Modelling of NTM Stabilization by RF Heating and Current Drive in Plasma with a Stiff Temperature Profile

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Neoclassical Tearing Modes (NTM) are a class of MHD instability whose non-linear growth is driven by the perturbation of the bootstrap current. Such instabilities must be controlled or suppressed to prevent a degradation of the energy confinement for future devices. This can be done applying RF-current (ECCD) or -heating (ECRH) at the rational surface where the instability appears. We report on the modelling of NTM stabilization by the combined effects of ECCD and ECRH depositions using the XTOR-2F code [1]. To consider the impact of the ECRH on the NTM decay rate, it is necessary to take into account the Tokamaks turbulent transport properties related to a critical temperature gradient [2, 3]. Such properties are considered through a heat diffusivity model depending on the stiffness σ only [4]. The stiffness and the ECRH consequence on the NTM decay rate is highlighted by a scan in P_{RF}/P_{eq} with P_{RF} the additional heat source centered at the O-point and P_{eq} the power injected inside the island position. Numerical simulations show that the island response to ECRH is on a short time scale. Also, the ECRH contribution to the NTM decay rate decreases as $\left(P_{RF}/P_{eq}\right)^{1/\sigma}$. On the contrary, the NTM reaction to ECCD acts during a longer time scale with a lasting effect on the island decay rate. A good agreement between the ECRH and ECCD efficiencies deduced from the simulations and the theoretical predictions is found. Furthermore, the results show that the ECCD and ECRH effects add up to contribute to the island decay. Finally, a generalized criteria for NTMs stabilization by RF that integrates the heating effect in a plasma with stiff temperature profile is derived.

References

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