The future of galaxy evolution and environment with incoming facilities

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OaPD days 2024

Scientific overview & open questions

- ➔ Low-z clusters: gx bulk properties known up to **1Rvir** with spectroscopy follow-up (WINGS+OmegaWINGS) **[30 papers]**

- ➔ Int-z clusters: good **photometric** knowledge

- ➔ Low-z, Int-z **resolved** properties: MUSE data fundamental (GASP) **[65+6 papers]**

- ➔ Not-cluster environment (field, voids, walls, filaments, groups): no systematic study

Scientific overview & open questions

- Low-z clusters: gx bulk properties known up to 1Rvir with spectroscopy follow-up (WINGS+OmegaWINGS)

Go big! →

Low-z clusters: need to extend coverage to cluster outskirts (**Weave-Clusters, 4MOST-Chances, WST**)

- Int-z clusters: good photometric knowledge

Go far! →

Int-z clusters: need to get spectroscopic coverage (**Weave-StePS, 4MOST-StePS**)

- Low-z, Int-z resolved properties: MUSE data fundamental (GASP)

Resolve! →

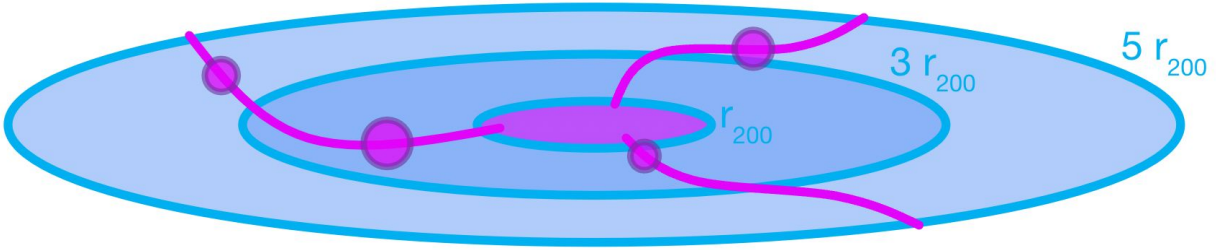
Low-z, Int-z need IFU + high angular resolution to get spatially resolved info (**MAVIS**)

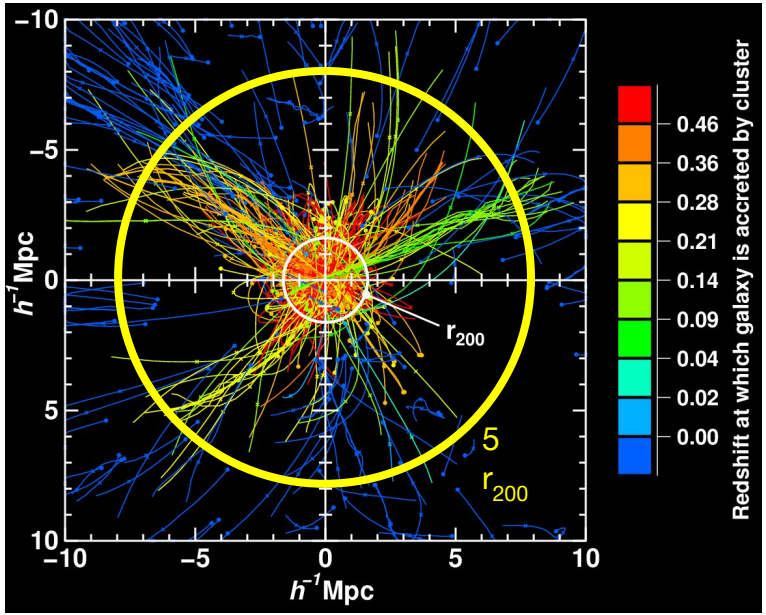
- Not-cluster environment (field, voids, walls, filaments, groups): no systematic study

Explore! →

Not-cluster environment: need to start from scratch a complete assessment (VST, MeerKAT+)

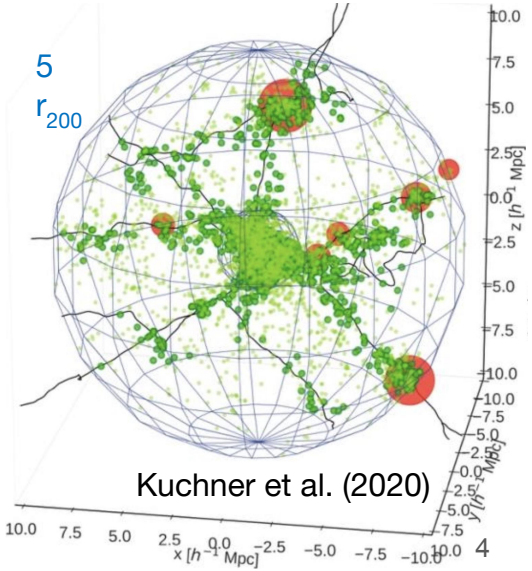
Go big!





Haines et al. (2015)

- Galaxies in the external regions keep track of the accretion history



@OaPD: Moretti, Bettoni

Weave cluster

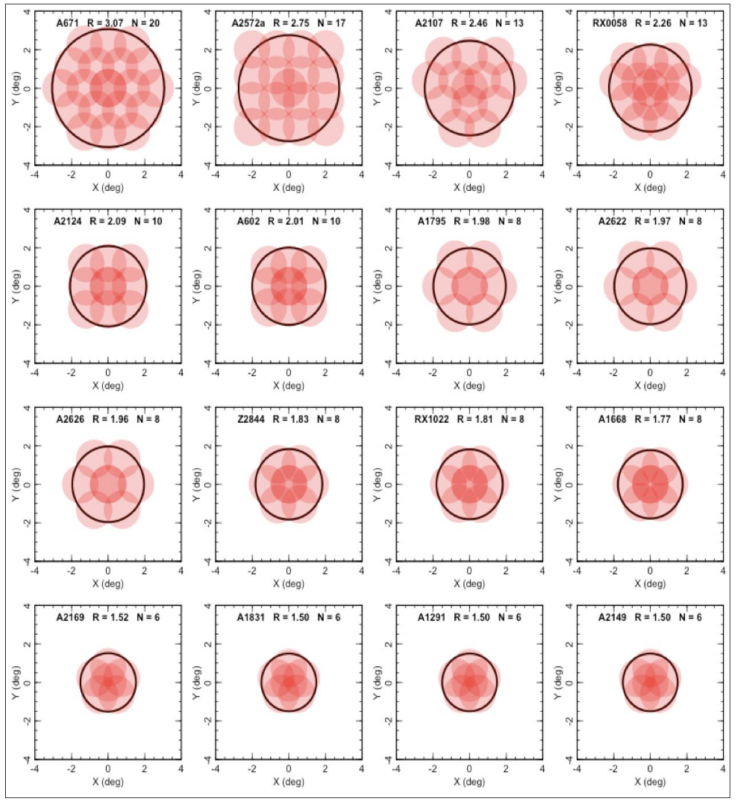
Dual beam spectrograph, feeding up to 1000 fibers (1.3”) over the 2x2 deg^2 FoV, with LR (5000) and HR (20000) and 3 modes:

- ***MOS***
- mIFU [20, 9” hex FoV]
- LIFU [1, 1.5’ hex FoV]

→ Weave-cluster survey [Aguerri]

3 core projects:

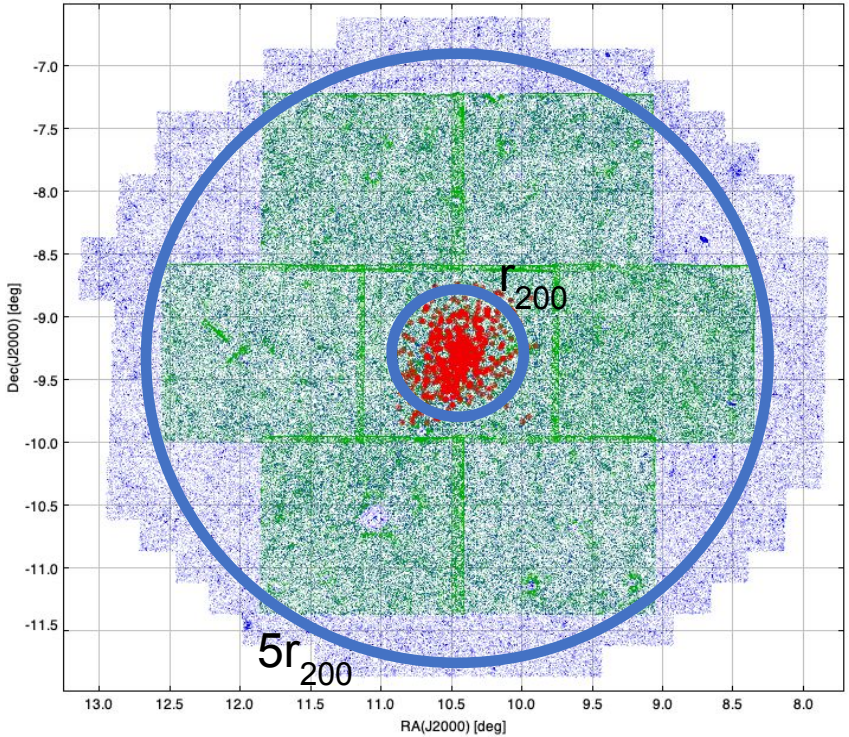
- low-z clusters (z<0.04): resolved stellar population of dwarf galaxies
- ***low-z clusters (mostly from WINGS): infalling regions***
- intermediate z clusters (up to 0.5): cosmological evolution of the inner cluster region



Chances cluster

@OaPD: Moretti, Poggianti, Vulcani

Abell 85 (z=0.055)



Wide field spectrograph, feeding up to ~2400 fibers (1.45") over the 2.5x2.5 deg^2 FoV, with 3 spectroscopic modes:

- HR spectrograph (~800 fibers, R~20000)
- 2 LR spectrographs (~1600 fibers, R~4000-7000)

→ 4MOST Chances survey at VISTA [Haines, Jaffe']

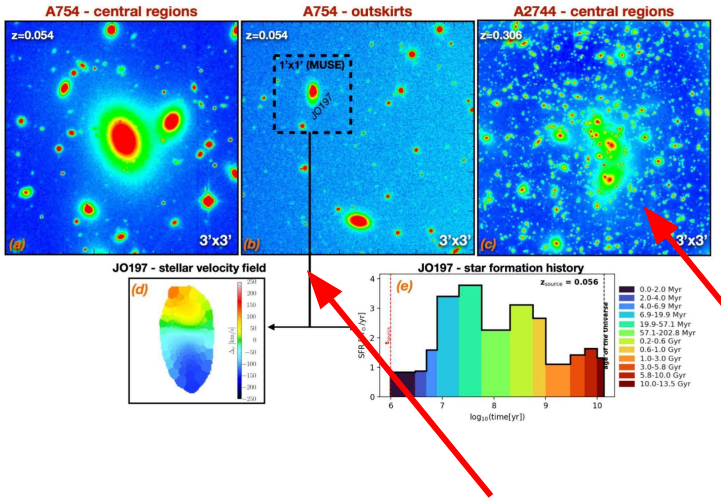
3 core projects

- Low-z survey (50 clusters, including WINGS up to z=0.07) reaching logM=8.5 and out to 5r$_{200}$
- Evolution survey (50 clusters up to z=0.45) reaching logM=10

Successfully installed on VISTA on 12th of June 2024!

@OaPD: Marasco, Gullieuszik, Moretti, Poggianti, Vulcani

Understanding the origin of present day galaxy Hubble types in different environments



10-m class **wide-field spectroscopic telescope (WST)** with

- a large field-of-view (5 sq. degree) and

- high multiplex (20,000) multi-object spectrograph facility with both medium and high resolution modes (MOS),

- a giant **(3'x3')** panoramic integral field spectrograph (IFS).

80 gx/pointing (center)/13 (periphery)

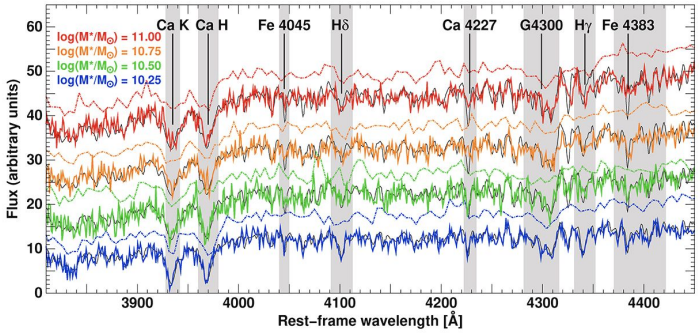
30 gx/pointing (center)/5 (periphery)

Go far!

→ Gx stellar population are hardly distinguishable for ages larger than ~ 5 Gyr ⇒ need to observe higher redshift galaxies to infer the first stages of star formation!

→ z>0.5 samples exist (albeit very limited, see LEGA-C, VIPERS) and suggest cases of rejuvenation… but have low spectral resolution

Fill the gap between 0.3 and 0.7 with high S/N observations of statistically significant sample of galaxies!



WEAVE

@OaPD: Gullieuszik, Poggianti, Vulcani, Moretti

Weave StePS

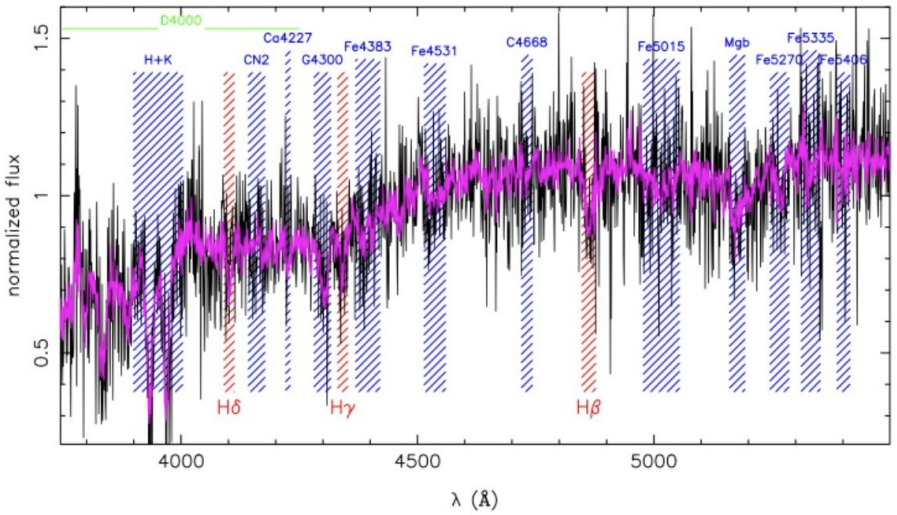
Dual beam spectrograph, feeding up to 1000 fibers (1.3”) over the 2x2 deg^2 FoV, with LR (5000) and HR (20000) and 3 modes:

- ***MOS***
- mIFU [20, 9” hex FoV]
- LIFU [1, 1.5’ hex FoV]

→ Weave-StePS survey [Iovino/Poggianti, Mercurio]

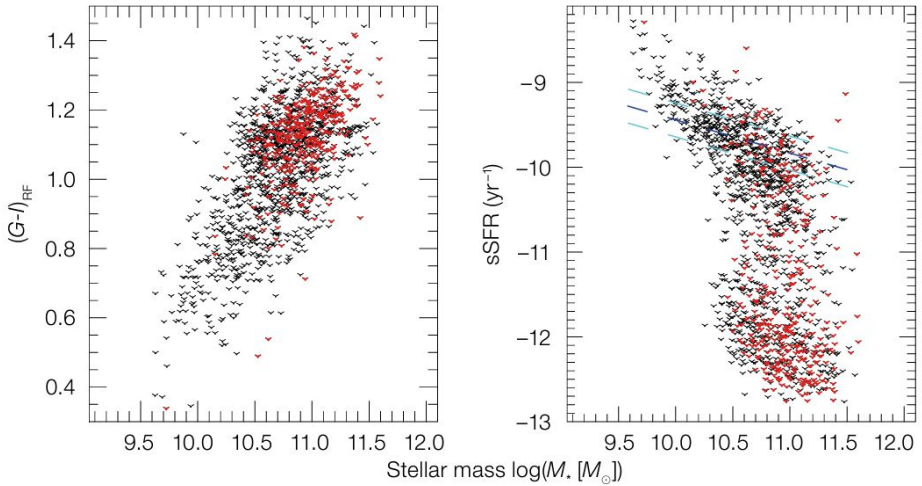
25000 gx at z=0.3-0.7 with ***S/N=10/A*** at R=5000 to track galaxy stellar populations as a function of stellar mass, SFH, environment

4 areas in the sky, mag limited sample (I_{AB}<20.5)



4MOST StePS

@OaPD: Moretti, Poggianti, Vulcani



Wide field spectrograph, feeding up to ~2400 fibers (1.45") over the 2.5x2.5 deg^2 FoV, with 3 spectroscopic modes:

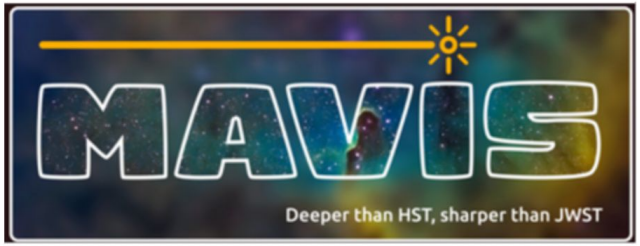
- HR spectrograph (~800 fibers, R~20000)
- 2 LR spectrographs (~1600 fibers, R~4000-7000)

→ 4MOST StePS survey at VISTA [Iovino]

- 3300 galaxies with I_{AB}<20.5 within the footprint of WAVES Deep survey with ***S/N=30/A***, R=5000, z=(0.3-0.7)

→ gx ages, metallicities/enhancement, sfh at int-z (unexplored) using also UV-based indices to infer rejuvenation processes
→ gas metallicities
→ kinematics of stars and gas
→ IMF signatures in the highest S/N spectra

Resolve the small scales!



What is the effect of the environment on

- morphological evolution ?
- size evolution/mass growth ?
- quenching mechanisms ?
- star formation ?

First light ~2030

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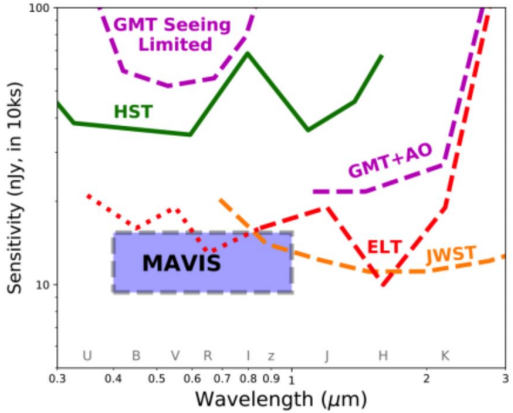
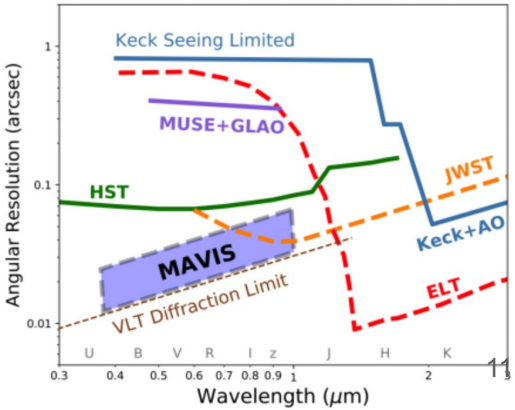


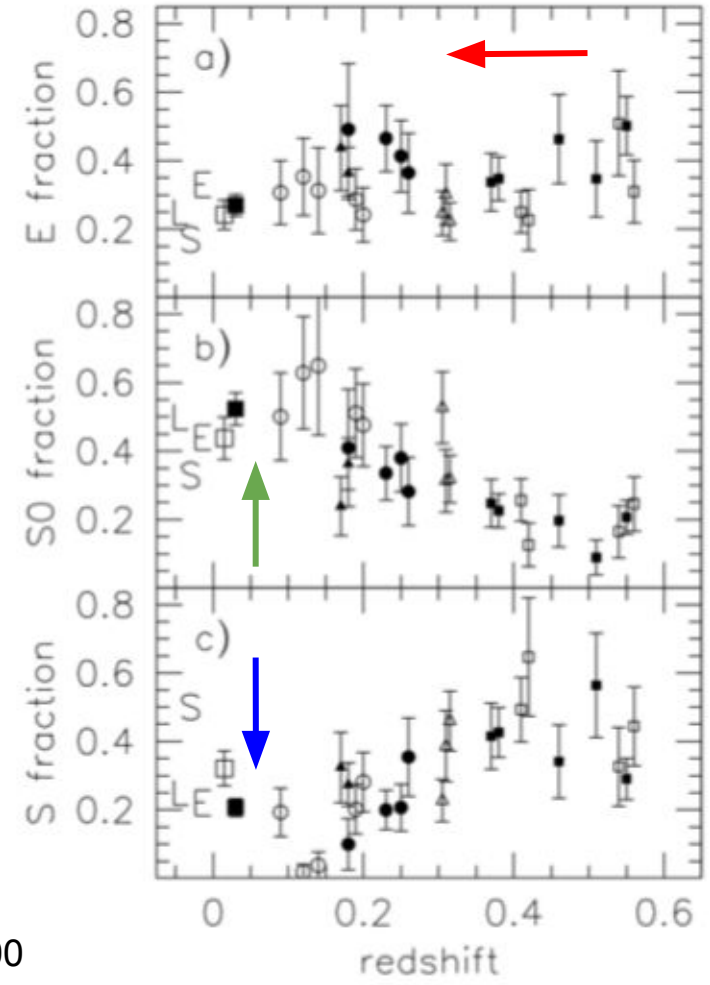


MAVIS science cases

→ Morphological evolution:

- distinguish E from S0
- are cluster and group/field S0 coming from different physical mechanisms?

MAVIS imaging (30”x30”) **in B** can do that for a large sample of cluster and groups environment at redshift 0.4-1 (with pre-selection on pre-existing surveys)



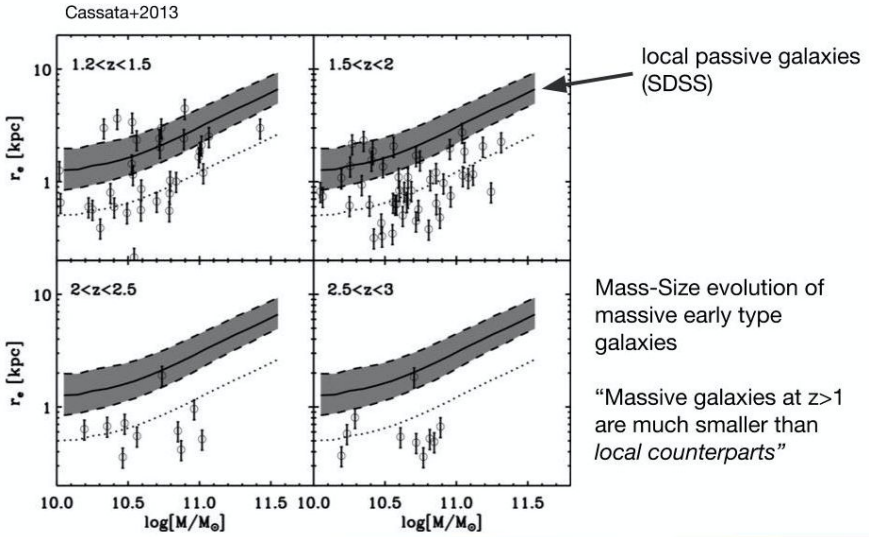
Fasano+2000

MAVIS science cases

→ Size/mass evolution:

- Build the correct progenitor-descendant tree in measuring the size evolution, i.e. who are the local counterpart of high-z supermassive gx?
- How significant/strong is the mass size evolution?

MAVIS imaging in R/I can map V rest-frame at 0.3-0.6 + high spatial resolution allow unprecedented size measurement



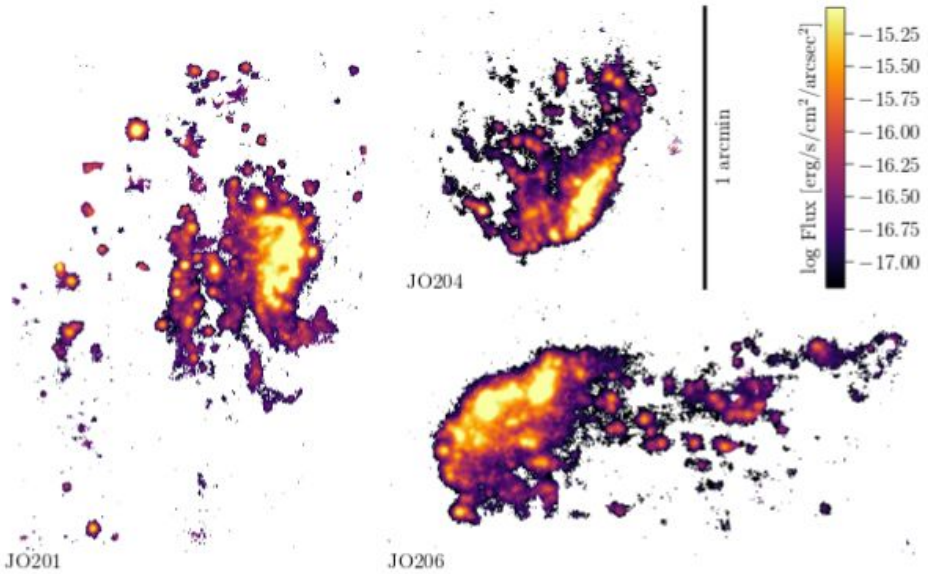
MAVIS science cases

→ Star forming clumps:

- SF clumps physical properties are related to environment?
- How are they distributed within a big complex seen through the PSF?
- Do they evolve with time?

[**BV-band imaging** at intermediate (0.5-1) z → UV restframe! W. 25 mas → ~200 pc

At low z map SF regions on tens of pc scale]



See Giunchi's poster for the HST data

MAVIS science cases

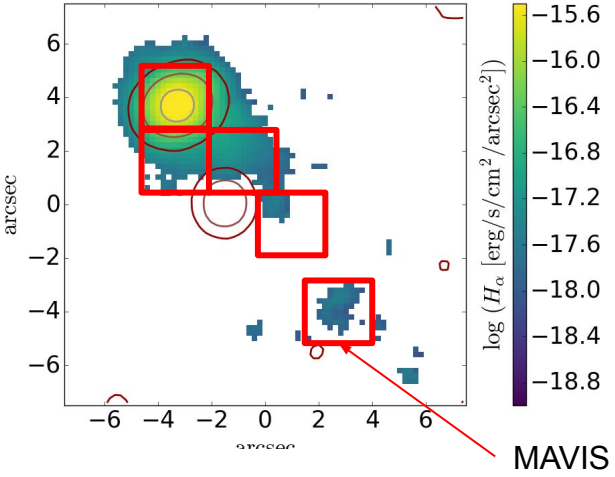
→ RPS at intermediate redshift:

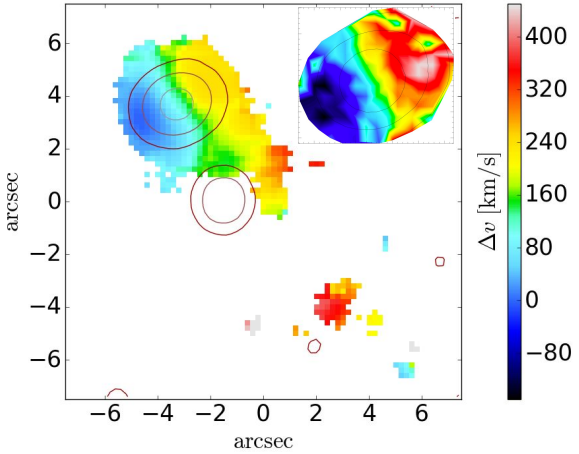
- Is the RPS important also at redshift ~0.3-0.7, i.e. when cluster form and many more galaxies are infalling?

  MAVIS IFU can map **OII, H_β** and **OIII** for a significant sample of galaxies preselected from McPartland+2016 (0.4), RELICS survey (0.2-1), ESO VLT CLASH (0.2-0.5)

  [2 pointings at z~1, 5 pointings at z~0.4, w. IFU 3”x3”; all lines out to 0.6 or 0.8 depending on reddest wavelength, mapping ~100 pc scale]

1 gx in A2744@z~0.3 w. MUSE-WFM ~5 kpc res





MAVIS science cases

→ RPS at intermediate redshift:

- Is the RPS important also at redshift ~0.3-0.7, i.e. when
  infalli

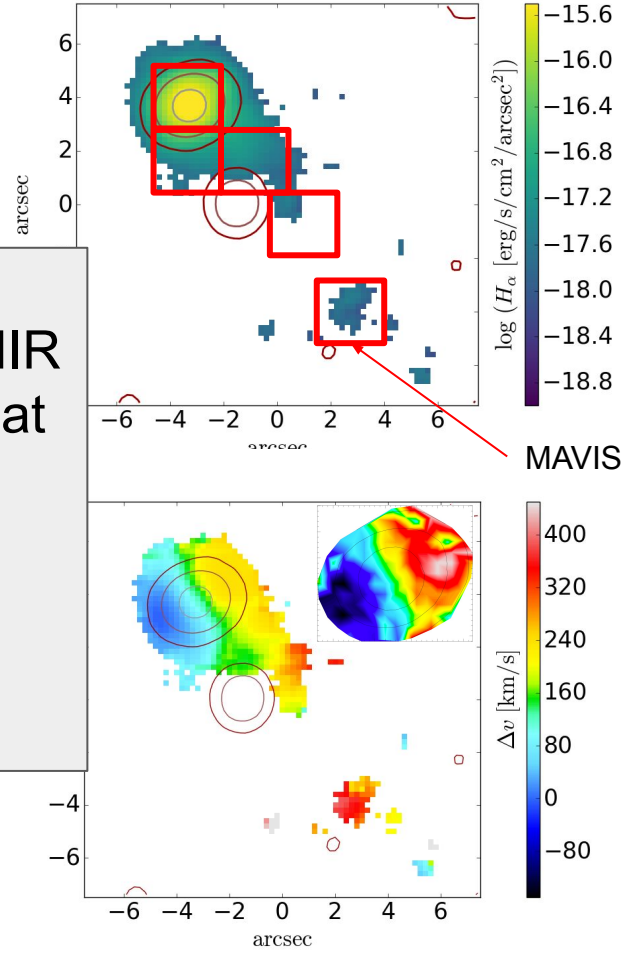
MAV
signif
McPa
ESO

[2 po
3”x3”
reddest wavelen pping ~100 pc scale]

Synergies with MICADO/MORFEO - NIR imaging at similar resolution (~70 pc) at any redshift!

Similar timescales (2029/2030)
Involved in the science case

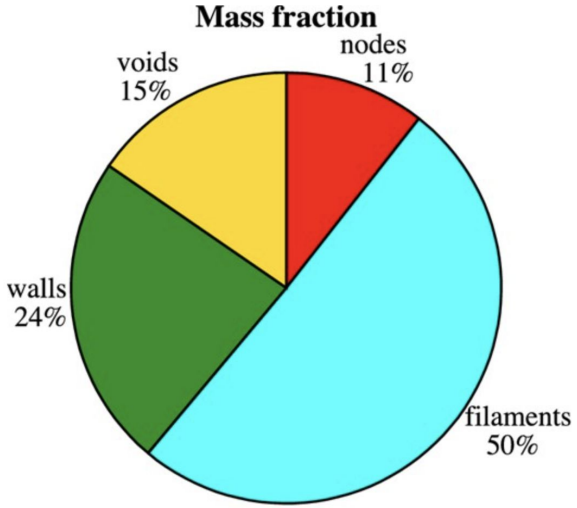
1 gx in A2744@z~0.3 w. MUSE-WFM ~5 kpc res



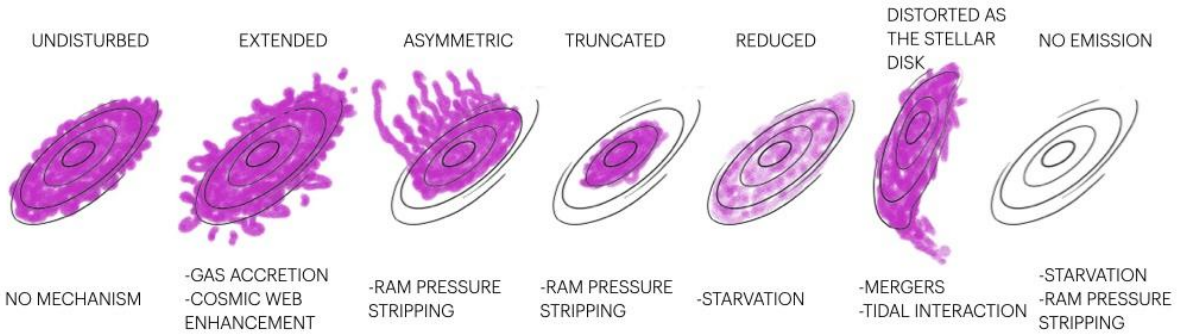
Explore the Universe…

→ most galaxies are NOT living their life within clusters!

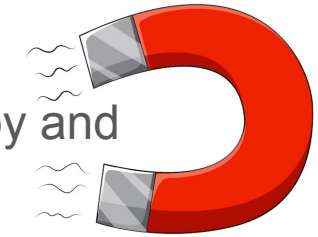
→ Many different processes can alter their stellar/gaseous distribution



Cautun+2014



MAGNET:
Mechanisms Affecting Galaxies Nearby and Environmental Trends



@OaPD: Gullieuszik, Marasco, Moretti, Poggianti, Vulcani + Ignesti, Lassen

Multiwavelength ambitious project to get data on
→ ionized gas (Hα)
→ cold neutral gas (HI)
→ cold molecular gas (H2)
→ stars

- in different environments (filaments, groups, voids)
- at low redshift (0.01-0.04)

STEP 1: VST-MAGNET proposal submitted to get Hα data on a 3-5 yrs timescale for a large region encompassing different environments

STAY TUNED!