GAME OF CONES

Non-Gaussian WL Convergence PDF
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with
A. Barthelemy, S. Codis,
R. Gavazzi, F. Bernardeau

Cora Uhlemann
DAMTP & Fitzwilliam College
Counts-in-cells

One-point statistics

non-Gaussian matter distribution

Density in cell probability

\[
\rho(\rho_0) = 0.7, \quad R = 10 \text{ Mpc}/h
\]
COUNTS-IN-CELLS

matter density in symmetric cells

symmetry statistics ↔ dynamics
Large-deviation theory

initial PDF: large deviations exp. unlikely

\[ \mathcal{P}_r^{\text{ini}}(\delta_L) \sim \exp \left[ - \frac{\delta_L^2}{2\sigma_L^2(r)} \right] \]

final PDF: most likely path dominates

\[ \mathcal{P}_{R,z}(\rho) \sim \exp \left[ - \frac{\delta_L(\rho)^2}{2\sigma_L^2(z, r(R, \rho))} \frac{\sigma_L^2}{\sigma_{NL}^2} \right] \]

Bernardeau 94, Valageas 02
CU, Codis ++ 16, Ivanov++ 19

expansion param
local primordial non-Gaussianity

Log10[\mathcal{P}(\rho)] for f_{NL}

\(f_{NL} = +100\)
\(f_{NL} = 0\)
\(f_{NL} = -100\)
local primordial non-Gaussianity

density-dependent clustering

 Counts-in-Cells

\[ b(\rho, f_{NL}) - b(\rho, 0) \]

\[ \rho \]

CU, Pajer++ 18
COUNTS-IN-CONES

weight matter density in slices

\[ \delta_{\text{disk}} \theta_\mathcal{D}(z) w(z, z_s) \]

lensing weight
WL CONVERGENCE

weight matter density in slices

lensing convergence

\[ \kappa_{< \theta} = \int_0^D(z_s) dD(z) \delta_{\text{disk}}^{\theta D(z)} w(z, z_s) \]

Mellier 99
weight matter density in slices

cumulant generator

\[ \phi_{\kappa}^{\omega}(\lambda) = \int_{0}^{D(z_s)} dD(\tilde{z}) \phi_{<\theta d}(\tilde{z}) (\lambda w(z, z_s)) \]

→ PDF Bernardeau & Valageas 02
WL CONVERGENCE

$z_s = 1.5$

NO NULLING

- $\theta = 10$ arcmin
- $\theta = 20$ arcmin
- $\theta = 30$ arcmin
- $\theta = 40$ arcmin
- $\theta = 50$ arcmin
towards low convergences, the LDT prediction captures relatively well the red curves), the distribution clearly gets more skewed for a pure Gaussian is clearly seen and well reproduced by Gaussian case, especially in the tails where the departure from a linear asymptotic behaviour of slope given by the CGF a linear asymptotic for its r.m.s value of slope given by the mean convergence). In addition, the lower panel shows the tails of the distributions (ie for large deviations from the critical value, ensemble averages of maximum value of \( \kappa \)) displays the CGF for three source redshifts and for different opening angles from 10 arcmin (red) to 50 arcmin (blue). This is because above a free parameter to match the data. Hence, we are only considered in subsamples. Similarly to the 3D case, this approach is imposed by definition to be zero and the variance is chosen as labelled. The source redshift is fixed here to 1.5. Solid lines display the LDT predictions given by equation (8) along the real axis for the projected SCGF/CGF.

Fig. 3. One point PDF of the weak-lensing convergence for 3 weak-lensing convergence PDFs with a log-scale to highlight the exponential decay in the middle panel displays the maximum of the PDF while the right panel shows the skewness as a free parameter to match the data. Hence, we are only interested in its shape which arises directly from the Legendre transform of the PDFs. A way to circumvent these issues by means of a nulling procedure will be presented in section 6.

Fig. 4. The maximum of single PDF for different opening angles from 10 arcmin (red) to 50 arcmin (blue) along the real axis for the simulated SCGF/CGF. This is because above a free parameter to match the data. Hence, we are only interested in its shape which arises directly from the Legendre transform of the PDFs. A way to circumvent these issues by means of a nulling procedure will be presented in section 6.

Fig. 5. The maximum of single PDF for different opening angles from 10 arcmin (red) to 50 arcmin (blue) along the real axis for the simulated SCGF/CGF. This is because above a free parameter to match the data. Hence, we are only interested in its shape which arises directly from the Legendre transform of the PDFs. A way to circumvent these issues by means of a nulling procedure will be presented in section 6.

Fig. 6. The maximum of single PDF for different opening angles from 10 arcmin (red) to 50 arcmin (blue) along the real axis for the simulated SCGF/CGF. This is because above a free parameter to match the data. Hence, we are only interested in its shape which arises directly from the Legendre transform of the PDFs. A way to circumvent these issues by means of a nulling procedure will be presented in section 6.

Fig. 7. The maximum of single PDF for different opening angles from 10 arcmin (red) to 50 arcmin (blue) along the real axis for the simulated SCGF/CGF. This is because above a free parameter to match the data. Hence, we are only interested in its shape which arises directly from the Legendre transform of the PDFs. A way to circumvent these issues by means of a nulling procedure will be presented in section 6.
BEYOND THE WALL

\[ \kappa_{<\theta} = \int_0^{D(z_s)} dD(z) \delta_{\text{disk}}^{<\theta D(z)} w(z, z_s) \]

mix scales
Nulled Convergence

weight 3 source redshifts

\[ w_1 = 0.09 \]
\[ w_2 = -0.89 \]
Nulled Convergence

$P_{\text{sim}}(\kappa_{\text{null}}) / P_{\text{th}}(\kappa_{\text{null}}) - 1$

$\kappa_{\text{null}} / \sigma$

Nulling On
Density-split statistics

DESY1: 10% Euclid, nonG visible
competitive with 3x2pt

DES (Friedrich++ 18, Gruen++ 18)

FIG. 1. Top panel: splitting the lines of sight in one DES-Y1 like Buzzard simulation into 5 quantiles of galaxy density (color coding from cyan, most underdense, to red, most overdense). The map uses a 20 arcmin top-hat radius and RED McGIC galaxies with a redshift range of 0.2-0.45.

Bottom left: histogram of RED MAGI C galaxy counts in 20 arcmin radii (counts-in-cells). We show the mean histogram from 4 Buzzard realisations of DES-Y1 (black points), our model based on perturbation theory and cylindrical collapse (solid line) and a model that assumes the projected density contrast to be a Gaussian random field (dotted line). The color coding corresponds exactly to the density quantiles in the top panel.

Bottom right: lensing signals around random points split by the density quantile in which these points are located. We show the mean measurement from 4 Buzzard realisations (black points), our perturbation theory model (solid line) and a model that assumes projected density contrast and lensing convergence to be joint Gaussian random variables (dotted line). Color coding is the same as in the other panels. The asymmetry between the lensing signals around the most underdense and most overdense lines-of-sight indicates the skewness of the cosmic density PDF.
RECAP: GAME OF CONES

Counts-in-cells
extra nonG information
robust & accurate predictions

Convergence PDF
WL convergence from density slices
fight scale mixing
null small scales