LOW FREQUENCY IONOSPHERIC PLASMA WAVES AT MARS AND THE IMPLICATIONS FOR SUBSURFACE SOUNDING
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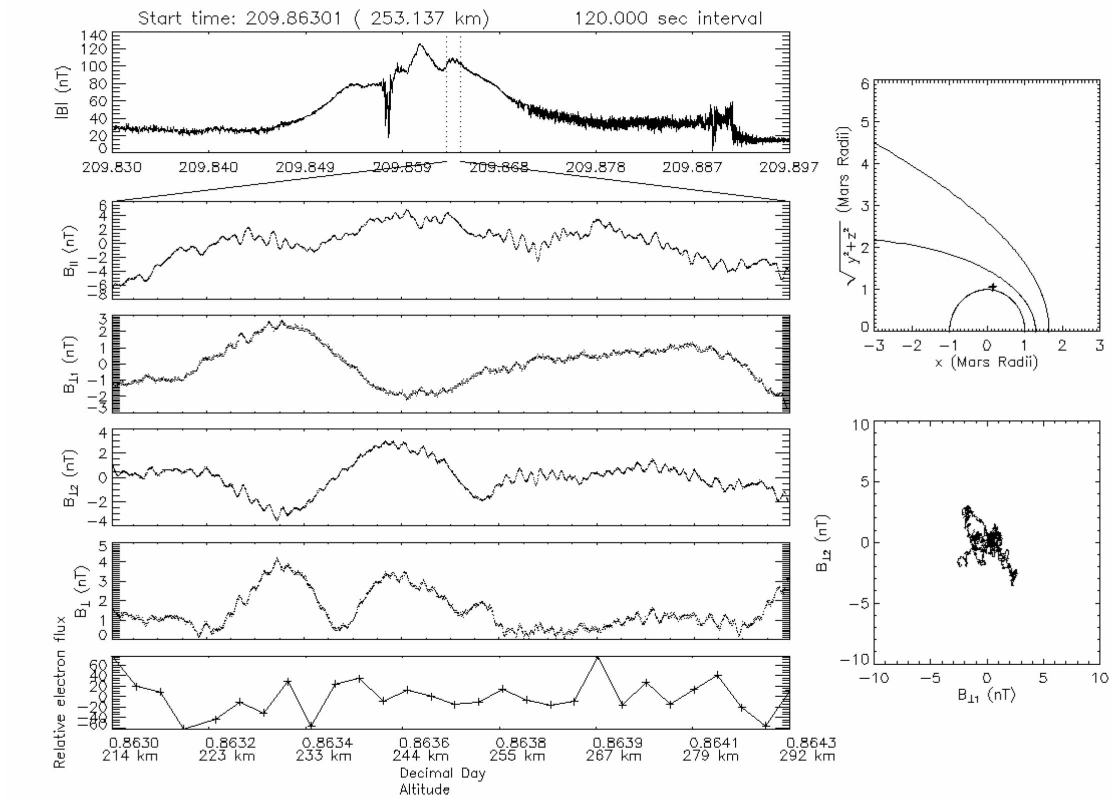
Introduction: A wide variety of plasma waves have been observed in the near Mars space [1]. The Mars Global Surveyor (MGS) Magnetometer/Electron Reflectometer (MAG/ER) instrument has made observations of magnetic and electron flux oscillations at altitudes as low as 200 km [2]. We report on the characteristics of these oscillations and note their relevancy for the exploration of the deep subsurface using inductive sounding techniques such as those found in magnetotelluric, magnetic gradiometry, and wave tilt methods.

Results: We are conducting a systematic survey of observations of low frequency ionospheric plasma waves using Mars Global Surveyor pre-mapping data. We report initial results on the characteristics of the waves with regards to location relative to crustal magnetic fields, the diurnal cycle, and the upstream solar wind conditions. We also report detailed analyses of selected case examples. The case studies examined so far indicate that low frequency plasma oscillations are found throughout the Martian ionosphere and are both close to and far from crustal magnetic fields. We include here an example of one case study.

Sample Observation: The figure below shows an example of our observations. In top left panel, the magnetic field magnitude (|B|) for the second orbit of July 28, 1998 (decimal day 209) is shown versus time. From second to the top to second to the bottom, the panels below the |B| profile show the magnetic field vector components for the interval of 209.863 to 209.8643 when MGS nearly at perigee for its orbit. The magnetic components are shown in a coordinate system aligned along the mean magnetic field for the interval. The $B_{\parallel}$ component is parallel to the mean magnetic field, the $B_{\perp 1}$ and $B_{\perp 2}$ components are perpendicular to the mean magnetic field and to each other and $B_{\perp} = B_{\perp 1} + B_{\perp 2}$. The last panel on the left shows the relative omni-directional flux (cm^{-2} s^{-1} sr^{-1} eV^{-1}) of electrons with energies of 191 eV. In the upper right, we show as plus signs the starting and ending locations (which overlap on this scale) of MGS for the interval in ecliptic plane coordinates coordinates (the sun is the right in the figure). We also show the best fit locations of the bow shock and MPB [3]. In the lower right panel, we show the perpendicular components of the magnetic field in MF coordinates plotted versus each other (a hodogram).

Distinct oscillations are observed in all components. These oscillations have spectral power at or below the local oxygen gyrofrequency. We note thatthe altitude range for these observations is below the normal ionopause altitude [4]. In our presentation we report further analyses of this interval including wavelet spectral analysis.

References: [1] Espley, J. R. *et al.* (2004), *JGR* doi:10.1029/2003JA010193. [2] Acuña, M. H. *et al.* (2001), *JGR, 106*, 23,403-23,417. [3] Vignes, D. *et al.* (2000), *GRL, 27*, 49-52. [4] Hanson, W. B. *et al.* (1977), *JGR, 82*, 4351-4363.


Start time: 209.86301 (253.137 km)
120.000 sec interval
|B| (nT)
$B_{\parallel}$ (nT)
$B_{\perp 1}$ (nT)
$B_{\perp 2}$ (nT)
$B_{\perp}$ (nT)
Relative electron flux
Decimal Day
Altitude
$\sqrt{y^2+z^2}$ (Mars Radii)
x (Mars Radii)
$B_{\perp 2}$ (nT)
$B_{\perp 1}$ (nT)