Buneman Turbulence and Anomalous Resivitivity in Collisionless Magnetic Reconnection

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1 Abstract

The role of turbulence around the X-line in collisionless magnetic reconnection is investigated by 3D and 2D full particle simulations. A current layer with a strong guide field, uniform density and low temperatures for electrons and ions is initialized . Following the formation of an intense current sheet within the diffusion region, localized and densely-packed electron holes are formed because of the buneman instability. The strong turbulent electron-scattering by electrostatic perturbation together with the electron inertia break the frozen-in condition around the X-line. During the limited time of these simulations, the transport of momentum associated with the off-diagonal pressure tensor is less important. We analyze the turbulence in a quasilinear model in which we calculate the slow-varying part of Vlasov equation. Analysis of our simulations shows: the drag force of the turbulence is comparable to the reconnection electric field when it reaches its peak; the turbulence broadens the current layer; and electrons are strongly scattered by the fluctuating electric field. The energy released by reconnection is efficiently transfered to the electron thermal energy by the turbulence while energy mostly goes to the kinetic energy of electron beams in the 2D simulations without turbulence. Turbulence does not accelerate the rate of magnetic reconnection, which is consistent with earlier simulation.