Main-ion and impurity rotation, temperature, and density evolution across the L-H transition on DIII-D

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Advances in main-ion charge exchange recombination spectroscopy (MICER) have enabled world first measurements of the simultaneous main-ion (D+) and impurity ion (C6+) properties from the core to the scrape off layer. This measurement capability is uncovering differences between the species temperature, rotation, and density evolution across the L-H transition and profile differences near the separatrix. The magnitude of the D+ temperature can be half the C6+ temperature at the separatrix in H mode, which may be due to cooling of D+ via charge exchange with cold edge deuterium neutrals. The C6+ toroidal rotation often develops a non monotonic notch feature that is not present in the main-ion rotation, which instead, depending on plasma parameters, can show a flat or peaked rotation near the separatrix. The peaked edge rotation of the main ions can have values up to 100km/s for low collisionality QH modes, while in lower power (P_{NBI}=0.8MW) H-modes the peaked edge toroidal rotation is still present but reduced to ~50km/s. The offset between the D+ and C6+ toroidal rotation are compared with the offset calculated using local neoclassical predictions of the main-ion and impurity poloidal rotation. Good agreement is found at the pedestal top but differences up to 30km/s are found in the steep gradient region. Additionally, measurements across an L-H transition obtained near the L-H power threshold show that the toroidal rotation of both species increases more slowly than the temperature and main ion density at the top of the pedestal. These observations highlight the importance of directly measuring the properties of the main-ion species, particularly at the plasma edge.

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