priority topic

CEA/CADARACHE
DIRECTION DES SCIENCES DE LA MATIÈRE (DSM)
INSTITUT DE RECHERCHE SUR LA FUSION PAR CONFINEMENT MAGNETIQUE (IRFM)
CEA/Cadarache - 13108 St Paul-lez-Durance Cedex - France

PhD PROPOSAL 2014

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Title : Energy transfer from the confinement zone to parallel transport during ELM relaxations.

Summary :

The physics basis for harnessing fusion power faces several challenges: it is usually admitted that a tokamak as e.g. ITER should operate in a so-called « High confinement » regime (H-mode) characterised by large currents and a large pressure gradient at the edge of the confined plasma. Our team has shown that such transport barriers are prone large relaxation events. An indeed there is an extensive experimental evidence of quasi-periodic large-scale instabilities known as Edge Localised Modes (ELMs) that transiently degrade the confinement. The impact of this cycling behavior is an issue for plasma-wall interaction and is addressed with considerable attention by the international community in support to ITER.

The degradation of confinement is visible through the prompt erosion of the edge plasma gradients and the onset of magnetic channels connecting the confined and open field line regions through which particles and heat may escape. The understanding of the mechanisms that drive this very effective channel between the two regions is the central goal of the proposed PhD work. In particular, the role of particle-particle collisions, which is backed by experimental scalings, should be better understood. The understanding of this complex nonlinear behavior, associating such aspects as chaos and front propagation is still far from complete. The physics basis of the experimental scalings that are presently considered crucially begs for a better understanding.

The modeling of the ELM instabilities is performed using a state-of-the-art in-house code named JOREK, based on the equations of reduced magnetohydrodynamics (MHD). This team work encompasses also many connections to other fields of plasma theoretical physics including astrophysics. The code runs on meso-scale supercomputers and typically uses 500 to 1,000 processors. The research project that is contemplated has both a theoretical (analytics & numerics) and an experimental background. Significant insight will be gained through a careful study of recent tokamak experiments at JET and ASDEX in the foreseen metallic environment of ITER. The tight connection between experimental and theoretical investigation will prove most efficient to guide novel diagnostics for the JOREK and the experimental data. Implementing required developments in JOREK will certainly be necessary. This work will also help in designing experiments in the coming WEST tokamak, currently being built at CEA, to determine the long time impact of ELM cycling on ITER grade wall elements.

Skills : Knowledge in statistical physics and interest for computational science. Some background in plasma physics will help but is not mandatory