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Large-magnetic field regimes and asymptotic preserving schemes for plasmas in a torus configuration

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Even in highly-oscillating dynamics may persist quantities that are evolving on slower scales and, at first-order, uncouple from fast oscillations. Thus asymptotically the slow dynamics obeys a closed system of uncoupled equations, which may be thought as averaged equations.

That is typically the case for plasmas subject to strong magnetic fields. In this case, the task of identifying a slow uncoupled dynamics is known as gyrokinetics. In the present talk, we shall review some contributions (mostly obtained jointly with Francis Filbet (Toulouse)), that fill some of the gaps of the analytic theory and design numerical schemes that capture accurately the slow part of the dynamics even when discretization meshes are too coarse to describe coexisting fast oscillations.

The emphasis will be on the case where the plasma is in a torus configuration, a toy-model for applications to tokamak fusion devices, and the class of numerical schemes introduced fits in the range of particle-in-cell schemes, with particle-pushers of implicit-explicit type, but are applied to a suitably augmented formulation.

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