Damped Lyman-α systems on a moving mesh

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Simulated DLAs

DLAs: neutral hydrogen reservoirs at z=4-2

Prochaska 2008
Simulations

- Moving mesh using AREPO
- $512^3$ particles
- 25 Mpc/h box
- Feedback using Illustris model
DLA Observations

1. Column density function

2. DLA bias

3. Velocity widths of metal lines

4. (Metallicity)
Column Density Function

Data: Noterdaeme 12, O’Meara 07, Prochaska 10
Stellar Feedback

Three models:

1. No feedback

2. Illustris: Stellar feedback with velocity proportional to halo circular velocity (high mass loading to suppress star formation in dwarfs)

3. Cutoff: As 2. with minimum velocity 600 km/s to impose cutoff (gives too many stars)
Column Density Distribution

$N_{\text{CDDF}}$ vs. $N_{\text{HI}}(\text{cm}^{-2})$

- No feedback
- Illustris
- Cutoff
DLA Bias

\[ b_{D}^{2} = \frac{P_{DLA}(k)}{P_{M}(k)} \]

Dominated by smallest halos: cutoff

Data: Font-Ribera 2013
Width in velocity space containing 90% of optical depth along spectra
Simulated Spectra

- Neutral fraction: Rahmati 2013
- Randomly place spectra until 5000 DLAs
- Metal ionisation using CLOUDY

\[ \delta v_{90} = 41.7 \]
Velocity Widths

Not enough large velocity width systems
Velocity Widths

Data (Neeleman, 2013)
Velocity Widths

Velocity Width (km/s)

Aligned Absorbers

Virial velocity
Aligned Absorbers

Sightlines intersecting two systems

\[ \delta v_{90} = [1271.1] \]
Why?

- More disc-like gas distribution
- SPH simulations suppressed metal mixing and diffusion

Metals mix, advect from star particles

$\delta v_{90} = [1271.1]$
Conclusions

1. Stellar feedback suppresses star-forming gas, matches CDDF for \( N > 10^{21} \)

2. Matching the bias needs a suppression of DLAs in small halos

3. The number of high velocity width systems matches even without any feedback
Making DLAs

Ionisation fraction from radiative transfer results of Rahmati 2013

High density gas is self-shielded and neutral
• Stars enrich gas element-by-element
• Metals advect and mix with fluid
Effect of metal loading

- From Paul’s simulations: change the wind metal loading normalisation
- Resolution of the 256 simulations
Effect of metal loading

- Once metal enriched beyond neutral region, no further effect
- Which regime are the dwarfs in?
Effect of metal loading

• Does not affect velocity width: independent of metallicity