Phd position at Aix-Marseille University

Title: Development of a reduced turbulent tran sport model for the simulation of a full discharge in ITER.

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Laboratory : M2P2

Key words : magnetic fusion – numerical modelling and simulation- turbulence - ITER

Research project : Fusion based on magnetic confinement aims at producing power by using the energy liberated by fusing deuterium and tritium nuclei at extremely high temperatures (10^7-10^8K), within a plasma confined by magnetic fields in machines of toroidal shape known as tokamaks. ITER (https://www.iter.org/), which was designed as the key experimental step between today's research machines and tomorrow's fusion power plants, is certainly among the most ambitious technological and scientific challenges that humanity has set itself in recent years. The success of ITER will require reliable and efficient numerical tools based on low-fidelity models to operate with optimal conditions.

This Phd project deals with the improvement of the turbulence modelling related to the transport of heat and particles in the perpendicular direction to magnetic flux surfaces and based in current state-of-the-art transport codes on the evolution of averaged quantities assuming transverse turbulent fluxes are governed by Fick's law with a constant diffusion coefficient. We will work on the development and implementation of a new model online with the recent work of the team (Baschetti et al. NF 2021) inspired from RANS in CFD, and based on the estimation the plasma turbulent kinetic energy and its dissipation rate, respectively. The suite of code SOLEDGE3X-HDG we will be used to analyze the impact of such modelling on transport properties in ITER relevant conditions. We will in particular analyze its ability to deal with transient regime and nonlocal behavior in the transport through turbulence spreading as expected from experimental measurements in tokamak. In addition, data assimilation will be investigated to reduce uncertainties on the free parameters of the model.
M2P2 associates skills in computational fluid mechanics, applied mathematics and plasma physics, and hosts the last generation of french edge plasma codes in connexion with IRFM-CEA. This latter operates the tokamak WEST in support to future ITER experiments located 80km north from Marseille.

Academic background : The candidate will be sought with solid competences in numerical modelling and coding. A background in plasma physics and/or fluid turbulence will be welcome.

Publications :

- Auroux, *et al*. Asymptotic behaviour, non-local dynamics and data assimilation tailoring of the reduced κ − ε model to address turbulent transport of fusion plasmas. Physics of Plasma, 2022
- Scotto, *et al.* Core-edge 2D fluid modeling of full tokamak discharge with varying magnetic equilibrium: from WEST start-up to ramp-down. Nucl. Fus., 2022
- Baschetti, et al. Self-consistent cross-field transport model for core and edge plasma transport. Nucl. Fus. 2021.