Turbulent impurity transport in DIII-D plasmas with additional on-axis electron heating

T. Odstrcil[1], N.T. Howard[1], F. Sciortino[1], P. Rodriguez-Fernandez[1], K. Thome[2]

[1] *MIT Plasma Science and Fusion Center, Cambridge, Massachusetts 02139, USA*

[2] *Oak Ridge Associated Universities, Oak Ridge, TN 37831, USA*

Impurities in the plasma present a serious threat to the operation of fusion reactors due to fuel dilution and excessive radiative cooling. On-axis electron heating is considered the most effective tool to control central impurity density. However, the actual mechanism of impurity removal is not trivial; the heating is known to modify neoclassical and turbulent transport [1] as well as the MHD activity associated with a core 1/1 mode [2]. To disentangle such complex behavior, experiments on the DIII-D tokamak were designed using a "predict-first" approach with TGYRO coupled with the TGLF and NEO codes to clarify role of turbulent flux driven by electron heating. Neoclassical and MHD contributions were reduced via optimization of impurity poloidal asymmetry profiles [3] in ELMy H-mode discharges without sawteeth activity. Initial modeling predicted a factor of five variation in the mid-radius impurity transport coefficients D and v caused by changes in NBI/ECRH heating mix. Impurity transport will be probed experimentally by trace injection of silicon and tungsten particles utilizing a new laser blow off (LBO) system recently installed on DIII-D. LBO is capable of producing multiple short injections ($\sim$0.1 ms) in a single discharge, which is essential for a seperate determination of diffusion and pinch effects. Low-k and intermediate-k plasma fluctuation are monitored by beam emission spectroscopy (BES) and Doppler back scattering (DBS) diagnostics, which combined with TGLF modelling allow for the determination of the dominant turbulent regime. Comparison of the measured transport coefficients for mid-Z and high-Z impurity transport with the TGLF modeling will be presented for various heating levels and deposition locations, spaning a wide range electron/ion heat fluxes.

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References

[1] R. Dux, R. Neu, A. G. Peeters et al., Plasma Phys. Controlled Fusion **45**, 1815-1825 (2003).

[2] M. Sertoli, T. Odstrcil, C. Angioni and ASDEX Upgrade Team, Nucl. Fusion **55**, 113029 (2015)

[3] T. Odstrcil, T. Putterich, C. Angioni et al., Plasma Phys. Controlled Fusion **60.1** (2017).