

Proposta di tesi magistrale

Thesis level: Master

Corso di Laurea: Physics

Thesis type: Plasma modeling/numerical (to be carried out by internship at CEA- Cadarache)

Title: Simulating edge plasma turbulence for ITER: Improving the numerical resolution of a very anisotropic, poorly conditioned diffusion problem

Thesis description:

To predict heat deposition on plasma-facing components of current tokamaks and future reactors, a major effort is being made to develop codes capable of modelling turbulence in the edge plasma. Many mathematical and numerical problems remain to be overcome in order to be able to simulate plasma in a machine the size of ITER. In particular, calculating the electric potential requires the inversion of a 3D anisotropic Laplacian. The anisotropy is very strong with diffusivity in the direction parallel to the magnetic field several million times greater than diffusivity in the transverse directions. In addition, the boundary condition of Robin type almost degenerated in Neumann conditions ($\nabla\Phi + \varepsilon\Phi = A$ with $\varepsilon \ll 1$ a small parameter) makes the problem difficult to invert because very poorly conditioned. Various linear solvers are used to solve the problem: direct solvers which work well but which do not make it possible to go up in resolution, the computation time being quickly prohibitive and the parallelization inefficient; iterative solvers, the most promising of which currently use an algebraic-multigrid type preconditioner. The subject of the internship will consist in seeking solutions to accelerate the resolution of the Laplacian by mainly following two tracks: building an adapted pre-conditioner by possibly reformulating the problem (play on the geometry, "physical" aggregation of the unknowns of the problem); test the libraries "on the shelf" to solve the problem by looking for a good parallelization of the computation (ex: implementation of multigrid algebraic solver on GPU [AMGX Nvidia]). The internship subject may continue into a PhD thesis.

RFX tutor:

P. Innocente

CEA Internal tutors:

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Submission date:

December the 08th, 2020

Status:

not assigned