

The growth of galaxies in the heart of the Cosmic Web at $z \sim 3$

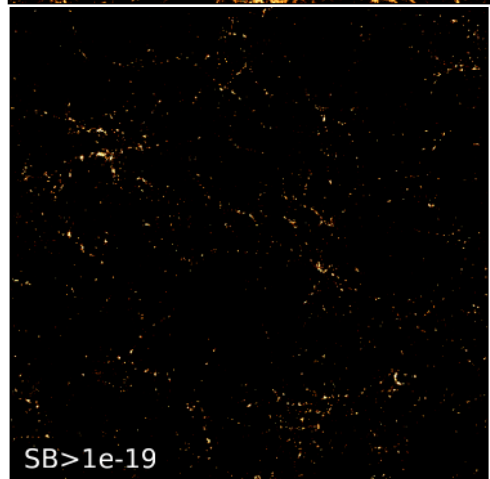
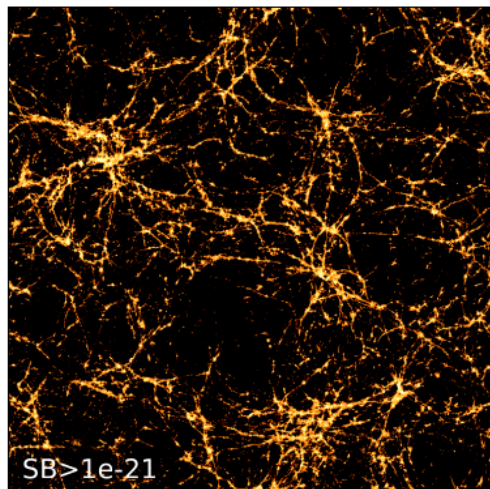
Marta Galbiati

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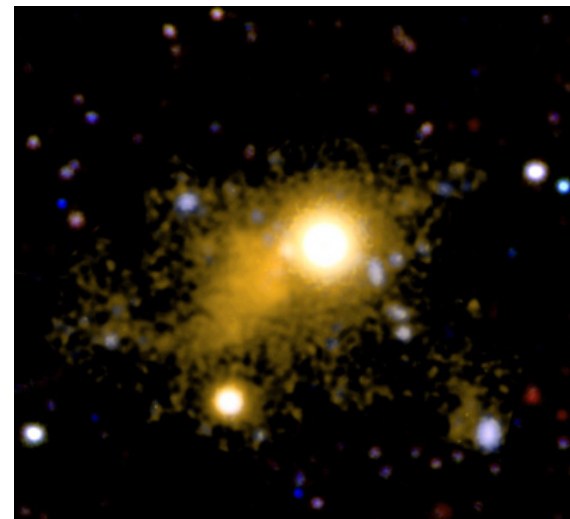
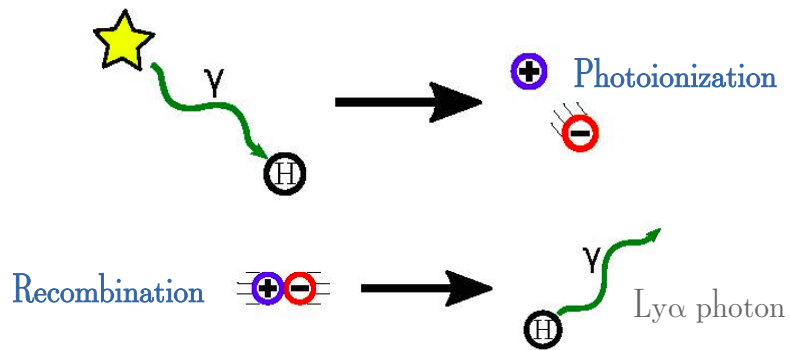


Most of the baryons in the Universe are
spread in a network of filaments called
“Cosmic Web”

The cosmic gas in emission



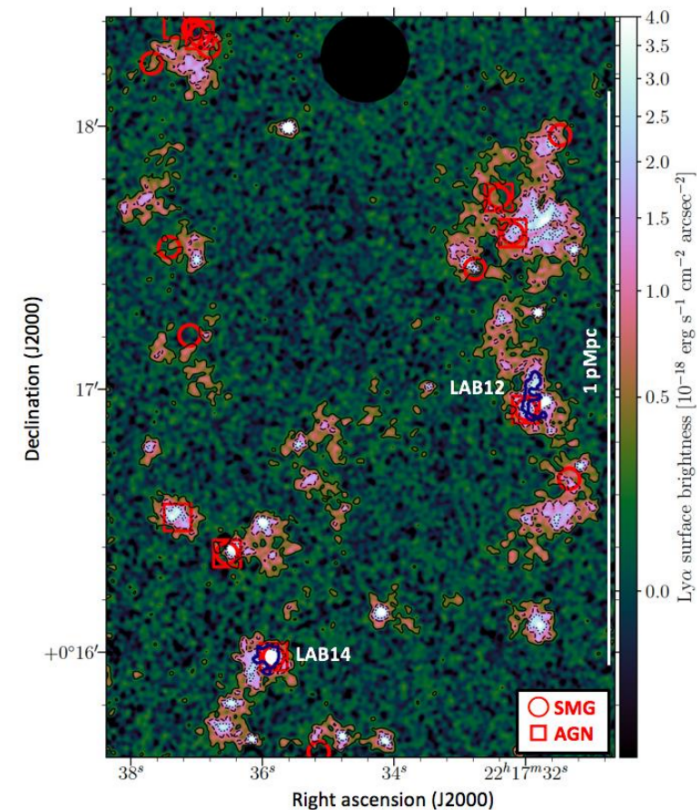
Incoming radiation from a
background bright source



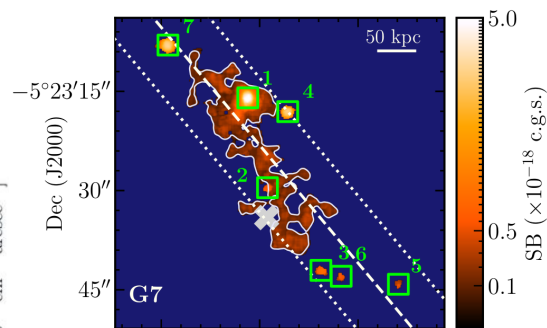
Hogan and Weymann 1987; Gould and Weinberg 1996;

Cantalupo+2005,2007,2008,2014,2017,2019; Pawlik+2009; Kollmeier+2010; Dijkstra+2014

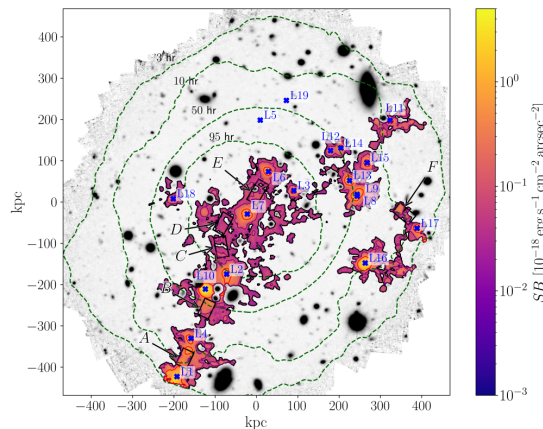
The cosmic gas in emission



Umehata+2019



Banerjee+2024

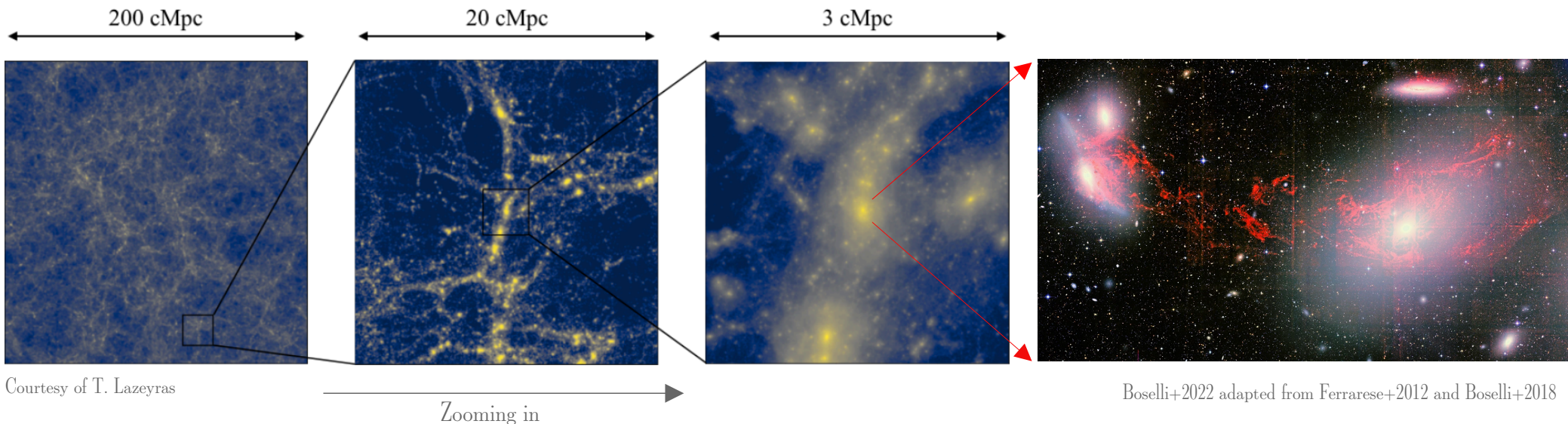


Tornotti+2024

The Cosmic Web in emission:

The ionizing radiation emitted by overdensities of star-forming galaxies and Active Galactic Nuclei (AGN) is able to illuminate the cosmic gas on IGM-scales

Open questions

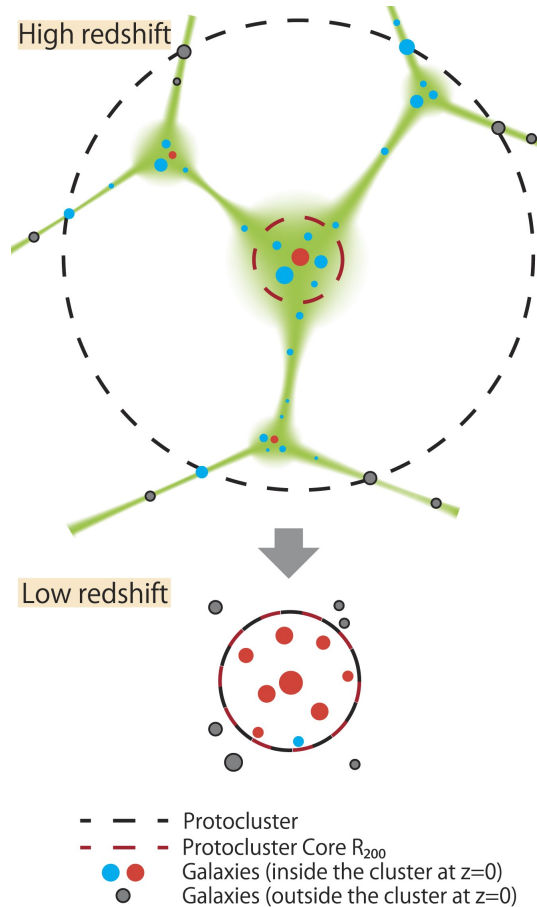


In the local Universe, environmental effects are known to affect the properties of gas and galaxies in overdensities

? What happens at $z > 3$, especially in extreme regions such as the nodes of the Cosmic Web?

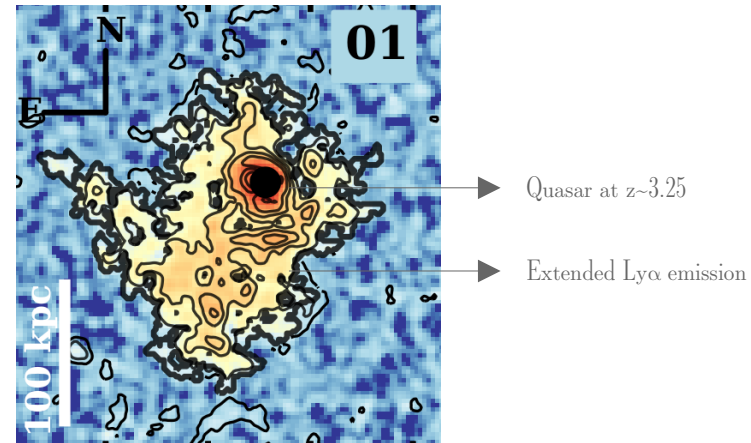
A unique view of galaxy formation and evolution

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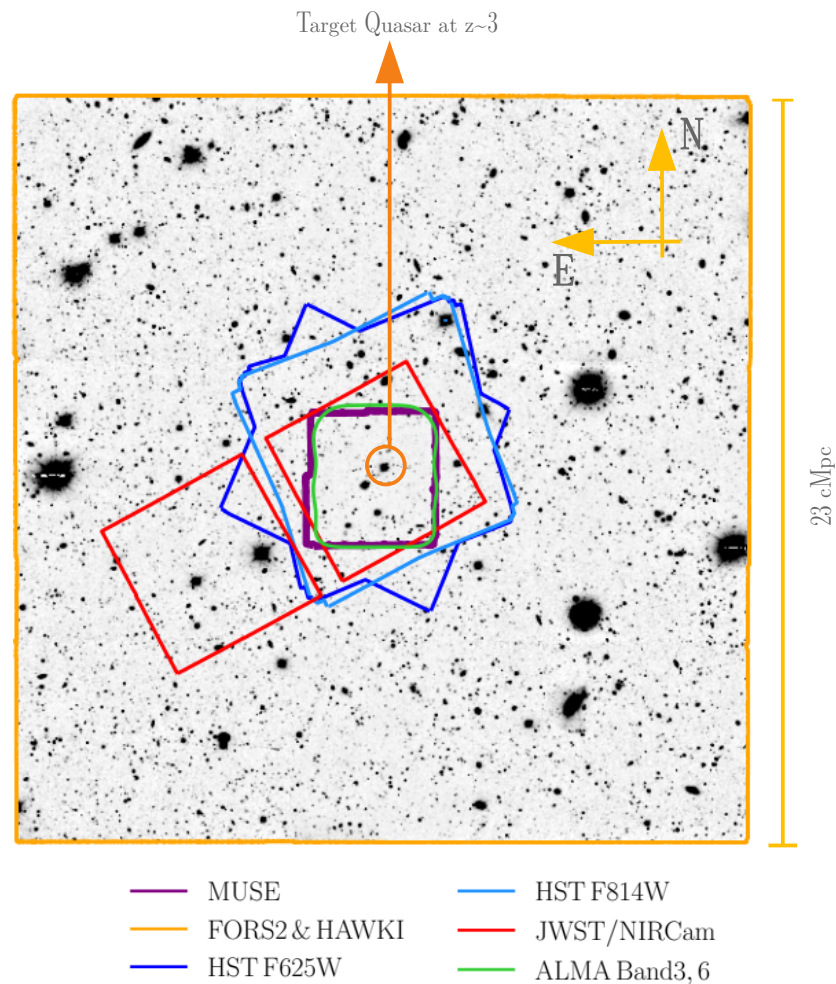
- Large overdensity of galaxies
- At the intersection of filaments

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



Borisova+2016

A unique view of galaxy formation and evolution

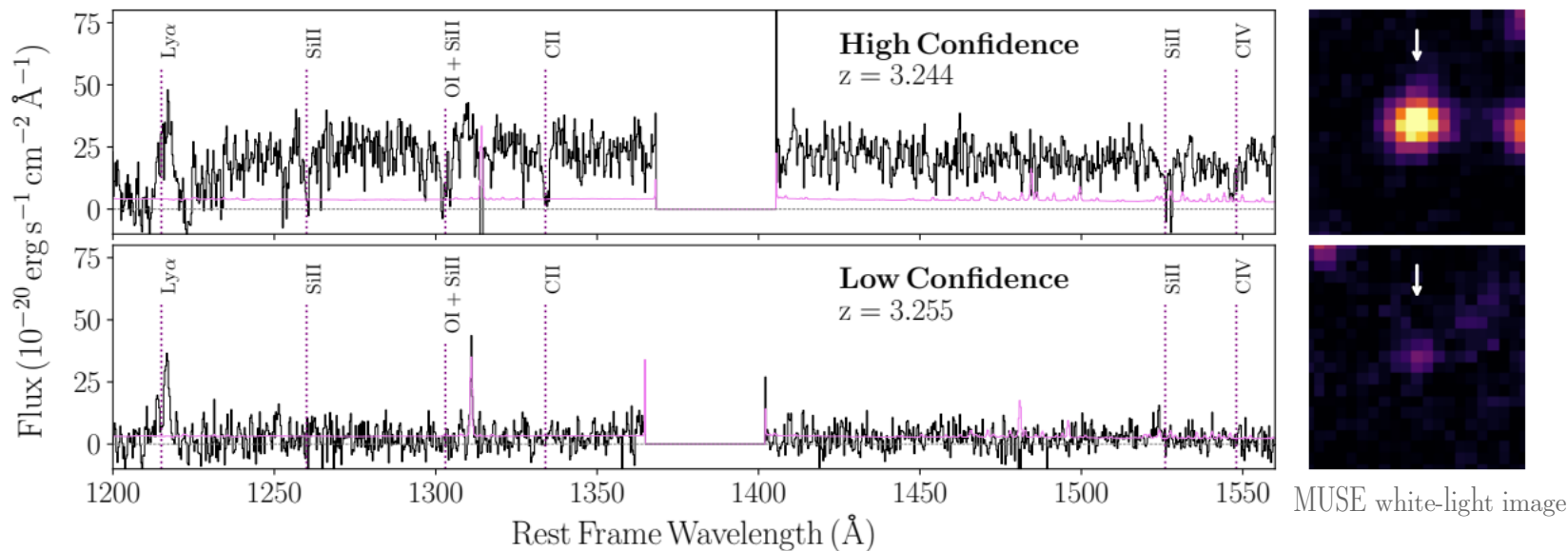


- **MUSE** (40h+84h) → Cosmic Gas via Ly α emission
- **FORS2** (16h) → Detect LBGs on large scales
U,B,R
- **HAWK-I** (7h) → Measure Stellar Masses and
K_s,CH₄,H select Balmer-break galaxies
- **ALMA** (42h) → Detect dusty star-forming galaxies
- **CHANDRA** (650 ks) → Census of the AGN population
- **JWST** (10h+40min) → Cosmic Gas via H α emission
NIRspec MSA/NIRCam
- **HST** (22 orbits) → Model galaxy morphology
ACS/F625W & F814W

Star-forming galaxies in MQN01 field

Searching for star forming galaxies clustered around the central quasar:

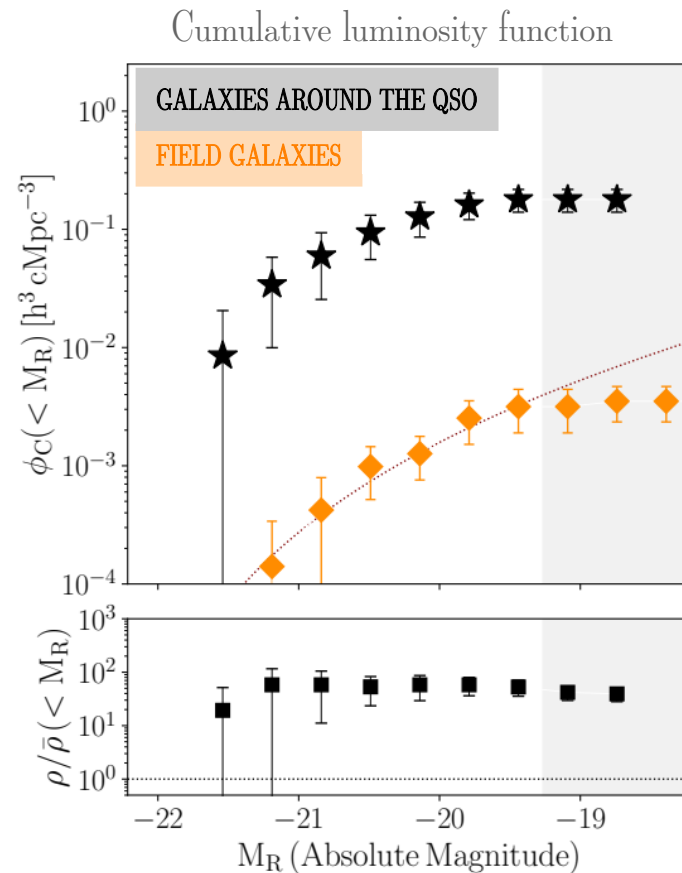
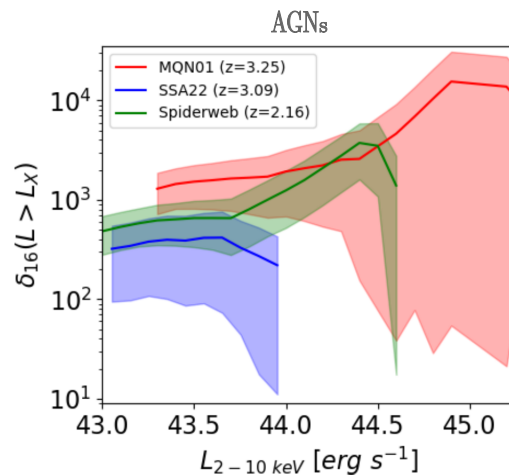
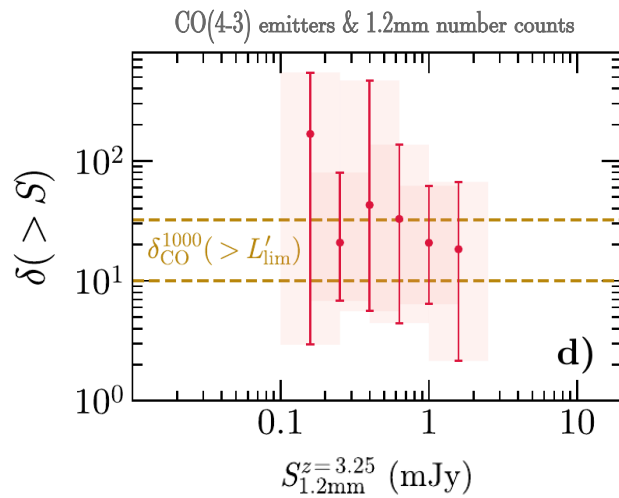
We identified 21 galaxies with secure spectroscopic redshift clustered within a small volume (± 1000 km/s and 4×4 cMpc²) around the quasar



Star-forming galaxies in MQN01 field

One of the largest overdensities at $z \sim 3$:

Around the quasar we found an excess of star forming galaxies, AGNs and SMGs.

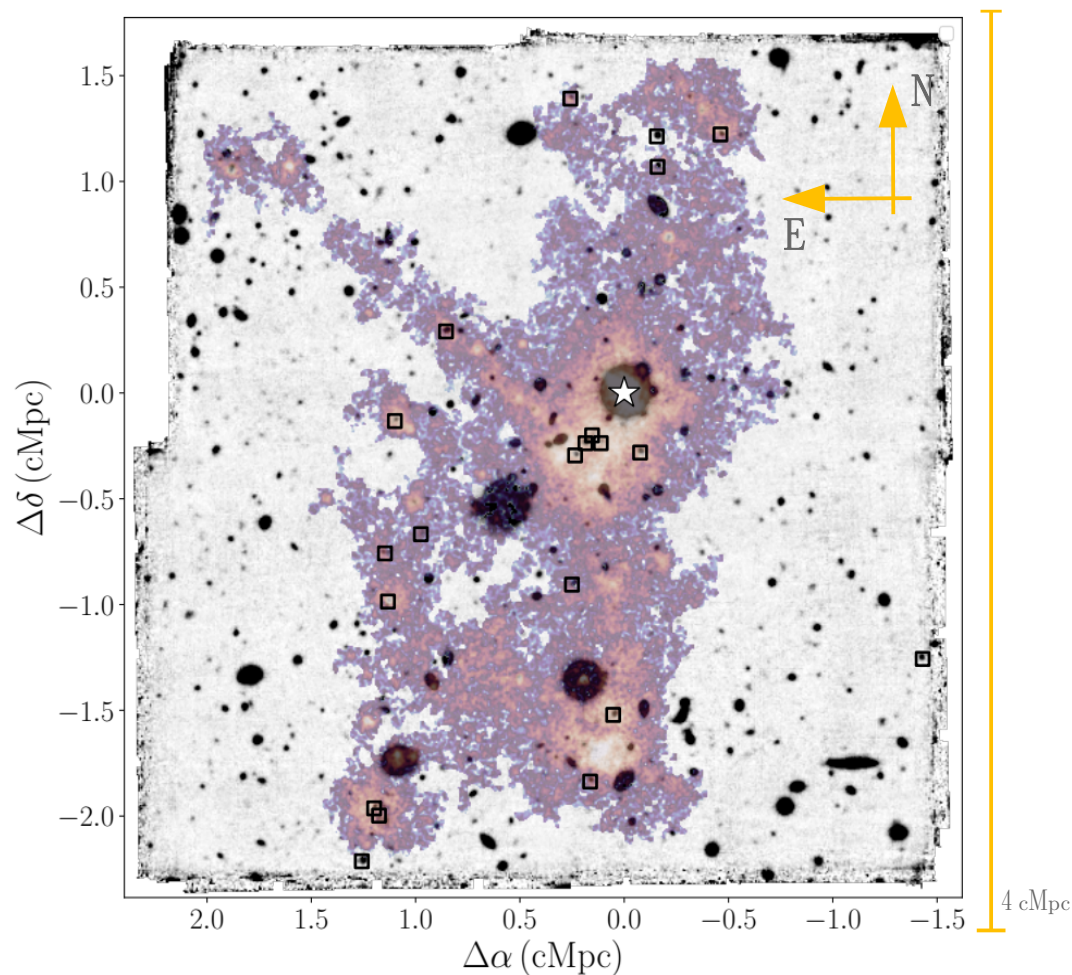


$$\delta = 53.0 \pm 17.4$$

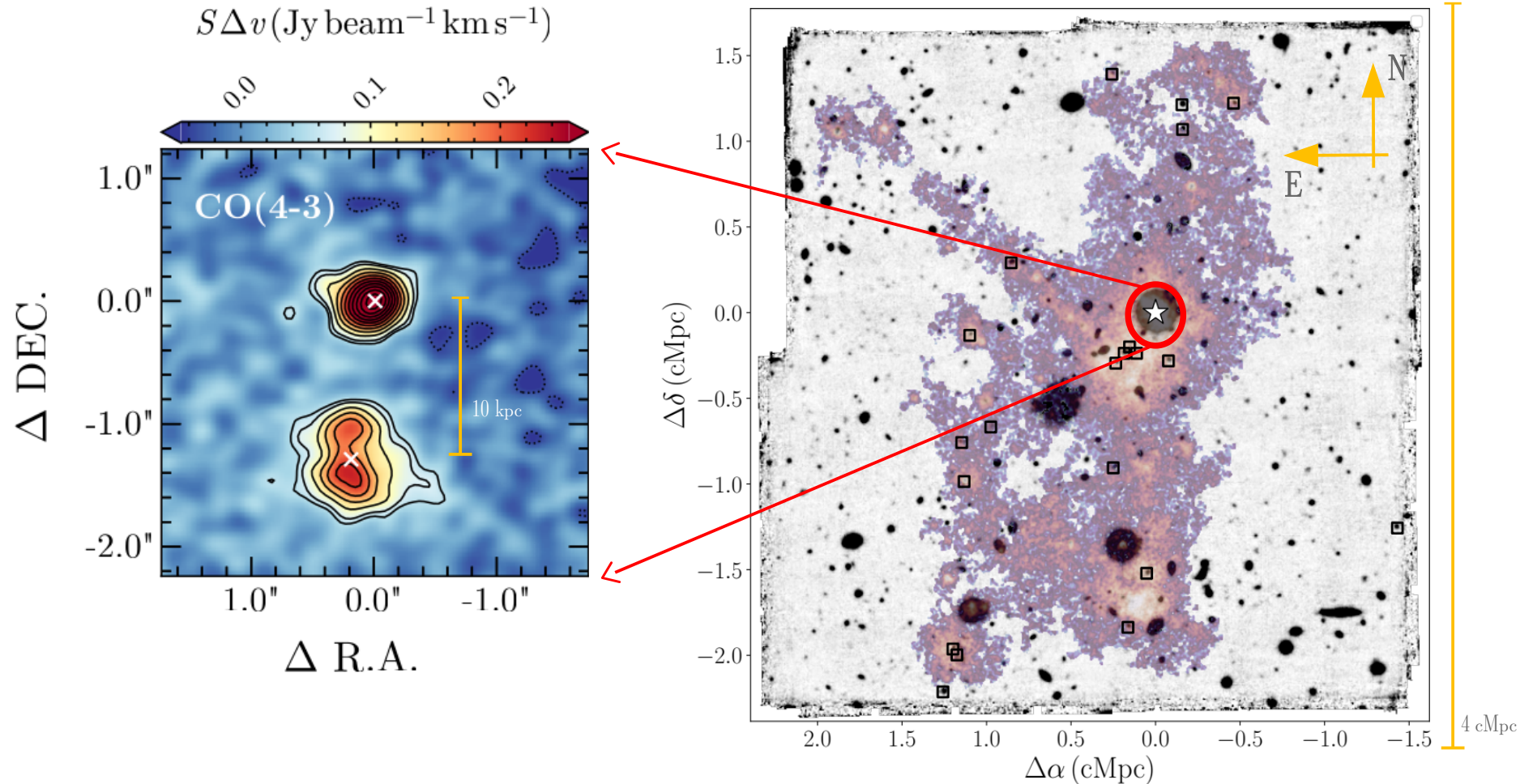
Star-forming galaxies in MQN01 field

A massive node of the Cosmic Web
observed in emission:

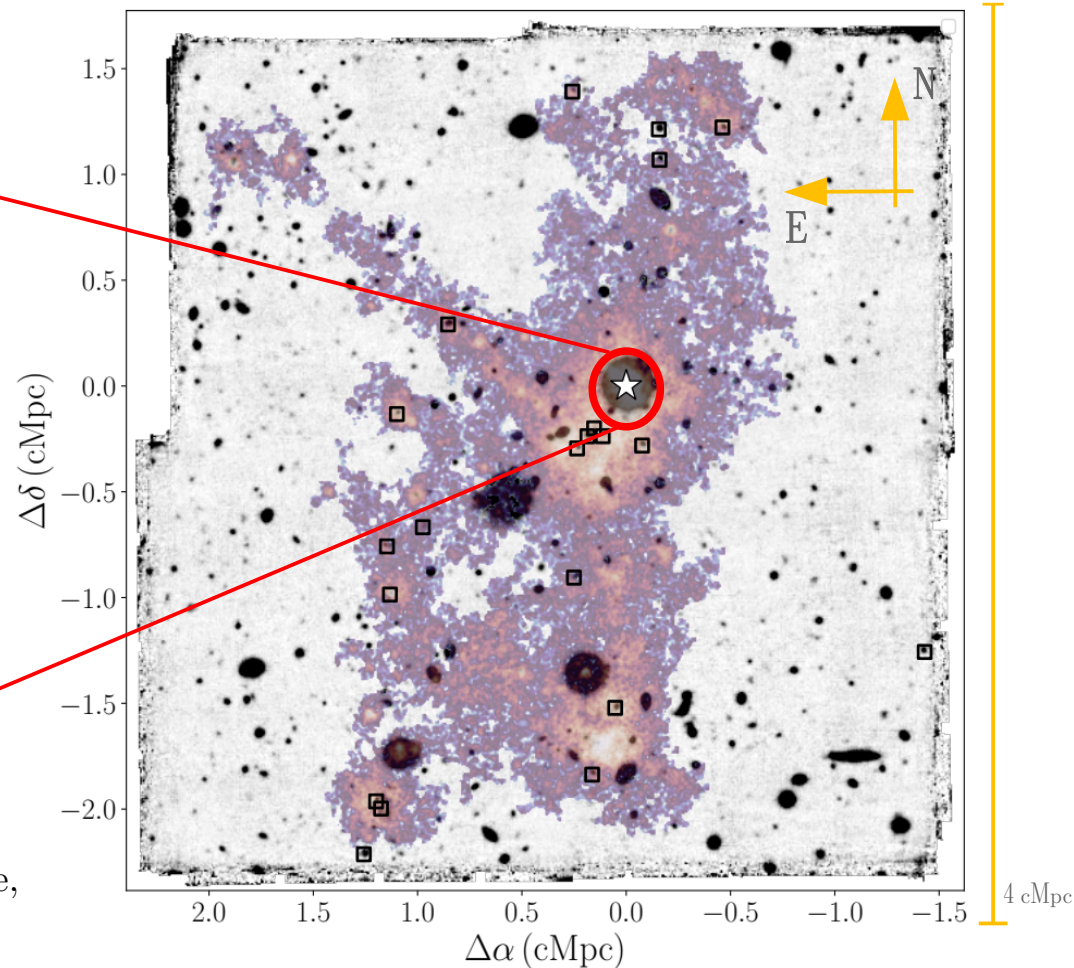
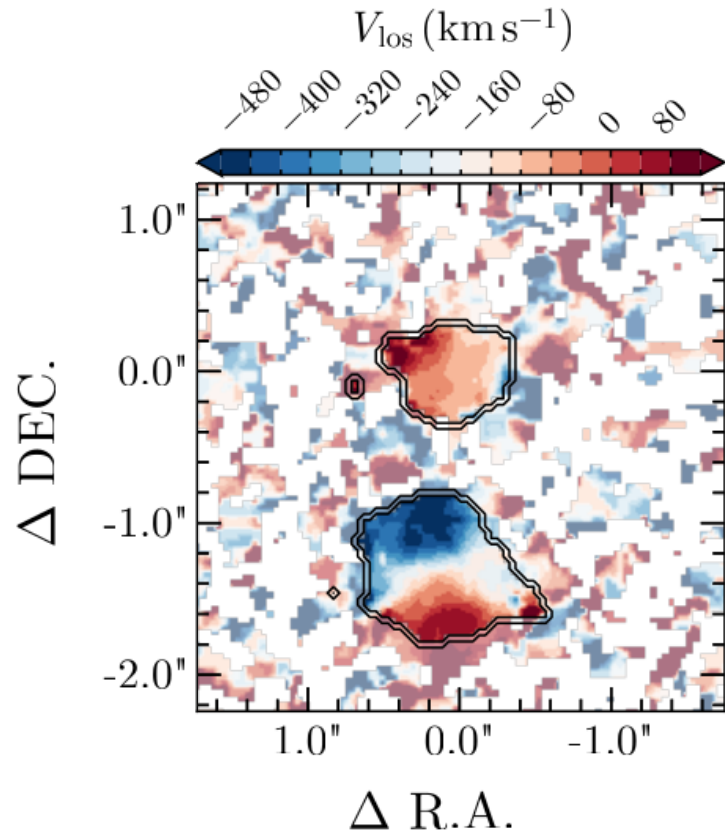
The 2D spatial distribution of the star
forming galaxies is strongly correlated
with the gaseous filaments



Star-forming galaxies in MQN01 field

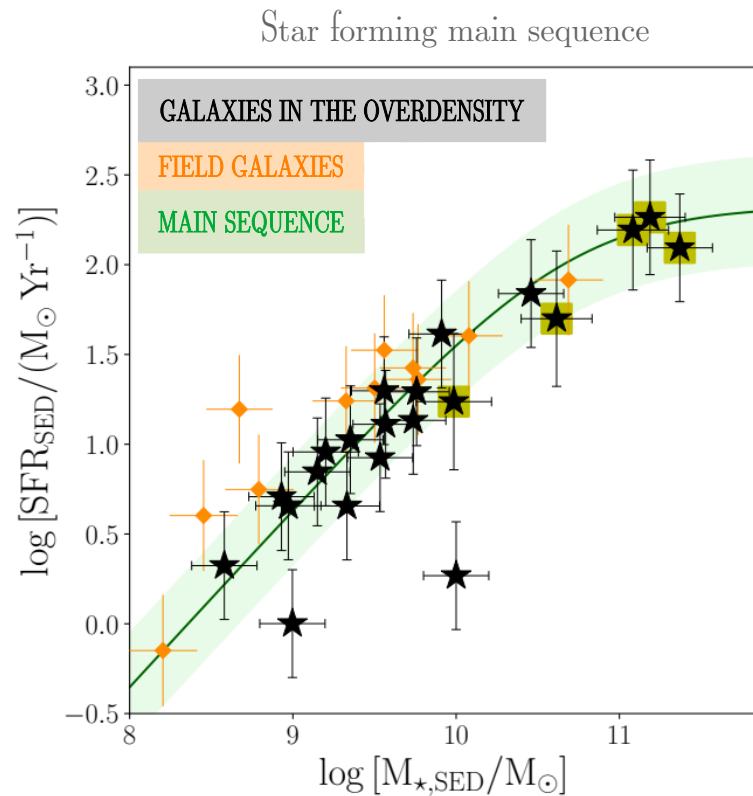


Star-forming galaxies in MQN01 field

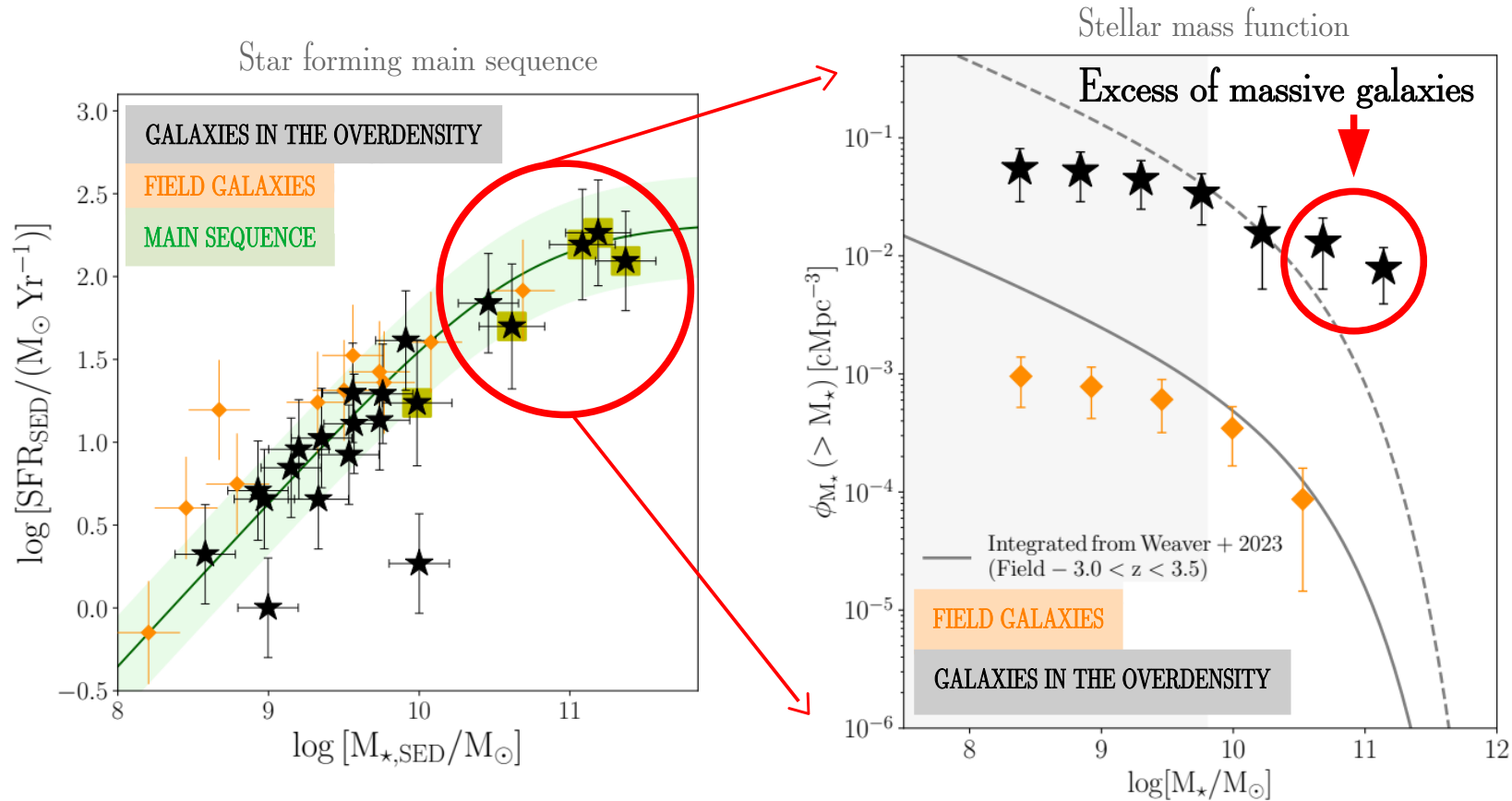


First quasar companion identified as a massive,
dynamically cold rotating disk

Star-forming galaxies in MQN01 field

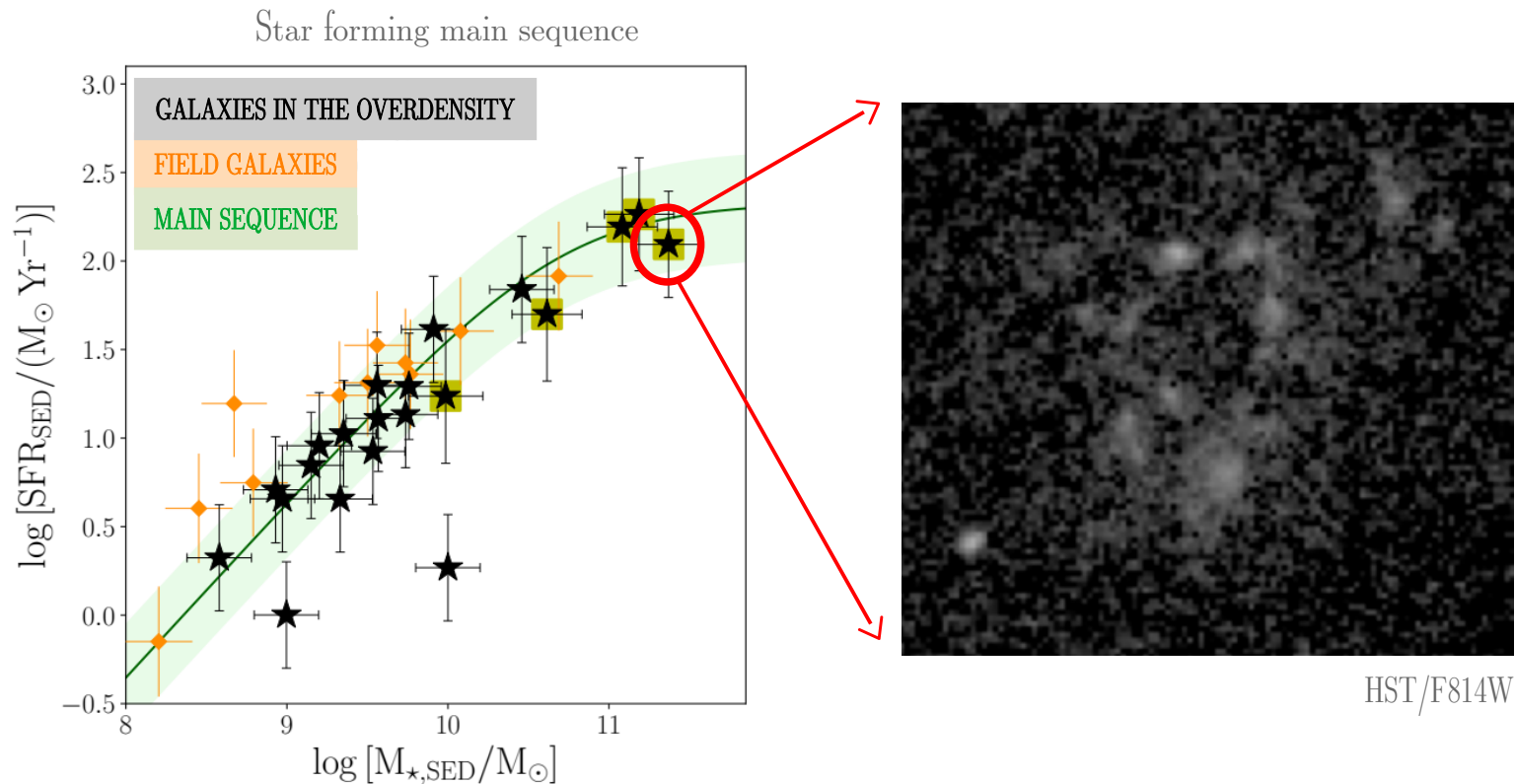


Star-forming galaxies in MQN01 field



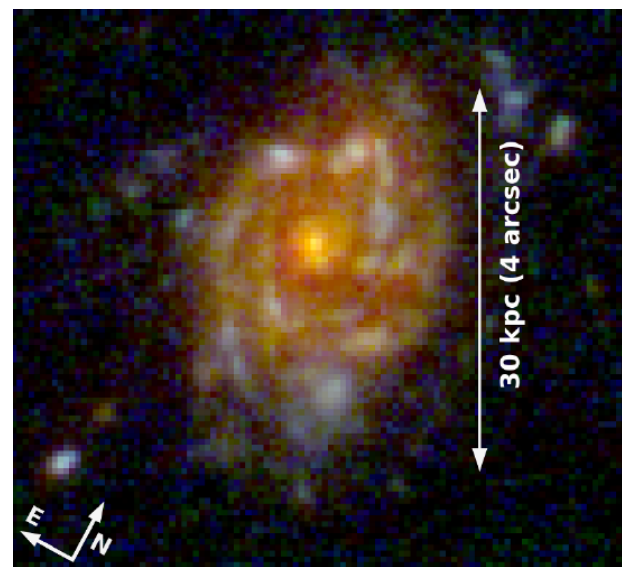
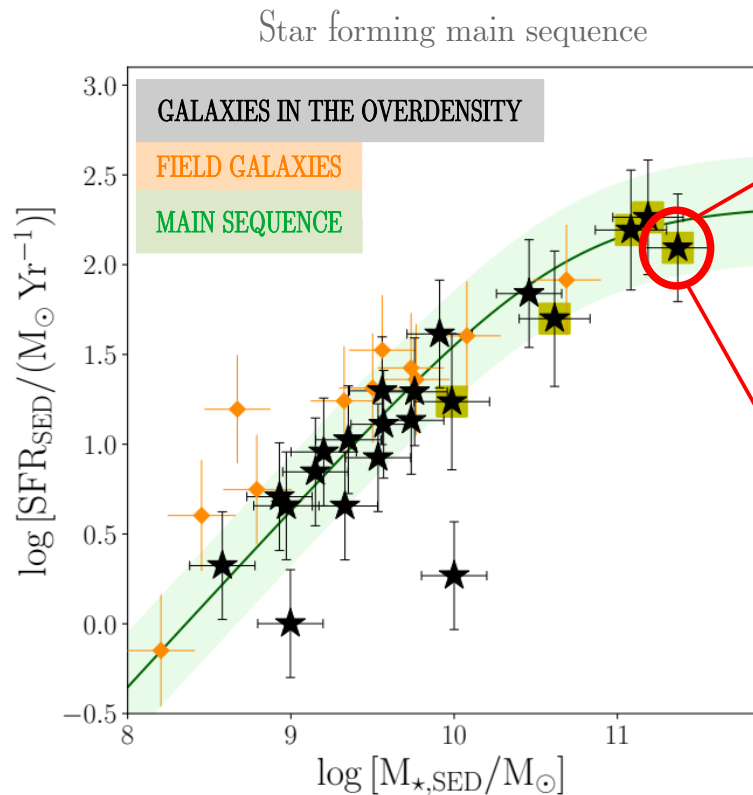
Accelerated or more efficient mass assembly at the intersection of filaments?

Star-forming galaxies in MQN01 field



Accelerated or more efficient mass assembly at the intersection of filaments?

Star-forming galaxies in MQN01 field



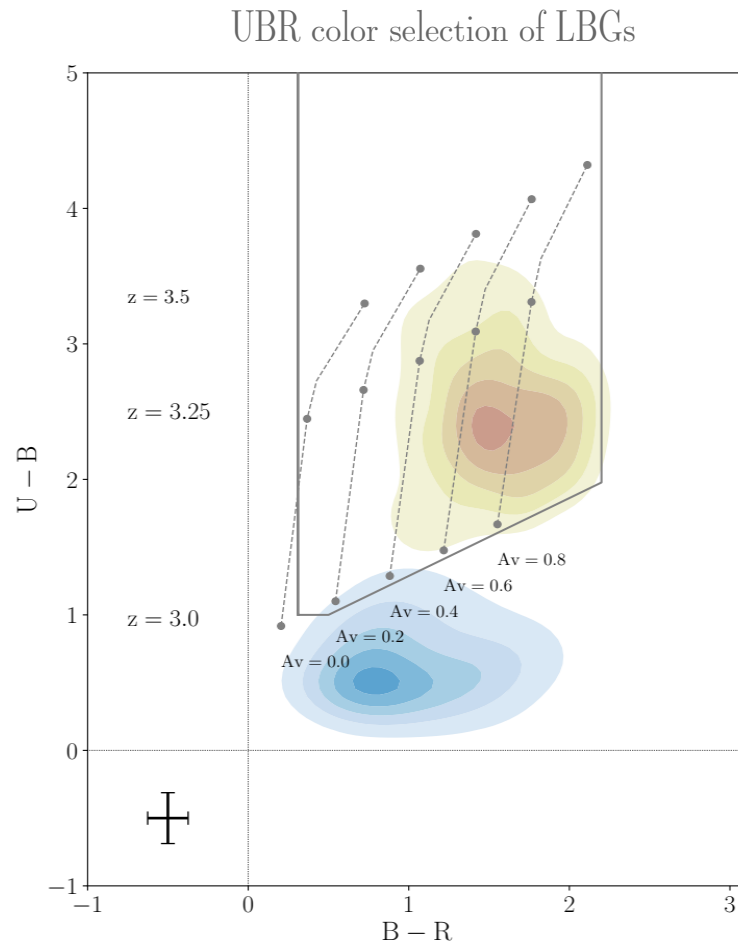
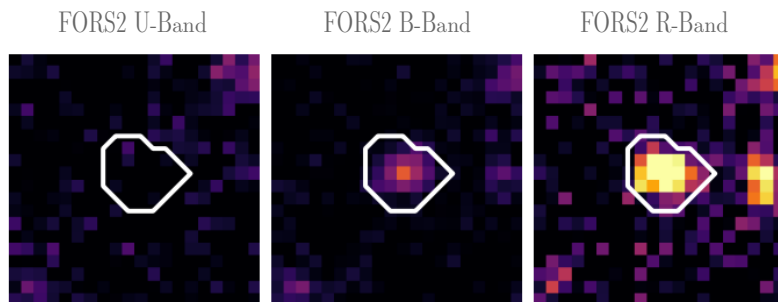
JWST/F322W2 + JWST/F150W2 + HST/F814W

Accelerated or more efficient mass assembly at the intersection of filaments?

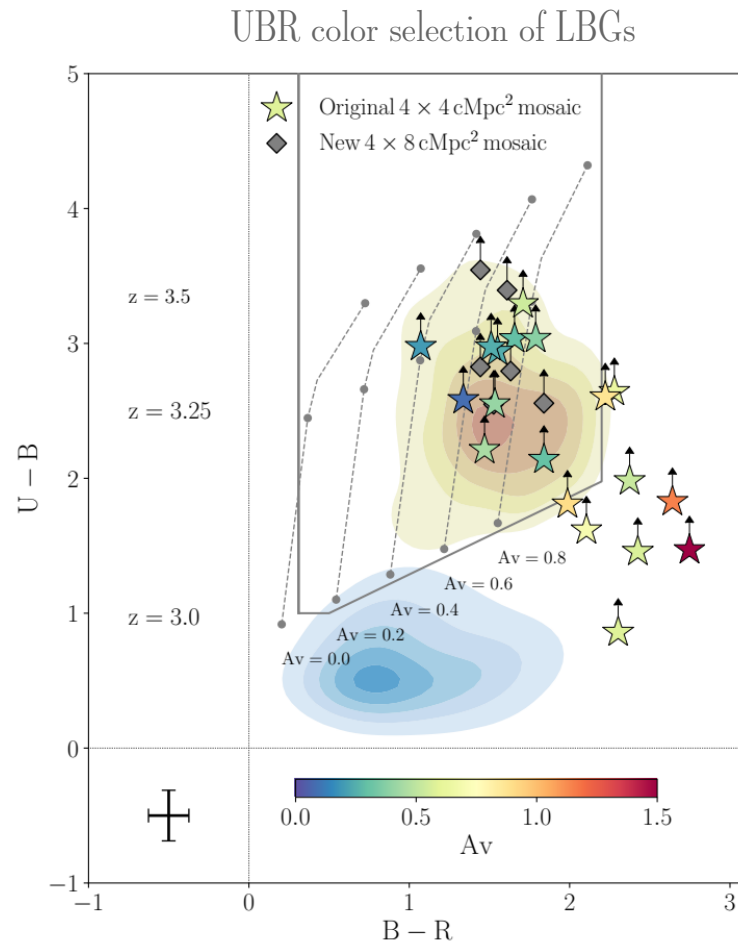
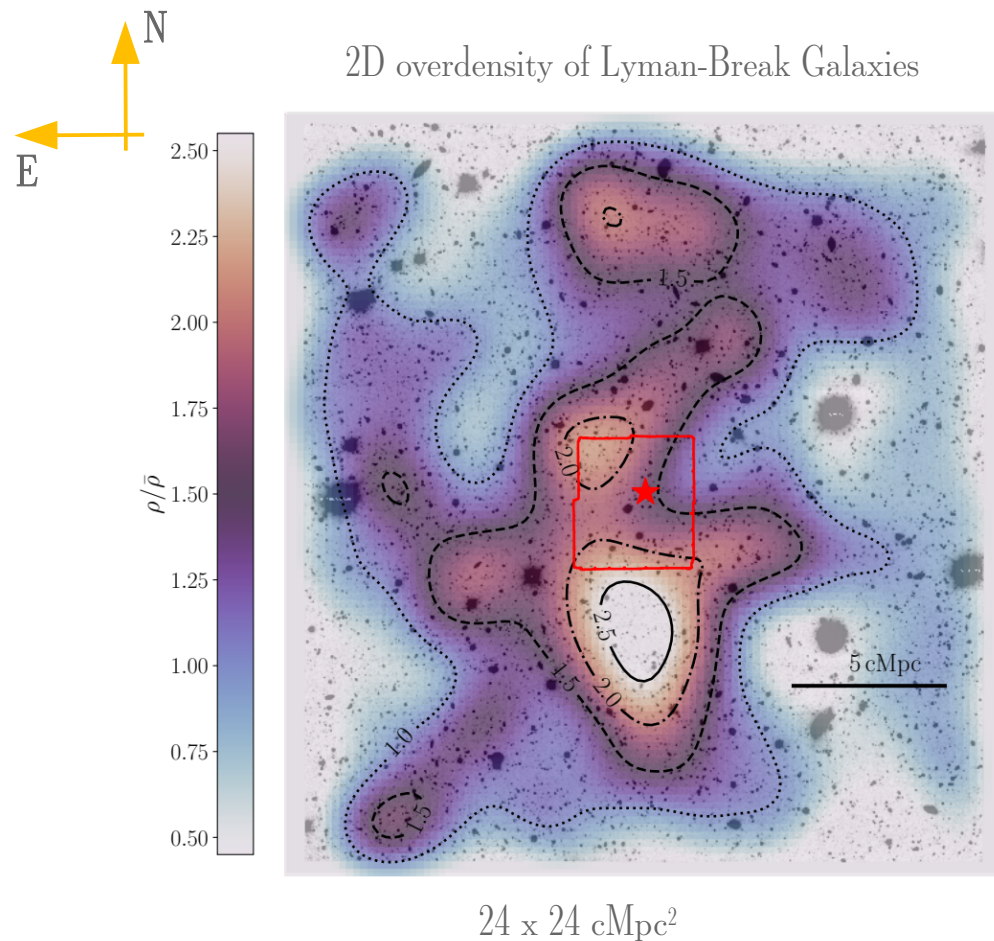
MQN01 structure over tens of cMpc

Lyman Break Galaxies (LBGs): **FORS2**

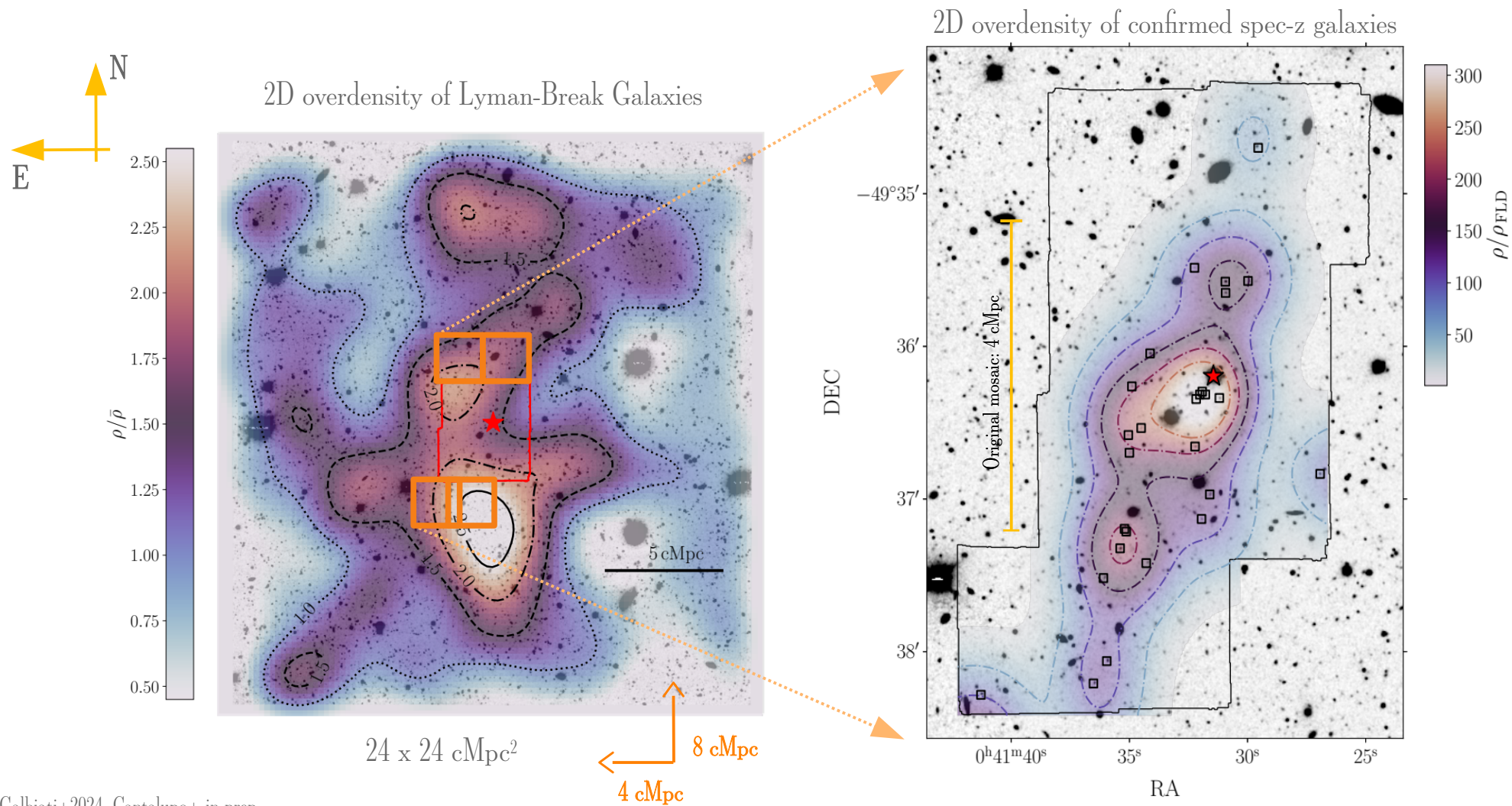
- UBR color selection
- Calibrated for SF galaxies at $3.0 < z < 3.5$
 $\rightarrow 24 \times 24 \text{ cMpc}^2 \text{ FoV}$



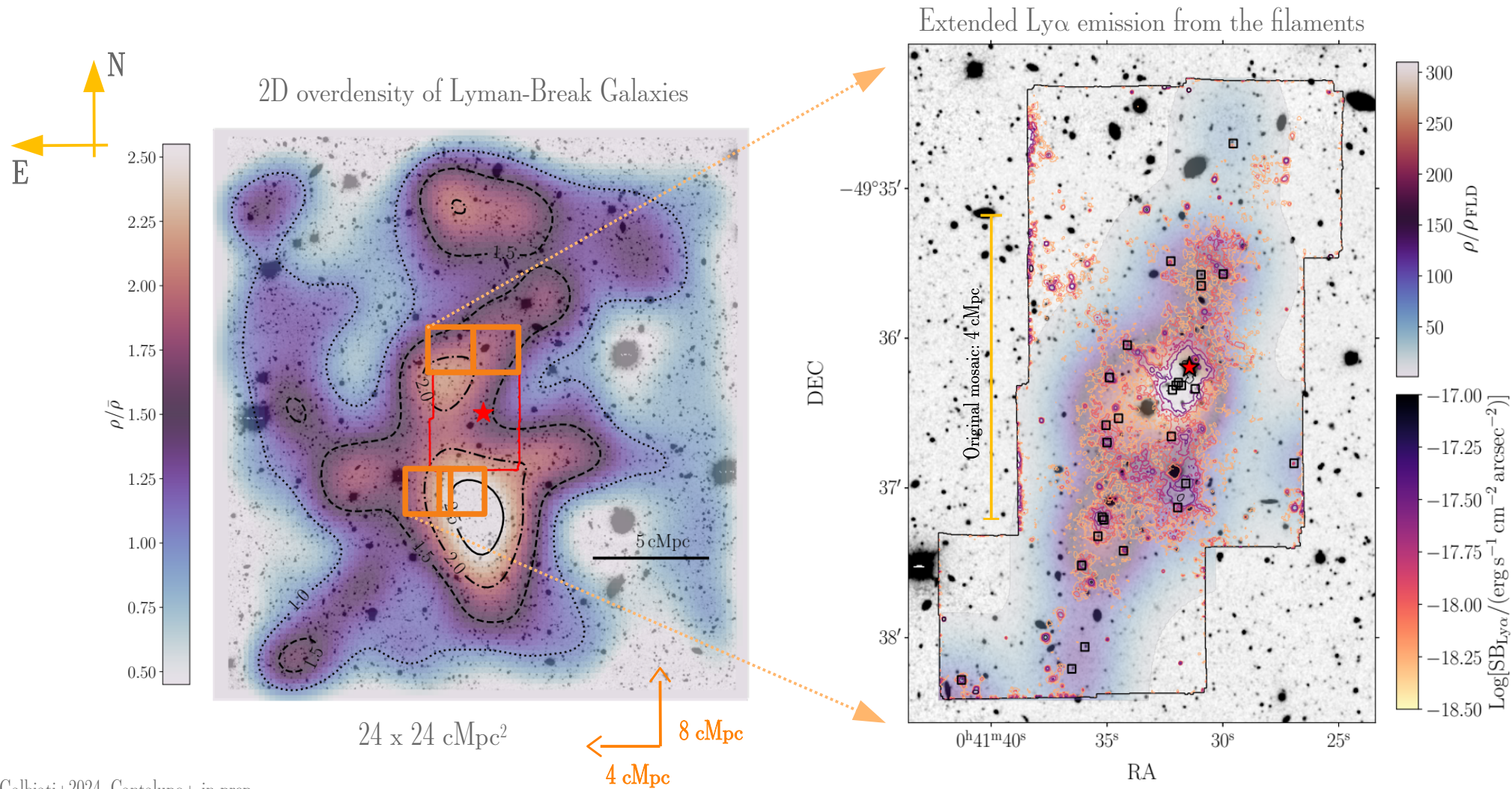
MQN01 structure over tens of cMpc



MQN01 structure over tens of cMpc

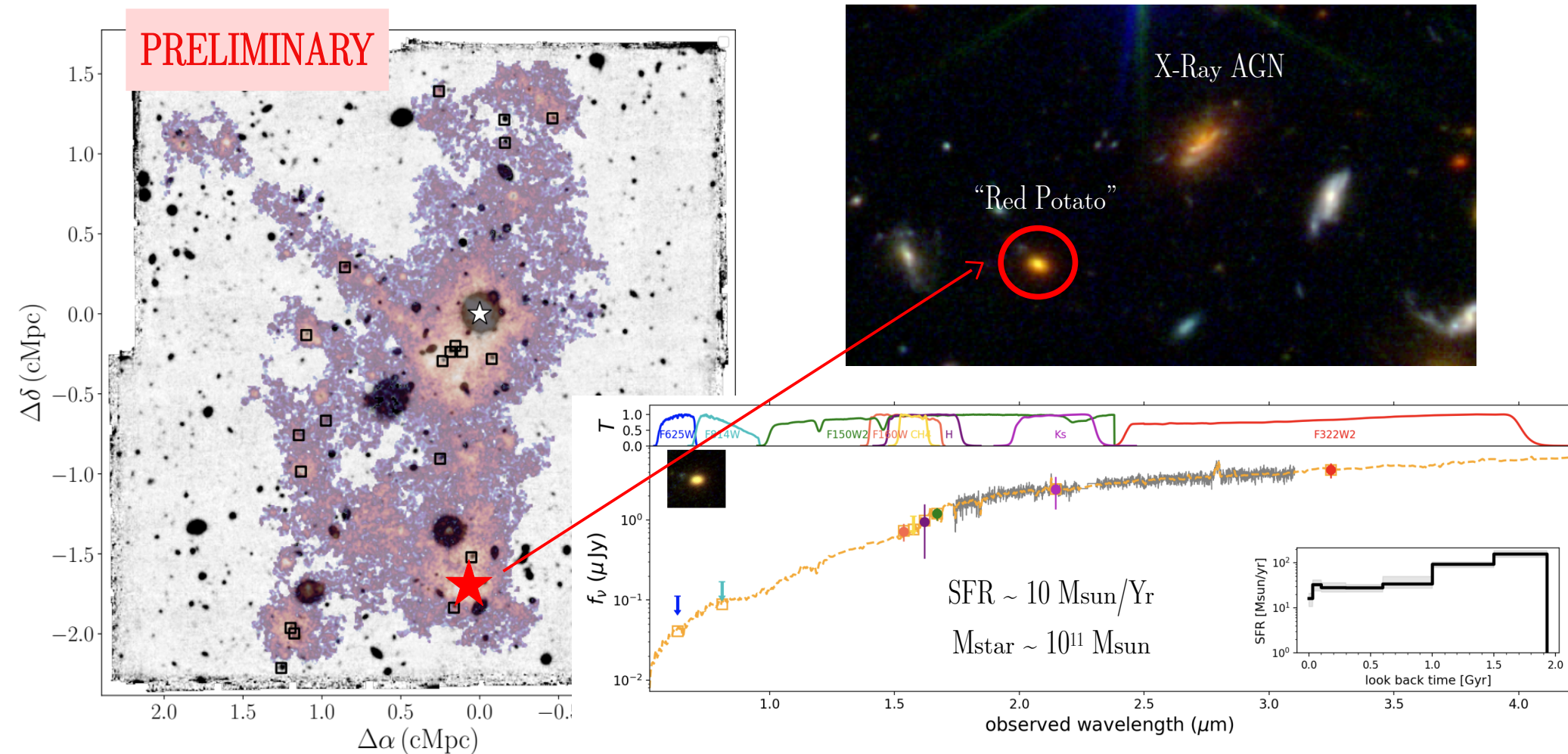


MQN01 structure over tens of cMpc



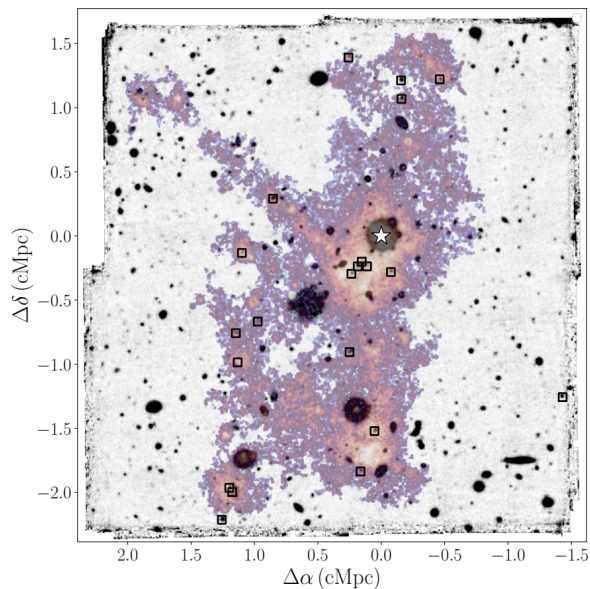
Uncovering the population of passive galaxies

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Summary and Conclusions

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



- We found one of the largest overdensities of star forming galaxies, AGNs and SMGs at $z \sim 3$;
 - These galaxies are embedded within a >4 cMpc $\text{Ly}\alpha$ -emitting structure and connected by filaments of gas;
 - There is an excess of massive galaxies in the overdensity;
- Hint that the large-scale environment accelerates the evolution of galaxies in extreme regions.

Thank you!

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