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Nonlinear dynamics of electrons interacting with oblique whistler-mode chorus in the magnetosphere

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We perform test particle simulations for relativistic electrons interacting with a whistler-mode chorus packet propagating at oblique angles. By confirming that the energy transport of oblique lower-band chorus is nearly along the ambient magnetic field, we apply the gyro-averaging method in calculating equations of motion of electrons. We trace evolution of a delta function of relativistic electrons in a phase space of kinetic energy and equatorial pitch angle, and obtain numerical Green's functions of the chorus wave particle interactions. Examining the Green's functions in a wide range of kinetic energies, we find that Landau resonance can accelerate MeV electrons efficiently, and that higher n-th resonances such as n = -1 and n = 2 also contribute to acceleration of electrons at high equatorial pitch angles (~70 degree) and high energies (~2 MeV). We investigate the rate of energy gain of the cyclotron resonance acceleration and the Landau resonance acceleration, and find that the perpendicular component of wave electric field dominates both accelerations for MeV electrons. Furthermore, the proximity between the parallel components of Vp and Vg of oblique whistler-mode waves and the nonlinear trapping condition make the interaction time of Landau resonance much longer than that of n = 1 cyclotron resonance, resulting in efficient acceleration of MeV electrons.