**2018-00471 - [PostDocPLFRatres-CASTOR] : Coupling Equilibrium and transport for Tokamak simulations.**

**Contract type:** Public service fixed-term contract  
**Level of qualifications required:** PhD or equivalent  
**Fonction:** Post-Doctoral Research Visit  
**Level of experience:** Recently graduated

### About the research centre or Inria department

The Inria Sophia Antipolis - Méditerranée center counts 37 research teams and 9 support departments. The center's staff (about 600 people including 400 Inria employees) is composed of scientists of different nationalities (250 foreigners of 50 nationalities), engineers, technicians and administrators. 1/3 of the staff are civil servants, the others are contractual. The majority of the research teams at the center are located in Sophia Antipolis and Nice in the Alpes-Maritimes. Six teams are based in Montpellier and a team is hosted by the computer science department of the University of Bologna in Italy. The Center is a member of the University and Institution Community (ComUE) “Université Côte d’Azur (UCA)”.

### Context

**Societal context:** The need to develop alternative energy sources to the current use of fossil fuel is of increasing importance. Indeed, the current rate of fossil fuel usage and its serious adverse environmental impacts (pollution, greenhouse gas emissions, ...) lead to an energy crisis accompanied by potentially disastrous global climate changes. Controlled fusion power is one of the most promising alternatives to the use of fossil resources, potentially with an unlimited source of fuel. One of the most successful concept for mastering fusion is magnetic confinement where an extremely hot ionized gas called a plasma is confined in a toroidal chamber thanks to a very strong magnetic field. This concept is studied in experimental devices called Tokamaks (A russian acronym for toroidal chamber). One of these machines called ITER (for International Thermonuclear Experimental Reactor : https://www.iter.org/fr/org/io) is currently being build in Cadarache (France) thanks to an international agreement involving 35 different countries. The physics of the plasma in a tokamak is extremely complex and its understanding requires a strong interaction between experiments, modeling and large scale numerical simulations.

**Collaboration:** This post-doc proposal requires strong interactions with the physicist teams in charge of the tokamak design and use. This may require frequent visits to the site of ITER in Cadarache.

### Assignment

**Description of the post-doctoral work:** In a tokamak at the slow resistive time scale, the magento-hydrodynamics equations (MHD) is composed of a set of unsteady convection-diffusion equations for the plasma density and temperature and poloidal flux (transport step) while the momentum equation reduces to an equilibrium between the plasma pressure and the magnetic forces (equilibrium step). The coupling between equilibrium and transport is today address by coupling the 2D equilibrium step with the 2D dependent variables of the equilibrium step (here the magnetic poloidal flux) becomes the independent variable of the 1D transport step obtained by averaging the variables along the magnetic flux lines. This leads to an highly non-standard set of partial differential equations where the 2D dependent variables of the equilibrium step is of the type of PDE. For this, it is proposed to extend some recent results on Asymptotic Preserving discretizations. Moreover, it will be necessary to show that this approach is able to recover the results of the 2D-1D coupling approach when this one is successful.
Main activities
Develop a mathematical model describing coupling between Equilibrium and transport in a tokamak.
Develop a consistent discretization for this model.
Participation to Conference and Workshop.
Integrate the developed code into larger software platforms written in C++, Fortran, Python or Matlab.

Skills
Knowledge in Computational Fluid dynamics and/or Plasma physics
Good programming skills in Python/Fortran/C or C++

Benefits package
- Subsidised catering service
- Partially-reimbursed public transport
- Social security
- Paid leave
- Flexible working hours
- Sports facilities

Remuneration
Gross Salary: 2650 brutto per month