
Systematic bias on lensing analysis using optical clusters

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Motivation

- ❖ Optical clusters tend to have larger systematics biases
 - ❖ Observables: Richness $\lambda = \sum p_{\text{mem},i}$
 - ❖ Problems: projection effects, orientation selection bias
 - ❖ In order to do cosmology, we need to know mass-richness relation for clusters: often cluster masses are measured through weak lensing
 - ❖ How do systematics affect mass-richness relation and lensing profiles?
- implement an optical cluster finder for simulations (similar to redMaPPer)

Outline

- ❖ Implementation of redMaPPer-like algorithm for simulations
- ❖ Result1: mass-richness relation & lensing profile before / after running redMaPPer
 - Can we explain the differences between pre / post-cluster samples by mass distribution?
- ❖ Result2: comparisons with emulator
 - Is spherical symmetry kept for optical clusters?

redMaPPer Algorithm

take all galaxies within $0.5h^{-1}$ Mpc of a candidate center and measure λ , setting the cluster redshift to z_{red} . Candidate centers with $\lambda/S < 3$ are rejected.

Find overall over-density regions

$$R_c(\lambda) = 1.0 \left(\frac{\lambda}{100} \right)^{0.2} h^{-1} \text{Mpc}$$

Find the brightest galaxy within the cylinder

1. Given cluster number i in the list, recompute λ and z_λ based on the percolated galaxy catalog. At the beginning of the percolation, the percolated galaxy catalog is simply the input galaxy catalog.
2. Determine the cluster center and centering probability via the method outlined in Section 8.
3. Perform a final calculation of λ and z_λ with respect to the new central galaxy.
4. Update the percolated galaxy catalog by masking out galaxies based on their membership probabilities.
5. Remove all lower-ranked possible centers that have a membership probability $p_{\text{mem}} > 0.5$ of being a member of cluster i . Note these galaxies are still allowed to provide membership weight to lower-ranked clusters as part of the percolated galaxy catalog.
6. Repeat Step 1 for the next cluster galaxy in the ranked list.

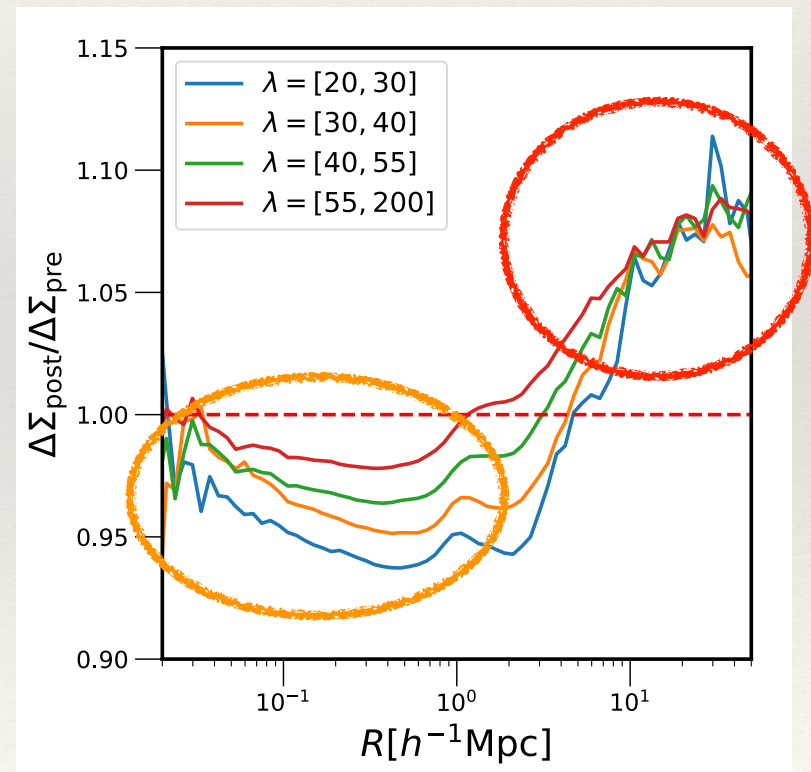
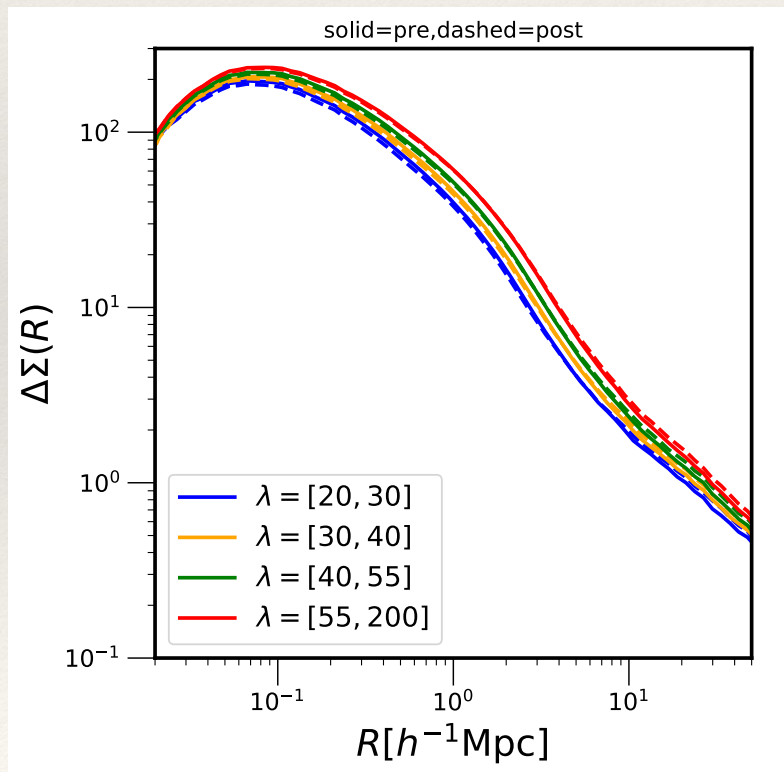
Assign membership probability and richness using radial filter

Photometric redshift:
Assume the projection length of
60 Mpc/h **with a top-hat filter**

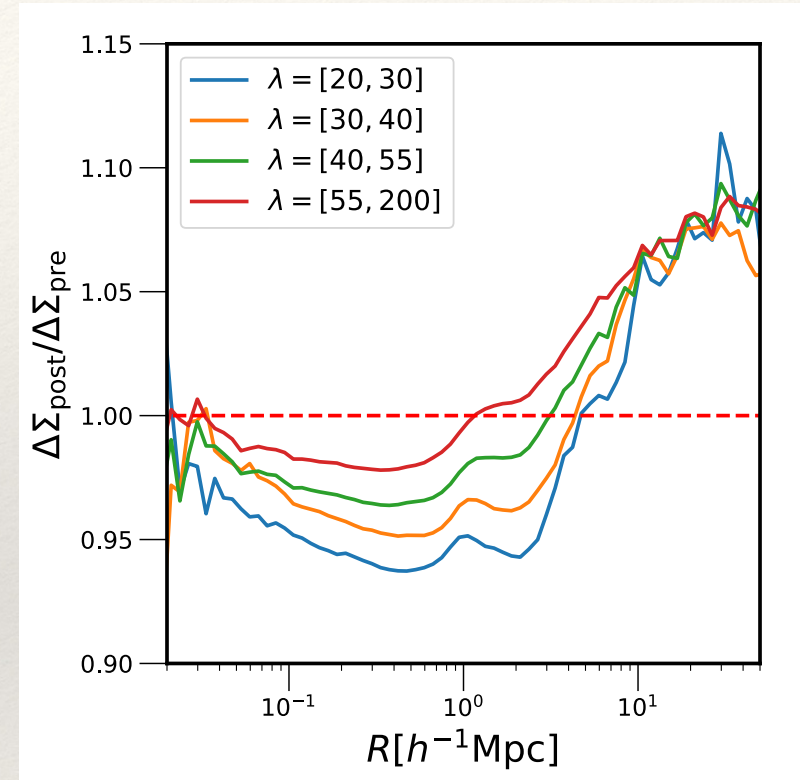
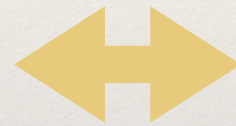
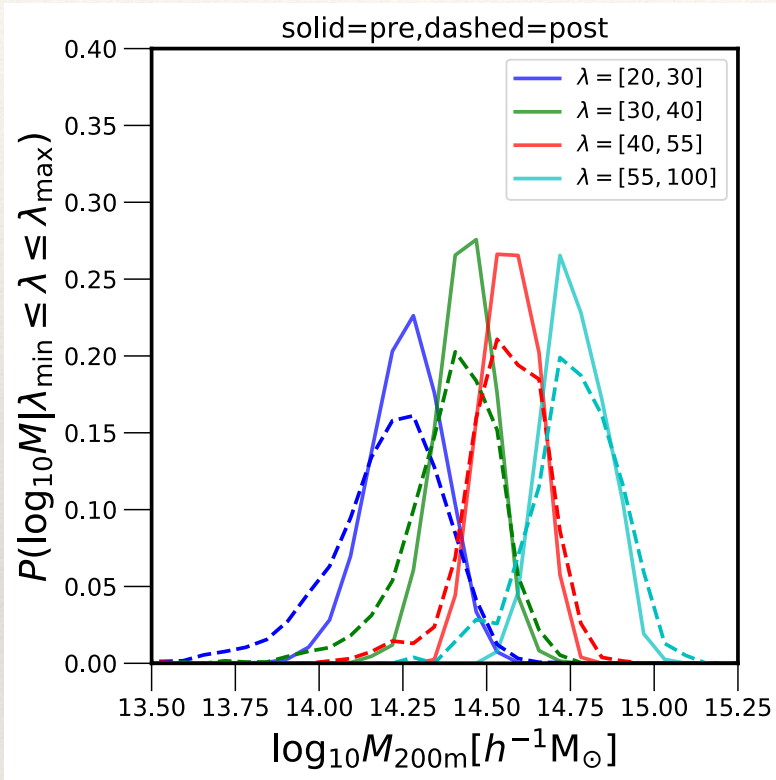
No line-of-sight filter based on magnitude

Lensing Profiles

- ❖ 1-halo term: Post-redMaPPer clusters show lower amplitude because there are more lower-mass halos
- ❖ 2-halo term: Lensing profiles of the post-redMaPPer clusters have larger amplitude



Can we fully explain the difference in lensing profiles by the difference in mass distribution?



- ❖ Using emulators to predict the lensing profile of the post-redMaPPer clusters by using their mass distribution as input

Dark (Halo) Emulator



T. Nishimichi
(U. Kyoto)

G-G LENSING SIMULATIONS

SIMULATION EFFORT

Simulations for Subaru HSC

✓ Building accurate theoretical templates

- ✓ Galaxy (cluster)-galaxy lensing
- ✓ Galaxy-3D spatial clustering

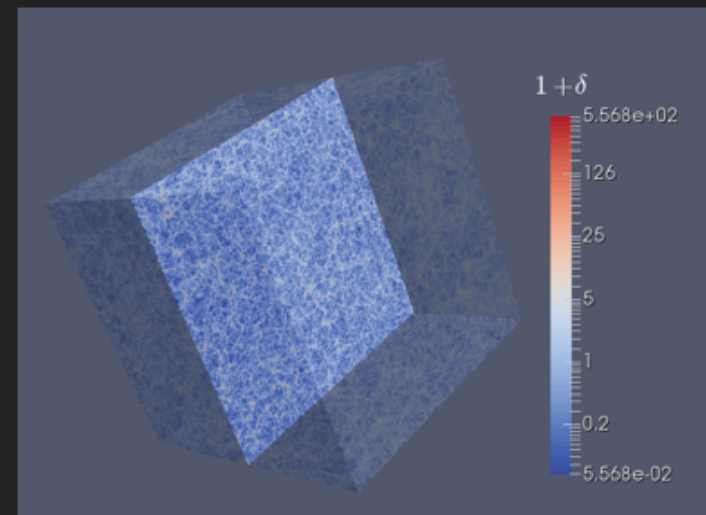
cross-correlation analysis w/ BOSS CMASS

dark matter (sub)-halos as a simplest representative of galaxies

✓ “Data driven” sciences with a large suite of simulations

DM, halos, and subhalos, velocity fields of halos/subhalos (~200TB)

“data driven” sciences with a large suite of simulations



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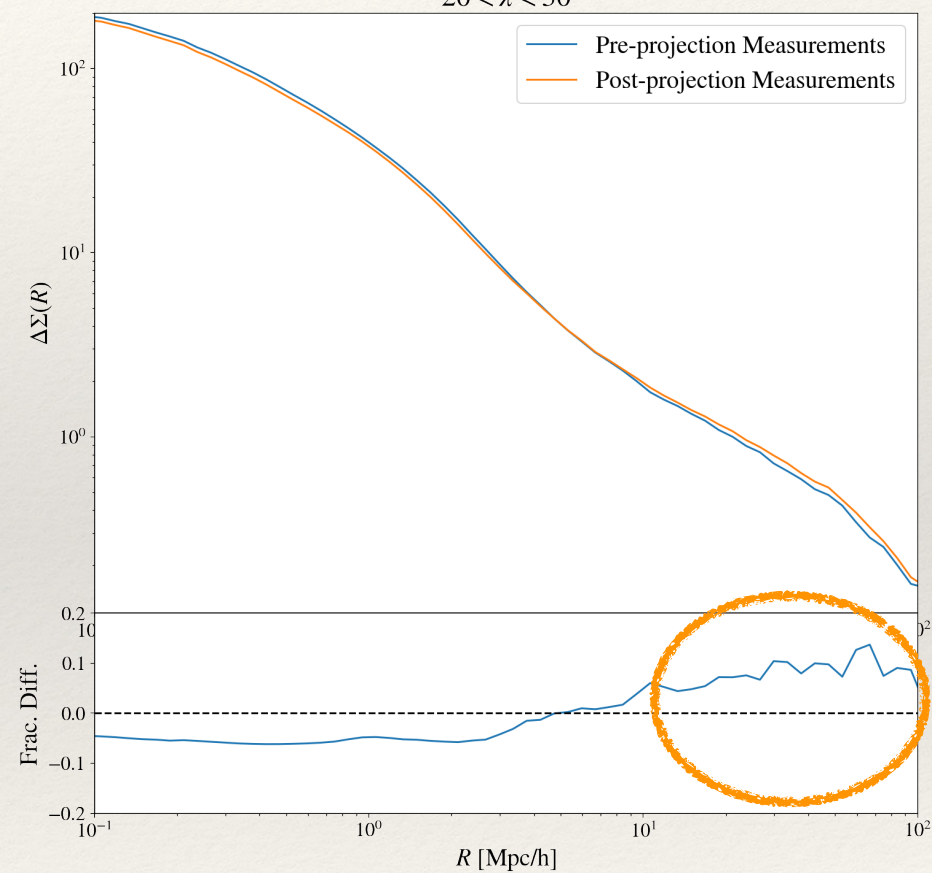
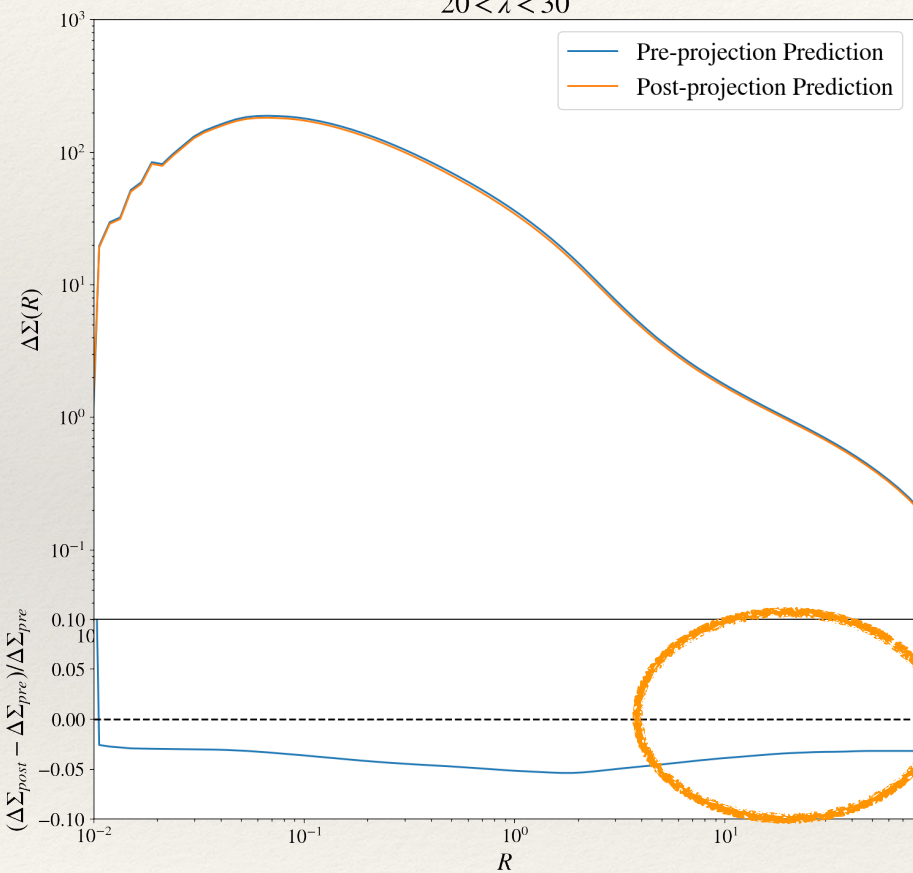
Can the emulator correctly predict the lensing profile for clusters?

Emulator

Simulation

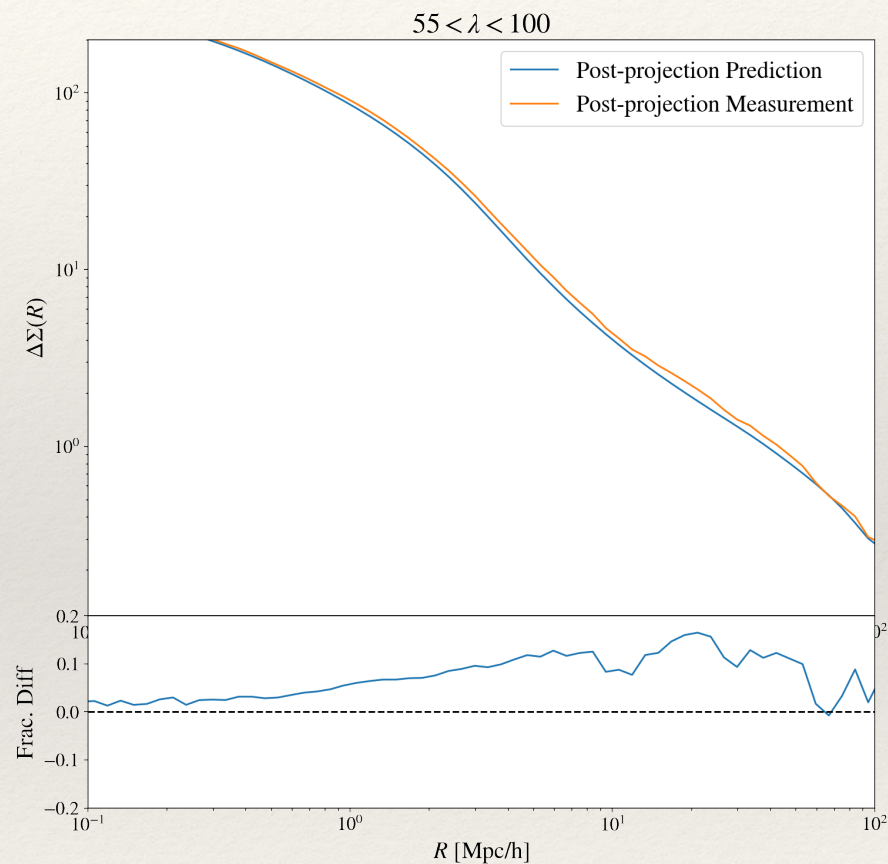
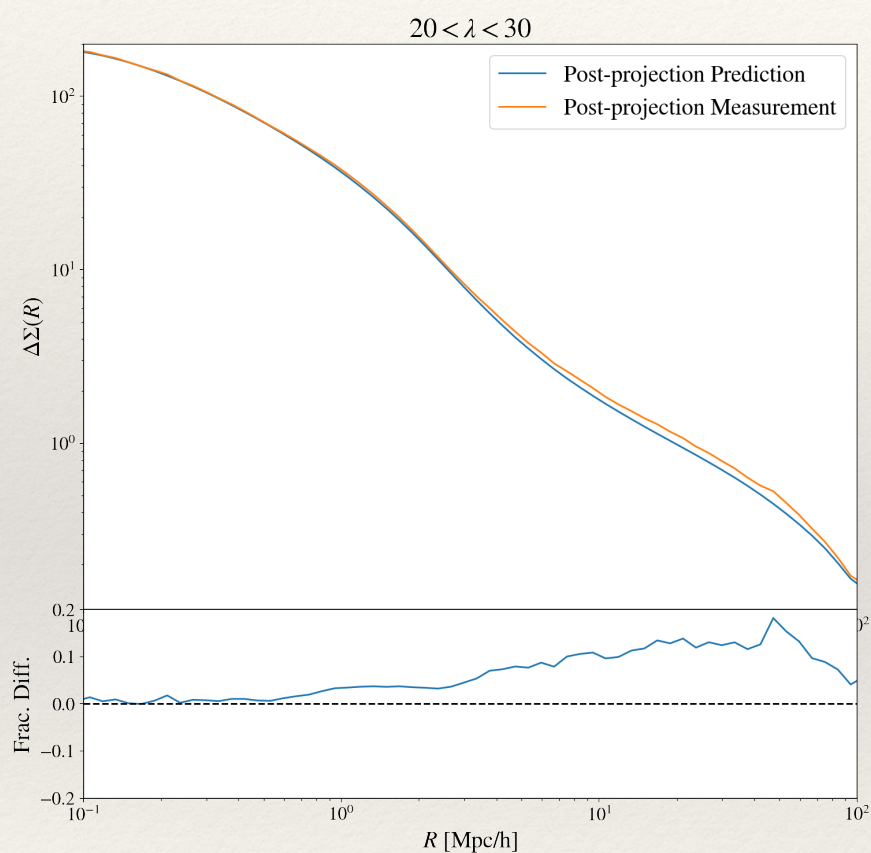
$20 < \lambda < 30$

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Low richness clusters disagree on 2-halo term

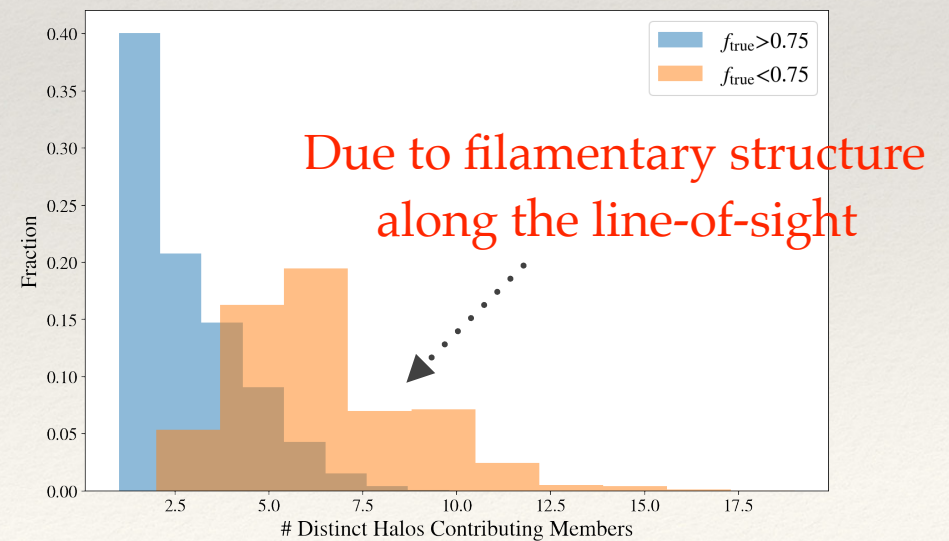
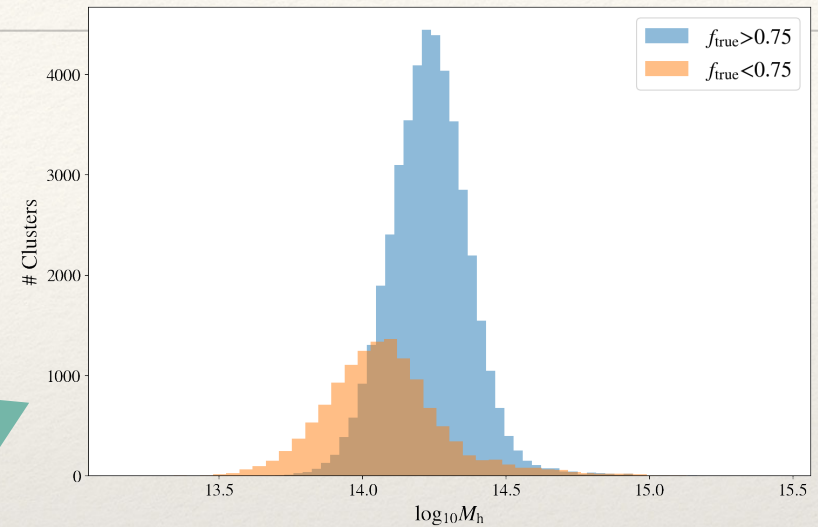
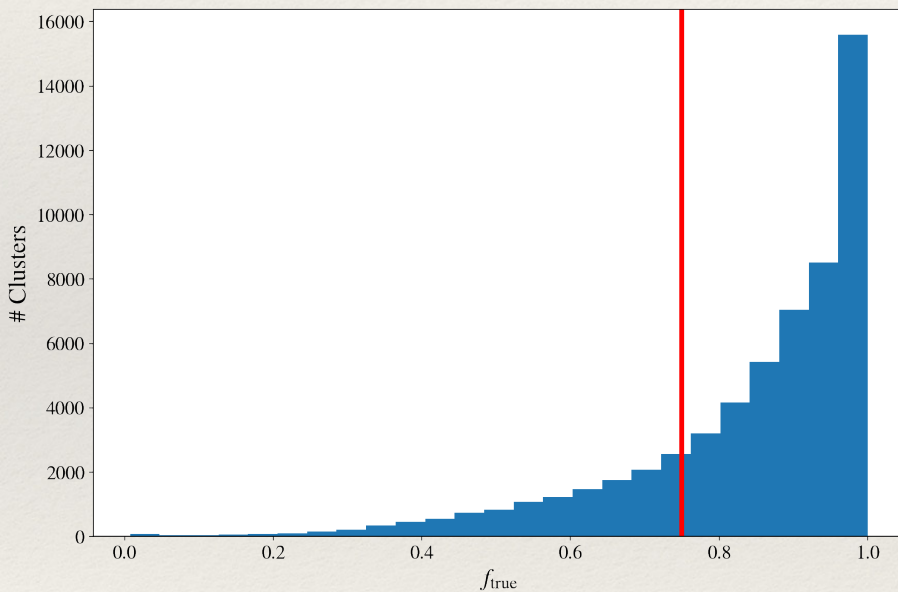
Can the emulator correctly predict the lensing profile for clusters?



Both low and high richness clusters disagree on 2-halo term!

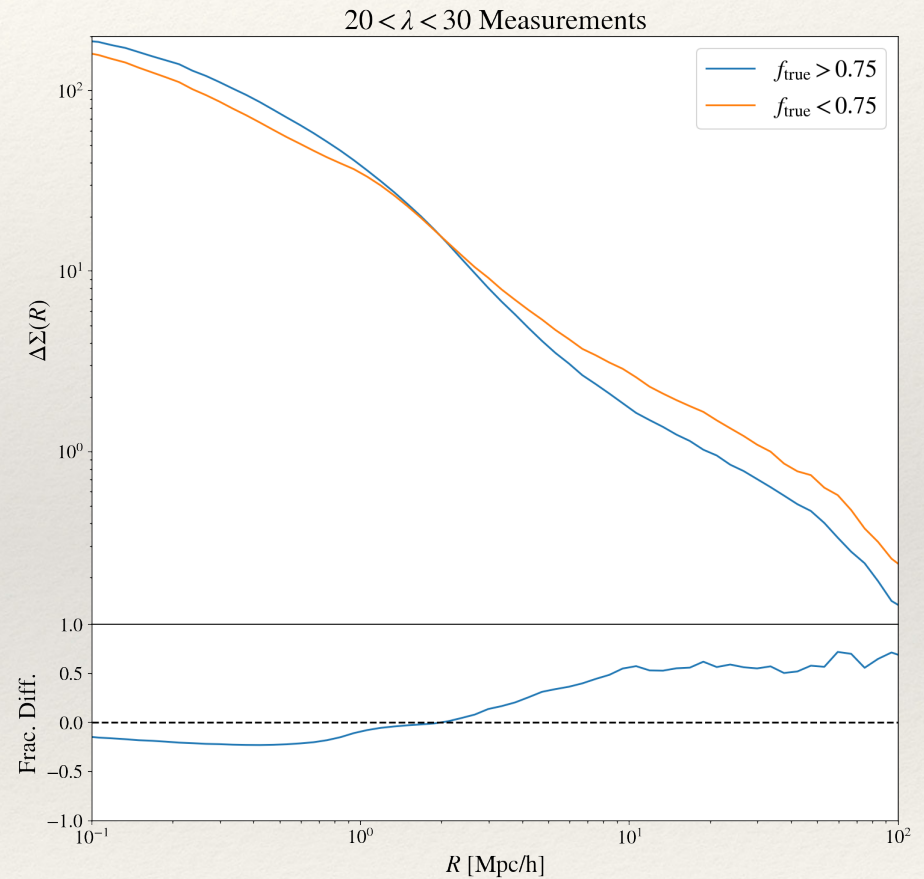
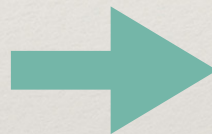
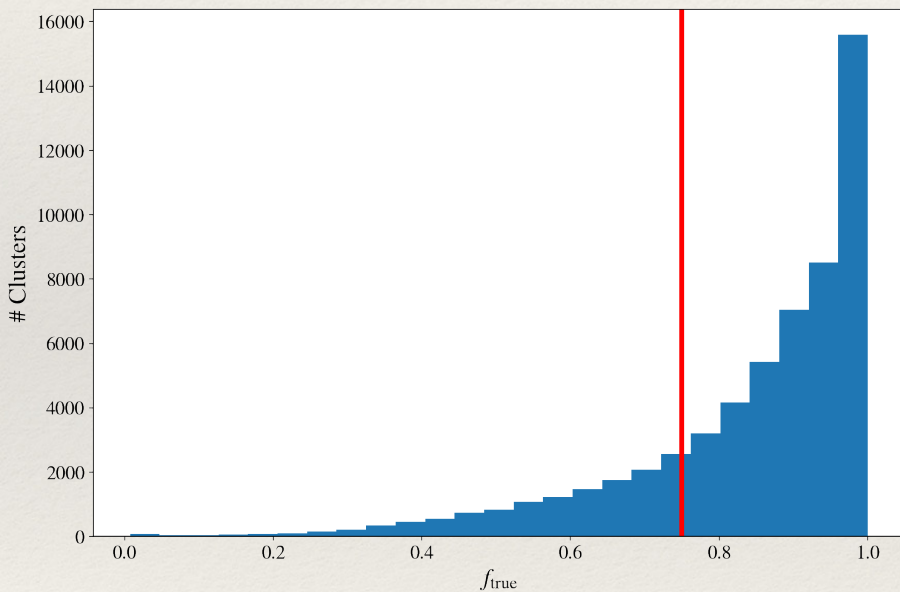
What is the fraction of true members in the clusters?

$$f_{\text{true}} = \Sigma p_{\text{mem,true}} / \Sigma p_{\text{mem,all}}$$



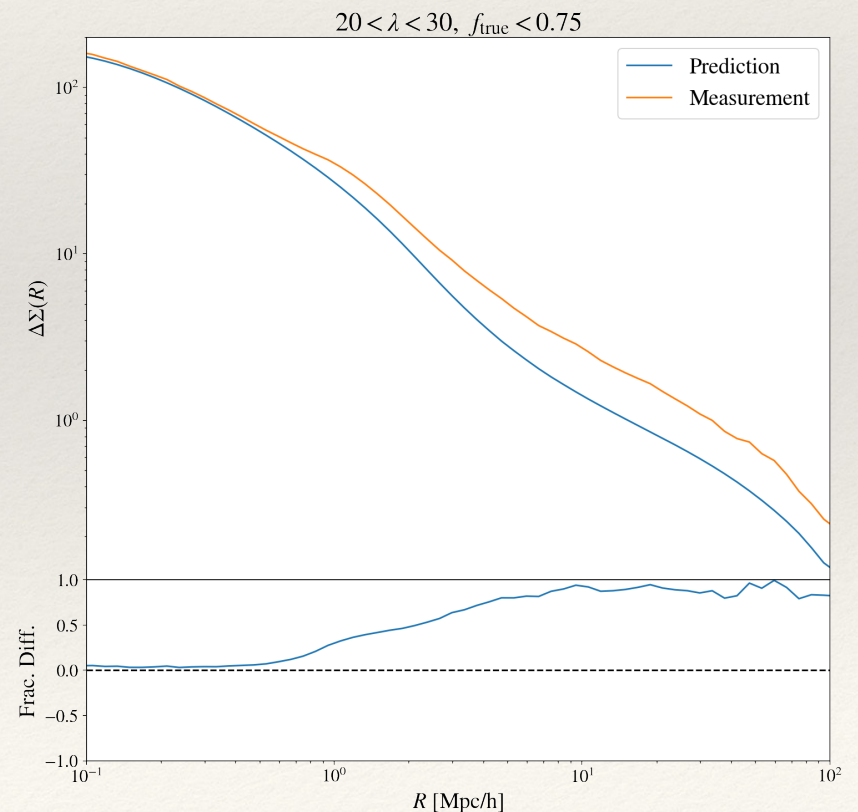
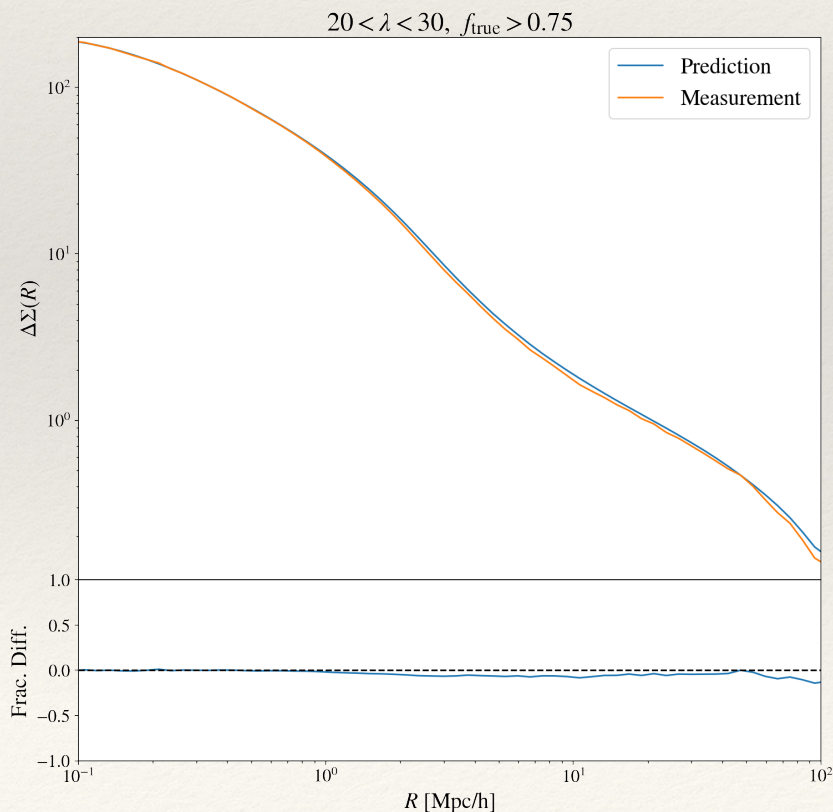
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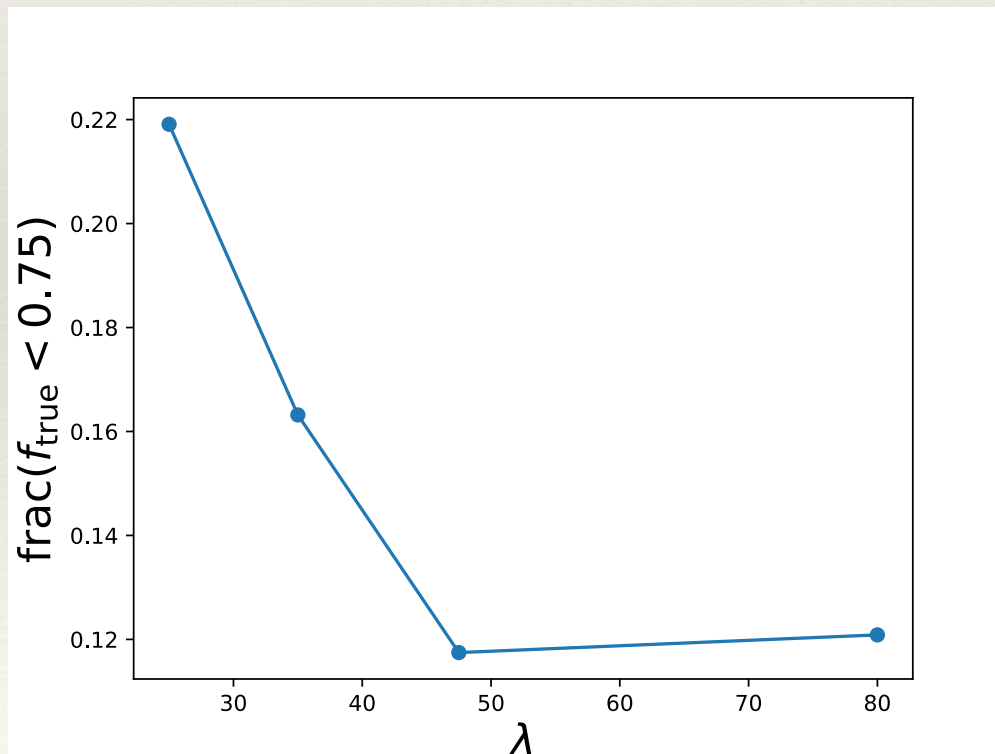
Lensing profiles of clusters with high fraction of true members agree with the prediction from the emulator

- ❖ Clusters with high fraction of true members do agree with the prediction from the emulator, and the ones with many interlopers are the ones causing the discrepancy from the prediction.



Low richness clusters tend to be more affected by the projection effect

- ❖ The reason the lensing profile of low richness clusters did not agree with the prediction from the emulator is due to higher fraction of clusters with many interlopers.



Conclusion/Future Work

- ❖ In order to model the optical cluster samples, mass-richness relation is not enough
- ❖ Clusters with many interlopers have higher amplitude than the ones with less interlopers
- ❖ This discrepancy is due to filamentary structure along the line-of-sight.
- ❖ Evaluate how this systemic bias propagates to the error in cosmological measurements