

Physical Properties of Ly α 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

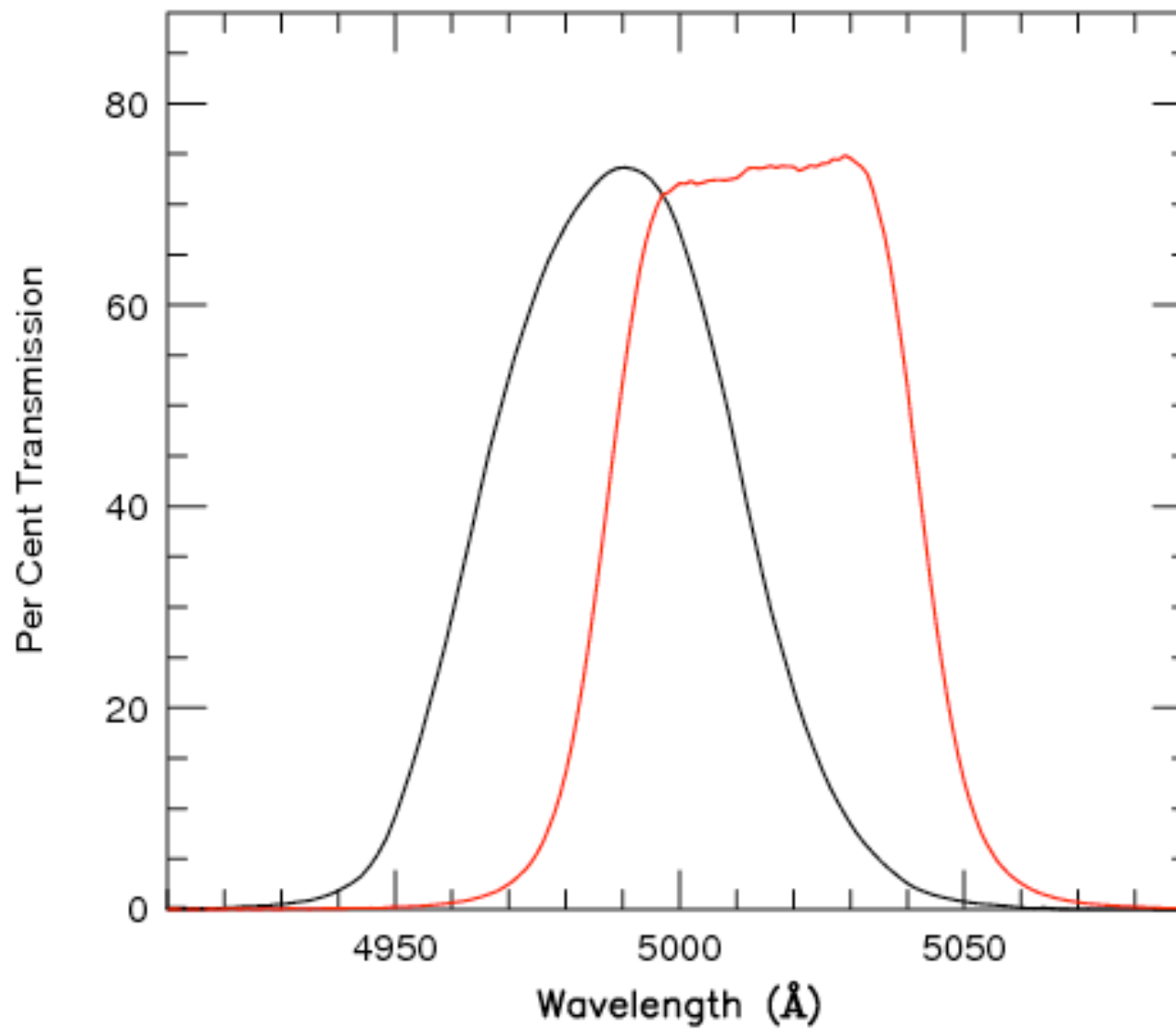
PSU undergrads: Tom Hickey, Justin McKane, Emily McCathran,
Chris Wolff, Shawn Sinawa

Why $z \sim 3.1$?

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

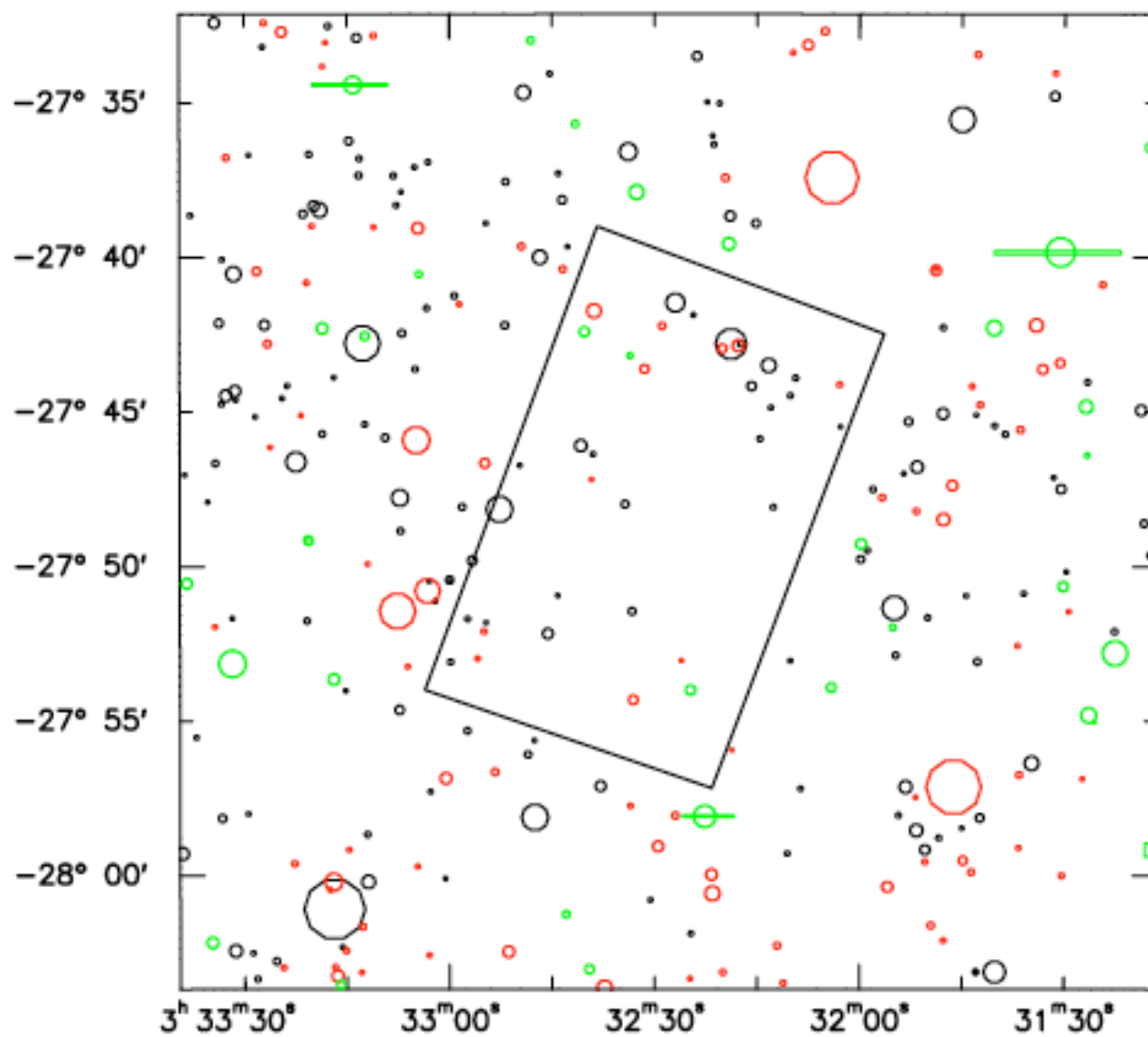
Our Observations

- Narrow-band [O III] $\lambda 4990, 5025$ 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
 - $\lambda 4990$ results published in Gronwall+ 2007, Gawiser+ 2007
 - Also have [OII]] $\lambda 3727$ data ($z \sim 2.1$), see poster by Guaita
- Detect galaxies via:
 - Difference image
 - On-band – Off-band color



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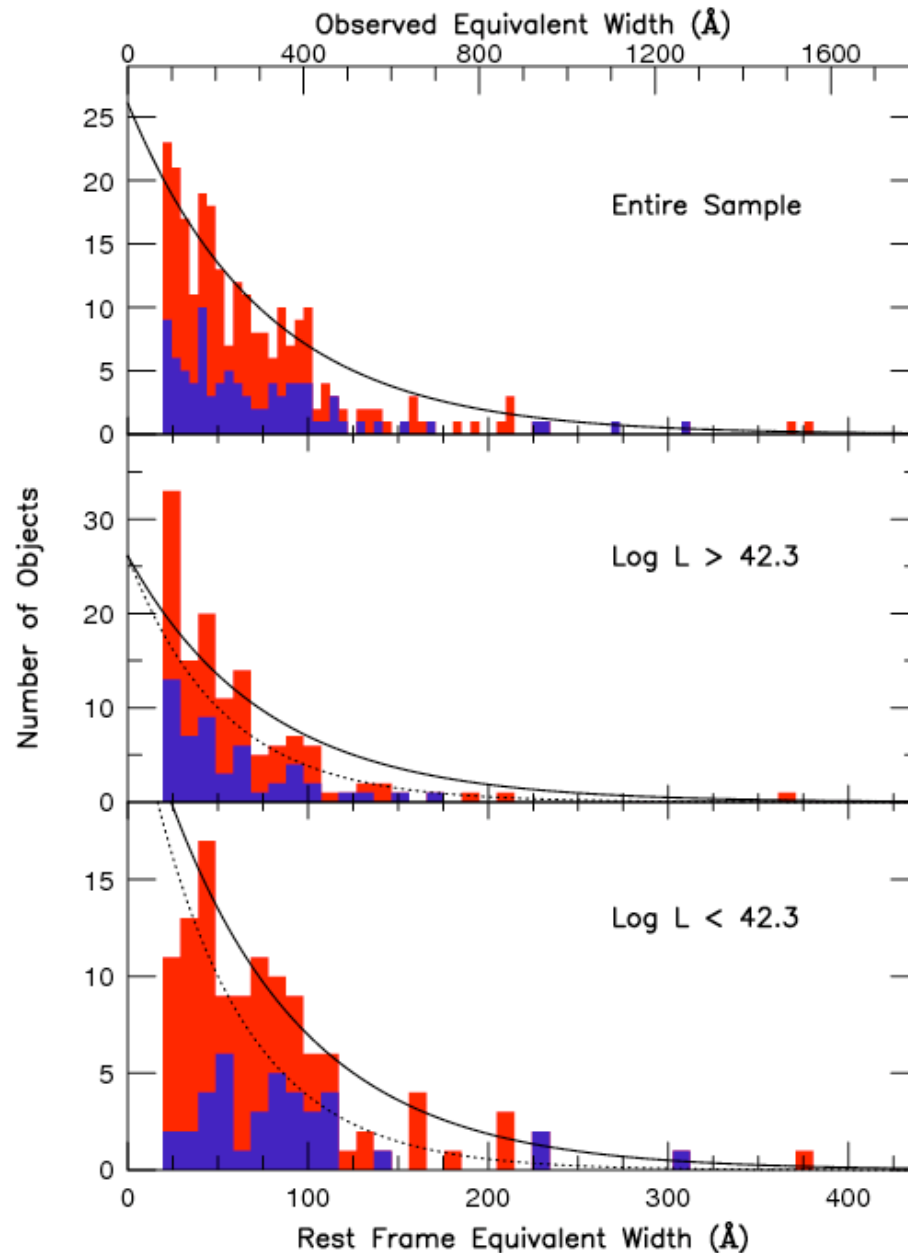
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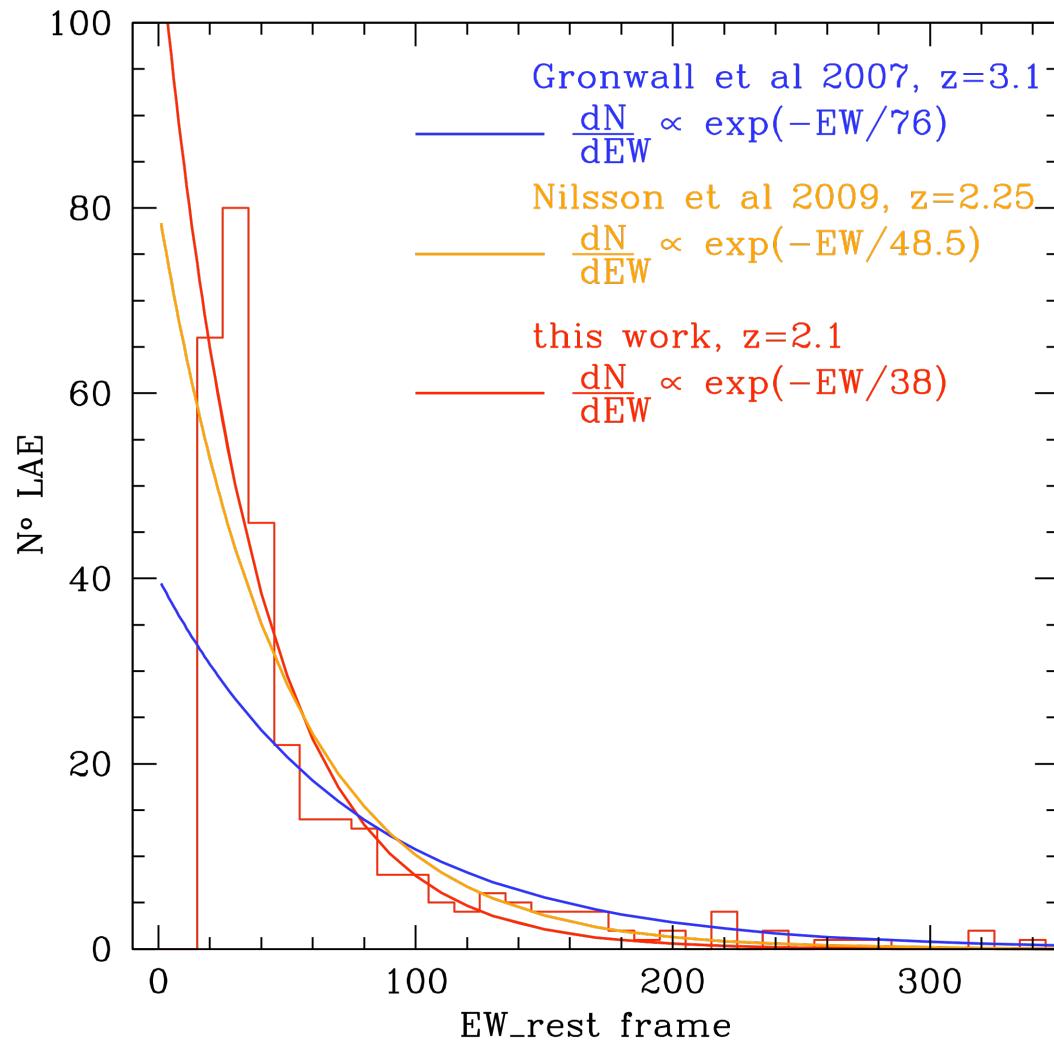
Results

- Detected 156 Ly α emitters in 4990, 158 in 5025 (96 new) with:
- observed EW > 80 Å
- monochromatic flux > 1.5×10^{-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

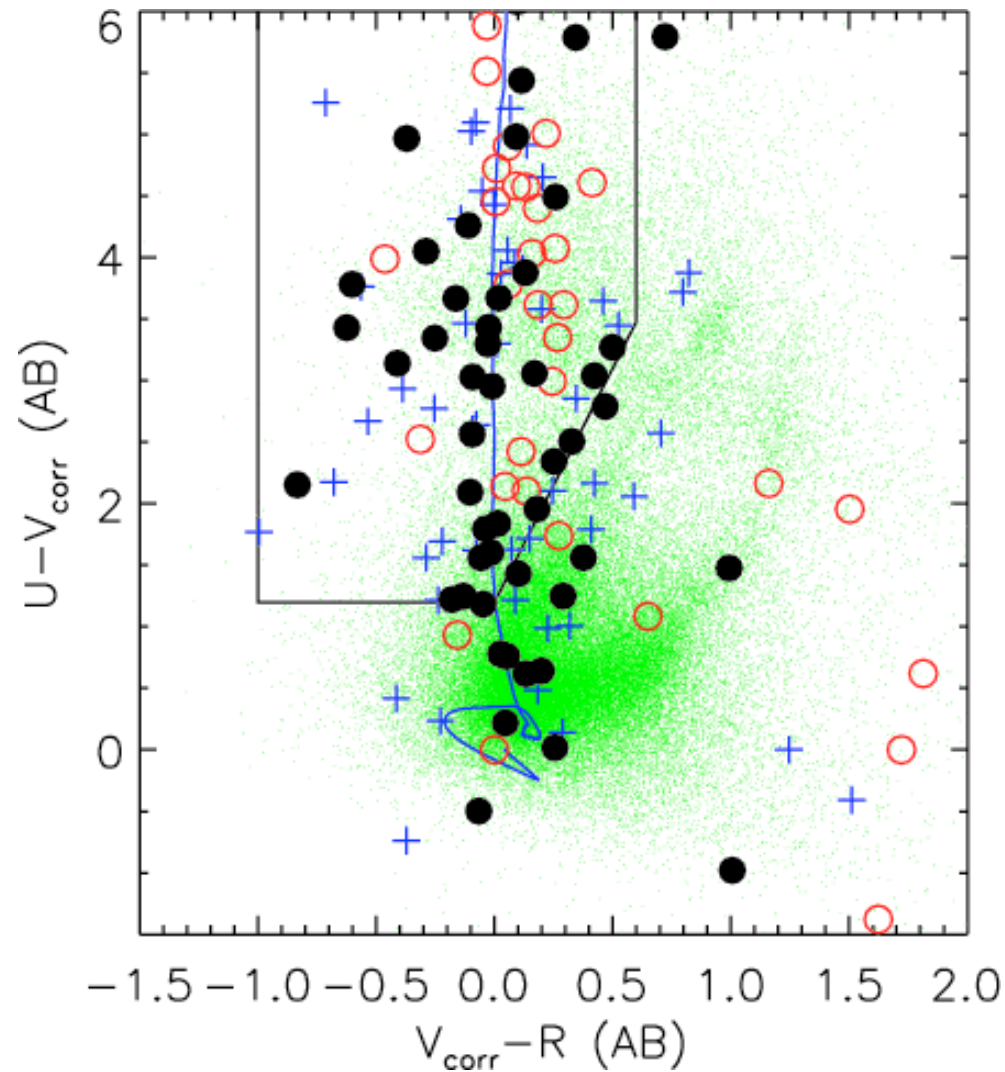


- Less than 10% of LAEs have $EW_0 > 240 \text{ \AA}$
- EW distribution is exponential with scale length of 76 \AA
- Extrapolation implies $\sim 20\%$ of LAEs fall below the EW cutoff



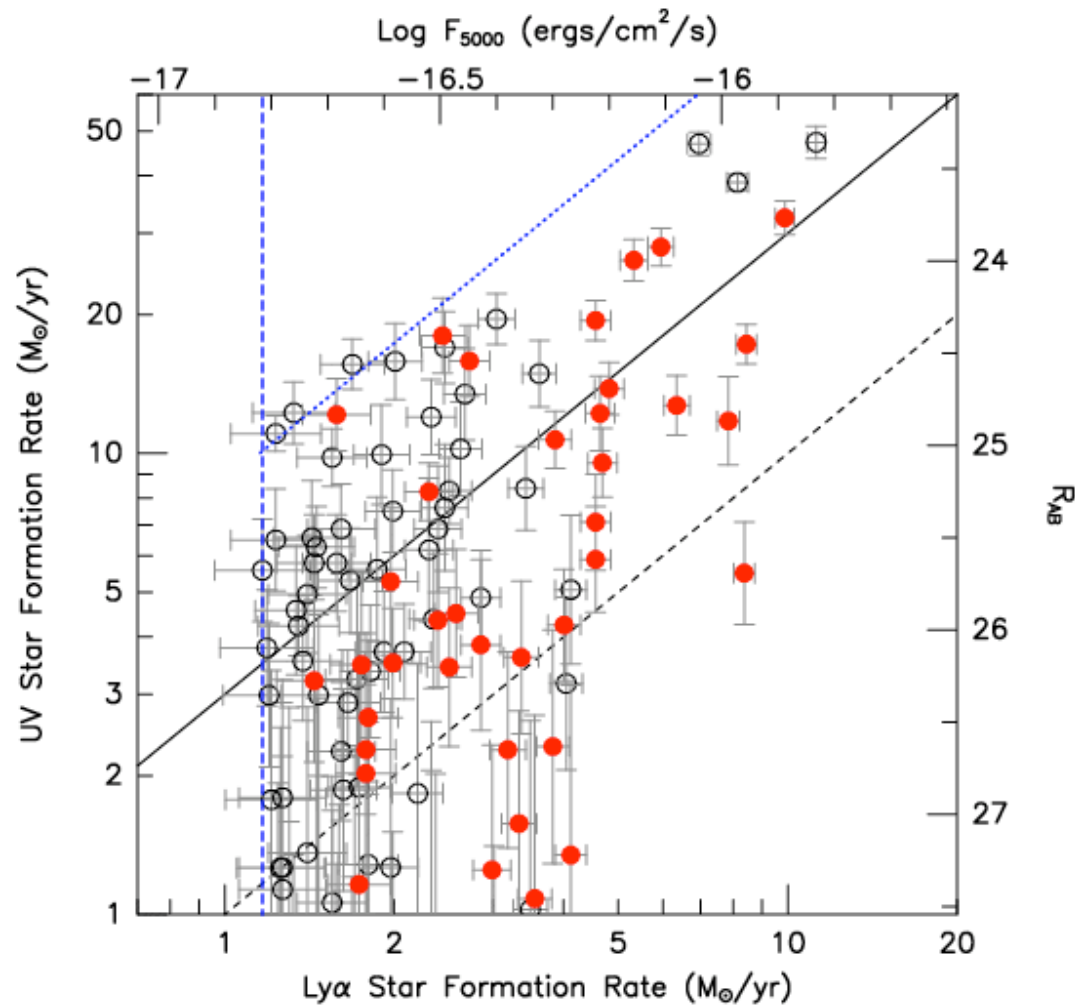
EWs at $z \sim 2$ are narrower, poster by Guaita

Comparison to LBGs



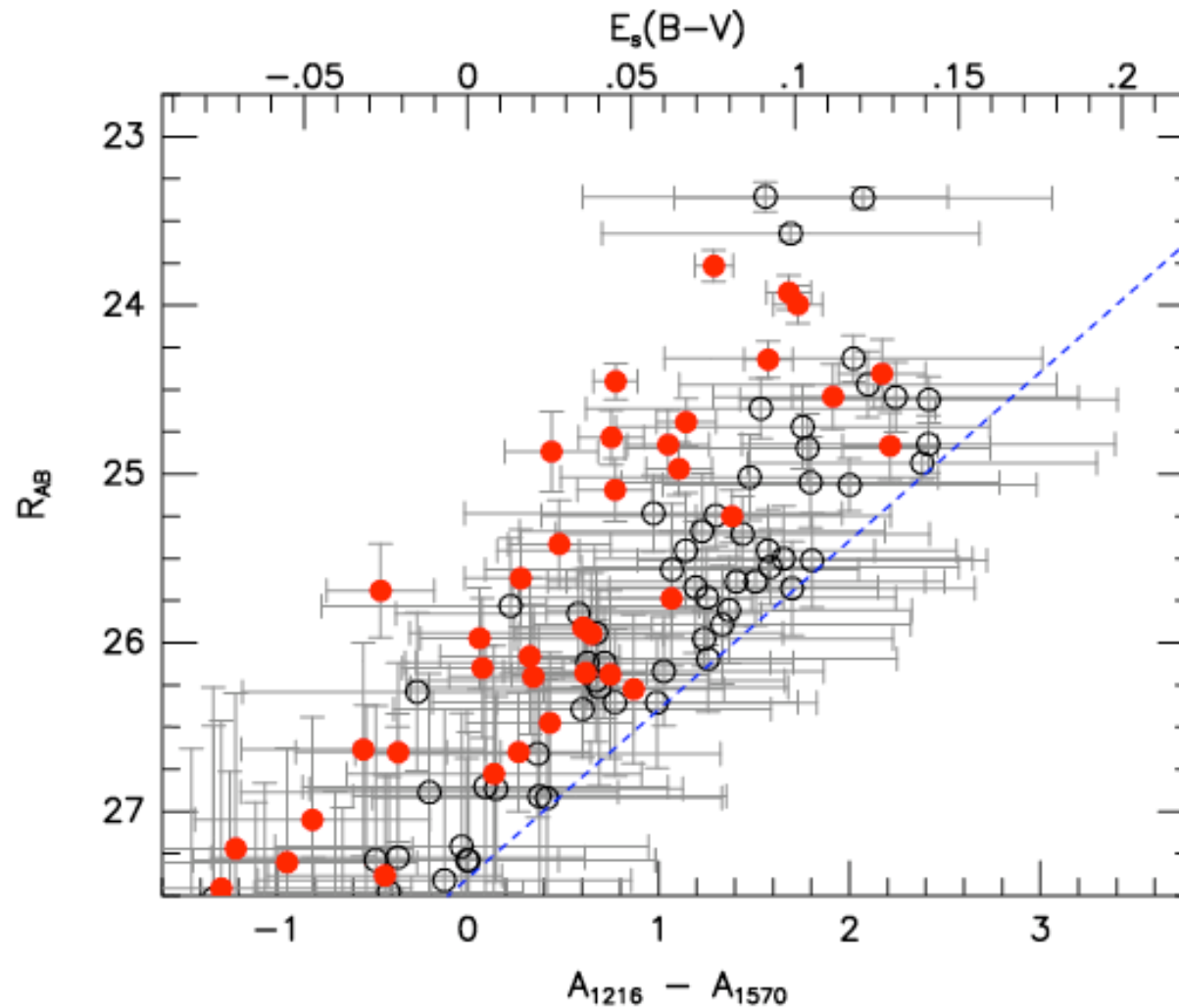
LAEs primarily
fall in same region
in color-color space
as LBGs

UV vs. emission-line SFR



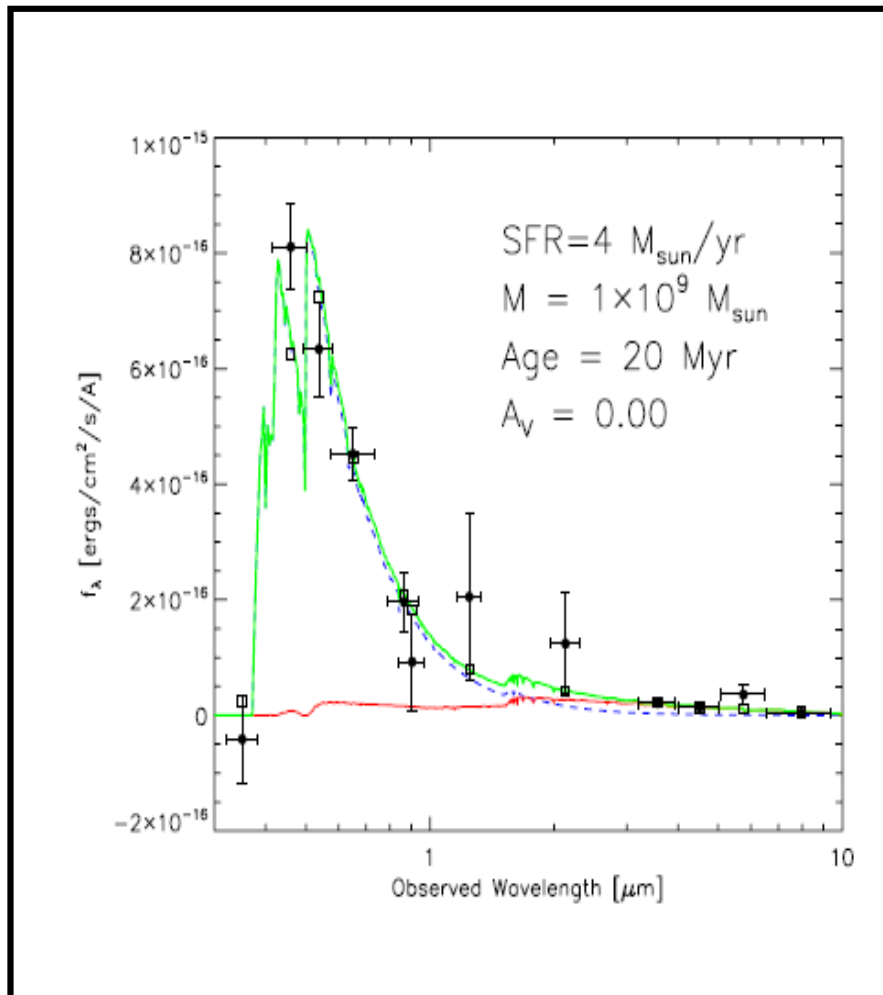
UV SFRs are 3x
emission-line SFRs
==> dust!

Extinction (assuming Calzetti law)



But amount
of extinction is
low!

SED Fitting

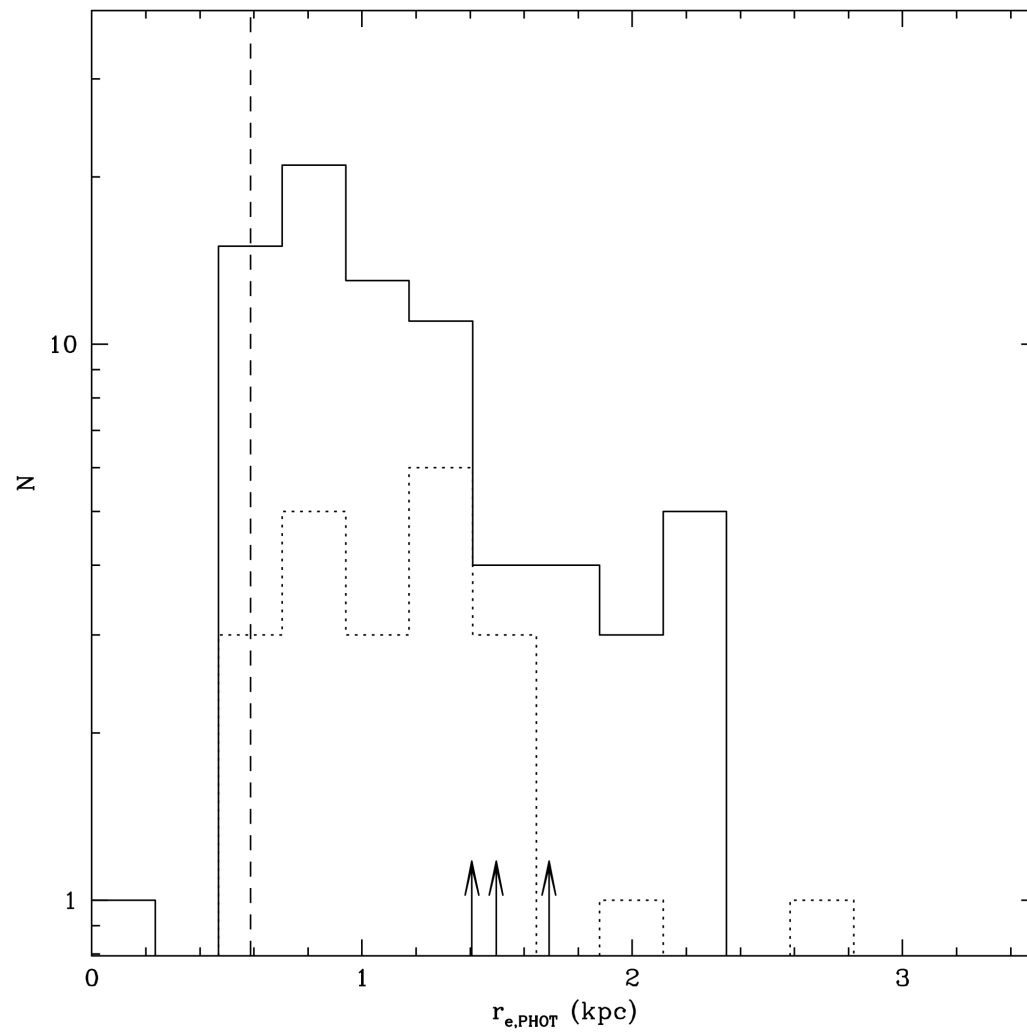


- Two component model, stacked photometry (optical, near-IR, mid-IR)
- Average age = 20 Myr
- Average mass = $10^9 M_{\odot}$
- Average SFR = $4 M_{\odot} / \text{yr}$
- High specific SFR

Morphologies of LAEs

- 120 Ly α 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 $n \sim 2$ (beginning of Hubble sequence?)
 - Need S/N ~ 30 to robustly measure morphology
 - To be published in Bond+ 2009, Gronwall+ 2009

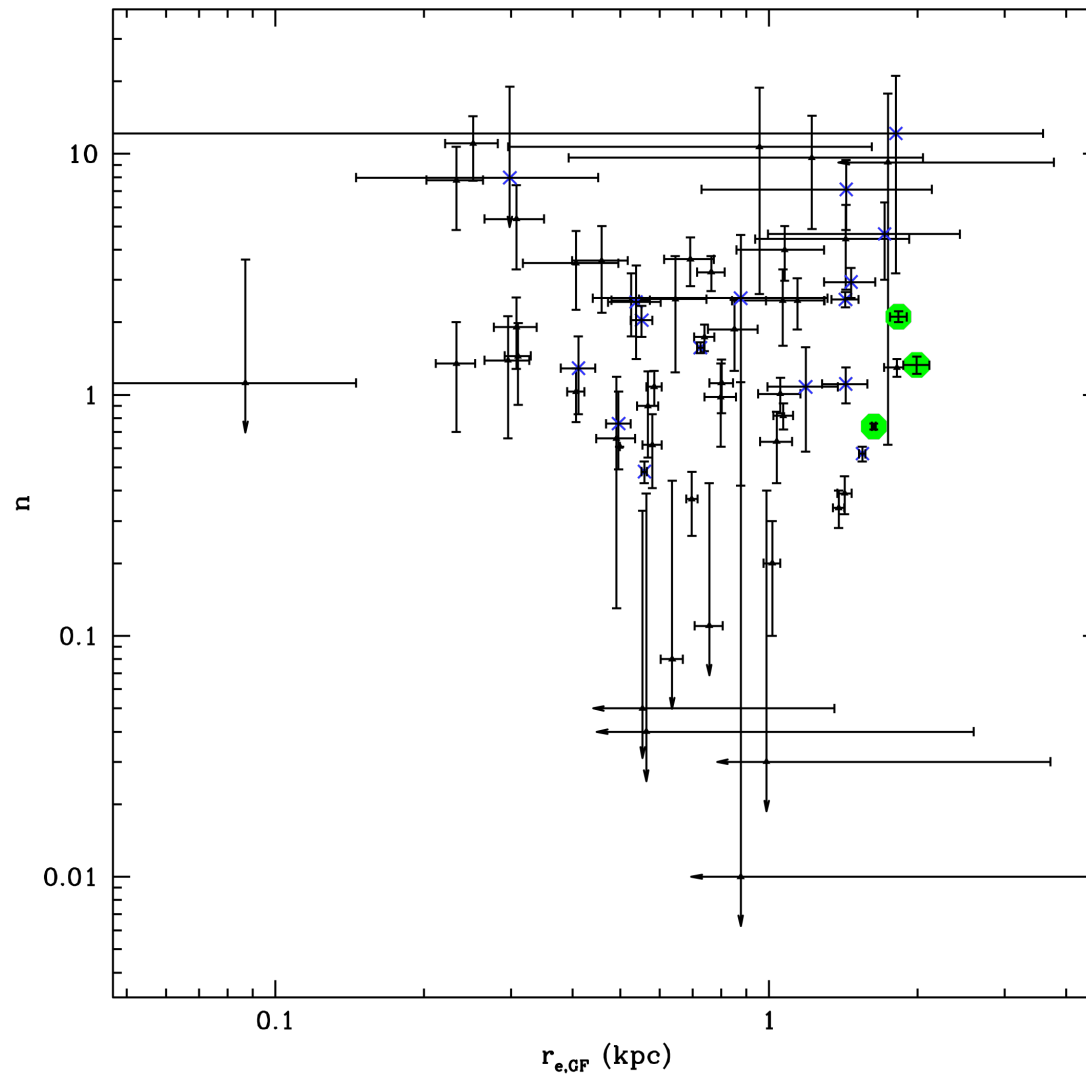
Sizes of LAEs



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Morphologies of LAEs



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Conclusions

- LAEs at $z \sim 3.1$ 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
- $\text{SFR} = 1 - 10 M_{\odot} / \text{yr} \implies$ 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 Ly α 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 ($z \sim 2.1$) in hand, see poster by Guaita
- Detailed comparison to LBGs at same redshift