Statistical Study of Betatron and Fermi Electron Acceleration at Dipolarization Fronts

Apostolos Kolokotronis*[1,2], Daniel Graham[1], Yuri Khotyaintsev[1], Cecilia Norgren[1,3], and Konrad Steinvall[4]

[1]Swedish Institute of Space Physics – Sweden
[2]Department of Physics and Astronomy, Uppsala University – Sweden
[3]University of Bergen, Bergen, Norway – Norway
[4]Department of Physics, Chalmers University of Technology, Gothenburg – Sweden

Abstract

Magnetic reconnection is a fundamental process responsible for explosive conversion of magnetic energy to kinetic energy of charged particles in solar and astrophysical plasmas. In outflows of Earth's magnetotail reconnection, electrons are heated and accelerated up to near-relativistic energies ($\sim$ 100 keV) by different processes, namely betatron, Fermi, and parallel electric field acceleration. The relative contribution of these mechanisms to electron acceleration, especially in suprathermal electrons and the regions where these mechanisms act remain open questions. We perform a statistical study of betatron and Fermi acceleration of earthward moving dipolarization fronts observed by MMS during the tail season. Using particle and field measurements, as well as four-spacecraft methods, we calculate the energy change of electrons due to these two mechanisms, as formulated by the guiding center theory. We perform an epoch analysis of the observed fronts, finding that betatron acceleration is dominant in the pre-existing plasma sheet, where suprathermal electron fluxes perpendicular to the background magnetic field are observed. Inside the outflow, Fermi acceleration acts on the low density reconnection electrons, driving them parallel to the field lines, with energies up to $\sim$ 100 keV.

*Speaker