A general MHD stability formulation for plasmas with flow and resistive walls

JEFFREY FREIDBERG, LUCA GUAZZOTTO, Massachusetts Institute of Technology, RICCARDO BETTI, University of Rochester — Plasma rotation, induced either by means of neutral beams (e.g. in NSTX and DIII-D) or appearing spontaneously (e.g. in Alcator C-Mod, JET and Tore Supra) is routinely observed in modern tokamak experiments. Plasma rotation has a major effect on plasma stability. In particular, flow and flow shear stabilize external modes such as the resistive wall mode (as observed e.g. in DIII-D), and also have a significant influence on turbulence, internal kinks and ballooning modes. A self-consistent analysis of the effect of rotation requires the use of numerical tools. In this work, we extend our previous analysis and present a general variational eigenvalue formulation of the stability problem. The analysis includes arbitrary (both toroidal and poloidal) plasma rotation and a thin resistive wall of arbitrary shape and resistivity. It is shown the problem can always be reduced to a classic eigenvalue formulation of the kind $i\omega A\cdot \zeta = B\cdot \zeta$, where $\zeta$ is the unknown eigenvector related to the plasma displacement, and $\omega$ the (complex) evolution frequency of the perturbation. The formulation is well suited for a finite element analysis.