

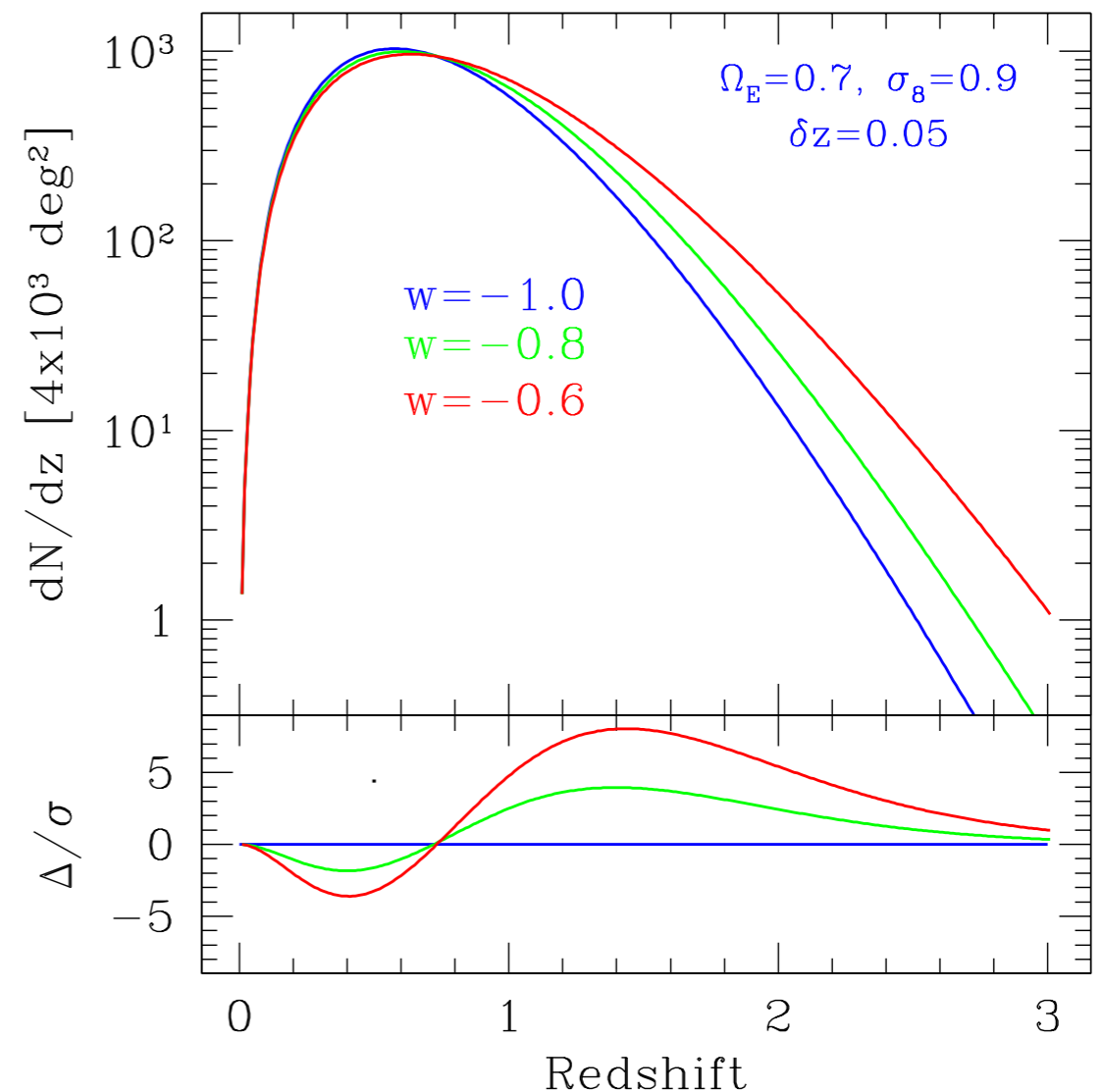
# Measuring Scatter in the Cluster Mass-Richness Relation For The Dark Energy Survey

Devon L. Hollowood

Tesla Jeltema, Arya Farahi, Xinyi Chen, August Evrard, Kathy Romer, Philip J.  
Rooney, Eli Rykoff, Eduardo Rozo

# Cosmology via Clusters

- Galaxy cluster evolution puts strong constraints on dark energy equation of state
- Higher dark energy density in the past  $\rightarrow$  slower forming clusters  $\rightarrow$  clusters need to have started forming sooner



Mohr (2005)

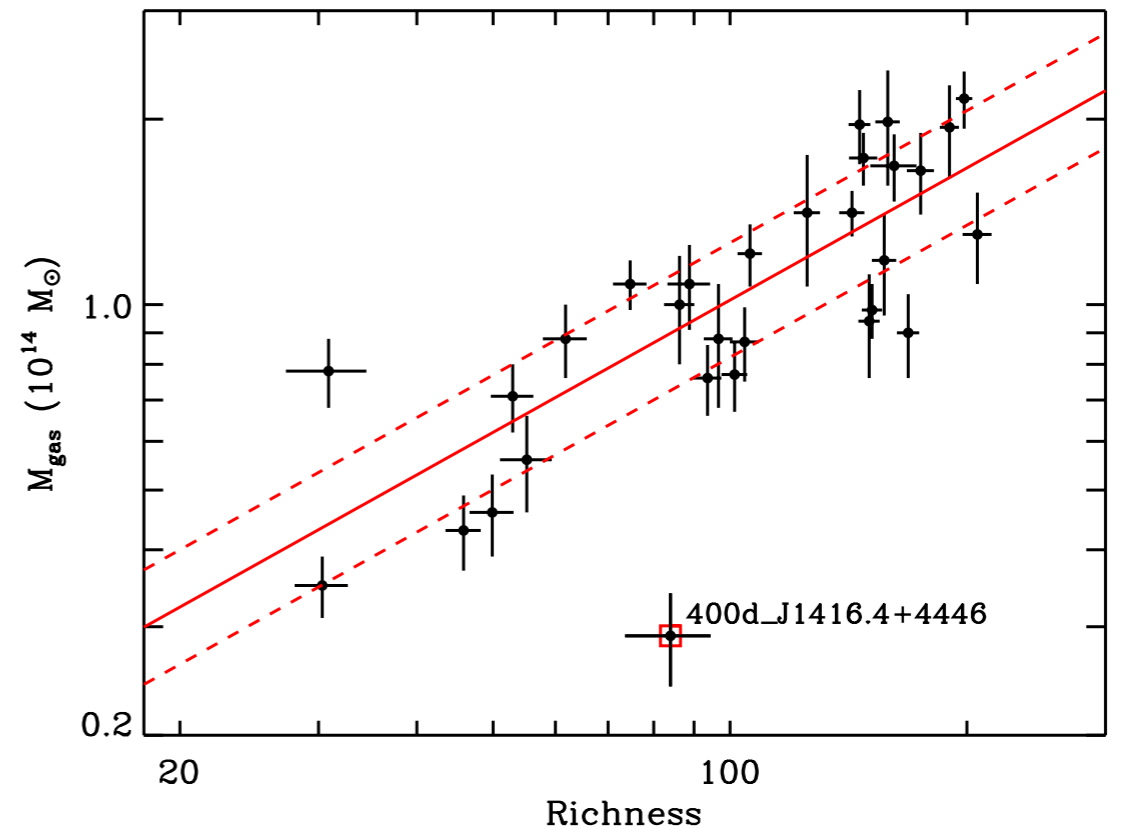
# Cosmology via Clusters (continued)

$$\underbrace{\frac{d^2 N(z)}{dz d\Omega}}_{\text{Observed Cluster Number Density}} = \underbrace{\frac{c}{H(z)} D_A^2 (1+z)^2}_{\text{Geometric Factor}} \int_0^\infty \underbrace{f(M, z)}_{\text{Observational Efficiency}} \underbrace{\frac{dn(z)}{dM} dM}_{\text{Actual Cluster Number Density}}$$

- Want to measure  $dn(z)/dM$ , but need to understand  $f(M, z)$

# Understanding Selection

- Need well-understood, robust cluster finder: redMaPPer
- Need mass proxy: richness (roughly: # of red-sequence galaxies in cluster)
- Need mass-proxy relation and scatter



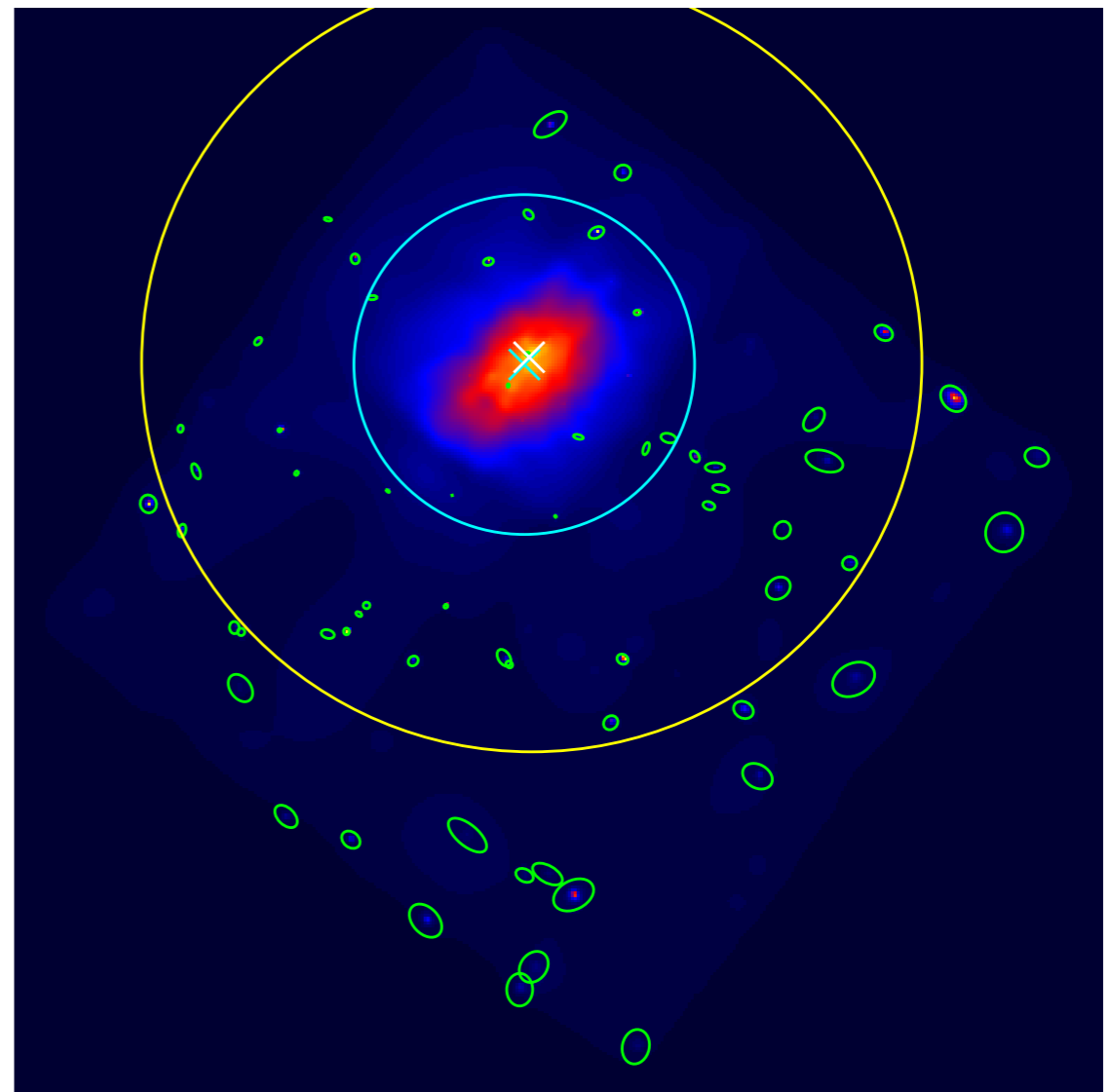
Rozo & Rykoff 2014 (redMaPPer II)

# The Mass-Richness Relation

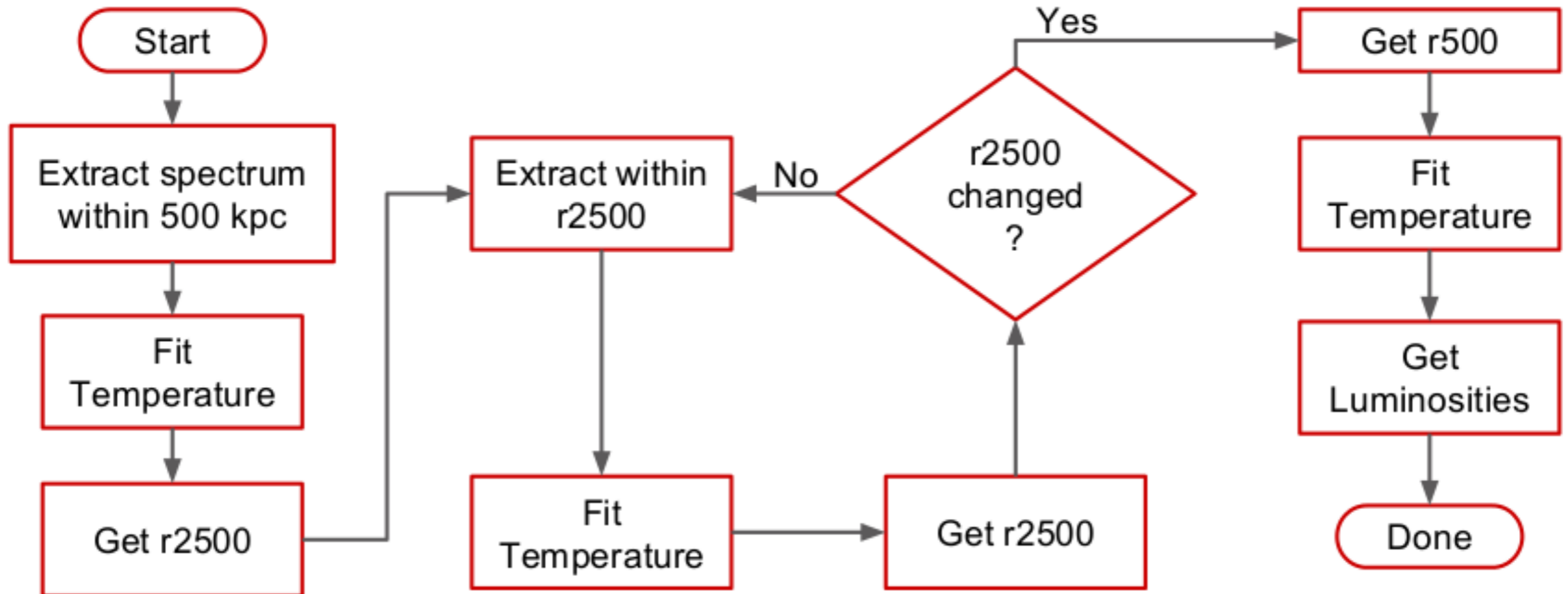
- Richness is cheap optical mass proxy
- Can use stacked weak lensing for mean relation, but not scatter
- If scatter not characterized to 5%, it is projected to be the largest source of error for DES cluster constraints [Wu 2010]
- Our goal: measure scatter through  $T_x$ ,  $L_x$  using archival Chandra Data

# Chandra Pipeline

- Takes (RA, Dec, z) from redMaPPer cluster finder
- Downloads and reduces corresponding archival Chandra data by running CIAO tools
- Iteratively finds X-ray centroid(s)
- Runs XSPEC to fit spectrum within 500 kpc, r2500, and r500.
  - Yields  $T_x$ ,  $L_x$
  - Does core cropping for r500



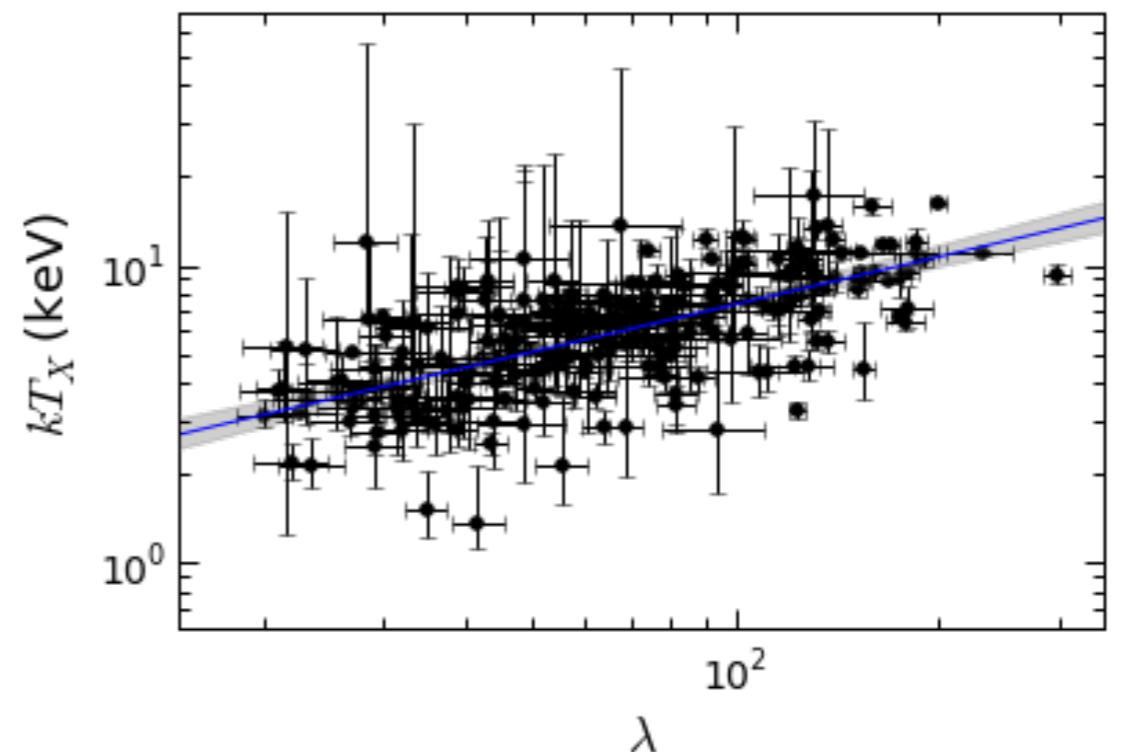
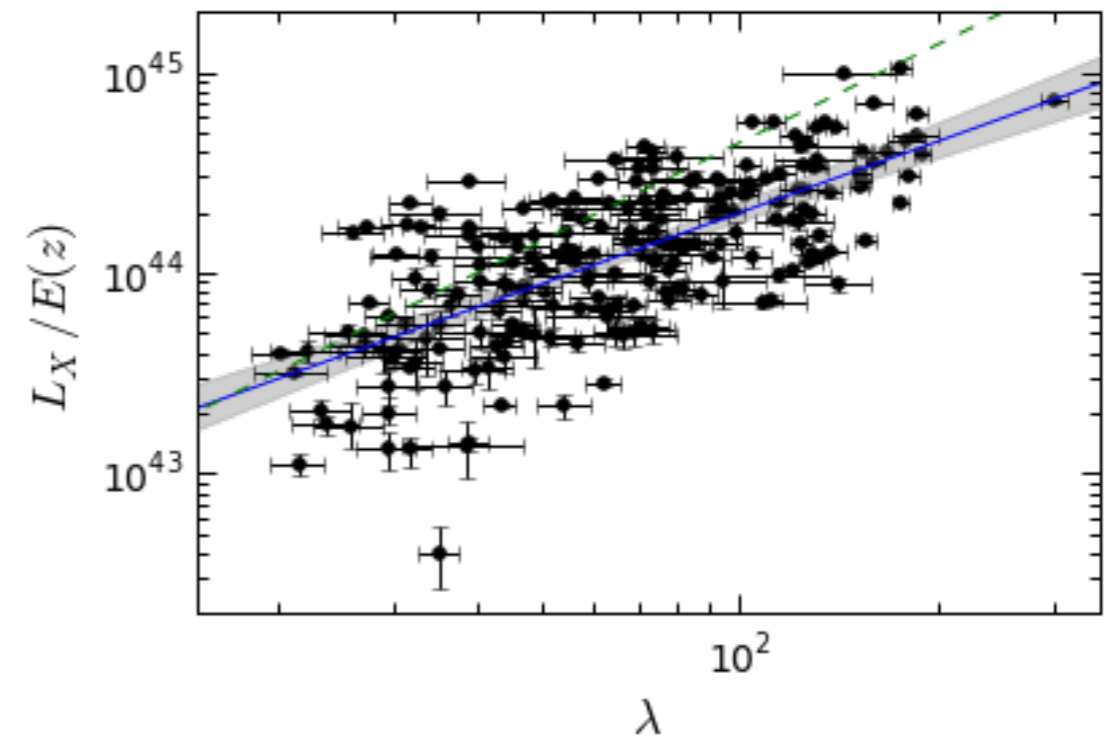
# Iterative Tx Algorithm



# SDSS Scaling Results

Green line is N200 from Rozo et al 2014

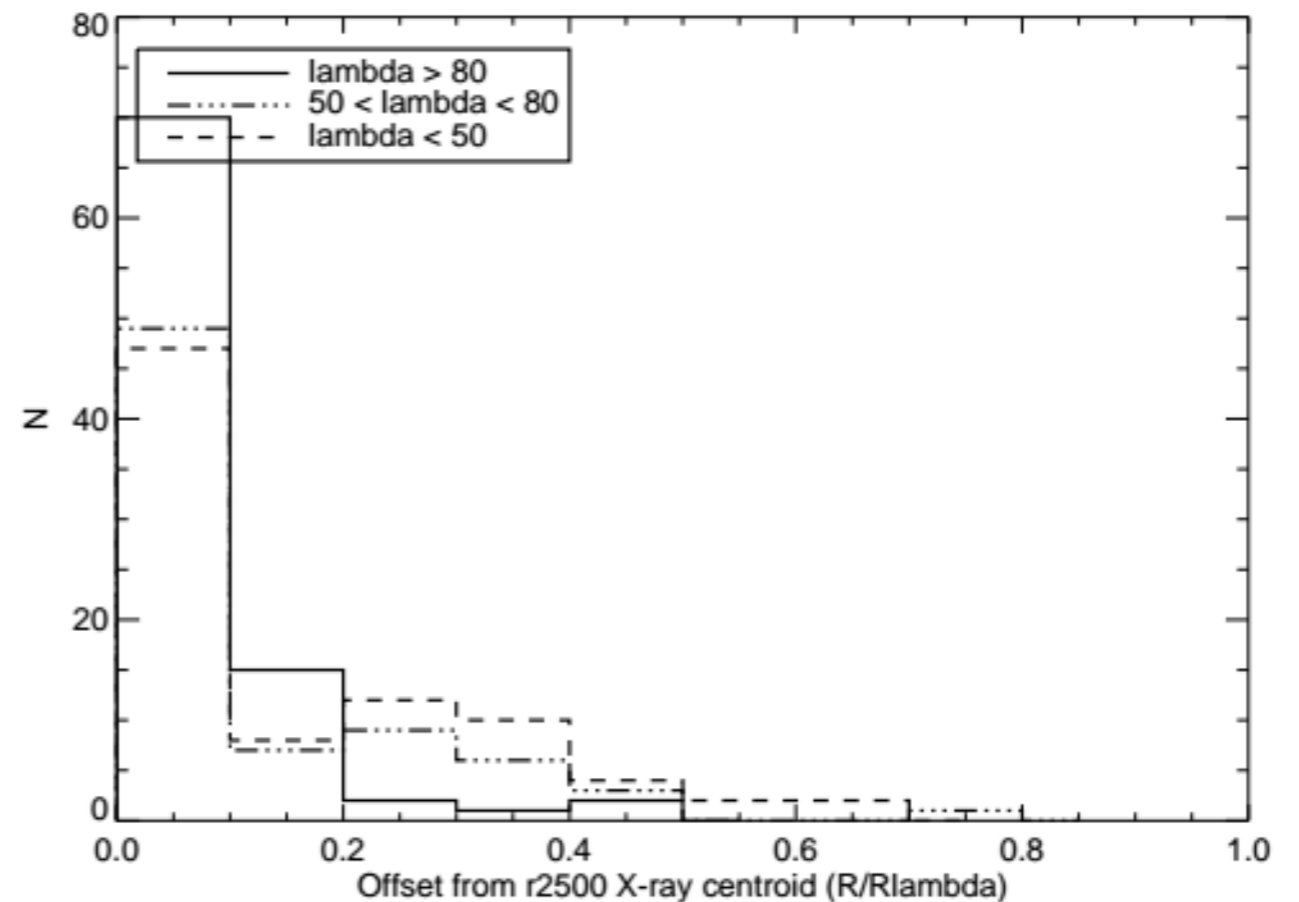
- 905 clusters w/in Chandra
- 571 detected, 270 not detected, 64 not useable
- 250 w/ r2500 Tx
- 188 w/ r500 core-cropped Lx
- $26 \pm 2\%$  r2500 Tx-Lambda scatter
- $64 \pm 3\%$  r500 core-cropped Lx-Lambda scatter



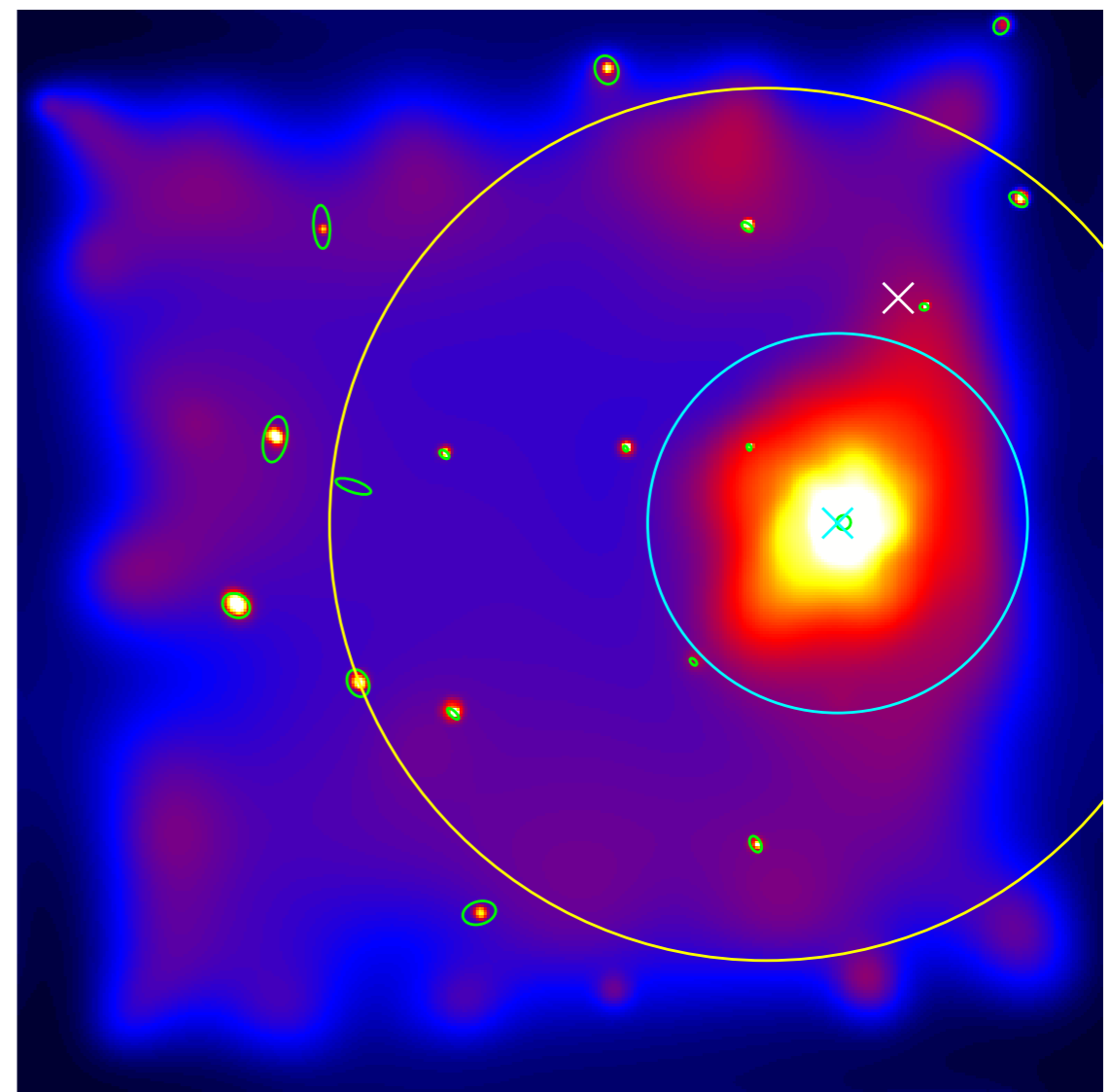
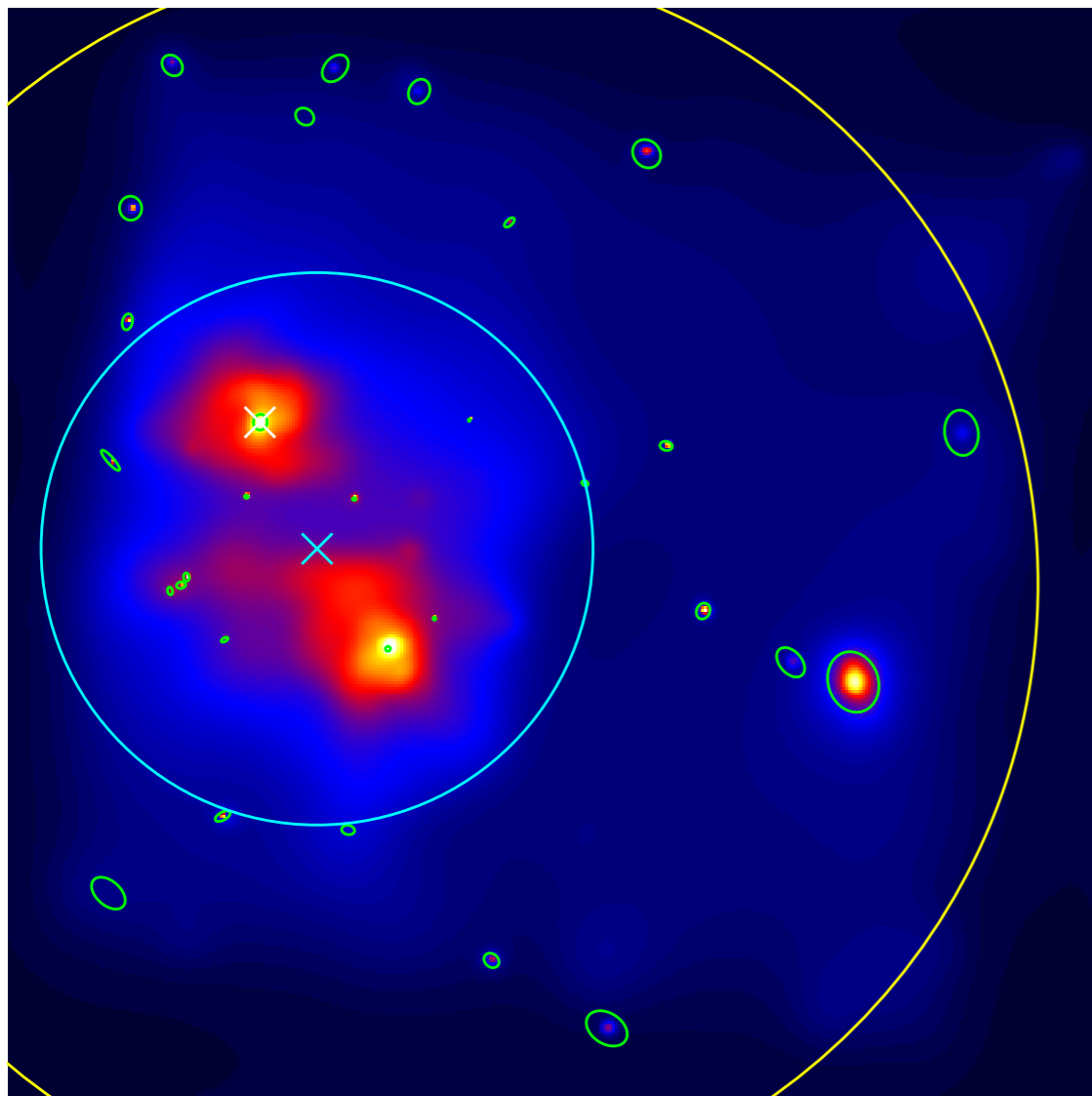


# Centering

- Also looked at offset between redMaPPer center and X-ray centroid
- Useful for weak lensing / as check on redMaPPer



# Centering Examples



# Next Steps

- Looking at luminosity upper limits for things which XSPEC cannot fit reliably
- Paper (hopefully) in the next few months (look for it on the arxiv!)

Thank you.