FULLY KINETIC SIMULATIONS OF THE SOLAR WIND INTERACTION WITH LUNAR MAGNETIC ANOMALIES: REINER GAMMA AND SWIRL FORMATION.

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Introduction: Located on the Oceanus Procellarum (centred at selenographic coordinates (7.5N, 59.0W)), the Reiner Gamma formation is one of the most well-known lunar surface features. Observations have shown that the tadpole-shaped albedo marking, the so-called swirl, is co-located with one of the strongest magnetic anomalies (LMAs) on our Moon [1-2]. Understanding better the relationship between the LMA and the albedo pattern could therefore have implications for our interpretation of the Moons thermal/geological history and to evaluate possible future lunar exploration opportunities.

Methods: We analyse the first fully kinetic iPic3D [3] simulations of the solar wind interaction with the observed lunar magnetic field surrounding the Reiner Gamma albedo pattern. To accomplish this, we have implemented a Surface Vector Mapping model based on Kaguya and Lunar Prospector magnetic field measurements [4].

Results: In previous work, using a horizontal dipole model [5-6], 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 now the most realistic observed magnetic field model available, two mini-magnetosphere-like structures prevail as ions are electrostatically de/reflected by the normal electric field anchored in the density halo. Various individual small-scale higher-density patches are present where the magnetic field has a significant perpendicular component to the lunar surface [7]. Locally more than 50% of incoming solar wind ions are reflected away from the surface, reaching observable altitudes (Figure 1). Note in particular the wings of reflected ions (bottom panel) associated with the mini-magnetospheres. The shape and amount of reflected ions might therefore be a tracer for the underlying magnetic structure [8].

Conclusions: In this presentation we report on our latest simulation results, taking into account the variability of the solar wind and the interplanetary magnetic field. We reproduce a surface weathering pattern closely resembling the details of the Reiner Gamma swirl, providing strong evidence that solar wind standoff must be the dominant process for lunar swirl formation.

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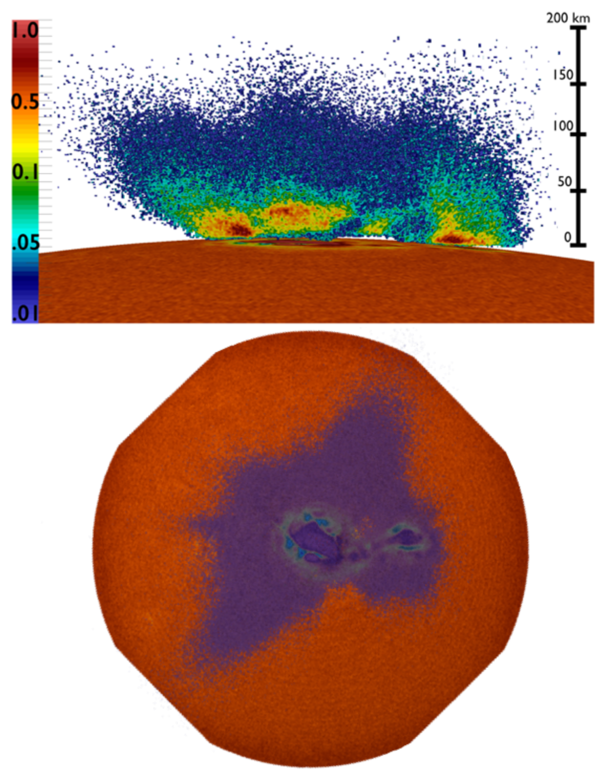

Figure 1: Reflected ion charge density in a side (top panel) and top-down view (bottom panel). The solar wind is flowing at 400 km/s perpendicular to the surface.

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