FRI Astronomy Lab #4

Alternate Instructions for a Dead Rocky

Goal: In this lab you start with the results of our automated aperture photometry reductions, select the "best" aperture, and then go all the way through the rest of the reduction process, producing light curves and Fourier transforms of the data.

The Final Phases of Reduction of Aperture Photometry Data

In the previous lab, we saw what it meant to do "aperture photometry", from bias, dark, and flat field correcting the images, to defining apertures around the target and comparison stars and getting "light curves".

This week, again using archival data, you will start by visually (i.e., "by eye") choosing the best aperture size for a given data set (it can be different for different data sets). You will then use several programs in our data reduction pipeline to arrive at final light curves and Fourier transforms.

Instructions

1. Since `rocky` is currently dead, we'll have to do all the data analysis on the 15th-floor Macs. So open a terminal window on your mac.
2. Just to make sure everything goes smoothly, let's copy over a fresh .bashrc before you get started. So, in your home directory type
   ```
   cp ~sp32743/.bashrc .
   ```
   Next, type
   ```
   source .bashrc
   ```
3. Finally, to finish jury-rigging things, type this in your home directory:
   ```
   cp -r ~mikemon/.wet .
   ```
4. We can't pick a run out of our archive at `http://rocky.as.utexas.edu/argos/` so you will just use one that we have pre-selected for you. To do this, execute the command
   ```
   cp -r ~mikemon/redjohn .
   ```
   This will place the directory `redjohn` into your home directory. Finally, `cd` into `redjohn`.
5. The remainder of this lab will closely follow Section 8.2 of the "Argos User's Manual" by Fergal Mullally, Dean Chandler, & JJ Hermes. This is available online for the curious at: `http://www.as.utexas.edu/mcdonald/facilities/2.1m/Argos-WhiteDwarfPulsations.pdf`.
6. You will use the command `chooselcfri` to compare by-eye the quality of the light curves obtained using different aperture sizes. To see brief instructions on how to use this command just type `chooselcfri` and then `Return`. You will just need to type `chooselcfri aXXXXpr -d`, where `aXXXXpr` stands for the actual beginning pattern of the file names. This allows you to consider the results of all the aperture extractions. Type `?` in the plot window to print a list of options to the Terminal. Basically, `[Enter]` and `[Backspace]` (or left and right click) let you cycle through the apertures in ascending and descending order. Your goal is to choose the aperture size which yields

the best looking data. Try to find the the one that minimizes the point-to-point scatter in the light curve. If you can't decided between many that all look close to best, don't worry about it; if you can't see much of a difference, then there isn't much of a difference. Once you've decided which aperture looks the best, write it down, hit `q` and follow the on-screen instructions.

To check that the right files have been created, type `ls -lth` for a list of files, with the most recent being the one at the top. There should be a `.wq` file and a `.app` file.

7. You will now use the `wqed` (pronounced "wicked") program to examine and save the final light curves for this data set[1] by typing `wqed a####.wq`. window should pop up showing you your light curve. The white dots are for the target star, the red dots are your first reference star, and the blue dots show the sky brightness. After highlighting the plot window, you can type '?' for a quick list of allowable commands.

   Select the target star by typing `1` with your mouse focus on the plot window. Remove obviously bad points by typing `g` and dragging a box around the region to "garbage." Then type `2` and garbage bad points from the comparison star. If you make a mistake or just want to undo something type `control+u`.

   Now divide the target light curve by the light curve of the comparison star to remove the effects of changing atmospheric transparency by typing `1` then `/` followed by the numbers of one or more reference stars.

   Remove remaining nightly systematic effects (mostly differential extinction caused by the difference in color between the target and comparison stars) from the divided light curve by fitting and removing a second-order polynomial (a parabola). Type `f`, followed by `2` to make this happen.

   Awesome work! Save this nicely reduced light curve by typing `shift+w` and then `e`. Your final light curve for the target star is saved as a ".lc1" file.

8. Now use the program `fitlc` to view and analyze the Fourier transform of this light curve by typing `fitlc a####.lc1`. After highlighting the plot window, type '?' for a quick summary of commands. First, type "H" to write out a plot of the data.

   We will get further into the details of Fourier analysis in the next lab and in an upcoming class. For now, just understand that our goal is to measure the periods (timescales) of pulsations (if any) in these white dwarf stars.

   Use the `9` function to show an approximate significance level for peaks in the Fourier transform. In order to do this, position the cursor near the left edge of the frequency range, hit `9`, then move it to near the right edge of the frequency range and click.

   Peaks that are above the colored lines are considered statistically significant. For each of these peaks, examine their window functions (the `w` and `b` commands). Next, with your cursor centered on the significant peaks, fit their periods (the `n` function) and "prewhiten" by them (the `p` function) one by one, writing the list of periods down as you go. Then clear the horizontal significance lines [type `(`] and recompute the significance levels (the `9` function). Continue finding and removing periods until the remaining peaks lie below the lines of significance. How many periodicities did you find?

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[1] an online manual for wqed can be found at http://www.physics.udel.edu/gp/darc/wqed/wqedmanualv2.ps

9. Now repeat steps 6–8 on this page for (1) the smallest aperture and (2) the largest aperture. First, rename (using the `mv` command) your current ".lc1" and ".ps" files so that they don't get overwritten. In step 9 don't bother fitting the periods. Instead, just output the FT and rename the file to `smallapp.ps` or `bigapp.ps`.
10. Upload all the ".lc1" and ".ps" files, along with a list of the periods you found, to Canvas.
11. Bask in the glory of a job well done...