Progress towards the development of a linear MHD stability code for axisymmetric plasmas with arbitrary equilibrium flow.

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Abstract

Fast toroidal plasma flows are routinely induced by neutral beam injection in current tokamaks such as NSXT and DIII-D. These equilibrium flows are beneficial to the overall plasma performance since they stabilize external modes such as the resistive wall mode and suppress turbulence when the flow shear is large enough. Flow and flow shear have also a significant influence on the stability and nonlinear evolution of the internal kink mode and ballooning modes. Theoretical results indicate that improvements in plasma stability usually occur regardless of the flow direction (toroidal or poloidal). Fast poloidal flows are difficult to drive in moderate and low beta plasmas because of the large poloidal viscosity. However, high beta plasmas (with beta of order unity) develop an omnigenous structure that should be optimal for driving large poloidal flows due to the reduced poloidal flow damping. While equilibria with both poloidal and toroidal flows can now be generated with the U. Rochester code FLOW [1], the tools available to tackle the stability problem are quite limited. With the exception of the code MARS [2], none of the available stability codes includes the effects of finite flow. MARS (developed at Chalmers University) includes only toroidal flow and, to the best of the authors' knowledge, it does not include the effects of flow in the equilibrium. With the goal of producing a tool capable of investigating MHD stability with arbitrary flow, we have begun the development of a new linear stability code. The code is based on a recent δW formulation in which the energy principle (including arbitrary flow) is reduced to an eigenvalue problem of the kind (ω**A-B)x=**0**.** Such a formulation is attractive because it allows a straightforward implementation of the finite element method to determine the elements of **A** and **B.** A finite element code has been developed to solve such an eigenvalue problem. The code is at an early stage and it is currently being tested to study the stability of simple slab equilibrium unstable to the Rayleigh-Taylor and the Kelvin-Helmoltz instabilities. Where possible, analytical solutions have been derived and are compared to the results of the code.

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[2] A. Bondeson, G. Vlad and H. Lütjens, in Proc. IAEA Technical Committee Meeting on Advances in simulation and Modelling of Thermonuclear Plasmas, June 1992, Montrèal, Canada (IAEA, Vienna, 1993) p. 306