# Multiscale methods for analyzing and computing fluid and plasma turbulence: Applications to magnetically confined plasmas in fusion devices.

The optimization of many industrial processes requires improved prediction and control capacities of fully developed turbulent flows. For their numerical simulation the developement of advanced numerical methods is essential. This aspect is particularly important in the case of magnetically confined plasmas encountered in tokamaks. The understanding of confinement properties necessitates a profound knowledge of turbulence and transport in plasmas, as the quality of the confinement determines the performance of the device.
Plasma turbulence shares numerous properties with fluid turbulence, especially that both involve a large number of spatial and temporal scales. Multiscale approaches are hence well suited to study turbulence in fluids and plasmas.
We propose to develop new adaptive numerical methods based on multiscale representations (e.g. wavelets) to model and compute different turbulent flows encountered in fluid mechanics and plasma physics, especially in tokamaks. Part of the program has already been realized in the context of fluid turbulence and we plan to extend it to plasma turbulence.

Plasma turbulence adds a level of specific complexity, especially in the case of tokamaks, like the toroidal geometry, the fast rotation of the plasma, the interaction of the plasma with the magnetic field and the resulting nonlinear collective effects, particularly in the scrape-off layer. The actual needs are twofold: the development and validation of efficient numerical methods to compute flows in tokamaks, in particular for ITER, and the development of analysis tools, which will be applied to experimantal data measured in the tokamak Tore-Supra (CEA, Cadarache) and also to results obtained by numerical simulation. The obtained results will guide the development of new numerical methods to study the interface between regions near the edge and the center of the plasma, where fundamental physics plays an important role for ITER and which is currently difficult to simulate numerically with standard methods.

The project integrates perfectly in the framework of the arrival of ITER at Cadarache (France) and has the objective to develop collectively new numerical methods for data analysis and numerical simulation. Another goal is to contribute to the training of students and young researchers in the field of fluid mechanics, physics of plasmas and numerical methods, adapted to study these problems encountered in tokamaks.