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Kinetic Analysis of Resistive Wall Modes in ITER Advanced Tokamak Scenario[1]

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A fully kinetic analysis of the stability of resistive wall modes in tokamaks is important. However, it is also challenging: first, because the conventional gyrokinetic equation cannot recover MHD; and, second, because the coupling to Alfvén continuum damping requires high-resolution computation of a mode near its singular surfaces, which is difficult to achieve with usual non-adaptive codes. Our current effort is aimed at resolving these two difficulties. First, we will describe our new derivation of an extended gyrokinetic theory that can fully recover MHD. Second, we will describe our numerical work to implement this extended gyrokinetic theory in the non-perturbative and non-hybrid kinetic code AEGIS-K as an adaptation of our existing, well-benchmarked AEGIS code. Our numerical results show that n=1 resistive wall modes in the ITER advanced tokamak scenario can be fully stabilized by modestly low rotation with a rotation frequency (normalized to the Alfvén frequency at the magnetic axis) of about 0.75%. Wave-particle resonances, shear Alfvén continuum damping, trapped particle effects, and the parallel electric field effects are all taken into account. The rotation frequency for full stabilization is much larger than the diamagnetic drift frequency; therefore, finite Larmor radius effects are negligible. We also find that the window for rotation stabilization window opens first near the ideal wall limit.

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