Edge gyrokinetic theory

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September 2, 2019

Nonlinear phenomena are ubiquitous in fusion plasmas. They are especially important for understanding the transition towards the high confinement regime, which takes place in the outer *edge* region of the fusion device. In this region due to the strong nonlinearity, a transport barrier is created leading to confinement improvement. This nonlinearity is caused by the interactions between small and large scales requiring nonlinear kinetic turbulence simulations. Perhaps the direct simulations of the Maxwell-Vlasov equations would be a perfect tool for plasma behaviour prediction; they still are unaffordable for nowadays supercomputers [1]. Therefore, the derivation and simulations of reduced kinetic models are required.

When the magnetic field is strong, it is natural to replace particles by their instantaneous centres of rotation around the magnetic field lines and therefore remove the fastest scale of rotation from the description of dynamics. It grounds the idea of the reduced kinetic (*gyrokinetic*) formalism. A multi-scaled Hamiltonian reduction procedure lies behind the construction of gyrokinetic dynamical reduction [2], [3].

It has been proved that the gyrokinetic models accurately predict violent, turbulent transport in the core region of a tokamak [4],[5]. However, understanding of processes in the *edge* of fusion devices, still be lacking. Several groups undertake the gyrokinetic simulations of the edge region across the world, i.e. [6],[7],[8]. However, the ordering used for the derivation of the core gyrokinetic models cannot be used for accurate modelling of the edge region. Indeed, concerning the core region, the simulations for the edge should include electromagnetic effects and be fully non-linear. There exist no gyrokinetic code nowadays, which possesses a model with these properties.

This talk will provide a pedagogical presentation of the principles of a unified theoretical framework for gyrokinetic models derivation suitable for code implementation.

References

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