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Transport studies with magnetic islands in fusion plasmas

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This work describes the development and the first applications of a new tool to study transport phenomena in fusion devices when magnetic islands are present.
Whether as large islands or narrow chains, magnetic islands change drastically the topology of the transport problem and the consequent strong modification of transport has effects that depend on the configuration under examination. The conventional application of 1.5D transport codes need a monotonic coordinate, hence it cannot manage topologies with more than one magnetic axis. The broken nesting of magnetic surfaces demands a piecewise treatment where radial coordinates are defined in domains around their own magnetic axes. Furthermore island separatrices become shared boundaries that require careful treatment. As an example in the case of m=1 island (m being the poloidal mode number) the domains are: the core enclosed by the island, the island itself and the plasma external to the island.
This is called Multiple Domain scheme (MD): the MD scheme, which has been initially tested in a simple transport code, is included in the 1.5D code ASTRA. Here we present quantitative analysis of transport with magnetic islands in the following devices:
RFX-mod: We investigated the role of separatrix disappearance, which is expected to increase the topology resilience to the magnetic chaos, in the behaviour of thermal conductivity found in the transport barriers and in the plasma bulk. The metrics elements that enter in the energy transport equation are provided by the SHeq code
LHD: The metrics elements are obtained from Poincarè plots based on HINT2 calculations for a plasma with an externally imposed n/m=1/1 'large'island. The MD scheme is used to perform an interpretative analysis of the experimental temperature profiles.
TJ-II: We have used TJ-II data to concentrate on the important topic of radial electric field modifications when a small island chain is present. A pseudo-cylindrical approximation is used to define the discontinuities in the metric coefficients around the separatrix. The modification of the unperturbed non-axisymmetric fluxes in the island region is based on Shaing's formulation.

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