PENNSTATE
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Physical Properties of Lyα Emitters at z=3.1

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Collaborators:

Robin Ciardullo (PSU), Eric Gawiser, Nicholas Bond (Rutgers), John Feldmeier (YSU), Harold Francke, Lucia Guaita (PUC) + the MUSYC collaboration

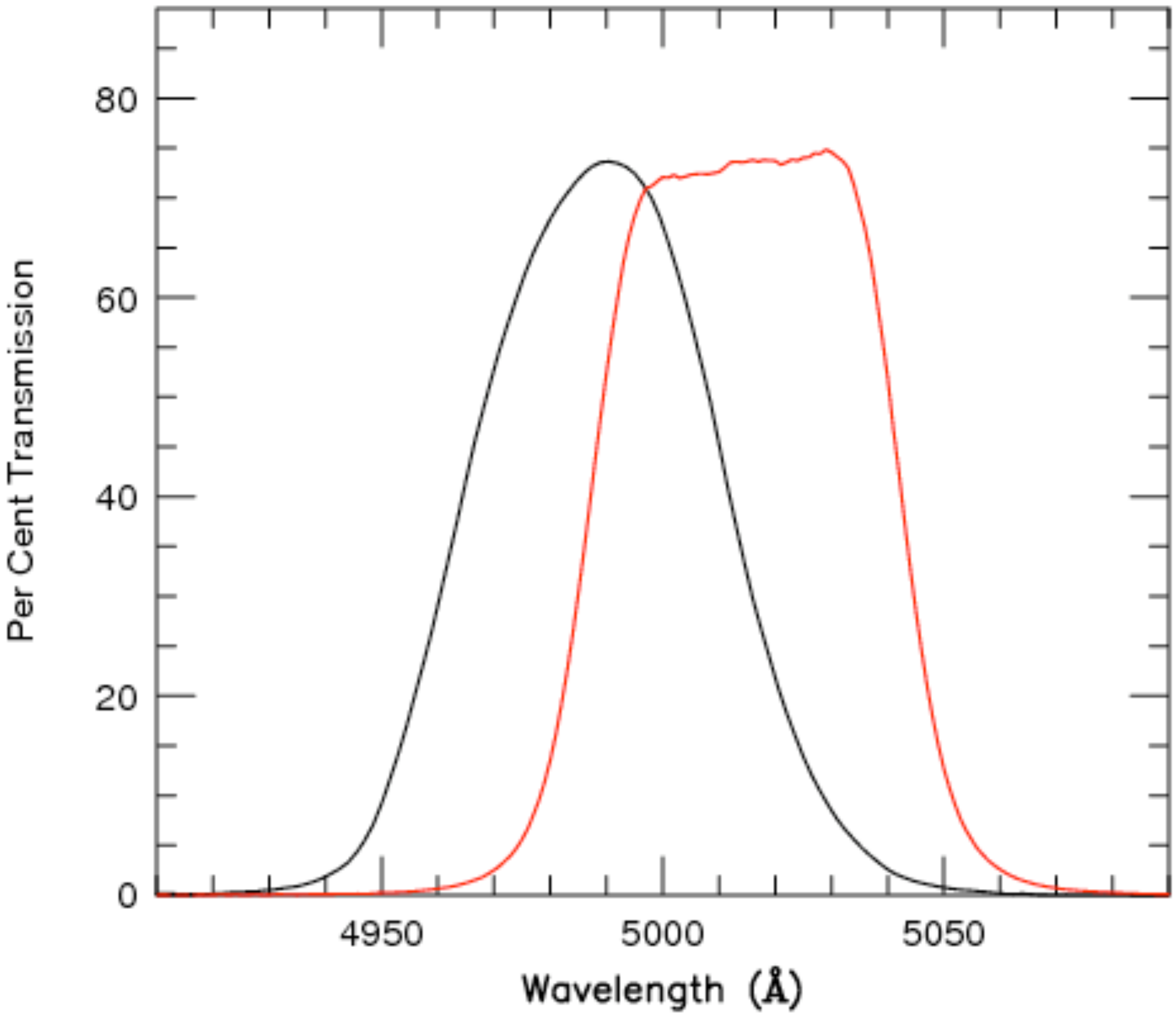
PSU undergrads: Tom Hickey, Justin McKane, Emily McCathran, Chris Wolff, Shawn Sinawa

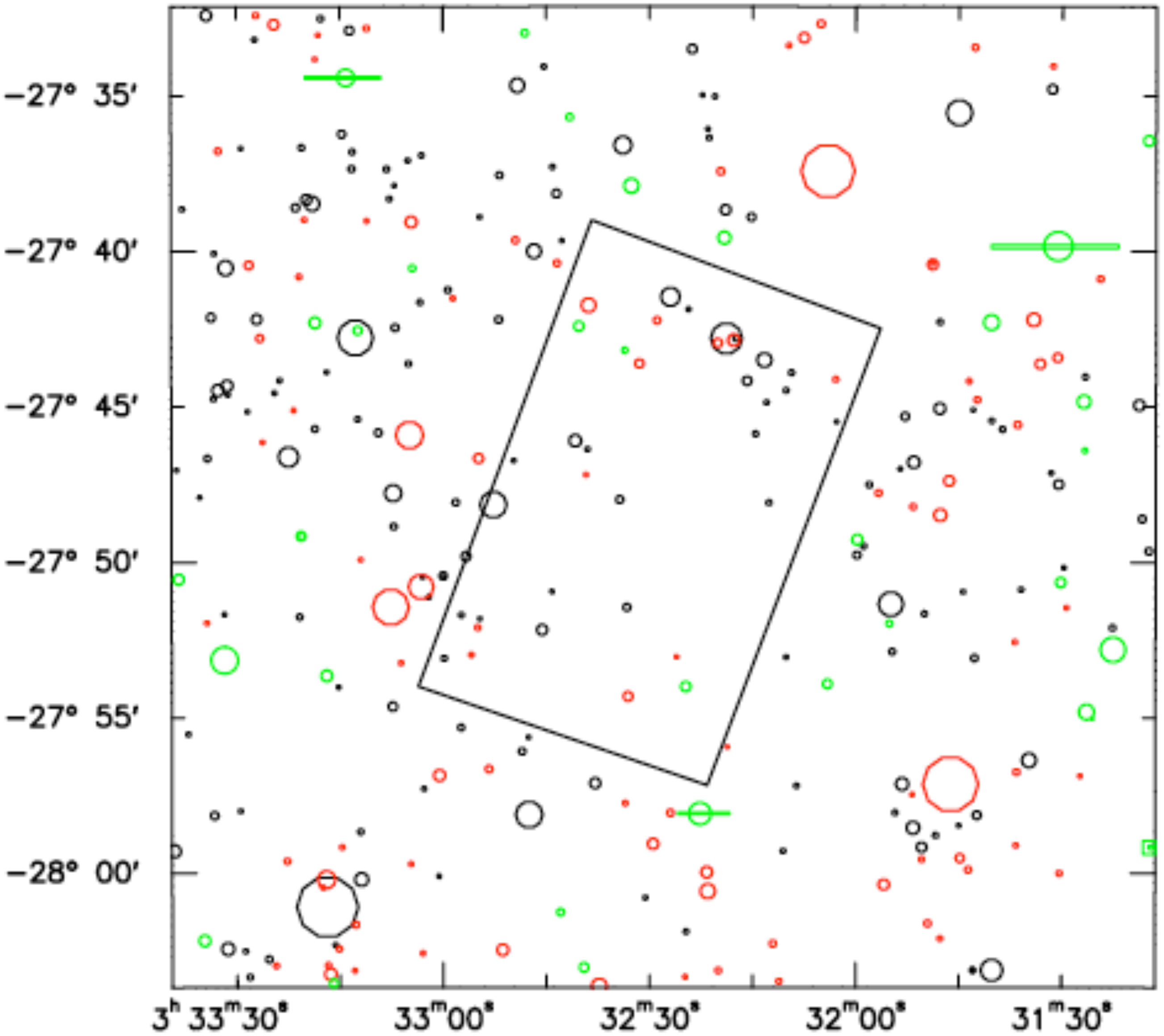
Why z ~ 3.1?

- Makes use of existing [O III] filters
- Enables direct comparison to z ~ 3 Lyman break galaxies; LAEs dominate the faint end of LF
- Can obtain large statistically complete samples
- Note at z ~ 4, Lyα emitters are as easy to detect as LBGs; at z ~ 6 they are the only galaxies observable from the ground.
- Samples at z > 4.4 are contaminated by Hα
- z ~ 3.1 provides an “intermediate” redshift for the population; most current efforts are concentrated on z > 5.

Our Observations

- Narrow-band [O III] λ4990,5025 imaging using Mosaic camera on the CTIO 4-m telescope
  - Region: the Extended Chandra Deep Field South
  - 32′ x 32′ region, 0.28 square degrees
  - 20-hour(!) exposures through the 50 Å FWHM filter
  - z = 3.08 - 3.15
  - Off-band derived from deep B + V (~3 hours in each band) images from MUSYC
  - λ4990 results published in Gronwall+ 2007, Gawiser+ 2007
  - Also have [OII]] λ3727 data (z~2.1), see poster by Guaita
- Detect galaxies via:
  - Difference image
  - On-band – Off-band color


80
60
40
20
0
Per Cent Transmission
4950
5000
5050
Wavelength (Å)

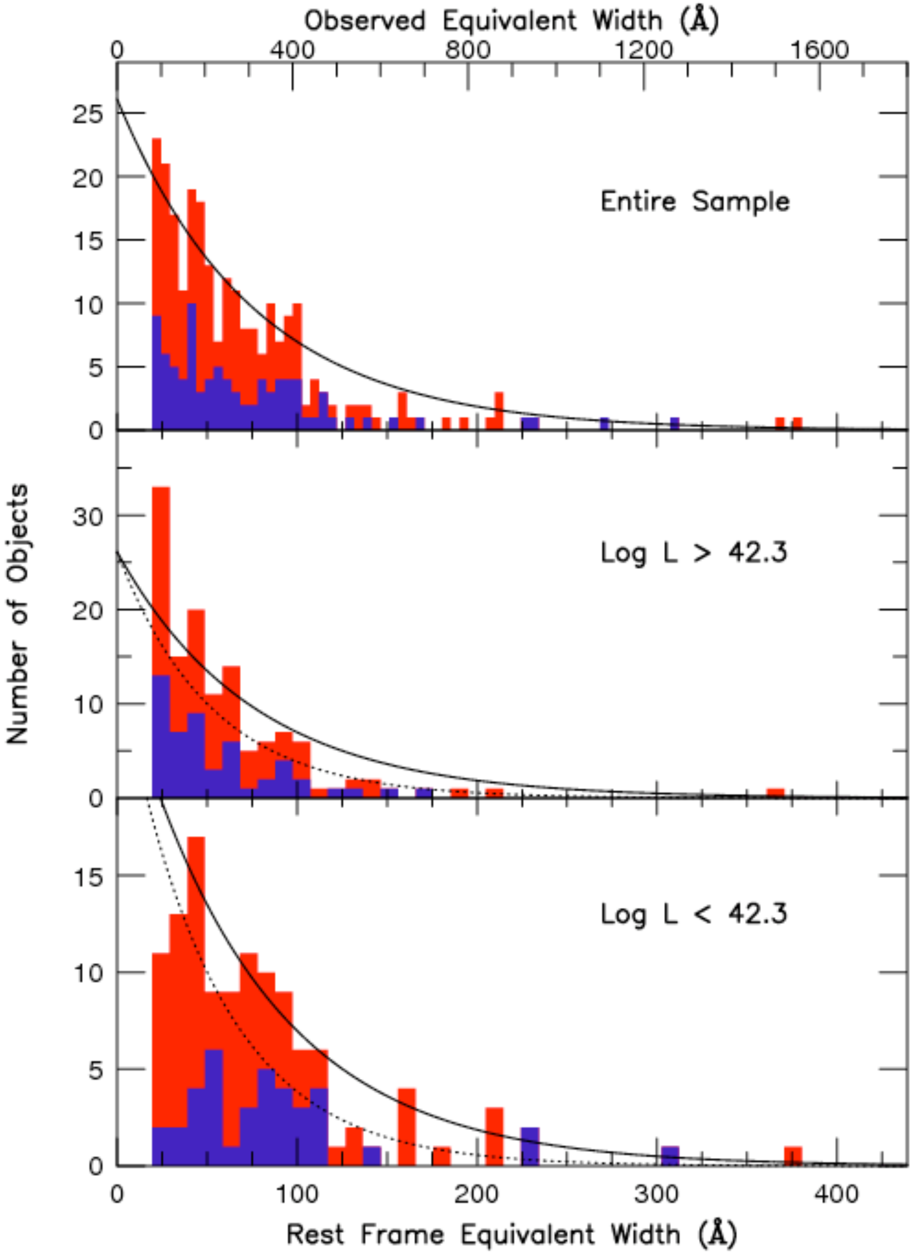


−27° 35′
−27° 40′
−27° 45′
−27° 50′
−27° 55′
−28° 00′
3h 33m30s
33m00s
32m30s
32m00s
31m30s

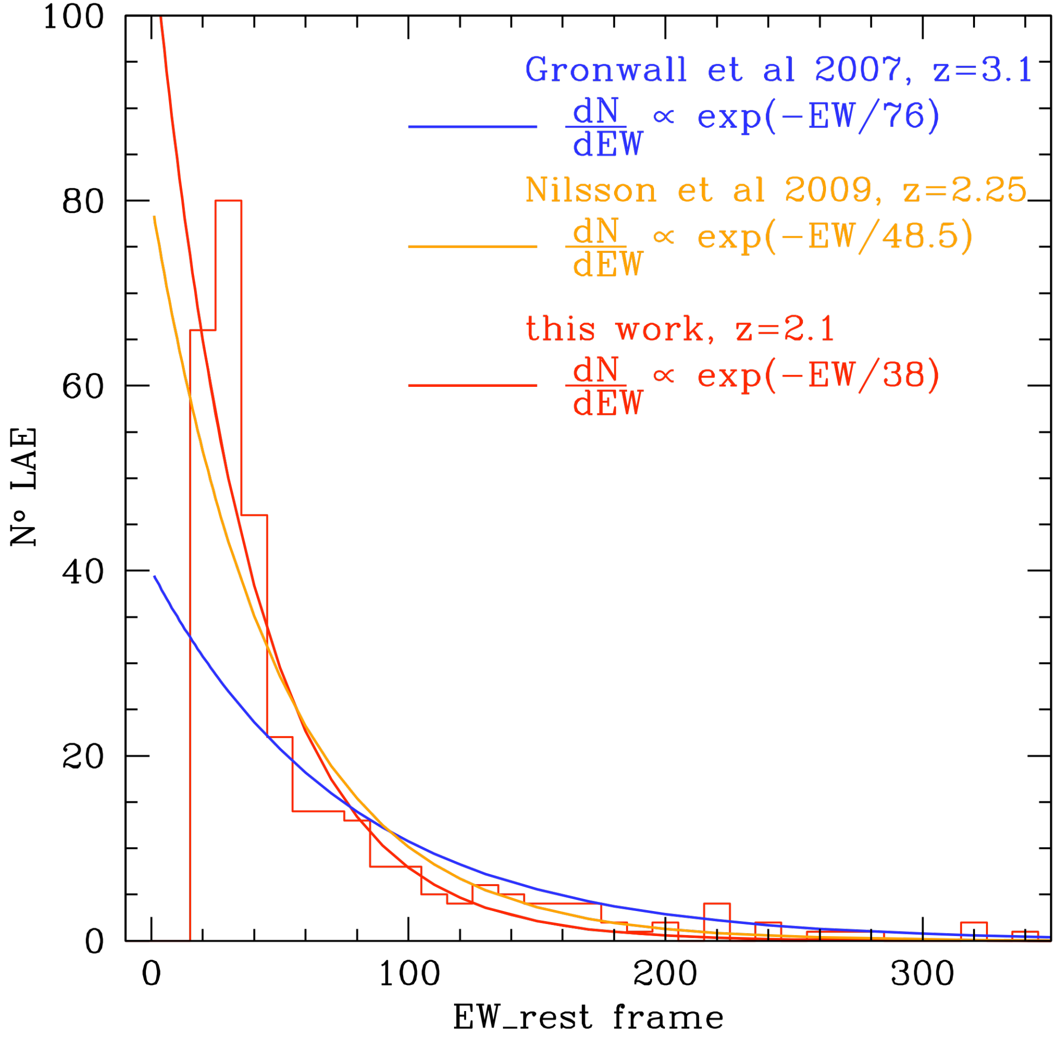
Results

- Detected 156 Lyα emitters in 4990, 158 in 5025 (96 new) with:
- observed EW > 80 Å
- monochromatic flux > 1.5 x 10^{-17} ergs-cm^{-2}-s^{-1}.
- This sample is large enough for statistical analysis, allowing us to study the evolution of these systems
- 4.6 +/- 0.4 per square arcmin per unit z .
- Leverages multiwavelength data in this field.

Rest Frame Equivalent Widths

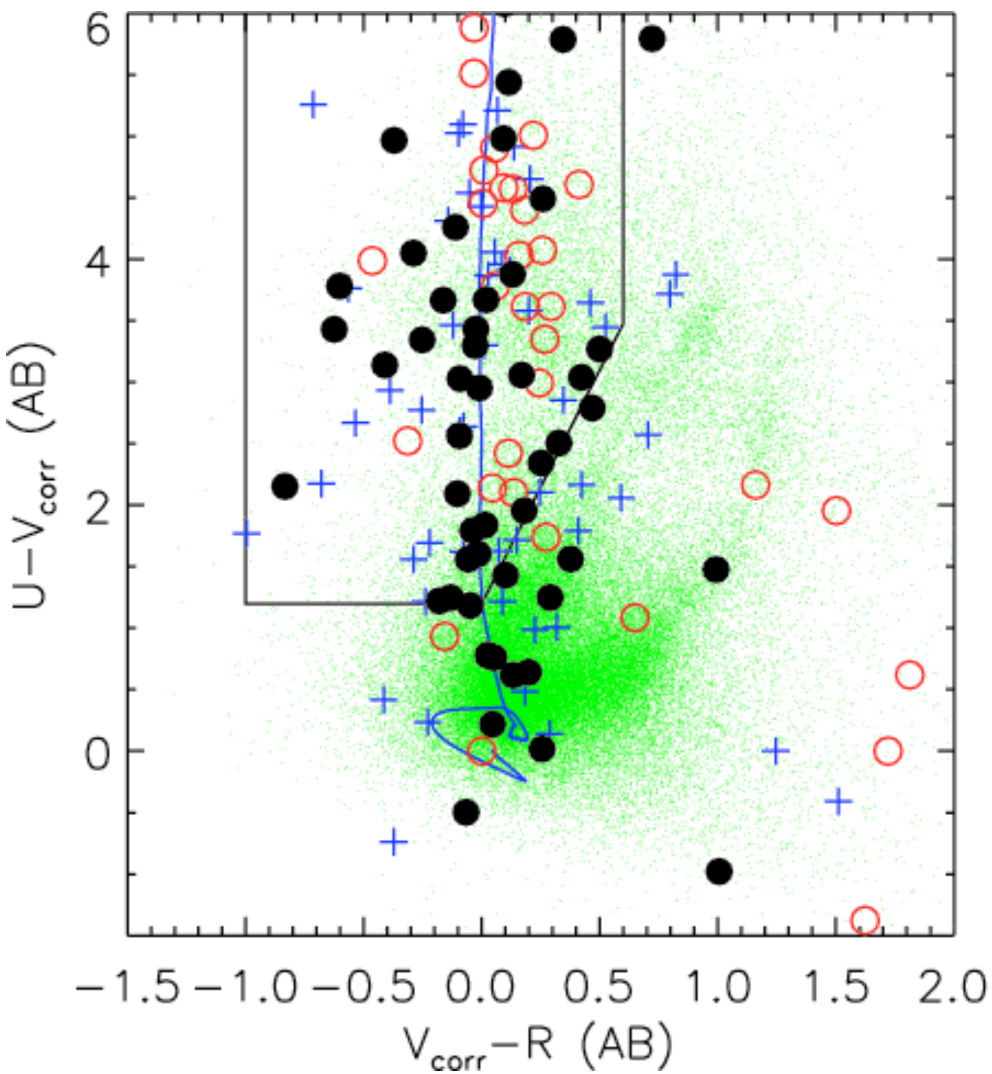


- Less than 10% of LAEs have EW_0 > 240 Å
- EW distribution is exponential with scale length of 76 Å
- Extrapolation implies ~20% of LAEs fall below the EW cutoff



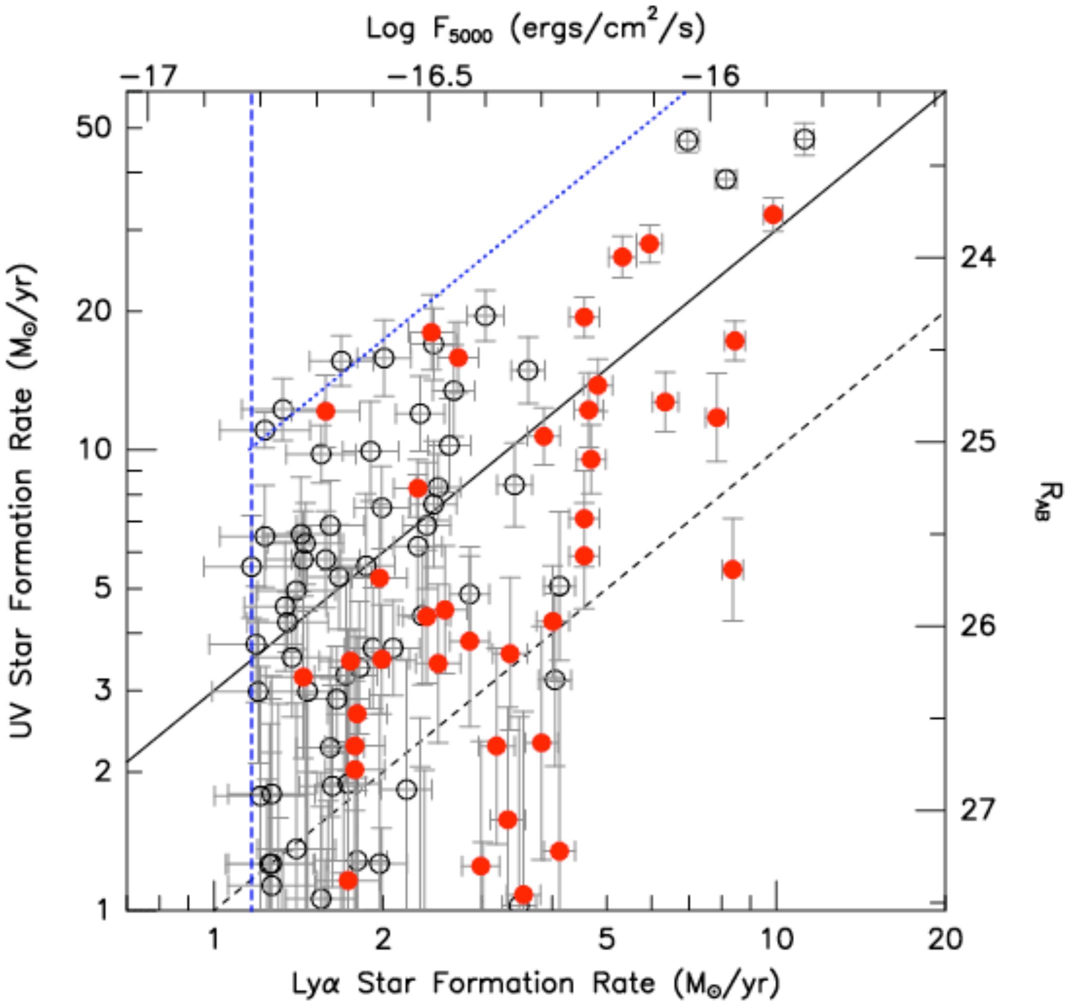
EWs at z~2 are narrower, poster by Guaita

Comparison to LBGs



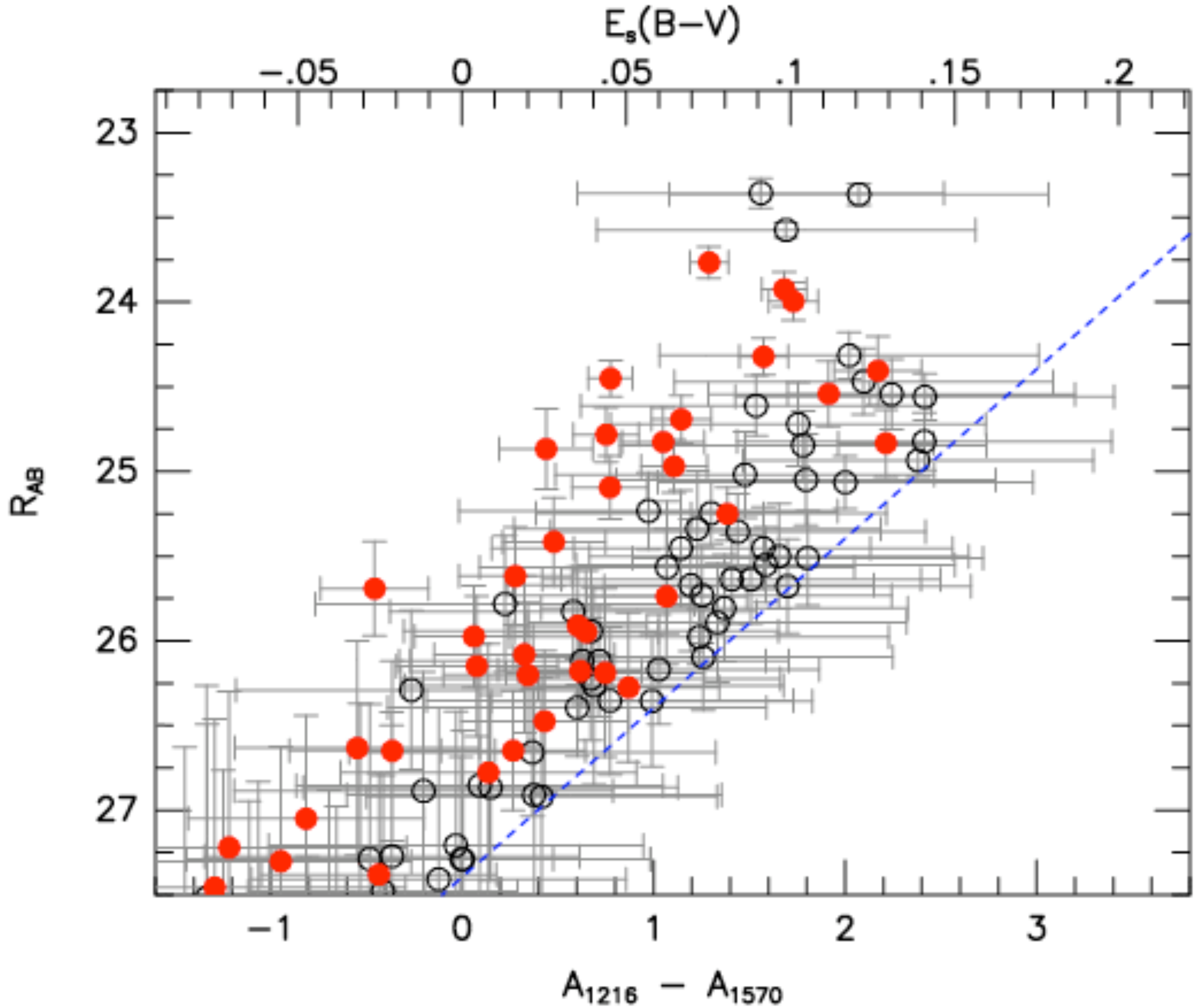
LAEs primarily fall in same region in color-color space as LBGs

UV vs. emission-line SFR



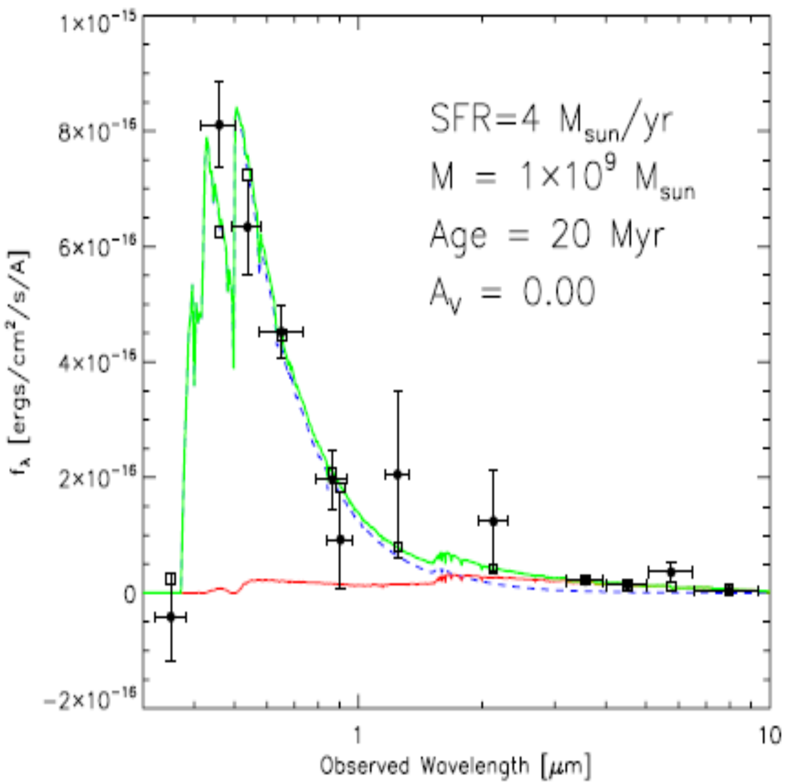
UV SFRs are 3x emission-line SFRs ==> dust!

Extinction (assuming Calzetti law)



But amount of extinction is low!

SED Fitting

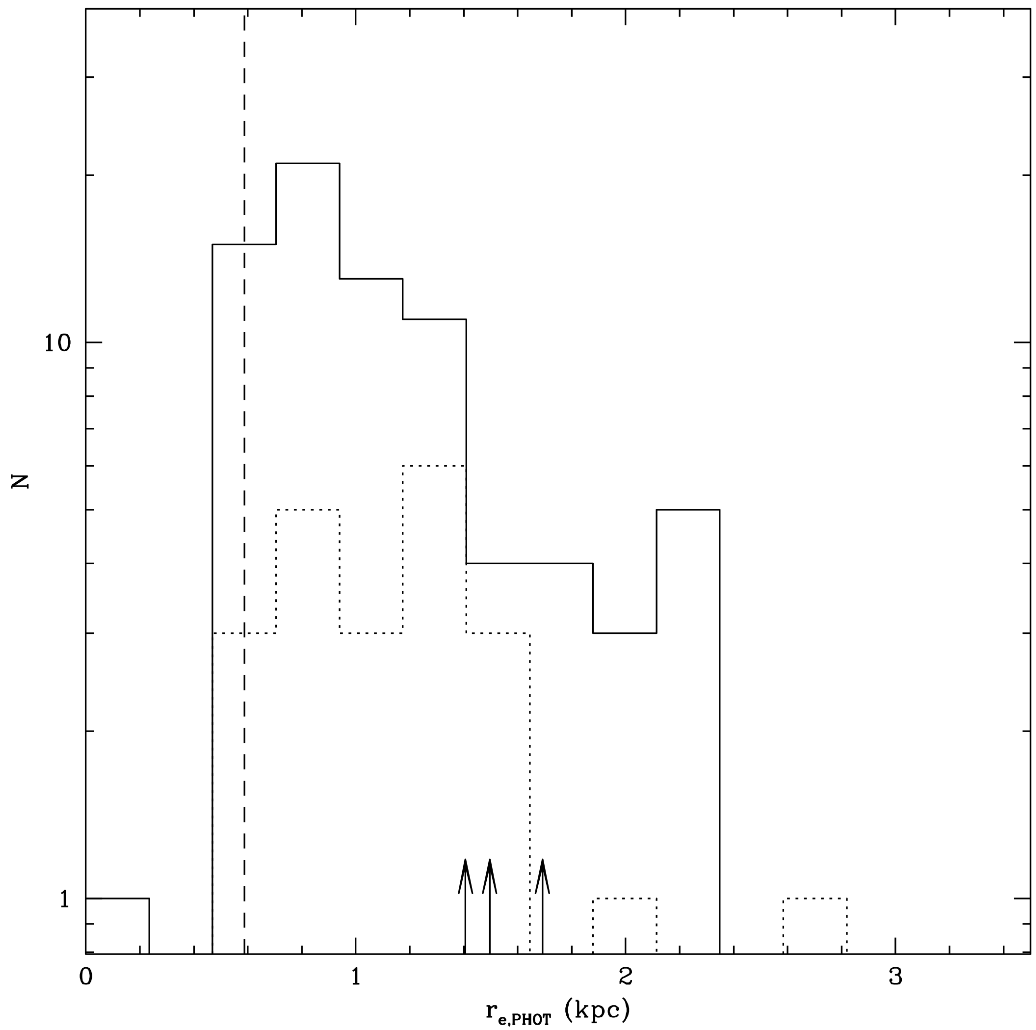


- Two component model, stacked photometry (optical, near-IR, mid-IR)
- Average age = 20 Myr
- Average mass = 10^9 $M_\odot$
- Average SFR = 4 $M_\odot$ / yr
- High specific SFR

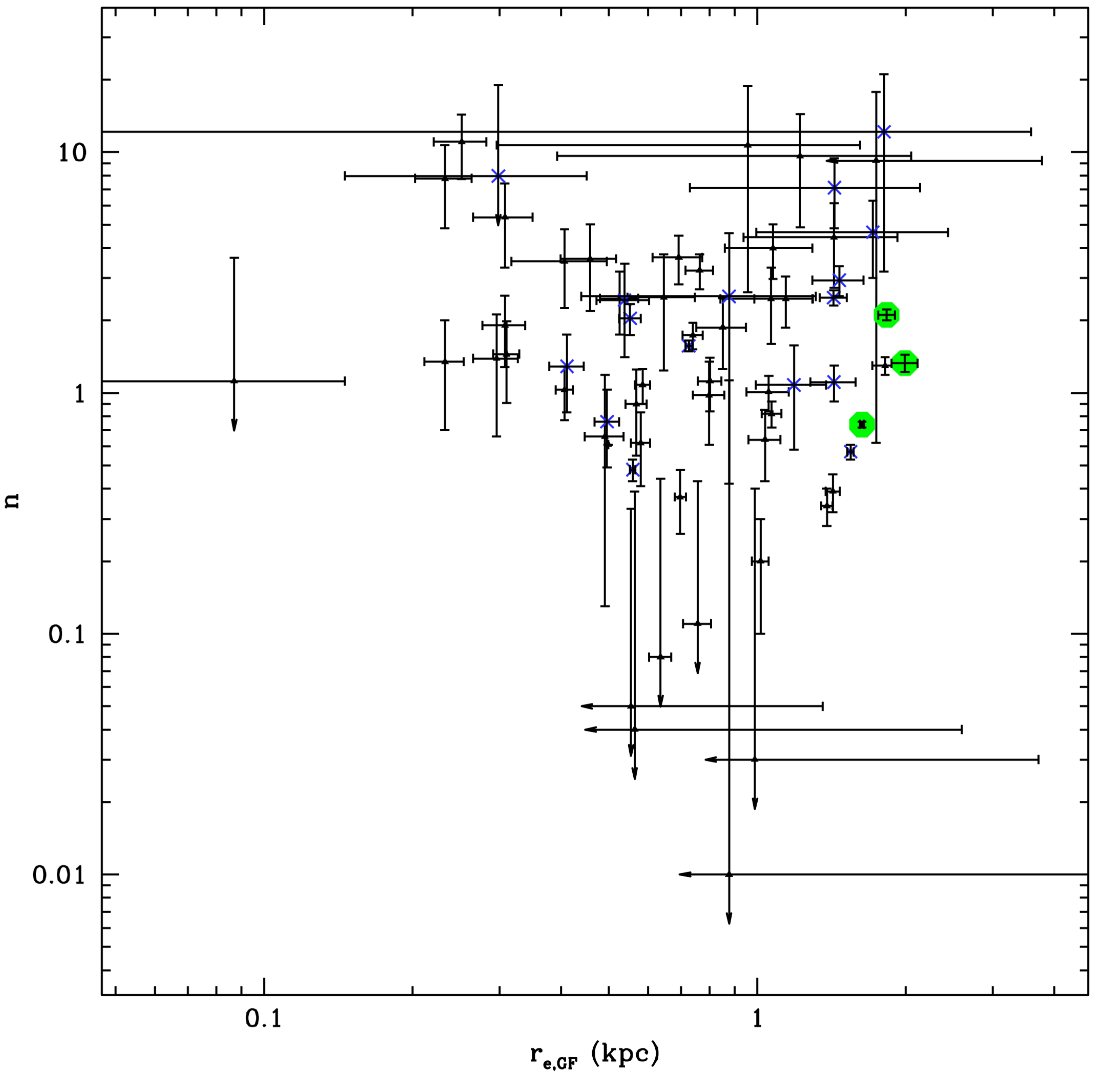
Morphologies of LAEs

- 120 Lyα emitters are located within HST/ACS GOODS field, allowing for a detailed study of their morphologies
  - Tend to be small (sub-arcsec radii), 0.5 – 2.4 kpc
  - Quantitative morphological analysis using GALFIT: majority are highly concentrated, variety of Sersic profiles
  - Evidence for bi-modality at n~2 (beginning of Hubble sequence?)
  - Need S/N ~ 30 to robustly measure morphology
  - To be published in Bond+ 2009, Gronwall+ 2009

Sizes of LAEs



Morphologies of LAEs



Conclusions

- LAEs at z ~ 3.1 are young, low-mass, low dust systems -- galaxies in the act of formation, but not Pop III
- No extremely high EW LAEs seen
- Low amount of inferred dust
- SFR = 1 - 10 $M_{\odot}$ / yr ==> high specific star formation rates
- Morphologies are varied, small
- Clustering (talk by Francke), luminosity function (see Gronwall+ 2007)
- Well defined large sample enables further detailed study of these important galaxies!

Upcoming Work

- Follow-up optical spectroscopy -- in progress using Magellan + VLT. Also plan to use SALT/RSS for higher resolution to resolve Lyα emission line --> kinematics and near-IR spectroscopy using Gemini/ FLAMINGOS-2
- Spatial correlation function
- Evolution and properties at lower redshift
  - Comparable data through [OII] filter (z ~ 2.1) in hand, see poster by Guaita
- Detailed comparison to LBGs at same redshift