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Effects of density duct on nonlinear interactions between whistler-mode chorus waves and energetic electrons

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Nonlinear interactions between energetic electrons and whistler-mode chorus waves play an important role in electron dynamics in the Earth's magnetosphere. Satellite observations and numerical simulations suggest that these nonlinear interactions are potentially responsible for electron microbursts and rapid formation of electron butterfly distributions. These nonlinear interactions significantly depend on the propagation properties of chorus waves such as propagation paths and wave normal angles. Density ducts as density irregularities are frequently detected in the Earth's magnetosphere, which can greatly affect chorus propagation. However, effects of density duct on nonlinear interactions between chorus waves and energetic electrons are not fully understood. In this study, nonlinear interactions of energetic electrons with upper-band chorus waves in plasmas with and without a depleted density duct are investigated using electron magnetohydrodynamics (EMHD) simulation and test particle simulation. Substantial differences in electron nonlinear processes are found between the two different scenarios, and resultant electron nonlinear effects are compared. Our study suggests that the effects of density ducts need to be properly included in future studies.

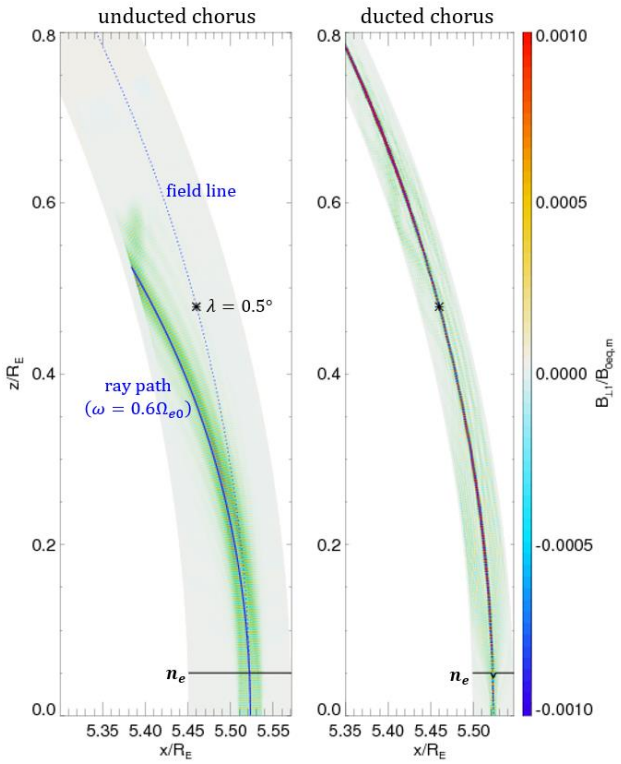

Figure 1. The spatial profile of perpendicular (to the simulation plane) magnetic fluctuations of unducted chorus (left) and ducted chorus (right) at frequency $\omega = 0.6\Omega_{e0}$ (Ω_{e0} is the equatorial electron gyrofrequency) in the Cartesian coordinates (x, z).

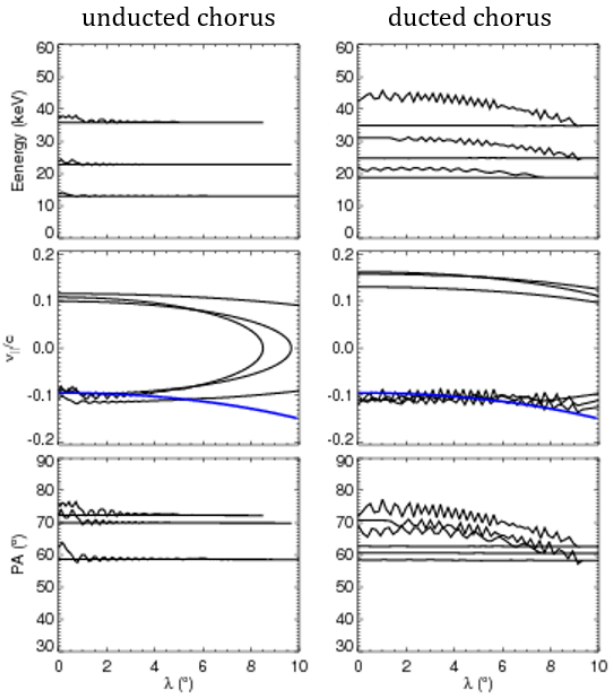

Figure 2. The energy (top), parallel velocity (middle) and pitch angle (bottom) of several electrons as functions of the magnetic latitude λ in the case with (right) and without (left) a density duct. The cyclotron resonant velocity is indicated by the blue line.

References
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