

Astroschool: Image Calibration



February 20th, 2014

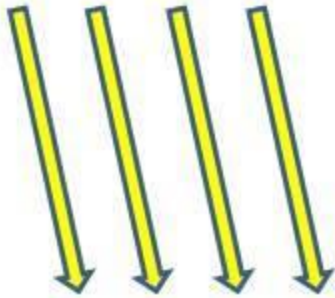
Image Calibration

- Why do we have to calibrate?

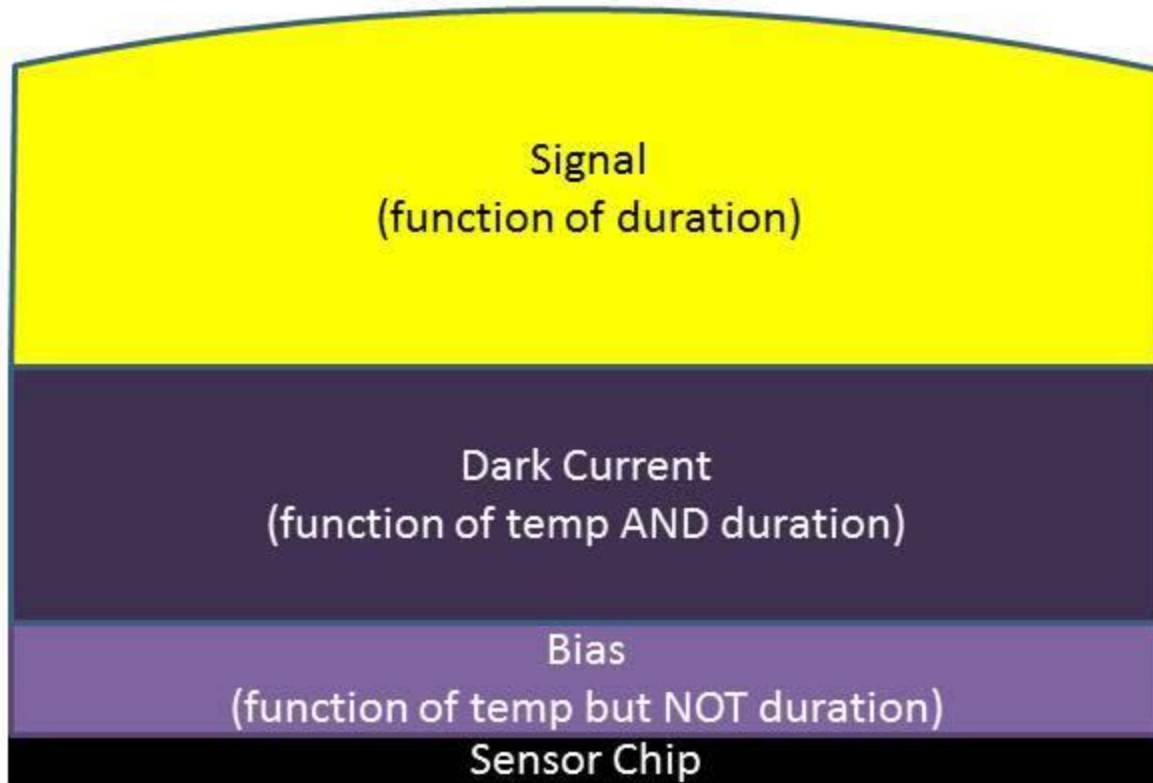
To remove unwanted signal and noise

- Dark current
- Read out signal/noise
- Uneven field illumination
(vignetting and dust donuts)

Photons from object



(not drawn to scale)



Light frames contain:

- Signal
- Radial variation
(Flats correct for this)
- Dark current
- Bias

Flat frames contain:

- Radial variation
- Bias

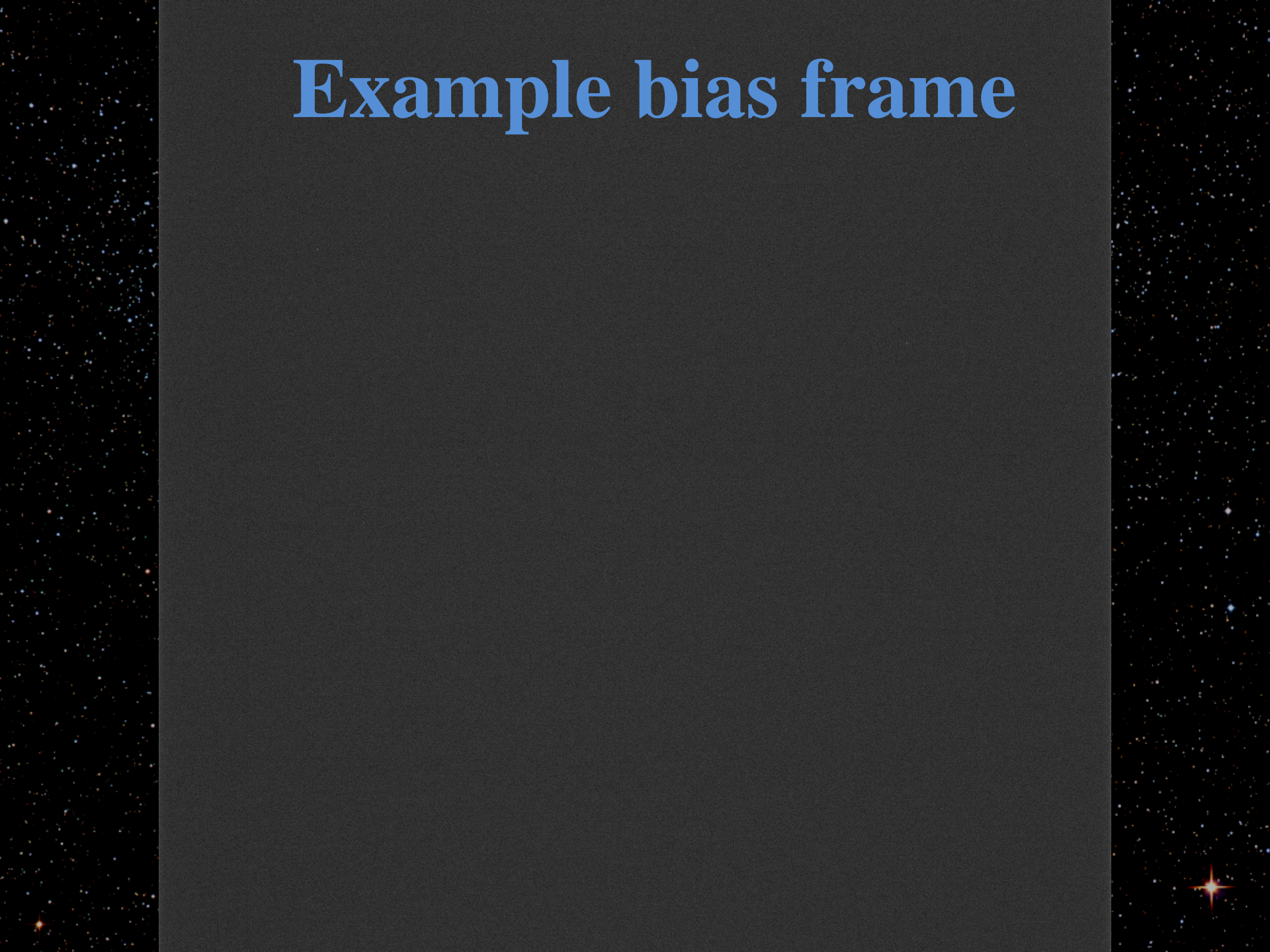
Dark frames contain:

- Dark current
- Bias

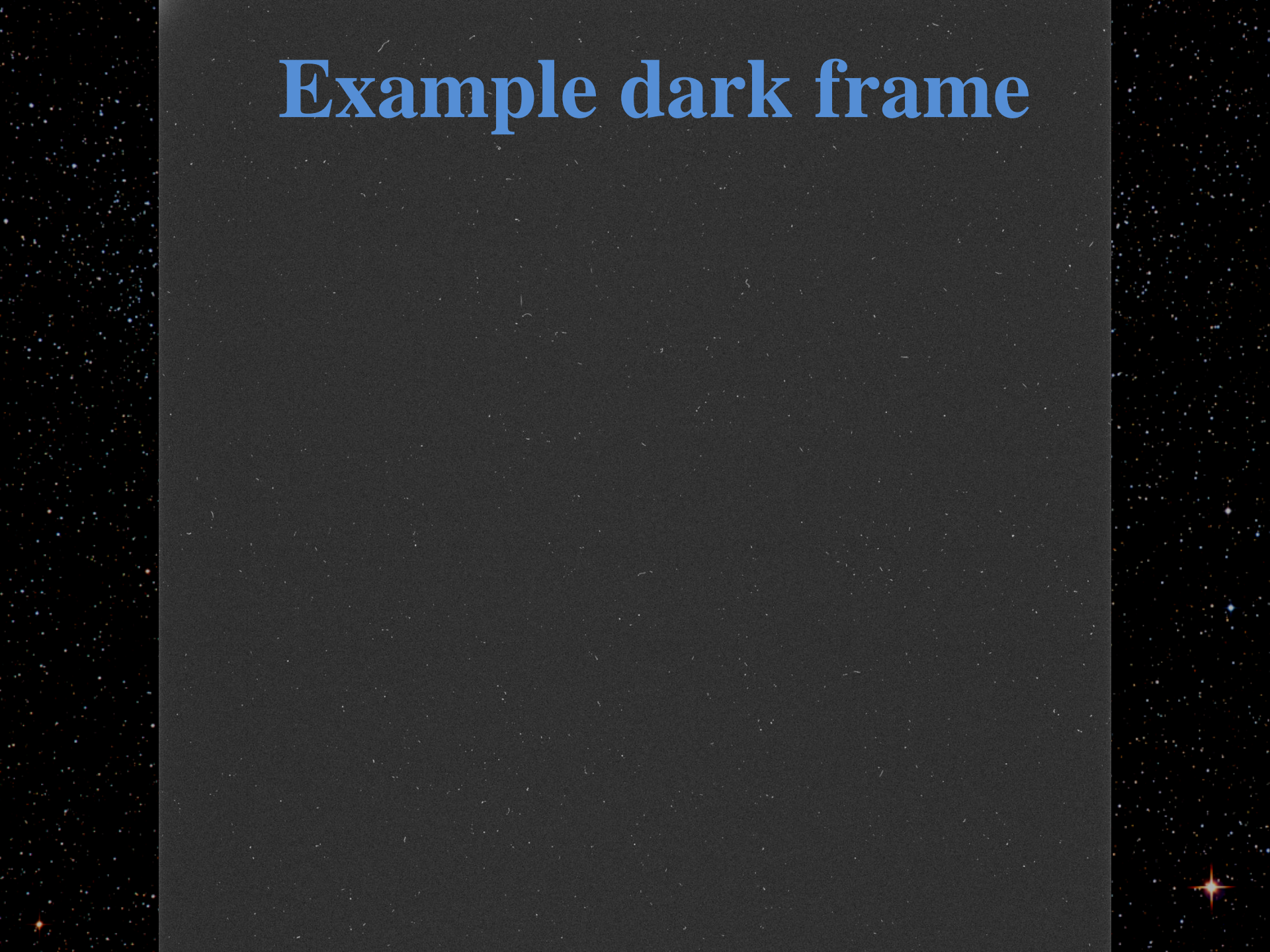
Bias frames contain:

- Bias

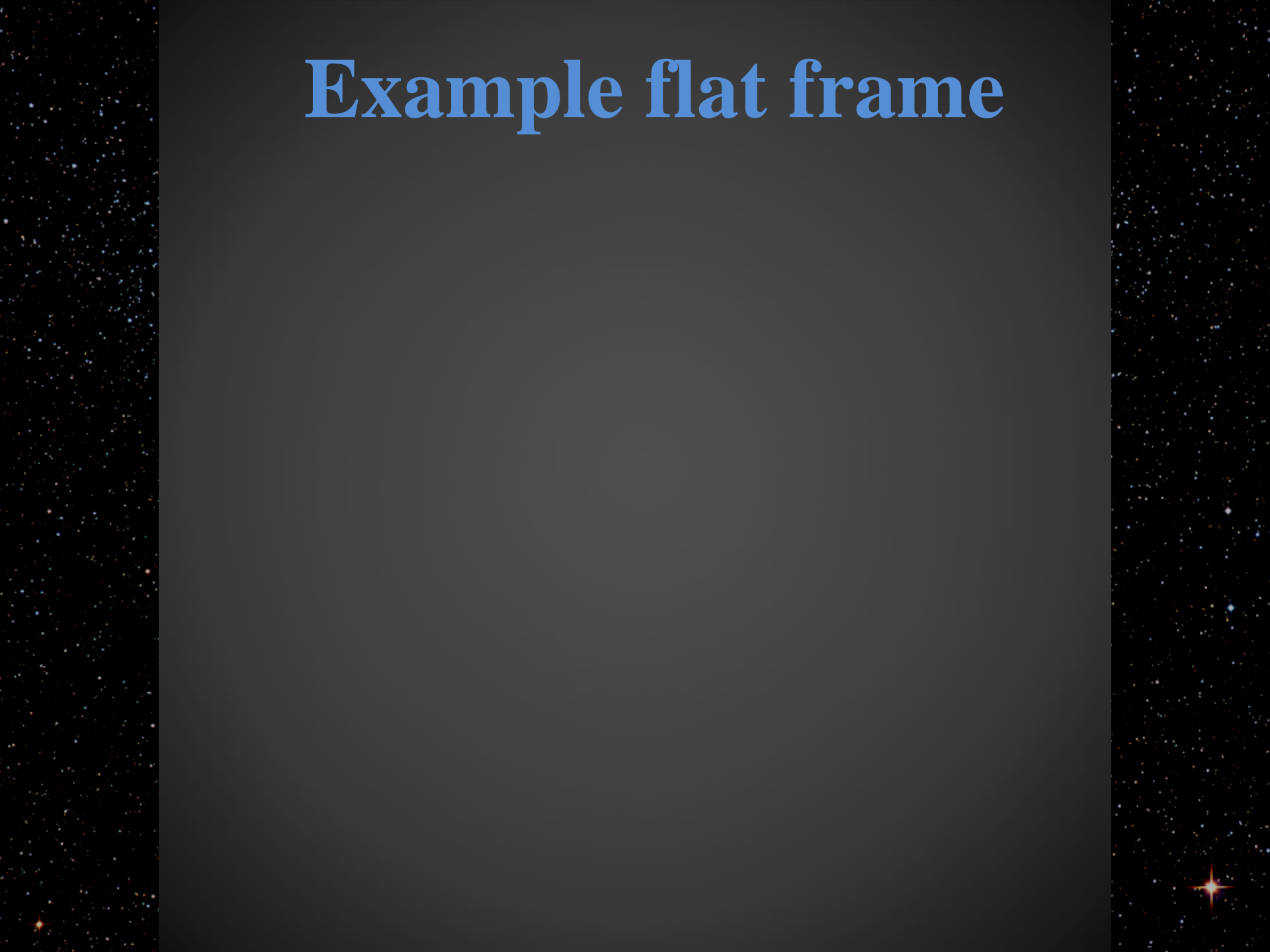
Example bias frame



Example dark frame

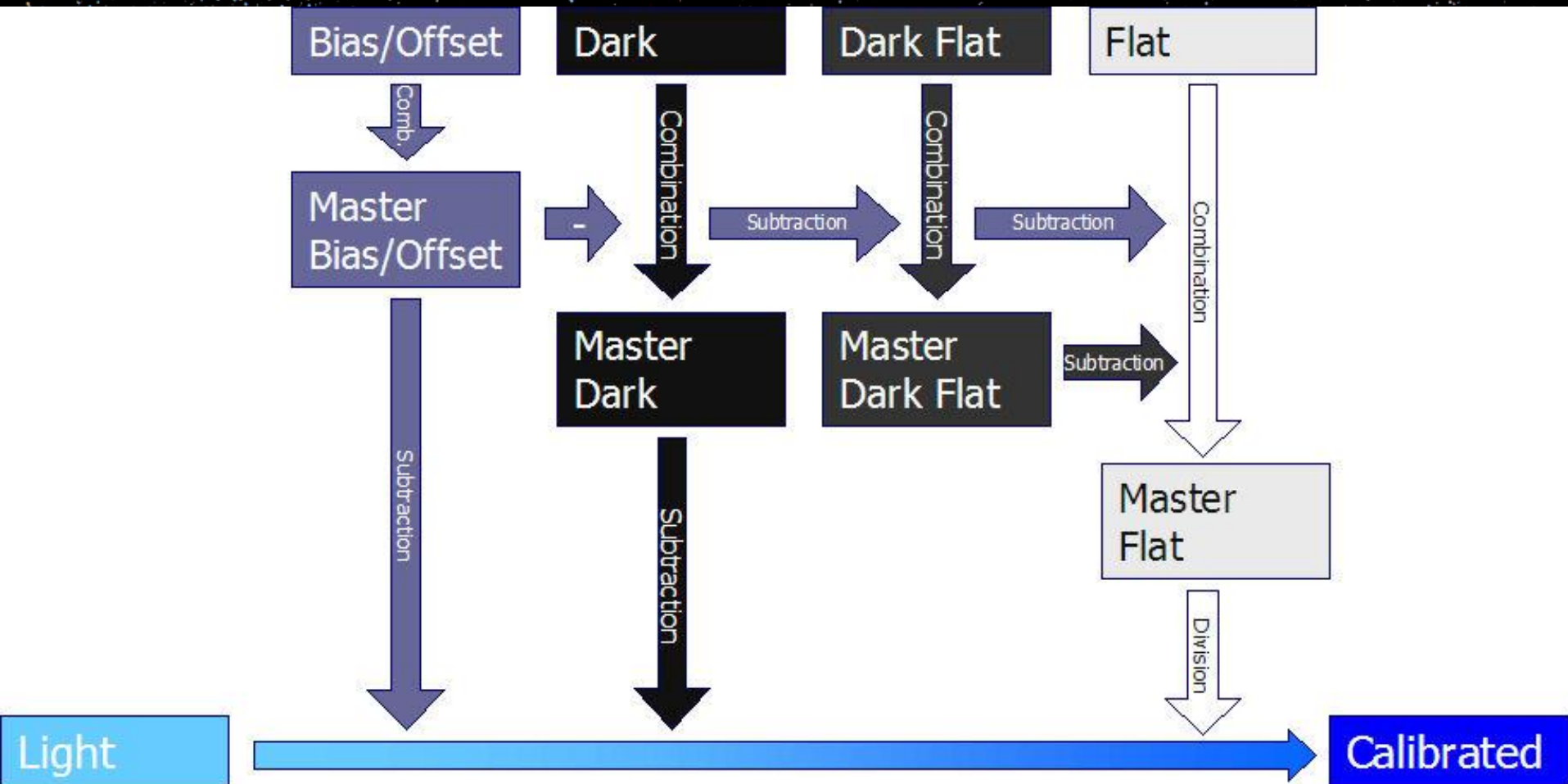


Example flat frame



Example flat frame (dirty)

Image Calibration



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 $1/2$ 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:

<http://pixinsight.com/tutorials/master-frames/en.html>

PI BatchPreProcessing tutorial:

<http://www.harrysastroshed.com/Calibration.htm>

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Deep Sky Stacker tutorial:

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