# Magnetic Reconnection and Intrinsically Associated Thermal Energy Transport*

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The so-called drift tearing mode that was described first in Ref. [1] couples the effects of magnetic reconnection, driven primarily by the plasma current density gradient, with those of the gradient of the longitudinal electron pressure in a strongly magnetized plasma. We have pointed out originally that for modes involving singular perturbations the effects of nonlinearities become important at very small amplitudes. In order to analyze these effects we have started by reformulating the linearized theory of the drift tearing mode and considered, in general, the limit where the electron thermal conductivity along the field is significant. The nonlinear effects included in the simple model equation for the plane geometry that we analyzed are related to i) the (quasilinear) decrease of $dp_{e\|}/dx$ due to the effects of pre-excited modes, of the same kind, that couple with the considered mode and ii) the fact that $\hat{B}_x \partial \hat{p}_{e\|}/\partial x$ becomes important relative to $\mathbf{B}\cdot\nabla\hat{p}_{e\|} = i(\mathbf{k}\cdot\mathbf{B})\hat{p}_{e\|}$ as $\mathbf{k}\cdot\mathbf{B}$ tends to vanish within $\delta_L$ while $|\partial \hat{p}_{e\|}/\partial x|/|\hat{p}_{e\|}| \sim 1/\delta_L$ tends to become singular. Consequently, the width of the layer where these two effects are comparable can exceed easily that of the resistive reconnection layer [1] for quite small amplitudes of the reconnected field. The growth rate of the mode evaluated by the considered model equation is enhanced relative to that found by the linearized resistive theory. We note that tridimensional stability analyses concerning both cylindrical [2] and toroidal [3] configurations indicated that when the effects of the parallel pressure gradient are included, the rate of reconnection produced by the excited modes increases considerably, and the width of the reconnection region is definitely broader. In fact we consider that nonlinear drift-tearing modes can provide the explanation for modes involving magnetic reconnection that have been observed experimentally [4], and do not appear to correspond to neoclassical tearing modes.

**References**

[1] B. Coppi, Phys. Fluids, **8** 2273 (1965).
[2] A. Aydemir, Phys. Fluids B, **4** 3469 (1992).
[3] L. Sugiyama, et al., (to be published, 2004).
[4] J. A. Snipes, et al., Plasma Phys. Cont. Fus. **44**, 381 (2002).

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