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PhD PROPOSAL 2013

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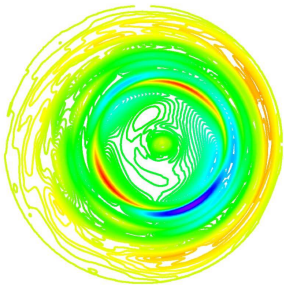
Title : Neoclassical Magneto-Hydro-Dynamics in Tokamaks

Summary :

The performance (fusion power) of tokamaks is limited by Magneto-Hydro-Dynamic instabilities (MHD) whose impact varies from local performance degradation (magnetic islands) to a complete loss of plasma control (global MHD). Magnetic islands are generated even in moderate performance plasmas, but in ITER they will be stabilized by the pressure gradient. However, the tokamak geometry generates intrinsic flows (called neoclassical), which can be a non linear drive for magnetic islands, as observed experimentally. This kind of mechanism is the main concern regarding magnetic islands on ITER. The analogy between an island and a counter-flowing current filament explains why the island size can be controlled by a localized current injection. This has been demonstrated experimentally, and this technique will be used in ITER.

The aim of the PhD is to study Neoclassical MHD and its control from a modelling point of view, using a non linear MHD code where the appropriate physical model has been implemented. This kind of issue has only been addressed using reduced models so far, and the use of a global code constitutes the novelty of the subject. Several issues of experimental interest will be addressed, in particular the role of neoclassical flows in island dynamics and in their triggering threshold (one speaks then of Neoclassical Tearing Mode or NTM), as well as the impact of the island on the flows (figure below). Analytical models will be developed for a better understanding of non linear computations. Preliminary work indicates that neoclassical forces have a destabilizing effect on magnetic islands, and the importance of such effect in Tore Supra and ITER plasmas shall be evaluated. The physics of NTM triggering will be addressed, as well as the saturation level. Finally, a localized current source will be implemented in order to study NTM stabilization in ITER. The computations will be performed on local as well as national computers, on the basis of realistic experimental situations.



Neoclassical flows in the presence of a magnetic island.

Skills : Plasma physics, computing, analytical theory