Triggering Process of Whistler-mode Chorus Emissions in the Magnetosphere

Yoshiharu Omura¹, and David Nunn¹²

¹Research Institute for Sustainable Humanosphere, Kyoto University, Gokasho, Uji, Kyoto 611-0011, Japan
(omura@rish.kyoto-u.ac.jp)

²School of Electronics and Computer Science, University of Southampton, Southampton, U.K. (dn@ecs.soton.ac.uk)

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 \(\omega_1\) 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 \(\omega_1 / T_N\), which gives an optimum wave amplitude of chorus emissions.

References


