Flat Fielding in Photometry

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Background: Photometry involves the study of light intensity with respect to the human eye, and in our case, we study the light variance of a binary star system. The optics involved in telescopes have both systematic and chaotic issues, both of which need to be corrected for when performing photometry. There are multiple methods of flat fielding established for correcting for these issues, such as dome flats and sky flats, each with varying success for a particular issue (Howell, 2000, p.48-51). Flat fielding involves taking images of a relatively blank and uniform area to use it to correct for later variances. At Clinton B. Ford Observatory, past students have tested rudimentary versions of these methods and were met with little success. The motivation for flat fielding is that publishable data requires a certain percentage of accuracy, and flat fielding allows for reducing the error on the data taken. The method I selected for use involves using a lightbox for taking flat field images.

Methods: There isn't a universally accepted design for a lightbox, so I looked through a few designs and settled upon one to base my lightbox on, shown in Figure 1. The way a lightbox works is by bouncing light around and through multiple diffuse surfaces so that the result is a uniform field of diffuse light. Once I had the materials, which included white foamboard, an acrylic sheet which transmits 40% light, drafting mylar, 8 white LEDs, and tons of hot glue, I set to work creating the pieces. The most difficult part was the circuitry, as there were many leads to solder together. I relied on the expertise of our lab technician, Jennifer Mellott, for coming up with clever techniques to cut the foamboard into the proper shapes and sizes. This work was largely completed in the Spring of 2016 for the preliminary smaller lightbox for use in the lab, but over the Summer of 2016, I also created a larger model with additional pieces for use on the telescope at the observatory, shown in Figure 2. By using a combination of the small model for cleaning the optics, and the large model for performing flat fields while observing, we were able to significantly improve the accuracy of our data.

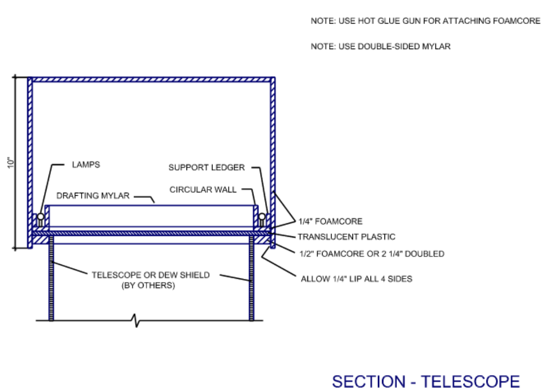

Figure 1: Example schematic of a lightbox (http://www.gregpyros.com/assets/Lightbox-pyros.pdf)

Figure 2: The large lightbox in black mounted on the telescope.

Results: By using this method of flat fielding, I improved the quality of our images, and hence the quality of our data. An example of the image improvement can be seen in Figure 3. Since the image is a graphical interpretation of the actual data taken, there is a direct relation between the quality of the image and the quality of the data.

Before **After**

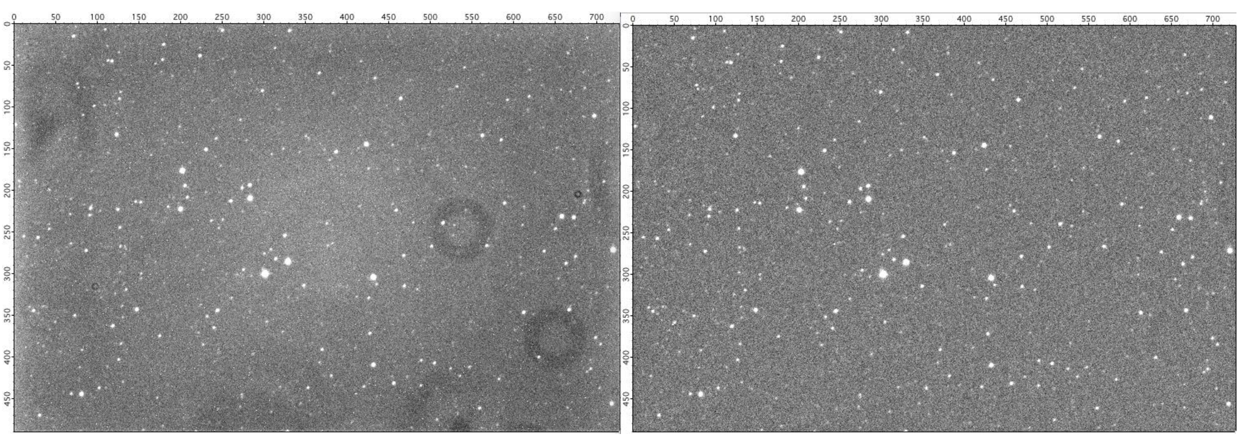

Figure 3: The sky in the R-filter.

Discussion: The results of this work show that the design is not perfect and that more can be done, both with the design and additional corrections. By improving upon this design and publishing it, I can contribute to the field of amateur astronomy and perhaps create a universally accepted design for flat fielding. One large issue I experienced was the range of light not being large enough for all the bands of light which are commonly used in the field, so finding the proper combination of LEDs would be a great help to other amateur astronomers. This is useful because amateur astronomers are key to breakthroughs in astronomy. Professional observatories/astronomers are not very numerous, so they rely on amateur astronomers to watch the skies and publish any strange occurrences which they may then observe with their more expensive equipment. Additionally, the necessity of additional corrections for our observing at the Clinton B. Ford observatory spurs further research into that matter, which I will briefly discuss as it pertains to Ithaca's climate patterns.

Citations:

Howell, S. B. (2000). *Handbook of CCD Astronomy*. Cambridge, U.K.: Cambridge University Press.