THE LCROSS PLUME AS OBSERVED BY LRO/LAMP. D. M. Hurley[1] G. R. Gladstone[2], S. A. Stern[3], K. D. Retherford[2], P. D. Feldman[4], W. Pryor[5], A. F. Egan[3], T. K. Greathouse[2], D. E. Kaufmann[3], M. Davis[2], M. Versteeg[2], A. R. Hendrix[6], [1]Johns Hopkins University Applied Physics Laboratory, 11100 Johns Hopkins Rd., Laurel, MD 20723 (dana.hurley@jhuapl.edu), [2]Southwest Research Institute, San Antonio, TX, [3]Southwest Research Institute, Boulder, CO, [4]Johns Hopkins University, Baltimore, MD, [5]Central Arizona University, [6]Planetary Science Institute

Introduction: The Lyman Alpha Mapping Project (LAMP) onboard the Lunar Reconnaissance Orbiter (LRO) has observed the exosphere of the Moon since its arrival in 2009. The LRO spacecraft was co-manifested with the Lunar Crater Observation and Sensing Satellite (LCROSS). LRO characterized the candidate impact sites enabling the final site selection. LRO participated in the investigation by observing the impact and the evolution of the environment on several subsequent orbits.

Instrument: The LAMP far ultraviolet (FUV) imaging spectrograph has a wavelength range of 57- 196 nm [1]. Exospheric spectra can be observed when LRO is in the geometry such that the line of sight includes illuminated exosphere but does not include the bright surface of the Moon. In nominal operations, this occurs for a short time while LRO crosses the terminator and the footprint of the field of view falls on the shadowed lunar surface. In addition, LRO performs maneuvers that point off-nadir. This can increase the illuminated column of exosphere and improve the signal to noise for the observation.

LCROSS impact: On 9 Oct. 2009, the Lunar Crater Observation and Sensing Satellite (LCROSS) mission performed an intentional impact into the permanently shadowed region (PSR) of Cabeus crater. The impact released vapor into the exosphere. LRO adjusted its phasing such that it would pass the impact site 90 s after the impact. LRO rolled to the side to observe the plume as it rose into sunlight against the background of the dark sky. LAMP detected the plume about 25 s after the impact. The brightness of the plume peaked quickly then decayed. A small hump is observed when the field of view passes the impact site, indicating a lesser slowly subliming source. No signal was detected on any subsequent orbit. Spectral analysis revealed the presence of H2 and CO. In addition, a feature at 185 nm appears is consistent with the combination of Hg, Ca, and Mg [2].

Model: A Monte Carlo model simulated the expansion and propagation of the vapor after released from the surface [3]. The model could reproduce the observed light curves only for a small range of initial conditions. The model assumed the vapor was released as a drifting Maxwellian characterized by a velocity with a thermal distribution is superposed on a constant bulk velocity. The best fit was found for a bulk velocity of ~3.5 km/s. The fits to the 180-190 nm light curve tightly constrained this value, but did not constrain the temperature. The fits to the 130-170 nm spectrum constrained the temperature to ~800 K. Most of the impact vapor escapes the Moon.

Conclusions: The LRO LAMP observation of the LCROSS impact identified some of the volatile constituents on the lunar PSRs. The dynamics of the vapor plume were well constrained. The vapor expanded rapidly and dissipated.

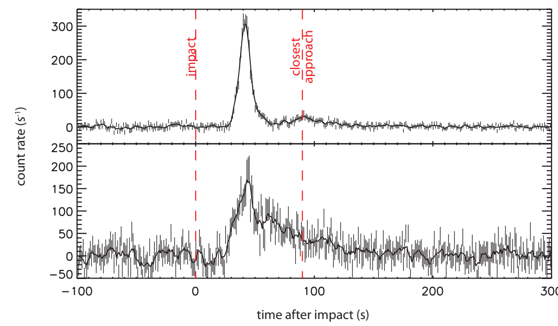

Figure 1. LAMP time series showing the light curve of the LCROSS plume in the 180-190 nm range (top) and 130-170 nm range (bottom).

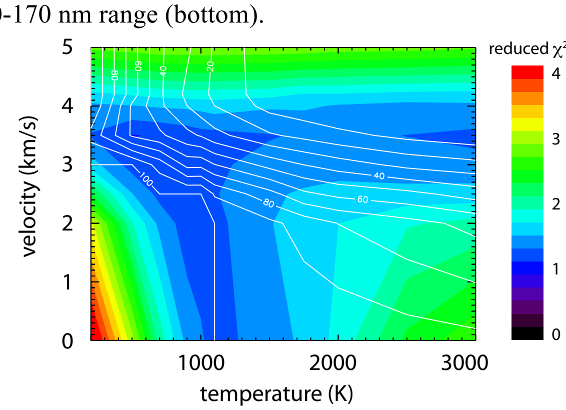

Figure 2. Goodness of fit for different modeled temperatures and bulk velocities to the 130-170 nm light curve. They indicate a bulk velocity of < 3.5 km/s and temperature < 1000 K.

References: [1] Gladstone, G. R. et al. (2010) *Space Sci. Rev. 150*, 161-181. [2] Gladstone G. R. et al. (2010) *Science 330*, 472-476. [3] Hurley, D. (2011) *J. Geophys. Res. 116*, E10007. [4] Hurley D. M. et al (2012) *J. Geophys. Res. 117*, E00H07.