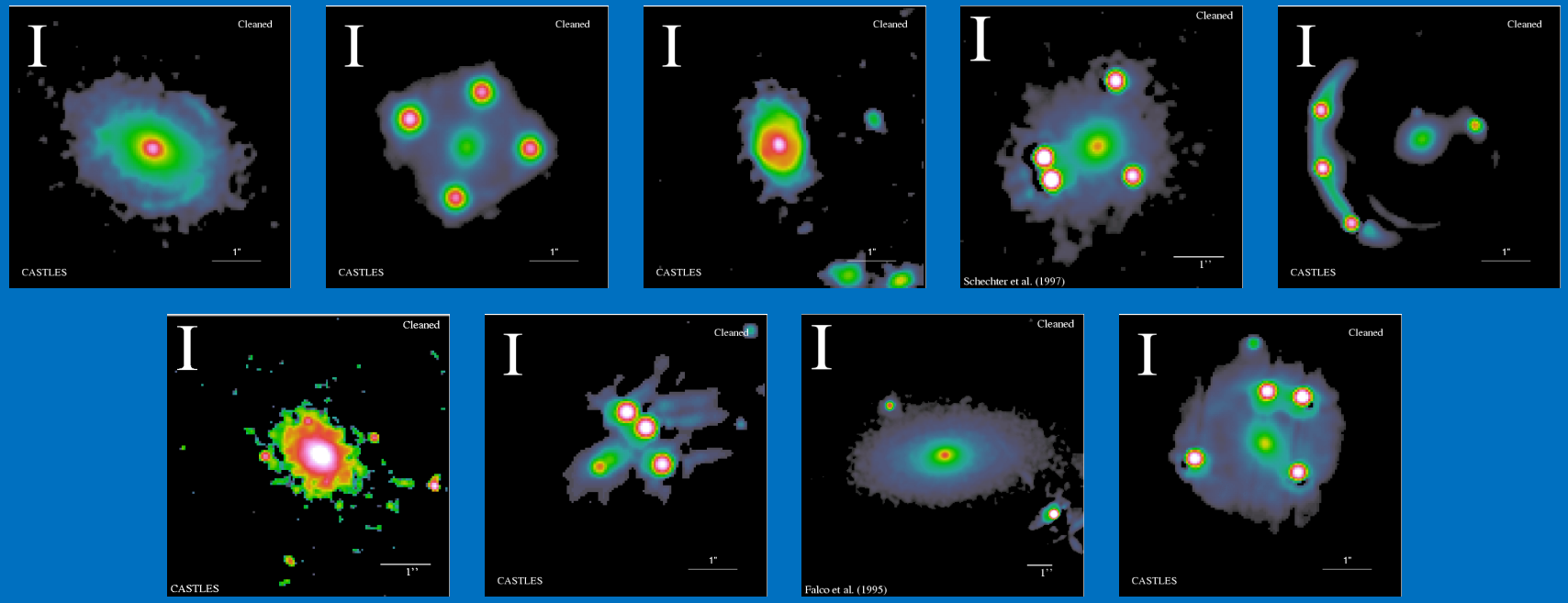
The Effect of Environment on Shear in Strong Gravitational Lenses



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MMT Symposium - May 19, 2010

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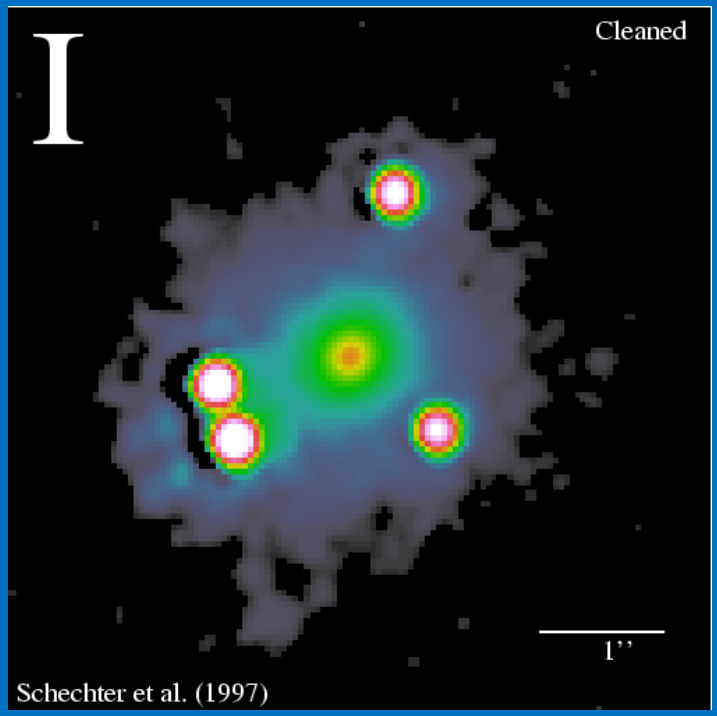
Ivelina Momcheva (OCIW), Ann Zabludoff (Arizona)

Motivation

- Local and line-of-sight (LOS) perturbers influence lens potential
- H_0 from lensing biased by environment (Keeton & Zabludoff, 2004)
- Quantify perturbations by the shear (γ) and convergence (κ)
- Lens models show γ~0.1 in groups, implies ~10% error in H_0 if κ comparable
- Measure lens environment directly to quantify perturbations independent of lens modeling
  - Is environment important? What parts matter most?
  - Does environment produce perturbations consistent with lens modeling? Only way to independently check lens model results
  - What observational and theoretical uncertainties matter?



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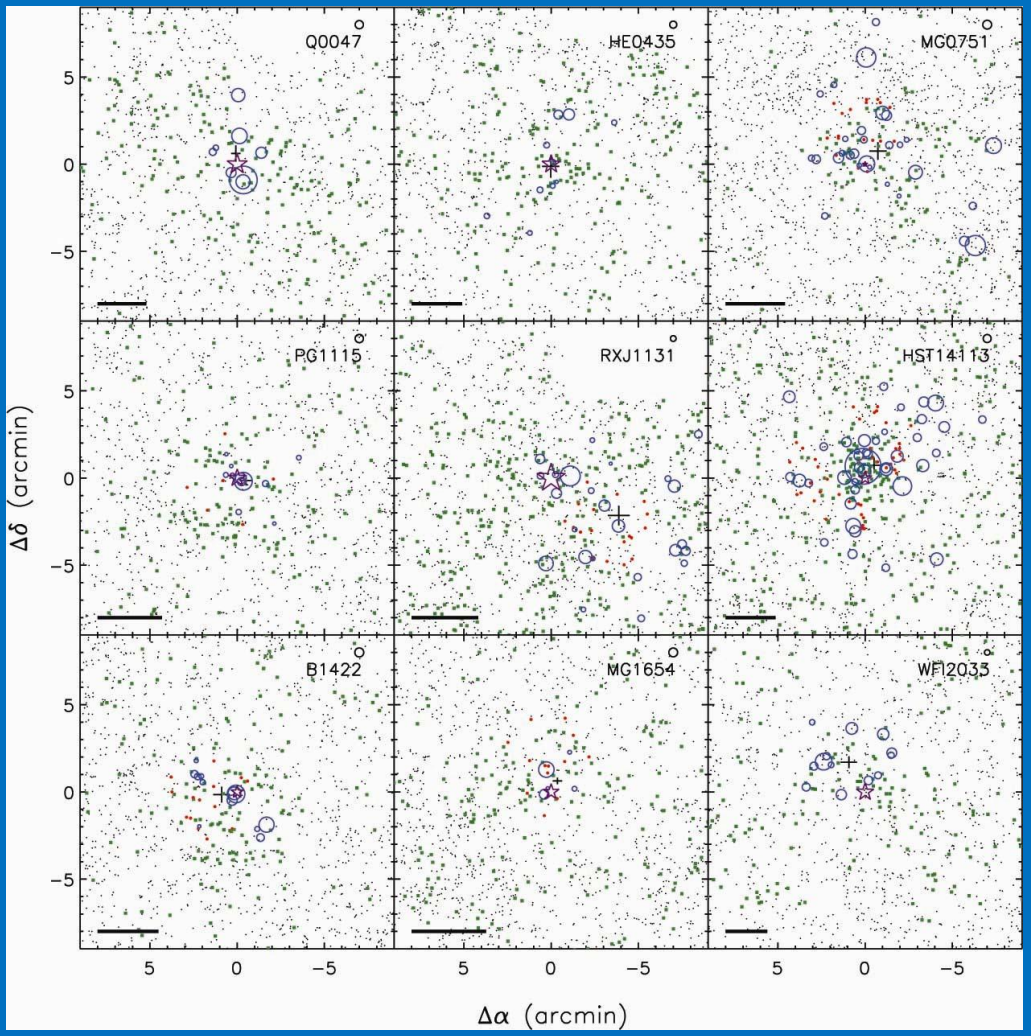
Data

- 9 lenses in galaxy groups
- Spectroscopic data to I ~ 21.5 from MMT + Magellan
- Photometric data to I ~ 24, I-band + V or R-band
- Lens model-derived shears on six 4-image lenses in our sample



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Environment Analysis

- Local Group Environment
  - Group dark matter halo
  - Individual group galaxies
- Line-of-sight galaxies
- Monte Carlo simulations
  - Correct for spectroscopic incompleteness
  - Allow for observational, theoretical uncertainties
  - Generate multiple realizations of environment
  - Get distribution of shear values from environment

Local Group

- Assume NFW group halo
- Assume galaxies are SIS
- Correct for incompleteness in group catalogs – RS galaxies
- Use SDSS Faber-Jackson relation (Bernardi et al. 2003) to determine galaxy velocity dispersions
- Apportion total group mass between halo and galaxies by scaling galaxies truncation radii – f_{halo} is a free parameter

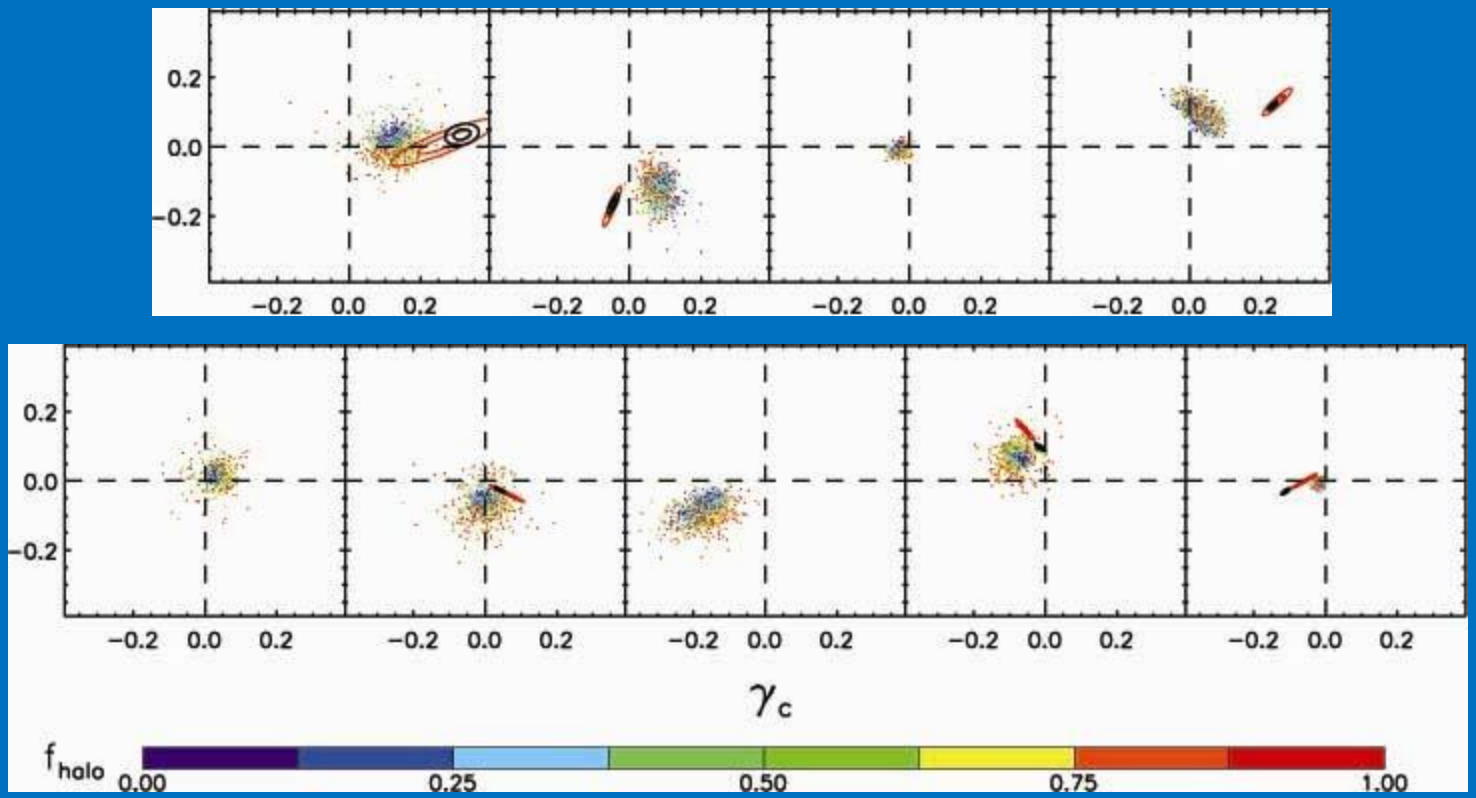
Line-of-Sight

- Cut LOS sample at d < 5’ and I < 21.5
- Spectroscopic incompleteness – draw redshifts for objects without spectroscopy from cumulative redshift distributions of galaxies with spectra
- Assume SIS profile, determine velocity dispersion with FJ, truncation radius = R_{200}

Theoretical and Observational Uncertainties

- Theoretical
  - SIS vs. NFW group halo
  - f_{halo}
  - NFW concentration parameter c_{vir}
- Observational
  - *Group centroid error*
  - Group velocity dispersion error
  - *Scatter in FJ relation*
  - Magnitude errors

Results



<γ> = 0.10 → Environment is important!

Results don't match lens models in 3/6 cases

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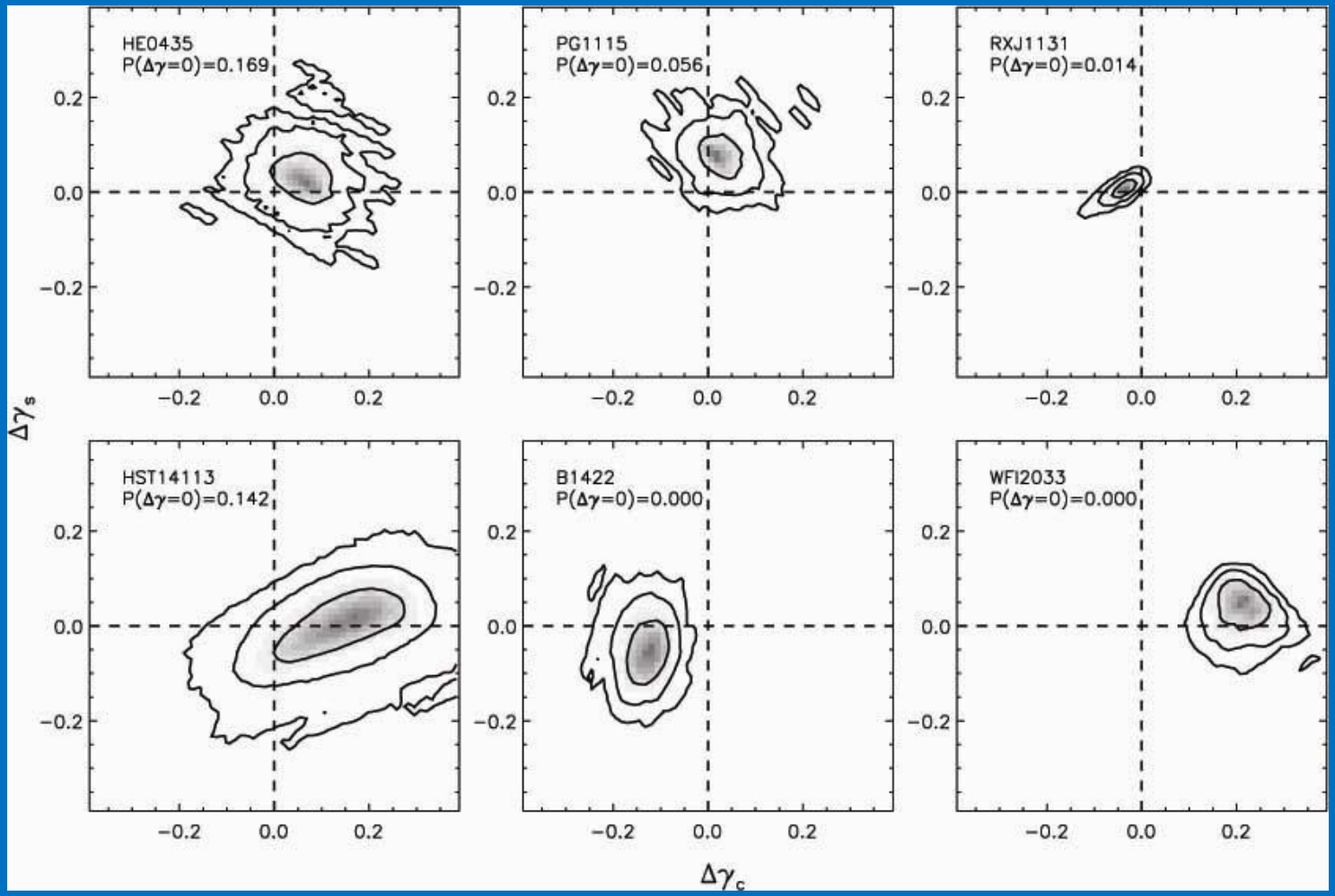
Results



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Conclusions & Future Work

- Results inconsistent with lens modeling in 3/6 cases –independent test, could teach us new things about lens models
- Environment contributes $\langle\gamma\rangle = 0.10$, $\rightarrow$ ~10% error in H_0 if κ is comparable
- Observational strategies of future surveys
  - Prioritize targeting of objects within 2' of lens, $I < 21.5$
  - Account for most important sources of uncertainty
- Improve environment measurement – account for other observational uncertainties, theoretical assumptions that we did not explicitly address here
- Improve lens models – 2-component lens galaxies, substructure, nonlinear effects from multiple lens planes
- Calculate convergence directly from environment measurements, effects on H_0