Lyman-alpha galaxies in the larger framework of Galaxy formation

S. Malhotra & J. Rhoads

Pirzkal et al. 2007

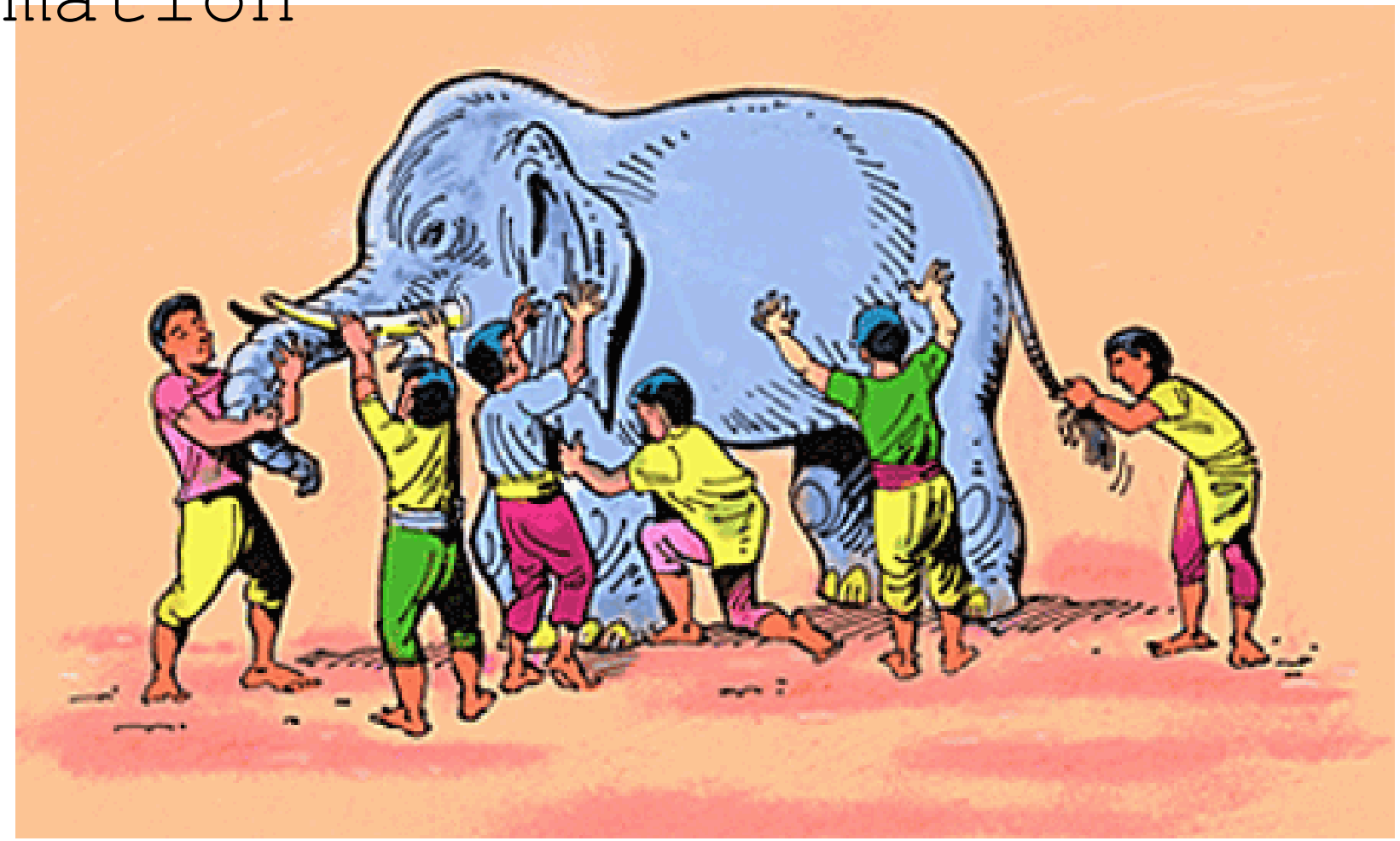
Dawson et al. 2007

S. Finkelstein et al. 2007, 2008

V. Tilvi et al. 2008

Kovac et al. 2007

Lyman-α galaxies and Galaxy formation



Ly-α galaxies:

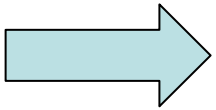
- have star-formation rates ~10 M_{sun}/year
- are young: ~ 10^7 years (Pirzkal et al. 07, Finkelstein et al. 08; Nilsson et al. ….)
- are not massive: 10^7-10^9 M_{sun} (Pirzkal et al. 2007, Finkelstein et al. 2008)
- have modest amounts of dust: (poster by Finkelstein et al.)
- have halo masses ~ 10^{11} M_{sun} (Kovac et al 2007; Gawiser et al 07; Ouchi et al 07)
- Only ~ 10% of such halos host LyA galaxies (Kovac et al 2007).
- can be reproduced by simple prescriptions for populating halos with LyA (Tilvi et al. 2008)

You definitely have the tail of the elephant, my friend!

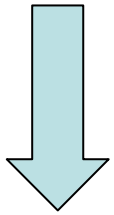
H-W

Rix

What *"should"* Lyman-α Galaxies be?

Young stars  ionizing UV

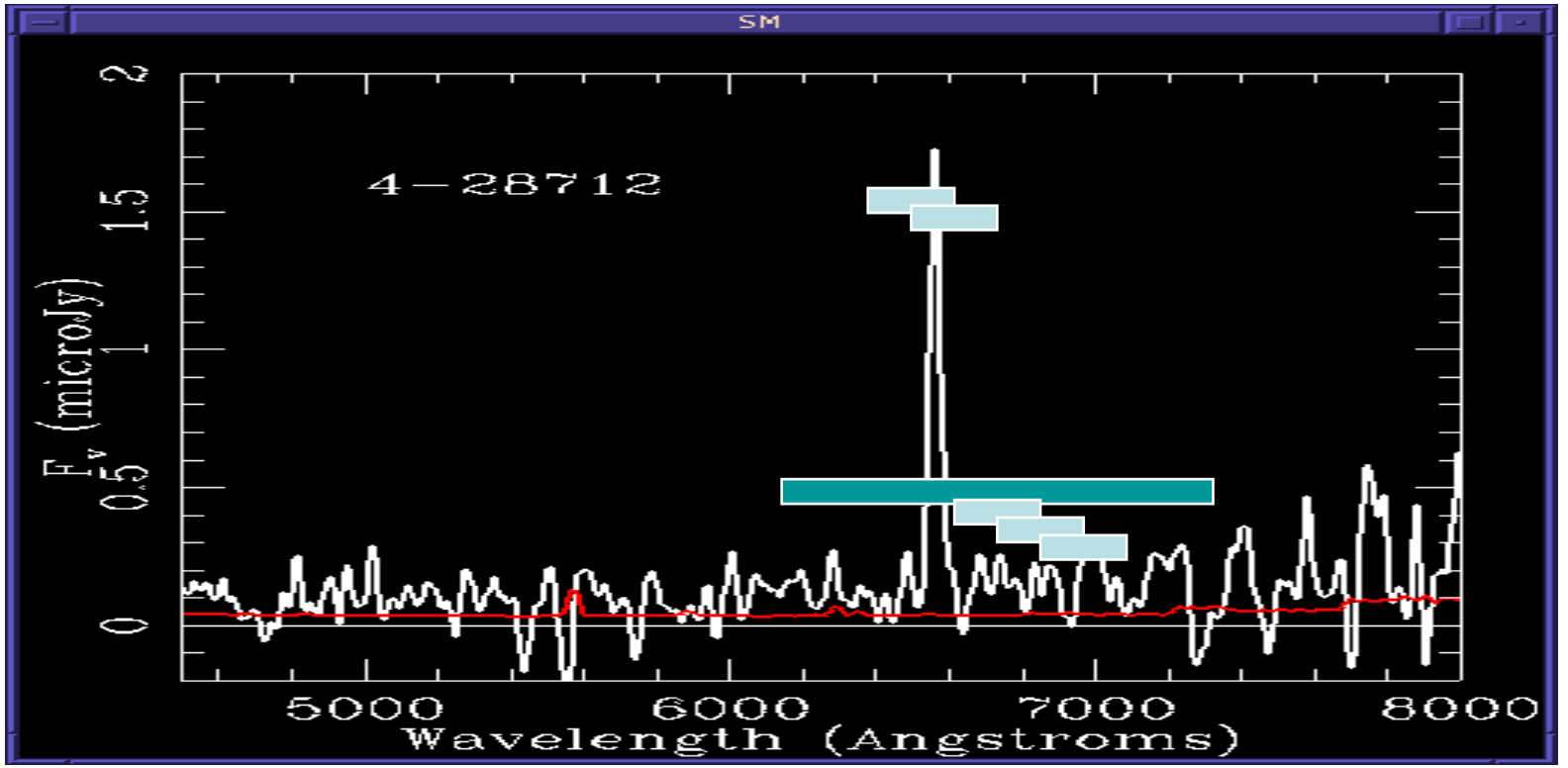
+ gas



6-7% of a young galaxy's luminosity may emerge in the Lyman-α line.

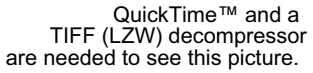
Partridge & Peebles 1967

What are Lyman-α galaxies? -operational answer



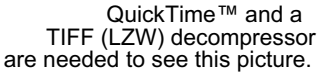
- Practically, I mean a galaxy *selected by its Lyman-α line emission.*

What *are* Lyman-α galaxies?

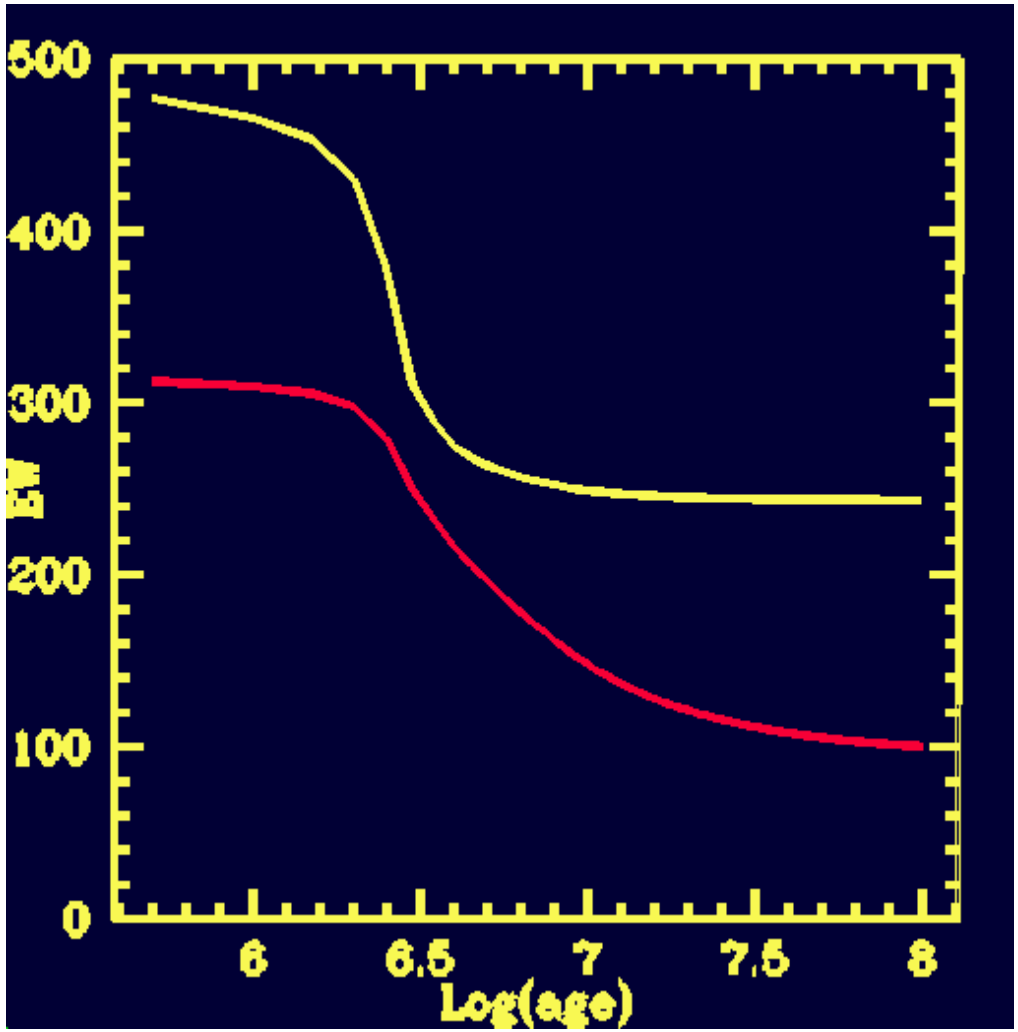


Shimasaku et al. 2006

Dawson et al. 2007



Expected equivalent width of Lyα line

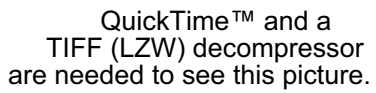


Malhotra & Rhoads 2002.

Possible explanations:

1. Active nuclei, type II quasars …
2. Young galaxies
3. IMF skewed towards higher end
4. Pop III stars
5. Dust. Wait a minute, dust !?!

Evidence for Young and Small LyA Galaxies



Pirzkal et al. 2007

Other support for young LyA galaxies from blue colors:

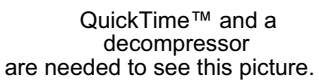
B. Venemans thesis;

Gawiser et al. 2006;

Nilsson et al. 2007;

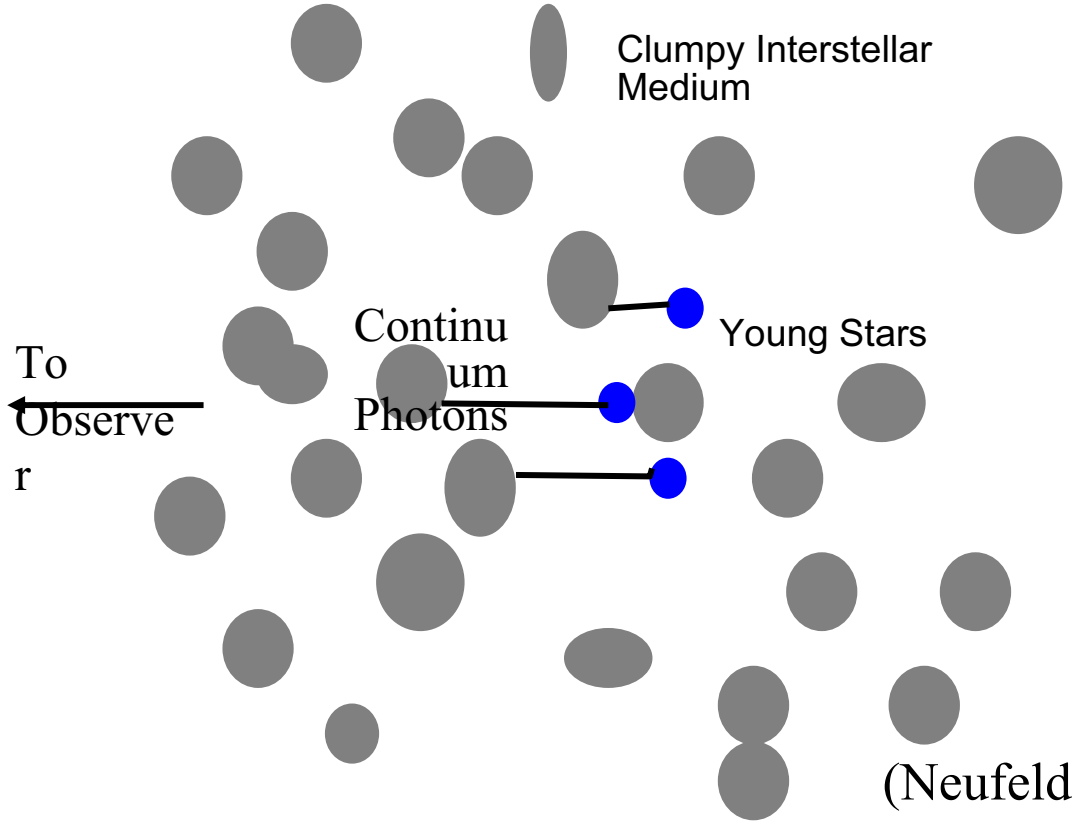
Finkelstein et al 2007.

But: see also Lai et al 2006, Chary et al 2005, Finkelstein et al. 2008 for some older, more massive objects.



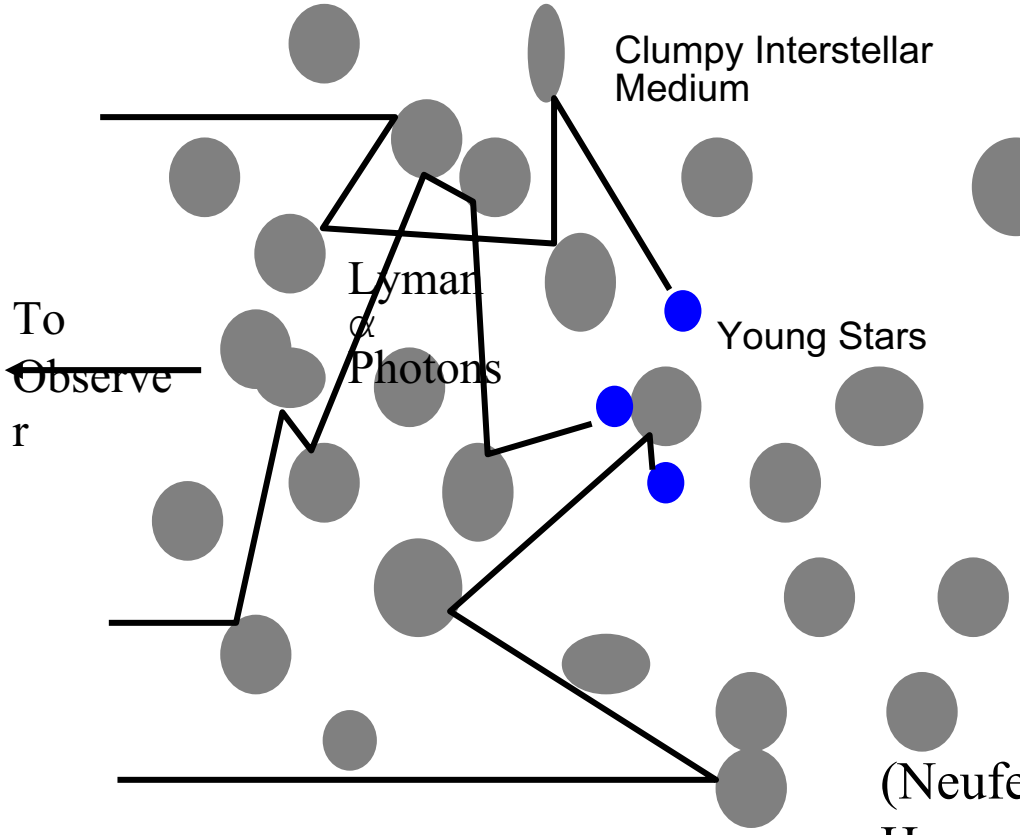
Pirzkal et al. 2007

Effects of Dust and Resonant Scattering in a Two Phase Medium



(Neufeld 1991; Hansen & Oh 2005)

Effects of Dust and Resonant Scattering in a Two Phase Medium

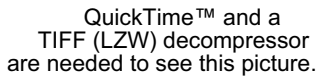


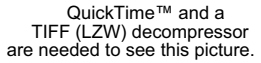
In this case, dust can actually enhance the equivalent width by factors of a few (or more).

(Neufeld 1991; Hansen & Oh 2005)

Testing Radiative Transfer Scenarios

- Continuum spectral slope:
  - Hot stellar photospheres → blue starlight.
  - Dust scenarios → reddened starlight.
- Test with broad band colors: MMT, HST, Spitzer.
  - Wide wavelength coverage helps separate the effects of dust from those of underlying older stars





Finkelstein et al. 2008a (ApJ 678, 655) and 2008b (ApJ, submitted):

SED fitting with a new dust parameter ‘q’:

q=0 implies no dust extinction on Lya (Neufeld model)

q=1 implies Lya is extinguished just like continuum

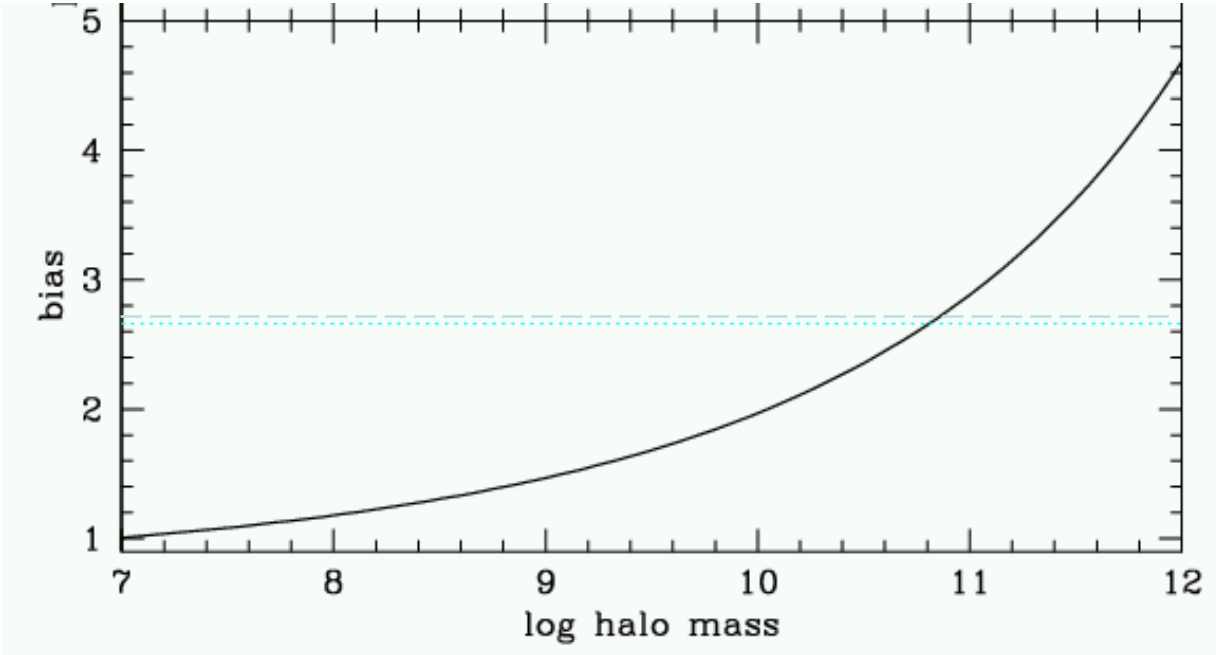
q >>1 is the regime of strong extinction due to multiple resonant scatterings.

QuickTime™ and a
decompressor
are needed to see this picture.

Chapman et al. 2003: Submm galaxies show Lya

Halo Mass and Duty Cycle

- Spatial correlation length implies halo masses around 10^{11} M_{sun}.

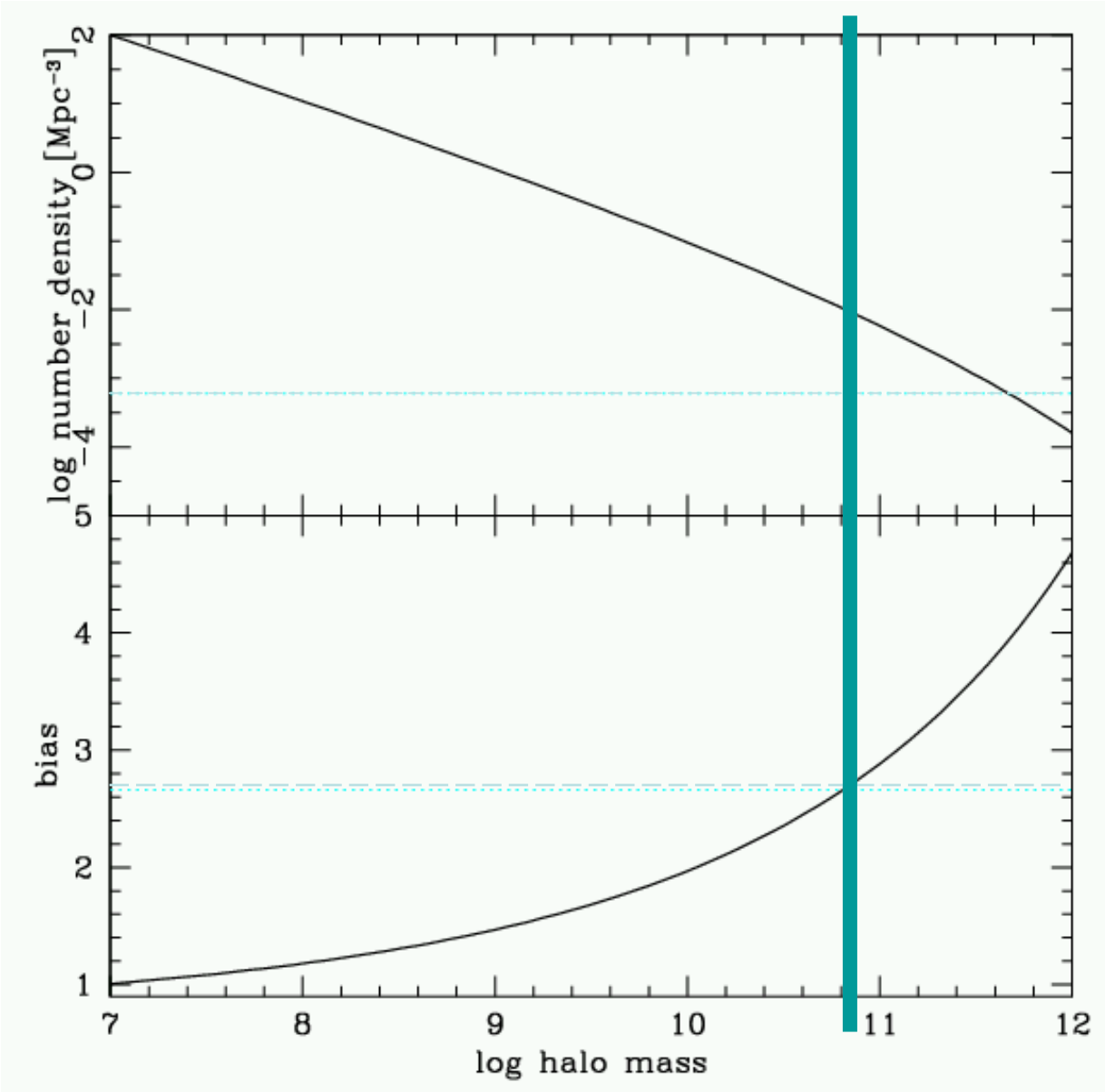


Halo Mass and Duty Cycle

- Spatial correlation length implies halo masses around $10^{11}\,M_{sun}$ at redshift z = 4.5.

- Number counts are lower. This suggests duty cycle ~ 10% for the Lyman-alpha phase

(Kovac,et al. 2007)



Simulating LyA Galaxies:

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

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

QuickTime™ and a
decompressor
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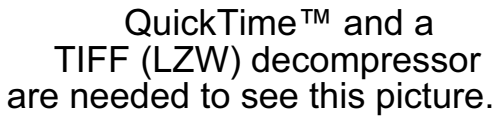
Modelling LyA Galaxies in Simulations (Tilvi et al 2008)

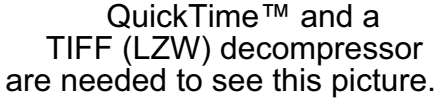


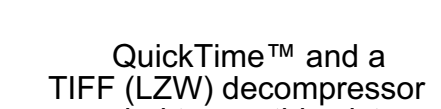
QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

We reproduce the

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

Modelling LyA Galaxies in Simulations





Line luminosity function:
Dawson et al. 2007

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

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Thank You