Abstract Submitted
for the DPP11 Meeting of
The American Physical Society

Incomplete Reconnection in Sawteeth due to Diamagnetic Effects

PAUL CASSAK, MATTHEW BEIDLER, West Virginia University — Magnetic reconnection is known to play an integral role in the dynamics of sawtooth phenomena in fusion devices. A long-standing puzzle is why reconnection is usually incomplete in sawteeth, meaning it ceases despite the availability of free magnetic energy. We present a model of how the self-consistent evolution of reconnection in tokamak settings can cause incomplete reconnection due to diamagnetic suppression. The crux of the model is that the reconnection inflow self-consistently causes the pressure gradient at the reconnection site to increase due to the ramp in the equilibrium pressure profile. It is known that reconnection ceases if the pressure gradient exceeds a threshold due to diamagnetic effects [1], so the reconnection will shut off if the gradient becomes large enough. This may explain why reconnection is often incomplete but not always. The basic picture is confirmed with proof-of-principle two-fluid simulations. Further, the model makes predictions for the properties of the plasma at the end of a sawtooth crash. We use data from the Mega Ampere Spherical Tokamak to check the predictions, finding good agreement. The present results should be valid both for existing tokamaks and future tokamaks such as ITER, and may be useful for improving transport modeling of sawteeth.

[1] M. Swisdak et al., J. Geophys. Res., 108, 1218 (2003).

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Date submitted: 26 Jul 2011 Electronic form version 1.4