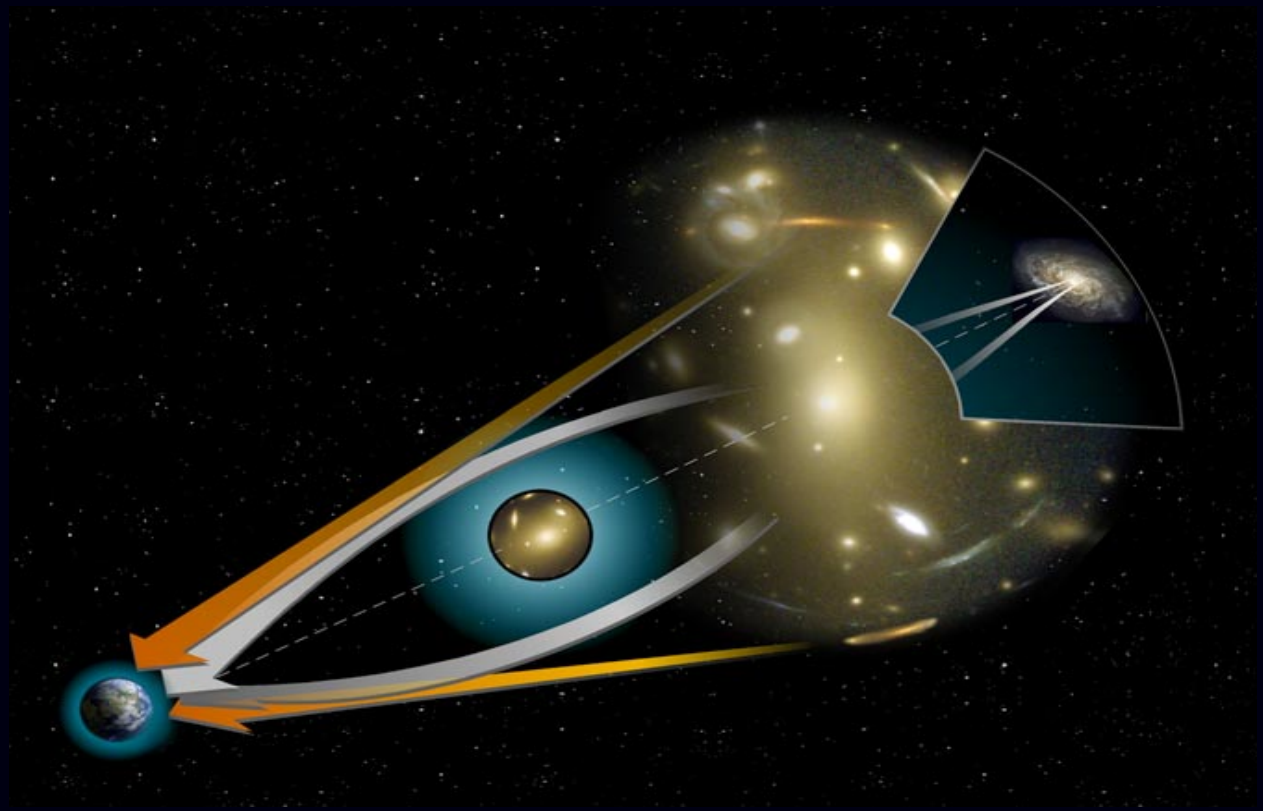
STRONG LENSING IN THE INNER HALOES OF GALAXY CLUSTERS



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Research Question

- Do the statistics of bright arcs in low-redshift galaxy clusters provide constraints on the cluster dark matter haloes?
- If yes, what can we learn from the application of this approach to a well defined sample of clusters?

Number of Strong lensing Arcs

$$N(M, z_l) = \int_{z_l}^{z_{\max}} \frac{cdt}{dz_s}(1+z_s)^3 dz_s \int_{y_{\min}}^{y_{\max}} n_o(\mu(x(y)), z_s)\frac{d\hat{\sigma}(y)}{dy}dy$$

n_o : Commoving density of galaxies at an specific redshift.
$d\sigma$: differencial cross section in the source plane.

Number of Strong lensing Arcs

DARK MATTER MODELS

NSIS Profile

$$\rho(r) = \frac{\sigma_v^2}{2\pi G(r^2 + r_c^2)}$$

NFW Profile

$r_s = r_\Delta / c_\Delta$

$$\rho(r) = \frac{\rho_s}{(r/r_s)(1 + r/r_s)^2}$$

Encircled Mass

- Parameters like r_c (NSIS) and c_Δ (NFW) control the encircled mass at size scales where strong lensing happen (at scales $r \sim 0.01\ r_\Delta$; r_Δ is the virial radius). Thus, the presence of strong arcs in low-z clusters--with its higher spatial resolution--can infer limits on these parameters.

Encircled Mass

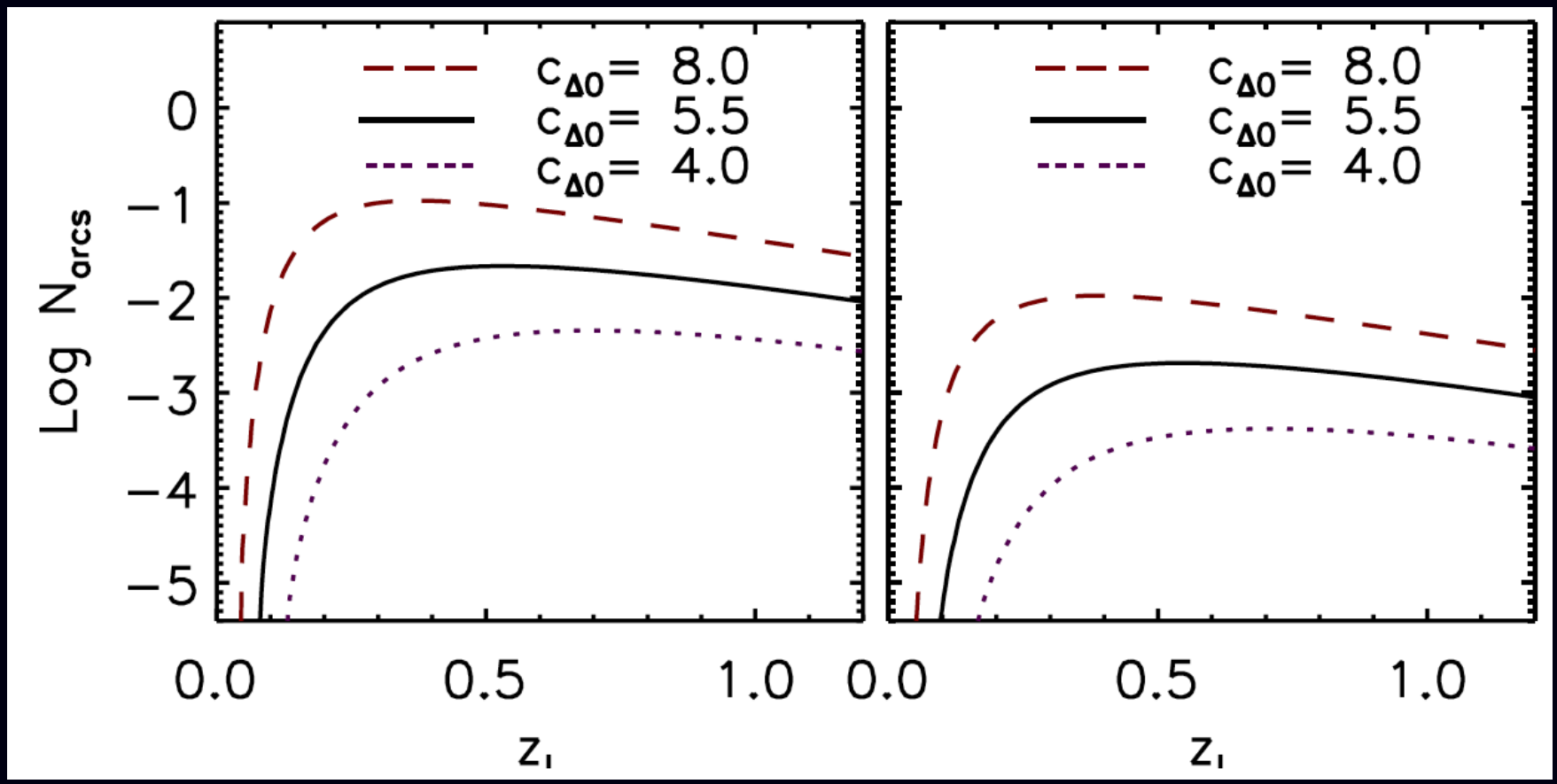
EXAMPLE:

- For a low redshift mass profile with virial mass $M_{\Delta}=M_{15}$:

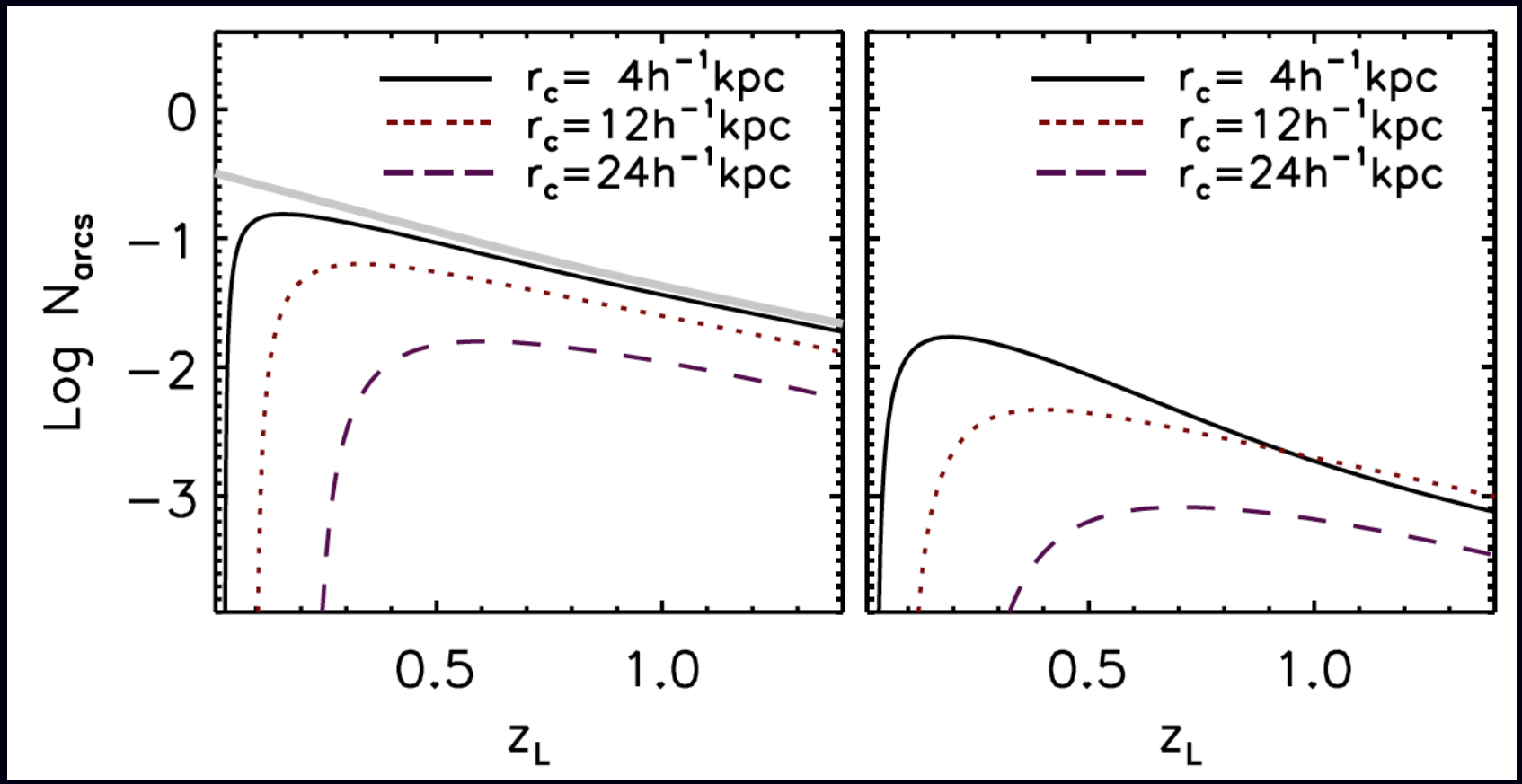
$M(r<0.01r_{\Delta})/M_{\Delta}$ change in a factor ~2 for c_{Δ} changing from 4 to 8 (NFW).

$M(r<0.01r_{\Delta})/M_{\Delta}$ change in a factor ~3 for r_c changing from 24 to 2 h^{-1}kpc (NSIS).

Number of arcs for various values of c_Δ in the NFW model



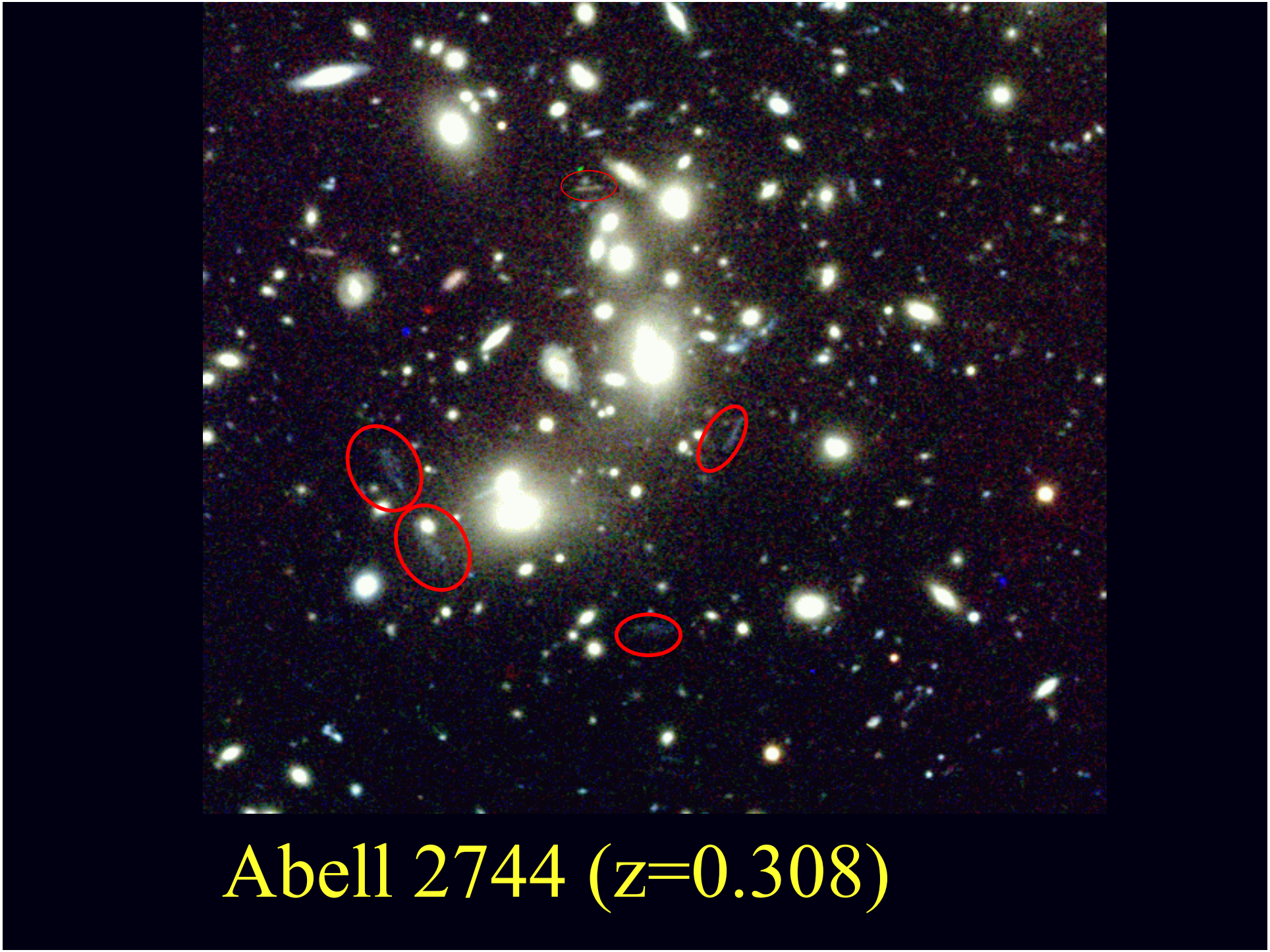
Number of Arcs for various values of r_c in the NSIS model



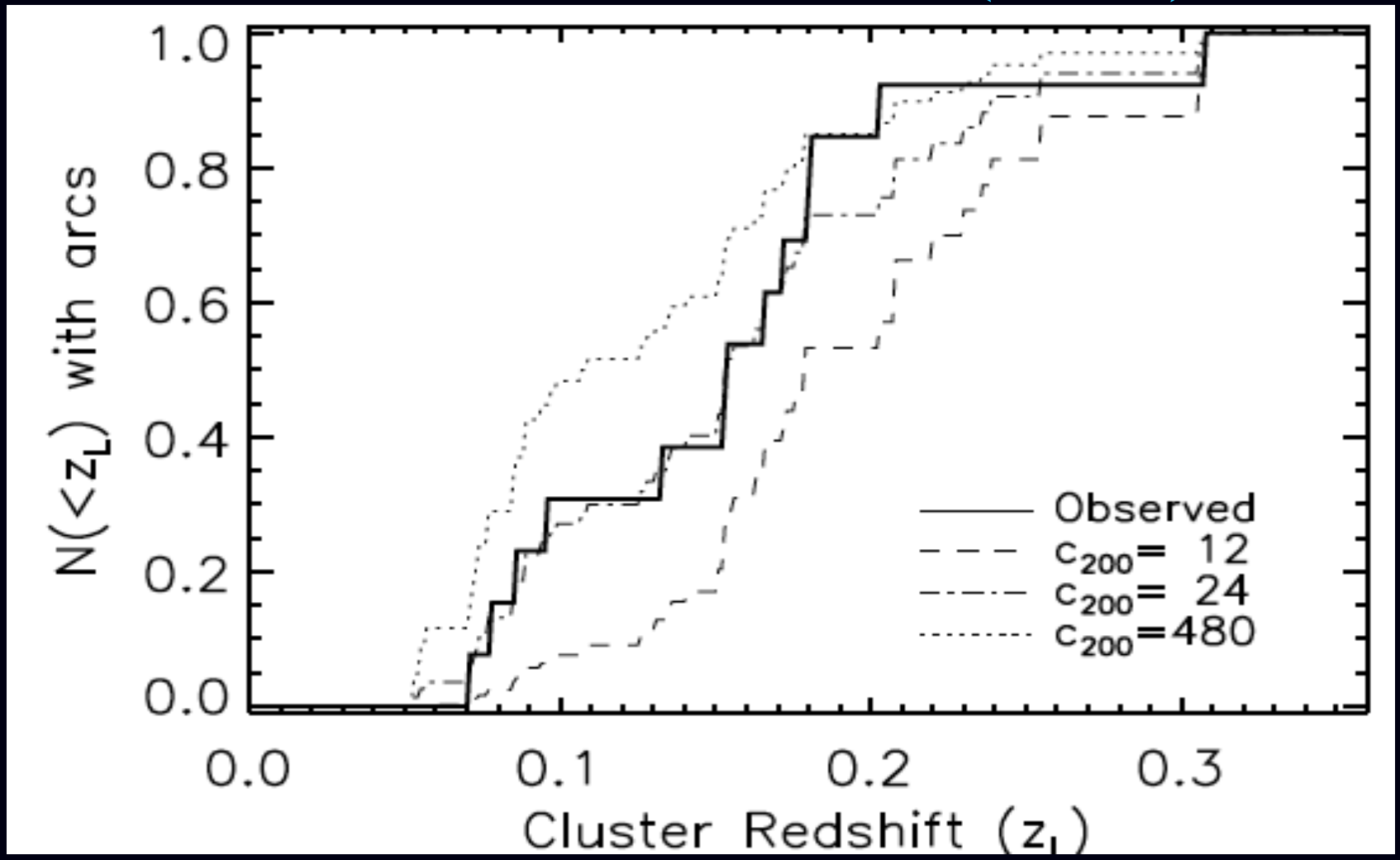
Cluster imaging selection

- We select bright X-ray (L_X>1.2 $10^{44}h^{-2}$ erg s^{-1}) clusters from Abell.
- z>0.05 allows that a large fraction of the clusters fit inside the FOV of the camera.
- -50° <δ<15°

Resulting on the selection of 48 clusters that were observed with VLT (FORS1). The images were obtained with an exposure of ~300 sec each in 3 filters (V, R, and I).

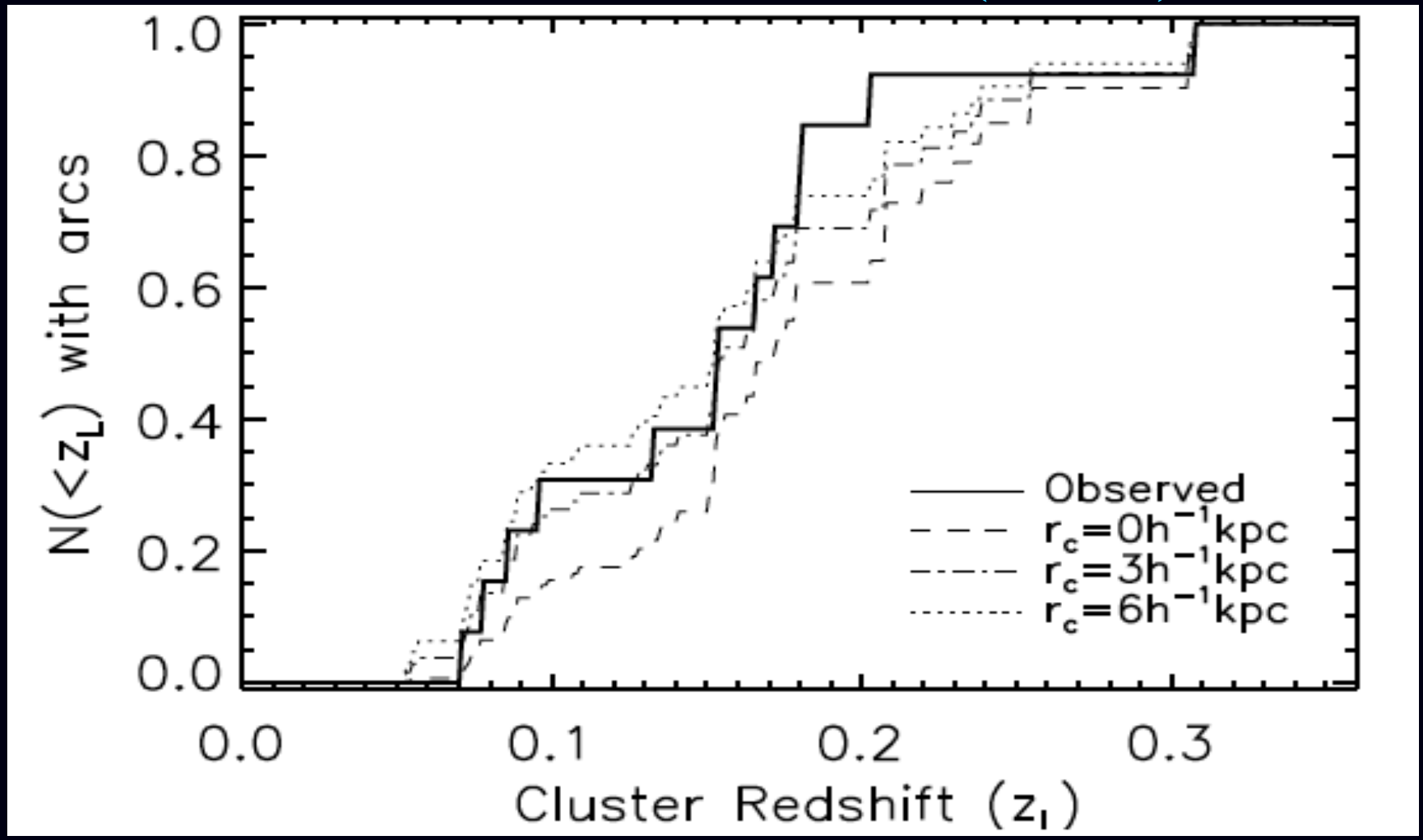

Abell 2744 (z=0.308)

Testing the observed cumulative distribution of arcs with a KS test (NFW)



We cannot reject the null Hypothesis that the model distribution is not different from the observed for $12<c_{200}<480$ ($\Delta=200$).

Testing the observed cumulative distribution of arcs with a KS test (NSIS)



We cannot reject the null Hypothesis that the model distribution is not different from the observed for rc<6h-1kpc

Conclusions

- The formulation presented in this work can be used to constrain halo parameters-- determining the concentration of the inner halo (e.g., r_c and c_Δ)-- of a prescribed sample of low-redshift clusters.
- From a K-S test we find that the haloes must be highly concentrated.
- These results, although preliminary--ellipticity will be added-- are indicative that cluster with strong lensing may be more concentrated than those predicted by L-CDM models.