Abstract Submitted
for the DPP15 Meeting of
The American Physical Society

Decoupling of double-tearing resonant layers by sheared flows

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Double-tearing modes consist of two resonant, reconnecting layers of the same mode number coupled together by an ideal MHD outer region. Linearly this interaction can result in faster growth as the two layers drive each other. Nonlinearly it may lead to explosive releases of energy, and is a possible driver for off-axis sawtooth crashes in advanced tokamaks. Recent work has shown that differential rotation effects, such as equilibrium sheared flows or diamagnetic drifts, can decouple the DTM layers leaving two drifting, single tearing modes. These isolated tearing layers are slower growing and easier to stabilize. Understanding and producing this decoupling is thus an important element of preventing disruptive DTM activity. In this work we present progress on developing an analytic theory of DTM decoupling. We show that the application of equilibrium sheared flows mixes the symmetric and antisymmetric DTM eigenmode solutions, reducing the growth rate. This representation predicts a linear relationship between the growth rate and the amplitude of differential sheared flow needed to decouple the layers, which we confirm with linear MHD simulations. Through numerical scaling studies we examine the relationship between mode decoupling and the slab-kink mode underlying DTM growth.

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Date submitted: 24 Jul 2015 Electronic form version 1.4