# Constraining Galaxy Assembly Bias Using Count Statistics

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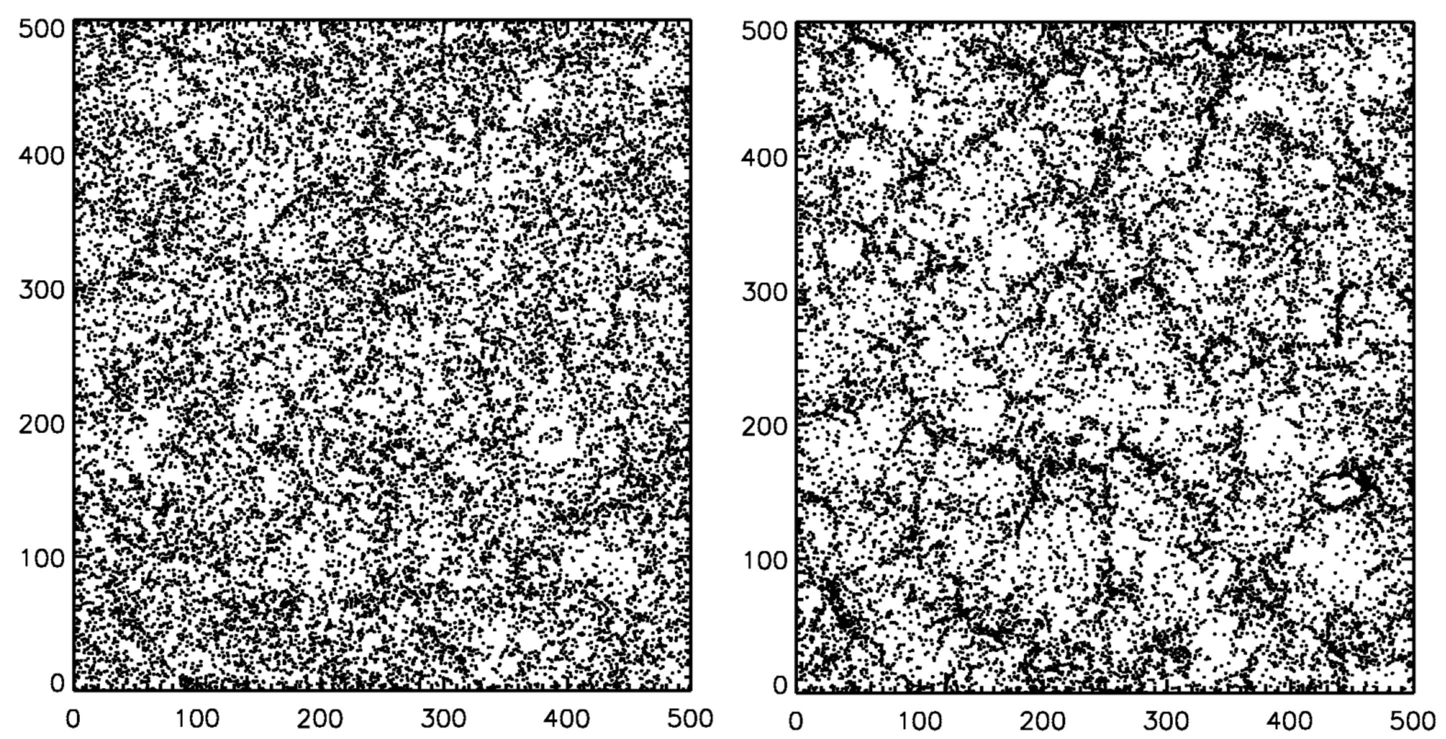
## Motivation

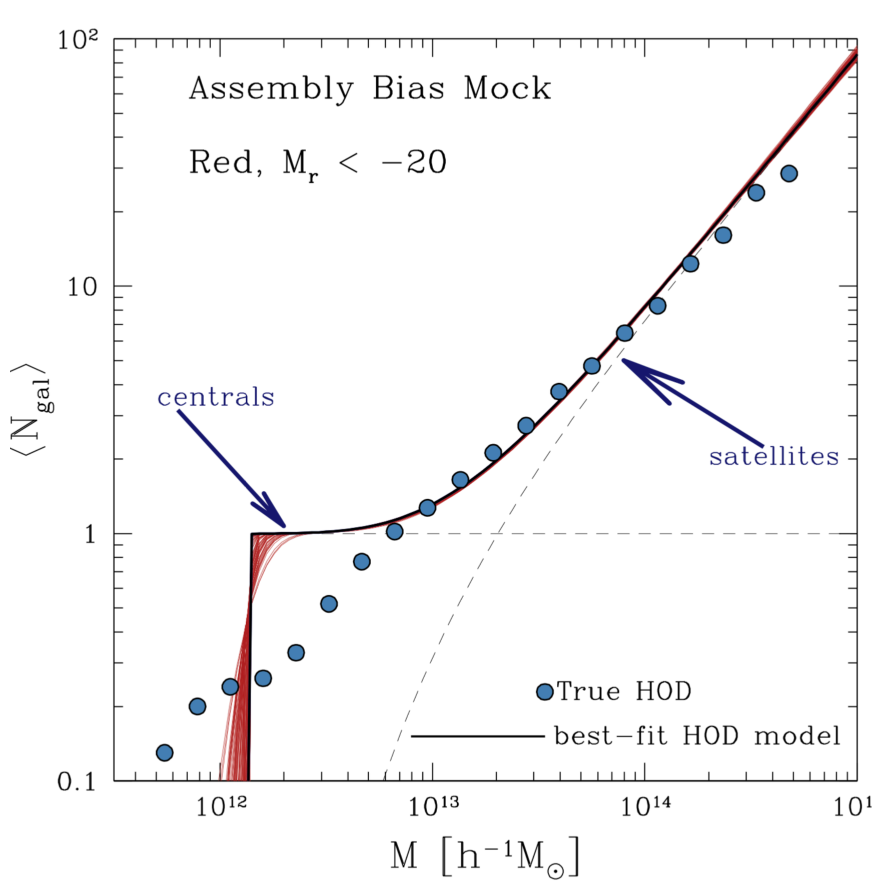
Halo populations of different ages cluster differently.




Comparison of the distribution of young and old halos containing between 100 and 200 particles, in a slice through the Millennium Simulation. The left panel shows the 20% youngest and the right panel shows the 20% oldest of these haloes. In this mass regime, halos that formed earlier cluster more strongly. [1]

If halo clustering depends on halo properties other than mass, it is possible that their galaxy occupation also does. Galaxy assembly bias: dependence of galaxy properties on properties of the halos they reside in besides mass.

Ignoring underlying galaxy assembly bias can lead to systematic errors in the interpretation of data.

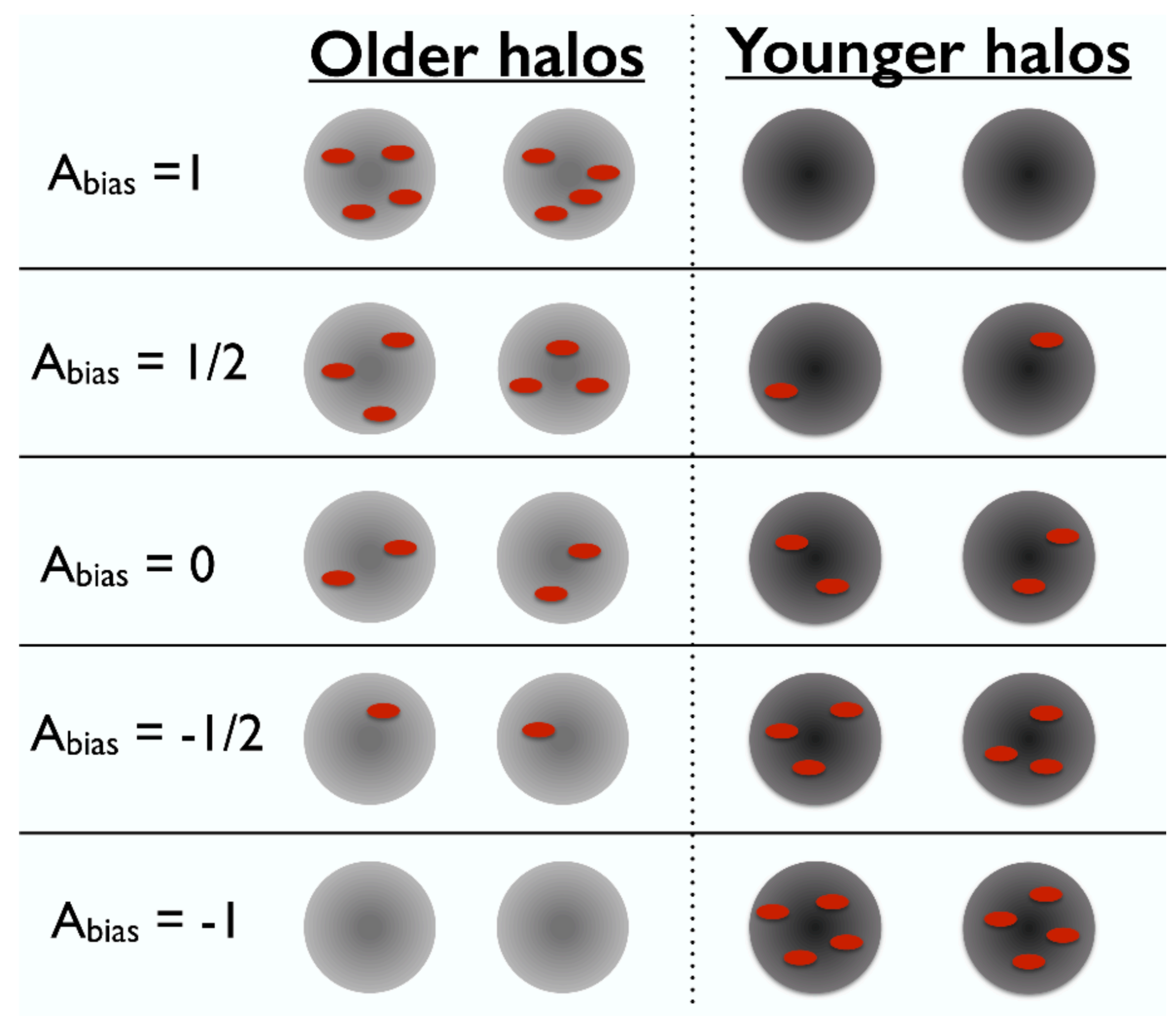



Comparison of the inferred galaxy-halo connection (HOD) models without galaxy assembly bias for red galaxies in the luminosity threshold $M_r < -20$ sample (thick black line and thin red lines) with the true underlying model with galaxy assembly bias used for producing the mock galaxy catalog (points). [2]

## Goal

We aim to identify a set of galaxy observables that efficiently constrains the galaxy-halo connection, especially the strength of galaxy assembly bias in the halo occupation distribution (HOD) framework.

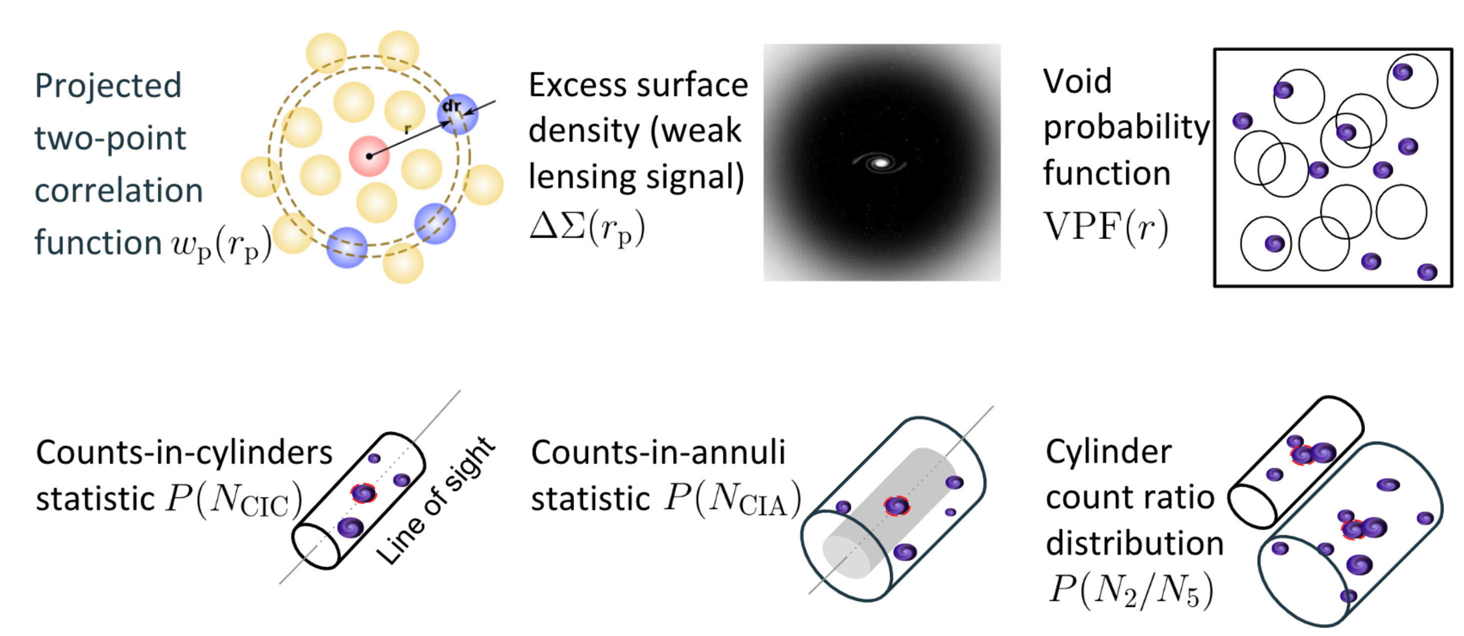
## Galaxy Assembly Bias



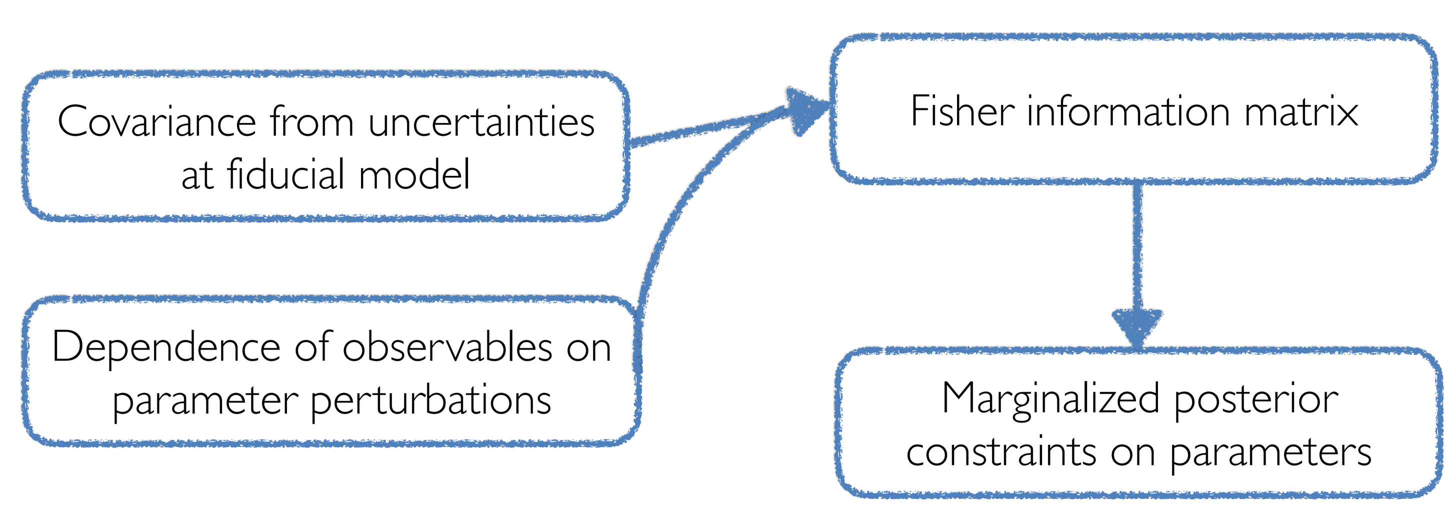

Galaxies populate halos of the same mass differently depending on secondary halo properties such as halo age. [3] We study the dependence of halo occupation on concentration.

## Approach

We investigate multiple statistics of the galaxy distribution including the canonical projected correlation function, and perform parameter constraint analysis on mock galaxy catalogs generated from HOD models by populating halos from the Bolshoi Planck simulation. We compare the constraining power on galaxy assembly bias from different observables.



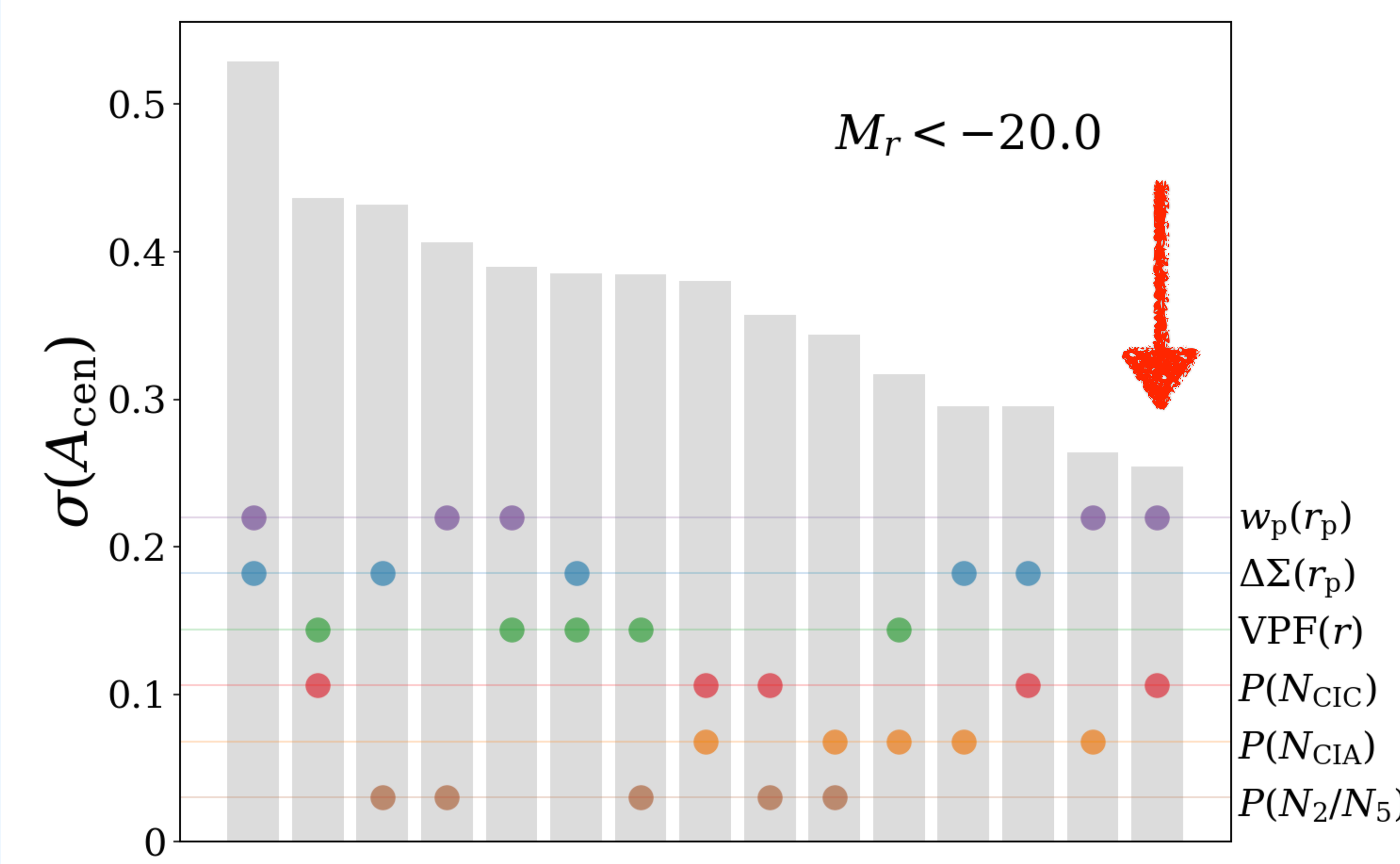

An illustration of the 6 candidate observables we study.




## Data and Simulation

HOD parameters fit from SDSS DR7 measurements, [4,5] and Bolshoi N-body simulation with Planck Cosmology. [6]

## Results




Comparison of constraining power on the central galaxy assembly bias from all the possible combinations of two individual observables. The observable combinations are marked by filled circles, and the constraints are shown in terms of the marginalized 1σ, with smaller values corresponding to tighter constraints.

Counts-in-cells statistics, when combined with the canonical projected two-point correlation function, outperform the traditionally studied combination of correlation function and weak lensing, in constraining central galaxy assembly bias.

## Conclusions

We show that in general, galaxy observables based on counts in cells complement projected correlation functions and efficiently constrain galaxy assembly bias as well as other aspects of galaxy-halo connection.

## Main References

1. Gao et al. 2005, MNRAS.363.66
2. Zentner et al. 2014, MNRAS.443.3044
3. Hearin et al. 2016, MNRAS.460.2552
4. Zehavi et al. 2011, ApJ.736.59Z
5. Zentner et al. 2016, arXiv160607817
6. Klypin et al. 2016, MNRAS.457.4340

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