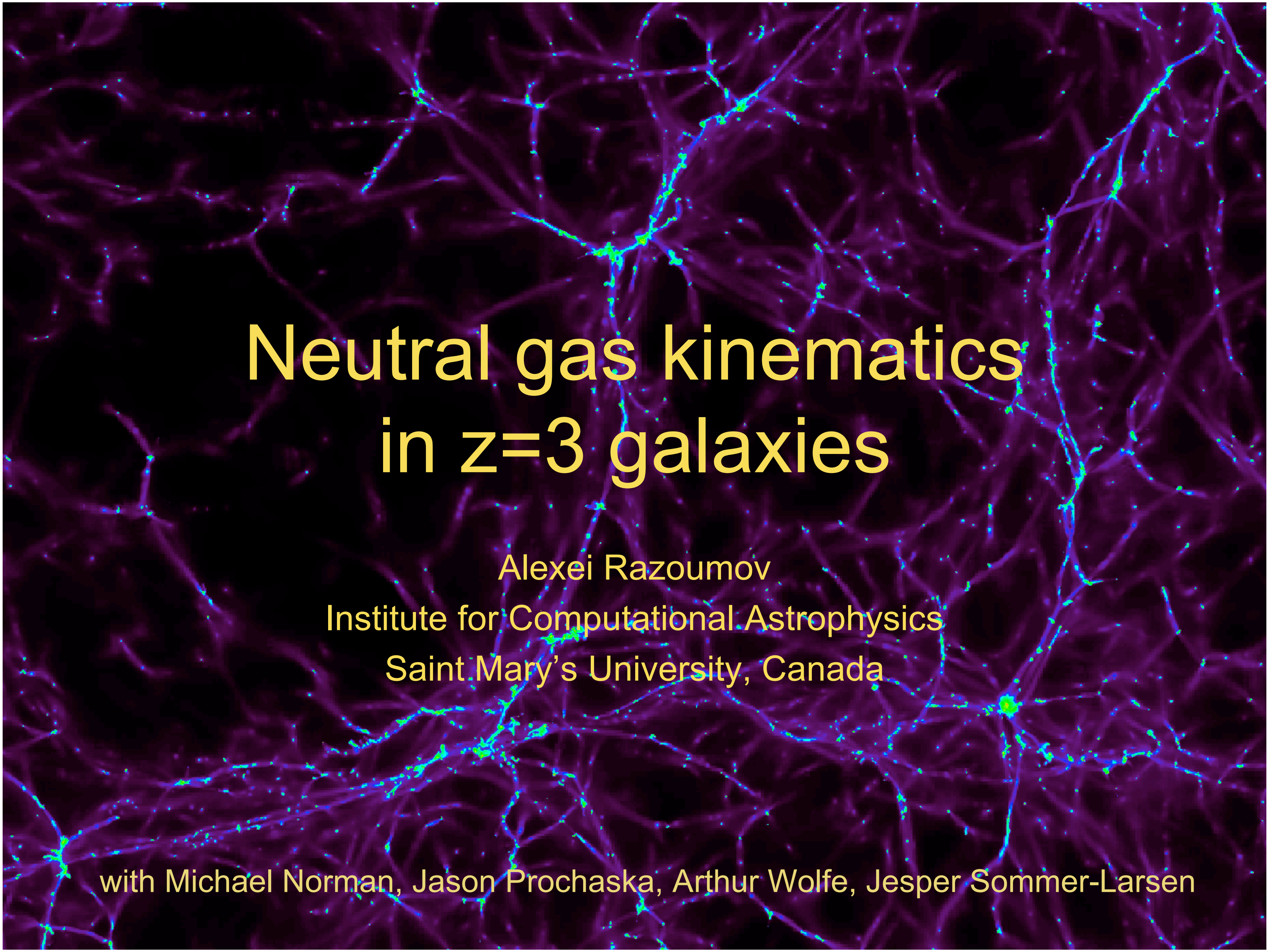


Neutral gas kinematics in z=3 galaxies

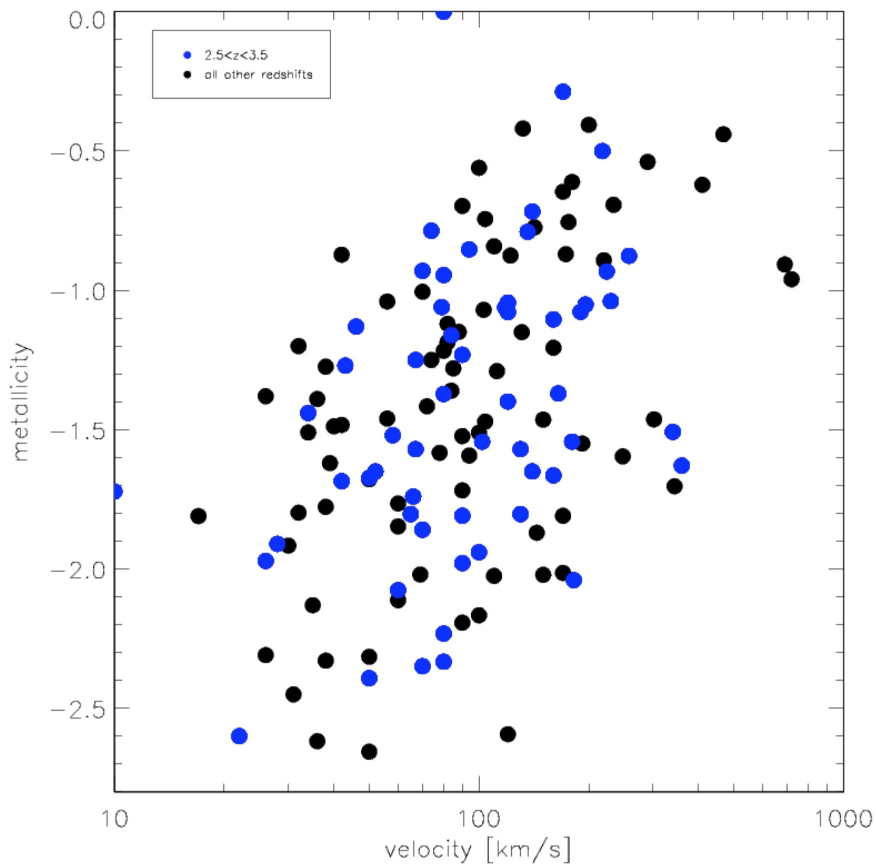
Alexei Razoumov

Institute for Computational Astrophysics

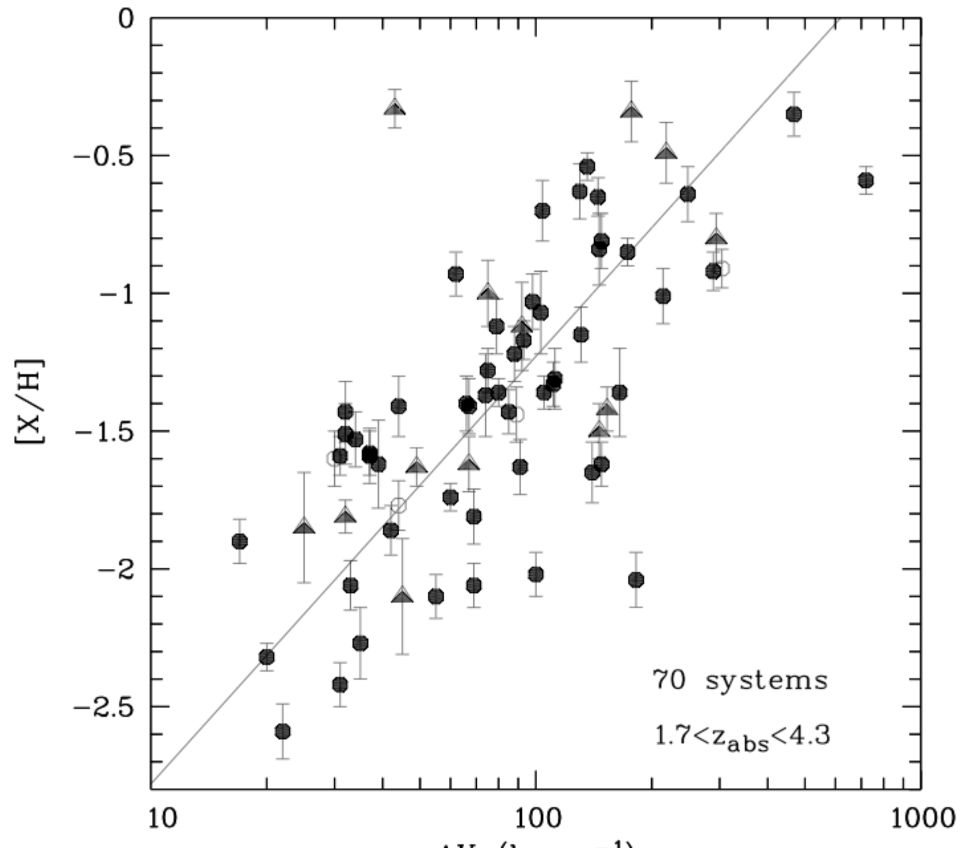
Saint Mary's University, Canada

with Michael Norman, Jason Prochaska, Arthur Wolfe, Jesper Sommer-Larsen

Velocity - metallicity relation



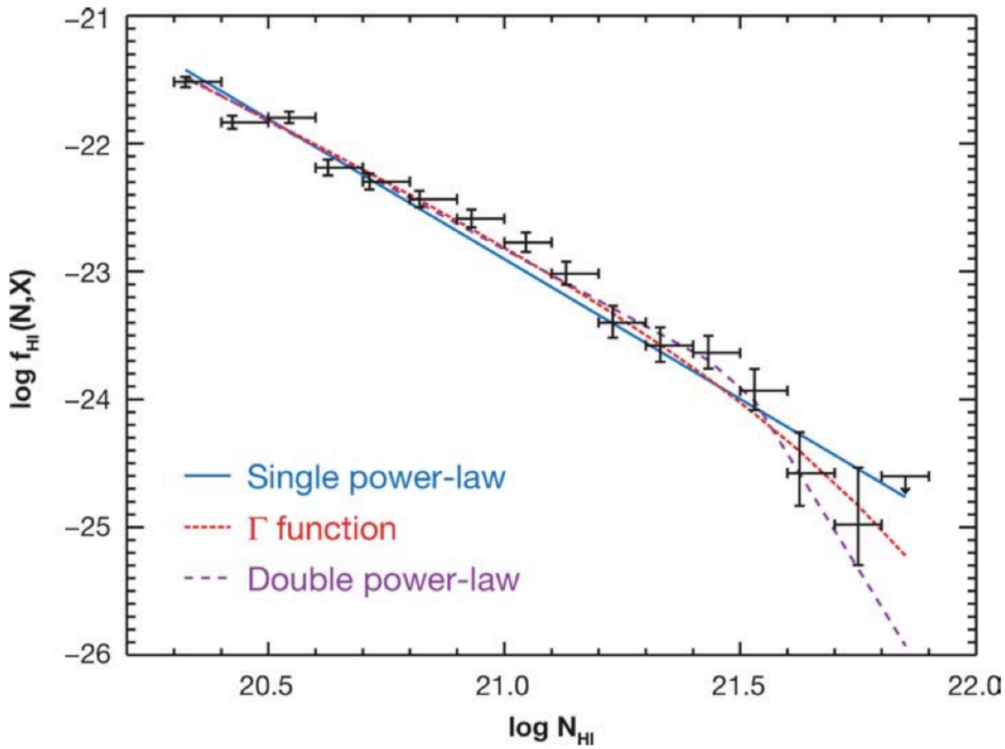
(data by Prochaska and Wolfe)



(Ledoux et al. 06)

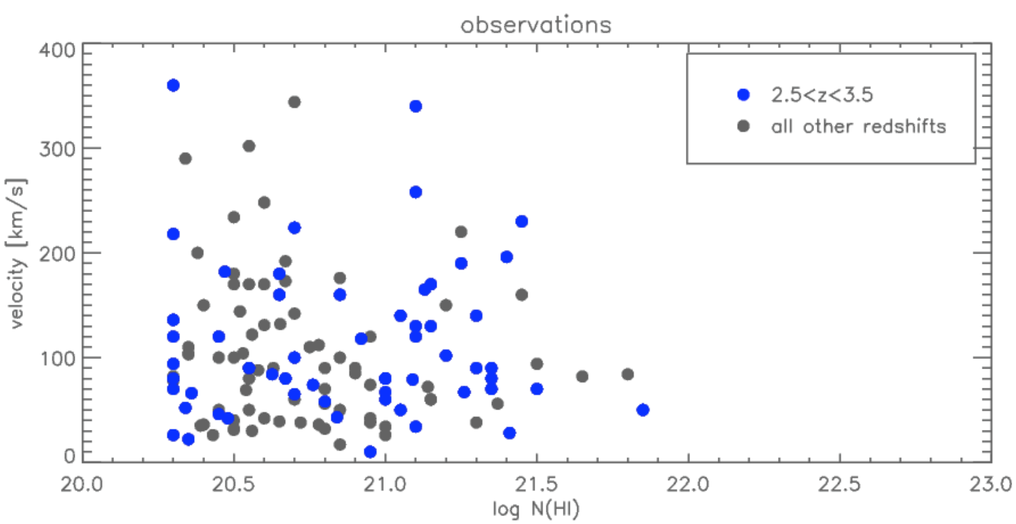
More massive systems have been around for longer time and must have accumulated more metals. In addition, their deeper potential wells contribute to more efficient conversion of gas into stars at any given time. These systems also have larger velocity dispersions.

What we really see is the effect of feedback:
more energetic winds disperse more metals into
the ISM/IGM. They also feature higher velocities.



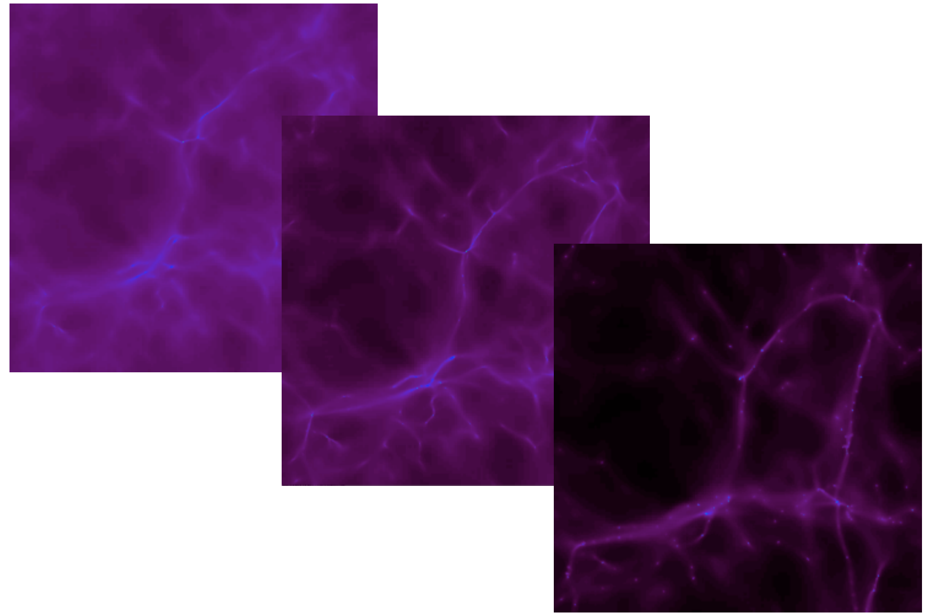
HI column density distribution

unit absorption distance $dX = H_0 / H(z) \times (1+z)^2 \, dz$

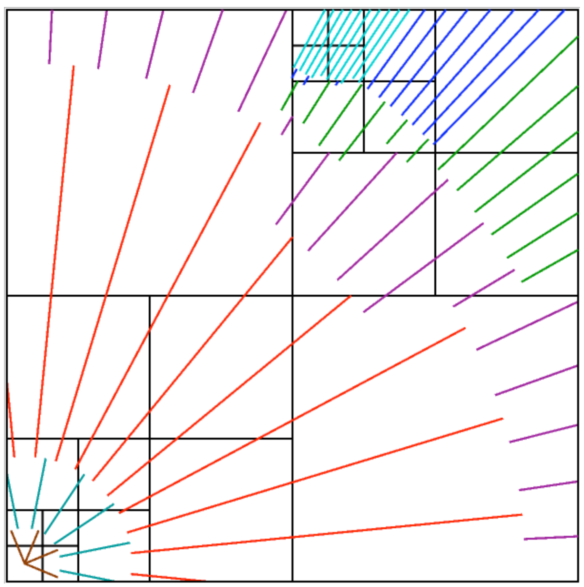


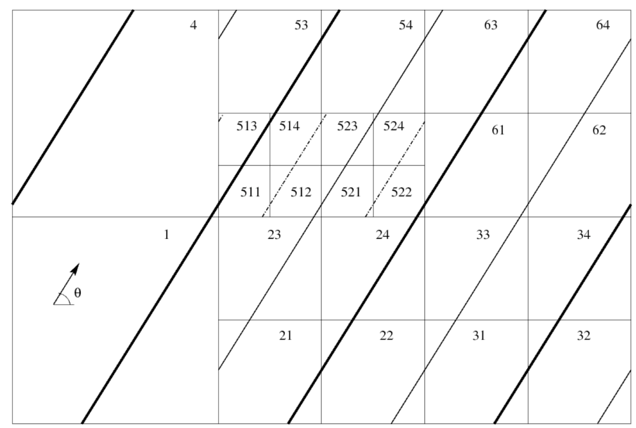
velocity widths vs. HI columns

enzo



- volumes from 4/h to 32/h Mpc on a side
- up to 7 levels of refinement
- higher res. models feature ~10^3 halos

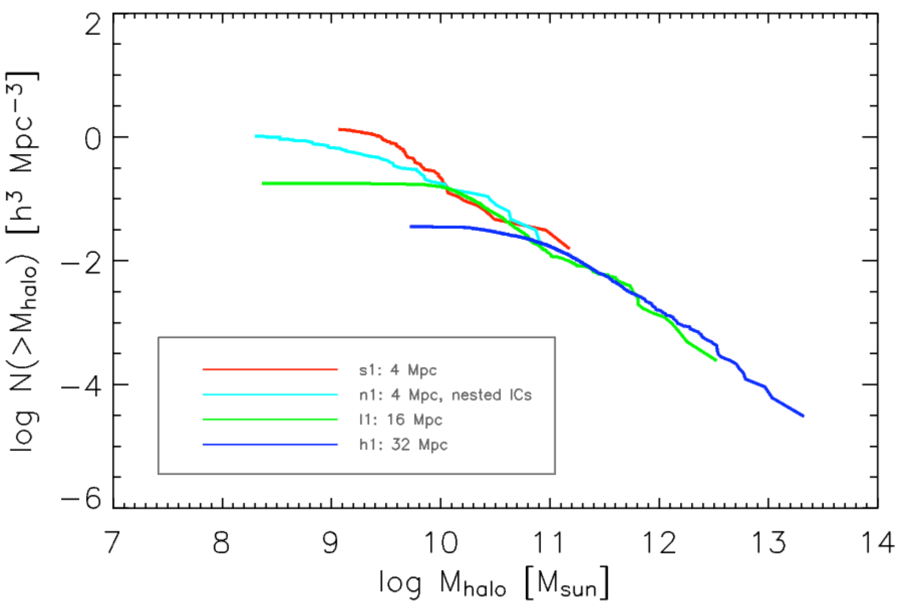


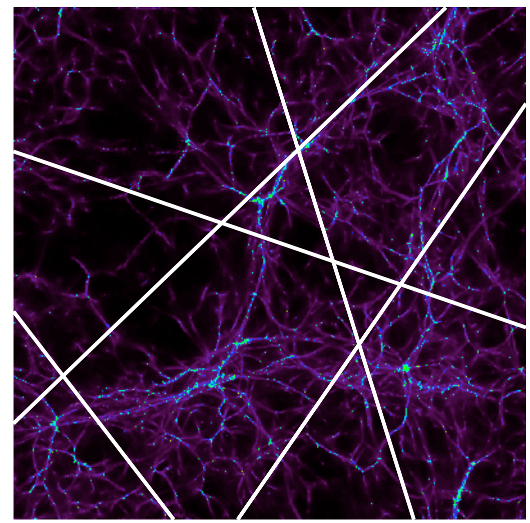


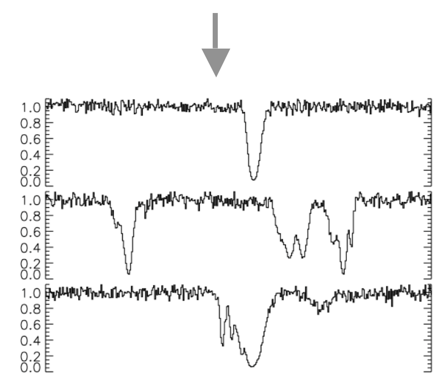
Numerical resolution very important for number of reasons:

- clumps above ~$10^{7.5}$ M_{sun} (without SF) can self-shield against ionizing UVB
- galaxies above ~10^{10} M_{sun} can retain feedback gas
- topology of HI regions at z=3 quite complex and depends on resolution
- need to resolve clumpy ISM (the scale of large H_2 clouds) to have sustained SF

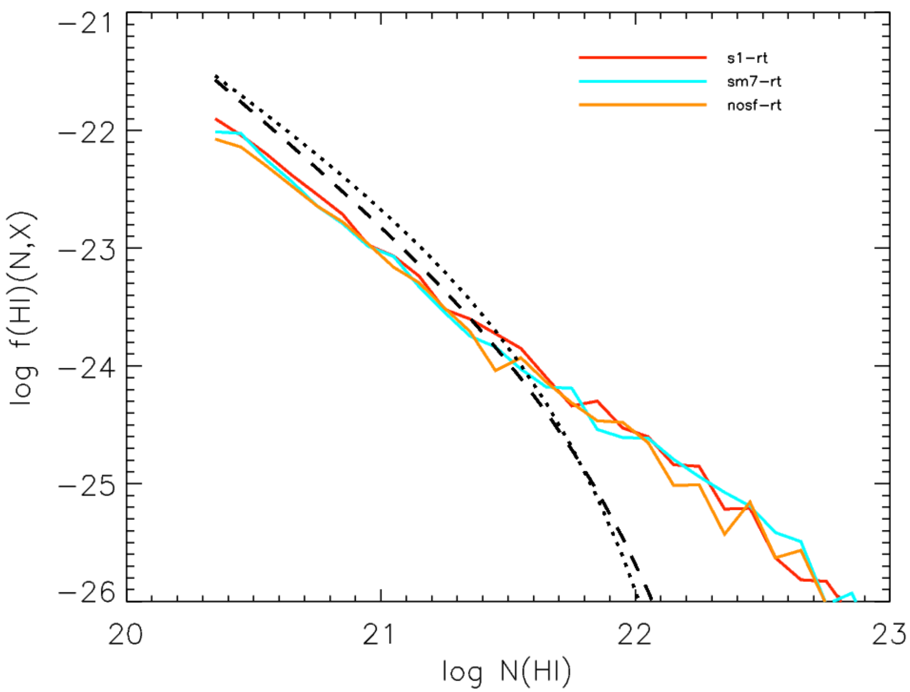
Currently max physical resolution 90 pc

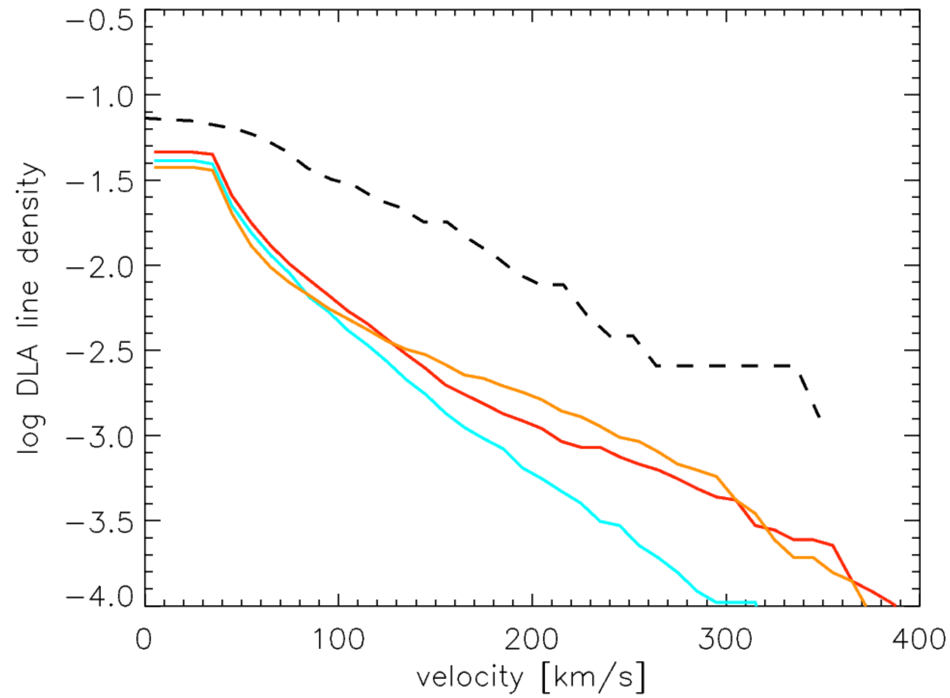


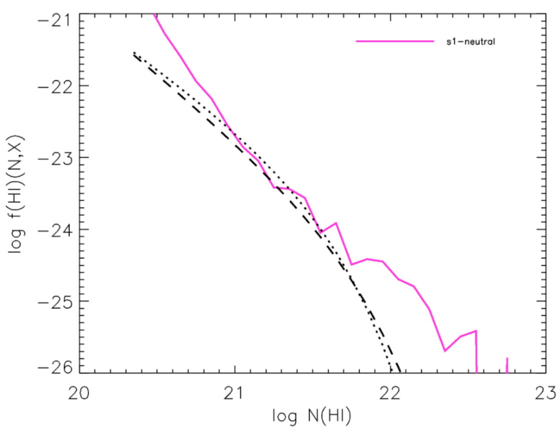


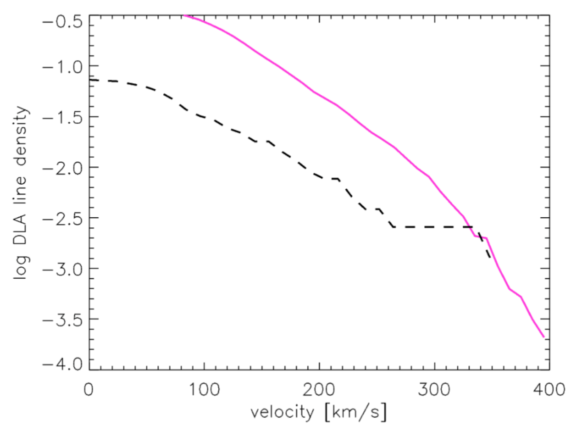


Smaller volumes (4/h Mpc), high resolution

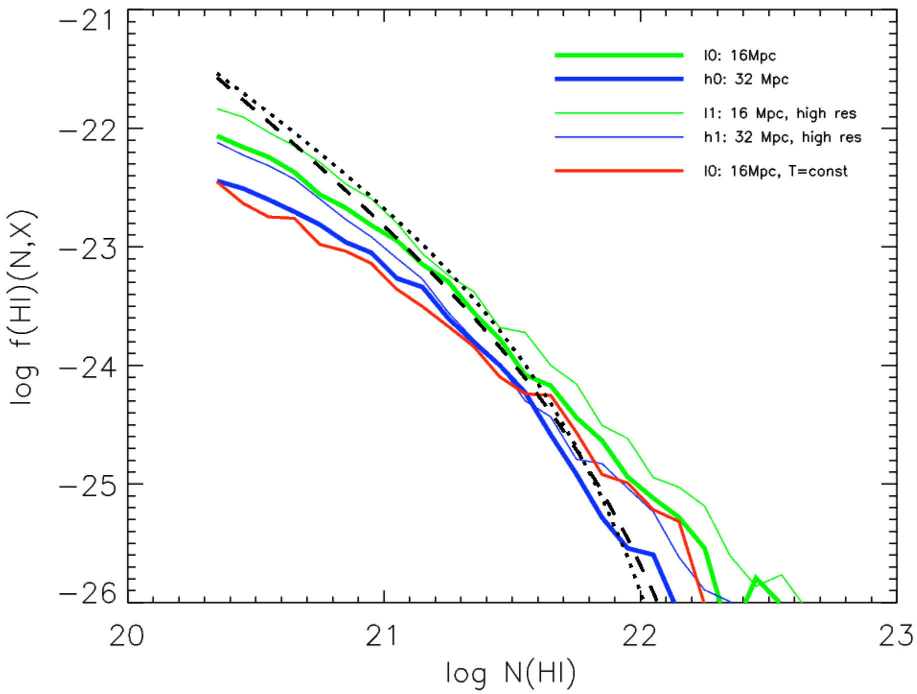


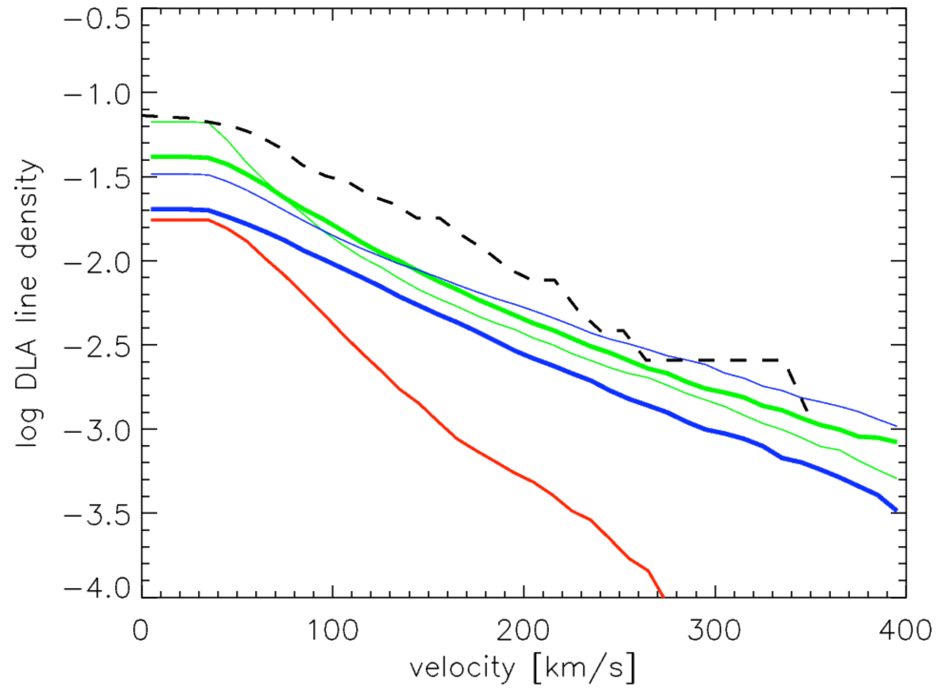


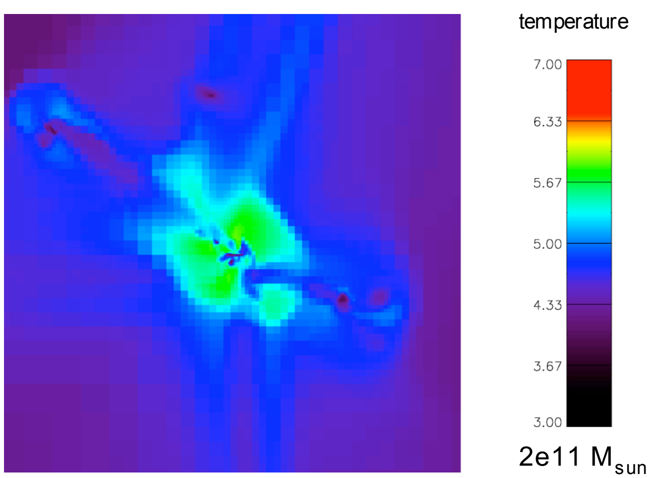




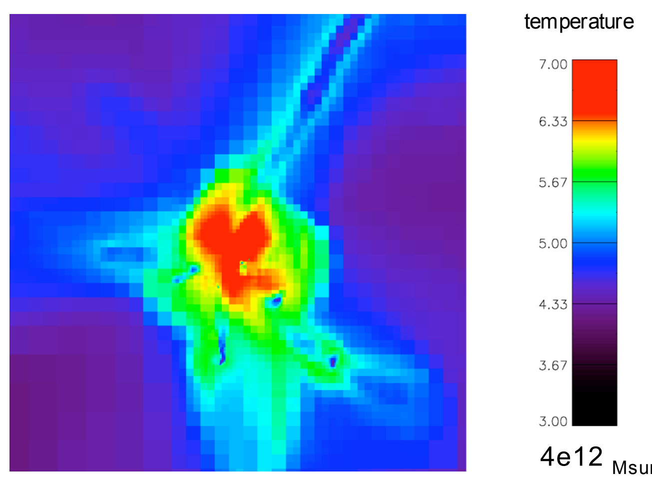
Larger volumes (16/h - 32/h Mpc), lower resolution





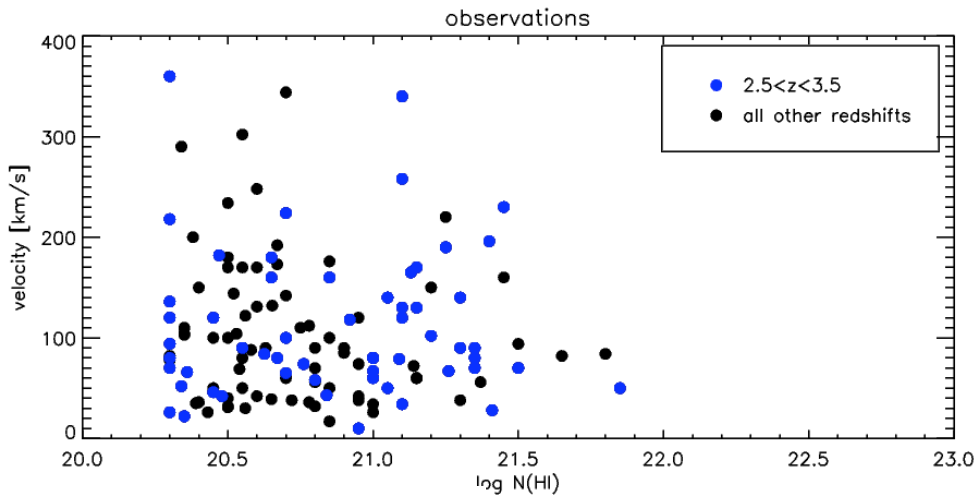


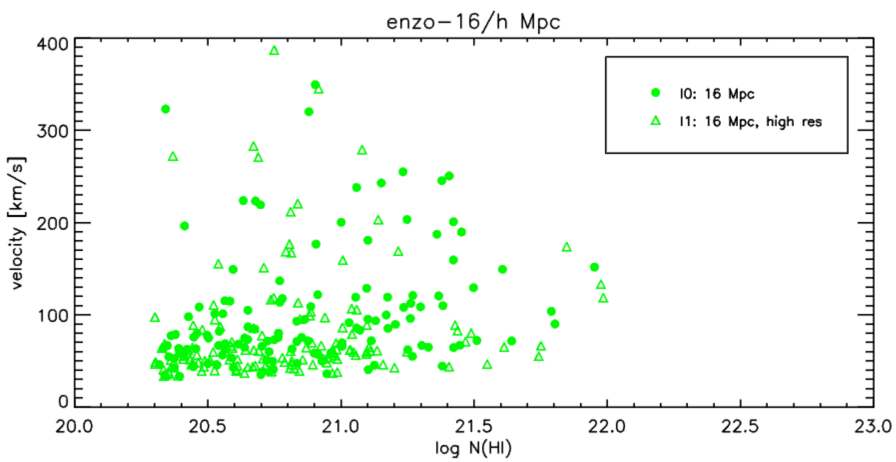
2e11 M_{sun}

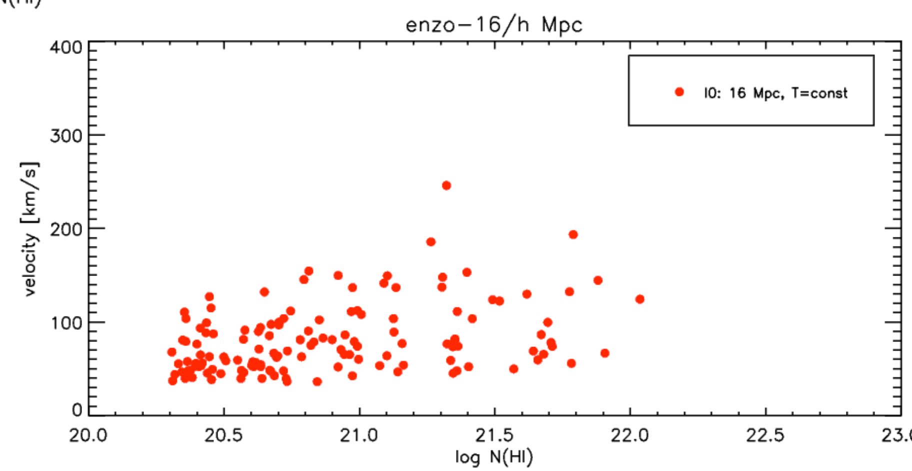


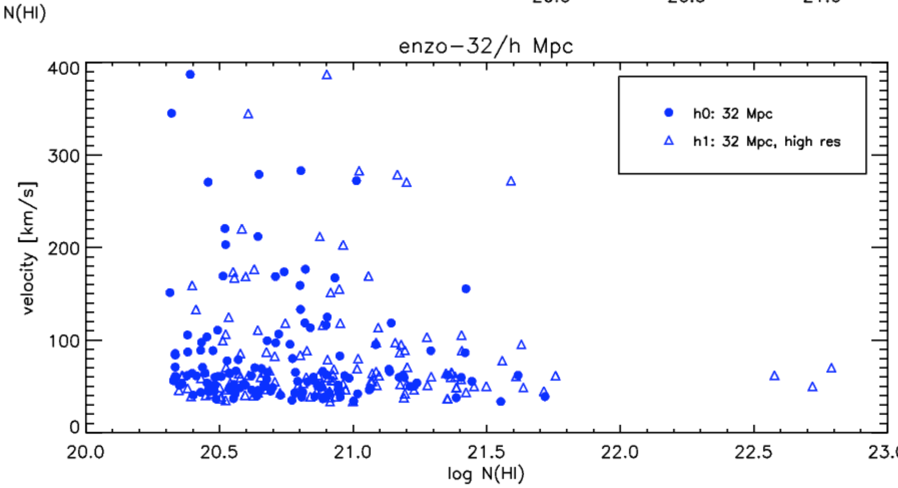
4e12 $_{Msun}$

velocity widths vs. HI columns









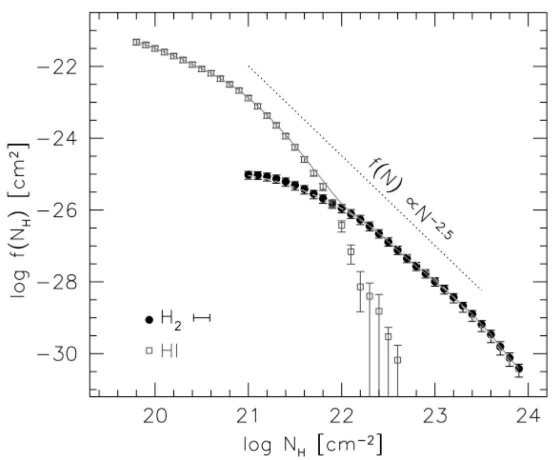
Possible solutions for …

the HI turn-off in the N(HI) plot

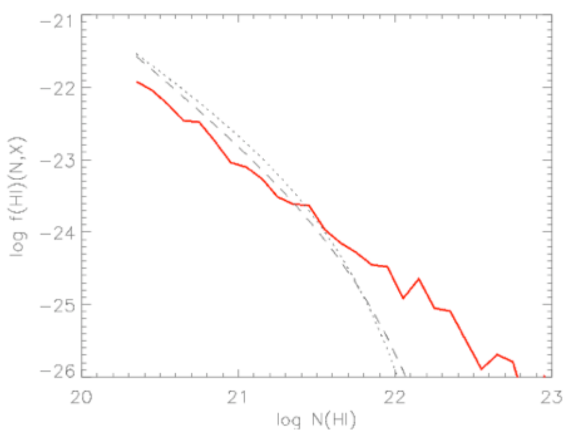
- H_2 formation
- Hydrodynamical effects - compression of HI into thinner, smaller clouds
- Stellar UV - ionization
- Resolution - densest filaments/cores continue to cool and collapse
- Dust bias against selecting high N(HI)

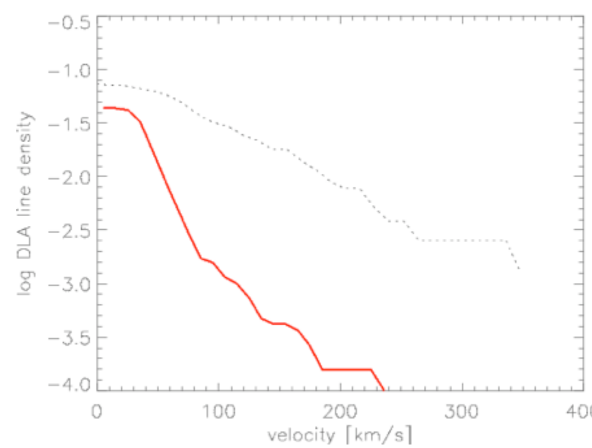
the high-end velocity tail

- More massive environments
- Resolution + physics of feedback
  - More efficient conversion of feedback energy into expansion
  - More efficient cooling, H_2 formation, clumpy ISM
- Non-trivial history of star formation and feedback

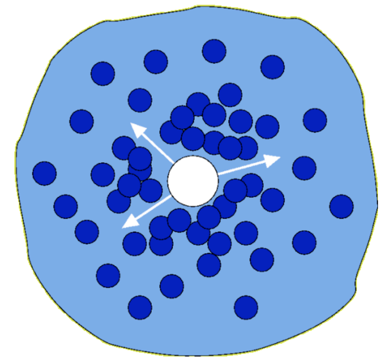


Zwaan & Prochaska 06, at z=0





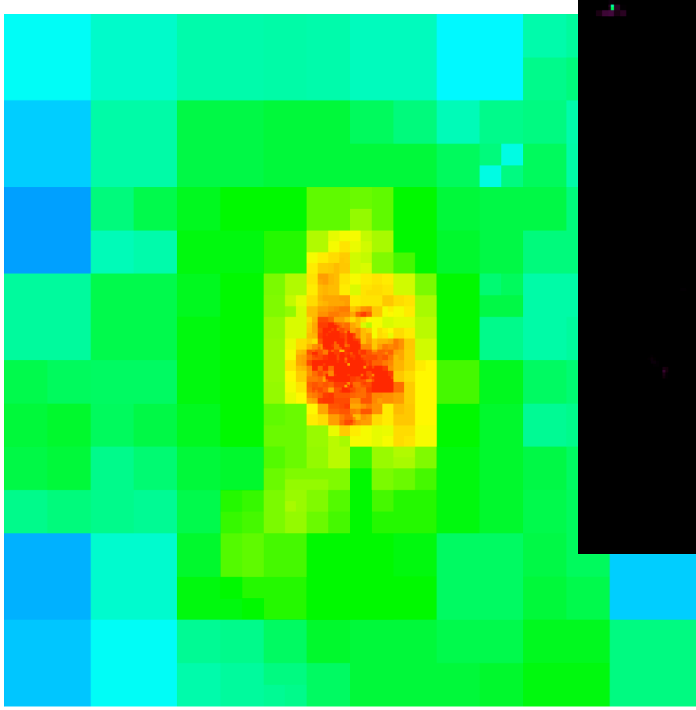
In shock-heated regions (halos > 10^{12} M_{sun}) there is enough velocity dispersion (from gravitational infall) to produce observed DLA velocity widths, if sufficiently large neutral patches can survive inside these regions.

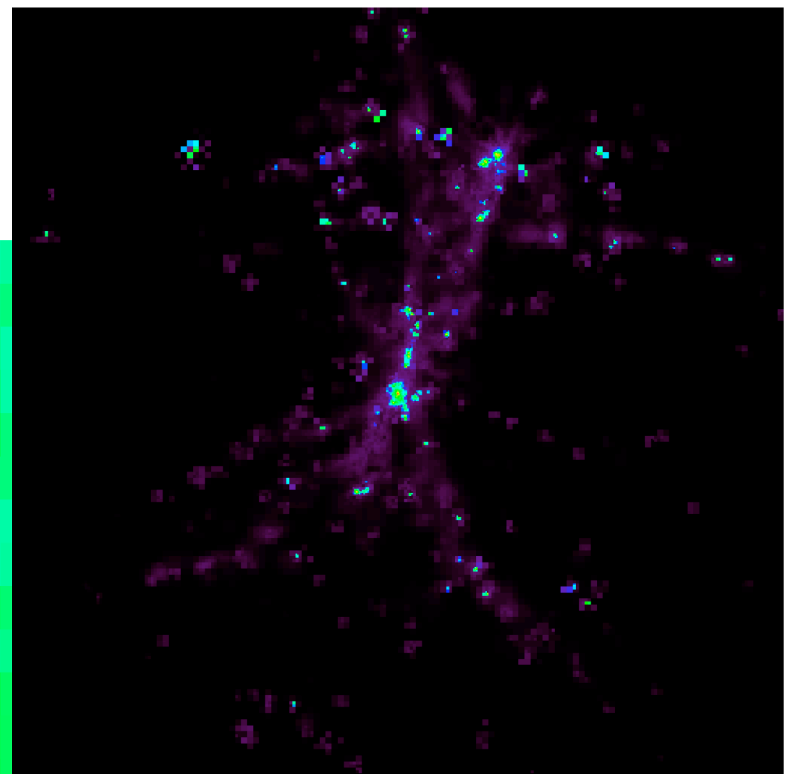


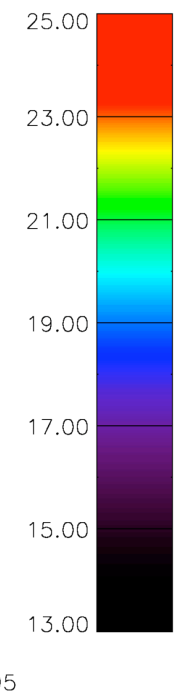
Two ways to get these patches:

- Dense cooling flows
- Feedback from star formation

with Jesper Sommer-Larsen (Copenhagen)

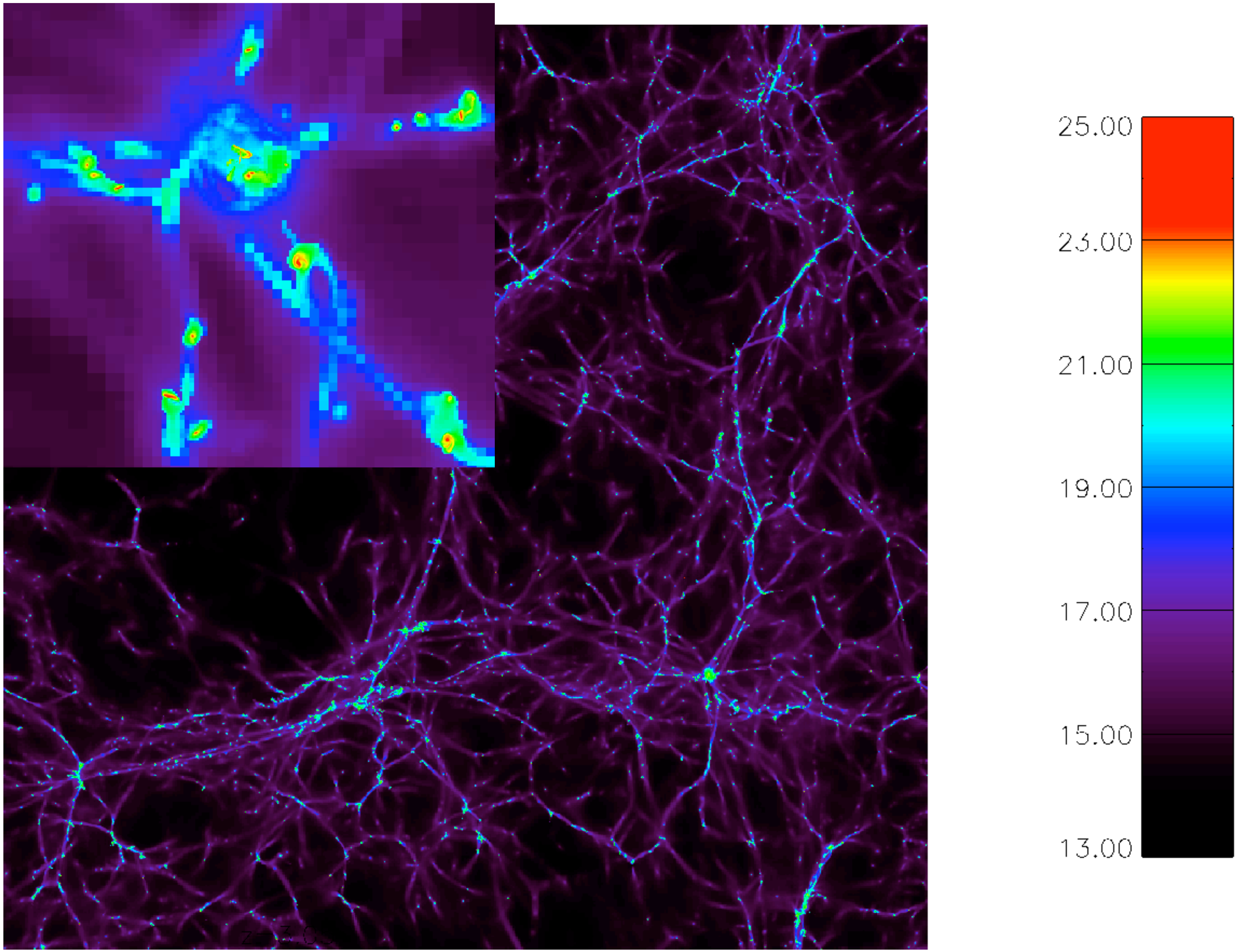






model AY15-uvb

1.5 Mpc physical = 4/h Mpc comoving at z=2.95, 45 pc physical resolution
Arimoto-Yoshii IMF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