

# Spectroscopy: What Optics Can Tell Us About Astronomy

Lucas Bloom | [lucasbloom2@gmail.com](mailto:lucasbloom2@gmail.com)

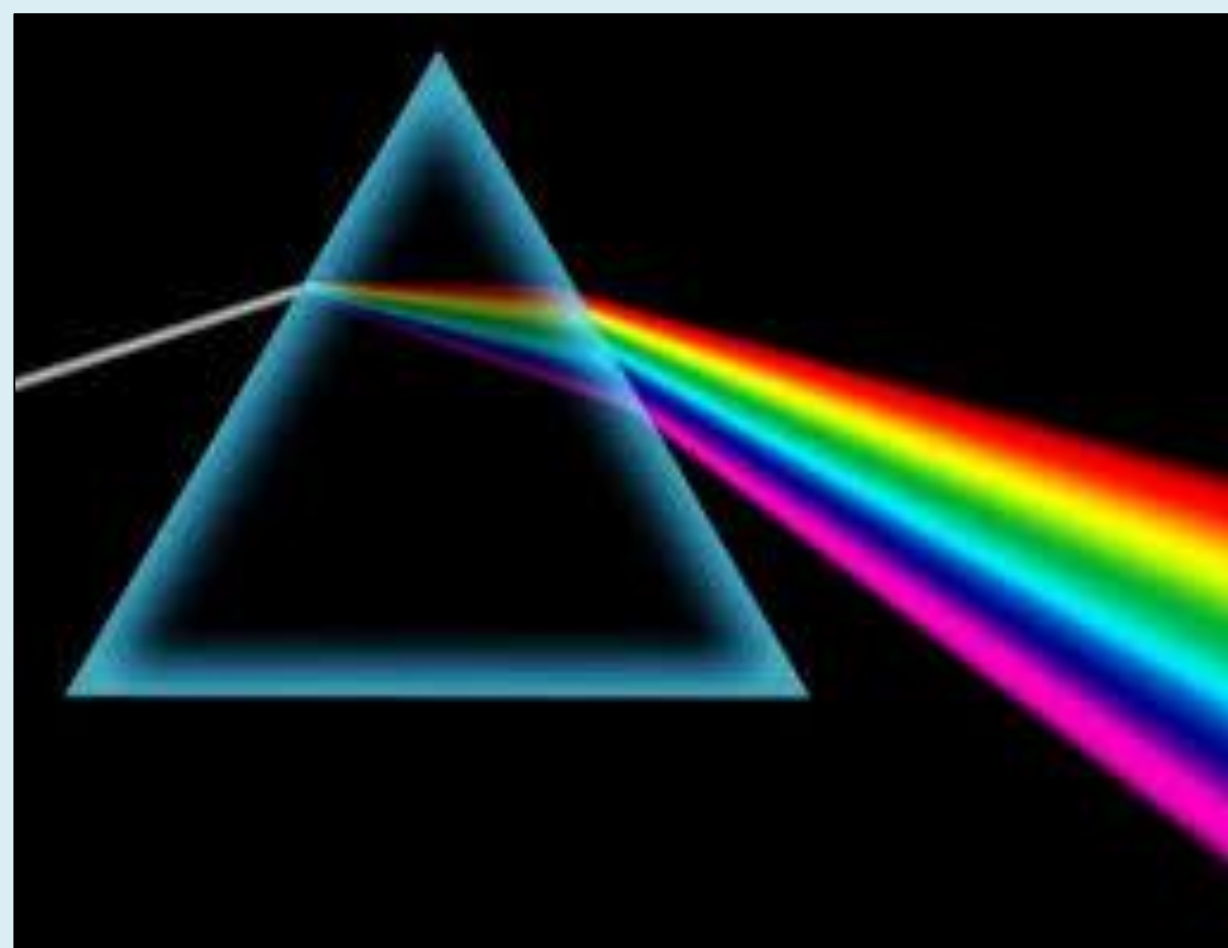
Science, Discovery and the Universe | Physics & Astronomy Double Major

## UMD Observatory

The UMD Observatory is home to many telescopes located just outside of the campus. Use of the facilities are mostly for educational or public outreach purposes.

## Issue

The observatory has a spectrometer that has not been implemented in many years and requires some tweaking and calibration. Spectrometers are used on the ends of telescopes in order to split the light that comes through into its spectra. This is done by diffracting the light, and best illustrated by the prism:



Stock image of a prism showing how light can be diffracted. In the spectrometer this is achieved by sending the light through a small slit and then onto a diffraction grating

Information obtained using a spectrometer can determine the composition of the object or where it is moving and how fast. The spectrometer that I was working with had two light paths. Some of the light was diffracted into a spectra and the rest was focused into an image. These two light paths are supposed to each be projected on their own CCD chip, which is a camera that is used to capture the light.

## Impact

Not only did this project teach me more about optics and how it can be used in astronomy, but it was also a valuable lesson on the setbacks of experimental science and how to approach obtaining real world data. Most classes in my major focus on calculations and clean data sets that I do not have to gather myself. This experience was a very useful introduction into how I might have to spend my time if I continue down this education path. Having to go back towards the end of the project to redo something that I thought I had completed in the beginning taught me that doing real experiments can sometimes be tedious work and you may have to revisit a few steps.

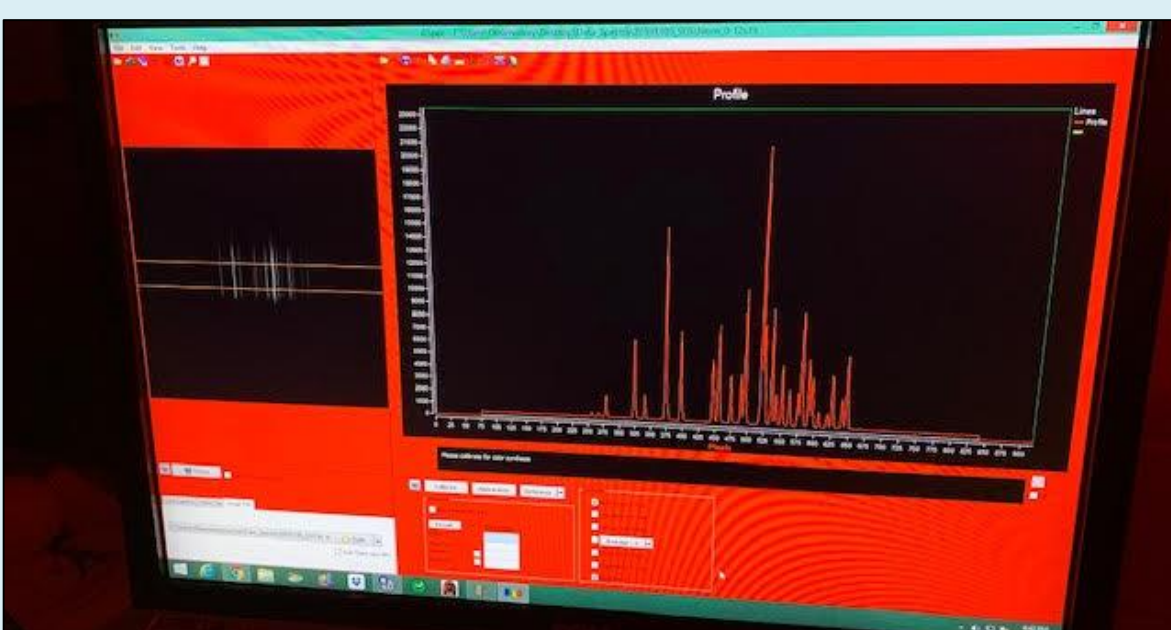
## My Activities

### Investigating and Altering the Light Path:

- One of the light paths goes through two adjustable mirrors and a focusing lens. I needed to make sure that all of the light reaches the correct CCD chip after going through the spectrometer.
- I used a laser to see where light was going through this path
- With careful adjustments on both the mirrors in order to position the beam, and on the lens in order to focus the beam, I was able to center the laser on the right location



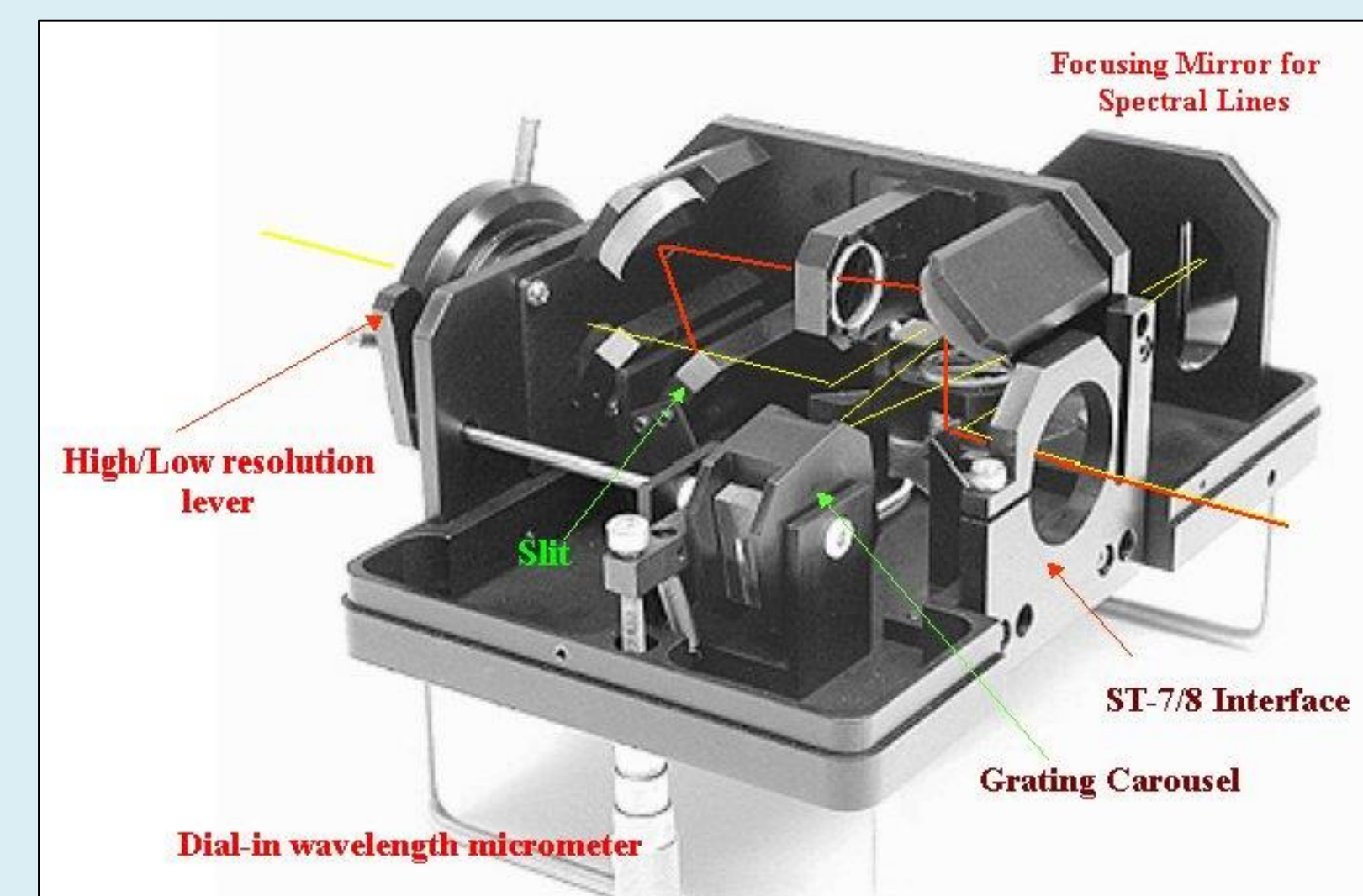
The laser shining into the spectrometer projected onto a piece of tape where the camera would be showing where the CCD chips are. Photo taken by Lucas Bloom



Spectra as seen in the program RSpec after an image was taken from the spectrometer using the CCDops program. Photo taken by Lucas Bloom

### Observing with a Telescope:

- I attached the spectrometer camera setup to a telescope at the observatory to observe a star and obtain its spectra for analysis.
- The light from the object never reached the spectrometer. This was either an issue with the focusing ability of the telescope, or the first light path was not properly lined up in order to see the image on the camera.
- I had to go back to the first few steps and readjust the mirrors and focusing lens. The goal of the rest of my time was to try and prove that light coming into the spectrometer could be seen by the camera while casting a shadow of the small slit that it went through.



The diagram of the spectrometer and the light paths was from Dale E. Mais's article: <http://users.erols.com/njastro/faas/articles/dmais01.htm>



An element tube shining light into the spectrometer where it is diffracted into that element's unique spectral pattern. Photo taken by Lucas Bloom

### Looking at the Spectra:

- I placed a hydrogen tube in front of the spectrometer and allowed it to glow, the spectrometer diffracted the light into a unique hydrogen spectrum
- Each element has their own unique spectrum, so I was able to test this with multiple different element tubes including neon, helium, xenon, and more.
- These images of spectra could then be uploaded to another program called RSpec for analysis. Most of my time was spent trying to understand how to operate this program, calibrate the spectra, and identify all the emission lines.

## Acknowledgements

I would like to thank Elizabeth Warner, who is the Observatory Director, for her mentorship and help with the project. She also provided transportation to and from the observatory.