Investigating the connection between galactic disks and the highest column density absorbers with the GAEA semi-analytical model

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DEGLI STUDI DI TRIESTE

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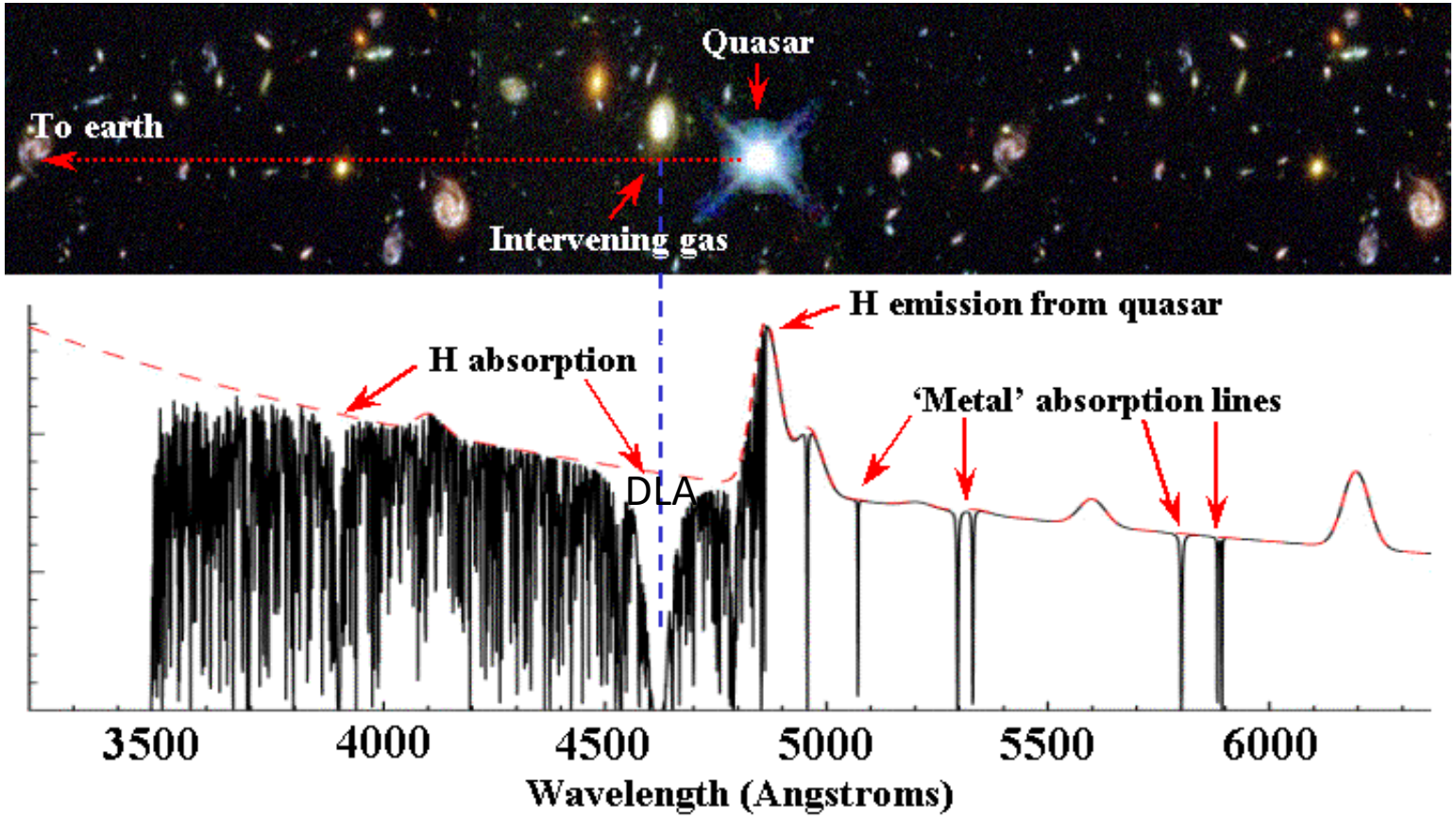
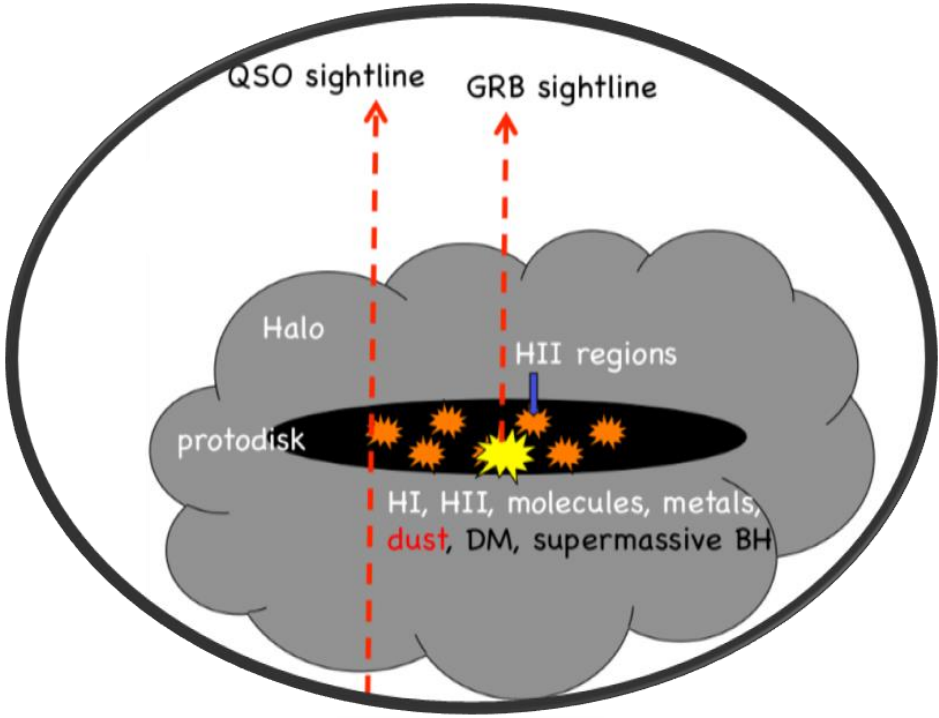
DI TRIESTE

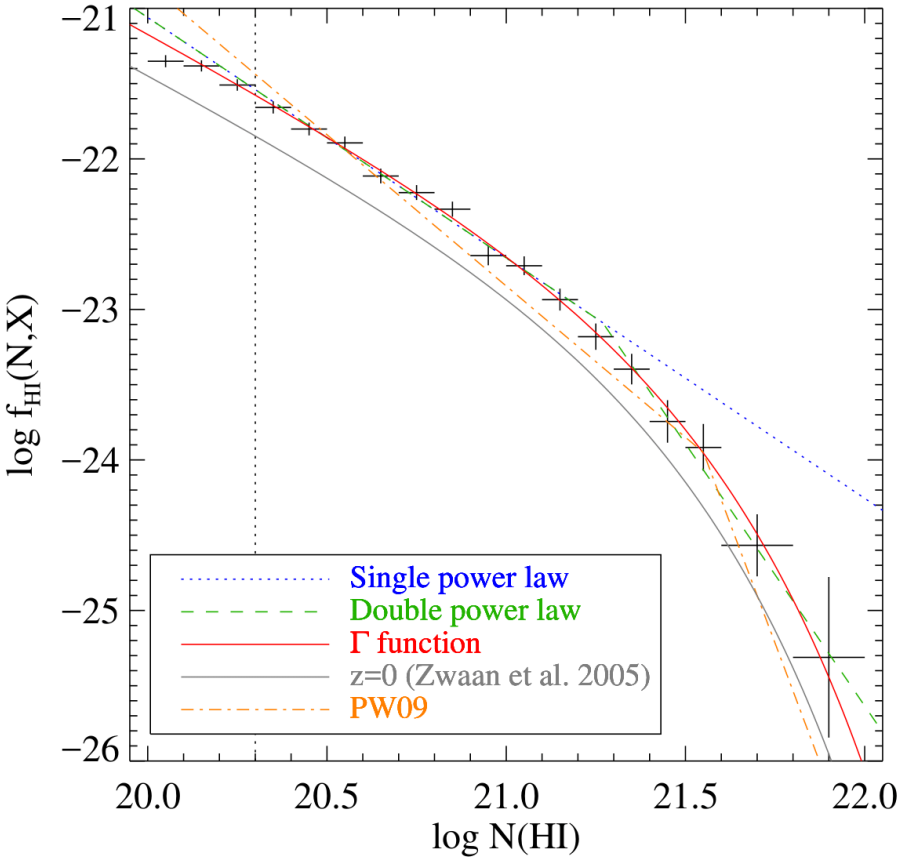
How do we observe DLAs (Damped Lyman-α systems)?



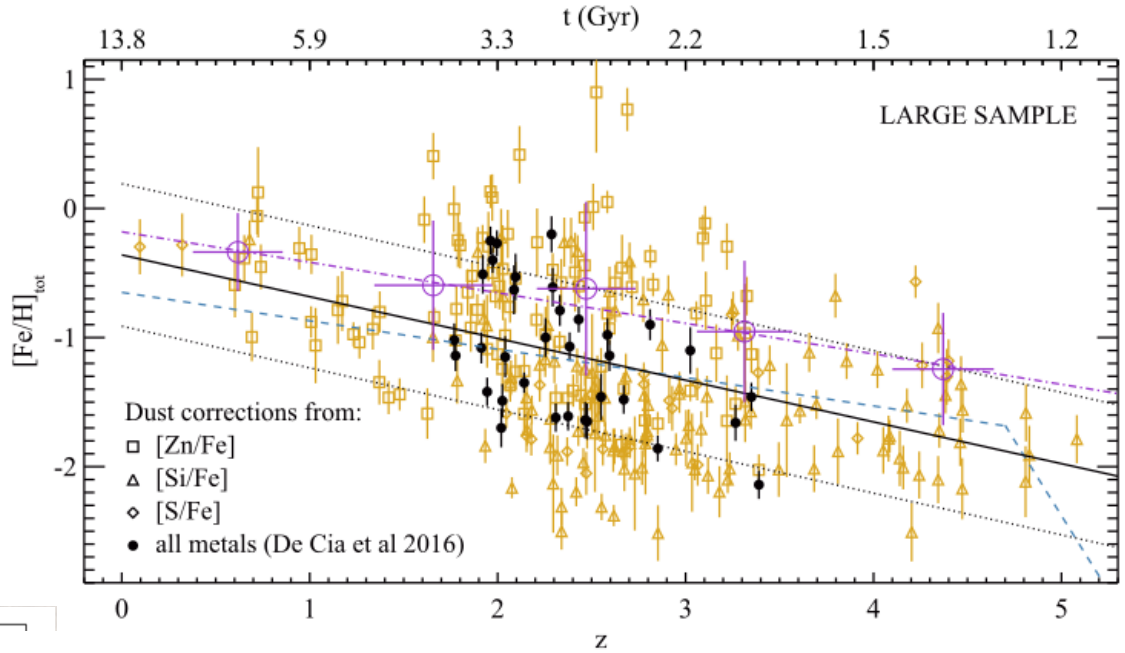


The densest absorbers are defined by their value of HI column density : $log(N_{HI}) >= 20.3$

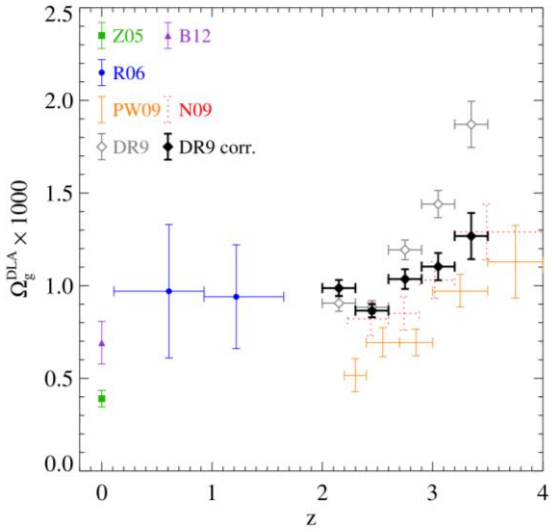
Properties of DLAs



CDDF -> double power-law



Mean metallicity evolution



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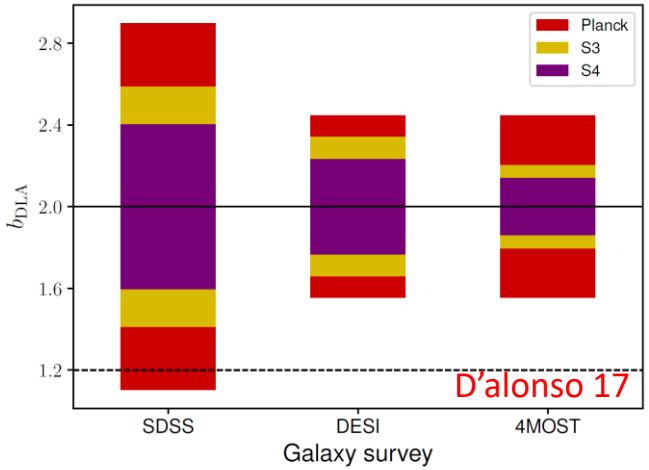
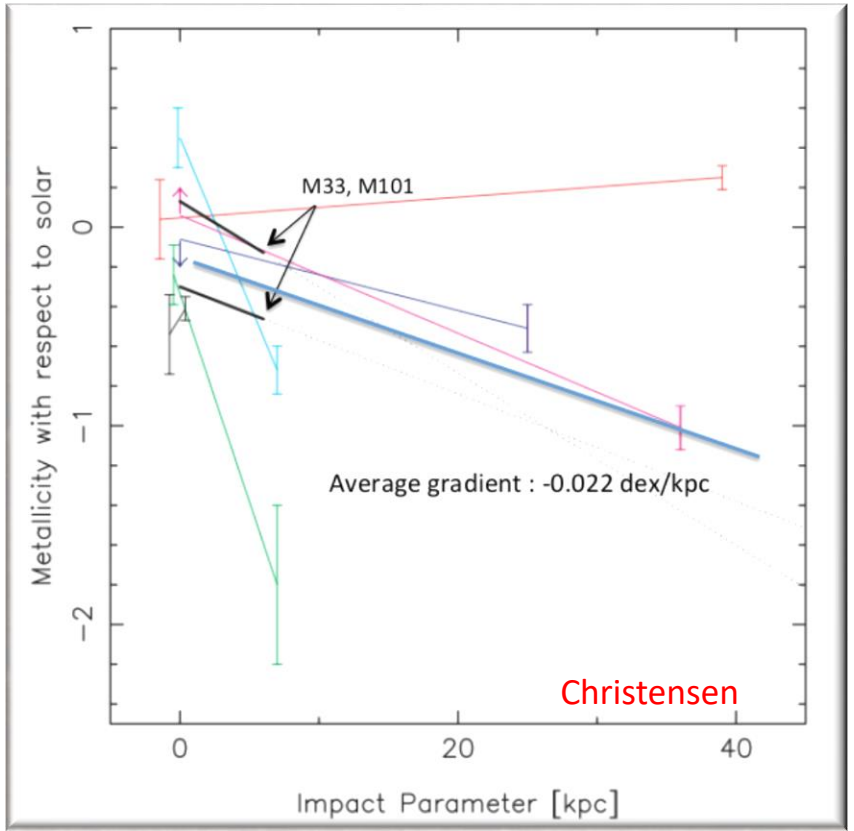
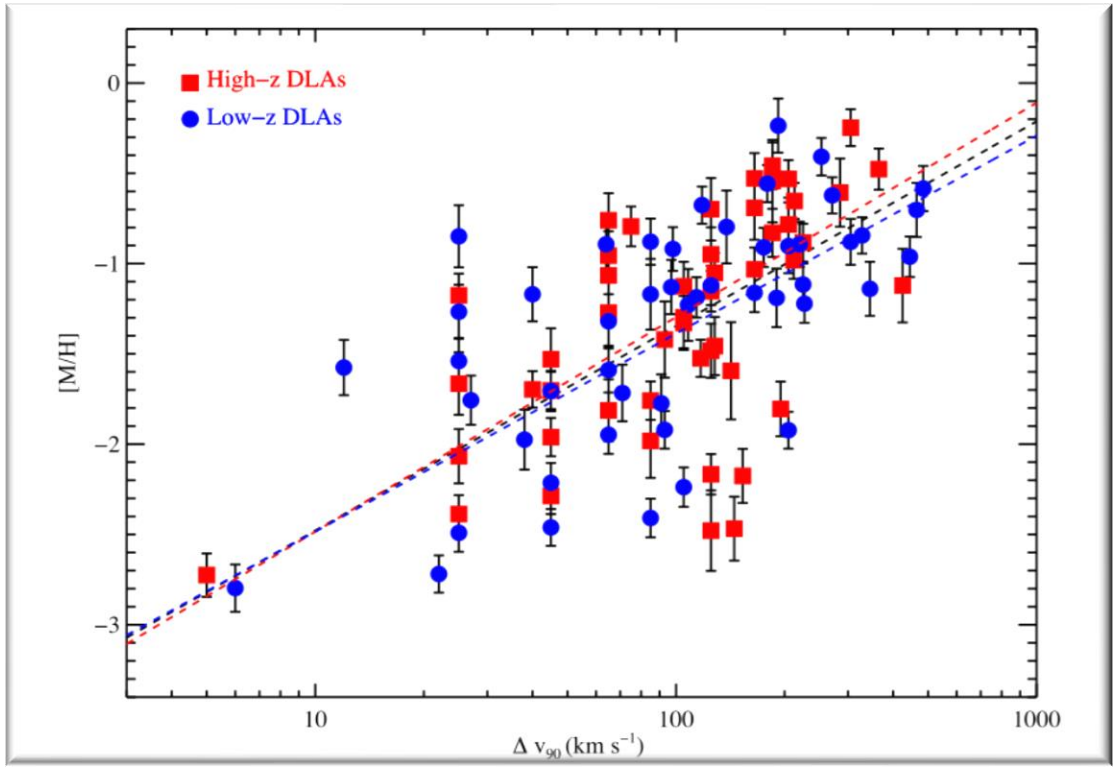


Clustering

Metallicity gradient

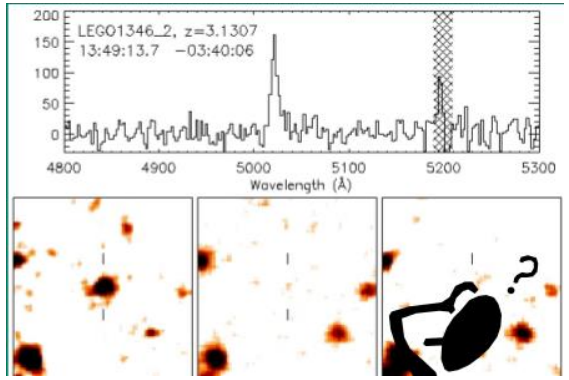


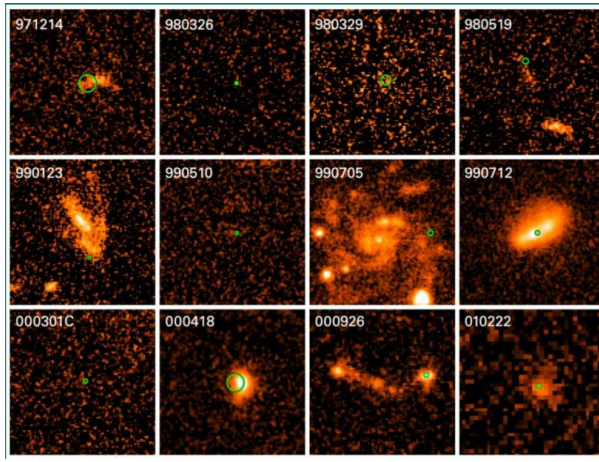


Alias of the M_*/metallicity rel. for DLAs

Different techniques to search for DLAs counterparts

- **Optical survey**
- **NB-imaging**
- **GRB survey**
- **NIR survey**
- **sub-mm surveys**

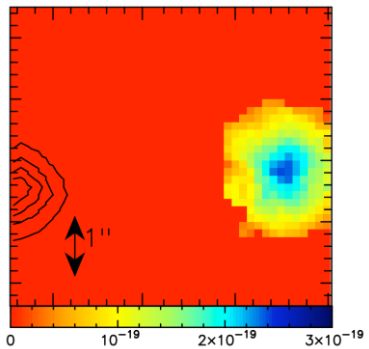




HSC NB survey for DLA counterparts:
NB400 imaging of LAEs in DLAs concentrated regions

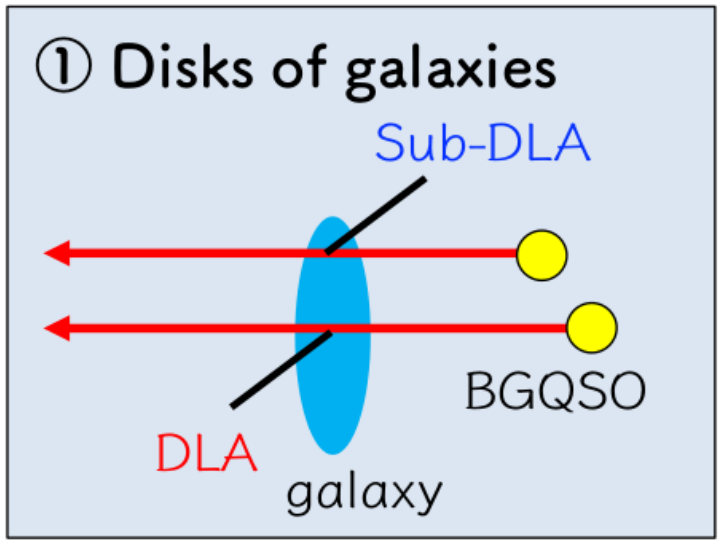
SINFONI (NIR IFU survey, Halpha-OIII)

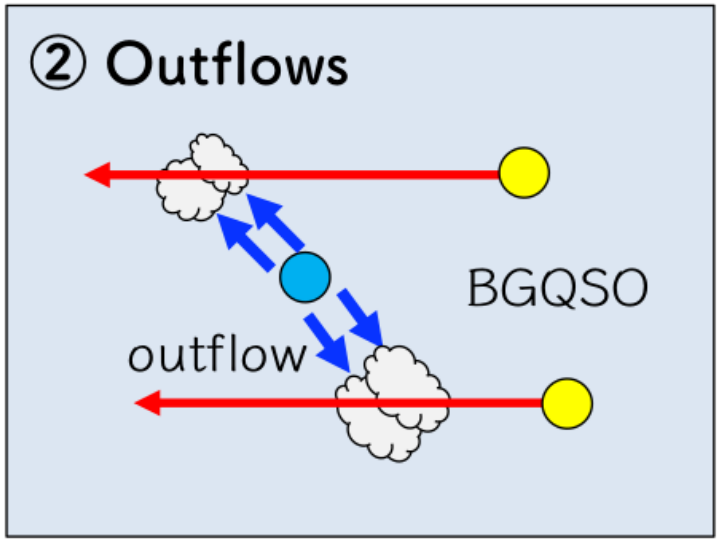
MUSE (cov:480-930 nm)

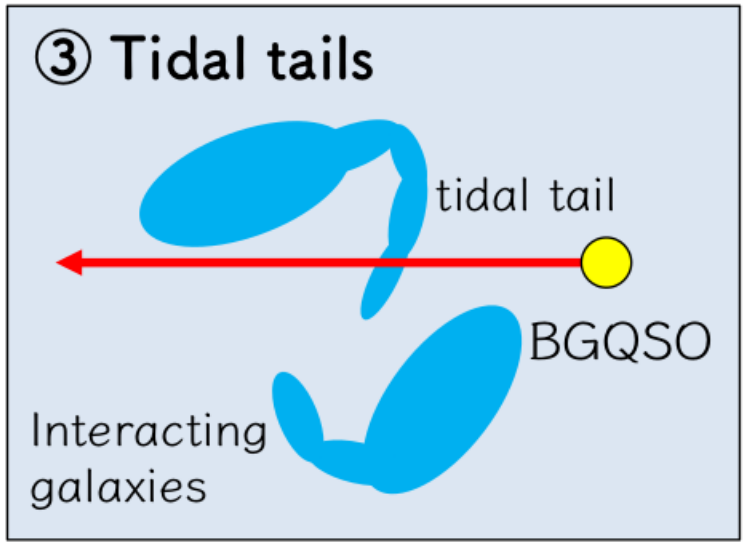


ALMA search for DLA counterparts,based on MUSE det.
(CO emission at 1<z<2) → Large impact parameter of >100 kpc
only ALMA observations (C+ emission , z>4)

Possible scenarios for the origin of DLAs







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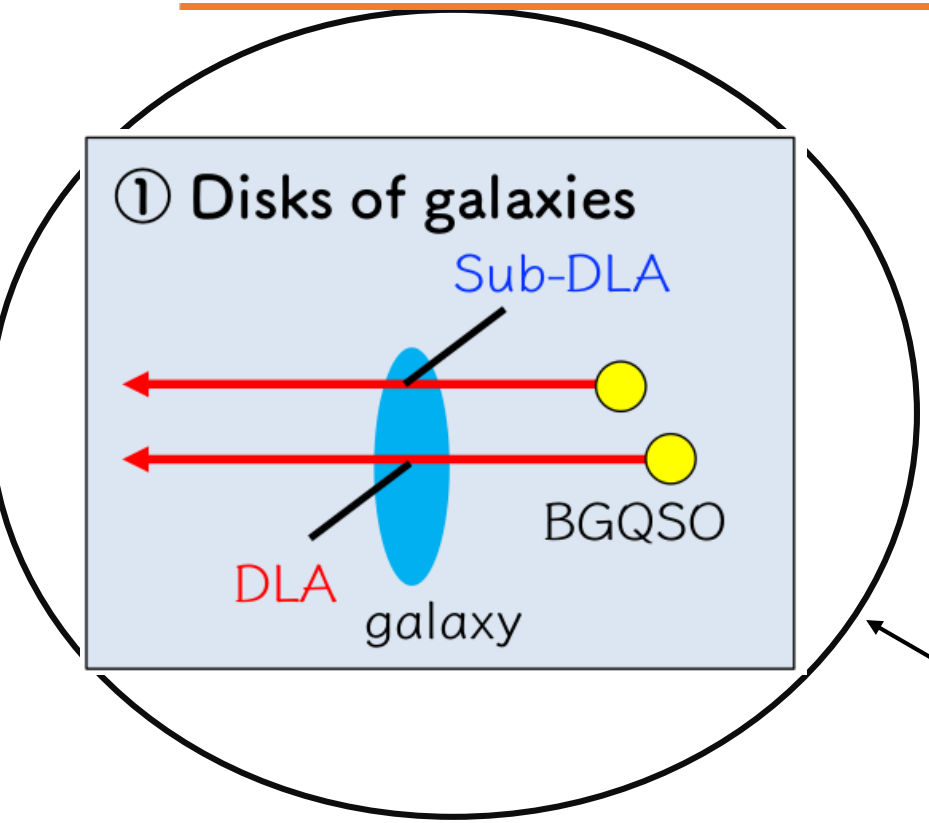
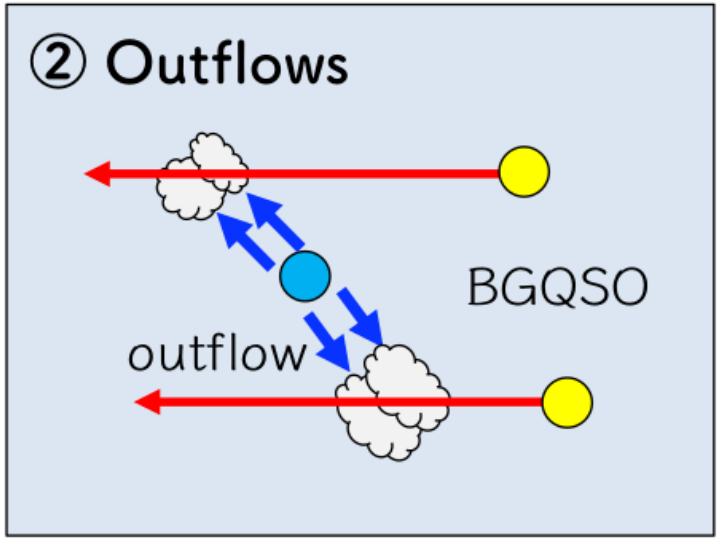
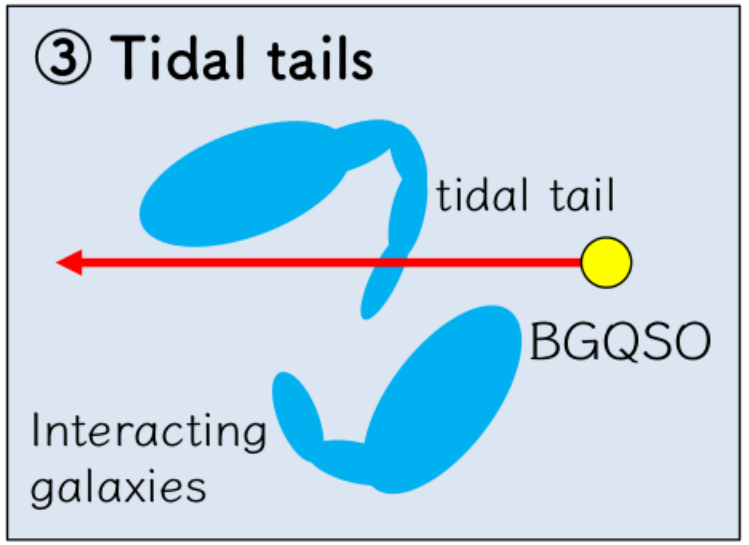






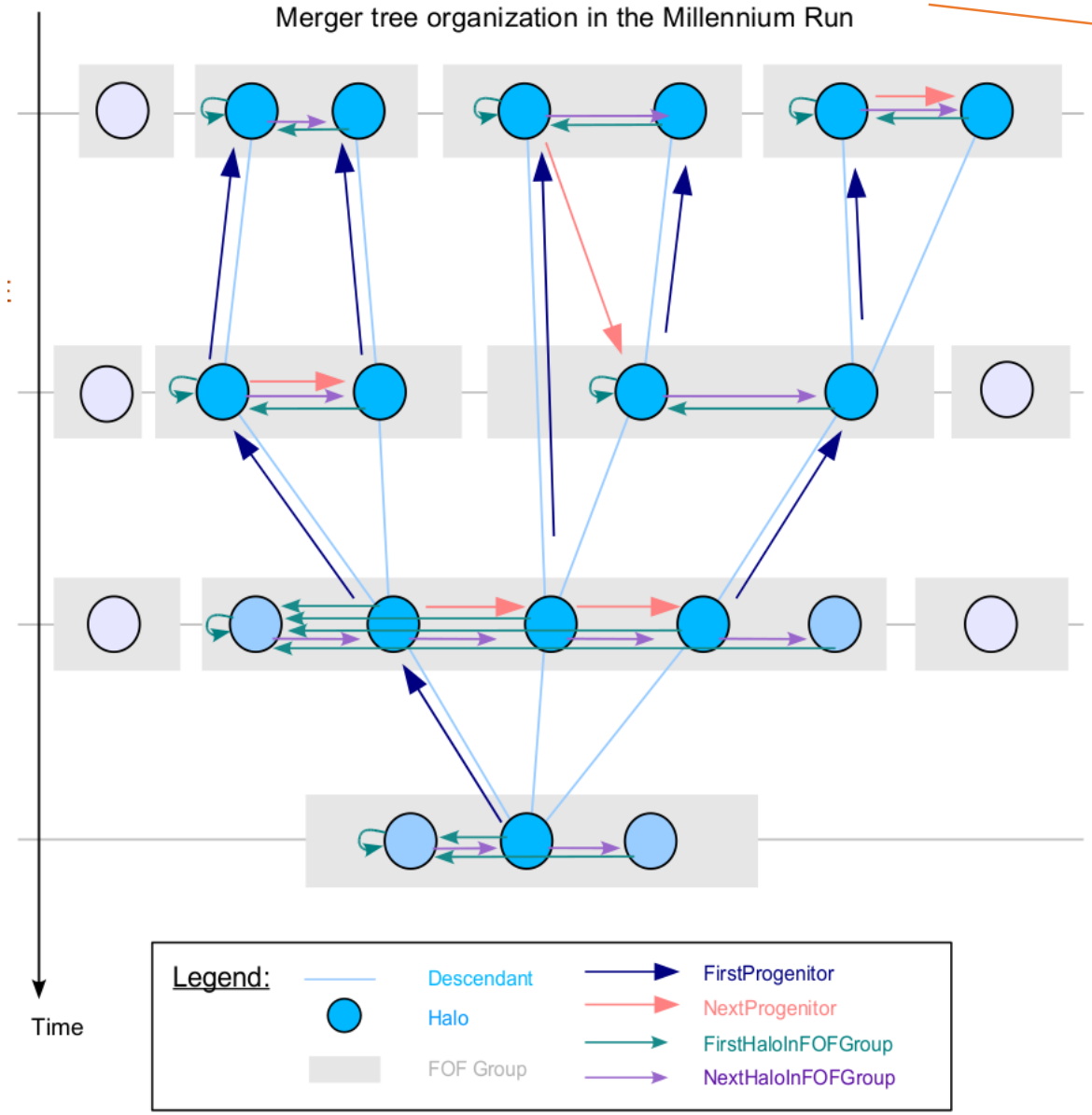
We investigated this scenario using a 'state-of-the-art' SAM

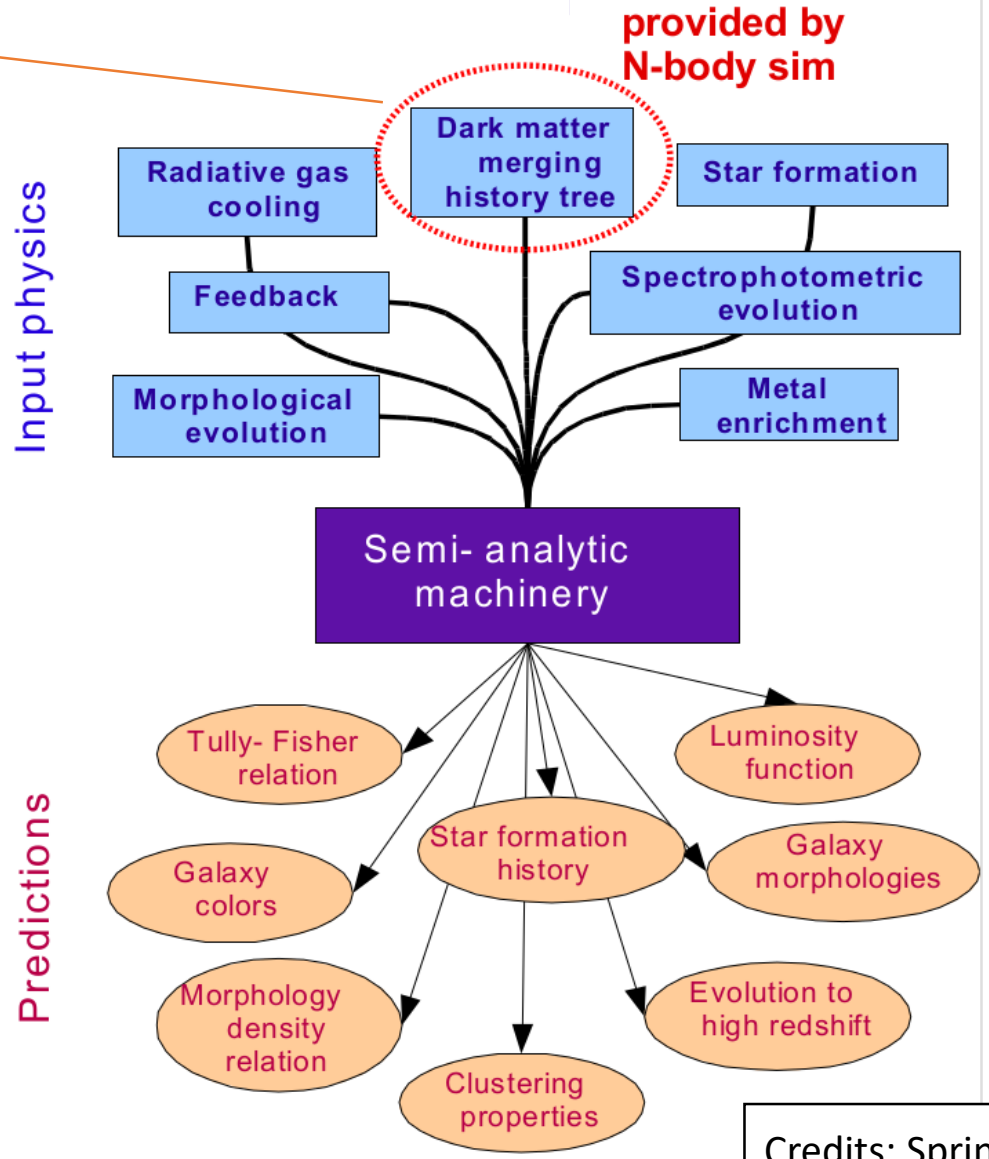
The galaxies hosting DLAs could be:

1. thick, extended disc galaxies
2. small halo galaxies

(data don't allow an easily identification of the population of DLA host galaxies)

What is a SEMI-ANALYTICAL MODEL for the galaxy formation?





Credits: Springel

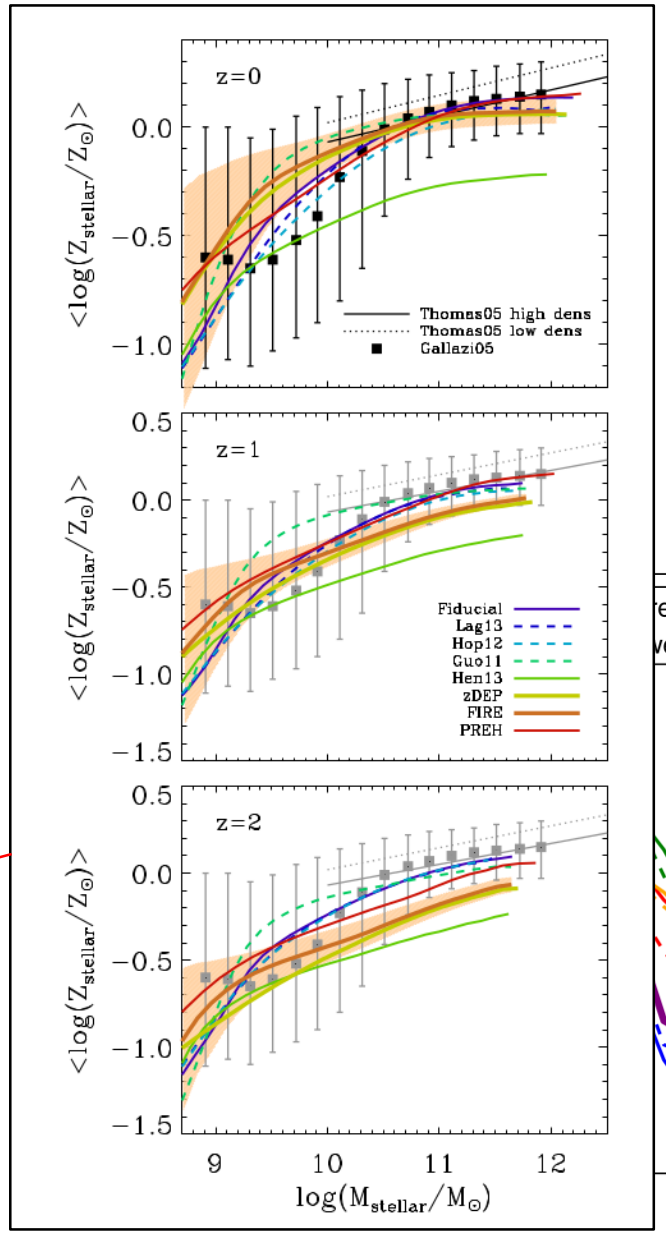
The semi-analytical model GAEA

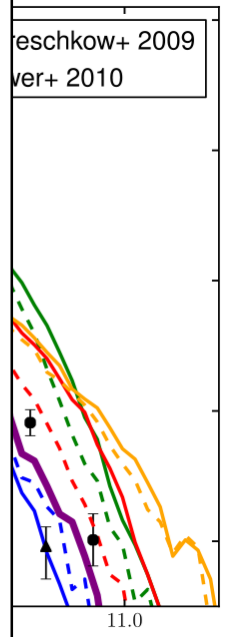
The GAEA (Galaxy Evolution and Assembly) model includes:

1. Stellar feedback scheme based on results from hydro-simulation (Hirschmann et al 2016)
2. Star formation based on molecular prescriptions (Ref: L.Xie et al. 2016)
3. non instantaneous recycling of gas and metals

and reproduces very well:

1. the **Stellar mass function** up to $z \sim 7$
2. the $\mathbf{M}_{star}$**- metallicity relation** up to $z \sim 2$
3. the **HI mass function** at $z \sim 0$





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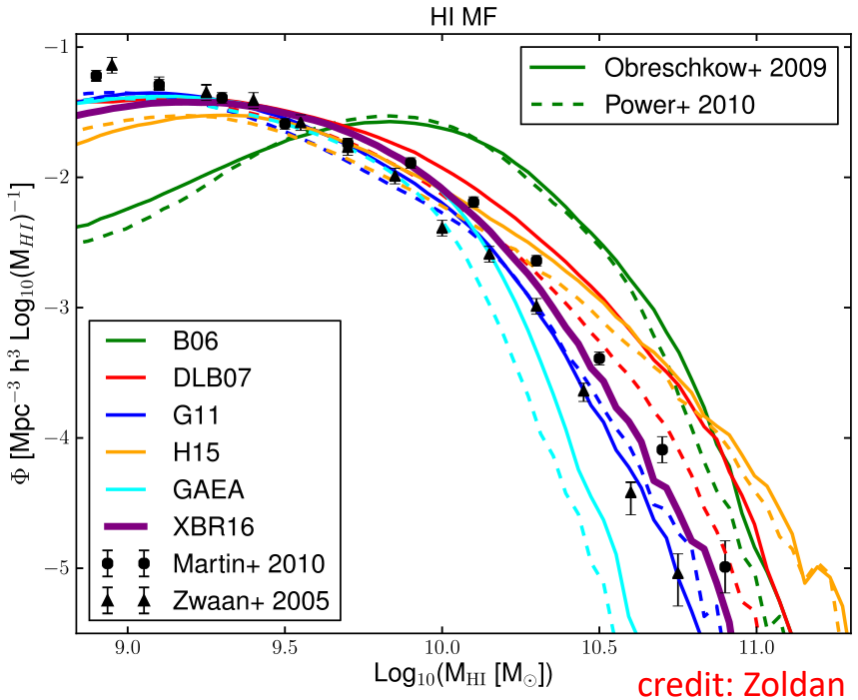
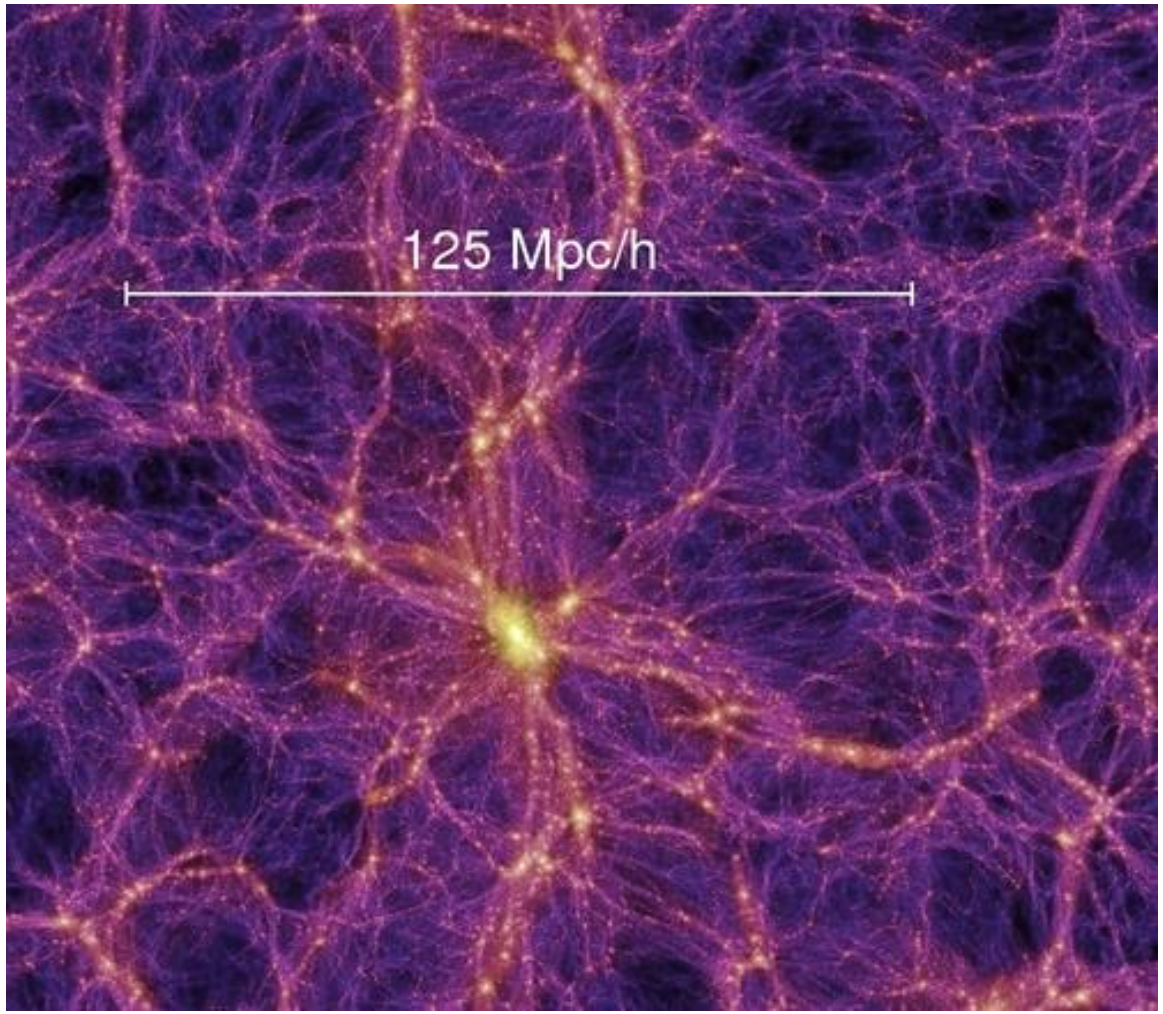


credit: Zoldan

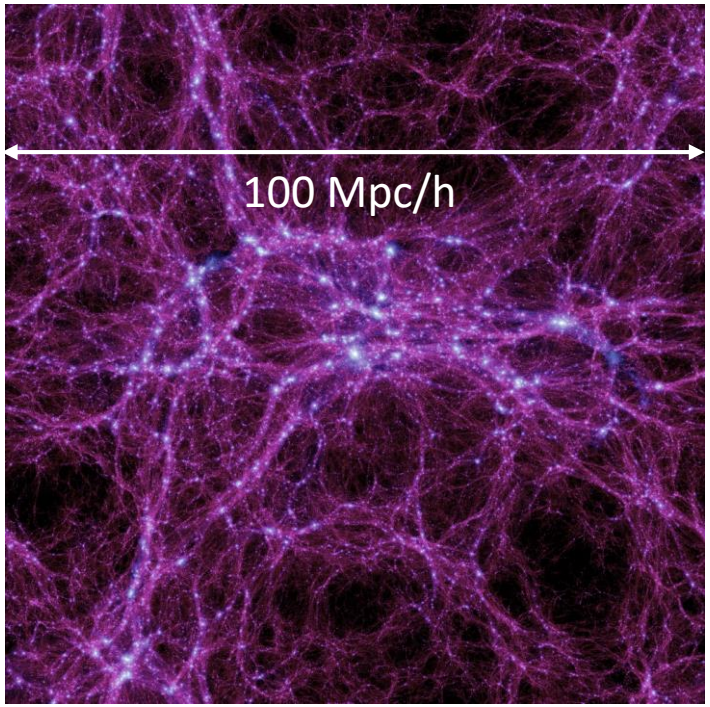
Millennium Simulation

MRI



$L_{box} = 500h^{-1}cMpc$ $\quad m_p = 8.61\,\mathbf{x}10^8\,\frac{M_\odot}{h}$

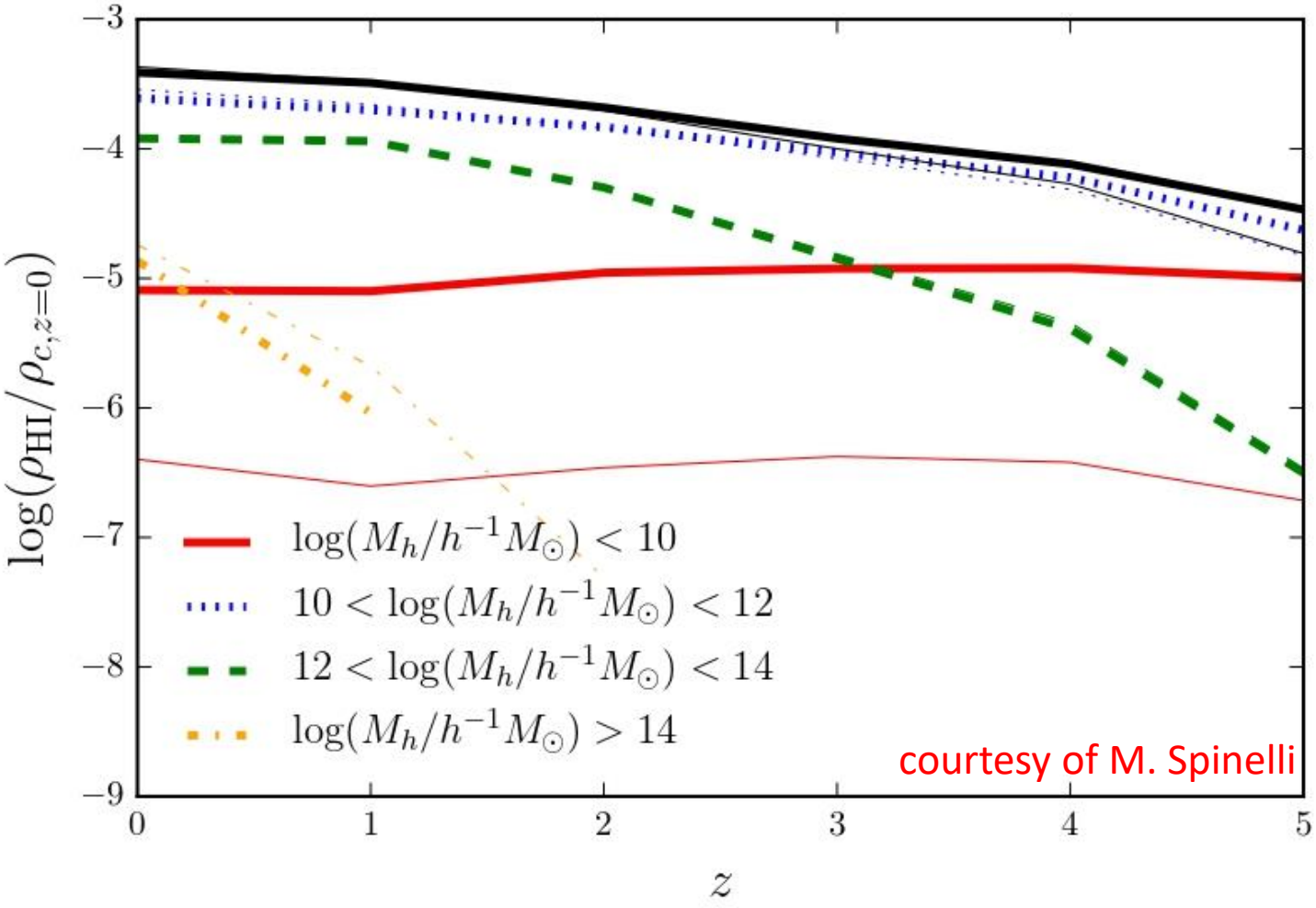
MRII



$L_{box} = 100h^{-1}cMpc$

$m_p = 6.89\,\mathbf{x}\ 10^6\,\frac{M_\odot}{h}$

Resolution effects on the HI content in MRI and MRII

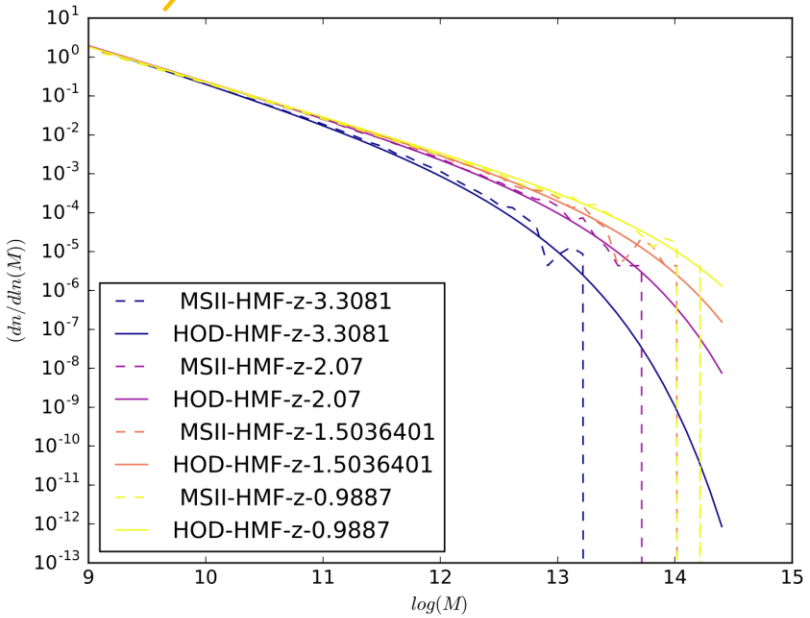


- thick lines → MRII
- thin lines → MRI

HOD model

Then we populate the box with haloes with $M_{halo} \leq 10^{9.1}\, M_{\odot}$ using an HOD model based on :

- Tinker HMF
- extrapolation of the median relation in MRII for



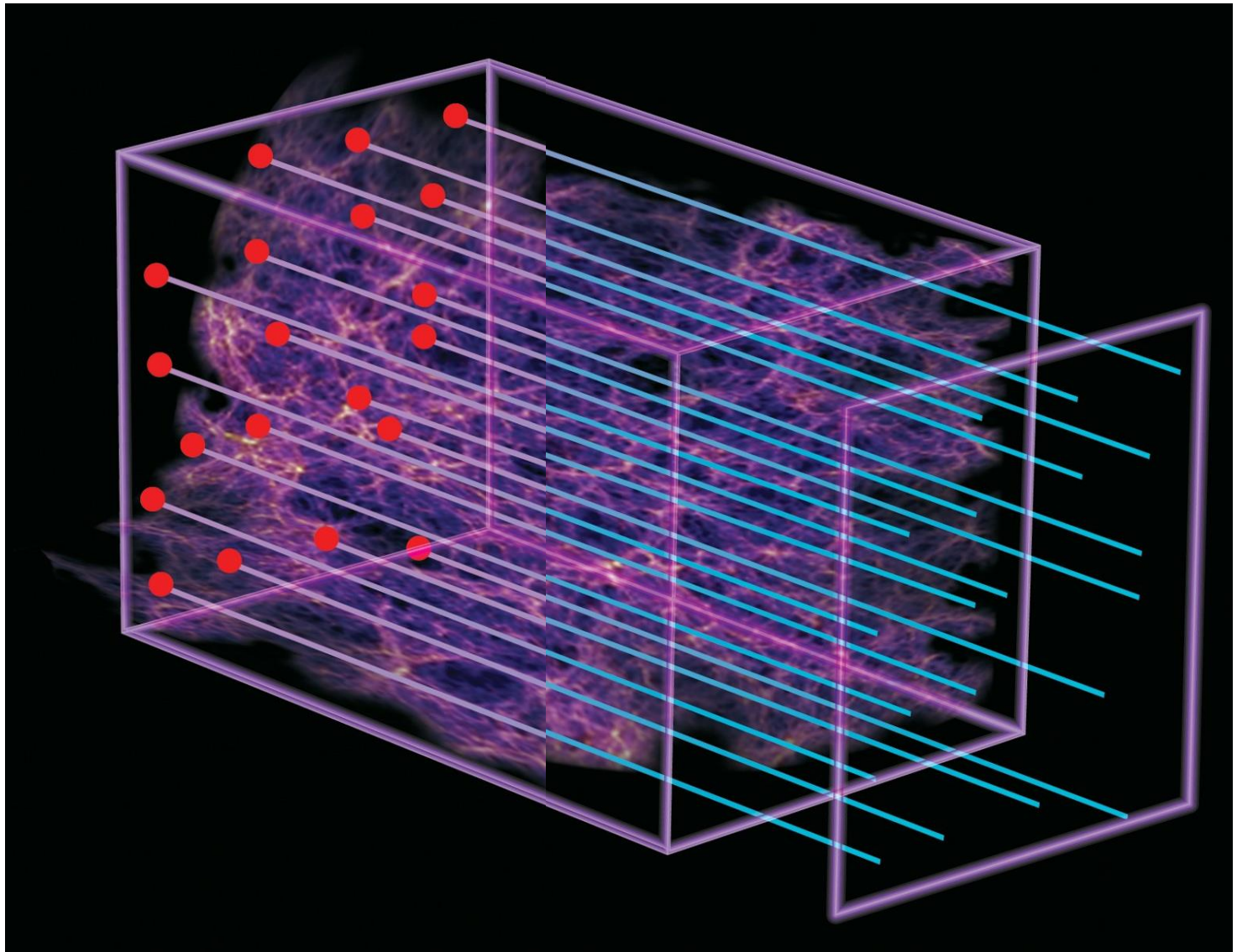
1 SMHM relation

2 CG mass VS HM (halo mass)

3 R_s(CG) VS Halo Mass

4 R_s(SD) VS Halo Mass

Creation of the catalog of simulated DLAs



Then I throw 10000 random generated l.o.s. in the box with

$$L_{box} = 100h^{-1}cMpc$$

and for each intervening galaxy I

estimate :

- N(HI)
- [Fe/H]

which depend on

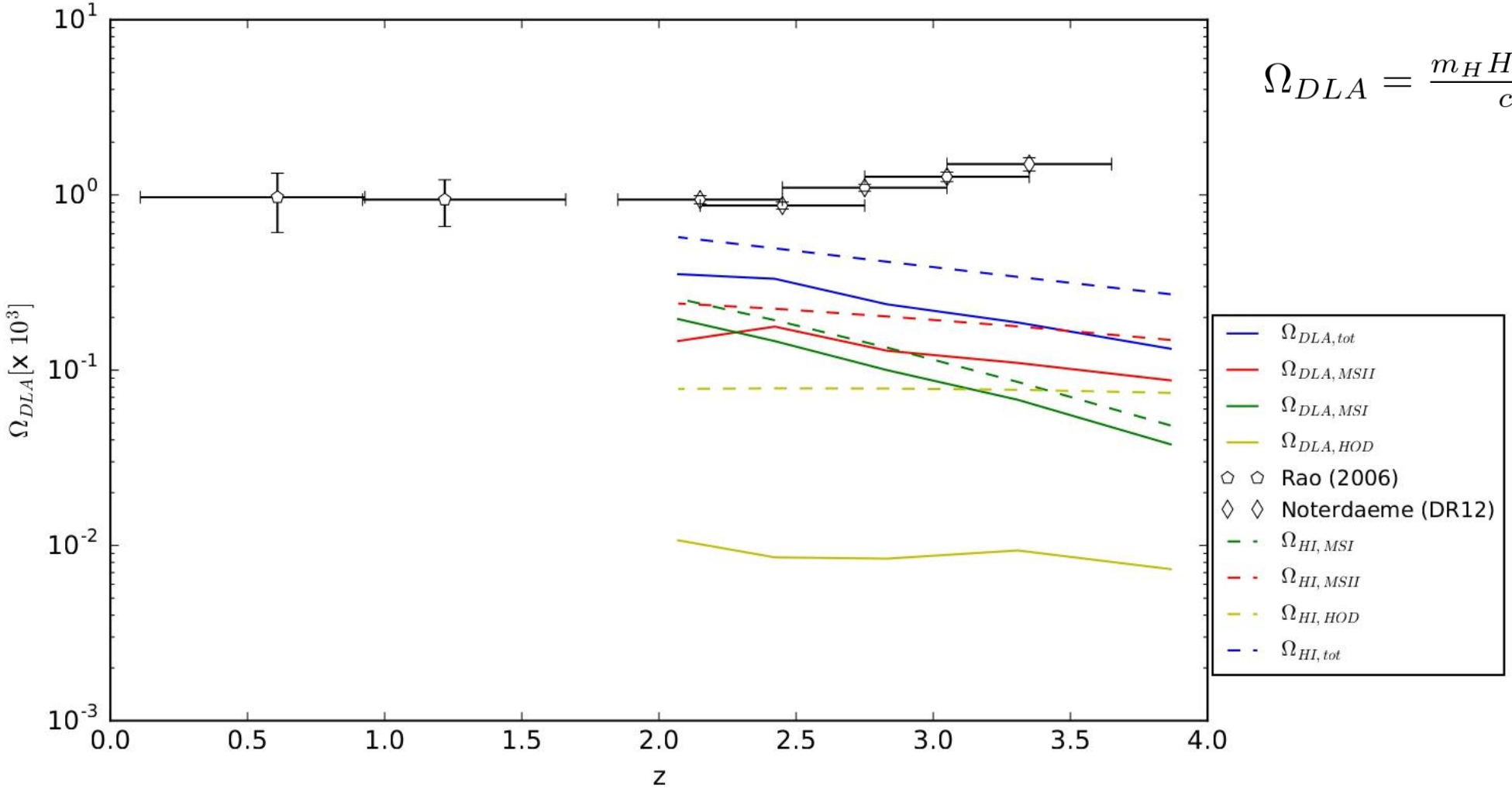
- θ
- b

Testing our results with the data

To compare our results with the observation of DLAs we focus on 4 main observables:

1. Ω_{DLA}
2. CDDF
3. $[\frac{Fe}{H}]$ **VS** N(HI)
4. Ω_Z

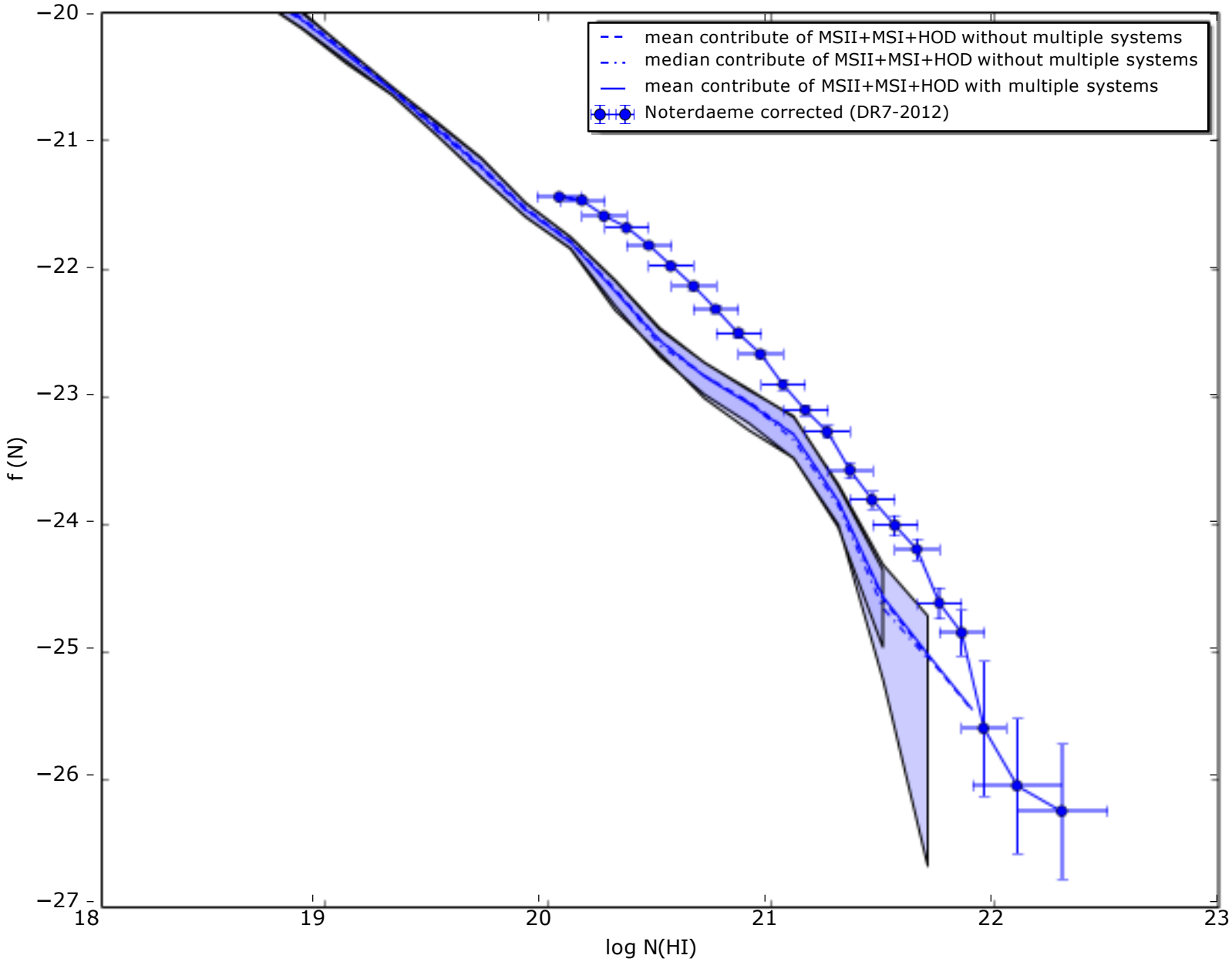
1st **observable:** Ω_{DLA}



$$\Omega_{DLA} = \frac{m_H H_0 \Sigma N(HI)}{c\rho\Delta X}$$

2nd observable:CDDF

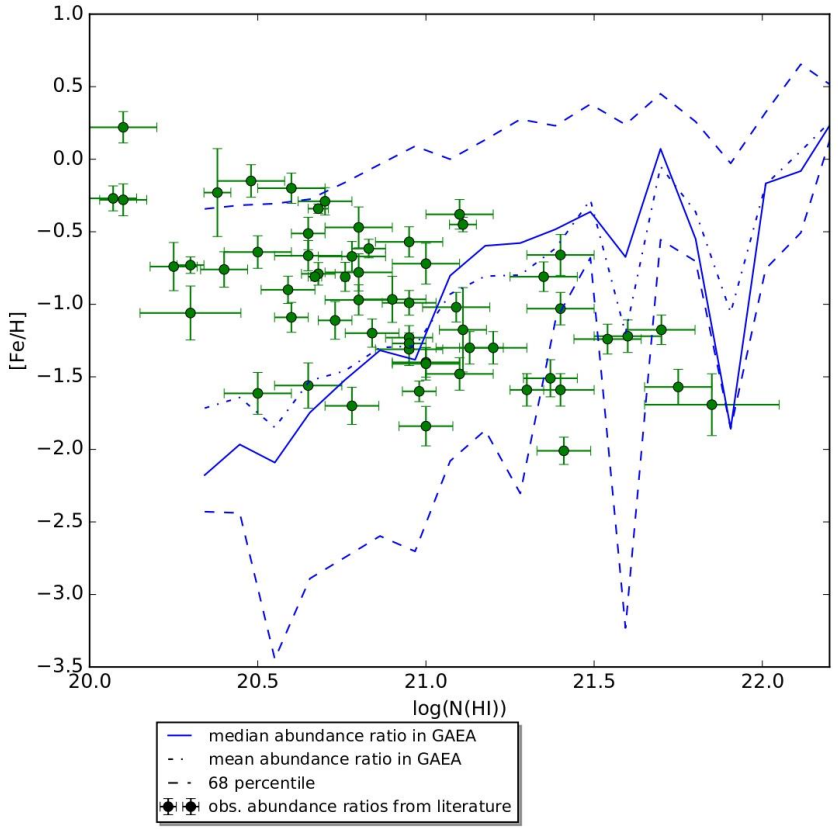
Median CDDF in the redshift range $2 < z < 3.89$



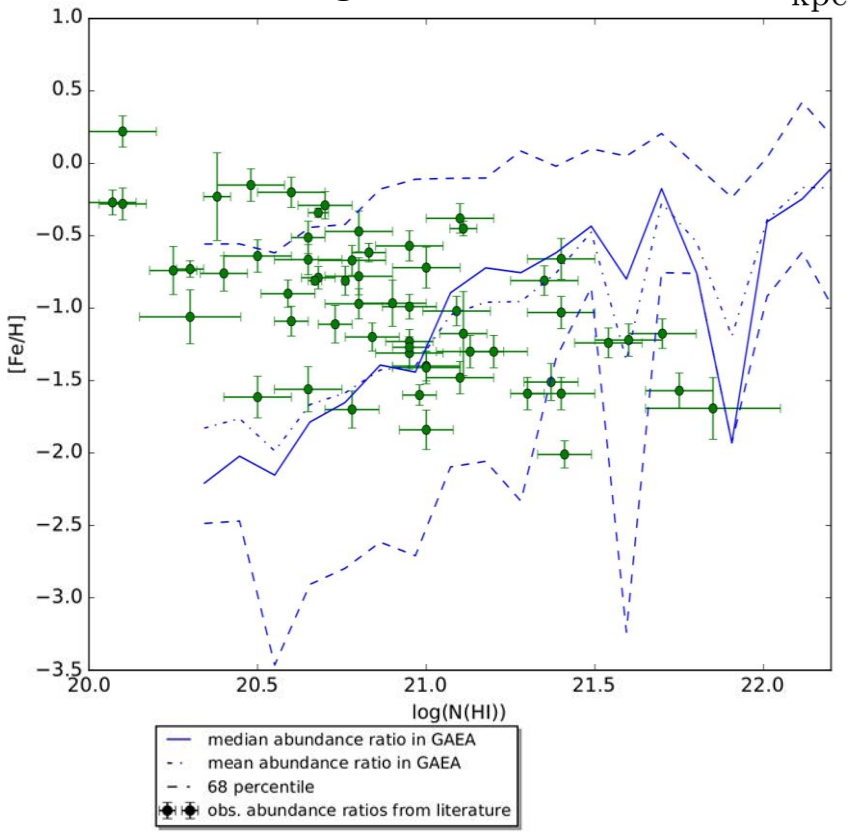
Preliminary results !!

3rd observable: $\left[\frac{Fe}{H}\right]$ vs N_{HI}

without gradient

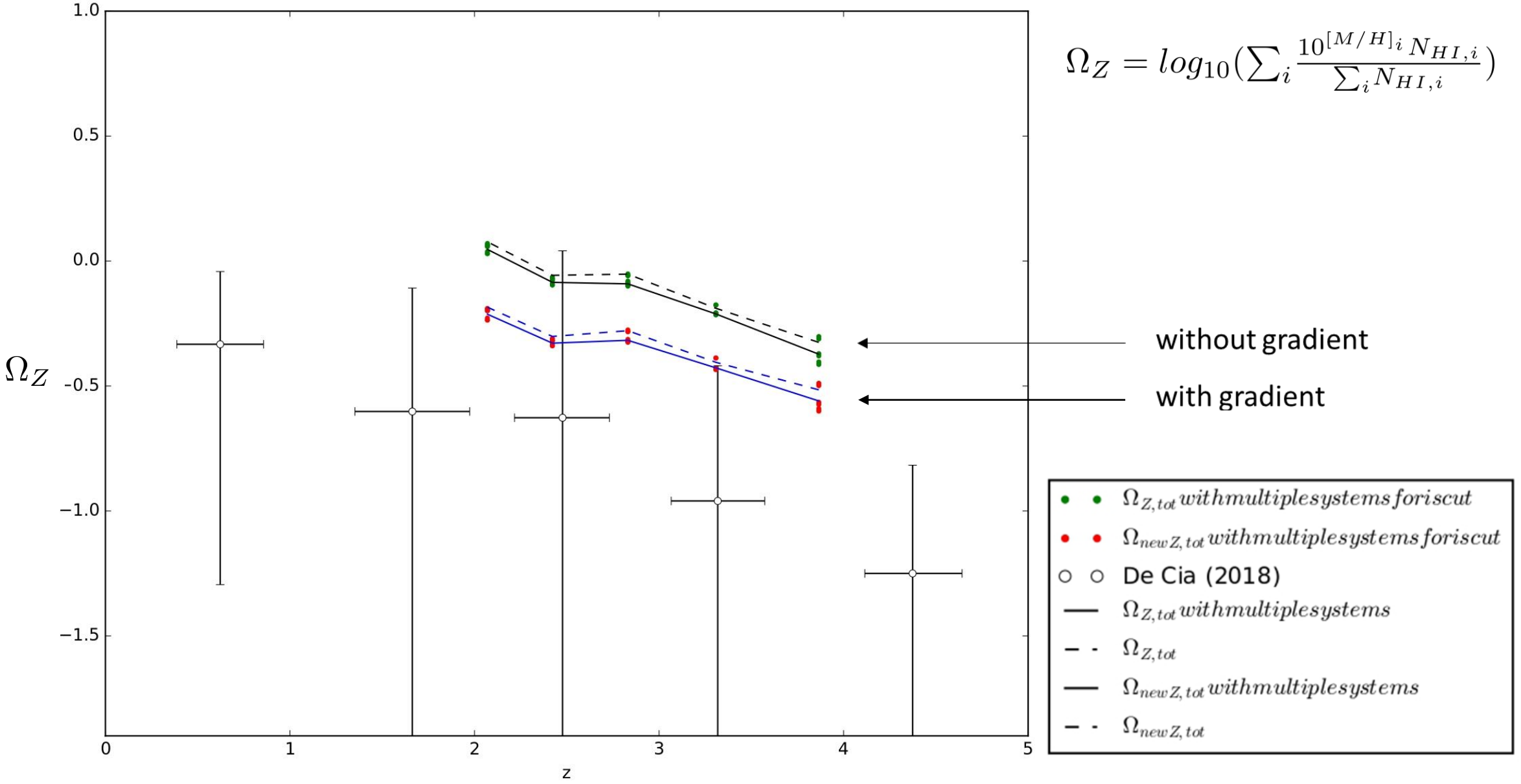


with gradient $\Gamma = -0.022\ \frac{dex}{\mathrm{kpc}}$



4th observable: Ω_Z

$$\Omega_Z = log_{10}(\sum_i \frac{10^{[M/H]_i} N_{HI,i}}{\sum_i N_{HI,i}})$$



Conclusions

- In our model the largest contribution to the DLAs' cross-section comes from galaxies contained in intermediate mass haloes (MRII)

- Our model underestimates the number and HI content of DLAs in the redshift range 2-3.89

- Our estimates of the [Fe/H] are in agreement with the data from literature, within 1 sigma error (although with a hint of opposite trends which we will investigate in the future)

- Once we applied the gradient, we find a metallicity evolution in agreement, within the errors, with the data for the dust corrected metallicity of DLAs(De Cia et al, 2018)


Thank you for your attention!
QUESTIONS?