Re-capturing cosmic information
(arXiv1008.0349)

Hee-Jong Seo

Berkeley Center for Cosmological Physics
UC Berkeley

In collaboration with

Masanori Sato (Nagoya University)
Scott Dodelson (Fermilab)
Bhuv Jain (University of Pennsylvania)
Masahiro Takada (University of Tokyo)

Cosmology in Northern California 10/22/2010

Motivation

- Bottom line: Re-captures cosmic information using the power spectrum of a simple function of the observed (nonlinear) convergence field.
- Logarithmic transform of the density field (Neyrinck et al. 2009) – ~Gaussian pdf of δ. $P_{\rm ln} \propto P_{\rm lin}$

  S/N ratio greatly improved in translinear region.

But how about with galaxy bias, shot noise, and RSD? (Neyrinck et al. 2010)

Convergence field does not suffer galaxy bias and RSD.

Log-mapping for lensing

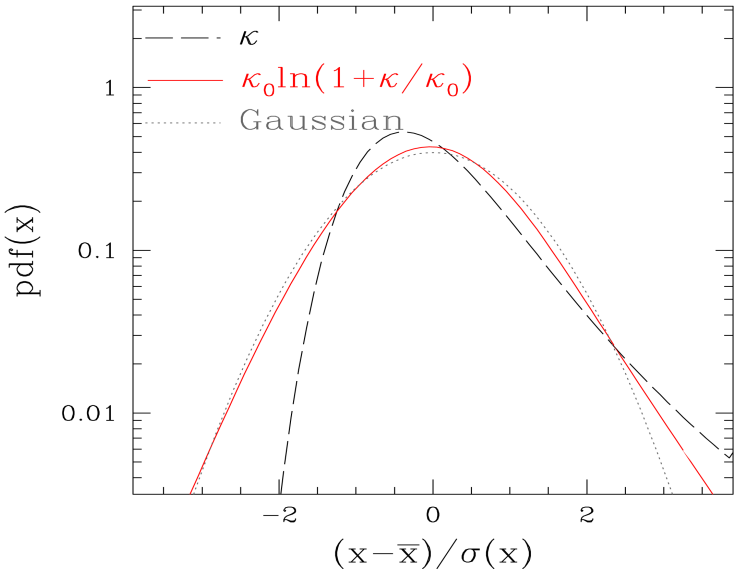
- Modified log-transform of the convergence field.

$$\kappa_{\ln}(\vec{\theta}) \equiv \kappa_0 \ln\left[1 + \frac{\kappa(\vec{\theta})}{\kappa_0}\right]$$

- κ_0 tunes the degree of alteration: the smaller, the more we alter the field.
- Sims : 100 convergence fields (5^oX5^o x100). Z_s=1 (M. Sato et al. 2009) -> Measure Cov and power spectrum.

pdf of $\kappa_{\ln}$

- Pdf of $\kappa_{\ln}$ is nearly Gaussian.

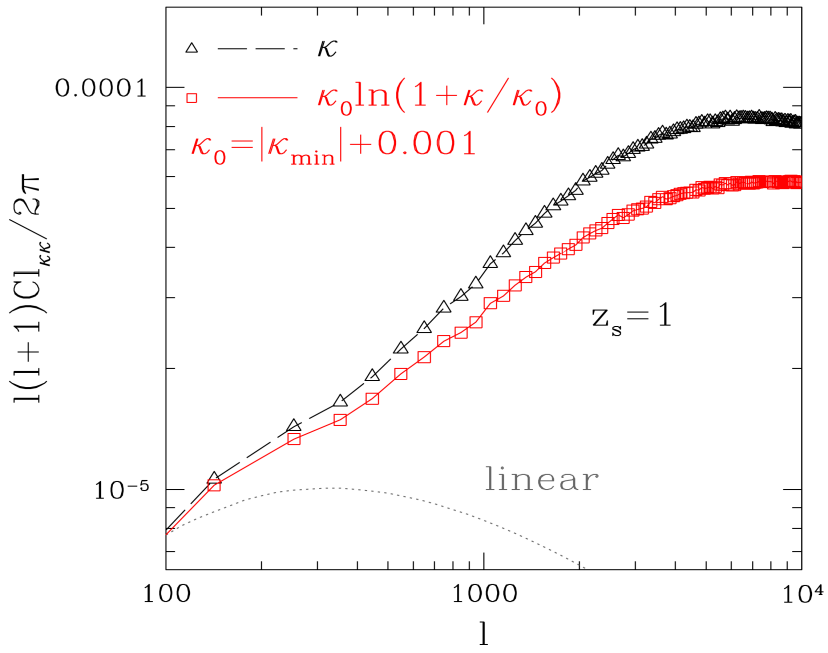


Power spectrum of the log-field

- The excess power on small scales is suppressed for the log-field.
- High density regions are smoothed out:

$$\kappa_{\ln} \ll \kappa$$

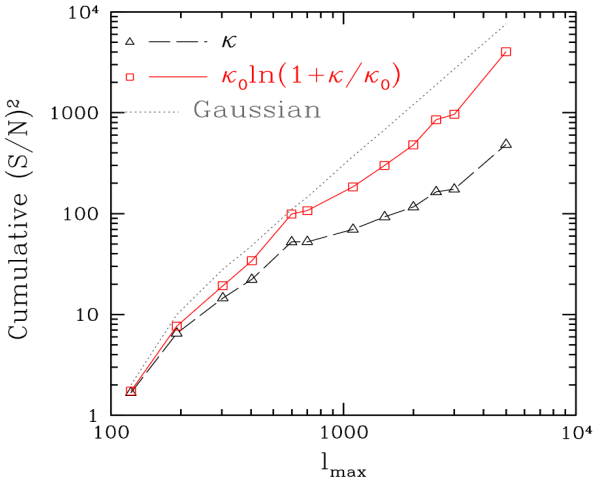
for large κ

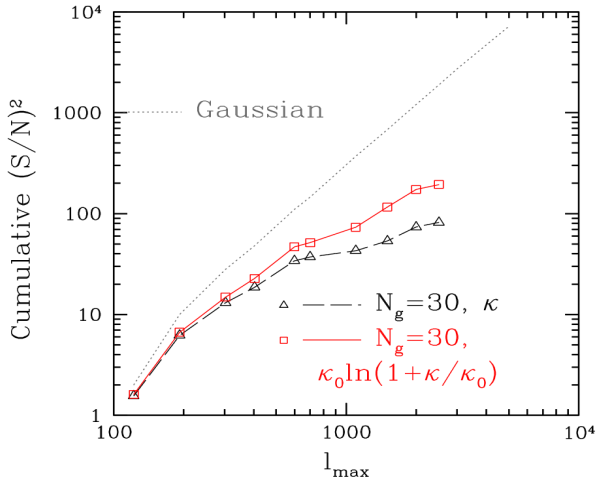


Recovery of cosmological info.

- Signal to Noise ratio or information content.

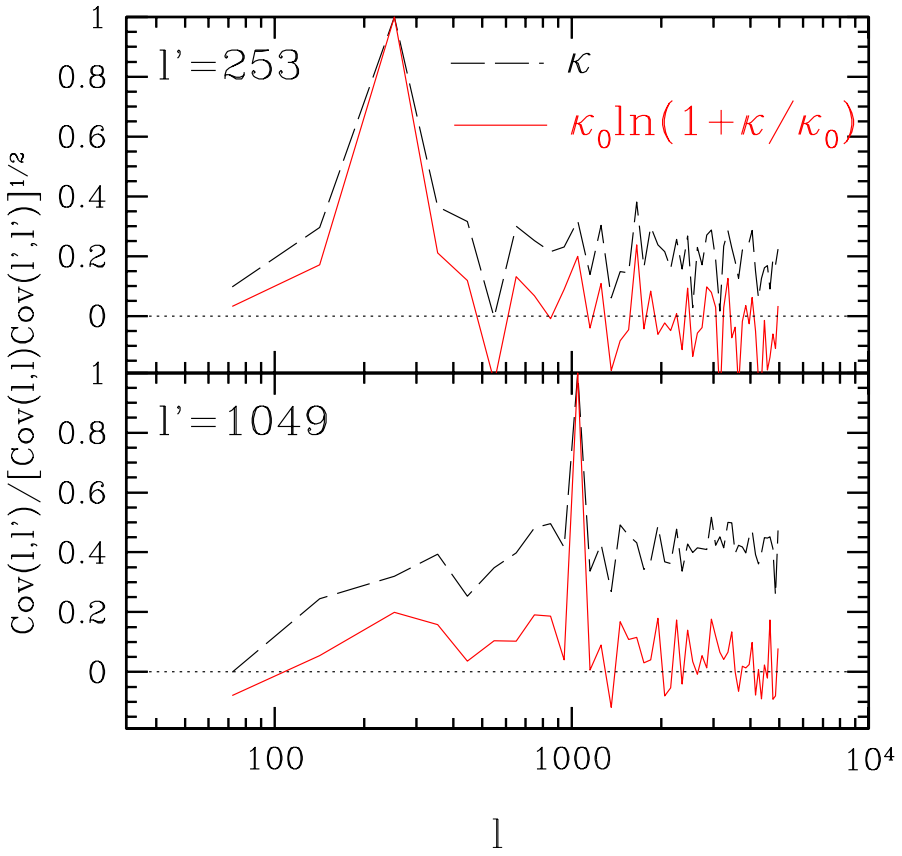
$$\frac{S}{N}(l_{\rm max}) \equiv \left[\sum_{l,l'<l_{\rm max}} C_l {\rm Cov}^{-1}(l,l') C_{l'}\right]^{1/2}$$





- The information in the log-field is close to the Gaussian case. Improvement of a factor of 2 even in the presence of realistic shape noise.

Improvement in the covariance matrix

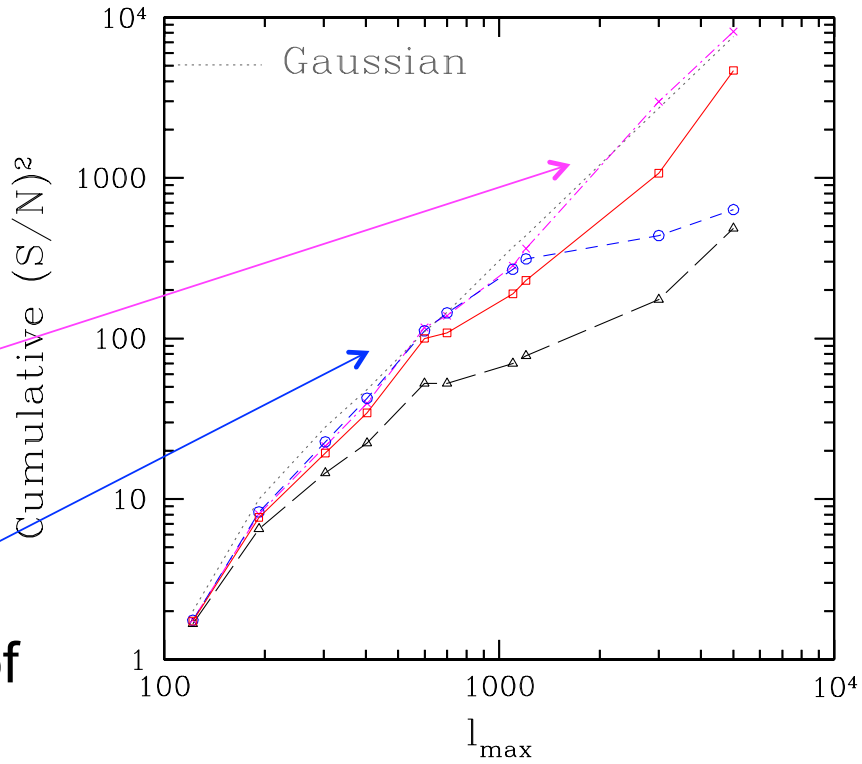


- The covariance matrix of the log-field is nearly diagonal.
- The approximation of Gaussian Cov is more accurate for the log-field.
- Where does this extra info coming from?

Captures higher order information in the power spectrum.

- The two point func of the log-field contains higher order correlations of κ.
- Taylor expansion (with high cutoff) $\kappa - \kappa^2/(2\kappa_0)$ replicates most of the improvement.
- Cross-correlation of κ and $\kappa - \kappa^2/(2\kappa_0)$ replicates most of the improv. up to l ~ 1000

→ Bispectrum is the dominant contributor (consistent with Takada & Jain 2003).



Seo et al. in preparation

Future direction

- Advantages of the log transform of κ

- S/N increase

- Nearly diagonal covariance matrix

- a shortcut for joint analysis of 2, 3, and higher correlation functions.

- Will investigate improvement in the precisions of sigma8 and dark energy parameters using Fisher matrix analysis based on simulations (Masanori Sato is running sims right now).