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WAVES AND INSTABILITIES IN THE MAGNETOSPHERIC PLASMA OF SATURN

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Ion Cyclotron Waves (ICW) and Mirror Mode Waves (MMW) have been observed by the Cassini spacecraft in Saturn's middle magnetosphere (Russell et al. 2006; Leisner et al. 2006). These waves have a common origin since they require plasma temperature anisotropy (pressure) to grow ($T_\perp/T_\parallel \gg 1$). ICW have frequencies close to the gyrofrequencies of water group ions (Ω_{W+}), they are left-handed and in most regions propagate at small angles to the ambient magnetic field ($B_\circ$). There are some regions where ICW have been observed with frequencies at twice the fundamental gyro-frequency and propagate at oblique angles. We interpret these waves as a Harmonic Mode Wave (HMW) (Rodríguez-Martínez et al. 2010). On the other hand, MMW are very compressive modes characterized by strong dips in $B_\circ$ which are anti-correlated with the density.

We present a study of wave properties and the regions of occurrence observed for ICW and their first HMW as well as for MMW using several Cassini's orbits of 2005. Such orbits have low inclination angles $< 0.5°$. The data were obtained from MAG and CAPS instruments. We observed that ICW occured between 4.7 R_S ($1R_S$ = 60268 km Saturn radii), and 5.5 R_S, and ICW+HMW between 3.8 R_S and 5.5 R_S, while the MMW were observed between 6 R_S and 7.1 R_S with respect to the Saturn center. Figure 1 shows an example of time series (intervals of 10 minutes) for regions with MMW and ICW (above and below panels respectivelly). The amplitudes observed for ICW were < 0.5 nT, while the amplitudes of MMW were larger ($\sim$1.5 nT). Moreover, MMW are characterized by strong dips in the magnetic field magnitude.

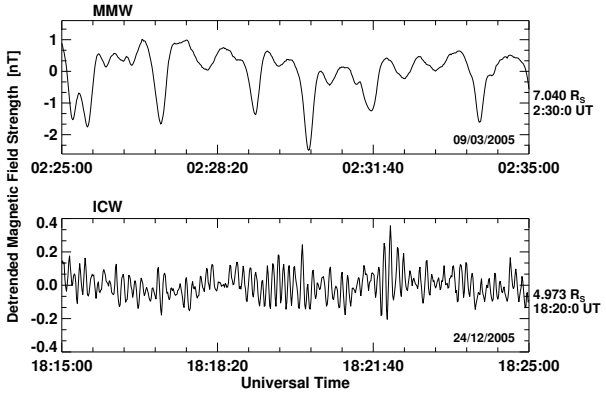

Fig. 1. Comparison between MMW and ICW series of the detrended magnetic field strength for two Cassini's observations of 2005. MMW are characterized by strong dips in the magnetic field strength, while the ICW have smaller amplitudes.

Minimum variance and Fourier analysis have shown that ICWs propagate at quasi-parallel angles to the $\mathbf{B}_\circ$ ($\theta_{B_\circ k} \sim 10° \pm 4°$) and they are left-handed circularly polarized growing close to frequencies Ω_{W+}. In addition, MMW are very compressive with frequencies below of $\sim$0.1 Hz.

Finally, we used WHAMP dispersion solver (Rönmark, 1982) to evaluate growth rates for ICW, ICW+HCW and MMW in a plasma with conditions resembling the E ring region. We found positive growth rates ($\gamma > 0$) for ICW and their first HMW. However, MMW had $\gamma > 0$ only if we considered a plasma with high beta value, suggesting that these modes were generated in other regions and they have migrated to the regions observed by Cassini. Further work is needed to understand the origin of MMW in the Saturnian environment.

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