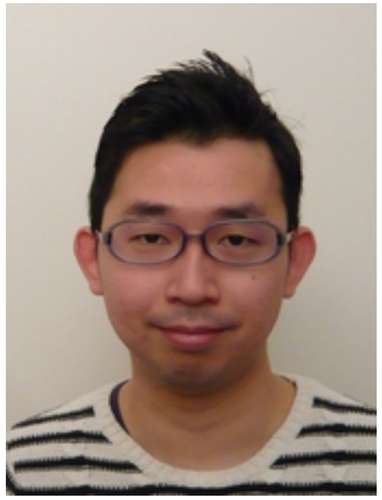
COSMOLOGY CHALLENGE TOWARDS ROBUST MODELING OF GALAXY–GALAXY LENSING AND CLUSTERING SIGNALS

HIRONAO MIYATAKE (NAGOYA UNIV./KAVLI IPMU)
ON BEHALF OF HSC SSP COLLABORATION

OUR TEAM

Nishimichi+ (2018)

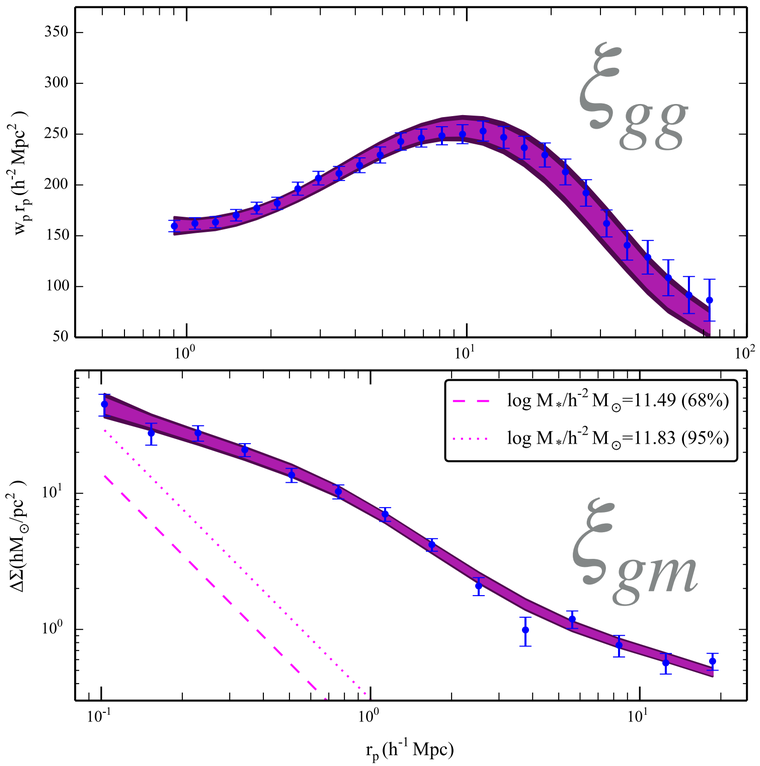


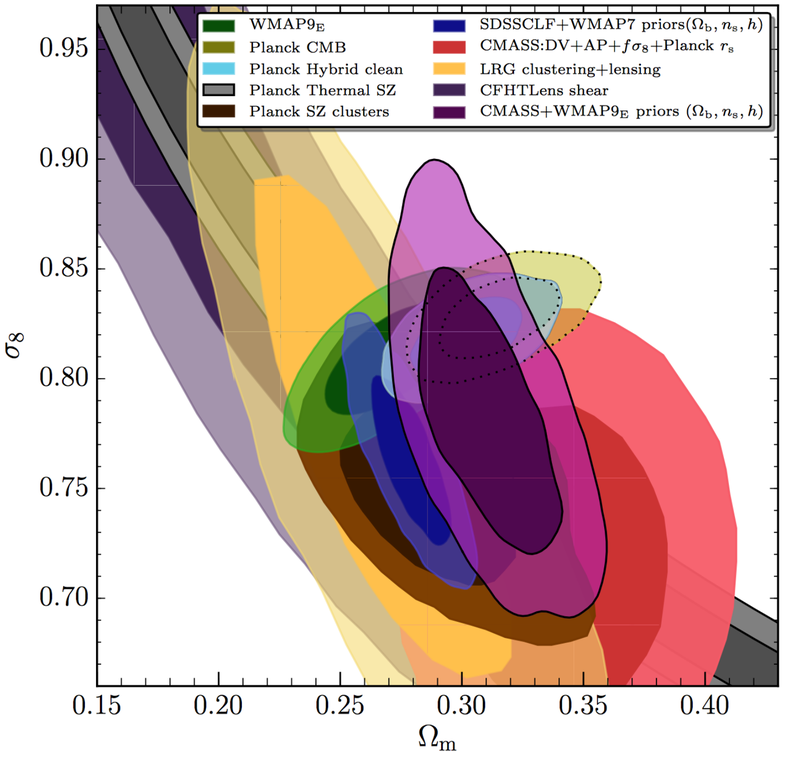
Takahashi+ (2017)

COSMOLOGICAL CONSTRAINTS FROM GALAXY-GALAXY LENSING AND CLUSTERING

- Infer underlying ξ_{mm} from the lensing and clustering signal.
- Pros: less prone to observational systematics such as additive shear bias and photo-z bias (Oguri & Takada 2012).
- Cons: Difficulties in robust modeling of the signals (e.g., Krause+ 2017).
  - Scale cuts, HOD, baryonic effects, non-linear galaxy bias, assembly bias, etc…

BOSS x CFHTLenS



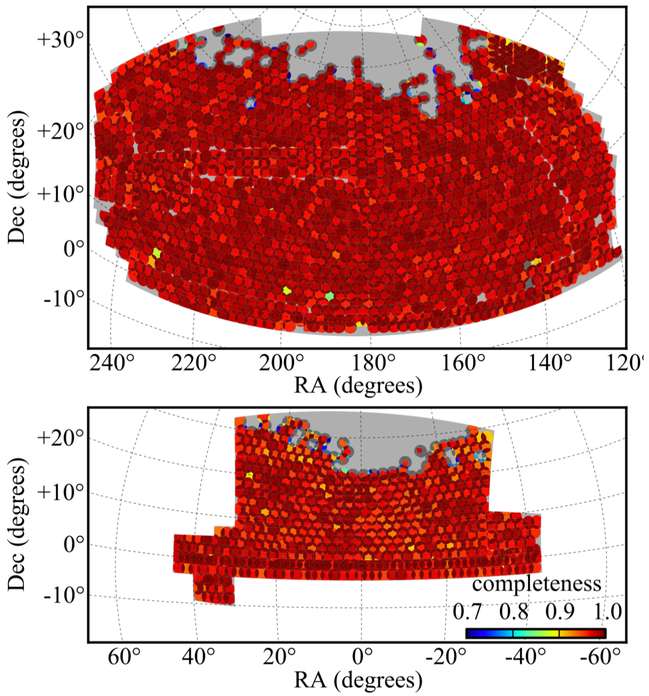


More, HM+ (2015)

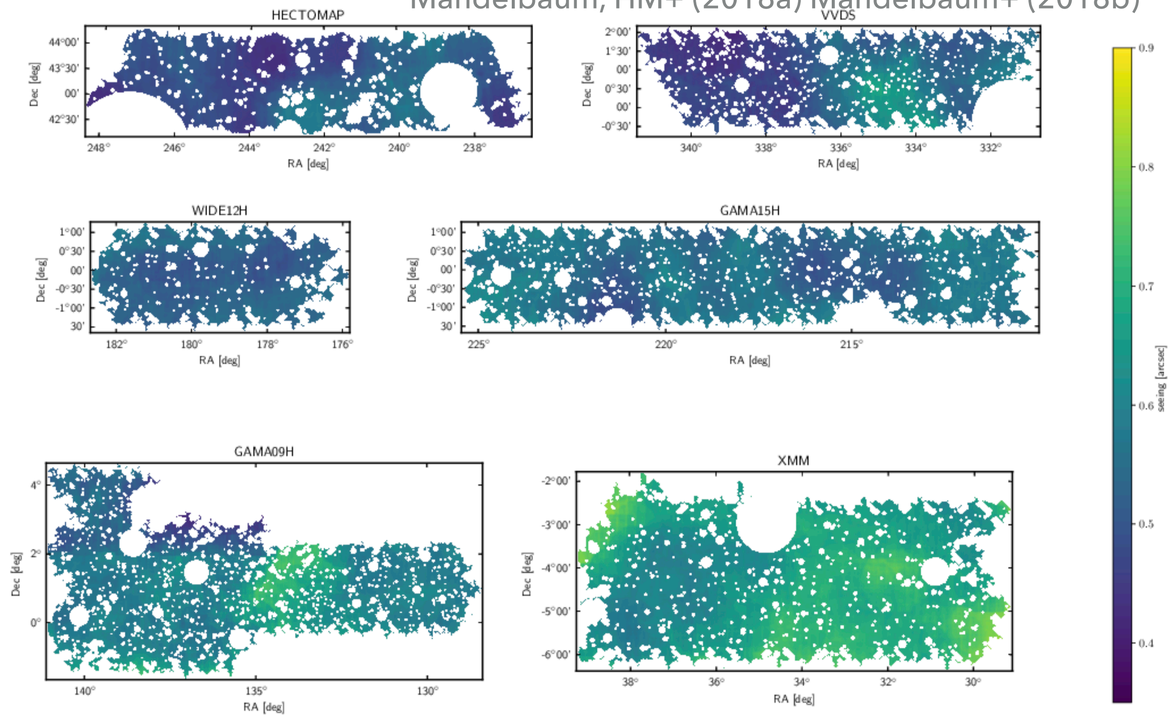
See also Cacciato+ (2013), Mandelbaum+ (2013), DES collaboration (2017), van Uitert + (2018)

BOSS FOR LENS GALAXIES, HSC FOR SOURCE GALAXIES

DR11 Alam+ (2015)



Mandelbaum, HM+ (2018a) Mandelbaum+ (2018b)



SDSS-III/BOSS DR11 spec-z sample

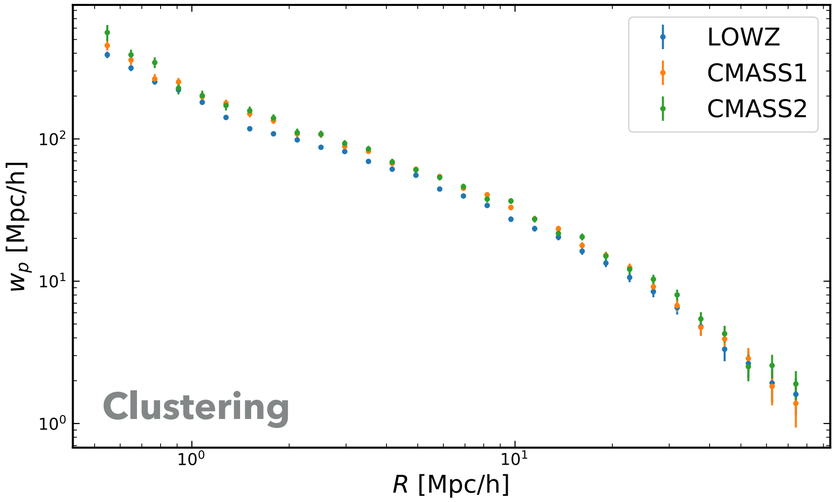
- ~8300 deg^2
- 3 redshift bins: z = [0.15, 0.35], [0.47, 0.55], [0.55, 0.70]

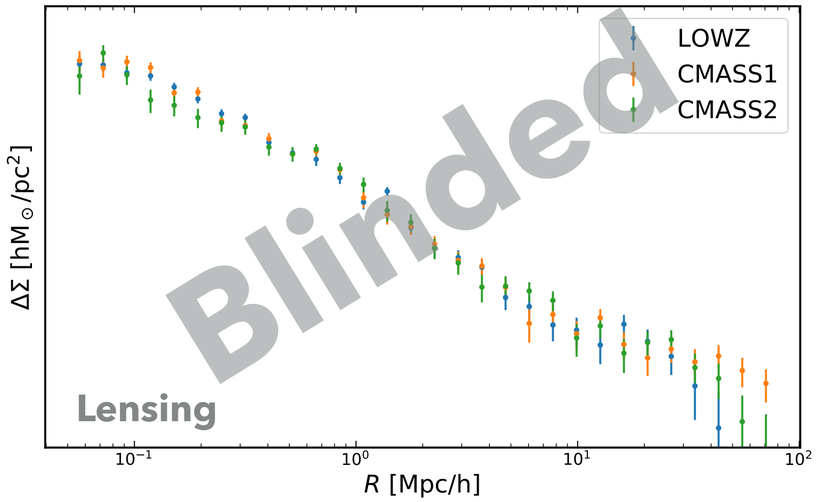
Clustering **Lensing**

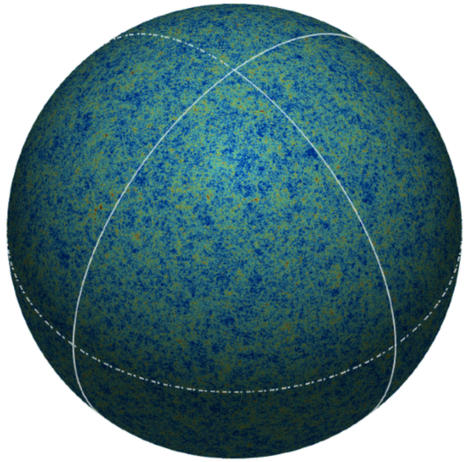
HSC first-year shape catalog

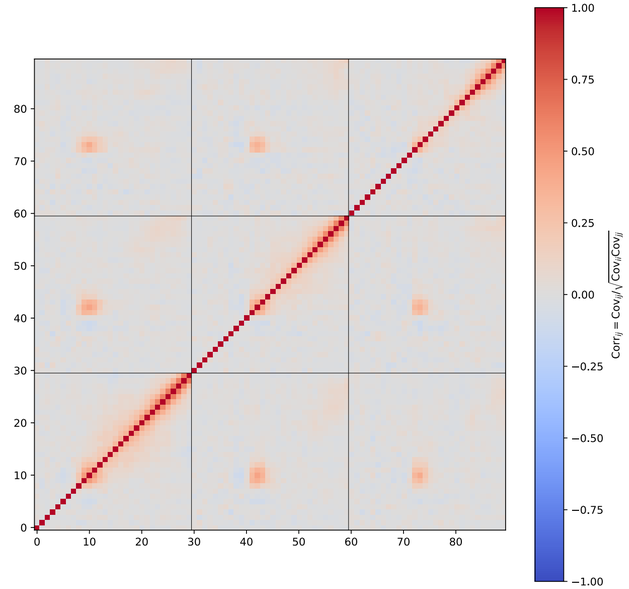
- 6 fields, in total 137 deg^2 (out of planned 1400deg^2)
- <z>~1.0, seeing=0.58", n_g~23gal/amin^2
- Use a single source population (z > 0.75) to self-calibrate photo-z bias (Oguri & Takada 2012).
- Multiplicative bias is blinded to avoid confirmation bias

CLUSTERING AND LENSING MEASUREMENTS AND COVARIANCE









Covariance is computed from all-sky ray-tracing simulations.
(Takahashi+ 2017, Shirasaki+ in prep.)

- 108 realizations x 21 HSC first year fields.
- Naturally take into account survey geometry effects.

MODELING GALAXY-GALAXY LENSING AND CLUSTERING SIGNAL

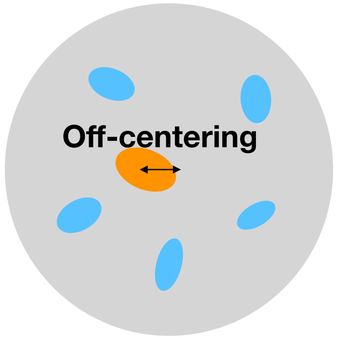
Dark Emulator

$dn/dz(M_h, z; \theta)$
$\xi_{hm}(r; M_h, z; \theta)$
$\xi_{hh}(r; M_h, z; \theta)$

θ: cosmology

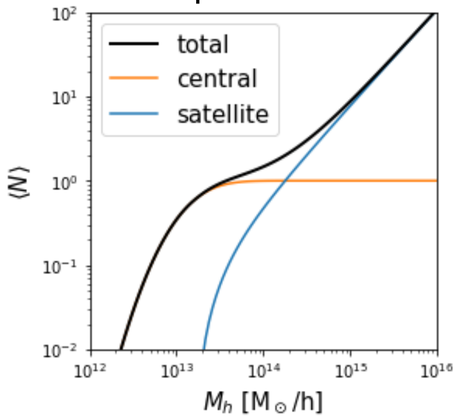
⊗

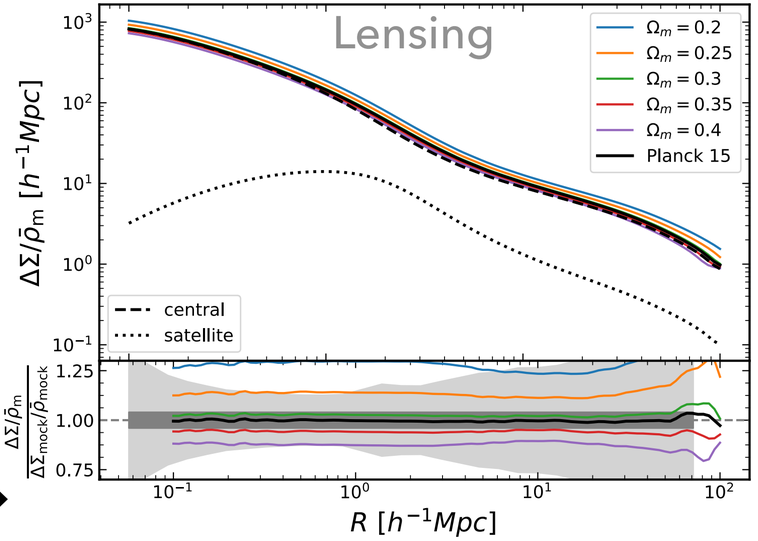
"Galaxy" parameters

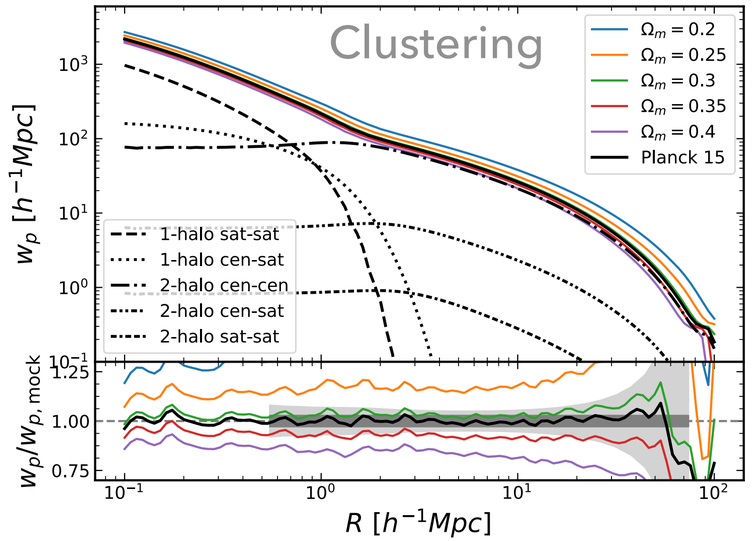


Satellite Distribution
Incompleteness

Halo Occupation Distribution







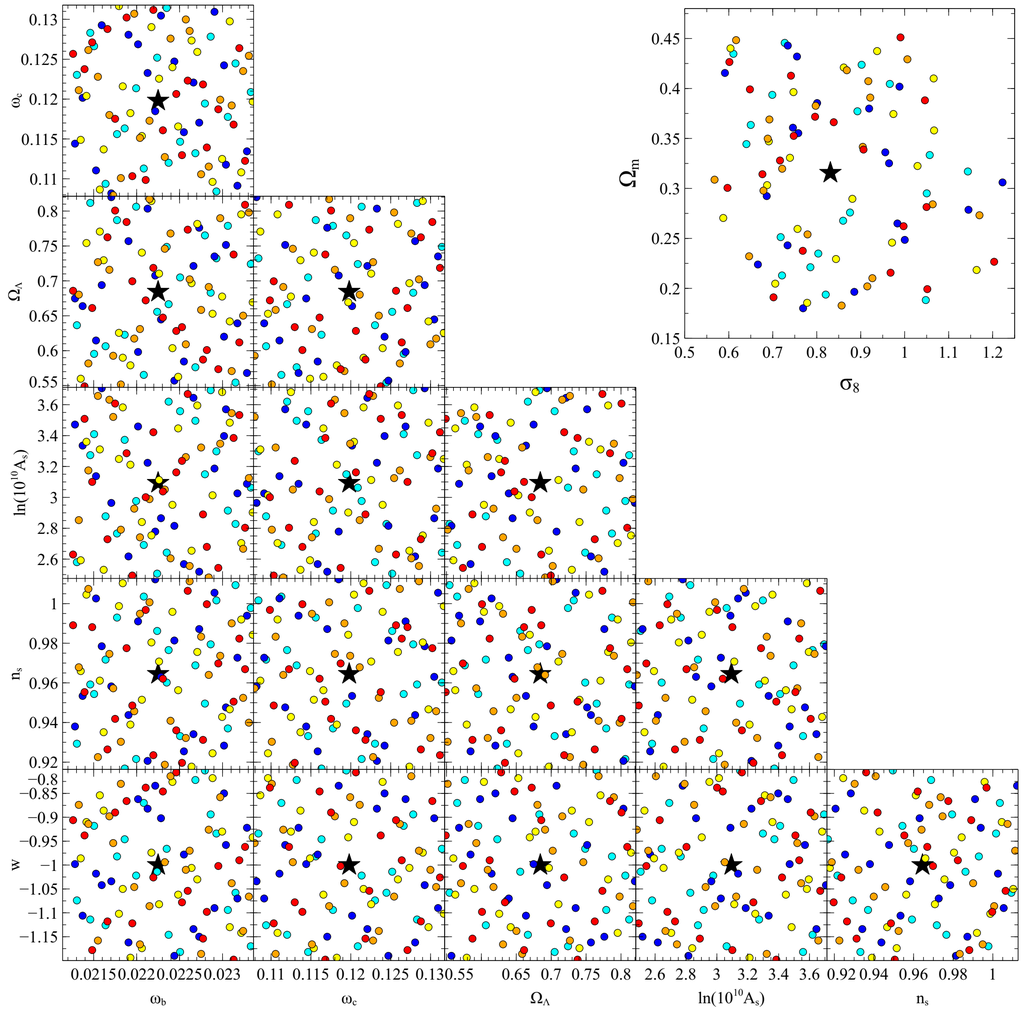
We need an "accurate" model

Nuisance parameters which will be marginalized over

DARK EMULATOR

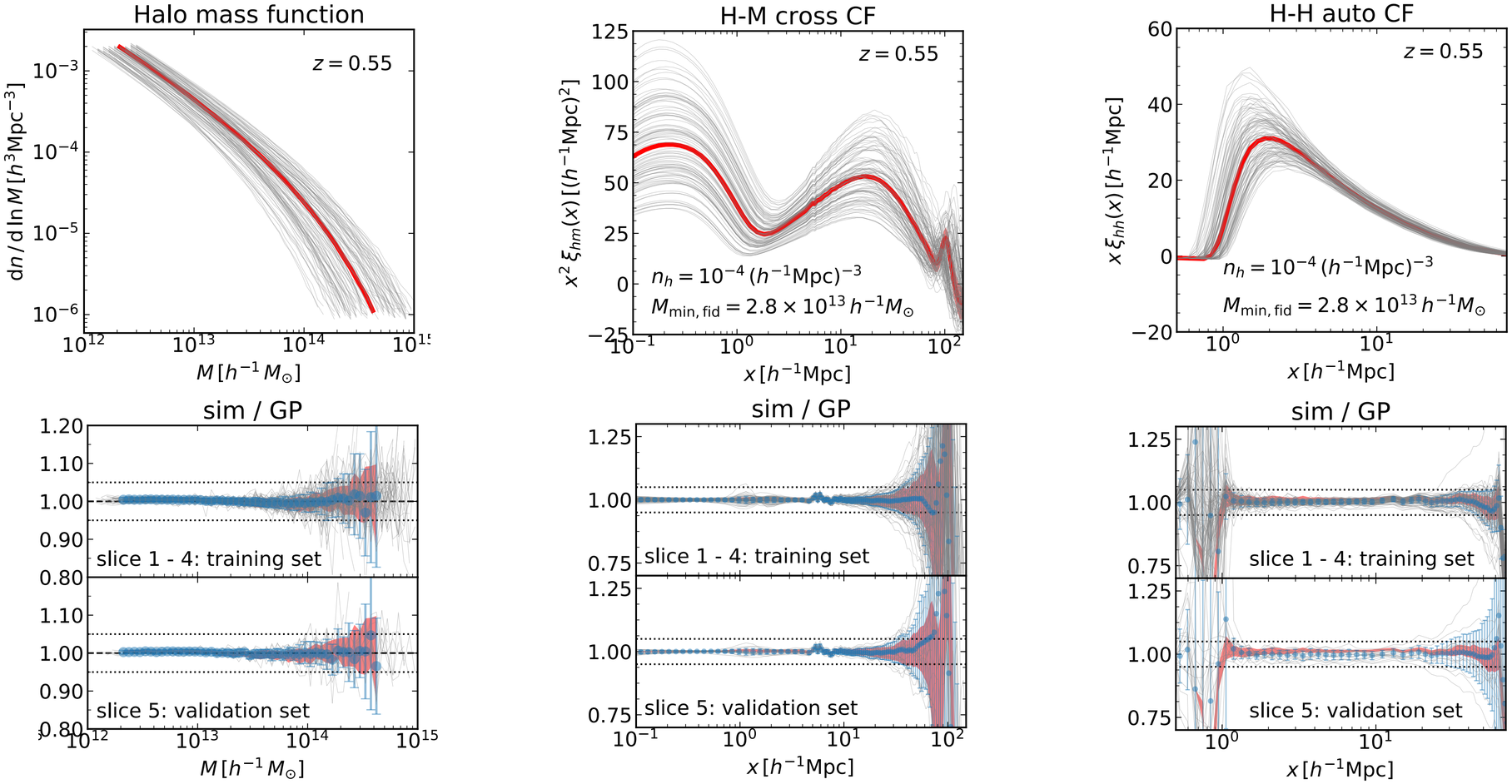
- Dark Emulator provides
  - Halo mass function: dn/dM
  - Halo-matter correlation function: ξ_{hm}
  - Halo-halo correlation function: ξ_{hh}
- Measure summary statistics in 1 $[Gpc/h]^3$ and 2$[Gpc/h]^3$ simulations with 2048^3 particles for 101 cosmological parameter sets.
- Interpolate these measurements to an arbitrary cosmology using Gaussian process.
- We don't have to care about galaxy bias!

$\theta=(\omega_b, \omega_c, \Omega_\Lambda, A_s, n_s, w)$



Nishimichi+ (2018)

VALIDATION TESTS



A few % accuracy is achieved!

Nishimichi+ (2018)

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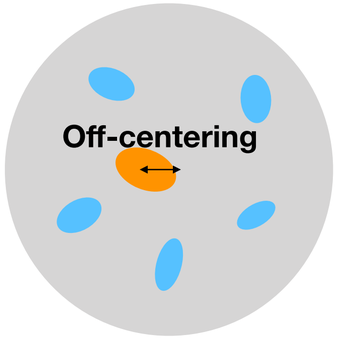

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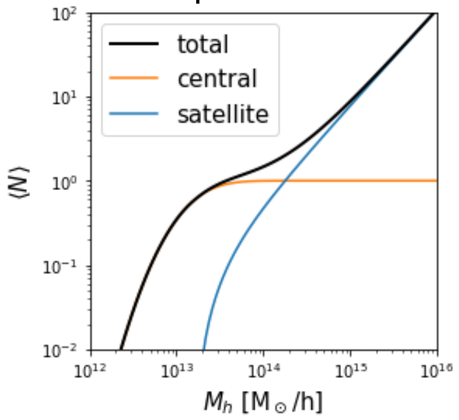

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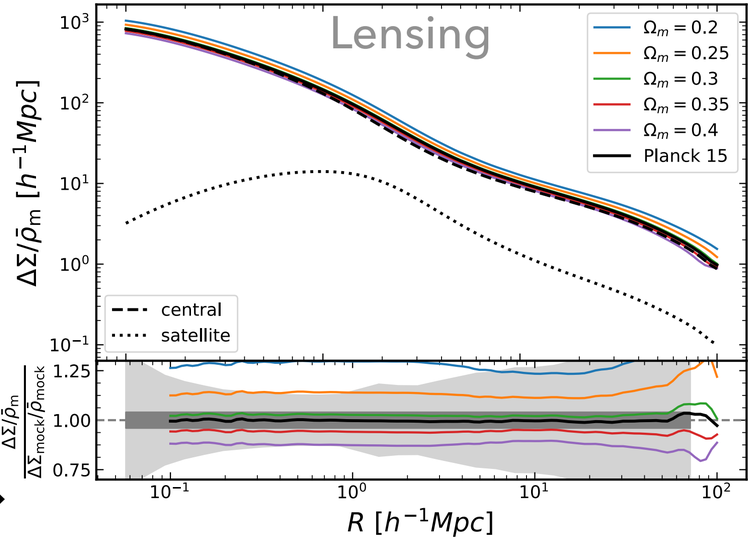
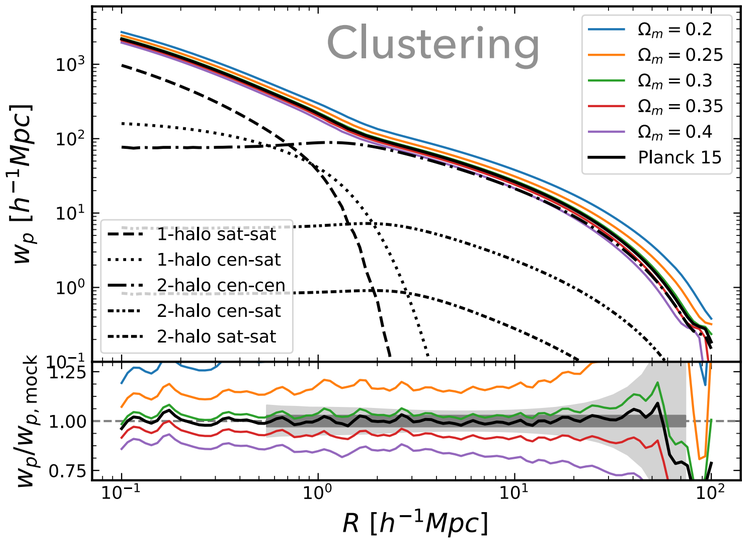
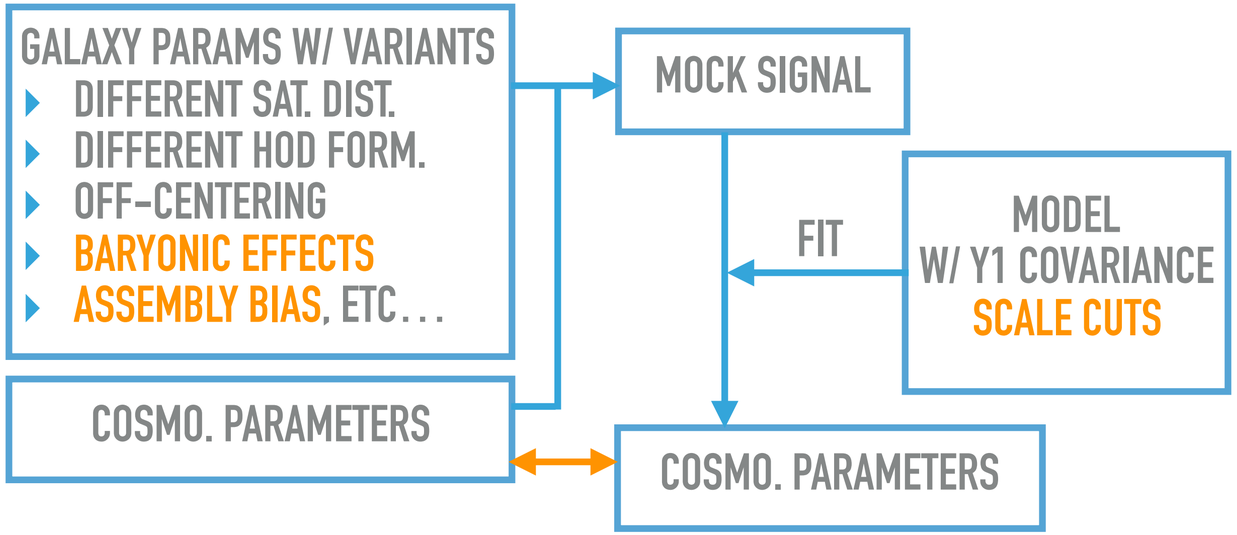




COSMOLOGY CHALLENGE

Test the robustness of our model by fitting mocks with variants.



Our model

- "Standard" HOD (Zheng et al. 2005)
- Off-centering PDF: Gaussian
- Satellite distribution: NFW

COSMOLOGY CHALLENGE

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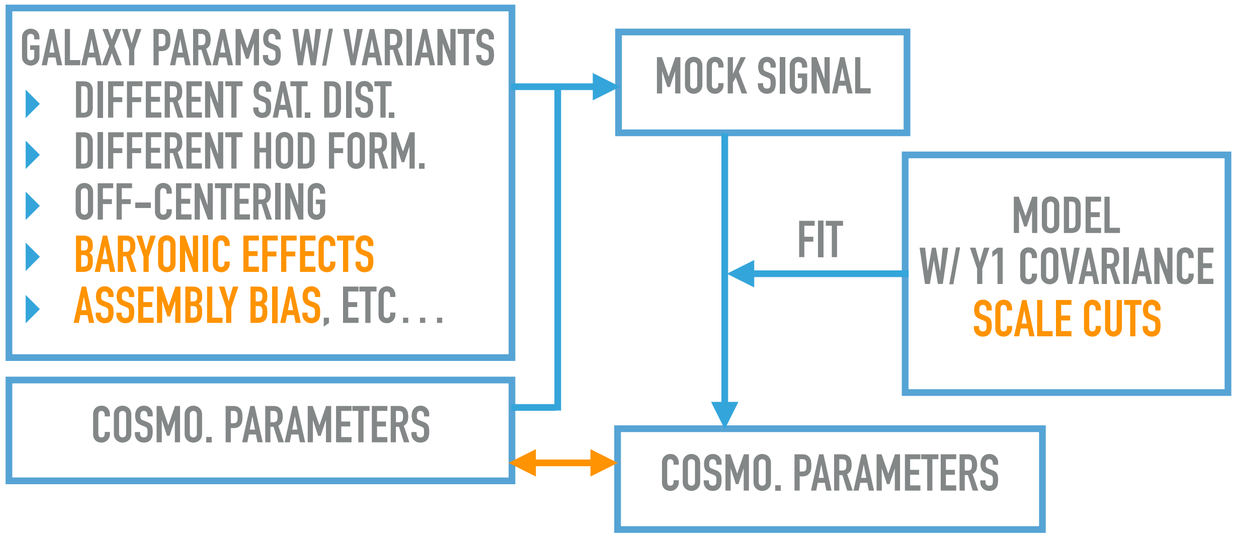

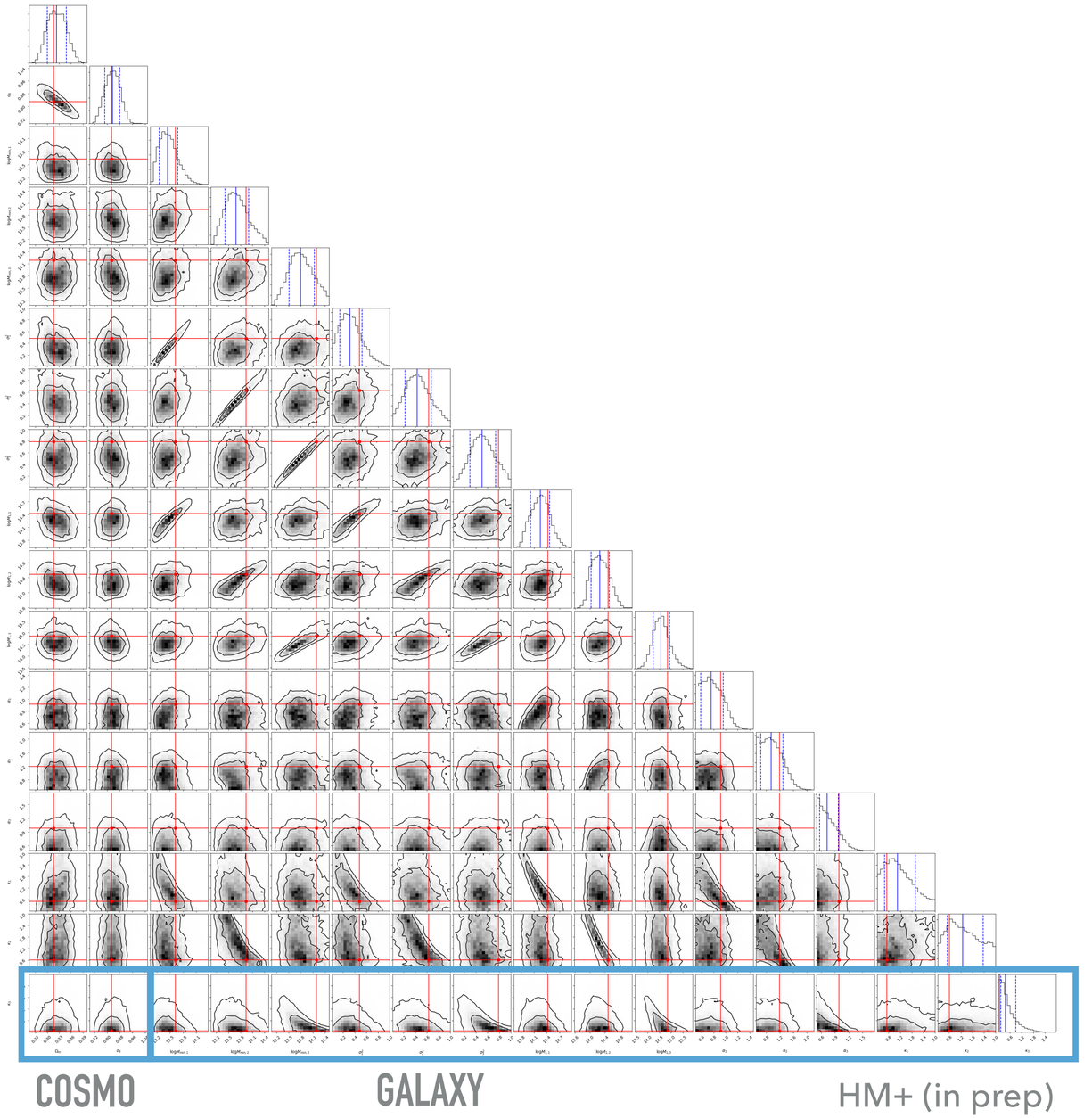

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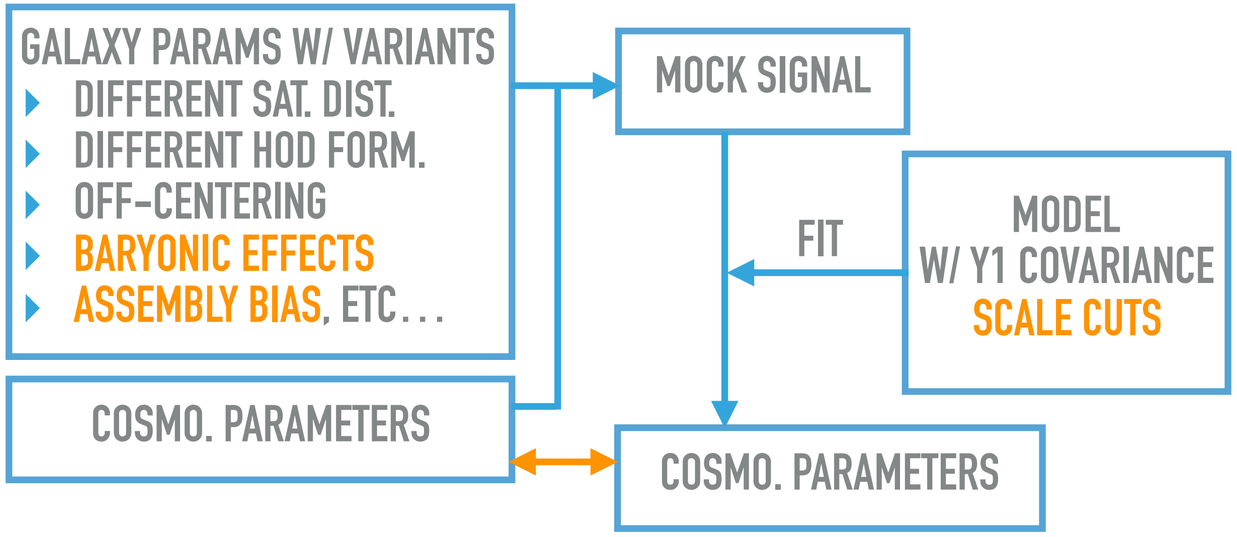
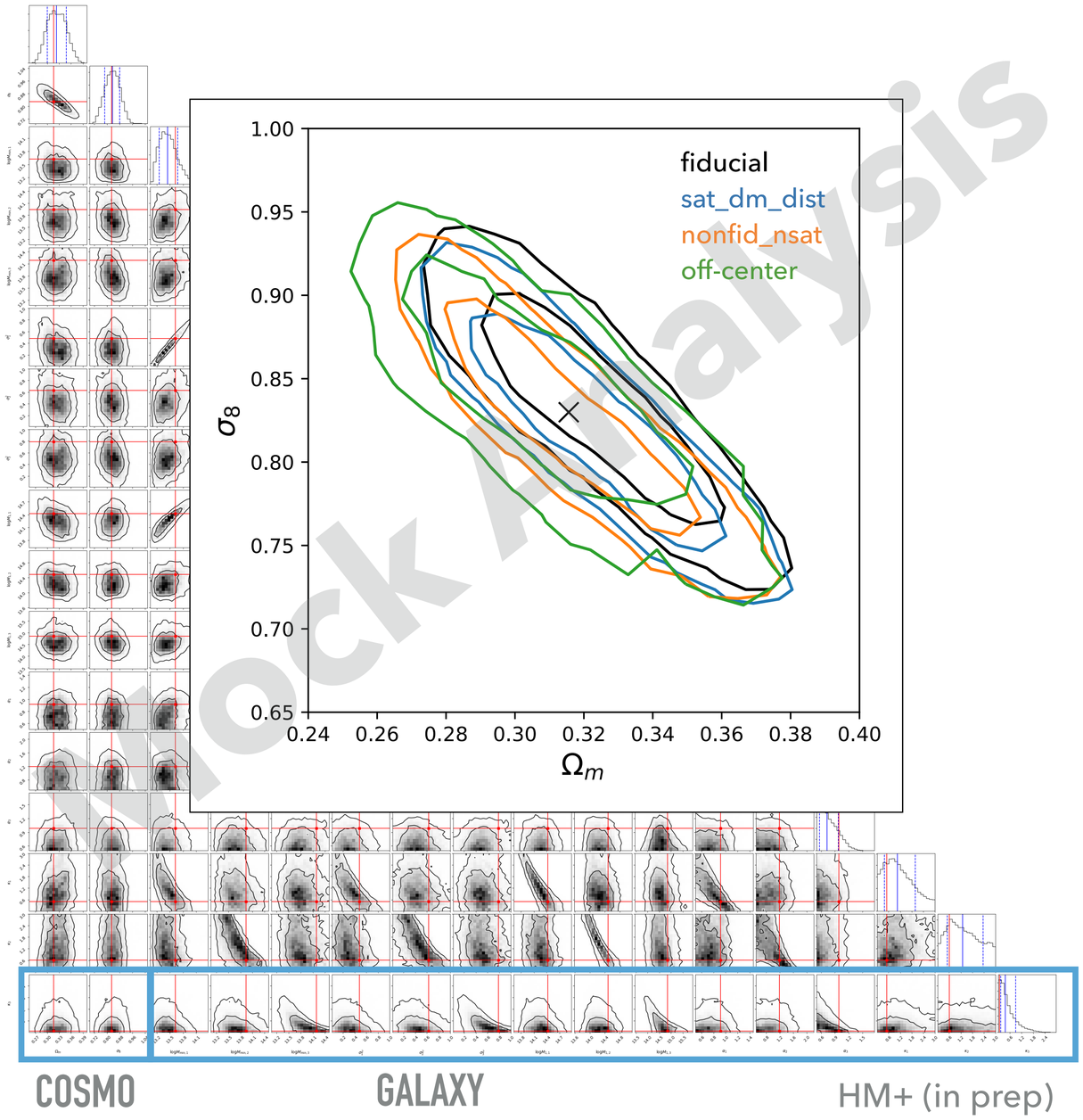
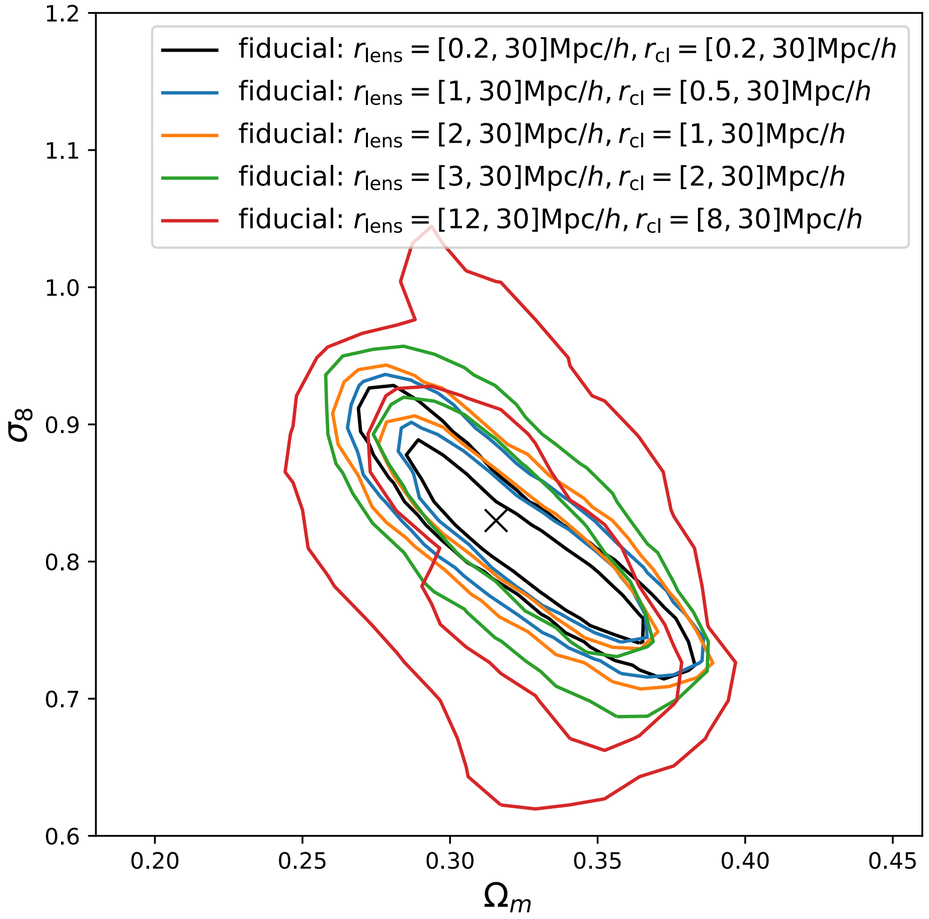


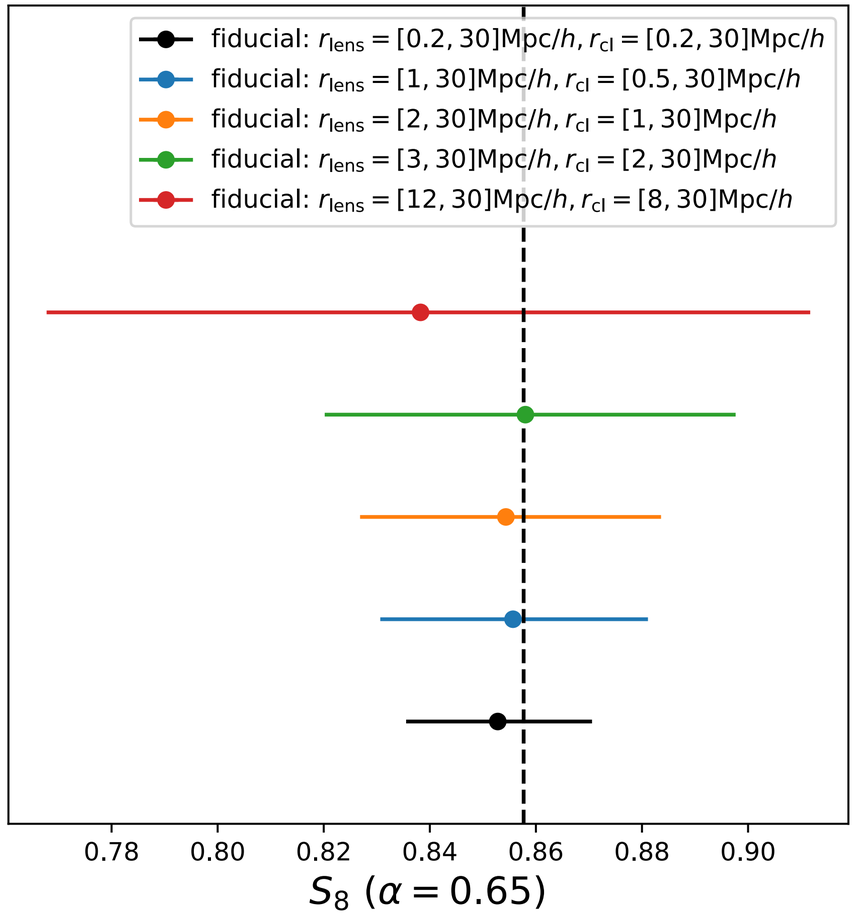


HM+ (in prep)

COSMOLOGY CHALLENGE: SCALE CUTS

Fit the fiducial mock signals varying scale cuts





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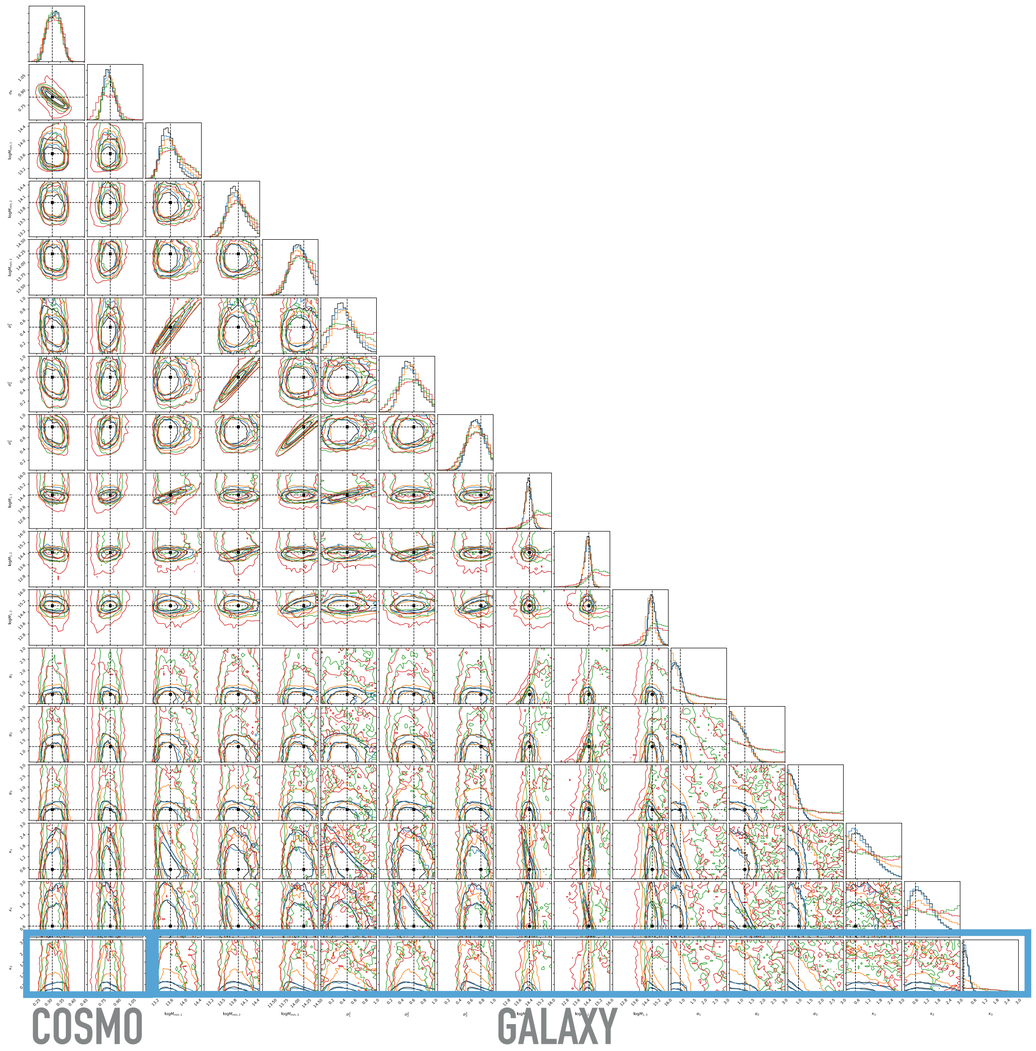

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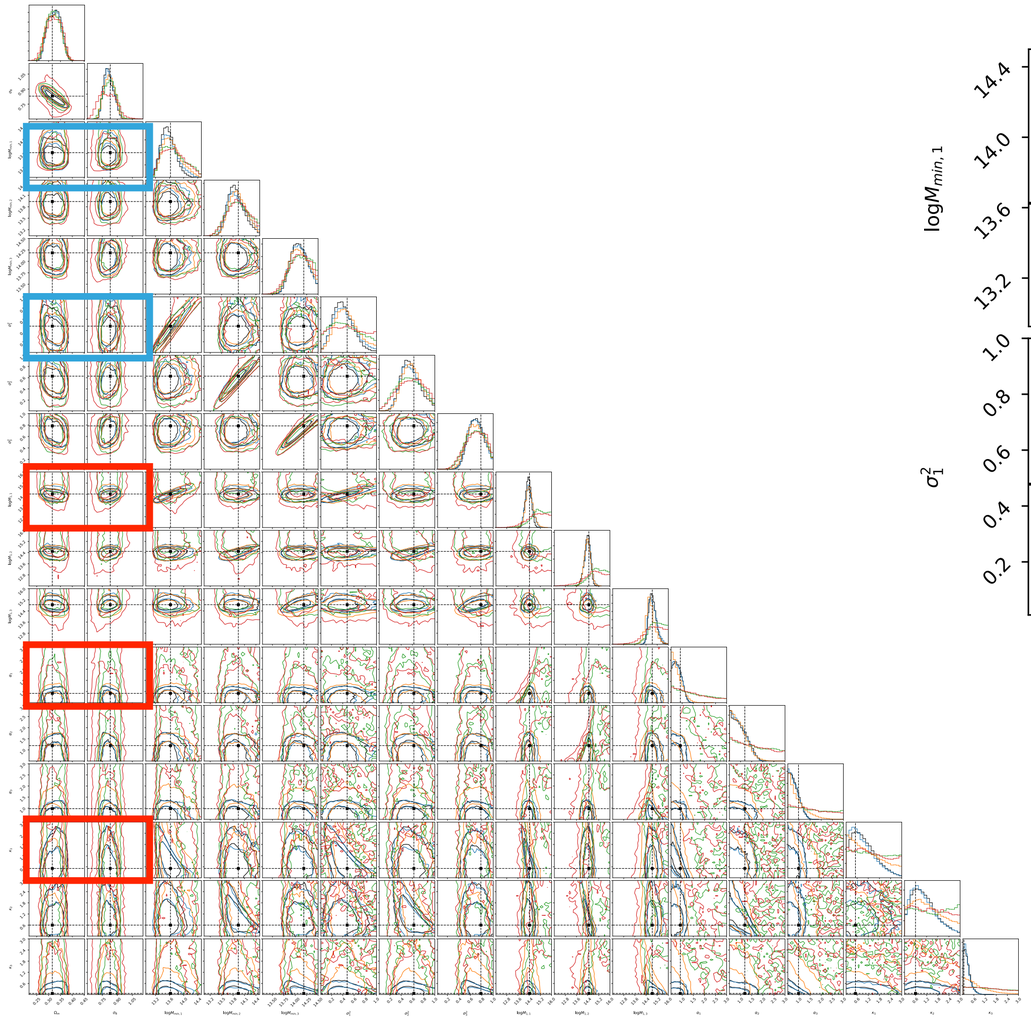
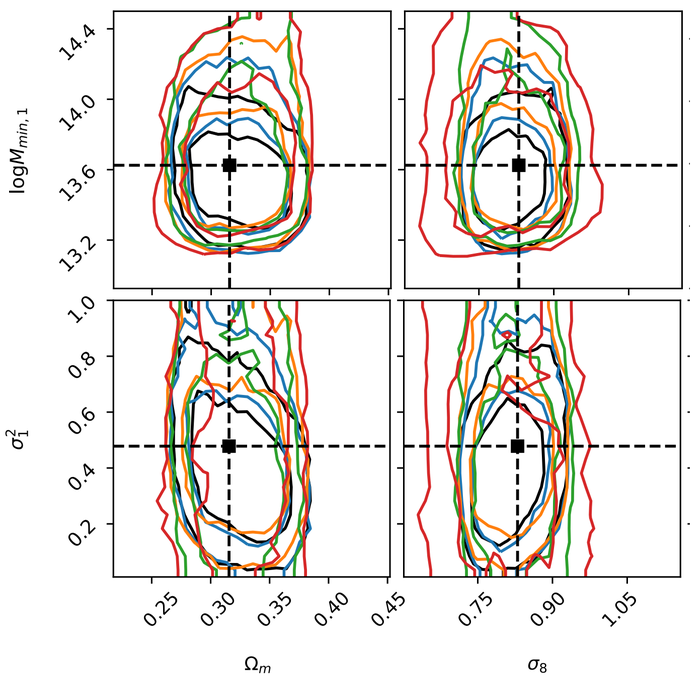
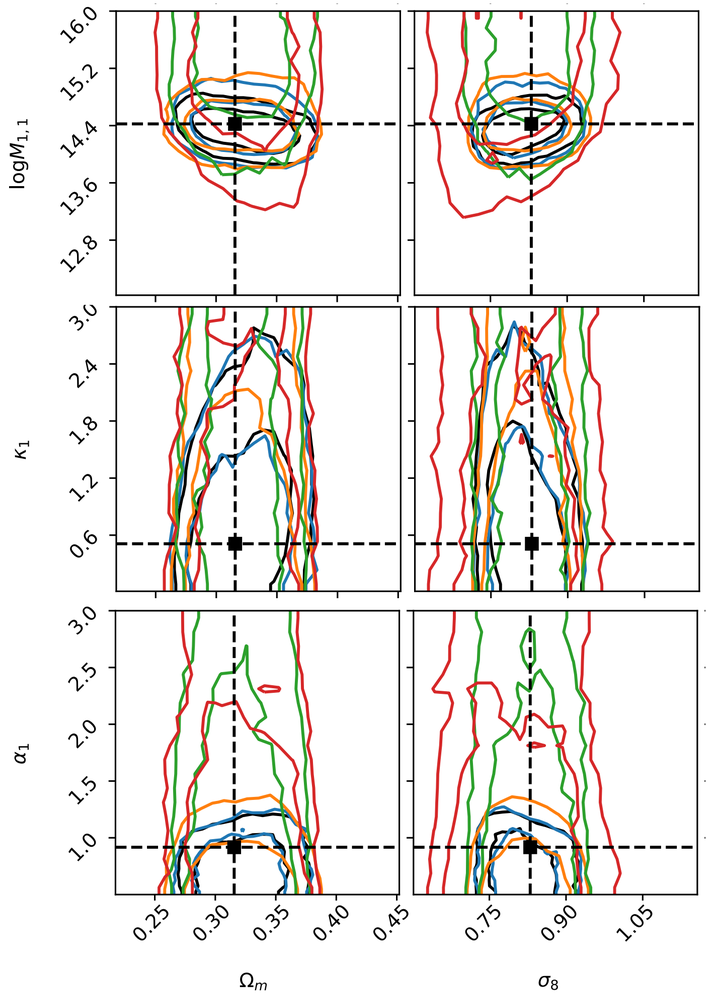


Central HOD



Satellite HOD



COSMOLOGY CHALLENGE: SCALE CUTS

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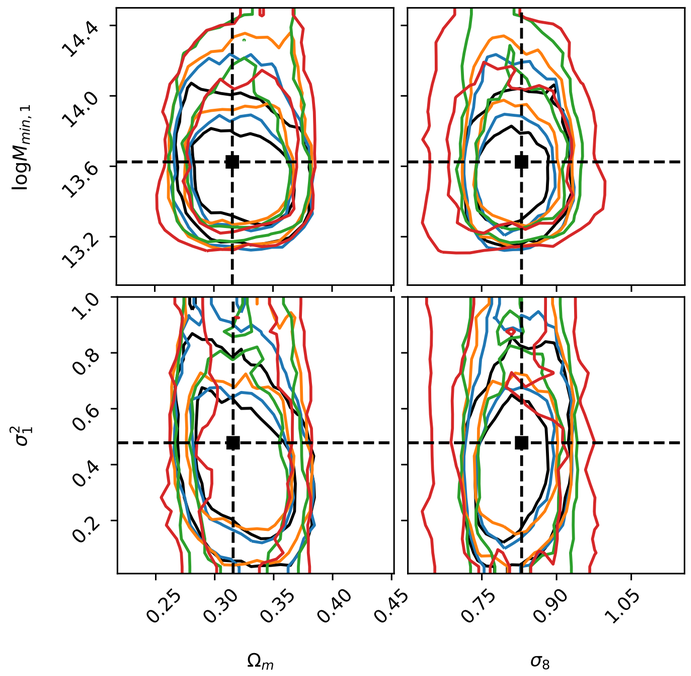

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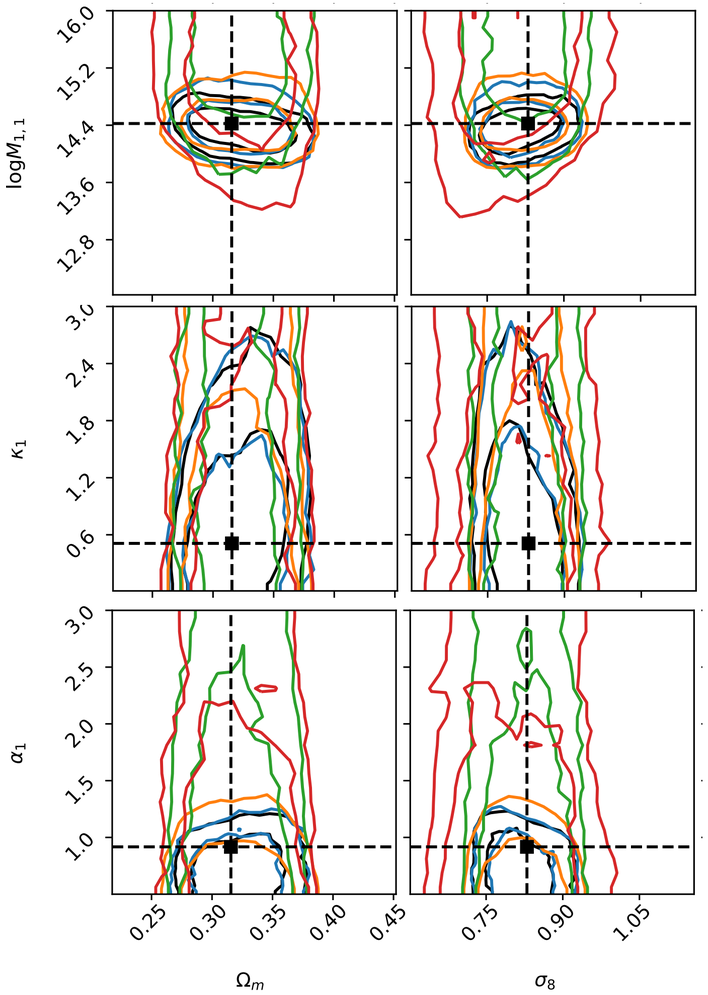
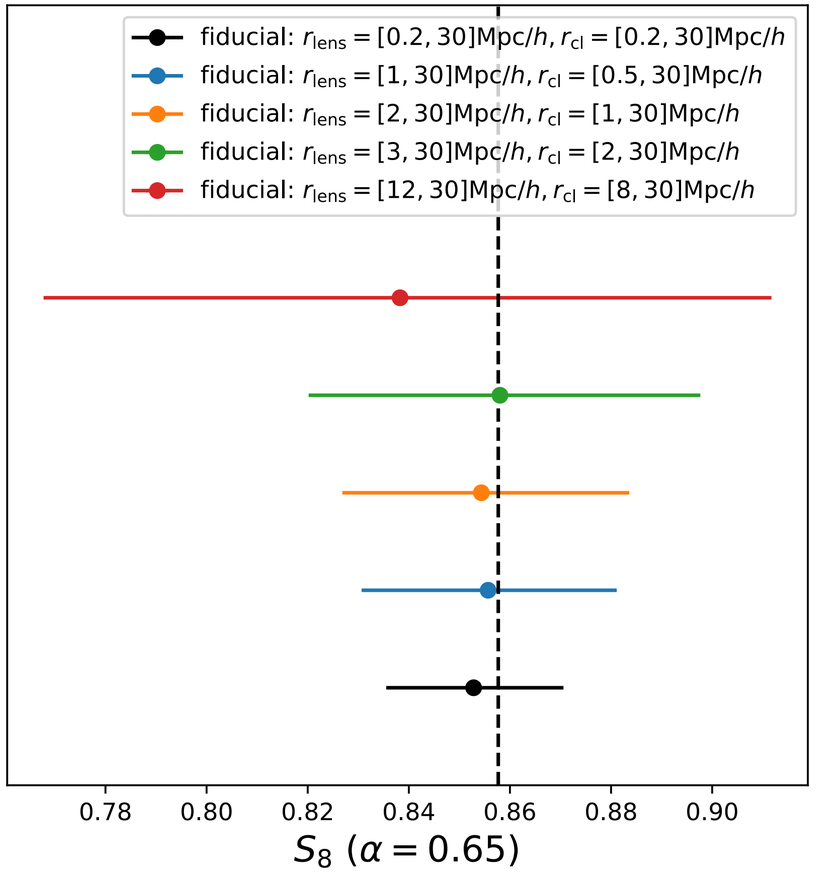
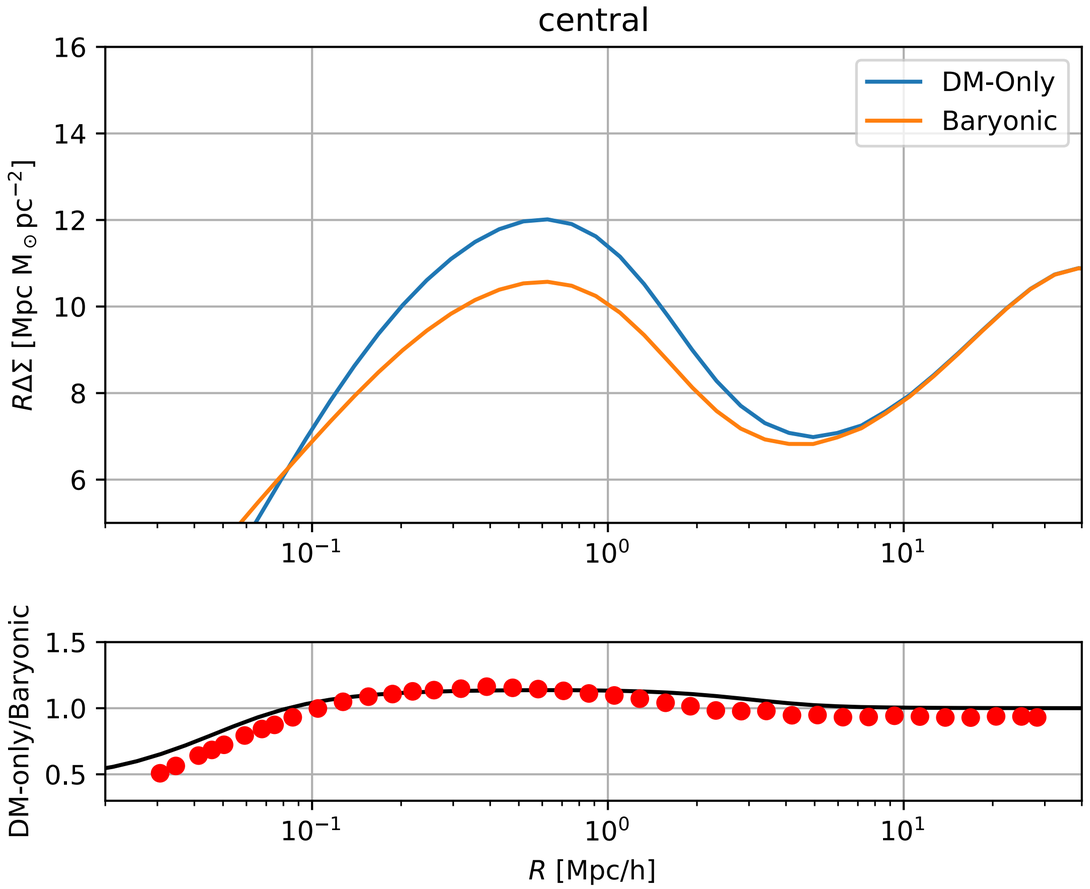




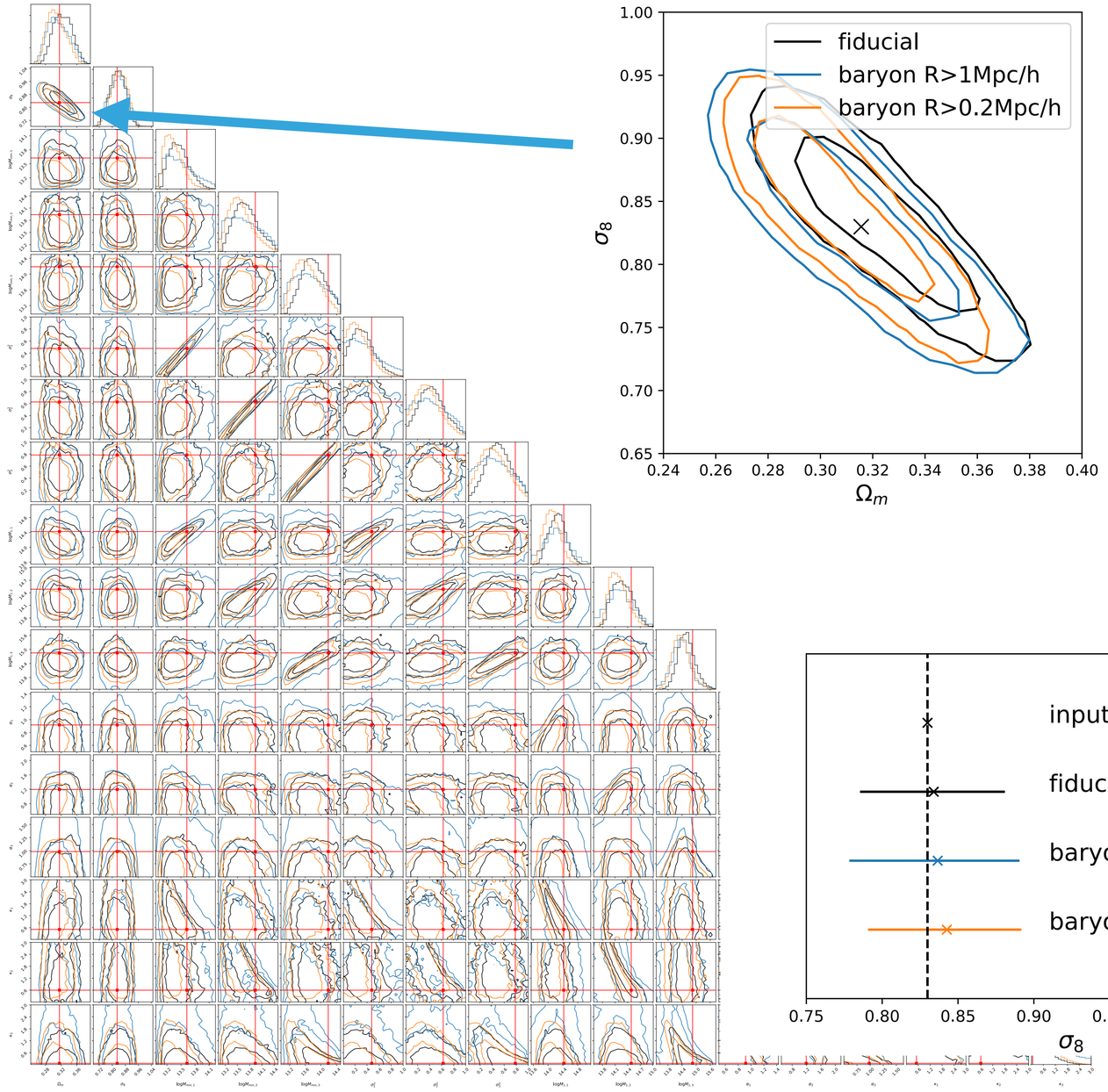
COSMOLOGY CHALLENGE: BARYONIC EFFECTS

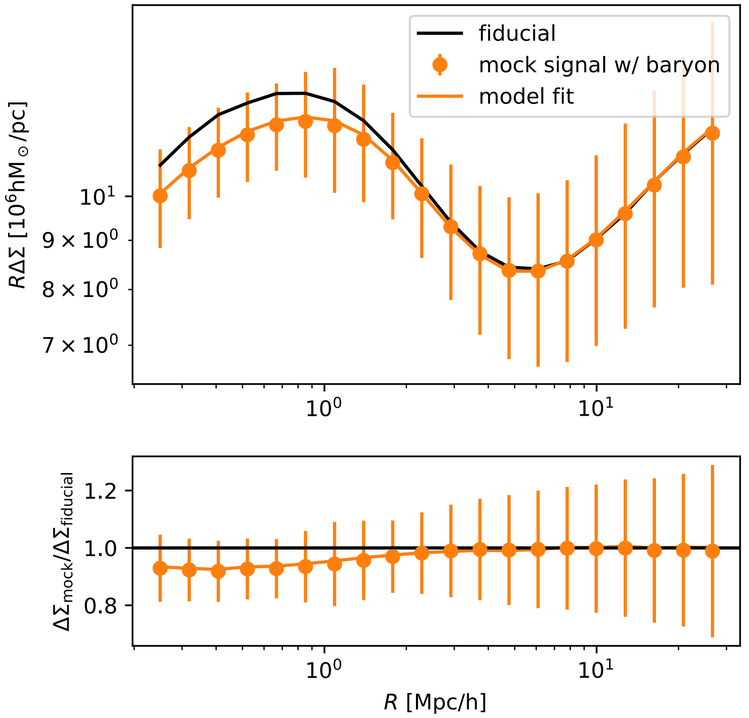
Generate mock signals

- Applied the prescription by Schneider & Teyssier (2016) to the halo-matter correlation function provided by Dark Emulator.
- Parameters were fixed to reproduce Leauthaud et al. (2017) which is based on the Illustris Simulations.
- Up to ~10% effect at ~1Mpc/h. No effect on the 2-halo term.



HSC-BOSS GALAXY-GALAXY LENSING AND CLUSTERING



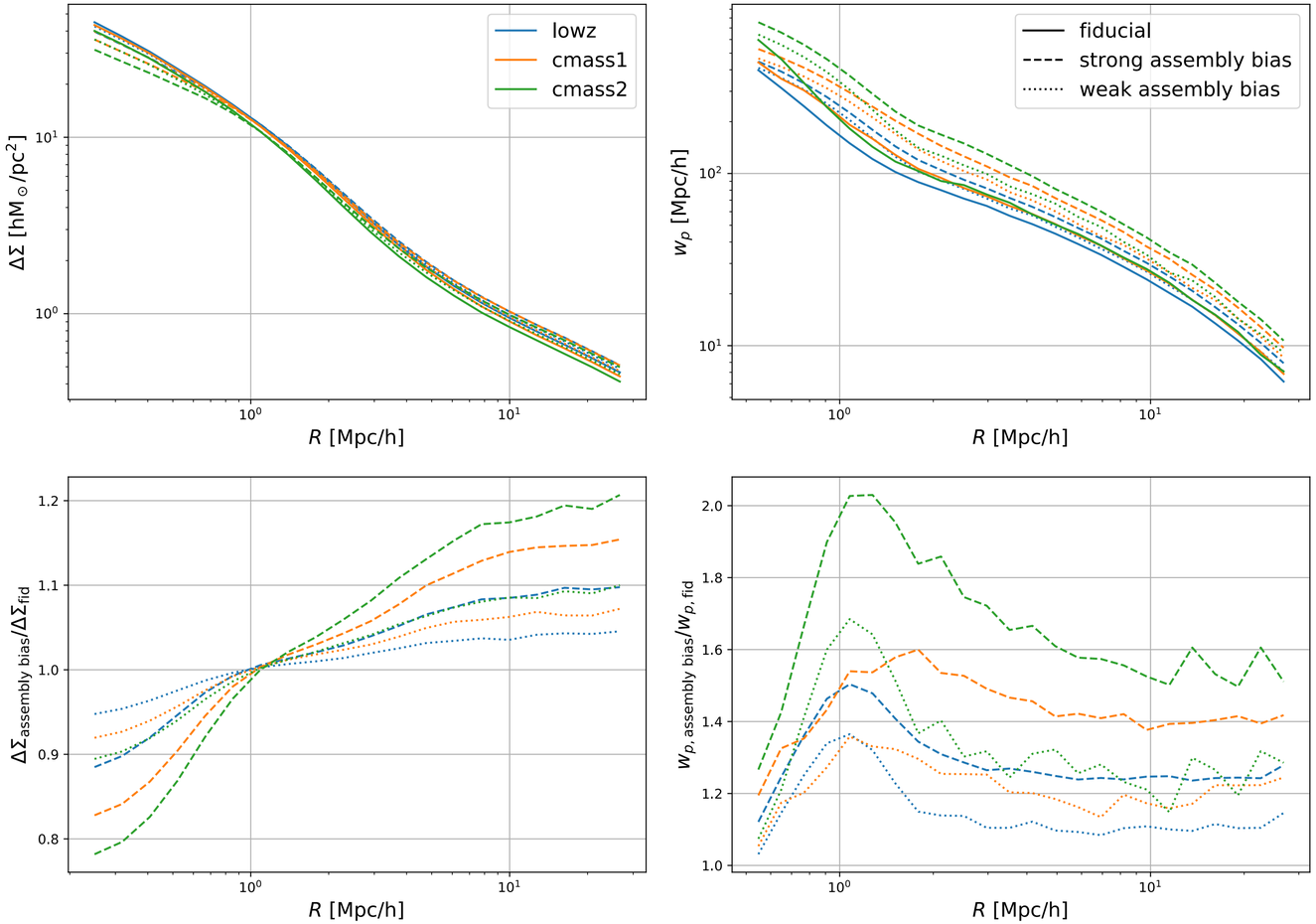


Baryonic effects won't significantly affect cosmology results in the HSC first year analysis.

COSMOLOGY CHALLENGE: ASSEMBLY BIAS

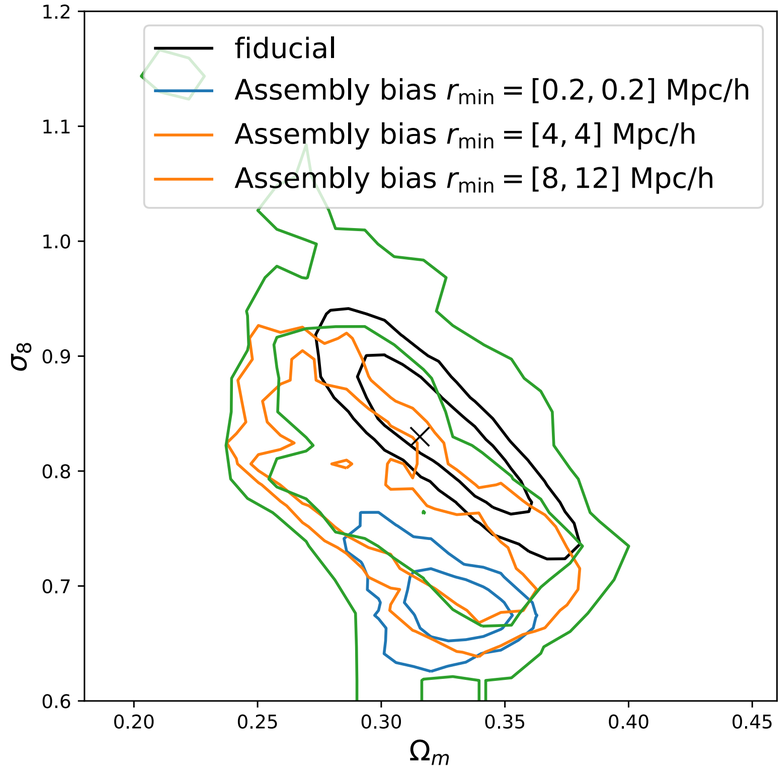
Generate mock signals

- Case 1: Assign central galaxies from halos with low concentration to $<N_{cen}(M)>$ → strong assembly bias $[b_{low\text{-}c}/b_{fid}]^2 \sim 1.5$
- Case2: Add stochasticity to the case 1 → weak assembly bias $[b_{low\text{-}c}/b_{fid}]^2 \sim 1.2$

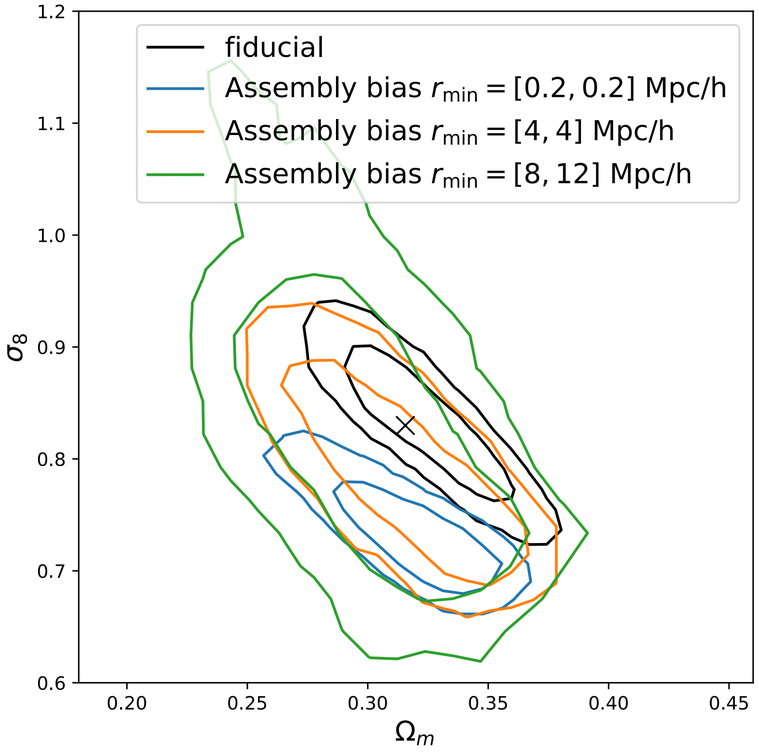


COSMOLOGY CHALLENGE: ASSEMBLY BIAS MATTERS!

Strong Assembly Bias



Weak Assembly Bias



We can monitor if there is assembly bias by looking at the shifts in cosmological constraints.

SUMMARY

- We are working on cosmological constraints from combined galaxy-galaxy lensing and clustering with BOSS DR11 and HSC 1st year data.
- Robust modeling of g-g lensing and clustering signal.
  - Cosmology challenge: fit mock signals with variants by our fiducial model.
  - Baryonic effects will not have a significant impact on the first year analysis.
  - Assembly bias matters! We need to monitor how cosmological constraints shifts with the scales for fit.
- Stay tuned with the cosmological constraint from real data!