6th Asia-Pacific Conference on Plasma Physics, 9-14 Oct, 2022, Remote e-conference

Nonlinear Wave Growth Analysis of Chorus Emissions Modulated by ULF Waves

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In Earth's magnetosphere, plasma waves play a key role in the acceleration, transport, and loss of energetic particles in the Van Allen radiation belts. These waves usually coexist and interact with one another. For example, whistler waves in the kHz range are often modulated by ultralow frequency (ULF) waves in the mHz range, which leads to fascinating phenomena such as pulsating auroral patches. In this paper, we report a representative case study of long-duration modulation of whistler-mode chorus emissions by ULF waves, in which chorus waves appear periodically at the trough of the ULF compressional magnetic field. There are two other interesting phenomena including the gradual widening of the chorus wave-power gap near half of the electron cyclotron frequency and the abrupt enhancement of the chorus wave intensity and frequency range after a substorm injection.

We utilize the nonlinear growth theory of chorus emissions to propose, for the first time, that the latitudinal configuration of the compressional ULF waves plays an important role in the modulation process. The nonlinear theory is also used to investigate the effect of substorm injection on chorus emissions and to understand the widening of the wave-power gap. They both show good agreement with the observations.

References
[1] Li, L., Omura, Y., Zhou, X.-Z., Zong, Q.-G., Rankin, R., Yue, C., Fu, S.-Y. (2022). Geophys. Res. Lett.

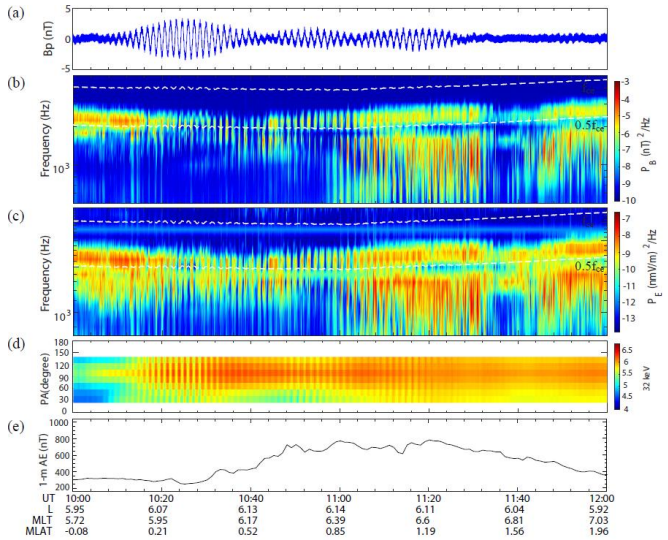

Figure 1. Event overview of whistler-mode chorus waves modulated by ULF waves. (a) The ULF compressional magnetic field components; (b-c) Power spectrum density of chorus wave magnetic and electric fields, respectively; (d) Pitch angle distributions of electron fluxes at 32 keV; (e) AE index.