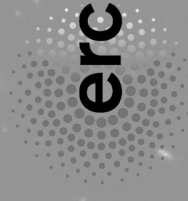


Linking galaxy evolution to the large-scale structure of the universe at $z \sim 3$

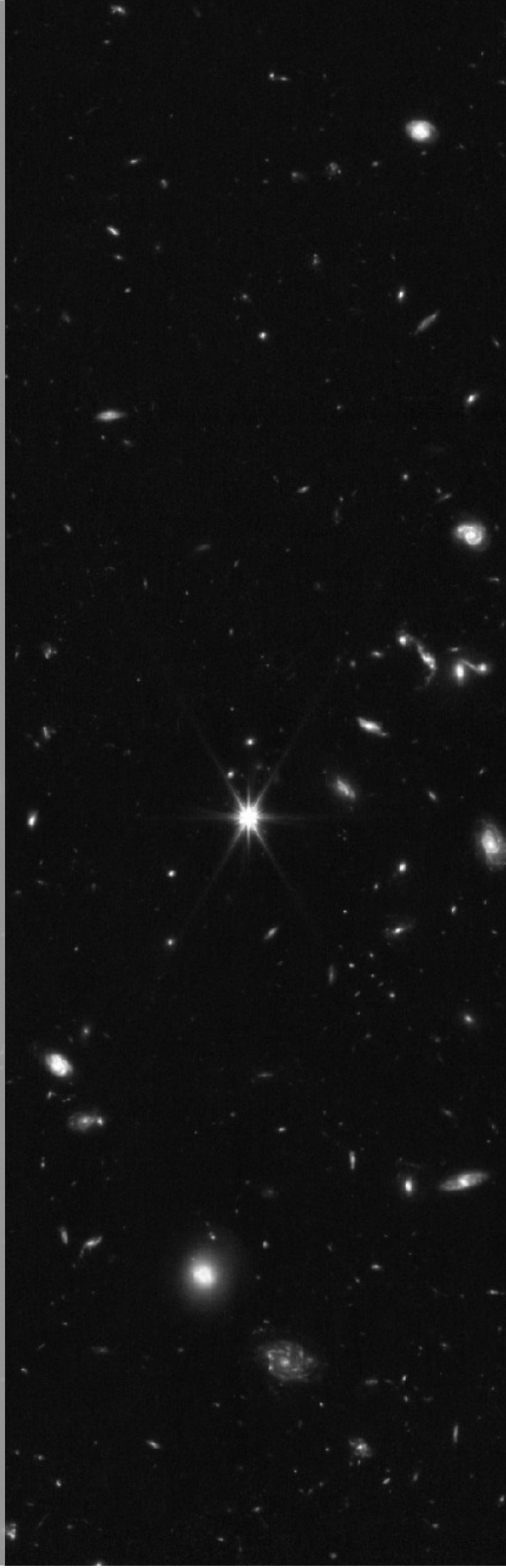
Marta Galbiati

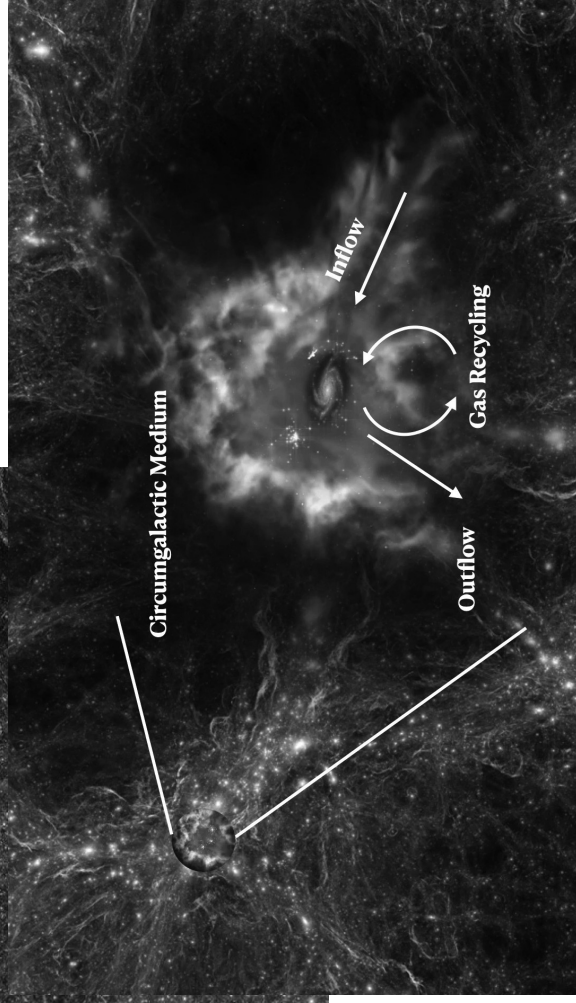
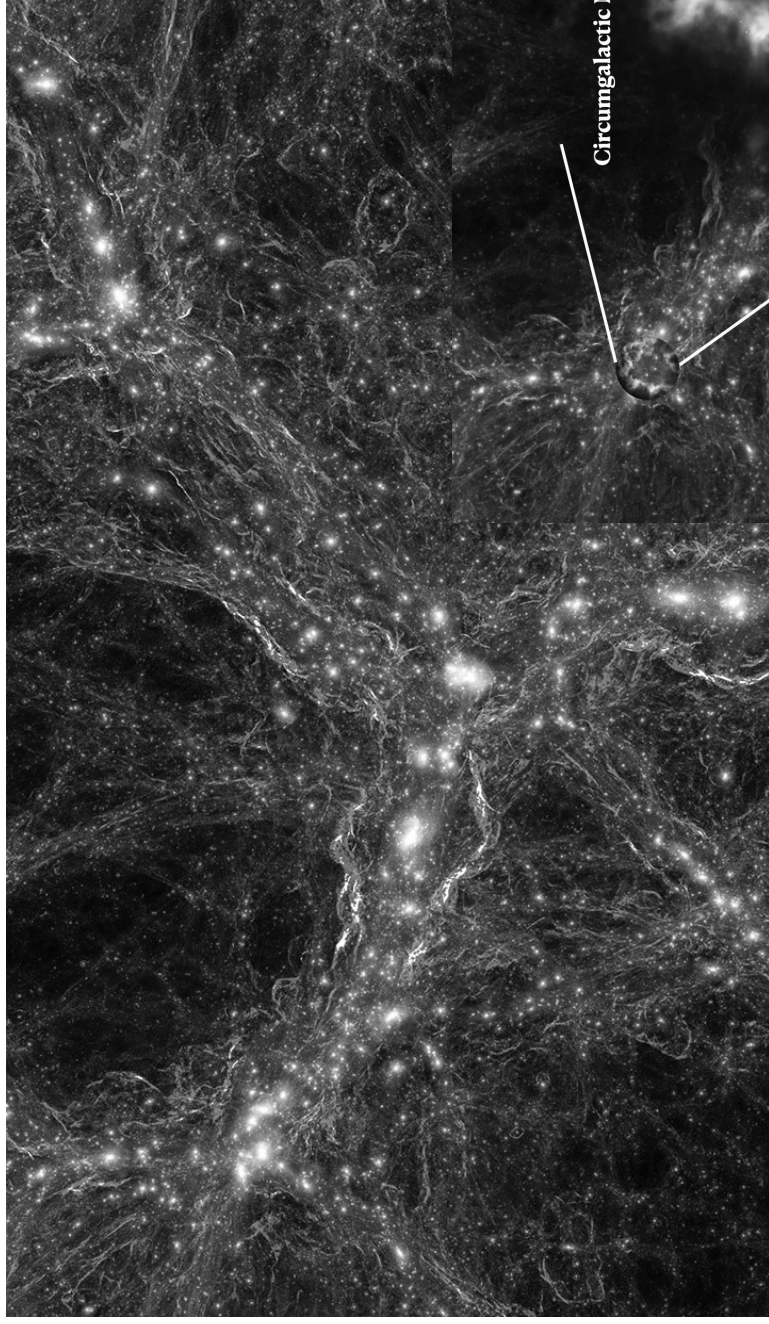
marta.galbiati@unimib.it

Università degli Studi di Milano-Bicocca



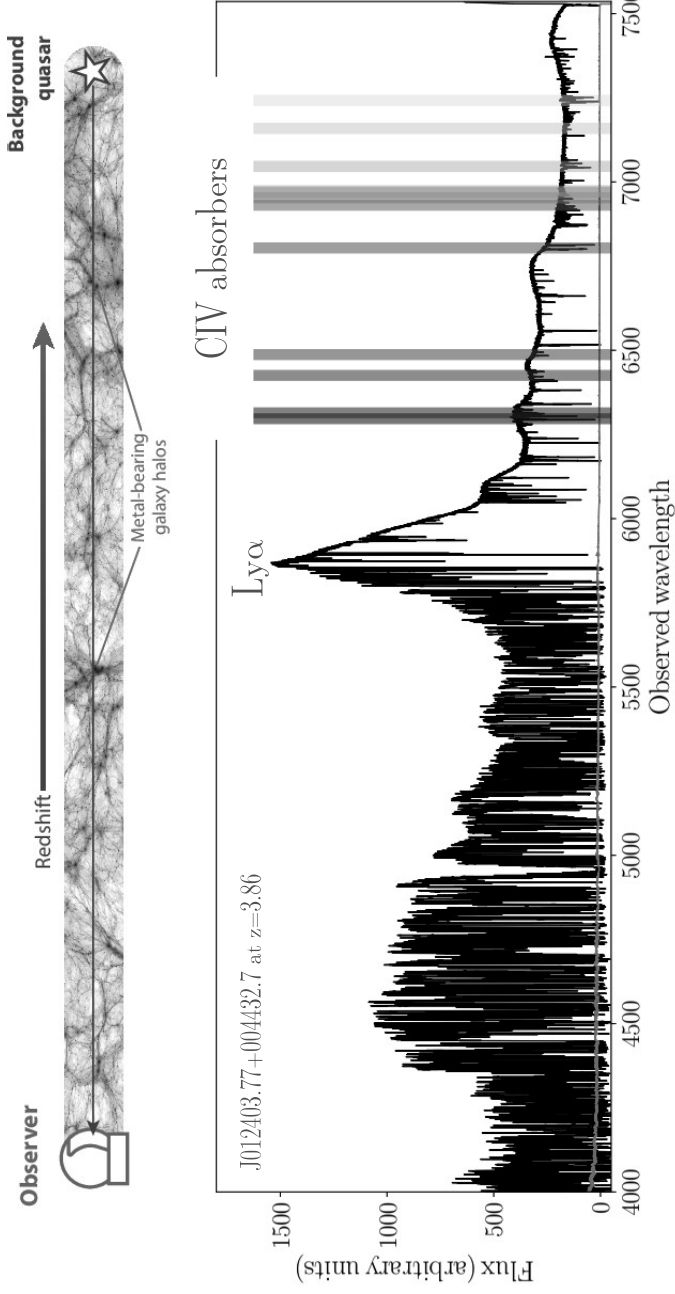
European Research Council
Established by the European Commission





How do the physical and chemical properties of the intergalactic and circumgalactic gas connect to galaxy evolution?

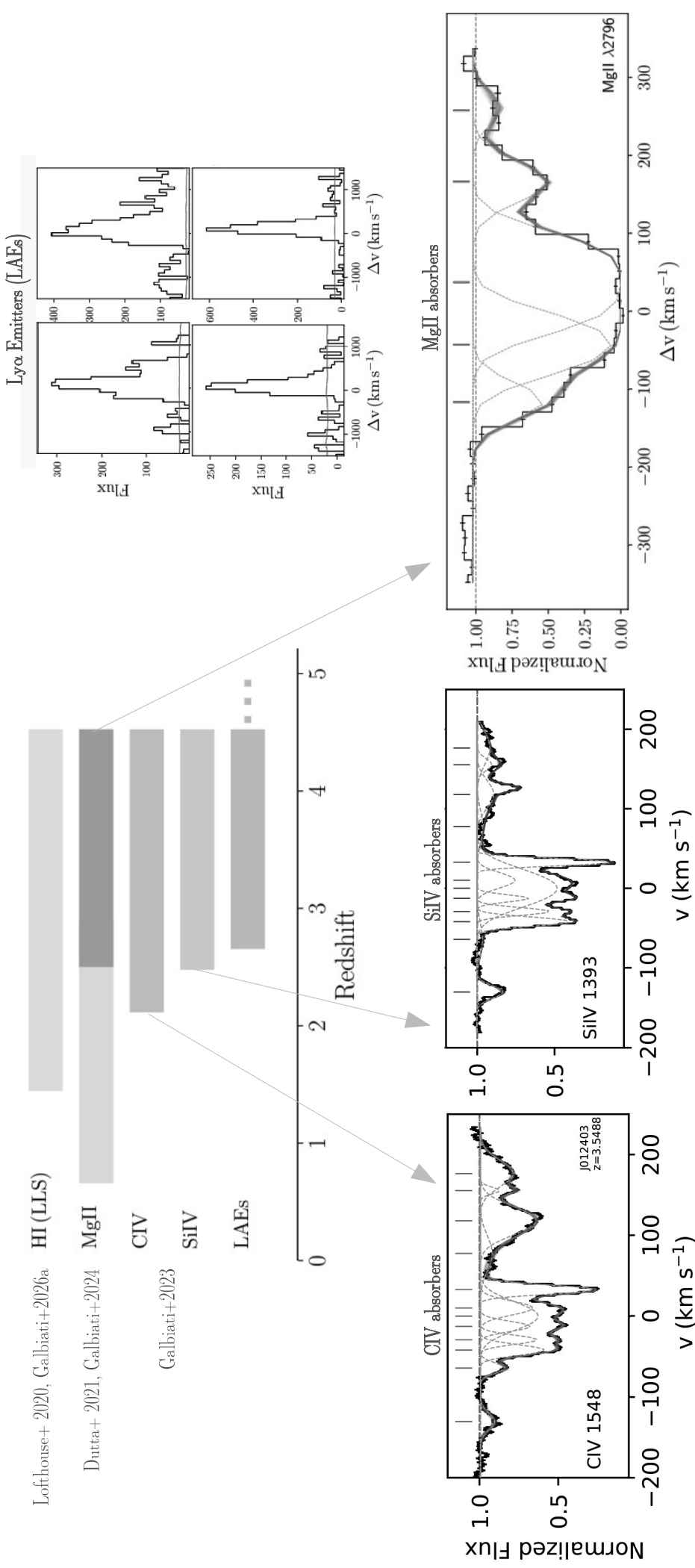
The cosmic gas in absorption



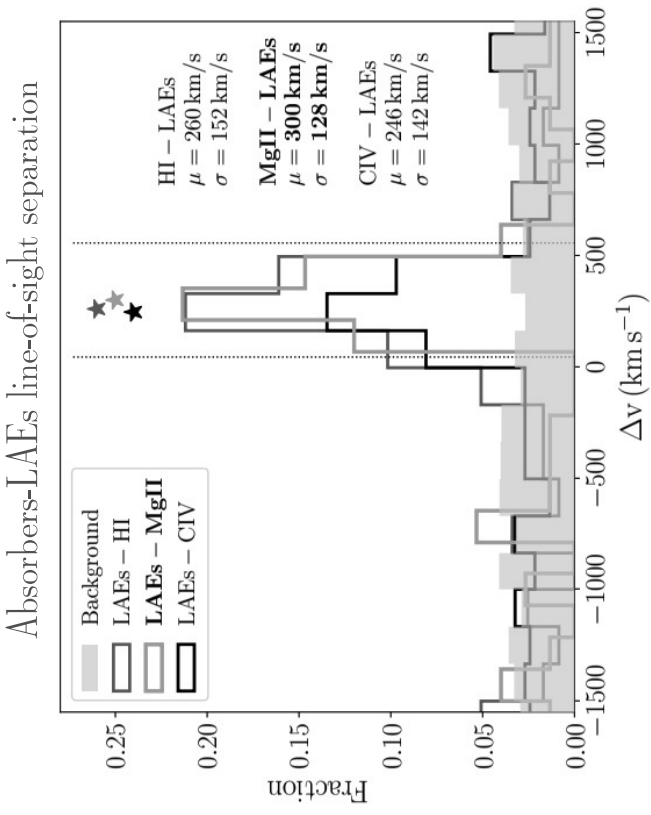
The MUSE Analysis of Gas Around Galaxies (MAGG) survey:

- 28 quasars at $z=3-4.5$
- Medium/High resolution quasar spectroscopy (ESI, X-Shooter, HIRES, UVES)
- 4-10h deep MUSE observations.

The multiphase gas around LAEs

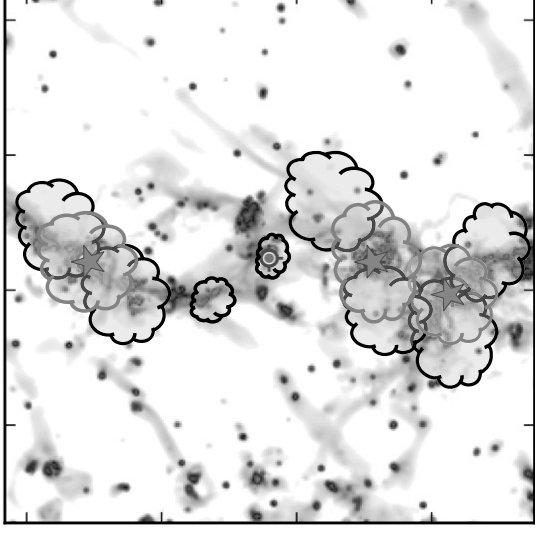
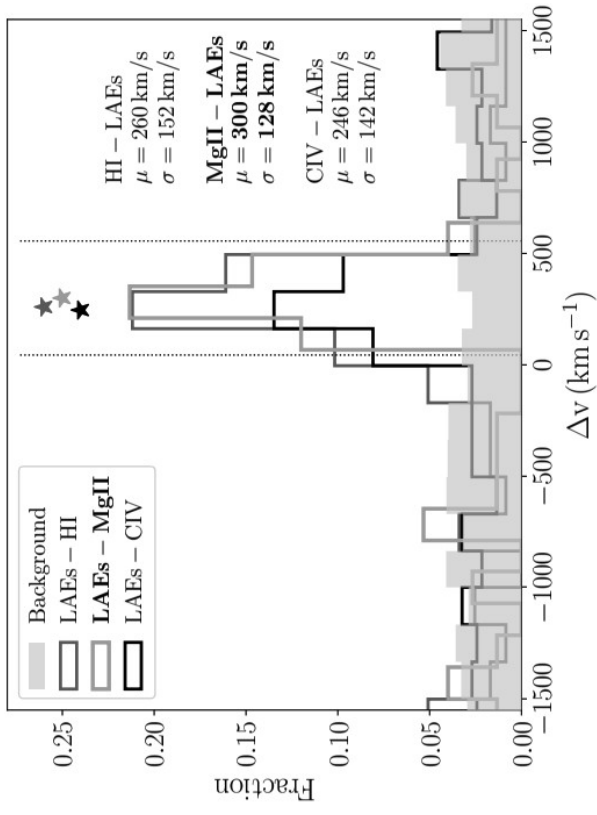


The multiphase gas around LAEs



The multiphase gas around LAEs

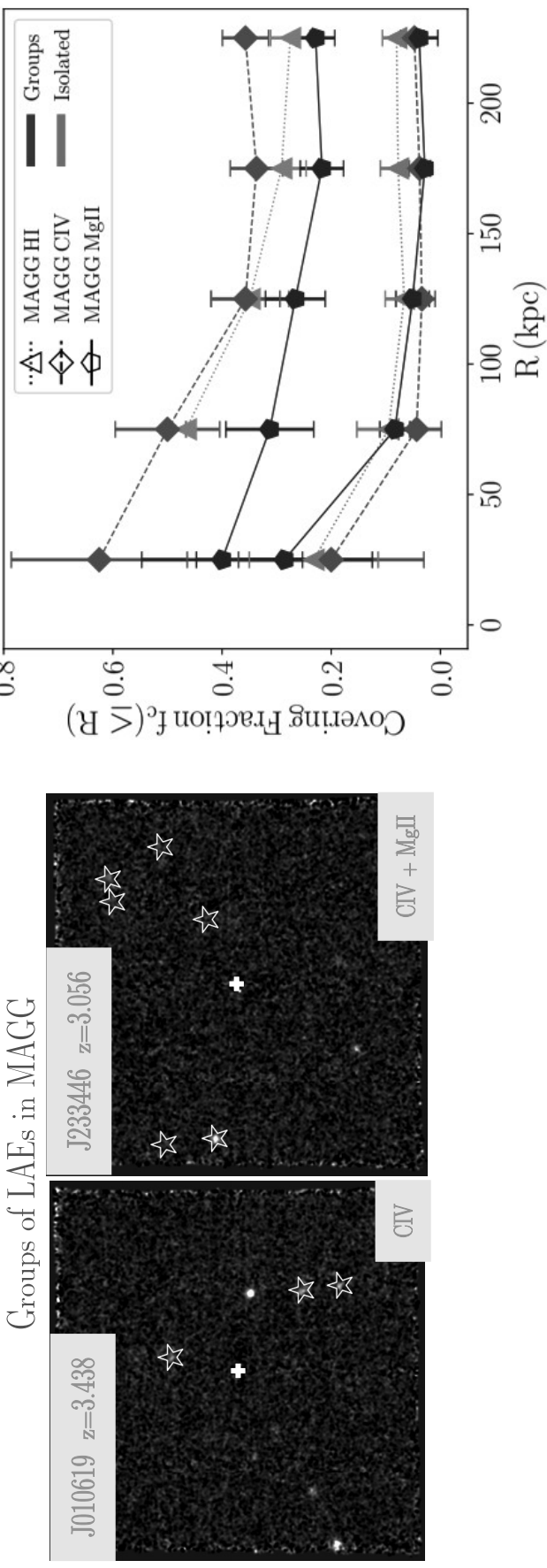
Absorbers-LAEs line-of-sight separation



Adapted from Mackenzie+2019

- A fraction of the strong absorbers arises from the CGM of LAEs;
- LAEs are connected by filaments of gas enriched with metals;
- There are pockets of lower density and enriched gas in the IGM located far from galaxies.

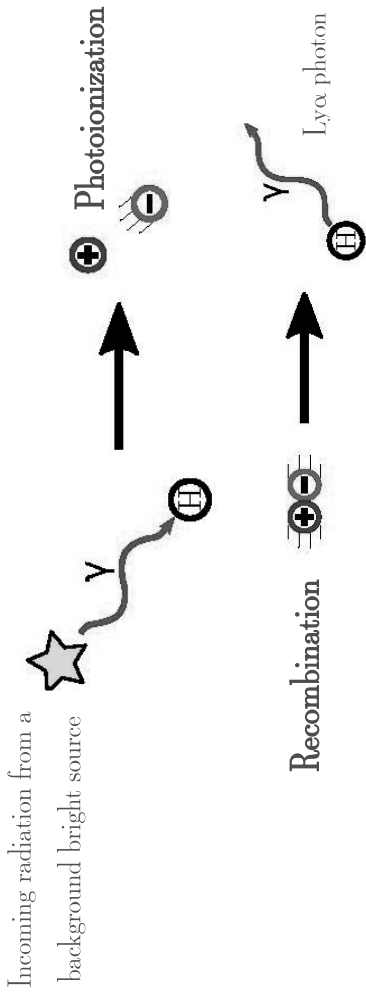
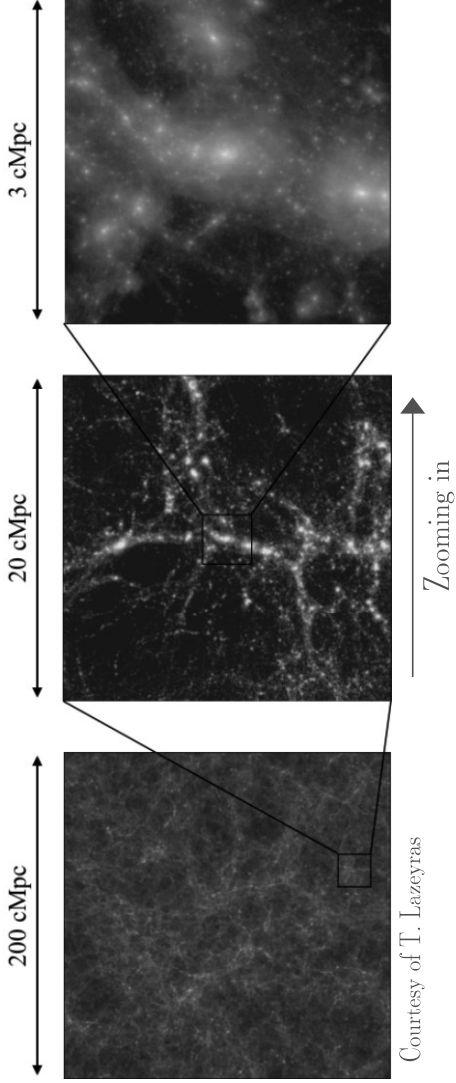
The multiphase gas around LAEs



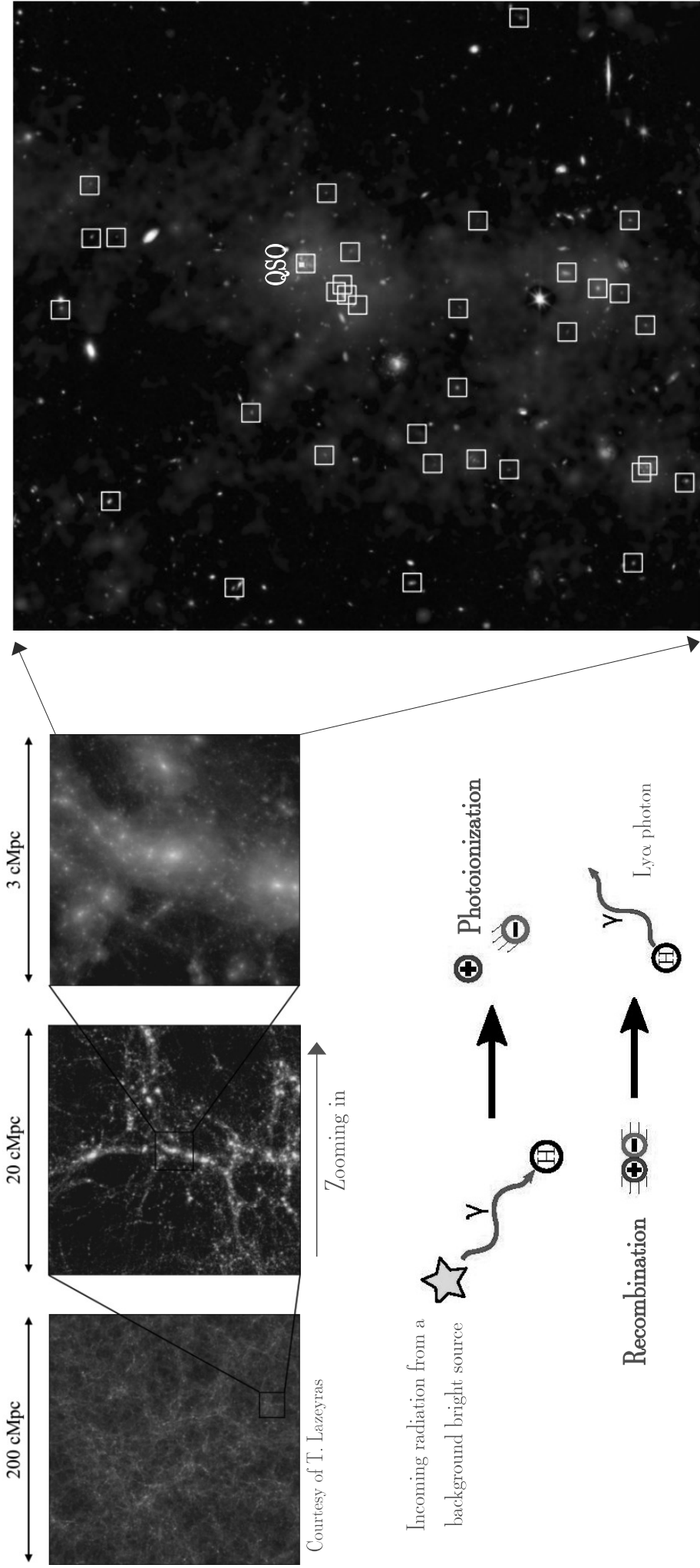
~56% of the LAEs in MAGG is in groups.

The incidence and the properties (e.g., strength & kinematics) of the gas around low-mass LAEs depend on the large-scale galaxy environment.

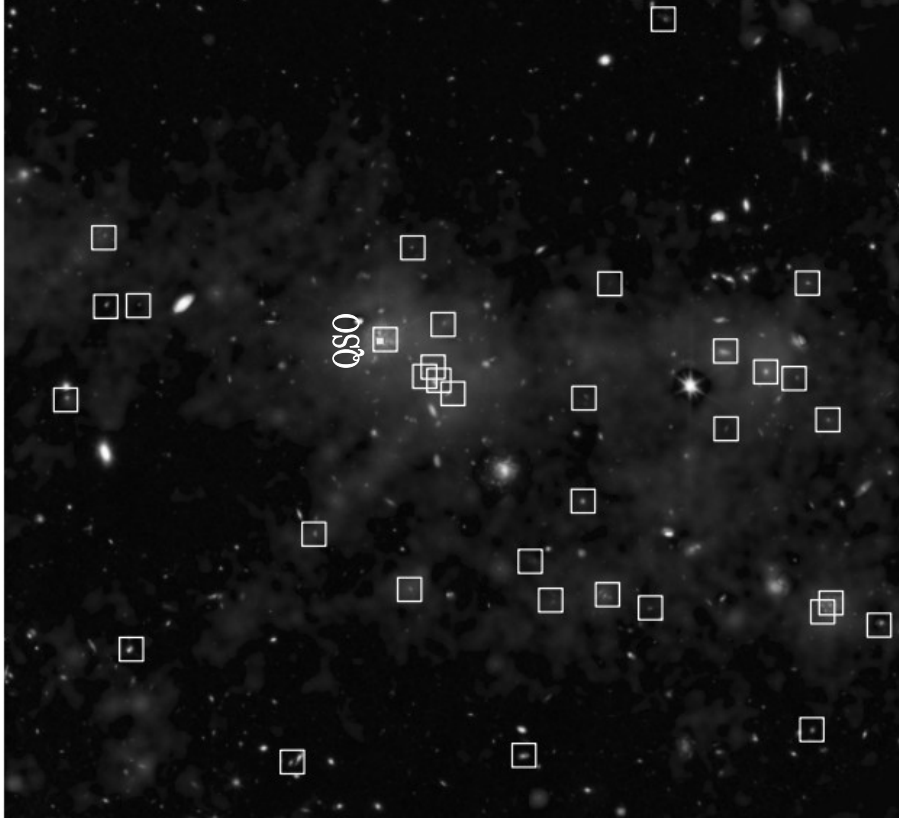
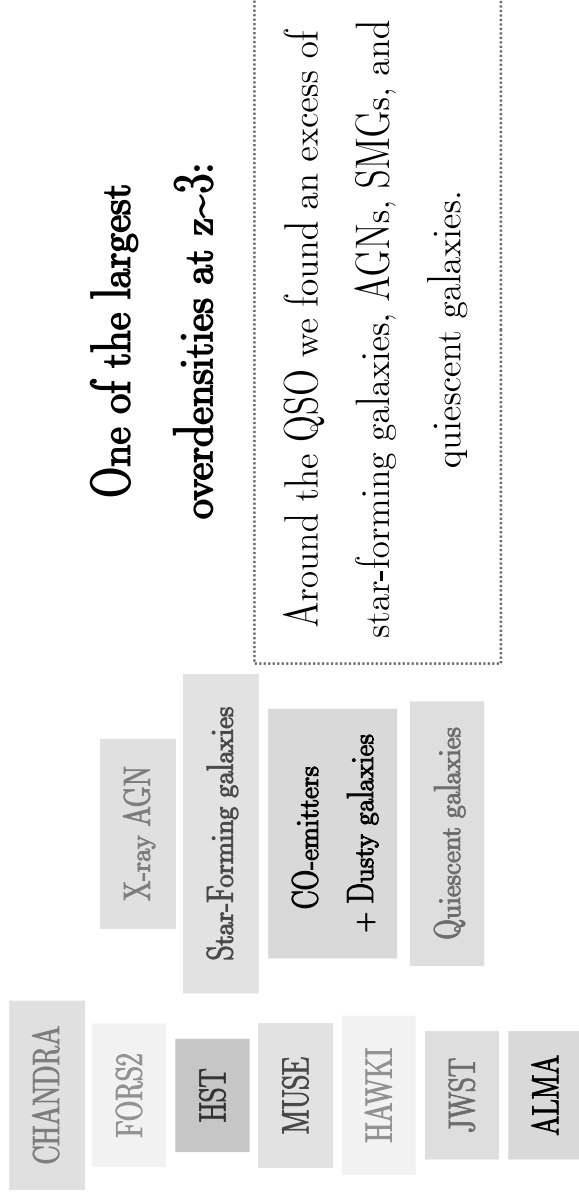
The cosmic gas in emission



The cosmic gas in emission

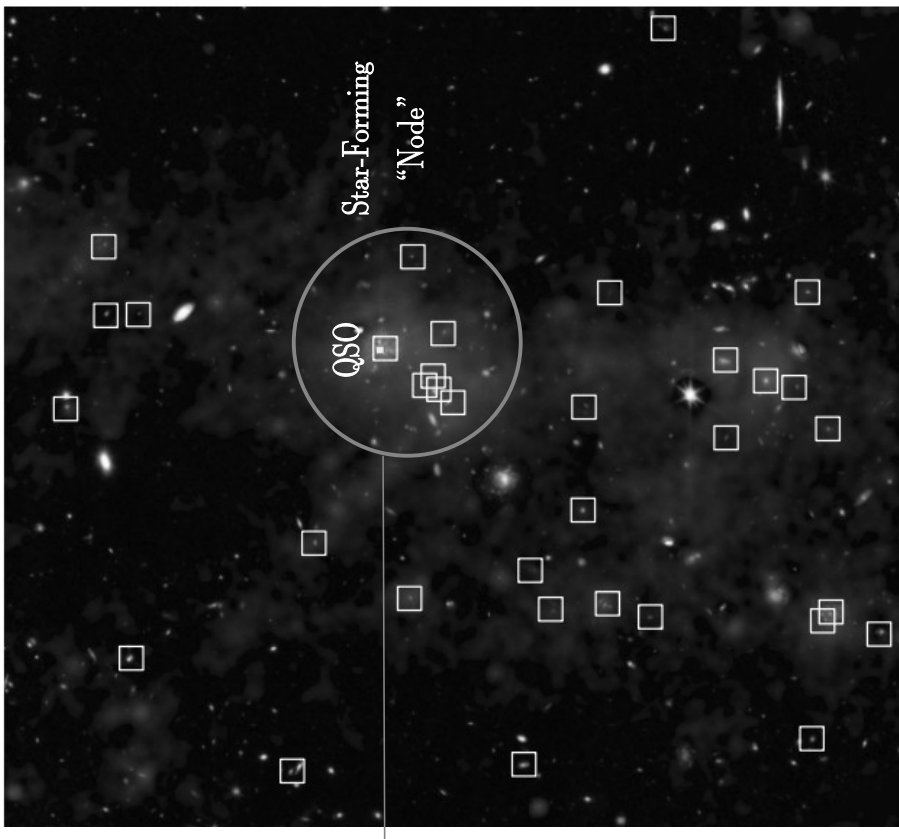
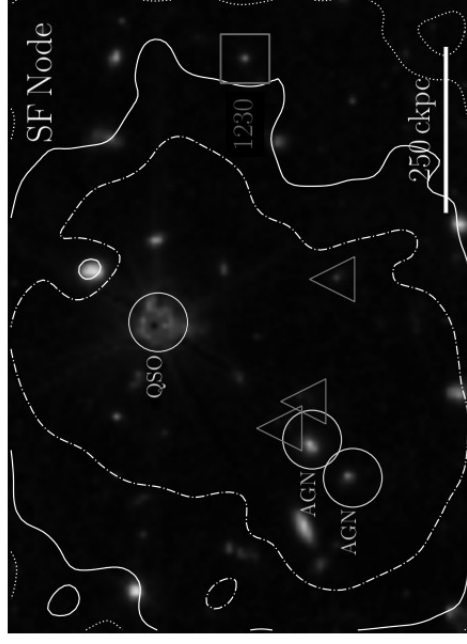


Exploring a node of the Cosmic Web

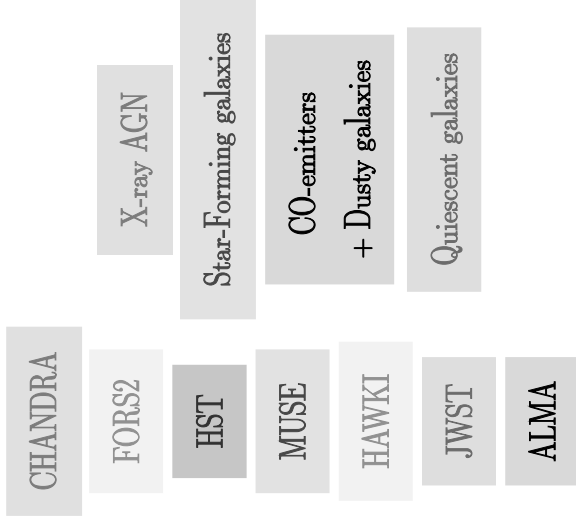


MQN01 structure at $z \sim 3.25$

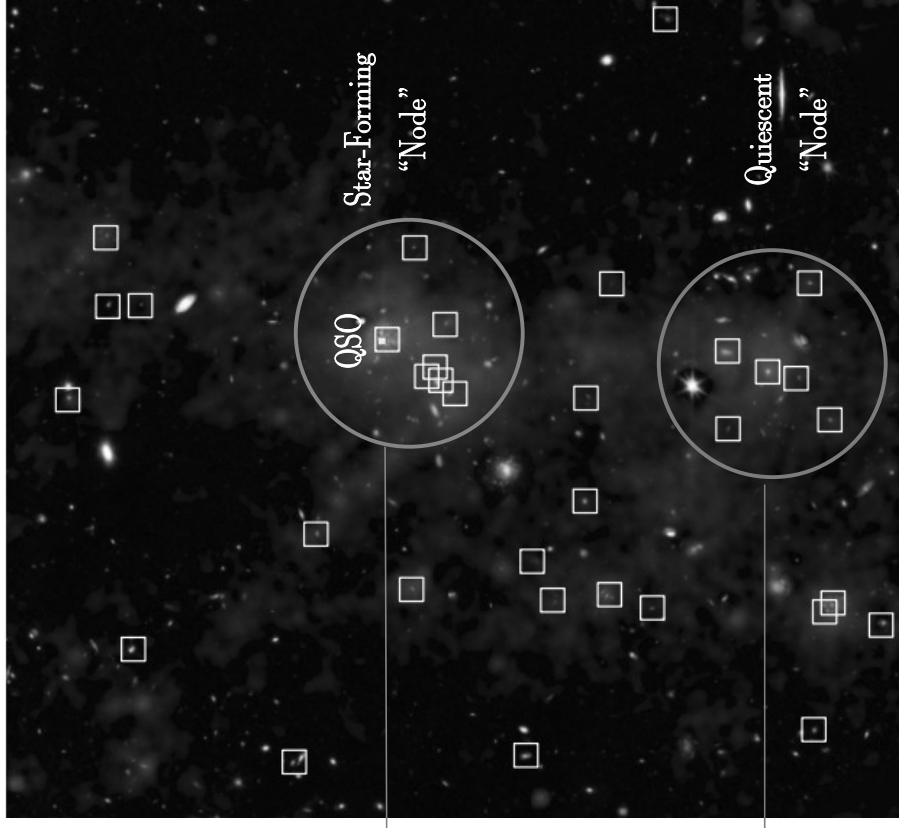
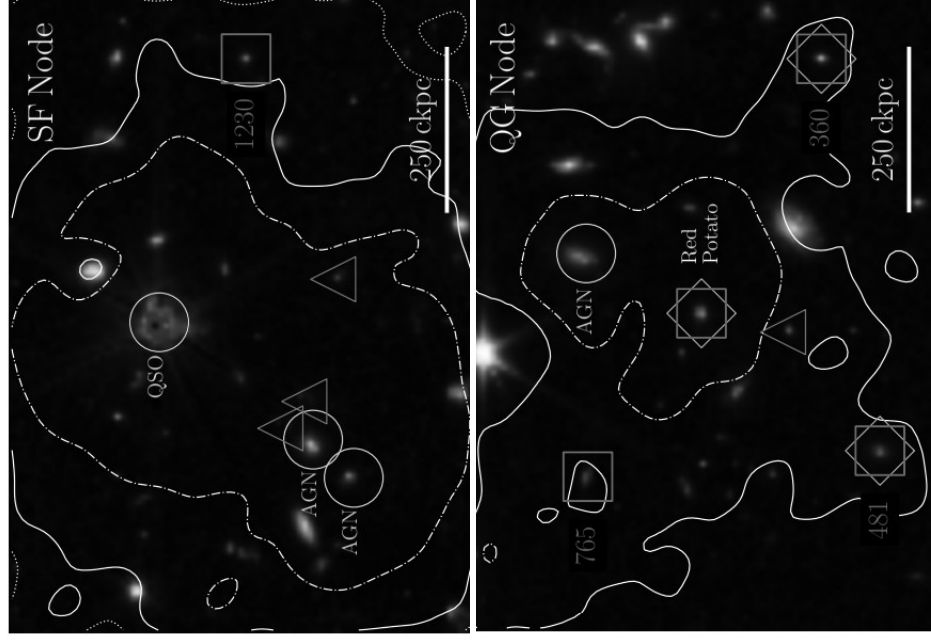
Exploring a node of the Cosmic Web



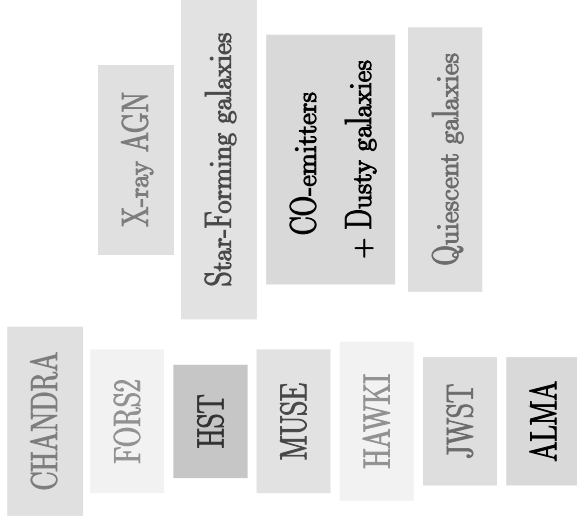
MQN01 structure at $z \sim 3.25$



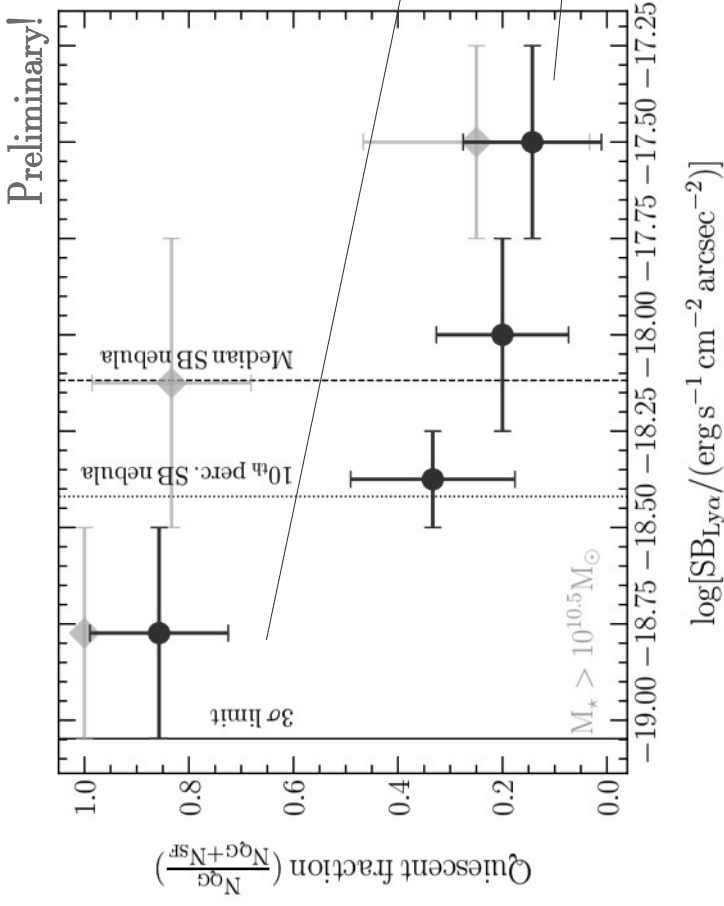
Exploring a node of the Cosmic Web



MQN01 structure at $z \sim 3.25$



Exploring a node of the Cosmic Web

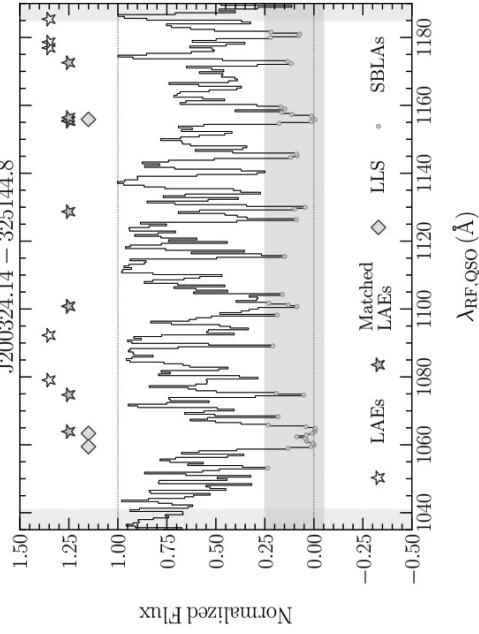


The overdensity and spatial distribution of the SF galaxies is strongly correlated with the emitting gas ... but the majority of the candidate quiescent galaxies do not live in the filaments.

Summer projects!

What happens when you realize that not a single soul stays in Milan after the end of June (especially last year)

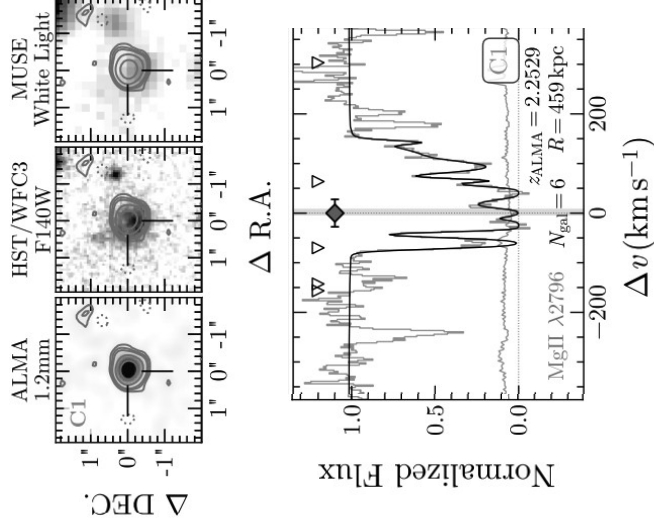
MAGG:
Link LAEs to HI absorbers (named SBLAs) at the interface between the forest and the DLAs



Galbiati + 2026a arXiv:2512.16422

MUDF:

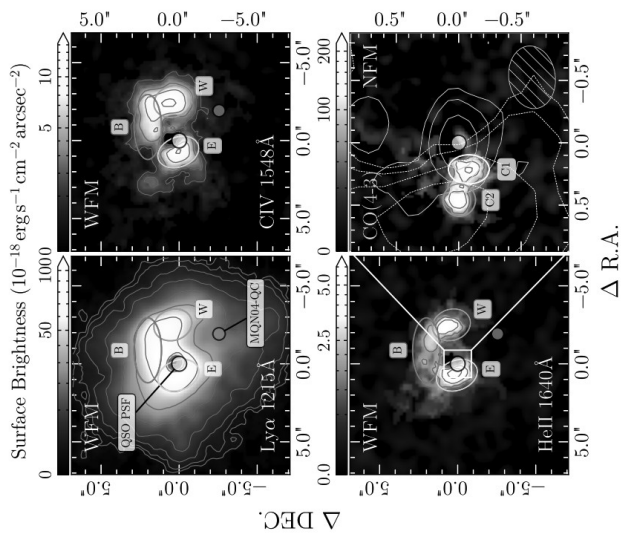
Connect metal absorbers to gas-/dust-rich massive galaxies with ALMA



Pensabene, Galbiati+2025b A&A, 696, A33

MQN04:

Study an HeII-emitting extended nebula
→ Non-resonant gas kinematics!



Galbiati, Pensabene+2026c (Accepted in A&A)

Summary & Conclusions

The multiphase gas around LAEs:

1. What are the properties of the gas around low-mass galaxies at $z > 3$?

The gas is multiphase and different components can be identified depending on the gas phase.

2. How does the large-scale galaxy environment shape the properties of the surrounding gas?

Metal absorbers are more likely to be found near groups and are stronger and with a more complex kinematics.

The Cosmic Web in emission and its link to galaxy evolution:

1. How do galaxies grow in extreme, overdense regions at the intersection of multiple filaments?

Galaxies are highly clustered and their growth and mass assembly is accelerated compared to those in the field.

2. Is there a link between the properties & evolution of galaxies and their location in the Cosmic Web?

In MQN01 the galaxies found in the filaments are mostly star-forming

and the only quiescent ones are clustered close to an AGN.