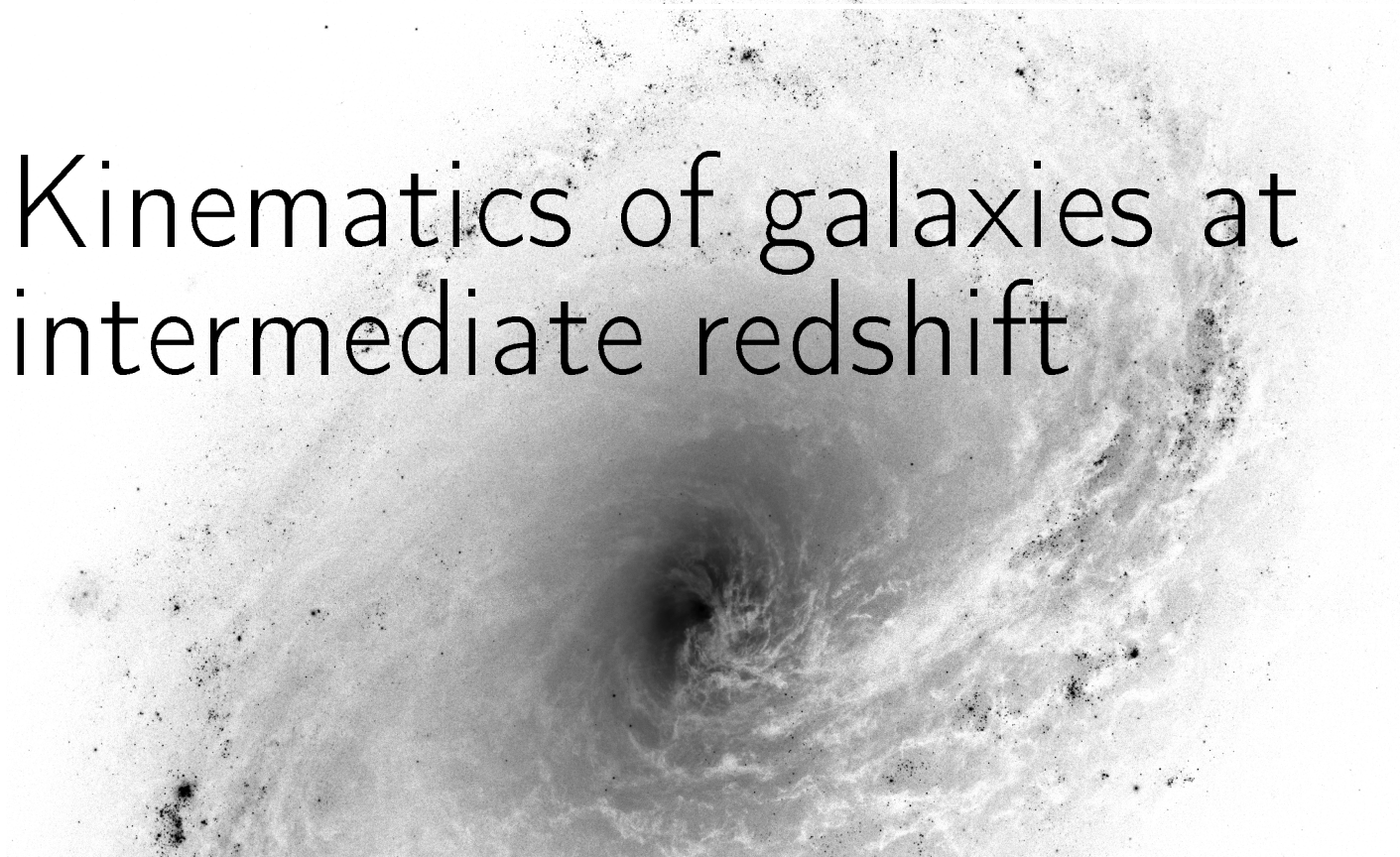
# Kinematics of galaxies at intermediate redshift



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

Internship at IRAP
11 March - 26 July 2019

# Galaxy evolution through cosmic time ?

# Why studying kinematics ?

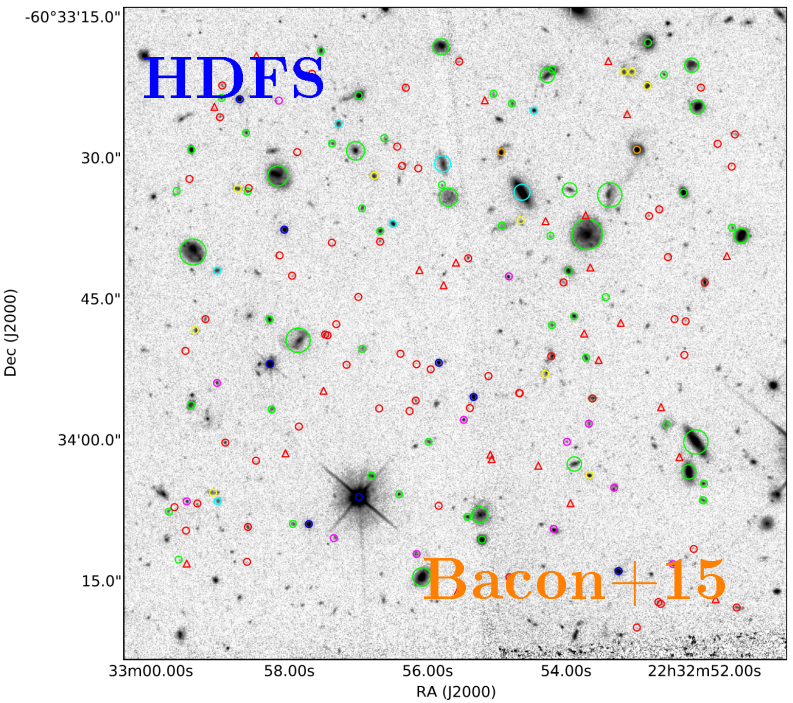

Explain the co-evolution of morphological and dynamical properties of galaxies

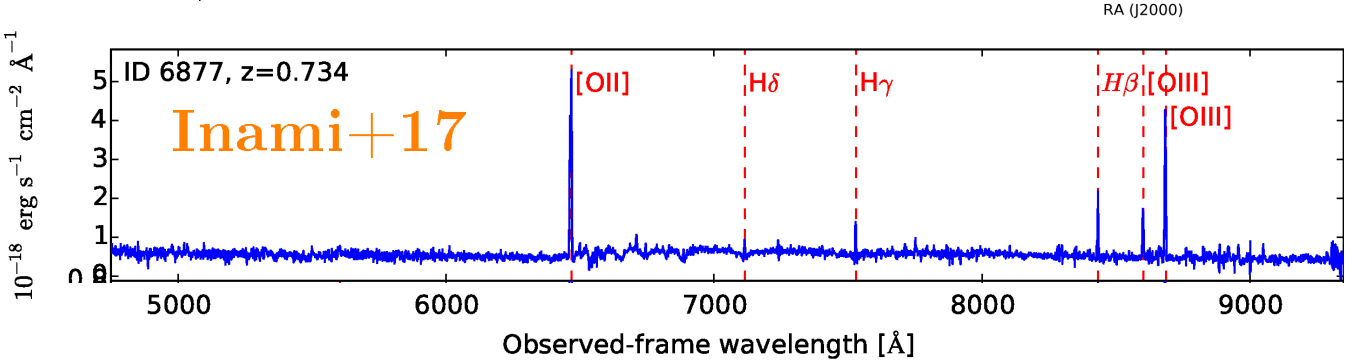
- ▷ main processes responsible for disc formation and settling ?
- ▷ impact of merging, inflows and outflows on these processes ?
- ▷ kinematics → rotation curve → dark matter and angular momentum (re)distribution ?

With IFS (MUSE):

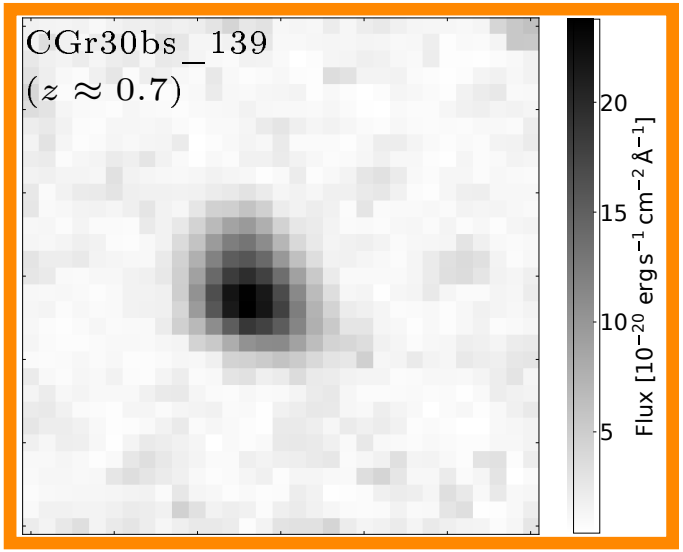
- ▷ **3D data cubes**
  - (a) Measure galaxy redshifts
  - (b) Select spatially-resolved galaxies at intermediate redshift ($\mathbf{0.4 \lesssim z \lesssim 1.4}$)
  - (c) Ionised gas kinematics with **bright** (rest-frame) optical **emission lines** (H$\beta$, [OII], [OIII], etc.)

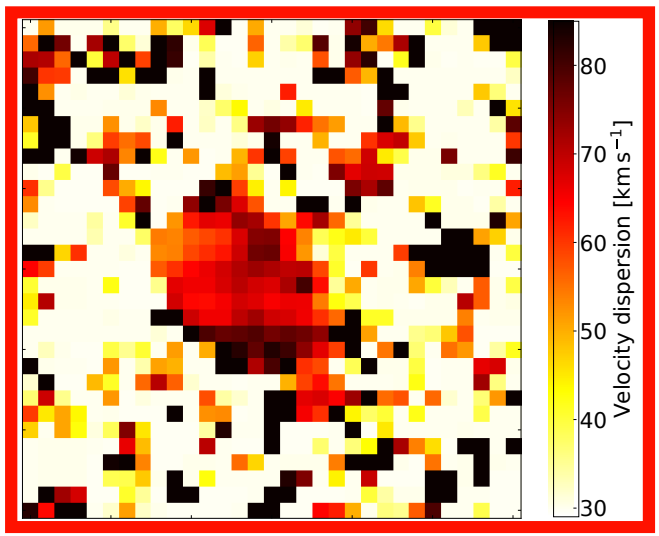
+ Stellar kinematics now achievable for the brightest (m $<$ 23) galaxies (Guérou+17)

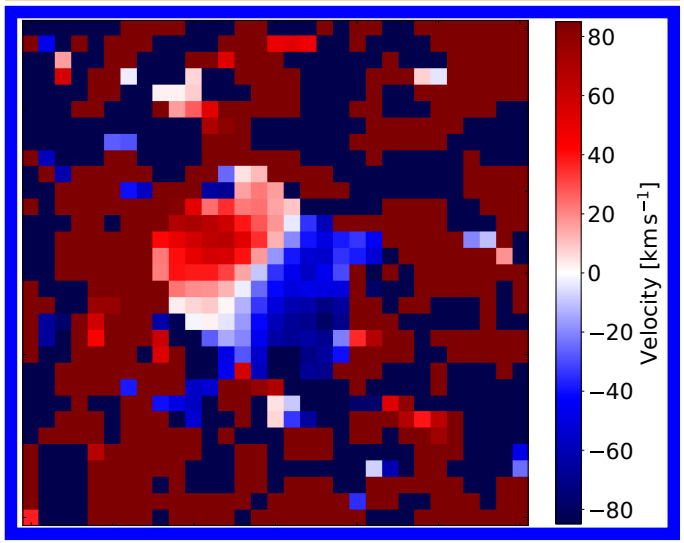


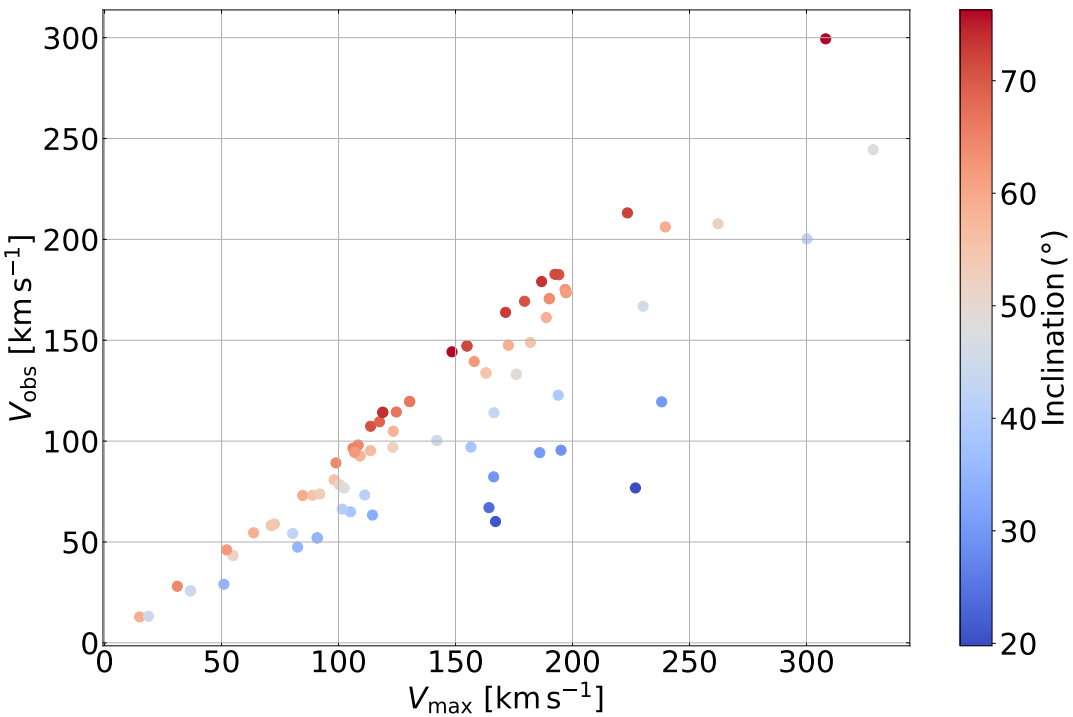
- ▷ Extract **2D maps** (flux, velocity field and velocity dispersion)
  - ◦ Gaussian fit and rest-frame Doppler shift give LOS velocity (centroid) and velocity dispersion (FWHM)

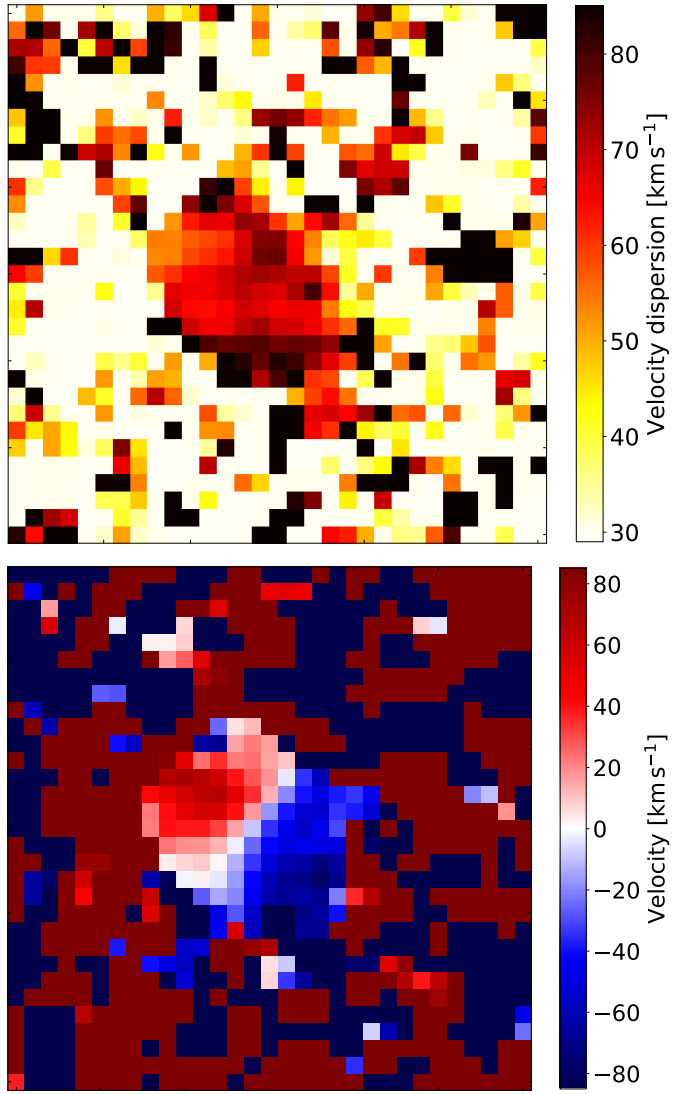


- ▷ $\sigma_{\mathrm{v}}$ **overestimated** → PSF and LSF must be taken into account (beam smearing)
- ▷ Need for ancillary data (high-res images, galaxies inclination and size, etc.)
  - ○ inclination required for modelling ($V_{\mathrm{obs}} \propto \sin i$)



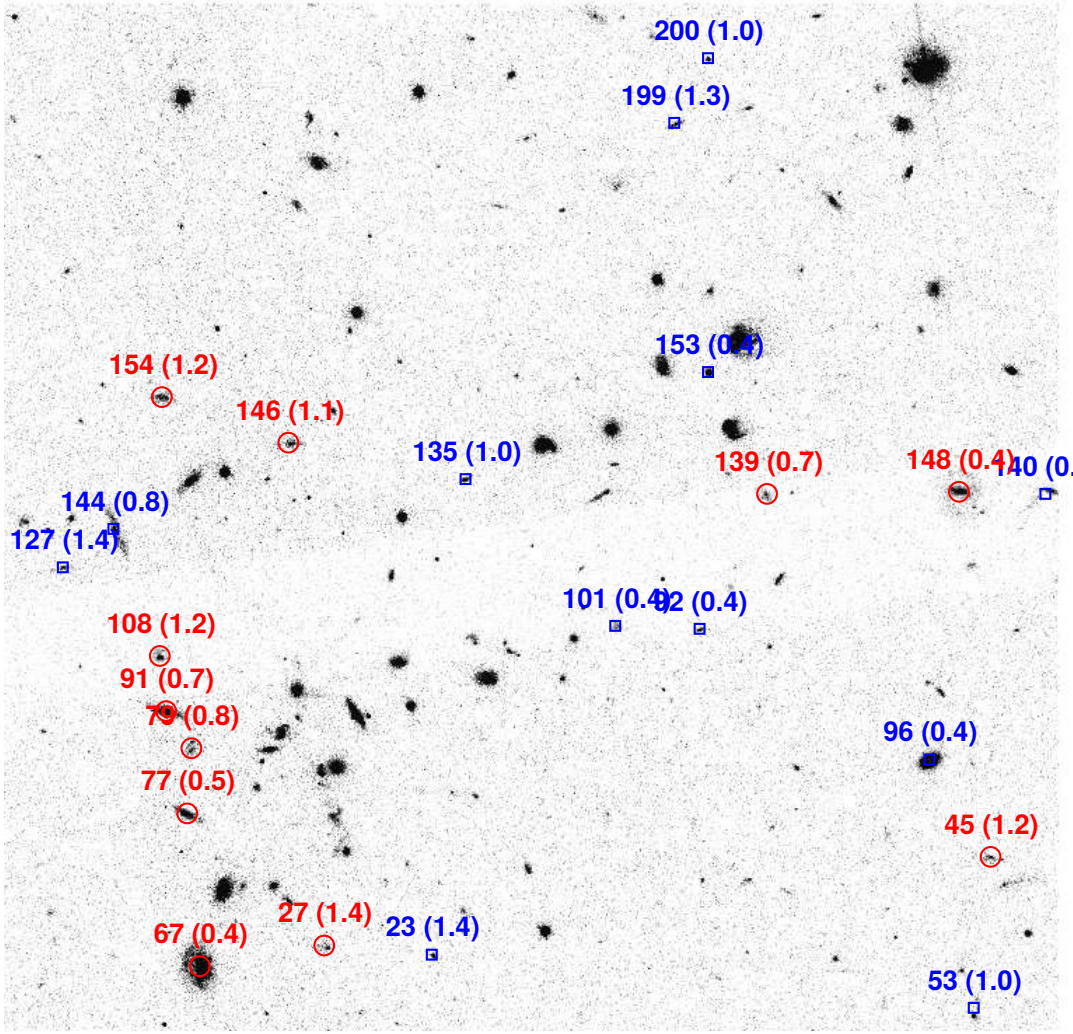



2D fitting:

- ▷ Works with 2D velocity field and dispersion assuming either
  - (a) a **mass distribution** (can describe declining curves at large radius)
  - (b) a **fixed function** (arctan, **ramp model**, etc.) which describes the observed flattening of curves

3D fitting:

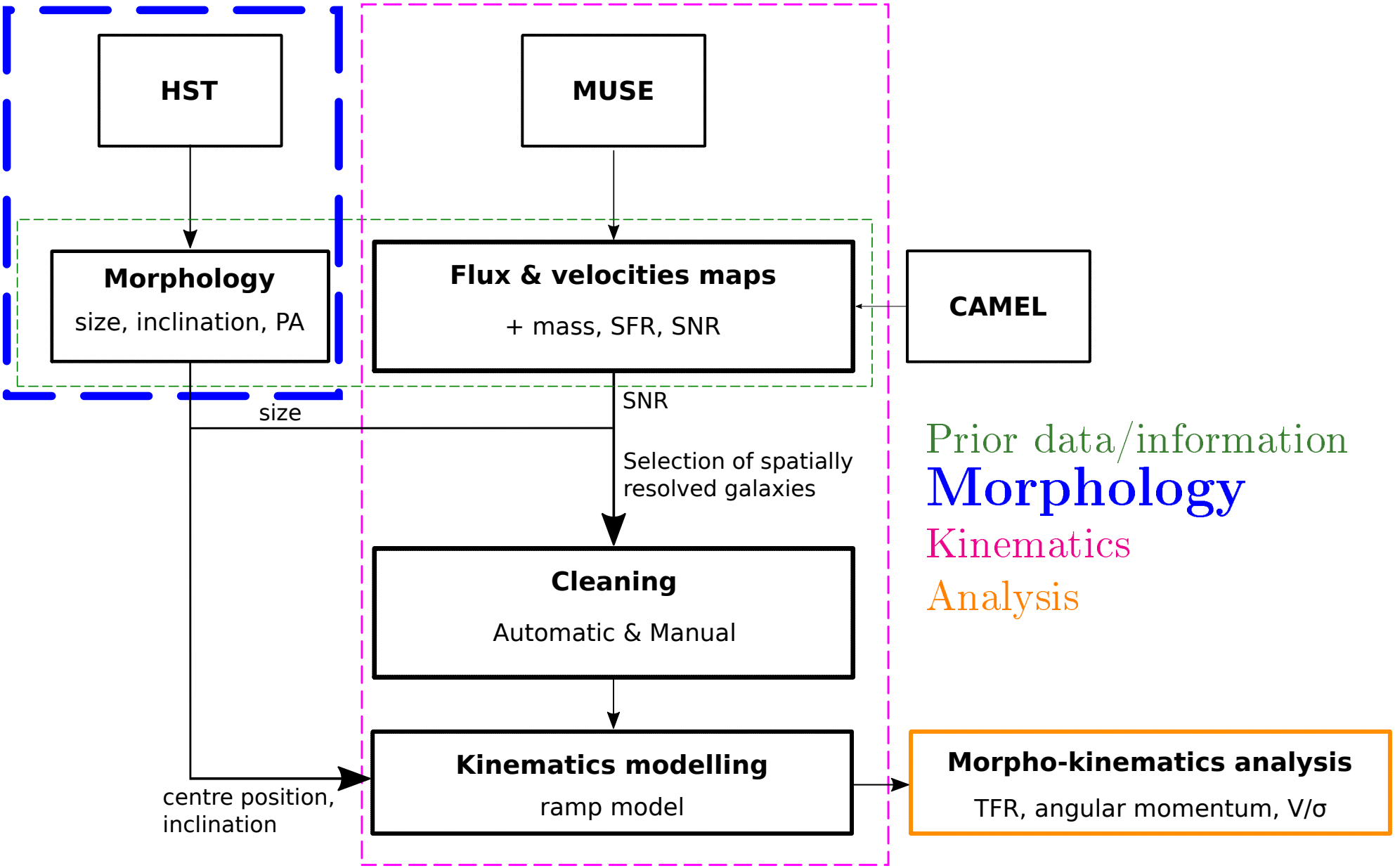
- ▷ improvement for faint and compact galaxies
  - ◦ GALPAK$^{3D}$ (Bouché+15)
  - ◦ $^{3D}$BAROLO (Di Teodoro & Fraternali+15)




HST image of COSMOS group CGr30

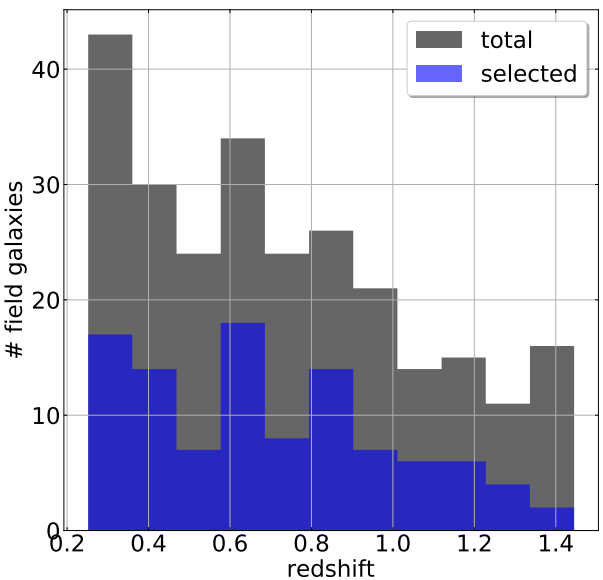
- 16 MUSE fields in COSMOS area
- exposures from 1 to 10 hr
- seeing-limited (FWHM $\lesssim 0.7$") or AO (FWHM $\lesssim 0.5$")
- **$\sim$ 500 field galaxies with [OII] detection**
  - HST-ACS counterparts
  - **$0.4 \leq z \leq 1.4$**

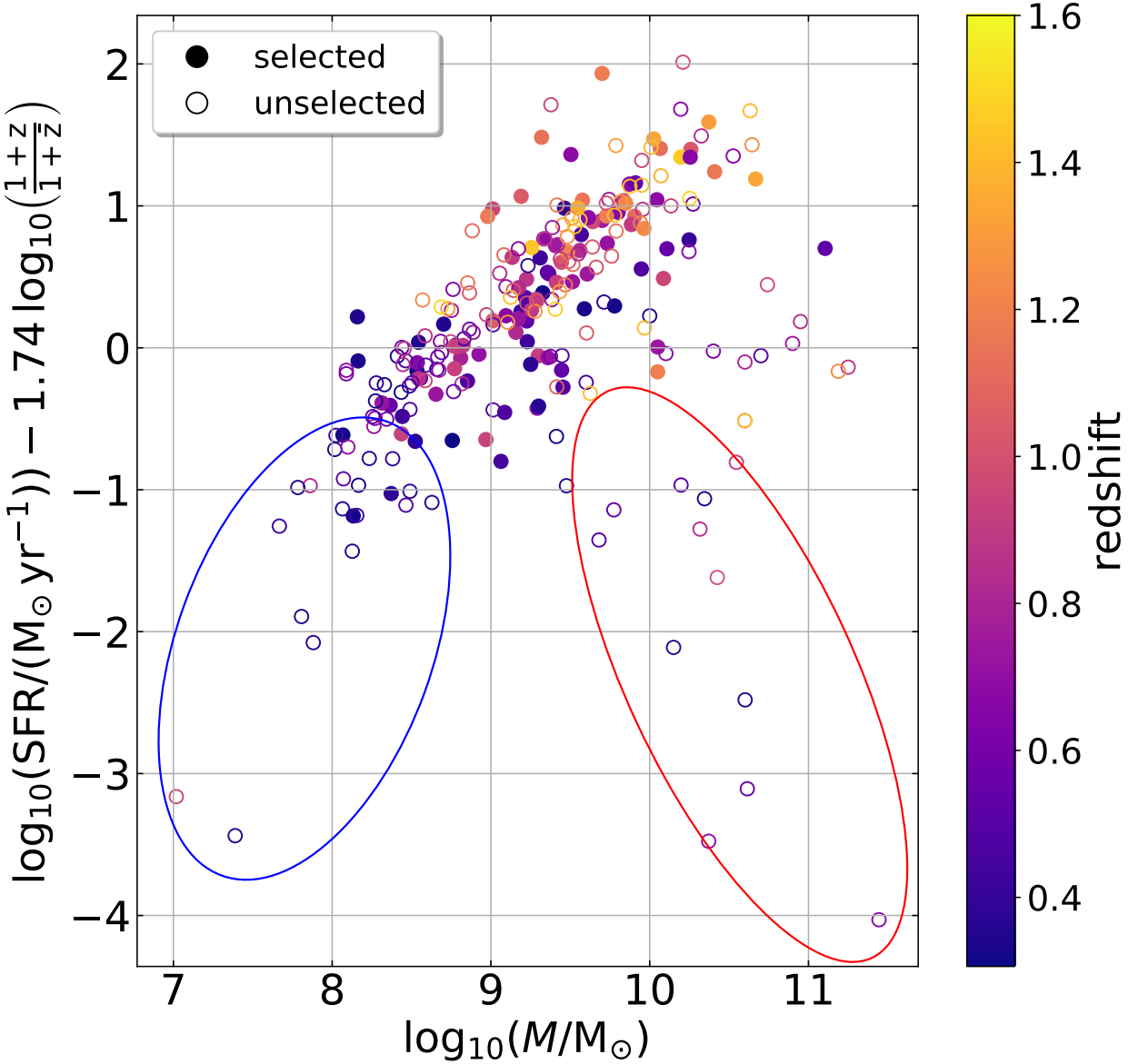
# Methodology



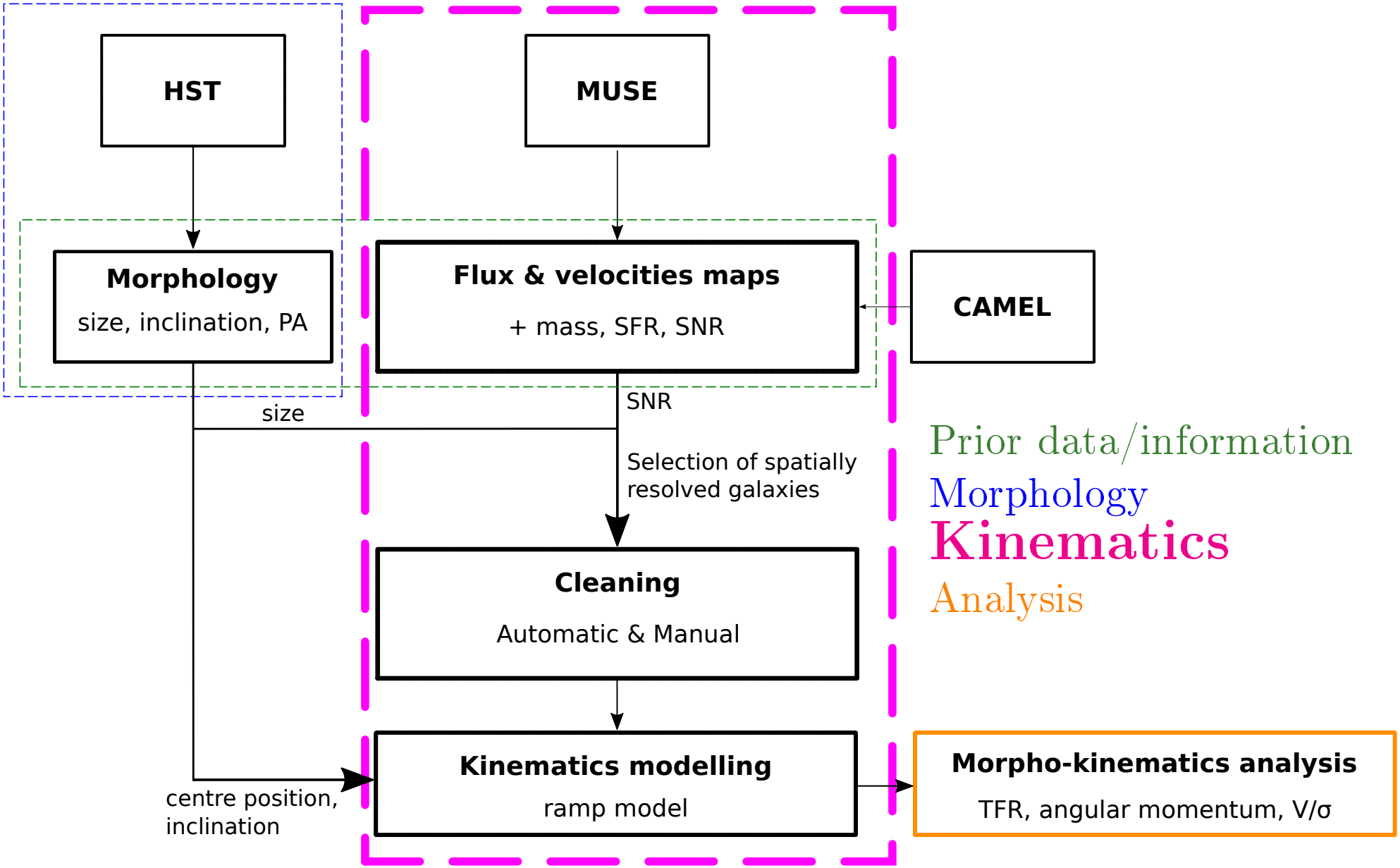
# Selection of a sample of spatially resolved galaxies

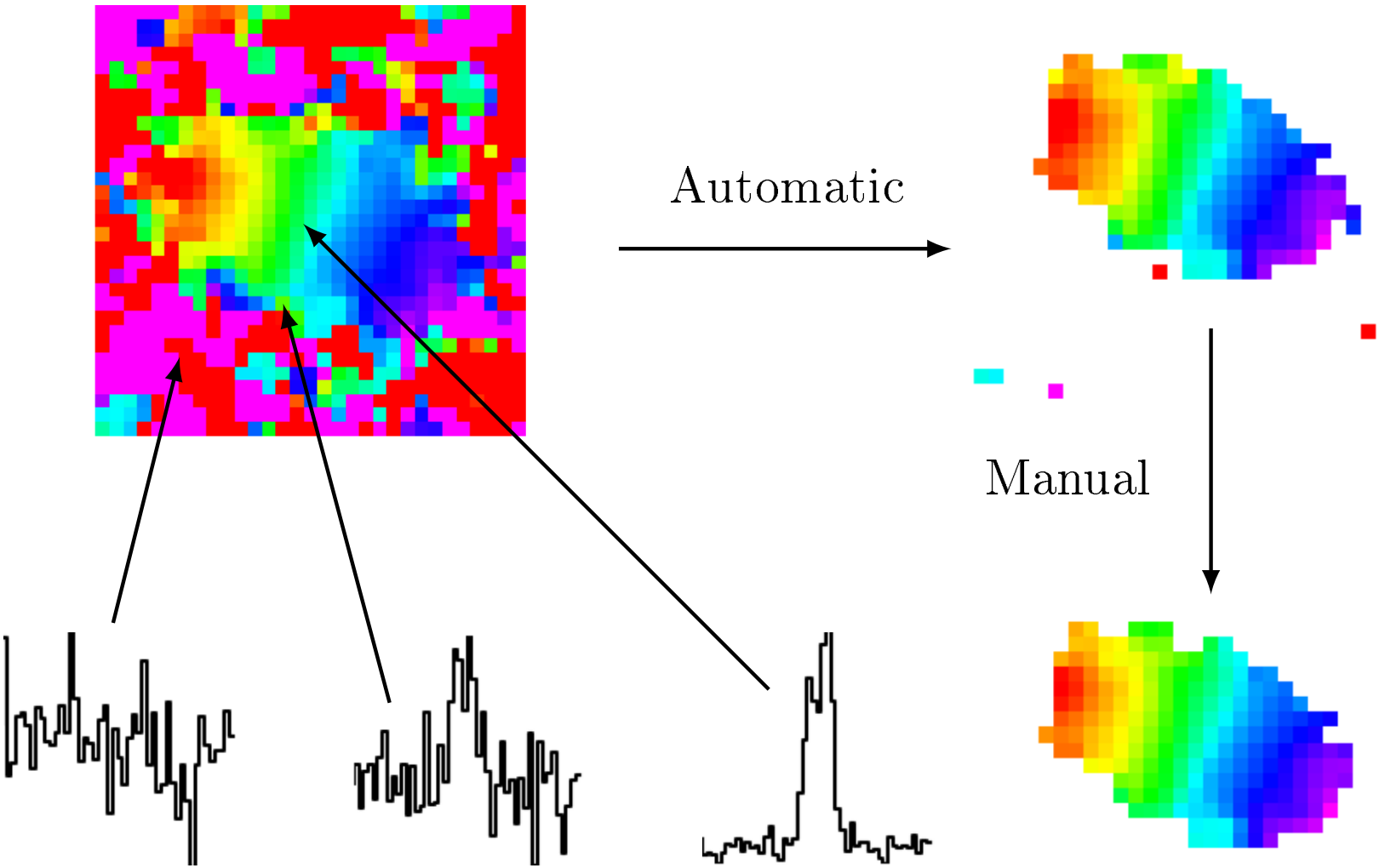
- Most of our sample galaxies are on the main sequence
- massive quiescent (low [OII]) and very low mass galaxies (small size) are lost



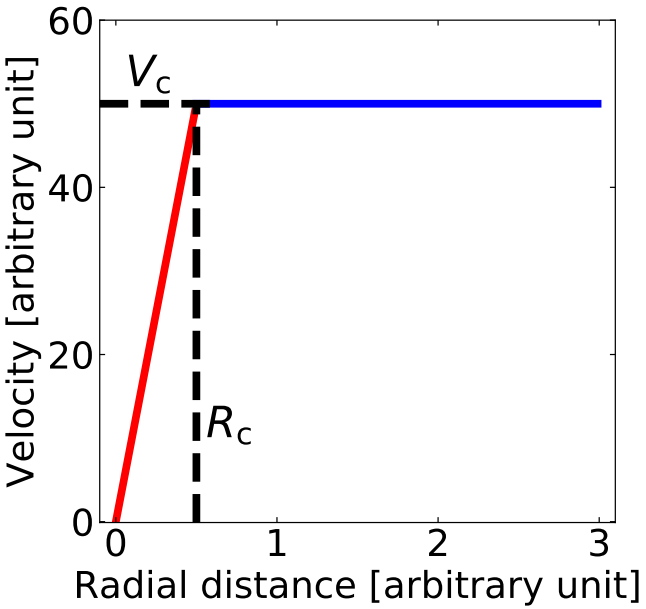



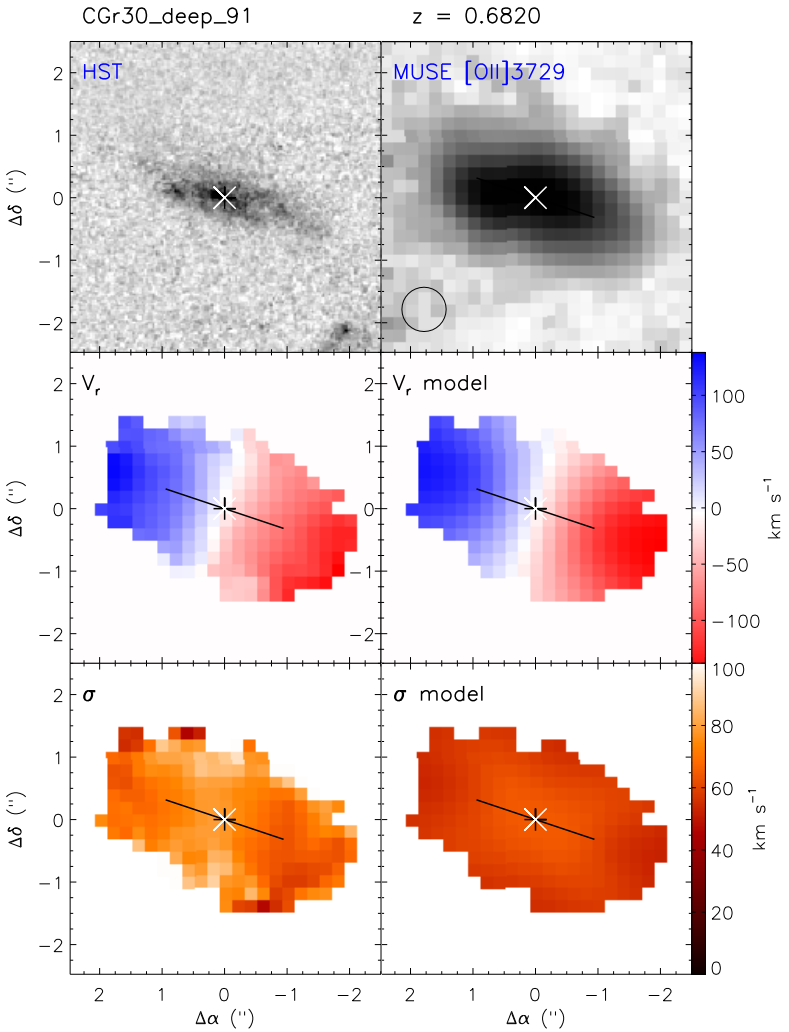
# Methodology

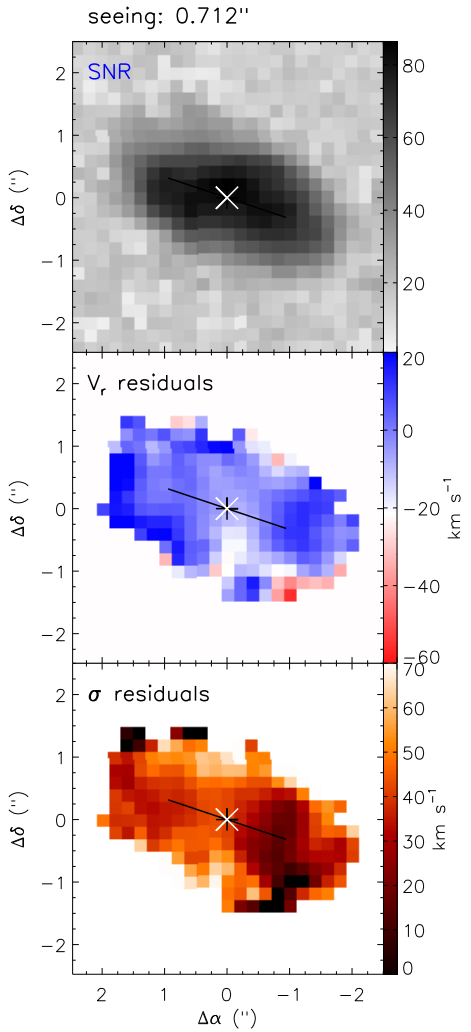



Automatic
Manual

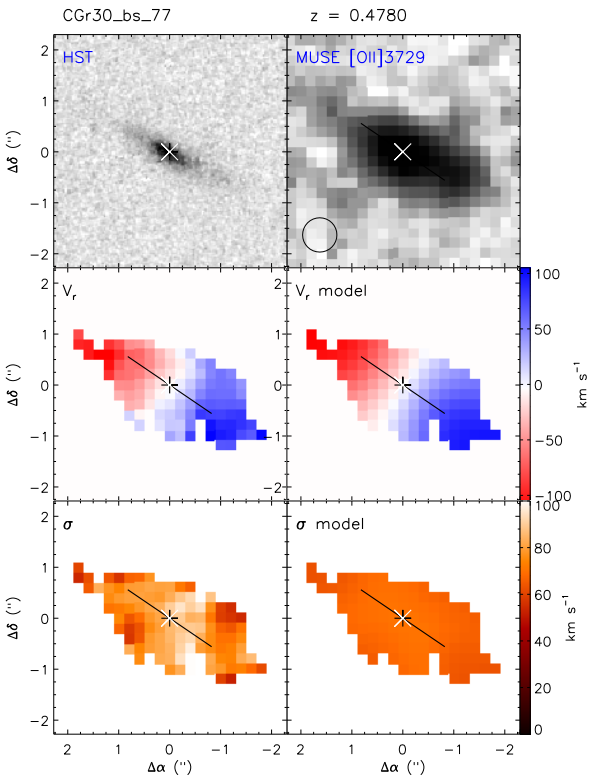
Use a ramp model with a linear internal variation and a plateau.

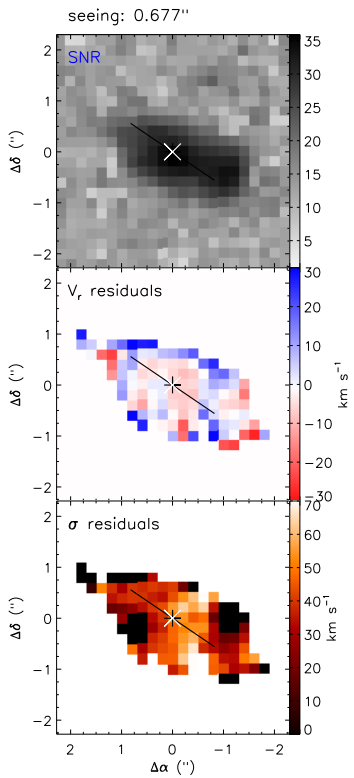


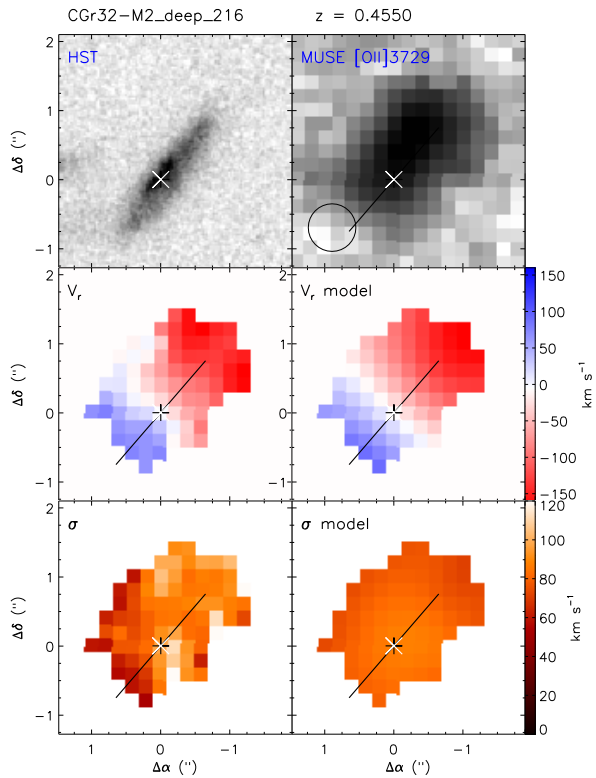



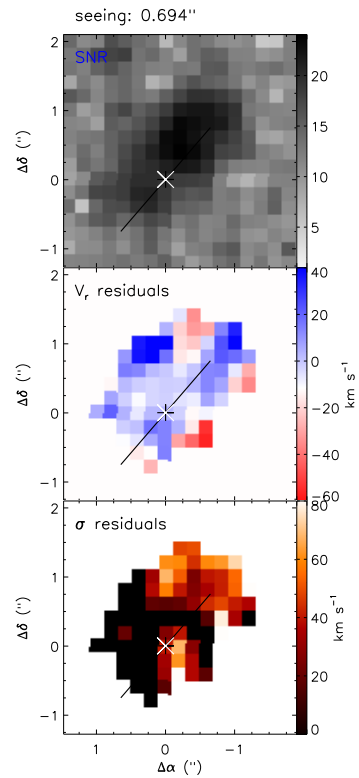
# Kinematics of edge-on galaxies



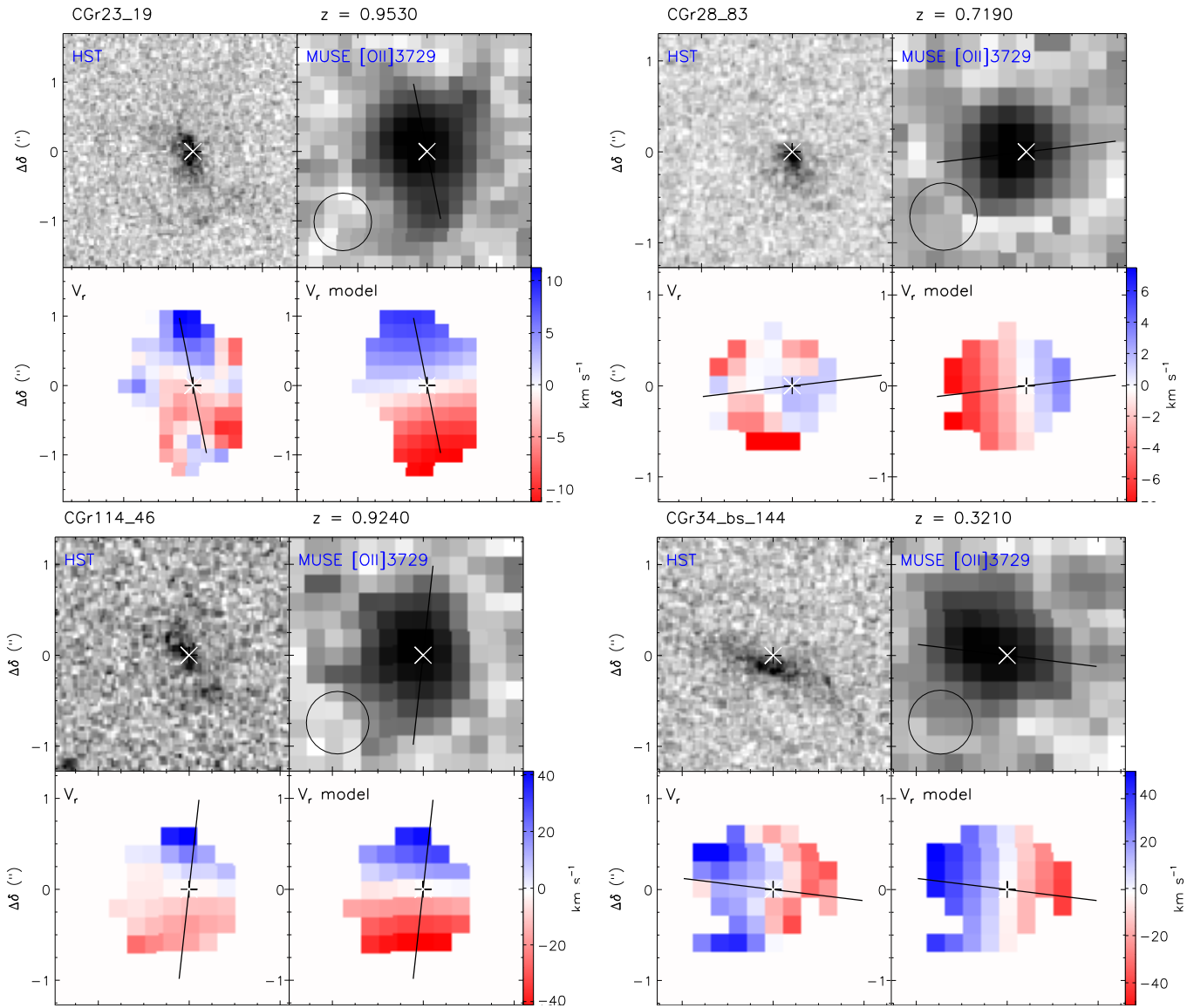

$i \approx 74°$



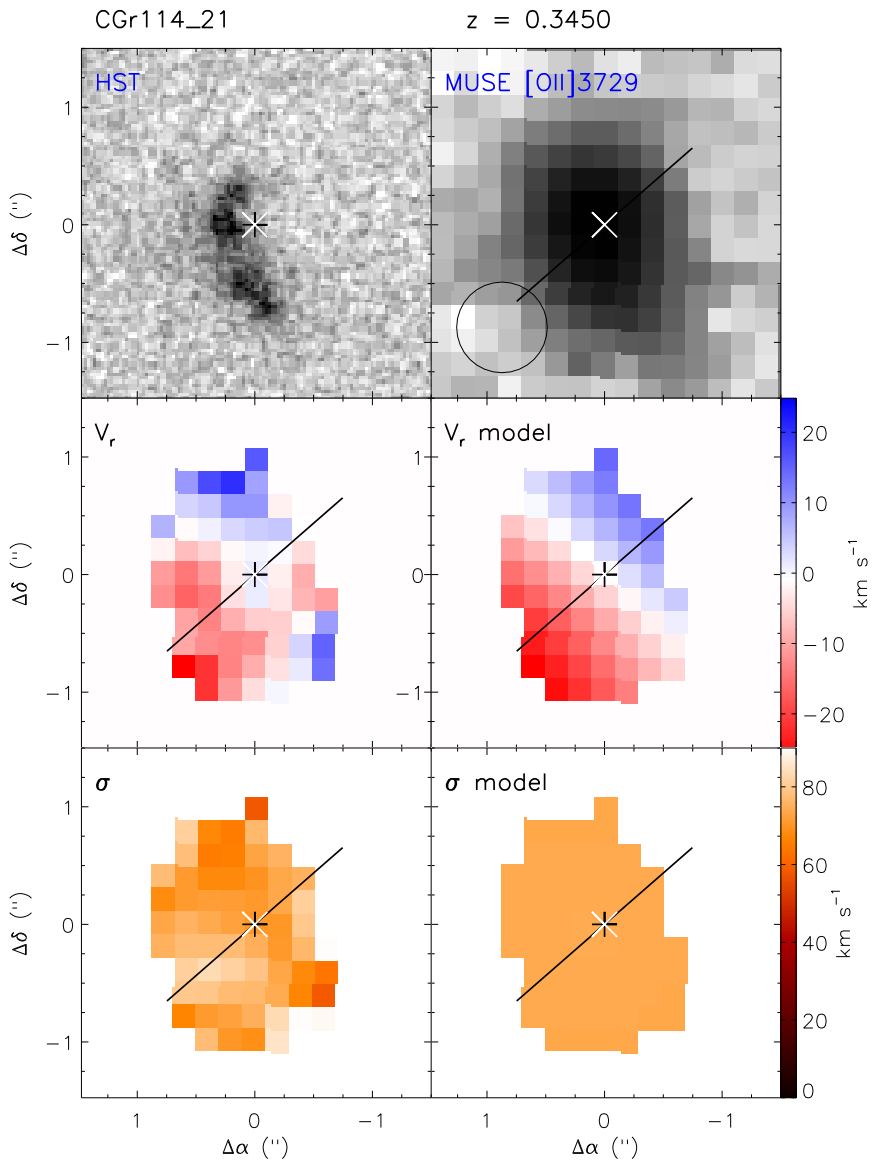

$i \approx 72°$

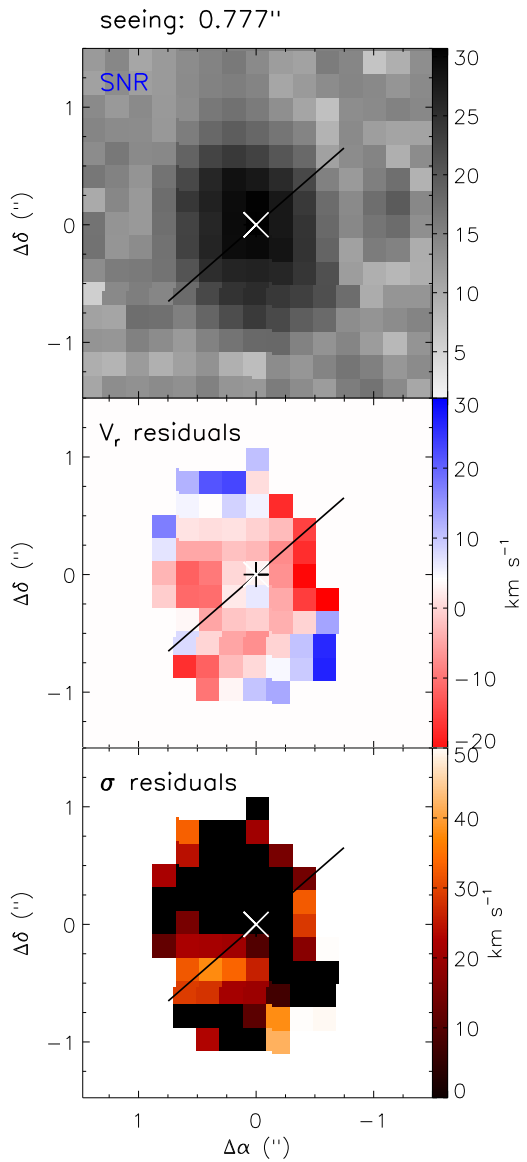
# Limitations for small galaxies




- Small and low SNR galaxies tend to have perturbed kinematics

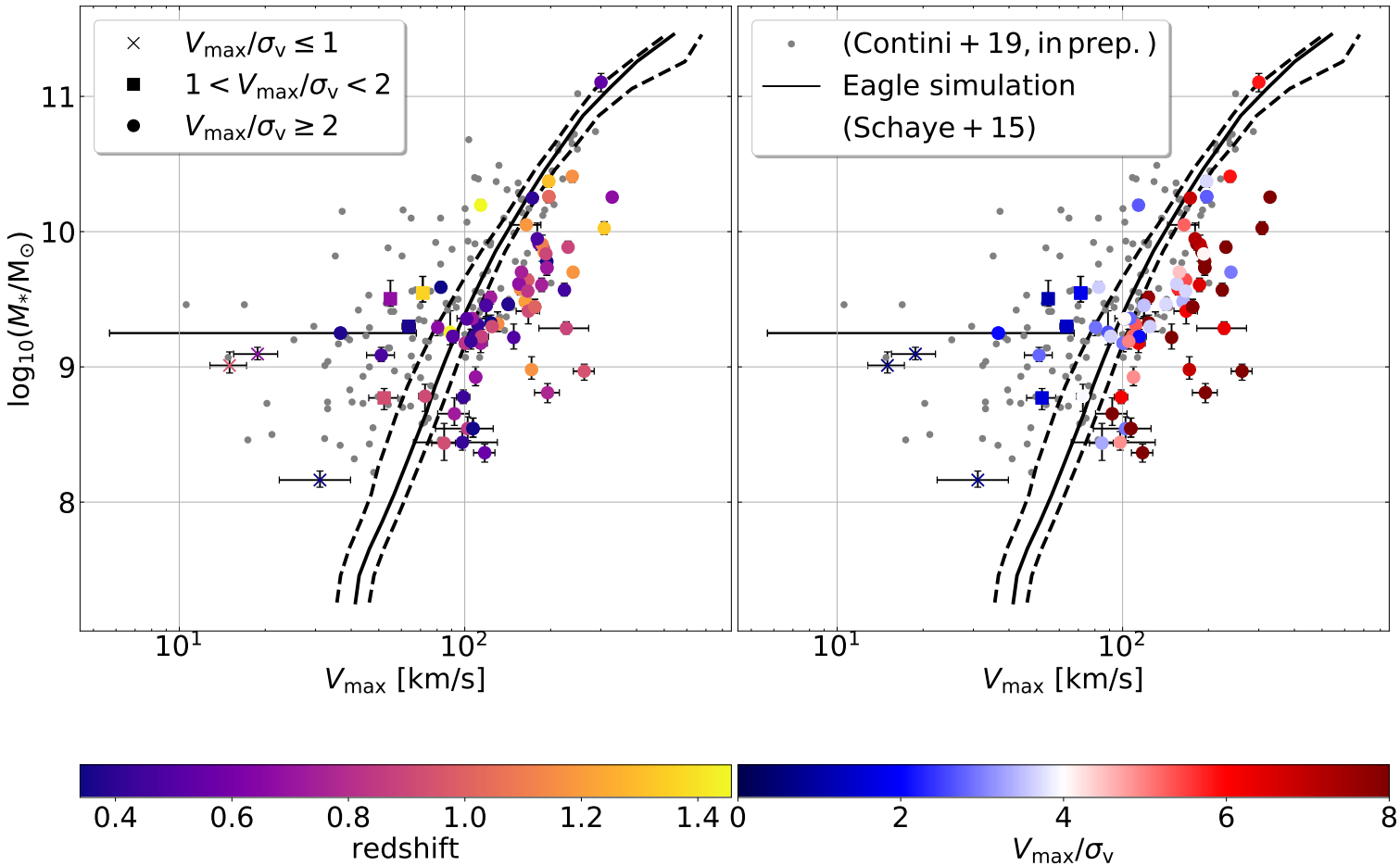
# Interacting galaxies ?



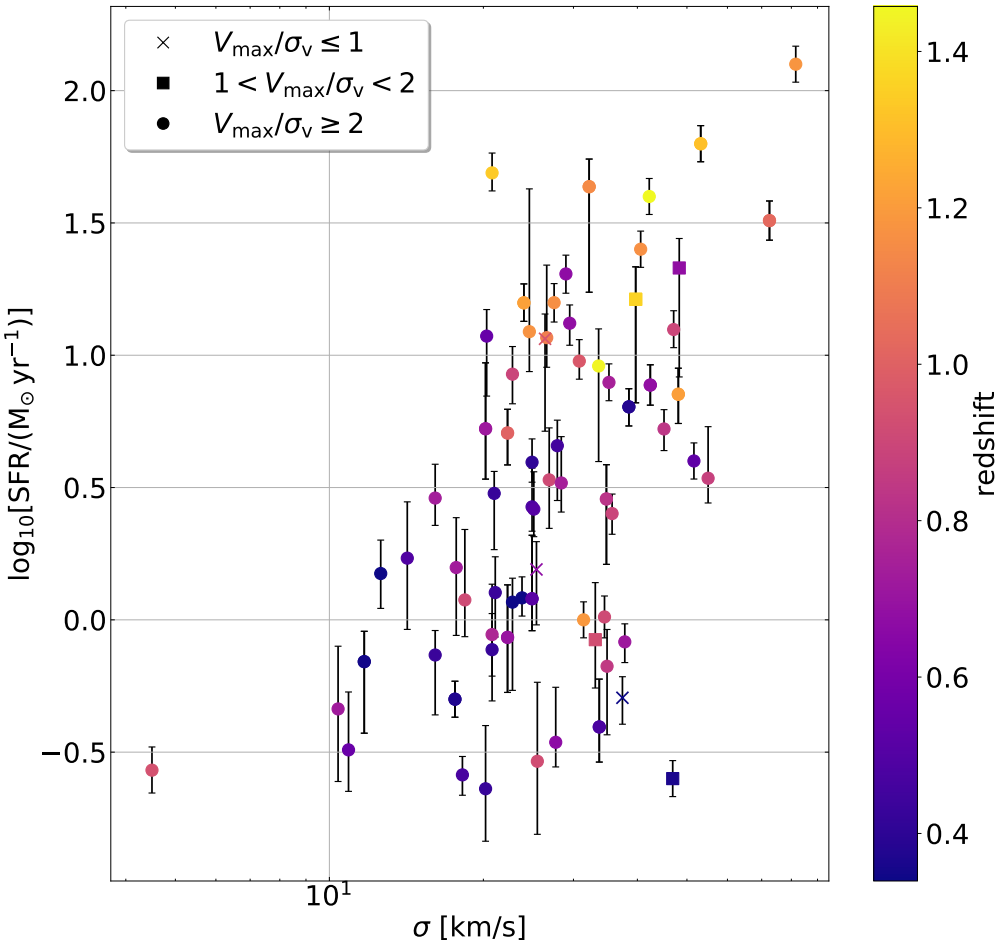

- ▷ Clumpy structure is lost in MUSE whitelight
- ▷ But **velocity field is highly perturbed**
- ▷ Clumps separated by $\approx$ 3kpc
- ▷ Interacting galaxies ?

# A few preliminary results
## Tully-Fisher Relation




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

# A few preliminary results
## A correlation between SFR and $\sigma_v$ ?



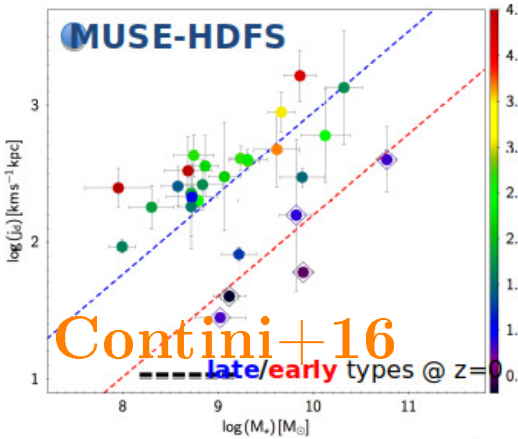

Correlation between SFR and

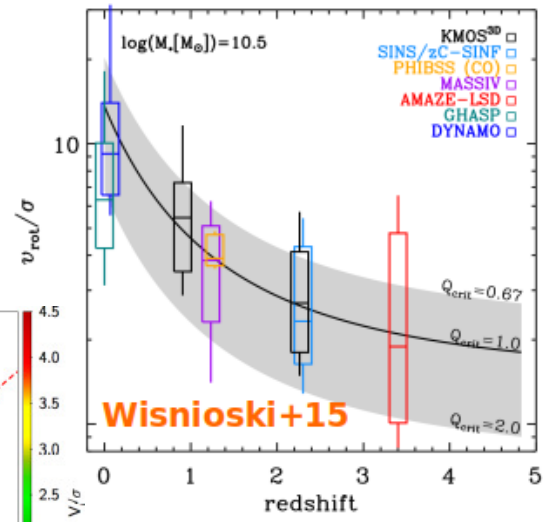
(a) **redshift** $\rightarrow$ consistent with mass-SFR relation

(b) **velocity dispersion**

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

- **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