ARTEMIS' Perspective on a Dynamic Moon

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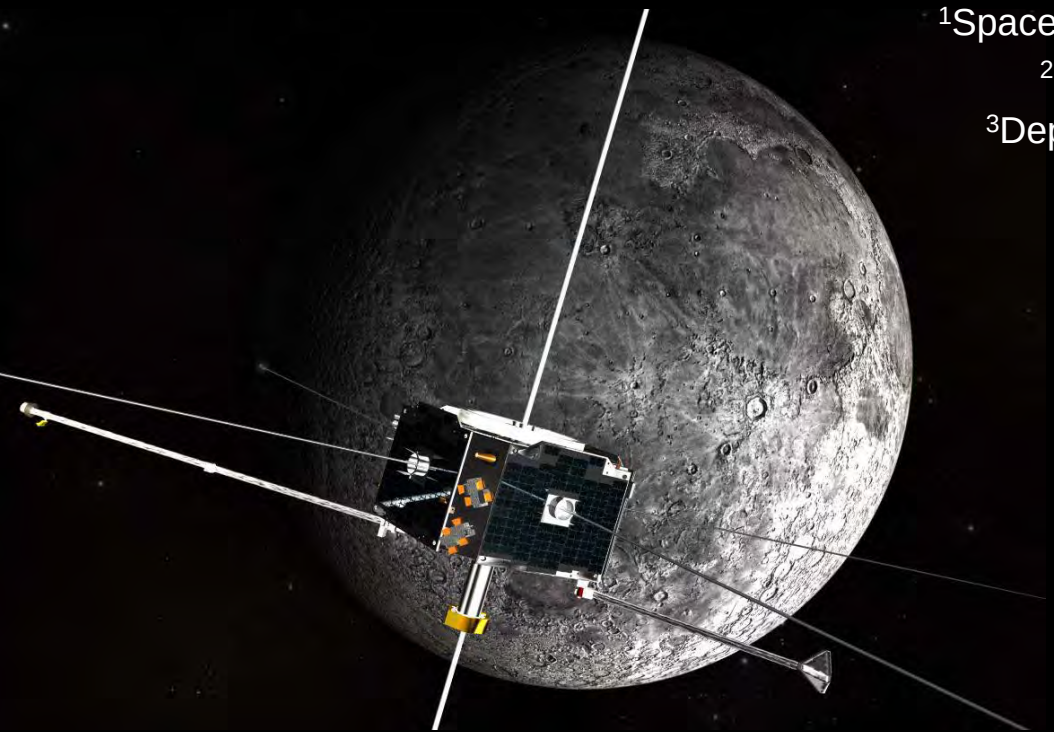

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LEAG Meeting
Columbia, MD

The Lunar Plasma Environment

A dynamic interaction

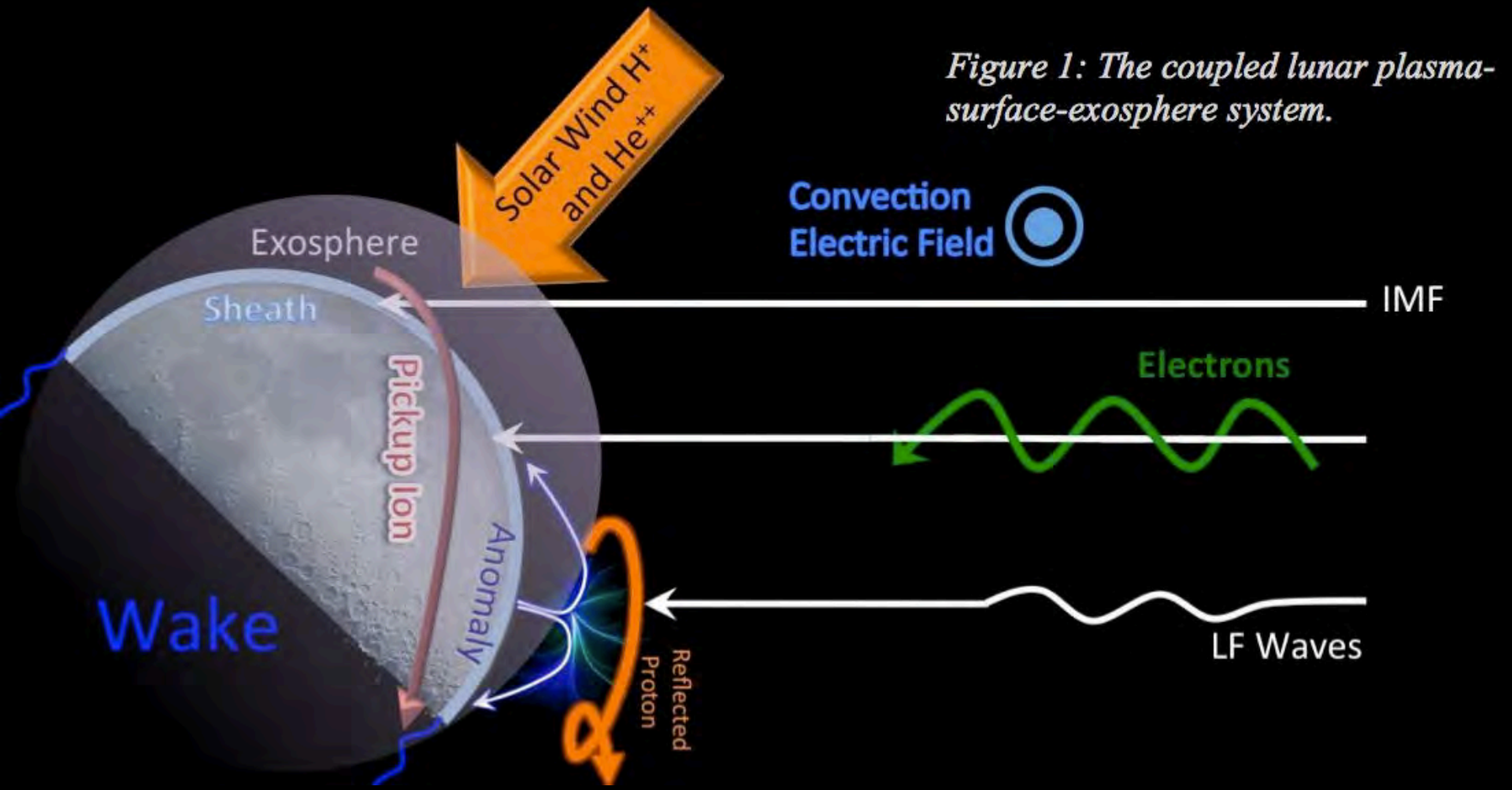


Figure 1: The coupled lunar plasma-surface-exosphere system.

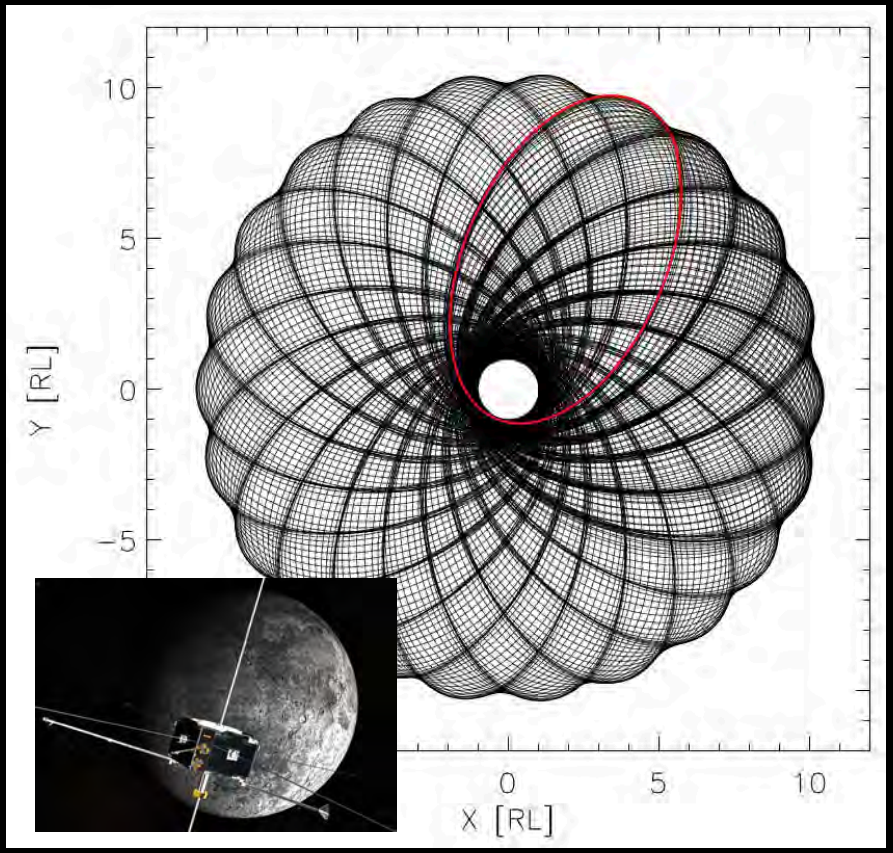
ARTEMIS Measurements at the Moon

Two-satellite mission, entered lunar orbit in June and July 2011

- Low & high energy electrons and ions
- Electromagnetic fields & waves

Elliptical orbits – distances 0.01 R_L up to ~10-12 R_L

Dual probe mission allows separation of external and lunar-induced space physics phenomena



Exospheric science: *solar wind alpha delivery, (pick-up ions, sputtering rates)*

Geophysical investigation: *Electromagnetic sounding of the lunar core*

Surface interactions: *SW proton reflection from surface / magnetic anomalies*

Surface-Plasma-Exosphere Interactions

Surface (airless)

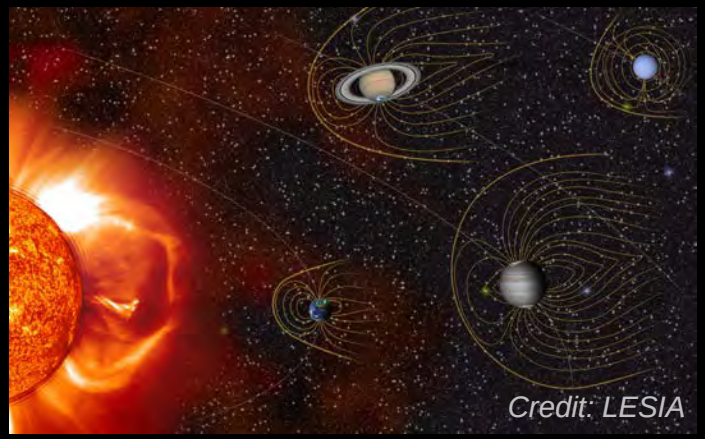
Charging
Surface sputtering
Wake formation

Thermal accommodation
Re-cycling
Self-sputtering

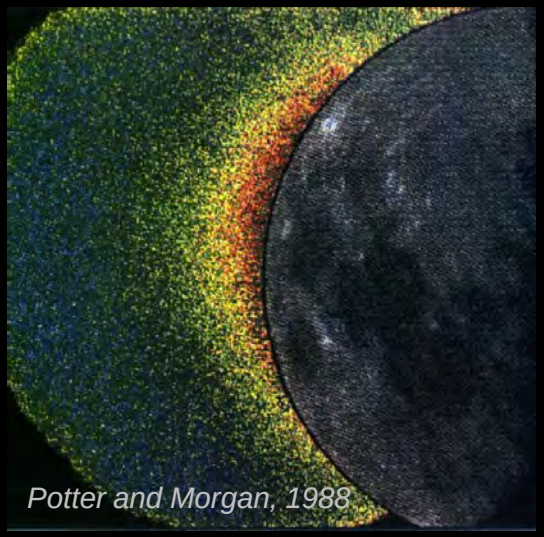
ARTEMIS

Atmospheric sputtering
Charge exchange

Pick-up ions
Current generation

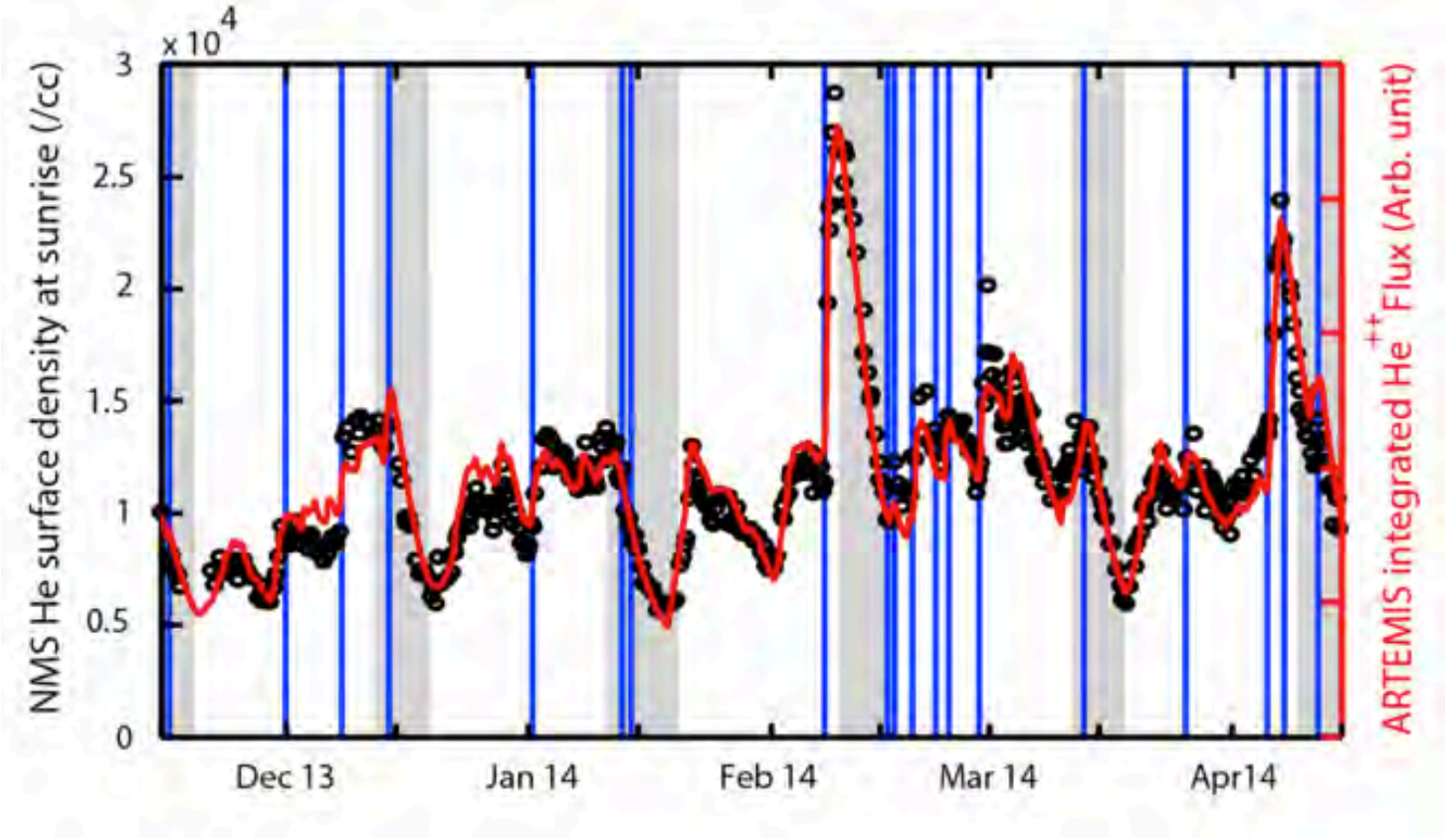


Plasma / Magnetosphere



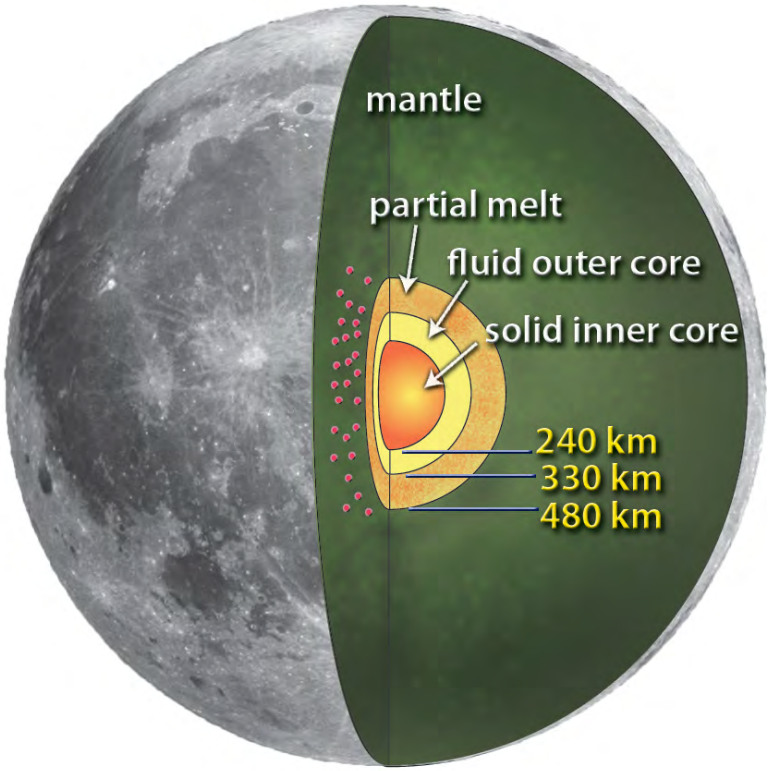
Exosphere

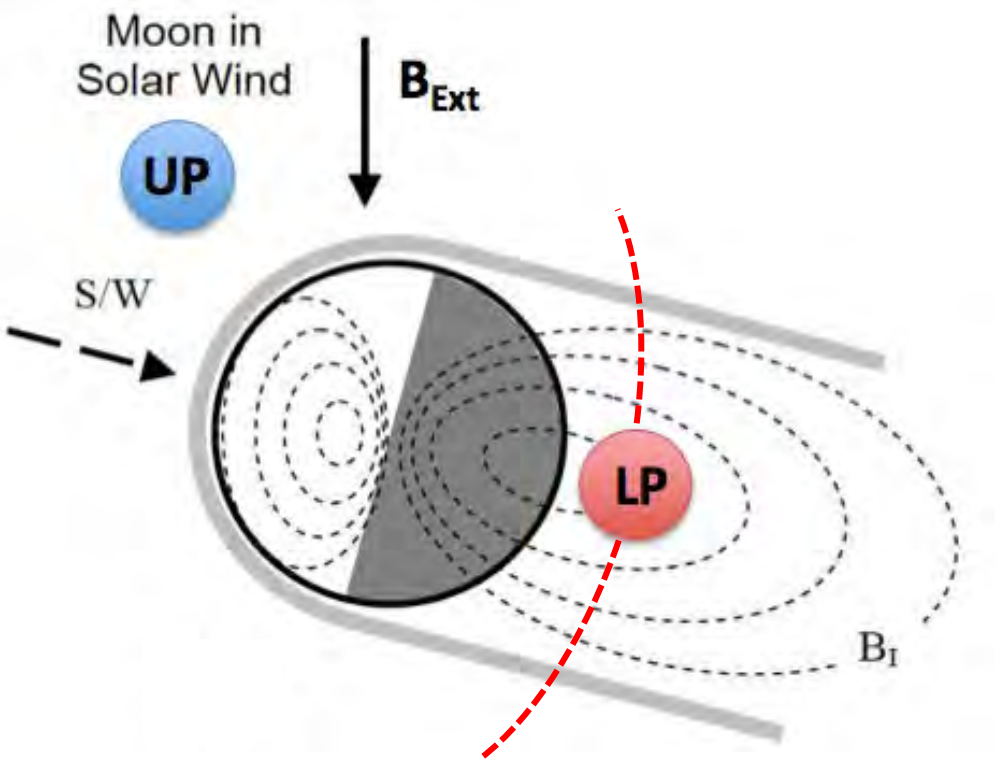
LADEE/ARTEMIS Synergy: He Exosphere



The lunar helium exosphere "breathes" according to the alpha content of the solar wind ➔ highly *dynamic* over short and long timescales [*Benna et al., 2015*]

Investigating the Lunar Interior with ARTEMIS

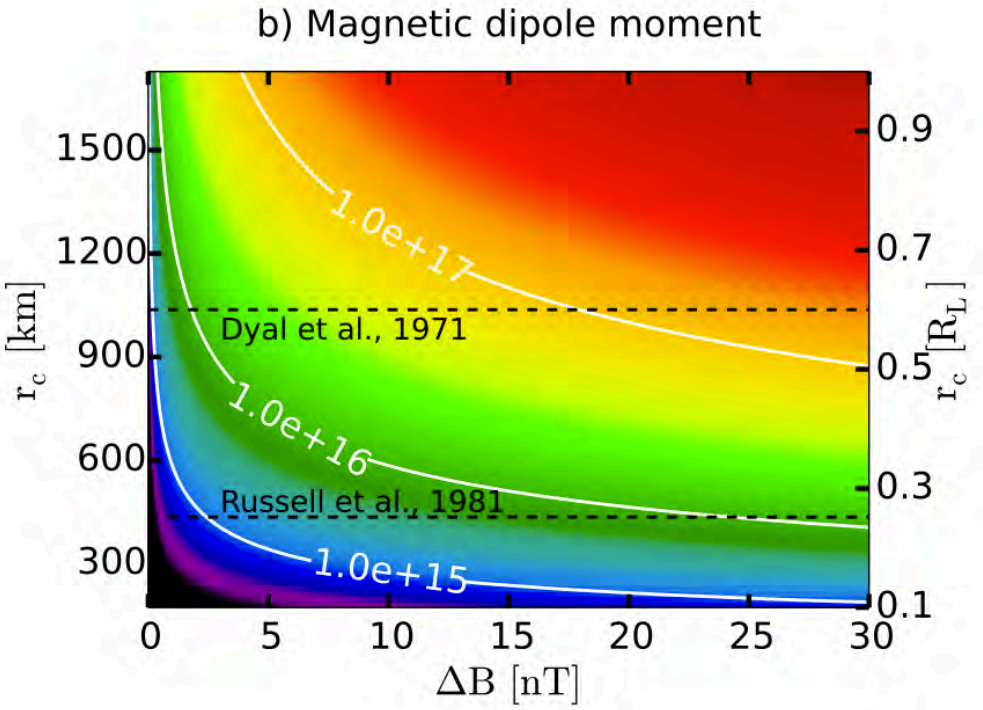


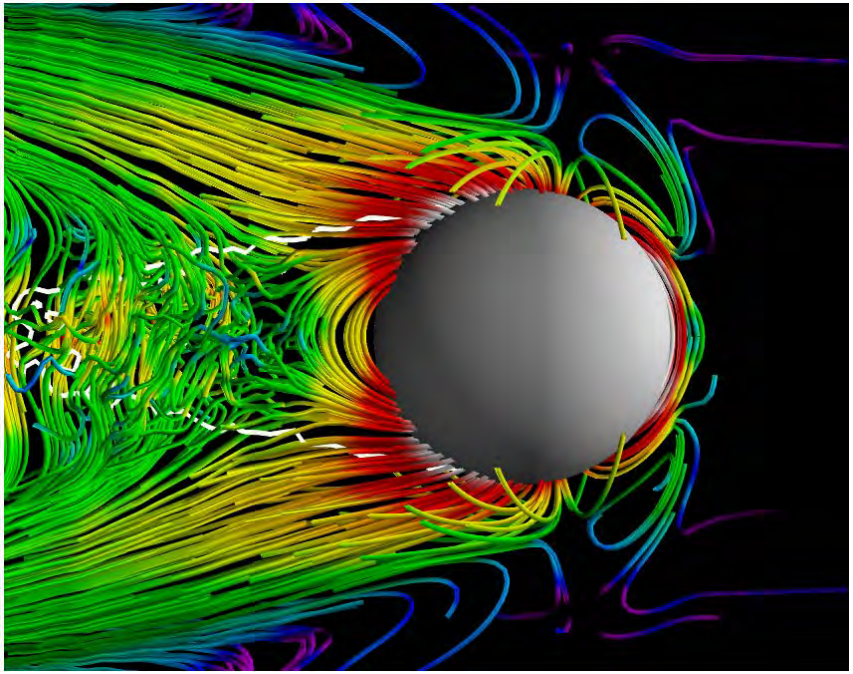


Courtesy: R. Weber /NASA MSFC

Electromagnetic Sounding leverages the dynamic nature of the solar wind – and its effect on the Moon – to probe the lunar interior

Investigating the Lunar Interior with ARTEMIS

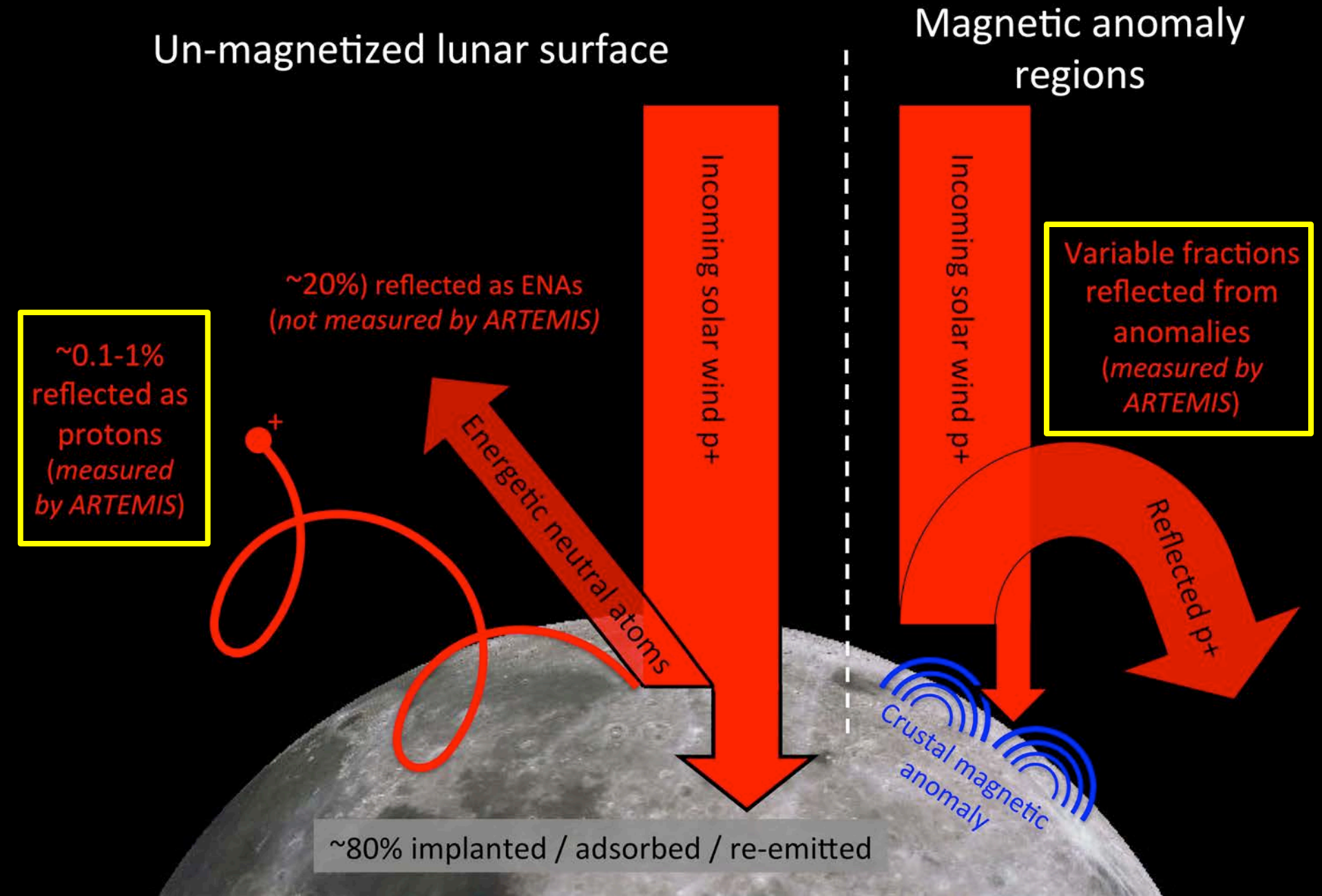




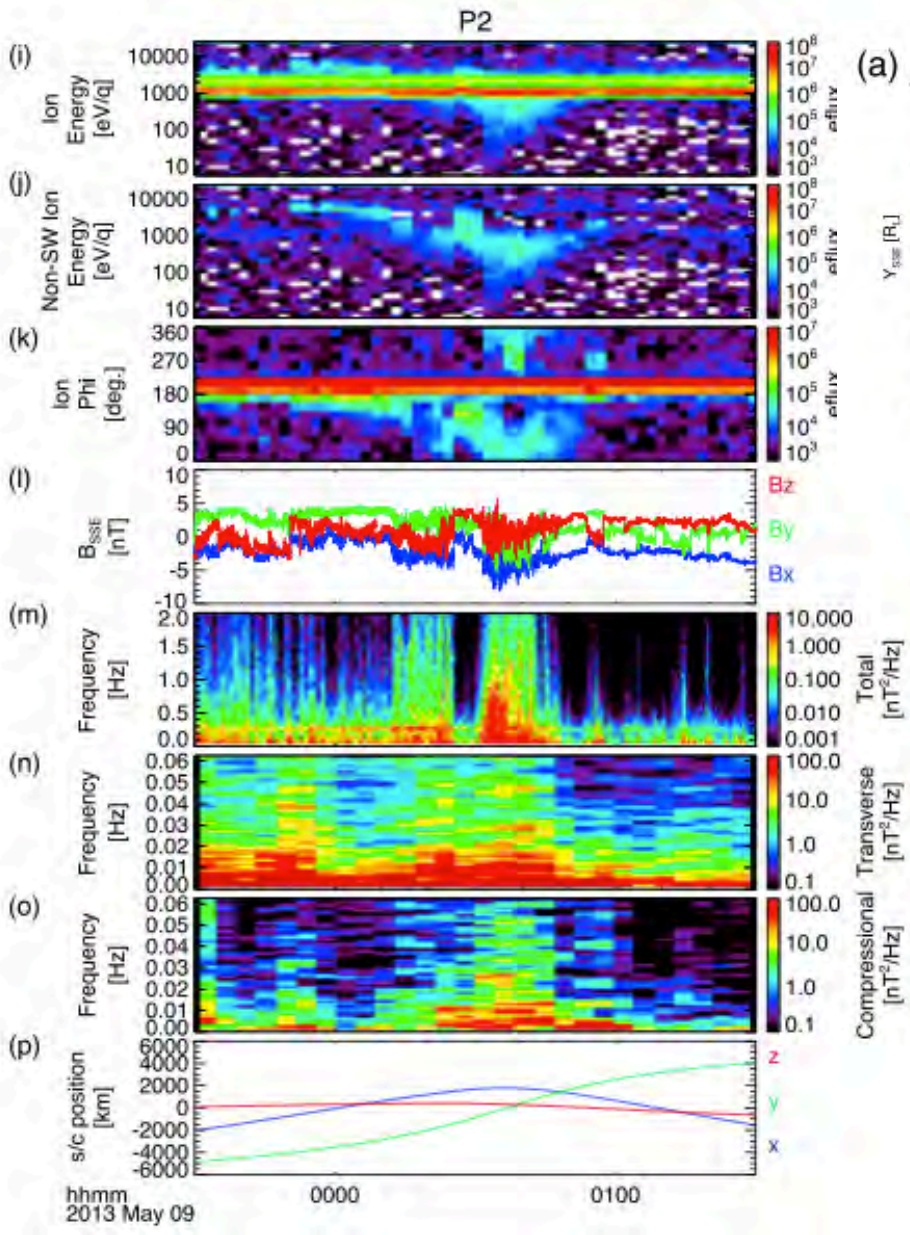
Solar wind perturbations induce a magnetic moment in the lunar core depending on the size/conductivity of the lunar interior and the magnitude of the perturbation

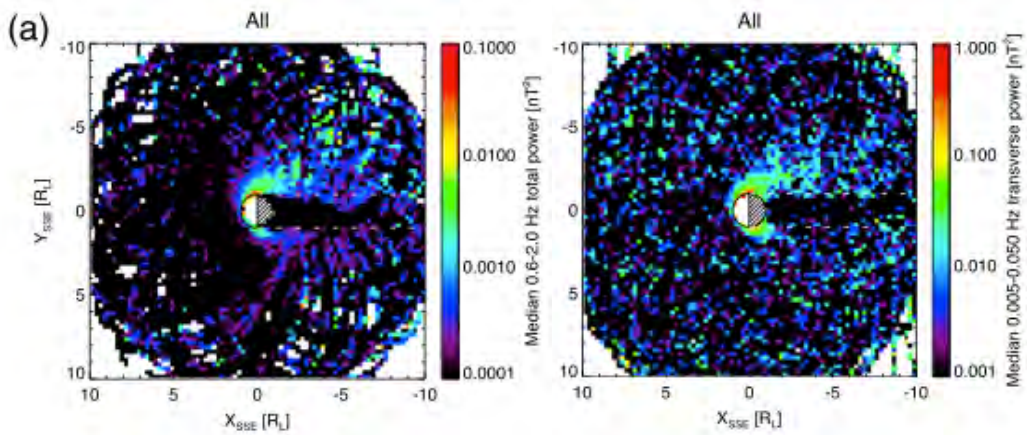
Modern plasma simulations are providing unprecedented insight into the physics of lunar induction [*Fatemi et al., GRL, 2015*]

The Lunar Reflected Proton Budget



Ion and electron “fore-moon”



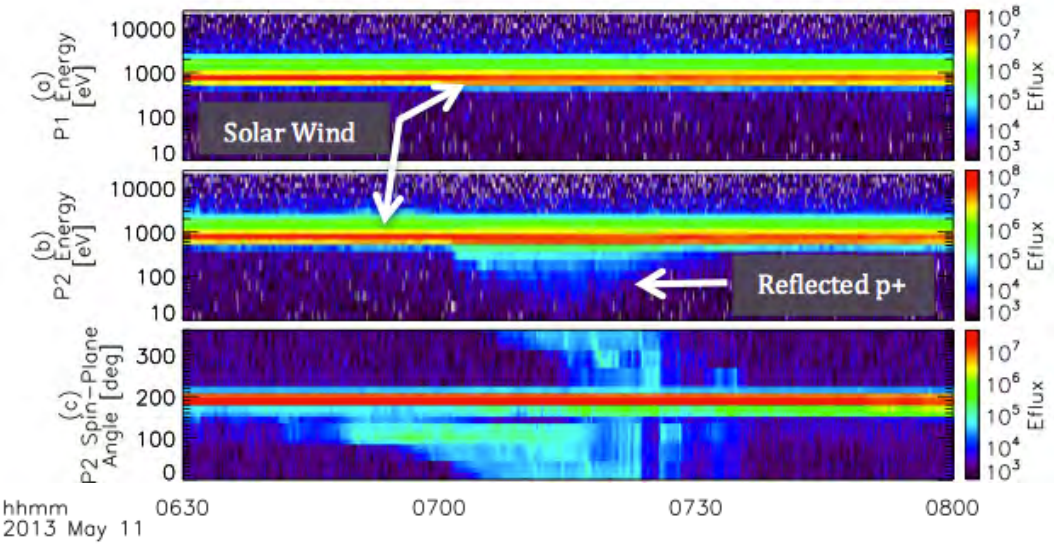


A statistical analysis of >3 years of ARTEMIS data show that the Moon induces a broad range of non-solar wind particle distributions and waves [*Harada et al., JGR, 2015*]

~~**Passive absorber**~~

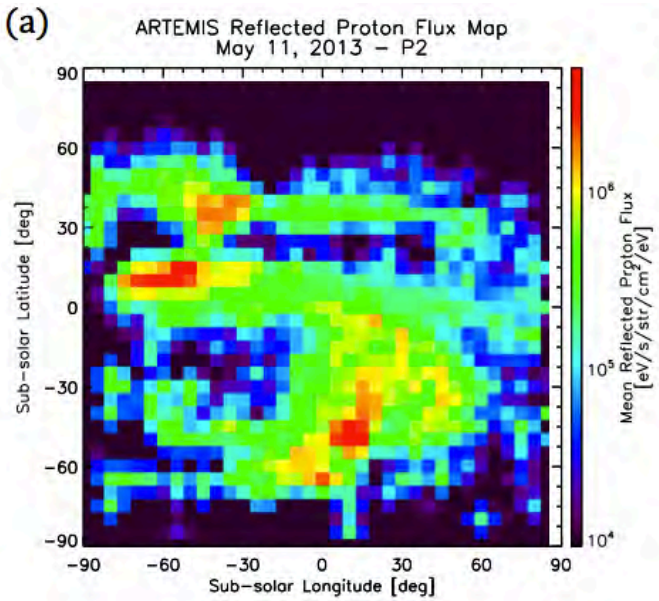
Dynamic perturber

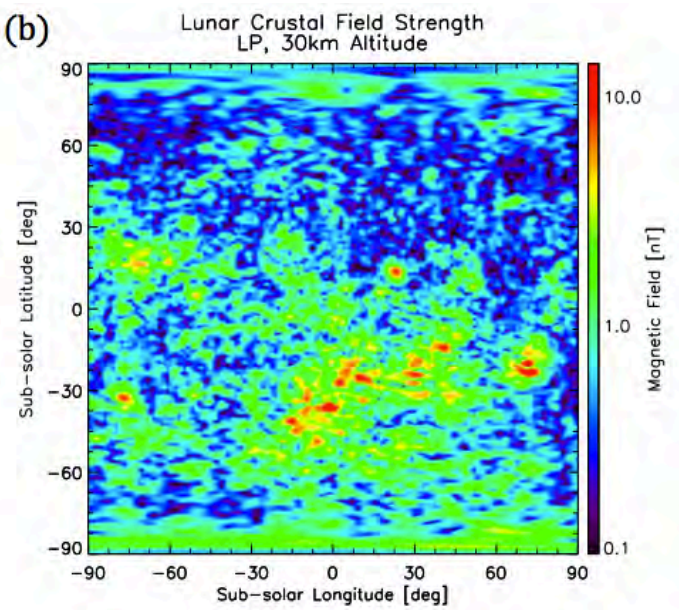
Mapping SW Proton Reflection with ARTEMIS



Non-SW protons from individual ARTEMIS fly-bys are mapped back to the lunar surface using observed ambient electric and magnetic fields

"*proton vision*"





Summary and Future Work

- ARTEMIS is a well-placed and well-timed investigation into the dynamics of the lunar plasma environment
  - Exospheric science (collaboration with LADEE)
  - Geophysical investigations ➔ lunar interior
  - Generation of non-SW waves and particles
  - Surface interaction / weathering science

- From ARTEMIS' perspective, much of **the dynamic nature** of the lunar environment is driven by the Sun
  - Solar wind / UV irradiation variability

- ARTEMIS continues to be in good health and to provide excellent data for both heliophysics and planetary science goals

Questions?