WL H2: Star/Galaxy separation

Or, can we use galaxies to learn about the PSF?

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Outline

- Previous work
- Custom galaxy catalogues, simulations.
- Open questions/issues





Motivation

• "the requirements for the star-galaxy separation algorithm are somewhat uncertain, so we need to provide Data Management better requirements for the algorithms they are developing. In particular, for the former, we need to know how many non-stellar objects (small galaxies, binary stars, stars with cosmic rays, etc.) may be permitted to be used for PSF estimation."





Previous work

- See document on (WL-H-2 web page):
 - Compare performance of different PSF interpolation algorithms using perfect star selection. Metric: correlation function of ellipticity residual at a point (model – true) – 'spurious shear correlation'.





FIG. 1: Spurious shear correlation function for polynomial PSF interpolation for a perfect star selection using different cuts on star SNR.

FIG. 2: Spurious shear correlation function for PSFEnt interpolation, for a perfect star selection using different cuts on star SNR.





Previous work

- See document on (WL-H-2 web page):
 - Contamination of the selected "star" sample of ~30% (from mis-identified galaxies) have no impact on the performance of psfEnt?







FIG. 12: Comparison of spurious shear for perfect star selection, a two-dimensional cut and a cut on NN output, for the PSFEnt interpolation method, with no cut on object SNR.





Plan:

- Follow-on question: can galaxies actually be useful in determining the PSF?
 - Focus on whether small, round galaxies can help.
- Procedure: add low-SNR galaxies to star selection and evaluate PSF interpolation methods.
- Figure of merit: correlation function of ellipticity residual
 - Model true ellipticity at a point
- For this I will need galaxies with real cosmological shear!



DESC Input galaxy catalogues

- See PhoSim power users session for details!
- Take DES mocks catalogues (from Risa Wechsler), mash the cosmology (ra, dec, redshift, shear) into the existing Millenium-based mocks.
 - DES mock galaxies and Millenium mock galaxies matched by redshift bins.
 - colour information is not propagated from DES mocks.
- Draw instance catalogue using catsim.
- Run this through phosim.
- Run sExtractor over the resulting eimage.





- Simulate separate images of stars and images of galaxies, for 100 atmospheres.
 - Also simulate a grid of 18th mag stars, to sample the PSF evenly across the field.
 - Simulate galaxies with and without shear applied.
- Simulate one chip at a time. Each set of 100x4 chip images takes ~2400 CPU hours, takes up ~50 GB disk space.
 - Using 3 chips for now.
 - Evaluating each chip individually, not interpolating PSF across chip boundaries.





• Stars



Galaxies (with shear)



• Grid of 18th mag stars

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→ This is a lot of data! would this dataset be of use to anyone else?



DESC Input galaxy catalogues

Sextractor galaxy properties for a single exposure







 Match objects across the 100 exposures (by measured ra/dec), and average their properties.







Correlation functions







 Adding galaxies with SNR<10 makes no discernible different to correlation function, but adding all galaxies seems to help a lot!





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 Adding galaxies with SNR<10 makes no discernible different to correlation function, but adding all galaxies seems to help a lot!







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• Compare uncorrected ellipticity correlation function for stars and galaxies:







- Compare ellipticity correlation function of galaxies, and the grid of stars.
- No idea what's going on here!
- Doesn't matter if I weight by SNR when I calculate the correlation function...





 Adding all galaxies appears to improve matters, but it's actually due to the oddly lower selfcorrelation function exhibited by galaxies compared to grid of stars.







- Figure out this business of the correlation functions!
- Answer the question of whether unresolved/low SNR galaxies can inform the PSF interpolation function.
- Coming at it from the other end:
 - Matt Becker has an idea of using the fact that galaxies are intrinsically the same shape to constrain the PSF over multiple exposures ('PSF afterburner'). Plan to explore this using galsim.



Extra Slides

DESC What does this give me?

- 3 chips of $13 \text{arcmin}^2 \rightarrow 507 \text{ arcmin}^2 (0.14 \text{ deg}^2)$
- ~2.3 stars/acrmin², 4 gals/arcmin², (~10 stars/arcmin² on the grid).
- Limiting magnitude 22.5.
- Image data: 150 GB
- Sextractor catalogues: ~10 GB
 - \rightarrow This is a lot of data!

..... would this dataset be of use to anyone else?





 Requirement on 'stellar' ellipticity restricts number of available galaxies in a single exposure.







PSF correction

- Do psf correction in each eimage, using KSB as implemented in the imcat pipeline.
 - PSF evaluated using only stars, interpolated using a 5th order polynomial.
- Match objects across the 100 atmospheres, average their properties...

