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EX/P3-18: Experimental Tests of Stiffness in the Electron and Ion Energy Transport in the DIII-D Tokamak

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Drift wave theories (ion or electron temperature gradient modes) have an onset threshold in gradient beyond which the flux transported is predicted to increase very rapidly. For fixed boundary condition, this type of behavior would manifest itselfg as a strong resistance to change in the temperature profiles or "stiffness". A new series of experiments exploiting the unique tools available in the DIII-D tokamak have explored this concept of stiffness in the electron channel in L-mode plasmas and in the ion channel in H-mode plasmas, specifically as a function of applied torque. In L mode, the electron temperature scale length in a narrow region was varied by a factor of 4 by changing the deposition location of the electron cyclotron heating (ECH) and changing the electron heat flux by a factor of 10. The response of the temperature profile is not dependent on the applied torque, as seen by self-similar response of the profile with balanced, co-current, and counter-current injection of neutral beams (NBI). One ECH source was also modulated to probe the flux/gradient relationship dynamically. The response is consistent with a threshold in gradient or scale length at quite low values, which is exceeded for virtually all cases with auxiliary heating in DIII-D. A similar tool for variation of the ion heat deposition is not available in DIII-D. However, the majority of the NBI heating power is deposited in the ions, so the response of the ion temperature profile to a power scan in H mode with low and high torque was obtained. The ion temperature scale length increases significantly with heating power at a normalized radius of 0.4 for both low and high torque. The change in the ion temperature scale length decreases strongly at increasing radius. The scale length is virtually constant at low torque input at a normalized radius of 0.7. This dependence on applied torque is in contrast to the electron profile results in L mode, which show little correlation with the applied torque.

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