A Geometric Model of Standard Neoclassical Orbit Loss and X-Loss with Integration into a Fluid Model

Robert William Brzozowski III[1,2], Frank Jenko[1,2], and Antti Snicker[2,3]

[1]Department of Physics and Astronomy, University of California Los Angeles, Los Angeles, California 90095, USA
[2]Tokamak Theory Division, Max-Planck-Institut für Plasmaphysik, Garching bei München, Bayern 85748, Deutschland
[3]Department of Applied Physics, Aalto University, Espoo, 00076, Finland

Abstract

A geometric approach is used to find the energy threshold for standard neoclassical ion orbit loss (SOL) in a realistic tokamak geometry, like that of ASDEX Upgrade. Furthermore, we maintain the effects of any existing radial electric field as it can non-trivially affect the calculations. The work is extended to find the minimum energies required for particle loss near the X-point (X-Loss). The analytically determined ion losses are compared to simulation results using the orbit following code ASCOT4. We find, the preferential loss of ions creates a radially dependent space-charge distribution, resulting in the generation of a radial electric field. The resultant back current introduces a rotation to the edge plasma, dependent on the ion losses. Both pitch-angle scattering, via collisions, and back-scattering into the plasma, via SOL as opposed to X-Loss, will be considered as possible contributions to the repopulation of the velocity-space loss hole. Furthermore, this model can be used to simulate the ion loss in a fluid code, such as GRILLIX. A self-consistent set of fluid equations will be developed to accurately integrate this effect. We hypothesize that coupling this effect into a fluid model will allow one to cheaply study the formation of an edge transport barrier and could lay the groundwork for simulating the L-H transition.