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A novel approach to the study of transport properties in plasma with magnetic islands

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The presence of magnetic islands in fusion plasmas modifies the topology of flux surfaces and impacts on the transport properties. Hence, to study transport phenomena in plasma with islands, 3D transport codes have to be applied. Such tools are powerful but also complex and time consuming. Conversely 1.5D transport codes (like ASTRA, CRONOS) are fast, user-friendly and well spread in the fusion community, but they are applicable only for nested flux surfaces.

In this work we present a new approach, compatible with 1.5D geometry, for modelling transport in presence of islands and its implementation in a numerical code dubbed Multiple Axis Solver (MAxS). The main idea is to divide the plasma in three regions, having the separatrix as common boundary. In each domain the metric elements are computed, considering the discontinuities on the separatrix. The transport equations for the kinetic quantities are, then, solved in each domain and the fluxes are matched at the common boundary. This scheme, being independent from the magnetic configuration, can be applied to Tokamaks, Stellarators and Reversed Field Pinches (RFPs).

Two examples are then reported. The first presents the study of cold pulse propagation in LHD plasmas featuring a large externally induced 1/1 island, where the thermal diffusivity results lower than in the background plasma. The second shows the MAxS application to RFP plasmas where a spontaneous m=1 island has a beneficial impact on the energy confinement, featuring temperature gradients of several keV/m.