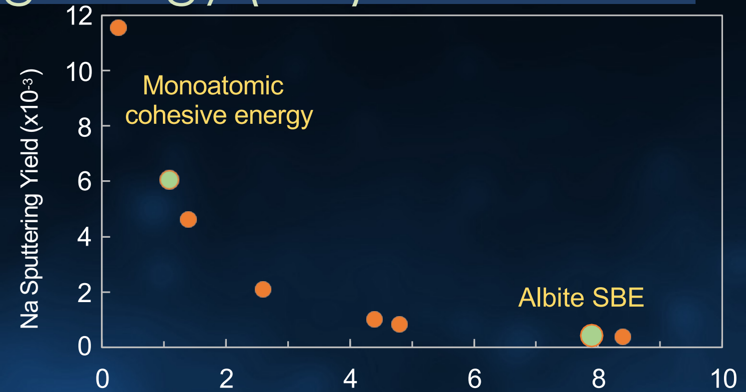
Exosphere Formation, Solar-Wind-Ion Sputtering, and the Importance of Surface Binding Energy (SBE)

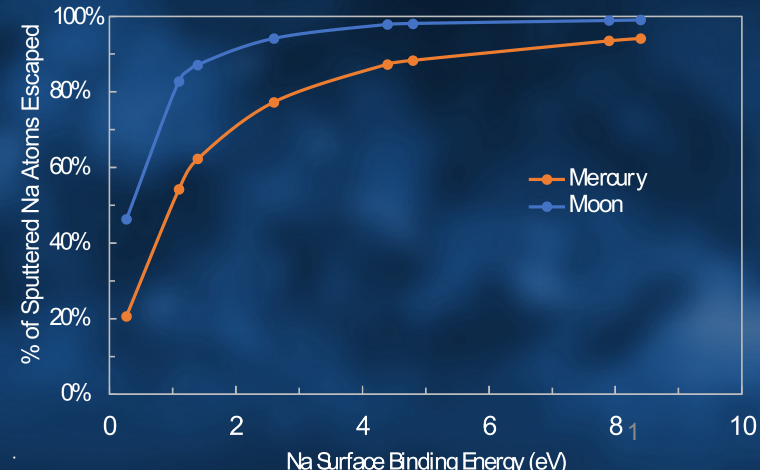
SOLAR SYSTEM EXPLORATION RESEARCH VIRTUAL INSTITUTE — SSERVI

LEADER — Lunar Environment And Dynamics for Exploration Research

Background:

- For 40 years, researchers studying how exospheres form on airless bodies have been hindered by a poor understanding of solar wind ion sputtering. These ion impacts on airless bodies play an important role in altering surface properties and the surrounding environment.
- Sputtering data relies on user-defined Surface Binding Energies (SBEs), which determine the sputtering yield and energy distribution, but these SBEs are not reliably known for many materials such as plagioclase feldspars and sodium pyroxenes, which are expected to be important for exospheric formation at Mercury and the Moon.
- SSERVI LEADER team (Morrissey et al. 2022) have developed a novel method of using molecular dynamics (MD) simulations to simulate mineral surfaces on the atomistic scale and directly quantify silicate SBEs.
- Results show that increasing SBEs from 1.1 eV to 7.9 eV increases the % sputtered Na atoms above escape energy from 55% to 95%.
- This has a significant effect on the predicted solar wind ion sputtering yield and energy distribution of Na and the formation of the corresponding Na exosphere.
- This is important to Planetary Science as these new MD SBE results will enable more accurate predictions for solar wind ion sputtering contributions to the exosphere of Mercury and the Moon.





Results show Na SBE derived for albite is 30x higher than values previously used in sputter calculations, decreasing the yield by a factor of over 30! SBEs for minerals can be 8x higher than the monoelemental cohesive energy approximation often used to estimate compound SBEs.

Morrissey, L. S., Tucker, O. J., Killen, R. M., Nakhla, S., & Savin, D. W. (2022). "Solar Wind Ion Sputtering of Sodium from Silicates Using Molecular Dynamics Calculations of Surface Binding Energies." The Astrophysical Journal Letters, 925(1), L6