# IRAF Task

Astrophysical Techniques and Data Reduction

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We built **iraf** and **x11iraf**, and installed **pyraf** on our Ubuntu 24.04 system on WSL. We will now follow the tutorial highlighted in the **IRAF\_task.pdf** document.

## 5) Data Reduction

### 5.1) Calibration

#### Baias Correction

1. Combination of the Bias Files

We have some bias FITS files, listed both in the **Copernico\_coded.txt** and **bias.txt** files. We will run the **zerocorrection** task:

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This outputs the **M\_bias file**, which can be seen below:

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1. Applying the bias correction and trimming

We can now use the task **ccdproc** to apply bias correction from **M\_bias** to all our images, saving the results with ‘**\_bias**’ after the filename. We define the new filenames in a separate file called **all\_bias.txt**.

TASK : ccdproc

PACKAGE : noao -> imred -> ccdred

input = @all.txt Text

output = @all\_bias.txt

ccdtype = BLANK

fixpix = no

oversca = no

trim = yes

zerocor = yes

darkcor = no

flatcor = no

trimsec = [26:2065,7:2044]

zero = M\_bias

The change in an example file and its bias-corrected counterpart can be seen below:

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#### Flat Normalisation

1. Combination of the flat images

We take our bias-corrected flat files, and use the task **flatcombine** to combine them:

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This produces a **M\_filat** file for us to do further corrections. It looks like the following:

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1. Fitting the flat lamp spectrum

We use the response task to model the flat lamp’s spectral response at high frequencies, so that only low frequency variations remain.

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We interactively edit the **spline3** function, removing some datapoint deviations and editing the order of the fit. We find that the order 3 best represents the response function without resorting to frequencies which were too high.

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1. Applying the flat correction

We once again use the **ccdproc** task, this time applying the flat correction to all of our bias corrected files using the **flat\_response** file.

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### 5.2) Spectrum Extraction

1. Image Stacking

We use the **imcombine** task to combine the bias and flat corrected images for each of our objects. **Copernico\_coded.txt** tells us which images are associated with which target files.

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The stacked **obj1** image plotted with **implot** looks like:

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1. Spectrum extraction

We then use the **apall** task to extract the spectrum, obtaining the following aperture, trace, and extracted spectrum files:

TASK : apall

PACKAGE : noao -> imred -> kpnoslit

input = obj1

output = obj1

recente = yes

resize = no

edit = yes

trace = yes

b\_funct = chebyshev

b\_order = 2

b\_sampl = -70:-40,40:70

b\_naver = -15

b\_niter = 2

width = 5

radius = 5

nfind = 1

bkg = yes

t\_nsum = 5

t\_step = 5

t\_funct = spline3

t\_niter = 1

backgro = fit

weights = variance

clean = yes

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And we’ll do the same for **obj2**. The stacked **obj2** image looks like:

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The aperture, trace, and extracted spectrum looks like:

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### 5.3 Wavelength Solution

#### Processing emission lamp spectra

1. Extraction of lamp spectra

We use the **apall** task to extract the spectra from each of the Ne lamps.

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This yields the following spectra files:A screen shot of a graph

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And we repeat the same procedure for the HgCd files:

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AI-generated content may be incorrect.Which yields the following spectra files:

1. Combining lamp spectra

We then combine all these spectra into a single **lamps\_combined** file with the **scombine** task.

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The combined file then looks like:

**A screen shot of a graph

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1. Line identification and wavelength fitting:

Now we can use the identify task to identify and mark lines. We make sure to identify a healthy number of lines (~13) across the wavelength range, using the Ne and MgCd emission lines presented in the task.

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The identified lines are shown below. We note that the **lamps\_combined** file is initially plotted with the wavelength on the x-axis in a descending order. We take care to flip our reference images before identifying the lines.

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The following file shows the residuals after fitting. We remove one point which had a higher than usual residual.

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After identification, the **lamps\_combined** file is flipped the right way around. We save this.

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#### Wavelength mapping in science spectra

1. Editing file header

It is now time to apply this spectrum reference to our **obj1** spectrum file.

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1. Apply the wavelength solution

With the information in the header, we can now apply the wavelength solution using the **dispcor** task.

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Finally, plotting **obj1\_speccor** using **splot** gives us the following graph:

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## 5.4) Flux Calibrations

#### Instrumental response

Let’s extract the spectrum for the calibration star BD284211 with **apall** as before.

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The aperture, trace and spectrum for the calibration star are as follows:

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We’ll add the reference spectrum information to the calibration star header:

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And then apply the wavelength solution to the calibration star from its header:

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The resulting calibration star spectrum looks like:

**A screen shot of a graph

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1. Setting up flux calibration

Iraf has this information in its database and will find the flux calibration using the **standard** task.

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1. Fitting the sensitivity function

Using the **sensfunc** task, we’ll fit the sensitivity function:

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This yields the following plot, which we accept:

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1. Applying the flux correction using the **calibrate** task:

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This gives us the following flux corrected spectrum for **obj1:**

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#### Correction for interstellar extinction

We use the **deredden** task as follows:

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Finally, we can plot the dereddened spectrum:

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