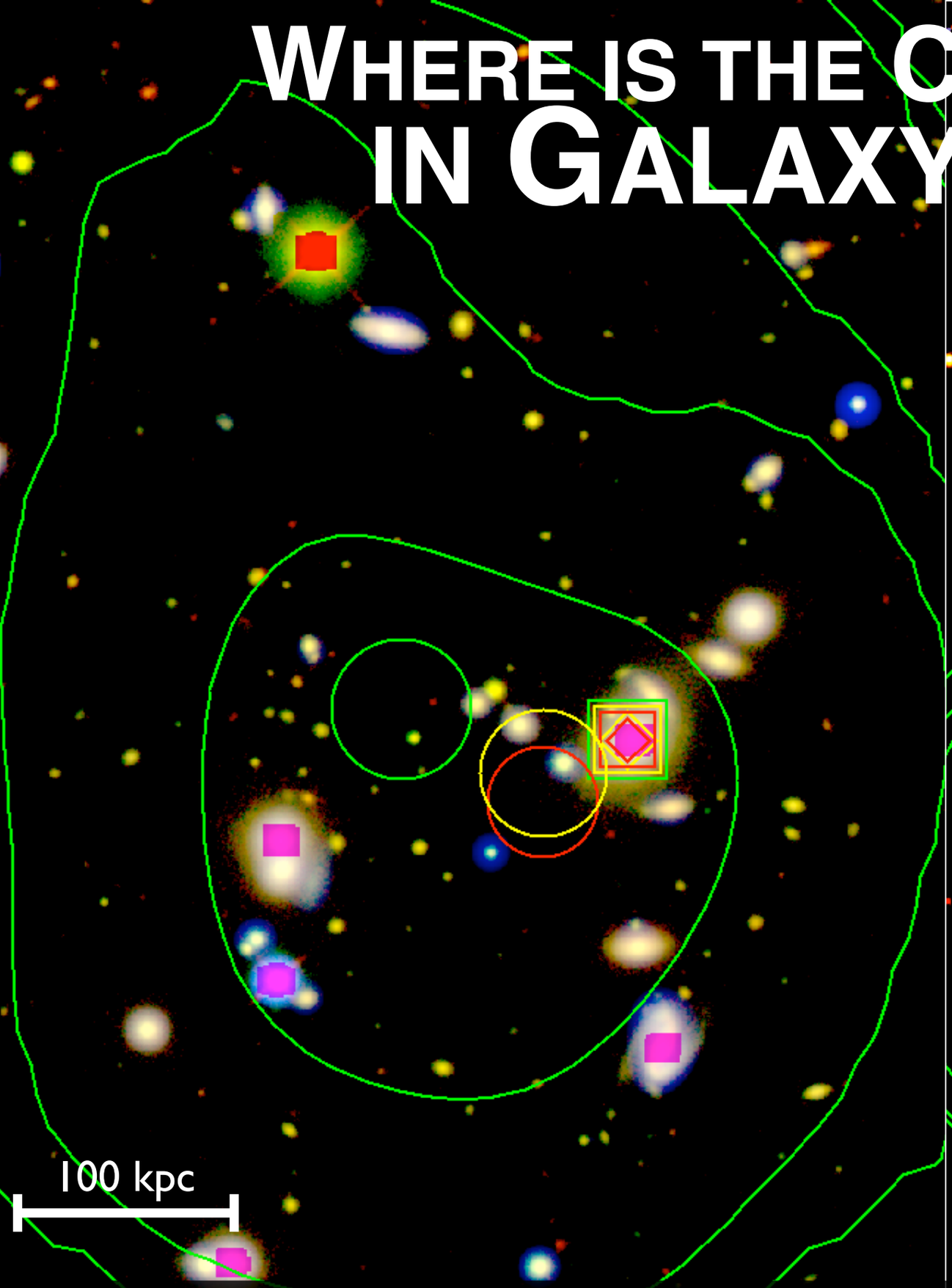
Where is the Center of Mass in Galaxy Groups?



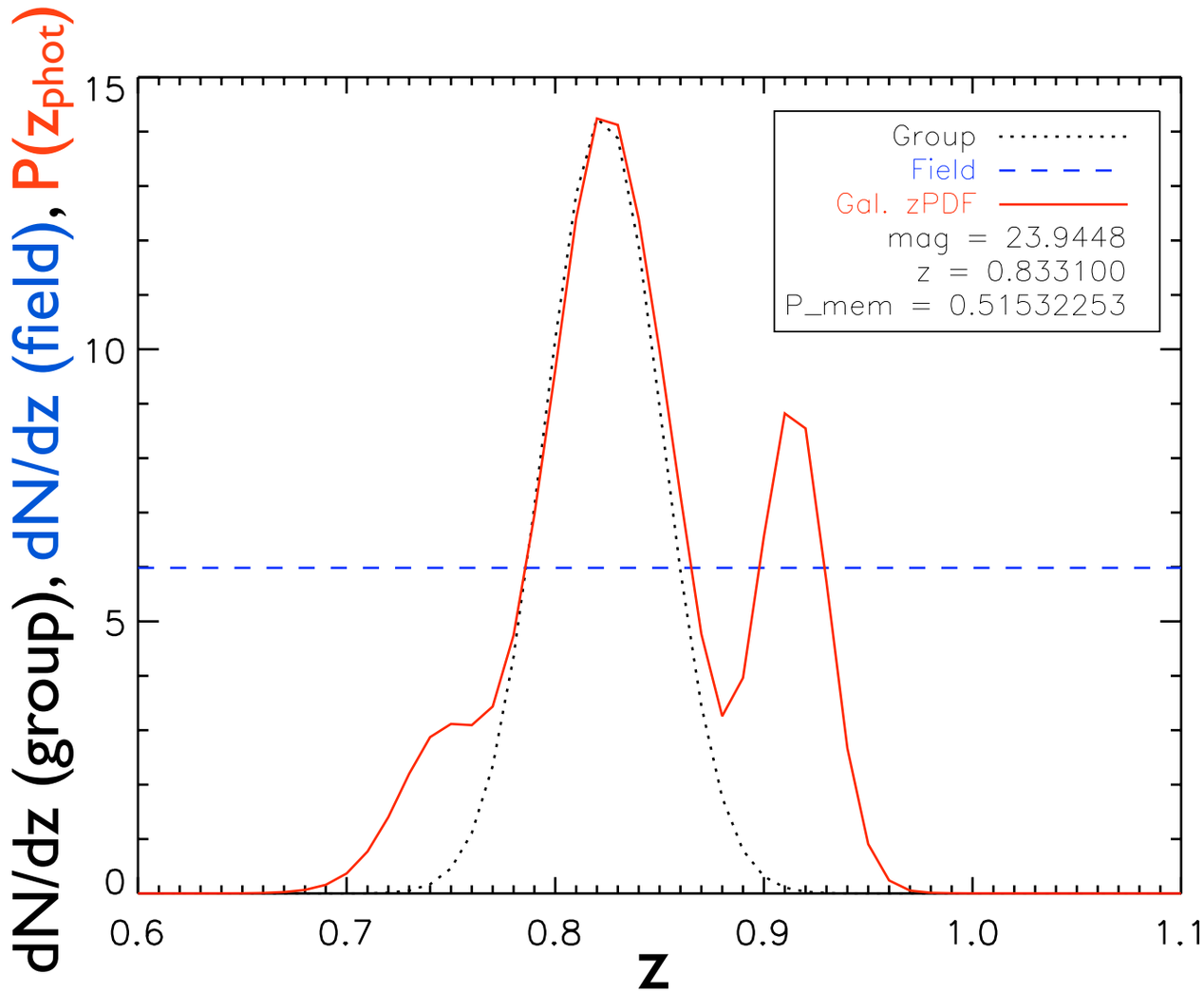
Matt George
UC Berkeley

with Alexie Leauthaud, Kevin Bundy, Jeremy Tinker, Peter Capak, Alexis Finoguenov, Olivier Ilbert, Simona Mei and the COSMOS Collaboration

Member Selection with Photometric Redshifts

Start with X-ray centers
(positions uncertain to ~200 kpc)

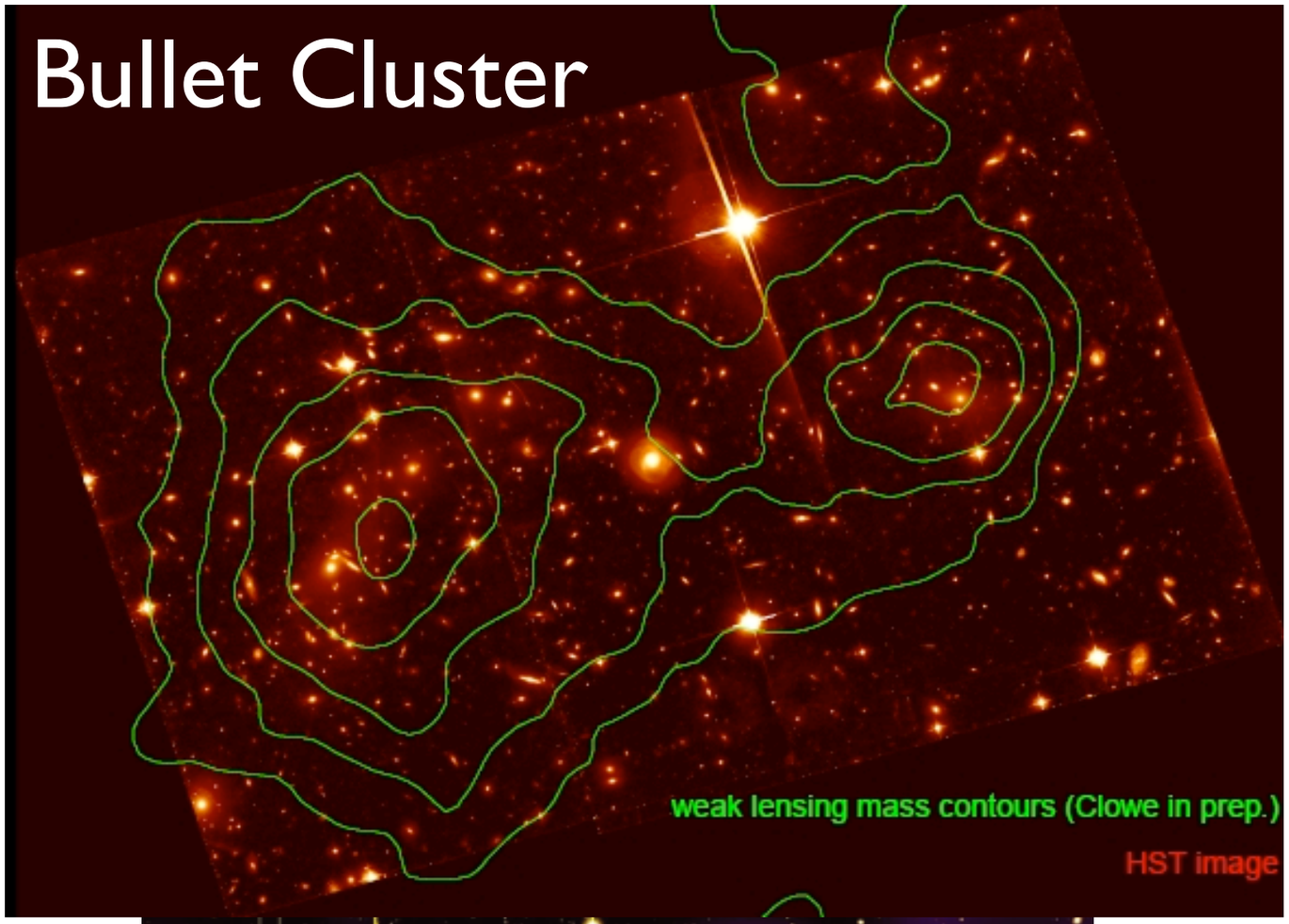
Identify member galaxies using
photoz probability distribution
+ measured field/group densities

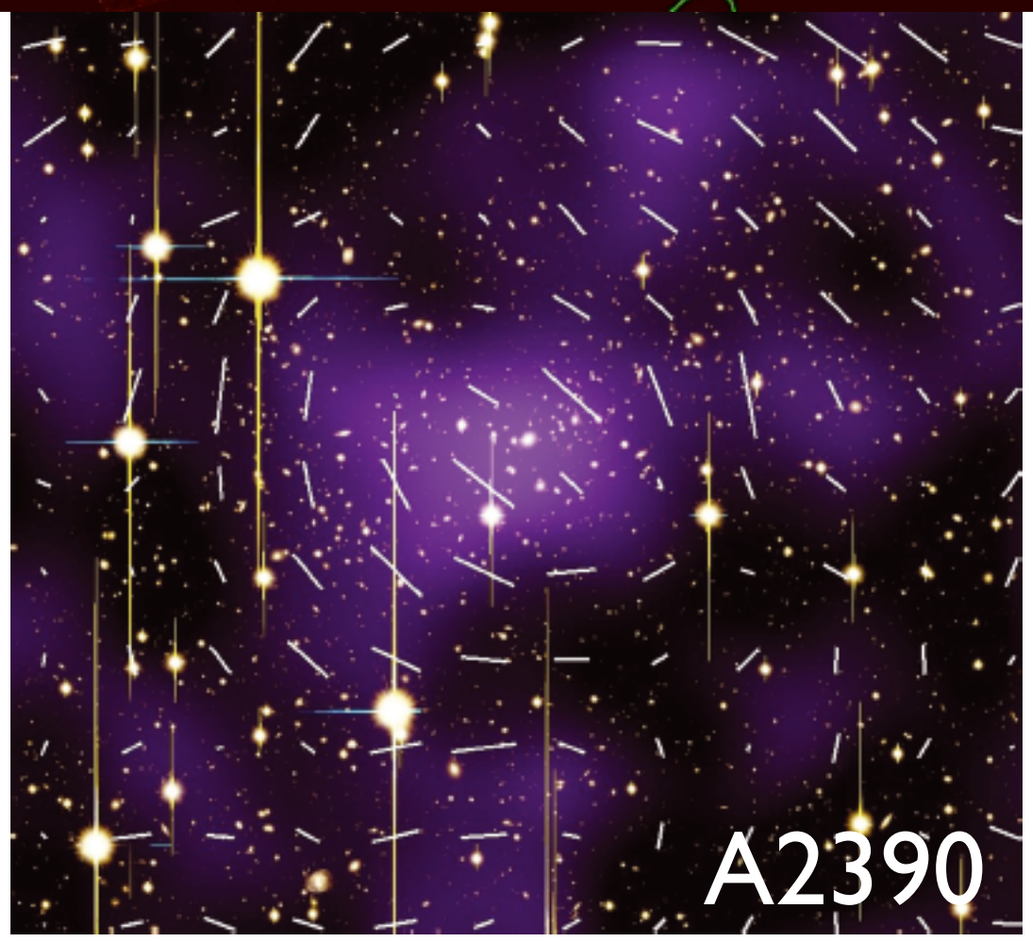


$$P(g \in G|\mathcal{P}(z)) = \frac{P(\mathcal{P}(z)|g \in G)P(g \in G)}{P(\mathcal{P}(z))}$$

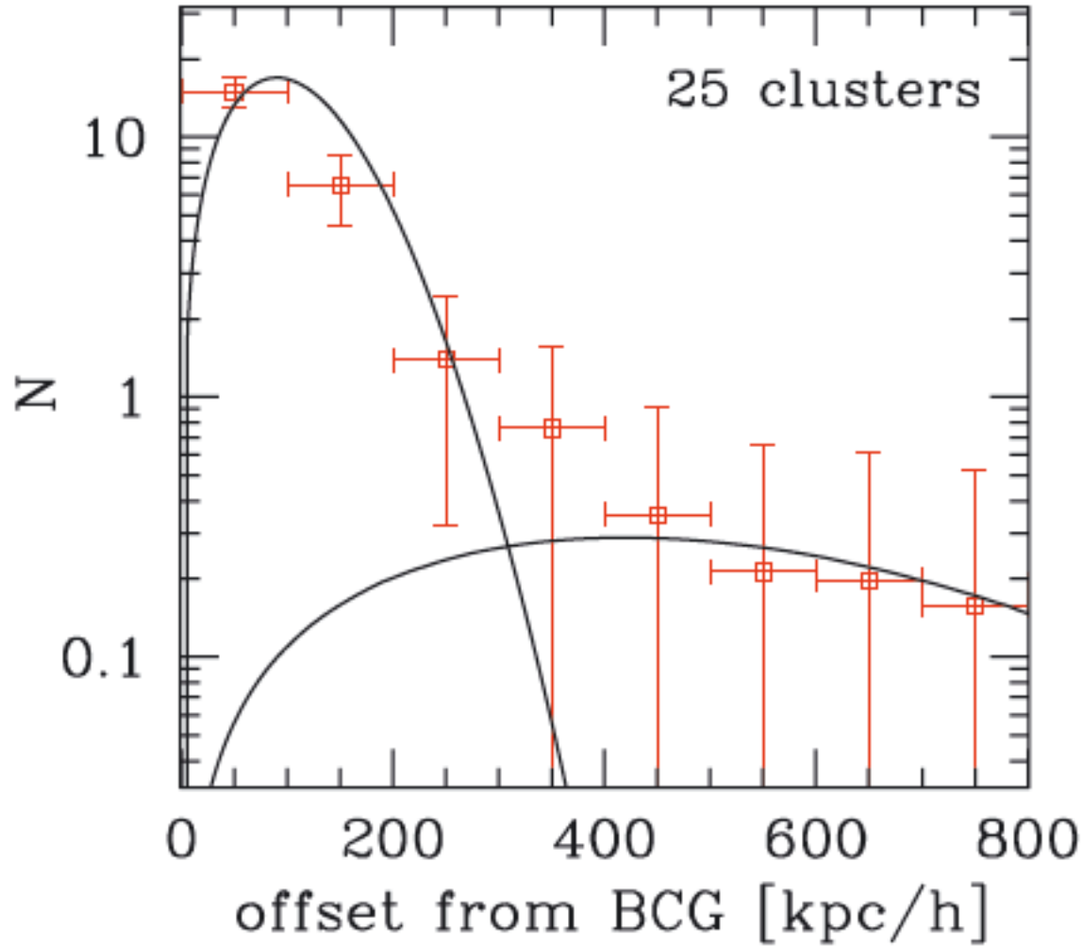
Good photoz's!

- Photometry in 31 UV/Opt/IR bands
- $\sigma(z_{spec}\text{-}z_{phot}) <\sim 0.01$ for $m_i < 23$, $\sigma \sim 0.03$ for $m_i < 24$
- ~94000 galaxies with $0<z<1$, $m_{F814W} < 24.2$
- ~3500 total members in 120 groups
- PDF gives good estimate of redshift uncertainty





Finding Group Centers



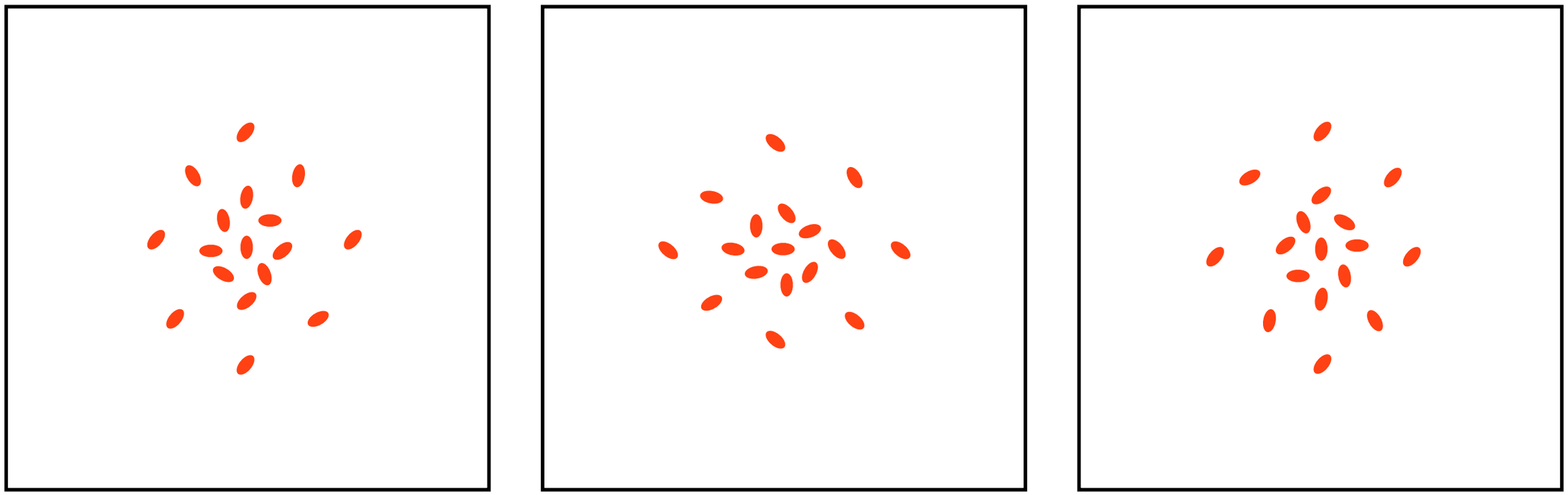
Oguri et al. 2010

Stacked Weak Lensing

Cluster 1

Cluster 2

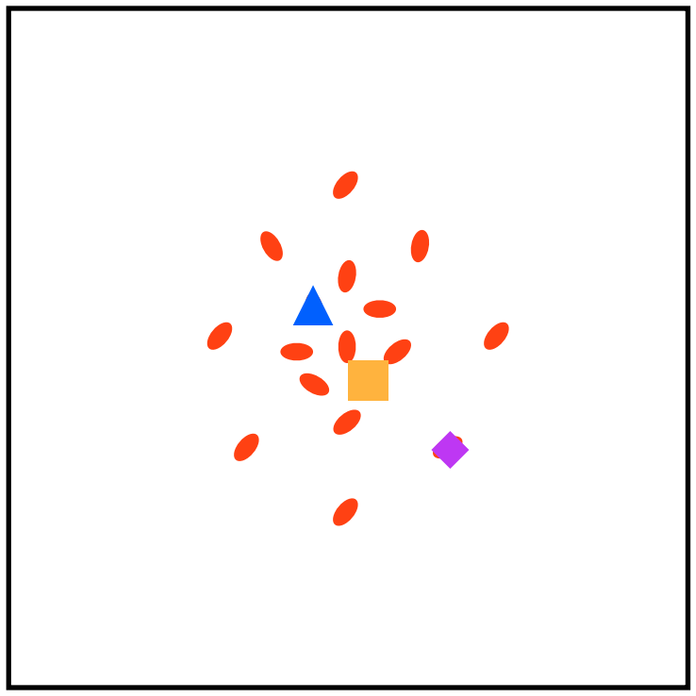
Cluster 3



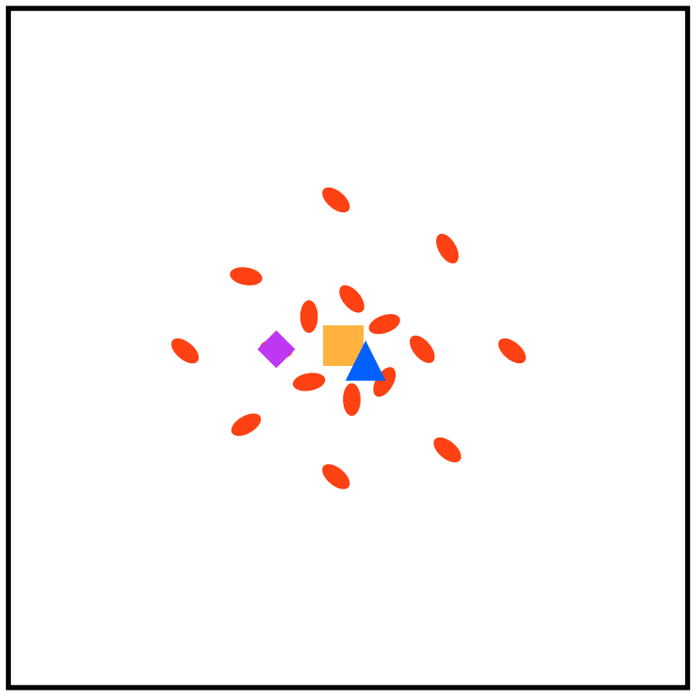
1. Find members ...

Stacked Weak Lensing

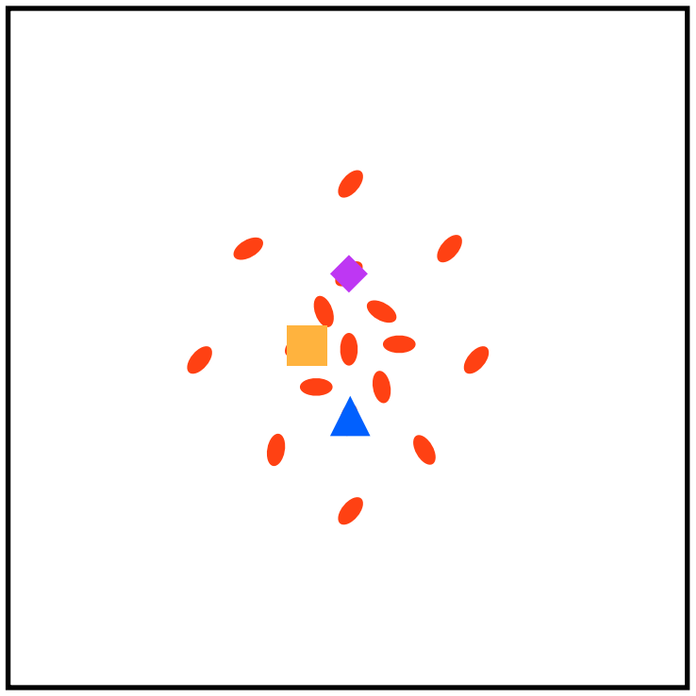
Cluster 1



Cluster 2



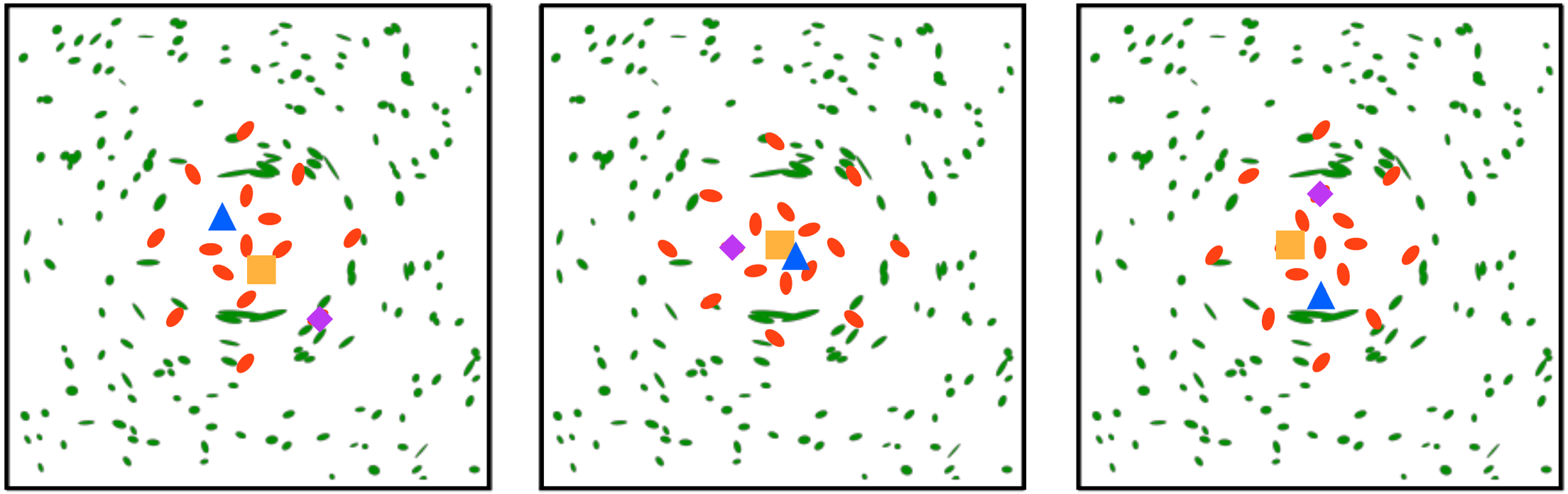
Cluster 3



1. Find members
2. Determine centers

Stacked Weak Lensing

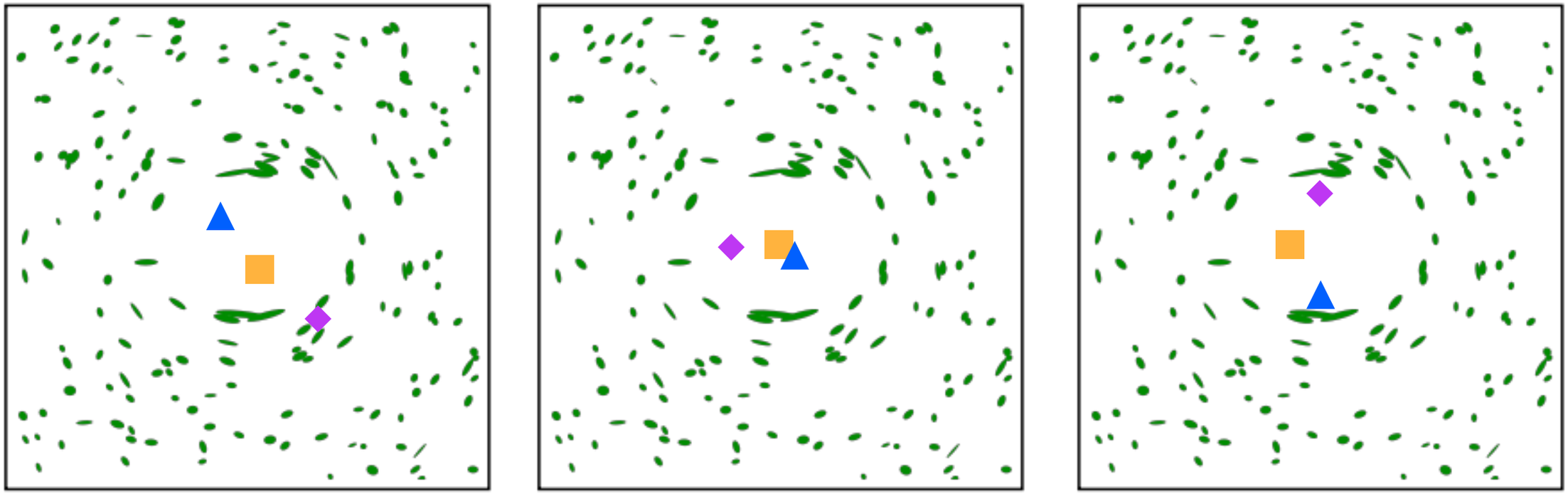
Cluster 1 | Cluster 2 | Cluster 3



1. Find members
2. Determine centers
3. Measure shapes of background sources

Stacked Weak Lensing

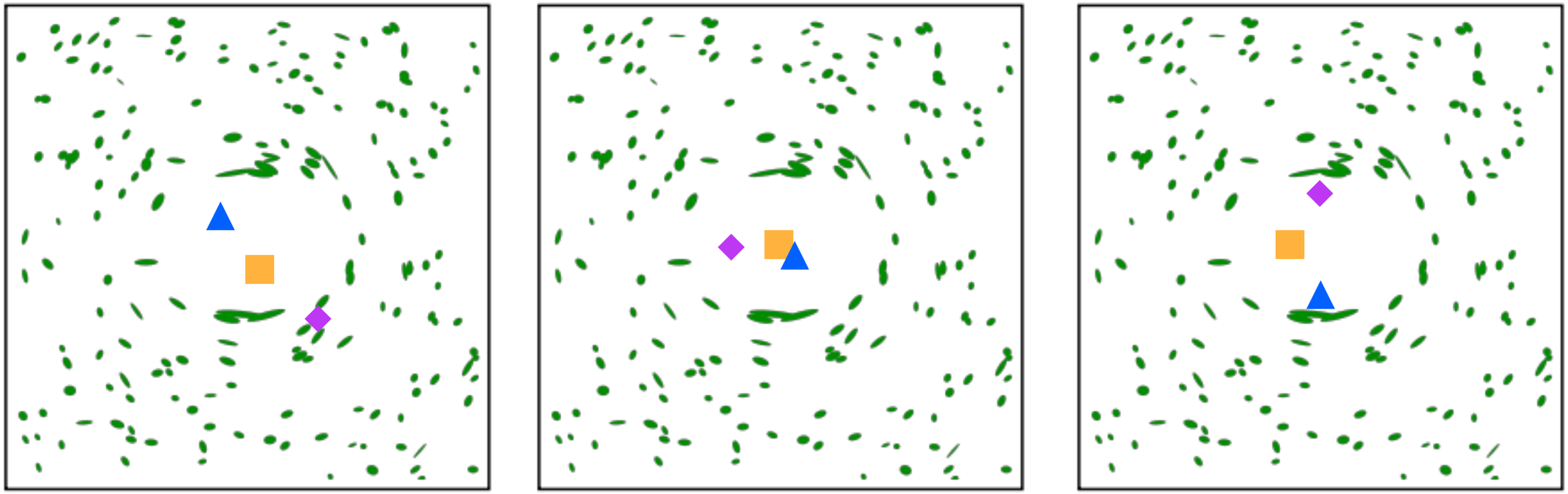
Cluster 1 | Cluster 2 | Cluster 3



1. Find members
2. Determine centers
3. Measure shapes of background sources

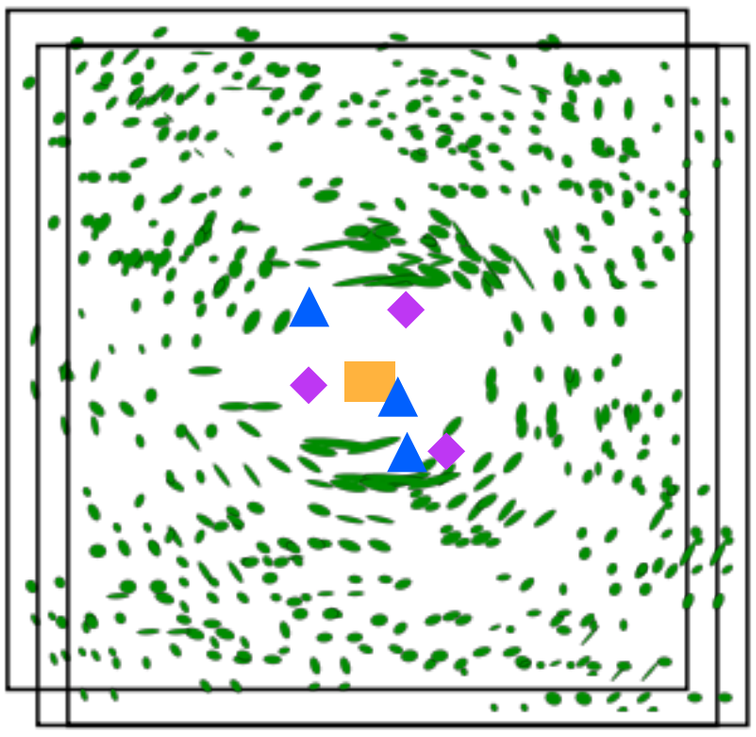
Stacked Weak Lensing

Cluster 1 | Cluster 2 | Cluster 3



1. Find members
2. Determine centers
3. Measure shapes of background sources
4. Stack on centers

Stacked Weak Lensing



1. Find members
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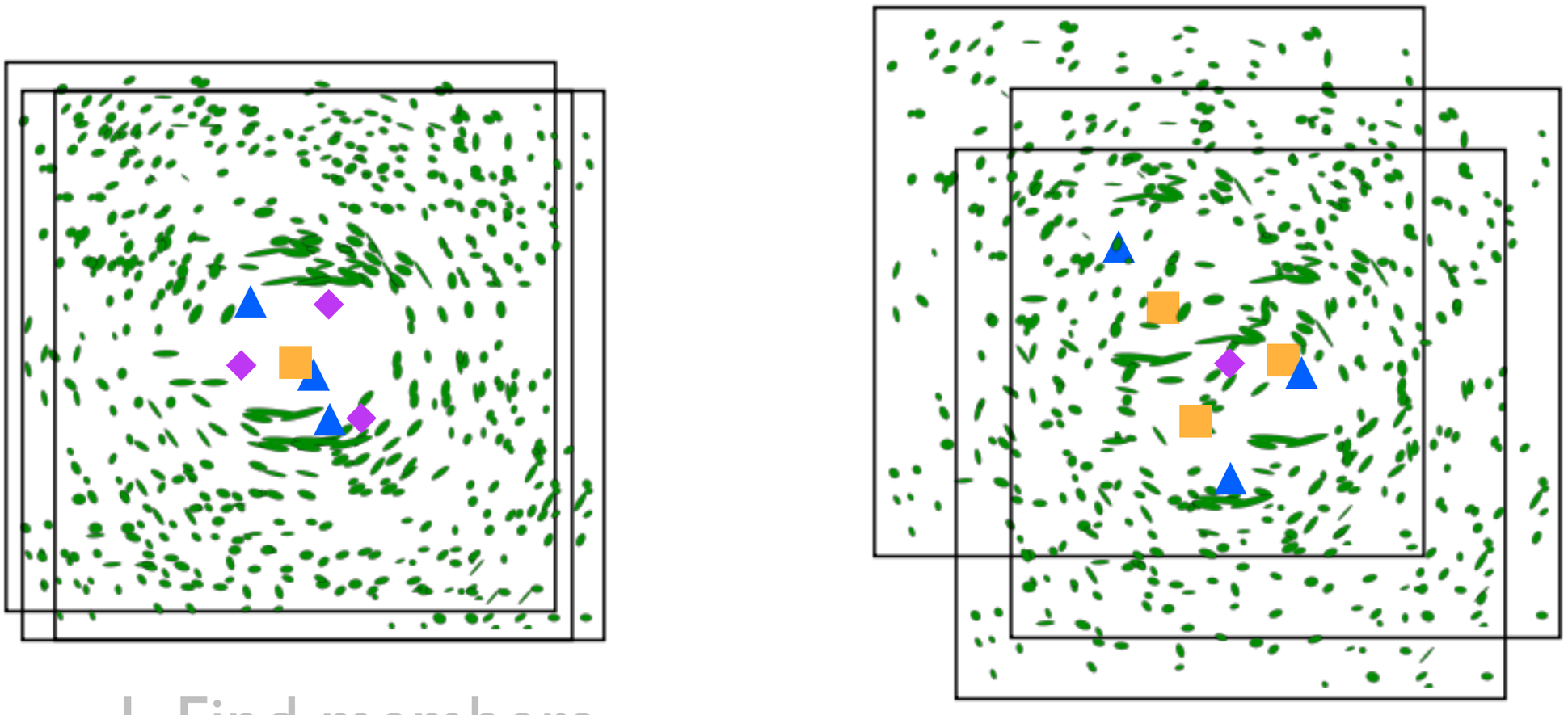
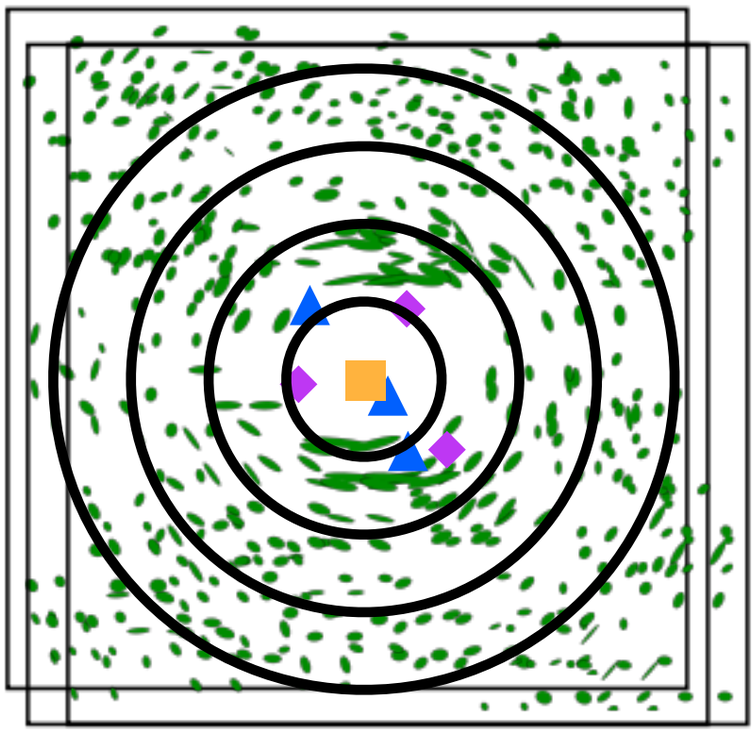
Stacked Weak Lensing



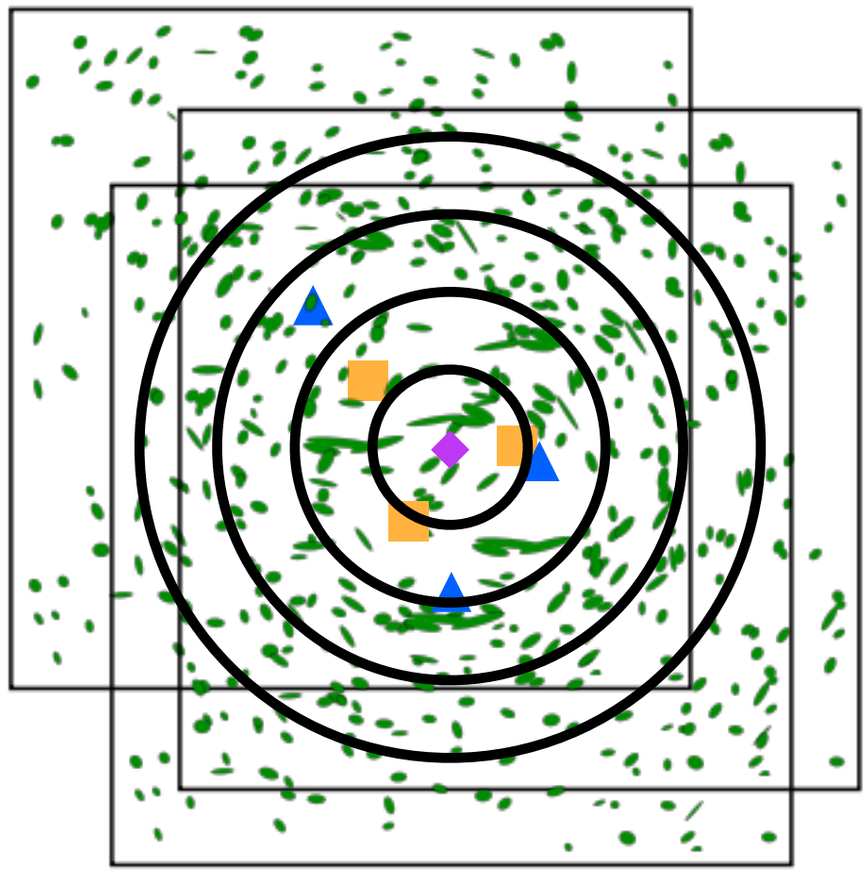
1. Find members
2. Determine centers
3. Measure shapes of background sources
4. Stack on centers

Stacked Weak Lensing

Good center



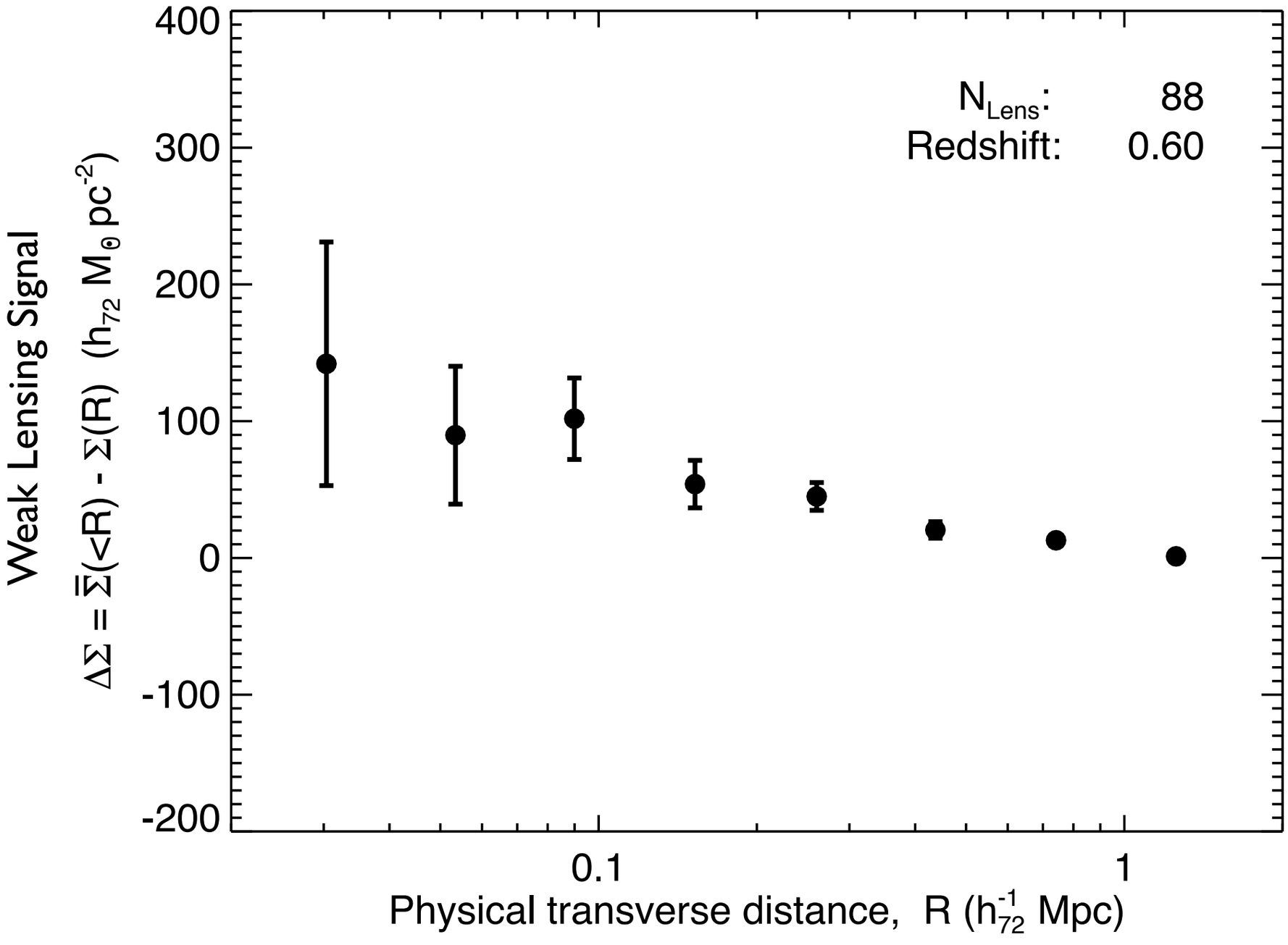
Bad center



1. Find members
2. Determine centers
3. Measure shapes of background sources
4. Stack on centers
5. Measure tangential shear in radial bins

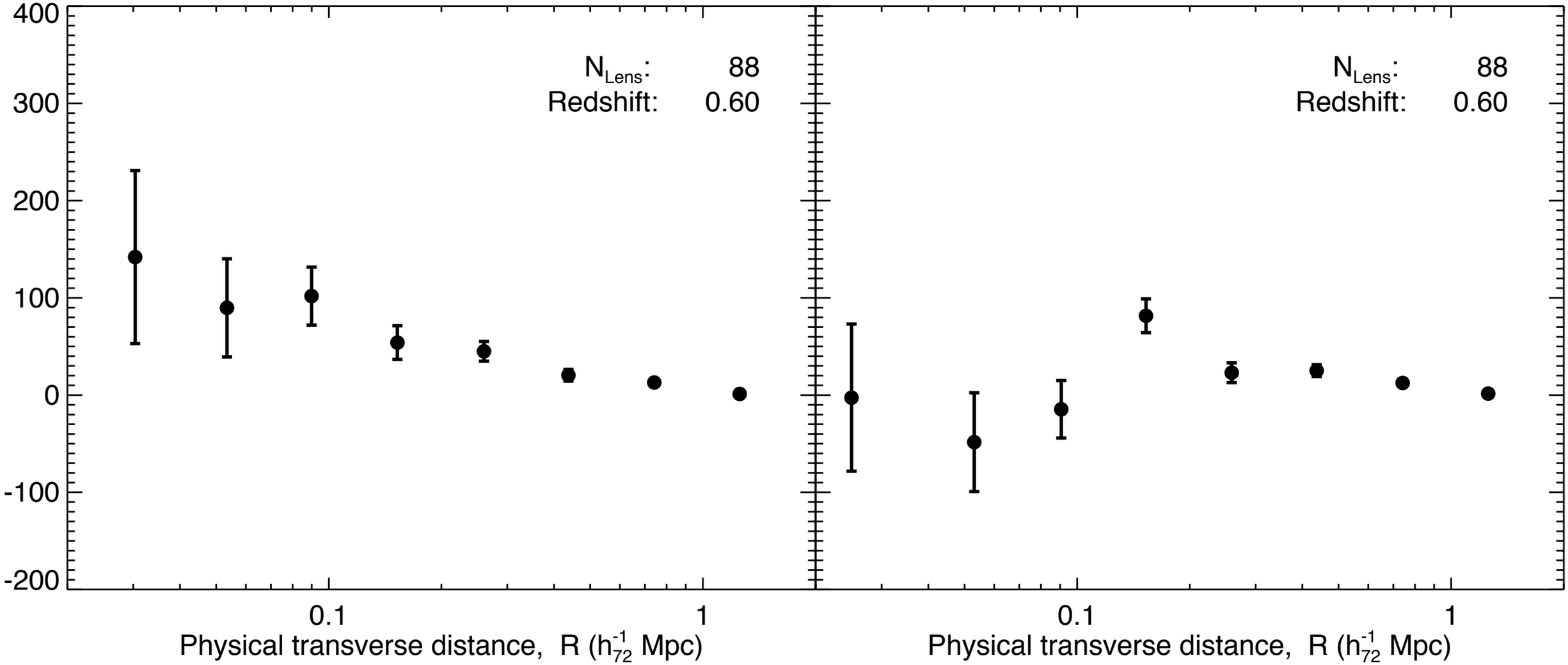
Preliminary Results

"BCG" ≡ galaxy with largest stellar mass within NFW scale radius of X-ray center



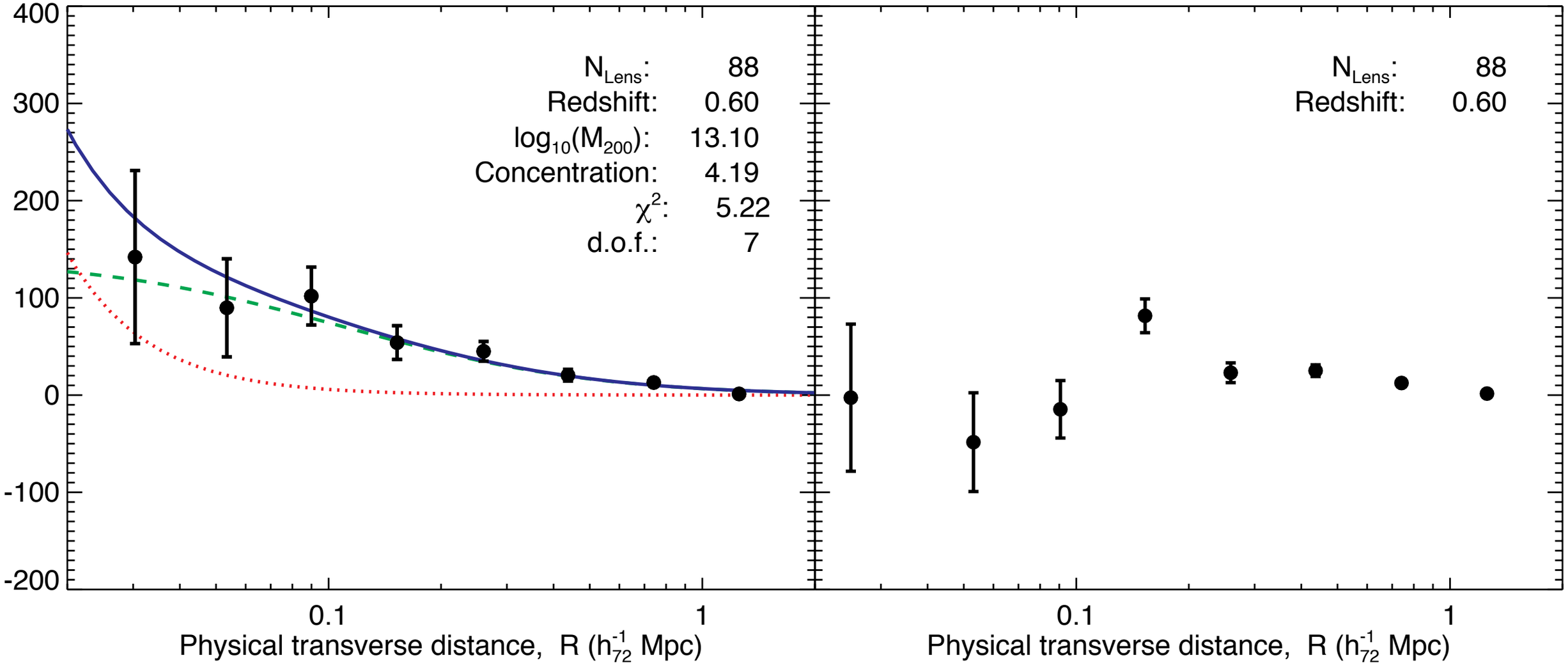
"BCG"

X-ray


N_Lens: 88
Redshift: 0.60
ΔΣ = Σ̄(<R) - Σ(R) (h_72 M_⊙ pc^-2)
400
300
200
100
0
-100
-200
0.1
1
Physical transverse distance, R (h_72^-1 Mpc)
N_Lens: 88
Redshift: 0.60
0.1
1
Physical transverse distance, R (h_72^-1 Mpc)

"BCG"

X-ray



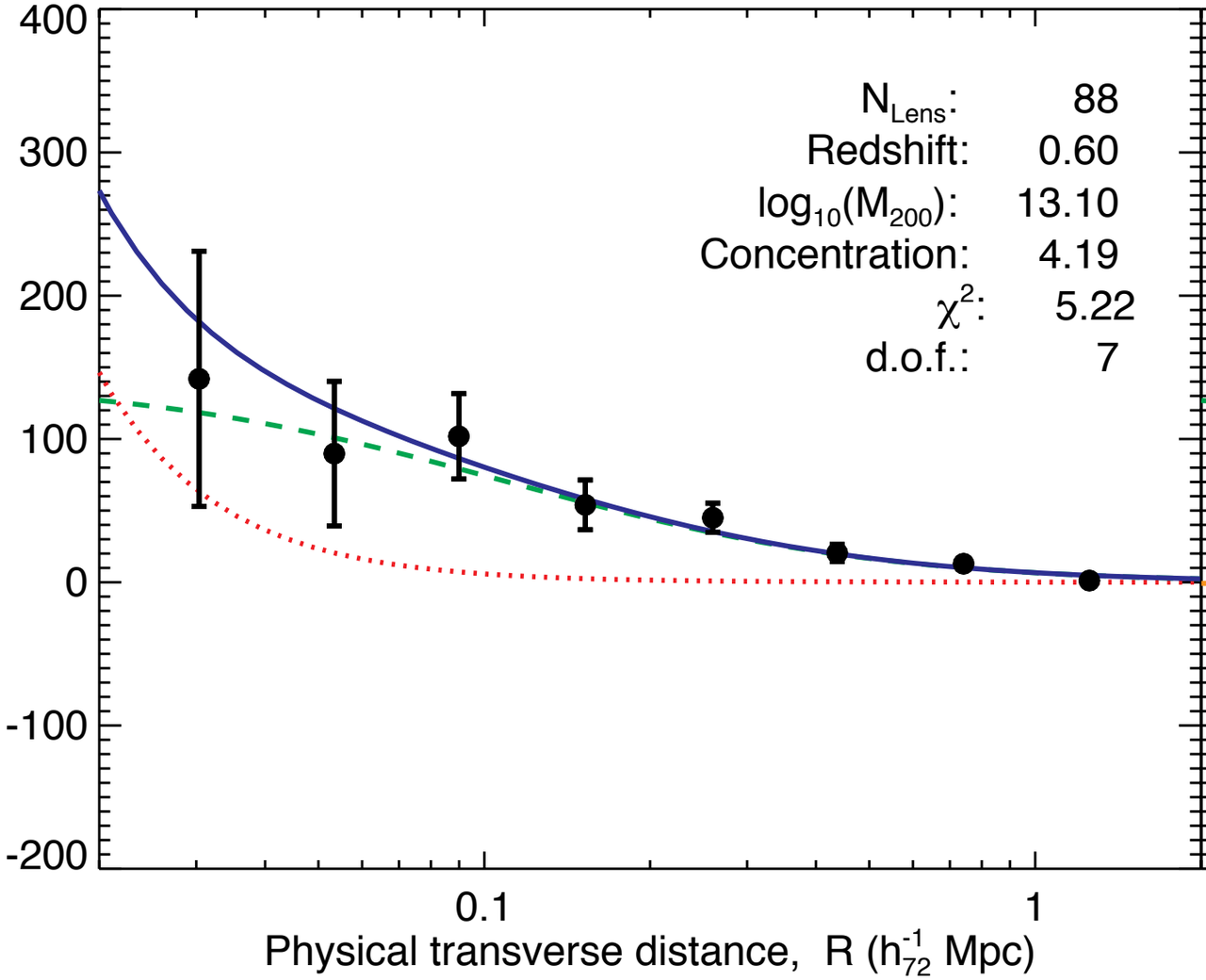
NFW

Central Galaxy

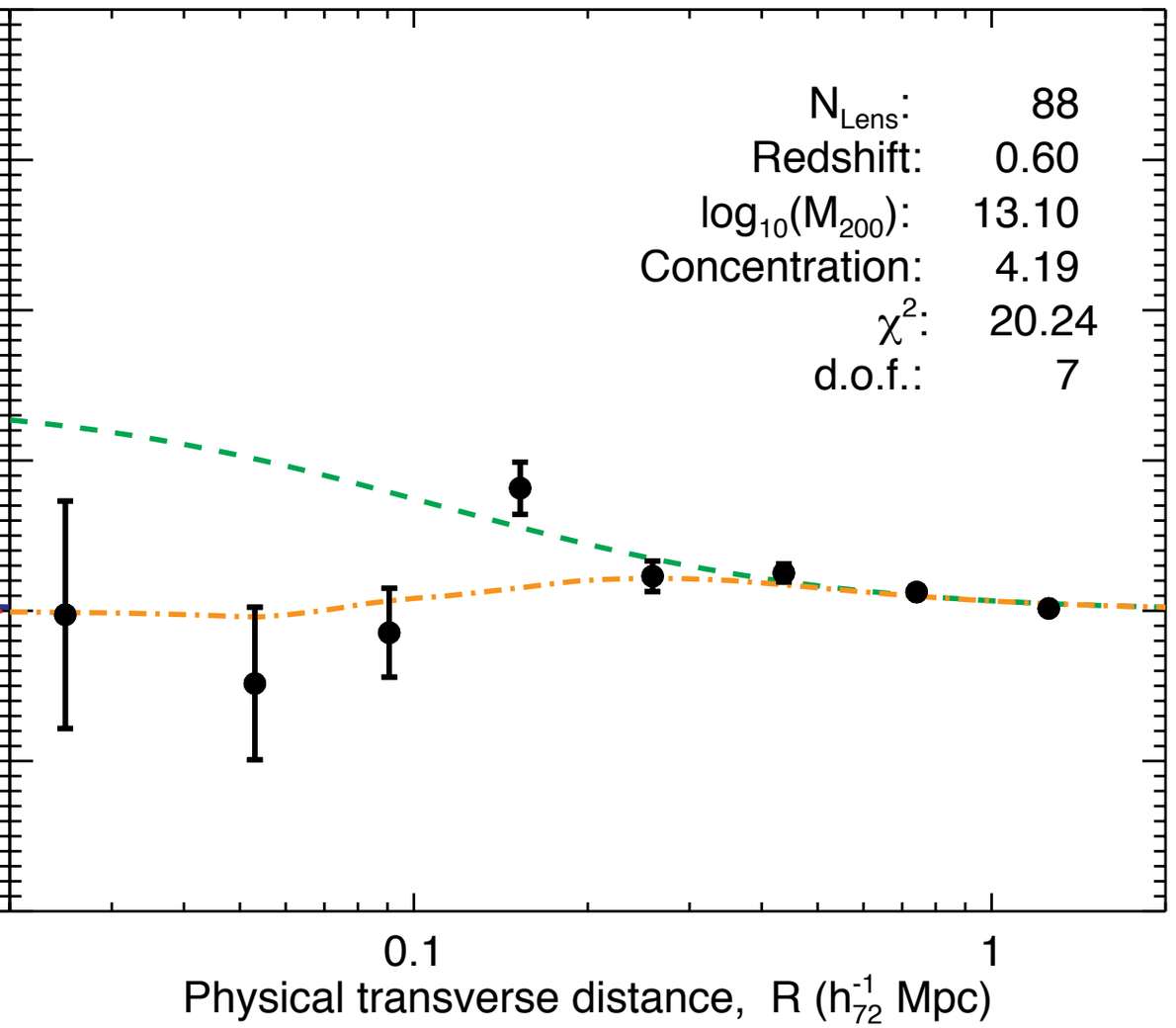
Offset NFW

Total

"BCG"



X-ray



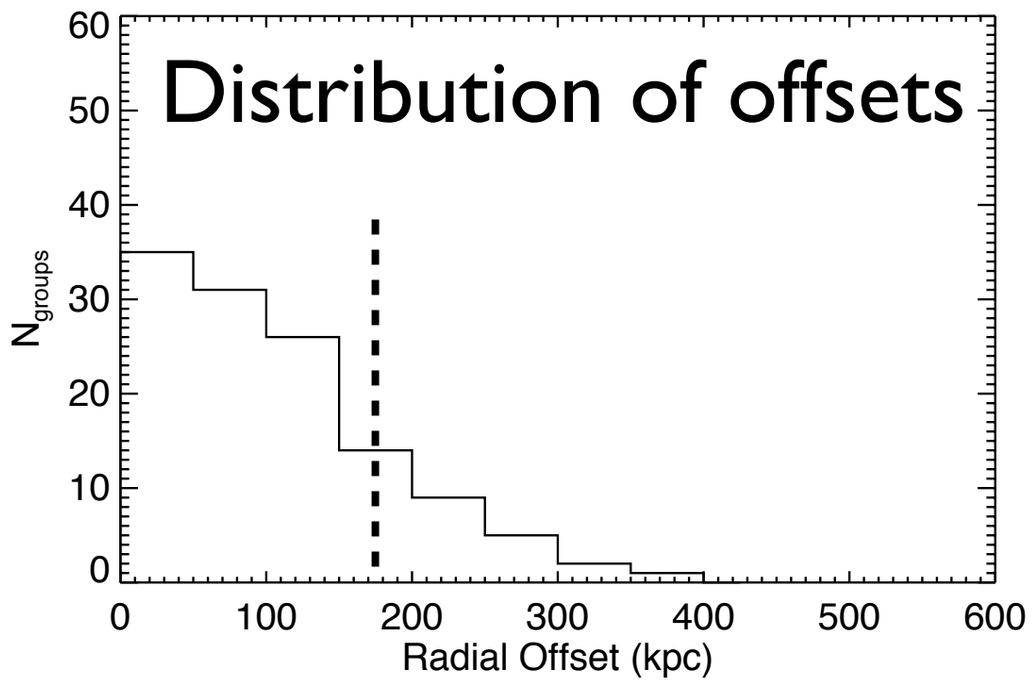
NFW

Central Galaxy

Offset NFW

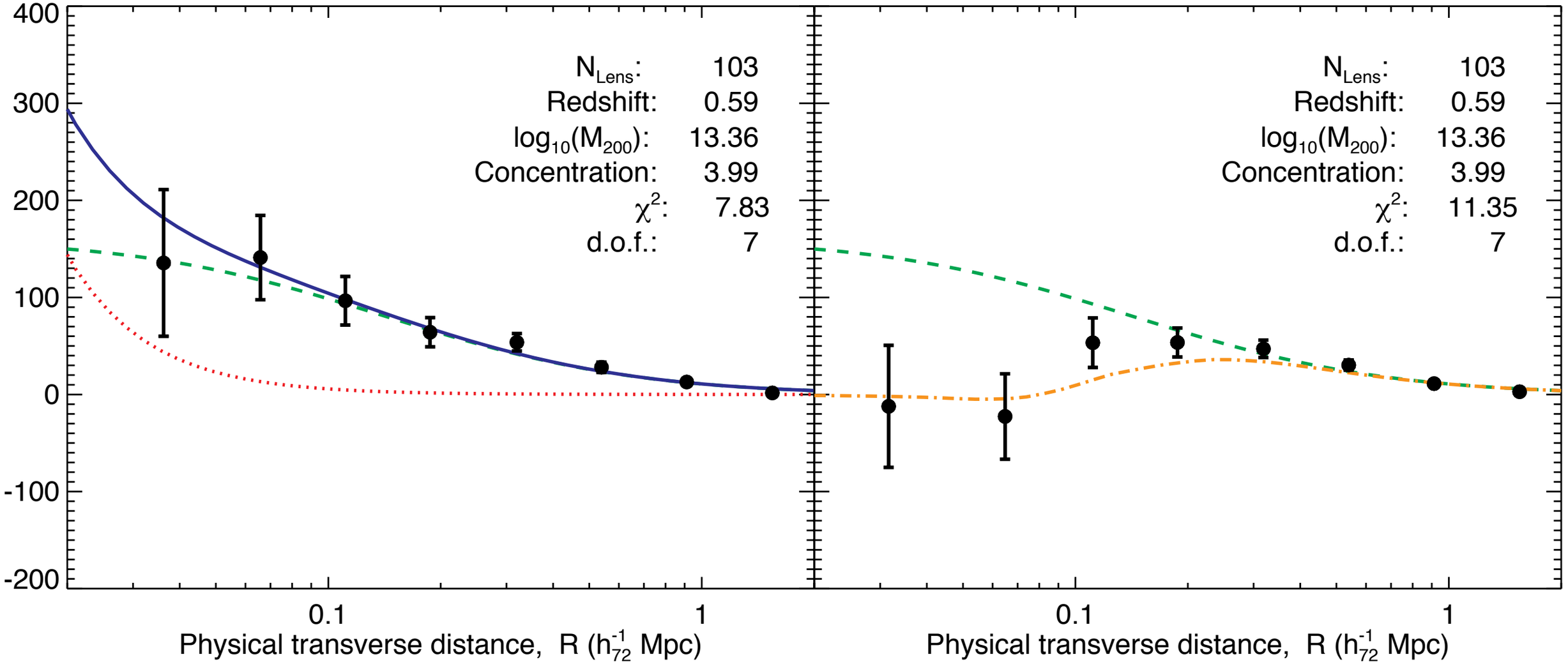
Total

Consistent with X-ray position uncertainty
i.e., this is ***not*** evidence for a physical offset
between gas and dark matter



"BCG"

Luminosity-Weighted Centroid

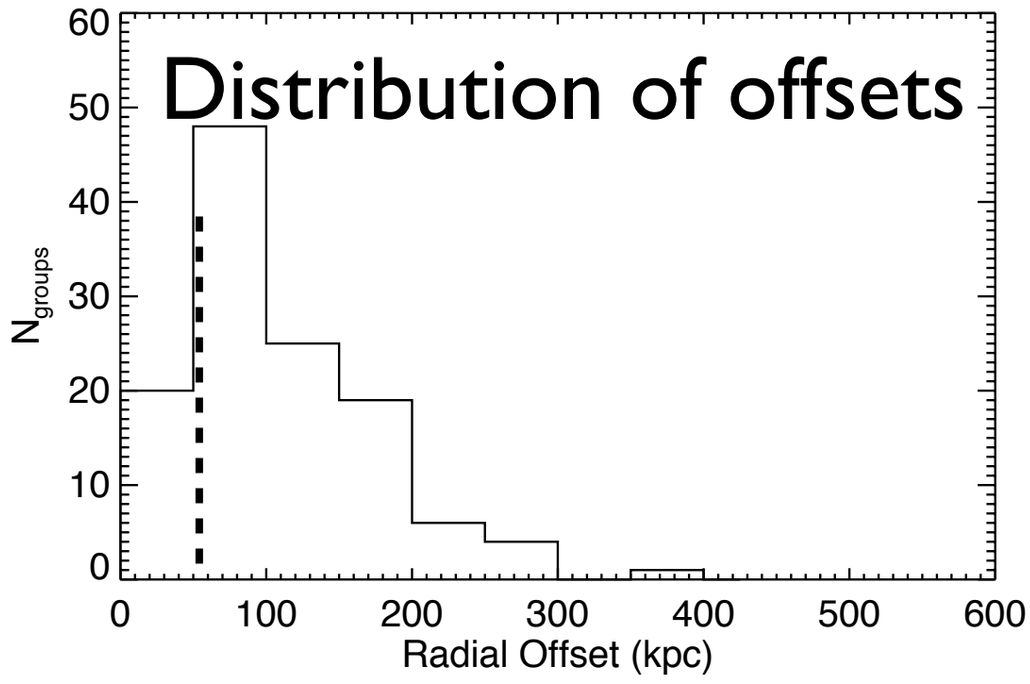


NFW

Central Galaxy

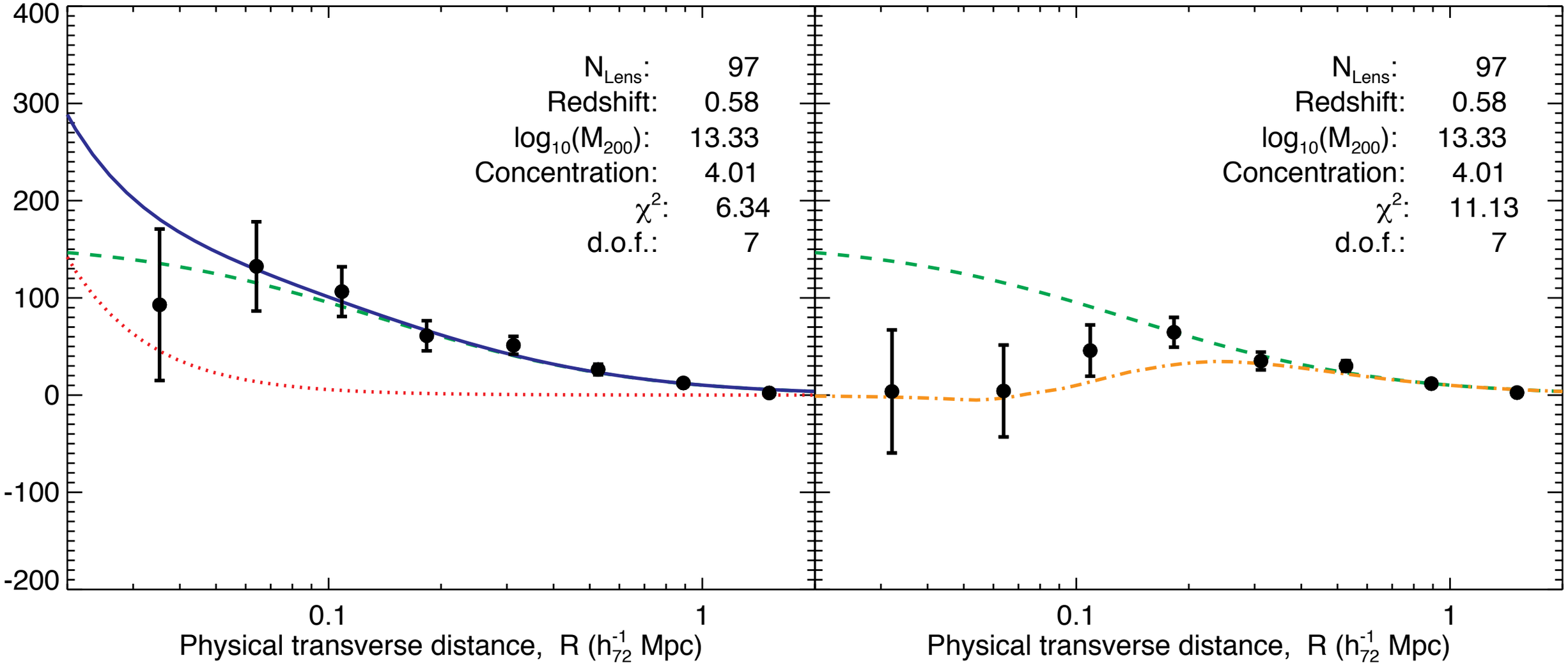
Offset NFW

Total



"BCG"

SM-Weighted Centroid

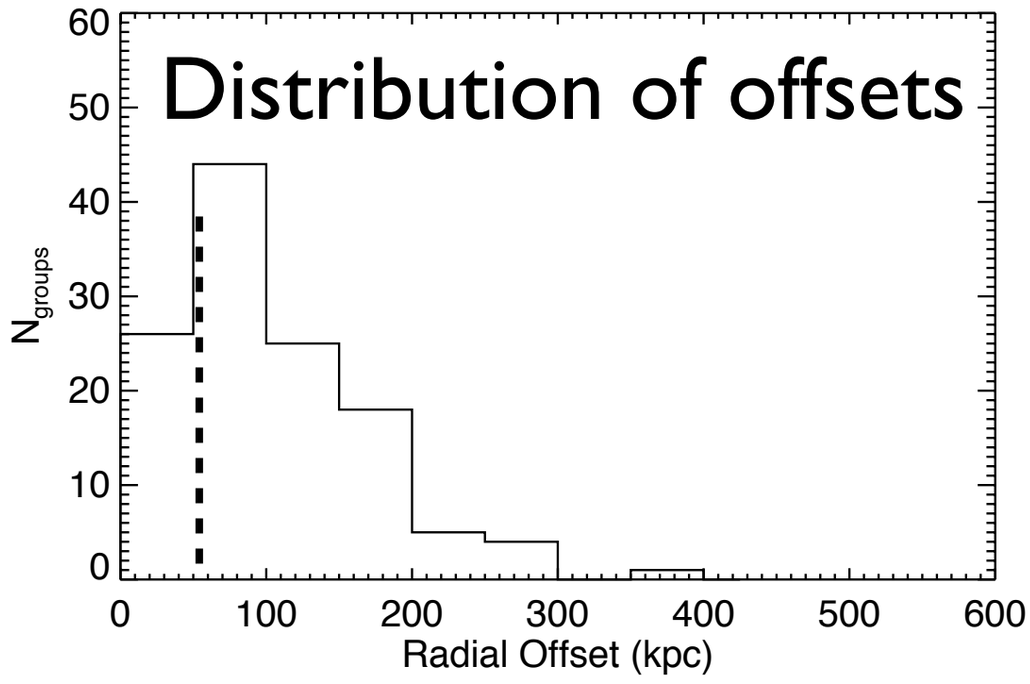


NFW

Central Galaxy

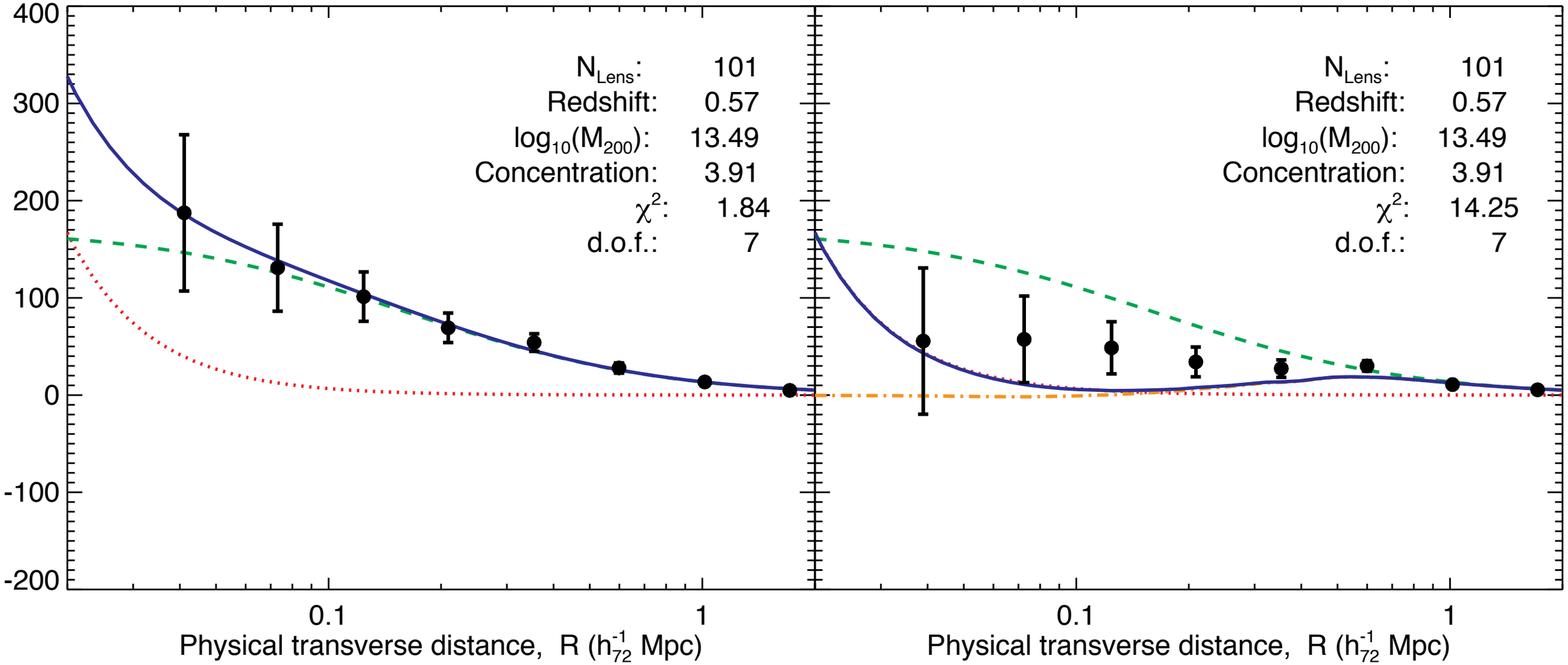
Offset NFW

Total



"BCG"

2nd Most Massive Member

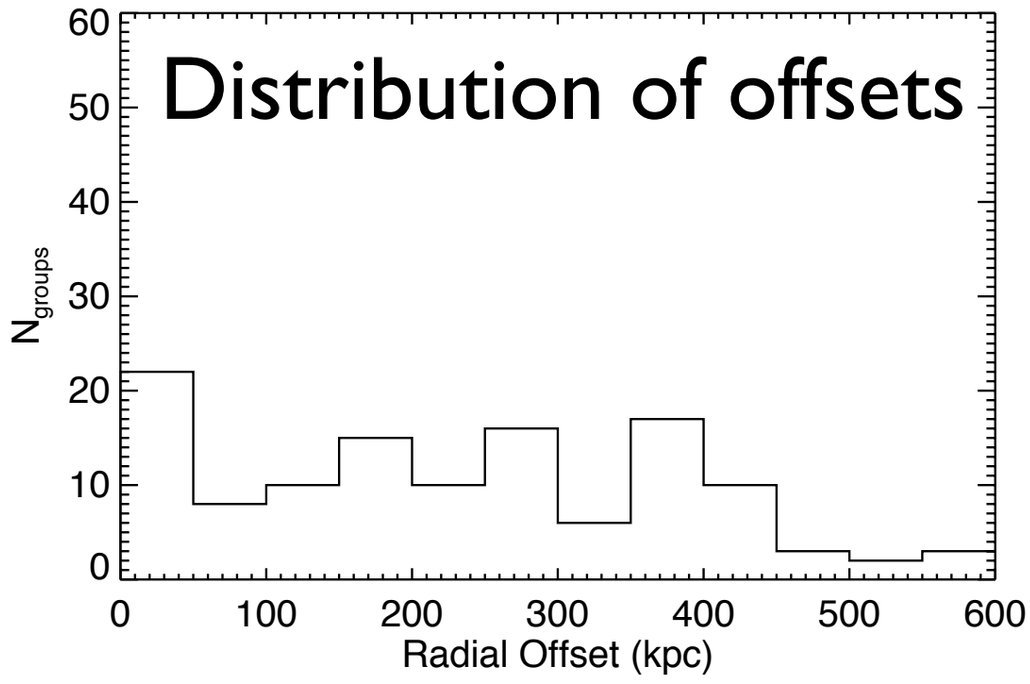


NFW

Central Galaxy

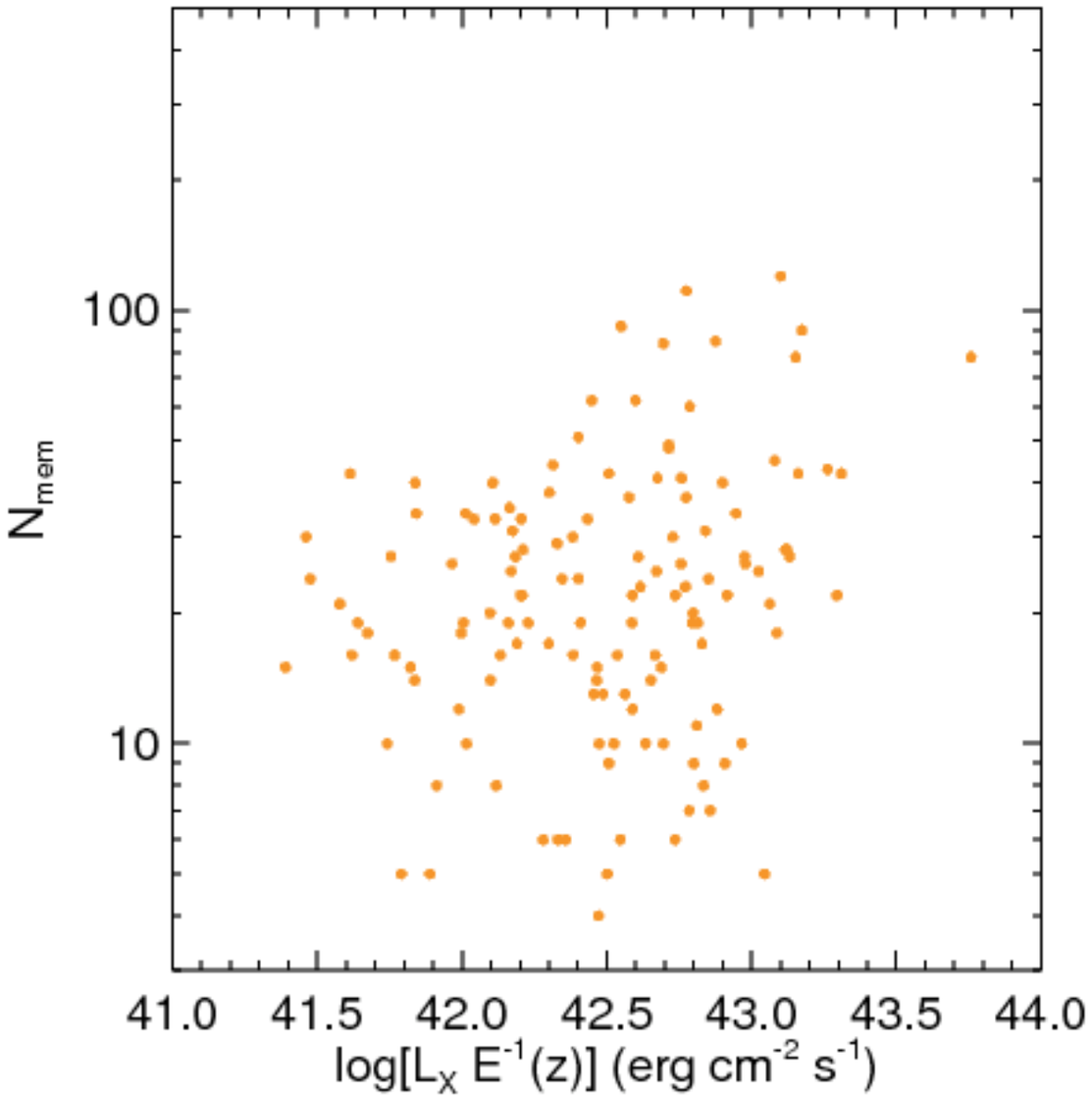
Offset NFW

Total

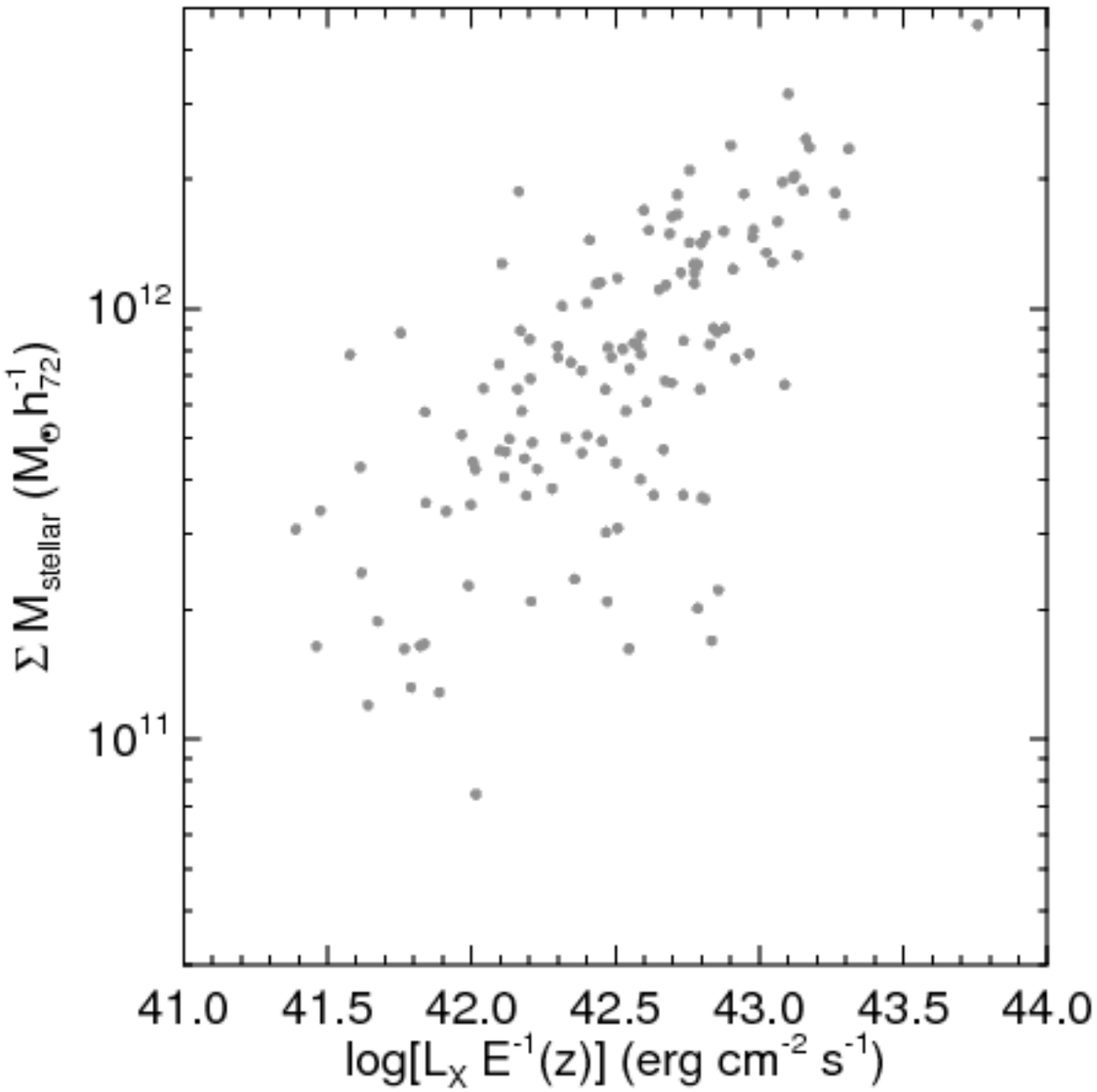


Halo Mass Proxies

Richness

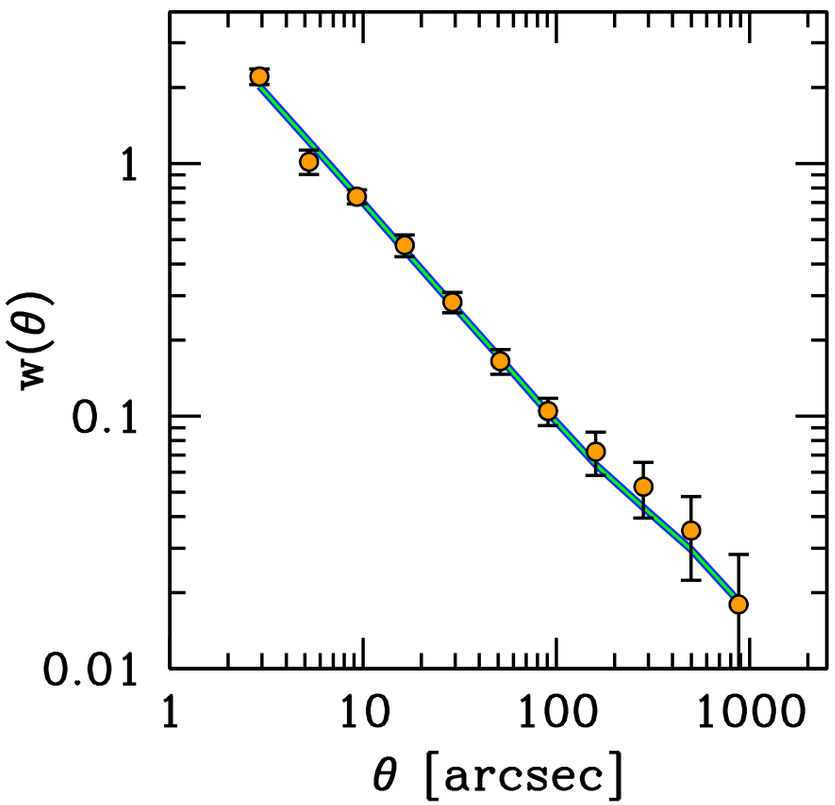


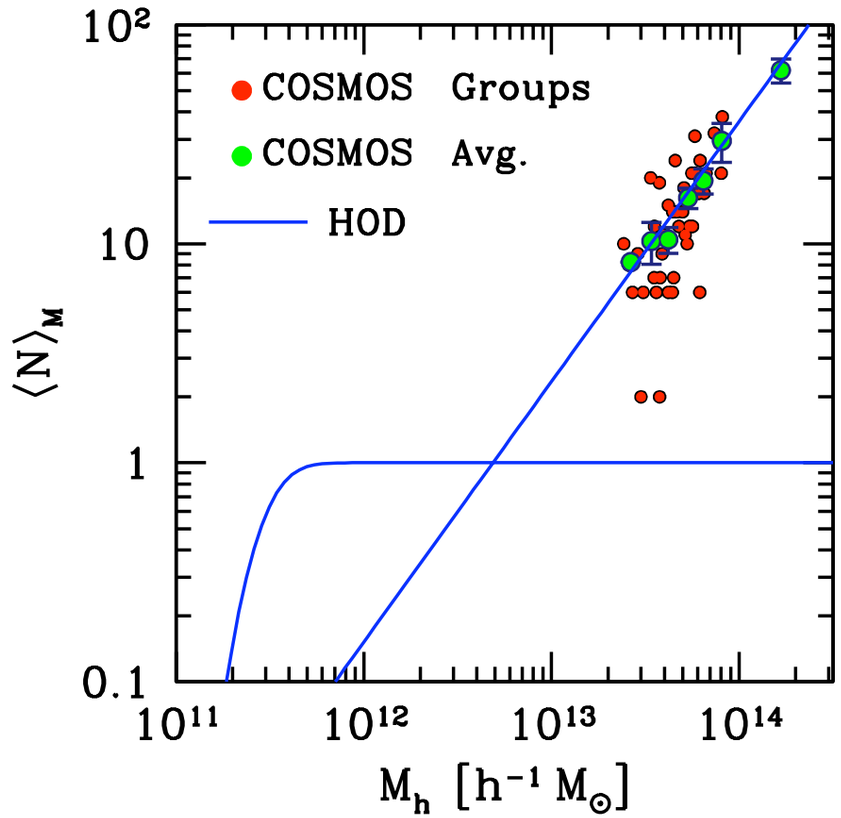
Total stellar mass

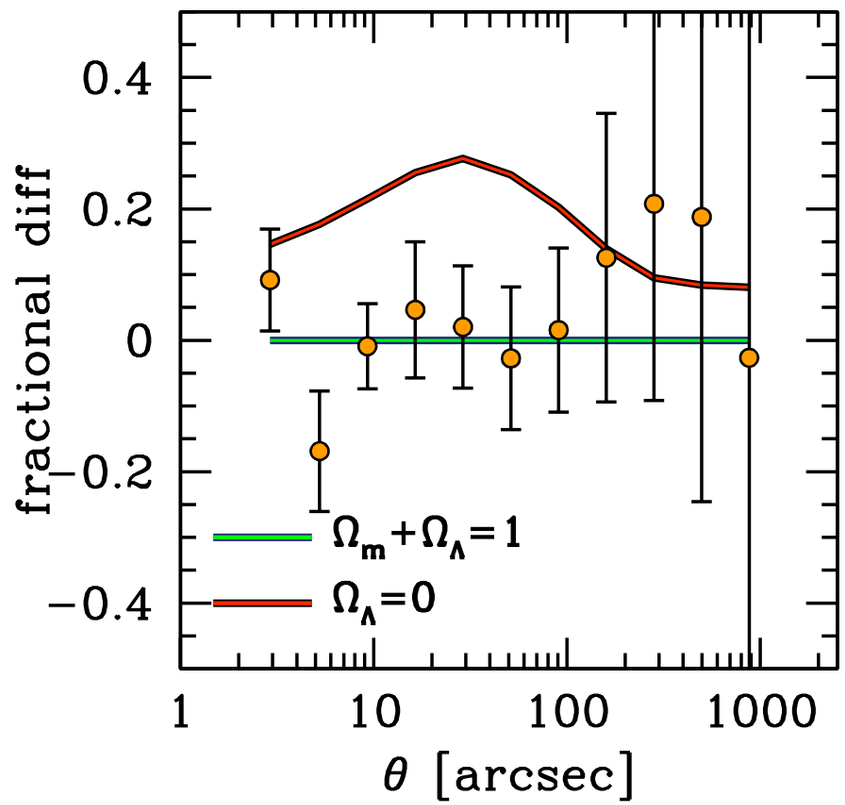


X-ray Luminosity

Clustering and HOD







Jeremy Tinker

Degeneracy between cosmological parameters and bias model when fitting correlation function→need halo occupation model

Counting number of members vs. halo mass gives direct constraint on HOD

Summary

- Galaxy with highest stellar mass near X-ray center appears to be the best tracer of CM for this catalog
- Other tracers can be offset by ~few hundred kpc
- Understanding centering problems will improve systematics for other cluster surveys

- Lots of other applications for this catalog: halo mass proxies, BCG and satellite evolution, mass-concentration, intrinsic alignments