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The Heuristic Drift Model of the Scrape-Off Layer: Physics Issues and Implications[1]

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A heuristic drift-based (HD) model [1] has recently been developed for the power scrape-off width in H-mode tokamaks, predicting a SOL width $\sim$ 2(a/R) $\rho_{p,i}$. It agrees both in value and scalings with scrape-off width measurements [2] on ASDEX-U, C-MOD, DIII-D, JET, MAST and NSTX. Even the projected aspect ratio scaling is consistent with the data. The implications for ITER and beyond are daunting, projecting SOLs in the range of 2mm, including additional broadening in the divertor region. As a result, the ITER divertor could operate in the sheath-limited regime at unacceptable power density and target temperature - but realistic upstream pressure [3] - unless a very large fraction of the alpha power is dissipated by radiation and charge-exchange. Using the HD model for the SOL width, it is found that the SOL ballooning stability limit has value and scalings similar to the Greenwald limit. The predicted MHD α is shown to rise with n/n_{GW}, as observed experimentally [4]. Interestingly, the narrow high-heat-flux regions observed in TEXTOR [5] and JET [6] limiter discharges are in the range of the HD projection, suggesting that the same mechanism could function in L-mode.

[1] R.J. Goldston, Nuclear Fusion 52 (2012) 013009
[2] T. Eich et al., Nuclear Fusion, submitted
[3] D. Whyte, Journal of Nuclear Materials, accepted
[4] LaBombard et al., Physics of Plasmas 18 (2010) 056104 (figure 14), R.J. Goldston IAEA 2012
[5] T. Denner et al., Nuclear Fusion 39 (1999) 83
[6] G. Arnoux et al., Nuclear Fusion, submitted

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