

**Gyrokinetic global full- f flux-driven simulations
based on semi-Lagrangian method
- GYSELA code -**

V. Grandgirard

Association Euratom-CEA, CEA/DSM/IRFM Cadarache, France

Abstract

Predicting the performance of fusion plasmas in terms of amplification factor, namely the ratio of the fusion power over the injected power, is among the key challenges in fusion plasma physics. In this perspective, turbulence and heat transport need being modeled within the most accurate theoretical framework, using first-principle non-linear simulation tools. The gyrokinetic equation for each species, coupled to Maxwell's equations are an appropriate self-consistent description of this problem. A new class of global full- f codes has recently emerged, solving the gyrokinetic equation for the entire distribution function on a large radial domain of the tokamak and using some prescribed external heat source [1]. Such simulations are extremely challenging and require state-of-the-art high performance computing (HPC).

The non-linear global full- f gyrokinetic 5D code GYSELA , which focuses on the electrostatic toroidal branch of the Ion Temperature Gradient driven turbulence with adiabatic electrons, is one of them [2]. One of its particularity is to solve the self-consistent problem on a fixed grid with a Backward Semi-Lagrangian scheme [3]. The advantages and drawback of such a scheme will be discussed and more precisely : (i) the different numerical locks which have been recently removed to obtain a relative efficiency of 61% on 65k cores ; (ii) and the high level of accuracy which has been obtained for the force balance equation and the toroidal momentum conservation equations [4].

[1] Garbet X, Idomura Y, Villard L and Watanabe T H, *Gyrokinetic simulations of turbulent transport*, Nucl. Fusion 50, 043002, 2010.

[2] Sarazin Y et al., *Predictions on Heat Transport and Plasma Rotation from Global Gyrokinetic Simulations*, Nuclear Fusion, 2011.

[3] Grandgirard V. et al., *A drift-kinetic Semi-Lagrangian 4D code for ion turbulence simulation*; Journal of Comp. Physics, 217, 2006.

[4] Abiteboul J et al., *Conservation equations and calculation of mean flows in gyrokinetics*, accepted in PoP 2011.