# Rotation and beta dependence of numerical two fluid layer stability limits in tokamaks

D.P. Brennan,[1] A.J. Cole,[2] C. Akcay,[3] and J.M. Finn[3]

[1] *Princeton University*

[2] *Columbia University*

[3] *Tibbar Plasma Technologies, Inc.*

The stability boundaries of a reduced model of a tokamak in $\beta$ vs $\Omega$, the ratio of thermal to magnetic energy vs the toroidal rotation frequency, are examined as the rotation varies across the Hall, Semi-Collisional and Inertial regimes, with a resistive wall included. A numerical solver for the two fluid layer response is presented, which solves the plasma layer response smoothly across these two fluid regimes. The equilibria are stable for low $\beta$, and the marginal stability values in $\beta$ and rotation are computed. The results show the Semi-Collisional regime to be most relevant to DIII-D experimental analysis, and the lowest limiting $\beta$. The stability boundary is non-monotonic in $\Omega$, and extends to lower $\beta$ as the finite frequency of the plasma response approaches the rotational frequency. A comparison is made between the analytic limits in each two fluid regime and the numerical solution to the plasma layer, showing significant deviation between the two over what is typically considered each two fluid regime. The impact of the rotation in both the plasma layer responses is used to interpret recent experimental results from DIII-D. Plans for including the effects of energetic ion interaction are discussed, which will be included as the numerical model becomes verified.