Triggering Process of Whistler-mode Chorus Emissions in the Magnetosphere

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Abstract

Chorus emissions are triggered from the linear cyclotron instability driven by the temperature anisotropy of energetic electrons (10 - 100 keV) in the magnetosphere. Chorus emissions grow as an absolute nonlinear instability near the magnetic equator due to the presence of an electromagnetic electron hole in velocity space. The transition process from the linear wave growth at a constant frequency to the nonlinear wave growth with a rising tone frequency is due to formation of a resonant current - J_B anti-parallel to the wave magnetic field. The rising-tone frequency introduces a phase shift to the electron hole at the equator, and results in a resonant current component anti-parallel to the wave electric field -J_E, which causes the nonlinear wave growth. To confirm this triggering mechanism, we perform Vlasov Hybrid Simulations with J_B and without J_B . The run without J_B does not reproduce chorus emissions, while the run with J_B does successfully reproduce chorus emissions. The nonlinear frequency shift ω_1 due to J_B plays a critical role in the triggering process. The nonlinear transition time T_N for the frequency shift is found to be of the same order as the nonlinear trapping period, which is confirmed by simulations and observation. The established frequency sweep rate is ω_1 / T_N, which gives an optimum wave amplitude of chorus emissions.

References

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