Impact of environment on galaxy evolution at intermediate redshift from the **MAGIC survey**

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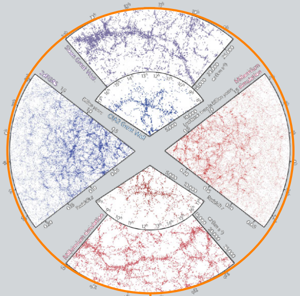
& Muse GTO Collaboration

Galaxy evolution with cosmic time

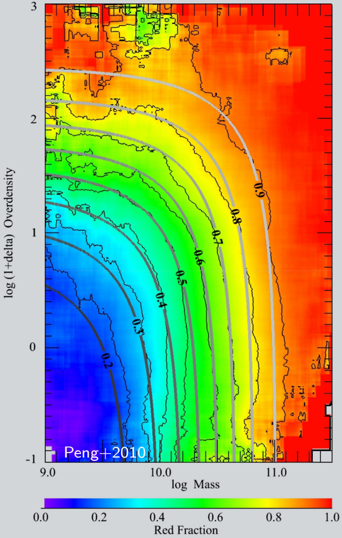


Springel+06

Impact of environment ?

Build-up of the Hubble Sequence ?

Impact of environment on galaxy evolution ?



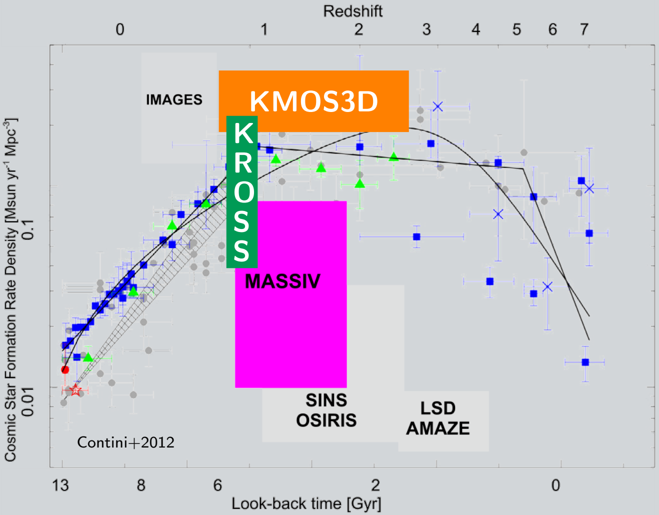
How efficient is the environment in shaping the Hubble sequence ?

- ▷ Build-up of the red sequence ?
- ▷ Environmental vs mass quenching ?

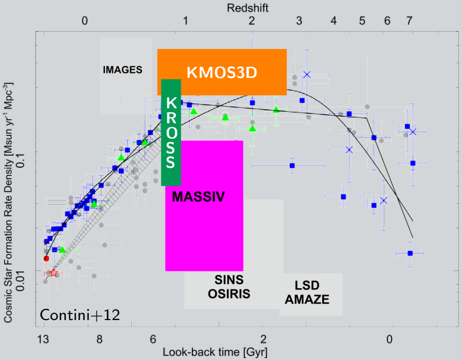
Which mechanisms play a crucial role ?

- ▷ Hydrodynamical ?
  - → stripping, evaporation, ...
- ▷ Gravitational ?
  - → merging, harassment, ...

The need for spatially resolved properties



The need for spatially resolved properties



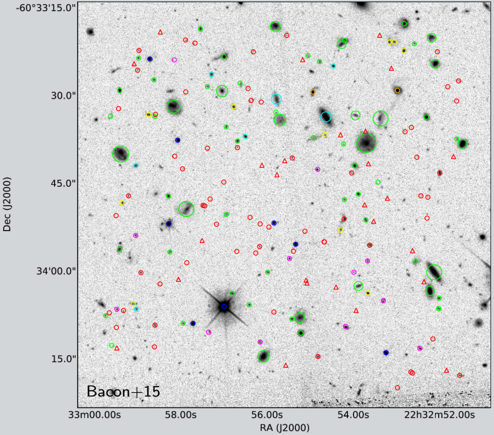
Survey	N gal.	z	$\log(M_*)$ $M_\odot$	log(SFR) $M_\odot\ yr^{-1}$	Operating band
MASSIV	84	0.9 – 1.8	9 –10	0.7 – 2.6	J, H SINFONI
KMOS 3D	739	0.6 – 2.7	9 – 11.4	-0.7 – 2.5	YJ, H, K KMOS
KROSS	795	0.6 – 1	10.0 ± 0.1	5 ± 1	J KMOS
IMAGES	68	0.4 – 0.75	10.2 – 11.1	2	Optical–NIR FLAMES GIRAFFE
SINS	80	1.3 – 2.6	10 –11.1	1.14 – 2.9	J,H,K SINFONI

- ▷ Need for statistics
- ▷ But studies usually probe massive SF galaxies
- ▷ And rarely probe the environment

Description of the MAGIC survey

MUSE: a powerful multi-IFU instrument for deep surveys

MUSE FoV (HDFS)



Large FoV and sensitivity

- ▷ Spectral coverage: $5000\,\text{Å} \lesssim \lambda \lesssim 9000\,\text{Å}$
- ▷ Blind survey
- ▷ Perfect to probe the environment

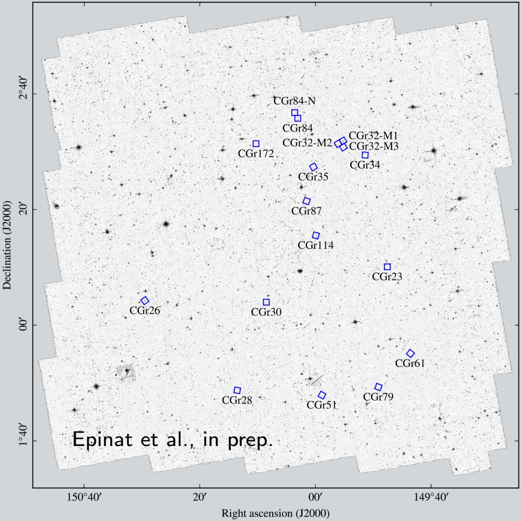
Spectral resolution

- ▷ $R \sim 3000$

Spatial resolution

- ▷ $\mathrm{FWHM} \sim 0.7 - 0.35$ arcsec

MUSE-gAlaxy Groups In Cosmos (MAGIC) survey



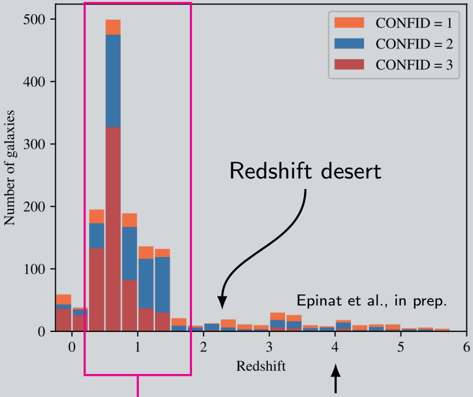
□ MUSE pointings

- ▷ **70 h on-source MUSE-GTO project**
  - → half with AO
- ▷ 17 fields in COSMOS (15 groups at $0.35 < z < 0.75$)
  - → Selected from COSMOS group catalogue (Knobel+12)
  - → COSMOS wall structure (Iovino+16) for 7 groups at $z \sim 0.7$
  - → **Multiwavelength data** (> 20 bands)
  - → **SED-fitting** with FAST (Kriek+09) & now CIGALE (Epinat et al., in prep)

Redshift determination in MAGIC

- ▷ Redshift determination from PSF-weigthed spectrum with MARZ (Hinton+16)
- ▷ Targets from COSMOS catalogue **without magnitude limit** (blind-like survey)
- ▷ Using **absorption & emission lines**
- ▷ Confidence flag (CONFID)

$\sim$ 2000 objects



$\gtrsim$ 1100 [OII] emitters with reliable redshifts

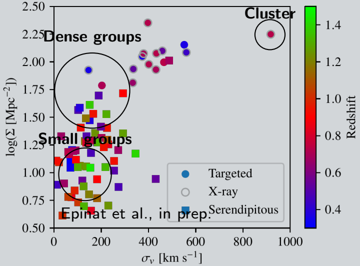
Structure identification with MUSE

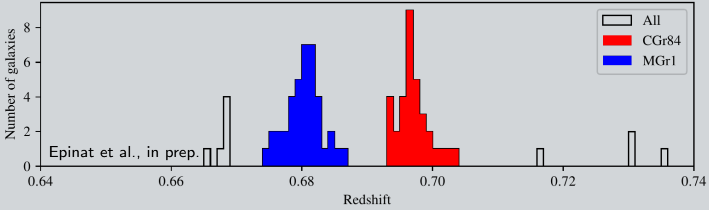
FoF algorithm

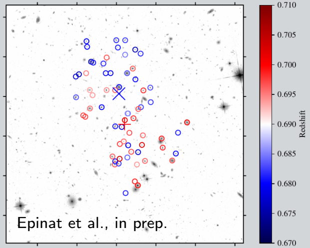
- ▷ $\Delta V = 500\,\mathrm{km\,s^{-1}}$
- ▷ $\Delta R = 450\,\mathrm{kpc}$

Identification of sub-structures

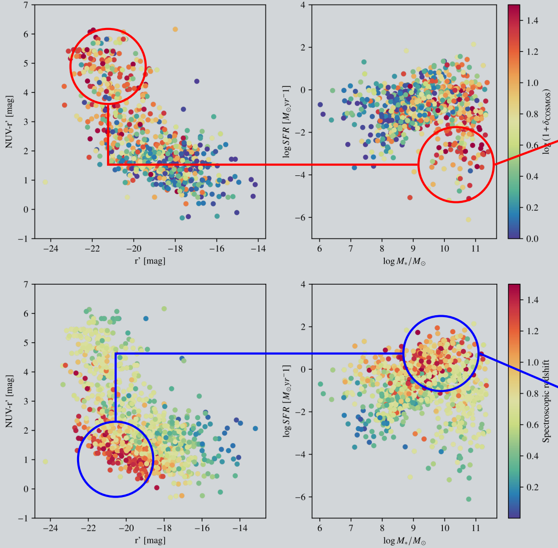
Various density estimates







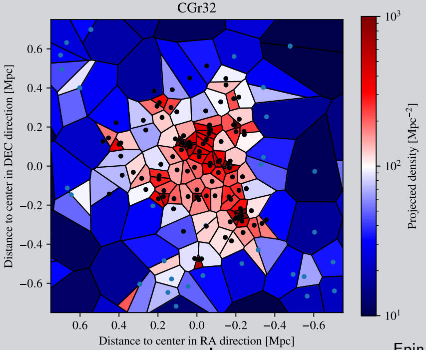
Galaxy population and dependence with environment



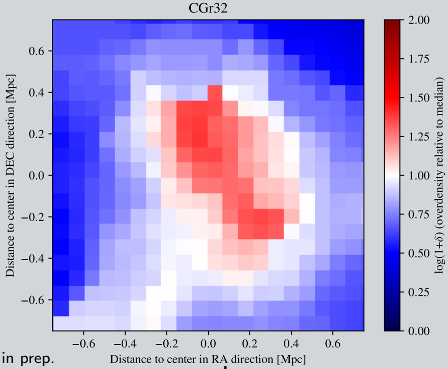
Mostly SF galaxies but **observed red sequence**

Redshift dependence due to survey design: **bluer galaxies at higher red-shift**

Local density estimates



Epinat et al., in prep.



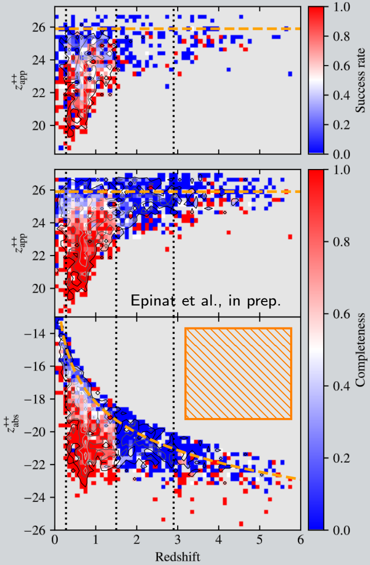
Voronoi tesselation

- **MUSE z-spec + zCOSMOS for the sides**
- No magnitude cut
- One tesselation per group

Voronoi Monte Carlo maps

- **zspec + zphot + zphot uncertainties**
- Magnitude cut: $18 \leq I^{+} \leq 24.5$
- Redshift bins: $\Delta V = \pm 1500\,\mathrm{km\,s^{-1}}$

MAGIC survey completeness



Completeness of 100% below $z^{++}_{app} \lesssim$ 24.5 & up to $z \approx 1.5$

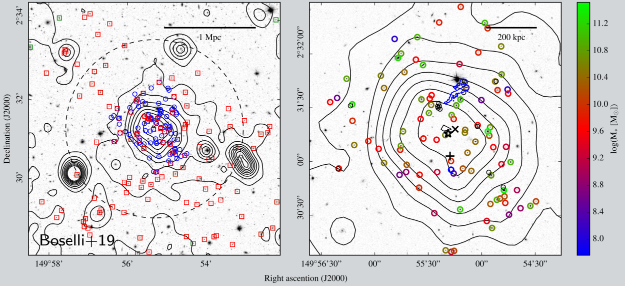
- ▷ Drop in completeness in $1.5 \lesssim z \lesssim 3$ (MUSE redshift desert)

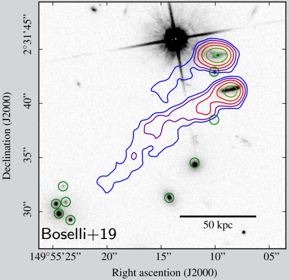
Blind-like survey

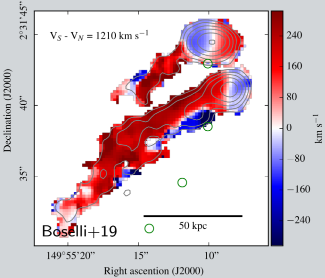
- ▷ Lack of faint galaxies at high-z (flux limited)

Main results

First evidence for ram pressure stripping at $z \sim 0.7$

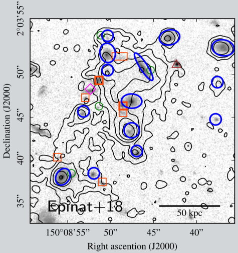


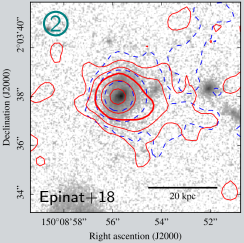


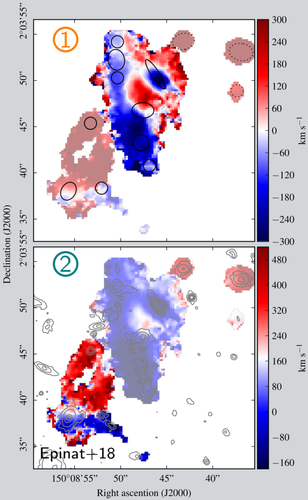


- Two massive gas-rich SF galaxies ($M_\star \sim M_{\rm gas} \sim 10^{10}\,{\rm M}_\odot$)
- Low SB ($\sim 1.5 \times 10^{-18}\,{\rm erg\,s^{-1}\,cm^{-2}\,arcsec^{-2}}$) long tails ($\sim 100 \times 20\,{\rm kpc}^2$)
- **No optical counterpart** in deep images
- Large gas deceleration

Giant ionised gas structure at $z \sim 0.7$

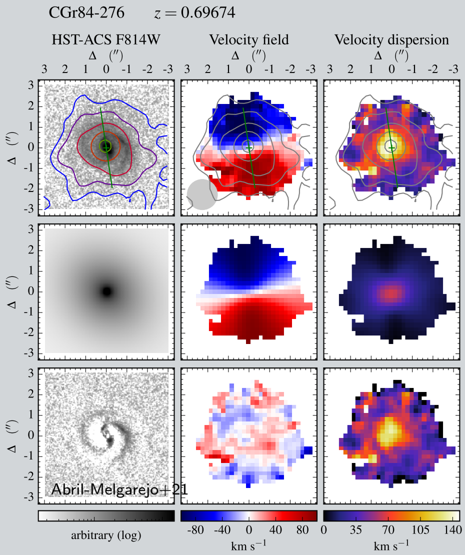






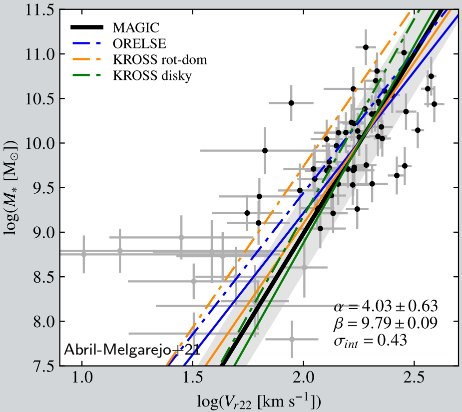
- ▷ **First detection** of two massive ($M_{gas} \sim 10^{10}$ $M_{\odot}$) and large ($\sim 10^4$ kpc^2) decoupled kinematic sub-structures:
  1. Gas kinematically bound to main galaxy → ouflow or gravitationnaly trapped stripped gas
  2. Presence of **tidal tails** & **AGN outflow**
- ▷ Different origins:
  1. Photo-ionisation & shocks
  2. At least AGN

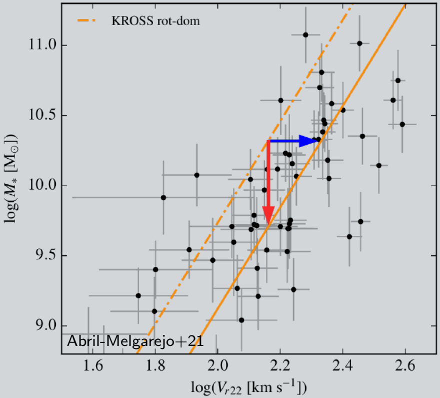
The TFR in dense groups at $z \sim 0.7$



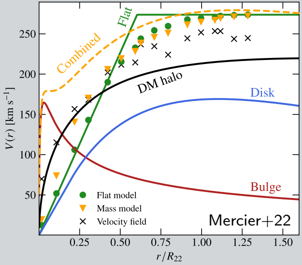
- Selection of well resolved and bright SF [OII] emitters in dense groups at $z \sim 0.7$
- **Morphological modelling** using HST maps
- **kinematical modelling** using the MUSE cubes
- Flat rotation curve

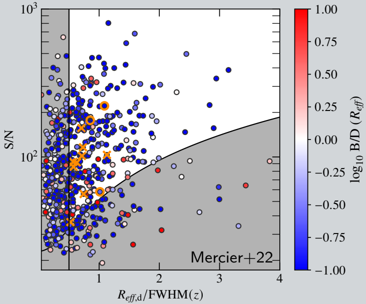
The TFR in dense groups at $z \sim 0.7$





- ▷ Comparison with KMOS3D, KROSS & ORELSE samples
- ▷ **Visible impact** of environment on the TFR
  - → Effect of quenching (mass build-up stopped in dense structures for a given DM halo) ?
  - → Effect of baryon contraction (peak velocity is increased by the contraction for a given stellar mass) ?

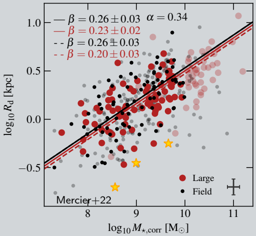




- ▷ Use of the entire sample of [OII] emitters
  - → **Field** galaxies (foreground & background)
  - → Separation between **small** & **large** structures
- ▷ Methodology similar to Abril-Melgarejo+21...
  - → ...except that we implement **mass models** constrained from morphology
  - → ...except that we study the **size-mass** and **mass-SFR** relations and the **TFR**
  - → ...and that we refine the selection

Galaxy scaling relations vs environment

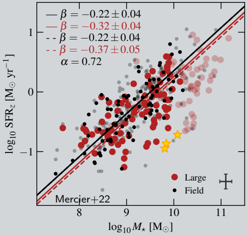
Size-Mass relation



Galaxies in massive structures **denser** than those in the field

▷ **15% smaller** at fixed stellar mass

MS relation

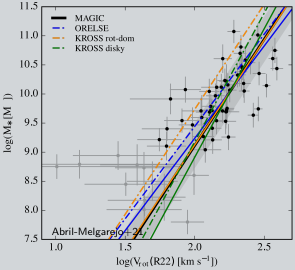


Reduced star formation in massive structures

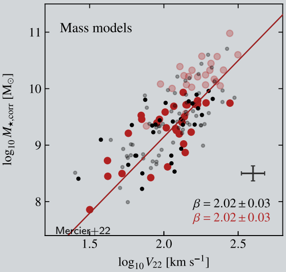
▷ reduction by a factor of **1.5** at fixed stellar mass

Galaxy scaling relations vs environment

Previous study (visible impact)



New study (no impact)



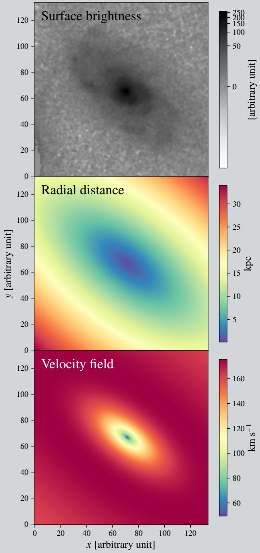
Previous positive result was a methodological effect

No impact on the TFR

⇓

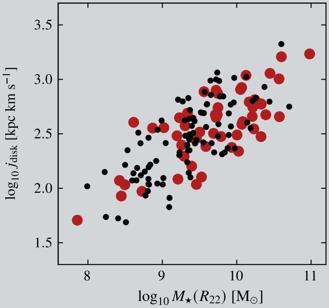
Environment **does not** impact the DM fraction of galaxies

Latest study: angular momentum in MAGIC



Disk hypothesis

$$j_{\rm disk} = \frac{\int_{\mathcal{S}} d\theta dR\, R^2 \Sigma(R,\theta) V_c(R)}{\int_{\mathcal{S}} d\theta dR\, R \Sigma(R,\theta)}$$



Conclusions

Impact of the environment on $z \sim 0.7$ SF galaxies with **MUSE**

- ▷ Multi-band data from COSMOS
- ▷ **High completeness and detection rate**
- ▷ Different environments (field, groups and clusters)
- ▷ Large statistics (>1000 [OII] emitters)

Synergy: HDUF & **MUSECATEL**

Data cubes already available

Catalogue upcoming (Epinat et al., in prep.)

Plenty of other science cases to study !