Reducing Systematic Error in Weak Lensing Cluster Surveys

UTSUMI, Yousuke (Hiroshima University)
MIYAZAKI, Satoshi, HAMANA, Takashi (NAOJ)
GELLER, Margaret J., KURTZ, Michael J., FABRICANT, Daniel G. (Smithsonian Astrophysical Observatory)
DEll'ANTONIO, Ian P. (Brown University)
OGURI, Masamune (University of Tokyo)

Weak lensing is a fundamental tool of modern cosmology. A weak-lensing map provides a weighted "picture" of the projected surface mass density and thus a route to identifying clusters of galaxies selected by mass. Subtle issues limit the application of weak lensing maps as sources of cluster catalogs. A serious astrophysical limitation is the projection of large-scale structure along the line-of-sight. An observational limitation is the presence of systematic errors in the maps. In this study we focus on a method of reducing these errors [1].

We use the B-mode signal to quantify this systematic error and to test methods for reducing this error. We show that two procedures are efficient in suppressing systematic error in the B-mode: (1) refinement of the mosaic CCD warping procedure to conform to absolute celestial coordinates and (2) truncation of the smoothing procedure on a scale of 10′. Application of these procedures reduces the systematic error to 20 % of its original amplitude. We provide an analytic expression for the distribution of the highest peaks in noise maps that can be used to estimate the fraction of false peaks in the weak lensing κ-S/N maps as a function of the detection threshold. Based on this analysis we select a threshold S/N = 4.56 for identifying an uncontaminated set of weak lensing peaks in two test fields covering a total area of ~3 deg^2. Taken together these fields contain seven peaks above the threshold. Among these, six are probable systems of galaxies and one is a superposition. We confirm the reliability of these peaks with dense redshift surveys, x-ray and imaging observations. The systematic error reduction procedures we apply are general and can be applied to future large-area weak lensing surveys. Our high peak analysis suggests that with a S/N threshold of 4.5, there should be only 2.7 spurious weak lensing peaks even in an area of 1000 deg^2 where we expect ~2000 peaks based on our Subaru fields.

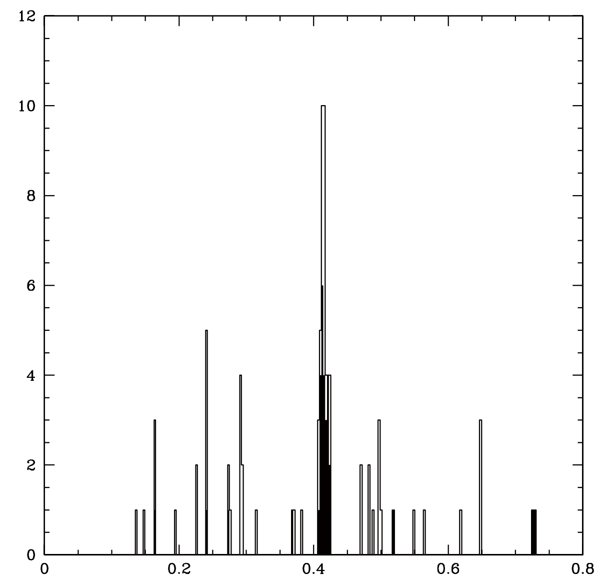

Figure 1: One example of redshift distribution for Peak GTO 00. The filled histogram shows objects within a cone of 3′ radius centered on the weak lensing peak; the open histogram shows objects within a 6′ cone. Bins in redshift are $0.002(1 + z)$ wide.

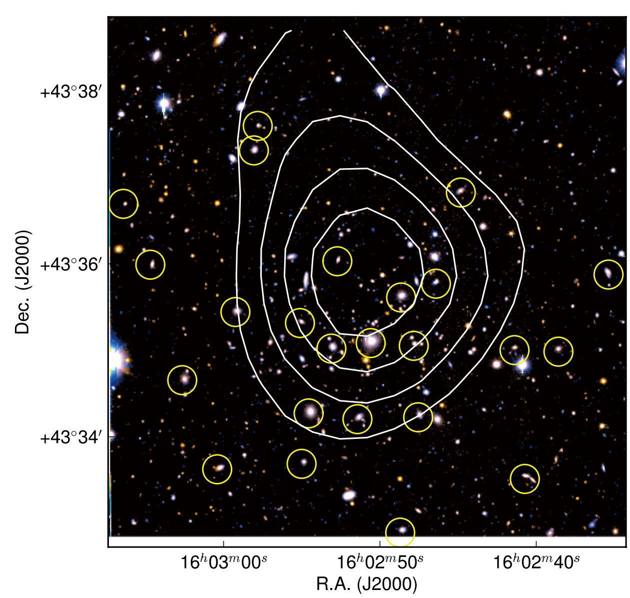

Figure 2: One example of close-up view for Peak GTO 00. The image is 6′×6′. Contours show the weak lensing peak. Small yellow circles identify galaxies in the redshift peak centered at a mean $z = 0.416$.

Reference

[1] Utsumi, Y., et al.: 2014, *ApJ*, **786**, 93.