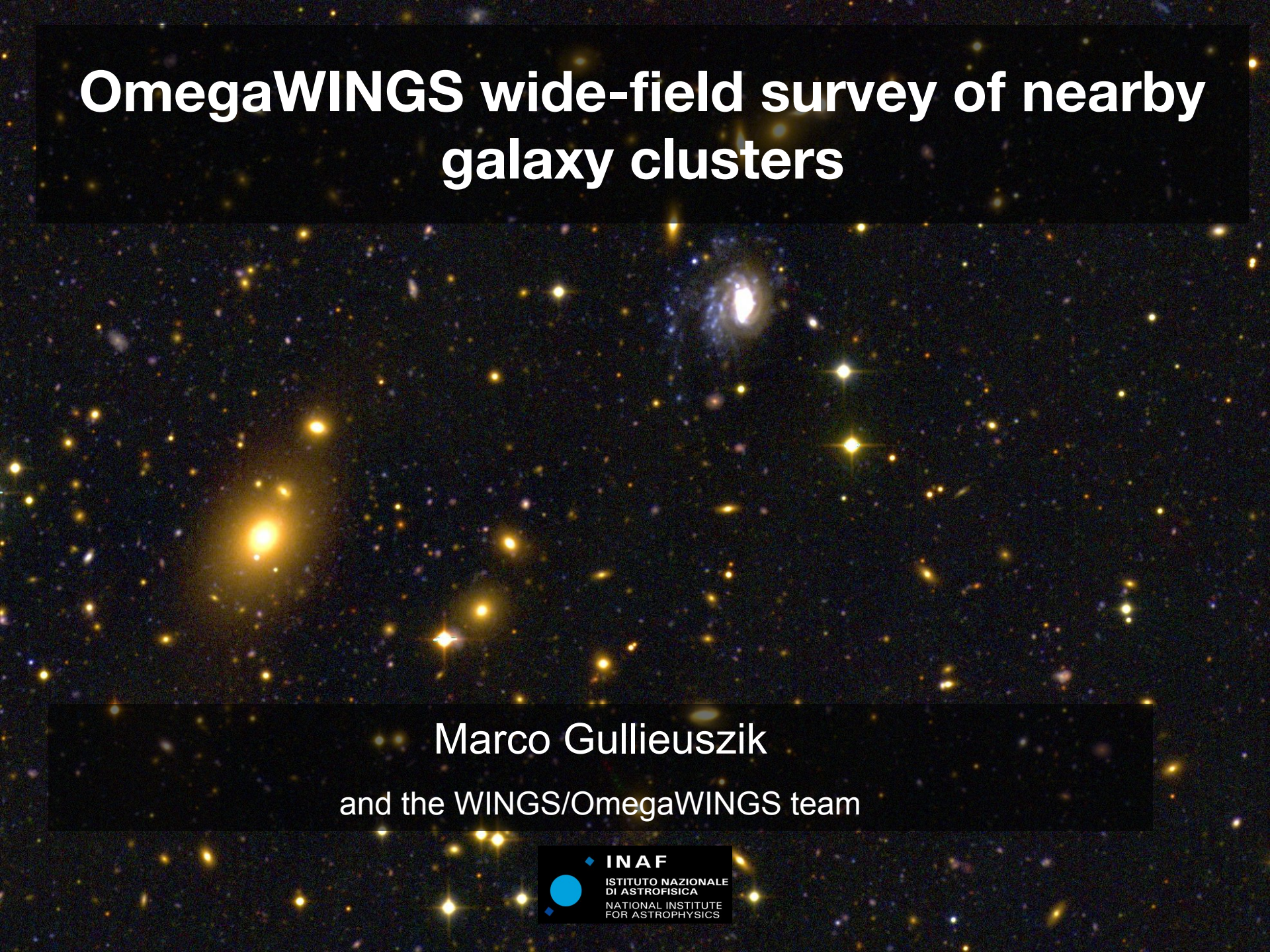
OmegaWINGS wide-field survey of nearby galaxy clusters



Marco Gullieuszik

and the WINGS/OmegaWINGS team

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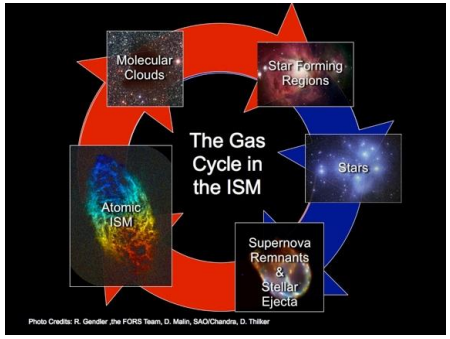
VLT Survey Telescope

- Galaxy evolution & environment
- **OmegaWINGS**:
  - a wide-field survey of nearby clusters with **OmegaCAM@VST**
  - selected results
- **GASP**
  - a OmegaWINGS followup with **MUSE@VLT**
- GASP progress and follow up programmes

Galaxy evolution

key physical mechanisms regulating galaxy evolution



internal mechanisms

> mass, AGN feedback, dynamics

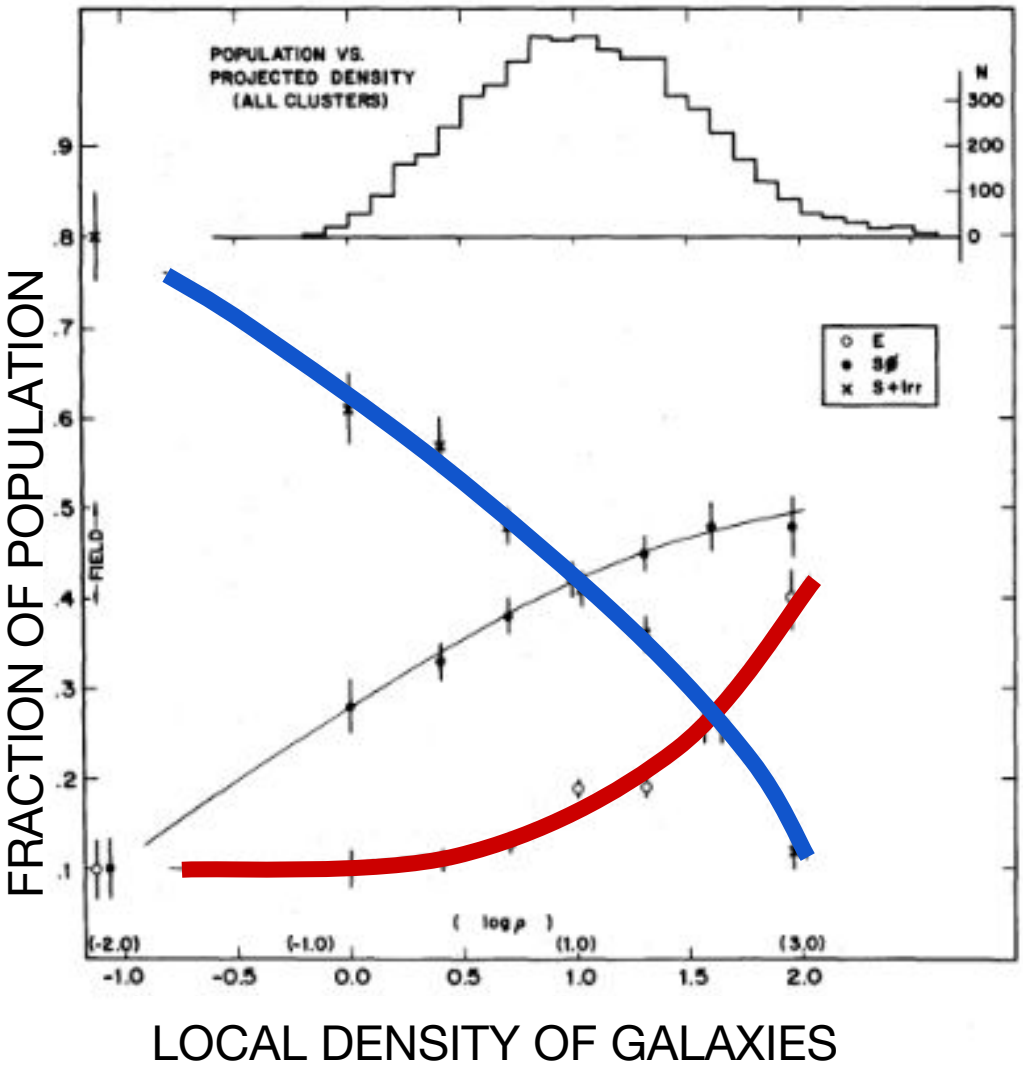
external mechanisms

> environment, interactions, mergers

What are the drivers of *diversity* in growth histories?
What shapes star formation histories?

Galaxy evolution

morphology - density relation

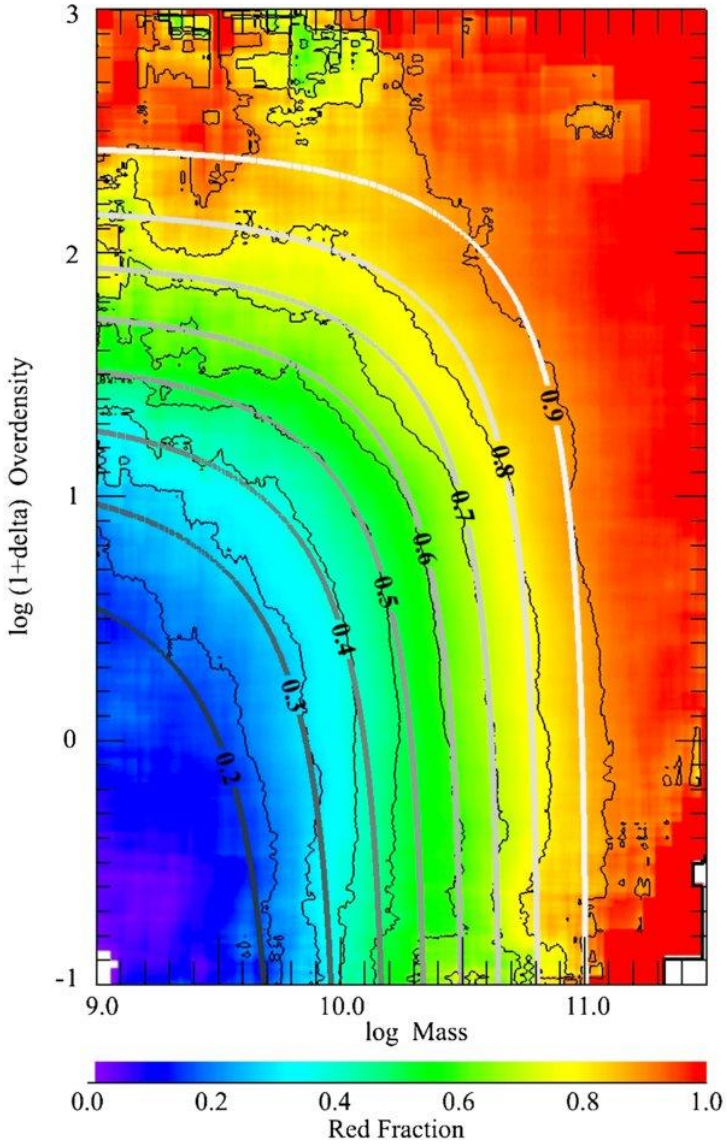


- ○ **ellipticals**
- ● So
- X **Spirals + Irr**

Dressler+1980

Galaxy evolution

Peng+2010



the differential effects of galactic mass and of the environment in the quenching of galaxies are fully separable (Peng+2010)

Mass quenching /
Environmental quenching

> What are the mechanisms that regulate the evolution of a galaxy?

> Is the quenching due to mass/environment/both?

> What is the mechanism acting in different conditions?

The WINGS survey

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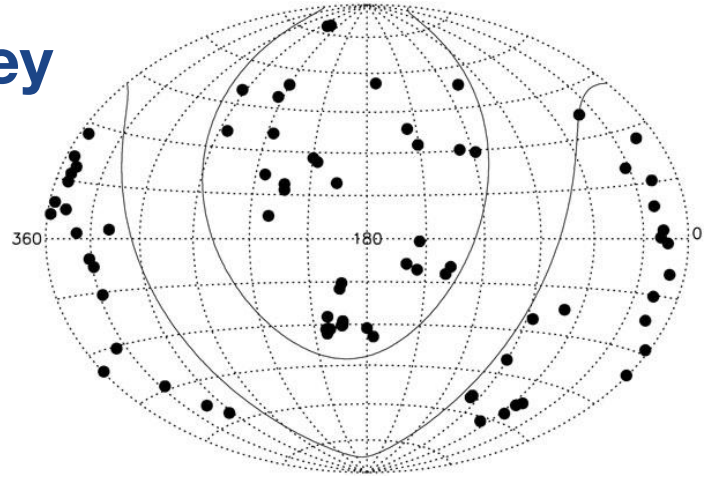
WIde-field Nearby Galaxy-cluster Survey



Fasano et al., 2002, Fasano et al., 2006, Moretti et al., 2014

Started back in 2001 to fill the redshift gap between Virgo/Coma and high-z clusters.

Survey of 76 X-rays selected clusters at z=[0.04-0.07]

30′ x 30′ FoV: B,V imaging (WFC@INT and WFI@2.2ESO

48 clusters have spectroscopic follow-up (~6000 redshifts, ~5300 SFH)

Complemented by NIR/U imaging

Images and catalogs available (VO tools)

The OmegaWINGS survey

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Gullieuszik et al., 2015, Moretti et al., 2017

Motivation

All WINGS results are based on data of the central regions (30 arcmin) of the target clusters.

these do not include the outskirts of clusters and the infalling regions, where clusters accrete new galaxies.

morphologies, sizes, structural parameter in different vs. distance from the center

cluster luminosity profiles out to virial radius

Data

u', B- and V- band OmegaCAM imaging

all WINGS clusters observable from Paranal

> 46/76 WINGS clusters

> 50% completeness at V=23 mag

AAOmega@AAT spectroscopy [18 Nights] 3800 and 9000 Å ; R=1300

> 33 clusters, ~18.000 redshifts

> 90% completeness at V=20 mag (7500 new members)

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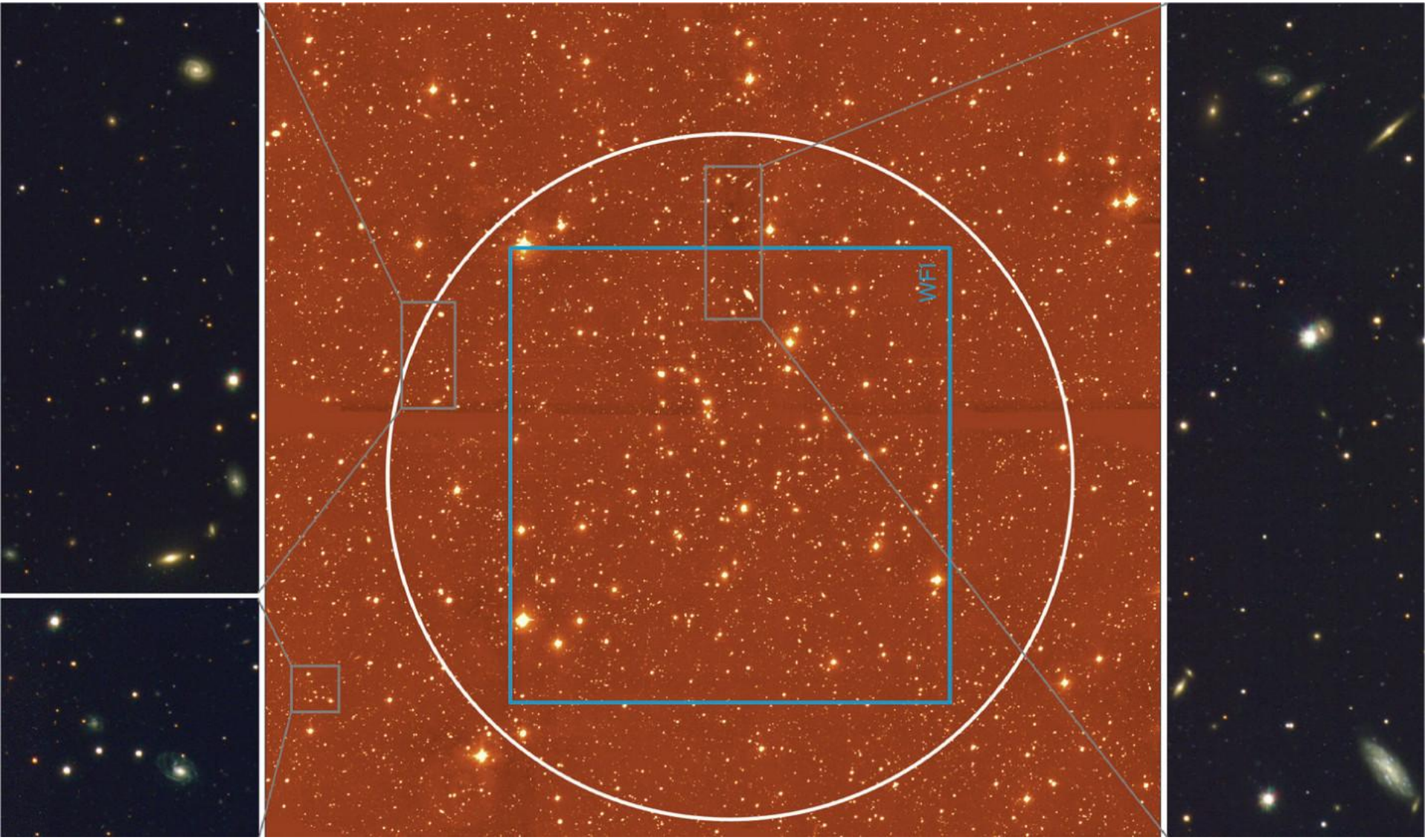

A2399 V-band (RGB images from OmegaWINGS u- B- V-band)

Gullieuszik+2015 The Messenger

The OmegaWINGS survey: transition galaxies

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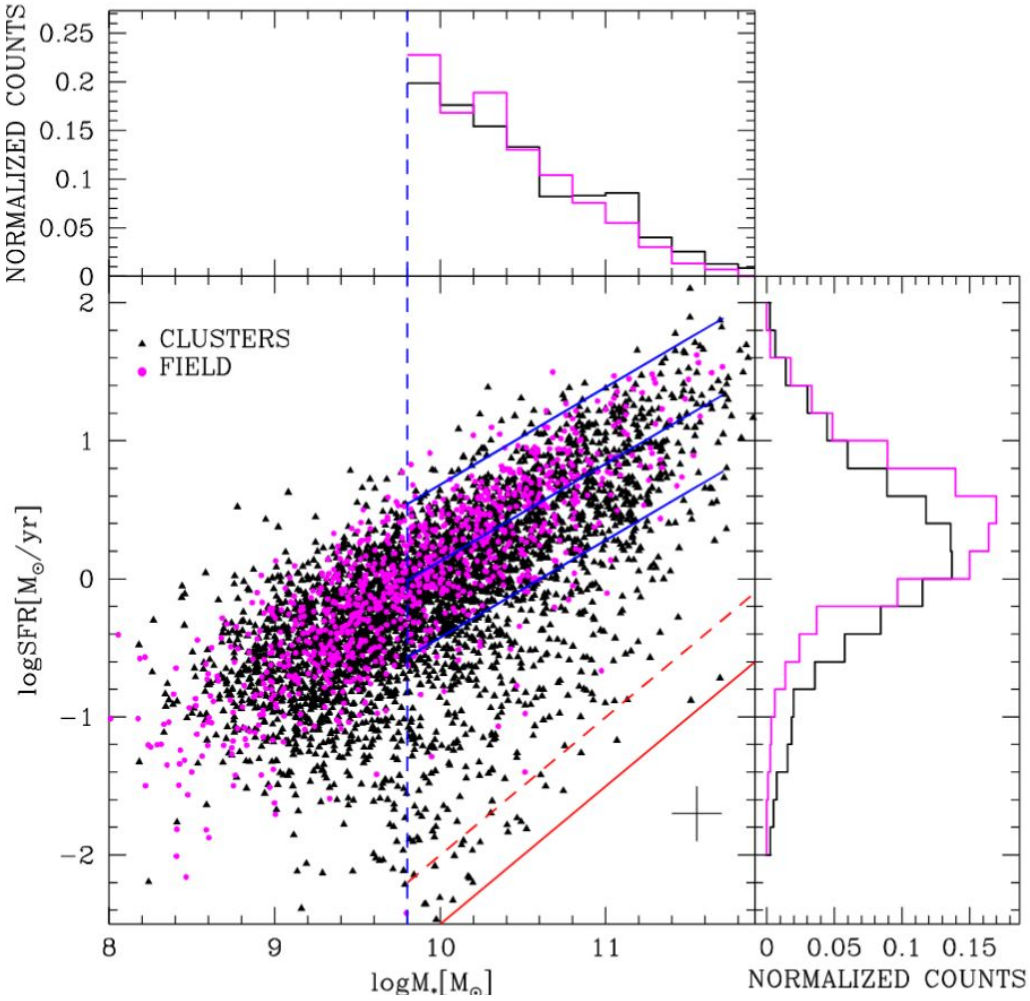
Low-z clusters possess a population of transition galaxies, which are seen in the act of being slowly quenched (strangulation/starvation?)



Paccagnella+2016

The OmegaWINGS survey: transition galaxies

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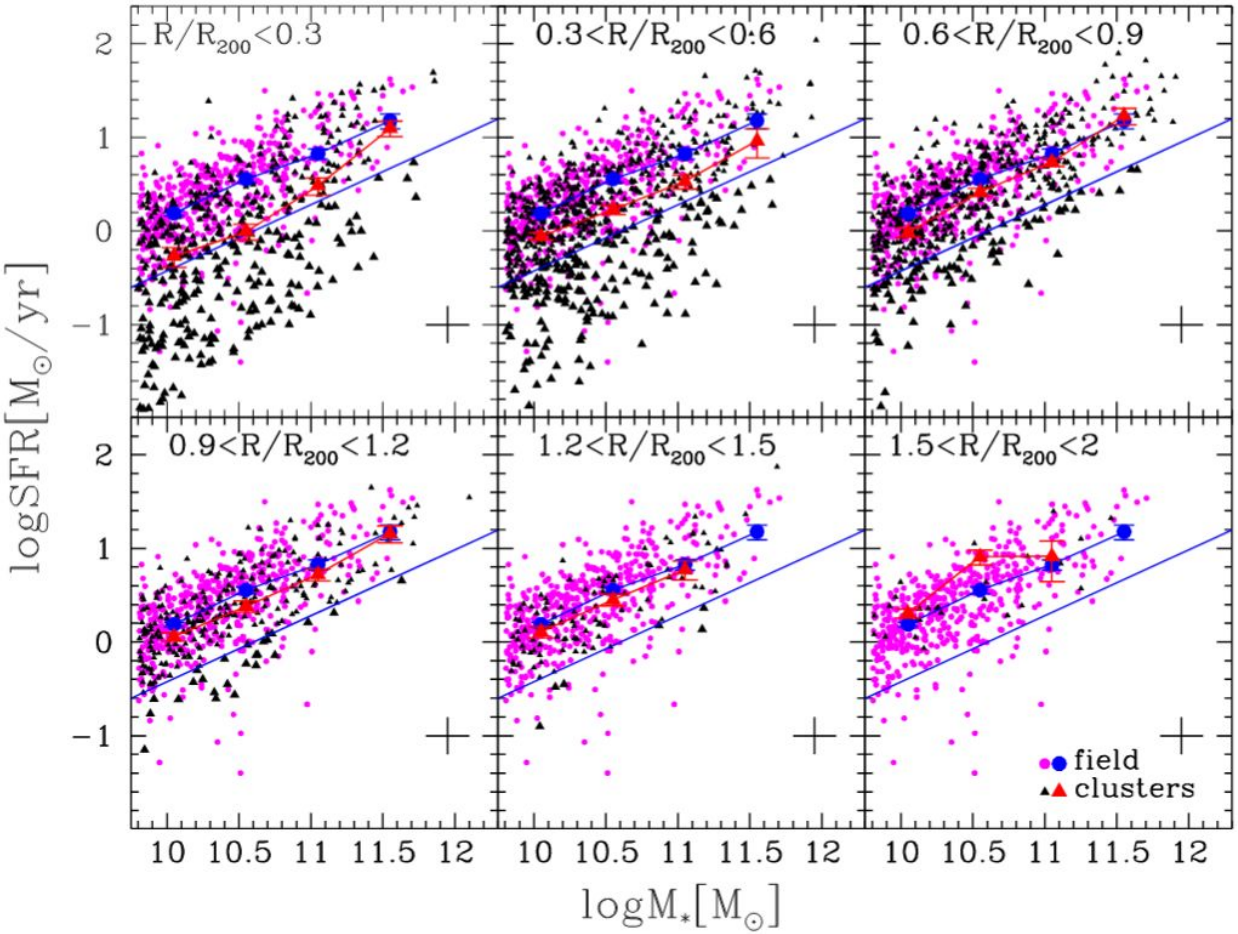


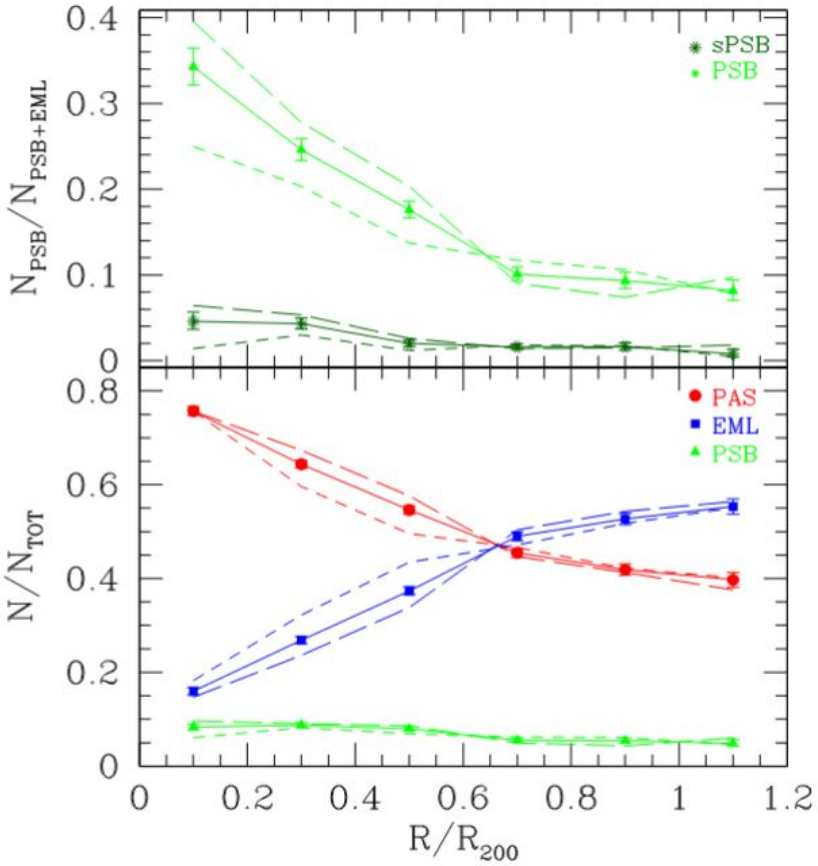
Paccagnella+2016

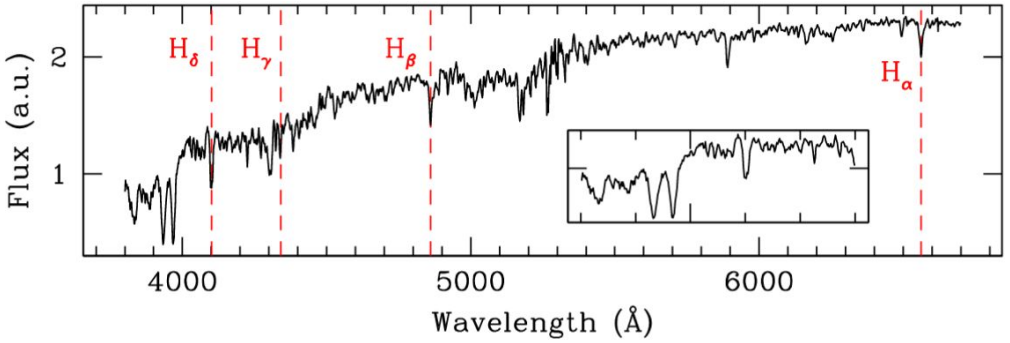
Transition galaxies are mainly found within $0.6R_{200}$ (30% of SF galaxies) where environment plays a major role

The OmegaWINGS survey: PSB

OmegaWINGS: The First Complete Census of Post-starburst Galaxies in Clusters in the Local Universe. Paccagnella+2017

First characterization of PSB galaxies (tracers of fast quenching - 1 Gyr) in clusters out to 1.2 R_{200}





More frequent toward cluster centers and in more massive/relaxed clusters

Fraction of PBS is similar to the fraction of transition galaxies.

If common progenitor, given the timescales, **the fast quenching is twice more efficient than the slow quenching channel** in the build up of the passive population

The OmegaWINGS survey: gas stripping

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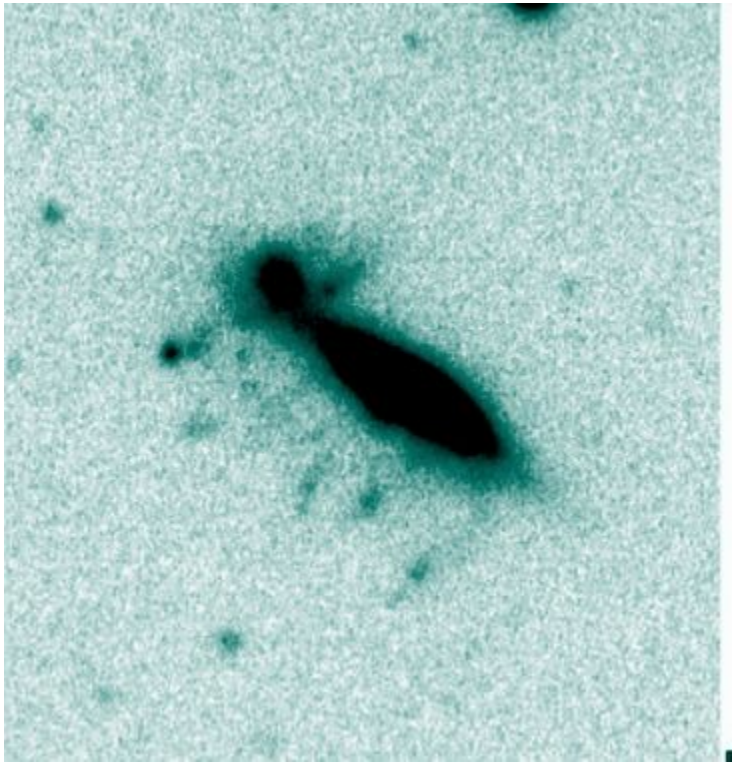
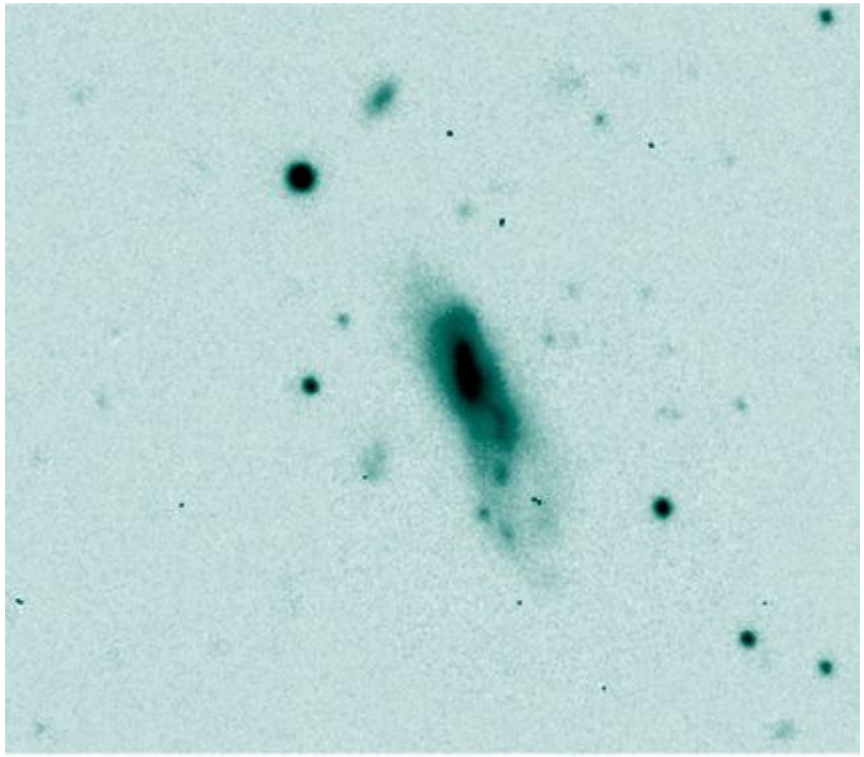
Fast quenching - Ram-pressure stripping

Poggianti+2016 : first systematic search for galaxies that are being stripped of their gas at low-z

WINGS/OmegaWINGS: clusters; PM2GC: groups and low-density environment





344 candidates in 71 galaxy clusters of the OMEGAWINGS+WINGS sample and **75** candidates in groups and lower mass structures in the PM2GC sample

GASP survey

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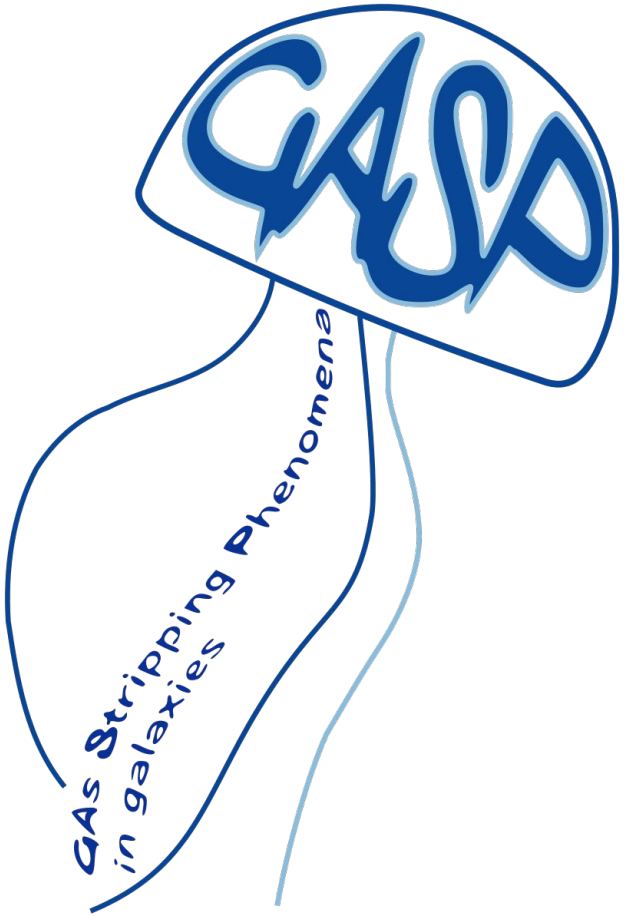
Gas Stripping Phenomena in galaxies
ESO Large Programme - PI Poggianti



120h with MUSE@VLT
94 Gas stripping candidates (clusters/groups/field)
20 galaxies as control sample
z=0.04 - 0.07

where, how, why is gas removed from galaxies?
what is the effect on the galaxy SFH?

Poggianti et al. (2017) ApJ, 844, 49
http://web.oapd.inaf.it/gasp

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K. George (India)
M. Mapelli (INAF-OaPD, Uni. Innsbruck)

GASP survey

→ Galaxies in different environments
clusters, groups, field+control sample

→ Galaxies with different masses
from 10^{9} to $10^{11.5}$ M_{SUN}

→ Galaxies with different stripping signatures
Jclass 1-5, taken from Poggianti et al., 2016

- 114 [94+20] gx, 120 hrs,
  2700s/pointing
- **Fov 1'x1' ~60x60 kpc^2**
- 1e5 spectra/pointing
- spatial: 0.2"/px
- spec: 4700-9300 A, 2.5 A FWHM

GASP survey

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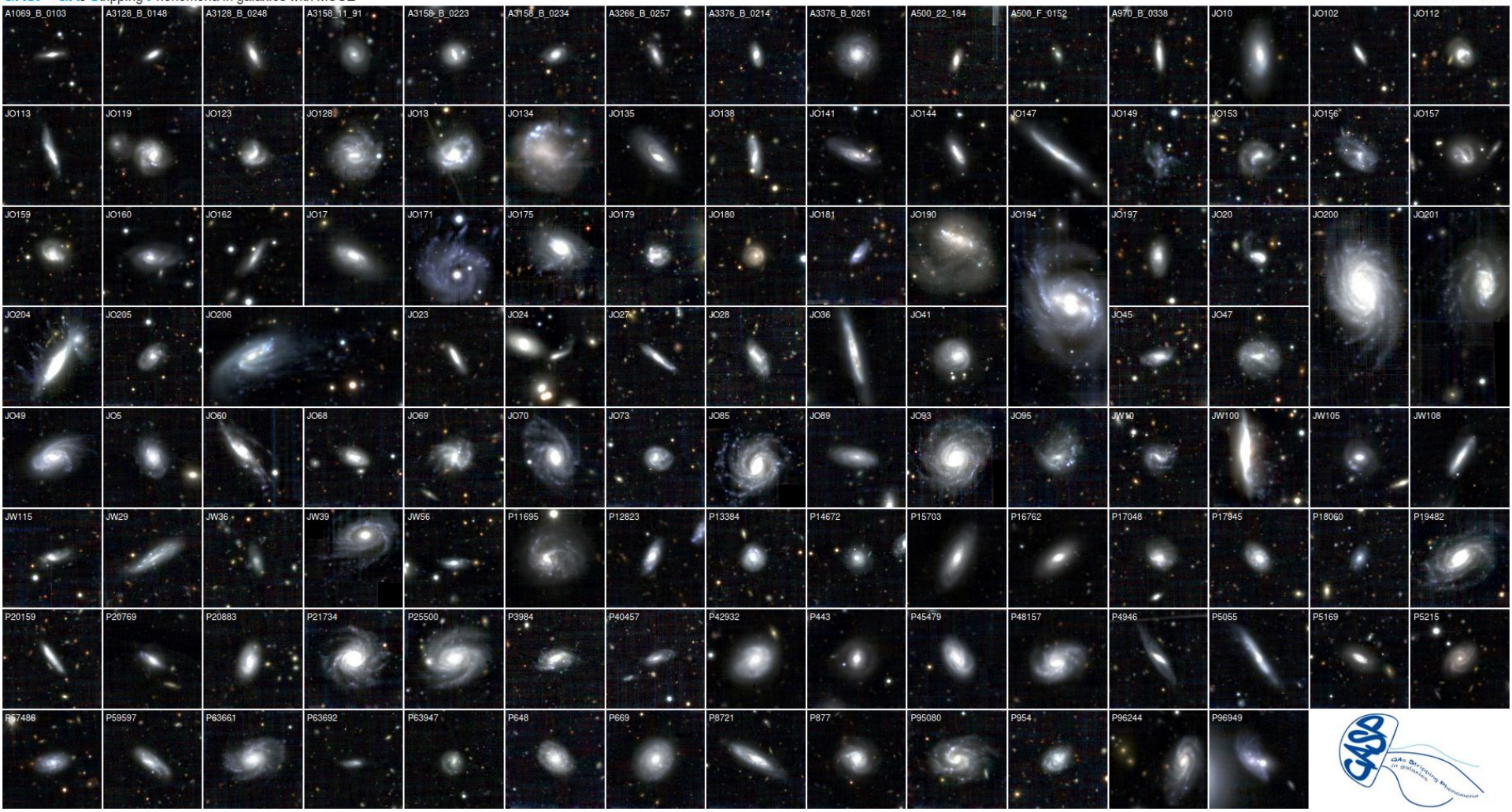
GASP - GAs Stripping Phenomena in galaxies with MUSE

Marco Gullieuszik



Observations completed April 15th 2018; 11 papers

DR1 released (50% of galaxies). DR2 (100%) in April 2019

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GASP - GAs Stripping Phenomena in galaxies with MUSE

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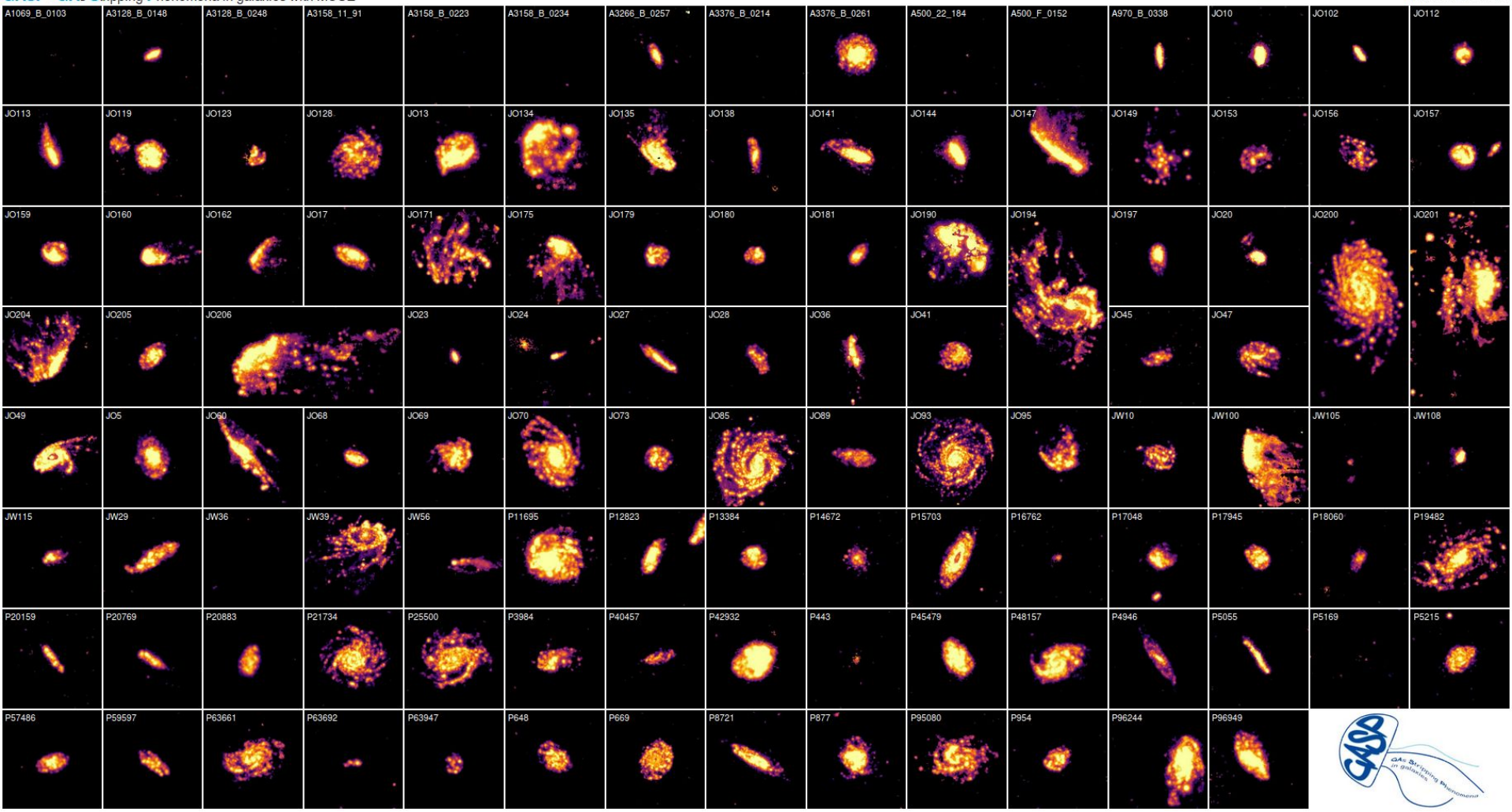

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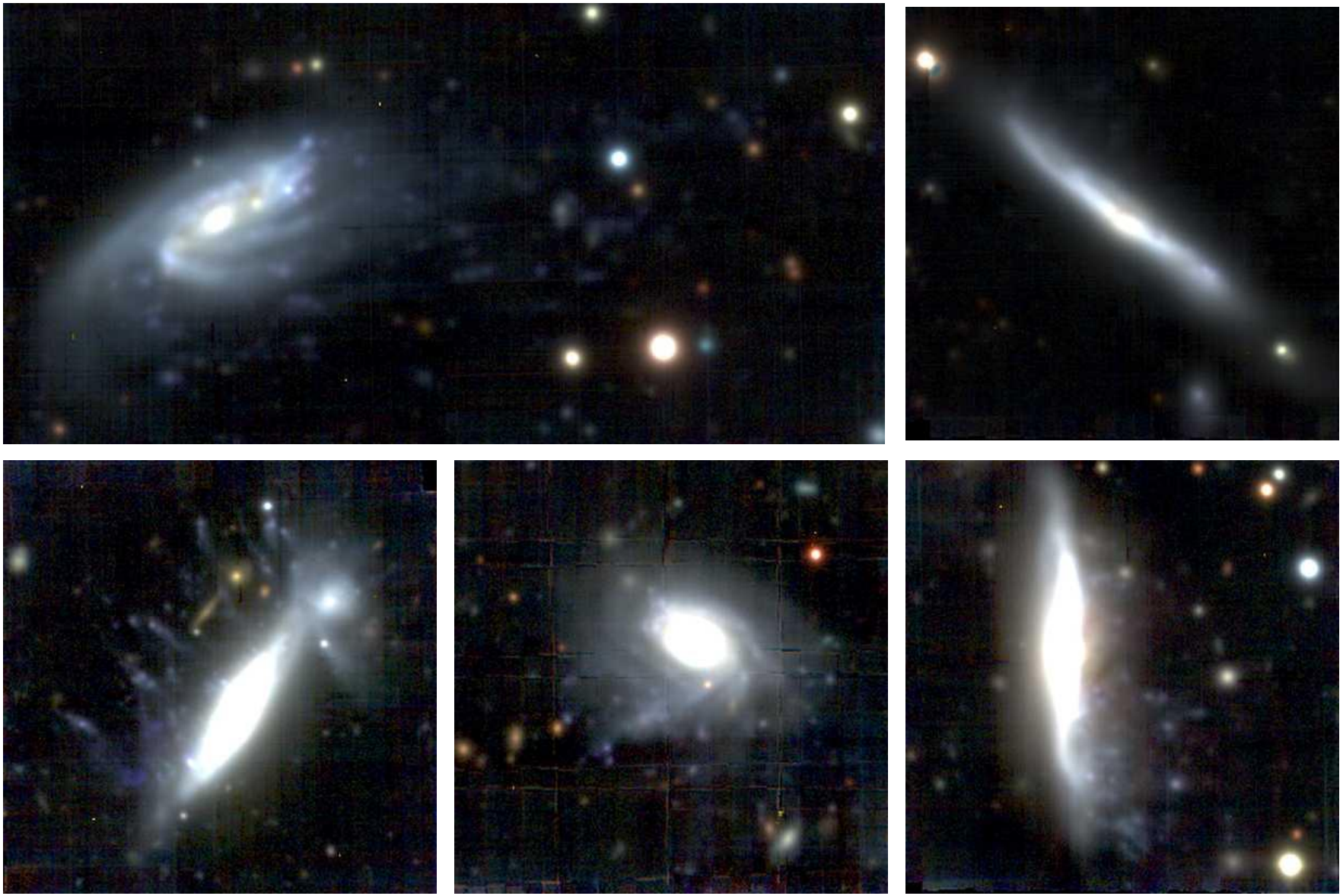
GASP survey



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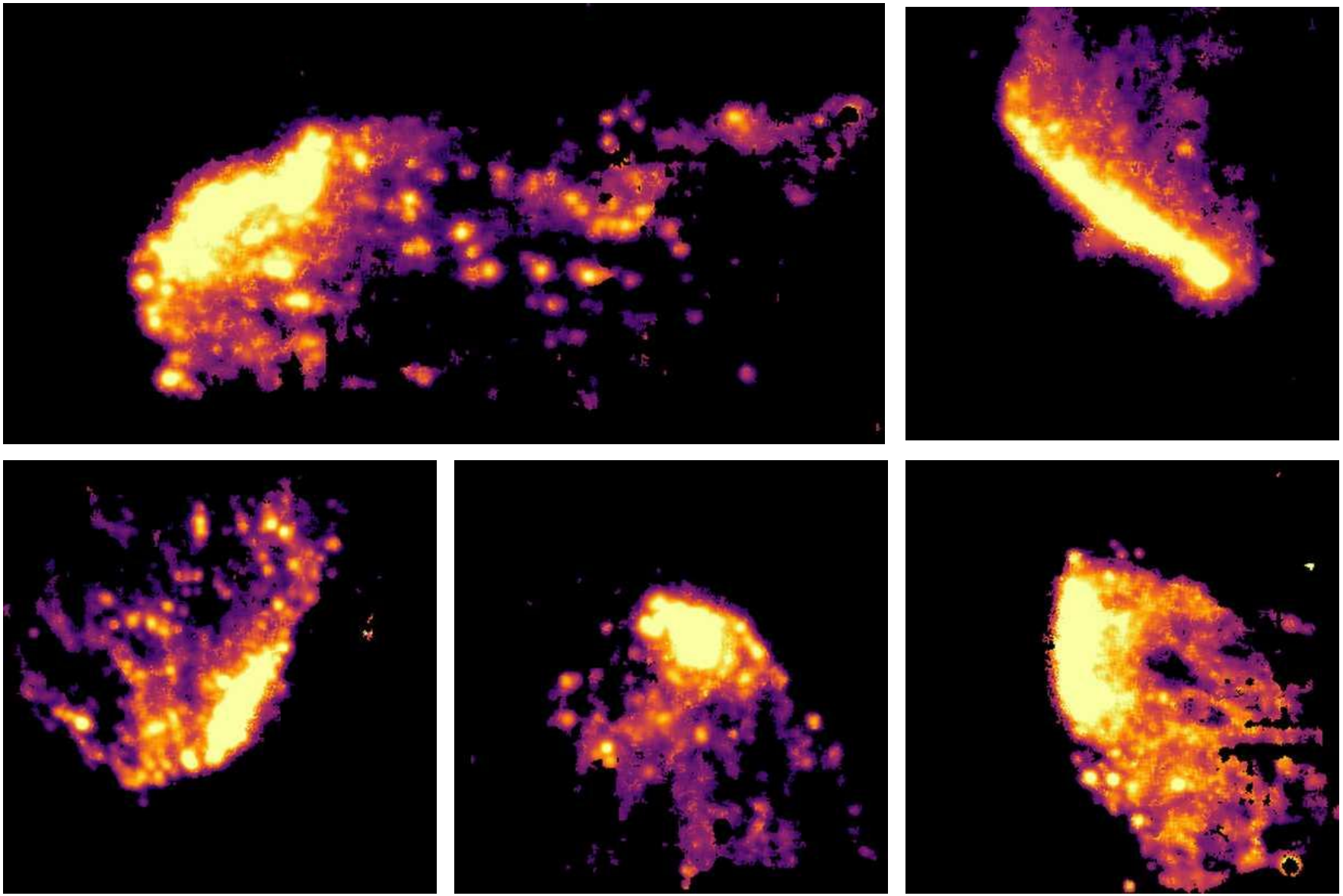

GASP multi-wavelength follow-up campaigns

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radio pol.

Magnetic field

→ Deep (50h) observations with **JVLA** to detect magnetic field in the tails and in the disc of JO206. Observations will be carried out next semester.

H2

Molecular gas

→ CO gas with **APEX** (33+44 hrs) for 5 galaxies to detect molecular hydrogen in the galaxies and in the tails: is the molecular gas stripped as well or is it formed in situ? How much molecular gas is present in the tails and left in the main body? Moretti et al., submitted.

→ **ALMA** observations [4 targets, 22 hrs allocated, all with AGN, in different clusters. 1 kpc resolution would allow to resolve the knots as in GASP. CO21 and CO10]. Ongoing observations

HI

Cold gas

→ Deep HI observations of 15 JF in 5 clusters with **JVLA** (100 hrs, 15 kpc resolution)[mainly to study the interplay of the different gas phases, but also to correlate HI deficiency to the JF appearance and to discover interactions, if any.]. Observations completed. Ongoing analysis

UV

Ongoing star formation

→ Ultraviolet view of RPS in action with **UVIT**/Astrosat (1” resolution; 30’ FoV; 3 clusters; 25ks each) Koshy et al. in press

X

→ **Chandra** observations [14 galaxies with masses >2e10 and JClass>=3, 10-60 ks each, 560 ks in total, 11 already show X-ray emission Nicastro et al., in preparation. To detect AGN signatures, shock fronts, ULXs]

GASP survey

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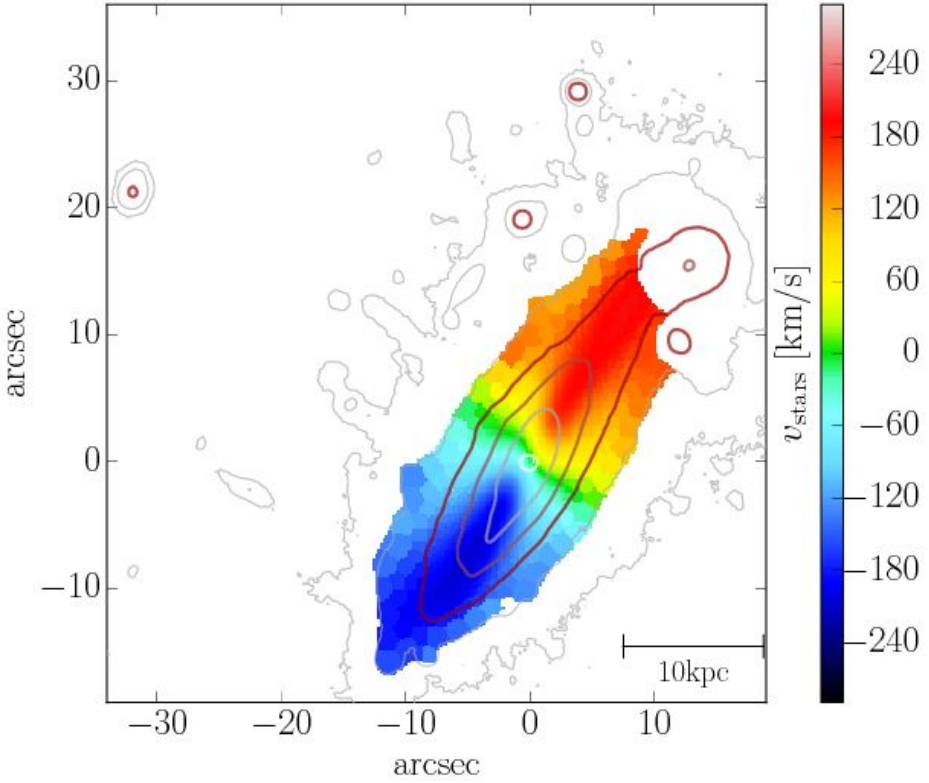
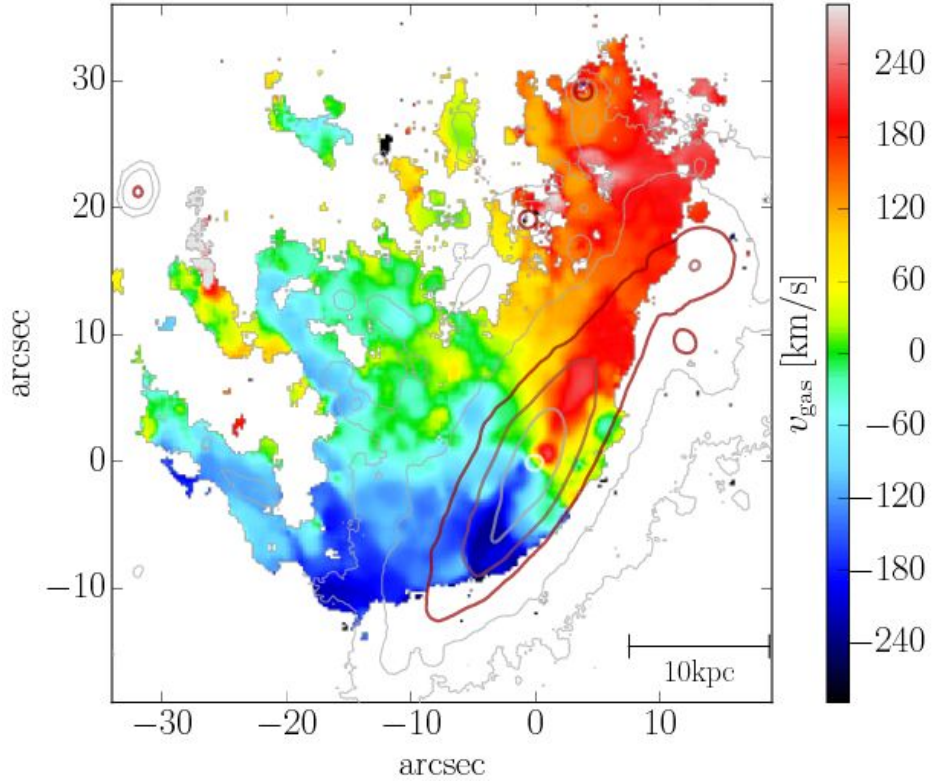
Stellar and gas kinematics: **evidence of ram-pressure stripping**

Stars

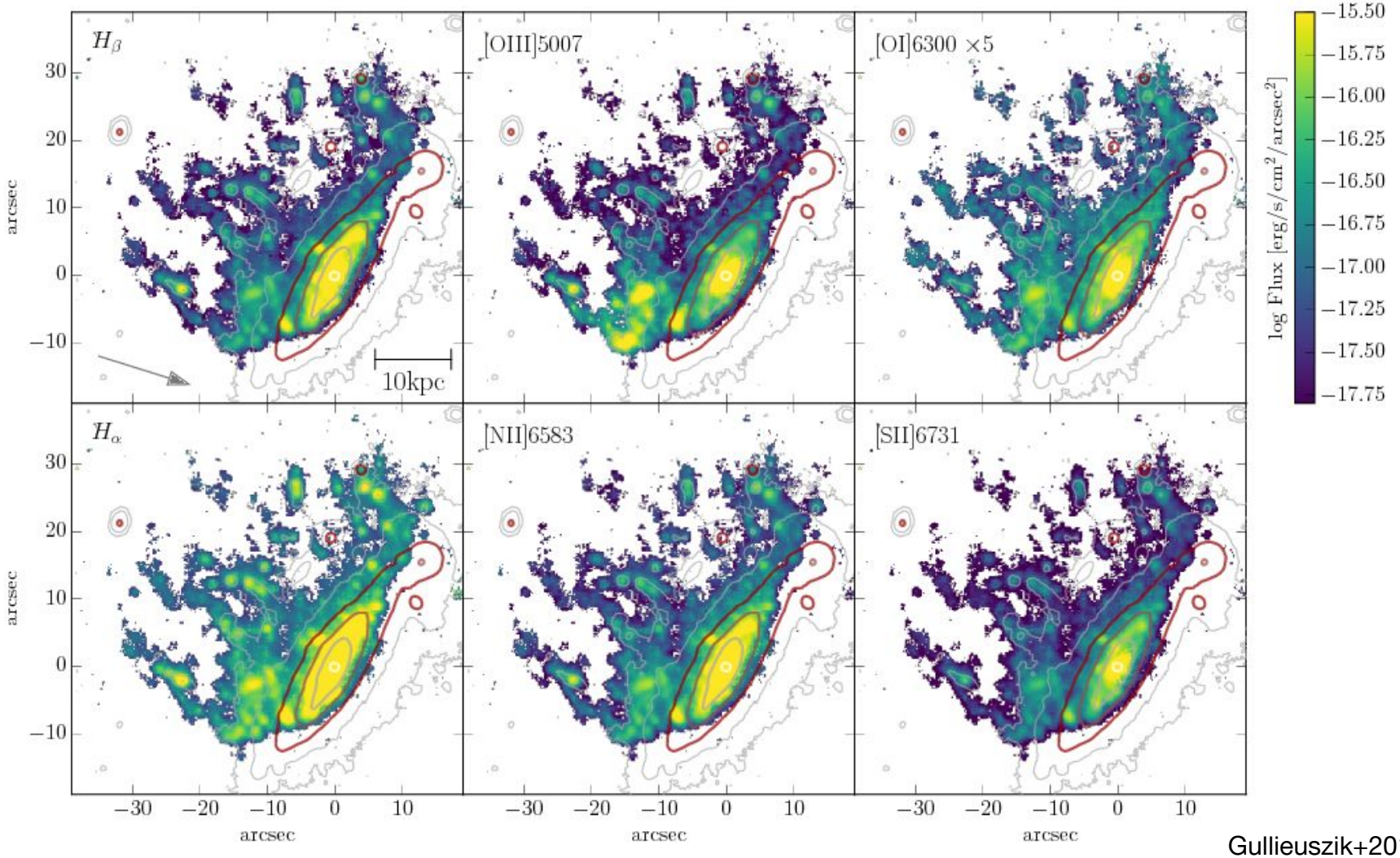


ionized gas



Gullieuszik+2017

GASP survey



Gullieuszik+2017