Intrinsic galaxy alignments as a contaminant for cosmic shear

Abell S0740

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In collaboration with Sarah Bridle, Donnacha Kirk *UCL,*
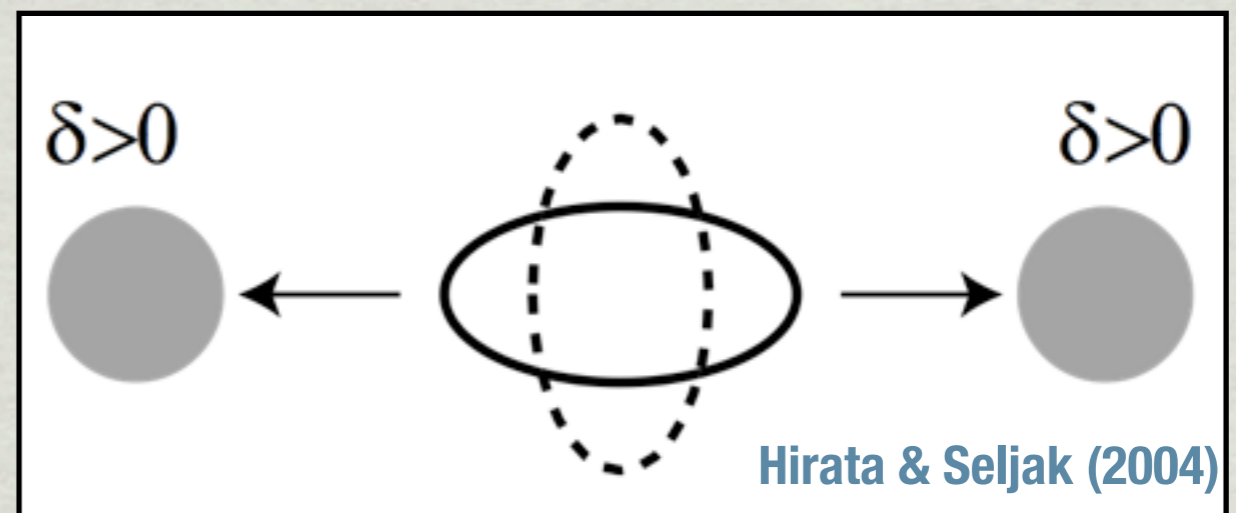**Carlos Frenk, Shaun Cole** *Durham*

Cosmic shear contamination terms

$$\gamma^{\mathrm{obs}} = \gamma^G + \gamma^I$$

$$\langle \gamma^{\mathrm{obs}} \gamma^{\mathrm{obs}*} \rangle = \underbrace{\langle \gamma^G \gamma^{G*} \rangle}_{\xi^{GG}} + \underbrace{\langle \gamma^I \gamma^{I*} \rangle}_{\xi^{II}} + \underbrace{\langle \gamma^I \gamma^{G*} \rangle + \langle \gamma^G \gamma^{I*} \rangle}_{\xi^{GI}}$$

GI cartoon

GI induces anticorrelation between lens and source galaxy ellipticities.

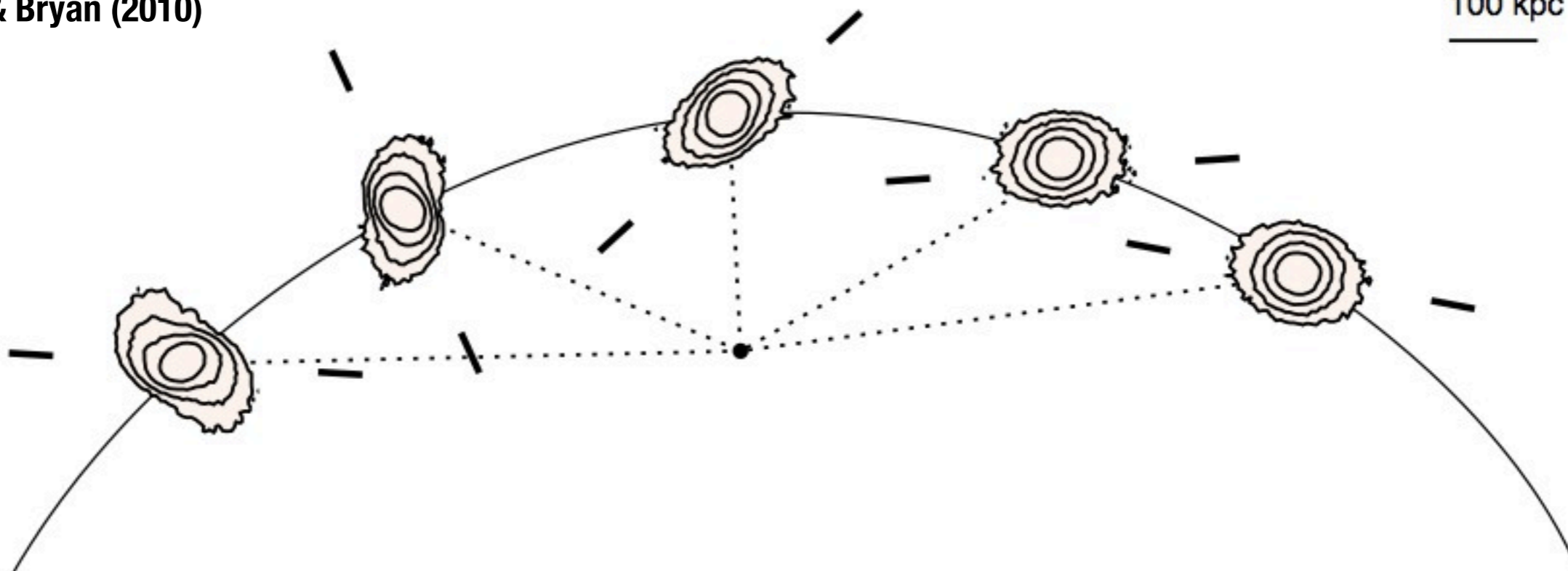$\delta > 0$ $\delta > 0$

Hirata & Seljak (2004)

Constraints on amplitude of intrinsic alignment power spectrum from galaxy-shear correlations

	Data set	Redshift range	Detection range	Max σ_8 bias (CFHTLS-like survey)
Red galaxies	SDSS + 2SLAQ (Hirata et al. 2007)	[0.15, 0.8]	1 - 60 Mpc/h	-0.1
Blue galaxies	SDSS + WiggleZ (Mandelbaum et al. 2010)	[0.01, 1.3]	Null	±0.06

Origin of intrinsic alignments?

Pereira & Bryan (2010)

100 kpc

100 Mpc/h

Millennium-2 simulation (Boylan-Kolchin et al. 2009)

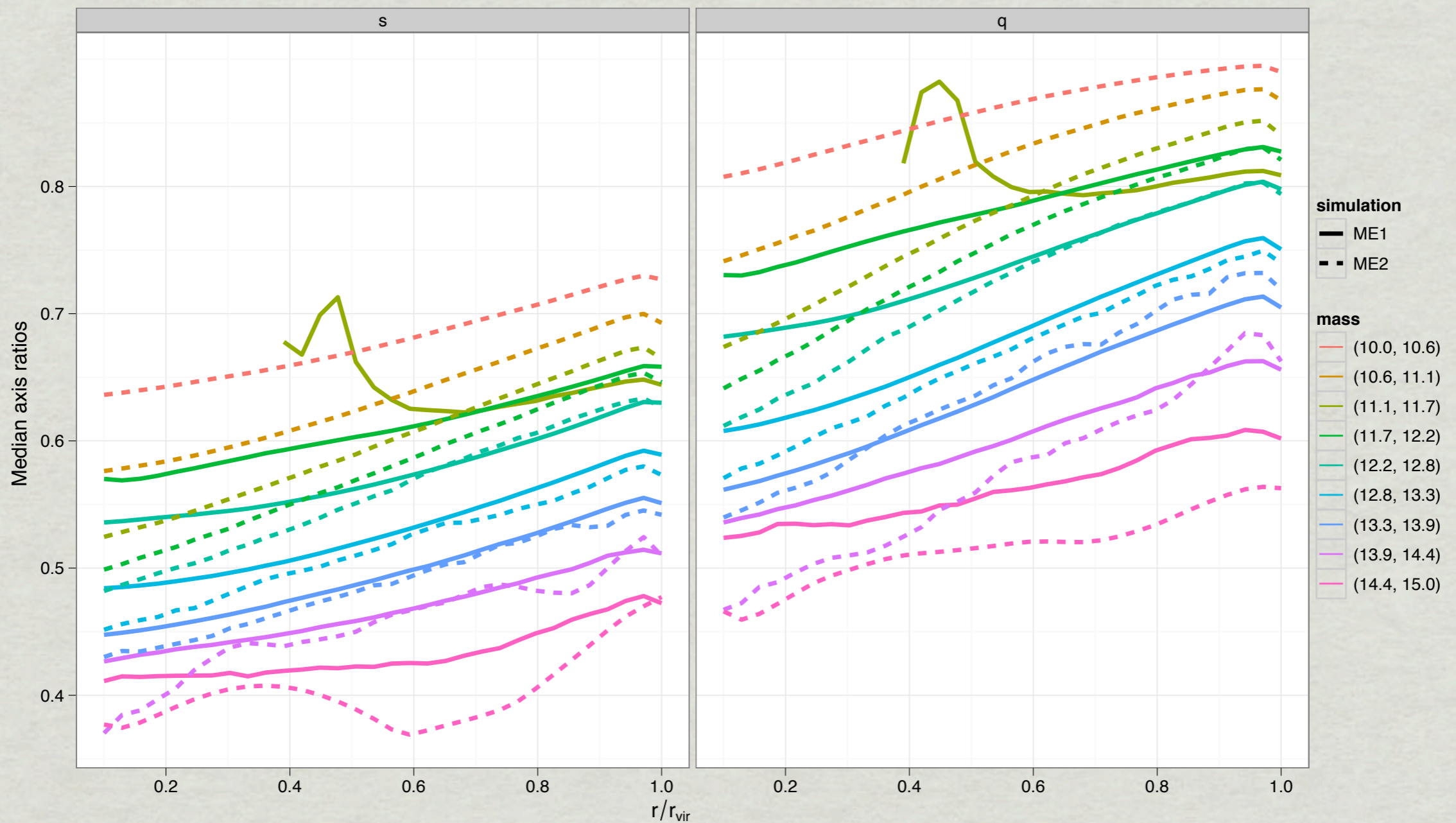# Halo model for elliptical halo alignments

❋ "Seed" correlation function:

$$\xi^{2h}(r) \sim \int dM_1 \, dM_2 \, da_1 \, da_2 \, d\varepsilon_1 \, d\varepsilon_2 \, n(M_1) \, n(M_2) \, p(a_1, \varepsilon_1) \, p(a_2, \varepsilon_2) \, \xi^{seed}(r; M_1, M_2, a_1, a_2, \varepsilon_1, \varepsilon_2)$$

❋ Affects DM clustering statistics

❋ II contribution: correlation of *interior* shapes of halos

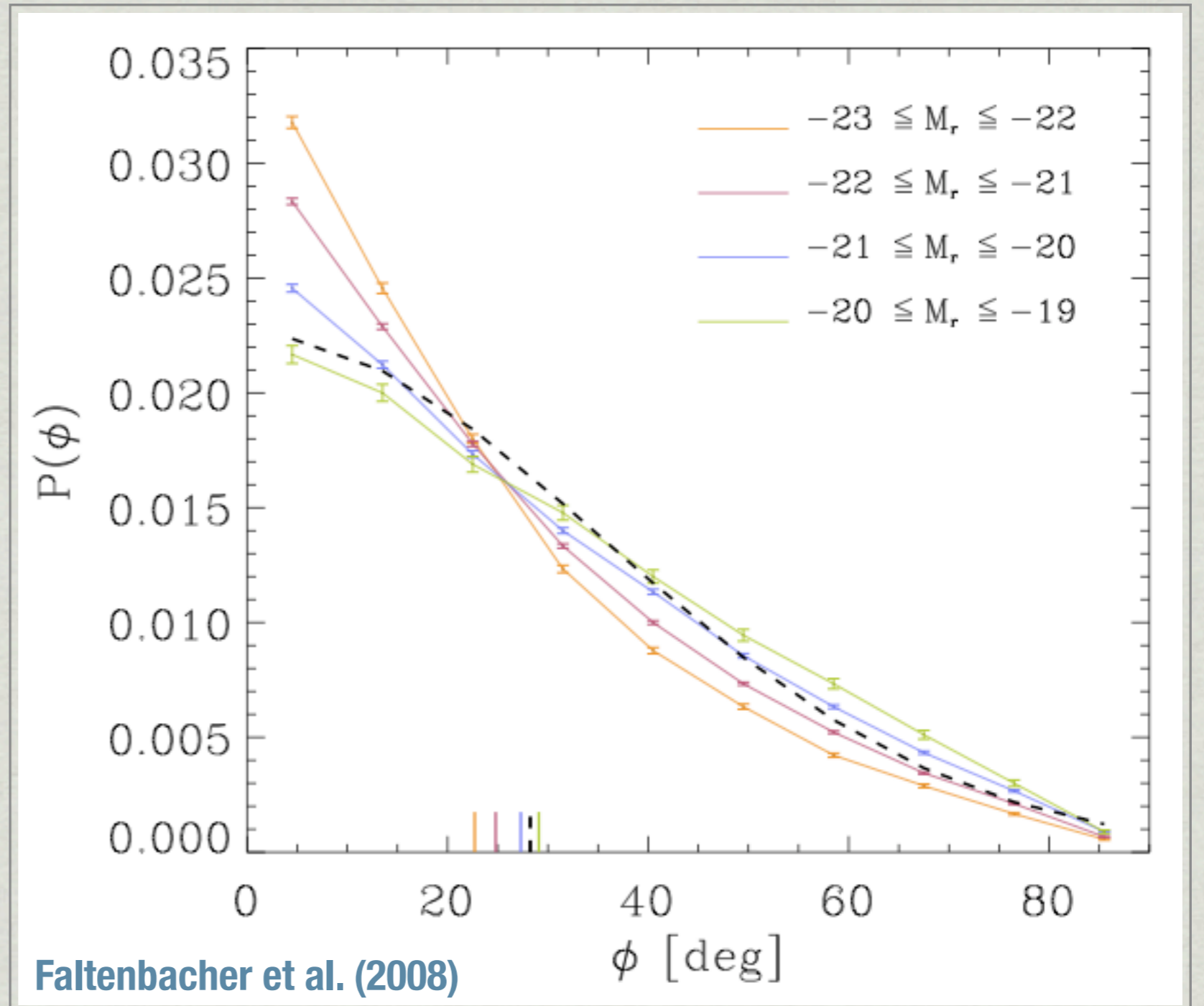❋ GI contribution: cross-correlation of *interior* shape with *outer* shape of total enclosed mass.
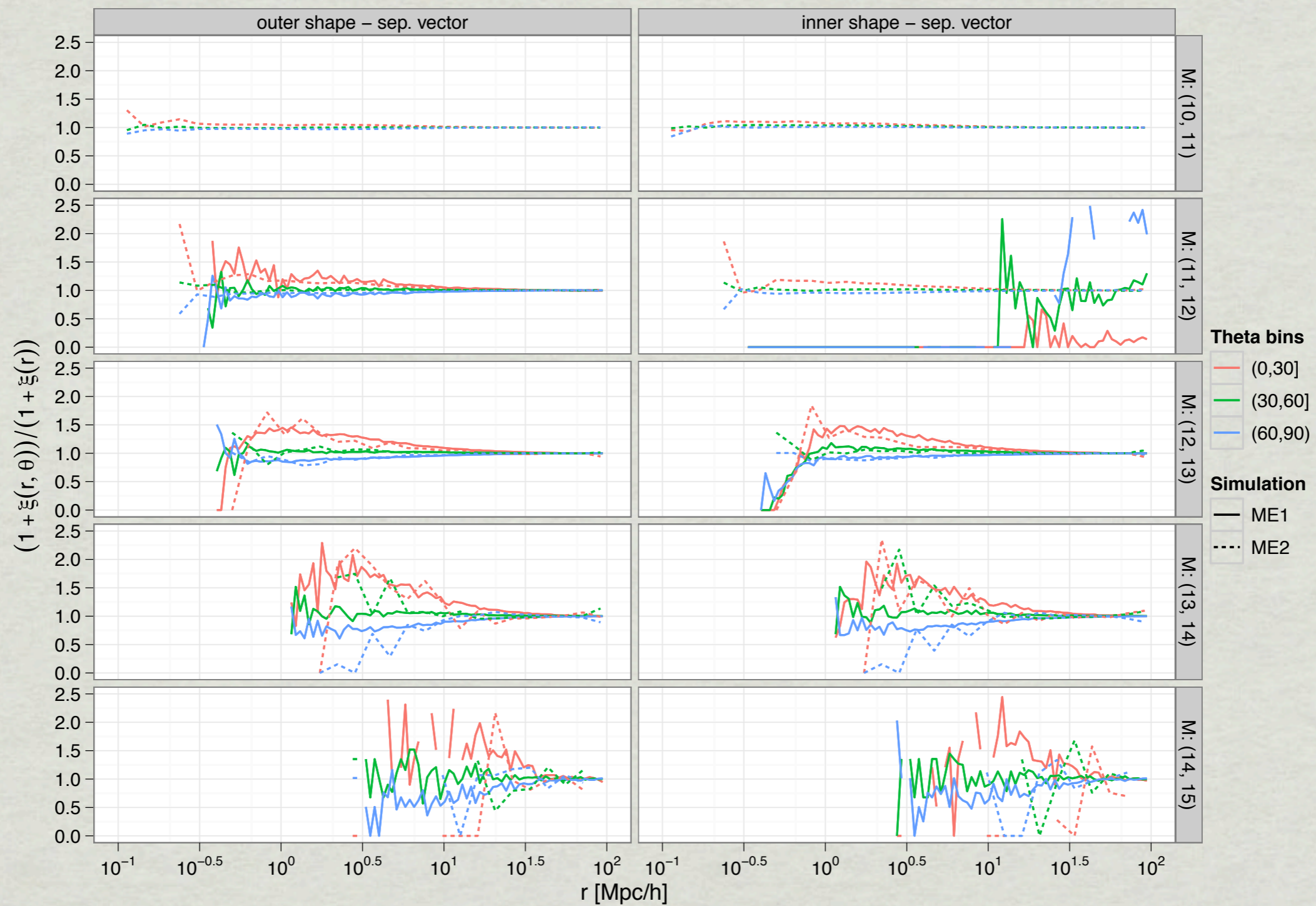
Axis ratios versus radius

Misalignment between halo and central galaxy

* Central galaxy orientation determined from inner halo

* Mean misalignment ~ 25 deg.

* Perfect alignment of central galaxies with halos overestimates SDSS signal by factor of ~ 2
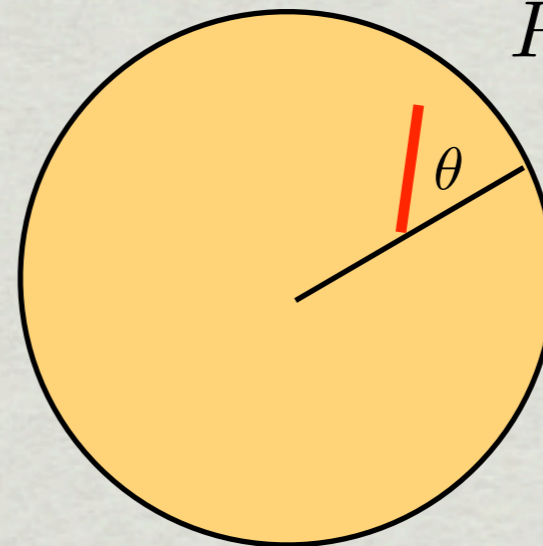
Okumura & Jing (2009) find 35 deg. misalignment

Faltenbacher et al. (2008)

Shape-sep. correlations

Model for satellite galaxy ellipticities

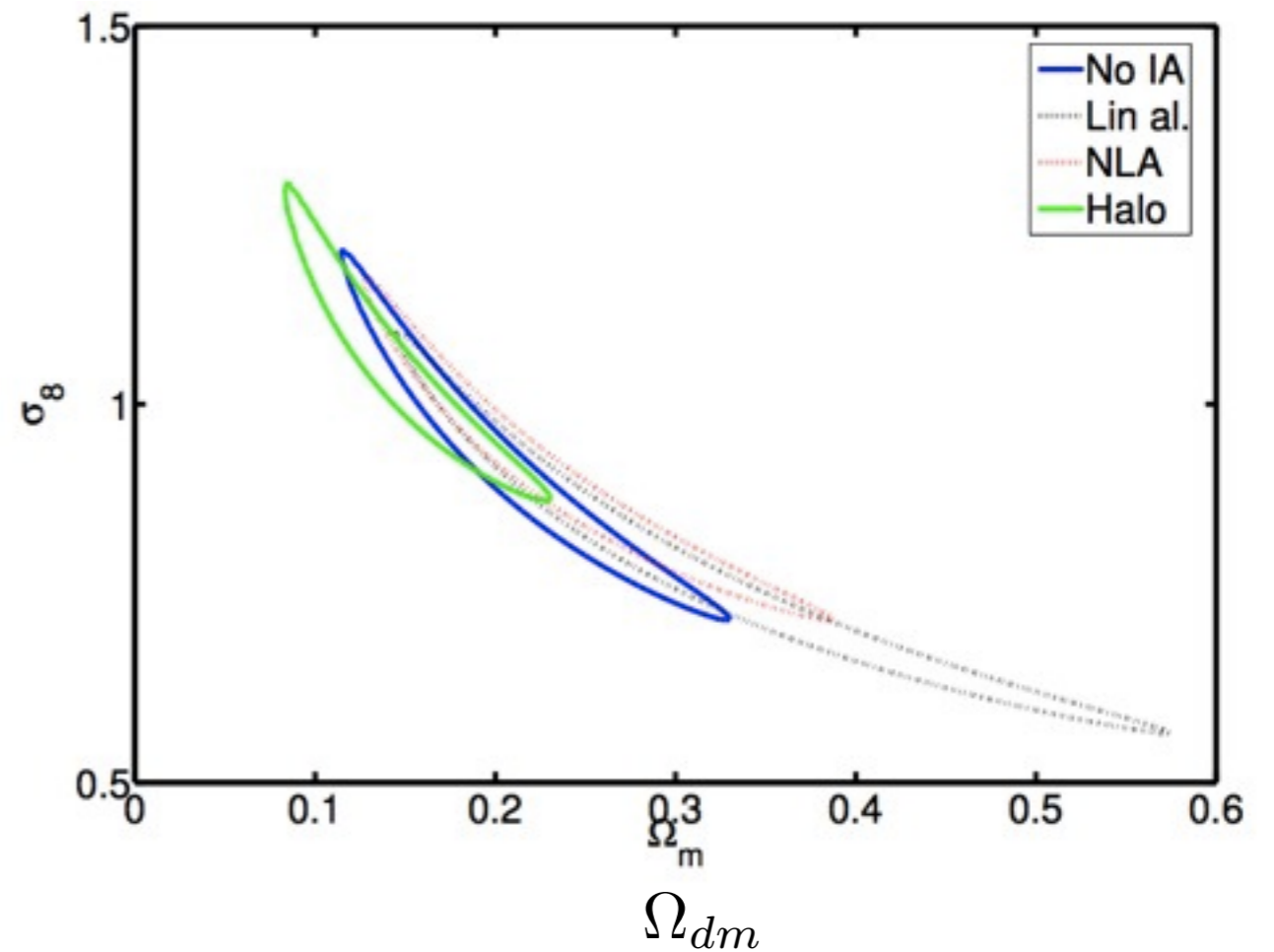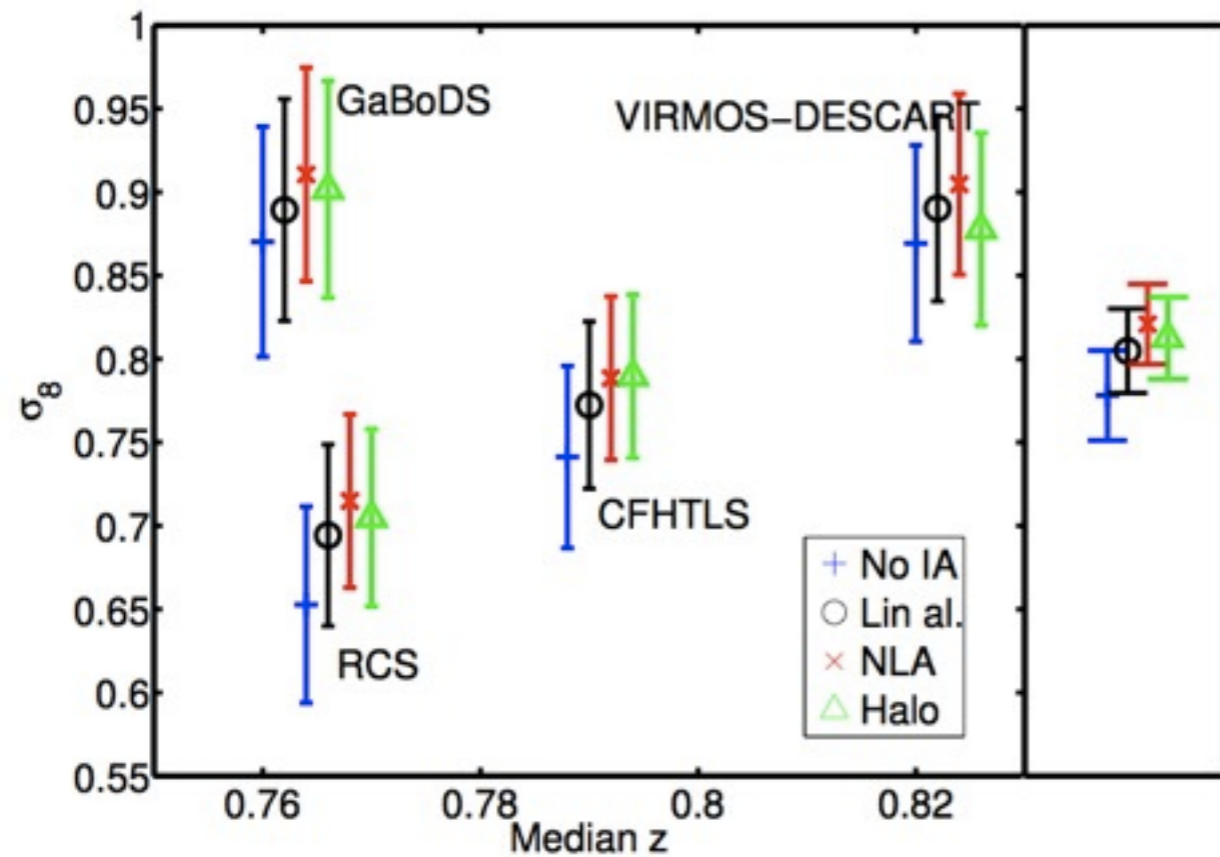✳ Sticks point towards center of halo

✳ Galaxy locations follow NFW profile

N-body simulations of DM sub-halos (Knebe et al. 2008):
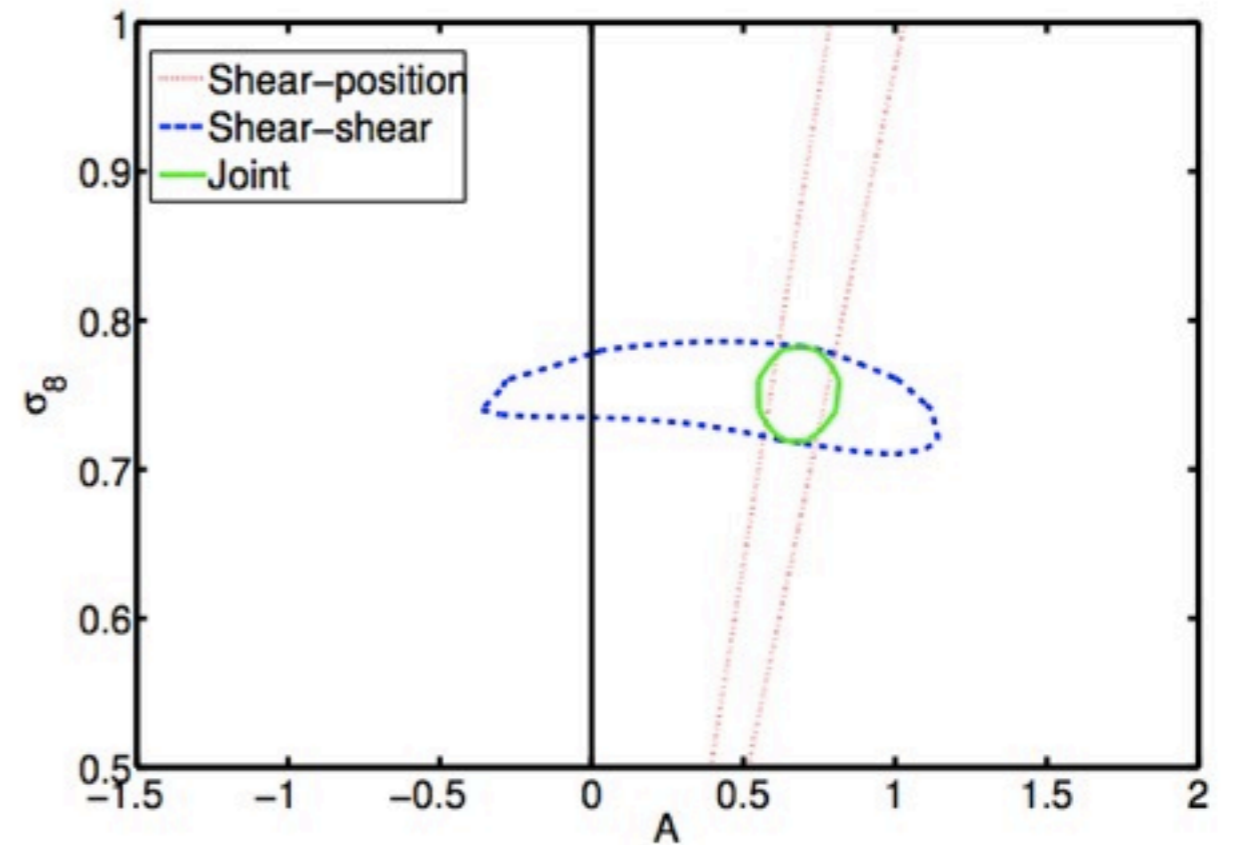
$$P(\cos\theta) \propto \cos^4\theta$$

θ

Schneider & Bridle (2010)

Parameter constraints assuming different IA models

$$\Omega_{dm}$$

Kirk, Bridle, Schneider (2010)

Constraints on IA model

$$P_\delta^{IA} = A^2 P_{\gamma^I} \left(\frac{L}{L_0}\right)^{2\beta} f_r^2 + A P_{\delta,\gamma^I} \left(\frac{L}{L_0}\right)^{\beta} f_r$$
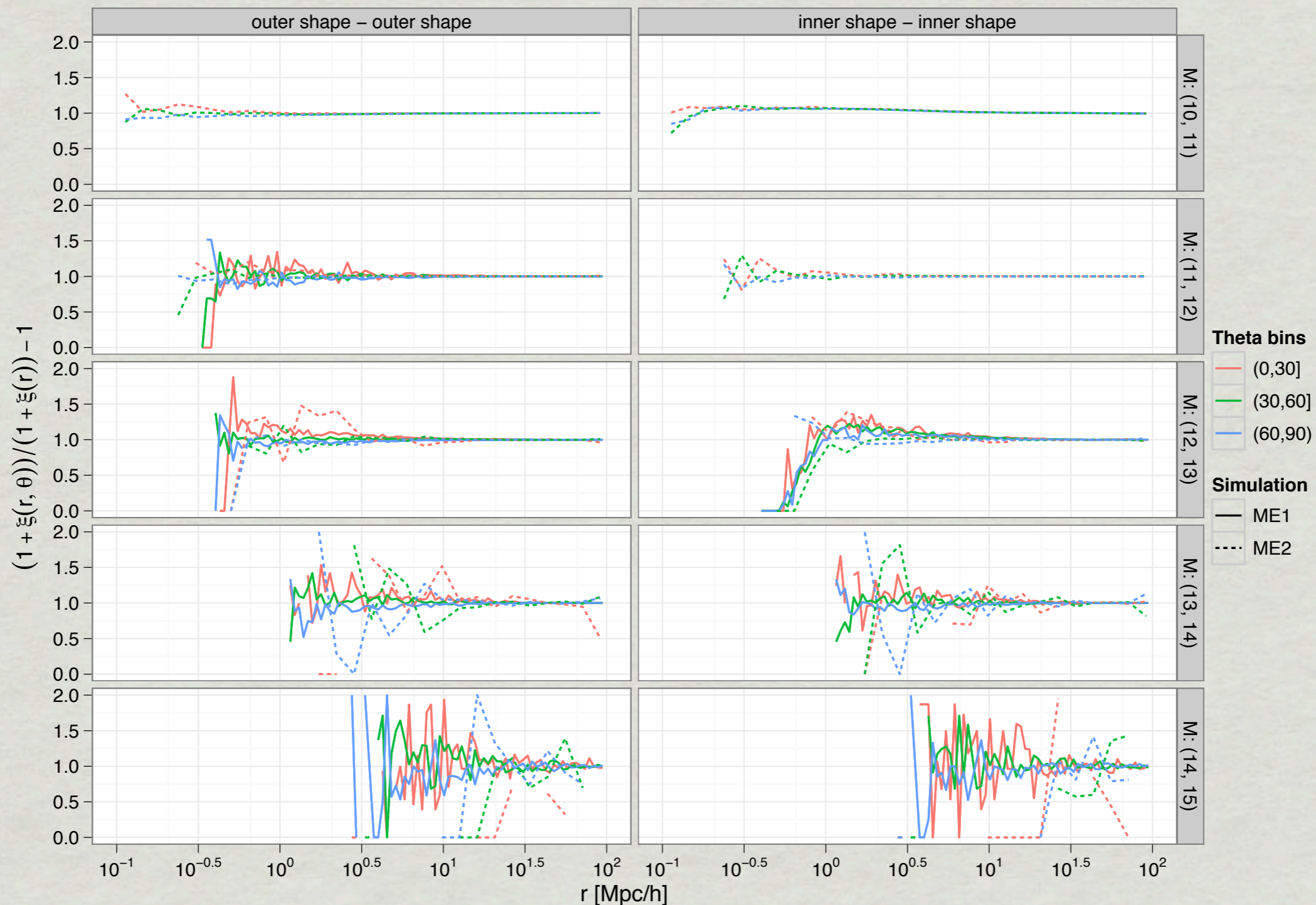

Kirk, Bridle, Schneider (2010)

Conclusions

* Physically motivated IA models may allow systematics removal from cosmic shear without large loss of S/N.

* Combining observables to constrain IA model parameters is interesting and useful.

* Dark matter alignments -> gas alignments?
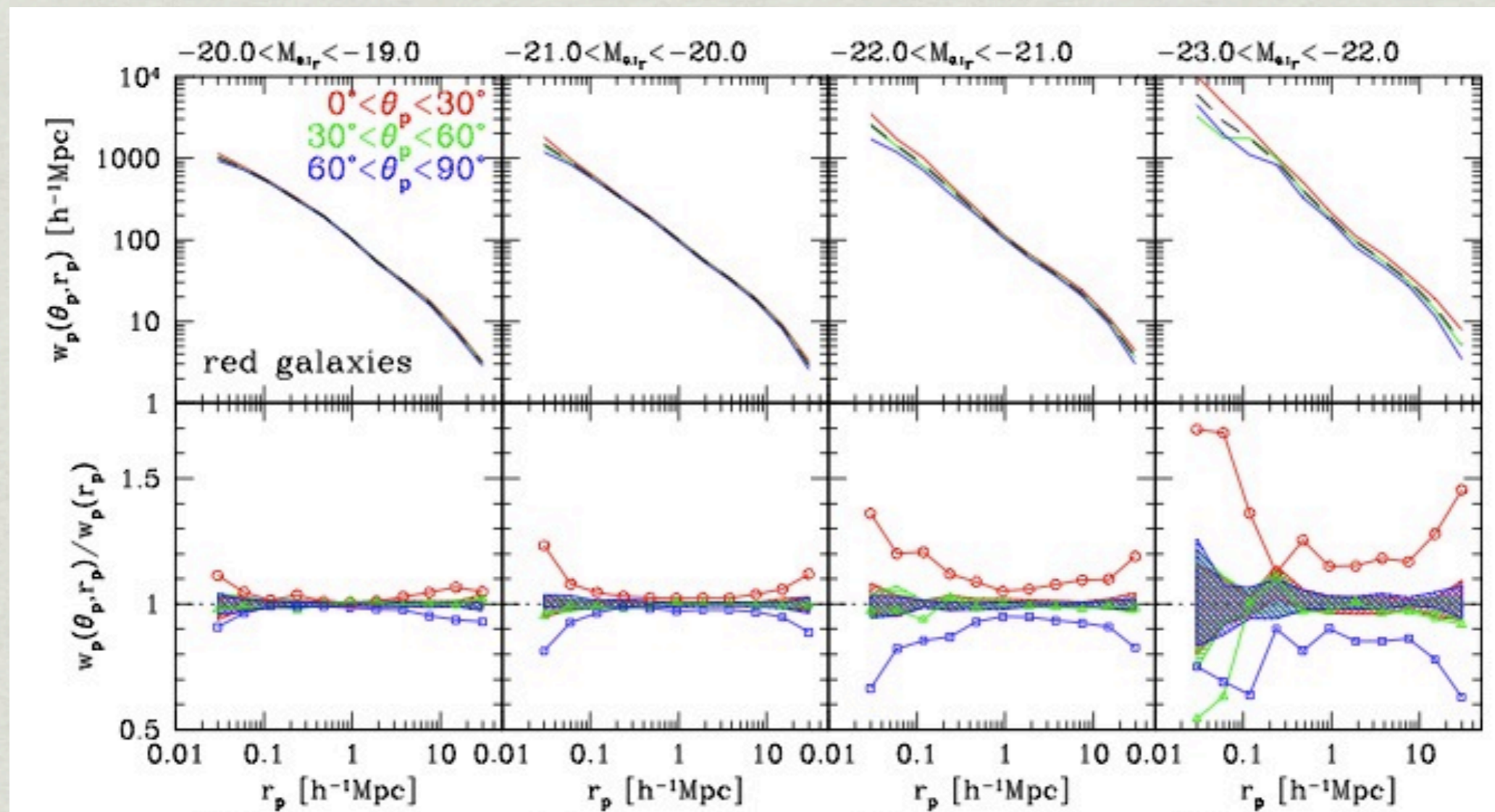
Shape-shape correlations

ALIGNMENT CORRELATIONS NOT READILY APPARENT

SDSS "red" galaxy corelations

Faltenbacher et al. (2008)

No Alignments detected for blue galaxies