**Secondary Ion Sputtering of Apollo Era Lunar Soils: Positive and Negative Ion Mass Spectra and Velocity Distributions.** J. L. McLain and J. W. Keller.[1] [1]NASA Goddard Space Flight Center, Code 695, Greenbelt, MD 20771 (jason.l.mclain@nasa.gov).

**Introduction:** The solar wind modifies the surface of the Moon and other solar system objects through implantation and sputtering. The sputtered secondaries can be either be positive and/or negative ions as well as neutral species. While negative ions have short lifetimes in space when exposed to solar radiation, they nevertheless provide insight into sputtering processes and open chemical pathways that are not observed in the positive ion species.

Sputtered products from solar wind irradiation contributes to the exospheres of planetary bodies which in turn are connected to the transport of volatiles to regions of long-term stability such as the permanently shaded regions of the Moon or Mercury.

Here we report our results from Reflectron Time-of-Flight (ReToF) mass and velocity analysis of sputtered ions from lunar samples when exposed to primary ions with solar wind energies.

**Background:** The solar wind consists of ions and electrons moving outwardly from the sun with flow velocities ranging from 250 to 750 km/s and averages to ~400 km/s on the ecliptic plane. Its ion composition consists primarily of protons (~95%) and alpha particles (~4 %) and with the heavy ion population (e.g. C, O, Fe) less than 1%, although these ratios can change significantly during solar energetic events such as coronal mass ejections.

For positive ions, secondary ion yields are strongly dependent on the first ionization potential of sputtered atoms, while negative ion yields depend on the atom's electron affinity. Therefore, the secondary ion mass spectra have different chemical species in the case of sputtered negative ions versus positive ions.

**Experiment:** An ion beam designed to simulate the solar wind is directed toward the Apollo soil samples under ultra-high vacuum. The primary ion source is pulsed with a time-phased extraction into the ReToF analyzer to determine the velocity of the sputtered ions. We will compare ion sputtering yields and velocity distributions from primary ions $H_2^+$, $He^+$, $Ar^+$.

**Results:** We will report results from measurements of positive and negative ions sputtered from lunar samples for protons, alpha particles at solar wind energies, and we simulate higher mass elements using 4 keV Ar ions. In the latter case, the Ar beam energy is lower than typical in the solar wind (e.g. ~16 keV for $O^{6+}$) but serves to illustrate qualitative differences in sputtering from heavy ions versus light ions with evidence of molecular formation in the expanding plume.

**Acknowledgments:** This work is supported by the Fundamental Laboratory Research project under NASA's Internal Scientist Funding Model, and the Lunar Exploration and Dynamics for Exploration Research program.