Subject of the abstract: 1) Ergodisation of the magnetic field

Ergodic magnetic limiter research in the TCABR tokamak: theoretical and experimental results.

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The ergodic magnetic limiter is a device designed to generate a cold boundary layer of chaotic magnetic field lines at the peripheral region of a tokamak, with the main purpose of reducing the plasma-wall interaction. In the TCABR tokamak an ergodic limiter was constructed and recently installed inside the vacuum chamber. In this work we present recent theoretical and experimental results on the effects of an ergodic magnetic limiter on the plasma confined in the TCABR tokamak. We present two theoretical models for the ergodic magnetic limiter. The first model uses the large aspect-ratio approximation for the equilibrium and limiter fields, and takes into account the finite width of the limiter and a non-uniform distribution of the limiter current segments, which is necessary to cope with the toroidicity effects. The perturbing limiter field is obtained as a vacuum field by analytically solving the Laplace equation. The theoretical results of this first model are in good agreement with measurements of the external magnetic field created by the limiter. Poincaré maps of field line flow are computed to reveal the resulting magnetic field line structure due to the ergodic limiter, and show that the operation of the ergodic limiter in the TCABR tokamak is feasible and results in a ergodic boundary layer, using limiter currents less than 6 % of the plasma current. The second model uses polar toroidal coordinates, the plasma equilibrium field being analytically obtained by solving, through an approximation scheme, the Grad-Schluter-Shafranov equation in such coordinate system. In this second model the poloidal distribution of the limiter currents is also determined by taking into account the toroidal geometry of this tokamak. The limiter action is modelled as a sequence of delta-function pulses, whereupon a symplectic map is derived by using a Hamiltonian formulation for the magnetic field line flow. With help of this Poincaré map, it is possible to study many dynamical properties of the field line flow, such as radial diffusion, bifurcation and field line escape through collisions with the wall. The latter aspect is particularly related to the homoclinic structure underlying the chaotic orbits in the tokamak edge region.