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Investigating the role of the edge radial electric field in the formation of shearless transport barriers in tokamaks

An $\mathbf{E} \times \mathbf{B}$ drift wave transport model was implemented to investigate chaotic transport at the edge of magnetised plasmas in tokamaks. We show that pronounced reversed-shear radial electric field profiles at the plasma edge can create shearless transport barriers (STBs) which confined most of the particle orbits inside the plasma. These barriers are related to the presence of extreme values of the rotation number profile and their behaviour enables us to identify confinement regimes for the chaotic transport as a function of the amplitude of the electrostatic fluctuations and the radial electric field intensity at the plasma edge. We found that, as the radial electric field increases, the STBs become more resistant to perturbations, enabling access to an improved confinement regime that prevents chaotic transport. In some way, strictly qualitative, we are seeing an L-H transition through the description of shearless transport barriers which, analogous to experimental results, exhibit better confinement regimes for larger radial electric fields at the plasma edge. In particular, the transition curve in the parameters plane associated with the STB has a fractal structure, thanks to the non-integrable nature of the associated Hamiltonian.

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