Analysis of Energetic Charged Particle Bursts in the Magnetotail by Numerical Modelling

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A method to simulate magnetotail bursts has been presented. These transient enhancements in the intensities of 10 keV to 1 MeV protons and electrons have been observed ever since satellites began exploring the magnetotail. Simulations of burst events are necessary to investigate proposed theories of particle energization. Actual observations of burst events supplied the initial conditions for numerically calculated solutions of the Lorentz force equation. The most realistic model of the magnetosphere yet to be presented, the three dimensional, divergenceless Beard-Hirschi-Propp model, was used. Simulations were computed without an electric field, and simulations were also computed with a constant cross tail electric field and with an electric field parallel to the magnetic field.

A number of noteworthy results were obtained from the simulation trajectories. The simulations were consistent with both a localized moving burst source near the observation point for events with large anisotropies, as well as a global propagation of burst particles throughout much of the magnetotail for isotropic events. Protons and electron trajectories can be broadly divided into two classes: those with small pitch angles which travel long distances along field lines, and those with pitch angles nearer 90° which travel shorter distances and which have significant interaction with the neutral sheet region. Both protons and electrons mirrored adiabatically at short distances above and below the neutral sheet region, while protons showed a nonadiabatic mirroring in the neutral sheet region.

Another important result is that the preferential occurrence of Earthward energetic proton burst anisotropies in the pre-midnight sector is explained by the fact that only the pre-midnight trajectories connect to reasonable source locations.