A New Way to Analyze Weak-Lensing Data

Sheng Wang
Brookhaven National Laboratory
Columbia University

Collaborators:
Zoltán Haiman (Columbia)
Morgan May (Brookhaven)

Outline

- Cosmology with galaxy clusters
- Projection effect
- An alternative approach
- Results

Galaxy Clusters with LSST

PHYSICAL REVIEW D **70,** 123008 (2004)

Constraining the evolution of dark energy with a combination of galaxy cluster observables

Sheng Wang,[1,2] Justin Khoury,[3] Zoltán Haiman,[4] and Morgan May[1]
[1]*Brookhaven National Laboratory, Upton, New York 11973-5000, USA*
[2]*Department of Physics, Columbia University, New York, New York 10027, USA*
[3]*Institute for Strings, Cosmology and Astroparticle Physics, Columbia University, New York, New York 10027, USA*
[4]*Department of Astronomy, Columbia University, New York, New York 10027, USA*
(Received 14 June 2004; published 17 December 2004)

Using a total number of ~ 200,000 clusters with 4.5σ detection, and combined with future CMB anisotropy measurements (Planck), LSST can reach a sensitivity of :

$$\Delta(w_0) \sim 0.03, \quad \Delta(w_a) \sim 0.09.$$

Galaxy Clusters with LSST

PRL **95,** 011302 (2005) PHYSICAL REVIEW LETTERS week ending 1 JULY 2005

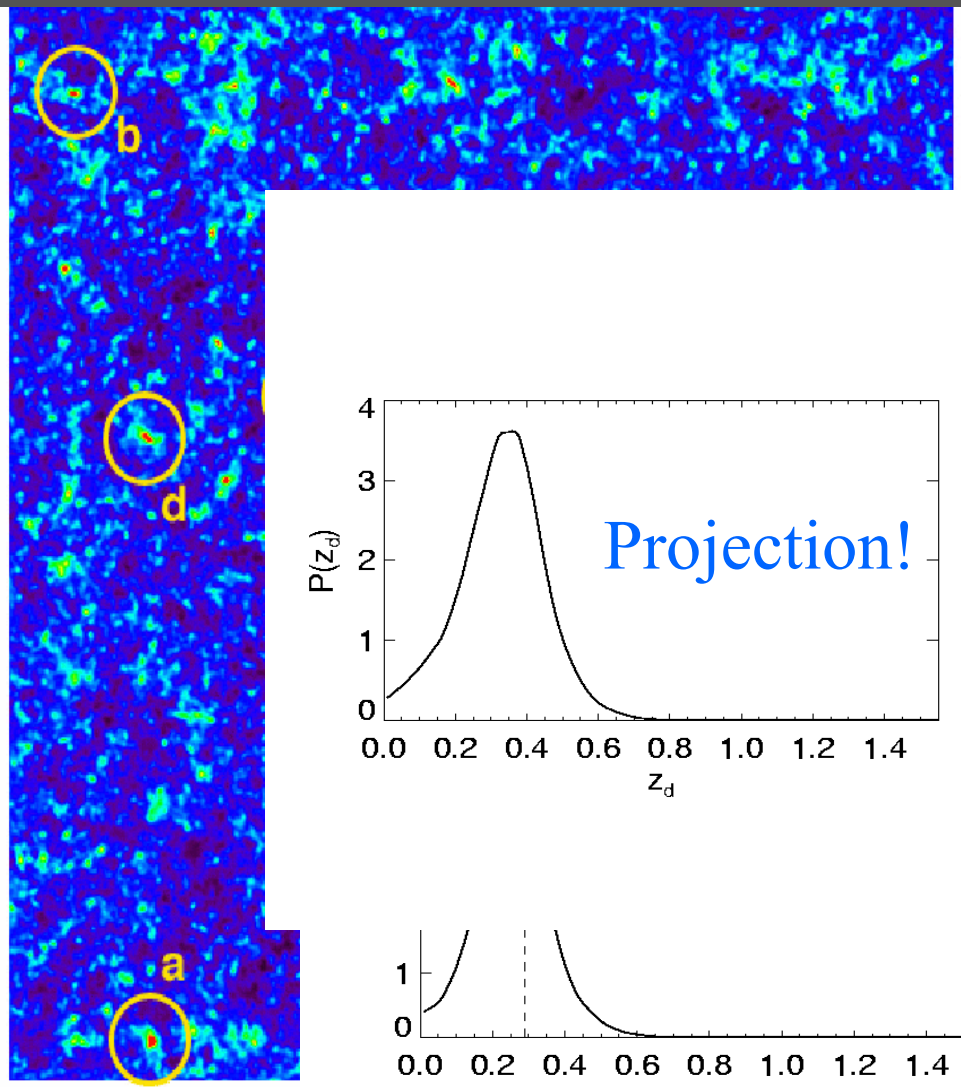
Weighing Neutrinos with Galaxy Cluster Surveys

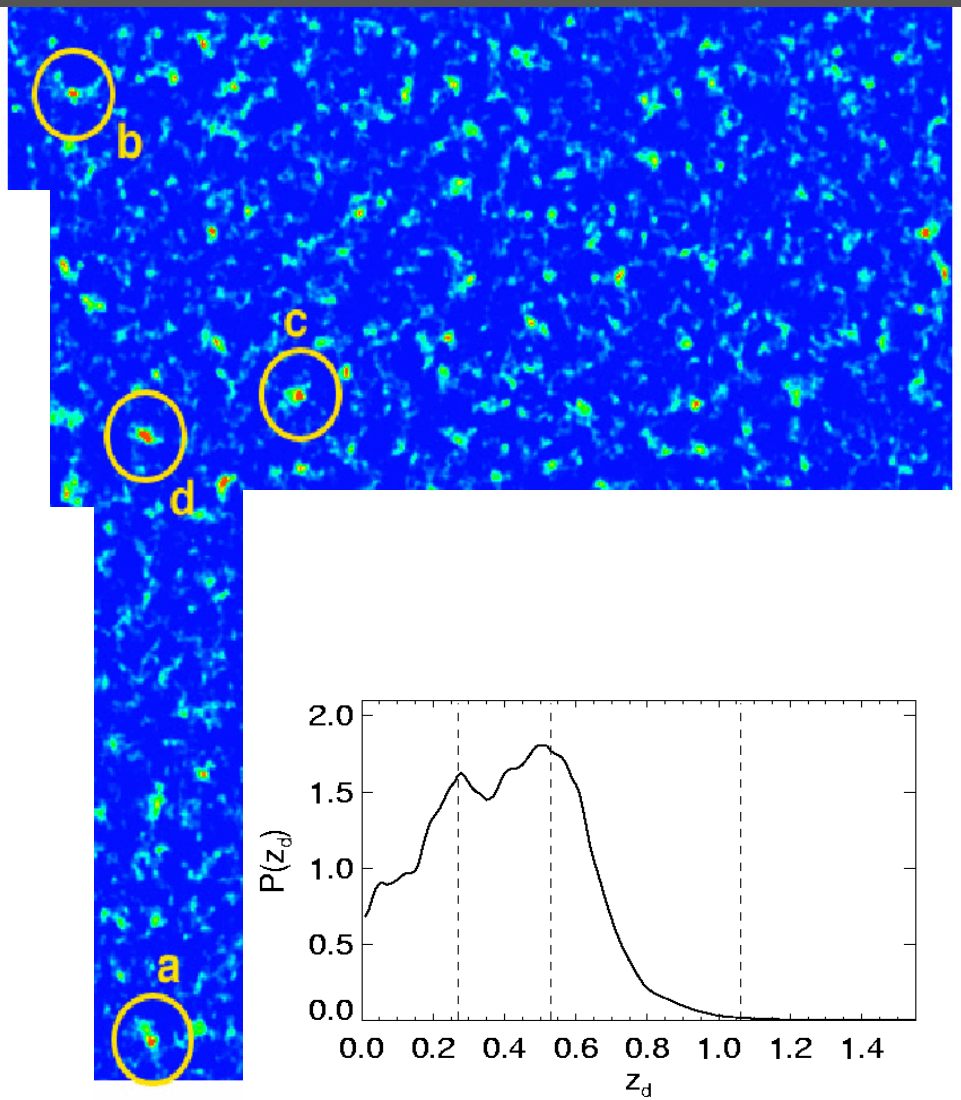
Sheng Wang,[1,2] Zoltán Haiman,[3] Wayne Hu,[4] Justin Khoury,[5] and Morgan May[1]
[1]*Brookhaven National Laboratory, Upton, New York 11973-5000, USA*
[2]*Department of Physics, Columbia University, New York, New York 10027, USA*
[3]*Department of Astronomy, Columbia University, New York, New York 10027, USA*
[4]*Kavli Institute for Cosmological Physics, Department of Astronomy and Astrophysics, Enrico Fermi Institute, University of Chicago, Chicago, Illinois 60637, USA*
[5]*Center for Theoretical Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA*
(Received 28 January 2005; published 30 June 2005)

LSST (+Planck) can reach a sensitivity of : $\Delta(\Sigma m_\nu) \sim 0.03$ eV.

Neutrino oscillation experiments suggest:
at least one neutrino species has a mass > 0.05eV.

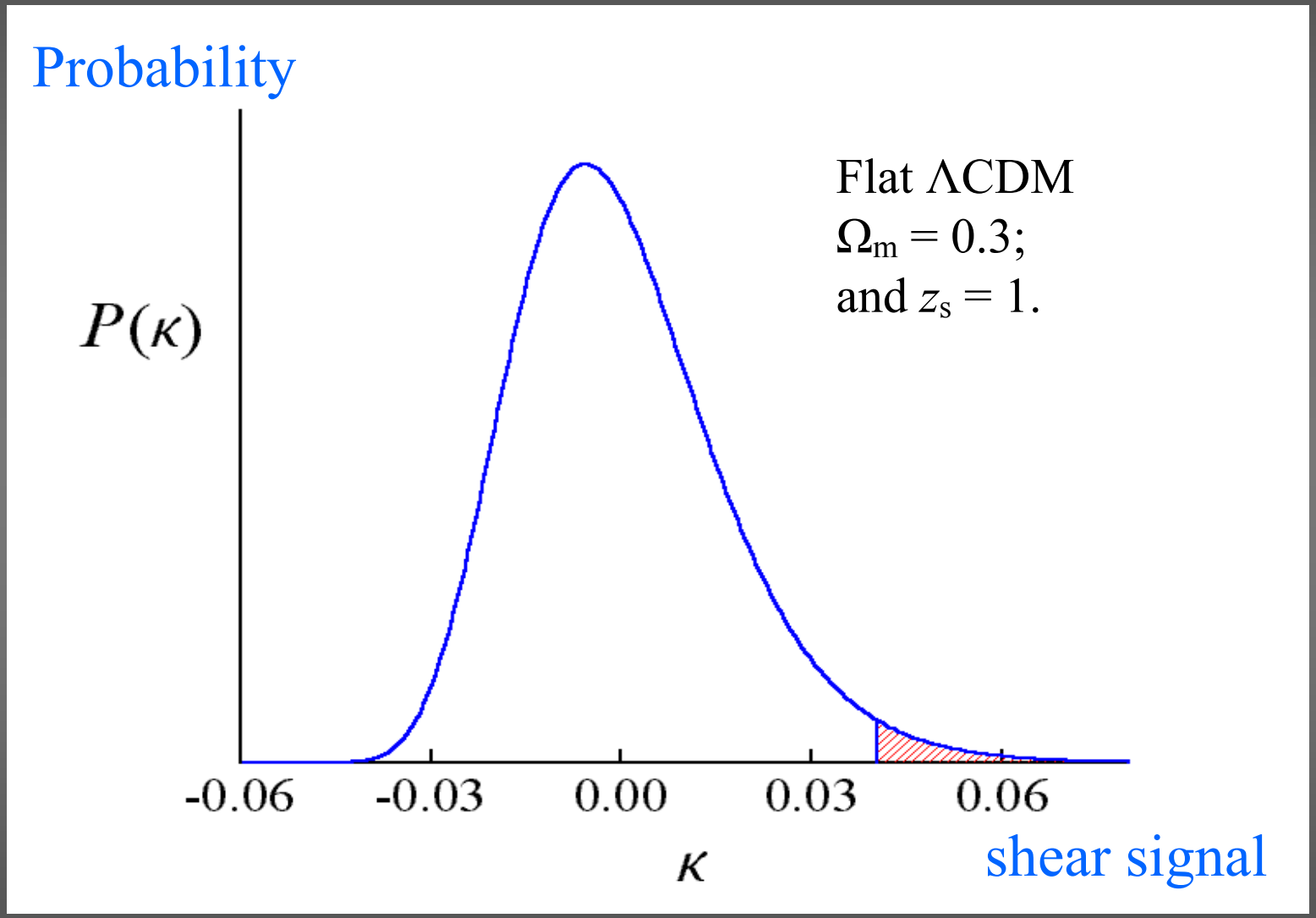
Projection Effects





Weak lensing is sensitive to all masses along the line of sight.

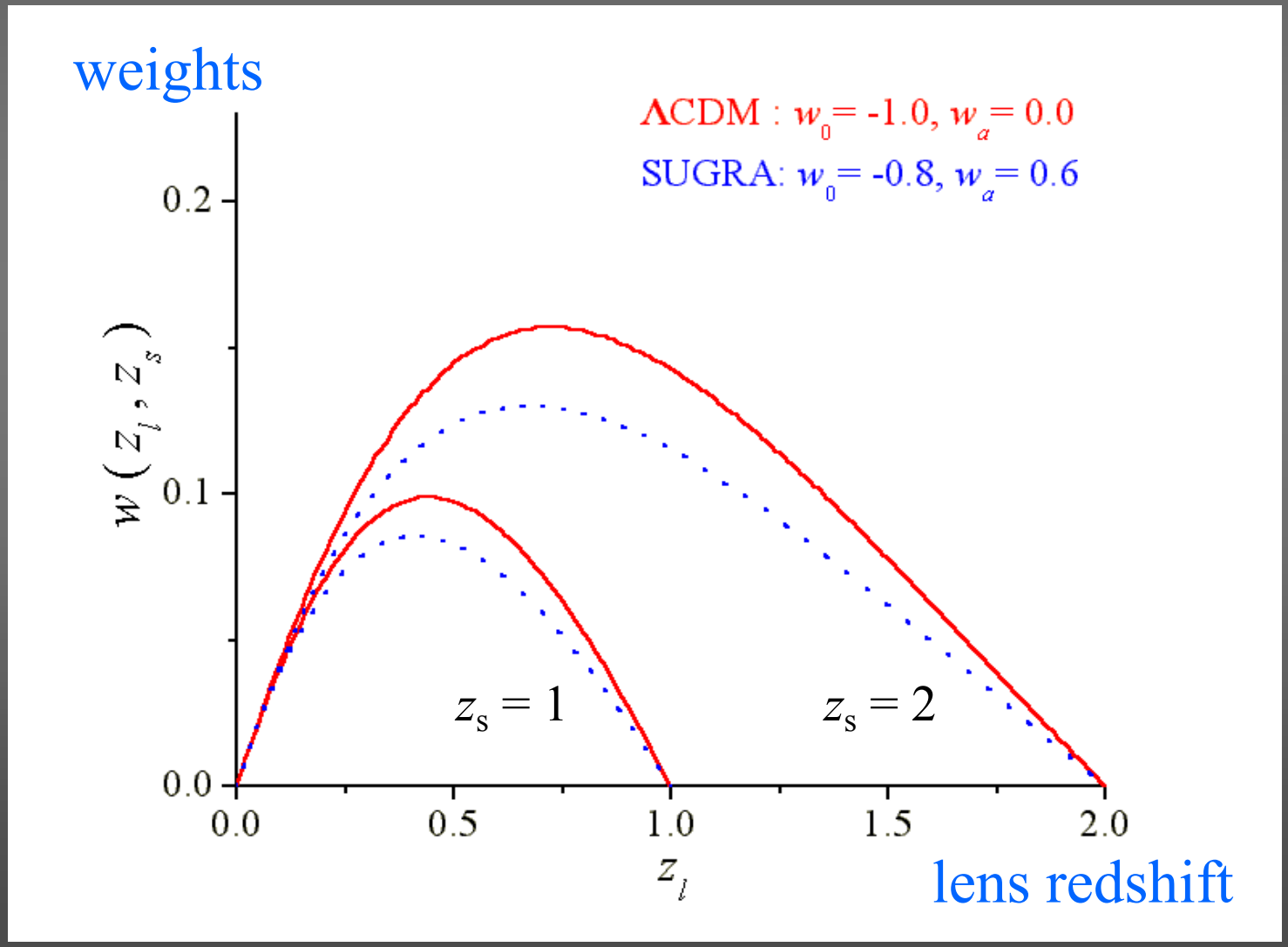
An Alternative Approach



Fractional area of high shear signal

Cosmological Dependence

- Underlying structures and their growth
- Lensing kernel



Results for LSST (preliminary)

Using three background galaxy redshift bins of $z_s \sim 0.6, 1.1, 1.9$,

and shear signal thresholds of $2.0\ \sigma$, $2.5\ \sigma$, $3.0\ \sigma$,

combined with future CMB anisotropy measurements (Planck),

this method can have a sensitivity of :

$\Delta(w_0) \sim 0.03, \quad \Delta(w_a) \sim 0.1.$

Conclusion

1. Weak gravitational lensing suffers from the projection effects when searching for galaxy clusters. We propose an alternative, more robust statistic using points in mass maps with high shear signal.

2. This statistic, combined with future CMB anisotropy measurements, such as Planck, can place constraints on cosmological parameters, such as the evolution of dark energy, that are comparable to those from galaxy clusters.

Shear Field Filter Comparison

Filters maximize shear signal of galaxy clusters by taking weighted average over background galaxies.

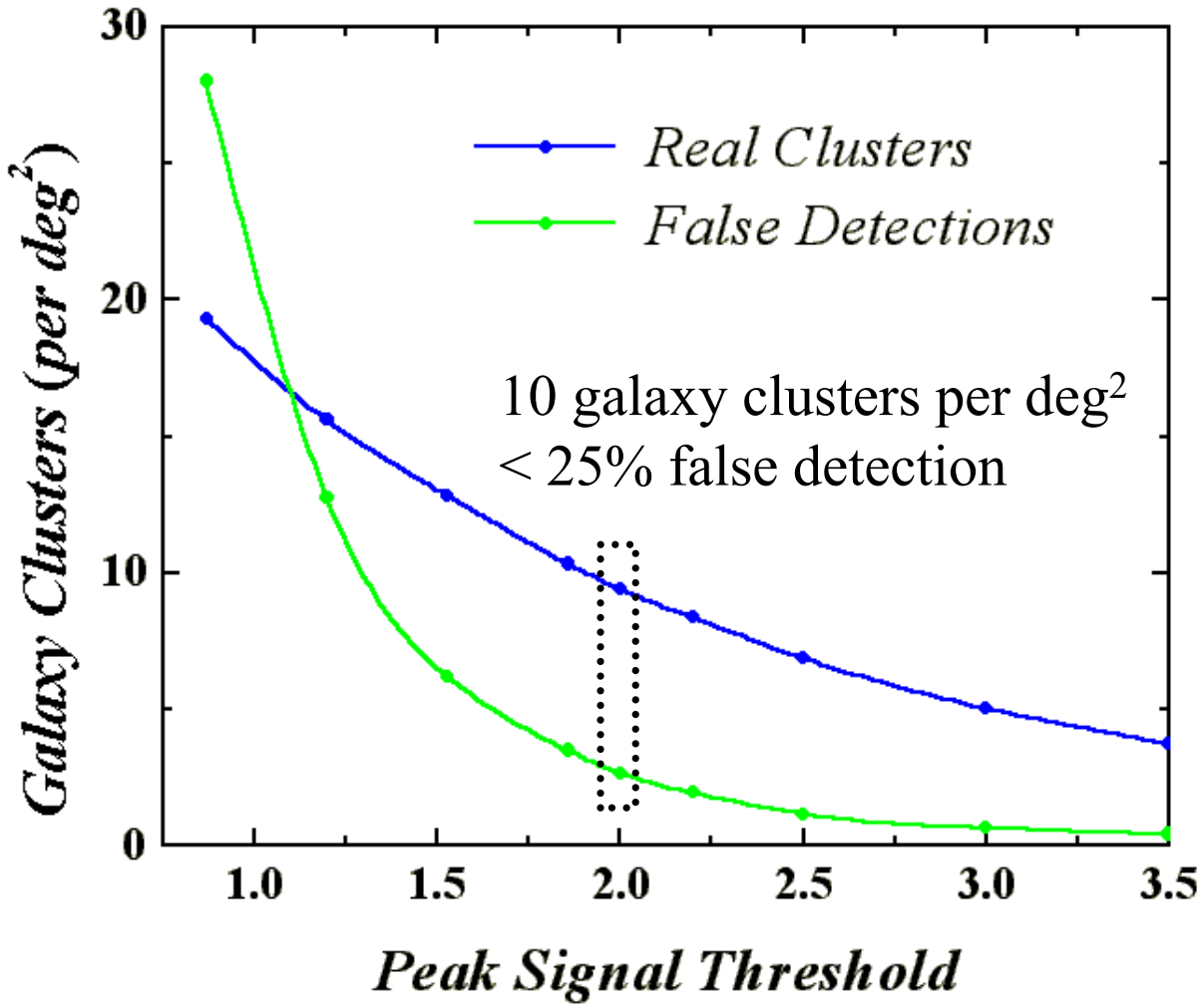
Analysis using N-body simulation data with 16 fields (9 deg^2),

M. White

and BNL LSST Computer Cluster with 72 processors.

J. Haggerty & T. Throwe

Tomographic Filter



Kehayias, Wang & May (in preparation)