Unveiling the nature of Lyman Alpha Emitters

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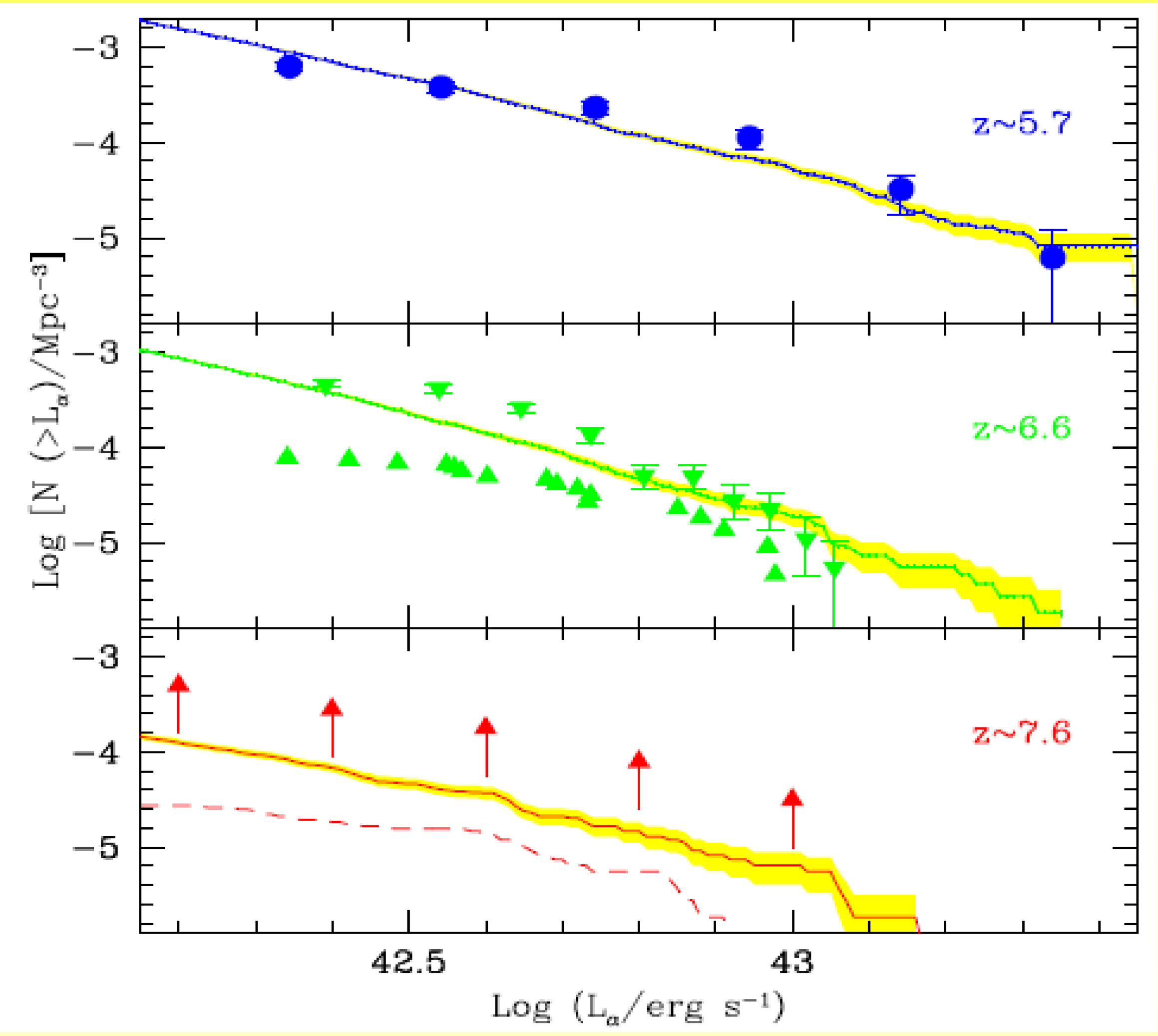
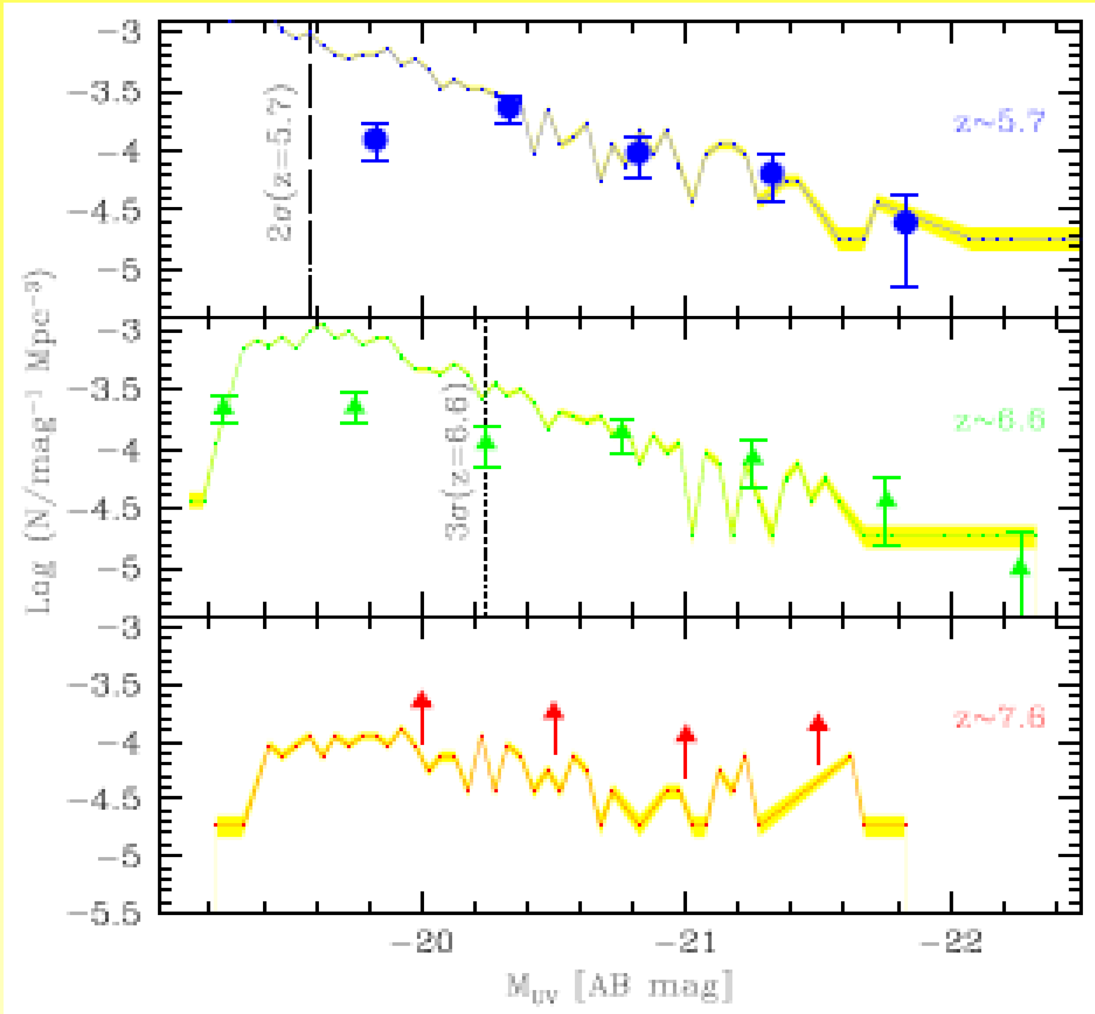
Combining state-of-art cosmological SPH simulations with a previously developed Lyα production/transmission model, we show how the LAE Lyα luminosity functions observed at various redshifts might be affected by the presence of intergalactic neutral gas. We clarify the role of dust evolution in shaping the Lyα and UV LFs. For the first time a coherent picture is developed in which the nature and global properties (stellar mass, star formation rate, metallicity, IMF) of the emitters are linked to their visibility. We also test our model by reproducing the SEDs of specific high-z LAEs, as observed by Lai et al. 2007, for which Spitzer data are available.

Simulations, Lyα and UV LF



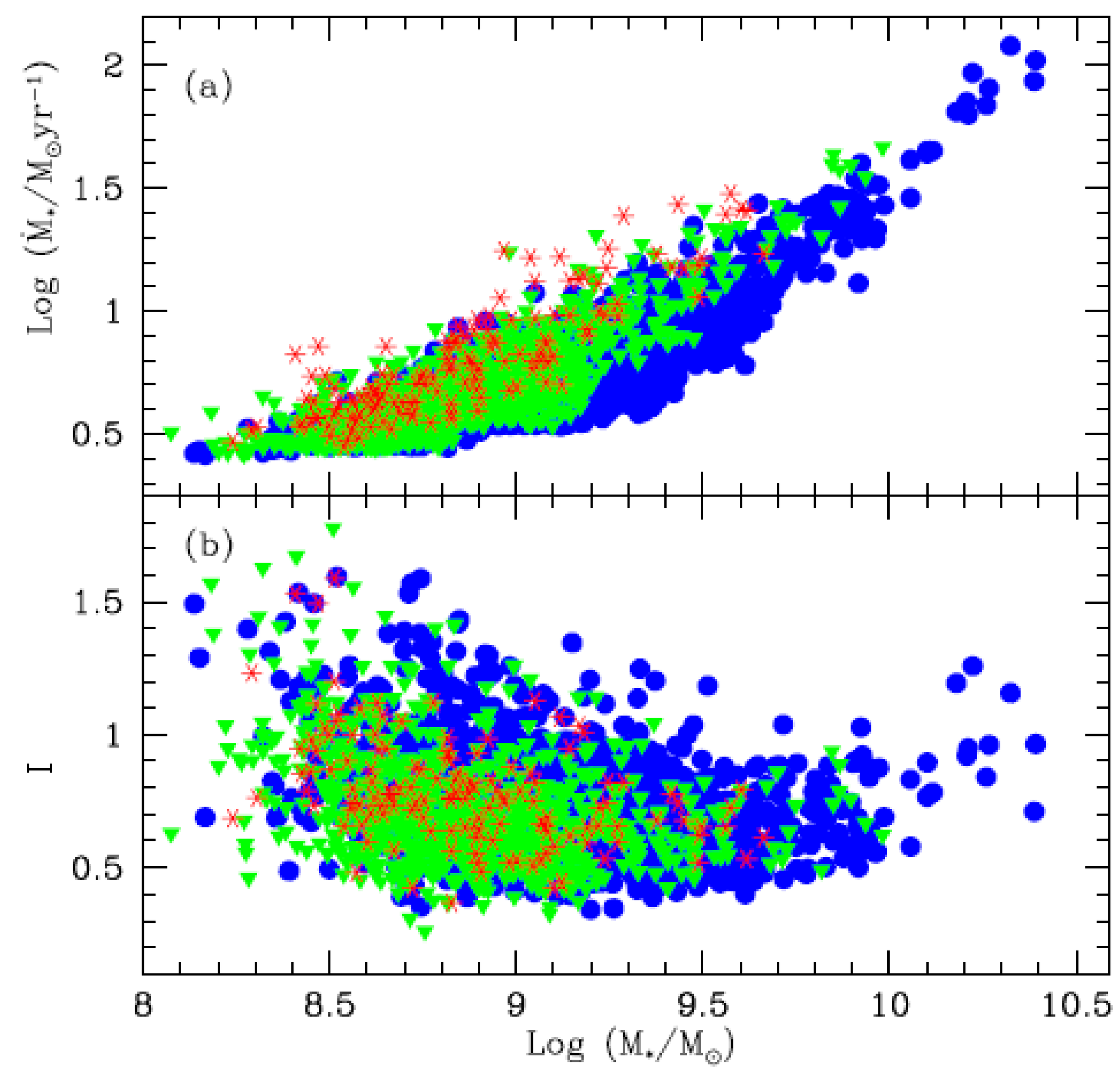
Cumulative Lyα LF for the ERM. Solid (dashed) lines in each panel refer to model predictions including (excluding) clustering effects which shows these are unimportant for a highly ionized IGM; observations are shown with points. Shaded regions show poissonian errors. Due to lack of RT, our results represent lower limits at z=7.6.

- Combine GADGET 2 with chemodynamics (Tornatore et al. 2007) to get state of the art cosmological simulations.
- Calculate the intrinsic Lyα and UV luminosity for each galaxy using STARBURST 99 depending on the intrinsic properties – SFR, age, stellar metallicity and IMF.
- Calculate the size of the HII region carved out by each galaxy and compare with the separation from other galaxies to obtain the photoionization boost due to spatial clustering.
- A single value of the escape fraction of Lyα photons =0.3 enough to reproduce data at both Z.
- escape fraction of continuum photons decreases from 37% at Z=7.6 to 22% at Z=5.7.
- E(B–V)=0.15 at z=5.7.



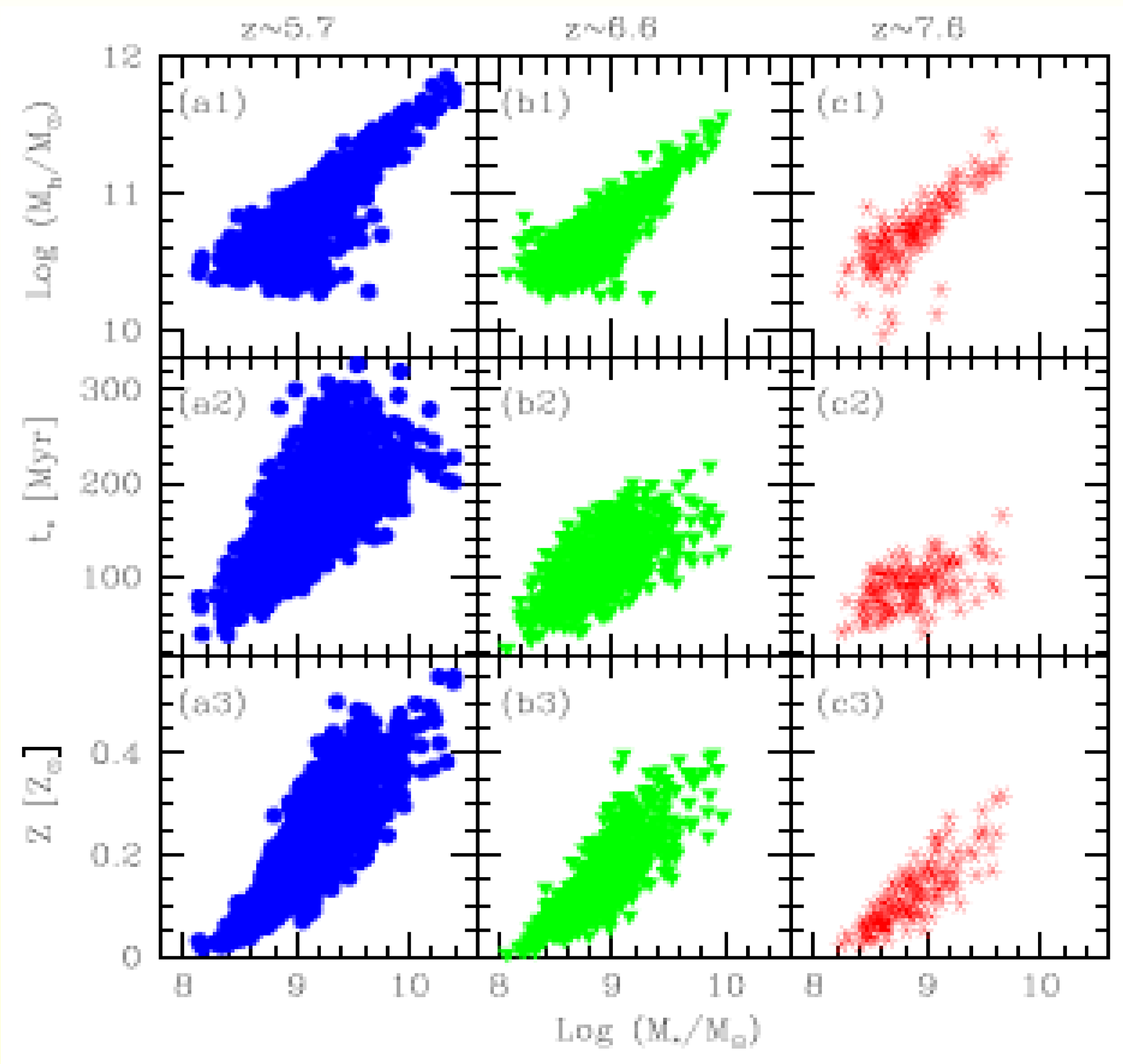
UV LAE LF for the ERM. Lines (points) refer to model predictions (observations) including clustering. The shaded regions show the poissonian errors. Because RT is not accounted for, our results represent lower limits at z=7.6.

The nature of LAEs



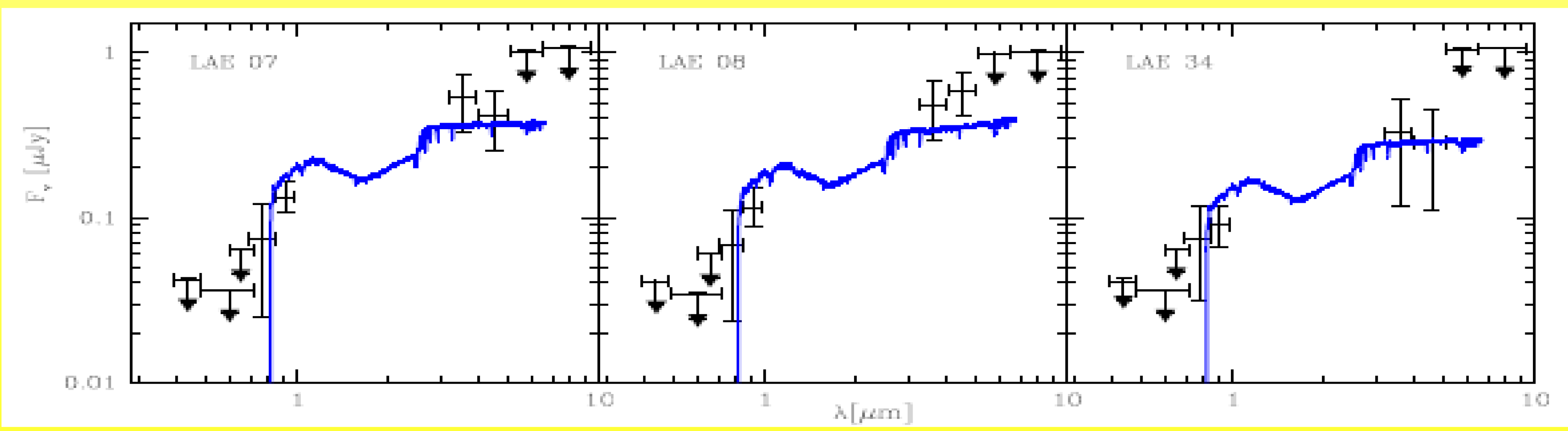
(a) SFR and (b) SFR indicator, $I = \dot{M}_* / t_*$, as a function of stellar mass (M_*) for LAEs at three redshifts: z ~ 5.7 (circles), z ~ 6.6 (triangles) and z ~ 7.6 (asterisks).

- LAE SFR are in the range 3–120 solar mass/yr and as expected, SF is suppressed in low mass dark matter halos.
- Most LAEs had a higher SFR averaged over the entire history as compared to the final value obtained.
- Range of halo masses narrows with increasing redshift due to shift in the mass function.
- LAEs are intermediate age objects (40–330 Myr), with the age range narrowing with redshift.
- Average stellar metallicity is ~12% of the solar value at z=7.6 and rises to ~22% of the solar value at z=5.7.
- LAEs contribute about 9% to the global SFR density at z=5.7.



Physical properties of LAEs at z ~ 5.7, 6.6 and 7.6 as referred to by columns. As a function of stellar mass, M_*, we show (a) the halo mass, M_h, (a1-c1), (b) mass-weighted stellar ages, t_*, (a2-c2), and (c) mass-weighted stellar metallicity, Z, (a3-c3).

LAE SEDs



Comparison of theoretical SEDs (lines) with observations (points) from Lai et al. (2007) at z=5.7. Points with downward pointing arrows represent the 3σ upper limits of the data.

- Choose 3 LAEs at z=5.7 whose observed Lyα luminosity matches most closely with the values obtained by Lai et al. (2007), and attenuate the spectra using E(B–V)=0.15.
- With no free parameters, we match the three spectra perfectly.

Conclusions

- LAEs contain dust, with E(B–V)=0.15 at z=5.7 and this decreases with redshift.
- The Lyα and UV LFs hint at a homogenous dust distribution in the ISM at z=6.6, which becomes clumpy at z=5.7.
- Photoionization boost due to clustering effects unimportant for an highly ionized IGM.
- LAEs are intermediate age objects (40–300 Myr) with no bimodality seen in the age distribution.
- SFR are in the range 3–120 solar mass/yr at z=5.7.
- With no free parameters, we match observed LAE SEDs perfectly.