Lunar Reflectance in Lyman α

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Outline

i. Scientific Background
ii. Data Reduction
iii. Lunar Albedo measurement
iv. Future Work
Why is the Lunar Albedo important?

✧ What is Albedo?
✧ Learn more about the Lunar Surface Properties
✧ Calibration for other Instruments

\[ A_M = \frac{E_M / \Omega_M}{E_S / \pi} \]
Remote Sensing of the Moon

- Mineralogy
- Surface composition
- Space Weathering
  - Changes to the reflectance properties of a material that’s exposed to the space environment for long periods of time
- Photometry
  - Reflectance properties as a function of phase angle depends on details of the surface
Lunar Observations as a Calibration Standard

- Photometrically stable
- Visible from any Earth orbit
- Ultraviolet instruments are difficult to calibrate accurately
- Limited sources that are well-characterized
- Carefully measuring the Moon with SOLSTICE could provide an ultraviolet standard from which future instruments could benefit
- The Robotic Lunar Observatory (ROLO) is a US Geological Survey project with this goal in the visible to near-infrared; SOLSTICE would extend this to the UV
Geometrical Terms

Phase Angle

Solar Zenith Angle
Wavelength Coverage

✧ SORCE Satellite – SOLSTICE instrument
✧ measures UV (∼115-310 nm) – Lyman α (121.6nm)
✧ 1 nm resolution in stellar mode and 0.1 nm resolution in solar mode
Solar Spectrum - Lyman $\alpha$
Airglow

锦标赛卫星仍然位于地球大气的一部分内。

- 导致光从大气中的氢原子散射。
- 这种背景光增加了SOLSTICE观测的月球信号。
Determine Airglow

- Three scans of just the atmosphere
- Data Reduction
- Each peak is at a different Solar Zenith Angle
  - 218.6°
  - 207.4°
  - 196.2°
- Gaussian Fits
Solar Zenith Angle vs. Maximum Count Rate

Background Prediction

- Polynomial fit
- 6th order

$\chi^2 = 57.395$
Lyman Alpha after Background Subtraction
Lunar Phase Curve at Lyman Alpha
Opposition Effect
Summary

- Lunar albedo can be a good thing to know
- Lunar properties
- Calibration
- Reduced the SOLSTICE data
- Airglow subtraction
- Found the lunar albedo
Future Work

- Improving the model to prevent the scatter in albedo
- Try other fits
- Testing the background prediction to find the uncertainty
Questions?
Space Weathering in the Ultraviolet

Lunar Rocks and Soil
- Spectra of lunar soils exhibit an upturn toward shorter wavelengths in the UV, while the spectra of lunar rocks do not exhibit this reversal, this suggests that the optical effects due to space weathering in the visible are different in the ultraviolet.
To Do This

- Make Corrections
- Issues with the data
- Flybacks
- Observations without data
- Observations with bad data
- Timing of instrument off

In the lunar observations, shifting of Wavelength due to movement of the Moon.

Remove background - Airglow according to the position of the satellite to predict background.
Data Reduction

- Filtering data points
- Observations without data
- Observations with bad data
- Shifting of Wavelength due to movement of the Moon
To Do This...

✧ Make Corrections
  ✧ Issues with the data
    ✧ Flybacks
    ✧ Observations without data
    ✧ Observations with bad data
    ✧ Timing of instrument off
  ✧ Shifting of Wavelength due to movement of the Moon
✧ Remove background - Airglow according to the position of the satellite to predict the amount of background