

CROSS-SCALE COUPLING WITHIN ROLLED-UP MHD-SCALE VORTICES AND ITS EFFECT ON LARGE SCALE PLASMA MIXING

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Kelvin-Helmholtz Instability (KHI) is an MHD-scale instability that grows in a velocity shear layer such as the low-latitude boundary layer of the magnetosphere. KHI is driven unstable when a velocity shear is strong enough to overcome the stabilization effect of magnetic field. When the shear is significantly strong, vortices in the nonlinear stage of KHI is so rolled-up as to situate magnetospheric plasma outward of the magnetosheath plasma and vice versa. The big question is if such highly rolled-up vortices contribute significantly to the plasma transport across the boundary and to the filling of the plasma sheet by cool magnetosheath component, which is observed under northward Interplanetary Magnetic Field (IMF) condition. Here we review our recent results from two-fluid simulations of MHD-scale KHI with finite electron inertia taken into account. The results indicate that there is coupling between the MHD-scale dynamics and electron-scale dynamics in the rolled-up stage of the vortices. While the details differ depending on the initial magnetic geometry, the general conclusion is that there is significant modification of the MHD-scale vortex flow pattern via coupling to the micro-physics. The kick-back from the parasitic micro-physics enhances highly the potential for large-scale plasma mixing of the parent MHD-scale vortices, which is prohibited by definition in ideal-MHD. We also review our recent 3-D MHD simulation results indicating that KHI vortex can indeed roll-up in the magnetotail-flank situation despite the strong stabilization by the lobe magnetic field. These results encouraged us to search for evidence of rolled-up vortices in the Cluster formation flying observations. As reviewed in this paper, a nice event was found during northward IMF interval. This interval is when the plasma transport via large scale reconnection becomes less efficient. The finding supports the argument that KHI is playing some role in transporting solar wind into the magnetosphere when the normal mode of transport cannot dominate.