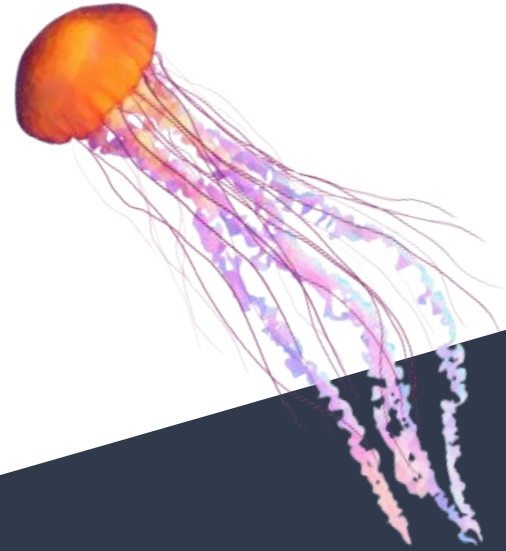
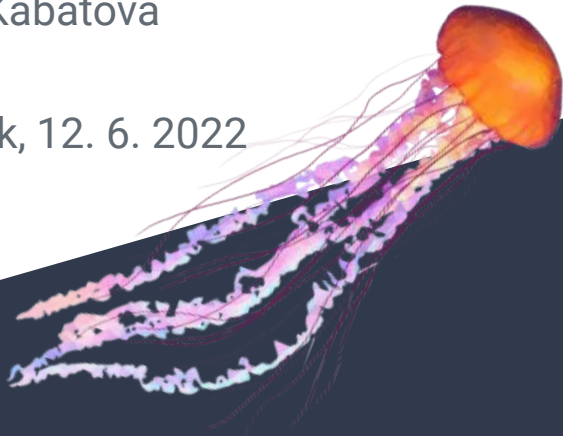


The molecular gas in tails of jellyfish galaxies

Anežka Kabátová

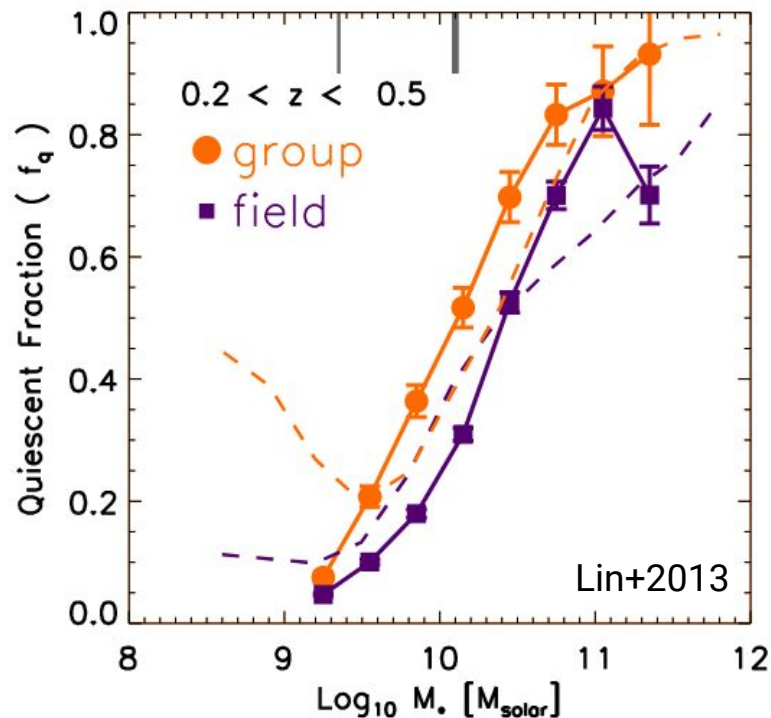
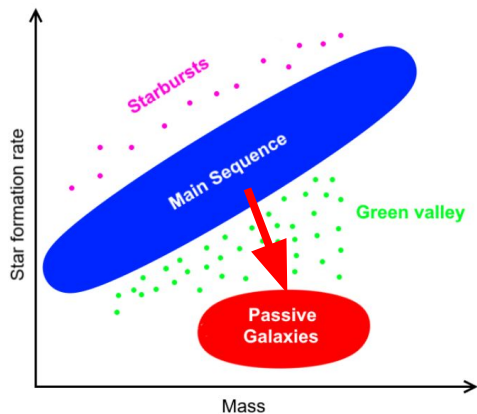
WJČF
Bílý potok, 12. 6. 2022



Galaxies in cluster environment

Cluster environment

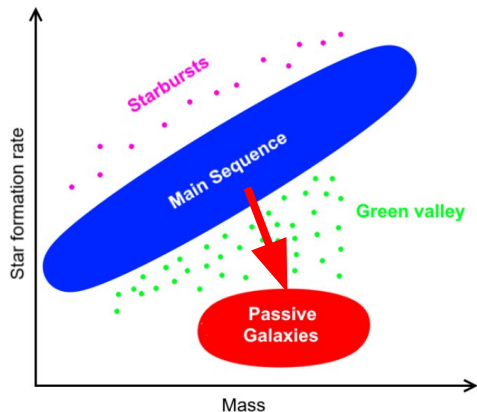
- $T \sim 10^7 - 10^8$ K
- $n_{\text{ICM}} \sim 10^{-4} - 10^{-2} \text{ cm}^{-3}$
- 100s - 1000s members



Galaxies in cluster environment

Cluster environment

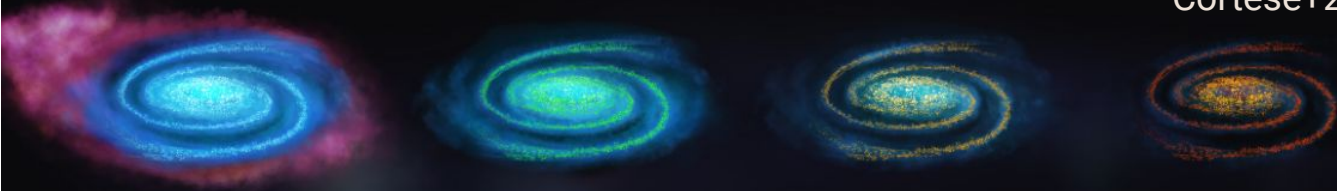
- $T \sim 10^7 - 10^8$ K
- $n_{\text{ICM}} \sim 10^{-4} - 10^{-2} \text{ cm}^{-3}$
- 100s - 1000s members



Quenching of galaxies in clusters

- Internal processes
 - ◆ AGN + SF feedback
- External processes
 - ◆ Starvation / strangulation
 - ◆ Stripping
 - Hydrodynamical
 - Gravitational
- Other effects
 - ◆ Inability to convert gas to stars

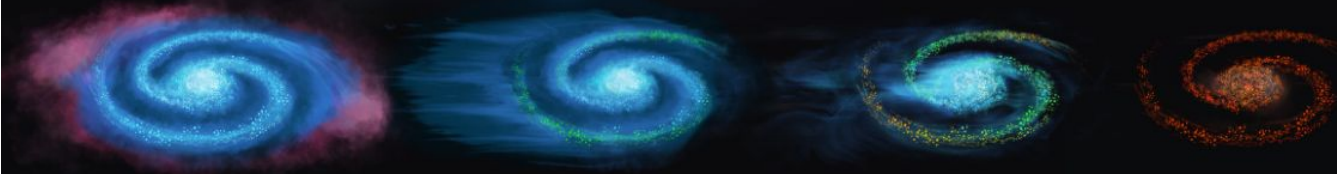
Starvation/Gas Consumption



Cortese+2021

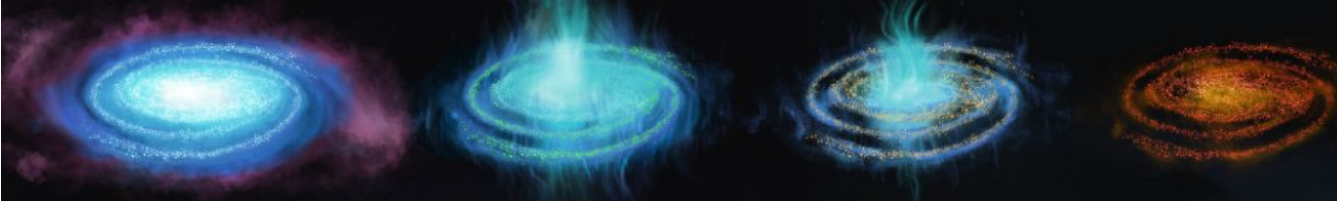
- Necessary condition of quenching

Stripping/Gas Removal



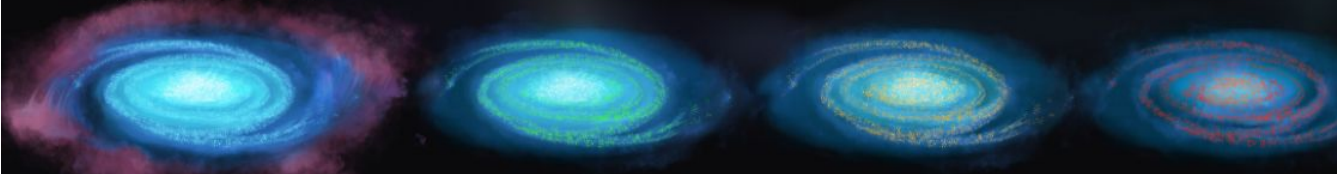
- Ram pressure
- Viscous
- Thermal evaporation
- Harassment

Outflow/Gas Ejection



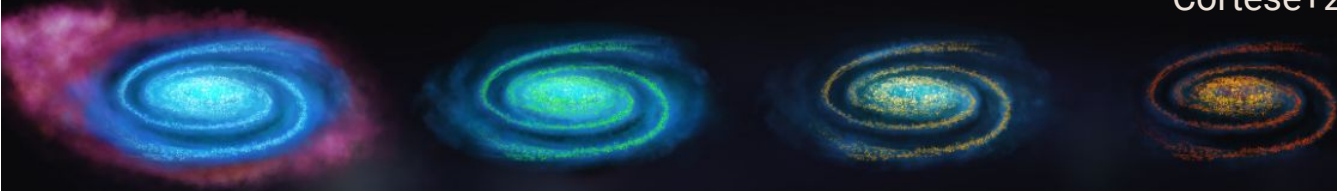
- AGN
- SF

Stability/Gas Not Forming Stars



- HI-to-H₂ conversion
- Clouds-to-stars c.

Starvation/Gas Consumption



Cortese+2021

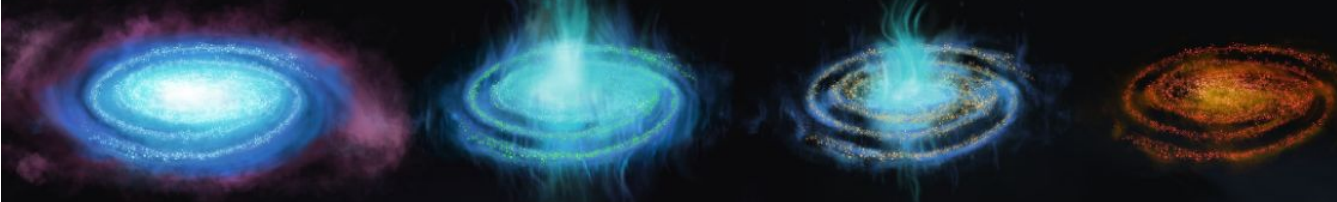
- Necessary condition of quenching

Stripping/Gas Removal



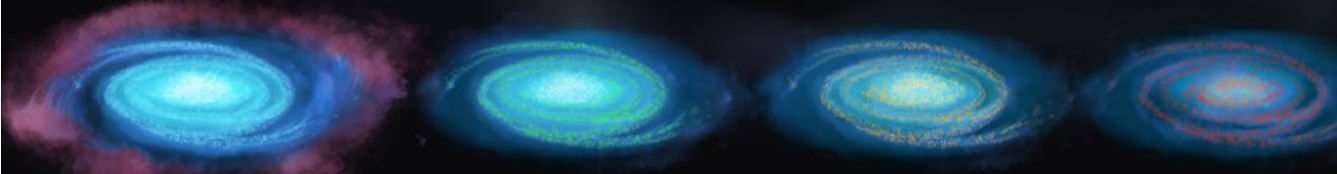
- Ram pressure
- Viscous
- Thermal evaporation
- Gravitational

Outflow/Gas Ejection



- AGN
- SF

Stability/Gas Not Forming Stars

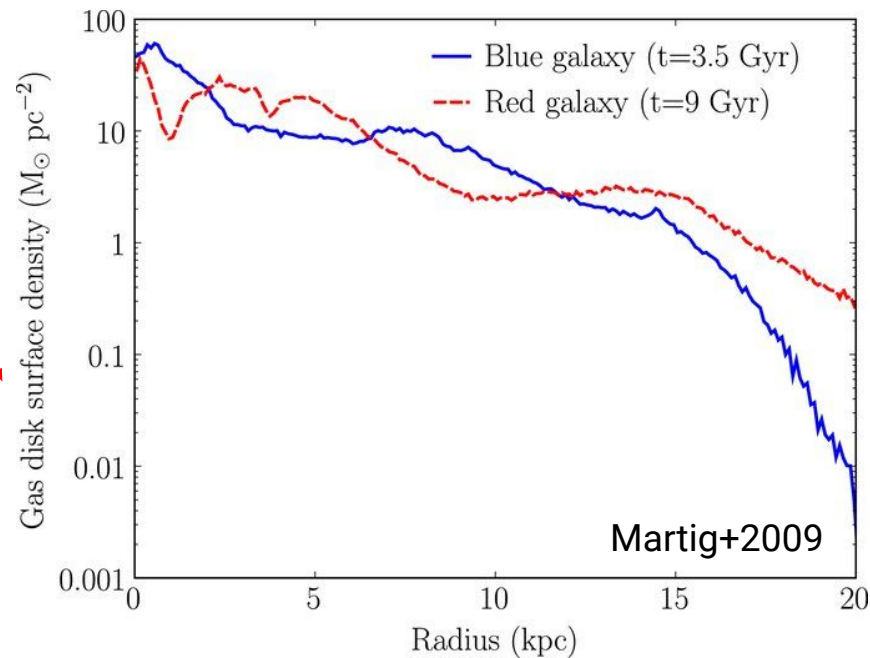


- HI-to-H₂ conversion
- Clouds-to-stars c.

Ram pressure stripping

$$P = \rho_{ICM} V^2$$

$$\rho_{ICM} V_{\perp}^2 > 2\pi G \Sigma_{star} \Sigma_{gas} = \frac{v_{rot}^2 \Sigma_{gas}}{R_{gal}}$$

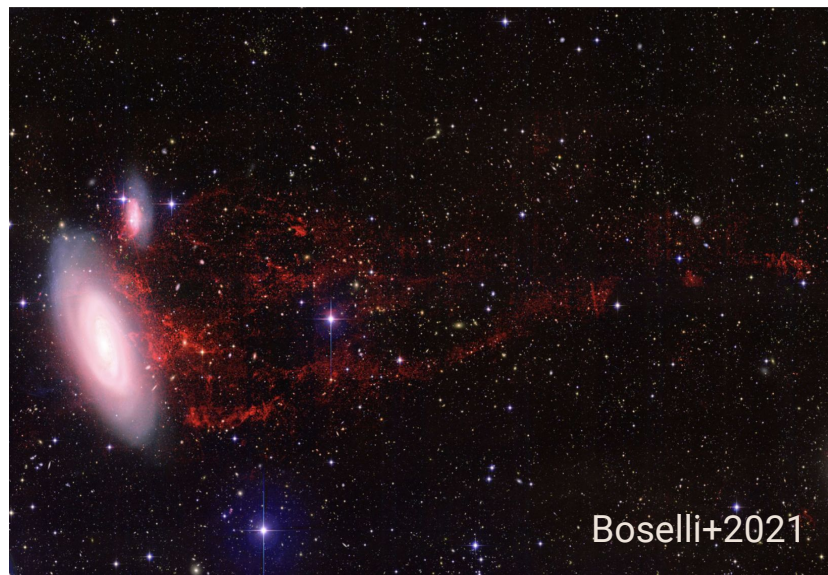


Observational evidence

Tidal interaction



Stripping event



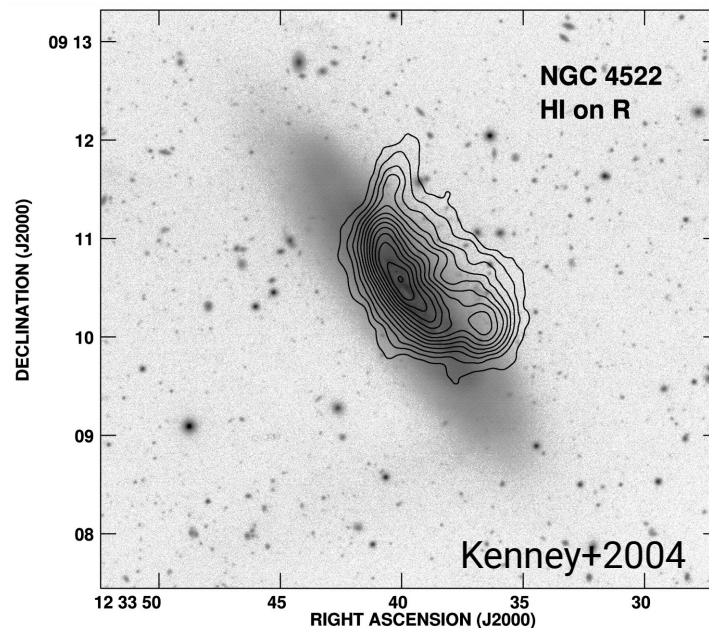
Observational evidence

Properties of galaxies in clusters

- HI-deficient
- Radial orbits → gas-poorer
- Different gas distribution - less extended Σ profiles

Typical RPS galaxy

- Disk truncation - sharp edge of gas distribution
- One-sided features
- Wake of gas behind
- Unperturbed stellar disk



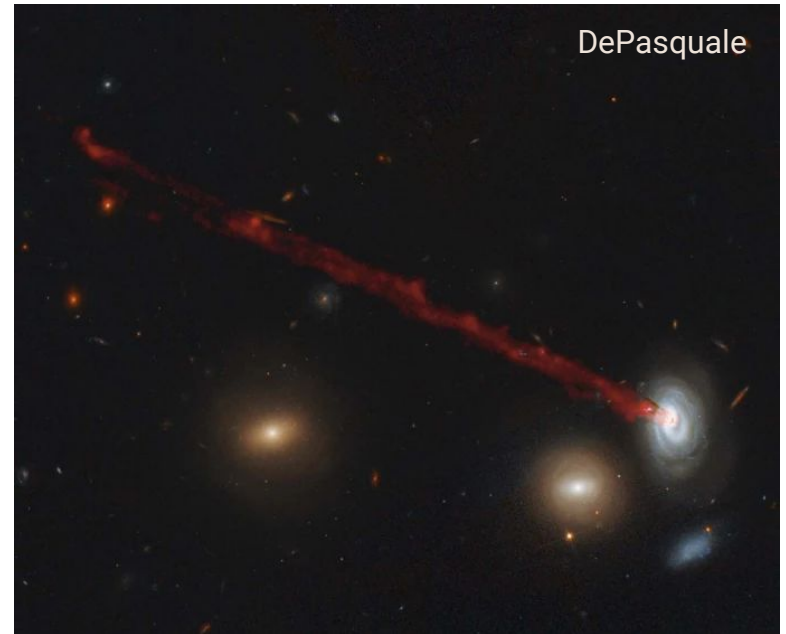
Observational evidence

Properties of galaxies in clusters

- HI-deficient
- Radial orbits \rightarrow gas-poorer
- Different gas distribution - less extended Σ profiles

Typical RPS galaxy

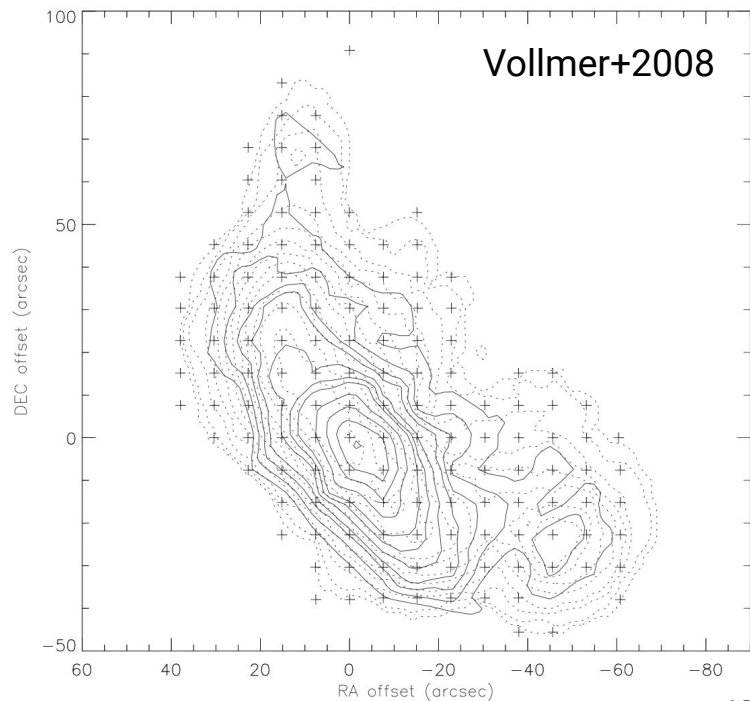
- Disk truncation - sharp edge of gas distribution
- One-sided features
- Wake of gas behind
- Unperturbed stellar disk



Molecular hydrogen in RPS galaxies

Studying the molecular hydrogen

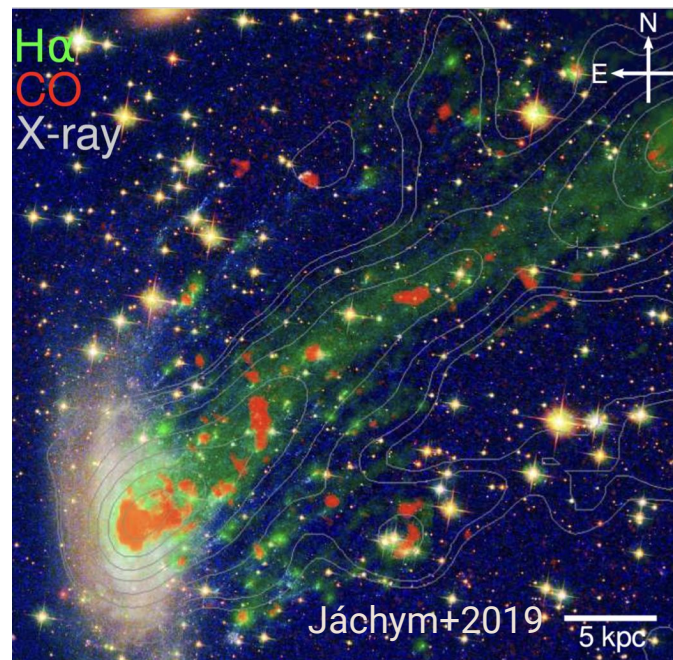
- Detected via CO - what is the conversion factor?
- In the parent galaxy
 - ◆ H₂ deficiency
 - Connected to significant *def HI* (>1)
 - Connected to stripping inside the stellar disk
 - ◆ Evidence of direct stripping
- In tails
 - ◆ Direct stripping vs. in-situ formation
 - ◆ SF - when does it occur?



Molecular hydrogen in RPS galaxies

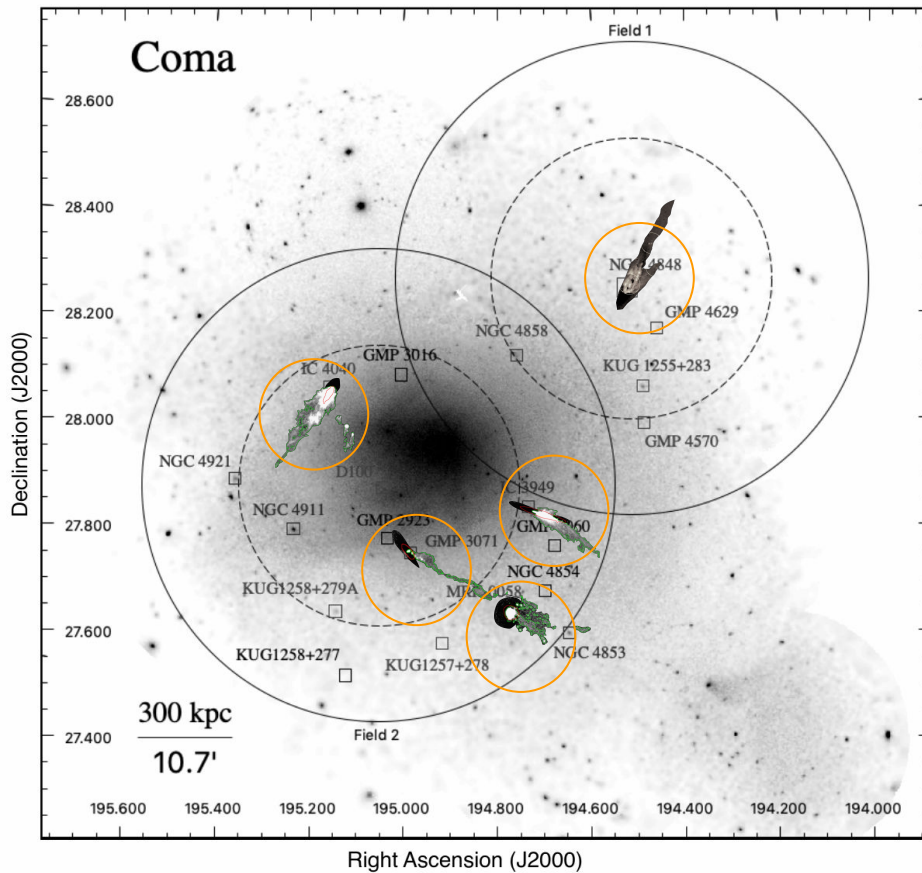
Studying the molecular hydrogen

- Detected via CO - what is the conversion factor?
- In the parent galaxy
 - ◆ H₂ deficiency
 - Connected to significant *def HI* (>1)
 - Connected to stripping inside the stellar disk
 - ◆ Evidence of direct stripping
- In tails
 - ◆ Direct stripping vs. in-situ formation
 - ◆ SF - when does it occur?

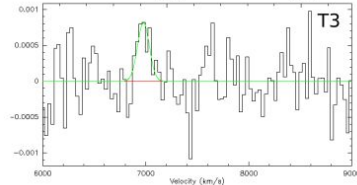
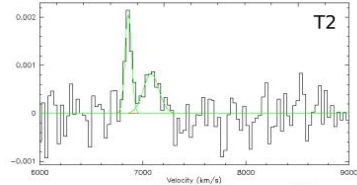
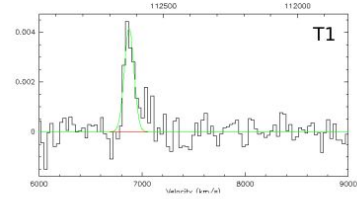
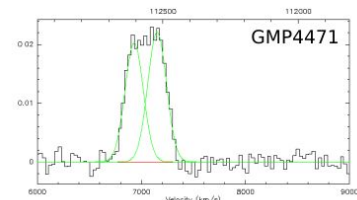
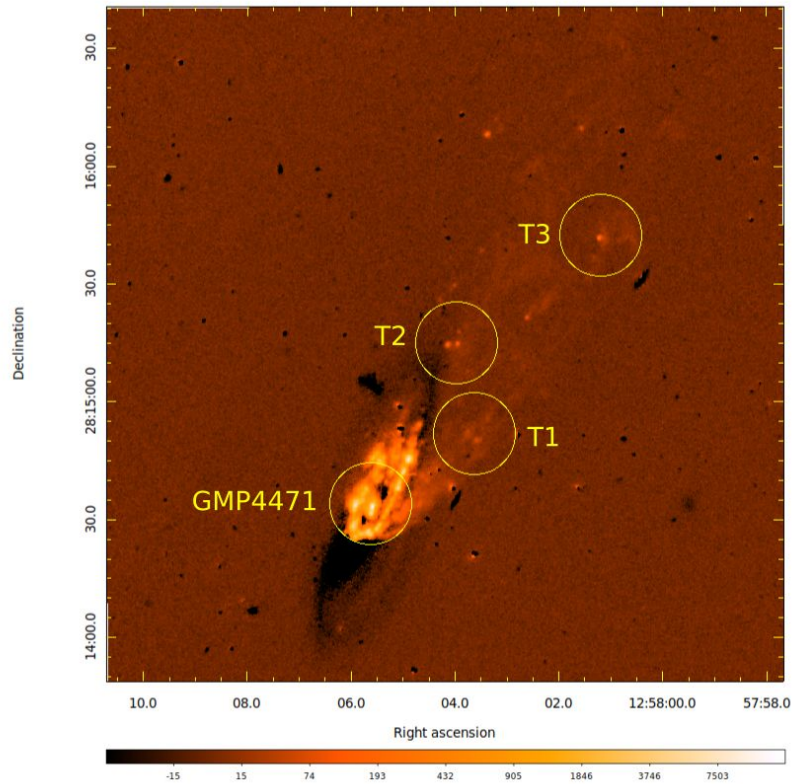




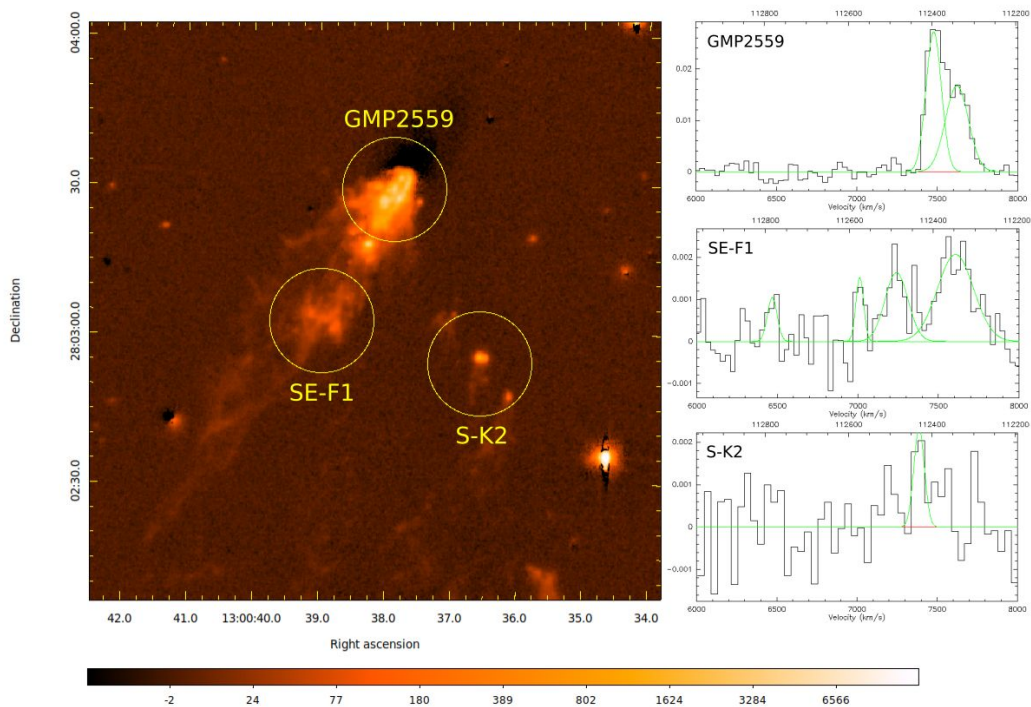
IRAM 30m telescope, Spain



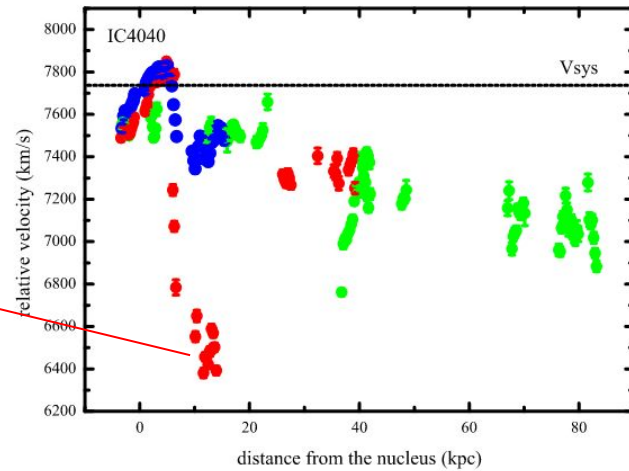
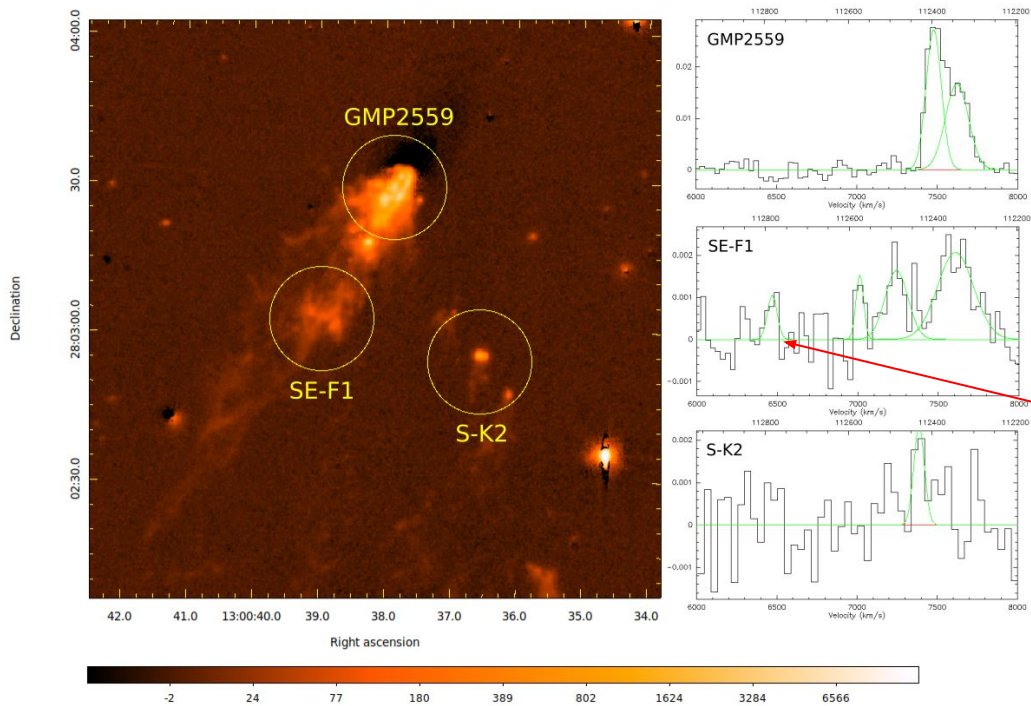
Coma cluster

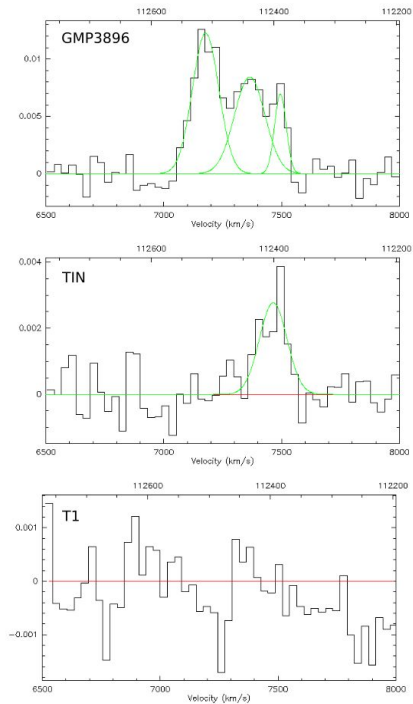
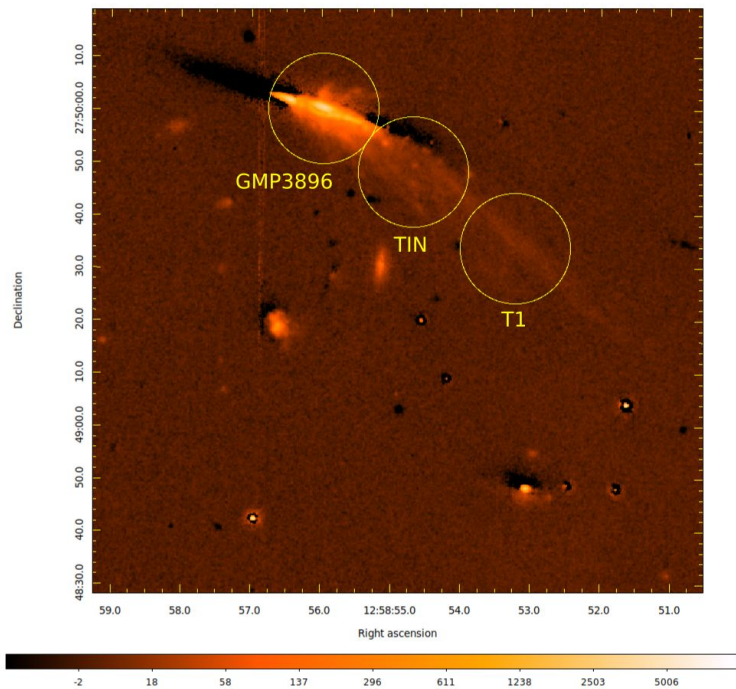


M_*	$208.9 \cdot 10^8 M_{\odot}$
d_{Coma}	804.2 kpc
v_{Coma}	124 km/s
$M_{H_2 \text{ disk}}$	$50.4 \cdot 10^8 M_{\odot}$
$M_{H_2 \text{ tail}}$	$4.7 \cdot 10^8 M_{\odot}$
$Def \text{ HI}$	0.25

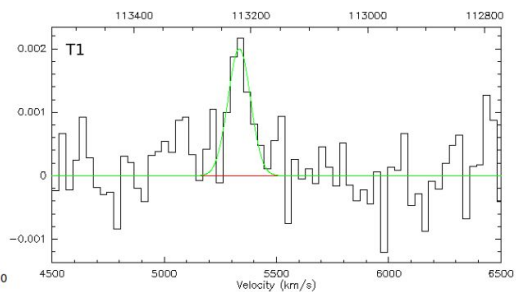
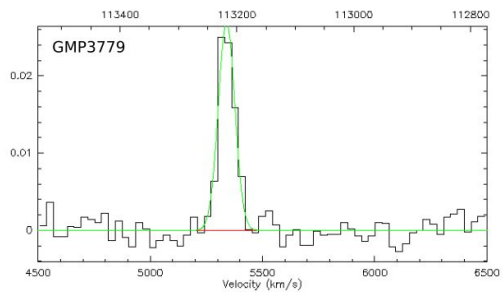
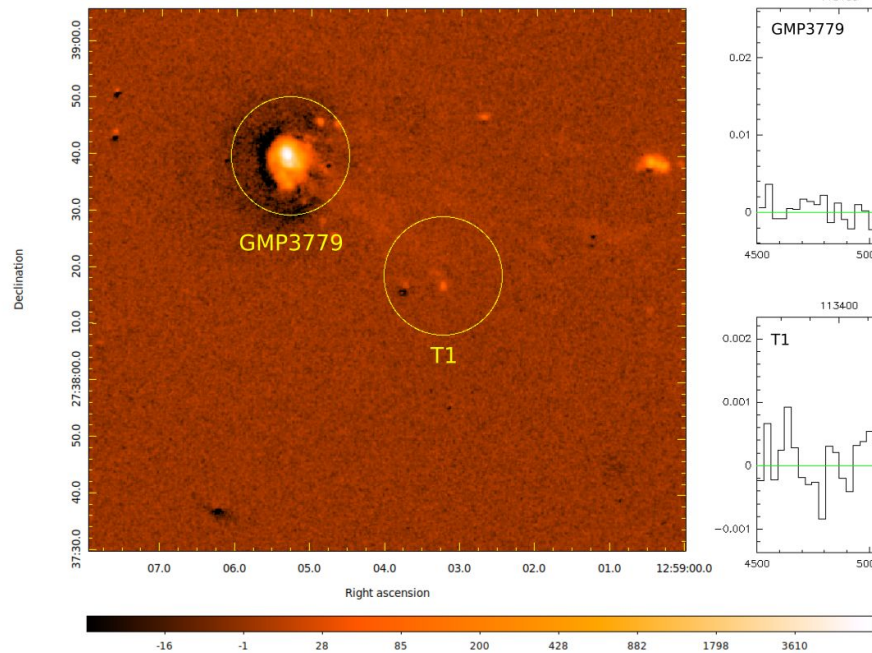


M_*	$44.7 \cdot 10^8 M_{\odot}$
d_{Coma}	343.4 kpc
v_{Coma}	720 km/s
$M_{H_2 \text{ disk}}$	$31.3 \cdot 10^8 M_{\odot}$
$M_{H_2 \text{ tail}}$	$6.5 \cdot 10^8 M_{\odot}$
$Def \text{ HI}$	0.45

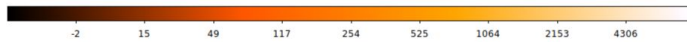
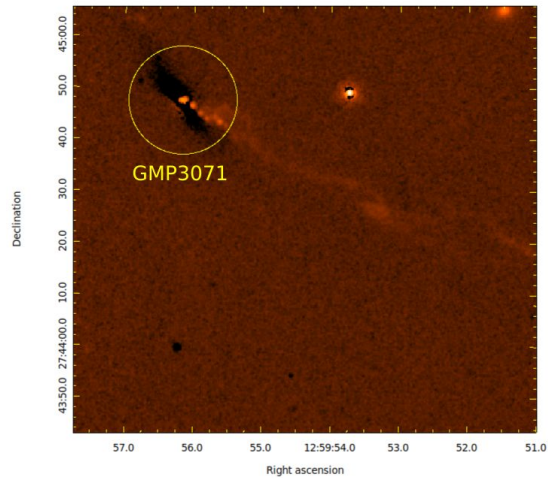
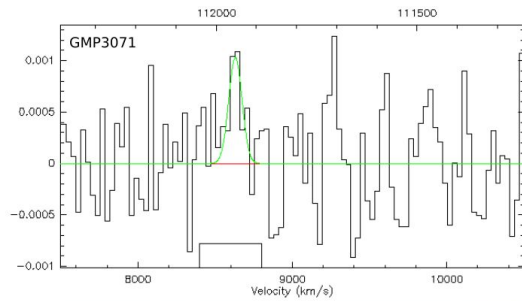




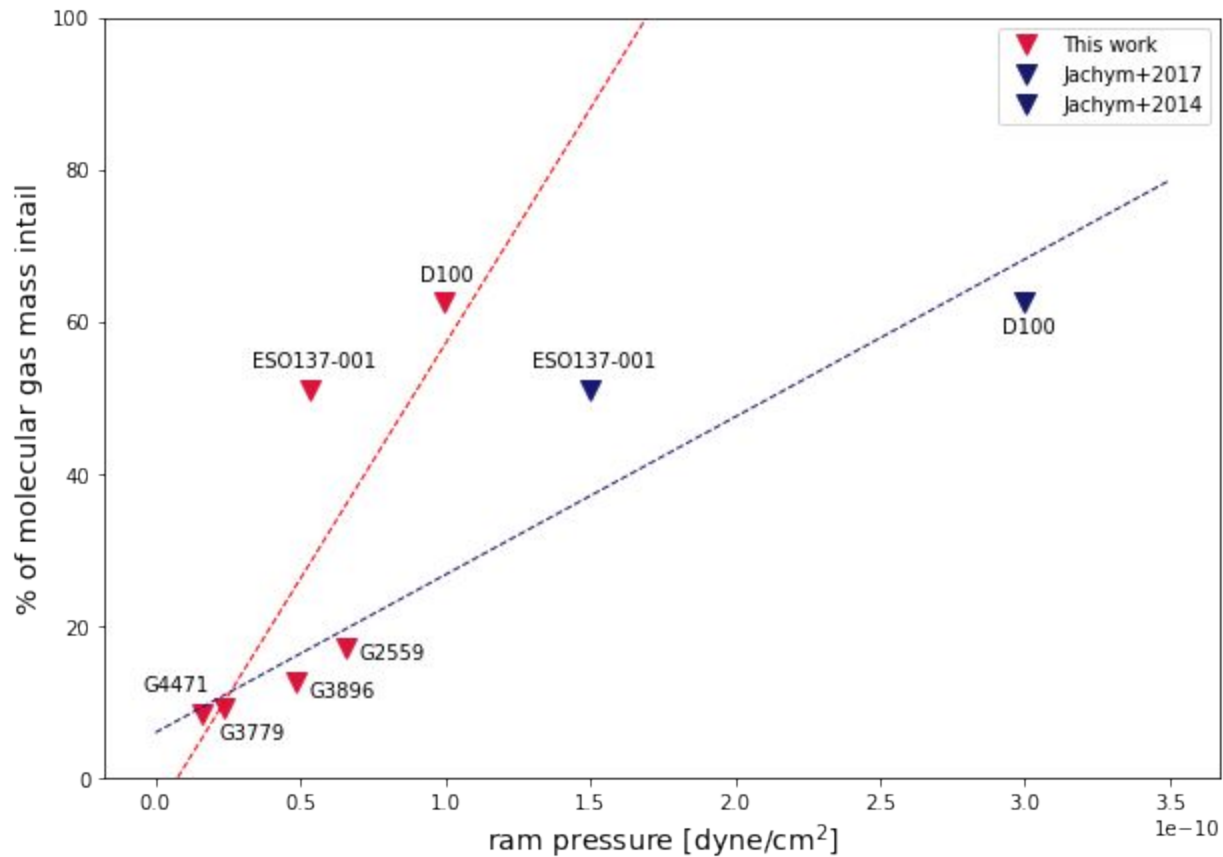
M_*	$263 \cdot 10^8 M_\odot$
d_{Coma}	425.3 kpc
v_{Coma}	629 km/s
$M_{H_2 \text{ disk}}$	$18.5 \cdot 10^8 M_\odot$
$M_{H_2 \text{ tail}}$	$2.7 \cdot 10^8 M_\odot$
$Def HI$	1.01



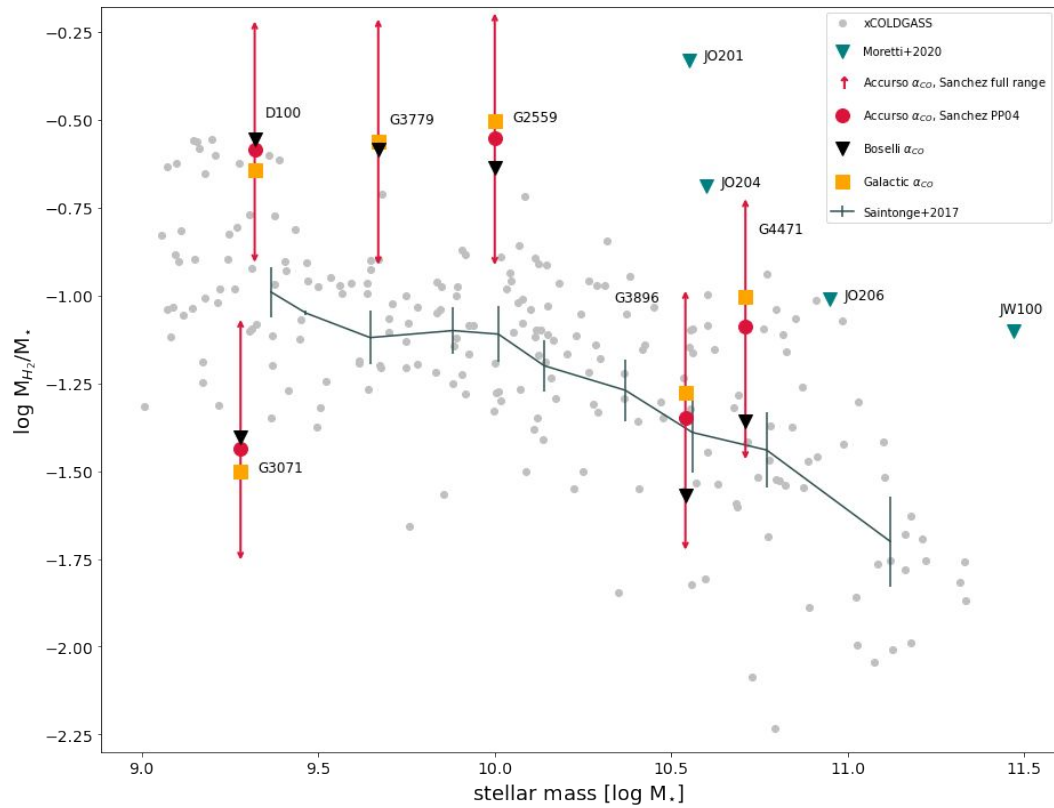
M_*	$54.9 \cdot 10^8 M_\odot$
d_{Coma}	649.9 kpc
v_{Coma}	-1499 km/s
$M_{H_2 \text{ disk}}$	$12.9 \cdot 10^8 M_\odot$
$M_{H_2 \text{ tail}}$	$1.3 \cdot 10^8 M_\odot$
$Def \text{ HI}$	0.82

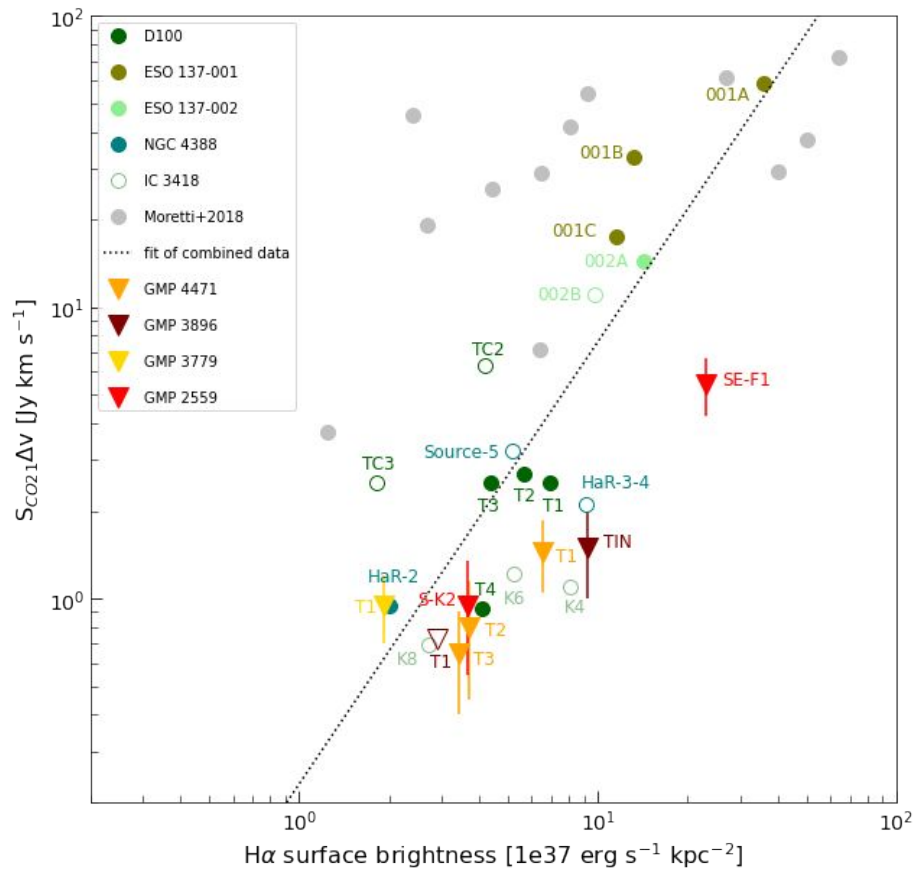


M_*	$8.1 \cdot 10^8 M_\odot$
d_{Coma}	411.4 kpc
v_{Coma}	2066 km/s
$M_{H_2 \text{ disk}}$	$0.6 \cdot 10^8 M_\odot$
$M_{H_2 \text{ tail}}$	$- M_\odot$
$Def HI$	> 0.35



RPS vs. fraction of molecular gas in tail





Conclusions

- Galaxies in clusters are affected by multiple processes
 - ◆ Hydrodynamical
 - ◆ Gravitational
- RPS is affecting all gas phases
- Tails of stripped galaxies contain molecular hydrogen
 - ◆ Directly stripped & newly formed
- New single-dish observations of RPS-stripped tails



Thanks for
your attention!

