FRI Astronomy Lab #3

CCD Data Reduction with Python

Goal: In this lab, you will build and use CCD calibration frames to reduce actual raw CCD imaging data on a pulsating white dwarf star taken recently from McDonald Observatory. You will learn to read, manipulate and write images in the FITS format with Python. Next week you will perform aperture photometry on these reduced images to detect the pulsation signatures of the star.

Instructions

1. There will be a few questions throughout this lab. Be sure to type up your answers and submit them on Canvas with your final plots.

2. It may be helpful to familiarize yourself with these astropy tutorials on working with FITS image data and headers; it may help to refer to them during this lab:
   https://learn.astropy.org/tutorials/FITS-images.html
   https://learn.astropy.org/tutorials/FITS-header.html

   Astropy is a huge package of Python tools that are specifically useful to astronomy research.

3. Use your Terminal commands to create a folder/directory on the computer you are working on: let's call it "lab3" since this is the third lab. Change into this directory ("cd lab3"). Now, using a browser, download the file `lab3.tar.gz` from our course's Canvas page: `AST 210K > Files > Labs > lab3`. After downloading, type `ls` in the Terminal to make sure this file is actually in the directory `lab3` that you just created.

   We need to unpack all the data in this file. First use `gunzip lab3.tar.gz`, and then extract the files from the tar file with the `tar xvf lab3.tar` command. Since there is quite a bit of data here, please delete the `.tar` file after you have extracted the `lab3/` directory to save disk space.

4. Untarring the file created a new subdirectory, also called `lab3/`. cd into the `lab3/` directory and open a Jupyter Notebook. Find the `lab3.ipynb` notebook and follow through the example and instructions to complete this week's lab.

   By the way, if you navigate to this directory in Finder, you can open the .fits files in a program called `SAOImageDS9` to view the images. You can also view the processed images that you generate during the lab with this program. Even though you *can* and *should* display the images in Python, `SAOImageDS9` provides an easy way to inspect the data in greater detail.

   There are a few questions highlighted throughout the Notebook. These questions are also online as a Canvas *Quiz*. Please answer all of the questions on Canvas and submit the following files (also as responses to the quiz): your 3-second master dark frame, your master flat frame, a fully reduced science frame, and a PDF copy of your completed `lab3.ipynb` notebook.

5. Don't forget the important last step of CCD image reduction: much rejoicing!