Relation between upstream SOL widths and divertor heat flux width in NSTX H-mode plasmas

J-W. Ahn[1], J. A. Boedo[1], R. Maingi[2], V. Soukhanovskii[3], and the NSTX Team

[1]University of California – San Diego, San Diego, CA 92093, USA
[2]Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA
[3]Lawrence Livermore National Laboratory, Livermore, CA 94551, USA

The upstream plasma parameter profiles and the heat flux profile at the divertor target were measured simultaneously by a mid-plane reciprocating probe and an IR camera, respectively, for the quiescent H-mode plasmas with Type-V ELMs (P_{NBI}=1MW, $\overline{n_e}$ =4×10^{19}m^{-3}) in the National Spherical Torus Experiment (NSTX). The SOL plasma is strongly collisional near the separatrix and becomes rapidly collisionless as the density drops toward the vessel wall. It thus enters the sheath-limited regime from the conduction-limited regime at ~3cm past the separatrix within the SOL. The near SOL temperature and heat flux widths (λ_{Te} and λ_q, respectively) were fit to a simple exponential function and the ratio, λ_{Te}/λ_q, was found close (within 30%) to the theoretically expected value, λ_{Te}/λ_q=7/2 , which is based on the dominant parallel electron conduction.

On the other hand, the far SOL widths do not follow classical relation neither for the conduction-limited nor the sheath-limited regime, with λ_q a factor of 3-4 longer than classical expectations. The anomalously high level of perpendicular transport in the far SOL may be an important contribution to the long tail of the profile in this region. We included this effect in the profile fitting equation, by approximating it as an offset value in the exponential function, and by using it to solve the parallel electron conduction equation. This reduces the conventionally expected ratio between λ_{Te} and λ_q, by an additional factor, *ie* $\frac{\lambda_{Te}}{\lambda_q} = \frac{7}{2}\left(\frac{T_e - T_{e0}}{T_e - Cq_0 T_e^{-5/2}}\right)$, for the near SOL, where T_{e0} and q_0 denote the offset value of the profiles and C is a constant. The observed ratio (λ_{Te}/λ_q ~1.8) agrees with the predicted ratio (~2.2) within 20%, with the use of the additional factor. This observation stresses that the near SOL transport is dominated by parallel electron conduction.

The relation between upstream SOL widths and the target heat flux width in a range of plasma parameters will be presented. Work is under way to identify dominant heat transport processes more clearly to determine the relation between the SOL widths in both near and far SOL regions. The implication of far SOL heat deposition due to the anomalous perpendicular heat transport will be also investigated.

This work was supported by the US Department of Energy, contract numbers DE-FG02-03ER54731, DE-AC02-76CH03073, DE-AC05-00OR22725, and W-7405-ENG-48.