The Aemulus Project:

Cosmological constraint from small scale clustering of BOSS galaxies

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Cosmology from Home

The Aemulus Project

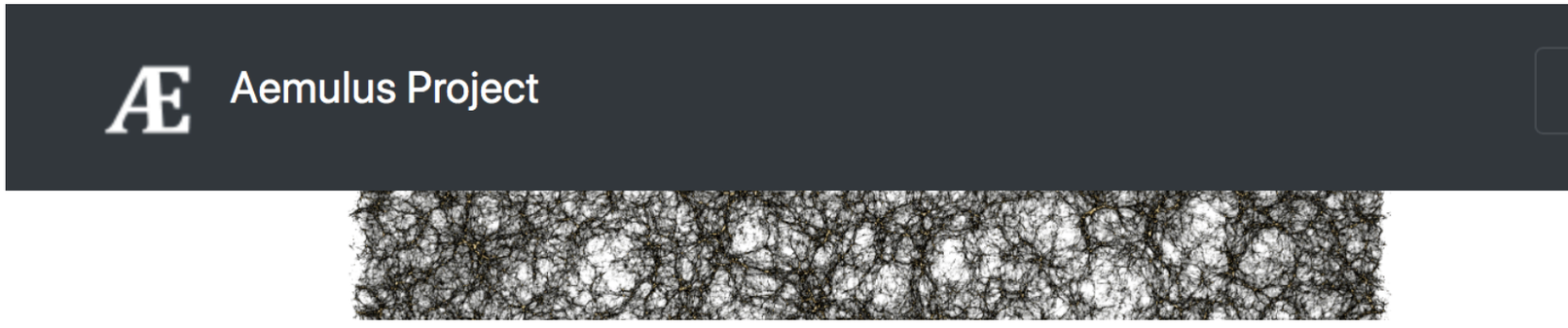
* Collobration with ~many faculty members, post-docs, students

* Multi-institution collaboration

* Results: Suite(s) of high-resolution N-body simulations spanning currently-allowed cosmological parameter space

* Goal: precision emulation of statistics of dark matter halos and galaxies:
  Halo mass function
  Halo bias function
  Galaxy correlation function
  Galaxy-galaxy lensing

https://aemulusproject.github.io/



Cosmological constraint

Galaxy clustering at non-linear scales

Within CMB allowed parameter space

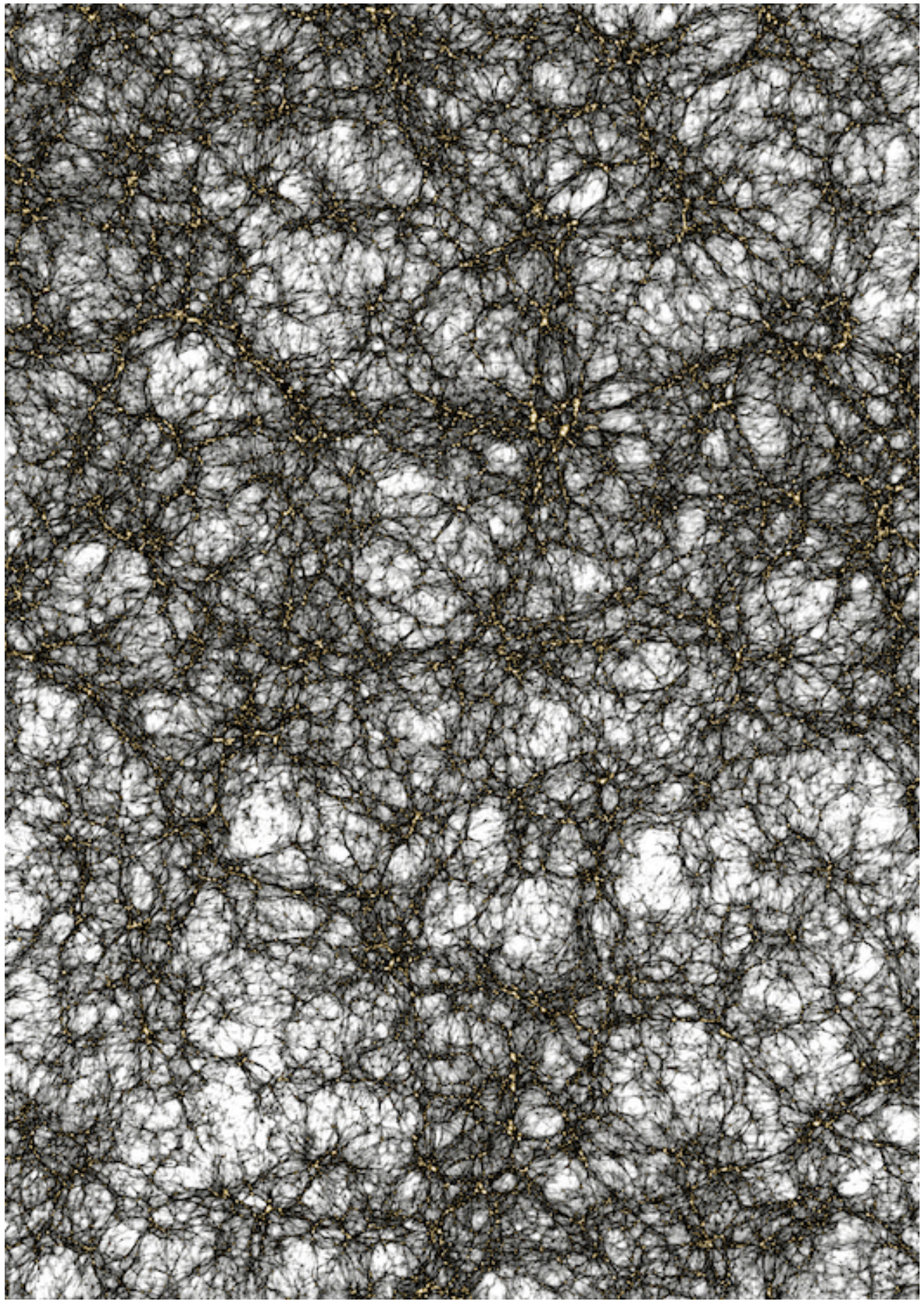
The growth rate of structure

$$f = \Omega_m^\gamma$$

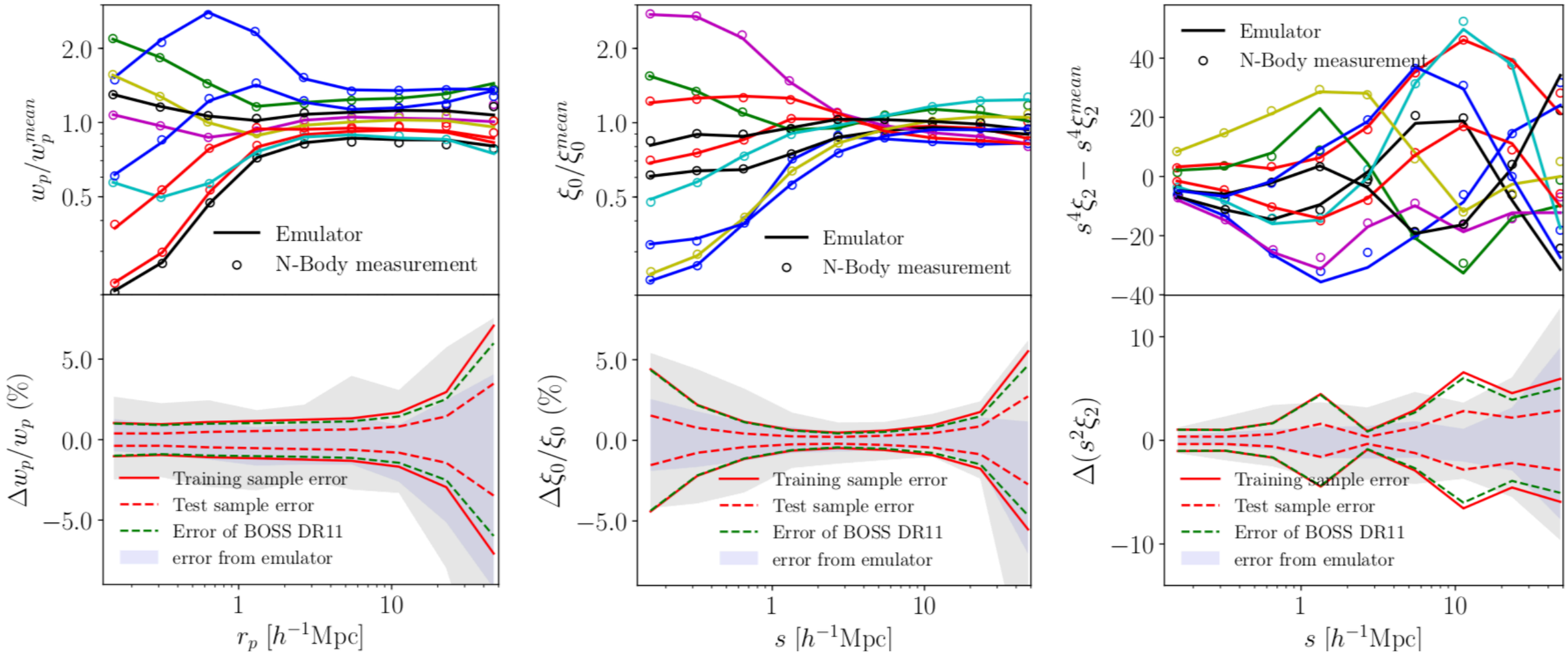
A new degree of freedom

$$\gamma_f = \frac{f}{f_{GR}}$$

GP-based emulator



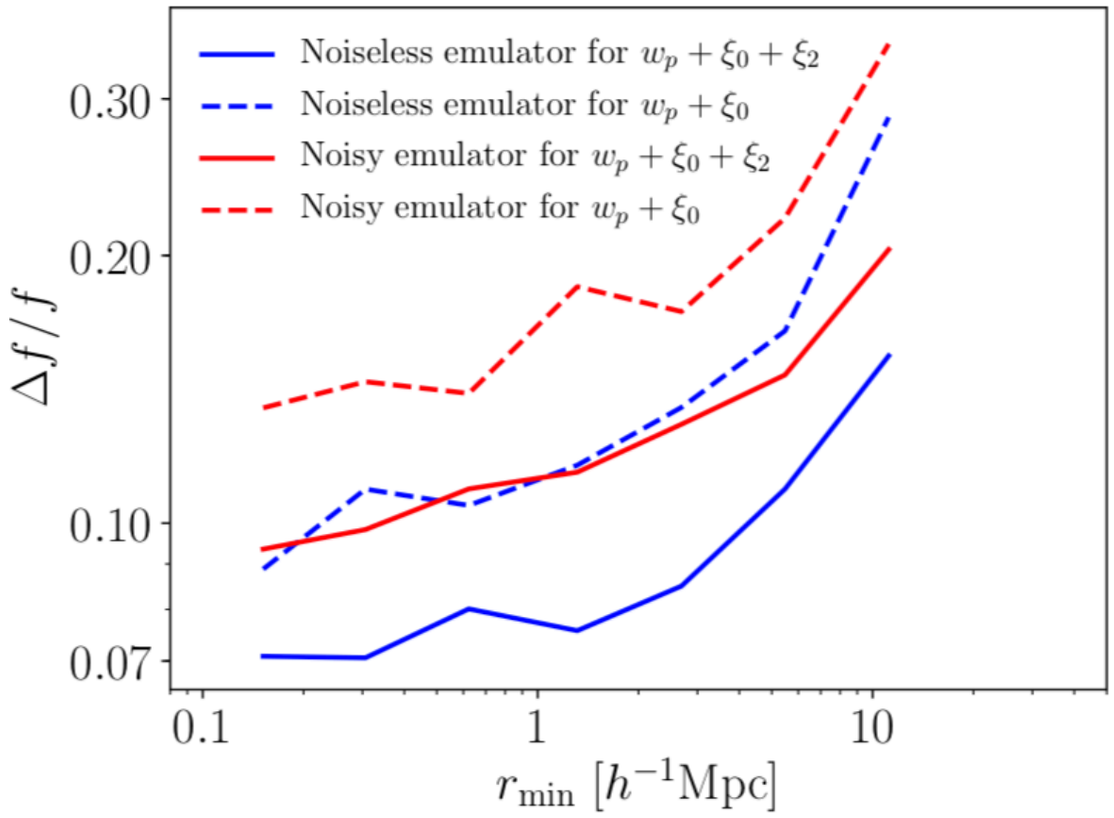
A first attempt

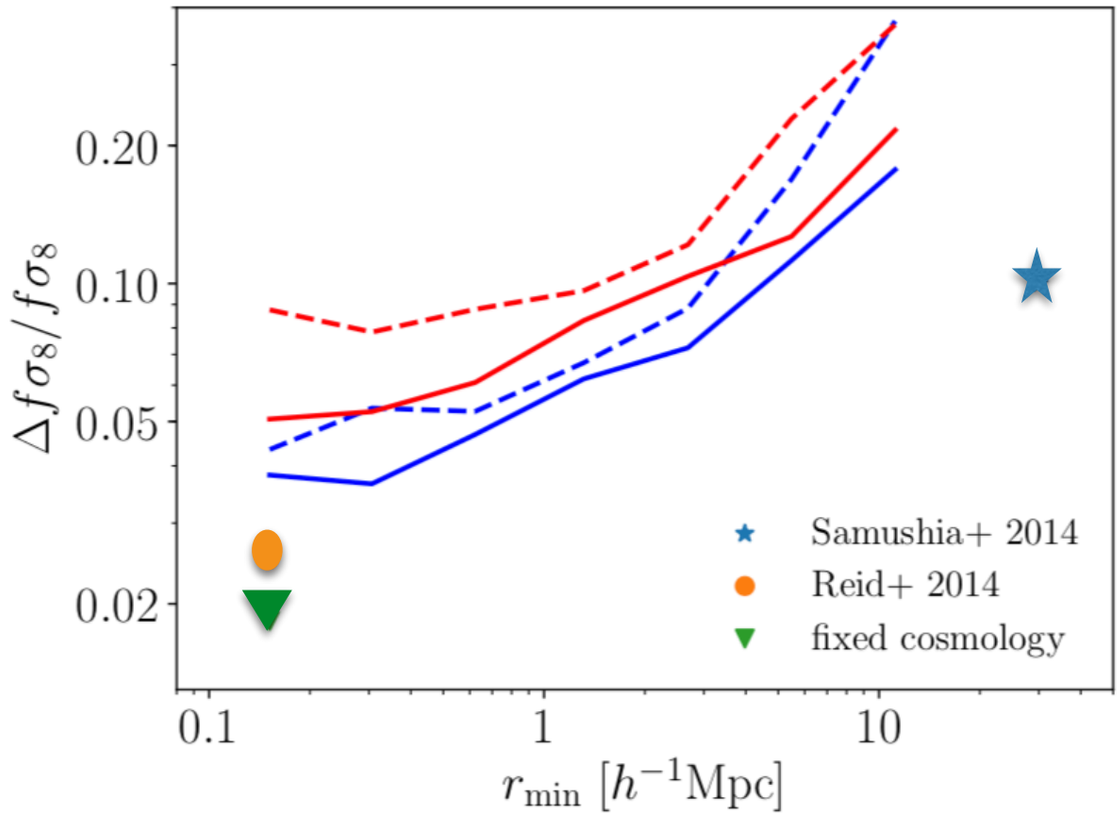


Construct the emulator for real and redshift space correlation function of galaxies at z=0.55, the accuracy is better than sample variance and reaches 1% at 1-10 Mpc/h

Zhai et al, ApJ, 874 (2019) 1, 95

Expected measurement of linear growth

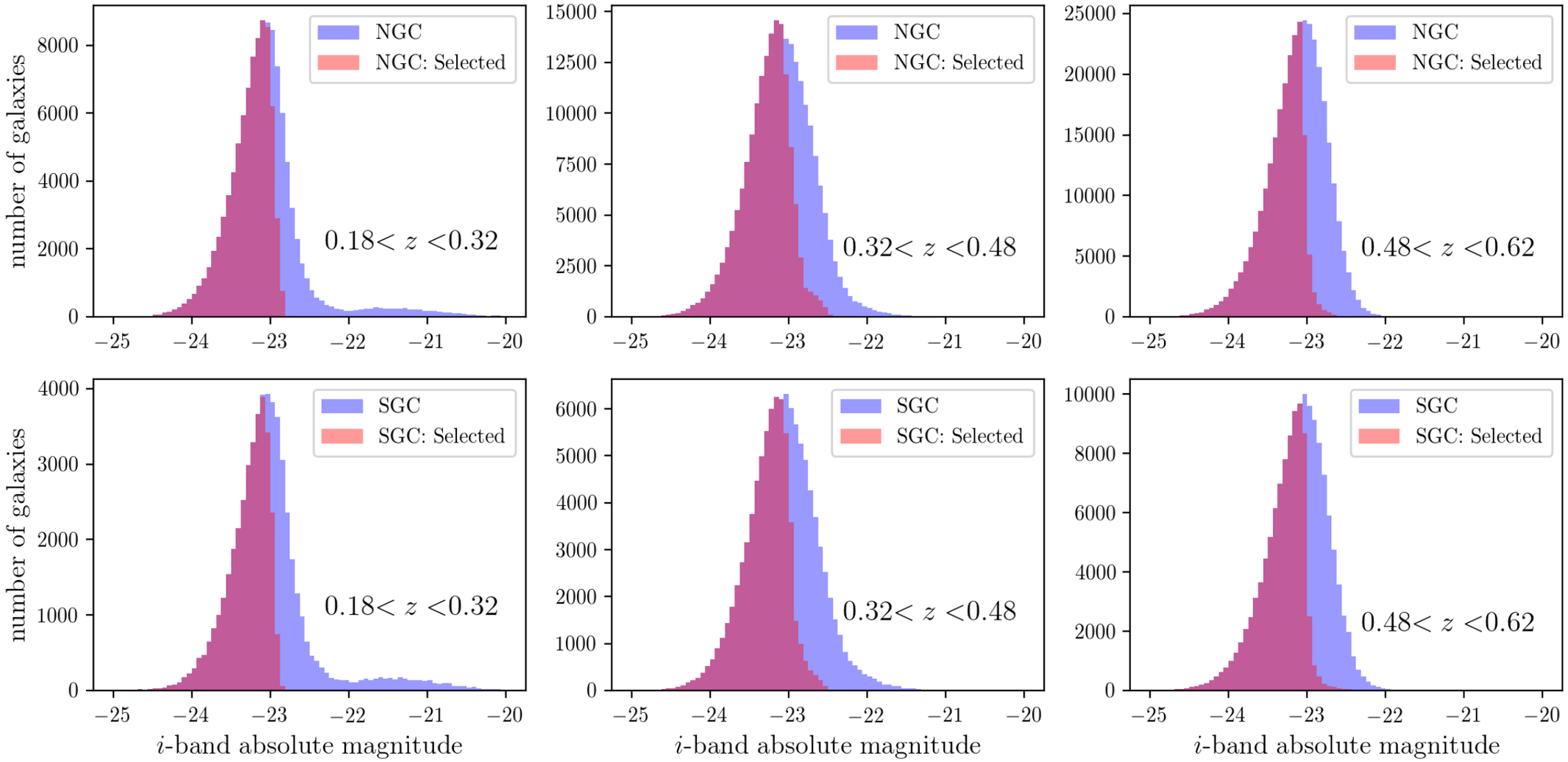




* Non-linear analysis is two times better than large scale analysis
* Constraints tighten monotonically with smaller scales
* Redshift space quadrupole has significant contribution

Zhai et al, ApJ, 874 (2019) 1, 95

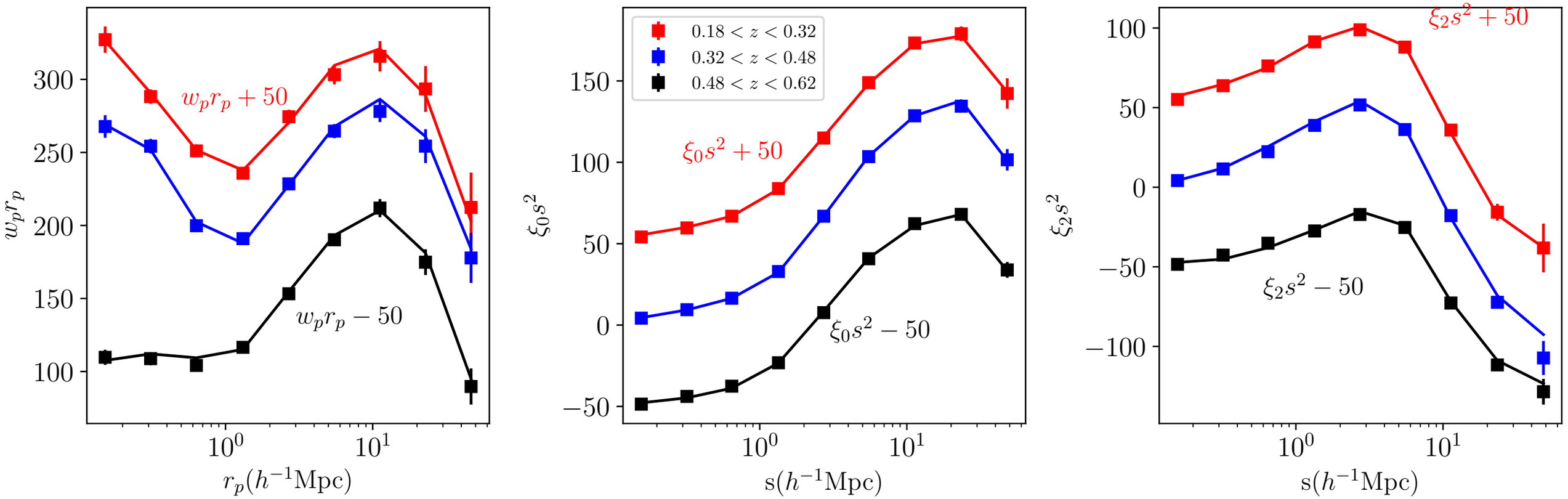
Select the SDSS-BOSS galaxies



Select galaxies based on their brightness -> a semi-complete sample.

Zhai et al, 2022
arXiv: 2203.08999

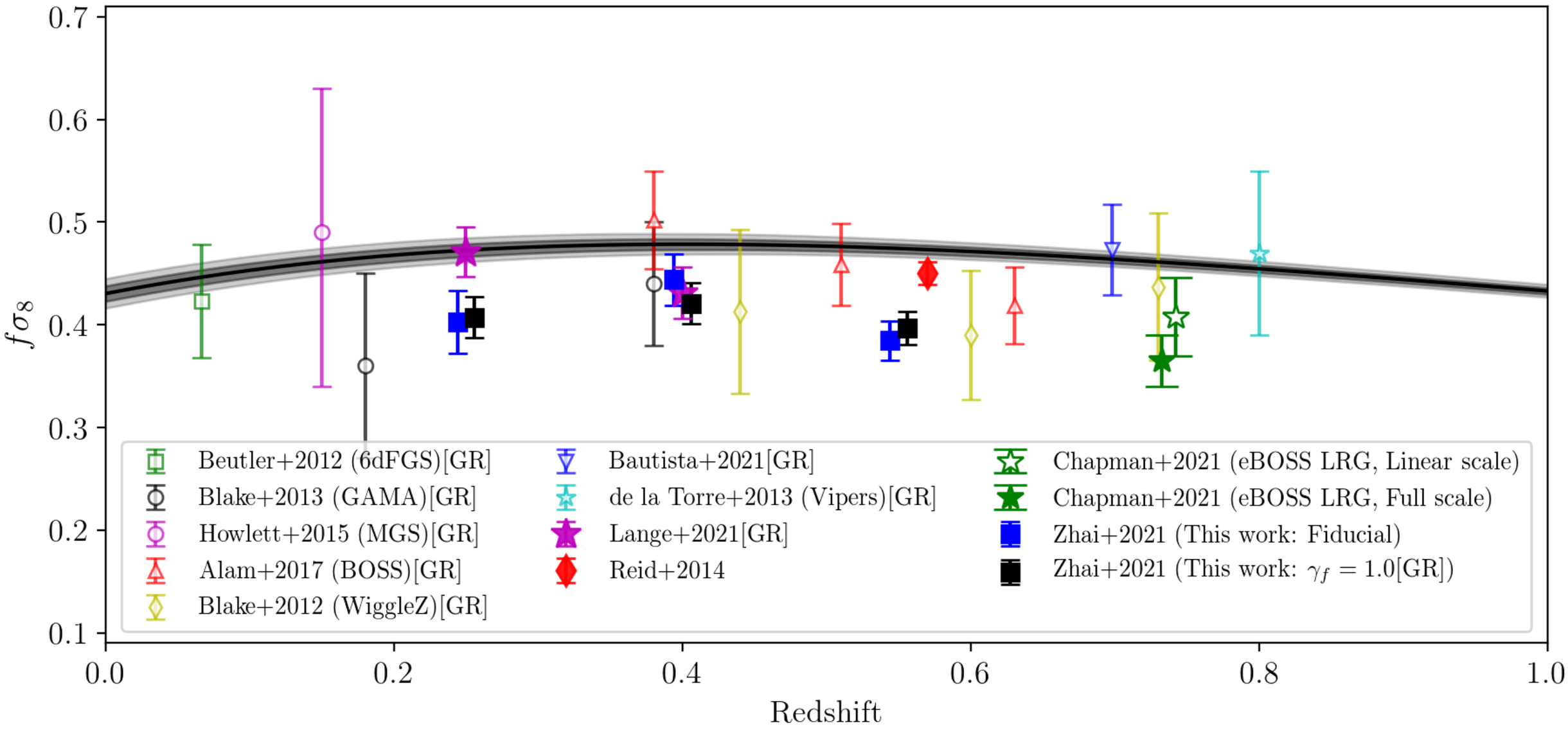
Modeling SDSS-BOSS galaxies



Zhai et al, 2022
arXiv: 2203.08999

All simulations assume GR
Allows deviation from GR
Modeling of galaxies: velocity bias, concentration, assembly bias, etc.
Both real and redshift space clustering can match

Measurement of structure growth



Zhai et al, 2022
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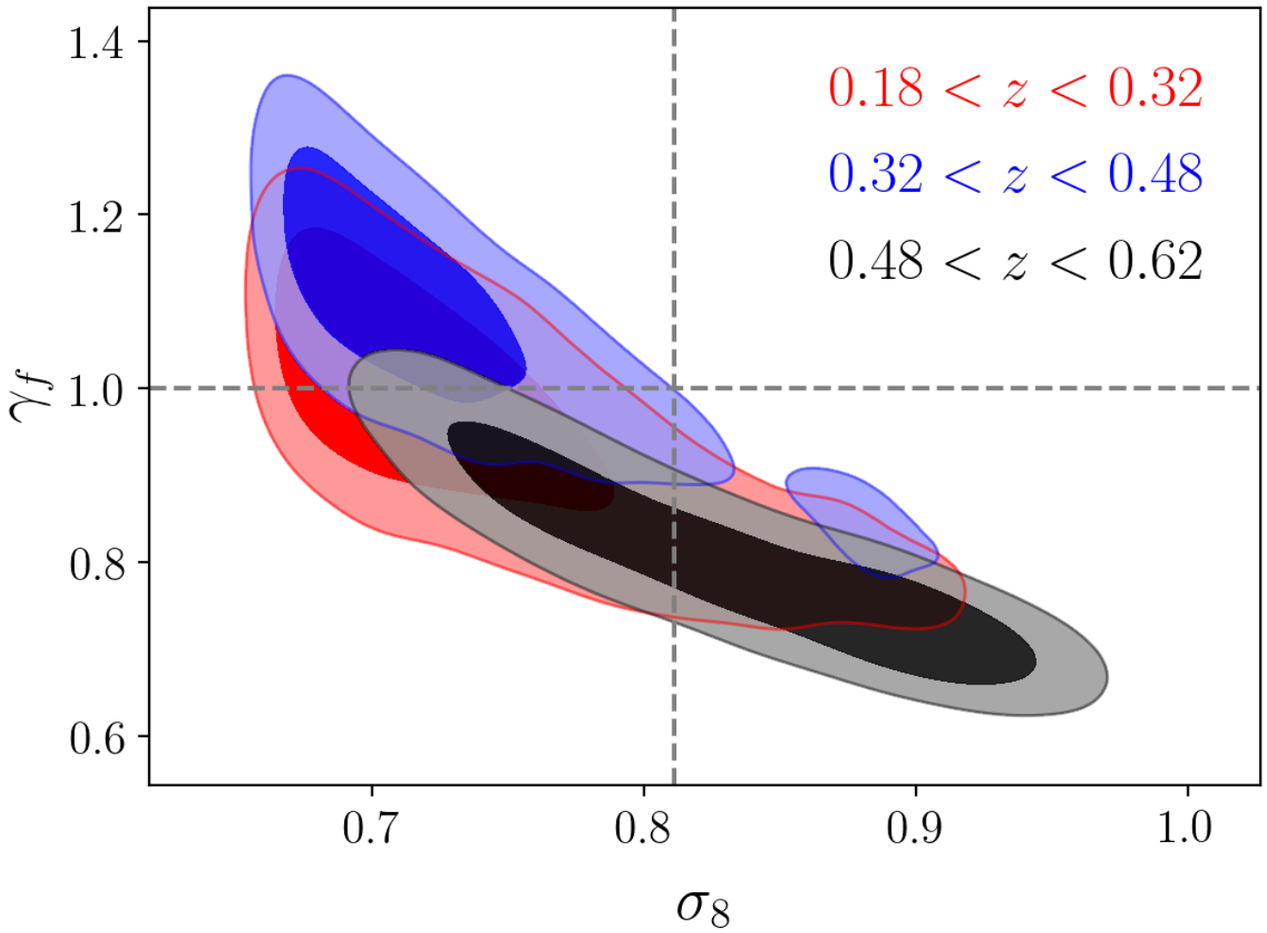
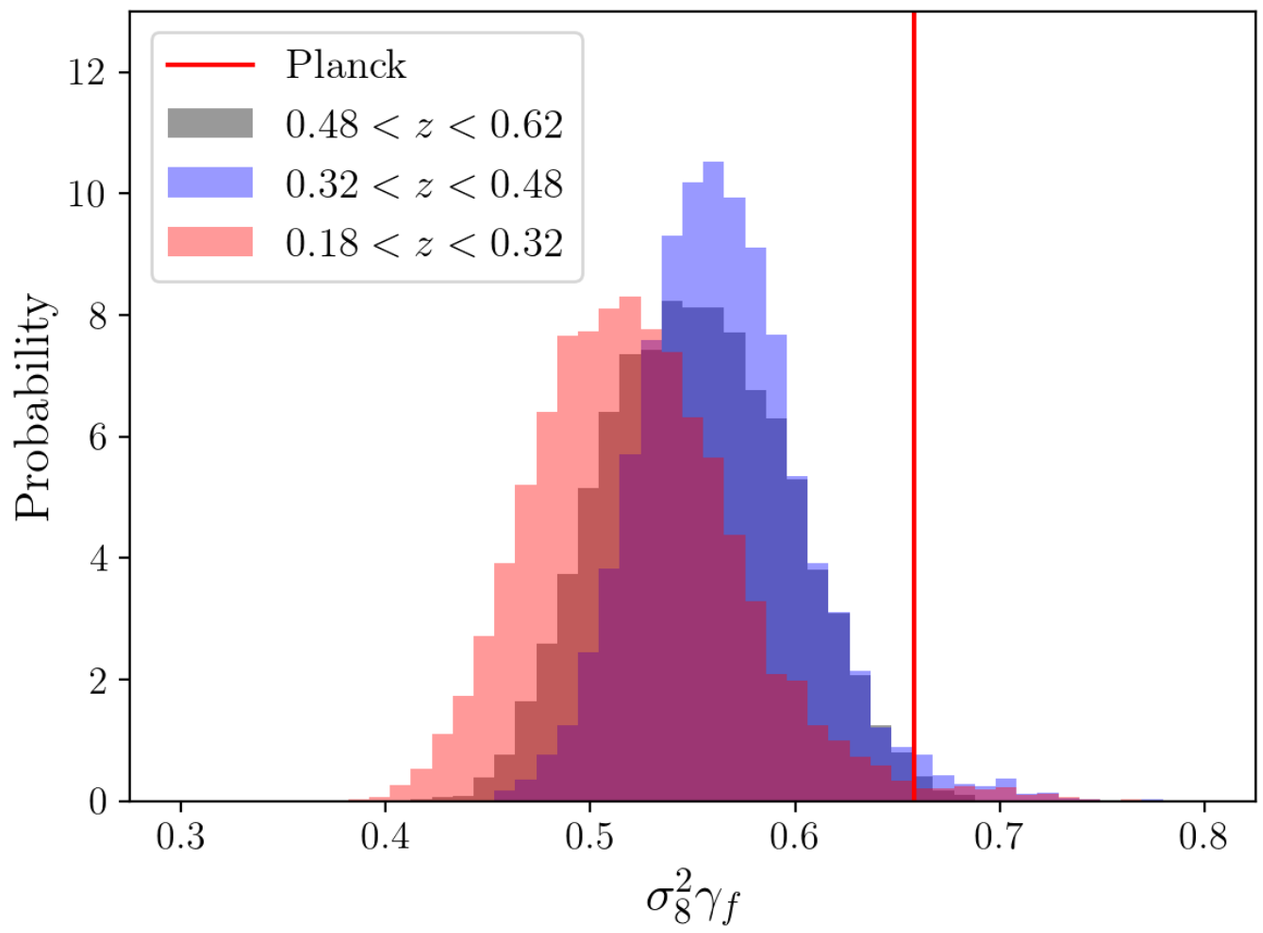
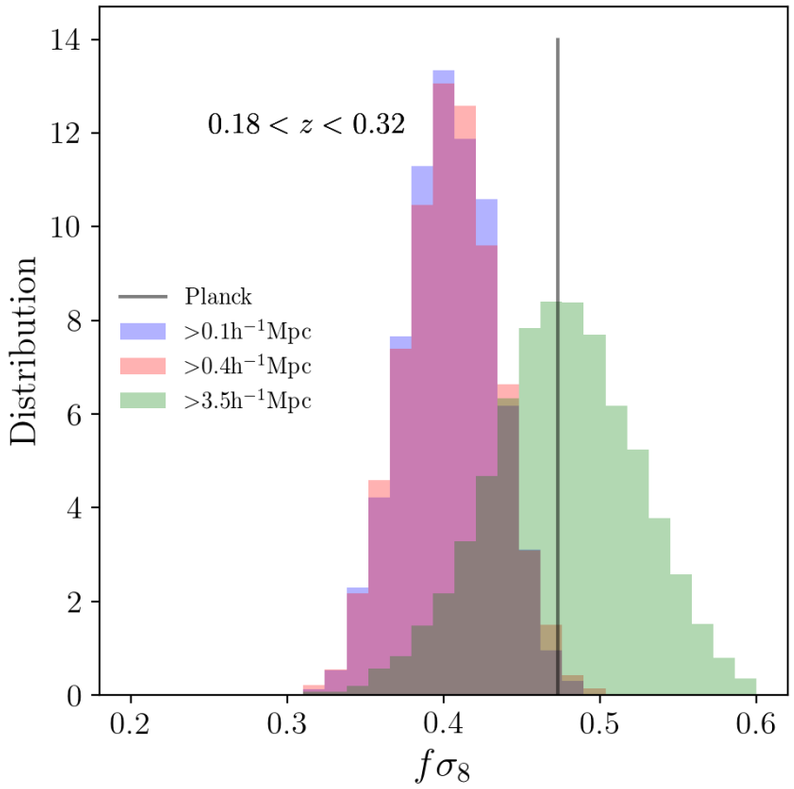
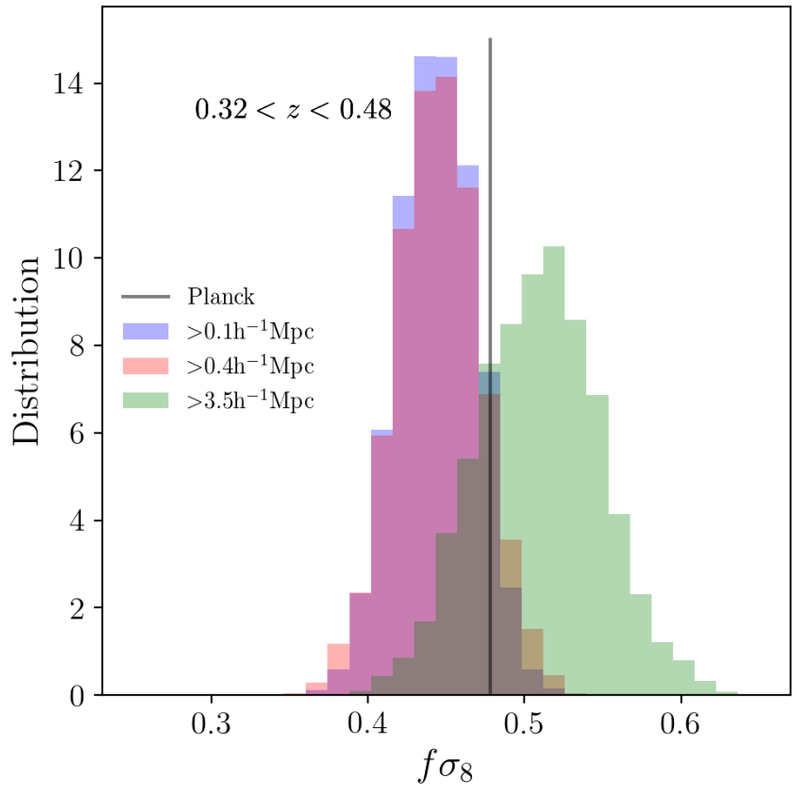
Comparison with Planck

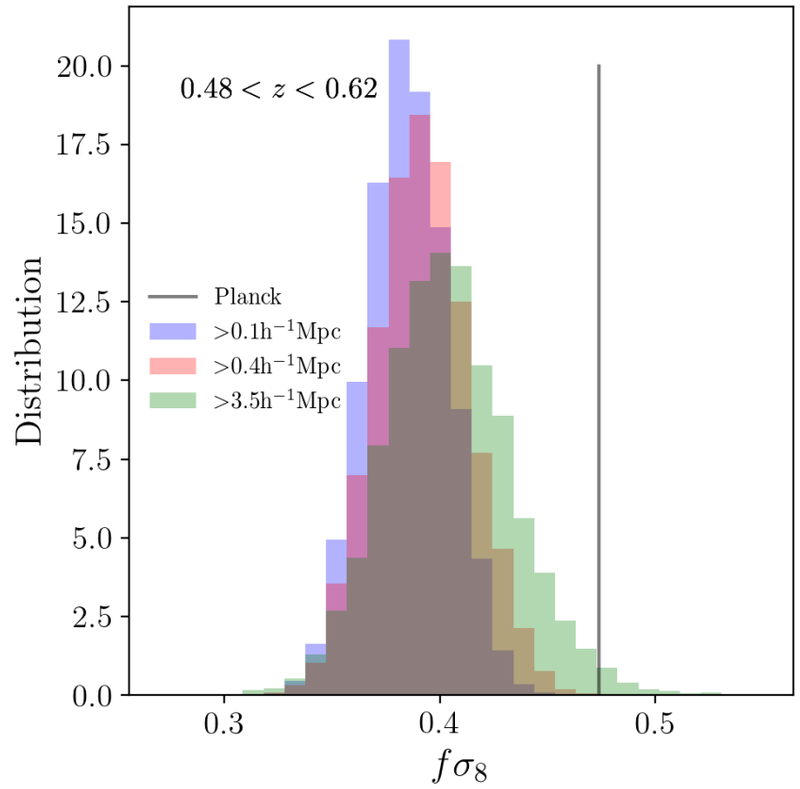




Scale Dependence

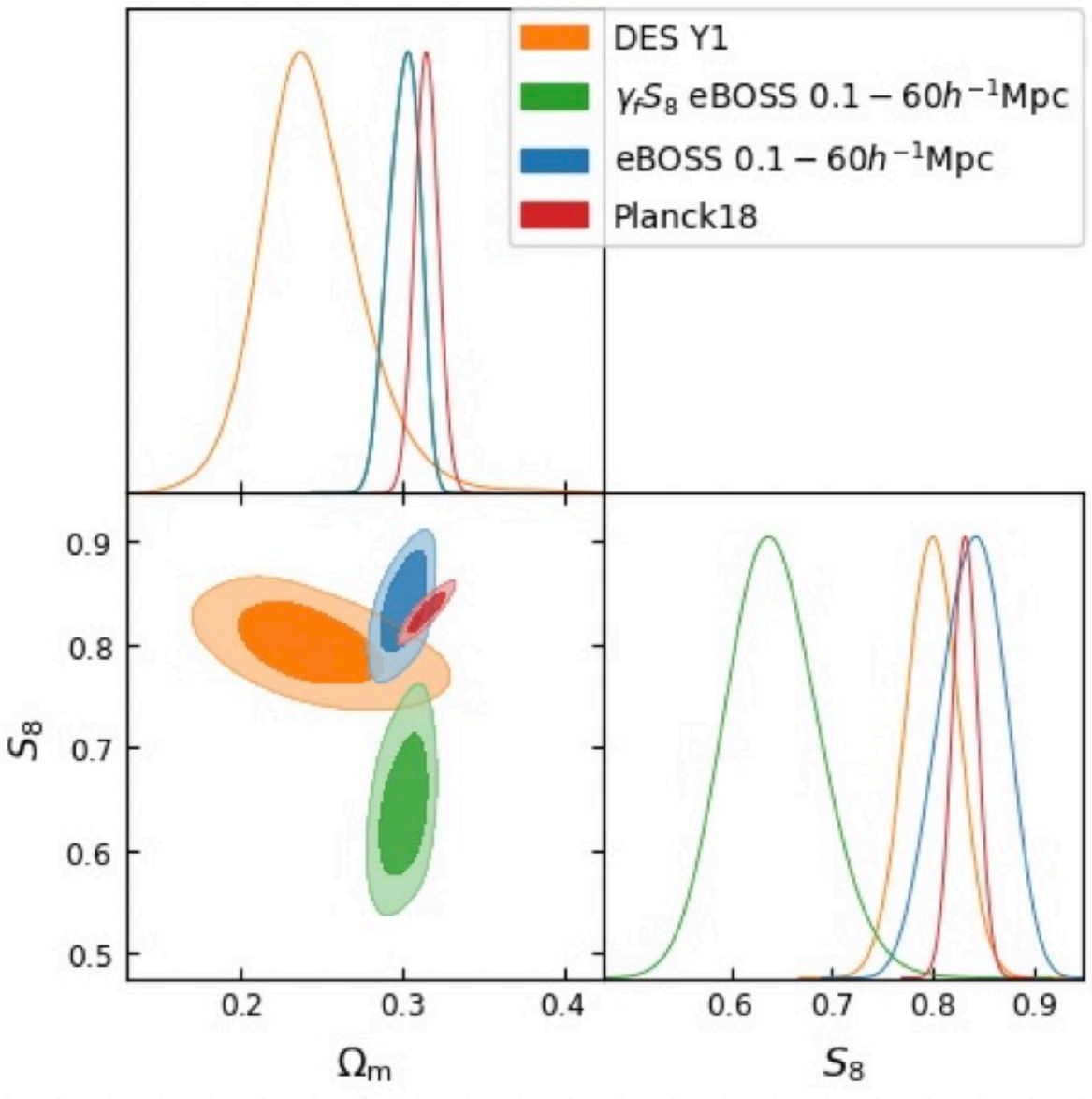


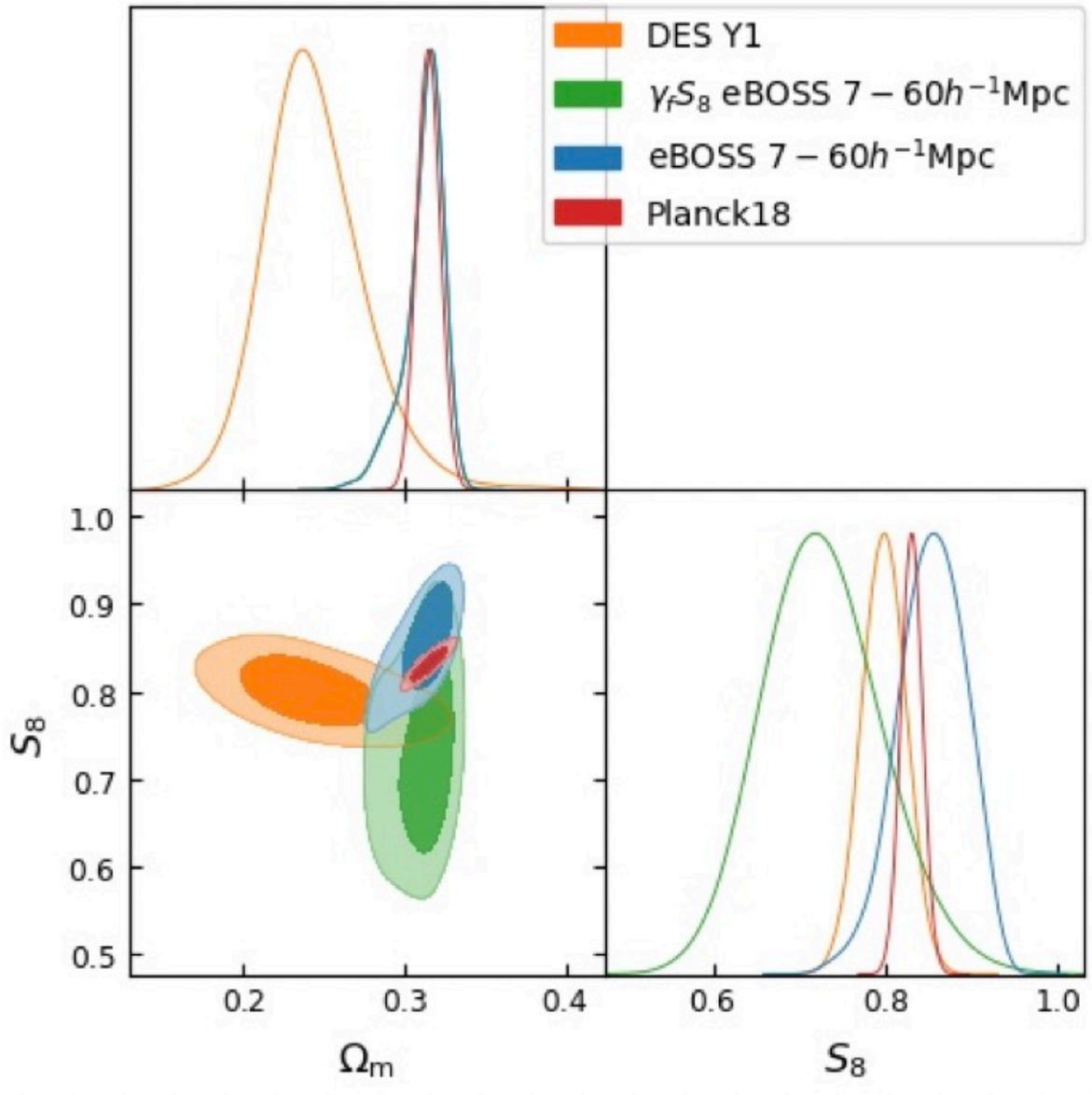




Liner scale is more consistent with Planck
High redshift subsample still has tension
Tension driven by fully non-linear scale

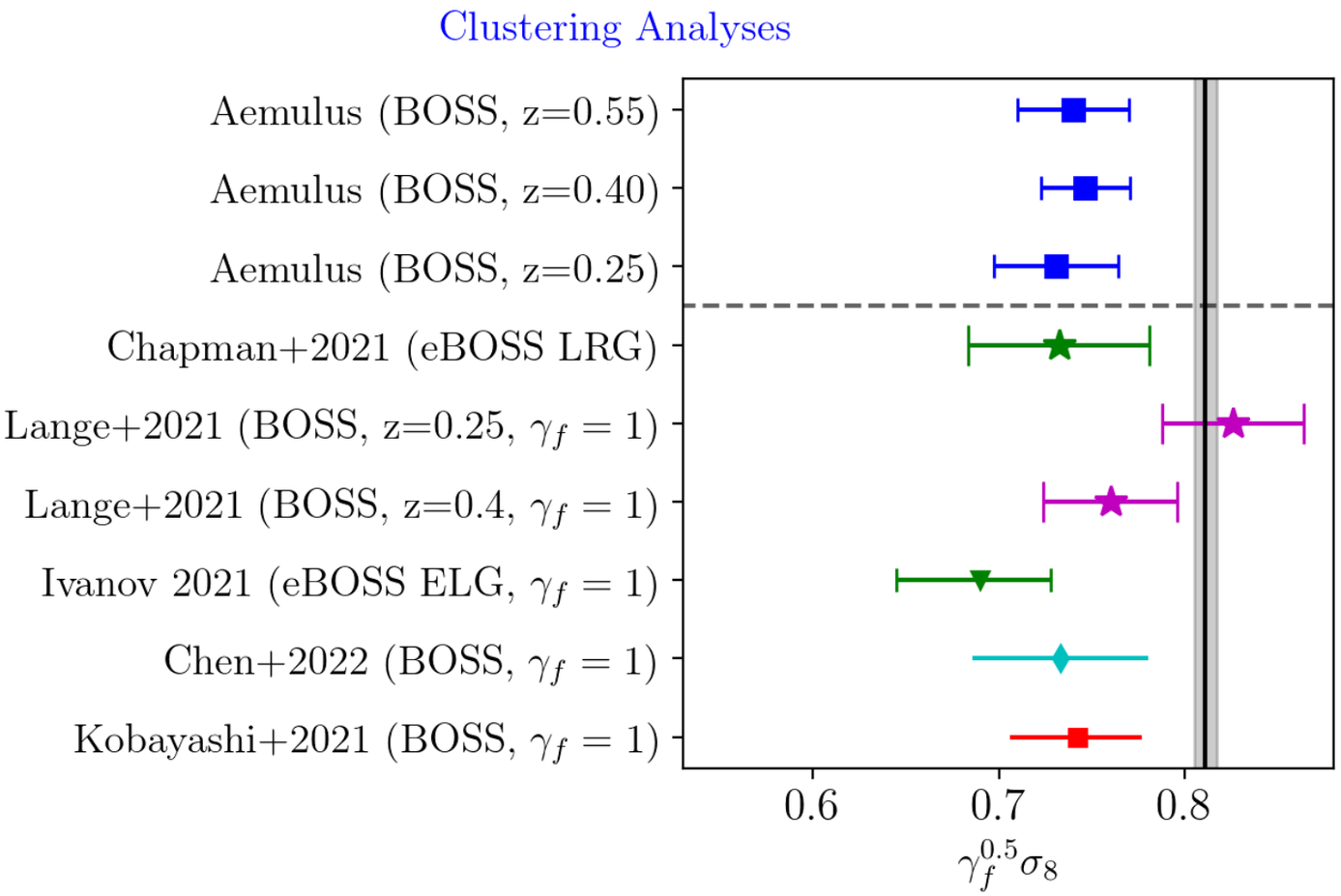
Results from eBOSS LRG

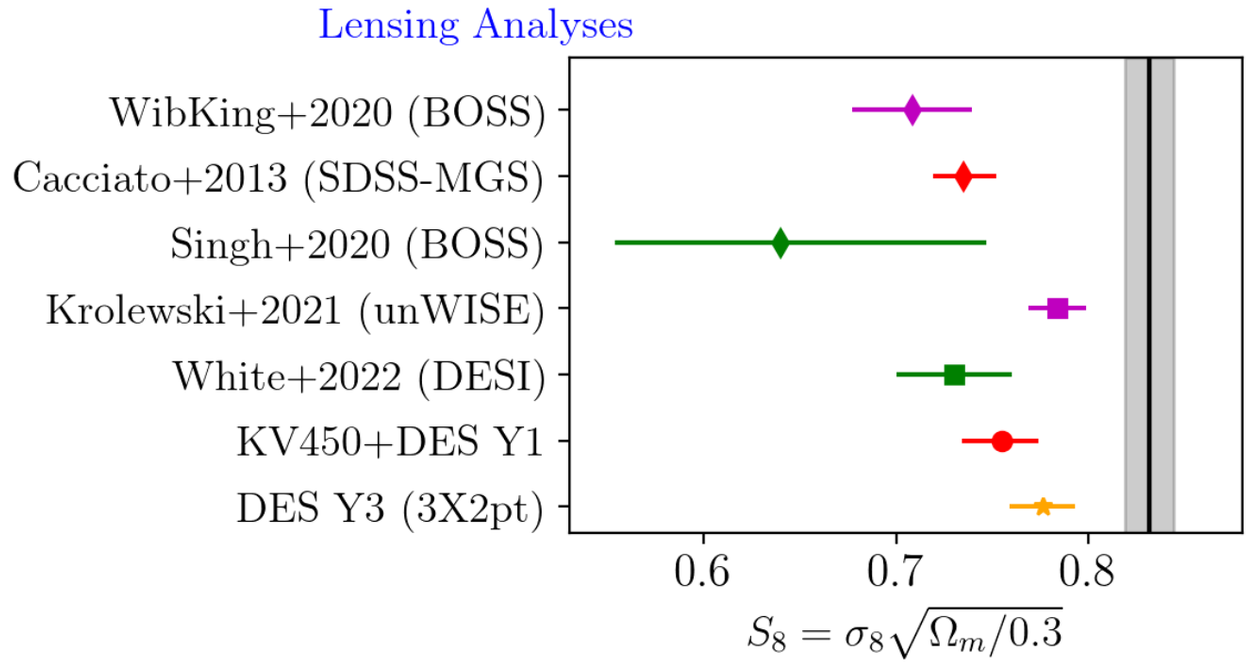




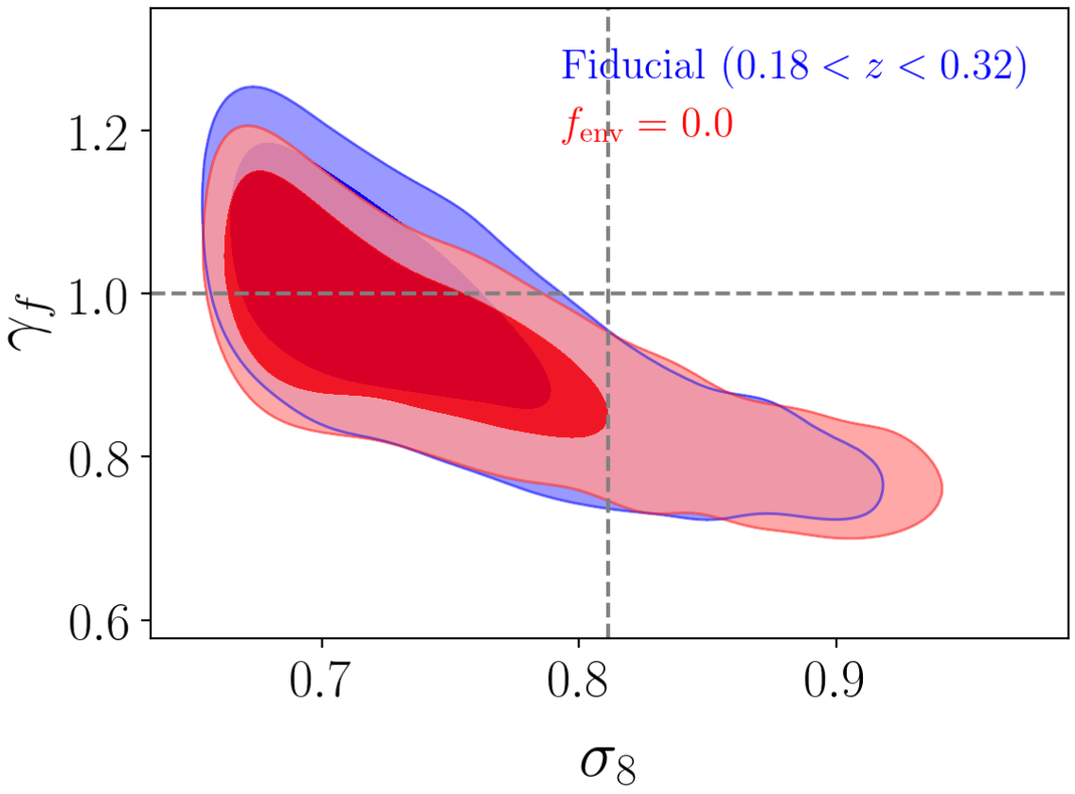
Chapman et al 2021
arXiv: 2106.14961

Comparison with literature

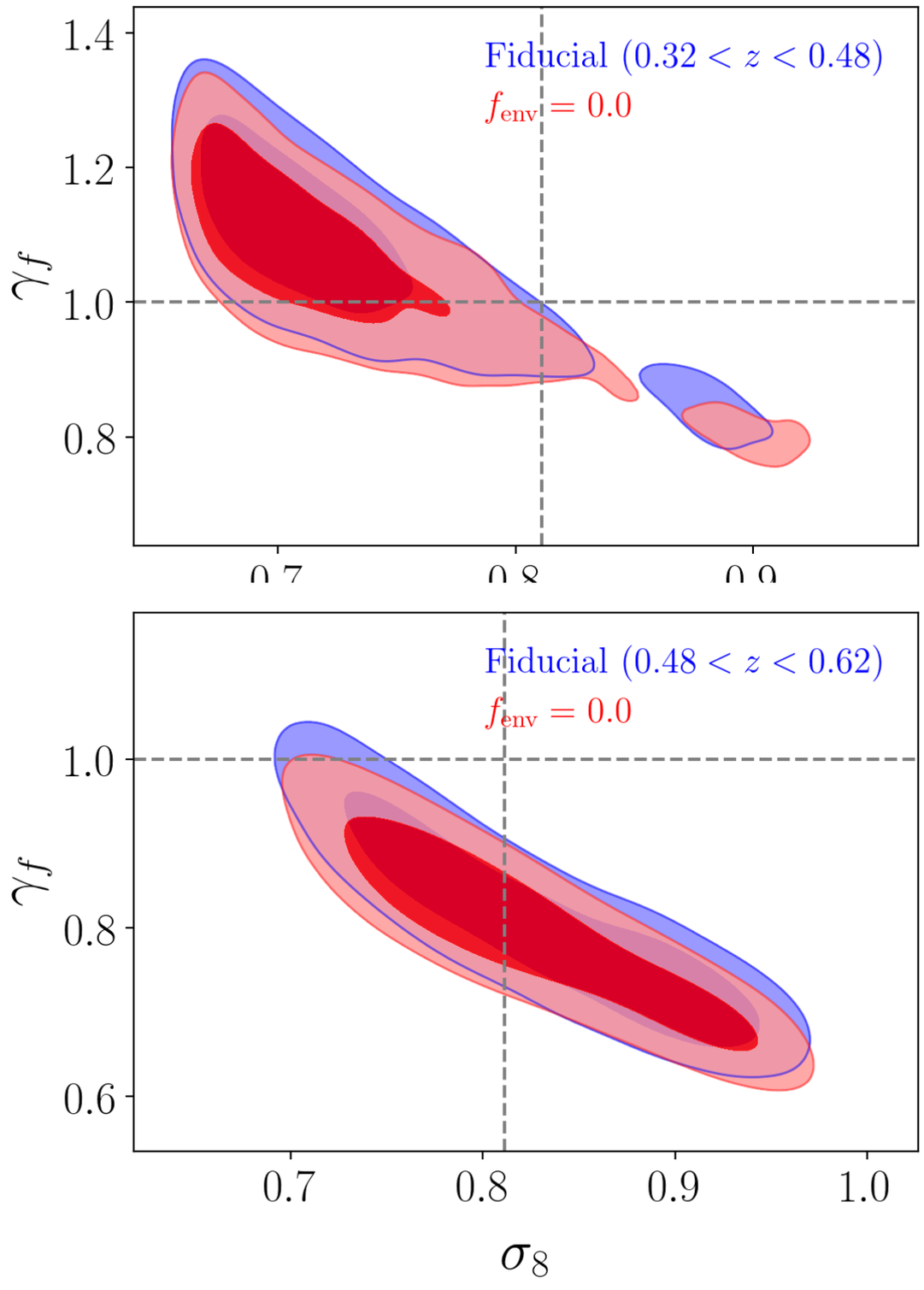




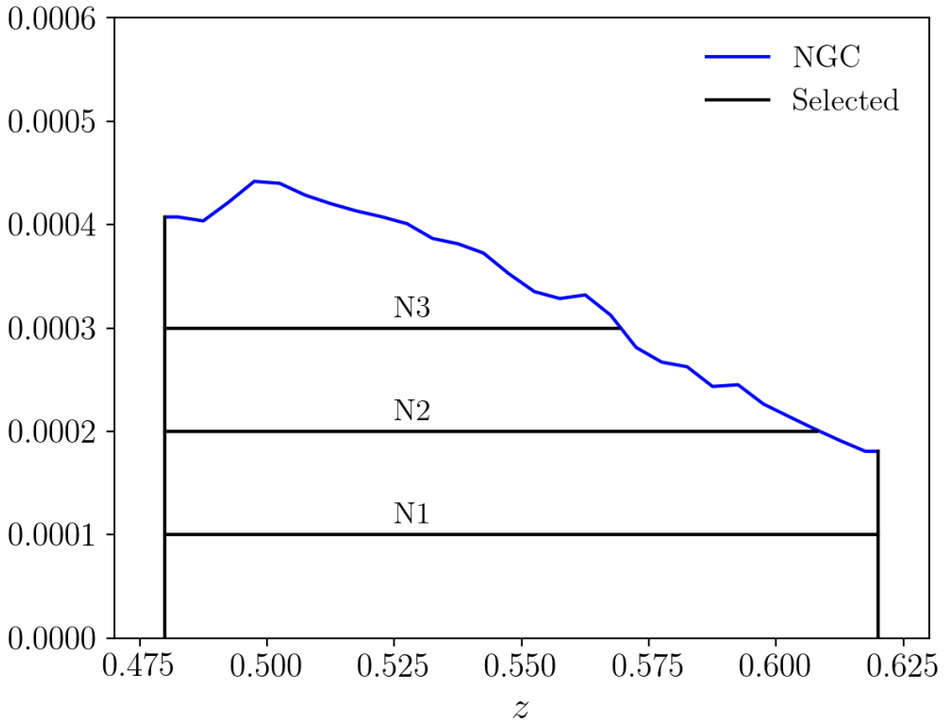
Assembly bias?

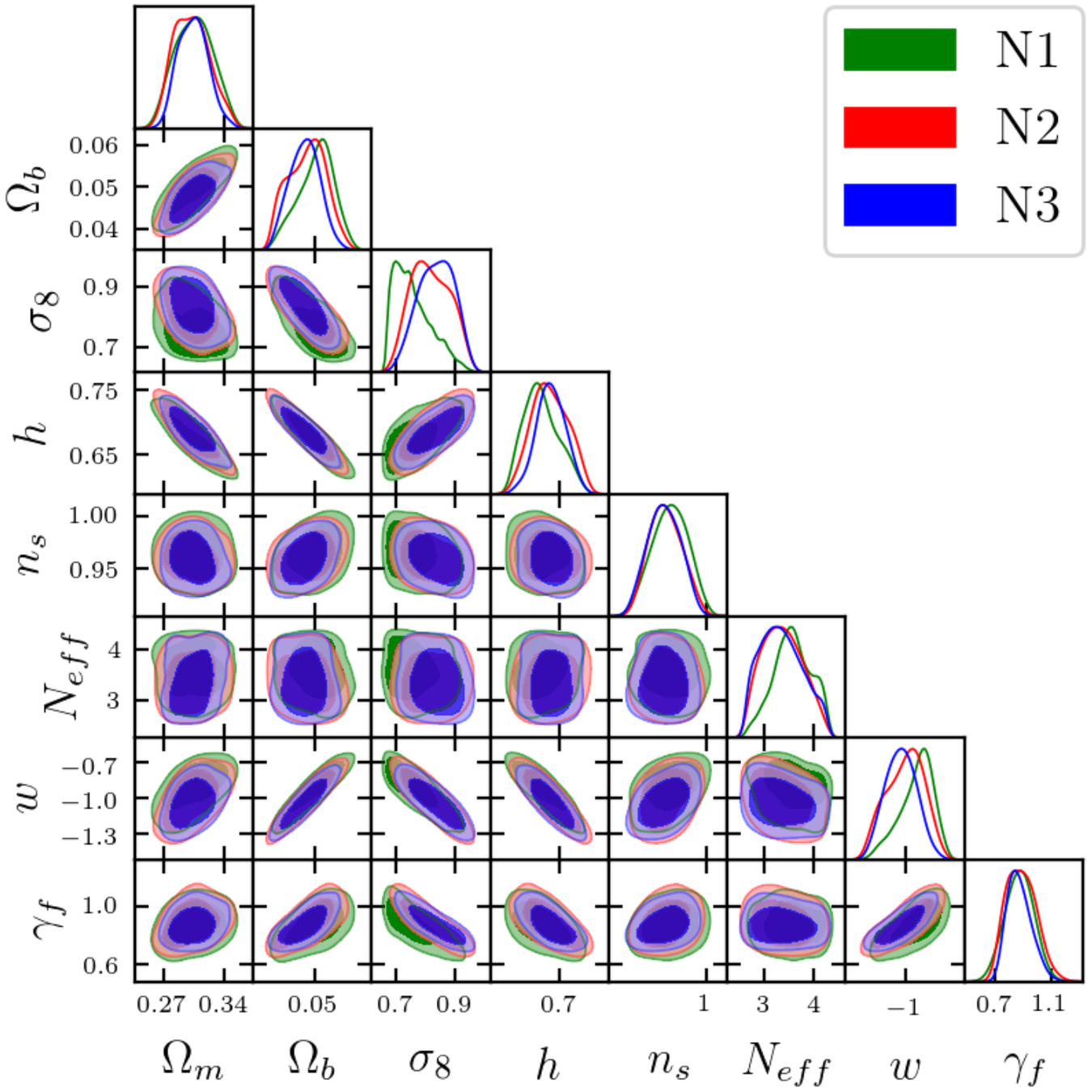


Probably won't bias the cosmological constraint.



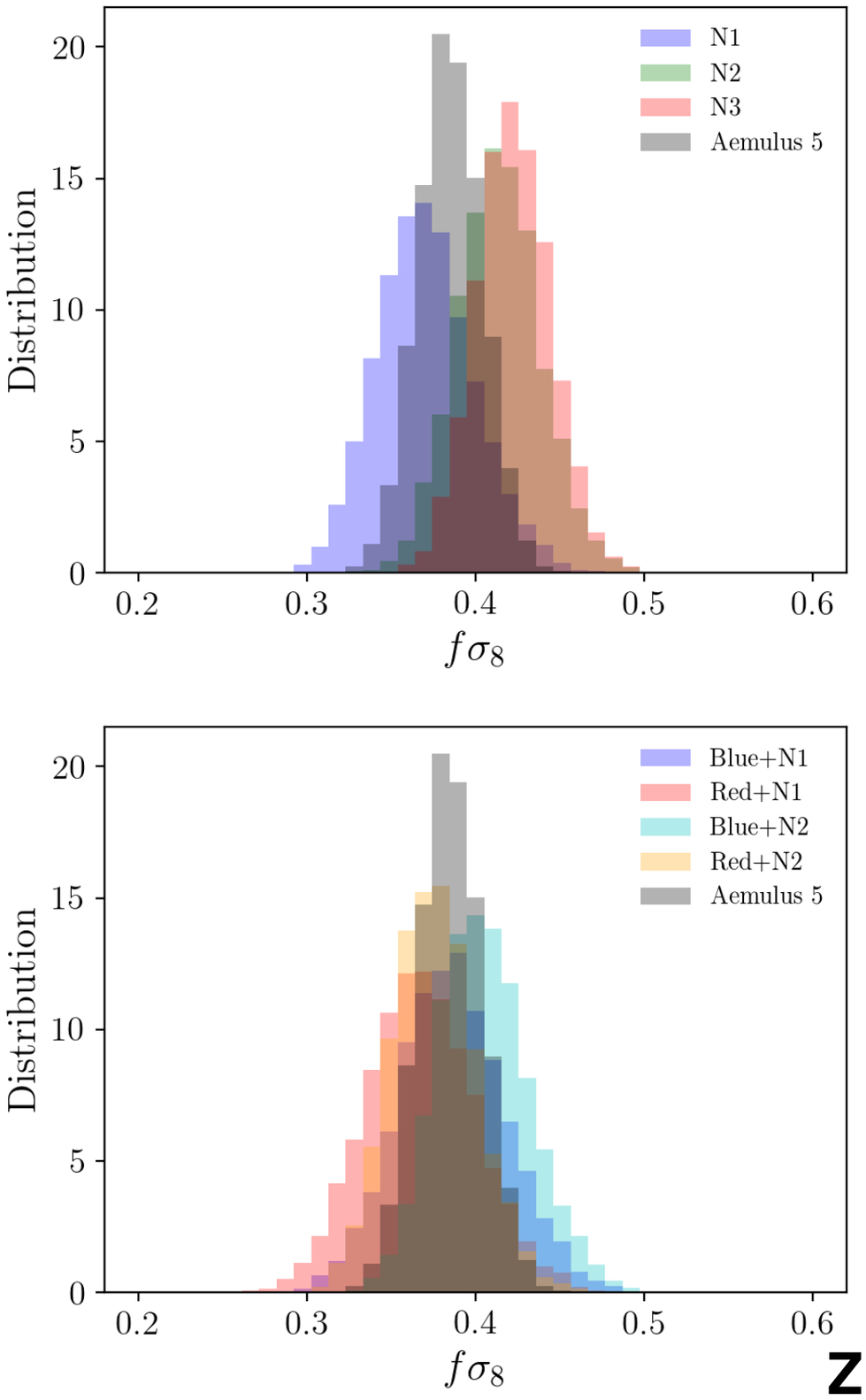
Sample selections

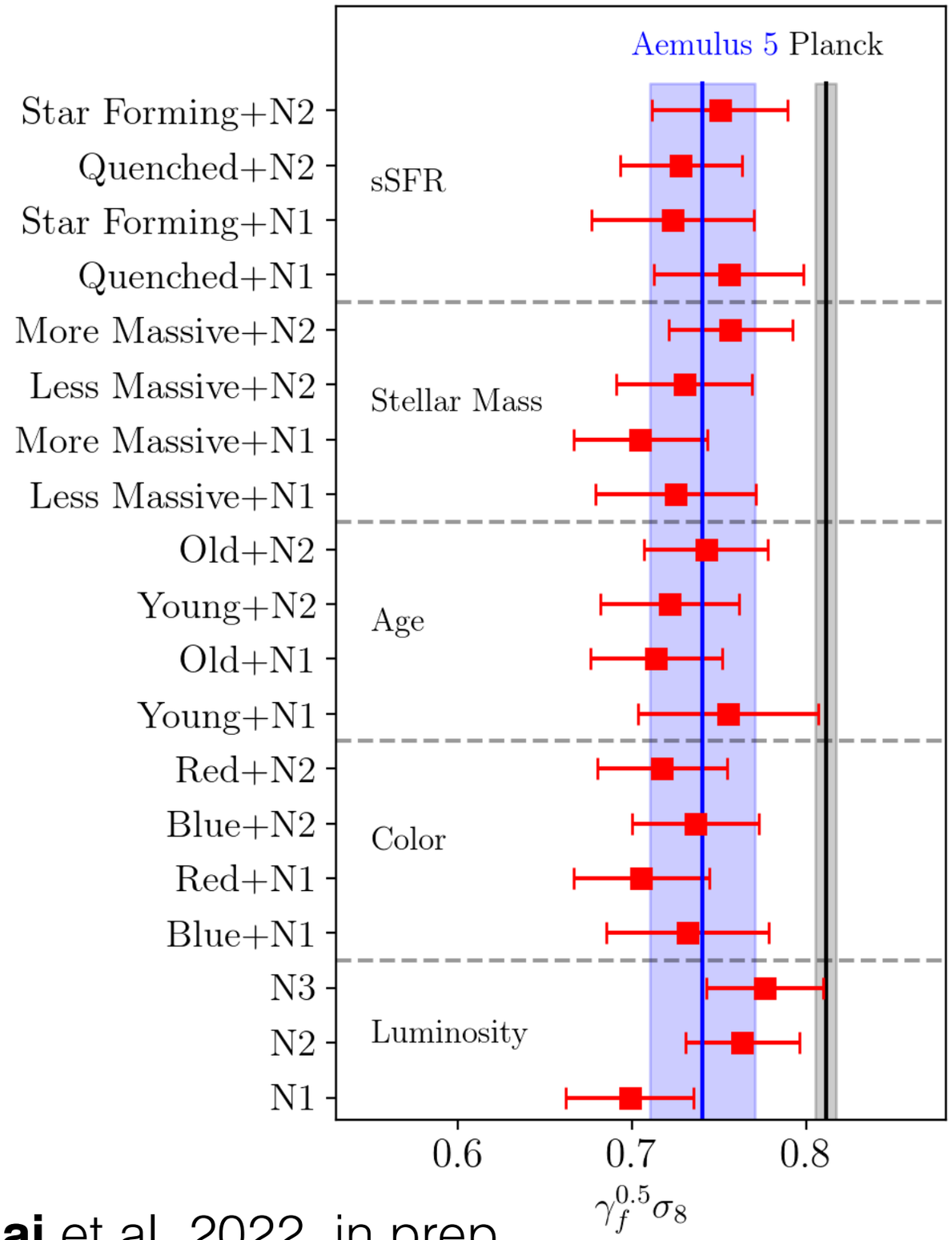




Zhai et al, 2022, in prep

Sample selections





Zhai et al, 2022, in prep

Thanks!