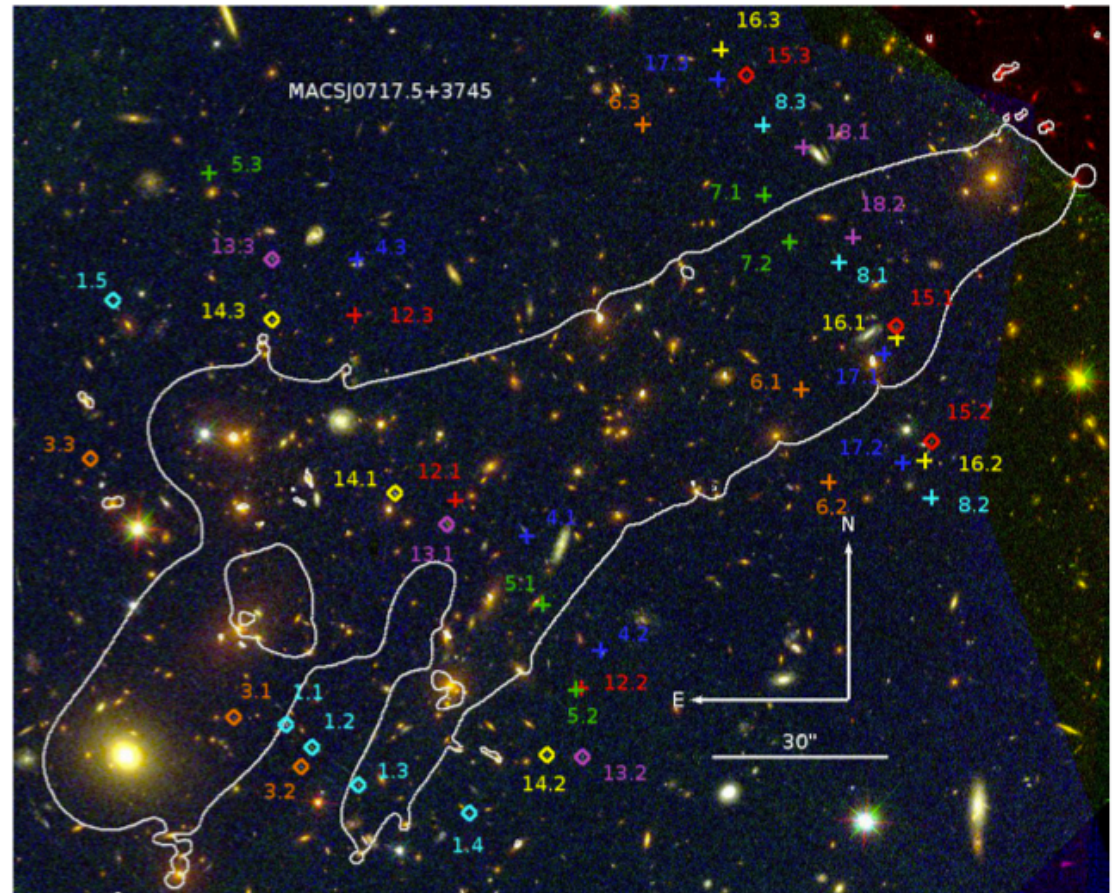


Strong lens modeling

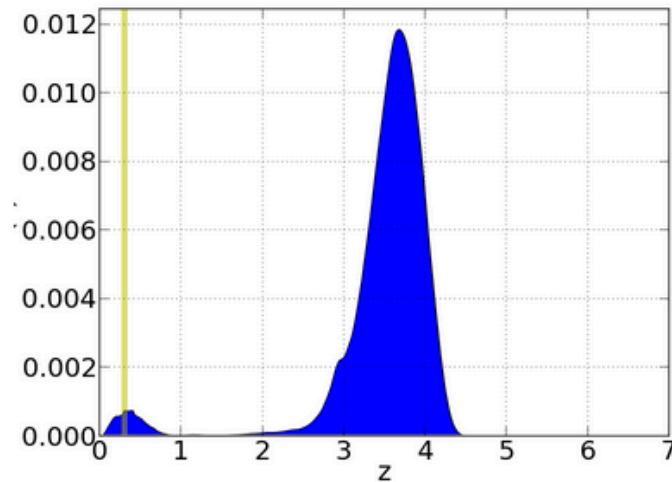
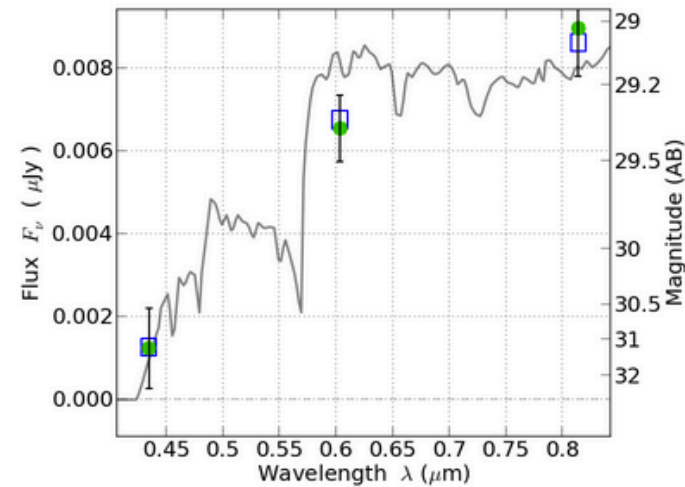
- Multiple images to constrain the lensing potential and mass distribution of the cluster core
 - ▣ Inner $\sim 100''$
- LENSTOOL (Jullo et al. 2007)
 - ▣ Parametric lens modeling



MACS J0717.5+3745 lens model, $z=9$ critical curve
Johnson et al., 2014 (ApJ, accepted)

Lensed arc redshifts

- Redshifts of lensed images
 - Fixed to spectroscopic z
 - Shared redshifts by lens model groups – summer 2013
 - Other arcs
 - Redshift is free parameter
 - Used 95% confidence range of photometric redshift for prior



Credit: Dan Coe

Components of lens models

- All halos are pseudo-isothermal elliptical mass distributions (Limousin et al. 2005)
 - ▣ Velocity dispersion, core & cut radii

$$\Sigma(R) = \frac{\sigma_0^2 r_{\text{cut}}}{2G(r_{\text{cut}} - r_{\text{core}})} \left(\frac{1}{\sqrt{r_{\text{core}}^2 + R^2}} - \frac{1}{\sqrt{r_{\text{cut}}^2 + R^2}} \right)$$

- Cluster-scale halos

- Galaxy-scale halos

- ▣ Red sequence galaxies

$$\sigma_0 = \sigma_0^* \left(\frac{L}{L^*} \right)^{1/4} \quad \text{and} \quad r_{\text{cut}} = r_{\text{cut}}^* \left(\frac{L}{L^*} \right)^{1/2}$$

- ▣ Scale dark matter mass to observed flux

- ▣ Most galaxy parameters are fixed, some are optimized

Revised models (v2)

(Johnson et al., 2014)



Abell 2744, $z = 2$ critical curve

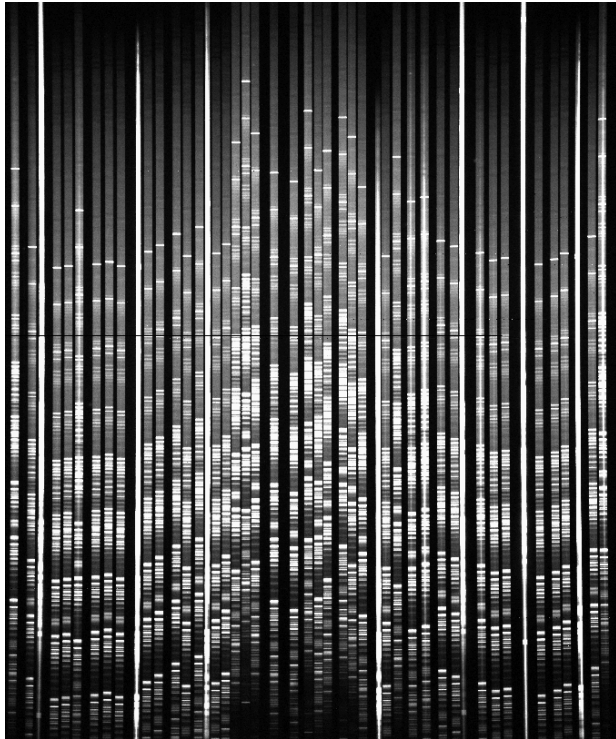
Revised models (v2)

(Johnson et al., 2014)

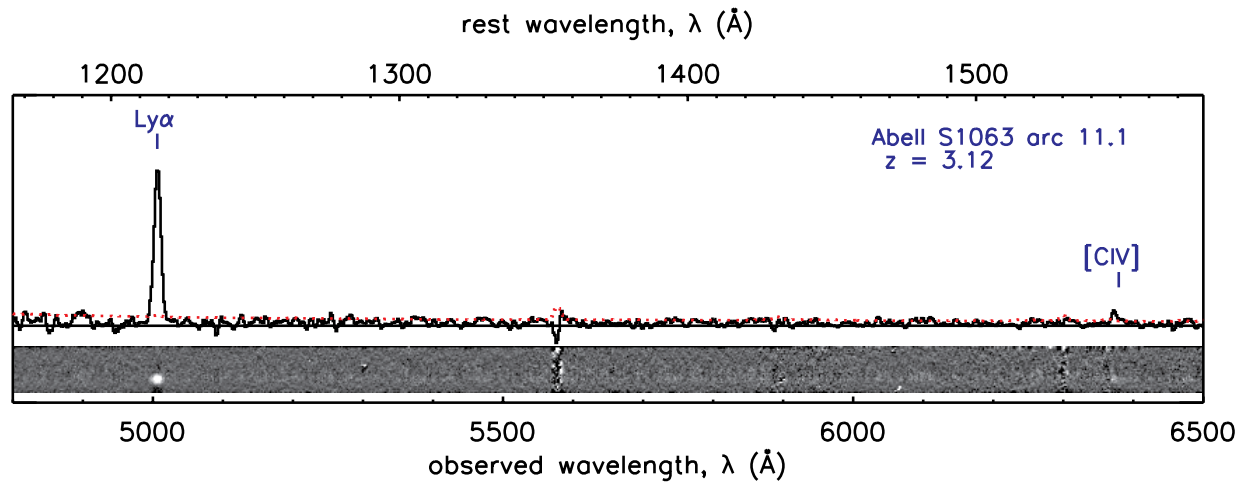
- New spectroscopic redshifts for image constraints
- RMS minimization in the ~~source plane~~ image plane
- Polished selection of image constraints
 - ▣ Misidentifications
 - ▣ Threw out ambiguous identifications
- Improved selection of priors (better sampling)
- Revised treatment of photometric redshifts in modeling process for images with unfixed redshifts
 - ▣ V1: prior set over wide range in redshift
 - ▣ V2: prior set to 95% CL for photometric redshift

Spectroscopic redshifts: Magellan

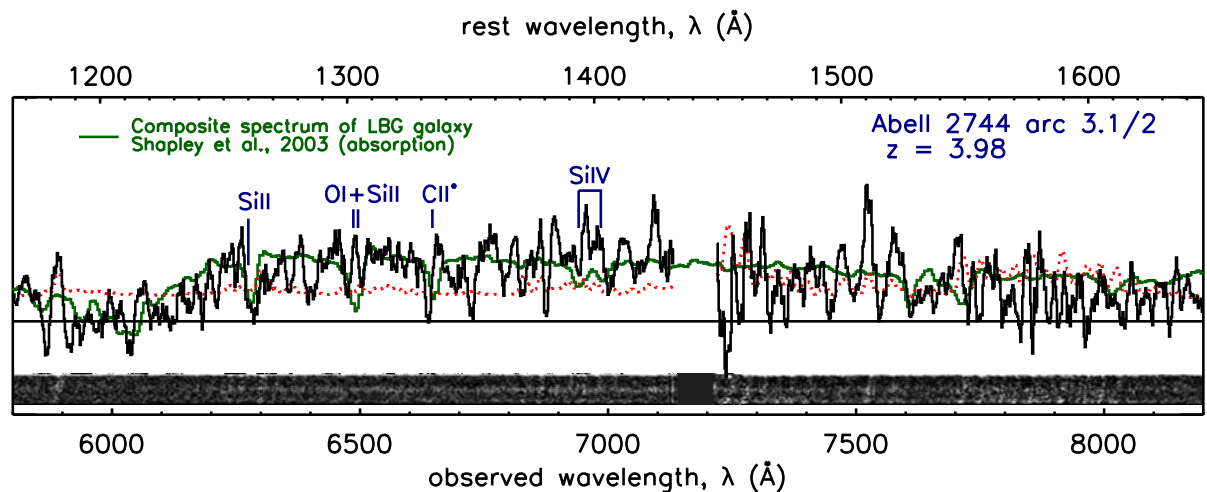
Redshifts measured for
13 lensed galaxies in FF



Raw 4.4 hr LDSS3 spectra of
Abell S1063 (Aug 2013)

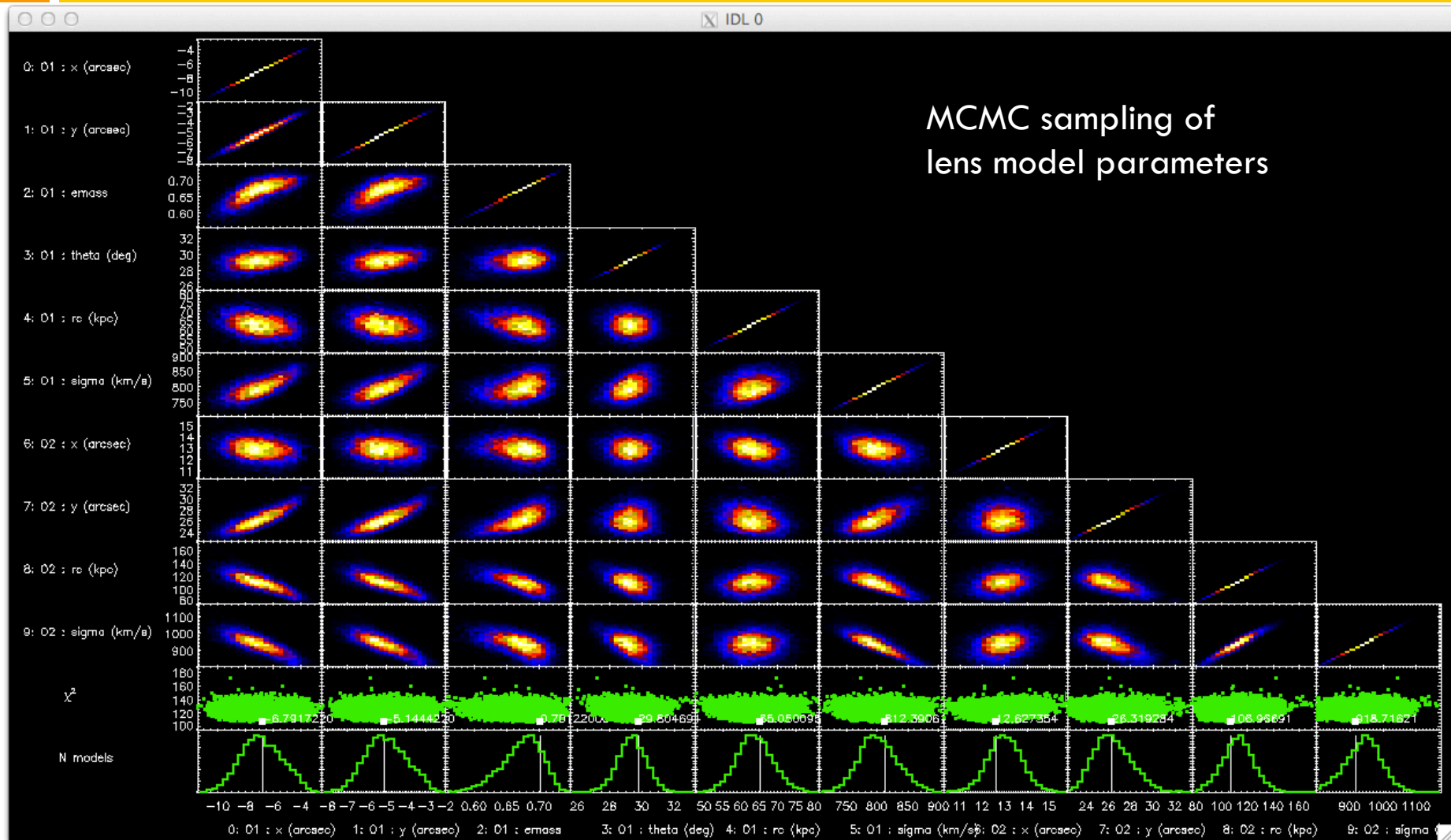


Johnson et al., (2014, in press)



Revised models (v2)

(Johnson et al., 2014)



Revised models (v2)

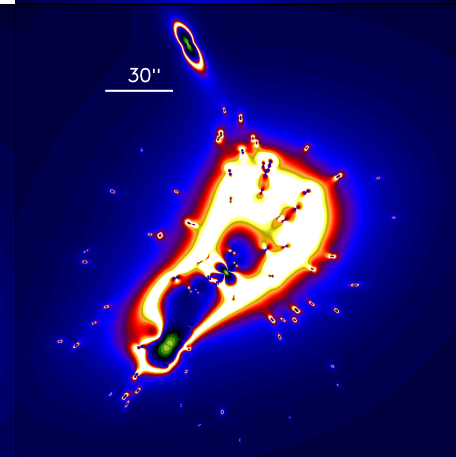
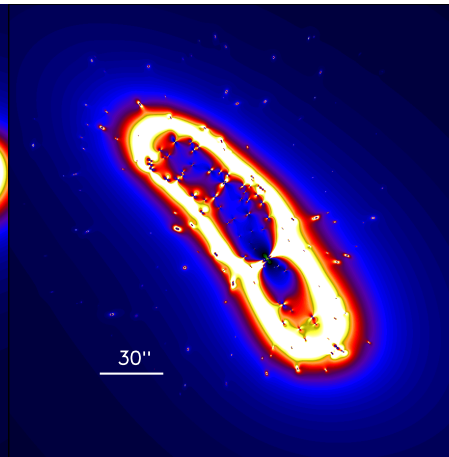
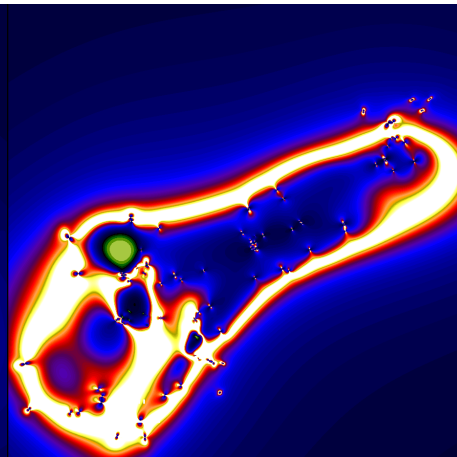
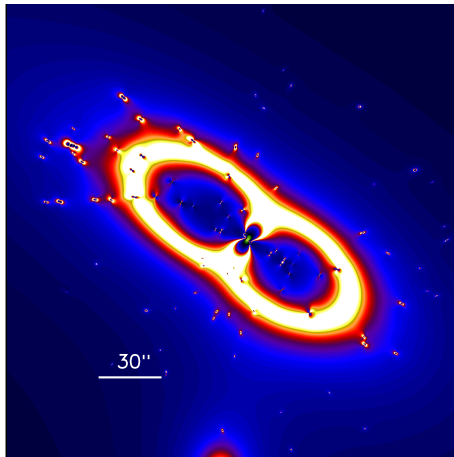
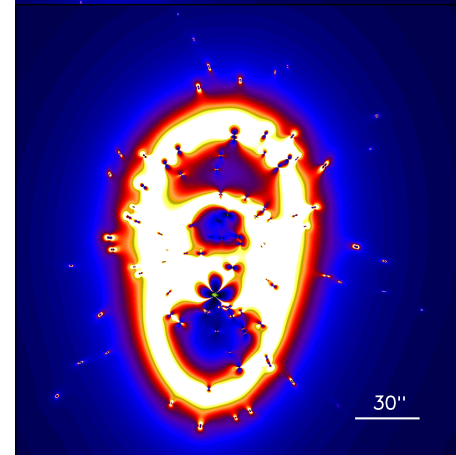
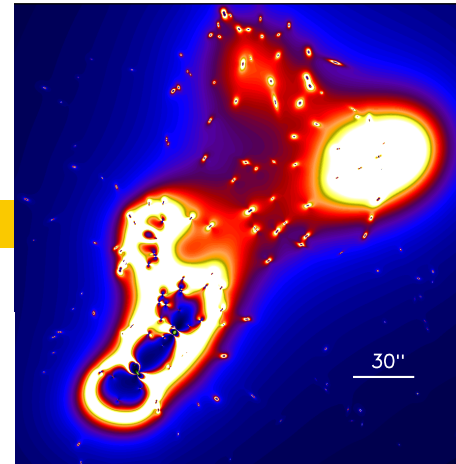
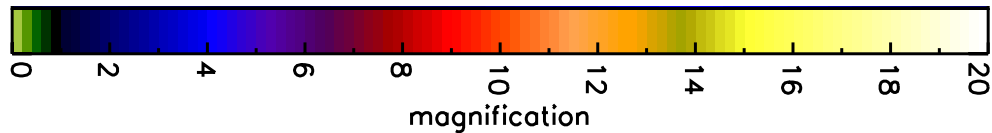
(Johnson et al., 2014)



Abell 2744, $z = 2$ critical curve

Lens models

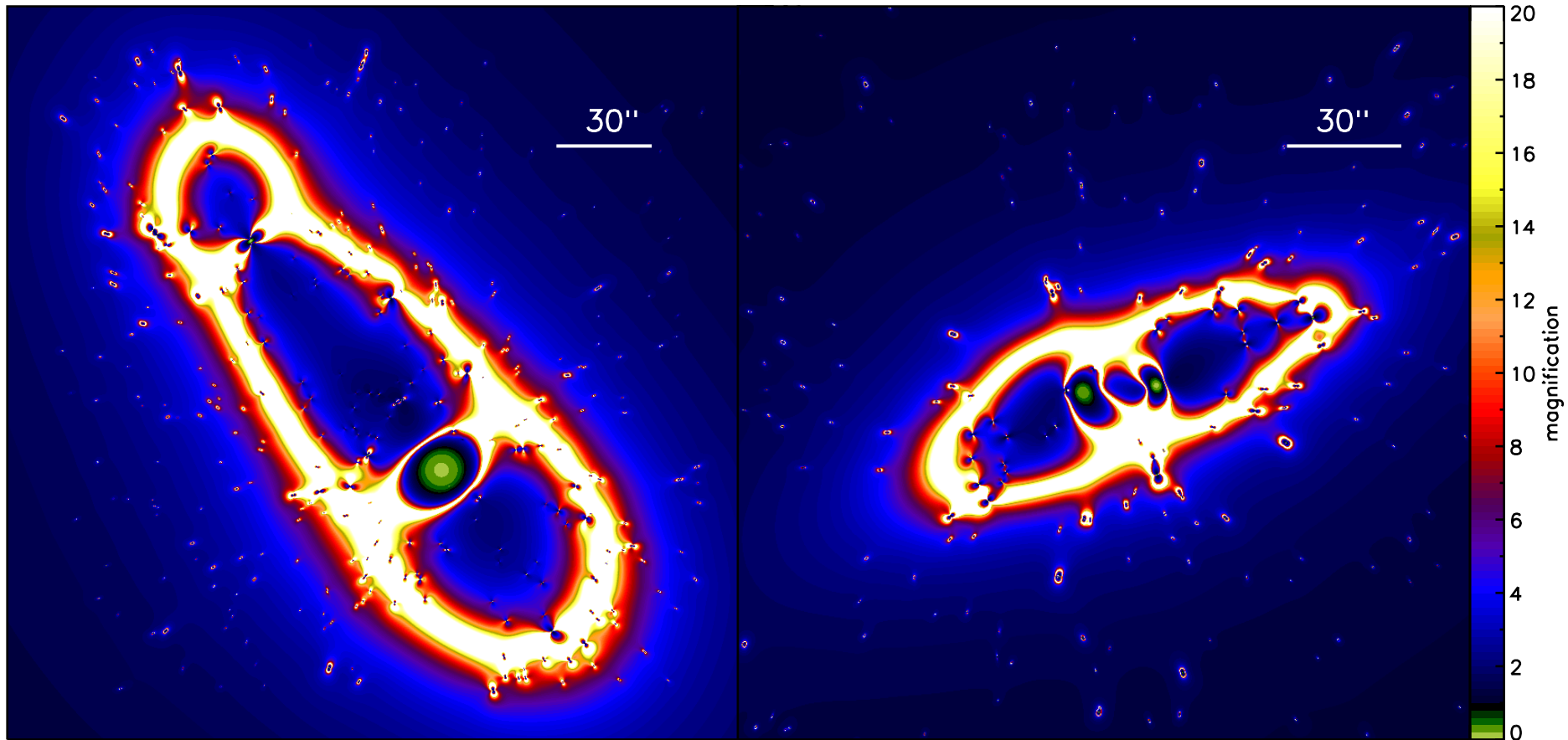
cluster	# constraints	# free parameters	image plane rms (")	total # systems (# spec z systems)
Abell 2744	64	38	0.40	15 (3)
MACS J0416.1-2403	50	21	0.51	15 (10)
MACS J0717.5+3745	56	38	0.38	14 (5)
MACS J1149.5+2223	46	25	0.52	12 (3)
Abell S1063	58	26	0.64	16 (6)
Abell 370	44	19	0.82	9 (5)



FF simulated clusters

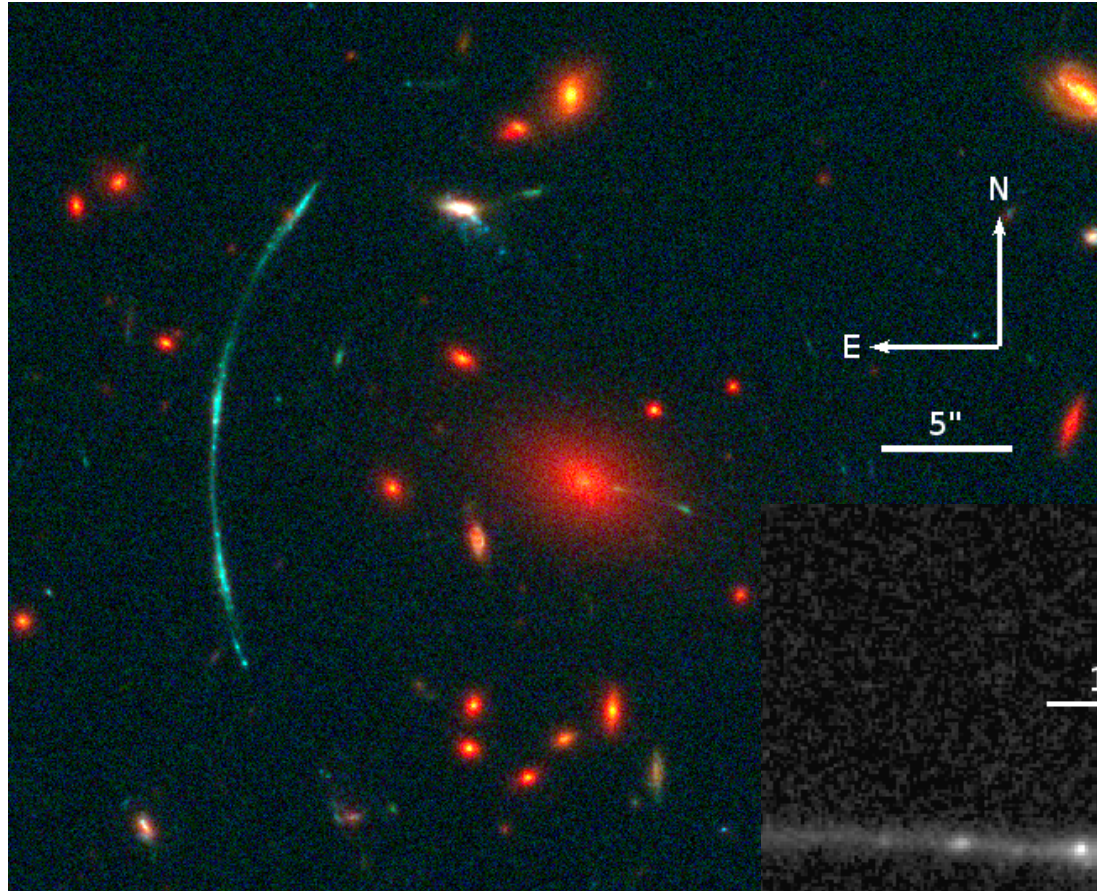
ARES

HERA



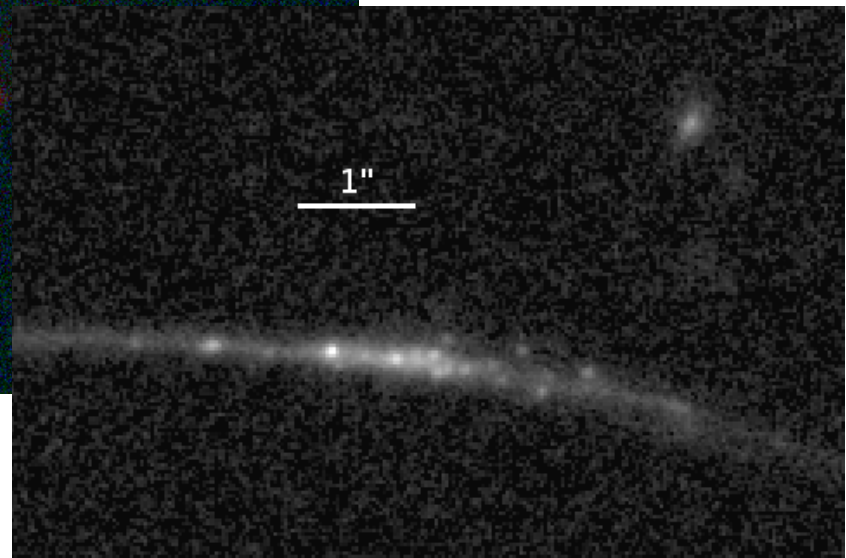
Source plane reconstruction

SGAS J1110+6459



$z=2.5$ galaxy

$z=0.659$
galaxy cluster



GO13003 – PI Gladders, Sharon,
Rigby et al.

WFC3/IR F160W

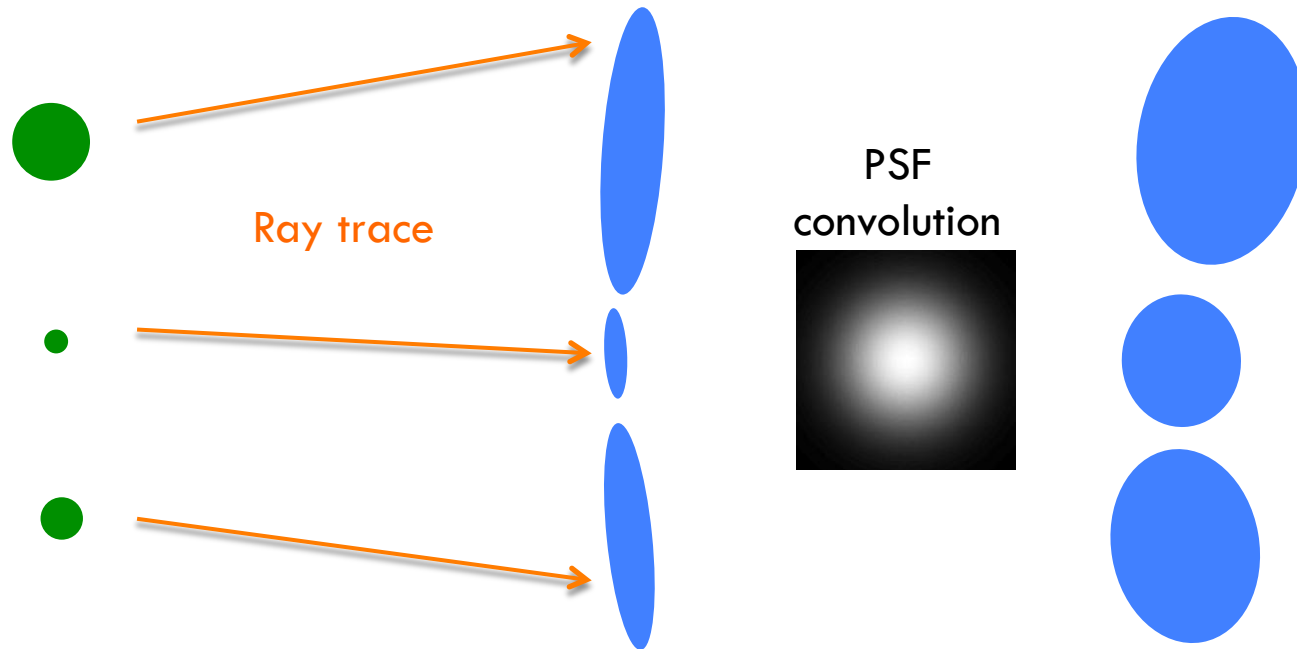
WFC3/UVIS F606W, F390W

Central arc image in F606W+F390W: very clumpy!

Forward modeling of clumps

Source plane

Image plane

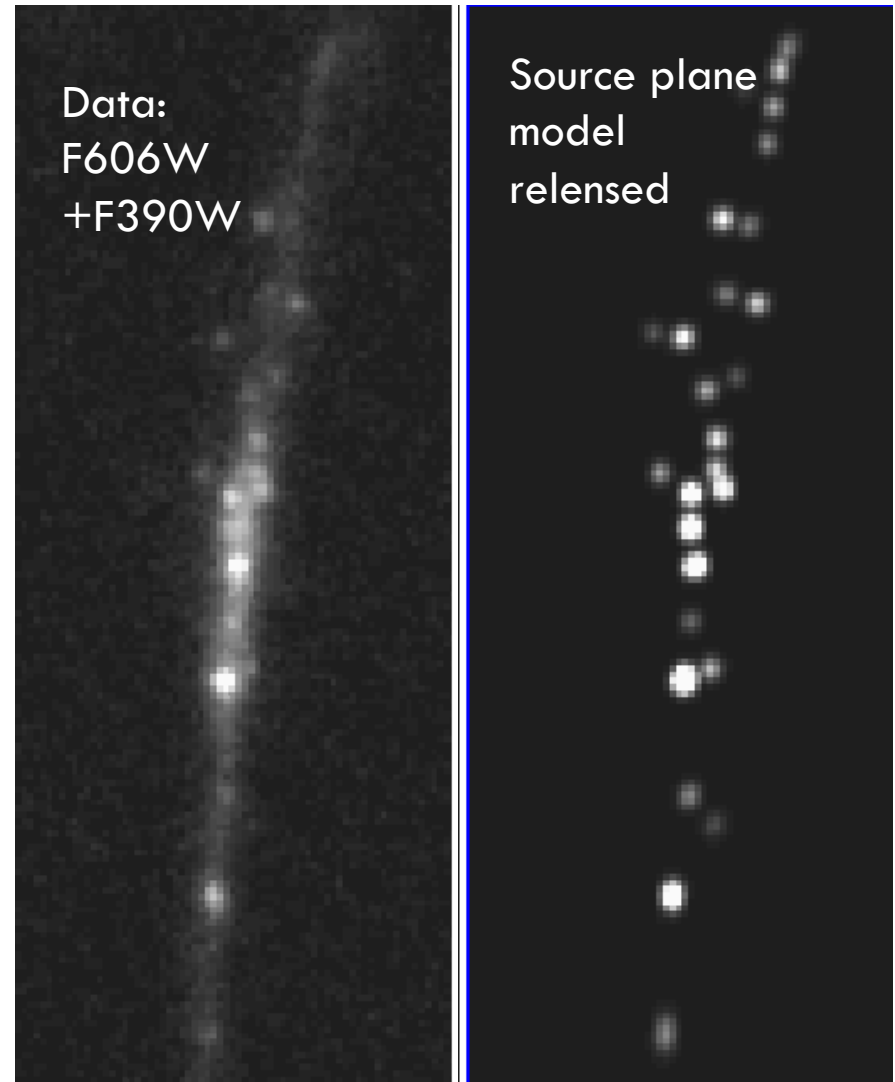


Source plane model



Source plane model of star forming clumps

PRELIMINARY



Good agreement between data and model

Summary

- Publicly-available lens models for all 6 HFF clusters
 - ▣ Johnson et al., 2014 (in press); arXiv:1405.0222
- Future plans:
 - ▣ Update models with new multiple image constraints
- Source reconstruction
 - ▣ Forward modeling necessary to fully resolve substructure in lensed galaxies