Analyzing Molecular Hydrogen in the Lunar Exosphere: Measuring Potential Water Products on the Moon
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Background: SW Implantation and H₂ Release
- Solar wind H⁺ is the main source of H₂
- H⁺ implants into the lunar regolith minerals and the H atoms bond with other atoms forming OH, H₂, etc
- H₂ is released from the soil due to thermal desorption and high energy events like micrometeorites impacts
- H₂ flux is expected to decrease during full moon while in Earth’s magnetotail when partially shielded from the SW

Methodology
LADEE (2013) measured the composition of the lunar exosphere using an NMS instrument

The NMS measured gas samples with Open & Closed sources. All data has been uploaded to the NASA Planetary Data Sys.

We are examining H₂ readings from channels 1.8 - 2.2 amu obtained with the closed ion source

A Python script under development is used to compare OMNI SW flux data during the time of the LADEE H₂ measurements, and to examine trends with lunar local time using the NAIF WebGeocalc tool

Objective: Examine H₂ measurements obtained by the NMS (~5 lunar cycles).
Hypothesis: Previous modeling (Fig. 1) suggests that SW is the dominant source of H₂ to the Moon’s exosphere. It is expected that H₂ densities markedly decrease while the Moon is in the magnetotail because of the decrease in SW flux.

Using LADEE H₂ & SW OMNI & ARTEMIS data, we seek to quantify the relationship between SW H⁺ & the H₂ exosphere to understand the hydrogen cycle

Fig.1: Monte Carlo model of H₂ time of day distribution at equator during the New/Full Moon phases (Tucker et al., 2021)

Summary
- Examined raw H₂ count rate in/outside the magnetotail
- Avg count in magnetotail was 10% less than outside
- However, constraining instrument outgassing using measurements made in the anti-ram direction was inconclusive, so it is not clear that the lower count rate is real
- We did not notice correlations of the count rate with SW or meteoroid streams
- We did not notice any time-of-day trends in count rate - "this is ongoing work"

Future Work
- Examine other species
- Work on background subtraction (suggestions welcome)
- Take another look at count rate during periods of high solar activity

* Future mass spectrometers must calibrate for H₂ and other hydrogen bearing molecules

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