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TH/P3-20: Tearing Mode Stability in a Toroidally Flowing Plasma

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We report on an analytic calculation of Delta_prime, the tearing mode stability index, in a toroidal tokamak geometry with an equilibrium sheared toroidal flow. A flow modified external kink equation is derived and a boundary layer formalism is adopted. The outer" solutions of this equation, obtained analytically using a perturbation theory are matched asymptotically to the analytic idealinner" solutions to get a closed expression for Delta_prime in terms of the plasma parameters. Our calculations are a generalization of the earlier work by Hegna and Callen [Phys. Plasmas 1, 2308 (1994)] that was done in the absence of flow. In the cylindrical limit we also recover the results of Gimblett et al [Phys. Plasmas 3, 3619 (1996)] that shows the destabilizing effect of purely axial flows. For a purely toroidal flow the various flow dependent terms of the "inner" solutions are compared and the nature of their contributions analyzed to delineate their influence on Delta_prime. We also extend our results to include finite beta corrections and nonlinear modifications arising from considerations of finite width of the island in the calculation of Delta_prime. Our analytic expressions should prove useful in providing a rigorous basis for assessing the validity of various ansatz for Delta_prime that are currently being used to explain experimental data and to benchmark
MHD code calculations of this stability index.

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