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Magnetic stochasticity in gyrokinetic simulations of plasma microturbulence[1]

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One of the fundamental components of a steady state tokamak or stellerator fusion reactor is the structural integrity of nested magnetic surfaces. The consequences of losing this integrity can have very serious implications, ranging from sawtooth crashes to disruptions. In the present work, we use GYRO to examine the perturbed magnetic field structure generated by electromagnetic gyrokinetic simulations of the CYCLONE base case as β is varied from .1% to .7%, as first investigated in [J. Candy, Phys. Plasmas **12**, 072307 (2005)]. By integrating the self-consistent magnetic field lines to produce Poincare surface of section plots, we demonstrate destruction of magnetic surfaces for all nonzero values of β. Despite widespread stochasticity of the perturbed magnetic fields, no significant increase in electron transport is observed. We can quantify the stochastic electron heat transport by using test particles to estimate the magnetic diffusion coefficient D_{st} [A.B. Rechester and M.N. Rosenbluth, PRL **40**, 38 (1978)] for hundreds of time slices in each simulation and find the time-history of D_{st} to be highly correlated with the electron heat transport due to "magnetic-flutter" computed in the simulations. The mechanism that couples electromagnetic turbulence to the linearly damped high-n tearing modes that are responsible for reconnection will be discussed.

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