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Stellar Populations of Lyman Alpha Emitters at z = 4.86: A Comparison to z~5 LBGs

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Introduction

In recent years, there are many studies about the stellar populations of Lyman alpha emitters (LAEs) at various redshifts (e.g., Gawiser et al. 2006, 2007; Lai et al. 2007, 2008; Nilsson et al. 2007; Finkelstein et al. 2007, 2008, 2009; Pirzkal et al. 2007). They found a large range of ages (1Myr-1Gyr) and stellar masses (10^6-$10^{10}M_\odot$). Most LAEs are found to have low dust extinction; however, some are dusty. The interesting question is how LAEs differ from Lyman break galaxies (LBGs). Although there are a number of papers concerning the stellar populations of LBGs at various redshifts (e.g., Shapley et al. 2001,2005; Stark et al. 2007; Verma et al. 2007; Yan et al. 2006; Eyles et al. 2007), few studies mentioned the comparison of the stellar populations between LAEs and LBGs (Shapley et al. 2001; Kornei et al. 2009; Pentericci et al. 2007). Shapley et al. (2001) and Kornei et al. (2009) found that LBGs with Ly α line at z~3 are older than those without Ly α line, whereas Pentericci et al. (2007) indicated that at z~4 LBGs with Ly α line are younger. At higher redshift, although there are some SED studies of LAEs and LBGs, the relation between them is still unknown. In this work, by using the same SED model, we make a fair comparison between the stellar populations of LAEs and LBGs which are selected in the same field at the same redshift down to the same UV luminosity limit.

Data and SED fitting

Data set : Optical : Suprime-Cam (V, NB711, I_c and z' bands)
Infrared : IRAC (ch1-2 (3.6-4.5μm))
Field : GOODS-N and flanking field (~450 arcmin^2)

24 objects selected as LAEs at z = 4.86 using Suprime-Cam images

16 objects have IRAC coverage.

12 LAEs without contamination by neighboring objects in IRAC images

- **Model parameters:**
  - Bruzual & Charlot (2003)
  - Salpeter IMF 0.1-100 $M_\odot$
  - 0.2$Z_\odot$ metallicity
  - Calzetti dust extinction law (2000)
  - Constant Star Formation History (CSF)
  - Adding Hα line (propositional to SFR) to IRAC 3.6μm band
  - Fix redshift at z =4.86

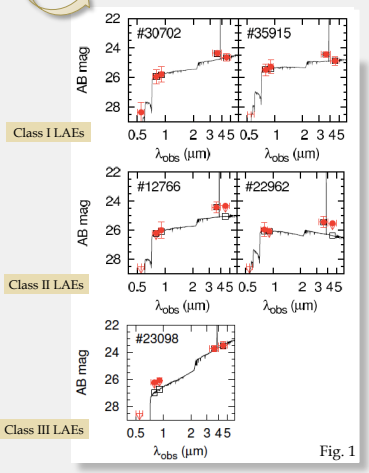


Fig. 1

12 LAEs without contamination by neighboring objects are divided into 4 classes:

Class I: Detected in Ic, z', IRAC 3.6μm and 4.5μm images
Class II: Undetected in IRAC 3.6μm and/or 4.5μm images
Class III: Undetected in Ic and/or z' images
Class IV: Undetected in more than 2 images

5 LAEs from class I, II, and III are used to fit with model SEDs

Comparison to LBGs: the same redshift, same field, same SED model

The difference between LAEs and LBGs at high redshift is one of the most interesting questions in the study of high-redshift galaxies. LBGs, which are used to compare with our results, are selected at the same redshift from the same field of observations (Yabe et al. 2009, ApJ, 693, 507). The stellar properties of LBGs are derived by using the same model parameters as described above. Since the different in model parameters may affect in different SED fitting results, using the same SED model will provide us unbiased comparison between LAEs and LBGs at the same redshift. **Down to the same UV luminosity limit ($M_{1500Å}$ < -20 mag)**, we compare 3 LAEs to 88 LBGs.

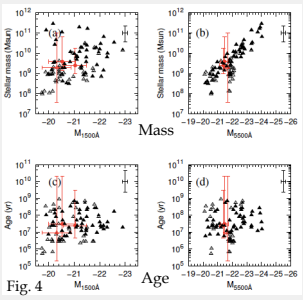


Fig. 4

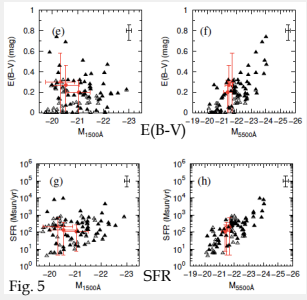


Fig. 5

* Class I and II LAE are indicated in red filled circles and open triangles, respectively, whereas LBGs are in filled and open triangles.

- No LAEs at the bright part of the UV plot (Figures 4 and 5). This supports the deficiency of Ly α emission of bright LBGs claimed by Ando et al. (1990, ApJ, 645, L9).
- LAEs also distribute at the faint part of optical magnitudes of LBGs at the same redshift.
- Both LAEs and LBGs show good relation between the stellar mass and optical absolute magnitude.
- LAEs lie at the lower part of LBGs' distributions of the stellar mass, dust extinction, and SFR

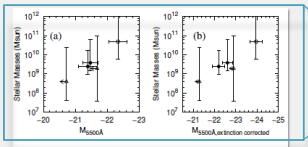
The stellar mass, dust extinction, and SFRs of LAEs are on average smaller than those of LBGs at the same redshift, but the values are comparable when we fix the UV or optical luminosity.

Results

Ranges of best estimated properties from SED fittings:

Stellar masses : 10^8-10^{10} $M_\odot$	median : 2.5x10^9 $M_\odot$
Age : 7.4 – 437 Myr	median : 25 Myr
E(B-V) : 0.0 – 0.4 mag	median : 0.27 mag
SFRs : 55 - 209 $M_\odot$/yr	median : 132 $M_\odot$/yr

Most LAEs are young and low dust extinction but old age and dusty LAE is also acceptable!


The brighter the optical luminosity, the more massive the stellar mass.

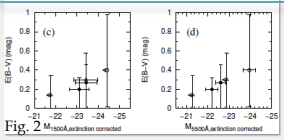

Massive LAEs tends to show higher star formation rates and more dusty environment.

Fig. 2

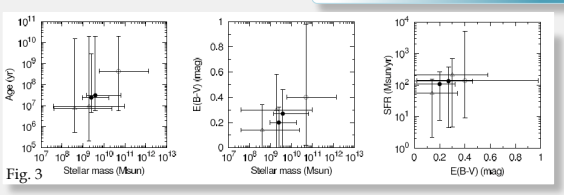


Fig. 3

* Class I LAEs: Filled circles
Class II LAEs: Open triangles
Class III LAEs: Open circles

What make LAE LAE?

In order to find the answer, we plot the relationship between the rest-frame Lya equivalent width and SED fitting outputs.

- We could not find any significant correlation.
- In contrast to Kornei et al. (2009) who studied the correlations for z~3 LBGs and found that the stellar mass does not correlate with Lya EW, but large Lya EW is seen in older, lower SFR, and less dusty LBGs.
- There maybe a redshift evolution?
- A larger sample at z~5 is required to see clearer relations if any.

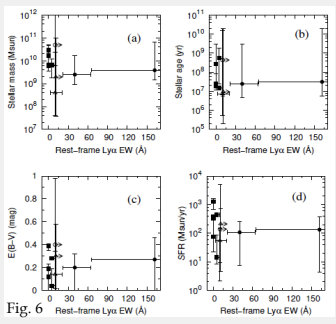


Fig. 6

* Symbols for LAEs are the same as those in Fig. 2 and 3.
* Filled squares represent LBGs with the spectroscopic Lya EWs.