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The Solar Wind Interaction with the Reiner Gamma Anomaly: The Effect of Varying the Solar Wind Incidence Angle

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The Reiner Gamma swirl is one of the most prominent albedo features on the Lunar surface. Its modest spatial scales and structure allows kinetic modeling. The region therefore presents an ideal case to test our knowledge and theories about the formation of Lunar swirls and the interaction of the Solar wind plasma with the magnetic anomalies that are co-located with these intriguing albedo patterns. In addition, Reiner Gamma may be a prime subject for one of our next landers or low-orbiting missions to the Moon.
Using the fully kinetic particle-in-cell code, iPIC3D [1], coupled with a surface vector mapping magnetic field model based on Kaguya and Lunar Prospector observations [2,3], we model the Solar wind interaction with Reiner Gamma for varying Solar wind incidence angles under quiet Solar wind conditions and construct an integrated profile of the Solar wind energy flux to the surface in the Reiner Gamma magnetic anomaly region.
We show that Solar wind standoff, an ion–electron kinetic interaction mechanism that locally prevents weathering by Solar wind ions, reproduces the large-scale signatures of the Reiner Gamma albedo pattern [4]. In addition, we find that Reiner Gamma's outer bright lobes emerge in the simulated weathering pattern only when integrating over all Solar wind incidence angles that reach the swirl location, and that both the Solar wind proton and He2+ energy flux to the surface needs to be taken into account. Integrated profiles of the Solar wind flux towards the surface help estimate the long-term effect of Solar wind standoff on the Lunar regolith.
[1] Markidis, S., et al., Math. Comput. Simul. 80, 1509-1519 (2010). [2] Tsunakawa, et al., Icarus 228, 35-53 (2014). [3] Tsunakawa, et al., J. Geophys. Res. (Planets) 120, 1160-1185 (2015). [4] Deca, J., et al., Nature Comm. Phys. 1:12 (2018).
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