IRAF Data Reduction for Imaging and Spectroscopy

Fall 2016

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Course Information

- Instructor: Clif Kirkpatrick
- Tuesdays in Physicum D211 from 12:15 to 14:00
  - Class will be held on a Monday the week of Independence Day
- Website:
  - https://wiki.helsinki.fi/display/ckirkpatrick/IRAF+Data+Reduction+for+Imaging+and+Spectroscopy

Overview

- IRAF (Image reduction and analysis facility)
  - Basics of IRAF commands and packages
  - Basic and advanced image reduction
  - Data calibration
  - Photometric source extraction
  - Surface brightness extraction and modeling
  - Spectra extraction and modeling
- Good habits
- Preparation for NOT Observing school
  - 53858 Advanced Course in Observational Astronomy I
  - November 7 - 12

“NOT School”

- This course is a prerequisite
- Description:
  - This is a national course on advanced observational astronomy, in which astronomy students from all over Finland participate.
  - The course involves an intense week at Tuorla Observatory (food and accommodation is covered) during Nov. 7-12 2016, when remote observations using a 2.6 meter telescope at La Palma will be conducted.
  - After that the students apply their knowledge of data reduction obtained during IRAF course and work in groups to prepare a presentation of their results. Individual reports describing the data acquisition and data reduction are used to form the final grade in January 2016.
- Instructors are responsible for enrolling students into this course

Materials

- “A User's Guide to CCD Reductions with IRAF”
- “A User's Guide to Reducing Slit Spectra with IRAF”
- Can be found at:
  - http://iraf.noao.edu/docs/recommend.html
- ALFOSC and NOTCAM cookbooks
  - http://www.not.iac.es/observing/cookbook/current/
- In class slides and tutorials on website

Class work

- All class work can be done from lab computers using your university login
  - $ ssh –X heaven.astro.helsinki.fi
- You may use your own computer
  - $ ssh –X login.physics.helsinki.fi
  - Then log into heaven
  - I will not troubleshoot computer issues
- Tutorial will cover topic of discussion
- Exercises will be assigned each session with unfinished work expected to be completed as homework
- Additional work may be assigned depending on topic and time

Schedule

Date	Lecture	Data
06.09.2016	Introduction to the Basics	lectureOne
13.09.2016	Create Master Bias and Super-Sky Flat	
20.09.2016	Calibrating the Final Image	
27.09.2016	Long-slit Spectroscopy	
04.10.2016	TBD	
11.10.2016	Infrared Data Reduction	
18.10.2016	TBD	
01.11.2016	Introduction to Observing	
29.11.2016	TBD	
05.12.2016*	TBD	
13.12.2016	TBD	

*Note class on Monday this week

Download data

- Data will be located every week on heaven server
  - /data/groups3/obs-astronomy/IRAF
- Or, a link on the course website
- Starting next week, I will email before the class which files need to be downloaded before the lecture
- Todays files: download folder ‘lectureOne’
  - wget *fileAddress* (Right click link on webpage, select “Copy Link Location”)
- Should look like: $ ls lectureOne/
  - bias.fits flatfield_raw.fits image_raw.fits

IRAF Installation

- Ureka
  - Collection of useful astronomy software
  - http://ssb.stsci.edu/ureka/
- Download the installer to desired directory
  - Run: $ sh install_ureka_*
  - Give permission to edit your login scripts
- Restart your terminal window
  - Launch: $ ur_setup
  - Alternatively: double-click Ureka desktop icon

IRAF first time setup

- Create working directory
  - $ mkdir *directoryName*
- Within the directory make a new IRAF instance
  - $ mkiraf
  - Enter terminal type: xgterm
- Should now see login.cl and uparm folder in your working directory

Edit login.cl

- Only need to make one basic edit, but there are others you could consider later
- Uncomment
  - set stdimage
- Change Value to
  - imt2048

IRAF startup

- Start IRAF: $ cl
  - Navigate the packages simply by typing the name
  - Try: noao -> imred -> ccdred
  - > help *taskName* gives documentation
  - Edit parameters: > epar *taskName*
    - Some commands
      - :wq --- save and quit or press ctrl-d (ctrl-c to quit without changes)
      - :r! --- reloads current presets
  - Execute task by typing its name (or :go from epar screen)
  - To logout: lo
- Start IRAF: $ pyraf
  - Execute same commands
  - Notice a difference?
  - To logout: > .exit

Before we start…

- What level is this class at?
- What do you want to get out of this class?
- Send feedback to:
  - charles.kirkpatrick@helsinki.fi

Astronomical data

- FITS
  - Flexible image transport system
  - Most commonly in the format of data array + header
    - Metadata stored as ASCII header
  - Can be much more though
    - Spectra
    - Photon list
    - Data cube
    - Multi-table database
- DS9 commonly used viewer

Exercise: DS9 basics

- Open the file image_raw.fits
  - $ ds9 *fileName* &
- Following along with the demonstration:
  - Scale: try min max + log, try zscale + linear/power
  - Zoom: to fit
  - Color: play with what you feel looks best to you
  - Edit: none
  - Hold right click: adjust scale/stretch
  - Frame: new -> File, Open… select bias.fits, do the same for flatfield_raw.fits
    - Try single, tile, blink, etc.

Exercise: Basics of Image Reduction

Instrument parameter

- IRAF installation on heaven server is missing an important parameter file
- This should not be an issue for personal installations of ureka
- Go to: > noao -> imred
- > epar ccdred
  - (instrument): "ccddb$kpno/camera.dat"

CCD Bias

- Every frame of data needs the bias removed as the first step
- At this point we will also trim the unused portion of the CCD
- The bias is the inherent charge in the CCD pixels
- Take a series of zero second exposures allows you to create a master bias frame to be removed from every image taken that night

Make bias correction with ccdproc

- Go to: > noao -> imred -> ccdred
- > epar ccdproc
- First step, set all Yes/No questions to NO
- Parameters to edit:
  - images: image_raw.fits[1] ← Raw file
  - (output): b-image.fits
  - (ccdtype): set this field to blank
  - (trim): Yes
  - (zerocor): Yes
  - (trimsec): In the format (area to include) -> [x1:x2,y1:y2]
  - (zero): bias.fits ← Formatted file
- Follow the exact same procedure for flatfield_raw.fits

Flat field image

- Illumination across the CCD is not uniform. This must be accounted for.
- “Sky flats” can be taken in the late evening/early morning. The sky after sunset is approximated as a uniformly illuminated source.
- “Dome flats” are similar, but instead you image the inside of the dome illuminated by lamps. This can be done at any point of day or night.

Correct flat field with ccdproc

- > epar ccdproc
- Again, set all Yes/No questions to NO
- Parameters to edit:
  - images: b-image.fits
  - (output): fb-image.fits
  - ccdtype: set this field to blank
  - (flatcor): Yes
  - (flat): b-flatfield.fits

Results

- The final image is the bare minimum that must be done to have an image that can be considered science ready.
- Is the background low? Is it mostly uniform?
- Blink the first and final images to illustrate the change after data reduction