Long term evolution of 3D collisionless magnetic reconnection

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Abstract

The nonlinear behavior of reconnecting modes in three spatial dimensions (3D) is investigated, on the basis of a collisionless fluid model in slab geometry, assuming a strong constant guide field in one direction [1]. Unstable modes in the so-called large Δ' regime are considered. The nonlinear coupling of initial perturbations with different helicities introduces additional helicities that evolve in time in agreement with quasilinear estimates, as long as their amplitudes remain relatively small. Magnetic field lines become stochastic when islands with different helicities are present [2]. In this paper we present new results obtained simulating the reconnection process starting with a Harris Pinch magnetic equlibrium configuration. We confirm the results concerning the first nonlinear phase, obtained in Ref.[2] with a periodic equilibrium configuration. The new equilibrium adoptded here allows us to extend the investigation to the long term evolution phase. We show the spatial distribution and the time evolution of the current density and vorticity structures that typically form in collisionless regimes. On the basis of the definiton of the reconnection rate presented in Ref. [2], we also present some speculations about the tendency of the system to reach a saturated state.

References

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