On the importance of measuring near-surface magnetic field structure during a future Mission to the Moon

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Kinetic simulations of the solar wind's interaction with a small but strong dipole crustal magnetic field reveal the formation of a micromagnetosphere (cf. Figure). Interestingly, although ions do not feel the effects of the magnetic field but separate from electrons, self-organizing a charge separation electric field that reflects many ions back into space. The solar wind-magnetic field interaction is found to depend upon the angle of the magnetic dipole and plasma flow with respect to the surface and the amount of photoemission produced by daily solar irradiation. The simulations allow derivation of ion energy and flux maps at the surface, which are used to estimate the daily amount of neutral sputtering in a magnetic anomaly that might contribute to surface weathering and swirl formation. The most significant unknown in this work is the actual structure of the magnetic field near the surface in a real lunar anomaly.

We support the view that magnetic anomalies represent a unique and nearby natural laboratory for studying the cross-section between plasma physics at airless bodies, magnetosphere formation, and even exosphere formation due to the way magnetic fields can influence ion bombardment of the surface. Resolving this field structure with high spatial (and temporal) resolution should be a high-priority scientific target of a future mission to the Moon, and will serve as a valuable input to kinetic and MHD simulations of these regions.

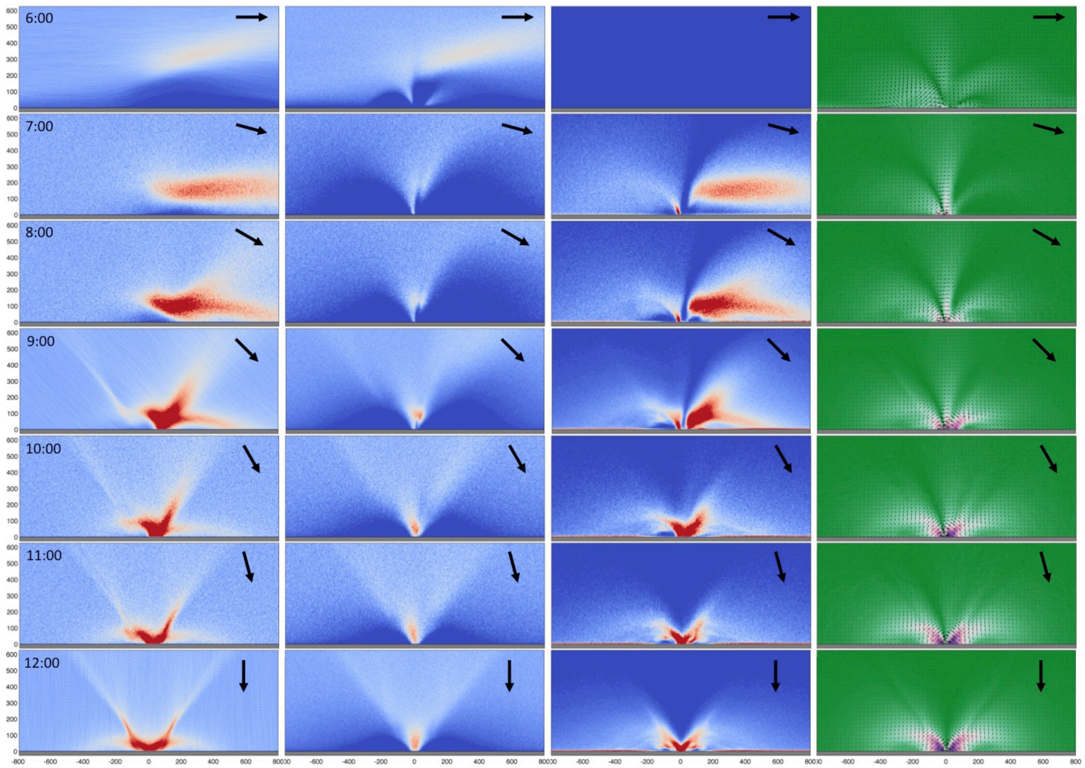

Figure: Micromagnetosphere structure in a vertical dipole crustal field at different times of lunar day, under nominal solar wind conditions. Left to right: ion concentration, electron concentration, photoelectron concentration, electric field and potential.