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New approach to MHD spectral theory of stationary plasma flows

HANS GOEDBLOED, FOM-Institute for Plasma Physics — The basic equations of MHD spectral theory date back to 1958 for static plasmas (Bernstein et al.) and to 1960 for stationary plasma flows (Frieman and Rotenberg). The number of papers on the two subjects appears to be inversely proportional to their complexity, with the vast majority of contributions to MHD stability of tokamaks being restricted to static equilibria and stationary equilibrium flows mostly being discussed analytically for trivial equilibria or numerically for complicated geometries. The problem with the latter is not that numerical approaches are inaccurate, but that they suffer from lack of analytical guidance concerning the structure of the spectrum. One of the reasons is the usual misnomer of "non-self adjointness" of the stationary flow problem. In fact, self-adjointness of the two occurring operators was proved right away. Based on the two quadratic forms corresponding to these operators, (a) we constructed an effective method to compute the eigenvalues in the complex plane, (b) we found the counterpart of the oscillation theorem for eigenvalues of static equilibria (Goedbloed and Sakanaka, 1974) for the eigenvalues of stationary flows, enabling one to map out sequences of eigenvalues in the complex plane. Examples will be given for Rayleigh-Taylor, Kelvin-Helmholtz and magneto-rotational instabilities.

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