Group Project Proposal

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1 Topic of Choice

Our goal is to create measure the spectra of 13 stars and compare the spectra to those found in literature. The chosen stars will vary in apparent magnitude and color (thereby giving a broad distribution of absolute magnitude and spectral class). We will analyze the spectrum obtained for each star and identify peaks that correspond to the chemical composition of the star (this form of analysis is similar to the Raman spectroscopy lab). Based on the prominent peaks, we will assign a spectral class to the star. In our analysis, we will present the stars we studied a Hertzprung-Russell diagram.

2 What makes this topic interesting

2.1 Comprehensiveness

This project brings together many of the topics we have studied as undergraduate physics students at UTD. Spectroscopy is rooted in quantum mechanics, which we studied as juniors in Dr. Gartstein's **PHYS 4301 Quantum Mechanics I** and **PHYS 4302 Quantum Mechanics II** courses. Identifying and observing celestial objects incorporates our background in astronomy (Ashlee and Chirag are taking/have taken Dr. Anderson's PHYS 3380 Astronomy course). Using the data to measure distances to globular clusters is relevant to the field of cosmology (in which such distances help measure the age of the Universe); Chirag and Ariel has background in this area from having taken Dr. King's **PHYS 4392 Extragalactic Astrophysics** course. The comprehensiveness of this project will help us reflect on all we have learned at UTD as we prepare for our futures this spring.

2.2 Challenge

The difficulty of obtaining the spectra of distant objects demands the same level of instrumental precision and technical skill as the PML labs demand. Driving to a dark site, setting up the telescope and spectroscope, and using the appropriate software to analyze the data poses additional challenges that exceed the level of difficulty of PML labs and make this project especially worth pursuing.

2.3 Historical Significance

Making sense of the positions, brightness, and color of the stars is an activity as ancient as humanity. Over the past five hundred years, our explanations of these three qualities have become increasingly related to physical reality, helping establish astronomy (and generally science) as a field independent of astrology (and generally alchemy, superstition, etc.).

Since the 17^{th} century, the Copernican principle[1] has been generalized to the modern notion that the universe is homogeneous and isotropic. This progression has shifted our focus from star's relative positions—historically their most important characteristic (defining constellations, asterisms, etc.)—to the study of their brightness (photometry) and color (spectroscopy). Creating a Hertzsprung-Russell diagram involves using both photometric data (which helps find the absolute magnitude of stars, plotted on the y-axis) and spectroscopic data (which helps identify spectral class, plotted on the x-axis). In this sense, the Hertzsprung-Russell diagram is a visual representation of the history of astronomy.

2.4 Aesthetic Beauty

Lastly, we would like to mention that the night sky is beautiful; collecting data will give us a good reason to get away from DFW's light-polluted skies for a few nights this fall.

[1] that the Earth is not the center of the solar system

3 How we will proceed

3.1 Equipment

Below is a tentative list of the equipment we will need for this project.

3.1.1 Telescope

While Chirag has extensive experience using UTD's Celestron 8" Schmidt-Cassegrain telescope and checked the telescope out early October, he thinks using his personal Tasco Newtonian reflector is more convenient and appropriate for this project. Using this smaller telescope will allow for a faster set-up and break-down when on site.

3.1.2 Diffraction grating

UTD alumnus Ian Grey has graciously offered to let our team borrow his fine diffraction grating filter.

3.1.3 CCD

We will need UTD's CCD attachment and corresponding USB cable. This CCD will also function as a photometer.

3.1.4 Software

Ian has suggested that Chirag (the one collecting the data) purchase the relevant spectroscopy software.

3.2 Responsibilities

Ariel, Ashlee, and Chirag will be responsible for the completion and presentation of the project, demanding from each student an understanding of the big picture of the project. However, each member possesses unique technological skills which will be employed so as to maximize the quality of the results.

3.2.1 Ariel

Ariel has previous experience working on various research projects utilizing Mathematica and Python at the State University of New York (SUNY). Ariel will apply her teamwork skills to assist Chirag with setting up the equipment and collecting data. Ariel also has experience writing comprehensive research reports and will contribute to analyzing the data and effectively communicating the results into the final report.

3.2.2 Ashlee

Ashlee has experience writing programs in Python and MatLab. Thus, Ashlee will be the one creating the programs to run the raw data through to generate the photometric values. Ashlee will then use the combined data of photometric values and spectral class to create the Hertzsprung-Russell Diagram. Ashlee will then use her experience in comparing data to published literature to determine how accurate the data collected is. This will then be used to write the report, which Ashlee will contribute her writing experience to in order to push this project to completion.

3.2.3 Chirag

Chirag has experience with taking astronomical measurements, setting up telescopes, and finding objects in the night sky. He will lead the efforts to collect the spectroscopic and photometric data. Once the data is collected, he will upload the raw files onto the GitHub page.

3.3 Logistics

3.3.1 Dark site

Chirag has scouted out a **dark site** that is northwest of Ft. Worth (a public park near the small town of Alvord). It is a quiet park with very little exposure to surrounding street lighting. This area is also far enough away from DFW to provide skies with relatively little light pollution. From past experience at this site, Chirag knows there is some pollution in the southwestern sky (the direction of DFW), but this should not interfere significantly since most objects will be observed close to the zenith.[2]

3.3.2 Communication

All inter-team communication will occur on a combination of texts and emails. When working on the project paper, we may also use Overleaf's "chat" feature.

3.3.3 File management

This project relies on data organization and processing. We will use the LaTeX interface Overleaf to type our report (similar to our normal PML lab reports), as well as store our data and images.

3.4 Timeline

- **Early September**: Project approval
- **September 18**: Obtain all necessary equipment

[2]Most globular clusters are in the southern summer sky (in the direction of the galactic nucleus); we can expect some light pollution to effect the spectra of these objects.

- **September 25**: Observation night 1
- **October 2**: Observation night 2
- **October 9**: Observation night 3
- **October 16-30**: Develop code to perform data analysis
- **November 6-13**: Write paper