Effect of symmetry-breaking on ballooning modes in quasi-symmetric stellarators

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Global ballooning stability is examined in three quasi-symmetric stellarators: the Quasi-Poloidal Stellarator (QPS), the Helically-Symmetric Experiment (HSX), and the National Compact Stellarator Experiment (NCSX). A focus of this work is the impact of symmetry-breaking on ballooning stability. In the ray tracing method, global ballooning mode stability is calculated by following rays in the eigenvalue space determined by the results of local, infinite-n ballooning theory. The eigenvalue is a function of the flux coordinate q (the safety factor), the field line label α, and the ballooning parameter, θ_k. For HSX and QPS configurations, the impact of breaking the symmetry (or degrading the quasi-symmetry) on ballooning modes is examined. For the HSX configuration, three cases are examined: the standard quasi-helically symmetric case, a mirror case, and a hill case. The mirror and hill cases represent degraded symmetry configurations for the HSX experiment. The weak global shear in HSX results in modes which only weakly depend on the ballooning parameter. For QPS, the standard quasi-poloidally symmetric case and a degraded symmetry case are examined. In all of the non-axisymmetric cases studied, the unstable modes are localized in the field-line label, α.

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