Galaxy-Mass Correlations via Galaxy-Galaxy Lensing in the Deep Lens Survey

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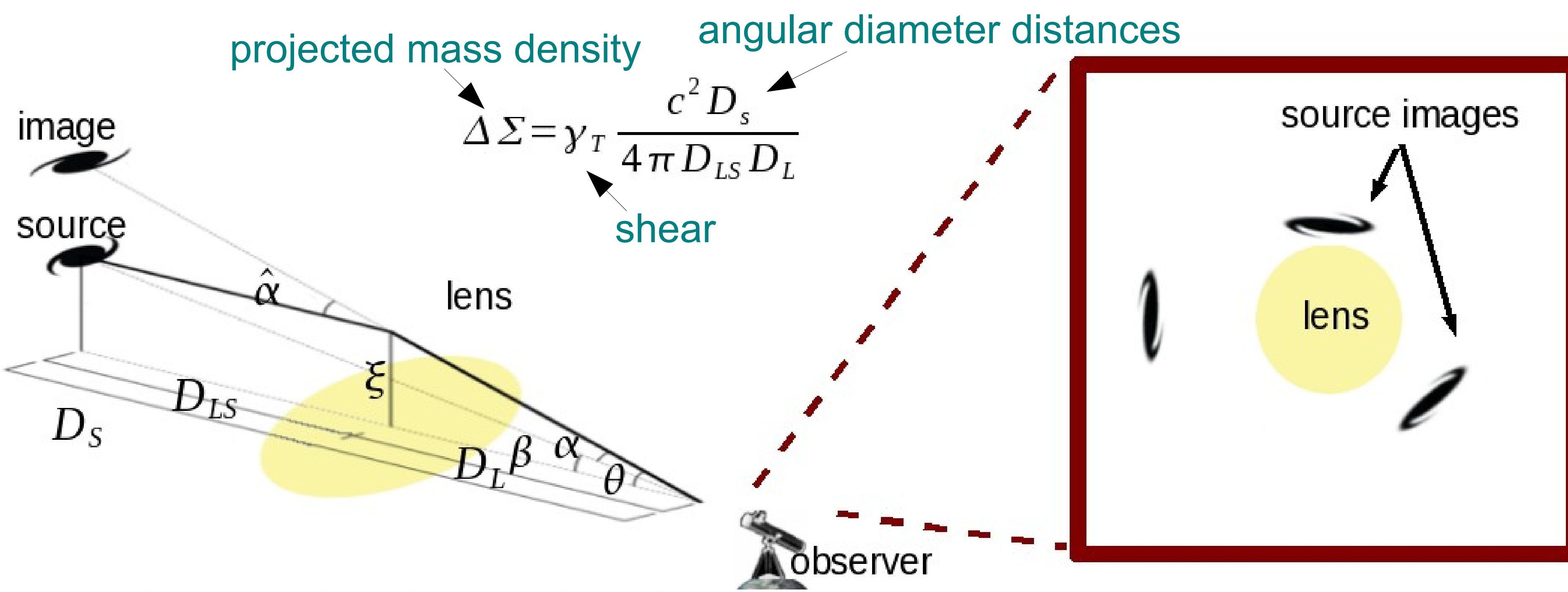
Weak gravitational lensing by galaxies



How do I measure the shear for a given source galaxy?

$$e^{observed} = e^{intrinsic} + \gamma_T$$

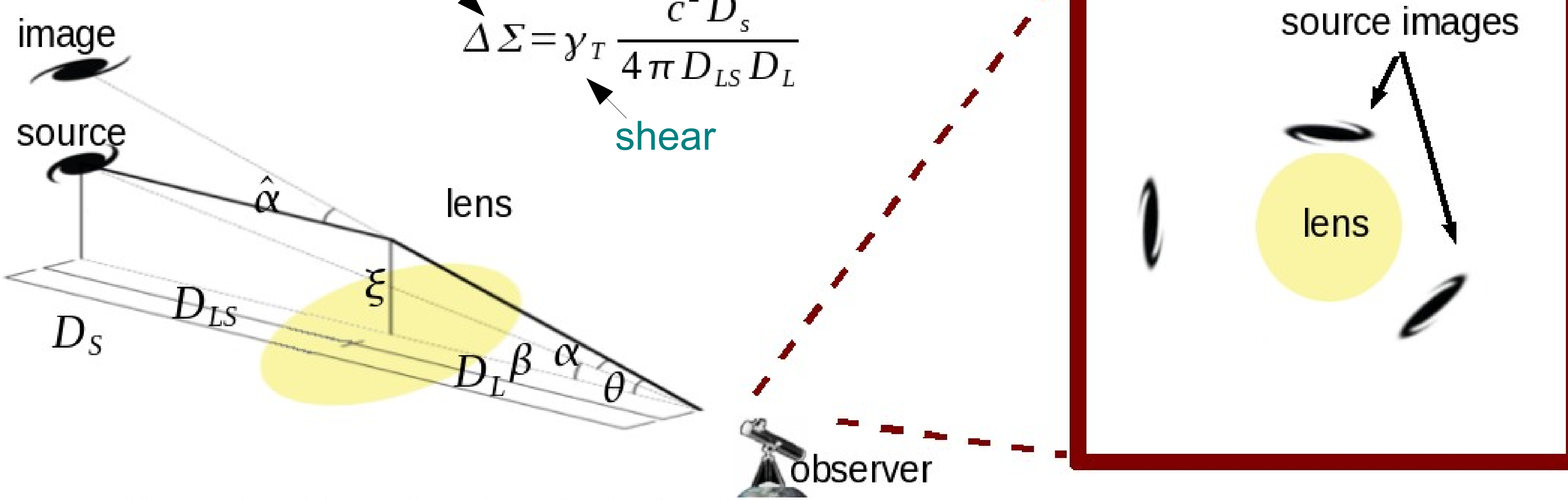
Weak gravitational lensing by galaxies

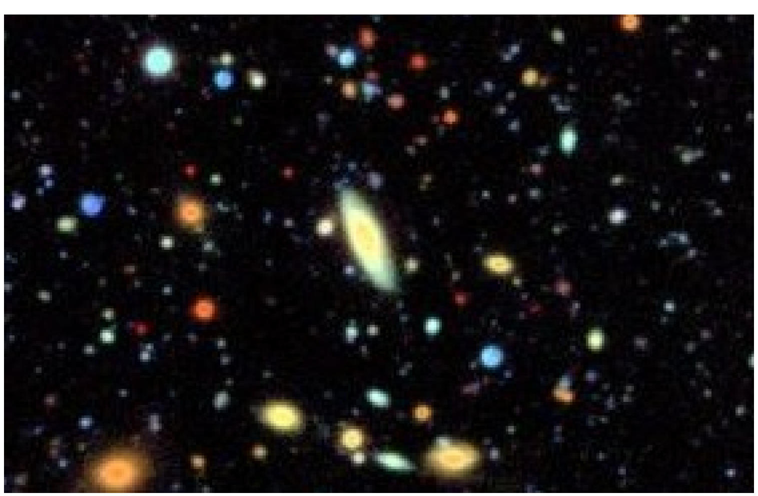
projected mass density

angular diameter distances

$$\Delta\Sigma = \gamma_T \frac{c^2 D_s}{4\pi D_{LS} D_L}$$

shear





Lensing assumes the distribution of intrinsic ellipticities is zero on average.

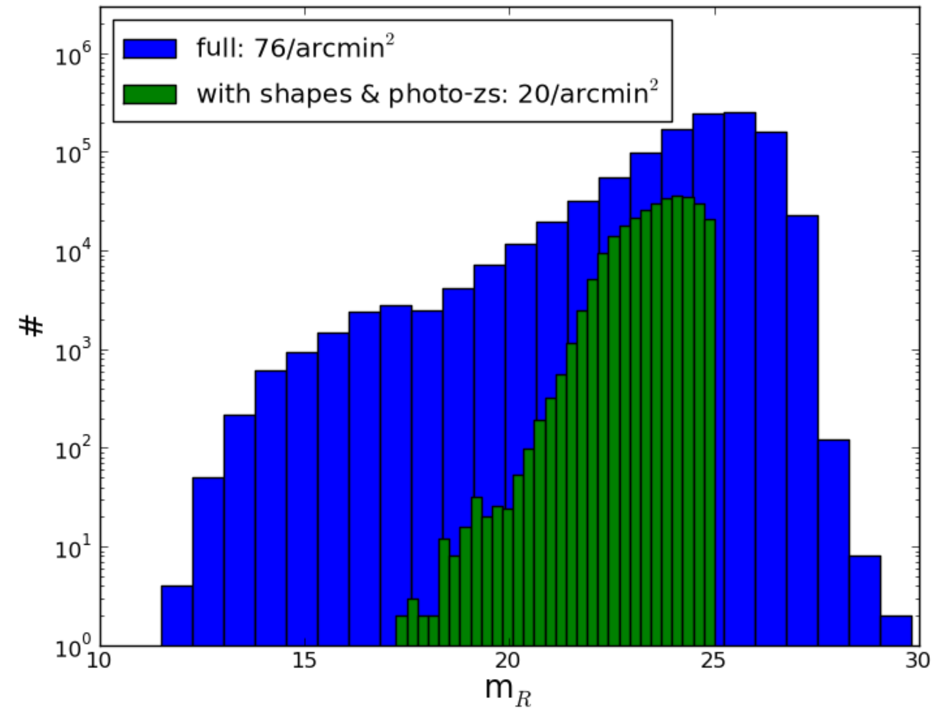
$$\langle e^{observed} \rangle = \langle e^{intrinsic} \rangle + \langle \gamma_T \rangle \quad (\langle e^{intrinsic} \rangle \rightarrow 0)$$

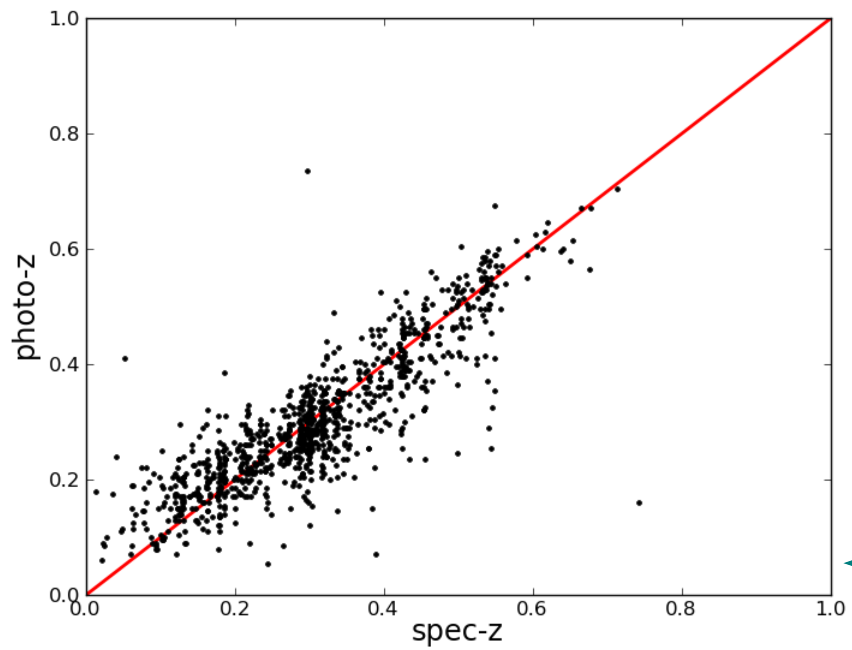
$$\langle e^{observed} \rangle = \langle \gamma_T \rangle$$

Deep Lens Survey (DLS)

BVRz' imaging of 20 sq. deg. over five fields at Kitt Peak and Cerro Tololo 4m + Mosaic (Wittman et al. 2002)

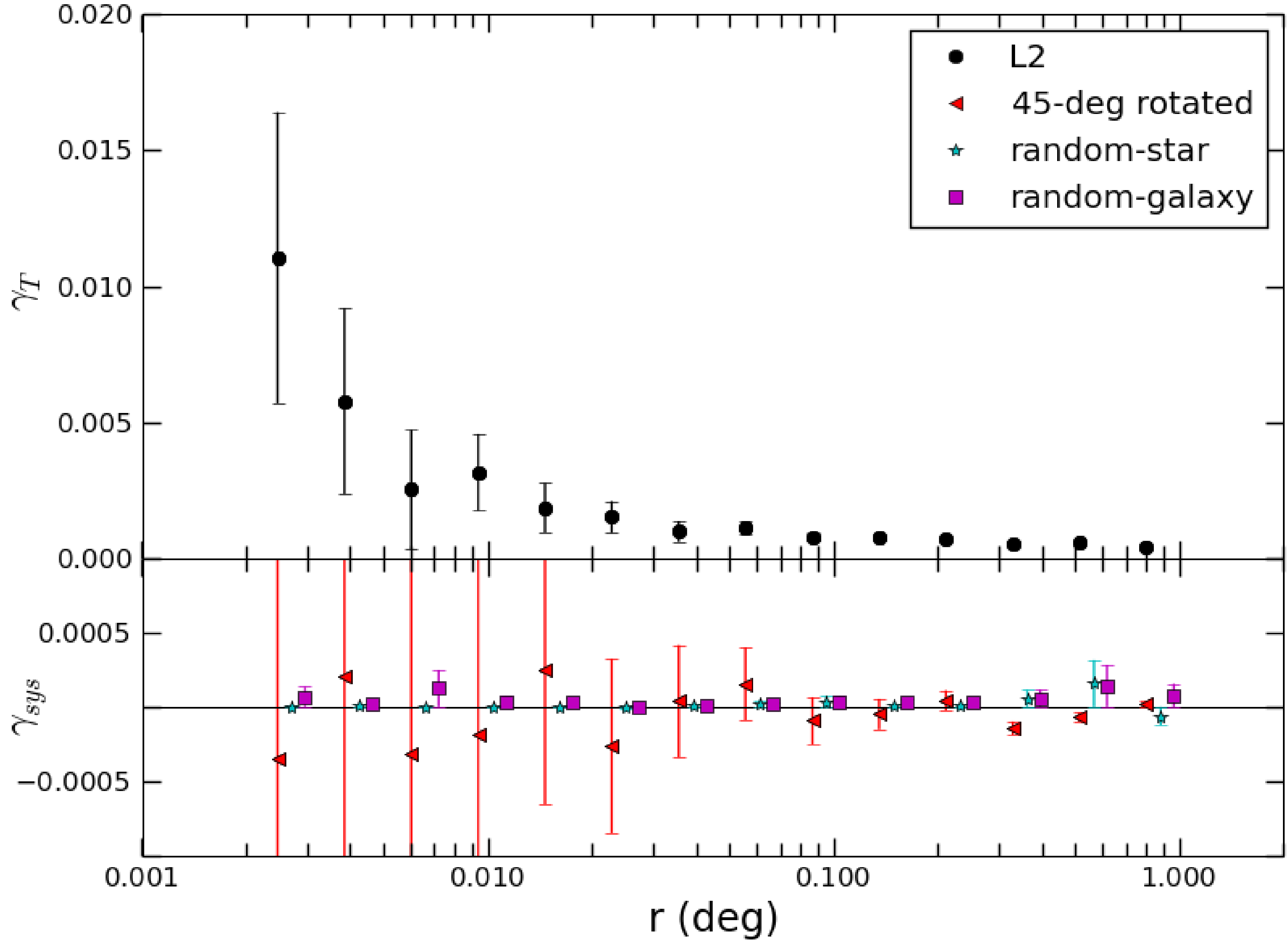
- seeing ≤0.9 in R
- 18,000s in R, 12,000s in Bvz'
- calibration using Übercal method (Padmanabhan et al. 2008)





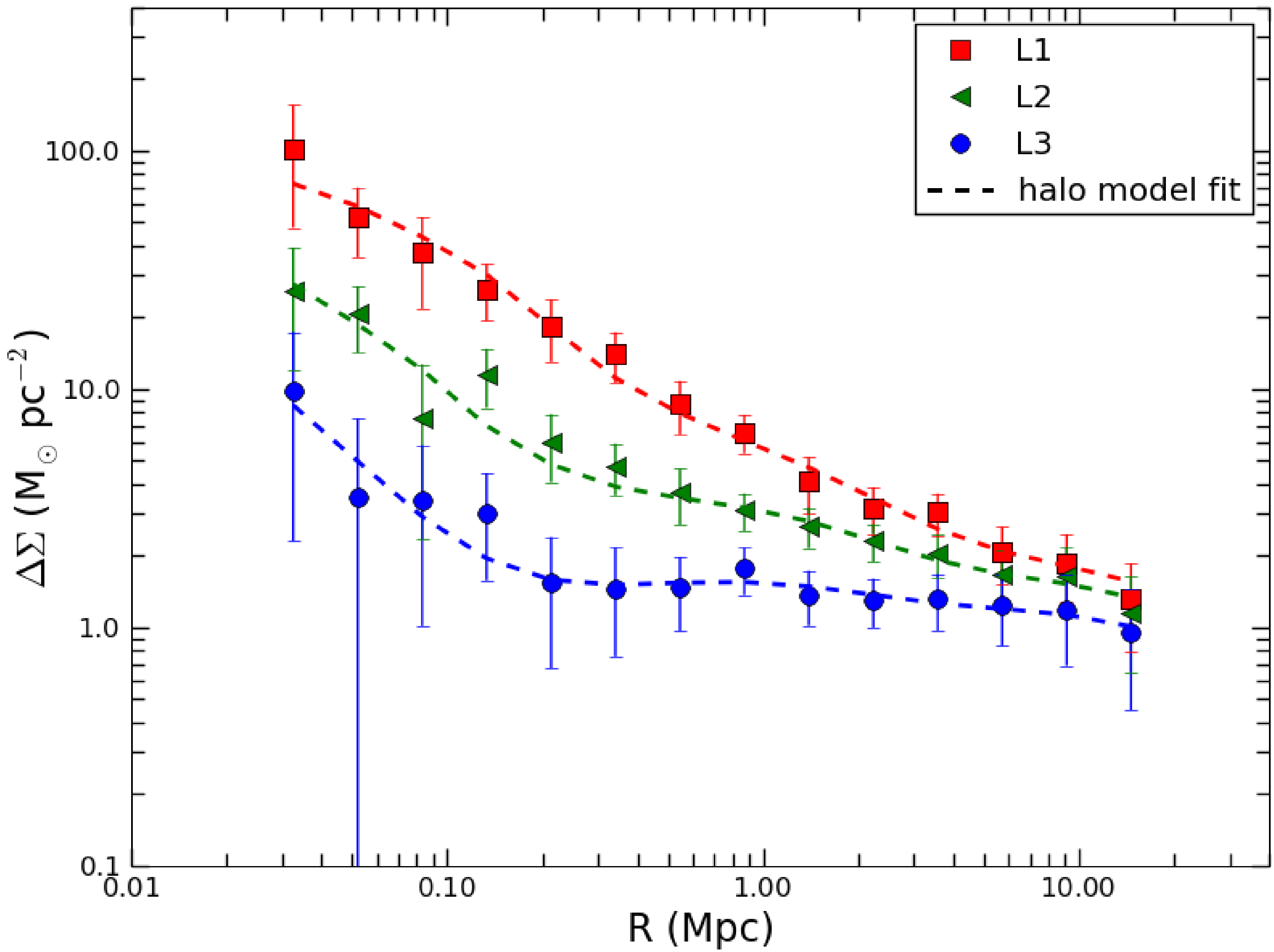
- shapes:
  PSF-convolved elliptical Gaussians using PCA to describe the PSF (Bernstein & Jarvis 2002; Jee et al. 2007)
- photometric redshifts (photo-zs):
  measured using BPZ (Benitez 2000)
  - Comparison of 1000 spec-zs from SHELS (Geller et al. 2005) gives σ ~ 0.036

Tangential shear and systematics tests



Top panel: cross-correlation between position of “lenses” with 0.1 < photo-z < 0.5 and shears of “sources” with 0.7 < photo-z < 1.5.
Bottom panel: systematics tests consistent with no systematics.

Lensing signal for luminosity bins



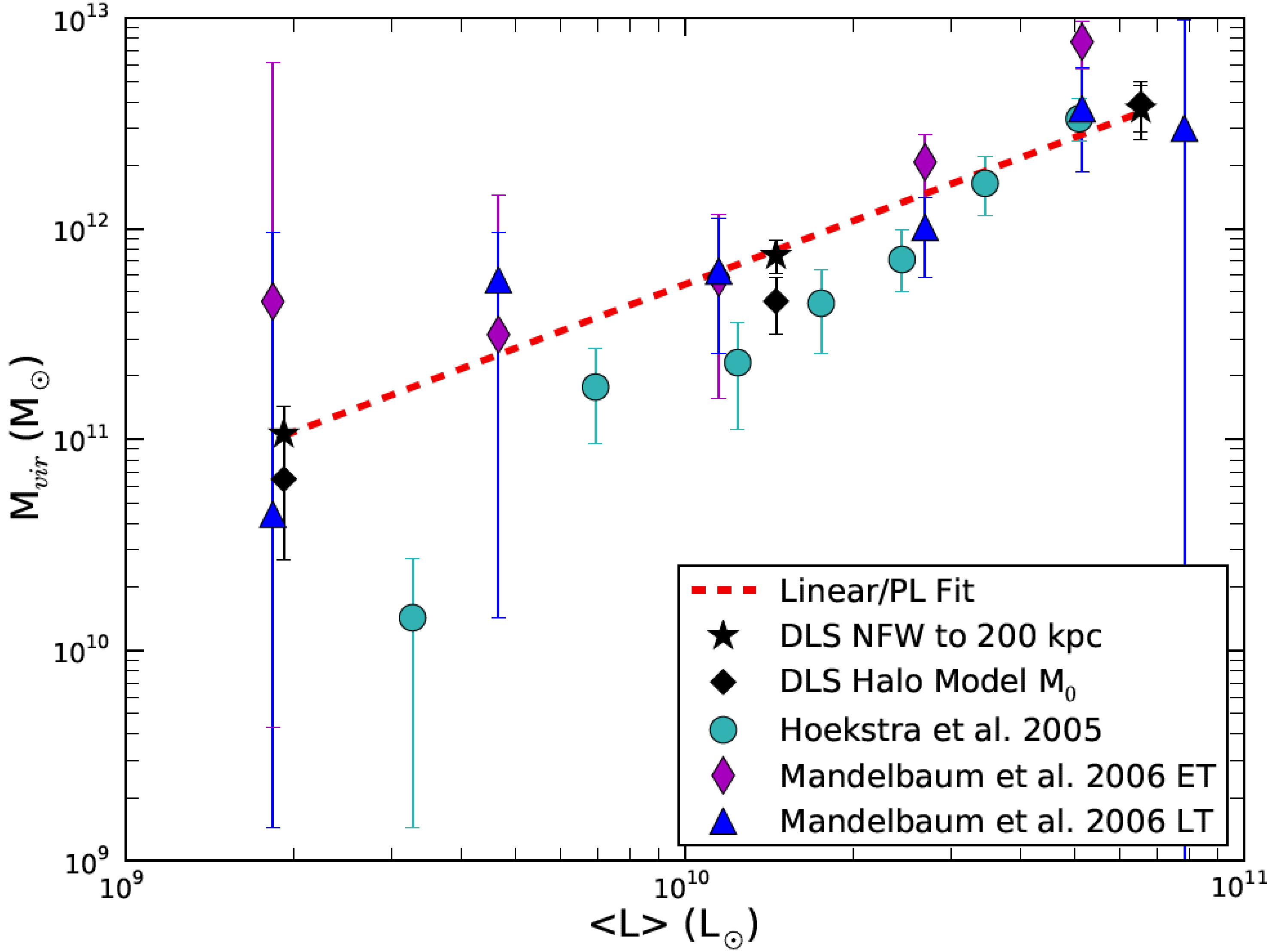
-24<M<-22

-22<M<-20

-20<M<-17

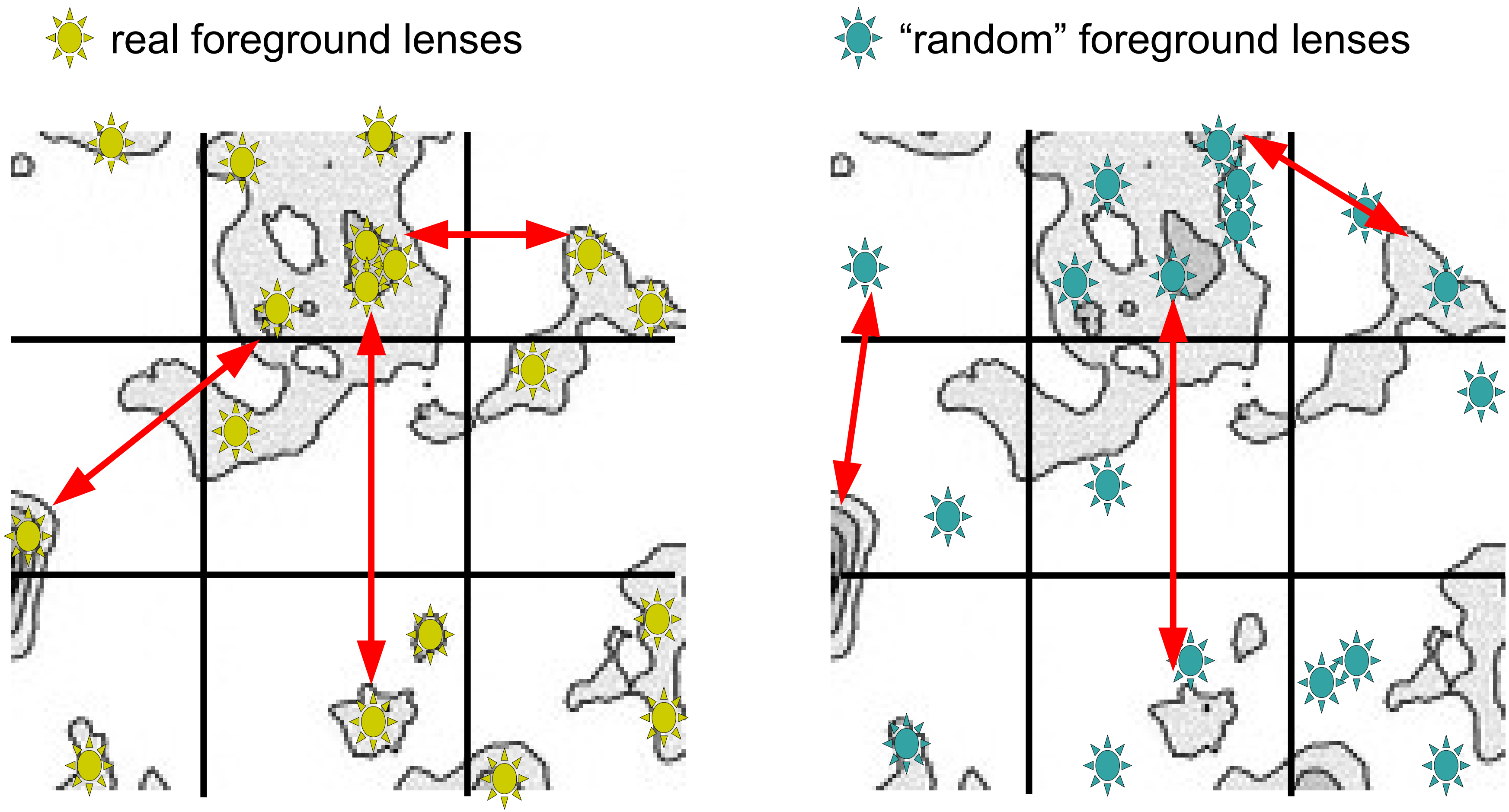
Now converting shear to projected excess mass density and angular separations to physical units.
Brighter lenses have stronger lensing signals: brighter = more mass.

Mass vs Luminosity



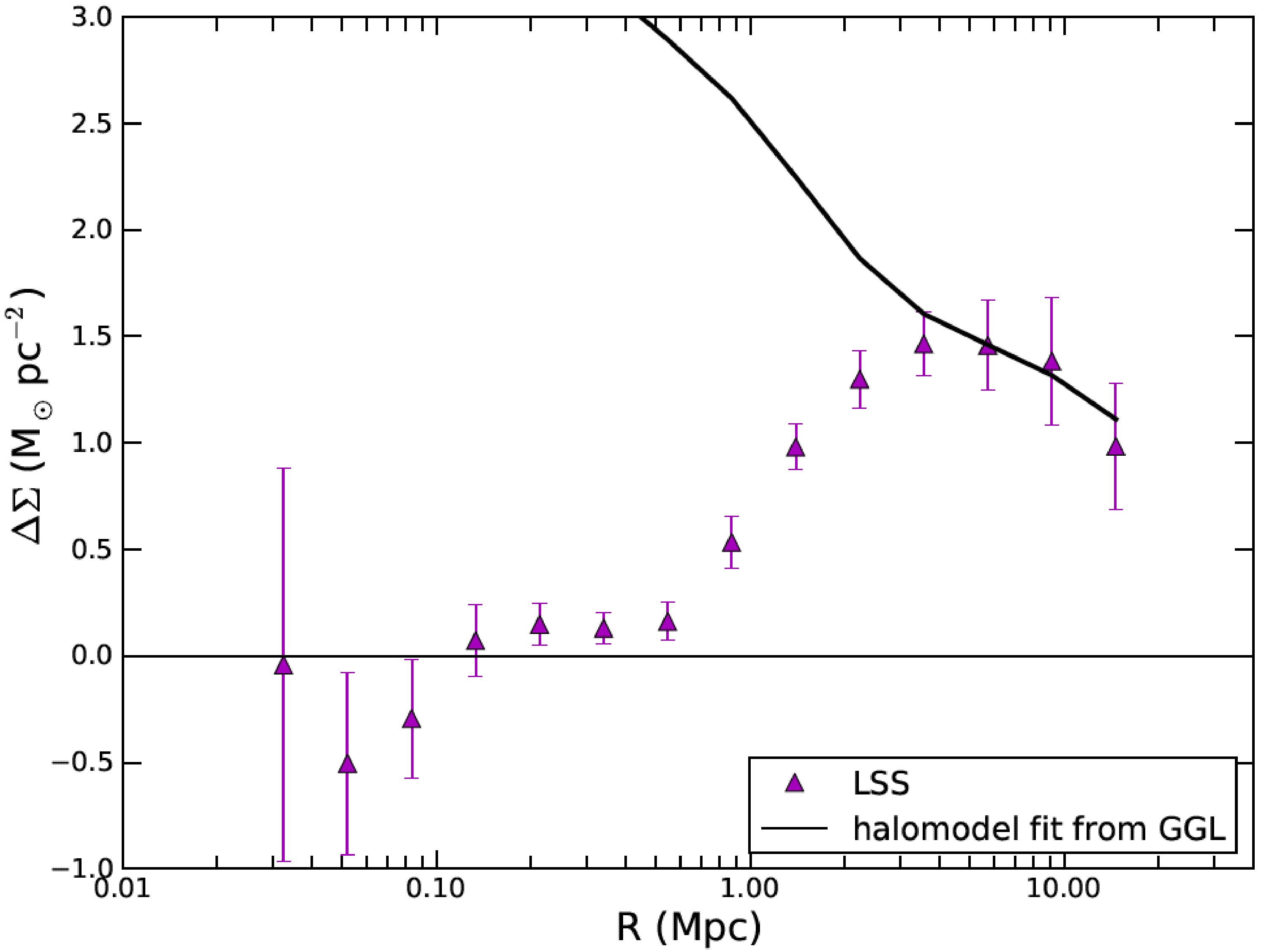
DLS results in black (Choi et al., submitted) agree well with previous results at lower redshifts in the literature.

Isolating the large-scale structure



Select “random” foreground lenses weighted by a galaxy density map but dithered off of the position of a true lens, and calculate lensing signal. Small radii signals are suppressed, and large radii signals correspond to the large-scale structure (LSS).

Isolating the large-scale structure



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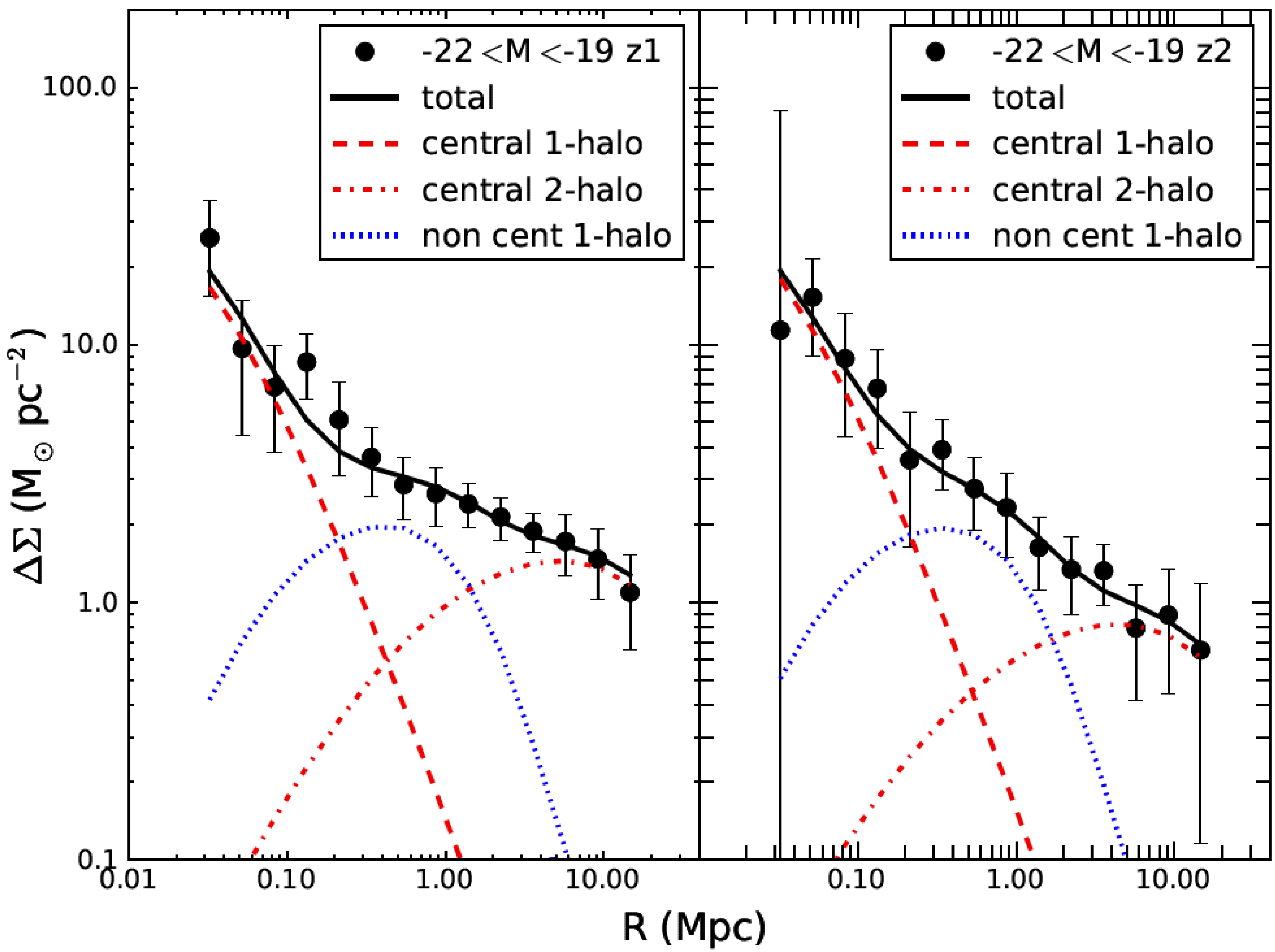
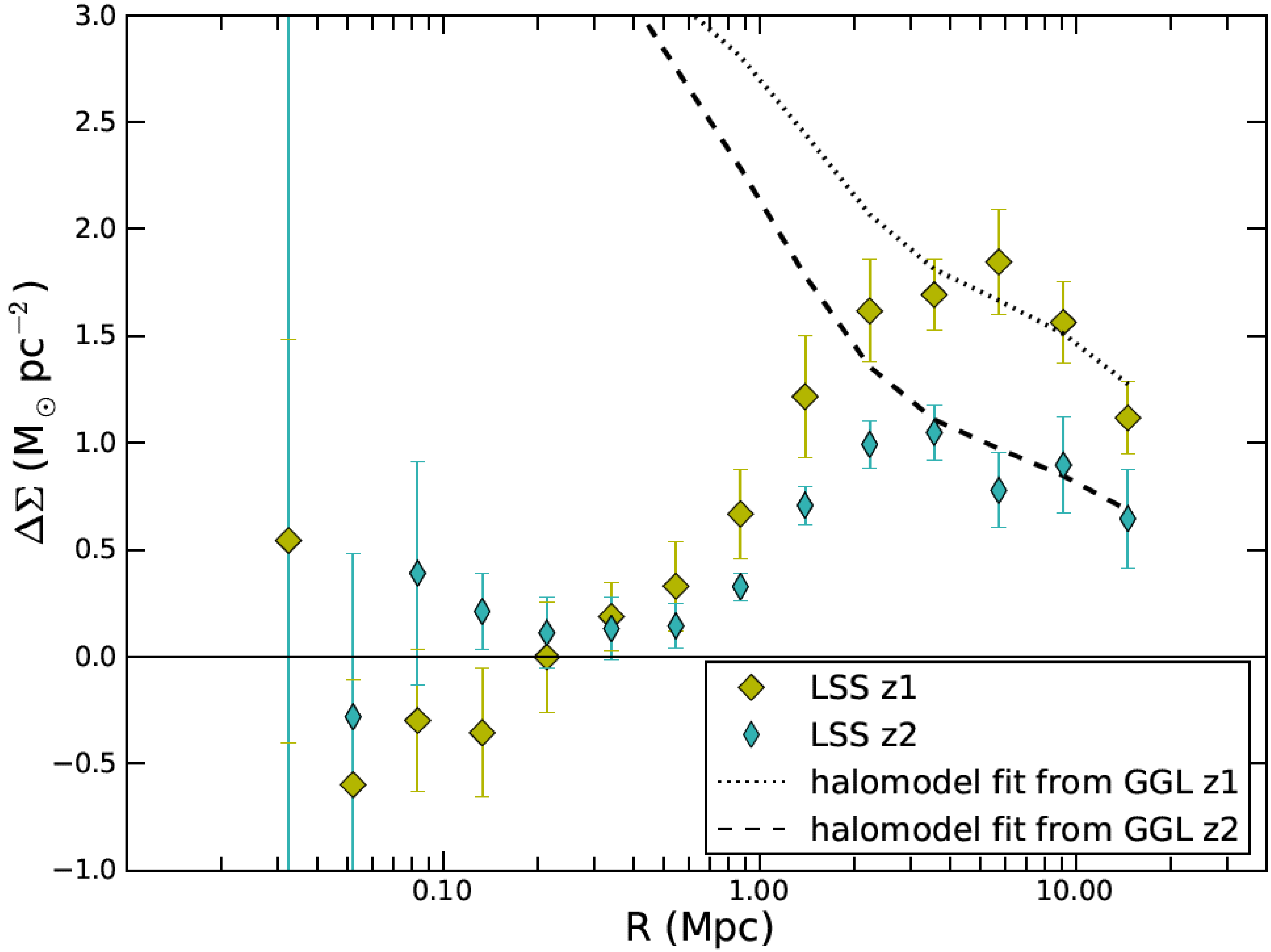
Redshift evolution of lensing signal



Now compare "complete" samples of lenses with 0.1 < photo-z < 0.4 and 0.4 < photo-z < 0.7

Redshift evolution of lss signal



Higher amplitude at lower redshift likely corresponds to more massive structures (i.e. clusters), but further work with simulations and modeling is necessary for interpretation.

Summary and Ongoing Work

• Lensing is a robust tool for measuring the projected mass density profiles of galaxies: dominated at small radii by the halos of the galaxies; dominated at large radii by neighboring halos.

• Intrinsically brighter galaxies are the more massive galaxies, and we see a hint of evolution in the neighboring halo contributions. Preliminary clustering measurements and halo modeling indicate the biases of our two redshift samples are very similar.

• Ongoing work includes:
  - comparison with simulations and improved analytic modeling, which will aid interpretation in terms of bias evolution and growth of structure.
  - more detailed investigation of photo-z errors.
  - joint analysis of the shear signal with clustering and magnification information.
  - Binning by color, stellar mass, environment, etc...