Weak Lensing Study of 16 DAFT/FADA Clusters: Substructures and filaments

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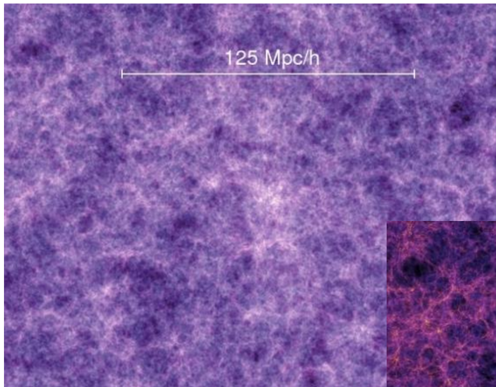
"Hot Spots in the XMM Sky: Cosmology from X-rays to Radio"

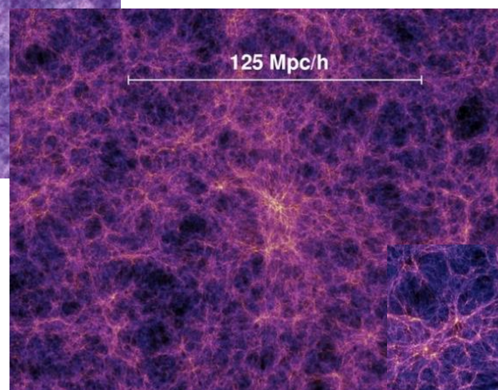
Mykonos, June 2016

N. Martinet, D. Clowe, **F. Durret, C. Adami**, A. Acebron, L. Hernandez-Garcia, I. Marquez, L. Guennou, **F. Sarron**, M. Ulmer, 2016, A&A, 590, A69

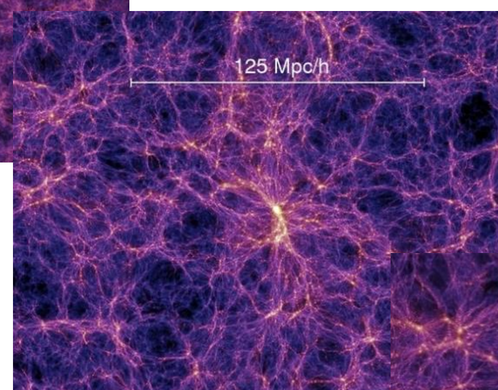
Cluster formation



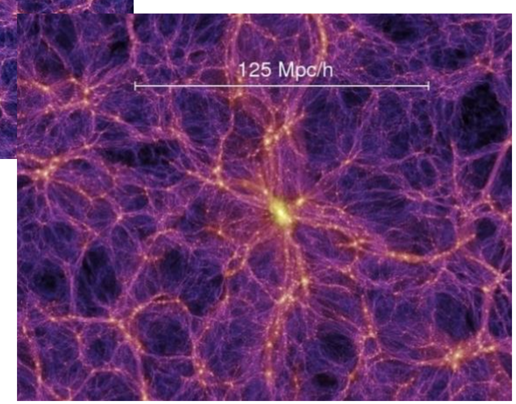
z=18.3 (t = 0.21 Gyr)



z=5.7 (t = 1.0 Gyr)



z=1.4 (t = 4.7 Gyr)



z=0 (t = 13.6 Gyr)

Millenium simulation
Springel+05

Goals and Data

- 16 DAFT/FADA clusters at $0.4<z<0.9$
- 8 CFHT/Megacam and 7 Subaru/Suprimecam fields with 3 optical bands (v,r,i,z)

- Get accurate masses -> observable-mass relation
- Study LSS -> filaments

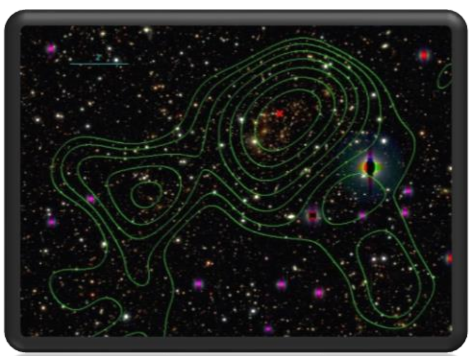
The DAFT/FADA survey (Dark energy American French Team)

- Sample of ~90 clusters with:
  - medium-high redshift ($0.4<z<0.9$)
  - high masses ($M>2x10^{14}M_{sol}$)
  - HST data
- And for most of them:
  - >4m ground based BVRIZJ follow up
  - good spectroscopy ($Nz>15$)
- And X-ray data (XMM or Chandra) for half

➢ 1st goal: Getting DE constraints through WL tomography with clusters

➢ 2nd goal: Studying a large sample of high redshift massive galaxy clusters

WL



SL

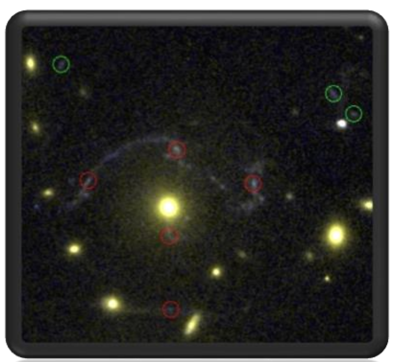
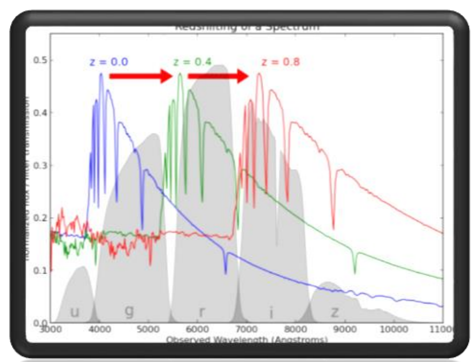
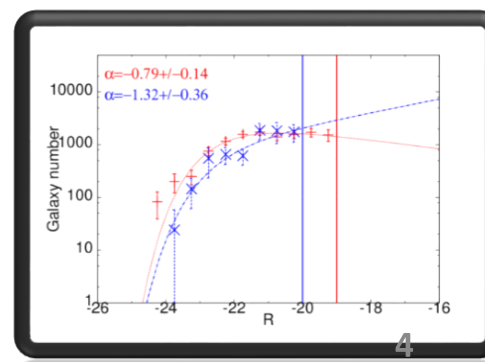


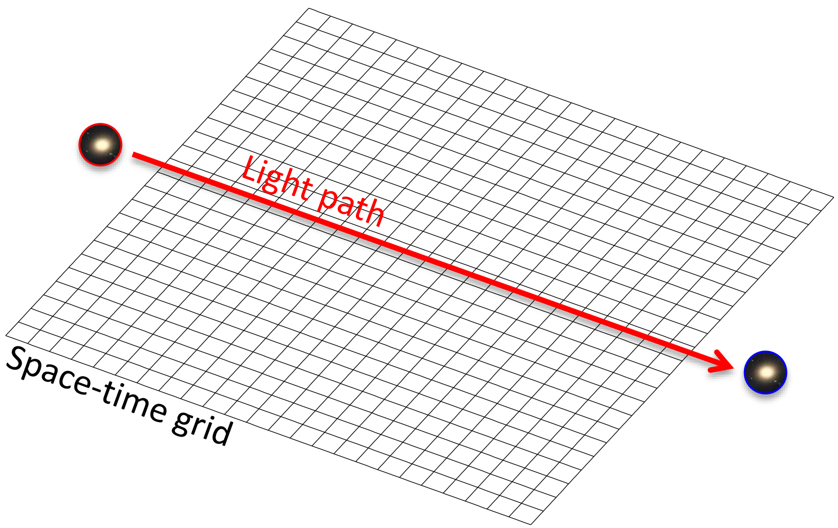
Photo-zs



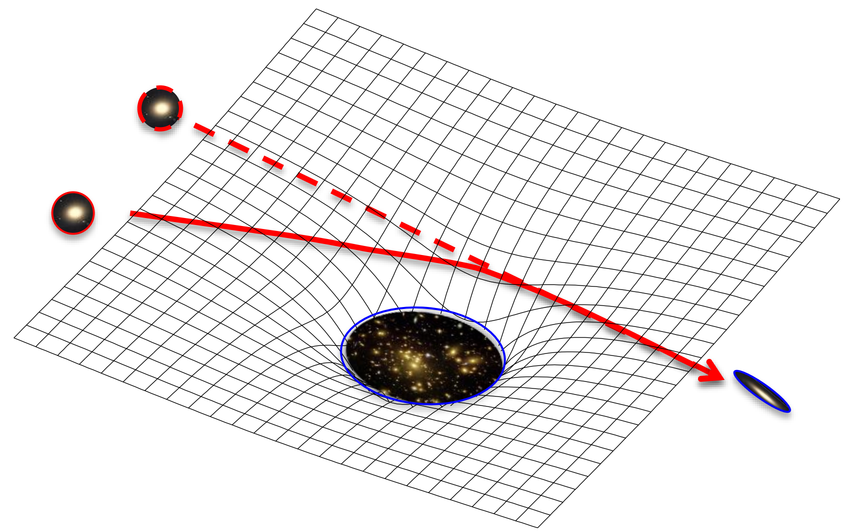
GLFs



Lensing theory



Flat space time

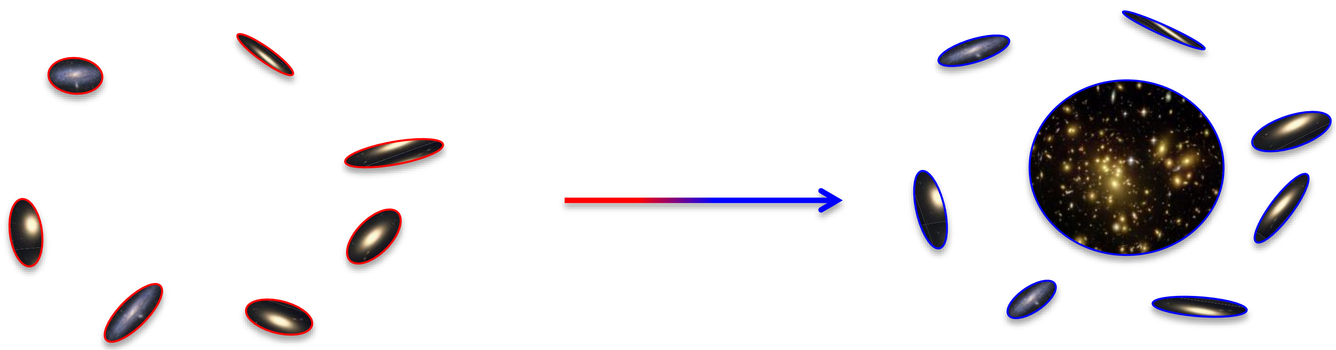


Curved space time

- A measure of κ or γ is a measure of the lens mass multiplied by the lens and source distance ratio

Weak lensing principle

- Relies on the hypothesis of null mean galaxy intrinsic ellipticity



Source plane
$\langle \varepsilon^{int} \rangle = 0$

Lens plane
$\langle \varepsilon^{obs} \rangle \neq 0$

- Observed ellipticity is equal to the shear in the WL regime
- Main problem is PSF anisotropies

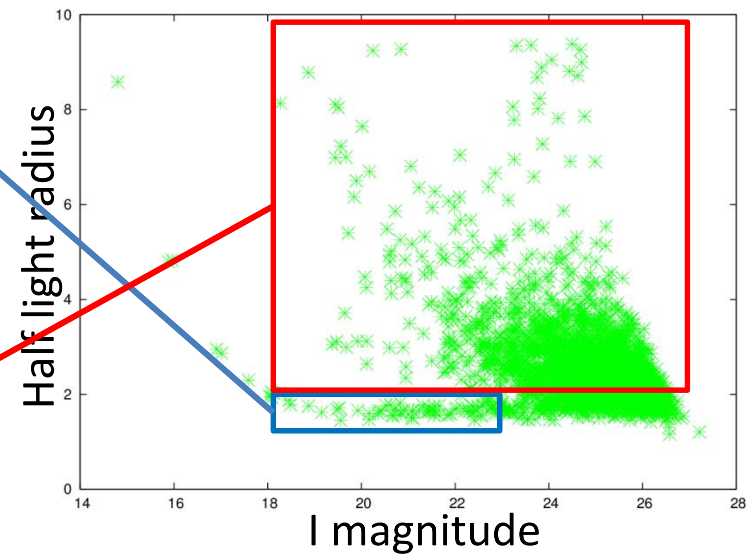
Measuring the shear

- Standard KSB method (Kaiser, Squires and Broadhurst 1995)
- Positions and magnitudes measured with SExtractor
- Ellipticities and surface brightness moments measured with imcat

Measure instrumental shape biases on stars

↓

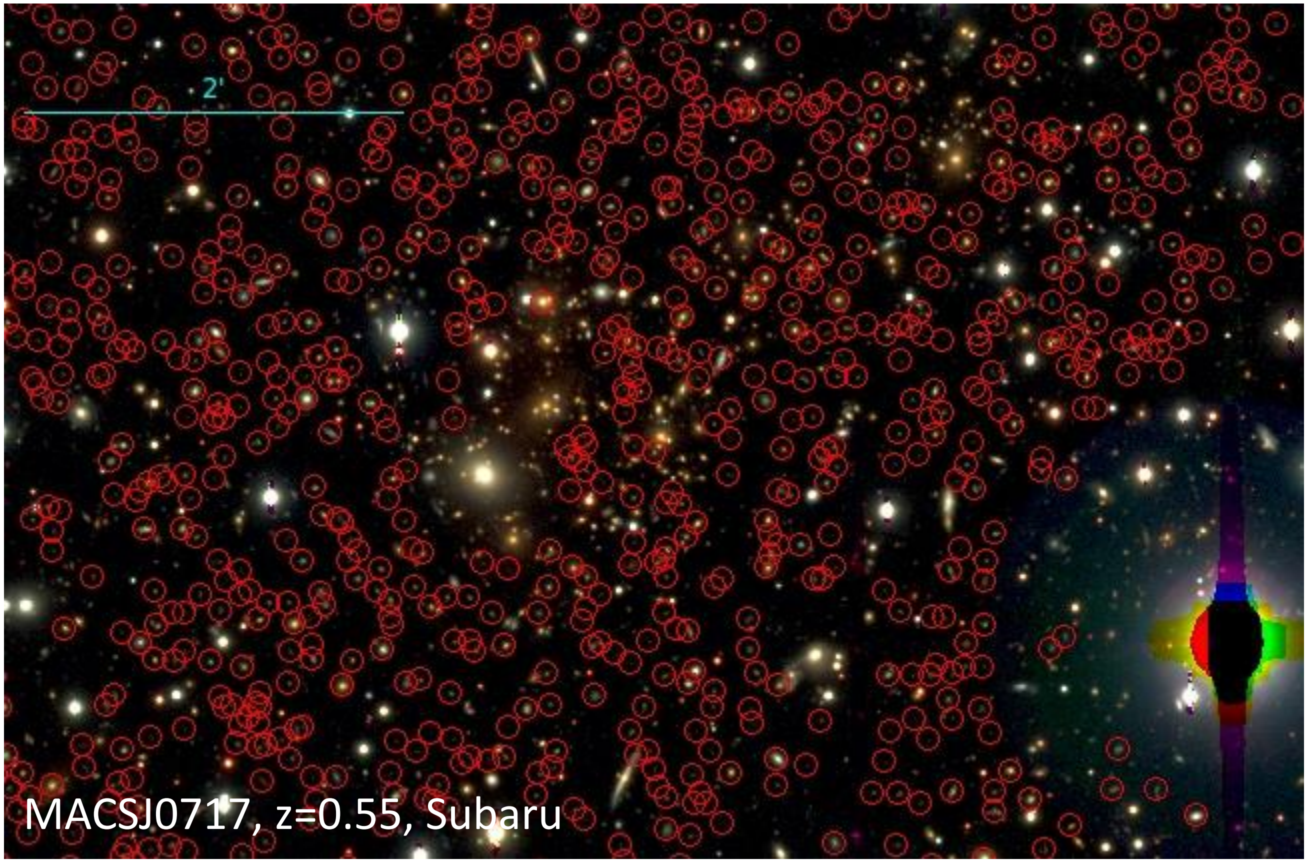
Correct galaxy shapes from instrumental biases



- Calibration on STEP2 ($m_{\gamma} \sim -0.05$)

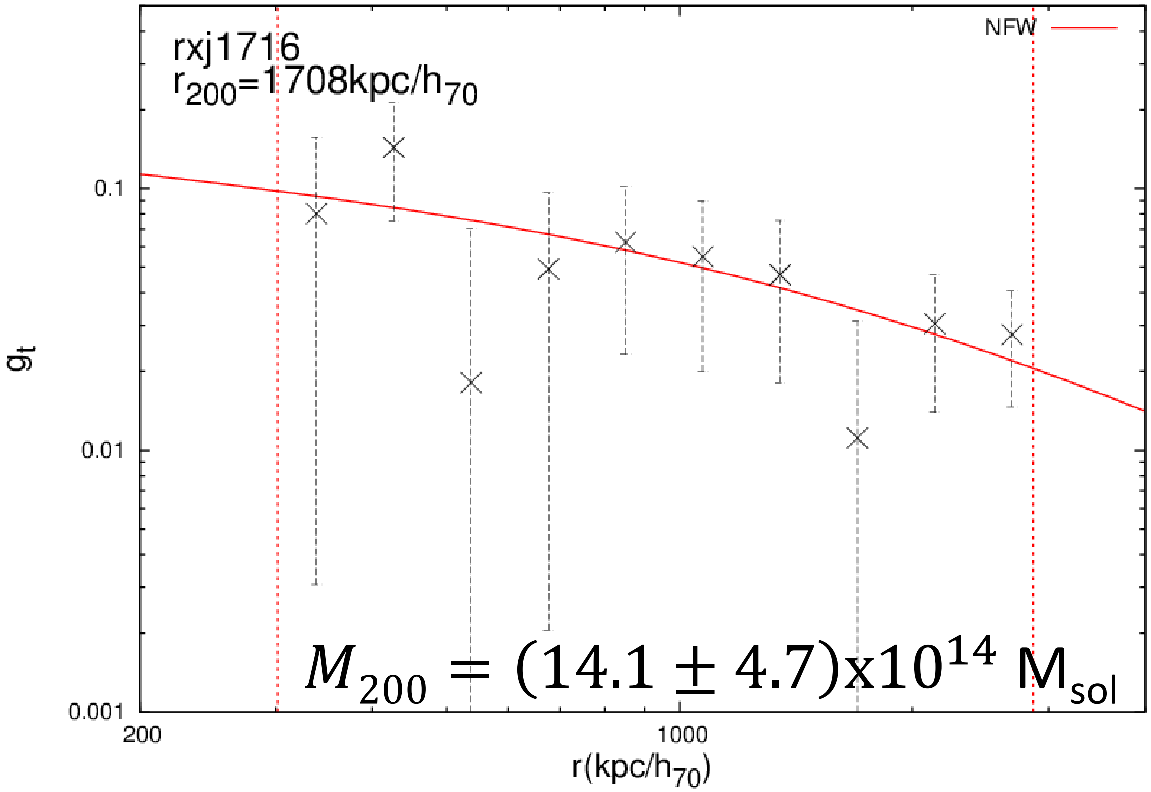
➢ Galaxy shear catalog corrected for PSF anisotropy

Measuring the shear



Red: Final background galaxy catalog

Cluster masses



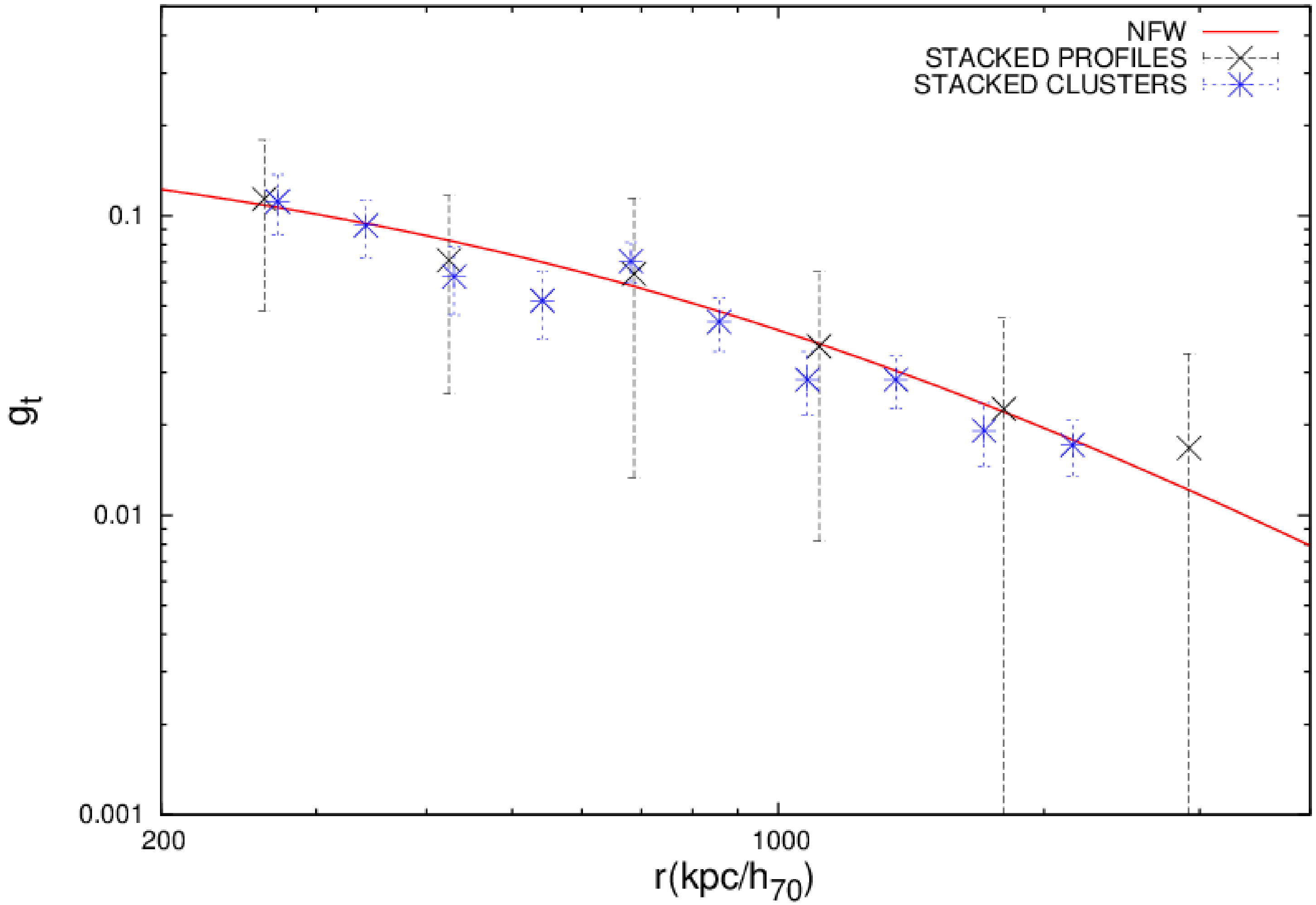
$$M_{200} = \frac{4\pi r_{200}{}^{3}}{3} 200 \boldsymbol{\rho}_{crit}(z)$$

$$g_{200}^{NFW} = f(r_{200}, c_{200})$$

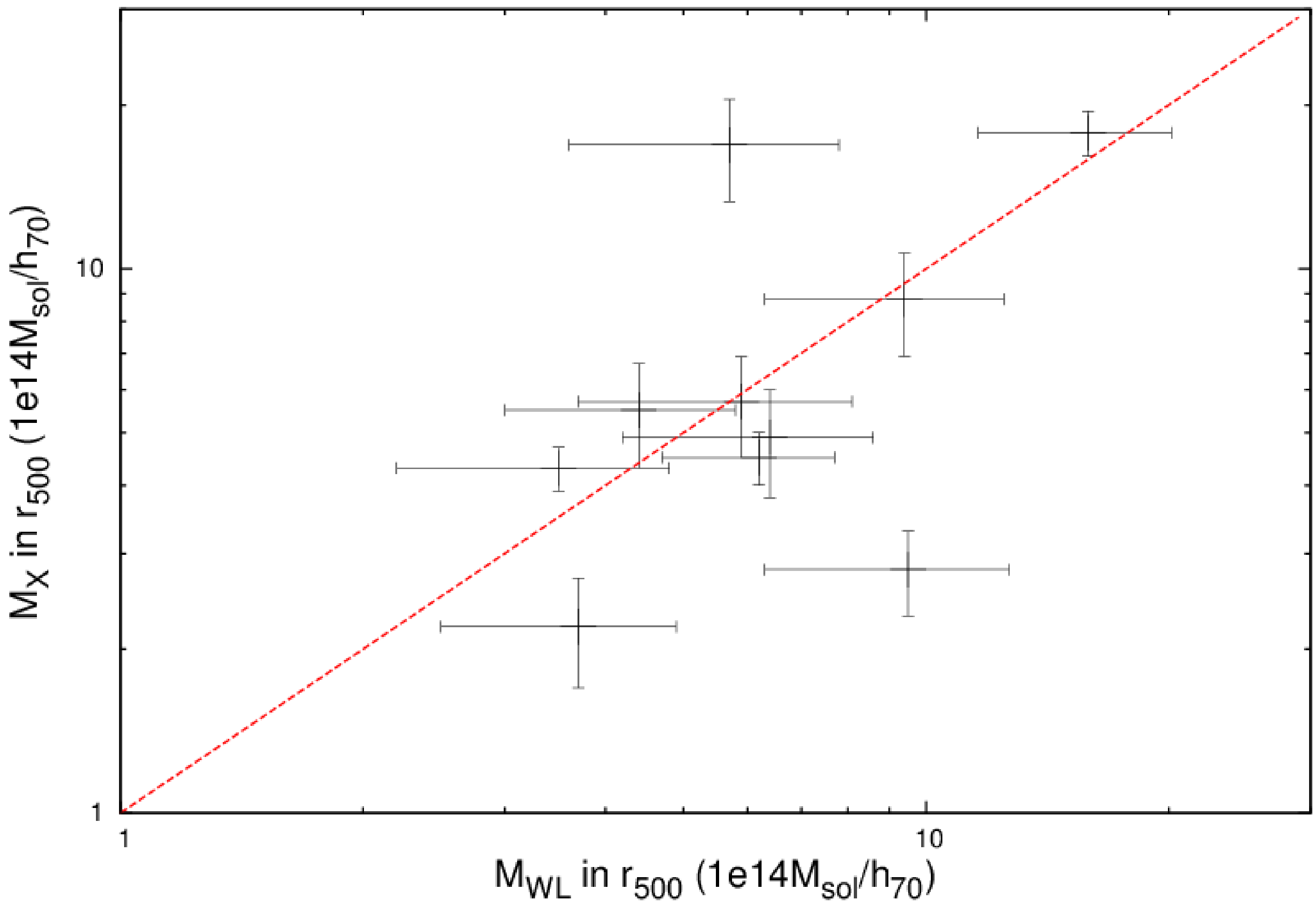
fixed to 3.5

Shear profile for RXJ1716, fitted with an NFW profile

Stacked profile



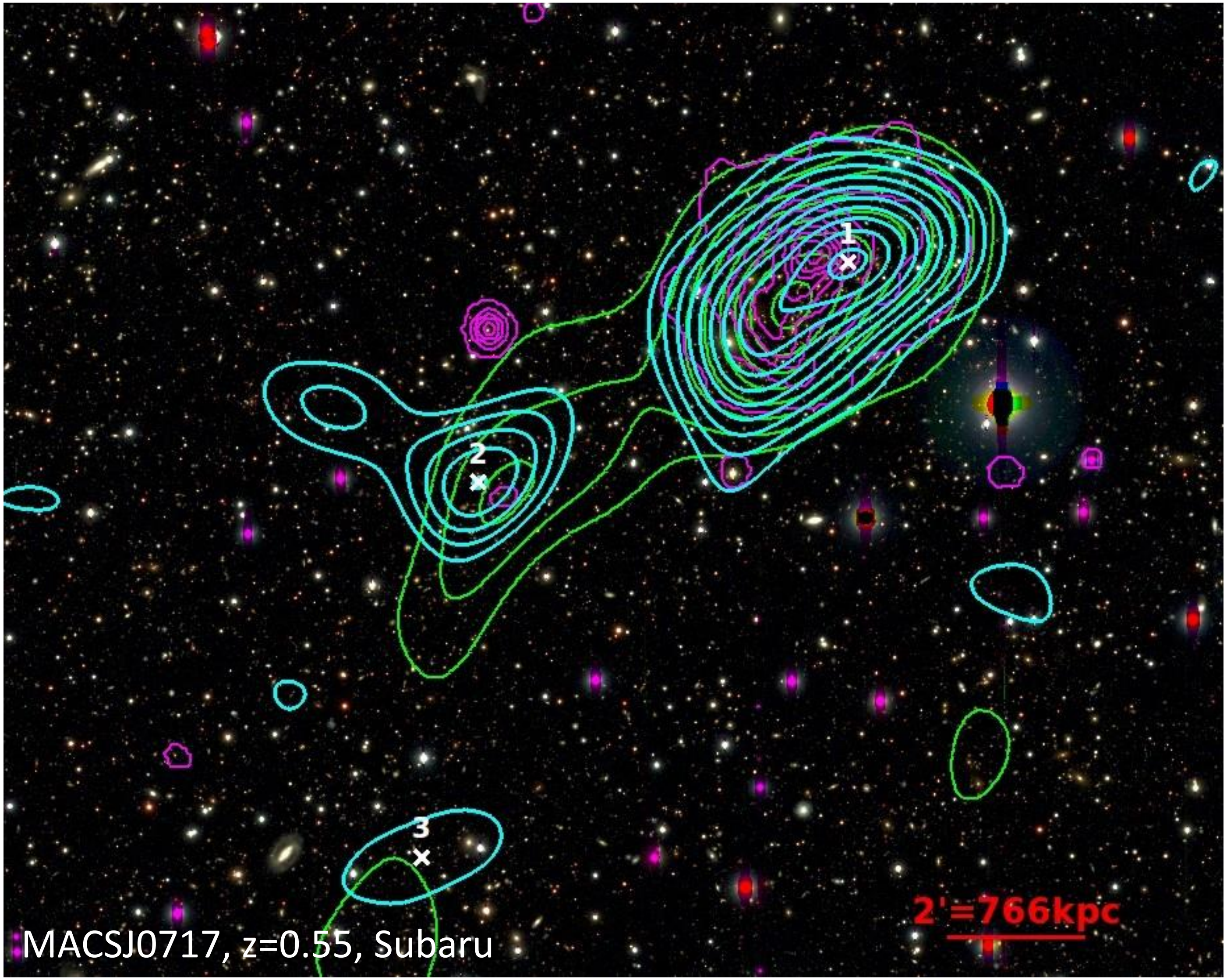
X-ray masses vs. WL masses



- WL masses 8% higher on average

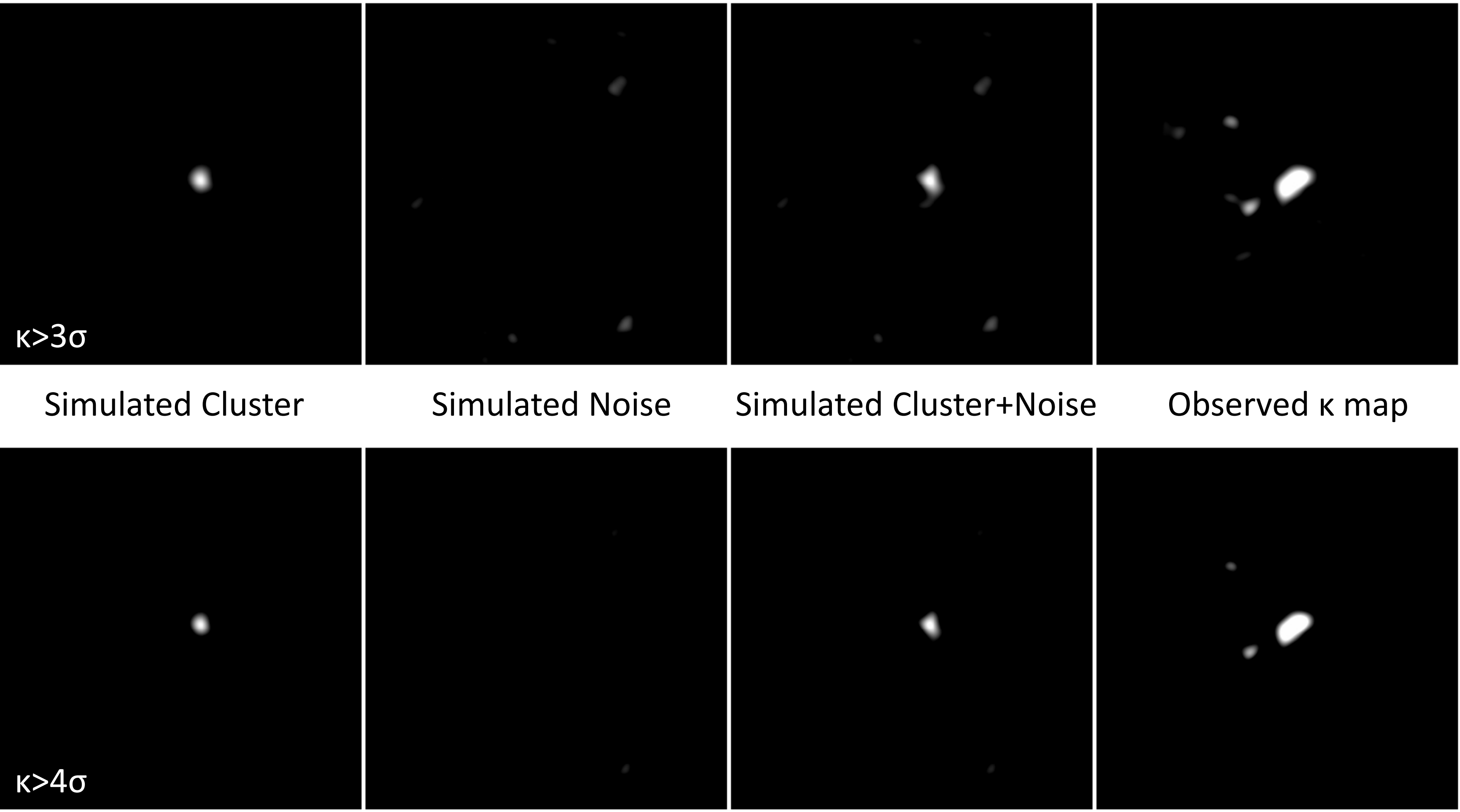
Mass maps

- Shear inverted into a convergence map
- Smoothed with gaussian filter, θ=1'

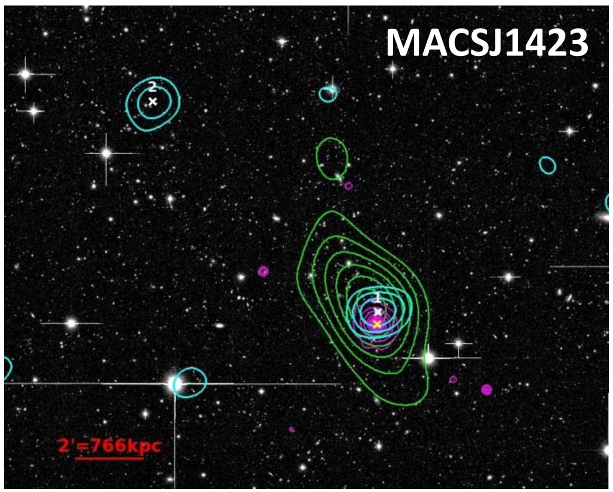


WL
X-ray
Light

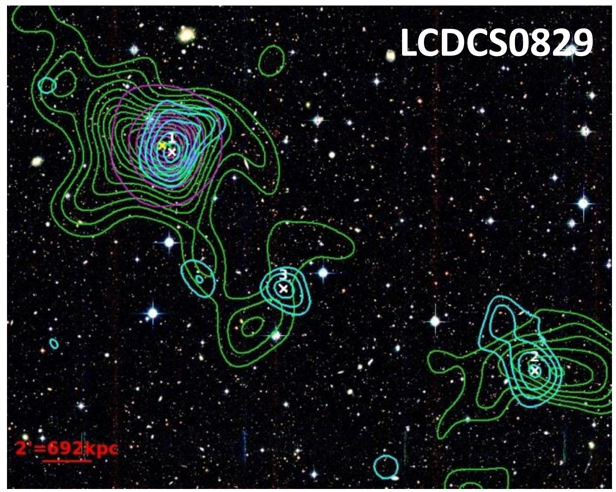
Fake peaks & noise re-sampling



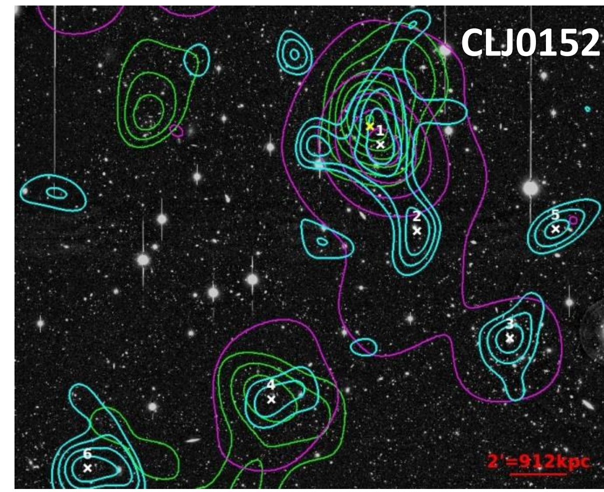
Cluster status



Relaxed
~ 7%



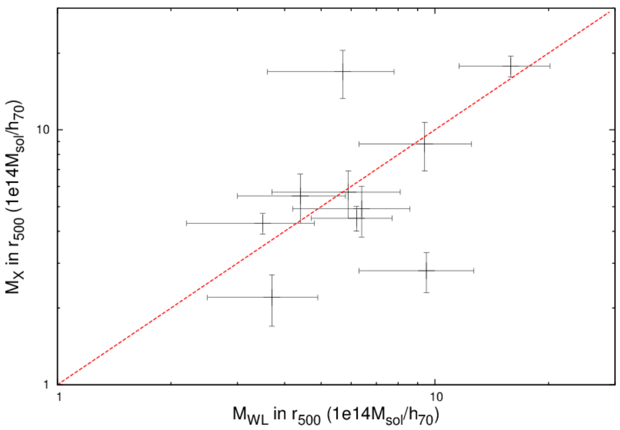
Old mergers
~ 21.5%

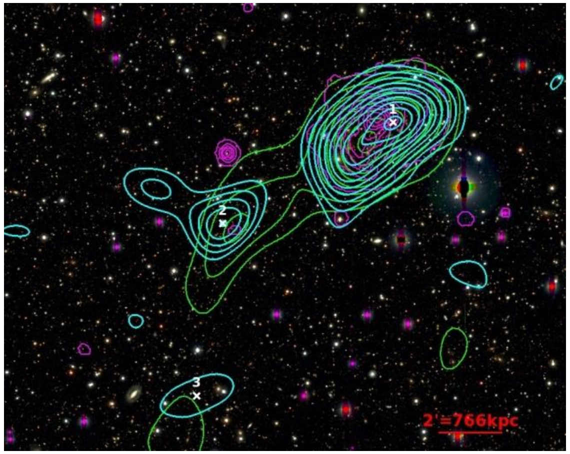


Present/Recent mergers
~ 71.5%

- WL
- X-ray
- Light

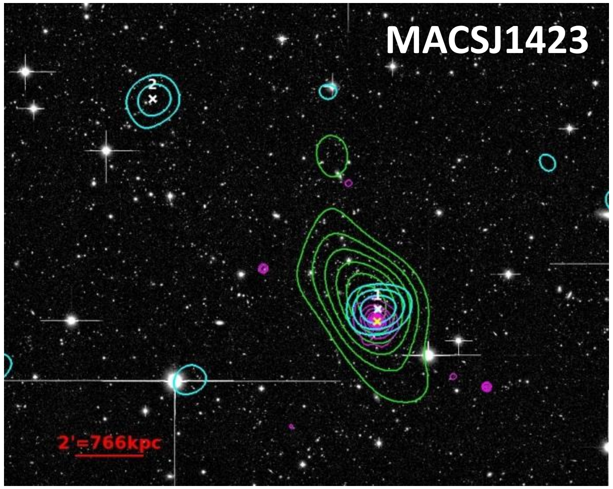
Conclusion

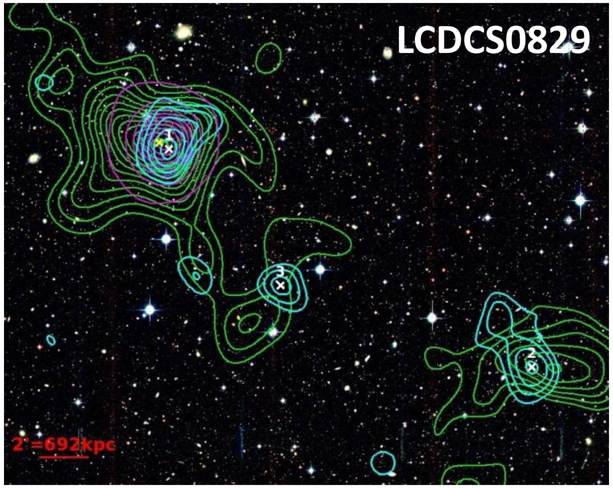


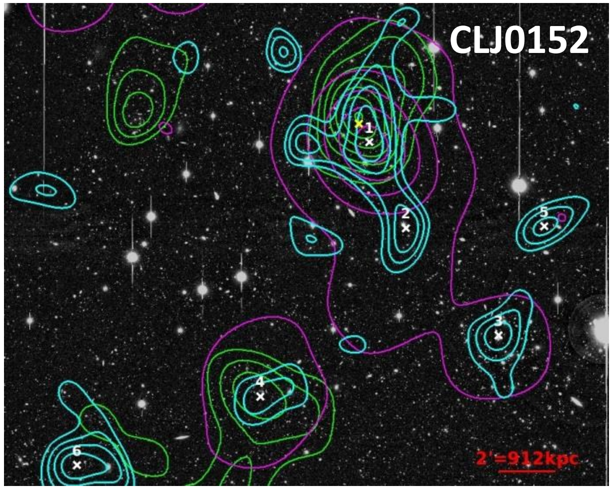


➢ Possible detection of filaments

➢ Calibration of the observable-mass relation





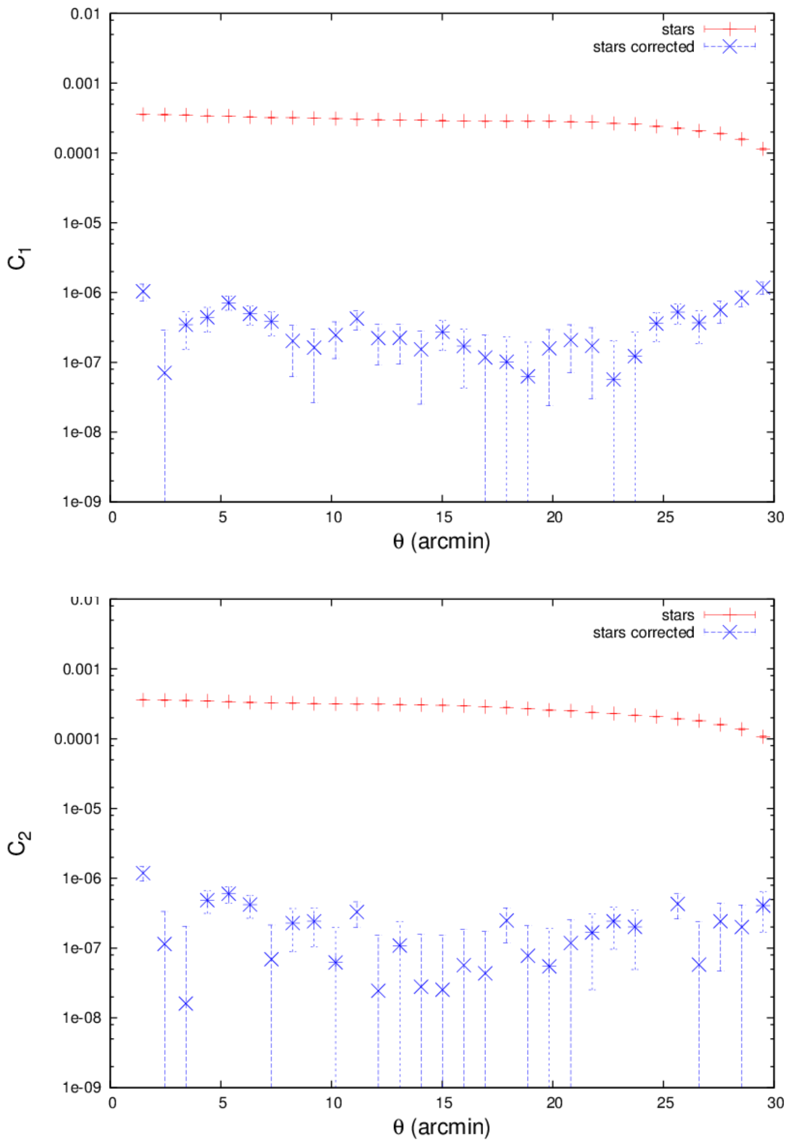


➢ Confirmation of hierarchical growth at 0.4<z<0.8

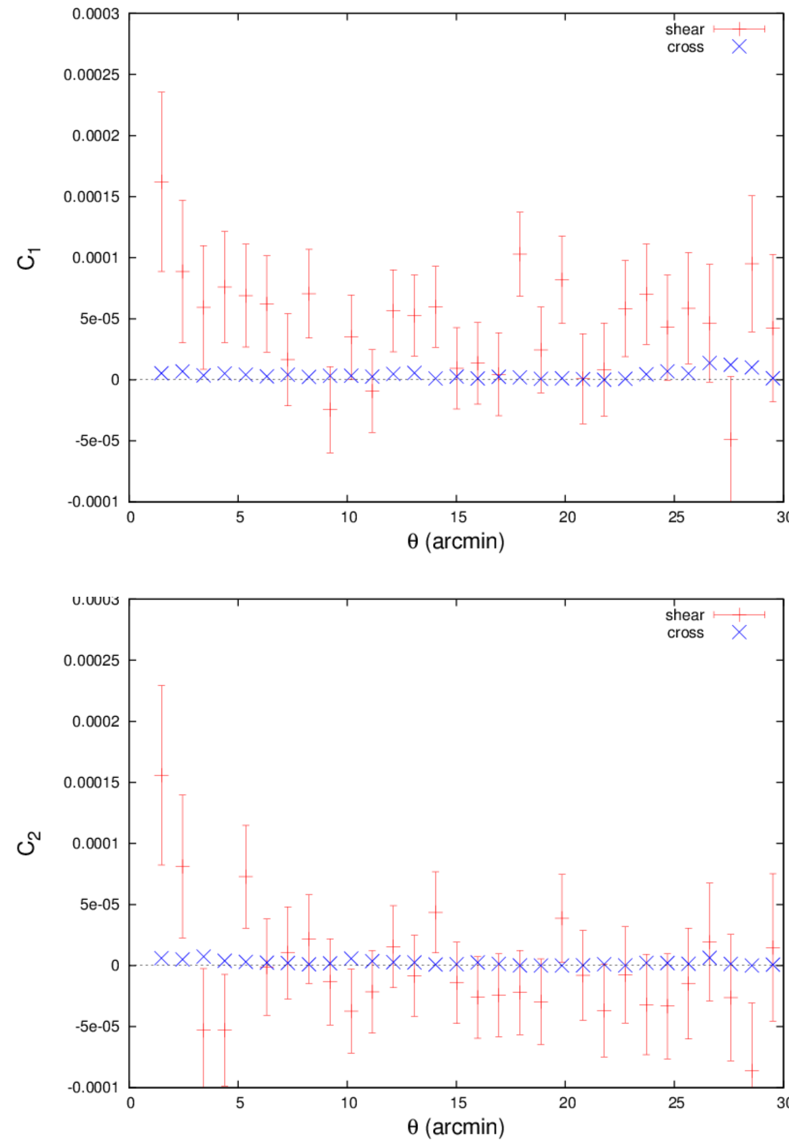
Thanks!

APPENDIX

Shear verification (1/2)

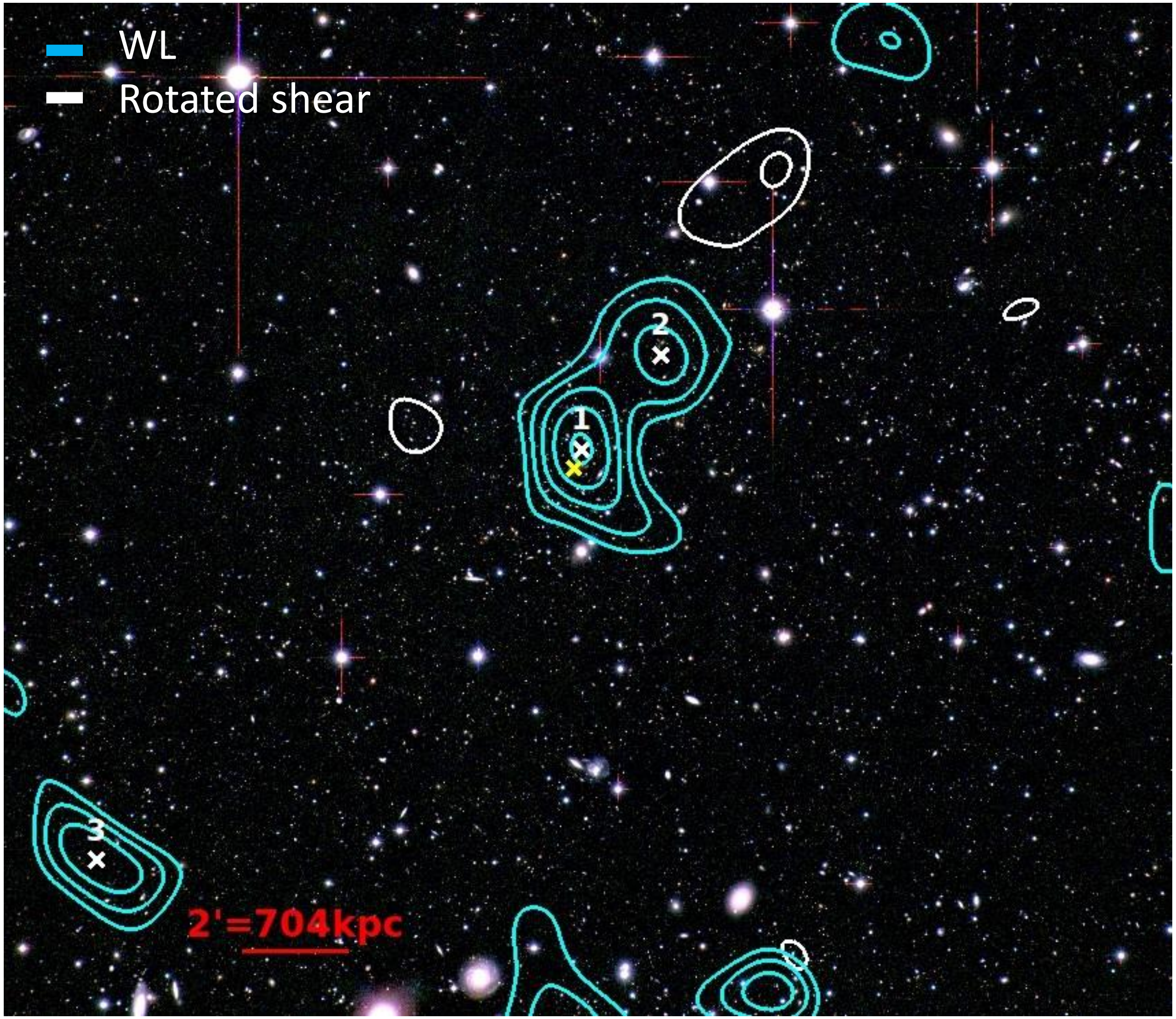


Stellar ellipticity auto-cf



Shear acf & shear-stellar ellipticy cross-cf

Shear verification (2/2)

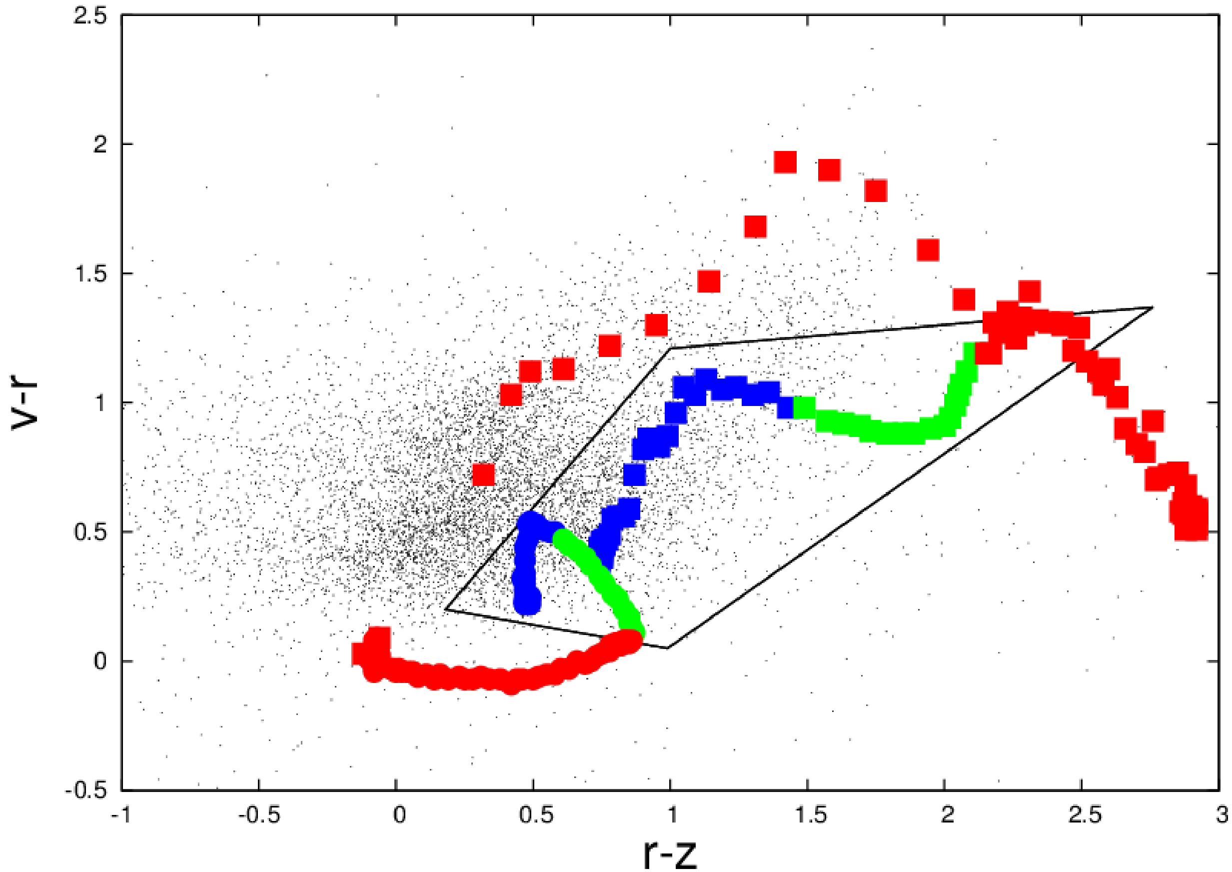


Color Color Cut

- Bruzual & Charlot 2003 calculated colors of galaxies for different redshifts

- We cut foreground and cluster galaxies

RXJ1716
z = 0.813
Cut at $\Delta z = 0.2$



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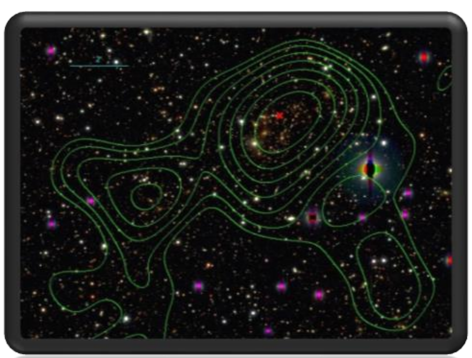
WL



SL

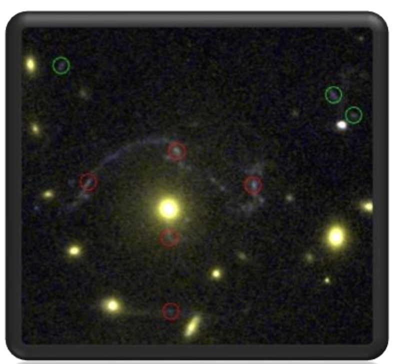
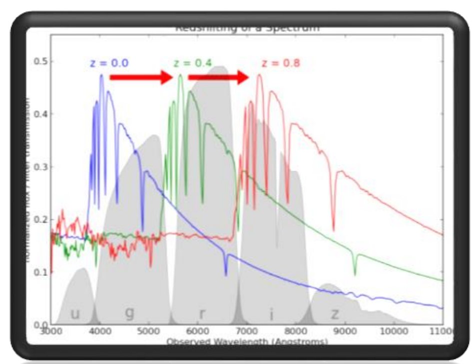
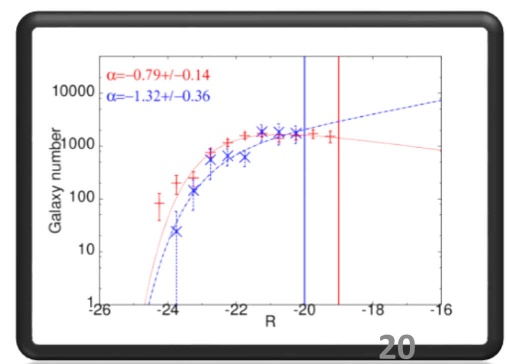


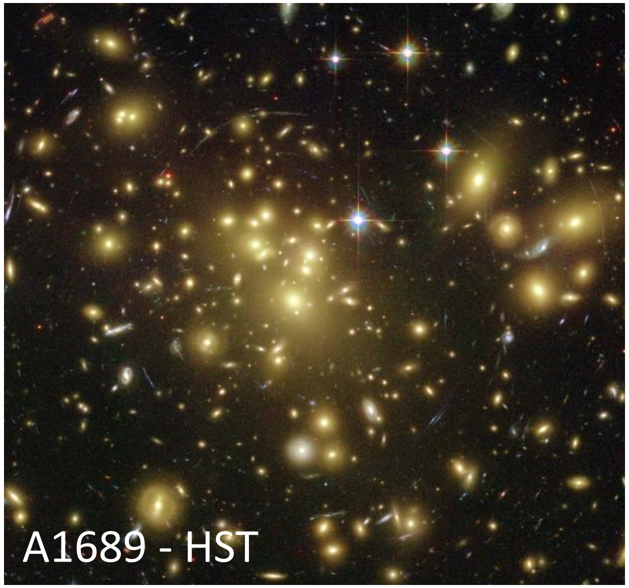
Photo-zs



GLFs

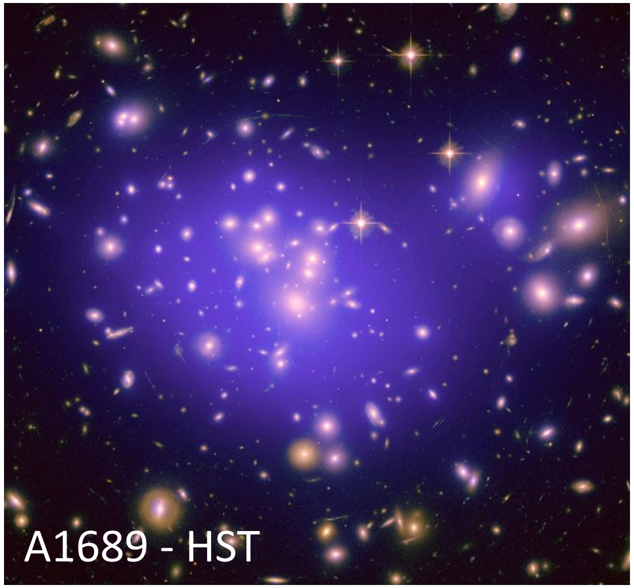


What’s a cluster?



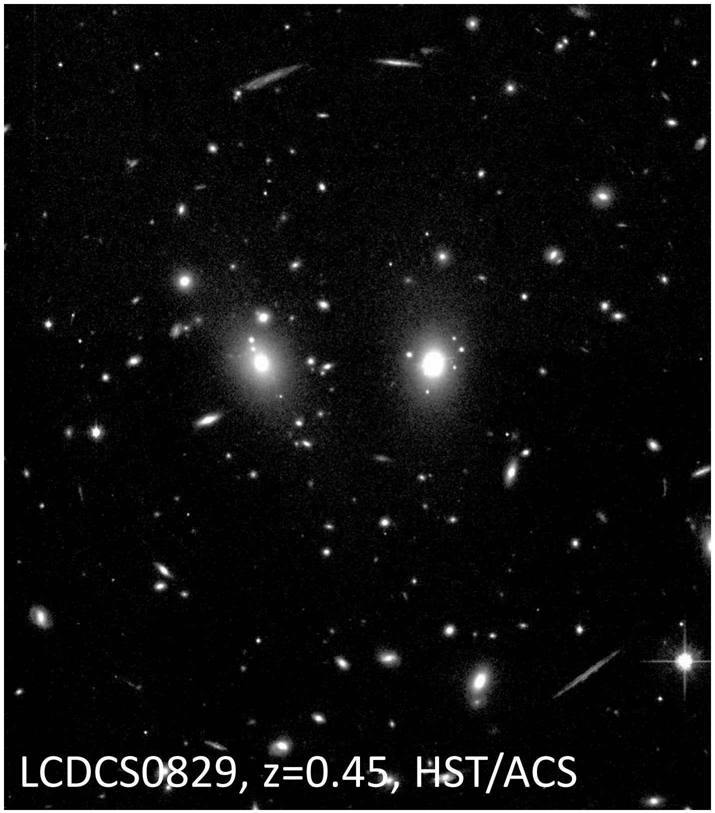
a few %
galaxies

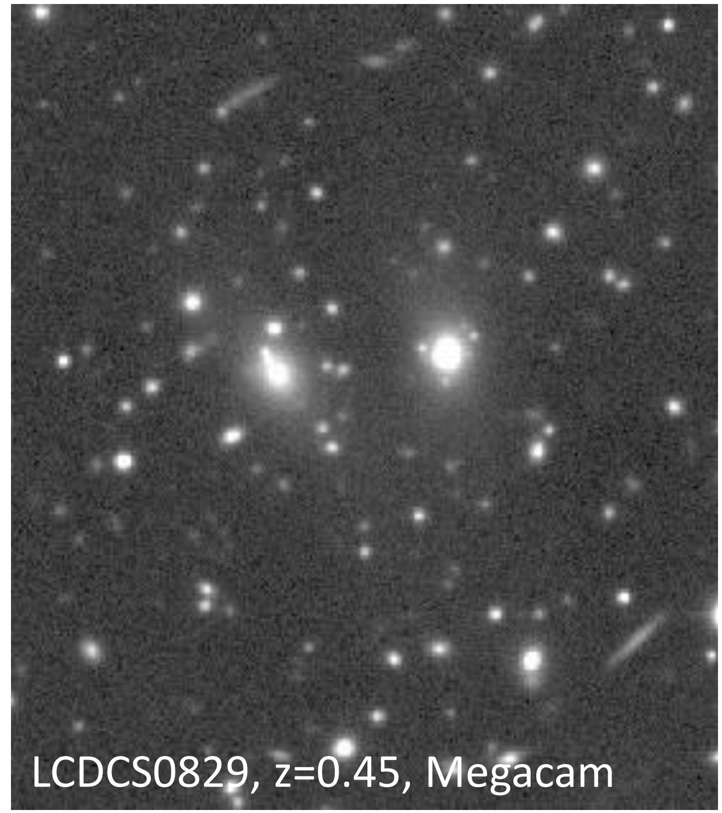
~10-15%
X-ray gas



~80-90%
dark matter

Why ground based WL?

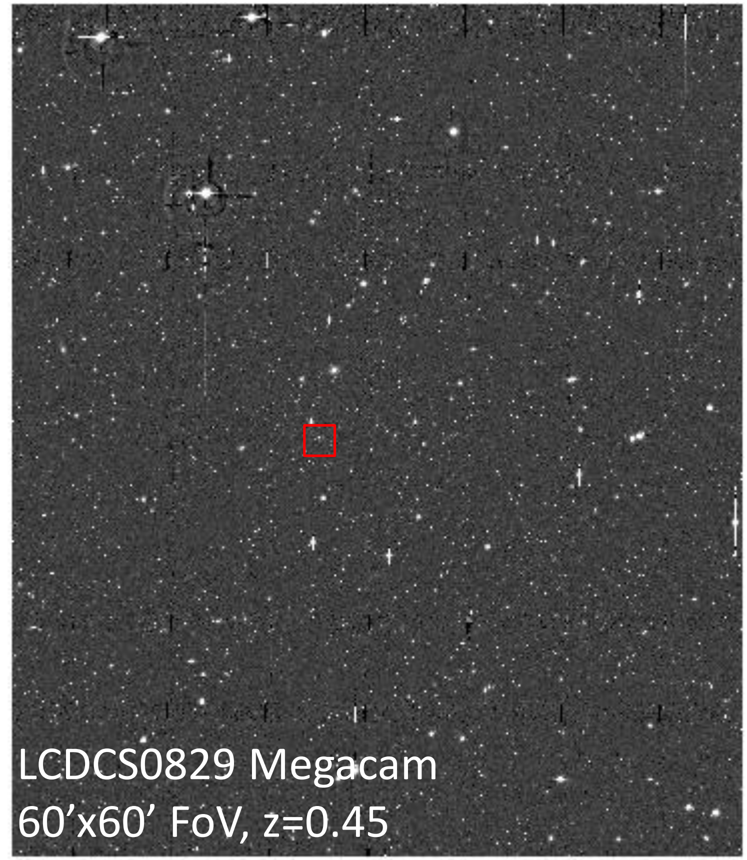




- HST has a much higher resolution and completeness

Why ground based WL?

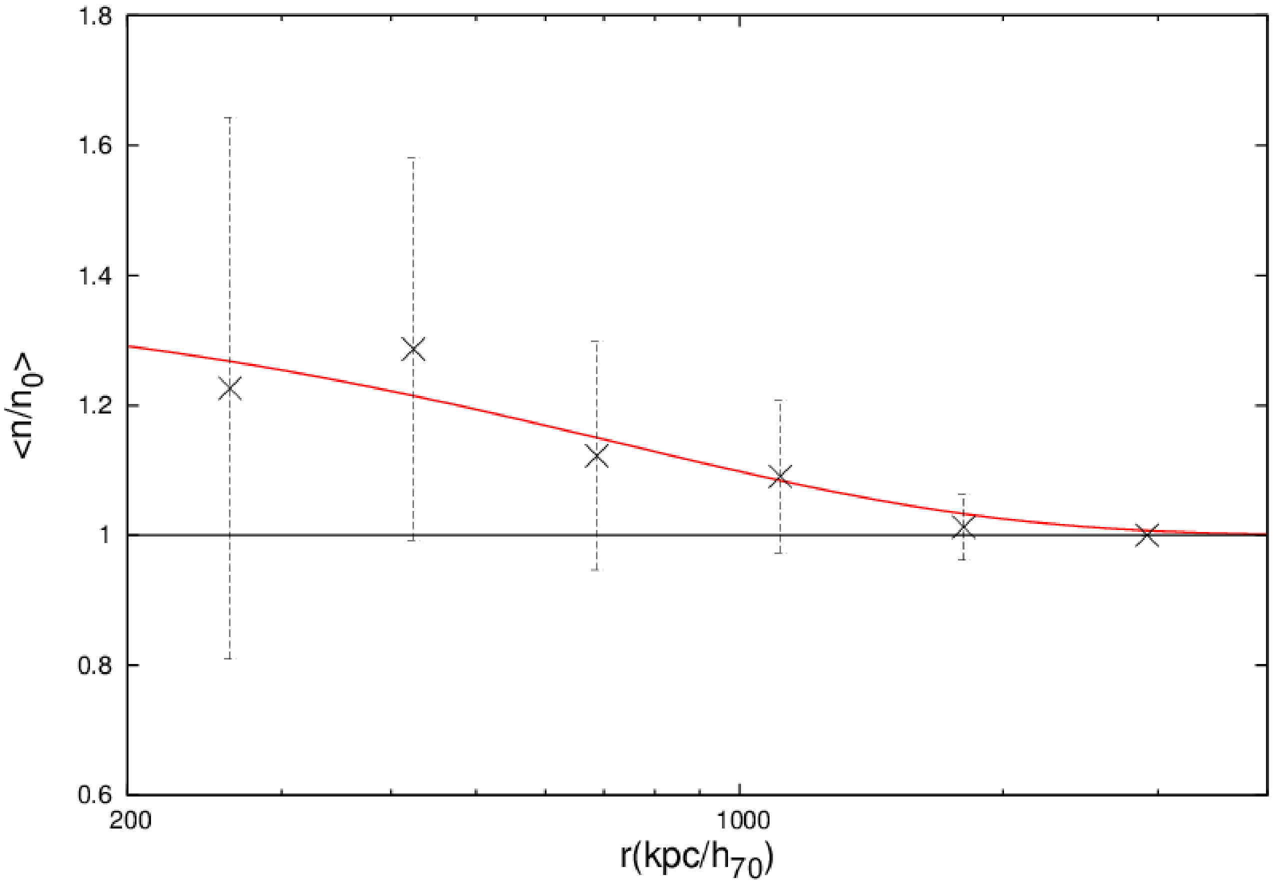
LCDCS0829 HST/ACS
3.4’x3.4’ FoV, z=0.45



LCDCS0829 Megacam
60’x60’ FoV, z=0.45

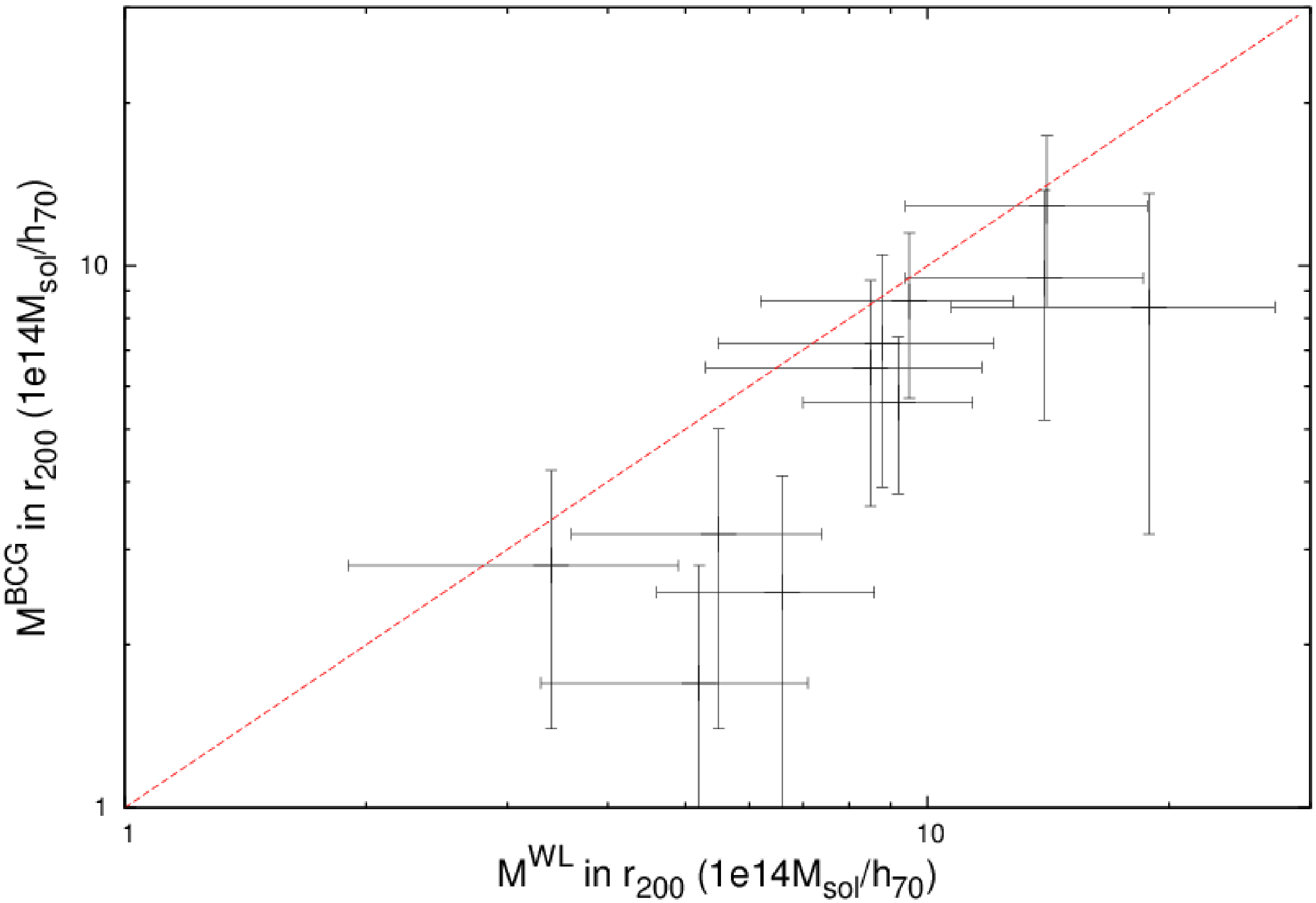
- But ground based field are much bigger!
  - Substructures & filaments
  - Mass sheet degeneracy

Boost factor



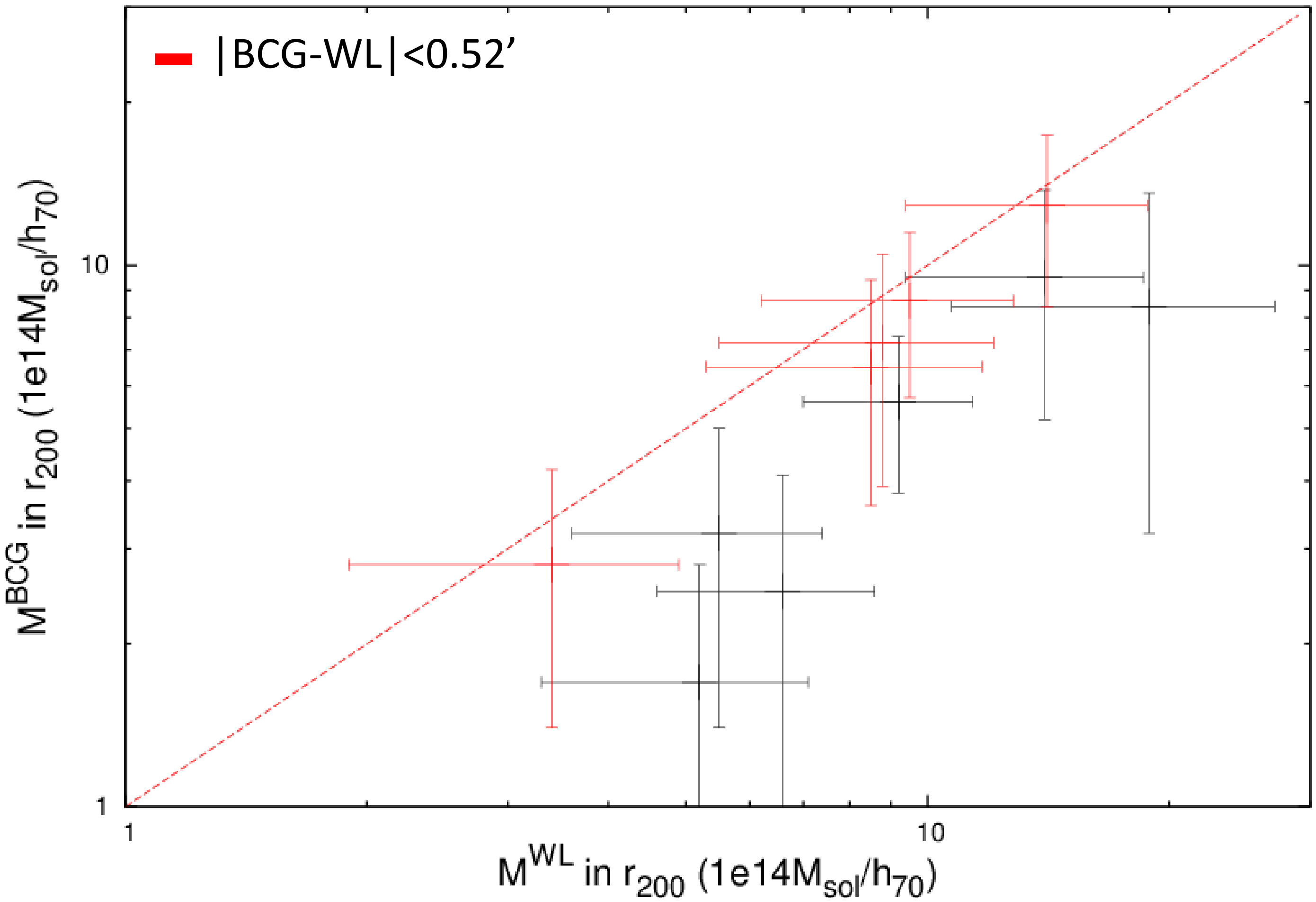
- Increase cluster masses by 9% in the mean

BCG vs. WL center



- Need to verify the BCG center assumption
- <true center - WL center> = 0.32’, σ(true center - WL center)=0.2’

BCG vs. WL center



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