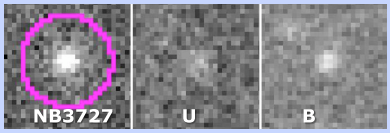
Lyman Alpha Emitting Galaxies at z=2.1: Understanding the Formation of Present-day L* Galaxies



Lucia Guaita[1], Eric Gawiser[2], Nelson Padilla[1], Harold Francke[1], Nick Bond[2], Caryl Gronwall[3], Robin Ciardullo[3], John Feldmeier[4] & MUSYC collaboration

1 Pontificia Universidad Católica de Chile, 2 Rutgers University, 3 Penn State, 4 Youngstown State University

Abstract:

We discovered a **sample of 350 Lyman Alpha Emitting (LAE**) galaxies at z = 2.1 in an ultra-deep 3727 Å narrow-band image (50 Å FWHM) of the Extended Chandra Deep Field South. Our analysis of this sample follows that used to determine the luminosity function, star formation rates, stellar masses, and dark matter masses of LAEs at z = 3.1 (Gronwall et al, ApJ, 667:79-91,2007, Gawiser et al, ApJ, 671:278-284, 2007). Our results show that the **luminosity function** of LAEs at z = 2.1 is **consistent** with that of LAEs at z = 3.1, but with **twice the number density.** LAEs at both epochs **show moderate star formation rates of ~ 3$M_\odot$/yr**. Clustering analysis shows that these two samples of objects, LAEs at z = 2.1 and at z = 3.1, have lower clustering bias than any other high-redshift galaxy population. Both samples of LAEs have dark matter halo masses ~ 10^{11} $M_\odot$, which are the **lowest-mass halos** yet probed at these redshifts. We used the Sheth-Tormen (Mon. Not. R. Astron. Soc. 308:119-126, 1999) conditional mass function to study the descendants of these LAEs and found that **they appear to represent progenitors of present-day L* galaxies** like the Milky Way.

Selection:

We apply the **narrow-band excess technique** to select a sample of 350 LAEs in the E-CDFS from narrow band images at 3727 Å, corresponding to Lyα emission at **z = 2.1.** We apply a **color cut,** requiring a narrow-band flux density excess versus UB (a linear interpolation of the U and B broad-band fluxes), consistent with Equivalent Width **(EW) bigger than 20 Å**. we choose objects brighter than the **5 σ detection limit** of mag_3727 = 25.1 and require that the narrow-band excess is statistically significant (Fig 1, Fig 2).

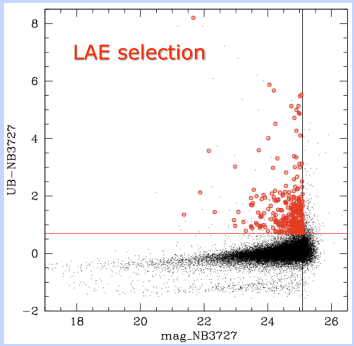


*Fig1: **narrow-band detected catalog**, UB-NB3727>0.7, mag_NB3727<25.1*

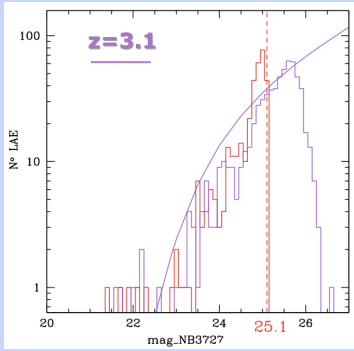


*Fig2: The **narrow-band magnitude distribution** is consistent with that predicted by the z=3.1 luminosity function (Gronwall et al 2007).*

Results:

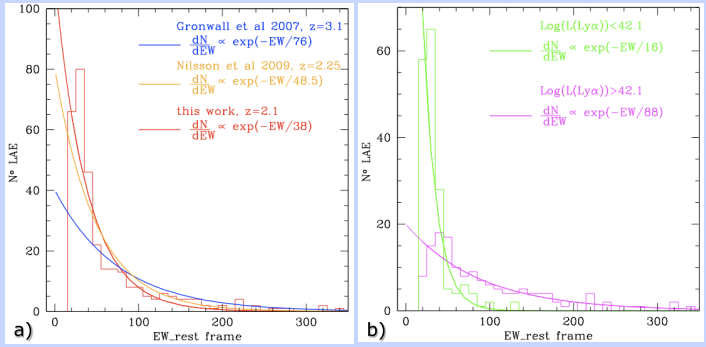


*Fig3: a) EW distribution of LAEs (red histogram) fitted with an **exponential** law. It is narrower than that observed at z=3.1 and similar to a z=2.25 sample (Nilsson et al, A&A 498, 13-23, 2009).*
*b) When dividing the sample based on Lyα luminosity, we find a **luminosity dependence**.*

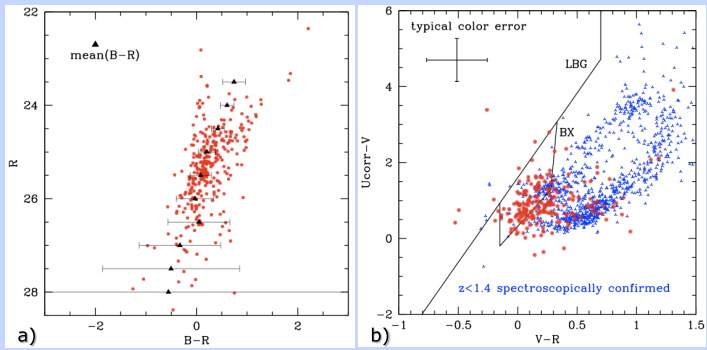


*Fig4: a) R magnitude as a function of the average LAE B-R color and its uncertainty (black triangles with error bars). LAEs are **blue galaxies**. The scatter in B-R color is bigger than the **typical** uncertainty for R<26.*
*b) UVR diagram subtracting the emission line contribution from the U magnitude. LAEs have colors consistent with **z=2 star forming** galaxies (central quadrilateral).*

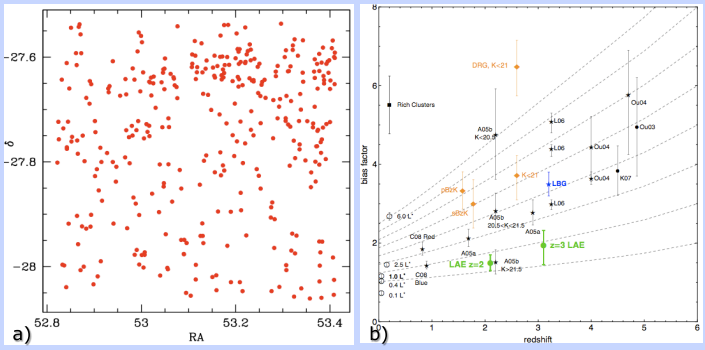


Fig5: a) LAE spatial distribution, from which we use the angular clustering to calculate the bias factor (galaxy clustering divided by dark matter clustering)
*b) Following bias evolution tracks predicted by the Sheth-Tormen (1999) conditional mass function, LAEs at z=2.1 appear to be **progenitors of z=0 L* galaxies**.*

Conclusions:

- We selected of 350 LAEs at z=2.1 (Guaita et al in prep) in the E-CDFS (Fig 1).
- We find **no evidence for luminosity evolution,** but a factor of 2 increase in number density (Fig 2) versus LAEs at z=3.1 (Gronwall et al 2007)
- The EW distribution appears narrower than that at z=3.1, but consistent with that reported for z=2.3 (Nilsson et al 2009) and we find the first evidence for **luminosity dependence** (Fig 3).
- LAEs are predominantly **blue** (B-R<1, Fig 4) and have similar continuum colors to **z=2 star forming** galaxies, but half of the z=2.1 LAEs are too dim to be found in continuum-selected samples.
- Our clustering analysis shows that LAEs at z=2.1 **typically evolve into L* galaxies at z=0** (Fig 5), consistent with the findings of Gawiser et al (2007) for LAEs at z=3.1.