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Role of current sheet instabilities in collisionless plasma turbulence

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An unsolved problem of the usually collisionless and turbulent space plasmas, e.g., of the solar wind, is the mechanism of dissipation of macroscopic energy into heat without the normal channels of collisional viscosity and electrical resistivity. The most viable process under consideration is the turbulent cascade of energy from macroscopic to kinetic scales, where collisionless plasma processes finally dissipate the energy into heat. A number of observational and simulation studies have shown that in plasma turbulence current sheets self-consistently form at kinetic scales. Plasma instabilities in these current sheets can provide collisionless dissipation and influence the properties of the turbulence. Hybrid simulations of plasma turbulence reveal structure of these current sheets in which, unlike Harris sheet, the current is carried mainly by electron shear flow susceptible to instabilities. Independent simulations of electron shear flow instabilities show development of electromagnetic turbulence in the shear layer. The instability driven turbulent fluctuations exhibit wave vector anisotropy with respect to the directions of both the electron flow and mean magnetic field. Possible consequences of the two kinds of anisotropy for the non-monotonic variation of wave vector anisotropy observed in solar wind will be discussed.