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NIMROD Simulations of a High Beta Disruption in the DIII-D Tokamak

S.E. Kruger, D.D. Schnack
Science Applications International Corporation
San Diego, CA 92121

Abstract

Linear ideal magnetohydrodynamic codes have long been used to predict the operating limits of tokamak experiments. As accurate equilibrium reconstructions have become available, the ability to compare the spatial structure of the linear eigenfunctions with diagnostic measurements for ideal modes has been possible [1]. An analytic theory has been put forth [2] to explain the time dependence of an ideal mode as it was heated past the marginal stability point. Combined with the linear results from GATO, this theory explained many of the features observed in the disruption of DIII-D shot #87009. In the present work, initial-value, nonlinear simulations of DIII-D shot #87009 are performed with the NIMROD code. The simulations include the region beyond the separatrix to provide an opportunity to do unprecedented theoretical-experimental comparisons. Starting with an equilibrium that is submarginal to the ideal mode, a heating source is applied to heat it above the marginal threshold. As predicted by the analytic theory, the mode grows faster than exponential on a time scale that is hybrid between the heating time scale and an ideal MHD time scale. As the plasma becomes nonlinear, forced reconnection causes stochasticity to occur, primarily near the X-points where the fields are most susceptible. Because of high anisotropic heat conduction, the heat load to the walls occurs primarily in the divertor region.

[1] A.D. Turnbull et.al. In the Proceeding of the 18th Fusion Energy Conference, IAEA, Sorrento, Italy (2000)

[2] J.D. Callen et.al., Phys. Plas. **6,** 2963 (1999)