Dissipation of the exhaust power entering into the tokamak scrape-off layer (SOL) is one of the key challenges for divertor operation in ITER and DEMO. Of particular concern are strongly peaked or asymmetrically distributed power loads on the low- and high-field-side target plates. This contribution analyses the role of cross-field drifts in modifying the divertor power load distribution, based on recent experiments and modelling of the ASDEX Upgrade tokamak.

The composition of divertor power fluxes has been analysed in 2D SOLPS5.0 fluid plasma simulations, using for the first time a combination of fully activated drift terms, kinetic neutrals and seeded impurities, in comparison to Langmuir probe and spectroscopic measurements at the targets and at the divertor entrance. The approach was tailored for distinguishing between the effects of main SOL and divertor drifts, in comparison to the divertor power dissipation by neutrals and impurities at varying collisionality. For experimental characterization, a series of lower-single-null L-mode discharges in both forward (ion $\nabla B$ drift downwards) and reversed magnetic field configuration has been performed, controlling the divertor power dissipation by the level of plasma fuelling and, in forward field, by seeding $N$ impurities.

The toroidal geometry alone tends to introduce outboard-favouring power flux asymmetries at the divertor entrance, which can be amplified in the divertor volume by neutral-plasma interactions. The ASDEX Upgrade experiments at low main plasma densities (Greenwald fractions $f_{GW} = 23\text{–}38\%$) demonstrate a further sensitivity of the peak target power flux to the magnetic field direction, with much stronger in/out asymmetry in forward field (1/10) compared to reversed field (1/2). The modelling shows that ExB drifts arise from temperature gradients in the divertor and modify the distribution of impurity radiation and power load in good agreement with the experiments. In both field directions, the measured divertor detachment and consequent power load reduction begins in the inner divertor ($f_{GW} = 25\text{–}50\%$), which is suggested to be due to outboard-favouring power flux profile at the divertor entrance. An enhanced density asymmetry due to the divertor ExB drifts facilitates detachment at low $f_{GW}$ in forward field.

The work was carried out under an EFDA fellowship and supported by the EFDA PPP&T department.