



# Statistics of water-group band ion cyclotron waves in Saturn's inner magnetosphere based on 13 years of Cassini measurements

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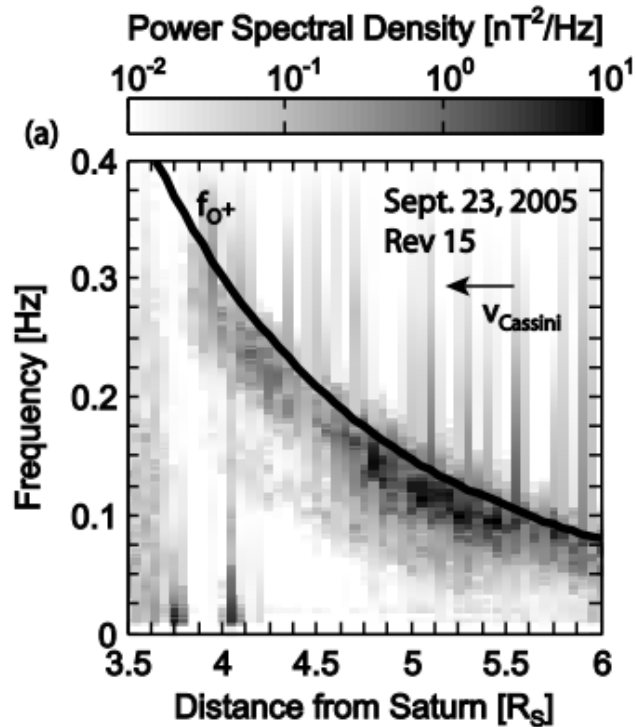
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## Ion cyclotron waves (ICW) in Saturn's magnetosphere



- ◆ ICWs are observed in the planetary magnetospheres of **Saturn and Jupiter and in the solar wind upstream of Mars, Venus, and comets**, and in the inner heliosphere from a non-planetary source.
- ◆ Based on Cassini observations from 2004 to 2016, we have performed a comprehensive statistical analysis of the global distribution of the **occurrence rate, averaged amplitude, wave normal angle (WNA), ellipticity, and power spectral density**.

Leisner *et al.*, 2011, *JGR: Space Physics*

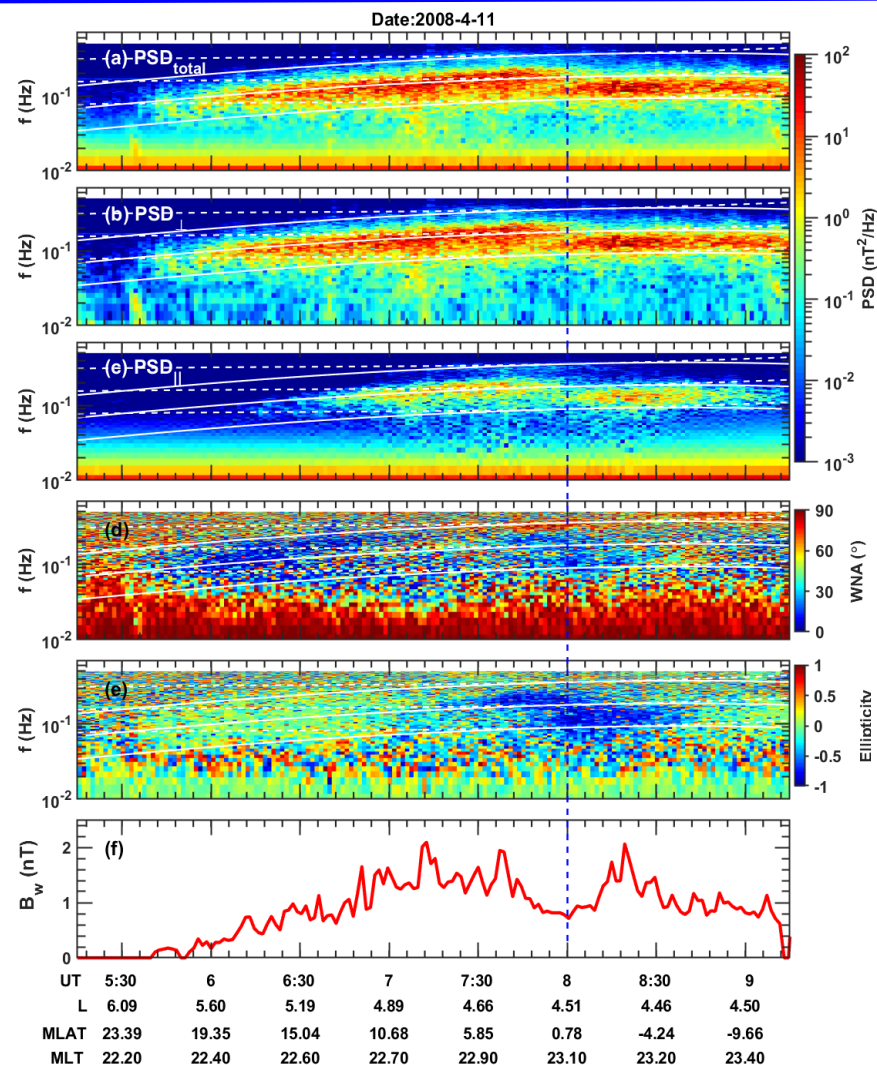


Fig. 1

- ① The WNA and wave polarization have obvious **spatial and frequency dependences**.
- ② The wave amplitude has an asymmetric **M-like pattern with respect to the magnetic latitude**.

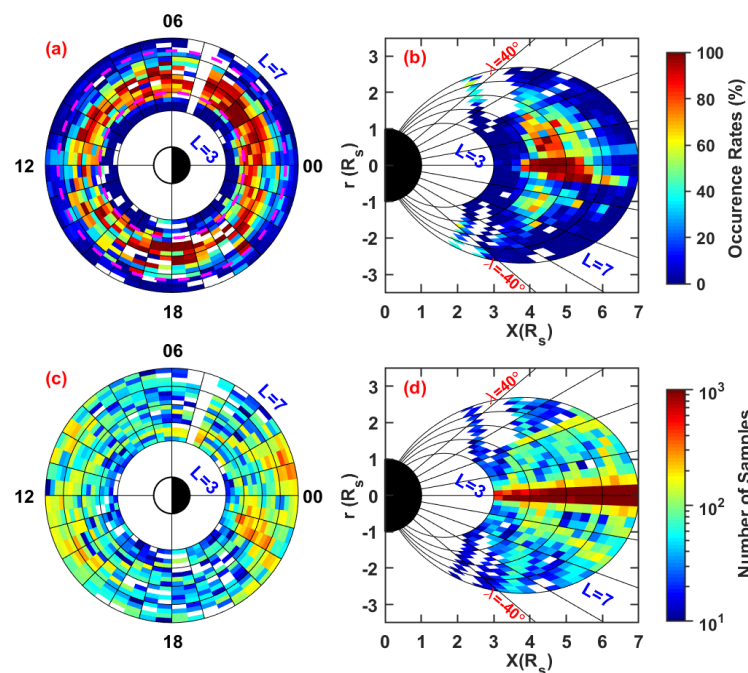


Fig. 2

- ① The waves are mainly located **near the equator**, with greater occurrence rates on the nightside than those on the dayside.
- ② An **enhancement at higher latitudes in the northern hemisphere**, and still elevated occurrence rates in the southern hemisphere.

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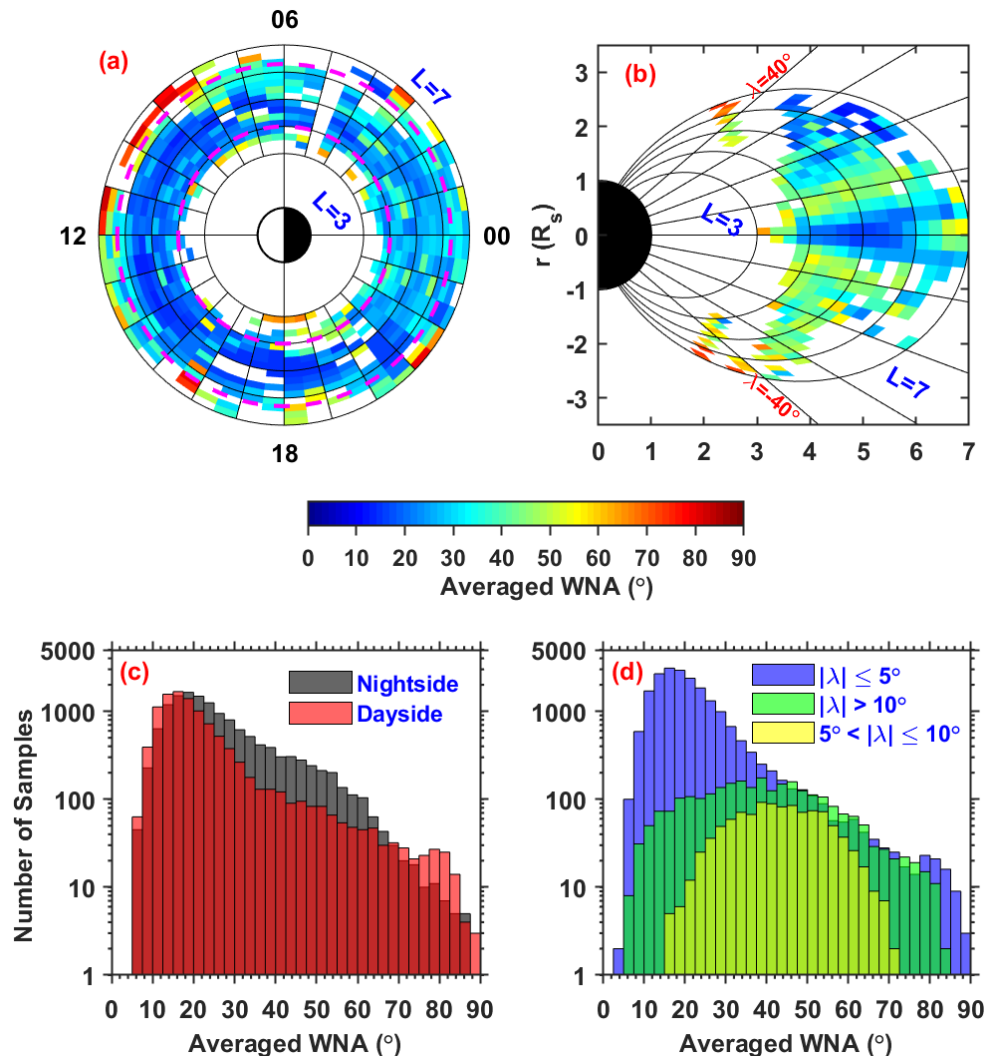


Fig. 3

- ① It is shown that **the averaged WNAs of Saturn's ion cyclotron waves on the dayside (MLT=06-18) are relatively smaller than those on the nightside (MLT=18-00)**, with the increasing WNAs outside L=4-6.
- ② **A strong latitudinal dependence of the averaged WNAs is found**, that is, the WNAs are  $< \sim 20^\circ$  near the equator ( $|\lambda| < 5^\circ$ ) and increase to  $\sim 30^\circ - 60^\circ$  at higher latitudes.
- ③ Nevertheless, at latitudes of  $\sim 20^\circ - 30^\circ$  in the northern hemisphere, the WNAs decrease to  $< 30^\circ$ , comparable to those near the equator.
- ④ It is also noted that **the WNAs in the southern hemisphere are generally larger than those in the northern hemisphere.**



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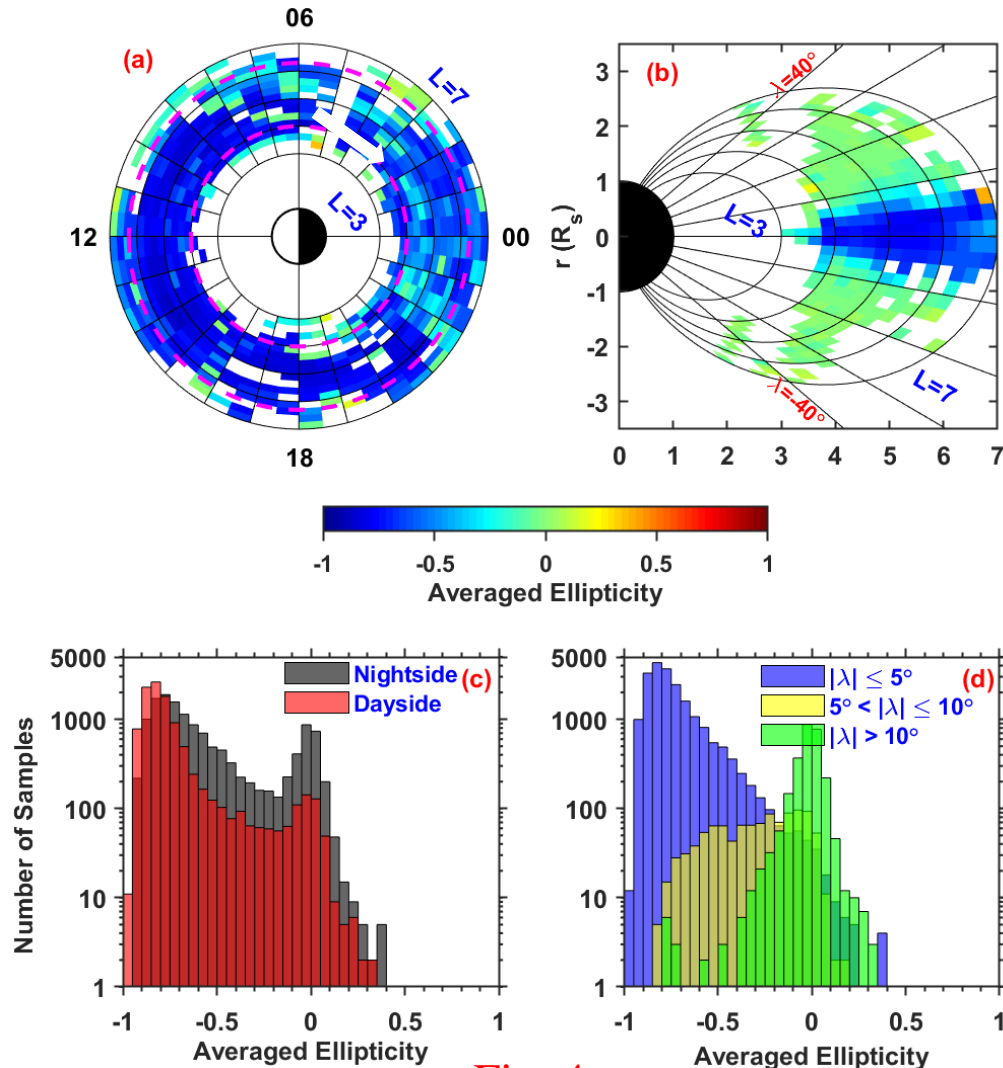


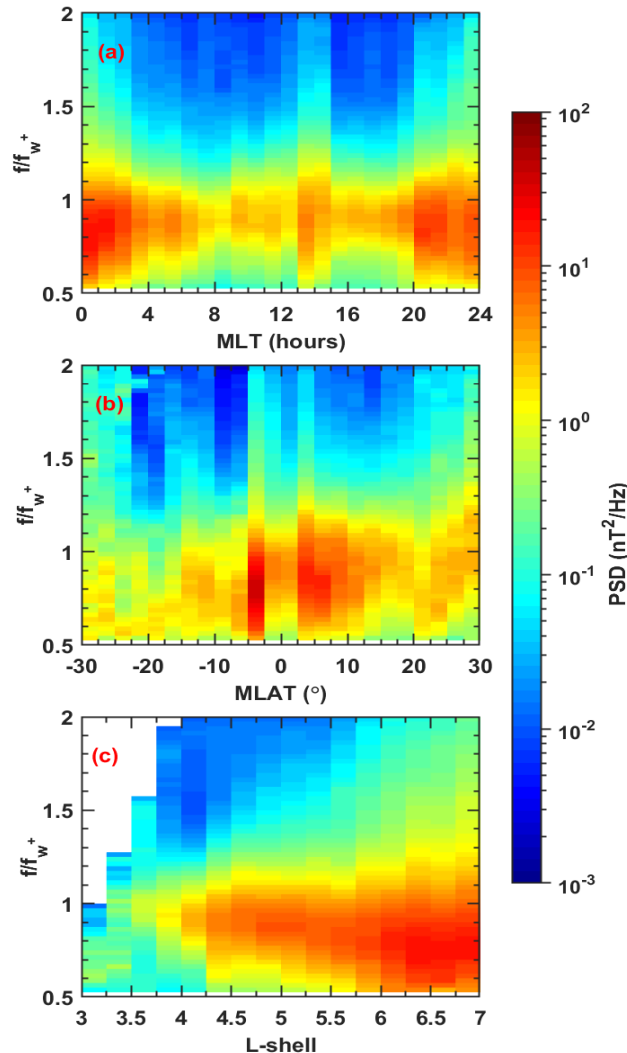
Fig. 4

- ① The wave ellipticity is slightly dependent on MLT and has a strong latitudinal dependence.
- ② Ion cyclotron waves are predominantly left-hand polarized in the near-equatorial region and become linearly polarized at higher latitudes.
- ③ Accordingly, the histograms of Figure 4c show the sample number peaks at ellipticity of  $\sim -0.8$  and  $\sim 0$ , with the former peak higher than the latter one.
- ④ Particularly, there are more samples at ellipticity  $> -0.8$  on the nightside than those on the dayside.



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Fig. 5



- ① The averaged wave intensities range from  $\sim 10^{-3} \text{ nT}^2/\text{Hz}$  to  $\sim 3 \times 10^1 \text{ nT}^2/\text{Hz}$  and **are primarily located at frequencies of  $0.5-1.2 f_{w+}$**  ( $f_{w+}$  is the equatorial gyrofrequency of  $\text{H}_2\text{O}^+$  ions).
- ② Compared with wave intensities on the dayside, **wave intensities on the nightside are larger and cover a broader frequency coverage.**
- ③ **Wave intensities in the northern hemisphere are generally stronger** than those in the southern hemisphere, with an obvious local minimum near the equator.
- ④ It is also shown that the peak wave frequency decreases with increasing L-shell, **with the maximum power intensity located at  $L \sim 6.5$ .**



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- ① Waves are frequently observed between the orbits of Enceladus and Dione within  $|\lambda| < 20^\circ$ , with higher occurrence rates on the nightside than those on the dayside.
- ② The averaged amplitudes are  $\sim 0.1\text{--}2$  nT with a strong day-night asymmetry and a pronounced minimum near the equator.
- ③ Ion cyclotron waves are predominantly **left-handed polarized with small WNAs ( $< 30^\circ$ ) near the equator ( $|\lambda| \leq 5^\circ$ ) and become linearly polarized with larger WNAs at higher latitudes.**
- ④ **The wave power spectral densities exhibit pronounced day-night and south-north asymmetries.** It is also found that the wave power spectral density peaks at  $L \sim 6.5$ , below which the peak wave frequency increases with decreasing L-shell.

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