Magnetic Reconnection in Large Systems: Flux Pileup and the Hall Effect

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The physics of steady, driven magnetic reconnection is reviewed in the context of two-dimensional resistive MHD and Hall MHD. In resistive MHD, the Petschek slow shock configuration is not valid unless the plasma resistivity is spatially localized in an *ad hoc* way, such that the length and width of the diffusion region scale like the plasma resistivity. Instead, flux pileup reconnection is typically observed in such simulations. For example, global MHD simulations of Earth's dayside magnetosphere are well described, along the Sun-Earth line in the magnetosheath, by the classical Sonnerup and Priest (1975) stagnation point flow solution. This implies that the subsolar magnetopause reconnection rate in such simulations decreases rapidly with plasma resistivity. Hall electric fields, on the other hand, can mitigate this reconnection time scale problem in two ways: 1) by producing an ion diffusion region which is microscopic in both dimensions, allowing for a matching to a Petchek-like external ideal MHD solution; 2) by reducing the amount of magnetic pileup which is required to support a given externally imposed reconnection rate. Nevertheless, flux pileup reconnection can still occur in the presence of strong Hall electric fields, resulting in a reconnection rate which decreases rapidly with the ratio of the ion inertial length to the system size. The conditions under which the two types of solutions – Petschek-like and flux pileup – occur, in the presence of strong Hall effects, are still being explored.