Effect of the ∇B Drift Direction on Plasma Edge Properties and the L-H Transition in DIII-D*

T.N. Carlstrom,[1] R.J. Groebner,[1] G.R. McKee,[2] R.A. Moyer,[3] T.L. Rhodes,[4] J.C. Rost,[5] G.D. Porter,[6] X.Q. Xu,[6] and W.M. Nevins[6]

[1]*General Atomics, P.O. Box 85608, San Diego, California 92186-5608 USA*
[2]*University of Wisconsin, Madison, Wisconsin 53706-1687 USA*
[3]*University of California, San Diego, 9500 Gilman Drive, La Jolla, California 92093 USA*
[4]*University of California, Los Angeles, Box 951597, Los Angeles, California 20742 USA*
[5]*Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 USA*
[6]*Lawrence Livermore National Laboratory, P.O. Box 808, Livermore, California 94551 USA*

The power threshold for the L-H transition, P_{TH}, increases from 1-2 MW when the ion ∇B drift is toward the X-point to over 5 MW when it is away from the X-point. In order to study the cause of this effect, we have compared discharges where the main operational difference is the location of the X-point relative to the ∇B drift direction. Edge profiles of density and temperature, as well as amplitudes of density and potential fluctuations were nearly identical in both cases, even though one discharge was near P_{TH} and the other was far from it. This indicates that the specific values of mid plane edge temperature, beta, or their gradients are probably not playing key roles in determining P_{TH}.

Spatially resolved edge density fluctuation measurements from beam emission spectroscopy and correlation reflectometry show a change in the poloidal group velocity, $V_{\theta gr}$, of the fluctuations when the ∇B drift direction was changed. High (low) shear in $V_{\theta gr}$ is associated with low (high) P_{TH}. Unlike usual core fluctuation measurements, the poloidal group velocity differs from the $E_r \times B_T$ velocity near the plasma edge. The change in the shear in $V_{\theta gr}$ is much greater than the modest change in the shear in the $E_r \times B_T$ velocity between the two cases. We speculate that shear in $V_{\theta gr}$ may stabilize turbulent transport similar to $E_r \times B_T$ shear stabilization. A power scan shows that the shear in $V_{\theta gr}$ increases with the heating power, consistent with the velocity shear being important for the L-H transition. Density fluctuations near the mid plane separatrix measured with phase contrast imaging shows the inward and outward propagating radial modes have roughly equal amplitude when the ion ∇B drift is away from the X-point, but the outward modes dominate when the ion ∇B drift is toward the X-point. The significance of inward verses outward propagating modes is under study.

We have begun modeling these discharges using a three dimensional, non local electromagnetic turbulence code called BOUT, which models the boundary plasma using fluid equations for plasma vorticity, density, electron and ion temperatures and parallel momenta. Preliminary results show that the edge turbulence can drive substantial poloidal velocities of the density fluctuations and that strong shear in this velocity exists near the separatrix when the ion ∇B drift is toward the X-point but not for the case when the ion ∇B drift is away from the X-point, qualitatively in agreement with the experimental results. The experimental results suggest that shear in the edge poloidal group velocity of the turbulence is important for obtaining H-mode and determining P_{TH}, while the simulation results may eventually lead to improved understanding of the source of the edge velocity shear.

---

*Work supported by U.S. Department of Energy under Contracts DE-AC03-99ER54463, W-7405-ENG-48, and Grants DE-FG03-96ER54373, DE-FG03-95ER54294, DE-FG03-01ER54615, and DE-FG02-94ER54235.