

**CEA/CADARACHE**

**DIRECTION DES SCIENCES DE LA MATIÈRE (DSM)**

**INSTITUT DE RECHERCHE SUR LA FUSION PAR CONFINEMENT MAGNETIQUE (IRFM)**

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**PhD PROPOSAL 2009**

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**Title :** Non linear Magneto-Hydro-Dynamic simulations for Fusion Plasmas

**Summary :**

In Magnetic Fusion Research, performances are limited by Magneto-Hydro-Dynamic instabilities that can lead to a loss of plasma control (hard limit, independent of plasma resistivity) or severely degrade the energy confinement (soft limit at lower performance due to finite resistivity). Magnetic islands due to resistive reconnection contribute to this soft limitation that prevents approaching the highest performance close to hard MHD limits. These islands are known to be sensitive to diamagnetic rotation (due to pressure gradient) of the electron population. The physics associated with this two-fluid effect (separation of electron and ion dynamics) has been widely studied with reduced MHD models, and is found to generate complex non-linear dynamics with different saturated states, depending on initial conditions. In high performance plasmas (such as in ITER or in a fusion reactor), magnetic islands are expected to be stabilized by pressure. However, a coupling between pressure and current make possible the existence of a metastable state: below a critical size, the island is stable, while it becomes unstable at larger size. The value of this critical size is of crucial importance for ITER and a fusion reactor.

The main objective of the PhD is to address two-fluid effects in a full MHD model, with realistic toroidal geometry, as implemented in the XTOR code (developed at Ecole Polytechnique). The work will consist of 3 parts. First, the model will be validated in the cylindrical limit, for which a reduced MHD model can be derived. Island dynamics will then be investigated on the basis of real plasma discharge cases (from Tore Supra and JET), in particular the possibility for the existence of a metastable small saturated island state. In a third part, the issue of metastable islands could also be addressed.

**Skills :** Knowledge in Plasma Physics, Computing