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Main-ion Thermal Transport in High Performance DIII-D Edge Transport Barriers[1]

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The inferred ion heat flux (Qi) in the pedestal region on DIII-D is approximately neoclassical at high ion collisionality (ν^*) but becomes increasingly anomalous as ν^* is lowered towards values expected on ITER, challenging the assumptions made in predictive models and extrapolations. In dedicated experiments on DIII-D, beam emission spectroscopy measurements in the steep gradient region of the H-mode pedestal reveal increased broadband, long wavelength ion scale fluctuations for the low ν^* discharges. Ion scale fluctuations are known to increase anomalous multi-channel transport in the plasma core, and have significant implications for confinement and the accessibility of ELM free transport limited pedestals if they dominate in the edge transport barrier region of future reactors. Unique pedestal main-ion temperature measurements on DIII-D are essential when calculating Qi in TRANSP to reveal this anomalous transport. These new observations are consistent with gyrokinetic calculations using CGYRO that show increased growth rates of long wavelength ion temperature gradient (ITG) and trapped electron modes (TEM). Taken together, increased fluctuations, power balance calculations and gyrokinetic simulations show that the anomalous Qi at low ν^* may be due to weakly suppressed ion scale turbulence. This analysis provides a bridge between impurity temperature based approximately neoclassical Qi results on ASDEX-Upgrade [E. Viezzer NF 2017] at higher ν^*, and anomalous transport contributions from ITG/TEM [D.R. Hatch NF 2017] at lower ν^* cases on JET-ILW. These new results are based on world first inferred ion and electron heat fluxes in the pedestal region of deuterium plasmas using direct measurements of the deuterium temperature for power balance across ion collisionalities covering an order of magnitude between ITER relevant ν^* of 0.1 up to 1.2.

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