The LBCC/OSGC Solar Coronal Imaging Polarimeter

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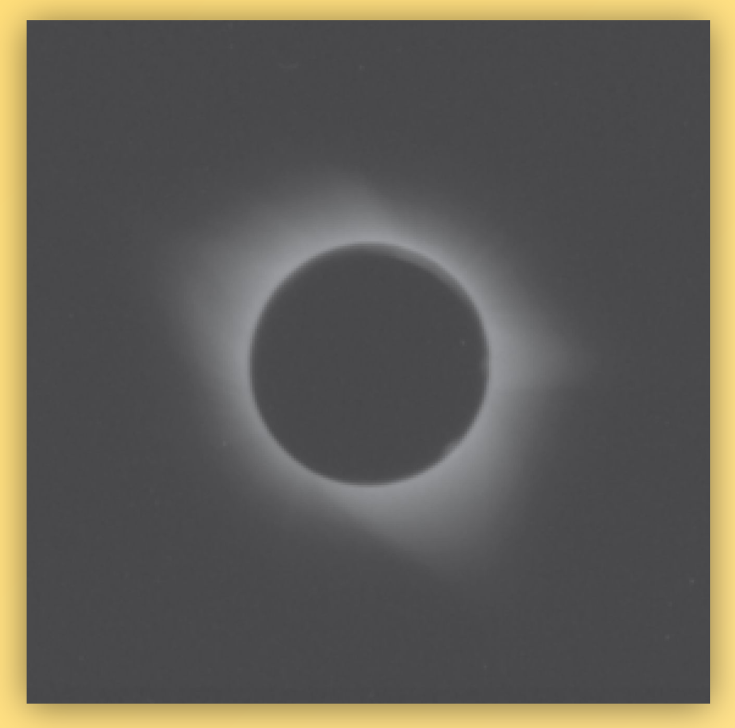
Goal of the Experiment

How are the photons that are emitted by the sun's corona polarized?

What Is Coronal Polarization?

As light travels from our Sun to Earth, it interacts with forces that cause the light to become polarized; from the magnetic fields of space dust, to the scattering of our own atmosphere, the polarization caused by these interactions must be accounted for when observing properties of our sun. The polarization of most of our sun's light has been well documented over the years (Nagendra & Stenflo, 1998); however, the sun's corona is particularly difficult to observe under normal conditions, due to its relatively low brightness. During events such as a solar eclipse, we can more directly observe the sun's corona, and more easily measure properties like polarization.



An example of white light emitted by our sun's corona during a total solar eclipse, taken during the 2017 eclipse. (Andersen, 2017)

Why Is Coronal Polarization Useful?

Knowing the polarization of light from our sun's corona allows us to make more accurate observations regarding its magnetic field, temperature, electron density, and many other properties (Raouafi et al, 2010). For example, current observations place the temperature of our sun's corona as being far higher than the sun's internal temperature, and our current understanding only allows for theories and approximations rather than the concrete answers we can give about the rest of the sun (Nicholeen et al, 2020). Polarimetry devices like the SCIP allow us to refine these observations and theories, and get closer to understanding the true behavior of our sun.

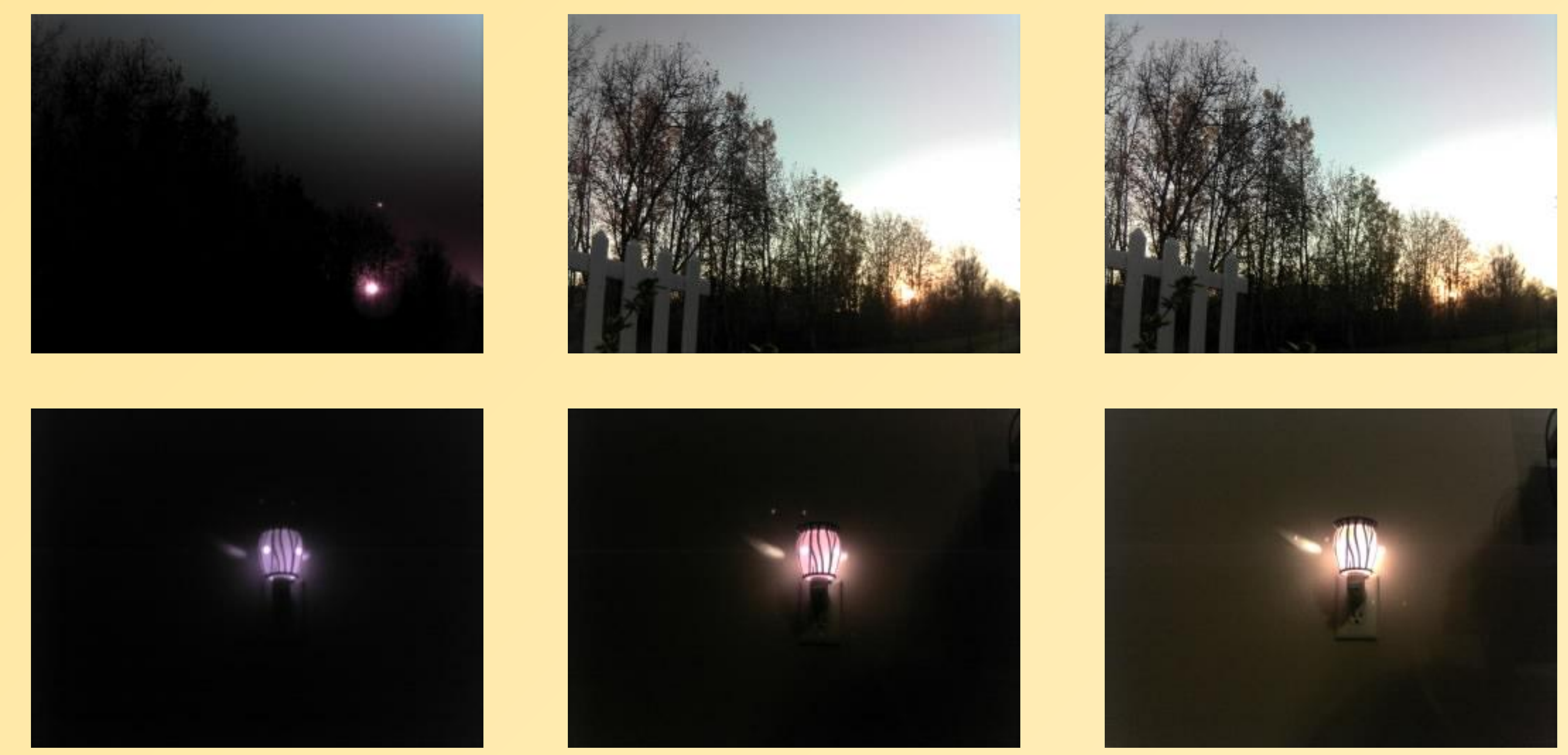
Our Polarimetry Device: Solar Coronal Imaging Polarimeter (SCIP)

The SCIP is an Arduino-powered camera with a Bower digital linear polarizing filter hooked up to a motor. When activated, the SCIP will begin taking pictures with its camera. After each picture, the polarization filter will rotate one degree, allowing for a new angle of polarization to be observed. The SCIP takes 181 photos, ranging from 0 to 180 degrees of polarization, and saves these photos to an SD card stored in the Arduino.

This entire process, from powering on to saving the final photo, takes approximately 3 minutes. This would allow an observer to quickly find the correct angle of polarization using the SCIP, and the use of an Arduino greatly reduces the cost of taking this observation compared to existing methods..

Sample Data and Results

These photos show samples of the SCIP's ability to take pictures of multiple polarization angles in rapid succession. The Arduino setup allows for the SCIP to be easily activated by simply powering the device; pictures can be quickly analyzed using the onboard SD card. Both examples use the 0, 45, and 90-degree polarization angles for maximum contrast.



Future Usage and Outreach

This project was chosen due to the approaching solar eclipse in South America on November 30th of 2020. The SCIP is currently being sent to a high school in Pucón, Chile, which will be able to use the device to take several photographs of the solar corona during the period of total eclipse, and analyze these photos to find the polarization angle of the sun's corona.

This quick method of finding and documenting a polarization angle allows for a more accessible way of measuring the sun's polarization. Our hope is that the SCIP will allow the Chilean students to learn more about the polarization of the sun's light, and inspire them to pursue an education and career in STEM fields.