Impact of SOL-like boundary on flux driven gyrokinetic simulations

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Quantifying the impact on the overall confinement of the interplay between the edge – and possibly the core – and the scrape-off layer (SOL) is among the most critical issues. This interaction is suspected to play a prominent role in two main critical issues for ITER: (i) the characteristic e-folding length of the heat flux profile in the SOL, which governs the power load on the divertor targets, and (ii) the power threshold of the L- to H-mode transition. The recent attempts to address this issue within the gyrokinetic framework reveal how challenging the task is.

First, the present presentation briefly reviews the critical physical challenges – and their numerical implications – of flux-driven gyrokinetic simulations from the core to the SOL of fusion plasmas. Special emphasis is put on the various sources of radial electric field, and their specificity in the edge-SOL region.

Second, recent advances in this direction are highlighted, by means of flux driven gyrokinetic simulations with the GYSELA code. Using the penalization technique as an immersed boundary condition, a toroidally symmetric limiter has been recently implemented in GYSELA to account for some of the SOL physics. For these simulations, the electron response is kept adiabatic. The ion temperature is forced to a low value in the limiter domain, while the flux-surface averaged potential is forced to scale like the electron temperature, according to the physics of plasma-wall interaction (Bohm's criterion). This boundary is compared to the one where the distribution function is forced, via a Krook term, to relax towards a poloidally homogeneous Maxwellian with e-folding density and temperature profiles characteristic of the SOL region. Importantly enough, the relative magnitude of density fluctuations exhibits an increase towards the separatrix in the limiter case only, in echo to experimental observations. An in depth analysis of the physical mechanisms at play will be presented.