New (Robust) Estimators of the Galaxy Correlation Function

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MNRAS, astro-ph/0612103

A Roadmap

- Why I care about correlation functions?
- Why it might be time for a new estimator?
- A new estimator for small scales
- Real data : DEEP2
- Extensions for large scale structure (and BAO)

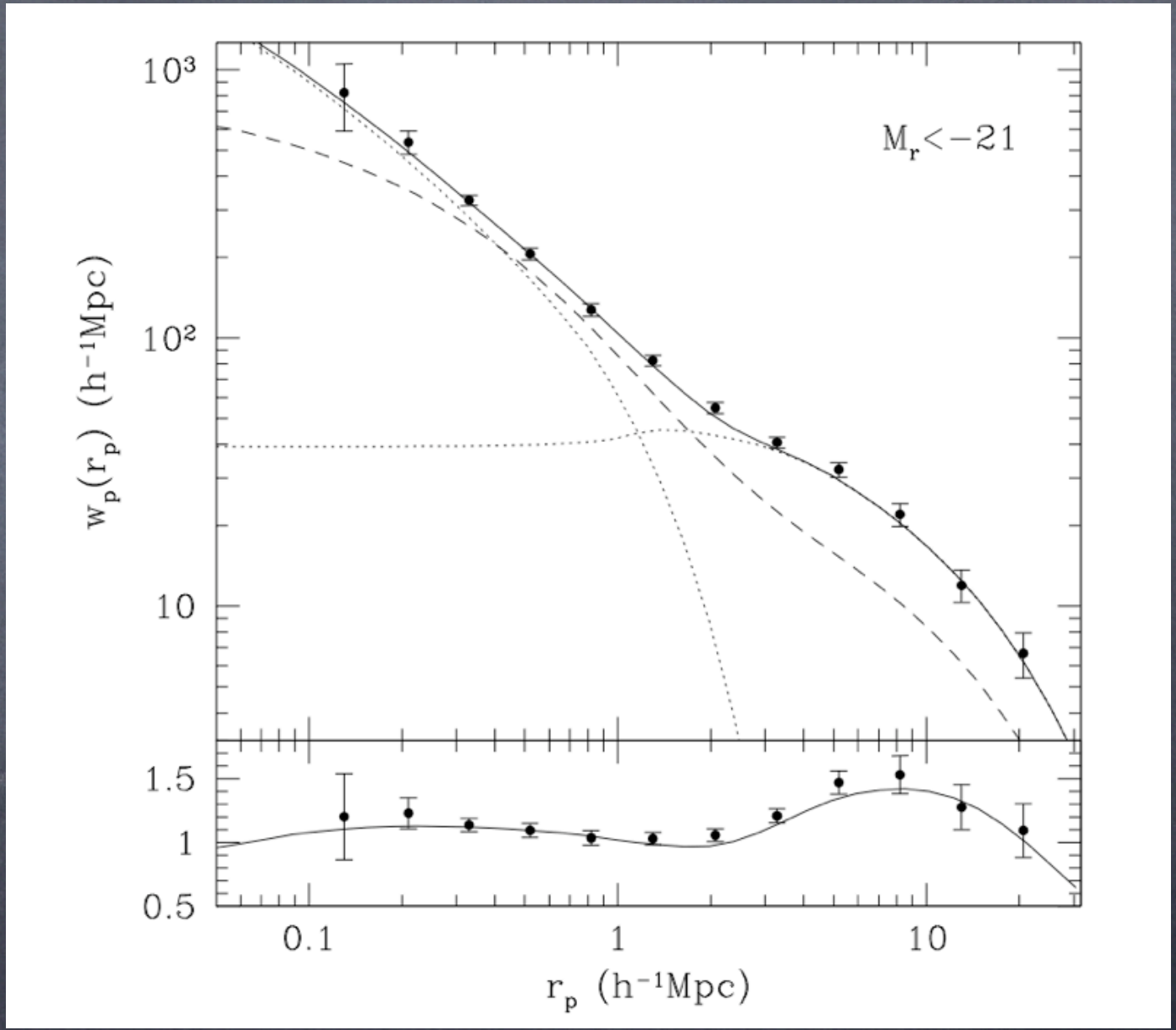
Why correlation functions?

Kinks.....

On Small Scales :

Probes the connection between DM halos and galaxies

Natural scale 1 Mpc -- transition from 1 to 2 halos



Zehavi et al

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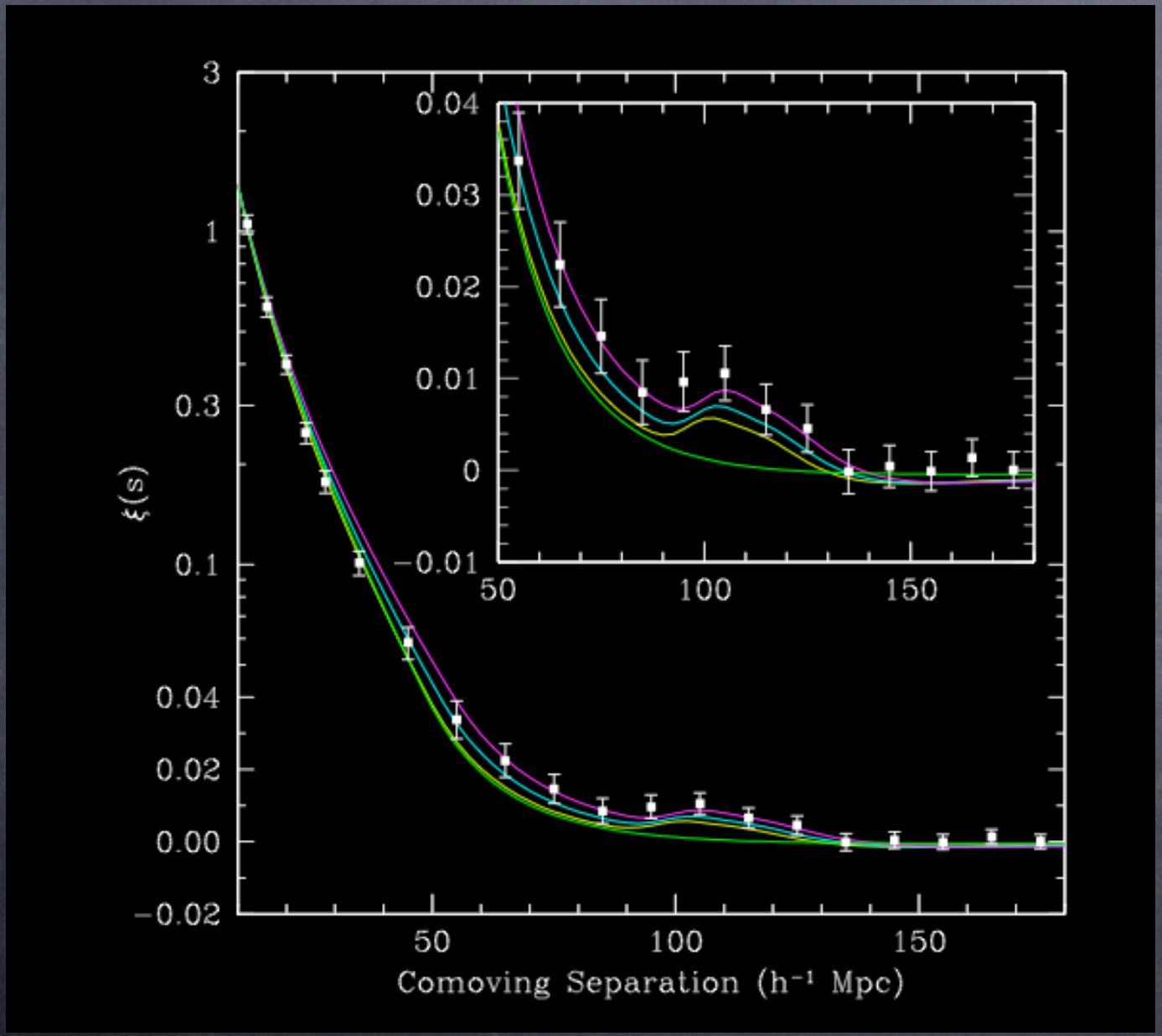
Why correlation functions?

... and bumps



Eisenstein et al, 2005

On Large Scales :

Scale set by acoustic horizon at last scattering

A standard ruler to measure the expansion rate of the Universe

Need to measure to < 1%!!

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Why a new estimator?

- Surveys are getting larger, need to control systematics
  - Good to have estimators that are robust
- Theory lives in real space
- .... but observations live in redshift space

An old solution : w_p

Integrate out the LOS direction

Z_{max} ?

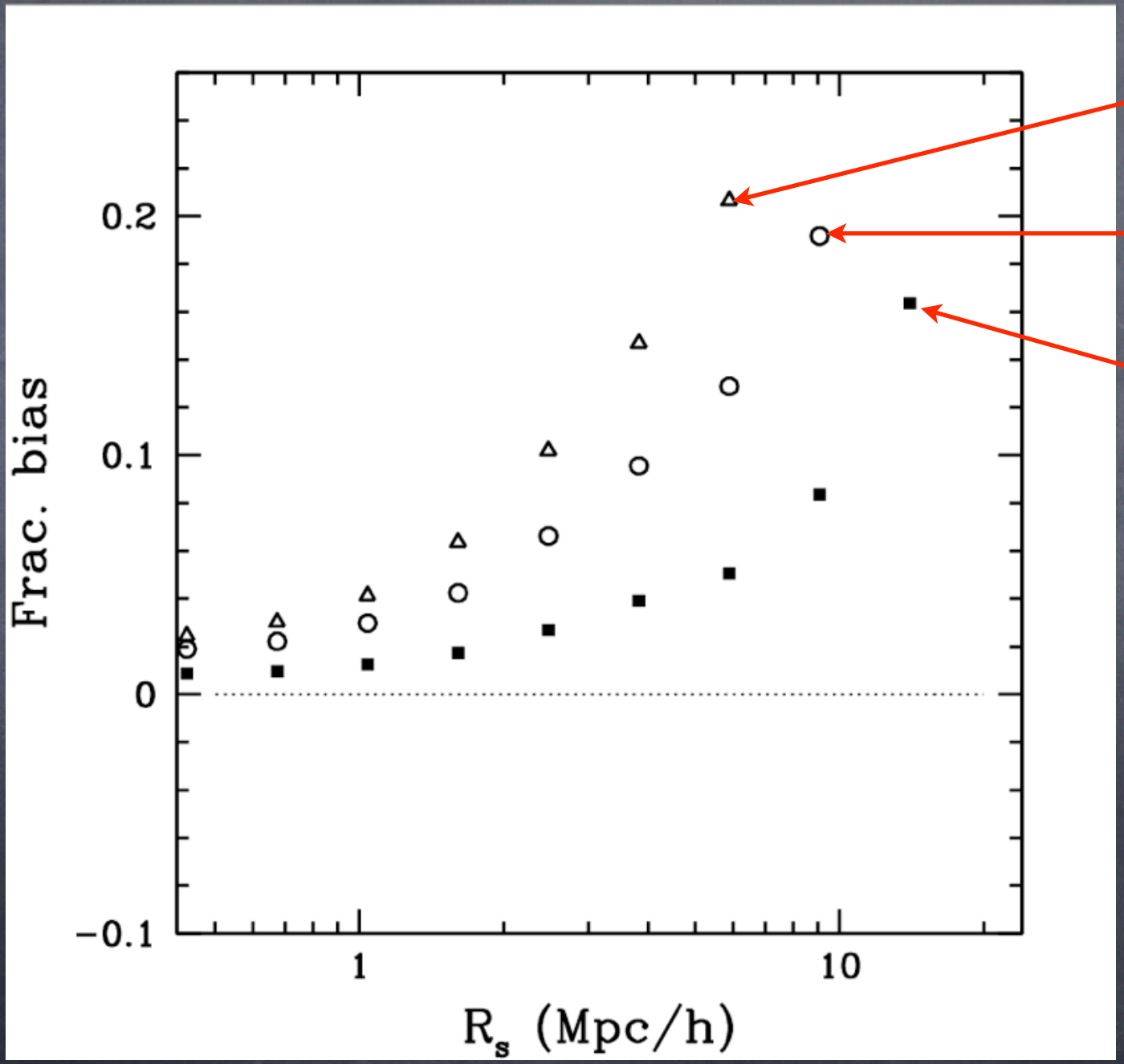
Interested in 1 Mpc -- noise

$$w_p(R) = 2 \int_0^\infty dZ\, \xi_s(R, Z)$$

Scale mixing

An old solution : w_p

Integrate out the LOS direction



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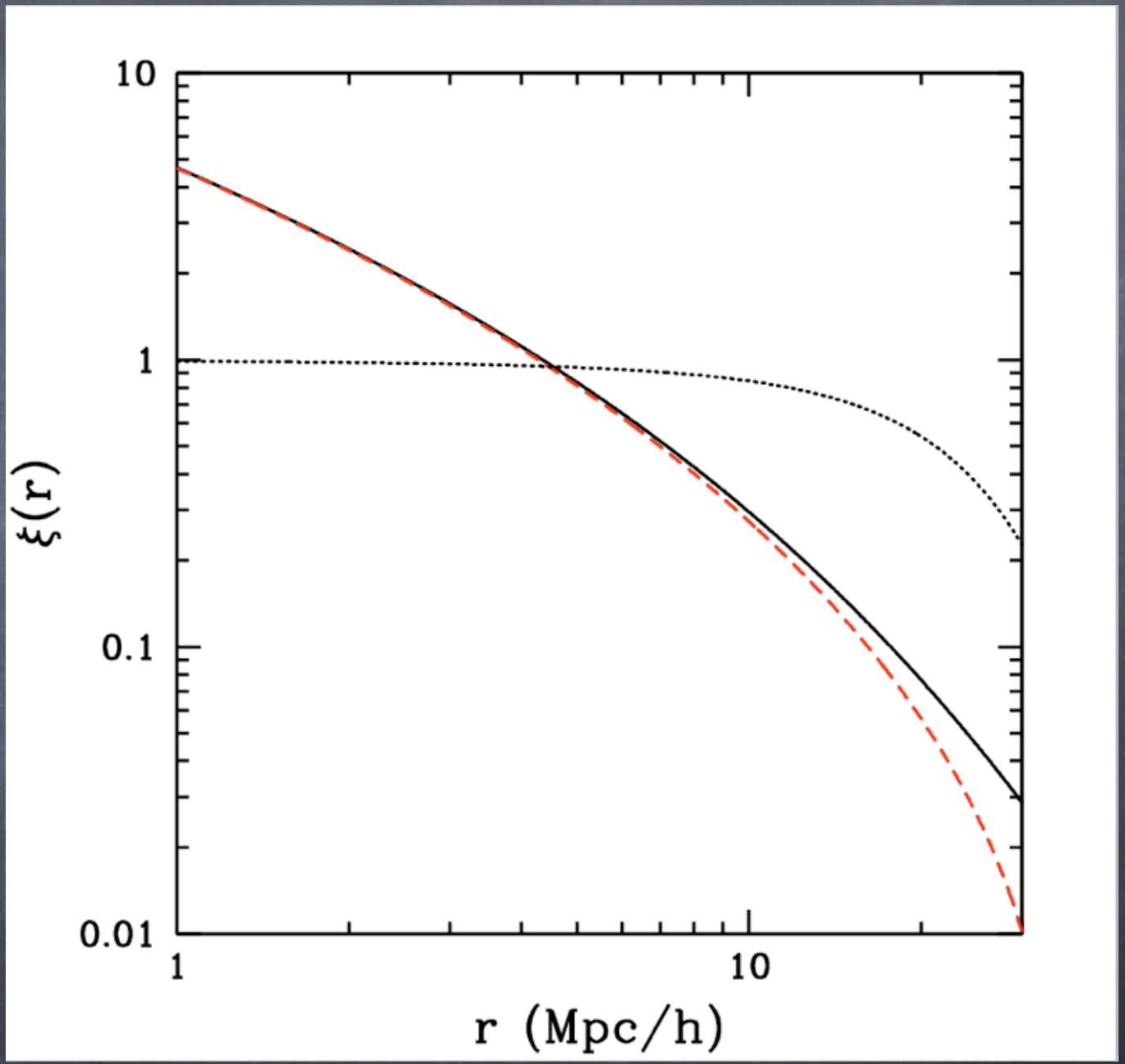
Why a new estimator?

- Surveys are getting larger, need to control systematics
  - Good to have estimators that are robust
- Theory lives in real space
- .... but observations live in redshift space
- Correlation functions drag in large scale (low k) power -- more scale mixing

Large scale power at small r

red = P(k) missing power
for k < 0.05 h/Mpc

Nyquist for
100 Mpc/h



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A solution : ω

Error term :

$$\Delta w_p(R) = 2 \int_{Z_{max}}^{\infty} dZ\, \xi_s(R, Z)$$

slowly varying in R ← Z >> R

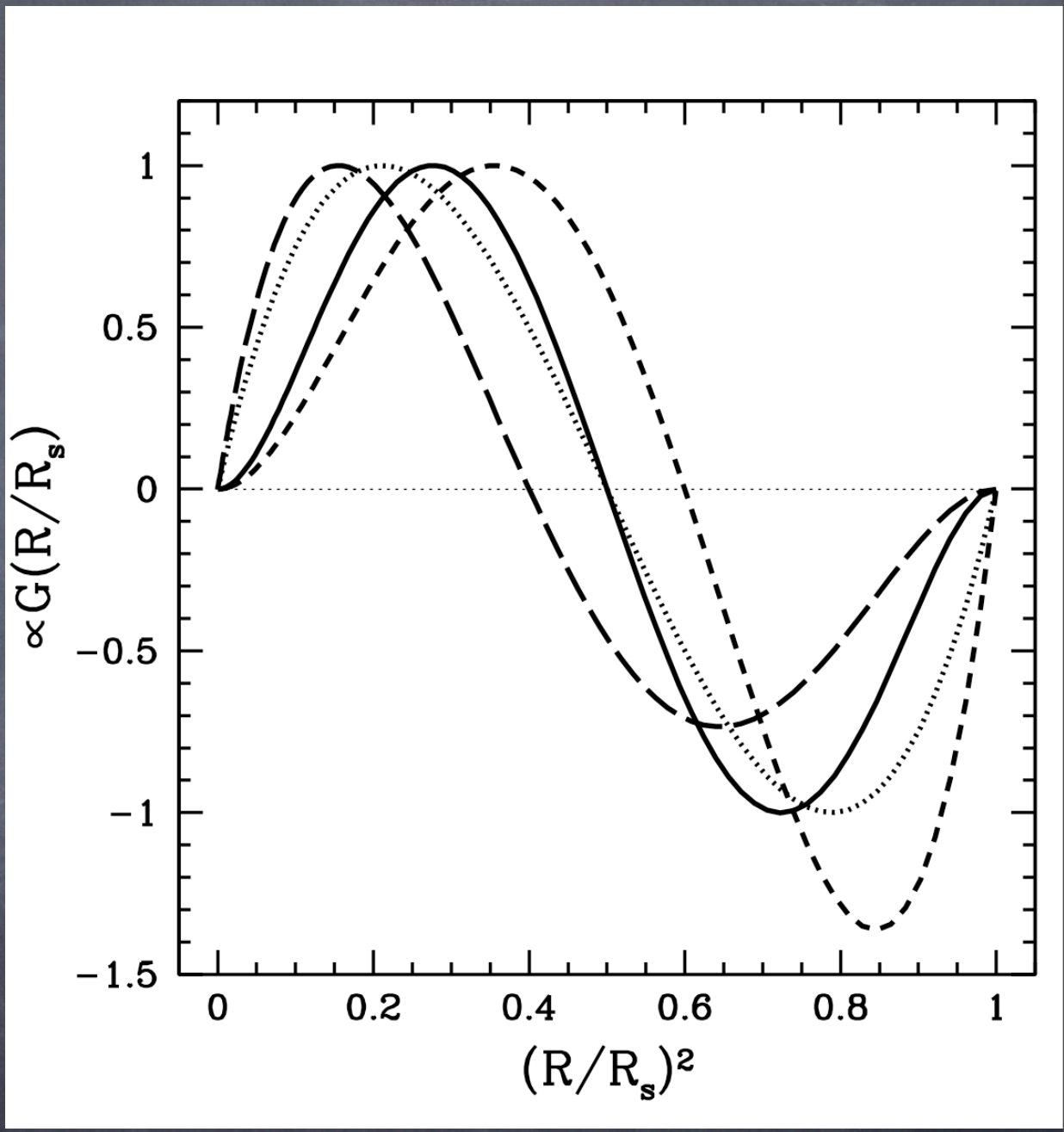
- Sky subtraction
- High Pass Filtering
- Differentiation

$$\omega(R_s) \propto \int_0^{R_s} dR^2\, w_p G$$

G?

$$\omega(R_s) \propto \int_0^{R_s} dR^2\, w_p G$$

- Sky subtraction
- High Pass Filtering
- Differentiation



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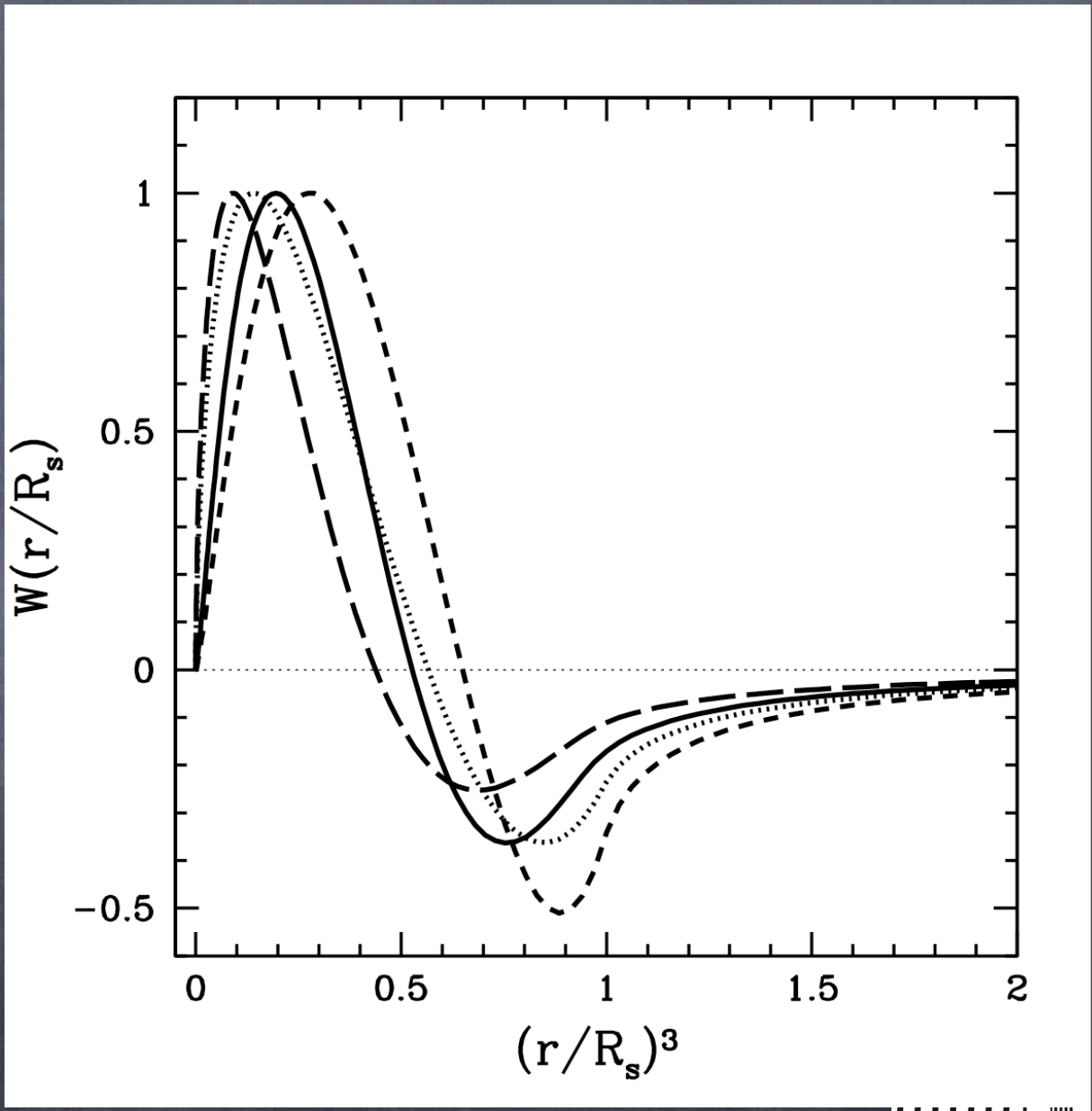
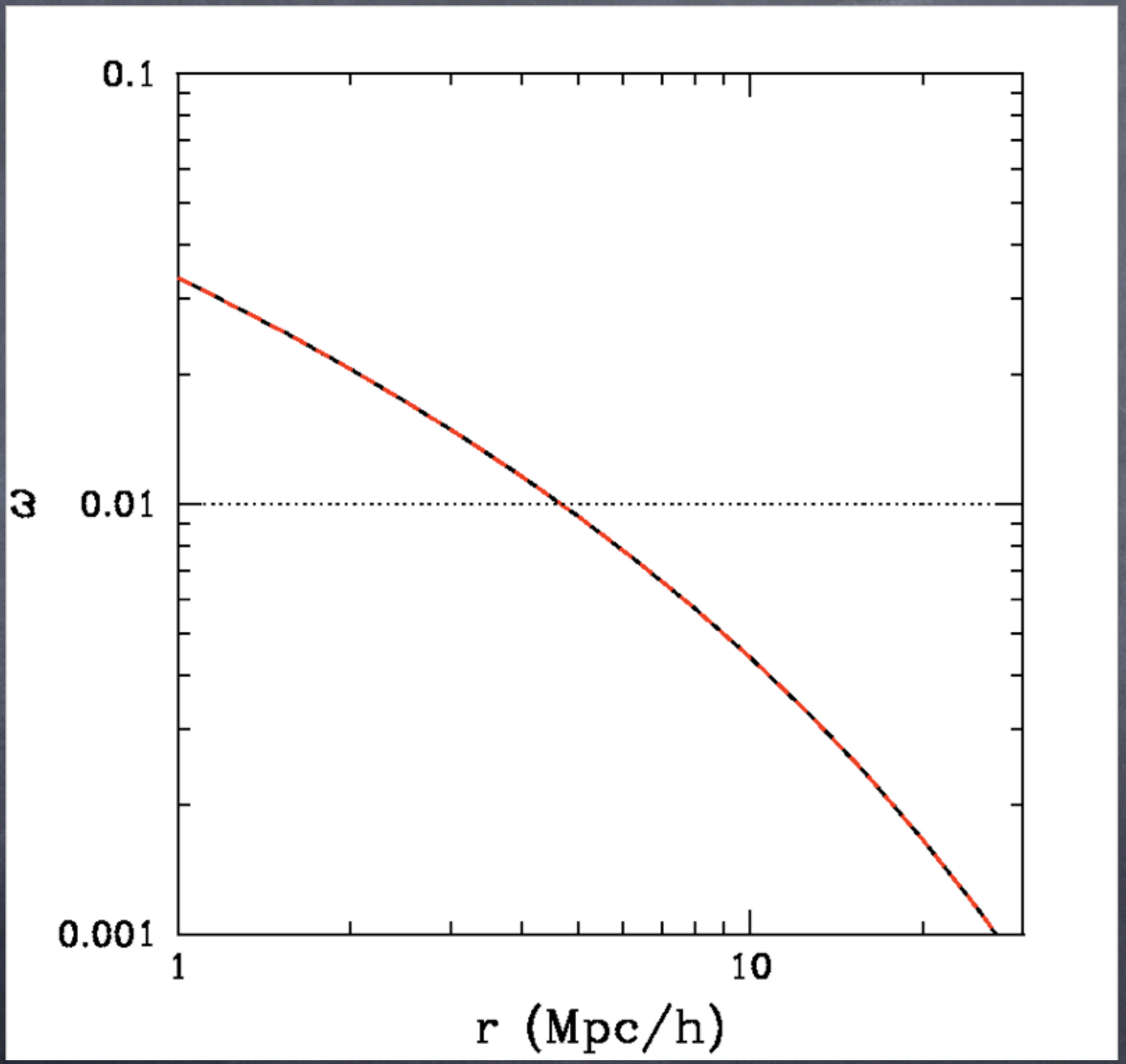
What does this measure?

$$\omega(R_s) \propto \int_0^\infty r^2 dr\, \xi(r) W(r)$$

- ~ compact
- no large scale power
- probes relatively narrow range of scales
- power law corr. func.



No Large Scale Power



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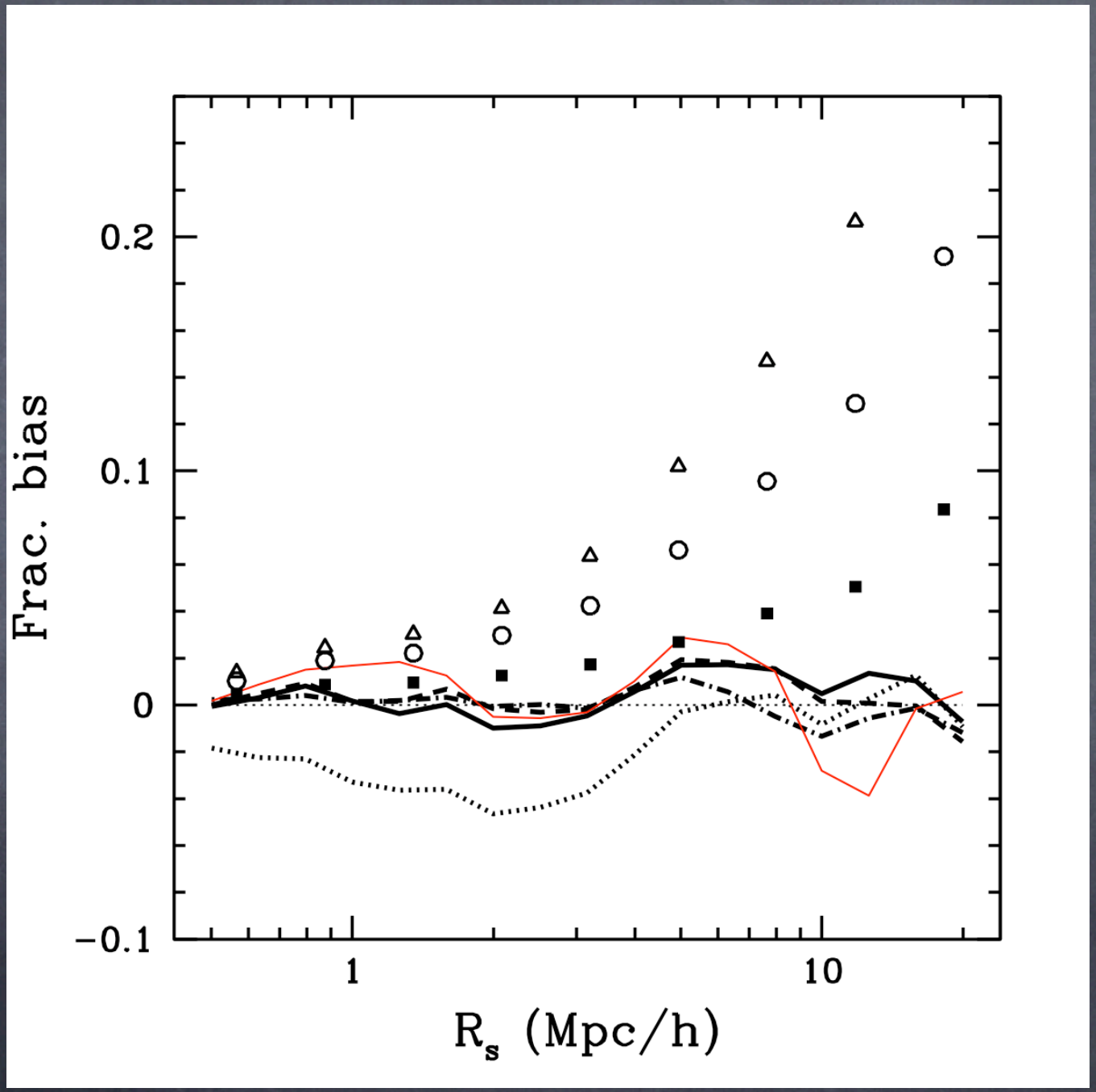
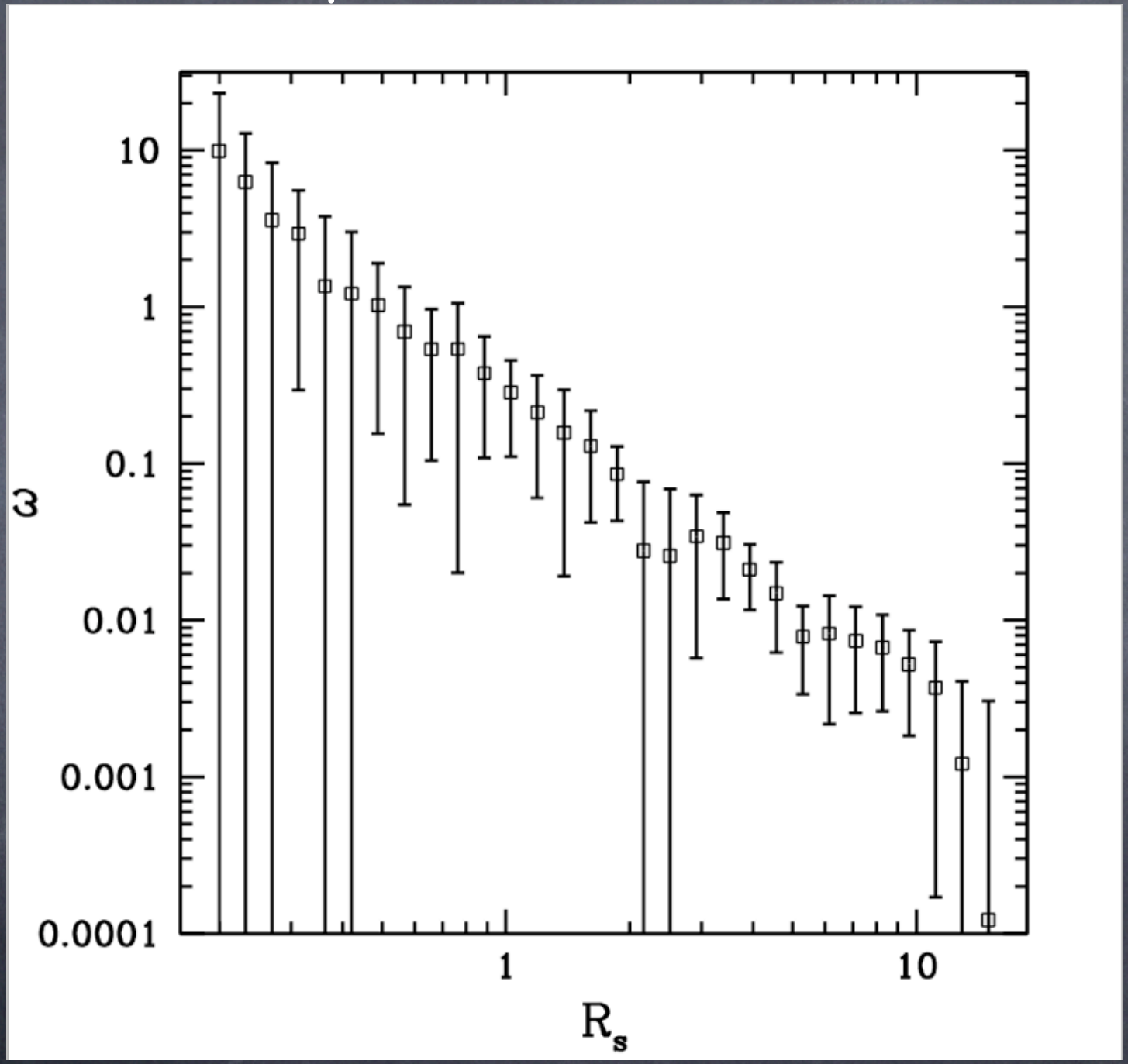
Does it work?



Advantages (or why you care)

- Real space statistic
- Directly comparable to theory
- Insensitive to large Z cutoff
- Unbinned - can be computed by simple weighted pair counts
- Probes a narrow range of scales
- Insensitive to large scales, no integral constraint
- Just as easy to compute as wp

DEEP2 - A red sample



Thanks to A. Coil

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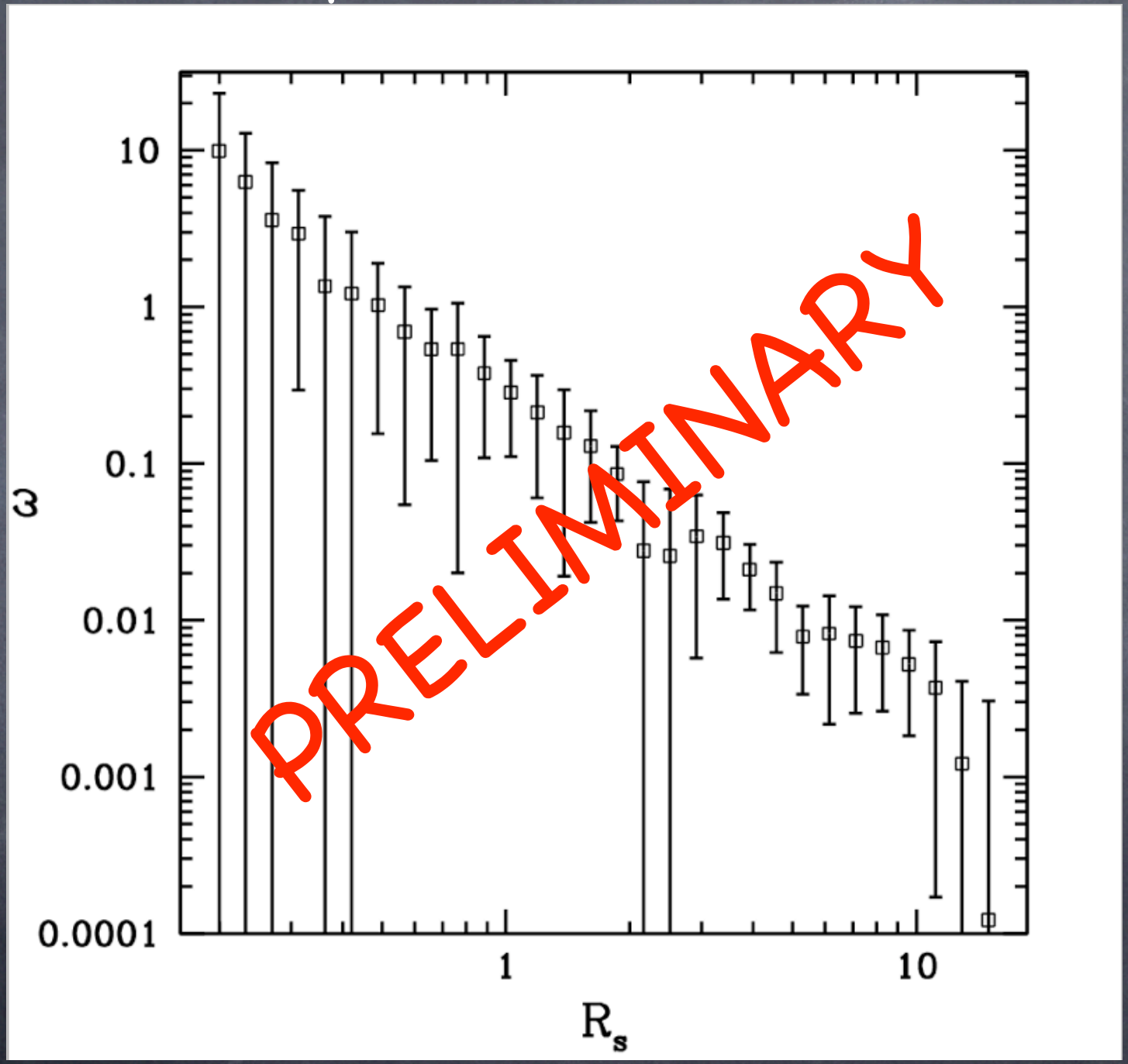

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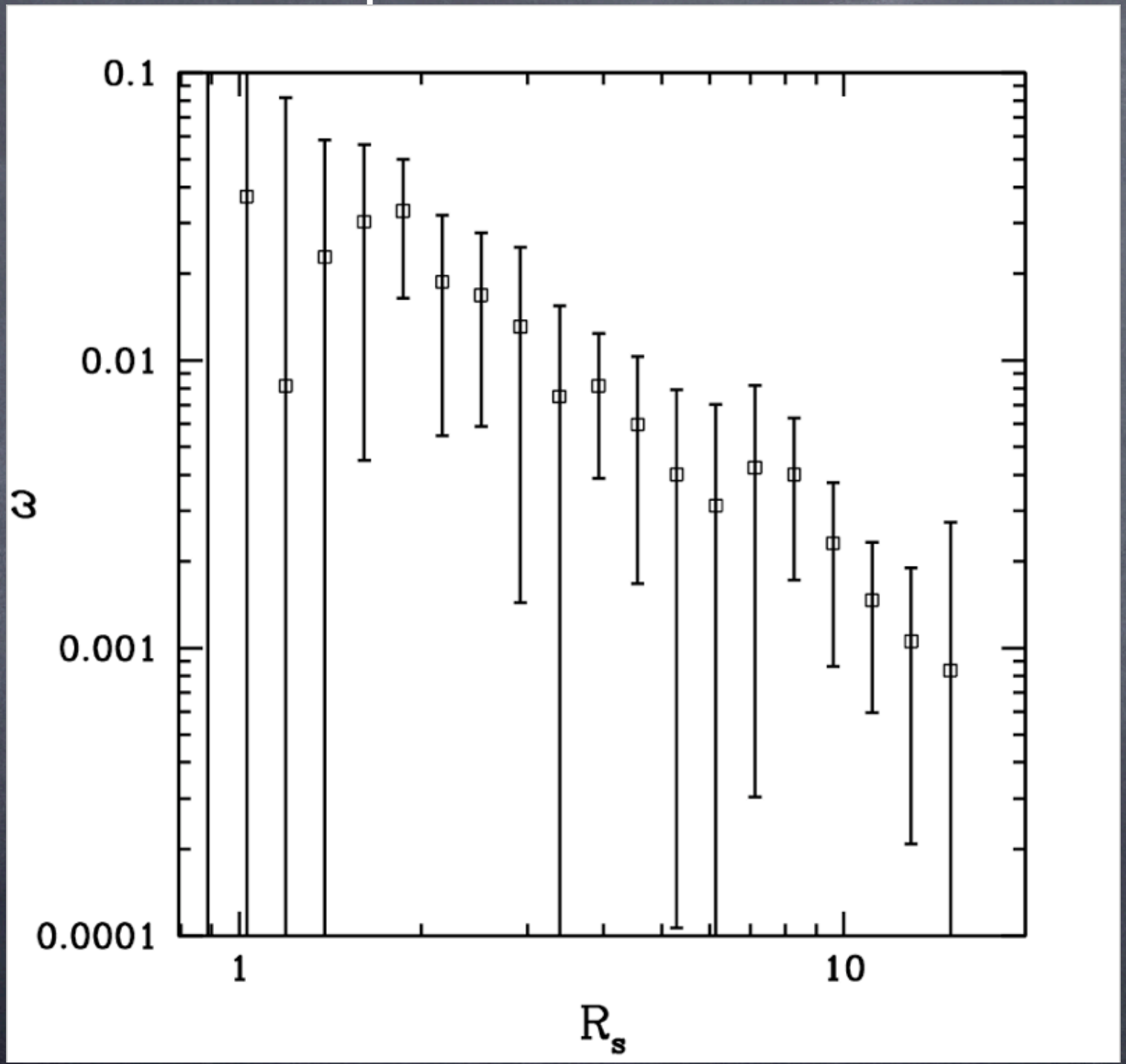
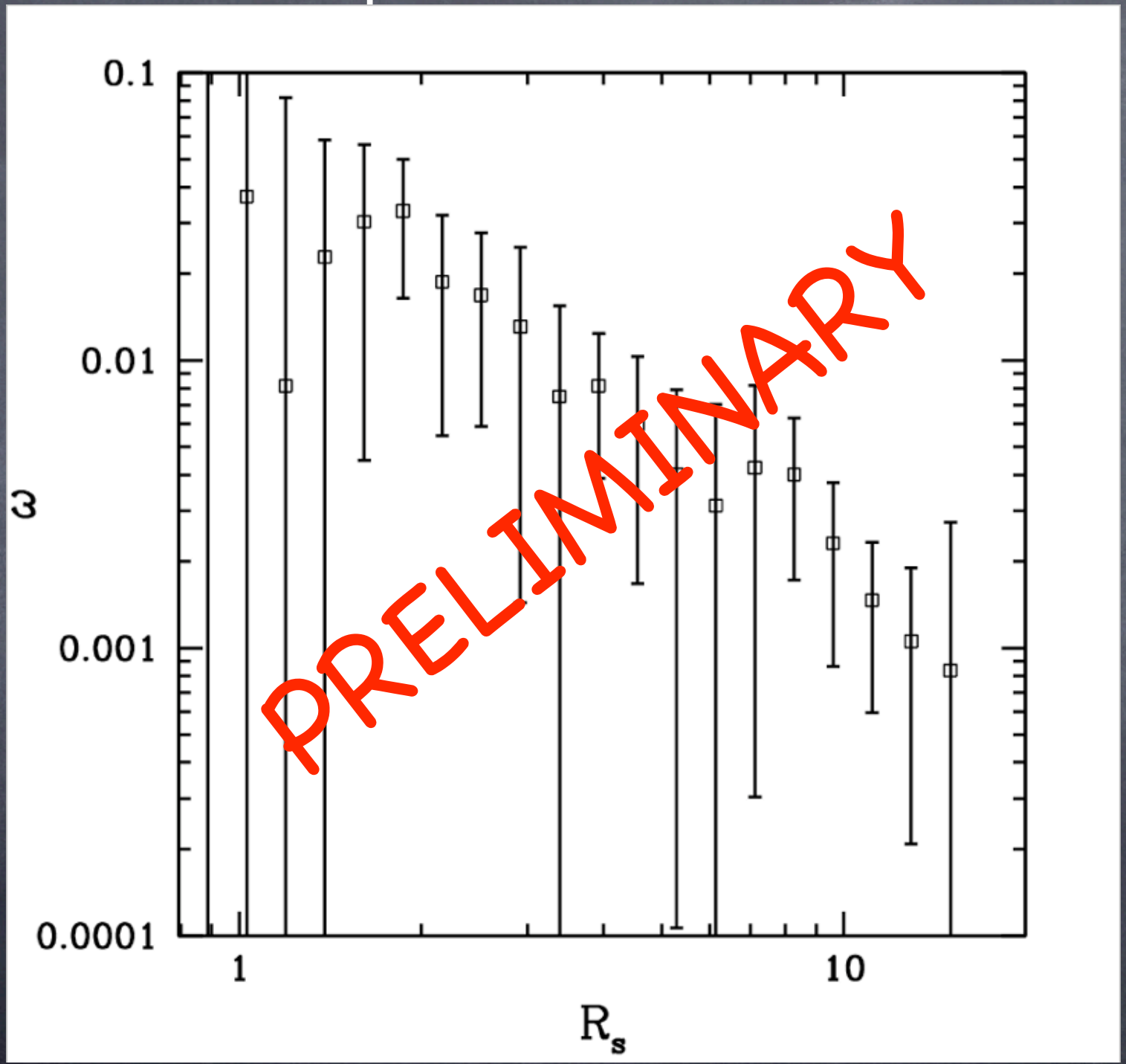
DEEP2 - A blue sample



DEEP2 - A blue sample



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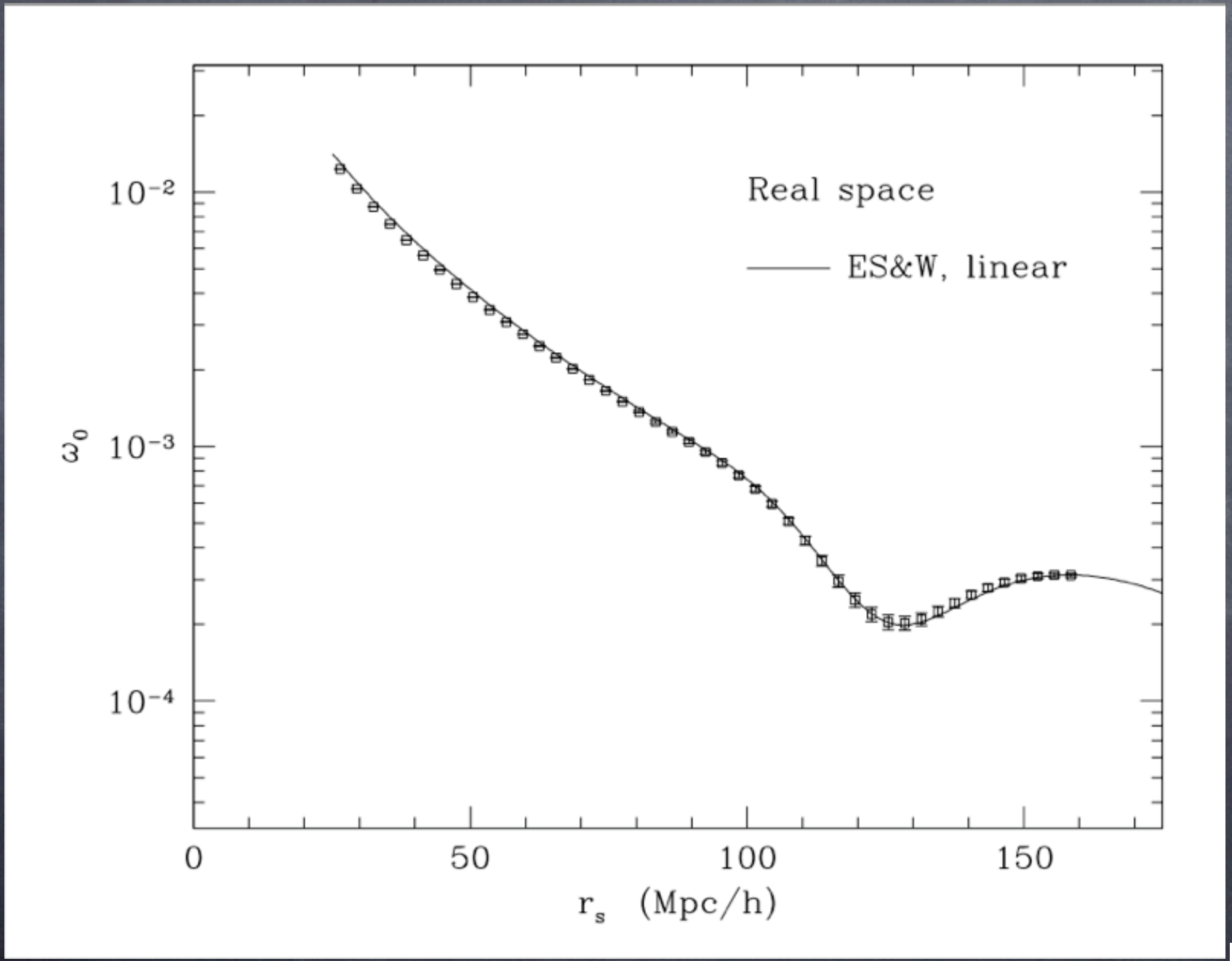
Baryon Oscillations

- Generalize to large scales
- Want a band-limited filter (insensitive to both small and large scales)
- Want a matched filter
- We care about z-space; take moments of 2D correlation function.

Baryon Oscillations



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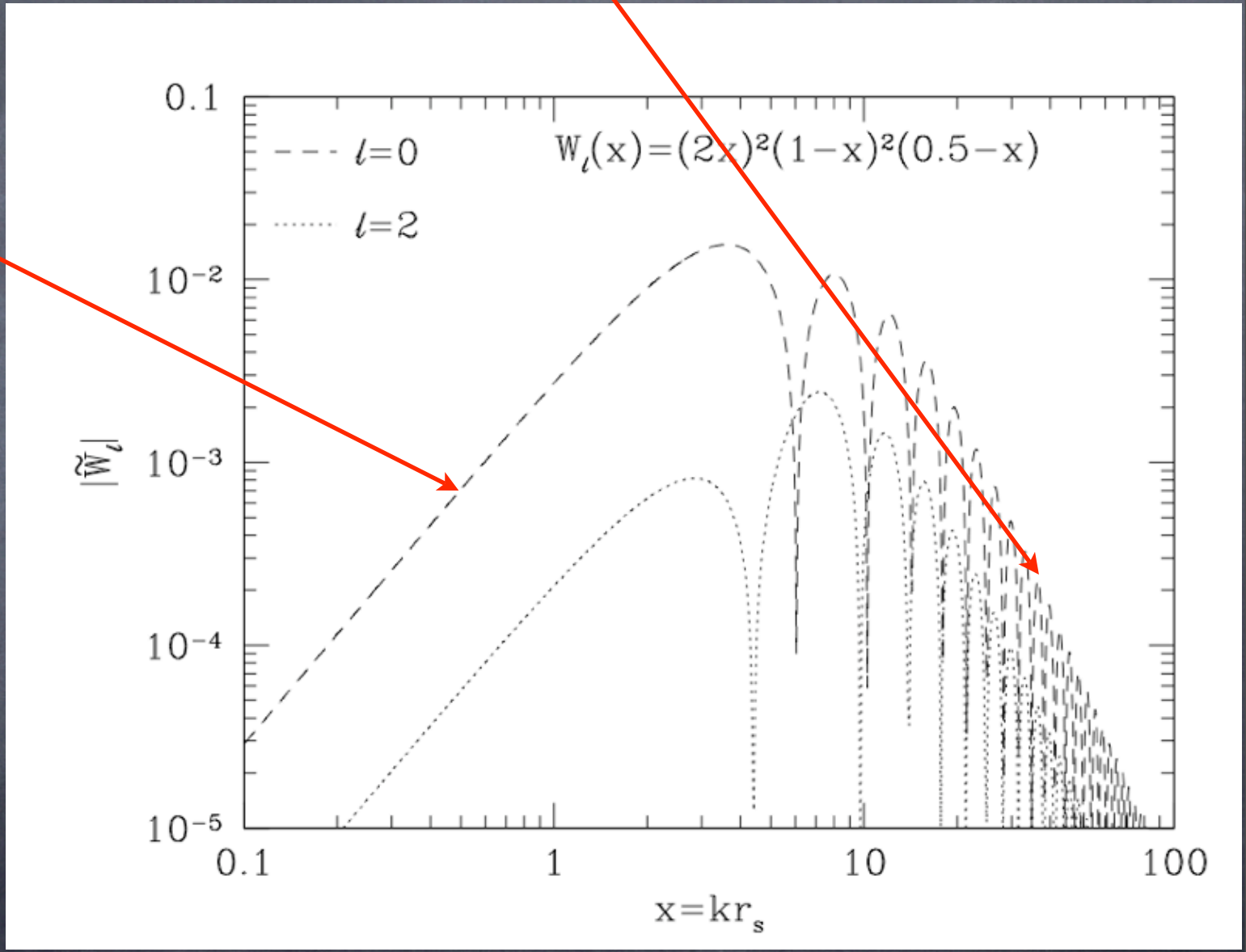
A Band Limited Function

k^4

k^2

Very insensitive to small and large scales



The Future

- Testing the large scale estimator
  - Recovering transverse and LOS distance constraints
  - Covariance matrices (are they Gaussian)?
- Applying the estimator to every data set in existence!