

Kinetic Effects on Resistive Wall Mode Stability

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The ultimate performance limit is set by Resistive Wall Modes (RWMs) [1] in advanced tokamak operating scenarios, such as those foreseen for ITER and compatible with the steady-state operation of a power plant. The RWM is a kink mode whose stability is related to damping arising from relative rotation between the fast rotating plasma and the slowly rotating wall mode. Plasma rotation, and the ensuing RWM damping, is a passive stabilising mechanism making it an attractive route for RWM control. It is thus important to understand how plasma rotational stabilisation of the RWM will scale to future devices. The nature of this stabilisation is still under study and several models have been studied, e.g. an empirical sound wave damping model [1] and a ‘semi-kinetic’ model [2] which has no free fitting parameters. A range of other damping models and mechanisms have also been proposed, e.g. [3,4,5].

This presentation will detail some areas of recent progress in developing new models for RWM damping. The drift-orbit particle-following HAGIS code [6] is being used in a perturbative manner to study kinetic resonance damping effects based on single fluid external kink eigenfunctions. This gives an exact treatment of the kinetic damping terms, but does not self consistently include the effect of the kinetic terms on the eigenmode structure. To attain a more self-consistent formulation the MARS-F linear MHD stability code [7] has been extended to include the kinetic damping terms in a non-perturbative manner. The drift kinetic equation for the perturbed distribution function is solved analytically to give the perturbed kinetic pressures, for inclusion in the MHD equations. The effects of the particle bounce resonance and precession drift resonance, for both passing and trapped particles, and ions and electrons (where appropriate), are included. It is found that the perturbed kinetic energy is sensitive to the structure of eigenmode and that the ideal kink eigenmode structure is modified by the resistive wall terms, and further modified by drift kinetic resonances. Thus the prediction of the RWM stability may depend on whether a perturbative or non-perturbative approach is used. Results for a range of experimentally relevant conditions will be presented.

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