Observational Astrophysics
22. Data reduction exercise

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Below are some instructions for the data reduction exercise.

1 Deadline

Please, send me the final extracted spectrum in FITS format by **February 11th, 2022**.

2 Data and data reduction steps

I am providing raw data obtained using the Coudé Spectrograph installed at the 1.6m telescope of the Pico dos Dias Observatory, in Brazil (the technical information about the instrument is available only in Portuguese, so I do not copy the link here). These are somewhat old data, obtained back in 2004. A thinned, back-illuminated CCD of 2048 × 4608 pixels with anti-reflection coating was used[1]. Not all of its size was read out, just about one quarter of it (to reduce reading out time). The spectra are of relatively bright red giants in our own Galaxy.

For calibration, the data set includes 10 bias images and 10 flat field images obtained with a lamp. Dark is not important and other types of flats were not obtained (i.e., sky or dome flats). There are spectra available for multiple stars and each student has been assigned data for **one (and only one)** individual star (the filename of the star assigned to you should include your surname, if you can not find such a star, please let me know).

The data reduction steps that you should perform for the star assigned to you are:

1. Bias correction

2. Flat-field correction

3. Spectrum extraction (i.e., producing the 1-dimensional spectrum)

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[1]Here are some technical data. Its all written in Portuguese, but you can easily translate the page using Google translator.

(there is no need to build a bad pixel map, or any other type of correction, just the ones listed above)

3 Software for data reduction

My suggestion is that you try to use IRAF[2]. Its an old, but well tested (and hated by many...) software for data reduction. In any case, feel free to use any other software that you are familiar with and that can perform the data reduction steps above (astropy, IDL, etc). Just please make sure that the data processing information is saved to the FITS header. IRAF will do that automatically.

For those from CAMK, if you do not have IRAF installed in your desktop, just ask the IT guys (adm at camk). If you are not at CAMK or you want to install it in your laptop, you should try using the STScI astroconda package[3].

The tutorials for data reduction with IRAF: if its your first time using IRAF, you might want to check the beginners guide (https://iraf.net/irafdocs/beguide.pdf). Step-by-step instructions for the bias and flat-field corrections can be found in the CCD reduction guide (https://iraf.net/irafdocs/ccduser3.pdf). Step-by-step instructions about how to extract the spectrum are in the guide to reduce slit spectrum (https://iraf.net/irafdocs/spect.pdf). All these and other IRAF manuals can be found in the documentation page: https://iraf.net/irafdocs/.

If you never did data reduction before, be aware that it will take some time for you to understand the steps. So do not start only at the last minute.

If you have doubts or run into problems, do let me know (before the deadline).

4 A few tips

1. Even if you decide to use Astropy or IDL or something else, and if you have no previous experience with data reduction, you might benefit from reading the IRAF tutorials. In particular the step-by-step instructions for bias and flat-field correction. There are tips of different manners of combining the multiple bias and flat-field images, and about normalizing the flat-field lamp spectrum before the correction of the stellar data.

2. The overscan region in the CCD that was used is not very well behaved. I recommend that you ignore the overscan correction and just use the 2D bias image for the correction.

3. The IRAF manuals mention that you should use "CTRL+Z" to get out of editing the task parameters. Do not do that. The correct way to exit is by typing ":q".

4. Note that I am not asking you to calibrate the 1D scale of the spectrum in units of wavelength. I am not providing the calibration image needed for that.

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[2]https://iraf.net/irafdocs/
[3]https://astroconda.readthedocs.io/en/latest/installation.html