Experimental and Numerical Studies of Separatrix Splitting and Magnetic Footprints in DIII-D*

T.E. Evans[1], I. Joseph[2], R.A. Moyer[2], M.E. Fenstermacher[3], and C.J. Lasnier[3]

[1]*General Atomics, San Diego, California 92186-5608, USA*
[2]*University of California-San Diego, La Jolla, California, 92093 USA*
[3]*Lawrence Livermore National Laboratory, Livermore, California, USA*

When subjected to small non-axisymmetric magnetic perturbations, the separatrix of a poloidally diverted tokamak is transformed from an axisymmetric 2D geometry into a set of intersecting invariant manifolds that define a somewhat more complex 3D topology [1]. This process is unavoidable when non-axisymmetric magnetic perturbations, such as those from external correction/control coils, field-errors or internal MHD modes, are present in the system, and it has significant implications for the deposition of heat and particle fluxes on divertor structures and first wall components. We refer to this process as separatrix splitting and the patterns formed by the intersection of the invariant manifolds with solid surfaces as magnetic footprints. For all cases tested to date, calculated magnetic footprints produced by seperatrix splitting are consistent with bifurcation seen in the heat and particle distributions (multiple peaks) on plasma facing surfaces in DIII-D. Large bifurcated peaks are often observed in the outer divertor heat flux profiles during locked modes. Here, the outer divertor strike point bifurcates into a pair of peaks separated by as much as 15 cm with roughly equal peak heights. Bifurcated or multiply split heat flux and particle recycling peaks are commonly observed when non-axisymmetric magnetic perturbations are introduced by correction coils (C-coil) and MHD control coils (I-coil) located outside the plasma. Separatrix splitting due to these magnetic perturbations, along with the associated magnetic footprints, have been calculated with the TRIP3D field line integration code [2] for several cases and are compared with experimental data showing the formation of bifurcated or multiple split peaks in the divertor. Results from TRIP3D modeling will also be compared with experimental observations showing that the splitting of the heat and particle flux in the DIII-D divertor is well correlated with the timing of the magnetic perturbation pulses from the DIII-D correction/control coils. In addition, time dependent modulation of the peaks produced by locked modes and various types of core and edge MHD modes are consistent with expected changes in the 3D structure of the separatrix due to magnetic perturbations from these modes. Implications for the ITER divertor design will be discussed and plans for modeling magnetic footprints due to separatrix splitting produced by the ITER field-error correction coils will be described.

[1] T.E. Evans, R.K. W. Roeder, J.A. Carter, *et al.,* J. Phys.: Conf. Ser. **7** (2005) 174.
[2] T.E. Evans, R.A. Moyer and P. Monat, Phys. Plasmas **9** (2002) 4957.

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