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Onset of multiple transport barriers in tokamak configurations

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For certain discharge configurations in tokamaks, transport barriers reduce particle transport, thereby improving plasma confinement. In this context, a model has been applied to describe turbulent transport caused by drift waves at the plasma edge, attributing this transport to chaotic orbits originated from $\mathbf{E} \times \mathbf{B}$ drift. In the present work, we use this model to investigate the influence of the magnetic safety factor profile on the onset, maintenance, and destruction of these particle transport barriers. The model yields a set of Hamiltonian differential equations that describe the motion of the guiding center of a test particle at the plasma edge, which are integrated numerically. We analyze the global behavior of trajectories using Poincaré sections. Introducing a nonmonotonic safety factor profile leads to a deep modification of the phase space structure, resulting in the appearance of shearless curves, robust against electrostatic fluctuations; therefore, they act as a transport barrier in phase space preventing chaotic orbits from escaping. The results of this work indicate that multiple shearless transport barriers can emerge in such advanced plasma discharges, with the safety factor profile acting as a triggering mechanism for such barriers.

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