Solar Wind Interaction with Lunar Magnetic Anomalies: Reiner Gamma.

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Discovered by early astronomers during the Renaissance, the **Reiner Gamma formation** is one of the most peculiar lunar surface features. Observations have shown that the tadpole-shaped albedo marking, the so-called swirl, found on the Oceanus Procellarum is co-located with one of the strongest magnetic anomalies (LMAs) on our Moon. In previous work, using a horizontal dipole model [Deca et al. 2014, 2015], we have described the formation of a mini-magnetosphere structure surrounding the swirl pattern, locally shielding the underlying lunar surface from the impinging solar wind, and hinting at a correlation with its main surface albedo brightness marking in a distinctive concentric oval shape. Using the **observed magnetic field model** [Tsunakawa et al. 2015] in our **3-D full-kinetic electromagnetic framework**, iPic3D, we **reproduce a surface weathering pattern** closely resembling the details of the Reiner Gamma swirls. This

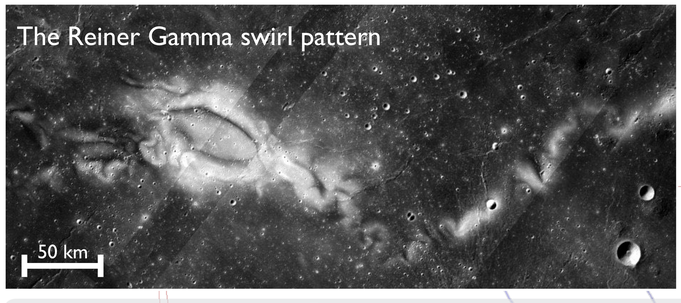

Figure 1.
Ion charge density at the lunar surface around the Reiner Gamma formation (650km x 650km, including surface curvature). A select number of magnetic field lines are traced in blue to indicate the magnetic structure.
Using the SVM model derived from the Kaguya magnetometer data the large-scale features of the observed albedo pattern are recovered. Two mini-magnetospheres prevail as ion are **electrostatically** de/reflected by the normal electric field anchored in the density halo [Deca et al. 2014, 2015]. In addition, various individual small-scale higher-density patches are present where the magnetic field has a significant perpendicular component to the lunar surface [Deca et al. 2016a].

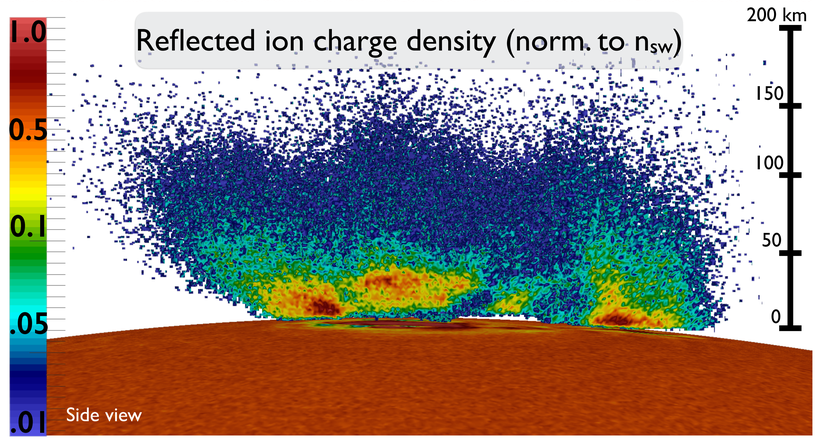

Figure 2.
Reflected ion charge density. Locally more than 50% of incoming solar wind ions are reflected away from the surface, reaching observable altitudes (top panel). Note in particular the wings of reflected ions (right panel) associated with the mini-magnetospheres. The shape and amount of reflected ions might therefore be a tracer for the underlying magnetic structure, but more reflected ions does not necessarily point to the existence of (larger) density cavities [Deca et al. 2016b].

Simulation parameters

m_i/m_e	256	Time step (ω_{pi}^{-1})	1.875×10^{-2}
T_{sw} (eV)	35	Domain size (km)	200x650x650
n_{sw} (m^{-3})	3×10^6	Grid size	144x488x488
$v_{th,e}$ (m/s)	9.3×10^5	Particles/cell/species	64
$v_{th,i}$ (m/s)	6.2×10^4	d_i (m)	1.3×10^5
v_{sw} (m/s)	$(-3.5 \times 10^5, 0, 0)$	d_e (m)	8.2×10^3
B_{IMF} (nT)	(0,0,0)	λ_D (m)	2.5×10^1

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