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Role of current sheet instabilities in collisionless magnetic reconnection and plasma turbulence

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In usually turbulent and collisionless space and astrophysical plasmas, dissipation and release of macroscopic magnetic energy in the form of heat and kinetic energy is a widespread phenomenon occurring, e.g., in eruptions in the solar as well as stellar coronae and substorms in the magnetosphere. A long standing puzzle is how magnetic energy is dissipated when collisions are not frequent enough. The dissipation in the absence of collisions is conjectured to be enabled by plasma physical processes at kinetic-scales such as Larmor radii and inertial lengths of plasma particles. These processes take place in kinetic-scale current sheets which form self-consistently as a part of either the large scale turbulence by turbulent cascades of energy from macro- to kinetic-scales, e.g., in solar wind, or the reconfiguration of large scale magnetic energy, e.g., in the Earth's magnetotail. Kinetic scale current sheets with thicknesses ranging from ion to electron scales are observed in space observations by multi-spacecraft missions (CLUSTER and MMS) and numerical simulations of collisionless magnetic reconnection and plasma turbulence. Plasma particles can be accelerated in current sheets by the parallel electric field and Fermi acceleration in contracting magnetic islands generated by magnetic reconnection which is considered to be one of the most viable plasma process for the dissipation of the magnetic energy. Magnetic reconnection can, however, be influenced, directly or indirectly, by plasma instabilities driven by spatial gradients of the fluid variables and/or non-Maxwellian features of the plasma particles' distribution function. We present simulation results on plasma instabilities of kinetic scale current sheets. The influence of the plasma instabilities on magnetic reconnection will be discussed.