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Turbulence simulations of the narrow heat flux feature in inner-wall limited tokamaks[1]

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A recent multi-machine experimental campaign initiated by the ITER Organization concluded that inner-wall limited (IWL) plasmas have a near scrape-off layer (SOL) heat-flux decay length of a few mm's, while the far SOL can have a width of several cm's. The ITER inner-wall design was revised last year in order to accommodate for the effects of this narrow feature. In the present talk, we address the physics behind the development of the narrow heat-flux feature in the near SOL of IWL discharges. Our investigations are aided by 3D flux-driven simulations of the SOL plasma dynamics carried out with GBS, a rigorously verified and validated turbulence code based on the drift-reduced Braginskii equations. Indeed, GBS simulations of IWL plasmas reveal the presence of steep gradients just outside the last closed flux surface. The analysis of the simulation results points out a clear distinction between the near SOL, where transport is diffusive, and the far SOL, where transport is convective and the fluctuation PDFs are skewed. In particular, we find that SOL plasma profile formation is strongly influenced by radially-sheared poloidal ExB flows. Non-local analysis of the linear mode structure reveals that the sheared flows modify the "meso-scale" correlation length, which in turn mitigates transport in the near SOL. A simplified transport equation using the new correlation length yields gyroBohm-like transport in the near SOL, leading to a two decay-length profile structure similar to what is observed in experiments.

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