Measurements of deuterium and impurity toroidal rotation profiles across the L-H transition in DIII-D and impact on momentum balance calculations*

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Analysis of main-ion and impurity toroidal rotation profiles during an L to H transition using the recently upgraded edge main-ion CER system shows differences of order unity between the impurity and deuterium toroidal rotation profiles. In L-mode, the rotational velocity of both carbon and deuterium is monotonic, but in H-mode, the carbon velocity profile has a stationary, non-monotonic feature with a localized profile dip in the region of steep pressure gradient—a feature which is not seen in the deuterium toroidal velocity. Recent completion of the thirty-two channel main-ion (deuterium) charge exchange recombination spectroscopy (CER) diagnostic at DIII-D enables detailed comparisons between impurity and main-ion temperature, density, and toroidal rotation. Sixteen sightlines cover the core of the plasma and another sixteen are densely packed towards the plasma edge, providing high resolution measurements of the pedestal and steep gradient region in H-mode plasmas. The monotonically decreasing main-ion rotation velocity produces qualitative differences in inferred momentum transport when using the carbon profile compared to the deuterium profile, highlighting the importance of the deuterium measurements. Differential toroidal rotation between the main-ions and impurity are presented and compared to calculations with the neoclassical code NEO. Alignment of the steep gradient region profiles is performed by satisfying quasi-neutrality with the three dominant contributors (electron, deuterium and carbon+6) directly measured. The ion density profiles are compared to STRAHL modeling assuming neoclassical impurity transport in the steep gradient region.

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