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Precipitation of resonant electrons interacting with parallel and oblique whistler mode chorus waves

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Wave-particle interaction between whistler mode chorus emissions and electrons is one of the reasons that causes energetic electron precipitation. Energy ranges of the precipitated electrons are from < 10 keV to > 1MeV in the Earth's magnetosphere. In this study, we perform test-particle simulations at L=4.5 for chorus emissions with different wave amplitudes, wave normal angles, and electrons at energies 10keV-6MeV. We use the results of the test particle simulation to build Green's function sets [1, 2]. By applying the Green's function sets, we investigate time scales of electron precipitation in different energy levels, and calculate the precipitation rates of electrons interacting with one chorus wave packet at different initial kinetic energies and pitch angles. The simulation results show that Oblique chorus emissions lead to more electron precipitation than purely parallel chorus emissions in the range 300 pT–2.1 nT [3].

Landau resonance plays an essential role in oblique wave-particle interactions. However, by checking the resonance conditions and energies, we find that energetic electrons are difficult to be scattered into the loss cone directly by Landau resonance. The combination effect of Landau resonance and cyclotron resonance by oblique chorus emissions results in a higher precipitation rate than the single cyclotron resonance by purely parallel chorus emissions. We propose a two-step precipitation process for oblique chorus emissions that contributes to more efficient electron loss: (a) Through Landau resonance interaction with a chorus emission, electrons at high pitch angles are effectively accelerated in the parallel direction, and their pitch angles become lower. (b) The electrons bounce back toward the equator, and they are pushed into loss cone through nonlinear scattering due to cyclotron resonance with another chorus emission.

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