NONLINEAR 3D MHD CODE NFTC FOR SIMULATIONS OF PLASMA INSTABILITIES.

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Abstract

The nonlinear three-dimensional magnetohydrodynamic (MHD) code NFTC and basic algorithms included in code are presented. The nonlinear 3D evolution of a tokamak plasma is described by the full non-reduced, compressible, MHD system of equations which include viscosity, resistivity and sources. NFTC code is used for simulations of nonlinear neoclassical plasma instabilities in Tokamaks. An effective fully implicit numerical scheme allows the transport profile to evolve self-consistently with the nonlinear MHD instabilities and an externally applied sources and sinks. Neoclassical terms are included in the basic dynamic equations of NFTC code for the magnetic field and pressure. The main effect in simulations is the selfconsistency of the pressure gradient in the bootstrap current representation with the full MHD equations through the equation of pressure in the system of equation.Parallel heat conductivity coefficient depends on helical magnetic field perturbations.The numerical resolution of the threshold effects for plasma instability, when plasma is linearly stable, is presented. The numerical algorithms for evaluation of the threshold magnetic island parameters in the limit of high Magnetic Reynolds number is discussed. The equations are formulated in general toroidal geometry in magnetic flux coordinates corresponding to a initial axisymmetric solution of the equilibrium equations.Metric elements are calculated corresponding to the straight field line coordinate system. The numerical solution is represented as finite Fourier series in both poloidal and toroidal angels. Fully implicit finite difference scheme is used in radial direction. Newton-Gauss-Seidel method is implemented to resolve nonlinear terms. Linear, quasilinear, and nonlinear operators are explicitly separated in the system and can be included or excluded in the code, thus permitting of the effect of each operator. Evaluation of threshold parameters for neoclassical tearing modes instability is presented on the examples of simulation of experiments in tokamak.

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