INVESTIGATING FAR-ULTRAVIOLET HYDRATION SIGNATURES IN THE SOUTHWEST ULTRAVIOLET REFLECTANCE CHAMBER (SwURC) IN SUPPORT OF LRO-LAMP OBSERVATIONS. U. Raut1, P. L. Karnes1, K. D. Retherford1,2, E. Czajka1,2, M. J. Poston1, M. W. Davis1, Y. Liu3, E. L. Patrick1, G. R. Gladstone1,2, T. K. Greathouse1, A. R. Hendrix4, P. Mokashi1 1Southwest Research Institute, Space Science and Engineering Division, San Antonio, TX 78238, 2Department of Physics and Astronomy, University of Texas at San Antonio, San Antonio, TX 78249, 3Lunar and Planetary Institute, Houston, TX 77058, 4Planetary Science Institute, Tucson, AZ 85719.

(uraut@swri.edu)

Introduction: Far-ultraviolet (FUV) reflectance spectra from the Lyman Alpha Mapping Project (LAMP) spectograph onboard the Lunar Reconnaissance Orbiter (LRO) shows evidence for surficial water frost in the permanently shadowed regions (PSRs) of the Moon [1]. It also showed the presence of a thin veneer of H2O and/or hydroxyl species in the lunar regolith with an abundance which varies systematically with latitude and on diurnal timescales [2]. The presence of the hydrated species induces FUV spectral reddening attributed to the strong water ice absorption edge at 165 nm [2].

Deriving accurate estimates of the PSR water content or the spatial abundance and distribution of the water in the lower-latitude lunar regolith from the LAMP FUV observations has proven challenging. Different flavors of radiative transfer theories to model the LAMP spectra require optical constants of endmember species – lunar regolith and water ice. However, these fundamental properties of lunar soils and ice-soil aggregates are largely uncharacterized in the FUV, thereby limiting the accuracy of the hydration estimate. As such, the PSR water abundance is constrained to ~ 1-2% [1], while the dayside abundance constrained to < 1% [2]. Both estimates were obtained by observing and/or modeling the variations in the spectral slope in the 164-173 nm region due to the strong water ice absorption edge at 165 nm.

The surficial water molecules present at lower latitudes can migrate to the lunar poles via ballistic hops [3] and could, therefore, be an important source to the water ice frost in the PSRs cumulated over the geological history of the Moon [4]. Accurate knowledge of the dayside abundance of the lunar hydration could further help constrain the supply rate to the PSRs.

With goals to further refine the LRO-LAMP hydration estimates, we are currently engaged in making bidirectional reflectance and phase curve measurements of dry Apollo soils and especially that of ice-Apollo soil aggregates in the SwURC. We will present robust data on the FUV reflectance of dry Apollo soils (Figure 1), followed by preliminary results on ice-coated and ice-soil aggregates.

Experimental Setup: The bidirectional reflectance measurements of the dry and water vapor-exposed Apollo soils are conducted in the Southwest Ultraviolet Reflectance Chamber (SwURC), which is an ultrahigh vacuum chamber (base pressure ~ 10^-9 Torr) coupled to a vacuum ultraviolet scanning monochromator that uses a combination of a rotating dispersive grating and a pair of entry/exit slits to select near monochromatic light from a 30 W deuterium lamp source. The monochromatic light is incident on the Apollo soils (mare and highland samples obtained from CAPTEM) assembled on the horizontal sample tray that resides within the high vacuum chamber. The sample tray can be cooled to ~ 85 K using an open-cycle LN2 flow.

We will also expose the Apollo soils to precisely controlled fluxes of water vapor. Currently, we are completing the installment of a calibrated gas dosing manifold and a micro-capillary array doser on the SwURC. The amount of water vapor leaked into the chamber from the gas manifold will be monitored using absolute MKS-Baratron capacitance manometer gauges. The micro-capillary doser will exude a collimated flux of water directed towards the cooled Apollo soils.
The diffuse light reflected by the dry and wet Apollo soils is received by a sealed CsI-coated channeltron detector which is installed on a rotating mount. The channeltron traces a circular track in the principal plane measuring the intensity of the reflected light over a wide range of emission or phase angles. Our measurements quantify the bidirectional reflectance distribution function $f_{BRDF}$, which is an invariant sample property for a pair of incidence and emission geometries. The BRDF function for the SwURC geometry simplifies to,

$$f_{BRDF}(g) = \frac{P_r(g)}{P_i \cos(-45^\circ) \Omega_d}$$

where $P_i$ and $P_r$ are the powers of the incident and reflected flux, $g$ is the phase angle and $\Omega_d$ is the projected solid angle. See Ref [5, 6] for more details on the SwURC instrumentation.

Our key objective will be to quantify the relationship between the magnitude of the BRDF slope change with respect to the water content in the wet Apollo soils and apply the laboratory data to obtain refined hydration estimates from LAMP spectral datasets for both PSRs and low-latitude regions.

**Acknowledgment:** We are thankful to CAPTEM for providing us with Apollo soil samples. The development of the SwURC facility was funded by SwRI Internal Research and Development funds. Measurements in support of LRO-LAMP investigations are funded by NASA.

**References:**