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Critical Processes of Tearing Mode Entrainment in the Presence of a Static Error Field

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DIII-D experiments on control of locked tearing modes are in good qualitative agreement with predictions of a non-linear reduced MHD code (AEOLUS-IT) [1]. Robust avoidance of locked tearing modes that may cause disruptions is a prerequisite for successful ITER operation. We have tested model predictions that entrainment of a locked mode by a rotating 3D field screens out the error field that caused the initial locking. The plasma condition was the ITER base line scenario target with low safety factor discharges. The simulation is nonlinear, but highlights the fundamental process by simplifying the physics to a zero beta, single helicity case with m/n=2/1, using only the vorticity equation and Ohm's law without any additional transport properties. Experiment and simulation both show coupling between the locked mode and a stable kink around the rational surface, and the screening that follows a bifurcation event in which the mode becomes locked to the rotating applied field. Experiments in DIII-D have illuminated some of the critical physical processes in the interaction of a locked tearing mode with a rotating 3D field, including torque balance bifurcation and entrainment in the presence of a static error field. Time evolution of local mode structure near q=2 rational surface including the perturbed rotation profile using Charge Exchange Recombination (CER) has been very useful for the comparisons. Predictive understanding of mode evolution is crucial to the design of locked mode control schemes that will help to avoid disruptions in present and future devices, and the non-linear reduced MHD model AEOLUS-IT is in good qualitative agreement with experimental observations. Such models will enable design of experiments on locked mode control and other nonlinear MHD processes in present devices, and extrapolation of these studies to large-scale experiments such as in ITER.
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(1) S. Inoue et al., NF 2017 57, 116020-10, S. Inoue et al., PPCF 2018 online

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