Multi-wavelength radiative transfer in prototypical Lyman Break Galaxies

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SCUOLA NORMALE SUPERIORE

Motivation

Key questions

1. What makes a LAE?
2. Seem to vanish at high redshift (>6) - why?

Possible scenarios

- increase of neutral fraction in the IGM at the end of EoR
- different ISM conditions, leading to smaller line shifts

Requirements

Hi-res cosmological hydro-simulations including Lyman-alpha and continuum radiative transfer are required

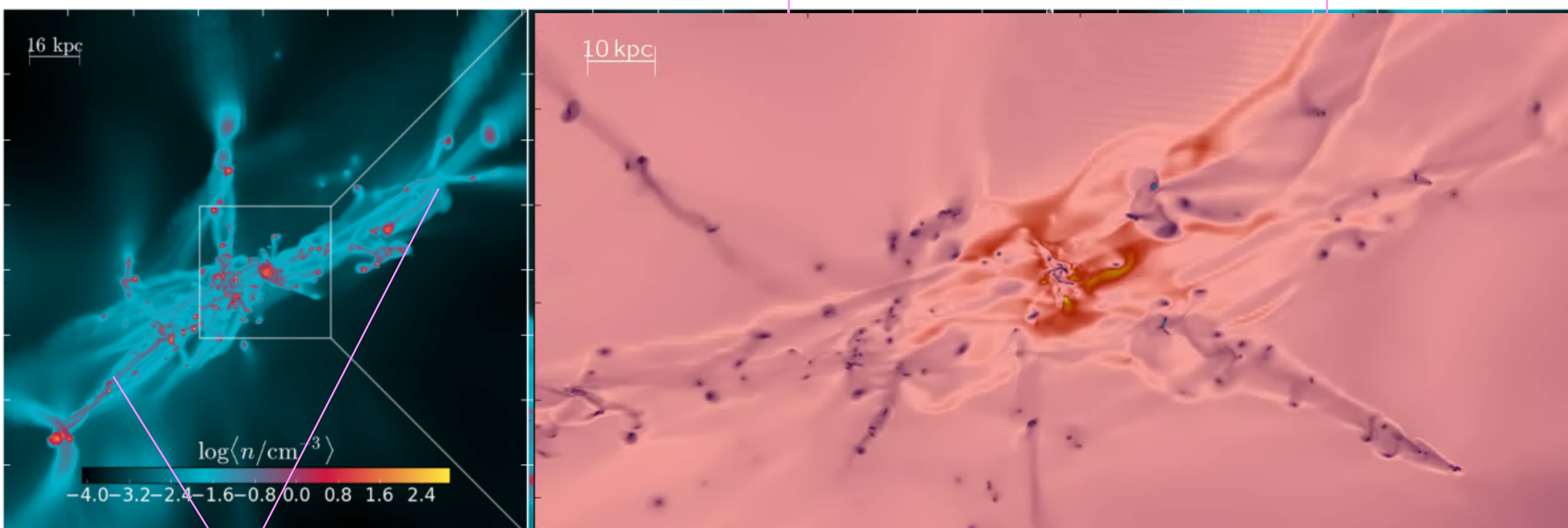
Pallottini+17a

ALTHAEA, A LBG @ $z = 6$

AMR zoom simulations
Spatial res = 8 pc
H_2- based SFR prescription
Updated SN feedback model
Radiation pressure (on dust)

$M_\star = 1.6\times10^{10}\ M_\odot$
$\Sigma_\star = 15\ M_\odot yr^{-1}\ kpc^{-2}$

$M_{H2} = 3\times10^{9}\ M_\odot$
$r_e = 0.6$ kpc



over-dense accreting filaments

merging clumps/satellites

Molecular/stellar disk
$< Z > = 0.5\ Z_\odot$

Radiative Transfer Setup

- Radiative transfer:

  - continuum + dust emission via *SKIRT* (e.g. Camps+16)
  - Lyman-alpha emission via *Iltis*
  - CII emission from cold/warm neutral medium and molecular clouds with CLOUDY (Vallini+15)

  What's an Iltis?

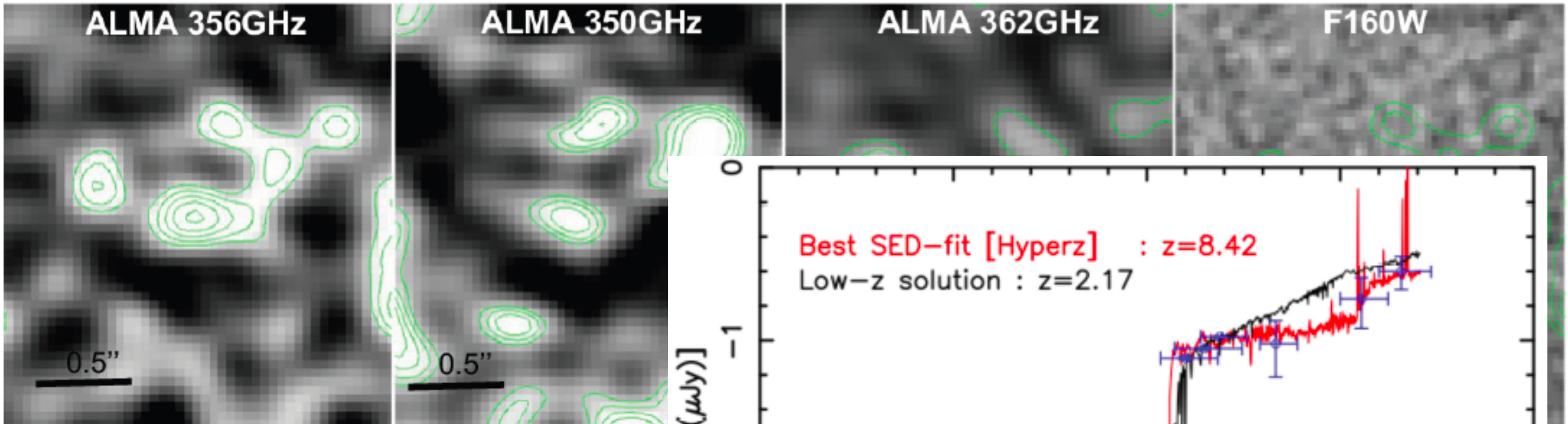
- Common dust model for continuum/Lyman_alpha (Weingartner+2001)

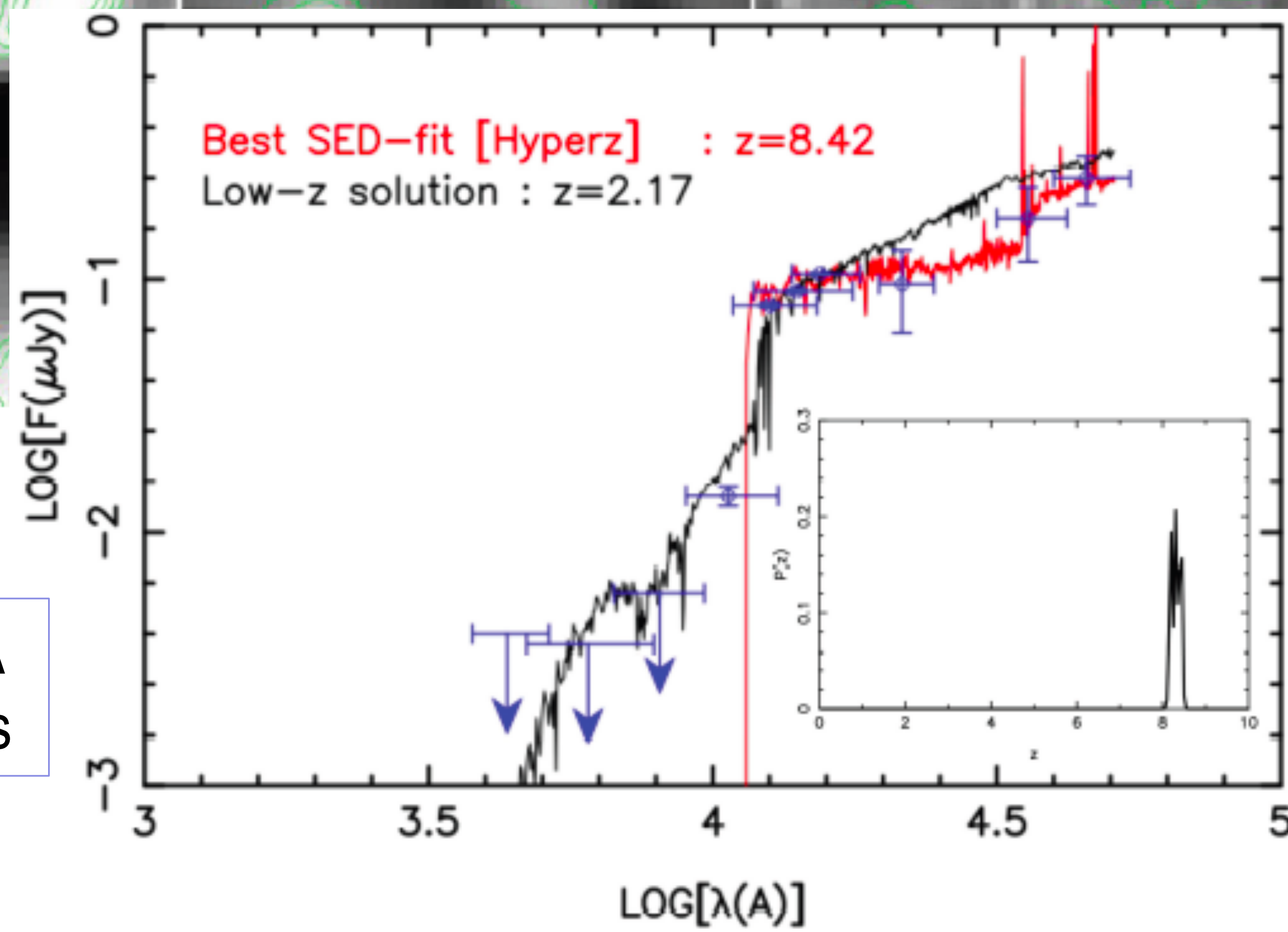
Laporte+17

ALMA BAND-7 DETECTION

$z = 8.38$

A2744 YD4, lensed galaxy in the HFF Abel 2744



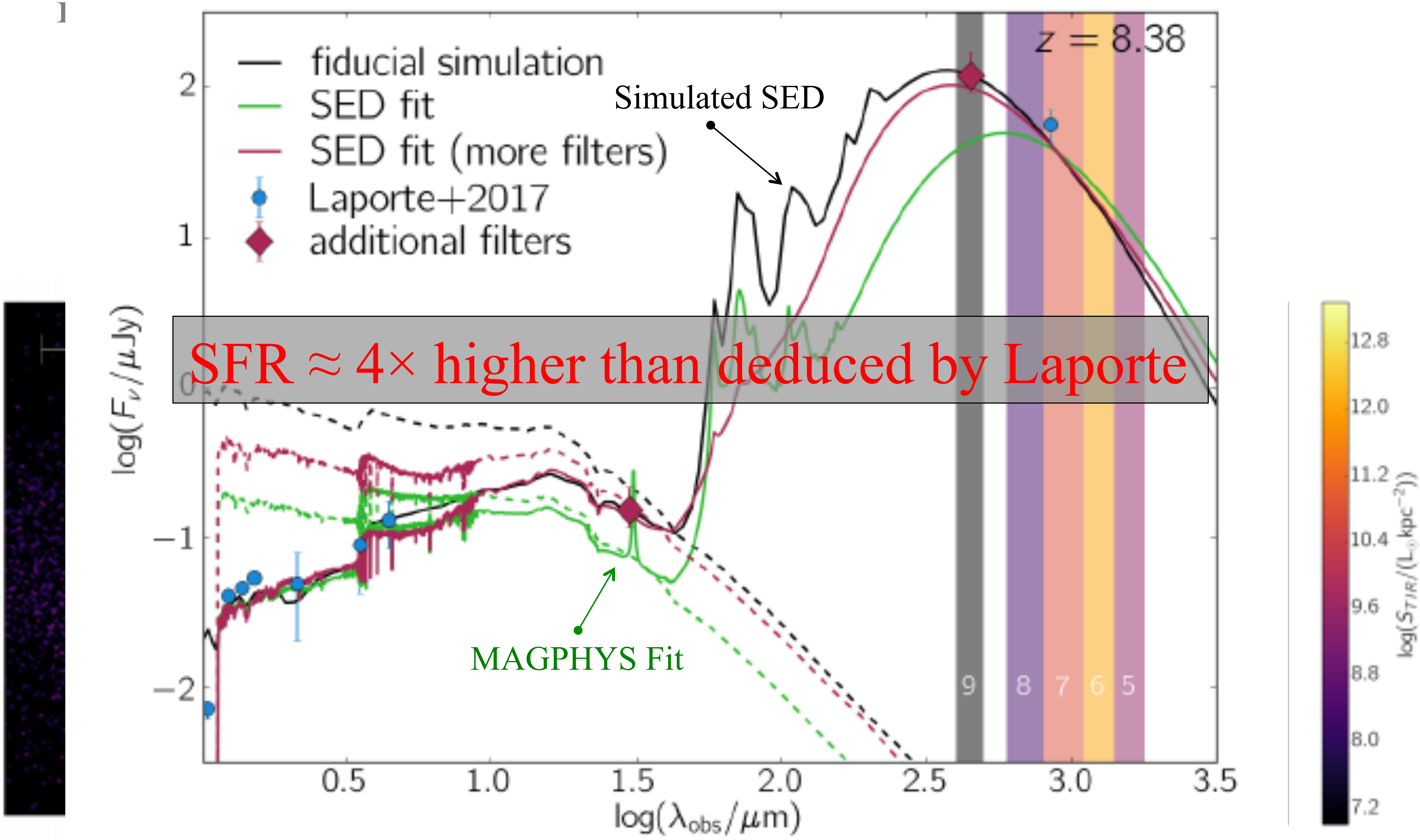


SED Fitting

SFR = 20 $M_\odot$/yr
$M_\star$ = 2x10^9 $M_\odot$
A_V = 0.74

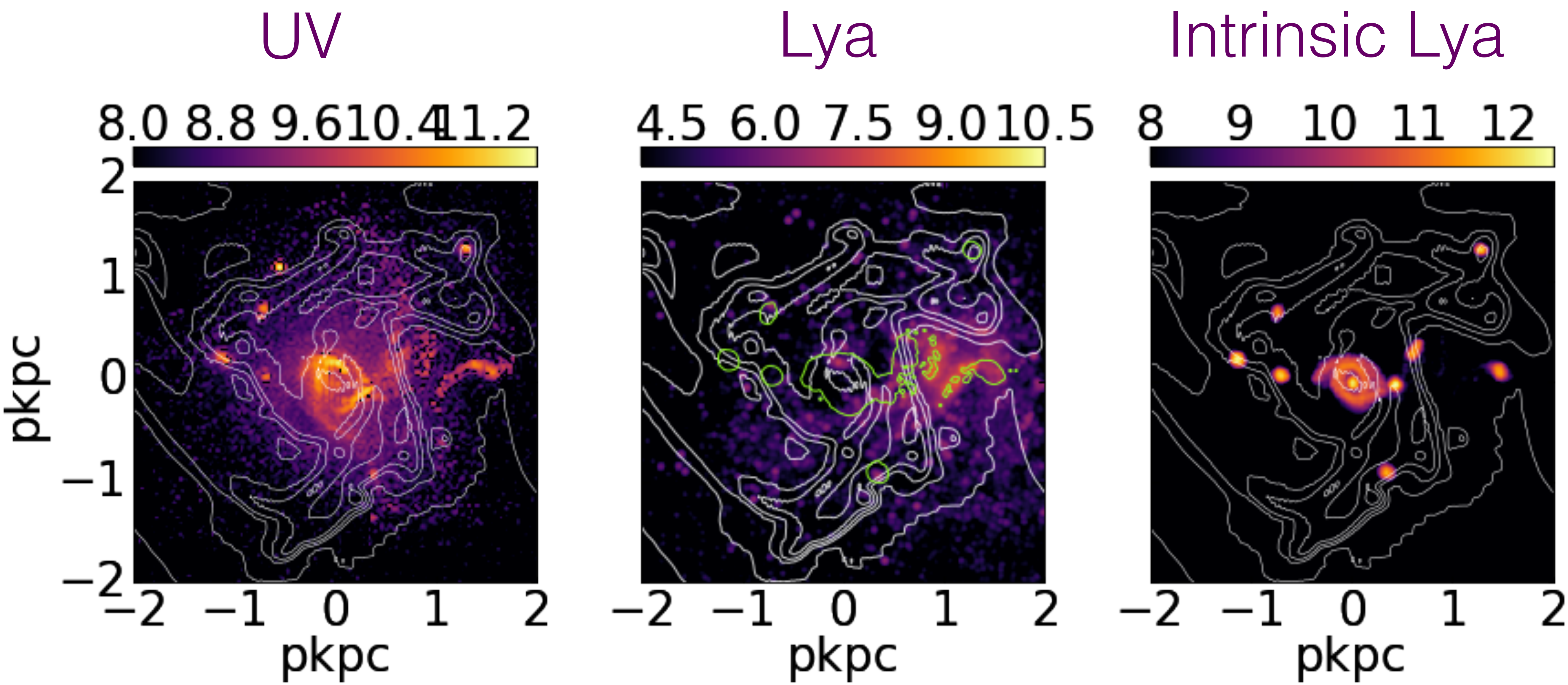
Lya line

EW=10.7 ± 2.7 Å
F_α= 1.8x10^{-18} cgs



IR bright, UV optically thick ($\tau_V > 8$)
star-forming molecular complexes

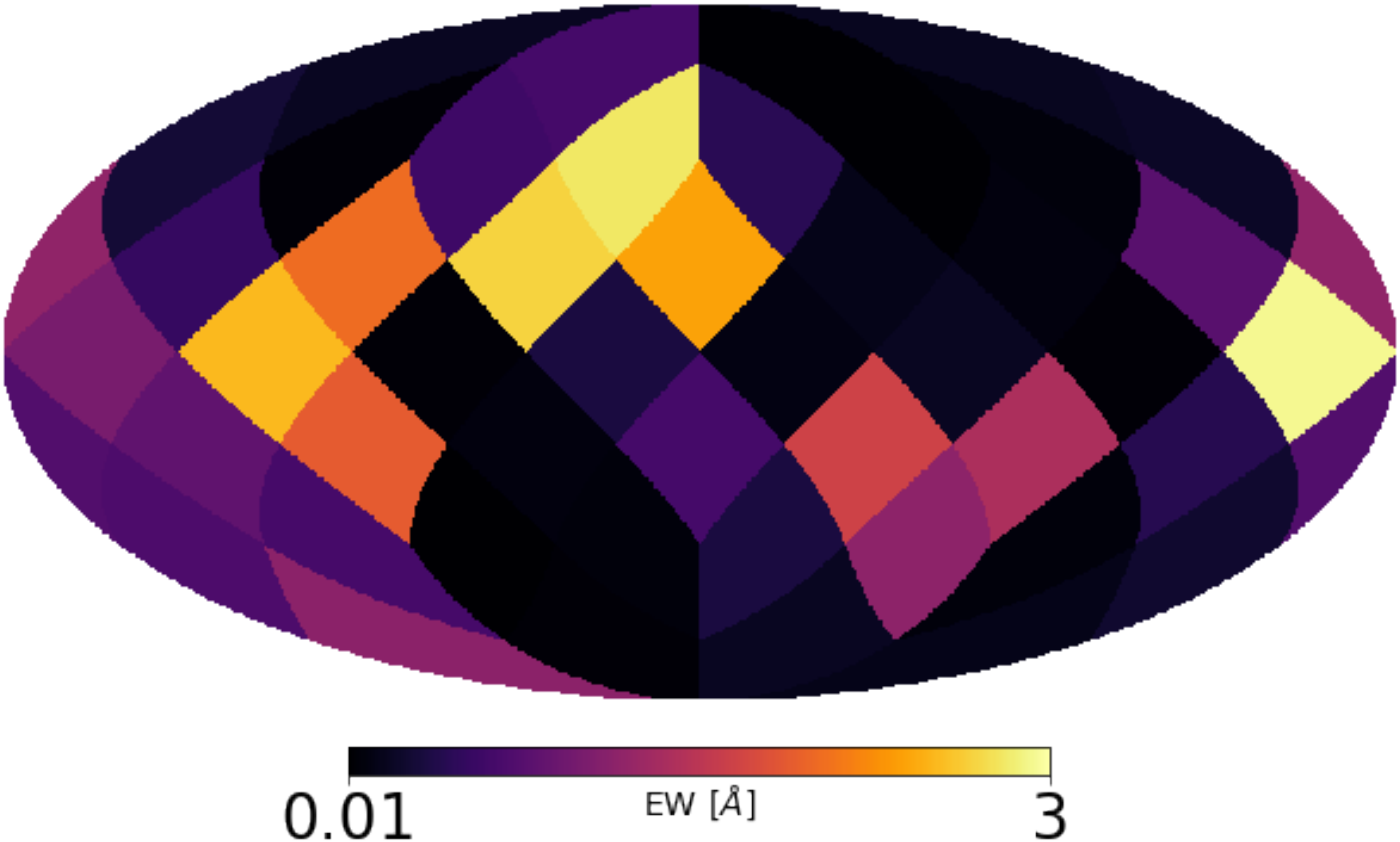
Surface Brightness Maps



Lya Luminosity

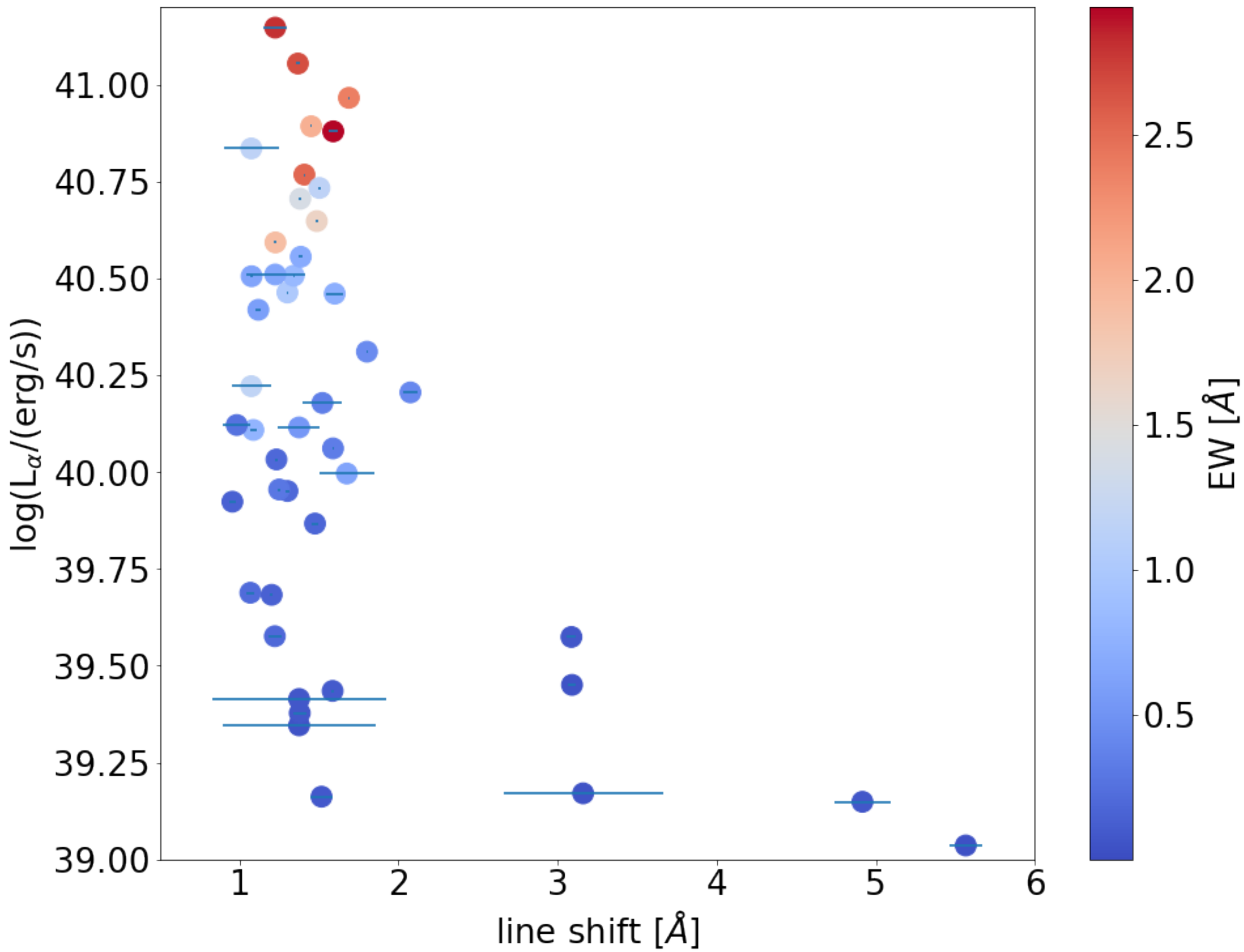
Intrinsic ~10^{44} erg/s, processed ~10^{40} erg/s, EW < 3 Å

The effect of inclination



Very chaotic compared to isolated galaxy simulations (e.g. Verhamme+12, Behrens+14), owing to more complex dynamics

Lya-CII line shift



- Typical line shifts of ~1 Angstrom
- Low EW/low Lyman alpha luminosity preferentially at larger line shifts

Can we turn Althæa into a LAE?

In short: NO!

- Numerical experiment #1: Reduce dust mass by 10x;
  Increases Lyman alpha only moderately (~10^{41}erg/s face-on)

- Numerical experiment #2: Remove dust from HII regions
  [60% of the dust removed]
  Boosts Lyman alpha up to 10^{43} erg/s in some lines of sight.
  Clumpiness compensates for scarcity of dust

BUT: IS IT PHYSICAL?

Conclusions

- Althæa is a very resilient LBG, with EWs of order ~few Å
- Resilience is driven by the clumpiness of dust, not by the total mass of dust
- Large variations of the EW as a function of line of sight, with no clear preference for face-on directions compared to isolated simulations, owing to accretion, tidal streams, etc.
- Indications for a negative correlation between the CII line shift and the observed luminosity, owing to the relation between frequency diffusion and path length through a dusty medium