EPSC Abstracts
Vol. 13, EPSC-DPS2019-966-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Advances in Far-Ultraviolet Surface Reflectance Mapping with the Lyman Alpha Mapping Project

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Abstract

Far ultraviolet (FUV) surface reflectance maps are produced using the Lunar Reconnaissance Orbiter (LRO) Lyman Alpha Mapping Project (LAMP)'s innovative nightside observing technique [3], together with traditional dayside albedo mapping. Permanently Shaded Regions (PSRs) are revealed by reflected UV starlight and interplanetary hydrogen skyglow. Dayside mapping quality has recently been improved by implementing a new observing mode with the LAMP instrument starting in October 2016. We summarize recent advances made by the LAMP team, and discuss newly appreciated strengths of the FUV imaging spectroscopy technique.

1. Introduction

LRO-LAMP FUV measurements of the lunar surface, together with recent FUV studies of icy satellites, comets, and asteroids have proven unexpectedly useful for advancing our understanding of planetary surfaces. The strengths of the FUV reflectance imaging spectroscopy technique with respect to LAMP results include: 1) PSR water frost and hydration signatures near 165 nm, 2) a relatively blue spectral slope diagnostic of space weathering at lunar swirl locations, 3) increases in porosity within the PSRs identified by relatively lower albedos, and 4) determination of relative surface ages using these far-UV signatures, e.g., to identify young impact craters [6]. These LAMP results are supported by ongoing laboratory investigations of Apollo returned samples [7] and volatile ice FUV reflectance measurements.

2. Far-UV Maps of the Moon

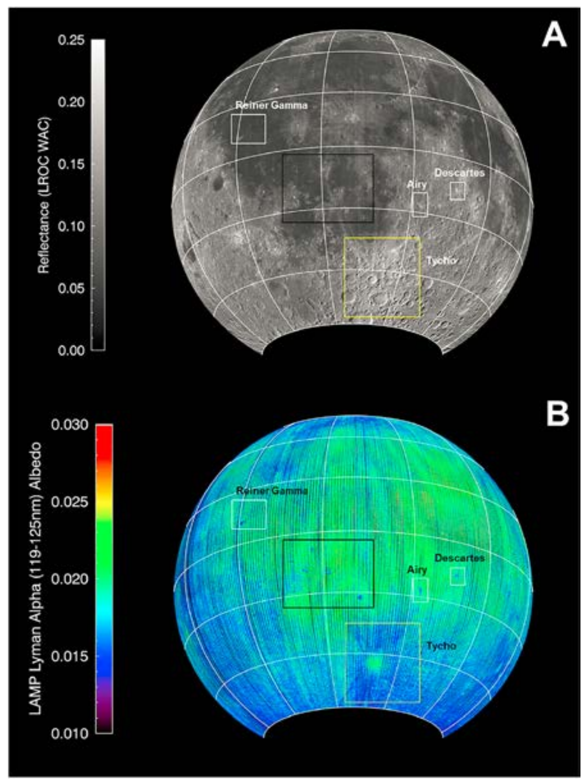

Figure 1: Cahill et al. 2019 [2] (figure 1 therein) investigate enigmatic low Lyman-α albedo features associated with photometric anomalies (black box) in the LAMP map at bottom (LROC Wide Angle Camera image at top for comparison). Nearby swirls (white boxes) also low Lyman-α albedo. Byron et al., *this meeting*, further investigate Tycho crater and crater ray features (yellow box).

LAMP maps are currently produced with two complementary methods for both nightside and dayside techniques. Global broad-bandpass (off-band, on-band, Lyman-α) maps are produced at FUV wavelengths with ~240 m × 240 m pixels poleward of and 32 pixels per degree equatorward of 60° latitude, revealing many UV features with unprecedented detail. Spectral image cube maps are also produced with 2 nm spectral resolution, enabling detailed compositional and space weathering investigations of regions of interest.

3. Recent Results

Newly produced PSR spectral image maps are reported in Magaña et al., *this meeting*, which will improve spectral mixing model fits to constrain the abundances of water frost and search for evidence of additional volatile species.

Hendrix et al. 2019 [4] report a new analysis of diurnally varying hydration signatures, with new constraints on the abundances of H_2O/OH temporarily adsorbed onto the surface in mare and highland regions.

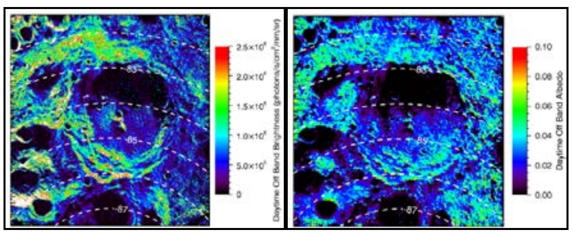

Figure 2: Amundsen crater far-UV off-band dayside brightness (left) and albedo (right) from Byron et al. 2019 [1] provide evidence for space weathering on the sunward/equatorward facing slopes near image bottom. Several regions within Amundsen crater provide additional case studies for constraining other processes as well using LAMP's far-UV nightside and dayside maps.

Liu et al. 2018 [5] and Raut et al. 2018 [7] compare Apollo soil 10084 lab measurements with LAMP surface reflectance spectra to determine photometric parameters and the bidirectional reflectance distribution function at far-UV wavelengths.

4. Summary and Conclusions

Far-UV measurements of the Moon have recently demonstrated an expanded utility in terms of being diagnostic of many regolith processing traits. These diagnostic features may translate to similar diagnostic measurements of other atmosphere-less solid bodies, including future investigations of icy satellite regolith processing and potentially other planetary processes.

Acknowledgements

We thank the LRO project. The LRO LAMP is funded by NASA under contract NNG05EC87C, whose financial support we greatly acknowledge.

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