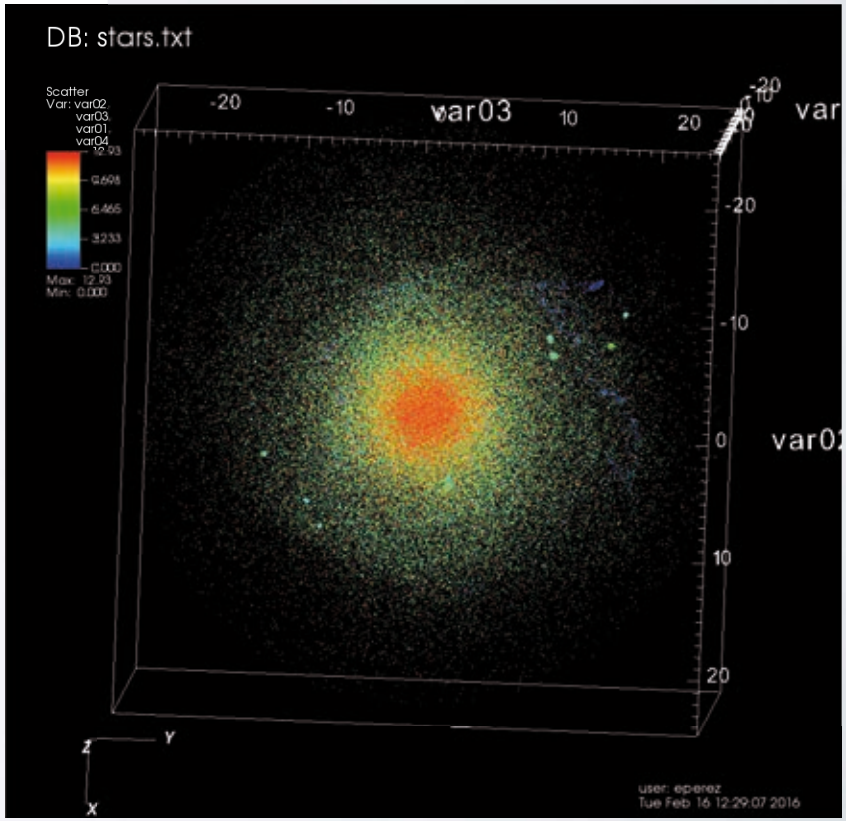
I band scale-length (asume exponential disc) = 2.25 kpc
R_{50} (radius enclosing half of stars) = 2.8 kpc
L_{bol} (**GRASIL3D***) = 1.4 10^{43} erg/s

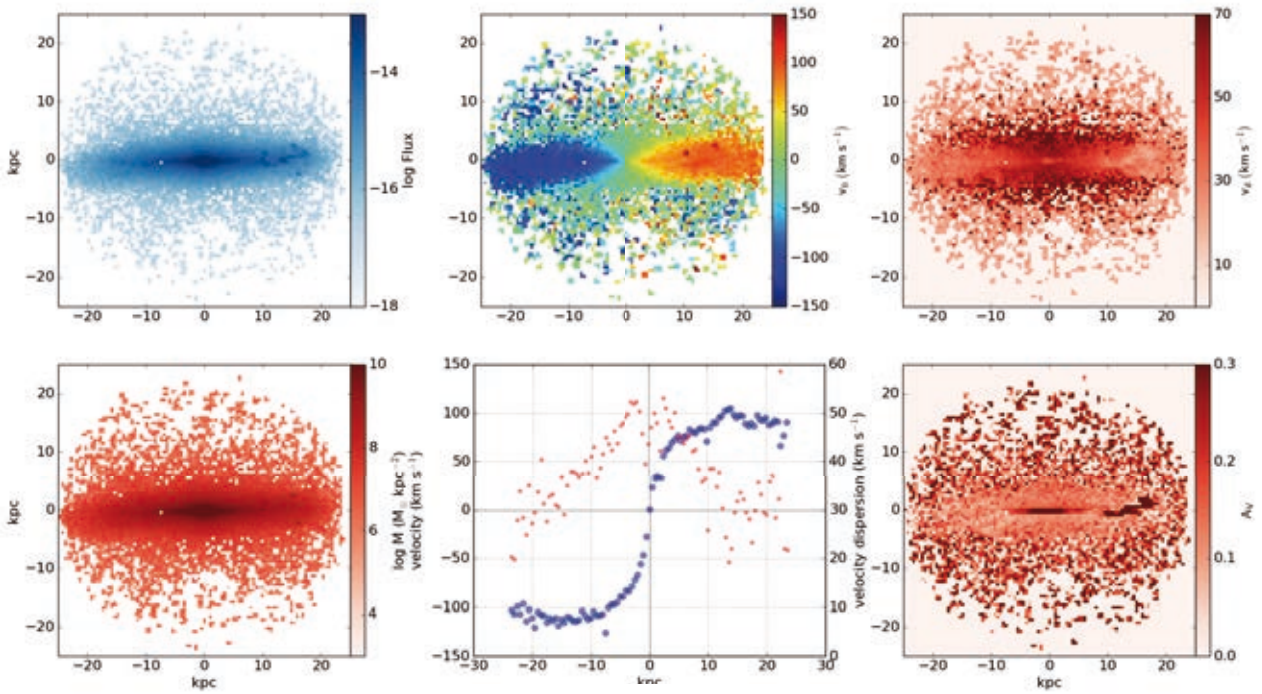


* Domínguez-Tenreiro et al 2014

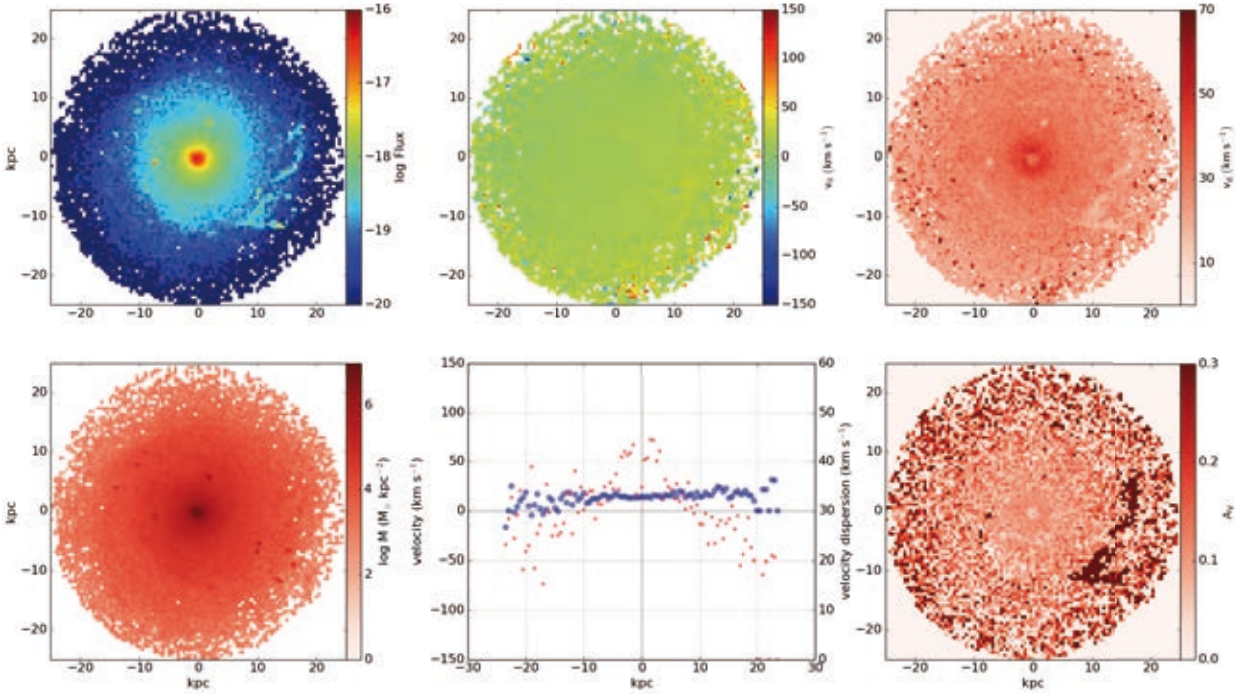

sims
fit
wavelength

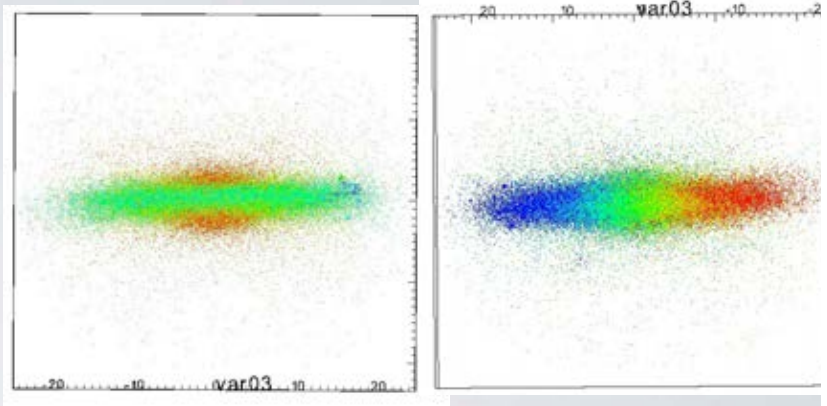

sims
fit
wavelength (A)


DB: stars.txt
Scatter
Var: var02,
var03,
var01,
var04
var03
var02
user: eperez
Tue Feb 16 12:29:07 2016

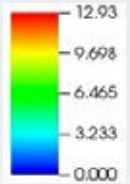


reconstructed



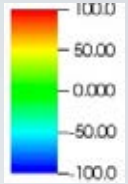


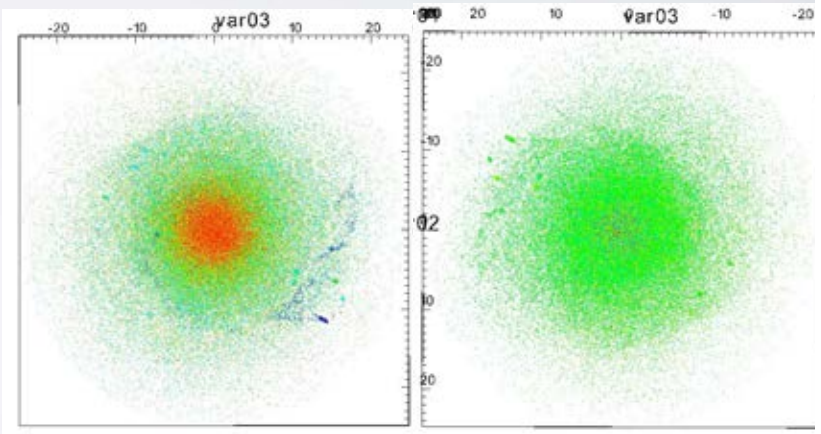
Sims



age

velo





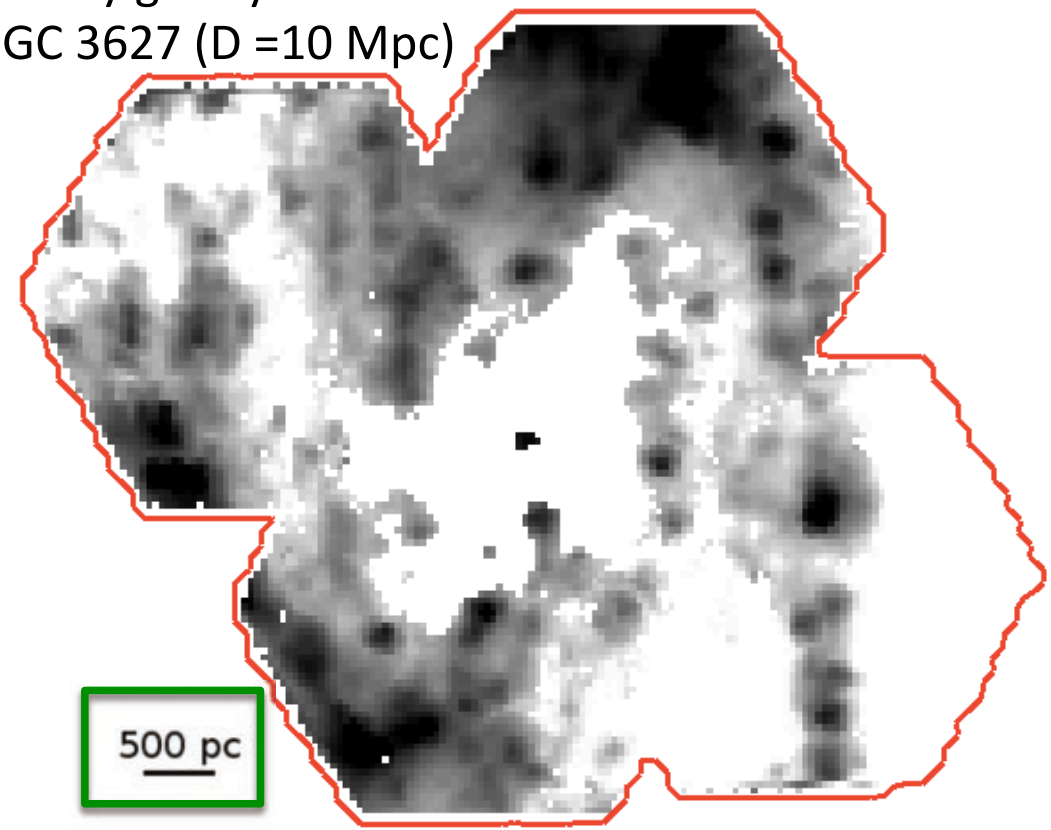
Recover DM profile

Kathryn Kreckel (MPIA)

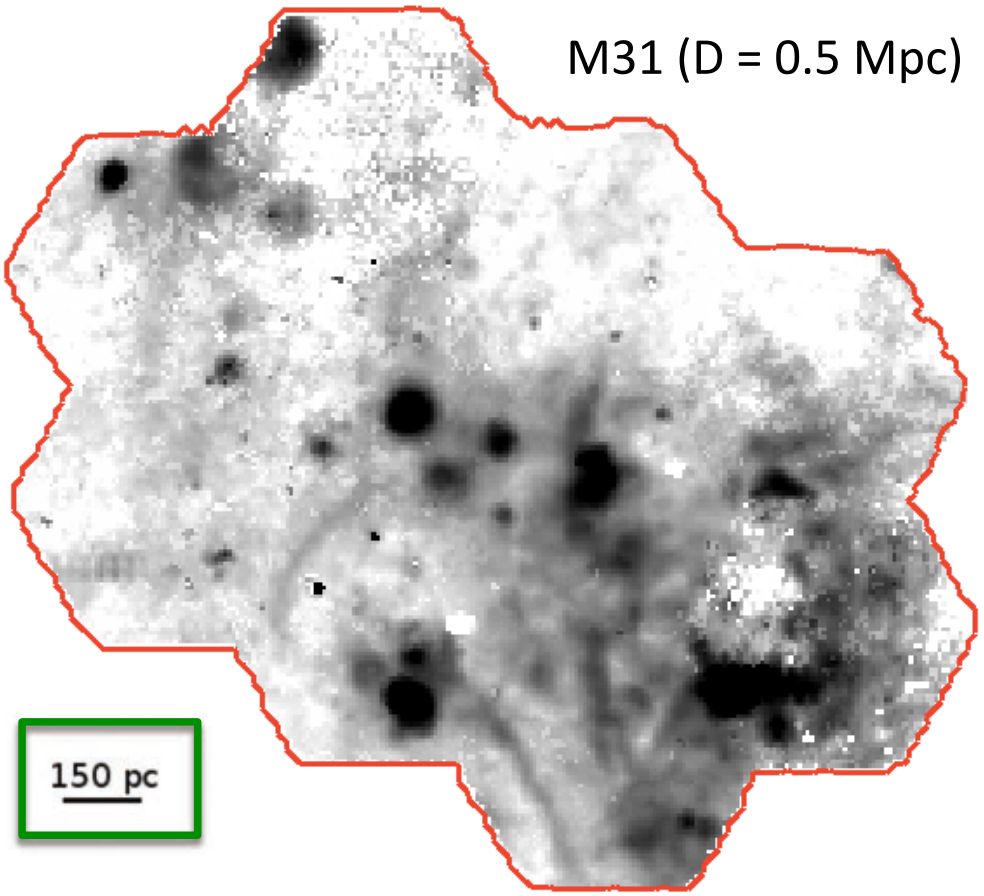
Optical IFU maps of nearby galaxies enable us to

- resolve HII regions
- reveal & resolve the diffuse ionized gas
- map dust within galaxies

Nearby galaxy
NGC 3627 (D =10 Mpc)



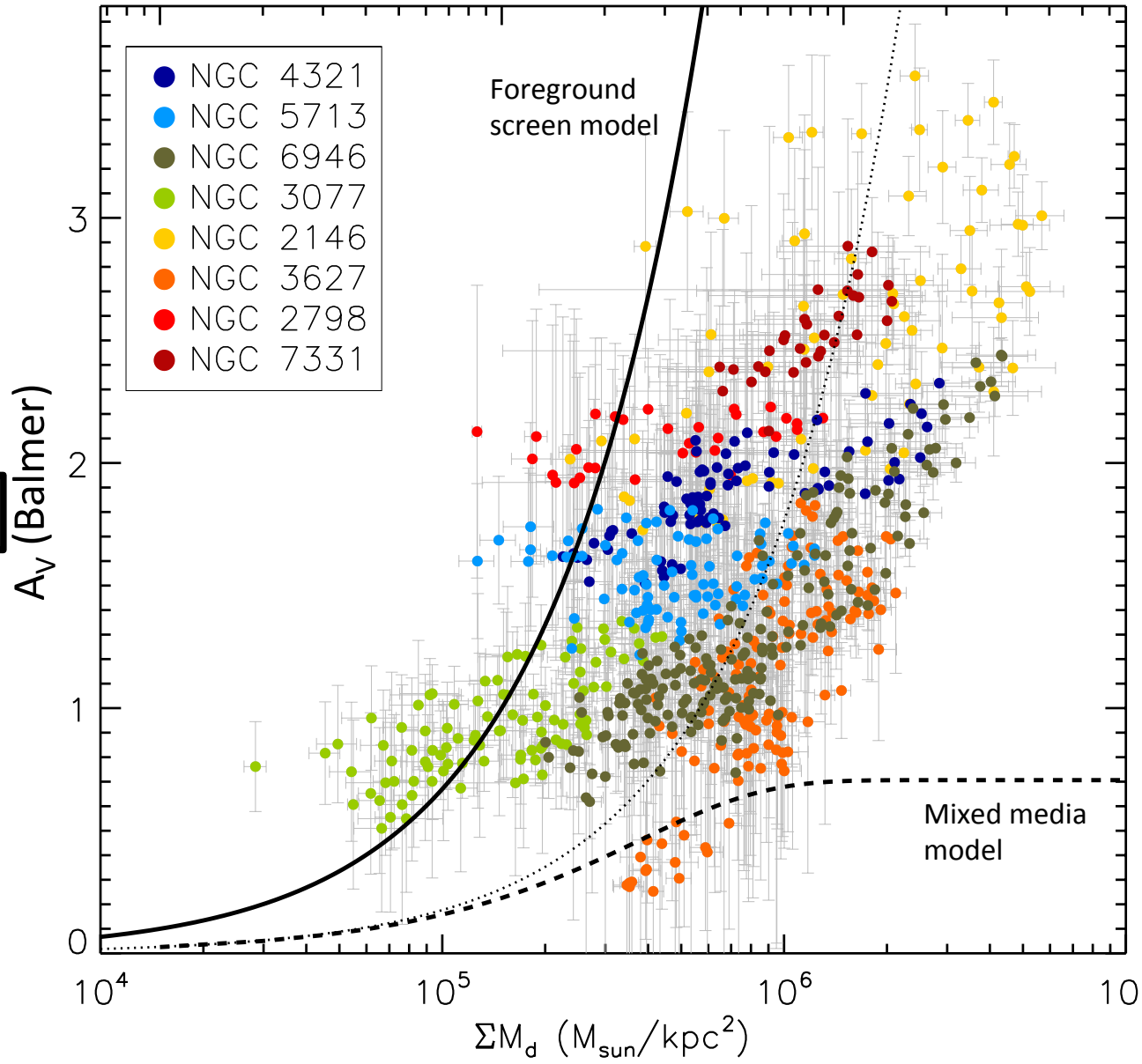
M31 (D = 0.5 Mpc)



Observed using PMAS/PPAK at Calar Alto

Balmer line reddening as a dust tracer

Kreckel et al. 2013



Hα/Hβ

Nearby galaxies
200-700 pc scales

Dust geometry on 500pc scales complicates modeling

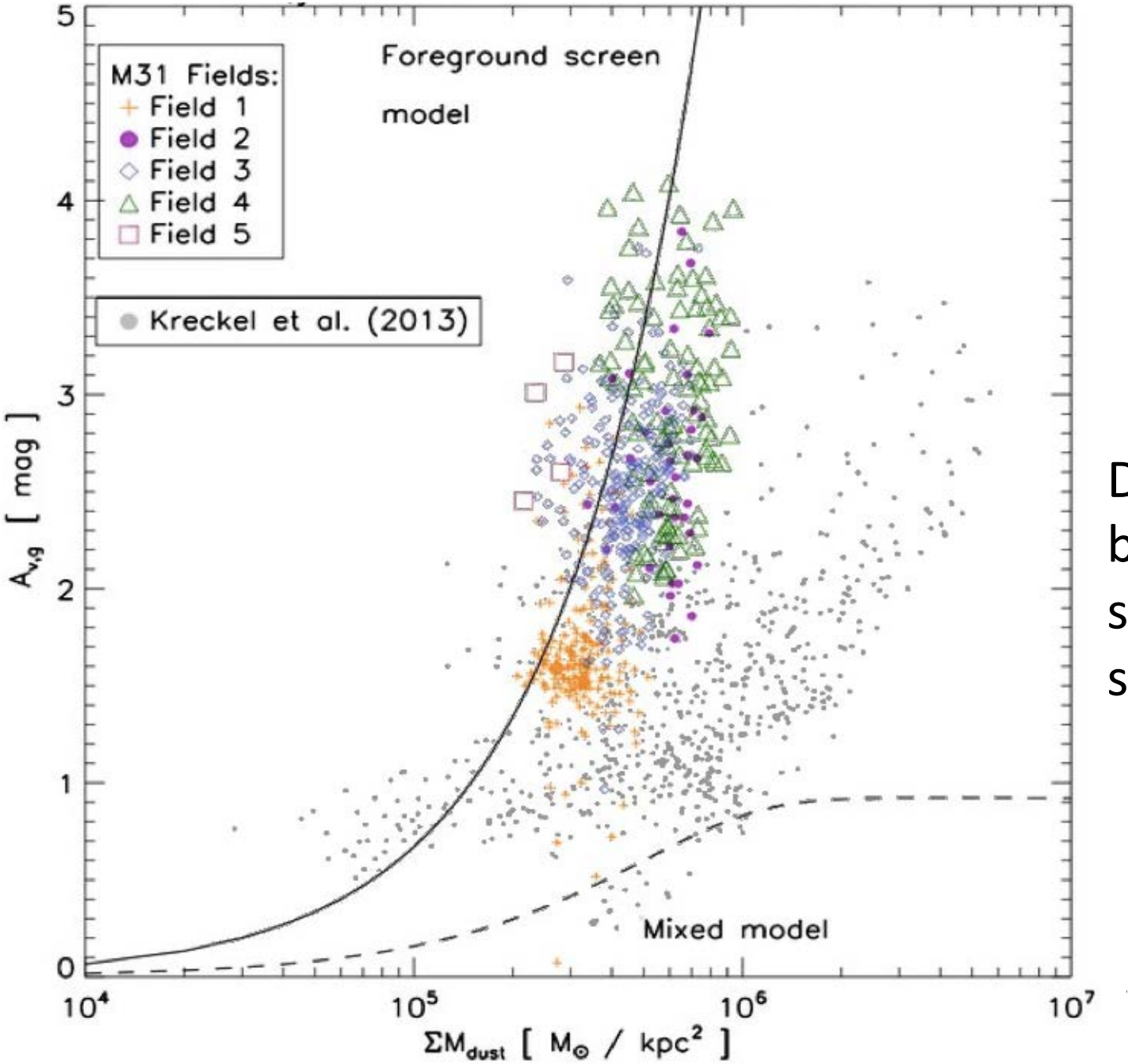
Far-IR SED modeled dust mass (KINGFISH, Aniano et al. 2012)

FIR Herschel

Balmer line reddening as a dust tracer

Tomicic et al. in prep

M31
100pc scales



Dust **well modeled** by a foreground screen at 100pc spatial scales

Kathryn Kreckel (MPIA)

M33 is ideal:
-high (32 pc) spatial scales
-low metallicity environment
-existing extensive multi-wavelength coverage
-high (50 pc) resolution CO maps (Rosolowsky et al. 2007)

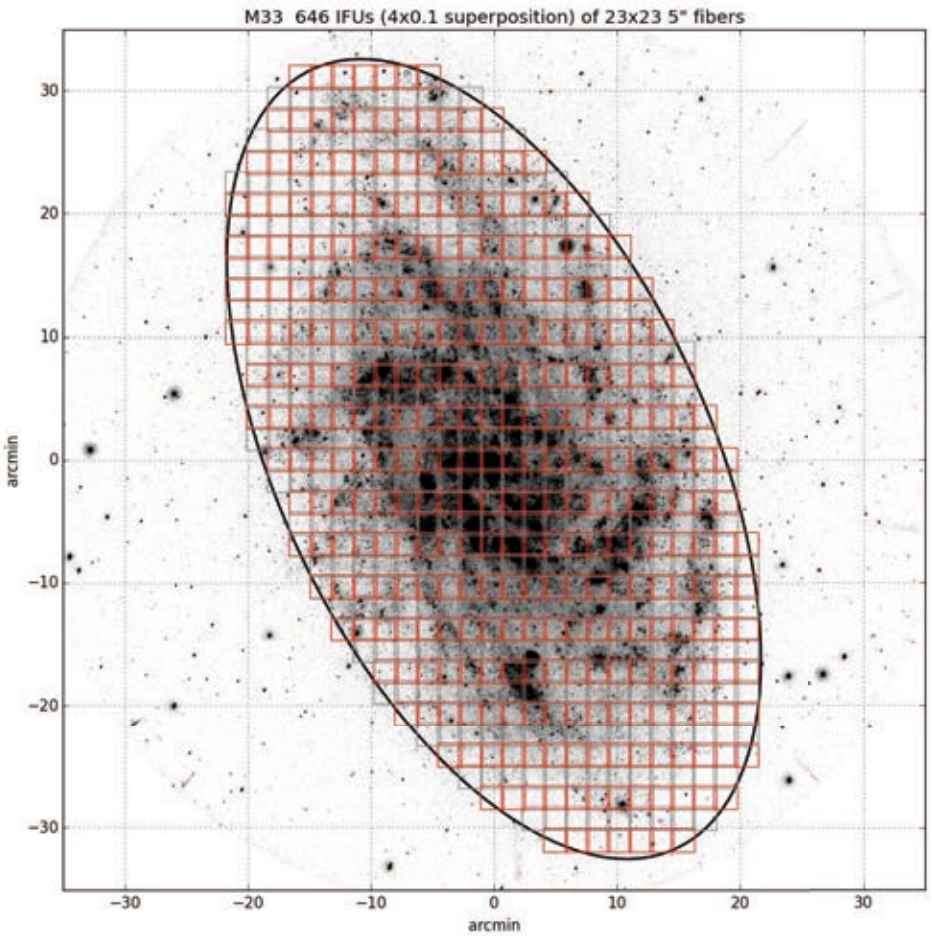
Enables studies of **HII regions** and **dust** at the spatial scales relevant for understanding the **physics** of star formation

CASE : M33-3D

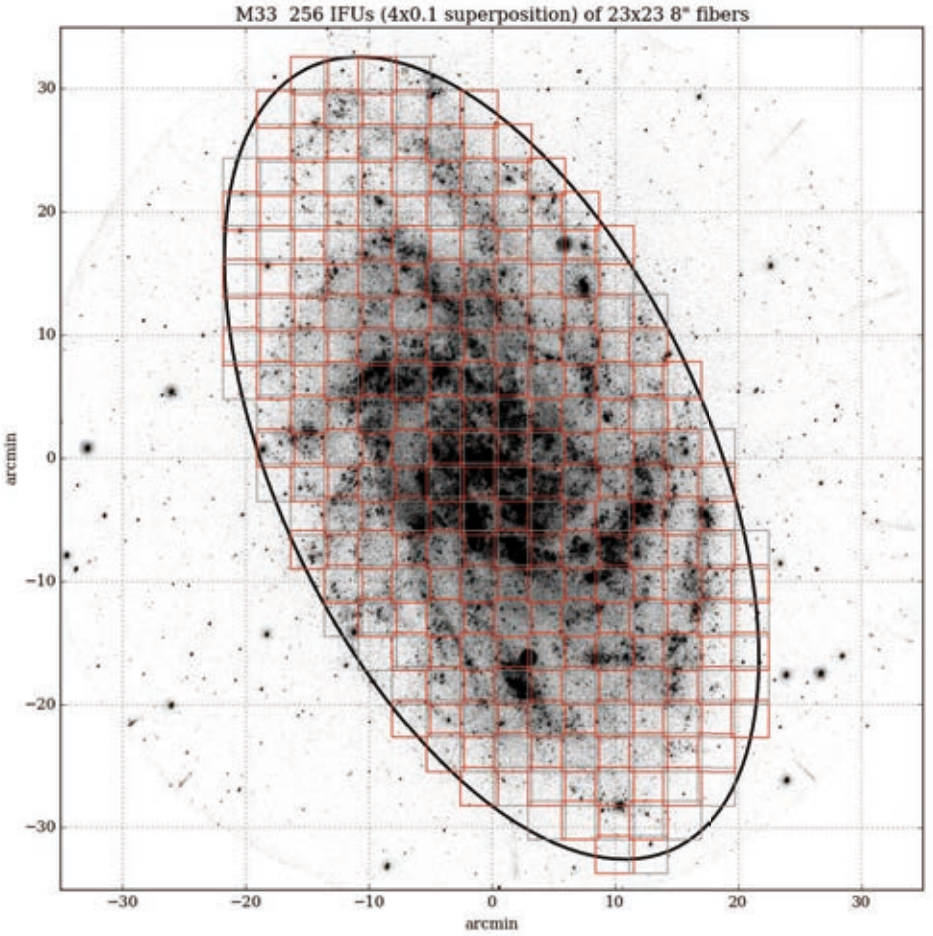
5”

8”

20 pc/fiber



32 pc/fiber



~340.000 spectra ~135.000

O.A. Javalambre T80 Hα

0.55 “/pixel

8 “/pixel

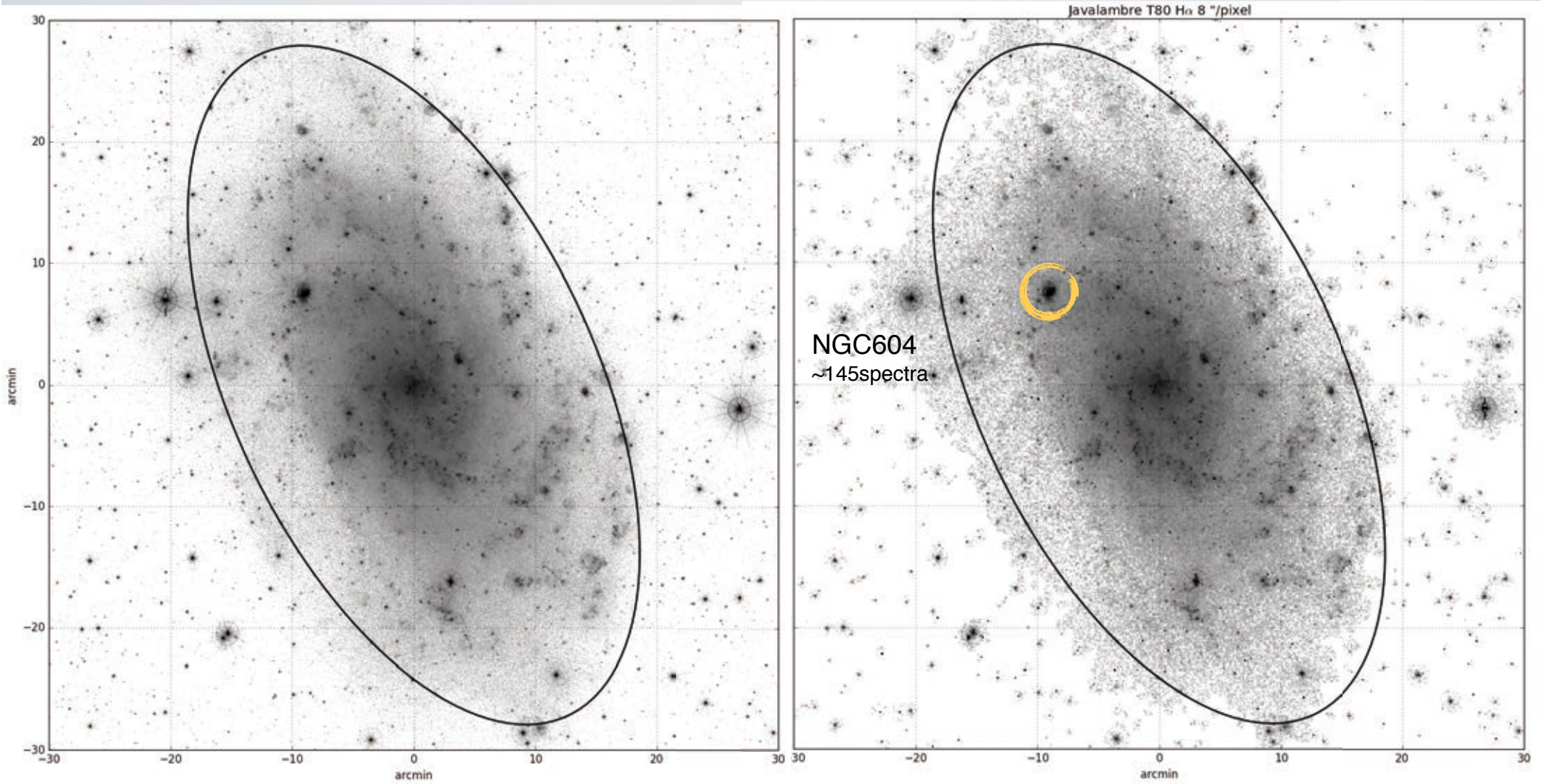


image provided by Izaskun San Román et al. (CEFCA)

ideas, comments, suggestions

eperez @ iaa.es

Thank you!