Intrinsic alignment of galaxies and the linear alignment model

Jonathan Blazek
UC Berkeley

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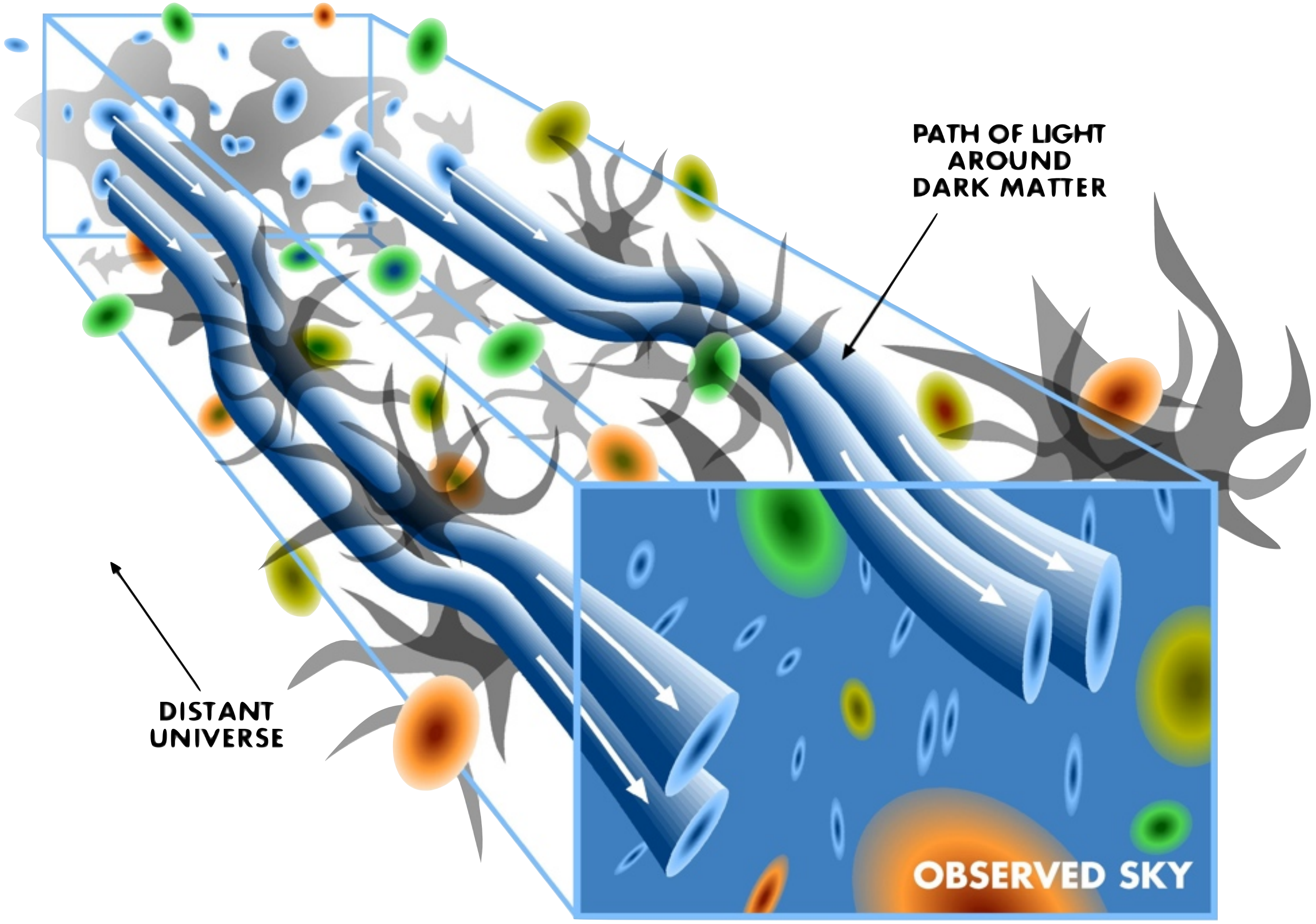
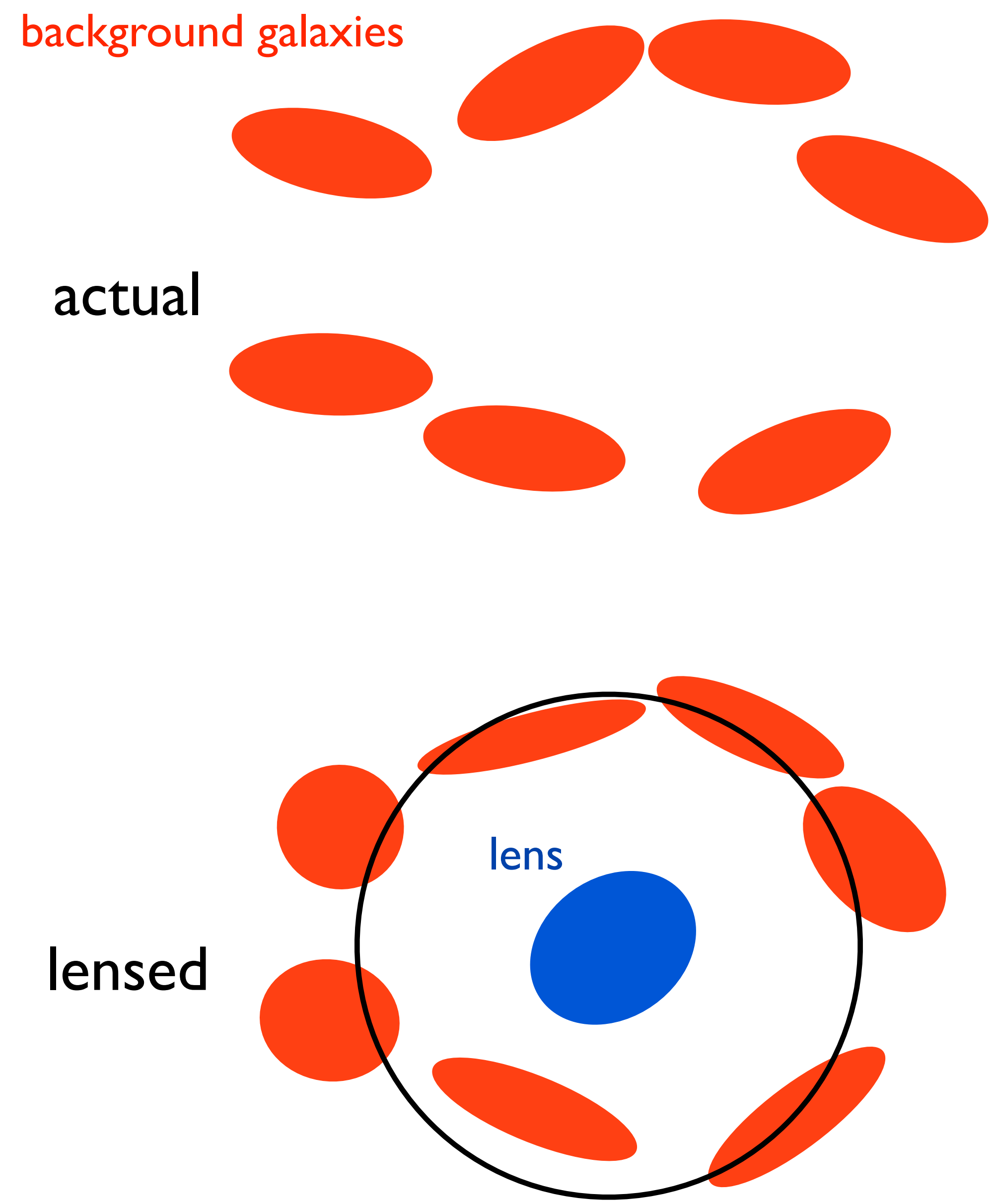
Collaborators: Matt McQuinn and Uros Seljak

Gravitational lensing





<u>Intrinsic alignment</u>

- Important lensing systematic
- Understand galaxy formation

Assumption of random orientation gives wrong result

Intrinsic alignment

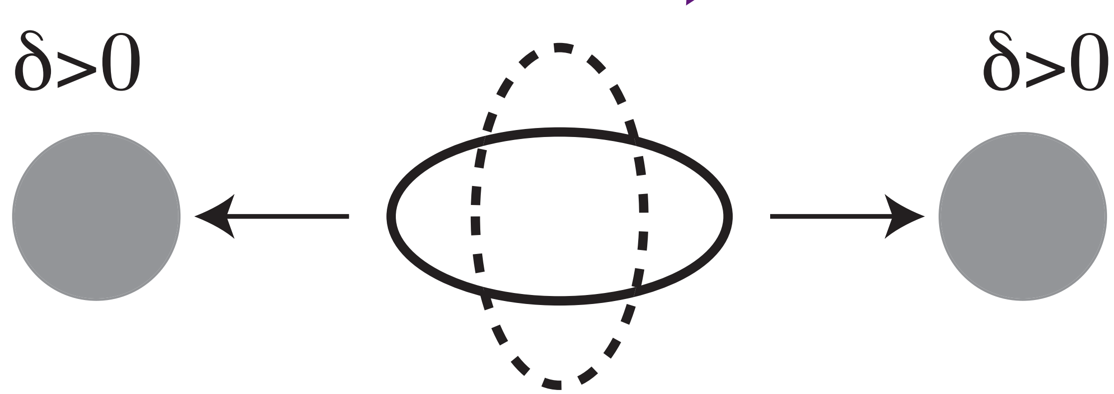
$$\gamma^{obs} = \gamma^I + \gamma^G$$

IA auto-correlation

$$\langle \gamma_i^{obs} \gamma_j^{obs} \rangle = \langle \gamma_i^G \gamma_j^G \rangle + \langle \gamma_i^I \gamma_j^G \rangle + \langle \gamma_i^G \gamma_j^I \rangle + \langle \gamma_i^I \gamma_j^I \rangle$$

lensing signal

IA-lensing cross-correlation
*harder to remove

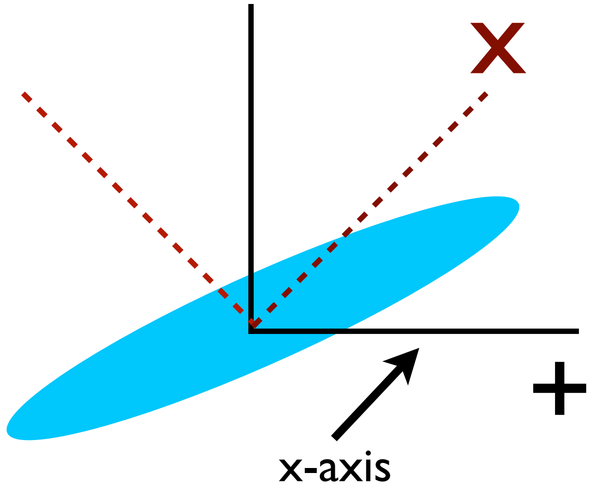


(Hirata & Seljak 2004)

Linear alignment model

$$\gamma^{I}_{(+,\times)} = -\frac{C_1}{4\pi G}(\nabla_x^2 - \nabla_y^2, 2\nabla_x\nabla_y)S[\Psi_P]$$

(Catelan, Kamionkowski, and Blandford 2001)

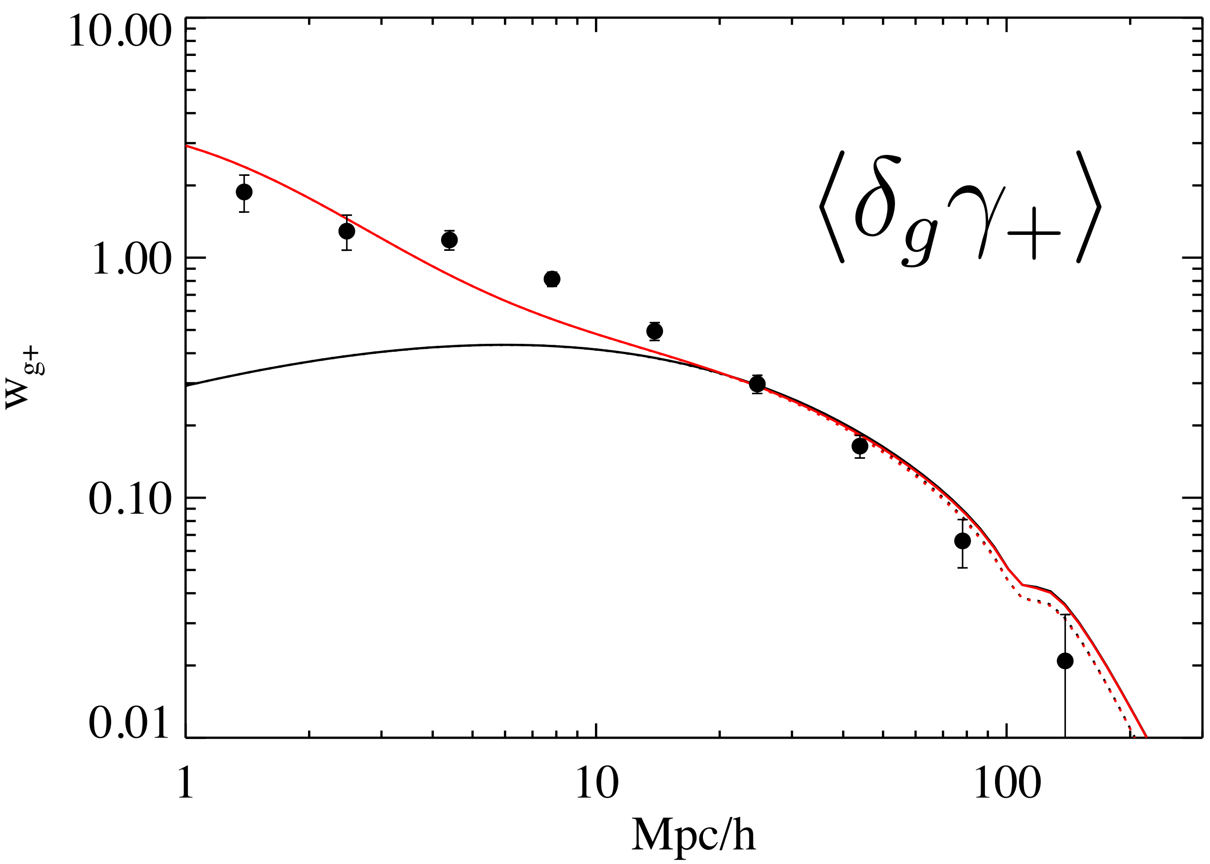


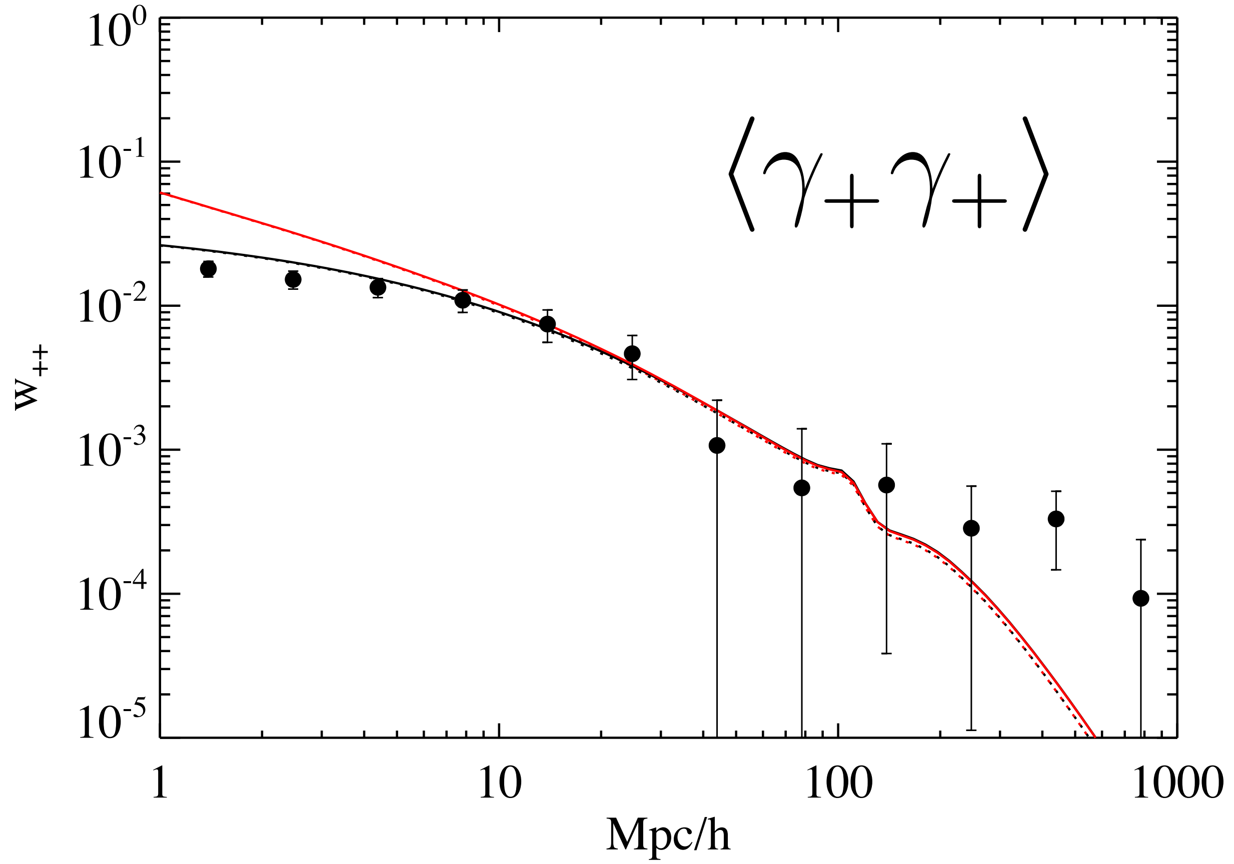
- Ellipticity aligns with tidal field
- Should dominate on large scales: ~ P(k)
- Inputs: C_1 Normalization constant

  Ψ_P Gravitational potential

relate to overdensity δ

Comparison to measurements





79K LRG's from SDSS

$0.16<z<0.47$ ($z_{mean}=0.32$)

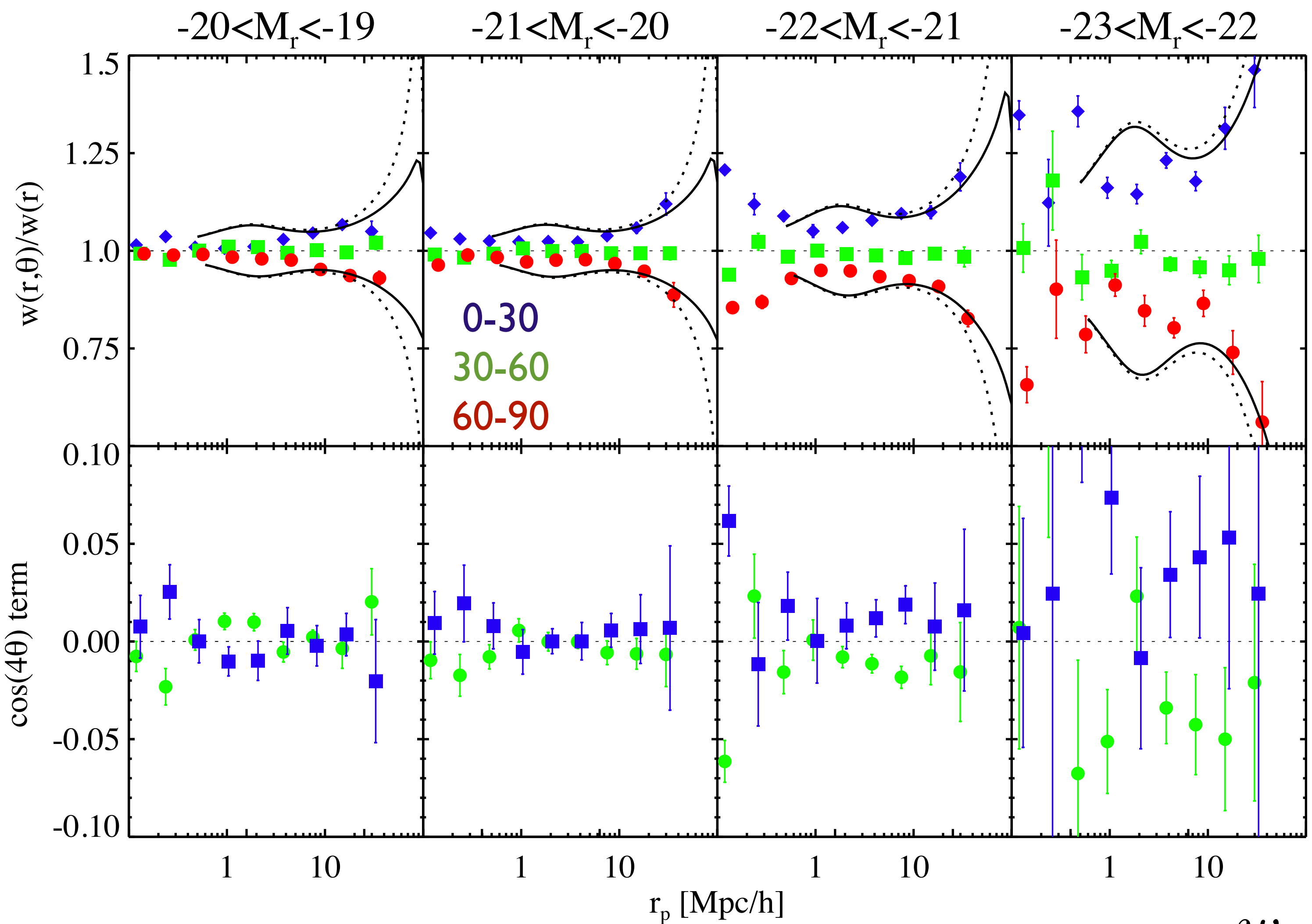
(Okumura et al 2009; Okumura & Jing 2009)

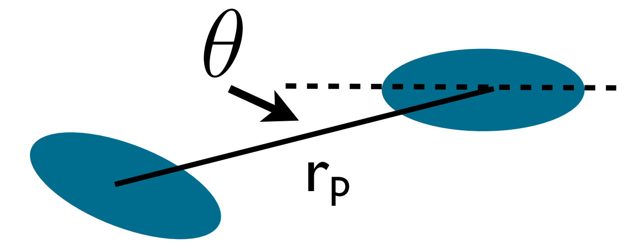
	from GI	from II
$AC_1\rho_{\rm crit}$	0.125 ± 0.007	0.114 ± 0.011

(consistent with GI measurement of Joachimi et al 2010)

Alignment correlation function

(Faltenbacher et al 2009)





- Measures alignment of ellipticity and density
- Dependence on angle could provide additional information
- Strength increases with luminosity
- Due to symmetries, must have general form:

$$w_{\rm g}(r_p,\theta) = w_{\rm g}(r_p) + \Sigma a_n(r_p)\cos(2n\theta)$$

For Gaussian density fields and the LA model, we find:

$$w_g(r_p,\theta) = w_g(r) + 2\tilde{w}_{g+}(r_p)\cos(2\theta)$$

look for higher cos(nθ) terms to probe non-Gaussianity and non-linear alignment

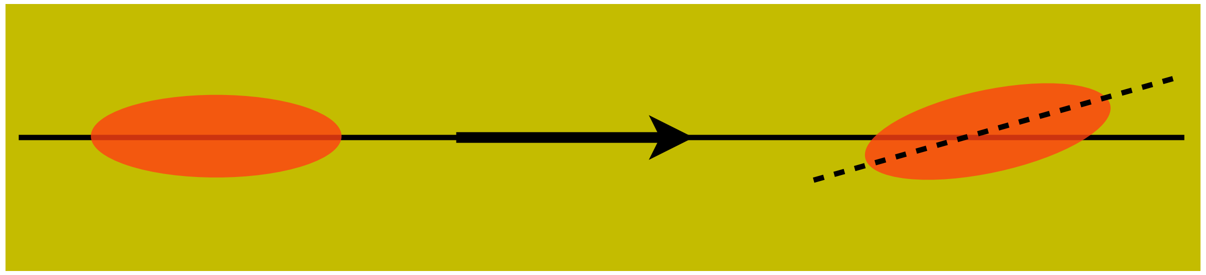
Summary

- The LA model provides a good description of IA at scales above ≈ 10 Mpc/h.
- Understanding how model parameters depend on galaxy sample properties will allow effective subtraction of IA.
- The angular correlation function may contain additional information, but it will be hard to observe.
- Other interesting things: stochasticity in the model, E and B modes, correlation between Υ_0 and θ... talk to me!

Come to the dinner tonight at 7!

Stochasticity

tidal field



Non-linear astrophysics and measurement errors will affect orientation and magnitude of galaxy ellipticities

Assume a misalignment angle with Gaussian distribution of width σ (e.g. Okumura et al 2009). For cos(nθ) terms, this yields a suppression:

$$\exp\left[-\frac{1}{2}n^2\sigma^2\right]$$

From simulations, Okumura et al find σ≈35 deg., consistent with measurements.

↓

Suppression factor

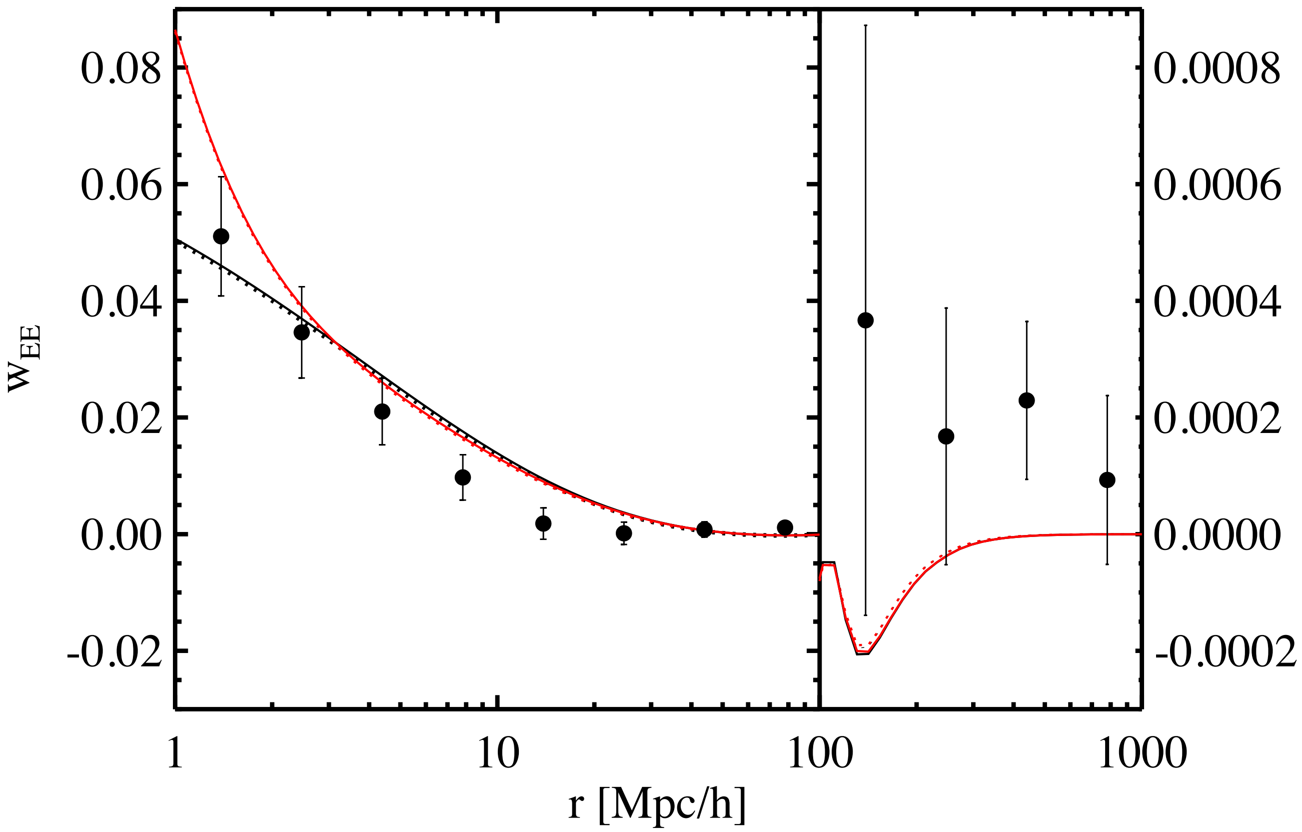
n=2: 0.5
n=4: 0.05

↓

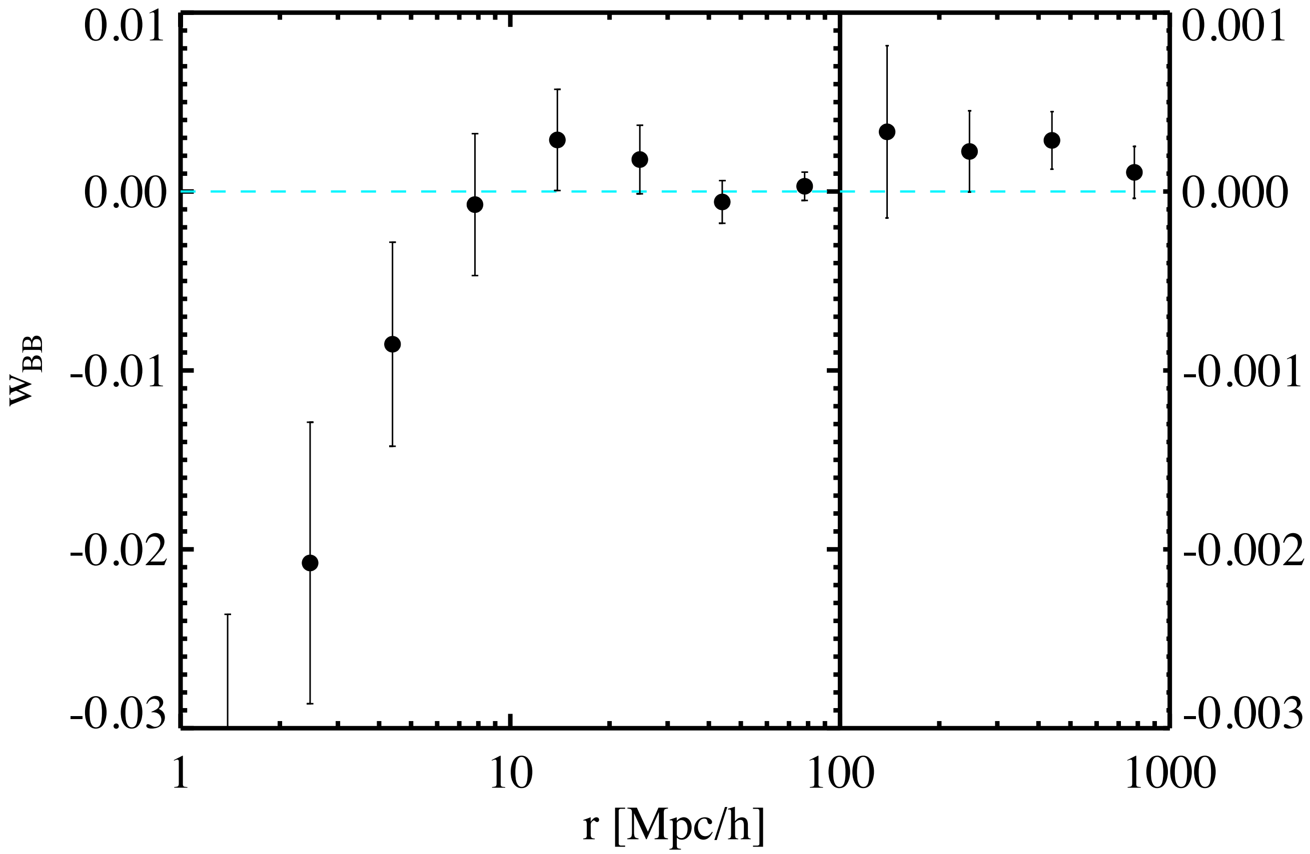
σ=σ(L) could explain luminosity dependence of signal

Higher n terms will be hard to observe

E and B modes

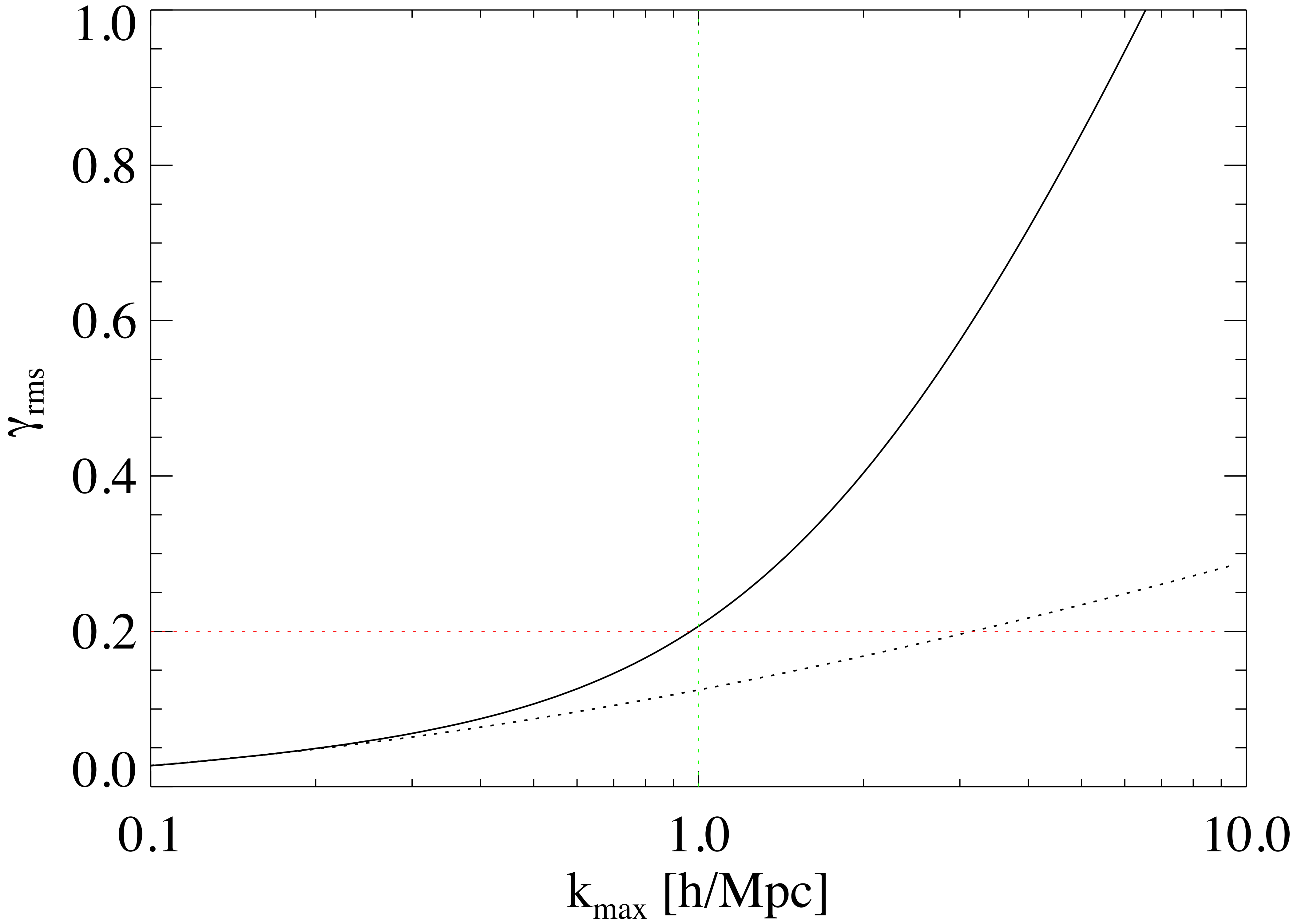


0.08
0.06
0.04
0.02
0.00
-0.02
w_{EE}
0.0008
0.0006
0.0004
0.0002
0.0000
-0.0002
1
10
100
1000
r [Mpc/h]



0.01
0.00
-0.01
-0.02
-0.03
w_{BB}
0.001
0.000
-0.001
-0.002
-0.003
1
10
100
1000
r [Mpc/h]

LA prediction of γ_{rms}



Outline

- Intrinsic alignment (IA)
- The linear alignment (LA) model
- Application to IA measurements
- Adding stochasticity