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Numerical study of chorus generation on the basis of the backward-wave oscillator model

A. G. Demekhov (1), V. Y. Trakhtengerts (1) and D. Nunn (2)

(1) Institute of Applied Physics, Nizhny Novgorod, Russia, (2) ECS, Southampton University, UK.

We study a model of chorus generation in the Earth's magnetosphere on the basis of numerical simulations. The model is based on the backward wave oscillator (BWO) regime of the cyclotron interaction of electrons with whistler-mode waves, i.e., on the absolute instability in the near-equatorial region of the magnetosphere. For realistic fluxes of energetic particles, the instability of parallel-propagating whistler-mode waves can become absolute if a step-like distortion exists in the distribution function of energetic electrons. Numerical modeling allows us to reproduce the main features of chorus emissions, such as their typical amplitudes, characteristic size of the source region, temporal pattern as quasi-periodic or chaotic sequences of wave spikes, and frequency drift. The magnetic-field inhomogeneity is significant for the generation regimes of whistler-mode waves. In particular, this inhomogeneity determines the size of chorus source region, and it ensures the preference for rising-tone emissions under typical magnetospheric conditions. The frequency variation in chorus emissions arises due to the combined effect of the adiabatic deceleration of electrons moving from the equator and nonlinear modification of the velocity distribution. This modification causes effective additional decelaration of radiating electrons which results in the frequency increase. The modeling confirms the idea that different frequencies within an individual chorus element can be generated at different distances from the source center and, therefore, the dynamic spectrum of individual chorus elements can differ noticeably between different observation points in the source region.