Distribution of HI in cosmological simulations

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Outline

Combining RT with cosmological simulations to model the cosmic distribution of HI

The impact of different ionizing processes on the HI distribution (e.g., UVB, RR, collisional ionization)

Comparing simulated and observed HI distributions

- How to account for self-shielding accurately
- Relation between HI absorbers and their host galaxies

HI in cosmological Simulations



Cosmological Simulations e.g., OVLS (Schaye et al. 10), FAGLE Ioniziation Processes RT using TRAPHIC, (Pawlik & Schaye08, 11)

- Gravity+Hydrodynamics: GADGET-3
- Star-Formation: subgrid KS
- Supernovae Feedback: Kinetic
- Radiative Heating/Cooling: Metals
- Chemical evolution
- Cosmology







Optically thin



RT result

Uniform UV Background (UVB)

Haard & Madau 01



Rahmati et al. 13a

Uniform UV Background (UVB)

Recombination Radiation (RR)



Uniform UV Background (UVB)

Recombination Radiation (RR)



Raicevic et al. 14

Uniform UV Background (UVB)

Recombination Radiation (RR)

Peaks at around self-shielding

Moves the self-shielding to higher densities

Makes the transition smoother



Rahmati et al. 13a

Uniform UV Background (UVB)

Recombination Radiation (RR)

Collisional Ionization (Col) Not high at z > I



Rahmati et al. 13a

Uniform UV Background (UVB)

Recombination Radiation (RR)

Collisional Ionization (Col) But high at z < I</p>



Rahmati et al. 13a

Distribution of HI Column Densities



Peroux et al. 05; OMeara et al 07; NoReatorentice teal al 589; Prochaska & Wolfe 09; Kim et al. 02

Accurate self-shielding vs. sharp cut-off



Rahmati et al. 13a

Different simulations give the same result



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A fitting function for accurate self-shielding



Distribution of dens HI gas around galaxies at the peak of galaxy formation around z ~ 3





Host galaxies



Rahmati & Schaye 14

Stellar mass of host galaxies



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The impact parameters



Rahmati & Schaye 14

Higher NHI systems are closer to their host galaxies

(in good agreement with observations)

There is a large scatter in the impact parameters

The impact parameters



Stellar mass of the observed hosts is likely to be around a **billion solar mass**

but most of absorbers are in less massive galaxies

Rahmati & Schaye 14

Observability of host galaxies



Rahmati & Schaye 14

Observability of host galaxies

Most of the host galaxies are below the typical detection limit!

Over-estimating the impact parameters

Missing host galaxies

Over-estimating the size of CGM

Attributing most of the HI absorption to bright galaxies instead of their faint close neighbours.



Rahmati & Schaye 14

Summary and Conclusions

- Using accurate RT simulations we studied the impact of different ionizing processes in shaping the cosmic HI distribution
- HI distribution in simulations is in excellent agreement with observations and shows weak evolution for LLs and DLAs
- RT results can be reproduced by a fitting-function that captures selfshielding accurately
- Stronger HI absorbers are closer to their host galaxies and tend to be in more massive galaxies
- Most of HI absorbers are in galaxies that are too faint to be observed easily at $z \sim 3$. This introduces strong observational biases