Abstract: Calibrating the Infrared Camera Clio

Begin by capturing the problem/question(s) you have been trying to address and your objective(s)

* Data isn’t linearized because of the nature of more brightness the longer the integration time is open. Infrared detectors aren’t really that linear
* So, we gotta linearize data for it to be useable and calibrated.

Next, summarize the methods / activities pursued to address the problem

* Lots of coding in Python
* Read in pictures through FITS- flexible image transport system
* Find best fit to data through manufacturing true counts for all, and the error of those true counts compared to the desired relationship
* Apply a correction to the data based off which fit was the best fit to the data

Next, summarize your results / accomplishments

* Learning python was hard lmao
* It took me 5 months to get one graph, and several messed up graphs and trials
* But we got it to work with two data sets (so far), so now, the data is calibrated

Finally, conclude with interpretations of those results and their significance. In the case of R&D work, science education, or science writing, conclude with your interpretations of the potential utility and impact the product / activities / articles will have.

* We corrected it!
* Show graph of corrected data
* Impact: the data is now usable. We can do science with it now
* What exactly do we do with it?

Notes:

A linear detector will record 2x the counts with a star 2x as bright or when you integrate for 2x as long.

Don’t put as many details about the procedure in the final abstract

Also include the results of linearity calibration, i. e. the coefficients

In the end, we measure the brightness of planets and stars accurately!

Super-In-Depth Abstract

For this project, I had to calibrate the Clio instrument using programming tools. Now, the Clio camera is an adaptive optics instrument, and it takes pictures in infrared. However, due to the nature of optics, an interesting side effect occurs when taking pictures with the instrument. When the Clio camera takes a picture, the two things we are interested is the integration time, which is basically how long the shutter is open, and the counts, which is a measurement of the amount of light gathered. The supposed relationship in the data between the integration time and counts readings should be linear, however, common across all detectors id that due to saturation from increased brightness, non-linearity appears within the data trends. In fact, a linear detector will record 2x the counts with a star 2x as bright or when you integrate for 2x as long, and that was not present here. Therefore, I had to write code to first calibrate the camera and then fix a separate data set with the calibration results. First, I had to obtain data where the exposure time (integration time) was gradually ramped up that I could calibrate with Clio. Then, I had to read them into arrays with Python code, with the independent variable being integration time (time the camera was open) and the dependent variable being counts (how bright a pixel was). I then found the most linear part of the data and used that as a basis of finding the most correct calibration. I then tried to find the true counts if the data was linear, and then found the true counts for second, third, and fourth order. From there, I could see which order of true counts fit the best, and I got coefficients from that order -6.32644177e-17x^4 + 5.55450534e-11x^3 + -2.19977738e-06x^2 + 1.02869293e+00x + -1.21422072e+02. I then used the coefficients gained from that order, and applied to a different data set taken at the same time, and got the calibrated pictures in the end. My biggest accomplishments revolved around 2 things. First, I learned python and saw how coding could be applied in a scientific setting. Second, I learned about the process of data collecting and how that relates to work beyond my undergraduate college career. This data set is now useable because we calibrated the camera. Now, we can do more adaptive optics. We can therefore calibrate more data sets from the Clio camera, and use those to accurately measure the brightness of other stars and planets taken with this camera.

150 Word Abstract

For this project, I had to calibrate the Clio infrared detector using Python code. Due to saturation from increased brightness, non-linear data appears with the detector. Therefore, I had to write code to calibrate the instrument, which could then let me fix a separate data set. Initially, I obtained data where the exposure time was gradually increased. Then, I had to read in every picture’s exposure and brightness count. I devised a way to linearize the pictures to correct them by an equation, and I took the coefficients generated and calibrated another set by applying the coefficients. My biggest accomplishments revolved around learning python and seeing how coding could be applied in a scientific setting. I also learned about the process of data collecting and how that relates to work beyond my undergraduate career. Because, the data set was now usable and calibrated, we can calibrate more data sets from the Clio camera, and use those to accurately measure the brightness of other stars and planets taken with this camera.

This is capturing the objective of my research. This summarizes the methods of my research.

This summarizes my research outcomes/results. This discusses the interpretation of my results.