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Delineating the magnetic field line escape pattern and stickiness in a poloidally diverted tokamak

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ABSTRACT

We analyze a Hamiltonian model with five wire loops that delineates magnetic surfaces of tokamaks with poloidal divertor. Non-axisymmetric magnetic perturbations are added by external coils, similar to the correction coils that have been installed or designed in present tokamaks. To show the influence of magnetic perturbations on the field line escape, we integrate numerically the field line differential equations and obtain the footprints and deposition patterns on the divertor plate. Moreover, we show that the homoclinic tangle describes the deposition patterns in the divertor plate, agreeing with results observed in sophisticated simulation codes. Additionally, we show that while chaotic lines escape to the divertor plates, some of them are trapped, for many toroidal turns, in complex structures around magnetic islands, embedded in the chaotic region, giving rise to stickiness evidences characteristic of chaotic Hamiltonian systems. Finally, we introduce a random collisional term to the field line mapping to investigate stickiness alterations due to particle collisions. Within this model, we conclude that, even reduced by collisions, the observed trapping still influences the field line transport. The results obtained for our numerical estimations indicate that the reported trapping may affect the transport in present tokamaks.

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