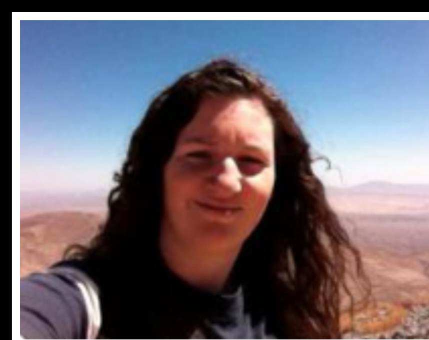
On the Effect of Lensing Constraints and Model Assumptions on Magnification Uncertainties

Keren Sharon (U. Michigan)

did most of the work:

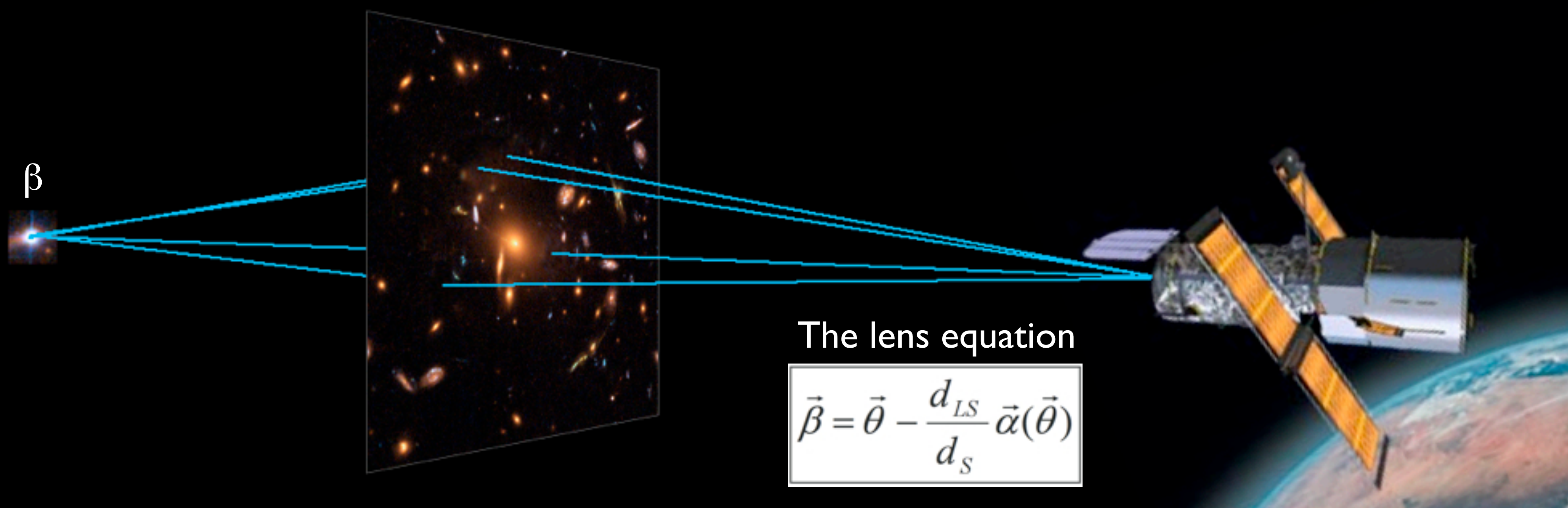
Traci Johnson (UMich)

Matt Bayliss (Harvard)



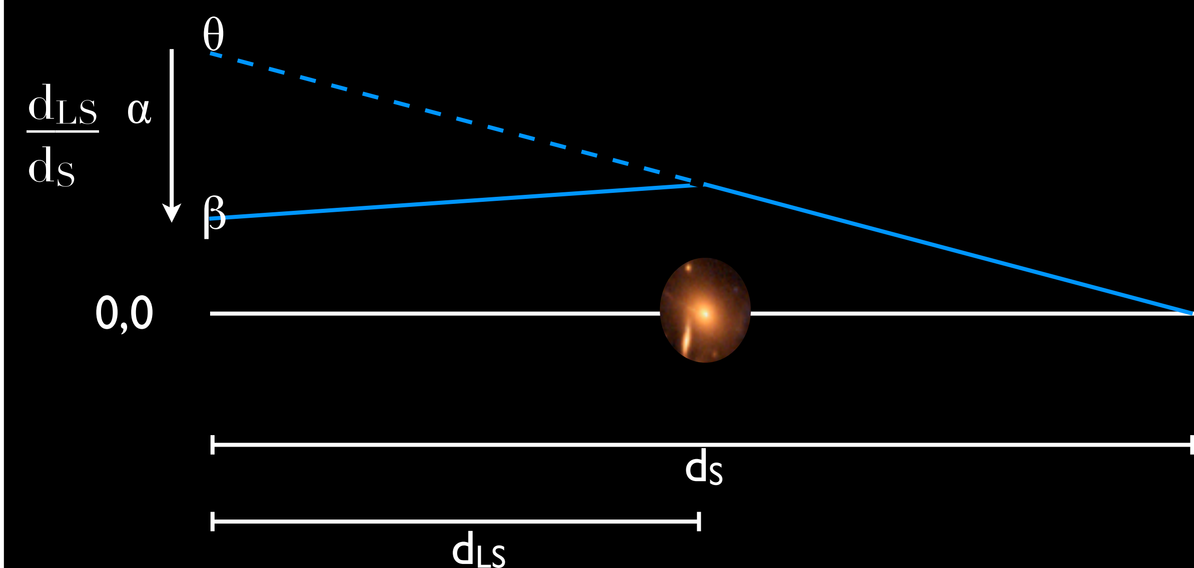
Outline

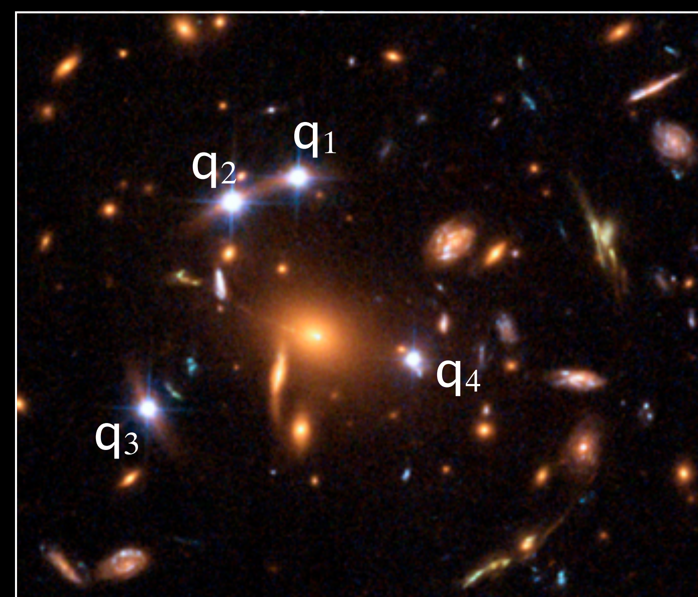
- 1) On the importance of source redshifts
- 2) Cosmological assumptions
- 3) Mass on the line of sight



The lens equation

$$\vec{\beta} = \vec{\theta} - \frac{d_{LS}}{d_S}\vec{\alpha}(\vec{\theta})$$

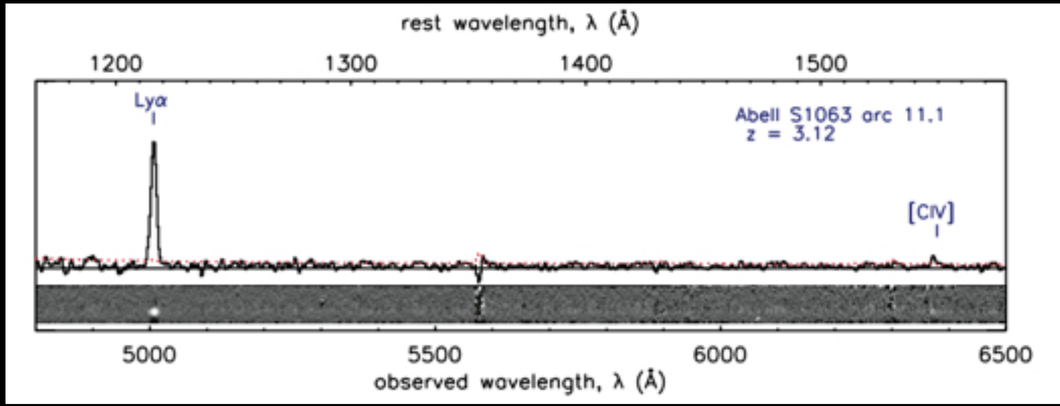


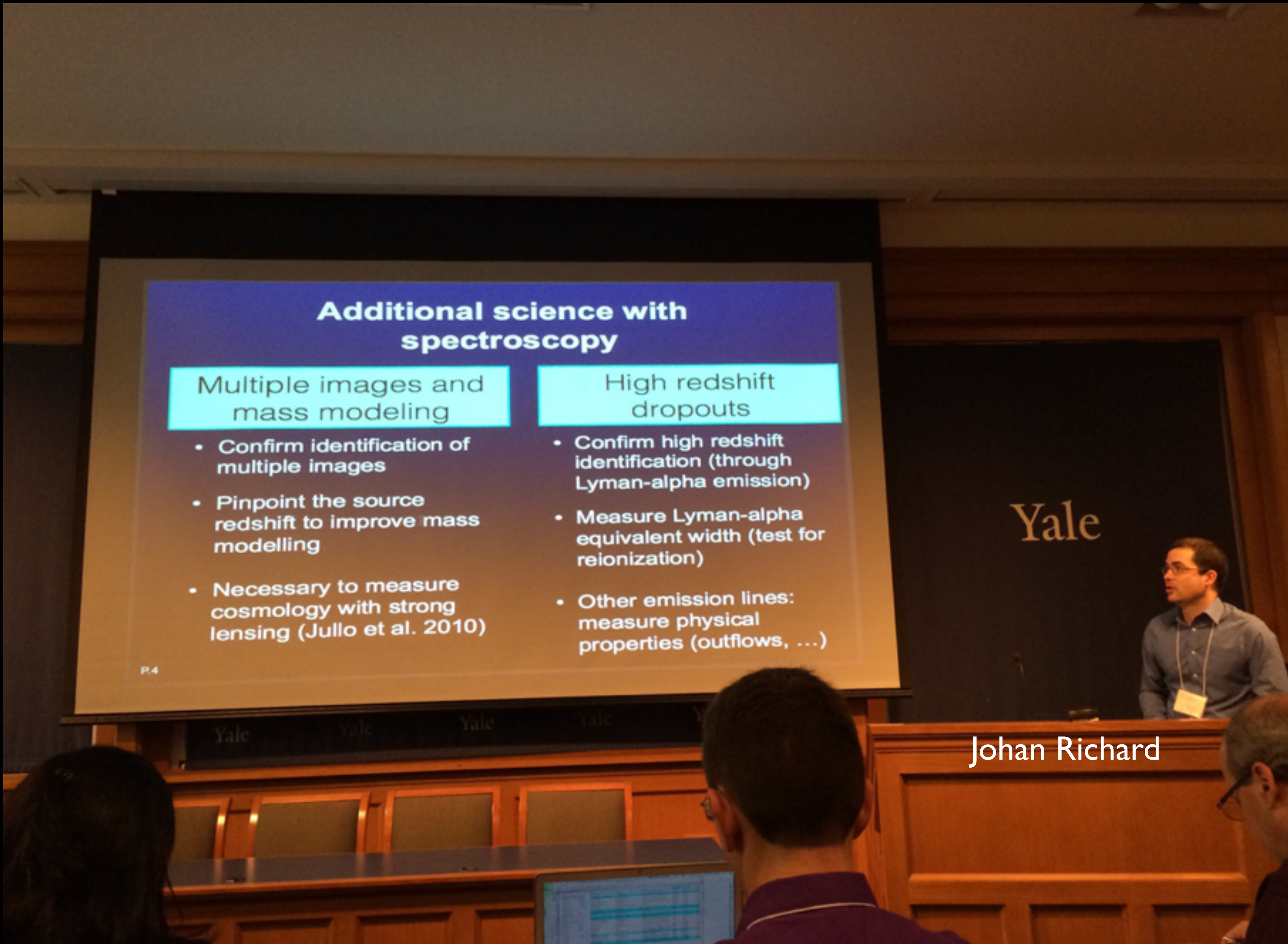


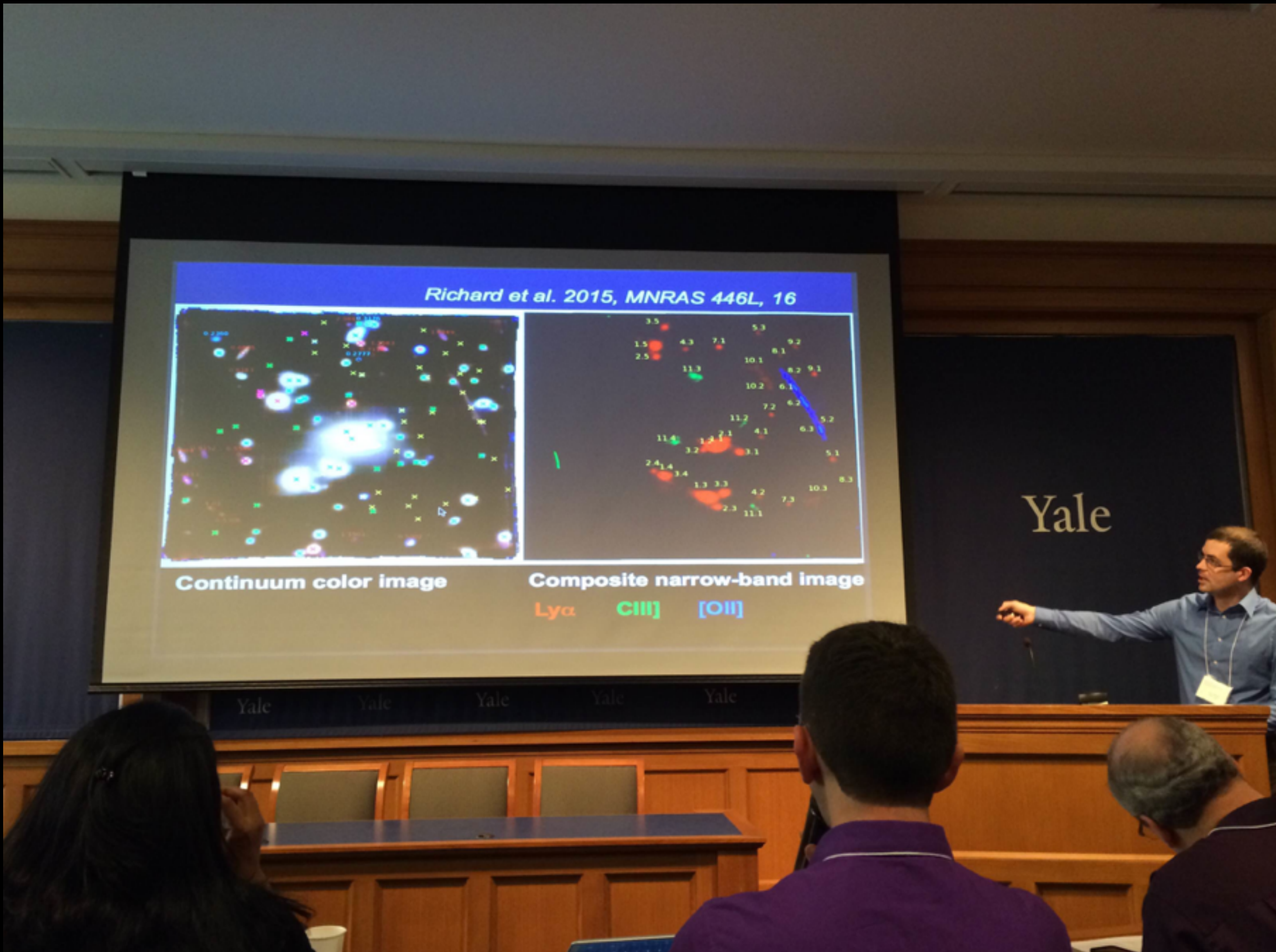
SDSS1004, Sharon et al. (2005), *HST*/ACS

Source Redshifts: New Measurements

- Magellan
- Multi Object Slit masks
- 4.4h Ldss3 AS1063
  - new redshift for source #11
  - confirmation of 8 counter-images
- 7.5h IMACS A2744
  - new redshift for source #3
  - confirmation of 8 counter-images

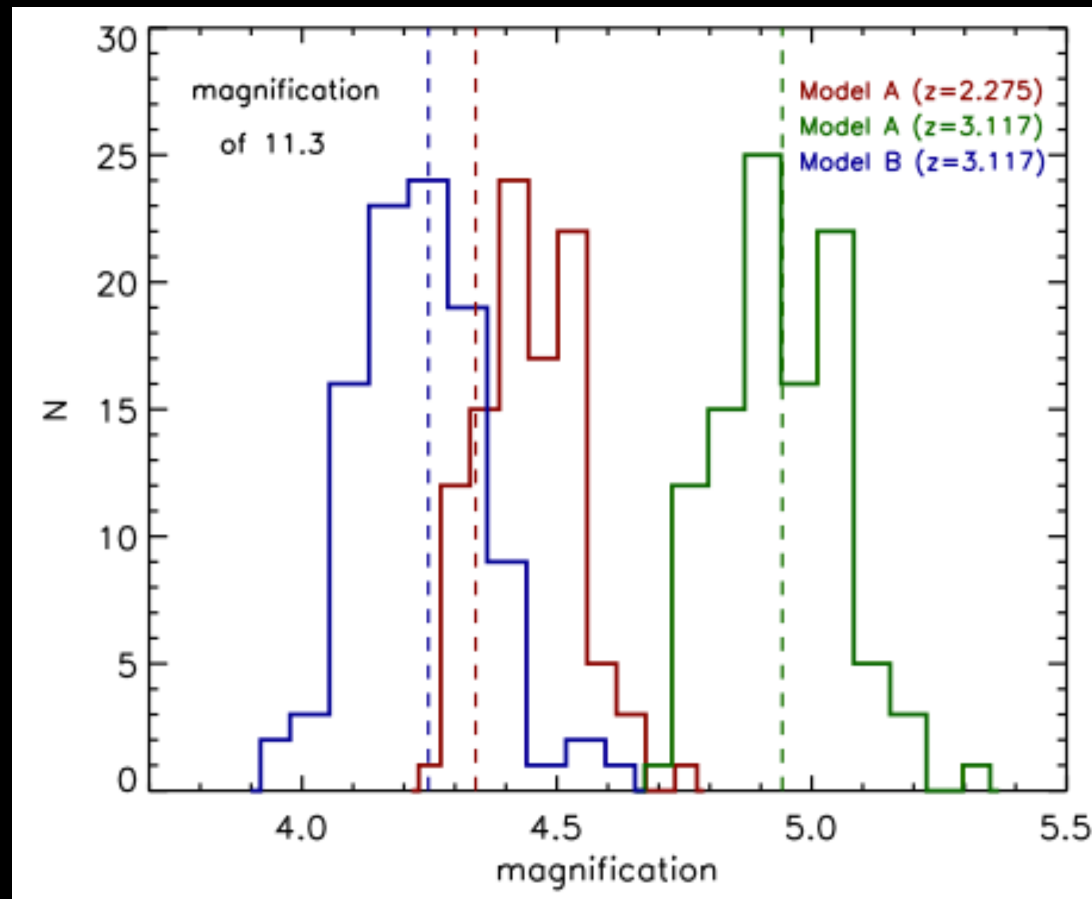



Additional science with spectroscopy
Multiple images and mass modeling
Confirm identification of multiple images
Pinpoint the source redshift to improve mass modelling
Necessary to measure cosmology with strong lensing (Jullo et al. 2010)
High redshift dropouts
Confirm high redshift identification (through Lyman-alpha emission)
Measure Lyman-alpha equivalent width (test for reionization)
Other emission lines: measure physical properties (outflows, ...)
P.4
Yale
Johan Richard


Richard et al. 2015, MNRAS 446L, 16
Continuum color image
Composite narrow-band image
Lyα
CIII]
[OII]
Yale

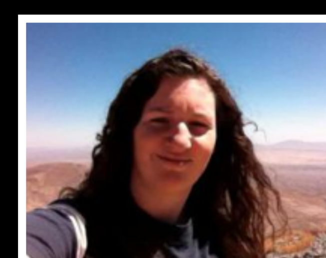
1) Spec z vs free redshifts

- Magnifications:
  - Fixing ONE redshift in AS1063 resulted in more complex model in order to satisfy the lensing constraints.
  - Setting z as free parameter* vs spec z changes the predicted magnification.



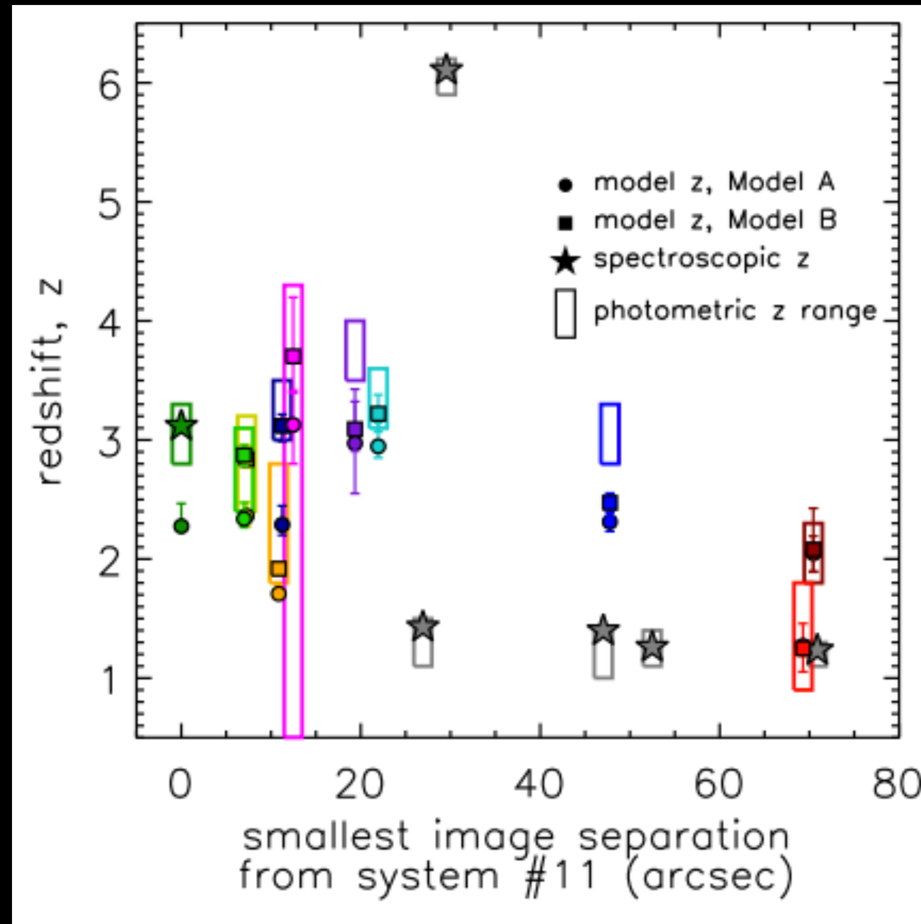
Johnson et al. (2014)

- Talk with Traci! →
  (+presentation on Friday)



1) Spec z vs free redshifts

- Magnifications:
  - Fixing ONE redshift in AS1063 resulted in more complex model in order to satisfy the lensing constraints.
  - Setting z as free parameter* vs spec z changes the predicted magnification.
  - Photometric redshifts have statistical strength.



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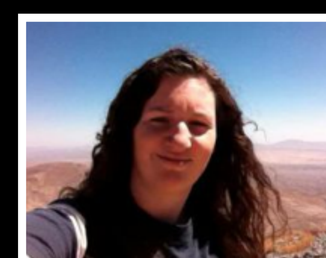
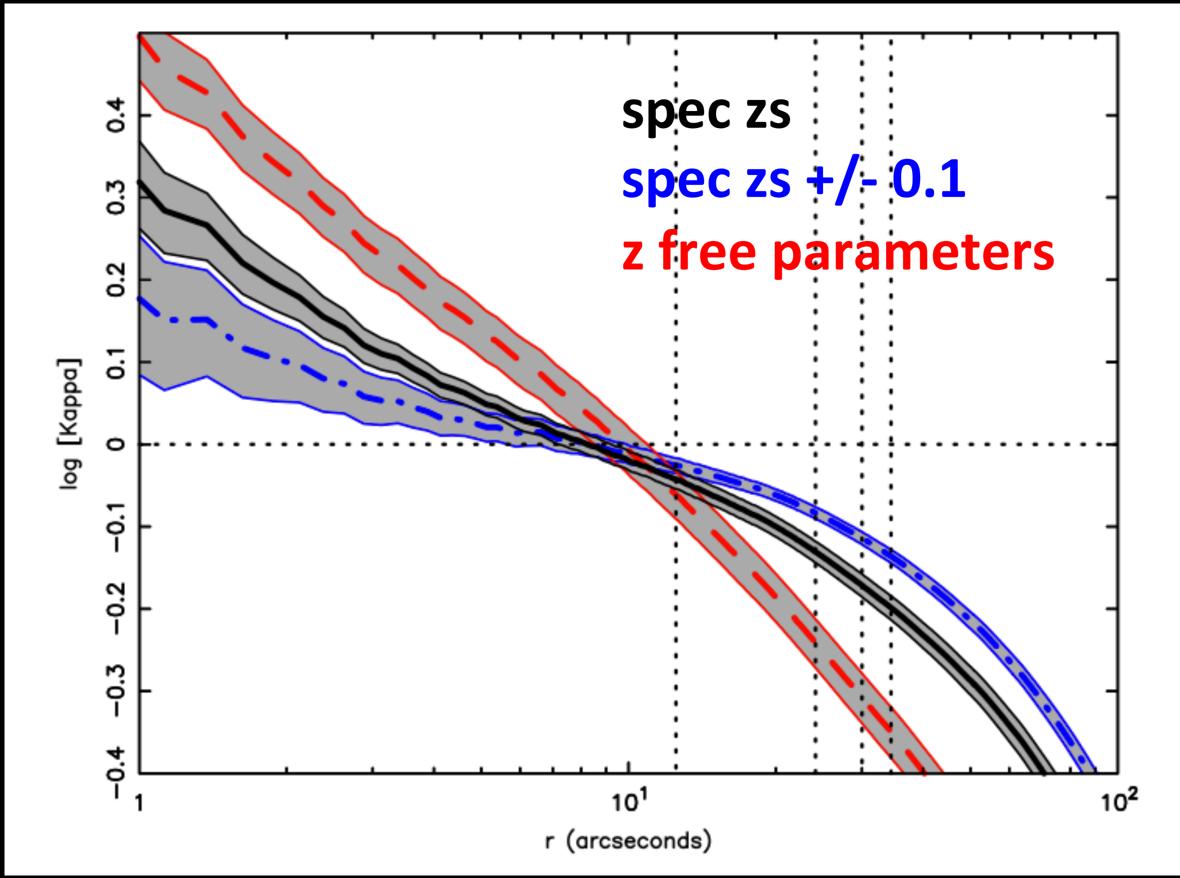


1) Spec z vs free redshifts

- Mass profile:
  - Arc redshifts correlate with total mass
  - Affect predicted mass slope and concentration



MACS1149+22 Smith+ 2009

2) Cosmological Assumptions

Throughout this paper, we assume ΛCDM cosmology with $\Omega_M = 0.3$, $\Omega_\Lambda = 0.7$, and $H_0 = 70$ km s^{-1} Mpc^{-1}. All magnitudes are reported in the AB system.

(Everyone et al.)

The lens equation depends on cosmology through d_{LS}/d_S

$$\vec{\beta} = \vec{\theta} - \frac{d_{LS}}{d_S}\vec{\alpha}(\vec{\theta})$$

What happens if you model the cluster assuming a different cosmology?

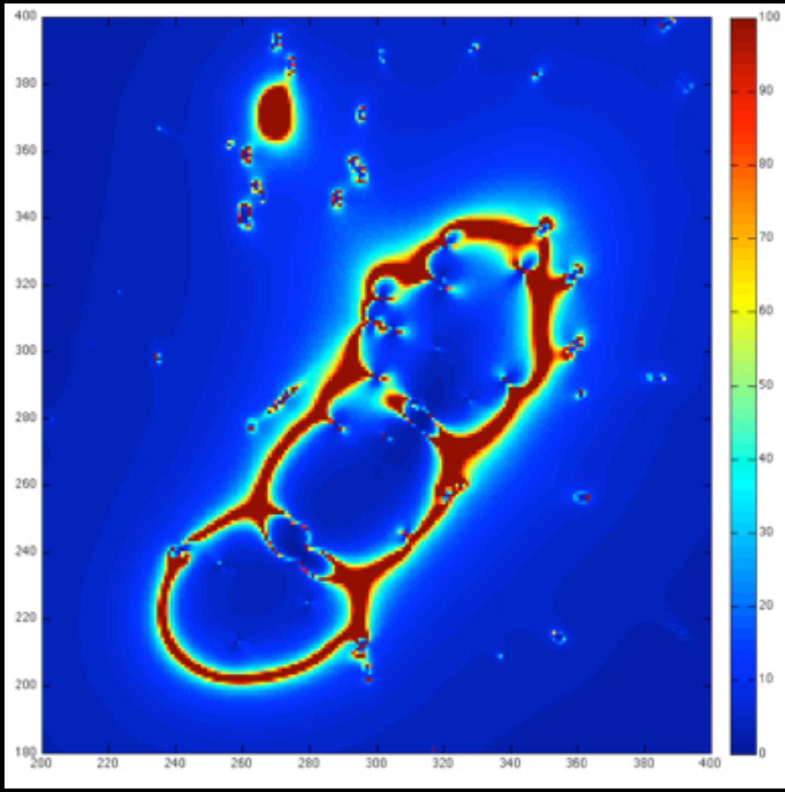
Source	Ω_M[a]	H_0 (km s^{-1})	Reference
fiducial "concordance cosmology"	0.300	70	—
Planck 2013+WP+hL+BAO	0.308	67.8	Planck Collaboration et al. (2013)
WMAP-9+eCMB+H_0+BAO	0.286	69.3	Hinshaw et al. (2013)
SPT Clusters+WMAP+SNe	0.255	71.6	Reichardt et al. (2013)

2) Cosmological Assumptions

- Model each cluster with all 4 cosmologies
- For each pixel: what is the distribution of *magnifications* from

  A: “statistical” model uncertainties

  B: varying cosmology



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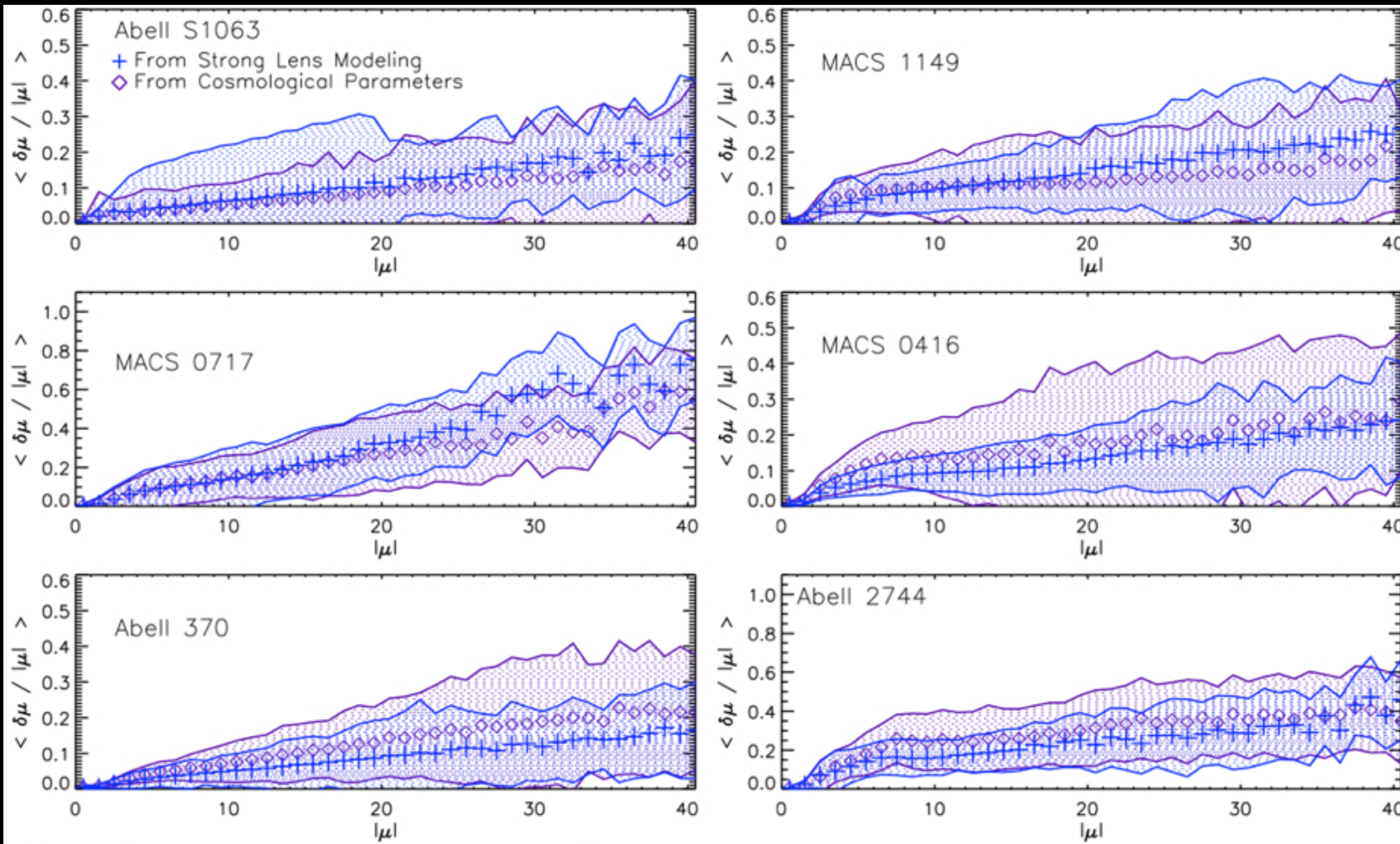

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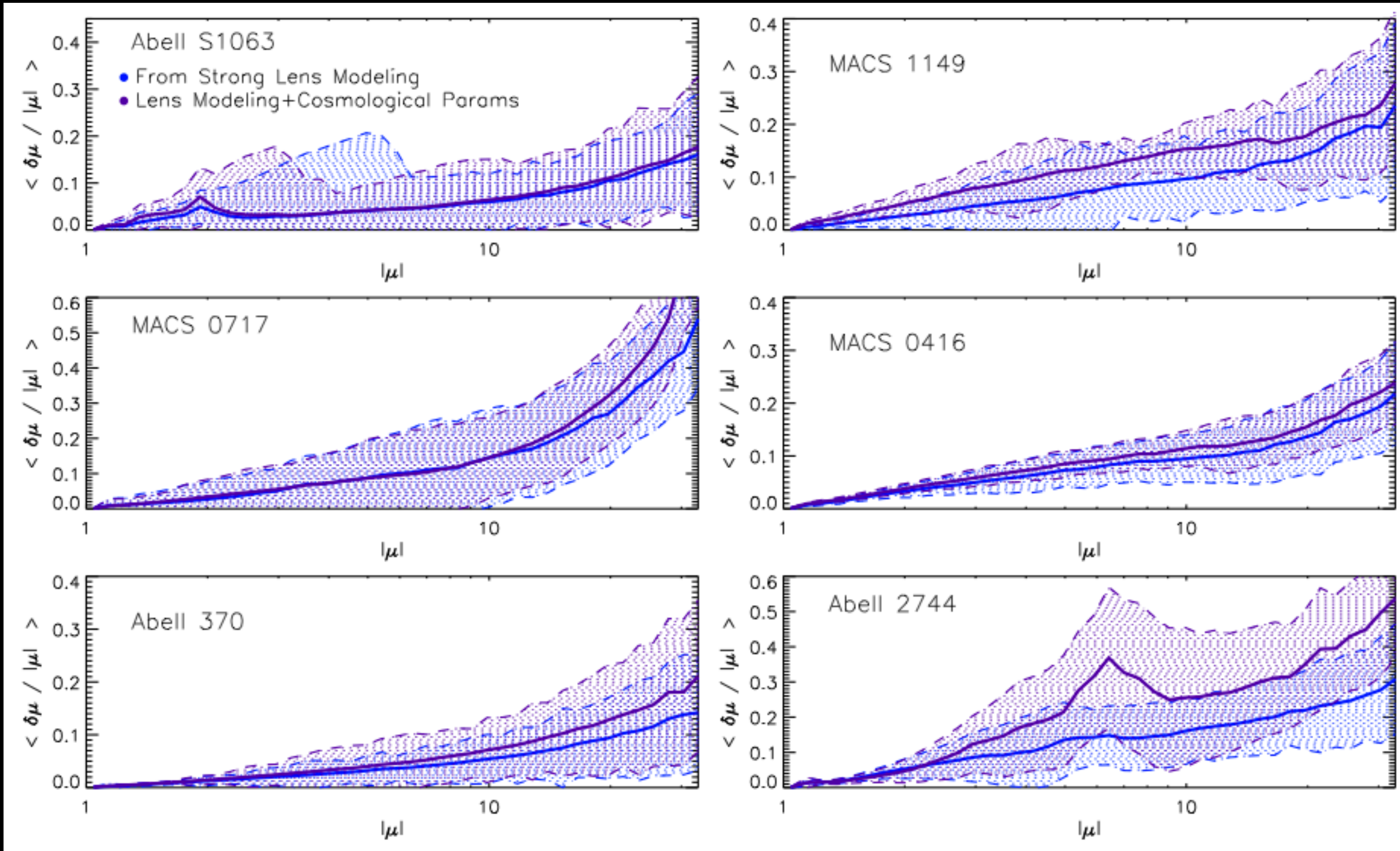
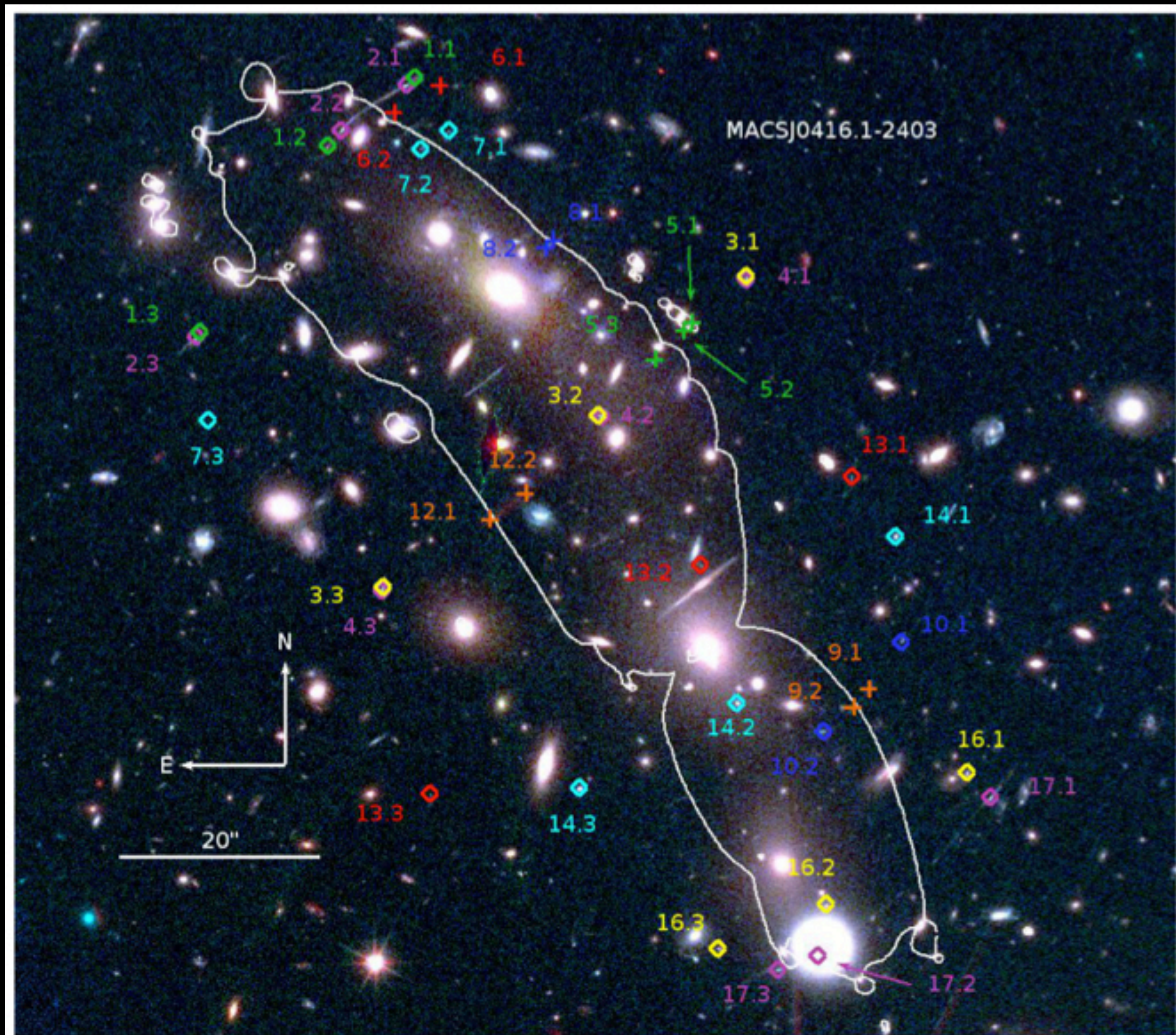


Bayliss, Sharon, Johnson (in prep.)

3) Mass on the Line of Sight



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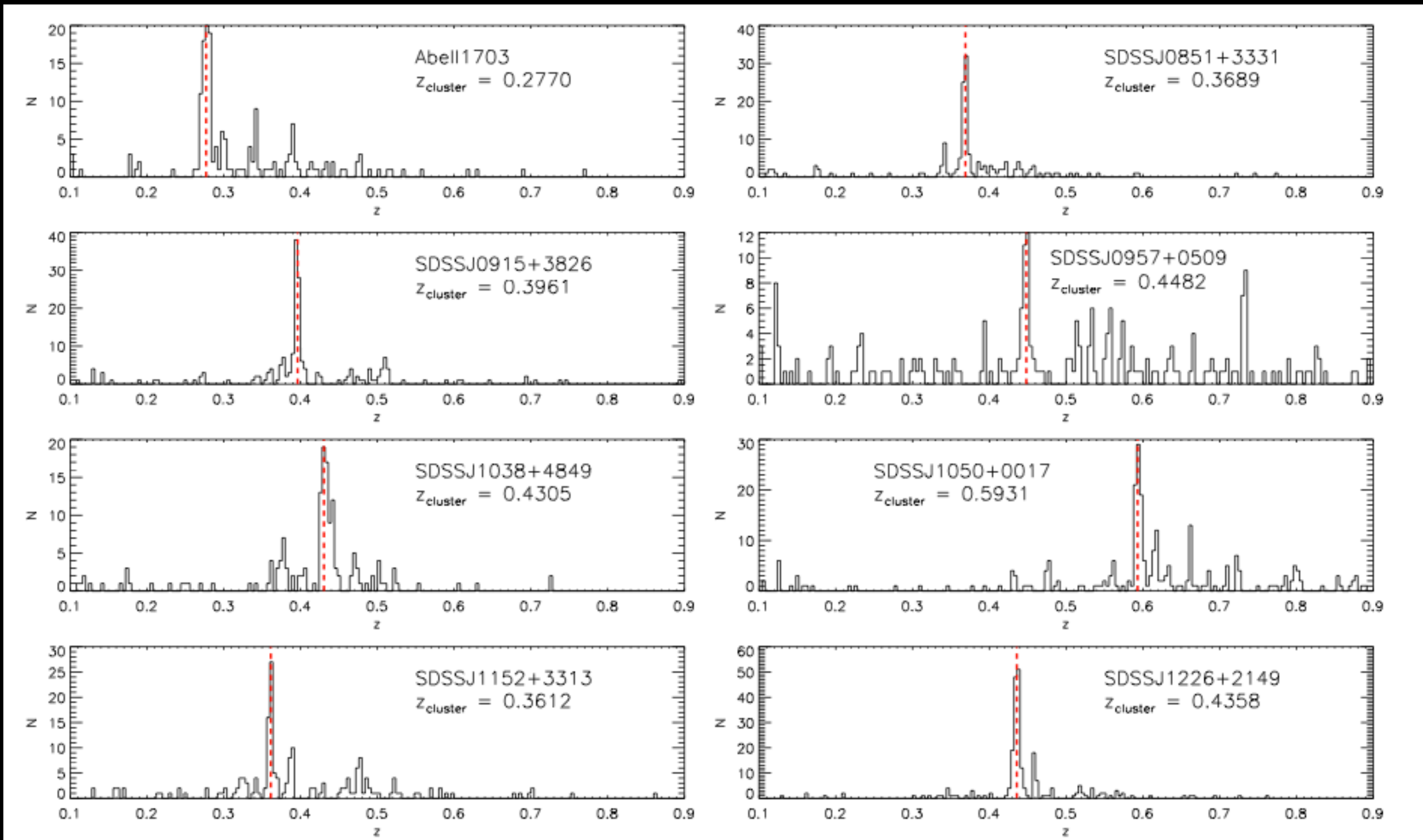

Bayliss et al. 2013

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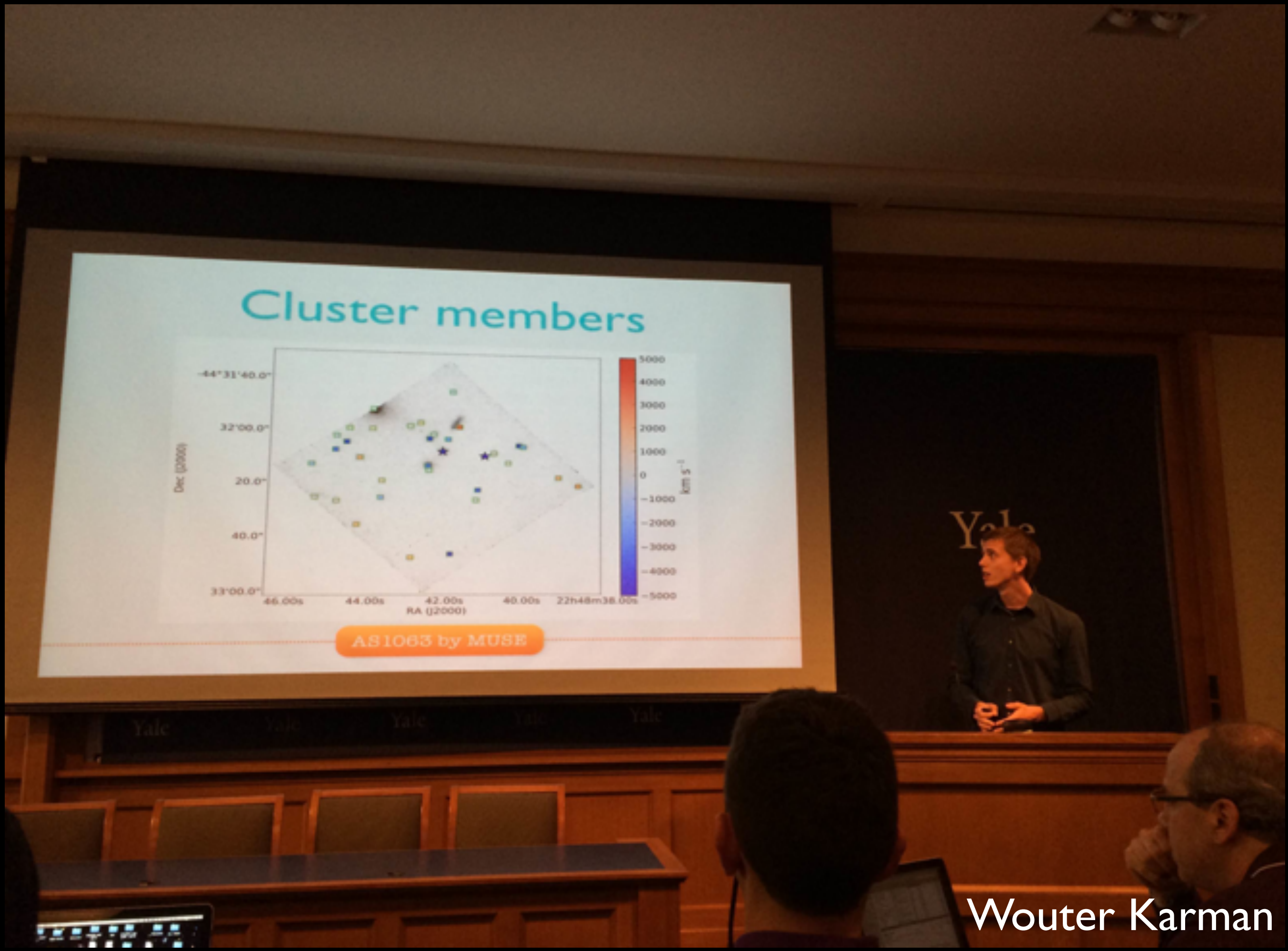
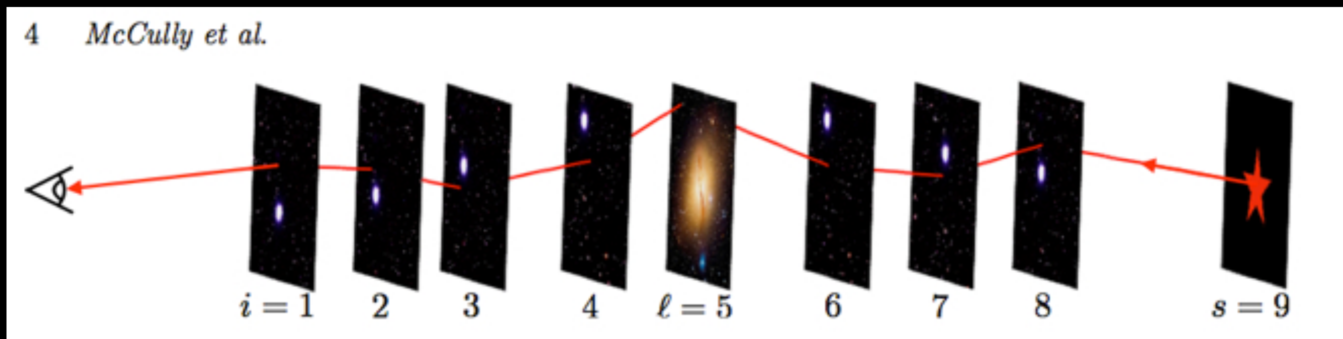


3) Mass on the Line of Sight

- Masses on the line of sight add to the lensing potential



+ Approximation: model the foreground galaxy at the same plane as the cluster

- Can't derive the galaxy mass from the lens parameters

The Effect of Large-Scale Structure on the Magnification of High-Redshift Sources by Cluster-Lenses

Anson D'Aloisio[1⋆], Priyamvada Natarajan[2,3], and Paul R. Shapiro[1]

Talk with Anson →
(+presentation on Friday)

Conclusions

- As we enter the era of "precision" lens modeling, we need to better understand sources of systematic uncertainties that are due to model assumptions and lensing constraints.
    - accurate redshifts
    - LOS structure
    - accounting for cosmological uncertainties
- A large step in this direction is in the community's combined effort to model simulated data (see Massimo's presentation on Friday)