Lyα Blob as a probe of Galaxy Formation

Tom Saito

(RCSCE/Ehime Univ.)

Collaborators

- **SXDS team:**
  - Y.Ono, K.Shimasaku, S.Okamura (Tokyo) M.Ouchi (OCIW), M.Akiyama (Tohoku), M.Yoshida (OAO), Y.Ueda (Kyoto), K.Sekiguchi (NAOJ) et al.
- **COSMOS team:**
  - Y.Taniguchi, Y.Shioya, T.Nagao, K.Matsuoka (Ehime), T.Murayama (Tohoku), P.Capak, C.Scarlata (Caltech), O.Ilbert (IfA) et al.
- **Kyoto 3DII team:**
  - H.Sugai, A.Shimono, K.Matsubayashi, A.Akita, A.Nakajima (Kyoto), T.Hattori(NAOJ)
- **Others:**
  - J.P.U.Fynbo (Dark), K.K.Nilsson (MPA), P.Møller (ESO) et al.

Contents

- Introduction: Why LABs?
- Deep sample at z~3-5
- Wide sample at z~3
- Toward ALMA & ELT

Why LABs?

-Extended in Lyα

-Faint/Compact in UV

-> **LABs**

LABs found with current detection limits

Projenitors of massive galaxies

Gas cooling

Initial starburst

Superwind

very young phases (age $<<10^7$ yrs)

LBGs, DRGs, etc.

LAB studies in the past

- Large velocity widths: superwinds?
  (e.g., Bower+04; Matsuda+05)
- High detection rate in NIR: stellar-massive?
  (e.g., Uchimoto+08)
- High detection rate in sub-mm & MIR:
  dusty starburst?
  (e.g., Geach+05; Colbert+07)

LAB studies in the past

- Large velocity widths: superwinds?
- [illegible]
- [illegible]

(e.g., Geach+05; Colbert+07)

Most follow-up studies are made for LABs **in protoclusters!**

HOW ABOUT ISOLATED LABs??

Unbiased surveys are quite essential

Unbiased --- How?

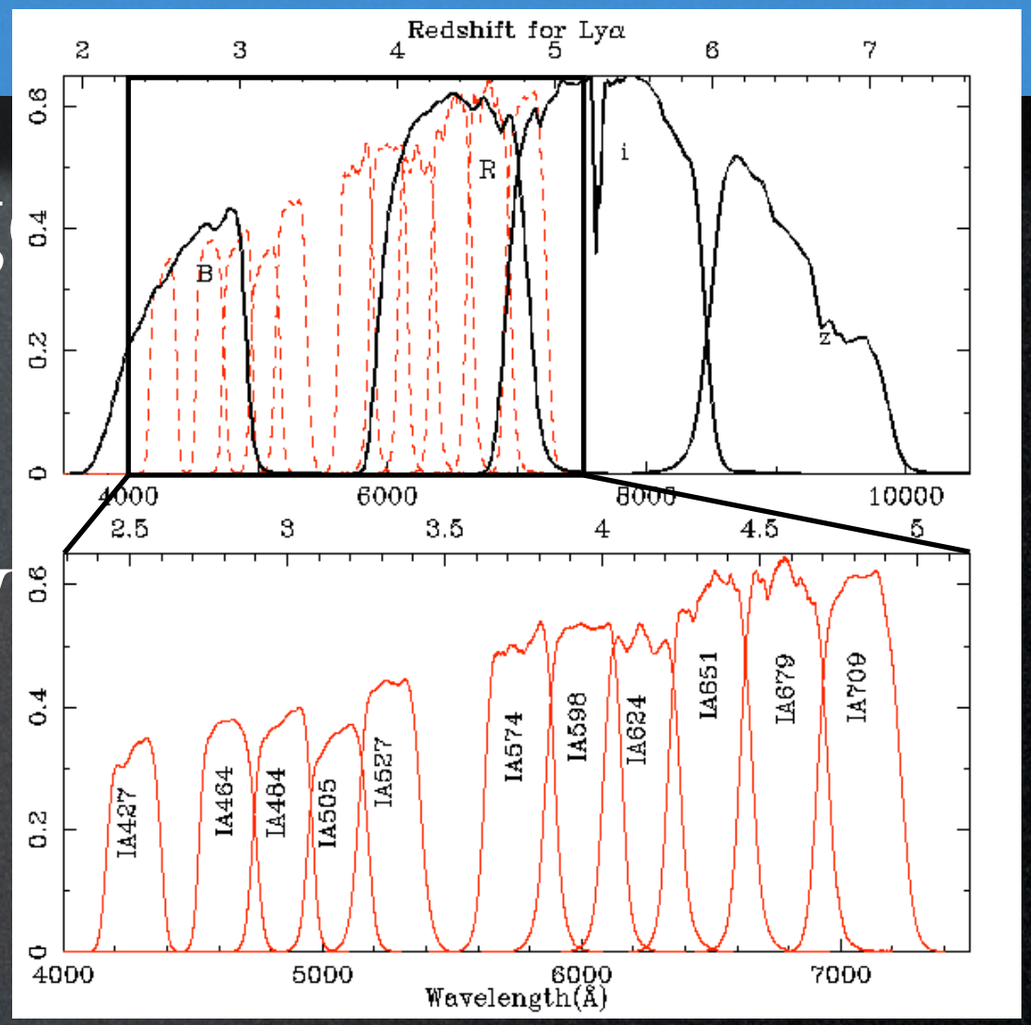
- RARE
  - (-) Need for large survey volume
- DIFFUSE
  - (-) Need for large correcting area
- LARGE EW
  - (+)Large narrow-band excess is expected

Unbiased --- How?

- RARE

Subaru + Suprime-Cam + IA filters

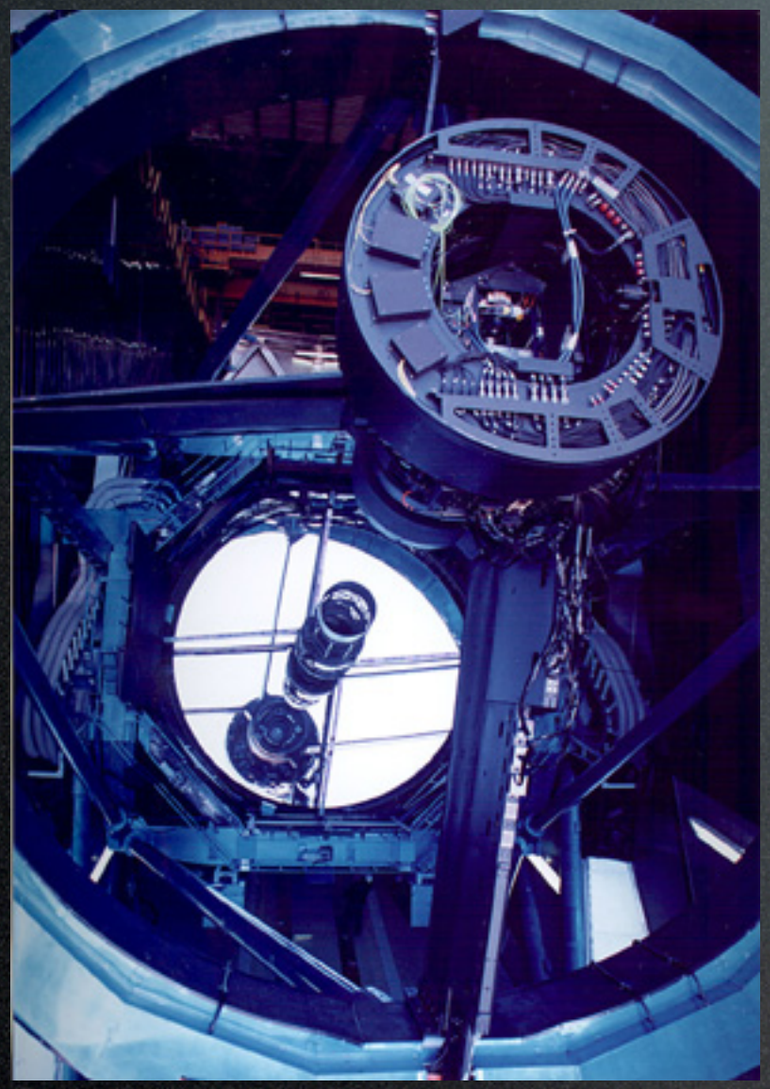
  - (-) Need for large
- LARGE EW
  - (+)Large narrow
    expected



Contents

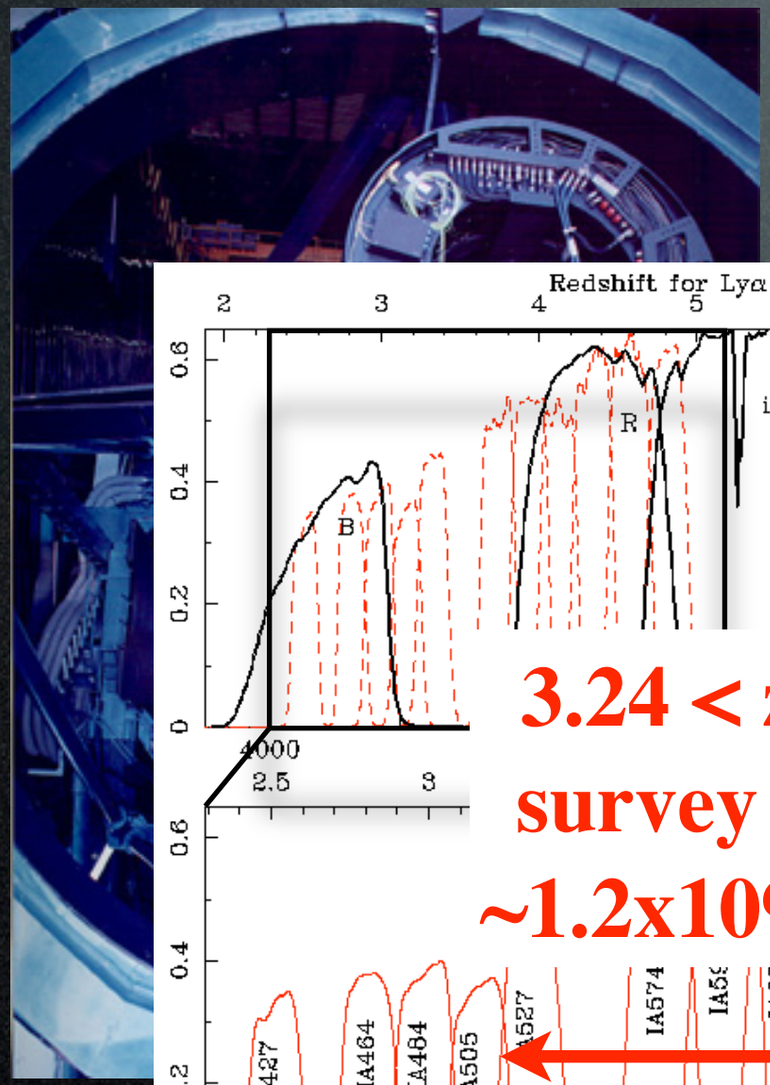
- Introduction: Why LABs?
- Deep sample at z~3-5
- Wide sample at z~3
- Toward ALMA & ELT

The deep sample (z~3-5)



- Field: SXDF-S
  (~900 arcmin^2)
- Redshift coverage:
  $3.24 < z < 4.95$
- 3σ limiting mags for IA:
  26.5-26.8 mag (AB)

The deep sample (z~3-5)



3.24 < z < 4.95
survey volume
~1.2x10^6h^{-3}Mpc^3

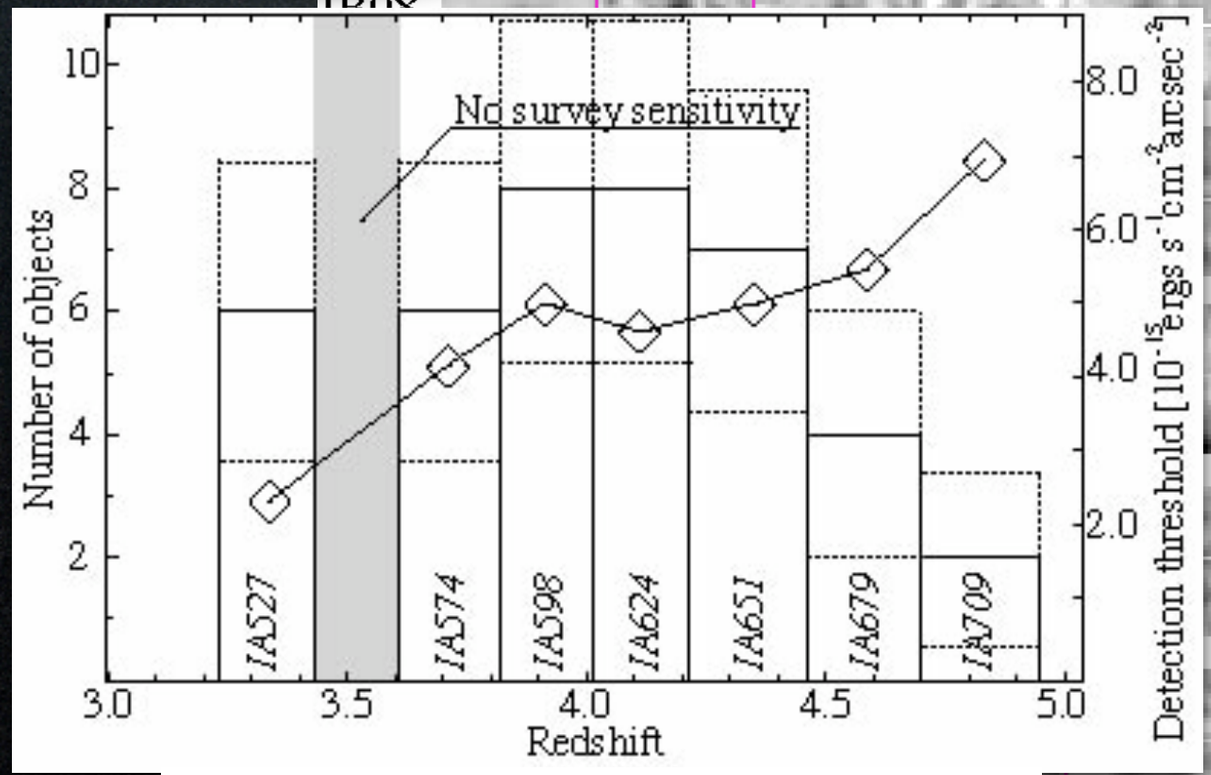
Seven bands

- Field: SXDF-S
  (~900 arcmin^2)
- Redshift coverage:
  3.24 < z < 4.95
- 3σ limiting mags for IA:
  26.5-26.8 mag (AB)

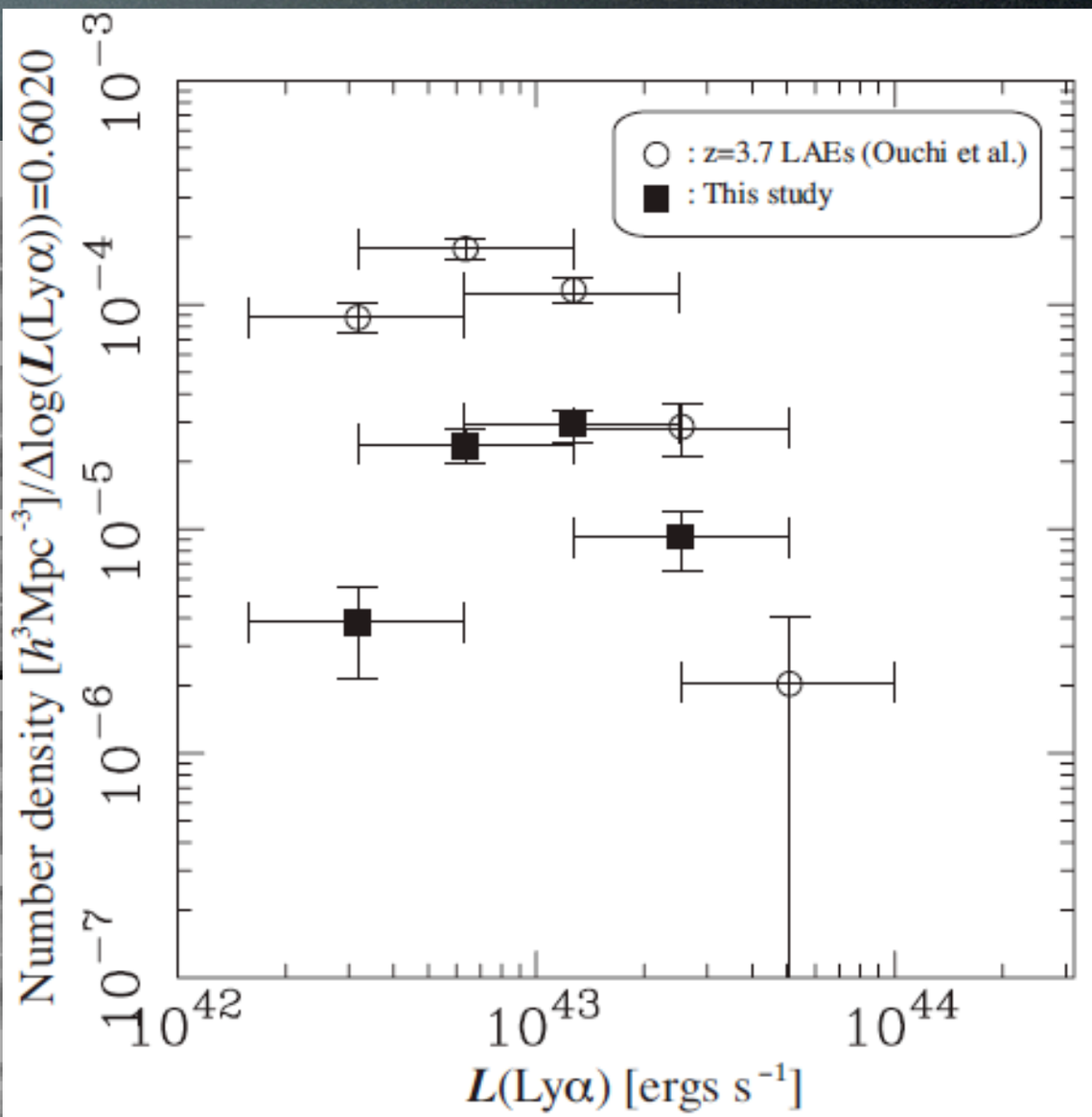
41 Objects

Statistics

41 objects



Redshift distribution:
almost uniform



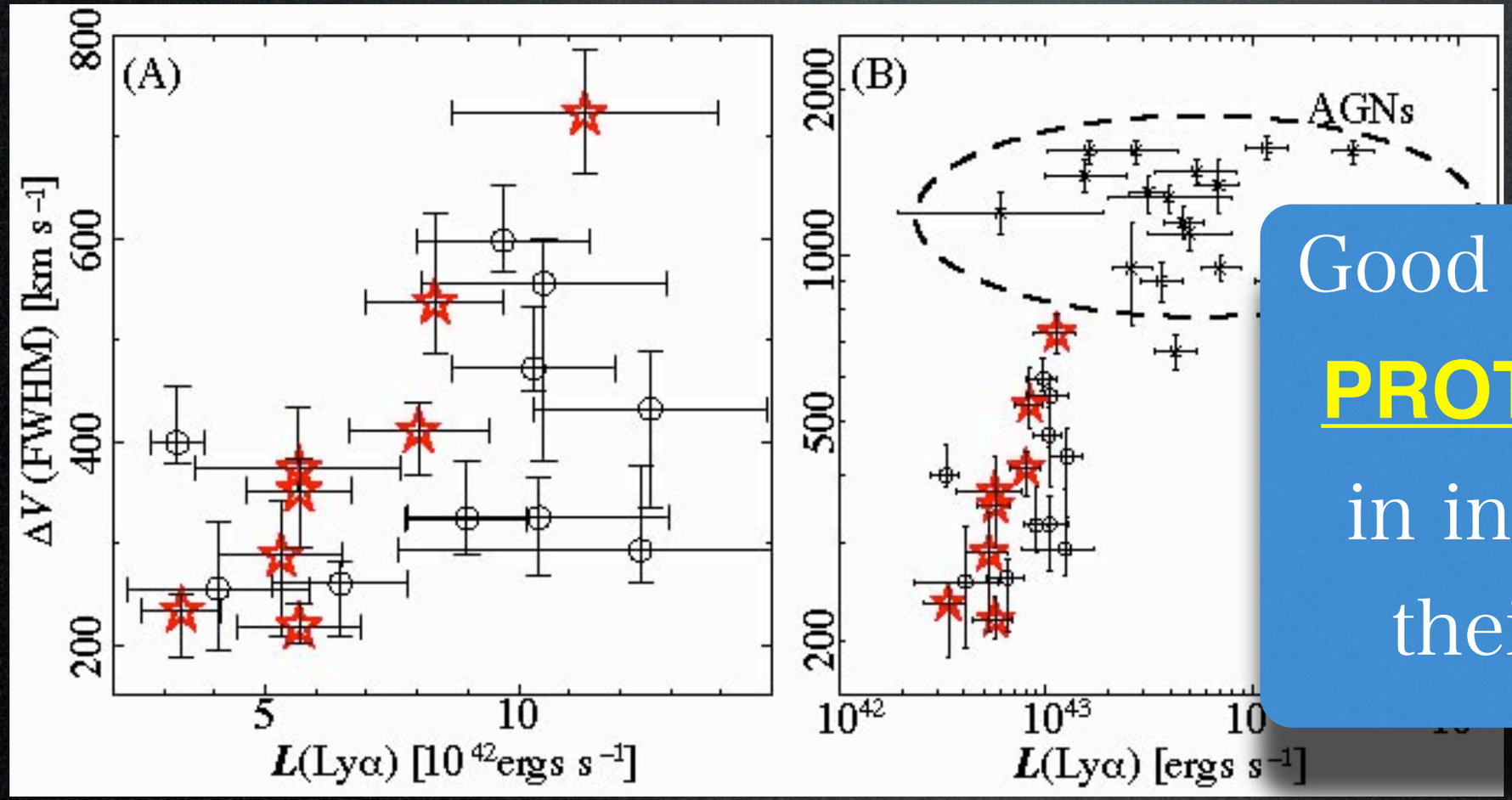
Luminosity func.
~10^{-1}-10^{-2} times the LAEs

No clear signatures of overdensity

Saito et al. 2006 & 2008

Follow-up studies

- VLT/VIMOS Spectroscopy:
  - ~40% have EW > 200A, no wing emission, and positive *L-ΔV* correlation -> **cooling clouds?**
- UKIDSS/UDS photometry (non-detection):
  - Stellar mass (3σ upper limit) M* ~ a few 10^9 Mo

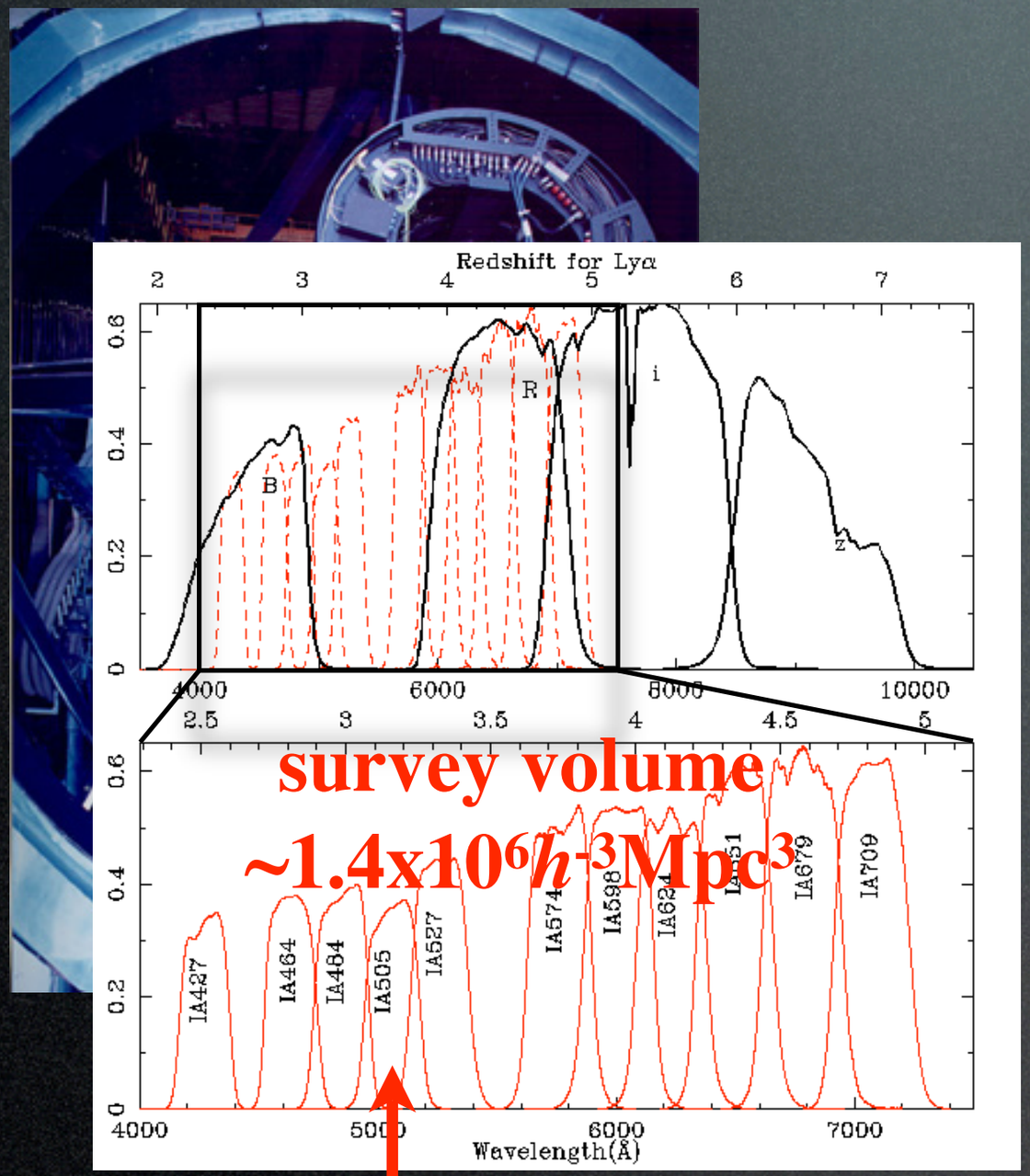


Good candidates for **PROTOGALAXIES** in initial-phase of their assembly.

Contents

- Introduction: Why LABs?
- Deep sample at z~3-5
- Wide sample at z~3
- Toward ALMA & ELT

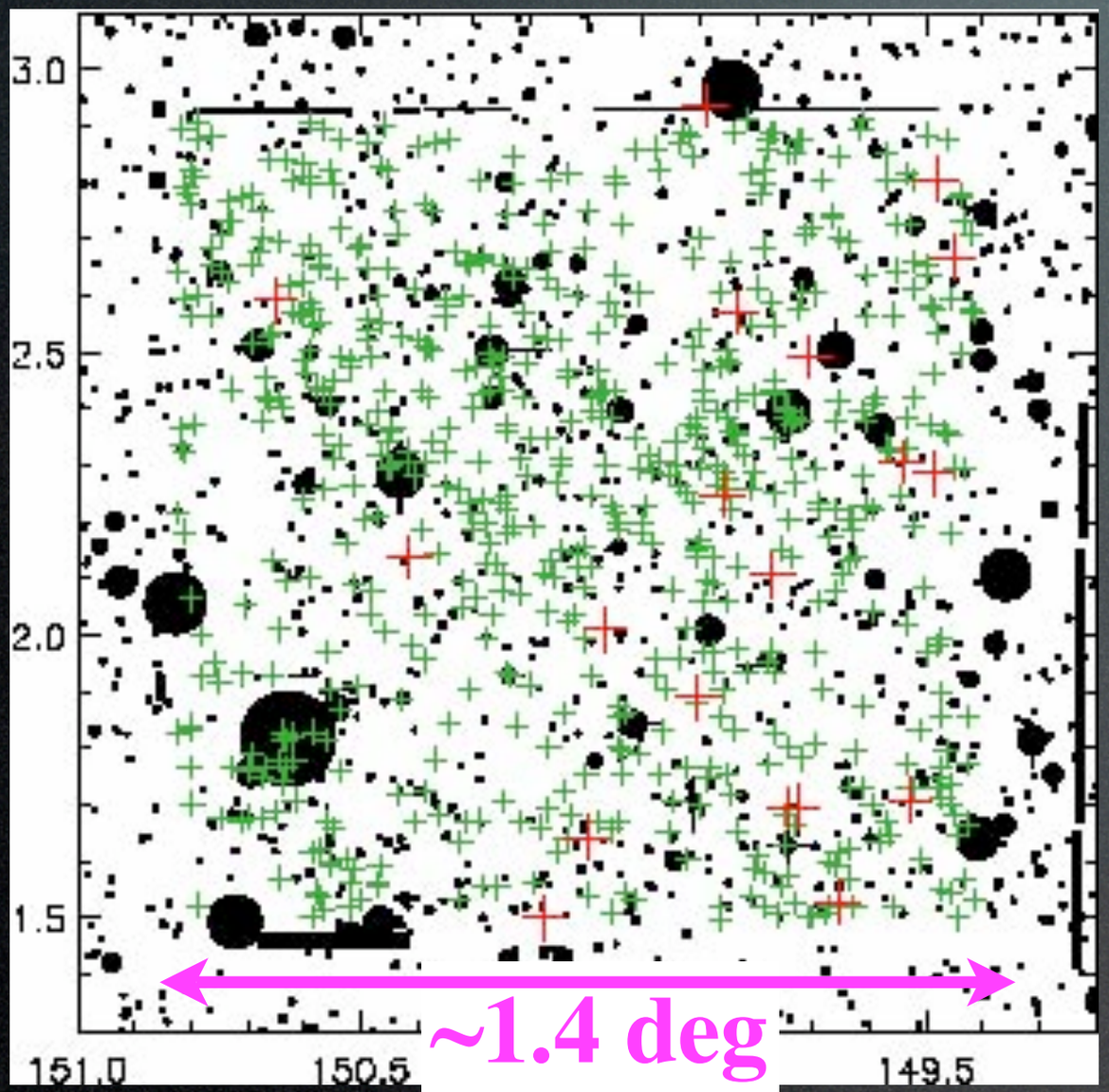
The wide sample (z~3)



- Field: COSMOS field
  (~2 deg²: 10 pointings)
- Redshift coverage:
  $3.05 < z < 3.25$
- 3σ limiting mags for IA:
  25.9 mag (AB)

19 Objects

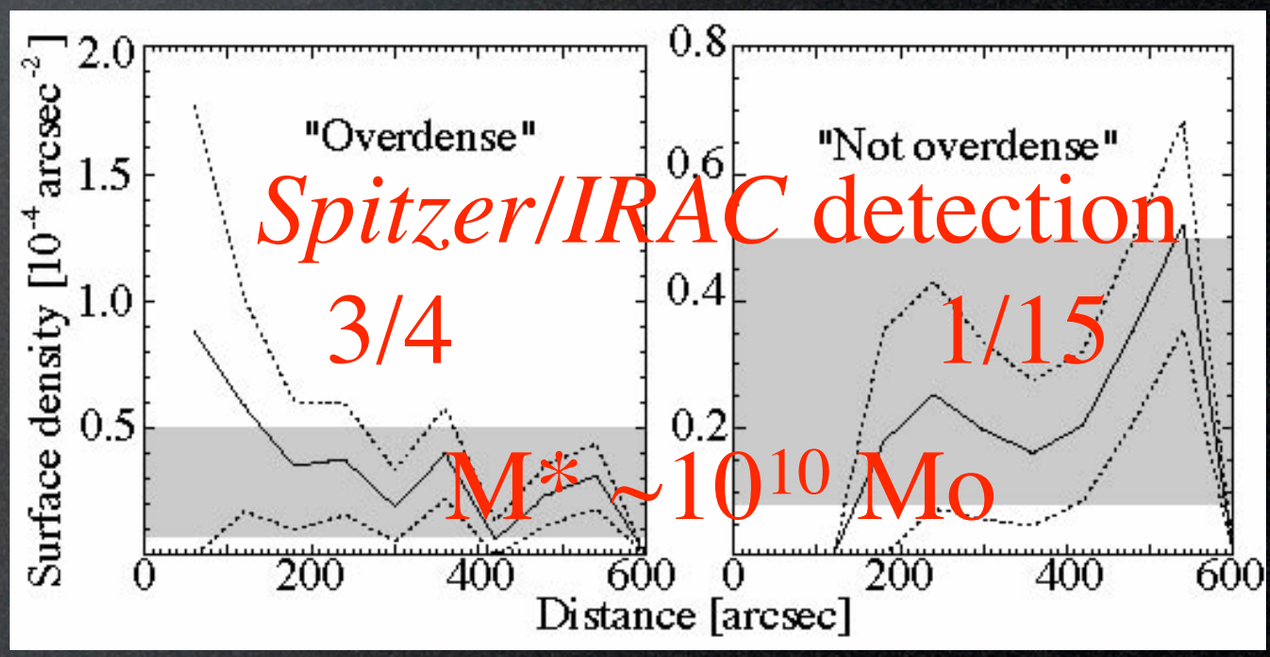
Wide-field, Multiwavelength analysis



Red: LABs

Green: photo-z sample

- Almost uniformly distributed over the sky, regardless of environment
- Both LABs with/without overdensity were found.



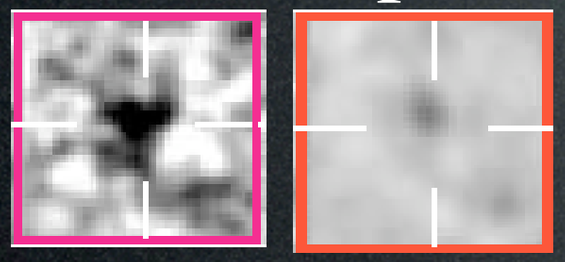
Contents

- Introduction: Why LABs?
- Deep sample at z~3-5
- Wide sample at z~3
- Toward ALMA & ELT

1. Stellar components

--obscured, absent, or very first ones?--

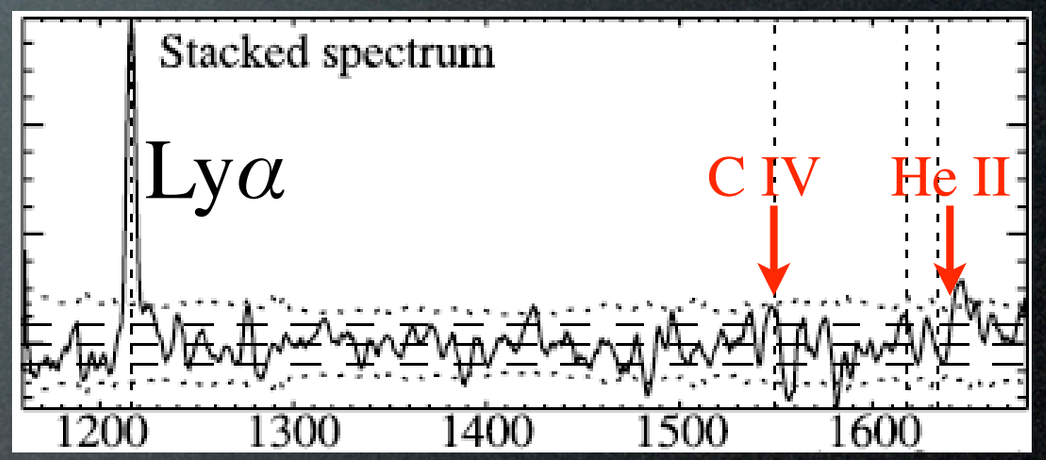
example: LAB @ z=3.68



Lyα (TS+06)

R

J H K (UKIDSS/UDS)



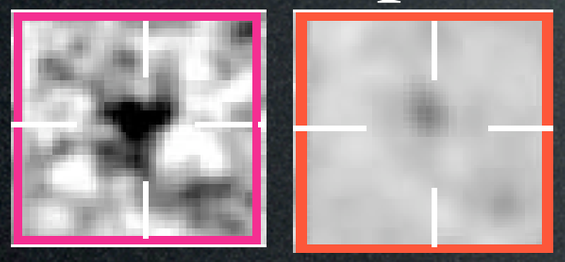
FOCAS spectrum (TS+06)

- "Isolated" LABs have no NIR counterparts
  --> low stellar-mass? obscured?
- Even with the stacked spectrum w/ Subaru other emission lines cannot be detected.

1. Stellar components

--obscured, absent, or very first ones?--

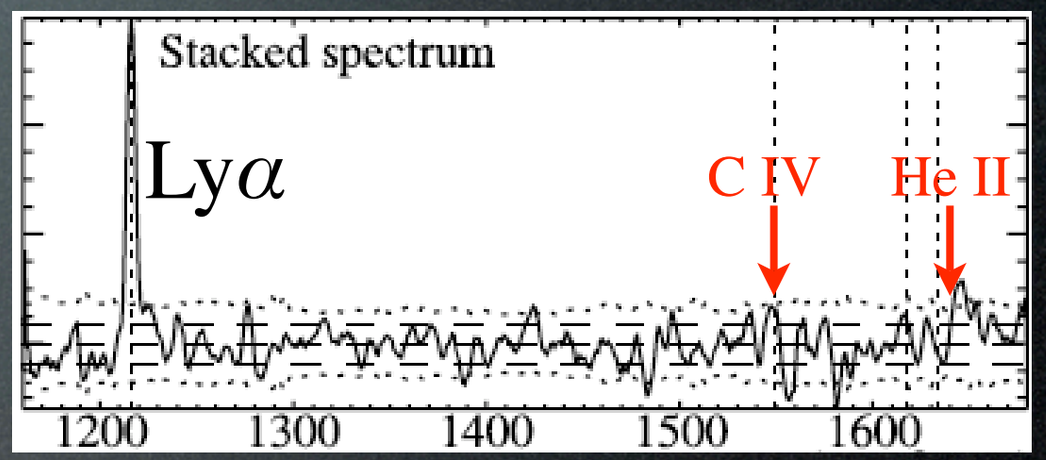
example: LAB @ z=3.68



Lyα (TS+06)

R

J H K (UKIDSS/UDS)



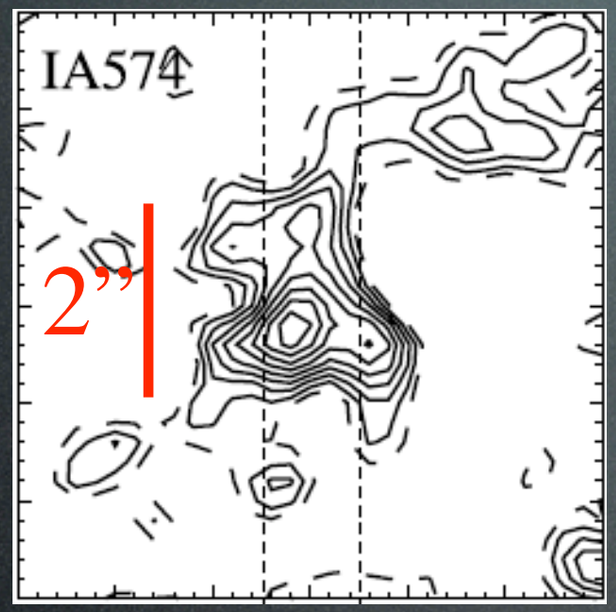
FOCAS spectrum (TS+06)

- "Isolated" LABs have no NIR counterparts
  --> **Dust emission in submm with great sensitivity & resolution** **ALMA!**
- Ev / Subaru ot tected.
  Optical & NIR spectroscopy with ~10x higher S/N ratio **ELT!**

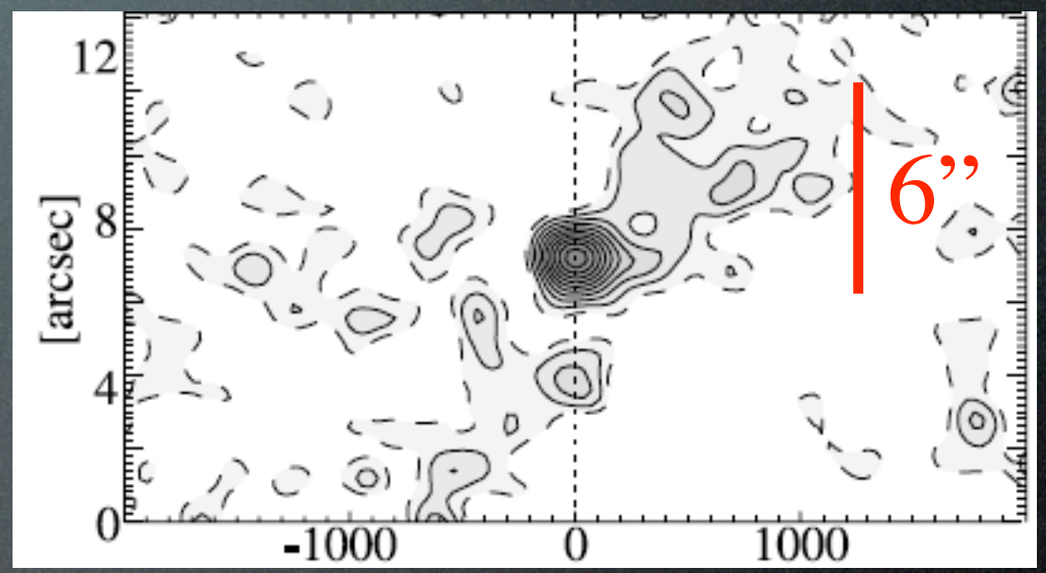
2. Diffuse components

--infalling or outflowing?--

example:
LAB
@z=3.68
(TS+08)



IA image



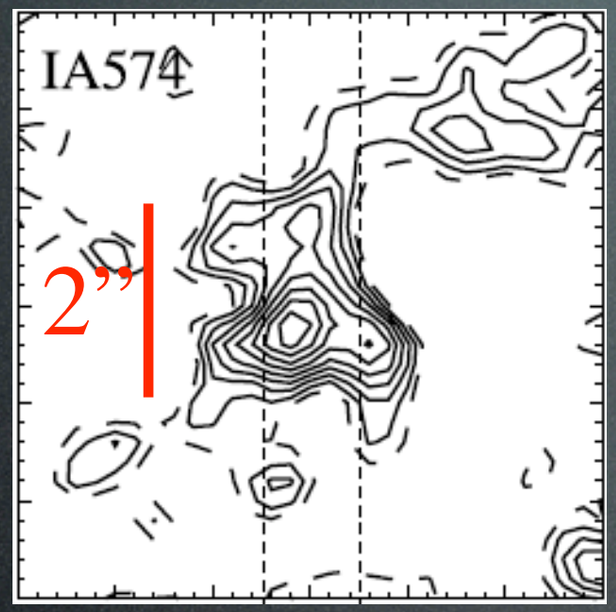
2-d spectrum

- Diffuse Lyα components cannot be detected w/ existing 8-10m telescopes
- Other emission lines (NV, CIV, HeII, etc.) are still not detected

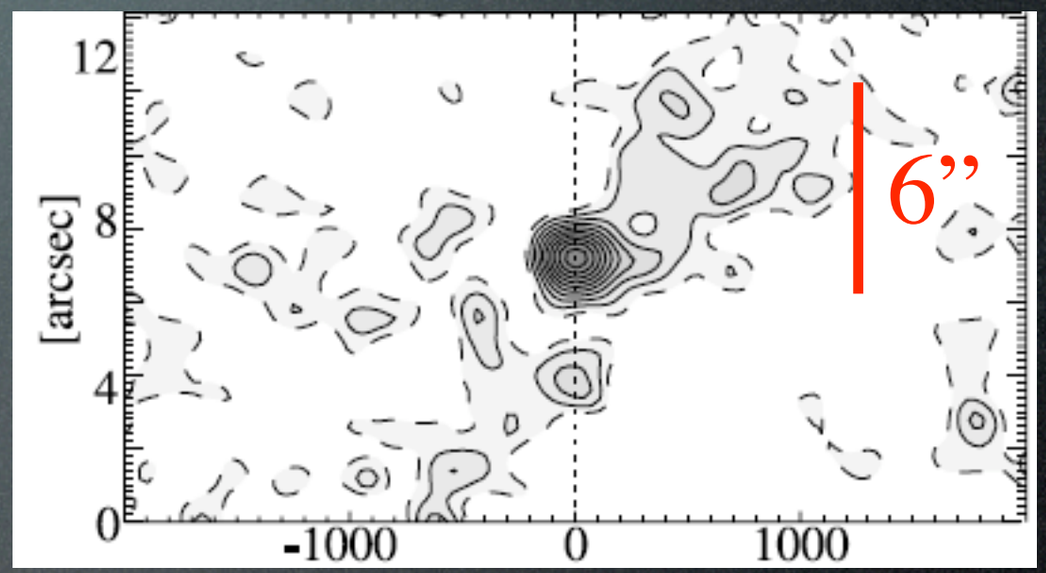
2. Diffuse components

--infalling or outflowing?--

example:
LAB
@z=3.68
(TS+08)



IA image



2-d spectrum

- Diffuse Lyα components cannot be detected w/ exi
- Other
  are sti

Gas dynamics:
IFU on ELTs, and/or ALMA

etc.)

ll not detected

Summary

Why do we observe LABs with ALMA & ELTs?

Why not?