Lunar Surface Ice Identifications by LRO Lyman Alpha Mapping Project (LAMP) Far-Ultraviolet Spectroscopy.
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Far ultraviolet (far-UV) reflectance measurements of the Moon, icy satellites, comets, and asteroids have proven useful for advancing our understanding of planetary surfaces and their volatile abundances. This new appreciation for planetary far-UV imaging spectroscopy is provided in large part thanks to a decade of investigations with the Lunar Reconnaissance Orbiter (LRO) Lyman Alpha Mapping Project (LAMP).

LAMP's innovative nightside observing technique [1,2] has revealed the Moon in a new light, using starlight and Lyman-α skyglow as illumination sources. Far-UV spectral imaging nightside maps produced through this technique are useful in understanding condensed water within permanently shaded regions (PSRs). Dayside far-UV maps are also obtained using the more traditional photometry technique with the Sun as the illumination source, and provide complementary imagery. Together, these LRO-LAMP measurements provide a unique perspective on the lunar "hydrological cycle," connecting the surface abundance of water ice trapped in the Moon's cryosphere to volatile transport processes involving the lunar exosphere.

LAMP data analyses allows for the study of how water is formed on the Moon, transported through the lunar exosphere, and deposited in PSRs [2,3]. LAMP nightside and dayside brightness maps cover a wavelength range of 57-196 nm. Lyman-α (Fig. 1), on-band, and off-band albedo maps (i.e., on and off the water ice absorption band at ~165 nm) are useful for constraining the abundance of surficial water ice (water ice within the topmost ~100 nm to ~200 nm) where previous analyses have found that PSRs may contain up to ~2% water ice by mass [1,4,5].

Detailed far-UV spectral analyses [6] supplemented by laboratory efforts [7] investigate regolith structure/porosity and the relative aging of surface features by space weathering and [8,9,10,11,12]. These findings support the previous identification of diurnal variations in hydration features [13,14], and identify compositional signatures in regolith (i.e., feldspar rich highlands) [12].

Global nightside and dayside maps are divided (at ±60° latitude) into polar and equatorial regions with stereographic and equirectangular projections, respectively. Additionally, spectral image cube maps have been created for several regions of interest with 2 nm resolution, and are being expanded to cover the full globe.

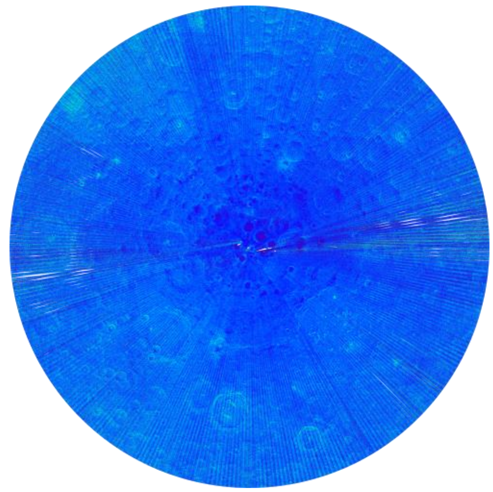

Fig 1. Nightside Lyman-α albedo maps of the lunar south pole used to constrain superficial water ice abundance.

Global searches for water signatures outside of lunar PSRs are allowing us to confirm and elucidate the findings of surface water/hydroxyl and its variability [13,14]. The present LRO extended science mission enables more surface reflectance data at a variety of incidence and emission angles to improve signal, spectral, and photometric quality and further develop our innovative UV reflectance techniques [15]. Ongoing laboratory studies are constraining the compositional and photometric properties of lunar samples and simulant analogs [16].

Science provided by LRO-LAMP investigations of the lunar dayside, nightside, and PSRs are a useful tool to plan for upcoming Artemis crewed missions in the context of understanding hydration of the lunar surface. Additionally, LRO-LAMP has helped to constrain surface ages with relative space weathering comparisons, and to understand the microphysical fairy-castle structure/porosity of regolith with additional composition constraints. Such far-UV surface reflectance investigations complement visible imaging and near-IR spectroscopy measurements and aid in the identification of new scientific research that could be enabled by human exploration.

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