

Electron acceleration in the radiation belts of Earth and Jupiter

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Adiabatic radial diffusion alone cannot account for the generation of the relativistic electrons observed in the radiation belts of Earth and Jupiter. A local acceleration mechanism that can generate relativistic electrons in a dipole magnetic field is energy diffusion due to electron gyroresonance with whistler-mode chorus waves. Quasi-linear theory predicts that for the Earth at $L=4$ the timescale for accelerating seed electrons of energy 100 keV to energies of several MeV by chorus diffusion is about 1 day. However, quasi-linear theory does not take account of nonlinear phenomena such as resonant wave trapping. Omura, Furuya, and Summers (2007) have extended the test-particle simulation of Omura and Summers (2006) and discovered a particularly efficient form of electron acceleration. The mechanism involves a special form of phase trapping by a whistler-mode wave and is called relativistic turning acceleration (RTA). In the Earth's outer radiation belt the RTA process can accelerate electrons of energy 100 keV to energies of a few MeV in a timescale of seconds to minutes dependent on the wave amplitude. Furuya, Omura, and Summers (2007) have demonstrated that the RTA process can take place for a wave packet with variable frequency such as that occurring in a rising tone of chorus emissions. RTA creates a high-energy tail in the electron distribution function. We show that RTA is a viable mechanism for generating relativistic electrons in the radiation belts of Earth and Jupiter.