Manifold Tracing For Symplectic Maps Of Magnetic Field Lines

D. Ciro, I. L. Caldas

Institute of Physics, University of São Paulo, São Paulo, Brazil

Invariant manifolds of unstable closed magnetic field lines (periodic saddles), organize the dynamics of chaotic field lines in magnetically confined plasmas. They are fundamental to understanding the structure of the chaotic field lines and provide insight into the mechanisms of transport at the plasma edge. In some situations, the geometry of the manifolds can be estimated through the mapping of a large collection of orbits close to the periodic saddle. However, without an ordering scheme and refinement this method is computationally expensive and limited in resolution. Here, we apply a recently proposed approximation technique [1], based on an intuitive geometrical decomposition of the manifolds in bare and fine details, for tracing the invariant manifolds of the unstable periodic orbits of the Ullmann Map, a symplectic map describing large aspect-ratio tokamaks perturbed by a magnetic limiter. The manifold tangles obtained for remnant internal islands near the last closed magnetic surface explain the field line stickiness and escape channels to the tokamak wall [2].

References

1- Efficient manifold tracing for planar maps. D. Ciro, T. Evans, I. L. Caldas. arXiv:1710.10140 (2018).

2- Escape patterns of chaotic magnetic field lines in a tokamak with reversed magnetic shear and an ergodic limiter. T. Kroetz, M. Roberto, E. C. Silva, I. L. Caldas, R. L. Viana. Physics of Plasmas *15*, 092310 (2008).