

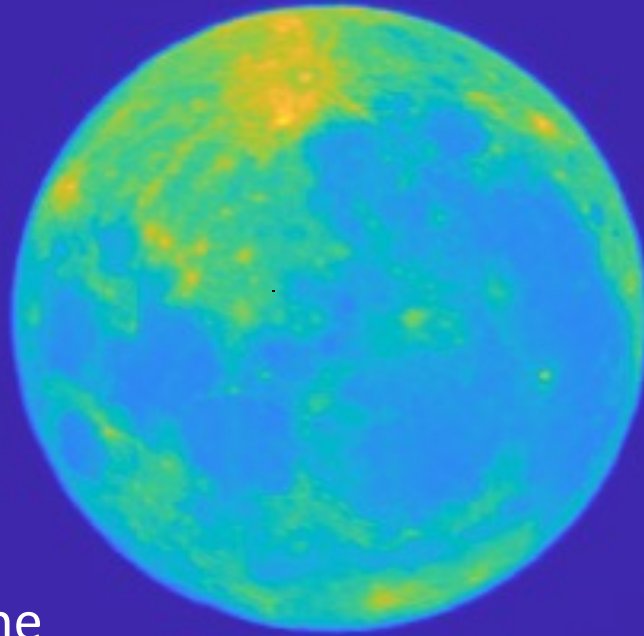
Moon Polarization in Narrow Spectral Bands

Solar REU 2024 Final Presentation

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Optical Remote Sensor Lab (ORSL)

Research Question

HOW DOES THE LUNAR POLARIZATION VERSUS PHASE
ANGLE CURVE CHANGE AS A FUNCTION OF WAVELENGTH?



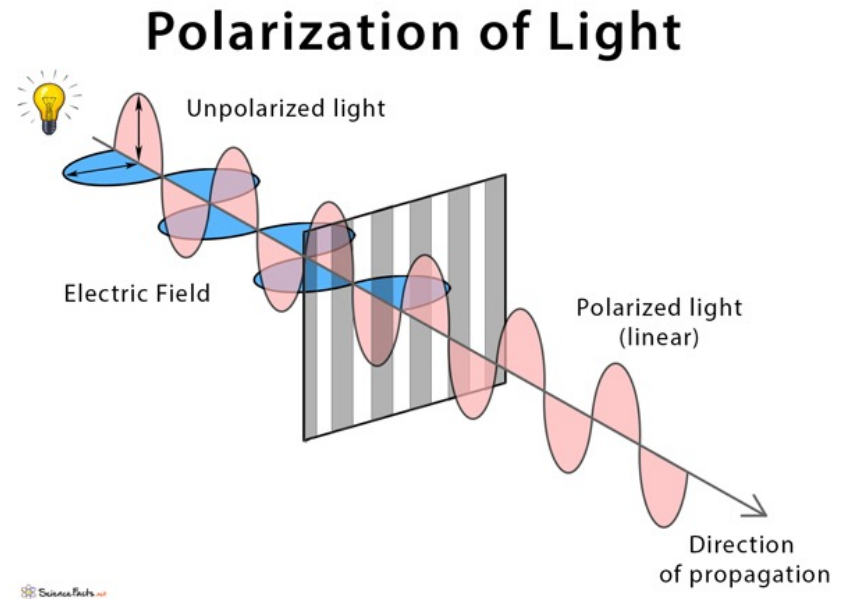
Goals:

- polarization images of the Moon
- see how filters in the visible and near-IR change the degree of linear polarization and how these results vary with phase angle.

- Final products:
- Create a preliminary DoLP curve with the moon images
- Process images for a crescent, half, and full moon night in all the filters

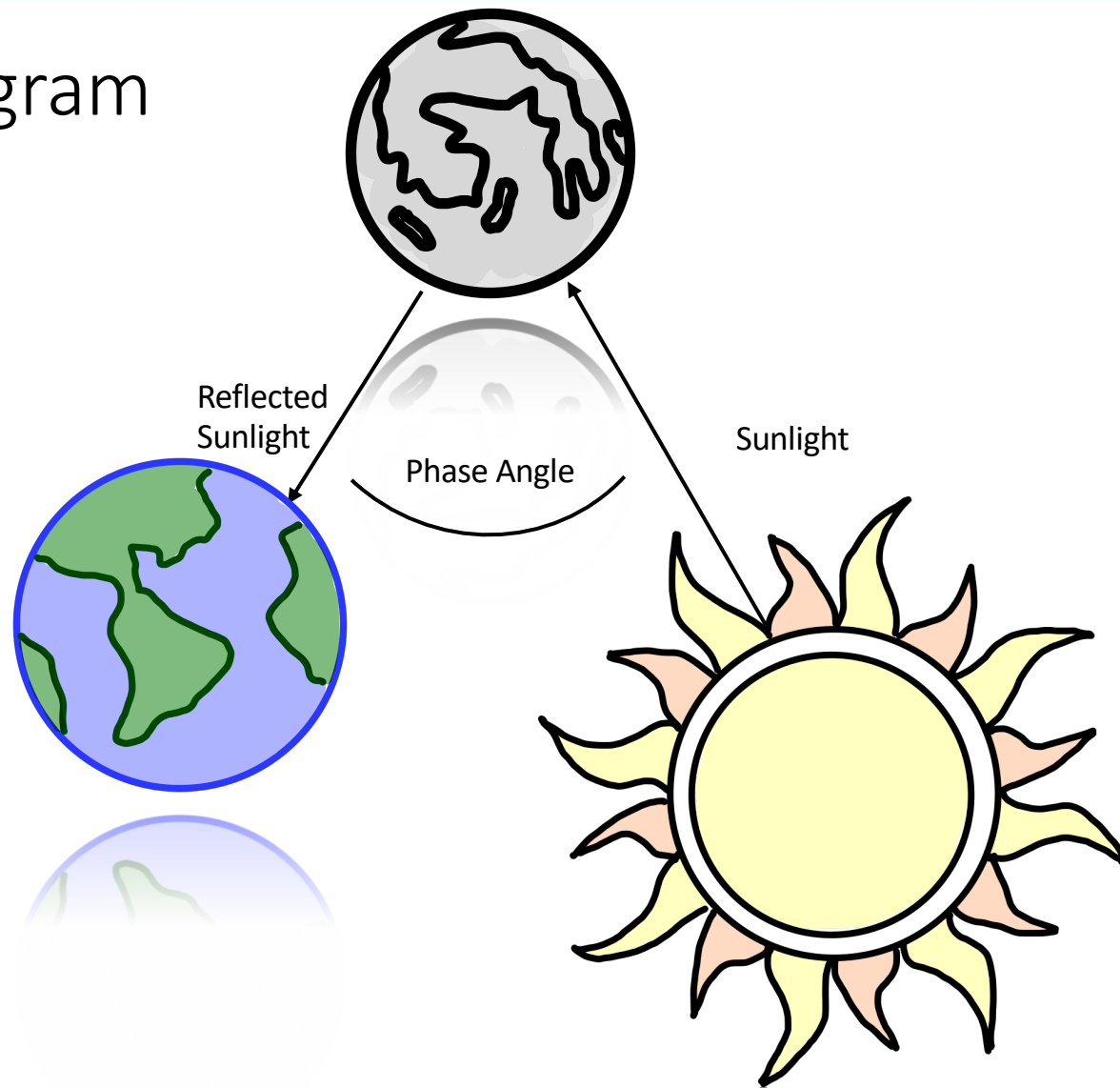
Quick Polarization and Polarimetry Recap

- Polarization is the tendency of electric field lines to oscillate directionally
 - Scattering
 - Reflection
 - Polarizing materials
- Direction of propagation is along the positive z-direction
- DoLP is the degree of linear polarization (% polarization)

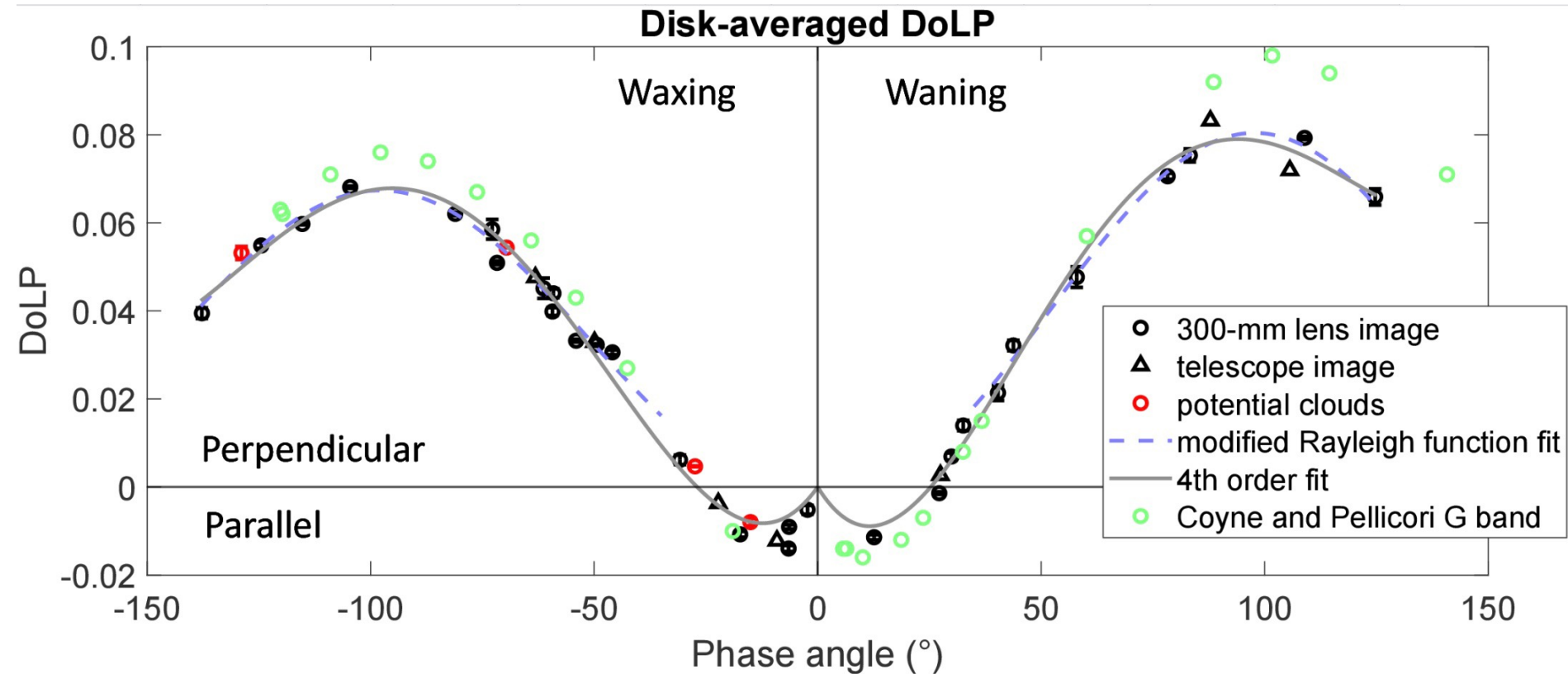


<https://www.sciencefacts.net/polarization-of-light.html>

Moon Diagram



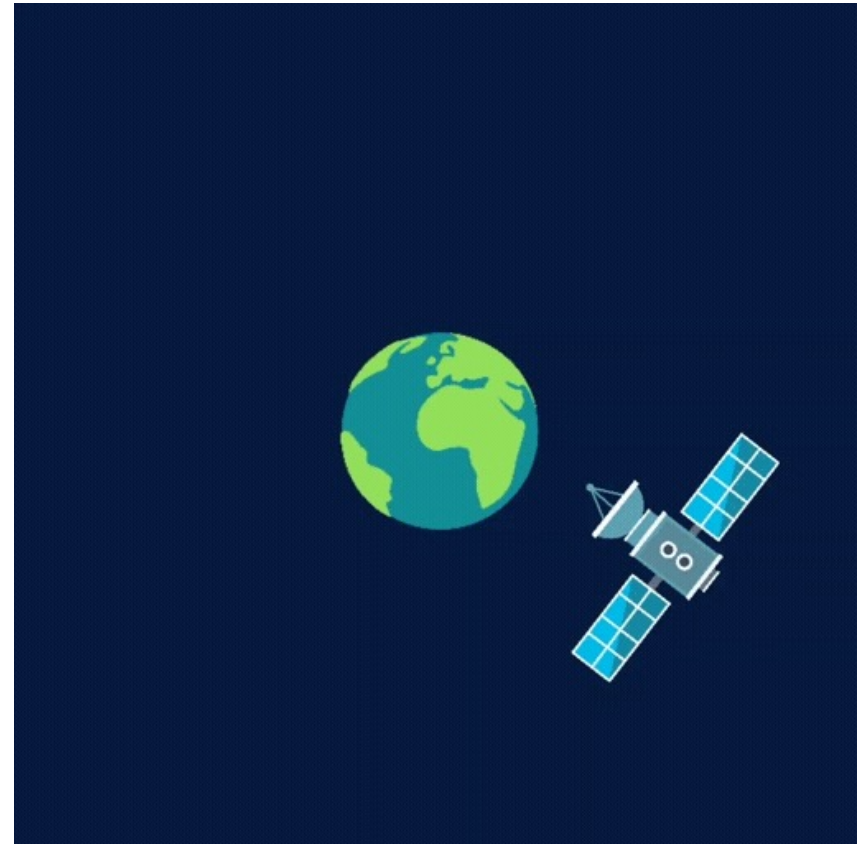
Previous ORSL Work in Broadband



Venkatesulu and Shaw

What Does This Research Lead To?

- Lunar Calibrations
 - Satellites using the Moon as a calibration source because it is a convenient calibration source
 - Currently have detailed radiometric Moon models but not polarization models

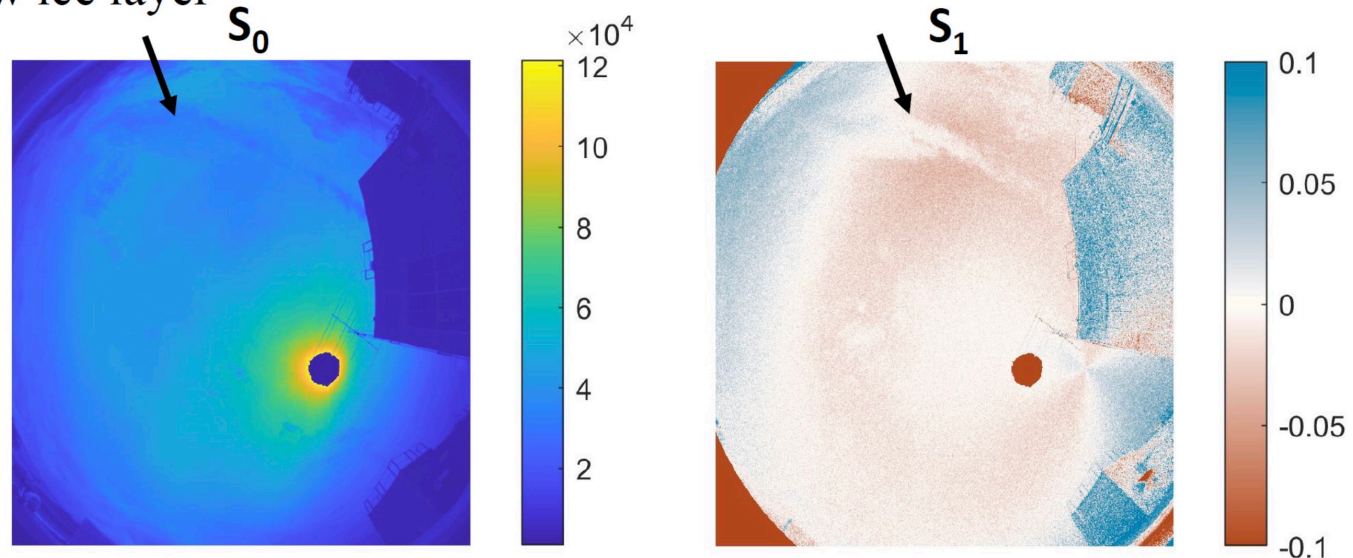


What Does This Research Lead To?

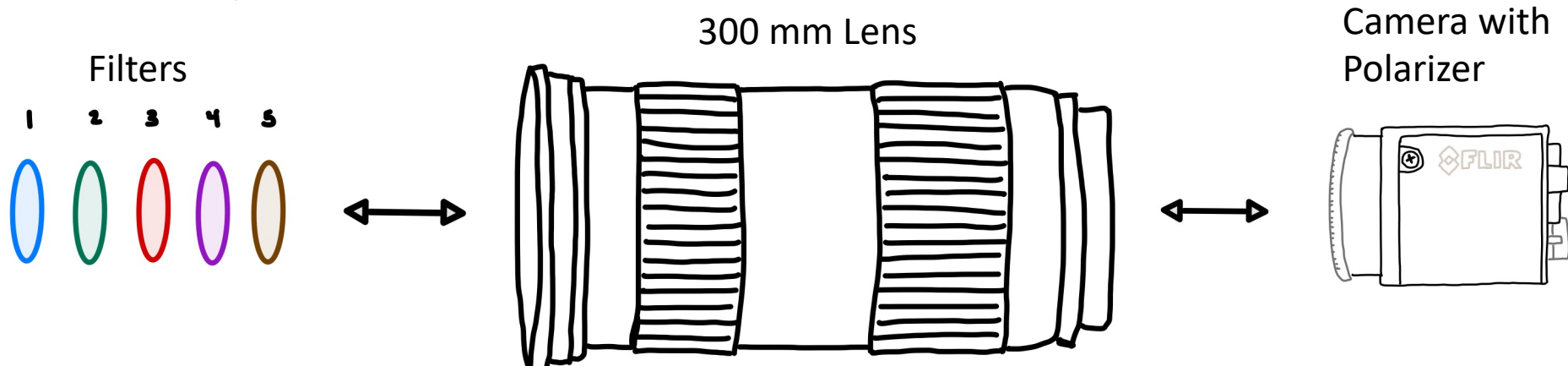
- Nighttime Polarization Remote Sensing
 - Polarized Cloud Data affected by polarization state of the moon at different phase angles

Liquid layer
below ice layer

Example of multilayered clouds



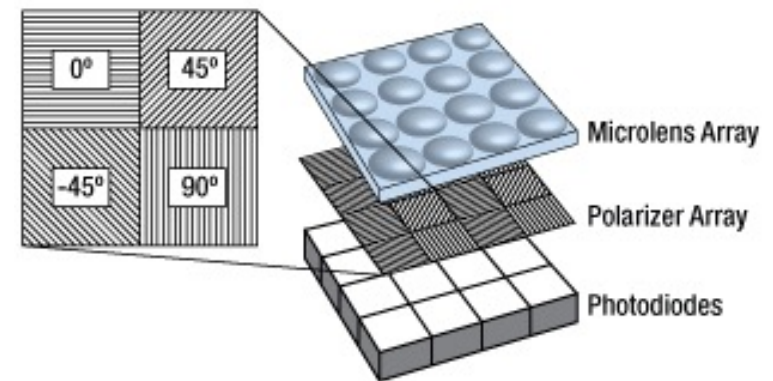
Set Up



Camera with Polarizer -> Lens -> Filter

- 5 Filters (nm)

1. 450
2. G (~520)
3. 650
4. 800
5. 900



Methods



FIVE FILTERS



TAKE THREE
IMAGES



PUT THE CAP
ON



TAKE A DARK
IMAGE



SWITCH THE
FILTER



REPEAT

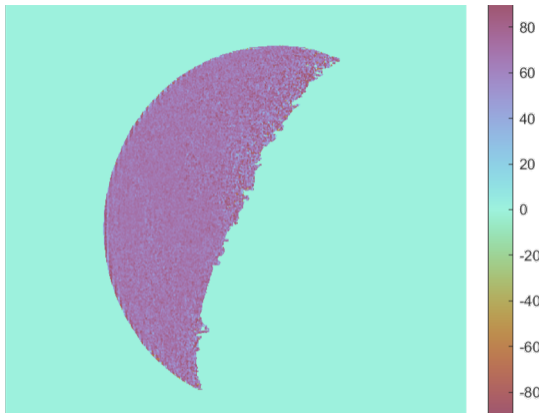
Obstacles and Nights Observed

- As of now, we got through all the filters on 16 different nights!
- Some obstacles included cloudy, rainy, and smokey nights
 - Smoke and haze should not affect the measurements because scattering should be forward

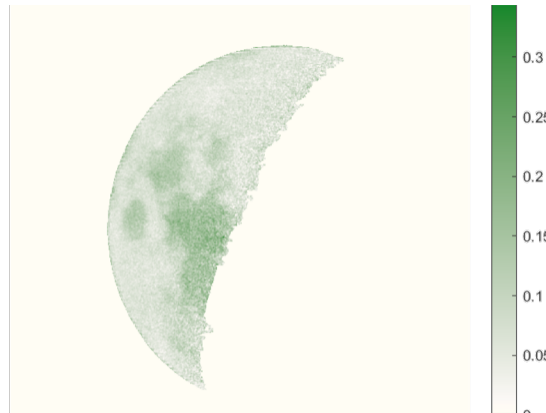


3 Parameters and Processed Images

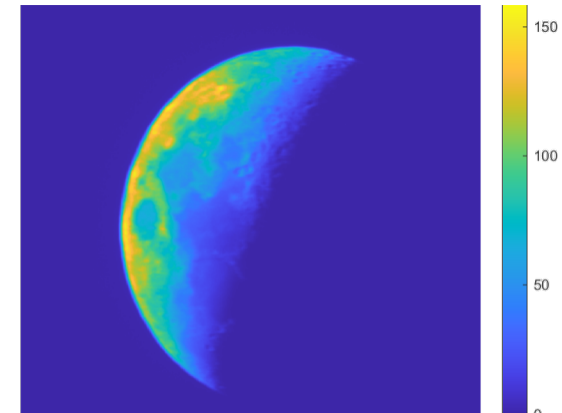
June 12, 2024 in the Green (~ 520 nm) Filter



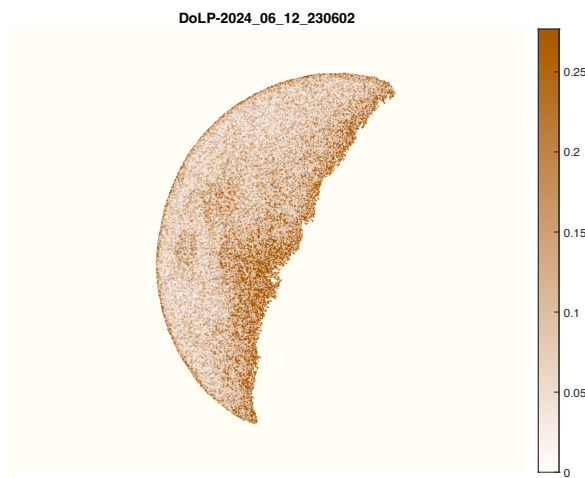
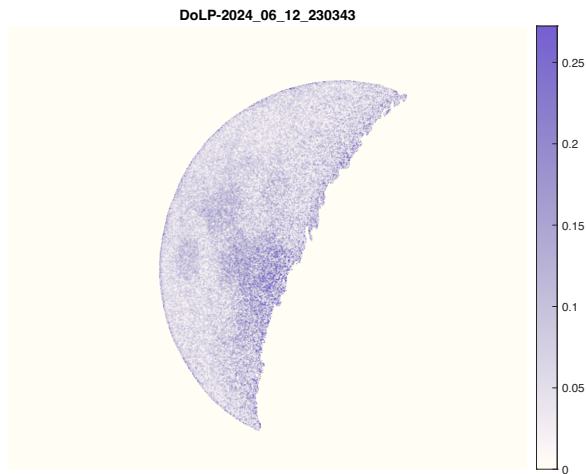
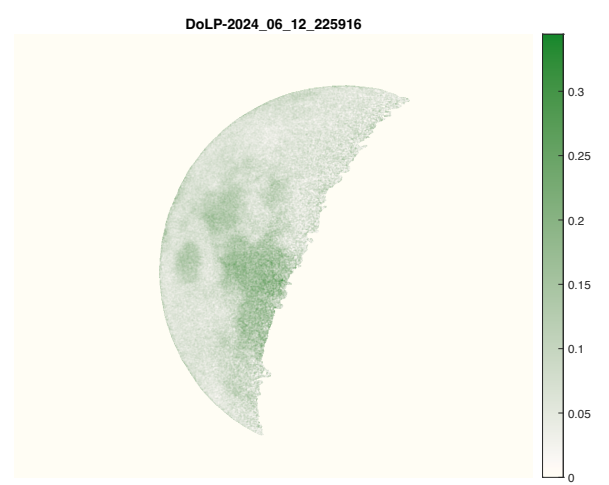
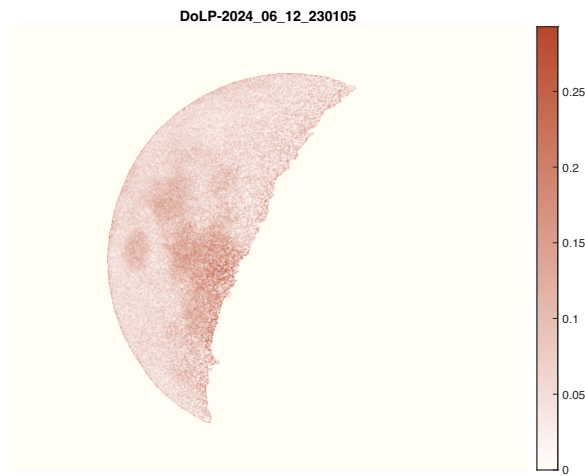
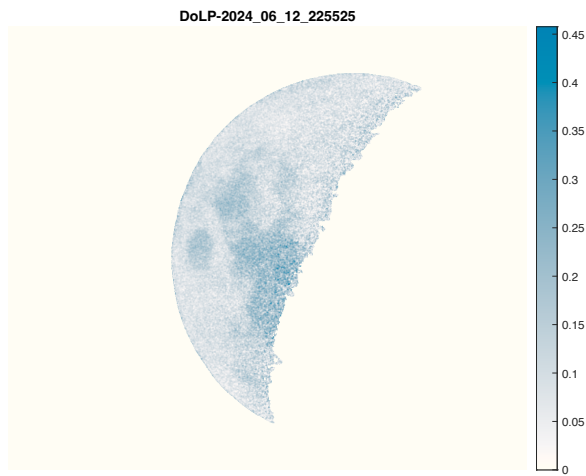
AoP



DoLP

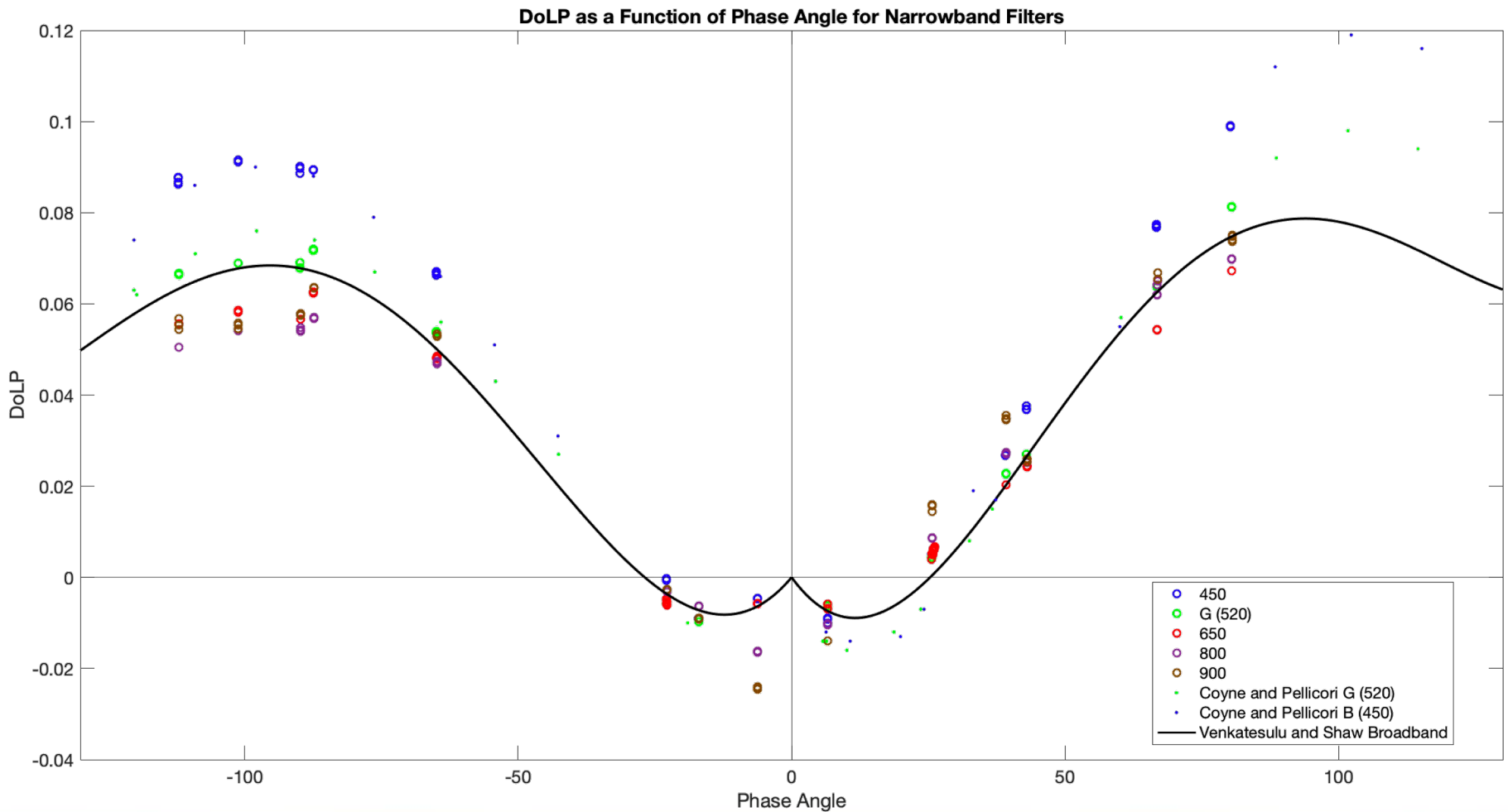


S0

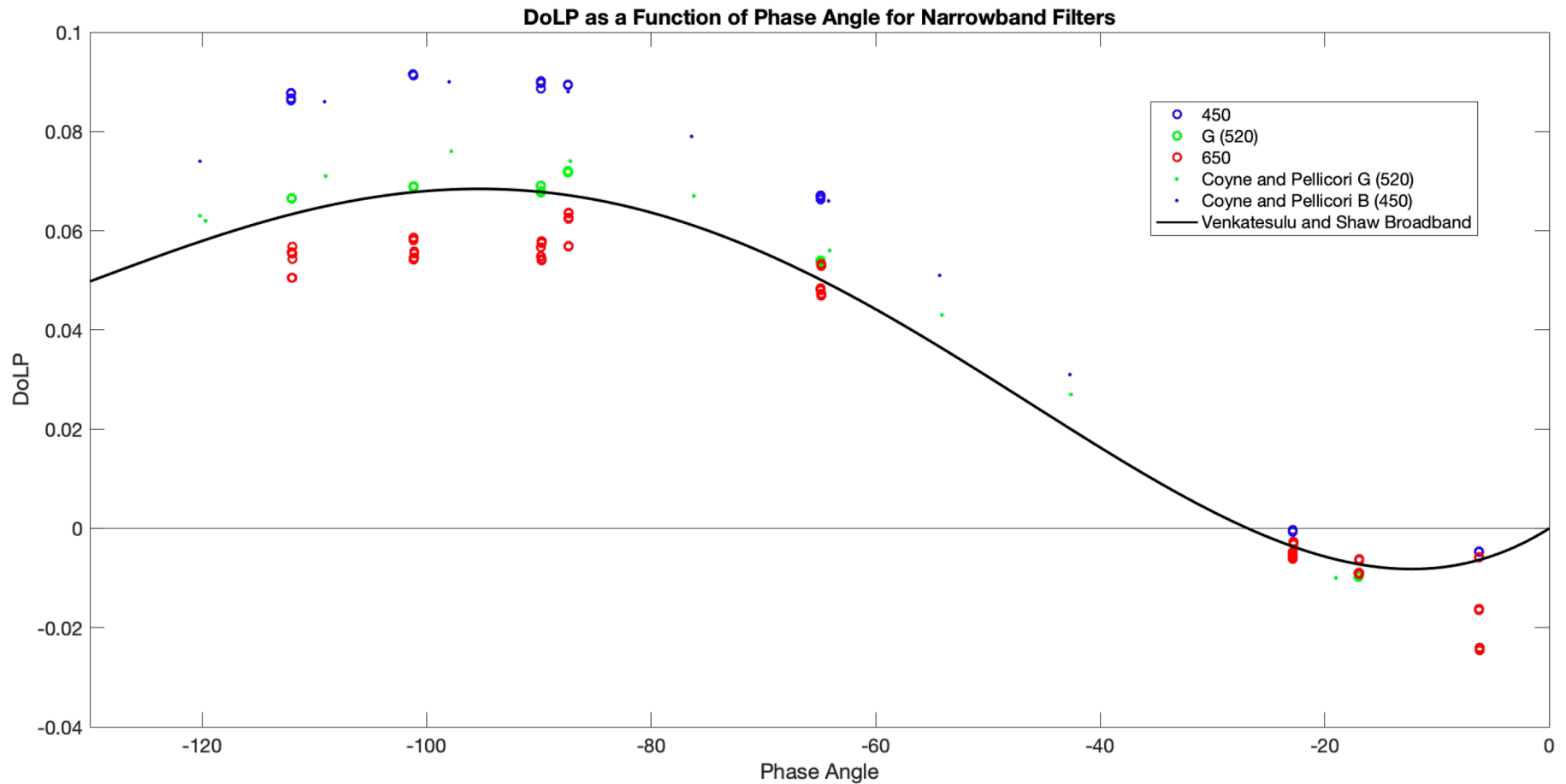


June 12, 2024 in all 5 Filters

DoLP Curve



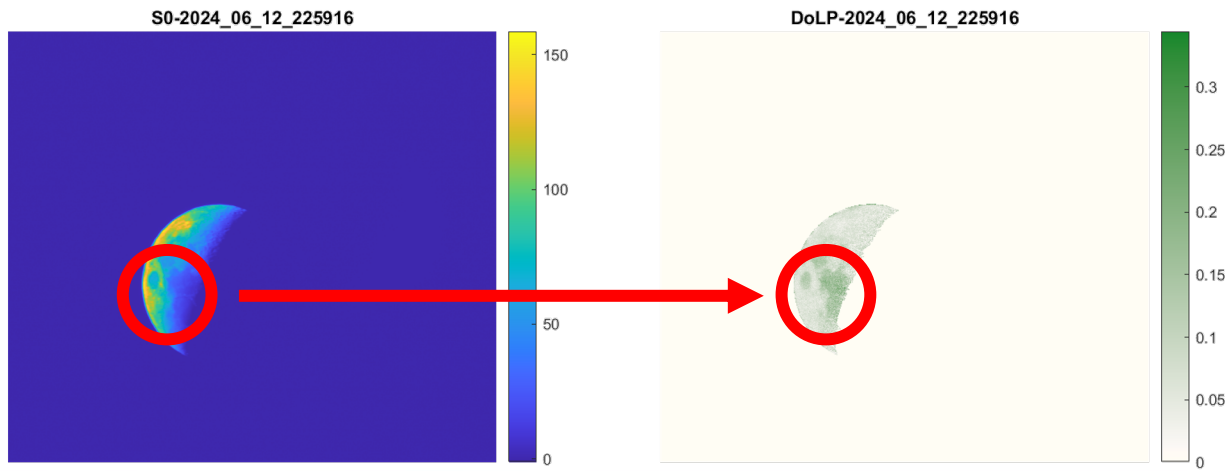
DoLP Curve in Strictly RGB



HOW DOES THE LUNAR POLARIZATION VERSUS PHASE ANGLE CURVE CHANGE AS A FUNCTION OF WAVELENGTH?

DoLP changes as a function of both wavelength and phase angle!

- As wavelength increases, DoLP decreases
- We might not be receiving enough light at 800 nm and 900 nm to determine the DoLP at those wavelengths
- It could be that after 650 nm that DoLP just evens out?
- Darker parts of the moon are more polarized



Darker on S0,
but brighter on
the DoLP

What happens now?

- We need to take more moon images to add to the DoLP curve
 - We can fill in the plot for the moon phase angles we do not have so far!
 - Figure out the correlation between DoLP and 800/900 nm filters
 - Does it get less noisy?
 - Is it the same?
- If the haze and smoke affected our DoLP measurements, it may be possible to determine the degree to which the smoke did change our measurements



Acknowledgments

- Erica Venkatesulu
- Dr. Joe Shaw
- ORSL and REU group



https://www.123rf.com/photo_7116729_smiling-moon-in-starry-night-sky-illustration.html

References

- Erica Venkatesulu and Joseph A. Shaw, "Polarization images of the Moon as a function of the lunar phase," Opt. Express 32, 24275-24292 (2024)
- Musaddeque A. Syed, Erica Venkatesulu, Joseph A. Shaw, "Cloud thermodynamic phase measured with a low-cost, ground-based, all-sky imaging polarimeter," Proc. SPIE 11833, Polarization Science and Remote Sensing X, 1183303 (1 August 2021);<https://doi.org/10.1117/12.2594204>
- <https://spaceplace.nasa.gov/all-about-the-moon/en/>

Questions?