Nonlinear Three-Dimensional Self-Consistent Simulations of Negative Central Shear Discharges in the DIII–D Tokamak

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Abstract

Nonlinear simulations of experimentally observed magnetohydrodynamic (MHD) bursts in DIII–D L–Mode negative central magnetic shear (NCS) discharges were performed with a full 3D nonlinear MHD code NFTC. The effects of plasma rotation in the presence of resistivity and viscosity are included and an effectively implicit numerical scheme allows the transport profile to evolve self-consistently with the nonlinear MHD instabilities and externally applied sources and sinks. The simulations follow the MHD bursts and disruptions through the linear and nonlinear phases and identify the connections between the early MHD bursts and the ultimate disruption phase. Specific predictions of the growth and saturation of the modes are directly compared with experimental diagnostic measurements in DIII–D. The simulations show that the bursts observed in experiments are triggered by MHD instability of a resistive interchange mode and a resistive kink mode that are excited for critical plasma profiles. The critical profiles are determined by the balance between inductive and non-inductive sources of current density.

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