

A decorative graphic on the left side of the slide consisting of two overlapping parallelograms. The front one is blue and the back one is a light green. They are positioned diagonally, with the blue one partially covering the green one.

Calibration Frames

Cheat Sheet



Light Frames

- Aka: subframes, lights, subs
- Images of the actual target object (galaxy, nebula, etc.)
- Many lights are taken and then stacked (averaged out) to have a maximum total exposure time and best signal to noise ratio
- Light frame optimal exposure time depends on sensor, light pollution/skyglow, filter, focal ratio, pixel size, gain/offset
- Light frames contain wanted signal (from the target), shot noise (from the target signal), dark current and associated thermal noise (from heat building up in the sensor), and bias signal and associated read noise (from the circuitry reading the camera pixels)
- Light frames are taken at a certain temperature (of the sensor), gain, offset, and with a certain optical system and configuration



Dark frames

- Dark frames are meant to remove fixed pattern noise caused by dark current, and bias signal / readout signal
- Dark frames are taken by closing the dust cap, making sure there are no light leaks, and that no light hits the camera sensor
- Dark frames should be taken at the same temperature, gain, offset, and even same USB limit for cameras that have it (just in case!), and generally should be of the same length as the light frames
- Dark frames contain both the bias signal and associated read noise, as well as dark current and associated thermal noise
- It is OK to take as many dark frames as possible - dark frames will be stacked, just like lights, to remove the random noise, and keep just the pure bias signal and dark current
- Dark frames from cameras that don't have amp glow (light pattern such as starburst on camera image, even in the absence of light) can be calibrated with bias frames, and then stretched (or optimized) to match light frames of a different length



Bias Frames

- Bias frames should be taken with the dust cover on, while making sure there are no light leaks or light hitting the sensor (same as dark frames)
- Bias frames should be taken at same sensor temperature, gain, offset (and USB limit, just in case) as the light frames (and thus dark frames) they may calibrate
- In theory bias frames should be as short as possible (using the shortest exposure time the camera is capable of) - however some cameras are allergic to that (1600MM, 294MC, others) and require the bias frame to be approximated using a 0.1s exposure (for 1600MM - according to CloudyNights) or even a 1-2s exposures (for 294MC - according to ZWO)
- Bias frame contain the bias signal along with associated read noise
- Bias frames can be used to calibrate and match dark frames with light frames of a different exposure length, if the camera doesn't have amp glow
- Bias frames are so short that taking many is easy
- If many dark frames have been taken to calibrate the proper lights, bias frames are superfluous and can be skipped



Flat Frames

- Flat frames are a type of light frames used to characterize problems with the optical system used (mainly vignetting and dust motes)
- Flat frames can be taken at a different temperature, gain, and offset than light frames
- Flat frames need to be taken through exactly the same optical system than the lights they are meant to calibrate: scope, OAG (which could have caused mechanical vignetting), filter (flats need to be taken per filter!) and camera. Distances must be the same. However, flats are not too sensitive to focus, as long as it's in the same ballpark
- You can take as many flat frames as you like (I take 25 per filter)
- Flat frames can be taken using a flat panel, or using the T-Shirt sky or evenly illuminated white wall method
- My way of taking flat frames is here: <https://youtu.be/HXZU27vEwEs>
- Flat frames can suffer at very short exposure times when using artificial lights, due to flickering of such lights
- I take flat frames of at least 1.5s long, and use a dedicated adjustable flat panel to reach roughly 1/3rd of the histogram
- Flat frames can cause the most headaches to beginners!



Flat Darks / Dark Flats

- Basically dark frames to calibrate flat frames
- Flat frames are typically short enough that they contain almost no dark current and can also be calibrated by bias frames!
- Just like regular dark frames, they should be taken at same sensor temperature, gain, offset, USB limit, and exposure time as the flat frames they are meant to calibrate
- You can take as many flat darks as you wish. I typically take 50.
- Some cameras have trouble taking short exposures for darks. So if the flat darks are too short, this can cause some issues for some cameras. In that case, they need to be changed to longer exposures
- The above problem will not occur if flat frames were 1.5s-5s long to begin with? But to control flat length a flat panel with brightness control is needed



Flow Charts

- Available from DeepSkyStacker Documentation

<http://deepskystacker.free.fr/english/theory.htm>