Cluster Mass Calibration from Cross-correlation Weak Lensing*

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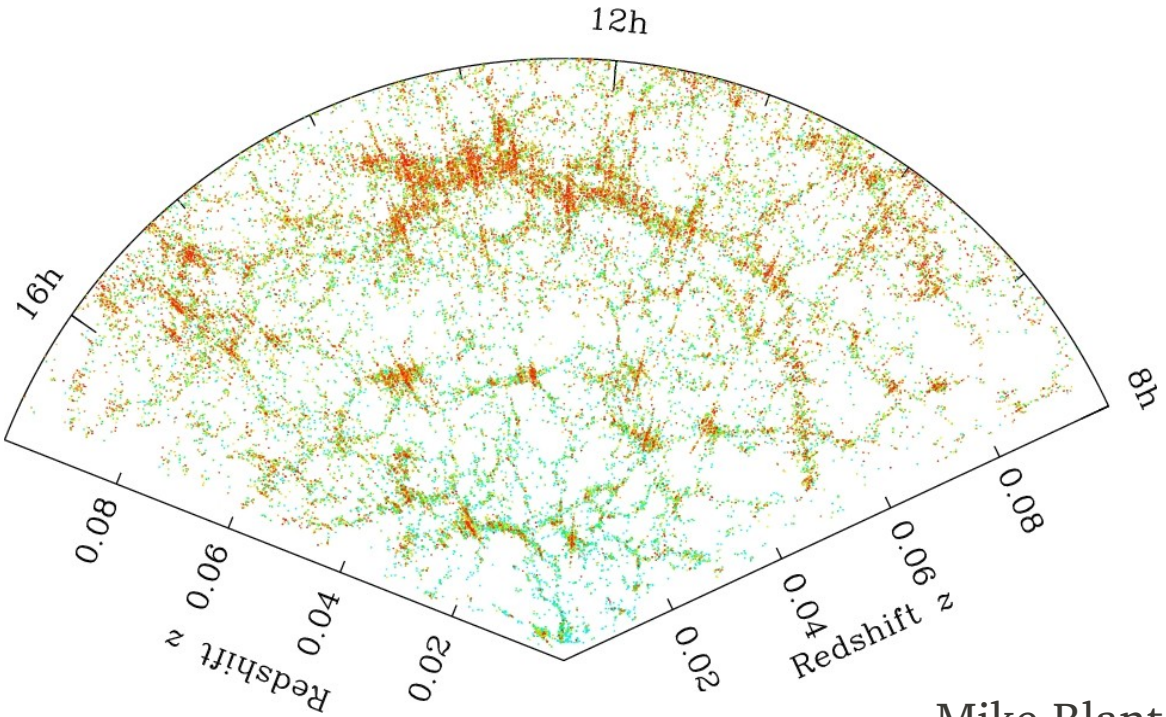
*AKA stacked weak lensing

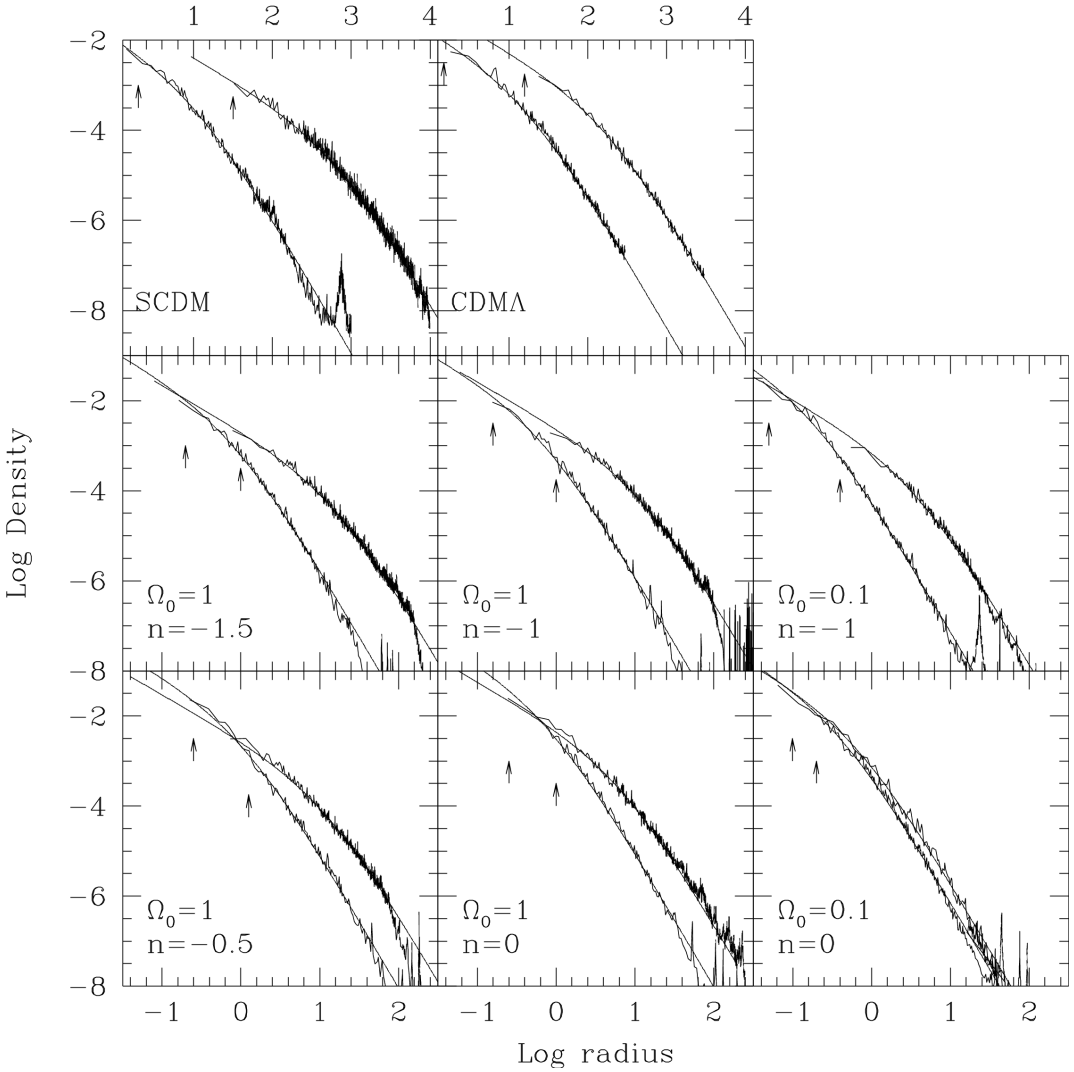
Clusters are Clustered

- Clusters are clustered with other stuff.
- E.g. other clusters, filaments, galaxies both bound and unbound.



Mike Blanton, NYU

NFW 1997


SCDM
CDMΛ
Ω_0=1
n=−1.5
Ω_0=1
n=−1
Ω_0=0.1
n=−1
Ω_0=1
n=−0.5
Ω_0=1
n=0
Ω_0=0.1
n=0
Log Density
Log radius

Clusters are Complex

Coma Cluster
-SDSS

Tri-axial

Merging

Lumpy

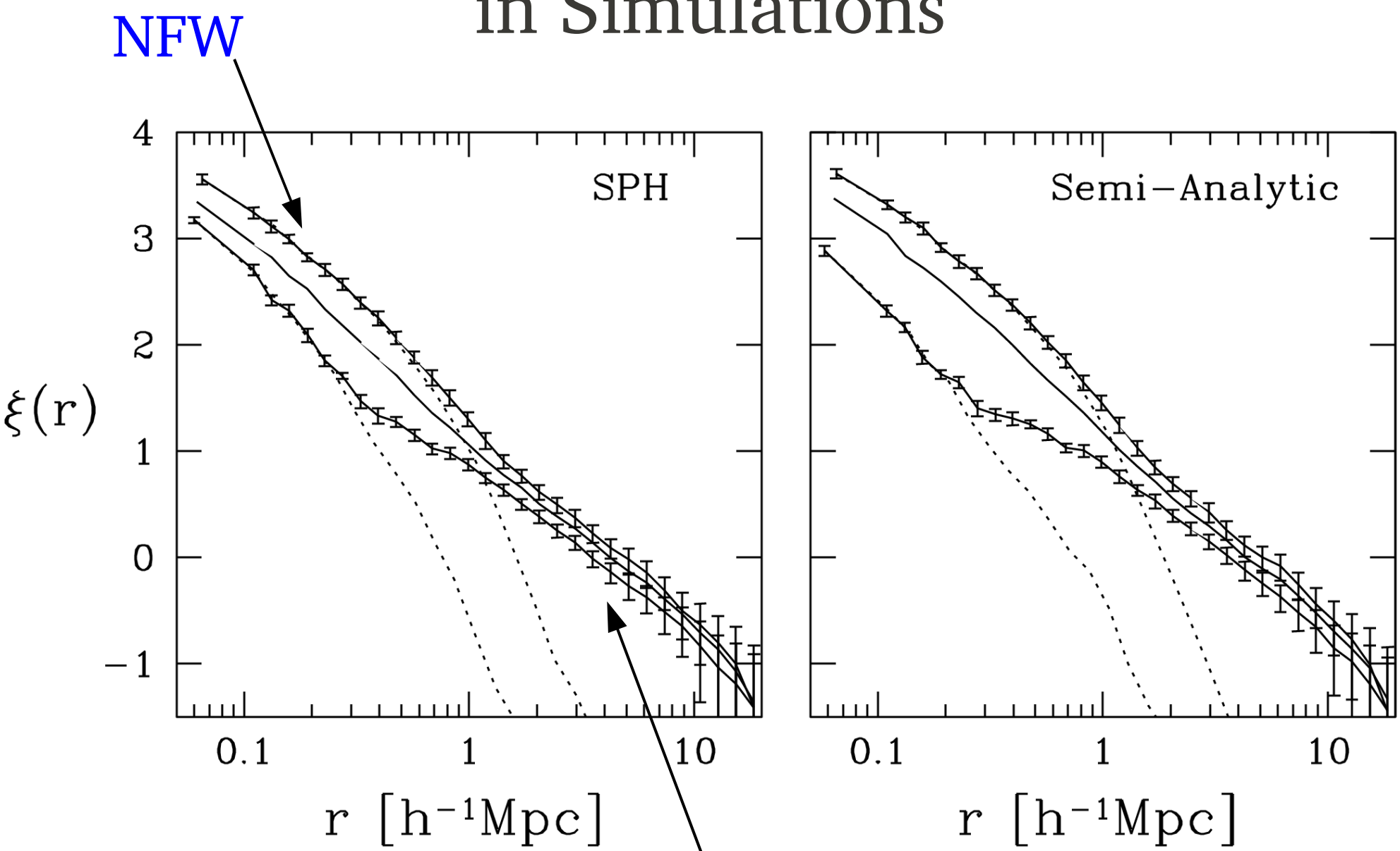
Multiple peaks

Clusters are Clustered and Complex

- There is no way to model these effects on a single cluster
- From simulations we understand the *average* effect i.e. *correlation functions*.
  - Bound material follows an ~NFW profile.
  - The rest of the clustered material follows linear theory, which is known!
- Average the shear and get a correlation function

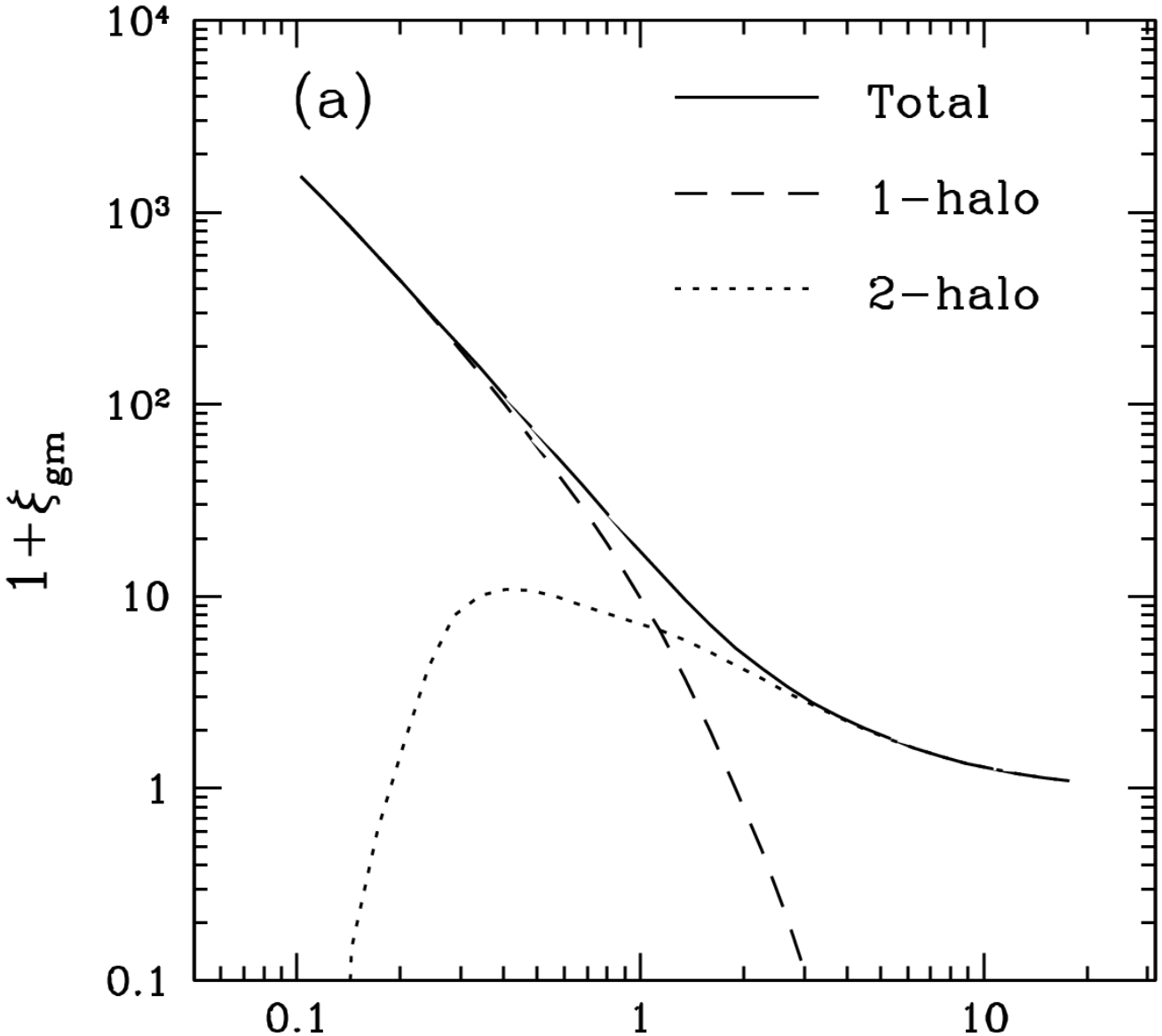
$$\Sigma_{crit} \times \gamma_T = \bar{\Sigma}(< R) - \bar{\Sigma}(R)$$

Correlation Functions in Simulations



Andreas Berlind

1-Halo and 2-Halo split



Yoo et al.

There is Stuff in Projection

- Clusters and Galaxies (more shear)
- Voids (less shear)
- But all of this averages down to the linear term when you average over enough lines of sight. There is nothing new here.
- In other words, only the clustered material contributes. The "mass-sheet degeneracy" actually **helps**!

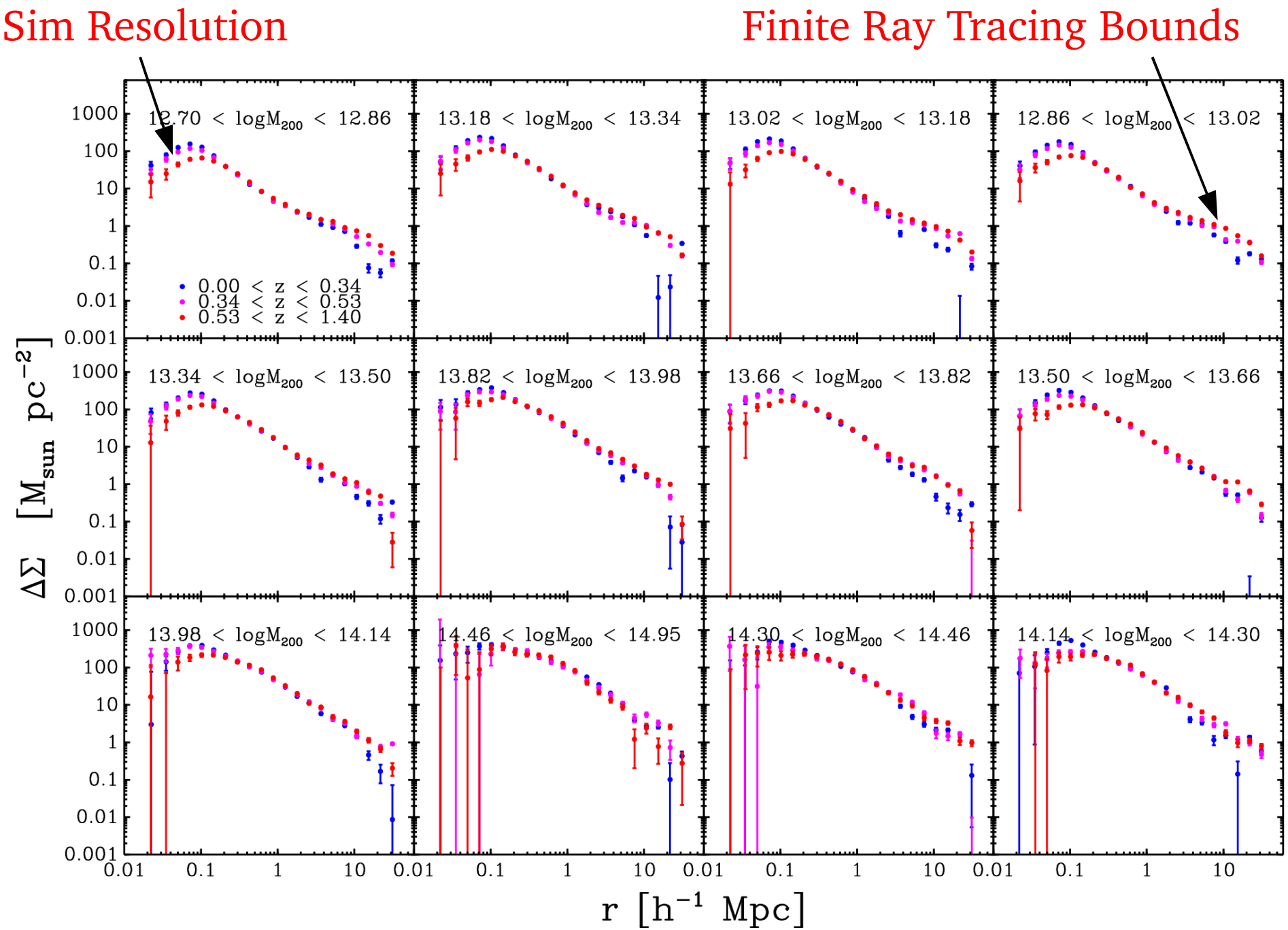
$$\langle \Sigma(< r) - \Sigma(r) \rangle \quad \rightarrow \quad \langle \rho(r) - \overline{\rho} \rangle$$

Reducing Systematics

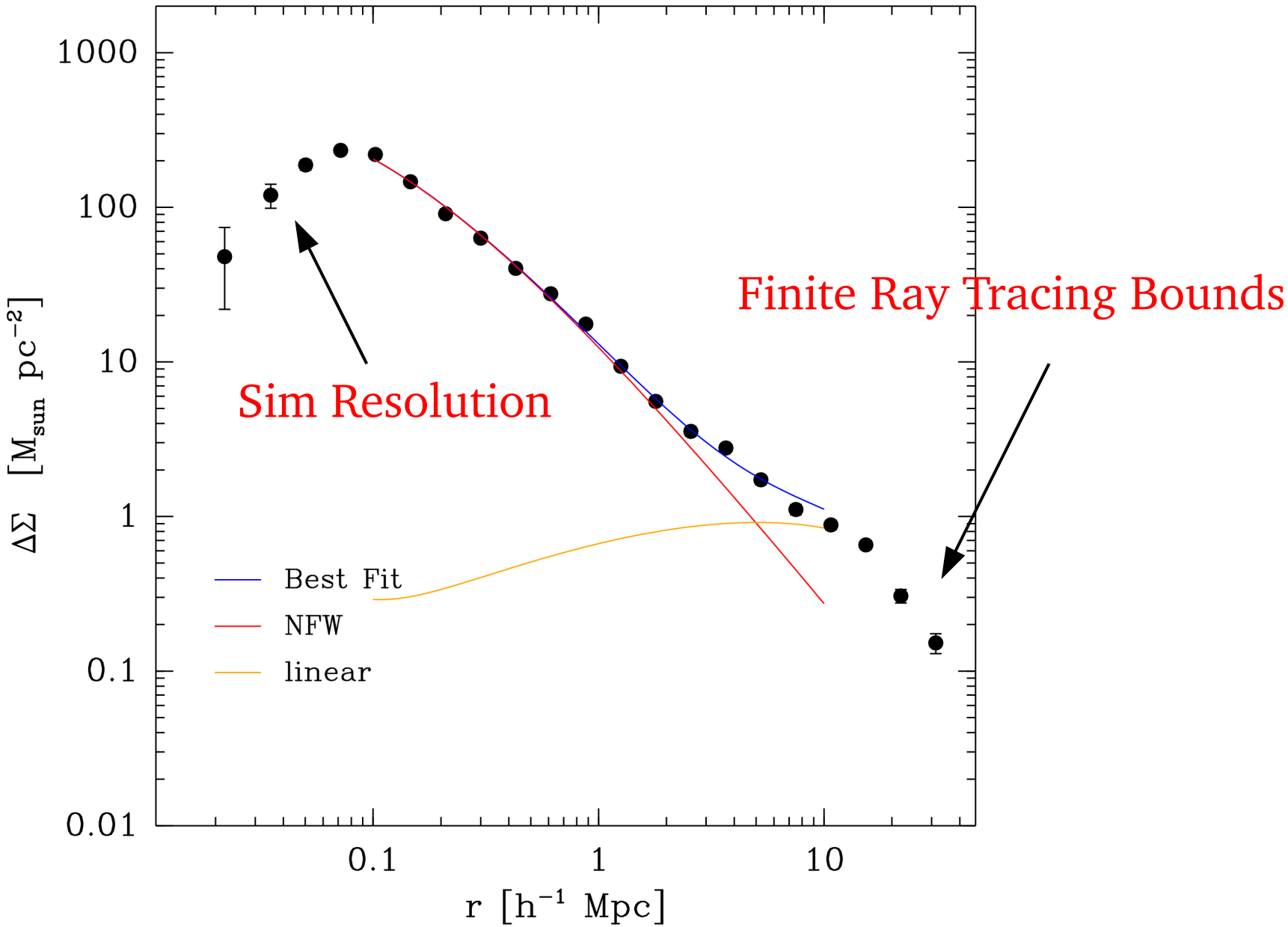
- Can examine stacked random points over DES footprint
  - Any shear around randoms should be an additive systematic: can be subtracted
- Can correct for mis-centering statistically

Application to DES Simulations

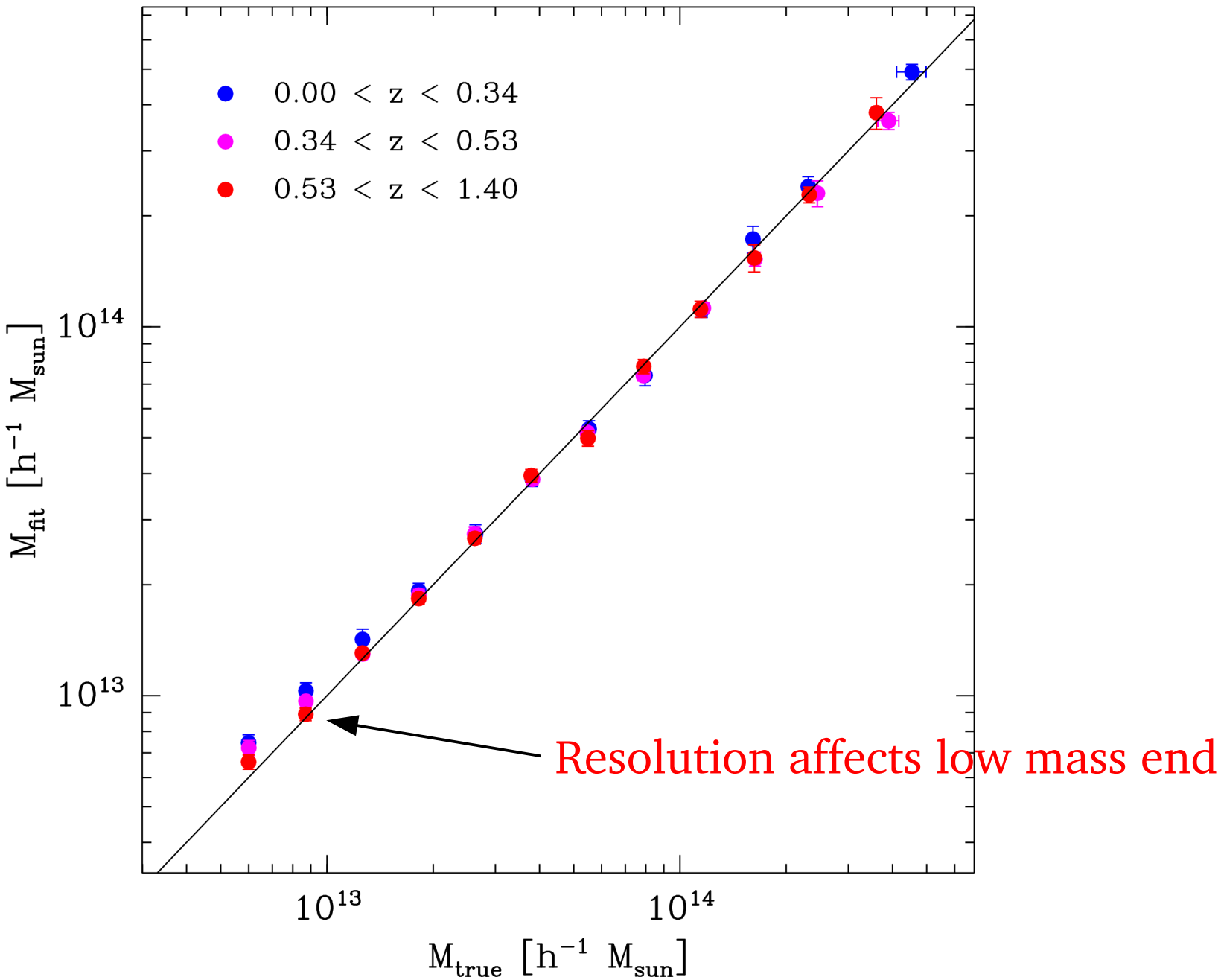
Perfect redshifts, true halo center, binned by mass



NFW+Linear Fits

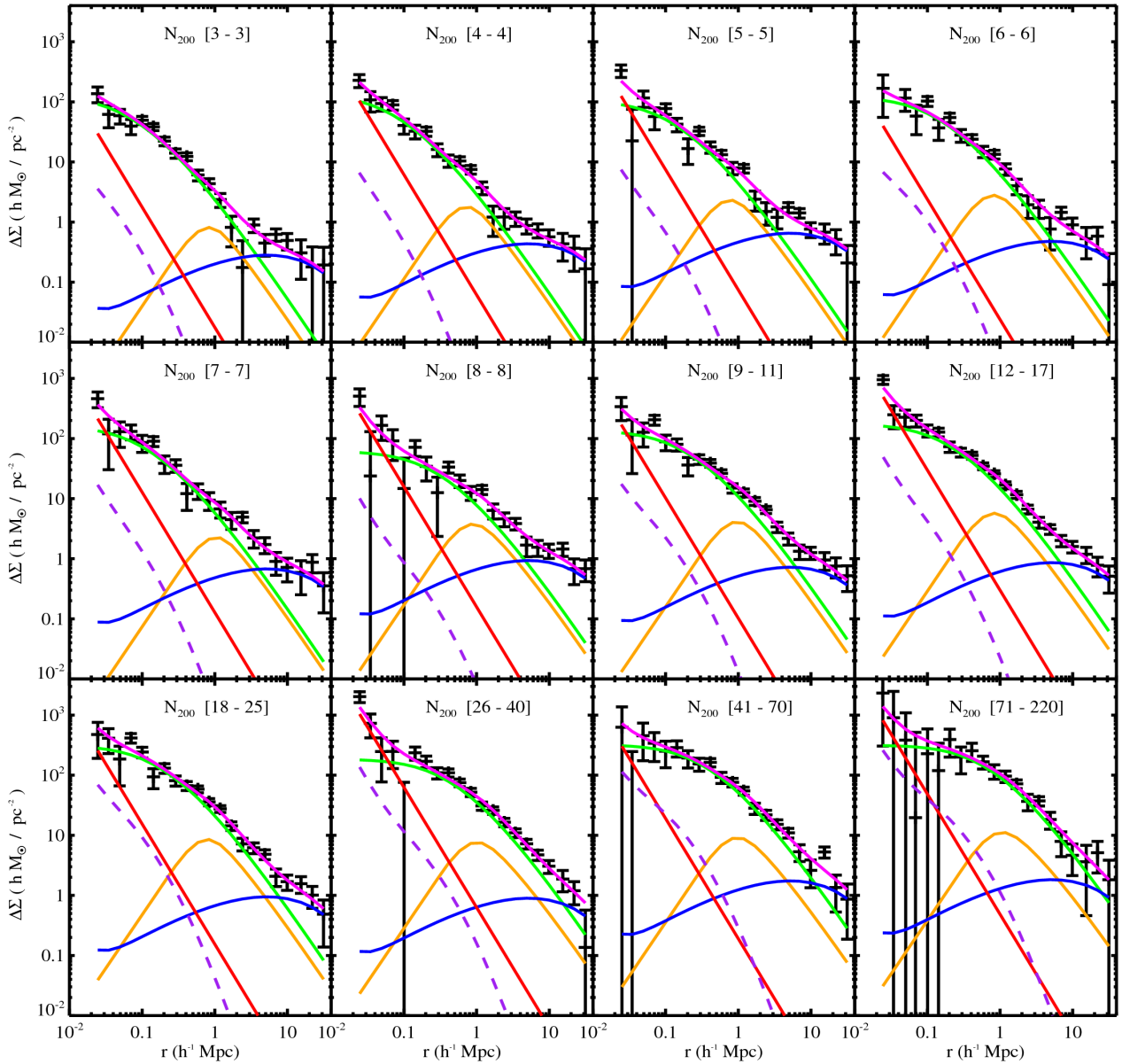


Fit Mass vs true Mass

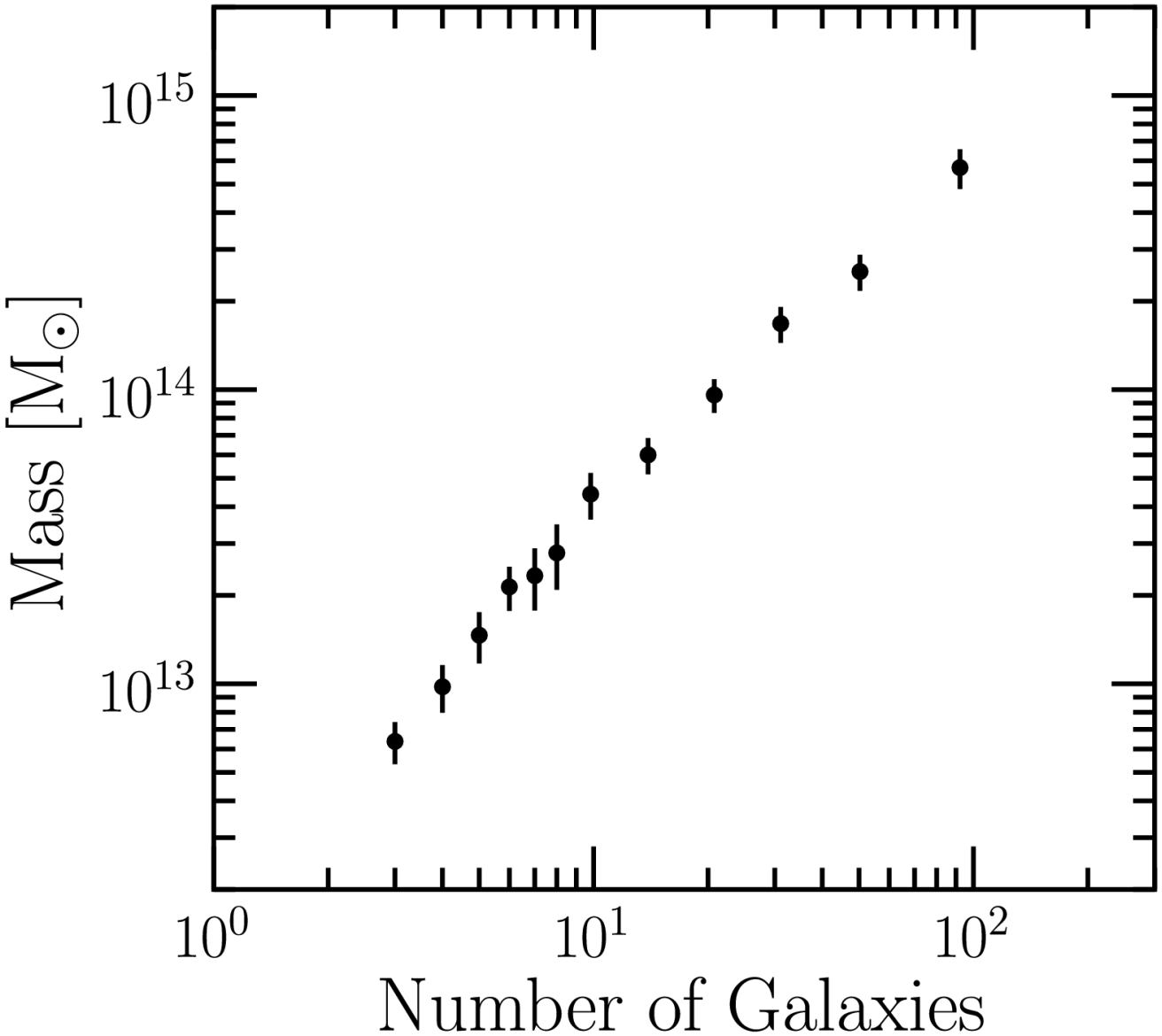


Application to SDSS MaxBCG

Photo-z, mis-centering, bin by galaxy counts, BCG



MaxBCG Mass-Ngals



Summary

- Stacking simplifies interpretation
  - Projection effects and clustered material reduce to linear correlation function (**known!**).
  - Unlike individual measurements, unlikely to discover cool things e.g. the bullet cluster
- Can remove additive systematics.
- By using correlation functions we leverage the knowledge of the large scale structure community