

Impact of turbulence spreading on Scrape-Off Layer width in HL-2A Ohmic plasma

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In this study, we have studied the impact of turbulence spreading on the SOL width. Detailed studies have been performed on the outer limited HL-2A plasma^[1-2]. It has been found that the SOL width λ_q is usually at least twice that of the neoclassical HD modal prediction (λ_{HD}). An exception is for the case of stronger LCFS shear, then $\lambda_q \geq \lambda_{HD}$. The measurements show that λ_q correlates with edge fluctuation intensity and turbulent transport. Significantly, mostly outward spreading is measured at the LCFS. Here 'spreading' refers to the radial flux of turbulent internal energy $C_S^2 \langle \tilde{V}_r (\tilde{n}_e / n_e)^2 \rangle$. The production ratio R_a is identified and calculated from experimental data. Here $R_a = \frac{\text{spreading influx to SOL}}{\text{integrated local production in SOL}}$. R_a characterizes the nature of the drive of SOL turbulence. The results are shown in figure 1. In most cases, $R_a > 1$, so spreading regulates SOL dynamics. Cases of small R_a correspond to those of stronger $\mathbf{E} \times \mathbf{B}$ shear at the separatrix. Spreading is thus seen as more sensitive to the $\mathbf{E} \times \mathbf{B}$ shear than are the particle flux and local production in SOL. Cases of large R_a , and stronger spreading, correspond to those where the turbulence has a significant 'blob' component. Blob content is deduced by conditional average.

Overall, these results indicate that

turbulence spreading from edge to SOL is a key element - indeed even a dominant dynamics - in the SOL width. The paper shows that the SOL is a new type of boundary layer - one with dual heat flux and spreading drive. The understanding of the SOL and SOL width must address this key point. The record is the critical physics insight necessary for understanding the power exhaust channels of a tokamak.

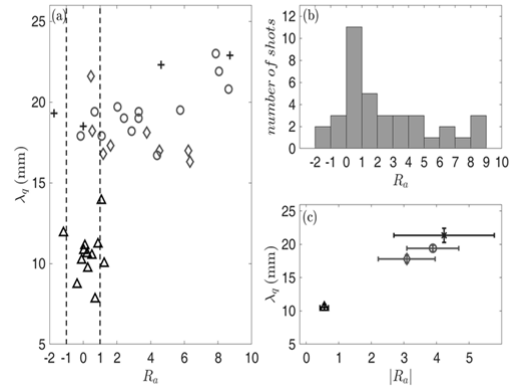


Figure 1. The plot of SOL width vs the ratio (R_a) of turbulence spreading at the LCFS to local interchange production; (b) the histogram of R_a and (c) the average SOL width plotted vs absolute ratio ($|R_a|$).

References

- [1] P. H. Diamond et al, APS 2021
- [2] T. Wu, PhD thesis 'Mechanism study of turbulent transport influencing the scrape-off layer width on HL-2A tokamak' 2022