H-1. Cl: Optimized methods for absolute cluster mass calibration

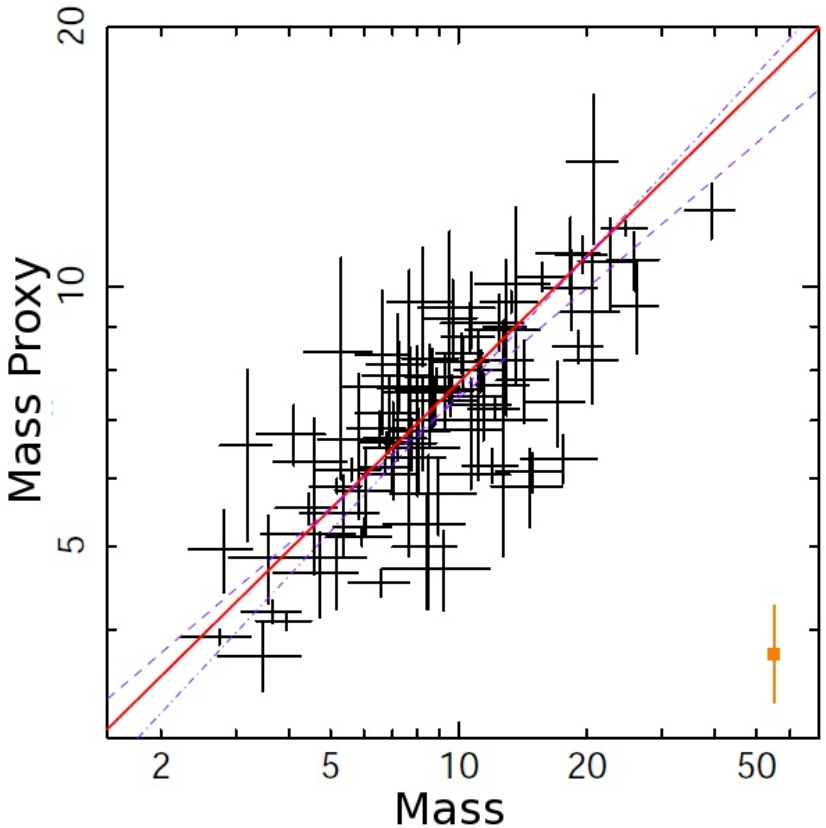
Douglas Applegate

4 Dec 2013 : DESC Face to Face

Outline

Outline

Mass Proxies



Mantz et al, 2010

Need to Measure:

- Slope
- Scatter
- **Normalization**

Currently: $\approx 7\%$ Uncertainty ($M_{500} > 3 \times 10^{14} M_{\odot}$; Applegate et al, 2013)

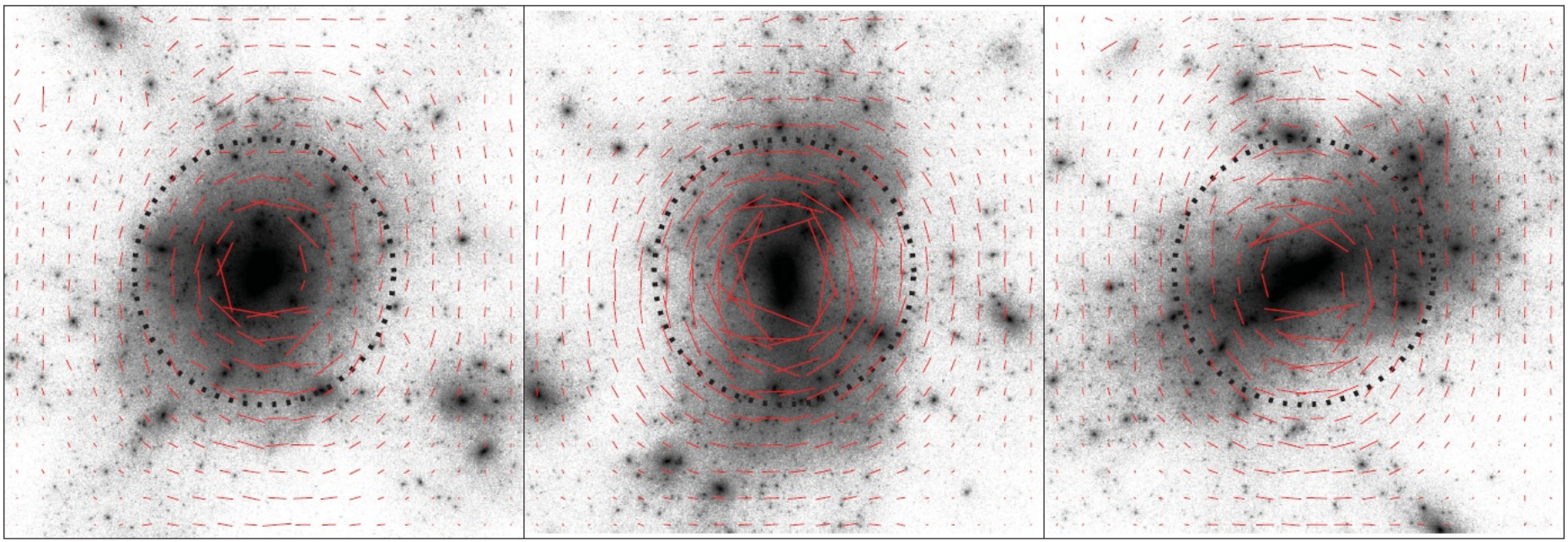
Will Need: $\approx 1\%$ for LSST (Wu et al, 2010)

What is the Task?

Motivation:

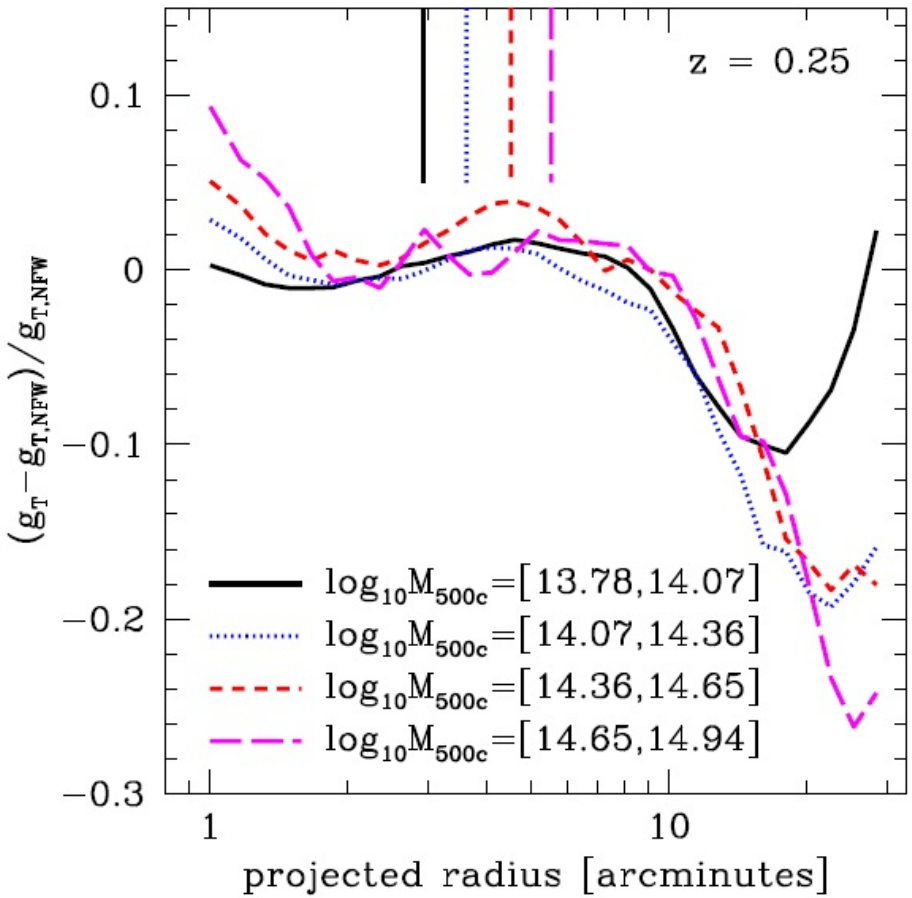
- WL cluster masses sets absolute cluster mass scale
- WL masses unbiased in principle, but *can be* in practice
- Biases come from:
  - Galaxy shape measurement
  - Redshift distribution
  - **Assumed mass profile**
  - Finite sampling ensemble w/intrinsic scatter

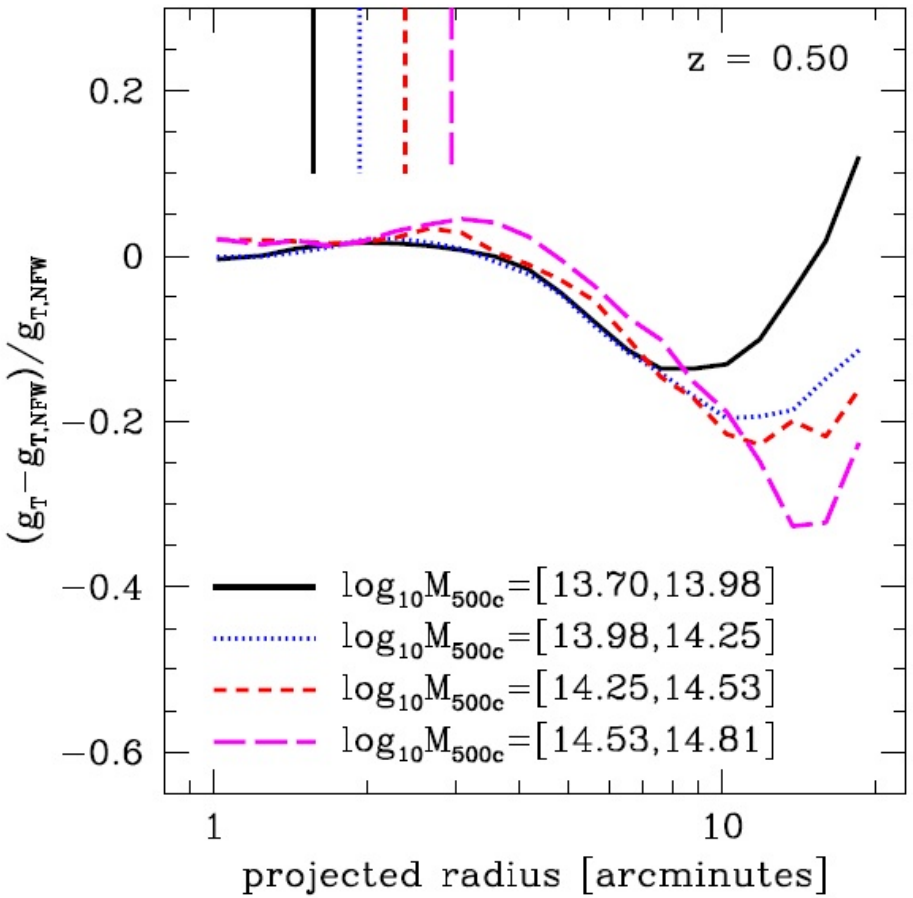
Clusters are Messy



Bahé et al., 2012. $M_{200} = 4 \times 10^{15} M_{\odot}$

Simulated Cluster Shear Profiles





Becker & Kravtsov 2011

What is the Task?

Activities:

- Use cosmological, ray-traced simulations
- Include realistic galaxy populations for miscentering, noise estimates
- Quantify mean bias & scatter wrt redshift, mass for different algorithms

Target: 1% Uncertainty in Bias

Same simulations can contribute to H-3: Photo-z & cluster contamination task.

Are We Repeating Work?

- Becker & Kravtsov 2011, Oguri & Hamana 2012, Bahé et al. 2012, ...
- But methods, choices *not the same* as observational studies
- Need to integrate complicating effects (see later...)

Breaking Down the Bias

Question to us: What do we need from simulators?

How well do we need to know bias in:

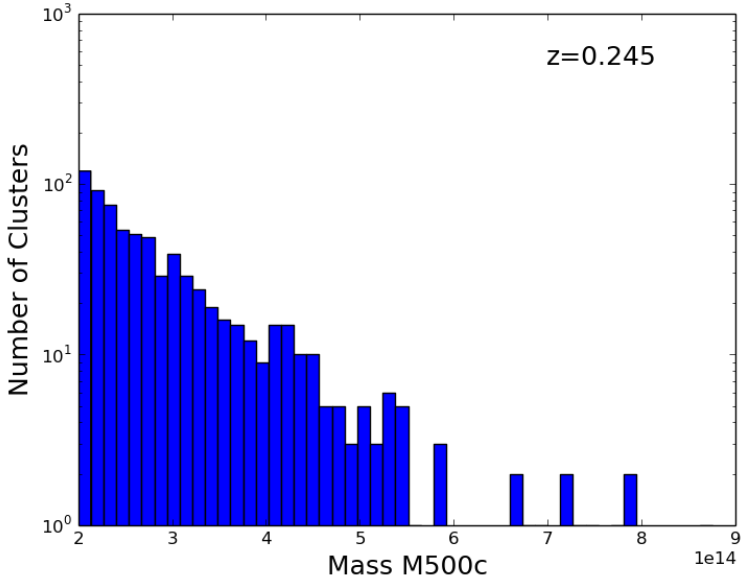
- mass? (and down to what mass?)
- redshift?
- cosmology?

What else needs to be added to simulations?

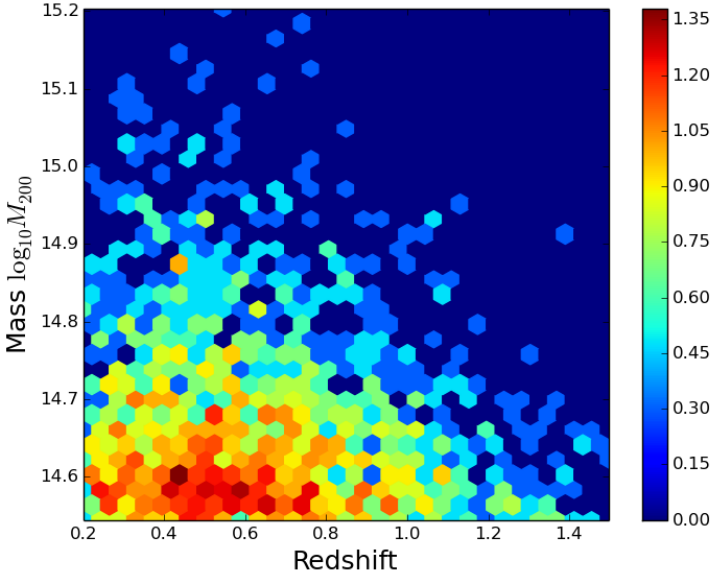
Outline

Simulations in hand

Becker & Kravtsov 2011



BCC Aardvark (Wechsler et al.)



- More halos available at lower masses, other redshifts.
- What mass measurement do we need to calibrate?

Current Tests

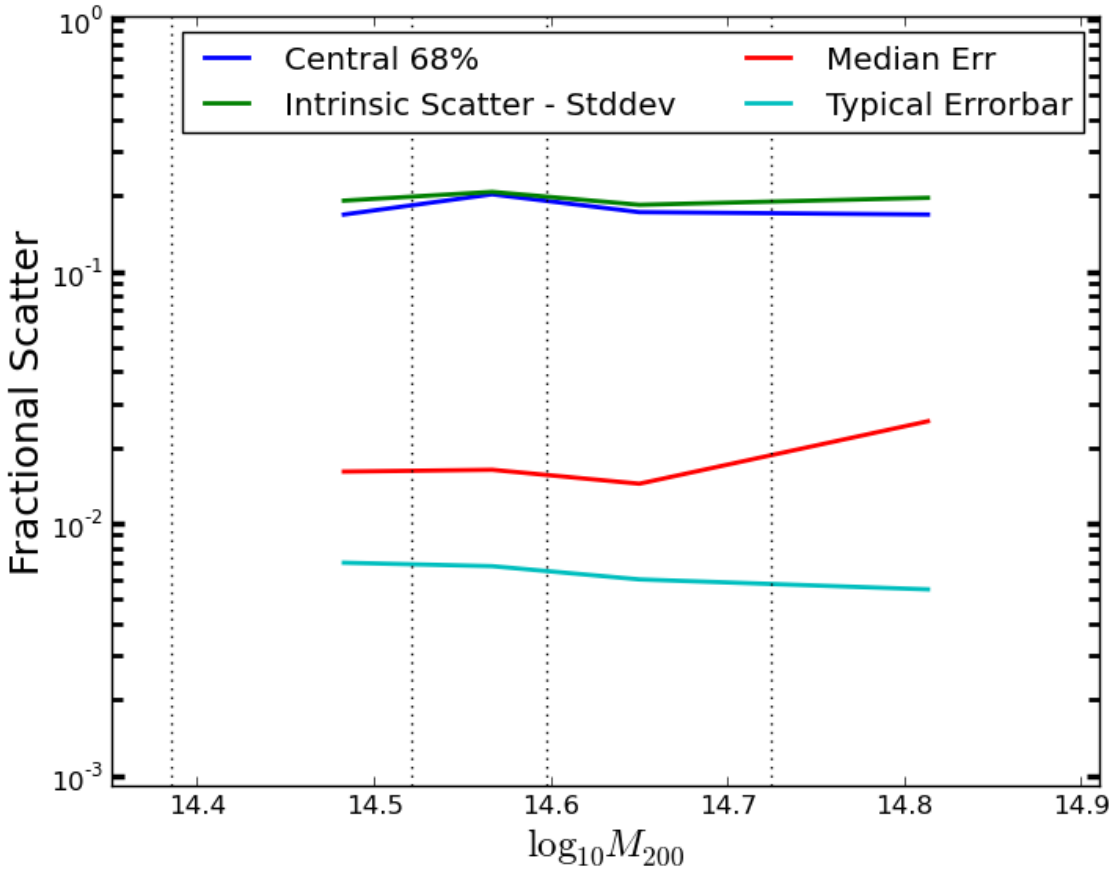
- Simulations: BK11 vs BCC Aardvark
- NFW Halo Fit: Inner fit radius (500kpc vs 750kpc)
- NFW Halo Fit: Mass-Concentration (c=4 vs Duffy08)
- NFW Halo Fit vs Mass Aperture

So far: Still understanding simulation & method IO, validating simulations.

Good back & forth: Finding bugs in simulations & interface code (HT: Wechsler, Becker, Buscha, Dietrich)

Scatter in Simulations

Preliminary!

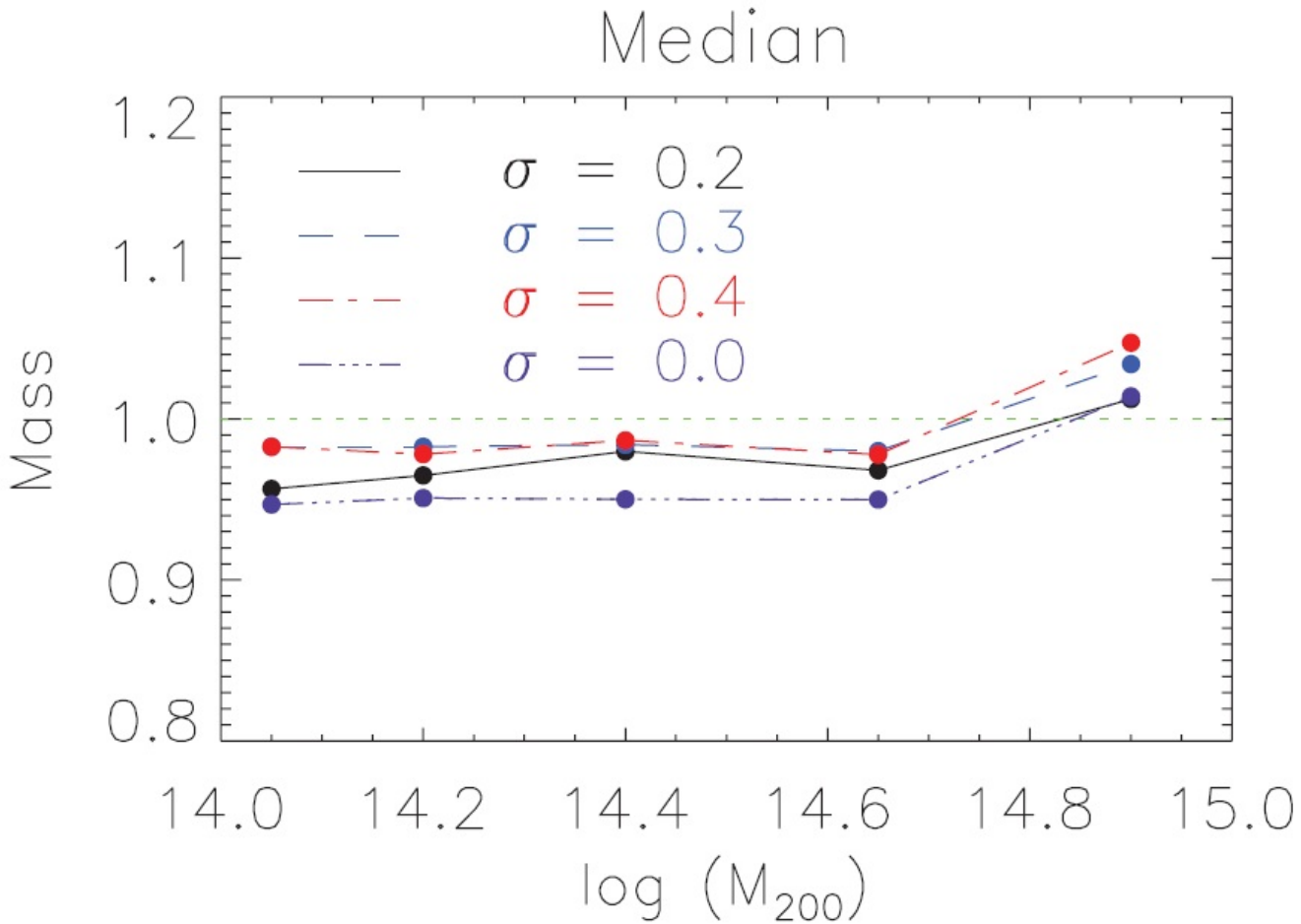


BK11 Sims

Outline

Effects of Noise on Bias

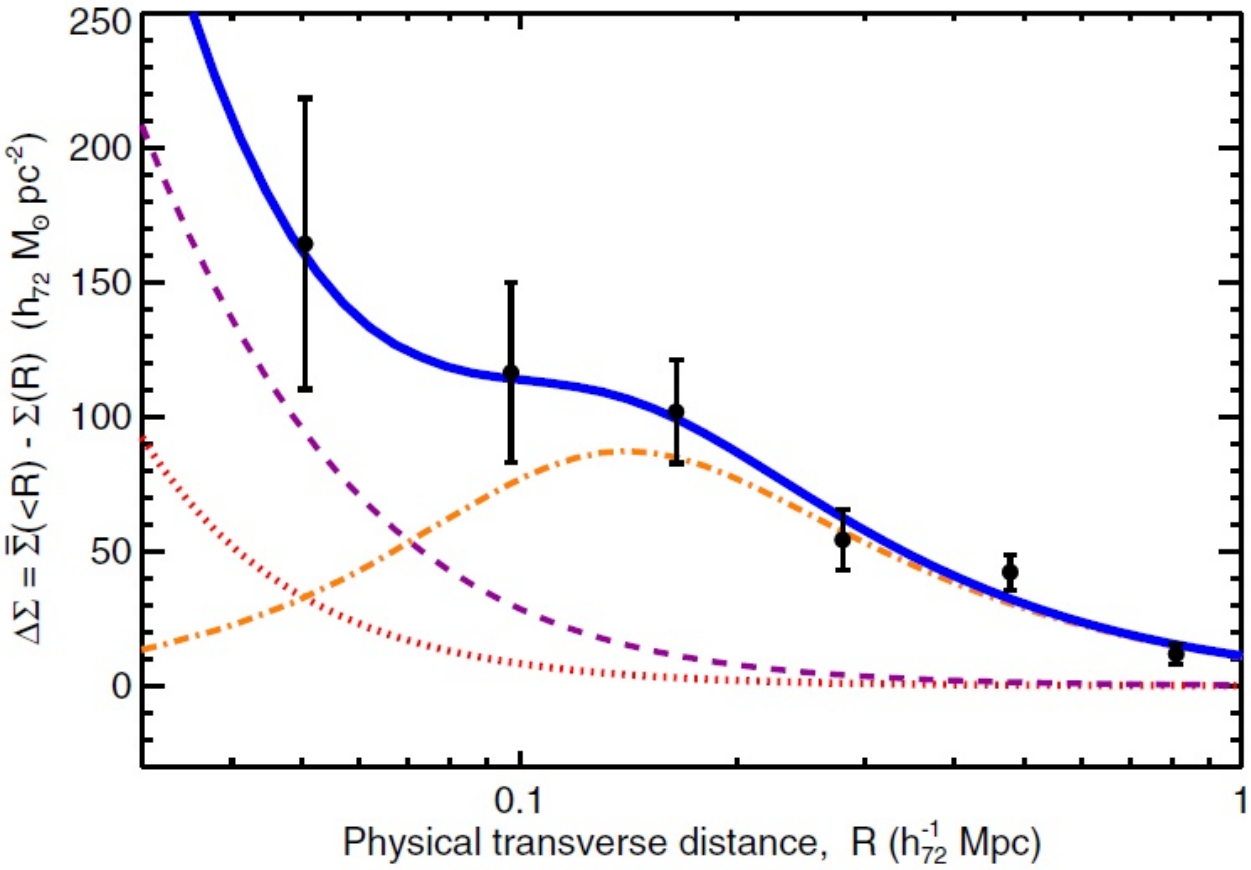
Shape noise smooths out substructure:



Bahé et al., 2012

Effects of Miscentering

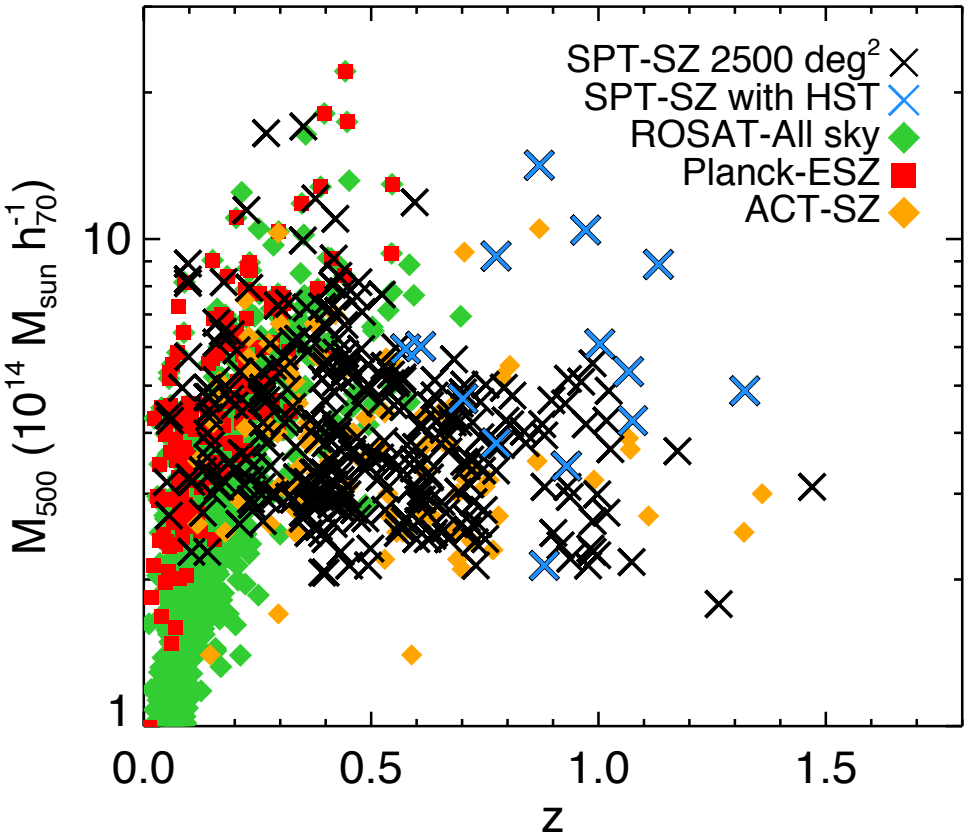
Miscentering stochastically alters expected profile:



George et al., 2013

Cluster Selection

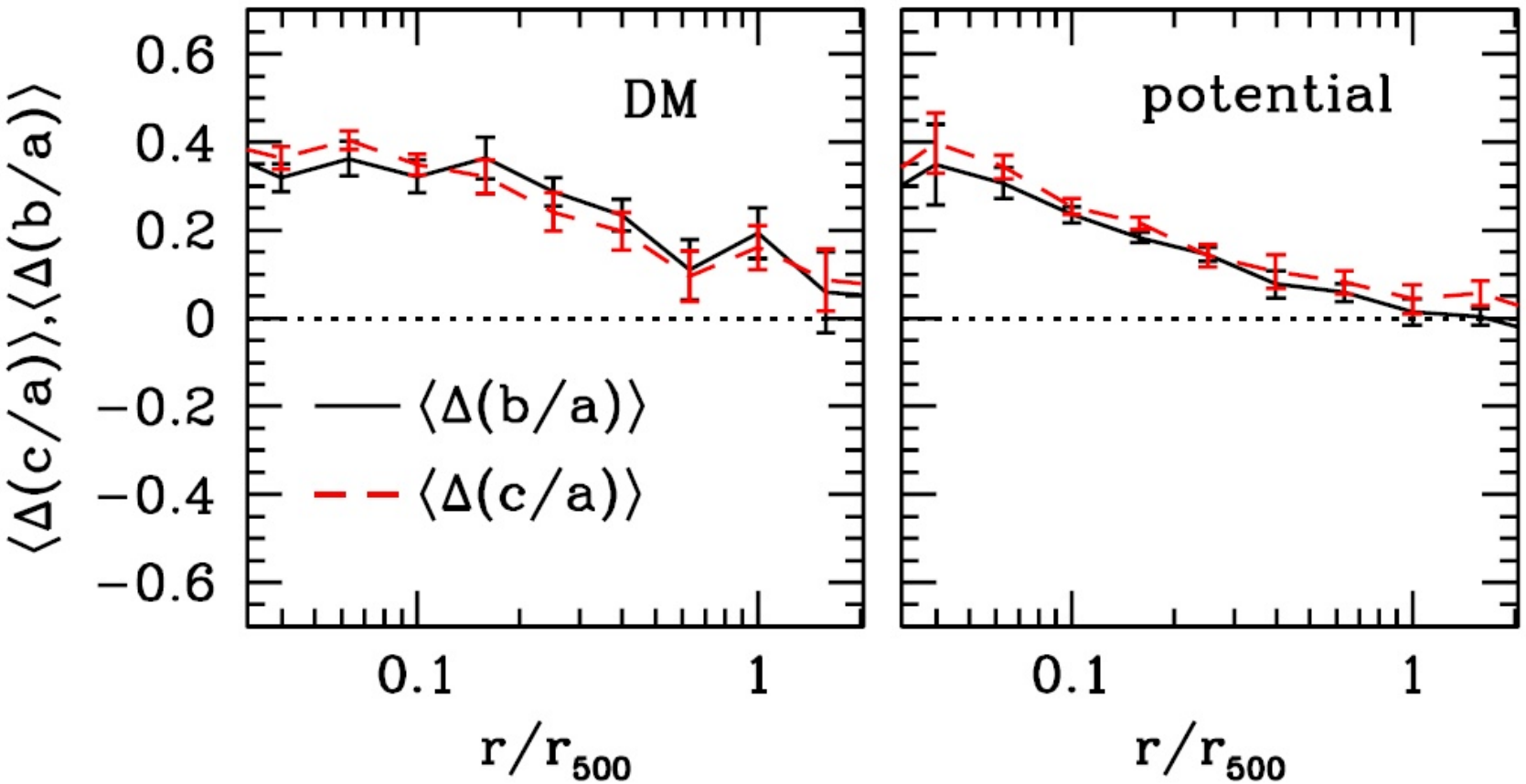
- Optical, X-ray, or SZ
- Different halo selections
  - Mass, redshift distribution
  - Purity & Completeness
- Miscentering distribution



Benson, priv comm

Baryonic Effects

Do baryons change the halo shape?



Lau et al., 2011

Simulation Effects

- Resolution: Is M_{500} accurately measured for least massive clusters?
- Centering: Are halo centers accurate enough?
- Galaxy populations: Realistic distributions (& offsets) for cluster galaxies?

A Plea: Software & Simulation Interfaces

- Considerable time spent on understanding simulation, mass codes I/O
- Many future simulations expected
- Many custom algorithms expected (Shear Profile, Mass Aperture, Mandelbaum2010, ...)
- Need to agree on a standard format (including allowing non-ΛCDM)

We will need to standardize for the computing group **regardless**.

Summary

- Work started w/ ray-tracing simulations
- Most complications currently ignored
- Currently seeing $< 2\%$ statistical uncertainty, mass-binning dependent $(2 \times 10^{14} < M_{200} < 1 \times 10^{15})$
- Question: How good do we have to do?
- Plea: Need to standardize code interfaces

Back-up Slides