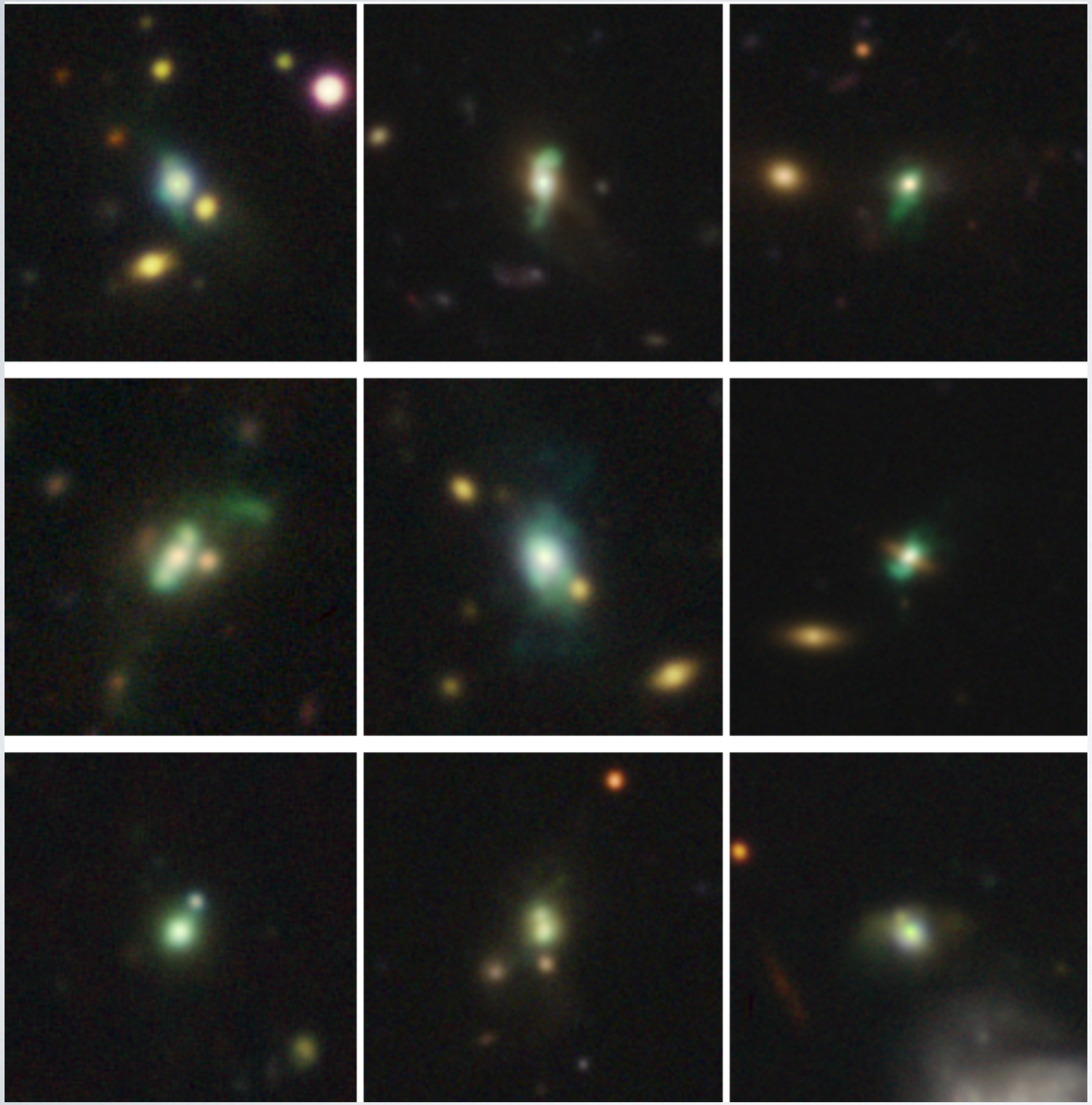

Hiding in Plain Sight
AGN Echoes of Low-Redshift Lyman Alpha Blobs

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Hiding in Plain Sight

AGN Echoes of Low-Redshift Lyman Alpha Blobs

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Mischa Schirmer

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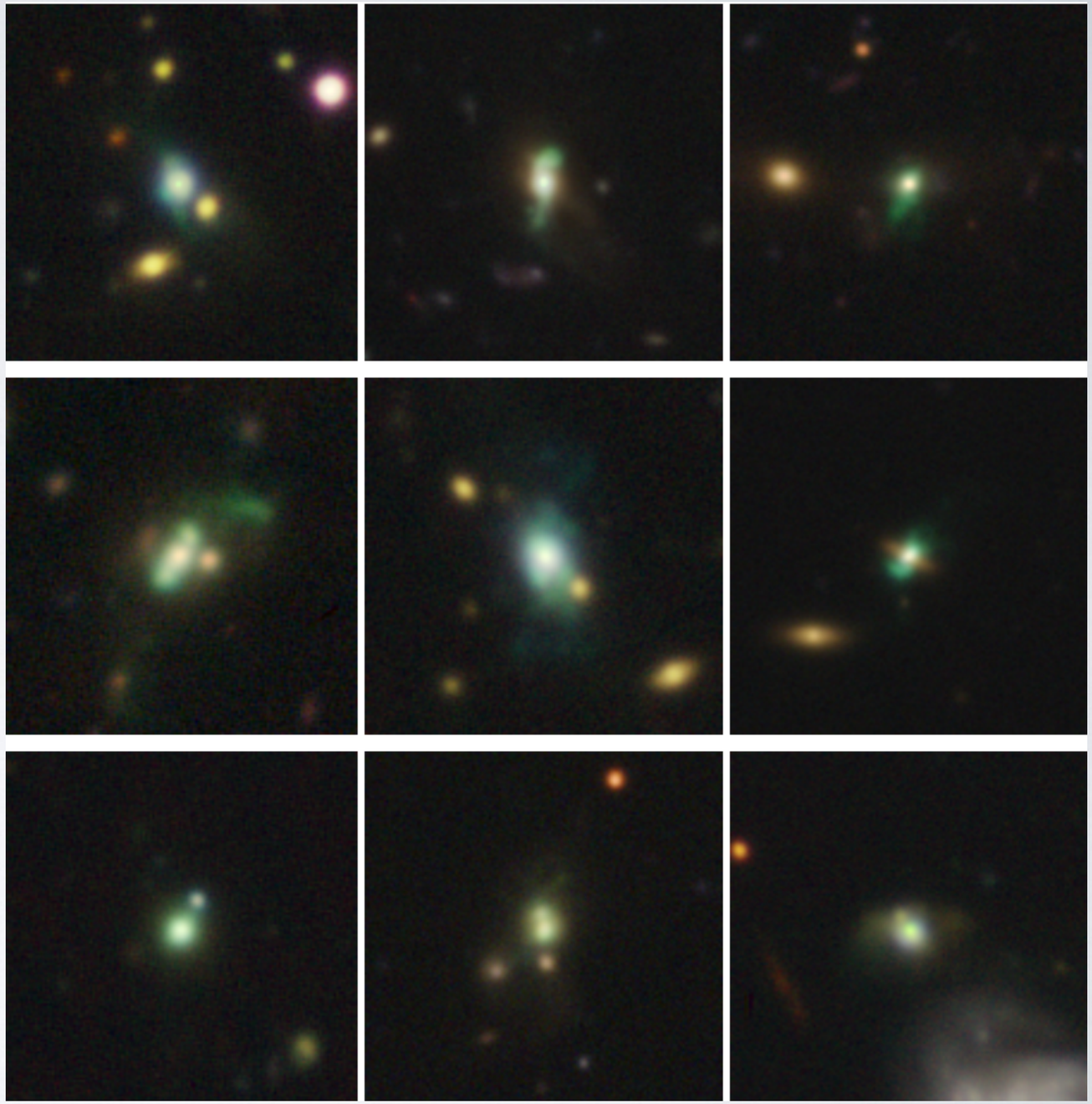
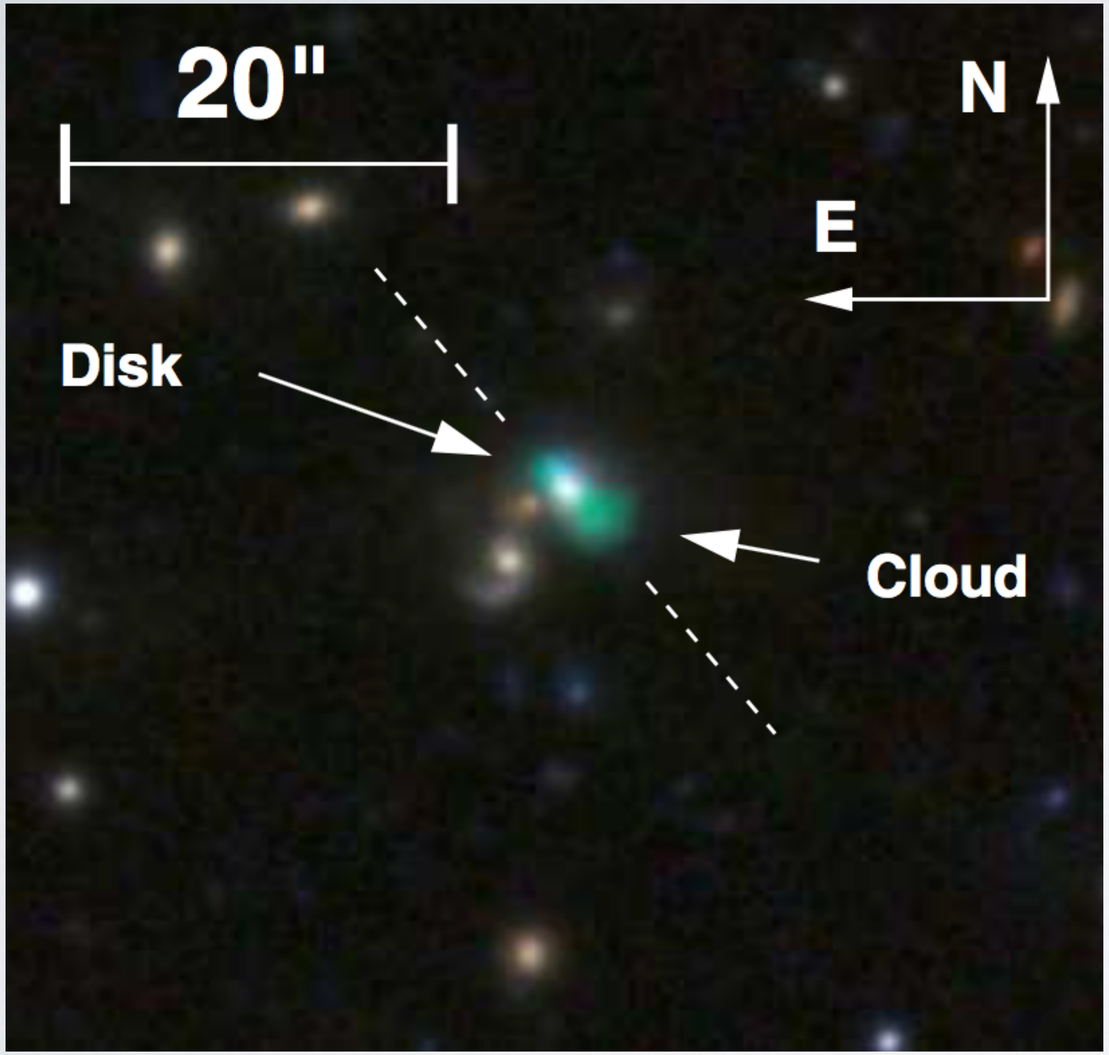
take-home themes

- AGN duty cycle
- Lyman alpha blobs in the local Universe



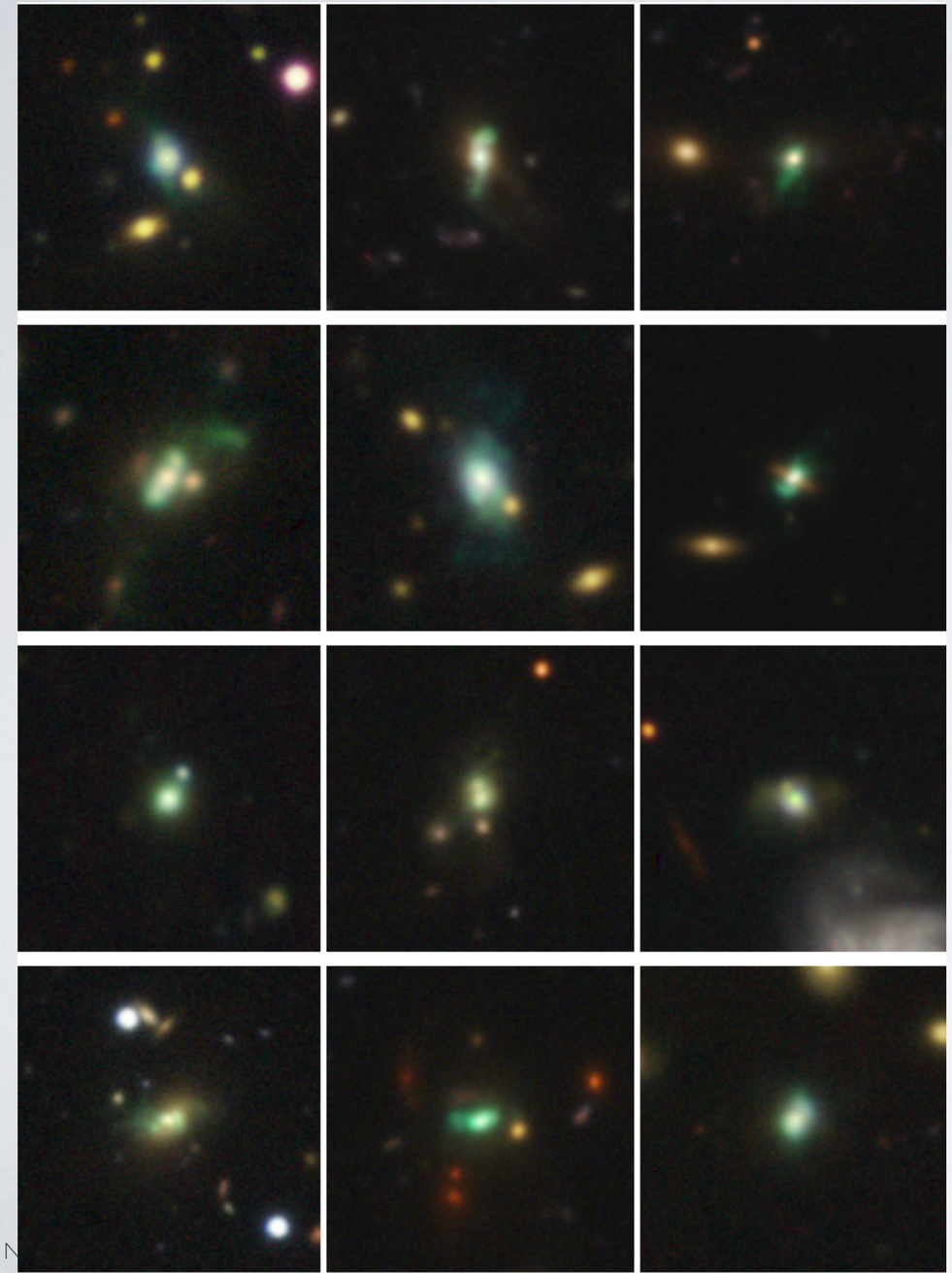
discovery of [OIII] luminous, extended emission



Schirmer+ 2013

- CFHT/Megaprime *gri* image
- $z = 0.326$
- 8 x 18 kpc cloud extent
- green colors, similar to "green peas" but larger
- [O III] luminosity = 5.6 x 10^{43} erg/s
- extended narrow-line region
  AGN diagnostic line ratios in spectrum

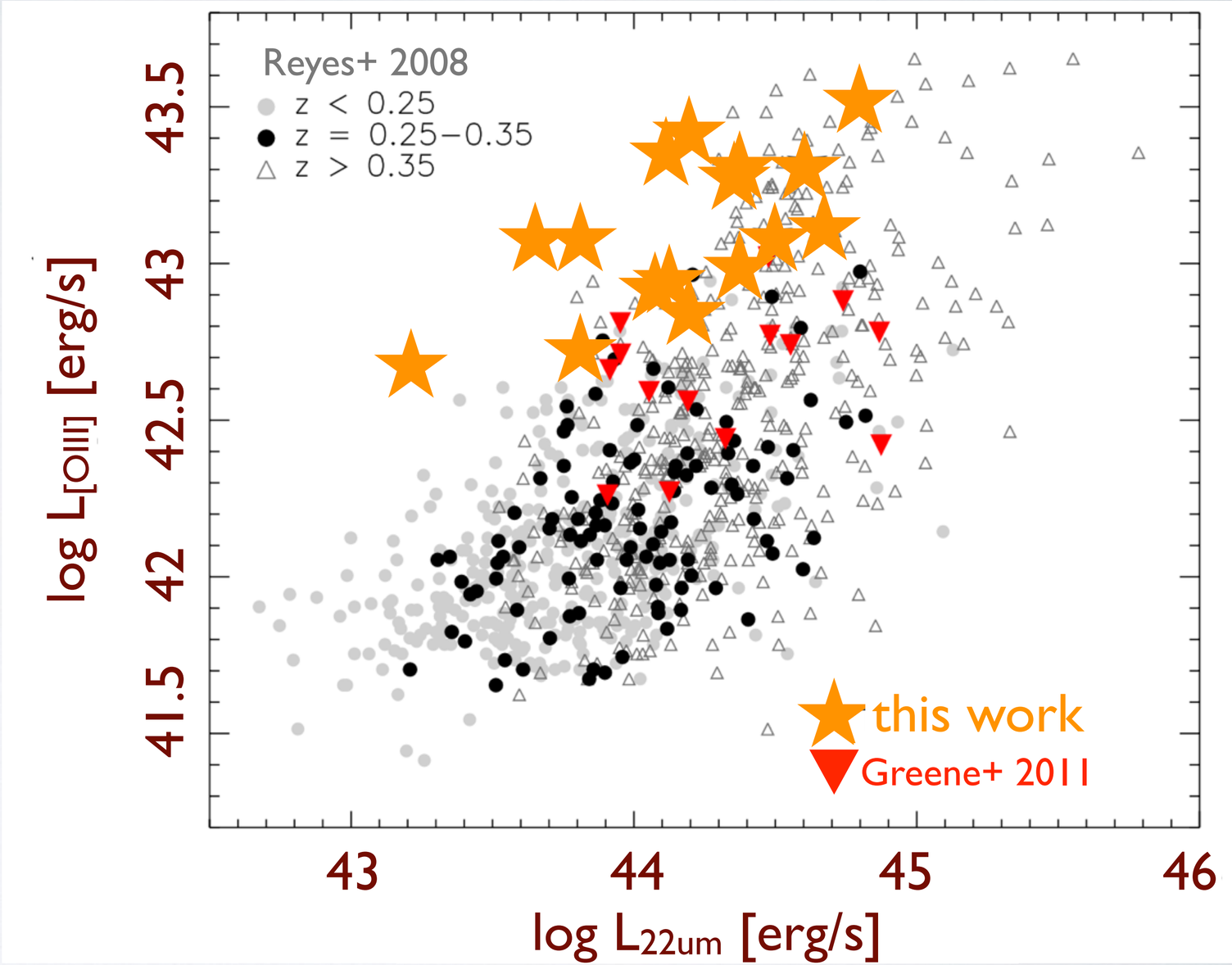
sample of 17 objects



- selected in SDSS for color and size
- spectroscopy to confirm AGN nature and luminous [O III] ($\gtrsim 10^{43}$ erg/s)
- galaxy-scale emission line regions
  15–20 kpc
- $z \sim 0.3$
  sensitive to $z = 0.12$,
  but lowest $z = 0.19$
- typically radio quiet
- **rare**
  1 per 1000 deg^2
- not viewing AGN continuum directly

under-luminous in MIR compared with [O III]

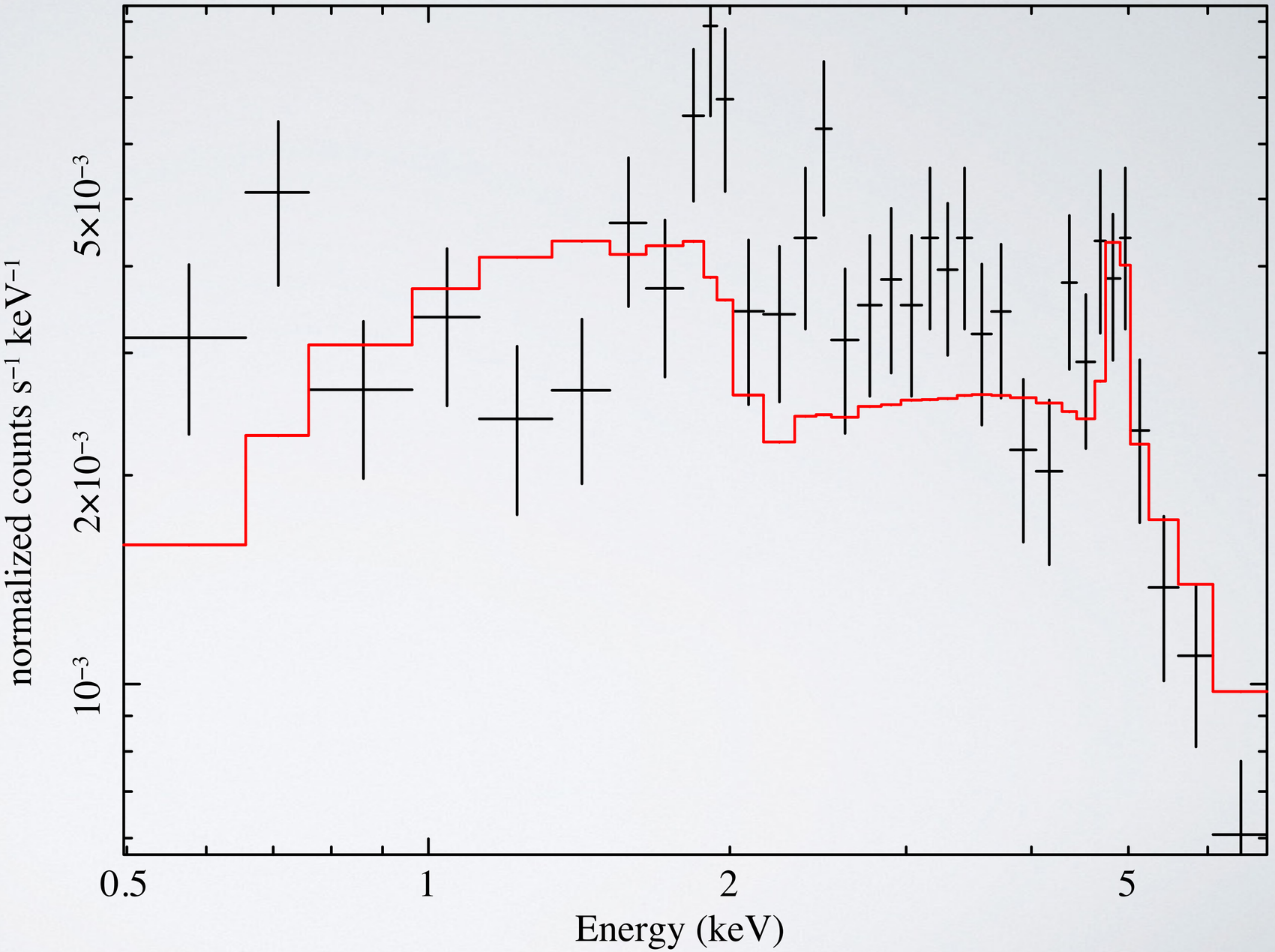
still mid-infrared luminous



Schirmer+ 2013

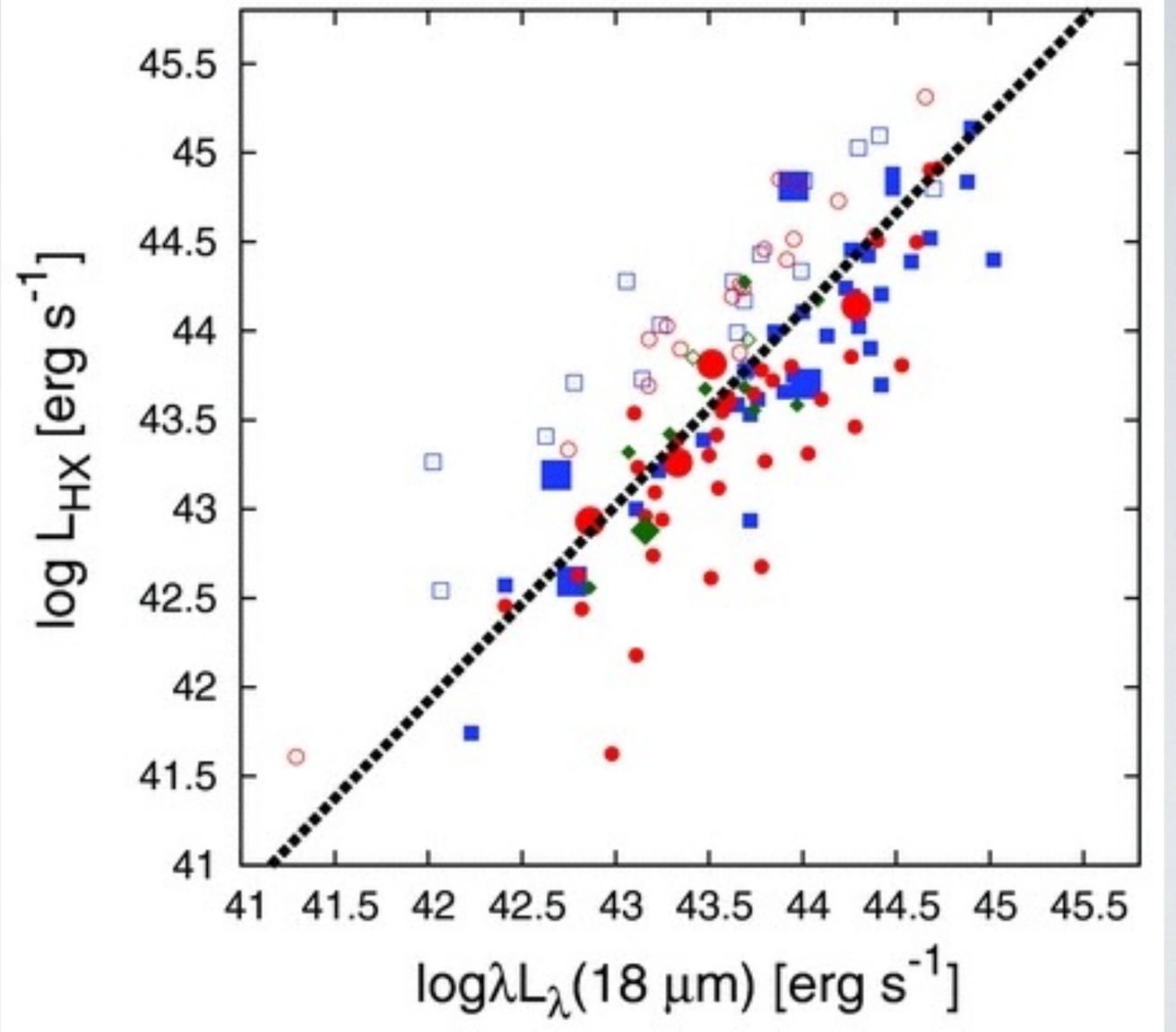
one example in the Chandra archive

- Compton thick
- strong Fe Kα line
- flat continuum (reprocessed)



new Chandra observations of 10 galaxies

- predicted X-ray flux based on IR-X-ray correlation
- considered possibility of Compton thick to set exposure times
- all galaxies detected, but faint
  10–20 times weaker than predicted
- no significant spectroscopy possible typically flat hardness ratios



Ichikawa+ 2012

AGN power source, with unusual features

properties

- **[O III]**: extremely luminous
- **IR**: luminous, but lower than usual [O III] relations
- **X-ray**: faint

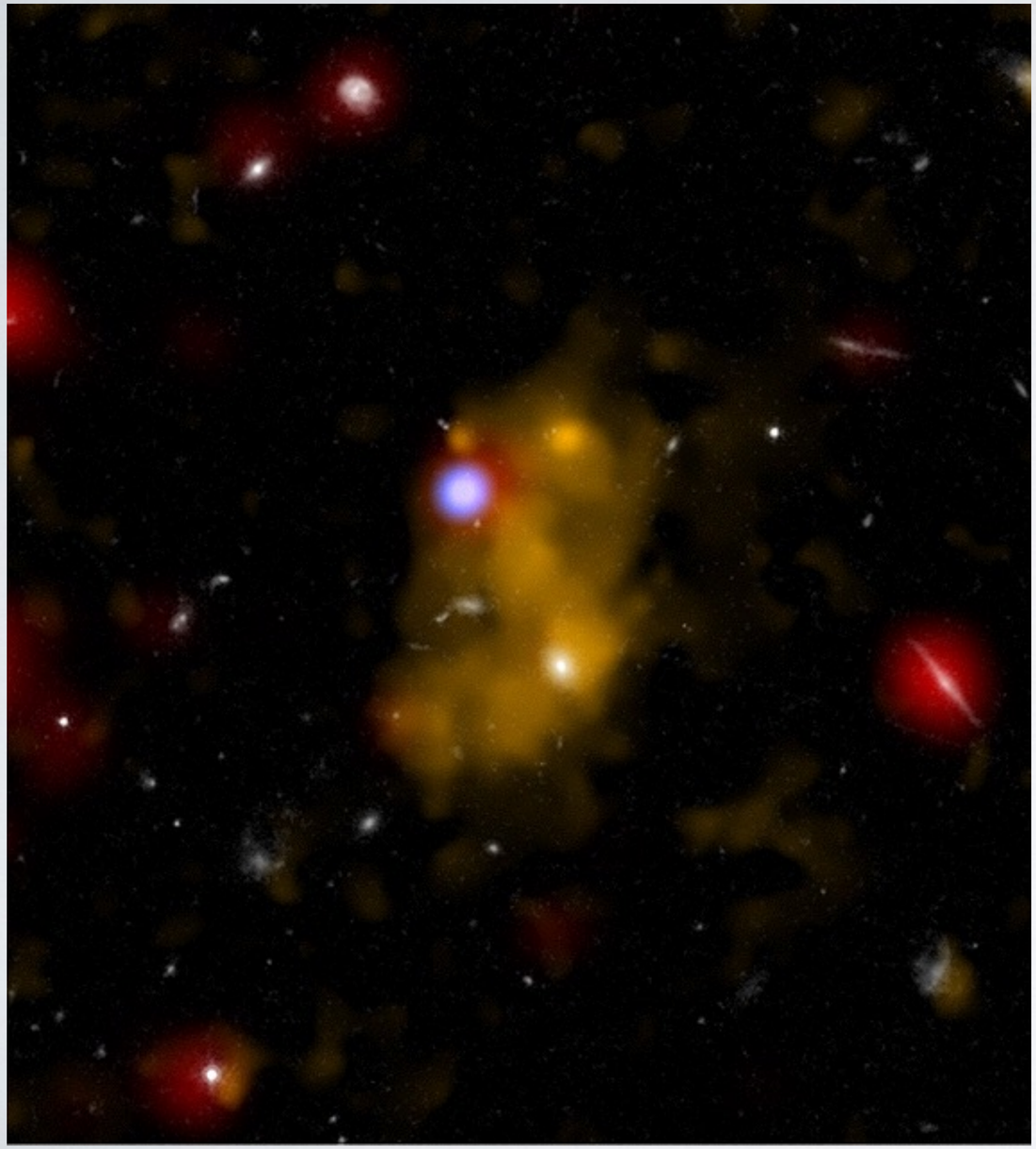
response timescale

- light-crossing time $>10^4$ years
- thermal response $\sim 10^3$ years
- ~intrinsic

AGN duty cycle

thermal + ionization echoes:
AGN faded by factors of 10^3–10^4
over last 10,000 to 100,000 years

high-z Lyman alpha blobs



CXC, Geach+ 2009

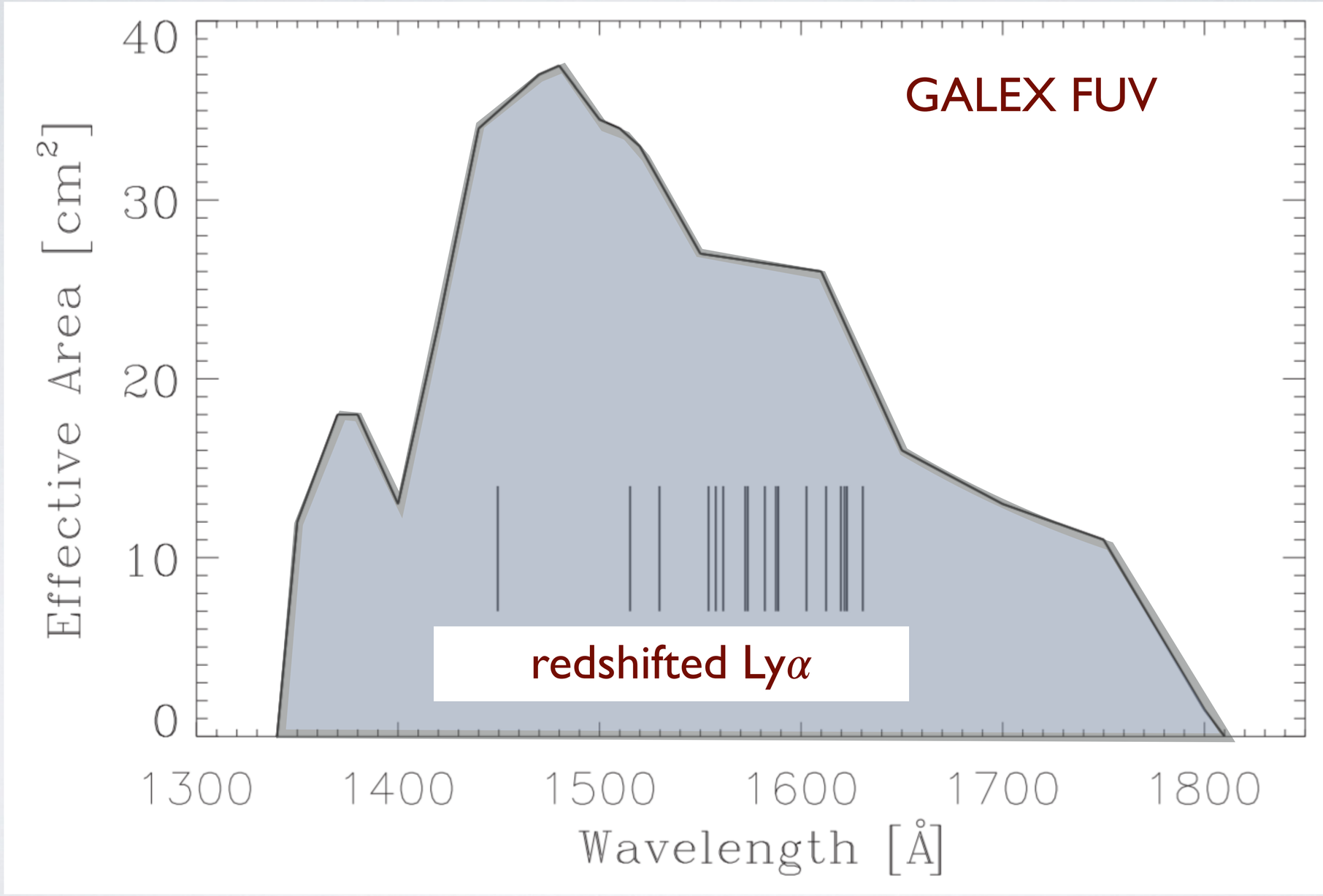
- typical Lyα luminosity 10^{42} – 10^{44} erg/s
- 20–200 kpc scales
- $z \gtrsim 2$

  direct optical detection of rest-frame Lyα
- sites of massive galaxy formation
- ionization escapes host

What is the ionizing source?

- (buried) photoionization – AGN or starburst?
- shock – starburst superwind?
- collisional – collapse of dark matter haloes?

Lyman alpha in GALEX band



Lyman alpha detected and strong

14/15 observed sources detected

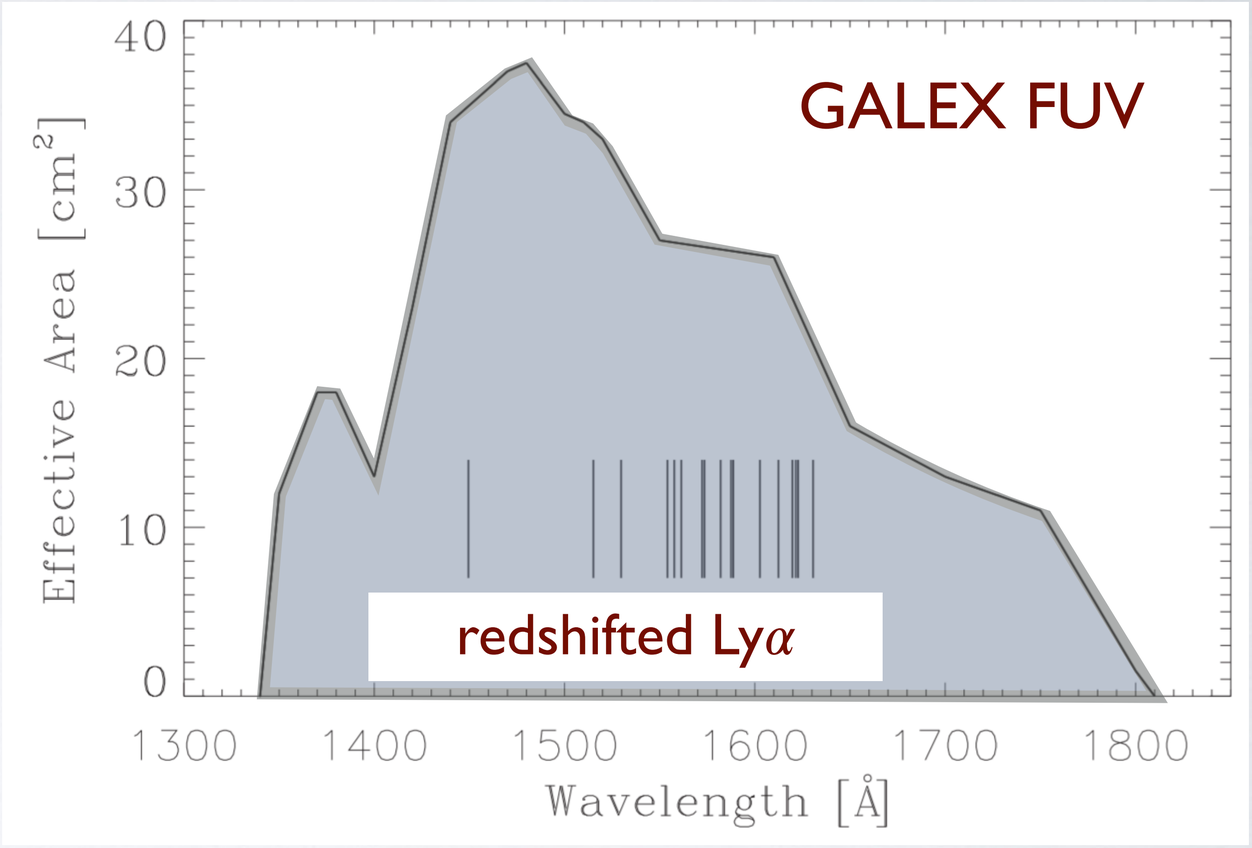
Is it Lyman alpha?

Consider other sources of UV emission:

stars? nebular continuum?

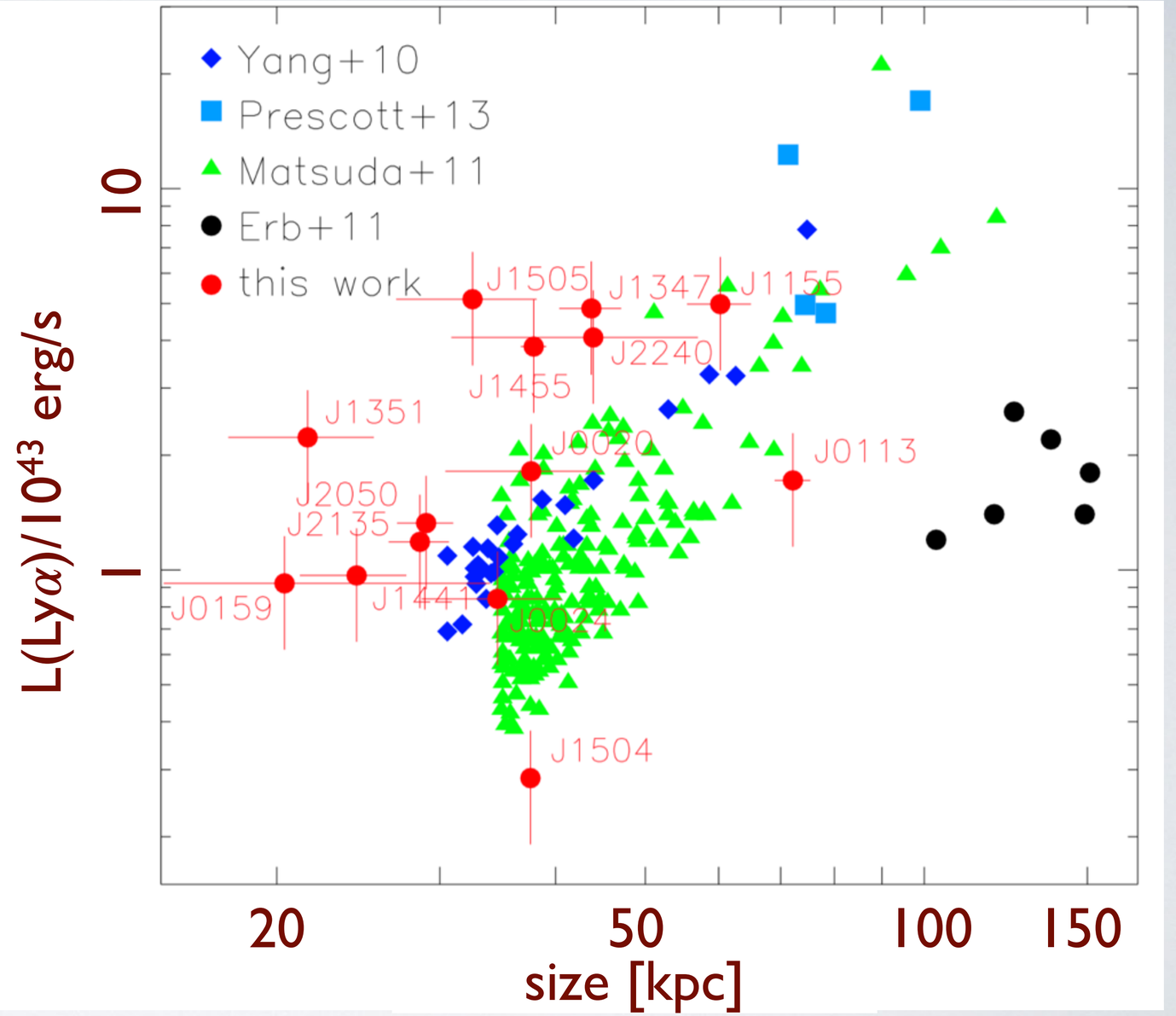
estimate 75% observed flux is Lyman alpha

typical luminosities > 10^{43} erg/s
similar to Lyman alpha blobs



low-z Lyman alpha blob differences

extended ionization regions, but smaller



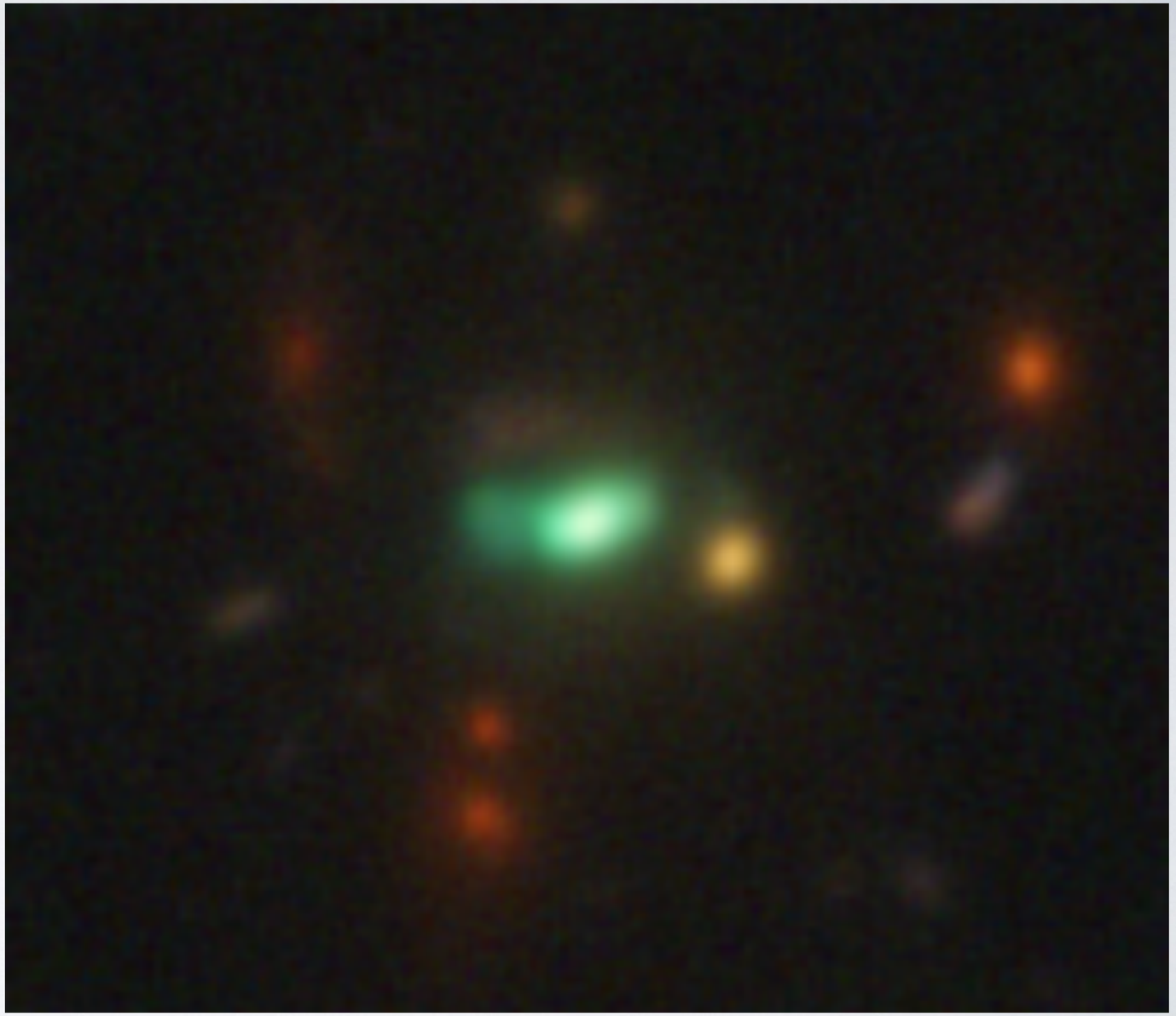
Schirmer+ 2016

low-z Lyman alpha blob differences

lower density environments

isolated, or small groups

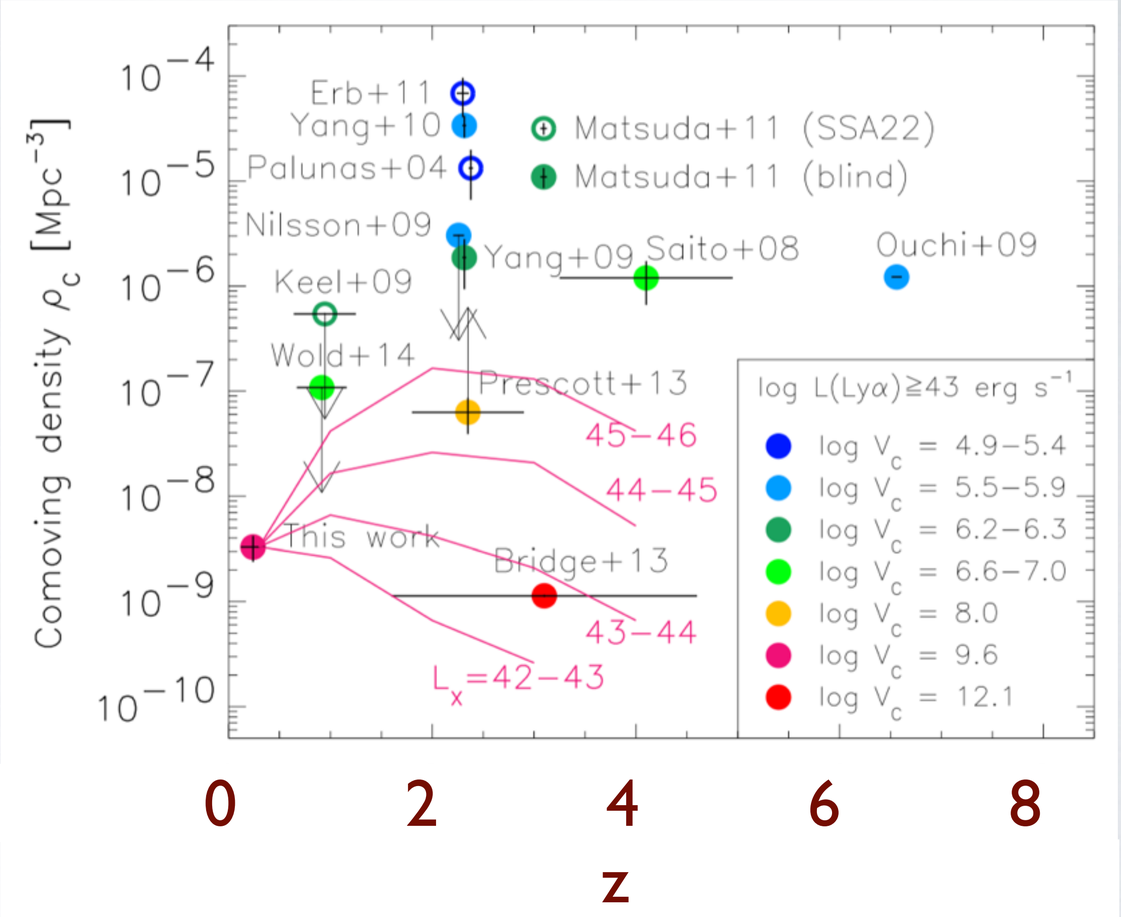
masses $\lesssim 10^{13} M_\odot$, not $10^{15} M_\odot$



low-z Lyman alpha blob differences

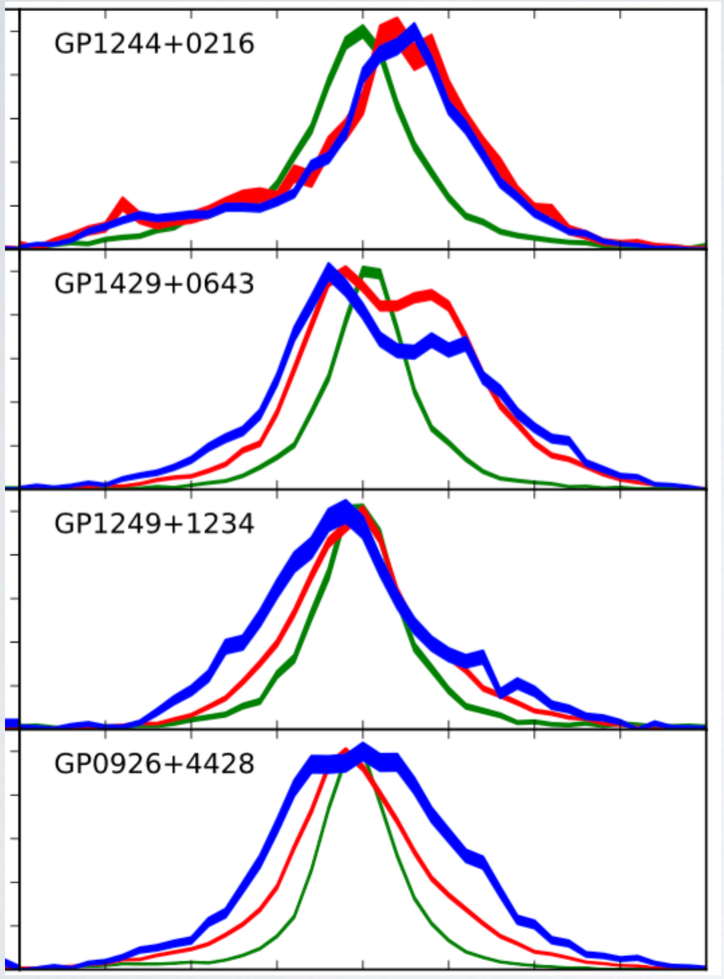
evolution

- regular "LABs" gone by z=0.3
- comoving density here much lower
  - 3.3 Gpc $^{-3}$
  - these aren't the same objects
- suggest these evolve like AGN



Schirmer+ 2016

Lyman alpha emission



Yang+ 2017

- useful to study physical processes, not direct analogs
- Lyman alpha emission lags ionization multiple scatterings to escape timescales up to 10^6 years

- Lyman alpha emission can be spatially **broader** than UV continuum

continuum

Lyman α

conclusions and next steps

- ionization and thermal echoes indicate AGN duty cycle
  - need more measurements to be quantitative e.g., corresponding unobscured sources, which are missed by selection criteria
  - caution: offset in MIR-X-ray relation does not imply obscuration
  - Lyman alpha also lags AGN cycle

- physical processes of Lyman alpha blobs available for detailed study
  - but not direct examples, given differences in environment, evolution, and ionizing source

N.A.