Effect of the thermal particles collisionality on resistive wall mode in tokamak

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Analytic results indicate that the kinetic damping of trapped thermal particles on resistive wall mode (RWM) significantly depends on the particles collision frequency (ν_{eff}). In this work, it is predicted that there exist two branches of the RWM when the kinetic damping of thermal particles is taken into account. Here, both trapped thermal ions and electrons are included in the model. When ν_{eff} is smaller than a critical value, plasma flow (ω_0) induced drift kinetic resonance tends to stabilize one branch of the mode but destabilize the other one. When collisionality is over the critical value, increasing of the flow velocity does not generally change the stability of either of the branches. The possible mechanism is discussed as follows. When $\left|\nu_{eff}\right| \sim |\omega_d + \omega_0 - \omega|$, either $\left|\nu_{eff}\right|$ or ω_0 can strongly affect the perturbed kinetic energy through the mode-particle resonance, which in turn influences the mode instability; Otherwise when $\left|\nu_{eff}\right| \gg |\omega_d + \omega_0 - \omega|$, $\left|\nu_{eff}\right|$ has dominant contribution to the perturbed energy, which is then insensitive to ω_0. Here, ω_d and ω denote the precession frequency of trapped particles and the mode frequency, respectively. Both the energy-independent and energy-dependent collision models yield the similar conclusion. In addition, self-consistent computations from MARS-K agree well with the analytical predictions, and show that the particles collisionality slightly modifies the mode structure. This work indicates that in the certain region of collision frequency, the stability of RWM is sensitive to the rotation frequency. Future experiments in low collisionality plasmas, such as NSTX-U and ITER, may find that the RWM stability is more sensitive to the changes in rotation than present day, high collisionality devices.