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Linear and nonlinear benchmarks of CLT code and M3D-C1 code[1]

ZHANG WEI, Zhejiang University, STEPHEN JARDIN, Princeton Plasma Physics Lab, ZHIWEI MA, Zhejiang University — MHD instabilities are a common phenomenon in tokamaks and have been investigated by many 3D toroidal MHD codes for many years. The validation of the codes in the linear regime is accomplished by reproducing analytic scaling laws, such as $\gamma \sim S^{-3/5}$for the tearing mode and $\gamma \sim S^{-1/3}$ for the resistive kink mode. Here $\gamma$is the linear growth rate and $S$is the Lundquist number. Nonlinear benchmarking between different codes presents a new challenge. M3D-C1 is an implicit, three-dimensional high-order finite element code for the solution of the time-dependent nonlinear two-fluid magnetohydrodynamic equations in cylindrical or toroidal geometry. CLT is an explicit three-dimensional finite-difference nonlinear magnetohydrodynamics code for toroidal geometry. They are both used to investigate MHD instabilities in tokamaks. In this work, we present quantitive benchmarks of CLT and M3D-C1 for several instabilities, including linear and nonlinear tearing modes, an ideal internal kink mode, and disruptive instabilities.

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