

No theory should be able to explain all observations, because some of the observations are wrong.

A simple model of Lyman-alpha galaxies: (Tilvi et al. 2008)

Commercial break

Address some of the morphology questions from yesterday

An even simpler model of high redshift galaxies

Thanks to:

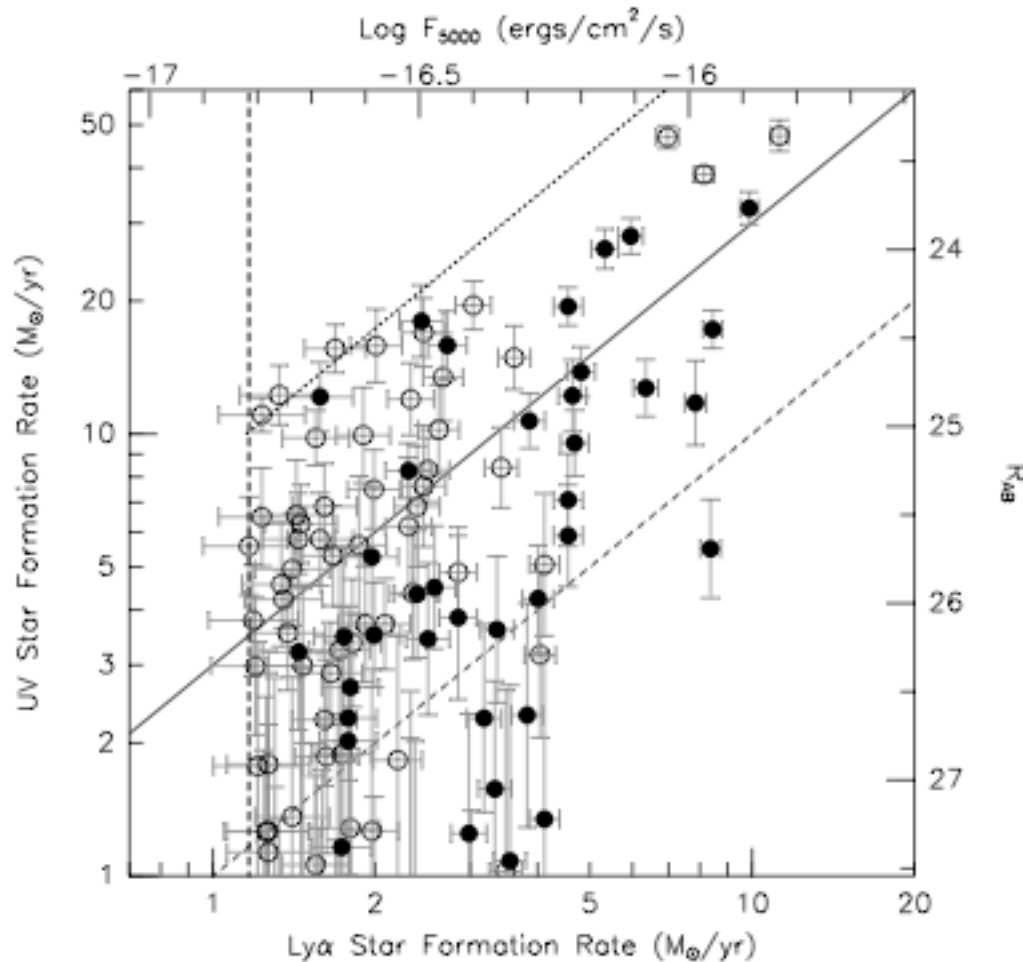
James Rhoads

Arjun Dey, Dan Stern, Hy Spinrad

Nor Pirzkal, JunXian Wang, Chun Xu, Seth
Cohen

Katarina Kovac, Steve Dawson, Steve
Finkelstein, Nimish Hathi, Vithal Tilvi, Emily
McLinden, Lifang Xia.

1. Star-formation rates $\sim 10 M_{\text{sun}}/\text{year}$ not $\sim 100 M_{\text{sun}}/\text{year}$



Gronwall et al. 07

Ouchi et al. 08 +

Almost everyone else.

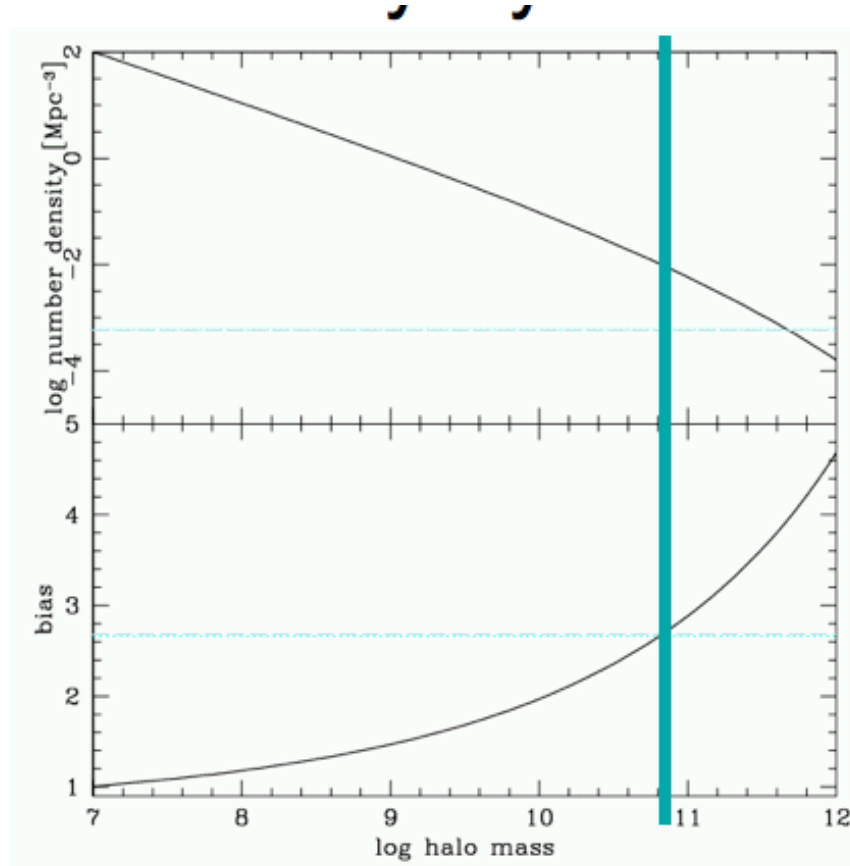
2. are young: $\sim 10^7$ years (Pirzkal et al. 07, Gawiser 06, Finkelstein et al. 08, Venemans et al. 05)

3. are not massive: 10^7 - $10^9 M_{\text{sun}}$ (Pirzkal et al. 2007, Finkelstein et al. 2008, Gawiser et al. 06, Gawiser et al., Veneman's et al., Reddy et al., Lai et al. 08)
(but see Lai et al. 07, Finkelstein 08 for exceptions)

4. have modest amounts of dust or not much dust

5. have halo masses $\sim 10^{11} M_{\text{sun}}$ (Kovac et al 2007; Gawiser et al 07)

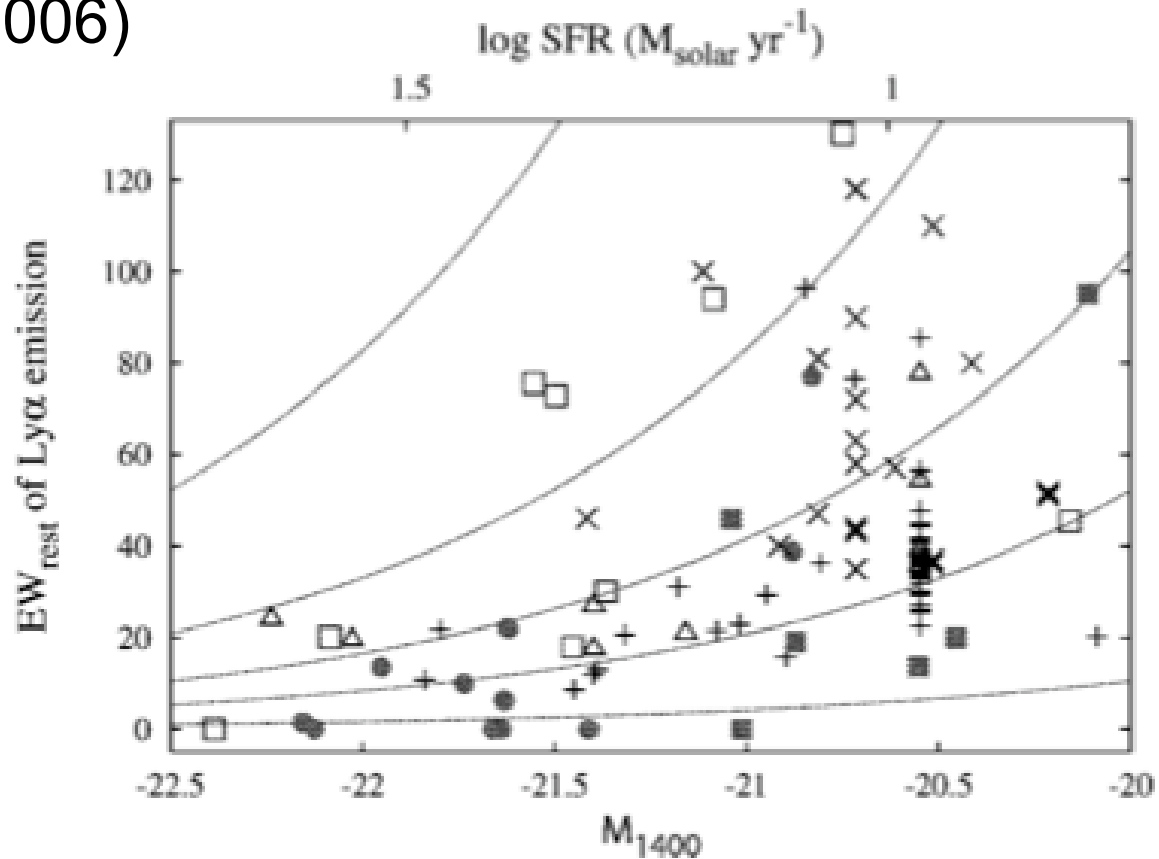
6. Only $\sim 10\%$ of such halos host LyA galaxies (Kovac et al 2007, Gawiser et al. 07).



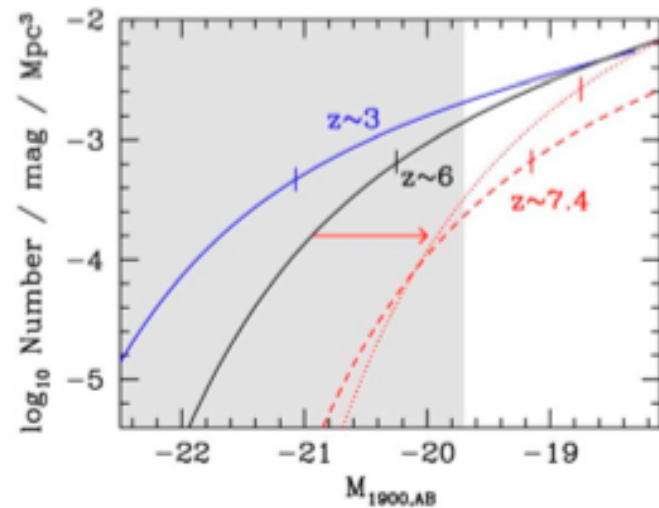
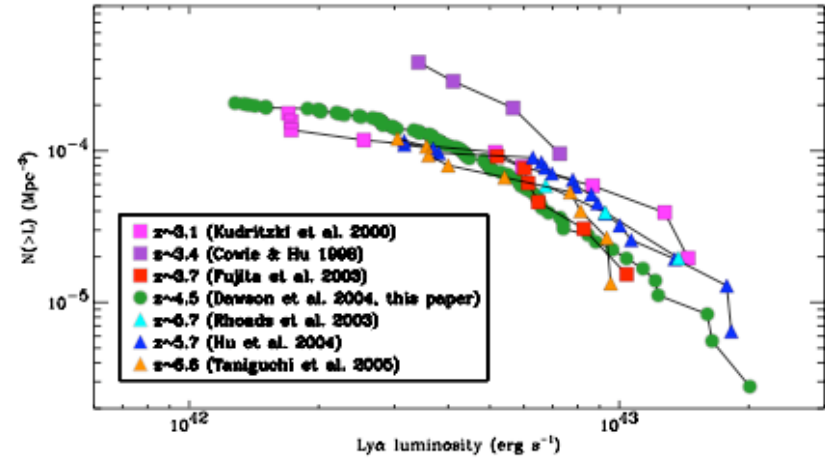
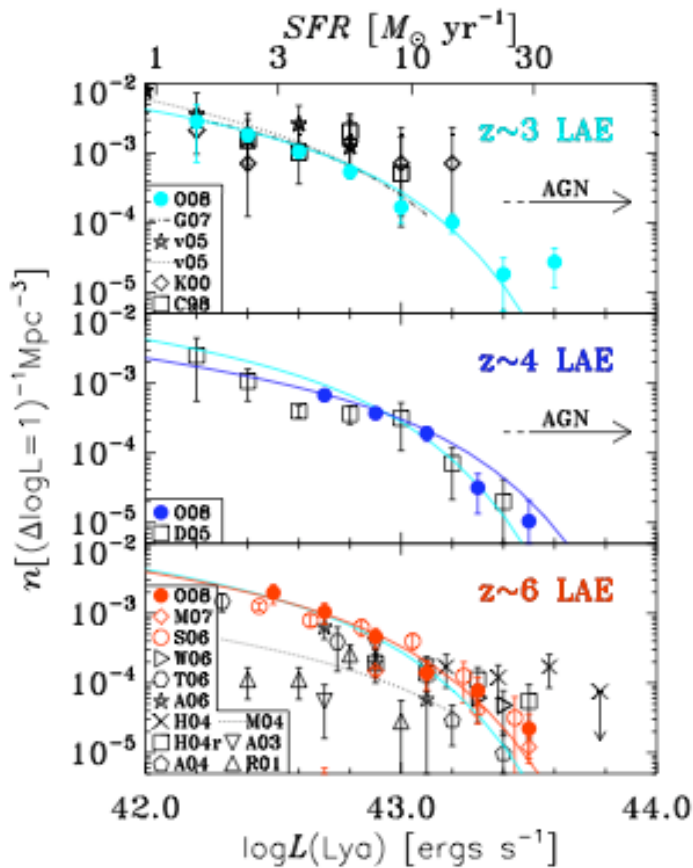
$\sim 10\%$ duty cycle is consistent with age and photometry and luminosity fn w.r.to LBGs (Malhotra & Rhoads 02).

7. Continuum bright galaxies show a lack of bright Ly α (Ando et al. 2006)

(e.g. Ando et al. 2006)



8. Very little redshift evolution in luminosity function compared to LBGs (Dawson et al. 2007, Ouchi et al. 2008, Bouwens et al. 2007)



- Star-formation in dark halos depends on sub-grid physics, so we build Lyman-alpha galaxies to fit the properties seen in these galaxies:

Simulating LyA Galaxies:

(Tilvi, Malhotra, Rhoads, Scannapeico, Iliev, Mellema 2008)

- Halos from N-body simulations
 - are Lyman alpha emitting if they are
 1. Accreting actively, and
 2. Below a cutoff mass threshold.

Lyman-alpha \propto SFR \propto Mass accreted

$$L_{Ly\alpha} = 1 \times 10^{42} \times \frac{SFR}{M_{\odot}\text{yr}^{-1}} \text{ erg s}^{-1}. \quad ($$

SFR is proportional to the mass accreted between two epochs according to

$$SFR = \epsilon \times \Delta M_{\text{DM}} = f_{\star} \times \dot{M}_b \quad . \quad ($$

Modelling LyA Galaxies in Simulations

(Tilvi et al 2008)

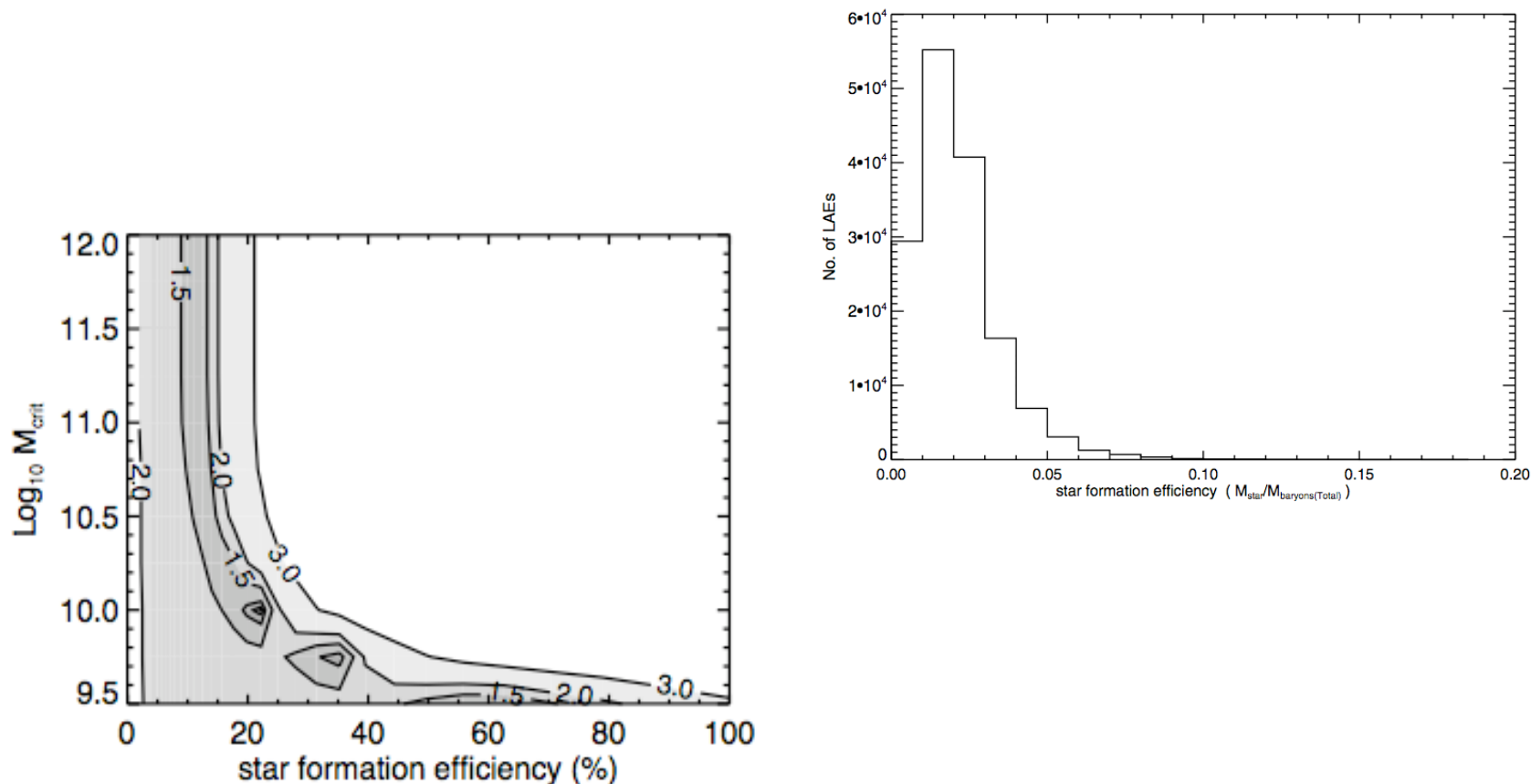
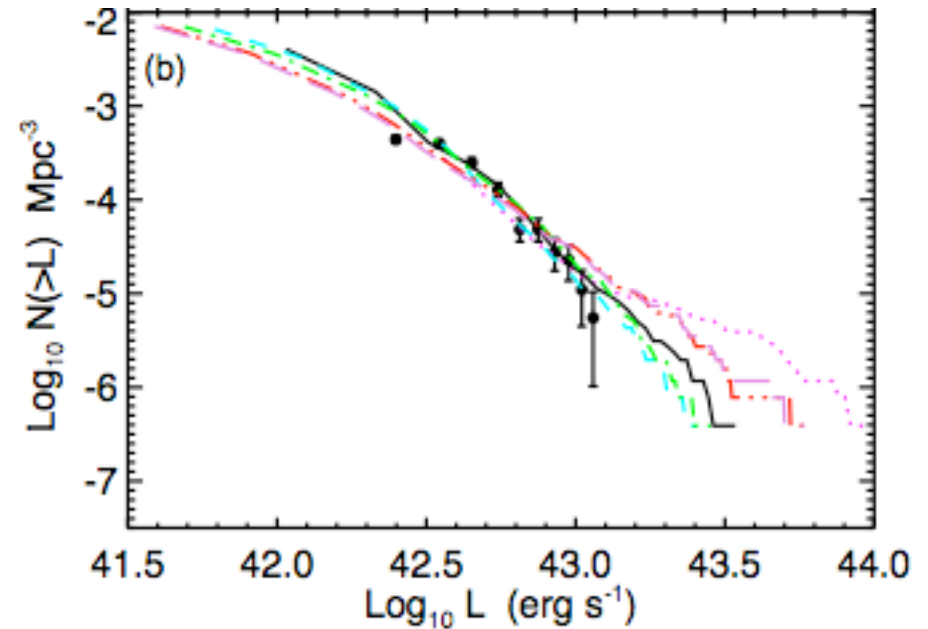


FIG. 2.— The best-fit parameters obtained by minimizing Chi-square as a function of upper halo mass M_{crit} and star-formation efficiency, f_* . The χ^2 values are in logarithmic units.

We reproduce the

1. luminosity function,
2. ages,
3. stellar masses
4. equivalent widths.
5. Correlation lengths



Modelling LyA Galaxies in Simulations

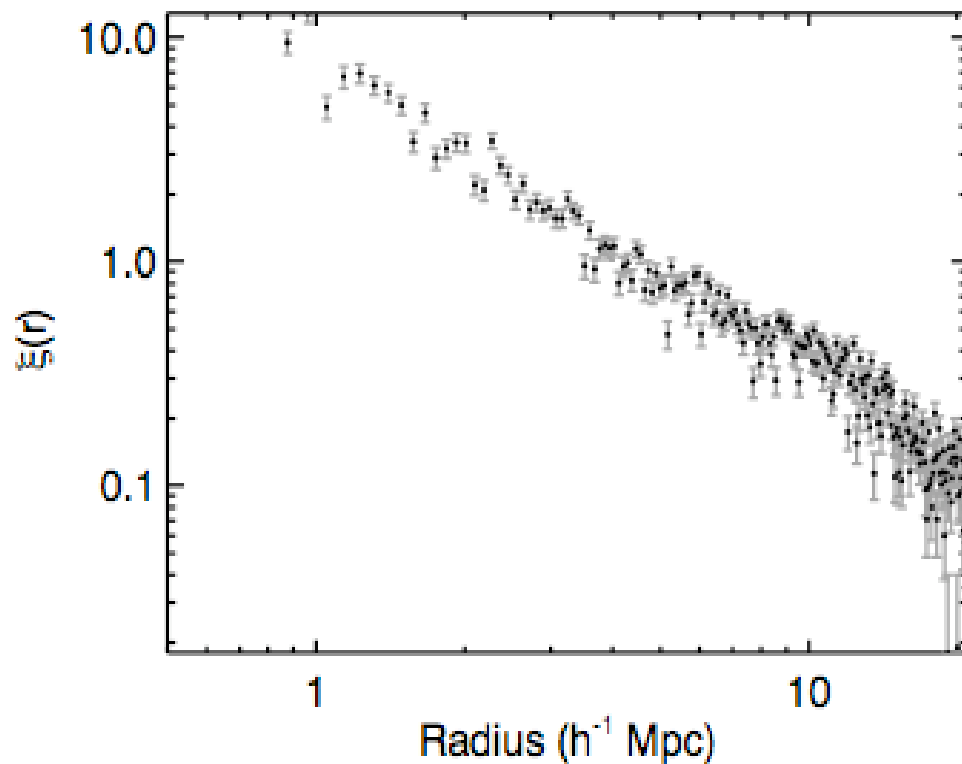


FIG. 3.— Two-point spatial correlation function of LAEs at $z = 6.6$. The error bars indicate the uncertainty from Poisson statistics. The correlation length $r_o = 4.46 \pm 0.37 h^{-1}$ Mpc.

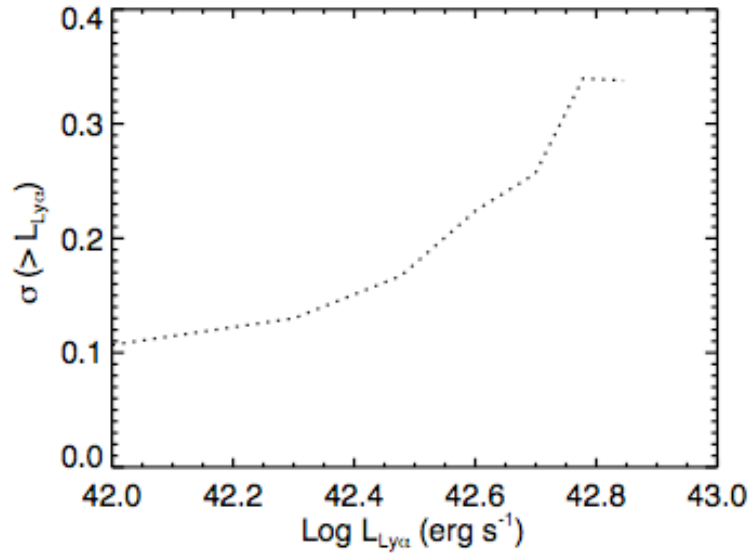
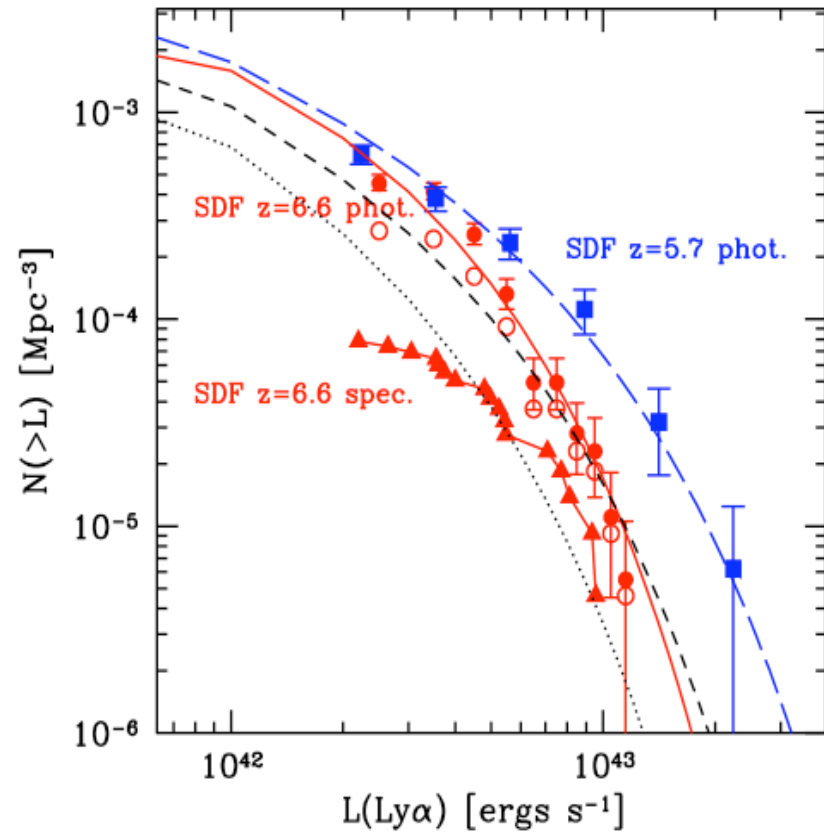
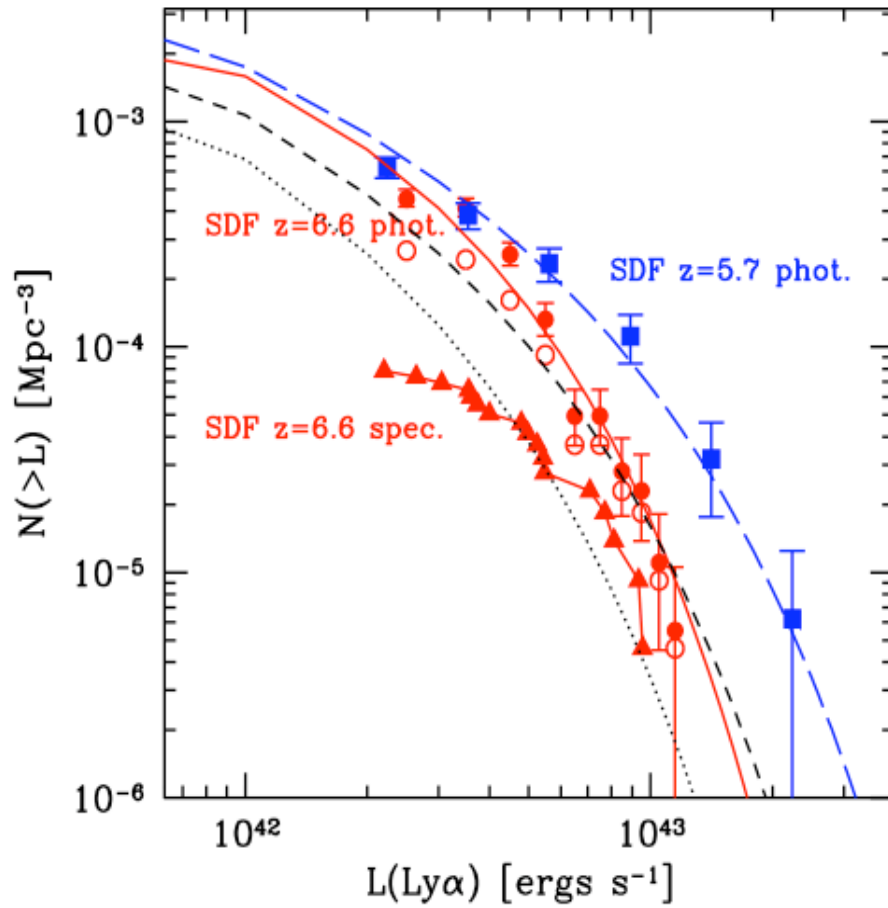


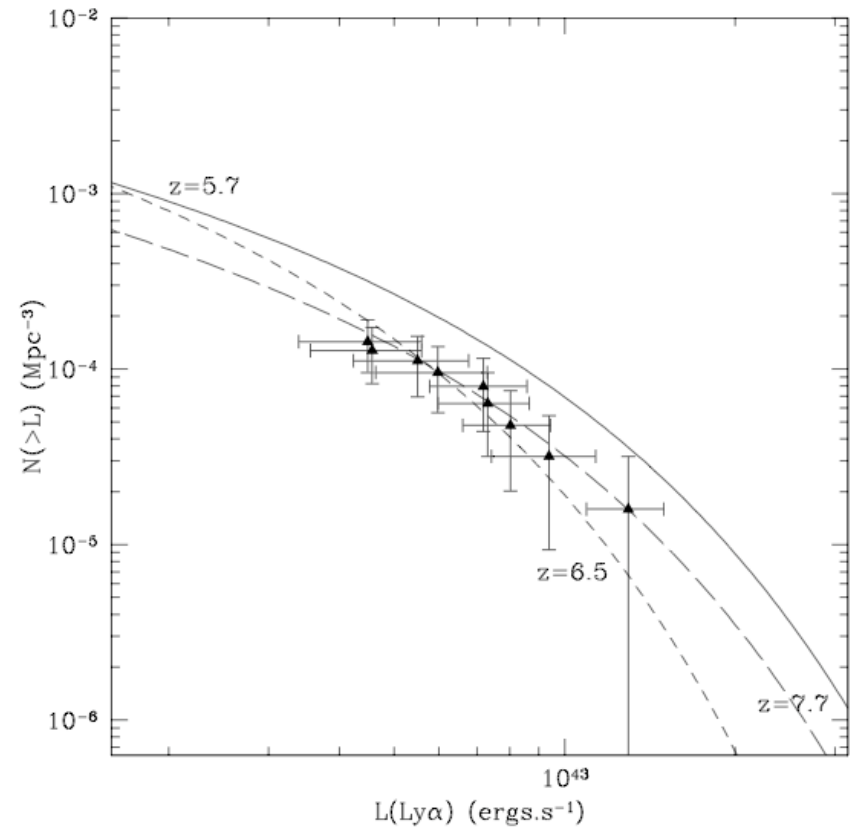
FIG. 4.— Field-to-field variation for a volume limited survey with varying Ly α flux detection limit. For a typical narrow-band LAE survey, the Ly α detection limit is $L_{\text{Ly}\alpha} > 3 \times 10^{42} \text{ erg s}^{-1}$. The field-to-field variation in such survey is $\approx 19\%$.

Affect reionization tests.
(Hu et al. this meeting)



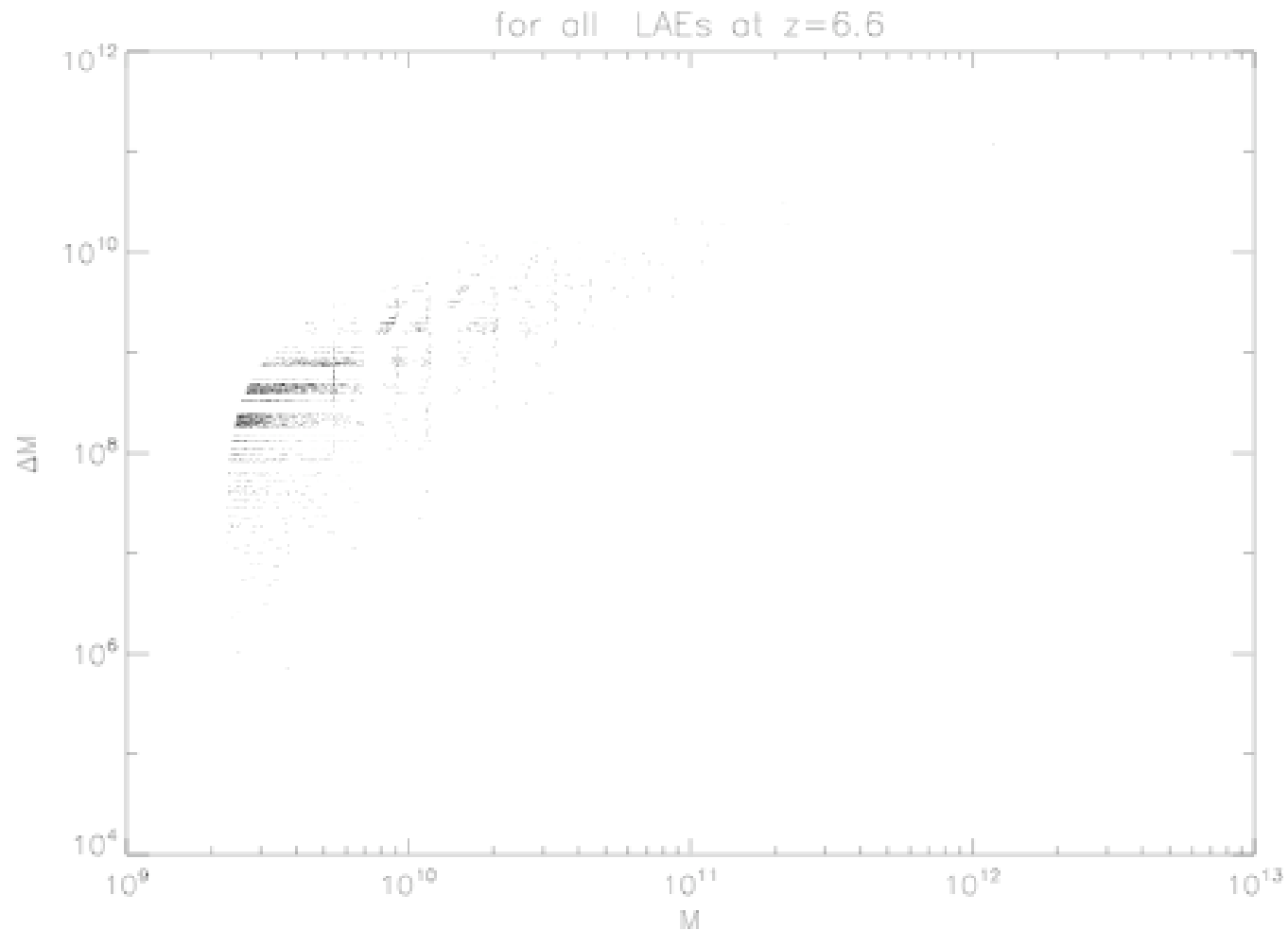


Kashikawa et al. 07



Hibon et al. 08 (this meeting)

Accreted mass gives a natural saturation point and duty cycle



Ly- α galaxies:

- have star-formation rates $\sim 10 M_{\text{sun}}/\text{year}$
- are young: $\sim 10^7$ years (Pirzkal et al. 07, Finkelstein et al. 08; Nilsson et al.)
- are not massive: 10^7 - $10^9 M_{\text{sun}}$ (Pirzkal et al. 2007, Finkelstein et al. 2008, Gawiser
- have modest amounts of dust or not much dust
- have halo masses $\sim 10^{11} M_{\text{sun}}$ (Kovac et al 2007; Gawiser et al 07; Ouchi et al 07)
- Only $\sim 10\%$ of such halos host LyA galaxies (Kovac et al 2007).
- Continuum bright galaxies show a lack of bright Ly α (Ando et al. 2006)
- Very little redshift evolution in luminosity function compared to Lyman-break Galaxies.