Multiply Resonant Resistive Stability of DIII-D Plasmas With Sawteeth*

D.P. Brennan,[1] A.D. Turnbull,[1] M.S. Chu,[1] L.L. Lao,[1] and L.E. Sugiyama[2]

[1]*General Atomics, P.O. Box 85608, San Diego, California 92138-9784, USA*
[2]*Massachusetts Institute of Technology, Cambridge, Massachusetts, USA*

The MHD stability of resistive modes in the presence of multiple resonant surfaces, including central sawtooth oscillations, is examined using reconstructions of experimental equilibria in the DIII-D tokamak at mode onset. Coupling to other rational surfaces, especially the 1/1, is important even at low beta. Both the outer global ideal MHD and inner layer solutions at rational surfaces are important in determining mode stability. The PEST3 code is used to determine matrix solutions for the global ideal MHD n=1 mode that have singular jumps at each of the rational surfaces. This outer region matrix of solutions is matched asymptotically to the resistive MHD inner layer solutions, both of which differ in high and low beta plasmas.

The interchange parameter *H* is small in the low beta DIII-D plasma, while the inverse beta parameter *G* is large, a configuration which differs significantly from the high beta plasma. In the low beta plasma the most important effects in the dispersion relation are found to be the resistive interchange parameter D_R and the coupling to the 1/1 surface, which combine with a slowly changing ideal global instability drive to determine the outcome. In the high beta plasma the outer layer is more sensitive to equilibrium changes,[1] but coupling still plays a major role.[2] Two-fluid diamagnetic effects were examined only in the uncoupled case, and modify the growth rates significantly. The large drift velocities suggest coupling would be significantly affected. Both electron and ion diamagnetic effects are important at large diamagnetic frequencies $\omega_{*i} \gg \gamma_{MHD}$ and $T_e \sim T_i$.

These insights are used to interpret the results from initial value MHD code NIMROD,[3] where the nonlinear evolution of the mode is also investigated. This work can lead to testing various physics effects, in the inner layer and the outer region, on mode stability in comparison with experiment.

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