Does the Hall Effect Solve the Flux Pileup Saturation Problem?

John C. Dorelli NASA/GSFC, Code 673 Greenbelt, MD 20771

ABSTRACT: It is well known that magnetic flux pileup can significantly speed up the rate of magnetic reconnection in high Lundquist number resistive MHD,allowing reconnection to proceed at a rate which is insensitive to the plasmaresistivity over a wide range of Lundquist number. Hence, pileup is a possible solution to the Sweet-Parker time scale problem. Unfortunately, pileup tends to saturate above a critical value of the Lundquist number, S_c, where the value of S_c depends on initial and boundary conditions, with Sweet-Parker scaling returning above S_c. It has been argued (see Dorelli and Birn [2003] and

Dorelli [2003]) that the Hall effect can allow flux pileup to saturate (when the scale of the current sheet approaches ion inertial scale, di) before the reconnection rate begins to stall. However, the resulting saturated reconnection rate, while insensitive to the plasma resistivity, was found to depend strongly on the di.

In this presentation, we revisit the problem of magnetic island coalescence (which is a well known example of flux pileup reconnection), addressing the dependence of the maximum coalescence rate on the ratio of di in the "large island" limit in which the following inequality is always satisfied: l_eta << di << lamda, where l_eta is the resistive diffusion length and lamda is the island wavelength.

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