Simulation of MHD Instabilities with Runaway Electron Current using M3D-C1

CHEN ZHAO, CHANG LIU, STEPHEN JARDIN, NATHANIEL FERRARO, Princeton Plasma Physics Laboratory — Runaway electrons can be generated in a tokamak during a plasma disruption and can be accelerated to high energies, potentially damaging the first wall. To predict the consequences of runaway generation during a disruption, it is necessary to consider resonant interactions of runaways with the bulk plasma. Here we consider the interactions of runaways on low mode-number tearing modes. For this study, we have developed a fluid runaway electron model for the 3D MHD code $M3D - C^1$ [Jardin et al., 2012]. The code employs high-order $C^1$ continuous finite elements in 3 dimensions. It can be switched into reduced MHD or full MHD, linear or non-linear, cylindrical or toroidal geometry. The code allows localized mesh adaptation around certain rational surfaces so that it can better resolve the near-singular behavior of the runaway electron current. To benchmark, we have reproduced the reduced-MHD linear tearing mode results (with runaway electrons) in a circular cylinder presented in previous studies [Matsuyama et al., 2017]. This work is being extended in several ways including generalization to full MHD, nonlinear evolution, and generalizing the kinetic runaway electron model. This work is supported by US DOE grant DE-AC02-09CH11466 and the SciDAC SCREAM and CTTS centers.

Chen Zhao
Princeton Plasma Physics Laboratory

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