Effect of B-field Direction and Core Torque Input on SOL Flows of Carbon Ions and Deuterons in USN Plasmas on DIII-D*

N.H. Brooks,[1] R.C. Isler,[2] J.A. Boedo,[3] D.L. Rudakov,[3] R.A. Moyer,[3] M. Groth,[4] W.P. West, A.W. Leonard, K.H. Burrell, W.M. Solomon[5]

[1]General Atomics, P.O. Box 85608, San Diego California, USA
[2]Oak Ridge National Laboratory, Oak Ridge, Tennessee, USA
[3]University of California-San Diego, San Diego, California, USA
[4]Lawrence Livermore National Laboratory, Livermore, California, USA
[5]Princeton Plasma Physics Laboratory, Princeton, New Jersey, USA

Understanding carbon dynamics in the SOL, as well as fuel ion flows, is crucial for ITER because of the impact of co-deposition on tritium retention. In experiments performed in 2006 with $\vec{B}_t \parallel \vec{I}_p$, Doppler shift spectroscopy of low-charge-state carbon ions along tangential viewchords through the crown of upper single null plasmas demonstrated entrainment of carbon in the fuel ion flow. The direction of impurity ion flow was independently confirmed by poloidally localized, methane injection and tangential imaging measurements of angular displacement in the emission zones of the stepwise-ionized, methane-sourced carbon. Parallel flow of the fuel ions measured with a reciprocating Mach probe indicated a similar flow velocity along open helical field lines toward the inner divertor as that of the entrained carbon ions. Attempts at modeling this result using UEDGE with ExB and ∇B drifts activated has not been successful.

In early 2008, experiments were performed with $\vec{B}_t$ anti-parallel to $\vec{I}_p$ in which torque input to the core was varied about zero by alternate use of co-beam injection, electron cyclotron heating, and counter-beam injection. Anti-parallel $\vec{B}_t$ changed the ∇B drift direction and permitted a clear reversal of core rotation without exceeding the L-H power threshold with tangential beam injection. Fuel ion flow, from the far SOL to just inside the separatrix, was measured with reciprocating Mach probes at both the plasma crown and the outer midplane of single null plasmas; detailed core rotation profiles (for fully stripped carbon) were measured with the mulitchordal CER system. Again, the entrainment of low charge state impurity ions in the deuteron SOL flow was quantified with Doppler shift spectroscopy and tangential TV imaging. These SOL flow results provide benchmarks against which recent models postulating boundary condition-dominance of core rotation in the absence of external torque must be reconciled.

*Work supported by the US Department of Energy under DE-FC02-04ER54698, DE-AC05-00OR22725, DE-FG02-04ER54758, DE-AC52-07NA27344, DE-AC02-76CH03073.