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Development of a Grid-Based Gyro-Kinetic Simulation Code XAVIER LAPILLONNE, MAURA BRUNETTI, TRACH-MINH TRAN, STEPHAN BRUNNER, CRPP - EPFL — A grid-based semi-Lagrangian code using cubic spline interpolation is being developed at CRPP, for solving the electrostatic drift-kinetic equations [M. Brunetti *et. al*, Comp. Phys. Comm. **163**, 1 (2004)] in a cylindrical system. This 4-dim code, CYGNE, is part of a project with long term aim of studying microturbulence in toroidal fusion devices, in the more general frame of gyro-kinetic equations. Towards their non-linear phase, the simulations from this code are subject to significant overshoot problems, reflected by the development of negative value regions of the distribution function, which leads to bad energy conservation. This has motivated the study of alternative schemes. On the one hand, new time integration algorithms are considered in the semi-Lagrangian frame. On the other hand, fully Eulerian schemes, which separate time and space discretisation (method of lines), are investigated. In particular, the Essentially Non Oscillatory (ENO) approach, constructed so as to minimize the overshoot problem, has been considered. All these methods have first been tested in the simpler case of the 2-dim guiding-center model for the Kelvin-Helmholtz instability, which enables to address the specific issue of the $\mathbf{E} \times \mathbf{B}$ drift also met in the more complex gyrokinetic-type equations. Based on these preliminary studies, the most promising methods are being implemented and tested in CYGNE.

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