

Ion Cyclotron Waves at Titan: Harbingers of Atmospheric Loss

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Abstract

When a flowing magnetized plasma intercepts a neutral atmosphere such as Titan's exosphere, we expect that any atoms or molecules that become ionized by photoionization impact ionization or charge exchange could lead to the acceleration and pick-up of those newly formed ions. This process creates an ion distribution function that often is highly unstable to the production of ion-cyclotron waves. Such waves have been observed in the Earth's polar cusp [1], at the Moon [2], at Mars [3], at Io [4], and at Enceladus [5]. We had expected also to observe these waves at Titan but neither the Voyager Titan passage nor the early Cassini Titan flybys produced ion-cyclotron waves. Modelling studies have suggested that the growth time is long and the waves will not grow until some distance far downstream. However, on two passes by Titan T63 and T98, ion cyclotron waves have been seen with the T98 wave field having been much more pronounced. Figure 1 below shows the transverse and compressional power as dynamic spectra versus time on the T98 inbound pass to Titan. The ion cyclotron waves clearly arise at the expected frequency just below the piston cyclotron frequency. It is remarkable that no such waves are seen outbound at T98. This is in agreement with the initial trajectories of newborn ions which lead away from the dense deeper atmosphere inbound and into the dense deeper atmosphere outbound. On the T63 pass, a short period of waves was seen near the proton and H_2^+ cyclotron frequencies. We discuss these rare ion cyclotron waves at Titan in the light of hybrid simulations of ion pickup under conditions in Saturn's outer magnetosphere.

Figures

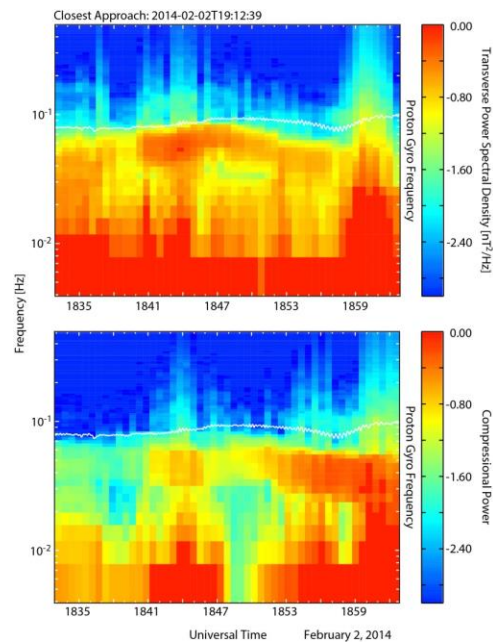


Figure 1: Dynamic spectra of transverse power and compressional power, inbound on Titan pass T98. Closest approach is 10 minutes to the right of this panel.

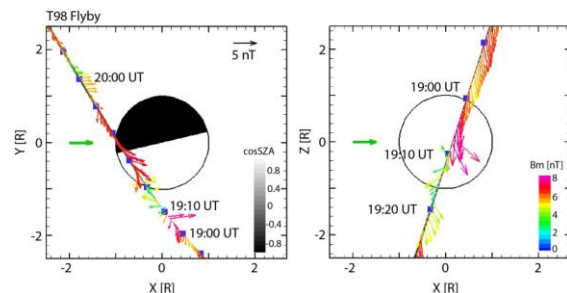


Figure 2: Cassini trajectory in Titan Interaction Coordinates with the corotation direction along X and Saturn along positive Y. Magnetic field vectors are projected on the Y-X and Z-X planes.

References

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