The Transition between Sweet-Parker and Hall Reconnection and its Impact on Onset

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Two independent paradigms of magnetic reconnection have emerged, collisional (Sweet-Parker) and collisionless (Hall) reconnection. Sweet-Parker reconnection leads to macroscopic current layers and is exceedingly slow. Hall reconnection is fast and takes the form of Petschek's open outflow configuration. For what resistivities are each configuration valid? We have found that for a wide range of resistivities, both the Sweet-Parker and Hall reconnection solutions are independently valid for identical values of the resistivity, a condition known as bistability. However, when the Sweet-Parker layer becomes thinner than the ion skin depth, the Hall effect controls the dynamics and the Sweet-Parker solution ceases to exist (i.e., there is a bifurcation). A catastrophic transition to Hall reconnection ensues, increasing the rate of reconnection by many orders of magnitude. This has a profound impact on the "Onset Problem", as it provides a self-consistent mechanism for the catastrophic onset of fast magnetic reconnection in a weakly collisional plasma. In the solar corona, the transition is spontaneous because the current sheet naturally becomes thinner during Sweet-Parker reconnection as stronger magnetic fields are convected toward the X-line. In this talk, we present theory and simulation results on the dynamics and onset of magnetic reconnection, and discuss the potential impact of this onset mechanism on solar flares.