Creating a Dark-Current Calibration Image

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Introduction

Detectors show signals which grow the longer one exposes, but are present even when no light is present. This signal is due to thermal noise in the electronics, the so-called DARK-CURRENT. The amount of thermal noise rises rapidly with increasing temperature, so ideally the detector should be cooled as much as possible.

dark-current images are taken with the camera shutter closed so no light falls on the detector. The exposure times used for such images can range from a few seconds for a non-cooled camera to tens of minutes for a very cold one. The average is often normalized to represent the dark-current rate (e.g. in ADU/second) so that it can be applied to images of any exposure time after multiplication by the exposure time.

What observations and preparations does one need?

Take many images of a given exposure time but with no light. These images then consist of the *time-independent* bias contribution (which can be removed using the previous measurement) and the *time-dependent* contribution due to thermal noise, which is what we are trying

to correct for. Of course, the dark-current calibration image should be taken at the same detector temperature as the normal observation.

If the dark-current image has the same exposure time as the raw image, then one simply subtracts it from the raw image, thereby subtracting the bias as well. However, the result will not be as good as if you subtracted the mean/median bias and dark-current obtained from averaging a large number of calibration images.

It pays to combine many dark-current images to reduce the noise. A "set" can consist of one, many, or dozens of images, depending upon how accurately the calibration should be performed. A good rule-of-thumb is that at least 10 images should be used so that statistical errors can be minimized by averaging, and more is better. It will be simpler to keep things organized if you keep the dark-current calibration images in their own sub-directory, e.g. in "`dark/`".

Creating the Average Dark-Current Image

The dark images should be corrected for the bias and combined to produce a median dark image. If they all have the same exposure time, one can simply obtain the median and subtract the median bias. If the dark images were taken with different exposure times but need to be combined, then each image needs to be corrected for the bias, which is independent of the exposure time (subtract the median bias image), and then multiplied or divided by the number which brings it to a common exposure time (e.g. if you have a bias-subtracted dark image taken for 1 minute and another for 3 minutes, then divide the 3-minute image by 3 to bring it to the same exposure level). Only then can one combine the dark-current images by averaging or finding the median.

Using the same techniques as for creating the bias calibration image, it is easy to create a median dark image:

1. Load the raw dark-current images into a stack using the same commands as before: `File > Import > Image Sequence ...`".

2. Assuming that the dark-current images all have the same exposure time, we can also obtain the median image using `Image > Stacks > Z Project ...` and selecting the `Median` option.

3. Since the median image effectively has the bias signal of a single image, we need only subtract our median bias image from the median of the dark-current images: this is done using the general-purpose "image calculator": use the `Process > Image Calculator...` menu item and you will get a dialogue window

which lets you perform arithmetic operations on whole images, pixel-by-pixel. We want to subtract the mean bias which we saved in the file `MedianBias.tif` from the median image obtain from the stack "darks", i.e. "Median of darks" - "MedianBias.tif", and

4. Save the result in a TIFF file for later use (e.g. `MedianDark-Bias.tif`).

Other Activities:

- *Creating a bias calibration image*
- *Creating a flatfield calibration image*
- *Creating a flatfield calibration image from sky-flats*

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