Calibrating the PAU Survey’s 46 Filters

Anne Bauer
IEEC/CSIC Barcelona
Physics of the Accelerating Universe

- William Herschel Telescope 4.2m, 40’ unvignetted field of view
- Data acquisition to start in 2013
- PAUCam is being designed, built, and tested in Barcelona and Madrid
- 18 CCDs
  - 8 central,
  - 10 boundary (vignetted)
- 6 broad band + 40 narrow band filters
  - ugriZy + 100Å-wide filters from 4500-8500Å
PAU Survey Goals

• On the order of 100-200 square degrees

• Depth ~24.5 in broad, 23.5 in narrow bands

• Narrow bands give a low-resolution spectrum → photo-z accuracy of 0.0035(1+z) for 70% of all imaged galaxies.

• Main goals: galaxy correlations with good 3D precision
  • Redshift space distortions
  • Weak lensing magnification
  • Photometric-spectroscopic cross-correlations (e.g. DESpec)

see Gaztañaga et al. http://arxiv.org/abs/1109.4852
PAU Data Management

- Nightly Processing Pipeline
- Level 1 products
- Level 2 products
- Data Monitor
- Multi-band & Multi-epoch
- Data Base
- Storage
- Pixel Simulation Pipeline
- RAW
- to science
- data arrival
- data centre
Nightly Pipeline Overview

Exposure Loop
Parallel processing Loop

Night Loop
Serial processing Loop

Instrumental Calibration Initialization

Cosmetics MASK
Master BIAS
Master FLAT

Detrending & Masking

Clean Image
Image MASK + Weight MAP (CR+Cosmetics+Sat)

Source Extraction 1 + Astrometry
Precomputed mosaic solution [ahead]
SExtractor – SCAMP
Calibrated header + PSF model

Source Extraction 2 + Photometric Calibration
SExtractor

Remapping

Data Base

Catalogue Ingestion

DETECTION Objects

REDUCED set
Image REDUCED + Image MASK + Weight MAP

REMAP set

RAW Science

Instrumental Calibration Initialization

Cosmetics MASK
Master BIAS
Master FLAT

Detrending & Masking

Clean Image
Image MASK + Weight MAP (CR+Cosmetics+Sat)

Source Extraction 1 + Astrometry
Precomputed mosaic solution [ahead]
SExtractor – SCAMP
Calibrated header + PSF model

Source Extraction 2 + Photometric Calibration
SExtractor

Remapping

Data Base

Catalogue Ingestion

DETECTION Objects

REDUCED set
Image REDUCED + Image MASK + Weight MAP

REMAP set

RAW Science
Nightly Pipeline Calibration Strategy I

- Broad band filters (ugriZ) can be calibrated against existing data (SDSS, CFHT) with “small” color terms
  - Each filter tray contains broad filters; use the broad band calibration to determine the observation’s extinction (ZP)
  - Extrapolate ZP to narrow bands
- Simple, straightforward
- How accurate is the $\lambda$ extrapolation?
- Only possible for photometric data
- Correlation of photometric errors on a filter tray
Nightly Pipeline Calibration Strategy II

- Create a standard catalog in PAU filters
  - Fit standard catalog’s colors to stellar spectral templates (e.g. Pickles), use the best-fit template to extrapolate the standard catalog to all PAU filters
- Calibration errors less correlated across the filter tray
- Possible with non-photometric data
- Dependent on the accuracy of the stellar templates
Nightly Pipeline Calibration Strategy II

- Create a standard catalog in PAU filters
  - Fit standard catalog’s colors to stellar spectral templates (e.g. Pickles), use the best-fit template to extrapolate the standard catalog to all PAU filters
- Calibration errors less correlated across the filter tray
- Possible with non-photometric data
- Dependent on the accuracy of the stellar templates

Do both strategies
Use agreement as a test (poor template match, bad weather)
Nightly Pipeline Calibration Status

- Strategy II implemented as default
- Diagnostic plots show ZP $\lambda$-dependence
- Tested using the Pixel Simulation
Multi-Epoch Calibration Strategy

- We will have $\geq 2$ observations in each filter
- Übercalibration: find ZPs that minimize the photometric offset between observations over the same area, in the same filter
Multi-Epoch Calibration Strategy

- Übercalibration recalibrates the magnitudes, not colors

- Color refinements / checks
  - Insist on main sequence colors (many-D color space!)
  - Spectrophotometric standards

- Not yet implemented
Pixel Simulation Overview

- Real Bright Star Catalogues (SDSS)
- Model Faint Star Catalogues (Besançon)
- Mock Galaxy Catalogues

Catalogue Factory

SkyMaker

Environmental Conditions model
Survey Strategy model

Observation request

Post-Production

Exposure
Exposure
Exposure
Exposure
Pixelsim Example Outputs

- Need to make it dirty!
 Pixelsim Example Outputs

- Implementing PSF distortions...
Pixelsim Example Outputs

- Implementing PSF distortions...
Calibration Testing status

• Current status:
  • Nightly pipeline runs on PC and GRID, with SQLite or Postgres DB
  • “Default” Sextractor configuration with MAG_AUTO gives ≲1% error (with pretty data)

• Immediate goals:
  • Test photometry’s robustness to, e.g., PSF variations, template uncertainties
  • Evaluate choices in survey strategy

• Longer term goals:
  • Run end-to-end data analyses to test propagation of errors onto cosmological parameters
The PAU Data Management Team

ICE IEEC

Anne Bauer
Christopher Bonnet
Ricard Casas
Francisco Castander
Martin Crocce
Samuel Farrens
Pablo Fosalba
Enrique Gaztañaga
Stephanie Jouvel
Santiago Serrano

EI3C

Eusebio Sanchez
Nacho Sevilla

PIC

Jorge Carretero
Josep Flix
Christian Neissner
Pau Tallada
Nadia Tonello

IFAE

Marino Maiorino
Pol Martí
Ramón Miquel
Carlos Sanchez