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The Dependence of the Impurity Transport on the Dominant Turbulent Regime in ELM-y H-mode discharges[1]

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Experiments and simulations on DIII-D in ELM-y H-mode plasmas demonstrate a large impact of a turbulence type on impurity particle transport, essential to reduce fuel dilution and avoid impurity accumulation in fusion devices. By changing the ratio of ion to electron heating using electron cyclotron (ECH) and neutral beam (NBI) heating in low collisionality plasmas, the electron to ion temperature ratio (T_e/T_i) is varied from 0.7 to 1.6, resulting in a clear transition from a turbulent regime dominated by Ion Temperature Gradient (ITG) mode to one with Trapped Electron Modes (TEM) and ITG mixture, as confirmed by gyrokinetic linear stability and changes in fluctuation measurements. Impurity transport for each T_e/T_i value is probed by trace injections of Al and W ions using the recently installed laser blow-off system. Experimental transport coefficients are determined using the STRAHL code coupled with a Bayesian framework that is constrained by change exchange spectroscopy and soft-X ray measurements. The inferred diffusion of both impurity species increases by more than an order of magnitude outside of the ECH resonance compared to NBI only heated cases, and the change is clearly correlated with a transition from ITG to mixed ITG/TEM. Such a dramatic change in impurity flux is accompanied by mere 50% increase of ion heat diffusion coefficients and a two-fold increase in electron heat diffusion. The reduced gyrofluid TGLF-SAT0 model quantitatively reproduces the increase in heat transport, but the change in impurity transport is underestimated across a large portion of the profile. In contrast, local non-linear gyrokinetic simulations performed with the CGYRO code match the heat flux as well as the impurity transport within experimental uncertainties.

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