Acceleration of MeV radiation belt electrons through interaction with whistler-mode chorus emissions

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We perform test particle simulations [1] of energetic electrons interacting with whistler mode chorus emissions. We compute trajectories of a large number of electrons forming a delta function with the same energy and equatorial pitch angle. The electrons are launched at different locations along the magnetic field line and different timings with respect to a pair of chorus emissions generated at the magnetic equator. We follow the evolution of the delta function and obtain a distribution function in energy and equatorial pitch angle, which is a numerical Green's function for one cycle of chorus wave-particle interaction. We obtain the Green's functions 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 with the distribution function of the injected electrons repeatedly, we follow a long-time evolution of the distribution function. We find that the energetic electrons are accelerated effectively by relativistic turning acceleration [2] and ultra-relativistic acceleration [3] through nonlinear trapping by chorus emissions. Further, these processes result in the rapid formation of a dumbbell distribution of highly relativistic electrons within a few minutes after the onset of the continuous injection of 10-30 keV electrons. We also compare the efficiency of electron acceleration by the cyclotron resonance and that of Landau resonance in oblique propagation [4]. We also study the effects of sub-packet structures found in chorus elements on electron acceleration.

References:

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