Nonlinear damping of oblique whistler mode waves through Landau resonance

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Nonlinear trapping of electrons through Landau resonance is a characteristic dynamics in oblique whistler-mode wave particle interactions. The resonance velocity of the Landau resonance at quasi-parallel propagation becomes very close to the parallel group velocity of whistler-mode wave at frequency around 0.5 f_{ce}, causing a long distance of resonant interaction and strong acceleration of resonant electrons (Hsieh and Omura, 2017). We demonstrate these effective accelerations for electrons with high equatorial pitch angle (greater than 60 degrees) by test particle simulations with parameters for the Earth's inner magnetosphere at L=5. In the simulations, we focus on slightly oblique whistler mode waves with wave normal angle less than 20 degrees. Analyzing the wave electric field **E** and the resonant current **J**, which is composed of electrons undergoing the Landau resonance, we find that the **J** dot **E** is mainly positive, which denotes the damping of the wave. Furthermore, we confirm that this positive **J** dot **E** is dominated by transverse component $\mathbf{J}_{perp}$ dot $\mathbf{E}_{perp}$ rather than by longitudinal component $\mathbf{J}_{para}$ dot $\mathbf{E}_{para}$. The simulation results reveal that the Landau resonance contributes to the nonlinear damping at 0.5 f_{ce} for whistler mode waves.