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Fast magnetic reconnection in thin current sheets: effects of different current profiles and electron inertia in Ohm's law.

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By examining sheets with thicknesses scaling as different powers of the Lundquist number S, we previously showed (Pucci and Velli, 2014) that the growth rate of the tearing mode increases as current sheets thin and, once the inverse aspect ratio reaches a scaling $a/L = S^{-1/3}$, the time-scale for the instability to develop becomes of the order of the Alfvén time. That means that a fast instability sets in well before Sweet-Parker type current sheets can form. In addition, such an instability produces many islands in the sheet, leading to fast nonlinear evolution and most probably a turbulent disruption of the sheet itself. This has fundamental implications for magnetically driven reconnection throughout the corona, and in particular for coronal heating and the triggering of coronal mass ejections.

Here we extend the study of reconnection instabilities to magnetic fields of grater complexity, displaying different current structures such as, for example, multiple or asymmetric current layers. We also consider the possibility of a Δ' dependence on wave-number k^{-p} for different values of p, studying analogies and variations of the trigger scaling relation $a/L \sim S^{-1/3}$ with respect to the Harris current sheet equilibrium.

At large Lundquist numbers in typical Heliospheric plasmas kinetic effects become more important in Ohm's law: we consider the effects of electron skin depth reconnection, showing that we can define a trigger relation similar to the resistive case. The results are important to the transition to fast reconnection in the solar corona, solar wind, magnetosphere as well as laboratory plasmas.

F. Pucci and M. Velli, "Reconnection of quasi-singular current sheets: the “ideal" tearing mode" ApJ 780:L19, 2014.