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Progress in Physics and Control of the Resistive Wall Mode in Advanced Tokamaks[1]

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The resistive wall mode (RWM) instability limits the achievable plasma pressure in present and future tokamaks operated in advanced scenarios. Motivated by the recent observation of enhanced stability of the RWM in low rotation plasmas in the collision-less regime, we extend the physics modeling of the RWM to include the drift kinetic resonance damping caused by thermal plasma particles. Starting from the drift kinetic equations, a self-consistent toroidal kinetic damping model of general plasma electromagnetic perturbations is developed and incorporated into the MARS stability code. This extended MARS-K code allows the study of the kinetic effects as both a perturbation to the basic MHD model resulting in a perturbed kinetic potential energy or in a non-perturbative manner resulting in a self-consistent kinetic potential energy based on a kinetic-MHD eigenfunction. MARS-K has been successfully benchmarked against other perturbative codes. With the unique capability of performing self-consistent kinetic calculations, MARS-K find that, in many cases, the non-perturbative approach leads to less stabilization than the perturbative approach. Detailed modeling of the plasmas in DIII-D, JET and ITER will be presented. We also extend our modeling capability to allow interaction of the 2D MHD code with the 3D eddy current structure. The new code, called CarMa, is capable of describing in much more detail the realistic geometry of the ITER walls and blanket modules, during feedback control of the RWM.

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