IRAF

Wstępna Redukcja Obrazów

Toma Tomov
CA UMK Torun

Basic preliminary reduction steps

- Removing overscan and bias and image trimming
- Dark current correction
- Flatfielding the images
- Bad pixels fixing

What to use

- For most of the preliminary reduction steps we use the package **noao.imred.ccdred**

```
imred.ccdred:
    badpiximage - Create a bad pixel mask image from a bad pixel file
      ccdgroups - Group CCD images into image lists
       ccdhedit - CCD image header editor
  ccdinstrument - Review and edit instrument translation files
        ccdlist - List CCD processing information
        ccdmask - Create bad pixel mask from CCD flat field images
        ccdproc - Process CCD images
        ccdtest - CCD test and demonstration package
        combine - Combine CCD images
    darkcombine - Combine and process dark count images
    flatcombine - Combine and process flat field images
    mkfringecor - Make fringe correction images from sky images
     mkillumcor - Make flat field illumination correction images
    mkillumflat - Make illumination corrected flat fields
       mkskycor - Make sky illumination correction images
      mkskyflat - Make sky corrected flat field images
  setinstrument - Set instrument parameters
    zerocombine - Combine and process zero level images
```

In the beginning

Before to begin take a look on

A User's Guide to CCD Reductions with IRAF (Philip Massey)

How to start

My suggestion is to start with the headers !

- Set in the image headers all the information you will need by using ccdinstrument package or by hand using hedit or asthedit packages

A good header is half of the work

LRS

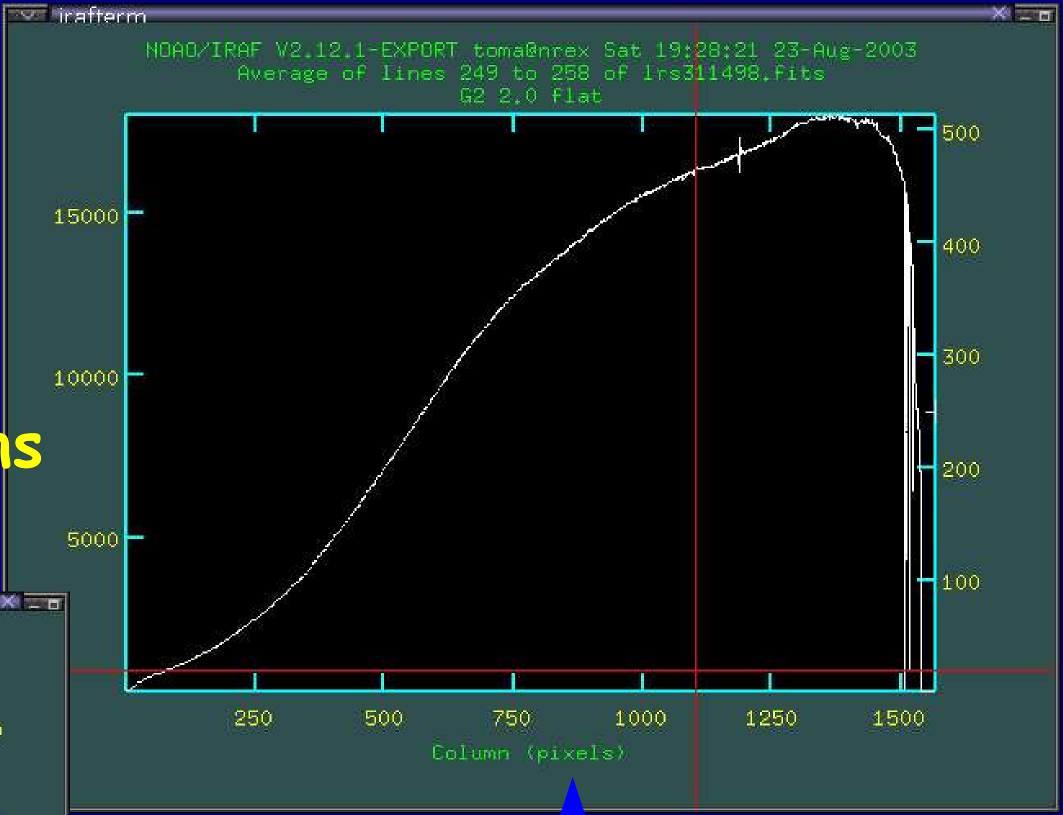
```
BITPIX  =                   16 / number of bits per data pixel
NAXIS   =                    2 / number of data axes
NAXIS1  =                 1568 / length of data axis 1
NAXIS2  =                  512 / length of data axis 2
EXTEND  =                    T / FITS dataset may contain extensions
COMMENT   FITS (Flexible Image Transport System) format defined in Astronomy and
COMMENT   Astrophysics Supplement Series v44/p363, v44/p371, v73/p359, v73/p365.
COMMENT   Contact the NASA Science Office of Standards and Technology for the
COMMENT   FITS Definition document #100 and other FITS information.
BZERO   =                32768 / offset data range to that of unsigned short
BSCALE  =                    1 / default scaling factor
OBJECT  = 'KU And LRS_g2_2.0_GG385' / Object name
OBSERVAT= 'MCDONALD'           / Observatory
OBSERVER= 'Resident Astronomer' / Observers
EXPTIME =               24.000 / Actual integration time
DARKTIME=               24.151 / Total elapsed time
IMAGETYP= 'object  '           / Object, dark, bias, etc.
DATE-OBS= '2002-12-08'         / Date (yyyy-mm-dd) of obs.
UT      = '04:58:07.57'        / Universal time
ST      = '03:09:11.00'        / Sidereal time
MJD     =       52616.20699500 / Modified julian date
RA      = '00:06:58.37'        / Right ascension
DEC     = '+43:06:11.8'        / Declination
EQUINOX =              2000.00 / Equinox of coordinate system
POINT   = 'mean    '           / Point type
HA      = '+03:02:08.04'       / Hour angle
ZD      = '37.90   '           / Zenith distance
AIRMASS =                 1.27 / Airmass
AZIMUTH =               302.10 / Azimuth
PARANGLE=               276.70 / Parallactic angle
STRUCTAZ=               302.52 / Azimuth of telescope structure
X_STRT  =        -5.826085E+01 / X position of tracker at start of exposure
Y_STRT  =         6.260340E+02 / Y position of tracker at start of exposure
Z_STRT  =         1.580782E+01 / Z position of tracker at start of exposure
RHO_STRT=        -2.691200E+00 / Rho position of tracker at start of exposure
THE_STRT=         2.864300E+00 / Theta position of tracker at start of exposure
PHI_STRT=        -2.644000E-01 / Phi position of tracker at start of exposure
RHO_OFFS=                 5.00 / Rho position offset
TELESCOP= 'het     '           / Telescope name
HOSTCOMP= 'lrs     '           / Host computer name
HOSTOPS = 'SunOS 5.6'          / Host computer operating system
PROGRAM = 'ICE V2-30May2002'   / Data acquistion program
DETECTOR= 'SF1     '           / Detector name
DETSIZE = '3072X1024'          / Detector size for DETSEC
MICROCOD= 'SF1_2009'           / Detector microcode name
CONTTYPE= 'McDonald Obs. V2'   / Detector controller type
BP      = 'V2.0 #2 Rev B'      / Backplane ID
PS      = 'V2.0 #2 Rev B'      / Power supply ID
CD      = 'V2.0 #2 Rev B'      / Clock driver ID
TC      = 'V2.0 #2 Rev B'      / Temperature controller ID
DSP     = 'V2.0 #2 Rev A'      / Digital signal processor ID
ASP1    = 'V2.0 #2 Rev C'      / Analog Signal Processor #1 ID
PH      = 'V2.0 #2 Rev B'      / Penthouse ID
AMPLIFIE= '2       '           / Amplifier(s) in use
ASPGAIN =                    1 / ASP gain setting
INTEGRAT=                    1 / Integrator setting
DETTEMP =              -105.00 / Detector temperature (Celsius)
CRYOTEMP=              -192.48 / Cold sink temperature (Celsius)
CONTTEMP=                13.40 / Controller temperature (Celsius)
SERVOPWR=                 0.57 / Servo heater power (watts)
NCCDS   =                    1 / Number of CCDs in detector
NAMPS   =                    1 / Number of amplifiers used
INSTRUME= 'lrs     '           / Instrument
INSPAOFF=                -0.45 / Instrument position angle offset
POSANGLE=               271.25 / Position angle of a column on the sky
APERTURE= 'slit2.0 '           / Aperture
PROBEPOS= '[none given]'       / Probe position file
DISPERSE= 'gr600   '           / Disperser
DECKER  = 'ls      '           / Decker
INSFOCUS= '101     '           / Instrument focus
CCDSUM  = '2 2     '           / On-chip summation
INSFILTE= 'GG385   '           / Instrument filters
DISPAXIS=                    1 / Dispersion axis: 1-along line, 2-along column
CAL_REV = '2001-09-28'         / Date of associated LRS Master Calibrations
RDNOISE2=                 5.10 / Readout noise for amplifier 2 (electrons)
GAIN2   =               1.8320 / Gain for amplifier 2 (electrons per ADU)
CCDSIZE = '3072X1024'          / CCD size
CCDSEC  = '[1:1536,1:512]'     / Orientation to full frame
AMPSEC  = '[1:3072,1:1024]'    / Amplifier section
DETSEC  = '[1:3072,1:1024]'    / Detector section
ORIGSEC = '[1:3072,1:1024]'    / Original size full frame
DATASEC = '[1:1536,1:512]'     / Image portion of frame
TRIMSEC = '[1:1536,1:512]'     / Region to be extracted
BIASSEC = '[1540:1568,1:512]'  / Overscan portion of frame
END
```

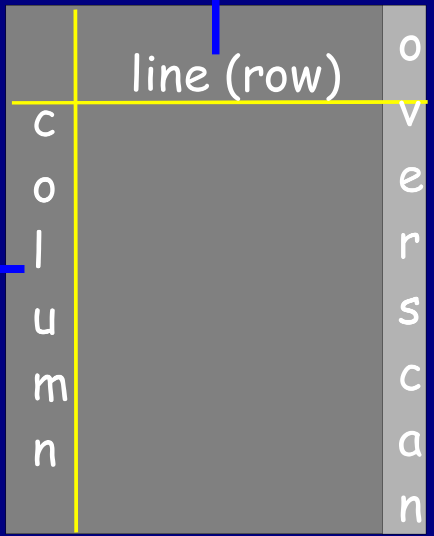
CCS

```
SIMPLE   =                    T    /(logical) file is basic fits format
BITPIX   =                   16    /(integer) number of bits per pixel
NAXIS    =                    2    /(integer) number of axes
NAXIS1   =                 1024    /(integer) pixels on fastest varying axes
NAXIS2   =                  256    /(integer) number of pixels on next axis
FAXIS1   =                   10    /(integer) device origin of first pixel
FAXIS2   =                    2    /(integer) device origin of first pixel
BAXIS1   =                    1    /(integer) binning factor on first axis
BAXIS2   =                    1    /(integer) binning factor on next axis
TIME-BEG=          22:01:31.100    /(character) exposure start time
TIME-END=          22:06:31.010    /(character) exposure end time
CAMGAIN  =                    0    /(numeric) camera gain setting
ZEROLEV  =                    0    /(integer) Value of true data zero
DATE-OBS=            '01/08/00'    /(character) date of data aquisition
END                                / end of fits header data
```

How to examine the images

- **Examine a flatfield exposure using implot and determine the area of the chip that contains good data and the area of the chip that contains good overscan information**





First pass through ccdproc

- Enter the proper biassec and trimsec into ccdproc parameters

- Combine the individual bias frames using zerocombine to produce an averaged, combined bias image (Zero, for example)

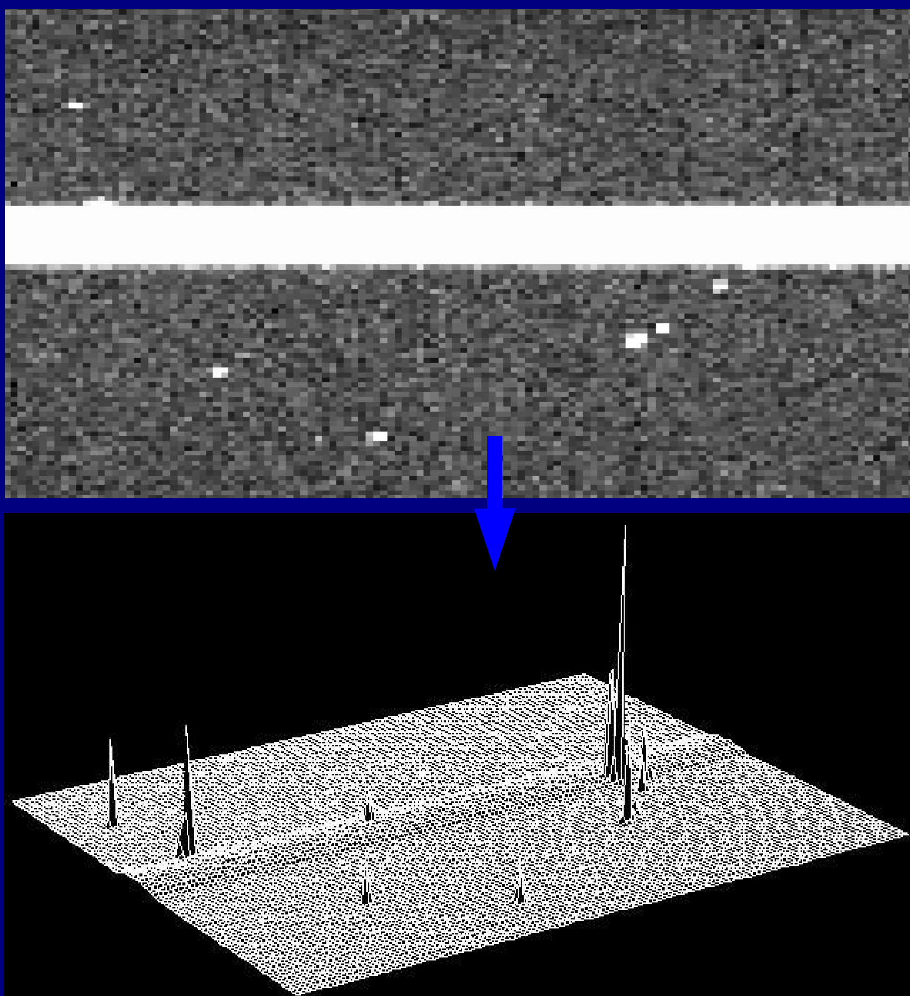
- Process all the frames to remove the overscan and average bias, and to trim the images (first pass through ccdproc). Be sure that you have the appropriate switch settings (overscan+, trim+, zerocor+, darkcor-, flatcor-, illum-, fring-) and that the name of the combined bias frame has been entered for the zero calibration image (zero=Zero)

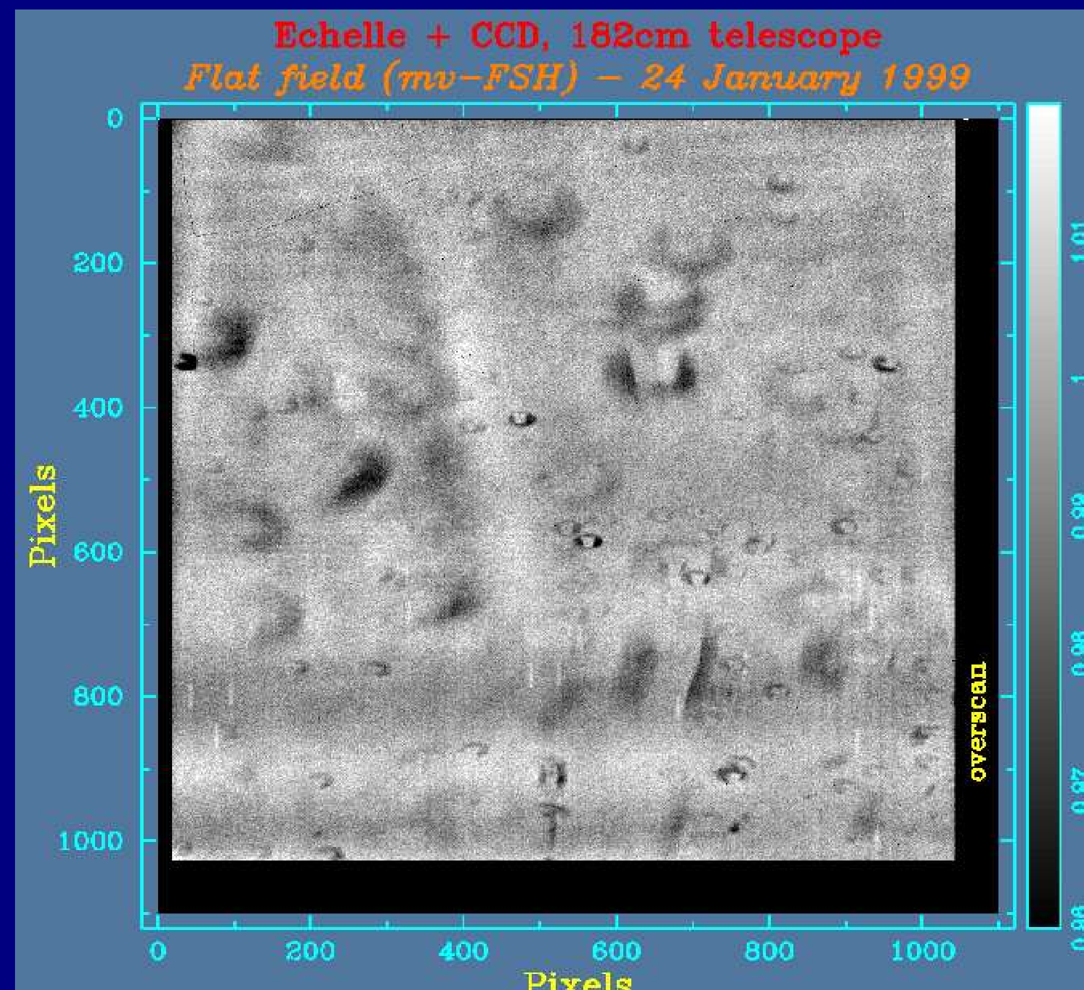
Dark current correction

- In most cases it is not necessary to correct for the dark current

Preparing a master flat

- **Combine your flat-field exposures using flatcombine. Suggested parameters are scale=mode reject=crreject gain=gain rdnoise=rdnoise. This will reject cosmic rays and scale by the mode**





Second pass through ccdproc

- For spectroscopic data, normalize the combined flat-field exposure along the dispersion axis by dividing it by a low-order fit using for example response (twodspec.longslit) or apnormalize or apflatten (!)

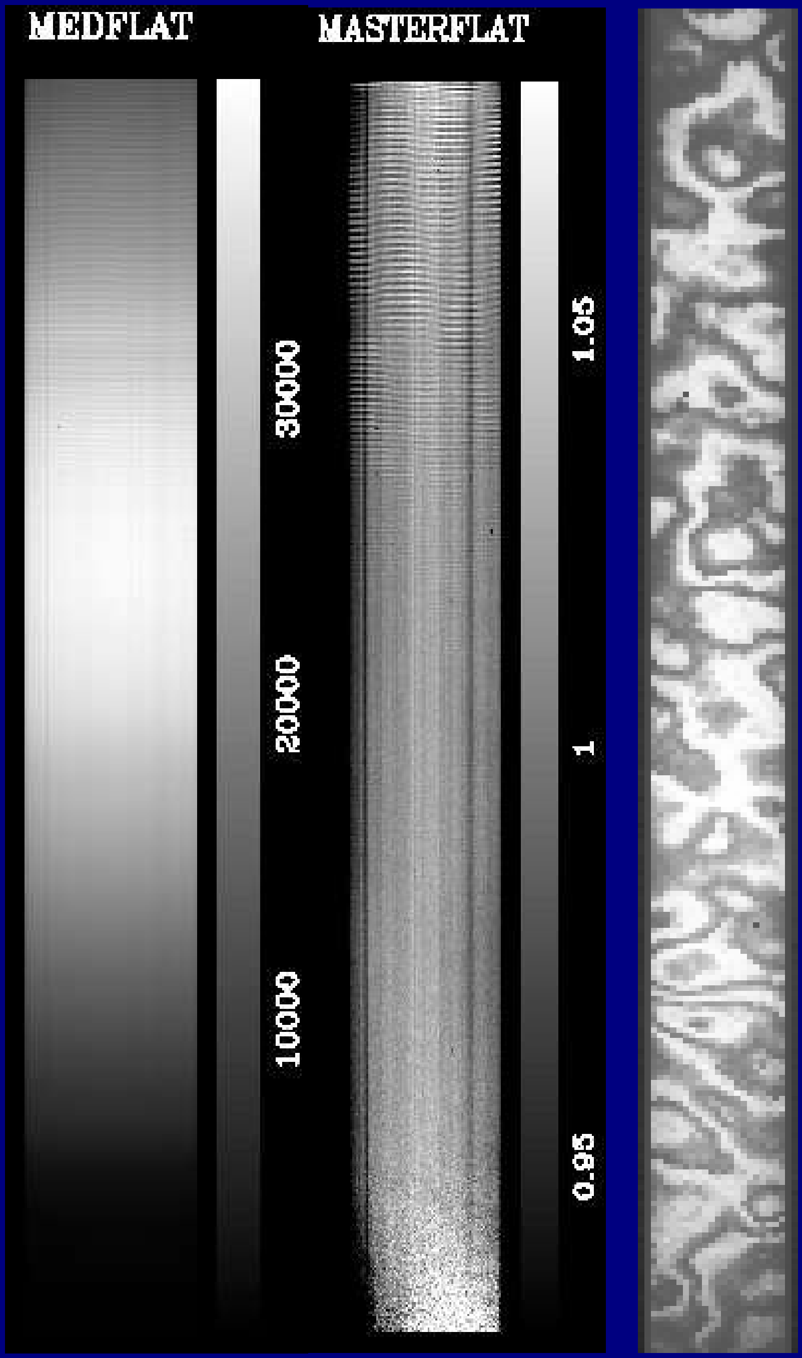
- Process all the program frames using the normalized combined flat-field exposure: flatcor+ flat=norFlat.imh. This will flatten your data to the first approximation (second pass through ccdproc)

Illumination correction

- If you need to correct your data for any illumination problem create an illumination correction:
  - Combine all blank sky or twilight frames with combine scaling and weighting by mode
  - For spectroscopic data use illum in the twodsp.longslit package to create a slit llumiination correction from the combined sky flat
- Finish flattening your data by turning on the illumination correction switch and specifying the illumination correction function in ccdproc (third and final pass)

Be careful with the fringes

- Some CCD chips produce interference fringes when they are illuminated by monochromatic light. The fringes are strong and good visible in the near-IR



Bad pixels mask

- Processing spectroscopic observations we may wish to fix bad pixels as a final step. To do this we need a bad pixels mask. It is not so easy to create such a mask. Because of this we will use a bad pixels mask provided by the HET staff.