GASP

Gas Stripping Phenomena in galaxies

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European Research Council
Established by the European Commission

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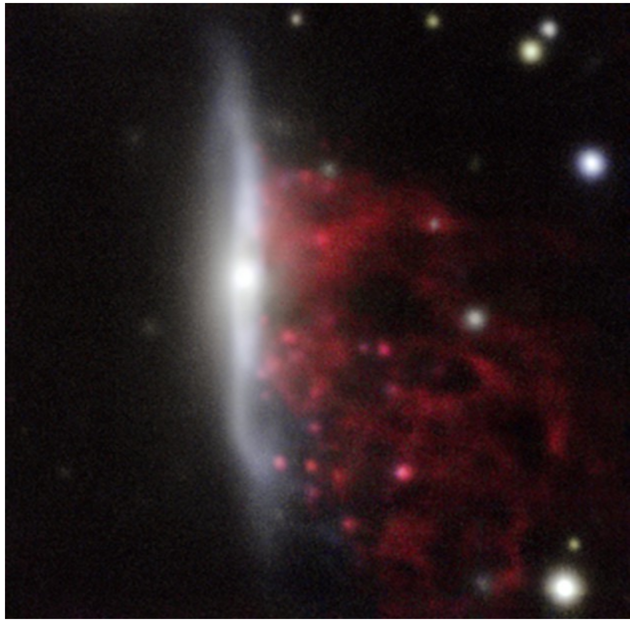
http://web.oapd.inaf.it/gasp/

GASP in a nutshell



Science goals: Study the physical processes that affect the gas in galaxies and understand their consequences on the galaxy stellar history

Keywords: Gas – Star formation – Galaxy evolution

Methods: Integral Field Spectroscopy and multi-wavelenght follow-ups for 114 galaxies at low redshift – Wide range of galaxy masses (10^9-10^11.5) and galaxy environments (clusters, groups, filaments, isolated)

Based on MUSE (1st) Large Program – approved in 2015 – data taken 2016-2018

Multi-wavelength data: ALMA, APEX, HST, UVIT@ASTROSAT, JVLA, MeerKAT, ATCA, X-Shooter, LOFAR, Chandra, XMM

ERC Advanced Grant: approved 2019, running until 2024

GASP is an INAF project

- 19 INAF participants (so far) + 2 associati INAF (35 GASP members in total)
- 4 INAF structures (Padova, Cagliari, IRA Bologna, Brera) + University of Bologna + Specola Vaticana
- Key GASP roles are in INAF:

  PIship + Steering Board (Poggianti, Moretti, Vulcani, Gullieuszik)
  MUSE data reduction and analysis (INAF-OAPd)
  ESO Data Releases (INAF-OAPd)
  ALMA (INAF-OABo/ARC + INAF-OAPd)
  MeerKAT and part of JVLA (INAF-OACagliari)
  HST (INAF-OAPd)
  LOFAR (INAF-OAPd)
  X-ray analysis (INAF-OAPd & OABrera, Dip. Bologna)
  Web page and database (INAF-OAPd)
  …..

GASP is an INAF project

INAF+associates

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D. Bettoni
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M. Gitti
E. Giunchi
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B. Vulcani
A. Werle
A. Wolter

+ 6.8 FTE PostDoc

Abroad

T. Deb
J. Fritz
K. George
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S. McGee
(M. Mingozzi)
A. Mueller
(M. Ramatsoku)
E. Roediger
R. Smith
S. Tonnesen
J. Van Gorkom
M. Verheijen

Over the whole duration of the project:

47 FTE INAF / 65 total
20/47 are TI

For 2021-2023 (2024): 32.9 FTE INAF

Sinergies with other "schede INAF":

X-GASP (Moretti)

MeerKAT/JVLA (HI gas) + ALMA/APEX (molecular gas) ► BaryonicCycling (Hunt) + SKA (Prandoni)

LOFAR MoU ► LOFAR-It (Brunetti)

"Training camp" for 4(+3) PhD students and 6-8(+1) PostDocs

Facilities

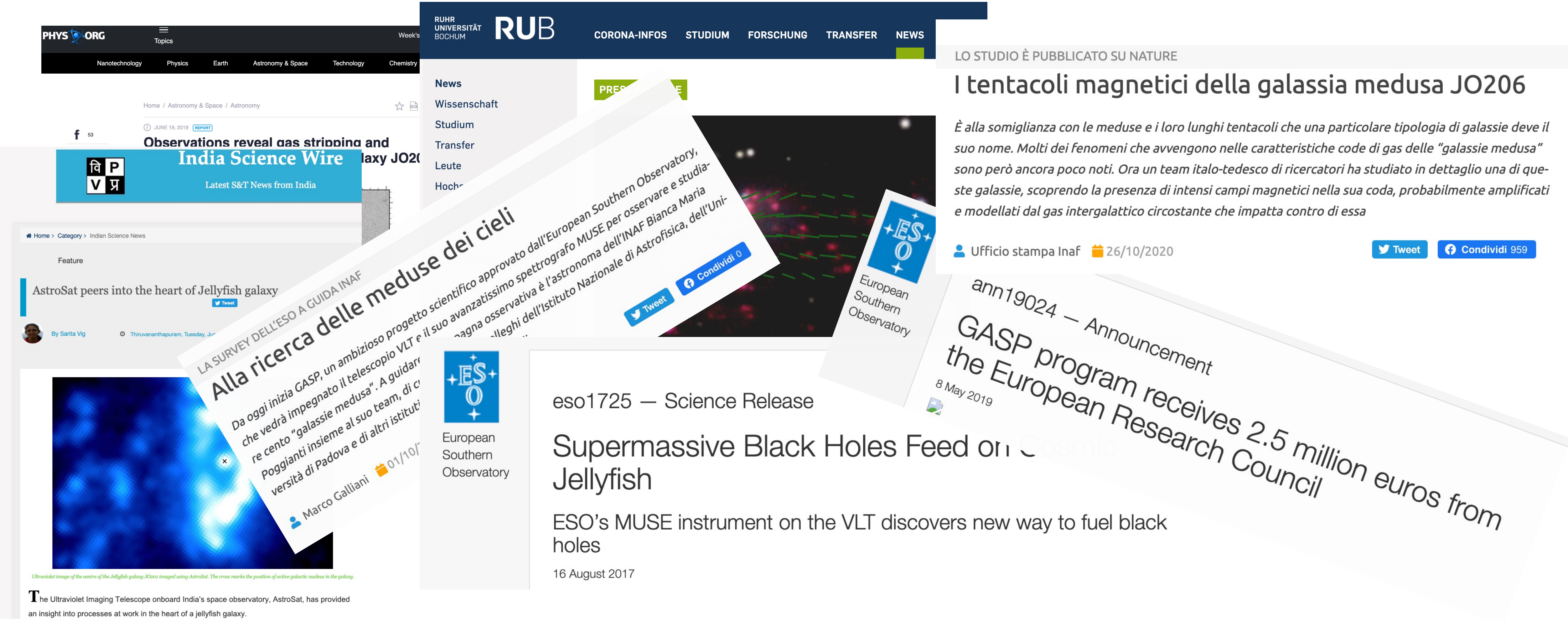
Facility	Range	Main goal	Status
MUSE@VLT	Optical IFS	Stellar and ionized gas properties	Completed
APEX	mm	Molecular gas (CO(2-1))	Completed+proposed
ALMA	mm	Molecular gas (CO(1-0)+CO(2-1))	Completed+proposed
JVLA	Radio	HI gas + radio continuum (+polarization)	Completed + ongoing
MeerKAT	Radio	HI gas + radio continuum + polarization	Completed + proposed +Science Verification
ATCA	Radio	Polarization + HI gas + radio continuum	Granted, partly taken
LOFAR	Low frequency radio	Low frequency radio tails	MoU
UVIT	UV (FUV for all, NUV for some)	UV stellar light	Completed+ongoing
HST	UV (F285, F336), optical (F606, F814) + Halpha (F680N)	Halpha, UV, V and I	Completed
X-Shooter@VLT	Long slit spectra (UVB+VIS+NIR: 3000-25000 A)	AGN	Partially completed + granted
Chandra	X-ray	X-ray emission (point sources and tails)	Archive + proposed
XMM	X-ray	X-ray emission(points+tails)	Archive

RESULTS

- 34 refereed papers published so far (Nature, Nature Astronomy, ApJL, ApJ, MNRAS, A&A) – of which 26 INAF 1st author
- + 2 submitted + several in preparation
- 2 ESO Data Releases
- Invited reviews, oral communications and posters at international conferences
- Colloquia and seminars around the world

RESULTS (?)

Press coverage from MediaINAF, ESO and other national and international sources

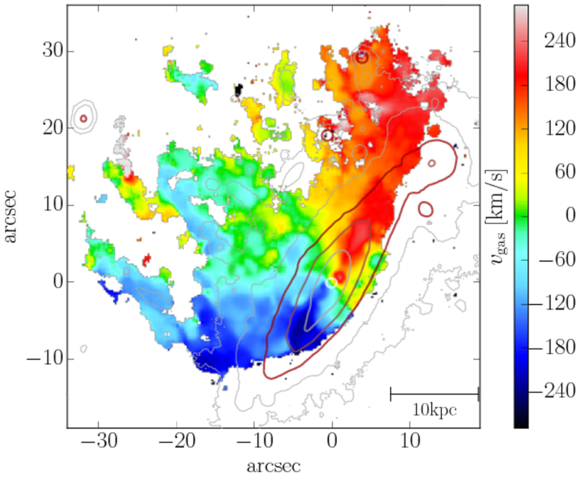


SOME HIGHLIGHTS

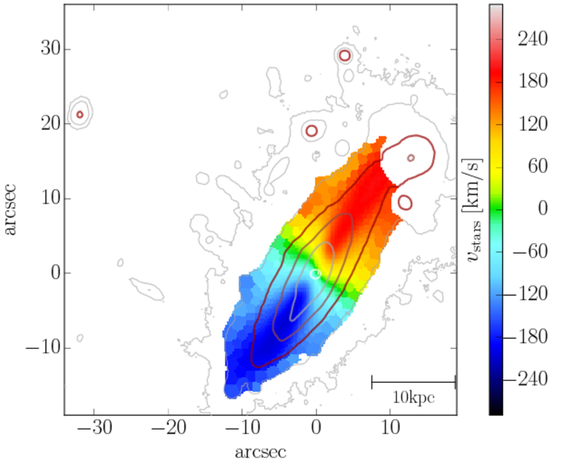
RAM PRESSURE STRIPPING IN CLUSTERS

First large sample of confirmed ram-pressure stripped galaxies in clusters with wide galaxy mass range and cluster mass range – various stages and degrees of stripping - before GASP, a handful of RPS galaxies with Integral Field Spectroscopy

GAS



STARS



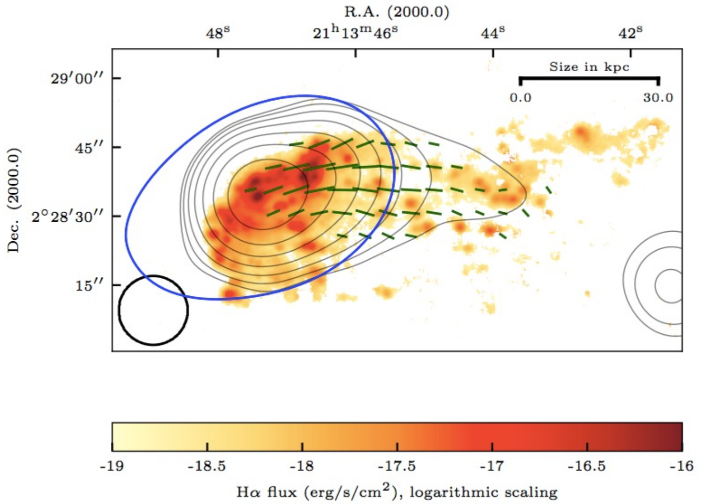
Star formation in stripped tails of gas: Halpha-bright, star-forming clumps with stellar masses 10^5-10^7 Msun, and how this extraplanar star formation depends on galaxy and cluster properties

Outside-in quenching and connection with post-starburst galaxies, after initial SF enhancement

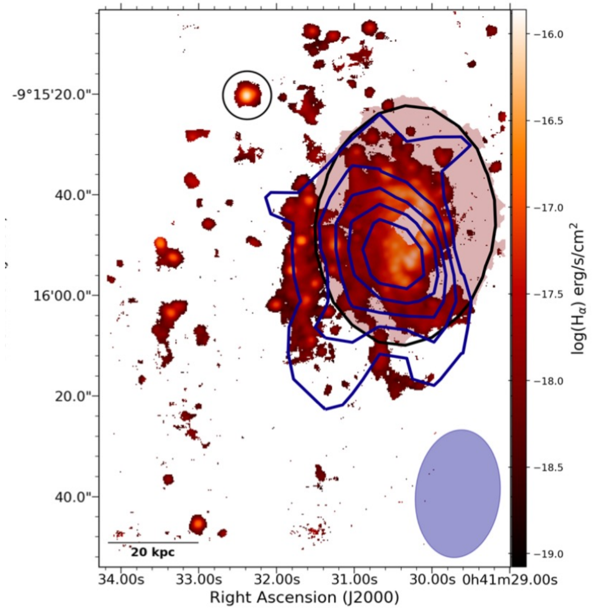
High frequency of AGN suggesting ram pressure stripping triggers AGN activity

Magnetic field measurement in a stripped tail: evidence for magnetic draping

Ram pressure stripping can cause unwinding of spiral arms

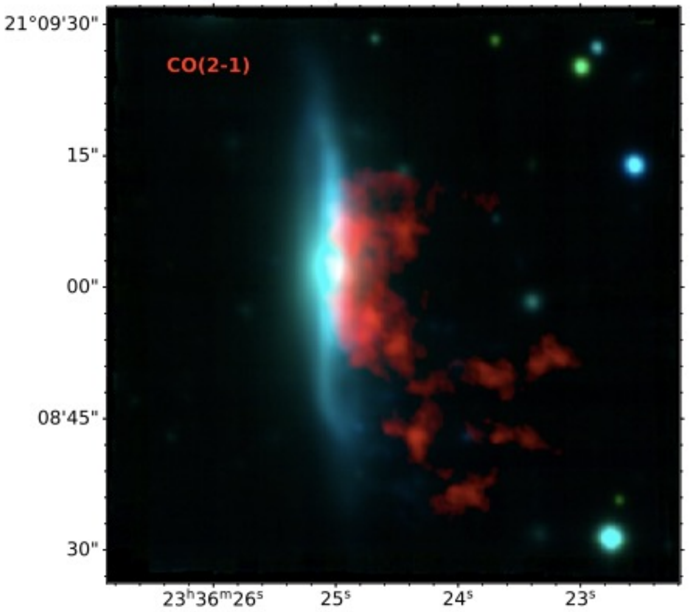


MULTIPHASE GAS



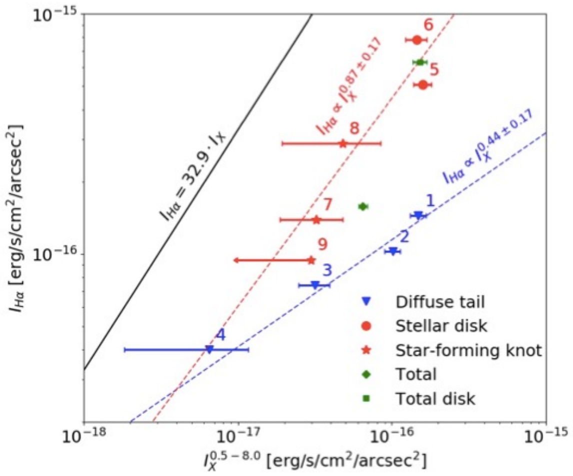
Building a sample where Halpha, HI, CO and X-ray stripped tails can be compared (non trivial!)

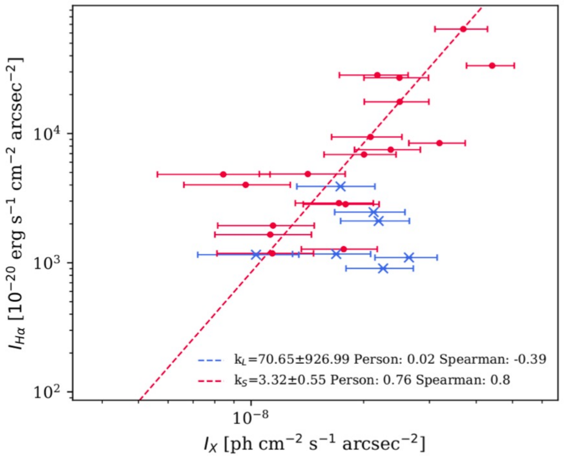
Our HI studies show that HI and Halpha tails have sometimes similar and sometimes different morphologies



Large amounts of molecular gas in galaxies with long tails, pointing to an efficient conversion of neutral gas into molecular gas

High HI star formation efficiency, low CO star formation efficiency

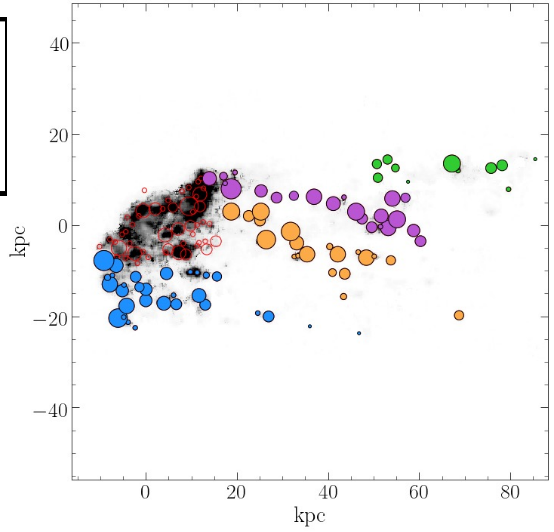




Halpha-Xray surface brightness correlation:

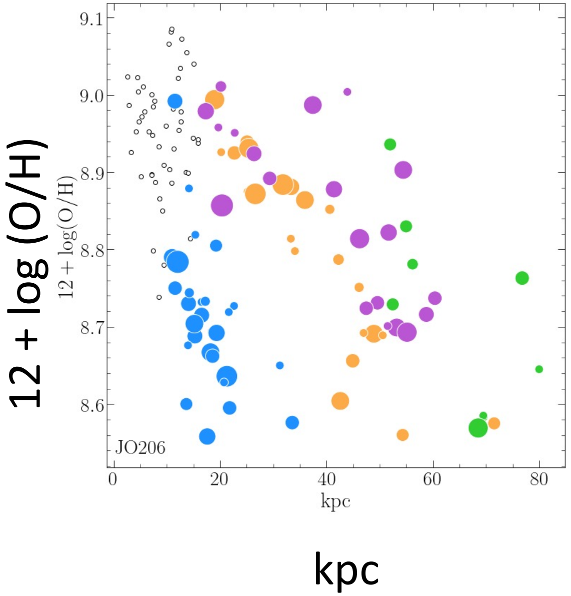
Hot plasma responsible for X-ray (and unsual optical emission lines) due to either cooling of ICM or mixing ISM-ICM

SPATIALLY RESOLVED GAS METALLICITIES, DIFFUSE IONIZED GAS AND STAR FORMATION: NORMAL vs STRIPPED GALAXIES



Mass-metallicity and Fundamental metallicity relations both in normal and stripped galaxies

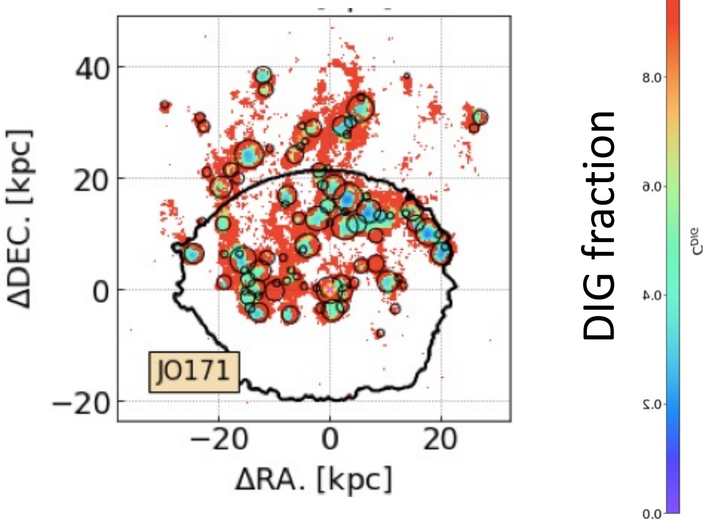
The trend of the metallicity gradient with galaxy stellar mass, its physical origin and its dependence on environment



The gas metallicity trends in the stripped tails and their physical origin

Quantify the amount of diffuse ionized gas and its properties in normal and stripped galaxies

The spatially resolved SFR-Mass relation in normal and stripped galaxies, and its relation with the global SFR-Mass relation

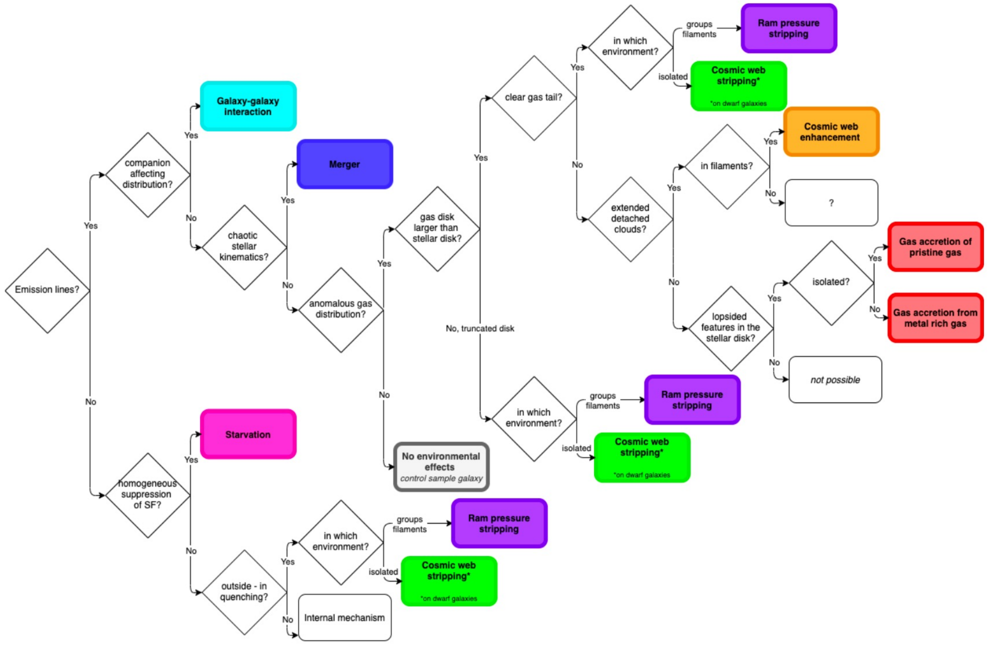


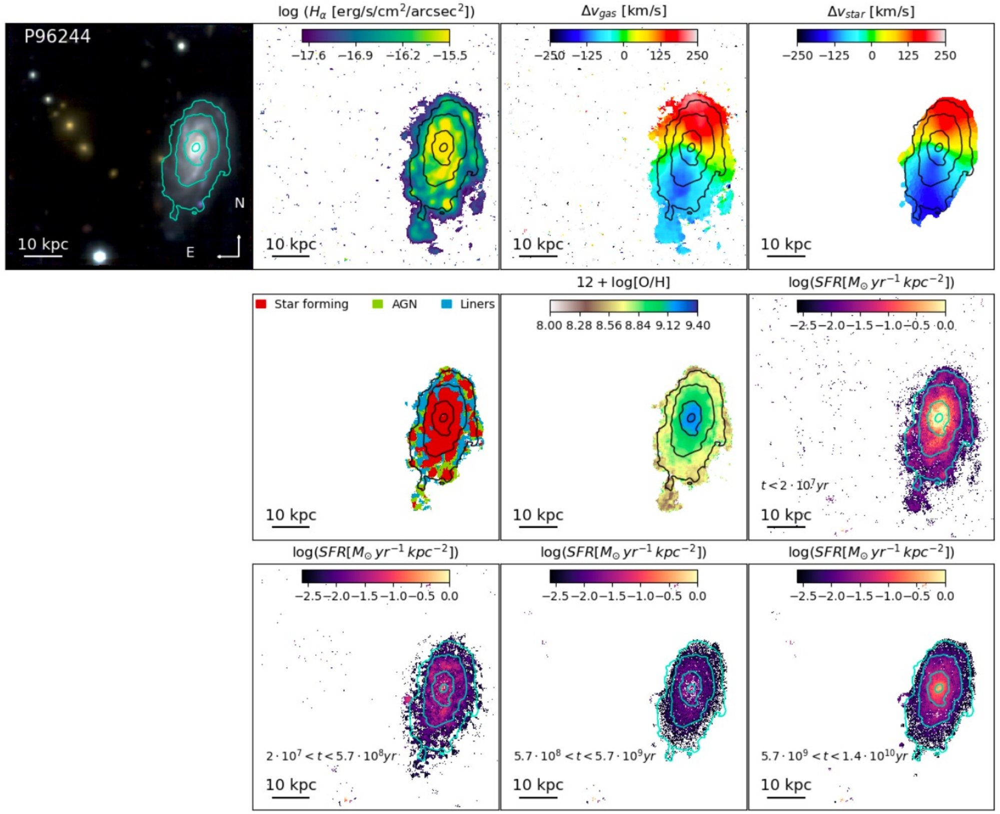
PHYSICAL PROCESSES IN GROUPS, FILAMENTS AND ISOLATED GALAXIES

Ram pressure stripping in groups

Cosmic web enhancement and cosmic web stripping

Candidates for strangulation and gas accretion





Pioneering work pointing to ways to identify the different mechanisms based on integral field spectroscopy, as well as the need for other types of observations

WHAT LIES AHEAD

Our program for the next 3 years

- HST: star-forming clumps and more
- Is AGN activity more frequent in ram pressure stripped galaxies? Observational results based on large samples and simulation insights
- Multi-wavelength tails in cluster galaxies, and machine learning methods to identify stripping
- Stripping and quenching in galaxy clusters: a global observational view and the cosmological hydro-simulation view
- Baryonic cycle: gas in different phases and star formation
- The interaction interstellar medium-intracluster medium
- Ram pressure stripping in galaxy clusters at z=0.3-0.5

FUNDING

Past funding: Premiale MITIC (Garilli)
PRIN-SKA ESKAPE-HI (Hunt)

TOTAL: ~2900 keuro, of which 2500 ERC

Still to spend:	Main stream INAF (Vulcani)	21keuro
	PRIN-MIUR (Cimatti, Massardi)	14keuro
	ERC Advanced Grant (Poggianti)	~1500 keuro

ERC funds: 1st tranche arrived in 2019
first ERC report approved in March 2021
2nd tranche arrived 2021

WHAT INAF HAS BEEN DOING FOR GASP

-- great support from the Office Bandi Competitivi (Guccione)

-- great support from MediaINAF (Galliani, Malaspina, Guglielmo)

-- great support at OAPd and at the national level

-- initial funding, to gain “momentum” for ERC

-- hiring of new staff members

WHAT GASP HAS BEEN DOING FOR INAF

-- give INAF the leadership of an internationally recognized program

-- a strong scientific outcome

-- attract European funds

-- train a group of young researchers but also gain INAF staff expertise on state-of-the-art techniques and usage of world-class facilities (MUSE, ALMA, HST, MeerKAT…)

Post-ERC: HARMONY + MOSAIC -- MAVIS + MICADO/MAORY – JWST -- SKA