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An examination of the chaotic magnetic field near the separatrix of magnetically confined plasmas

S.R. Hudson[1] and Y. Suzuki[2]

[1] *Princeton Plasma Physics Laboratory, P.O. Box 451, Princeton, New Jersey 08543, USA*

[2] *National Institute for Natural Sciences, National Institute for Fusion Sciences, 322-6 Oroshi, Toki, 509-5292, Japan*

Understanding the chaotic structure of the magnetic field near the plasma edge is important for computing the MHD equilibrium, understanding the MHD stability, and for understanding a variety of transport phenomena. All magnetically confined plasmas are surrounded by a separatrix, which for perfectly-axisymmetric tokamaks usually defines the plasma edge. As three-dimensional perturbations are applied, the stable and unstable branches of the separatrix split, the homoclinic tangle is formed, and flux surfaces near the separatrix are destroyed. For strongly-nonaxisymmetric stellarators and heliotrons, the flux-surface destruction near the separatrix is usually considerable and the boundary surface (i.e. the last closed magnetic surface) may be sufficiently far from the separatrix so that the homoclinic tangle, or heteroclinic tangle, does not require special attention in computational simulations.

Efficient numerical techniques for locating the boundary surface, the cantori and for constructing straight-fieldline coordinates (where possible) have been implemented [1] for the chaotic magnetic fields near the plasma edge in LHD, as computed by HINT2 [2]. These techniques will be extended to tokamak geometry, for which the proximity of the separatrix to the plasma edges demands additional care. The singular structure of the separatrix will be treated analytically, so that the computational coordinates are smooth and well-behaved. The interplay between the homoclinic tangle and the cantori will be illustrated.

References

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Corresponding author: Stuart Hudson shudson@pppl.gov