Extended magnetohydrodynamics calculations of linear plasma response to external three-dimensional magnetic perturbations

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The extended magnetohydrodynamics (MHD) code M3D-C^1 [1] is used to study the time-independent, linear response of tokamak equilibria to applied three-dimensional magnetic perturbations. In doing so, we seek to develop a more complete understanding of what MHD phenomena are responsible for the mitigation and suppression of edge-localized modes (ELMs) and to explain why the success of ELM suppression experiments differs both within a single tokamak and across different tokamaks. Both resonant (tearing/screening) and non-resonant (kink) responses are considered and correlated to observations of ELM suppression/mitigation. Initial results indicate that while suppression or peak mitigation is correlated to the resonant response, the magnitude of the kink response can also impact the degree of ELM mitigation. Particular attention is paid to cross-code verification studies between M3D-C^1, IPEC [2], and MARS-F [3], along with validation studies comparing the code results to experimental magnetics measurements. Fourier decompositions of the magnetic fields are used to explain the mixed success of these studies by examining the detailed structure of the plasma response calculated by each code. Results from various experiments will be considered, particularly DIII-D and ASDEX Upgrade. The importance of two-fluid effects and a variety of plasma equilibrium parameters (especially the rotation profile), along with various numerical parameters, are investigated.

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[1] Comput. Sci. Discovery 5, 014002 (2012)
[2] Phys. Plasmas 14, 052110 (2007)
[3] Phys. Plasmas 7, 3681 (2000)