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Global fluid simulations of bounded magnetized plasma

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The understanding of fundamental transport processes in the edge and scrape off layer region of magnetized fusion devices is, even after many years of research, still not advanced enough to allow reliable predictions of heat and power loads on the plasma facing components. Basic understanding of Edge/SOL transport phenomena such as the LH transition, ELMs, blobs is missing. One reason for this lack of understanding is the immense complexity of this plasma region, where nonlinear effects leading to a wide range of active spatial and temporal scales and resulting in complex self organized structures finally meet with the world of chemistry and atomic physics.

Here we investigate the usefulness of global simulations of a two fluid model in a cylindrical magnetized geometry for a number of issues that are of interest. In particular the formation of blobs, the impact of turbulence on the observed fluxes at the sheath entry, as well as the general balance between parallel and perpendicular transport will be considered. The relation between upstream fluctuations and fluxes at the sheath entry is dependent on the statistics of the upstream turbulence, and thus evades capture by simple steady state models.

In the presence of sheared poloidal flows the residual stresses and their impact on momentum transport are investigated, showing the importance of residual stresses for parallel momentum transport.

In addition to the possibility of analyzing the interaction of turbulence with the background, which is in practice an entity neither existing separated from the fluctuations nor to be easily defined as steady state, a manifold of experimental devices allow comparing theoretical and numerical results with the real world in detail. This can be used to qualify the code development for the more complex task of providing insight into the tokamak SOL dynamics, where the transition from 2D turbulence or transport codes to a fully 3D description provides to be extremely useful.