

Update on Metacalibration for Weak Lensing Shear Measurement

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Outline

- ▶ Metacalibration
- ▶ Selection Effects
- ▶ Metacal on Y1

Shear Accuracy Requirements

- ▶ In order to measure the Dark Energy equation of state to the desired accuracy for DES/LSST, we must measure shear with exquisite accuracy.

$$\gamma = (1 + m) \times \gamma_{true} + c$$

- ▶ LSST Requirements
 - ▶ Multiplicative errors: $m \lesssim 0.001$
 - ▶ Additive errors: $c \lesssim 0.0001$

Metacalibration Idea from Eric Huff

- Say we have a biased shear estimator e . Then we can write

$$e(\gamma) = e|_{\gamma=0} + \gamma \left. \frac{\partial e}{\partial \gamma} \right|_{\gamma=0} + \dots$$
$$\approx \gamma R$$

- Use image manipulation to estimate the derivative of the estimator with respect to shear

$$R = \frac{e(+\Delta\gamma) - e(-\Delta\gamma)}{2\Delta\gamma}$$

- Deconvolve the PSF
- Shear the image by a small amount
- Reconvolve by the PSF. Use a slightly larger PSF to suppress the noise amplification

Metacalibration Idea from Eric Huff

- ▶ Corrects for modeling biases
- ▶ Corrects for *ordinary* noise-related biases
- ▶ Works well at high shear.

Correlated Noise

- ▶ These convolutions and shears result in *correlated noise*. I have shown previously how to correct for this by adding a cancelling noise field.

Recent Work: Selection Effects

- ▶ Applying a selection to objects, for example on the signal-to-noise ratio S/N , can indirectly select the shapes of galaxies and result in a biased shear recover.
- ▶ For example, putting a threshold on S/N tends to select less elliptical galaxies.

Selection Effects

- Say we have a selection function S

$$\langle e \rangle = \int S(e) P(e) e \, de, \quad (1)$$

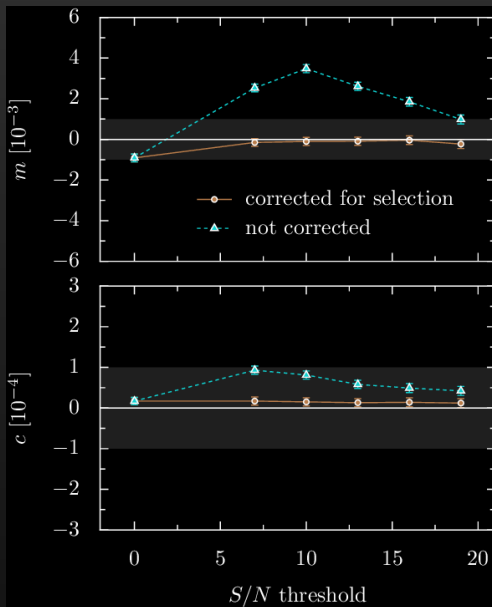
- We can use the same quantities we have already calculated to correct for selections.

$$\begin{aligned} \left. \frac{\partial \langle e \rangle}{\partial \gamma} \right|_{\gamma=0} &\approx \langle R \rangle + \frac{\langle eS^+ \rangle - \langle eS^- \rangle}{2\Delta\gamma} \\ &\equiv \langle R \rangle + \langle R_S \rangle, \end{aligned} \quad (2)$$

Where $\langle eS^+ \rangle$ represents the mean unsheared shape, with selection applied to the positively sheared parameters. Similar for $\langle eS^- \rangle$.

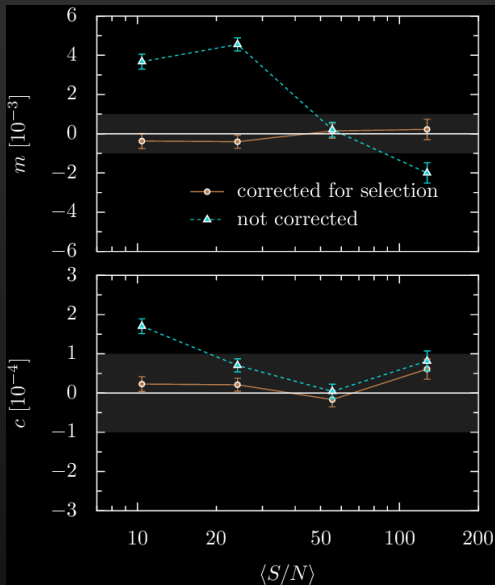
S/N Thresholds

- Select objects with S/N greater than some threshold.



S/N Ranges

- Select objects with S/N within a range.



Issues for Metacal on Real Data

- ▶ For FFTs need to replace bad pixels and masked regions.
- ▶ I've shown that using the best-fit model works fine as long as the mask fraction isn't too high. E.g. epochs in which an object is near an edge should be removed.
- ▶ To perform null tests, the terms to correct for selection effects must be applied

Metacal on Y1

- ▶ I've run on a stripe 82 using the recently released MEDS files
- ▶ The null tests are not passing yet.
- ▶ We also see issues in the most recent multi-object fitting run; I suspect a bug was introduced into the PSF fitting code.

Metacal on Y1

- ▶ Despite the known issues, it would be good to begin testing with the catalogs to become familiar with the corrections for selection effects.
- ▶ The recent run is `us82-001` and is in the “usual” place
 - ▶ `$DESDATA/wlpipe/us82-001` at BNL
 - ▶ On the web at `DESDATA=http://www.cosmo.bnl.gov/Private/gpfs/workarea/desdata`
- ▶ Example code for doing null tests can be found at
 - ▶ https://github.com/esheldon/ngmixer_tests.
 - ▶ See the `ngmix_tests.averaging` module
 - ▶ E.g. `PSFShapeBinner`