

External kink mode stability in a tokamak with a finite current density in the SOL

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A conducting plasma outside the separatrix affects the stability of the external kink modes in tokamaks with a divertor. Large values of the pressure gradient and current density in the scrape-off layer (SOL) region driven by both the thermoelectric current between the divertor plates with different plasma temperatures and the bootstrap current can be expected according to the transport simulations [1]. Here we apply the equilibrium and stability codes CAXE-SOL/KINX-SOL [2] to study in a systematic way the dependence of the stability of the peeling-ballooning (PB) mode localized in the pedestal region on the plasma parameters in the SOL. We show that the limiting pressure pedestal height is not very sensitive to the pressure gradient distribution over the SOL and pedestal region, but a high current density parallel to the magnetic field in the SOL leads to the instability of the external kink modes localized at the conducting plasma edge. The development of such instabilities can be an alternative trigger for the ELMs, in addition to the standard model based on destabilization of the Peeling-Ballooning (PB) modes. For reconstructed JET H-mode equilibria including the pedestal, the possibility of ELMs being triggered due to the existence of currents in the SOL has been studied and found to be a viable mechanism, particularly for the cases when the pedestal height is insufficient to destabilize the PB modes [3]. The same finding is reproduced for typical NSTX H-mode plasma conditions. Since accurate measurements and estimates of the current density in the SOL are not available, the stability limits and their sensitivity to variations of the current profiles and of the width of the conducting plasma layer outside the separatrix are investigated. This analysis will also be performed in the paper for ITER plasma equilibria in reference H-mode operational conditions including various levels of SOL current density.

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[1] A. Loarte, F. Liu, G.T.A. Huijsmans, A.S. Kukushkin and R.A. Pitts. *J. Nucl. Mater.* 463 (2015) 401.

[2] S.Yu. Medvedev et al. *Plasma Phys. Control. Fusion* 59 (2017) 025018.

[3] C. Bowman et al. *Nucl. Fusion* 58 (2018) 016021.

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