Parallel Electric Fields and 3D Alfvenic Reconnection

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Active plasmas carrying a large current are characterized by inhomogeneity in space and variability in time, as well as strong electric fields, including field-aligned electric fields (e.g., *Alfvén*, 1981; *Fälthammar*, 1997). However, the dynamical processes associated with localized breaking down of the frozen-in condition occurring in the current sheets at the magnetopause and in the tail are not well-understood. The generation of parallel electric fields is a necessary condition for reconnection onset. However, the most widely accepted theoretical explanation of the generation of parallel electric fields now relies mainly on the generalized Ohm's law, which yields a force balance or the relationship between force and acceleration, not the generation of parallel electric field itself. The basic dynamical theory of the generation of parallel electric fields has yet to be established. Moreover, most studies of reconnection are based on the quasi-steady laminar models, where 3D mesoscale dynamical processes accompanying the change of magnetic linkage are intrinsically excluded.

Magnetic reconnection is a 3D dynamical process and often a natural result of the interaction of magnetofluids at the current sheets. MHD wave propagation, particularly the nonlinear wave packet dynamics, plays a crucial role in reconnection processes, where the microscale and mesoscale physics are closely coupled.

We here present the dynamical theory of the generation of parallel electric fields. Based on the theoretical results, we illustrate the theory of 3D Alfvenic reconnection, including the location and threshold of reconnection onset, the energy deposition during reconnection, and the role of the radiation of Alfven waves in reconnection processes**.** The characteristics and theoretical predictions of 3D Alfvénic reconnection will be given.