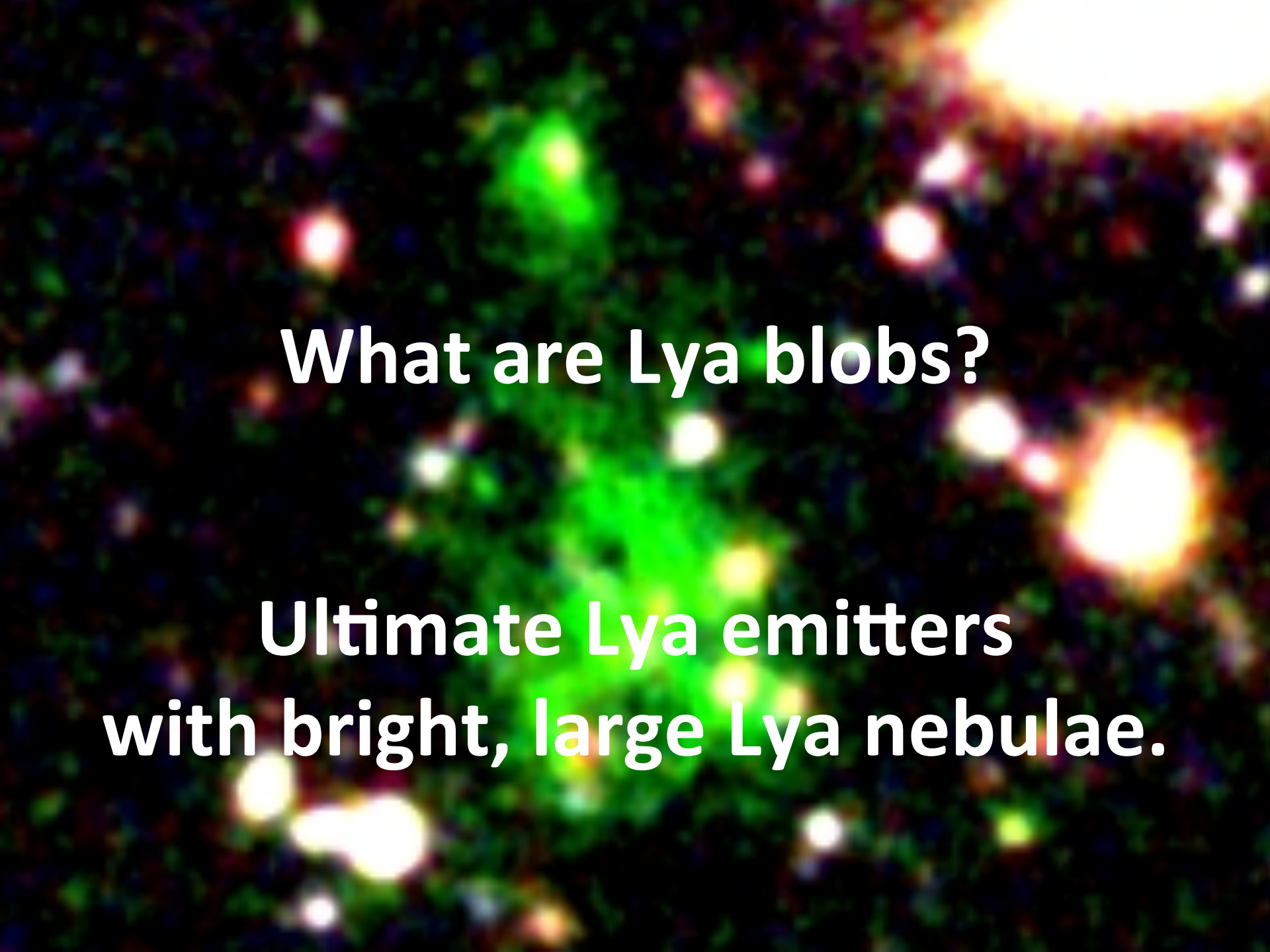
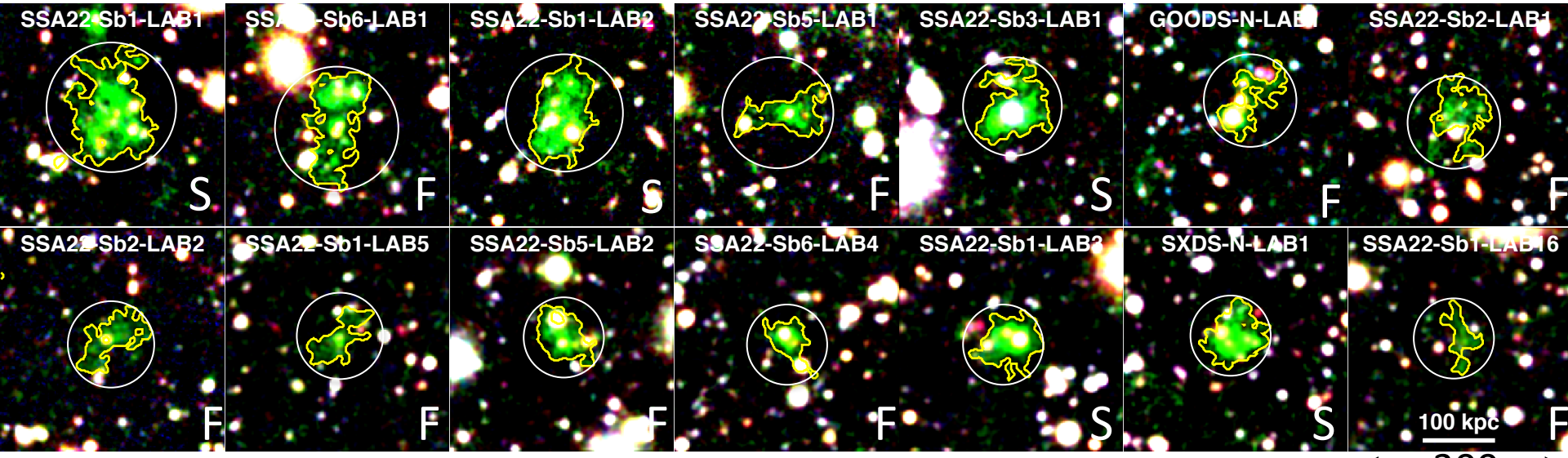
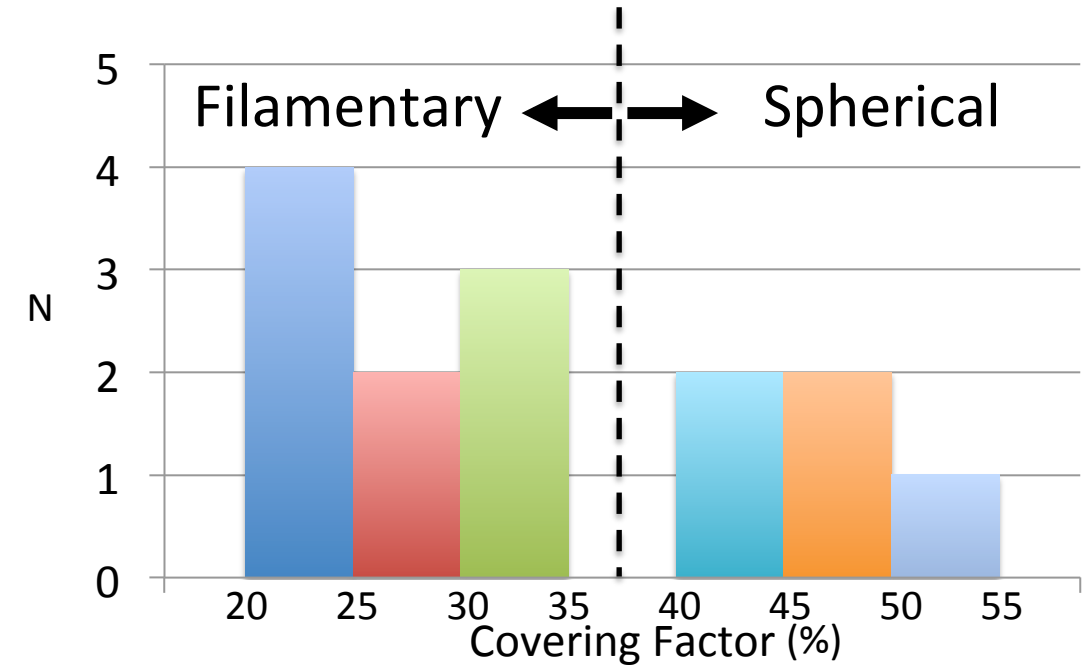
Science-9 (Lya blobs)

Y. Matsuda (NAOJ)


What are Lya blobs?
Ultimate Lya emitters
with bright, large Lya nebulae.

Filamentary & Spherical Lya blobs





Matsuda et al. 11

- 20-25%
- 25-30%
- 30-35%
- 35-40%
- 40-45%
- 45-50%
- 50-55%

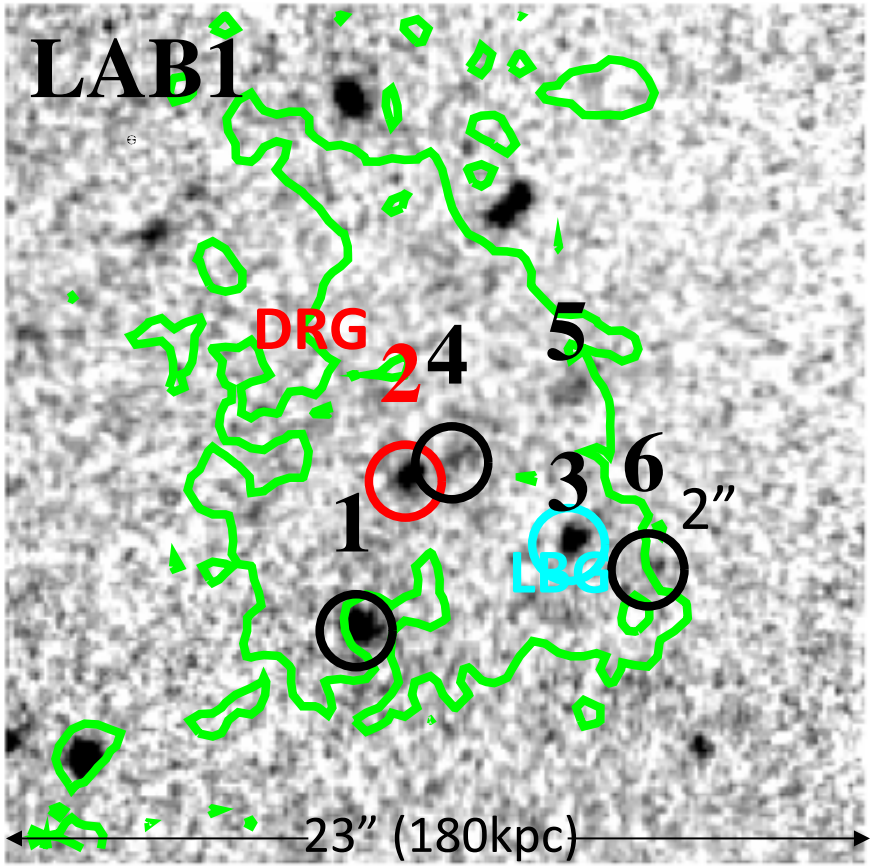
The areas of nebulae are measured above a threshold of 1.4×10^{-18} erg/s/cm^2/arcsec^2.

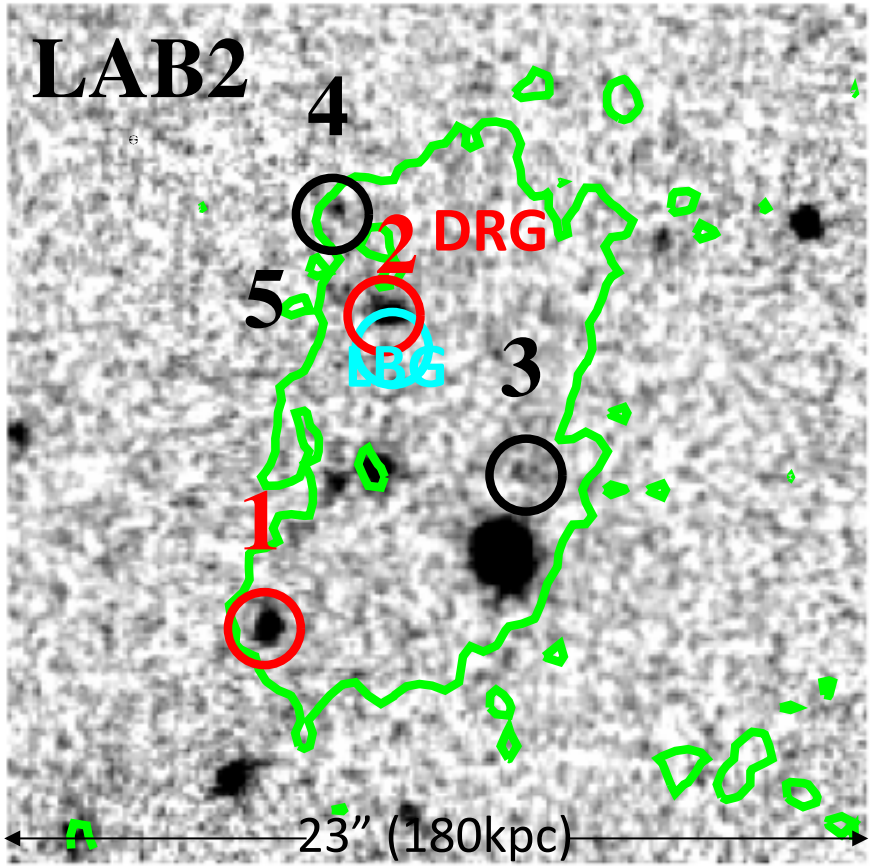
The circles have diameters of the major axis of the Lya nebulae.

Why are they interesting?

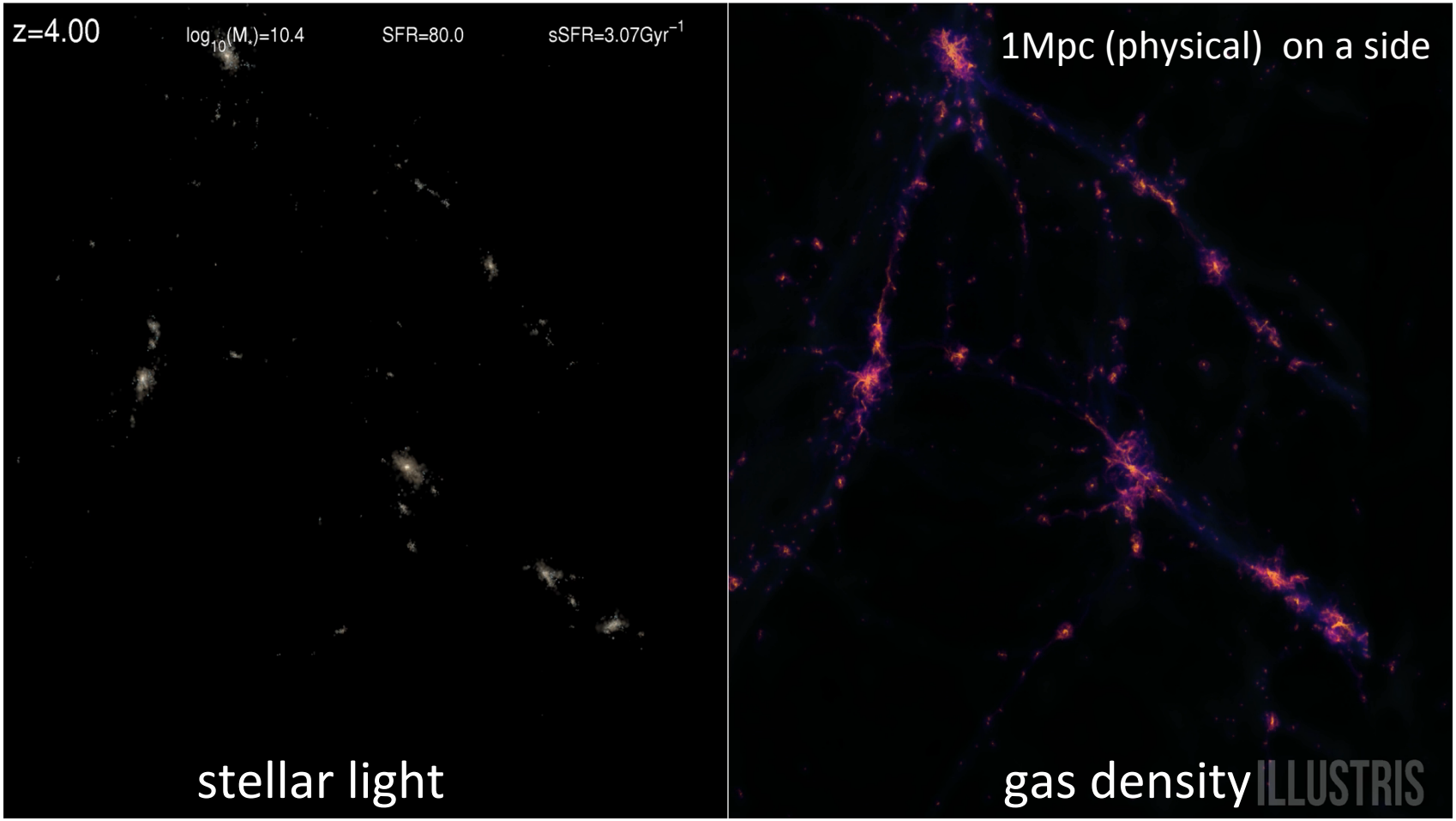
Because the spherical Lya blobs may be related to multiple mergers and massive galaxy formation.

MOIRCS Ks-band image of z=3.1 Lya blobs (Uchimoto et al. 12)
5-6 galaxies are found in each Lya blob.





Formation of an elliptical galaxy by multiple major merger (simulation)

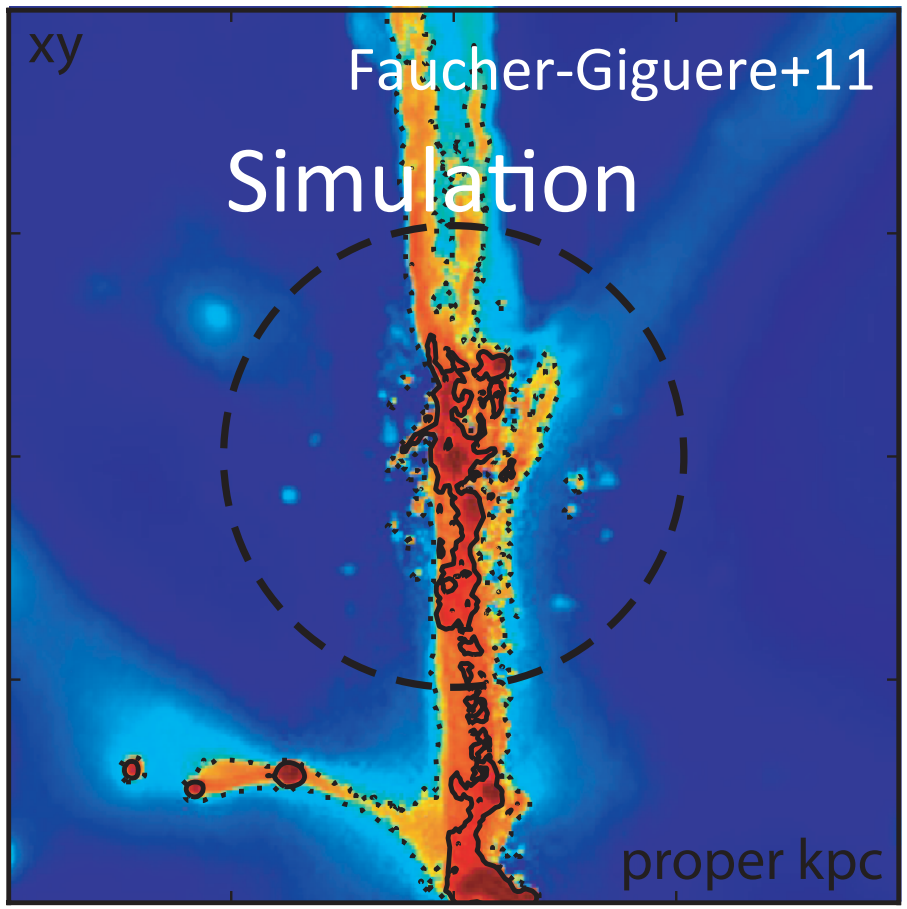


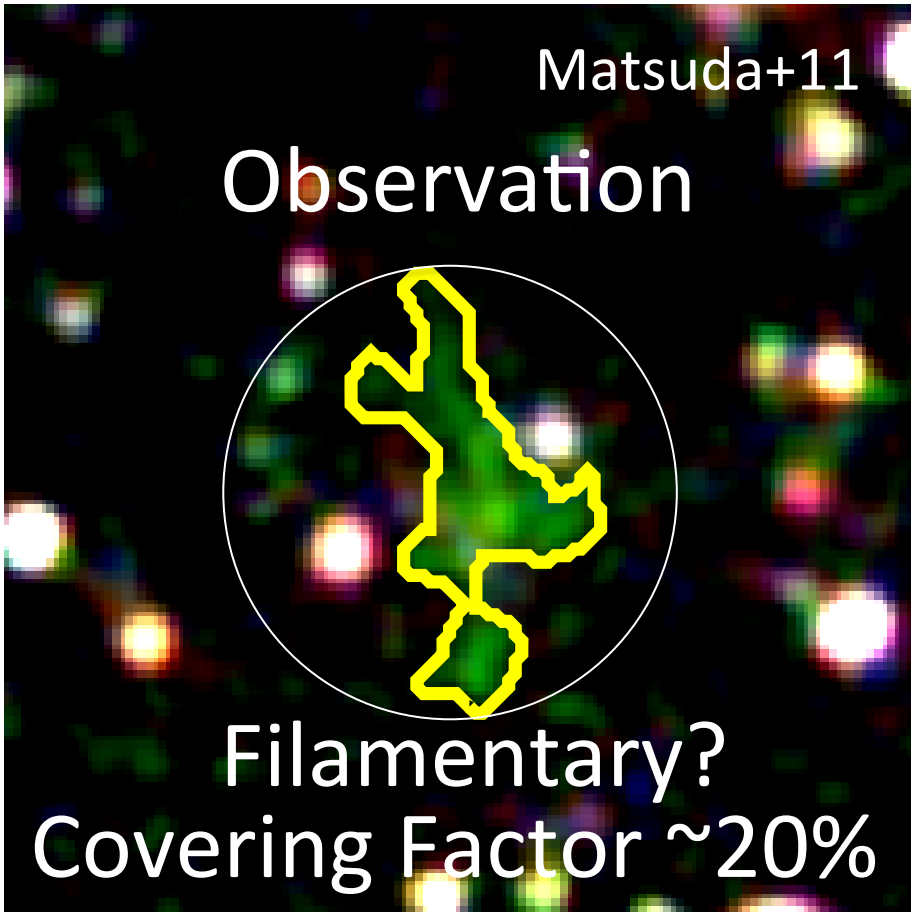
http://www.illustris-project.org/movies/illustris_movie_elliptical_formation_1pMpc.mp4

Why are they interesting?

Because filamentary blobs may be related to cold gas streams and formation of gas rotating discs.

z=3



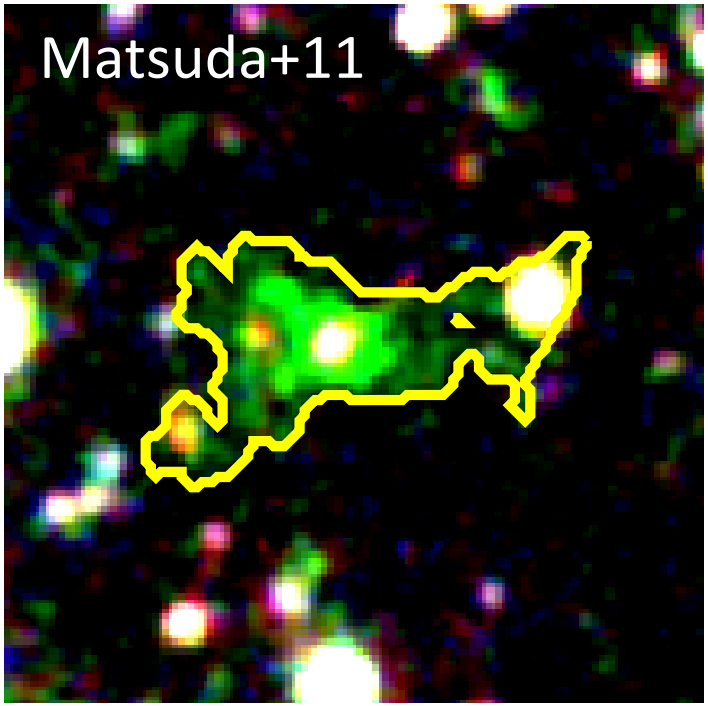


200 kpc

200 kpc

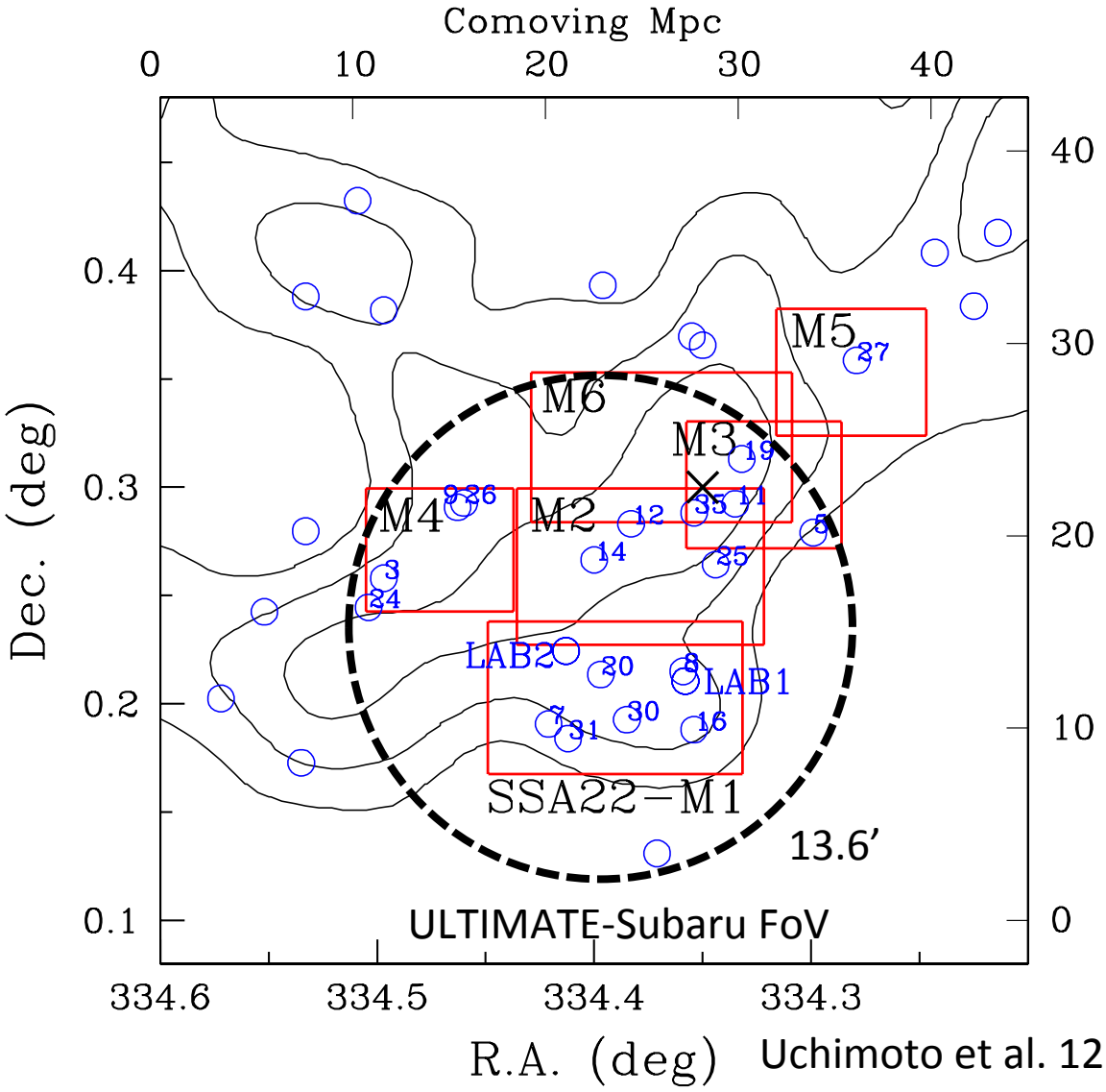
Why are they interesting?

Because filamentary blobs may be related to cold gas streams and formation of gas rotating discs.



Ultimate observations of multiple mergers and gas discs in Lya blobs

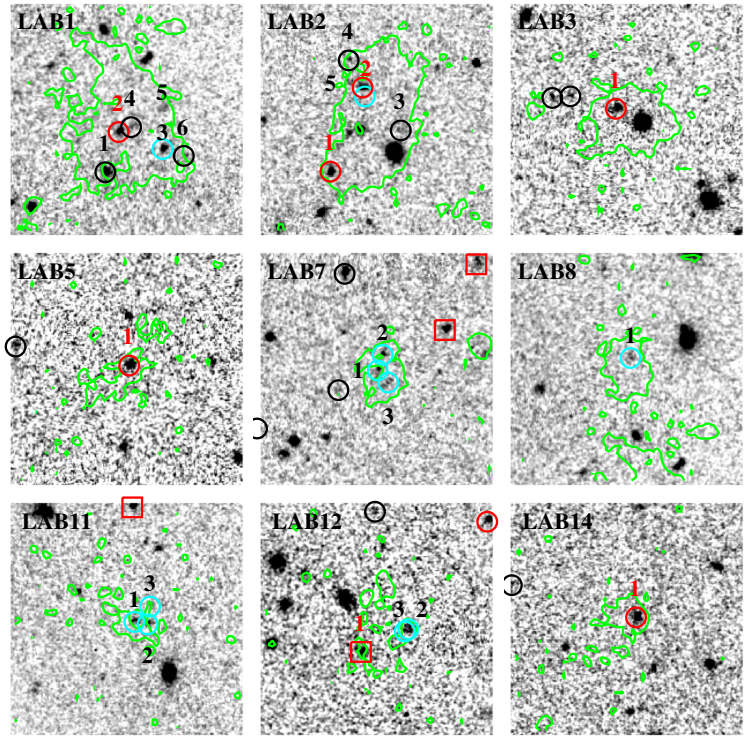
Observations of [OII]3727 emission in H-band



Uchimoto et al. 12

ULTIMATE can cover >20 Lya blobs simultaneously in the 13.6' FoV (centre of the z=3.1 SSA22 protocluster)

We need multiple setup to observe multiple galaxies in each Lya blob.



Q&A

=== Phase-I instrument (Starbugs (fiber bundle IFU) + new MOIRCS) Specifications ===

(Q1,Q2) What is the optimum spatial sampling (or diameter in arcsec of each fiber in the bundle) and FOV of the bundle? What is the optimum and minimum number of the fiber bundles (or multiplicity) in the 13'.6 diameter FOV?

Large FoV of the bundle is better: (Config3): spatial sampling=0 ".2, number of fibers=61, FOV of the bundle~1 ".8, number of bundles~16

(Q3) What is the critical wavelength range in near-infrared covered by the Starbug system (0.9-2.0micron)? Current baseline specification does not include K-band since the fiber throughput severely decreases at 2.0 micron or longer. Implementation of the K-band fiber would be very hard and expensive.

Obviously, K-band is useful to see Ha of z~2 galaxies, [OIII] for z~3 galaxies.

(Q4) What is the optimum spectral resolution? The spectral resolution of the Starbugs + newMOIRCS with 0 ".2 sampling is expected to be roughly 2-3 times higher than that of current MOIRCS with 0 ".6 slit.

R>3000 is needed to resolve ~100km/s line of galaxies.

(Q5) What is the sensitivity requirement for the phase-I instrument?

Around 40-50% is preferable.

Q&A

=== Science Cases with the Phase-I instrument ===

(Q6) Please describe a brief observation plan for your science case with the fiber bundle multi-object IFU. - Number of objects / Survey area - Fields - Number of nights to complete your survey – Uniqueness

(Q7) How could the proposed science cases be competitive or complementary to the science with 30m class telescopes (e.g. TMT) or space telescopes (e.g. JWST) in 2020s?

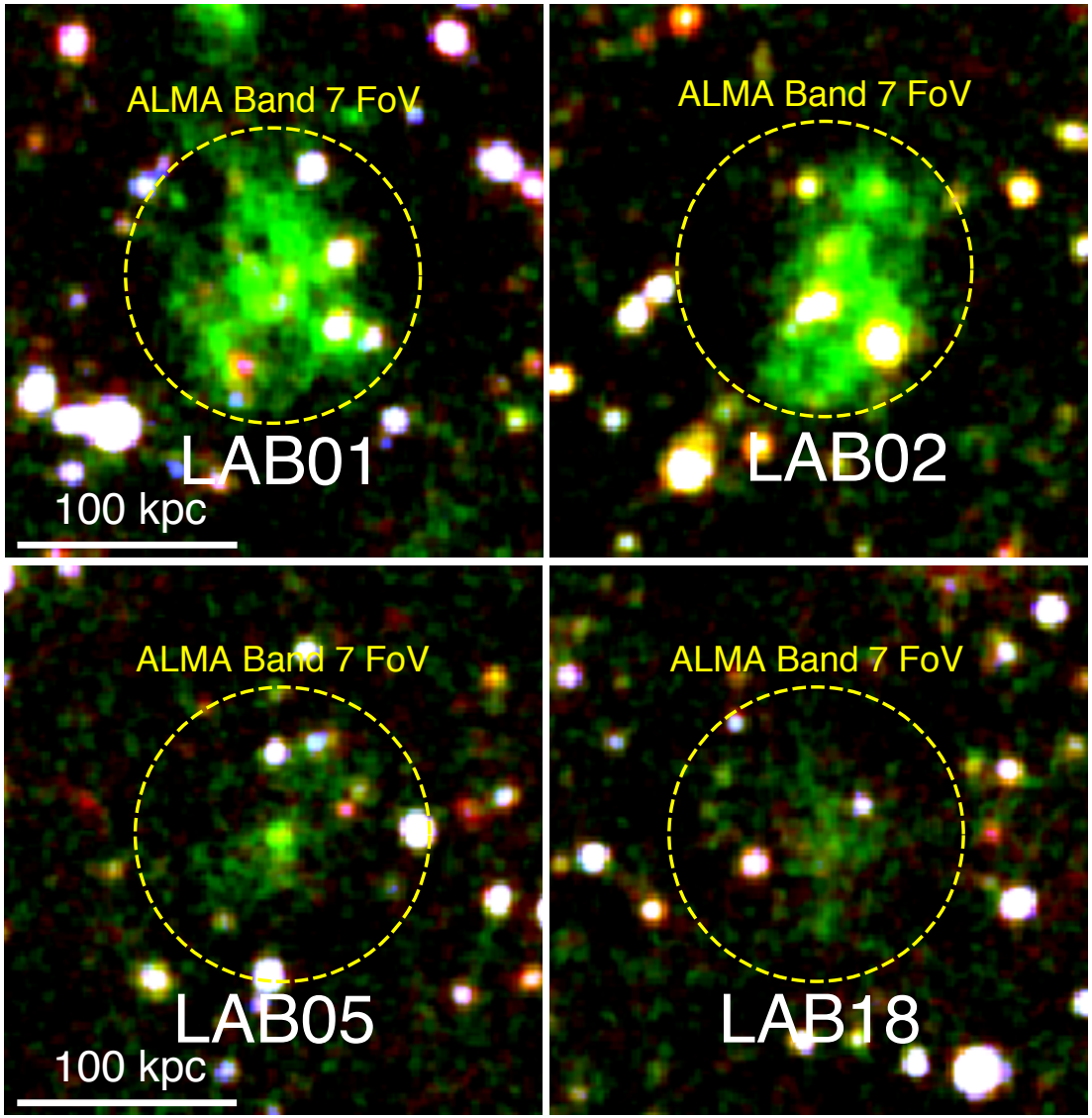
=== Requirements for the Phase-II instrument ===

(Q8) Please describe the requirements for Phase-II instrument (Starbugs + dedicated spectrograph) to develop your science case. - Fiber bundle configurations (spatial sampling, FOV of each bundle, number of bundles in 13'.6 FOV) - Wavelength coverage - Spectral resolution – Sensitivity

=== Uniqueness of the instrument ===

(Q9) What is the unique point of the fiber bundle multi-object IFU with Starbugs compared to the imager or multi-object slit spectrograph?

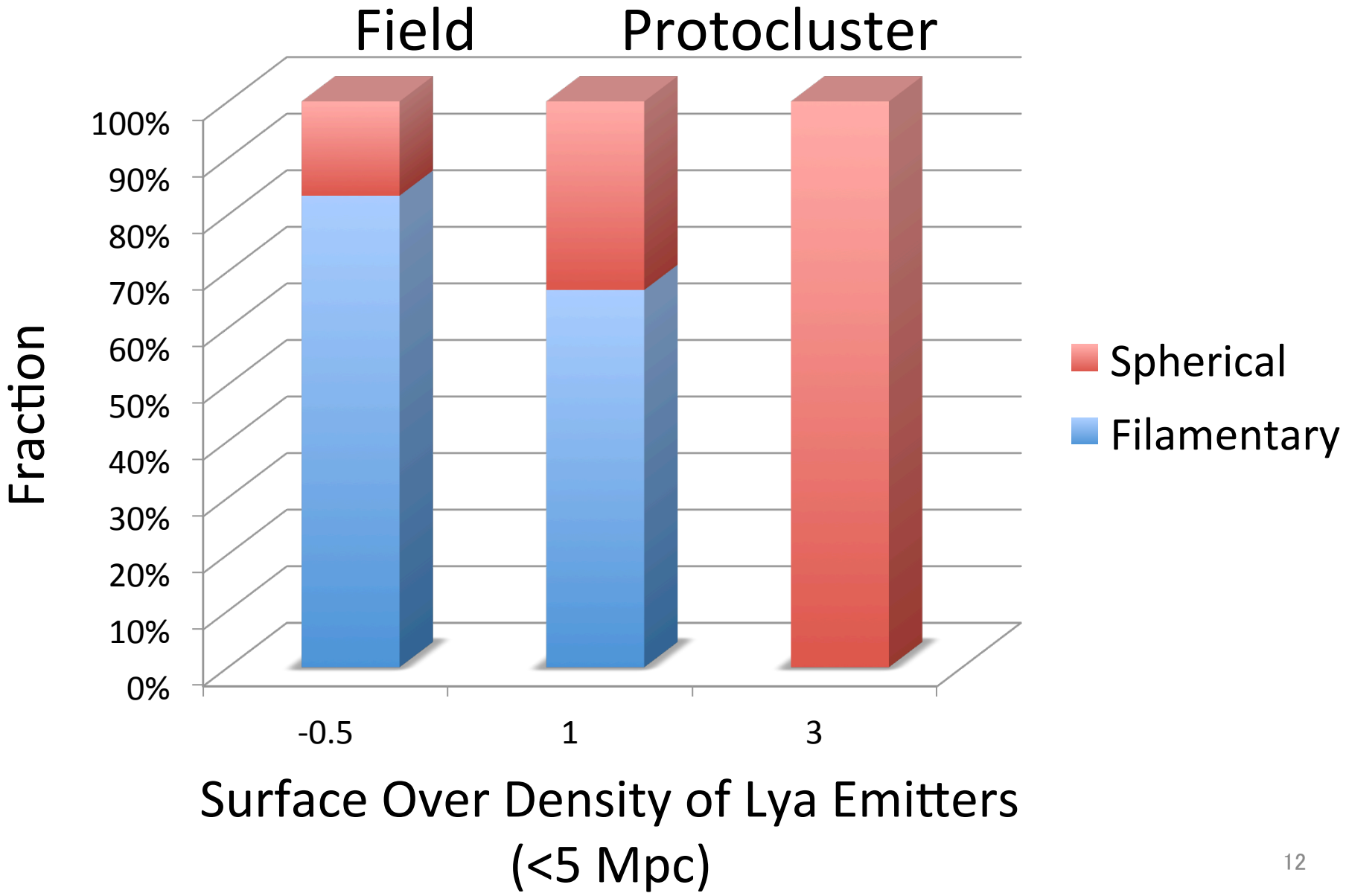
ALMA will be able to observe [NII]/[CII]/CO emission line of galaxies in the Lya blobs



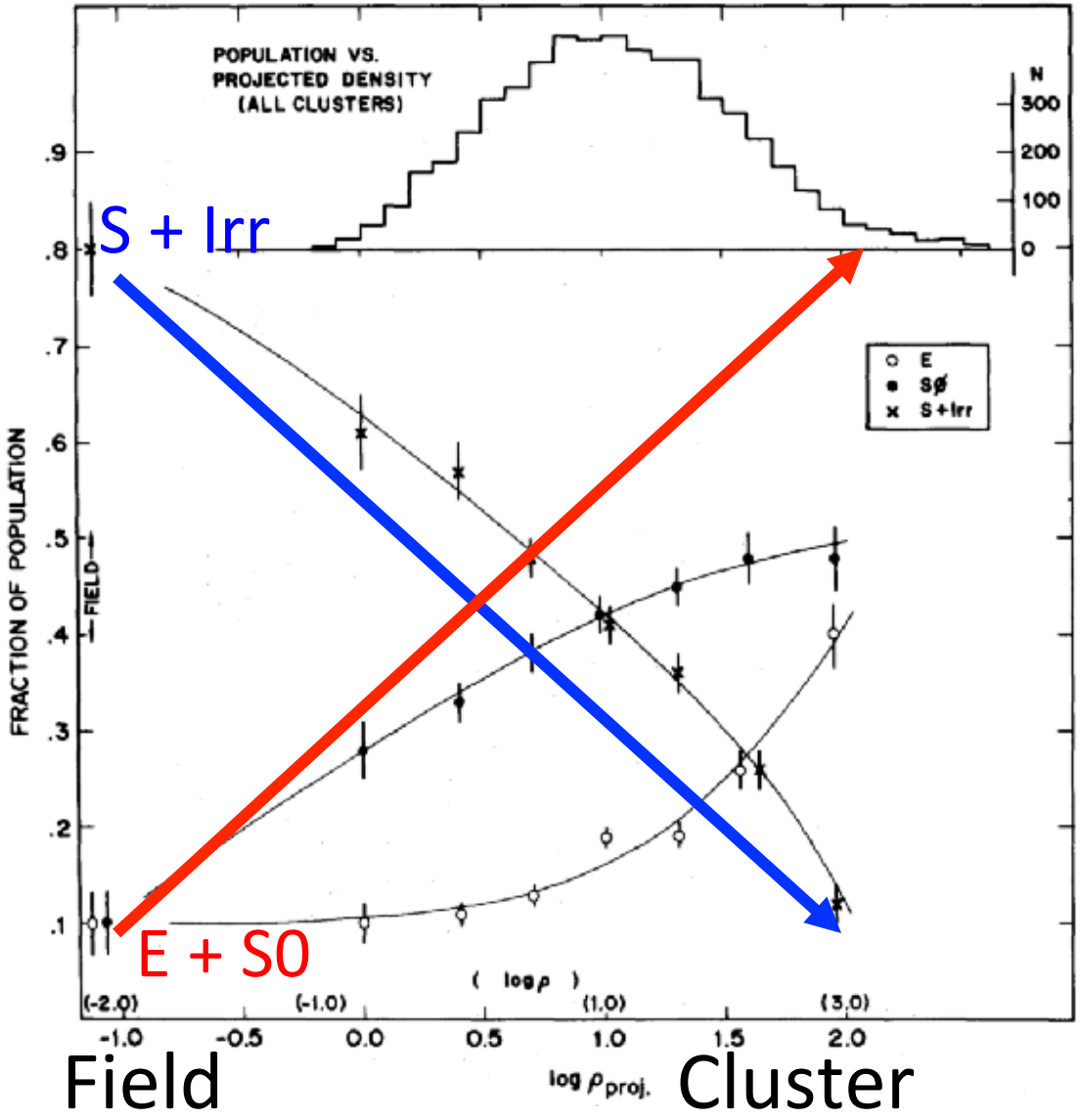
We have approved ALMA Cycle2 project to see dust continuum emission (870um) in 4 Lya blobs (2 spherical and 2 filamentary blobs).

If we are lucky, we can detect redshifted [NII]205um to measure kinematics of galaxies in the blobs.

Lya Morphology Density Relation?



Local Morphology Density Relation



Fraction

Field

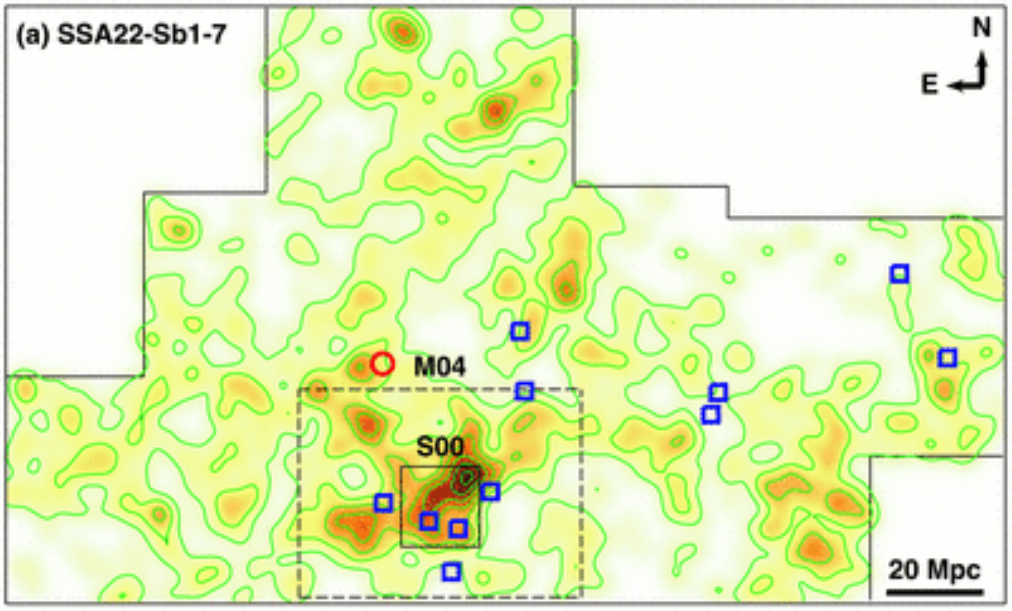
Cluster

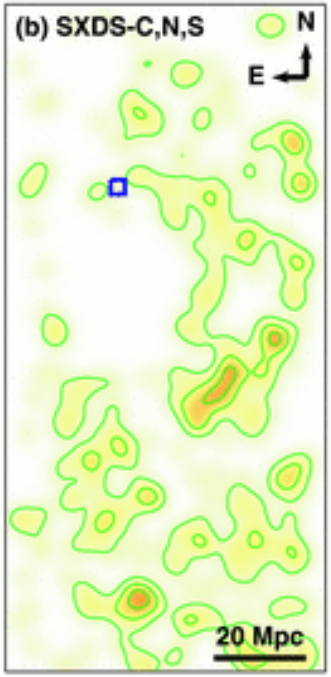
Surface Density of galaxies

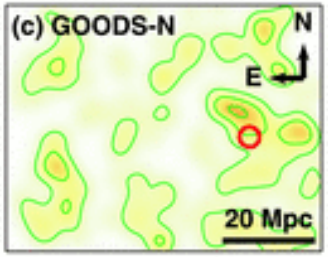
Dressler 80

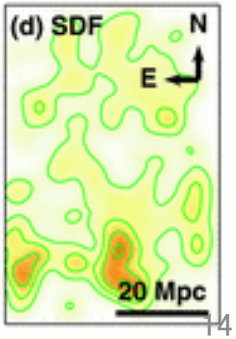
Subaru / Suprime-Cam Survey at z=3

- ✧ 2.4 sq deg deep Lya imaging survey (Yamada+12)
- ✧ 12 pointings (SSA22 + 6 surrounding fields, Subaru Deep Field, GOODS-N, Subaru-XMM Deep Survey Fields)
- ✧ 1-sigma Lya surface brightness~10^{-18} erg s^{-1} cm^{-2} $arcsec^{-2}$
- ✧ 2200 Lyman-alpha emitters (Yamada+12)
- ✧ 14 giant (>100kpc) Lyman-alpha nebulae (Matsuda+11)





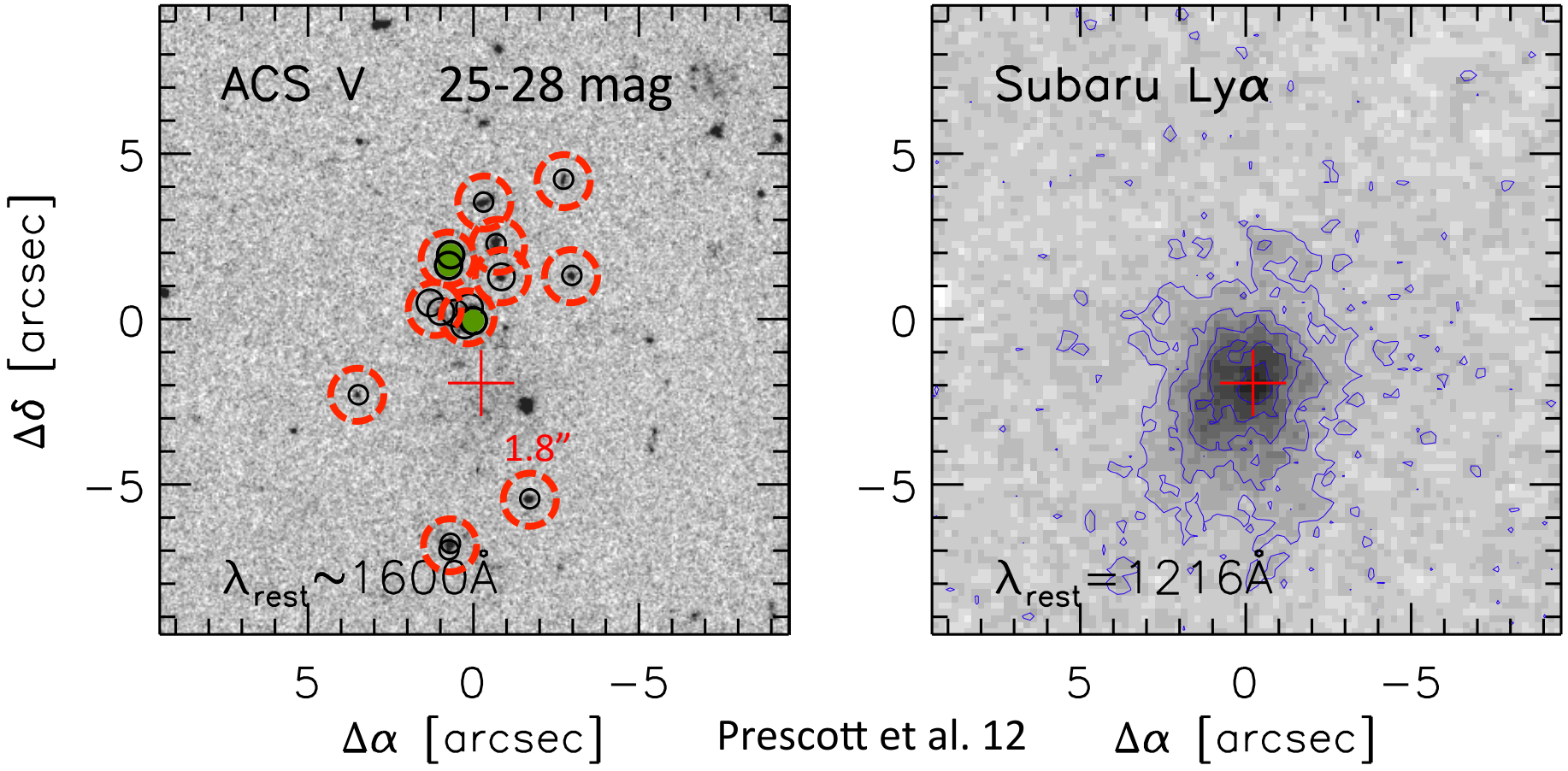




Why are they interesting?

Because the spherical Lya blobs may be related to multiple mergers and massive galaxy formation.

HST/ACS V-band and S-Cam Lya images of z=2.7 Lya blob
17 disk-like galaxies are found in the blob.



Prescott et al. 12

Comparison between Lya and nebular lines

z=2.3 Lya blobs (Yang et al. 2011)