Simulation of Neoclassical Tearing Modes (NTMs) in the DIII-D Tokamak Part I – NTM Excitation

A.M. Popov,* R.J. La Haye, Y.Q. Liu,† M. Murakami,‡
N.N. Popova,* A.D. Turnbull

General Atomics, P.O. Box 85608, San Diego, California 92186-5608.

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Abstract

Nonlinear self-consistent magnetohydrodynamic (MHD) stability simulations of neoclassical tearing modes (NTM) are performed with the three-dimensional (3D) MHD code Nonlinear Full Toroidal Code (NFTC) in real geometry. The numerical model is based on the nonlinear three-dimensional MHD equations including neoclassical effects: bootstrap current perturbations, and the transport and the polarization current thresholds. Neoclassical terms are included in the basic equations for magnetic field and pressure. An effective fully implicit numerical scheme allows the transport profile to evolve self-consistently with the nonlinear MHD instabilities and externally applied sources.

A direct comparison of NTM evolution with experimental observations in different DIII-D discharges is performed. As a result, the nonlinear NTM stability diagram — dependences of the critical and the saturated island width on plasma current profile parameters are obtained. The stability criterion for the time evolution of the plasma profiles against neoclassical tearing modes is also investigated.

*Moscow State University, Moscow, Russia.
†Chalmers University of Technology, Goteborg, Sweden.
‡Oak Ridge National Laboratory, Oak Ridge, Tennessee.