Can Cosmic Shear Detect Baryon Oscillations?

Fergus Simpson
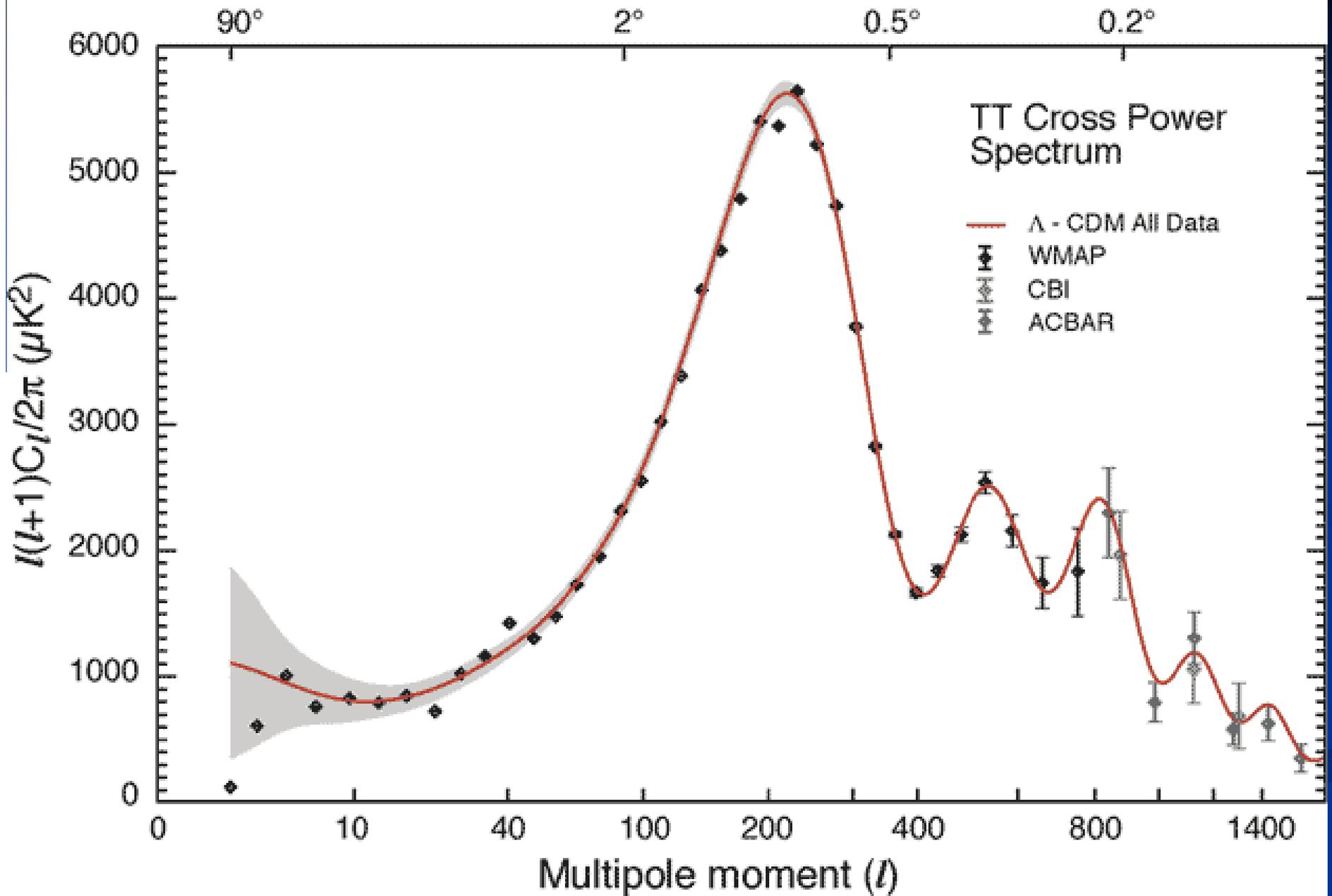
IoA, Cambridge
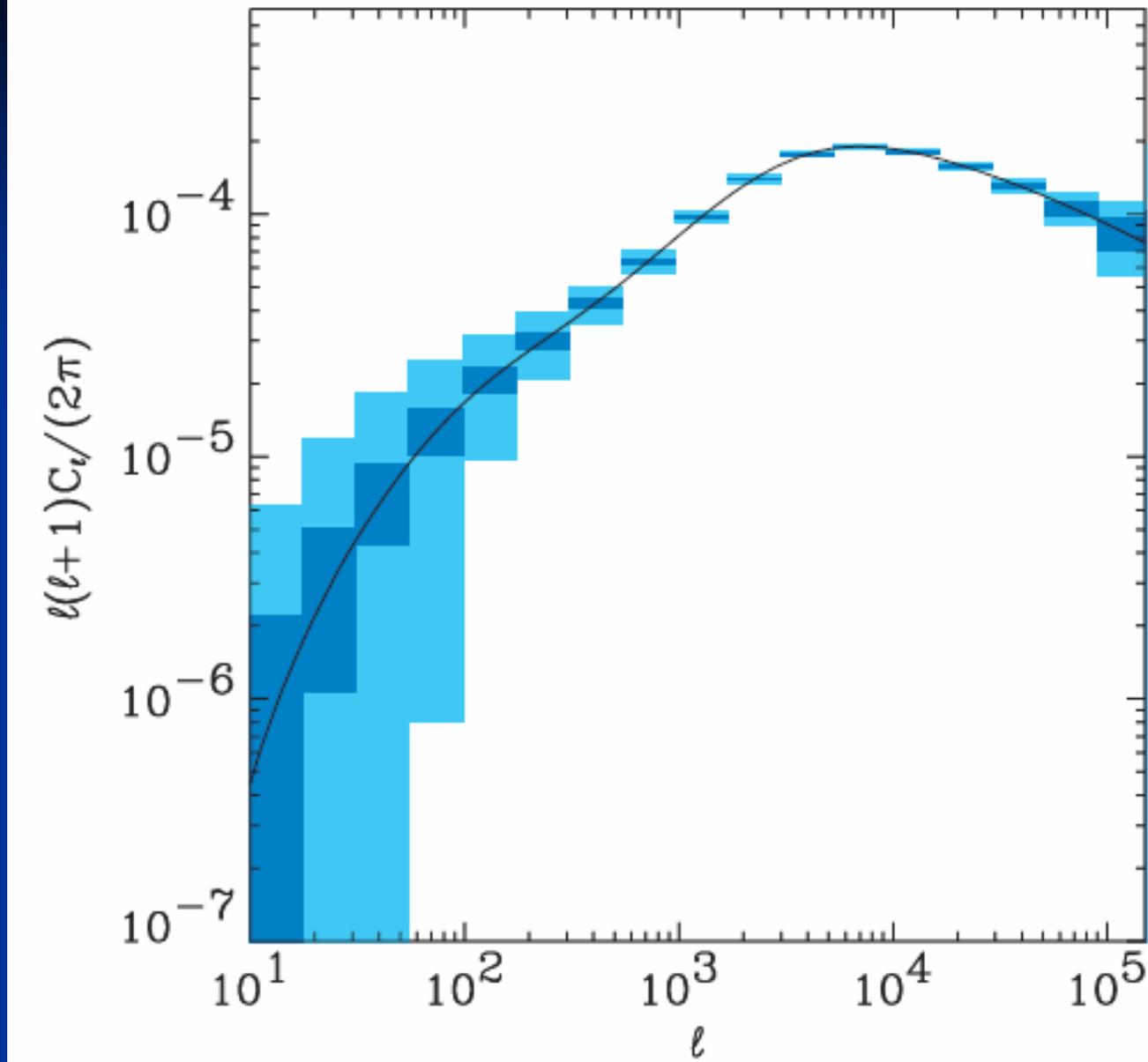
August 28th 2005

Overview

- Introduction to Cosmic Shear
- Smoothing Problem
- Tomography
- Bin Selection
- The Null Statistic
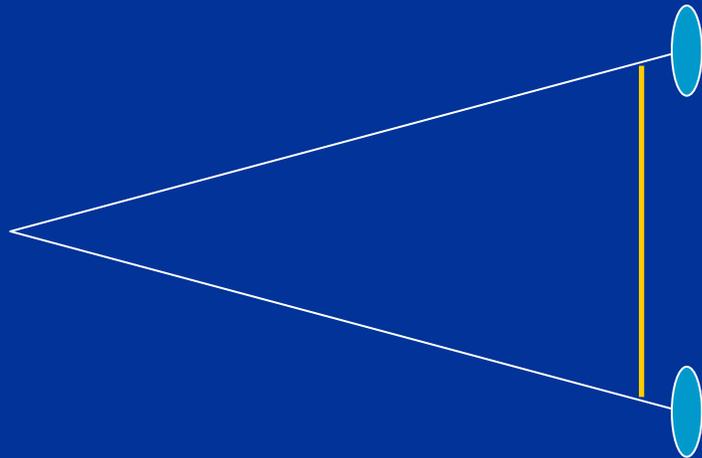- Conclusions

Angular Scale

TT Cross Power Spectrum

— Λ - CDM All Data
WMAP
CBI
ACBAR

$l(l+1)C_l/2\pi\ (\mu K^2)$

Multipole moment (l)

WMAP

Refregier et al (2004)

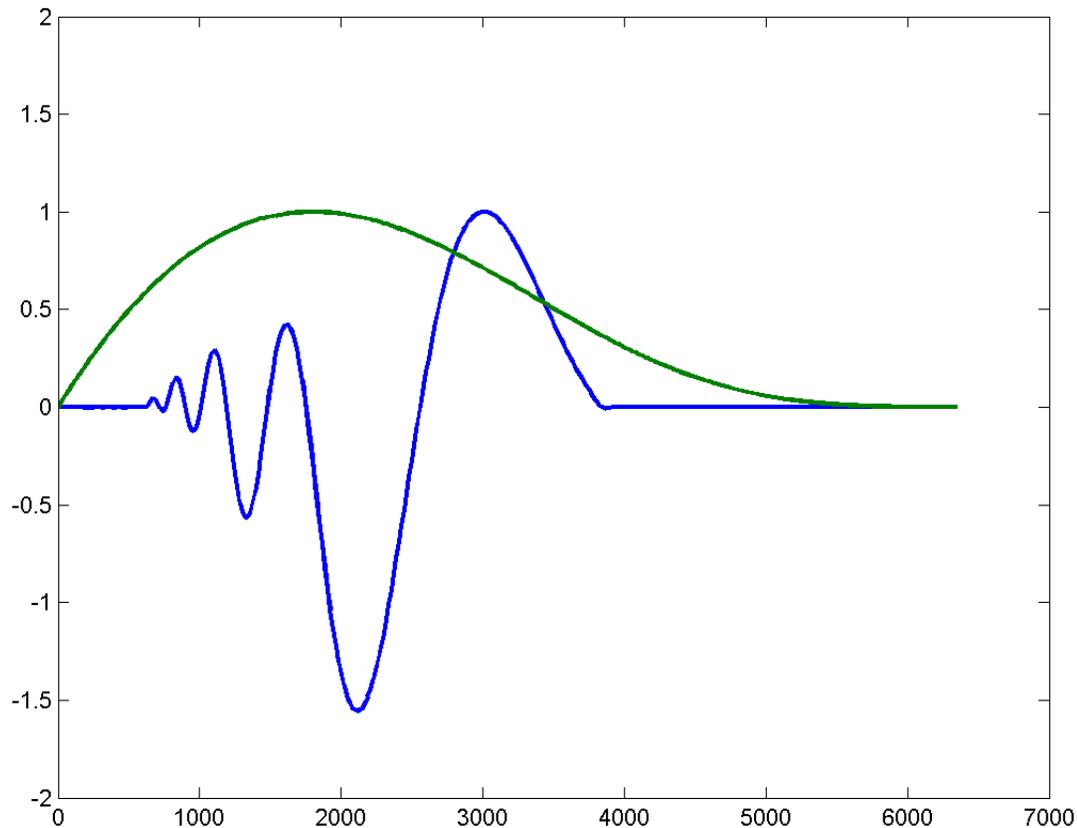# Cosmic Shear

- **Consider observing a pair of distant galaxies**

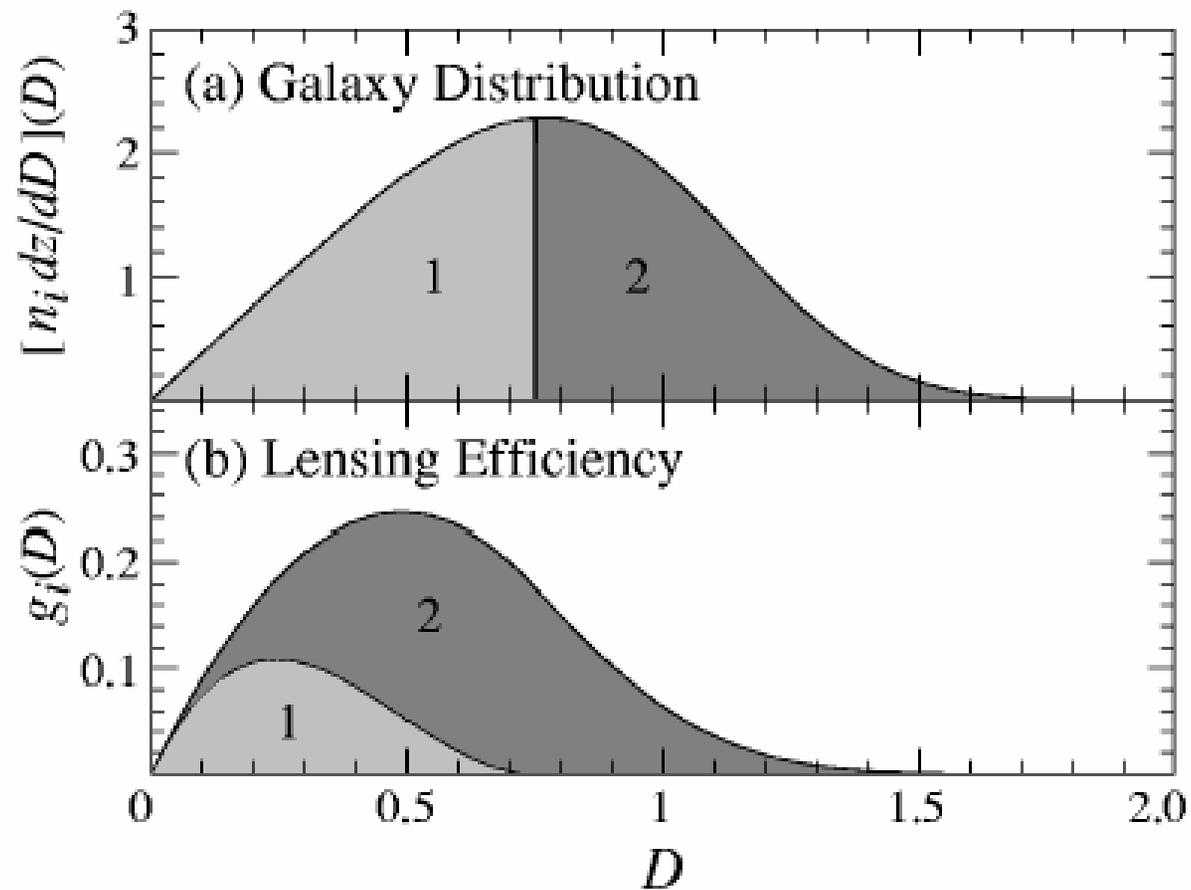$$C_\ell \propto \int \left[\frac{g(\chi)}{ar(\chi)} \right]^2 P(k,z) d\chi$$

$$(\frac{\ell}{r}, \chi)$$

Smoothing Effect

Impact of the oscillations:

$$C_\ell - C_\ell^{smooth} \propto \int \left[\frac{g(\chi)}{ar(\chi)} \right]^2 (P - P^{smooth}) d\chi$$

Tomography

W. Hu (1999)

Tuning

- Oscillatory envelope in P(k) of the form

$$j_0(k\bar{s})$$

- Aim to produce g which traces this. Would like:

$$g(\chi) \propto \sin(\frac{\ell\bar{s}}{\chi})$$

Tuning

- Assuming flatness:

$$\frac{\mathrm{d}^3 g}{\mathrm{d}\chi^3} = 2\frac{\mathrm{d}n}{\mathrm{d}\chi} + \frac{4n}{\chi}$$

- Oscillating n would help….

Lensing Efficiency

- Problems
  - Cosmic variance dominant
  - Can't generate negative n!
- Create two bins, and compare

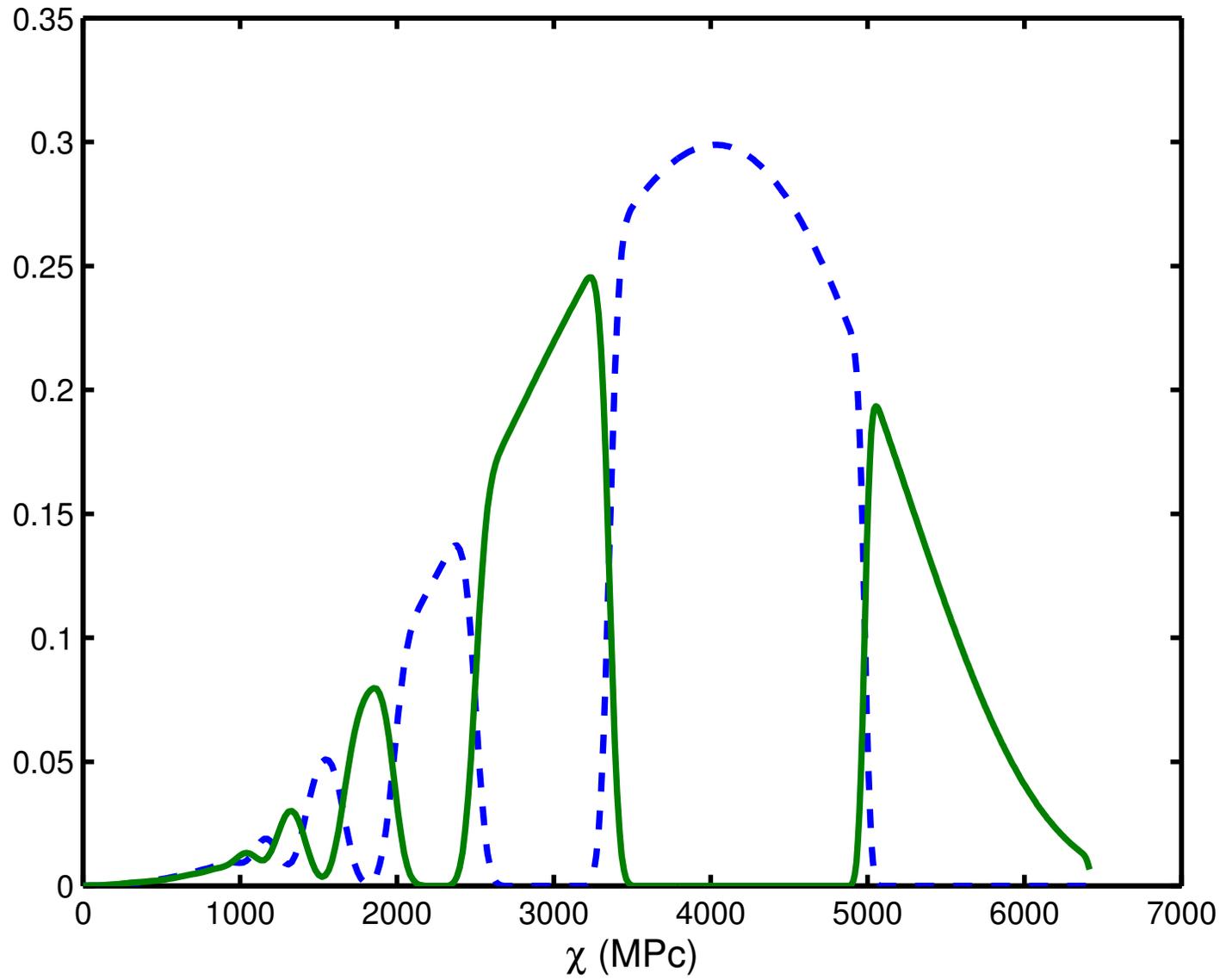$$C_\ell^A - C_\ell^B \propto \int \left[\frac{g_A^2(\chi) - g_B^2(\chi)}{a^2 r^2(\chi)} \right] P(k,z) d\chi$$

- The *effective lensing efficiency*

Bin Selection

- Trial function:

$$\varepsilon(\ell, \chi) \equiv \sin(\frac{\overline{s}\,\ell}{\chi} + \phi)$$

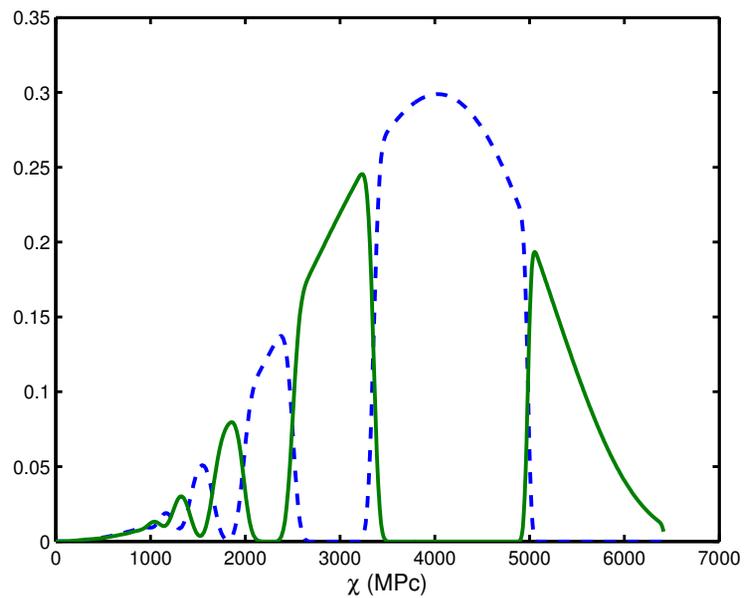- Use ε to split galaxies into bins A and B
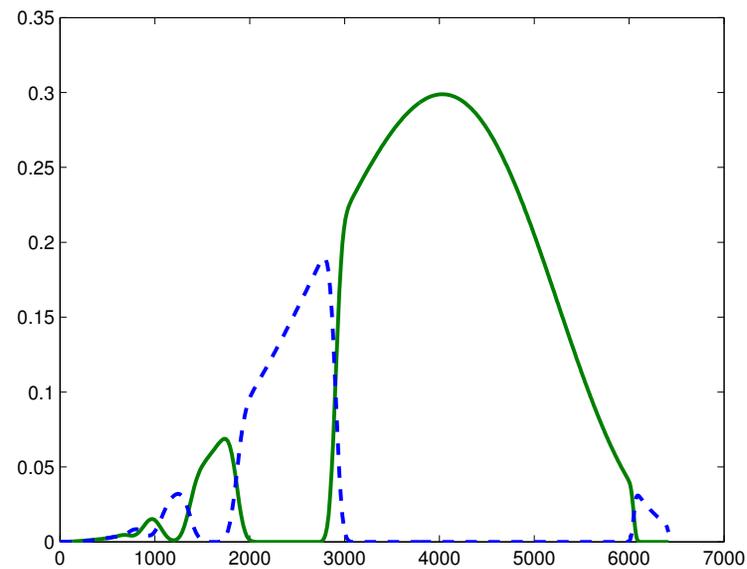
$\ell = 100$

Null Statistic

- Define

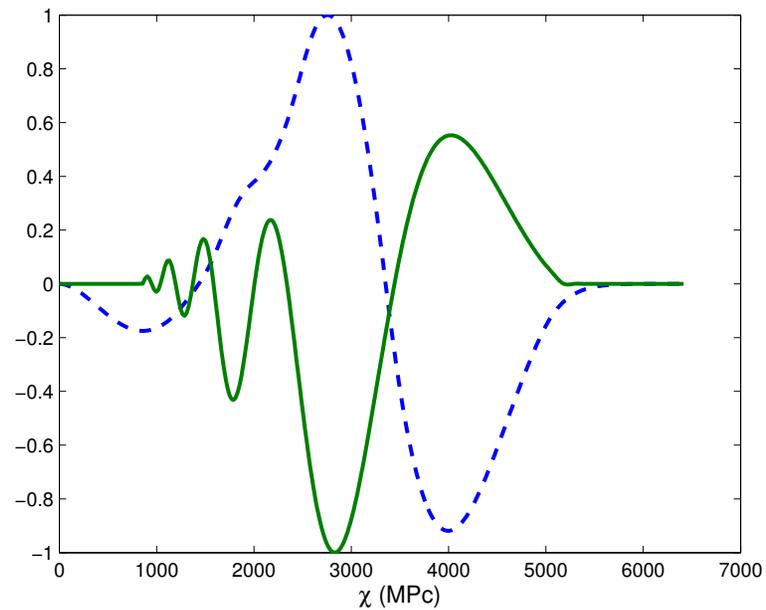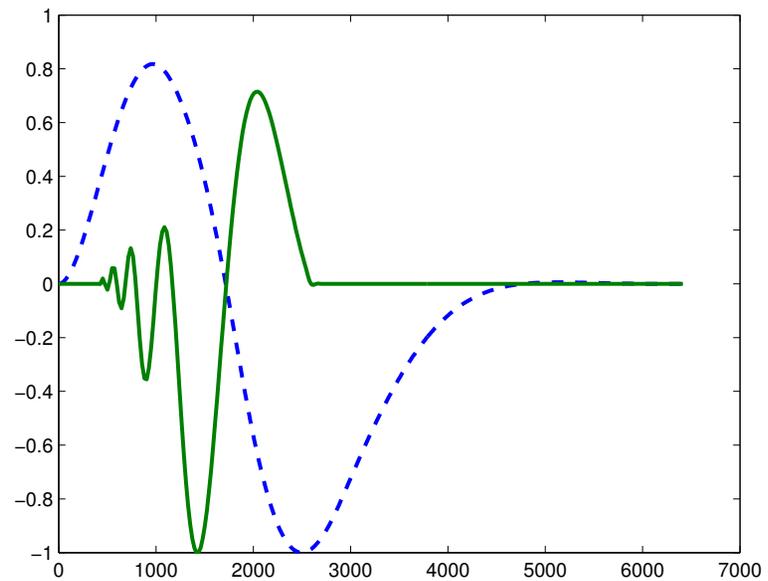$$F(\ell) = \frac{\tilde{C}_\ell^B}{\tilde{C}_\ell^A} C_\ell^A - C_\ell^B$$

- F(ℓ) indicates accuracy of fiducial model
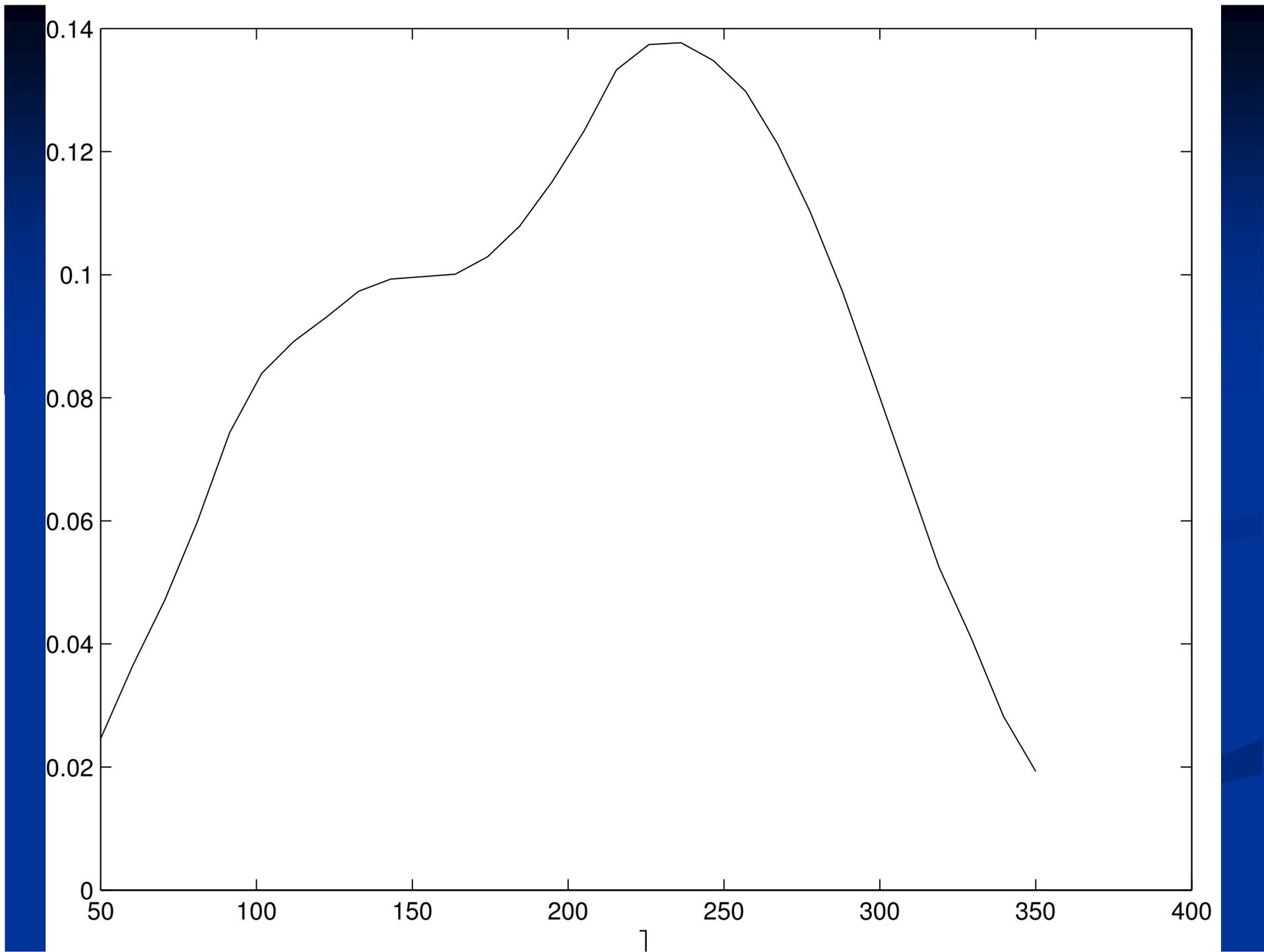
$\ell = 100$

$\ell = 200$

Signal v Error

- Errors highly correlated
    - Same structure lensed both bins
    - Cosmic variance largely cancels
- Unique $F(\ell)$ generated by oscllations
- 20,000 deg^2 survey could exclude smoothed power spectrum at ~2σ level

Conclusions

- The answer is yes!

- Further details at astro-ph/0507301

- Future surveys capable of direct detection of the oscillations at the 2σ level