Theoretical and Simulation Studies of Field-Aligned Electron Accelerations

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Abstract

The magnetic field reconfigurations in the magnetotail are strongly associated with the field-aligned electron accelerations. The field-aligned electron accelerations at different spatial scale and time scale are studied by means of numerical simulations and theoretical modeling. The following nonlinear processes will be addressed in this presentation:

(1) A quasi-steady field-aligned potential jump can be established at the boundary of hot electrons and cold electrons with field-aligned spatial scale much greater than the electron Debye length. The cold electrons can be accelerated to a speed greater than the thermal speed of the hot electrons.

(2) A non-steady but large amplitude field-aligned electric field can be generated by field-aligned ion-ion beam instability or low-density electron beam instability. Long-wavelength and large-amplitude soliton structures can be formed as a result of the beam instability. The electrons, which surfing along the soliton, can be accelerated to a speed greater than the speed of the soliton.

(3) Vortex structures in a magnetized plasma can generate a group of Alfven waves or kinetic Alfven waves to twist the magnetic field and to form a localized field-aligned electric field behind the wave front. The localized field-aligned wave electric field could accelerate the electrons to a speed greater than the speed of the Alfven wave.

(4) The inertial Alfven waves can exist in a region with very low plasma beta. The inertial Alfven waves is characterized by a quasi-steady electric field distribution, which is spatially periodic in the direction perpendicular to the local magnetic field. Electrons can be accelerated by the quasi-steady wave electric field along the magnetic field line.

Relationship between the field-aligned electron beam and the magnetic reconfigurations in the magnetotail will also be discussed.