Extended MHD stability analysis for transport modeling of ELMs

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Abstract

One of the key elements of the modeling of Edge-Localized Modes (ELMs) in tokamak plasmas is the triggering condition for ELM crashes. There is a consensus that ELMs can be triggered either by ballooning or peeling instabilities. The ELM triggering conditions have been recently studied in the ideal MHD limit [1, 2]. There are circumstances in which these conditions can be strongly modified by finite resistivity and viscosity. A set of equlibria applicable to the DIII-D geometry is generated with the TOQ and TEQ equilibrium codes and initial studies are carried out with the ideal MHD stability codes DCON, ELITE and BALOO. In this report, the extended MHD NIMROD code is used to study the effects of resistivity and viscosity on ELM triggering conditions for the cases that are close to the peeling-ballooning threshold. The modified peeling-ballooning threshold, which includes the effects of resistivity and viscosity, is implemented in the ASTRA code model for the H-mode pedestal and ELMs [3]. The model for the pedestal and ELMs is used in the ASTRA code to follow the time evolution of tokamak discharges from L-mode through the transition from L-mode to H-mode, with the formation of the H-mode pedestal, and, subsequently, to the triggering of ELMs. The model for the H-mode pedestal and for the triggering of ELMs predicts the height, width, and shape of the H-mode pedestal and the frequency and width of ELMs. Several systematic scans with plasma parameters, such as auxiliary heating power and elongation are presented. The new dependence for the ballooning threshold, derived from the MHD described above, is implemented in the ASTRA transport code. Results of integrated modeling of DIII-D like discharges are presented. The effects of the modified peeling-ballooning stability threshold on the ELM and pedestal parameters are discussed and the resulting dependences are compared with experimental observations.

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