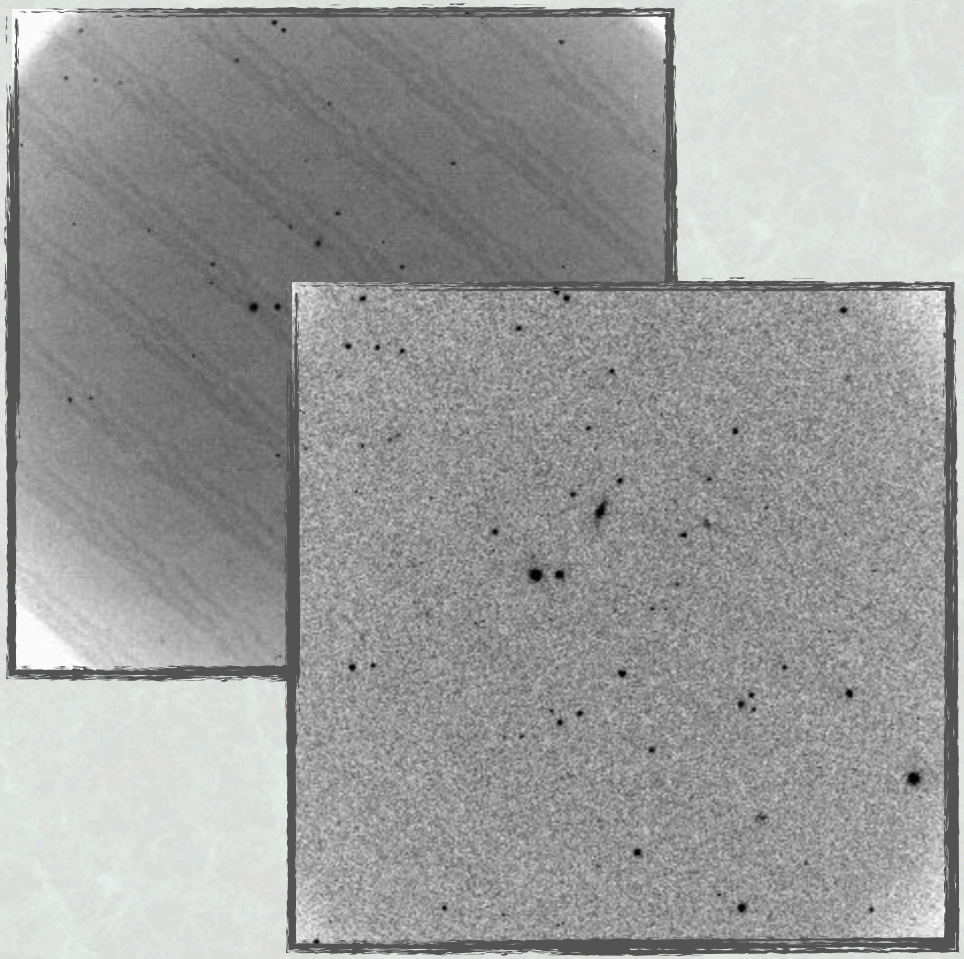
Observational Astronomy & Data Reduction



Lecture 5:
Data Reduction (hands-on!)

https://tinyurl.com/ISYA2018-ObservationalAstro

Go to:
/home/isya/
ObservationalAstronomy/Group#

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Observatório do Valongo

IRAF – get it running!

- Go to /home/isya
  - Type ./iraf on command line —> this will open an *iraf* terminal and a *ds9* window
  - On *iraf* terminal, type:
    - *set stdimage = imt2048*

      Note:

      Will need to type this again if you restart your iraf window. Can also alter this directly on the login.cl file, or better yet, create a loginuser.cl file and input this line.

Reducing your images — what does it mean?

(1) **Remove readout noise**

- Subtract (master) bias image from all images

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- **First, need to create master bias:**
  - Identify all bias frames from the observing run:
    - Use log sheet
    - Verify with image header information

Which information on the header is revealing of a bias?

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    - Use log sheet
    - Verify with image header information
      - With iraf, `hselect bias*fits $I,$EXPTIME yes`

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- **First, need to create master bias:**
  - Identify all bias frames from the observing run:
    - Use log sheet
    - Verify with image header information
      - With iraf, `hselect bias*fits $I,$EXPTIME yes`
  - With *iraf*, imcombine:
    - `imcombine @list MasterBias combine=median`

      OR, if you've set all bias frames in a separate folder:
    - `imcombine *fits MasterBias combine=median`
  - Can also look at the full list of editable parameters:
  - `epar imcombine`
- **Repeat for (master) darks!** (details in a couple of slides)

Reducing your images – what does it mean?

(1) **Remove readout noise**

- Subtract (master) bias image from all images
  - With *iraf*, imarith:

```
imarith AGN2200-181_006 - MasterBias AGN2200-181_006_b
```

Karín's way of keeping track of what has been done to images!

- Repeat for all other images:
  - –> MasterDark_10s_b.fits
  - –> MasteDark_300s_b.fits
  - –> MasterFlat_B_b.fits
  - –> MasterFlat_I_b.fits
  - –> std1_..._b.fits
  - –> std2_..._b.fits
  - –> AGN..._b.fits

Reducing your images – what does it mean?

(2) **Remove dark current**

- **Create master darks** (one for each exposure time):
  - Identify all dark frames (and respective exposure times) from the observing run:
    - Use log sheet
    - Verify with image header information
      - With iraf, `hselect DARK*fits $I,$EXPTIME yes`

—> MasterDark_10s.fits

—> MasteDark_300s.fits

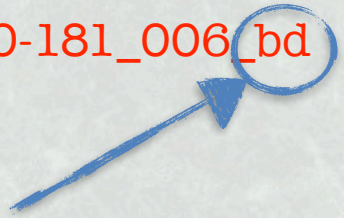
Reducing your images – what does it mean?

(2) **Remove dark current**

- Subtract (master, bias-subtracted) dark image from all (bias-subtracted) images with same exposure time

```
imarith MasterFlat_I_b - MasterDark_10s_b MasterFlat_I_bd
imarith MasterFlat_B_b - MasterDark_10s_b MasterFlat_B_bd

imarith AGN2200-181_006_b - MasterDark_300s_b AGN2200-181_006_bd
```



Karín's way of keeping track of what has been done to images!

Reducing your images – what does it mean?

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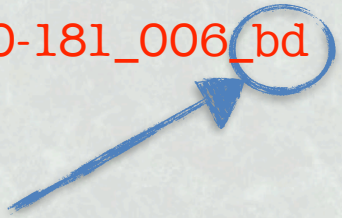
- Subtract (master, bias-subtracted) dark image from all (bias-subtracted) images with same exposure time

```
imarith MasterFlat_I_b - MasterDark_10s_b MasterFlat_I_bd
imarith MasterFlat_B_b - MasterDark_10s_b MasterFlat_B_bd
```

```
imarith AGN2200-181_006_b - MasterDark_300s_b AGN2200-181_006_bd
```



Karín's way of keeping track of what has been done to images!

- **Need to identify which science images are useful**
  - i.e., no need to include field-recognition images
    - Use log sheet
    - Verify with image header information (exptime, filter)
      - With iraf,

```
hselect AGN*fits $I,$EXPTIME,$FILTER yes
```

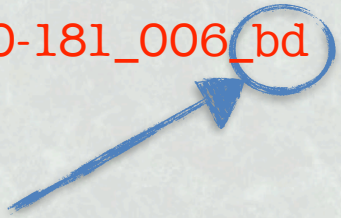
Reducing your images – what does it mean?

(2) **Remove dark current**

- Subtract (master, bias-subtracted) dark image from all (bias-subtracted) images with same exposure time

```
imarith MasterFlat_I_b - MasterDark_10s_b MasterFlat_I_bd
imarith MasterFlat_B_b - MasterDark_10s_b MasterFlat_B_bd
```

```
imarith AGN2200-181_006_b - MasterDark_300s_b AGN2200-181_006_bd
```



Karín's way of keeping track of what has been done to images!

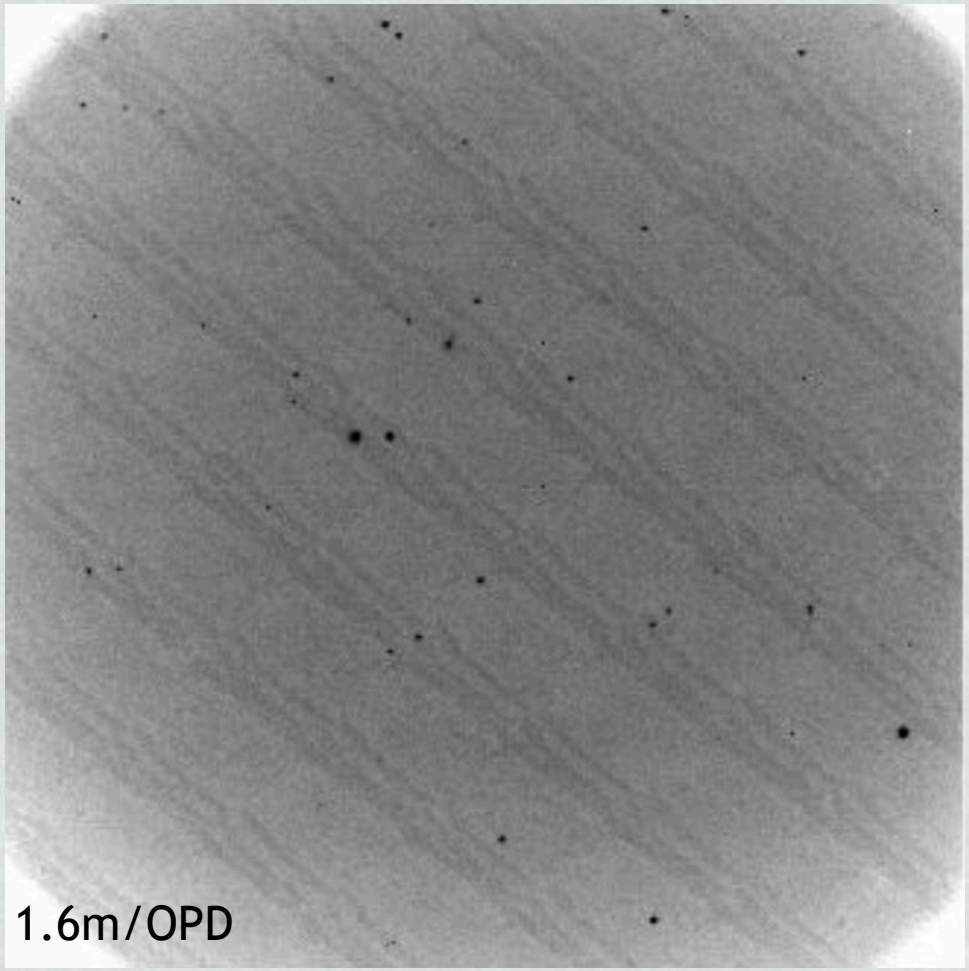
—> MasterFlat_I_bd.fits

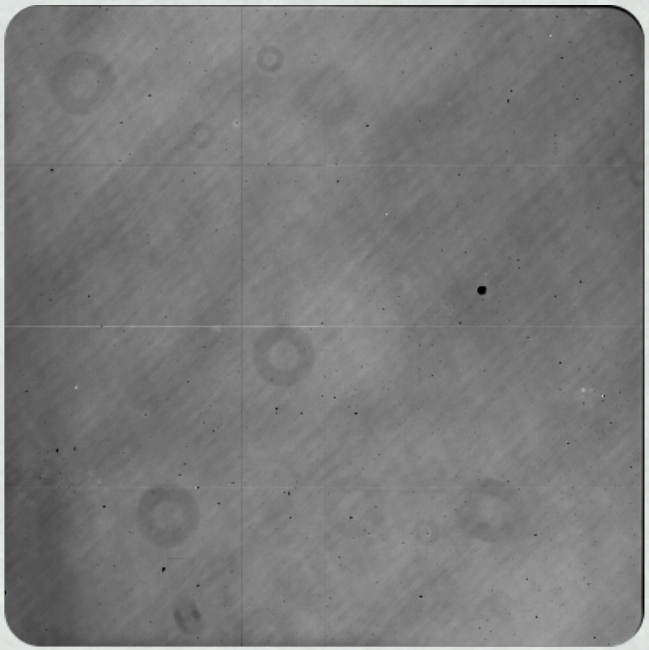
—> MasterFlat_B_bd.fits

—> AGN..._bd.fits

(3) **Flat fielding**

Flat-fielding your images — what does it mean?





http://munipack.physics.muni.cz/flatfielding.html

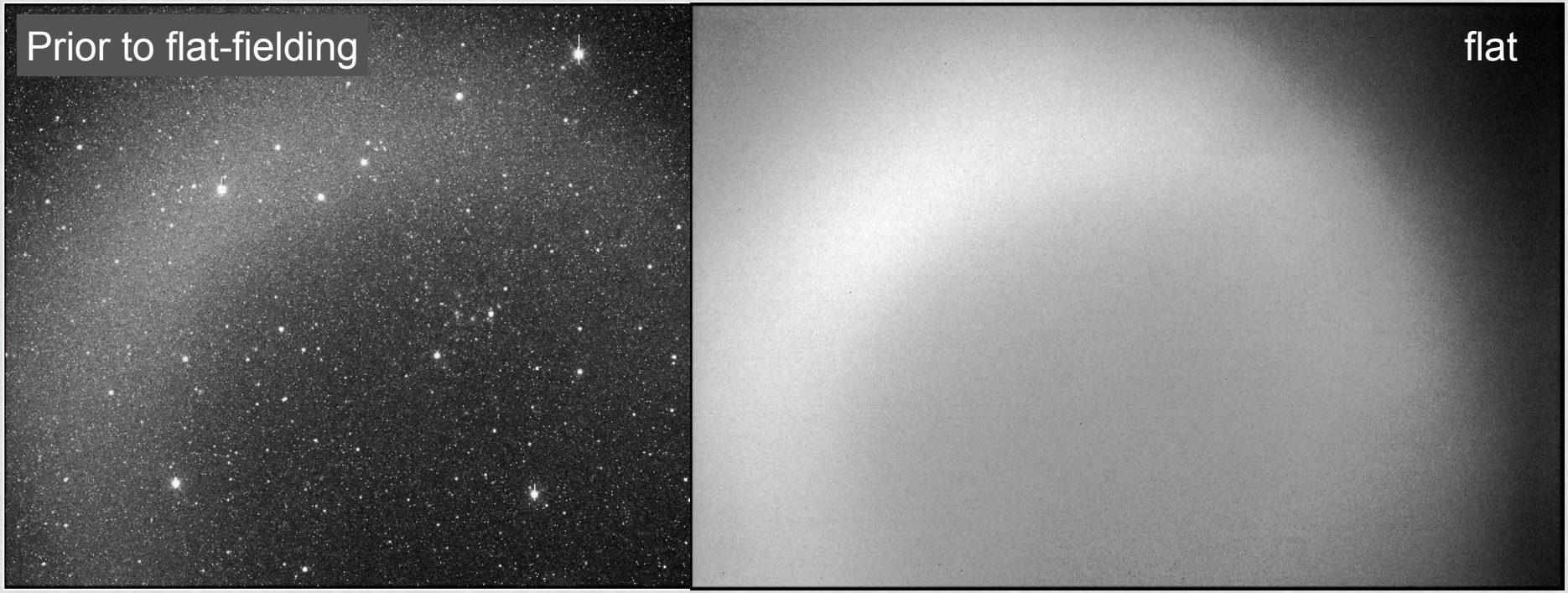
Variations in sensitivity across the focal plane. Three main culprits:

- vignetting
- surface defects of the CCD
- shadows cast by dust

More details:
http://spiff.rit.edu/classes/phys445/lectures/flats/flats.html

Flat-fielding your images — what does it mean?

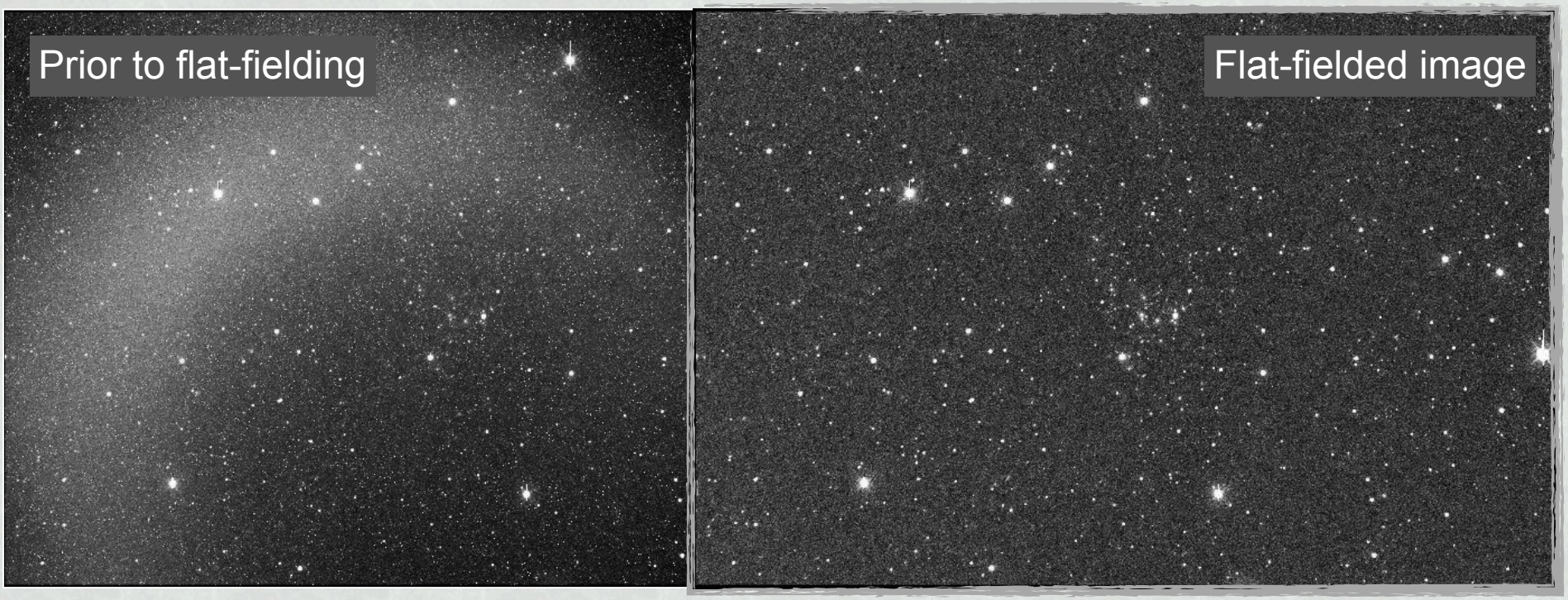
- Objective:
  - give different weights to different pixels to factor in the different pixel sensitivities
- Use the flat field image as a grid of weights: values: —> 1
  - Assign a smaller weight to pixels that are very sensitive and a greater weight to those that are less sensitive



http://www.astro.uni-bonn.de/~mischa/datareduction/superflat.html

Flat-fielding your images — what does it mean?

- Objective:



- To effectively flat-field your science image, divide by the normalized flat
  - The counts in the most sensitive pixels will not change much, while the counts of the less-sensitive pixels will be “pumped up”

http://www.astro.uni-bonn.de/~mischa/datareduction/superflat.html

Reducing your images — what does it mean?

(3) **Flat fielding**

- Divide (bias-/dark-subtracted) images by the normalized, bias-/dark-subtracted (master) flat for each filter
- How do you normalize the master flat?

Reducing your images – what does it mean?

(3) **Flat fielding**

- Divide (bias-/dark-subtracted) images by the normalized, bias-/dark-subtracted (master) flat for each filter
- How do you normalize the master flat?

imstat MasterFlat_B_bd fields="npix, mean, stddev, min, max"

imarith MasterFlat_B_bd / <max> MasterFlat_Bnorm

imarith AGN2200-181_006_bd / MasterFlat_Bnorm **AGN2200-181_006_bdf**

Reduced science image!

—> AGN..._bdf.fits

—> std#_<filter>_bf.fits