Workshop Precision Astronomy with Fully Depleted CCDs

POSTER SESSION

Monday November 18th, 2013

1. **STEP mission: High precision Space Astrometry**

Ding Chen (Center for Space Science and Applied Research, Chinese Academy of Sciences)

Search for Terrestrial Exo-Planest (hereafter STEP) mission is a latest advanced research project in Chinese Strategic Pioneer Program (SPP) on Space Science. STEP aims at the nearby earth-alike planets detection, comprehensive research on the planetary system and some astrometry research in the space, which will get the fruitful achievements in the exo-planetary and astrometry research fields. STEP will take the Space Astrometry technique in the optical band which is based on a single-dish 1.2m primary and focus length is 50m. The special metrology technique required to reach 0.5 uas astrometry precision, which will be ideal for terrestrial exo-planets detection. The mission will take the L2 orbit.

2. **Spot Scan probe of edge and midline effects in fully-depleted CCDs**

Paul O'Connor (Brookhaven National Laboratory)

Flatfield images in fully-depleted thick CCDs exhibit systematic nonuniformities near the edges of the chip and elsewhere. The origin of these effects can be due to either the photometric response (quantum efficiency) or the effective pixel area being modified in these regions. As an experimental check to distinguish between the two effects, we performed measurements scanning an artificial star image across the affected regions of one device (e2v CCD250). We find that in these regions (1) the total flux in the spot does not follow the flatfield response, (2) the position of the charge centroid does not follow the centroid of the optical image, (3) there is an increase in ellipticity of the PSF. These results are consistent with charge drift under the influence of combined vertical and lateral electric fields in the thick depleted bulk.

3. X-ray Analysis of Fully Depleted Thick CCDs with Small Pixel Size

Ivan Kotov (Brookhaven National Laboratory)

55Fe X-rays frames offer a lot of information about CCD characteristics. They are traditionally being used for CCD gain and charge transfer efficiency (CTE) measurements. The pixel size of modern scientific CCDs is getting smaller. The charge diffusion causes the charge spread among neighboring pixels especially in thick fully depleted sensors. This enables measurement of the charge diffusion using 55Fe X-rays. On the other hand, the usual CTE characterization method based on single pixel X-ray events becomes statistically deficient. A new way of measuring CTE using shape and amplitude analysis of X-ray clusters is presented and discussed. This method requires high statistical samples. Advances in test automation and express analysis technique allows for acquiring such statistical samples in a short period of time. The details of our measurement procedure are presented. This analysis can reveal CTE problems. The lateral diffusion measured using e2v CCD250 is presented and implications for X-ray cluster size and expected cluster shape are discussed.

4. The GREAT3 Challenge

Hironao Miyatake (Princeton University)

We describe the ongoing weak lensing community data challenge, GREAT3, and the associated open-source image simulation software, GalSim. The GREAT3 challenge has started in October 2013 with the 6 month challenge period. The challenge tests the impact on weak lensing measurements of (a) realistic galaxy morphologies, (b) realistic uncertainty in the point-spread function estimation, and (c) the need to combine multiple exposures when estimating the galaxy shape. It includes simulated ground- and space-based data. We describe some technical considerations for generating the challenge data and for testing weak lensing measurements with the next generation of weak lensing surveys, such as DES, HSC, KiDS, and Pan-STARRS. We also describe possible extensions of GalSim to make the simulation more realistic, which would include more complex and physically-motivated detector models.

5. Impact of Chromatic Effects on Measurements of Galaxy Position, Shape and Flux

Josh Meyers (SLAC National Accelerator Laboratory)

In large astronomical imaging surveys, precision measurements of the fluxes, positions, and shapes of galaxies often depend on measurements made with stars. For example, the size and shape of the point spread function (PSF) are typically determined from the observed images of stars, which are effectively point sources before being smeared by the PSF. Galaxy images can then be deconvolved with the estimated convolution kernel. Implicit in the approach of using stellar PSFs to deconvolve galaxy images is the assumption that the convolution kernel for galaxies is the same as the kernel for stars. If the PSF is dependent on wavelength, this assumption is violated since stars and galaxies have different spectral energy distributions (SEDs). The PSF is determined by the atmosphere (for ground-based telescopes), the optics and the detectors response - all of which can introduce chromatic effects. We discuss how biases on the shape or size of the PSF lead to biases in the estimated ellipticity of a galaxy. We present the results of both analytic studies and simulations of two wavelength-dependent atmospheric contributions to the PSF: differential chromatic refraction and wavelength dependence of seeing. The former leads to differences in the centroid and shape of the PSF, while the latter introduces differences in the size of the PSF, for objects with different SEDs. We find that using the PSF measured with stars to determine the shape of a galaxy that has a different SED leads to significant biases for galaxy shape measurements, primarily due to the wavelength dependence of seeing -- biases that exceed the estimated requirements for weak-lensing measurements, if uncorrected, even for current surveys. We describe the types of chromatic effects due to optics and sensor response that must be understood and measured so that they do not dominate the uncertainties on weak-lensing measurements.

6. PAU: A Fully Depleted Mosaic Imager with Narrow Band Filters

Santiago Serrano (Instituto de Ciencias del Espacio, Barcelona)

The Physics of the Accelerating Universe (PAU) is a survey that aims to study the existence and properties of dark energy from the observations of redshift space distortions and weak lensing magnification from galaxy cross-correlations as main cosmological probes. To accomplish this goal, a camera (PAUCam) and a data management (PAUdm) system are being designed, implemented and commissioned. PAUCam is a mosaic CCD instrument with 18 HPK fully depleted detectors that will be installed at the William Herschel Telescope (WHT) covering a field of view of 1 sq. deg. The camera will be provided with a system of 40 narrow-band (10 nm) filters spanning the wavelength range from 450nm to 850nm, and with 6 wide-band filters, namely u, g, r, i, z, and Y similar to those used in the SDSS and DES surveys. An automated data reduction system has been set up at the Port d'Informació Científica (PIC) Data Center to calibrate and analyze the large amount of data coming from the camera (~300GB/night).

7. DECal Calibration System

William Wester (Fermilab)

Data from the DECal spectrophotometric flat field system installed at the CTIO Blanco 4m telescope has been acquired throughout the first calendar year of operations of the DECam instrument. An initial analysis has been performed that allows for the a measurement of the total system throughput (less atmosphere) – the response of the instrument as a function of wavelength, focal plane position, and time.