Introduction

Weak Gravitational Lensing has long been identified as a prime technique for measuring dark energy (Albrecht et al. 2008). As light from distant galaxies travels to Earth, distortions are imprinted in their shapes and sizes according to the pattern of mass overdensities. This distortion depends both on the evolution of mass clustering and on the angular diameter distances involved, both of which are affected by the dark energy density (and its evolution) directly and in different ways. Because the distortion of the vast majority of distant galaxies is very small compared to the intrinsic

Higher order correlations—the bispectrum

The shear power spectrum does not encode all of the cosmological information contained in the shear correlation functions. Because of non-linear clustering, the three point correlation function, or its Fourier transform, the bispectrum, contains significant signal. Because the bispectrum depends on the geometry of the Universe in a different way than the shear power spectrum (Takada & Jain 2004), measurement of the bispectrum improves the cosmological constraints and reduces the effect of systematic errors in the shape measurements compared to just using the shear correlations.

Cluster Tomography

The distortion of background galaxies behind an individual cluster of galaxies depends only on the ratio of angular diameter distances. Therefore, the cosmological expansion of the Universe is mapped by the amplitude of the distortion as a function of background galaxy redshift. In practice, we average the tomographic signal over many clusters to obtain a cosmological constraint (Jain & Taylor 2003). LSST will measure the angular correlation signal for a sample 100 times larger than any studied so far, yielding a dark energy measure that is competitive with that due to the shear correlations.

Galaxy-shear cross-correlations

In addition to shear-shear cross-correlations, LSST will measure the galaxy-shear and galaxy-galaxy cross-correlations. Because these statistics together can calibrate important systematic errors for either shear or galaxy method alone, combining the measurements greatly improves the cosmological constraints from both methods. Figure 2 shows that systematic uncertainties in the photo-z error distribution can weaken the WL (shear-shear correlations) constraints on the dark energy equation-of-state (EOS) parameters considerably. When all the shear and galaxy cross-correlations are analyzed jointly, the constraints are much tighter and less susceptible to photo-z systematics.

Tests of Theories of Gravity

We will combine the weak lensing results with those from techniques that measure the geometry of the universe (supernovae or BAO) to test the nature of gravity. General relativity and alternate gravity theories (such as f(R) gravity) make different predictions for the relation between the geometry and the growth of structure. Demanding consistency between the different measurements of dark energy can therefore act as an independent test of general relativity. (Wang et al. 2004)

Ellipticity Systematics

Although the combination of different gravitational lensing techniques and the cross-correlation with the galaxy power spectrum provides numerous cross-checks on the effect of shape systematics, LSST will still be in the regime where the largest contribution to the uncertainty in the dark energy parameters arises from systematic errors; see Jee et al. and Chang et al. in this poster session.

References

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