SOLAR WIND BACKSCATTERING FROM THE MOON AND MERCURY FOR STUDIES OF PRECIPITATION AND SURFACE PROPERTIES.

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Introduction: Observations at the Moon have shown that a significant fraction of incident solar wind protons is backscattered from the surface to space, mostly as energetic neutral atoms (ENAs) [1-3]. While the scattering properties have been empirically characterized in detail, a fundamental understanding of this process has not yet been achieved. This would especially be important for future observations of Mercury by BepiColombo , where ENA measurements provide the chance to study precipitation in the complex hermean plasma environment, as well as surface properties. We have recently developed a 3D model for the ion-regolith interaction and demonstrate that it reproduces the ENA characteristics at the Moon, which can then be simulated for Mercury.

Figure 1: An example of a modeled regolith structure (from [4]).

SDTrimSP-3D Model: We model solar wind protons impacting regolith grains using the SDTrimSP-3D code [4], which simulates interatomic collisions to trace an ion's path through a solid. By using an algorithm to derive grain stackings from randomly dropping spheres into a box, we create regolith input files for SDTrimSP-3D using different porosities and grain shapes.

Results: *ENA Emission at the Moon.* Simulations of backscattered H atoms from SDTrimSP-3D reproduce ENA observations from Chandrayaan-1 and IBEX. Our model confirms that the significant sunwards emission of ENAs can be related to the regolith geometry, while the ENA energies are mostly related to the energies of the precipitating ions. The total proton reflection probability is found to be significantly dependent on the porosity of the regolith. Comparison with spacecraft measurements allows constraining the porosity at the lunar surface to 85% ± 15% [5].

ENAs from the Surface of Mercury. Using our regolith model, we predict ENA fluxes around Mercury as observed by BepiColombo. The ENA environment is found to be much more variable for different solar wind parameters, especially for the nightside emission.

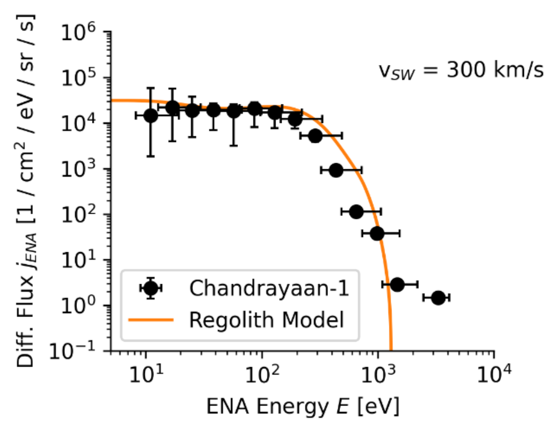

Figure 2: Measured and modeled ENA energy spectra.

Conclusions: Studying ENAs from solar wind backscattering represents a promising opportunity to learn about planetary surfaces and how they are precipitated. Our SDTrimSP-3D model provides a validated description of this process on the Moon and can be applied to other bodies in the future, such as Mercury for upcoming BepiColombo studies.

References: [1] D.J. McComas, et al., *Geophys. Res. Lett.* 36.12 (2009). [2] M. Wieser, et al., *Planet. Space Sci.* 57.14-15 (2009), 2132. [3] A. Zhang, et al., *Planet. Space Sci.* 189 (2020), 104970. [4] U. v. Toussaint, et al., *Phys. Scr.* T170 (2017), 014056. [5] P.S. Szabo, et al., *Geophys. Res. Lett.,* e2022GL101232 (2022).