Evolution of galaxy dynamics over the last 10 Gyrs with MUSE/VLT

Author: Mercier Wilfried
Supervisor: Contini Thierry (IRAP)
Co-Supervisor: Epinat Benoit (LAM)

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Galaxy evolution through cosmic time

Why studying kinematics ?

Explain the co-evolution of morphological and dynamical properties of galaxies

- ▷ main processes responsible for disc formation and settling ?
- ▷ impact of merging, inflows and outflows on these processes ?
- ▷ kinematics → rotation curve → dark matter and angular momentum distribution ?

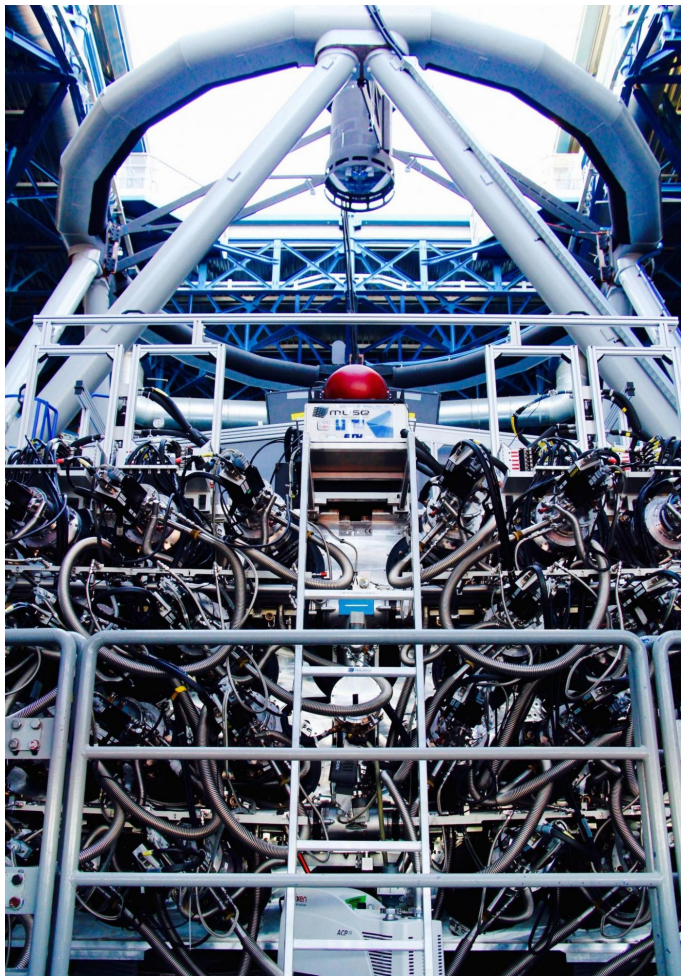
Integral Field Spectroscopy & MUSE

IFS:

- ▷ 3D cubes (2D spatial + 1D spectral)
  → **photometry + kinematics**

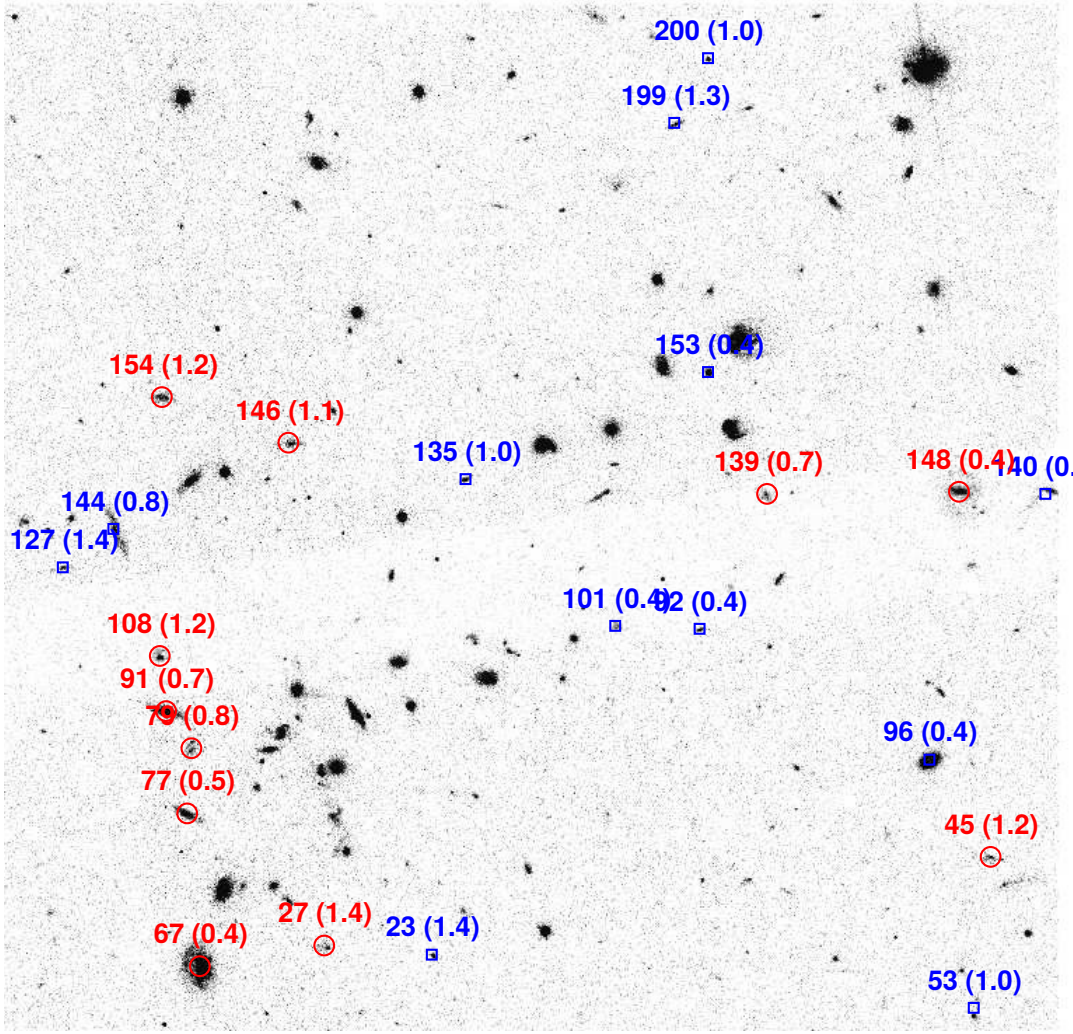
MUSE:

- ▷ $1 \times 1\,\mathrm{arcmin}^2$ FoV → **environment**
- ▷ 0.2 arcsec spatial sampling
- ▷ spectral range $[4650\,\text{Å}, 9300\,\text{Å}]$
- ▷ seeing-limited or AO observations
- ▷ high sensitivity
  → **low-mass galaxies + blind surveys**



MUSE instrument. Credit: Contini Thierry (IRAP)

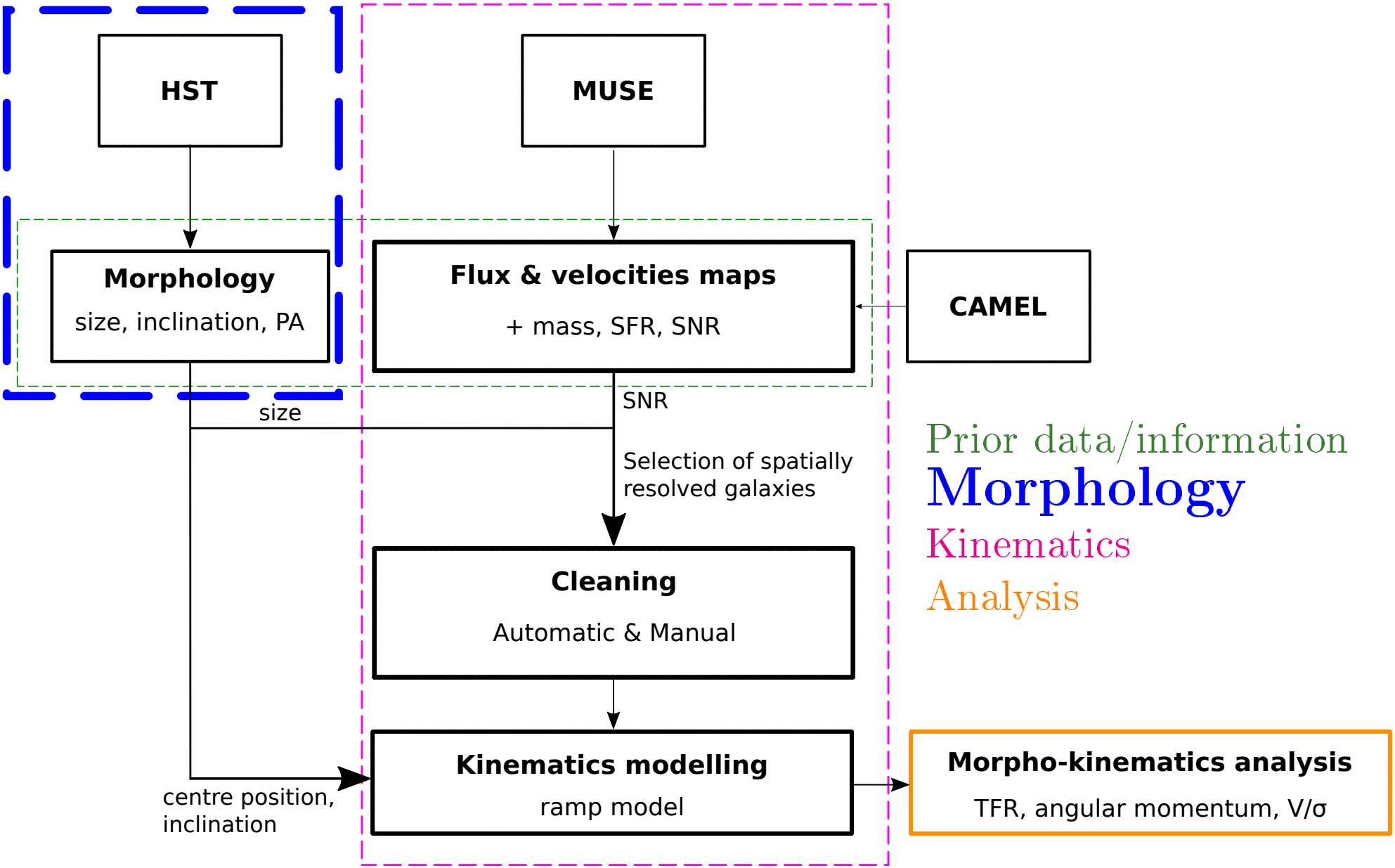
Initial sample



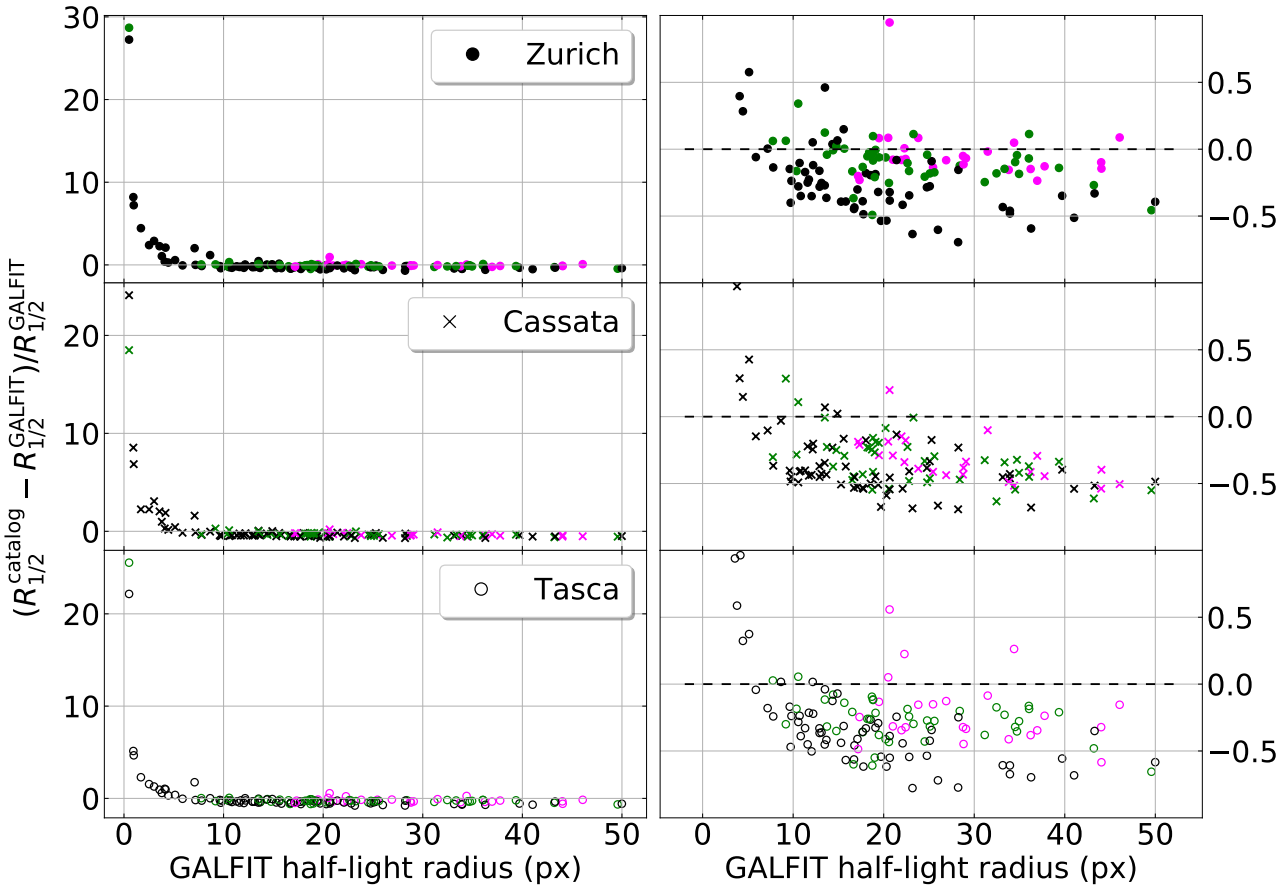
HST image of COSMOS group CGr30

- ▷ 16 MUSE fields in COSMOS area
- ▷ exposures from 1 to 10 hr
- ▷ seeing-limited (FWHM $\lesssim 0.7$”) or AO (FWHM $\lesssim 0.5$”)
- ▷ **$\sim$ 500 field galaxies with [OII] detection**
  - HST-ACS counterparts
  - **$0.4 \leq z \leq 1.4$**

Methodology



Checking morphological parameters
Half-light radius

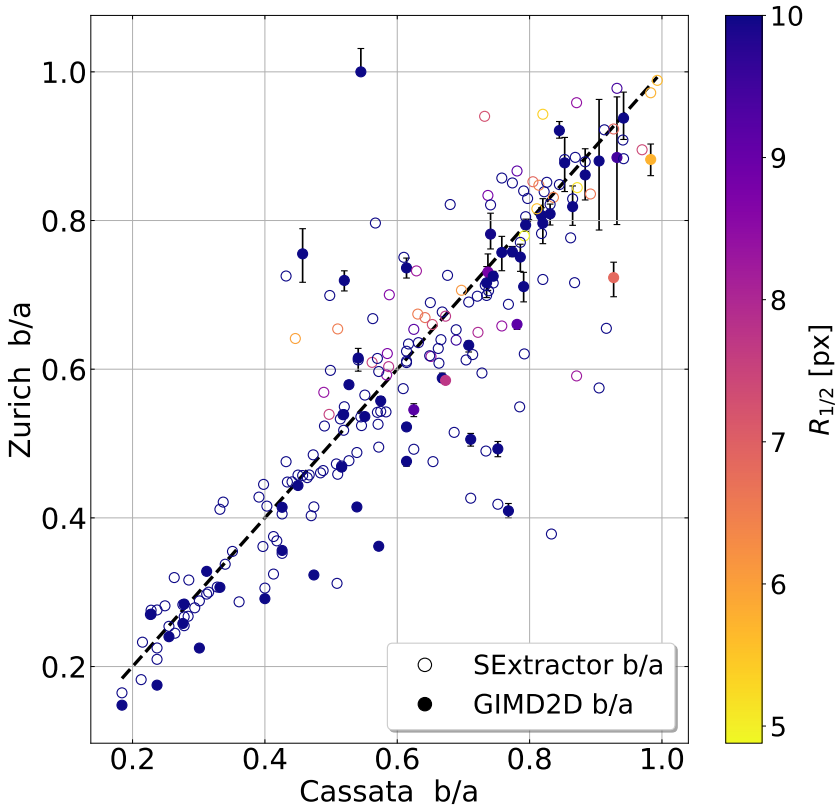


spheroidal disk-like irregulars

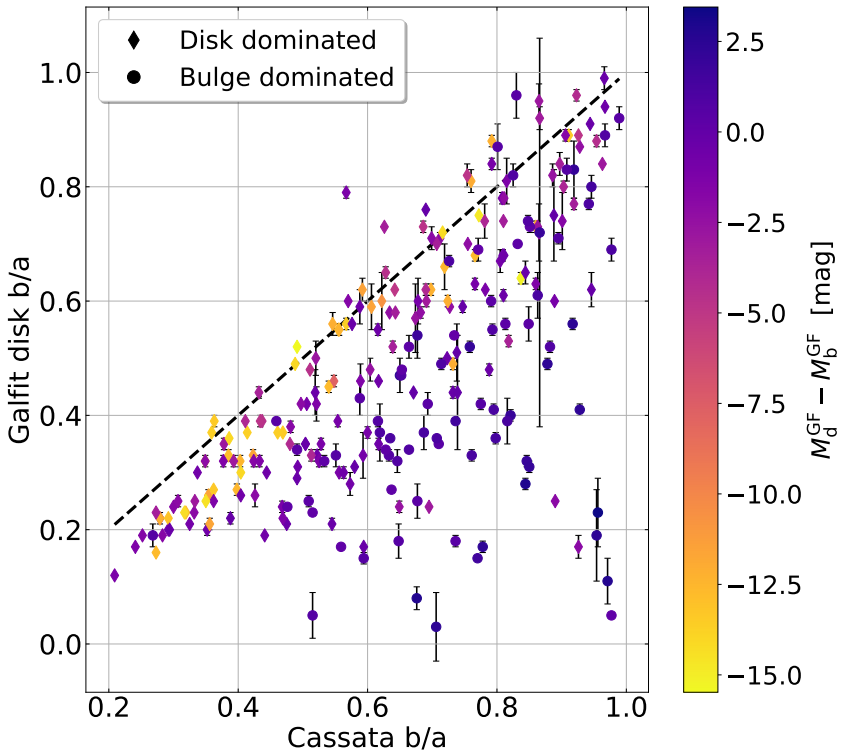
GALFIT run by V. Abril-Melgajero (LAM) on structure galaxies

- ▷ GALFIT radius used as a reference

Checking morphological parameters
Ellipticity

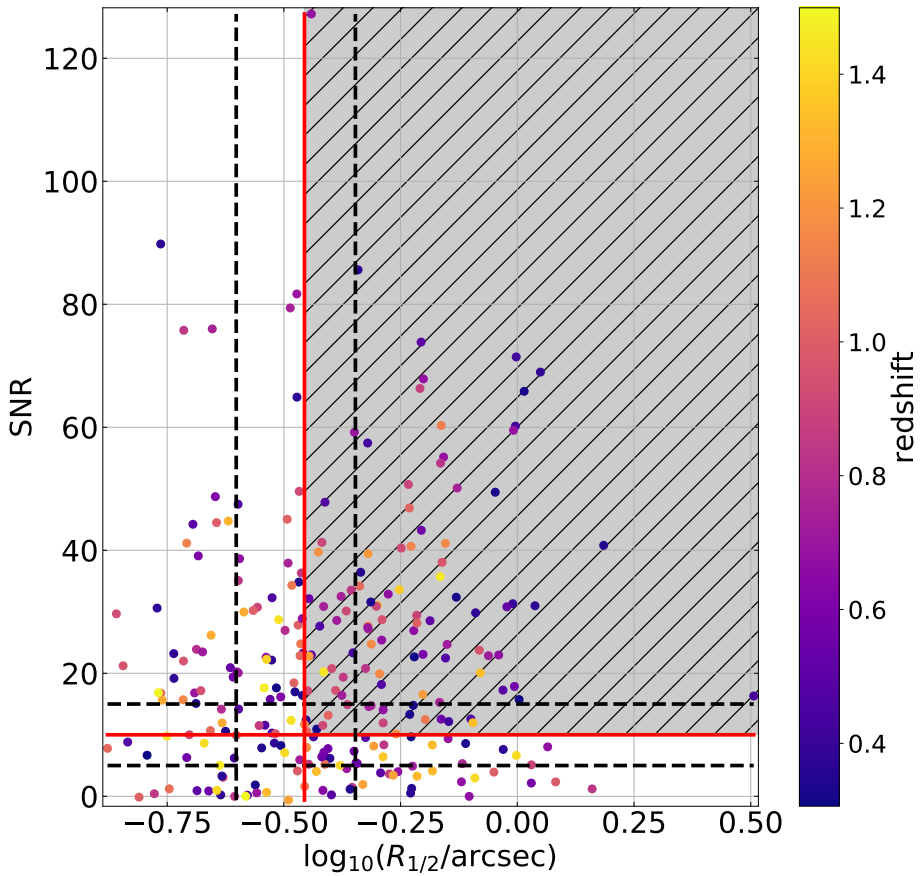


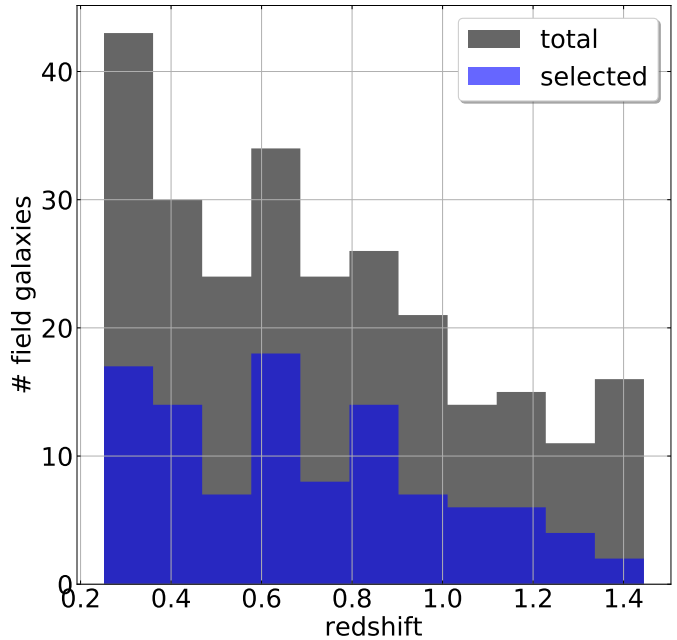
▷ values are consistent between catalogues



▷ scatter is due to bulge dominated (spherically symmetric) systems

Sample selection and redshift distribution



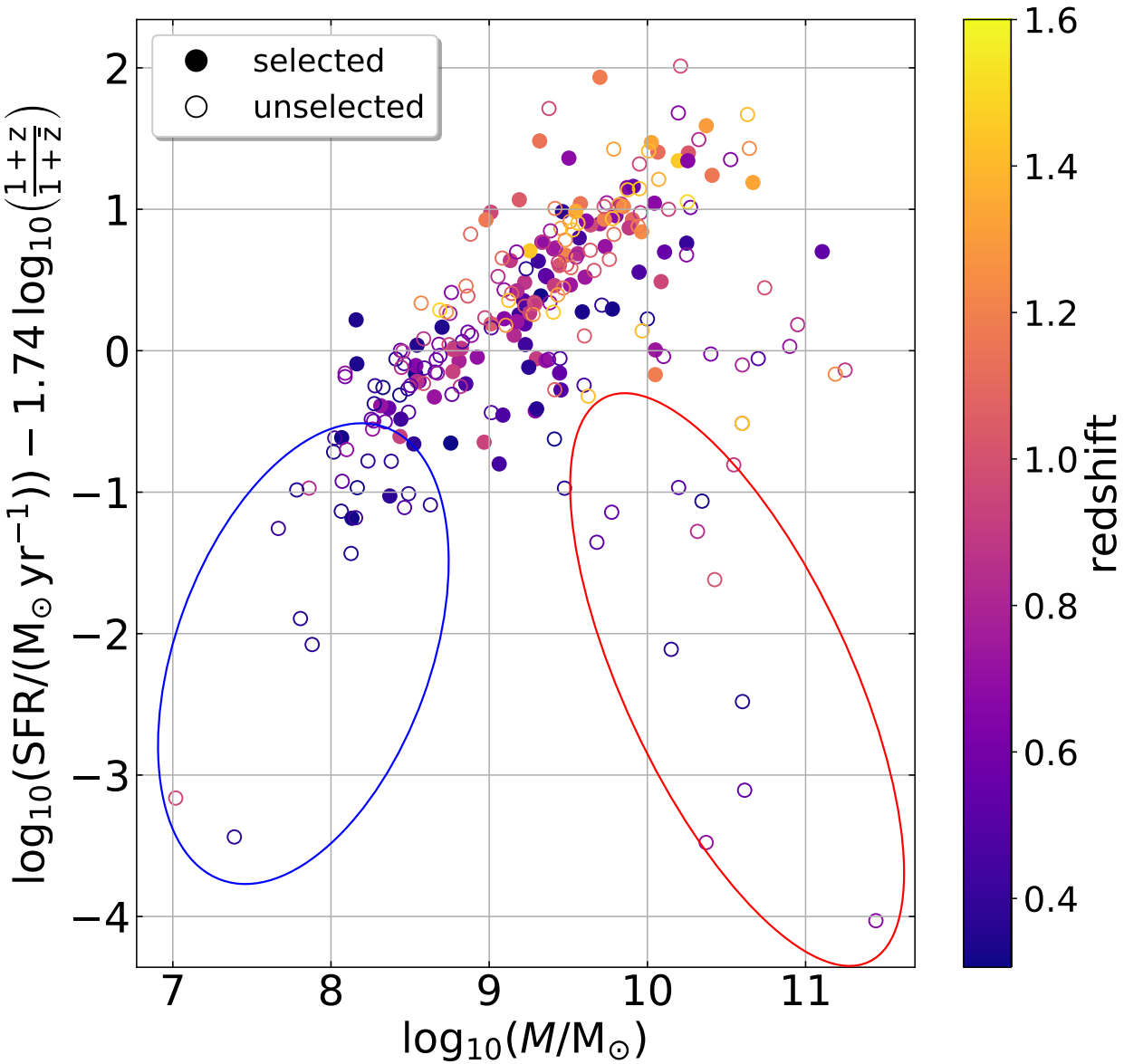


The total number corresponds to galaxies with photometric data in Cassata and/or Zurich catalogues.

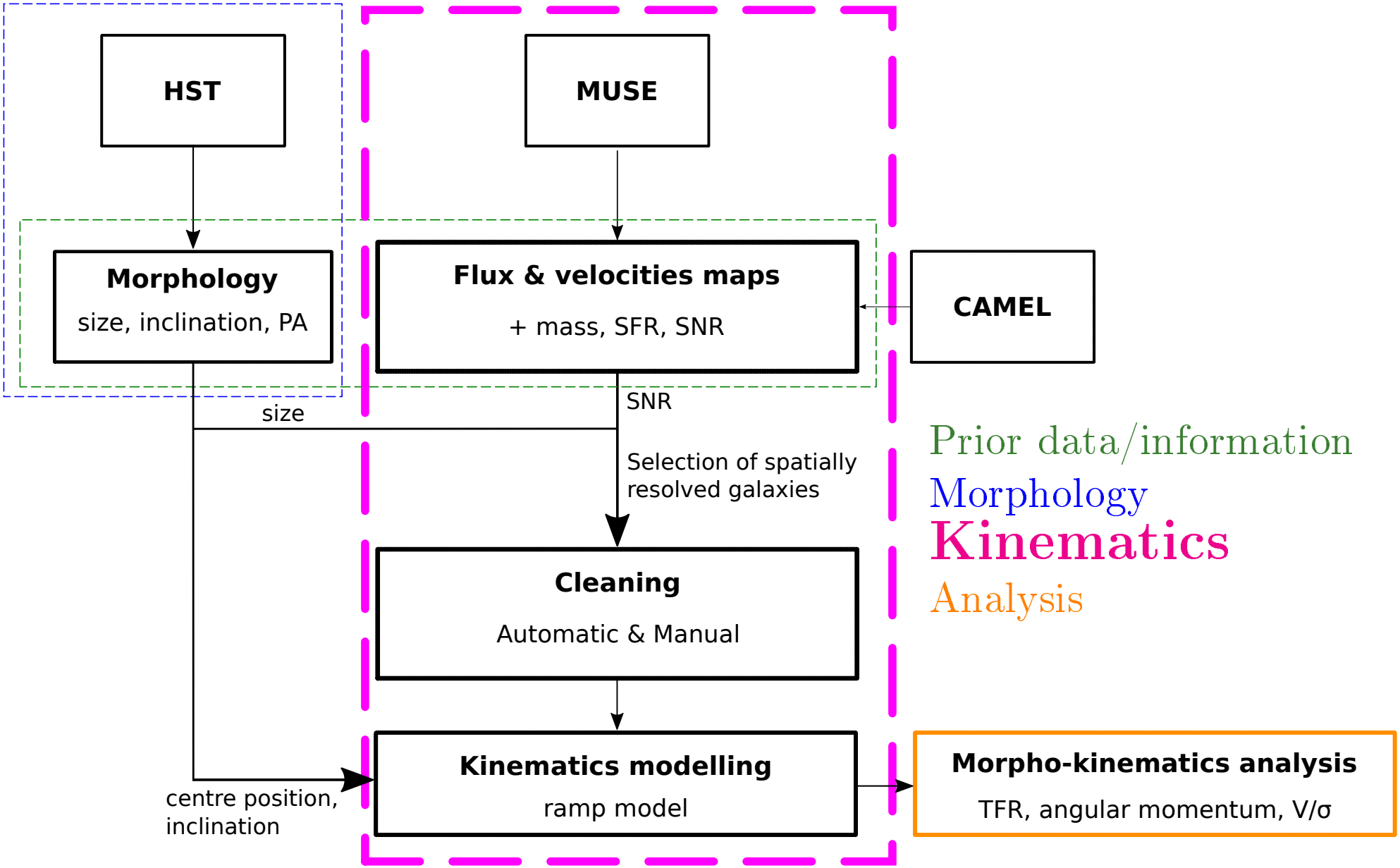
- ▷ sample of **103 galaxies** with $R_{1/2} > 0.35$" and SNR > 10
- ▷ we loose galaxies at $z \approx 1.4$
- ▷ redshift distribution is not drastically changed

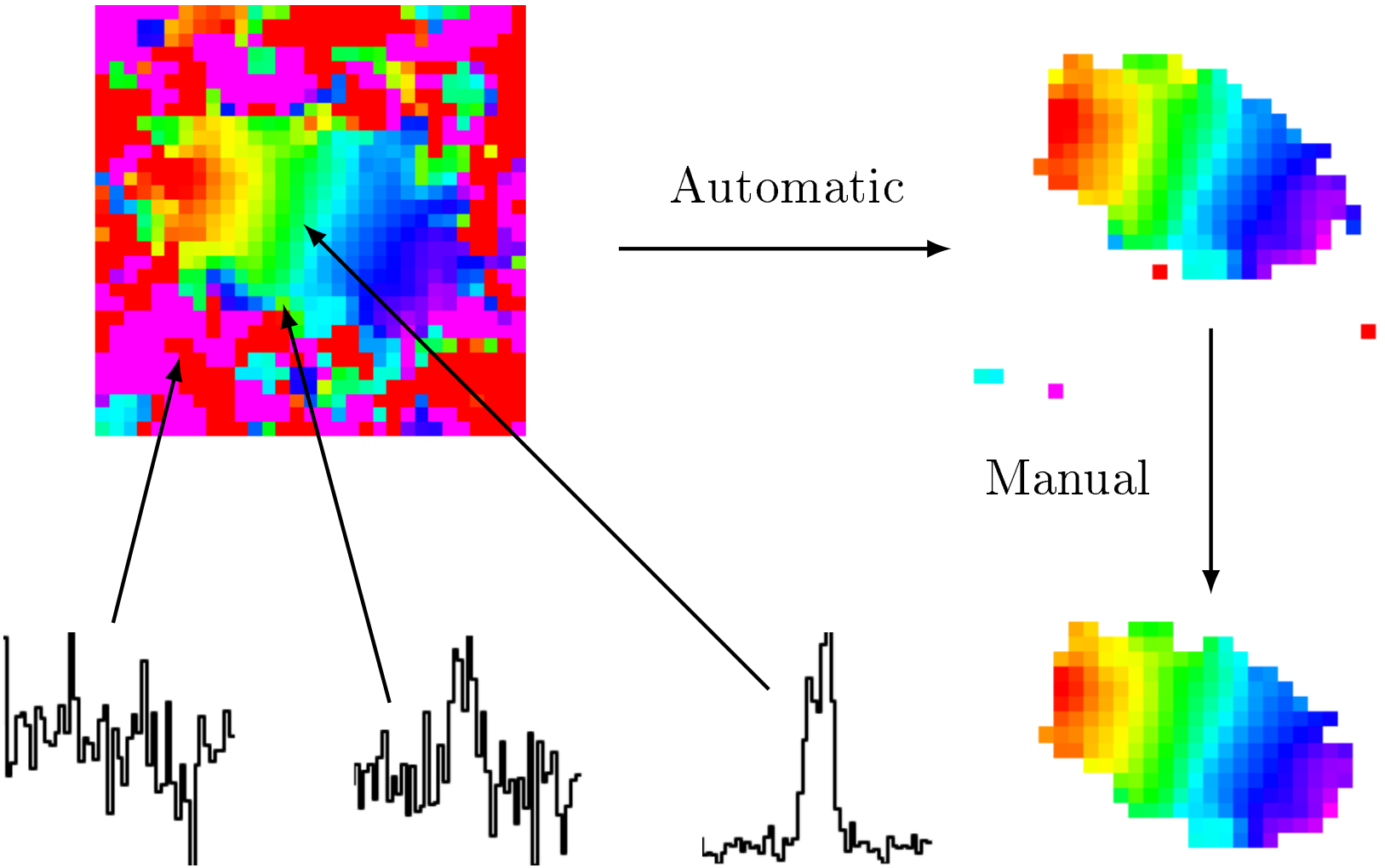
Characteristics of our sample
Mass-SFR relation

- Most of our sample galaxies are on the main sequence
- massive quiescent (low [OII]) and very low mass galaxies (small size) are lost

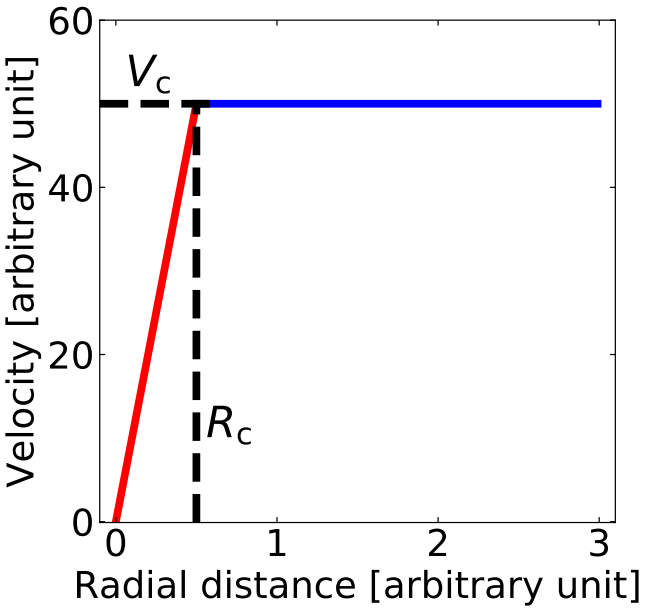


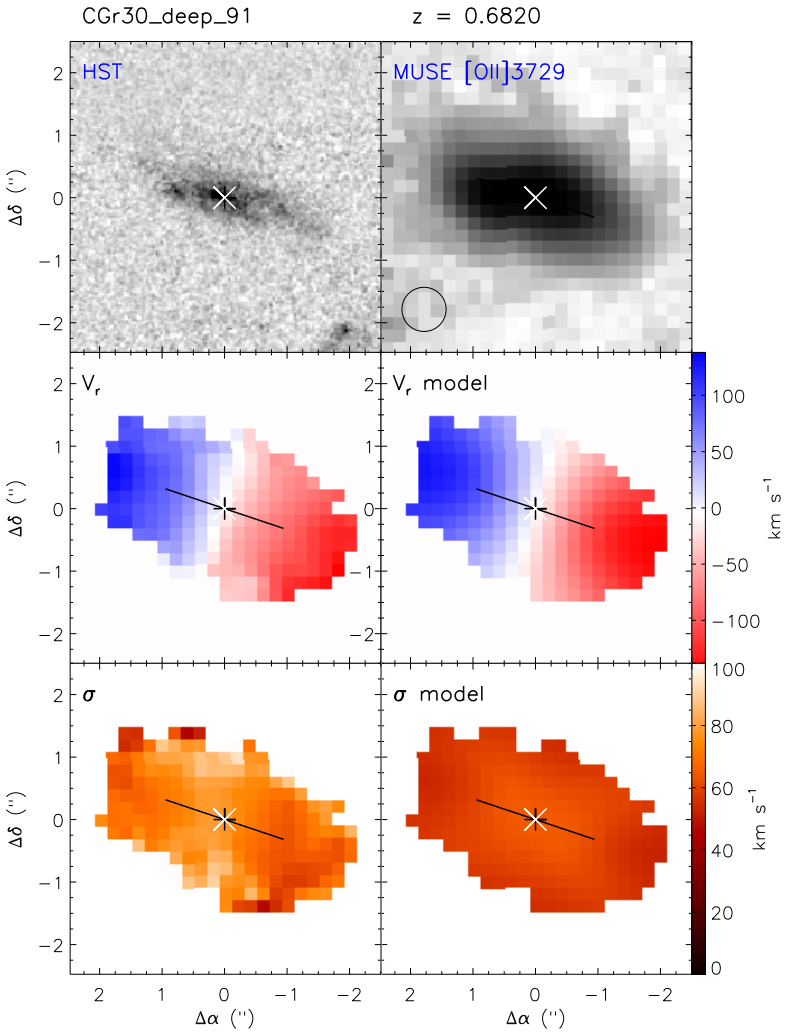
Methodology

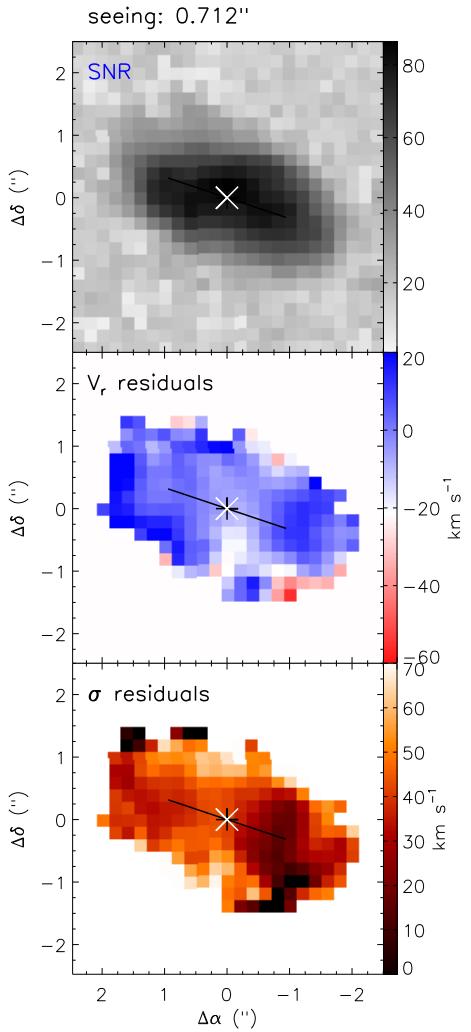



Automatic
Manual

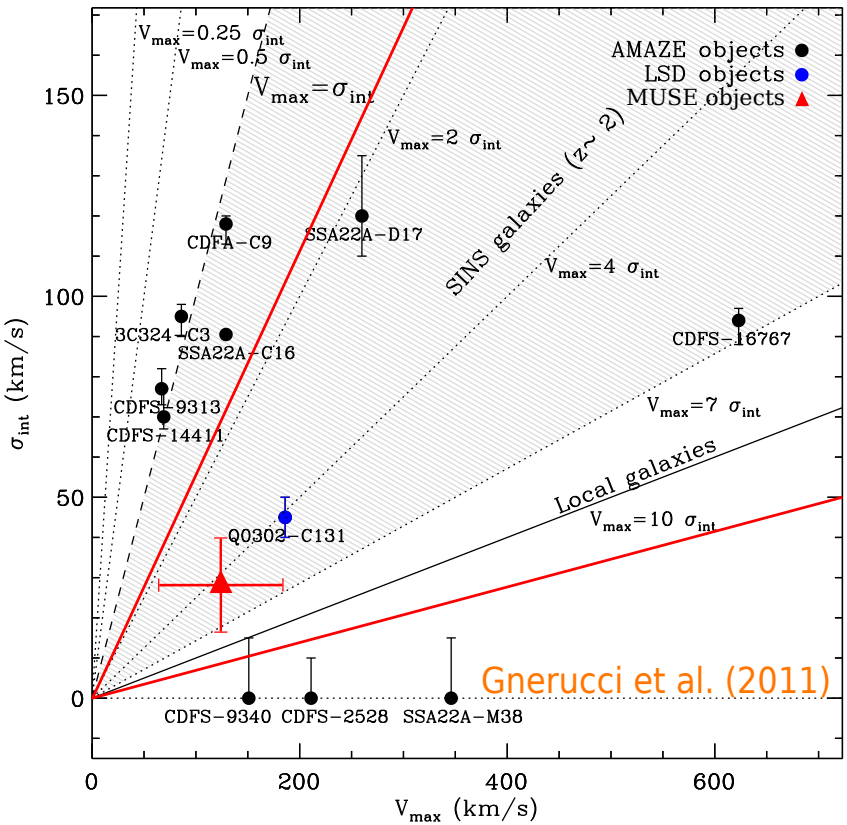
Use a ramp model with a linear internal variation and a plateau.

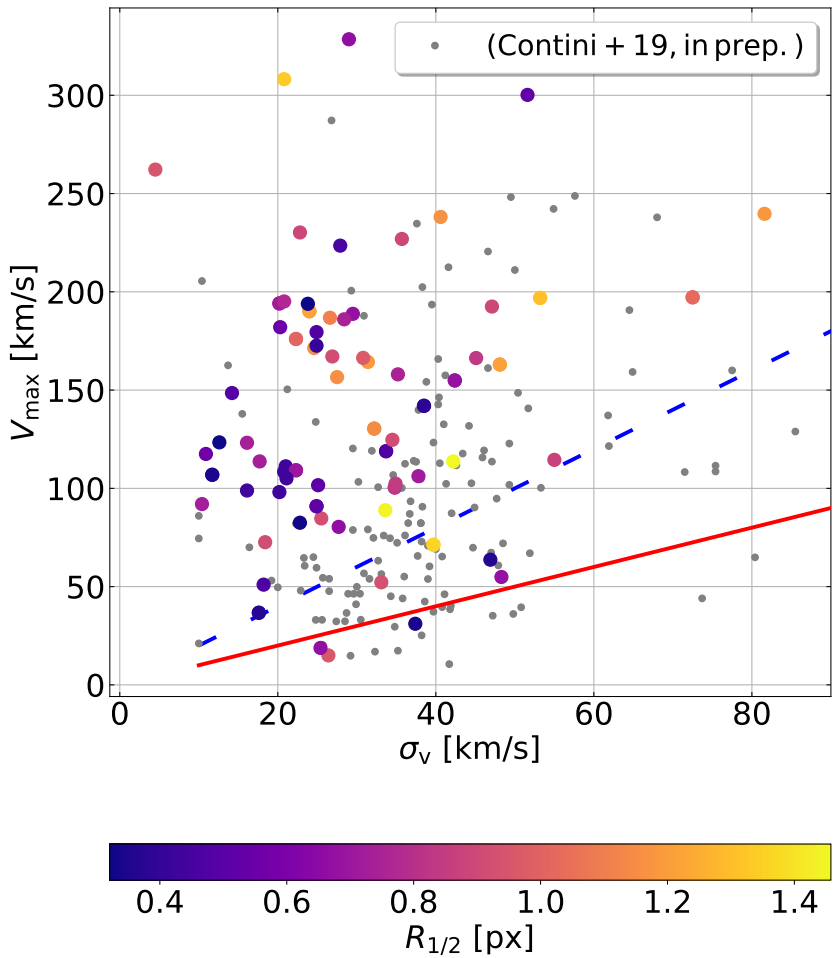




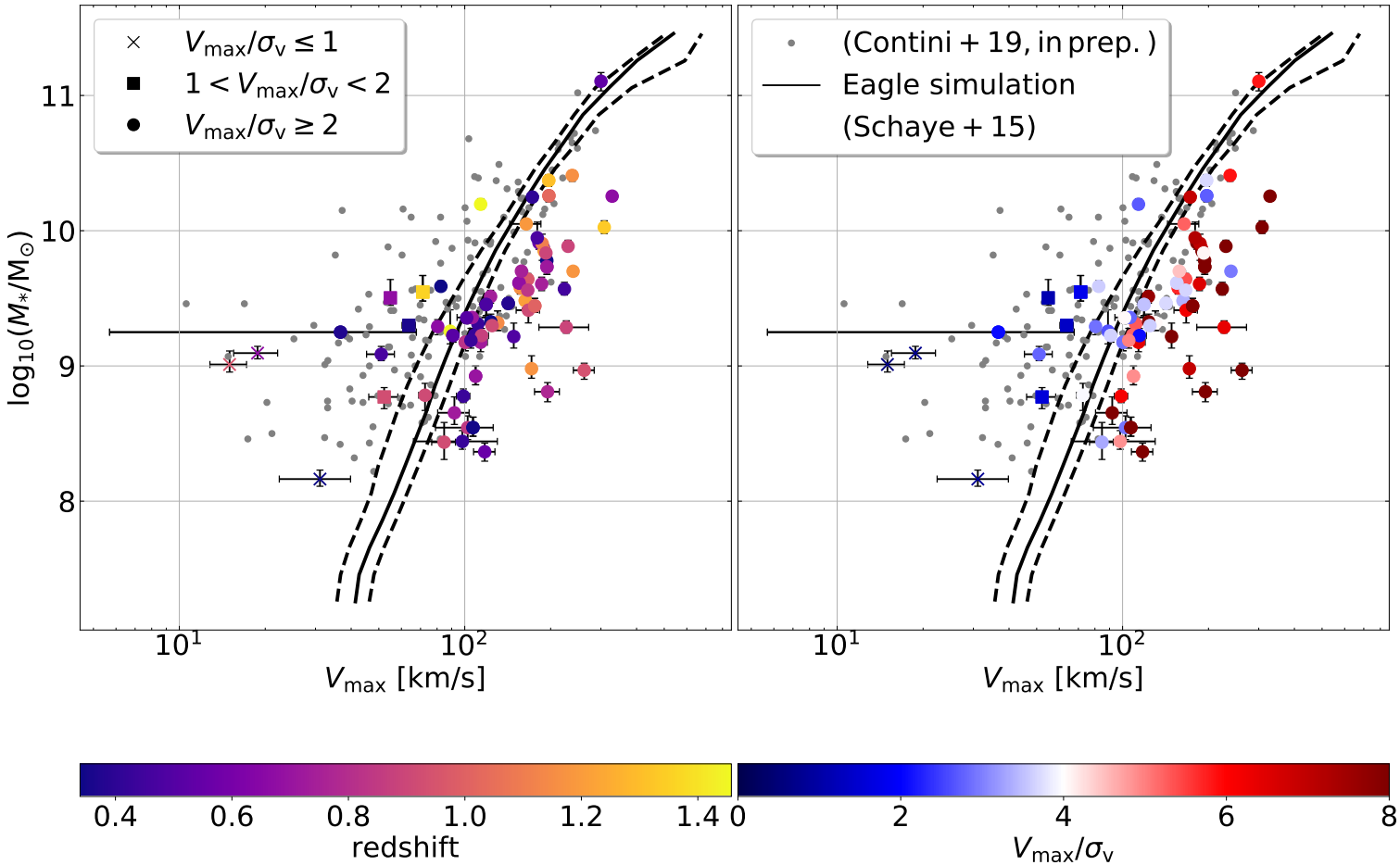


First results
Rotationally supported vs dispersion dominated galaxies ?



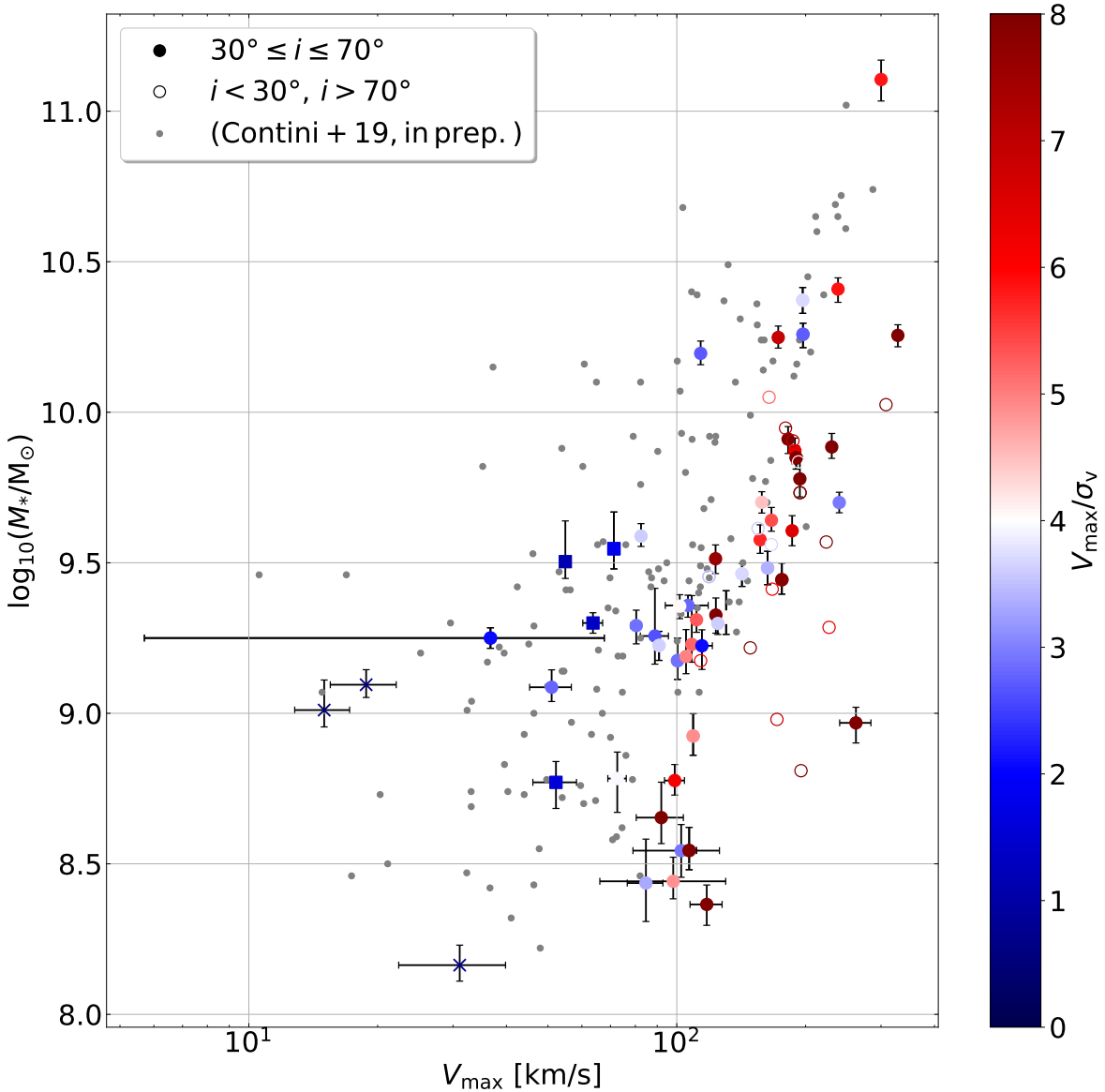


Median of $V_{\rm max}$ and $\sigma_{\rm v}$ consistent with SINS galaxies at $z \sim 2$ (Förster Schreiber et al., 2009), **but with higher scatter.**

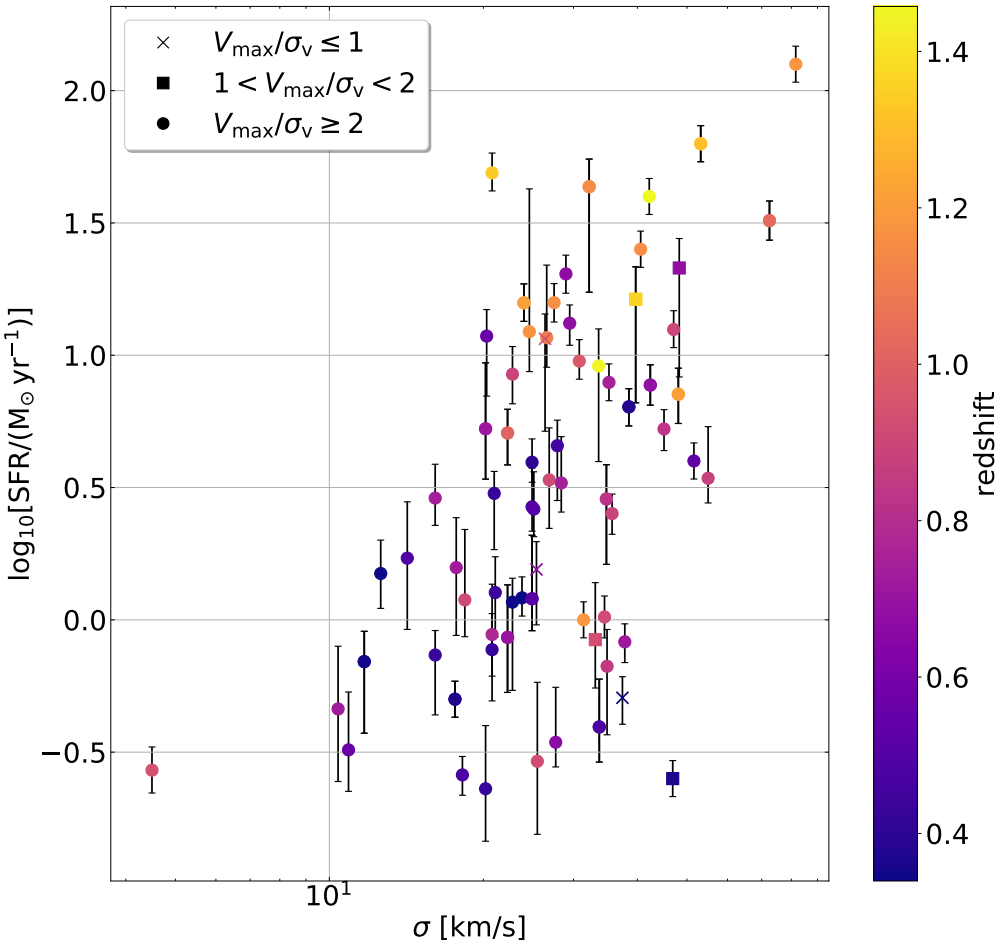


- ▷ **higher $\mathbf{V}_{max}$** than in MUSE sample in HUDF of Contini et al. (2019) and EAGLE simulation
- ▷ **no** evolution with redshift found

- **face-on** and **edge-on** galaxies (unfilled circles) have **overestimated** values of $V_{\rm max}$



First results
A correlation between SFR and σ_v ?



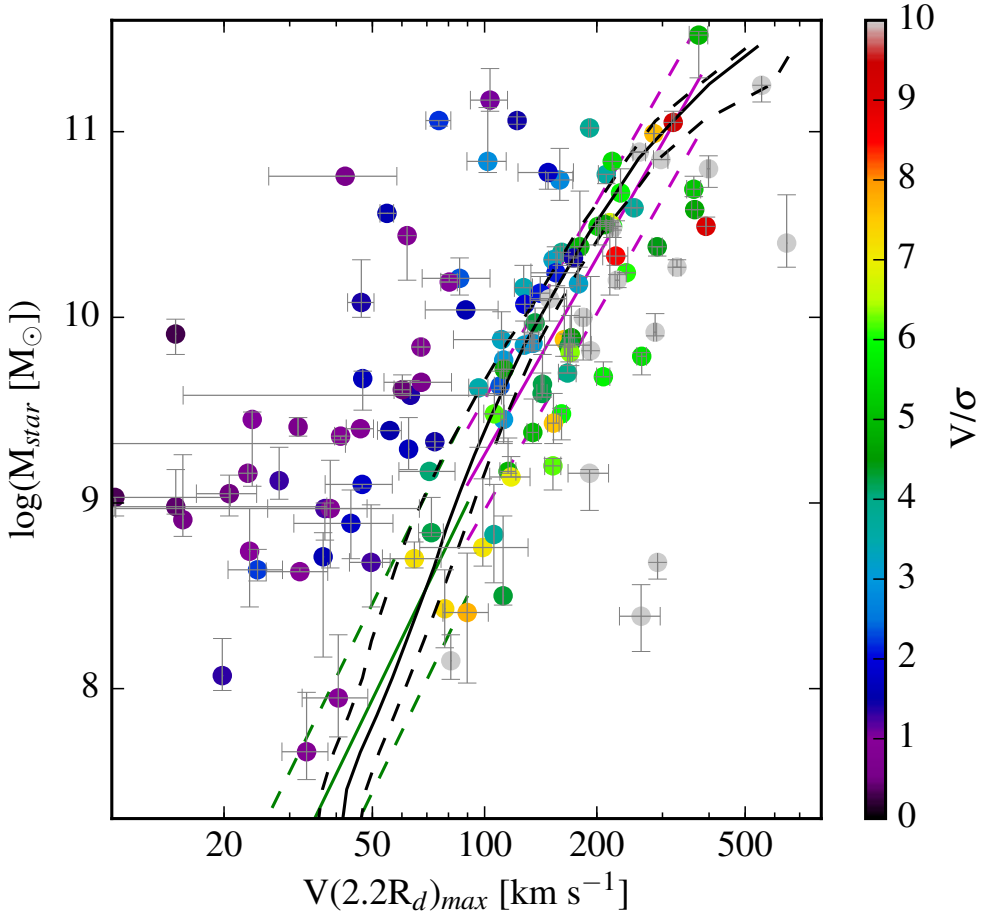
Correlation between SFR and

(a) **redshift** $\rightarrow$ consistent with mass-SFR relation

(b) **velocity dispersion**

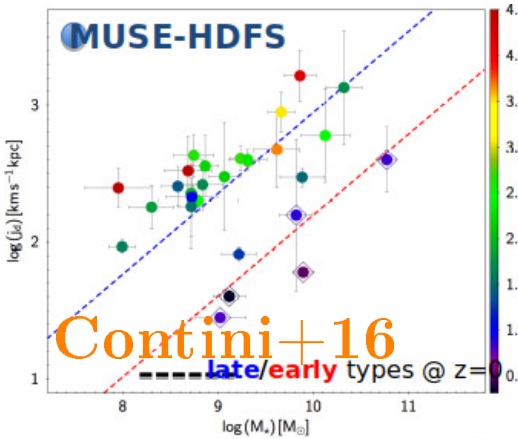
Origin ? According to Lehnert et al. (2013), energy injection from star-formation.

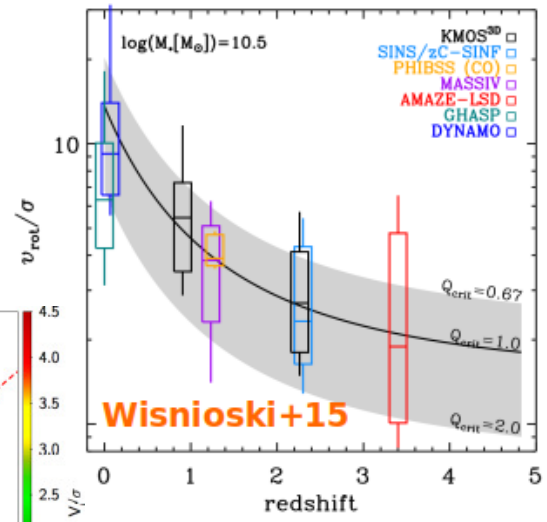
- ▷ Origin of the velocity offset ?
- ▷ Comparison between "field" galaxies and those in structures
  - · Check influence of different selection criteria
  - · **Difference** in the TFR ?
  - · More **disturbed kinematics** ?
  - · Higher nb. of interacting galaxies ?



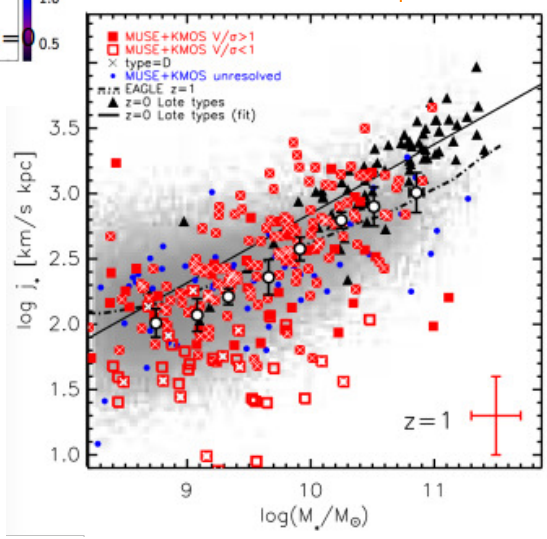
Abril-Melgajero+19, in prep.

- **better selection + larger sample (x10)**
- Improve morphological modelling
- Angular momentum evolution ?
- Dark matter vs. luminous mass ?
- **Very deep** observations + **stacking**
  → explore dark matter distribution at large radii

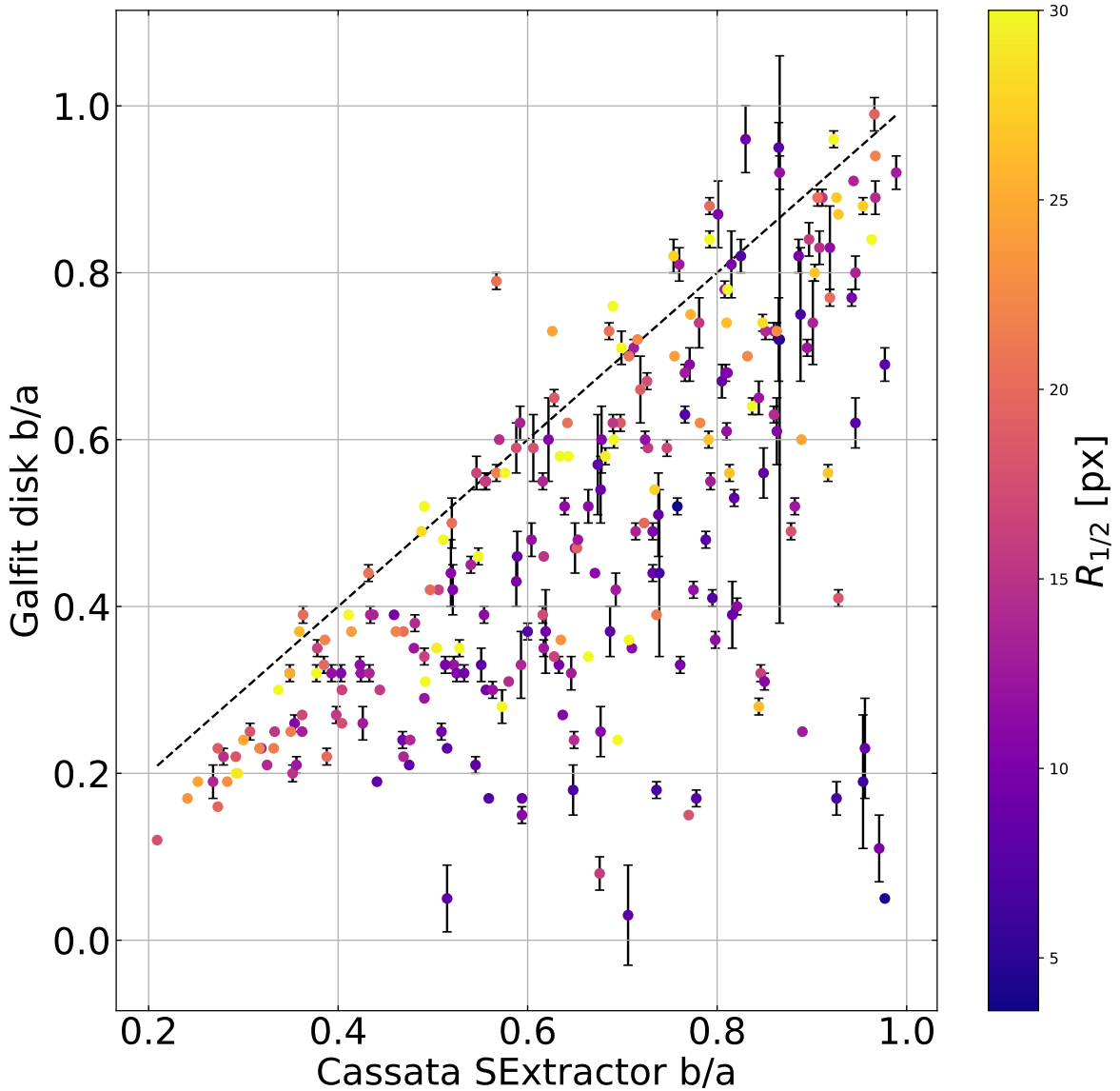




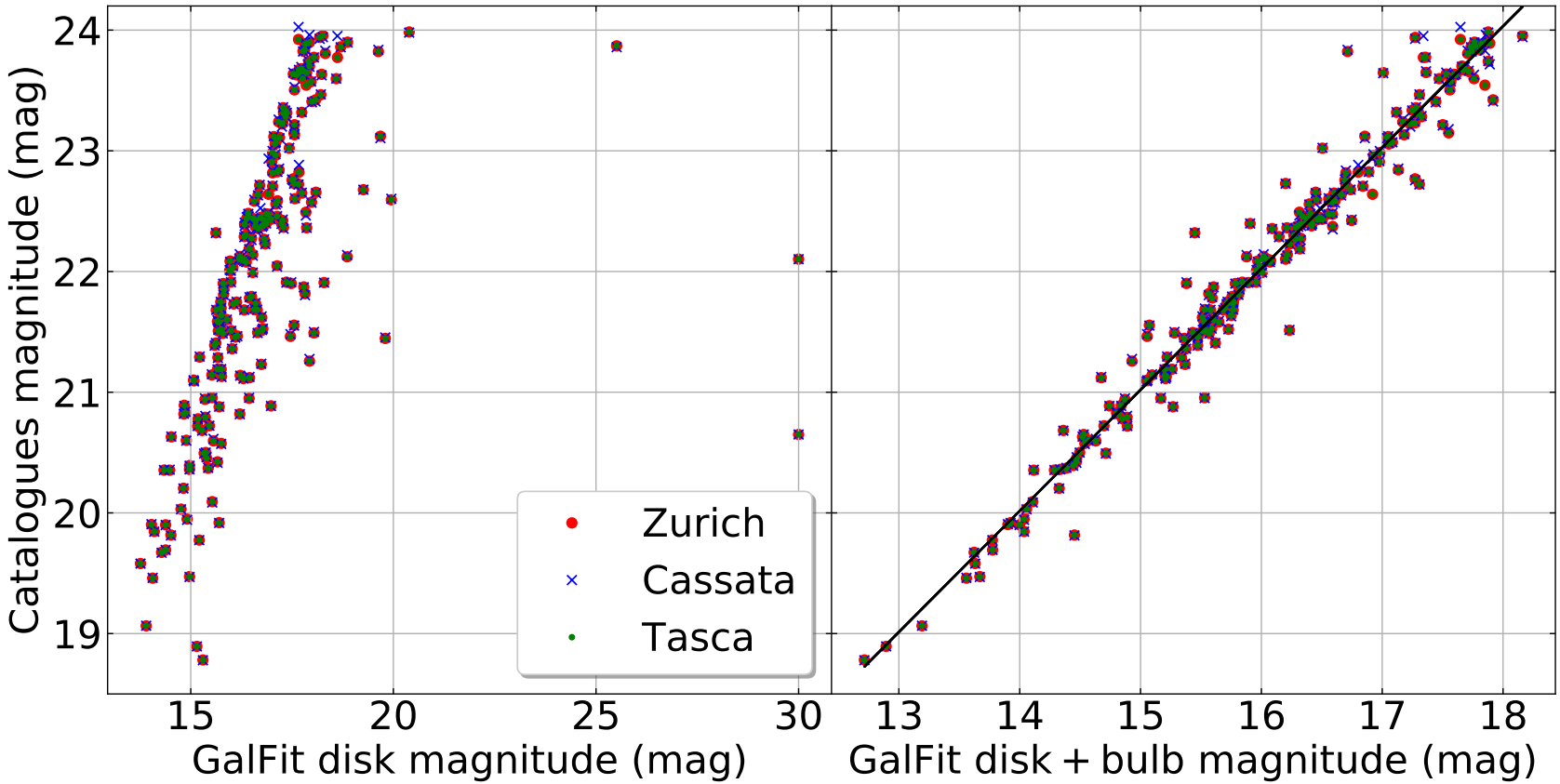
Swinbank+17



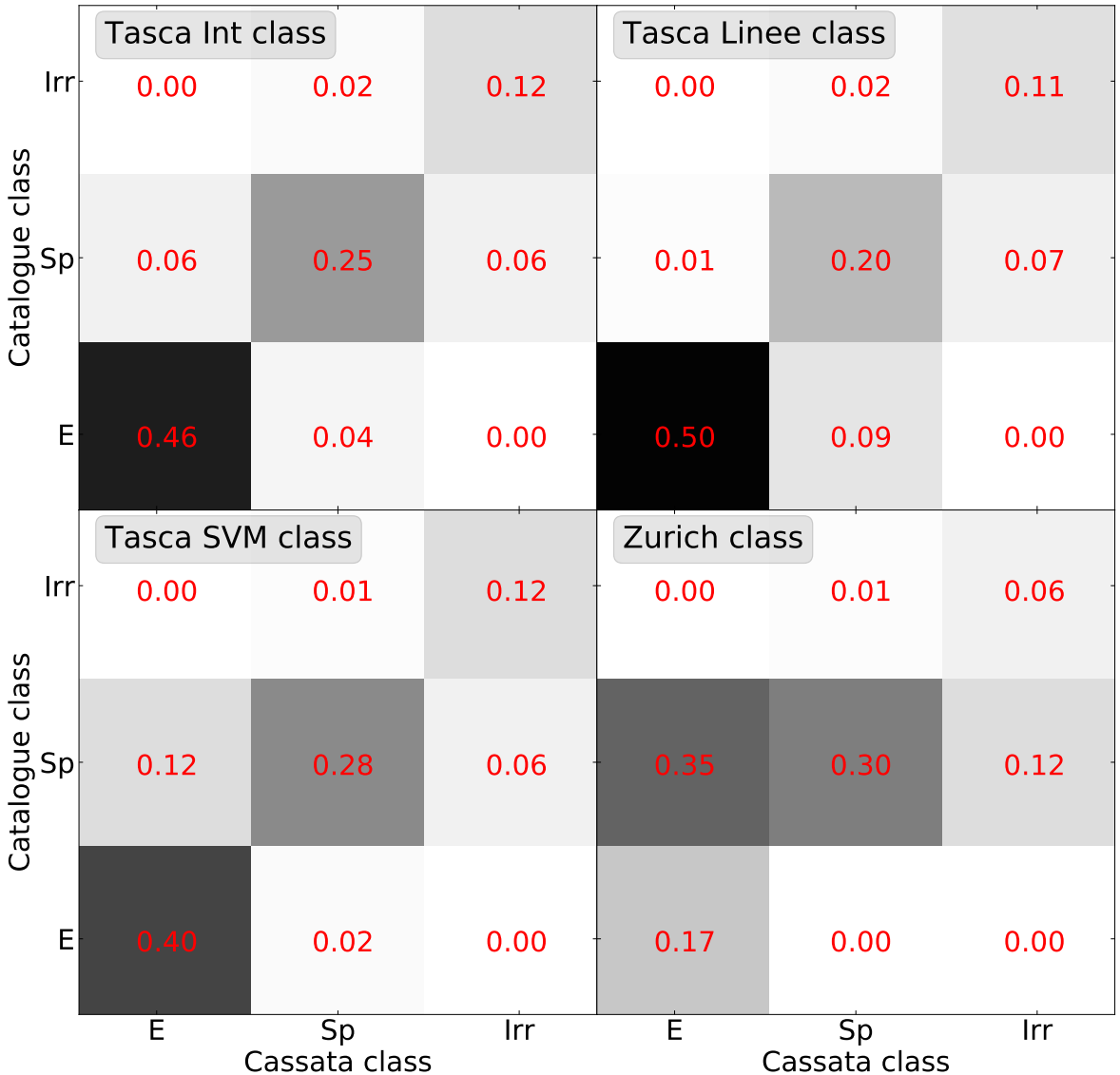
Annexes


Galfit disk b/a
Cassata SExtractor b/a
0.0
0.2
0.4
0.6
0.8
1.0
0.2
0.4
0.6
0.8
1.0
$R_{1/2}$ [px]
5
10
15
20
25
30

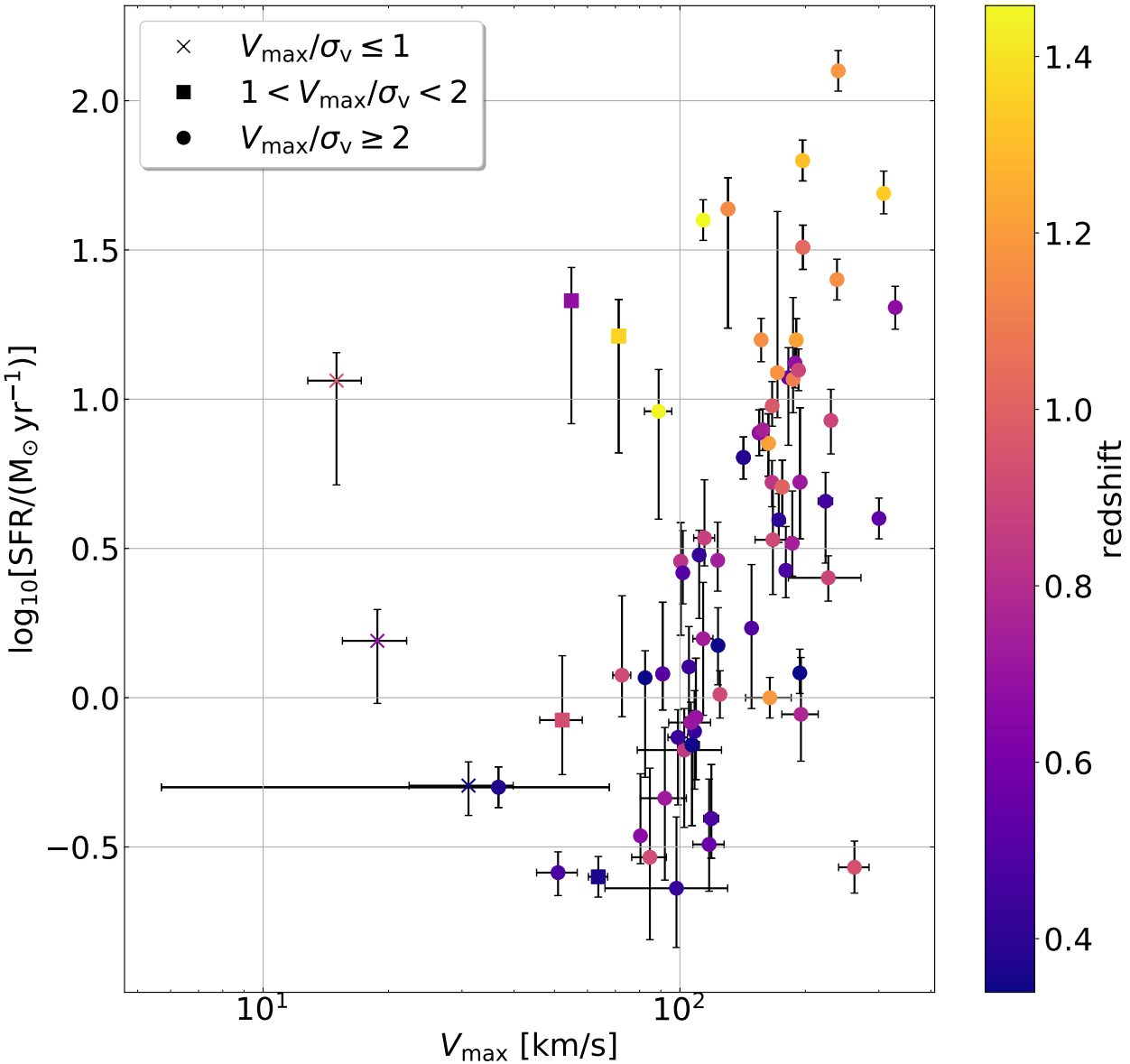
Annexes


Catalogues magnitude (mag)
24
23
22
21
20
19
15
20
25
30
GalFit disk magnitude (mag)
Zurich
Cassata
Tasca
13
14
15
16
17
18
GalFit disk + bulb magnitude (mag)

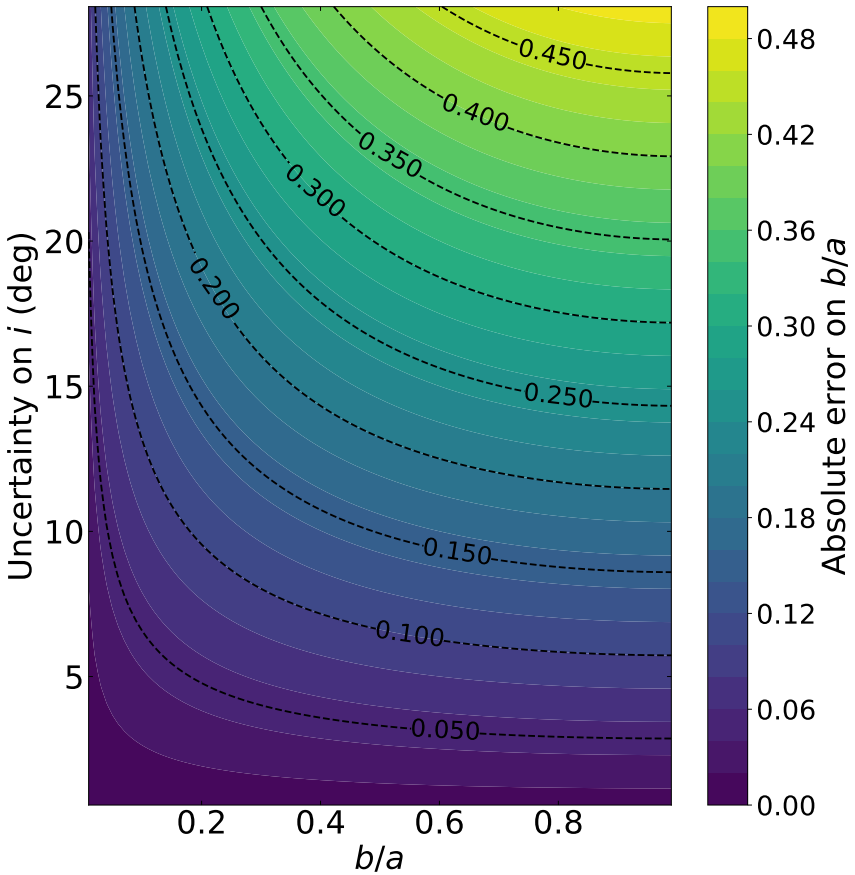
Annexes

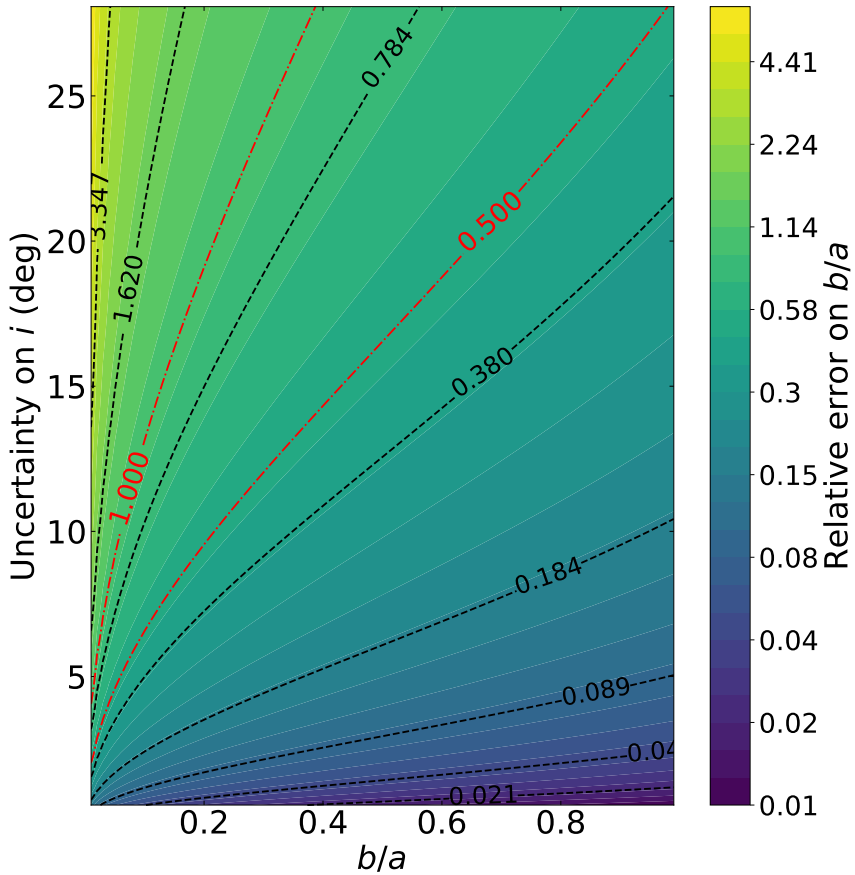

Tasca Int class
0.00
0.02
0.12
0.06
0.25
0.06
0.46
0.04
0.00
Tasca Linee class
0.00
0.02
0.11
0.01
0.20
0.07
0.50
0.09
0.00
Tasca SVM class
0.00
0.01
0.12
0.12
0.28
0.06
0.40
0.02
0.00
Zurich class
0.00
0.01
0.06
0.35
0.30
0.12
0.17
0.00
0.00
Irr
Sp
E
Catalogue class
E
Sp
Irr
Cassata class

Annexes

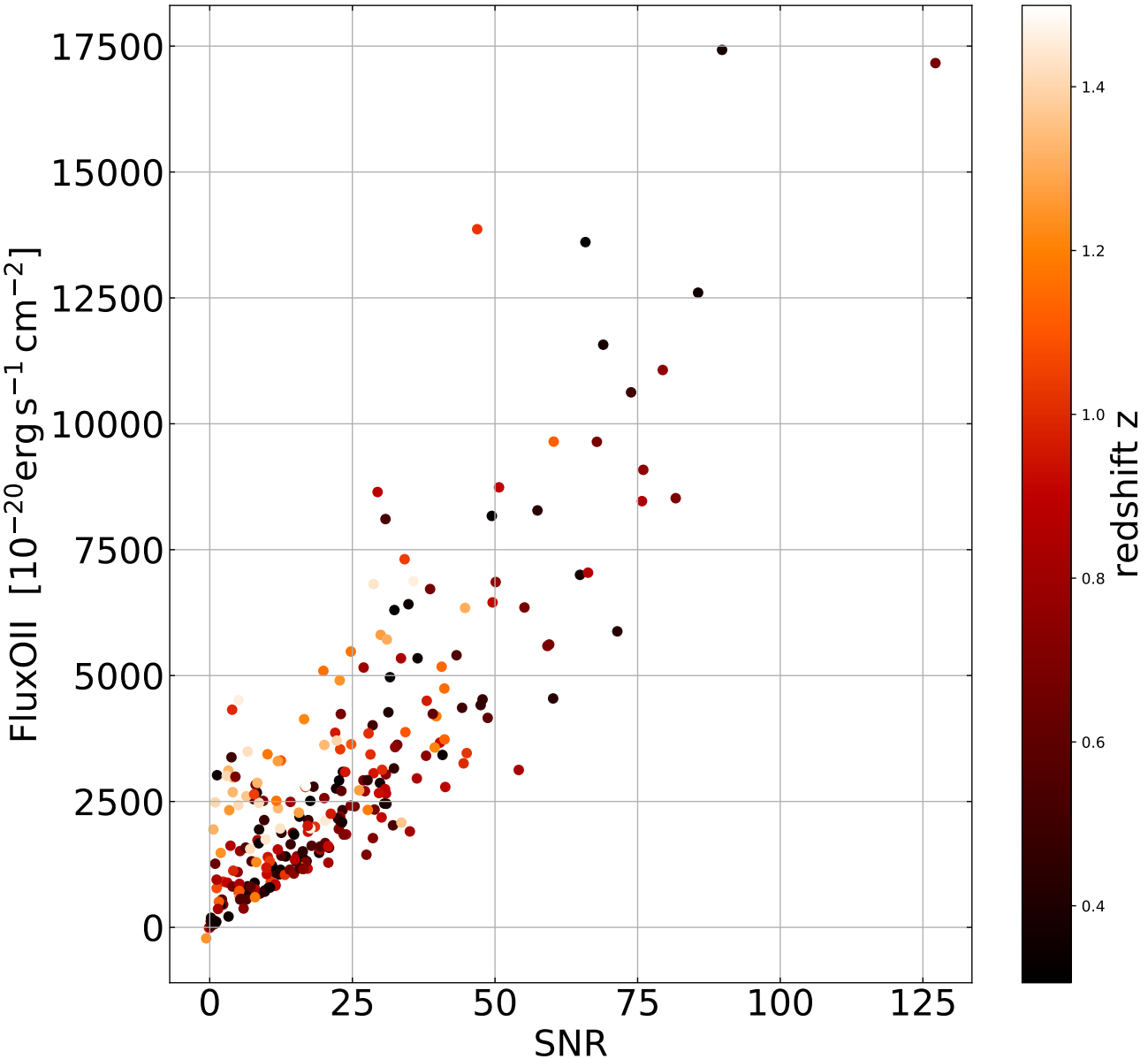

$V_{max}/\sigma_v \leq 1$
$1 < V_{max}/\sigma_v < 2$
$V_{max}/\sigma_v \geq 2$
$\log_{10}[SFR/(M_\odot\,yr^{-1})]$
V_{max} [km/s]
redshift
2.0
1.5
1.0
0.5
0.0
−0.5
10^1
10^2
1.4
1.2
1.0
0.8
0.6
0.4

Annexes

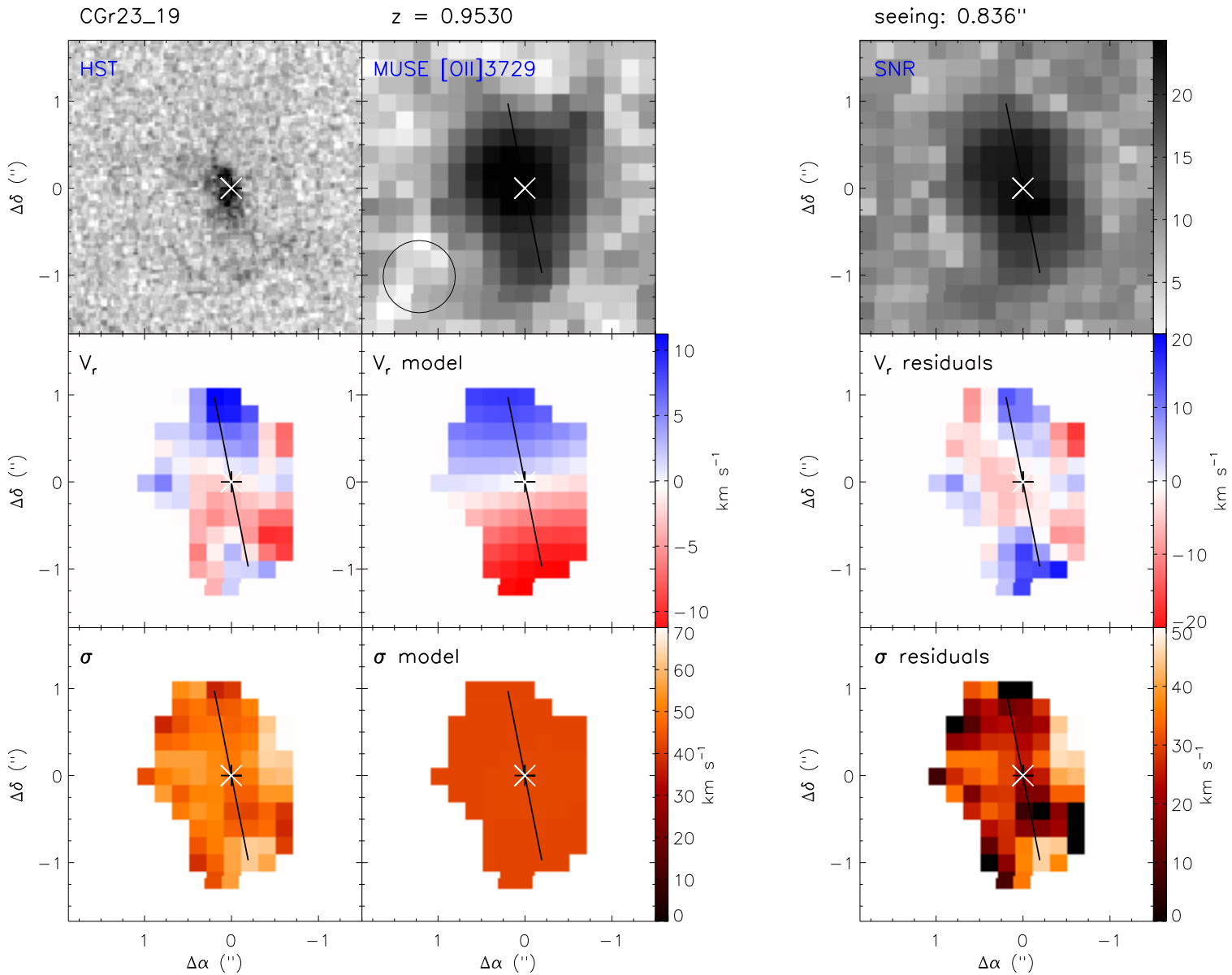

Uncertainty on i (deg)
b/a
Absolute error on b/a
0.450
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050


Uncertainty on i (deg)
b/a
Relative error on b/a
3.347
1.620
1.000
0.784
0.500
0.380
0.184
0.089
0.021

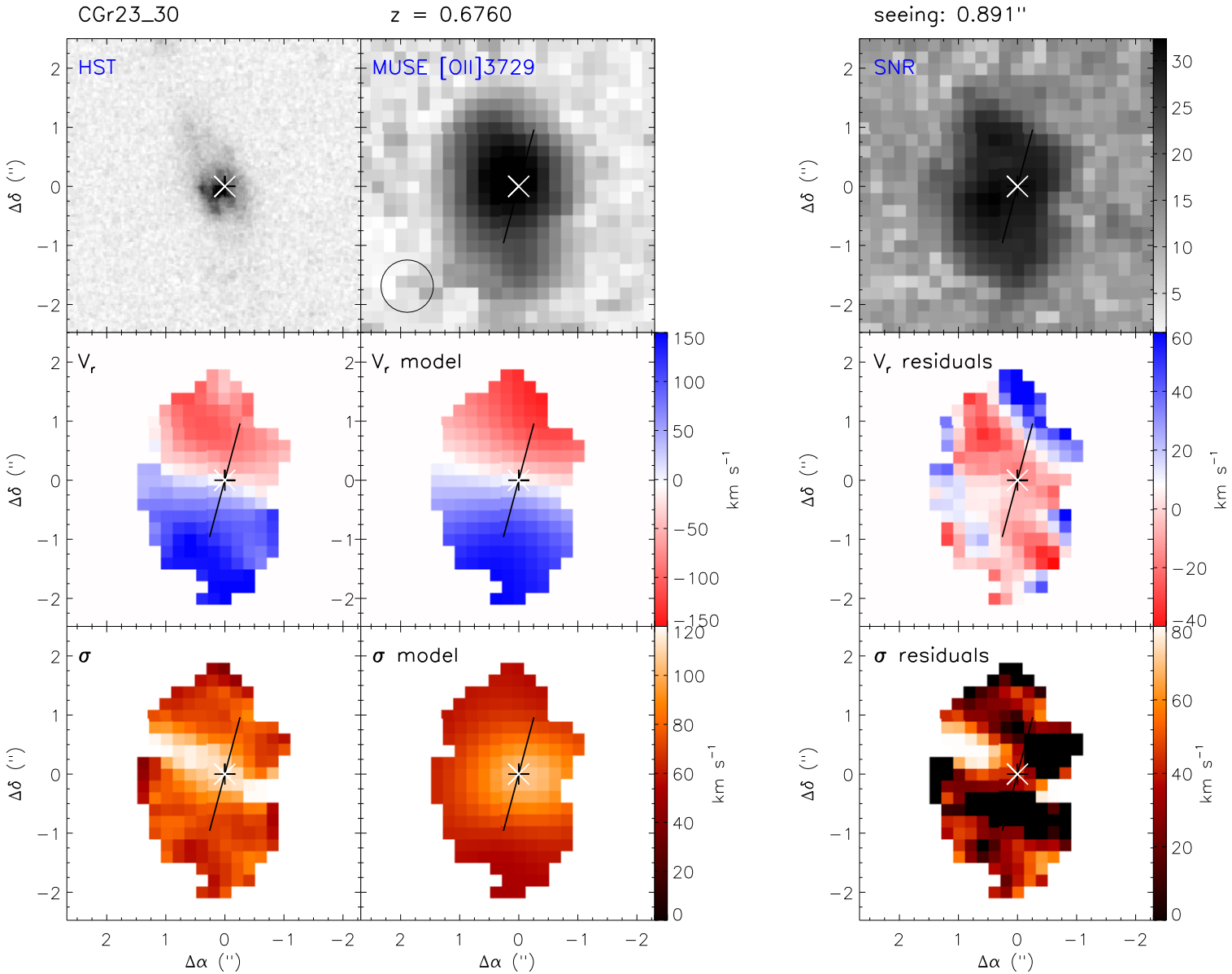
Annexes


17500
15000
12500
10000
7500
5000
2500
0
FluxOII [10^{-20}erg s^{-1} cm^{-2}]
0
25
50
75
100
125
SNR
1.4
1.2
1.0
0.8
0.6
0.4
redshift z

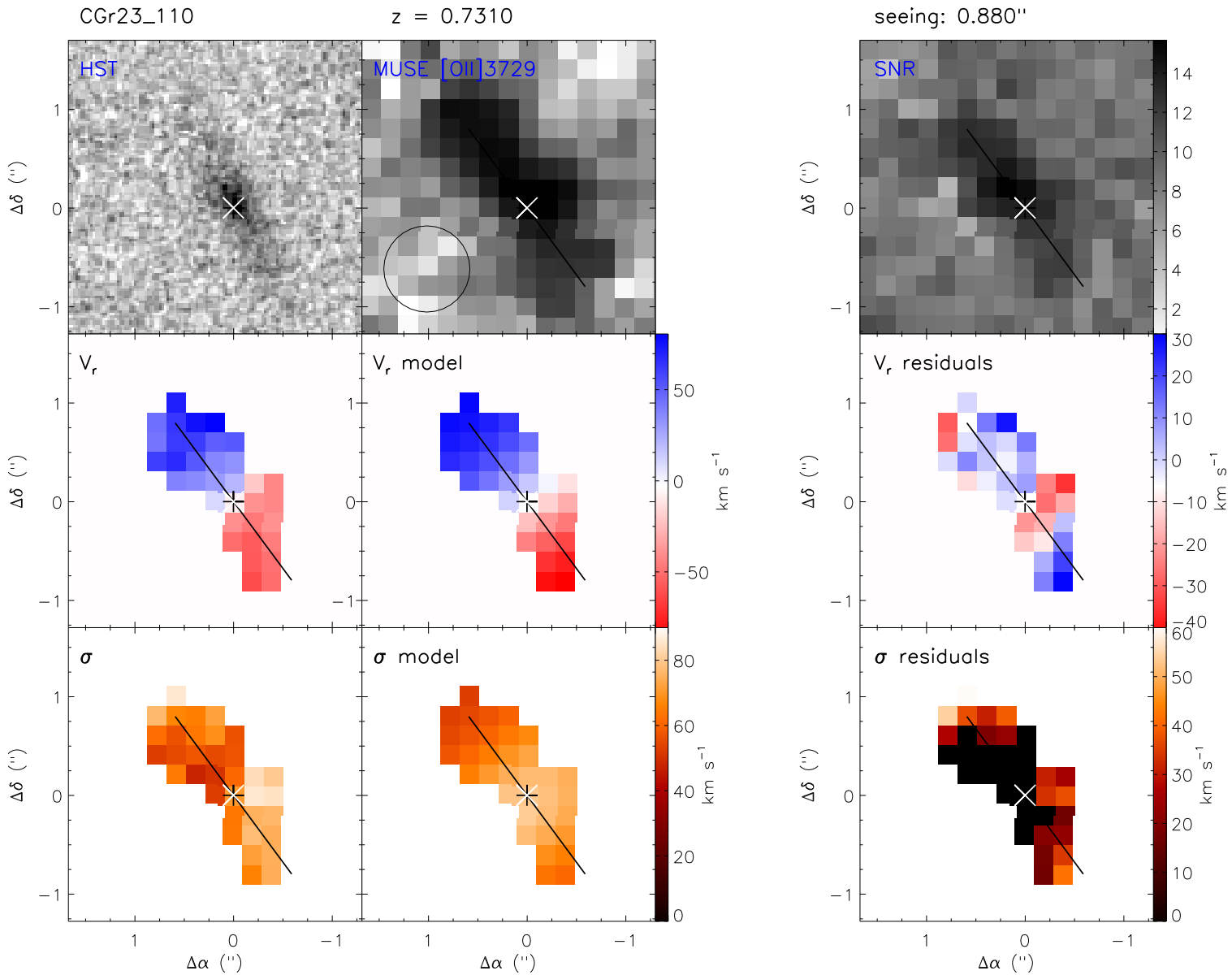
Annexes


CGr23_19
z = 0.9530
seeing: 0.836''
HST
MUSE [OII]3729
SNR
V_r
V_r model
V_r residuals
σ
σ model
σ residuals
$\Delta\delta$ ('')
$\Delta\alpha$ ('')
km s^{-1}

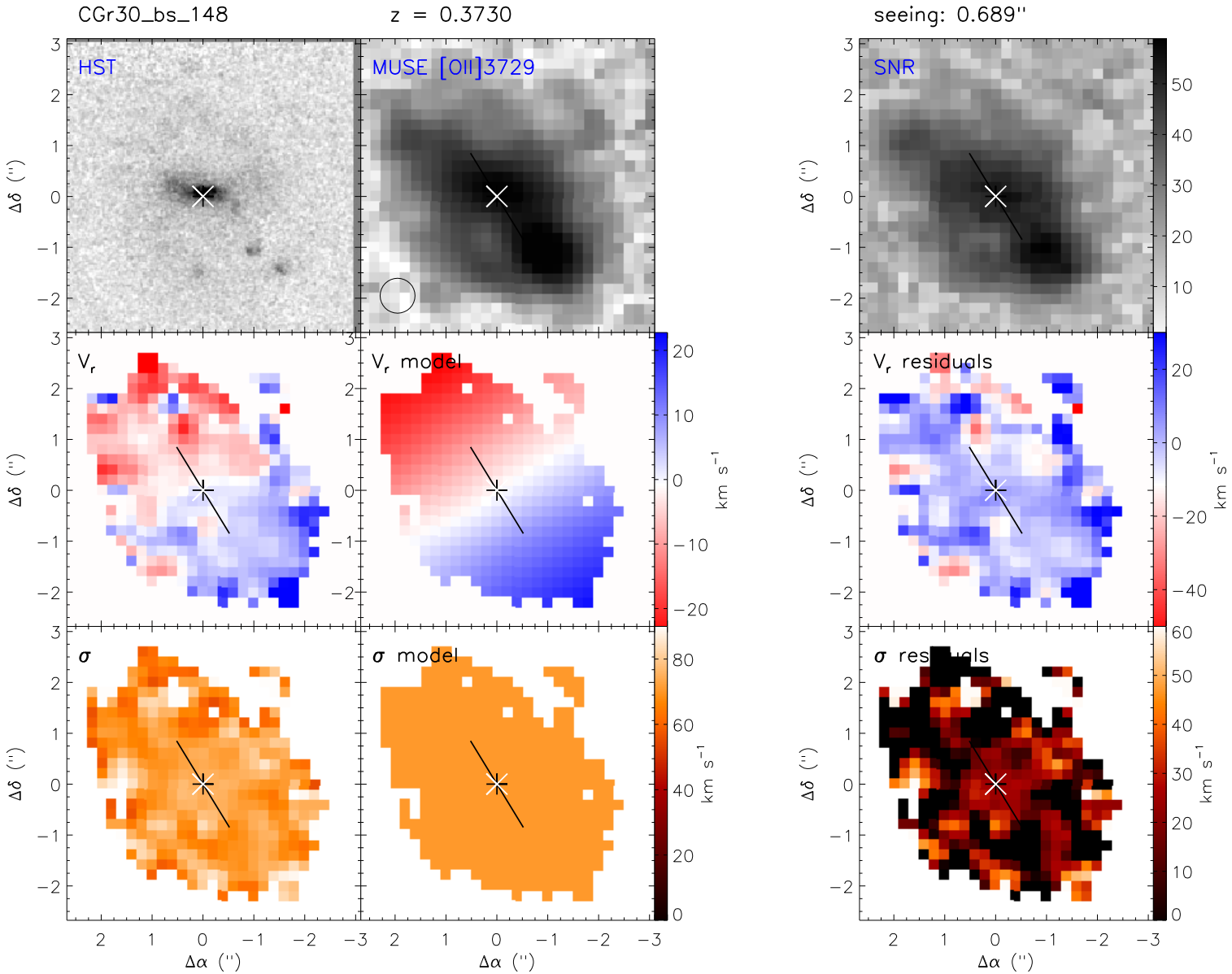
Annexes


CGr23_30
z = 0.6760
seeing: 0.891''
HST
MUSE [OII]3729
SNR
V_r
V_r model
V_r residuals
σ
σ model
σ residuals
Δδ ('')
Δα ('')
km s^-1

Annexes


CGr23_110
z = 0.7310
seeing: 0.880''
HST
MUSE [OII]3729
SNR
V_r
V_r model
V_r residuals
σ
σ model
σ residuals
Δδ ('')
Δα ('')
km s^-1

Annexes


CGr30_bs_148
z = 0.3730
seeing: 0.689''
HST
MUSE [OII]3729
SNR
V_r
V_r model
V_r residuals
σ
σ model
σ residuals
Δδ ('')
Δα ('')
km s^-1