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Scrape Off Layer and Divertor Physics Advances in MAST

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We review the recent MAST exhaust programme which focused on the interplay between Scrape Off Layer (SOL) profiles and filaments, and on the physics of advanced divertors. MAST experiments demonstrated that the broadening of the SOL density profiles observed at high fuelling can occur in the absence of detachment and independently from ionisation sources and that it is reduced at high Ip. At the midplane, Ball-pen and Retarding Field (RF) probes showed that Er is sheared, peaks at ˜1kV/m and increases with Ip and that Ti˜2-4 Te. A new binning technique of the High Resolution Thomson Scattering data showed that near SOL decay lengths decrease with Ip and increase with fuelling and that are well correlated with light emission, suggesting a role for the neutral particles in setting the profiles. A database of double null inter-ELM target heat flux profiles was generated and their fall off length was extracted. The best scaling found utilizes the Ip and PSOL but the quality of fit suggests that additional parameters might be required. Infrared thermography showed that L-mode filaments can account for the full target heat flux, and the RF probe that they carry significant ion energy to large distances. Fast visible imaging showed that their radial size (˜2cm) and velocity (˜1km/s) decrease as Ip increases. Measurements of individual blobs were compared to 3D simulations carried out with STORM to validate the code. An analytic model was developed to assess the effect of the observed ellipticity of the filaments. The effect of low divertor temperature, as expected when detached, was simulated by increasing the resistivity at the target, finding that blobs become electrically disconnected and speed up only for Te< 1eV. A theoretical framework was developed to interpret experimental density profiles using simple properties of the filaments. Each event is modelled with a wave function with amplitude and width distributed according to experimental observations and evolving according to fluid equations. Multi-fluid simulations of the MAST-U Super-X divertor show that it will detach at lower density (×1/3) or higher power (×4) with respect to the conventional divertor. The new divertor is predicted to reduce the target power load through magnetic geometry and baffling as the closure of the divertor leads to an increase in neutral density with concomitant power losses.

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