RRG Method

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WEAK LENSING MEASUREMENTS: A REVISITED METHOD AND APPLICATION TO *HUBBLE SPACE TELESCOPE* IMAGES

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ABSTRACT

The weak distortions produced by gravitational lensing in the images of background galaxies provide a unique method to measure directly the distribution of mass in the universe. However, because the induced distortions are only of a few percent, this technique requires high-precision measurements of the lensing shear and cautious corrections for systematic effects. Kaiser, Squires, & Broadhurst proposed a method to calibrate the ellipticity-shear relation in the presence of point-spread function (PSF) aniso-tropies and camera distortions. Here, we revisit the Kaiser, Squires, & Broadhurst method in the context of the demanding search for weak lensing by large-scale structure. We show that both the PSF and the camera distortions can be corrected for using source moments, as opposed to ellipticities. We clarify the applicability of some of the approximations made in this method. We derive expressions for the corrections that involve only the galaxy moments. By decomposing the moments into spinors, we derive an explicit relation between the shear and the average ellipticity. We discuss the shortcomings of the method and test its validity using numerical simulations. As an application of the method, we repeat the analysis of the *Hubble Space Telescope* (*HST*) WFPC2 camera performed by Hoekstra et al. We confirm the presence of sizable ($\sim 10\%$) PSF ellipticities at the edge of the WFPC2 chips. However, we find that the camera distortion is radial, rather than tangential. We also show that the PSF ellipticity varies by as much as 2% over time. We use these measurements to correct the shape of galaxies in the *HST* Survey Strip (the "Groth" Strip). By considering the dependence of the ellipticities on object size, we show that, after corrections, the residual systematic uncertainty for galaxies with radii greater than $0\rlap{.}''15$ is about 0.4% when averaged over each chip. We discuss how these results provide good prospects for measuring weak lensing by large-scale structure with deep *HST* surveys.

RRG Basics

- **Variant on KSB optimized for space**

- **Used on WFPC2, STIS, ACS data**

- **All measurements and PSF corrections done at the moment level**

- **2nd order (I_{ij}) and 4th order (I_{ijkl}) moments are measured**

- **Stars are measured with a fixed Gaussian weight function**

- **Galaxies are measured with a weight function set by their size**

- **Weighting and PSF corrections are made using moments**

- **4th order moments are used as correction to 2nd order moments**

RRG Shear

- **Shear susceptibility G calculated from all galaxies used in shear measurement**

- **$G=f(I_{ij}, I_{ijkl})$**

- **$\gamma_i = e_i/G$**