Galaxy Bias in Illustris Simulations

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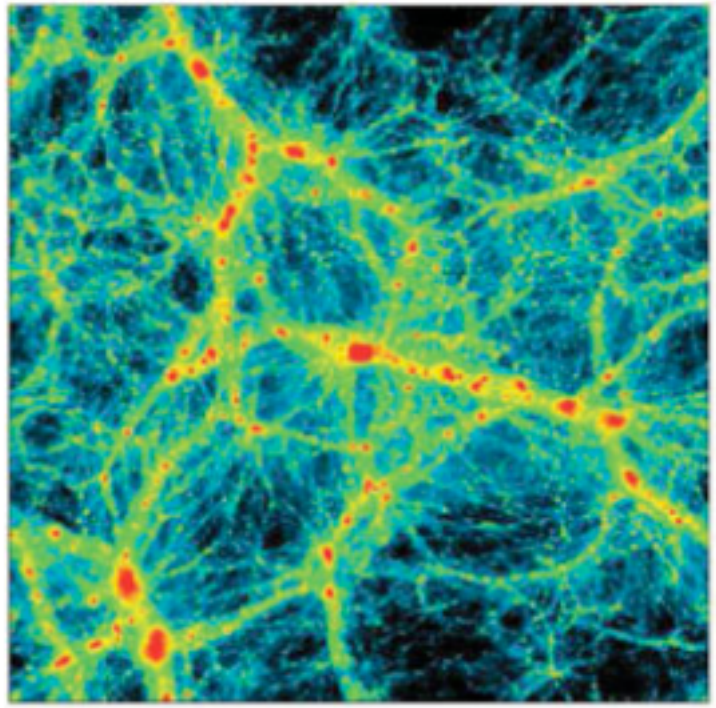
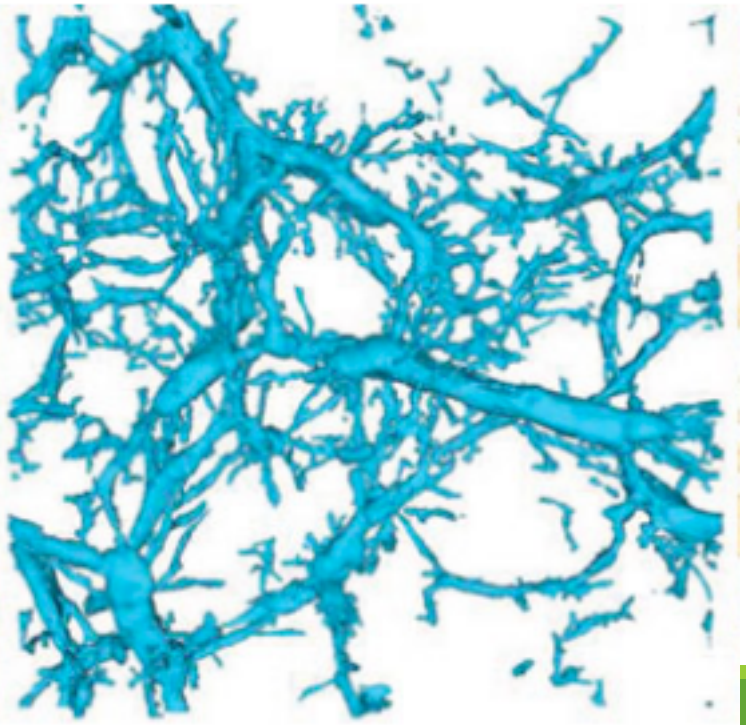
- In ΛCDM the galaxies are formed inside to Dark Matter Halos
- The Dark Matter Halos are formed form tiny fluctuations in the density field during the inflationary epoch and this evolved under gravity.
- The galaxy distribution can be used to reconstruct the underlying distribution of dark matter.

Bias

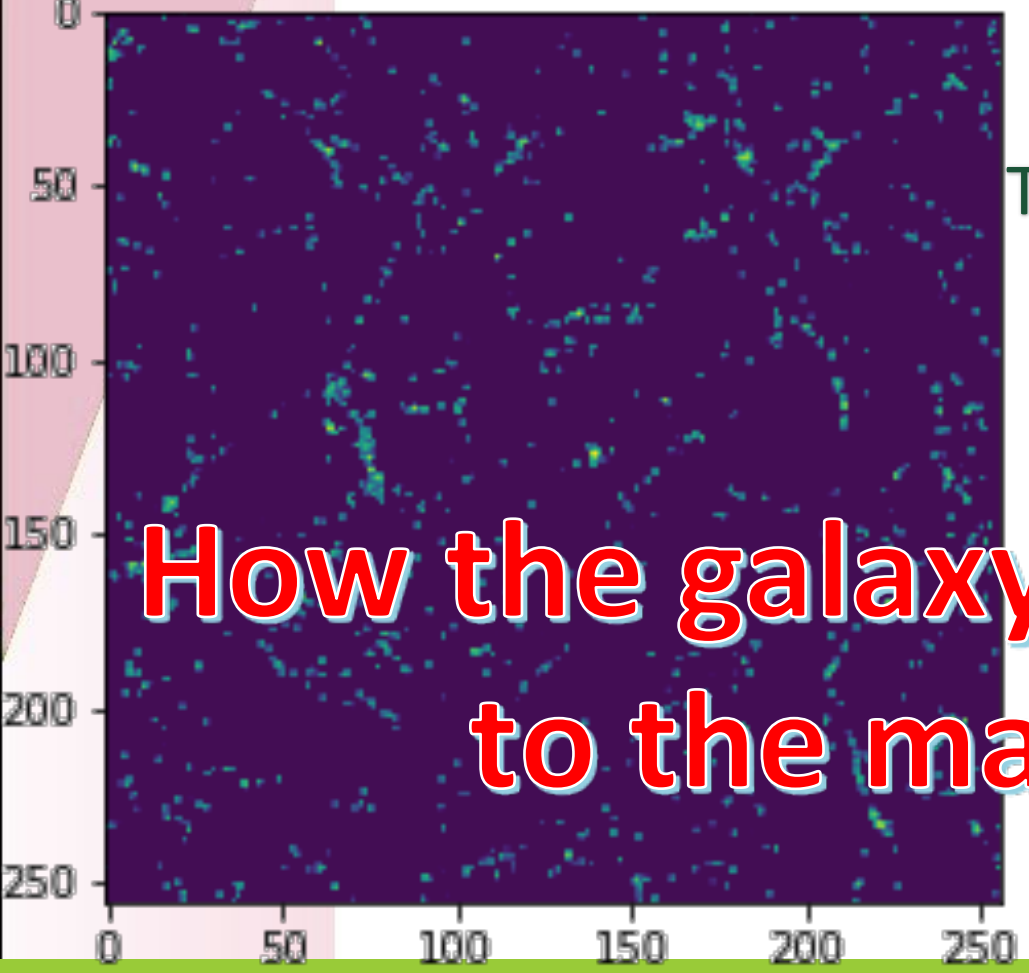




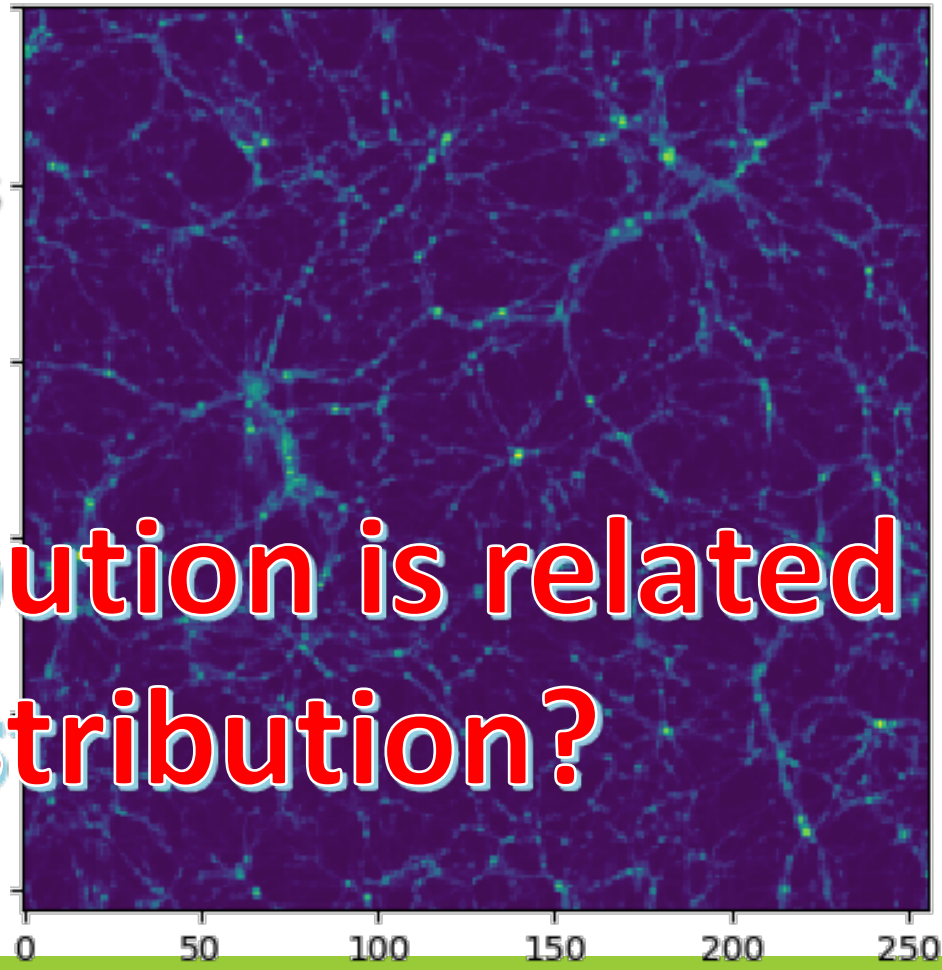
The distribution is NOT uniforme neither random it follows a web-like

arXiv:1501.01306 [astro-ph.CO]

Galaxies Distribution IllustrisTNG-302



DM Distribution IllustrisTNG-302



The light traces mass?

How the galaxy distribution is related to the matter distribution?

Objective:

- Understand how the cosmic web influences the galaxy bias

We use data from state-of-the-art hydrodynamical simulations Illustris and Illustris-TNG.

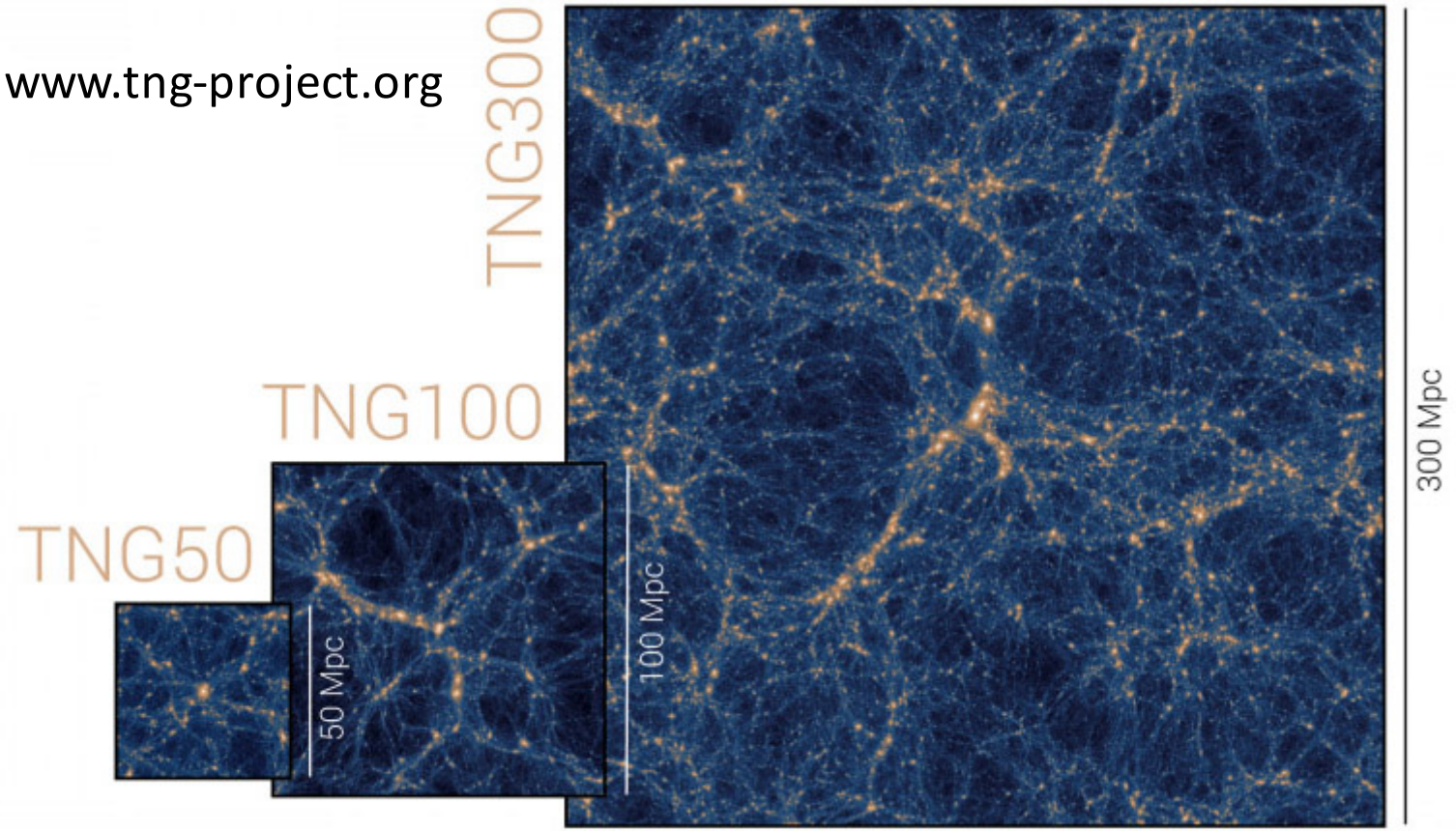
We use galaxies masses spanning a mass range from $10^8 M_\odot/h$ to $10^{13} M_\odot/h$.

We calculated the power espectra using NBODYKIT for overdensity field using the CIC interpolation in a cubic grid with $N = 256^3$.

We obtain the galaxy Bias from each mass range for 25% youngest galaxies and 25% oldest galaxies

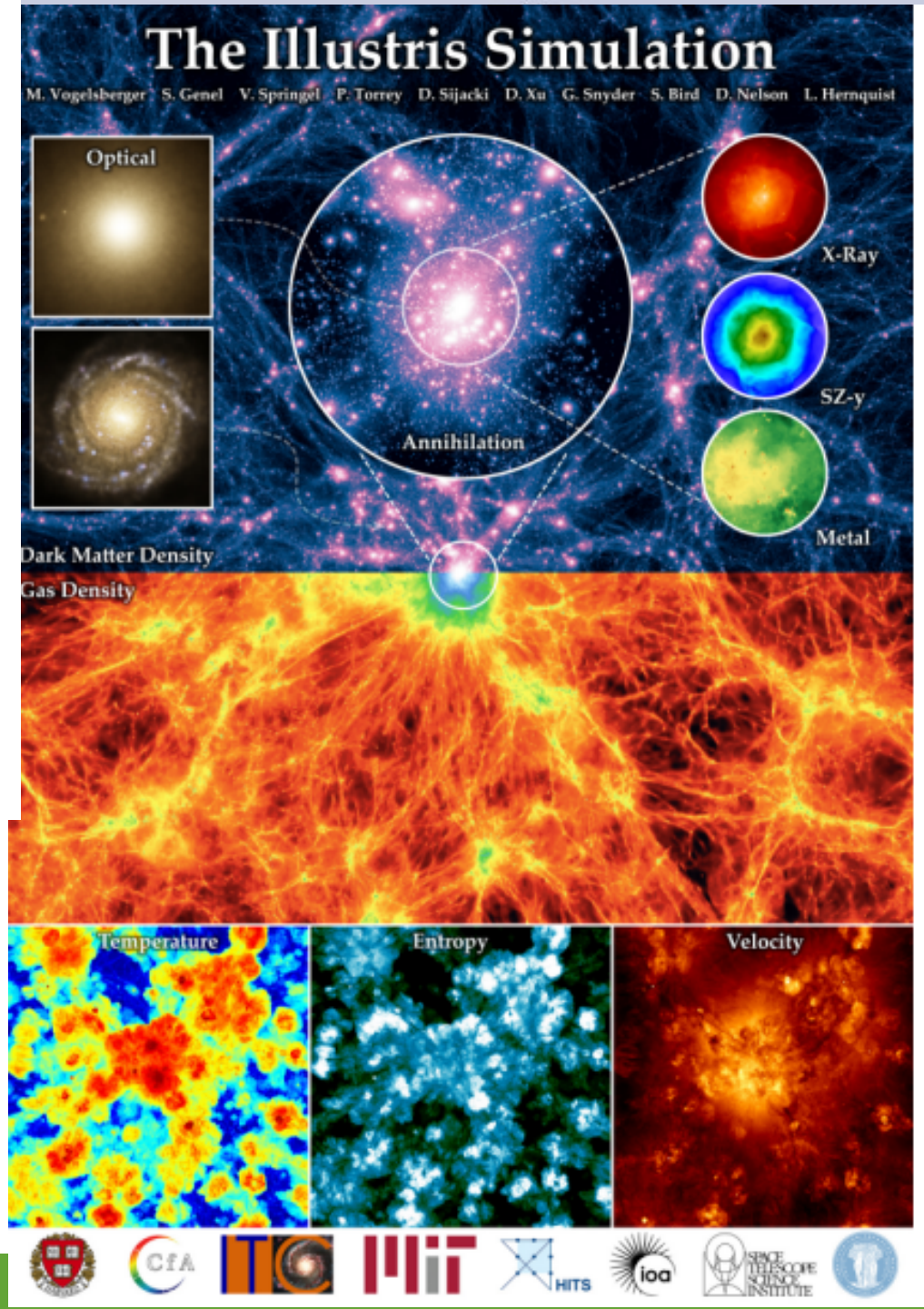
Calculate the Tidal Anisotropy.

www.tng-project.org



name	volume $[(\mathrm{Mpc})^3]$
TNG300-1	302.6^3
TNG300-2	302.6^3
TNG300-3	302.6^3

name	volume $[(\mathrm{Mpc})^3]$
Illustris-1	106.5^3
Illustris-2	106.5^3
Illustris-3	106.5^3



- The Illustris project is a suite of state-of-the-art cosmological galaxy formation simulations. Each simulation in IllustrisTNG evolves a large swath of a mock Universe from soon after the Big-Bang until the present day while taking into account a wide range of physical processes that drive galaxy formation

- TNG300, hydrodynamical simulations have reached a sufficient volume and resolution to study clustering of all matter components in The Universe on the relevant scales.

- Free Data access.

ΛCDM cosmology:

$\Omega_m = 0.2726$, $\Omega_b = 0.0456$,

$\Omega_\Lambda = 0.7274$, $\sigma_8 = 0.809$

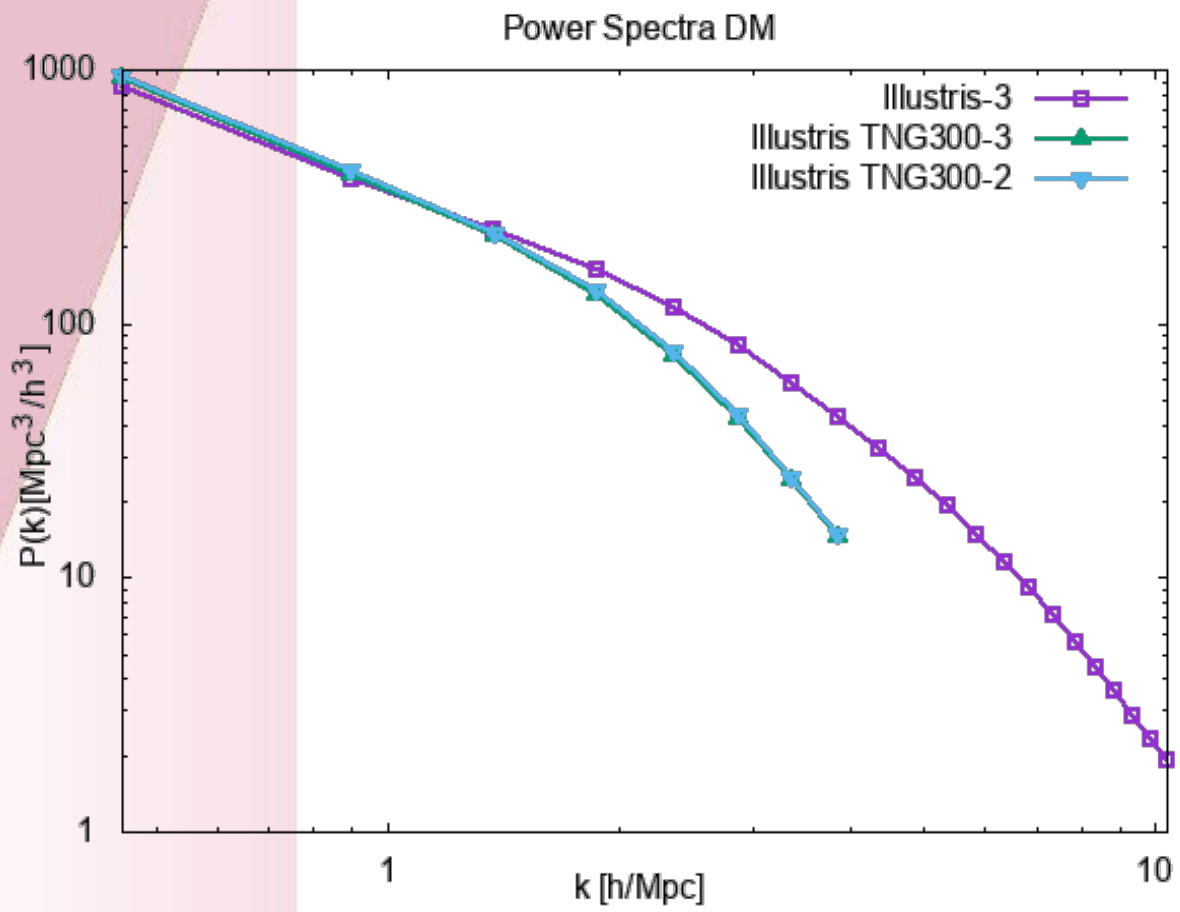
$h = 0.704$. (Vogelsberger, et al. 2014)

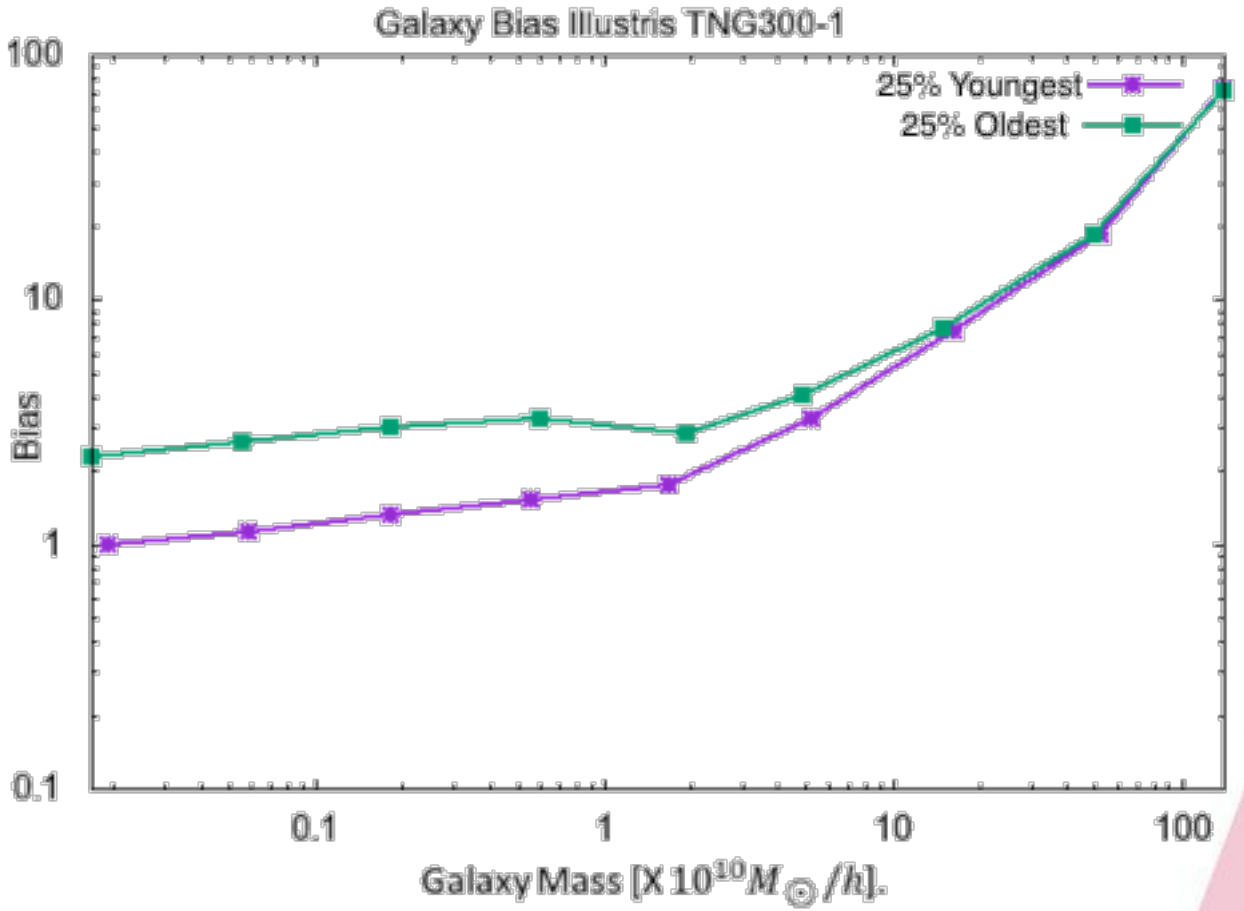
Illustris TNG:

$\Omega_m = 0.38089$, $\Omega_b = 0.0486$,

$\Omega_\Lambda = 0.6911$, $h = 0.6774$

(Planck Collaboration, et al. 2016).



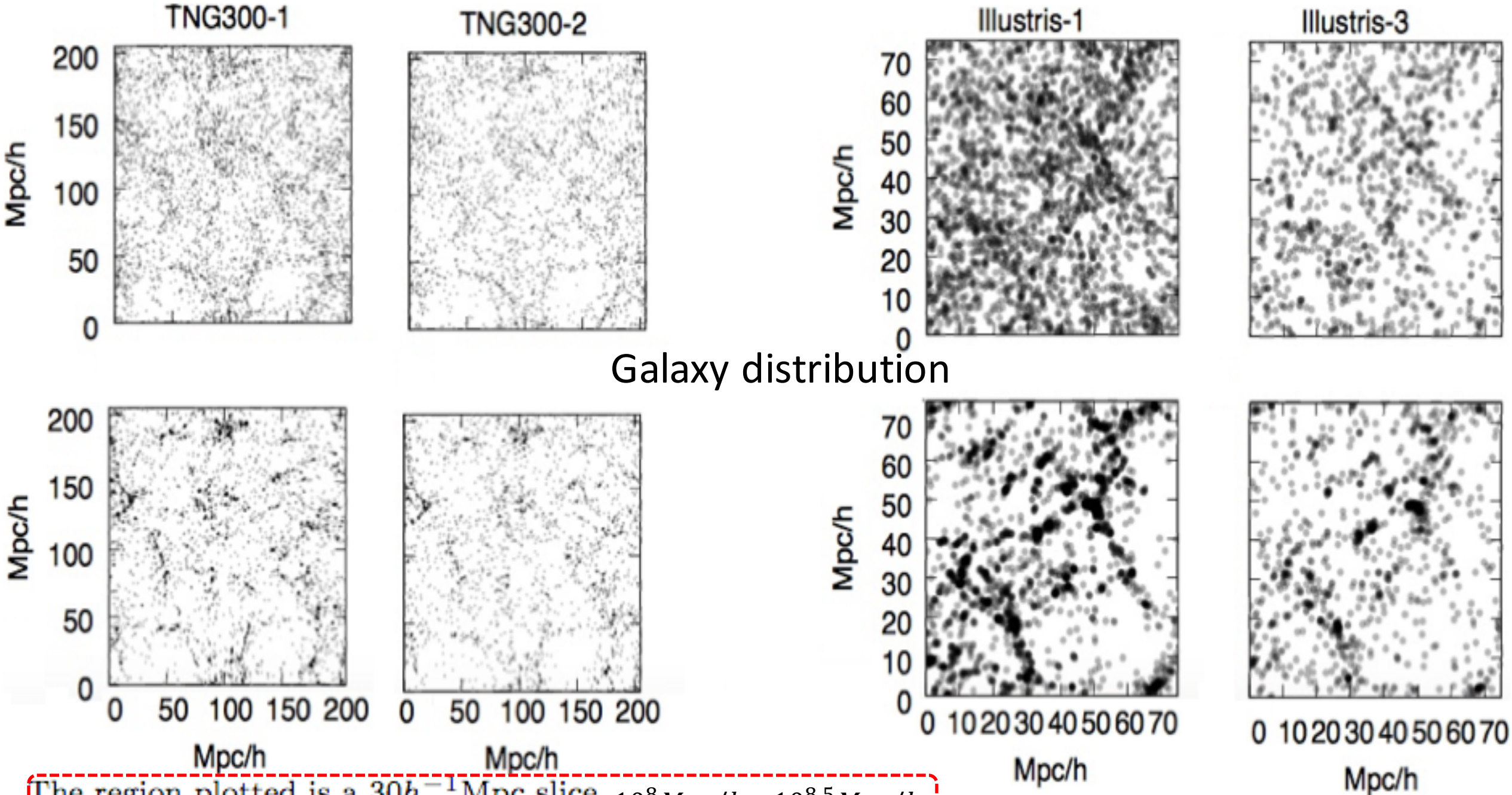


$k = \pi N_{mesh} / L_{box}$

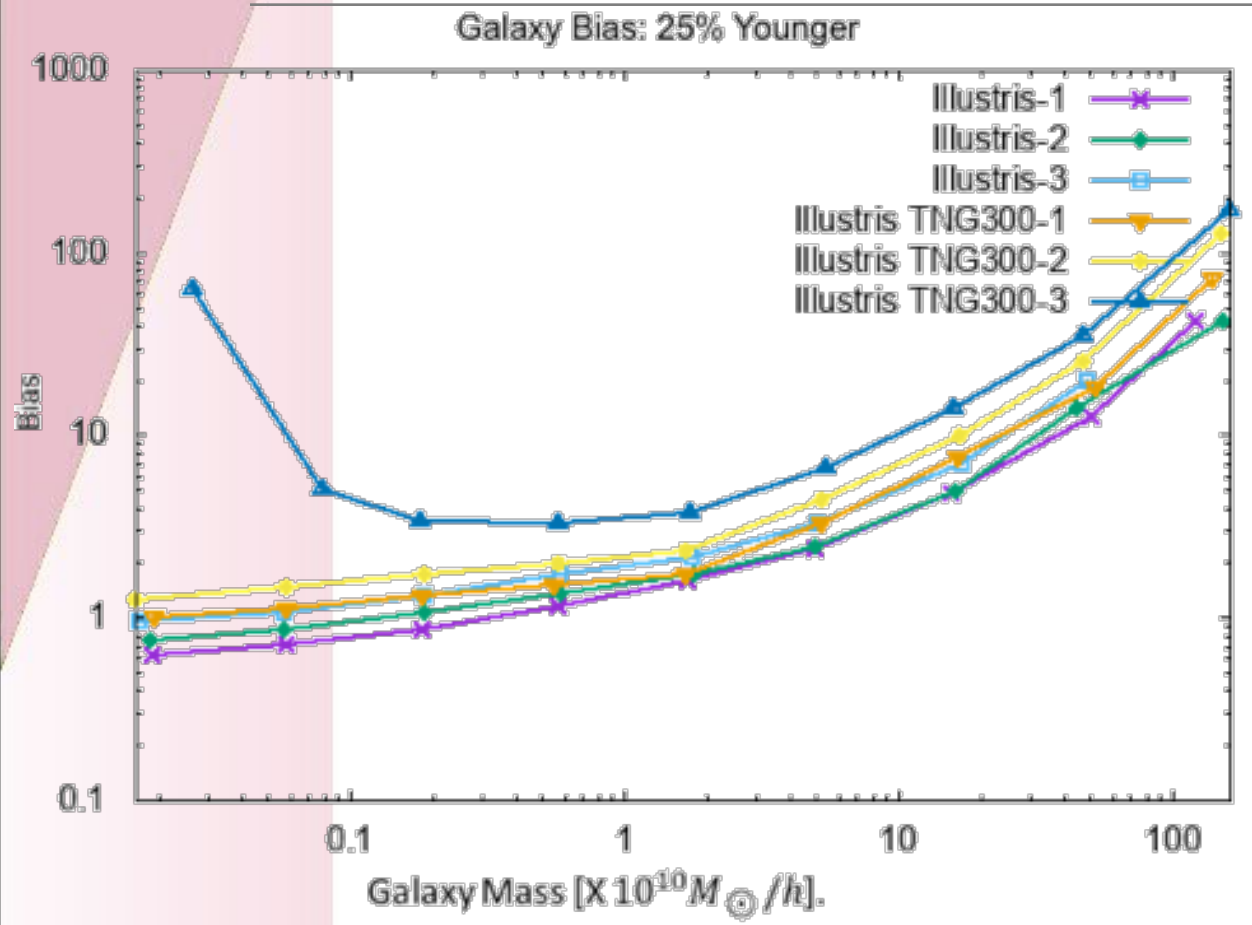
We found the Galaxy Bias depends on formation time.

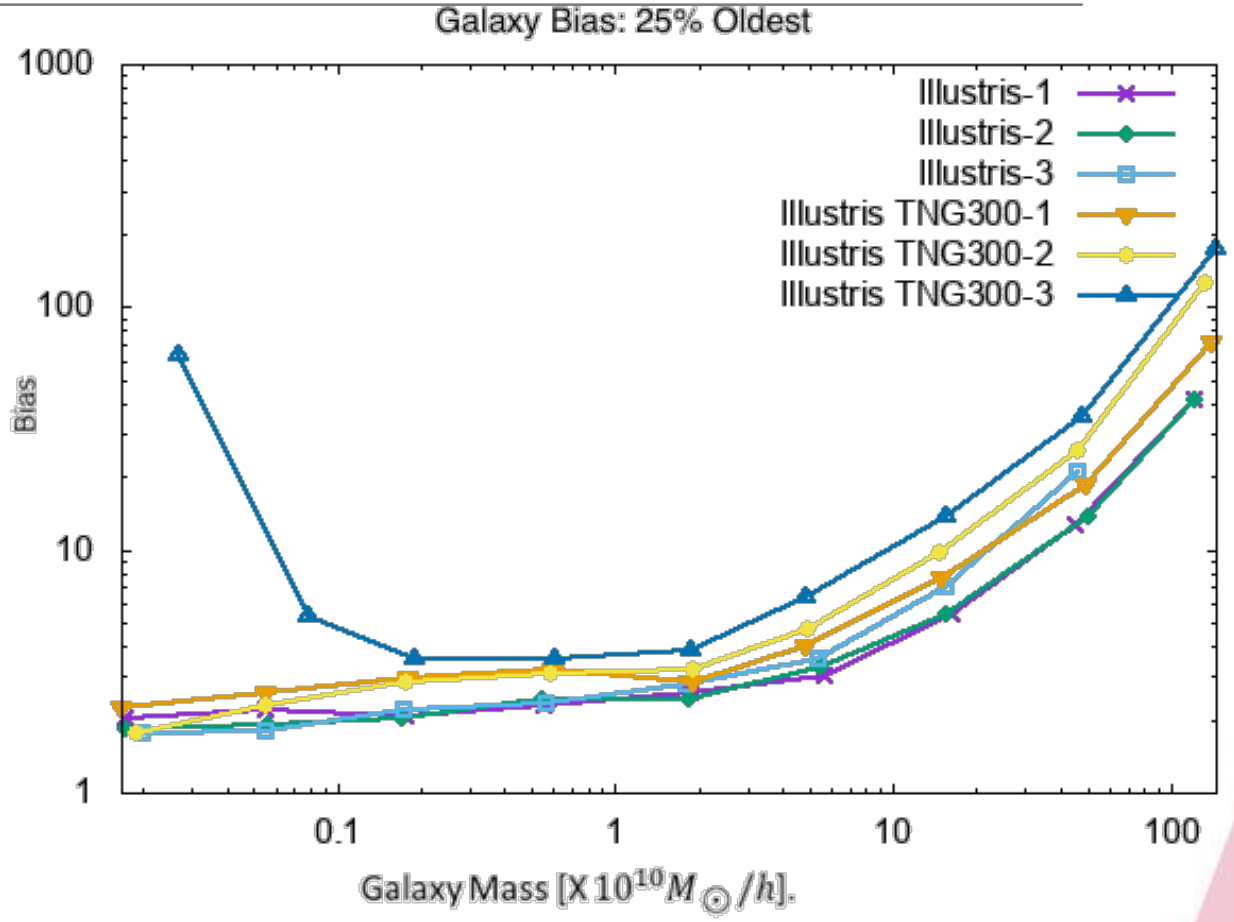
- The clustering dependence is strong on formation time for masses in the range $10^8 M_\odot/h - 10^{11} M_\odot/h$

- Galaxies that form early tend to be located in cosmic-web environments with higher anisotropy than its late-forming counterparts

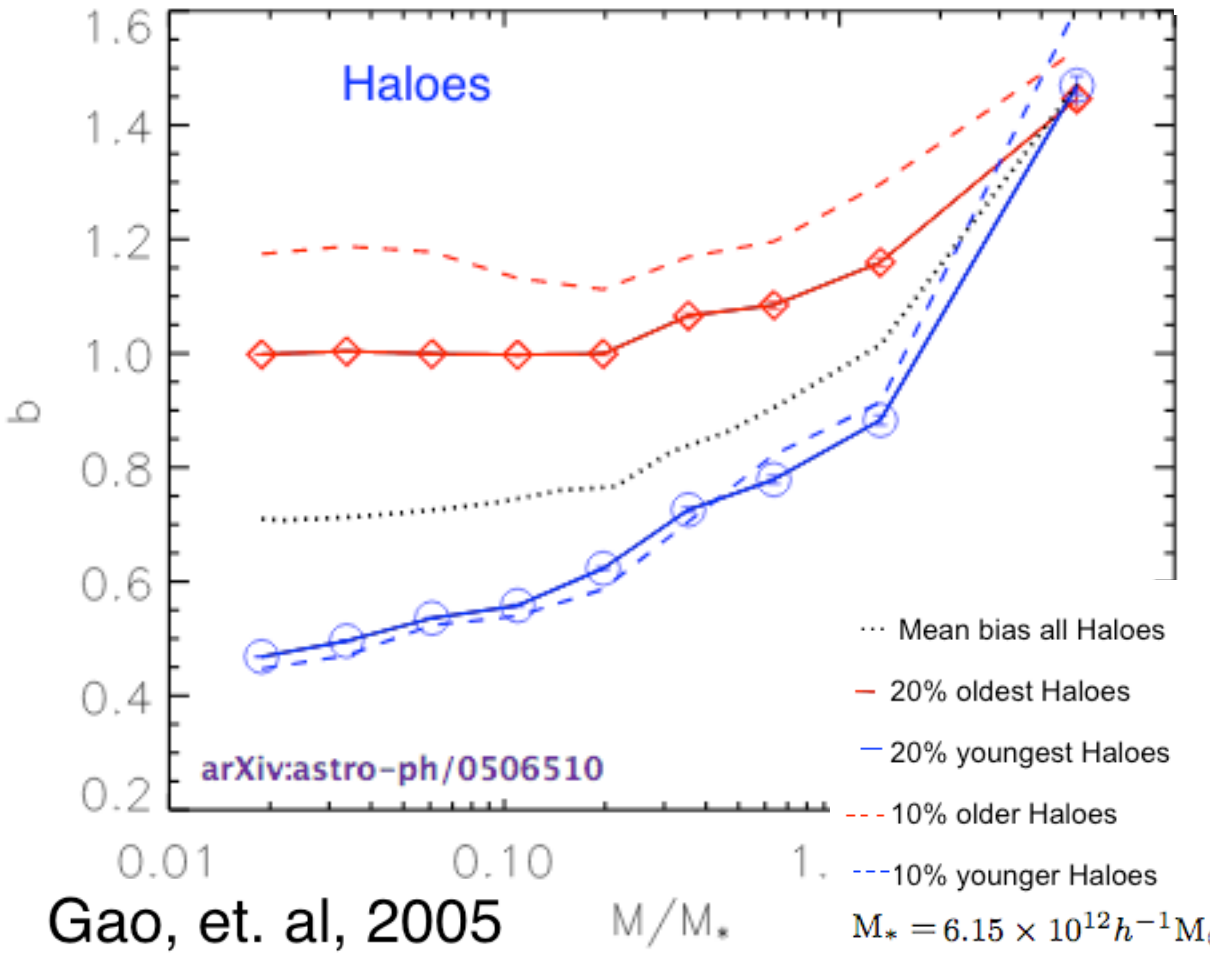


The region plotted is a $30h^{-1}$Mpc slice $10^8 M_\odot/h$ - $10^{8.5} M_\odot/h$

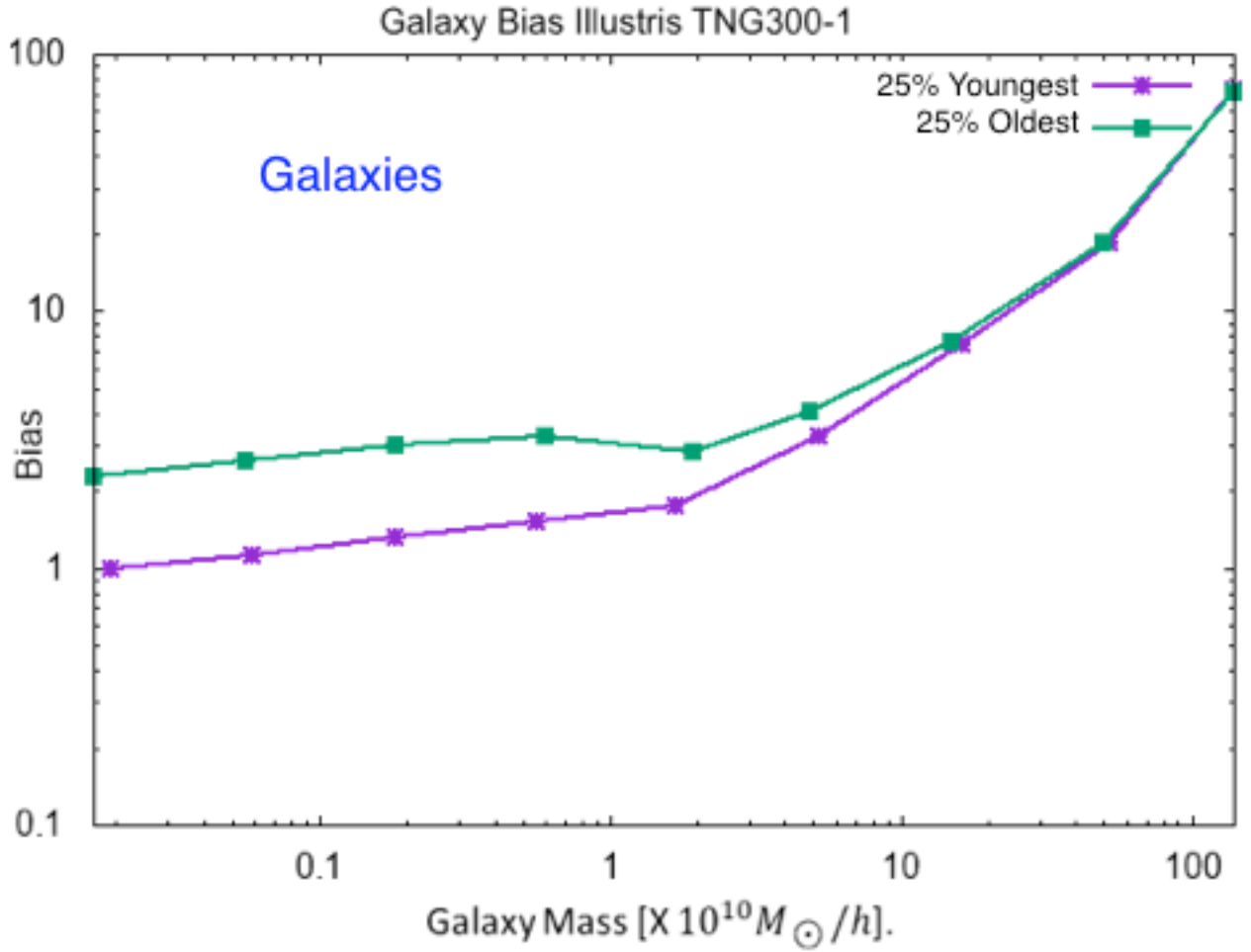

Galaxy Bias: 25% Younger
Illustris-1
Illustris-2
Illustris-3
Illustris TNG300-1
Illustris TNG300-2
Illustris TNG300-3
Bias
1000
100
10
1
0.1
0.1
1
10
100
Galaxy Mass [X $10^{10} M_{\odot}/h$].

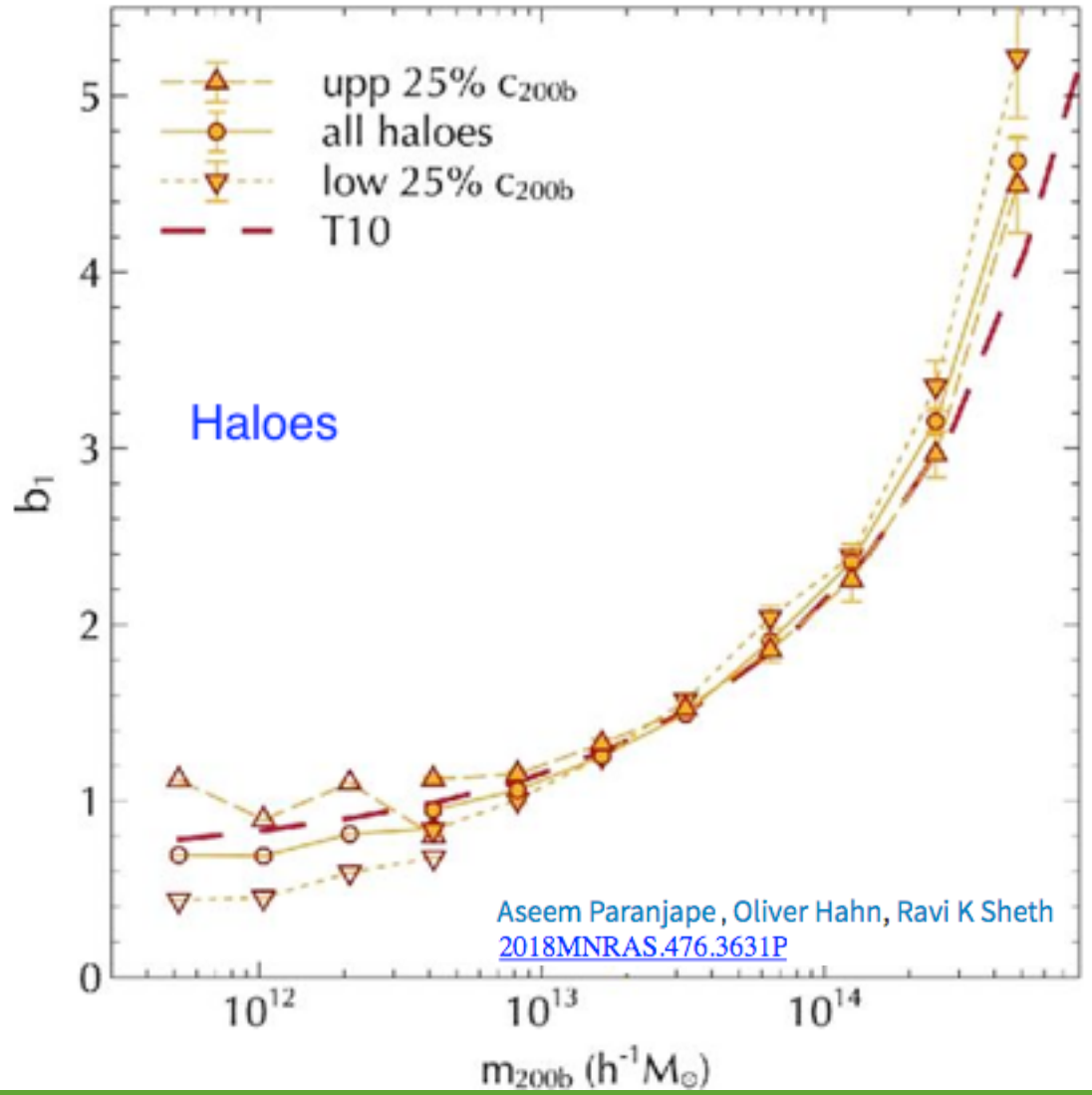

Galaxy Bias: 25% Oldest
Illustris-1
Illustris-2
Illustris-3
Illustris TNG300-1
Illustris TNG300-2
Illustris TNG300-3
Bias
1000
100
10
1
0.1
1
10
100
Galaxy Mass [X $10^{10} M_{\odot}/h$].

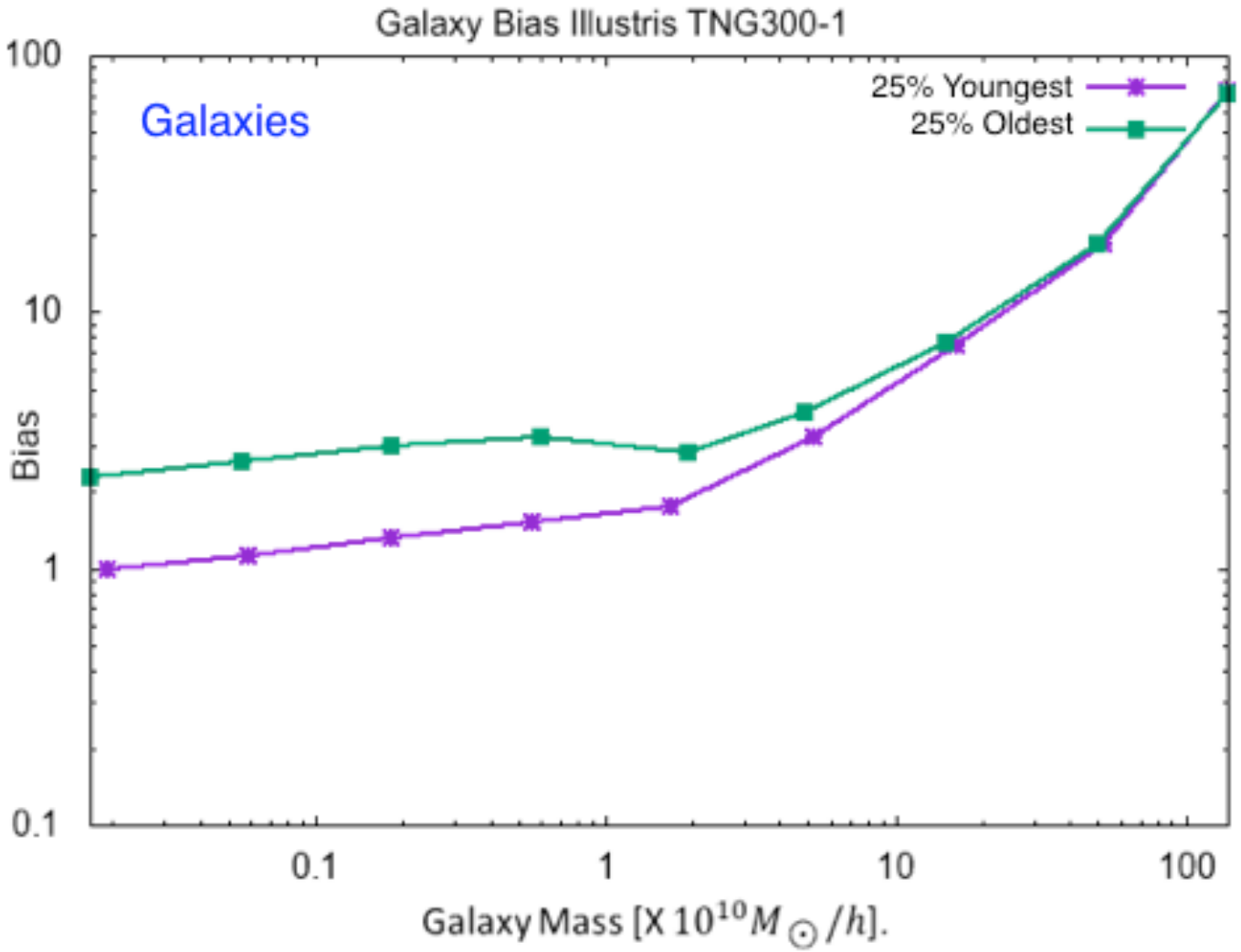
Previous Results

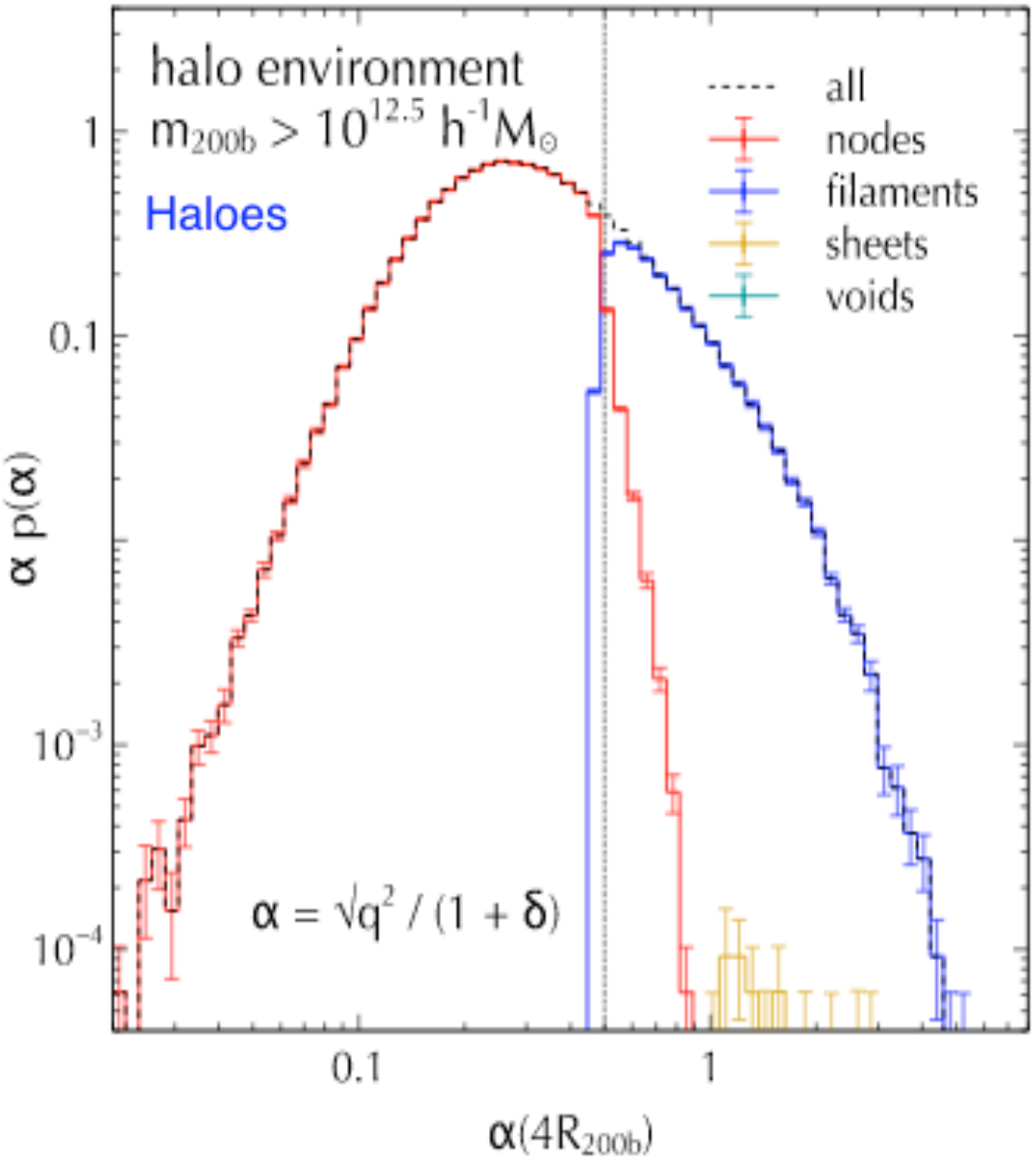


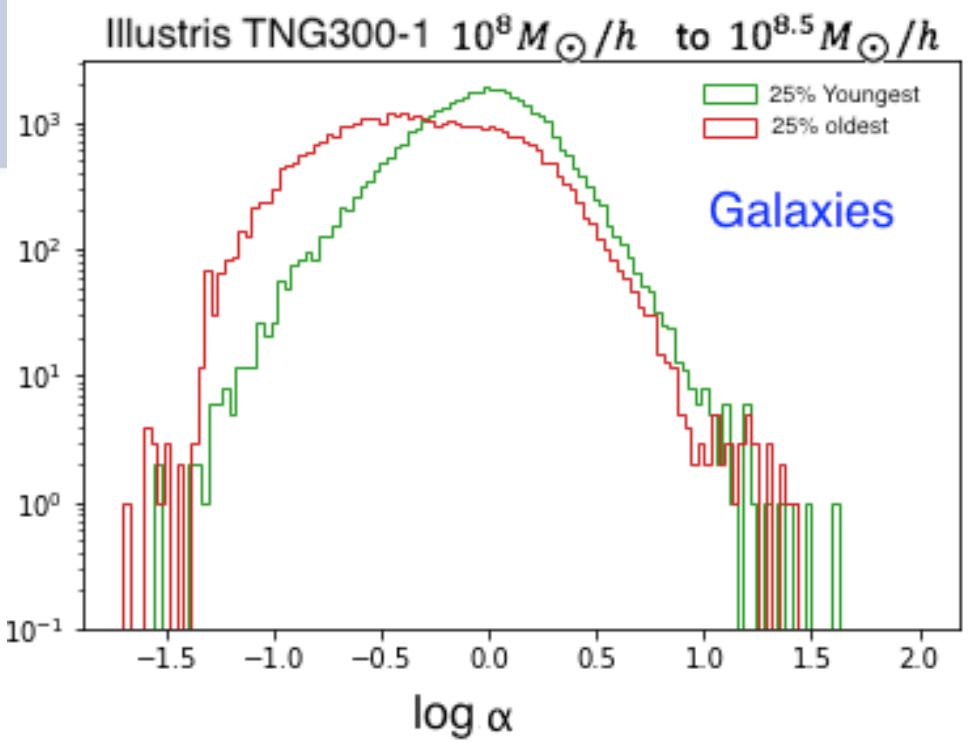
Gao, et. al, 2005

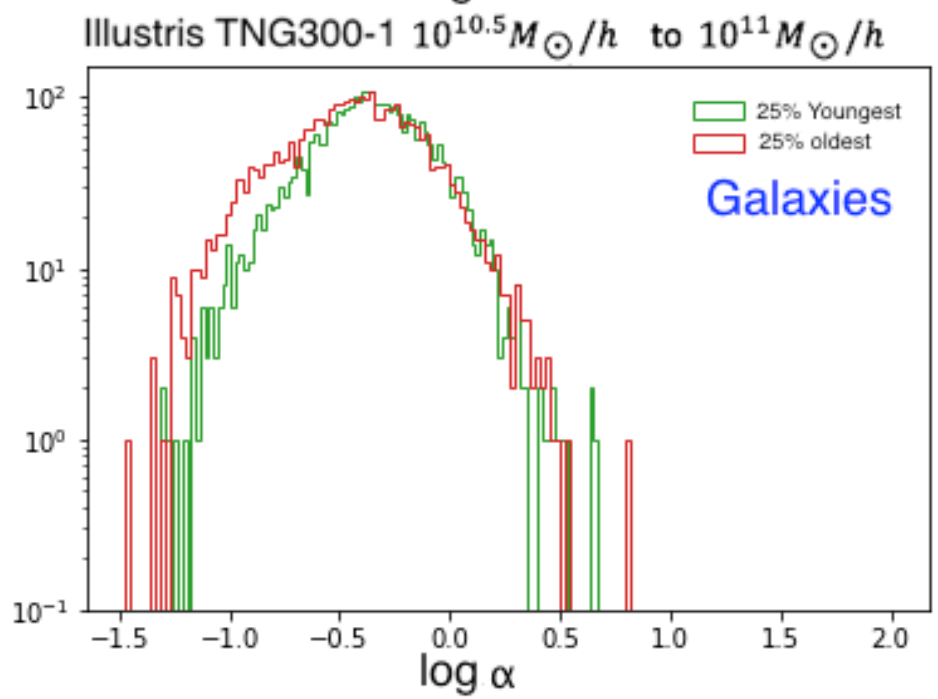



upp 25% c_{200b}
all haloes
low 25% c_{200b}
T10
Haloes
b_1
m_{200b} ($h^{-1}M_\odot$)
Aseem Paranjape, Oliver Hahn, Ravi K Sheth
2018MNRAS.476.3631P


Galaxy Bias Illustris TNG300-1
Galaxies
25% Youngest
25% Oldest
Bias
Galaxy Mass [X $10^{10} M_\odot/h$].


halo environment
$m_{200b} > 10^{12.5}\ h^{-1}M_\odot$
Haloes
all
nodes
filaments
sheets
voids
$\alpha = \sqrt{q^2} / (1 + \delta)$
$\alpha\ p(\alpha)$
$\alpha(4R_{200b})$
1
0.1
10^{-3}
10^{-4}
0.1
1


Illustris TNG300-1 $10^8 M_\odot/h$ to $10^{8.5} M_\odot/h$
25% Youngest
25% oldest
Galaxies
10^3
10^2
10^1
10^0
10^{-1}
−1.5
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0
log α


Illustris TNG300-1 $10^{10.5} M_\odot/h$ to $10^{11} M_\odot/h$
25% Youngest
25% oldest
Galaxies
10^2
10^1
10^0
10^{-1}
−1.5
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0
log α

FUTURE DIRECTIONS

Quatify the bias in the galaxy formation in this enviroments

Study the bias in halos in terms this enviroments for this simulations

Explore to different smoothing lengths in this simulation.

References

Cautun M., van de Weygaert R., Jones B.J.T., Frenk C.S., 2016, The Zeldovich Universe: Genesis and Growth of the Cosmic Web.

Gao L., Springel V., White S.D.M., 2005, MNRAS, 363, L66

Paranjape A., Hahn O., Sheth R.K., 2018, MNRAS, 476, 3631