AOGS 2005

Electron Surfing Acceleration under Small-Scale Nonlinear Waves in Magnetic Reconnection

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The role of non-thermal particle acceleration by reconnection becomes important in many astroplasma and space plasma phenomena. We give one of the updated ideas on the non-thermal particle acceleration in the course of magnetic reconnection by drawing from particle-in-cell simulation and satellite observations. It is well known that electric and magnetic field turbulences act to accelerate the plasma through scattering of particles by the turbulent waves, but, in contrast to this standard paradigm, we suggest that the coherent, small-scale, large-amplitude electric field structure is responsible to the nonthermal electron acceleration. We discuss that the strong polarized electric fields directing towards the neutral sheet are formed near the X-type neutral lines in association with the Hall electric current, and the fields play an important role to interfere with the electrons entering into the neutral sheet. During the trapping of electrons by the electrostatic potential well of the polarized field, the electrons can gain their energies from the convection/inductive reconnection electric fields. By this mechanism, relativistic electrons are quickly generated in and around the X-type neutral region.