P41C-1631
Plasma Interactions with Airless Bodies

Electromagnetic Wave Power Observed Near the Moon during Terrestrial Bow Shock Crossings and Its Importance for Subsurface Sounding

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Introduction

Electromagnetic (EM) sounding is a group of geophysical methods used to characterize the interiors of planetary bodies

In the magnetotelluric (MT) method, surface measurements of the horizontal electric and magnetic fields are used to discern the subsurface conductivity structure

Target layers, depths, and frequency ranges necessary for MT sounding of the Moon

Target	Depth	Frequency
Crust	0 - 60 km	> 1 Hz
Mantle	60 - 1500 km	10^{-3} - 1 Hz
Core	> 1500 km	< 10^{-3} Hz

On the terrestrial planets, electromagnetic discharges (e.g., lightning) or magnetic field variations due to interactions with the solar wind can provide MT source signals.

On airless bodies such as the Moon, solar wind turbulence, shocks, and plasma waves can create source signals.

The Moon encounters a wide variety plasma regimes and EM source signals over a broad range of frequencies in its orbit about Earth

Previously, we catalogued EM wave power observed in the solar wind and magnetotail

Here, we present observations of EM wave power near the Moon during terrestrial bow shock crossings, speculate on the origin of the waves, and describe their utility for MT sounding

Observations

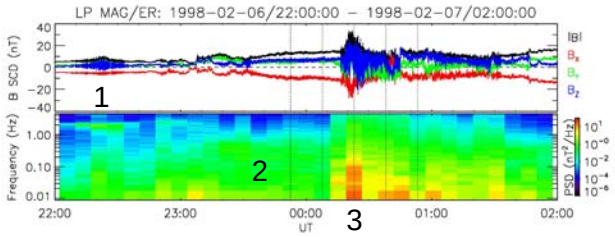
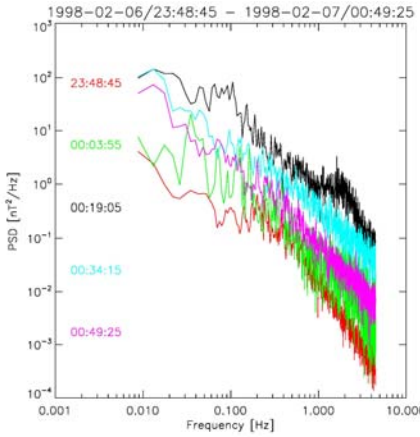


Figure 1: Lunar Prospector (LP) magnetic field data during a bow shock crossing (top); FFT of 9 Hz magnetic field data (bottom)

1. Narrow-band whistlers ~ 1 Hz in the solar wind (cf. Halekas et al., 2006; Tsugawa et al., 2011)
2. Broad-band (< 1 Hz) whistler mode (?) noise (cf. Nakagawa et al., 2011)
3. Large increase in magnetic field strength and wave power at the bow shock

Figure 2: Power spectral density of magnetic field fluctuations centered on the bow shock crossing (vertical dashed lines in Figure 1 mark the times of power spectra).



Power increases by ~ 2 orders of magnitude at the bow shock over a broad range of frequencies from several mHz to several Hz.

Observations (continued)

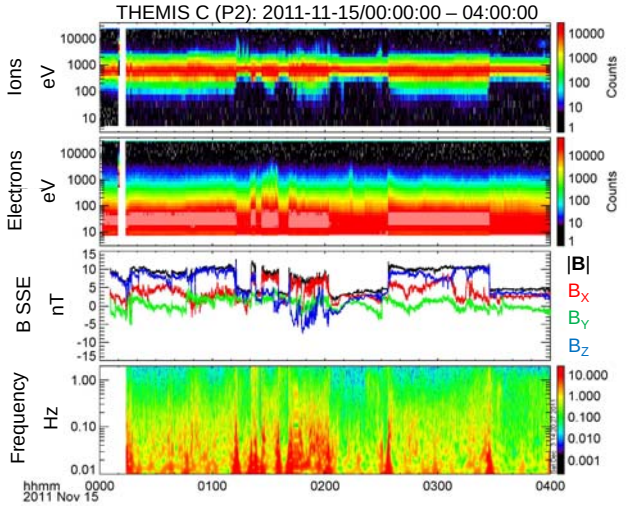


Figure 3: ARTEMIS P2 plasma and fields data – top to bottom: ion, electron energy spectrograms, magnetic field data, wavelet transform of 4 Hz magnetic field data

Multiple – up to nine – bow shock crossings are evident in the plasma and magnetic field data

Increase in wave power over a broad range of frequencies at each crossing

Slightly higher power in the magnetosheath

Conclusion

We observe increases in the low frequency magnetic power during bow shock crossings

These fluctuations should be useful sources for MT sounding of the deep lunar interior

Next: What are the sources of the fluctuations?