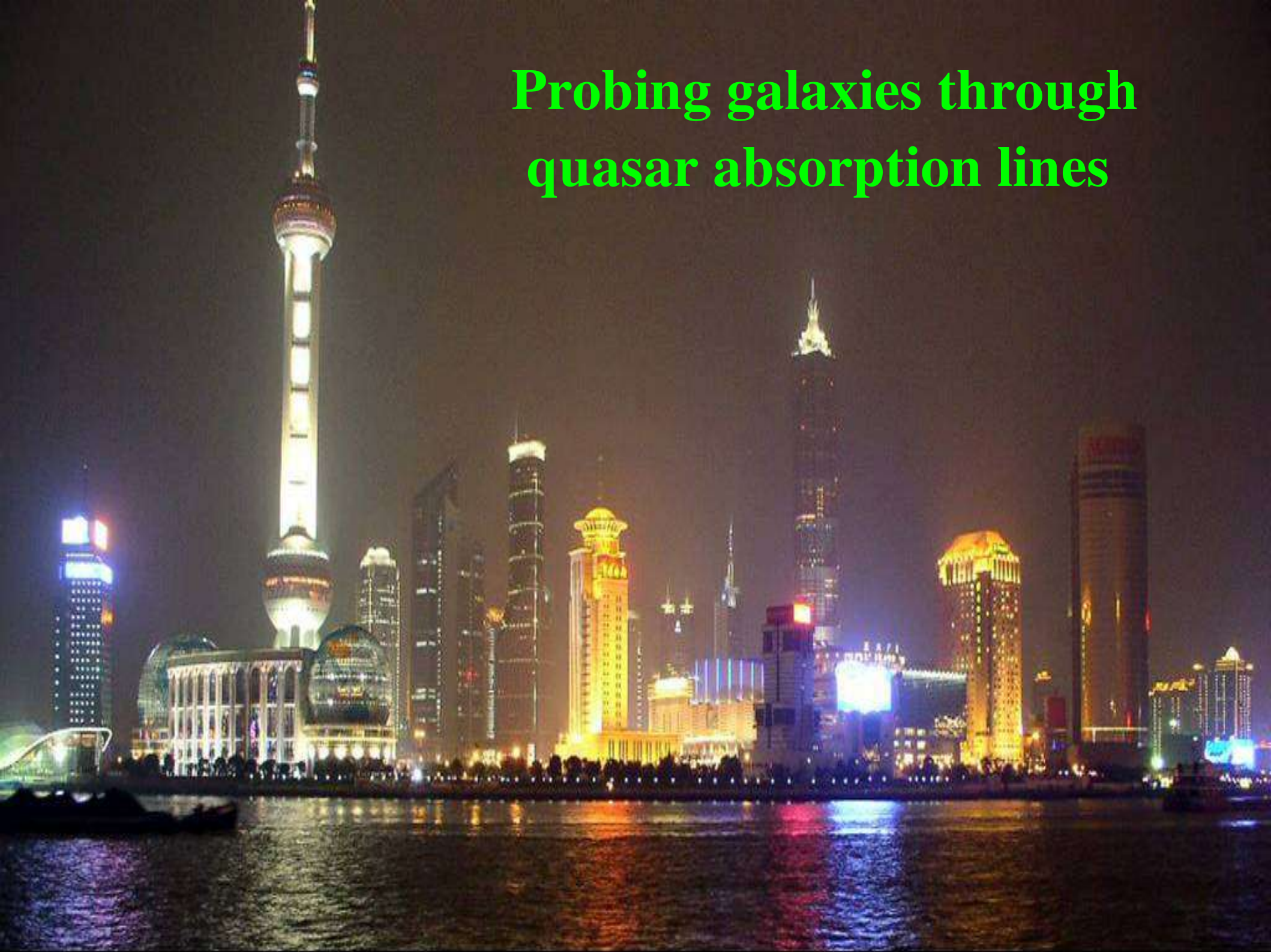
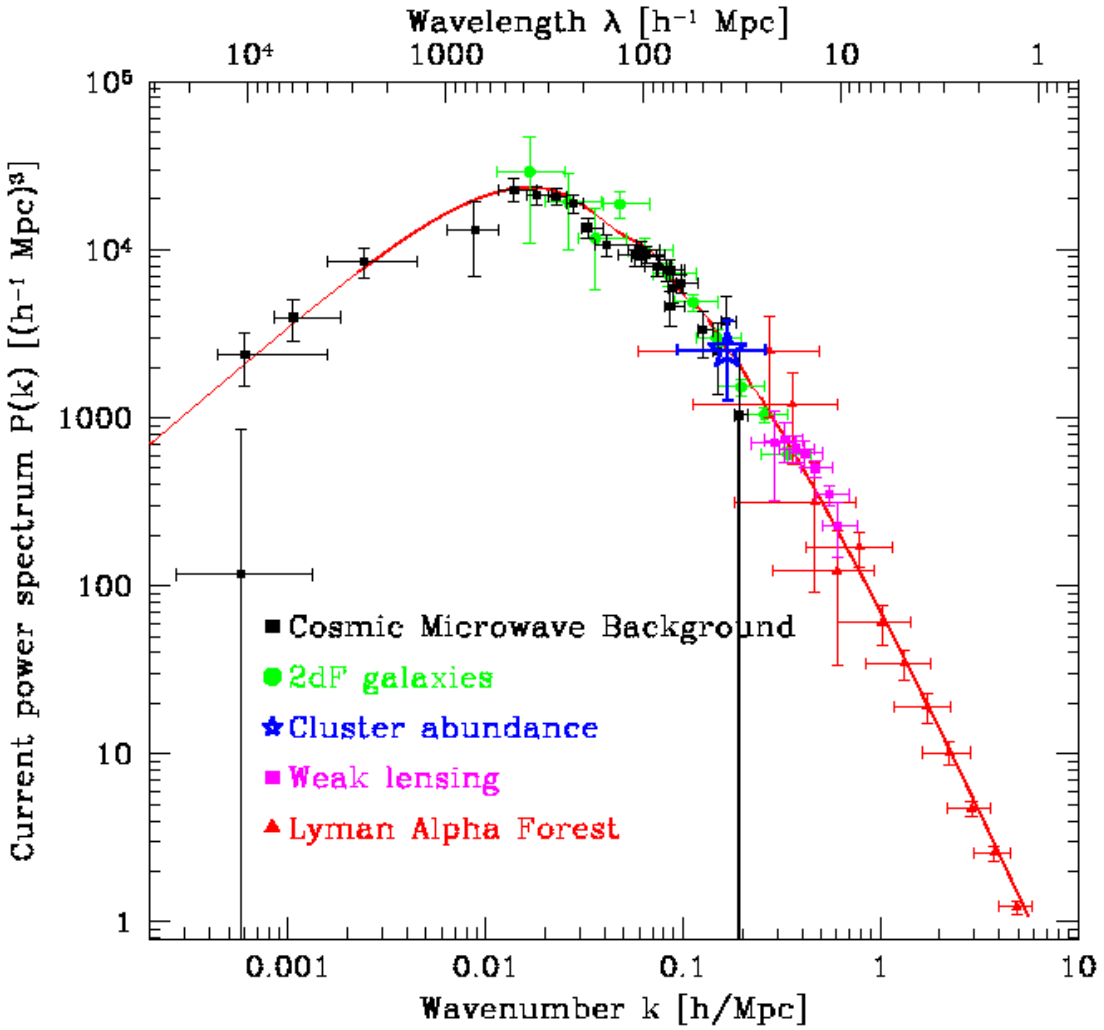


# Probing galaxies through quasar absorption lines




# Precision cosmology with QSO absorbers?

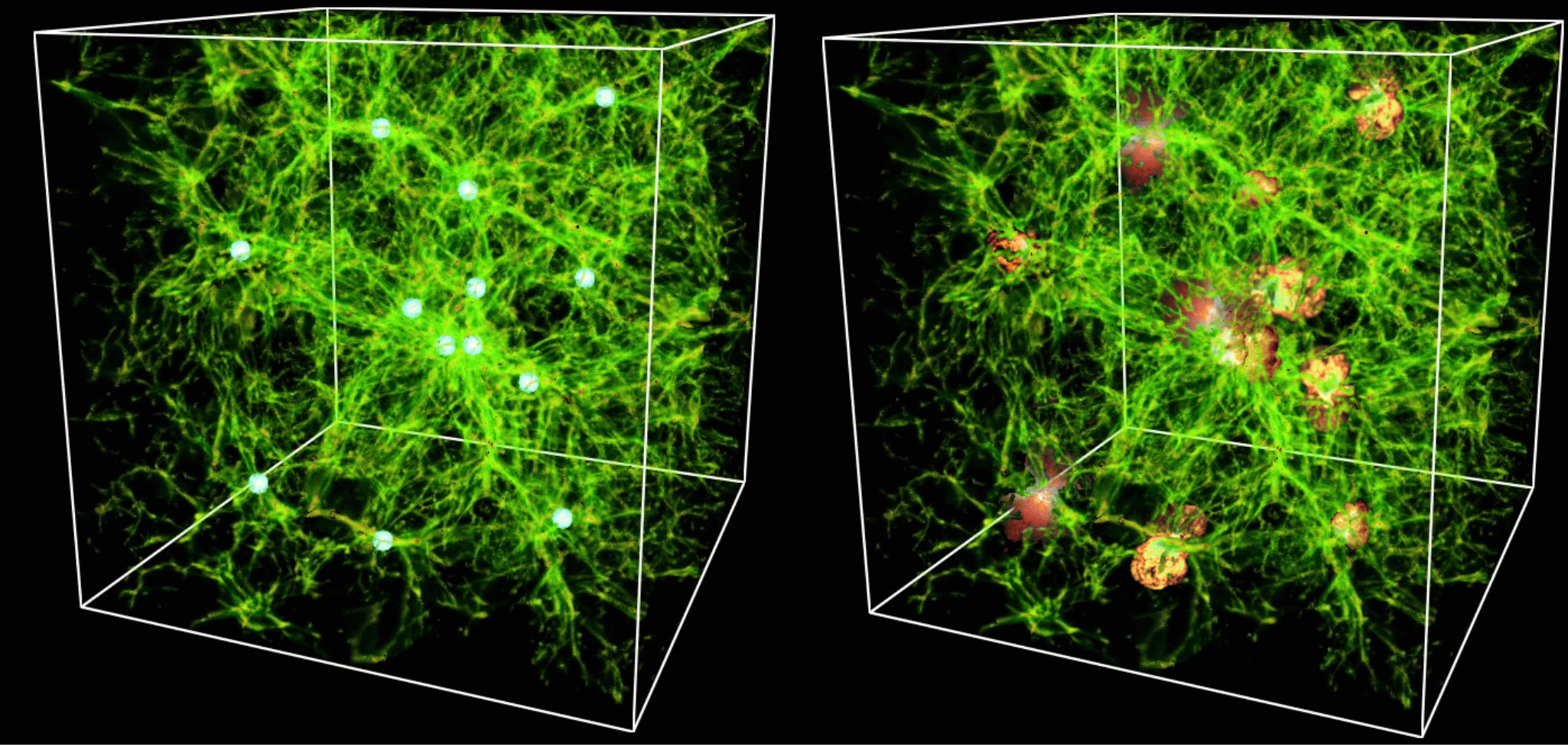
We would like to measure inflationary parameters, the neutrino/axion mass, constrain WDM...

Will this ever really be possible?

Our structure formation simulations must be accurate enough

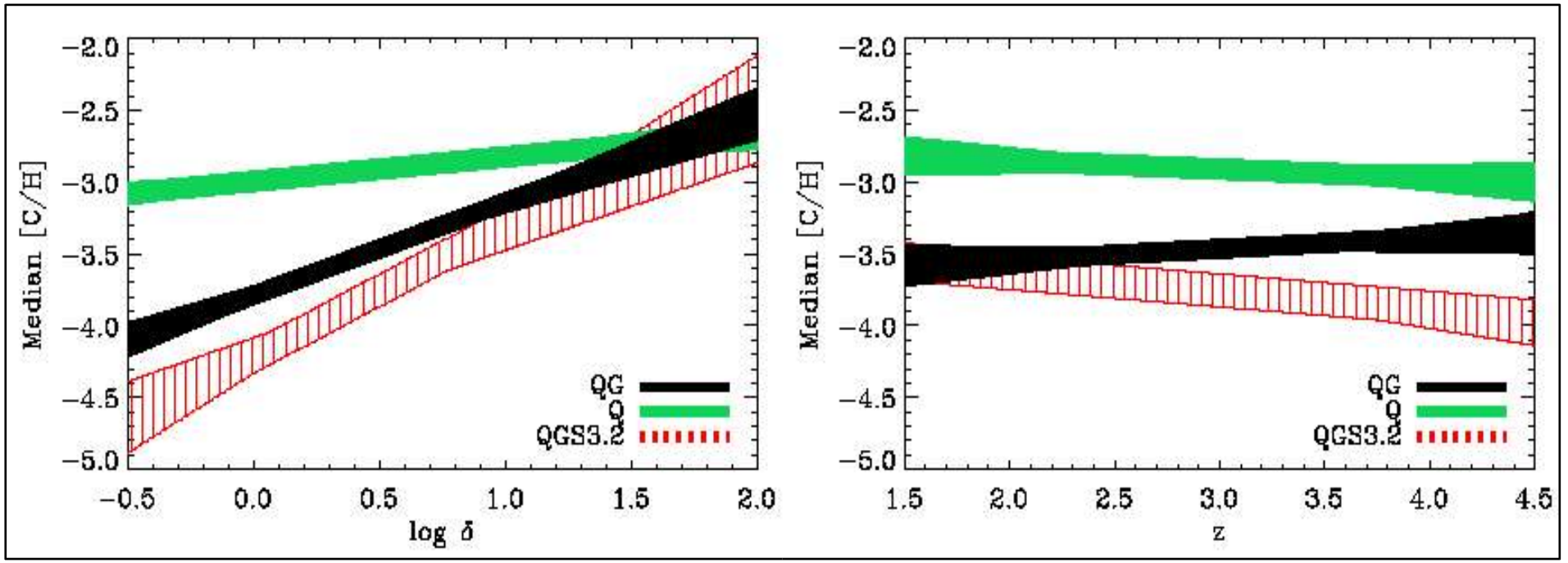
They must contain <u>all</u> the IGM physics

## The Basic Question: Which Picture is More Correct?



Is either correct?

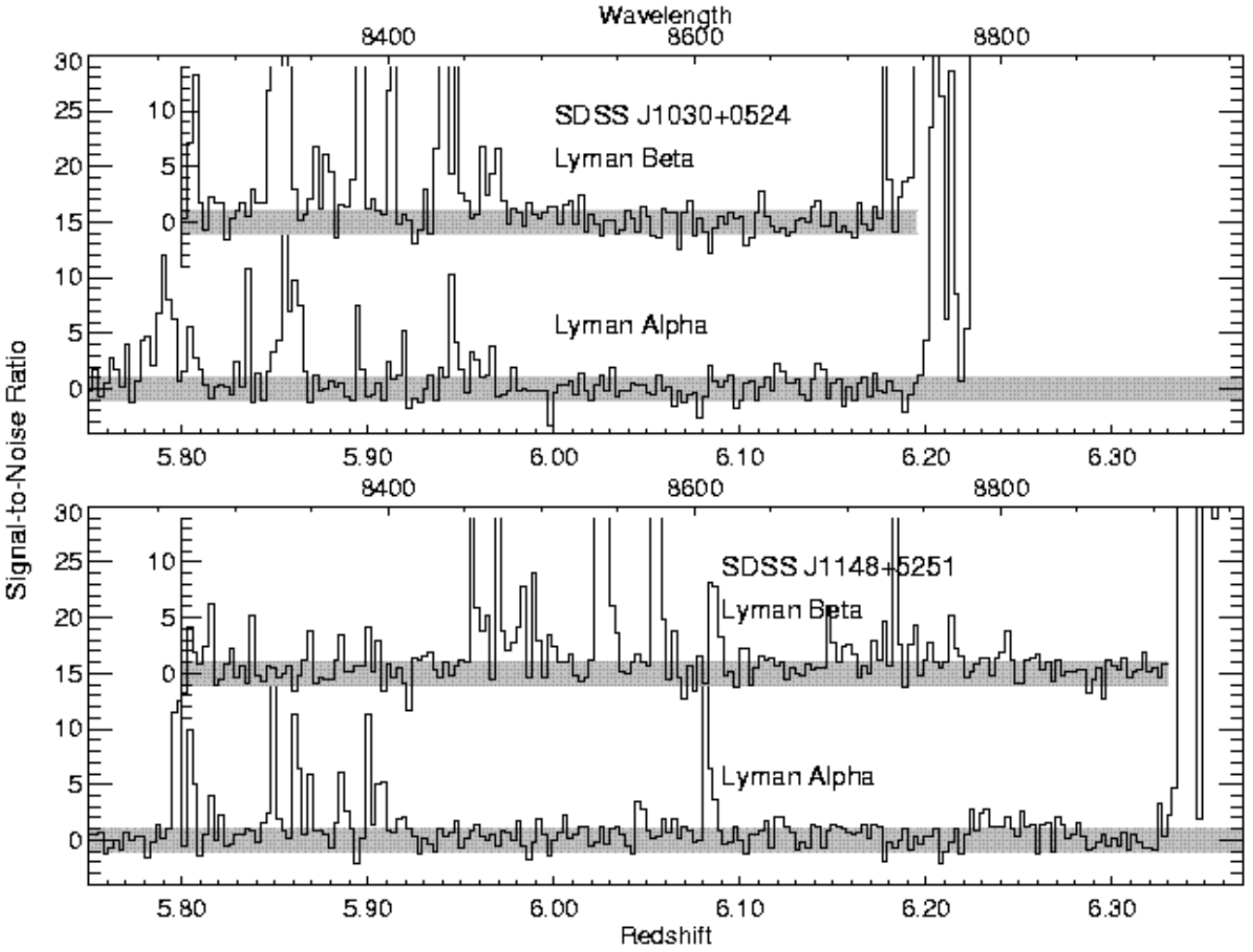
Where did the IGM metals come from?




The IGM metals are preferentially in dense regions...

..but they appear less inhomogeneous than predicted for winds from bright galaxies

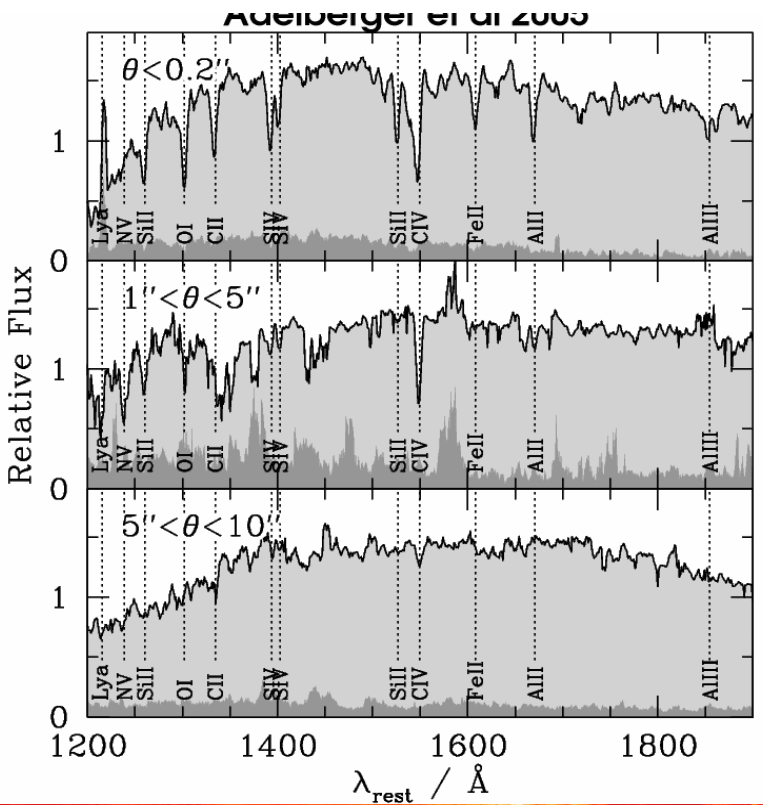
Why doesn't their abundance and distribution evolve with redshift?




The IGM optical depth becomes high and patchy at z>6

The end of reionisation? The onset of galaxies and quasars?

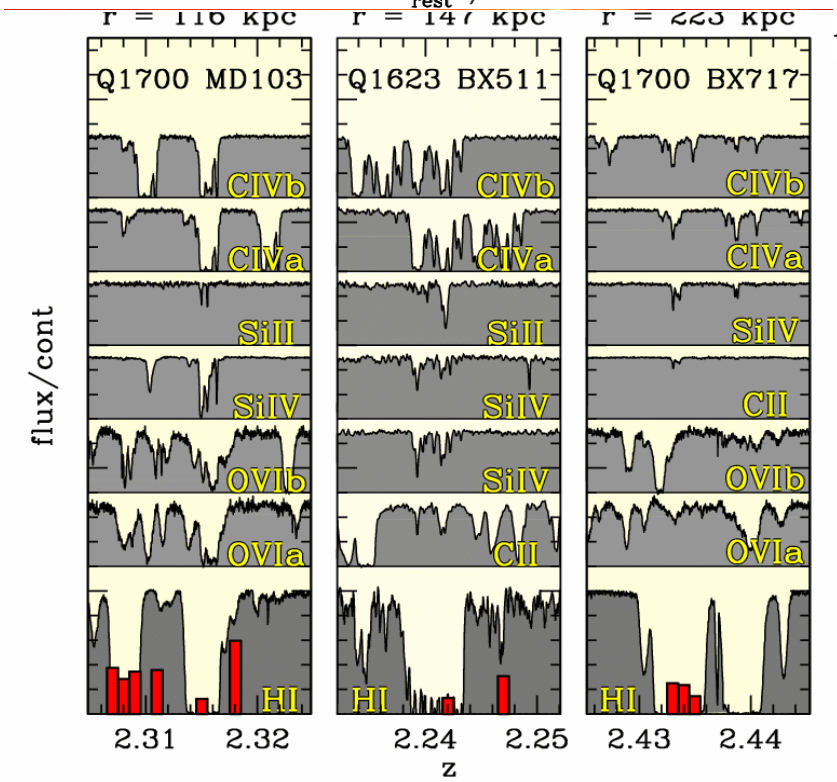
Then why is [C/H] high at z=5? Pregalactic metals?

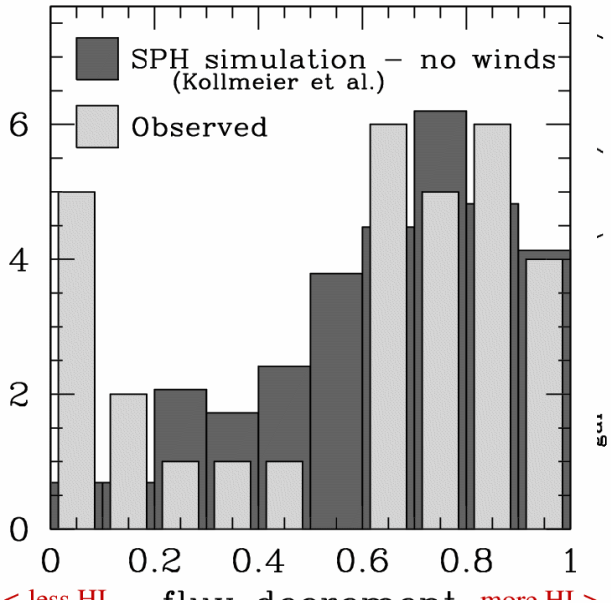


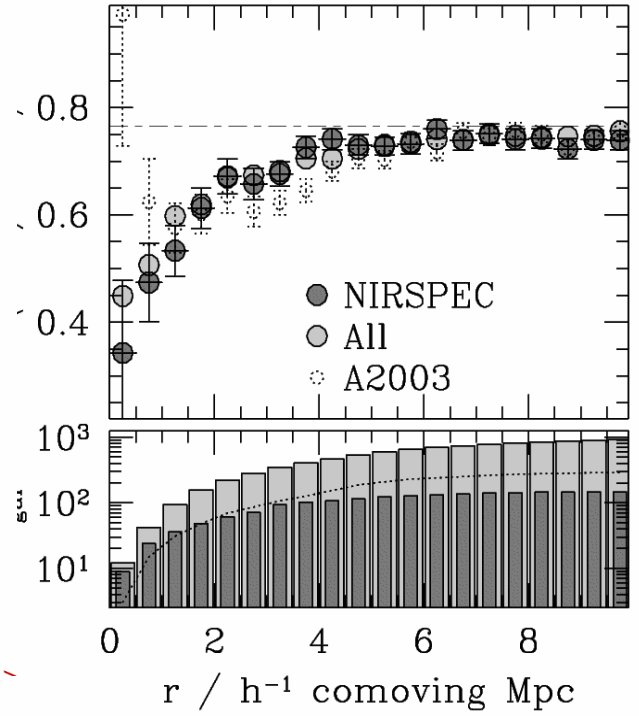

Winds seem to blow around most LBGs out to at least 40 kpc and around some out to 200 kpc

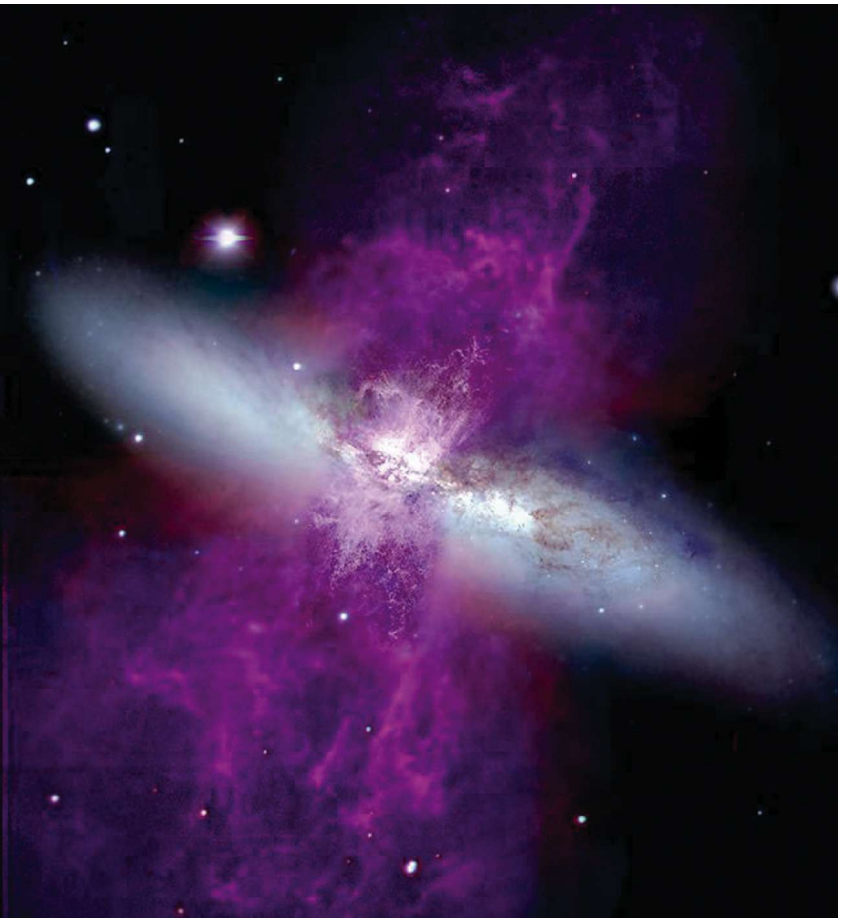
Despite this, Ly $\alpha$ absorption is enhanced in the mean down to small separations

Why can't M. Rauch see the evidence or A. Aguirre fit the inhomogeneities?



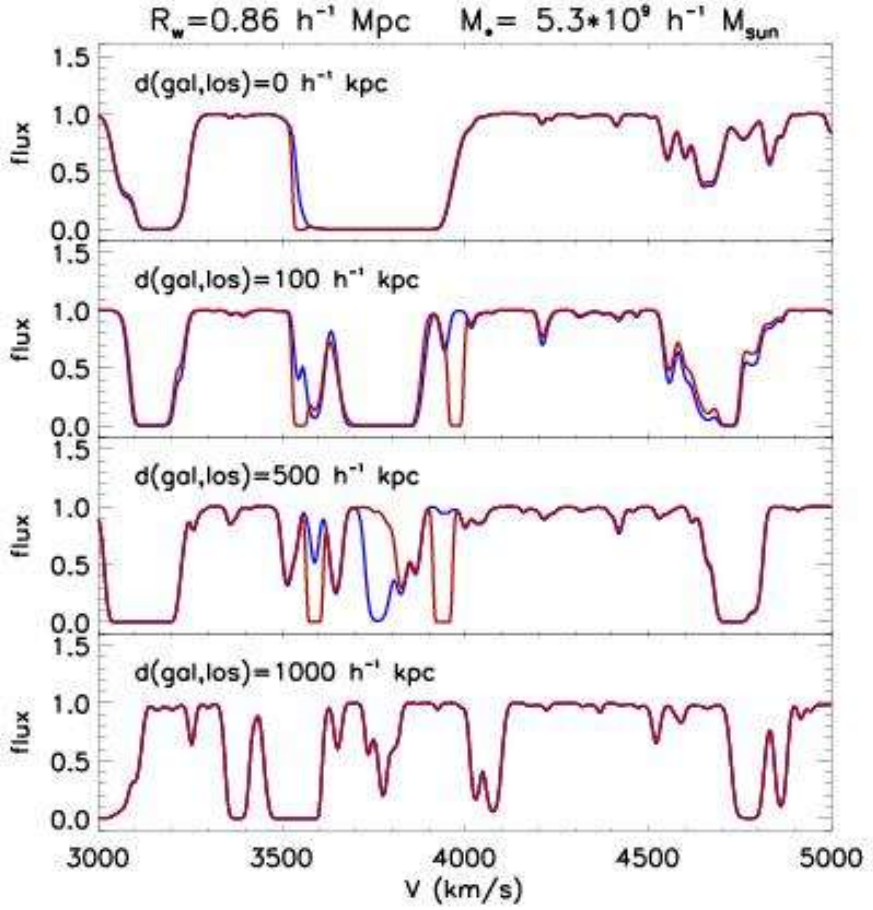


Are we really missing metals at z=2.5?

Are they hiding in wind bubbles?

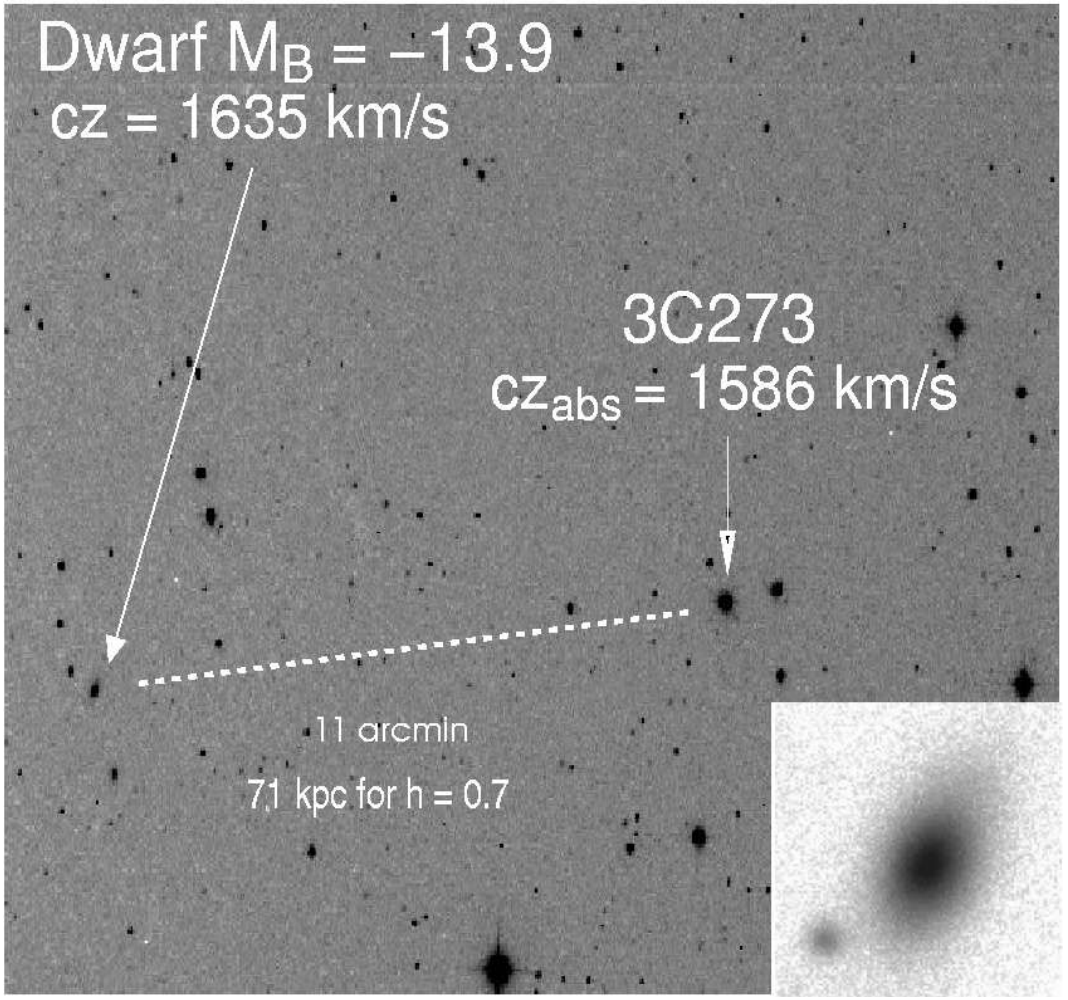
Are these the type 1 OVI absorbers?

What about at z=0?




Why don't the bubbles cool down if they are metal rich?

Why don't we see shells at the edge of cooling bubbles?




# An amazingly large shell?

3C273 ABSORBER

cz= 1586 ± 5 km/s

$N_{HI} = 7 \times 10^{15}$ cm$^{-2}$

$n = 1.4 \times 10^{-3}$ cm$^{-3}$

Shell thickness = 70 pc

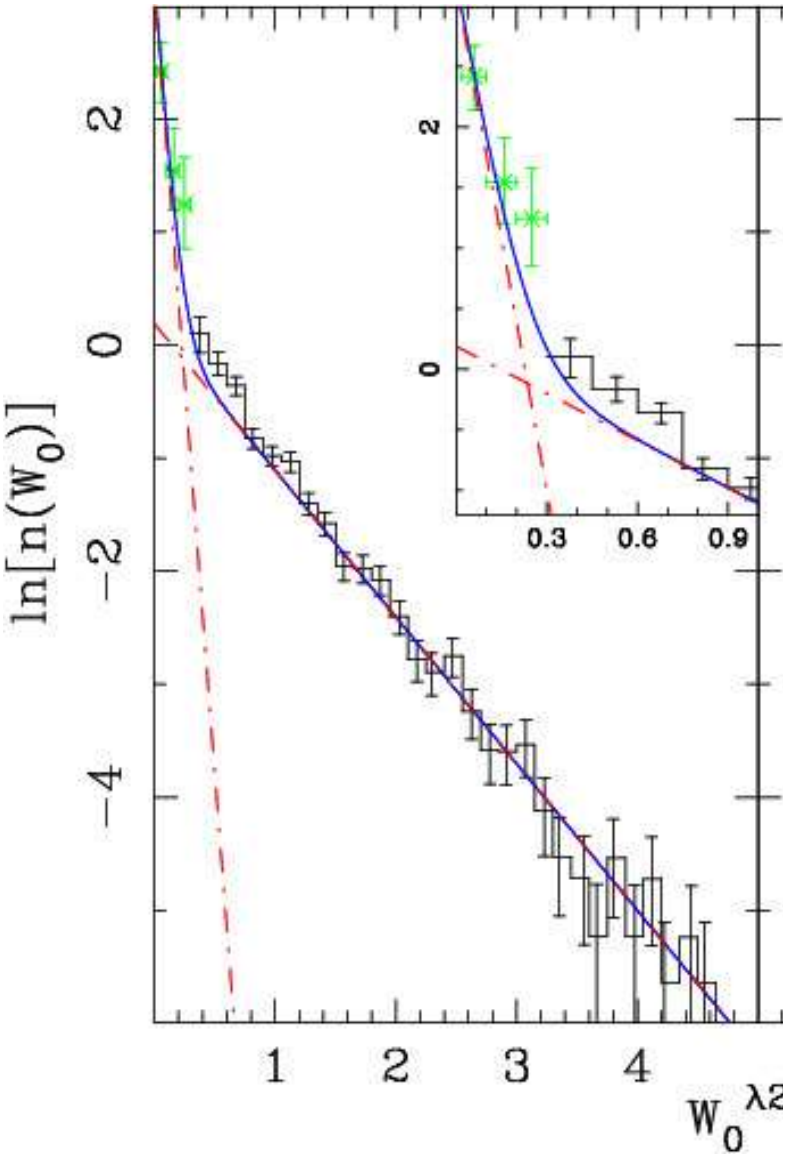
Shell mass < $10^8$ $M_{sun}$

(if centered on dwarf)

[Fe/H] = -1.2

[Si/C] = +0.2

# MgII absorbers and galaxies



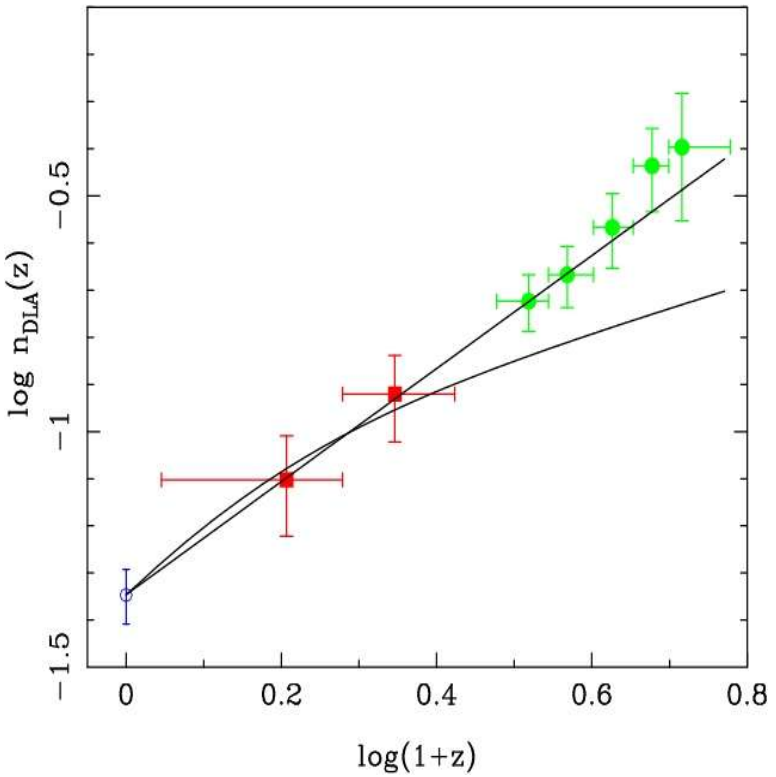

Most SDSS MgII absorbers are at large distances from their galaxies, yet most stronger absorbers lie within galaxies

Why is the MgII covering factor so large out to 50kpc?

Does absorption really extend out to 200 kpc? (CIV goes to > 150kpc)

Why does it depend on the asymmetry of the galaxy yet not on its orientation?

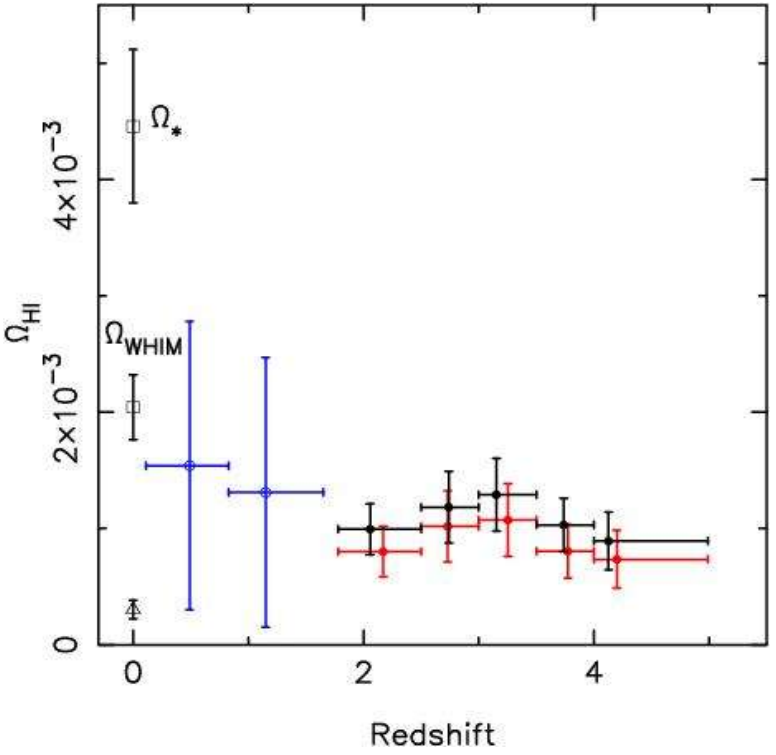
Does the dust really get carried out to 50 or 100 kpc?




‹*n A*› for DLA's is constant to z~1.5 then doubles out to z~4

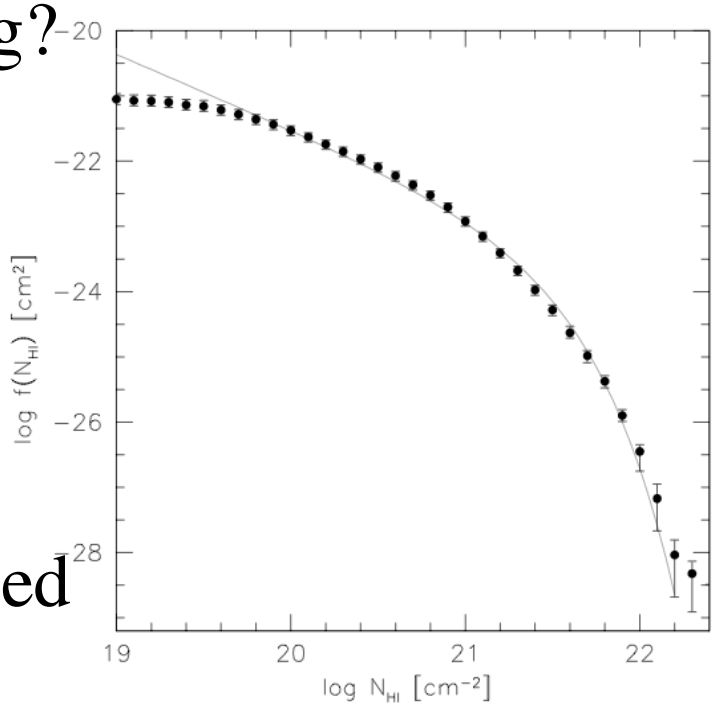
The HI content of DLA's doubles to z~1 then is roughly constant to z~4

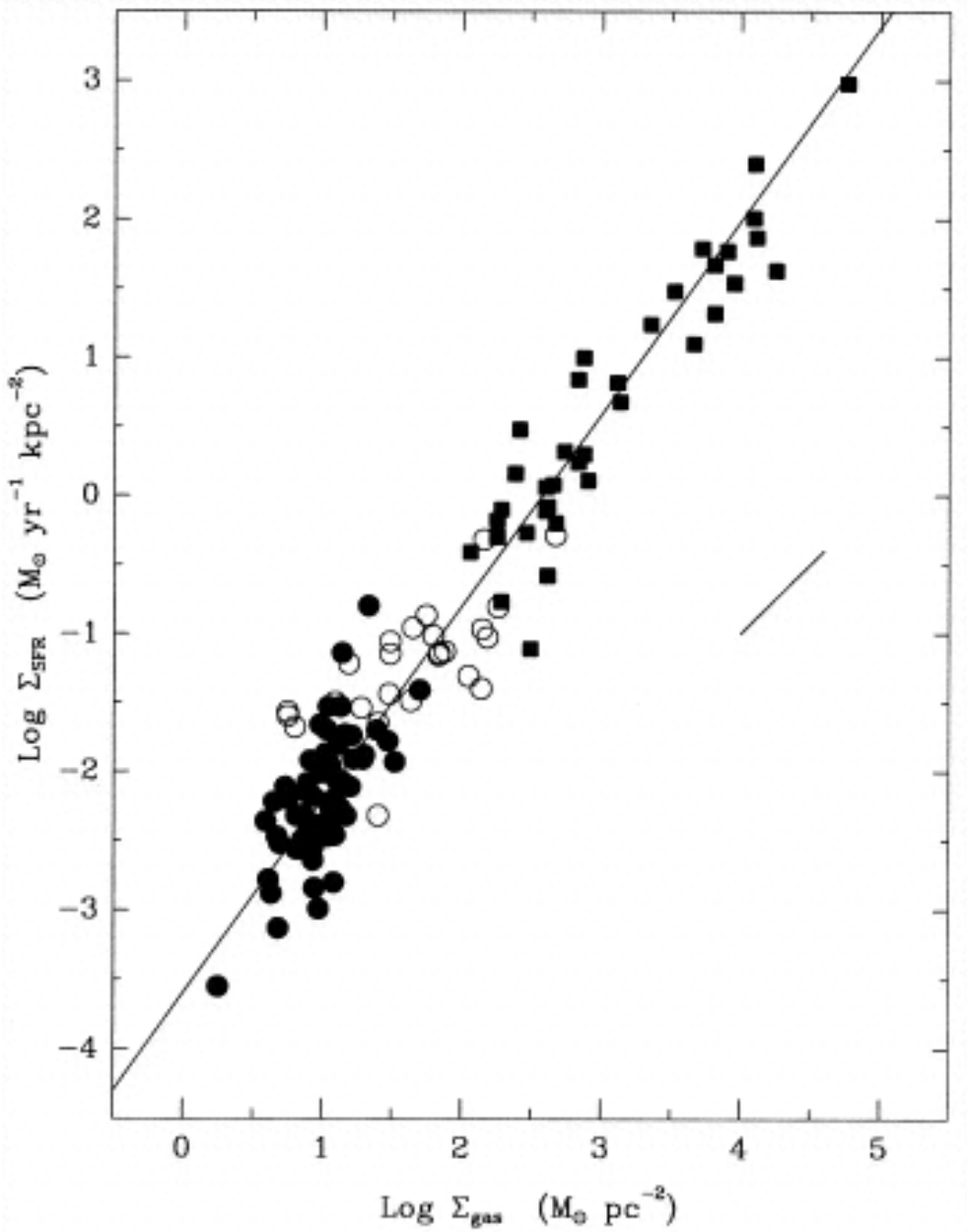
Are objects dropping out of the sample (turning into S0/E's)?




Are they shrinking?

Is is just a coincidence that the N(HI) range of DLA's is exactly that spanned by z=0 galaxies?






1 $M_{sun}/pc^2$ = 1.2 x $10^{20}$ $cm^{-2}$

The N(HI) where star formation occurs at z=0 and especially z>2 do not overlap those of DLA's

Stars form from molecular clouds NOT from neutral hydrogen

We do not see enough high redshift $H_2$ to explain the SFR...

...but the covering factor of LBGs is too small to have seen any

Can DLA gas be heated by LBG stars if they are in different places?

Dust selection effects?

# Winds/multiphase halos are required for galaxy formation?

Relatively small number of low luminosity/low HI mass galaxies inconsistent with CDM predictions -- requires preheating to 0.5 million degrees (H.J. Mo)

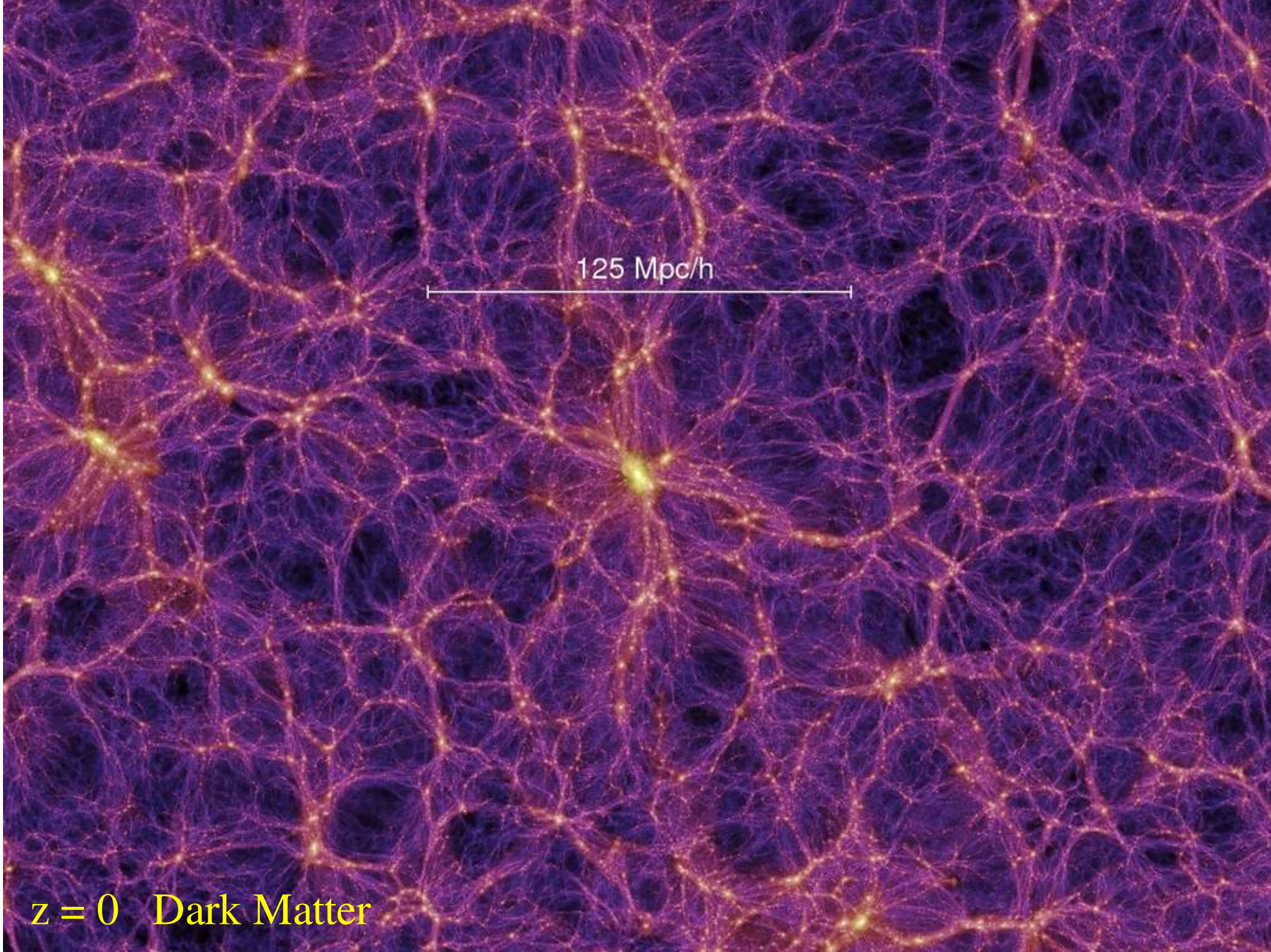
Relatively small number of very high mass galaxies requires reduction of cooling in high mass systems (A. Maller)

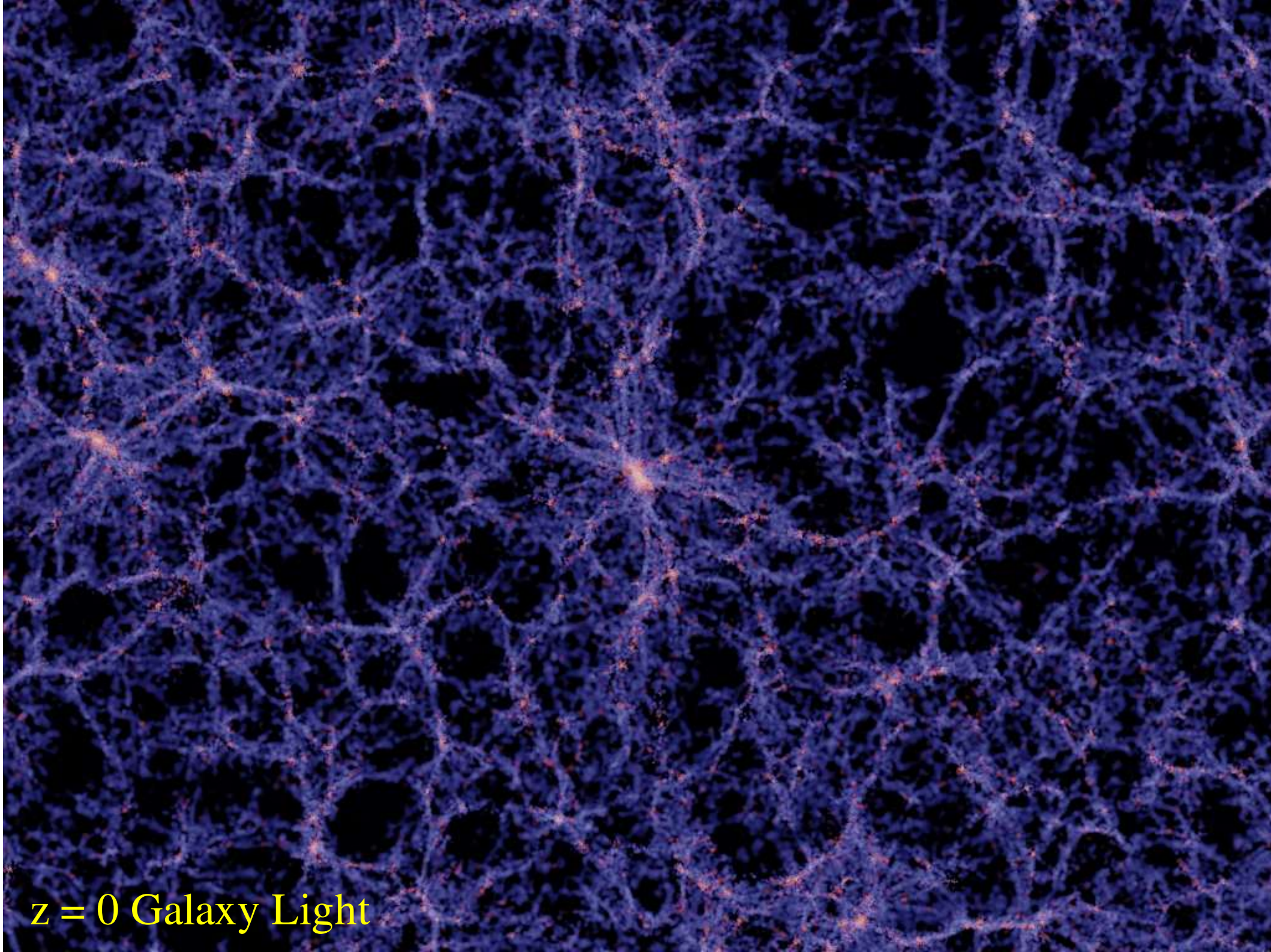
# Winds/multiphase halos are required for galaxy formation?

Relatively small number of low luminosity/low HI mass galaxies inconsistent with CDM predictions -- requires preheating to 0.5 million degrees (H.J. Mo)

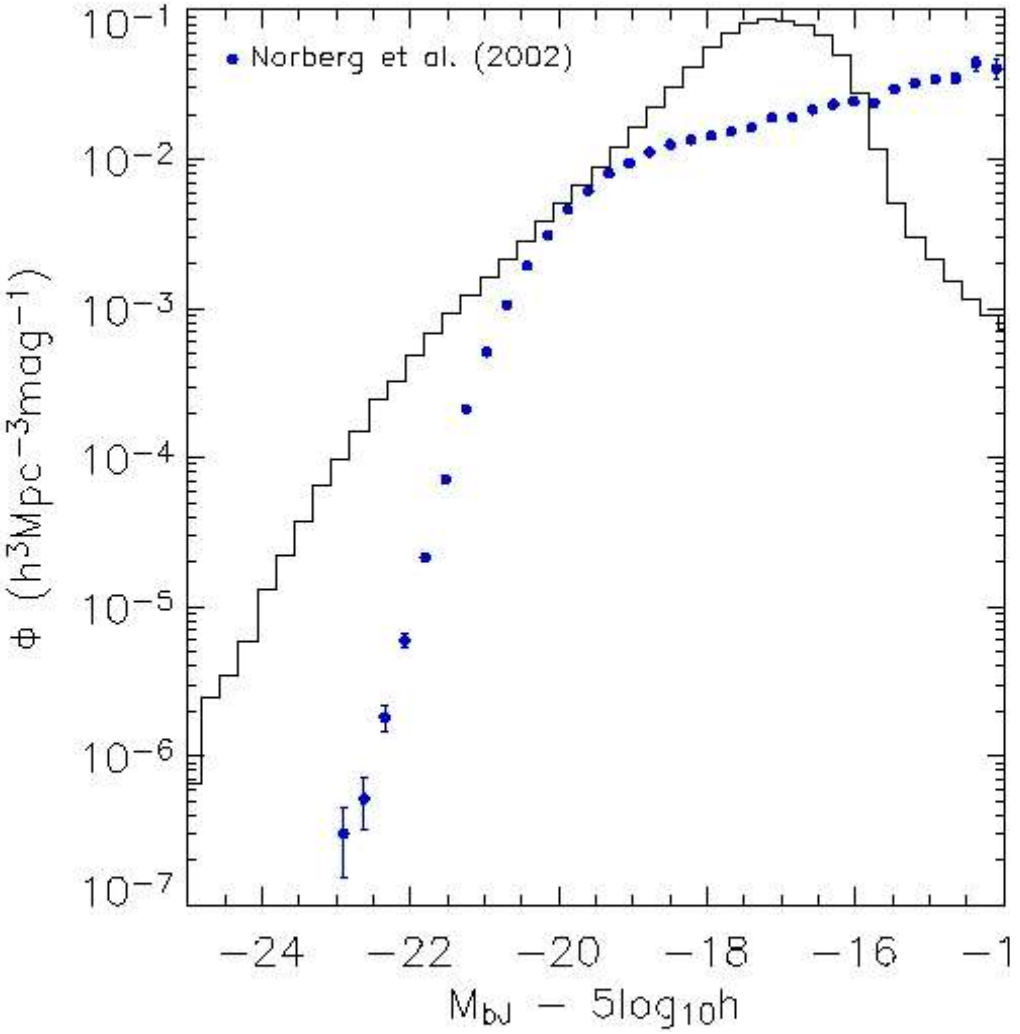
Relatively small number of very high mass galaxies requires reduction of cooling in high mass systems (A. Maller)

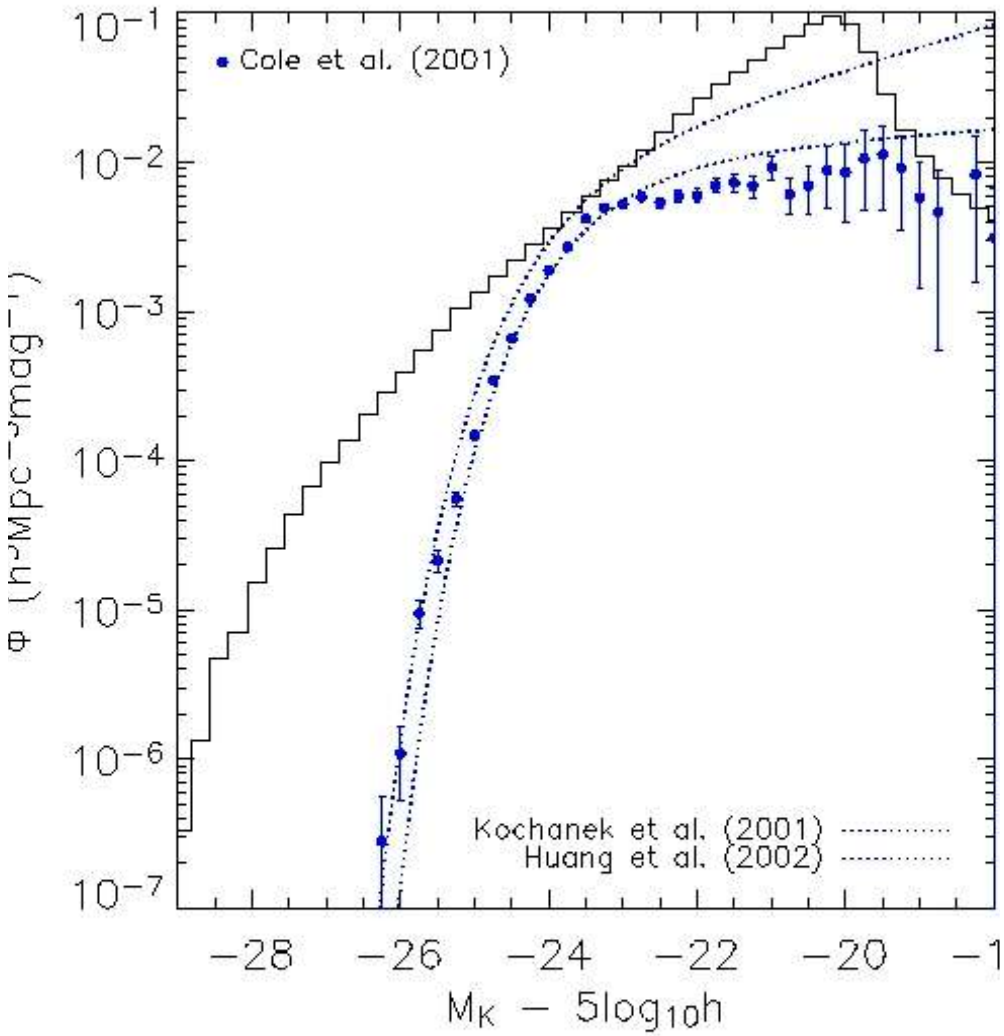
Our models may be wrong but reality is correct (H.J. Mo)


125 Mpc/h
z = 0 Dark Matter


z = 0 Galaxy Light

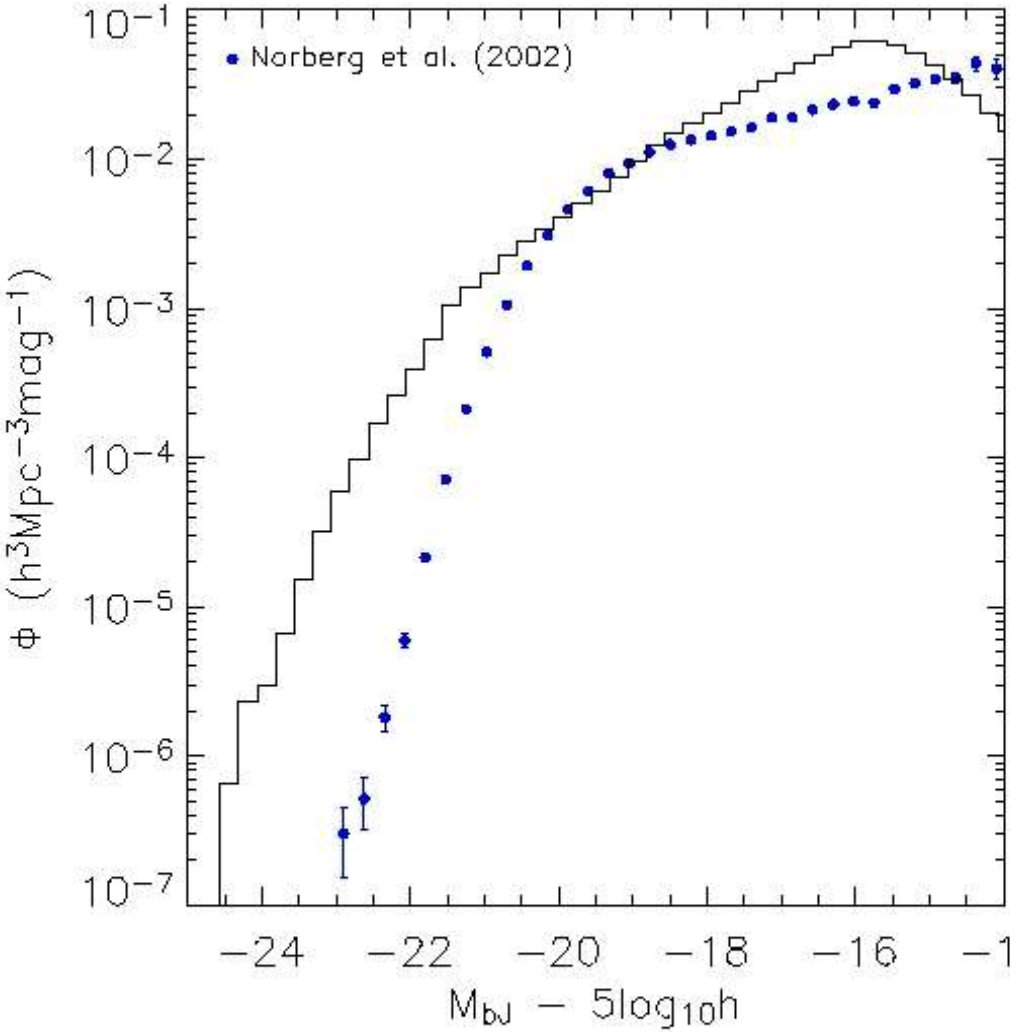
# Effect of feedback on the Luminosity Function

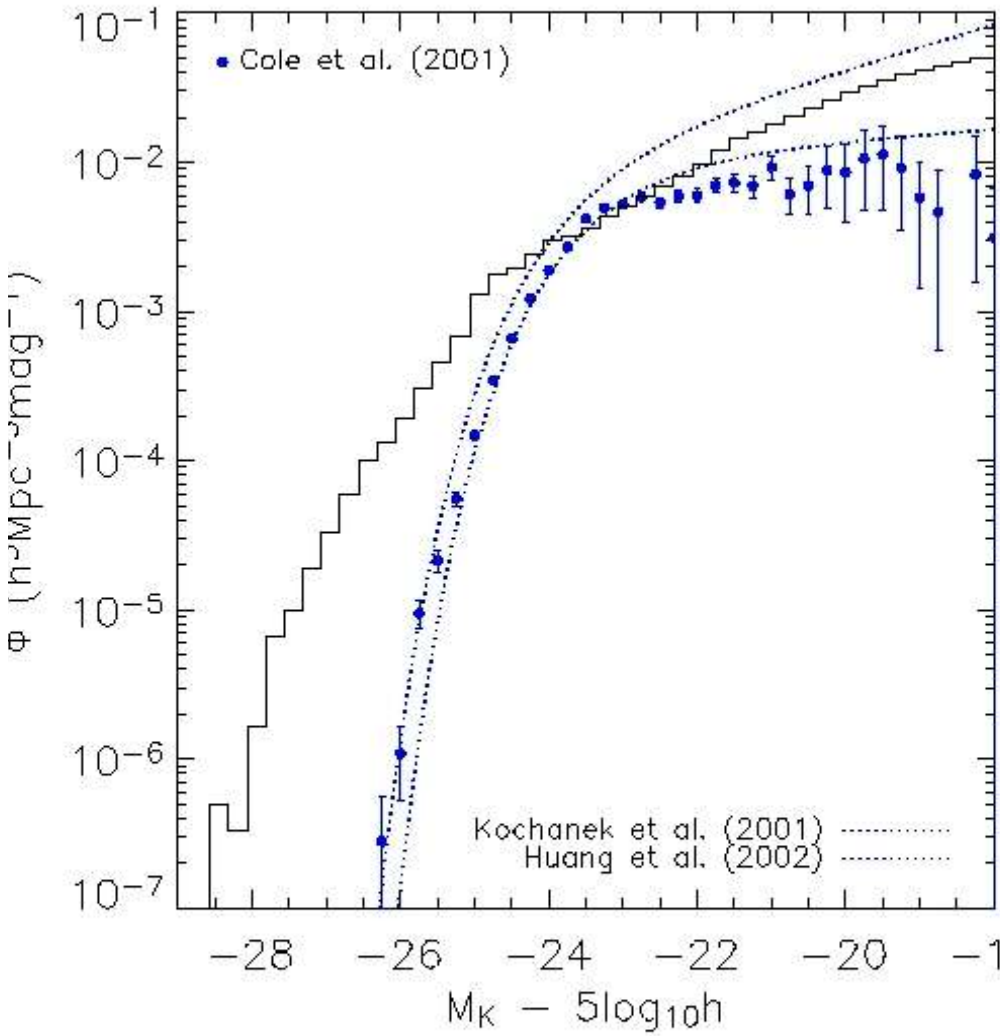



Full model with ~~reionisation~~, ~~AGN~~ and ~~SN~~ feedback Croton et al 2005

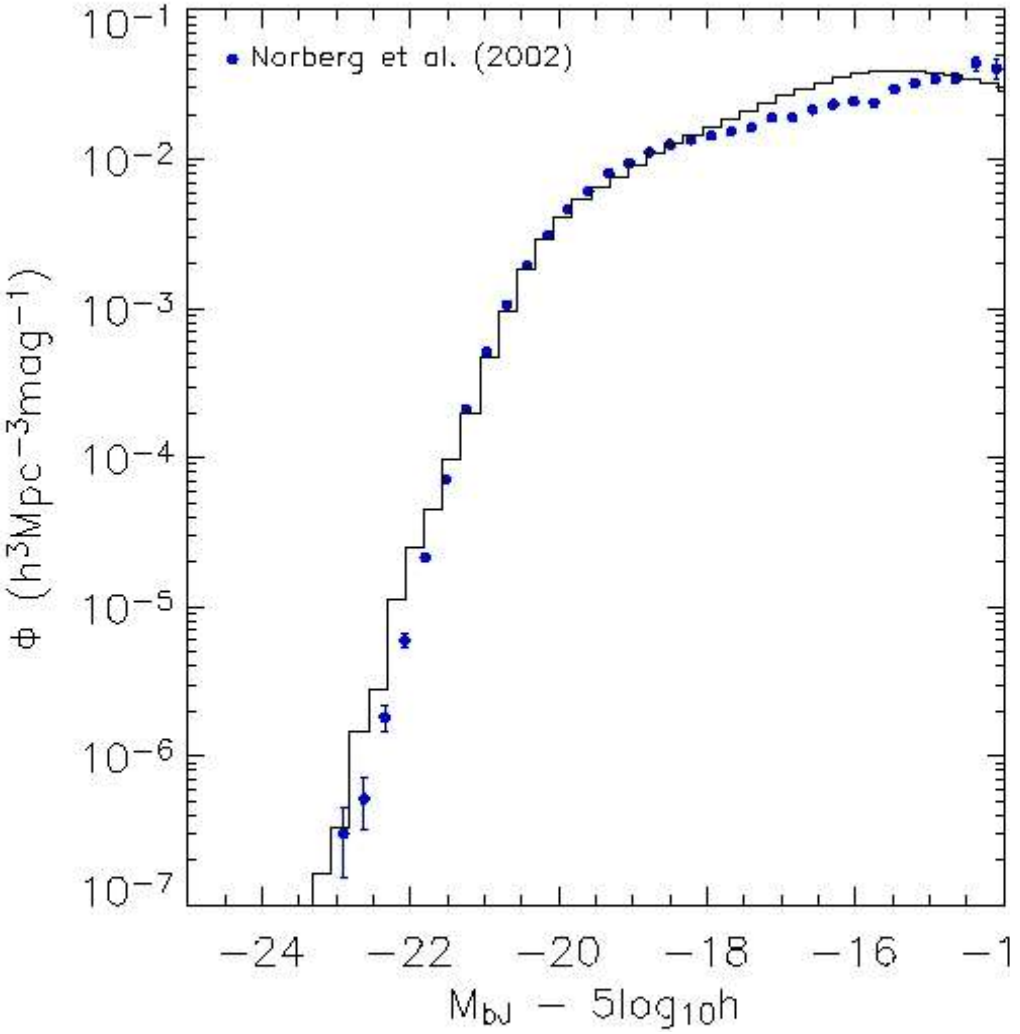
# Effect of feedback on the Luminosity Function

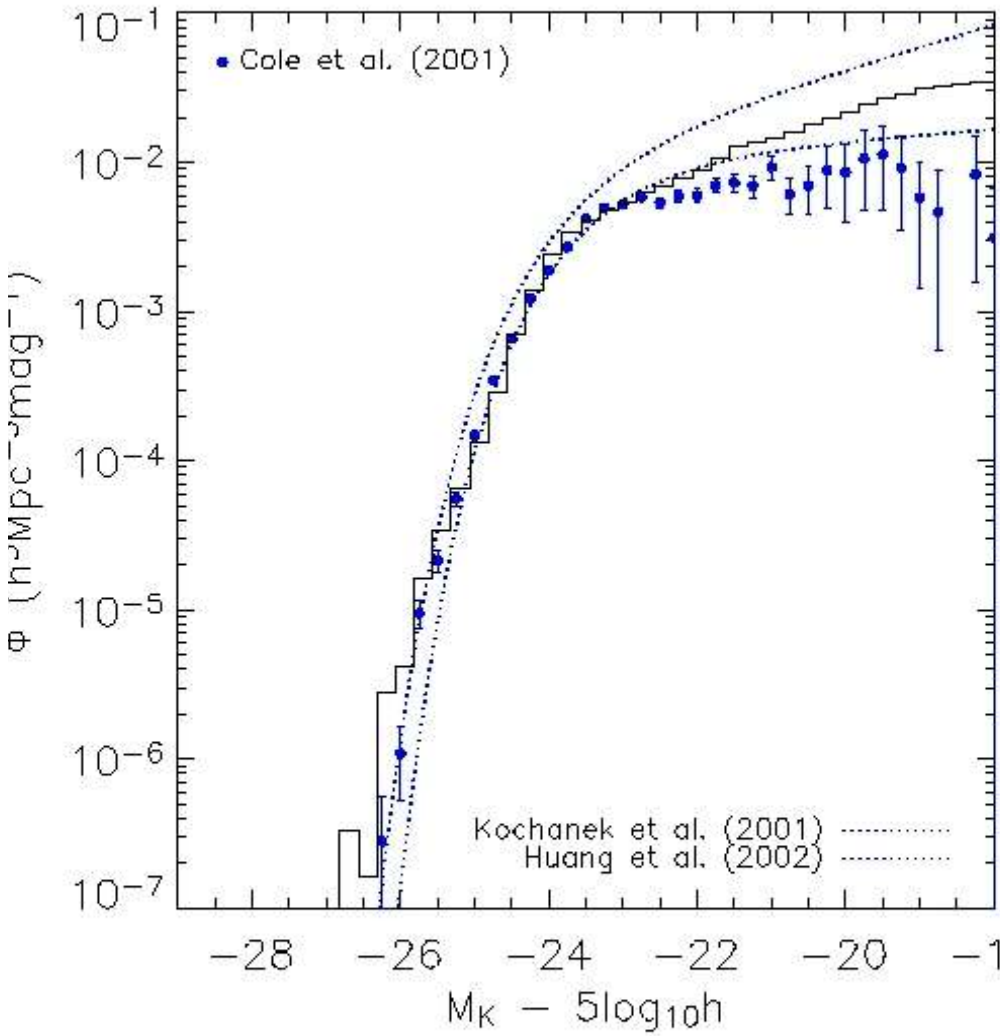



Full model with ~~reionisation~~, ~~AGN~~ and SN feedback Croton et al 2005

# Effect of feedback on the Luminosity Function




Full model with reionisation, AGN and SN feedback Croton et al 2005

- What do we need for precision cosmology?
- What is happening at z ~ 6.2?
- Does a significant fraction of the metals come from z > 5?
- Where are the metals relative to galaxies and the web?
- How do we check the effectiveness of winds?
- What is relation of the shocked WHIM to the enriched WHIM?
- What is the state of MgII and CIV halos?
- Uncertainties in metal/baryon/HI density and their evolution?
- Are we missing the action in absorption?
- How can we use new facilities to make progress?


Thank you!