Implications of Filamentary Transport in the Divertor for Exhaust Design

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Studies of filamentary transport in the divertor of MAST using high-speed imaging of D\textsubscript{a} light have improved our understanding of particle transport in the scrape-off layer (SOL) and private flux region (PFR). Filaments appear in three regions in the divertor, 1) in the PFR, 2) in the SOL close to the equilibrium separatrix and 3) deeper into the SOL away from the separatrix in both L-mode and H-mode. The size, velocity and lifetime of these filaments are found to vary significantly from one region to the other, suggesting distinct filamentary transport mechanisms. The lifetime of filaments in region 3 is $<8\mu$s in region 2, and $\sim100\mu$s in regions 1 and 3, comparable with the parallel ion transport time. Preliminary 2D simulations of the filaments in region 1) have been modelled with the BOUT++ code, and have been able to qualitatively reproduce their appearance and propagation.

An experimental characterization of the filaments in the private flux region will be summarised alongside a comparison of the filaments in the divertor with the decay lengths of ion saturation current profiles in the PFR inferred from Langmuir probes. It was found that the filaments in the PFR appear brightest on the inner leg, thought to be due to the higher neutral density in this region, and move poloidally toward the inner target. Furthermore, the characteristics (size, velocity and lifetime) of the two categories of filaments in the SOL (regions 2 and 3) will be presented and compared with the radial decay length of the ion flux to the divertor to estimate the role of these filaments in establishing the shape of the profiles.

These findings will be used to suggest experiments where filamentary transport in the divertor can be modified through changes to the magnetic geometry of the divertor leg, thereby changing the alignment of the radial pressure gradient and the field line curvature. The aim of these experiments would be to broaden the SOL by increasing cross-field transport, which could be a consideration in the design of the divertor for DEMO.

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