DISCOVERY OF HEAVY ATOMS IN THE EXOSPHERE ABOVE THE PERMANENTLY SHADOWED REGION IN CABEUS. D. H. Wooden[1] , A. Colaprete[1], J. L. Heldmann[1], K. D. Retherford[2], R. M. Killen[3], R. Elphic[1] and K. Ennico[1], [1]NASA Ames Research Center, MS 245-3, Moffett Field, CA 94035-0001, Diane.Wooden@nasa.gov, [2]Southwest Research Institute, 6220 Culebra Rd., San Antonio, TX 78228, [3]NASA Goddard Space Flight Center, Code 695, Greenbelt MD 20771.

Introduction: The LCROSS (Lunar Crater Observation and Sensing Satellite) mission impacted the permanently shadowed region (PSR) of the Cabeus crater near the south pole of the Moon on 9 October 2009. A plume was created by the impact of the Centaur upper stage of the launch vehicle and observed by the LCROSS Shepherding Spacecraft (S-SC) instrument suite that allows us to characterize the water and volatile concentrations and to characterize the nature of the particulates released from the permanently shadowed region (PSR) on the floor of Cabeus crater [1, 2].

Emergence of UV Emission Lines as UV-Visible spectrometer FOV narrows in on Cabeus PSR: During the hour before impact, the LCROSS S-SC followed behind the Centaur by a distance of ~625 km and the LCROSS S-SC instrument suite took data to serve as a baseline for the study of the Centaur impact plume. Figure 1 shows the Radiance of the Mg I line growing in contrast to the solar reference spectrum as the spectrometer 1˚ nadir Field-of-View (FOV) narrows in on where the Centaur will hit the permanently shadowed region (PSR) of Cabeus.

During the last 125 [s] before Centaur impact, the spectrometer FOV no longer contains sunlit terrain. The "Cabeus PSR Exosphere" spectrum is derived from the last 19 spectra acquired before the S-SC observes the Centaur impact plume as follows. We remove the cosmic-ray hits from each of the 19 spectra prior to statistical analyses. The 19 spectra are then co-added to derive a mean and error in the mean without using those pixels identified as cosmic-ray hits. The result of subtracting a scaled solar reference spectrum from the mean of 19 scans is the high signal-to-noise emission line spectrum.

Cabeus PSR Exosphere: The UV spectrum of the nadir-view of Cabeus PSR at 900–625 km altitude is complex. These spectra reveal a forest of UV emission lines that we hypothesize are detection of new species in the lunar exosphere. Never before has the moon been investigated at these short wavelengths at such close distance. In the LCROSS UV spectra, we have identified Mg I (285.2 nm) with a high Signal-to-Noise Ratio (SNR=46). We tentatively identified lines of Ca, Fe, and Ti, where most but not all lines appear to be neutral species fluorescing from near the ground state. Specifically, the Fe I (372.1 nm) line (SNR=41) is present, which was predicted by [3]. Initial analyses of the Cabeus PSR Exosphere spectrum will be discussed during the Wet versus Dry Moon meeting.

Discussion: Studying the lunar exosphere can tell us generally about volatile transport processes, e.g., how the water and hydroxyl molecules seen by M3 and EPOXI at low latitudes are transported to the poles. Detection of heavy atoms above Cabeus PSR supports the goals of the LADEE Mission to detect heavy atoms in the Exosphere at mid-latitudes [4, 5].

References: [1] Colaprete A. et al. (2010) *Science, 330,* 463-468. [2] Schulz, P. et al. (2010) *Science 330*, 468. [3] Morgan T. H. and Killen R. M. (1997) *Planet. Space Sci. 45,* 81–94. [4] Sarantos M. et al. (2010) Lunar Exploration Analysis Group (LEAG) LPI Contrib. No. 1595, p. 62. [5] Author G. H. (1996) *LPS XXVII,* 1344–1345. [4] Killen R. M. et al. (2010) AGU Abstract #P42A-04.

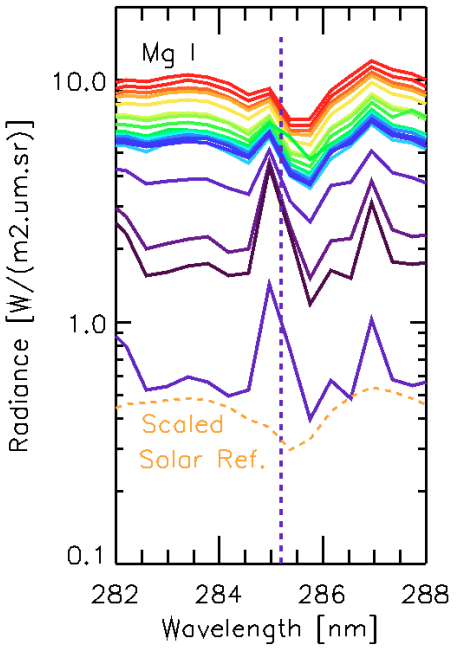

Figure 1. Mg I line revealed in the ~hour-long pre-impact descent of the LCROSS S-SC from 8100 km to 600 km. As less lit terrain is in the spectrometer's nadir 1˚ Field-of-View, the Radiance decreases and the Mg I line contrast increases with respect to a scaled solar reference spectrum, obtained from lit terrain at ~8000 km. A vertical line marks the rest wavelength of 285.2 [nm]; the LCROSS UV-Visible spectrometer wavelength scale has an uncertainty of +/- 0.25 [nm].