2C38

Modeling of effects of magnetic perturbation on the quality of flux surfaces in SSPX spheromak

M.V. Umansky, R.H. Bulmer, D.N. Hill, W.M. Nevins, D.D. Ryutov, S. Woodruff

Lawrence Livermore National Laboratory
Livermore, CA 94551 USA

Abstract

We present results showing the effect of magnetic fluctuations on the quality of flux surfaces in realistic spheromak geometries. In the SSPX spheromak at LLNL, the thermal diffusivity can at times be higher than the Bohm value [1]. This may be due to degradation of magnetic flux surfaces by magnetic fluctuations when islands produced on mode-rational surfaces overlap. Few systematic studies of the effect of magnetic perturbations on the quality of flux surfaces exist. Most recently, NIMROD simulations have shown that large amplitude n=1 modes can produce completely stochastic magnetic field lines in strongly driven spheromaks [2]. However, in the SSPX experiment, low edge-field fluctuation amplitudes (dB/B < 1%) and strongly peaked pressure profiles with Te being a flux function [1] are commonly observed. Therefore, a study relating magnetic fluctuations to the quality of flux surfaces and global energy confinement is timely.

We analyze the effect of magnetic field fluctuations on the quality of confinement in SSPX spheromak plasmas by analyzing a perturbed magnetic field. The unperturbed magnetic field is calculated from MHD equilibrium code CORSICA [3], and a perturbation model is added to it. The perturbation is set analytically as a set of Fourier harmonics, and its poloidal and toroidal structure is constrained by available data on edge magnetic field fluctuations.

Using numerical magnetic line integration we construct Poincare maps for the perturbed field. Magnetic perturbation causes formation of islands, and as the amplitude of the perturbation is turned up, the islands overlap and stochastic regions are observed. We estimate the effective heat transport induced by the presence of stochastic magnetic field and compare our calculations with the scaling of peak electron temperature and global energy confinement time as a function of the amplitude of the magnetic fluctuations.

[1] H.S. McLean et al., Phys. Rev. Lett. 88 125004 (2002)
[2] C.R. Sovinec et al., Phys. Plasmas 8, 475 (2001)
[3] E.B. Hooper et al., Nucl. Fusion 39, 863 (1999)

Work performed for U.S. DOE by UC LLNL under contract W-7405-Eng-48.