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Poloidal Asymmetries in Edge Transport Barriers

R.M. CHURCHILL, Princeton Plasma Physics Laboratory

Investigations of the poloidal structure within edge transport barriers on Alcator C-Mod using novel impurity measurements are presented, revealing large poloidal variations of parameters within a flux surface in the H-mode pedestal region, and significantly reduced poloidal variation in L-mode or I-mode pedestals. These measurements provide complete sets of impurity density, temperature, flow velocity, and electrostatic potential at both the low- and high-field side midplane, utilizing the Gas Puff-CXRS technique[1]. Uncertainties in magnetic equilibrium reconstructions require assumptions to be made in order to properly align the LFS/HFS profiles. In H-mode plasmas, if profiles are aligned assuming impurity temperature is constant on a flux surface, large potential asymmetries would result ($e\Delta\Phi/T_e \approx 0.6$). If instead total pressure is assumed constant on a flux-surface, then the measured potential asymmetry is significantly reduced, but large in-out asymmetries result in the impurity temperature (>1.7x) [2]. This shows that impurity temperature and potential can not both be flux functions in the pedestal region. In both alignment cases, large asymmetries in impurity density (>6x) are present in H-mode plasmas[3]. In I-mode plasmas, which lack an electron density pedestal but do have a temperature pedestal, the poloidal variation of impurity temperature is weaker (∼1.3x) and the impurity density nearly symmetric between the LFS and HFS. These measurements indicate that the sharp gradients in the pedestal region, particularly of main ion density, have a significant effect on the poloidal and radial distribution of impurities, which could have important implications for the prediction of impurity contamination in future fusion reactors such as ITER. Estimates of particle and heat transport timescales suggest that the radial and parallel transport timescales are of the same order in the pedestal region of C-Mod, supporting the idea that two-dimensional transport effects need to be retained in impurity modeling of the pedestal region. To this end, initial comparisons to global neoclassical transport codes in the pedestal region[4] will be presented.

[1]RM Churchill, et al, RSI 84 (9), 093505 (2013)
[2]C Theiler, et al, Nucl. Fusion 54 083017 (2014)
[3]RM Churchill, et al,Nucl. Fusion 53 122002 (2013)
[4]CS Chang, et al, PoP, 16, 056108 (2009)