IMPLICATIONS OF TOPOLOGICAL COMPLEXITY AND HAMILTONIAN CHAOS IN THE EDGE MAGNETIC FIELD OF TOROIDAL FUSION PLASMAS

T. E. EVANS

General Atomics, P.O. Box 85608
San Diego, California 92186 USA

The edge region of magnetically confined toroidal fusion plasmas, such as those found in tokamaks and stellarators, is both dynamically active and topologically complex. The topological properties of the magnetic structures observed in the active edge region of high performance poloidally diverted plasmas are qualitatively consistent with those of a time varying web of intersecting homoclinic tangles defined by invariant manifolds of the primary separatrix of the system interacting with the invariant manifolds of resonant helical magnetic islands. Here, intersections of stable and unstable manifolds produce Hamiltonian chaos in the edge magnetic field that can strongly affect the transport and stability properties of the plasma. A quantitative description of the dynamics involved in these processes requires developing a better understanding of the plasma response to such complex topologies. A review of the recent experimental observations and progress on 3D fluid, kinetic and extended magnetohydrodynamic modeling of the edge plasma in tokamaks is given in this paper. These are related to the topological structure of the invariant manifolds and the chaotic structure of the field lines based on conservative dynamical system theory.