CASTOR3D: linear stability studies for tokamak and stellarator configurations

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Three-dimensional tokamak and stellarator equilibria are in the focus of present fusion research. While stellarators are characterized by a complex 3D magnetic field topology, 3D tokamaks are devices with weakly broken axisymmetry. Reasons for the asymmetry of tokamak configurations are e.g. three-dimensional resistive wall structures which can reduce the growth rates of external modes, and magnetic perturbation fields. The latter are applied to mitigate or even to suppress edge localized modes (ELMs). The design of 3D fusion devices, as well as the analysis and interpretation of the corresponding plasma discharges require appropriate numerical tools that are able to handle their geometry. The newly developed, linear stability CASTOR3D code [1] is such a tool. It is a hybrid of the linear stability CASTOR_3DW code [2] and the resistive wall mode STARWALL code [3]. Numerous modifications and extensions of both code parts led to a synergistic effect. The possible applications of the CASTOR3D code exceed easily the possibilities of both of them. The code has a number of significant advantages. It allows: (i) to choose between various kinds of flux coordinates, (ii) to perform ideal and resistive stability studies for 3D equilibria, (iii) to take plasma inertia and resistive walls simultaneously into account, (iv) to study the effects of plasma rotation and viscosity on the stability properties, (v) to investigate vertical instabilities, and (vi) to deal with coils and multiply-connected wall structures. The MPI parallelization of the code including the implementation of a parallel eigenvalue solver for non-hermitian eigenvalue problems (SLEPc [4]), allows an efficient solution of large eigenvalue problems.

Stability studies demonstrating the large variety of possible application of the CASTOR3D code will be presented for a 3D tokamak and a quasi-axisymmetric stellarator configuration.

References

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