Effects of magnetic perturbations on axisymmetric divertors

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The behavior of the magnetic turnstiles that depart plasma from axisymmetry to strongly perturbed is studied. An analytic model is derived in which the width and nature of the intersection of points of magnetic flux tubes can be studied. This exact model is based on the Boozer-Rechester two wire model [A. H. Boozer and A. B. Rechester, Phys. Fluids **21**, 682 (1978)]. Boozer and Rechester represented the magnetic field using the complete elliptic integrals and the Jacobi elliptic functions, but they did not place the equations in terms of an explicit magnetic field line Hamiltonian. In our model this is done and the magnetic field lines are modified by the addition of a fixed small radial spiraling velocity. The lines eventually cross the outermost confining magnetic surface and form flux tubes that strike the surrounding walls. The width and nature of the intersection of points of these flux tubes are studied in the limit as the spiraling velocity vanishes. This is done for both an axisymmetric divertor and for an axisymmetric divertor subjected to a quadrupole perturbation that has an orientation that rotates with the toroidal angle. The flux escaping through the turnstiles must exactly equal the returning flux. The scaling of the loss time and the size of intersection with the spiraling velocity are studied. General universal scaling laws characterizing the effects of perturbation on the axisymmetric divertors are sought. This work is supported by the US DOE grants DE-FG02-01ER54624 and DE-FG02-04ER54793 to Hampton University and DE-FG02-95ER54333 to Columbia University. This research used resources of the NERSC, supported by the Office of Science, US DOE, under Contract No. DE-AC02-05CH11231.