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Ideal MHD ballooning modes and stability boundaries of near helically symmetric stellarators

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Abstract

A method for generating a set of three-dimensional MHD equilibria has been developed which allows for variations in the plasma profiles in the vicinity of a magnetic surface associated with an existing equilibrium.[1] Two free profile functions, in particular the variation of pressure and rotational transform gradients, appear in parameterizing the new class of equilibria. In this work, we examine the effect of profile variations on the ideal MHD ballooning stability properties of a near helically symmetric configuration. Marginal stability boundaries are denoted by constructing generalized $s-\alpha$ curves, where s and α are dimensionless measures of the rotational transform and pressure gradient, respectively. In particular, we apply this technique to magnetic configurations available to the HSX stellarator. A result of these studies is that in contrast to axisymmetric configurations, we find no evidence of a second stability regime of operation for the HSX stellarator. Moreover, the ballooning eigenvalues are highly field line dependent indicating that the most unstable ballooning modes will be highly localized on a given magnetic surface.

The analysis is based on the numerical solution of the ballooning equation, where the boundary conditions are taken to be the vanishing of the eigenfunctions after a finite number of field period revolutions around the major axis of the torus. We analytically explore how to determine the length of the field period revolutions.

[1] C.C. Hegna and N. Nakajima, *Phys. Plasmas* **5**, 1336 (1998).

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