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Detectability of lunar exospheric constituents: simulations for LADEE

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A major science objective of the proposed Lunar Atmosphere and Dust Experiment Explorer (LADEE) mission is the specification of the Moon's rarified exosphere with neutral mass and UV/Vis spectroscopic measurements from orbit. Model simulations of the expected release processes for several species indicate that, within uncertainties in the micrometeroid influx and the sputter yield, impact vaporization and ion sputtering contribute equally to the release of exospheric refractories (e.g., Mg, O, Ca, Al, Fe, Ti) for fluxes typical of the solar wind at 1 AU. Consequently, several microphysical parameters describing the interaction of exospheric particles with the surface can be determined provided these detections are possible. Counts and/or radiance for species that do not condense from gas to solid states following hypervelocity impacts should vary by a factor of two as the Moon enters and then exits the Earth's magnetosphere. In contrast, species for which condensates or molecules form will exhibit steeper variations during passages through the magnetosphere as they will be dominated by the sputtering source which varies by a factor of ten. The modeled phase space density of exospheric neutrals reveals that, as a result of the collisionless nature of the exosphere, detection of sputtered ejecta with neutral mass spectrometry (NMS) is possible only for off-ram pointings. This is contrary to thermalized ejecta which are best observed by pointing the LADEE NMS towards the ram direction. Convolution of the model density with the instrument response function for different boresights shows that sodium from photon-stimulated desorption and oxygen from impacts should yield detectable counts for integration times $\geq$ 200 s. We furthermore assess the optimum pointing scenarios for the detection of resonant scattering by UV/Vis in the presence of coronal-zodiacal light and (closer to the horizon) scattering by exospheric dust.