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Modeling and Analytic Study of Plasma Flows on Tearing Mode Stability

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Neoclassical tearing modes (NTMs) can severely degrade plasma confinement and thus prevent the achievement of high values of in ITER. Recent experimental observations from some tokamaks indicate that equilibrium sheared-toroidal flows have a beneficial influence on NTMs: thus, an increase in the equilibrium flow [with shear] leads to an increase of the NTM excitation threshold and also decreases the size of the saturated island size. In the present work, motivated by such considerations, we examine effects of flow shear on the stability of tearing modes. We have used a cylindrical model computation using the CUTIE code and asymptotic analysis to study the (2,1) mode stability in the presence of sub-Alfvenic toroidal and poloidal sheared flows. Sheared toroidal flows appear to have a destabilizing effect, whilst moderate poloidal flows tend to be stabilizing. We have derived scalings and associated symmetries involving both resistivity and viscosity. The model equations will next be enlarged to include two fluid and poloidal flow effects to study their influence on the tearing growth rate. The final phase of CUTIE studies will involve nonlinear simulations to study the scaling of the island size with the size and sign of flow shear. In contrast to the cylindrical results, our simulations with the toroidal MHD code, NEAR, for a toroidal flow show stabilizing effects on the evolution of a single (2, 1) tearing mode both in the linear stage as well as in the nonlinear saturated state. The principal component of this stabilizing effect is identified as arising due to a flow induced 'Shafranov'like shift in the profiles of the equilibrium current (q profile) and the pressure profile. This results in a stabilizing change in the stability index. Other stabilizing effects arise from poloidal flow, toroidal geometry, toroidal mode coupling and viscosity contributions. A quantitative assessment of their relative contributions is currently in progress.

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