Scrape-Off Layer Features of the QH–mode*

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In this paper we examine the scrape-off layer (SOL) plasma incurred in the quiescent high-confinement mode (QH–mode). The QH–mode is a regime of long-duration stationary H–mode performance without ELMs,[1] so far observed only at low density with counter neutral beam injection, strong pumping, and a large outer gap between the separatrix and the wall. In place of ELMs, there is an edge MHD mode which facilitates pumping and density control. In most cases this is the edge harmonic oscillation (EHO), a steadily oscillating (not bursting) mode very near the separatrix.

During QH–mode, the edge density pedestal is unusually low (~0.2 n_{GW}, where is n_{GW} the Greenwald density), while the edge ion temperature pedestal measured for C^{+6} ions is very high, ~ 5 keV. We also find elevated ion temperatures of several keV in the scrape-off layer. From IR thermography we find an extra heat flux peak in the SOL, several centimeters from the separatrix when mapped to the outer midplane (Ψ_N~1.04). This peak is clearly distinct from the outer strike point heat flux peak. The anomalous heat flux peak is not found during the intial ELMing part of these discharges, even though the hot ions are present in the scrape-off layer. The heat flux peak appears after the EHO begins.

Langmuir probes show a particle flux at the same radial location as the anomalous heat flux. The magnitude of the particle flux is roughly consistent with the measured ion energy and thermographic heat flux. A plume of radiated power appears on field lines connected to the divertor location of the anomalous heat flux peak. The radiated power there is greater than that from any other location in the plasma. As in normal ELMing H–mode, we observe a negative potential well just inside the separatrix, but in QH–mode the well is ~5 times deeper.

The hot ions present in the scrape-off layer, perhaps banana-trapped, appear to flow to the divertor only during the EHO (or in one case tearing modes instead of EHO). However, the particle flux at the location of the anomalous heat flux peak is only weakly modulated at the EHO frequency, and strongly at a 1 kHz frequency not seen near the separatrix. The plunging Langmuir probe produces plasma signal when located as far out as the wall and beyond, out into the port, which could be consistent with banana-trapped particles. Low levels of EHO have been observed without increased particle flux at the location which later shows the anomalous heat, possibly indicating a threshold amplitude for de-trapping hot ions. The gap in the heat flux profile between the strike point and the anomalous peak might be explained by ergodic field lines or fast orbit physics in the boundary plasma.

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[1]C.M. Greenfield, et al., Phys. Rev. Lett. **86**, (2001) 4544.