Simulating high-redshift galaxies

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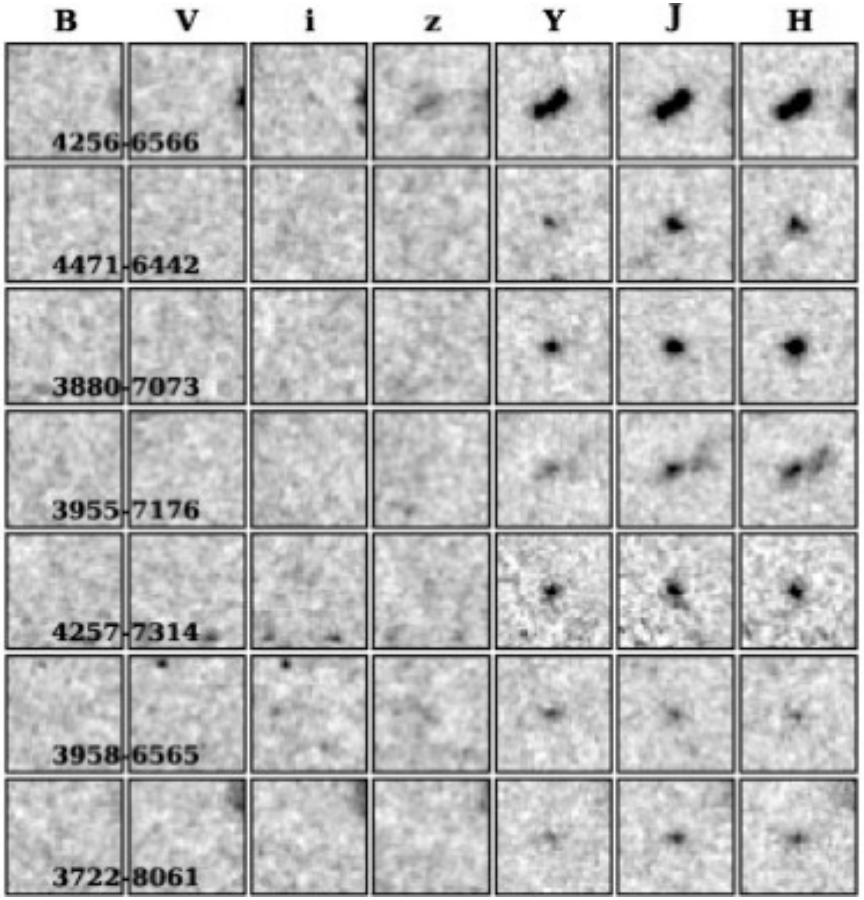
DEX VIII

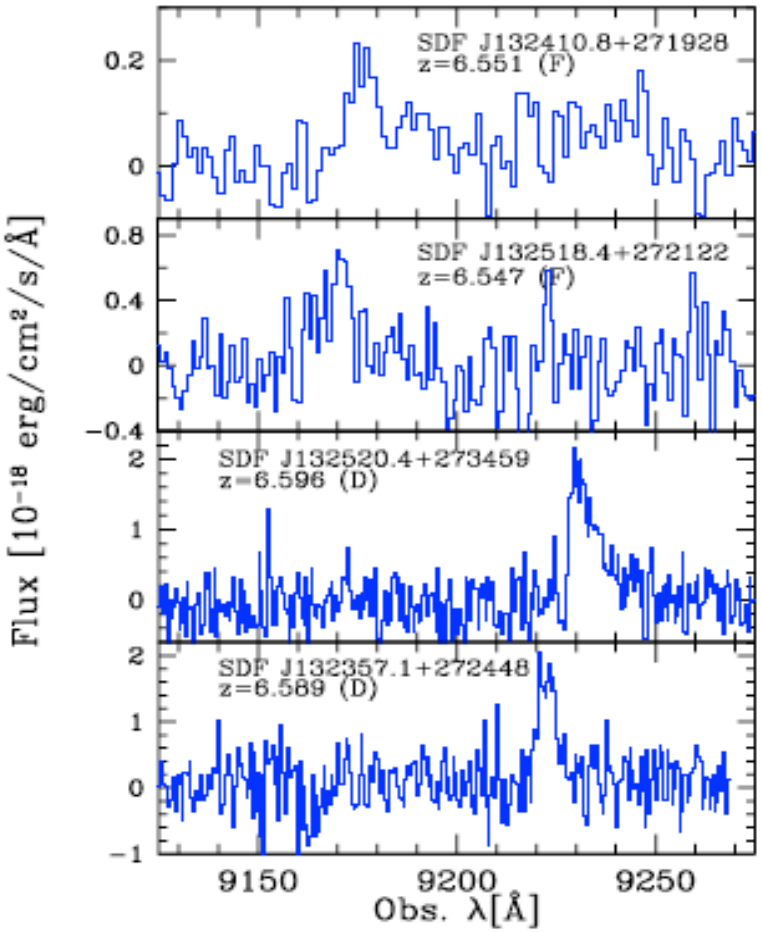
Observing LBGs & LAEs

LBGs - Broad band



Oesch et al. 2006

LAEs - narrow band



Kashikawa et al. 2006

Motivation : the LAE-LBG connection

- Present a physically motivated self-consistent model to understand LAEs and LBGs, and their connection.

- What can we infer 'cosmologically' from such galaxies?

LBGs

- Broad band colors, specially the spectral slopes can be used to get a hint on the physical properties (stellar metallicity, age, dust content) of LBGs, and their redshift evolution.

- UV LF slope can be used to infer their contribution to Reionization.

LAEs

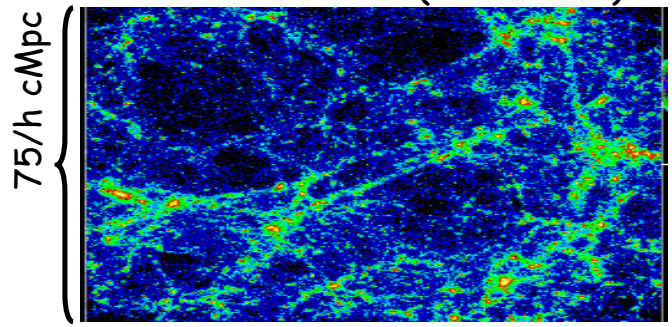
- SEDs can be used to get a hint on the physical properties (SFR, stellar / gas metallicity, halo mass, stellar mass) of LAEs, and their redshift evolution.

- Attenuation of UV photons (~ 1375 Angstroms) can be used to get a hint of the dust amounts in LAEs.

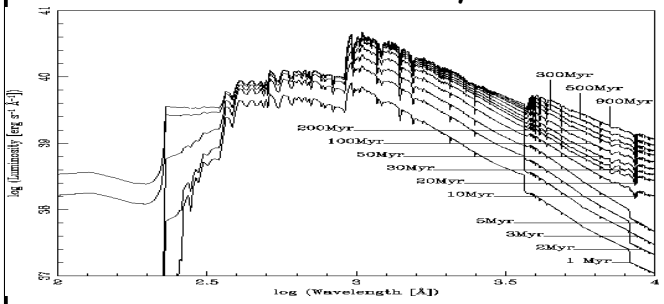
- The high sensitivity of Lya photons to HI make them excellent probes of the (Re)ionization state of the IGM.

The model - SPH + post-processing

1. SPH simulations (GADGET3)



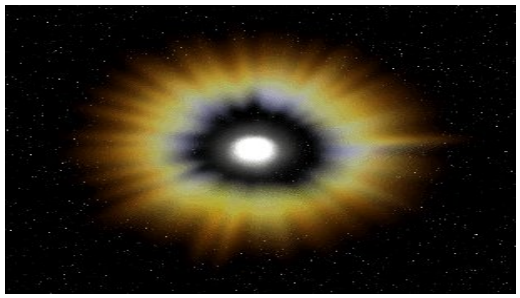
2. Intrinsic luminosity calculation



Obtain the escape fraction of UV photons, f_c

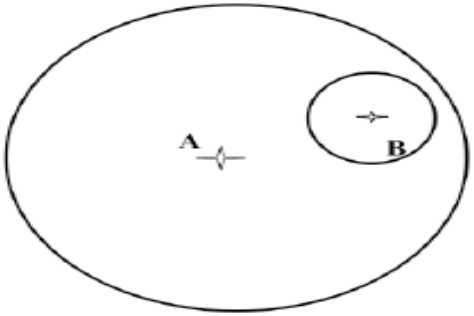
This fixes the UV luminosities of all galaxies.

3. SNII dust enrichment

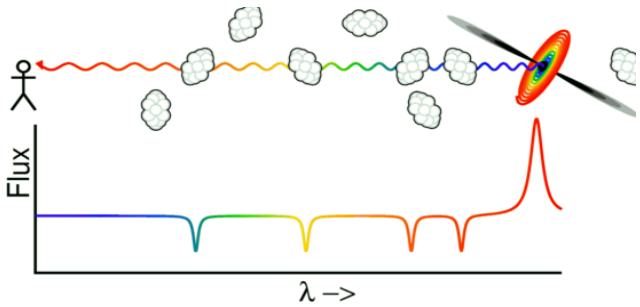


Only free parameter to match LAE Lya LF is f_α / f_c

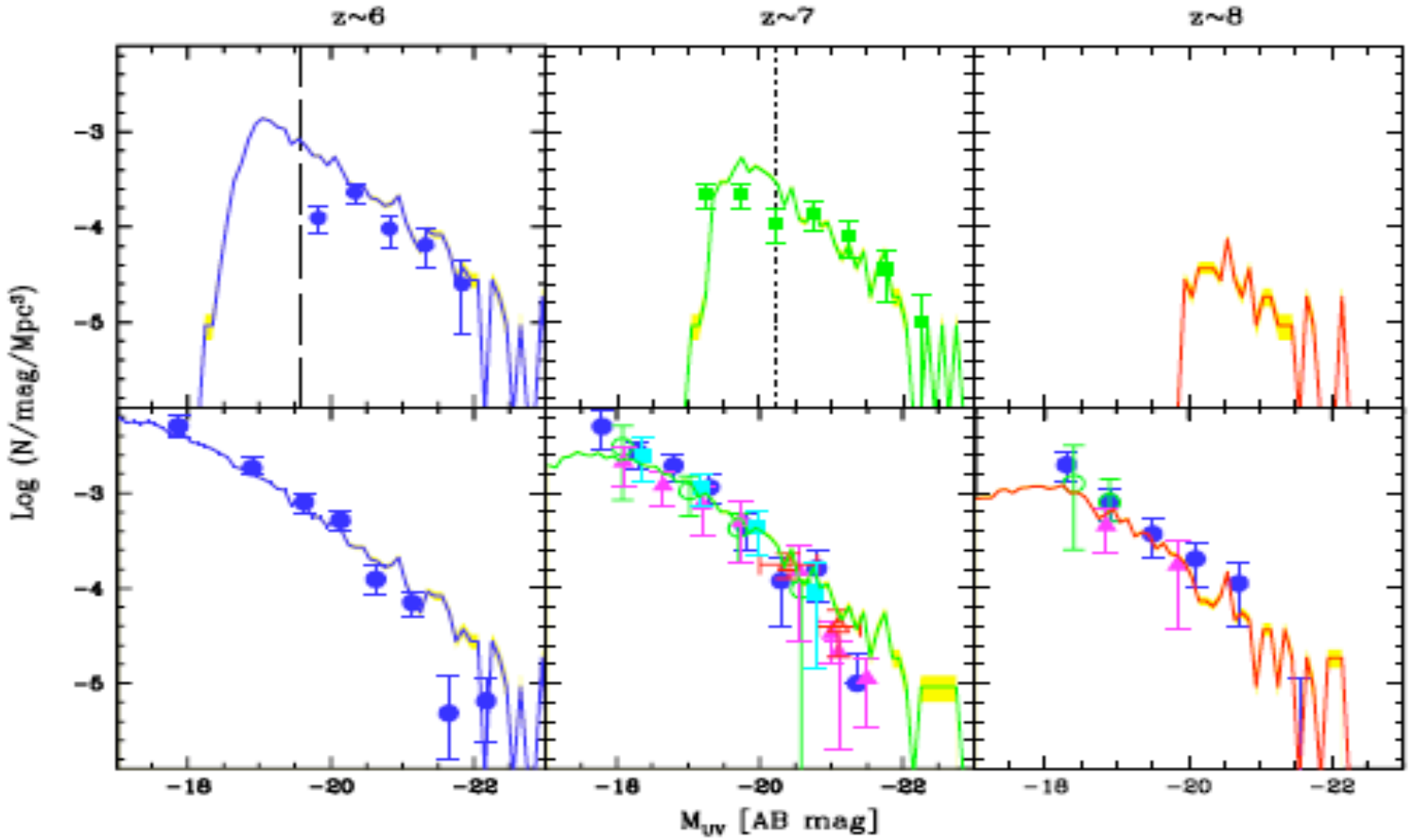
4. Clustered galaxies



5. IGM Transmission



The LAE & LBG UV Luminosity Functions

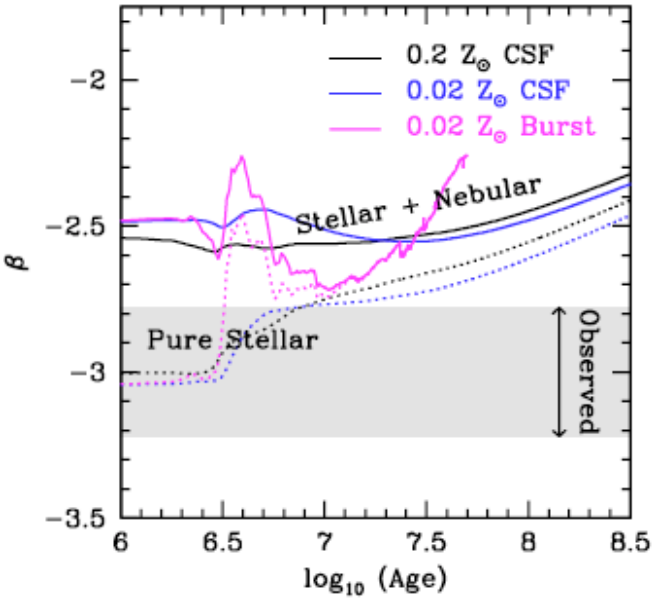


PD & Ferrara, arXiv:1109.0297

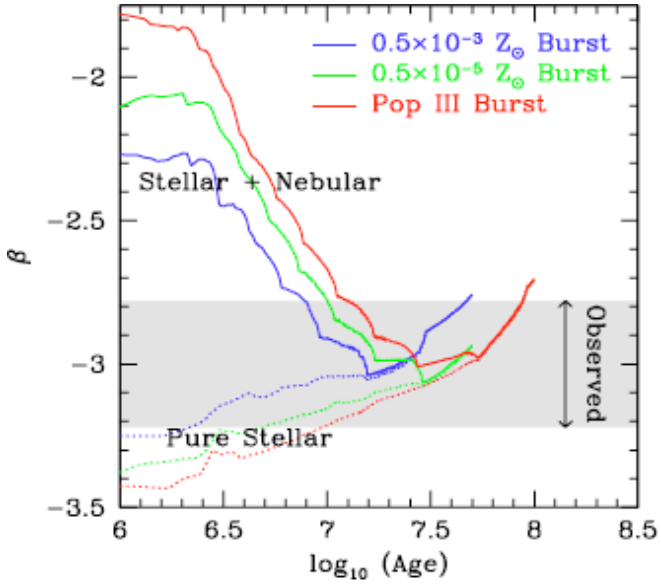
- Using same parameters to calculate dust optical depth to continuum photons as for LAEs, both amplitude and slope of LBG UV LFs extremely well reproduced at z~6,7,8.
- Escape fraction of continuum photons ~ 0.19, 0.3, 0.36 at z~6,7,8 respectively.
- Find faint end slope ~-1.6 upto -18 at all redshifts; fainter galaxies not resolved numerically.

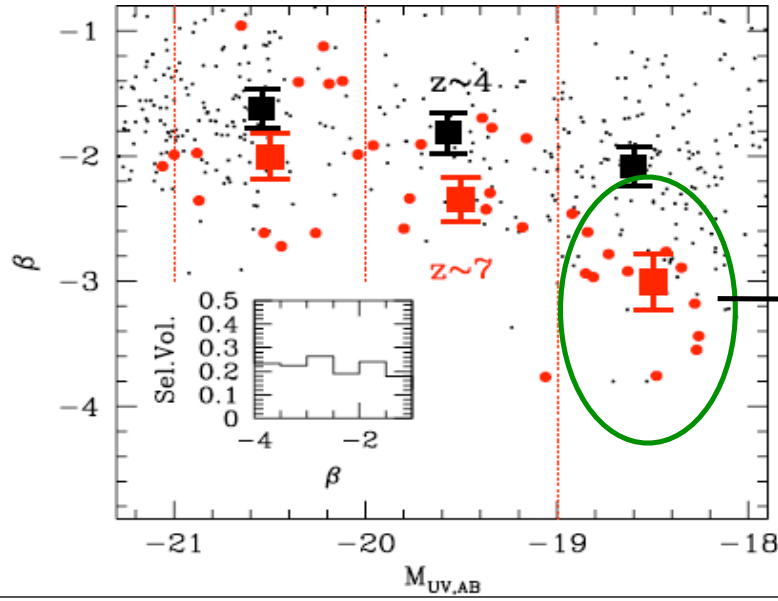
The LBG UV spectral slopes - evidence for popIII?

Schaerer 2002



Schaerer 2003



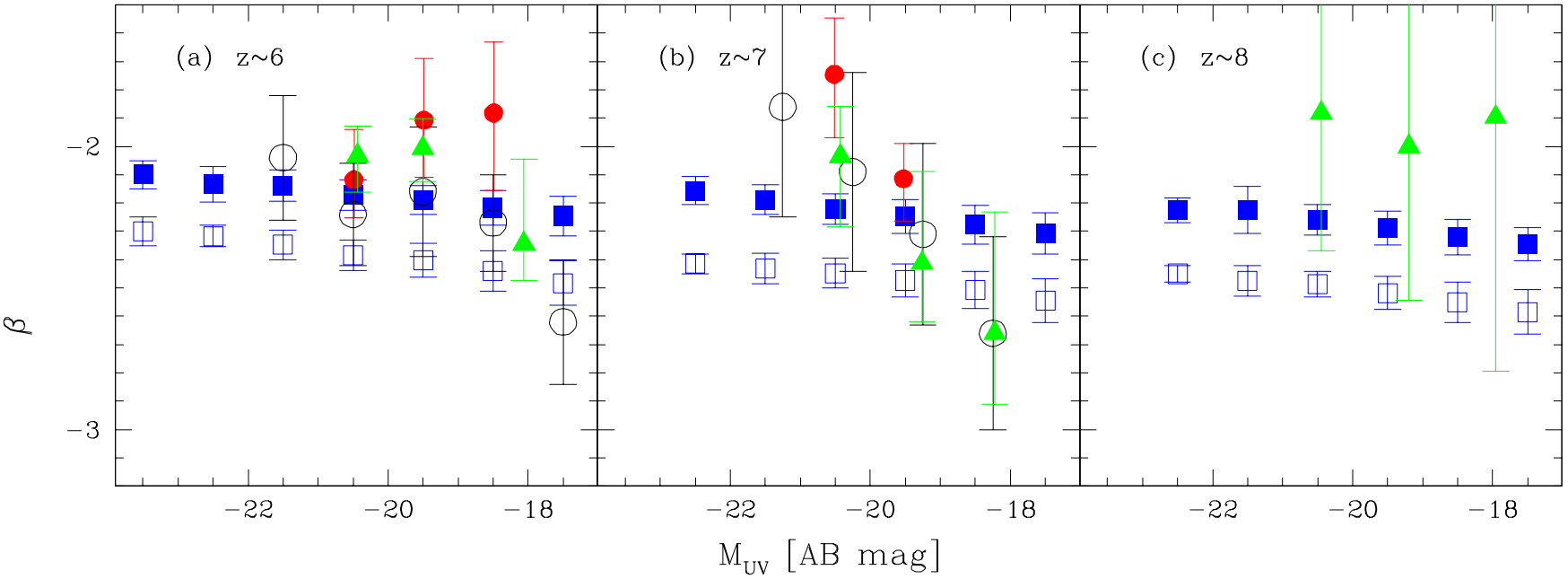


PopIII candidates?

Bouwens et al. 2010

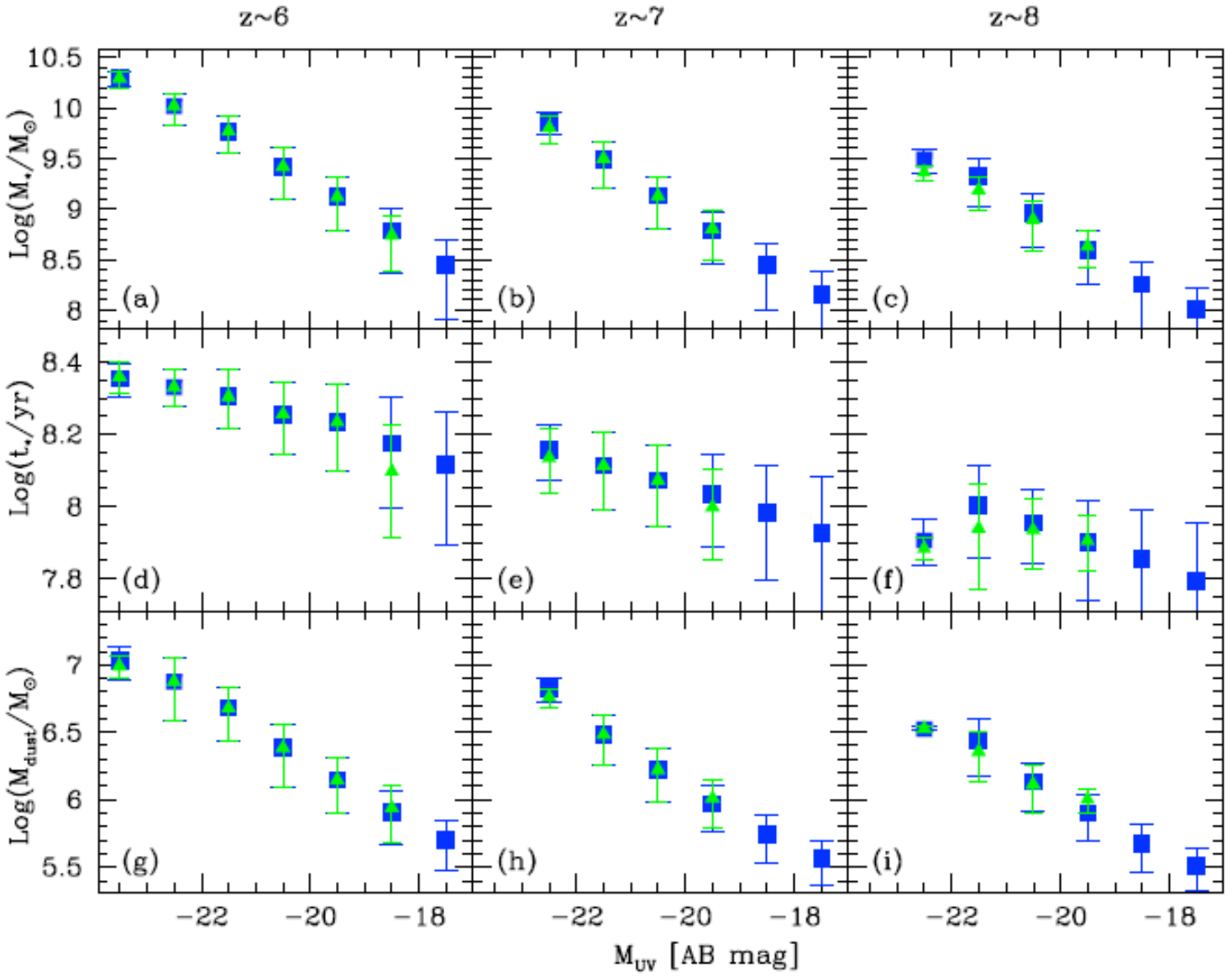
The LBG UV spectral slopes

PD & Ferrara, arXiv:1109.0297



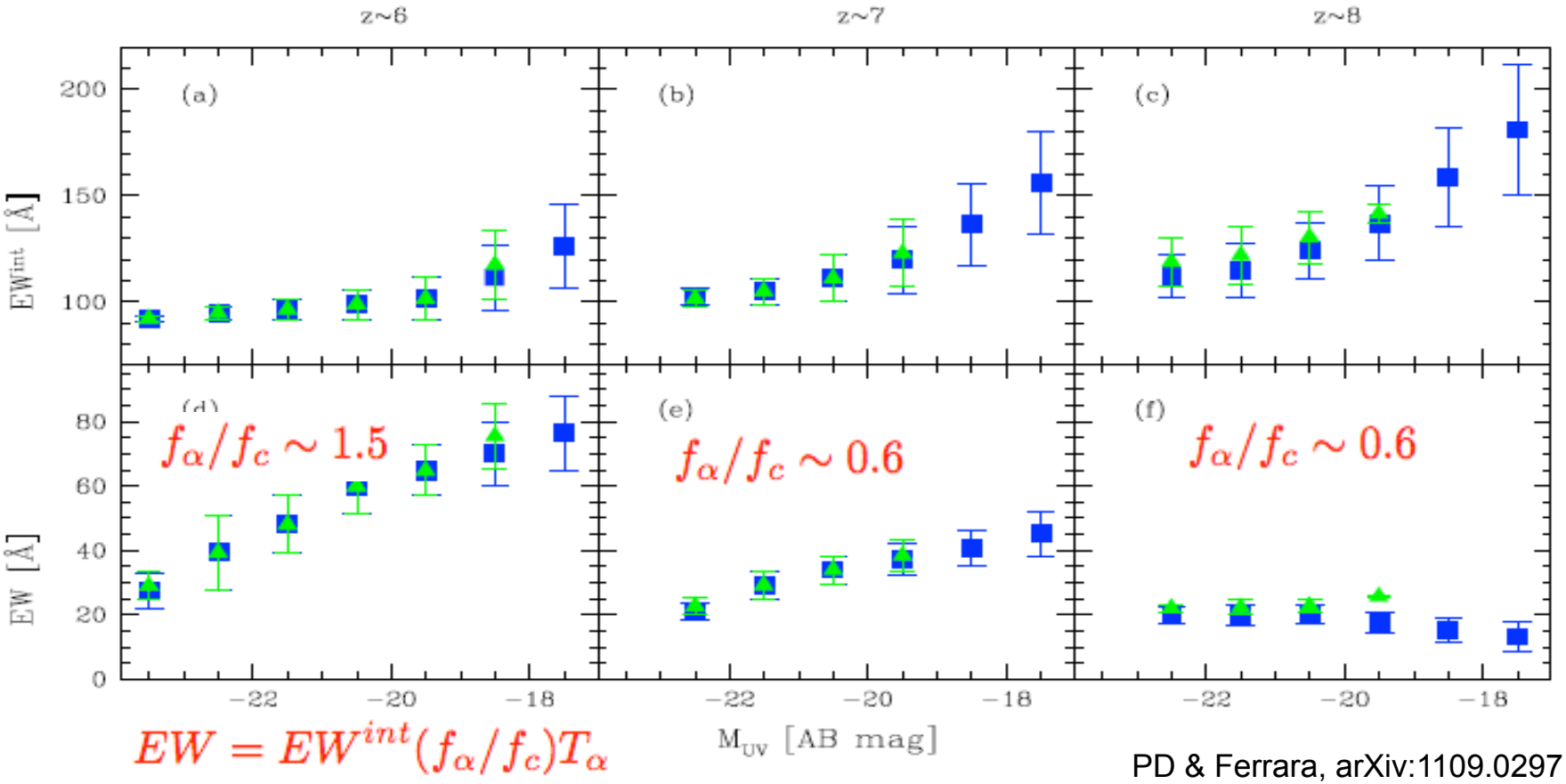
- Intrinsic UV spectral slope, beta, becomes slightly bluer with increasing magnitude and redshift.
- Convolve intrinsic spectrum with SN extinction curve to obtain observed beta.
- Observed beta becomes redder at all magnitudes and redshifts, although its value still decreases slightly with increasing magnitude/redshift.
- At all z, observed beta consistent with a value ~ -2.2.

The LAE-LBG connection



PD & Ferrara, arXiv:1109.0297

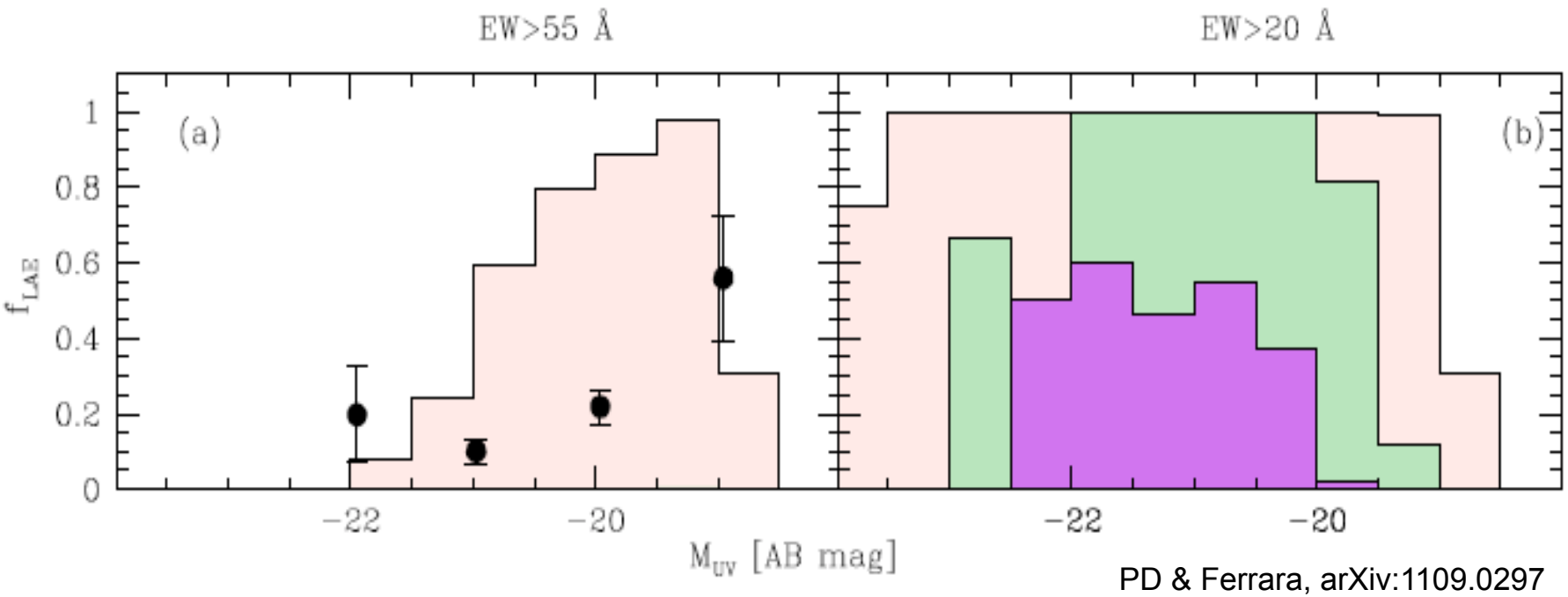
Imprints of reionization ?



PD & Ferrara, arXiv:1109.0297

- Intrinsic Lya EWs increase with increasing magnitude and redshift due to decreasing ages/ stellar metallcities.
- Observed Lya EWs still increase with magnitude but decrease from z~6-7 due to the effects of the dust distribution.
- From z~7-8, observed EWs decrease due to a combination of dust and reionization.

Ongoing problem: fraction of LBGs showing a Lya line



PD & Ferrara, arXiv:1109.0297

- For EW>55 A, trend of LBGs showing a Lya line at any magnitude similar to that observed by Stark at z~6.
- For EW>20 A, essentially all LBGs show Lya between UV magnitudes of -19 to -23.
- At any magnitude, fraction of LBGs showing a Lya line depends sensitively on choice of the observed Lya EW cut chosen.
- Irrespective of choice of EW cut fraction of LBGs showing Lya decrease from z~6-7 due to the effects of dust and between z~7-8 due to the combined effects of dust and reionization.

SUMMARY

• Using a self-consistent model based in SPH and post processing, derive LAEs and LBGs from the same underlying galaxy population.

• Using this model, reproduce a number of observables for both LAEs and LBGs including the LFs, mass functions, SFR densities, beta slopes..

• Physical properties (metallicity, ages, masses, SFR) very similar for LAEs and LBGs with a wide swath of LBGs showing a visible Lya line.

• Caution: fraction of LBGs showing a Lya line depends sensitively on EW criterion used.