コーラス放射による相対論的電子フラックスの形成過程

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Formation process of relativistic electron flux through interaction with chorus emissions in the Earth’s inner magnetosphere

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We perform test particle simulations of energetic electrons interacting with whistler-mode chorus emissions. We first obtain a spatial and temporal profile of a chorus wave packet based on the nonlinear wave growth theory for parallel propagation. We assume the lower band chorus emissions by terminating the rising tone at half the electron cyclotron frequency because of the nonlinear damping due to the quasi-oblique propagation. We then calculate trajectories of a large number of electrons with the same initial energy and pitch angle launched at different locations of the magnetic field line and different timings with respect to a pair of chorus emissions generated at the magnetic equator. By casting the pitch angles after the interaction to the equator, and by taking into account the phase space volume including the bounce motion along the magnetic field line, we compute the equatorial distribution function of the electrons started from the delta function. The distribution function can be regarded as a numerical Green’s function for one cycle of chorus wave-particle interaction. We obtain the Green’s function for the energy range 10 keV - 6 MeV and all pitch angles greater than the loss cone angle. By taking the convolution integral of the Green’s functions and the distribution of the injected electrons, we can obtain the time evolution of the distribution function due to interaction with one cycle of chorus emissions. Repeating the convolution integral of the Green’s functions and the evolving distribution function, we can follow a long time evolution of the electron distribution function in the radiation belts. We find that the effective acceleration processes of the relativistic turning acceleration and the ultra-relativistic acceleration through interaction with chorus emissions contribute to a rapid formation of the relativistic MeV electron flux within an hour after the injection of tens of keV electrons.