SOL-KiT – a new fully implicit code for kinetic modelling of electron transport in the Scrape-Off Layer

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The problem of electron transport along the open field lines in the Scrape-Off Layer(SOL) of the tokamak has been of interest in predicting heat flow onto plasma-facing components of the reactor, namely the divertor. Currently, fluid codes used to treat the SOL mainly use some form of the Braginskii transport equations, assuming either local Spitzer-Härm heat flow, or using a flux limiter[1]. This assumption cannot capture non-local effects due to steep temperature gradients in the upstream region of the SOL (e.g. during ELMs), which can significantly change the heat flow, and has been identified as a possible deficiency of the fluid approach to SOL modelling[2].

Previous approaches to kinetic modelling of the SOL have mostly been focused on solving the full Vlasov-Fokker-Planck equation, sometimes coupled with neutral physics[3,4]. We take a slightly different approach, using a spherical harmonic decomposition of the electron distribution function – a method widely used in laser plasmas[5,6] (with some success in SOL modelling[7]). This allows for an integrated treatment of both the almost collisionless upstream region, as well as the highly collisional divertor region of the SOL. We couple this approach for the plasma with a Boltzmann collision approach for inelastic electron collisions with atomic hydrogen and follow the atomic state distribution of hydrogen with a simple collisional-radiative model.

To solve the Vlasov-Fokker-Planck-Boltzmann system, we use the newly developed fully implicit code SOL-KiT, and will present the model behind the code, as well as both individual and integrated benchmarking of various model features.

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