Correlation of the near SOL transport with plasma properties of the confined edge region in ASDEX Upgrade

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Improvements to the Thomson Scattering edge system have enabled, for the first time in ASDEX Upgrade, the study of upstream SOL electron density (n_e) and temperature (T_e) profiles and thermal transport over a wide set of plasma parameters and regimes, which include H-, L-, and I- mode, as well as the high density limit (HDL). Results show that parallel transport in the near SOL region is always dominated by Spitzer-Harm conduction in both L-and H-mode, consistent with SOLPS modelling. The near SOL n_e and T_e profiles are found to be closely coupled across different plasma regimes and divertor conditions, with gradient ratio $1 \leq \eta_e \leq 2$. A study of H-L back transitions show that there is a bifurcation between H- and L-mode plasmas in near SOL perpendicular transport, at the same global parameters and heating power. An expression for the perpendicular thermal diffusivity, $\chi_\perp = c_{L,H}^{\chi} n_e^{-1} T_e^{3/2}$ with $c_H^{\chi}/c_L^{\chi} \approx 0.5$, is derived from the wider database. Also the transition from L-mode to I-mode shows a change in perpendicular thermal transport.

For H-mode plasmas under attached conditions, steep pedestal gradients and higher pedestal top values of both T_e and p_e, which are beneficial for plasma performance, appear to correlate with narrower SOLs, which are unfavourable for plasma exhaust. However, the same trend is not observed for fixed plasma current. Here, the pedestal T_e gradients can vary by a factor of 2 while the SOL T_e decay lengths do not change. This suggests that the pedestal-SOL correlation is a consequence of the pedestal and the SOL regions being influenced differently by the same global parameters rather than a direct dependence of one on the other. This offers the prospect of optimising the two regions separately. A good example is the increase of the pedestal top pressure by N seeding while no influence on the SOL T_e decay lengths is observed.

Across the database of H-mode plasmas, the SOL MHD ballooning parameter, α_{sep}, increases almost linearly with separatrix density for α_{sep} <2, consistent with JET results. After α_{sep} reaches 2-2.5, it doesn't vary with density which is consistent with the theoretically predicted onset of ballooning modes. A confinement degradation caused by these modes may be the mechanism for the HDL.