The REGLENS method

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Software Pipeline

- SDSS software (PHOTO) does basic image processing (sky estimation, deblending, star-galaxy separation, PSF measurement)
- Use PHOTO outputs as inputs to PSF-correction code (re-Gaussianization)
- Final object selection and processing

PHOTO processing

- For STEP: David Johnston, Robert Lupton
- Deblending: meant for less crowded fields
- Star-galaxy separation: compare PSF versus cmodel magnitudes
- PSF estimation (details in astro-ph/0101420)
  - Uses unsaturated bright (r<19) stars
  - Fits for Karhunen-Loève (KL) basis functions
  - Allows polynomial variation of coefficients in both dimensions

Noise properties

- Different for STEP (correlated noise)
- Determine noise structure function

$$S(a,b)=2[\xi_{noise}(0,0)- \xi_{noise}(a,b)]$$

- Noise on shape measurement (e<<1 approximation) expressed in terms of S to get N_{eff}, the effective noise variance per pixel, as a function of object size

$$\frac{S}{N} = \frac{F}{(4\pi\sigma^2 N_{eff})^{1/2}} = \frac{1}{R_2\sigma_\gamma}$$

Geneology of PSF Correction Schemes

Trivial covariance matrix summation	Exact for Gaussian galaxies and Gaussian PSFs when using weighted moments
Linear PSF Correction Bernstein & Jarvis 2002 Appendix C	Accounts for non-Gaussianity of galaxy profile if well-resolved
Linear a4 Hirata & Seljak, 2003 Appendix B	Same as previous method but with linear-order correction for PSF non-Gaussianity
re-Gaussianization Hirata & Seljak, 2003 Section 2.4	Perturbatively accounts for PSF non-Gaussianity, then uses BJ02 on "re-Gaussianized" image

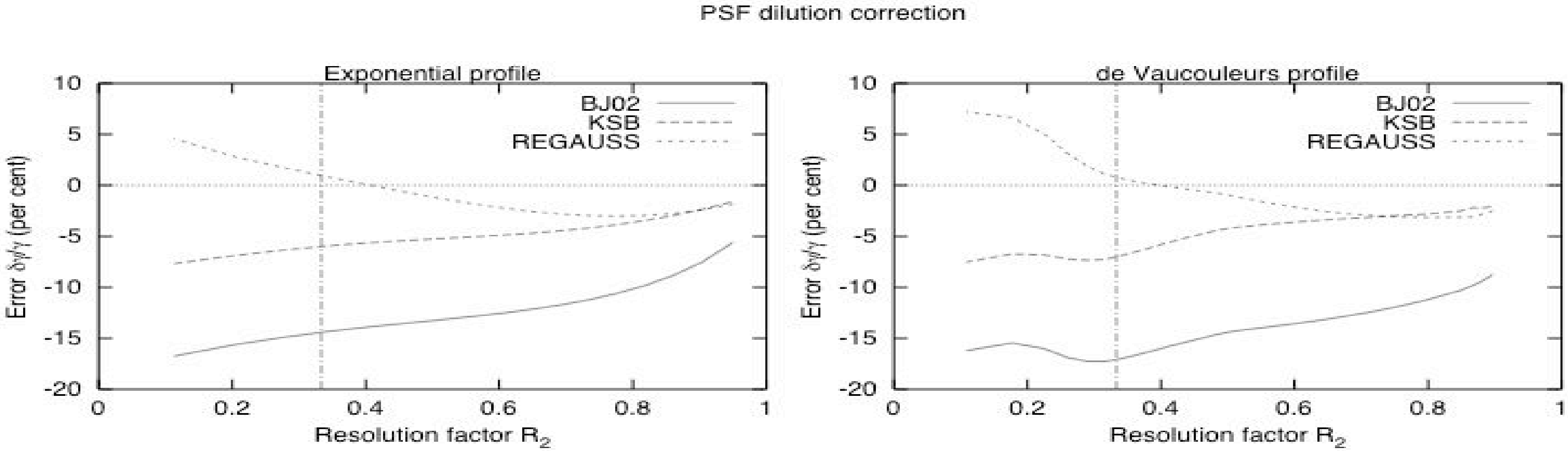
Re-Gaussianization in detail

- PSF g, best-fit Gaussian G (M_G), residual ε
- Measured image I (M_I):

$$I = G \otimes f + \varepsilon \otimes f, \text{ or } I' = G \otimes f = I - \varepsilon \otimes f$$

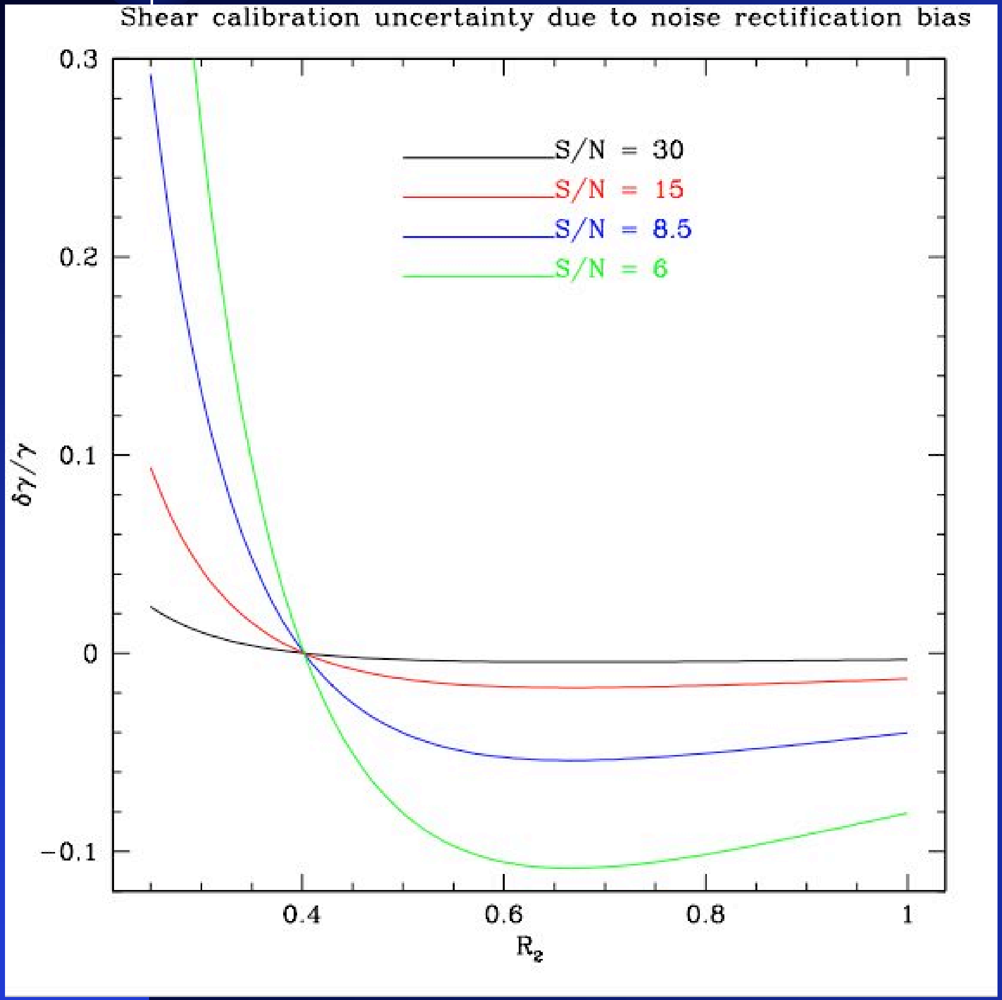
- $|\varepsilon| \ll |G| \Rightarrow$ compute $\varepsilon \otimes f$ using f=Gaussian obtained via $M_f = M_I - M_g$
- Construct I' = galaxy image convolved with Gaussian PSF, compute weighted moments
- Use BJ02 (linear) PSF correction on I'

Performance in simulations



- Noiseless simulations (Hirata & Seljak, 2003)
- Results shown for fixed e=0.30

Object selection



- Require $R_2 > 1/3$
- Require r < 21.8 (SDSS) or S/N on shear measurement > 8.5 (STEP)
- Minimizes PSF dilution
- Avoids worst-case noise-rectification bias (Hirata, et. al. 2004)

Weighting scheme

- Weight by inverse shape + measurement error:

$$w_i = \frac{1}{\sigma_{SN}^2 + \sigma_e^2}$$

- $\sigma_{SN}^2 = \langle e^2 - \sigma_e^2 \rangle$
- More certain for real data than for STEP
- Data: no statistically significant change in mean signal

Shear computation

- Weighted summation over individual galaxy ellipticities performed via

$$\gamma = \frac{\sum w_i e_i}{2 S_{sh} \sum w_i}$$

- Shear responsivity S_{sh} computed using results from BJ02

Current status

- Systematics tests (Mandelbaum et al. 2005, astro-ph/0501201):
  - Placed limits on shear calibration uncertainty
  - Studied effects of redshift distributions
  - Other contaminants (e.g. stellar contamination) constrained
- Bias (Seljak et al. 2005, PRD, 71, 043511)
- Halo ellipticity (Mandelbaum et al. 2005, astro-ph/0507108)
- More to come: intrinsic alignments, dark matter power spectrum, M/L