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Surfing acceleration of energetic electrons during magnetic reconnection

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The production of energetic electrons has been reported in observations in the terrestrial magnetosphere as well as solar flares, but the understanding of those electrons remains poor. We discuss a new mechanism of electron acceleration that occurs under strong and small-scale electric fields. Specifically, we explore that the electron surfing acceleration plays an important role on the energization. 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 find that the strong ambipolar 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.