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Conductive and convective transport in the Scrape-Off layer of JT-60U

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Control of heat load onto divertor target is one of critical issues in fusion devices. To predict the heat load, understanding of physical mechanism of the heat transport in Scrape-Off Layer (SOL) is important. The heat flux parallel to the magnetic field in SOL is transported by conduction and convection [1]; in low density SOL plasma, conductive transport dominates while in high density convective transport (heat transport by plasma particles) dominates [2,3]. However, density dependence of the radial distribution of the conductive and the convective transport contribution, in particular in high density detached plasmas, is not yet understand quantitatively.

In this study, the parallel heat flux by the conductive and convective transport contribution in the SOL plasma is evaluated with high radial resolution based on measurements by reciprocating Mach probes at the outer midplane and near the X-point in L-mode plasmas with a line-averaged density ($\bar{n}_e$) range 1.1×10^{19} m^{-3} and 3.9×10^{19} m^{-3}, a plasma current I_p of 1.4 MA, a toroidal field B_t of 3.2 T, and NBI heating power P_{NBI} of 4.5 MW. Figure 1 shows the parallel heat flux distribution together with conductive and convective contributions at $\bar{n}_e$ of 1.7×10^{19} m^{-3}(Greenwald density fraction n_e/n_{GW} of 0.32). The conductive term exceeds the convective term around the separatrix. In contrast, in the distance range larger than 7 mm from the separatrix, the convective contribution is larger than the conductive. The same analysis for the other densities indicates that the conductive heat flux decreases with increasing $\bar{n}_e$ and that the convective heat flux increases and exceeds the conductive heat flux in the whole radial range, including the range near the separatrix. This trend of gradual change from conduction- to convection-dominated transport is consistent with previous studies [2,3]. In addition, density dependence of the heat transport in the SOL plasma will be discussed together with target heat flux and radiation losses.

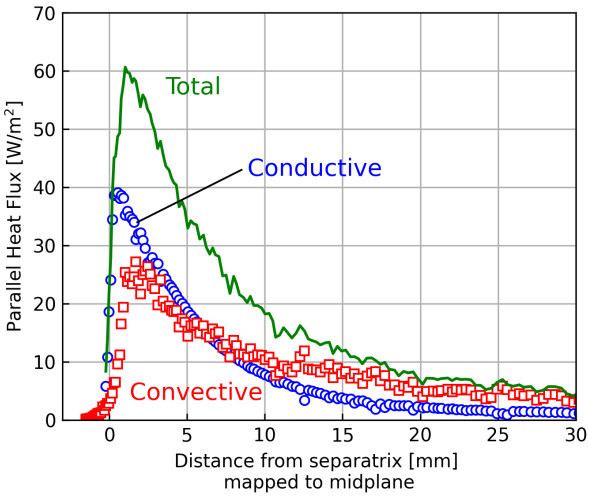

Figure 1. Parallel heat flux distribution below the X-point. The blue circles and red squares indicate conductive and convective heat flux respectively. The green line is the sum of the conductive and convective heat fluxes.

References

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