Elliptically Weighted HOLICs for Weak-lensing Shear Measurement. I. Definitions and Isotropic Point-spread Function Correction

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Restriction of cosmological parameters is most important study of Cosmology. These cosmological parameters can express behavior of the universe from early universe to future, and because these parameters contain the dark energy and the dark matter, this restriction is a one of chances to investigate them. One of methods of the restriction is to measure the power spectrum of mass of large scale structure which depends on cosmological parameters, and because gravitational lensing are made by mass distribution, cosmological paramters can be restricted by measuring cosmic shear which is made by mass distoributioin of large scale structure.

Shear is a component of distortion by gravitational lensing and is analyzed by weak lensing analysis method. One of the most widely used analysis is KSB method[1] which measures quadrupole moments, defines ellipticity by the moments and estimates shear from the ellipticity. KSB method can obtain shear easily, but precision is not high by rough correction and approximation. Because cosmic shear is especially weak, it is widely recognised that KSB method doesn't have enough precision. Therefore many new analysis methods and corrections have been developed.

Our studies HOLICs[2] also developed new analysis methods. HOLICs method series can obtain more precise results by using higher order moments. KSB method has a systematic error which is due to approximate a elliptical weight function by a circular weight function. E-HOLICs method can avoid the error by using the elliptical weight. This systematic error can be estimated in simple case. If image is simple elliptical Gaussian which has ellipticity $\delta_{\rm true}$, estimated ellipticity by KSB method $\delta_{\rm estimate}$ is obtained as

$$\delta_{estimate} = \delta_{true}\frac{1-\delta_{true}^2/4}{1-\delta_{true}^2} \qquad (1)$$

Therefore KSB method estimate ellipticity with over-estimation. However, E-HOLICs method can obtain $\delta_{\rm true}$ without systematic error in this situation.

For verification, we tested E-HOLICs method with "Shear TEsting Programme 2" simulation data[3], and obtain the results that KSB method has a systematic error which depended on ellipticity and E-HOLICs method doesn't have the systematic error. Figure 1 shows the result, the horizontal axis means input shear and the vertical axis means difference between estimated shear and input shear, and left hand is plots of the result of KSB method and right hand is plots of the result of E-HOLICs KSB method. We can see the dependencies on ellipticity of these methods.

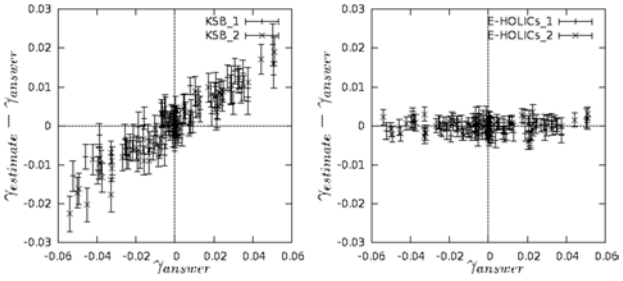

Figure 1: Plots of results of tests of STEP 2. The left side shows results of the KSB method and the right side shows results of the E-HOLICs method, with the selection rh > 3.3 (pixels), S/N > 20, and $|\delta$ intrinsic$| < 1.0$. The horizontal axis represents the value of inputted shear (answer), and the vertical axis represents the value of the difference between estimated shear and inputted shear. The subscripts 1 and 2 are components of directions.

We developed E-HOLICs method which can correct the systematic error which depends on ellipticity which KSB method has. However , there are other many systematic error, for example these depend on S/N. We still must correct much systematic error for analysing cosmic.

References

[1] Kaiser, N., Squires, G., Broadhurst, T.: 1995, *ApJ*, **449**, 460.
[2] Okura, Y., Futamase, T.: 2011, *ApJ*, **730**, 9.
[3] Massey, R., et al.: 2007, *MNRAS*, **376**, 13.