Advanced Astronomical Observations 2022
Session 09: Basic CCD Data Reduction 2

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08 April 2022
publicly accessible version

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  - Contact address: `https://www.instagram.com/daisuke23888/`

Try CCD data reduction of optical direct imaging data.

1 Downloading data

Download a set of data.

```
% curl -k -o data_s09.tar.xz \
? https://s3b.astro.ncu.edu.tw/advobs_202202/data/data_s09.tar.xz
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100 1647M  100 1647M    0     0  2343k      0  0:11:59  0:11:59 --:--:-- 3376k
% ls -lF data_s09.tar.xz
-rw-r--r--  1 daisuke  taiwan  1727643756 Apr  7 14:41 data_s09.tar.xz
% file data_s09.tar.xz
data_s09.tar.xz: XZ compressed data, checksum CRC64
```

2 Extracting data

Extract the data. 534 FITS files are extracted from the tar archive file.

```
% tar xJvf data_s09.tar.xz
x data_s09/
x data_s09/lot_20210214_0085.fits
x data_s09/lot_20210214_0086.fits
```

```
x data_s09/lot_20210214_0087.fits
x data_s09/lot_20210214_0088.fits
x data_s09/lot_20210214_0089.fits
x data_s09/lot_20210214_0093.fits
x data_s09/lot_20210214_0094.fits
x data_s09/lot_20210214_0095.fits
x data_s09/lot_20210214_0096.fits
x data_s09/lot_20210214_0097.fits
x data_s09/lot_20210214_0098.fits
x data_s09/lot_20210214_0099.fits
x data_s09/lot_20210214_0100.fits
x data_s09/lot_20210214_0101.fits
x data_s09/lot_20210214_0105.fits

.....

x data_s09/lot_20210214_0957.fits
x data_s09/lot_20210214_0958.fits
x data_s09/lot_20210214_0959.fits
x data_s09/lot_20210214_0960.fits
x data_s09/lot_20210214_0961.fits
x data_s09/lot_20210214_0962.fits
x data_s09/lot_20210214_0963.fits
x data_s09/lot_20210214_0964.fits
x data_s09/lot_20210214_0965.fits
x data_s09/lot_20210214_0966.fits
x data_s09/lot_20210214_0967.fits
x data_s09/lot_20210214_0968.fits
x data_s09/lot_20210214_0969.fits
x data_s09/lot_20210214_0970.fits
x data_s09/lot_20210214_0971.fits
% ls -l data_s09 | head
total 4306
-rw-r--r--  1 daisuke  taiwan  8398080 Feb 15  2021 lot_20210214_0085.fits
-rw-r--r--  1 daisuke  taiwan  8398080 Feb 15  2021 lot_20210214_0086.fits
-rw-r--r--  1 daisuke  taiwan  8398080 Feb 15  2021 lot_20210214_0087.fits
-rw-r--r--  1 daisuke  taiwan  8398080 Feb 15  2021 lot_20210214_0088.fits
-rw-r--r--  1 daisuke  taiwan  8398080 Feb 15  2021 lot_20210214_0089.fits
-rw-r--r--  1 daisuke  taiwan  8400960 Feb 15  2021 lot_20210214_0093.fits
-rw-r--r--  1 daisuke  taiwan  8400960 Feb 15  2021 lot_20210214_0094.fits
-rw-r--r--  1 daisuke  taiwan  8400960 Feb 15  2021 lot_20210214_0095.fits
-rw-r--r--  1 daisuke  taiwan  8400960 Feb 15  2021 lot_20210214_0096.fits
% ls -l data_s09/*.fits | wc
     534    4806   44856
```

3 Checking data

Make your own single Python script to check whether the data set is self-consistent. Execute the script and show the result.

4 Data reduction

Make your own single Python script to carry out CCD data reduction. Execute the script. Check followings.

1. Do all the necessary combined dark frames exist?
2. Do all the necessary dark-subtracted object and flatfield frames exist?

3. Do all the necessary combined flatfield frames exist?
4. Do all the necessary normalised flatfield frames exist?
5. Do all the necessary flatfielded object frames exist?
6. Do combined dark frames look OK?
7. Do combined flatfield frames look OK?

5 Visual inspection of reduced data

Use Ginga to show dark-subtracted flat-fielded frames for visual inspection and compare it to corresponding raw frames. Do reduced frames look OK?

6 For your further reading

1. Read chapter 4 of "Handbook of CCD Astronomy" to learn about basic CCD data reduction.
   - Handbook of CCD Astronomy (2nd Edition)
     - Steve B. Howell
     - Cambridge University Press
     - `https://doi.org/10.1017/CBO9780511807909`
2. Read the document "A User's Guide to CCD Reductions with IRAF" and learn about basic CCD data reduction.
   - A User's Guide to CCD Reductions with IRAF
     - Philip Massey
     - `http://iraf.noao.edu/iraf/ftp/docs/ccduser3.ps.Z`
3. Read the document "An Introduction to Astronomical Photometry using CCDs" and learn about basic CCD data reduction.
   - An Introduction to Astronomical Photometry using CCDs
     - William Romanishin
     - `http://hildaandtrojanasteroids.net/wrccd22oct06.pdf`

7 Exercise

No exercise for this session.