

Relativistic Electron Acceleration by Whistler-mode Chorus Emissions in Radiation Belts

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Abstract

Whistler-mode chorus emissions are generated at the geomagnetic equator by injection of energetic electrons into the inner magnetosphere during geomagnetically disturbed periods[1]. We perform test particle simulations assuming whistler-mode chorus wave packets that are generated at the geomagnetic equator propagate away from the equator in both poleward directions. While electrons in the energy range 10 - 100 keV are primarily responsible for the generation of chorus waves through pitch angle diffusion into the loss cone, it has been found that a fraction of the higher-energy electrons from a few hundred keV to a few MeV are effectively accelerated by chorus due to special nonlinear trapping processes called relativistic turning acceleration (RTA)[2] and ultra-relativistic acceleration (URA)[3]. In the present study we confirm that the RTA and URA processes take place for a wave packet with variable frequency such as that occurring in a rising tone of chorus emissions. We study the efficiency of the RTA and URA processes for different particle energies. A Green's function method is used to describe the evolution of the particle energy distribution function. The RTA and URA processes due to chorus emissions create a high-energy tail in the electron energy distribution function[4]. The shape of the high-energy tail is determined by the distribution function of the seed electrons in the lower-energy range. The RTA and URA can accelerate electrons in a much shorter timescale than that estimated by quasi-linear diffusion theory, e.g., it typically takes tens of minutes to hours for a few keV seed electrons to be accelerated to energies of a few MeV by RTA and URA.

References

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