Blend Exclusion Bias

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Summary

- Context
- Simulation Setup
- The measurement
- Results
- Future
The Context

- Blending (and obscuration) occurs between close pairs of galaxy (or luminous objects)
- The shapes of blended galaxies are poorly measured, sometimes down-weighted (as in KiDS)
- Blended pairs are sometimes removed (as in DES)
The Blend-Exclusion Bias

Foreground: Void

Cluster

more blended shapes
The Blend-Exclusion Bias

- Blending rate is higher in high-density regions, e.g. foreground galaxy clusters are more affected than foreground voids.

- Consequently, there are fewer ‘good shapes’ behind clusters... but these are regions of maximal weak lensing signal!

- Observed background sources are therefore correlated with foreground mass, causing a bias on cosmic shear.
In the Literature so far...

- Revisited in JHD+(this work), with KiDS-like and LSST-like N-body sims. Provide fit function and covariance matrix.
Simulation setup
**N-body from the SLICS**

- Scinet LightCone Simulations (JHD & van Waerbeke 2015)
- Ensemble of 900 independent N-body runs (not all used here)
- $L_{\text{box}} = 505 \, \text{Mpc/h}; \, np = 1536^3, \, nc = 3072^3$
- Particle mass = $\sim 2.9 \, \text{E9 M}_{\text{sun}}/\text{h}$
- Resolve $2.9 \, \text{E11 M}_{\text{sun}}/\text{h}$ haloes with 100 particles
- 2D projections and SO Halofinder were run ‘on-the-fly’ at 18 redshifts, up to $z=3$
Ray Tracing

• Ray trace each simulation under multiple thin lens approximation, also assume Born approximation.

• Extract 18 mass, kappa and shear planes for each LOS, with $7745^2$ pixels and covering 100 sq. deg.

• Produce only one Line-of-Sight (LOS) per N-body.

• Extract Haloes within every light cones.
Inpaint galaxies with HOD

- HOD Based on a Conditional Luminosity Function that reproduces well GAMA and KiDS data
- Central positions from halo peaks
- Satellite positions from N_sat, assuming NFW
- HOD produces luminosity/mag
- Final N(z) and gal_density from simulations + HOD + Down sampling
- 20 LSST-like runs, 120 KiDS-like runs (could have 700+)
- Compute shear for each objects, from the maps
The Measurement
The bias:

\[ \beta_{\pm}^{ij}(\vartheta) = \left( \frac{\xi_{\pm}^{ij}(\vartheta)}{\bar{\xi}_{\pm}^{ij}(\vartheta)} \right) \times \left( \frac{\xi^{ij}(\vartheta)}{\xi_{\pm, \vartheta}^{ij} \mid \text{filtered}} \right) \]

If blending was homogeneous, these functions would be flat at 1.0
KiDS-like

$\text{ngal} \sim 7/\text{arcmin}^2$

Centrals
Satellites

Reject both
Reject the faintest
Measurement from mocks
Best fit from mocks

\[ \beta_{\text{fit}}(\vartheta) = \frac{1}{(1 + \vartheta^{-\alpha_1})^{\alpha_2}} \]
...In the Data...

DES-SV

KiDS
Measurement from mocks at KiDS-depth

\[ \beta^\text{faint} \]

\[ \beta^\text{both} \]

KiDS \[ \vartheta [\text{arcmin}] \]

DES-SV \[ \vartheta [\text{arcmin}] \]

\[ \vartheta [\text{arcmin}] \]

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**LSST-like**

\[ n_{\text{gal}} \sim 26/\text{arcmin}^2 \]

### Graphs

- **Left Graph**
  - Title: Centrals Satellites
  - Y-axis: \( N(z)/\text{deg}^2 \)
  - X-axis: \( z \)
  - Legend:
    - --- Mocks
    - --- Chang+13

- **Right Graph**
  - Title: Reject both
  - Y-axis: Normalized \( N(z) \)
  - X-axis: \( z \)
  - Legends:
    - 1"
    - 2"

### Notes
- Reject both
- Reject the faintest
**LSST-like**

$n_{gal} \sim 26/\text{arcmin}^2$  

$1''$ vs $2''$ blending

- $0.5\%$ effect
- $0.2\%$ effect
- $1-2\%$ effect
- $0.5\%$ effect
Future Considerations

- MacCrann+2017 showed that this is degenerate with baryon feedback models.
- This is also degenerate with an ‘angle-dependent m-calibration’, as in Samuroff +(2017).
- Could measure with DC2 simulations and investigate the effect of realistic noise, morphologies, PSF, de-blending algorithms, etc.
- Could influence the angular scales we analyse?
- Others?
Summary

- Blend exclusion bias affects cosmic shear measurement at ~1-2% at small scales.
- This effect can be understood and quantified from tailored N-body simulations.
- We advocate for marginalisation over this effect, and provide a simple fit function.
- Other ideas?