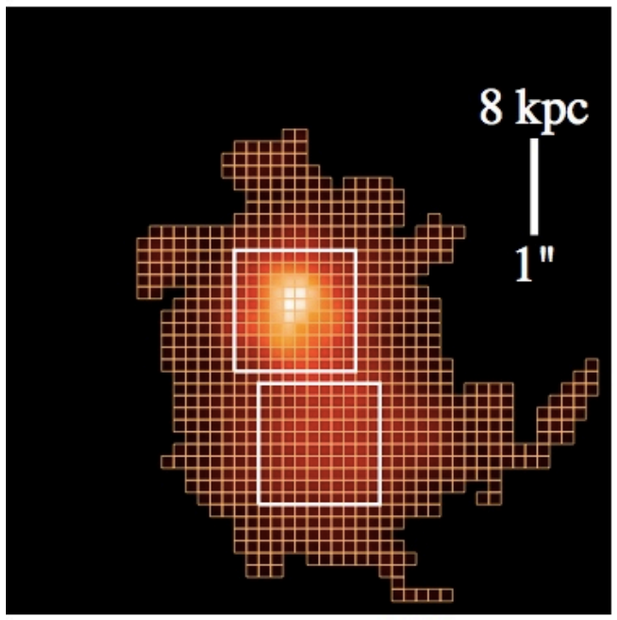
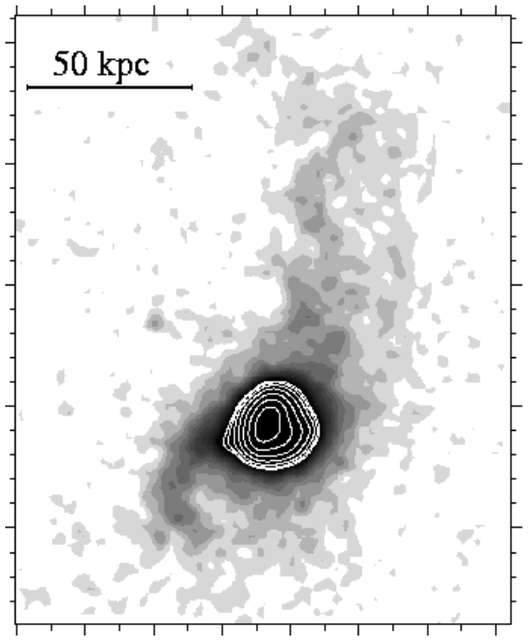
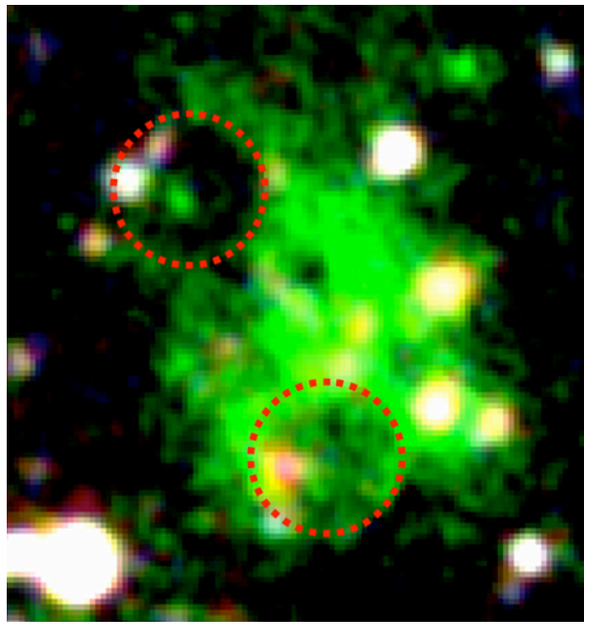
The (un)surprising similarities between *Lyα blobs*, *radio galaxies* and *quasars*







Roderik Overzier

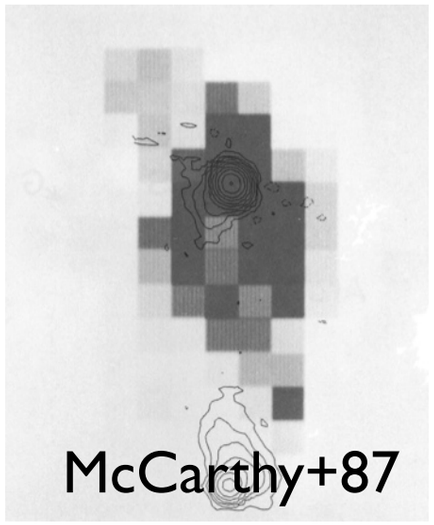
Rio de Janeiro, Brazil

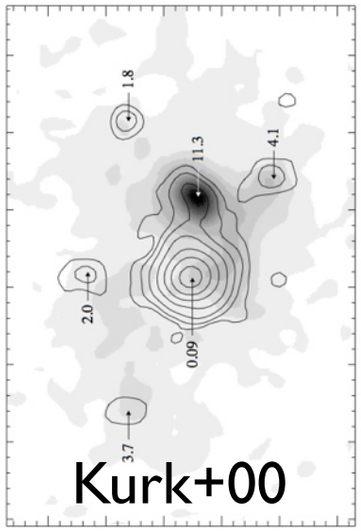
Observatório Nacional

ESO 3D Conference, March 12, 2014

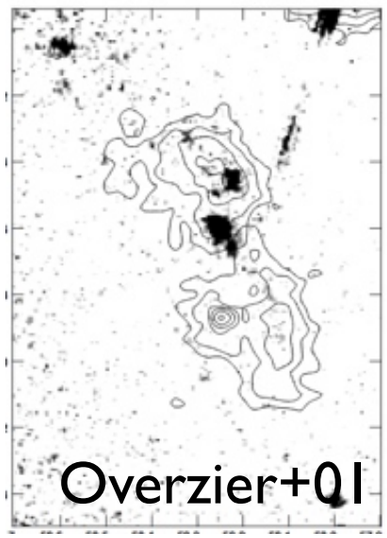
Zoo of Luminous Extended Lyα structures

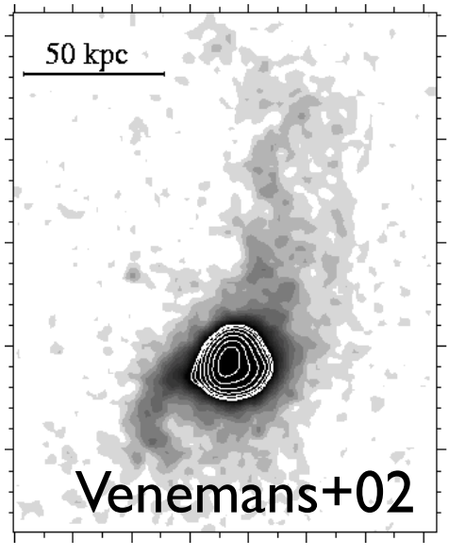
Radio Galaxies


McCarthy+87



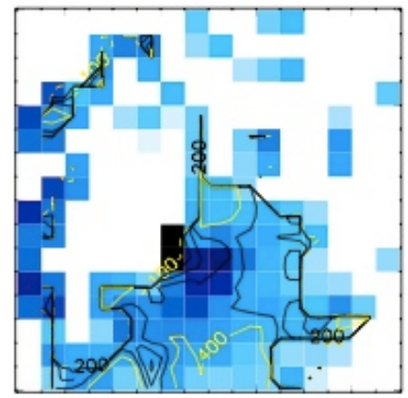
Kurk+00

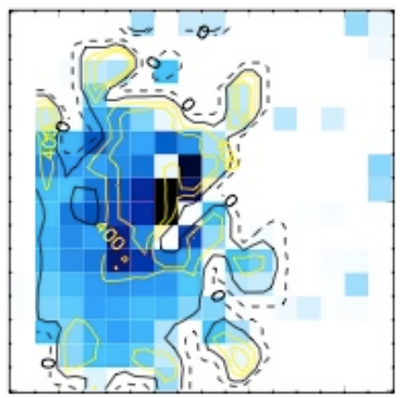

Overzier+01



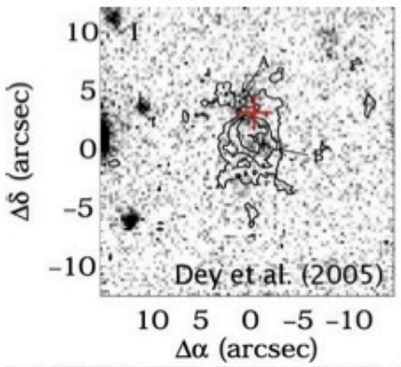
Venemans+02

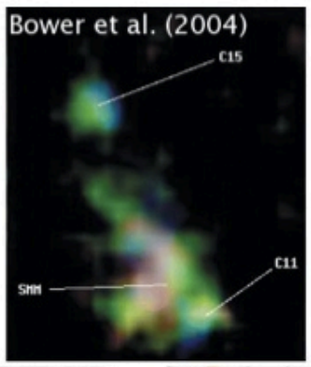
Quasars

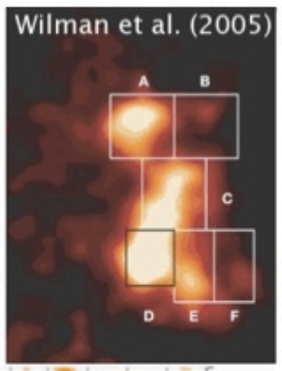


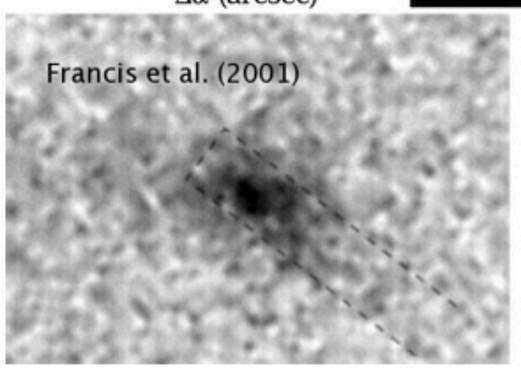


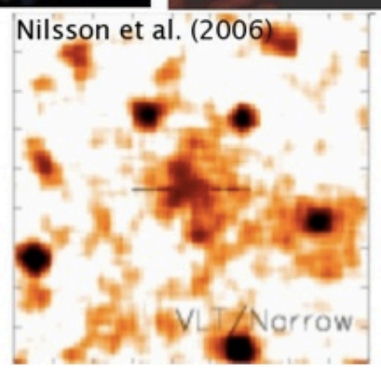
eg. Heckman+91, Christensen+06

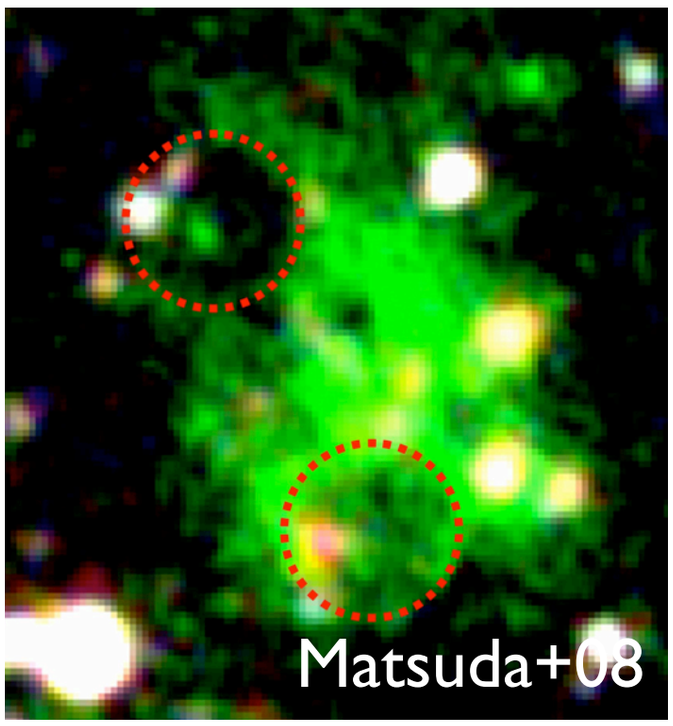












"Lyα blobs"

$L_{Lya} > 10^{44}$ erg/s
Size ~ 50 - 150 kpc
z ~ 2 - 6

- due to the absence of obvious radio structures and quasar-like spectra, the very intriguing “Lyα blobs” (only known since early 2000s), appeared to be a unique new class of objects of unknown cosmological origin

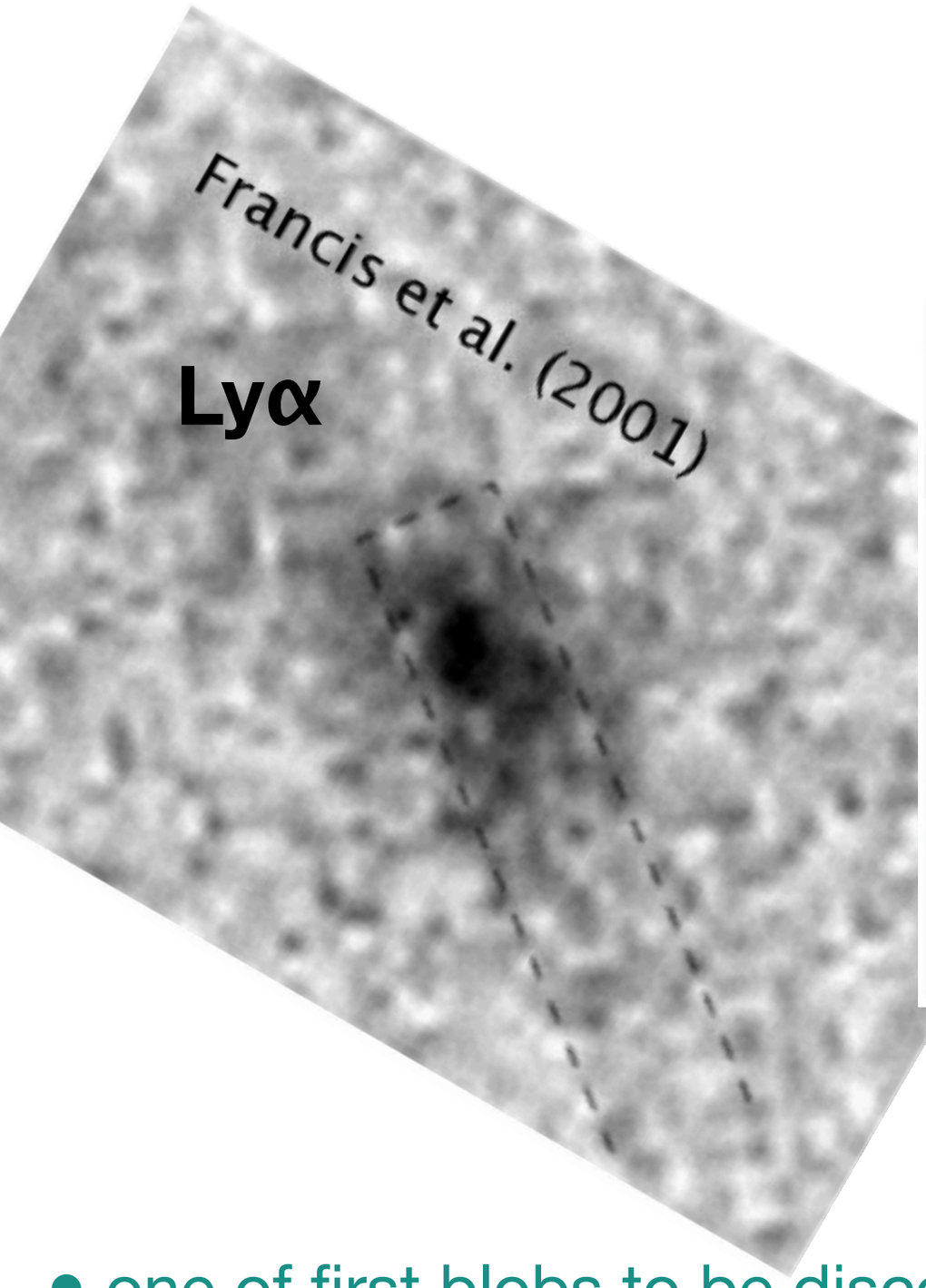
- like radio galaxies, they seem to be preferentially found in overdense (cluster-like) regions at very high redshifts (but some literature bias)

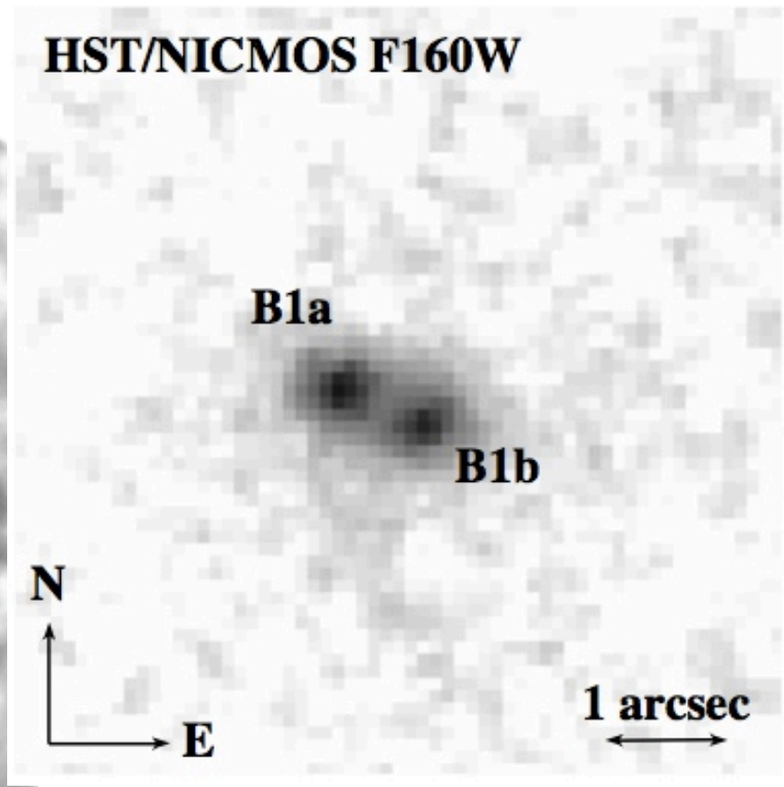
- it is claimed they are the “smoking gun” of the predicted large cosmo-logical cold gas flows streaming into dense regions of the early universe

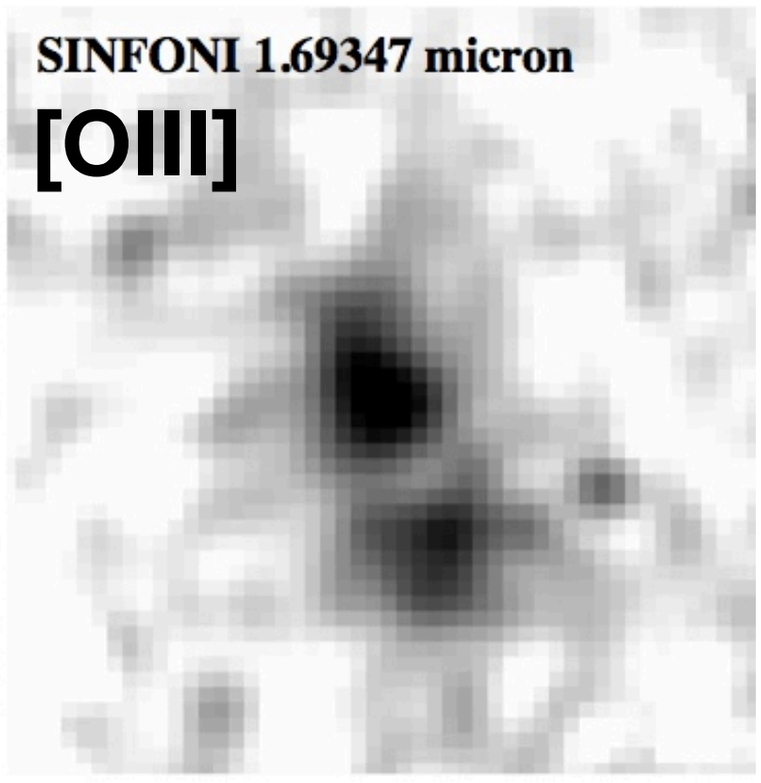
- in this scenario, the Lyα emission originates from collisionally excited HI in filamentary gas streams onto forming massive galaxies

- the radio galaxy/quasar community has been skeptical of this...

The Case of LAB "B1" at z=2.38

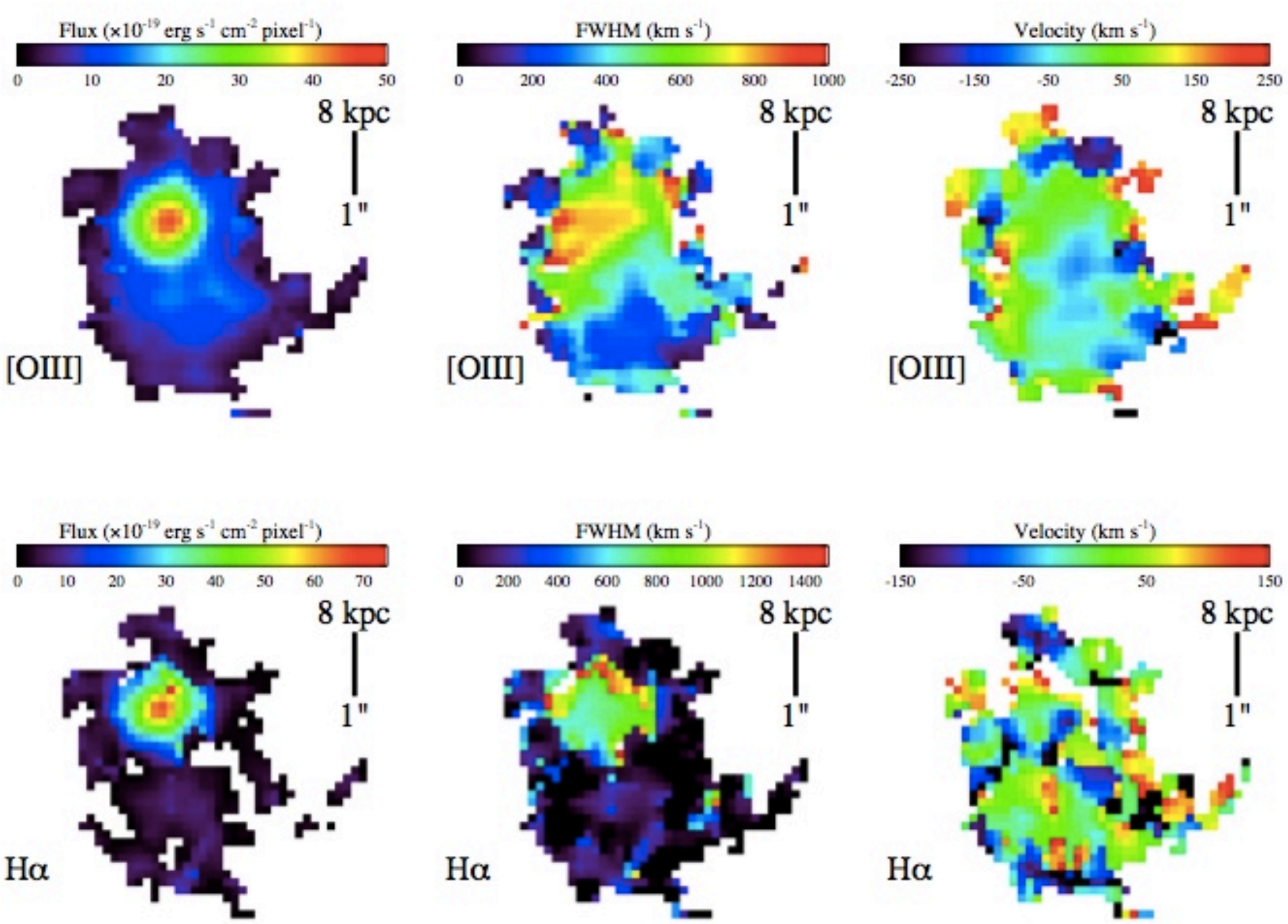






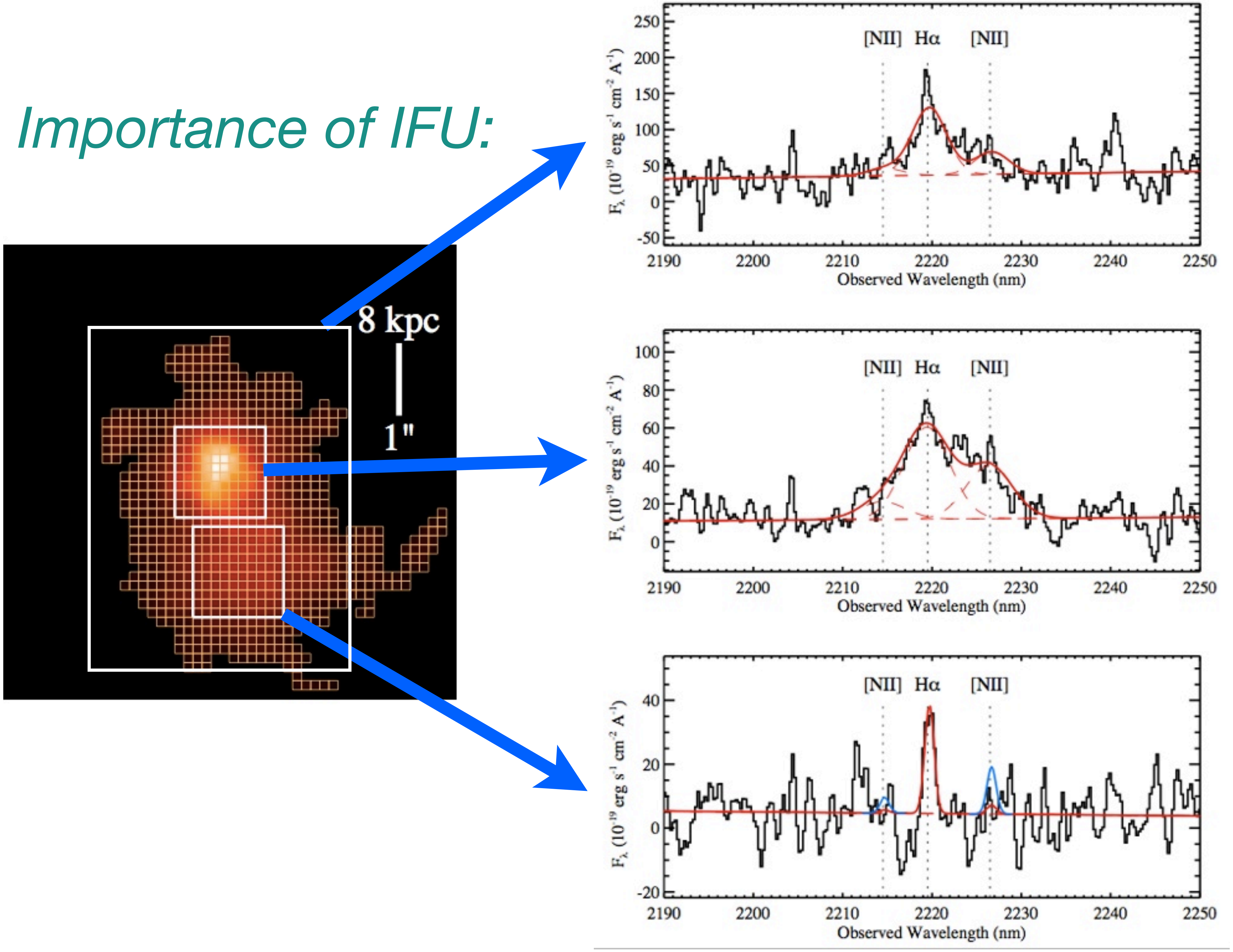
- one of first blobs to be discovered, and one of the biggest and brightest
- ~18 yrs of investigation, no obvious power source was found
- AGN? Star formation? Lyα cooling radiation from cold flows?

- one of the lowest redshift LABs, access to optical diagnostics in NIR
- just 4 hrs in each of J,H,K with VLT/SINFONI (non-AO) solved the mystery



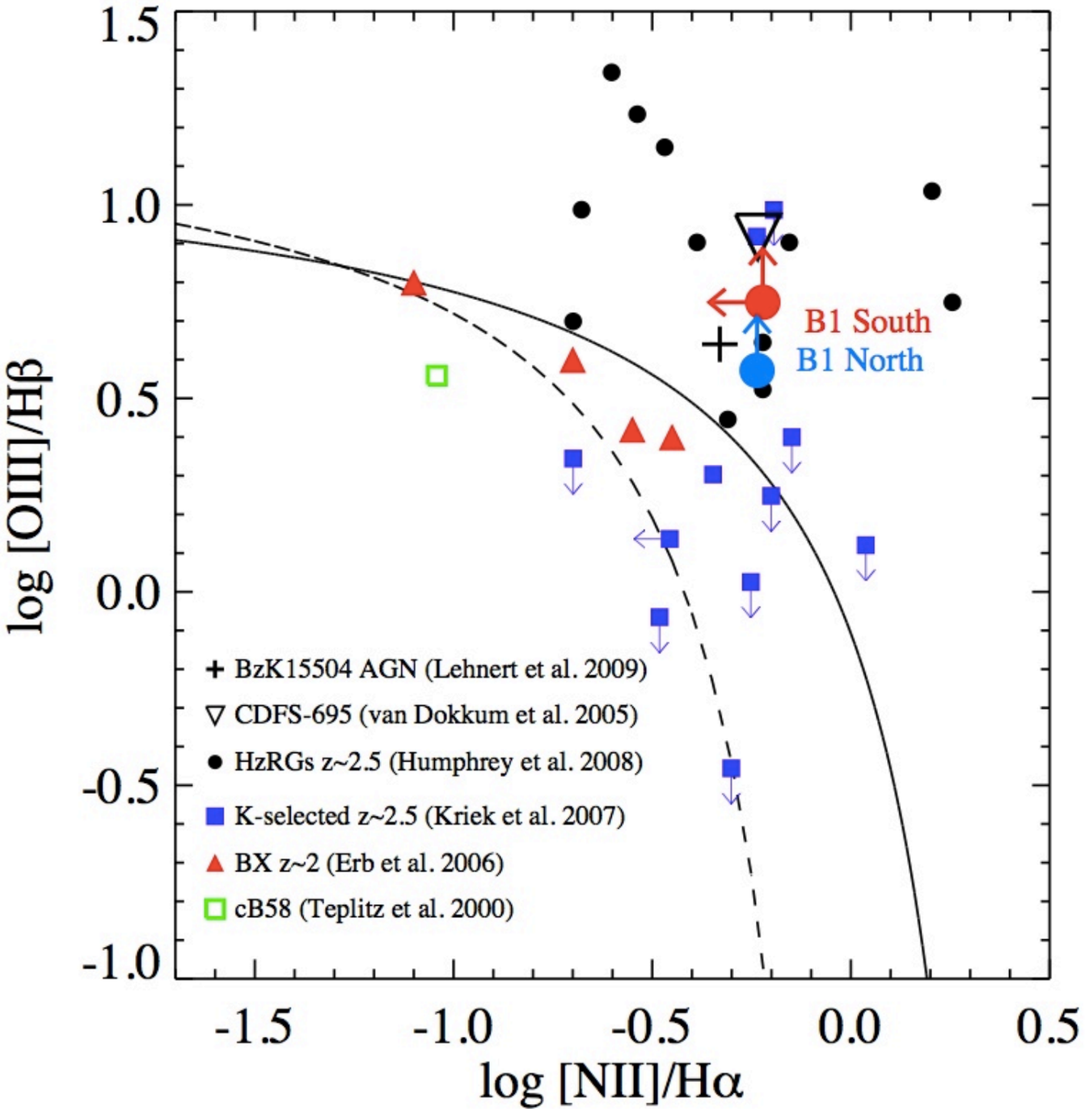
Overzier et al. 2013

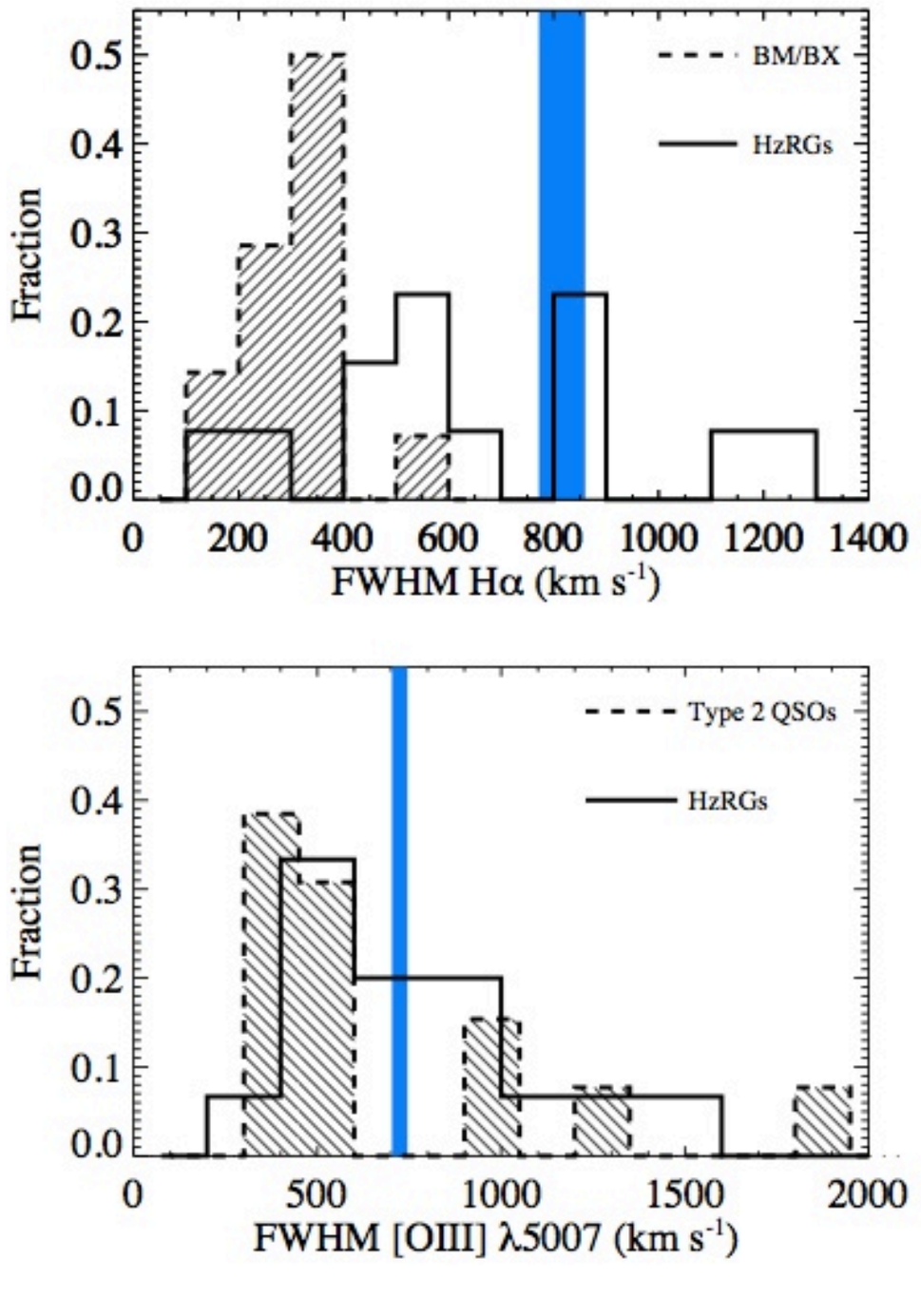
Importance of IFU:



Overzier et al. 2013

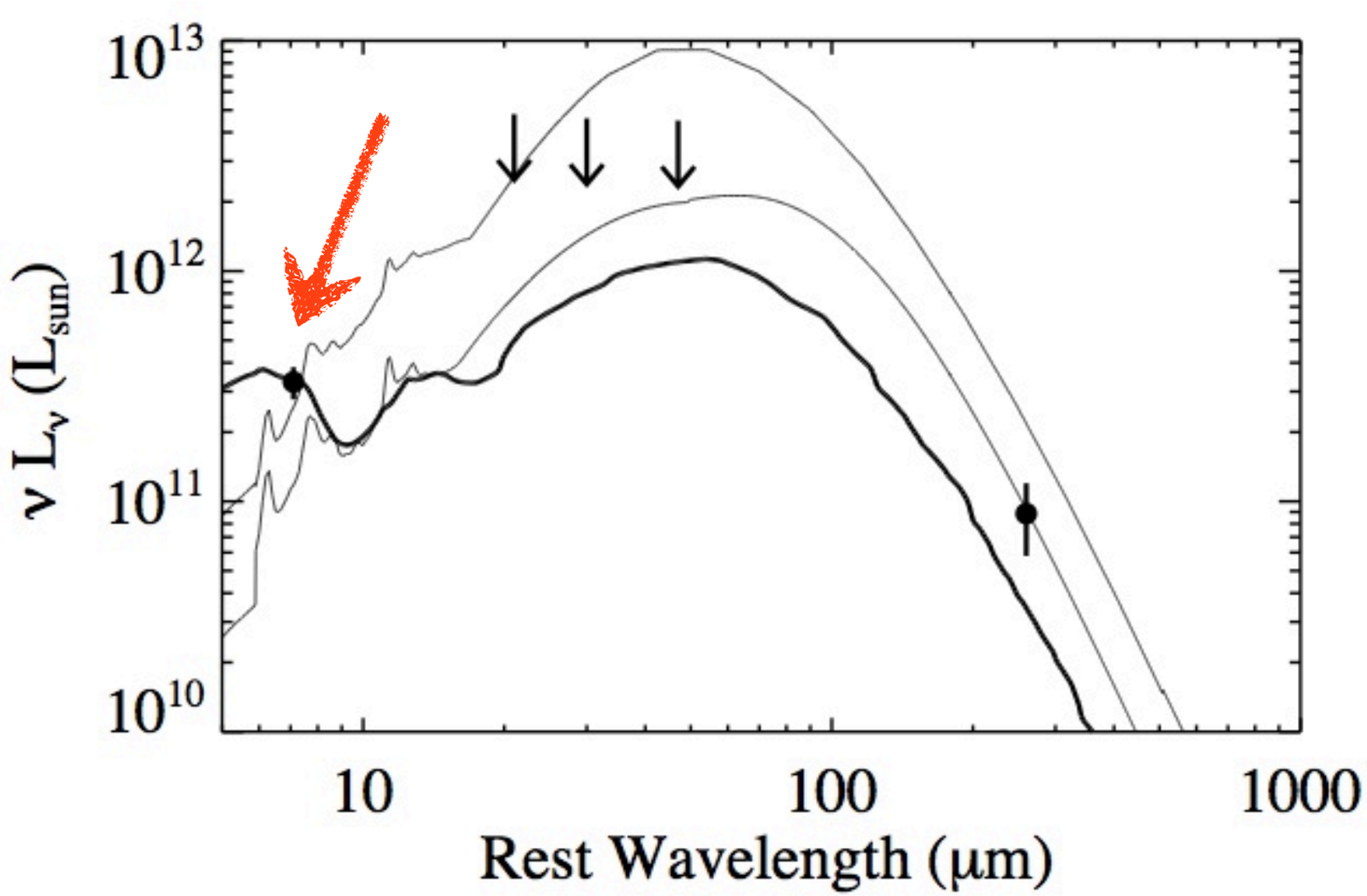
- BPT diagram clearly suggests that B1 is photo-ionized by an AGN
- narrow lines of ~800 km/s very similar to radio galaxies and Type II quasars





Overzier et al. 2013

- Herschel/PACS upper limits rule out previous claims of a hyperluminous obscured starburst (>1000 Msun/yr)
- mid to far-IR spectrum more like that of typical Type II AGN



Extinction-corrected [OIII] luminosity suggests a hidden AGN of $L_{bol,AGN} \sim 3 \times 10^{46}$ erg/s and $L_{ion} \sim 4 \times 10^{45}$ erg/s: **easily capable of powering the $L_{Lya} \sim 10^{44}$ erg/s observed in B1** (outshining any SF or cooling radiation)

Overzier et al. 2013

A census of Lyα blobs (see Overzier et al. 2013)

ID	Redshift	$\log L_{Ly\alpha}$ (erg s^{-1})	size[a] (kpc)	Notes[b]	References[c]
			Lyα blobs		
SSA22–Sb1–LAB1	3.10	44.0	175	(Type II AGN; detected in X-ray stack)	G09
SSA22–Sb3–LAB1	3.10	44.3	126	RQ-QSO; broad lines	S07, M11
LAB1709+5913	2.83	44.3	95	–[d]	Sm07, Sm08
SST24J1434110+331733	2.66	44.2	160	Type II AGN; narrow C IV, He II, power-law SED	D05
AMS05	2.85	44.2	80	Type II AGN; strong 24 μm	Sm09
LAB1_J2143–4423 (B1)	2.38	43.9	137	Type II AGN; narrow C IV, BPT	F96, C06, C11, This paper
CDFS-LAB01	2.3	43.9	60	(Type II AGN; narrow C IV, He II)	Y10, Y11
LAB6_J2143–4423 (B6)	2.38	43.8	64	Type II AGN; narrow He II, power-law SED	Sc09,C11
LAB5_J2143–4423 (B5)	2.38	43.8	56	–[d]	C11
SSA22–Sb1–LAB2	3.09	43.8	157	Type II AGN; X-ray	BS04
SSA22–Sb6–LAB1	3.10	43.8	166	–[d]	M11
SSA22–Sb1–LAB3	3.10	43.7	103	Type II AGN; X-ray	G09
GOODS-N–LAB1	3.08	43.7	124	RQ-QSO; broad lines, X-ray	B02, M11
53W002-Object 18	2.39	43.7	>40	Type II AGN; narrow N V, C IV, He II	P96, K99
Yang–LAB3	2.32	43.7	61	Type I AGN; broad C IV, X-ray	Y09, G09
PRG1	1.67	43.7	56	(Type II AGN; narrow C IV, He II, C III)	P09

High-z Radio Galaxy Lyα halos

log $L_{Ly\alpha}$ ~ 43-45 erg/s

Size ~ 30-250 kpc

High-z Quasars Lyα halos

RL/RQQs at z ~ 2-4

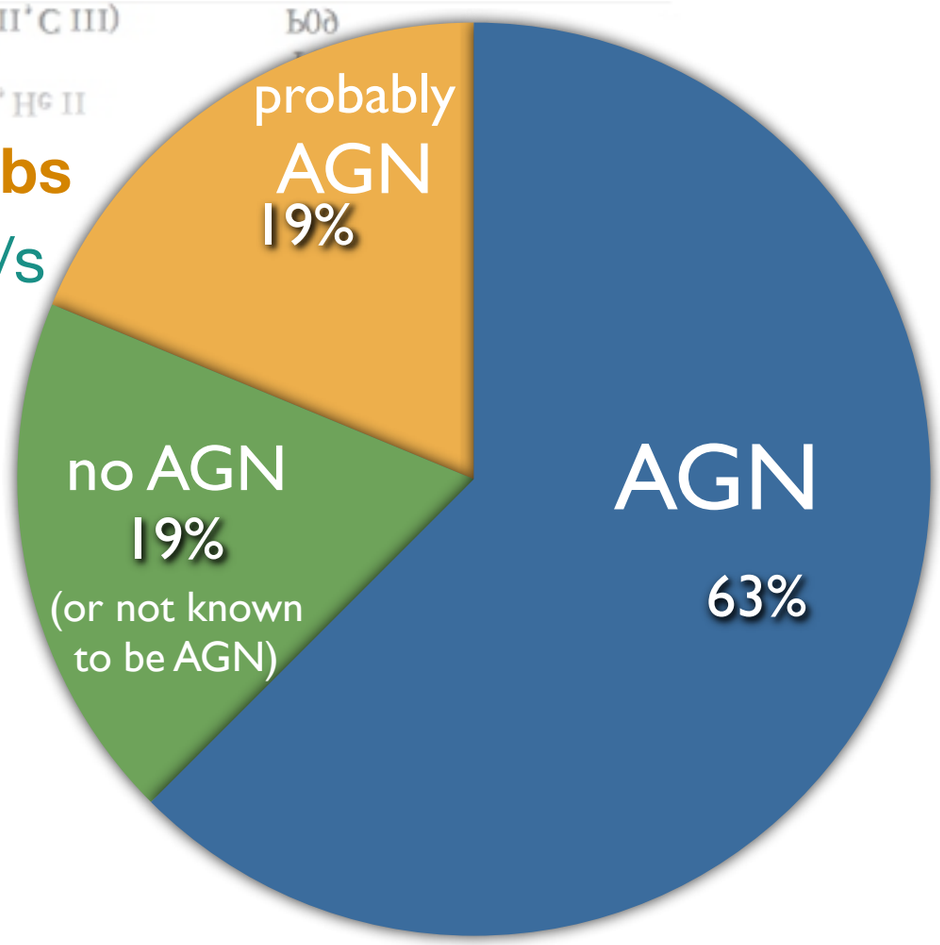
log $L_{Ly\alpha}$ ~ 44 erg/s

Size ~ 50-100 kpc

Lyα blobs

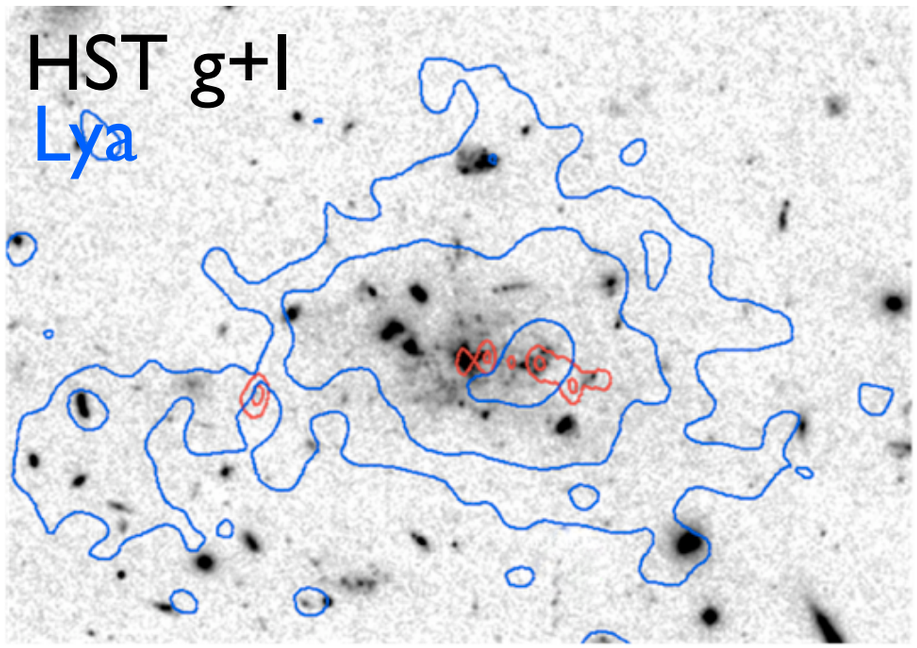
log $L_{Ly\alpha}$ > 43.7 erg/s

Size ~ 30-200 kpc

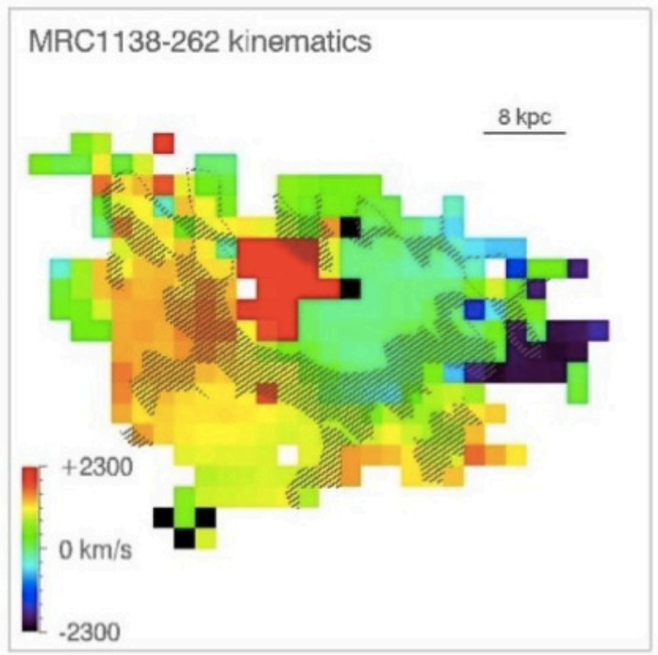


Is the gas inflowing, outflowing, stationary ???

MRC1138, z=2.2

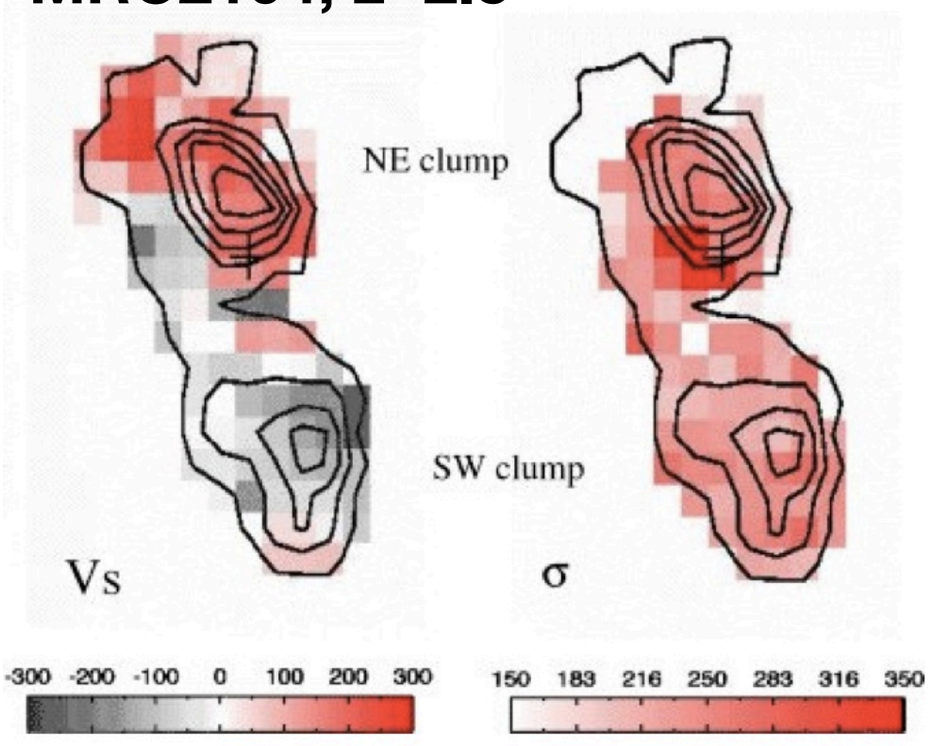


Miley et al. 2006

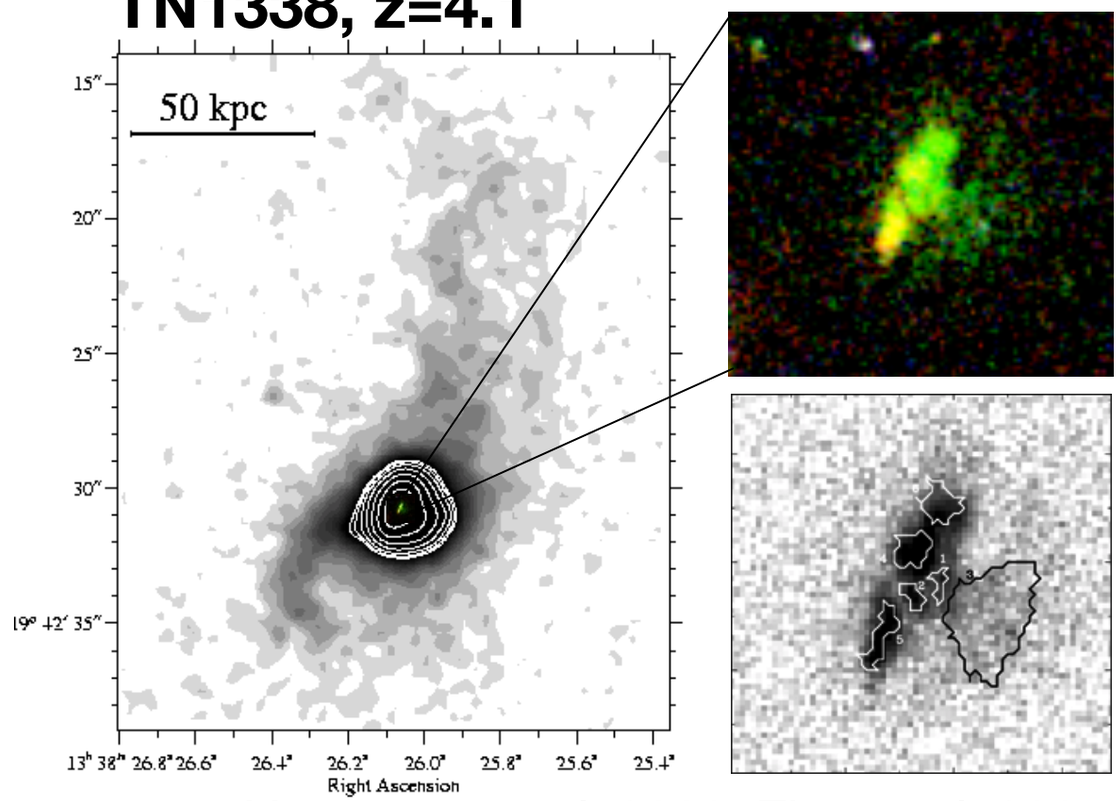


Nesvadba et al. 2007

MRC2104, z=2.5

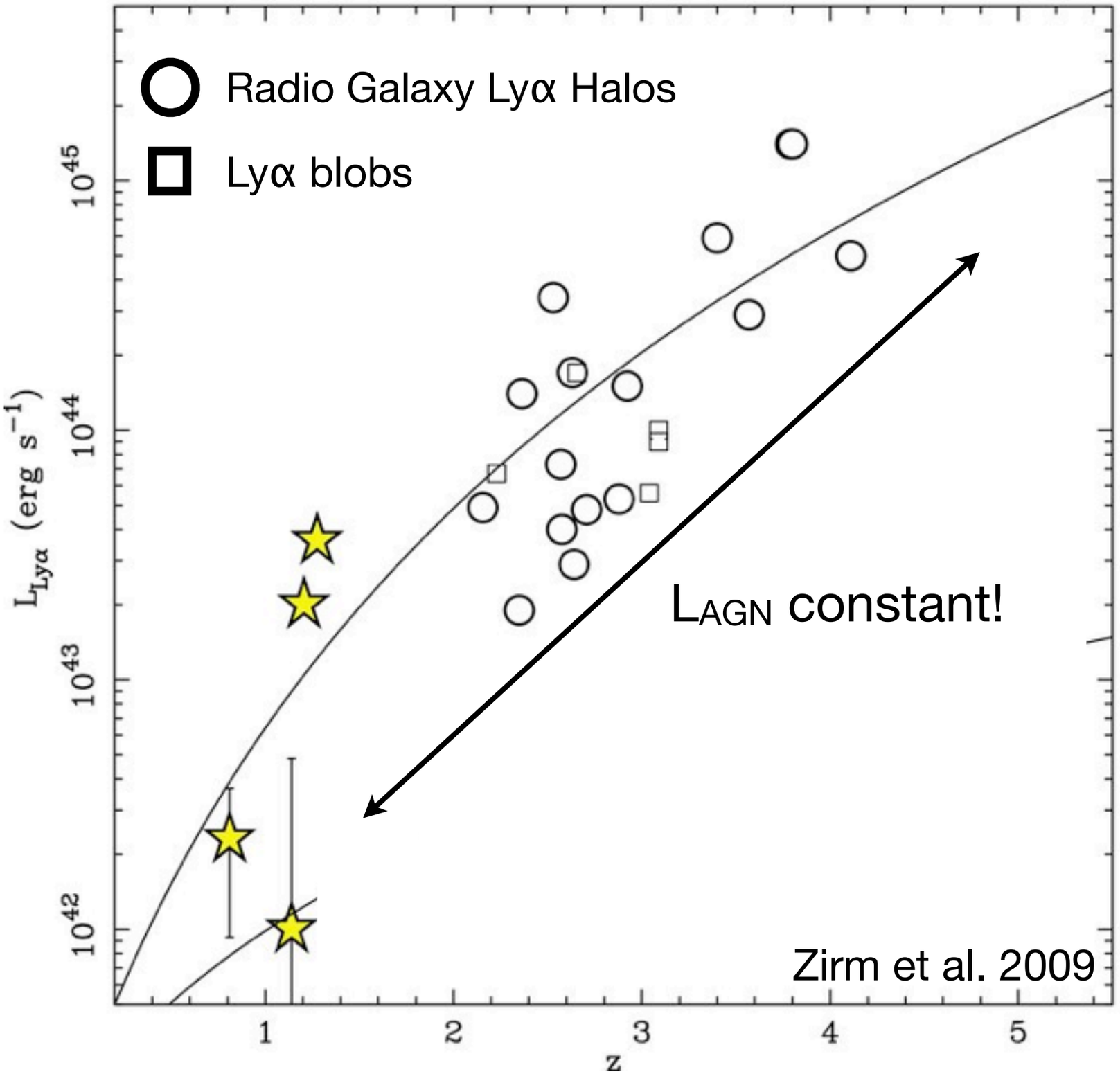


TN1338, z=4.1

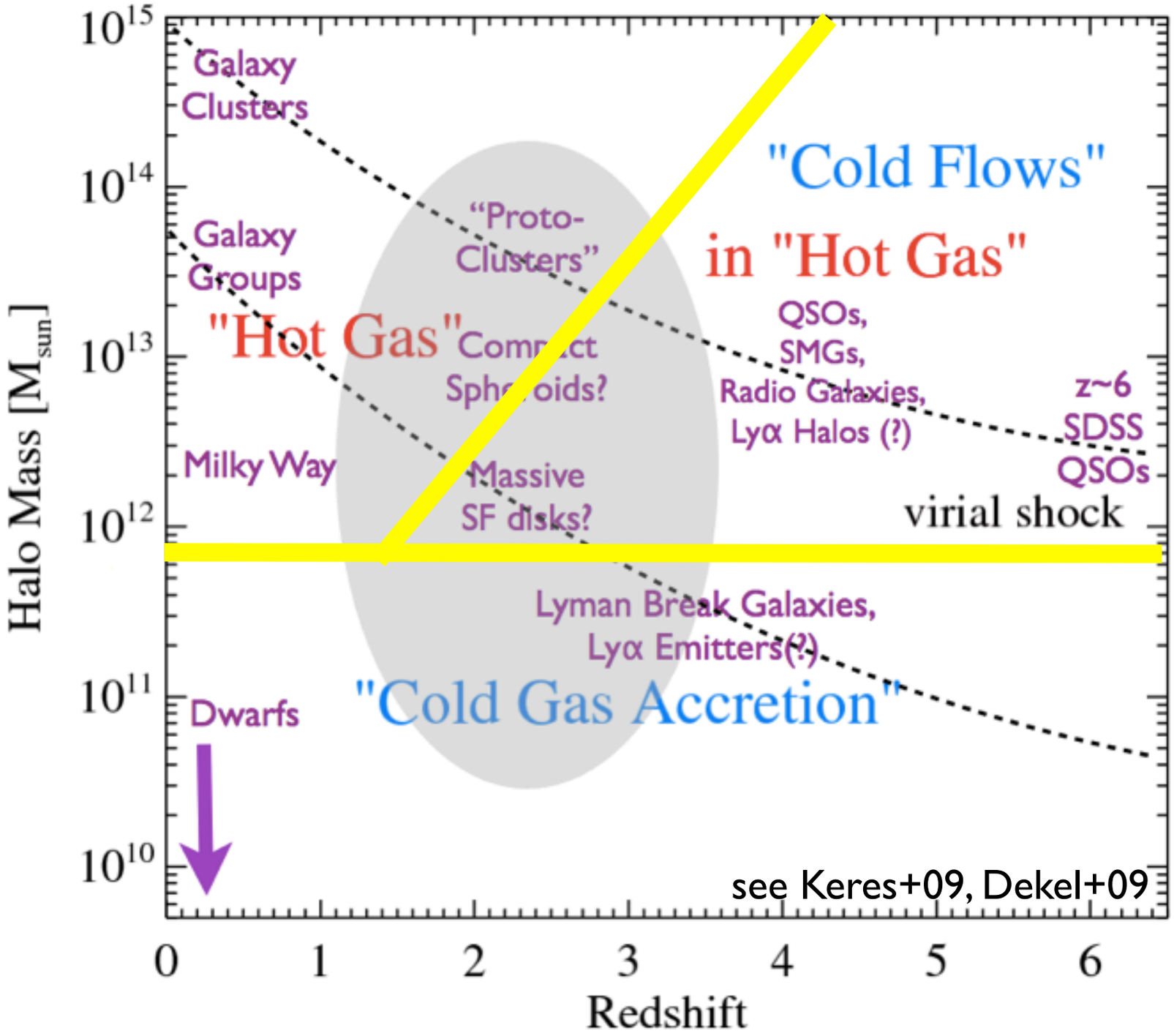


Venemans et al. 2002, Zirm et al. 2005

- apparent redshift evolution in the sizes and luminosities of Lyα halos
- disappearance of extended Lyα halos related to formation of the hot intra-cluster medium (?)

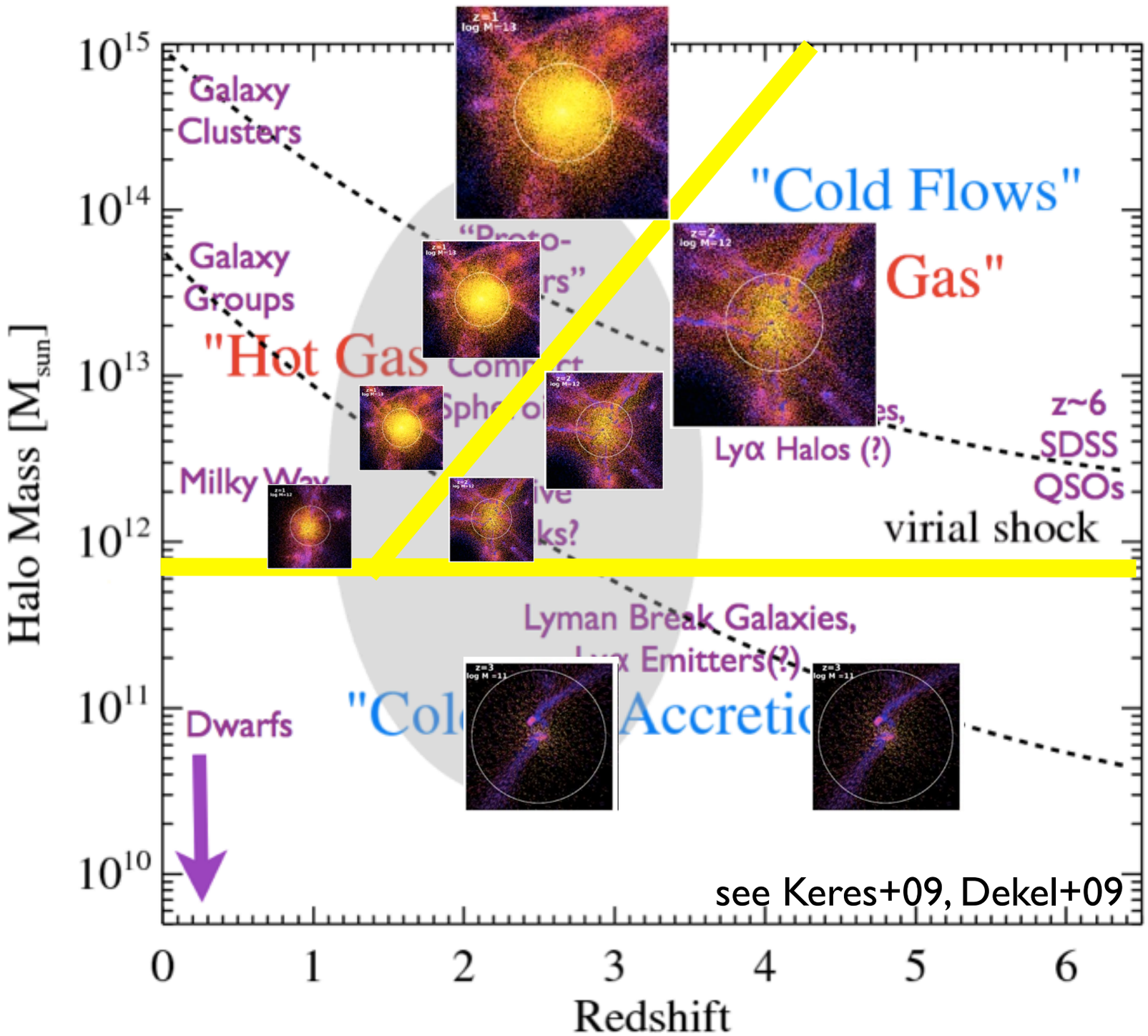


The Missing Ingredient: What is the underlying gas accretion process?



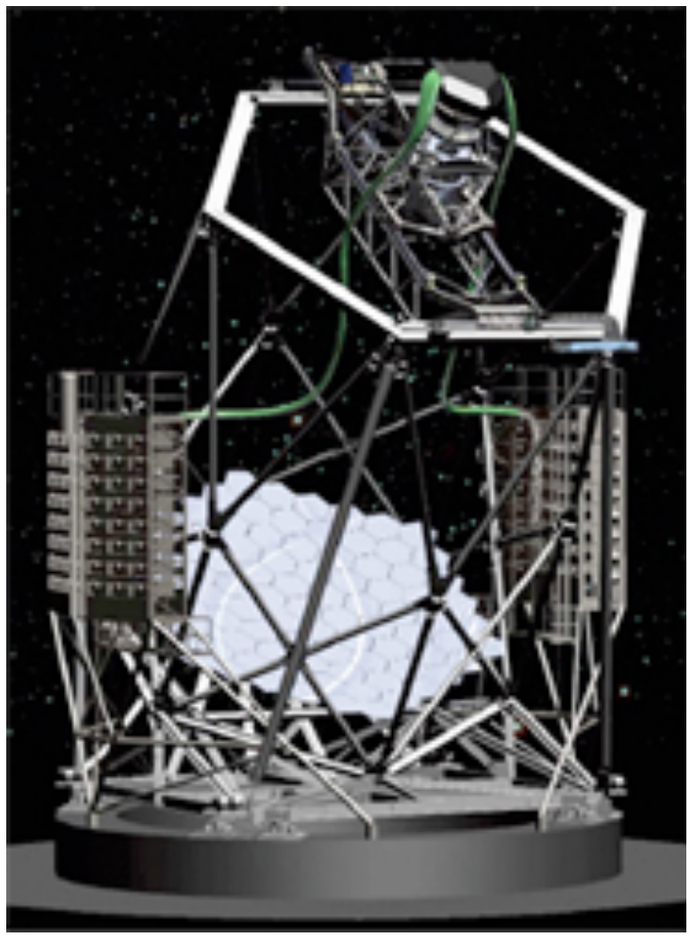
<u>Overdense regions</u> should be the first to transition from the “free-flowing” regime to the “shock-heated” regime

The Missing Ingredient: What is the underlying gas accretion process?

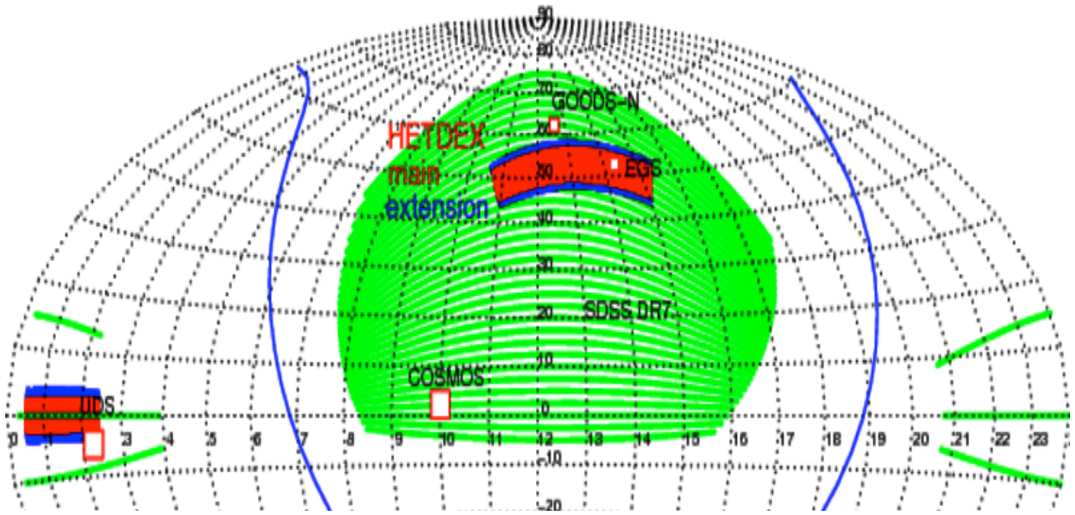


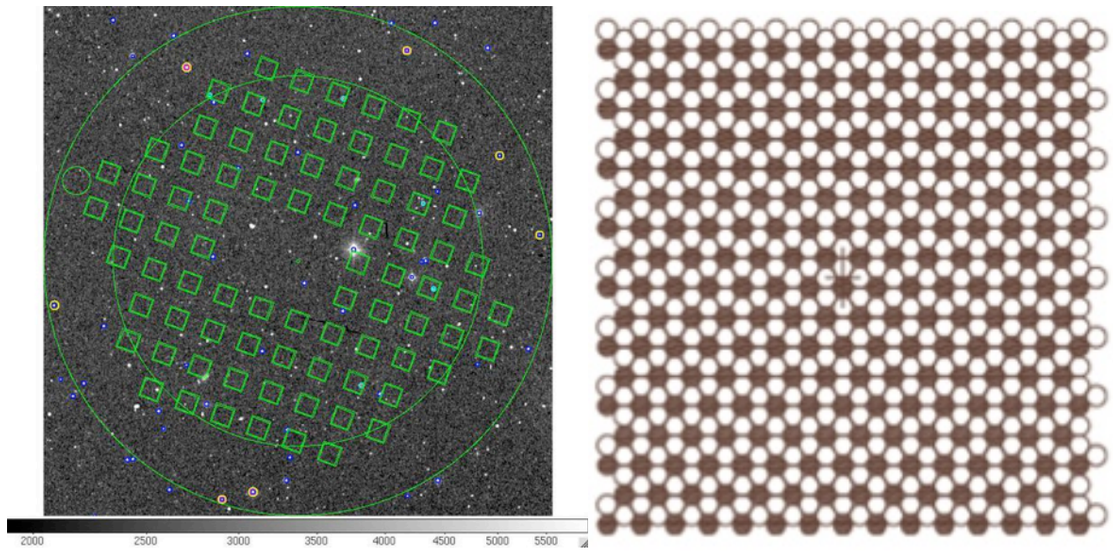
Overdense regions should be the first to transition from the “free-flowing” regime to the “shock-heated” regime

Hobby-Eberly Telescope Dark Energy Experiment (HETDEX, ~2014-2017)



PI: Gary Hill / Karl Gebhardt
(University of Texas)



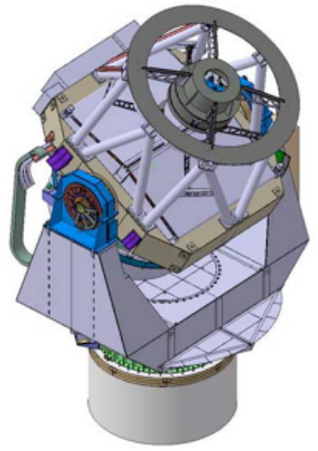


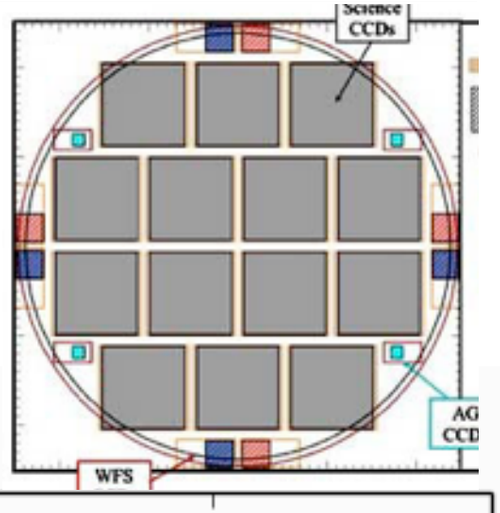
22 arcminutes

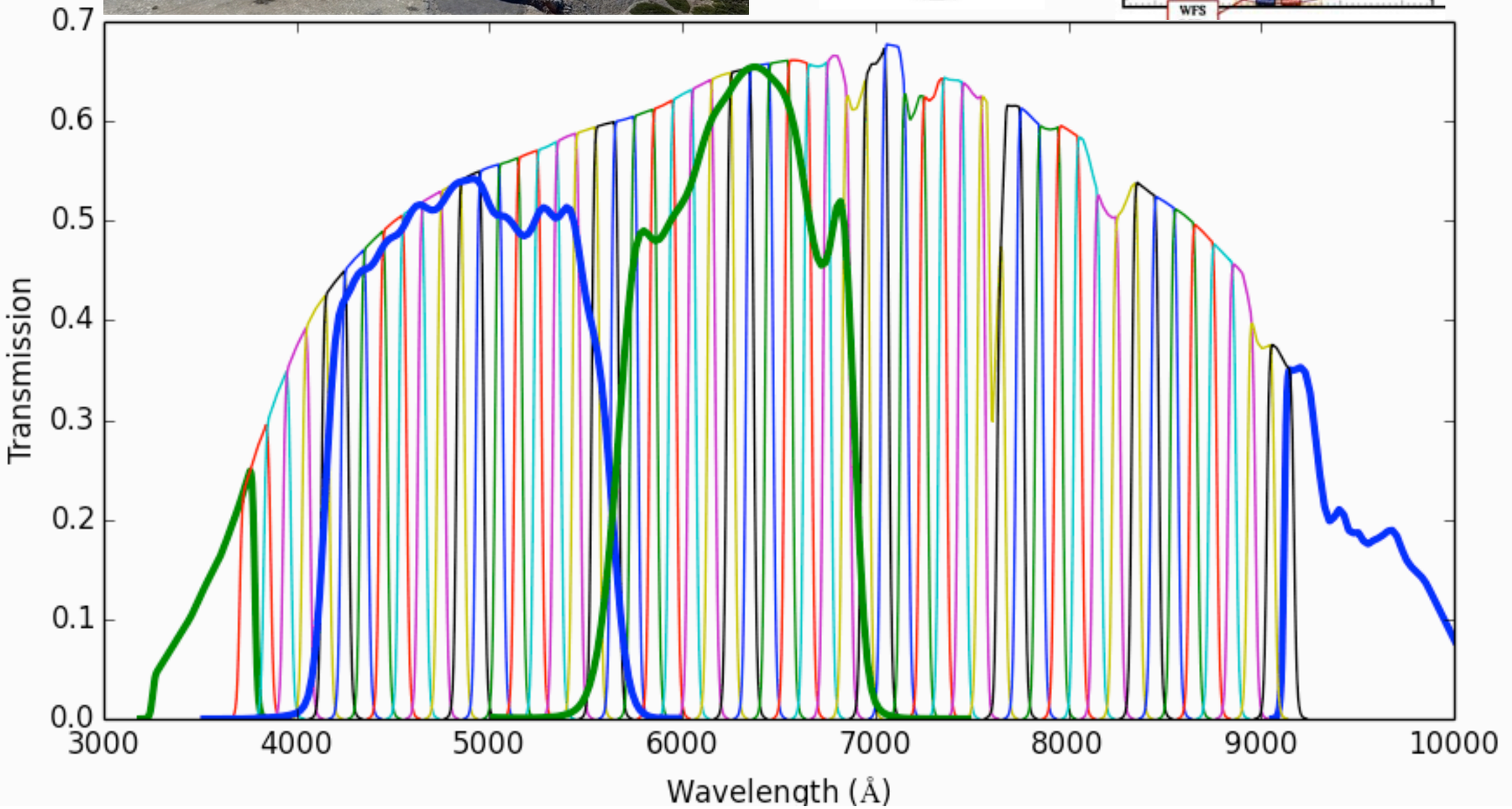
- One million Lyα emitting galaxies at z=2-4
- Perfect for finding **all** the halos, independent of radio/QSO/NB selection + environment for free

Javalambre
Physics of the Accelerating Universe
Astrophysical
Survey

J-PAS



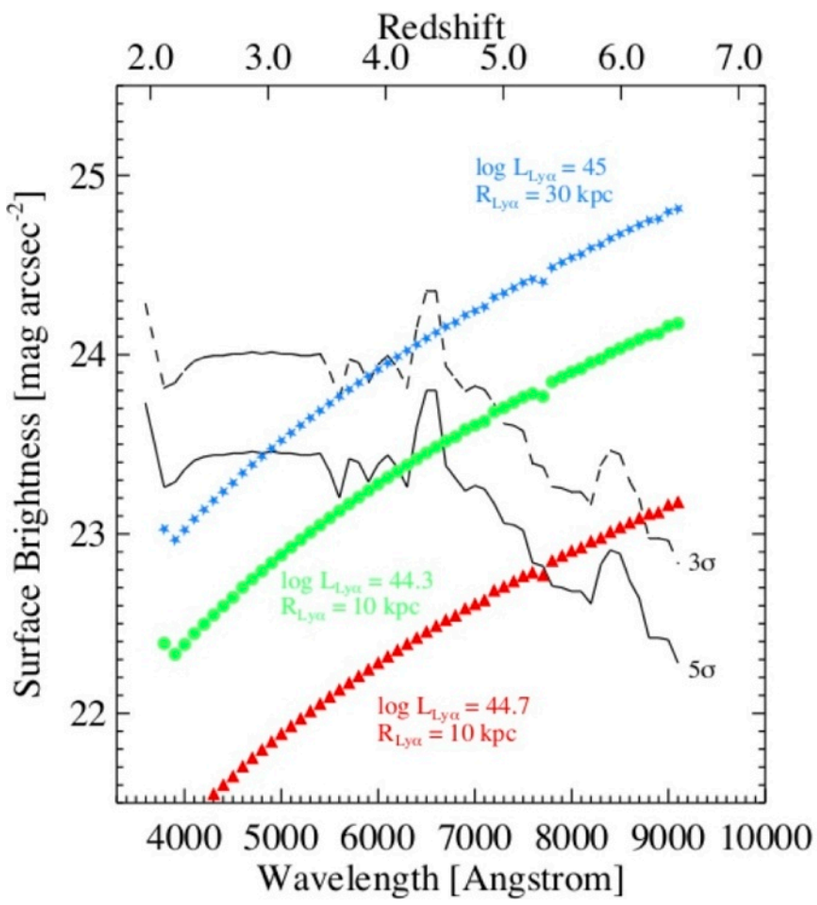


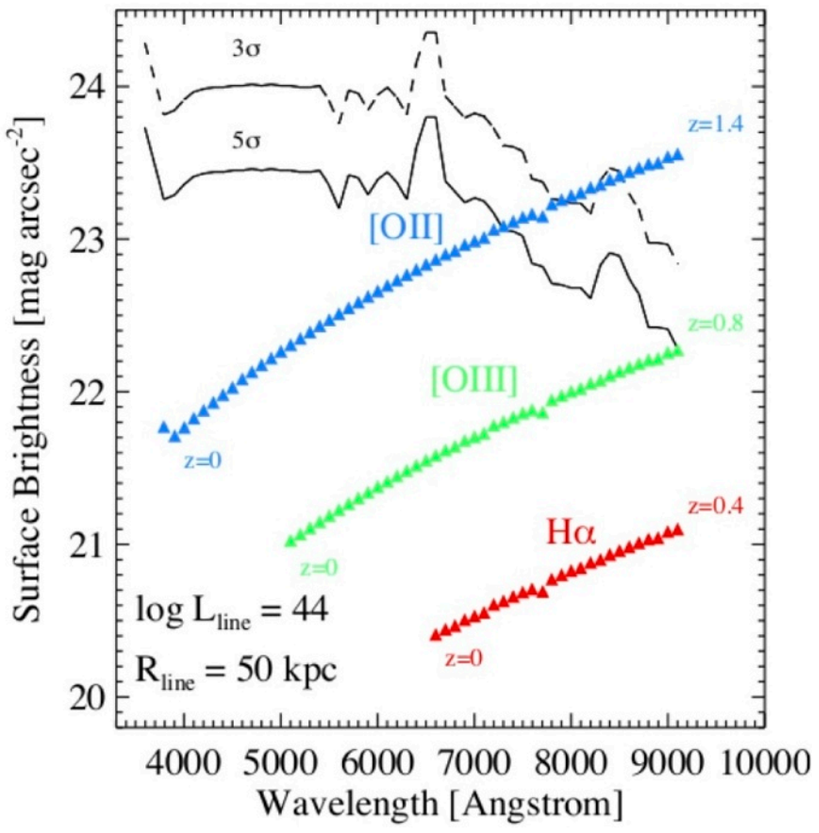


J-PAS Galaxy Evolution Survey

coord: Javier Cenarro (CEFCA), RO (ON)

- J-PAS will cover ~8500 deg^2 with 52 narrow-band filters
- Will detect the brightest Lyα halos at z = 2-3
- Will unbiasedly detect all luminous extended halos in [OII] (z<1.4), [OIII] (z<0.8), or Ha (z<0.4)





Summary

- contrary to popular belief, Lyα blobs are highly similar to the Lyα halos of radio galaxies and radio-loud and radio-quiet quasars (e.g. in terms of power, ionization, velocity, size, metallicity)

- like radio galaxies and quasars, in virtually all Lyα blobs, the Lyα is powered by an (obscured) quasar, as opposed to gravitational heating/cooling predicted by the popular cold flow models and/or star formation

- the connection between these enormous Lyα structures and the IGM is still unclear, but they might still offer powerful ways for probing the evolution of cosmological gas accretion and massive galaxy formation

- the empirical relation between Lyα blobs and dense environments observed must be a relation between luminous AGN and environment (or massive galaxy formation and environment)

- promising new surveys (e.g. HETDEX, J-PAS, PFS)

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information: overzier@on.br