DPP15-2015-000651

Abstract for an Invited Paper
for the DPP15 Meeting of
the American Physical Society

Free-Boundary 3D Equilibria and Resistive Wall Instabilities with Extended-MHD[1]

N.M. FERRARO, General Atomics

The interaction of the plasma with external currents, either imposed or induced, is a critical element of a wide range of important tokamak phenomena, including resistive wall mode (RWM) stability and feedback control, island penetration and locking, and disruptions. A model of these currents may be included within the domain of extended-MHD codes in a way that preserves the self-consistency, scalability, and implicitness of their numerical methods. Such a model of the resistive wall and non-axisymmetric coils is demonstrated using the M3D-C1 code for a variety of applications, including RWMs, perturbed non-axisymmetric equilibria, and a vertical displacement event (VDE) disruption. The calculated free-boundary equilibria, which include Spitzer resistivity, rotation, and two-fluid effects, are compared to external magnetic and internal thermal measurements for several DIII-D discharges. In calculations of the perturbed equilibria in ELM suppressed discharges, the tearing response at the top of the pedestal is found to correlate with the onset of ELM suppression. Nonlinear VDE calculations, initialized using a vertically unstable DIII-D equilibrium, resolve in both space and time the currents induced in the wall and on the plasma surface, and also the currents flowing between the plasma and the wall. The relative magnitude of these contributions and the total impulse to the wall depend on the resistive wall time, although the maximum axisymmetric force on the wall over the course of the VDE is found to be essentially independent of the wall conductivity.

[1]This research was supported by US DOE contracts DE-FG02-95ER54309, DE-FC02-04ER54698 and DE-AC52-07NA27344.