Landau resonant acceleration of relativistic electrons by whistler mode waves at oblique angles

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We perform test particle simulations of relativistic electrons interacting with whistler-mode waves propagating from magnetic equator at oblique angles in this study to reveal the acceleration processes of electrons in radiation belt. First we demonstrated the validity of gyro-averaging method, which solved the equations of motion of relativistic electrons with oblique propagated whistler-mode waves. In a simulation, initial distribution of kinetic energy and equatorial pitch angle are set to be a delta function, and the location of electrons are set to be different along a magnetic field line. Following the trajectories of electrons, we obtain the numerical Green's function of evolution of kinetic energy and equatorial pitch angle. We have computed several cases with energy ranges from 50 keV –2 MeV, and equatorial pitch angle ranges from 20°-70° for both parallel and oblique propagating waves. By analyzing the trajectories and Green's functions of electrons, we understand that the accelerated mechanism under Landau resonance, which appear in oblique whistler-mode wave-particle interactions but not in parallel waves, is very different from n=1 cyclotron resonance. Furthermore, by comparing the efficiency of acceleration in parallel propagating cases and oblique propagating cases at different energy ranges covering the MeV electrons, we found that MeV electrons are accelerated with remarkable efficiency through n=0 resonance.

Keywords: whistler-mode waves, oblique propagation, relativistic electrons