ARTEMIS Mapping of Lunar Crustal Magnetic Reflection of Solar Wind Protons

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Lunar crustal magnetic fields, sporadically located across the lunar surface and ranging in strength up to several hundred nanoTesla, have previously been observed to reflect significant portions of the incoming solar wind flux. Theoretical models and some observational evidence have suggested that kV scale electric fields are set up by differential reflection of solar wind electrons and ions within crustal magnetic anomalies and that these electric fields are responsible for the reflection of the solar wind protons. The reflection of solar wind protons over crustal magnetic anomalies has important implications for surface weathering rates (including lunar swirls) and for the global plasma interaction of the Moon.

The twin ARTEMIS spacecraft, in orbit around the Moon since mid-2011, have amassed a large set of observations of solar wind protons reflecting from various lunar crustal magnetic anomalies for a wide range of upstream solar wind conditions, crustal magnetic anomaly locations (i.e., solar zenith angle), and observational positions. We have used this large observational dataset to construct both a spatial map of the average reflected proton percentage and the three-dimensional velocity space distribution of the reflected protons near the lunar surface. Our preliminary results confirm that found by previous missions, including Chandraya'an-1 and Kaguya, including strong reflection by the South Pole/Aitken Basin anomaly, and smaller reflection at anomalies such as Gerasimovich and Mare Marginis. Furthermore, our reconstructed reflected proton distributions within lunar crustal magnetic anomalies show evidence of significant deceleration and heating, consistent with theoretical models. In this talk, we will present both the detailed methodology for reconstructing the proton distributions inside crustal anomalies and the resulting maps and distributions, with comparisons to previous modeling studies.