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Cassini's Flyby Through Rhea's Distant Alfven Wing

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Abstract

During its 132nd orbit around Saturn, Cassini flew downstream of Rhea at the closest approach (CA) distance of 102 R_H (June 3, 2010). The electron channels of the MIMI-LEMMS instruments showed sharp depletions in particle counts over the energy range of 18-183 keV near the CA (see Figure 1). In addition the magnetometer onboard Cassini measured a sharp rotation of the magnetic field suggesting that the field perturbation is Alfvénic in nature (Figure 1). A detailed analysis of the signature shows that the observed signatures were produced by the passage of the Cassini spacecraft through the northern Alfvén wing of Rhea. The formation of Alfvénic wings by Rhea is a major surprise because the moon is known to act mainly as an inert plasma absorber (Khurana et al. 2007). The discovery of Alfvén wings suggests that Rhea is able to slow the upstream plasma either through plasma pick-up or through an enhanced ionospheric conductivity. The implied Alfvénic Mach number of unity is understandable if the plasma density was a factor of 2 higher during this flyby than during the first flyby. The Alfvén wing is displaced inward from Rhea because the wave propagates towards Saturn at large distances from Rhea.

A second downstream passage of Cassini at a large distance (54 R_H) from Rhea occurred on October 17, 2010 during orbit 139. The data from the MIMI-LEMMS instrument again show sharp depletions in most of the electron channels. The magnetic data on the other hand do not show a related magnetic field rotation. The observed signature can be understood if the spacecraft was downstream of the Alfvén wing where the electrons are still depleted but no passage through the current carrying region occurs. If average Alfvén Mach number = 1 as in previous case, the Alfvén wing would be located at X = 22 R_H whereas the spacecraft flew by X = 48 R_H (way downstream). The absorption region is again shifted inward towards Saturn from Rhea's location because the nearly dipolar flux tube would be crossed inwards of Rhea at high latitudes.

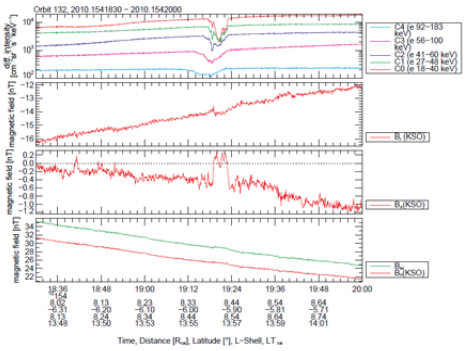

Figure 1 The elctron fluxes observed in five electron channels (top panel) of the MIMI-LEMMS instrument and the magnetic field components in the spherical coordinate system (the next three panels).

References

[1] Khurana, KK, Russell CT, and Dougherty MK, Magnetic portraits of Tethys and Rhea, Icarus, 193, 465-474, doi: 10.1016/j.icarus.2007.08.005, 2008.