

# 大規模数値 シミュレーションで探る 吸収線系と銀河進化

Cosmological simulations of galaxy evolution  
and HI absorption systems

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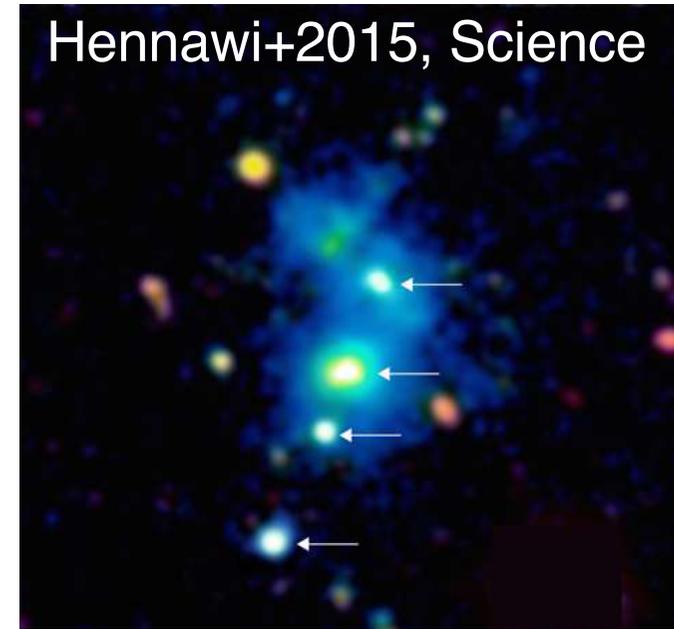
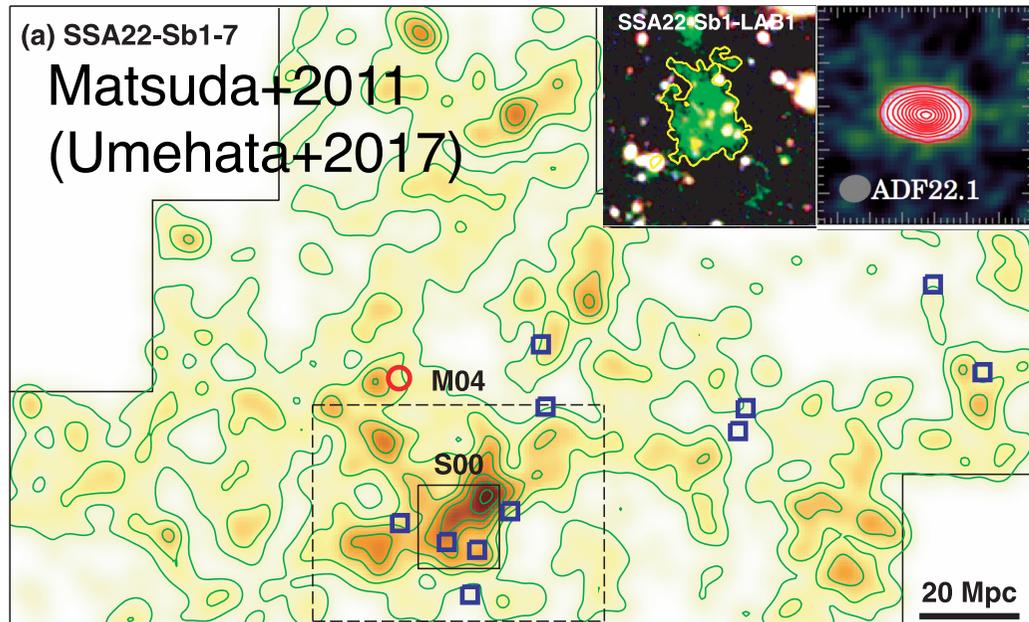
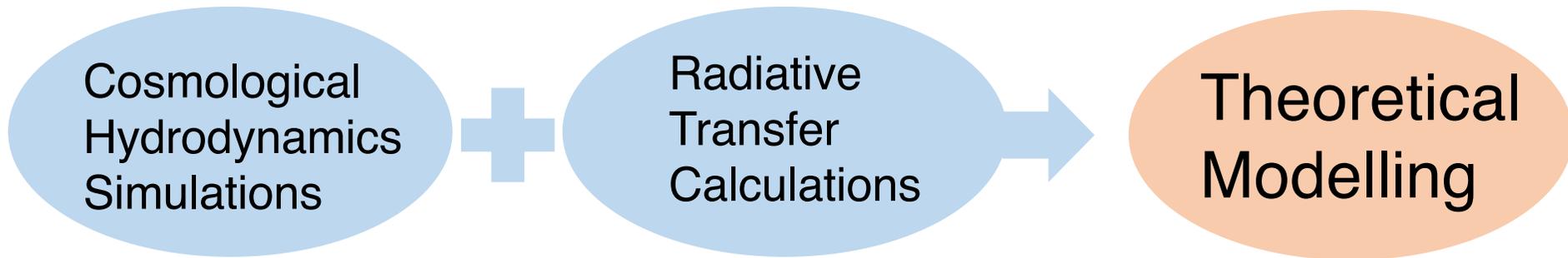
Sadegh Khochfar (Edinburgh), Claudio Dalla Vecchia (Kanaria)

# Outline

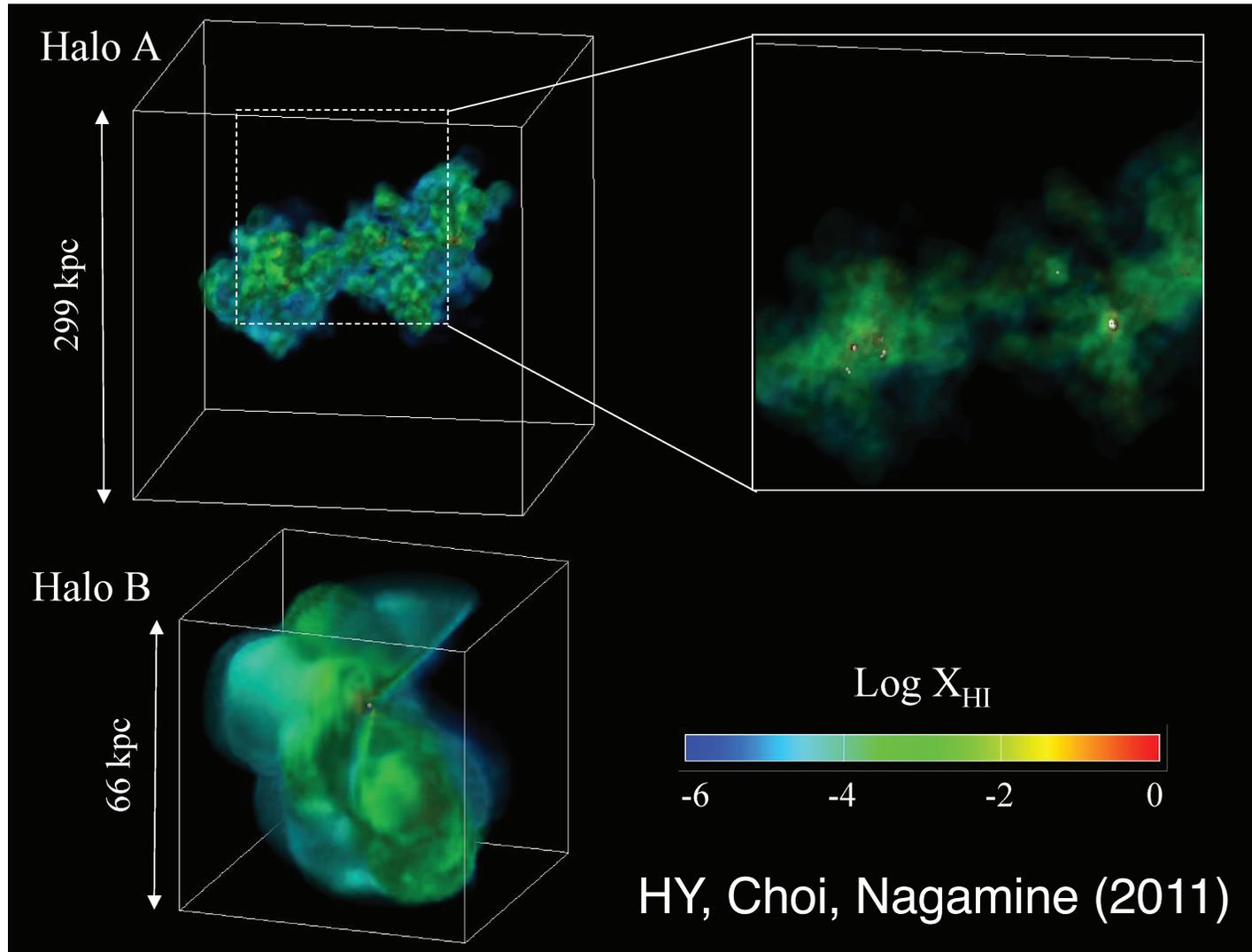
- Introduction
- Key physics for DLA study (Yajima et al. 2012)
- Protocluster regions (Abe, Yajima et al. in prep.)
- Summary

# Galaxy evolution

How galaxies form and evolve in the early Universe?  
How galaxy evolution is related with CGM/IGM?

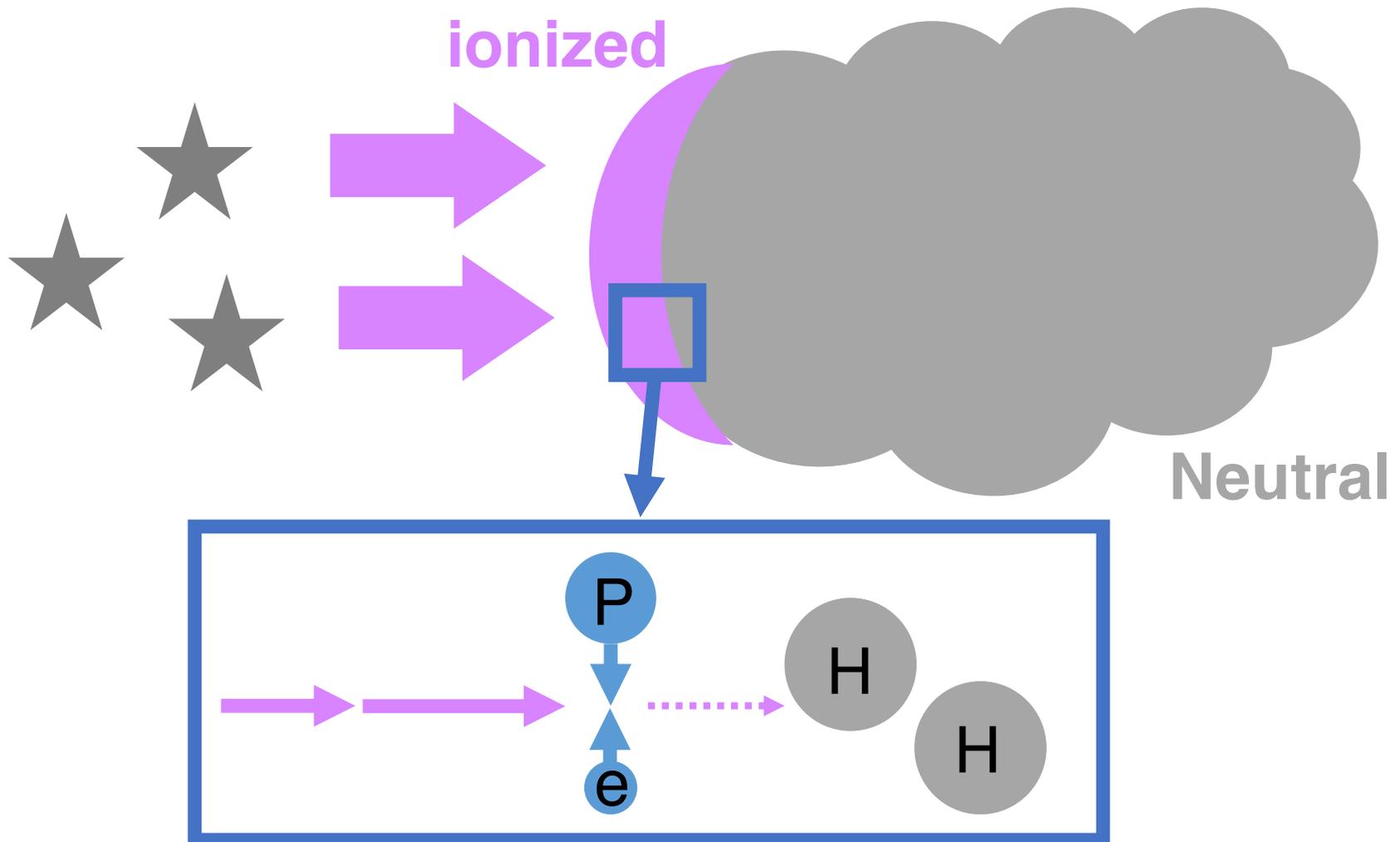


# Ionization structure of ISM in galaxies



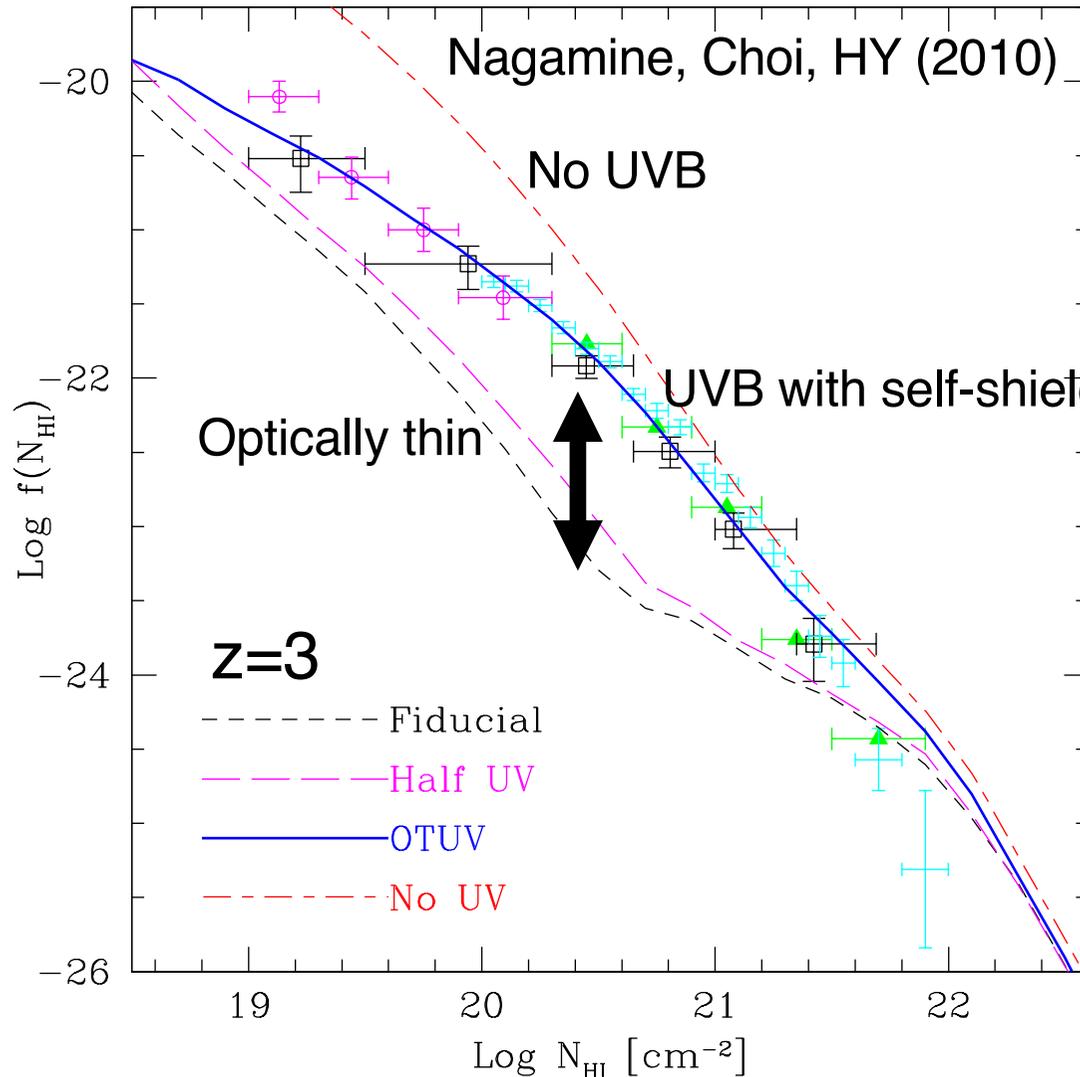
# Key physics for HI absorption system

## Self-shielding effect



# Column density distribution function

Can simulations reproduce the abundances of DLA/LLS?



Radiative transfer effects of UVB has a large impact (stellar UV is secondary)

UVB ionizes outside regions significantly, while stellar rad. is shielded by nearby clumps.

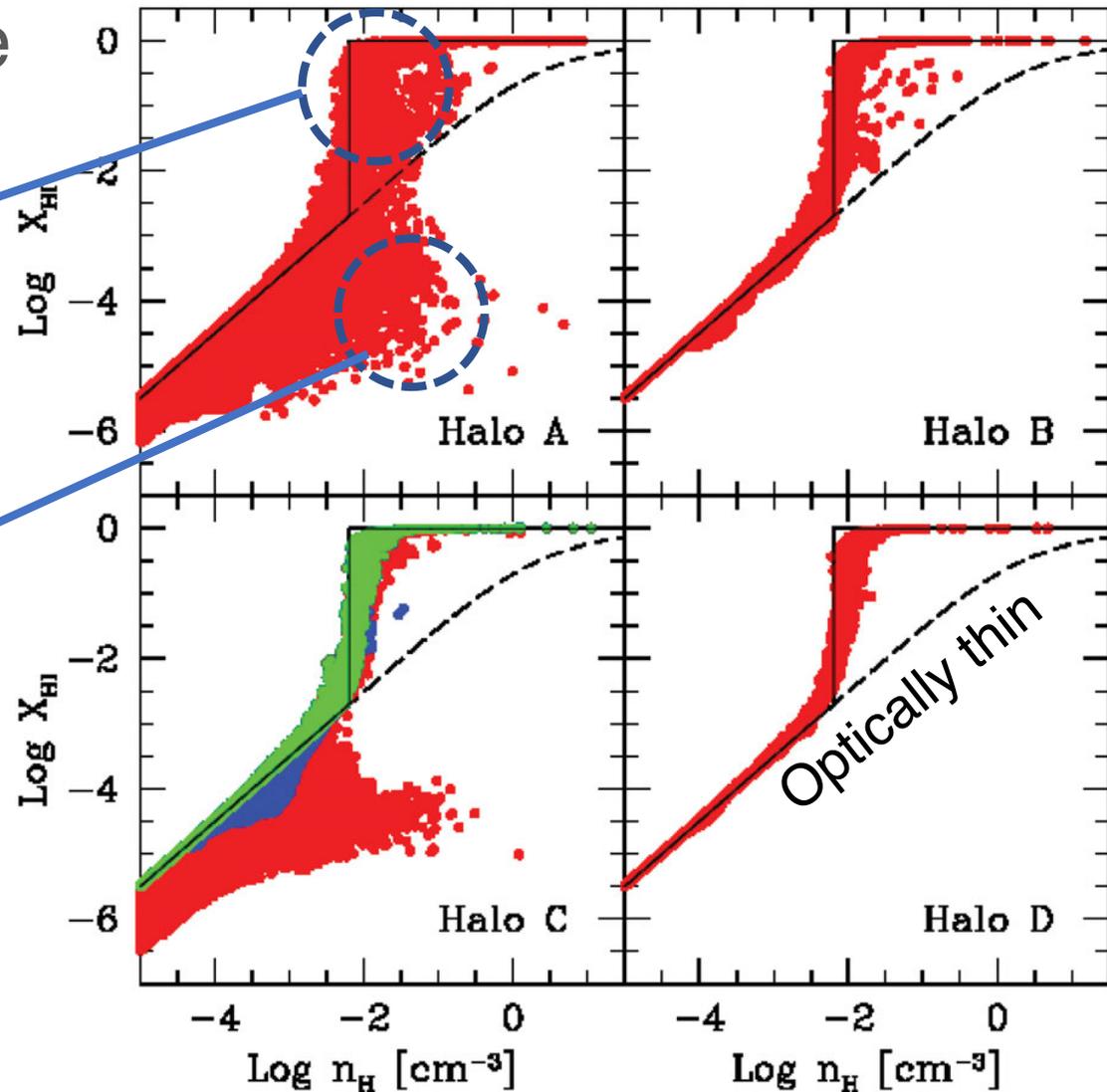
# 3D radiative transfer calculations

HY, Choi, Nagamine (2012)

Ionization degree

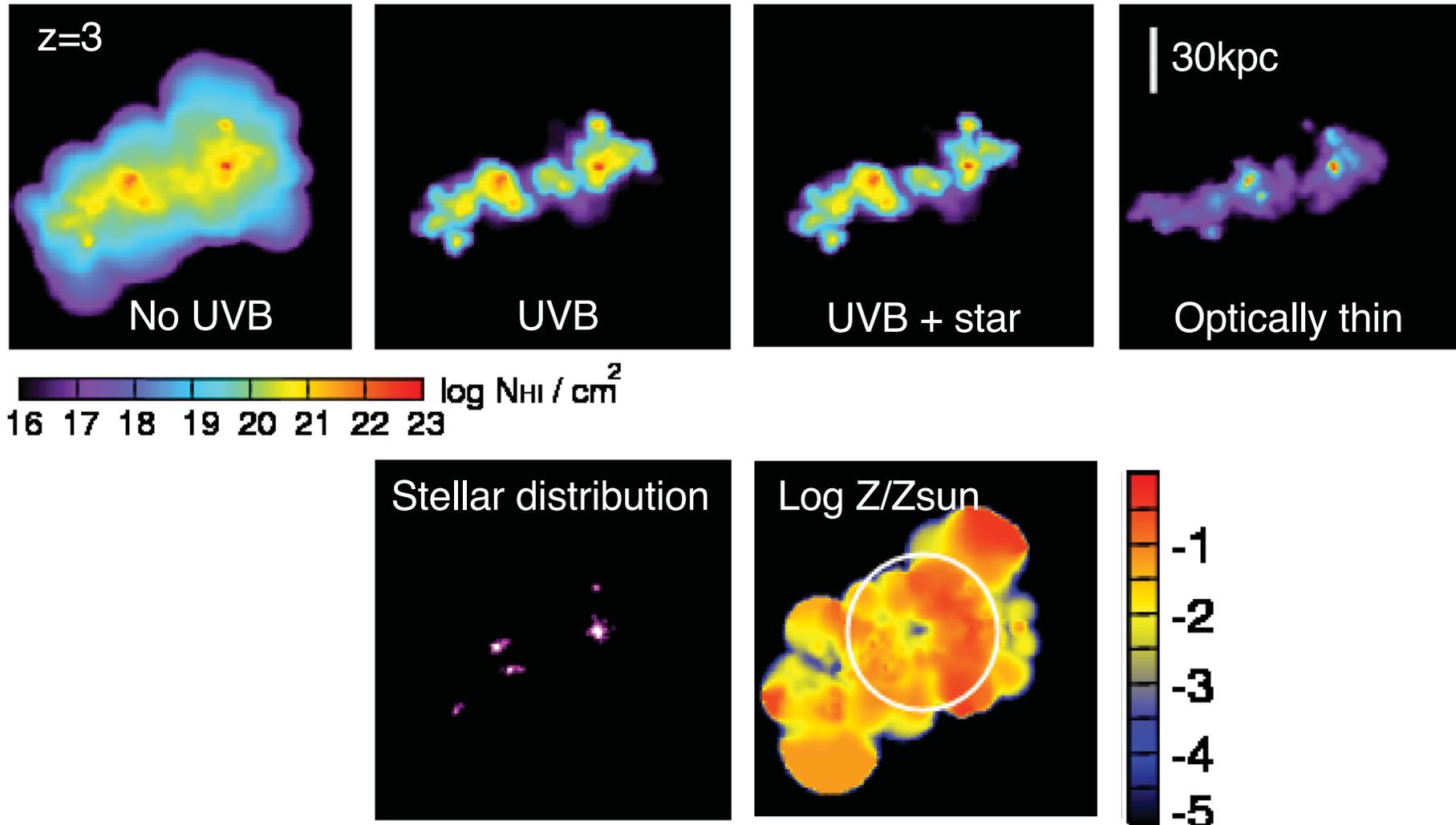
Self-shielding  
to UVB

Ionization by  
stellar radiation



# Distribution of DLA

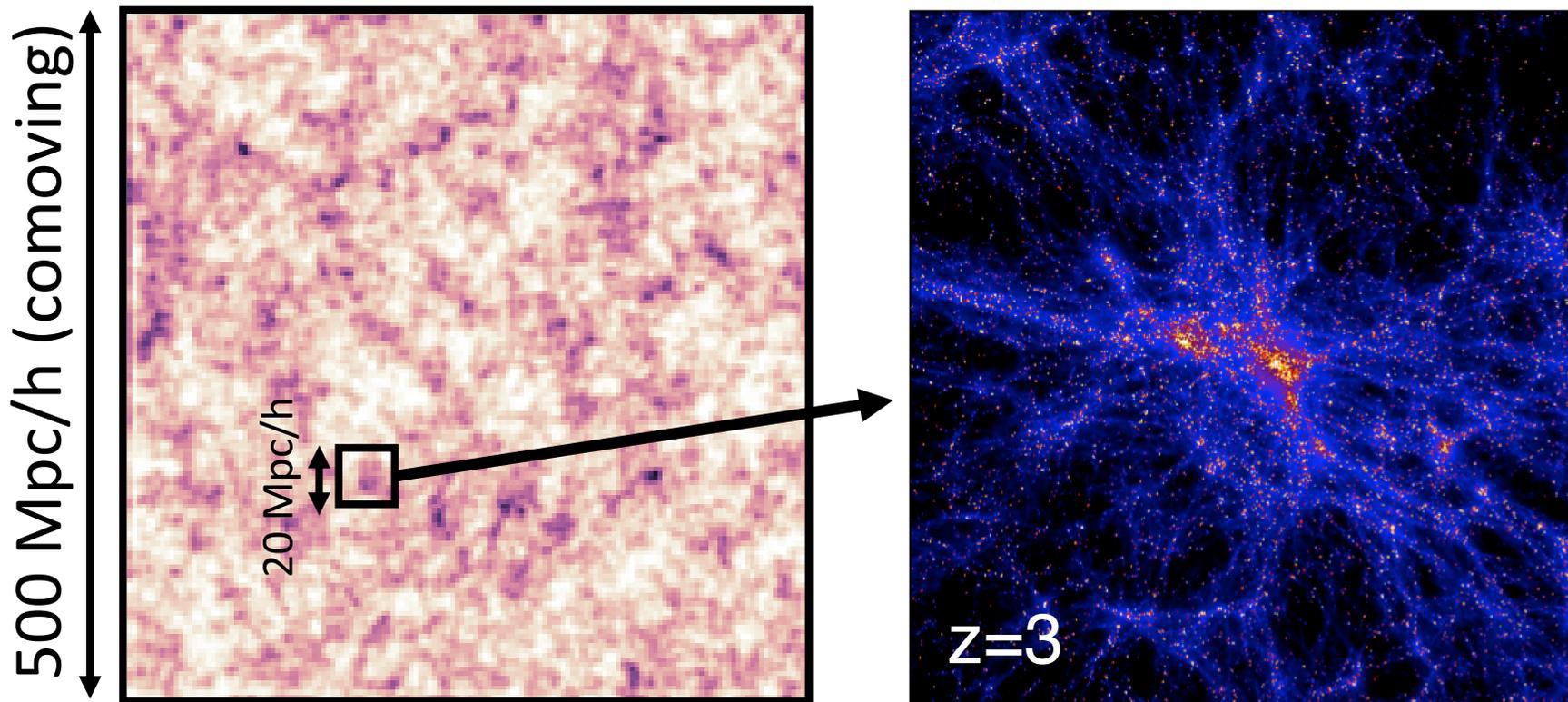
$1 \times 10^{11}$  Msun halo



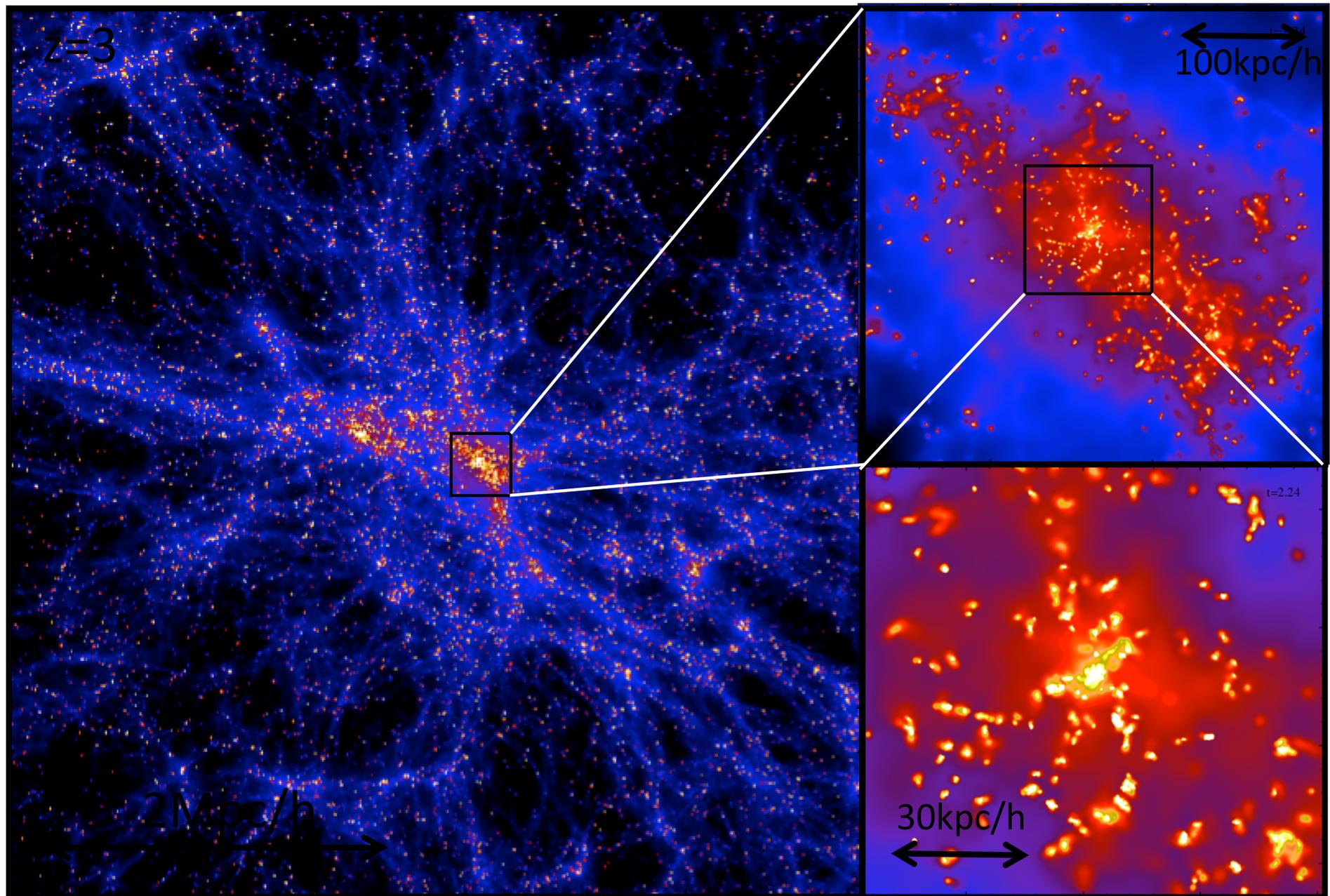
# Simulations of protocluster region (PCR)

Environmental effects on galaxy evolution  
and absorption systems??

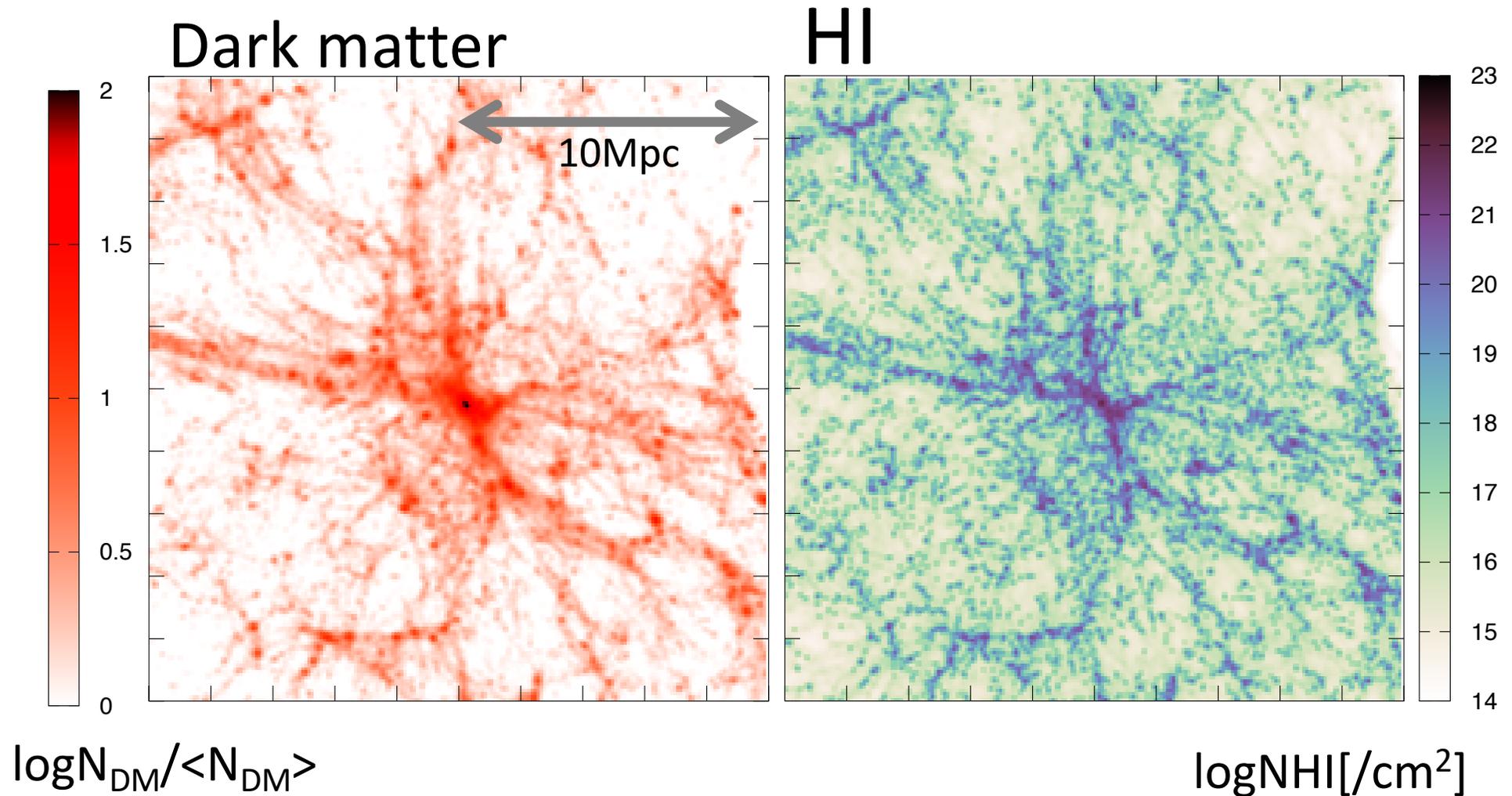
Cosmological simulations for reproducing protoclusters



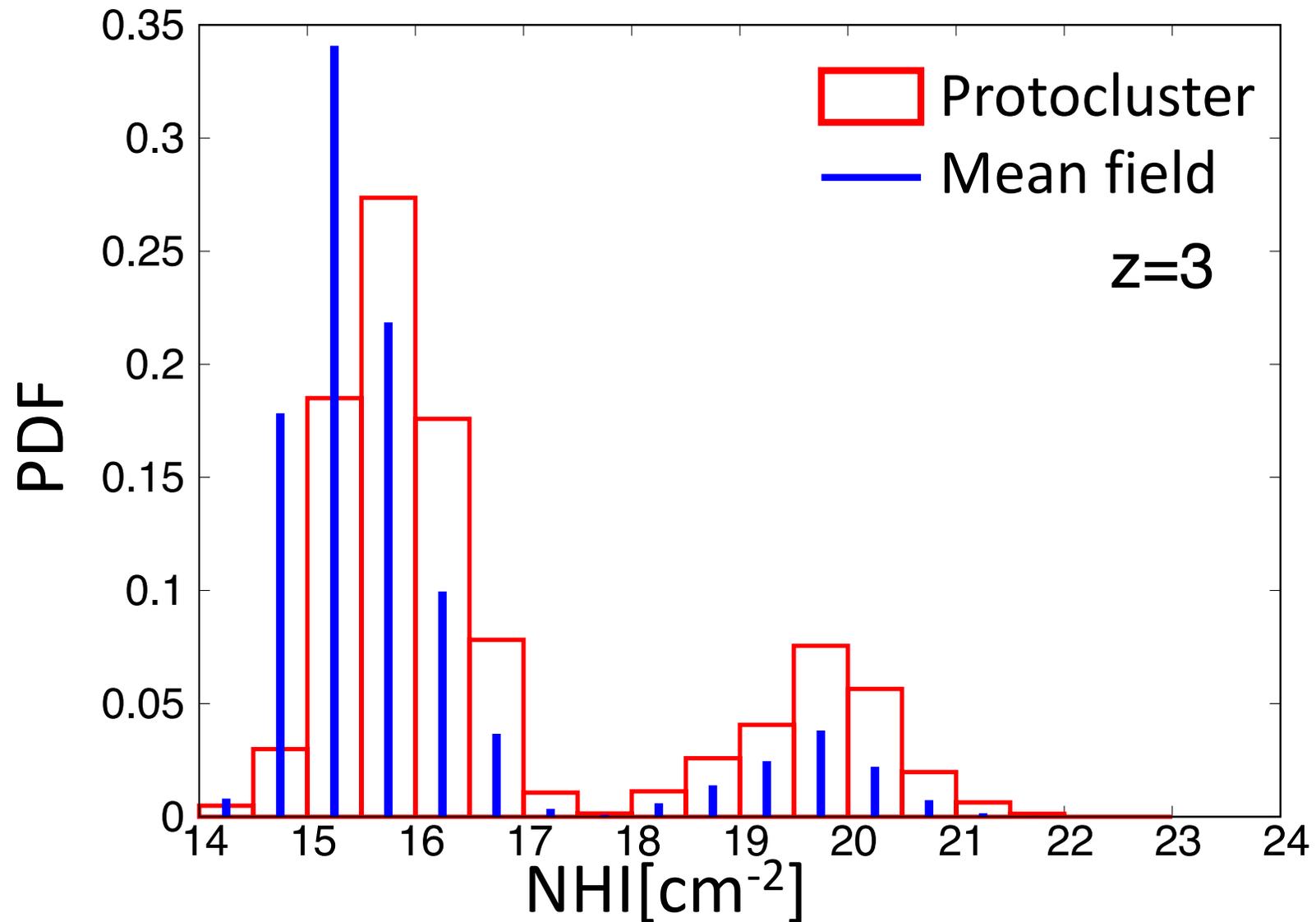
# Gas distribution (PC1)



# Distribution of dark matter and HI gas(z=3)



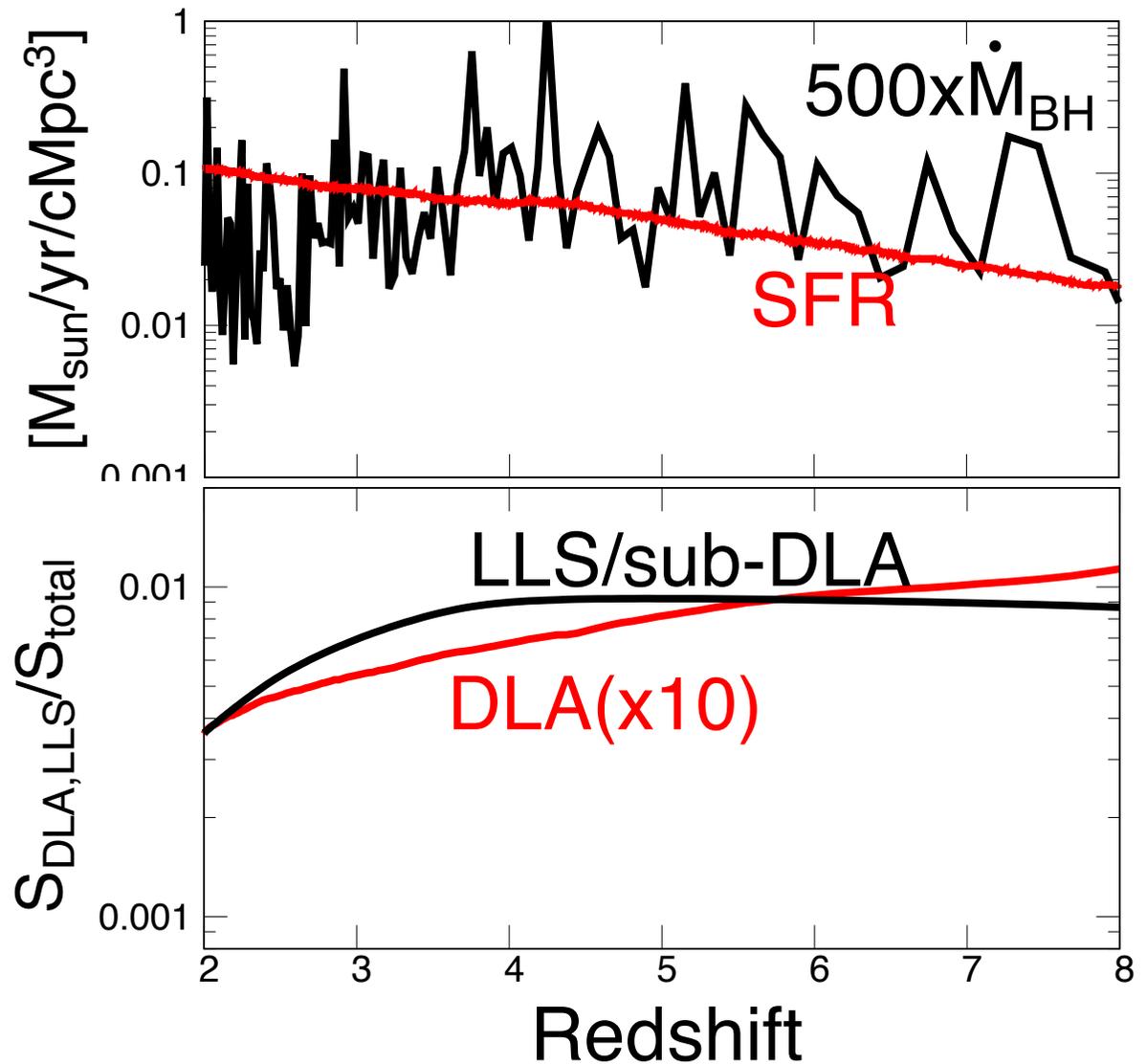
# HI column density distribution



# Redshift evolution of PCR

SFR  
BH growth rate

Fractions of  
DLA/LLS areas  
to the entire region

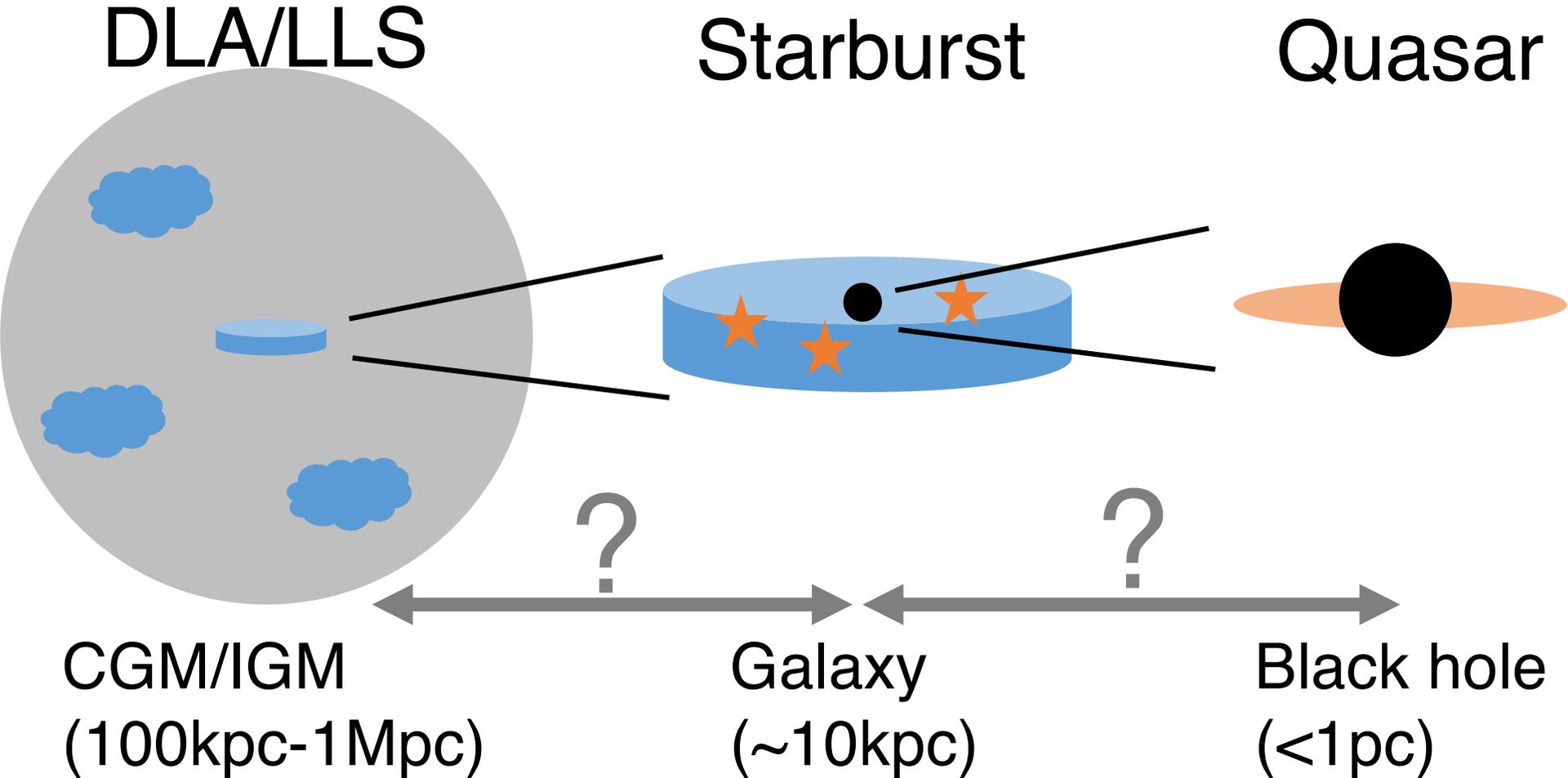


# Summary

- Combining cosmological simulations and radiative transfer calculations, we study galaxy evolution and HI absorption systems
- UVB with self-shielding effect is a key to reproduce the observed abundances of DLAs/LLSs
- Impact of stellar radiation is secondary
- Protocluster regions can form DLAs/LLSs by a factor of 2-3
- DLAs in proclusters distribute along IGM filaments

# Future work

< Protocluster regions >



End