The Impact of Light Pollution on Observational Resources

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Abstract

The 1-meter telescope at the Embry-Riddle Aeronautical University Daytona Beach campus is the largest university-based research telescope in Florida. In ideal conditions, it should have some of the best observational abilities in the state. However, the light pollution and lighting practices from facilities and outdoor light fixtures greatly interfere with these abilities. Our team works to identify the greatest contributors to light pollution on campus so that we can develop cost effective and accessible solutions to increase the quality of our data. The results of this project will be shared with Embry-Riddle Aeronautical University leadership in hopes that improvements can be made. Using a Unihedron Sky Quality Meter, we measured the severity of the light pollution under various locations and conditions. These conditions include measurements with and without temporary light covers, yellow cellophane light filters, and shades applied to the Mori Hosseini Student Union. We additionally compare spectroscopy data analysis from before and after the construction of the Mori Hosseini Student Union. Our project is new, and therefore ongoing. We require more data to thoroughly investigate our results before reporting our findings. However, as of now, our preliminary analysis suggests that improvements to the lighting practices around the College of Arts and Sciences, particularly with the Mori Hosseini Student Union, would greatly enhance the capabilities of the 1-meter telescope. Using covers on outdoor light fixtures to redirect light and using yellow light filters have been shown to reduce the light pollution. The final solution is still currently under investigation.

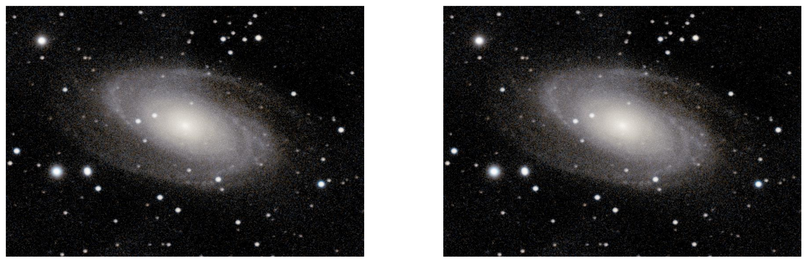
Introduction and Background

Embry-Riddle students are lucky to have many great resources and facilities on campus that provide aesthetic and practical uses. These include the Mori Hosseini Student Union, the Stick Lights surrounding the Quad and Walkways, and the Parking Garage. Although these resources are great for student and resident life, they pose a problem to astronomy research. The bright light emitted from these facilities produces light pollution which negatively effects observational practices, such as spectroscopy. These negative effects include:

- Light trespass
- Skyglow

Some specific methods of research and astronomy are directly impacted. Some of these include Astrophotography and Spectroscopy.

Astrophotography On and Off Campus



Figures 1a and 1b: Photographs of M81 taken on campus (left) and off campus (right) illustrating the severity of light pollution on campus. Pictures taken and processed by Sean Smith.

Figures 2a and 2b: Photographs of sky under Ursa Major taken on campus (left) and off campus (right) illustrating the severity of light pollution on campus. Pictures taken and processed by Harrison Zimmermann.

Spectroscopy with Light Pollution

Spectroscopy is useful to astronomy in many ways. Light pollution is a major obstacle in taking accurate spectroscopy data.

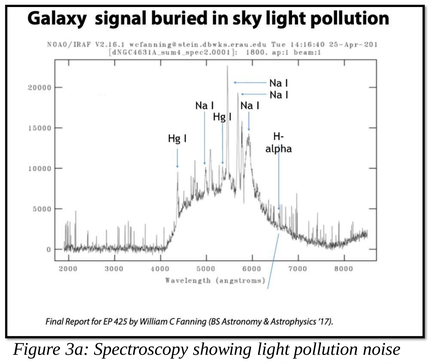


Figure 3a: Spectroscopy showing light pollution noise obtained by 1-meter telescope in 2017 provided by Dr. Jason Aufdenberg [1].

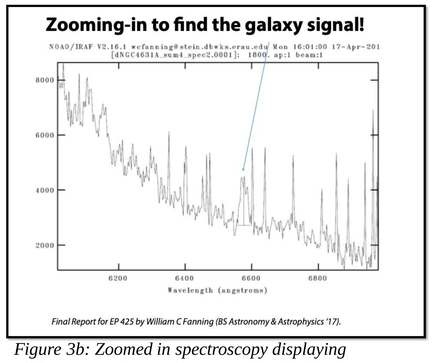


Figure 3b: Zoomed in spectroscopy displaying difficulty associated with data analysis of a target object provided by Dr. Jason Aufdenberg [1].

Specifics of Experiment

These sources of bright light present the main issues associated with light pollution on campus. Multiple experiments were exercised, taking measurements with a Unihedron Sky Quality Meter (SQM). The SQM takes readings by scanning the sky and giving a number ranging from 17-23 magnitudes per square arcsecond (mpsas). This means that the lower the number is, the brighter the sky is.

Experimental Methods

Several different methods of redirecting and filtering light have shown to improve the conditions of the light pollution. The experiments used for this project were a light cover experiment, a yellow light filter experiment, and a mapping experiment.

Light Cover Experiment

The methods of this experiment consisted of:

- Construction of prototype light covers
- Data collection without the cover on
- Data collection with the cover off
- Analysis of collected data

The data suggests an improvement of 0.85 on average when the covers are on and redirecting the light toward the ground.

Yellow Light Filter Experiment

The methods of this experiment consist of:

- Addition of yellow cellophane filter
- Data collection with the filter on
- Analysis of collected data

The data suggests that the improvement increases with the light filtered toward the yellow end of the spectrum. As compared to no filtration or coverage, there is an improvement of 1.11. There is also an improvement of 0.26 when there is a yellow filter added to an existing cover.

Mapping Light Pollution on Campus Experiment

The methods of this experiment consist of:

- Designing a grid system to map data around the College of Arts and Sciences
- Data collection under ideal and consistent conditions
- Transferring the data into a mapping Python program to show the severity of light pollution in different areas

The data suggests higher severity of light pollution in certain areas that are affected disproportionately by artificial light. This software is still under development, however, when it is complete it could suggest which facilities on campus emit the most harmful light.

Results

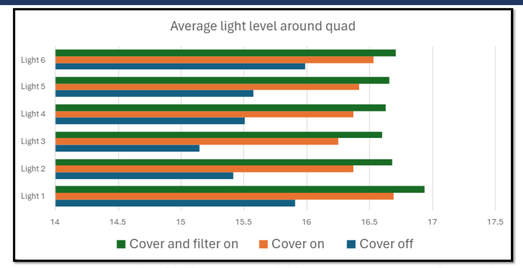


Figure 4a: Graph of light cover and filter experiments in the quad showing the light pollution severity under different conditions

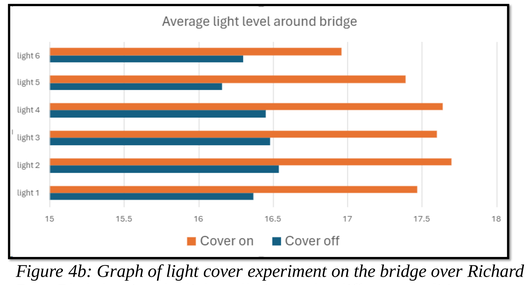


Figure 4b: Graph of light cover experiment on the bridge over Richard Petty Blvd showing the light pollution under different conditions

As a result of the experiments performed on the lights around campus, it is evident from all three methods of measurement that the covers and filters have a substantial effect on the intensity of light and visibility of its surroundings. Both graphs show that combinations of light covers and yellow filters provide a considerable reduction in the effects of light pollution.

Conclusions

Improvements to the light pollution conditions on this campus would increase the quality of astronomy research. There are several viable ways to reduce the impact of light pollution. The two techniques found thus far in this project are:

- Using **covers** to direct light toward the ground rather than into the sky
- Using yellow **light filters** to shift the light toward the much less disruptive yellow end of the spectrum

Light pollution has also been shown to affect student's sleep patterns and circadian rhythms [2]. It can disrupt natural ecosystems and even impact the behavior of all organisms [3]. Although the reduction of light pollution would be an improvement to the physics and astronomy departments on the Embry-Riddle campus, the benefits could go further than can even be predicted. It would be a change for the betterment of astronomy and the quality life on campus overall.

References and Acknowledgements

[1] Spectroscopy data (figures 3a and 3b), 2017, provided by Dr. Jason Aufdenberg

[2] Trueman Media Network, *Professor investigates light pollution on campus*, 2016

[3] University of North Carolina at Chapel Hill, *Capstone project looks at impact of light pollution*, 2024

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