Two rings of light in the galaxy SDSSJ0946+1006

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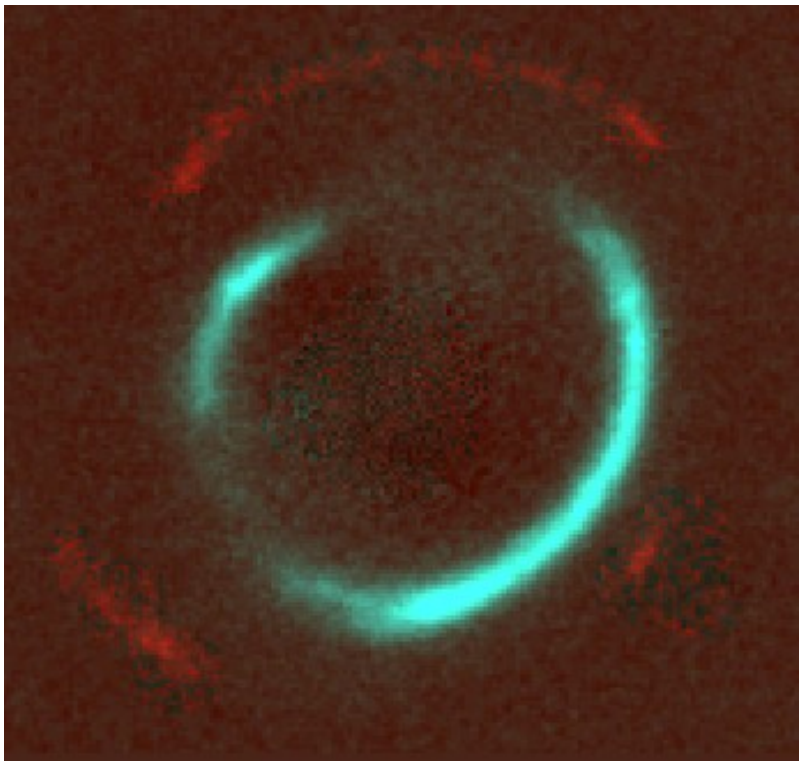
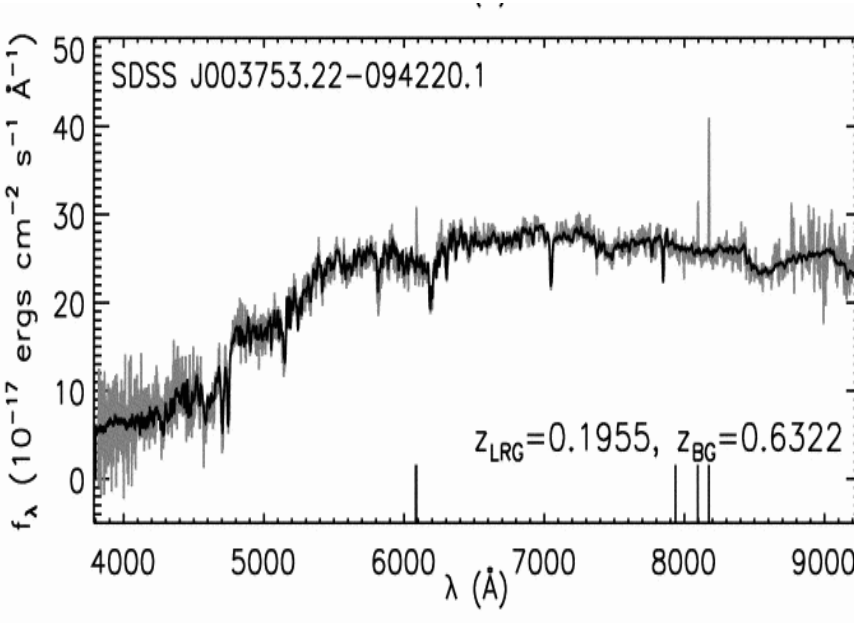
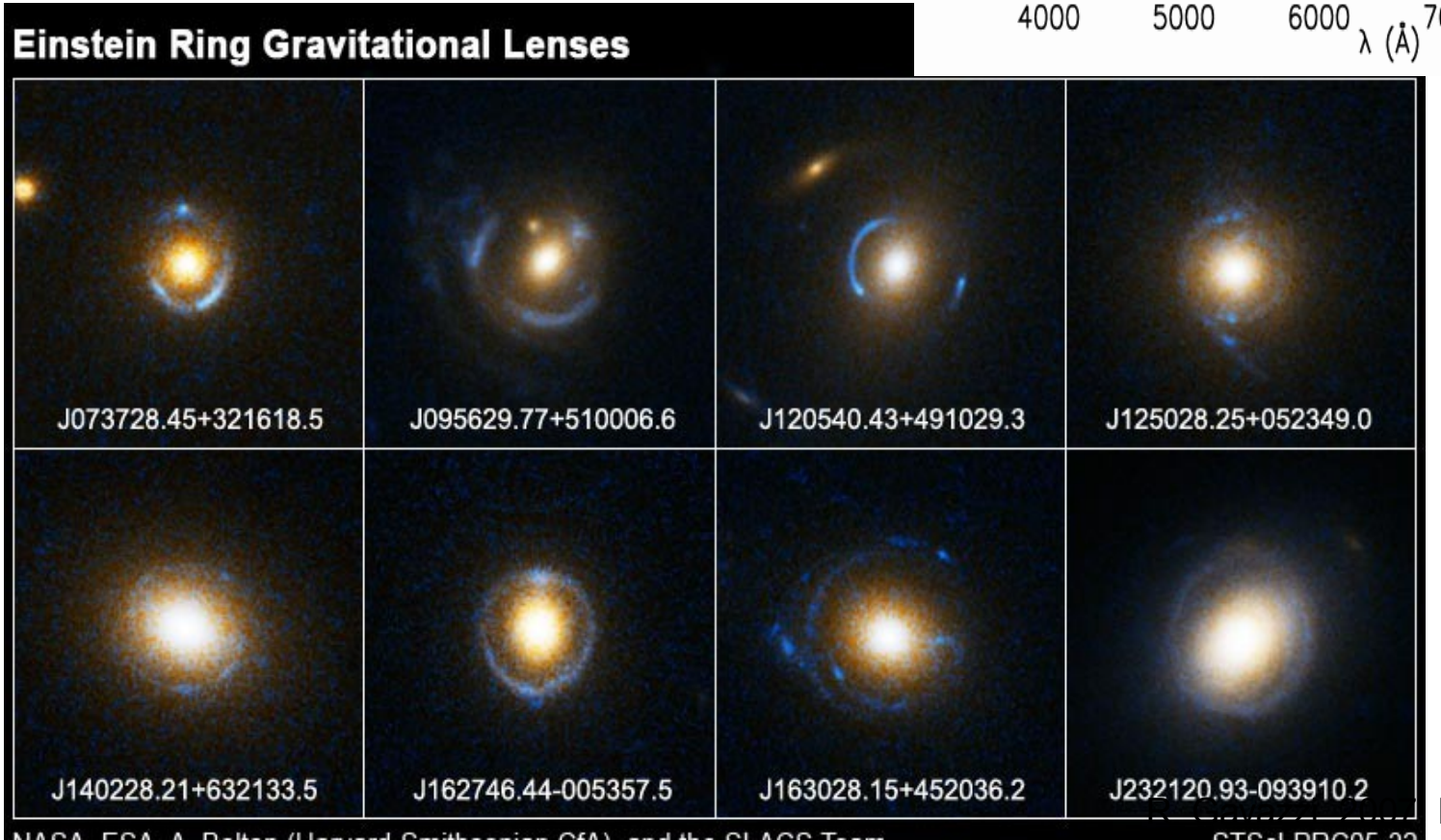


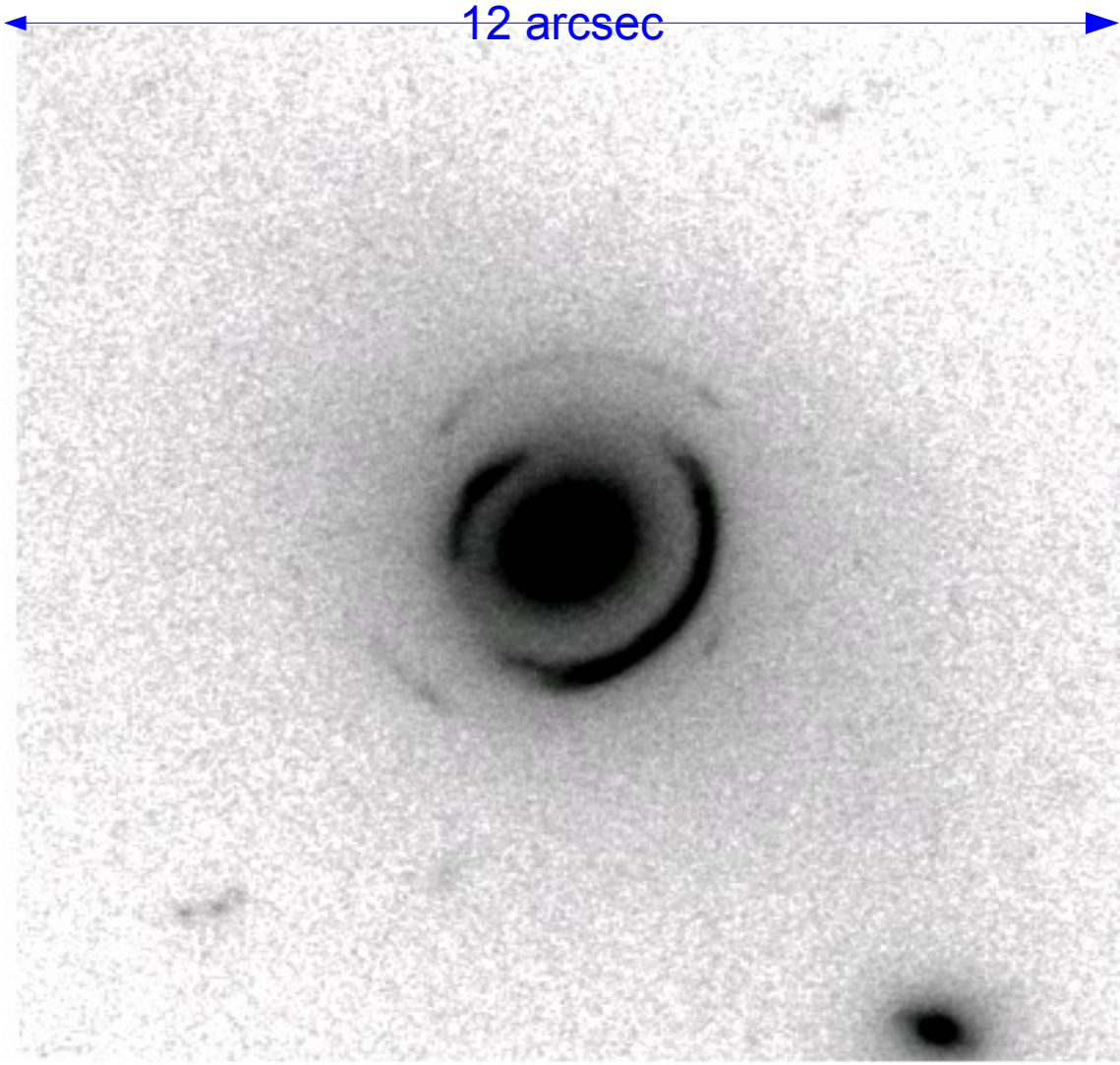
The Sloan Lens ACS Survey (SLACS)

- ***Spectroscopic selection in SDSS database: spurious emission lines at $z_s > z_l$***
- ***HST follow-up imaging for confirmation and accurate modeling***
- ***So far, ~97 new massive lens galaxies (z_l=0.06-0.4, σ>200km/s, z_s=0.3-1.1)***





SDSSJ0946+1006



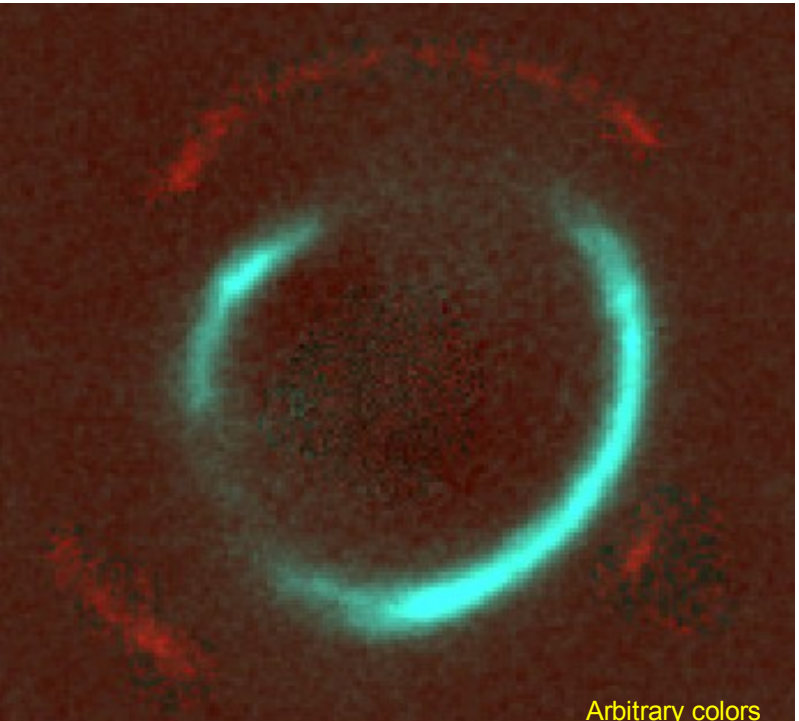
HST/ACS imaging: 2000sec in F814W

SDSS fiber spectroscopy:

z_{lens} = 0.222

$z_{source1}$ = 0.609

central velocity dispersion: 285±25 km/s



Second source redshift ? unknown!

8 hours LRIS@Keck additional longslit spectroscopy unable to provide $z_{source2}$. Very faint (I_{AB}~23 arcsec^{-2}) and no obvious emission lines from 3500 to 8400A.

SDSSJ0946+1006, the jackpot?

First double galaxy-scale strong lensing event as part of just 50 SLACS systems with deep ACS/F814W imaging!

How likely? ~1/200 ellipticals is a strong lens would suggest ~1/200 lensing ellipticals is a double lens...

The abundance of such multiple events tells us about the pop. of faint (I>25) high z sources.

"Well, would you believe it? I won last night's lottery jackpot! "

The jackpot, not just a curiosity....

Double ring tells us about:

- Mass density profile of the lens? YES!
- Cosmography? UNFORTUNATELY NOT
- Mass of the inner ring? APPROXIMATELY...

Lens modeling

Total (DM+stars) density profile

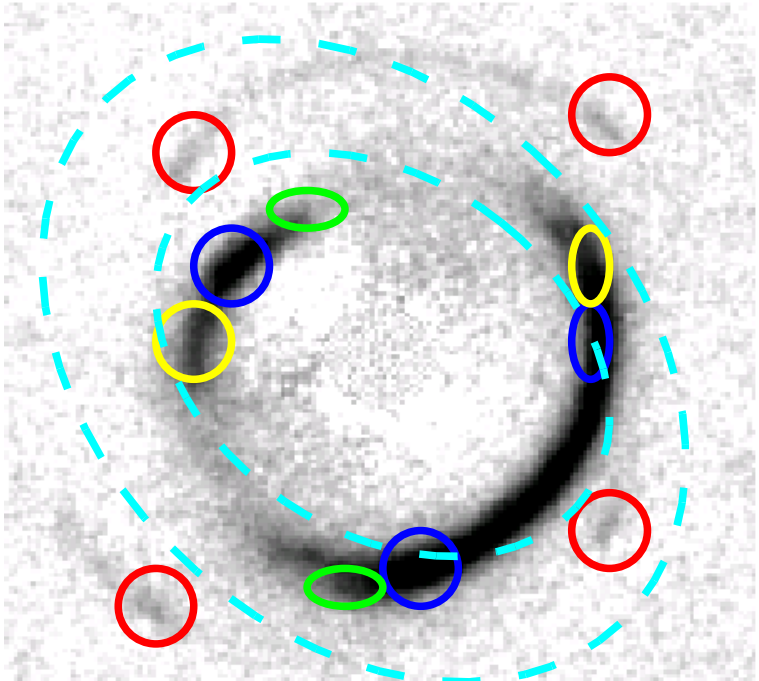
$$\kappa(\vec{r}, z_s) = \frac{b^n}{2}\left(x^2 + y^2/q^2\right)^{-n/2} \frac{D_{ls}}{D_{os}}$$

$$b = 4\pi(\sigma_v/c)^2 = \left(\frac{\sigma_v}{186.2\,\mathrm{km.s^{-1}}}\right)^2$$

b, n, q, PA, z_{s2}

+ external shear (γ_{ext}, PA_{ext})

} 7 free parameters!

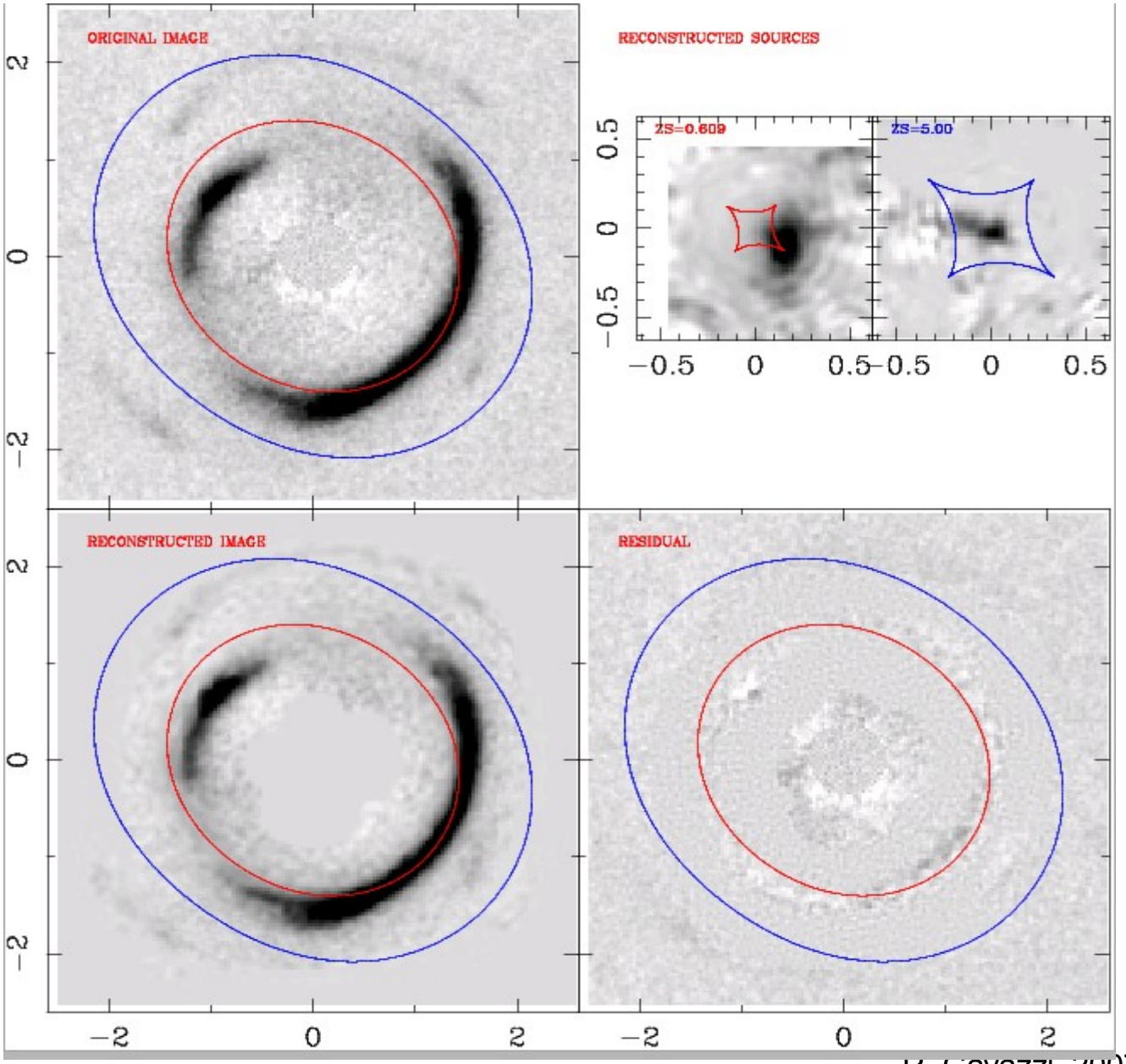


Preliminary analysis:

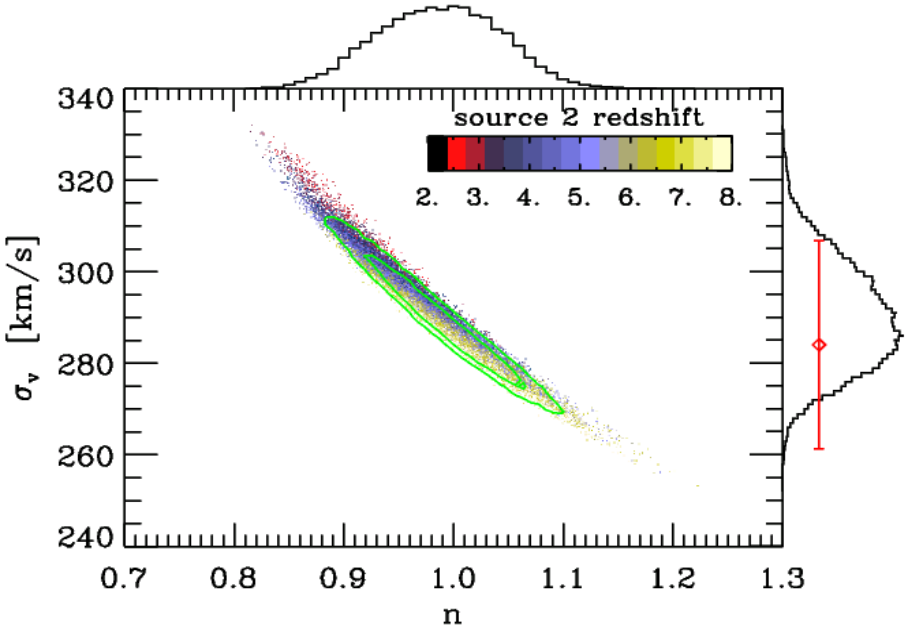
- guess the location of critical lines
- identify conjugate points
- point source χ^2 inversion

Easy and gives fair weight to very dim source2 (1:36 in flux wrt source1)

Confirmation with pixelized source inversion of each source.



Some constraints

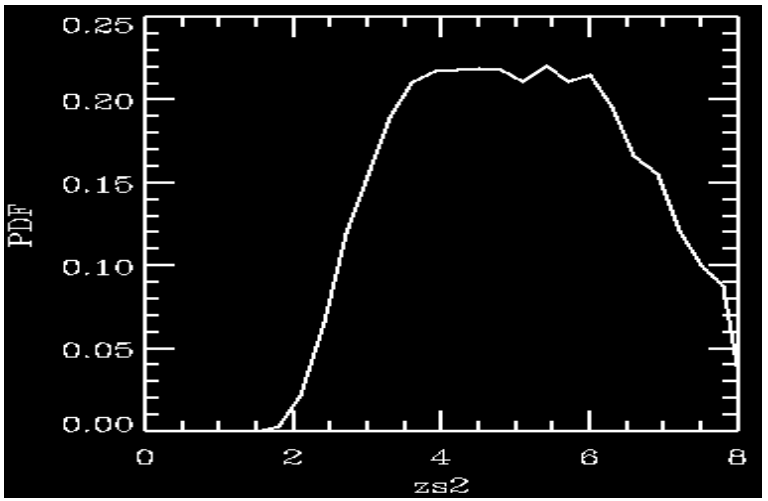


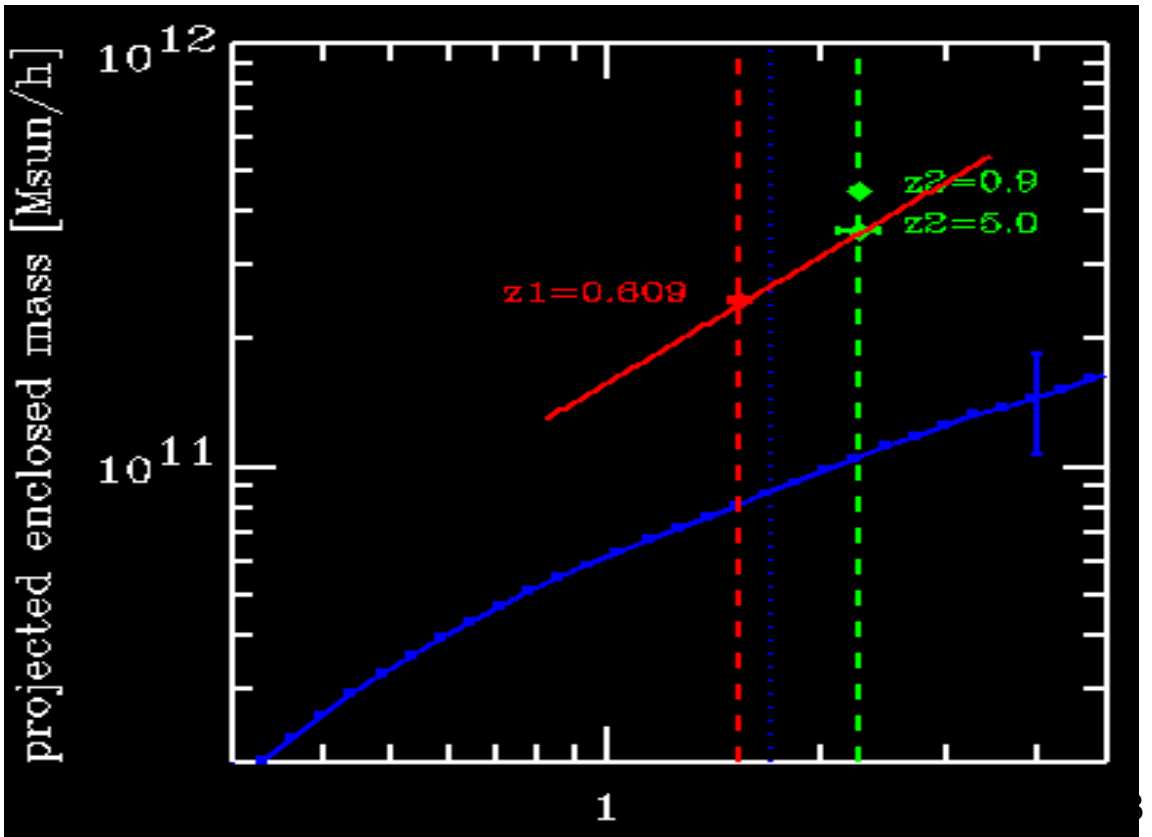
Velocity dispersion 289±11 km/s consistent with SDSS spectro

Slope ~isothermal n=0.99±0.06.

Source2 redshift loosely constrained but >3

Fdm(<Reff) ~ 68%





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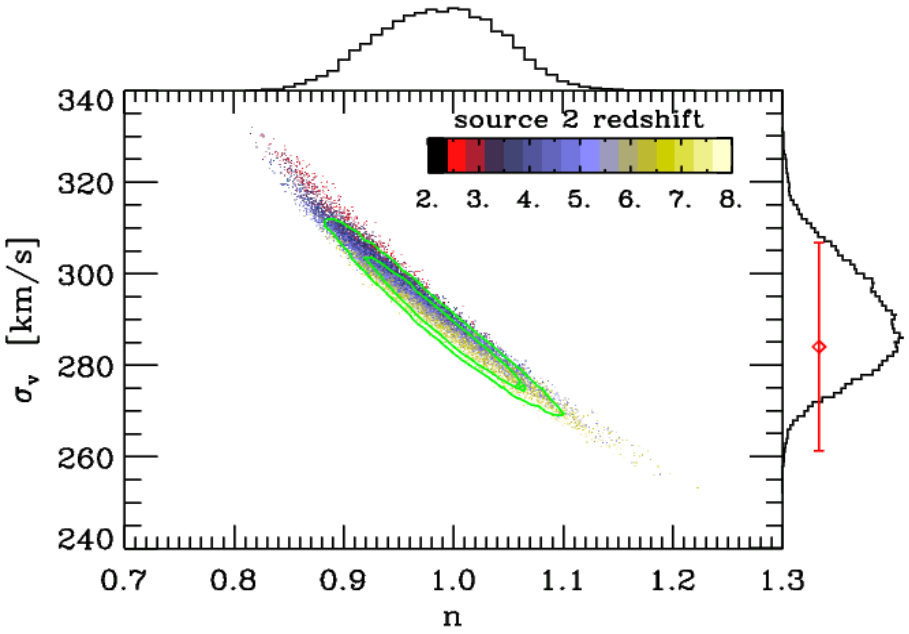

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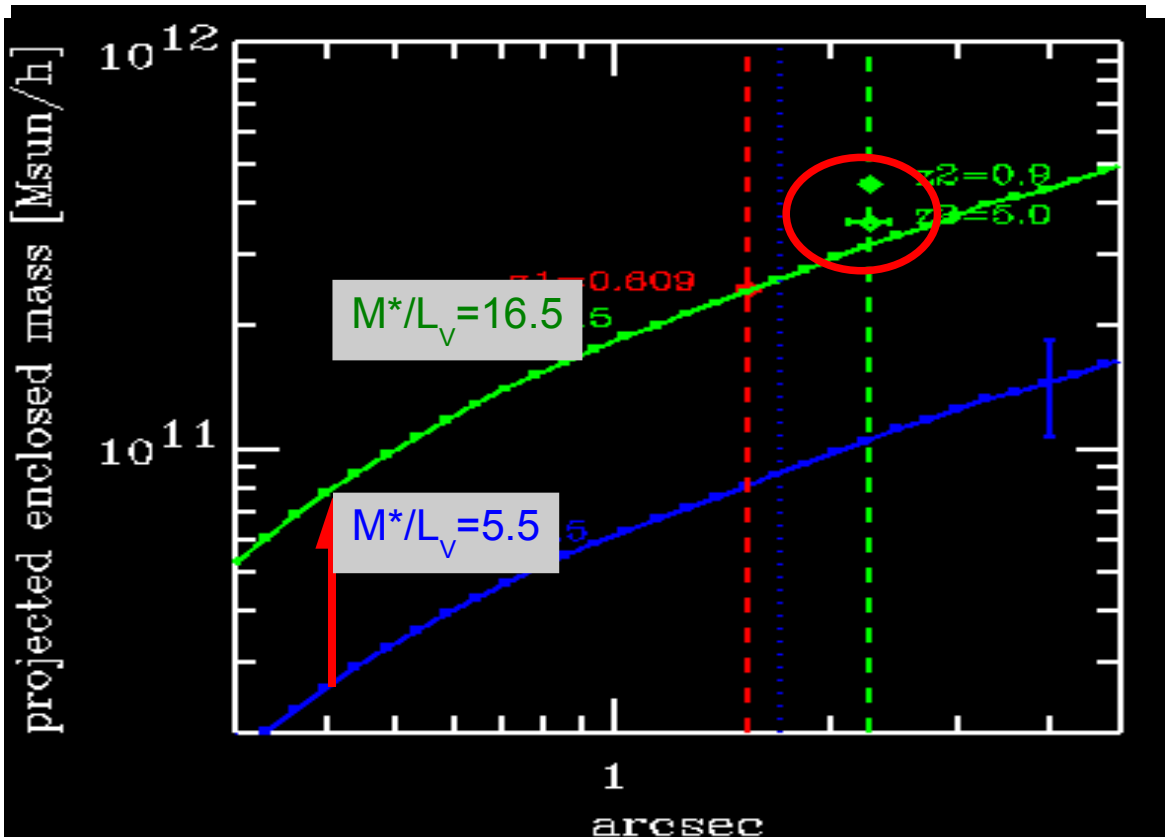
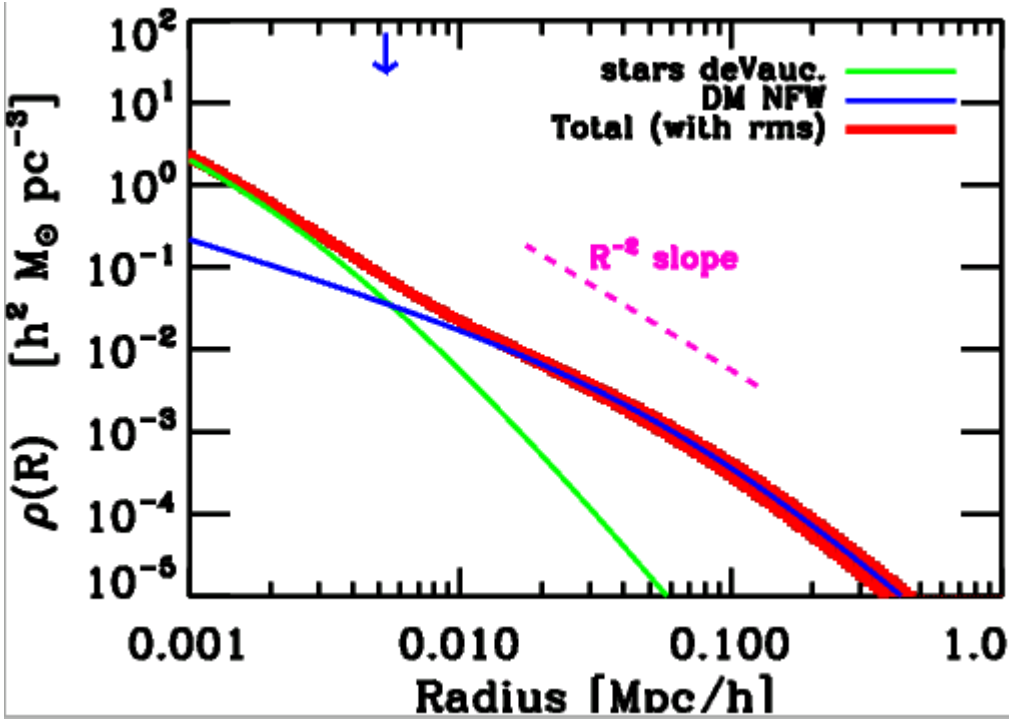
Let's push as high as possible stellar M/Lv to reproduce ring1

... then falls short for ring2!!

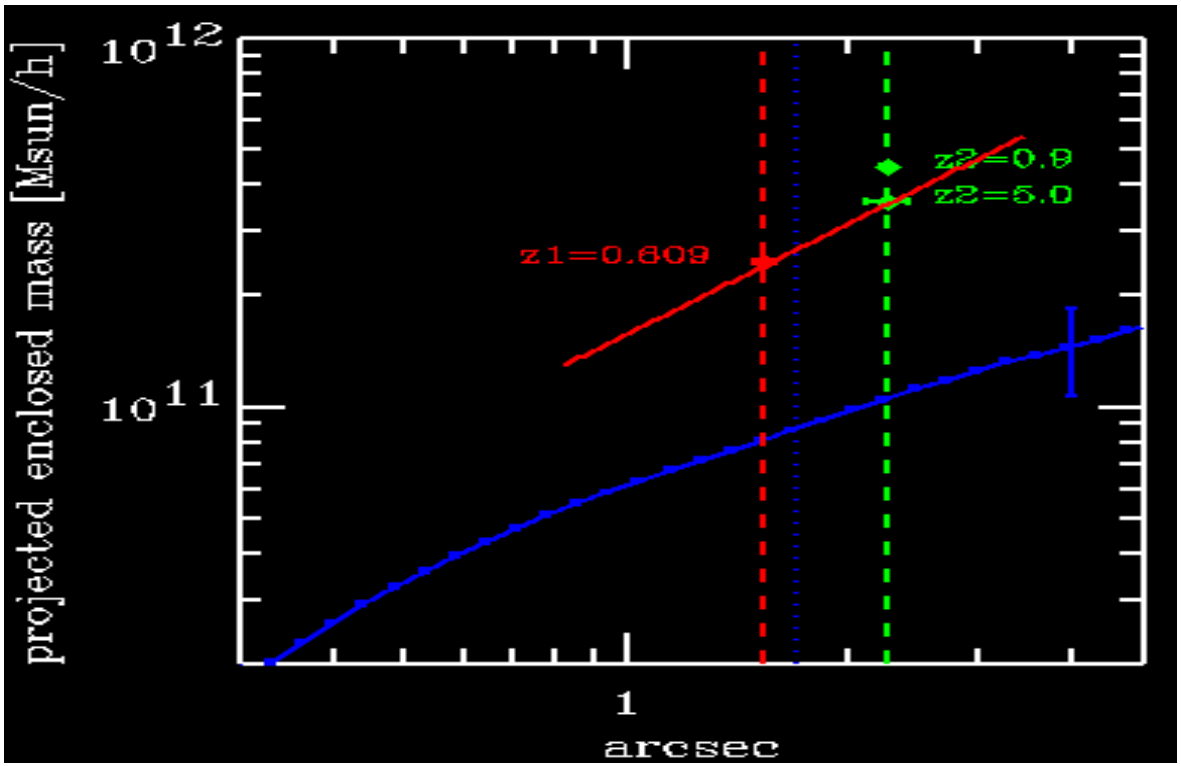
We need extra mass (a halo?!)

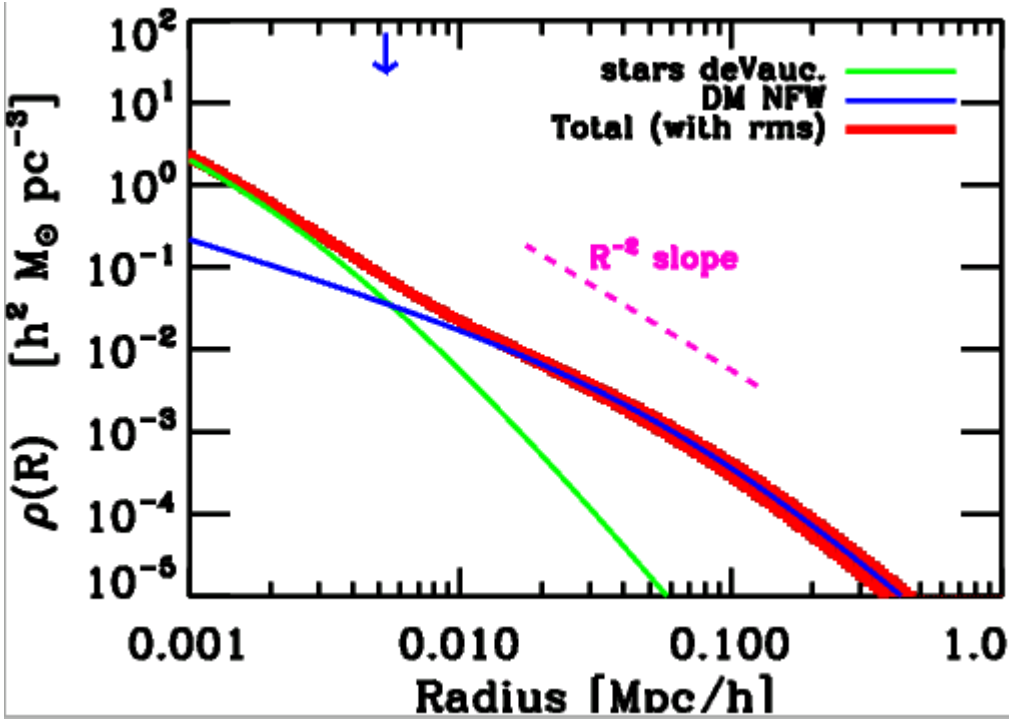




Results from Strong & Weak lensing analysis : Average 3D density profile.

Gavazzi et al 07





Results from Strong & Weak lensing analysis : Average 3D density profile.

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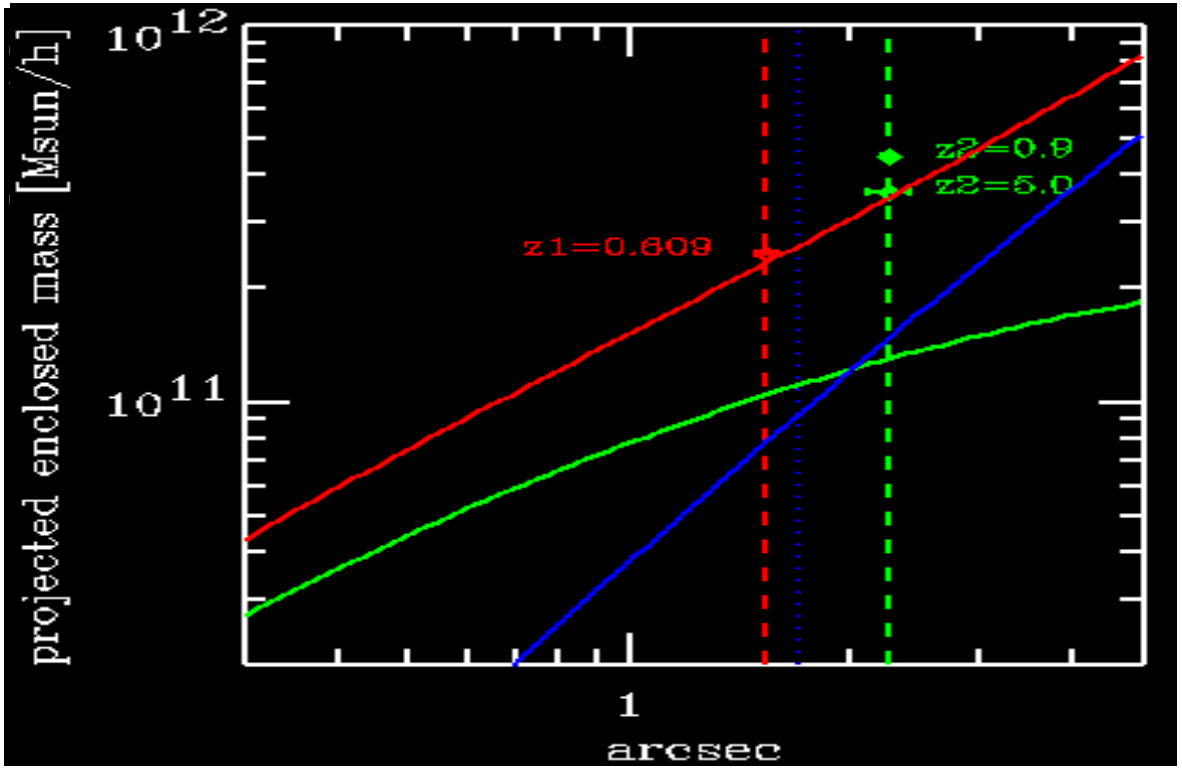
Excellent agreement when using S+WL results SLACS once rescaled to the actual lens σ_v



The jackpot, conclusions so far....

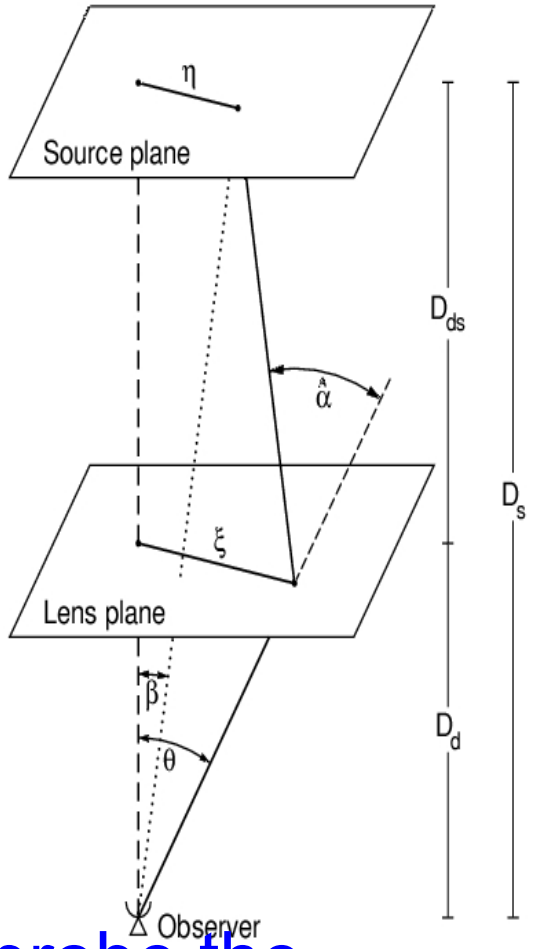
- Successful model: it's a double gravitational lens!
- Bulge-halo conspiracy confirmed with **strong lensing only** (isothermal profile)
- Standard light+NFW ok
- What you see is what you get: Strong Lensing needs DM

(true for all SLACS single lenses with sensible M/L)*

COSMOGRAPHY?

$$\vec{\beta} = \vec{\theta} - \vec{\alpha} \equiv \vec{\theta} - \vec{\nabla}\psi(\vec{\theta}).$$

$$\psi(\vec{\theta}) = \frac{2}{c^2}\frac{D_{ls}D_{ol}}{D_{os}}\phi(\vec{\theta}).$$

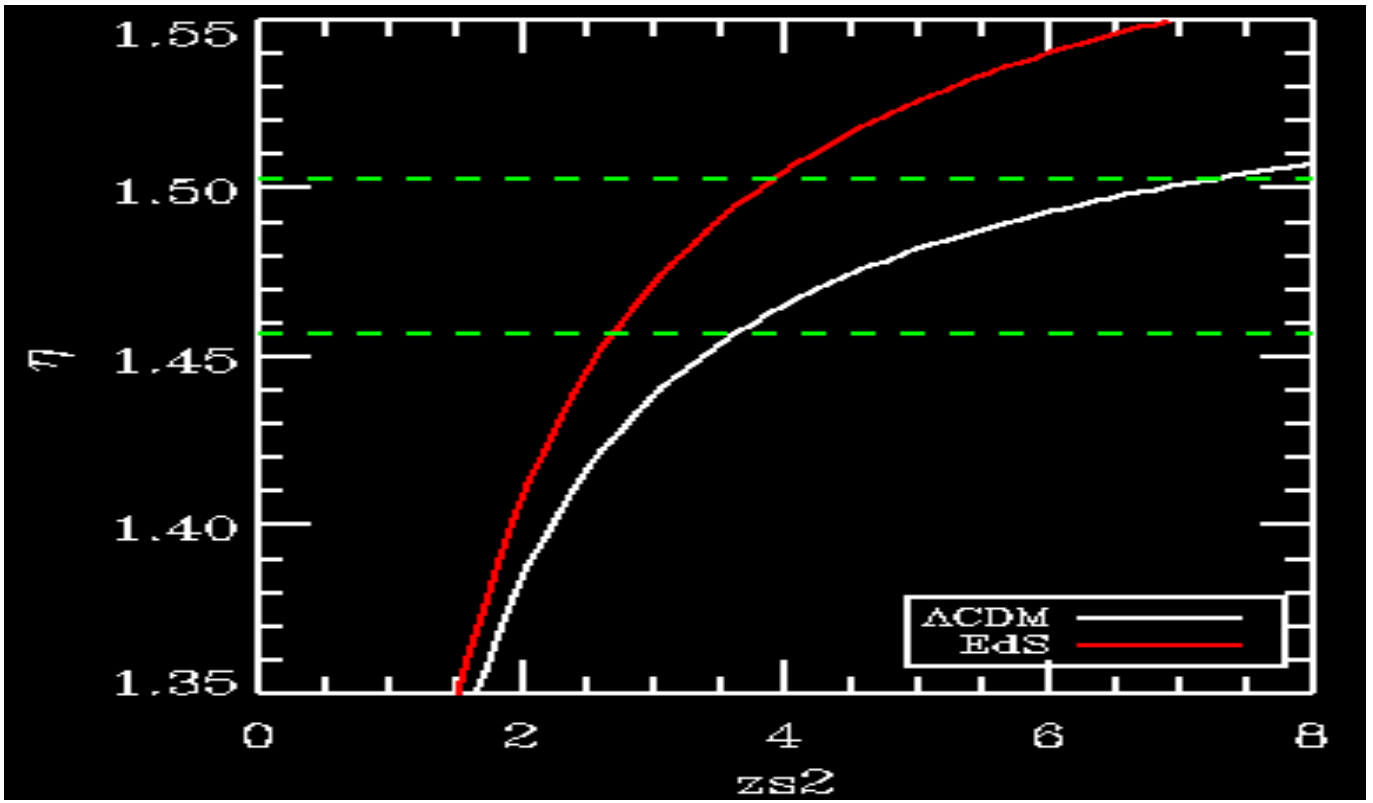


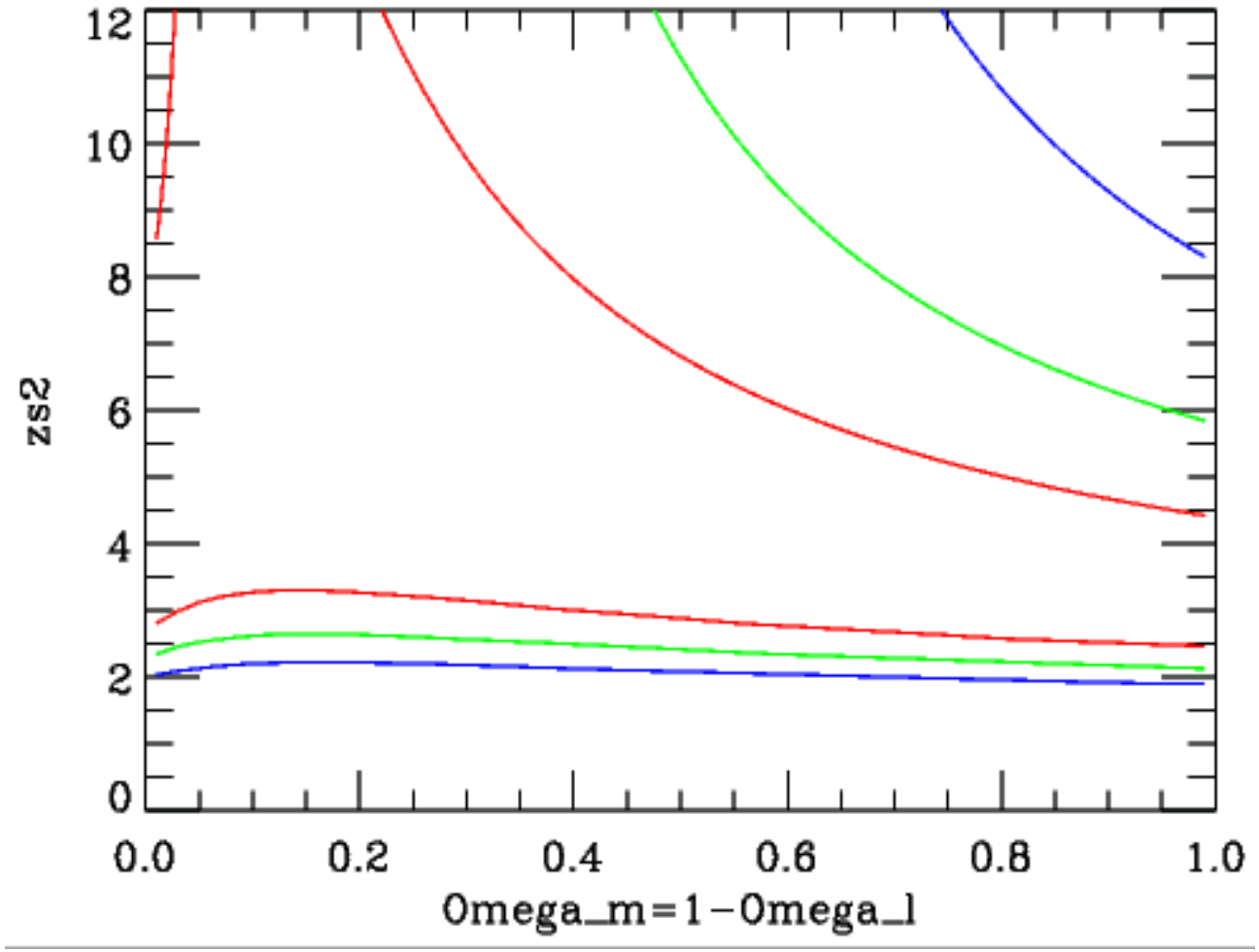
If the potential is known, then we can probe the geometry of the universe.

For SDSSJ0946+1006:

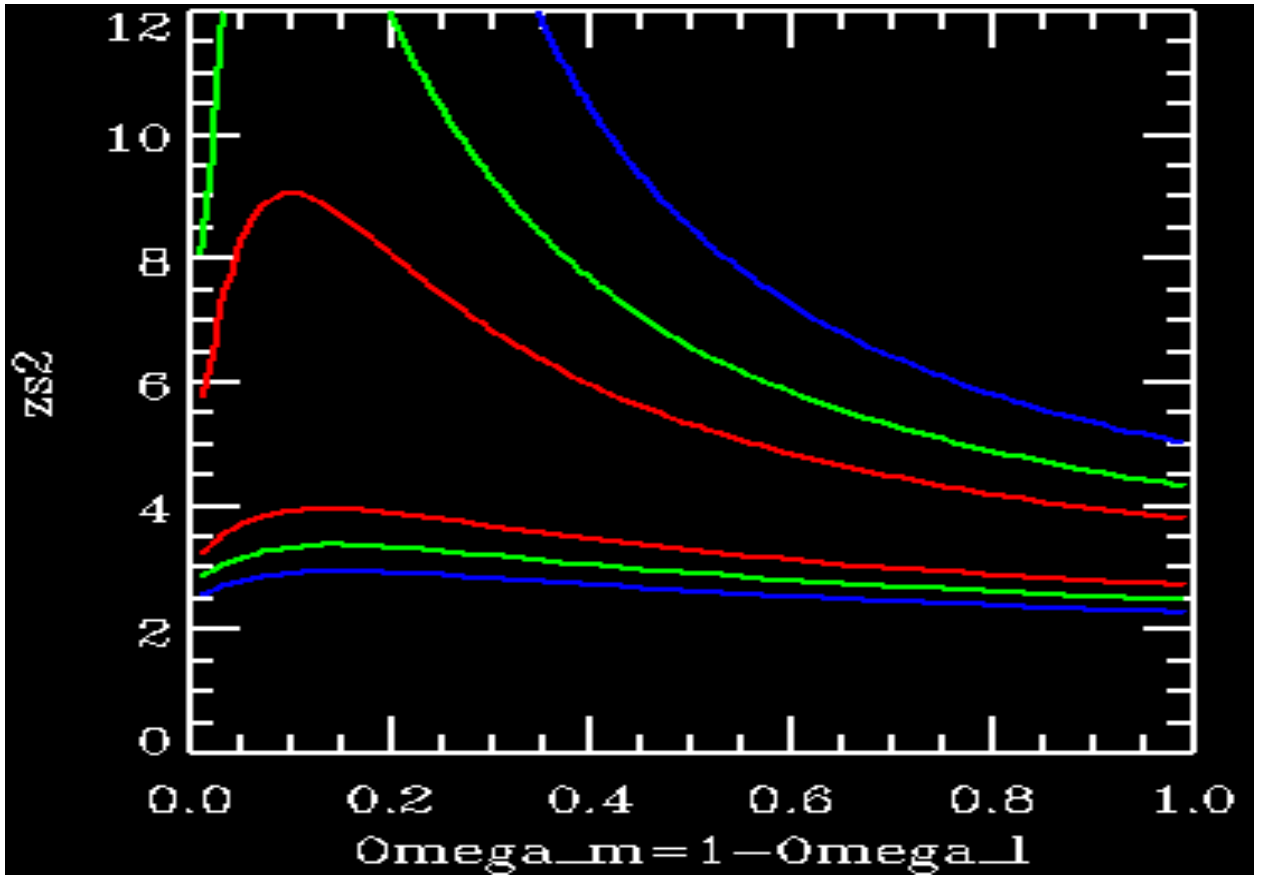
we can measure $\alpha(z_{s1})/\alpha(z_{s2})$: Ratio of distance ratios : a function of cosmological parameters?

Lens model *(after marginalisation of ALL unknown params.)* gives a PDF for
η=ratio of observed Einstein Radii = Dls/Ds(z2) / Dls/Ds(z1)





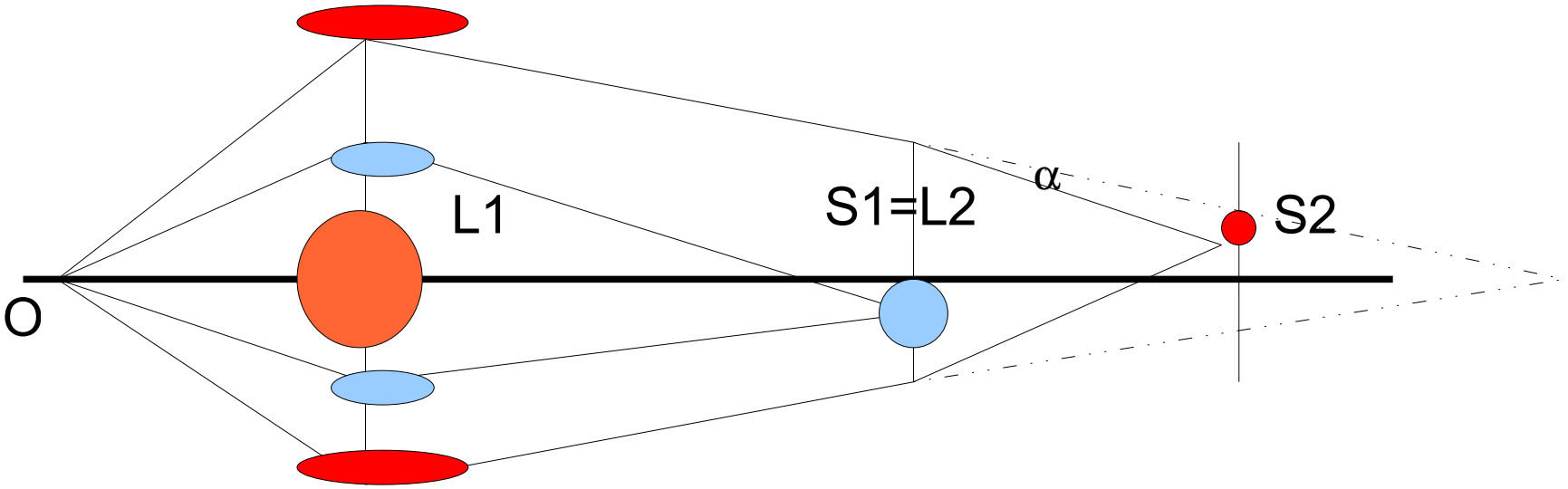
So much for "precision cosmology"...

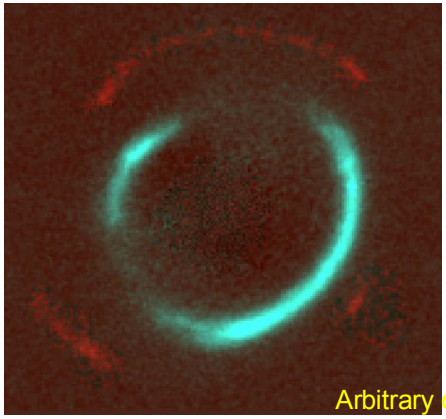


May be improved a bit with more realistic errors... but...

An ideal optical bench?

Consider the mass contained in source1 that may add extra focusing to source2. That's even more complicated!



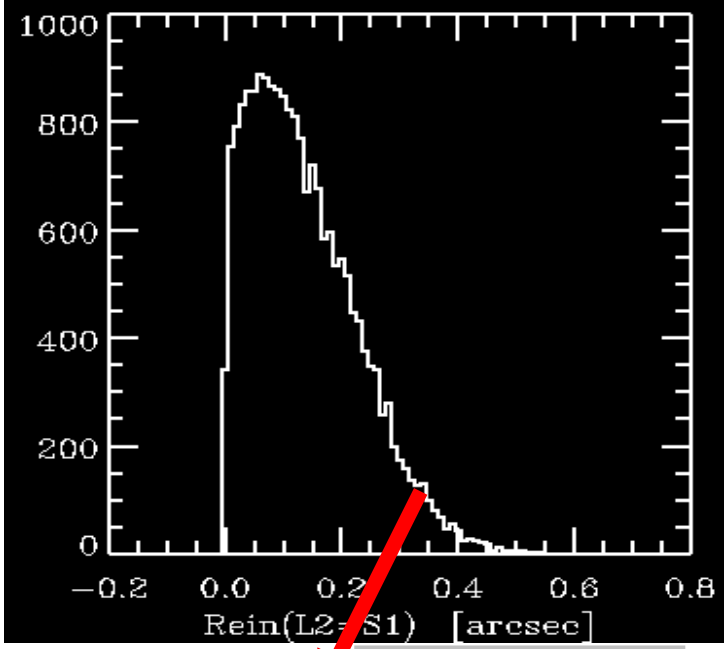


Arbitrary colors

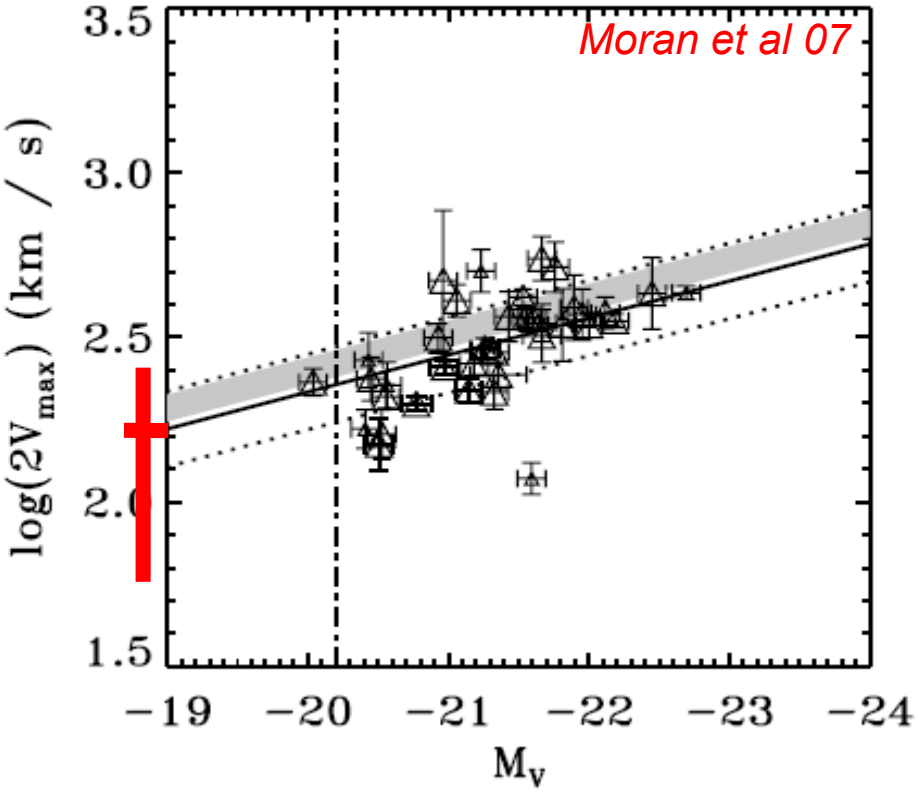
But everybody's noise is somebody's signal...

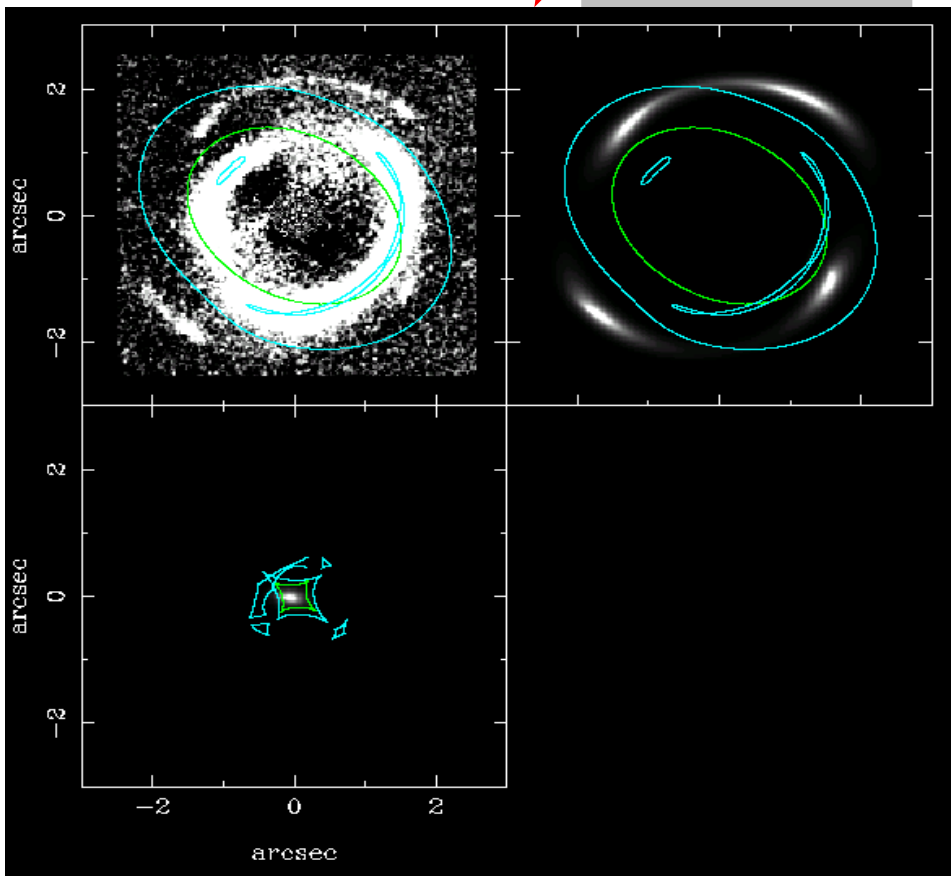
Positive mass in L2 SIS marginally favored, consistent with rotation velocity $V=90^{+30}_{-60}$ km/s.

Given unlensed luminosity Mv=-19.0, falls well onto z~0.5 Tully-Fisher relation. (FBCNELLGs #2)



Extreme case





Conclusions

- SDSSJ0946+1006 is a great surprise from SLACS
- Statistics of such events: at least 1 in the sky! We may learn about faint distant sources.
- Mass profile very well probed (normalization and slope) even without z_{s2} and again close to isothermal and need for DM.
- Cosmology poorly constrained with such an unusual optical bench!
- Source1 should also be seen as Lens2 for which we get a sensible V_{rot}.