Expanded capabilities of the CarMa code in modeling resistive wallmode dynamics with 3-D conductors

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Abstract:

In this work, an improved version of the CarMa code is presented, called CarMa-D, for the analysis of resistive wall modes(RWMs)in fusion devices, simultaneously considering the effects of volumetric three-dimensional conducting structures, plasma dynamics, toroidal rotation or drift-kinetic damping. Unlike static CarMa, CarMa-D does not rely on the simplifying assumptions such as neglecting the plasma mass, toroidal rotation and kinetic damping. The new coupling strategy is based on matrix-based Padé rational functions approximation of plasma a response. The arising mathematical model is formally equivalent to the original CarMa model, but with a higher number of degrees of freedom to model the dynamics of the plasma. CarMa-D overcomes the main limitations of the original CarMa, in particular:(i)the massless assumption for the plasma is removed, allowing modeling of global modes growing both on ideal kink time scales and in the typical RWM growth rate regime, with a suitable treatment of the model;(ii)the effects of toroidal plasma flow and drift kinetic damping can be included into the new model, providing a powerful tool to study macroscopic phenomena where both plasma dynamics and 3-D conducting structures play important roles.