Astroschool: Image Calibration

February 20th, 2014
Image Calibration

Why do we have to calibrate?

To remove unwanted signal and noise

- Dark current
- Read out signal/noise
- Uneven field illumination (vignetting and dust donuts)
Why do we have to calibrate?

Light frames contain:
- Signal
- Radial variation
  (Flats correct for this)
- Dark current
- Bias

Flat frames contain:
- Radial variation
- Bias

Dark frames contain:
- Dark current
- Bias

Bias frames contain:
- Bias

Image credit: John Strong, iTelescope.net Facebook user group
Example bias frame
Example dark frame
Example flat frame
Example flat frame (dirty)
Taking Bias Frames

Bias frames are zero-length exposures with the shutter closed (on a DSLR, use shortest exposure time your camera allows)

DSLR: use same ISO

So short in duration, dark current is negligible, so temperature is not important

Take a lot of Bias frames (I use 200)
Taking Dark Frames

Should be same duration as your light frames (DSLR – same ISO, too)

Cover the lens, or keep the shutter closed

Should be taken at same temperature as your lights

Take at least 10, but preferably 20-30
Taking Flat Frames

- Shoot an evenly-illuminated field

  Duration long enough to achieve 1/3 to ½ saturation of pixels

  Same focus as your lights

  DSLR – same ISO and f/ratio as lights, use Aperture Priority (Av)

  Temperature not that important if exposures are fairly short

  Take at least 10, but preferably 20-30.

  If using filters, take flats through each filter
Processing Bias and Dark Frames

Simply integrate (stack)

Average combine, no normalization or weighting

Reject outliers (hot and cold pixels, cosmic ray hits) using Winsorized Sigma clipping
Processing Flat Frames

Start by calibrating – subtract Master Bias
If you subtract Master Dark as well, then make sure the Master Bias is subtracted from the Master Dark first

Stack using average combine,
Multiplicative Normalization,
No weighting,
Pixel rejection: percentile clipping or Winsorized Sigma Clipping,
Equalize fluxes
Calibrating light frames

For each light frame:

- Subtract Master Bias
- Subtract Bias-subtracted Master Dark
- Apply Master Flat (divide light by normalized Master Flat)
Registering light frames

Registration involves aligning each light frame to a reference frame based on the stars in the image.

Be very particular in choosing your reference frame. Choose one with the tightest stars (best focus and seeing). Look at image statistics, like FWHM and eccentricity.

PI: Blink, Image statistics, SubframeSelector script, StarAlignment
Integrating light frames

Image Integration (stacking) involves creating a light master from your individual frames.

Use Average combination

Reject pixels using Winsorized Sigma clipping (if enough sub frames)

In PI, you pick a reference frame for weighting; choose one with best SNR and no artifacts (planes, cosmic ray strikes, etc.)

PI: Blink, SubframeSelector, ImageStatistics, ImageIntegration
Calibration software

PixInsight:  ImageCalibration, ImageIntegration, StarAlignment, BatchPreProcessing

CCDStack
Deep Sky Stacker
IRIS
Maxim DL
Calibration links

Understanding Read Noise:
http://qsimaging.com/ccd_noise.html

PixInsight master calibration frames tutorial:

PI BatchPreProcessing tutorial:
http://www.harrysastrophed.com/Calibration.html

Deep Sky Stacker tutorial:
http://deepskystacker.free.fr/english/theory.htm