Homoclinic tangles, bifurcations and edge stochasticity in diverted tokamaks

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The boundary and pedestal region of a poloidally diverted tokamak is particularly susceptible to the onset of vacuum magnetic field stochasticity due to small non-axisymmetric resonant perturbations. Recent calculations of the separatrix topology in diverted tokamaks, when subjected to small magnetic perturbations, show the existence of complex invariant manifold structures known as homoclinic tangles. These structures appear above a relatively low perturbation threshold that depends on certain equilibrium shape parameters. Homoclinic tangles represent a splitting of the unperturbed separatrix into stable and unstable invariant manifolds associated with each X-point (hyperbolic point). The manifolds that make up homoclinic tangles set the boundaries that prescribe how stochastic field line trajectories are organized i.e., how field lines from the inner domain of the unperturbed separatrix mix and are transported to plasma facing surfaces such as divertor target plates and protruding baffle structures. Thus, the topology of these tangles determines which plasma facing components are most likely to interact with escaping magnetic field lines and the parallel heat and particle flux they carry.

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