

Gas stripping
phenomena with MUSE
integral-field
spectroscopy

Bianca Poggianti

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

[Data release GASP DR1:](http://www.eso.org/sci/observing/phase3/news.html#gasp)

<http://www.eso.org/sci/observing/phase3/news.html#gasp>

[see December 2017 ESO Messenger](#)

GASP team:

PI B. M. Poggianti (INAF-OaPD)

C. Bellhouse (ESO)

D. Bettoni (INAF-OaPD)

A. Cava (Observatoire de Geneve)

W. Couch (AAO)

M. D'Onofrio (UniPD)

G. Fasano (INAF-OaPD)

A. Franchetto (INAF-OAPd)

J. Fritz (IRyA, UNAM)

M. Gullieuszik (INAF-OaPD)

G. Hau (ESO)

Y. Jaffe' (ESO)

S. McGee (University of Birmingham)

A. Moretti (INAF-OaPD)

A. Omizzolo (INAF-OaPD, Sp. Vaticana)

M. Owers (Macquarie University)

M. Radovich (INAF-OAPd)

B. Vulcani (INAF-OaPD, Uni Melbourne)

S. Tonnesen (CCA, New York)

C. Bischko (Innsbruck)

R. Paladino (INAF-IRA)

J. Van Gorkom (Columbia)

P. Serra (INAF_Cagliari)

Mpati Ramatsoku (INAF-Cagliari)

M. Verheijen (Kapteyn, Groningen)

Tirna Deb (Kapteyn, Groningen)

K. George (India)

M. Mapelli (INAF-OAPd-Innsbruck)

Observational evidence for gas stripping in clusters from:



HI (see Vollmer's talk yesterday)
UV imaging
H-alpha narrow band imaging
IFU spectroscopy
X-ray.....even optical images



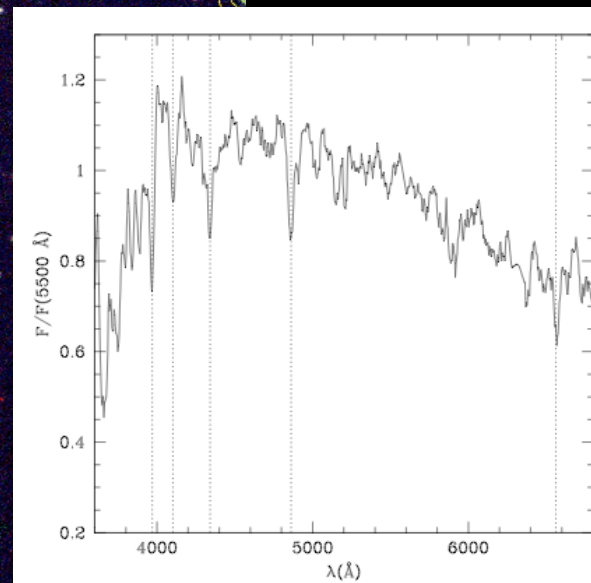
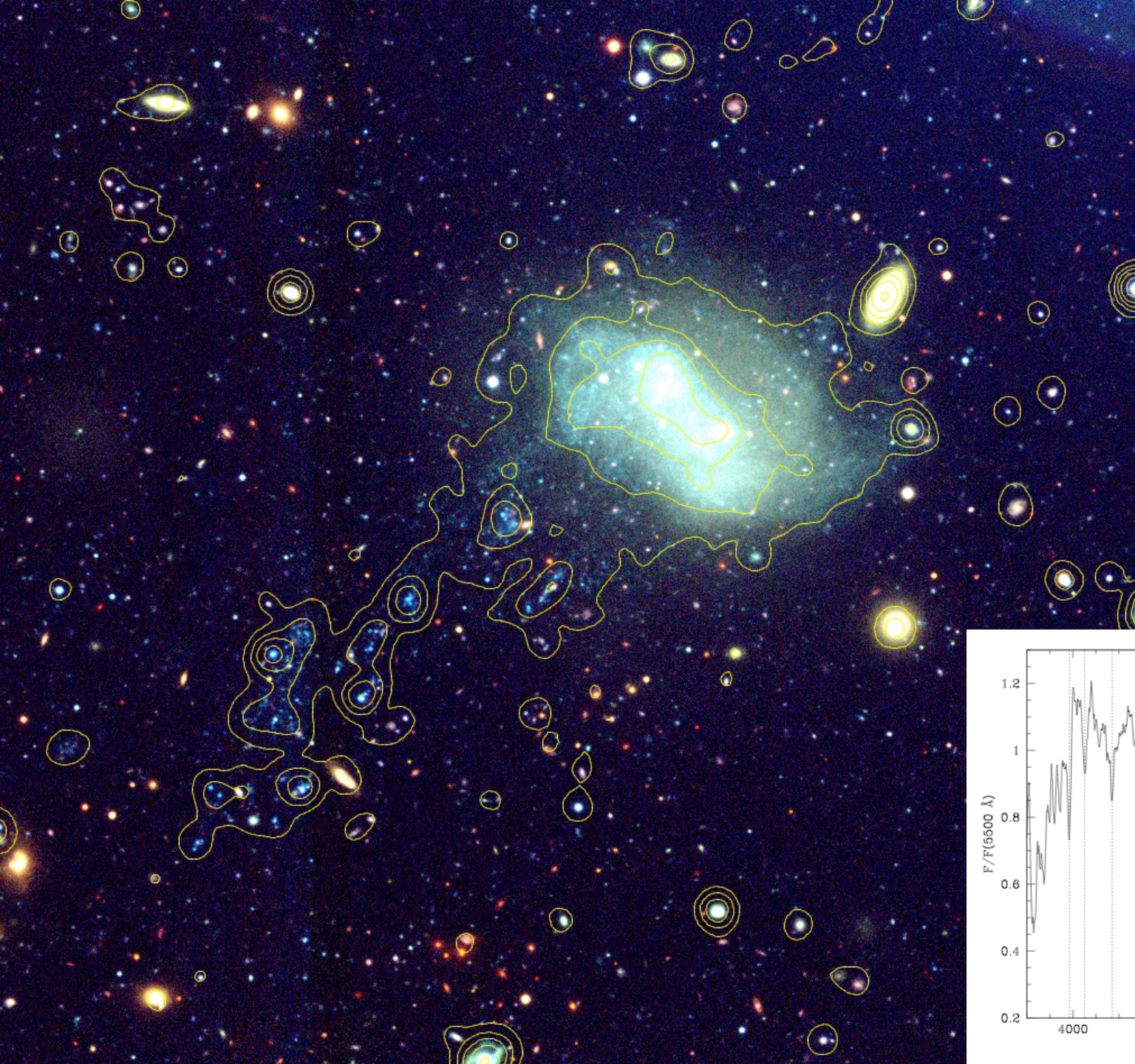
“JELLYFISH GALAXIES”:

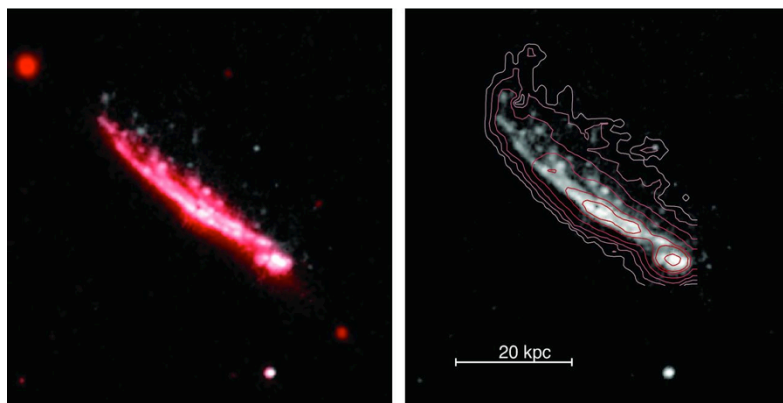
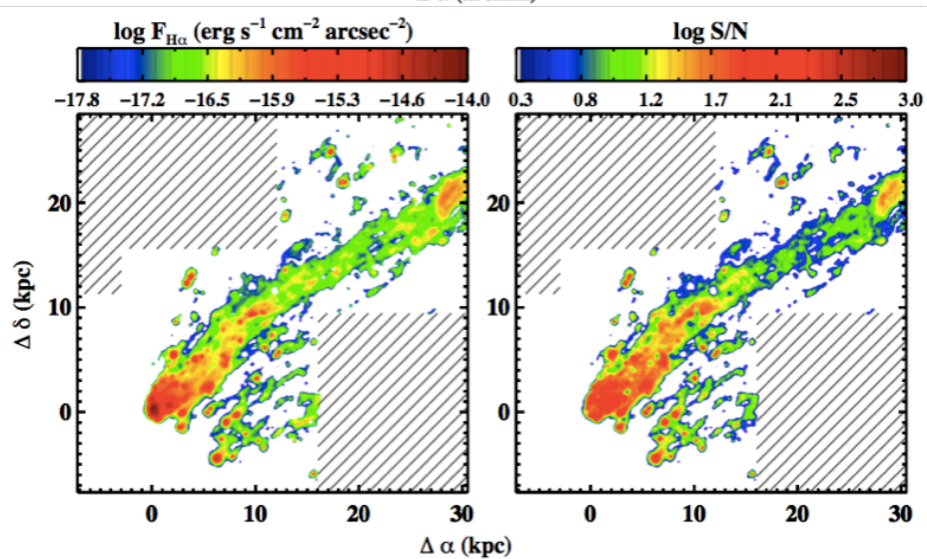
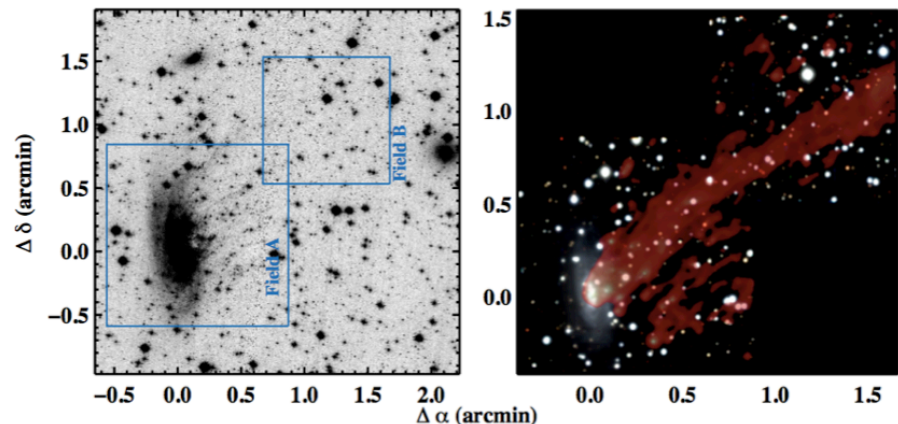
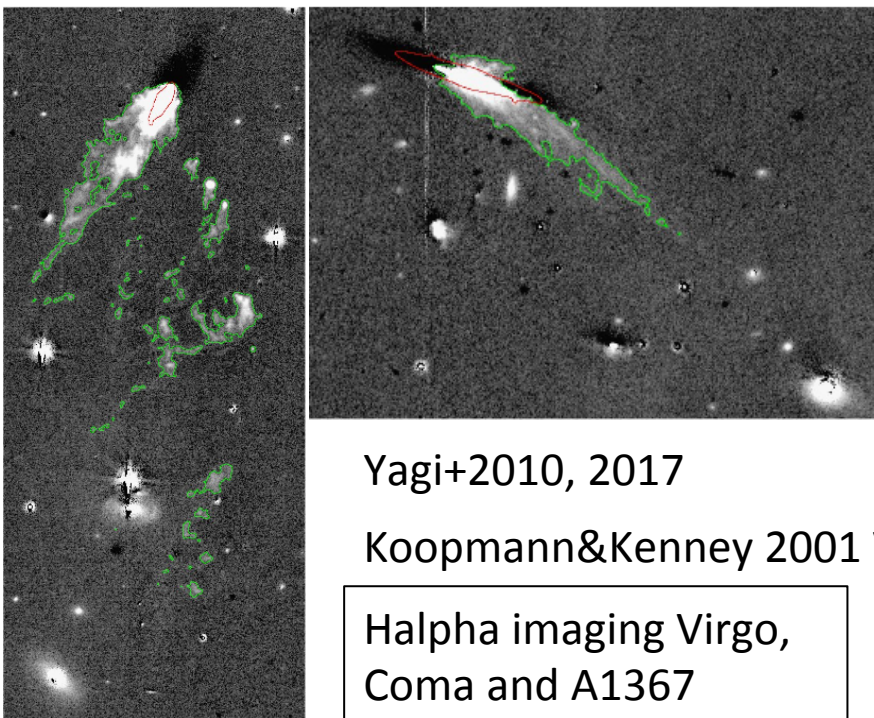
“Galaxies with clearly distorted images, with optical data resolving multiple filaments offset asymmetrically from the galaxy” [Smith et al., 2010, UV asymmetry]

Boselli+ 2016

VCC121 (IC3418) in the Virgo cluster

Hester+2010,
Fumagalli
+2011,
Kenney
+2014





ESO137-001, Fumagalli+
 14, Fossati et al. 2016,
 Consolandi+ 2017

First systematic searches for stripping candidates from optical images Poggianti+2016 (low-z) and McPartland+ 2016 (interm.-z)

At z=0.2-0.4, Cortese+ 2007, Owers+12, Ebeling+2014

GASP ESO Large Programme

120h with MUSE@VLT

End of observations: ~2018

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



Target galaxies selected from optical images to have signatures of GAS-ONLY removal processes (no mergers, no tidal interactions)

1. Debris trails, tails or surrounding debris on one side of the galaxy
2. Asymmetric/disturbed morphology
3. Distribution of star forming knots/region suggesting induced SF on one side



→ Galaxies in different environments (WINGS X-ray selected clusters, groups, field +control sample)

see **Benedetta Vulcani's talk for GROUPS**

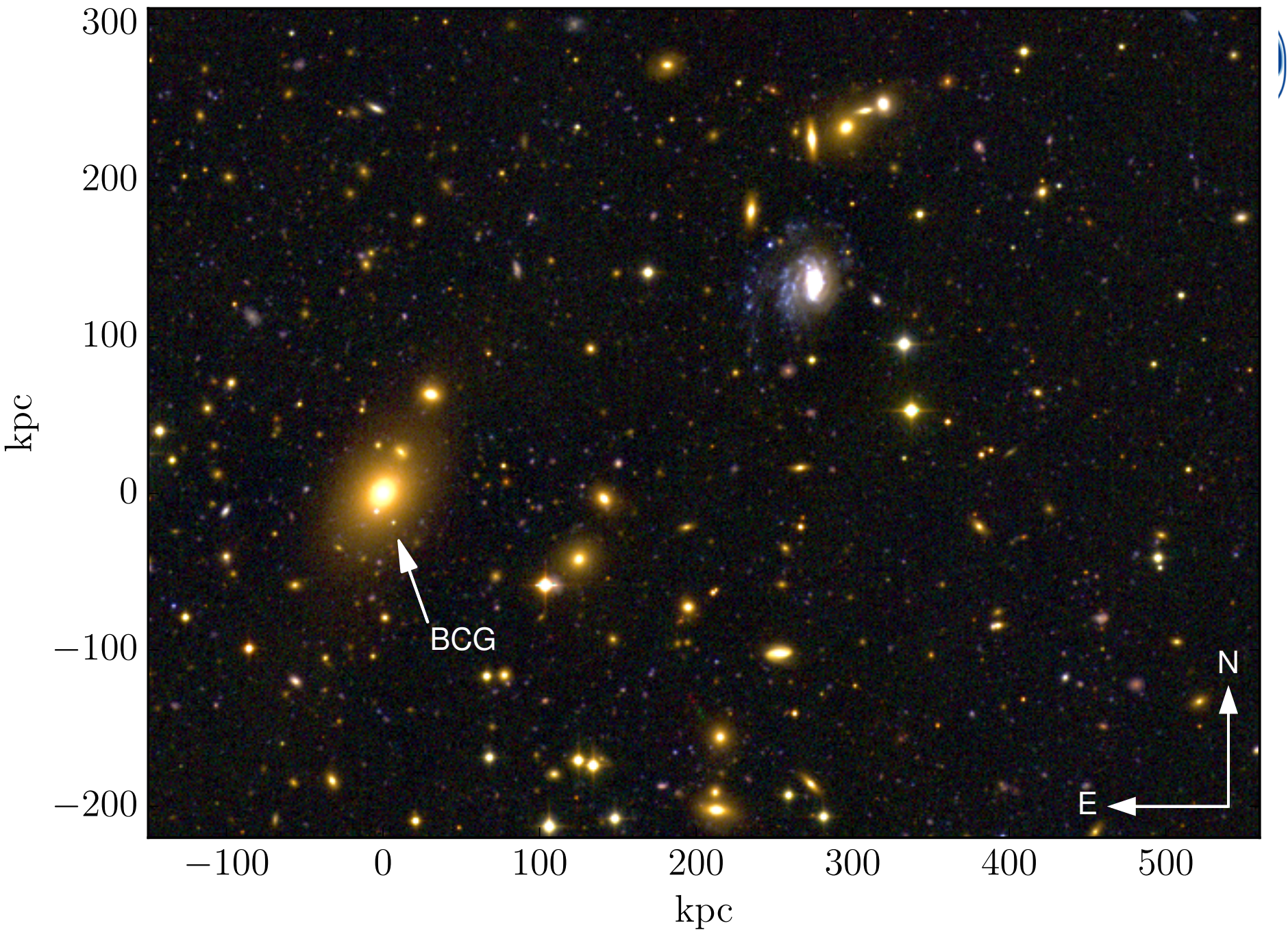
→ Galaxies with different masses (from 10^9 to $10^{11.5} M_{\text{sun}}$)

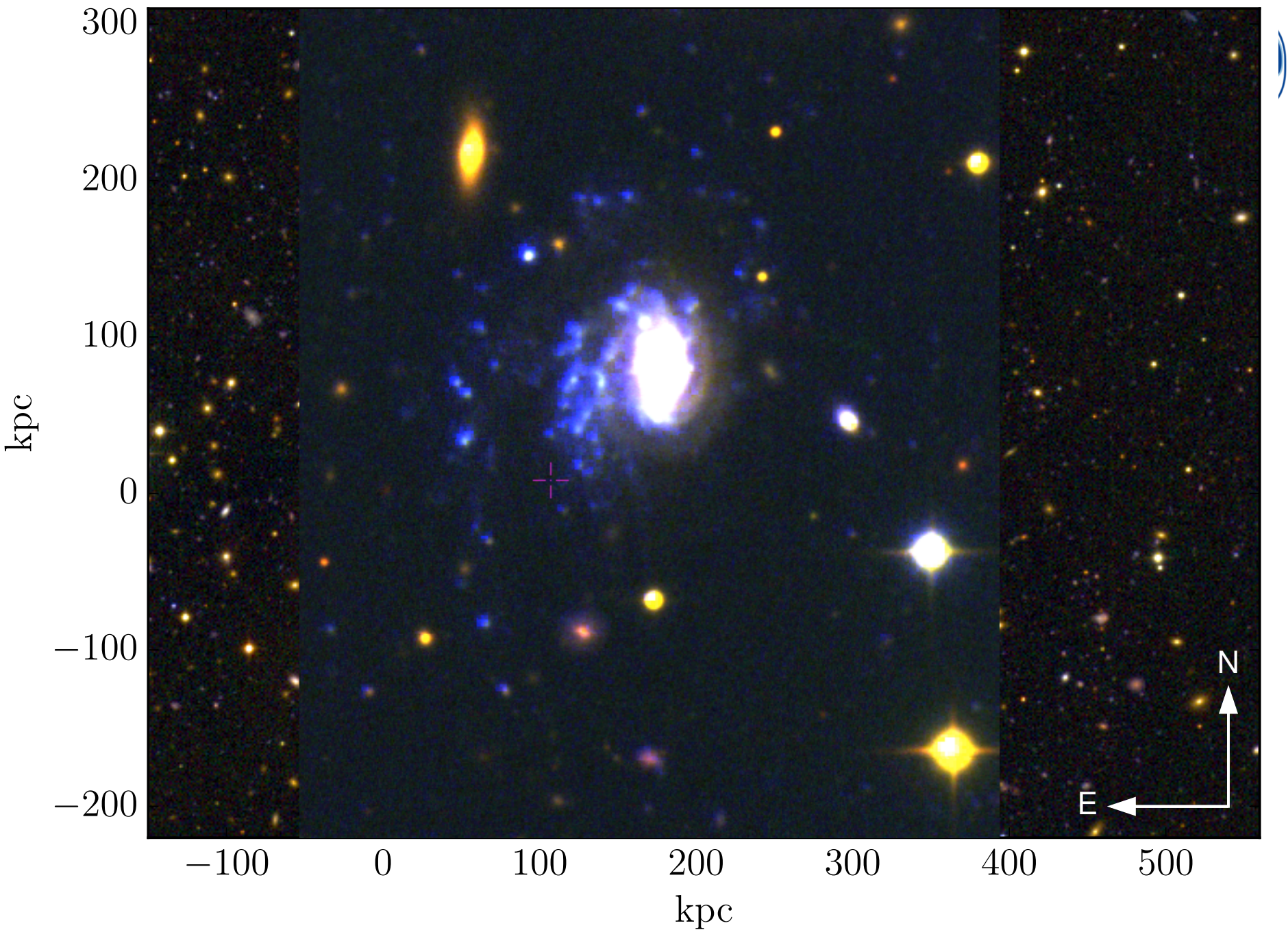
→ Galaxies with different stripping signatures (Jclass 1-5, taken from Poggianti et al., 2016)

Large areal coverage (10Re): Fov(1'X1')~60x60kpc

0.2"/pix, 2.5A FWHM, 4700-9300AA

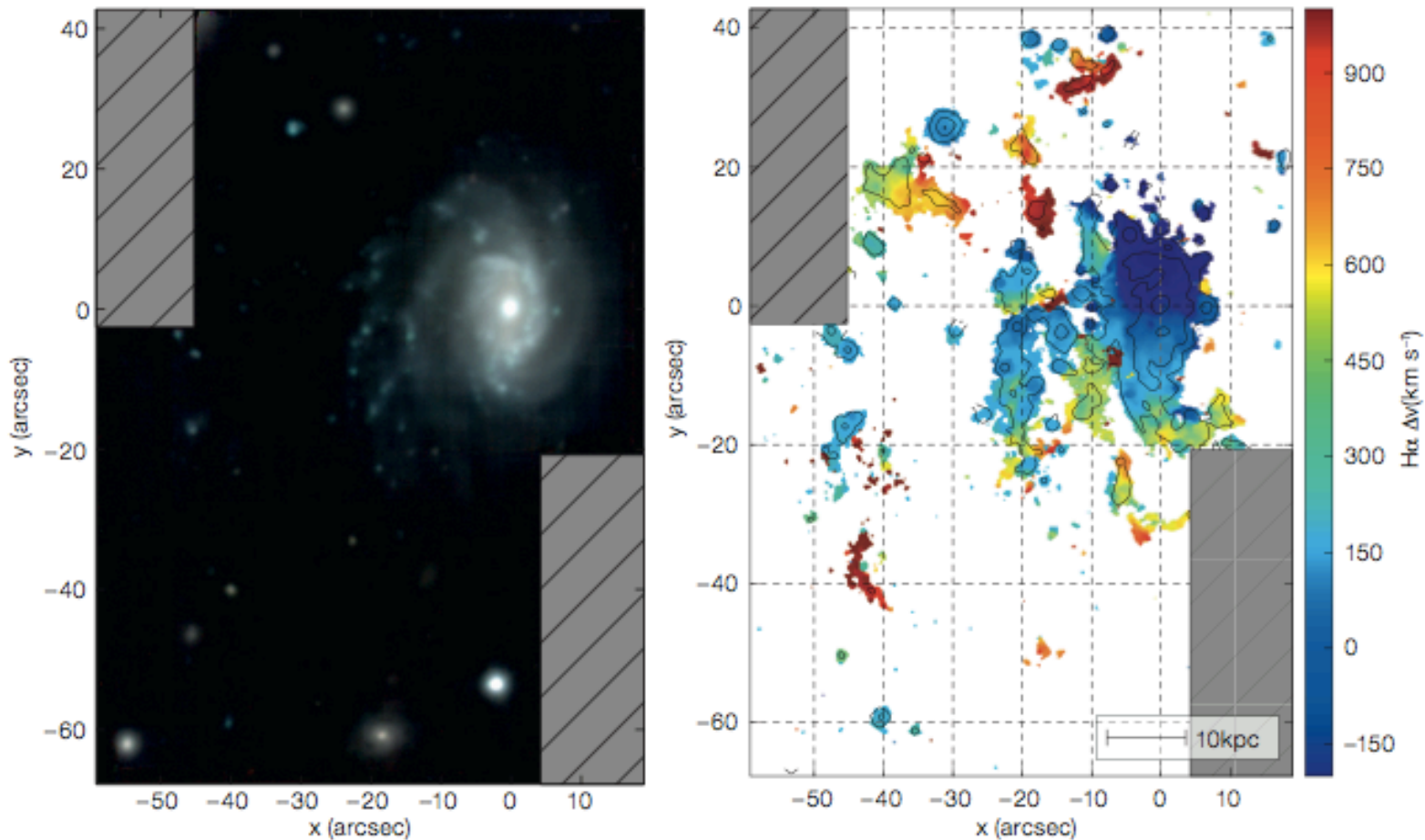
2700sec/pointing, ~90.000 spectra/pointing





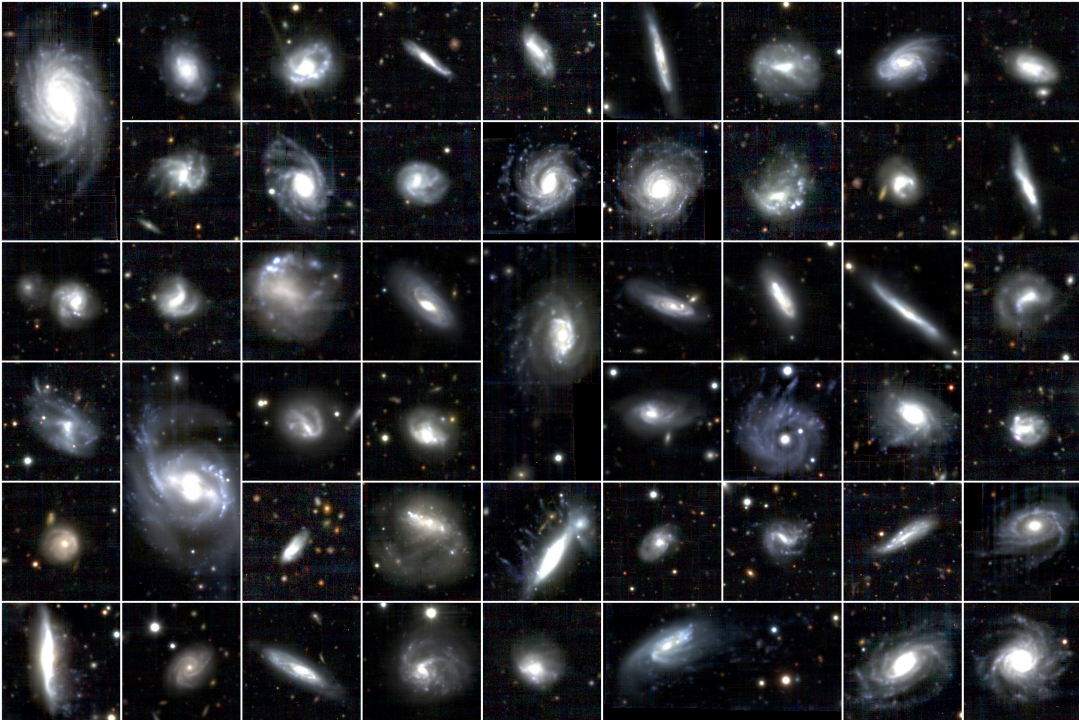


Evidence for ram pressure much more striking when looking at ionized gas

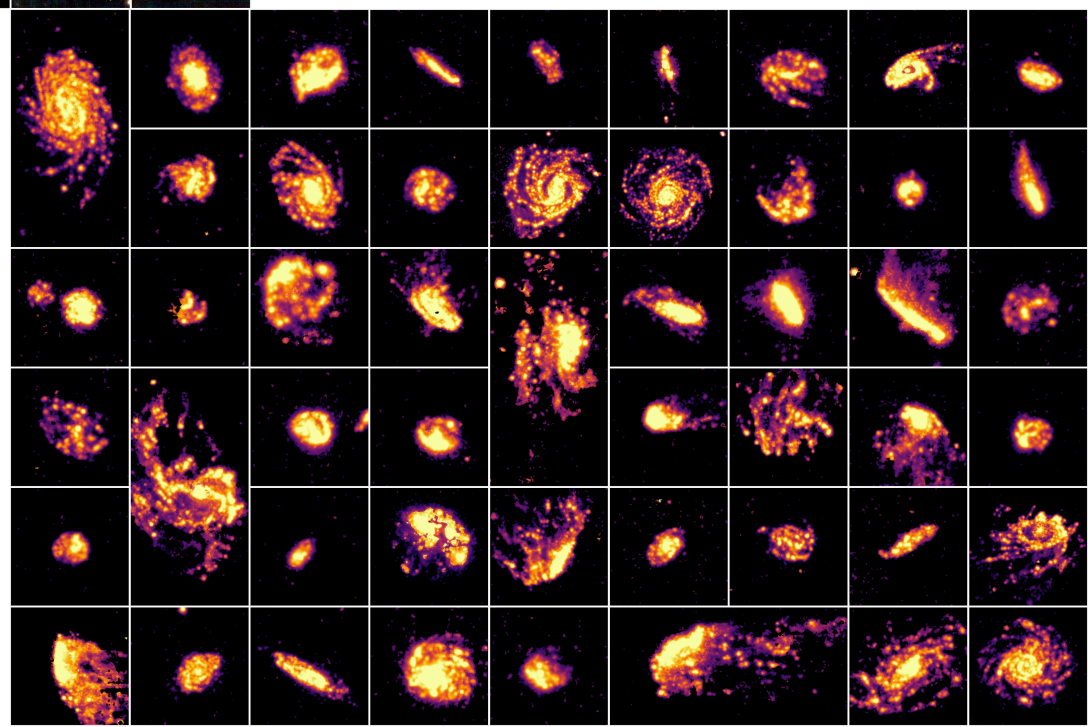


Bellhouse+ 2017

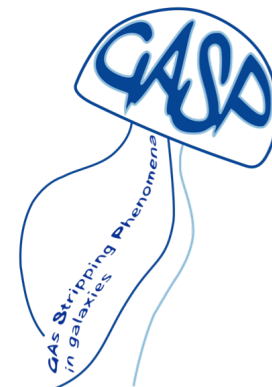
JO201, 10^{11} galaxy in massive cluster, falling as part of a group
– complex velocity structure, including rotation and dragging
behind, seen mostly coming toward observer



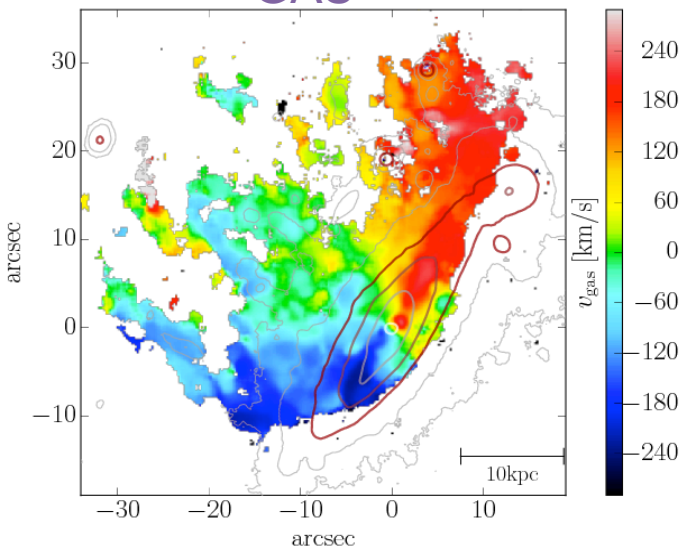
CURRENT STATUS
86/114 observed



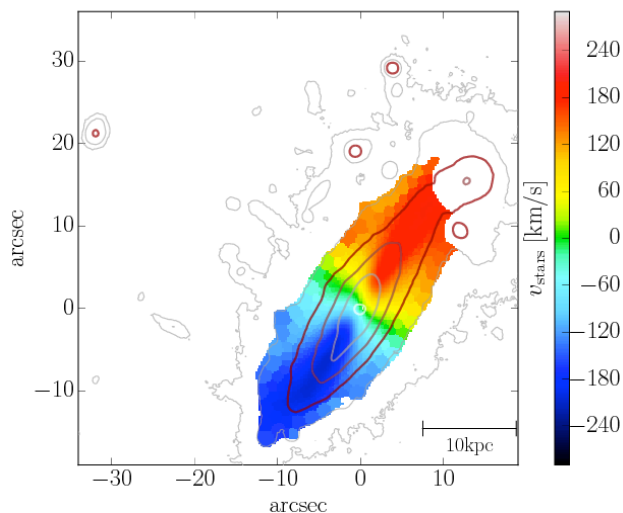
RAM PRESSURE STRIPPING



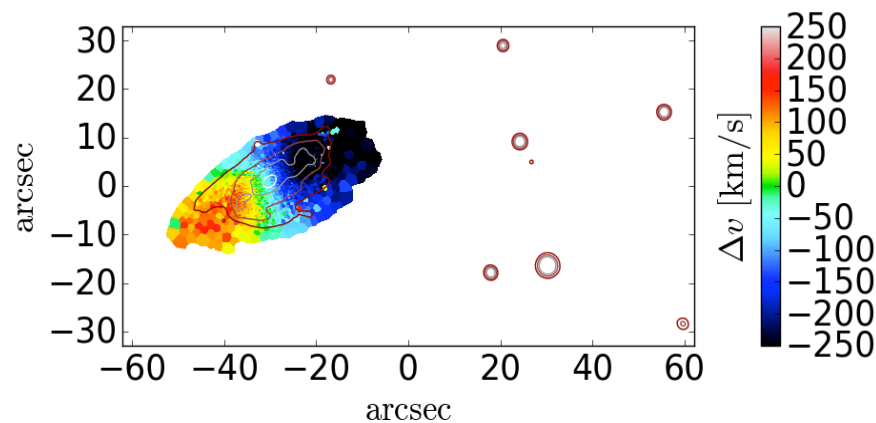
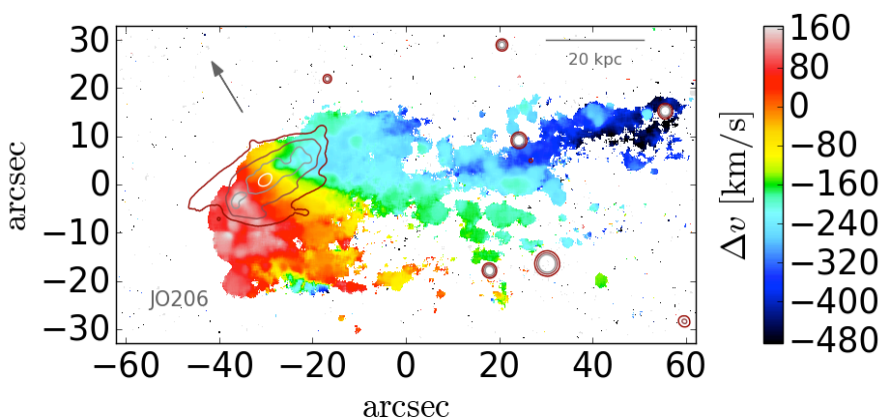
GAS



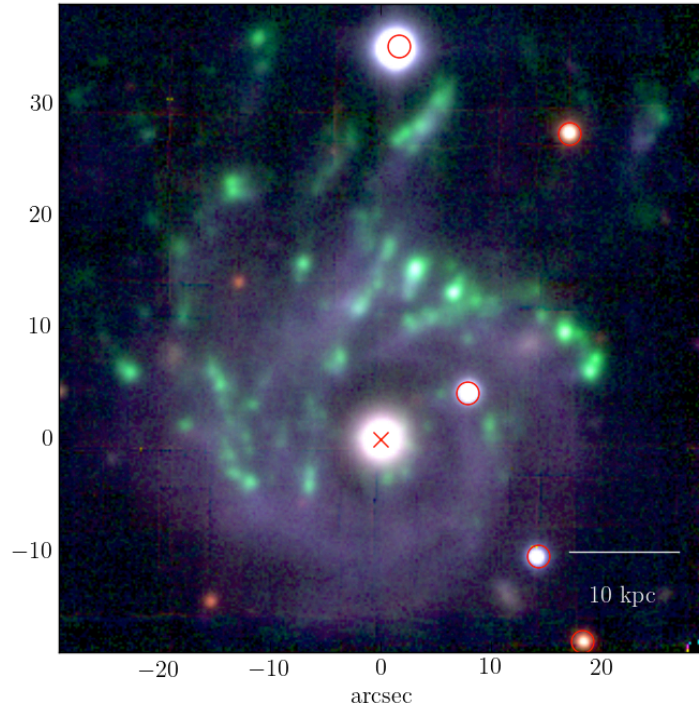
STARS



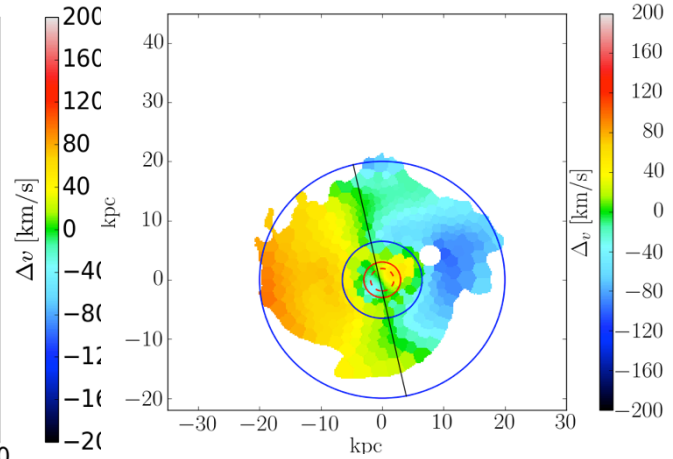
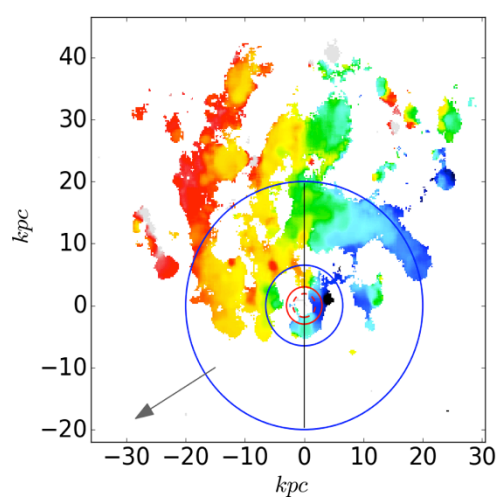
The stellar component is not disturbed, regular stellar kinematics:
gas-only stripping
Stripped gas maintains coherent rotation



JO171 : two dramatic events!
 a Hoag's galaxy falling into a merging cluster



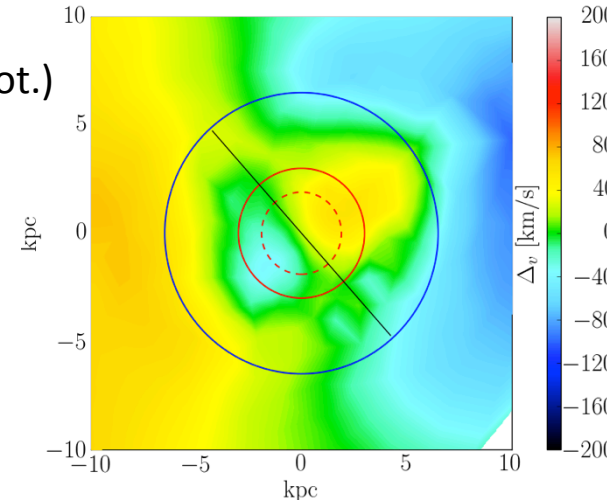
Moretti+ 2018



Central round spheroid (fast rot.)
 + stripped ring
 Gas only in the north region
 +
 Counter-rotation of central
 spheroid!

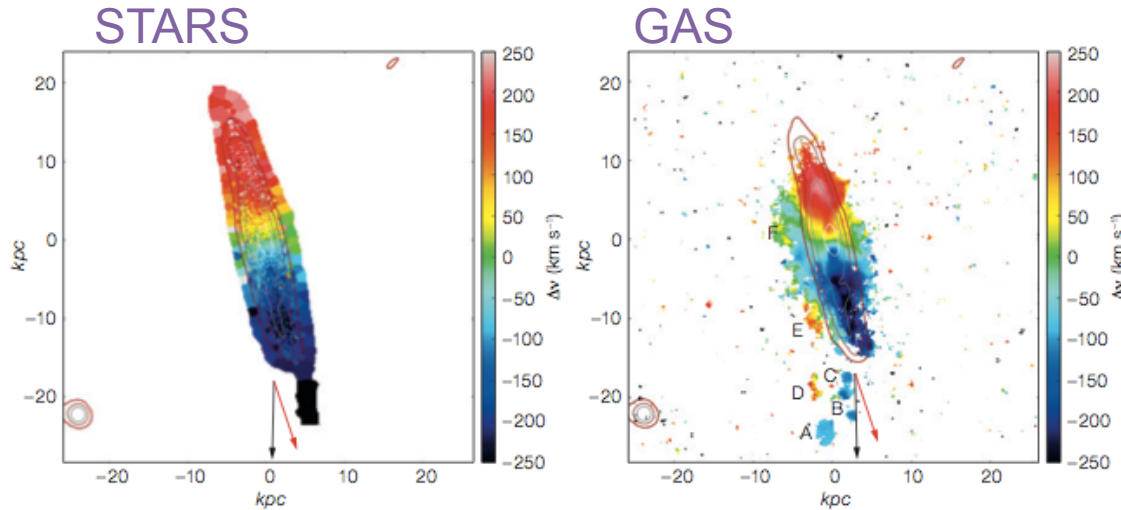
No merger remnant, no bar

→ most probable gas accretion,
 or gas-rich merger



OBSERVING VARIOUS STRIPPING PHASES

From pre-stripping, to initial stripping, ongoing stripping, extreme stripping (100+kpc tails), post-stripping, post-starburst, passive spirals



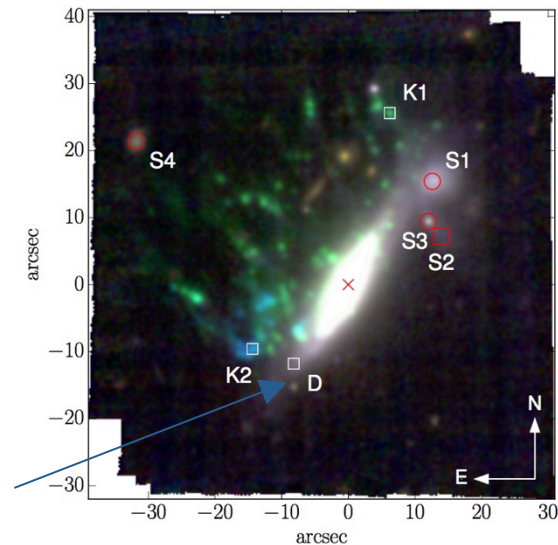
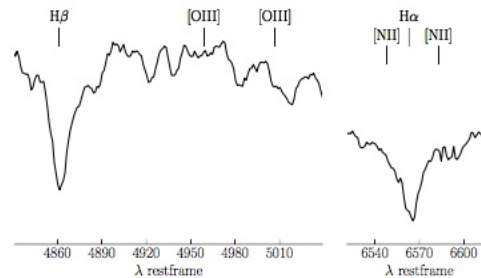
JO36, a truncated H α disk.
The stripping proceeds from the outside-in.
Stellar tail for tidal interaction.
Hidden AGN from Chandra.

Fritz+ 2017

Even massive galaxies in low-mass clusters (500km/s) can be strongly stripped

k+a (post-starburst) spectrum

Gullieuszik+ 2017



STAR FORMATION IN GAS OUTSIDE GALAXIES



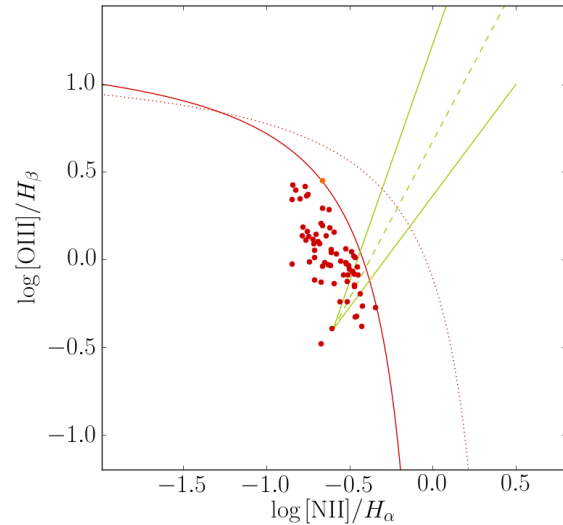
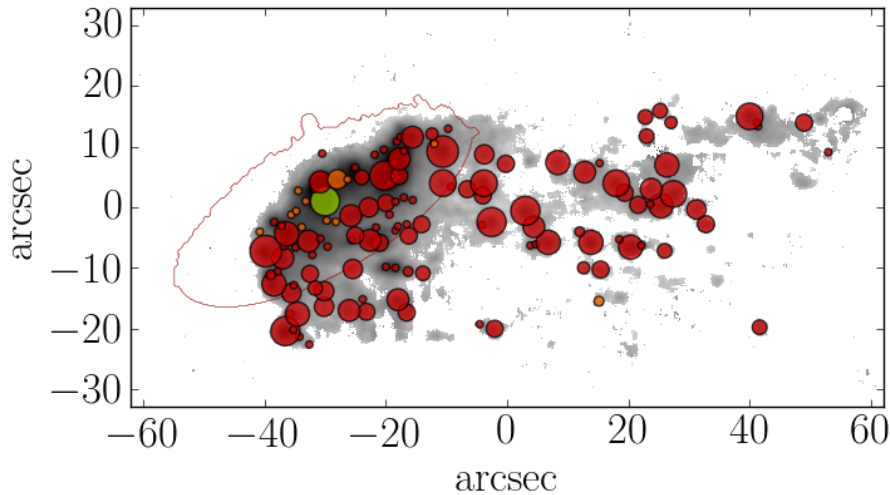
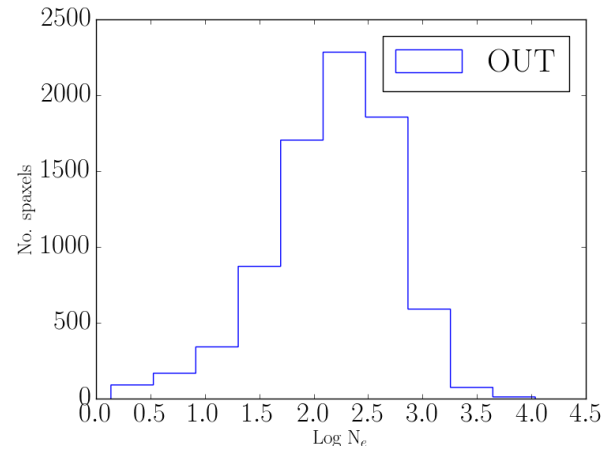
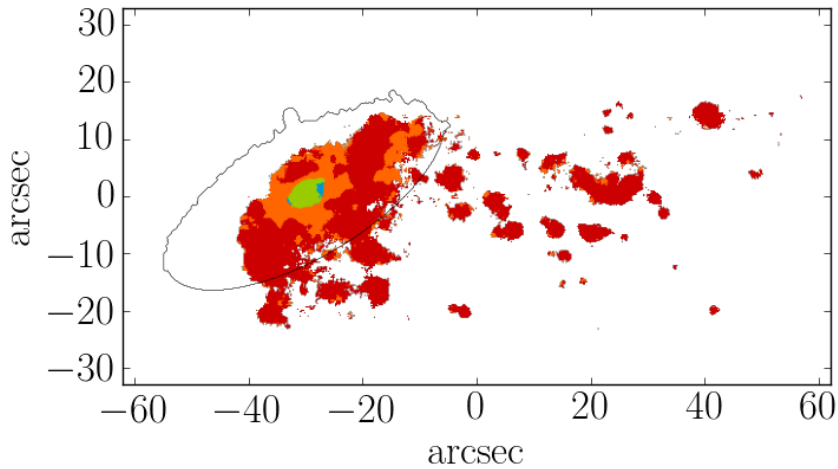
New stars form in situ in the stripped gas

In tails: HII complexes/clumps + diffuse emission – dyn. cold, dense gas

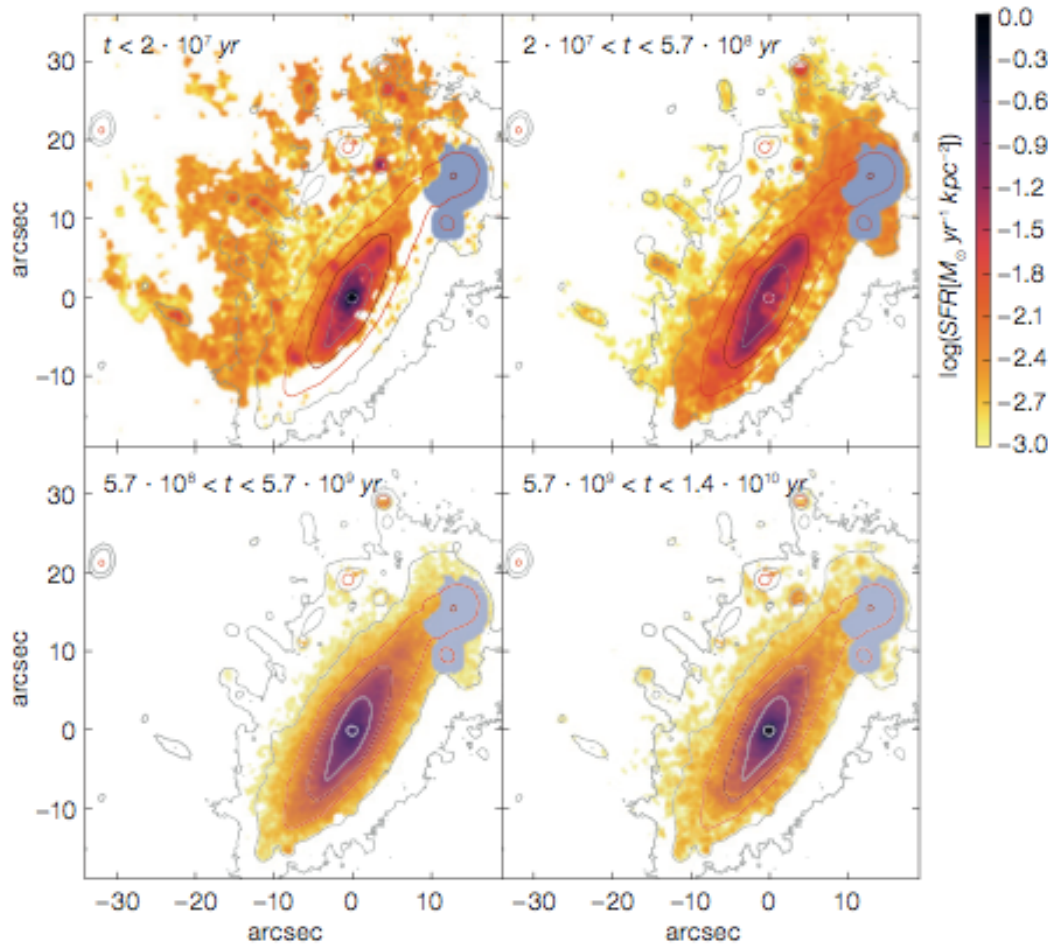
Also CO (see later) and UV knots

■ Star forming
 ■ Composite
 ■ AGN
 ■ Liners

selection!



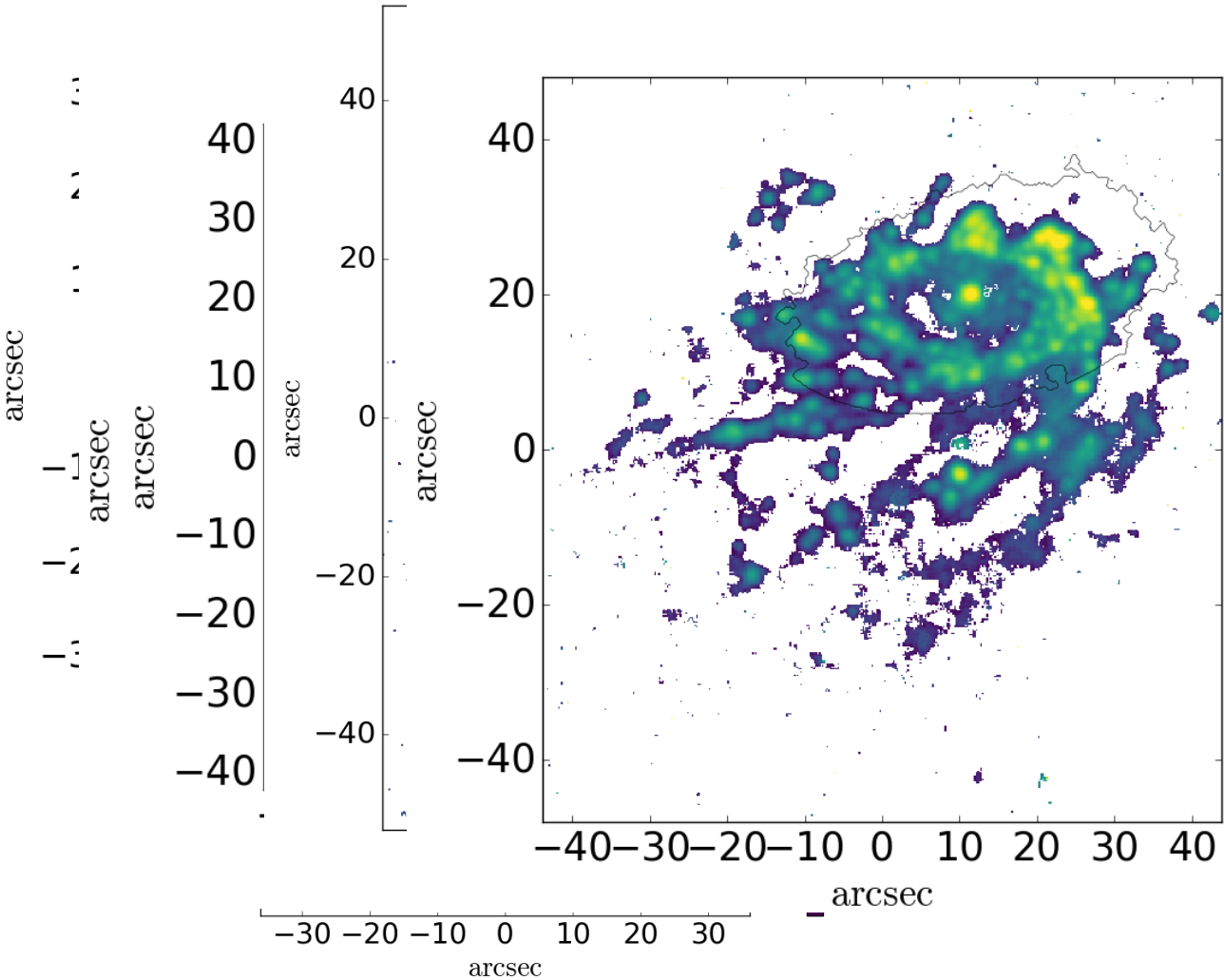
STAR FORMATION IN GAS OUTSIDE GALAXIES



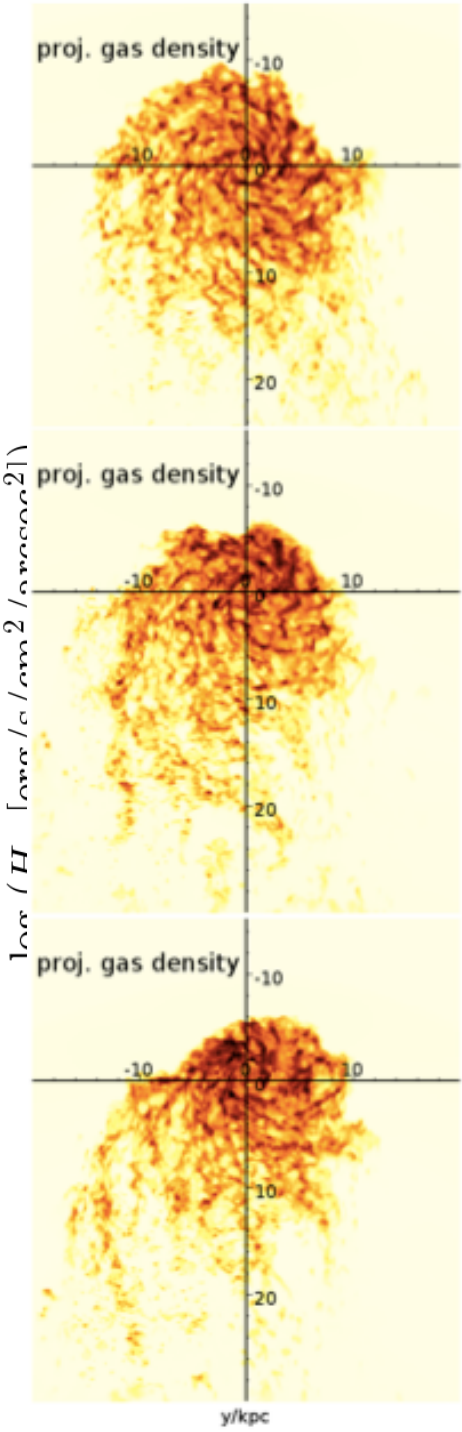
Ongoing and recent star formation in the tails, older stars confined in disk

star formation history from full fitting spectrophotometric modeling

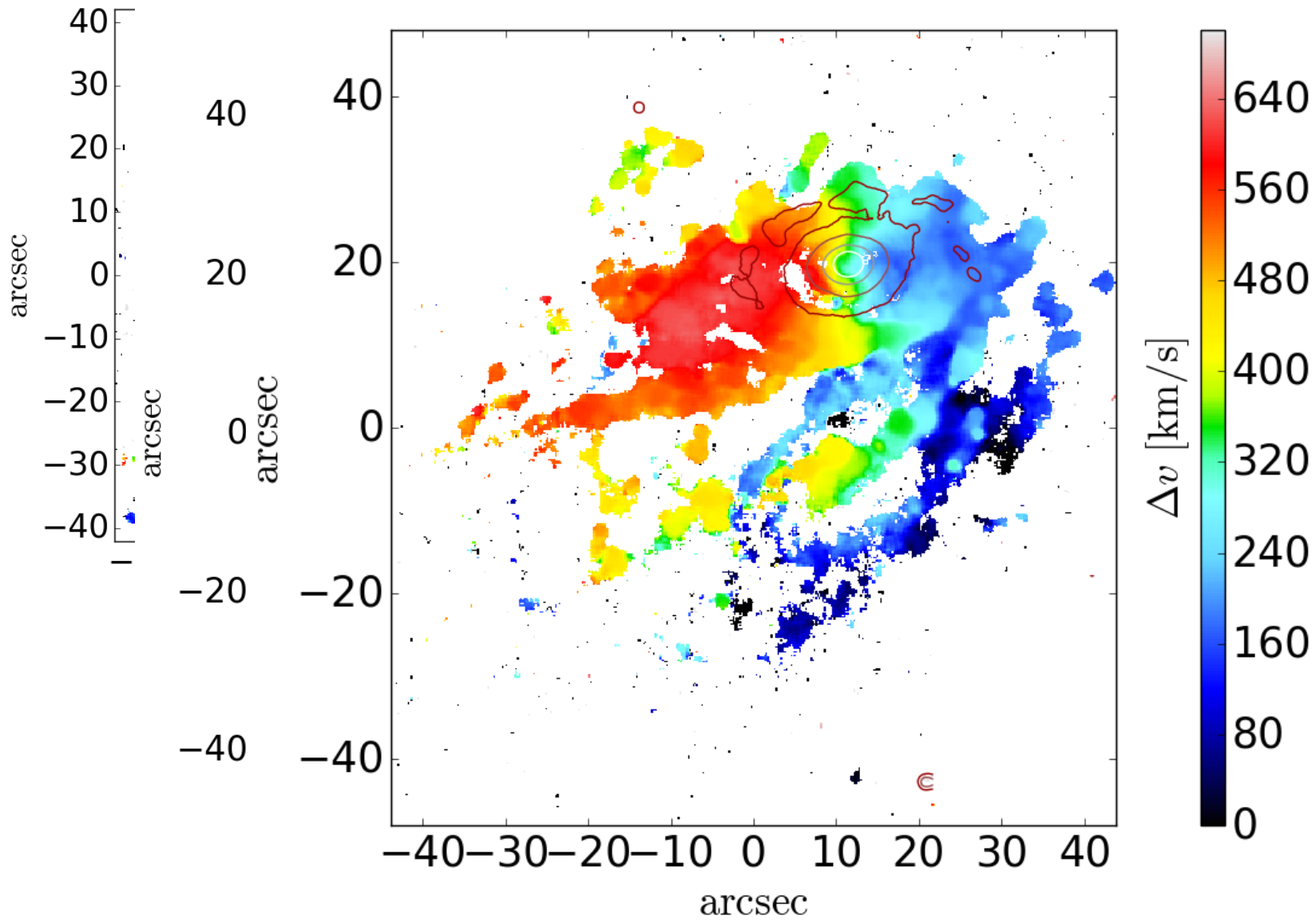
UNWINDING ARMS



Roediger+ 2014



UNWINDING ARMS



RAM PRESSURE-AGN CONNECTION



selection criterion: H α tentacles longer than the diameter of the stellar disk

>> 7 galaxies

>> all massive: $4 * 10^{10} - 3 * 10^{11} M_{\text{sun}}$

The screenshot shows the top navigation bar of the Nature journal website. The main header is dark red with the 'nature' logo in white. Below the logo is the text 'International weekly journal of science'. A horizontal menu contains links for Home, News & Comment, Research, Careers & Jobs, Current Issue, Archive, Audio & Video, and For Authors. Below this is a secondary navigation bar with arrows pointing to Archive, Volume 548, Issue 7667, Letters, and Article. The main content area has a white background. At the top left of the article page, it says 'NATURE | LETTER' with a share icon and a printer icon to the right. Below that is a blue link for '日本語要約'. The article title 'Ram-pressure feeding of supermassive black holes' is prominently displayed. The authors' names are listed in blue: Bianca M. Poggianti, Yara L. Jaffé, Alessia Moretti, Marco Gullieuszik, Mario Radovich, Stephanie Tonnesen, Jacopo Fritz, Daniela Bettoni, Benedetta Vulcani, Giovanni Fasano, Callum Bellhouse, George Hau & Alessandro Omizzolo. Below the authors are links for 'Affiliations', 'Contributions', and 'Corresponding author'. At the bottom, the publication details are given: 'Nature 548, 304–309 (17 August 2017) | doi:10.1038/nature23462' and 'Received 26 April 2017 | Accepted 21 June 2017 | Published online 16 August 2017'.

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Archive > Volume 548 > Issue 7667 > Letters > Article

NATURE | LETTER  

[日本語要約](#)

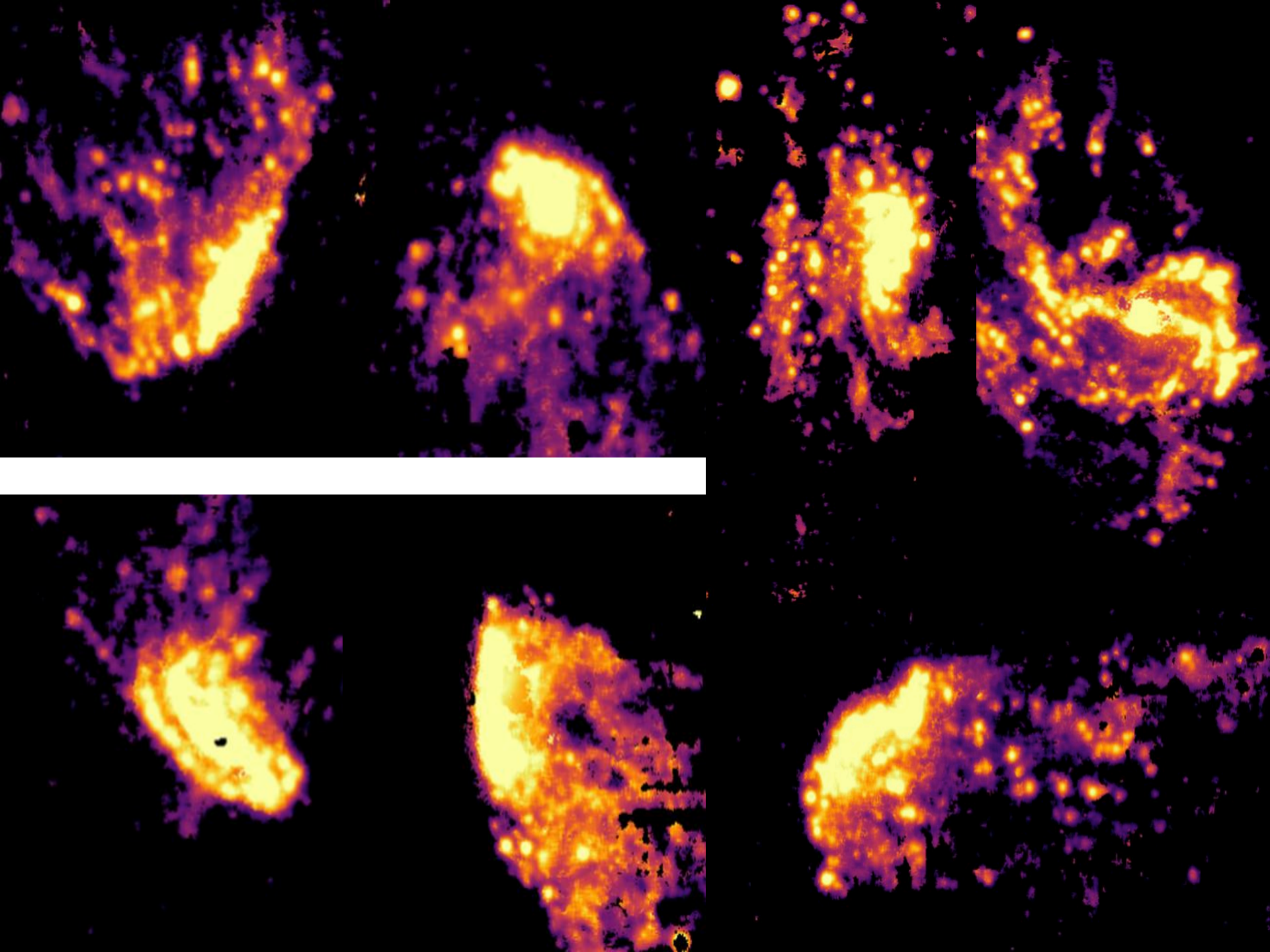
Ram-pressure feeding of supermassive black holes

[Bianca M. Poggianti](#), [Yara L. Jaffé](#), [Alessia Moretti](#), [Marco Gullieuszik](#), [Mario Radovich](#), [Stephanie Tonnesen](#), [Jacopo Fritz](#), [Daniela Bettoni](#), [Benedetta Vulcani](#), [Giovanni Fasano](#), [Callum Bellhouse](#), [George Hau](#) & [Alessandro Omizzolo](#)

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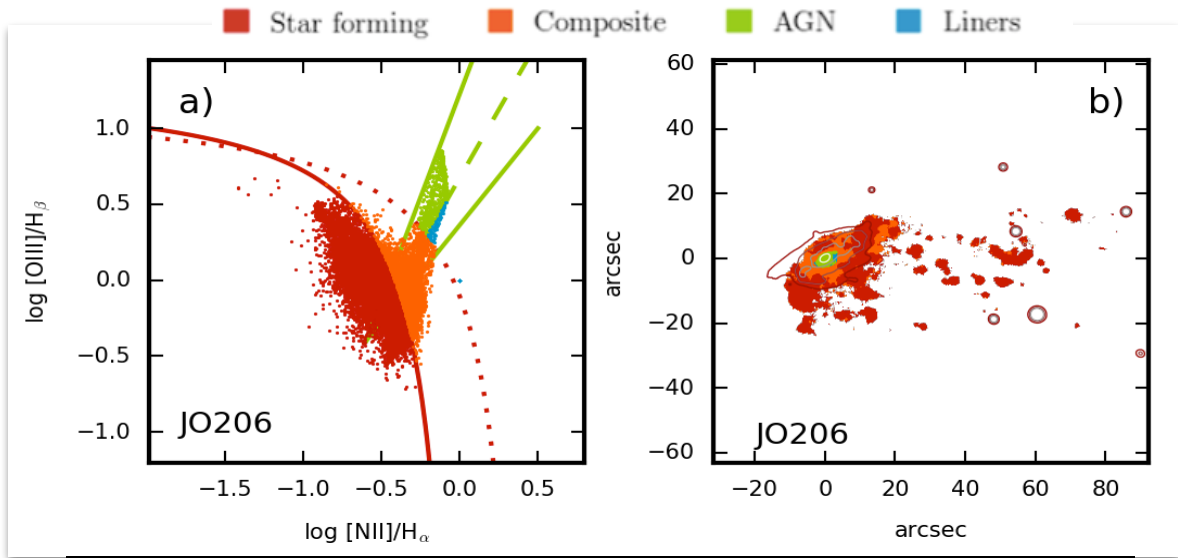
AGN are usually rare:

3% among WINGS cluster galaxies (Marziani et al. 2017)

8% among galaxies (Brinchmann et al. 2004)

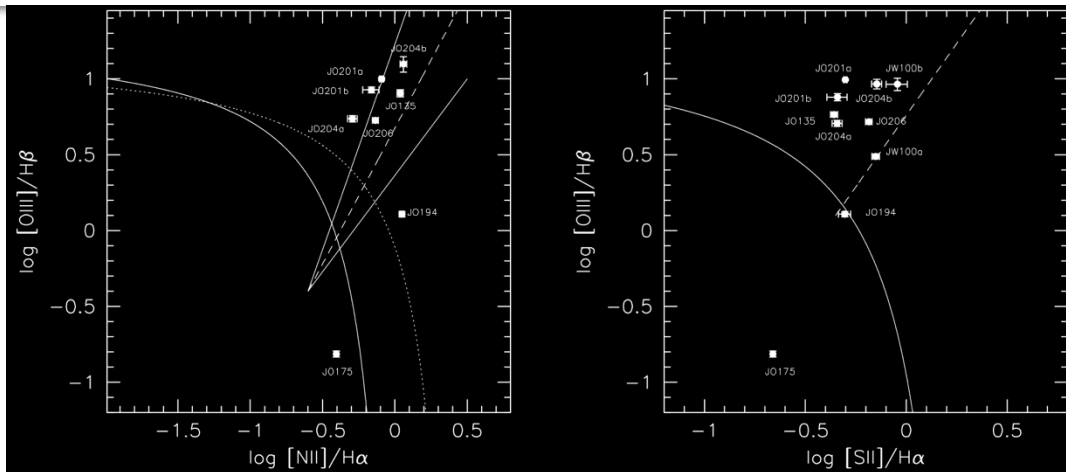


We found 5 AGN (Seyfert2) and 1 LINER in our sample of 7 jellyfish galaxies
 ----- Link between ram-pressure stripping and AGN activity.



AGN >> RPS

AGN inject energy in the ISM
 Decrease binding energy
 Increase efficiency of RPS

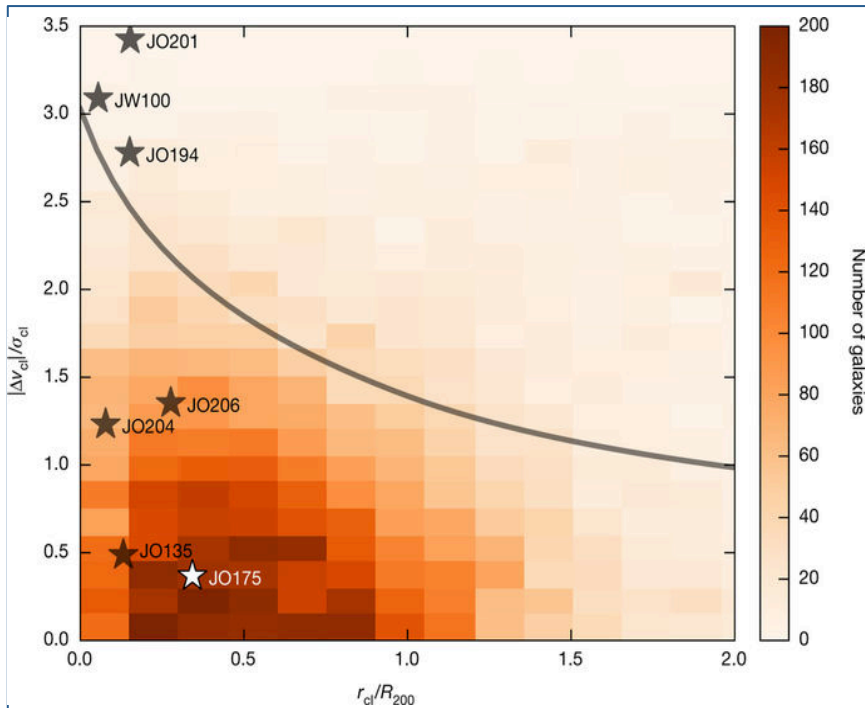


or

RPS >> AGN

RPS can bring gas toward the center feeding the central BH and triggering the AGN.

(projected) phase-space diagram



The 7 galaxies are in the inner regions of the cluster and they move at high speed in the ICM (we measure LOS velocity!)

>> conditions are favourable for RPS

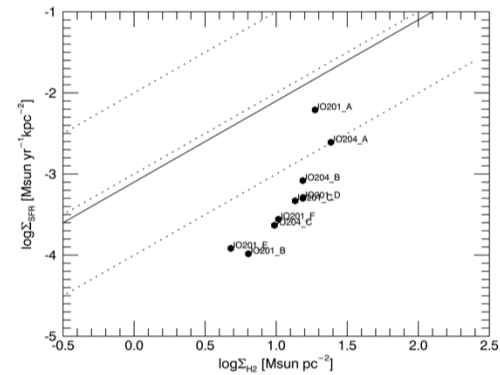
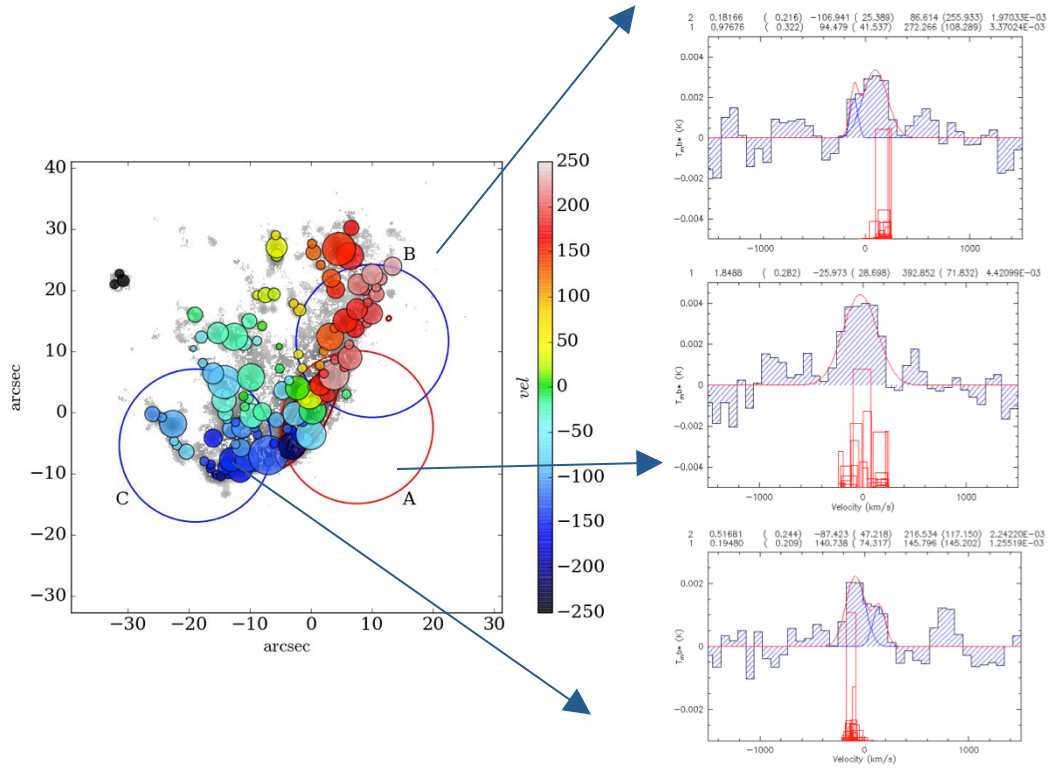
Suggest that high incidence of AGN among jellyfish galaxies may be due to ram-pressure causing gas to flow toward the center and triggering the AGN

Hydro-sims: ISM interacting with non-rotating ICM loses angular momentum
oblique shocks in a disk flared by magnetic field

GASP FOLLOW-UPS



- CO gas with APEX (5 galaxies, 77hrs) and ALMA (4 galaxies, 22hrs)
- HI gas with JVLA: 100hrs, 5 clusters, C-array (15" res.)
- FUV and NUV deep imaging with UVIT/ASTROSAT: 3 clusters so far



Low SFE
See Jachym's talk

GASP I: Gas stripping phenomena in galaxies with MUSE, Poggianti et al., 2017a ApJ, 844, 49

GASP II: A MUSE view of extreme ram-pressure stripping along the line of sight: kinematics of the jellyfish galaxy JO201, Bellhouse et al., 2017 ApJ, 844, 49

GASP III: JO36: a case of multiple environmental effects at play?, Fritz et al., 2017 ApJ, 848, 132

GASP IV: A MUSE view of extreme ram pressure stripping in the plane of the sky: the case of jellyfish galaxy JO204, Gullieuszik et al., 2017, ApJ, 846, 27

GASP V: Ram pressure stripping of a ring Hoag's-like galaxy in a massive cluster, Moretti et al., 2017, submitted

(GASP VI): Ram pressure feeding of supermassive black holes, Poggianti et al., 2017b Nature, 548, 304

GASP VII: Signs of gas inflow onto a lopsided galaxy, Vulcani et al. 2017, ApJ in press

GASP VIII: Capturing the birth of a tidal dwarf galaxy in a merging system at $z \sim 0.5$, Vulcani et al. 2017, ApJ, 850, 163

GASP IX: Jellyfish galaxies in phase-space, Jaffe' et al. 2017 submitted

